IRIT
Programmers’ Manual

A Solid modeling Program

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**Notes:**
- Functions listed are part of various source files mentioned in the comments, indicating their implementation details.
- The functions are related to computational geometry and algebraic operations.
- The files and directories referenced are part of a larger software system, likely used for geometric modeling and operations.
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Chapter 1

Introduction

This manual describes the different libraries of the IRIT solid modeling environment. Quite a few libraries can be found
to manipulate geometry in general, freeform curves and surfaces, symbolic computation, trimmed surfaces, triangular
patches, freeform trivariate functions, Boolean operations, input output data file parsing, and miscellaneous.

All interface to the libraries should be made via the appropriate header files that can be found in the include
subdirectory. Most libraries have a single header file that is named the same as the library. Functions and constants
that are visible to the users of the libraries are prefixed with a unique prefix, usually derived from the library name
itself. External definitions that start with an underscore should not be used, even if found in header files.

The header file `include/irit_sm.h` must be sourced by every source file in the solid modeller. In most cases, this
file is sourced indirectly via local header files.

The following libraries are available in IRIT:

<table>
<thead>
<tr>
<th>Name of Library</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>bool</td>
<td>Boolean operations on polygonal models.</td>
</tr>
<tr>
<td>cagd</td>
<td>Low level freeform curves and surfaces.</td>
</tr>
<tr>
<td>geom</td>
<td>General geometry functions.</td>
</tr>
<tr>
<td>grap</td>
<td>General graphics/display functions.</td>
</tr>
<tr>
<td>mdl</td>
<td>Model's processing functions.</td>
</tr>
<tr>
<td>misc</td>
<td>Memory allocation, configuration files, attributes, etc.</td>
</tr>
<tr>
<td>mvar</td>
<td>Multi variate functions.</td>
</tr>
<tr>
<td>prsr</td>
<td>Input and output for file/sockets of objects of IRIT.</td>
</tr>
<tr>
<td>rndr</td>
<td>Scan conversion rendering functions.</td>
</tr>
<tr>
<td>symb</td>
<td>Symbolic manipulation of curves and surfaces.</td>
</tr>
<tr>
<td>trim</td>
<td>Trimmed surfaces support.</td>
</tr>
<tr>
<td>triv</td>
<td>Freeform trivariate functions.</td>
</tr>
<tr>
<td>trng</td>
<td>Triangular patches support.</td>
</tr>
<tr>
<td>user</td>
<td>General high level user interface functions.</td>
</tr>
<tr>
<td>xtra</td>
<td>Public domain code that is not part of IRIT.</td>
</tr>
</tbody>
</table>

1.0.1 Tools and Programs

The IRIT package includes several complete programs such as poly3d-h (hidden line removal), irender (scan conversion
tool), and irit2ps (a filter to Postscript). Somewhat different than most other programs is the kernel interpreter,
also called irit. The irit program is nothing more than an interpreter (written in C) that invokes numerous functions
in the several libraries provided. In order to add a new function to the irit interpreter, the following sequence of
operations must be followed:

1. Write a C function that accepts only one or more of the following type of parameters. All parameters, including
the IrtRType, must be transferred by address:
   - IrtRType (seeirit_sm.h).
   - IrtVecType (seeirit_sm.h).
   - IrtPtType (seeirit_sm.h).
   - CagdCtlPtStruct (see cagd_lib.h).
   - IrtPlnType (seeirit_sm.h).
   - StringType (char *).
   - IPObjectStruct (seeiritprsr.h). This includes all object types in IPObjectStruct other than the above.
2. The written C function can return one of:
   - IrtRType by value.
   - IPOObjectStruct by address.
   - Nothing (a procedure).

3. According to the returned type by the new C function, go to file `inptprsl.h`, and add a new enum NEW_FUNC for the new function in enum RealValueFuncType (for IrtRType returned value), in enum ObjValueFuncType (for IPOObjectStruct * returned value), or in enum GenValueFuncType (for no returned value).

4. In `inptevl1.c`, add one new line in one of NumFuncTable, ObjFuncTable, or GenFuncTable (depends upon the return value). The line will have the form of:

   ```
   { ‘FuncName’, NEW_FUNC, CFunctionName, N, { Param1Type, Param2Type, ... ParamNType } }
   ```

   for procedures with no return values, and of the form of:

   ```
   { ‘FuncName’, NEW_FUNC, CFunctionName, N, { Param1Type, Param2Type, ... ParamNType }, RetValType }
   ```

   otherwise. \( N \) is the number of parameters, ‘FuncName’ is the (unique) name that will be used in the interpreter, CFunctionName is the name of the C function you have written. This C function must be declared in one of the header files that inptevl1.c includes. ParamIType, for \( I \) between 1 and \( N \), and RetValType are of type IritExprType (see inptprsl.h).

5. Thats it!

For example, to add the C function declared as

```c
IPObjectStruct *PolyhedraMoments(IPObjectStruct *IPObjectStruct, IrtRType *m);
```

one has to add the following line to ObjFuncTable in iritevl1.c

```c
{ ‘PMOMENT’, PMOMENT, { POLY_EXPR, REAL_EXPR }, VECTOR_EXPR },
```

where PMOMENT needs to be added to ObjValueFuncType in iritprsl.h.

While all objects in the interpreted space are of type IPOObjectStruct, the functions’ interface unfolds many types to simplify matter. IrtRType, IrtVecType, Strings, etc. are all extracted from the given (IPOObjectStruct) parameters and passed directly by address. For returned values, only numeric real data is allowed where everything else must be returned wrapped in an IPOObjectStruct.

The following chapters reference the different functions of the different libraries. Chapter 17 provides several examples of writing C code using the IRIT libraries.
Chapter 2

Boolean Library, bool_lib

2.1 General Information

On of the crucial operation in any solid modeling environment is the ability to perform Boolean operations among different geometric objects. The interface of the library is defined in include/bool_lib.h. This library supports only Boolean operations of polygonal objects. The Boolean operations of OR, AND, SUBtract, NEGate, CUT, and MERGE are supported via the `BoolOperType` typedef:

<table>
<thead>
<tr>
<th>BoolOperType</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOOL_OPER_OR</td>
<td>Union of two geometrical objects</td>
</tr>
<tr>
<td>BOOL_OPER_AND</td>
<td>Intersection of two geometrical objects</td>
</tr>
<tr>
<td>BOOL_OPER_SUB</td>
<td>The difference of two geometrical objects</td>
</tr>
<tr>
<td>BOOL_OPER_NEG</td>
<td>Unary Inside-out of one geometrical object</td>
</tr>
<tr>
<td>BOOL_OPER_CUT</td>
<td>Boundary of one object outside the other</td>
</tr>
<tr>
<td>BOOL_OPER_MERGE</td>
<td>Simple merge without any computation</td>
</tr>
</tbody>
</table>

The `BoolOperType` typedef is used in two dimensional Boolean operations invoked via `Boolean2D`. Three dimensional Boolean operations are invoked via `BooleanXXX` where XXX is one of OR, AND, SUB, NEG, CUT or MERGE, denoting the same as in the table above.

In addition several state functions are available to control the way the Boolean operations are conducted. Functions to enable the dump of (only) the intersection curves, to handle coplanar polygons, and to set the axis along which the sweep is performed are provided.

All globals in this library have a prefix of `Bool`.

2.2 Algorithmic Hints Behind the Boolean Operations

Let \( M_i, \ i = 1, 2 \) be two polygonal models to compute a Boolean operation between and let \( P_m \) denote the \( m \)'th polygon of \( M_i \). Denote by \( InterList(P_m) \), \( P_m \in M_i \), the list of line segments representing the intersections of polygon \( P_m \) with polygons in \( M_j \). A naive first, intersection, step in a Boolean operation between two polyhedra models, \( M_1 \) and \( M_2 \), will consist of the following stages:

For each polygon \( P_m \) in \( M_1 \)
begin
\( InterList(P_m) \leftarrow \emptyset \)
end

For each polygon \( P_n \) in \( M_2 \)
begin
\( InterList(P_n) \leftarrow \emptyset \)
end

For each polygon \( P_m \) in \( M_1 \)
begin
For each polygon \( P_n \) in \( M_2 \)
begin
If \( \{ P_m \cap P_n \} \)
begin

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\[ L \Leftarrow P_m \cap P_n; \]
\[ \text{InterList}(P_m) \Leftarrow \text{InterList}(P_m) \cup L; \]
\[ \text{InterList}(P_n) \Leftarrow \text{InterList}(P_n) \cup L; \]
end
end
end

At the end of the first, intersection stage, each polygon, \( P_m \) in either \( M_1 \) (or \( P_n \in M_2 \)) contains in its \( \text{InterList}(P_m) \) the set of line segments of the intersection(s) of \( P_m \) with all polygons in the other model. In order to figure out orientation, each intersection line segment also contains an orientation hint as to the inside direction of the two polygons that intersect at that line segment. This list of intersection line segments can now be processed:

For each polygon \( P_m \) in \( M_1 \)
begin
\[ \text{Polys} \Leftarrow \text{InterList}(P_m) \text{ sorted into polylines}; \]
\[ \text{OpenList}(P_m) \Leftarrow \text{Open polylines of Polys}; \]
\[ \text{ClosedList}(P_m) \Leftarrow \text{Closed polylines of Polys}; \]
end
For each polygon \( P_n \) in \( M_2 \)
begin
\[ \text{Polys} \Leftarrow \text{InterList}(P_n) \text{ sorted into polylines}; \]
\[ \text{OpenList}(P_n) \Leftarrow \text{Open polylines of Polys}; \]
\[ \text{ClosedList}(P_n) \Leftarrow \text{Closed polylines of Polys}; \]
end

Open polylines, \( \text{OpenList}(P_m) \), are intersection polylines that are open. These polylines starts on the boundary of polygon \( P_m \) and also ends on the boundary, at a different boundary location though. In contrast, the set of closed polylines, \( \text{ClosedList}(P_n) \), contains closed loops that are completely contained in \( P_n \).

The polygons are now ready for trimming. Depending upon the Boolean operation that is requested, the inside or the outside of \( M_1 \) or \( M_2 \) is selected for the output result. Denote by \( M_i \ Out M_j \) (\( M_i \ In M_j \)) the region of \( M_i \) that is outside (inside) \( M_j \). Then,

<table>
<thead>
<tr>
<th>Boolean Operation</th>
<th>implementation as</th>
</tr>
</thead>
<tbody>
<tr>
<td>( M_1 \cup M_1 )</td>
<td>{ ( M_1 \ Out M_2 ) } \cup { ( M_2 \ Out M_1 ) }</td>
</tr>
<tr>
<td>( M_1 \cap M_1 )</td>
<td>{ ( M_1 \ In M_2 ) } \cup { ( M_2 \ In M_1 ) }</td>
</tr>
<tr>
<td>( M_1 - M_1 )</td>
<td>{ ( M_1 \ Out M_2 ) } \cup \text{Inverse} { ( M_2 \ In M_1 ) }</td>
</tr>
</tbody>
</table>

Note the \( \text{Inverse} \) operation that reverses the orientation inside out.

At this point, all Boolean operations are translated into two complementary type of operations, \( \text{In} \) and \( \text{Out} \). The computation of \( M_i \ Out M_j \) is conducted by tracing the outside regions of the polygons of \( M_i \) that \( \text{intersect} \ M_j \) and \( \text{propagating} \) this inside–outside information to the non intersecting polygons:

For each polygon \( P_m \) in \( M_1 \) with non empty \( \text{OpenList}(P_m) \)
begin
\[ P_m^{in} \Leftarrow \text{Inside region of } P_m; \]
\[ P_m^{out} \Leftarrow \text{Outside region of } P_m; \]
For each original edge, \( e \in P_m^{in} \)
begin
Push \( e \) onto \emph{InsideStack};
end
For each original edge, \( e \in P_m^{out} \)
begin
Push \( e \) onto \emph{OutSideStack};
end
end

While \emph{InsideStack} not empty
begin
  e ⇐ edge popped from top of InsideStack;
  P_m, P_l ⇐ two polygons sharing e in M_1;

  If ( P_m has empty OpenList(P_m) and empty ClosedList(P_m),
       and P_m is not classified yet )
    begin
      Classify P_m as inside;
      push all edges of P_m, but e, onto InsideStack;
    end
  If ( P_l has empty OpenList(P_l) and empty ClosedList(P_l),
       and P_l is not classified yet )
    begin
      Classify P_l as inside;
      push all edges of P_l, but e, onto InsideStack;
    end
end

While OutsideStack not empty
begin
  e ⇐ edge popped from top of outsideStack;
  P_m, P_l ⇐ two polygons sharing e in M_1;

  If ( P_m has empty OpenList(P_m) and empty ClosedList(P_m),
       and P_m is not classified yet )
    begin
      Classify P_m as outside;
      push all edges of P_m, but e, onto OutsideStack;
    end
  If ( P_l has empty OpenList(P_l) and empty ClosedList(P_l),
       and P_l is not classified yet )
    begin
      Classify P_l as outside;
      push all edges of P_l, but e, onto OutsideStack;
    end
end

At the end of this process, M_1 is completely split into two sets of polygons, classified as either inside M_2 or outside M_2. An identical splitting process can be applied to M_2. The proper inside/outside lists of M_1 can now be combined with the proper list of classified polygons of M_2 to yield the proper result of the requested Boolean operation.

While this completes the Boolean operation, vast room for improvements can be found, with some improvements implemented in IRIT. For example, the first step of the intersection computation necessitates an O(n^2) polygon–polygon intersection tests, where n is in the order of the number of polygons in M_i. Clearly, one can hope for a better time complexity. Bounding boxes, hierarchical bounding boxes, or three dimensional space sweep techniques can all be applied to reduce the overhead invested in these O(n^2) tests. Efficient sorting of line segments within a polygon, when forming the open and closed loops is another optimization consideration.

2.3 Library Functions

2.3.1 BoolClnAdjacencies (adjacency.c:871)

void BoolClnAdjacencies(IPObjectStruct *PObj)
  
  PObj: Polygon object to clean adjacency information.

  Returns: void

  Description: Clean the adjacency pointers in the given polygonal model.

  See also: BoolGenAdjacencies,
2.3.2  BoolCutPolygonAtRay (bool2low.c:416)

IPVertexStruct *BoolCutPolygonAtRay(IPPolygonStruct *Pl, IrtPtType Pt)

Pl: The polygon to compute the ray intersection with.
Pt: The origin of the ray point.

Returns: The added vertex on Pl where the intersection with the ray occurred.

Description: Finds the intersection of the ray fired from Pt to +X direction with the given polygon. Note Pt MUST be in the polygon. Two vertices equal to ray/polygon intersection point are added to polygon vertex list, and a pointer to the first one is also returned. The polygon is NOT assumed to be convex and we look for the minimum X intersection. The polygon might not be convex as a result of combining some other closed loop before we got to do this test.

2.3.3  BoolDescribeError (bool_err.c:61)

const char *BoolDescribeError(BoolFatalErrorType ErrorNum)

ErrorNum: Type of the error that was raised.
Returns: A string describing the error type.

Description: Returns a string describing a the given error. Errors can be raised by any member of this bool library as well as other users. Raised error will cause an invocation of BoolFatalError function which decides how to handle this error. BoolFatalError can for example, invoke this routine with the error type, print the appropriate message and quit the program.

2.3.4  BoolDfltFatalError (bool-hi.c:1536)

void BoolDfltFatalError(BoolFatalErrorType ErrID)

ErrID: Error type that was raised.
Returns: void

Description: Defaul fatal error trapping rotuine of the Boolean library.
See also: BoolSetFatalErrorFunc,

2.3.5  BoolExtractPolygons (bool2low.c:997)

IPObjectStruct *BoolExtractPolygons(IPObjectStruct *PObj, int AinB)

PObj: Object that need to be rebuilt according to the intersection curves that were found, both closed and open loops.
AinB: Type of inclusion/exclusion requested.

Returns: The newly created clipped object.

Description: This routine coordinates all the extraction of the polygons from the intersecting lists. Does it in the following steps:
1. Mark all polygons with no intersection at all as complete polygons. (this is because this polygon will be totally in or out, according to inter-polygon adjacencies propagation...) Also mark them as undefined (if in output or undefined) yet. Uses IPPolygonStruct Tags to save these bits.
2. do
   2.1. Convert the unordered segment list of each polygon to closed loops (if create a hole in polygon) or open (if crosses its boundary).
   2.2. Order the open loops along the perimeter of the polygon (note these loops camnt intersect. For example (5 vertices polygon):
2.3. "Break" the polygon at each open loop that has no enclosed loops in it. For example we can start at L1, L2, L4, L5 and then L3. "Break" means - replace the vertex chain between the two loop end points, with the loops itself. Depends upon the relation required we may need to output a new polygon form from the deleted chain and that loop. In addition we may form a new polygon from last loop and was was left from the original polygon For each formed polygon, for each complete edge of it (i.e. edge which was originally in the polygon) test the adjacent polygon if it is complete (as marked in 1.) and if in or undefined (marked undefined in 1.) is still undefined:

2.3.1. set it to be in.
2.3.2. push it on adjacency stack.

2.4. For each closed loop - find in which polygon (from polygons created in 2.3.) it is enclosed, and decompose it.

3. While adjacencies stack not empty do:

3.1. pop top polygon from stack and output it.
3.2. For each of its edges (which obviousely must be complete edges) if adjacent polygon is complete and undefined:

3.3.1. set it to be in.
3.3.2. push it on adjacency stack.

3.3 go back to 3.

The above algorithm defines in as in output, but dont be confused with the required inter-object AinB (or AoutB if FALSE), which used to determine which side of the trimming loop should be output. Note this routine may return non-convex polygons (but marked as so) even though the input for the booleans must be convex polygons only! In order to keep the given object unchanged, a whole new copy off the polygon list is made. The polygons of the list that are not in the output are freed: a global list of all polygons (pointers) is used to scan them in the end and free the unused ones (list PolysPtr).

2.3.6 BoolFilterCollinearities (bool-2d.c:273)

```c
int BoolFilterCollinearities(IPPolygonStruct *Pl)
```

Pl: To filter, in place. The polygon is assumed to have a circular vertex list.

Returns: TRUE if the polygon has been modified, FALSE otherwise.

Description: Filters out collinear edges and duplicated vertices, in the given polygon.

2.3.7 BoolGenAdjSetSrfBoundaries (adjacency.c:386)

```c
int BoolGenAdjSetSrfBoundaries(IrtRType UMin,
                                 IrtRType VMin,
                                 IrtRType UMax,
                                 IrtRType VMax)
```

UMin, VMin: Minimal UV value of the domain, zeros to disable.

UMax, VMax: Maximal UV value of the domain, zeros to disable.

Returns: Old values of surface domain validation option.

Description: Sets boundary definition using UV coordinates of original surface. If the original surface was closed, polygons along the seam are usually not detected as boundary since the other side of the seam shares the edge. If the prescribed domain is valid (non zero) edges found on a surface boundary are always considered boundary, even if the surface is closed at the (shared) seam.

See also: BoolGenAdjacencies,
2.3.8 **BoolGenAdjacencies** *(adjacncy.c:124)*

```c
int BoolGenAdjacencies(IPObjectStruct *PObj)
```

PObj: The polygonal object to compute the adjacency information for.

**Returns:** TRUE if all adjacencies were resolved, or the object is completely closed.

**Description:** Routine to generate adjacencies to the given object. Note an edge might be only partially adjacent to another edge, and a second attempt is made to find (again only part of - see below) them. Any case, FALSE will be returned as there is no way we can say the object is perfectly closed! This is the only routine to generate the adjacencies of a geometric object. These adjacencies are needed for the Boolean operations on them: Algorithm: for each edge, for each polygon in the object, the edges are sorted according to the key defined by EdgeKey routine (sort in hash tbl). A second path on the table is made to match common keys edges and set the pointers from one to another. Note that each edge is common to exactly 2 faces if it is internal, or exactly 1 face if it is on the border (if the object is open).

**See also:** BoolGenAdjSetSrfBoundaries, BoolGetAdjEdge, BoolClnAdjacencies,

2.3.9 **BoolGetAdjEdge** *(adjacncy.c:1027)*

```c
IPVertexStruct *BoolGetAdjEdge(IPVertexStruct *V)
```

V: Vertex of a mesh defining edgee (V, V->Pnext) to extract its adjacent edge, if any.

**Returns:** First vertex of adjacent edge to edge (V, V->Pnext) or NULL if none.

**Description:** Given a polygonal mesh with adjacent information, find the adjacent edge (VAdj, VAdj->Pnext) that is adjacent to edge (V, V->Pnext), if any.

**See also:** BoolGenAdjacencies,

2.3.10 **BoolGetDisjointPart** *(adjacncy.c:991)*

```c
IPPolygonStruct *BoolGetDisjointPart(IPObjectStruct *PObj, int Index)
```

PObj: Object to extract part number Index from.

Index: Index of part to fetch from PObj.

**Returns:** Extract polygonal list with disjoint number Index.

**Description:** Get the disjoint part number Index from object PObj.

**See also:** BoolMarkDisjointParts,

2.3.11 **BoolInterPolyPoly** *(bool1low.c:788)*

```c
IPPolygonStruct *BoolInterPolyPoly(IPPolygonStruct *Pl1, IPPolygonStruct *Pl2)
```

Pl1: First polygon to compute intersection for.

Pl2: Second polygon to compute intersection for.

**Returns:** The intersection segment, if any, NULL otherwise.

**Description:** Routine to intersect polygon Pl1, with polygon Pl2. If found common intersection, that segment will be added to the InterSegmentStruct list saved in Pl1 PAux list. Note that as the two polygons convex, at most one line segment can result from such intersection (of two non coplanar polygons). Algorithm: intersect all Pl2 edges with Pl1 plane. If found that (exactly) two vertices (one segment) of Pl2 do intersect Pl1 plane then: Perform clipping of the segment against Pl1. If result is not empty, add the result segment to Pl1 InterSegmentStruct list (saved at PAux of polygon - see IPPolygonStruct).
2.3.12  **BoolLoopsFromInterList**  (bool1low.c:1173)

```c
int BoolLoopsFromInterList(IPPolygonStruct *Pl,
                          InterSegListStruct **PClosed,
                          InterSegListStruct **POpen)
```

**Pl:** Polygon with intersection information in its PAux slot.

**PClosed:** To be updated with the closed loops found in Pl.

**POpen:** To be updated with the open loops found in Pl.

**Returns:** TRUE if has loops.

**Description:** Given a polygon with the intersection list, creates the polylines loop(s) out of it, which can be one of the two:
1. Closed loop - all the intersections create a loop in one polygon.
2. Open polyline - if the intersections cross the polygon boundary. In this case the two end point of the polyline, must lay on polygon boundary.

In both cases, the polyline will be as follows: First point at first list element at PtSeg[0] (see InterSegmentStruct). Second point at first list element at PtSeg[1] (see InterSegmentStruct). Point i at list element (i-1) at PtSeg[0] (PtSeg[1] is not used!). In the closed loop case the last point is equal to first. Both cases returns NULL terminated list.

2.3.13  **BoolMarkDisjointParts**  (adjacncy.c:907)

```c
int BoolMarkDisjointParts(IPObjectStruct *PObj)
```

**PObj:** To analyze for different disjoint parts.

**Returns:** Number of disjoint parts.

**Description:** Mark polygons in the given object based on their association with different disjoint object parts.

**See also:** BoolGetDisjointPart,

2.3.14  **BoolSetFatalErrorFunc**  (bool-hi.c:1511)

```c
BoolFatalErrorFuncType BoolSetFatalErrorFunc(BoolFatalErrorFuncType ErrFunc)
```

**ErrFunc:** New error trapping function to use.

**Returns:** Old error trapping function.

**Description:** Sets the fatal error trapping routine of the boolean library.

**See also:** BoolDfltFatalError,

2.3.15  **BoolSetHandleCoplanarPoly**  (bool-hi.c:1459)

```c
int BoolSetHandleCoplanarPoly(int HandleCoplanarPoly)
```

**HandleCoplanarPoly:** If TRUE, coplanar polygons are handled.

**Returns:** Old value.

**Description:** Controls if coplanar polygons should be handled or not.

**See also:** BooleanOR, BooleanAND, BooleanSUB, BooleanCUT, BooleanMERGE, BooleanNEG, , Boolean2D, BoolSetOutputInterCurve, BoolSetPolySortAxis, , BoolSetParamSurfaceUVVals, BoolSetPerturbAmount,
2.3.16 **BoolSetOutputInterCurve** (bool-hi.c:1402)

```c
int BoolSetOutputInterCurve(int OutputInterCurve)
```

- **OutputInterCurve:** If TRUE only intersection curves are computed. If false, full blown Boolean is applied.
- **Returns:** Old value.
- **Description:** Controls if intersection curves or full Boolean operation is to be performed.
- **See also:** BooleanOR, BooleanAND, BooleanSUB, BooleanCUT, BooleanMERGE, BooleanNEG, , Boolean2D, BoolSetHandleCoplanarPoly, BoolSetPolySortAxis, , BoolSetParamSurfaceUVVals, BoolSetPerturbAmount,

2.3.17 **BoolSetParamSurfaceUVVals** (bool-hi.c:1486)

```c
int BoolSetParamSurfaceUVVals(int HandleBoolParamSrfUVVals)
```

- **HandleBoolParamSrfUVVals:** If TRUE, UV values are to be returned.
- **Returns:** Old value.
- **Description:** Controls if UV parameter values of original surface should be returned.
- **See also:** BooleanOR, BooleanAND, BooleanSUB, BooleanCUT, BooleanMERGE, BooleanNEG, , Boolean2D, BoolSetOutputInterCurve, BoolSetHandleCoplanarPoly, , BoolSetPolySortAxis, BoolSetPerturbAmount,

2.3.18 **BoolSetPerturbAmount** (bool-hi.c:1432)

```c
IrtRType BoolSetPerturbAmount(IrtRType PerturbAmount)
```

- **PerturbAmount:** Perturbation amount of objects before reattempting Booleans that ends up empty.
- **Returns:** Old value.
- **Description:** Controls the perturbation amount, if any, of the second object to improve the success likelihood. Perturbations are applied once the Booleans return with an empty intersection.
- **See also:** BooleanOR, BooleanAND, BooleanSUB, BooleanCUT, BooleanMERGE, BooleanNEG, , Boolean2D, BoolSetOutputInterCurve, BoolSetHandleCoplanarPoly, BoolSetPolySortAxis, , BoolSetParamSurfaceUVVals, BoolSetOutputInterCurve,

2.3.19 **BoolSetPolySortAxis** (bool1low.c:569)

```c
int BoolSetPolySortAxis(int PolySortAxis)
```

- **PolySortAxis:** Sorting axis. Either 0(x), 1 (y), or 2 (z).
- **Returns:** Old value.
- **Description:** Routine to set polygonal sorting axis.

2.3.20 **BoolSortOpenInterList** (bool1low.c:1423)

```c
void BoolSortOpenInterList(IPPolygonStruct *Pl, InterSegListStruct **POpen)
```

- **Pl:** To sort the loops for.
- **POpen:** The set of open loops. Updated in place.
- **Returns:** void
- **Description:** Sorts the open loops of given polygon to an order that can be used in subdividing into sub polygons later (see comment of BoolExtractPolygons). This order is such that each loops will have no other loop between its end points, if we walk along the polygon in the (linked list direction) perimeter from one end to the other, before it. For example:
In this case, any order such that L1, L2 are before L3 will do. Obviously this is not a total order, and they are few correct ways to sort it. Algorithm: For each open loop, for each of its two end, evaluate a IrtRTType key for the end point P between segment P(i) .. P(i+1) to be i + t, where: t is the ratio (P - P(i) / (P(i+1) - P(i)). This maps the all perimeter of the polygon onto 0..N-1, where N is number of vertices of that polygon. Sort the keys, and while they are keys in data structure, search and remove a consecutive pair of keys associated with same loop, and output it. Note that each open loop point sequence is tested to be such that it starts on the first point (first and second along vertex list) on polygon perimeter, and the sequence end is on the second point, and the sequence is reversed if not so. This order will make the replacement of the perimeter from first to second points by the open loop much easier. This may be real problem if there are two intersection points almost identical - floating point errors may cause it to loop forever. We use some reordering heuristics in this case, and return fatal error if fail!

2.3.21 Boolean2D (bool-2d.c:70)

IPPolygonStruct *Boolean2D(IPPolygonStruct *Pl1,
IPPolygonStruct *Pl2,
BoolOperType BoolOper)

Pl1: First convex polygon to compute 2D Boolean for.
Pl2: Second convex polygon to compute 2D Boolean for.
BoolOper: Boolean operation requested (and, or, etc.)

Returns: The resulting Boolean operation.

Description: Given two convex polygons assumed to be in the same plane, compute their 2D Boolean operation BoolOper and return it as a new polygon(s). NULL is returned if an error occur (No intersection or invalid BoolOper).

See also: BooleanOR, BooleanAND, BooleanCUT, BooleanMERGE, BooleanNEG, , BoolSetHandleCoplanarPoly, BoolSetOutputInterCurve, , Boolean2DComputeInters,

2.3.22 Boolean2DComputeInters (bool-2d.c:563)

Bool2DInterStruct *Boolean2DComputeInters(IPPolygonStruct *Poly1,
IPPolygonStruct *Poly2,
int HandlePolygons,
int DetectIntr)

Poly1, Poly2: The two polygons/lines to intersect.
HandlePolygons: If polygons, needs to handle normals etc.
DetectIntr: If TRUE, return non NULL dummy pointer if the two polys do indeed intersect. For detection of intersection!

Returns: Intersection information.

Description: Given two polygons/lines, Detect all edges in Pl1 that intersect with edges in Pl2. Returned is the information about all intersections as a Bool2DInter structure list.

See also: Boolean2D,

2.3.23 BooleanAND (bool-hi.c:422)

IPObjectStruct *BooleanAND(IPObjectStruct *PObj1, IPObjectStruct *PObj2)

PObj1: First object to perform the Boolean operation on.
PObj2: Second object to perform the Boolean operation on.

Returns: The result of the Boolean operation.

Description: Performs a Boolean AND between two objects.

See also: BooleanOR, BooleanSUB, BooleanCUT, BooleanMERGE, BooleanNEG, , Boolean2D, BoolSetOutputInterCurve, BoolSetHandleCoplanarPoly, , BoolSetPolySortAxis, BoolSetParamSurfaceUVVals, BooleanSELF, BooleanICUT, , BooleanCONTOUR, BoolSetPerturbAmount,
2.3.24 BooleanCONTOUR (bool-hi.c:760)

IPObjectStruct *BooleanCONTOUR(IPObjectStruct *PObj, IrtPlnType Plane)

PObj: Object to perform the contouring operation on.
Plane: Plane to use in the contouring.
Returns: The result of the contouring operation.

Description: Performs a contouring of the given poly object with the given plane.
See also: BooleanMultiCONTOUR, BooleanOR, BooleanAND, BooleanSUB, BooleanMERGE, BooleanNEG, Boolean2D, BoolSetOutputInterCurve, BoolSetHandleCoplanarPoly, BoolSetPolySortAxis, BoolSetParamSurfaceUVVals, BooleanSELF, BooleanCUT, BoolSetPerturbAmount,

2.3.25 BooleanCUT (bool-hi.c:604)

IPObjectStruct *BooleanCUT(IPObjectStruct *PObj1, IPObjectStruct *PObj2)

PObj1: First object to perform the Boolean operation on.
PObj2: Second object to perform the Boolean operation on.
Returns: The result of the Boolean operation.

Description: Performs a Boolean CUT between two objects.
See also: BooleanOR, BooleanAND, BooleanSUB, BooleanMERGE, BooleanNEG, Boolean2D, BoolSetOutputInterCurve, BoolSetHandleCoplanarPoly, BoolSetPolySortAxis, BoolSetParamSurfaceUVVals, BooleanSELF, BooleanICUT, BooleanCONTOUR, BoolSetPerturbAmount,

2.3.26 BooleanComputeRotatedPolys (bool-hi.c:1316)

IPPolygonStruct *BooleanComputeRotatedPolys(IPPolygonStruct *Pl, int CopyOnePl, IrtHmgnMatType RotMat)

Pl: Polygon(s) to transform. Assumed to be convex.
CopyOnePl: Should we copy? Also if FALSE Pl might be non convex!
RotMat: Transformation matrix.
Returns: Transformed polygon(s).

Description: Routine to optionally copy (if CpolyOnePl) a single polygon and rotate according to the rotation matrix provided. If, however, CopyOnePl is False all polygons in list are converted.

2.3.27 BooleanICUT (bool-hi.c:682)

IPObjectStruct *BooleanICUT(IPObjectStruct *PObj1, IPObjectStruct *PObj2)

PObj1: First object to perform the Boolean operation on.
PObj2: Second object to perform the Boolean operation on.
Returns: The result of the Boolean operation.

Description: Performs a Boolean Inside CUT between two objects.
See also: BooleanOR, BooleanAND, BooleanSUB, BooleanMERGE, BooleanNEG, Boolean2D, BoolSetOutputInterCurve, BoolSetHandleCoplanarPoly, BoolSetPolySortAxis, BoolSetParamSurfaceUVVals, BooleanSELF, BooleanCUT, BooleanCONTOUR, BoolSetPerturbAmount,
2.3.28 BooleanLow1In2 (bool1low.c:157)

IPObjectStruct *BooleanLow1In2(IPObjectStruct *PObj1, IPObjectStruct *PObj2)

PObj1: First object of Boolean operation.
PObj2: Second object of Boolean operation.

Returns: Result of one in two.

Description: Finds the part of PObj1 which is in of PObj2:
See also: BooleanLow1Out2, BooleanLowSelfInOut,

2.3.29 BooleanLow1Out2 (bool1low.c:96)

IPObjectStruct *BooleanLow1Out2(IPObjectStruct *PObj1, IPObjectStruct *PObj2)

PObj1: First object of Boolean operation.
PObj2: Second object of Boolean operation.

Returns: Result of one out two.

Description: Finds the part of PObj1 which is out of PObj2:
See also: BooleanLow1In2, BooleanLowSelfInOut,

2.3.30 BooleanLowSelfInOut (bool1low.c:202)

IPObjectStruct *BooleanLowSelfInOut(IPObjectStruct *PObj, int InOut)

PObj: Object of Boolean operation with itself (self intersection).
InOut: What are we looking for? in or out.

Returns: Result of Boolean in/out with self.

Description: Finds the part of PObj which is in/out of itself:
See also: BooleanLow1Out2, BooleanLow1In2,

2.3.31 BooleanMERGE (bool-hi.c:956)

IPObjectStruct *BooleanMERGE(IPObjectStruct *PObj1, IPObjectStruct *PObj2)

PObj1: First object to perform the Boolean operation on.
PObj2: Second object to perform the Boolean operation on.

Returns: The result of the Boolean operation.

Description: Performs a Boolean MERGE between two objects.
See also: BooleanOR, BooleanAND, BooleanSUB, BooleanCUT, BooleanNEG, , Boolean2D, BoolSetOutputInterCurve, BoolSetHandleCoplanarPoly, , BoolSetPolySortAxis, BoolSetParamSurfaceUVVals, BooleanSELF, BooleanICUT, , BooleanCONTOUR, BoolSetPerturbAmount,
2.3.32 **BooleanMultiCONTOUR** (bool-hi.c:834)

```c
IPObjectStruct *BooleanMultiCONTOUR(IPObjectStruct *PObj,
  IrtRType CntrLevel,
  int Axis,
  int Init,
  int Done)
```

- **PObj**: Object to perform the multi-contouring operation on. Relevant only when Init = TRUE.
- **CntrLevel**: Level to contour at. Relevant only if Init = Done = FALSE. Contouring requests must come in increasing level order.
- **Axis**: 0, 1, 2 for X/Y/Z constant planes to use.
- **Init**: TRUE to initialize a multi-contouring process.
- **Done**: TRUE to terminate a multi-contouring process.

**Returns**: The result of the contouring operation.

**Description**: Performs multiple contouring of the given poly object with parallel planes. Planes must be X/Y/Z constant. This function is called 3 times: + With Init=TRUE, to initialize the process. Returns NULL. + With Done=TRUE, to terminate the process. Returns NULL. + Otherwise performs contouring at the requested level and returns the computed contour (can be empty polyline object).

**See also**: BooleanCONTOUR, BooleanOR, BooleanAND, BooleanSUB, BooleanMERGE, , BooleanNEG, Boolean2D, BoolSetOutputInterCurve, , BoolSetHandleCoplanarPoly, BoolSetPolySortAxis, , BoolSetParamSurfaceUVVals, BooleanSELF, BooleanCUT, BoolSetPerturbAmount,

2.3.33 **BooleanNEG** (bool-hi.c:1001)

```c
IPObjectStruct *BooleanNEG(IPObjectStruct *PObj)
```

- **PObj**: Object to negate.

**Returns**: The result of the Boolean operation.

**Description**: Performs a Boolean NEG between two objects. Negation is simply reversing the direction of the plane equation of each polygon - the simplest Boolean operation...

**See also**: BooleanOR, BooleanAND, BooleanSUB, BooleanCUT, BooleanMERGE, , Boolean2D, BoolSetOutputInterCurve, , BoolSetHandleCoplanarPoly, , BoolSetPolySortAxis, , BoolSetParamSurfaceUVVals, BooleanSELF, BooleanCUT, , BooleanCONTOUR, BoolSetPerturbAmount,

2.3.34 **BooleanOR** (bool-hi.c:308)

```c
IPObjectStruct *BooleanOR(IPObjectStruct *PObj1, IPObjectStruct *PObj2)
```

- **PObj1**: First object to perform the Boolean operation on.
- **PObj2**: Second object to perform the Boolean operation on.

**Returns**: The result of the Boolean operation.

**Description**: Performs a Boolean OR between two objects.

**See also**: BooleanAND, BooleanSUB, BooleanCUT, BooleanMERGE, BooleanNEG, Boolean2D, , BoolSetOutputInterCurve, , BoolSetHandleCoplanarPoly, , BoolSetPolySortAxis, , BoolSetParamSurfaceUVVals, BooleanSELF, BooleanCUT, , BooleanCONTOUR, BoolSetPerturbAmount,

2.3.35 **BooleanPrepObject** (bool1low.c:491)

```c
void BooleanPrepObject(IPObjectStruct *PObj)
```

- **PObj**: To prepare.

**Returns**: void

**Description**: Routine to compute BBox for all polygons in provided object PObj. Also, the polygons are sorted in the list with according to their minimal BBox value in GlblPolySortAxis axis.
2.3.36 **BooleanSELF** (bool-hi.c:1058)

`IPObjectStruct *BooleanSELF(IPObjectStruct *PObj)`

- **PObj**: Object to perform the self intersecting Boolean operation on.
- **Returns**: The result of the Boolean operation.

**Description**: Performs a Boolean Self intersection operation.

**See also**: BooleanOR, BooleanAND, BooleanSUB, BooleanMERGE, BooleanNEG, Boolean2D, BoolSetOutputInterCurve, BoolSetHandleCoplanarPoly, BoolSetPolySortAxis, BoolSetParamSurfaceUVVals, BooleanCUT, BooleanICUT, BooleanCONTOUR, BoolSetPerturbAmount,

2.3.37 **BooleanSUB** (bool-hi.c:510)

`IPObjectStruct *BooleanSUB(IPObjectStruct *PObj1, IPObjectStruct *PObj2)`

- **PObj1**: First object to perform the Boolean operation on.
- **PObj2**: Second object to perform the Boolean operation on.
- **Returns**: The result of the Boolean operation.

**Description**: Performs a Boolean SUBtraction between two objects.

**See also**: BooleanOR, BooleanAND, BooleanCUT, BooleanMERGE, BooleanNEG, Boolean2D, BoolSetOutputInterCurve, BoolSetHandleCoplanarPoly, BoolSetPolySortAxis, BoolSetParamSurfaceUVVals, BooleanSELF, BooleanICUT, BooleanCONTOUR, BoolSetPerturbAmount,
Chapter 3

CAGD Library, cagd_lib

3.1 General Information

This library provides a rich set of function to create, convert, display and process freeform Bezier and NURBs curves and surfaces. The interface of the library is defined in include/cagdlib.h. This library mainly supports low level freeform curve and surface operations. Supported are curves and surfaces from scalars to five dimensions as E1/P1 to E5/P5 using the CagdPointType. Pi is a rational (projective) version of Ei, with an additional W coefficient. Polynomial in the power basis have some very limited support as well. Different data structures to hold UV parameter values, control points, vectors, planes, bounding boxes, polylines and polygons are defined as well as the data structures to hold the curves and surfaces themselves.

typedef struct CagdCrvStruct {
    struct CagdCrvStruct *Pnext;
    struct IPAttributeStruct *Attr;
    CagdGeomType GType;
    CagdPointType PType;
    int Length; /* Number of control points (== order in Bezier). */
    int Order; /* Order of curve (only for Bspline, ignored in Bezier). */
    CagdBType Periodic; /* Valid only for Bspline curves. */
    CagdRType *Points[CAGD_MAX_PT_SIZE]; /* Pointer on each axis vector. */
    CagdCrvStruct *KnotVector;
} CagdCrvStruct;

typedef struct CagdSrfStruct {
    struct CagdSrfStruct *Pnext;
    struct IPAttributeStruct *Attr;
    CagdGeomType GType;
    CagdPointType PType;
    int ULength, VLength; /* Mesh size in the tensor product surface. */
    int UOrder, VOrder; /* Order in tensor product surface (Bspline only). */
    CagdBType UPeriodic, VPeriodic; /* Valid only for Bspline surfaces. */
    CagdRType *Points[CAGD_MAX_PT_SIZE]; /* Pointer on each axis vector. */
    CagdSrfStruct *UKnotVector, *VKnotVector;
} CagdSrfStruct;

Curves and surfaces have a geometric type GType to prescribe the type of entity (such as CAGD_SBEZIER_TYPE for Bezier surface) and a point type PType to prescribe the point type of the entity (such as CAGD_PTE3_TYPE for three dimensional Euclidean control points). Length and Order slots are used to hold the number of control points in the mesh and/or control polygon and the order(s) of the basis functions. Periodic flag(s) are used to denote periodic end conditions. In addition, KnotVector slot(s) are used if the entity exploits Bspline basis functions, or NULL otherwise.

The control polygon and/or mesh itself is organized in the Points slot as a vector of size CAGD_MAX_PT_SIZE of vectors of CagdRType. For surfaces, the mesh is ordered U first and the macros of CAGD_NEXT_U, CAGD_NEXT_V, and CAGD_MESH_UV can be used to determine indices in the mesh.

All structures in the cagd library can be allocated using New constructors (i.e. CagdUVNew or CagdCrvNew), freed using Free destructors (i.e. CagdSrfFree or CagdBoxFree, linked list free using FreeList destructors (i.e. CagdPolylineFreeList), and copied using copy constructors i.e. CagdPtCopy or CagdCrvPtCopyList).

This library has its own error handler, which by default prints an error message and exit the program called CagdFatalError.

Most globals in this library have a prefix of Cagd for general cagd routines. Prefix of Bzr is used for Bezier routines, prefix of Bsp for Bspline specific routines, prefix of Cnvr for conversion routines, and Afd for adaptive forward differencing routines.
3.2 Library Functions

3.2.1 AfdApplyAntiLStep (afd_cube.c:230)  

```c
void AfdApplyAntiLStep(CagdRType Coef[4])
```

**Coef:** Four coefficients of the AFD basis functions.

**Returns:** void

**Description:** Given four coefficients of a cubic afd polynomial, apply the anti L step, in place.

**See also:** AfdApplyLStep, AfdApplyEStep, AfdApplyLn, AfdCnvrtCubicBzrToAfd, AfdComputePolyline, AfdBzrCrvEvalToPolyline,

3.2.2 AfdApplyEStep (afd_cube.c:180)  

```c
void AfdApplyEStep(CagdRType Coef[4])
```

**Coef:** Four coefficients of the AFD basis functions.

**Returns:** void

**Description:** Given four coefficients of a cubic afd polynomial, apply the E (step 1) in place.

**See also:** AfdApplyAntiLStep, AfdApplyLStep, AfdApplyLn, AfdCnvrtCubicBzrToAfd, AfdComputePolyline, AfdBzrCrvEvalToPolyline,

3.2.3 AfdApplyLStep (afd_cube.c:205)  

```c
void AfdApplyLStep(CagdRType Coef[4])
```

**Coef:** Four coefficients of the AFD basis functions.

**Returns:** void

**Description:** Given four coefficients of a cubic afd polynomial, apply the L step, in place.

**See also:** AfdApplyAntiLStep, AfdApplyEStep, AfdApplyLn, AfdCnvrtCubicBzrToAfd, AfdComputePolyline, AfdBzrCrvEvalToPolyline,

3.2.4 AfdApplyLn (afd_cube.c:81)  

```c
void AfdApplyLn(CagdRType Coef[4], int n)
```

**Coef:** Four coefficients of the AFD basis functions.

**n:** How many times to compute the L transform.

**Returns:** void

**Description:** Given four coefficients of a cubic afd polynomial, apply the L (half the step size) n times to them, in place. We basically precomputed $L^n$ and apply it here once. Every instance of L half the domain and so $L^n$ divides the domain by $2^n$.

**See also:** AfdApplyAntiLStep, AfdApplyLStep, AfdApplyEStep, AfdCnvrtCubicBzrToAfd, AfdComputePolyline, AfdBzrCrvEvalToPolyline,
3.2.5 **AfdBzrCrvEvalToPolyline** *(afd_cube.c:312)*

```c
void AfdBzrCrvEvalToPolyline(const CagdCrvStruct *Crv,
   int FineNess,
   CagdRType *Points[])
```

- **Crv**: A cubic Bezier curve to piecewise linear sample using AFD.
- **FineNess**: Of samples.
- **Points**: Where to place the piecewise linear approximation.
- **Returns**: void

**Description**: Samples the curves at FineNess location equally spaced in the Bezier parametric domain [0..1]. If Cache is enabled, and FineNess is power of two, upto or equal to CacheFineNess, the cache is used, otherwise the points are evaluated manually for each of the samples. Data is saved at the Points array of vectors (according to Curve PType), each vector is assumed to be allocated for FineNess CagdRType points. Bezier curve must be cubic.

**See also**: AfdApplyAntiLStep, AfdApplyLStep, AfdApplyEStep, AfdApplyLn, AfdCnvrtCubicBzrToAfd, AfdComputePolyline

3.2.6 **AfdCnvrtCubicBzrToAfd** *(afd_cube.c:49)*

```c
void AfdCnvrtCubicBzrToAfd(CagdRType Coef[4])
```

- **Coef**: Converts, in place, cubic Bezier Coef to AFD Coef.
- **Returns**: void

**Description**: Given four coefficents of a cubic Bezier curve, computes the four coefficients of the cubic afd basis functions, in place.

**See also**: AfdApplyAntiLStep, AfdApplyLStep, AfdApplyEStep, AfdApplyLn, AfdComputePolyline, AfdBzrCrvEvalToPolyline

3.2.7 **AfdComputePolyline** *(afd_cube.c:265)*

```c
void AfdComputePolyline(CagdRType Coef[4],
   CagdRType *Poly,
   int Log2Step,
   CagdBType NonAdaptive)
```

- **Coef**: Four coefficients of a cubic Bezier curve.
- **Poly**: Where to put the polyline computed.
- **Log2Step**: How many steps to take (2 to the power of this).
- **NonAdaptive**: if TRUE, ignore the adaptive option.
- **Returns**: void

**Description**: Given four coefficents of a cubic Bezier curve, computes the four coefficients of the cubic afd basis functions and step along them to create a piecewise polynomial approximating the curve. If NonAdaptive is TRUE then $2^{\log_{2}\text{Log2Step}}$ constant steps are taken, creating $2^{\log_{2}\text{Log2Step}} + 1$ points along the curve. Otherwise the full blown adaptive algorithm is used.

**See also**: AfdApplyAntiLStep, AfdApplyLStep, AfdApplyEStep, AfdApplyLn, AfdCnvrtCubicBzrToAfd, AfdBzrCrvEvalToPolyline
3.2.8 BBoxDiagonalInitCrvCalculator (cbsp_fit.c:2051)

static CagdCrvStruct *BBoxDiagonalInitCrvCalculator(CagdPType *PtList,
    int NumOfPoints,
    int Length,
    int Order,
    CagdBType Periodic)

PtList: Points cloud.
NumOfPoints: Number of points in PtList.
Length: The desired length of the output b-spline curve.
Order: The desired order of the output b-spline curve.
Periodic: TRUE for periodic output curve, FALSE for open end.
Returns: B-spline curve which is a bounding box diagonal \( / \) of the points cloud.
Description: Computes an initial b-spline fitting curve which is a diagonal of the points cloud bounding box.

3.2.9 BBoxPerimeterInitCrvCalculator (cbsp_fit.c:1519)

static CagdCrvStruct *BBoxPerimeterInitCrvCalculator(CagdPType *PtList,
    int NumOfPoints,
    int Length,
    int Order,
    CagdBType Periodic)

PtList: Points cloud.
NumOfPoints: Number of points in PtList.
Length: The desired length of the output b-spline curve.
Order: The desired order of the output b-spline curve.
Periodic: TRUE for periodic output curve, FALSE for open end.
Returns: B-spline curve with control points equally spread on a perimeter of the points cloud bounding box.
Description: Computes an initial b-spline fitting curve which control points lies on a perimeter of the points cloud bounding box.

3.2.10 BspBasisFuncMultEval (bspcoxdb.c:306)

CagdBspBasisFuncEvalStruct *BspBasisFuncMultEval(const CagdRType *KnotVector,
    int KVLength,
    int Order,
    CagdBType Periodic,
    CagdRType *Params,
    int NumOfParams,
    CagdBspBasisFuncMultEvalType EvalType)

KnotVector: Knot sequence defining the spline space.
KVLength: Length of KnotVector.
Order: Of the spline space.
Periodic: TRUE if space is periodic.
Params: At which to evaluate and compute the spline functions.
NumOfParams: Size of Params vector.
EvalType: Type of evaluation requested: value (position), 1st derivative, or 2nd derivative.
Returns: A vector of size NumOfParams of evaluation results, each holding the index of the first non zero basis function and the (at most) Order non zero basis function values.
Description: Computes multiple evaluations of the given spline space basis functions, as prescribed by KnotVector and Order, at the requested NumOfParams parameter values, Params.
See also:
3.2.11 BspBasisFuncMultEvalFree (bspcoxdb.c:451)

```c
void BspBasisFuncMultEvalFree(CagdBspBasisFuncEvalStruct *Evals,
int NumOfParams)

Evals: Structure to free.
NumOfParams: Size of Evals - number of parameter evaluations we have.
Returns: void
Description: Frees the allocated structure for multiple evaluations.
See also:
```

3.2.12 BspBasisFuncMultEvalPrint (bspcoxdb.c:419)

```c
void BspBasisFuncMultEvalPrint(const CagdBspBasisFuncEvalStruct *Evals,
int Order,
CagdRType *Params,
int NumOfParams)

Evals: Structure to print.
Order: Of evaluated basis functions.
Params: Parameters the basis functions were evaluated at.
NumOfParams: Size of Evals/Params - number of parameters/evaluations.
Returns: void
Description: Prints to stdout the allocated structure for multiple evaluations.
See also:
```

3.2.13 BspC1Srf2PolygonsSamples (bsp2poly.c:404)

```c
int BspC1Srf2PolygonsSamples(const CagdSrfStruct *Srf,
int FineNess,
CagdBType ComputeNormals,
CagdBType ComputeUV,
CagdBType **PtWeights,
CagdPtStruct **PtMesh,
CagdVecStruct **PtNrml,
CagdUVStruct **UVMesh,
int *FineNessU,
int *FineNessV)

Srf: To sample in a grid.
FineNess: Control on accuracy, the higher the finer.
ComputeNormals: If TRUE, normal information is also computed.
ComputeUV: If TRUE, UV values are stored and returned as well.
PtWeights: Weights of the evaluations, if rational, to detect poles. NULL if surface nor rational.
PtMesh: Evaluated positions of grid of samples.
PtNrml: Evaluated normals of grid of samples or NULL if none.
UVMesh: Evaluated UV vals of grid of samples or NULL if none.
Returns: FALSE is returned in case of an error, TRUE otherwise.
Description: Routine to uniformly sample a single C1 continuous Bspline srf as grid. FineNess is a fineness control on the result and the larger it is more samples may result. A value of 10 is a good starting value. FALSE is returned in case of an error, TRUE otherwise.
See also: BzrSrf2Polygons, IritSurface2Polygons, IritTrimSrf2Polygons, , CagdSrf2Polygons, TrimSrf2Polygons, BspSrf2PolygonsSamplesNuNu,
3.2.14 BspCrv2Polyline (bsp2poly.c:916)

CagdPolylineStruct *BspCrv2Polyline(const CagdCrvStruct *Crv,
    int SamplesPerCurve,
    BspKnotAlphaCoeffStruct *A,
    CagdBType OptiLin)

Crv: To approximate as a polyline.
SamplesPerCurve: Number of samples to approximate with.
A: Alpha matrix (Oslo algorithm) if precomputed.
OptiLin: If TRUE, optimize linear curves.

Returns: A polyline representing the piecewise linear approximation from, or NULL in case of an error.

Description: Routine to approx. a single Bspline curve as a polyline with SamplesPerCurve samples. Polyline
is always E3 CagdPolylineStruct type. Curve is refined equally spaced in parametric space, unless the curve is linear
in which the control polygon is simply being copied. If A is specified, it is used to refine the curve. NULL is returned
in case of an error, otherwise CagdPolylineStruct.

See also: BzrCrv2Polyline, BspSrf2Polylines, IritCurve2Polylines, SymbCrv2Polyline

3.2.15 BspCrvBiNormal (cbsp_aux.c:730)

CagdVecStruct *BspCrvBiNormal(const CagdCrvStruct *Crv,
    CagdRType t,
    CagdBType Normalize)

Crv: Crv for which to compute a (unit) binormal.
t: The parameter at which to compute the unit binormal.
Normalize: If TRUE, attempt is made to normalize the returned vector. If FALSE, length is a function of
given parametrization.

Returns: A pointer to a static vector holding the binormal information.

Description: Returns a (unit) vector, equal to the binormal to Crv at parameter value t. Algorithm: insert
(order - 1) knots and using 3 consecutive control points at the refined location (p1, p2, p3), compute to binormal to
be the cross product of the two vectors (p1 - p2) and (p2 - p3). Since a curve may have not BiNormal at inflection
points or if the 3 points are collinear, NULL will be returned at such cases.

3.2.16 BspCrvCoxDeBoorBasis (bspcoxdb.c:134)

CagdRType *BspCrvCoxDeBoorBasis(const CagdRType *KnotVector,
    int Order,
    int Len,
    CagdBType Periodic,
    CagdRType t,
    int *IndexFirst)

KnotVector: To evaluate the Bspline Basis functions for this space.
Order: Of the geometry.
Len: Number of control points in the geometry. The length of KnotVector is equal to Len + Order (+ (Order - 1)
    if periodic).
Periodic: TRUE if freeform is periodic.
t: At which the Bspline basis functions are to be evaluated.
IndexFirst: Index of the first Bspline basis function that might be non zero.

Returns: A vector of length Order thats holds the values of the Bspline basis functions for the given t. A
Bspline of order Order might have at most Order non zero basis functions that will hence start at IndexFirst
and upto (*IndexFirst + Order - 1).
Description: Returns a pointer to a vector of size Order, holding values of the non zero basis functions of a given curve at given parametric location \( t \). This vector SHOULD NOT BE FREED. Although it is dynamically allocated, the returned pointer does not point to the beginning of this memory and it it be maintained by this routine (i.e. it might be freed next time this routine is being called). IndexFirst returns the index of first non zero basis function for the given parameter value \( t \). Uses the recursive Cox de Boor algorithm, to evaluate the Bspline basis functions. Algorithm: Use the following recursion relation with \( B(i,0) = 1 \):

\[
\frac{t - t(i)}{t(i+k) - t(i)} B(i,k) + \frac{t(i+k) - t}{t(i+k) - t(i+1)} B(i+1,k) = B(i,k)
\]

Starting with constant Bspline \((k==0)\) only one basis function is non zero and is equal to one. This is the constant Bspline spanning interval \( t(i)...t(i+1) \) such that \( t(i) < t < t(i+1) \). We then raise this constant Bspline to the prescribed Order and find in this process all the basis functions that are non zero in \( t \) for order Order. Sound simple hah!?

3.2.17 BspCrvCoxDeBoorIndexFirst (bspcqxdb.c:258)

```c
int BspCrvCoxDeBoorIndexFirst(const CagdRType *KnotVector, int Order, int Len, CagdRType t)
```

**KnotVector**: To evaluate the Bspline Basis functions for this space.

**Order**: Of the geometry.

**Len**: Number of control points in the geometry. The length of KnotVector is equal to Len + Order.

**t**: At which the Bspline basis functions are to be evaluated.

**Returns**: The index.

Description: Computes the index of the first non zero basis function as returned by the BspCrvCoxDeBoorBasis function.

3.2.18 BspCrvCreateApproxHelix (cagdarc.c:572)

```c
CagdCrvStruct *BspCrvCreateApproxHelix(CagdRType NumOfLoops, CagdRType Pitch, CagdRType Radius, int Sampling, int CtlPtsPerLoop)
```

**NumOfLoops**: Number of loops in the helix - can be fractional.

**Pitch**: Essentially the size of the helix. A Pitch of one will step one unit in \( Z \) for one full circle.

**Radius**: Radius of helix. If radius is negative, the radius will change monotonically from zero to abs(Radius) at the end.

**Sampling**: Number of samples to compute on the helix. Should be several hundreds for a reasonable result.

**CtlPtsPerLoop**: Number of control points to use per loop. Use at least 5 for a reasonable approximation.

**Returns**: A helix Bspline curve approximation.

Description: Constructs an approximated polynomial helix curve, along the +Z axis.

See also: BspCrvCreateCircle, BspCrvCreateApproxSine, BspCrvCreateApproxSpiral,
### 3.2.19 BspCrvCreateApproxSine (cagd_arc.c:627)

```c
CagdCrvStruct *BspCrvCreateApproxSine(CagdRType NumOfCycles,
   int Sampling,
   int CtlPtsPerCycle)
```

**NumOfCycles**: Number of cycles in the sine - can be fractional.
**Sampling**: Number of samples to compute on the sine. Should be several hundreds for a reasonable result.
**CtlPtsPerCycle**: Number of control points to use per cycle. Use at least 5 for a reasonable approximation.

**Returns**: A sine wave B spline curve approximation.

**Description**: Constructs an approximated polynomial sine curve.

**See also**: BspCrvCreateCircle, BspCrvCreateApproxSine, BspCrvCreateApproxHelix,

### 3.2.20 BspCrvCreateApproxSpiral (cagd_arc.c:514)

```c
CagdCrvStruct *BspCrvCreateApproxSpiral(CagdRType NumOfLoops,
   CagdRType Pitch,
   int Sampling,
   int CtlPtsPerLoop)
```

**NumOfLoops**: Number of loops in the spiral - can be fractional.
**Pitch**: Essentially the size of the spiral. A Pitch of one will construct a roughly size-one spiral curve.
**Sampling**: Number of samples to compute on the spiral. Should be several hundreds for a reasonable result.
**CtlPtsPerLoop**: Number of control points to use per loop. Use at least 5 for a reasonable approximation.

**Returns**: A spiral B spline curve approximation.

**Description**: Constructs an approximated spiral curve (not rational!)

**See also**: BspCrvCreateCircle, BspCrvCreateApproxSine, BspCrvCreateApproxHelix,

### 3.2.21 BspCrvCreateCircle (cagd_arc.c:363)

```c
CagdCrvStruct *BspCrvCreateCircle(const CagdPtStruct *Center, CagdRType Radius)
```

**Center**: Of circle to be created.
**Radius**: Of circle to be created.

**Returns**: A circle centered at Center and radius Radius that is parallel to the XY plane represented as a rational quadratic B spline curve.

**Description**: Creates a circle at the specified position as a rational quadratic B spline curve. Circle is always parallel to the XY plane.

**See also**: BspCrvCreateUnitCircle, BspCrvCreatePCircle, BspCrvCreateUnitPCircle, , CagdCreateConicCurve, CagdCrvCreateArc, BzrCrvCreateArc,

### 3.2.22 BspCrvCreatePCircle (cagd_arc.c:475)

```c
CagdCrvStruct *BspCrvCreatePCircle(const CagdPtStruct *Center,
   CagdRType Radius)
```

**Center**: Of circle to be created.
**Radius**: Of circle to be created.

**Returns**: A circle approximation centered at Center and radius Radius that is parallel to the XY plane represented as a polynomial cubic B spline curve.

**Description**: Approximates a circle as a cubic polynomial B spline curve at the specified position and radius. Construct the circle as four 90 degrees arcs of polynomial cubic Bezier segments using predefined constants. See Faux & Pratt "Computational Geometry for Design and Manufacturing" for a polynomial approximation to a circle.

**See also**: BspCrvCreateCircle, BspCrvCreateUnitCircle, BspCrvCreateUnitPCircle, , CagdCreateConicCurve, CagdCrvCreateArc, BzrCrvCreateArc,
3.2.23 BspCrvCreateUnitCircle (cagdarc.c:310)

CagdCrvStruct *BspCrvCreateUnitCircle(void)

Returns: A rational quadratic bsplinecurve representing a unit circle.

Description: Creates a circle at the specified position as a rational quadratic B spline curve. Constructs a unit circle as 4 90 degrees arcs of rational quadratic Bezier segments using a predefined constants.

See also: BspCrvCreateCircle, BspCrvCreatePCircle, BspCrvCreateUnitPCircle, , CagdCreateConicCurve, CagdCrvCreateArc, BzrCrvCreateArc,

3.2.24 BspCrvCreateUnitPCircle (cagdarc.c:400)

CagdCrvStruct *BspCrvCreateUnitPCircle(void)

Returns: A cubic polynomial Bspline curve approximating a unit circle

Description: Approximates a unit circle as a cubic polynomial Bspline curve. Construct a circle as four 90 degrees arcs of polynomial cubic Bezier segments using predefined constants. See Faux & Pratt "Computational Geometry for Design and Manufacturing" for a polynomial approximation to a circle.

See also: BspCrvCreateCircle, BspCrvCreateUnitCircle, BspCrvCreatePCircle, , CagdCreateConicCurve, CagdCrvCreateArc, BzrCrvCreateArc, , BspCrvCreateApproxSpiral,

3.2.25 BspCrvDegreeRaise (bspaux.c:457)

CagdCrvStruct *BspCrvDegreeRaise(const CagdCrvStruct *Crv)

Crv: To raise it degree by one.

Returns: A curve with one degree higher representing the same geometry as Crv.

Description: Returns a new curve, identical to the original but with one degree higher.

3.2.26 BspCrvDegreeRaiseN (bspaux.c:400)

CagdCrvStruct *BspCrvDegreeRaiseN(const CagdCrvStruct *Crv, int NewOrder)

Crv: To raise its degree to a NewOrder.

NewOrder: NewOrder for Crv.

Returns: A curve of order NewOrder representing the same geometry as Crv.

Description: Returns a new curve, identical to the original but with order N. Degree raise is computed by multiplying by a constant 1 curve of order

3.2.27 BspCrvDerive (bspaux.c:907)

CagdCrvStruct *BspCrvDerive(const CagdCrvStruct *Crv)

Crv: To differentiate.

Returns: Differentiated curve.

Description: Returns a new curve, equal to the given curve, differentiated once. Let old control polygon be P(i), i = 0 to k-1, and Q(i) be new one then:

Q(i) = Degree * (P(i+1) - P(i)) / (Kv(i + k) - Kv(i + 1)), i = 0 to k-2.

See also: BzrCrvDerive, CagdCrvDerive, BzrCrvDeriveRational, BspCrvDeriveRational, , BspCrvDeriveScalar,
3.2.28 BspCrvDeriveScalar (cbsp_aux.c:987)

CagdCrvStruct *BspCrvDeriveScalar(const CagdCrvStruct *Crv)

Crv: To differentiate.

Returns: Differentiated curve.

Description: Returns a new curve, equal to the given curve, differentiated once. Let old control polygon be P(i), i = 0 to k-1, and Q(i) be new one then:

Q(i) = (k - 1) * (P(i+1) - P(i)) / (Kv(i + k) - Kv(i + 1)), i = 0 to k-2.

For a Euclidean curve this is the same as CagdCrvDerive but for a rational curve the returned curve is not the vector field but simply the derivatives of all the curve’s coefficients, including the weights.

See also: BzrCrvDerive, CagdCrvDerive, BzrCrvDeriveRational, BspCrvDeriveRational, BspCrvDerive, BzrCrvDeriveScalar, CagdCrvDeriveScalar.

3.2.29 BspCrvDomain (bsp_gen.c:217)

void BspCrvDomain(const CagdCrvStruct *Crv, CagdRType *TMin, CagdRType *TMax)

Crv: To get its parametric domain.

TMin: Where to put the minimal domain’s boundary.

TMax: Where to put the maximal domain’s boundary.

Returns: void

Description: Returns the parametric domain of a Bspline curve.

See also: CagdCrvDomain.

3.2.30 BspCrvEvalAtParam (cbseval.c:99)

CagdRType *BspCrvEvalAtParam(const CagdCrvStruct *Crv, CagdRType t)

Crv: To evaluate at the given parametric location t.

t: The parameter value at which the curve Crv is to be evaluated.

Returns: A vector holding all the coefficients of all components of curve Crv’s point type. If for example the curve’s point type is P2, the W, X, and Y will be saved in the first three locations of the returned vector. The first location (index 0) of the returned vector is reserved for the rational coefficient W and XYZ always starts at second location of the returned vector (index 1). This vector is allocated statically and a second invocation of this function will overwrite the first.

Description: Returns a pointer to a static data, holding the value of the curve at given parametric location t. The curve is assumed to be Bspline. Uses the Cox de Boor recursive algorithm.

See also: CagdCrvEval, BzrCrvEvalAtParam, BzrCrvEvalVecAtParam, BspCrvEvalVecAtParam, BspCrvEvalCoxDeBoor, CagdCrvEvalToPolyline.

3.2.31 BspCrvEvalCoxDeBoor (bspcoxdb.c:40)

CagdRType *BspCrvEvalCoxDeBoor(const CagdCrvStruct *Crv, CagdRType t)

Crv: To evaluate at the given parametric location t.

t: The parameter value at which the curve Crv is to be evaluated.

Returns: A vector holding all the coefficients of all components of curve Crv’s point type. If for example the curve’s point type is P2, the W, X, and Y will be saved in the first three locations of the returned vector. The first location (index 0) of the returned vector is reserved for the rational coefficient W and XYZ always starts at second location of the returned vector (index 1).

Description: Returns a pointer to a static data, holding the value of the curve at the prescribed parametric location t. Uses the recursive Cox de-Boor algorithm, to evaluate the spline, which is not very efficient if many evaluations of the same curve are necessary Use knot insertion when multiple evaluations are to be performed.
3.2.32 BspCrvEvalVecAtParam (cbspeval.c:42)

CagdRType BspCrvEvalVecAtParam(const CagdRType *Vec,
    int VecInc,
    const CagdRType *KnotVector,
    int Order,
    int Len,
    CagdBType Periodic,
    CagdRType t)

- **Vec**: Coefficients of a scalar Bspline univariate function.
- **VecInc**: Step to move along Vec.
- **KnotVector**: Knot vector of associated geometry.
- **Order**: Order of associated geometry.
- **Len**: Length of control vector.
- **Periodic**: If this geometry is Periodic.
- **t**: Parameter value where to evaluate the curve.

**Returns**: Geometry’s value at parameter value t.

**Description**: Assumes Vec holds control points for scalar Bspline curve of order Order length Len and knot vector KnotVector. Evaluates and returns that curve value at parameter value t. Vec is incremented by VecInc (usually by 1) after each iteration.

3.2.33 BspCrvExtension (bsp_gen.c:706)

CagdCrvStruct *BspCrvExtension(const CagdCrvStruct *OrigCrv,
    const CagdBType *ExtDirs,
    CagdRType Epsilon,
    CagdBType RemoveExtraKnots)

- **OrigCrv**: The curve to be extended.
- **ExtDirs**: A boolean array of size 2 to determine the required directions of extension MinDmn, MaxDmn. A NULL here means (TRUE, TRUE).
- **Epsilon**: The length of the requested extension, in the param. domain.
- **RemoveExtraKnots**: If FALSE, the resulting curve will not have minimal multiplicity at the first internal knot on the extension side.

**Returns**: The new extended curve.

**Description**: Extends a B-spline curve. The domain of Crv is extended, such that the trace coincides with the input curve’s trace over the original domain. An interface function for the one-sided curve extension function.

**See also**: BspCrvExtraKnotRmv, BspSrfExtension, BspCrvExtensionOneSide,

3.2.34 BspCrvExtensionOneSide (bsp_gen.c:754)

CagdCrvStruct *BspCrvExtensionOneSide(const CagdCrvStruct *OrigCrv,
    CagdBType MinDmn,
    CagdRType Epsilon,
    CagdBType RemoveExtraKnots)

- **OrigCrv**: The curve to be extended.
- **MinDmn**: TRUE for min domain extension, FALSE for max domain extension.
- **Epsilon**: The length of the extension in the domain.
- **RemoveExtraKnots**: If FALSE, the resulting curve will not have minimal multiplicity at the first internal knot on the extension side.

**Returns**: The new extended curve.

**Description**: Extends a B-spline curve, at the min/max end. The domain of Crv is extended, such that the trace coincides with the original trace over the original domain. Assumes Crv has open end conditions.

**See also**: BspCrvExtraKnotRmv, BspSrfExtension,
3.2.35 BspCrvExtraKnotRmv (bsp_gen.c:904)

CagdCrvStruct *BspCrvExtraKnotRmv(const CagdCrvStruct *Crv, 
    int RmvIndex)

Crv: The curve to be updated.
RmvIndex: The index in the knot vector of the knot to be removed.
Returns: The new updated curve.

Description: Reverse operation of the knot insertion, assuming it is guaranteed that the knot currently does not
have its minimal multiplicity, that is: it is possible to remove it and maintain the exact trace. Indices and conventions
follow Boehm’s Knot Insertion algo, as in E. Cohen, R.F. Riesenfeld, G. Elber, “Geometric Modeling with Splines:
an Introduction”, CH 07.
See also: BspCrvExtensionOneSide, BspSrfextension,

3.2.36 BspCrvFitLstSqr (cbsp_int.c:893)

CagdCrvStruct *BspCrvFitLstSqr(const CagdCrvStruct *Crv, 
    int Order, 
    int Size, 
    CagdBType Periodic, 
    CagdParametrizationType ParamType, 
    int EndPtInterp, 
    int EvalPts, 
    CagdRType *Err)

Crv: Curve to fit a new curve to.
Order: Of the to be created curve.
Size: Control polygon size the to be created curve.
Periodic: Constructed curve should be Periodic.
ParamType: Type of parametrization.
EndPtInterp: TRUE to force Crv’s end point interpolation. Has affect only if has open end-conditions.
EvalPts: TRUE to evaluate the samples points at equal parametric interval, FALSE to simply copy the control
points.
Err: The maximum error is updated into here
Returns: Fitted surface.

Description: Fits a curve to the give curve by sampling points on Crv and fitting a curve of orders Order and
Size control points. Error is measured by the difference between the original and the fitted surface, as maximum
error norm.
See also: BspCrvInterpPts,

3.2.37 BspCrvHasBezierKV (bsp_knot.c:29)

CagdBType BspCrvHasBezierKV(const CagdCrvStruct *Crv)

Crv: To check for KV that mimics Bezier polynomial curve.
Returns: TRUE if same as Bezier curve, FALSE otherwise.
Description: Returns TRUE iff the given curve has no interior knot open end KV.

3.2.38 BspCrvHasOpenEC (bsp_knot.c:89)

CagdBType BspCrvHasOpenEC(const CagdCrvStruct *Crv)

Crv: To check for open end conditions.
Returns: TRUE, if curve has open end conditions, FALSE otherwise.
Description: Returns TRUE iff the given B-spline curve has open end conditions.
3.2.39 BspCrvIntegrate (cbsp_aux.c:1033)

CagdCrvStruct *BspCrvIntegrate(const CagdCrvStruct *Crv)

Crv: Curve to integrate.
Returns: Integrated curve.
Description: Returns a new B spline curve, equal to the integral of the given B spline crv. The given B spline curve should be nonrational.

\[ C(t) = \sum_{i=0}^{n} \sum_{j=i+1}^{n+1} P_i B_j(t) \]

\[ = \sum_{i=0}^{n+1} \sum_{j=1}^{n+1} P_i (t - t_i) B_j(t) \]

See also: BzrCrvIntegrate, BspSrfIntegrate, CagdCrvIntegrate,

3.2.40 BspCrvInterpBuildKVs (cbsp_int.c:208)

void BspCrvInterpBuildKVs(const CagdCtlPtStruct *PtList, int Order, int CrvSize, CagdParametrizationType ParamType, CagdBType Periodic, CagdRType **RetPtKnots, CagdRType **RetKV)

PtList: List of point to interpolate.
Order: Order of interpolating curve.
CrvSize: Number of control points in interpolating curve.
ParamType: Parametrization type: Uniform, chord length, etc.
Periodic: TRUE for a periodic interpolating curve
RetPtKnots: Parameter values assigned to the interpolation.
RetKV: Knot sequence built for the interpolation, unless CAGD_KV_NODAL_PARAM in which case the KV is assumed given.
Returns: void
Description: Build knot sequence and sampling parameter for the given data to interpolate, curve type and the parameterization type desired.

3.2.41 BspCrvInterpPts (cbsp_int.c:91)

CagdCrvStruct *BspCrvInterpPts(const CagdPtStruct *PtList, int Order, int CrvSize, CagdParametrizationType ParamType, CagdBType Periodic)
PtList: List of points to interpolate/least square approximate.
Order: Of interpolating/approximating curve.
CrvSize: Number of degrees of freedom (control points) of the interpolating/approximating curve.
ParamType: Type of parametrization.
Periodic: Constructed curve should be Periodic. Periodic necessitates uniform knot sequence in ParamType.
Returns: Constructed interpolating/approximating curve.

Description: Given a set of points, PtList, computes a B spline curve of order Order that interpolates or least square approximates the set of points. The size of the control polygon of the resulting B spline curve defaults to the number of points in PtList (if CrvSize = 0). However, this number is can smaller to yield a least square approximation. The created curve can be parametrized as specified by ParamType.

See also: BspCrvInterpolate, BspCrvInterpPts1, BspCrvInterpPts2, MvarBspCrvInterpVecs.

3.2.42 BspCrvInterpPts2 (cbsp_int.c:161)

CagdCrvStruct *BspCrvInterpPts2(const CagdCtlPtStruct *PtList,
int Order,
int CrvSize,
CagdParametrizationType ParamType,
CagdBType Periodic)

PtList: List of points to interpolate/least square approximate.
Order: Of interpolating/approximating curve.
CrvSize: Number of degrees of freedom (control points) of the interpolating/approximating curve.
ParamType: Type of parametrization.
Periodic: Constructed curve should be Periodic. Periodic necessitates uniform knot sequence in ParamType.
Returns: Constructed interpolating/approximating curve.

Description: Given a set of points, PtList, computes a B spline curve of order Order that interpolates or least square approximates the set of points. The size of the control polygon of the resulting B spline curve defaults to the number of points in PtList (if CrvSize = 0). However, this number is can smaller to yield a least square approximation. The created curve can be parametrized as specified by ParamType.

See also: BspCrvInterpolate, BspCrvInterpPts.

3.2.43 BspCrvInterpPtsError (cbsp_int.c:1190)

CagdRType BspCrvInterpPtsError(const CagdCrvStruct *Crv,
const CagdPtStruct *PtList,
CagdParametrizationType ParamType,
CagdBType Periodic)

Crv: Curve that was fitted to the data set.
PtList: The data set.
ParamType: Parameter values at with curve should interpolate PtList.
Periodic: Constructed curve should be Periodic. Periodic necessitates uniform knot sequence in ParamType.
Returns: Error measured in the L1 norm.

Description: Given a set of points, and a curve least square fitting them using the BspCrvInterpPts function, computes an error measure as a the maximal distance between the curve and points (L1 norm).
3.2.44 BspCrvInterpolate (cbsp_int.c:462)

CagdCrvStruct *BspCrvInterpolate(const CagdCtlPtStruct *PtList,
    const CagdRType *Params,
    const CagdRType *KV,
    int Length,
    int Order,
    CagdBType Periodic)

PtList: List of points to interpolate/least square approximate.
Params: At which to interpolate the points in PtList.
KV: Computed knot vector for the constructed curve.
Length: Number of degrees of freedom (control points) of the interpolating/approximating curve.
Order: Of interpolating/approximating curve.
Periodic: Constructed curve should be Periodic.
Returns: Constructed interpolating/approximating curve, NULL if singular.

Description: Given set of points, PtList, parameter values the curve should interpolate or approximate these points, Params, and the expected knot vector, KV, length Length and order Order of the Bspline curve, computes the Bspline curve's coefficients. All points in PtList are assumed of the same type. If Periodic, Order - 1 more constraints (and DOF's) are added so that the first Order - 1 points are the same as the last Order - 1 points.

3.2.45 BspCrvIsC1DiscontAt (cbspeval.c:246)

CagdBType BspCrvIsC1DiscontAt(const CagdCrvStruct *Crv,
    CagdRType t)

Crv: Curves to examine for a C1 discontinuity.
t: Parameter value to examine at.
Returns: TRUE if Crv has a C1 discontinuity at parameter t, FALSE otherwise.

Description: Examines the control polygon at given parametric location for a real C1 discontinuity, in Euclidean space.
See also: BspSrfIsC1DiscontAt,

3.2.46 BspCrvKnotC0Discont (bsp_gen.c:369)

CagdBType BspCrvKnotC0Discont(const CagdCrvStruct *Crv, CagdRType *t)

Crv: To examine its potential discontinuity.
t: Where to put the parameter value (knot) that can be C0 discontinuous.
Returns: TRUE if found a C0 discontinuity, FALSE otherwise.

Description: Scans the given knot vector of the given curve for a potential C0 discontinuity. Looks for multiplicities in the knot sequence and then examine the mesh if indeed the mesh is discontinuous at that location. Assumes knot vectors has open end condition.
See also: BspCrvKnotC1Discont, BspCrvKnotC2Discont, BspKnotC0Discont, , BspCrvMeshC1Continuous, BspCrvKnotC1Discont,

3.2.47 BspCrvKnotC1Discont (bsp_gen.c:402)

CagdBType BspCrvKnotC1Discont(const CagdCrvStruct *Crv, CagdRType *t)

Crv: To examine its potential discontinuity.
t: Where to put the parameter value (knot) that can be C1 discontinuous.
Returns: TRUE if found a C1 discontinuity, FALSE otherwise.

Description: Scans the given knot vector of the given curve for a potential C1 discontinuity. Looks for multiplicities in the knot sequence and then examine the mesh if indeed the mesh is discontinuous at that location. Assumes knot vectors has open end condition.
See also: BspCrvKnotC0Discont, BspCrvKnotC2Discont, BspKnotC1Discont, , BspCrvMeshC1Continuous,
3.2.48 BspCrvKnotC2Discont (bsp_gen.c:435)

CagdBType BspCrvKnotC2Discont(const CagdCrvStruct *Crv, CagdRType *t)

Crv: To examine its potential discontinuity.
t: Where to put the parameter value (knot) that can be C1 discontinuous.

Returns: TRUE if found a C2 discontinuity, FALSE otherwise.

Description: Scans the given knot vector of the given curve for a potential C2 discontinuity. Looks for multiplicities in the knot sequence and then examine the mesh if indeed the mesh is discontinuous at that location. Assumes knot vectors has open end condition.

See also: BspCrvKnotC0Discont, BspCrvKnotC1Discont, BspKnotC1Discont, , BspCrvMeshC1Continuous,

3.2.49 BspCrvKnotInsert (bspboehm.c:60)

CagdCrvStruct *BspCrvKnotInsert(const CagdCrvStruct *Crv, CagdRType t)

Crv: To refine by adding a new knot with value equal to t. If Crv is a periodic curve, it is first unwrapped to a float end condition curve.
t: New knot to insert into Crv.

Returns: The refined curve.

Description: Returns a new curve refined at t (t is inserted as a new knot in Crv). If however the multiplicity of t in the current knot vector is equal (or greater!!) to the degree or t is not in the curve's parametric domain, no new knot is insert and NULL is returned instead. Control mesh is updated as follows (P is old ctl polygon, Q is new): Let Index be the last knot in old knot vector less than t and let j be j = Index - order + 1. Also let k be the curve order. Then,

Case 1: Q(i) = P(i), i <= j

Case 2: Q(i) = P(i) + --------------- P(i-1), j<i<=Index
           t(i+k-1) - t(i)

Case 3: Q(i) = P(i-1), Index < i

Note: Althoug works, this is not the optimal way to insert many knot! See also the BspKnotEvalAlpha set of routines.

For more see: "Recursive proof of Boehm’s knot insertion technique", by Phillip J Barry Ronald N Goldman, CAD, Volume 20 number 4 1988, pp 181-182. Which also references the original 1980 paper by Boehm.

See also: BspCrvKnotInsertNSame, BspCrvKnotInsertNDiff, BspSrfKnotInsert, BspKnotEvalAlphaCoef,

3.2.50 BspCrvKnotInsertNDiff (cbsp_aux.c:296)

CagdCrvStruct *BspCrvKnotInsertNDiff(const CagdCrvStruct *Crv, CagdBType Replace, CagdRType *t, int n)

Crv: To refine by insertion (upto) n knot of value t.
Replace: if TRUE, the n knots in t should replace the knot vector of size n of Crv. Sizes must match. If False, n new knots as defined by t will be introduced into Crv.
t: New knots to introduce/replace knot vector of Crv.
n: Size of t.

Returns: Refined Crv with n new knots.

Description: Inserts n knot with different values as defined by the vector t. If, however, Replace is TRUE, the knot are simply replacing the current knot vector.
3.2.51  BspCrvKnotInsertNSame (cbsp_aux.c:247)

CagdCrvStruct *BspCrvKnotInsertNSame(const CagdCrvStruct *Crv, 
   CagdRType t, 
   int n)

Crv: To refine by insertion (upto) n knot of value t.

\textbf{t}: Parameter value of new knot to insert.

\textbf{n}: Maximum number of times t should be inserted.

\textbf{Returns}: Refined Crv with n knots of value t.

\textbf{Description}: Inserts n knot, all with the value t. In no case will the multiplicity of a knot be greater or equal to the curve order.

3.2.52  BspCrvMaxCoefParam (bsp_knot.c:1743)

CagdRType BspCrvMaxCoefParam(const CagdCrvStruct *Crv, 
   int Axis, 
   CagdRType *MaxVal)

Crv: To compute the parameter node value of the largest coefficient.

\textbf{Axis}: Which axis should we search for maximal coefficient? 1 for X, 2 for Y, etc.

\textbf{MaxVal}: The coefficient itself will be place herein.

\textbf{Returns}: The node parameter value of the detected maximal coefficient.

\textbf{Description}: Finds the parameter value with the largest coefficient of the curve using nodes values to estimate the coefficients’ parameters.

3.2.53  BspCrvMeshC1Continuous (bsp_gen.c:467)

CagdBType BspCrvMeshC1Continuous(const CagdCrvStruct *Crv, 
   int Idx, 
   CagdRType *CosAngle)

Crv: To examine its potential discontinuity.

\textbf{Idx}: Index where to examine the discontinuity.

\textbf{CosAngle}: If not NULL, updated with the cosine of the deviation angle.

\textbf{Returns}: TRUE if continuous there, FALSE otherwise.

\textbf{Description}: Examine the control polygon of the given curve in index Idx for a real C1 discontinuity in the mesh. This index will typically be for a knot multiplicity potential discont.

\textbf{See also}: BspKnotC1Discont,

3.2.54  BspCrvMoebiusTransform (cbsp_aux.c:1101)

CagdCrvStruct *BspCrvMoebiusTransform(const CagdCrvStruct *CCrv, CagdRType c)

CCrv: Curve to apply the Moebius transformation to.

\textbf{c}: The scaling coefficient - c^n is the ratio between the first and last weight of the curve. If c == 0, the first and last weights are made equal.

\textbf{Returns}: The modified curve with the same shape but different speed.


\textbf{See also}: BzrCrvMoebiusTransform, BspSrfMoebiusTransform,
3.2.55 BspCrvNew (bsp_gen.c:132)

CagdCrvStruct *BspCrvNew(int Length, int Order, CagdPointType PType)

**Length:** Number of control points

**Order:** The order of the curve

**PType:** Type of control points (E2, P3, etc.).

**Returns:** An uninitialized freeform Bspline curve.

**Description:** Allocates the memory required for a new Bspline curve.

**See also:** BzrCrvNew, BspPeriodicCrvNew, CagdCrvNew, CagdPeriodicCrvNew, TrimCrvNew

3.2.56 BspCrvNormal (cbsp_aux.c:870)

CagdVecStruct *BspCrvNormal(const CagdCrvStruct *Crv, CagdRType t, CagdBType Normalize)

**Crv:** Crv for which to compute a (unit) normal.

**t:** The parameter at which to compute the unit normal.

**Normalize:** If TRUE, attempt is made to normalize the returned vector. If FALSE, length is a function of given parametrization.

**Returns:** A pointer to a static vector holding the normal information.

**Description:** Returns a (unit) vector, equal to the normal of Crv at parameter value t. Algorithm: returns the cross product of the curve tangent and binormal.

3.2.57 BspCrvOpenEnd (bsp_gen.c:282)

CagdCrvStruct *BspCrvOpenEnd(const CagdCrvStruct *Crv)

**Crv:** To convert to a new curve with open end conditions.

**Returns:** Same curve as Crv but with open end conditions.

**Description:** Returns a curve with open end conditions, similar to given curve. Open end curve is computed by extracting a subregion from Crv that is the entire curve's parametric domain, by inserting multiple knots at the domain's boundary.

**See also:** BspSrfOpenEnd

3.2.58 BspCrvSubdivAtParam (cbsp_aux.c:162)

CagdCrvStruct *BspCrvSubdivAtParam(const CagdCrvStruct *Crv, CagdRType t)

**Crv:** To subdivide at parametr value t.

**t:** Parameter value to subdivide Crv at.

**Returns:** A list of the two subdivided curves.

**Description:** Given a Bspline curve - subdivides it into two sub-curves at the given parametric value. Returns pointer to first curve in a list of two subdivided curves. The subdivision is achieved by inserting (order-1) knot at the given parameter value t and splitting the control polygon and knot vector at that location.
3.2.59 BspCrvSubdivCtlPoly (cbsp\aux\c:55)

```c
void BspCrvSubdivCtlPoly(const CagdCrvStruct *Crv,
    CagdRType **LPoints,
    CagdRType **RPoints,
    int LLength,
    int RLength,
    CagdRType t,
    int Mult)
```

**Crv**: To subdivide at parametr value \( t \).
**LPoints, RPoints**: Where the results are kept.
**LLength, RLength**: Lengths of respective vectors.
**t**: Parameter value to subdivide Crv at.
**Mult**: Current multiplicity of \( t \) in the knot sequence.

**Returns**: void

**Description**: Apply B-spline subdivision to the given curve Crv at parameter value \( t \), and save the result in curves' LPoints/RPoints.

**See also**: BzrCrvSubdivCtlPoly, BspCrvSubdivAtParam,

3.2.60 BspCrvTangent (cbsp\aux\c:535)

```c
CagdVecStruct *BspCrvTangent(const CagdCrvStruct *Crv,
    CagdRType t,
    CagdBType Normalize)
```

**Crv**: Crv for which to compute a (unit) tangent.
**t**: The parameter at which to compute the unit tangent.
**Normalize**: If TRUE, attempt is made to normalize the returned vector. If FALSE, returned is an unnormalized vector in the right direction of the tangent.

**Returns**: A pointer to a static vector holding the tangent information.

**Description**: Returns a (unit) vector, equal to the tangent to Crv at parameter value \( t \). Algorithm: insert \((\text{order} - 1)\) knots and return control polygon tangent. The unnormalized normal does not equal \( dC/dt \) in its magnitude, only in its direction.

3.2.61 BspGenBasisFuncsAsCurves (bsp\_gen\c:1156)

```c
CagdCrvStruct *BspGenBasisFuncsAsCurves(int Order,
    int Length,
    const CagdRType *KV)
```

**Order**: Of space to create basis functions for.
**Length**: Number of control points in this space.
**KV**: Knot sequence of this space, of length \((\text{Order} + \text{Length})\).

**Returns**: Length curves representing the basis functions.

**Description**: Creates a list of curves representing the B-spline basis functions of the given space (order and knot sequence). All basis functions will be scaled to fit into the unit square \([0, 1]^2\). If the space is periodic, Length should reflect this in the input (i.e. length should be enlarged by order - 1).

**See also**: BspGenKnotsGeometryAsCurves,
3.2.62 BspGenKnotsGeometryAsCurves (bsp_gen.c:1243)

CagdCrvStruct *BspGenKnotsGeometryAsCurves(int Order,  
    int Length,  
    const CagdRType *KV,  
    CagdRType SizeOfKnot)

Order: Of space to create the geometry of the knots for.
Length: Number of control points in this space.
KV: Knot sequence of this space, of length (Order + Length).
SizeOfKnot: The size of the plot knot. Knots are created as triangles

Returns: Length curves representing the Length knots.

Description: Creates a list of linear B-spline curves representing the B-spline knots in the given space (order and knot sequence). All knots will be scaled to fit just below the unit square [0, 1]^2. If the space is periodic, Length should reflect this in the input (i.e. length should be enlarged by order - 1).

See also: BspGenBasisFuncsAsCurves,

3.2.63 BspIsKnotDiscontUniform (bsp_knot.c:694)

CagdEndConditionType BspIsKnotDiscontUniform(int Len,  
    int Order,  
    const CagdRType *KnotVector)

Len: Of control polygon/mesh of curve/surface that is using this knot vector.
Order: Of the curve/surface that is using this knot vector.
KnotVector: The knot vector to verify.

Returns: CAGD_END_COND_GENERAL if general knot vector, or CAGD_END_COND_OPEN/FLOAT/PERIODIC if knot vector is uniform with open/float/periodic end conditions.

Description: Tests the given knot vector for discontinuous uniformity and open/float end conditions. That is all interior knots are of multiplicity Order-1 and are uniformly spaced.

3.2.64 BspIsKnotUniform (bsp_knot.c:626)

CagdEndConditionType BspIsKnotUniform(int Len,  
    int Order,  
    const CagdRType *KnotVector)

Len: Of control polygon/mesh of curve/surface that is using this knot vector.
Order: Of the curve/surface that is using this knot vector.
KnotVector: The knot vector to verify.

Returns: CAGD_END_COND_GENERAL if general knot vector, or CAGD_END_COND_OPEN/FLOAT/PERIODIC if knot vector is uniform with open/float/periodic end conditions.

Description: Tests the given knot vector for uniformity and open/float end conditions.

3.2.65 BspKnotAffineTrans (bsp_knot.c:844)

void BspKnotAffineTrans(CagdRType *KnotVector,  
    int Len,  
    CagdRType Translate,  
    CagdRType Scale)

KnotVector: To affinely transform.
Len: Of knot vector. This is not the length of the curve or surface using this knot vector.
**Translate:** Amount to translate the knot vector.

**Scale:** Amount to scale the knot vector.

**Returns:** void

**Description:** Applies an affine transformation to the given knot vector. Note affine transformation on the knot vector does not change the Bspline curve. Knot vector is translated by Translate amount and scaled by Scale as

\[ KV[i] = (KV[i] - KV[0]) \ast Scale + (KV[0] + Translate). \]

All transformation as taken place in place.

**See also:** BspKnotScale, BspKnotAffineTrans2, BspKnotAffineTransOrder,

### 3.2.66 BspKnotAffineTrans2 (bsp_knot.c:888)

```c
void BspKnotAffineTrans2(CagdRType *KnotVector,  
int Len,  
CagdRType MinVal,  
CagdRType MaxVal)
```

- **KnotVector:** To affinely transform.
- **Len:** Of knot vector. This is not the length of the curve or surface using this knot vector.
- **MinVal, MaxVal:** New parametric domain of knot vector.

**Returns:** void

**Description:** Applies an affine transformation to the given knot vector. Note affine transformation on the knot vector does not change the Bspline curve. Knot vector is translated and scaled so as to span the domain from MinVal to MaxVal. This works for open end condition curves only.

\[ KV[i] = (KV[i] - KV[0]) \ast Scale + MinVal, \]

where Scale = \((MaxVal - MinVal) / (KV[Len - 1] - KV[0]). All transformation as taken place in place.

**See also:** BspKnotScale, BspKnotAffineTrans, BspKnotAffineTransOrder2,

### 3.2.67 BspKnotAffineTransOrder (bsp.knot.c:935)

```c
void BspKnotAffineTransOrder(CagdRType *KnotVector,  
int Order,  
int Len,  
CagdRType Translate,  
CagdRType Scale)
```

- **KnotVector:** To affinely transform.
- **Order:** Order of the space using this knot vector.
- **Len:** Of knot vector. This is not the length of the curve or surface using this knot vector.
- **Translate:** Amount to translate the knot vector.
- **Scale:** Amount to scale the knot vector.

**Returns:** void

**Description:** Applies an affine transformation to the given knot vector. Note affine transformation on the knot vector does not change the Bspline curve. Knot vector is translated by Translate amount and scaled by Scale as

\[ KV[i] = (KV[i] - KV[Order-1]) \ast Scale + (KV[Order-1] + Translate). \]

All transformation as taken place in place.

**See also:** BspKnotScale, BspKnotAffineTrans2,
3.2.68 BspKnotAffineTransOrder2 (bsp\_knot.c:981)

```c
void BspKnotAffineTransOrder2(CagdRType *KnotVector,
    int Order,
    int Len,
    CagdRType MinVal,
    CagdRType MaxVal)
```

**KnotVector**: To affinely transform.

**Order**: Order of the space using this knot vector.

**Len**: Of knot vector. This is not the length of the curve or surface using this knot vector.

**MinVal, MaxVal**: New parametric domain of knot vector.

**Returns**: void

**Description**: Applies an affine transformation to the given knot vector. Note affine transformation on the knot vector does not change the B spline curve. Knot vector is translated and scaled so as to span the domain from MinVal top MaxVal. This works for open end condition curves only.

\[ KV[i] = (KV[i] - KV[Order - 1]) \times Scale + MinVal, \]

where \( Scale = (MaxVal - MinVal) / (KV[Len - Order] - KV[Order - 1]) \). All transformation as taken place in place.

**See also**: BspKnotScale, BspKnotAffineTrans2,

3.2.69 BspKnotAllC0Discont (bsp\_knot.c:2250)

```c
CagdRType *BspKnotAllC0Discont(const CagdRType *KnotVector,
    int Order,
    int Length,
    int *n)
```

**KnotVector**: To test for potential C0 discontinuities.

**Order**: Of geometry that exploits KnotVector.

**Length**: Length of curve/surface using KnotVector. This is NOT the length of KnotVector which is equal to \( (Length + Order) \).

**n**: Length of returned vector - number of potential C0 discontinuities found.

**Returns**: Vector holding all parametr values with potential C0 discontinuities.

**Description**: Scans the given knot vector for all potential C0 discontinuity. Returns a vector holding the parameter values of the potential C0 discontinuities, NULL of none found. Sets \( n \) to length of returned vector. Assumes knot vector has open end condition. A knot vector with multiplicity of a knot of Order can be C0 discontinuous at that knot. However, this is only a necessary condition for C0 discontinuity in the geometry.

3.2.70 BspKnotAllC1Discont (bsp\_knot.c:2316)

```c
CagdRType *BspKnotAllC1Discont(const CagdRType *KnotVector,
    int Order,
    int Length,
    int *n)
```

**KnotVector**: To test for potential C1 discontinuities.

**Order**: Of geometry that exploits KnotVector.

**Length**: Length of curve/surface using KnotVector. This is NOT the length of KnotVector which is equal to \( (Length + Order) \).

**n**: Length of returned vector - number of potential C1 discontinuities found.

**Returns**: Vector holding all parametr values with potential C1 discontinuities.

**Description**: Scans the given knot vector for all potential C1 discontinuity. Returns a vector holding the parameter values of the potential C1 discontinuities, NULL of none found. Sets \( n \) to length of returned vector. Assumes knot vector has open end condition. A knot vector with multiplicity of a knot of \((Order - 1)\) can be C1 discontinuous at that knot. However, this is only a necessary condition for C1 discontinuity in the geometry.
3.2.71 BspKnotAlphaLoopBlendNotPeriodic (cagdoslo.c:700)

    void BspKnotAlphaLoopBlendNotPeriodic(const BspKnotAlphaCoeffStruct *A,
                                          int IMin,
                                          int IMax,
                                          const CagdRType *OrigPts,
                                          CagdRType *RefPts)

    A: Alpha matrix to use.
    IMin, IMax: Domain of refined controls points to blend.
    OrigPts: original coefficients.
    RefPts: Refined (returned) coefficients.
    Returns: void

    Description: Blend the input control points using the given Alpha matrix. A non periodic case is assumed.
    See also: BspKnotEvalAlphaCoef, BspKnotAlphaLoopBlendPeriodic, BspKnotAlphaLoopBlendStep,

3.2.72 BspKnotAlphaLoopBlendPeriodic (cagdoslo.c:779)

    void BspKnotAlphaLoopBlendPeriodic(const BspKnotAlphaCoeffStruct *A,
                                         int IMin,
                                         int IMax,
                                         const CagdRType *OrigPts,
                                         int OrigLen,
                                         CagdRType *RefPts)

    A: Alpha matrix to use.
    IMin, IMax: Domain of refined controls points to blend.
    OrigPts: original coefficients.
    OrigLen: Original length of OrigPts.
    RefPts: Refined (returned) coefficients.
    Returns: void

    Description: Blend the input control points using the given Alpha matrix. A non periodic case is assumed.
    See also: BspKnotEvalAlphaCoef, BspKnotAlphaLoopBlendNotPeriodic, , BspKnotAlphaLoopBlendStep,

3.2.73 BspKnotAlphaLoopBlendStep (cagdoslo.c:886)

    void BspKnotAlphaLoopBlendStep(const BspKnotAlphaCoeffStruct *A,
                                    int IMin,
                                    int IMax,
                                    const CagdRType *OrigPts,
                                    int OrigPtsStep,
                                    int OrigLen,
                                    CagdRType *RefPts,
                                    int RefPtsStep)

    A: Alpha matrix to use.
    IMin, IMax: Domain of refined controls points to blend.
    OrigPts: original coefficients.
    OrigPtsStep: Steps between adjacent coefficients, in multi-dim. arrays.
    OrigLen: Original length of OrigPts.
    RefPts: Refined (returned) coefficients.
    Returns: void

    Description: Blend the input control points using the given Alpha matrix. A non periodic case is assumed.
    See also: BspKnotEvalAlphaCoef, BspKnotAlphaLoopBlendNotPeriodic, , BspKnotAlphaLoopBlendPeriodic,
3.2.74  BspKnotAverage  (bsp_knot.c:1440)

`CagdRType *BspKnotAverage(const CagdRType *KnotVector, int Len, int Ave)`

- **KnotVector**: To average out.
- **Len**: Length of KnotVector. This is not the length of the curve or surface using this knot vector.
- **Ave**: How many knots to average each time.
- **Returns**: The averaged knot vector of length (Len - Ave + 1).

**Description**: Creates a new knot vector from the given KnotVector that averages Ave consecutive knots. Resulting vector will have (Len - Ave + 1) elements.

**See also**: BspKnotNodes,

3.2.75  BspKnotC0Discont  (bsp_knot.c:2036)

`CagdBType BspKnotC0Discont(const CagdRType *KnotVector, int Order, int Length, CagdRType *t)`

- **KnotVector**: To test for potential C0 discontinuities.
- **Order**: Of geometry that exploits KnotVector.
- **Length**: Length of curve/surface using KnotVector. This is NOT the length of KnotVector which is equal to (Length + Order).
- **t**: Where to put the parameter value (knot) that can be C0 discontinuous.
- **Returns**: TRUE if found a potential C0 discontinuity, FALSE otherwise.

**Description**: Scans the given knot vector to a potential C0 discontinuity. Returns TRUE if found one and set t to its parameter value. Assumes knot vector has open end condition. A knot vector with multiplicity of a knot of (Order) can be C0 discontinuous at that knot. However, this is only a necessary condition for C0 discontinuity in the geometry.

**See also**: BspSrfKnotC1Discont, BspKnotC1Discont, BspKnotC2Discont, BspKnotAllC1Discont,

3.2.76  BspKnotC1Discont  (bsp_knot.c:2094)

`CagdBType BspKnotC1Discont(const CagdRType *KnotVector, int Order, int Length, CagdRType *t)`

- **KnotVector**: To test for potential C1 discontinuities.
- **Order**: Of geometry that exploits KnotVector.
- **Length**: Length of curve/surface using KnotVector. This is NOT the length of KnotVector which is equal to (Length + Order).
- **t**: Where to put the parameter value (knot) that can be C1 discontinuous.
- **Returns**: TRUE if found a potential C1 discontinuity, FALSE otherwise.

**Description**: Scans the given knot vector to a potential C1 discontinuity. Returns TRUE if found one and set t to its parameter value. Assumes knot vector has open end condition. A knot vector with multiplicity of a knot of (Order - 1) can be C1 discontinuous at that knot. However, this is only a necessary condition for C1 discontinuity in the geometry.

**See also**: BspSrfKnotC1Discont, BspKnotC0Discont, BspKnotC2Discont, BspKnotAllC1Discont,
3.2.77 BspKnotC2Discont  (bsp_knot.c:2173)

CagdRType BspKnotC2Discont(const CagdRType *KnotVector, int Order, int Length, CagdRType *t)

KnotVector: To test for potential C1 discontinuities.
Order: Of geometry that exploits KnotVector.
Length: Length of curve/surface using KnotVector. This is NOT the length of KnotVector which is equal to (Length + Order).
t: Where to put the parameter value (knot) that can be C1 discontinuous.

Returns: TRUE if found a potential C2 discontinuity, FALSE otherwise.

Description: Scans the given knot vector to a potential C2 discontinuity. Returns TRUE if found one and set t to its parameter value. Assumes knot vector has open end condition. A knot vector with multiplicity of a knot of (Order - 1) can be C2 discontinuous at that knot. However, this is only a necessary condition for C2 discontinuity in the geometry.

See also: BspSrfKnotC1Discont, BspKnotC0Discont, BspKnotC1Discont, BspKnotAllC1Discont,

3.2.78 BspKnotContinuityMergeTwo  (bsp_knot.c:1305)

CagdRType *BspKnotContinuityMergeTwo(const CagdRType *KnotVector1, int Len1, int Order1, const CagdRType *KnotVector2, int Len2, int Order2, int ResOrder, int *NewLen)

KnotVector1: First knot vector.
Len1: Length of KnotVector1. This is not the length of the curve or surface using this knot vector.
Order1: Order of first knot vector’s geometry.
KnotVector2: Second knot vector.
Len2: Length of KnotVector2. This is not the length of the curve or surface using this knot vector.
Order2: Order of second knot vector’s geometry.
ResOrder: Expected order of geometry that will use the merged knot vector.
NewLen: To save the size of the knot vector that contains the merged knot vectors.

Returns: The merged knot vector (KnotVector1 U KnotVector2).

Description: Merges two knot vector KnotVector1 and KnotVector2 of length Len1 and Len2 respectively into one, from geometries of orders Order1 and Order2. Merged knot vector is for order ResOrder so that the resulting curve can represent the discontinuities in both geometries. Assumes both knot vectors are open end spanning the same domain.

3.2.79 BspKnotCopy  (bsp_knot.c:1015)

CagdRType *BspKnotCopy(CagdRType *DstKV, const CagdRType *SrcKV, int Len)

DstKV: Destination address or NULL for a whole new copy.
SrcKV: Knot vector to duplicate
Len: Length of knot vector. This is not the length of the curve or surface using this knot vector.

Returns: The duplicated (destination) knot vector.

Description: Creates an identical copy of a given knot vector KnotVector of length Len.
3.2.80 BspKnotCopyAlphaCoef (cagdoslo.c:454)

BspKnotAlphaCoeffStruct *BspKnotCopyAlphaCoef(const BspKnotAlphaCoeffStruct *A)

A: Alpha matrix to copy.

Returns: Copied matrix.

Description: Copies the BspKnotAlphaCoeffStruct data structure.

See also: BspKnotEvalAlphaCoef, BspKnotEvalAlphaCoefMerge, BspKnotFreeAlphaCoef,  BspCrvKnotInsert, BspSrfKnotInsert,

3.2.81 BspKnotDegreeRaisedKV (bsp_knot.c:1094)

CagdRType *BspKnotDegreeRaisedKV(const CagdRType *KV, int Len, int Order, int NewOrder, int *NewLen)

KV: Current knot vector of freeform.
Len: Length of the freeform - number of control points.
Order: Order of the freeform.
NewOrder: New order of the freeform.
NewLen: New length of (dynamically) allocated knot vector.

Returns: A new knot vector, allocated dynamically, that would fit this same freeform if degree raised.

Description: Computes a knot vector for a freeform that will fit the freeform if it was degree raised to NewOrder.

3.2.82 BspKnotDiscontUniformOpen (bsp_knot.c:578)

CagdRType *BspKnotDiscontUniformOpen(int Len, int Order, CagdRType *KnotVector)

Len: Of control polygon/mesh of curve/surface that is to use this knot vector.
Order: Of the curve/surface that is to use this knot vector.
KnotVector: If new knot vector is to be saved here, otherwise a new space is allocated.

Returns: The created uniform open knot vector, either newly allocated or given in Knotvector and just initialized.

Description: Returns a discontinuous uniform open knot vector for Len Control points and order Order. The actual length of the KV is Len + Order. The generated sequence is of the form "0 0 0 1 1 1 2 2 2 ... n n n n" and Hence Len + Order must equal 2 * Order + 3 * x * (Order - 1). If KnotVector is NULL it is being allocated dynamically.

3.2.83 BspKnotDoubleKnots (bsp_knot.c:1399)

CagdRType *BspKnotDoubleKnots(const CagdRType *KnotVector, int *Len, int Order)

KnotVector: To average out.
Len: Length of KnotVector. This is not the length of the curve or surface using this knot vector. Len is updated in the end to the length of the returned vector.
Order: Order of freeform geometry using this knot sequence.

Returns: The averaged knot vector of length (Len - Ave + 1).

Description: Creates a new knot vector from the given KnotVector that includes knot values in the middle of any two adjacent knots that are different in value.

See also: BspKnotNodes,
3.2.84  BspKnotEvalAlphaCoef  (cagdoslo.c:87)

BspKnotAlphaCoeffStruct *BspKnotEvalAlphaCoef(int k,
          CagdRType *KVT,
          int LengthKVT,
          CagdRType *KVt,
          int LengthKVt,
          int Periodic)

  k: Order of geometry.
  KVT: Original knot vector.
  LengthKVT: Length of original control polygon with KVT knot vector.
  KVt: Refined knot vector. Must contain all knots of KVT.
  LengthKVt: Length of refined control polygon with KVt knot vector.
  Periodic: If the refinement is for a periodic entity.

  Returns: A matrix to multiply the coefficients of the geometry using KVT, in order to get the coefficients
  under the space defined using KVt that represent the same geometry.

  Description: Computes the values of the alpha coefficients, Ai,k(j) of order k:

\[
C(t) = \sum_{i=0}^{n} \Pi_{j=0}^{m} A_{i,k}(j) N_{j,k}(t) = \sum_{i=0}^{n} \Pi_{j=0}^{m} A_{i,k}(j) N_{j,k}(t)
\]

Let T be the original knot vector and let t be the refined one, i.e. T is a subset of t. The Ai,k(j) are computed from
the following recursive definition:

\[
A_{i,1}(j) = \begin{cases} 
1, \ T(i) \leq t(i) < T(i+1) \\
0, \text{otherwise.}
\end{cases}
\]

\[
A_{i,k}(j) = \frac{T(j+k-1) - T(i)}{T(i+k) - T(i+k-1)} A_{i,k-1}(j) + \frac{T(i+k) - T(i)}{T(i+k) - T(i+1)} A_{i+1,k-1}(j)
\]

LengthKVT + k is the length of KVT and similarly LengthKVt + k is the length of KVt. In other words, LengthKVT
and LengthKVt are the control points len...
The output matrix has LengthKVT rows and LengthKVt columns (#cols > #rows) ColIndex/Length hold Length-
KVT pairs of first non zero scalar and length of non zero values in that column, so not all LengthKVT scalars are
blended.

See also: BspKnotFreeAlphaCoef, BspKnotEvalAlphaCoefMerge, BspCrvKnotInsert, , BspSrfKnotInsert, Bsp-
KnotAlphaLoopBlendPeriodic, , BspKnotAlphaLoopBlendNotPeriodic, BspKnotAlphaLoopBlendStep,

3.2.85  BspKnotEvalAlphaCoefMerge  (cagdoslo.c:617)

BspKnotAlphaCoeffStruct *BspKnotEvalAlphaCoefMerge(int k,
          CagdRType *KVT,
          int LengthKVT,
          CagdRType *NewKV,
          int LengthNewKV,
          int Periodic)

k: Order of geometry.
KVT: Original knot vector.
LengthKVT: Length of original knot vector.
NewKV: A sequence of new knots to introduce into KVT.
LengthNewKV: Length of new knot sequence.
Periodic: If the refinement is for a periodic entity.
Returns: A matrix to multiply the coefficients of the geometry using KVT, in order to get the coefficients under the space defined using KVt that represent the same geometry.

Description: Same as EvalAlphaCoef but the new knot set NewKV is merged with KVT to form the new knot vector KVt.

See also: BspKnotFreeAlphaCoef, BspKnotEvalAlphaCoef, BspCrvKnotInsert, BspSrfKnotInsert

3.2.86 BspKnotFindMult (bsp_knot.c:1943)

int BspKnotFindMult(const CagdRType *KnotVector, int Order, int Len, CagdRType t)

KnotVector: To test multiplicity of knot value t at.
Order: Of geometry that exploits KnotVector.
Len: Length of curve/surface using KnotVector. This is NOT the length of KnotVector which is equal to (Len + Order).
t: The knot to verify the multiplicity of.
Returns: Multiplicity of t in KnotVector.

Description: Returns the multiplicity of knot t in knot vector KnotVector, zero if none.

3.2.87 BspKnotFirstIndexG (bsp_knot.c:364)

int BspKnotFirstIndexG(const CagdRType *KnotVector, int Len, CagdRType t)

KnotVector: To search for a knot with the G relation to t.
Len: Of knot vector. This is not the length of the curve/surface using this KnotVector.
t: The parameter value to search for the G relation.

Returns: Index of first knot in KnotVector that is greater than t or Len if t is greater than last knot in KnotVector.

Description: Returns the index of the first knot which is greater than t in the given knot vector KnotVector of length Len. IRIT_APX_EQ_EPS is used for equality. Parameter t is assumed to be in the parametric domain for the knot vector.

3.2.88 BspKnotFreeAlphaCoef (cagdoslo.c:553)

void BspKnotFreeAlphaCoef(BspKnotAlphaCoeffStruct *A)

A: Alpha matrix to free.

Returns: void

Description: Frees the BspKnotAlphaCoeffStruct data structure.

See also: BspKnotEvalAlphaCoef, BspKnotEvalAlphaCoefMerge, BspKnotCopyAlphaCoef, BspCrvKnotInsert, BspSrfKnotInsert,
3.2.89 BspKnotHasBezierKV (bsp_knot.c:71)

CagdBType BspKnotHasBezierKV(const CagdRType *KnotVector, int Len, int Order)

KnotVector: To check for open end and no interior knots conditions.
Len: Of control mesh of this knot vector.
Order: Of curve/surface the exploits this knot vector.
Returns: TRUE if has open end conditions and no interior knots, FALSE otherwise.
Description: Returns TRUE iff the given knot vector of length (Len + Order) has no interior knots and it has
an open end conditions.

3.2.90 BspKnotHasOpenEC (bsp_knot.c:165)

CagdBType BspKnotHasOpenEC(const CagdRType *KnotVector, int Len, int Order)

KnotVector: To check for open end condition.
Len: Of control mesh of this knot vector.
Order: Of curve/surface the exploits this knot vector.
Returns: TRUE if KV has open end conditions.
Description: Returns TRUE iff the given knot vector of length (Len + Order) has open end conditions.

3.2.91 BspKnotInsertMult (bsp_knot.c:1887)

CagdRType *BspKnotInsertMult(const CagdRType *KnotVector, int Order,
int *Len, CagdRType t, int Mult)

KnotVector: To insert new knot t in.
Order: Of geometry that exploits KnotVector.
Len: Length of curve/surface using KnotVector. This is NOT the length of KnotVector which is equal to
(Length + Order).
t: The new knot t to insert.
Mult: The multiplicity that this knot should have in resulting knot vector.
Returns: A new knot vector derived from KnotVector that has a multiplicity of exactly Mult at the knot t.
Description: Inserts Mult knots with value t into the knot vector KnotVector. Attempt is made to make sure
in knot vector domain. If a knot equal to t (up to Irita_APX_EQ) already exists with multiplicity i only (Mult
- i) knot are being inserted into the new knot vector. Len is updated to the resulting knot vector. It is possible
to DELETE a knot using this routine by specifying multiplicity less then current multiplicity! This function only
constructs a refined knot vector and does not compute the actual refined coefficients.

3.2.92 BspKnotInsertOne (bsp_knot.c:1847)

CagdRType *BspKnotInsertOne(const CagdRType *KnotVector,
int Order, int *Len, CagdRType t)

KnotVector: To insert new knot t in.
Order: Of geometry that exploits KnotVector.
Len: Length of curve/surface using KnotVector. This is NOT the length of KnotVector which is equal to
(Length + Order).
t: The new knot t to insert.
Returns: A new knot vector larger by one than KnotVector that contains t.
Description: Creates a new vector with t inserted as a new knot. Attempt is made to make sure t is in the knot
vector domain. No test is made for the current multiplicity of knot t in KnotVector. This function only constructs a
refined knot vector and does not compute the actual refined coefficients.
3.2.93 BspKnotLastIndexL (bsp_knot.c:317)

```c
int BspKnotLastIndexL(const CagdRType *KnotVector, int Len, CagdRType t)
```

**KnotVector:** To search for a knot with the L relation to t.

**Len:** Of knot vector. This is not the length of the curve/surface using this KnotVector.

**t:** The parameter value to search for the L relation.

**Returns:** Index of last knot in KnotVector that is less than t or -1 if t is below the first knot.

**Description:** Returns the index of the last knot which is less than t in the given knot vector KnotVector of length Len. IRIT_APX_EQ_EPS is used for equality. Parameter t is assumed to be in the parametric domain for the knot vector.

3.2.94 BspKnotLastIndexLE (bsp_knot.c:269)

```c
int BspKnotLastIndexLE(const CagdRType *KnotVector, int Len, CagdRType t)
```

**KnotVector:** To search for a knot with the LE relation to t.

**Len:** Of knot vector. This is not the length of the curve/surface using this KnotVector.

**t:** The parameter value to search for the LE relation.

**Returns:** Index of last knot in KnotVector that is LE t, or -1 if t is below the first knot.

**Description:** Returns the index of the last knot which is less than or equal to t in the given knot vector KnotVector of length Len. IRIT_APX_EQ_U EPS is used in equality. Parameter t is assumed to be in the parametric domain for the knot vector.

3.2.95 BspKnotMakeRobustKV (bsp_knot.c:2472)

```c
int BspKnotMakeRobustKV(CagdRType *KV, int Len)
```

**KV:** Knot vector to make robust, in place.

**Len:** Length of knot vector KV.

**Returns:** TRUE if the knot sequence has been modified.

**Description:** Given a knot vector, make sure adjacent knots that are close "enough" are actually identical. Important for robustness of subdiv/refinement algs.

**See also:** BspKnotVerifyKVValidity,

3.2.96 BspKnotMergeTwo (bsp_knot.c:1217)

```c
CagdRType *BspKnotMergeTwo(const CagdRType *KnotVector1, int Len1, const CagdRType *KnotVector2, int Len2, int *NewLen)
```

**KnotVector1:** First knot vector.

**Len1:** Length of KnotVector1. This is not the length of the curve or surface using this knot vector.

**KnotVector2:** Second knot vector.

**Len2:** Length of KnotVector2. This is not the length of the curve or surface using this knot vector.

**Mult:** Maximum multiplicity to allow in merged knot vector.

**NewLen:** To save the size of the knot vector that contains the merged knot vectors.

**Returns:** The merged knot vector (KnotVector1 U KnotVector2).

**Description:** Merges two knot vector KnotVector1 and KnotVector2 of length Len1 and Len2 respectively into one. If Mult is not zero then knot multiplicity is tested not to be larger than Mult value. NewLen is set to new KnotVector length.
3.2.97 BspKnotMultiplicity (bsp\_knot.c:408)

```c
int BspKnotMultiplicity(const CagdRType *KnotVector, int Len, int Idx)
```

**KnotVector**: To compute the multiplicity of knot index Idx.

**Len**: Of knot vector. This is not the length of the curve/surface using this KnotVector.

**Idx**: Index of knot to compute its multiplicity.

**Returns**: Multiplicity of the knot. At least one.

**Description**: Computes the multiplicity of given knot index Idx in KnotVector.

3.2.98 BspKnotNodes (bsp\_knot.c:1503)

```c
CagdRType *BspKnotNodes(const CagdRType *KnotVector, int Len, int Order)
```

**KnotVector**: To average out as nodes.

**Len**: Length of KnotVector. This is not the length of the curve or surface using this knot vector.

**Order**: Of curve or surface that exploits this knot vector.

**Returns**: The nodes computed for the given knot vector.

**Description**: Creates a new vector with the given KnotVector Node values. The given knot vector is assumed to have open end conditions. The nodes are the approximated parametric value associated with the each control point. Therefore for a knot vector of length Len and order Order there are Len - Order control points and therefore nodes. Nodes are defined as (k = Order - 1 or degree):

\[
N(i) = \frac{i+k}{k} - \frac{j=i+1}{/ KnotVector(j)} \quad \text{First Node } N(i = 0) \quad \text{Last Node } N(i = Len - k - 2)
\]

**See also**: BspKnotAverage, BspKnotPeriodicNodes,

3.2.99 BspKnotParamInDomain (bsp\_knot.c:232)

```c
CagdBType BspKnotParamInDomain(const CagdRType *KnotVector, int Len, int Order, CagdBType Periodic, CagdRType t)
```

**KnotVector**: To verify t is indeed in.

**Len**: Length of curve/surface using KnotVector. This is NOT the length of KnotVector which is equal to (Length + Order).

**Order**: Order of curve/surface using KnotVector.

**Periodic**: TRUE if this KnotVector is periodic.

**t**: Parametric value to verify.

**Returns**: TRUE, if t is contained in the parametric domain, FALSE otherwise.

**Description**: Returns TRUE iff t is in the parametric domain as define by the knot vector KnotVector, its length Len, and the order Order.
3.2.100 BspKnotParamValues (bsp_knot.c:2379)

CagdRType *BspKnotParamValues(CagdRType PMin,
CagdRType PMax,
int NumSamples,
CagdRType *C1Disconts,
int NumC1Disconts)

PMin: Minimum of parametric domain.
PMax: Maximum of parametric domain.
NumSamples: To allocate for the vector of samples.
C1Disconts: A vector of potential C1 discontinuities in the (PMin, PMax) domain. This vector is freed by this routine, if it is not NULL.
NumC1Disconts: Length of C1Discont. if zero then C1Discont == NULL.
Returns: A vector of the suggested set of sampling locations.

Description: Routine to determine where to sample along the provided parametric domain, given the C1 discontinuities along it. Returns a vector of length NumSamples. If C1Disconts != NULL (NumC1Disconts > 0), C1Discont is being freed.

3.2.101 BspKnotPeriodicNodes (bsp_knot.c:1572)

CagdRType *BspKnotPeriodicNodes(const CagdRType *KnotVector,
int Len,
int Order)

KnotVector: To average out as nodes.
Len: Length of periodic KnotVector. This is not the length of the curve or surface using this knot vector.
Order: Of curve or surface that exploits this knot vector.
Returns: The nodes computed for the given knot vector.

Description: Creates a new vector with the given KnotVector Node values. The given knot vector is assumed to have periodic end conditions. The nodes are the approximated parametric value associated with the each control point. Therefore for a knot vector of length Len and order Order there are Len - Order control points and therefore nodes. Nodes are defined as (k = Order - 1 or degree):

\[
N(i) = \frac{i+k}{j=i+1} - \frac{\text{first Node } N(i = 0)}{j=\text{Last Node } N(i = \text{Len} - k - 2)} - \frac{\text{KnotVector}(j)}{k}
\]

See also: BspKnotAverage, BspKnotNodes,

3.2.102 BspKnotPrepEquallySpaced (cagdoslo.c:655)

CagdRType *BspKnotPrepEquallySpaced(int n, CagdRType Tmin, CagdRType Tmax)

n: Number of knots to introduce.
Tmin: Minimum domain to introduce knots.
Tmax: Maximum domain to introduce knots.
Returns: A vector of n knots uniformly spaced between Tmin and Tmax.

Description: Prepares a refinement vector for the given knot vector domain with n inserted knots equally spaced.
3.2.103 BspKnotReverse (bsp_knot.c:1052)

CagdRType *BspKnotReverse(const CagdRType *KnotVector, int Len)

**KnotVector**: Knot vector to be reversed.

**Len**: Length of knot vector. This is not the length of the curve or surface using this knot vector.

**Returns**: The reversed knot vector.

**Description**: Reverse a knot vector of length Len. Reversing of knot vector keeps the knots monotonically non-decreasing as well as the parametric domain. Only the spaces between the knots are being flipped. For example the knot vector:

\[ [0 \ 0 \ 0 \ 0 \ 1 \ 2 \ 6 \ 6 \ 6 \ 6] \]

is reversed to be:

\[ [0 \ 0 \ 0 \ 4 \ 4 \ 5 \ 6 \ 6 \ 6 \ 6] \]

3.2.104 BspKnotScale (bsp_knot.c:768)

void BspKnotScale(CagdRType *KnotVector, int Len, CagdRType Scale)

**KnotVector**: To affinely transform.

**Len**: Of knot vector. This is not the length of the curve or surface using this knot vector.

**Scale**: Amount to scale the knot vector.

**Returns**: void

**Description**: Applies a scale transformation to the given knot vector. Note scale transformation on the knot vector does not change the Bspline curve. Knot vector is scaled by Scale as KV[i] = KV[i] * Scale. Scaling is taken place in place.

**See also**: BspKnotTranslate, BspKnotAffineTrans, BspKnotAffineTrans2,

3.2.105 BspKnotSubtrTwo (bsp_knot.c:1156)

CagdRType *BspKnotSubtrTwo(const CagdRType *KnotVector1, int Len1, const CagdRType *KnotVector2, int Len2, int *NewLen)

**KnotVector1**: First knot vector.

**Len1**: Length of KnotVector1. This is not the length of the curve or surface using this knot vector.

**KnotVector2**: Second knot vector.

**Len2**: Length of KnotVector2. This is not the length of the curve or surface using this knot vector.

**NewLen**: To save the size of the knot vector that contains the computed subset of KnotVector1 / KnotVector2.

**Returns**: The subset of knot in KnotVector1 that are not in KnotVector2 (KnotVector1 / KnotVector2).

**Description**: Returns a knot vector that contains all the knots in KnotVector1 that are not in KnotVector2. NewLen is set to new KnotVector length.

3.2.106 BspKnotTranslate (bsp_knot.c:804)

void BspKnotTranslate(CagdRType *KnotVector, int Len, CagdRType Trans)

**KnotVector**: To translate.

**Len**: Of knot vector. This is not the length of the curve or surface using this knot vector.

**Trans**: Amount to translate the knot vector.

**Returns**: void

**Description**: Applies a translation transformation to the given knot vector. Note translation transformation on the knot vector does not change the Bspline curve. Knot vector is translated by Trans as KV[i] = KV[i] + Trans. Translation is taken place in place.

**See also**: BspKnotScale, BspKnotAffineTrans, BspKnotAffineTrans2,
3.2.107  **BspKnotUniformFloat**  (bsp_knot.c:481)

```c
CagdRType *BspKnotUniformFloat(int Len, int Order, CagdRType *KnotVector)
```

**Len:** Of control polygon/mesh of curve/surface that is to use this knot vector.

**Order:** Of the curve/surface that is to use this knot vector.

**KnotVector:** If new knot vector is to be saved here, otherwise a new space is allocated.

**Returns:** The created uniform floating knot vector, either newly allocated or given in Knotvector and just initialized.

**Description:** Returns a uniform floating knot vector for Len Control points and order Order. The actual length of the KV is Len + Order. If KnotVector is NULL it is being allocated dynamically.

---

3.2.108  **BspKnotUniformOpen**  (bsp_knot.c:526)

```c
CagdRType *BspKnotUniformOpen(int Len, int Order, CagdRType *KnotVector)
```

**Len:** Of control polygon/mesh of curve/surface that is to use this knot vector.

**Order:** Of the curve/surface that is to use this knot vector.

**KnotVector:** If new knot vector is to be saved here, otherwise a new space is allocated.

**Returns:** The created uniform open knot vector, either newly allocated or given in Knotvector and just initialized.

**Description:** Returns a uniform open knot vector for Len Control points and order Order. The actual length of the KV is Len + Order. If KnotVector is NULL it is being allocated dynamically.

---

3.2.109  **BspKnotUniformPeriodic**  (bsp_knot.c:442)

```c
CagdRType *BspKnotUniformPeriodic(int Len, int Order, CagdRType *KnotVector)
```

**Len:** Of control polygon/mesh of curve/surface that is to use this knot vector.

**Order:** Of the curve/surface that is to use this knot vector.

**KnotVector:** If new knot vector is to be saved here, otherwise a new space is allocated.

**Returns:** The created uniform periodic knot vector, either newly allocated or given in Knotvector and just initialized.

**Description:** Returns a uniform periodic knot vector for Len Control points and order Order. The actual length of the KV is Len + Order + Order - 1. If KnotVector is NULL it is being allocated dynamically.

---

3.2.110  **BspKnotVectorsSame**  (bsp_knot.c:2514)

```c
CagdBType BspKnotVectorsSame(const CagdRType *KV1, const CagdRType *KV2, int Len, CagdRType Eps)
```

**KV1, KV2:** The two knot vectors to compare.

**Len:** Length of knot vectors.

**Eps:** Tolerance of equality.

**Returns:** TRUE if knot vectors are the same, FALSE otherwise.

**Description:** Compare the two knot vectors for similarity.

**See also:** CagdCtlPointsSame, CagdCrvsSame, CagdSrfsSame,
3.2.111  **BspKnotVerifyKVValidity** (bsp\_knot.c:2587)

```c
int BspKnotVerifyKVValidity(CagdRType *KV, int Order, int Len, CagdRType Tol)
```

- **KV**: To update its knots outside the entity's domain.
- **Order**: Of the entity.
- **Len**: Such that Len + Order equals the number of knots in KV.
- **Tol**: Tolerance to consider two knots the same.

**Returns**: TRUE if valid, FALSE if failed to validate.

**Description**: Verify that the given knot sequence is a valid one up to tolerance Tol. That is no more than order knots are similar up to Tol and that the knot sequence is monotone.

3.2.112  **BspKnotVerifyPeriodicKV** (bsp\_knot.c:2546)

```c
void BspKnotVerifyPeriodicKV(CagdRType *KV, int Order, int Len)
```

- **KV**: To update its knots outside the entity’s domain.
- **Order**: Of the entity.
- **Len**: Such that Len + Order equals the number of knots in KV.

**Returns**: void

**Description**: Update the two ends (knots outside the curve’s domain) to match the same spacing as the inner knots on the other end... Updates KV in place.

3.2.113  **BspKnotsMultiplicityVector** (bsp\_knot.c:1987)

```c
int BspKnotsMultiplicityVector(const CagdRType *KnotVector, int Len, CagdRType *KnotValues, int *KnotMultiplicities)
```

- **KnotVector**: To derive its multiplicity/value vectors.
- **Len**: Length of the KnotVector.
- **KnotValues**: Vector of the unique values found in KnotVector.
- **KnotMultiplicities**: Multiplicity of unique values found in Knotvector.

**Returns**: Size of vectors KnotValues/KnotMultiplicities.

**Description**: Computes the multiplicity/value vectors of the given knot sequence. For example: (0, 0, 0, 1, 2, 2, 3, 3, 3) will be converted to: KnotValue of (0, 1, 2, 3) and KnotMult of (3, 1, 2, 3). KnotValue and KnotMult are assumed big enough vectors to hold the result.

3.2.114  **BspMakeReparamCurve** (cbsp\_int.c:1516)

```c
CagdCrvStruct *BspMakeReparamCurve(const CagdPtStruct *PtsList, int Order, int DegOfFreedom)
```

- **PtsList**: List of points on the reparametrization curve.
- **Order**: of reparametrization curve.
- **DegOfFreedom**: of reparametrization curve (== number of coefficients).

**Returns**: Result of reparametrization curve, computed using list squares fit.

**Description**: Computes a reparametrization scalar Bspline curve, y(x), so that each at each point in PtsList, the curve parameter value of X is evaluated into Y.

**See also**: BspCrvInterpolate,
3.2.115  BspPeriodicCrvNew  (bsp_gen.c:180)

CagdCrvStruct *BspPeriodicCrvNew(int Length,
   int Order,
   CagdBType Periodic,
   CagdPointType PType)

Length:  Number of control points
Order:   The order of the curve
Periodic:  Is this curve periodic?
PType:  Type of control points (E2, P3, etc.).

Returns:  An uninitialized freeform Bspline curve. If Periodic is FALSE, this function is identical to BspCrvNew.

Description: Allocates the memory required for a new, possibly periodic, Bspline curve.
See also:  BzrCrvNew, BspCrvNew, CagdCrvNew, CagdPeriodicCrvNew, TrimCrvNew,

3.2.116  BspPeriodicSrfNew  (bsp_gen.c:91)

CagdSrfStruct *BspPeriodicSrfNew(int ULength,
   int VLength,
   int UOrder,
   int VOrder,
   CagdBType UPeriodic,
   CagdBType VPeriodic,
   CagdPointType PType)

ULength:  Number of control points in the U direction.
VLength:  Number of control points in the V direction.
UOrder:  The order of the surface in the U direction.
VOrder:  The order of the surface in the V direction.
UPeriodic:  Is this surface periodic in the U direction?
VPeriodic:  Is this surface periodic in the V direction?
PType:  Type of control points (E2, P3, etc.).

Returns:  An uninitialized freeform Bspline surface. If both UPeriodic and VPeriodic are FALSE, this function is identical to BspSrfNew.

Description: Allocates the memory required for a new, possibly periodic, Bspline surface.
See also:  BspSrfNew, BzrSrfNew, CagdSrfNew, CagdPeriodicSrfNew, TrimSrfNew,

3.2.117  BspPtsSamplesToKV  (cbsp_int.c:398)

CagdRType *BspPtsSamplesToKV(const CagdRType *PtsSamples,
   int NumPts,
   int CrvOrder,
   int CrvLength)

PtsSamples:  The parameter values of the data.
NumPts:  Number of parameters in PtsSamples.
CrvOrder:  Order of curve that will employ the constructed knot vector.
CrvLength:  Length of curve that will employ constructed knot vector.

Returns:  Constructed knot vector.

Description: Given NumPts parameter values (in PtsSamples), construct a knot vector for a curve of order CrvOrder and CrvLength control points to fit to this data set.
See also:  BspKnotAverage,
3.2.118 BspReparameterizeCrv (cbsp_aux.c:1608)

```c
void BspReparameterizeCrv(CagdCrvStruct *Crv, 
   CagdParametrizationType ParamType)

Crv: The curve to update its parametrization.
ParamType: The desired parametrization type: uniform, chord len., etc.
Returns: void
Description: Reparameterize a curve to follow a desired parametrization.
See also: BspCrvInterpBuildKVs, BspReparameterizeSrf,
```

3.2.119 BspReparameterizeSrf (sbsp_aux.c:1965)

```c
void BspReparameterizeSrf(CagdSrfStruct *Srf, 
   CagdSrfDirType Dir, 
   CagdParametrizationType ParamType)

Srf: The surface to update its parametrization.
Dir: Parametric direction to reparameterize.
ParamType: The desired parametrization type: uniform, chord len., etc.
Returns: void
Description: Reparameterize a surface to follow a desired parametrization.
See also: BspCrvInterpBuildKVs, BspReparameterizeCrv,
```

3.2.120 BspSrf2Curves (bsp2poly.c:816)

```c
CagdCrvStruct *BspSrf2Curves(const CagdSrfStruct *Srf, 
   int NumOfIsocurves[2])

Srf: To extract isoparametric curves from.
NumOfIsocurves: In each (U or V) direction.
Returns: List of extracted isoparametric curves. These curves inherit the order and continuity of the original 
Srf. NULL is returned in case of an error.
Description: Routine to extract from a B spline surface NumOfIsoline isocurve list in each param. direction. Iso 
parametric curves are sampled equally spaced in parametric space. NULL is returned in case of an error, otherwise 
list of CagdCrvStruct.
See also: BspSr22Polylines, BzrSrf2PCurves, SymbSrf2Curves,
```

3.2.121 BspSrf2PolygonSetErrFunc (bsp2poly.c:91)

```c
CagdSrfErrorFuncType BspSrf2PolygonSetErrFunc(CagdSrfErrorFuncType Func)

Func: New function to use, NULL to disable.
Returns: Old value of function.
Description: Sets the surface approximation error function. The error function will return a negative value if 
this patch must be purged or otherwise a non negative error measure.
See also: BspSrf2Polygons,
```
3.2.122 BspSrf2Polygons (bsp2poly.c:135)

CagdPolygonStruct *BspSrf2Polygons(const CagdSrfStruct *Srf,  
int FineNess,  
CagdBType ComputeNormals,  
CagdBType FourPerFlat,  
CagdBType ComputeUV)

Srf: To approximate into triangles.
FineNess: Control on accuracy, the higher the finer.
ComputeNormals: If TRUE, normal information is also computed.
FourPerFlat: If TRUE, four triangles are created per flat surface. If FALSE, only 2 triangles are created.
ComputeUV: If TRUE, UV values are stored and returned as well.

Returns: A list of polygons with optional normal and/or UV parametric information. NULL is returned in case of an error.

Description: Routine to convert a single Bspline surface to set of triangles approximating it. FineNess is a fineness control on result and the larger is more triangles may result. A value of 10 is a good start value. NULL is returned in case of an error, otherwise list of CagdPolygonStruct. This routine looks for C1 discontinuities in the surface and splits it into C1 continuous patches to invoke BspC1Srf2Polygons to gen. polygons.

See also: BspSrfr2PolygonSetErrFunc, BzrSrf2Polygons, IritSurface2Polygons, , IritTrimSrf2Polygons, CagdSrf2Polygons, TrimSrf2Polygons, , BspClSrfr2Polygons, CagdSrf2Polygons, BspSrf2Polygons, , BzrSrf2PolygonsN, CagdSrf2PolygonsN

3.2.123 BspSrf2PolygonsN (bsp2poly.c:237)

CagdPolygonStruct *BspSrf2PolygonsN(const CagdSrfStruct *Srf,  
int Nu,  
int Nv,  
CagdBType ComputeNormals,  
CagdBType FourPerFlat,  
CagdBType ComputeUV)

Srf: To approximate into triangles.
Nu, Nv: The number of uniform samples in U and V of surface.
ComputeNormals: If TRUE, normal information is also computed.
FourPerFlat: If TRUE, four triangles are created per flat surface. If FALSE, only 2 triangles are created.
ComputeUV: If TRUE, UV values are stored and returned as well.

Returns: A list of polygons with optional normal and/or UV parametric information. NULL is returned in case of an error.

Description: Routine to convert a single Bspline surface to set of triangles approximating it. FineNess is a fineness control on result and the larger is more triangles may result. A value of 10 is a good start value. NULL is returned in case of an error, otherwise list of CagdPolygonStruct. This routine looks for C1 discontinuities in the surface and splits it into C1 continuous patches to invoke BspC1Srf2Polygons to gen. polygons.

See also: BspSrfr2PolygonSetErrFunc, BzrSrf2Polygons, IritSurface2Polygons, , IritTrimSrf2Polygons, CagdSrf2Polygons, TrimSrf2Polygons, , BspClSrfr2Polygons, CagdSrf2Polygons, BspSrf2Polygons, , BzrSrf2PolygonsN, CagdSrf2PolygonsN

3.2.124 BspSrf2PolygonsSamplesNuNv (bsp2poly.c:288)

int BspSrf2PolygonsSamplesNuNv(const CagdSrfStruct *Srf,  
int Nu,  
int Nv,  
CagdBType ComputeNormals,  
CagdBType ComputeUV,  
CagdRType *PtWeights,  
CagdPtStruct **PtMesh,  
CagdVecStruct **PtNrml,  
CagdUVStruct **UVMesh)
Srf: To sample in a grid.
Nu, Nv: The number of uniform samples in U and V of surface.
ComputeNormals: If TRUE, normal information is also computed.
ComputeUV: If TRUE, UV values are stored and returned as well.
PtWeights: Weights of the evaluations, if rational, to detect poles. NULL if surface nor rational.
PtMesh: Evaluated positions of grid of samples.
PtNrmrl: Evaluated normals of grid of samples or NULL if none.
UVMesh: Evaluated UV vals of grid of samples or NULL if none.
Returns: FALSE is returned in case of an error, TRUE otherwise.

Description: Routine to uniformly sample a single Bspline srf as a grid. Nu and Nv fix the grid’s sizes. FALSE is returned in case of an error, TRUE otherwise.

See also: BspSrf2Polygons, IritSurface2Polygons, IritTrimSrf2Polygons, CagdSrf2Polygons, TrimSrf2Polygons, BsrSrf2PolygonsSamples,

3.2.125 BspSrf2Polylines (bsp2poly.c:657)

CagdPolylineStruct *BspSrf2Polylines(const CagdSrfStruct *Srf,
int NumOfIsocurves[2],
int SamplesPerCurve)

Srf: Srf to extract isoparametric curves from.
NumOfIsocurves: To extract from Srf in each (U or V) direction.
SamplesPerCurve: Fineness control on piecewise linear curve approximation.
Returns: List of polygons representing a piecewise linear approximation of the extracted isoparametric curves or NULL is case of an error.

Description: Routine to convert a single Bspline surface to NumOfIsolines polylines in each parametric direction with SamplesPerCurve in each isoparametric curve. Polyline are always E3 of CagdPolylineStruct type. Iso parametric curves are sampled equally spaced in parametric space. NULL is returned in case of an error, otherwise list of CagdPolylineStruct. Attempt is made to extract isolines along C1 discontinuities first.

See also: BspCrv2Polyline, BsrSrf2Polylines, IritSurface2Polylines, IritTrimSrf2Polylines, SymbSrf2Polylines, TrimSrf2Polygons, CagdSrf2Polylines,

3.2.126 BspSrfC1DiscontCrvs (sbspeval.c:409)

CagdCrvStruct *BspSrfC1DiscontCrvs(const CagdSrfStruct *Srf)

Srf: To extract its C1 discontinuity curves.
Returns: The C1 discontinuities as a list of isoparametric curves.

Description: Extracts the C1 discontinuity curves from the given Bspline surface. This routine detects potential discontinuities in the control mesh by seeking knots of Order-1 multiplicity. Potential discontinuities that materialize as real (by examining the mesh itself along that line) are extracted as isoparametric curves.

See also: BspCrvC1Discont, BspKnotAllC1Discont, BspSrfIsC1DiscontAt, BspSrfHasC1Discont,

3.2.127 BspSrfCrvFromMesh (sbspeval.c:329)

CagdCrvStruct *BspSrfCrvFromMesh(const CagdSrfStruct *Srf,
int Index,
CagdSrfDirType Dir)

Srf: To extract a curve from.
Index: Index along the mesh of Srf to extract the curve from.
Dir: Direction of extracted curve. Either U or V.
Returns: A curve from Srf. This curve inherit the order and continuity of surface Srf in direction Dir. However, thiscurve is not on surface Srf, in general.

Description: Extracts a curve from the mesh of a tensor product Bspline surface Srf in direction Dir at index Index.

See also: CagdCrvFromSrf, BzrSrfCrvFromSrf, BspSrfCrvFromSrf, CagdCrvFromMesh, BsrSrfCrvFromMesh,
3.2.128 BspSrfCrvFromSrf (sbspeval.c:236)

CagdCrvStruct *BspSrfCrvFromSrf(const CagdSrfStruct *Srf,  
    CagdRTypet,  
    CagdSrfDirTypedir)

- **Srf**: To extract an isoparametric curve from.
- **t**: Parameter value of extracted isoparametric curve.
- **dir**: Direction of the isocurve on the surface. Either U or V.

**Returns**: An isoparametric curve of Srf. This curve inherits the order and continuity of surface Srf in direction Dir.

**Description**: Extracts an isoparametric curve out of the given tensor product B-spline surface in direction Dir at the parameter value of t. Operations should prefer the CONST U_DIR, in which the extraction is somewhat faster if that is possible.

**See also**: CagdCrvFromSrf, BzrSrfCrvFromSrf, CagdCrvFromMesh, BzrSrfCrvFromMesh, BspSrfCrvFromMesh.

3.2.129 BspSrfDegreeRaise (sbspaux.c:627)

CagdSrfStruct *BspSrfDegreeRaise(const CagdSrfStruct *Srf, CagdSrfDirTypedir)

- **Srf**: To raise its degree by one.
- **dir**: Direction of degree raising. Either U or V.

**Returns**: A surface with one degree higher in direction Dir, representing the same geometry as Srf.

**Description**: Returns a new B-spline surface, identical to the original but with one degree higher, in the requested direction Dir.

**See also**: CagdSrfDegreeRaise, BzrSrfDegreeRaise, TrimSrfDegreeRaise, BspSrfDegreeRaiseN,

3.2.130 BspSrfDegreeRaiseN (sbspaux.c:796)

CagdSrfStruct *BspSrfDegreeRaiseN(const CagdSrfStruct *Srf,  
    int NewUOrder,  
    int NewVOrder)

- **Srf**: To raise its degree.
- **NewUOrder**: New U order of Srf.
- **NewVOrder**: New V order of Srf.

**Returns**: A surface with higher degrees as prescribed by NewUOrder/NewVOrder.

**Description**: Returns a new B-spline surface, identical to the original but with higher degrees, as prescribed by NewUOrder, NewVOrder.

**See also**: CagdSrfDegreeRaise, BzrSrfDegreeRaise, TrimSrfDegreeRaise, BspSrfDegreeRaise, BzrSrfDegreeRaiseN, CagdSrfDegreeRaiseN,

3.2.131 BspSrfDerive (sbspaux.c:873)

CagdSrfStruct *BspSrfDerive(const CagdSrfStruct *Srf, CagdSrfDirTypedir)

- **Srf**: To differentiate.
- **dir**: Direction of differentiation. Either U or V.

**Returns**: Differentiated surface.

**Description**: Returns a new surface equal to the given surface, differentiated once in the direction Dir. Let old control polygon be P(i), i = 0 to k-1, and Q(i) be new one then:

\[ Q(i) = (k - 1) \times (P(i+1) - P(i)) / (Kv(i + k) - Kv(i + 1)), \quad i = 0 \text{ to } k-2. \]

This is applied to all rows/cols of the surface.

**See also**: CagdSrfDerive, BzrSrfDerive, BzrSrfDeriveRational, BspSrfDeriveRational, BspSrfDeriveScalar,
3.2.132  BspSrfDeriveScalar (sbsp_aux.c:995)

CagdSrfStruct *BspSrfDeriveScalar(const CagdSrfStruct *Srf, CagdSrfDirType Dir)

Srf: To differentiate.
Dir: Direction of differentiation. Either U or V.

Returns: Differentiated curve.

Description: Returns a new surface equal to the given surface, differentiated once in the direction Dir. Let old control polygon be \( P(i), i = 0 \) to \( k-1 \), and \( Q(i) \) be new one then:

\[
Q(i) = (k - 1) \times (P(i+1) - P(i)), i = 0 \) to \( k-2.
\]

This is applied to all rows/cols of the surface. For a Euclidean surface this is the same as BspSrfDerive but for a rational surface the returned surface is not the vector field but simply the derivatives of all the surface's coefficients, including the weights.

See also: BzrSrfDerive, CagdSrfDerive, BzrSrfDeriveRational, BspSrfDeriveRational, BspSrfDerive, BzrSrfDeriveScalar, CagdSrfDeriveScalar,

3.2.133  BspSrfDomain (bsp_gen.c:250)

void BspSrfDomain(const CagdSrfStruct *Srf, 

CagdRType *UMin, 
CagdRType *UMax, 
CagdRType *VMin, 
CagdRType *VMax)

Srf: To get its parametric domain.
UMin: Where to put the minimal U domain's boundary.
UMax: Where to put the maximal U domain's boundary.
VMin: Where to put the minimal V domain's boundary.
VMax: Where to put the maximal V domain's boundary.

Returns: void

Description: Returns the parametric domain of a Bspline surface.

See also: CagdSrfDomain, TrimSrfDomain,

3.2.134  BspSrfEvalAtParam (sbspeval.c:49)

CagdRType *BspSrfEvalAtParam(const CagdSrfStruct *Srf, 

CagdRType u, 
CagdRType v)

Srf: Surface to evaluate at the given (u, v) location.
u, v: Location where to evaluate the surface.

Returns: A vector holding all the coefficients of all components of curve Crv's point type. If for example the curve's point type is P2, the W, X, and Y will be saved in the first three locations of the returned vector. The first location (index 0) of the returned vector is reserved for the rational coefficient W and XYZ always starts at second location of the returned vector (index 1). This vector is allocated statically and a second invocation of this function will overwrite the first.

Description: Evaluates the given tensor product Bspline surface at a given point, by extracting an isoparametric curve along u from the surface and evaluating the curve at parameter v.

See also: CagdSrfEval, BzrSrfEvalAtParam, BspSrfEvalAtParam2, TrimSrfEval,
3.2.135 BspSrfEvalAtParam2 (sbspeval.c:194)

```
CagdRType *BspSrfEvalAtParam2(const CagdSrfStruct *Srf, 
    CagdRType u, 
    CagdRType v)
```

- **Srf**: Surface to evaluate at the given (u, v) location.
- **u, v**: Location where to evaluate the surface.

**Returns**: A vector holding all the coefficients of all components of curve Crv's point type. If for example the curve's point type is P2, the W, X, and Y will be saved in the first three locations of the returned vector. The first location (index 0) of the returned vector is reserved for the rational coefficient W and XYZ always starts at second location of the returned vector (index 1). This vector is allocated statically and a second invocation of this function will overwrite the first.

**Description**: This function is the same as BspSrfEvalAtParam above. Cleaner, but much less efficient. Evaluates the given tensor product Bspline surface at a given point, by extracting an isoparametric curve along u from the surface and evaluating the curve at parameter v.

**See also**: CagdSrfEval, BzrSrfEvalAtParam, BspSrfEvalAtParam, TrimSrfEval,

3.2.136 BspSrfExtension (bsp_gen.c:1037)

```
CagdSrfStruct *BspSrfExtension(const CagdSrfStruct *OrigSrf, 
    const CagdBType *ExtDirs, 
    CagdRType EpsilonU, 
    CagdRType EpsilonV, 
    CagdBType RemoveExtraKnots)
```

- **OrigSrf**: The surface to be extended.
- **ExtDirs**: A vector of four boolean values to set the extension directions. The convention is MinU, MinV, MaxU, MaxV. if NULL, all four directions are extended.
- **EpsilonU**: The length of the extension in the u direction.
- **EpsilonV**: The length of the extension in the v direction.
- **RemoveExtraKnots**: If FALSE, the resulting surface will not have minimal multiplicity at the first internal knot on the extension side. This is boolean controls all extensions that were performed, one decision for all of them.

**Returns**: The new extended surface.

**Description**: Extension of a B-spline surface, in any (or more than one) of the four optional directions of the 2D domain. The domain is extended, such that the trace coincides with the original trace over the original domain. Assumes open end conditions (in both knot vectors u and v).

**See also**: BspCrvExtensionOneSide, BspCrvExtraKnotRmv,

3.2.137 BspSrfFitLstSqr (sbsp_int.c:366)

```
CagdSrfStruct *BspSrfFitLstSqr(const CagdSrfStruct *Srf, 
    int UOrder, 
    int VOrder, 
    int USize, 
    int VSize, 
    CagdParametrizationType ParamType, 
    CagdRType *Err)
```

- **Srf**: Surface to fit a new surface to.
- **UOrder**: Of the to be created surface.
- **VOrder**: Of the to be created surface.
- **USize**: U size of the to be created surface.
- **VSize**: V size of the to be created surface.
- **ParamType**: Type of parametrization.
Err: The maximum error is updated into here

Returns: Fitted surface.

Description: Fits a surface to the give surface by sampling points on Srf and fitting a surface of orders U/Order and U/VSize control points. Error is measured by the difference between the original and the fitted surface, as maximum error norm.

See also: BspSrfInterpPts,

3.2.138 BspSrfHasBezierKVs (bsp_knot.c:47)

CagdBType BspSrfHasBezierKVs(const CagdSrfStruct *Srf)

Srf: To check for KVs that mimics Bezier polynomial surface.

Returns: TRUE if same as Bezier surface, FALSE otherwise.

Description: Returns TRUE iff the given surface has no interior knot open end KVs.

3.2.139 BspSrfHasC1Discont (bspeval.c:483)

CagdBType BspSrfHasC1Discont(const CagdSrfStruct *Srf)

Srf: To examine for C^1 discontinuity curves.

Returns: True if Srf has C^1 discontinuities, false otherwise. curves.

Description: Examines if the given Bspline surface has C^1 discontinuities. This routine detects potential discontinuities in the control mesh by seeking knots of Order-1 multiplicity. Only potential discontinuities that materialize as real (by examining the mesh itself along that line) are reported as true.

See also: BspSrfC1DiscontCrvs, BspKnotAllC1Discont, BspSrfIsC1DiscontAt,

3.2.140 BspSrfHasOpenEC (bsp_knot.c:108)

CagdBType BspSrfHasOpenEC(const CagdSrfStruct *Srf)

Srf: To check for open end conditions.

Returns: TRUE, if surface has open end conditions, FALSE otherwise.

Description: Returns TRUE iff the given B-spline surface has open end conditions.

3.2.141 BspSrfHasOpenECDir (bsp_knot.c:132)

CagdBType BspSrfHasOpenECDir(const CagdSrfStruct *Srf, CagdSrfDirType Dir)

Srf: To check for open end conditions.

Dir: Either the U or the V parametric direction.

Returns: TRUE, if surface has open end conditions, FALSE otherwise.

Description: Returns TRUE iff the given B-spline surface has open end conditions in the specified direction.

3.2.142 BspSrfIntegrate (bsbsp_aux.c:1027)

CagdSrfStruct *BspSrfIntegrate(const CagdSrfStruct *Srf, CagdSrfDirType Dir)

Srf: Surface to integrate.

Dir: Direction of integration. Either U or V.

Returns: Integrated surface.

Description: Returns a new Bspline surface, equal to the integral of the given Bspline srf. The given Bspline surface should be nonrational.

See also: BsrSrfIntegrate, BspCrvIntegrate, CagdSrfIntegrate,
3.2.143  BspSrfInterpPts (sbsp_int.c:105)

CagdSrfStruct *BspSrfInterpPts(const CagdPtStruct **PtList,
   int UOrder,
   int VOrder,
   int SrfUSize,
   int SrfVSize,
   CagdParameterizationType ParamType)

PtList: A NULL terminating array of linked list of points.
UOrder: Of the to be created surface.
VOrder: Of the to be created surface.
SrfUSize: U size of the to be created surface. Must be at least as large as the array PtList.
SrfVSize: V size of the to be created surface. Must be at least as large as the length of each list in PtList.
ParamType: Type of parametrization.

Returns: Constructed interpolating/approximating surface.

Description: Given a set of points, PtList, computes a Bspline surface of order UOrder by VOrder that interpolates or least square approximates the given set of points. PtList is a NULL terminated array of linked lists of CagdPtStruct structs. All linked lists in PtList must have the same length. U direction of surface is associated with array, V with the linked lists. The size of the control mesh of the resulting Bspline surface defaults to the number of points in PtList (if SrfUSize = SrfVSize = 0). However, either numbers can smaller to yield a least square approximation of the given data set. The created surface can be parametrized as specified by ParamType.

3.2.144  BspSrfInterpScatPts (sbsp_int.c:466)

CagdSrfStruct *BspSrfInterpScatPts(const CagdCtlPtStruct *PtList,
   int UOrder,
   int VOrder,
   int USize,
   int VSize,
   CagdRType *UKV,
   CagdRType *VKV)

PtList: A NULL terminating array of linked list of points.
UOrder: Of the to be created surface.
VOrder: Of the to be created surface.
USize: U size of the to be created surface.
VSize: V size of the to be created surface.
UKV: Expected knot vector in U direction, NULL for uniform open.
VKV: Expected knot vector in V direction, NULL for uniform open.

Returns: Constructed interpolating/approximating surface.

Description: Given a set of scattered points, PtList, computes a Bspline surface of order UOrder by VOrder that interpolates or least square approximates the given set of scattered points. PtList is a NULL terminated lists of CagdCtlPtStruct structs, with each point holding (u, v, x [, y[, z]]). That is, E3 points create an E1 scalar surface and E5 points create an E3 surface.

3.2.145  BspSrfInterpScatPts2 (sbsp_int.c:615)

CagdSrfStruct *BspSrfInterpScatPts2(const CagdCtlPtStruct *PtList,
   int UOrder,
   int VOrder,
   int USize,
   int VSize,
   CagdRType *UKV,
   CagdRType *VKV,
   CagdRType *MatrixCondition)
PtList: A NULL terminating array of linked list of points.

UOrder: Of the to be created surface.

VOrder: Of the to be created surface.

USize: U size of the to be created surface.

VSize: V size of the to be created surface.

UKV: Expected knot vector in U direction, NULL for uniform open.

VKV: Expected knot vector in V direction, NULL for uniform open.

MatrixCondition: address of a IrtRType to return SVD matrix condition number to. if NULL, this option is ignored

Returns: Constructed interpolating/approximating surface.

Description: This function is a variation BspSrfInterpScatPts function that is less accurate/stable but is faster. The difference is that we solve a LSQ problem as $A' \cdot A \cdot \text{Vertices} = A' \cdot \text{points}$ where $A'$ is the transpose matrix of $A$. This method is also referred to as pseudo inverse. The SVD decomposition is still used to calculate the above equation set. Given a set of scattered points, PtList, the function computes a Bspline surface of order UOrder by VOrder that interpolates or least square approximates the M given set of scattered points. PtList is a NULL terminated lists of CagdPtStruct structs, with each point holding $(u, v, x[, y[, z]])$. That is, E3 points create an E1 scalar surface and E5 points create an E3 surface.

3.2.146 BspSrfInterpolate (sbssp_int.c:242)

CagdSrfStruct *BspSrfInterpolate(const CagdCtlPtStruct *PtList,
 int NumUPts,
 int NumVPts,
 const CagdRType *UParams,
 const CagdRType *VParams,
 const CagdRType *UKV,
 const CagdRType *VKV,
 int ULength,
 int VLength,
 int UOrder,
 int VOrder)

PtList: A long linked list (NumUPts * NumVPts) of points to interpolated or least square approximate.

NumUPTs: Number of points in PtList in the U direction.

NumVPTs: Number of points in PtList in the V direction.

UParams: Parameter at which surface should interpolate or approximate PtList in the U direction.

VParams: Parameter at which surface should interpolate or approximate PtList in the V direction.

UKV: Requested knot vector form the surface in the U direction.

VKV: Requested knot vector form the surface in the V direction.

ULength: Requested length of control mesh of surface in U direction.

VLength: Requested length of control mesh of surface in V direction.

UOrder: Requested order of surface in U direction.

VOrder: Requested order of surface in V direction.

Returns: Constructed interpolating/approximating surface.

Description: Given a set of points on a rectangular grid, PtList, parameter values the surface should interpolate or approximate these grid points, U/VParams, the expected two knot vectors of the surface, U/VKV, the expected lengths U/VLength and orders U/VOrder of the Bspline surface, computes the Bspline surface’s coefficients. All points in PtList are assumed of the same type.
3.2.147 BspSrfIsC1DiscontAt (bspeval.c:535)

CagdBType BspSrfIsC1DiscontAt(const CagdSrfStruct *Srf, 
   CagdSrfDirType Dir, 
   CagdRType t)

Srf: Surface to examine for C1 discontinuity.
Dir: Parametric direction to examine at.
t: Parameter value to examine at.

Returns: TRUE if Srf has a C1 discontinuity at parameter t in direction Dir, FALSE otherwise.

Description: Examines the mesh at given parametric location for a C1 discontinuity.
See also: BspSrfC1DiscontCrvs, BspKnotAllC1Discont, BspSrfMeshC1Continuous, , BspSrfHasC1Discont,

3.2.148 BspSrfKnotC0Discont (bsp_gen.c:518)

CagdBType BspSrfKnotC0Discont(const CagdSrfStruct *Srf, 
   CagdSrfDirType Dir, 
   CagdRType *t)

Srf: To examine its potential discontinuity across Dir.
Dir: Direction to examine the discontinuity across.
t: Where to put the parameter value (knot) that can be C0 discontinuous.

Returns: TRUE if found a C0 discontinuity, FALSE otherwise.

Description: Scans the given knot vector of the given surface for a potential C0 discontinuity. Looks for multiplicities in the knot sequence and then examine the mesh if indeed the mesh is discontinuous at that location. Assumes knot vectors has open end condition.
See also: BspSrfKnotC1Discont, BspKnotC1Discont, BspSrfMeshC1Continuous,

3.2.149 BspSrfKnotC1Discont (bsp_gen.c:554)

CagdBType BspSrfKnotC1Discont(const CagdSrfStruct *Srf, 
   CagdSrfDirType Dir, 
   CagdRType *t)

Srf: To examine its potential discontinuity across Dir.
Dir: Direction to examine the discontinuity across.
t: Where to put the parameter value (knot) that can be C1 discontinuous.

Returns: TRUE if found a C1 discontinuity, FALSE otherwise.

Description: Scans the given knot vector of the given surface for a potential C1 discontinuity. Looks for multiplicities in the knot sequence and then examine the mesh if indeed the mesh is discontinuous at that location. Assumes knot vectors has open end condition.
See also: BspSrfKnotC0Discont, BspKnotC1Discont, BspSrfMeshC1Continuous,

3.2.150 BspSrfKnotInsert (bspboehm.c:143)

CagdSrfStruct *BspSrfKnotInsert(const CagdSrfStruct *Srf, 
   CagdSrfDirType Dir, 
   CagdRType t)

Srf: To refine by adding a new knot with value equal to t. If Srf is a periodic curve, it is first unwrapped to a float end condition curve.
Dir: Of refinement, either U or V.
t: New knot to insert into Srf.

Returns: The refined surface.

Description: Returns a new surface refined at t (t is inserted as a new knot in Srf) in parametric direction Dir. See BspCrvKnotInsert for the mathematical background of this knot insertion algorithm.
See also: BspSrfKnotInsertNSame, BspSrfKnotInsertNDiff, BspCrvKnotInsert, BspKnotEvalAlphaCoef,
3.2.151  BspSrfKnotInsertNDiff (sbsp_aux.c:430)

CagdSrfStruct *BspSrfKnotInsertNDiff(const CagdSrfStruct *Srf,
CagdSrfDirType Dir,
int Replace,
CagdRType *t,
int n)

Srf: To refine by insertion (upto) n knot of value t.
Dir: Direction of refinement. Either U or V.
Replace: if TRUE, the n knots in t should replace the knot vector of size n of Srf. Sizes must match. If False, n new knots as defined by t will be introduced into Srf.
t: New knots to introduce/replace knot vector of Srf.
n: Size of t.
Returns: Refined Srf with n new knots in direction Dir.

Description: Inserts n knot with different values as defined by the vector t. If, however, Replace is TRUE, the knot are simply replacing the current knot vector.

3.2.152  BspSrfKnotInsertNSame (sbsp_aux.c:357)

CagdSrfStruct *BspSrfKnotInsertNSame(const CagdSrfStruct *Srf,
CagdSrfDirType Dir,
CagdRType t,
int n)

Srf: To refine by insertion (upto) n knot of value t.
Dir: Direction of refinement. Either U or V.
t: Parameter value of new knot to insert.
n: Maximum number of times t should be inserted.
Returns: Refined Srf with n knots of value t in direction Dir.

Description: Inserts n knot, all with the value t in direction Dir. In no case will the multiplicity of a knot be greater or equal to the curve order.

3.2.153  BspSrfMaxCoefParam (bsp_knot.c:1790)

CagdRType *BspSrfMaxCoefParam(const CagdSrfStruct *Srf,
int Axis,
CagdRType *MaxVal)

Srf: To compute the parameter node value of the largest coefficient.
Axis: Which axis should we search for maximal coefficient? 1 for X, 2 for Y, etc.
MaxVal: The coefficient itself will be place herein.
Returns: The node UV parameter values of the detected maximal coefficient.

Description: Finds the parameter value with the largest coefficient of the surface using nodes values to estimate the coefficients’ parameters. Returns a pointer to a static array of two elements holding U and V.

3.2.154  BspSrfMeshC1Continuous (bsp_gen.c:587)

CagdBType BspSrfMeshC1Continuous(const CagdSrfStruct *Srf,
CagdSrfDirType Dir,
int Idx)

Srf: To examine its potential discontinuity across Dir.
Dir: Direction to examine the discontinuity across.
Idx: Index where to examine the discontinuity.
Returns: TRUE if continuous there, FALSE otherwise.

Description: Examine the mesh of the given surface across direction Dir in index of mesh Index for a real discontinuity in the mesh. This index will typically be for a knot multiplicity potential discont.
See also: BspKnotC1Discont, BspSrfIsC1DiscontAt,
3.2.155  **BspSrfMeshNormals** (sbsp\_aux.c:1267)

```
CagdVecStruct *BspSrfMeshNormals(const CagdSrfStruct *Srf,
   int UFineNess,
   int VFineNess)
```

- **Srf**: To compute normals on a grid of its parametric domain.
- **UFineNess**: U Fineness of imposed grid on Srf’s parametric domain.
- **VFineNess**: V Fineness of imposed grid on Srf’s parametric domain.

**Returns**: An vector of unit normals (u increments first).

**Description**: Evaluates the unit normals of a surface at a mesh defined by subdividing the parametric space into a grid of size UFineNess by VFineNess. The normals are saved in a linear CagdVecStruct vector which is allocated dynamically. Data is saved u inc. first. This routine is much faster than evaluating normal for each point, individually.

**See also**: CagdSrfNormal, BspSrfNormal, SymbSrfNormalSrf, BzrSrfMeshNormals,

3.2.156  **BspSrfMeshNormalsSymb** (sbsp\_aux.c:1571)

```
CagdVecStruct *BspSrfMeshNormalsSymb(CagdSrfStruct *Srf,
   int UFineNess,
   int VFineNess)
```

- **Srf**: To compute normals on a grid of its parametric domain.
- **UFineNess**: U Fineness of imposed grid on Srf’s parametric domain.
- **VFineNess**: V Fineness of imposed grid on Srf’s parametric domain.

**Returns**: An vector of unit normals (u increments first).

**Description**: Evaluates the unit normals of a surface at a mesh defined by subdividing the parametric space into a grid of size UFineNess by VFineNess. The normals are saved in a linear CagdVecStruct vector which is allocated dynamically. Data is saved u inc. first. This routine is much faster than evaluating normal for each point, individually.

**See also**: CagdSrfNormal, BspSrfNormal, SymbSrfNormalSrf, BzrSrfMeshNormals,

3.2.157  **BspSrfMoebiusTransform** (sbsp\_aux.c:1645)

```
CagdSrfStruct *BspSrfMoebiusTransform(const CagdSrfStruct *CSrf,
   CagdType c,
   CagdSrfDirType Dir)
```

- **CSrf**: Surface to apply the Moebius transformation to.
- **c**: The scaling coefficient - $c^{-n}$ is the ratio between the first and last weight of the surface, along each row or column. If c == 0, the first and last weights are made equal, in the first row/column.
- **Dir**: Direction to apply the Moebius transformation, row or col. If Dir == CAGD\_BOTH\_DIR, the transformation is applied to both the row and column directions, in this order.

**Returns**: The modified surface with the same shape but different speeds.


**See also**: BspCrvMoebiusTransform, BzrSrfMoebiusTransform,
3.2.158 BspSrfNew (bsp_gen.c:38)

CagdSrfStruct *BspSrfNew(int ULength,
    int VLength,
    int UOrder,
    int VOrder,
    CagdPointType PType)

ULength: Number of control points in the U direction.
VLength: Number of control points in the V direction.
UOrder: The order of the surface in the U direction.
VOrder: The order of the surface in the V direction.
PType: Type of control points (E2, P3, etc.).

Returns: An uninitialized freeform Be spline surface.

Description: Allocates the memory required for a new Be spline surface.
See also: BzrSrfNew, BspPeriodicSrfNew, CagdSrfNew, CagdPeriodicSrfNew, TrimSrfNew,

3.2.159 BspSrfNormal (sbsp_aux.c:1204)

CagdVecStruct *BspSrfNormal(const CagdSrfStruct *Srf,
    CagdRType u,
    CagdRType v,
    CagdBType Normalize)

Srf: Be spline surface to evaluate (unit) normal vector for.
u, v: Parametric location of required (unit) normal.
Normalize: If TRUE, attempt is made to normalize the returned vector. If FALSE, length is a function of
given parametrization.

Returns: A pointer to a static vector holding the (unit) normal information.

Description: Evaluate the (unit) normal of a surface at a given parametric location. If we fail to compute the
normal at given location we retry by moving a tad.
See also: CagdSrfNormal, BzrSrfNormal, BspSrfMeshNormals, SymbSrfNormalSrf,

3.2.160 BspSrfOpenEnd (bsp_gen.c:322)

CagdSrfStruct *BspSrfOpenEnd(const CagdSrfStruct *Srf)

Srf: To convert to a new surface with open end conditions. Input can also be periodic.

Returns: Same surface as Srf but with open end conditions.

Description: Returns a surface with open end conditions, similar to given surface. Open end surface is computed
by extracting a subregion from Srf that is the entire surface's parametric domain, by inserting multiple knots at the
domain's boundary.
See also: BspCrvOpenEnd,

3.2.161 BspSrfSubdivAtParam (sbsp_aux.c:67)

CagdSrfStruct *BspSrfSubdivAtParam(const CagdSrfStruct *Srf,
    CagdRType t,
    CagdSrfDirType Dir)

Srf: To subdivide at parameter value t.
t: Parameter value to subdivide Srf at.
Dir: Direction of subdivision. Either U or V.

Returns: A list of the two subdivided surfaces.

Description: Given a Be spline surface - subdivides it into two sub-surfaces at the given parametric value. Returns
pointer to first surface in a list of two subdivided surfaces.
See also: CagdSrfSubdivAtParam, BzrSrfSubdivAtParam, TrimSrfSubdivAtParam,
### 3.2.162 BspSrfTangent (sbsp_aux.c:1154)

```c
CagdVecStruct *BspSrfTangent(const CagdSrfStruct *Srf,
CagdRType u,
CagdRType v,
CagdSrfDirType Dir,
CagdBType Normalize)
```

**Srf**: Bspline surface to evaluate (unit) tangent vector for.

**u, v**: Parametric location of required (unit) tangent.

**Dir**: Direction of tangent vector. Either U or V.

**Normalize**: If TRUE, attempt is made to normalize the returned vector. If FALSE, length is a function of given parametrization.

**Returns**: A pointer to a static vector holding the (unit) tangent information.

**Description**: Evaluates the (unit) tangent to a surface at a given parametric location (u, v) and given direction Dir.

**See also**: CagdSrfTangent, BzrSrfTangent,

### 3.2.163 BspVecSpreadEqualItems (bsp_knot.c:2657)

```c
int BspVecSpreadEqualItems(CagdRType *Vec, int Len, CagdRType MinDist)
```

**Vec**: Vector of reals to spread (almost) equal items in. Modified in place.

**Len**: Length of vector Vec.

**MinDist**: The minimal distance two adjacent item should have.

**Returns**: TRUE if successful, FALSE if cannot be done (MinDist too large).

**Description**: Given a monotone vector of reals, spread (almost) equal items so they are MinDist apart while keeping the minimal and maximal values the same.

### 3.2.164 BzrCrv2Polyline (bzr2poly.c:1159)

```c
CagdPolylineStruct *BzrCrv2Polyline(const CagdCrvStruct *Crv,
int SamplesPerCurve)
```

**Crv**: To approximate as a polyline.

**SamplesPerCurve**: Number of samples to approximate with.

**Returns**: A polyline representing the piecewise linear approximation from, or NULL in case of an error.

**Description**: Routine to approx. a single Bezier curve as a polyline with SamplesPerCurve samples. Polyline is always E3 CagdPolylineStruct type. Curve is sampled equally spaced in parametric space. NULL is returned in case of an error, otherwise CagdPolylineStruct.

**See also**: BspCrv2Polyline, BzrSrf2Polylines, IritCurve2Polylines, , SymbCrv2Polyline,

### 3.2.165 BzrCrvBiNormal (cbzr_aux.c:578)

```c
CagdVecStruct *BzrCrvBiNormal(const CagdCrvStruct *Crv,
CagdRType t,
CagdBType Normalize)
```

**Crv**: Crv for which to compute a (unit) binormal.

**t**: The parameter at which to compute the unit binormal.

**Normalize**: If TRUE, attempt is made to normalize the returned vector. If FALSE, length is a function of given parametrization.

**Returns**: A pointer to a static vector holding the binormal information.

**Description**: Returns a (unit) vector, equal to the binormal to Crv at parameter value t. Algorithm: insert (order - 1) knots and using 3 consecutive control points at the refined location (p1, p2, p3), compute to binormal to be the cross product of the two vectors (p1 - p2) and (p2 - p3). Since a curve may have not BiNormal at inflection points or if the 3 points are collinear, NULL will be returned at such cases.
3.2.166  BzrCrvCreateArc  (cagd_arc.c:50)

CagdCrvStruct *BzrCrvCreateArc(const CagdPtStruct *Start, 
    const CagdPtStruct *Center, 
    const CagdPtStruct *End)

Start:  Point of beginning of arc.
Center: Point of arc.
End:  Point of end of arc.

Returns: A rational quadratic Bezier curve representing the arc.

Description: Creates an arc at the specified position as a rational quadratic Bezier curve. The arc is assumed to be less than 180 degrees from Start to End in the shorter path as arc where Center as arc center.

See also: BspCrvCreateCircle, BspCrvCreateUnitCircle, BspCrvCreatePCircle, CagdCreateConicCurve, CagdCrvCreateArc, BspCrvCreateUnitPCircle, CagdCrvCreateArcCCW, CagdCrvCreateArcCW,

3.2.167  BzrCrvDegreeRaise  (cbzr_aux.c:253)

CagdCrvStruct *BzrCrvDegreeRaise(const CagdCrvStruct *Crv)

Crv: To raise its degree by one.

Returns: A curve of one order higher representing the same geometry as Crv.

Description: Returns a new curve, identical to the original but with one degree higher. Let old control polygon be P(i), i = 0 to k-1, and Q(i) be new one. Then:

\[
Q(0) = P(0), \quad Q(i) = \frac{i}{k} P(i-1) + \frac{k-i}{k} P(i), \quad Q(k) = P(k-1).
\]

See also: BzrCrvDegreeReduce, BzrCrvDegreeRaiseN, PwrCrvDegreeRaise,

3.2.168  BzrCrvDegreeRaiseN  (cbzr_aux.c:205)

CagdCrvStruct *BzrCrvDegreeRaiseN(const CagdCrvStruct *Crv, int NewOrder)

Crv: To raise its degree to a NewOrder.
NewOrder: NewOrder for Crv.

Returns: A curve of order NewOrder representing the same geometry as Crv.

Description: Returns a new curve, identical to the original but with order NewOrder. Degree raise is computed by multiplying by a constant 1 curve of order

See also: BzrCrvDegreeRaise, PwrCrvDegreeRaiseN,

3.2.169  BzrCrvDegreeReduce  (cbzr_aux.c:324)

CagdCrvStruct *BzrCrvDegreeReduce(const CagdCrvStruct *Crv)

Crv: To reduce its degree by one.

Returns: A curve of one order lower representing a similar geometry to Crv. The result is optimal in the infinity norm and will be identical to the given curve if the original curve was degree raised.

Description: Returns a new curve, usually similar to the original but with one degree smaller. Let old control polygon be P(i), i = 0 to n, and Q(i) be new one. Then:

\[
Q_r(i) = \frac{n P(i) - i Q_r(i-1)}{n - i}, \quad i = 0, 1, \ldots, n - 1.
\]

See also:
\[ Q_{l(i-1)} = \frac{n P(i) - (n - i) Q_{l(i)}}{i}, \quad i = n, n - 1, \ldots, 1. \]

and

\[
g(i) = \frac{\sum_{j=0}^{2n-1} \binom{2n}{2j} \frac{1}{(2n-1)^{2j}}}{2n^{2j}}\]

yielding,

\[ Q(i) = (1 - g(i)) Q_{r(i)} + g(i) Q_{l(i)}. \]


See also: BzrCrvDegreeRaise,

### 3.2.170 BzrCrvDerive (cbzr_aux.c:727)

CagdCrvStruct *BzrCrvDerive(const CagdCrvStruct *Crv)

**Crv:** To differentiate.

**Returns:** Differentiated curve.

**Description:** Returns a new curve, equal to the given curve, differentiated once. Let old control polygon be \( P(i), i = 0 \) to \( k-1 \), and \( Q(i) \) be new one then:

\[ Q(i) = (k - 1) \* (P(i+1) - P(i)), \quad i = 0 \text{ to } k-2. \]

See also: CagdCrvDerive, BspCrvDerive, BzrCrvDeriveRational, BspCrvDeriveRational, BzrCrvDeriveScalar, BspCrvDeriveScalar.

### 3.2.171 BzrCrvDeriveScalar (cbzr_aux.c:777)

CagdCrvStruct *BzrCrvDeriveScalar(const CagdCrvStruct *Crv)

**Crv:** To differentiate.

**Returns:** Differentiated curve.

**Description:** Returns a new curve, equal to the given curve, differentiated once. Let old control polygon be \( P(i), i = 0 \) to \( k-1 \), and \( Q(i) \) be new one then:

\[ Q(i) = \frac{(k - 1) \* (P(i+1) - P(i))}{Kv(i + k) - Kv(i + 1)}, \quad i = 0 \text{ to } k-2. \]

For a Euclidean curve this is the same as CagdCrvDerive but for a rational curve the returned curve is not the vector field but simply the derivatives of all the curve's coefficients, including the weights.

See also: BzrCrvDerive, CagdCrvDerive, BzrCrvDeriveRational, BspCrvDeriveRational, BspCrvDerive, BzrCrvDeriveScalar, CagdCrvDeriveScalar,
3.2.172 BzrCrvEvalAtParam (cbzreval.c:150)

CagdRType *BzrCrvEvalAtParam(const CagdCrvStruct *Crv, CagdRType t)

Crv: To evaluate at the given parametric location t.

Returns: A vector holding all the coefficients of all components of curve Crv’s point type. If for example the curve’s point type is P2, the W, X, and Y will be saved in the first three locations of the returned vector. The first location (index 0) of the returned vector is reserved for the rational coefficient W and XYZ always starts at second location of the returned vector (index 1). This vector is allocated statically and a second invocation of this function will overwrite the first.

Description: Returns a pointer to a static data, holding the value of the curve at given parametric location t. The curve is assumed to be Bezier.

See also: CagdCrvEval, BspCrvEvalAtParam, BspCrvEvalVecAtParam, BzrCrvEvalVecAtParam, BspCrvEvalCoxDeBoor, CagdCrvEvalToPolyline,

3.2.173 BzrCrvEvalAtParam2 (cbzreval.c:202)

CagdRType *BzrCrvEvalAtParam2(CagdCrvStruct *Crv, CagdRType t)

Crv: To evaluate at the given parametric location t.

Returns: A vector holding all the coefficients of all components of curve Crv’s point type. If for example the curve’s point type is P2, the W, X, and Y will be saved in the first three locations of the returned vector. The first location (index 0) of the returned vector is reserved for the rational coefficient W and XYZ always starts at second location of the returned vector (index 1). This vector is allocated statically and a second invocation of this function will overwrite the first.

Description: Returns a pointer to a static data, holding the value of the curve at given parametric location t. The curve is assumed to be Bezier.

See also: CagdCrvEval, BspCrvEvalAtParam, BspCrvEvalVecAtParam, BzrCrvEvalVecAtParam, BspCrvEvalCoxDeBoor, CagdCrvEvalToPolyline,

3.2.174 BzrCrvEvalBasisFunc (cbzreval.c:319)

CagdRType BzrCrvEvalBasisFunc(int i, int k, CagdRType t)

i: I’th basis function.

k: Order of the basis function.

t: Parameter value at which to evaluate the Bezier basis function.

Returns: Value of basis function.

Description: Evaluates the i’th Bezier basis function of order k, at parametric value t (t in [0..1]).

The functions is: i i k - i - 1

\[ B_{i,k-1}(t) = \binom{k}{i} \cdot t \cdot (1 - t) \]

See also: BzrCrvEvalBasisFuncs,

3.2.175 BzrCrvEvalBasisFuncs (cbzreval.c:351)

CagdRType *BzrCrvEvalBasisFuncs(int k, CagdRType t)

k: Order of the basis function.

t: Parameter value at which to evaluate the Bezier basis function.

Returns: Value of basis function’s vector (allocated statically).

Description: Evaluates the vector of Bezier basis functions of order k, at parametric value t (t in [0..1]).

The functions are:

\[ B_{i,k-1}(t) = \binom{k}{i} \cdot t \cdot (1 - t) \]

See also: BzrCrvEvalBasisFunc,
3.2.176 BzrCrvEvalToPolyline (cbzreval.c:256)

void BzrCrvEvalToPolyline(const CagdCrvStruct *Crv,
                          int Fineness,
                          CagdRType *Points[])

Crv: To approximate as a polyline.
Finess: Control on number of samples.
Points: Where to put the resulting polyline.
Returns: void

Description: Samples the curve at Fineness locations equally spaced in the curve’s parametric domain.
See also: CagdCrvEval, BspCrvEvalAtParam, BzrCrvEvalVecAtParam, , BspCrvEvalVecAtParam, BspCrvEvalCoxDeBoor, CagdCrvEvalToPolyline,

3.2.177 BzrCrvEvalVecAtParam (cbzreval.c:102)

CagdRType BzrCrvEvalVecAtParam(const CagdRType *Vec,
                                 int VecInc,
                                 int Order,
                                 CagdRType t,
                                 CagdRType *BasisFuncs)

Vec: Coefficients of a scalar Bspline univariate function.
VecInc: Step to move along Vec.
Order: Order of associated geometry.
t: Parameter value where to evaluate the curve.
BasisFuncs: Optional basis functions, if not NULL, in which case t is ignored.
Returns: Geometry’s value at parameter value t.

Description: Assumes Vec holds control points for scalar bezier curve of order Order, and evaluates and returns
that curve value at parameter value t. Vec is incremented by VecInc (usually by 1) after each iteration.
See also: CagdCrvEval, BspCrvEvalAtParam, BzrCrvEvalAtParam, , BspCrvEvalVecAtParam, BspCrvEval-
CoxDeBoor, CagdCrvEvalToPolyline,

3.2.178 BzrCrvIntegrate (cbzr_aux.c:824)

CagdCrvStruct *BzrCrvIntegrate(const CagdCrvStruct *Crv)

Crv: Curve to integrate.
Returns: Integrated curve.

Description: Returns a new Bezier curve, equal to the integral of the given Bezier crv. The given Bezier curve
should be non-rational.

\[
\begin{array}{cccccc}
& n & & n & & n+1 \\
/ & - & & - & - & P \\
| C(t) = | / P B(t) = / P B(t) = / ----- B(t) = \\
| \begin{array}{cccc}
 i=0 & i=0 & i=0 & j=i+1 \\
/ \begin{array}{cccc}
 n & i & i & j \\
 \begin{array}{cccc}
 \begin{array}{cccc}
 i=0 & i=0 & j=i+1 \\
 n & j=1 & i=0 \\
 \end{array}
\end{array}
\end{array}\end{array}
\end{array}
\]

\[
\begin{array}{cccccc}
& n & & n & & n+1 \\
/ & - & & - & - & P \\
| C(t) = | / P B(t) = / P B(t) = / ----- B(t) = \\
| \begin{array}{cccc}
 i=0 & i=0 & i=0 & j=i+1 \\
/ \begin{array}{cccc}
 n & i & i & j \\
 \begin{array}{cccc}
 \begin{array}{cccc}
 i=0 & i=0 & j=i+1 \\
 n & j=1 & i=0 \\
 \end{array}
\end{array}
\end{array}
\end{array}\end{array}
\end{array}
\]

See also: BspCrvIntegrate, BzrSrfIntegrate, CagdCrvIntegrate,
### 3.2.179 BzrCrvInterp2 (bzr_intr.c:453)

```c
int BzrCrvInterp2(IrtRType *Result, const IrtRType *Input, int Size)
```

**Result:** Where the interpolated control points will be placed.

**Input:** Points to interpolate at node parameter values.

**Size:** Of control polygon. Same as the Bezier order.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Interpolates the given Input data sets at node points and place the Bezier coefficients in Result.

### 3.2.180 BzrCrvMoebiusTransform (cbzr_aux.c:996)

```c
CagdCrvStruct *BzrCrvMoebiusTransform(const CagdCrvStruct *CCrv, CagdRType c)
```

**CCrv:** Curve to apply the Moebius transformation to.

**c:** The scaling coefficient - c^n is the ratio between the first and last weight of the curve. If c == 0, the first and last weights are made equal.

**Returns:** The modified curve with the same shape but different speed.

**Description:** Apply the Moebius transformation to a rational Bezier curve.

**See also:** BspCrvMoebiusTransform, BzrSrfMoebiusTransform,

### 3.2.181 BzrCrvNew (bzr_gen.c:61)

```c
CagdCrvStruct *BzrCrvNew(int Length, CagdPointType PType)
```

**Length:** Number of control points

**PType:** Type of control points (E2, P3, etc.).

**Returns:** An uninitialized freeform Bezier curve.

**Description:** Allocates the memory required for a new Bezier curve.

**See also:** BspCrvNew, BspPeriodicCrvNew, CagdCrvNew, CagdPeriodicCrvNew, TrimCrvNew, PwrCrvNew,

### 3.2.182 BzrCrvNormal (cbzr_aux.c:689)

```c
CagdVecStruct *BzrCrvNormal(const CagdCrvStruct *Crv, CagdRType t, CagdBType Normalize)
```

**Crv:** Crv for which to compute a (unit) normal.

**t:** The parameter at which to compute the unit normal.

**Normalize:** If TRUE, attempt is made to normalize the returned vector. If FALSE, length is a function of given parametrization.

**Returns:** A pointer to a static vector holding the normal information.

**Description:** Returns a (unit) vector, equal to the normal of Crv at parameter value t. Algorithm: returns the cross product of the curve tangent and binormal.

### 3.2.183 BzrCrvSetCache (cbzreval.c:37)

```c
void BzrCrvSetCache(int FineNess, CagdBType EnableCache)
```

**FineNess:** Number of samples to support.

**EnableCache:** Are we really planning on using this thing?

**Returns:** void

**Description:** Sets the bezier sampling cache - if enabled, a Bezier can be evaluated directly from presampled basis function.
3.2.184  BzrCrvSubdivAtParam (cbzrAux.c:168)

CagdCrvStruct *BzrCrvSubdivAtParam(const CagdCrvStruct *Crv, CagdRType t)

Crv: To subdivide at parameter value t.

\[ t: \text{Parameter value to subdivide Crv at.} \]

\[ \text{Returns: A list of the two subdivided curves.} \]

\[ \text{Description: Given a Bezier curve - subdivides it into two sub-curves at the given parametric value. Returns} \]

\[ \text{pointer to first curve in a list of two subdivided curves.} \]

\[ \text{See also: BzrSubdivCtlPoly, BspCrvSubdivAtParam,} \]

3.2.185  BzrCrvSubdivCtlPoly (cbzrAux.c:48)

\[ \text{void BzrCrvSubdivCtlPoly(CagdRType * const *Points,} \]

\[ \text{CagdRType **LPoints,} \]

\[ \text{CagdRType **RPoints,} \]

\[ \text{int Length,} \]

\[ \text{CagdPointType PType,} \]

\[ \text{CagdRType t)} \]

\[ \text{Points: To subdivide at parameter value t.} \]

\[ \text{LPoints, RPoints: Where the results are kept.} \]

\[ \text{Length: Of this Bezier curve.} \]

\[ \text{PType: Points types we have here.} \]

\[ t: \text{Parameter value to subdivide curve at.} \]

\[ \text{Returns: void} \]

\[ \text{Description: Apply Bezier subdivision to the given curve at parameter value t, and save the result in data} \]

\[ \text{LPoints/RPoints. Note this function could also be called from a B-spline curve with a Bezier knot sequence.} \]

\[ \text{See also: BzrCrvSubdivAtParam, BspCrvSubdivCtlPoly, BzrCrvSubdivCtlPolyStep,} \]

3.2.186  BzrCrvSubdivCtlPolyStep (cbzrAux.c:108)

\[ \text{void BzrCrvSubdivCtlPolyStep(CagdRType * const *Points,} \]

\[ \text{CagdRType **LPoints,} \]

\[ \text{CagdRType **RPoints,} \]

\[ \text{int Length,} \]

\[ \text{CagdPointType PType,} \]

\[ \text{CagdRType t,} \]

\[ \text{int Step)} \]

\[ \text{Points: To subdivide at parameter value t.} \]

\[ \text{LPoints, RPoints: Where the results are kept.} \]

\[ \text{Length: Of this Bezier curve.} \]

\[ \text{PType: Points types we have here.} \]

\[ t: \text{Parameter value to subdivide data at.} \]

\[ \text{Step: Stride along the data, 1 for curves, ULength for a surface subdivision along V.} \]

\[ \text{Returns: void} \]

\[ \text{Description: Apply Bezier subdivision to the given data at parameter value t, and save the result in data} \]

\[ \text{LPoints/RPoints. Note this function could also be called from a B-spline curve with a Bezier knot sequence. This} \]

\[ \text{function is used to Bezier subdivide surfaces (See Step size!).} \]

\[ \text{See also: BzrCrvSubdivAtParam, BspCrvSubdivCtlPoly, BzrCrvSubdivCtlPoly,} \]
3.2.187 BzrCrvTangent (cbzrux.c:400)

CagdVecStruct *BzrCrvTangent(const CagdCrvStruct *Crv, CagdRType t, CagdBType Normalize)

Crv: Crv for which to compute a (unit) tangent.

t: The parameter at which to compute the unit tangent.

Normalize: If TRUE, attempt is made to normalize the returned vector. If FALSE, returned is an unnormalized vector in the right direction of the tangent.

Returns: A pointer to a static vector holding the tangent information.

Description: Returns a (unit) vector, equal to the tangent to Crv at parameter value t. Algorithm: pseudo subdivide Crv at t and using control point of subdivided curve find the tangent as the difference of the 2 end points.

3.2.188 BzrSrf2Curves (bzsrf2poly.c:1089)

CagdCrvStruct *BzrSrf2Curves(const CagdSrfStruct *Srf, int NumOfIsocurves[2])

Srf: To extract isoparametric curves from.

NumOfIsocurves: In reach (U or V) direction

Returns: List of extracted isoparametric curves. These curves inherit the order and continuity of the original Srf. NULL is returned in case of an error.

Description: Routine to extract from a bezier surface NumOfIsoLine isocurve list in each param. direction. Iso parametric curves are sampled equally spaced in parametric space. NULL is returned in case of an error, otherwise list of CagdCrvStruct.

See also: BzrSrf2Polylines, BspSrf2PCurves, SymbSrf2Curves,

3.2.189 BzrSrf2Polygons (bzsrf2poly.c:139)

CagdPolygonStruct *BzrSrf2Polygons(const CagdSrfStruct *Srf, int FineNess, CagdBType ComputeNormals, CagdBType FourPerFlat, CagdBType ComputeUV)

Srf: To approximate into triangles.

FineNess: Control on accuracy, the higher the finer.

ComputeNormals: If TRUE, normal information is also computed.

FourPerFlat: If TRUE, four triangles are created per flat surface. If FALSE, only 2 triangles are created.

ComputeUV: If TRUE, UV values are stored and returned as well.

Returns: A list of polygons with optional normal and/or UV parametric information. NULL is returned in case of an error.

Description: Routine to convert a single Bezier surface to set of triangles approximating it. FineNess is a fineness control on result and the larger is more triangles may result. A value of 10 is a good start value. NULL is returned in case of an error, otherwise list of CagdPolygonStruct.

See also: BspSrf2Polygons, IritSurface2Polygons, IritTrimSrf2Polygons, , CagdSrf2Polygons, TrimSrf2Polygons, CagdSrf2Polygons,
3.2.190 BzrSrf2PolygonsN (bzr2poly.c:188)

CagdPolygonStruct *BzrSrf2PolygonsN(const CagdSrfStruct *Srf,
   int Nu,
   int Nv,
   CagdBType ComputeNormals,
   CagdBType FourPerFlat,
   CagdBType ComputeUV)

Srf: To approximate into triangles.
Nu, Nv: The number of uniform samples in U and V of surface.
ComputeNormals: If TRUE, normal information is also computed.
FourPerFlat: If TRUE, four triangles are created per flat surface. If FALSE, only 2 triangles are created.
ComputeUV: If TRUE, UV values are stored and returned as well.

Returns: A list of polygons with optional normal and/or UV parametric information. NULL is returned in case of an error.

Description: Routine to convert a single freeform surface to set of triangles approximating it using a uniform fixed resolution of Nu x Nv. NULL is returned in case of an error, otherwise list of CagdPolygonStruct.

See also: BzrSrf2Polygons, BspSrf2Polygons, CagdCrv2Polyline, CagdSrf2Polylines, CagdSrf2PolygonStrip, CagdSrf2Polygons,

3.2.191 BzrSrf2PolygonsSamples (bzr2poly.c:826)

int BzrSrf2PolygonsSamples(const CagdSrfStruct *Srf,
   int FineNess,
   CagdBType ComputeNormals,
   CagdBType ComputeUV,
   CagdRType **PtWeights,
   CagdPtStruct **PtMesh,
   CagdVecStruct **PtNrml,
   CagdUVStruct **UVMesh,
   int *FineNessU,
   int *FineNessV)

Srf: To sample in a grid.
FineNess: Control on accuracy, the higher the finer.
ComputeNormals: If TRUE, normal information is also computed.
ComputeUV: If TRUE, UV values are stored and returned as well.
PtWeights: Weights of the evaluations, if rational, to detect poles. NULL if surface not rational.
PtMesh: Evaluated positions of grid of samples.
PtNrml: Evaluated normals of grid of samples or NULL if none.
UVMesh: Evaluated UV vals of grid of samples or NULL if none.


Returns: FALSE is returned in case of an error, TRUE otherwise.

Description: Routine to uniformly sample a single Bezier srf as a grid. FineNess is a fineness control on the result and the larger it is, more samples may result. A value of 10 is a good starting value. FALSE is returned in case of an error, TRUE otherwise.

See also: BspSrf2Polygons, IritSurface2Polygons, IritTrimSrf2Polygons, , CagdSrf2Polygons, TrimSrf2Polygons, BzrSrf2PolygonsSamplesNuNv,
3.2.192 BzrSrf2PolygonsSamplesNuNv (bzr2poly.c:906)

```c
int BzrSrf2PolygonsSamplesNuNv(const CagdSrfStruct *Srf,
    int Nu,
    int Nv,
    CagdBType ComputeNormals,
    CagdBType ComputeUV,
    CagdRType **PtWeights,
    CagdPtStruct **PtMesh,
    CagdVecStruct **PtNrml,
    CagdUVStruct **UVMesh)
```

- **Srf**: To sample in a grid.
- **Nu**, **Nv**: The number of uniform samples in U and V of surface.
- **ComputeNormals**: If TRUE, normal information is also computed.
- **ComputeUV**: If TRUE, UV values are stored and returned as well.
- **PtWeights**: Weights of the evaluations, if rational, to detect poles. NULL if surface not rational.
- **PtMesh**: Evaluated positions of grid of samples.
- **PtNrml**: Evaluated normals of grid of samples or NULL if none.
- **UVMesh**: Evaluated UV vals of grid of samples or NULL if none.

**Returns**: FALSE is returned in case of an error, TRUE otherwise.

**Description**: Routine to uniformly sample a single Bezier srf as a grid. Nu and Nv fix the grid’s sizes. FALSE is returned in case of an error, TRUE otherwise.

**See also**: BspSr2Polygons, IritSurface2Polygons, IritTrimSrf2Polygons, CagdSrf2Polygons, TrimSrf2Polygons, BzrSrf2PolygonsSamples,

3.2.193 BzrSrf2Polylines (bzr2poly.c:1011)

```c
CagdPolylineStruct *BzrSrf2Polylines(const CagdSrfStruct *Srf,
    int NumOfIsocurves[2],
    int SamplesPerCurve)
```

- **Srf**: Srf to extract isoparametric curves from.
- **NumOfIsocurves**: To extract from Srf in each (U or V) direction.
- **SamplesPerCurve**: Fineness control on piecewise linear curve approximation.

**Returns**: List of polygons representing a piecewise linear approximation of the extracted isoparametcric curves or NULL is case of an error.

**Description**: Routine to convert a single Bezier surface to NumOfIsolines polylines in each parametric direction with SamplesPerCurve in each isoparametric curve. Polyline are always E3 of CagdPolylineStruct type. Iso parametric curves are sampled equally spaced in parametric space. NULL is returned in case of an error, otherwise list of CagdPolylineStruct.

**See also**: BzrCrv2Polyline, BspSr2Polylines, IritSurface2Polylines, IritTrimSrf2Polylines, SymbSr2Polylines, TrimSr2Polylines, CagdSr2Polylines,

3.2.194 BzrSrfCrvFromMesh (sbzreval.c:180)

```c
CagdCrvStruct *BzrSrfCrvFromMesh(const CagdSrfStruct *Srf,
    int Index,
    CagdSrfDirType Dir)
```

- **Srf**: To extract a curve from.
- **Index**: Index along the mesh of Srf to extract the curve from.
- **Dir**: Direction of extracted curve. Either U or V.

**Returns**: A curve from Srf. This curve inherit the order and continuity of surface Srf in direction Dir. However, this curve is not on surface Srf, in general.

**Description**: Extracts a curve from the mesh of a tensor product Bezier surface Srf in direction Dir at index Index.

**See also**: CagdCrvFromSrf, BzrSrfCrvFromSrf, BspSrCrvFromSrf, CagdCrvFromMesh, BspSrCrvFromMesh,
3.2.195  BzrSrfCrvFromSrf (sbzreval.c:104)

CagdCrvStruct *BzrSrfCrvFromSrf(const CagdSrfStruct *Srf,
                               CagdRType t,
                               CagdSrfDirType Dir)

  Srf: To extract an isoparametric curve from.
  t: Parameter value of extracted isoparametric curve.
  Dir: Direction of the isocurves on the surface. Either U or V.

Returns: An isoparametric curve of Srf. This curve inherits the order and continuity of surface Srf in direction Dir.

Description: Extracts an isoparametric curve out of the given tensor product Bezier surface in direction Dir at the parameter value of t. Operations should prefer the CONST_U_DIR, in which the extraction is somewhat faster if that is possible.

See also: CagdCrvFromSrf, BspSrfCrvFromSrf, CagdCrvFromMesh, BzrSrfCrvFromMesh, BspSrfCrvFromMesh,

3.2.196  BzrSrfDegreeRaise (sbzr_aux.c:165)

CagdSrfStruct *BzrSrfDegreeRaise(const CagdSrfStruct *Srf, CagdSrfDirType Dir)

  Srf: To raise it degree by one.
  Dir: Direction to degree raise. Either U or V.

Returns: A surface with one degree higher in direction Dir, representing the same geometry as Srf.

Description: Returns a new Bezier surface, identical to the original but with one degree higher, in the requested direction Dir. Let old control polygon be P(i), i = 0 to k-1, and Q(i) be new one then:

\[ Q(0) = P(0), \quad Q(i) = \binom{k-i}{k} P(i-1) + \binom{k}{k} P(i), \quad Q(k) = P(k-1). \]

This is applied to all rows/cols of the surface.

See also: CagdSrfDegreeRaise, BspSrfDegreeRaise, TrimSrfDegreeRaise, PwrSrfDegreeRaise, PwrSrfDegreeRaiseN,

3.2.197  BzrSrfDegreeRaiseN (sbzr_aux.c:253)

CagdSrfStruct *BzrSrfDegreeRaiseN(const CagdSrfStruct *Srf,
                                    int NewUOrder,
                                    int NewVOrder)

  Srf: To raise its degrees.
  NewUOrder: New U order of Srf.
  NewVOrder: New V order of Srf.

Returns: A surface with higher degrees as prescribed by NewUOrder/NewVOrder.

Description: Returns a new Bezier surface, identical to the original but with higher degrees, as prescribed by NewUOrder, NewVOrder.

See also: CagdSrfDegreeRaise, BzrSrfDegreeRaise, TrimSrfDegreeRaise, PwrSrfDegreeRaise, BzrSrfDegreeRaiseN, CagdSrfDegreeRaiseN, PwrSrfDegreeRaise, PwrSrfDegreeRaiseN,

3.2.198  BzrSrfDerive (sbzr_aux.c:414)

CagdSrfStruct *BzrSrfDerive(const CagdSrfStruct *Srf, CagdSrfDirType Dir)

  Srf: To differentiate.
  Dir: Direction of differentiation. Either U or V.

Returns: Differentiated surface.

Description: Returns a new surface equal to the given surface, differentiated once in the direction Dir. Let old control polygon be P(i), i = 0 to k-1, and Q(i) be new one then:

\[ Q(i) = \binom{k-1}{i} \cdot (P(i+1) - P(i)), \quad i = 0 \text{ to } k-2. \]

This is applied to all rows/cols of the surface.

See also: CagdSrfDerive, BspSrfDerive, BzrSrfDeriveRational, BspSrfDeriveRational, BzrSrfDeriveScalar,
3.2.199  BzrSrfDeriveScalar (sbzr\aux.c:488)

CagdSrfStruct *BzrSrfDeriveScalar(const CagdSrfStruct *Srf, CagdSrfDirType Dir)

Srf: To differentiate.
Dir: Direction of tangent vector. Either U or V.

Returns: Differentiated curve.

Description: Returns a new surface equal to the given surface, differentiated once in the direction Dir. Let old control polygon be P(i), i = 0 to k-1, and Q(i) be new one then:

\[ Q(i) = (k - 1) \times (P(i+1) - P(i)), \quad i = 0 \text{ to } k-2. \]

This is applied to all rows/cols of the surface. For a Euclidean surface this is the same as CagdCrvDerive but for a rational surface the returned surface is not the vector field but simply the derivatives of all the surface's coefficients, including the weights.

See also: BzrSrfDerive, CagdSrfDerive, BzrSrfDeriveRational, BspSrfDeriveRational, BspSrfDerive, BspSrfDeriveScalar, CagdSrfDeriveScalar.

3.2.200  BzrSrfEvalAtParam (sbzreval.c:48)

CagdRType *BzrSrfEvalAtParam(const CagdSrfStruct *Srf, CagdRType u, CagdRType v)

Srf: Surface to evaluate at the given (u, v) location.
u, v: Location where to evaluate the surface.

Returns: A vector holding all the coefficients of all components of curve Crv’s point type. If for example the curve’s point type is P2, the W, X, and Y will be saved in the first three locations of the returned vector. The first location (index 0) of the returned vector is reserved for the rational coefficient W and XYZ always starts at second location of the returned vector (index 1). This vector is allocated statically and a second invocation of this function will overwrite the first.

Description: Evaluates the given tensor product Bezier surface at a given point, by extracting an isoparametric curve along u from the surface and evaluating the curve at parameter v.

See also: CagdSrfEval, BspSrfEvalAtParam, BspSrfEvalAtParam2, TrimSrfEval.

3.2.201  BzrSrfIntegrate (sbzr\aux.c:520)

CagdSrfStruct *BzrSrfIntegrate(const CagdSrfStruct *Srf, CagdSrfDirType Dir)

Srf: Surface to integrate.
Dir: Direction of integration. Either U or V.

Returns: Integrated surface.

Description: Returns a new Bezier surface, equal to the integral of the given Bezier srf. The given Bezier surface should be nonrational.

See also: BspSrfIntegrate, BzrCrvIntegrate, CagdSrfIntegrate,
### 3.2.202  BzrSrfMeshNormals (sbzr\_aux.c:712)

CagdVecStruct *BzrSrfMeshNormals(const CagdSrfStruct *Srf,  
    int UFineNess,  
    int VFineNess)

- **Srf**: To compute normals on a grid of its parametric domain.
- **UFineNess**: U Fineness of imposed grid on Srf’s parametric domain.
- **VFineNess**: V Fineness of imposed grid on Srf’s parametric domain.

**Returns**: An vector of unit normals (u increments first).

**Description**: Evaluates the unit normals of a surface at a mesh defined by subdividing the parametric space into a grid of size UFineNess by VFineNess. The normals are saved in a linear CagdVecStruct vector which is allocated dynamically. Data is saved u inc. first. This routine is much faster than evaluating normal for each point, individually.

**See also**: CagdSrfNormal, BspSrfNormal, SymbSrfNormalSrf, BspSrfMeshNormals,

### 3.2.203  BzrSrfMoebiusTransform (sbzr\_aux.c:917)

CagdSrfStruct *BzrSrfMoebiusTransform(const CagdSrfStruct *CSrf,  
    CagdRType c,  
    CagdSrfDirType Dir)

- **CSrf**: Surface to apply the Moebius transformation to.
- **c**: The scaling coefficient - c^n is the ratio between the first and last weight of the surface, along each row or column. If c == 0, the first and last weights are made equal, in the first row/column.
- **Dir**: Direction to apply the Moebius transformation, row or col. If Dir == CAGD\_BOTH\_DIR, the transformation is applied to both the row and column directions, in this order.

**Returns**: The modified surface with the same shape but different speeds.

**Description**: Apply the Moebius transformation to a ration Bezier surface.

**See also**: BzrCrvMoebiusTransform, BspSrfMoebiusTransform,

### 3.2.204  BzrSrfNew (bzr\_gen.c:30)

CagdSrfStruct *BzrSrfNew(int ULength, int VLength, CagdPointType PType)

- **ULength**: Number of control points in the U direction.
- **VLength**: Number of control points in the V direction.
- **PType**: Type of control points (E2, P3, etc.).

**Returns**: An uninitialized freeform Bezier surface.

**Description**: Allocates the memory required for a new Bezier surface.

**See also**: BspSrfNew, BspPeriodicSrfNew, CagdSrfNew, CagdPeriodicSrfNew, TrimSrfNew, PwrSrfNew,

### 3.2.205  BzrSrfNormal (sbzr\_aux.c:655)

CagdVecStruct *BzrSrfNormal(const CagdSrfStruct *Srf,  
    CagdRType u,  
    CagdRType v,  
    CagdBType Normalize)

- **Srf**: Bezier surface to evaluate (unit) normal vector for.
- **u, v**: Parametric location of required (unit) normal.
- **Normalize**: If TRUE, attempt is made to normalize the returned vector. If FALSE, length is a function of given parametrization.

**Returns**: A pointer to a static vector holding the (unit) normal information.

**Description**: Evaluate the (unit) normal of a surface at a given parametric location. If we fail to compute the normal at given location we retry by moving a tad.

**See also**: CagdSrfNormal, BspSrfNormal, SymbSrfNormalSrf,
3.2.206  **BzrSrfSubdivAtParam**  (sbzr_aux.c:121)

CagdSrfStruct *BzrSrfSubdivAtParam(const CagdSrfStruct *Srf,
    CagdRType t,
    CagdSrfDirType Dir)

    **Srf:** To subdivide at parameter value t.
    **t:** Parameter value to subdivide Srf at.
    **Dir:** Direction of subdivision. Either U or V.

**Returns:** A list of the two subdivided surfaces.

**Description:** Given a Bezier surface - subdivides it into two sub-surfaces at the given parametric value. Returns pointer to first surface in a list of two subdivided surfaces.

**See also:** CagdSrfSubdivAtParam, BspSrfSubdivAtParam, TrimSrfSubdivAtParam,

3.2.207  **BzrSrfSubdivCtlMesh**  (sbzr_aux.c:56)

void BzrSrfSubdivCtlMesh(CagdRType *const *Points,
    CagdRType **LPoints,
    CagdRType **RPoints,
    int ULength,
    int VLength,
    CagdPointType PType,
    CagdRType t,
    CagdSrfDirType Dir)

    **Points:** To subdivide at parametr value t.
    **LPoints, RPoints:** Where the results are kept.
    **ULength, VLength:** Of this Bezier surface, dimensions of Points.
    **PType:** Points types we have here.
    **t:** Parameter value to subdivide curve at.
    **Dir:** Direction of subdivision.

**Returns:** void

**Description:** Apply Bezier subdivision to the given curve at parameter value t, and save the result in data LPoints/RPoints. Note this function could also be called from a B-spline curve with a Bezier knot sequence.

**See also:** BzrCrvSubdivAtParam, BspCrvSubdivCtlPoly, BzrCrvSubdivCtlPolyStep,

3.2.208  **BzrSrfTangent**  (sbzr_aux.c:605)

CagdVecStruct *BzrSrfTangent(const CagdSrfStruct *Srf,
    CagdRType u,
    CagdRType v,
    CagdSrfDirType Dir,
    CagdBType Normalize)

    **Srf:** Bezier surface to evaluate (unit) tangent vector for.
    **u, v:** Parametric location of required (unit) tangent.
    **Dir:** Direction of tangent vector. Either U or V.

**Normalize:** If TRUE, attempt is made to normalize the returned vector. If FALSE, length is a function of given parametrization.

**Returns:** A pointer to a static vector holding the (unit) tangent information.

**Description:** Evaluates the (unit) tangent to a surface at a given parametric location u, v) and given direction Dir.

**See also:** CagdSrfTangent, BspSrfTangent,
3.2.209 **Cagd2PolyClipPolysAtPoles** (bzr2poly.c:95)

```c
int Cagd2PolyClipPolysAtPoles(int ClipPolysAtPoles)
```

**ClipPolysAtPoles**: New setting to use or CAGD_QUERY_VALUE to query.

**Returns**: Old value.

**Description**: Sets the option of clipping polylines and polygon at poles (when the rational curves/surface goes to infinity due to division by zero.). If ClipPolysAtPoles == CAGD_QUERY_VALUE, current state is only queried.

**See also**: CagdSrf2Polygons, CagdSrf2PolygonFast, CagdSrf2PolygonStrip, CagdSrf2PolygonMergeCoplanar.

3.2.210 **CagdAllWeightsNegative** (cagd2gen.c:1860)

```c
CagdBType CagdAllWeightsNegative(CagdRType * const *Points,
                                  CagdPointType PType,
                                  int Len,
                                  CagdBType Flip)
```

**Points**: Control points to consider and possibly modify in place.

**PType**: Input point type, as given in Points.

**Len**: Number of points in Points.

**Flip**: If TRUE, flips all weights (and points coefficients) so we end up with positive weights only.

**Returns**: TRUE if original has negative weights, FALSE otherwise.

**Description**: Returns TRUE if the given control points has negative weights.

**See also**: CagdPointsHasPoles, CagdAllWeightsSame,

3.2.211 **CagdAllWeightsSame** (cagd2gen.c:1912)

```c
CagdBType CagdAllWeightsSame(CagdRType * const *Points, int Len)
```

**Points**: Control points to consider.

**Len**: Number of points in Points.

**Returns**: TRUE if all weights are the same, FALSE otherwise.

**Description**: Returns TRUE if given control points has idential weights throughout.

**See also**: CagdPointsHasPoles, CagdAllWeightsNegative,

3.2.212 **CagdAreClosedCrvs** (cag1gen.c:1401)

```c
CagdBType CagdAreClosedCrvs(const CagdCrvStruct *Crvs,
                            const CagdSrfStruct *Srf)
```

**Crvs**: To test if form a closed loop.

**Srf**: If not NULL, Crvs are assumed in the parameteric space of Srf, and crossing a boundary of Srf can still be valid loop. Otherwise, if NULL, curves end points are compared directly.

**Returns**: TRUE if closed, FALSE otherwise.

**Description**: Returns TRUE if the curves form a closed loop.

**See also**: CagdIsClosedCrv, CagdIsClosedSrf, CagdIsZeroLenCrv,
3.2.213  **CagdBBoxArrayFree** (cagd2gen.c:846)

```c
void CagdBBoxArrayFree(CagdBBoxStruct *BBoxArray, int Size)
```

**BBoxArray**: To be deallocated.
**Size**: Of the deallocated array.
**Returns**: void
**Description**: Deallocates and frees an array of BBox structure.

3.2.214  **CagdBBoxArrayNew** (cagd1gen.c:514)

```c
CagdBBoxStruct *CagdBBoxArrayNew(int Size)
```

**Size**: Size of BBox array to allocate.
**Returns**: An array of BBox structures of size Size.
**Description**: Allocates and resets all slots of an array of BBox structures.

3.2.215  **CagdBBoxCopy** (cagd1gen.c:1047)

```c
CagdBBoxStruct *CagdBBoxCopy(const CagdBBoxStruct *BBox)
```

**BBox**: To be copied.
**Returns**: A duplicate of BBox.
**Description**: Allocates and copies all slots of a BBox structure.

3.2.216  **CagdBBoxCopyList** (cagd2gen.c:130)

```c
CagdBBoxStruct *CagdBBoxCopyList(const CagdBBoxStruct *BBoxList)
```

**BBoxList**: To be copied.
**Returns**: A duplicated list of bbox’s.
**Description**: Allocates and copies a list of bbox structures.

3.2.217  **CagdBBoxFree** (cagd2gen.c:798)

```c
void CagdBBoxFree(CagdBBoxStruct *BBox)
```

**BBox**: To be deallocated.
**Returns**: void
**Description**: Deallocates and frees all slots of a BBox structure.

3.2.218  **CagdBBoxFreeList** (cagd2gen.c:821)

```c
void CagdBBoxFreeList(CagdBBoxStruct *BBoxList)
```

**BBoxList**: To be deallocated.
**Returns**: void
**Description**: Deallocates and frees a BBox structure list:
3.2.219 CagdBBoxNew (cagd1gen.c:542)

CagdBBoxStruct *CagdBBoxNew(void)

Returns: A BBox structure.

Description: Allocates and resets all slots of a BBox structure.

3.2.220 CagdBilinearSrf (cagdruld.c:125)

CagdSrfStruct *CagdBilinearSrf(const CagdPtStruct *Pt00,
                               const CagdPtStruct *Pt01,
                               const CagdPtStruct *Pt10,
                               const CagdPtStruct *Pt11)

Pt00, Pt01, Pt10, Pt11: The four points to construct a bilinear between.

Returns: A bilinear surface with four corners at Ptij.

Description: Constructs a bilinear surface between the four provided points.

3.2.221 CagdBlendTwoSurfaces (hermite.c:259)

CagdSrfStruct *CagdBlendTwoSurfaces(const CagdSrfStruct *Srf1,
                                      const CagdSrfStruct *Srf2,
                                      int BlendDegree,
                                      CagdRType TanScale)

Srf1: First surface to blend.

Srf2: Second surface to blend.

BlendDegree: Degree of the blending function in U. 2 for C^0, 4 for C^1, 6 for C^2.

TanScale: If C^1, sets the tangency scale factor.

Returns: Resulting blended surface.

Description: Blends the two given surfaces along the u (first) parameter value. Returned surface will start at Srf1(UMin) and terminate at Srf2(UMax). Continuity is governed by the blending degree. 2 for C^0, 4 for C^1. Odd degree will be rounded up to the next even degree. Uses Hermite interpolation for the C^1 case.

See also: SymbBlendTwoSurfaces,

3.2.222 CagdBlossomDegreeRaiseMat (blossom.c:719)

CagdBlsmAlphaCoeffStruct *CagdBlossomDegreeRaiseMat(const CagdRType *KV,
                                                      int Order,
                                                      int Len)

KV: Of space to degree raise.

Order: Of space to degree raise.

Len: Of control poly/mesh.

Returns: Degree raising matrix.

Description: Computes a new degree raising matrix to degree raise once the following function space, defined using the Order, and knot vector KV of length Len + Order (Len is the length of the control poly/mesh using KV).

See also: CagdCrvBlossomDegreeRaise, CagdSrfBlossomDegreeRaise, CagdCrvDegreeRaise, CagdBlossomDegreeRaiseNMat, CagdDegreeRaiseMatProd,
### 3.2.223 CagdBlossomDegreeRaiseNMat (blossom.c:812)

```c
CagdBlossomDegreeRaiseNMat(const CagdRType *KV, int Order, int NewOrder, int Len)
```

**KV**: Of space to degree raise.

**Order**: Of space to degree raise.

**NewOrder**: Destination order to raise to.

**Len**: Of control poly/mesh.

**Returns**: Degree raising matrix.

**Description**: Computes a degree raising matrix to degree raise the following function space to order NewOrder. The space is defined using the Order, and knot vector KV of length Len + Order (Len is the length of the control poly/mesh using KV).

**See also**: CagdCrvBlossomDegreeRaise, CagdSrfBlossomDegreeRaise, CagdCrvDegreeRaise, CagdBlossomDegreeRaiseMat, CagdDegreeRaiseMatProd

### 3.2.224 CagdBlossomEval (blossom.c:319)

```c
CagdBlossomEval(const CagdRType *Pts, int PtsStep, int Order, const CagdRType *Knots, int KnotsLen, const CagdRType *BlsmVals, int BlsmLen)
```

**Pts**: Coefficient or scalar control points to blossom.

**PtsStep**: Step size between coefficients, typically one.

**Order**: Order of the freeform geometry.

**Knots**: Knots of the freeform geometry. If NULL assumed Bezier.

**KnotsLen**: Length of Knots knot vectors.

**BlsmVals**: Blossoming values to consider.

**BlsmLen**: Length of BlsmVals vector.

**Returns**: Evaluated Blossom

**Description**: Computes the Blossom over the given points, Pts, with knot sequence Knots, and Blossoming factors BlsmVals. Evaluation is conducted via the Cox - De Boor algorithm with a possibly different parameter at each iteration as prescribed via the Blossoming factors. Note that the Bezier case is supported via the case for which the Knots are NULL. This function assumes no Order multiplicity of knots in interior of KV.

**See also**: CagdCrvBlossomDegreeRaise, CagdBlossomEvalSymb

### 3.2.225 CagdBlsmAAddRowAlphaCoef (blossom.c:1413)

```c
void CagdBlsmAAddRowAlphaCoef(CagdBlsmAAlphaCoefStruct *A, CagdRType *Coefs, int ARow, int ColIndex, int ColLength)
```

**A**: The current blossome alpha matrix to update.

**Coefs**: The coefficients to add to the alpha matrix in row ARow.

**ARow**: The row in A to update.

**ColIndex**: Starting index in column Col to update.

**ColLength**: Number of coefficients to update in column Col.

**Returns**: void

**Description**: Updates one row, ARow, in the blossom alpha matrix. New coefficients are being added to the current values from ColIndex to ColIndex+ColLength-1.

**See also**: CagdBlossEvalSymb, CagdBlsmAAlcAlphaCoef, CagdBlsmCopyAlphaCoef, , CagdBlsmFreeAlphaCoef, CagdBlsmScaleAlphaCoef, , CagdBlsmSetDomainAlphaCoef,
### 3.2.226 CagdBlsmAllocAlphaCoef (blossom.c:1198)

CagdBlsmAlphaCoeffStruct *CagdBlsmAllocAlphaCoef(int Order, 
int Length, 
int NewOrder, 
int NewLength, 
int Periodic)

**Order, Length:** Current Order and Length of current function space.

**NewOrder, NewLength:** New function space, after the blossom.

**Periodic:** TRUE, if periodic.

**Returns:** Allocated blossom Alpha matrix.

**Description:** Allocates the CagdBlsmAlphaCoeffStruct data structure.

**See also:** CagdCrvBlossomDegreeRaise, CagdBlossomEvalSymb, CagdBlsmAddRowAlphaCoef, CagdBlsmCopyAlphaCoef, CagdBlsmFreeAlphaCoef, CagdBlsmScaleAlphaCoef, , CagdBlsmSetDomainAlphaCoef

### 3.2.227 CagdBlsmCopyAlphaCoef (blossom.c:1283)

CagdBlsmAlphaCoeffStruct *CagdBlsmCopyAlphaCoef(const CagdBlsmAlphaCoeffStruct *A)

**A:** Blossom alpha matrix to copy.

**Returns:** Copied matrix.

**Description:** Copies the CagdBlsmAlphaCoeffStruct data structure.

**See also:** CagdCrvBlossomDegreeRaise, CagdBlossomEvalSymb, CagdBlsmAddRowAlphaCoef, CagdBlsmAllocAlphaCoef, CagdBlsmFreeAlphaCoef, CagdBlsmScaleAlphaCoef, , CagdBlsmSetDomainAlphaCoef

### 3.2.228 CagdBlsmEvalSymb (blossom.c:62)

CagdRType *CagdBlsmEvalSymb(int Order, 
const CagdRType *Knots, 
int KnotsLen, 
const CagdRType *BlsmVals, 
int BlsmLen, 
int *RetIdxFirst, 
int *RetLength)

**Order:** Order of the freeform geometry,

**Knots:** Knots of the freeform geometry. If NULL assumed Bezier.

**KnotsLen:** Length of Knots knot vectors.

**BlsmVals:** Blossoming values to consider.

**BlsmLen:** Length of BlsmVals vector.

**RetIdxFirst:** Index of first input coefficient to blend returned vector with.

**RetLength:** Length of returned blend vector.

**Returns:** Vector of blending values of the input coefficients for this blossom evaluation. This vector is maintained by this function and should not be freed by the caller of this function.

**Description:** Same as CagdBlossomEval, but computes the result symbolically. That is, get the contribution of each input coefficients to this blossom. This function assumes no Order multiplicity of knots in interior of KV.

**See also:** CagdCrvBlossomDegreeRaise, CagdBlossomEval, CagdBlsmAddRowAlphaCoef, CagdBlsmAllocAlphaCoef, CagdBlsmCopyAlphaCoef, , CagdBlsmFreeAlphaCoef, CagdBlsmScaleAlphaCoef, , CagdBlsmSetDomainAlphaCoef,
3.2.229 CagdBlsmFreeAlphaCoef (blossom.c:1371)

`void CagdBlsmFreeAlphaCoef(CagdBlsmAlphaCoeffStruct *A)`

**A:** Blossom Alpha matrix to free.

**Returns:** void

**Description:** Frees the CagdBlsmAlphaCoeffStruct data structure.

**See also:** CagdCrvBlossomDegreeRaise, CagdBlossomEvalSymb, CagdBlsmAddRowAlphaCoef, CagdBlsmAllocAlphaCoef, CagdBlsmCopyAlphaCoef, CagdBlsmScaleAlphaCoef, CagdBlsmSetDomainAlphaCoef.

3.2.230 CagdBlsmScaleAlphaCoef (blossom.c:1456)

`void CagdBlsmScaleAlphaCoef(CagdBlsmAlphaCoeffStruct *A, CagdRType Scl)`

**A:** Blossom alpha matrix to scale all its coefficients.

**Scl:** Scaling factor.

**Returns**:

**Description:** Scale all the coefficients in the given blossom alpha matrix by Scl.

**See also:** CagdBlsmEvalSymb, CagdBlsmAllocAlphaCoef, CagdBlsmCopyAlphaCoef, CagdBlsmFreeAlphaCoef, CagdBlsmSetDomainAlphaCoef.

3.2.231 CagdBlsmSetDomainAlphaCoef (blossom.c:1483)

`void CagdBlsmSetDomainAlphaCoef(CagdBlsmAlphaCoeffStruct *A)`

**A:** Blossom alpha matrix to update its ColIndex/ColLength settings, in place.

**Returns**:

**Description:** Update domain bounds ColIndex/ColLength in the blossom alpha matrix A.

**See also:** CagdBlsmEvalSymb, CagdBlsmAllocAlphaCoef, CagdBlsmCopyAlphaCoef, CagdBlsmFreeAlphaCoef, CagdBlsmScaleAlphaCoef, CagdBlsmAddRowAlphaCoef.

3.2.232 CagdBndryCrvsFromSrf (cagd_aux.c:1717)

`CagdCrvStruct **CagdBndryCrvsFromSrf(const CagdSrfStruct *Srf)`

**Srf:** To extract the boundary from.

**Bndry:** The boundary to extract.

**Returns:** The extracted boundary curve.

**Description:** Extracts one boundary curve of the given surface.

3.2.233 CagdBndryCrvsFromSrf (cagd_aux.c:1752)

`CagdCrvStruct *CagdBndryCrvsFromSrf(const CagdSrfStruct *Srf,`  

CagdSrfBndryType Bndry)`

**Srf:** To extract the boundary from.

**Bndry:** The boundary to extract.

**Returns:** The extracted boundary curve.

**Description:** Extracts one boundary curve of the given surface.
3.2.234 CagdBoolSumSrf (cagdsum.c:47)

CagdSrfStruct *CagdBoolSumSrf(const CagdCrvStruct *CCrvLeft,
    const CagdCrvStruct *CCrvRight,
    const CagdCrvStruct *CCrvTop,
    const CagdCrvStruct *CCrvBottom)

    CCrvLeft: Left boundary curve of Boolean sum surface to be created.
    CCrvRight: Right boundary curve of Boolean sum surface to be created.
    CCrvTop: Top boundary curve of Boolean sum surface to be created.
    CCrvBottom: Bottom boundary curve of Boolean sum surface to be created.

    Returns: A Boolean sum surface constructed using given four curves.

    Description: Constructs a Boolean sum surface using the four provided boundary curves. Curve’s end points 
must meet at the four surface corners if surface boundary are to be identical to the four given curves.

    \[\begin{array}{c}
    & \text{bottom} \\
    \text{left} & \text{right} \\
    \text{top} \end{array}\]

3.2.235 CagdBspCrvPDMFitting (cbsp_fit.c:1333)

static CagdCrvStruct *CagdBspCrvPDMFitting(
    CagdPType *PtList,
    int NumOfPoints,
    CagdCrvStruct *InitCrv,
    RegTermCalculatorFuncType CalcRegularization,
    RegMatrixCalculatorFuncType CalcRegMatrix,
    int MaxIterations,
    CagdRType ErrorLimit,
    CagdRType ErrorChangeLimit,
    CagdRType Lambda)

    PtList: Points cloud we want to approximate.
    NumOfPoints: Number of points in PtList.
    InitCrv: Pointer to an initial fitting curve. Its order and length will be taken as order and length of the desired 
fitting curve.
    CalcRegularization: Pointer to a function that should be used for calculating regularization term value.
    CalcRegMatrix: Pointer to a function that should be used for calculating regularization term minimization 
matrix.
    MaxIterations: Maximum iterations to perform (stop condition).
    ErrorLimit: Minimum error (stop condition).
    ErrorChangeLimit: Minimum error change (stop condition).
    Lambda: Weight of regularization term.

    Returns: B-spline curve that fits the input points cloud.

    Description: Calculates b-spline curve that fits (approximates) the given points Using input init curve, PDM 
fitting method and specified regularization term.
    See also: CagdBspCrvSDMFitting,
3.2.236 CagdBspCrvSDMFitting (cbsp_fit.c:1161)

```c
static CagdCrvStruct *CagdBspCrvSDMFitting(
    CagdPType *PtList,
    int NumOfPoints,
    CagdCrvStruct *InitCrv,
    RegTermCalculatorFuncType CalcRegularization,
    RegMatrixCalculatorFuncType CalcRegMatrix,
    int MaxIterations,
    CagdRType ErrorLimit,
    CagdRType ErrorChangeLimit,
    CagdRType Lambda)
```

**PtList:** Points cloud we want to approximate.
**NumOfPoints:** Number of points in PtList.
**InitCrv:** Pointer to an initial fitting curve. Its order and length will be taken as order and length of the desired fitting curve.
**CalcRegularization:** Pointer to a function that should be used for calculating regularization term value.
**CalcRegMatrix:** Pointer to a function that should be used for calculating regularization term minimization matrix.
**MaxIterations:** Maximum iterations to perform (stop condition).
**ErrorLimit:** Minimum error (stop condition).
**ErrorChangeLimit:** Minimum error change (stop condition).
**Lambda:** Weight of regularization term.

**Returns:** B-spline curve that fits the input points cloud.

**Description:** Calculates b-spline curve that fits (approximates) the given points Using input init curve, SDM fitting method and specified regularization term.

See also: CagdBspCrvPDMFitting,

3.2.237 CagdBsplineCrvFitting (cbsp_fit.c:231)

```c
CagdCrvStruct *CagdBsplineCrvFitting(CagdPType *PtList,
    int NumOfPoints,
    int Length,
    int Order,
    CagdBType IsPeriodic,
    CagdBspFittingType AlgorithmType,
    int MaxIter,
    CagdRType ErrorLimit,
    CagdRType ErrorChangeLimit,
    CagdRType Lambda)
```

**PtList:** Points cloud we want to approximate.
**NumOfPoints:** Number of points in PtList.
**Length:** The desired length of the output b-spline curve.
**Order:** The desired order of the output b-spline curve.
**IsPeriodic:** TRUE for periodic output curve, FALSE for open end.
**AlgorithmType:** Fitting algorithm type (CAGD_PDM_FITTING, CAGD_SDM_FITTING, etc).
**MaxIter:** Maximum iterations to perform (stop condition).
**ErrorLimit:** Minimum error (stop condition).
**ErrorChangeLimit:** Minimum error change (stop condition).
**Lambda:** Weight of regularization term.

**Returns:** Output b-spline curve.

**Description:** Calculates b-spline curve that fits (approximates) the given points cloud using SD error function and Energy2 regulation function. There are three stop conditions: 1) 100 iterations 2) Error = 0.1 3) Error change = 0.005 The initial curve is a least square approximating b-spline.
3.2.238  CagdBsplineCrvFittingWithInitCrv (cbsp.fit.c:163)

CagdCrvStruct *CagdBsplineCrvFittingWithInitCrv(CagdPType *PtList,
   int NumOfPoints,
   CagdCrvStruct *InitCrv,
   CagdBspFittingType AlgorithmType,
   int MaxIter,
   CagdRType ErrorLimit,
   CagdRType ErrorChangeLimit,
   CagdRType Lambda)

   PtList: Points cloud we want to approximate.
   NumOfPoints: Number of points in PtList.
   InitCrv: Initial fitting curve.
   AlgorithmType: Fitting algorithm type (CAGDPDMFITTING, CAGDSDFITTING, etc).
   MaxIter: Maximum iterations to perform (stop condition).
   ErrorLimit: Minimum error (stop condition).
   ErrorChangeLimit: Minimum error change (stop condition).
   Lambda: Weight of regularization term.

Returns: Output b-spline curve.

Description: Calculates b-spline curve that fits (approximates) the given points cloud using SD error function
   and Energy2 regulation function. There are three stop conditions: 1) Maximum iterations. 2) Error = 0 (i.e. curve
   passes through all the points) 3) Error change = 0 (the iteration gives no improvement)

3.2.239  CagdCnvrtBsp2BzrCrv (cbzr_aux.c:908)

CagdCrvStruct *CagdCnvrtBsp2BzrCrv(const CagdCrvStruct *CCrv)

CCrv: A Bspline curve to convert to a Bezier curve.

Returns: A list of Bezier curves representing the Bepline curve Crv.

Description: Converts a Bspline curve into a set of Bezier curves by subdividing the Bspline curve at all its
   internal knots. Returned is a list of Bezier curves.
   See also: CagdCnvrtBzr2BspCrv, CagdCnvrtBzr2PwrCrv, CagdCnvrtPwr2BzrCrv,

3.2.240  CagdCnvrtBsp2BzrSrf (sbzr_aux.c:817)

CagdSrfStruct *CagdCnvrtBsp2BzrSrf(const CagdSrfStruct *CSrf)

CSrf: Bspline surface to convert to a Bezier surface.

Returns: A list of Bezier surfaces representing same geometry as Srf.

Description: Convert a Bspline surface into a set of Bezier surfaces by subdiving the Bspline surface at all its
   internal knots. Returned is a list of Bezier surface.
   See also: CagdCnvrtBzr2BspSrf,

3.2.241  CagdCnvrtBsp2OpenCrv (cbsp_aux.c:1505)

CagdCrvStruct *CagdCnvrtBsp2OpenCrv(const CagdCrvStruct *Crv)

Crv: Bspline curve to convert to open end conditions.

Returns: A Bspline curve with open end conditions, representing the same geometry as Crv.

Description: Converts a Bspline curve to a Bspline curve with open end conditions.
3.2.242 CagdCnvrtBsp2OpenSrf (sbsp\_aux.c:1908)

CagdSrfStruct *CagdCnvrtBsp2OpenSrf(const CagdSrfStruct *Srf)

Srf: Bspline surface to convert to open end conditions.

Returns: A Bspline surface with open end conditions, representing the same geometry as Srf.

Description: Converts a Bspline surface to a Bspline surface with open end conditions.

3.2.243 CagdCnvrtBzr2BspCrv (cbzr\_aux.c:868)

CagdCrvStruct *CagdCnvrtBzr2BspCrv(const CagdCrvStruct *Crv)

Crv: A Bezier curve to convert to a B spline curve.

Returns: A Bspline curve representing Bezier curve Crv.

Description: Converts a Bezier curve into Bspline curve by adding an open knot vector.
See also: CagdCnvrtBsp2BzrCrv, CagdCnvrtBzr2PwrCrv, CagdCnvrtPwr2BzrCrv

3.2.244 CagdCnvrtBzr2BspSrf (sbzr\_aux.c:774)

CagdSrfStruct *CagdCnvrtBzr2BspSrf(const CagdSrfStruct *Srf)

Srf: Bezier surface to convert to a Bspline surface.

Returns: A Bspline surface representing same geometry as Srf.

Description: Converts a bezier surface into a Bspline surface by adding open end knot vector with no interior knots.
See also: CagdCnvrtBsp2BzrSrf

3.2.245 CagdCnvrtBzr2PwrCrv (bzr\_pwr.c:57)

CagdCrvStruct *CagdCnvrtBzr2PwrCrv(const CagdCrvStruct *Crv)

Crv: To convert into Power basis function representation.

Returns: Same geometry, but in the Power basis.

Description: Converts the given curve from Bezier basis functions to a Power basis functions. Using:

\[
B(t) = \sum_{i=0}^{n} \binom{n}{i} B_i^{(n)} (t) = \sum_{i=0}^{n} \binom{n}{i} \binom{t}{i} \binom{1-t}{n-i} t^i (1-t)^{n-i}
\]

Which can be derived by expanding the \((1-t)\) term in bezier basis function definition as:

\[
(1-t) = \sum_{j=0}^{n-i} \binom{n-i}{j} (-t)^j 
\]

using binomial expansion.
This routine simply take the weight of each Bezier basis function \( B(t) \) and spread it into the different power basis \( t^j \) function scaled by:

\[
\begin{align*}
\text{See also: CagdCnvrtBzr2BspCrv, CagdCnvrtBsp2BzrCrv, CagdCnvrtPwr2BzrCrv,}
\end{align*}
\]

3.2.246 **CagdCnvrtBzr2PwrSrf** (bzr\_pwr.c:195)

\[
\text{CagdSrfStruct *CagdCnvrtBzr2PwrSrf(const CagdSrfStruct *Srf)}
\]

\begin{itemize}
\item **Srf**: To convert into Power basis function representation.
\item **Returns**: Same geometry, but in the Power basis.
\item **Description**: Converts the given surface from Bezier basis functions to a Power basis functions. Using:
\end{itemize}

\[
B(t) = \sum_{i=0}^{n} \sum_{j=0}^{p} (-1)^{i+j} \binom{n}{i} \binom{p}{j} t^i (1-t)^j
\]
or

\[
B(u) B(v) = \sum_{i=0}^{n} \sum_{j=0}^{m} \sum_{p=0}^{n} \sum_{q=0}^{m} (-1)^{i+j+p+q} \binom{n}{i} \binom{m}{j} \binom{p}{i} \binom{q}{j} u^i v^j
\]

This routine simply take the weight of each product of two Bezier basis functions \( B_i(u) B_j(v) \) and spread it into the different power basis \( u^j v^k \) functions scaled by:

\[
(-1)^{i+j} \binom{p}{i} \binom{q}{j} t^i (1-t)^j
\]

3.2.247 **CagdCnvrtCrvToCtlPts** (cbsp\_aux.c:1564)

\[
\text{CagdCtlPtStruct *CagdCnvrtCrvToCtlPts(const CagdCrvStruct *Crv)}
\]

\begin{itemize}
\item **Crv**: To the curve to convert to list of control points.
\item **Returns**: List of control points of curve Crv.
\item **Description**: Convert a curve into a list of control points.
\end{itemize}

3.2.248 **CagdCnvrtFloat2OpenCrv** (cbsp\_aux.c:1450)

\[
\text{CagdCrvStruct *CagdCnvrtFloat2OpenCrv(const CagdCrvStruct *Crv)}
\]

\begin{itemize}
\item **Crv**: Bspline curve to convert to open end conditions.
\item **Returns**: A Bspline curve with open end conditions, representing the same geometry as Crv.
\item **Description**: Converts a float Bspline curve to a Bspline curve with open end conditions.
\end{itemize}
3.2.249  CagdCnvrtFloat2OpenSrf (sbsp_aux.c:1873)

CagdSrfStruct *CagdCnvrtFloat2OpenSrf(const CagdSrfStruct *Srf)

Srf: Bspline surface to convert to open end conditions.
Returns: A Bspline surface with open end conditions, representing the same geometry as Srf.
Description: Converts a float Bspline surface to a Bspline surface with open end conditions.
See also: CagdCnvrtPeriodic2FloatSrf,

3.2.250  CagdCnvrtLinBspCrv2Polyline (cbsp_aux.c:1346)

CagdPolylineStruct *CagdCnvrtLinBspCrv2Polyline(const CagdCrvStruct *Crv)

Crv: A linear Bspline curve to convert to a polyline.
Returns: A polyline same as linear curve Crv.
Description: Returns a new polyline representing same geometry as the given linear Bspline curve.
See also: UserPolylines2LinBsplineCrvs, UserPolyline2LinBspCrv, , CagdCnvrtPolyline2LinBspCrv, Cagd-CnvrtPtList2Polyline,

3.2.251  CagdCnvrtPeriodic2FloatCrv (cbsp_aux.c:1397)

CagdCrvStruct *CagdCnvrtPeriodic2FloatCrv(const CagdCrvStruct *Crv)

Crv: Bspline curve to convert to floating end conditions. Assume Crv is either periodic or has floating end condition.
Returns: A Bspline curve with floating end conditions, representing the same geometry as Crv.
Description: Converts a Bspline curve to a Bspline curve with floating end conditions.

3.2.252  CagdCnvrtPeriodic2FloatSrf (sbsp_aux.c:1798)

CagdSrfStruct *CagdCnvrtPeriodic2FloatSrf(const CagdSrfStruct *Srf)

Srf: Bspline surface to convert to floating end conditions. Assume Srf is either periodic or has floating end condition.
Returns: A Bspline surface with floating end conditions, representing the same geometry as Srf.
Description: Converts a Bspline surface into a Bspline surface with floating end conditions.
See also: CagdCnvrtFloat2OpenSrf,

3.2.253  CagdCnvrtPolyline2LinBspCrv (cbsp_aux.c:1282)

CagdCrvStruct *CagdCnvrtPolyline2LinBspCrv(const CagdPolylineStruct *Poly)

Poly: To convert to a linear bspline curve.
Returns: A linear Bspline curve representing Poly.
Description: Returns a new linear Bspline curve constructed from the given polyline.
See also: UserPolylines2LinBsplineCrvs, CagdCnvrtPolyline2LinBspCrv, , CagdCnvrtLinBspCrv2Polyline, Cagd-CnvrtPtList2Polyline,
3.2.254  CagdCnvrtPolyline2PtList  (cbsp_aux.c:1246)

CagdPtStruct *CagdCnvrtPolyline2PtList(const CagdPolylineStruct *Poly)

    Poly: Input polyline to convert into a point list.
    Returns: Converted point list.
    Description: Converts a polyline into a list of points.
See also: CagdCnvrtLinBspCrv2Polyline, CagdCnvrtPolyline2LinBspCrv, CagdCnvrtPtList2Polyline,

3.2.255  CagdCnvrtPtList2Polyline  (cbsp_aux.c:1189)

CagdPolylineStruct *CagdCnvrtPtList2Polyline(const CagdPtStruct *Pts,
                                                CagdPolylineStruct **Params)

    Pts: Input point list to convert into a polyline.
    Params: Optional polylines of parameters if found is saved here.
    Returns: Converted polyline.
    Description: Converts a list of points into a polyline.
See also: CagdCnvrtLinBspCrv2Polyline, CagdCnvrtPolyline2LinBspCrv, CagdCnvrtPolyline2PtList,

3.2.256  CagdCnvrtPwr2BzrCrv  (bzr_pwr.c:124)

CagdCrvStruct *CagdCnvrtPwr2BzrCrv(const CagdCrvStruct *Crv)

    Crv: To convert to Bezier basis functions.
    Returns: Same geometry, in the Bezier basis functions.
    Description: Converts the given curve from Power basis functions to Bezier basis functions. Using:

    \[
    n \quad j \\
    i \quad \quad \quad \quad \quad \equiv \quad \quad (\cdot) \quad \q
|P0 \ P_{i-1}|
|\ P_i \ P_{2i-1}|
|\ P_{n-i} \ P_{n-1}|

Parametric space orientation - control mesh.

\[ u \rightarrow \]

\[ n \ m \ i \ j \]
\[ p \ q \]
\[ u \ v = \]
\[ \left[ \begin{array}{c}
B(u) \\
B(v)
\end{array} \right] \]
i=p \ j=q \ ( ) ( )
\[ \left[ \begin{array}{c}
p \\
q
\end{array} \right] \]

\[ i \ j \]
\[ \left[ \begin{array}{c}
p \\
q
\end{array} \right] \]

\[ C = \]
\[ \left[ \begin{array}{c}
A
\end{array} \right] \]
i j

\[ \left[ \begin{array}{c}
p=0 \\
q=0 ( ) ( )
\end{array} \right] \]

\[ \left[ \begin{array}{c}
p \\
q
\end{array} \right] \]

3.2.258 CagdCoerceCrvTo (cagdcoer.c:693)

CagdCrvStruct *CagdCoerceCrvTo(const CagdCrvStruct *Crv,
CagdPointType PType,
CagdBType AddParametrization)

Crv: To be coerced to a new point type PType.

PType: New point type for Crv.

AddParametrization: If TRUE, the input is a scalar curve and the requested output is 2D, add a parametrization to newly added axis.

Returns: The new, coerced to PType, curve.

Description: Coerces a curve to a new point type PType. If given curve is E1 or P1 and requested new type is E2 or P2 the Y coefficients are updated to hold the parametric domain of the curve, if AddParametrization.

3.2.259 CagdCoerceCrvsTo (cagdcoer.c:659)

CagdCrvStruct *CagdCoerceCrvsTo(const CagdCrvStruct *Crv,
CagdPointType PType,
CagdBType AddParametrization)

Crv: To be coerced to a new point type PType.

PType: New point type for Crv.

AddParametrization: If TRUE, the input is a scalar curve and the requested output is 2D, add a parametrization to newly added axis.

Returns: The new, coerced to PType, curves.

Description: Coerces a list of curves to a new point type PType. If given curves are E1 or P1 and requested new type is E2 or P2 the Y coefficients are updated to hold the parametric domain of the curve, if AddParametrization.
3.2.260  CagdCoercePointTo (cagdcoer.c:251)

    void CagdCoercePointTo(CagdRType *NewPoint,
                           CagdPointType NewPType,
                           CagdRType * const Points[CAGD_MAX_PT_SIZE],
                           int Index,
                           CagdPointType OldPType)

    NewPoint: Where the coerced information is to be saved.
    NewPType: Point type of the coerced new point.
    Points: Array of vectors if Index >= 0, a single point if Index < 0.
    Index: Index into the vectors of Points.
    OldPType: Point type to be expected from Points.
    Returns: void

    Description: Coerces Srf/Crv Point from index Index of Points array of Type PType to a new type NewPType. If however Index < 0 Points is considered single point.

3.2.261  CagdCoercePointsTo (cagdcoer.c:481)

    void CagdCoercePointsTo(CagdRType *Points[],
                           int Len,
                           CagdPointType OldPType,
                           CagdPointType NewPType)

    Points: Where the old and new points are placed.
    Len: Length of vectors in the array of vectors, Points.
    OldPType: Point type to be expected from Points.
    NewPType: Point type of the coerced new point.
    Returns: void

    Description: Coerces an array of vectors of points of point type OldPType to point type NewPType, in place.

3.2.262  CagdCoerceSrfTo (cagdcoer.c:800)

    CagdSrfStruct *CagdCoerceSrfTo(const CagdSrfStruct *Srf,
                                   CagdPointType PType,
                                   CagdBType AddParametrization)

    Srf: To be coerced to a new point type PType.
    PType: New point type for Srf.
    AddParametrization: If TRUE, the input is a scalar surface and the requested output is 3D, add a parametrization to newly added axis.
    Returns: The new, coerced to PType, surface.

    Description: Coerces a surface to a new point type PType. If given surface is E1 or P1 and requested new type is E3 or P3 the Y and Z coefficients are updated to hold the parametric domain of the surface, if AddParametrization.

3.2.263  CagdCoerceSrfsTo (cagdcoer.c:766)

    CagdSrfStruct *CagdCoerceSrfsTo(const CagdSrfStruct *Srf,
                                    CagdPointType PType,
                                    CagdBType AddParametrization)

    Srf: To be coerced to a new point type PType.
    PType: New point type for Srf.
    AddParametrization: If TRUE, the input is a scalar surface and the requested output is 2D, add a parametrization to newly added axis.
    Returns: The new, coerced to PType, surfaces.

    Description: Coerces a list of surfaces to a new point type PType. If given surfaces are E1 or P1 and requested new type is E2 or P2 the Y coefficients are updated to hold the parametric domain of surface, if AddParametrization.
3.2.264 CagdCoerceToE2 (cagdcoer.c:32)

void CagdCoerceToE2(CagdRType *E2Point,
    CagdRType * const Points[CAGD_MAX_PT_SIZE],
    int Index,
    CagdPointType PType)

E2Point: Where the coerced information is to be saved.
Points: Array of vectors if Index >= 0, a single point if Index < 0.
Index: Index into the vectors of Points.
PType: Point type to be expected from Points.
Returns: void

Description: Coerce Srf/Crv Point from index Index of Points array of Type PType to a point type E2. If however Index < 0 Points is considered single point.

3.2.265 CagdCoerceToE3 (cagdcoer.c:93)

void CagdCoerceToE3(CagdRType *E3Point,
    CagdRType * const Points[CAGD_MAX_PT_SIZE],
    int Index,
    CagdPointType PType)

E3Point: Where the coerced information is to be saved.
Points: Array of vectors if Index >= 0, a single point if Index < 0.
Index: Index into the vectors of Points.
PType: Point type to be expected from Points.
Returns: void

Description: Coerce Srf/Crv Point from index Index of Points array of Type PType to a point type E3. If however Index < 0 Points is considered single point.

3.2.266 CagdCoerceToP2 (cagdcoer.c:154)

void CagdCoerceToP2(CagdRType *P2Point,
    CagdRType * const Points[CAGD_MAX_PT_SIZE],
    int Index,
    CagdPointType PType)

P2Point: Where the coerced information is to be saved.
Points: Array of vectors if Index >= 0, a single point if Index < 0.
Index: Index into the vectors of Points.
PType: Point type to be expected from Points.
Returns: void

Description: Coerce Srf/Crv Point from index Index of Points array of Type PType to a point type P2. If however Index < 0 Points is considered single point.

3.2.267 CagdCoerceToP3 (cagdcoer.c:202)

void CagdCoerceToP3(CagdRType *P3Point,
    CagdRType * const Points[CAGD_MAX_PT_SIZE],
    int Index,
    CagdPointType PType)

P3Point: Where the coerced information is to be saved.
Points: Array of vectors if Index >= 0, a single point if Index < 0.
Index: Index into the vectors of Points.
PType: Point type to be expected from Points.
Returns: void

Description: Coerce Srf/Crv Point from index Index of Points array of Type PType to a point type P3. If however Index < 0 Points is considered single point.
### 3.2.268 CagdConic2Quadric (cagd\_cnc.c:1281)

```c
int CagdConic2Quadric(CagdRType *A,
    CagdRType *B,
    CagdRType *C,
    CagdRType *D,
    CagdRType *E,
    CagdRType *F,
    CagdRType *G,
    CagdRType *H,
    CagdRType *I,
    CagdRType *J)
```

**A, B, C, D, E, F, G, H, I, J:** Input - in A-F the conic and in J the Z height. Output - the new 10 coefficients of the quadric.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Construct rational quadric surface above (and below) the given conic in the XY plane of Z height. The conic is given in the A-F coefficients as $Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0$ and the quadric is returned in the A-J coefficients as: $A x^2 + By^2 + Cz^2 + Dxy + Eyz + Fz + Gx + Hy + Iz + J = 0$.

See also: CagdCreateQuadricSrf, CagdEllipse3Points, CagdEllipsePoints, CagdEllipseOffset,

### 3.2.269 CagdConicMatTransform (cagd\_cnc.c:1132)

```c
int CagdConicMatTransform(CagdRType *A,
    CagdRType *B,
    CagdRType *C,
    CagdRType *D,
    CagdRType *E,
    CagdRType *F,
    CagdMType Mat)
```

**A, B, C, D, E, F:** The six coefficients of the conic. Updated in place.

**Mat:** Transformation matrix in the XY plane.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Transform given conic form $Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0$, using Mat, in the XY plane. Algorithm:

1. Convert the implicit conic to a matrix form as:
   $$
   \begin{bmatrix}
   A & B/2 & 0 & D/2 \\
   x & x & y & 0 & 1
   \end{bmatrix}
   \begin{bmatrix}
   B/2 & C & 0 & E/2 \\
   y & x & y & z & 0
   \end{bmatrix}
   \begin{bmatrix}
   A & B/2 & 0 & D/2 \\
   x & x & y & z & 0 & 1
   \end{bmatrix}^T
   = 0
   $$

2. Compute $N = Mat^{-1}$ the inverse of the desired transformation.


See also: CagdQuadricMatTransform, CagdStrfTransform, CagdCrvTransform,
3.2.270 CagdCreateConicCurve (cagd_cnc.c:57)

```c
CagdCrvStruct *CagdCreateConicCurve(CagdRType A,
    CagdRType B,
    CagdRType C,
    CagdRType D,
    CagdRType E,
    CagdRType F,
    CagdRType ZLevel,
    CagdBType RationalEllipses)
```

**A, B, C, D, E, F:** The six coefficients of the conic curve.

**ZLevel:** Sets the Z level of this XY parallel conic curve.

**RationalEllipses:** TRUE for rational ellipses, FALSE for a polynomial approximation.

**Returns:** A quadratic curve representing the conic.

**Description:** Construct rational quadratic curve out of the 6 coefficients of the conic section: \( A x^2 + B xy + C y^2 + D x + E y + F = 0 \). Based on: Bezier Curves and Surface Patches on Quadrics, by Josef Hoschek, Mathematical methods in Computer aided Geometric Design II, Tom Lyche and Larry L. Schumaker (eds.), pp 331-342, 1992.

**See also:** BspCrvCreateCircle, BspCrvCreateUnitCircle, CagdCrvCreateArc, , BzrCrvCreateArc, CagdCreateConicCurve2, CagdCreateQuadricSrf,

3.2.271 CagdCreateConicCurve2 (cagd_cnc.c:226)

```c
CagdCrvStruct *CagdCreateConicCurve2(CagdRType A,
    CagdRType B,
    CagdRType C,
    CagdRType D,
    CagdRType E,
    CagdRType F,
    CagdRType ZLevel,
    const CagdRType *PStartXY,
    const CagdRType *PEndXY,
    CagdBType RationalEllipses)
```

**A, B, C, D, E, F:** The six coefficients of the conic curve.

**ZLevel:** Sets the Z level of this XY parallel conic curve.

**PStartXY, PEndXY:** Domain of conic section - starting/end points, in the XY plane. If NULL, the most complete conic possible is created.

**RationalEllipses:** TRUE for rational ellipses (if full ellipse), FALSE for a polynomial approximation.

**Returns:** A quadratic curve representing the conic.

**Description:** Construct rational quadratic curve out of the 6 coefficients of the conic section: \( A x^2 + B xy + C y^2 + D x + E y + F = 0 \). If NULL, the most complete conic possible is created.

**See also:** BspCrvCreateCircle, BspCrvCreateUnitCircle, CagdCrvCreateArc, , BzrCrvCreateArc, CagdCreateConicCurve, CagdCreateQuadricSrf,

3.2.272 CagdCreateConicCurveSingular (cagd_cnc.c:471)

```c
CagdCrvStruct *CagdCreateConicCurveSingular(CagdRType A,
    CagdRType B,
    CagdRType C,
    CagdRType D,
    CagdRType E,
    CagdRType F,
    CagdRType ZLevel)
```

**A, B, C, D, E, F:** The six coefficients of the singular conic curve.

**ZLevel:** Sets the Z level of this XY parallel conic curve.

**Description:** Construct rational quadratic curve out of the 6 coefficients of the conic section: \( A x^2 + B xy + C y^2 + D x + E y + F = 0 \). If NULL, the most complete conic possible is created.

**See also:** BspCrvCreateCircle, BspCrvCreateUnitCircle, CagdCrvCreateArc, , BzrCrvCreateArc, CagdCreateConicCurve, CagdCreateQuadricSrf,
Returns: A line/list of lines representing the singular conic.

Description: Handles construction of singular conics, when the conic degenerates into line/2lines out of the 6 coefficients: \( A x^2 + B xy + C y^2 + D x + E y + F = 0 \). The conic is singular if the following 3x3 determinant vanishes:

\[
\begin{vmatrix}
A & 0.5*B & 0.5*D \\
0.5*B & C & 0.5*E \\
0.5*D & 0.5*E & F
\end{vmatrix}
\]

See also [http://mathworld.wolfram.com/QuadraticCurve.html](http://mathworld.wolfram.com/QuadraticCurve.html).

See also: CagdCreateConicCurve,

### 3.2.273 CagdCreateQuadricSrf (cagdnc.c:1348)

CagdSrfStruct *CagdCreateQuadricSrf(CagdRType A,
CagdRType B,
CagdRType C,
CagdRType D,
CagdRType E,
CagdRType F,
CagdRType G,
CagdRType H,
CagdRType I,
CagdRType J)


Returns: A quadric surface representing the given form.

Description: Construct rational quadric surface out of the 9 coefficients of: \( A x^2 + B y^2 + C z^2 + D x y + E x z + F y z + G x + H y + I z + J = 0 \). Based on: Bezier Curves and Surface Patches on Quadrics, by Josef Hoschek, Mathematical methods in Computer aided Geometric Design II, Tom Lyche and Larry L. Schumaker (eds.), pp 331-342, 1992.

See also: BspCrvCreateCircle, BspCrvCreateUnitCircle, CagdCrvCreateArc, , BzrCrvCreateArc, CagdCreateConicCurve, CagdCreateConicCurve2, , CagdConic2Quadric,

### 3.2.274 CagdCrv2CtrlPoly (cagdmesh.c:24)

CagdPolylineStruct *CagdCrv2CtrlPoly(const CagdCrvStruct *Crv)

Crv: To extract a control polygon from.

Returns: The control polygon of Crv.

Description: Extracts the control polygon of a curve as a polyline.

### 3.2.275 CagdCrv2DNormalField (cagd_aux.c:726)

CagdCrvStruct *CagdCrv2DNormalField(const CagdCrvStruct *Crv)

Crv: To compute a normal field for. This normal field is well defined at inflection points and is not flipped there.

Returns: Resulting normal field.

Description: Given a curve assumed to be planar, computes a normal field for the curve by rotating the tangent field 90 degrees.

See also: CagdCrvDerive, CagdCrvDeriveScalar,
3.2.276  CagdCrv2Polyline  (bsp2poly.c:1017)

CagdPolylineStruct *CagdCrv2Polyline(const CagdCrvStruct *Crv,
   int SamplesPerCurve,
   CagdBType OptiLin)

Crv:  To approximate as a polyline.

SamplesPerCurve:  Number of samples to compute on polyline.

OptiLin:  If TRUE, optimize linear curves.

Returns:  A polyline representing the piecewise linear approximation from, or NULL in case of an error.

Description:  Routine to approx. a single curve as a polyline with TolSamples samples/tolerance. Polyline is always E3 CagdPolylineStruct type. NULL is returned in case of an error, otherwise CagdPolylineStruct.

See also:  BspCrv2Polyline, BzrCrv2Polyline, IritCurve2Polylines,

3.2.277  CagdCrvArcLenPoly  (cagdcmrg.c:744)

CagdRType CagdCrvArcLenPoly(const CagdCrvStruct *Crv)

Crv:  To bound its length.

Returns:  An upper bound on the curve Crv length as the length of Crv's control polygon.

Description:  Computes a bound on the arc length of a curve by computing the length of its control polygon.

See also:  CagdLimitCrvArcLen, CagdSrfAvgArgLenMesh,

3.2.278  CagdCrvBBox  (cagdbbox.c:98)

void CagdCrvBBox(const CagdCrvStruct *Crv, CagdBBoxStruct *BBox)

Crv:  To compute a bounding box for.

BBox:  Where bounding information is to be saved.

Returns:  void

Description:  Computes a bounding box for a freeform curve.

See also:  CagdCrvListBBox, CagdSrfBBox, CagdTightBBox, CagdIgnoreNonPosWeightBBox, , CagdPolygonBBox,

3.2.279  CagdCrvBiNormal  (cagdaux.c:2109)

CagdVecStruct *CagdCrvBiNormal(const CagdCrvStruct *Crv,
   CagdRType t,
   CagdBType Normalize)

Crv:  To compute (unit) binormal vector for.

t:  Location where to evaluate the binormal of Crv.

Normalize:  If TRUE, attempt is made to normalize the returned vector. If FALSE, length is a function of given parametrization.

Returns:  A pointer to a static vector holding the unit binormal information.

Description:  Given a curve Crv and a parameter value t, returns the (unit) binormal direction of Crv at t.
3.2.280  CagdCrvBlossomDegreeRaise  (blossom.c:968)

CagdCrvStruct *CagdCrvBlossomDegreeRaise(const CagdCrvStruct *Crv)

  Crv: Curve to degree raise.
  Returns: Degree raised curve, or NULL if error.
  Description: Computes a new curve with its degree raised once, given curve Crv, using blossoming.
  See also: CagdCrvBlossomDegreeRaiseN, BspCrvDegreeRaise, BzrCrvDegreeRaise, CagdCrvDegreeRaise, CagdSrfBlossomDegreeRaise,

3.2.281  CagdCrvBlossomDegreeRaiseN  (blossom.c:865)

CagdCrvStruct *CagdCrvBlossomDegreeRaiseN(const CagdCrvStruct *Crv, int NewOrder)

  Crv: Curve to degree raise.
  NewOrder: New desired order of curve Crv.
  Returns: Degree raised curve, or NULL if error.
  Description: Computes a new curve with its degree raised to NewOrder, given curve Crv, using blossoming.
  See also: CagdCrvBlossomDegreeRaise, BspCrvDegreeRaise, BzrCrvDegreeRaise, CagdCrvDegreeRaise, CagdSrfBlossomDegreeRaiseN,

3.2.282  CagdCrvBlossomEval  (blossom.c:456)

CagdRType *CagdCrvBlossomEval(const CagdCrvStruct *Crv, const CagdRType *BlsmVals, int BlsmLen)

  Crv: Curve to blossom.
  BlsmVals: Blossoming values to consider.
  BlsmLen: Length of BlsmVals vector; assumed less than curve order!
  Returns: Evaluated Blossom.
  Description: Computes the Blossom over the given curve, Crv, and Blossoming factors BlsmVals.
  See also: CagdSrfBlossomEval, CagdSrfBlossomEvalU,

3.2.283  CagdCrvCopy  (cagd1gen.c:720)

CagdCrvStruct *CagdCrvCopy(const CagdCrvStruct *Crv)

  Crv: To be copied.
  Returns: A duplicate of Crv.
  Description: Allocates and copies all slots of a curve structure.

3.2.284  CagdCrvCopyList  (cagd1gen.c:1145)

CagdCrvStruct *CagdCrvCopyList(const CagdCrvStruct *CrvList)

  CrvList: To be copied.
  Returns: A duplicated list of curves.
  Description: Allocates and copies a list of curve structures.
3.2.285  CagdCrvCreateArc (cagd\_arc.c:137)

CagdCrvStruct *CagdCrvCreateArc(const CagdPtStruct *Center,
                                    CagdRType Radius,
                                    CagdRType StartAngle,
                                    CagdRType EndAngle)

Center: Point of arc.
Radius: Of arc.
StartAngle: Starting angle of arc, in degrees.
EndAngle: End angle of arc, in degrees.

Returns: A rational quadratic Bezier (or Bspline) curve representing the arc.

Description: Creates an arc at the specified position as a rational quadratic Bspline curve, with up to two Bezier pieces. The arc is defined from StartAngle to EndAngle counterclockwise, and is assumed to be less than 360 degrees from Start to End.

See also: BspCrvCreateCircle, BspCrvCreateUnitCircle, BspCrvCreatePCircle, , CagdCreateConicCurve, BzrcrvCreateArc, BspCrvCreateUnitPCircle, , CagdCrvCreateArcCCW, CagdCrvCreateArcCW,

3.2.286  CagdCrvCreateArcCCW (cagd\_arc.c:203)

CagdCrvStruct *CagdCrvCreateArcCCW(const CagdPtStruct *Start,
                                      const CagdPtStruct *Center,
                                      const CagdPtStruct *End)

Start: Starting position of arc.
Center: Center point of arc.
End: End position of arc.

Returns: A rational quadratic Bezier (or Bspline) curve representing the arc, or NULL if error.

Description: Creates a counter clockwise arc at the specified position as a rational quadratic Bspline curve, with up to two Bezier pieces. The arc is defined from Start to End, and is assumed to be less than or equal to 360 degrees (full circle, if Start == End).

See also: BspCrvCreateCircle, BspCrvCreateUnitCircle, BspCrvCreatePCircle, , CagdCreateConicCurve, BzrcrvCreateArc, BspCrvCreateUnitPCircle, , CagdCrvCreateArc, CagdCrvCreateArcCW,

3.2.287  CagdCrvCreateArcCW (cagd\_arc.c:275)

CagdCrvStruct *CagdCrvCreateArcCW(const CagdPtStruct *Start,
                                     const CagdPtStruct *Center,
                                     const CagdPtStruct *End)

Start: Starting position of arc.
Center: Center point of arc.
End: End position of arc.

Returns: A rational quadratic Bezier (or Bspline) curve representing the arc, or NULL if error.

Description: Creates a counter clockwise arc at the specified position as a rational quadratic Bspline curve, with up to two Bezier pieces. The arc is defined from Start to End, and is assumed to be less than or equal to 360 degrees (full circle, if Start == End).

See also: BspCrvCreateCircle, BspCrvCreateUnitCircle, BspCrvCreatePCircle, , CagdCreateConicCurve, BzrcrvCreateArc, BspCrvCreateUnitPCircle, , CagdCrvCreateArc, CagdCrvCreateArcCCW,
3.2.288  CagdCrvCrvInter  (cagd_cci.c:222)

CagdPtStruct *CagdCrvCrvInter(const CagdCrvStruct *Crv1,
   const CagdCrvStruct *Crv2,
   CagdRType Eps)

Crv1, Crv2: Two curves to compute their intersection points.
Eps: Accuracy of computation.
Returns: List of intersection points. Each points would contain (u1, u2, 0.0).
Description: Computes the intersection points, if any, of the two given curves.
See also: CagdCrvTanAngularSpan, SymbCrvCrvInter, UserSrfsrInter, , CagdCrvCrvInterArrangement,

3.2.289  CagdCrvCrvInterArrangement  (cagd_cci.c:641)

CagdCrvStruct *CagdCrvCrvInterArrangement(const CagdCrvStruct *ArngCrvs,
   CagdBType SplitCrvs,
   CagdRType Eps)

ArngCrvs: Curves to intersect.
SplitCrvs: TRUE, to also split the curves at detected intersections.
Eps: Tolerance of CCI computations.
Returns: (Sub) curves as split due to cci's, or identical curves with "InterPts" attributes.
Description: Computes the intersections in the plane between all given curves and optionally split the curves
at those parameters. If the curves are not split, a list of intersection parameters is returned in an attribute called
"InterPts", holding the parameter in X coordinate of pts.
See also: CagdCrvCrvInter, SymbCrvCrvInter, CagdCrvsLowerEnvelop,

3.2.290  CagdCrvDegreeRaise  (cagd_aux.c:1513)

CagdCrvStruct *CagdCrvDegreeRaise(const CagdCrvStruct *Crv)

Crv: To raise its degree.
Returns: A curve with same geometry as Crv but with one degree higher.
Description: Returns a new curve representing the same curve as Crv but with its degree raised by one.

3.2.291  CagdCrvDegreeRaiseN  (cagd_aux.c:1575)

CagdCrvStruct *CagdCrvDegreeRaiseN(const CagdCrvStruct *Crv, int NewOrder)

Crv: To raise its degree.
NewOrder: Expected new order of the raised curve.
Returns: A curve with same geometry as Crv but with order that is equal to NewOrder.
Description: Returns a new curve representing the same curve as Crv but with its degree raised to NewOrder

3.2.292  CagdCrvDegreeReduce  (cagd_aux.c:1543)

CagdCrvStruct *CagdCrvDegreeReduce(const CagdCrvStruct *Crv)

Crv: To raise its degree.
Returns: A curve with same geometry as Crv but with one degree higher.
Description: Returns a new curve representing the same curve as Crv but with its degree raised by one.
3.2.293  CagdCrvDeletePoint (cagdedit.c:146)

CagdCrvStruct *CagdCrvDeletePoint(const CagdCrvStruct *Crv, int Index)

Crv: Input curve to delete a point from.
Index: Index of control point to delete from Crv.

Returns: A new curve of length smaller by one than Crv.

Description: Delete a point at Index from curve Crv. Returned curve's length is smaller by one than the length of Crv. Knot vector is updated (if B spline curve) to a uniform open. Order of curve is reduced if greater than new number of control points.
See also: CagdCrvInsertPoint

3.2.294  CagdCrvDerive (cagd_aux.c:556)

CagdCrvStruct *CagdCrvDerive(const CagdCrvStruct *Crv)

Crv: To compute its Hodograph curve.

Returns: Resulting hodograph.

Description: Given a curve, computes its derivative curve (Hodograph).
See also: BzrCrvDerive, BspCrvDerive, BzrCrvDeriveRational, BspCrvDeriveRational, CagdCrvDeriveScalar, CagdCrvScalarCrvSlopeBounds

3.2.295  CagdCrvDeriveScalar (cagd_aux.c:591)

CagdCrvStruct *CagdCrvDeriveScalar(const CagdCrvStruct *Crv)

Crv: To compute derivatives of all its components.

Returns: Resulting derivative.

Description: Given a curve, computes the derivative of all is scalar components. For a Euclidean curve this is the same as CagdCrvDerive but for a rational curve the returned curves is not the vector field but simply the derivatives of all the curve’s coefficients, including the weights.
See also: BzrCrvDerive, BspCrvDerive, BzrCrvDeriveRational, BspCrvDeriveRational, CagdCrvDerive, BzrCrvDeriveScalar, BspCrvDeriveScalar

3.2.296  CagdCrvDomain (cagd_aux.c:32)

void CagdCrvDomain(const CagdCrvStruct *Crv, CagdRType *TMin, CagdRType *TMax)

Crv: To get its parametric domain.
TMin: Where to put the minimal domain’s boundary.
TMax: Where to put the maximal domain’s boundary.

Returns: void

Description: Returns the parametric domain of a curve.
See also: BspCrvDomain,
3.2.297 CagdCrvEval (cagd_aux.c:122)

CagdRType *CagdCrvEval(const CagdCrvStruct *Crv, CagdRType t)

Crv: To evaluate at the given parametric location t.
    t: The parameter value at which the curve Crv is to be evaluated.

Returns: A vector holding all the coefficients of all components of curve Crv’s point type. If for example the curve's point type is P2, the W, X, and Y will be saved in the first three locations of the returned vector. The first location (index 0) of the returned vector is reserved for the rational coefficient W and XYZ always starts at second location of the returned vector (index 1). This vector is allocated statically and a second invocation of this function will overwrite the first.

Description: Given a curve and parameter value t, evaluate the curve at t.
See also: BzrCrvEvalAtParam, BspCrvEvalAtParam, BzrCrvEvalVecAtParam, , BspCrvEvalVecAtParam, BspCrvEvalCoxDeBoor, CagdCrvEvalToPolyline,

3.2.298 CagdCrvEvalToPolyline (cbspEval.c:135)

int CagdCrvEvalToPolyline(const CagdCrvStruct *Crv, int FineNess, CagdRType *Points[], BspKnotAlphaCoeffStruct *A, CagdBType OptiLin)

Crv: To approximate as a polyline.
    FineNess: Control on number of samples.
    Points: Where to put the resulting polyline.
    A: Optional alpha matrix for refinement.
    OptiLin: If TRUE, optimize linear curves.

Returns: The actual number of samples placed in Points. Always less than or equal to FineNess.

Description: Samples the curve at FineNess location equally spaced in the curve’s parametric domain. Computes a refinement alpha matrix (If FineNess > 0), refines the curve and uses refined control polygon as the approximation to the curve. If FineNess == 0, Alpha matrix A is used instead. Returns the actual number of points in polyline (<= FineNess). Note this routine may be invoked with Bezier curves as well as Bspline.
See also: BzrCrvEvalToPolyline, AfdBzrCrvEvalToPolyline, CagdCrvEval,

3.2.299 CagdCrvFirstMoments (cbsp_int.c:1445)

void CagdCrvFirstMoments(const CagdCrvStruct *Crv, int n, CagdPType Loc, CagdVType Dir)

Crv: To compute zero and first moment.
    n: Number of samples the curve should be sampled at.
    Loc: Center of curve as zero moment.
    Dir: Main direction of curve as first moment.

Returns: void
Description: Computes zero and first moments of a curve.

3.2.300 CagdCrvFree (cagd2gen.c:217)

void CagdCrvFree(CagdCrvStruct *Crv)

Crv: To be deallocated.

Returns: void
Description: Deallocaotes and frees all slots of a curve structure.
3.2.301  CagdCrvFreeList  (cagd2gen.c:268)

void CagdCrvFreeList(CagdCrvStruct *CrvList)

  CrvList: To be deallocated.
  Returns: void
  Description: Deallocates and frees a curve structure list:

3.2.302  CagdCrvFromMesh  (cagd_aux.c:1791)

CagdCrvStruct *CagdCrvFromMesh(const CagdSrfStruct *Srf,
                                int Index,
                                CagdSrfDirType Dir)

  Srf: To extract a curve from.
  Index: Index along the mesh of Srf to extract the curve from.
  Dir: Direction of extracted curve. Either U or V.
  Returns: A curve from Srf. This curve inherit the order and continuity of surface Srf in direction Dir. However, this curve is not on surface Srf, in general.
  Description: Extracts a curve from the mesh of surface Srf in direction Dir at index Index.
  See also: CagdCrvFromSrf, BzrSrfCrvFromSrf, BspSrfCrvFromSrf, BzrSrfCrvFromMesh, , BspSrfCrvFromMesh, CagdCrvToMesh,

3.2.303  CagdCrvFromSrf  (cagd_aux.c:1686)

CagdCrvStruct *CagdCrvFromSrf(const CagdSrfStruct *Srf,
                                CagdRType t,
                                CagdSrfDirType Dir)

  Srf: To extract an isoparametric curve from.
  t: Parameter value of extracted isoparametric curve.
  Dir: Direction of extracted isoparametric curve. Either U or V.
  Returns: An isoparametric curve of Srf. This curve inherit the order and continuity of surface Srf in direction Dir.
  Description: Extracts an isoparametric curve from the surface Srf in direction Dir at the parameter value of t.
  See also: BzrSrfCrvFromSrf, BspSrfCrvFromSrf, CagdCrvFromMesh, BzrSrfCrvFromMesh, , BspSrfCrvFromMesh, TrngCrvFromTriSrf,

3.2.304  CagdCrvInsertPoint  (cagdedit.c:90)

CagdCrvStruct *CagdCrvInsertPoint(const CagdCrvStruct *Crv,
                                   int Index,
                                   const CagdPType Pt)

  Crv: Input curve to insert a new point into.
  Index: Index of control point to insert into Crv. Zero inserts at first location in Crv.
  Pt: New point to insert that will be coerced to Crv point type.
  Returns: A new curve of length larger by one than Crv.
  Description: Inserts a new point Pt at Index into curve Crv. Returned curve’s length is larger by one than the length of Crv. Knot vector is updated (if B spline curve) to a uniform open.
  See also: CagdCrvDeletePoint,
3.2.305  **CagdCrvIntegrate** *(cagd_aux.c:693)*

```c
CagdCrvStruct *CagdCrvIntegrate(const CagdCrvStruct *Crv)
```

- **Crv**: To compute its integral curve.
- **Returns**: Resulting integral curve.
- **Description**: Given a curve, compute its integral curve.
- **See also**: BzrCrvIntegrate, BspCrvIntegrate,

3.2.306  **CagdCrvIsCtlPolyMonotone** *(cagd_aux.c:806)*

```c
int CagdCrvIsCtlPolyMonotone(const CagdCrvStruct *Crv, int Axis, CagdRType Eps)
```

- **Crv**: To examine if monotone in axis Axis.
- **Axis**: 1 for X, 2 for Y, etc.
- **Eps**: For monotonicity epsilon test. Zero for strictly monotone.
- **Returns**: 1 if increasingly monotone in axis Axis, -1 if decreasingly monotone and 0 otherwise.
- **Description**: Examines if the given curve’s control polygon is monotone in given Axis.

3.2.307  **CagdCrvListBBox** *(cagdbbox.c:153)*

```c
void CagdCrvListBBox(const CagdCrvStruct *Crvs, CagdBBoxStruct *BBox)
```

- **Crvs**: To compute a bounding box for.
- **BBox**: Where bounding information is to be saved.
- **Returns**: void
- **Description**: Computes a bounding box for a list of freeform curves.
- **See also**: CagdCrvBBox, CagdSrfBBox, CagdTightBBox,

3.2.308  **CagdCrvMatTransform** *(cagd2gen.c:1443)*

```c
CagdCrvStruct *CagdCrvMatTransform(const CagdCrvStruct *Crv, CagdMType Mat)
```

- **Crv**: To be transformed.
- **Mat**: Defining the transformation.
- **Returns**: Returned transformed curve.
- **Description**: Applies an homogeneous transformation, to the given curve Crv as specified by homogeneous transformation Mat.
- **See also**: CagdTransform, CagdSrfMatTransform, CagdMatTransform, CagdCrvRotateToXY,

3.2.309  **CagdCrvMinMax** *(cagdbbox.c:566)*

```c
void CagdCrvMinMax(const CagdCrvStruct *Crv,
                   int Axis,
                   CagdRType *Min,
                   CagdRType *Max)
```

- **Crv**: To test for minimum/maximum.
- **Axis**: 0 for W, 1 for X, 2 for Y etc.
- **Min**: Where minimum found value should be place.
- **Max**: Where maximum found value should be place.
- **Returns**: void
- **Description**: Computes a min max bound on a curve in a given axis. The curve is not coerced to anything and the given axis is tested directly where 0 is the W axis and 1, 2, 3 are the X, Y, Z etc.
3.2.310  **CagdCrvMoebiusTransform** (cagd\_aux.c:768)

```c
CagdCrvStruct *CagdCrvMoebiusTransform(const CagdCrvStruct *Crv, CagdRType c)
```

**Crv:** To compute its moebius transformation.

**c:** The scaling coefficient - c\(^n\) is the ratio between the first and last weight of the curve. If c == 0, the first and last weights are made equal.

**Returns:** Resulting curve after the moebius transformation.

**Description:** Given a curve, compute its moebius transformation.

**See also:** BzrCrvMoebiusTransform, BspCrvMoebiusTransform

3.2.311  **CagdCrvNew** (cagd1gen.c:32)

```c
CagdCrvStruct *CagdCrvNew(CagdGeomType GType, CagdPointType PType, int Length)
```

**GType:** Type of geometry the curve should be - Bspline, Bezier etc.

**PType:** Type of control points (E2, P3, etc.).

**Length:** Number of control points

**Returns:** An uninitialized freeform curve.

**Description:** Allocates the memory required for a new curve.

**See also:** BzrCrvNew, BspPeriodicCrvNew, bspCrvNew, CagdPeriodicCrvNew, TrimCrvNew

3.2.312  **CagdCrvNodes** (bsp\_knot.c:1624)

```c
CagdRType *CagdCrvNodes(const CagdCrvStruct *Crv)
```

**Crv:** To compute node values for.

**Returns:** Node values of the given curve.

**Description:** Returns the nodes of a freeform curve.

3.2.313  **CagdCrvNormal** (cagd\_aux.c:2145)

```c
CagdVecStruct *CagdCrvNormal(const CagdCrvStruct *Crv, CagdRType t, CagdBType Normalize)
```

**Crv:** To compute (unit) normal vector for.

**t:** Location where to evaluate the normal of Crv.

**Normalize:** If TRUE, attempt is made to normalize the returned vector. If FALSE, length is a function of given parametrization.

**Returns:** A pointer to a static vector holding the unit normal information.

**Description:** Given a curve Crv and a parameter value t, returns the (unit) normal direction of Crv at t.

3.2.314  **CagdCrvNormalXY** (cagd\_aux.c:2184)

```c
CagdVecStruct *CagdCrvNormalXY(const CagdCrvStruct *Crv, CagdRType t, CagdBType Normalize)
```

**Crv:** To compute (unit) normal vector for.

**t:** Location where to evaluate the normal of Crv.

**Normalize:** If TRUE, attempt is made to normalize the returned vector. If FALSE, length is a function of given parametrization.

**Returns:** A pointer to a static vector holding the unit normal information.

**Description:** Given a curve Crv and a parameter value t, returns the (unit) normal direction of Crv at t, that is consistent over inflection points. That is, this normal is not flipped over inflection points and is always 90 rotation from the tangent vector. Needless to say, this function is for two dimensional planar curves.
3.2.315  CagdCrvOnOneSideOfLine (cagd_aux.c:2597)

```c
CagdBType CagdCrvOnOneSideOfLine(const CagdCrvStruct *Crv,
    CagdRType X1,
    CagdRType Y1,
    CagdRType X2,
    CagdRType Y2)
```

**Crv:** Curve to examine if totally on one side of the line, in XY plane.

**X1, Y1:** First points defining the line in the XY plane.

**X2, Y2:** First points defining the line in the XY plane.

**Returns:** TRUE if Crv totally on one side of the line between (X1, Y1) and (X2, Y2), in the XY plane, or FALSE otherwise.

**Description:** Examines if the given curve is totally on one side of the line prescribed by points (X1, Y1) and (X2, Y2), in the XY plane.

3.2.316  CagdCrvOrientationFrame (cagdswep.c:509)

```c
CagdBType CagdCrvOrientationFrame(CagdCrvStruct *Crv,
    CagdRType CrntT,
    CagdVecStruct *Tangent,
    CagdVecStruct *Normal,
    CagdBType FirstTime)
```

**Crv:** Curve to evaluate orientation frame for.

**CrntT:** Parameter value where to evaluate.

**Tangent:** Of curve at parameter value t.

**Normal:** Of curve at parameter value t.

**FirstTime:** TRUE if first time to compute a frame for this curve.

**Returns:** TRUE if computed, FALSE if error/failed.

**Description:** Estimates an orientation frame (tangent and normal) for the given curve at the given parameter t.

3.2.317  CagdCrvRefineAtParams (cagd_aux.c:1317)

```c
CagdCrvStruct *CagdCrvRefineAtParams(const CagdCrvStruct *Crv,
    CagdBType Replace,
    CagdRType *t,
    int n)
```

**Crv:** To refine.

**Replace:** If TRUE, t holds knots in exactly the same length as the length of the knot vector of Crv and t simply replaces the knot vector.

**t:** Vector of knots with length of n.

**n:** Length of vector t.

**Returns:** A refined curve of Crv after insertion of all the knots as specified by vector t of length n.

**Description:** Given a curve - refines it at the given n knots as defined by vector t. If Replace is TRUE, the values in t replaces current knot vector. Returns pointer to refined surface (Note a Bezier curve will be converted into a B spline curve).
3.2.318  **CagdCrvRegionFromCrv** (cagd\_aux.c:1223)

```c
CagdCrvStruct *CagdCrvRegionFromCrv(const CagdCrvStruct *Crv,
                                      CagdRType t1,
                                      CagdRType t2)
```

- **Crv:** To extract a sub-region from.
- **t1, t2:** Parametric domain boundaries of sub-region.

**Returns:** Sub-region extracted from Crv from t1 to t2.

**Description:** Given a curve - extracts a sub-region within the domain specified by t1 and t2.

3.2.319  **CagdCrvReverse** (cagd\_aux.c:1356)

```c
CagdCrvStruct *CagdCrvReverse(const CagdCrvStruct *Crv)
```

- **Crv:** To be reversed.

**Returns:** Reversed curve of Crv.

**Description:** Returns a new curve that is the reversed curve of Crv by reversing the control polygon and the knot vector of Crv is a Bspline curve. See also BspKnotReverse.

**See also:** CagdCrvReverseUV,

3.2.320  **CagdCrvReverseUV** (cagd\_aux.c:1417)

```c
CagdCrvStruct *CagdCrvReverseUV(const CagdCrvStruct *Crv)
```

- **Crv:** To be UV reversed.

**Returns:** UV reversed curve of Crv.

**Description:** Returns a new curve in which the first two (UV or XY) coordinates are reversed from the input Crv.

**See also:** CagdCrvReverse,

3.2.321  **CagdCrvRotateToXY** (cagd2gen.c:1786)

```c
CagdCrvStruct *CagdCrvRotateToXY(const CagdCrvStruct *Crv)
```

- **Crv:** To rotate, to the XY plane.

**Returns:** Rotated Crv if reasonably successful, NULL if failed.

**Description:** Rotates the given (hopefully planar) curve to the XY plane. If the curve is not planar, the rotation is heuristic and is not optimal in any sense.

**See also:** CagdCrvTransform, CagdCrvMatTransform, CagdCrvRotateToXYMat,

3.2.322  **CagdCrvRotateToXYMat** (cagd2gen.c:1786)

```c
int CagdCrvRotateToXYMat(const CagdCrvStruct *Crv, IrtHmgnMatType Mat)
```

- **Crv:** To compute a matrix that rotate (and possibly translate) Crv to the XY plane.
- **Mat:** Defining the transformation.

**Returns:** TRUE if reasonably successful, FALSE if failed.

**Description:** Computes a rotation matrix to rotate the given (hopefully planar) curve to the XY plane, in place. If the curve is not planar, the rotation is heuristic and is not optimal in any sense.

**See also:** CagdCrvTransform, CagdCrvMatTransform, CagdCrvRotateToXY,
3.2.323 CagdCrvScalarCrvSlopeBounds (cagd\_aux.c:626)

```c
void CagdCrvScalarCrvSlopeBounds(const CagdCrvStruct *Crv,
                                 CagdRType *MinSlope,
                                 CagdRType *MaxSlope)
```

- **Crv**: Scalar curve to estimate its extreme slopes.
- **MinSlope**: Minimal slope detected.
- **MaxSlope**: Maximal slope detected.

**Returns**: void

**Description**: Compute slopes' bounds to a scalar curve.

**See also**: CagdCrvDerive,

3.2.324 CagdCrvScale (cagd2gen.c:1230)

```c
void CagdCrvScale(CagdCrvStruct *Crv, const CagdRType *Scale)
```

- **Crv**: To be nonuniformly scaled.
- **Scale**: Scaling amount.

**Returns**: void

**Description**: Applies a nonuniform scaling transform, in place, to given curve Crv as specified by Scale.

**See also**: CagdSrfTransform, CagdTransform, CagdCrvMatTransform, CagdCrvRotateToXY, CagdCrvTransform,

3.2.325 CagdCrvSetDomain (cagd\_aux.c:69)

```c
CagdCrvStruct *CagdCrvSetDomain(CagdCrvStruct *Crv,
                                  CagdRType TMin,
                                  CagdRType TMax)
```

- **Crv**: To reset its parametric domain.
- **TMin**: Minimal domain's new boundary.
- **TMax**: Maximal domain's new boundary.

**Returns**: Modified curve, in place.

**Description**: Affinely reset the parametric domain of a curve, in place.

**See also**: BspCrvDomain, BspKnotAffineTrans2, CagdSrfSetDomain,

3.2.326 CagdCrvSubdivAtAllC1Discont (cagd\_aux.c:1458)

```c
CagdCrvStruct *CagdCrvSubdivAtAllC1Discont(const CagdCrvStruct *Crv,
                                             IrtBType EuclideanC1Discont,
                                             IrtRType Tolerance)
```

- **Crv**: To subdivide at all C\(^1\) potential discontinuity locations.
- **EuclideanC1Discont**: TRUE to compute the C\(^1\) discontinuities and verify them in the Euclidean space. FALSE to only consider C\(^1\) discontinuities by knot multiplicity in parametric space.
- **Tolerance**: Of parametric C\(^1\) discontinuity that is also a Euclidean discontinuity - deviation from inner product of unit tangents before and after discontinuity by less than Tolerance (1.0 if tangent identical, 0.0 if orthogonal, -1.0 if opposite). Ignored if < -1.0 or EuclideanC1Discont is FALSE.

**Returns**: Curve segments result from the subdivision.

**Description**: Subdivides the given curve at all C\(^1\) potential discontinuity locations.

**See also**: CagdCrvSubdivAtParams, BspKnotAllC1Discont,
3.2.327  CagdCrvSubdivAtParam (cagd_aux.c:1045)

CagdCrvStruct *CagdCrvSubdivAtParam(const CagdCrvStruct *Crv, CagdRType t)

Crv:  To subdivide at the prescribed parameter value t.

Returns: A list of the two curves resulting from the process of subdivision.

Description: Given a curve - subdivides it into two curves at the given parameter value t. Returns pointer to first curve in a list of two subdivided curves.

See also: CagdCrvSubdivAtParams,

3.2.328  CagdCrvSubdivAtParams (cagd_aux.c:1149)

CagdCrvStruct *CagdCrvSubdivAtParams(const CagdCrvStruct *CCrv, const CagdPtStruct *Pts, CagdRType Eps, int *Proximity)

CCrv: Curve to split at all parameter values as prescribed by Pts. Bezier curves are promoted to Bspline curves in this function.

Pts: Ordered list of parameter values (first coordinate of point) to split curve Crv at.

Eps: parameter closer than Eps to boundary or other parameters are ignored.

Proximity: A 3 bits marker to return if the first (last) parameter was too close to the boundary and/or two middle parameters were too close and one of them was ignored as follows, 0x01 - first parameter to split at was too close to the boundary. 0x02 - last parameter to split at was too close to the boundary. 0x04 - a middle parameter was too close to another parameter.

Returns: List of splitted curves, in order.

Description: Given a curve - subdivides it into curves at all the given parameter values Pts. Pts is assumed to hold the parameters in order in the first point coordinate. Returns pointer to first curve in a list of subdivided curves.

See also: CagdCrvSubdivAtParam, CagdCrvSubdivAtParams2,

3.2.329  CagdCrvSubdivAtParams2 (cagd_aux.c:1096)

CagdCrvStruct *CagdCrvSubdivAtParams2(const CagdCrvStruct *CCrv, const CagdPtStruct *Pts, int Idx, CagdRType Eps, int *Proximity)

CCrv: Curve to split at all parameter values as prescribed by Pts. Bezier curves are promoted to Bspline curves in this function.

Pts: Ordered list of parameter values (first coordinate of point) to split curve Crv at.

Idx: Index of parameter in Pts points: 0 for X, 1 for Y, etc.

Eps: parameter closer than Eps and/or closer to boundary than Eps are ignored.

Proximity: A 3 bits marker to return if the first (last) parameter was too close to the boundary and/or two middle parameters were too close and one of them was ignored as follows 0x01 - first parameter to split at was too close to the boundary. 0x02 - last parameter to split at was too close to the boundary. 0x04 - a middle parameter was too close to another parameter.

Returns: List of splitted curves, in order.

Description: Given a curve - subdivides it into curves at all the given parameter values Pts. Pts can hold the parameters in any order in the Idx point coordinate. Returns pointer to first curve in a list of subdivided curves.

See also: CagdCrvSubdivAtParam, CagdCrvSubdivAtParams,
### 3.2.330 CagdCrvTanAngularSpan (cagd.ccl.c:59)

CagdBType CagdCrvTanAngularSpan(const CagdCrvStruct *Crv,  
CagdVType ConeDir,  
CagdRType *AngularSpan)

**Crv**: Curve to consider  
**ConeDir**: General, median, direction of tangent field, in XY plane.  
**AngularSpan**: Maximal deviation of tangent field from Dir, in radians.  

**Returns**: TRUE if angular span of curve is less than 180 degrees, FALSE otherwise. In the later case, Dir and Angle are invalid.  

**Description**: Given a curve, computes the angular span of its tangent field, in XY plane.  
**See also**: CagdCrvCrvInter,

### 3.2.331 CagdCrvTangent (cagd.aux.c:2073)

CagdVecStruct *CagdCrvTangent(const CagdCrvStruct *Crv,  
CagdRType t,  
CagdBType Normalize)

**Crv**: To compute (unit) tangent vector for.  
**t**: Location where to evaluate the tangent of Crv.  
**Normalize**: If TRUE, attempt is made to normalize the returned vector. If FALSE, returned is an unnormalized vector in the right direction of the tangent.  

**Returns**: A pointer to a static vector holding the unit tangential information.  

**Description**: Given a curve Crv and a parameter value t, returns the (unit) tangent direction of Crv at t. The unnormalized normal does not equal dC/dt in its magnitude, only in its direction.

### 3.2.332 CagdCrvToMesh (cagd.aux.c:1831)

void CagdCrvToMesh(const CagdCrvStruct *Crv,  
int Index,  
CagdSrfDirType Dir,  
CagdSrfStruct *Srf)

**Crv**: To substitute into the surface Srf.  
**Index**: Of mesh where the curve Crv should be substituted in.  
**Dir**: Either U or V.  
**Srf**: That a row or a column of should be replaced by Crv.  

**Returns**: void  

**Description**: Substitutes a row/column of surface Srf from the given curve Crv at surface direction Dir and mesh index Index. Curve must have the same PtType/Length as the surface in the selected direction.  
**See also**: CagdCrvFromSrf, CagdCrvFromMesh,

### 3.2.333 CagdCrvTransform (cagd2gen.c:1190)

void CagdCrvTransform(CagdCrvStruct *Crv,  
const CagdRType *Translate,  
CagdRType Scale)

**Crv**: To be affinely transformed.  
**Translate**: Translation amount, NULL for non.  
**Scale**: Scaling amount.  

**Returns**: void  

**Description**: Applies an affine transform, in place, to given curve Crv as specified by Translate and Scale. Each control point is first translated by Translate and then scaled by Scale.  
**See also**: CagdSrfTransform, CagdTransform, CagdCrvMatTransform, CagdCrvRotateToXY, CagdCrvScale,
3.2.334  CagdCrvTwoCrvsOrient (crvmatch.c:1129)

int CagdCrvTwoCrvsOrient(CagdCrvStruct *Crv1, CagdCrvStruct *Crv2, int n)

Crv1, Crv2: The two curves to consider.
  n: Number of samples to take on the curves.

Returns: TRUE if needs to reverse, FALSE if as is is better.

Description: Check if matched points on the given two curves are closer as is or when one of the curves is reversed.

3.2.335  CagdCrvUnitMaxCoef (cagd2gen.c:1621)

CagdCrvStruct *CagdCrvUnitMaxCoef(CagdCrvStruct *Crv)

Crv: Curve to normalize in place its coefficients.

Returns: Normalized curve.

Description: Normalize in place the given curve so its maximal coefficient is of unit size.
See also: CagdSrfUnitMaxCoef,

3.2.336  CagdCrvUpdateLength (cagd1gen.c:1910)

CagdCrvStruct *CagdCrvUpdateLength(CagdCrvStruct *Crv, int NewLength)

Crv: Curve to update its length.
  NewLength: New length to reallocate for the curve.

Returns: Resized curve, in place.

Description: Resize the length of the curve, in place. The new curve is not the same as the original while a minimal effort is invested to keep it similar.
See also: CagdSrfUpdateLength,

3.2.337  CagdCrvsSame (cagd1gen.c:1665)

CagdBType CagdCrvsSame(const CagdCrvStruct *Crv1,
const CagdCrvStruct *Crv2,
CagdRType Eps)

Crv1, Crv2: The two curves to compare.
  Eps: Tolerance of equality.

Returns: TRUE if curves are the same, FALSE otherwise.

Description: Compare the two curves for similarity.
See also: CagdCtlMeshsSame, BspKnotVectorsSame, CagdSrfsSame, CagdCrvsSame2, , CagdCrvsSameUptoRigidScl2D, CagdSrfsSameUptoRigidScl2D,

3.2.338  CagdCrvsSame2 (cagd1gen.c:1714)

CagdBType CagdCrvsSame2(const CagdCrvStruct *Crv1,
const CagdCrvStruct *Crv2,
CagdRType Eps)

Crv1, Crv2: The two curves to compare.
  Eps: Tolerance of equality.

Returns: TRUE if curves are the same, FALSE otherwise.

Description: Compare the two curves for similarity, after bringing them to a common function space, by degree raising and refinement.
See also: CagdCtlMeshsSame, BspKnotVectorsSame, CagdCrvsSame, , CagdCrvsSameUptoRigidScl2D, CagdSrfsSameUptoRigidScl2D,
3.2.339 CagdCrvsSameUptoRigidScl2D (cagd1gen.c:1617)

CagdBType CagdCrvsSameUptoRigidScl2D(const CagdCrvStruct *Crv1,
    const CagdCrvStruct *Crv2,
    IrtPtType Trans,
    CagdRType *Rot,
    CagdRType *Scl,
    CagdRType Eps)

Crv1, Crv2: The two curves to compare.
Trans: Translation amount to apply to Crv1 to bring to Crv2 (after rotation/scale).
Rot, Scl: Rotation and scale amounts to apply to Crv1 to bring to Crv2 (before translation). Rot is specified in degrees.
Eps: Tolerance of equality.

Returns: TRUE if curves are the same, FALSE otherwise. Trans & Rot are valid only if this function returns TRUE.

Description: Compare the two planar curves for similarity up to rigid motion and scale in the XY plane.
See also: CagdCtlMeshsSame, BspKnotVectorsSame, CagdSrfsSame, CagdCrvsSame, CagdSrfsSameUptoRigidScl2D,

3.2.340 CagdCtlMeshsSame (cagdcoer.c:312)

CagdBType CagdCtlMeshsSame(CagdRType * const Mesh1[],
    CagdRType * const Mesh2[],
    int Len,
    CagdRType Eps)

Mesh1, Mesh2: Two control meshs to compare.
Len: Length of control meshs.
Eps: Tolerance of equality.

Returns: TRUE if control meshs are the same, FALSE otherwise.

Description: Compare the two control meshs for similarity.
See also: BspKnotVectorsSame, CagdCrvsSame, CagdSrfsSame,

3.2.341 CagdCtlMeshsSameUptoRigidScl2D (cagdcoer.c:368)

CagdBType CagdCtlMeshsSameUptoRigidScl2D(CagdRType * const Mesh1[],
    CagdRType * const Mesh2[],
    int Len,
    IrtPtType Trans,
    CagdRType *Rot,
    CagdRType *Scl,
    CagdRType Eps)

Mesh1, Mesh2: Two control meshs to compare.
Len: Length of control meshs.
Trans: Translation amount to apply second to Mesh1 to bring to Mesh2.
Rot, Scl: Rotation and scale amounts to apply first to Mesh1 to bring to Mesh2. Rot is specified in degrees.
Eps: Tolerance of equality.

Returns: TRUE if control meshs are the same, FALSE otherwise.

Description: Compare the two control meshs for similarity up to rigid motion and scale. Comparison is conducted in the XY plane and only X and Y (and W) are considered.
See also: BspKnotVectorsSame, CagdCrvsSame, CagdSrfsSame,
### 3.2.342 CagdCtlPtArrayFree
(cagd2gen.c:633)

```c
void CagdCtlPtArrayFree(CagdCtlPtStruct *CtlPtArray, int Size)

CtlPtArray: To be deallocated.
Size: Of the deallocated array.
Returns: void
Description: Deallocates and frees an array of CtlPt structure.
```

### 3.2.343 CagdCtlPtArrayNew
(cagd1gen.c:357)

```c
CagdCtlPtStruct *CagdCtlPtArrayNew(CagdPointType PtType, int Size)

PtType: Point type of control point.
Size: Size of CtlPt array to allocate.
Returns: An array of CtlPt structures of size Size.
Description: Allocates and resets all slots of an array of CtlPt structures.
```

### 3.2.344 CagdCtlPtCopy
(cagd1gen.c:972)

```c
CagdCtlPtStruct *CagdCtlPtCopy(const CagdCtlPtStruct *CtlPt)

CtlPt: To be copied.
Returns: A duplicate of CtlPt.
Description: Allocates and copies all slots of a CtlPt structure.
```

### 3.2.345 CagdCtlPtCopyList
(cagd1gen.c:1290)

```c
CagdCtlPtStruct *CagdCtlPtCopyList(const CagdCtlPtStruct *CtlPtList)

CtlPtList: To be copied.
Returns: A duplicated list of CtlPt’s.
Description: Allocates and copies a list of CtlPt structures.
```

### 3.2.346 CagdCtlPtFree
(cagd2gen.c:585)

```c
void CagdCtlPtFree(CagdCtlPtStruct *CtlPt)

CtlPt: To be deallocated.
Returns: void
Description: Deallocates and frees all slots of a CtlPt structure.
```

### 3.2.347 CagdCtlPtFreeList
(cagd2gen.c:608)

```c
void CagdCtlPtFreeList(CagdCtlPtStruct *CtlPtList)

CtlPtList: To be deallocated.
Returns: void
Description: Deallocates and frees a CtlPt structure list:
```
3.2.348 **CagdCtlPtNew** (cagd1gen.c:386)

CagdCtlPtStruct *CagdCtlPtNew(CagdPointType PtType)

**PtType:** Point type of control point.
**Returns:** A CtlPt structure.
**Description:** Allocates and resets all slots of a CtlPt structure.

3.2.349 **CagdCubicHermiteCrv** (hermite.c:29)

CagdCrvStruct *CagdCubicHermiteCrv(const CagdPType Pt1, const CagdPType Pt2, const CagdVType Dir1, const CagdVType Dir2)

**Pt1, Pt2:** Starting and end points of curve.
**Dir1, Dir2:** Starting and end vectors of curve.
**Returns:** A cubic Bezier curve, satisfying the four constraints.
**Description:** Construct a cubic Bezier curve using the Hermite constraints - two positions and two tangents.

3.2.350 **CagdCubicHermiteSrf** (hermite.c:67)

CagdSrfStruct *CagdCubicHermiteSrf(const CagdCrvStruct *CPos1Crv, const CagdCrvStruct *CPos2Crv, const CagdCrvStruct *CDir1Crv, const CagdCrvStruct *CDir2Crv)

**CPos1Crv, CPos2Crv:** Starting and end curves of surface.
**CDir1Crv, CDir2Crv:** Starting and end tangent fields surface.
**Returns:** A cubic by something Bezier surface, satisfying the four constraints. The other something degree is the largest of the four given curves.
**Description:** Construct a cubic surface using the Hermite constraints - two positions and two tangents. Other direction’s degree depends on input.

3.2.351 **CagdDbg** (cagd_dbg.c:29)

void CagdDbg(const void *Obj)

**Obj:** Either a curve or a surface - to be printed to stderr.
**Returns:** void
**Description:** Prints curves and surfaces to stderr. Should be linked to programs for debugging purposes, so curves and surfaces may be inspected from the debugger.

3.2.352 **CagdDbgV** (cagd_dbg.c:82)

void CagdDbgV(const void *Obj)

**Obj:** Either a curve or a surface - to be printed to stderr.
**Returns:** void
**Description:** Views curves and surfaces in a display device. Should be linked to programs for debugging purposes, so curves and surfaces may be inspected from the debugger.
3.2.353 CagdDegreeRaiseMatProd (blossom.c:650)

CagdBlsmAlphaCoeffStruct *CagdDegreeRaiseMatProd(CagdBlsmAlphaCoeffStruct *A1,
                                                    CagdBlsmAlphaCoeffStruct *A2)

  A1, A2: matrices to multiply.
  Returns: Resulting product matrix.
  Description: Computes the product of two adjacent degree raising matrices. Matrics are adjacent if A1 raises
               from Order to Order+k and A2 from Order+k to Order+n. Returned matrix is a degree raising matrix from Order
to Order+n.
  See also: CagdBlossomDegreeRaiseMat, CagdCrvDegreeRaise,

3.2.354 CagdDescribeError (cagd_err.c:111)

const char *CagdDescribeError(CagdFatalErrorType ErrorNum)

  ErrorNum: Type of the error that was raised.
  Returns: A string describing the error type.
  Description: Returns a string describing the a the given error. Errors can be raised by any member of this cagd
               library as well as other users. Raised error will cause an invocation of CagdFatalError function which decides how
to handle this error. CagdFatalError can for example, invoke this routine with the error type, print the appropriate
message and quit the program.

3.2.355 CagdDistCrvLine (cagd_cci.c:145)

CagdRType CagdDistCrvLine(const CagdCrvStruct *Crv, CagdLType Line)

  Crv: Planar curve to compute its signed distance to the line. Assumed to be a Bezier or a Bspline curve.
  Line: Line Equations, in the XY plane.
  Returns: Zero if might intersect. Otherwise, a bound on the minimal possible distance, signed.
  Description: Given a curve and a line in the XY Plane, finds a bound on the minimal signed distance between
               the two. Returns positive/negative minimal expected distance if curve on either side of the line or zero if might
               intersect. Computation is performed by measuring the signed distance between the line and all control points of the
curve.
  See also: SymbDistCrvLine, SymbLclDistCrvLine,

3.2.356 CagdDistPtPlane (mshplanr.c:142)

CagdRType CagdDistPtPlane(const CagdPlaneStruct *Plane,
                            CagdRType * const *Points, int Index,
                            int MaxDim)

  Plane: To compute the distance to.
  Points: To compute the distance from.
  Index: Index in Points for the point to consider.
  MaxDim: Number of dimensions to consider. Less or equal to three.
  Returns: Resulting distance.
  Description: Computes and returns distance between point Index and given plane which is assumed to be
               normalized, so that the A B C plane;s normal has a unit length. Also assumes the Points are non rational with
               MaxDim dimension.
3.2.357  CagdDistTwoCtlPt (cagdcoer.c:928)

CagdRType CagdDistTwoCtlPt(CagdRType * const Pt1[CAGD_MAX_PT_SIZE],
int Index1,
CagdRType * const Pt2[CAGD_MAX_PT_SIZE],
int Index2,
CagdPointType PType)

Pt1, Index1, Pt2, Index2: Two Control points to compute distance between, and incides into the vectors of
Points, Pt1 and Pt2. If, however, Index? < 0, Pt? is a single point.

PType: Type of points Pt?.

Returns: The distance between Pt1 and Pt2

Description: Computes the L2 distance between two arbitrary control points.

3.2.358  CagdEditSingleCrvPt (cagdedit.c:33)

CagdCrvStruct *CagdEditSingleCrvPt(CagdCrvStruct *Crv,
CagdCtlPtStruct *CtlPt,
int Index,
CagdBType Write)

Crv: Curve to be modified/query.
CtlPt: New control point to be substituted into Crv. Must carry the same PType as Crv if to be written to
Crv.
Index: In curve CRV’s control polygon to substitute/query CtlPt.
Write: If TRUE CtlPt is copied into Crv, if FALSE the point is copied from Crv to CtlPt.

Returns: If Write is TRUE, the new modified curve, if WRITE is FALSE, NULL.

Description: Provides the way to modify/get a single control point into/from the curve.

3.2.359  CagdEditSingleSrfPt (cagdedit.c:206)

CagdSrfStruct *CagdEditSingleSrfPt(CagdSrfStruct *Srf,
CagdCtlPtStruct *CtlPt,
int UIndex,
int VIndex,
CagdBType Write)

Srf: Surface to be modified/query.
CtlPt: New control point to be substituted into Srf. Must carry the same PType as Srf if to be written to Srf.
UIndex, VIndex: In surface Srf’s control mesh to substitute/query CtlPt.
Write: If TRUE CtlPt is copied into Srf, if FALSE the point is copied from Srf to CtlPt.

Returns: If Write is TRUE, the new modified curve, if WRITE is FALSE, NULL.

Description: Provides the way to modify/get a single control point into/from a surface.

3.2.360  CagdEllipse3Points (cagdncnc.c:701)

int CagdEllipse3Points(CagdPType Pt1,
CagdPType Pt2,
CagdPType Pt3,
CagdRType *A,
CagdRType *B,
CagdRType *C,
CagdRType *D,
CagdRType *E,
CagdRType *F)
**Pt1, Pt2, Pt3:** The 3 input points. Assumed non-colinear.

**A, B, C, D, E, F:** Coefficients of the computed bounding ellipse.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Constructs an ellipse in the XY plane through the given 3 points of minimal area. The A,B,C,D,E,F coefficients of the bounding ellipse as in \( A x^2 + B xy + C y^2 + D x + E y + F = 0 \) are returned.

**Algorithm:**
1. Compute center, \( C := (Pt1 + Pt2 + Pt3) / 3 \)

2. Compute a 2x2 matrix \( N = 1/3 \sum_{i=1}^{3} (Pti - C) (Pti - C)^T \)

3. \( M = N^{-1} \)

4. The ellipse \( E: (P - C)^T M (P - C) - Z = 0 \), \( Z \) constant, \( P = (x, y) \).

See also: "Exact Primitives for Smallest Enclosing Ellipses", by Bernd Gartner and Sven Schonherr, Proceedings of the 13th annual symposium on Computational geometry, 1997.

**See also:** CagdEllipseOffset, CagdCreateConicCurve, CagdCreateConicCurve2, CagdEllipse4Points, 3.2.361 CagdEllipse4Points

### 3.2.361 CagdEllipse4Points (cagd\_nc\_c:868)

```c
int CagdEllipse4Points(CagdPType Pt1,
CagdPType Pt2,
CagdPType Pt3,
CagdPType Pt4,
CagdRType *A,
CagdRType *B,
CagdRType *C,
CagdRType *D,
CagdRType *E,
CagdRType *F)
```

**Pt1, Pt2, Pt3, Pt4:** The 4 input points. Assumed in general position.

**A, B, C, D, E, F:** Coefficients of the computed bounding ellipse.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Constructs an ellipse in the XY plane through the given 4 points of minimal area. The A,B,C,D,E,F coefficients of the bounding ellipse as in \( A x^2 + B xy + C y^2 + D x + E y + F = 0 \) are returned.

**Algorithm:**

1. Using the four points \((x_1,y_1)\ldots(x_4,y_4)\), the following matrices:

\[
\begin{bmatrix}
\begin{array}{cccccc}
1 & x_1 & y_1 & x_1^2 & y_1^2 & x_1 y_1 \\
2 & x_2 & y_2 & x_2^2 & y_2^2 & x_2 y_2 \\
3 & x_3 & y_3 & x_3^2 & y_3^2 & x_3 y_3 \\
4 & x_4 & y_4 & x_4^2 & y_4^2 & x_4 y_4 \\
\end{array}
\end{bmatrix}
\]

\[
\text{ACBDEF} = \begin{bmatrix}
1 & x_1 & y_1 & x_1^2 & y_1^2 & x_1 y_1 \\
2 & x_2 & y_2 & x_2^2 & y_2^2 & x_2 y_2 \\
3 & x_3 & y_3 & x_3^2 & y_3^2 & x_3 y_3 \\
4 & x_4 & y_4 & x_4^2 & y_4^2 & x_4 y_4 \\
\end{bmatrix}
\]

\[
\text{matBDEF} = \begin{bmatrix}
1 & x_1 & y_1 & x_1^2 & y_1^2 & x_1 y_1 \\
2 & x_2 & y_2 & x_2^2 & y_2^2 & x_2 y_2 \\
3 & x_3 & y_3 & x_3^2 & y_3^2 & x_3 y_3 \\
4 & x_4 & y_4 & x_4^2 & y_4^2 & x_4 y_4 \\
\end{bmatrix}
\]

and the following vectors:

\[
x = \begin{bmatrix}
A & C & B & D & E & F
\end{bmatrix}
\]

\[
\text{Zeros} = \begin{bmatrix}
0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
\]

are defined, and the 4 point interpolation constraints can be written as:

\[
\text{ACBDEF} \cdot x = \text{Zeros}
\]
2. Using this, the following can be written:

\[
BDEF_{\text{fromAC}} = \text{inv(matBDEF)} \ast ACBDEF
\]

which, by construction, is a matrix in the form:

\[
\begin{bmatrix}
AB & CB & 1 & 0 & 0 & 0 \\
AD & CD & 0 & 1 & 0 & 0 \\
AE & CE & 0 & 0 & 1 & 0 \\
AF & CF & 0 & 0 & 0 & 1
\end{bmatrix}
\]

Where AB, AD, AE, AF, CB, CD, CE, CF are functions of (x1,y1)...(x4,y4).

Using the previous equations, it is possible to write:

\[
BDEF_{\text{fromAC}} \ast x = \text{Zeros}
\]

And conclude the following equations:

\[
AB \ast A + CB \ast C + B = 0 \\
AD \ast A + CD \ast C + D = 0 \\
AE \ast A + CE \ast C + E = 0 \\
AF \ast A + CF \ast C + F = 0
\]

3. The A..F ellipse coefficients can be scaled so that C = 1 - A, allowing the following equations to be written, using the previous step:

\[
C(A) = (-1) \ast A + 1 \\
B(A) = (CB - AB) \ast A - CB \\
D(A) = (CD - AD) \ast A - CD \\
E(A) = (CE - AE) \ast A - CE \\
F(A) = (CF - AF) \ast A - CF
\]

4. This allows writing the ellipse area function:

\[
\text{area}(A) = f(A)\ast 3 / g(A)^2
\]

where:

\[
f(A) = A \ast C(A) - B(A)\ast 2 \\
g(A) = -d(A)\ast 2 \ast C(A) + 2 \ast d(A) \ast E(A) \ast B(A) - E(A) \ast 2 \ast A + F(A) \ast A \ast C(A) - F(A) \ast B(A)\ast 2
\]

as a function of A alone. The extreme (minimum) area values can be found by locating where its derivative with respect to A equals zero, by solving the cubic polynomial:

\[
(-3 \ast \text{diff}(f(A),A) \ast g(A) + 2 \ast f(A) \ast \text{diff}(g(A),A))
\]

which coefficients are defined using AB, AD, AE, AF, CB, CD, CE, CF mentioned above.

If solutions for A exist, they define the other ellipse coefficients (B, C, D, E, F) as mentioned above. If these coefficients define an ellipse, they are returned to the user. Otherwise, the function returns false.

See also: "Exact Primitives for Smallest Enclosing Ellipses", by Bernd Gartner and Sven Schonherr, Proceedings of the 13th annual symposium on Computational geometry, 1997.

See also: CagdEllipseOffset, CagdCreateConicCurve, CagdCreateConicCurve2,

3.2.362 CagdEllipseOffset (cagd_rnc.c:1038)

int CagdEllipseOffset(CagdRType *A,
                      CagdRType *B,
                      CagdRType *C,
                      CagdRType *D,
                      CagdRType *E,
                      CagdRType *F,
                      CagdRType Offset)

A, B, C, D, E, F: The six coefficients of the ellipse.
Offset: Offset amount.
Returns: TRUE if successful, FALSE otherwise.
Description: Update the implicit form of the given ellipse with some offset Offset.
See also: CagdEllipse3Points, CagdEllipse4Points, CagdEllipse4Points, , CagdCreateConicCurve, CagdCreateConicCurve2,

3.2.363 CagdEstimateCrvCollinearity (mshplanr.c:212)

CagdRType CagdEstimateCrvCollinearity(const CagdCrvStruct *Crv)

Crv: To measure its collinearity.
Returns: Collinearity relative measure.
Description: Tests polygonal collinearity by testing the distance of interior control points from the line connecting the two control polygon end points. Returns a relative ratio of deviation from line relative to its length. Zero means all points are collinear. If two end points are same (no line can be fit) IRIT\_INFNTY is returned.
3.2.364  CagdEstimateSrfPlanarity  (mshplanr.c:300)

CagdRTypen CagdEstimateSrfPlanarity(const CagdSrfStruct *Srf)

Srf: To measure its coplanarity.

Returns: Coplanarity measure.

Description:  ests mesh collinearity by testing the distance of interior points from the plane thru 3 corner points. Returns a relative ratio of deviation from plane relative to its size. Zero means all points are coplanar. If end points are same (no plane can be fit) IRIT_INFNTY is returned.

3.2.365  CagdEvaluateSurfaceVecField  (cagd_aux.c:510)

void CagdEvaluateSurfaceVecField(CagdVTypen Vec,
                                 CagdSrfStruct *VecFieldSrf,
                                 CagdRTypen U,
                                 CagdRTypen V)

Vec: Where resulting unit length vector is to be saved.

VecFieldSrf: A surface representing a vector field.

U, V: Parameter locations.

Returns: void

Description: Evaluates a vector field surface to a unit size vector. If fails, moves a tad until success. Useful for normal field evaluations.

3.2.366  CagdExtrudeSrf  (cagdextr.c:32)

CagdSrfStruct *CagdExtrudeSrf(const CagdCrvStruct *CCrv,
                               const CagdVecStruct *Vec)

CCrv: To extrude in direction specified by Vec.

Vec: Direction as well as magnitude of extursion.

Returns: An extrusion surface with Orders of the original Crv order and 2 in the extrusion direction.

Description: Constructs an extrusion surface in the Vector direction for the given profile curve. Input curve can be either a B spline or a Bezier curve and the resulting output surface will be of the same type.

See also: CagdZTwistExtrudeSrf

3.2.367  CagdFatalError  (cagd_ftl.c:53)

void CagdFatalError(CagdFatalErrorType ErrID)

ErrID: Error type that was raised.

Returns: void

Description: Trap CagdLib errors right here. Provides a default error handler for the cagd library. Gets an error description using CagdDescribeError, prints it and exit the program using exit.
3.2.368  CagdFitPlaneThruCtlPts  (mshplanr.c:37)

CagdRType CagdFitPlaneThruCtlPts(CagdPlaneStruct *Plane,  
CagdPointType PType,  
CagdRType * const *Points,  
int Index1,  
int Index2,  
int Index3,  
int Index4)

Plane: To compute and save here.
PType: Point type expected of four points. Must be E2 or E3.
Points: Point array where to look for the four points.
Index1, Index2, Index3, Index4: Four indices of the points.

Returns: Measure on the distance between the data points, 0.0 if fitting failed.

Description: Fits a plane through the four points from Points indices Index?. Points may be either E2 or E3 only. Returns 0.0 if failed to fit a plane, otherwise a measure on the size of the mesh data (distance between points) is returned.

3.2.369  CagdIChooseK  (cbzreval.c:433)

CagdRType CagdIChooseK(int i, int k)

i, k: Coefficients of i choose k.

Returns: Result of i choose k, in floating point, to prevent from overflows.

Description: Evaluates the following (in floating point arithmetic):

\[
\binom{k}{i} = \frac{k!}{i! \cdot (k - i)!}
\]

3.2.370  CagdIgnoreNonPosWeightBBox  (cagdbbox.c:70)

CagdBType CagdIgnoreNonPosWeightBBox(CagdBType IgnoreNonPosWeightBBox)

IgnoreNonPosWeightBBox: TRUE to ignore negative and zero weight control points in the bounding box computation.

Returns: old value.

Description: Computes a bounding box for a freeform curve.
See also: CagdCrvBBox, CagdSrfBBox, CagdTightBBox,

3.2.371  CagdInsertInterPointInit  (cagd.cci.c:551)

CagdPtStruct *CagdInsertInterPointInit(void)

Returns: Old list of points found on the intersections list.

Description: Reset the list of intersection points to insert & returns the old list.
See also: CagdInsertInterPoints,
3.2.372 CagdInsertInterPoints  (cagd.RECI.c:579)

void CagdInsertInterPoints(CagdRType t1, CagdRType t2, CagdRType Eps)

  t1, t2: New parameter values to insert to global GlblInterList list.
  Eps: Accuracy of insertion computation.
  Returns: void

Description: Insert t1/t2 values into GlblInterList, provided no equal t1/t2 value exists already in the list. List is in ascending order with respect to t1.
See also: CagdInsertInterPointInit,

3.2.373 CagdIsClosedCrv  (cagd1gen.c:1347)

CagdBType CagdIsClosedCrv(const CagdCrvStruct *Crv)

  Crv: To test for a closed loop.
  Returns: TRUE if closed, FALSE otherwise.

Description: Returns TRUE if the curve is a closed loop.
See also: CagdAreClosedCrvs, CagdIsClosedSrf, CagdIsZeroLenCrv,

3.2.374 CagdIsClosedSrf  (cagd1gen.c:1557)

CagdBType CagdIsClosedSrf(const CagdSrfStruct *Srf, CagdSrfDirType Dir)

  Srf: To test for a closed boundary.
  Dir: Direction to test if surface is closed. Either U or V.
  Returns: TRUE if closed, FALSE otherwise.

Description: Returns TRUE if the surface is closed in the given direction. That is, if the min curve boundary equal the max curve boundary
See also: CagdIsClosedCrv,

3.2.375 CagdIsCrvInsideCH  (cagdbbox.c:703)

int CagdIsCrvInsideCH(const CagdCrvStruct *Crv, 
  const IrtE2PtStruct *CHPts, 
  int NumCHPts)

  Crv: The input curve.
  CHPts: Points in convex hull in GMR2Struct form.
  NumCHPts: Number of Points in the convex hull.
  Returns: TRUE if successful, FALSE otherwise.

Description: Identifying whether the given curve is inside the convex hull. Test is conducted by verifying that all the control points of Crv are inside the convex hull.
See also: CagdIsCrvInsideCirc, GMConvexHull,
3.2.376  CagdIsCrvInsideCirc (cagdbbox.c:659)

```c
int CagdIsCrvInsideCirc(const CagdCrvStruct *Crv,
const CagdRType Center[2],
CagdRType Radius)
```

- **Crv**: Curve to test for containment in the circle.
- **Center**: Center of the circle to test against.
- **Radius**: Radius of the circle to test against.

**Returns**: TRUE if Crv is indeed inside the circle, FALSE otherwise.

**Description**: Tests if a circle is contained in the given prescribed circle. Test is conducted by verifying that all the control points of Crv are inside the circle.

**See also**: CagdIsCrvInsideCH, MvarIsCrvInsideCirc,

3.2.377  CagdIsZeroLenCrv (cagd1gen.c:1323)

```c
CagdBType CagdIsZeroLenCrv(const CagdCrvStruct *Crv, CagdRType Eps)
```

- **Crv**: Curve to examine.
- **Eps**: Epsilon to consider the curve degenerate below this length.

**Returns**: TRUE if zero length, FALSE otherwise.

**Description**: Checks if the given curve is degenerate and have almost zero length.

**See also**: CagdIsClosedCrv, CagdIsZeroLenSrfBndry,

3.2.378  CagdIsZeroLenSrfBndry (cagd1gen.c:1507)

```c
CagdBType CagdIsZeroLenSrfBndry(const CagdSrfStruct *Srf,
CagdSrfBndryType Bndry,
CagdRType Eps)
```

- **Srf**: Surface to examine its boundary.
- **Bndry**: The boundary, out of the four of Srf, to examine.
- **Eps**: Epsilon to consider the curve degenerate below this length.

**Returns**: TRUE if zero length, FALSE otherwise.

**Description**: Checks if the prescribed boundary of the given surface is degenerate and has an almost zero length.

**See also**: CagdIsClosedCrv, CagdIsZeroLenCrv,

3.2.379  CagdLimitCrvArcLen (cagdcmrg.c:783)

```c
CagdCrvStruct *CagdLimitCrvArcLen(const CagdCrvStruct *Crv,
CagdRType MaxLen)
```

- **Crv**: To subdivide into curves, each with control polygon length less than MaxLen.
- **MaxLen**: Maximum length of control polygon to allow.

**Returns**: List of subdivided curves from Crv, each with control polygon size of less than or equal to MaxLen.

**Description**: Subdivides the given curves to curves, each with size of control polygon less than or equal to MaxLen. Returned is a list of curves.

**See also**: CagdCrvArcLenPoly, CagdSrfAvgArgLenMesh,
3.2.380  CagdLineFitToPts  (cbsp_int.c:1666)

CagdRType CagdLineFitToPts(CagdPtStruct *PtList,
                           CagdVType LineDir,
                           CagdPType LinePos)

    PtList: List of points to interpolate/least square approximate.
    LineDir: A unit vector of the line.
    LinePos: A point on the computed line.

    Returns: Average distance between a point and the fitted line, or IRIT_INFNTY if failed.

    Description: Given set of points, PtList, fits a line using least squares fit to them.
    See also: MvarLineFitToPts,

3.2.381  CagdListAppend  (cagd2gen.c:1149)

VoidPtr CagdListAppend(VoidPtr List1, VoidPtr List2)

    List1, List2: Two lists of cagd objects to append, in place.
    Returns: Appended list.

    Description: Appends two lists, in place.

3.2.382  CagdListInsert  (cagd2gen.c:1071)

VoidPtr CagdListInsert(VoidPtr List,
                        VoidPtr NewElement,
                        CagdCompFuncType CompFunc,
                        CagdBType InsertEqual)

    List: The list to update, in place. Can be empty list.
    NewElement: New element to insert, in place into List.
    CompFunc: A comparison function. Gets two elements of the list and compare and return a positive, zero, or
    negative values if first elements is smaller, equal, larger than second element, strcmp style.
    InsertEqual: If TRUE, a new item that is found to be equal to an item in the list will be insert anyway. If
    FALSE, NULL is returned and no modification is made to the list, if equal.

    Returns: The updated list. NULL if !InsertEqual and found equality. If NULL is returned, no modification
    was made to List.

    Description: Inserts a new element NewElement into an ordered list List. Ordering is prescribed by CompFunc.

3.2.383  CagdListLast  (cagd2gen.c:1005)

VoidPtr CagdListLast(VoidPtr List)

    List: To return its last element.

    Returns: Last element.

    Description: Returns the last element of given list of cagd library objects.

3.2.384  CagdListLength  (cagd2gen.c:1125)

int CagdListLength(const VoidPtr List)

    List: List of cagd objects.

    Returns: Length of list.

    Description: Computes the length of a list.
3.2.385  CagdListPrev  (cagd2gen.c:1033)

VoidPtr CagdListPrev(VoidPtr List, VoidPtr Item)

List: To seek the previous element to Item.
Item: Item to seek its prev.
Returns: Previous item to Item or NULL if not found (or Item is the first item in List).
Description: Returns the element previous to given Item in List of cagd library objs.

3.2.386  CagdListReverse  (cagd2gen.c:970)

VoidPtr CagdListReverse(VoidPtr List)

List: To be reversed.
Returns: Reversed list.
Description: Reverses a list of cagd library objects, in place.

3.2.387  CagdMakeCrvsCompatible  (cagdcmpt.c:37)

CagdBType CagdMakeCrvsCompatible(CagdCrvStruct **Crv1,
                                CagdCrvStruct **Crv2,
                                CagdBType SameOrder,
                                CagdBType SameKV)

Crv1, Crv2: Two curves to be made compatible, in place.
SameOrder: If TRUE, this routine make sure they share the same order.
SameKV: If TRUE, this routine make sure they share the same knot vector and hence continuity.
Returns: TRUE if successful, FALSE otherwise.
Description: Given two curves, makes them compatible by:
1. Coercing their point type to be the same.
2. Making them have the same curve type.
3. Raising the degree of the lower one to be the same as the higher.
4. Refining them to a common knot vector (If Bspline and SameOrder).
Note 3 is performed if SameOrder TRUE, 4 if SameKV TRUE. Both curves are modified IN PLACE.

3.2.388  CagdMakeRectangle  (cagd2gen.c:2185)

CagdPolygonStruct *CagdMakeRectangle(CagdBType ComputeNormals,
                                       CagdBType ComputeUV,
                                       const CagdRType *Pt1,
                                       const CagdRType *Pt2,
                                       const CagdRType *Pt3,
                                       const CagdRType *Pt4,
                                       const CagdRType *Nl1,
                                       const CagdRType *Nl2,
                                       const CagdRType *Nl3,
                                       const CagdRType *Nl4,
                                       const CagdRType *UV1,
                                       const CagdRType *UV2,
                                       const CagdRType *UV3,
                                       const CagdRType *UV4,
                                       CagdBType *GenPoly)
**ComputeNormals:** If TRUE then use Nl? parameters. Nl? are valid.

**ComputeUV:** If TRUE then use UV? parameters. UV? are valid.

**Pt1, Pt2, Pt3, Pt4:** Euclidean locations of vertices.

**N11, N12, N13, N14:** Optional Normals of vertices (if ComputeNormals).

**UV1, UV2, UV3, UV4:** Optional UV parametric location of vertices (if ComputeUV).

**GenPoly:** Returns TRUE if a polygon was generated, FALSE otherwise. Note this function can return NULL and still generate a polygon as a callback for CagdSrf2Polygons.

**Returns:** A polygonal rectangle structure, or NULL if points are collinear.

**Description:** Routine to create one triangular polygon, given its vertices. Returns NULL if Triangle is degenerated.

**See also:** CagdMakeTriangle, CagdSrf2Polygons, CagdSrfAdap2Polygons,

### 3.2.389 CagdMakeSrfsCompatible (cagdcmpt.c:195)

```c
CagdBType CagdMakeSrfsCompatible(CagdSrfStruct **Srf1,
                                 CagdSrfStruct **Srf2,
                                 CagdBType SameUOrder,
                                 CagdBType SameVOrder,
                                 CagdBType SameUKV,
                                 CagdBType SameVKV)
```

**Srfl, Srf2:** Two surfaces to be made compatible, in place.

**SameUOrder:** If TRUE, this routine make sure they share the same U order.

**SameVOrder:** If TRUE, this routine make sure they share the same V order.

**SameUKV:** If TRUE, this routine make sure they share the same U knot vector and hence continuity.

**SameVKV:** If TRUE, this routine make sure they share the same V knot vector and hence continuity.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Given two surfaces, makes them compatible by:

1. Coercing their point type to be the same.
2. Making them have the same curve type.
3. Raising the degree of the lower one to be the same as the higher.
4. Refining them to a common knot vector (If B spline and SameOrder).

Note 3 is performed if SameOrder TRUE, 4 if SameKV TRUE. Both surface are modified IN PLACE.

### 3.2.390 CagdMakeTriangle (cagd2gen.c:2081)

```c
CagdPolygonStruct *CagdMakeTriangle(CagdBType ComputeNormals,
                                      CagdBType ComputeUV,
                                      const CagdRType *Pt1,
                                      const CagdRType *Pt2,
                                      const CagdRType *Pt3,
                                      const CagdRType *Nl1,
                                      const CagdRType *Nl2,
                                      const CagdRType *Nl3,
                                      const CagdRType *UV1,
                                      const CagdRType *UV2,
                                      const CagdRType *UV3,
                                      CagdBType *GenPoly)
```

**ComputeNormals:** If TRUE then use Nl? parameters. Nl? are valid.

**ComputeUV:** If TRUE then use UV? parameters. UV? are valid.

**Pt1, Pt2, Pt3:** Euclidean locations of vertices.

**N11, N12, N13:** Optional Normals of vertices (if ComputeNormals).

**UV1, UV2, UV3:** Optional UV parametric location of vertices (if ComputeUV).
**GenPoly**: Returns TRUE if a polygon was generated, FALSE otherwise. Note this function can return NULL and still generate a polygon as a call back for CagdSrf2Polygons.

**Returns**: A polygonal triangle structure, or NULL if points are collinear.

**Description**: Routine to create one triangular polygon, given its vertices. Returns NULL if Triangle is degenerated.

**See also**: CagdMakeRectangle, CagdSrf2Polygons, CagdSrfAdap2Polygons,

### 3.2.391 CagdMatTransform (cagd2gen.c:1564)

```c
void CagdMatTransform(CagdRType **Points,
    int Len,
    int MaxCoord,
    CagdBType IsNotRational,
    CagdMType Mat)
```

**Points**: To be affinely transformed. Array of vectors.

**Len**: Of vectors of Points.

**MaxCoord**: Maximum number of coordinates to be found in Points.

**IsNotRational**: Do we have weights as vector Points[0]?

**Mat**: Defining the transformation.

**Returns**: void

**Description**: Applies an homogeneous transformation, in place, to given set of points Points which as array of vectors, each vector of length Len. Array Points optionally contains (if !IsNotRational) in Points[0] the weights coefficients and in Points[i] the coefficients of axis i, up to and include MaxCoord (X = 1, Y = 2, etc.).

**See also**: CagdTransform, CagdSrfMatTransform, CagdCrvMatTransform,

### 3.2.392 CagdMatchBisectorNorm (crvmatch.c:349)

```c
CagdRType CagdMatchBisectorNorm(const CagdVType T1,
    const CagdVType T2,
    const CagdVType P1,
    const CagdVType P2)
```

**T1**: A pointer to unit tangent to the first curve at i-th point.

**T2**: A pointer to unit tangent to the second curve at j-th point.

**P1**: A pointer to value of the first curve at i-th point.

**P2**: A pointer to value of the second curve at j-th point.

**Returns**: A numeric matching value, the smaller the better.

**Description**: Computes the bisector norm to the matching.

**See also**: CagdMatchDistNorm, CagdMatchRuledNorm, CagdMatchMorphNorm, , CagdMatchingTwoCurves,

### 3.2.393 CagdMatchDistNorm (crvmatch.c:316)

```c
CagdRType CagdMatchDistNorm(const CagdVType T1,
    const CagdVType T2,
    const CagdVType P1,
    const CagdVType P2)
```

**T1**: A pointer to unit tangent to the first curve at i-th point.

**T2**: A pointer to unit tangent to the second curve at j-th point.

**P1**: A pointer to value of the first curve at i-th point.

**P2**: A pointer to value of the second curve at j-th point.

**Returns**: A numeric matching value, the smaller the better.

**Description**: Computes the distance norm to the matching, \| P1 - P2 \|.

**See also**: CagdMatchBisectorNorm, CagdMatchRuledNorm, CagdMatchMorphNorm, , CagdMatchingTwoCurves,
3.2.394  CagdMatchMorphNorm (crvmatch.c:401)

CagdRType CagdMatchMorphNorm(const CagdVType T1,
    const CagdVType T2,
    const CagdVType P1,
    const CagdVType P2)

T1: A pointer to unit tangent to the first curve at i-th point.
T2: A pointer to unit tangent to the second curve at j-th point.
P1: A pointer to value of the first curve at i-th point.
P2: A pointer to value of the second curve at j-th point.

Returns: -1 for no matching or the cost of the matching for the point between zero and one.

Description: Computes the default morphing norm to the matching, \(1.0 - <T1, T2>\).
See also: CagdMatchDistNorm, CagdMatchBisectorNorm, CagdMatchRuledNorm, CagdMatchingTwoCurves,

3.2.395  CagdMatchRuled2Norm (crvmatch.c:484)

CagdRType CagdMatchRuled2Norm(const CagdVType T1,
    const CagdVType T2,
    const CagdVType P1,
    const CagdVType P2)

T1: A pointer to unit tangent to the first curve at i-th point.
T2: A pointer to unit tangent to the second curve at j-th point.
P1: A pointer to value of the first curve at i-th point.
P2: A pointer to value of the second curve at j-th point.

Returns: -1 for no matching or the cost of the matching for the point between zero and one, the minimum (non negative) the better.

Description: Computes the default ruled norm to the matching, \(<T1 x (P2 - P1), T2 x (P2 - P1)>\) must be non negative and then the norm is \(1.0 - \frac{\|T1 x (P2 - P1)\|^2 + \|T2 x (P2 - P1)\|^2}{\|P2 - P1\|^2}\).
See also: CagdMatchDistNorm, CagdMatchBisectorNorm, CagdMatchMorphNorm, CagdMatchingTwoCurves,

3.2.396  CagdMatchRuledNorm (crvmatch.c:439)

CagdRType CagdMatchRuledNorm(const CagdVType T1,
    const CagdVType T2,
    const CagdVType P1,
    const CagdVType P2)

T1: A pointer to unit tangent to the first curve at i-th point.
T2: A pointer to unit tangent to the second curve at j-th point.
P1: A pointer to value of the first curve at i-th point.
P2: A pointer to value of the second curve at j-th point.

Returns: -1 for no matching or the cost of the matching for the point between zero and one, the minimum (non negative) the better.

Description: Computes the default ruled norm to the matching, \(<T1 x (P2 - P1), T2 x (P2 - P1)>\) must be non negative and then the norm is \(1.0 - <T1, T2>\).
See also: CagdMatchDistNorm, CagdMatchBisectorNorm, CagdMatchMorphNorm, CagdMatchingTwoCurves,
3.2.397 CagdMatchingFixCrv (crvmatch.c:852)

```c
void CagdMatchingFixCrv(CagdCrvStruct *Crv)
```

**Crv:** The input curve to be fixed.

**Returns:** void

**Description:** Fix the input curve to be monotone.

3.2.398 CagdMatchingFixVector (crvmatch.c:801)

```c
void CagdMatchingFixVector(int *OldVec, CagdRType *NewVec, int Len)
```

**OldVec:** The input vector.

**NewVec:** The output (fixed) vector

**Len:** The length of the vector.

**Returns:** void

**Description:** Fix the input integer vector, so that NewVec is increasingly monotone.

3.2.399 CagdMatchingPolyTransform (crvmatch.c:886)

```c
void CagdMatchingPolyTransform(CagdRType **Poly,
    int Len,
    CagdRType NewBegin,
    CagdRType NewEnd)
```

**Poly:** A pointer to points to change.

**Len:** The length of the input poly.

**NewBegin:** The new begin.

**NewEnd:** The new end.

**Returns:** void

**Description:** Affine transform a set of points, so its new end locations are NewBegin and NewEnd, respectively.

3.2.400 CagdMatchingTwoCurves (crvmatch.c:975)

```c
CagdCrvStruct *CagdMatchingTwoCurves(const CagdCrvStruct *Crv1,
    const CagdCrvStruct *Crv2,
    int Reduce,
    int SampleSet,
    int ReparamOrder,
    int RotateFlag,
    int AllowNegativeNorm,
    int ReturnReparamFunc,
    CagdBType MinimizeMaxError,
    CagdMatchNormFuncType MatchNormFunc)
```

**Crv1:** The first curve.

**Crv2:** The second curve.

**Reduce:** The degrees of freedom of the reparametrization curve. The larger this number is, the better the reparametrization will be at the cost of more computation. Must be less than SampleSet.

**SampleSet:** Number of samples the two curves are sampled at. The larger this number is, the better the reparametrization will be.

**ReparamOrder:** Order of reparametrization curve.

**RotateFlag:** use or not use rotation in finding best matching.
**AllowNegativeNorm:** If TRUE, negative norms are locally allowed.

**ReturnReparamFunc:** If TRUE, return the reparameterization function instead of Crv2 reparameterized.

**MinimizeMaxError:** TRUE for minimizing maximal error, FALSE to minimize the error’s sum over the entire domain.

**MatchNormFunc:** A pointer to the matching norm.

**Returns:** The second curve, Crv2, after reparameterization that matches the first curve. Error of returned result is saved in an “Error” attr.

**Description:** Gets two freeform curves, Crv1, nd Crv2, computes a new parametrization to Crv2 using composition between Crv2 and a computed reparameterization that establishes a matching correspondence between Crv1 and Crv2.

**See also:** CagdMatchDistNorm, CagdMatchBisectorNorm, CagdMatchMorphNorm, CagdMatchRuledNorm

### 3.2.401 CagdMatchingVectorTransform (crvmatch.c:918)

```c
void CagdMatchingVectorTransform(CagdRType *Vec,
     CagdRType NewBegin,
     CagdRType NewEnd,
     int Len)
```

**Vec:** The input and the output vector.

**NewBegin:** The new begin.

**NewEnd:** The new end.

**Len:** The length of the input vector.

**Returns:** void

**Description:** Affine transform a set of vectors, so its new end locations are NewBegin and NewEnd, respectively.

### 3.2.402 CagdMergeBBox (cagdbbox.c:533)

```c
void CagdMergeBBox(CagdBBoxStruct *DestBBox, const CagdBBoxStruct *SrcBBox)
```

**DestBBox:** One BBox operand as well as the result.

**SrcBBox:** Second BBox operand.

**Returns:** void

**Description:** Merges (union) two bounding boxes into one, in place.

### 3.2.403 CagdMergeCrvCrv (cagdcmrg.c:50)

```c
CagdCrvStruct *CagdMergeCrvCrv(const CagdCrvStruct *CCrv1,
     const CagdCrvStruct *CCrv2,
     int InterpolateDiscont)
```

**CCrv1:** To connect to Crv1’s starting location at its end.

**CCrv2:** To connect to Crv2’s end location at its start.

**InterpolateDiscont:** If TRUE, linearly interpolate discontinuity.

**Returns:** The merged curve.

**Description:** Merges two curves by connecting the end of Crv1 to the beginning of Crv2. If the end of Crv1 is identical to the beginning of Crv2 then the result is as expected. However, if the curves do not meet, their end points are linearly interpolated if InterpolateDiscont is TRUE or simply blended out in a freeform shape if InterpolateDiscont is FALSE.

**See also:** CagdMergeCtlPtCtlPt, CagdMergePtPt, CagdMergePtCrv, CagdMergeCrvPt, CagdMergeCrvList,
3.2.404 CagdMergeCrvList (cagdcmrg.c:160)

CagdCrvStruct *CagdMergeCrvList(const CagdCrvStruct *CrvList, int InterpDiscont)

CrvList: To connect into one curve.
InterpDiscont: If TRUE, linearly interpolate discontinuity.
Returns: The merged curve.
Description: Merges a list of curves by connecting the end of one curve to the beginning of the next.
See also: CagdMergeCtlPtCtlPt, CagdMergePtPt, CagdMergePtCrv, CagdMergeCrvCrv, CagdMergeCrvList2,

3.2.405 CagdMergeCrvList2 (cagdcmrg.c:201)

CagdCrvStruct *CagdMergeCrvList2(CagdCrvStruct *CrvList, IrtRType Tolerance)

CrvList: To connect into larger curves.
Tolerance: To consider two end points the same.
Returns: The merged curves.
Description: Merges a list of curves by connecting end points that are the same, in place.
See also: CagdMergeCtlPtCtlPt, CagdMergePtPt, CagdMergePtCrv, CagdMergeCrvCrv, CagdMergeCrvList,

3.2.406 CagdMergeCrvPt (cagdcmrg.c:296)

CagdCrvStruct *CagdMergeCrvPt(const CagdCrvStruct *Crv, const CagdPtStruct *Pt)

Crv: To connect to Pt its end.
Pt: To connect to Crv’s end point.
Returns: The merged curve.
Description: Merges a curve and a point by connecting the end of Crv to Pt, using a linear segment.
See also: CagdMergeCtlPtCtlPt, CagdMergePtPt, CagdMergePtCrv, CagdMergeCrvCrv,

3.2.407 CagdMergeCtlPtCtlPt (cagdcmrg.c:546)

CagdCrvStruct *CagdMergeCtlPtCtlPt(const CagdCtlPtStruct *Pt1, const CagdCtlPtStruct *Pt2, int MinDim)

Pt1, Pt2: Two control points to connect using a linear segment.
MinDim: Minimal ctlpts dimension to build the curve with, 2 for E2 or P2, etc.
Returns: The merged curve.
Description: Merges two control points by connecting Pt1 to Pt2, using linear segment.
See also: CagdMergePtPt, CagdMergePtCrv, CagdMergeCrvCrv, CagdMergeCrvList,

3.2.408 CagdMergeIrtPtType (cagdcoer.c:897)

CagdPointType CagdMergeIrtPtType(CagdPointType PType1, CagdPointType PType2)

PType1, PType2: To point types to find the point type of their union.
Returns: A point type of the union of the spaces of PType1 and PType2.
Description: Returns a point type which spans the spaces of both two given point types.
3.2.409 CagdMergePtCrv (cagdcmrg.c:370)

CagdCrvStruct *CagdMergePtCrv(const CagdPtStruct *Pt, const CagdCrvStruct *Crv)

    Pt: To connect to Crv's starting point.
    Crv: To connect to Pt its starting point.

    Returns: The merged curve.

    Description: Merges a point and a curve by connecting Pt to the starting point of Crv, using a linear segment.

    See also: CagdMergeCtlPtCtlPt, CagdMergePtPt, CagdMergeCrvPt, CagdMergeCrvCrv,

3.2.410 CagdMergePtPt (cagdcmrg.c:441)

CagdCrvStruct *CagdMergePtPt(const CagdPtStruct *Pt1, const CagdPtStruct *Pt2)

    Pt1, Pt2: Two points to connect using a linear segment.

    Returns: The merged curve.

    Description: Merges two points by connecting Pt1 to Pt2, using a linear segment.

    See also: CagdMergeCtlPtCtlPt, CagdMergePtCrv, CagdMergeCrvPt, CagdMergeCrvCrv, CagdMergePtPt2, CagdMergeUvUv,

3.2.411 CagdMergePtPt2 (cagdcmrg.c:489)

CagdCrvStruct *CagdMergePtPt2(const CagdPType Pt1, const CagdPType Pt2)

    Pt1, Pt2: Two points to connect using a linear segment.

    Returns: The merged curve.

    Description: Merges two points by connecting Pt1 to Pt2, using a linear segment.

    See also: CagdMergeCtlPtCtlPt, CagdMergePtCrv, CagdMergeCrvPt, CagdMergeCrvCrv, CagdMergePtPt, CagdMergeUvUv,

3.2.412 CagdMergeSrfList (cagdsmrg.c:306)

CagdSrfStruct *CagdMergeSrfList(const CagdSrfStruct *SrfList,
    CagdSrfDirType Dir,
    CagdBType SameEdge,
    int InterpolateDiscont)

    SrfList: To connect into one surface.
    Dir: Direction the merge should take place. Either U or V.
    SameEdge: If the two surfaces share a common edge.
    InterpolateDiscont: If TRUE, linearly interpolate discontinuity.

    Returns: The merged surface.

    Description: Merges a list of surfaces by connecting the end of one surface to the beginning of the next. See also CagdMergeSrfSrf.
3.2.413 CagdMergeSrfSrf (cagdsmrg.c:41)

CagdSrfStruct *CagdMergeSrfSrf(const CagdSrfStruct *CSrf1,
const CagdSrfStruct *CSrf2,
CagdSrfDirType Dir,
CagdBType SameEdge,
int InterpolateDiscont)

CSrf1: To connect to Srf2’s starting boundary at its end.
CSrf2: To connect to Srf1’s end boundary at its start.
Dir: Direction the merge should take place. Either U or V.
SameEdge: If the two surfaces share a common edge.
InterpolateDiscont: If TRUE, linearly interpolate discontinuity.
Returns: The merged surface.

Description: Merges two surfaces in the requested direction Dir. If SameEdge, it is assumed last edge of Srf1 is identical to first edge of Srf2 and one row is dropped from new mesh. Otherwise a ruled surface is fit between the two edges.

3.2.414 CagdMergeUvUv (cagdcmsg.c:515)

CagdCrvStruct *CagdMergeUvUv(const CagdUVType UV1, const CagdUVType UV2)

UV1, UV2: Two UV coordinates to connect using a linear segment.
Returns: The merged curve.

Description: Merges two UV coordinates by connecting UV1, UV2, using a linear segment.
See also: CagdMergeCtlPtCtlPt, CagdMergePtCrv, CagdMergeCrvPt, CagdMergeCrvCrv, CagdMergePtPt, CagdMergePtPt2

3.2.415 CagdOneBoolSumSrf (cagdbsum.c:229)

CagdSrfStruct *CagdOneBoolSumSrf(const CagdCrvStruct *BndryCrv)

BndryCrv: To be subdivided into four curves for a Boolean sum construction.
Returns: A Boolean sum surface constructed using given curve

Description: Constructs a Boolean sum surface using the single boundary curve. The curve is subdivided into four, equally spaced in parameter space, sub-regions which are used as the four curves to the Boolean sum constructor. See CagdBoolSumSrf.

3.2.416 CagdPDError (cbsp_fit.c:438)

static CagdRType CagdPDError(const CagdPType Point, const CagdPType FootPoint)

Point: (Xk) Points to calculate the error for.
FootPoint: (P(tk)) Footpoint (the closest point to Xk on the curve)
Returns: PD error.

Description: Computes PD (Point Distance) error for a single point, which is:

$$e_{PD,k} = ||P(tk) - Xk||^2$$
3.2.417  **CagdPeriodicCrvNew**  (cagd1gen.c:104)

CagdCrvStruct *CagdPeriodicCrvNew(CagdGeomType GType,
CagdPointType PType,
int Length,
CagdBType Periodic)

**GType**: Type of geometry the curve should be - Bspline, Bezier etc.
**PType**: Type of control points (E2, P3, etc.).
**Length**: Number of control points
**Periodic**: Is this curve periodic?

**Returns**: An uninitialized freeform curve.

**Description**: Allocates the memory required for a new, possibly periodic, curve.
**See also**: BzrCrvNew, BspCrvNew, BspPeriodicCrvNew, CagdCrvNew, TrimCrvNew,

3.2.418  **CagdPeriodicSrfNew**  (cagd1gen.c:206)

CagdSrfStruct *CagdPeriodicSrfNew(CagdGeomType GType,
CagdPointType PType,
int ULength,
int VLength,
CagdBType UPeriodic,
CagdBType VPeriodic)

**GType**: Type of geometry the surface should be - Bspline, Bezier etc.
**PType**: Type of control points (E2, P3, etc.).
**ULength**: Number of control points in the U direction.
**VLength**: Number of control points in the V direction.
**UPeriodic**: Is this surface periodic in the U direction?
**VPeriodic**: Is this surface periodic in the V direction?

**Returns**: An uninitialized freeform surface.

**Description**: Allocates the memory required for a new, possibly periodic, surface.
**See also**: BzrSrfNew, BspSrfNew, BspPeriodicSrfNew, CagdSrfNew, TrimSrfNew,

3.2.419  **CagdPlaneArrayFree**  (cagd2gen.c:775)

void CagdPlaneArrayFree(CagdPlaneStruct *PlaneArray, int Size)

**PlaneArray**: To be deallocated.
**Size**: Of the deallocated array.

**Returns**: void

**Description**: Deallocates and frees an array of plane structure.

3.2.420  **CagdPlaneArrayNew**  (cagd1gen.c:462)

CagdPlaneStruct *CagdPlaneArrayNew(int Size)

**Size**: Size of Plane array to allocate.

**Returns**: An array of Plane structures of size Size.

**Description**: Allocates and resets all slots of an array of Plane structures.


### 3.2.421 CagdPlaneCopy (cagd1gen.c:1022)

```c
CagdPlaneStruct *CagdPlaneCopy(const CagdPlaneStruct *Plane)
```

**Arguments:**
- `Plane`: To be copied.

**Returns:** A duplicate of `Plane`.

**Description:** Allocates and copies all slots of a `Plane` structure.

### 3.2.422 CagdPlaneCopyList (cagd2gen.c:101)

```c
CagdPlaneStruct *CagdPlaneCopyList(const CagdPlaneStruct *PlaneList)
```

**Arguments:**
- `PlaneList`: To be copied.

**Returns:** A duplicated list of planes.

**Description:** Allocates and copies a list of `Plane` structures.

### 3.2.423 CagdPlaneFitToPts (cbsp_int.c:1758)

```c
CagdRType CagdPlaneFitToPts(CagdPtStruct *PtList,
IrtPlnType Pln,
IrtVecType MVec,
IrtPtType Cntr,
IrtRType *CN)
```

**Arguments:**
- `PtList`: List of points to fit an approximated plane.
- `Pln`: The fitted plane's coefficients.
- `MVec`: Direction in the plane with the major change.
- `Cntr`: The centroid of the data.
- `CN`: Condition number of the fitting. The smaller this number is the more planar the input is.

**Returns:** Average distance between a point and the fitted plane, or `IRIT_INFNTY` if failed.

**Description:** Given set of points, `PtList`, fits an (approximated) plane fit to them.

### 3.2.424 CagdPlaneFitToPts2 (cbsp_int.c:1807)

```c
CagdRType CagdPlaneFitToPts2(CagdRType **Points,
int NumPts,
CagdPointType PType,
IrtPlnType Pln,
IrtVecType MVec,
IrtPtType Cntr,
IrtRType *CN)
```

**Arguments:**
- `Points`: List of points to fit an approximated plane, in format as in `CagdCrvStruct` or `CagdSrfStruct`.
- `NumPts`: Length of the vector of `Points`.
- `PType`: Type of points in `Points`.
- `Pln`: The fitted plane's coefficients.
- `MVec`: Direction in the plane with the major change.
- `Cntr`: The centroid of the data.
- `CN`: Condition number of the fitting. The smaller this number is the more planar the input is.

**Returns:** Average distance between a point and the fitted plane, or `IRIT_INFNTY` if failed.

**Description:** Given set of points, `PtList`, fits an (approximated) plane fit to them.
3.2.425 CagdPlaneFitToPts3 (cbsp_int.c:1851)

CagdRType CagdPlaneFitToPts3(CagdPType *Points,
   int NumPts,
   IrtPlnType Pln,
   IrtVecType MVec,
   IrtPtType Cntr,
   IrtRType *CN)

Points: List of points to fit an approximated plane,
NumPts: Length of the vector of Points.
Pln: The fitted plane’s coefficients.
MVec: Direction in the plane with the major change.
Cntr: The centroid of the data.
CN: Condition number of the fitting. The smaller this number is the more planar the input is.
Returns: Average distance between a point and the fitted plane, or IRIT\_INFNTY if failed.
Description: Given set of points, PtList, fits an (approximated) plane fit to them.

3.2.426 CagdPlaneFree (cagd2gen.c:727)

void CagdPlaneFree(CagdPlaneStruct *Plane)

Plane: To be deallocated.
Returns: void
Description: Deallocates and frees all slots of a plane structure.

3.2.427 CagdPlaneFreeList (cagd2gen.c:750)

void CagdPlaneFreeList(CagdPlaneStruct *PlaneList)

PlaneList: To be deallocated.
Returns: void
Description: Deallocates and frees a plane structure list:

3.2.428 CagdPlaneNew (cagd1gen.c:490)

CagdPlaneStruct *CagdPlaneNew(void)

Returns: A Plane structure.
Description: Allocates and resets all slots of a Plane structure.

3.2.429 CagdPointsBBox (cagdbbox.c:398)

void CagdPointsBBox(CagdRType * const *Points,
   int Length,
   int Dim,
   CagdRType *BBoxMin,
   CagdRType *BBoxMax)

Points: To compute bounding box for.
Length: Length of vectors of Points array.
Dim: Dimensions of points, typically 3 for R^3.
BBoxMin, BBoxMax: Where bounding information is to be saved.
Returns: void
Description: Computes a bounding box for a set of control points.
3.2.430 **CagdPointsHasPoles** (cagd2gen.c:1815)

CagdBType CagdPointsHasPoles(CagdRType * const *Points, int Len)

- **Points**: Control points to consider.
- **Len**: Number of points in Points.
- **Returns**: TRUE if has poles, FALSE otherwise.

**Description**: Returns TRUE if the given control points have poles - that is have both negative and positive weights.

**See also**: CagdAllWeightsNegative, CagdAllWeightsSame,

3.2.431 **CagdPolyApproxErrEstimate** (poly.err.c:43)

```c
int CagdPolyApproxErrEstimate(CagdPolyErrEstimateType Method, int Samples)
```

- **Method**: 1. Samples one distance at the center of each polygon. 2. Samples Samples samples uniformly distributed in the parametric area of each polygon and selects the maximum. 3. Samples Samples samples uniformly distributed in the parametric area of each polygon and selects the average.
- **Samples**: Number of samples to sample in the parametric domain of each polygon.
- **Returns**: Old sampling method + Old sampling rate << 8

**Description**: Sets the methods of sampling the error of a polygonal approximation.

3.2.432 **CagdPolyApproxErrs** (poly.err.c:116)

```c
CagdRType *CagdPolyApproxErrs(const CagdSrfStruct *Srf, const CagdPolygonStruct *Polys)
```

- **Srf**: Approximated surface.
- **Polys**: The given polygonal approximation. Assumes UV slots are computed and updated in Polys.
- **Returns**: Errors between surface and its polygons. A vector of size (number of polygons + 1) holding the maximal error of each polygon. The last element of the vector will be negative.

**Description**: Returns the errors between the surface and its polygonal approx.

3.2.433 **CagdPolyApproxMaxErr** (poly.err.c:81)

```c
CagdRType CagdPolyApproxMaxErr(const CagdSrfStruct *Srf, const CagdPolygonStruct *Polys)
```

- **Srf**: Approximated surface.
- **Polys**: The given polygonal approximation. Assumes UV slots are computed and updated in Polys.
- **Returns**: Maximal error between surface and polygonal approximation

**Description**: Returns the maximal error between the surface and its polygonal approx.

3.2.434 **CagdPolygonArrayNew** (cagd1gen.c:566)

```c
CagdPolygonStruct *CagdPolygonArrayNew(int Size)
```

- **Size**: Size of Polygon array to allocate.
- **Returns**: An array of Polygon structures of size Size.

**Description**: Allocates and resets all slots of an array of Polygon structures.
3.2.435 CagdPolygonBBox (cagdbbox.c:261)

void CagdPolygonBBox(const CagdPolygonStruct *Poly, CagdBBoxStruct *BBox)

Poly: To computes its bbox.
BBox: Where bounding information is to be saved.
Returns: void
Description: Computes a bounding box for a cagd polygon.
See also: CagdPolygonListBBox, CagdCrvBBox, CagdSrfBBox,

3.2.436 CagdPolygonCopy (cagd1gen.c:1072)

CagdPolygonStruct *CagdPolygonCopy(const CagdPolygonStruct *Poly)

Poly: To be copied.
Returns: A duplicate of Polygon.
Description: Allocates and copies all slots of a Polygon structure.

3.2.437 CagdPolygonCopyList (cagd2gen.c:188)

CagdPolygonStruct *CagdPolygonCopyList(const CagdPolygonStruct *PolyList)

PolyList: To be copied.
Returns: A duplicated list of polygons.
Description: Allocates and copies a list of polygon structures.

3.2.438 CagdPolygonFree (cagd2gen.c:917)

void CagdPolygonFree(CagdPolygonStruct *Poly)

Poly: To be deallocated.
Returns: void
Description: Deallocates and frees all slots of a polygon structure.

3.2.439 CagdPolygonFreeList (cagd2gen.c:946)

void CagdPolygonFreeList(CagdPolygonStruct *PolyList)

PolyList: To be deallocated.
Returns: void
Description: Deallocates and frees a polygon structure list:

3.2.440 CagdPolygonListBBox (cagdbbox.c:312)

void CagdPolygonListBBox(const CagdPolygonStruct *Polys, CagdBBoxStruct *BBox)

Polys: To computes its bbox.
BBox: Where bounding information is to be saved.
Returns: void
Description: Computes a bounding box for a list of cagd polygons.
See also: CagdPolygonBBox, CagdCrvListBBox, CagdSrfListBBox,
3.2.441  CagdPolygonNew (cagd1gen.c:599)

CagdPolygonStruct *CagdPolygonNew(int Len)

Len: Number of vertices
Returns: A Polygon structure.
Description: Allocates and resets all slots of a Polygon structure.

3.2.442  CagdPolygonSetErrFunc (cagd2gen.c:1946)

CagdPlgErrorFuncType CagdPolygonSetErrFunc(CagdPlgErrorFuncType Func)

Func: New function to use, NULL to disable.
Returns: Old value of function.
Description: Sets the polygon approximation error function. The error function will return a negative value if
this triangle must be purged or otherwise a non negative error measure.

3.2.443  CagdPolygonStripNew (cagd1gen.c:629)

CagdPolygonStruct *CagdPolygonStripNew(int Len)

Len: Number of polygons in strip.
Returns: A Polygon structure.
Description: Allocates and resets all slots of a Polygon structure as a strip.

3.2.444  CagdPolylineArrayNew (cagd1gen.c:662)

CagdPolylineStruct *CagdPolylineArrayNew(int Length, int Size)

Length: Length of each polyline in the polyline array.
Size: Size of Polyline array to allocate.
Returns: An array of Polyline structures of size Size.
Description: Allocates and resets all slots of an array of Polyline structures.

3.2.445  CagdPolylineCopy (cagd1gen.c:1116)

CagdPolylineStruct *CagdPolylineCopy(const CagdPolylineStruct *Poly)

Poly: To be copied.
Returns: A duplicate of Polyline.
Description: Allocates and copies all slots of a Polyline structure.

3.2.446  CagdPolylineCopyList (cagd2gen.c:159)

CagdPolylineStruct *CagdPolylineCopyList(const CagdPolylineStruct *PolyList)

PolyList: To be copied.
Returns: A duplicated list of polylines.
Description: Allocates and copies a list of polyline structures.
3.2.447 CagdPolylineFree (cagd2gen.c:869)

void CagdPolylineFree(CagdPolylineStruct *Poly)

Poly: To be deallocated.
Returns: void
Description: Deallocates and frees all slots of a polyline structure.

3.2.448 CagdPolylineFreeList (cagd2gen.c:893)

void CagdPolylineFreeList(CagdPolylineStruct *PolyList)

PolyList: To be deallocated.
Returns: void
Description: Deallocates and frees a polyline structure list:

3.2.449 CagdPolylineNew (cagd1gen.c:692)

CagdPolylineStruct *CagdPolylineNew(int Length)

Length: Length of polyline.
Returns: A Polyline structure.
Description: Allocates and resets all slots of a Polyline structure.

3.2.450 CagdPrimBoxSrf (cagdprim.c:346)

CagdSrfStruct *CagdPrimBoxSrf(CagdRType MinX, CagdRType MinY, CagdRType MinZ, CagdRType MaxX, CagdRType MaxY, CagdRType MaxZ)

MinX, MinY, MinZ: Minimum range of box model.
MaxX, MaxY, MaxZ: Maximum range of box model.
Returns: Constructed box model, as a set of six bilinear srfs.
Description: A surface constructor of a box, parallel to main axes.

3.2.451 CagdPrimCone2Srf (cagdprim.c:593)

CagdSrfStruct *CagdPrimCone2Srf(const CagdVType Center, CagdRType MajorRadius, CagdRType MinorRadius, CagdRType Height, CagdBType Rational, CagdPrimCapsType Caps)

Center: of constructed cone (center of its base).
MajorRadius: of constructed cone.
MinorRadius: of constructed cone.
Height: of constructed cone.
**Rational:** If TRUE exact ration sphere is created. If FALSE an approximated integral surface is created.

**Caps:** Do we want caps (top and/or bottom) for the cone?

**Returns:** A Bspline surface representing a cone.

**Description:** A surface constructor of a truncated cone, centered at Center and radii of MajorRadius and MinorRadius. A MinorRadius of zero would construct a regular cone. Otherwise, a truncated cone. Axis of cone is Z axis.

**See also:** CagdPrimPlaneSrf, CagdPrimSphereSrf, CagdPrimTorusSrf, CagdPrimConeSrf, CagdPrimCylinderSrf

### 3.2.452 CagdPrimConeSrf (cagdprim.c:669)

```c
CagdSrfStruct *CagdPrimConeSrf(const CagdVType Center,
    CagdRType Radius,
    CagdRType Height,
    CagdBType Rational,
    CagdPrimCapsType Caps)
```

**Center:** of constructed cone (center of its base).

**Radius:** of constructed cone’s base.

**Height:** of constructed cone.

**Rational:** If TRUE exact ration sphere is created. If FALSE an approximated integral surface is created.

**Caps:** Do we want caps (top and/or bottom) for the cone?

**Returns:** A Bspline surface representing a cone.

**Description:** A surface constructor of a cone, centered at Center, radii of Radius, and height of Height. Axis of cone is Z axis.

**See also:** CagdPrimPlaneSrf, CagdPrimSphereSrf, CagdPrimTorusSrf, CagdPrimCone2Srf, CagdPrimCylinderSrf

### 3.2.453 CagdPrimCubeSphereSrf (cagdprim.c:445)

```c
CagdSrfStruct *CagdPrimCubeSphereSrf(const CagdVType Center,
    CagdRType Radius,
    CagdBType Rational)
```

**Center:** Of constructed sphere.

**Radius:** Of constructed sphere.

**Rational:** If TRUE exact ration sphere is created. If FALSE an approximated integral surface is created.

**Returns:** A Bspline surface representing a sphere.

**Description:** A surface constructor of a sphere, centered at Center and radius Radius. Constructs the rational sphere out of six patches in a cube topology. See also: "Tiling the Sphere with Rational Bezier Patches" by Jim Cobb.

**See also:** CagdPrimPlaneSrf, CagdPrimTorusSrf, CagdPrimCone2Srf, CagdPrimConeSrf, CagdPrimCylinderSrf, CagdPrimSphereSrf

### 3.2.454 CagdPrimCylinderSrf (cagdprim.c:701)

```c
CagdSrfStruct *CagdPrimCylinderSrf(const CagdVType Center,
    CagdRType Radius,
    CagdRType Height,
    CagdBType Rational,
    CagdPrimCapsType Caps)
```

**Center:** of constructed Cylinder (center of its base).

**Radius:** of constructed Cylinder.

**Height:** of constructed Cylinder.
Rational: If TRUE exact ration sphere is created. If FALSE an approximated integral surface is created.

Caps: Do we want caps (top and/or bottom) for the cone?

Returns: A Bspline surface representing a cylinder.

Description: A surface constructor of a Cylinder, centered at Center, radii of Radius, and height of Height. Axis of cylinder is Z axis.

See also: CagdPrimPlaneSrf, CagdPrimSphereSrf, CagdPrimTorusSrf, CagdPrimCone2Srf, , CagdPrimConeSrf,

3.2.455 CagdPrimPlaneSrf (cagdprim.c:141)

CagdSrfStruct *CagdPrimPlaneSrf(CagdRType MinX,
CagdRType MinY,
CagdRType MaxX,
CagdRType MaxY,
CagdRType ZLevel)

MinX, MinY: Minimum X coordinates of plane.
MaxX, MaxY: Maximum Y coordinates of plane.
ZLevel: Z level of plane, parallel to the XY plane.

Returns: Constructed plane, as a bilinear surface.

Description: A surface constructor of a plane, parallel to XY plane at level Zlevel.

See also: CagdPrimSphereSrf, CagdPrimTorusSrf, CagdPrimCone2Srf, CagdPrimConeSrf, , CagdPrimCylinderSrf, CagdPrimRectangleCrv,

3.2.456 CagdPrimPlaneSrfOrderLen (cagdprim.c:201)

CagdSrfStruct *CagdPrimPlaneSrfOrderLen(CagdRType MinX,
CagdRType MinY,
CagdRType MaxX,
CagdRType MaxY,
CagdRType ZLevel,
int Order,
int Len)

MinX, MinY: Minimum XY coordinates of plane.
MaxX, MaxY: Maximum XY coordinates of plane.
ZLevel: Z level of plane, parallel to the XY plane.

Order: Order of plane surface that is requested.
Len: Number of control points (via refinement).

Returns: Constructed surface.

Description: A surface constructor of a plane, parallel to XY plane at level Zlevel.

See also: CagdPrimSphereSrf, CagdPrimTorusSrf, CagdPrimCone2Srf, CagdPrimConeSrf, , CagdPrimCylinderSrf, CagdPrimPlaneSrf,

3.2.457 CagdPrimPlaneXZSrf (cagdprim.c:251)

CagdSrfStruct *CagdPrimPlaneXZSrf(CagdRType MinX,
CagdRType MinZ,
CagdRType MaxX,
CagdRType MaxZ,
CagdRType YLevel)

MinX, MinZ: Minimum X coordinates of plane.
MaxX, MaxZ: Maximum Z coordinates of plane.
YLevel: Y level of plane, parallel to the XZ plane.

Returns: Constructed plane, as a bilinear surface.

Description: A surface constructor of an XZ plane, parallel to XZ plane at level Ylevel.

See also: CagdPrimSphereSrf, CagdPrimTorusSrf, CagdPrimCone2Srf, CagdPrimConeSrf, , CagdPrimCylinderSrf, CagdPrimRectangleCrv, CagdPrimPlaneSrf,
3.2.458 CagdPrimPlaneYZSrf (cagdprim.c:301)

CagdSrfStruct *CagdPrimPlaneYZSrf(CagdRType MinY,
CagdRType MinZ,
CagdRType MaxY,
CagdRType MaxZ,
CagdRType XLevel)

MinY, MinZ: Minimum Y coordinates of plane.
MaxY, MaxZ: Maximum Z coordinates of plane.
XLevel: X level of plane, parallel to the YZ plane.

Returns: Constructed plane, as a bilinear surface.

Description: A surface constructor of a YZ plane, parallel to YZ plane at level Ylevel.
See also: CagdPrimSphereSrf, CagdPrimTorusSrf, CagdPrimCone2Srf, CagdPrimConeSrf, CagdPrimCylinderSrf, CagdPrimRectangleCrv, CagdPrimPlaneSrf.

3.2.459 CagdPrimRectangleCrv (cagdprim.c:90)

CagdCrvStruct *CagdPrimRectangleCrv(CagdRType MinX,
CagdRType MinY,
CagdRType MaxX,
CagdRType MaxY,
CagdRType ZLevel)

MinX, MinY: Minimum XY coordinates of rectangle.
MaxX, MaxY: Maximum XY coordinates of rectangle.
ZLevel: Z level of rectangle, parallel to the XY plane.

Returns: Constructed curve.

Description: A curve constructor of a rectangle, parallel to XY plane at level Zlevel.
See also: CagdPrimPlaneSrf.

3.2.460 CagdPrimSphereSrf (cagdprim.c:387)

CagdSrfStruct *CagdPrimSphereSrf(const CagdVType Center,
CagdRType Radius,
CagdBType Rational)

Center: Of constructed sphere.
Radius: Of constructed sphere.
Rational: If TRUE exact ration sphere is created. If FALSE an approximated integral surface is created.

Returns: A B spline surface representing a sphere.

Description: A surface constructor of a sphere, centered at Center and radius Radius.
See also: CagdPrimPlaneSrf, CagdPrimTorusSrf, CagdPrimCone2Srf, CagdPrimConeSrf, CagdPrimCylinderSrf, CagdPrimCubeSphereSrf.

3.2.461 CagdPrimTorusSrf (cagdprim.c:530)

CagdSrfStruct *CagdPrimTorusSrf(const CagdVType Center,
CagdRType MajorRadius,
CagdRType MinorRadius,
CagdBType Rational)

Center: of constructed torus.
MajorRadius: of constructed torus.
MinorRadius: of constructed torus.
Rational: If TRUE exact ration sphere is created. If FALSE an approximated integral surface is created.
Returns: A Bspline surface representing a torus.

Description: A surface constructor of a torus, centered at Center and radii of MajorRadius and MinorRadius.
See also: CagdPrimPlaneSrf, CagdPrimSphereSrf, CagdPrimCone2Srf, CagdPrimConeSrf, CagdPrimCylinderSrf,

3.2.462 CagdPromoteCrvToSrf (cagdruld.c:160)

CagdSrfStruct *CagdPromoteCrvToSrf(const CagdCrvStruct *Crv,
                    CagdSrfDirType Dir)

Crv: A Crv to promote into a surface
Dir: Direction of ruling. Either U or V.
Returns: The surface promoted from Crv.

Description: Promotes a curve to a surface by creating a ruled surface between the curve to itself. Dir controls
if the curve should be U or V surface direction. The resulting surface is degenerate in that its speed is zero in the
ruled direction and hence the surface is not regular.

3.2.463 CagdPtArrayFree (cagd2gen.c:562)

void CagdPtArrayFree(CagdPtStruct *PtArray, int Size)

PtArray: To be deallocated.
Size: Of the deallocated array.
Returns: void

Description: Deallocates and frees an array of Pt structure.

3.2.464 CagdPtArrayNew (cagd1gen.c:281)

CagdPtStruct *CagdPtArrayNew(int Size)

Size: Size of Pt array to allocate.
Returns: An array of Pt structures of size Size.
Description: Allocates and resets all slots of an array of Pt structures.

3.2.465 CagdPtCopy (cagd1gen.c:922)

CagdPtStruct *CagdPtCopy(const CagdPtStruct *Pt)

Pt: To be copied.
Returns: A duplicate of Pt.
Description: Allocates and copies all slots of a Pt structure.

3.2.466 CagdPtCopyList (cagd1gen.c:1232)

CagdPtStruct *CagdPtCopyList(const CagdPtStruct *PtList)

PtList: To be copied.
Returns: A duplicated list of points.
Description: Allocates and copies a list of point structures.
3.2.467  **CagdPtFree**  (cagd2gen.c:467)

```c
void CagdPtFree(CagdPtStruct *Pt)

    Pt: To be deallocated.
    Returns: void
    Description: Deallocates and frees all slots of a point structure.
```

3.2.468  **CagdPtFreeList**  (cagd2gen.c:490)

```c
void CagdPtFreeList(CagdPtStruct *PtList)

    PtList: To be deallocated.
    Returns: void
    Description: Deallocates and frees a point structure list:
```

3.2.469  **CagdPtNew**  (cagd1gen.c:308)

```c
CagdPtStruct *CagdPtNew(void)

    Returns: A Pt structure.
    Description: Allocates and resets all slots of a Pt structure.
```

3.2.470  **CagdPtPolyline2E3Polyline**  (bzr2poly.c:1231)

```c
CagdPolylineStruct *CagdPtPolyline2E3Polyline(
    CagdRType * const Polyline[CAGD_MAX_PT_SIZE],
    int n,
    int MaxCoord,
    int IsRational)

    Polyline: A vector of evaluations with MaxCoord each evaluation.
    n: Number of evaluation (length of Polyline).
    MaxCoord: Number of coordinates in the polyline Polyline.
    IsRational: TRUE, if original curve was rational, FALSE otherwise.
    Returns: A list of E3 polylines representing the piecewise linear approximation. Typically, only one polyline, unless the (rational) curve has poles.
    Description: Routine to approx. a single Bspline curve as a polyline with SamplesPerCurve samples. Polyline is always E3 CagdPolylineStruct type. Curve is refined equally spaced in parametric space, unless the curve is linear in which the control polygon is simply being copied. If A is specified, it is used to refine the curve. NULL is returned in case of an error, otherwise CagdPolylineStruct.
    See also: BzrCrv2Polyline, Bspsrf2Polylines, IritCurve2Polylines, SymbCrv2Polyline,
```

3.2.471  **CagdPtsSortAxis**  (cbsp_int.c:1615)

```c
CagdPtStruct *CagdPtsSortAxis(CagdPtStruct *PtList, int Axis)

    PtList: List of points to sort.
    Axis: Axis to sort along: 1,2,3 for X,Y,Z.
    Returns: Sorted list of points, in place.
    Description: Sorts given list of points based on their increasing order in axis Axis. Sorting is done in place.
3.2.472  CagdQuadricMatTransform  \((cagd\_cnc.c:1207)\)

```c
int CagdQuadricMatTransform(CagdRType *A,
    CagdRType *B,
    CagdRType *C,
    CagdRType *D,
    CagdRType *E,
    CagdRType *F,
    CagdRType *G,
    CagdRType *H,
    CagdRType *I,
    CagdRType *J,
    CagdMType Mat)
```

**A, B, C, D, E, F, G, H, I, J:** The ten coefficients of the quadric. Updated in place.

**Mat:** Transformation matrix.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Transform given quadric form \(A x^2 + B y^2 + C z^2 + D x y + E x z + F y z + G x + H y + I z + J = 0\), using \(\text{Mat}\). Algorithm:

1. Convert the implicit quadric to a matrix form as:
   \[
   \begin{bmatrix}
   A & D/2 & E/2 & G/2 \\
   D/2 & B & F/2 & H/2 \\
   E/2 & F/2 & C & I/2 \\
   G/2 & H/2 & I/2 & J
   \end{bmatrix}
   \begin{bmatrix}
   x \\
y \\
z \\
1
   \end{bmatrix} = P^T M P = 0
   \]

2. Compute \(N = \text{Mat}^{-1}\) the inverse of the desired transformation.

3. Compute \(K = N M N^T\) and decompose \(K\) back to \(A-J\) coefficients.

**See also:** CagdConicMatTransform, CagdSrfTransform, CagdCrvTransform,

3.2.473  CagdQuinticHermiteSrf  \((\text{hermite.c:152})\)

```c
CagdSrfStruct *CagdQuinticHermiteSrf(const CagdCrvStruct *CPos1Crv,
    const CagdCrvStruct *CPos2Crv,
    const CagdCrvStruct *CDir1Crv,
    const CagdCrvStruct *CDir2Crv,
    const CagdCrvStruct *C2Dir1Crv,
    const CagdCrvStruct *C2Dir2Crv)
```

**CPos1Crv, CPos2Crv:** Starting and end curves of surface.

**CDir1Crv, CDir2Crv:** Starting and end tangent fields surface.

**C2Dir1Crv, C2Dir2Crv:** Starting and end 2nd derivative fields surface.

**Returns:** A cubic by something Bezier surface, satisfying the four constraints. The other something degree is the largest of the four given curves.

**Description:** Construct a cubic surface using the Hermite constraints - two positions and two tangents. Other direction's degree depends on input.
3.2.474 CagdRayTraceBzrSrf (bez_clip.c:111)

CagdBType CagdRayTraceBzrSrf(CagdPType StPt,
       CagdVType Dir,
       const CagdSrfStruct *BzrSrf,
       CagdUVStruct **IntrPrm,
       CagdPtStruct **IntrPt)

StPt: Start point of the ray.
Dir: Direction of the ray.
BzrSrf: A rational Bezier surface to be ray-traced.
IntrPrm: Ray/Bezier surface intersection parameter (of the surface).
IntrPt: Ray/Bezier surface intersection points.

Returns: FALSE if no intersection, TRUE for intersection(s).


3.2.475 CagdRayTraceMultIntrsTol (bez_clip.c:229)

CagdRType CagdRayTraceMultIntrsTol(CagdRType Tol)

Tol: A new tolerance for multiple intersections.

Returns: An Old tolerance before changing.

Description: Sets a new tolerance for multiple intersections. If a Bezier Clip fails to reduce the parameter interval width by at least (1-tolerance), there is a probability for multiple intersections.

3.2.476 CagdReorderCurvesInLoop (cagdbsum.c:290)

CagdCrvStruct *CagdReorderCurvesInLoop(CagdCrvStruct *UVCrvs)

UVCrvs: Curves forming one loop to reorder so end point of one curve is the beginning of the next curve.

Returns: Curves properly reordered in loop.

Description: Properly reorder given curves of one closed loops, in place. That is, input is assumed to define a complete loop where one curve ends where another begins. Compare end points in R^3 (XYZ). Input curves can be in arbitrary order and even partially reversed. Orientation of loop will be following first curve in the list.

See also: CagdSrfFromNBndryCrvs,

3.2.477 CagdRuledSrf (cagdruld.c:33)

CagdSrfStruct *CagdRuledSrf(const CagdCrvStruct *CCrv1,
                              const CagdCrvStruct *CCrv2,
                              int OtherOrder,
                              int OtherLen)

CCrv1, CCrv2: The two curves to form a ruled surface in between.
OtherOrder: Usually two, but one can specify higher orders in the ruled direction. OtherOrder must never be larger than OtherLen.
OtherLen: Usually two control points in the ruled direction which necessitates a linear interpolation.

Returns: The ruled surface.

Description: Constructs a ruled surface between the two provided curves. OtherOrder and OtherLen (equal for Bezier) specifies the desired order and refineness level (if B spline) of the other ruled direction.
3.2.478 CagdSDError (cbsp_fit.c:479)

```c
static CagdRType CagdSDError(const CagdPType Point,
   const CagdPType FootPoint,
   const CagdRType Distance,
   const CagdPType Tangent,
   const CagdPType Normal,
   const CagdRType Curvature)
```

- **Point**: (Xk) Points to calculate the error for.
- **FootPoint**: (P(tk)) Footpoint (the closest point to Xk on the curve)
- **Distance**: (dk) Distance between Point and FootPoint
- **Tangent**: (Tk) Curve tangent at Footpoint.
- **Normal**: (Nk) Curve normal at Footpoint.
- **Curvature**: (pk) Curve curvature at Footpoint.

**Returns**: SD error.

**Description**: Computes SD (Squared Distance) error for a single point, which is:

\[
e = \begin{cases} 
\frac{dk}{2} \frac{T}{2} \left( (P(tk) - Xk) \cdot Tk \right) & \text{if } dk < 0 \\
\frac{(P(tk) - Xk) \cdot Nk}{2} & \text{if } 0 \leq dk < pk \\
\end{cases}
\]

3.2.479 CagdScale (cagd2gen.c:1415)

```c
void CagdScale(CagdRType **Points,
   int Len,
   int MaxCoord,
   const CagdRType *Scale)
```

- **Points**: To be affinely transformed. Array of vectors.
- **Len**: Of vectors of Points.
- **MaxCoord**: Maximum number of coordinates to be found in Points.
- **Scale**: Scaling amount.

**Returns**: void

**Description**: Applies a scale transform, in place, to given set of points Points which as array of vectors, each vector of length Len. Array Points optionally contains (if IsNotRational) in Points[0] the weights coefficients and in Points[i] the coefficients of axis i, up to and include MaxCoord (X = 1, Y = 2, etc.). Points are scaled as prescribed by Scale.

**See also**: CagdSrfScale, CagdCrvScale, CagdTransform,

3.2.480 CagdSetFatalErrorFunc (cagd_ft1.c:28)

```c
CagdSetErrorFuncType CagdSetFatalErrorFunc(CagdSetErrorFuncType ErrorFunc)
```

- **ErrorFunc**: New error function to use.
- **Returns**: Old error function reference.

**Description**: Sets the error function to be used by CagdLib.
### 3.2.481 CagdSetLinear2Poly (cagd2gen.c:2269)

void CagdSetLinear2Poly(CagdLin2PolyType Lin2Poly)

**Lin2Poly:** Specification.

**Returns:** void

**Description:** Sets the way (co)linear surfaces are converted into polygons.

### 3.2.482 CagdSparseMatFree (sbsp_int.c:851)

void CagdSparseMatFree(CagdSparseMatStruct *Mat)

**Mat:** Pointer to the sparse matrix.

**Returns:** void

**Description:** Free the memory of the sparse matrix (including all the memory allocated for the cells and for the indicator array).

**See also:** CagdSparseMatNew,

### 3.2.483 CagdSparseMatMultNonSparseResult (sbsp_int.c:1055)

IrtRType *CagdSparseMatMultNonSparseResult(CagdSparseMatStruct *Mat1,
                                         CagdSparseMatStruct *Mat2)

**Mat1:** Pointer to first sparse matrix.

**Mat2:** Pointer to second sparse matrix.

**Returns:** An array containing the member values of the non sparse matrix. The array size will be \((\text{Mat1->RowNum} \times \text{Mat2->ColNum})\) The matrix member should be accessed as Result[Row*Mat2->ColNum + Col]

**Description:** Multiply two sparse matrices (the result is non-sparse matrix), Result = Mat1 * Mat2. NULL will be returned if the input matrix sizes’ are incompatible.

### 3.2.484 CagdSparseMatNew (sbsp_int.c:799)

CagdSparseMatStruct *CagdSparseMatNew(int RowNum, int ColNum, int AddIndicator)

**RowNum:** Number of rows in the matrix.

**ColNum:** Number of columns in the matrix.

**AddIndicator:** A Boolean indicating whether to allocate memory and initialize the indicator of cell existance.

**Returns:** Pointer to allocated sparse matrix.

**Description:** Allocates memory and initialize a sparse matrix of size RowNum, ColNum.

**See also:** CagdSparseMatFree,

### 3.2.485 CagdSparseMatNewCell (sbsp_int.c:946)

void CagdSparseMatNewCell(CagdSparseMatStruct *Mat,
                          int CellRow,
                          int CellCol,
                          IrtRType CellValue)

**Mat:** Pointer to the sparse matrix.

**CellRow:** The new cell row index.

**CellCol:** The new cell col index.

**CellValue:** The Value stored in the cell.

**Returns:** void

**Description:** Add a cell to the sparse matrix in the appropriate row and column.

**See also:**
3.2.486 CagdSparseMatTranspose (cagdsparsemat.c:1114)

CagdSparseMatStruct *CagdSparseMatTranspose(CagdSparseMatStruct *Mat, int AddIndicator)

**Mat:** Pointer to the sparse matrix we want to transpose.

**AddIndicator:** If TRUE, the returned matrix will contain a bit indicator.

**Returns:** Newly allocated sparse matrix which is the transpose of the input matrix.

**Description:** Returns the transpose of the matrix in the input. The newly allocated matrix is returned in sparse format (with or without an indicator as pointed in the AddIndicator parameter).

3.2.487 CagdSrf2CtrlMesh (cagdmesh.c:60)

CagdPolylineStruct *CagdSrf2CtrlMesh(const CagdSrfStruct *Srf)

**Srf:** To extract a control mesh from.

**Returns:** The control mesh of Srf.

**Description:** Extracts the control mesh of a surface as a list of polylines.

**See also:** CagdSrf2KnotLines, CagdSrf2KnotCurves

3.2.488 CagdSrf2Curves (cagdaux.c:470)

CagdCrvStruct *CagdSrf2Curves(const CagdSrfStruct *Srf, int NumOfIsocurves[2])

**Srf:** To extract isoparametric curves from.

**NumOfIsocurves:** In each (U or V) direction.

**Returns:** List of extracted isoparametric curves. These curves inherit the order and continuity of the original Srf. NULL is returned in case of an error.

**Description:** Routine to extract from a surface NumOfIsoline isocurve list in each param. direction. Iso parametric curves are sampled equally spaced in parametric space. NULL is returned in case of an error, otherwise list of CagdCrvStruct.

**See also:** BspSrf2PCurves, BzrSrf2Curves, SymbSrf2Curves

3.2.489 CagdSrf2KnotCurves (cagdmesh.c:201)

CagdCrvStruct *CagdSrf2KnotCurves(const CagdSrfStruct *Srf)

**Srf:** To extract a control mesh from.

**Returns:** Isoparametric curves along all knot lines.

**Description:** Extracts a list of isoparametric curves in a grid along all knots in U and V.

**See also:** CagdSrf2CtrlMesh, CagdSrf2KnotLines

3.2.490 CagdSrf2KnotLines (cagdmesh.c:118)

CagdPolylineStruct *CagdSrf2KnotLines(const CagdSrfStruct *Srf)

**Srf:** To extract a control mesh from.

**Returns:** The control mesh of Srf.

**Description:** Extracts a polyline grid along all knot in U and V as a list of polylines.

**See also:** CagdSrf2CtrlMesh, CagdSrf2KnotCurves
3.2.491  CagdSrf2PolyAdapSetAuxDataFunc (cagd2ply.c:169)

**CagdSrfAdapAuxDataFunc**

**CagdSrf2PolyAdapSetAuxDataFunc**

**Func**: New function to use, NULL to disable.

**Returns**: Old value of function.

**Description**: Sets the surface approximation auxiliary function. This function will be invoked on each subdivision step during the approximation process, for auxiliary processing that are application specific.

**See also**: CagdSrfAdap2Polygons, CagdSrf2PolyAdapSetPolyGenFunc, , CagdSrf2PolyAdapSetErrFunc,

3.2.492  CagdSrf2PolyAdapSetErrFunc (cagd2ply.c:139)

**CagdSrfErrorFunc**

**CagdSrf2PolyAdapSetErrFunc**

**Func**: New function to use, NULL to disable.

**Returns**: Old value of function.

**Description**: Sets the surface approximation error function. The error function will return a negative value if this patch is flat enough, and positive value if flat enough. Either case, the magnitude will equal to the actual error.

**See also**: CagdSrfAdap2Polygons, CagdSrf2PolyAdapSetAuxDataFunc, , CagdSrf2PolyAdapSetPolyGenFunc,

3.2.493  CagdSrf2PolyAdapSetPolyGenFunc (cagd2ply.c:198)

**CagdSrfAdapPolyGenFunc**

**CagdSrf2PolyAdapSetPolyGenFunc**

**Func**: New function to use, NULL to disable.

**Returns**: Old value of function.

**Description**: Sets the function to convert flat surface rectangle domains into polygons.

**See also**: CagdSrfAdap2Polygons, CagdSrf2PolyAdapSetAuxDataFunc, , CagdSrf2PolyAdapSetErrFunc,

3.2.494  CagdSrf2PolygonFast (bsp2poly.c:64)

**int CagdSrf2PolygonFast**

**PolygonFast**: New setting to use.

**Returns**: Old value.

**Description**: Sets the polygonal approximation of surfaces to create polygonal data ast and approximated (if TRUE) or slowly and exact (if FALSE).

**See also**: CagdSrf2Polygons, CagdSrf2PolygonStrip, CagdSrf2PolygonMergeCoplanar,

3.2.495  CagdSrf2PolygonMergeCoplanar (bzej2poly.c:67)

**int CagdSrf2PolygonMergeCoplanar**

**MergeCoplanarPolys**: New setting to use.

**Returns**: Old value.

**Description**: Sets the polygonal approximation of surfaces to merge or not adjacent coplanar polygons into one. The default is to apply this optimization but in cases where a uniform mesh is need, it should be disabled.

**See also**: CagdSrf2Polygons, CagdSrf2PolygonFast, CagdSrf2PolygonStrip, Cagd2PolyClipPolysAtPoles,
3.2.496  CagdSrf2PolygonStrip  (bsp2poly.c:38)

    int CagdSrf2PolygonStrip(int PolygonStrip)

    PolygonStrip: New setting to use.
    Returns: Old value.

    Description: Sets the polygonal approximation of surfaces to create polygonal strips (if TRUE) or regular
regular individual polygons (if FALSE). If TRUE this hints the ability and desire to use polygonal strips but it does not
not guarantee that only polygonal strips would indeed be returned. Regular polygonal data should always be handled as
well.

    See also: CagdSrf2Polygons, CagdSrf2PolygonFast, CagdSrf2PolygonMergeCoplanar,

3.2.497  CagdSrf2Polygons  (cagd_aux.c:312)

    CagdPolygonStruct *CagdSrf2Polygons(const CagdSrfStruct *Srf,
                                          int FineNess,
                                          CagdBType ComputeNormals,
                                          CagdBType FourPerFlat,
                                          CagdBType ComputeUV)

    Srf: To approximate into triangles.
    FineNess: Control on accuracy, the higher the finer.
    ComputeNormals: If TRUE, normal information is also computed.
    FourPerFlat: If TRUE, four triangles are created per flat surface. If FALSE, only 2 triangles are created.
    ComputeUV: If TRUE, UV values are stored and returned as well.
    Returns: A list of polygons with optional normal and/or UV parametric information. NULL is returned in
case of an error.

    Description: Routine to convert a single freeform surface to set of triangles approximating it. FineNess is a
fineness control on result and the larger is more triangles may result. A value of 10 is a good start value. NULL is
returned in case of an error, otherwise list of CagdPolygonStruct.

    See also: BzrSrf2Polygons, BspSrf2Polygons, CagdCrv2Polyline, CagdSrf2Polylines, , CagdSrf2PolygonStrip,
CagdSrf2PolygonsN,

3.2.498  CagdSrf2PolygonsGenPolys  (bzs2poly.c:242)

    CagdPolygonStruct *CagdSrf2PolygonsGenPolys(const CagdSrfStruct *Srf,
                                                 CagdBType FourPerFlat,
                                                 CagdBType *PtWeights,
                                                 CagdPtStruct *PtMesh,
                                                 CagdVecStruct *PtNrml,
                                                 CagdUVStruct *UVMesh,
                                                 int FineNessU,
                                                 int FineNessV)

    Srf: To approximate into triangles.
    FourPerFlat: If TRUE, four triangles are created per flat surface. If FALSE, only 2 triangles are created.
    PtWeights: Weights of the evaluations, if rational, to detect poles. NULL if surface not rational. Freed by
this function.
    PtMesh: Evaluated positions of grid of samples. Freed by this function.
    PtNrml: Evaluated normals of grid of samples or NULL if none. Freed by this function.
    UVMesh: Evaluated UV vals of grid of samples or NULL if none. Freed by this function.
    Returns: A list of polygons with optional normal and/or UV parametric information. NULL is returned in
case of an error.

    Description: Routine to convert uniform grid samples of a freeform srf to a set of triangles/rectangles/polystrips
approximating it.

    See also: BzrSrf2Polygons, BspSrf2Polygons, IritSurface2Polygons, , IritTrimSrf2Polygons, CagdSrf2Polygons,
TrimSrf2Polygons,
3.2.499 CagdSrf2PolygonsN (cagd_aux.c:367)

CagdPolygonStruct *CagdSrf2PolygonsN(const CagdSrfStruct *Srf,
   int Nu,
   int Nv,
   CagdBType ComputeNormals,
   CagdBType FourPerFlat,
   CagdBType ComputeUV)

Srf: To approximate into triangles. 
Nu, Nv: The number of uniform samples in U and V of surface.
ComputeNormals: If TRUE, normal information is also computed.
FourPerFlat: If TRUE, four triangles are created per flat surface. If FALSE, only 2 triangles are created.
ComputeUV: If TRUE, UV values are stored and returned as well.
Returns: A list of polygons with optional normal and/or UV parametric information. NULL is returned in case of an error.

Description: Routine to convert a single freeform surface to set of triangles approximating it using a uniform fixed resolution of Nu x Nv. NULL is returned in case of an error, otherwise list of CagdPolygonStruct.
See also: BzrSrf2Polygons, BspSrf2Polygons, CagdCrv2Polyline, CagdSrf2Polylines, , CagdSrf2PolygonStrip, CagdSrf2Polygons,

3.2.500 CagdSrf2Polylines (cagd_aux.c:427)

CagdPolylineStruct *CagdSrf2Polylines(const CagdSrfStruct *Srf,
   int NumOfIsocurves[2],
   int SamplesPerCurve)

Srf: Srf to extract isoparametric curves from.
NumOfIsocurves: To extract from Srf in each (U or V) direction.
SamplesPerCurve: Fineness control on piecewise linear curve approximation.
Returns: List of polygons representing a piecewise linear approximation of the extracted isoparametric curves or NULL is case of an error.

Description: Routine to convert a single Bspline surface to NumOfIsolines polylines in each parametric direction with SamplesPerCurvel in each isoparametric curve. Polyline are always E3 of CagdPolylineStruct type. Iso parametric curves are sampled equally spaced in parametric space. NULL is returned in case of an error, otherwise list of CagdPolylineStruct. Attempt is made to extract isolines along C1 discontinuities first.
See also: BspCrv2Polyline, BzrSrf2Polylines, IritSurface2Polylines, , IritTrimSrf2Polylines, SymbSrf2Polylines, TrimSrf2Polylines,

3.2.501 CagdSrfA2PGridFetchPts (cagd2pl2.c:584)

CagdSrfPtStruct *CagdSrfA2PGridFetchPts(struct CagdA2PGridStruct *A2PGrid,
   CagdSrfDirType Dir,
   int StartIndex,
   int EndIndex,
   int OtherDirIndex,
   CagdSrfPtStruct **LastPt,
   CagdBType Reversed)

A2PGrid: This grid data structure.
Dir: Are we to fetch sampled points along U or V direction?
StartIndex, EndIndex: Limit indices along this direction to fetch.
OtherDirIndex: Index along the other direction to fetch points.
LastPt: Will be set to last point in linked list.
Reversed: TRUE to fetch the linked list reversed.
Returns: Sampled points.

Description: Fetch an interval of sampled points along isoparametric direction.
See also: CagdSrfA2PGridInit,
3.2.502 CagdSrfA2PGridFetchRect (cagd2pl2.c:507)

CagdSrfPtStruct *CagdSrfA2PGridFetchRect(struct CagdA2PGridStruct *A2PGrid,
    int UIndex1,
    int VIndex1,
    int UIndex2,
    int VIndex2)

A2PGrid: This grid data structure.
UIndex1, VIndex1: Start point of rectangle domain.
UIndex2, VIndex2: End point of rectangle domain.

Returns: List of points found around the rectangle, or NULL if error.

Description: Fetch a all sampled points in the rectangle region defined from [UIndex1, VIndex1] to [UIndex2, VIndex2].

See also: CagdSrfA2PGridInit,

3.2.503 CagdSrfA2PGridFree (cagd2pl2.c:119)

void CagdSrfA2PGridFree(struct CagdA2PGridStruct *A2PGrid)

A2PGrid: The data structure to free.

Returns: void

Description: Free the grid data structure.

See also: CagdSrfA2PGridInit,

3.2.504 CagdSrfA2PGridInit (cagd2pl2.c:82)

struct CagdA2PGridStruct *CagdSrfA2PGridInit(const CagdSrfStruct *Srf)

Srf: Surface to prepare the grid structure point sampling support.

Returns: The structure if successful, NULL otherwise.

Description: Initializes a data structure to efficiently save UV sample locations on a surface and allow fast fetching of them as well.

See also: CagdSrfAdap2Polygons,

3.2.505 CagdSrfA2PGridInsertUV (cagd2pl2.c:162)

void CagdSrfA2PGridInsertUV(struct CagdA2PGridStruct *A2PGrid,
    int UIndex,
    int VIndex,
    CagdRType u,
    CagdRType v)

A2PGrid: This grid data structure.
UIndex, VIndex: Indices of these U / V parameter values.
u, v: The parameter values.

Returns: void

Description: Insert one UV location to sample the surfaces, into the data grid.

See also: CagdSrfA2PGridInit,
3.2.506 CagdSrfA2PGridProcessUV (cagd2pl2.c:309)

```c
int CagdSrfA2PGridProcessUV(struct CagdA2PGridStruct *A2PGrid)

A2PGrid: This grid data structure.
Returns: TRUE if successful, FALSE otherwise.
Description: Once all surface sampled points are insert, this function is invoked to process the data for fast fetch. Two vectors, UGridVec and VGridVec are processed and updated to hold evaluate surface locations. Each entry in UGridVec (respectively in VGridVec) will hold a linked list of surface evaluated locations sort in V for that particular U value.
See also: CagdSrfA2PGridInit,
```

3.2.507 CagdSrfAdap2PolyDefErrFunc (cagd2ply.c:228)

```c
CagdRType CagdSrfAdap2PolyDefErrFunc(const CagdSrfStruct *Srf)

Srf: Surface to test for flatness.
Returns: Negative value if flat enough, positive if not flat. Either case, magnitude will equal to the actual error.
Description: Tolerance evaluation of flatness for given surface. Constructs a plane from the four corner points, if possible, and measure distance to rest of control points.
See also: CagdSrfIsCoplanarCtlMesh, CagdSrfIsLinearBndryCtlMesh, , CagdSrfAdap2Polygons,
```

3.2.508 CagdSrfAdap2PolyEvalNrmlBlendedUV (cagd2ply.c:1467)

```c
CagdRType *CagdSrfAdap2PolyEvalNrmlBlendedUV(const CagdRType *UV1,

UV1: To compute the surface normal close to.
UV2, UV3: Two other UV”s of the triangle.
Returns: Computed normal in a static location. Upto 4 normals could be satatically saved simultaneously.
Description: Compute the normal to the surface very close to UV1 in the triangle defined by UV1/UV2/UV3.
See also: CagdSrfAdap2Polygons,
```

3.2.509 CagdSrfAdap2Polygons (cagd2ply.c:600)

```c
CagdPolygonStruct *CagdSrfAdap2Polygons(const CagdSrfStruct *Srf,

Srf: To approximate into triangles.
Tolerance: of approximation - a value that depends on the error function used.
ComputeNormals: If TRUE, normal information is also computed.
FourPerFlat: If TRUE, four triangles are created per flat surface. If FALSE, only 2 triangles are created.
ComputeUV: If TRUE, UV values are stored and returned as well.
AuxSrfData: Optional data structure that will be passed to all subdivided sub-surfaces, or NULL if not needed. See also CagdSrf2PolyAdapSetAuxDataFunc.
Returns: A list of polygons with optional normal and/or UV parametric information. NULL is returned in case of an error or if use of call back function to collect the polygons.
Description: Routine to convert a single surface to set of polygons approximating it. Tolerance is a tolerance control on result, typically related to the the accuracy of the apporximation. A value of 0.1 is a good rough start. NULL is returned in case of an error or use of call back function to get a hold over the created polygons, otherwise list of CagdPolygonStruct.
See also: CagdSrf2PolygonSetErrFunc, CagdSrfAdap2PolyDefErrFunc, , CagdSrf2PolyAdapSetErrFunc, CagdSrf2PolyAdapSetAuxCagdSrf2PolyAdapSetPolyGenFunc, BzrSrf2Polygons, CagdSrf2Polygons, , CagdSrf2Polygons, TrimSrf2Polygons, BspC1Srf2Polygons, CagdSrf2Polygons,
```
3.2.510  CagdSrfAdapGetE3Pt (cagd2ply.c:267)

static void CagdSrfAdapGetE3Pt(CagdRType *E3Point,  
    CagdRType * const Points[CAGD_MAX_PT_SIZE],  
    int Index,  
    CagdPointType PType)

    E3Point: Where the coerced information is to be saved.
    Points: The control points vector of the surface.
    Index: Index into the vectors of Points.
    PType: Point type of Srf.
    Returns: void

Description: Fetches an E3 point at given Index. Input control points are assumed E3 or P3 only.

3.2.511  CagdSrfAdapRectPolyGen (cagd2ply.c:1211)

CagdPolygonStruct *CagdSrfAdapRectPolyGen(const CagdSrfStruct *Srf,  
    CagdSrfPtStruct *SrfPtList,  
    const CagdSrfAdapRectStruct *Rect)

    Srf: Bspline surface with no discontinuities to approximate into triangles.
    SrfPtList: Circular list of a convex surface domain to convert to triangles.
    Rect: The rectangular domain to convert to polygons.
    Returns: List of polygons out of the closed srf pt list; Could be NULL if polygons are call back created.

Description: Converts the given circular list of surface points into polygons. The list is assumed a convex parametric domain (which ease the process of decomposition).
See also: CagdSrfAdap2Polygons, CagdSrf2PolygonSetErrFunc, , CagdSrfAdap2PolyDefErrFunc, CagdSrf2PolyAdapSetErrFunc, , CagdSrf2PolyAdapSetAuxDataFunc,

3.2.512  CagdSrfAvgArgLenMesh (cagdsmrg.c:385)

CagdRType CagdSrfAvgArgLenMesh(const CagdSrfStruct *Srf,  
    CagdRType *AvgULen,  
    CagdRType *AvgVLen)

    Srf: To computer average mesh edge length in the U and the V directions.
    AvgULen, AvgVLen: Average length of edges of the control mesh of Srf in the U and V mesh directions.
    Returns: The ratio of AvgULen / AvgVLen.

Description: Computes an average of edge lengths of edges of the control mesh of the given surface in the U direction and in the V direction.
See also: CagdCrvArcLenPoly, CagdLimitCrvArcLen,

3.2.513  CagdSrfBBox (cagdbbox.c:183)

void CagdSrfBBox(const CagdSrfStruct *Srf, CagdBBoxStruct *BBox)

    Srf: To compute a bounding box for.
    BBox: Where bounding information is to be saved.
    Returns: void

Description: Computes a bounding box for a freeform surface.
See also: CagdCrvBBox, CagdSrfListBBox, CagdTightBBox, CagdIgnoreNonPosWeightBBox, , CagdPolygonBBox,
3.2.514  CagdSrfBlossomDegreeRaise (blossom.c:1153)

CagdSrfStruct *CagdSrfBlossomDegreeRaise(const CagdSrfStruct *Srf,
                                           CagdSrfDirType Dir)

Srf:  Surface to degree raise.
Dir:  Direction of degree raising. Either U or V.

Returns:  Degree raised surface, or NULL if error.

Description: Computes a new surface with its degree raised once, given surface Srf, using blossoming.
See also:  CagdSrfBlossomDegreeRaiseN, BspSrfDegreeRaise, BzrSrfDegreeRaise, CagdSrfDegreeRaise, Cagd-
          CrvBlossomDegreeRaise,

3.2.515  CagdSrfBlossomDegreeRaiseN (blossom.c:995)

CagdSrfStruct *CagdSrfBlossomDegreeRaiseN(const CagdSrfStruct *Srf,
                                            int NewUOrder,
                                            int NewVOrder)

Srf:  Surface to degree raise.
NewUOrder:  New U order of Srf.
NewVOrder:  New V order of Srf.

Returns:  Degree raised surface, or NULL if error.

Description: Computes a new surface with its degree raised to NewOrder, given surface Srf, using blossoming.
See also:  CagdSrfBlossomDegreeRaise, BspSrfDegreeRaise, BzrSrfDegreeRaise, CagdSrfDegreeRaise, Cagd-
          CrvBlossomDegreeRaiseN,

3.2.516  CagdSrfBlossomEval (blossom.c:507)

CagdRType *CagdSrfBlossomEval(const CagdSrfStruct *Srf,
                                  const CagdRType *BlsmUVals,
                                  int BlsmULen,
                                  const CagdRType *BlsmVVals,
                                  int BlsmVLen)

Srf:  Surface to blossom.
BlsmUVals:  U Blossoming values to consider.
BlsmULen:  Length of BlsmUVals vector; assumed less than Srf U order!
BlsmVVals:  V Blossoming values to consider.
BlsmVLen:  Length of BlsmVVals vector; assumed less than Srf V order!

Returns:  Evaluated Blossom.

Description: Computes the Blossom over the given surface, Srf, and Blossoming factors BlsmU/VVals.
See also:  CagdSrfBlossomEvalU, CagdCrvBlossomEval,

3.2.517  CagdSrfBlossomEvalU (blossom.c:589)

CagdCrvStruct *CagdSrfBlossomEvalU(const CagdSrfStruct *Srf,
                                     const CagdRType *BlsmUVals,
                                     int BlsmULen)

Srf:  Surface to blossom.
BlsmUVals:  U Blossoming values to consider.
BlsmULen:  Length of BlsmUVals vector; assumed less than Srf U order!

Returns:  Evaluated Blossom in U as a curve in V. This curve holds as many control points as Srf has in the
          V direction.

Description: Computes the Blossom over the given surface, Srf, and Blossoming factors BlsmUVals, in the U
          direction only. Returned is a curve in V.
See also:  CagdSrfBlossomEval, CagdCrvBlossomEval,
3.2.518 CagdSrfCopy (cagd1gen.c:809)

CagdSrfStruct *CagdSrfCopy(const CagdSrfStruct *Srf)

Srf: To be copied.

Returns: A duplicate of Srf.

Description: Allocates and copies all slots of a surface structure.

3.2.519 CagdSrfCopyList (cagd1gen.c:1174)

CagdSrfStruct *CagdSrfCopyList(const CagdSrfStruct *SrfList)

SrfList: To be copied.

Returns: A duplicated list of surfaces.

Description: Allocates and copies a list of surface structures.

3.2.520 CagdSrfDegreeRaise (cagd_aux.c:1610)

CagdSrfStruct *CagdSrfDegreeRaise(const CagdSrfStruct *Srf, CagdSrfDirType Dir)

Srf: To raise its degree.

Dir: Direction of degree raising. Either U or V.

Returns: A surface with same geometry as Srf but with one degree higher.

Description: Returns a new surface representing the same surface as Srf but with its degree raised by one.

See also: BzrSrfDegreeRaise, BspSrfDegreeRaise, TrimSrfDegreeRaise,

3.2.521 CagdSrfDegreeRaiseN (cagd_aux.c:1648)

CagdSrfStruct *CagdSrfDegreeRaiseN(const CagdSrfStruct *Srf, int NewUOrder, int NewVOrder)

Srf: To raise its degree.

NewUOrder: New U order of Srf.

NewVOrder: New V order of Srf.

Returns: A surface with higher degrees as prescribed by NewUOrder/NewVOrder.

Description: Returns a new surface, identical to the original but with higher degrees, as prescribed by NewUOrder, NewVOrder.

See also: CagdSrfDegreeRaise, BzrSrfDegreeRaise, TrimSrfDegreeRaise, BspSrfDegreeRaise, BzrSrfDegreeRaiseN, BspSrfDegreeRaiseN,

3.2.522 CagdSrfDerive (cagd_aux.c:872)

CagdSrfStruct *CagdSrfDerive(const CagdSrfStruct *Srf, CagdSrfDirType Dir)

Srf: To compute its derivative surface in direction Dir.

Dir: Direction of differentiation. Either U or V.

Returns: Resulting partial derivative surface.

Description: Given a surface, computes its partial derivative in the prescribed direction Dir.

See also: BzrSrfDerive, BspSrfDerive, BzrSrfDeriveRational, BspSrfDeriveRational, CagdSrfDeriveScalar,
3.2.523 CagdSrfDeriveScalar (cagd_aux.c:917)

CagdSrfStruct *CagdSrfDeriveScalar(const CagdSrfStruct *Srf, CagdSrfDirType Dir)

- **Srf**: To compute derivatives of all its components.
- **Dir**: Direction of differentiation. Either U or V.
- **Returns**: Resulting derivative.

**Description**: Given a surface, computes its partial derivative in the prescribed direction Dir of all its scalar components. For a Euclidean surface this is the same as CagdSrfDerive but for a rational surface the returned surfaces is not the vector field but simply the derivatives of all the surface's coefficients, including the weights.

**See also**: BzrSrfDerive, BspSrfDerive, BzrSrfDeriveRational, BspSrfDeriveRational, CagdSrfDerive, BzrSrfDeriveScalar, BspSrfDeriveScalar.

3.2.524 CagdSrfDomain (cagd_aux.c:161)

void CagdSrfDomain(const CagdSrfStruct *Srf, CagdRType *UMin, CagdRType *UMax, CagdRType *VMin, CagdRType *VMax)

- **Srf**: To get its parametric domain.
- **UMin**: Where to put the minimal U domain's boundary.
- **UMax**: Where to put the maximal U domain's boundary.
- **VMin**: Where to put the minimal V domain's boundary.
- **VMax**: Where to put the maximal V domain's boundary.
- **Returns**: void

**Description**: Returns the parametric domain of a surface.

**See also**: BspSrfDomain.

3.2.525 CagdSrfEffiNrmlEval (nrmleval.c:81)

CagdVecStruct *CagdSrfEffiNrmlEval(CagdRType u, CagdRType v, CagdBType Normalize)

- **u, v**: Parameter values of the location on the surface to compute the normal for. For efficiency, no test is made as for the validity of the (u, v) position.
- **Normalize**: if TRUE, the normal is normalized into a unit length.
- **Returns**: A pointer to a statically allocated normal vector. A all zero vector is returned if failed to compute.

**Description**: Evaluate the surface normal at the given (u, v) surface location. The normal is normalized if Normalize is TRUE. For best performance normal locations with the same U values should be invoking this function in a sequence before moving on to a different U value.

**See also**: CagdSrfNormal, CagdSrfEffiNrmlPrelude, CagdSrfEffiNrmlPostlude.

3.2.526 CagdSrfEffiNrmlPostlude (nrmleval.c:160)

void CagdSrfEffiNrmlPostlude(void)

- **Returns**: void

**Description**: Released all data structures allocated by this efficient normal evaluation routines.

**See also**: CagdSrfNormal, CagdSrfEffiNrmlEval, CagdSrfEffiNrmlPrelude.
3.2.527  **CagdSrfEffiNrmlPrelude** (nrmleval.c:40)

```c
void CagdSrfEffiNrmlPrelude(const CagdSrfStruct *Srf)
```

**Srf**: Do preprocess for fast normal evaluations.

**Returns**: void

**Description**: Do the necessary preprocessing so we can efficiently evaluate normal on Srf. For best efficiency normals with same U values should be evaluated in a sequence, before moving to the next U.

**See also**: CagdSrfNormal, CagdSrfEffiNrmlEval, CagdSrfEffiNrmlPostlude,

3.2.528  **CagdSrfEstimateCurveness** (bzr2poly.c:1305)

```c
void CagdSrfEstimateCurveness(const CagdSrfStruct *Srf,
                               CagdRType *UCurveness,
                               CagdRType *VCurveness)
```

**Srf**: To consider.

**UCurveness**: The surface curveness in the U direction.

**VCurveness**: The surface curveness in the V direction.

**Returns**: void

**Description**: Estimate a relative surface curveness measure in U and V (no twist consideration). A flat surface (or a bilinear) would return two zeros. A highly curved surface would return values near one.

3.2.529  **CagdSrfEval** (cagd_aux.c:265)

```c
CagdRType *CagdSrfEval(const CagdSrfStruct *Srf, CagdRType u, CagdRType v)
```

**Srf**: To evaluate at the given parametric location (u, v).

**u, v**: The parameter values at which the curve Crv is to be evaluated.

**Returns**: A vector holding all the coefficients of all components of surface Srf's point type. If for example the surface's point type is P2, the W, X, and Y will be saved in the first three locations of the returned vector. The first location (index 0) of the returned vector is reserved for the rational coefficient W and XYZ always starts at second location of the returned vector (index 1). This vector is allocated statically and a second invocation of this function will overwrite the first.

**Description**: Given a surface and parameter values u, v, evaluate the surface at (u, v).

**See also**: CagdCrvEval, BspSrfEvalAtParam, BzrSrfEvalAtParam, , BspSrfEvalAtParam2, TrimSrfEval,

3.2.530  **CagdSrfFree** (cagd2gen.c:292)

```c
void CagdSrfFree(CagdSrfStruct *Srf)
```

**Srf**: To be deallocated.

**Returns**: void

**Description**: Deallocates and frees all slots of a surface structure.

3.2.531  **CagdSrfFreeCache** (cagd2gen.c:346)

```c
void CagdSrfFreeCache(CagdSrfStruct *Srf)
```

**Srf**: To deallocate its cache.

**Returns**: void

**Description**: Deallocates and frees a surface cache structure.
### 3.2.532 CagdSrfFreeList (cagd2gen.c:372)

```c
void CagdSrfFreeList(CagdSrfStruct *SrfList)
{
    SrfList: To be deallocated.
    Returns: void
    Description: Deallocates and frees a surface structure list:
}
```

### 3.2.533 CagdSrfFromCrvs (cagdcsrf.c:141)

```c
CagdSrfStruct *CagdSrfFromCrvs(const CagdCrvStruct *CrvList,
                                int OtherOrder,
                                CagdEndConditionType OtherEC,
                                IrtRType *OtherParamVals)
{
    CrvList: List of curves to construct a surface with.
    OtherOrder: Other order of surface.
    OtherEC: End condition in the other (non CrvList) srf direction.
    OtherParamVals: If not NULL, updated with other direction set parameters of the curves in the new surfaces.
    Returns: Constructed surface from curves.
    Description: Constructs a surface using a set of curves. Curves are made to be compatible and then each is substituted into the new surface’s mesh as a row. If the OtherOrder is less than the number of curves, number of curves is used. If OtherOrder is negative, the absolute value is employed and a periodic surface is constructed in the other direction. A knot vector is formed with OtherEC end conditions for the other direction. Note, however, that only the first and the last curves are interpolated if open end conditions are selected and OtherOrder is greater than 2.
    See also: CagdSrfInterpolateCrvs,
}
```

### 3.2.534 CagdSrfFromNBndryCrvs (cagdbsum.c:437)

```c
CagdSrfStruct *CagdSrfFromNBndryCrvs(const CagdCrvStruct *Crvs,
                                       CagdBType MinimizeSize)
{
    Crvs: To build 1/2 surfaces with these curves as boundaries.
    MinimizeSize: If true, minimize the size of the output, on expense of accuracy. N
    Returns: One or two planar surfaces spanning the curves.
    Description: Builds tensor product surfaces that spans the given list of surface boundary curves in one closed loop. Can be 1 to 6 input boundary curves, and 1 to 2 surfaces are returned.
    See also: CagdReorderCurvesInLoop,
}
```

### 3.2.535 CagdSrfIntegrate (cagd_aux.c:956)

```c
CagdSrfStruct *CagdSrfIntegrate(const CagdSrfStruct *Srf, CagdSrfDirType Dir)
{
    Srf: To compute its integral surface.
    Dir: Direction of integration. Either U or V.
    Returns: Resulting integral surface.
    Description: Given a surface, compute its integral surface.
    See also: BzrSrfIntegrate, BspSrfIntegrate,
}
```
3.2.536  CagdSrfInterpolateCrvs (cagdcsrf.c:288)

CagdSrfStruct *CagdSrfInterpolateCrvs(const CagdCrvStruct *CrvList,
                        int OtherOrder,
                        CagdEndConditionType OtherEC,
                        CagdParametrizationType OtherParam,
                        ItrtType *OtherParamVals)

CrvList: List of curves to construct a surface with.
OtherOrder: Other order of surface.
OtherEC: End condition in the other (non CrvList) srf direction.
OtherParam: Currently only Chord length and uniform are supported.
OtherParamVals: If not NULL, updated with other direction set parameters of the curves in the new surfaces.

Returns: Constructed surface from curves.

Description: Constructs a surface using a set of curves. Curves are made to be compatible and then interpolated by the created surfaces. If the OtherOrder is less than the number of curves, number of curves is used. If OtherOrder is negative, the absolute value is employed and a periodic surface is constructed in the other direction. A knot vector is formed with OtherEC end conditions for the other direction.

See also: CagdSrfFromCrvs, CagdSrfInterpolateCrvsChordLenParams,

3.2.537  CagdSrfInterpolateCrvsChordLenParams (cagdcsrf.c:213)

CagdRType *CagdSrfInterpolateCrvsChordLenParams(const CagdCrvStruct *CrvList)

CrvList: List of curves to construct a surface with.

Returns: Vectors of parameters normalized to [0, 1] of parameters, of size of number of curves, allocated dynamically.

Description: Computes parameters to interpolate the given curves at, as a surface. Estimate a middle point from each curve and set parameters based on chord length from each middle point to the next.

See also: CagdSrfFromCrvs, CagdSrfInterpolateCrvs, CagdSrfInterpolateCrvs,

3.2.538  CagdSrfIsCoplanarCtlMesh (cagd2ply.c:468)

CagdRType CagdSrfIsCoplanarCtlMesh(const CagdSrfStruct *Srf)

Srf: Surface to test for flatness of its control mesh.

Returns: A bound on the distance between the control points and the plane fitted to the four corners.

Description: evaluate the coplanarity of the control mesh for a given surface. Constructs a plane from the four corner points, if possible, and measure distance to rest of control points.

See also: CagdSrfAdap2Polygons, CagdSrfAdap2PolyDefErrFunc,

3.2.539  CagdSrfIsLinearBndryCtlMesh (cagd2ply.c:432)

CagdRType CagdSrfIsLinearBndryCtlMesh(const CagdSrfStruct *Srf)

Srf: Surface to test for linearity of of its control mesh’s boundary.

Returns: A bound on the distance between the control mesh boundary and a linear rectangle connecting the four corners.

Description: Evaluate the linearity of the boundary of the control mesh for a given surface. Constructs a line for each boundary, if possible, and measure distance to rest of control points on that boundary.

See also: CagdSrfAdap2Polygons, CagdSrfAdap2PolyDefErrFunc,
3.2.540  CagdSrfIsLinearCtlMesh (cagd2ply.c:391)

```c
CagdRTypen CagdSrfIsLinearCtlMesh(const CagdSrfStruct *Srf, CagdBType Interior)
```

**Srf:** Surface to test for linearity of its control mesh's boundary.

**Interior:** TRUE to handle interior rows/columns only. FALSE to check Boundary as well.

**Returns:** A bound on the distance between the control mesh boundary and a linear rectangle connecting the four corners.

**Description:** Evaluate the linearity of the control mesh for a given surface. Constructs a line for each row/col, if possible, and measures distance to rest of control points on that row/col.

**See also:** CagdSrfIsLinearBndryCtlMesh, CagdSrfIsLinearCtlMeshOneRowCol,

3.2.541  CagdSrfIsLinearCtlMeshOneRowCol (cagd2ply.c:309)

```c
CagdRTypen CagdSrfIsLinearCtlMeshOneRowCol(const CagdSrfStruct *Srf, int Idx, CagdSrfDirType Dir)
```

**Srf:** Surface to test for linearity of its control mesh's row/col.

**Idx:** Of row/column.

**Dir:** A row or column specification.

**Returns:** A bound on the distance between the control points on the row/col and the line through end points of that row/column.

**Description:** Evaluate the linearity of the control mesh for a given surface, along one row or column. Constructs a line through the two end points and measures distance to rest of control points on that row/col.

**See also:** CagdSrfIsLinearBndryCtlMesh, CagdSrfIsLinearCtlMesh,

3.2.542  CagdSrfIsPtIndexBoundary (cag1gen.c:2065)

```c
CagdSrfBndryType CagdSrfIsPtIndexBoundary(CagdSrfStruct *Srf, int PtIdx)
```

**Srf:** Surface to examine if PtIdx is of a boundary control point.

**PtIdx:** Index into Points vectors to examine if of a boundary point.

**Returns:** Boundary type, or CAGD_NO_BNDRY if interior.

**Description:** Checks if the given control point index (in the Points vector of control points in CagdSrfStruct) is of a boundary control point.

3.2.543  CagdSrfListBBox (cagdbbox.c:366)

```c
void CagdSrfListBBox(const CagdSrfStruct *Srfs, CagdBBoxStruct *BBox)
```

**Srfs:** To compute a bounding box for.

**BBox:** Where bounding information is to be saved.

**Returns:** void

**Description:** Computes a bounding box for a list of freeform surfaces.

**See also:** CagdCrvBBox, CagdSrfBBox, CagdPolygonListBBox, CagdTightBBox,
3.2.544  

**CagdSrfMatTransform**  
(cagd2gen.c:1499)

```c
CagdSrfStruct *CagdSrfMatTransform(const CagdSrfStruct *Srf,  
CagdMType Mat)
```

- **Srf**: To be transformed.
- **Mat**: Defining the transformation.

**Returns**: Returned transformed surface.

**Description**: Applies an homogeneous transformation, to the given surface Srf as specified by homogeneous transformation Mat.

**See also**: CagdTransform, CagdCrvMatTransform, CagdMatTransform,

3.2.545  

**CagdSrfMinMax**  
(cagdbbox.c:612)

```c
void CagdSrfMinMax(const CagdSrfStruct *Srf,  
int Axis,  
CagdRType *Min,  
CagdRType *Max)
```

- **Srf**: To test for minimum/maximum.
- **Axis**: 0 for W, 1 for X, 2 for Y etc.
- **Min**: Where minimum found value should be place.
- **Max**: Where maximum found value should be place.

**Returns**: void

**Description**: Computes a min max bound on a surface in a given axis. The surface is not coerced to anything and the given axis is tested directly where 0 is the W axis and 1, 2, 3 are the X, Y, Z etc.

3.2.546  

**CagdSrfMoebiusTransform**  
(cagd_aux.c:1003)

```c
CagdSrfStruct *CagdSrfMoebiusTransform(const CagdSrfStruct *Srf,  
CagdRType c,  
CagdSrfDirType Dir)
```

- **Srf**: Surface to apply the Moebius transformation to.
- **c**: The scaling coefficient - c^"n is the ratio between the first and last weight of the surface, along each row or column. If c == 0, the first and last weights are made equal, in the first row/column.
- **Dir**: Direction to apply the Moebius transformation, row or col. If Dir == CAGD_BOTH_DIR, the transformation is applied to both the row and column directions, in this order.

**Returns**: Resulting surface after the moebius transformation.

**Description**: Given a surface, compute its moebius transformation.

**See also**: BzrSrfMoebiusTransform, BspSrfMoebiusTransform,

3.2.547  

**CagdSrfNew**  
(cagd1gen.c:136)

```c
CagdSrfStruct *CagdSrfNew(CagdGeomType GType,  
CagdPointType PType,  
int ULength,  
int VLength)
```

- **GType**: Type of geometry the surface should be - Bspline, Bezier etc.
- **PType**: Type of control points (E2, P3, etc.).
- **ULength**: Number of control points in the U direction.
- **VLength**: Number of control points in the V direction.

**Returns**: An uninitialized freeform surface.

**Description**: Allocates the memory required for a new surface.

**See also**: BzrSrfNew, BspPeriodicSrfNew, BspSrfNew, CagdPeriodicSrfNew, TrimSrfNew,
### 3.2.548 CagdSrfNodes (bsp.knot.c:1670)

CagdRType *CagdSrfNodes(const CagdSrfStruct *Srf, CagdSrfDirType Dir)

* Srf: To compute node values for.
* Dir: Either the U or the V parametric direction.
* **Returns**: Node values of the given surface and given parametric direction.
* **Description**: Returns the nodes of a freeform surface.

### 3.2.549 CagdSrfNormal (cagd_aux.c:2283)

CagdVecStruct *CagdSrfNormal(const CagdSrfStruct *Srf, CagdRType u, CagdRType v, CagdBType Normalize)

* Srf: To compute (unit) normal vector for.
* u, v: Location where to evaluate the normal of Srf.
* Normalize: If TRUE, attempt is made to normalize the returned vector. If FALSE, length is a function of given parametrization.
* **Returns**: A pointer to a static vector holding the unit normal information.
* **Description**: Given a surface Srf and a parameter values u, v, returns the (unit) normal vector of Srf.
* **See also**: BzrSrfNormal, BspSrfNormal, SymbSrfNormalSrf, TrngTriSrfNrml, , pSrfMeshNormals,

### 3.2.550 CagdSrfPtCopy (cagd1gen.c:947)

CagdSrfPtStruct *CagdSrfPtCopy(const CagdSrfPtStruct *Pt)

* Pt: To be copied.
* **Returns**: A duplicate of SrfPt.
* **Description**: Allocates and copies all slots of a surface Pt structure.

### 3.2.551 CagdSrfPtCopyList (cagd1gen.c:1261)

CagdSrfPtStruct *CagdSrfPtCopyList(const CagdSrfPtStruct *SrfPtList)

* SrfPtList: To be copied.
* **Returns**: A duplicated list of points.
* **Description**: Allocates and copies a list of surface point structures.

### 3.2.552 CagdSrfPtFree (cagd2gen.c:514)

void CagdSrfPtFree(CagdSrfPtStruct *SrfPt)

* SrfPt: To be deallocated.
* **Returns**: void
* **Description**: Deallocates and frees all slots of a point structure.
3.2.553  CagdSrfPtFreeList  (cagd2gen.c:537)

void CagdSrfPtFreeList(CagdSrfPtStruct *SrfPtList)

SrfPtList: To be deallocated.

Returns: void

Description: Deallocates and frees a point structure list:

3.2.554  CagdSrfPtNew  (cagd1gen.c:332)

CagdSrfPtStruct *CagdSrfPtNew(void)

Returns: A surface Pt structure.

Description: Allocates and resets all slots of a Surface Pt structure.

3.2.555  CagdSrfRefineAtParams  (cagd_aux.c:2029)

CagdSrfStruct *CagdSrfRefineAtParams(const CagdSrfStruct *Srf, CagdSrfDirType Dir, CagdBType Replace, CagdRType *t, int n)

Srf: To refine.

Dir: Direction of refinement. Either U or V.

Replace: If TRUE, t holds knots in exactly the same length as the length of the knot vector of Srf and t simply replaces the knot vector.

n: Length of vector t.

t: Vector of knots with length of n.

Returns: A refined curve of Srf after insertion of all the knots as specified by vector t of length n.

Description: Given a surface - refines it at the given n knots as defined by vector t. If Replace is TRUE, the values in t replaces current knot vector. Returns pointer to refined surface (Note a Bezier surface will be converted into a Bspline surface).

3.2.556  CagdSrfRegionFromSrf  (cagd_aux.c:1934)

CagdSrfStruct *CagdSrfRegionFromSrf(const CagdSrfStruct *Srf, CagdRType t1, CagdRType t2, CagdSrfDirType Dir)

Srf: To extract a sub-region from.

t1, t2: Parametric domain boundaries of sub-region.

Dir: Direction of region extraction. Either U or V.

Returns: Sub-region extracted from Srf from t1 to t2.

Description: Given a surface - extracts a sub-region within the domain specified by t1 and t2, in the direction Dir.
3.2.557  CagdSrfReverse (cagd\_aux.c:2414)

CagdSrfStruct *CagdSrfReverse(const CagdSrfStruct *Srf)

Srf: To be reversed.
Returns: Reversed surface of Srf.
Description: Returns a new surface that is the reversed surface of Srf by reversing the control mesh and the knot vector (if Bspline surface) of Srf in the U direction. See also BspKnotReverse.
See also: CagdSrfReverse2, CagdSrfReverseDir,

3.2.558  CagdSrfReverse2 (cagd\_aux.c:2529)

CagdSrfStruct *CagdSrfReverse2(const CagdSrfStruct *Srf)

Srf: To be reversed.
Returns: Reversed surface of Srf.
Description: Returns a new surface that is the reversed surface of Srf by flipping the U and the V directions of the surface. See also BspKnotReverse.
See also: CagdSrfReverse, CagdSrfReverseDir,

3.2.559  CagdSrfReverseDir (cagd\_aux.c:2438)

CagdSrfStruct *CagdSrfReverseDir(const CagdSrfStruct *Srf, CagdSrfDirType Dir)

Srf: To be reversed.
Dir: Direction to reverse the Mesh along. Either U or V.
Returns: Reversed surface of Srf.
Description: Returns a new surface that is the reversed surface of Srf by reversing the control mesh and the knot vector (if Bspline surface) of Srf in the Dir direction. See also BspKnotReverse.
See also: CagdSrfReverse2,

3.2.560  CagdSrfScale (cagd2gen.c:1311)

void CagdSrfScale(CagdSrfStruct *Srf, const CagdRType *Scale)

Srf: To be nonuniformly scaled.
Scale: Scaling amount.
Returns: void
Description: Applies a nonuniform scaling transform, in place, to given curve Srf as specified by Scale.
See also: CagdCrvTransform, CagdTransform, CagdSrfMatTransform, CagdSrfRotateToXY, CagdSrfTransform,

3.2.561  CagdSrfSetDomain (cagd\_aux.c:204)

CagdSrfStruct *CagdSrfSetDomain(CagdSrfStruct *Srf, CagdRType UMin, CagdRType UMax, CagdRType VMin, CagdRType VMax)

Srf: To reset its parametric domain.
UMin: Minimal domain’s new U boundary.
UMax: Maximal domain’s new U boundary.
VMin: Minimal domain’s new V boundary.
VMax: Maximal domain’s new V boundary.
Returns: Modified surface, in place.
Description: Affinely reset the parametric domain of a surface, in place.
See also: BspSrfDomain, BspKnotAffineTrans2, CagdCrvSetDomain,
3.2.562 CagdSrfSetMakeOnlyTri (cagd2gen.c:2033)

CagdBType CagdSrfSetMakeOnlyTri(CagdBType OnlyTri)

OnlyTri: TRUE for triangles only, FALSE otherwise.

Returns: Old value of flag.

Description: Sets a flag to control if only triangles are to be generated from the tesselation code. If TRUE only triangular polygons will be in the output set

See also: CagdSrfSetMakeRectFunc, CagdSrf2Polygons, CagdSrfAdap2Polygons, , CagdMakeTriangle, CagdSrfSetMakeTriFunc,

3.2.563 CagdSrfSetMakeRectFunc (cagd2gen.c:2004)

CagdSrfMakeRectFuncType CagdSrfSetMakeRectFunc(CagdSrfMakeRectFuncType Func)

Func: New function to use, NULL to disable.

Returns: Old value of function.

Description: Sets the call back function to generate rectangles. The function will be invoked with each rectangle in the polygonal approximation. Default call back function used is CagdMakeRectangle.

See also: CagdSrfSetMakeTriFunc, CagdSrf2Polygons, CagdSrfAdap2Polygons, , CagdMakeRectangle, CagdSrfSetMakeOnlyTri,

3.2.564 CagdSrfSetMakeTriFunc (cagd2gen.c:1975)

CagdSrfMakeTriFuncType CagdSrfSetMakeTriFunc(CagdSrfMakeTriFuncType Func)

Func: New function to use, NULL to disable.

Returns: Old value of function.

Description: Sets the call back function to generate triangles. The function will be invoked with each triangle in the polygonal approximation. Default call back function used is CagdMakeTriangle.

See also: CagdSrfSetMakeRectFunc, CagdSrf2Polygons, CagdSrfAdap2Polygons, , CagdMakeTriangle, CagdSrfSetMakeOnlyTri,

3.2.565 CagdSrfSubdivAtParam (cagd_aux.c:1899)

CagdSrfStruct *CagdSrfSubdivAtParam(const CagdSrfStruct *Srf,
CagdRType t,
CagdSrfDirType Dir)

Srf: To subdivide at the prescribed parameter value t.

Returns: A list of the two surfaces resulting from the process of subdivision.

Description: Given a surface - subdivides it into two sub-surfaces at given parametric value t in the given direction Dir. Returns pointer to first surface in a list of two subdivided surfaces.
### 3.2.566 CagdSrfTangent (cagd_aux.c:2242)

```c
CagdVecStruct *CagdSrfTangent(const CagdSrfStruct *Srf,
    CagdRType u,
    CagdRType v,
    CagdSrfDirType Dir,
    CagdBType Normalize)
```

- **Srf**: To compute (unit) tangent vector for.
- **u, v**: Location where to evaluate the tangent of Srf.
- **Dir**: Direction of tangent. Either U or V.
- **Normalize**: If TRUE, attempt is made to normalize the returned vector. If FALSE, length is a function of given parametrization.

**Returns**: A pointer to a static vector holding the unit tangent information.

**Description**: Given a surface Srf and a parameter values u, v, returns the (unit) tangent vector of Srf in direction Dir.

**See also**: BzrSrfTangent, BspSrfTangent,

### 3.2.567 CagdSrfTransform (cagd2gen.c:1271)

```c
void CagdSrfTransform(CagdSrfStruct *Srf,
    const CagdRType *Translate,
    CagdRType Scale)
```

- **Srf**: To be affinely transformed.
- **Translate**: Translation amount, NULI for non.
- **Scale**: Scaling amount.

**Returns**: void

**Description**: Applies an affine transform, in place, to given surface Srf as specified by Translate and Scale. Each control point is first translated by Translate and then scaled by Scale.

**See also**: CagdCrvTransform, CagdTransform, CagdSrfMatTransform,

### 3.2.568 CagdSrfUVDirOrthoE3 (cagd_aux.c:2319)

```c
CagdUVType *CagdSrfUVDirOrthoE3(const CagdSrfStruct *Srf,
    const CagdUVType *UV,
    const CagdUVType *UVDir)
```

- **Srf**: Surface to compute orthogonal direction to, in its tangent plane.
- **UV**: Location on Srf where to compute the orthogonal direction.
- **UVDir**: Direction to compute its orthogonal direction in Euclidean space.

**Returns**: UV direction that is orthogonal to UVDir, in Euclidean space, allocated statically. NULL, if error.

**Description**: Computes a new parametric direction OrthoUVDir that is orthogonal, in Euclidean space, to given parametric UVDir at parametric position UV of Srf. Clearly both Srf(OrthoUVDir) and Srf(UVDir) are in the tangent space.

### 3.2.569 CagdSrfUnitMaxCoef (cagd2gen.c:1662)

```c
CagdSrfStruct *CagdSrfUnitMaxCoef(CagdSrfStruct *Srf)
```

- **Srf**: Surface to normalize in place its coefficients.

**Returns**: Normalized surface.

**Description**: Normalize in place the given surface so its maximal coefficient is of unit size.

**See also**: CagdCrvUnitMaxCoef,
3.2.570  CagdSrfUpdateLength (cagd1gen.c:1973)

CagdSrfStruct *CagdSrfUpdateLength(CagdSrfStruct *Srf,
    int NewLength,
    CagdSrfDirType Dir)

Srf: Surface to update its mesh length.
NewLength: New length to reallocate for the surface.
Dir: Direction to resize the mesh length, U or V.
Returns: Resized surface, in place.

Description: Resize the mesh length of the surface, in place. The new surface is not the same as the original while a minimal effort is invested to keep the surface similar.
See also: CagdCrvUpdateLength,

3.2.571  CagdSrfsSame (cagd1gen.c:1812)

CagdBType CagdSrfsSame(const CagdSrfStruct *Srf1,
    const CagdSrfStruct *Srf2,
    CagdRType Eps)

Srf1, Srf2: The two surfaces to compare.
Eps: Tolerance of equality.
Returns: TRUE if surfaces are the same, FALSE otherwise.

Description: Compare the two surfaces for similarity.
See also: CagdCtlMeshsSame, BspKnotVectorsSame, CagdCrvsSame, CagdSrfsSame2, CagdCrvasSameUptoRigidScl2D, CagdSrfsSameUptoRigidScl2D,

3.2.572  CagdSrfsSame2 (cagd1gen.c:1873)

CagdBType CagdSrfsSame2(const CagdSrfStruct *Srf1,
    const CagdSrfStruct *Srf2,
    CagdRType Eps,
    int *Modified)

Srf1, Srf2: The two surfaces to compare.
Eps: Tolerance of equality.
Modified: 0 if no surface was refined/degree raised, 1 if Srf1 was refined/degree raised, 2 if Srf2 was refined/degree raised, 3 if both Srf1 and Srf2 were refined/degree raised.
Returns: TRUE if surfaces are the same, FALSE otherwise.

Description: Compare the two surfaces for similarity, after bringing them to a common function space, by degree raising and refinement.
See also: CagdCtlMeshsSame, BspKnotVectorsSame, CagdSrfsSame, , CagdSrfsSameUptoRigidScl2D, CagdSrfsSameUptoRigidScl2D,

3.2.573  CagdSrfsSameUptoRigidScl2D (cagd1gen.c:1758)

CagdBType CagdSrfsSameUptoRigidScl2D(const CagdSrfStruct *Srf1,
    const CagdSrfStruct *Srf2,
    IrtPtType Trans,
    CagdRType *Rot,
    CagdRType *Scl,
    CagdRType Eps)

Srf1, Srf2: The two surfaces to compare.
Trans: Translation amount to apply to Srf1 to bring to Srf2 (after rotation/scale).
Rot, Scl: Rotation and scale amounts to apply to Srf1 to bring to Srf2 (before translation). Rot is specified in degrees.
Eps: Tolerance of equality.
Returns: TRUE if surfaces are the same, FALSE otherwise.

Description: Compare the two surfaces for similarity up to rigid motion and scale in the XY plane.
See also: CagdCtlsMeshesSame, BspKnotVectorsSame, CagdCrvsSame, CagdCrvsSameUptoRigidScl2D,

3.2.574 CagdStructOnceCoercePointsTo (cagdcoer.c:567)

VoidPtr CagdStructOnceCoercePointsTo(CagdRType * const *OldPoints,
constr VoidPtr OldStruct,
int OldStructLen,
int ExtraMem,
int PtsLen,
CagdPointType OldPType,
CagdPointType NewPType)

OldPoints: Where the old points in OldStruct are placed.
OldStruct: A pointer to the original structure hold Points.
OldStructLen: Size of OldStruct structure.
ExtraMem: Do we seek to allocate extra memory at the end?
PtsLen: Length of vectors in the array of vectors, Points.
OldPType: Point type of the coerced new point.
NewPType: Point type of the coerced new point.
Returns: A duplicated parent structure with new point types.

Description: Coerces an array of vectors of points of point type OldPType to point type NewPType, while duplicating the parent’s structure.

3.2.575 CagdSurfaceRev (cagdsrev.c:47)

CagdSrfStruct *CagdSurfaceRev(const CagdCrvStruct *CCrv)

CCrv: To create surface of revolution around Z with.
Returns: Surface of revolution.

Description: Constructs a surface of revolution around the Z axis of the given profile curve. Resulting surface will be a Bspline surface, while input may be either a Bspline or a Bezier curve.
See also: CagdSurfaceRev2, CagdSurfaceRevAxis, CagdSurfaceRev2Axis, CagdSurfaceRevPolynomialApprox,

3.2.576 CagdSurfaceRev2 (cagdsrev.c:212)

CagdSrfStruct *CagdSurfaceRev2(const CagdCrvStruct *Crv,
CagdBType PolyApprox,
CagdRType StartAngle,
CagdRType EndAngle)

Crv: To create surface of revolution around Z with.
PolyApprox: TRUE for a polynomial approximation, FALSE for a precise rational construction.
StartAngle: Starting Angle to consider rotating Crv from, in degrees.
EndAngle: Terminating Angle to consider rotating Crv from, in degrees.
Returns: Surface of revolution.

Description: Constructs a surface of revolution around the Z axis of the given profile curve from StartAngle to EndAngle. Resulting surface will be a Bspline surface, while input may be either a Bspline or a Bezier curve.
See also: CagdSurfaceRev, CagdSurfaceRevAxis, CagdSurfaceRev2Axis, CagdSurfaceRevPolynomialApprox,
3.2.577  CagdSurfaceRev2Axis  (cagdsrev.c:294)

CagdSrfStruct *CagdSurfaceRev2Axis(const CagdCrvStruct *Crv,
CagdBType PolyApprox,
CagdRType StartAngle,
CagdRType EndAngle,
const CagdVType Axis)

Crv:  To create surface of revolution around Axis.

PolyApprox:  TRUE for a polynomial approximation, FALSE for a precise rational construction.

StartAngle:  Starting Angle to consider rotating Crv from, in degrees.

EndAngle:  Terminating Angle to consider rotating Crv from, in degrees.

Axis:  Of rotation of Crv.  This axis is always through the origin.

Returns:  Surface of revolution.

Description:  Constructs a surface of revolution around vector Axis of the given profile curve from StartAngle to EndAngle. Resulting surface will be a Bspline surface, while input may be either a Bspline or a Bezier curve.

See also:  CagdSurfaceRev, CagdSurfaceRev2, CagdSurfaceRev2Axis, , CagdSurfaceRevPolynomialApprox,

3.2.578  CagdSurfaceRevAxis  (cagdsrev.c:160)

CagdSrfStruct *CagdSurfaceRevAxis(const CagdCrvStruct *Crv, CagdVType Axis)

Crv:  To create surface of revolution around Axis.

Axis:  Of rotation of Crv.  This axis is always through the origin.

Returns:  Surface of revolution.

Description:  Constructs a surface of revolution around vector Axis of the given profile curve. Resulting surface will be a Bspline surface, while input may be either a Bspline or a Bezier curve.

See also:  CagdSurfaceRev, CagdSurfaceRev2, CagdSurfaceRev2Axis, , CagdSurfaceRevPolynomialApprox,

3.2.579  CagdSurfaceRevPolynomialApprox  (cagdsrev.c:343)

CagdSrfStruct *CagdSurfaceRevPolynomialApprox(const CagdCrvStruct *Crv)

Crv:  To approximate a surface of revolution around Z with.  Crv is assumed planar in a plane holding the Z axis.

Returns:  Surface of revolution approximation.

Description:  Constructs a surface of revolution around the Z axis of the given profile curve. Resulting surface will be a Bspline surface, while input may be either a Bspline or a Bezier curve. Resulting surface will be a polynomial Bspline surface, approximating a surface of revolution using a polynomial circle approx. (See Faux & Pratt "Computational Geometry for Design and Manufacturing").

See also:  CagdSurfaceRev, CagdSurfaceRev2, CagdSurfaceRevAxis, CagdSurfaceRev2Axis,

3.2.580  CagdSweepAxisRefine  (cagdswep.c:756)

CagdCrvStruct *CagdSweepAxisRefine(const CagdCrvStruct *Axis,
const CagdCrvStruct *ScalingCrv,
int RefLevel)

Axis:  Axis to be used in future sweep operation with the associated ScalingCrv.

ScalingCr:  If sweep is to have one, NULL otherwise.

RefLevel:  Some refinement control.  Keep it low like 2 or 3.

Returns:  Refined Axis curve.

Description:  Routine to refine the axis curve, according to the scaling curve to better approximate the requested sweep operation.
3.2.581 CagdSweepSrf (cagdswep.c:84)

CagdSrfStruct *CagdSweepSrf(CagdCrvStruct *CrossSection,
   CagdCrvStruct *Axis,
   const CagdCrvStruct *ScalingCrv,
   CagdRType Scale,
   const VoidPtr Frame,
   CagdBType FrameIsCrv)

CrossSection: Of the constructed sweep surface. If more than one curve is given as a linked list of curves, the
cross sections are modified as we progresses along the sweep, blending between the cross sections so that
last cross section is used in the last parameter value of the Axis.

Axis: Of the constructed sweep surface.

ScalingCrv: Optional scale or profiel curve.

Scale: If no Scaling Crv, Scale is used to apply a fixed scale on the CrossSection curve.

Frame: An optional vector or a curve to specified the binormal orientation. Otherwise Frame must be NULL.

FrameIsCrv: If TRUE Frame is a curve, if FALSE a vector (if Frame is not NULL).

Returns: Constructed sweep surface.

Description: Constructs a sweep surface using the following curves:
1. CrossSection - defines the basic cross section of the sweep. Must be in the XY plane. Can be several curves to be
   blended along the Axis.
2. Axis - a 3D curve the CrossSection will be swept along such that the Axis normal aligns with the Y axis of the
cross section. If Axis is linear (i.e. no normal), the normal is picked randomly or to fit the non linear part of
the Axis (if any).
3. Scale - a scaling curve for the sweep, If NULL a scale of Scale is used.
4. Frame - a curve or a vector that specifies the orientation of the sweep by specifying the axes curve’s binormal. If
   Frame is a vector, it is a constant binormal. If Frame is a curve (FrameIsCrv = TRUE), it is assumed to be
   a vector field binormal. If NULL, it is computed from the Axis curve’s pseudo Frenet frame, that minimizes
   rotation.

This operation is only an approximation. See CagdSweepAxisRefine for a tool to refine the Axis curve and improve
accuracy.

3.2.582 CagdTightBBox (cagdbbox.c:38)

CagdBType CagdTightBBox(CagdBType TightBBox)

TightBBox: TRUE for tight bbox on freeforms, FALSE for, simpler, looser bbox that is derived using the
control poly/mesh.

Returns: old value.

Description: Enforce the computation of a tighter bounding box for a freeform.
See also: CagdCrvBBox, CagdSrfBBox, CagdIgnoreNonPosWeightBBox,

3.2.583 CagdTransform (cagd2gen.c:1363)

void CagdTransform(CagdRType **Points,
   int Len,
   int MaxCoord,
   CagdBType IsNotRational,
   const CagdRType *Translate,
   CagdRType Scale)

Points: To be affinely transformed. Array of vectors.
Len: Of vectors of Points.
MaxCoord: Maximum number of coordinates to be found in Points. At most 3 - R^3.
IsNotRational: Do we have weights as vector Points[0]?

Translate: Translation amount, NULL for non.

Scale: Scaling amount.

Returns: void

Description: Applies an affine transform, in place, to given set of points Points which as array of vectors, each vector of length Len. Array Points optionally contains (if !IsNotRational) in Points[0] the weights coefficients and in Points[i] the coefficients of axis i, up to and include MaxCoord (X = 1, Y = 2, etc.). Points are translated and scaled as prescribed by Translate and Scale. Each control point is first translated by Translate and then scaled by Scale.

See also: CagdSrfTransform, CagdCrvTransform, CagdTransform,

3.2.584 CagdUVArrayFree (cagd2gen.c:444)

void CagdUVArrayFree(CagdUVStruct *UVArray, int Size)

UVArray: To be deallocated.

Size: Of the deallocated array.

Returns: void

Description: Deallocates and frees an array of UV structure.

3.2.585 CagdUVArrayNew (cagd1gen.c:230)

CagdUVStruct *CagdUVArrayNew(int Size)

Size: Size of UV array to allocate.

Returns: An array of UV structures of size Size.

Description: Allocates and resets all slots of an array of UV structures.

3.2.586 CagdUVCopy (cagd1gen.c:896)

CagdUVStruct *CagdUVCopy(const CagdUVStruct *UV)

UV: To be copied.

Returns: A duplicate of UV.

Description: Allocates and copies all slots of a UV structure.

3.2.587 CagdUVCopyList (cagd1gen.c:1203)

CagdUVStruct *CagdUVCopyList(const CagdUVStruct *UVList)

UVList: To be copied.

Returns: A duplicated list of UV’s.

Description: Allocates and copies a list of UV structures.

3.2.588 CagdUVFree (cagd2gen.c:396)

void CagdUVFree(CagdUVStruct *UV)

UV: To be deallocated.

Returns: void

Description: Deallocates and frees all slots of a UV structure.
3.2.589  CagdUVFreeList  (cagd2gen.c:419)

void CagdUVFreeList(CagdUVStruct *UVList)

    UVList: To be deallocated.
    Returns: void
    Description: Deallocates and frees a UV structure list:

3.2.590  CagdUVNew  (cagd1gen.c:257)

CagdUVStruct *CagdUVNew(void)

    Returns: A UV structure.
    Description: Allocates and resets all slots of a UV structure.

3.2.591  CagdVecArrayFree  (cagd2gen.c:704)

void CagdVecArrayFree(CagdVecStruct *VecArray, int Size)

    VecArray: To be deallocated.
    Size: Of the deallocated array.
    Returns: void
    Description: Deallocates and frees an array of vector structure.

3.2.592  CagdVecArrayNew  (cagd1gen.c:411)

CagdVecStruct *CagdVecArrayNew(int Size)

    Size: Size of Vec array to allocate.
    Returns: An array of Vec structures of size Size.
    Description: Allocates and resets all slots of an array of Vec structures.

3.2.593  CagdVecCopy  (cagd1gen.c:997)

CagdVecStruct *CagdVecCopy(const CagdVecStruct *Vec)

    Vec: To be copied.
    Returns: A duplicate of Vec.
    Description: Allocates and copies all slots of a Vec structure.

3.2.594  CagdVecCopyList  (cagd2gen.c:72)

CagdVecStruct *CagdVecCopyList(const CagdVecStruct *VecList)

    VecList: To be copied.
    Returns: A duplicated list of vectors.
    Description: Allocates and copies a list of vector structures.
3.2.595 CagdVecFree (cagd2gen.c:656)

```c
void CagdVecFree(CagdVecStruct *Vec)

(Vec: To be deallocated.
Returns: void
Description: Deallocates and frees all slots of a vector structure.
```

3.2.596 CagdVecFreeList (cagd2gen.c:679)

```c
void CagdVecFreeList(CagdVecStruct *VecList)

(VecList: To be deallocated.
Returns: void
Description: Deallocates and frees a vector structure list:
```

3.2.597 CagdVecNew (cagd1gen.c:438)

```c
CagdVecStruct *CagdVecNew(void)

Returns: A Vec structure.
Description: Allocates and resets all slots of a Vec structure.
```

3.2.598 CagdZTwistExtrudeSrf (cagdextr.c:142)

```c
CagdSrfStruct *CagdZTwistExtrudeSrf(const CagdCrvStruct *CCrv,
CagdTType Rational,
CagdRType ZPitch)

(CCrv: To twist and extrude in the +Z direction.
Rational: TRUE to construct a rational (and precise) twist, FALSE to approximate using polynomials.
ZPitch: The +Z amount for full 360 degrees. If zero, the result will be a planar (degenerated) surface. A
negative value will reverse the twist.
Returns: A twisted extrusion surface.
Description: Constructs a full circular twisted/rotated extrusion surface in the +Z direction for the given profile
curve. Input curve can be either a Bspline or a Bezier curve.
See also: CagdExtrudeSrf,
```

3.2.599 Energy1Calc (cbsp_fit.c:1881)

```c
static CagdRType Energy1Calc(CagdCrvStruct *Crv)

(Crv: A curve to derive and integrate.
Returns: The calculated integral value.
Description: Calculates the curve first derivative energy integral:
```

\[
\int_{-\infty}^{\infty} \left\| Crv'(t) \right\|^2 dt
\]
3.2.600 Energy1MatrixCalc (cbsp_fit.c:1933)

```c
static void Energy1MatrixCalc(CagdCrvStruct *Crv,
                              CagdRType *A,
                              CagdRType *b,
                              CagdRType Lambda)
```

Crv: Input b-spline curve.
b: Input/output initialized offset vector, which size = 2 * Crv -> Length x 1.
Lambda: Weight.
Returns: void
Description: Calculates the curve first derivative energy (see Energy1Calc) minimization matrix. The calculated coefficients are ADDED to A and b.

3.2.601 Energy2Calc (cbsp_fit.c:1687)

```c
static CagdRType Energy2Calc(CagdCrvStruct *Crv)
```

Crv: A curve to derive and integrate.
Returns: The calculated integral value.
Description: Calculates the curve second derivative energy integral:

\[
\int |Crv''(t)| \, dt
\]

3.2.602 Energy2MatrixCalc (cbsp_fit.c:1738)

```c
static void Energy2MatrixCalc(CagdCrvStruct *Crv,
                              CagdRType *A,
                              CagdRType *b,
                              CagdRType Lambda)
```

Crv: Input b-spline curve.
b: Input/output initialized offset vector, which size = 2 * Crv -> Length x 1.
Lambda: Weight.
Returns: void
Description: Calculates the curve second derivative energy (see Energy2Calc) minimization matrix. The calculated coefficients are ADDED to A and b.

3.2.603 LeastSquareInitCrvCalculator (cbsp_fit.c:1474)

```c
static CagdCrvStruct *LeastSquareInitCrvCalculator(CagdPType *PtList,
                                                    int NumOfPoints,
                                                    int Length,
                                                    int Order,
                                                    CagdBType Periodic)
```

PtList: Points cloud.
NumOfPoints: Number of points in PtList.
Length: The desired length of the output b-spline curve.
Order: The desired order of the output b-spline curve.
Periodic: TRUE for periodic output curve, FALSE for open end.
Returns: The calculated b-spline curve.
Description: Computes an initial b-spline fitting curve that least square approximates the input points.
3.2.604 PDMErrorCalc (cbsp_fit.c:530)

```c
static CagdRType PDMErrorCalc(int NumOfPoints,
    CagdPType *Points,
    CagdPType *FootPoints)

    NumOfPoints: Number of points in the points cloud.
    Points: (X) Points cloud. Array of points with size = NumOfPoints.
    FootPoints: (P(t)) Footpoints (the closest points on the curve) array. Array size must be 'NumOfPoints'.
    Returns: PD error.

Description: Computes PD Minimization method error, which is:

\[
\frac{1}{2} \sum_{k=1}^{N} \frac{1}{2} \frac{\|P(t_k)-X_k\|^2}{PD,k}
\]

See also: CagdSDError,
```

3.2.605 PDMatrixCalc (cbsp_fit.c:1632)

```c
static void PDMatrixCalc(int Length,
    int NumOfPoints,
    CagdPType *Points,
    CagdRType *Basis,
    CagdPType *FootPoints,
    CagdRType *A, /* MATRIX */
    CagdRType *b)

    Length: Fitting curve Length.
    NumOfPoints: Number of points in the points cloud.
    Points: Points cloud. Array of points with size = NumOfPoints.
    Basis: Array of size (NumOfPoints * Length) containing basis function coefficients at the foot points
    FootPoints: Footpoints (the closest points on the curve) array of size NumOfPoints.
    A: Input/output matrix (2Length * 2Length).
    b: Input/output offset vector (2Length * 1).
    Returns: void

Description: Calculates the PD error minimization equation Matrix and offset vector, i.e. A and b of the Ax=b
equation. The calculated values are ADDED to the A and b parameters The order of variables in x is assumed to
be: (D1x,D2x,...,DLengthx,D1y,D2y,...,DLengthy)
```

3.2.606 PwrCrvDegreeRaise (cpwr_aux.c:254)

```c
CagdCrvStruct *PwrCrvDegreeRaise(const CagdCrvStruct *Crv)

    Crv: To raise its degree by one.
    Returns: A curve of one order higher representing the same geometry as Crv.

Description: Returns a new curve, identical to the original but with one degree higher. Adds one more, highest
degree coefficient, that is identically zero.

See also: BzrCrvDegreeRaiseN, BzrCrvDegreeRaise, PwrCrvDegreeRaiseN,
3.2.607  PwrCrvDegreeRaiseN (cpwr_aux.c:207)

CagdCrvStruct *PwrCrvDegreeRaiseN(const CagdCrvStruct *Crv, int NewOrder)

Crv: To raise its degree to a NewOrder.
NewOrder: NewOrder for Crv.

Returns: A curve of order NewOrder representing the same geometry as Crv.
Description: Returns a new curve, identical to the original but with order NewOrder. Degree raise is computed by adding zeros at high order coefs.
See also: BzrCrvDegreeRaise, BzrCrvDegreeRaiseN, PwrCrvDegreeRaise,

3.2.608  PwrCrvDerive (cpwr_aux.c:80)

CagdCrvStruct *PwrCrvDerive(const CagdCrvStruct *Crv)

Crv: To differentiate.

Returns: Differentiated curve.
Description: Returns a new curve, equal to the given curve, differentiated once.
See also: CagdCrvDerive, BspCrvDerive, BzrCrvDerivePwr, BspCrvDeriveRational, , CrvDeriveRational, PwrCrvDeriveScalar,

3.2.609  PwrCrvDeriveScalar (cpwr_aux.c:134)

CagdCrvStruct *PwrCrvDeriveScalar(const CagdCrvStruct *Crv)

Crv: To differentiate.

Returns: Differentiated curve.
Description: Returns a new curve, equal to the given curve, differentiated once. For a Euclidean curve this is the same as CagdCrvDerive but for a rational curve the returned curve is not the vector field but simply the derivatives of all the curve's coefficients, including the weights.
See also: PwrCrvDerive, CagdCrvDerive, PwrCrvDeriveRational, BspCrvDeriveRational, BspCrvDerive, PwrCrvDeriveScalar, CagdCrvDeriveScalar,

3.2.610  PwrCrvEvalAtParam (cpwr_aux.c:42)

CagdRType *PwrCrvEvalAtParam(const CagdCrvStruct *Crv, CagdRType t)

Crv: To evaluate at the given parametric location t.
t: The parameter value at which the curve Crv is to be evaluated.

Returns: A vector holding all the coefficients of all components of curve Crv's point type. If for example the curve's point type is P2, the W, X, and Y will be saved in the first three locations of the returned vector. The first location (index 0) of the returned vector is reserved for the rational coefficient W and XYZ always starts at second location of the returned vector (index 1).
Description: Returns a pointer to a static data, holding the value of the curve at given parametric location t. The curve is assumed to be a power basis. Evaluation is conducted using the Horner rule.
See also: CagdCrvEval, BspCrvEvalAtParam, BzrCrvEvalAtParam,

3.2.611  PwrCrvIntegrate (cpwr_aux.c:163)

CagdCrvStruct *PwrCrvIntegrate(const CagdCrvStruct *Crv)

Crv: Curve to integrate.

Returns: Integrated curve.
Description: Returns a new Bezier curve, equal to the integral of the given power
See also: BspCrvIntegrate, BzrSrfIntegrate, CagdCrvIntegrate,
3.2.612  **PwrCrvNew** *(bzr_gen.c:128)*

*CagdCrvStruct *PwrCrvNew(int Length, CagdPointType PType)*

- **Length**: Number of control points
- **PType**: Type of control points (E2, P3, etc.).
- **Returns**: An uninitialized freeform Power basis curve.

**Description**: Allocates the memory required for a new Power basis curve.

**See also**: BspCrvNew, BspPeriodicCrvNew, CagdCrvNew, CagdPeriodicCrvNew, TrimCrvNew, BzrCrvNew,

3.2.613  **PwrSrfDegreeRaise** *(sbzr_aux.c:309)*

*CagdSrfStruct *PwrSrfDegreeRaise(const CagdSrfStruct *Srf, CagdSrfDirType Dir)*

- **Srf**: To raise it degree by one.
- **Dir**: Direction to degree raise. Either U or V.
- **Returns**: A surface with one degree higher in direction Dir, representing the same geometry as Srf.

**Description**: Returns a new power basis surface, identical to the original but with one degree higher, in the requested direction Dir.

**See also**: CagdSrfDegreeRaise, BzrSrfDegreeRaise, TrimSrfDegreeRaise, , BspSrfDegreeRaise, BzrSrfDegreeRaiseN, CagdSrfDegreeRaiseN, , PwrSrfDegreeRaiseN,

3.2.614  **PwrSrfDegreeRaiseN** *(sbzr_aux.c:348)*

*CagdSrfStruct *PwrSrfDegreeRaiseN(const CagdSrfStruct *Srf, CagdSrfDirType Dir, int NewUOrder, int NewVOrder)*

- **Srf**: To raise its degrees.
- **NewUOrder**: New U order of Srf.
- **NewVOrder**: New V order of Srf.
- **Returns**: A surface with higher degrees as prescribed by NewUOrder/NewVOrder.

**Description**: Returns a new power basis surface, identical to the original but with higher degrees, as prescribed by NewUOrder, NewVOrder.

**See also**: CagdSrfDegreeRaise, BzrSrfDegreeRaise, TrimSrfDegreeRaise, , BspSrfDegreeRaise, BzrSrfDegreeRaiseN, CagdSrfDegreeRaiseN, , PwrSrfDegreeRaise,

3.2.615  **PwrSrfNew** *(bzr_gen.c:97)*

*CagdSrfStruct *PwrSrfNew(int ULength, int VLength, CagdPointType PType)*

- **ULength**: Number of control points in the U direction.
- **VLength**: Number of control points in the V direction.
- **PType**: Type of control points (E2, P3, etc.).
- **Returns**: An uninitialized freeform Power basis surface.

**Description**: Allocates the memory required for a new Power basis surface.

**See also**: BspSrfNew, BspPeriodicSrfNew, CagdSrfNew, CagdPeriodicSrfNew, TrimSrfNew, BzrSrfNew,
3.2.616  SDMErrorCalc (cbsp_fit.c:589)

static CagdRType SDMErrorCalc(int NumOfPoints,
     CagdPType *Points,
     CagdPType *FootPoints,
     CagdRType *Distances,
     CagdPType *Tangents,
     CagdPType *Normals,
     CagdRType *Curvatures,
     CagdBType *IsOuter)

NumOfPoints: Number of points in the points cloud.
Points: (X) Points cloud. Array of points with size = NumOfPoints.
FootPoints: (P(t)) Footpoints (the closest points on the curve) array.
Distances: (d) Array of distances between each point to the corresponding footpoint.
Tangents: (T) Array of curve tangents at each footpoint.
Normals: (N) Array of curve normals at each footpoint.
Curvatures: (p) Array of curve curvature radiiuses at each footpoint.
IsOuter: Array of booleans that indicates outer points.

Returns: SD error.

Description: Computes SD Minimization method error, which is:

\[
\frac{1}{\text{NumOfPoints}} - \sum_{k=1}^{\text{SD},k} \left\{ \begin{array}{ll}
\frac{e}{2} \sum_{k=1}^{\text{SD},k} [(P(tk) - Xk) * Tk] + [(P(tk) - Xk) * Nk], & \text{if } dk<0 \\
\frac{e}{2} \sum_{k=1}^{\text{SD},k} [(P(tk) - Xk) * Ni], & \text{if } 0<=dk<pk \\
\end{array} \right.
\]

NOTE: The size of each array must be 'NumOfPoints'.
See also: CagdSDError,

3.2.617  SDMatrixCalc (cbsp_fit.c:317)

static void SDMatrixCalc(int Length,
     int NumOfPoints,
     CagdPType *Points,
     CagdRType *Basis,
     CagdPType *FootPoints,
     CagdRType *Distances,
     CagdPType *Tangents,
     CagdPType *Normals,
     CagdRType *Curvatures,
     CagdBType *IsOuter,
     CagdRType *A,
     CagdRType *b)

Length: Fitting curve Length.
NumOfPoints: Number of points in the points cloud.
Points: Points cloud. Array of points with size = NumOfPoints.
Basis: Array of size (NumOfPoints * Length) containing basis function coefficients at the foot points
FootPoints: Footpoints (the closest points on the curve) array.
**Distances:** Array of distances between each point to the corresponding footpoint.

**Tangents:** Array of curve tangents at each footpoint.

**Normals:** Array of curve normals at each footpoint.

**Curvatures:** Array of curve curvature radiiuses at each footpoint.

**IsOuter:** Array of booleans that indicates outer points.

**A:** Input/output matrix (2Length * 2Length).

**b:** Input/output offset vector (2Length * 1).

**Returns:** void

**Description:** Calculates the SD error minimization equation Matrix and offset vector, i.e. A and b of the Ax=b equation. The calculated values are ADDED to the A and b parameters The order of variables in x is assumed to be: (D1x,D2x,...,Lengthx,D1y,D2y,...,Lengthy) NOTE: The size of each array except Basis must be 'NumOfPoints'.
Chapter 4

Geometry Library, geom_lib

4.1 General Information

This library handles general computational geometry algorithms and geometric queries such as a distance between two lines, bounding boxes, convexity and convex hull of polygons, polygonal constructors of primitives (cylinders, spheres, etc.), basic scan conversion routines, etc.

4.2 Library Functions

4.2.1 GM2BiTansFromCircCirc (geom_bsc.c:2692)

```c
int GM2BiTansFromCircCirc(const IrtPtType Center1,
                           IrtRType Radius1,
                           const IrtPtType Center2,
                           IrtRType Radius2,
                           int OuterTans,
                           IrtPtType TanPts[2][2])
```

- **Center1, Radius1**: Geometry of first circle.
- **Center2, Radius2**: Geometry of second circle.
- **OuterTans**: TRUE for outer two tangents, FALSE for inner two.
- **TanPts**: The two tangents designated by the end points of the Segments.
- **Returns**: TRUE for successful computation, FALSE for failure or no such bitangents exist for the current configuration.

**Description**: Finds the two pairs of tangent points of the given two planar circles.

**See also**: GM2PointsFromLineLine, GM2PointsFromCircCirc3D, GMCircleFrom3Points, , GMCircleFrom2Pts2Tans, GM2PointsFromCircCirc, GM2TanLinesFromCircCirc, , GM2IsPtInsideCirc,

4.2.2 GM2PointsFromCircCirc (geom_bsc.c:2269)

```c
int GM2PointsFromCircCirc(const IrtPtType Center1,
                           IrtRType Radius1,
                           const IrtPtType Center2,
                           IrtRType Radius2,
                           IrtPtType Inter1,
                           IrtPtType Inter2)
```

- **Center1, Radius1**: Geometry of first circle.
- **Center2, Radius2**: Geometry of second circle.
- **Inter1, Inter2**: Where the two intersection locations will be placed.
- **Returns**: TRUE for successful computation, FALSE for failure.

**Description**: Finds the two intersection points of the given two planar circles.

**See also**: GM2PointsFromLineLine, GM2PointsFromCircCirc3D, GMCircleFrom3Points, , GMCircleFrom2Pts2Tans, GM2BiTansFromCircCirc, GM2TanLinesFromCircCirc, , GM2IsPtInsideCirc,
4.2.3  GM2PointsFromCircCirc3D (geom_bsc.c:2353)

int GM2PointsFromCircCirc3D(const IrtPtType Cntr1,
const IrtVecType Nrml1,
IrtRType Rad1,
const IrtPtType Cntr2,
const IrtVecType Nrml2,
IrtRType Rad2,
IrtPtType Inter1,
IrtPtType Inter2)

Cntr1, Nrml1, Rad1: Center, normal and radius of first circle.
Cntr2, Nrml2, Rad2: Center, normal and radius of second circle.
Inter1: First intersection location in E3.
Inter2: Second intersection location in E3.

Returns: Number of intersections found - 0, 1, or 2.

Description: Compute the intersection of two circles in general position in R^3. The circles are centered at Cntr1/2 in a plane normal to Nrml1/2 and have a radius of Rad1/2. The up to two intersections are returned in Inter1/2.

See also: GM2PointsFromLineLine, GM2PointsFromCircCirc, GMCircleFrom3Points, GMCircleFrom2Pts2Tans, GM2BiTansFromCircCirc, GM2TanLinesFromCircCirc, GM2IsPtInsideCirc.

4.2.4  GM2PointsFromLineLine (geom_bsc.c:987)

int GM2PointsFromLineLine(const IrtPtType Pl1,
const IrtPtType Vl1,
const IrtPtType Pl2,
const IrtPtType Vl2,
IrtPtType Pt1,
IrtRType *t1,
IrtPtType Pt2,
IrtRType *t2)

Pl1, Vl1: Position and direction defining the first line.
Pl2, Vl2: Position and direction defining the second line.
Pt1: Point on Pt1 that is closest to line 2.
t1: Parameter value of Pt1 as (Pl1 + Vl1 * t1).
Pt2: Point on Pt2 that is closest to line 1.
t2: Parameter value of Pt2 as (Pl2 + Vl2 * t2).

Returns: TRUE, if successful.

Description: Routine to find the two points Pti on the lines (Pli, Vli), i = 1, 2 with the minimal Euclidian distance between them. In other words, the distance between Pt1 and Pt2 is defined as distance between the two lines. The two points are calculated using the fact that if V = (Vl1 cross Vl2) then these two points are the intersection point between the following: Point 1 - a plane (defined by V and line1) and the line line2. Point 2 - a plane (defined by V and line2) and the line line1. This function returns TRUE iff the two lines are not parallel! This function is also valid for the case of coplanar lines.

See also: GM2PointsFromCircCirc.

4.2.5  GM2TanLinesFromCircCirc (geom_bsc.c:2741)

int GM2TanLinesFromCircCirc(const IrtPtType Center1,
IrtRType Radius1,
const IrtPtType Center2,
IrtRType Radius2,
int OuterTans,
IrtLnType Tans[2])
Center1, Radius1: Geometry of first circle.
Center2, Radius2: Geometry of second circle.
OuterTans: TRUE for outer two tangents, FALSE for inner two.
Tans: The two tangent lines designated by line equations.

Returns: TRUE for successful computation, FALSE for failure or no such bitangents exist for the current configuration.

Description: Finds the two tangent lines to the given two planar circles.
See also: GM2PointsFromLineLine, GM2PointsFromCircCirc3D, GMCircleFrom3Points, GMCircleFrom2Pts2Tans, GM2PointsFromCircCirc, GM2BiTansFromCircCirc, GM2IsPtInsideCirc,

4.2.6 GM3Pts2EqltrlTriMat (geomat3d.c:1140)

int GM3Pts2EqltrlTriMat(const IrtPtType Pt1Orig, const IrtPtType Pt2Orig, const IrtPtType Pt3Orig, IrtHmgnMatType Mat)

Pt1Orig, Pt2Orig, Pt3Orig: The three vertices of the input triangle.
Mat: The computed transform.

Returns: TRUE if successful, FALSE otherwise.

Description: Compute the linear transform that maps the given planar triangle Pt1Pt2Pt3 to an equilateral triangle around the origin so that edge Pt1Pt2 is horizontal and remains of the same size.
See also: GMGenMatrix3Pts2EqltrlTri,

4.2.7 GMAffineTransUVVals (polypts.c:1610)

void GMAffineTransUVVals(IPObjectStruct *PObj, const IrtRType Scale[2], const IrtRType Trans[2])

PObj: A polygonal object to affine transform the UV vals.
Scale: UV scale factors.
Trans: UV translational factors.

Returns: void

Description: Affine transform the given UV coordinates in polygonal object PObj, in place.
See also: GMGenUVValsForPolys,

4.2.8 GMAngleSphericalTriangle (geombsc.c:1649)

IrtRType GMAngleSphericalTriangle(const IrtVecType Dir, const IrtVecType ODir1, const IrtVecType ODir2)

Dir: Spherical vertex to compute its angle with respect to ODir1/2.
ODir1, ODir2: Other two vertices of spherical triangle.

Returns: Spherical angle at Dir.

Description: Computes the angle at Dir, with respect to ODir1 and ODir2.
See also: GMAreaSphericalTriangle,
4.2.9  **GMAnimAffineTransAnimation** (animate.c:310)

```
int GMAnimAffineTransAnimation(const IPObjectStruct *PObjs,
                               IrtRType Trans,
                               IrtRType Scale)
```

PObjs: Objects to update animation domain.
Trans: Translation amount.
Scale: Scale amount.

Returns: TRUE if there are animation attributes. FALSE otherwise.

Description: Affine transform the animation domain in the given object(s), in place. Domain "D" is mapped to domain "D * Scale + Trans".

See also: GMAnimHasAnimationOne,

4.2.10  **GMAnimAffineTransAnimation2** (animate.c:505)

```
int GMAnimAffineTransAnimation2(const IPObjectStruct *PObjs,
                                  IrtRType Min,
                                  IrtRType Max)
```

PObjs: Objects to update animation domain.
Min, Max: Desired time domain of animation.

Returns: TRUE if there are animation attributes. FALSE otherwise.

Description: Affine transform the animation domain in the given object(s), in place. Animation domain is mapped to "Min, Max".

See also: GMAnimHasAnimationOne,

4.2.11  **GMAnimAffineTransAnimationOne** (animate.c:343)

```
int GMAnimAffineTransAnimationOne(const IPObjectStruct *PObj,
                                  IrtRType Trans,
                                  IrtRType Scale)
```

PObj: Object to update animation domain.
Trans: Translation amount.
Scale: Scale amount.

Returns: TRUE if there are animation attributes. FALSE otherwise.

Description: Affine transform the animation domain in the given object, in place. Domain "D" is mapped to domain "D * Scale + Trans".

See also: GMAnimHasAnimation,

4.2.12  **GMAnimAffineTransAnimationOne2** (animate.c:540)

```
int GMAnimAffineTransAnimationOne2(const IPObjectStruct *PObj,
                                   IrtRType Min,
                                   IrtRType Max)
```

PObj: Object to update animation domain.
Min, Max: Desired time domain of animation.

Returns: TRUE if there are animation attributes. FALSE otherwise.

Description: Affine transform the animation domain in the given object, in place. Animation domain is mapped to "Min, Max".

See also: GMAnimHasAnimation,
4.2.13 **GMAnimCheckInterrupt** *(anim\_aux.c:44)*

```c
int GMAnimCheckInterrupt(GMAnimationStruct *Anim)
```

- **Anim**: The animation to abort.
- **Returns**: TRUE if we need to abort, FALSE otherwise.
- **Description**: Should we stop this animation. Senses the event queue of X11.

4.2.14 **GMAnimDoAnimation** *(animate.c:967)*

```c
void GMAnimDoAnimation(GMAnimationStruct *Anim, IObjectStruct *PObjs)
```

- **Anim**: Animation structure.
- **PObjs**: Objects to render.
- **Returns**: void.
- **Description**: Routine to run a sequence of objects through an animation according to animation attributes of matrices and curves that are attached to them.
- **See also**: GMAnimEvalAnimation,

4.2.15 **GMAnimDoSingleStep** *(animate.c:1203)*

```c
void GMAnimDoSingleStep(GMAnimationStruct *Anim, IObjectStruct *PObjs)
```

- **Anim**: Animation structure.
- **PObjs**: Objects to render.
- **Returns**: void.
- **Description**: Routine to execute a single step the animation, at current time.
- **See also**: GMAnimDoAnimation, GMAnimEvalAnimation, GMAnimSetAnimInternalNodes,

4.2.16 **GMAnimEvalAnimation** *(animate.c:1095)*

```c
void GMAnimEvalAnimation(IrtRType t, IObjectStruct *PObj)
```

- **t**: Time to evaluate the animation at.
- **PObj**: To evaluate their animation curves.
- **Returns**: void
- **Description**: Evaluate the animation curves at the given time, setting the proper animation attributes ("animation\_mat" and "\_isvisible"), in place.
- **See also**: GMAnimDoAnimation, GMAnimEvalAnimationList, GMAnimSetAnimInternalNodes, , GMAnimEvalObjAtTime,

4.2.17 **GMAnimEvalAnimationList** *(animate.c:1178)*

```c
void GMAnimEvalAnimationList(IrtRType t, IObjectStruct *PObjList)
```

- **t**: Time to evaluate the animation at.
- **PObjList**: A list of objects to evaluate their animation curves.
- **Returns**: void
- **Description**: Evaluate the animation curves at the given time, setting the proper animation attributes ("animation\_mat" and "\_isvisible"), in place.
- **See also**: GMAnimDoAnimation, GMAnimEvalAnimation, GMAnimSetAnimInternalNodes,
4.2.18 GMAnimEvalObjAtTime (animate.c:1129)

IPObjectStruct *GMAnimEvalObjAtTime(IrtRType t, IPObjectStruct *PObj)

- **t:** Time to evaluate the animation at.
- **PObj:** To evaluate their animation curves.

**Returns:** Input object positioned at time t.

**Description:** Evaluate the animation curves at the given time, and creating the object in the proper place in time.

**See also:** GMAnimDoAnimation, GMAnimEvalAnimationList, GMAnimSetAnimInternalNodes, GMAnimEvalAnimation,

4.2.19 GMAnimFindAnimationTime (animate.c:573)

void GMAnimFindAnimationTime(GMAnimationStruct *Anim,
                           const IPObjectStruct *PObjs)

- **Anim:** Animation structure to update.
- **PObjs:** Objects to scan for animation attributes.

**Returns:** void

**Description:** Computes the time span for which the animation executes.

**See also:** GMAnimFindAnimationTimeOne,

4.2.20 GMAnimFindAnimationTimeOne (animate.c:616)

void GMAnimFindAnimationTimeOne(GMAnimationStruct *Anim,
                                const IPObjectStruct *PObj)

- **Anim:** Animation structure to update.
- **PObj:** One object to scan for animation attributes.

**Returns:** void

**Description:** Computes the time span for which the animation executes.

**See also:** GMAnimFindAnimationTime,

4.2.21 GMAnimGetAnimInfoText (animate.c:97)

void GMAnimGetAnimInfoText(GMAnimationStruct *Anim)

- **Anim:** The animation state to update.

**Returns:** void

**Description:** Getting input parameters of animation from user using textual user interface.

4.2.22 GMAnimHasAnimation (animate.c:238)

int GMAnimHasAnimation(const IPObjectStruct *PObj)

- **PObj:** Objects to scan for animation attributes.

**Returns:** TRUE if there are animation attributes. FALSE otherwise.

**Description:** Scan the given geometry for possible animation attributes.

**See also:** GMAnimHasAnimationOne,
4.2.23 GMAnimHasAnimationOne (animate.c:266)

int GMAnimHasAnimationOne(const IPObjectStruct *PObj)

PObj: One object to scan for animation attributes.

Returns: TRUE if there are animation attributes. FALSE otherwise.

Description: Scan the given geometry for possible animation attributes.

See also: GMAnimHasAnimation,

4.2.24 GMAnimResetAnimStruct (animate.c:64)

void GMAnimResetAnimStruct(GMAnimationStruct *Anim)

Anim: The animation state to reset.

Returns: void

Description: Resets the slots of an animation structure.

4.2.25 GMAnimSaveIterationsAsImages (anim_aux.c:64)

void GMAnimSaveIterationsAsImages(GMAnimationStruct *Anim,
                                  IPObjectStruct *PObjs)

Anim: Animation structure.

PObjs: Objects to render.

Returns: void

Description: Saves one iteration of the animation sequence as an image.

4.2.26 GMAnimSaveIterationsToFiles (animate.c:1243)

void GMAnimSaveIterationsToFiles(GMAnimationStruct *Anim,
                                   IPObjectStruct *PObjs)

Anim: Animation structure.

PObjs: Objects to render.

Returns: void

Description: Saves one iteration of the animation sequence as IRIT data (*.itd). The objects that are saved are those that are visible on the current time frame as set via current animation mat attribute.

4.2.27 GMAnimSetAnimInternalNodes (animate.c:1067)

int GMAnimSetAnimInternalNodes(int AnimInternalNodes)

AnimInternalNodes: New setting for internal animation nodes.

Returns: Old settings.

Description: Allows animation transformations to be saved at internal nodes.

See also: GMAnimEvalAnimation,
4.2.28  GMAnimSetAnimMatHierarchy (animate.c:1042)

int GMAnimSetAnimMatHierarchy(int AnimMatHierarchy)

  AnimMatHierarchy: TRUE for animation matrices computed accumulative, FALSE for each node computed individually.

  Returns: Old settings.

  Description: Controls the way animation matrices are computed in a hierarchy of parts (object tree).

  See also: GMAnimEvalAnimation,

4.2.29  GMAreaOfTriangle (geombsc.c:2880)

IrtRType GMAreaOfTriangle(const IrtRType *Pt1,
   const IrtRType *Pt2,
   const IrtRType *Pt3)

  Pt1, Pt2, Pt3: Points to compute the area of a triangle formed by Pt1, Pt2, and Pt3, in the XY plane.

  Returns: Resulting area.

  Description: Computing the Area of the triangle formed by points Pt1, Pt2 and Pt3. This can be used as a test to identify whether point Pt3 lies to the left, right, or on the line (vector) formed by Pt1 and Pt2 using the this signed area of the triangle’s computation.

4.2.30  GMAreaSphericalTriangle (geombsc.c:1613)

IrtRType GMAreaSphericalTriangle(const IrtVecType Dir1,
   const IrtVecType Dir2,
   const IrtVecType Dir3)

  Dir1, Dir2, Dir3: Vertices of the spherical triangle. unit vectors.

  Returns: Computed area.

  Description: Computes the area of a spherical triangle over the unit sphere with given three (unit vector) vertices, Dir1, Dir2, Dir3. Area is equal to (Alpha1 + Alpha2 + Alpha3 - Pi) where Alphai is the angle at vertex Diri with the other two vertices.

  See also: GMAngleSphericalTriangle,

4.2.31  GMBBComputeBboxObject (bbox.c:76)

GMBBBboxStruct *GMBBComputeBboxObject(const IObjectStruct *PObj)

  PObj: To compute a bounding box for.

  Returns: A pointer to a statically allocated bounding box holding bounding box information on PObj.

  Description: Computes a bounding box of a given object of any type.

  See also: ,

4.2.32  GMBBComputeBboxObjectList (bbox.c:216)

GMBBBboxStruct *GMBBComputeBboxObjectList(const IObjectStruct *PObj)

  PObj: To compute a bounding box for.

  Returns: A pointer to a statically allocated bounding box holding bounding box information on objects PObj.

  Description: Computes a bounding box of a list of objects of any type.
4.2.33  GMBBComputeOnePolyBbox (bbox.c:274)

GMBBBboxStruct *GMBBComputeOnePolyBbox(const IPPolygonStruct *PPoly)

PPoly: To compute a bounding box for.
Returns: A pointer to a statically allocated bounding box holding bounding box information on PPoly.
Description: Computes a bounding box of a polygon/polyline/pointlist object.

4.2.34  GMBBComputePointBbox (bbox.c:343)

GMBBBboxStruct *GMBBComputePointBbox(const IrtRType *Pt)

Pt: To compute a bounding box for.
Returns: A pointer to a statically allocated bounding box holding bounding box information on Pt.
Description: Computes a bounding box of a point object.

4.2.35  GMBBComputePolyListBbox (bbox.c:306)

GMBBBboxStruct *GMBBComputePolyListBbox(const IPPolygonStruct *PPoly)

PPoly: To compute a bounding box for.
Returns: A pointer to a statically allocated bounding box holding bounding box information on PPoly list.
Description: Computes a bounding box for a list of polygon/polyline/pointlist objects.

4.2.36  GMBBMergeBbox (bbox.c:370)

GMBBBboxStruct *GMBBMergeBbox(const GMBBBboxStruct *Bbox1, const GMBBBboxStruct *Bbox2)

Bbox1: First bounding box to union up.
Bbox2: Second bounding box to union up.
Returns: A unioned bounding box the contains both BBox1 and BBox2.
Description: Merges (union) given two bounding boxes into one. Either Bbox1 or Bbox2 can be pointing to the static area Bbox used herein.

4.2.37  GMBBSetBBoxInvisibles (bbox.c:50)

int GMBBSetBBoxInvisibles(int BBoxInvisibles)

BBoxInvisibles: TRUE to include invisible geometry in bbox computation.
Returns: Old state of invisible geometry’s bbox computation.
Description: Controls whether or not to include invisible geometry in the bbox computations. Invisible geometry is tagged using ”invisible” attribs.
See also: ,

4.2.38  GMBBSetGlblBBObjList (bbox.c:250)

const IPObjStruct *GMBBSetGlblBBObjList(const IPObjStruct *BBObjList)

BBObjList: Global object list to search instances at.
Returns: Old global object list.
Description: Sets the global list object to search instances at.
4.2.39 GMBaryCentric3Pts (geom_bsc.c:2193)

```c
void *GMBaryCentric3Pts(const IrtPtType Pt1,
            const IrtPtType Pt2,
            const IrtPtType Pt3,
            const IrtPtType Pt)
```

**Pt1, Pt2, Pt3:** Three points forming a triangular in general position.

**Pt:** A point for which the barycentric coordinates are to be computed.

**Returns:** A pointer to a static space holding the three Barycentric coefficients, or NULL if point Pt is outside the triangle Pt1 Pt2 Pt3.

**Description:** Computes the Barycentric coordinates of given point Pt with respect to given Triangle Pt1 Pt2 Pt3. All points are assumed to be coplanar.

**See also:** GMBaryCentric3Pts2D,

4.2.40 GMBaryCentric3Pts2D (geom_bsc.c:2135)

```c
void *GMBaryCentric3Pts2D(const IrtPtType Pt1,
            const IrtPtType Pt2,
            const IrtPtType Pt3,
            const IrtPtType Pt)
```

**Pt1, Pt2, Pt3:** Three points forming a triangular in general position.

**Pt:** A point for which the barycentric coordinates are to be computed.

**Returns:** A pointer to a static space holding the three Barycentric coefficients, or NULL if point Pt is outside the triangle Pt1 Pt2 Pt3.

**Description:** Computes the Barycentric coordinates of given point Pt with respect to given Triangle Pt1 Pt2 Pt3. All points are assumed to be in the XY plane.

**See also:** GMBaryCentric3Pts,

4.2.41 GMBasicSetEps (geom_bsc.c:59)

```c
void GMBasicSetEps(IrtRType Eps)
```

**Eps:** New epsilon to use.

**Returns:** Old epsilon value.

**Description:** Sets the epsilon to use in basic geometry processing.

4.2.42 GMBlendNormalsToVertices (intrnrm.c:739)

```c
void GMBlendNormalsToVertices(IPPolygonStruct *PlList,
            IrtRType MaxAngle)
```

**PlList:** List of polygons to blend the normals of their vertices

**MaxAngle:** Between approximated normal at vertex and polygon normal of the vertex to allow averaging. In degrees. If Negative, all vertices normals are cleared and all polygon normals reevaluated.

**Returns:** void

**Description:** Approximate normals to all vertices of the given geometry by blending the normals of the faces that share the vertex. Assumes polygons are properly oriented. Places on each vertex an "CosNrmlMaxDeviation" attribute with the maximal deviation of this normal from an adjacent polygon plane (cosine of the maximal angle).

**See also:** GMUpdateVerticesByInterp, GMFixNormalsOfPolyModel,
4.2.43 GMCircleFrom2Pts2Tans (geom_bsc.c:2528)

```c
int GMCircleFrom2Pts2Tans(IrtPtType Center,
    IrtRType *Radius,
    const IrtPtType Pt1,
    const IrtPtType Pt2,
    const IrtVecType Tan1,
    const IrtVecType Tan2)

Center: Of computed circle.
Radius: Of computed circle.
Pt1, Pt2: Two points to fit a circle through.
Tan1, Tan2: Two tangents to the circle at Pt1, Pt2.
```

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Routine to construct a circle through given 3 points. If two of the points are the same or the three points are collinear it returns FALSE, otherwise (successful), it returns TRUE.

**See also:** GM2PointsFromCircCirc3D, GM2PointsFromLineLine, GM2PointsFromCircCirc, GM2CircleFrom3Points, GM2BiTanFromCircCirc, GM2TanLinesFromCircCirc, GM2IsPtInsideCirc,

4.2.44 GMCircleFrom3Points (geom_bsc.c:2461)

```c
int GMCircleFrom3Points(IrtPtType Center,
    IrtRType *Radius,
    const IrtPtType Pt1,
    const IrtPtType Pt2,
    const IrtPtType Pt3)

Center: Of computed circle.
Radius: Of computed circle.
Pt1, Pt2, Pt3: Three points to fit a circle through.
```

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Routine to construct a circle through given 3 points. If two of the points are the same or the three points are collinear it returns FALSE, otherwise (successful), it returns TRUE.

**See also:** GM2PointsFromCircCirc3D, GM2PointsFromLineLine, GM2PointsFromCircCirc, GM2CircleFrom2Pts2Tans, GM2BiTanFromCircCirc, GM2TanLinesFromCircCirc, GM2IsPtInsideCirc,

4.2.45 GMCircleFromLstSqrPts (geom_bsc.c:2591)

```c
int GMCircleFromLstSqrPts(CagdPType Center,
    IrtRType *Radius,
    const CagdPType *Pts,
    int PtsSize)

Center: The circle's center is returned in this param.
Radius: The circle's radius is returned in this param.
Pts: Vector of points to fit a circle to, least squares.
PtsSize: Size of the Pts vector.
```

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Compute a least-squares fitted circle to a set of points, in the XY plane. Returns the center and radius of the computed circle. Solving the problem in a new (U,V) space by minimizing $P^2 = (U-Uc)^2 + (V-Vc)^2 - R^2$, where $(Uc,Vc)$ the circle center. For the full solution, see http://www.dtcenter.org/met/users/docs/write_ups/circle_fit.pdf.

**See also:**
4.2.46 GMCleanUpDupPolys (poly_cln.c:147)

IPPolygonStruct *GMCleanUpDupPolys(IPPolygonStruct **PPolygons, IrtRType Eps)

*PPolygons: List of polygons to clean, in place.
Eps: Tolerance of vertices equality, etc.
Returns: Reference to the filtered polygons.
Description: Routine to search and remove duplicated identical polygons in the input model, in place.
See also: GMCleanUpPolylineList, GMVrtxListToCircOrLin, GMFilterInteriorVertices, GMCleanUpPolygonList, GMTwoPolySameGeom.

4.2.47 GMCleanUpPolygonList (poly_cln.c:192)

IPPolygonStruct *GMCleanUpPolygonList(IPPolygonStruct **PPolygons, IrtRType Eps)

*PPolygons: List of polygons to clean, in place.
Eps: Tolerance of vertices equality, etc.
Returns: Reference to the filtered polygons.
Description: Routine to clean up polygons - delete zero length edges, and polygons with less than 3 vertices, in place.
See also: GMCleanUpPolylineList, GMVrtxListToCircOrLin, GMFilterInteriorVertices, GMCleanUpDupPolys.

4.2.48 GMCleanUpPolylineList (poly_cln.c:281)

IPPolygonStruct *GMCleanUpPolylineList(IPPolygonStruct **PPolylines, IrtRType Eps)

*PPolylines: List of polylines to clean, in place.
Eps: Tolerance of vertices equality, etc.
Returns: Reference to the filtered polylines.
Description: Routine to clean up polylines of zero length, in place.
See also: GMCleanUpPolygonList, GMVrtxListToCircOrLin, GMFilterInteriorVertices, GMCleanUpPolylineList2.

4.2.49 GMCleanUpPolylineList2 (poly_cln.c:348)

IPPolygonStruct *GMCleanUpPolylineList2(IPPolygonStruct *PPolylines)

*PPolylines: List of polylines to clean, in place.
Returns: Reference to the filtered polylines.
Description: Routine to clean up colinear points in polylines, in place.
See also: GMCleanUpPolygonList, GMVrtxListToCircOrLin, GMFilterInteriorVertices, GMCleanUpPolylineList,

4.2.50 GMClipPolysAgainstPlane (poly_cln.c:599)

IPPolygonStruct *GMClipPolysAgainstPlane(IPPolygonStruct *PHead, IPPolygonStruct **PClipped, IPPolygonStruct **PInter, IrtPlnType Plane)

*PHead: Pointer to head of a NULL terminated list of polygons.
*PClipped: List of clipped polygons on the negative side of Plane, if any.
PInter: List of polygons that intersects Plane, if any.
Plane: Plane to clip against.
Returns: List of polygons in the positive domain of the Plane.
Description: Clips polygons that are at the negative side of the plane foreach Ax + By + Cz + D < 0. Clipped polygons are returned in PClipped list whereas polygons that intersects the plane Plane are returned in PInter.
4.2.51 GMCollinear3Pts (geom_jsc.c:265)

int GMCollinear3Pts(const IrtPtType Pt1,
const IrtPtType Pt2,
const IrtPtType Pt3)

Pt1, Pt2, Pt3: Three points to verify for collinearity.

Returns: TRUE if collinear, FALSE otherwise.

Description: Verifies the collinearity of three points.
See also: GMCollinear3PtsInside,

4.2.52 GMCollinear3PtsInside (geom_jsc.c:346)

int GMCollinear3PtsInside(const IrtPtType Pt1,
const IrtPtType Pt2,
const IrtPtType Pt3)

Pt1, Pt2, Pt3: Three points to verify for collinearity.

Returns: TRUE if collinear and inside segment, FALSE otherwise (including the case of Pt1 == Pt2 or Pt3 == Pt2).

Description: Verifies the collinearity of three points and that Pt2 is inside (up to GMBasicColinEps) the line segment (Pt1, Pt3).
See also: GMCollinear3Pts,

4.2.53 GMCollinear3Vertices (intrnrml.c:207)

int GMCollinear3Vertices(const IPVertexStruct *V1,
const IPVertexStruct *V2,
const IPVertexStruct *V3)

V1, V2, V3: Vertices to test for collinearity.

Returns: TRUE if collinear, FALSE otherwise.

Description: Verify the collinearity of the given three vertices.

4.2.54 GMComplexRoot (geom_jsc.c:3450)

void GMComplexRoot(IrtRType RealVal,
IrtRType ImageVal,
IrtRType *RealRoot,
IrtRType *ImageRoot)

RealVal, ImageVal: The number to compute the root for.

RealRoot, ImageRoot: The computed root.

Returns: void

Description: Computes one root of an imaginary number.
4.2.55  **GMComputeAverageVertex** (polysmth.c:341)

```c
int GMComputeAverageVertex(const IPVertexStruct *VS,  
                          IrtPtType CenterPoint,  
                          IrtRType BlendFactor)
```

**VS:** List of vertices of the Polygon.

**CenterPoint:** Input center location into which average is to be blended.

**BlendFactor:** 1.0 to move the vertex all the way to the average position otherwise (less than 1.0) to the proper fraction.

**Returns:** TRUE if computed average is valid, FALSE otherwise.

**Description:** Computes the average location of the vertices in poly VS and blend this average with CenterPoint with ratio BlendFactor (== CenterPoint if 0).

**See also:** GMPolyCentroid, GMComputeAverageVertex2,

4.2.56  **GMComputeAverageVertex2** (polysmth.c:294)

```c
int GMComputeAverageVertex2(const int *NS,  
                            const IPPolyVrtxIdxStruct *PVIdx,  
                            IrtPtType CenterPoint,  
                            IrtRType BlendFactor)
```

**NS:** List of indices of vertices to average in PVIdx.

**PVIdx:** Vertex array data structure.

**CenterPoint:** Input center location into which average is to be blended.

**BlendFactor:** 1.0 to move the vertex all the way to the average position otherwise (less than 1.0) to the proper fraction.

**Returns:** TRUE if computed average is valid, FALSE otherwise.

**Description:** Computes the average location of the vertices in vertex indices NS and blend this average with CenterPoint with ratio BlendFactor (== CenterPoint if 0).

**See also:** GMPolyCentroid, GMComputeAverageVertex,

4.2.57  **GMConvertPolysToNGons** (poly_pts.c:101)

```c
IPObjectStruct *GMConvertPolysToNGons(IPObjectStruct *PolyObj, int n)
```

**PolyObj:** Polyogonal object to split into up to n-gons.

**n:** Maximal number of vertices.

**Returns:** A polygonal object containing polygons with up to n vertices, representing the same model as PolyObj.

**Description:** Creates a new polygonal objects out of given one, that contains only polygons of upto n vertices. Non convex polygons are split to convex one so the result will contain convex data only.

**See also:** ConvexPolyObjectN, GMConvertPolysToTriangles, GMConvertPolysToRectangles,

4.2.58  **GMConvertPolysToRectangles** (poly_pts.c:582)

```c
IPObjectStruct *GMConvertPolysToRectangles(IPObjectStruct *PolyObj)
```

**PolyObj:** Polyogonal object to split into rectangles, in place.

**Returns:** Return list of rectangular polygons.

**Description:** Creates a new polygonal objects out of given one, that contains only rectangles. Non convex polygons with an empty kernel will generate self-intersecting results. By selecting a centroid location in the kernel of each polygon and connecting that centroid location to all the middle two adjacent edges, for all edges, n rectangular regions are defined for each n-gon, about half the (edge) size.

**See also:** ConvexPolyObjectN, GMConvertPolysToNGons, GMLimitTrianglesEdgeLen, GMConvertPolysToTriangles, GMConvertPolysToTriangles2,
4.2.59 GMConvertPolysToTriangles (poly_pts.c:181)

IPObjectStruct *GMConvertPolysToTriangles(IPObjectStruct *PolyObj)

PolyObj: Polygonal object to split into triangles.
Returns: A polygonal object containing only triangles representing the same model as PolyObj.
Description: Creates a new polygonal objects out of given one, that contains only triangles. Non convex polygons are split to convex one which, in turn, converted to triangles. Collinear points are purged away.
See also: ConvexPolyObjectN, GMConvertPolysToNGons, GMLimitTrianglesEdgeLen, GMConvertPolysToTriangles2, GMConvertPolysToRectangles

4.2.60 GMConvertPolysToTriangles2 (poly_pts.c:356)

IPObjectStruct *GMConvertPolysToTriangles2(IPObjectStruct *PolyObj)

PolyObj: Polygonal object to split into triangles.
Returns: A polygonal object containing only triangles representing the same model as PolyObj.
Description: Creates a new polygonal objects out of given one, that contains only triangles. Non convex polygons are split to convex one which, in turn, converted to triangles. Collinear points are purged away.
See also: ConvexPolyObjectN, GMConvertPolysToNGons, GMLimitTrianglesEdgeLen, GMConvertPolysToTriangles, GMConvertPolysToRectangles

4.2.61 GMConvertPolysToTrianglesIntrrPt (poly_pts.c:486)

IPObjectStruct *GMConvertPolysToTrianglesIntrrPt(IPObjectStruct *PolyObj)

PolyObj: Polygonal object to split into triangles.
Returns: A polygonal object containing only triangles representing the same model as PolyObj.
Description: Creates a new polygonal objects out of given one, that contains only triangles. Non convex polygons are split to convex one which, in turn, converted to triangles. Collinear points are purged away.
See also: ConvexPolyObjectN, GMConvertPolysToNGons, GMLimitTrianglesEdgeLen, GMConvertPolysToTriangles, GMConvertPolysToRectangles

4.2.62 GMConvexHull (cnvxhull.c:60)

int GMConvexHull(IrtE2PtStruct *DTPts, int *NumOfPoints)

DTPts: The set of point to compute their convex hull.
NumOfPoints: Number of points in set DTPts.
Returns: TRUE if successful, FALSE otherwise.
Description: Convex Hull computation of a set of points. The Convex Hull is returned in place, updating NumOfPoints. Algorithm is based on two articles:
See also: GMMonotonePolyConvex
4.2.63 GMConvexPolyNormals (convex.c:160)

```c
int GMConvexPolyNormals(int HandleNormals)

HandleNormals: TRUE for treating normals, FALSE to ignore them.

Returns: Previous state of normal handling.
```

**Description:** If TRUE, normals of vertices will be treated. If FALSE, only positions are considered in the convex decompositions. This function also affects the propagation of attributes as well such as rgb color and uv coordinates.

**See also:** GMConvexPolyObjectN, GMConvertPolysToTriangles, ConvexPolyObject, , nvexPolygon, SplitNonConvexPoly, GMConvexRaysToVertices

4.2.64 GMConvexPolyObject (convex.c:246)

```c
void GMConvexPolyObject(IPObjectStruct *PObj)

PObj: To test for convexity of its polygons, and split into convex polygons non convex polygons found, in place. Either a polygonal object or a list of polygonal objects.

Returns: void
```

**Description:** Routine to test all polygons in a given object for convexity, and split non convex ones, in place. This function will introduce new vertices to the split polygons.

**See also:** GMConvertPolysToTriangles, GMConvexPolyObjectN, GMIsConvexPolygon, , SplitNonConvexPoly

4.2.65 GMConvexPolyObjectN (convex.c:215)

```c
IPObjectStruct *GMConvexPolyObjectN(IPObjectStruct *PObj)

PObj: To test for convexity of its polygons.

Returns: A duplicate of PObj, but with convex polygons only.
```

**Description:** Routine to test all polygons in a given object for convexity, and split non convex ones, non destructively - the original object is not modified. This function will introduce new vertices to the split polygons.

**See also:** GMConvertPolysToTriangles, ConvexPolyObject, ConvexPolygon, , litNonConvexPoly

4.2.66 GMConvexRaysToVertices (convex.c:187)

```c
int GMConvexRaysToVertices(int RaysToVertices)

RaysToVertices: TRUE for rays to vertices, FALSE bisector rays.

Returns: Previous state of ray casting.
```

**Description:** If TRUE, ray will be fired to vertices. If FALSE, ray as angle bisectors will be used.

**See also:** GMConvexPolyObjectN, GMConvertPolysToTriangles, ConvexPolyObject, , nvexPolygon, SplitNonConvexPoly, GMConvexPolyNormals

4.2.67 GMCoplanar4Pts (geom.bsc.c:386)

```c
int GMCoplanar4Pts(const IrtPtType Pt1,
                   const IrtPtType Pt2,
                   const IrtPtType Pt3,
                   const IrtPtType Pt4)

Pt1, Pt2, Pt3, Pt4: Four points to verify for coplanarity.

Returns: TRUE if coplanar, FALSE otherwise.
```

**Description:** Verifies the coplanarity of four points.

**See also:** GMCollinear3Pts
4.2.68 GMDecimateObjSetDcmRatioParam (decimate.c:152)

void GMDecimateObjSetDcmRatioParam(int DcmRatio)

DcmRatio: Maximal participation number.
Returns: void
Description: Function set parameter of the maximal number of the participation of each vertex in the triangulation process.
See also: GMDecimateObject,

4.2.69 GMDecimateObjSetDistParam (decimate.c:109)

void GMDecimateObjSetDistParam(IrtRType Dist)

Dist: Threshold distance value.
Returns: void
Description: Function set parameter of the maximal tolerant distance from the removed vertex to the average plane.
See also: GMDecimateObject,

4.2.70 GMDecimateObjSetMinAspRatioParam (decimate.c:174)

void GMDecimateObjSetMinAspRatioParam(IrtRType MinAspRatio)

MinAspRatio: minimal aspect ratio.
Returns: void
Description: Function set parameter of the maximal number of the aspect ratio of the loop splitting.
See also: GMDecimateObject,

4.2.71 GMDecimateObjSetPassNumParam (decimate.c:130)

void GMDecimateObjSetPassNumParam(int PassNum)

PassNum: Passages number.
Returns: void
Description: Function set parameter of the maximal number of the decimation passages
See also: GMDecimateObject,

4.2.72 GMDecimateObject (decimate.c:202)

IPObjectStruct *GMDecimateObject(IPObjectStruct *IPObj)

IPObj: Input polygonal object in IRIT format.
Returns: The decimated object.
Description: This function implement the decimation of the polygonal mesh by applying Schroeder’s decimation scheme. The percentage of the decimation depends on setting of the global variables: NumberOfPassages, VertexDcmRatio and DistToAvrgPln. If Splitting option is set to TRUE, retriangilation of the vertices loop is performed by using recursive splitting algorithm where minimal aspect ratio parametr is equal to AspectRatio. Otherwise, simple sequential triangilation is exploited.
See also: GMDecimateObjSetMinAspRatioParam, GMDecimateObjSetDcmRatioParam, , GMDecimateObjSetPassNumParam, GMDecimateObjSetDistParam,
4.2.73  GMDistLineLine (geom.bsc.c:1086)

IrtRType GMDistLineLine(const IrtPtType P11,
                const IrtPtType V11,
                const IrtPtType P12,
                const IrtPtType V12)

P11, V11: Position and direction defining the first line.
P12, V12: Position and direction defining the second line.
Returns: Distance between the two lines.
Description: Routine to find the distance between two lines (Pli, Vli) , i = 1, 2.

4.2.74  GMDistPoint1DWithEnergy (dist_pts.c:42)

IrtRType *GMDistPoint1DWithEnergy(int N,
    IrtRType XMin,
    IrtRType XMax,
    int Resolution,
    GMDistEnergy1DFuncType EnergyFunc)

N: Number of points to distribute,
XMin: Minimum of domain to distribute points.
XMax: Minimum of domain to distribute points.
Resolution: Fineness of integral calculation.
EnergyFunc: Energy function to use.
Returns: A vector of N points distributed as requested.
Description: Distributes N points with a given energy in the region in the X line that is bounded by XMin, XMax. Energy is specified via the EnergyFunc that receives the X location. Resolution * N specifies how many samples to take from EnergyFunc. Returns an array of N distributed points. The solution to the distribution is analytic provided EnergyFunc can be integrated. Herein, this integral is computed numerically.

4.2.75  GMDistPointLine (geom.bsc.c:739)

IrtRType GMDistPointLine(const IrtPtType Point,
                const IrtPtType Pl,
                const IrtPtType Vl)

Point: To find the distance to on the line.
Pl, Vl: Position and direction that defines the line.
Returns: The computed distance.
Description: Routine to compute the distance between a 3d point and a 3d line. The line is prescribed using a point on it (Pl) and vector (Vl).
See also: MvarDistPointLine,

4.2.76  GMDistPointPlane (geom.bsc.c:776)

IrtRType GMDistPointPlane(const IrtPtType Point, const IrtPlnType Plane)

Point: To find the distance to on the plane.
Plane: To find the distance to on the point.
Returns: The computed distance.
Description: Routine to compute the distance between a Point and a Plane. The Plane is prescribed using its four coefficients : Ax + By + Cz + D = 0 given as four elements vector.
4.2.77  GMDistPointPoint (geom_bsc.c:467)

IrtRType GMDistPointPoint(const IrtPtType P1, const IrtPtType P2)

P1, P2: Two points to compute the distance between.
Returns: Computed distance.
Description: Routine to compute the distance between two 3d points.

4.2.78  GMDistPolyPoly (geom_bsc.c:1288)

IrtRType GMDistPolyPoly(const IPPolygonStruct *Pl1,
const IPPolygonStruct *Pl2,
IPVertexStruct **V1,
IPVertexStruct **V2,
int TagIgnoreV)

Pl1, Pl2: Two polys we seek the closest vertices of the two.
V1, V2: Two vertices on Pl1 and Pl2, respectively that are closest.
TagIgnoreV: If non zero, vertices that own this tag are ignored.
Returns: Distance between V1 and V2.
Description: Finds the closest vertices of Pl1 and Pl2.
See also: GMDistPolyPt,

4.2.79  GMDistPolyPt (geom_bsc.c:1131)

IrtRType GMDistPolyPt(const IPPolygonStruct *Pl,
IrtPtType Pt,
const IPVertexStruct **ExtremeV,
int MaxDist)

Pl: Poly to examine its extreme distance from point Pt.
Pt: Point to examine its extreme distance from poly Pl.
ExtremeV: Will be set to the vertex at the extreme distance. If NULL it is ignored.
MaxDist: TRUE to compute the maximum distance, FALSE for the minimum.
Returns: Extreme distance, -1.0 if error.
Description: Computes the extreme distance between point Pt and polygons/lines Poly. The extreme distance is computed on the vertices of Pl only.
See also: GMDistPolyPoly, GMDistPolyPt2,

4.2.80  GMDistPolyPt2 (geom_bsc.c:1198)

IrtRType GMDistPolyPt2(const IPPolygonStruct *Pl,
int IsPolyline,
IrtPtType Pt,
IrtRType *ExtremePt,
int MaxDist)

Pl: Poly to examine its extreme distance from point Pt.
IsPolyline: TRUE if Pl holds polylines, FALSE if polygons.
Pt: Point to examine its extreme distance from poly Pl.
ExtremePt: Will be set to the location at the extreme distance. If NULL it is ignored.
MaxDist: TRUE to compute the maximum distance, FALSE for the minimum.
Returns: Extreme distance, -1.0 if error.
Description: Computes the extreme distance between point Pt and polygons/lines Poly. The extreme distance is computed on the vertices and edges of Pl only.
See also: GMDistPolyPoly, GMDistPolyPt,
4.2.81  **GMEvalWeightsVFromPl** (intrnrml.c:257)

```c
int GMEvalWeightsVFromPl(const IrtRType *Coord,
                        const IPPolygonStruct *Pl,
                        IrtRType *Wgt)
```

**Coord**: Of vertex that its weights we seek.

**Pl**: Polygon including V.

**Wgt**: Vector to update with two weights. Must be of length larger or equal to the number of vertices in Pl.

**Returns**: TRUE if successful, FALSE if failed (V outside Pl).

**Description**: Computes blending weights for a vertex inside a polygon. Computes the barycentric coordinates of the triangle in Pl, V is in.

**See also**: GMUpdateVerticesByInterp, GMInterpVrtxNrmlBetweenTwo, GMInterpVrtxNrmlBetweenTwo2, GMInterpVrtxNrmlFromPl, GMInterpVrtxRGBBetweenTwo, GMInterpVrtxRGBFromPl, GMInterpVrtxUVBetweenTwo, GMInterpVrtxUVFromPl,

4.2.82  **GMExecuteAnimationEvalMat** (animate.c:856)

```c
IrtRType GMExecuteAnimationEvalMat(IPObjectStruct *AnimationP,
                                   IrtRType Time,
                                   IrtHmgnMatType ObjMat)
```

**AnimationP**: A (list of) animation curve(s) to evaluate at time t.

**Time**: Time of animation.

**ObjMat**: A matrix to chain the new animation matrices into.

**Returns**: Positive if visible (between zero and one hints on opacity), 0.0 otherwise, -1.0 if no visible curve found.

**Description**: Auxiliary function of ExecuteAnimation. Processes a linked list of objects.

4.2.83  **GMFilterInteriorVertices** (poly_cln.c:517)

```c
IPVertexStruct *GMFilterInteriorVertices(IPVertexStruct *VHead,
                                        IrtRType MinTol,
                                        int n)
```

**VHead**: Pointer to head of NULL terminated list of vertices.

**MinTol**: Vertices that the inner product of previous edge direction and next edge direction is more than MinTol are purged.

**n**: Number of interior vertices to keep.

**Returns**: Similar list modified in place with only n interior vertices.

**Description**: Filters out interior vertices to upto n interior vertices, in place. Computes the angle between adjacent edges and purge the almost collinear ones until we have n interior vertices.

**See also**: GMCleanUpPolylineList, GMCleanUpPolygonList, GMVrtxListToCircOrLin,

4.2.84  **GMFindLinComb2Vecs** (geom_bsc.c:507)

```c
int GMFindLinComb2Vecs(const IrtVecType V1,
                       const IrtVecType V2,
                       const IrtVecType V,
                       IrtRType w[2])
```

**V1, V2**: The two vectors that span the plane containing V.


**w**: The two scalar coefficients to be computed.

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: Computes the linear combination of V1 and V2 that yields V. It is assumed that the three vectors are coplanar.
4.2.85  GMFindPtInsidePolyKernel (polysmth.c:462)

    int GMFindPtInsidePolyKernel(const IPVertexStruct *VE, IrtPtType KrnlPt)

    VE: Cyclic list of vertices of the Polygon.
    KrnlPt: Computed interior kernel point.
    Returns: TRUE if kernel is not empty, FALSE otherwise.
    Description: Computes a point inside the kernel of the given polygon, if has any.

4.2.86  GMFindThirdPointInTriangle (polycln.c:663)

    IPVertexStruct *GMFindThirdPointInTriangle(const IPPolygonStruct *Pl,
                                             const IPVertexStruct *V,
                                             const IPVertexStruct *VNext)

    Pl: Triangle containing edge (V, VNext).
    V, VNext: Two given points in triangle.
    Returns: Pointer to the third vertex, or NULL if error.
    Description: Given two points in triangle, find the third (other) point (vertex) in the triangle.

4.2.87  GMFindUnConvexPolygonNormal (polysmth.c:570)

    void GMFindUnConvexPolygonNormal(const IPVertexStruct *VL, IrtVecType Nrml)

    VL: List of vertices of the Polygon.
    Nrml: Computed normal of the polygon. Not normalized.
    Returns: void
    Description: Finds the normal of polygon that can be non-convex.

4.2.88  GMFitData (fit1pts.c:81)

    IrtRType GMFitData(IrtRType** PointData,
                       unsigned int NumberOfPointsToFit,
                       GMFittingModelType FittingModel,
                       IrtRType ModelExtParams[],
                       IrtRType Tolerance)

    PointData: List of data points.
    NumberOfPointsToFit: The length of the list of points.
    FittingModel: An enumerator indicating which shape type to fit.
    ModelExtParams: The resulting external params of the shape.
    Tolerance: If the error is smaller then Tolerance return.
    Returns: The average squared error.
    Description: This function finds the best model params in the least-squares sense.
    See also:
4.2.89 GMFitDataWithOutliers (fit1pts.c:396)

IrtRType GMFitDataWithOutliers(IrtRType **PointData,
   unsigned int NumberOfPointsToFit,
   GMFittingModelType FittingModel,
   IrtRType ModelExtParams[],
   IrtRType Tolerance,
   unsigned int NumOfChecks)

   PointData: List of data points.
   NumberOfPointsToFit: The length of the list of points.
   FittingModel: An enumerator indicating which shape type to fit.
   ModelExtParams: The resulting params of the shape.
   Tolerance: If the error is smaller then Tolerance return.
   NumOfChecks: The number of attempts to calculate best sigma.

   Returns: The median squared error.

   Description: This function finds the best model params in the minimal median least squares sense.

See also: GMFitData,

4.2.90 GMFitEstimateRotationAxis (fit1pts.c:827)

IrtRType GMFitEstimateRotationAxis(IrtPtType *PointsOnObject,
   IrtVecType *Normals,
   unsigned int NumberOfPoints,
   IrtPtType PointOnRotationAxis,
   IrtVecType RotationAxisDirection)

   PointsOnObject: Points on the surface.
   Normals: Corresponding normals.
   NumberOfPoints: The number of points/normals.
   PointOnRotationAxis: The result.
   RotationAxisDirection: The result.

   Returns: The error.

   Description: This function estimates a rotation axis of a surface of revolution.

See also:

4.2.91 GMFitObjectWithOutliers (fit1pts.c:668)

IrtRType GMFitObjectWithOutliers(IPPolygonStruct *PPoly,
   GMFittingModelType FittingModel,
   IrtRType ModelExtParams[],
   IrtRType Tolerance,
   unsigned int NumOfChecks)

   PPoly: Pointer the object to estimate.
   FittingModel: An enumerator indicating which shape type to fit.
   ModelExtParams: The resulting params of the shape. If FittingModel is GM_FIT_PLANE - A, B, C, D
   of plane equation. GM_FIT_SPHERE - Xcntr, Ycntr, Zcntr, Radius. GM_FIT_CYLINDER - Xcntr, Ycntr, Zcntr, Xdir, Ydir, Zdir, Radius.
   GM_FIT_CIRCLE - Xcntr, Ycntr, Radius. GM_FIT_CONE - Xapex, Yapex, Zapex, apex semi angle, Xdir, Ydir, Zdir.
   GM_FIT_TORUS - Xpnt, Ypnt, Zpnt, DiscRad, ExtRad, Xdir, Ydir, Zdir.
   Tolerance: If the error is smaller than Tolerance return.
   NumOfChecks: The number of attempts to calculate best sigma, 100 is a good start.

   Returns: The median squared error.

   Description: This function finds the best model params in the minimal median least squares sense. Warning:
   This function is NOT thread-safe.

See also: GMFitDataWithOutliers,
4.2.92 **GMFixNormalsOfPolyModel** (intrnrml.c:1000)

```c
void GMFixNormalsOfPolyModel(IPPolygonStruct *PlList, int TrustFixedPt)

PlList: Polygonal object to correct normals.
TrustFixedPt: 0 to trust the vertices’ normal, 1 to trust the orientation of polygons’ normals, 2 to reorient the polygons so all plane normals point outside or all inside (based on first poly).

Returns: void
Description: Fix orientation discrepancy between polygon normals and vertices normals.
See also: GMBlendNormalsToVertices, GMFixOrientationOfPolyModel,
```

4.2.93 **GMFixOrientationOfPolyModel** (intrnrml.c:877)

```c
void GMFixOrientationOfPolyModel(IPPolygonStruct *Pls)

Pls: Polygons to reorient them all based on first polygon.

Returns: void
Description: Using computed adjacency information, propagate the orientation of first polygon in the given poly object until all polygons are processed. Disjoint poly-meshes will be marked with an "OrientDisjoint" attribute on the first polygon of each disjoint part.
See also: ,
```

4.2.94 **GMGenMatObjectRotVec** (geomat3d.c:177)

```c
IPObjectStruct *GMGenMatObjectRotVec(const IrtVecType Vec, const IrtRType *Degree)

Vec: Vector to rotate along its axis.
Degree: Amount of rotation, in degrees.

Returns: A matrix object.
Description: Routine to generate rotation object around the vector Vec in Degree degs:
See also: GMGenMatrixZ2Dir, GMGenMatrixZ2Dir2, GMGenMatObjectZ2Dir2, GMGenMatrixRotVec,
```

4.2.95 **GMGenMatObjectRotX** (geomat3d.c:48)

```c
IPObjectStruct *GMGenMatObjectRotX(const IrtRType *Degree)

Degree: Amount of rotation, in degrees.

Returns: A matrix object.
Description: Routine to generate rotation object around the X axis in Degree degrees:
```

4.2.96 **GMGenMatObjectRotY** (geomat3d.c:70)

```c
IPObjectStruct *GMGenMatObjectRotY(const IrtRType *Degree)

Degree: Amount of rotation, in degrees.

Returns: A matrix object.
Description: Routine to generate rotation object around the Y axis in Degree degrees:
4.2.97  **GMGenMatObjectRotZ** (geomat3d.c:92)

*IP_objectStruct* (*GMGenMatObjectRotZ*(const *IrtRType* *Degree*)

**Degree**: Amount of rotation, in degrees.
**Returns**: A matrix object.
**Description**: Routine to generate rotation object around the Z axis in Degree degrees:

4.2.98  **GMGenMatObjectScale** (geomat3d.c:228)

*IP_objectStruct* (*GMGenMatObjectScale*(const *IrtVecType* *Vec*)

**Vec**: Amount of scaling, in X, Y, and Z.
**Returns**: A matrix object.
**Description**: Routine to generate a scaling object.
**See also**: MatGenMatScale,

4.2.99  **GMGenMatObjectTrans** (geomat3d.c:202)

*IP_objectStruct* (*GMGenMatObjectTrans*(const *IrtVecType* *Vec*)

**Vec**: Amount of translation, in X, Y, and Z.
**Returns**: A matrix object.
**Description**: Routine to generate a translation object.
**See also**: MatGenMatTrans,

4.2.100  **GMGenMatObjectV2V** (geomat3d.c:1109)

*IP_objectStruct* (*GMGenMatObjectV2V*(const *IrtVecType* *V1*, const *IrtVecType* *V2*)

**V1, V2**: To compute the rotation from (V1) to (V2).
**Returns**: A matrix object.
**Description**: Generates a transformation matrix that rotates V1 to V2.
**See also**: GMGenMatrixZ2Dir, GMGenMatrixZ2Dir2, GMGenMatObjectZ2Dir2, GMGenMatrixRotVec, GMGenMatrixRotV2V,

4.2.101  **GMGenMatObjectZ2Dir** (geomat3d.c:118)

*IP_objectStruct* (*GMGenMatObjectZ2Dir*(const *IrtVecType* *Dir*)

**Dir**: Vector to rotate Z axis to it.
**Returns**: A matrix object.
**Description**: Routine to generate rotation object to rotate Z to Dir.
**See also**: GMGenMatrixZ2Dir, GMGenMatrixZ2Dir2, GMGenMatObjectZ2Dir2, GMGenMatrixRotV2V, GMGenMatrixRotVec,
### 4.2.102  GMGenMatObjectZ2Dir2 (geomat3d.c:149)

```
**Description:** Routine to generate rotation object around the vector Dir in Degree degs:
```

**Dir:** Vector to rotate Z axis to it.
**Dir2:** Vector to rotate X axis to it.

**Returns:** A matrix object.

**See also:** GMGenMatrixZ2Dir2, E, GMGenMatrixZ2Dir2, GMGenMatrixZ2Dir2, GMGenMatObjectZ2Dir2, GMGenMatrixRotV2V, GMGenMatrixRotVec,

### 4.2.103  GMGenMatrix3Pts2EqltrlTri (geomat3d.c:1234)

```
**Description:** Compute the linear transform that maps the given planar triangle Pt1Pt2Pt3 to an equilateral triangle around the origin so that edge Pt1Pt2 is horizontal and remains of the same size.
```

**Pt1, Pt2, Pt3:** The three points to compute the mapping for.

**Returns:** A matrix object.

**See also:** GM3Pts2EqLtrlTriMat,

### 4.2.104  GMGenMatrixRotV2V (geomat3d.c:1051)

```
**Description:** Generates a transformation matrix that rotates V1 to V2.
```

**Mat:** To place the computed transformation.
**V1, V2:** Vector to rotate from (V1) to (V2).

**Returns:** void

**See also:** GMGenMatrixZ2Dir, GMGenMatrixZ2Dir2, GMGenMatObjectZ2Dir2, GMGenMatrixRotVec,

### 4.2.105  GMGenMatrixRotVec (geomat3d.c:1266)

```
**Description:** Generates a transformation matrix that rotates the object around Vec, Angle degrees.
```

**Mat:** To place the computed transformation.
**Vec:** Vector to rotate along its axis.
**Degrees:** Amount of rotation, in degrees.

**Returns:** void

**See also:** GMGenMatrixZ2Dir, GMGenMatrixZ2Dir2, GMGenMatObjectZ2Dir2, GMGenMatrixRotV2V,
4.2.106 GMGenMatrixX2Dir (geomat3d.c:851)

```c
void GMGenMatrixX2Dir(IrtHmgnMatType Mat, const IrtVecType Dir)
```

- **Mat**: To place the computed transformation.
- **Dir**: Direction to take X axis to.
- **Returns**: void
- **Description**: Routine to generate rotation matrix to rotate X to Dir.

4.2.107 GMGenMatrixY2Dir (geomat3d.c:874)

```c
void GMGenMatrixY2Dir(IrtHmgnMatType Mat, const IrtVecType Dir)
```

- **Mat**: To place the computed transformation.
- **Dir**: Direction to take Y axis to.
- **Returns**: void
- **Description**: Routine to generate rotation matrix to rotate Y to Dir.

4.2.108 GMGenMatrixZ2Dir (geomat3d.c:897)

```c
void GMGenMatrixZ2Dir(IrtHmgnMatType Mat, const IrtVecType Dir)
```

- **Mat**: To place the computed transformation.
- **Dir**: Direction to take Z axis to.
- **Returns**: void
- **Description**: Same as GMGenTransMatrixZ2Dir but with no scaling and/or translation.

4.2.109 GMGenMatrixZ2Dir2 (geomat3d.c:979)

```c
void GMGenMatrixZ2Dir2(IrtHmgnMatType Mat, const IrtVecType Dir,
                        const IrtVecType Dir2)
```

- **Mat**: To place the computed transformation.
- **Dir**: Direction to take Z axis to.
- **Dir2**: Direction to take X axis to.
- **Returns**: void
- **Description**: Same as GMGenTransMatrixZ2Dir2 but with no scaling and/or translation.

4.2.110 GMGenPolyline2Vrtx (polyprop.c:382)

```c
IPPolygonStruct *GMGenPolyline2Vrtx(IrtVecType V1,
                                     IrtVecType V2,
                                     IPPolygonStruct *Pnext)
```

- **V1, V2**: Two vertices of the constructed polyline.
- **Pnext**: Next is chain of polylines, in linked list.
- **Returns**: The constructed polyline.
- **Description**: Routine to create a polyline out of a list of 2 vertices V1/2. No test is made to make sure the 2 points are not the same... The points are placed in order.
- **See also**: PrimGenPolygon3Vrtx, PrimGenPolygon4Vrtx,
4.2.111  GMGenProjectionMat  (geomat3d.c:1302)

void GMGenProjectionMat(const IrtPlnType ProjPlane,
                         const IrtRType EyePos[4],
                         IrtHmgnMatType Mat)

  ProjPlane: The plane to project the objects onto.
  EyePos: The position of the eye.
  Mat: Matrix to update.

Returns: void

Description: Constructs a matrix that projects 3D objects to the Projection Plane ProjPlane, having the eye at EyePos. This solution is derived by solving for the intersection point of the line through the eye and the projected point and the given plane.

See also: GMGenReflectionMat,

4.2.112  GMGenReflectionMat  (geomat3d.c:1348)

void GMGenReflectionMat(const IrtPlnType ReflectPlane, IrtHmgnMatType Mat)

  ReflectPlane: The plane to computed a reflection matrix for.
  Mat: Matrix to update.

Returns: void

Description: Constructs a matrix that reflects 3D objects based upon the prescribed reflection plane, ReflectPlane.

See also: GMGenProjectionMat, GMGenMatrixZ2Dir,

4.2.113  GMGenRotateMatrix  (convex.c:112)

void GMGenRotateMatrix(IrtHmgnMatType Mat, const IrtVecType Dir)

  Mat: To place the constructed homogeneous transformation.
  Dir: To derive a transformation such that Dir is parallel to the Z axes.

Returns: void

Description: Routine to prepare a transformation martix to rotate such that Dir is parallel to the Z axes. Used by the convex decomposition to rotate the polygons to be XY plane parallel. Algorithm: form a 4 by 4 matrix from Dir as follows:

\[
\begin{pmatrix}
T_x & T_y & T_z & 0 \\
B_x & B_y & B_z & 0 \\
0 & 0 & 0 & 1 \\
0 & 0 & 0 & 1
\end{pmatrix}
\]

A transformation which takes the coord system into T, N & B as required.

N is exactly Dir, but we got freedom on T & B which must be on a plane perpendicular to N and perpendicular between them but thats all! T is therefore selected using this (heuristic ?) algorithm: Let P be the axis of which the absolute N coefficient is the smallest. Let B be (N cross P) and T be (B cross N).

4.2.114  GMGenTransMatrixZ2Dir  (geomat3d.c:803)

void GMGenTransMatrixZ2Dir(IrtHmgnMatType Mat,
                           const IrtVecType Trans,
                           const IrtVecType Dir,
                           IrtRType Scale)

  Mat: To place the computed transformation.
  Trans: Translation factor.
**Dir:** Direction to take Z axis to.

**Scale:** Scaling factor.

**Returns:** void

**Description:** Routine to prepare a transformation matrix to do the following (in this order): scale by Scale, rotate such that the Z axis is in direction Dir and then translate by Trans. Algorithm: given the Trans vector, it forms the 4th line of Mat. Dir is used to form the second line (the first 3 lines set the rotation), and finally Scale is used to scale first 3 lines/columns to the needed scale:

\[
\begin{bmatrix}
X & Y & Z & 1
\end{bmatrix} \times \begin{bmatrix}
T_x & T_y & T_z & 0 \\
B_x & B_y & B_z & 0 \\
N_x & N_y & N_z & 0 \\
C_x & C_y & C_z & 1
\end{bmatrix} = \text{A transformation which takes the coord system into T, N & B as required and then translate it to C. T, N, B are scaled by Scale.}
\]

\[
\begin{bmatrix}
T_x & T_y & T_z & 0 \\
B_x & B_y & B_z & 0 \\
N_x & N_y & N_z & 0 \\
C_x & C_y & C_z & 1
\end{bmatrix} \times \begin{bmatrix}
N_x & N_y & N_z & 0 \\
C_x & C_y & C_z & 1
\end{bmatrix} = \text{scaled by Scale.}
\]

N is exactly Dir (unit vec) but we got freedom on T & B which must be on a plane perpendicular to N and perpendicular between them but thats all! T is therefore selected using this (heuristic ?) algorithm: Let P be the axis of which the absolute N coefficient is the smallest. Let B be (N cross P) and T be (B cross N).

### 4.2.115 GMGenTransMatrixZ2Dir2

#### (geomat3d.c:936)

```c
void GMGenTransMatrixZ2Dir2(IrtHmgnMatType Mat, 
  const IrtVecType Trans, 
  const IrtVecType Dir, 
  const IrtVecType Dir2, 
  IrtRType Scale)
```

**Mat:** To place the computed transformation.

**Trans:** Translation factor.

**Dir:** Direction to take Z axis to.

**Dir2:** Direction to take X axis to.

**Scale:** Scaling factor.

**Returns:** void

**Description:** Routine to prepare a transformation matrix to do the following (in this order): scale by Scale, rotate such that the Z axis is in direction Dir and X axis is direction Dir2 and then translate by Trans. Algorithm: given the Trans vector, it forms the 4th line of Mat. Dir is used to form the second line (the first 3 lines set the rotation), and finally Scale is used to scale first 3 lines/columns to the needed scale:

\[
\begin{bmatrix}
X & Y & Z & 1
\end{bmatrix} \times \begin{bmatrix}
T_x & T_y & T_z & 0 \\
B_x & B_y & B_z & 0 \\
N_x & N_y & N_z & 0 \\
C_x & C_y & C_z & 1
\end{bmatrix} = \text{A transformation which takes the coord system into T, N & B as required and then translate it to C. T, N, B are scaled by Scale.}
\]

N is exactly Dir (unit vec) and T is exactly Dir2.

### 4.2.116 GMGenUVValsForPolys

#### (poly_pts.c:1658)

```c
void GMGenUVValsForPolys(IPObjectStruct *PObj, 
  IrtRType UTextureRepeat, 
  IrtRType VTextureRepeat, 
  IrtRType WTextureRepeat, 
  int HasXYZScale)
```

**PObj:** A polygonal object to update UV vals for.

**UTextureRepeat, VTextureRepeat, WTextureRepeat:** Repeat texture factors.

**HasXYZScale:** If TRUE, WTextureRepeat is also valid - use XYZ coords.

**Returns:** void

**Description:** Generates UV values for polygonal geometry, based on the XY(Z) coordinates of the geometry. Will NOT overwrite existing "uvvals", if any.

**See also:** GMAffineTransUVVals,
4.2.117  GMGetMatTransPortion (geomat3d.c:255)

IPObjectStruct *GMGetMatTransPortion(const IPObjectStruct *MatObj, int TransPortion)

MatObj: To operate on.
TransPortion: TRUE to extract translational portion out of Mat, FALSE to dump the translational portion from Mat.
Returns: A matrix object hold either the translational portion of Mat or anything but the translational part.
Description: Routine to extract the translational part of a matrix or dump it.

4.2.118  GMIIdentifyTJunctions (poly_pts.c:1962)

int GMIIdentifyTJunctions(IPObjectStruct *PObj, GMIIdentifyTJunctionFuncType TJuncCB, IrtRType Eps)

PObj: Polygonal mesh to search for T junctions in.
TJuncCB: Call back function to invoke with every detected T junction. If E0 = (V0, V0 -> Pnext) is adjacent to both E1 = (V1, V1 -> Pnext) and E2 = (V2, V2 -> Pnext) so E2 is a T junction vertex on edge E0, the TJuncCB will be invoked as TJuncCB(V0, V1, V2, Pl0, Pl1, Pl2).
Eps: Tolerance of testing.
Returns: Number of detected T junctions, zero if none.
Description: Function to search for T junctions in given polygonal mesh Polys. The call back function TJuncCB is invoked pn every such T junction. This functions offers a naive and non-optimal (N^2) solution.
See also: GMIIsTJunction,

4.2.119  GMInterpVrtxNrmlBetweenTwo (intrnrml.c:310)

void GMInterpVrtxNrmlBetweenTwo(IPVertexStruct *V, const IPVertexStruct *V1, const IPVertexStruct *V2)

V: Vertex that its normal is to be updated.
V1, V2: Edge V is assumed to be on so that the two normals of V1 and V2 can be blended to form the normal of V.
Returns: void
Description: Update Normal of the middle vertex V, assumed to be between V1 and V2.
See also: GMIUpdateVerticesByInterp, GMInterpVrtxNrmlBetweenTwo2, GMInterpVrtxNrmlFromPl, GMInterpVrtxRGBBetweenTwo, GMInterpVrtxRGBFromPl, GMInterpVrtxUVBetweenTwo, GMInterpVrtxUVFromPl,

4.2.120  GMInterpVrtxNrmlBetweenTwo2 (intrnrml.c:359)

void GMInterpVrtxNrmlBetweenTwo2(IrtPtType Pt, IrtVecType Normal, const IPVertexStruct *V1, const IPVertexStruct *V2)

Pt: Middle position at which a normal is to be computed.
Normal: Where resulting vector is to be placed.
V1, V2: Edge V is assumed to be on so that the two normals of V1 and V2 can be blended to form the normal of V.
Returns: void
Description: Update normal of middle position Pt, assumed to be between V1 and V2.
See also: GMIUpdateVerticesByInterp, GMInterpVrtxNrmlBetweenTwo2, GMInterpVrtxNrmlFromPl, GMInterpVrtxRGBBetweenTwo, GMInterpVrtxRGBFromPl, GMInterpVrtxUVBetweenTwo, GMInterpVrtxUVFromPl,
4.2.121  GMInterpVrtxNrmlFromPl (intrnrml.c:402)

int GMInterpVrtxNrmlFromPl(IPVertexStruct *Vrtx, const IPPolygonStruct *Pl)

**Vrtx:** Vertex that its normal is to be updated.
**Pl:** Polygon surrounding V to interpolate normal from.

**Returns:** TRUE if point is inside polygon, FALSE otherwise.

**Description:** Update Normal of vertex V, based on surrounding polygon Pl.

**See also:** GMUpdateVerticesByInterp, GMInterpVrtxNrmlBetweenTwo, GMInterpVrtxNrmlBetweenTwo2, GMInterpVrtxRGBBetweenTwo, GMInterpVrtxRGBFromPl, GMInterpVrtxUVBetweenTwo, GMInterpVrtxUVFromPl.

4.2.122  GMInterpVrtxRGBBetweenTwo (intrnrml.c:456)

int GMInterpVrtxRGBBetweenTwo(IPVertexStruct *V, const IPVertexStruct *V1, const IPVertexStruct *V2)

**V:** Vertex that its rgb color is to be updated.
**V1, V2:** Edge V is assumed to be on so that the two rgb colors of V1 and V2 can be blended to form the rgb color of V.

**Returns:** TRUE if successful, FALSE if failed.

**Description:** Update RGB of the middle vertex V, assumed to be between V1 and V2.

**See also:** GMUpdateVerticesByInterp, GMInterpVrtxNrmlBetweenTwo, GMInterpVrtxNrmlBetweenTwo2, GMInterpVrtxRGBFromPl, GMInterpVrtxUVBetweenTwo, GMInterpVrtxUVFromPl.

4.2.123  GMInterpVrtxRGBFromPl (intrnrml.c:502)

int GMInterpVrtxRGBFromPl(IPVertexStruct *Vrtx, const IPPolygonStruct *Pl)

**Vrtx:** Vertex that its rgb color is to be updated.
**Pl:** Polygon surrounding V to interpolate rgb color from.

**Returns:** TRUE if point is inside polygon, FALSE otherwise.

**Description:** Update rgb color of vertex V, based on surrounding polygon Pl.

**See also:** GMUpdateVerticesByInterp, GMInterpVrtxNrmlBetweenTwo, GMInterpVrtxNrmlBetweenTwo2, GMInterpVrtxRGBBetweenTwo, GMInterpVrtxUVBetweenTwo, GMInterpVrtxUVFromPl.

4.2.124  GMInterpVrtxUVBetweenTwo (intrnrml.c:567)

int GMInterpVrtxUVBetweenTwo(IPVertexStruct *V, const IPVertexStruct *V1, const IPVertexStruct *V2)

**V:** Vertex that its UV coordinates are to be updated.
**V1, V2:** Edge V is assumed to be on so that the two UV coords of V1 and V2 can be blended to form the UV coords of V.

**Returns:** TRUE if successful, FALSE if failed.

**Description:** Update UV of the middle vertex V, assumed to be between V1 and V2.

**See also:** GMUpdateVerticesByInterp, GMInterpVrtxNrmlBetweenTwo, GMInterpVrtxNrmlBetweenTwo2, GMInterpVrtxRGBBetweenTwo, GMInterpVrtxRGBFromPl, GMInterpVrtxUVBetweenTwo, GMInterpVrtxUVFromPl.
4.2.125  GMInterpVrtxUVFromPl  (intrnml.c:615)

int GMInterpVrtxUVFromPl(IPVertexStruct *Vrtx, const IPPolygonStruct *Pl)

  Vrtx: Vertex that its UV coordinate is to be updated.
  Pl: Polygon surrounding V to interpolate UV coordinate from.
  Returns: TRUE if successful, FALSE if failed.
  Description: Update UV coordinate of vertex V, based on surrounding polygon Pl.
  See also: GMUpdateVerticesByInterp, GMInterpVrtxNrmlBetweenTwo, GMInterpVrtxNrmlBetweenTwo2,
            GMInterpVrtxNrmlFromPl, GMInterpVrtxRGBBetweenTwo, GMInterpVrtxRGBFromPl, GMInterpVrtxUVBetweenTwo,

4.2.126  GMIsConvexPolygon  (convex.c:458)

int GMIsConvexPolygon(IPPolygonStruct *Pl)

  Pl: To test its convexity condition.
  Returns: TRUE if convex, FALSE otherwise.
  Description: Routine to test if the given polygon is convex or not. Algorithm: The polygon is convex iff the
                normals generated from cross products of two consecutive edges points to the same direction. Note a 5 star
                polygon satisfies this constraint but it is self intersecting and we assume given polygon is not self intersecting.
                The computed direction is also verified against the polygon’s plane normal. The routine returns TRUE iff the polygon is convex.
                In addition the polygon CONVEX tag (see IPPolygonStruct) is also updated. If the polygon is already marked as convex, nothing is tested!
                See also: GMConvertPolysToTriangles, GMConvexPolyObject, GMConvexPolyObjectN, SplitNonConvexPoly, GMIsConvexPolygon2,

4.2.127  GMIsConvexPolygon2  (convex.c:391)

int GMIsConvexPolygon2(const IPPolygonStruct *Pl)

  Pl: To test for convexity.
  Returns: TRUE if PL convex, FALSE otherwise.
  Description: Routine to test if the given polygon is convex (by IRIT definition) or not. For both closed and
               open vertex lists. Algorithm: The polygon is convex iff the normals generated from cross products of two consecutive
               edges points to the same direction. The same direction is tested by a positive dot product.
               See also: GMIsConvexPolygon,

4.2.128  GMIsInterLineLine2D  (polysmth.c:428)

static int GMIsInterLineLine2D(const IrtPtType A1, const IrtPtType A2, const IrtPtType B1, const IrtPtType B2, IrtRType *t)

  A1, A2: The two points of first line.
  B1, B2: The two points of second line.
  t: The blending value from V1 to V2 where the intersection has occurred. Can be NULL to ignore.
  Returns: TRUE if the two lines intersect, FALSE otherwise.
  Description: Check if the two lines A1A2 and B1B2 interest in the XY plane. End points intersections, up to
               IRIT_EPS, are ignored.
4.2.129  GMIsInterLinePolygon2D  (polysnth.c:386)

int GMIsInterLinePolygon2D(const IPVertexStruct *VS,
                         const IrtPtType V1,
                         const IrtPtType V2,
                         IrtRType *t)

VS:  Cyclic List of vertices of the Polygon.
V1, V2:  The end points of the line.
t:  The blending value from V1 to V2 where the intersection has occurred. Can be NULL to ignore.

Returns:  TRUE if line and polygon do interest, FALSE otherwise.

Description:  Check if a line V1V2 and polygon VS interest, in 2D.

4.2.130  GMIsPtInsideCirc  (geom_bsc.c:2826)

int GMIsPtInsideCirc(const IrtRType *Point,
                     const IrtRType *Center,
                     IrtRType Radius)

Point:  Point to test for containment in the circle in XY plane.
Center:  Center of the circle to test against.
Radius:  Radius of the circle to test against.

Returns:  TRUE if Point is indeed inside the circle, FALSE otherwise.

Description:  Tests if a point is contained in the given prescribed circle in XY plane. Points on the circle are
not considered inside (open domain).
See also:  GM2PointsFromLineLine, GM2PointsFromCircCirc3D, GMCircleFrom3Points, GMCircleFrom2Pts2Tans,
GM2BiTansFromCircCirc, GM2TanLinesFromCircCirc, GM2PointsFromCircCirc, GMIsPtOnCirc,

4.2.131  GMIsPtOnCirc  (geom_bsc.c:2855)

int GMIsPtOnCirc(const IrtRType *Point,
                 const IrtRType *Center,
                 IrtRType Radius)

Point:  Point to test for including in circle boundary in XY plane.
Center:  Center of the circle to test against.
Radius:  Radius of the circle to test against.

Returns:  TRUE if Point is indeed on the circle, FALSE otherwise.

Description:  Tests if a point is on the given prescribed circle’s boundary, in the N XY plane.
See also:  GM2PointsFromLineLine, GM2PointsFromCircCirc3D, GMCircleFrom3Points, GMCircleFrom2Pts2Tans,
GM2BiTansFromCircCirc, GM2TanLinesFromCircCirc, GM2PointsFromCircCirc, GMIsPtInsideCirc,

4.2.132  GMLimitTrianglesEdgeLen  (poly_pts.c:1472)

IPPolygonStruct *GMLimitTrianglesEdgeLen(const IPPolygonStruct *OrigPls,
                                        IrtRType MaxLen)

OrigPls:  List of triangles.
MaxLen:  Maximum allowed length of an edge of a triangle.

Returns:  Splitted polygons with edges smaller/equal to MaxLen.

Description:  Splits all triangles that has edge length larger than MaxLen. The output will have no edge in no
triangle with length larger than Maxlen.
See also:  ConvexPolyObjectN, GMConvertPolysToNGons, GMConvertPolysToTriangles,
4.2.133 GMLineFrom2Points (geom_bsc.c:565)

int GMLineFrom2Points(IrtLnType Line, const IrtPtType Pt1, const IrtPtType Pt2)

Line: To compute as $Ax + By + C$, such that $A^2 + B^2 = 1$.
Pt1, Pt2: Two points to fit a line through. Only XY coordinates are considered.

Returns: TRUE if successful, FALSE otherwise.

Description: Routine to construct a line through 2 points, in the plane. If the points are the same it returns FALSE, otherwise (successful), TRUE.

4.2.134 GMLineSweep (ln_sweep.c:45)

void GMLineSweep(GMLsLineSegStruct **Lines)

Lines: To compute all intersections against each other, in the plane.

Returns: void

Description: Computes all intersections between all given lines, in the plane. The Lines segments are updated so the Inters slot holds the list of intersections with the other segments, NULL if none. Returned is a list with possibly a different order than that is given.

4.2.135 GMLoadTextFont (text.c:40)

int GMLoadTextFont(const char *FName)

FName: Name of IRIT font file to load.

Returns: TRUE if successful, FALSE otherwise.

Description: Loads the IRIT font file that is specified by the FName file name. An IRIT font file contains the geometries of the characters as a list ordered according to the ASCII table starting from 32 (space). Chars can, alternatively, be prescribed by their names in the list as ASCII???

See also: GMMakeTextGeometry,

4.2.136 GMMakeTextGeometry (text.c:98)

IPObjectStruct *GMMakeTextGeometry(const char *Str, const IrtVecType Spacing, const IrtRType *Scaling)

Str: The text to convert to geometry.
Spacing: Between individual characters, in X, Y, Z.
Scaling: Relative, with scaling of one generates unit size chars.

Returns: Geometry representing the given text.

Description: Constructs a geometry representing the given text in Str, with Spacing space between character and scaling factor of Scale. If no font is loaded, this functions also loads the default font in iritfont.itd in the directory that is prescribed by the IRIT\_PATH environment variable.

See also: GMLoadTextFont,
4.2.137  GMMatFromPosDir (geomat3d.c:1009)

int GMMatFromPosDir(const IrtPtType Pos,  
const IrtVecType Dir,  
const IrtVecType UpDir, 
IrtHmgnMatType Mat)

Pos: The location of the viewer.
Dir: The viewing direction.
UpDir: The direction of up. Must be different than Dir.
Mat: Matrix to update.

Returns: TRUE if successful, FALSE otherwise.

Description: Routine to create a viewing transformation matrix, standing at Pos, and looking in direction Dir, 
with UpDir being the upper viewing direction. Creates a transformation matrix that takes Pos to DEFAULT_VIEW_POS 
and rotate Dir into the Z axis, and UpDir into the Y axis.

4.2.138  GMMatchPointListIntoPolylines (poly_pts.c:798)

IPPolygonStruct *GMMatchPointListIntoPolylines(IPObjectStruct *PtsList, 
IrtRType MaxTol)

PtsList: Point list to connect into polylines.
MaxTol: Maximum distance allowed to connect to points.

Returns: Connected polylines, upto MaxTol tolerance.

Description: Connect the list of points into polylines by connecting the closest point pairs, until the distances 
between adjacent points/polylines is more than MaxTol. Points are assumed to be in E3.

4.2.139  GMMatrixToTransform (quatrn.c:898)

void GMMatrixToTransform(IrtHmgnMatType Mat,  
IrtVecType S,  
GMQuatType R,  
IrtVecType T)

Mat: Source matrix to decompose.
S: Scaling components.
R: Rotation Components.
T: Translation components.

Returns: void

Description: Decompose the affine transformation matrix into uniform scaling, rotation and translation com-
ponents. Rotation is defined as normal and angle.

4.2.140  GMMergeGeometry (merge.c:344)

int GMMergeGeometry(void **GeomEntities, 
int NumOfGEntities,  
IrtRType Eps,  
IrtRType IdenticalEps,  
GMMergeGeomInitFuncType InitFunc,  
GMMergeGeomDistFuncType DistSqrFunc,  
GMMergeGeomKeyFuncType KeyFunc,  
GMMergeGeomMergeFuncType MergeFunc)
**GeomEntities:** Geometry to merge, typically points or polylines, as a vector of reference pointers to the entities. Returned, merged, data will also be stored here.

**NumOfGEntities:** Number of geometric entities. Also length of GeomEntities.

**Eps:** Epsilon of similarity to merge entities at. Entities farther than Eps will not be merged.

**IdenticalEps:** Epsilon to consider two entities’ distance as zero.

**InitFunc:** A function to initialize all geometry. NULL for the initialization of IPPolygonStruct polylines.

**DistSqrFunc:** A distance computation function. NULL for two IPPolygonStruct polylines compare. This function computes the minimal distance squared between two entities.

**KeyFunc:** A function to return a Key to sort the entities so that similar/adjacent entities will get similar a Key.

**MergeFunc:** A merge function. NULL to merge two IPPolygonStructs polylines merge. This function returns a merged entity while destroying the two input entities.

**Returns:** Number of merged entities in the end or 0 if error.

**Description:** Merges separated geometric entities into longer ones, in place, as much as possible. Given a list of entities (typically points or polylines), find and merge closest ones as possible and in place.

**See also:** MvarPolyMergePolylines, GMMergePolylines, GMMergeSameGeometry,

### 4.2.141 GMMergePolylines (poly_pts.c:730)

```c
IPPolygonStruct *GMMergePolylines(IPPolygonStruct *Polys, IrtRType Eps)
```

**Polys:** Polylines to merge, in place.

**Eps:** Epsilon of similarity to merge points at.

**Returns:** Merged as possible polylines.

**Description:** Merges separated polylines into longer ones, in place, as possible. Given a list of polylines, matches end points and merged as possible polylines with common end points, in place.

**See also:** GMMergeGeometry, MvarPolyMergePolylines, GMMergePolylines2,

### 4.2.142 GMMergeSameGeometry (merge.c:253)

```c
int GMMergeSameGeometry(void **GeomEntities, 
                        int NumOfGEntities, 
                        IrtRType IdenticalEps, 
                        GMMergeGeomInitFuncType InitFunc, 
                        GMMergeGeomDistFuncType DistSqrFunc, 
                        GMMergeGeomKeyFuncType KeyFunc, 
                        GMMergeGeomMergeFuncType MergeFunc)
```

**GeomEntities:** Geometry to merge, typically points or polylines, as a vector of reference pointers to the entities. Returned, merged, data will also be stored here.

**NumOfGEntities:** Number of geometric entities. Also length of GeomEntities.

**IdenticalEps:** Epsilon to consider two entities’ distance as zero. This epsilon is typically very small, i.e., IRIT_EQ_EPS.

**InitFunc:** A function to initialize all geometry. NULL for the initialization of IPPolygonStruct polylines.

**DistSqrFunc:** A distance computation function. NULL for two IPPolygonStruct polylines compare. This function computes the minimal distance squared between two entities.

**KeyFunc:** A function to return a Key to sort the entities so that similar/adjacent entities will get similar a Key.

**MergeFunc:** A merge function. NULL to merge two IPPolygonStructs polylines merge. This function returns a merged entity while destroying the two input entities.

**Returns:** Number of merged entities in the end or 0 if error.

**Description:** Merges separated geometric entities into longer ones, in place, as much as possible. Given a list of entities (typically points or polylines), find and merge closest ones as possible and in place. This function should only be used to merge geometry that is very precise and adjacent entities distance is very small.

**See also:** GMMergeGeometry,
4.2.143  **GMMinSpanCirc** (ms_circ.c:65)

```c
int GMMinSpanCirc(IrtE2PtStruct *DTPts,
                  int NumOfPoints,
                  IrtE2PtStruct *Center,
                  IrtRType *Radius)
```

**DTPts**: The set of point to compute their MSC.
**NumOfPoints**: Number of points in set DTPts.
**Center**: Of computed MSC.
**Radius**: Of computed MSC.

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: Minimum spanning circle (MSC) computation of a set of points. Algorithm is based on Section 4.7 of "Computational Geometry, Algorithms and Applications" by M. de Berg et. al.

**See also**: GMMinSpanCone,

4.2.144  **GMMinSpanCone** (ms_circ.c:284)

```c
int GMMinSpanCone(IrtVecType *DTVecs,
                   int VecsNormalized,
                   int NumOfVecs,
                   IrtVecType ConeAxis,
                   IrtRType *ConeAngle)
```

**DTVecs**: The set of vectors to compute their MSC.
**VecsNormalized**: TRUE if vectors are normalized, FALSE otherwise.
**NumOfVecs**: Number of vectors in set DTVecs.
**ConeAxis**: Of computed MSC.
**ConeAngle**: Of computed MSC, in radians.

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: Minimum spanning cone (MSC) computation of a set of vectors. Algorithm is based on the Minimum Spanning Circle in Section 4.7 of "Computational Geometry, Algorithms and Applications" by M. de Berg et. al.

**See also**: GMMinSpanCirc, GMMinSpanConeAvg,

4.2.145  **GMMinSpanConeAvg** (ms_circ.c:215)

```c
int GMMinSpanConeAvg(IrtVecType *DTVecs,
                      int VecsNormalized,
                      int NumOfVecs,
                      IrtVecType ConeAxis,
                      IrtRType *ConeAngle)
```

**DTVecs**: The set of vectors to compute their MSC.
**VecsNormalized**: TRUE if vectors are normalized, FALSE otherwise.
**NumOfVecs**: Number of vectors in set DTVecs.
**ConeAxis**: Of computed MSC.
**ConeAngle**: Of computed MSC, in radians.

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: Minimum spanning cone (MSC) computation of a set of vectors. Find a central vector as the average of all given vectors and find the vector with maximal angular distance from it.

**See also**: GMMinSpanCirc, GMMinSpanCone,
4.2.146 GMMinSpanSphere (mspher.c:60)

int GMMinSpanSphere(IrtE3PtStruct *DTPts,
                     int NumOfPoints,
                     IrtE3PtStruct *Center,
                     IrtRType *Radius)

DTPts: The set of point to compute their MSS.
NumOfPoints: Number of points in set DTPts.
Center: Of computed MSS.
Radius: Of computed MSS.
Returns: TRUE if successful, FALSE otherwise.

Description: Minimum spanning sphere (MSS) computation of a set of points.
See also: GMMinSpanCirc,

4.2.147 GMMonotonePolyConvex (cnvxhull.c:332)

int GMMonotonePolyConvex(IPVertexStruct *VHead, int Cnvx)

VHead: An X-monotone polyline to make into a convex (concave) one. Note the first and last vertices will always be in the output sequence.
Cnvx: TRUE to make the vertex sequence Vhead convex, FALSE to make it concave, in the functional sense.
Returns: TRUE if succesful, FALSE otherwise.

Description: Compute the convex (concave) envelope of an X-monotone shape, in the XY plane, by purging all concave (convex) vertices in the sequence, in place.
See also: GMConvexHull,

4.2.148 GMOrthogonalVector (geombsc.c:298)

int GMOrthogonalVector(const IrtVecType V, IrtVecType OV, int UnitLen)

V: Input vector to find an orthogonal vector for.
OV: Output newly computed orthogonal (possibly unit) vector to V, in \( \mathbb{R}^3 \).
UnitLen: If TRUE, normalize the output vector.
Returns: TRUE if successful, FALSE otherwise.

Description: Computes an orthogonal vector in \( \mathbb{R}^3 \) to the given vector.

4.2.149 GMPICrvtrSetCurvatureAttr (plycrvtr.c:54)

void GMPICrvtrSetCurvatureAttr(IPPolygonStruct *PolyList,
                               int NumOfRings,
                               int EstimateNrmls)

PolyList: The triangular two-manifold mesh data.
NumOfRings: Number of rings around a vertex in the paraboloid fitting.
EstimateNrmls: If TRUE estimate normals to the vertices on the fly. This functions needs these normals for its proper work.
Returns: void

Description: Estimates the Gaussian and Mean curvature values for the given triangular regular mesh and initializes the corresponding attributes: for each vertex: "K1Curv", "K2Curv", "D1", "D2" and "K" and "H". Uses a least squares osculating quadratic function in the estimate. Mesh is assumed to be a triangular regular mesh.
See also: GMPICrvtrSetFitDegree, SymbEvalSrfCurvPrep, SymbEvalSrfCurvature,
4.2.150  **GMPlCrvtrSetFitDegree** (plycrvtr.c:311)

```c
int GMPlCrvtrSetFitDegree(int UseCubic)

UseCubic: TRUE to use cubic fit, FALSE for a quadratic
Returns: Old value of fitting degree.
Description: Sets the degree for the continuous function we fit at the vertex.
See also: GMPlCrvtrSetCurvatureAttr,
```

4.2.151  **GMPlSilImportanceAttr** (plyimprt.c:34)

```c
void GMPlSilImportanceAttr(IPPolygonStruct *PolyList)

PolyList: The triangular two-manifold mesh data.
Returns: void
Description: Estimates the importance of vertices of a polygonal mesh based on the probability of their adjacent edges to possess silhouettes. Mesh is assumed to be a triangular regular mesh. Each vertex in the mesh is assigned a new "SilImp" attribute which is a positive value.
See also: GMPlCrvtrSetCurvatureAttr,
```

4.2.152  **GMPlSilImportanceRange** (plyimprt.c:242)

```c
IPPolygonStruct *GMPlSilImportanceRange(IPPolygonStruct *PolyList)

PolyList: The triangular two-manifold mesh data.
Returns: the extracted geometry.
Description: Extract the silhouette importance range of a polygonal mesh with "SilImp" attribute. See also GMPlSilImportanceAttr. Mesh is assumed to be a triangular regular mesh.
See also: GMPlSilImportanceAttr,
```

4.2.153  **GMPlanarVecVecAngle** (geom.bsc.c:180)

```c
IrtRType GMPlanarVecVecAngle(const IrtVecType V1,
                            const IrtVecType V2,
                            int Normalize)

V1, V2: Planar vectors to compute their relative angle, in degrees.
Normalize: TRUE if vectors need normalization first, FALSE if unit size.
Returns: Angle between V1 and V2, in degree.
Description: Compute the angle between two planar vectors V1 and V2. Angle is zero if V2 is in the exact same direction as V1, negative if V2 turns right and positive if V2 turns left. Angle is returned in degrees in the domain of (-180, +180]. Only the XY coefficients of V1 and V2 are considered.
```

4.2.154  **GMPlaneFrom3Points** (geom.bsc.c:636)

```c
int GMPlaneFrom3Points(IrtPlnType Plane,
                       const IrtPtType Pt1,
                       const IrtPtType Pt2,
                       const IrtPtType Pt3)

Plane: To compute.
Pt1, Pt2, Pt3: Three points to fit a plane through.
Returns: TRUE if successful, FALSE otherwise.
Description: Routine to construct the plane from given 3 points. If two of the points are the same or the three points are collinear it returns FALSE, otherwise (successful), it returns TRUE.
```
4.2.155  GMPointCoverOfPolyObj  (poly_cv.c:42)

IPObjectStruct *GMPointCoverOfPolyObj(IPObjectStruct *PolyObj,
    int n,
    IrtRType *Dir,
    char *PlAttr)

PolyObj: Object to compute a uniform point distribution on.
 n: Number of points to distribute (estimate).
 Dir: If given - use it as view dependent uniform distribution. Note that if Dir != NULL less than n points will
 be generated.
 PlAttr: If not NULL, the created points are placed as attributes named PlAttr in each polygon in the return
 (copied) model.

Returns: A point list object.

Description: Computes a uniform distribution of points on a polygonal object. If an "Imprt" attribute is found
in a polygon then it is used to weigh the importance of this polygon and hence the number of points that will be
allocated to (on) it.

4.2.156  GMPointCoverOfUnitHemiSphere  (sph_pts.c:30)

IPObjectStruct *GMPointCoverOfUnitHemiSphere(IrtRType HoneyCombSize)

HoneyCombSize: Size of honey comb.

Returns: A point list object.

Description: Computes a honey comb distribution of points on a sphere. Result is an approximation.

4.2.157  GMPointFrom3Planes  (geom_bsc.c:1047)

int GMPointFrom3Planes(const IrtPlnType Pl1,
    const IrtPlnType Pl2,
    const IrtPlnType Pl3,
    IrtPtType Pt)

Pl1, Pl2, Pl3: Three planes to consider.
 Pt: Intersection point found (if any).

Returns: TRUE if exists an intersection point, FALSE otherwise.

Description: Find the intersection point (if exists) of three planes.

4.2.158  GMPointFromLinePlane  (geom_bsc.c:866)

int GMPointFromLinePlane(const IrtPtType Pl,
    const IrtPtType Vl,
    const IrtPlnType Plane,
    IrtPtType InterPoint,
    IrtRType *t)

Pl, Vl: Position and direction that defines the line.
 Plane: To find the intersection with the line.
 InterPoint: Where the intersection occurred.
 t: Parameter along the line of the intersection location (as Pl + Vl * t).

Returns: TRUE, if successful.

Description: Routine to find the intersection point of a line and a plane (if any). The Plane is prescribed using
four coefficients : Ax + By + Cz + D = 0 given as four elements vector. The line is define via a point on it Pl and
a direction vector Vl. Returns TRUE only if such point exists.
4.2.159 GMPointFromLinePlane01 (geom_bsc.c:919)

```c
int GMPointFromLinePlane01(const IrtPtType Pl,
const IrtPtType Vl,
const IrtPlnType Plane,
IrtPtType InterPoint,
IrtRType *t)
```

- **Pl, Vl:** Position and direction that defines the line.
- **Plane:** To find the intersection with the line.
- **InterPoint:** Where the intersection occurred.
- **t:** Parameter along the line of the intersection location (as Pl + Vl * t).

**Returns:** TRUE, if successful and t between zero and one.

**Description:** Routine to find the intersection point of a line and a plane (if any). The Plane is prescribed using four coefficients : \( Ax + By + Cz + D = 0 \) given as four elements vector. The line is define via a point on it Pl and a direction vector Vl. Returns TRUE only if such point exists. this routine accepts solutions only for t between zero and one.

4.2.160 GMPointFromPointLine (geom_bsc.c:689)

```c
IrtRType GMPointFromPointLine(const IrtPtType Point,
const IrtPtType Pl,
const IrtPtType Vl,
IrtPtType ClosestPoint)
```

- **Point:** To find the closest to on the line.
- **Pl, Vl:** Position and direction that defines the line. Vl need not be a unit length vector.
- **ClosestPoint:** Where closest point found on the line is to be saved.

**Returns:** Parameter along the line where if the closest point is Pl equal zero and if closest point is Pl + Vl equal one. In other words, the closest point is on the finite line segment for return value in \([0, 1]\).

**Description:** Routine to compute the closest point on a given 3d line to a given 3d point. The line is prescribed using a point on it (Pl) and vector (Vl).

See also: MvarPointFromPointLine,

4.2.161 GMPointFromPointPlane (geom_bsc.c:815)

```c
int GMPointFromPointPlane(const IrtPtType Pt,
const IrtPlnType Plane,
IrtPtType ClosestPoint)
```

- **Pt:** Point to find closest point on Plane to.
- **Plane:** To find the closest point on to Pt.
- **ClosestPoint:** Where the closest point on Plane to Pt is.

**Returns:** TRUE, if successful.

**Description:** Routine to compute the closest point on a given plane to a given 3d point. The Plane is prescribed using four coefficients : \( Ax + By + Cz + D = 0 \) given as four elements vector.

4.2.162 GMPointInsideCnvxPolygon (geomat3d.c:1396)

```c
int GMPointInsideCnvxPolygon(const IrtPtType Pt,
const IPPolygonStruct *Pl)
```

- **Pt:** Point to test for inclusion in convex polygon Pl. Pt is assumed to be on the plane holding polygon Pl.
- **Pl:** Convex polygon to test for inclusion of Pt.

**Returns:** TRUE if Pt is inside Polygon Pl, FALSE otherwise.

**Description:** Test if a given points is contained in the given convex polygon.

See also: GMPointOnPolygonBndry,
4.2.163 GMPointOnPolygonBndry (geomat3d.c:1445)

```c
int GMPointOnPolygonBndry(const IrtPtType Pt,
const IPPolygonStruct *Pl,
IrtRType Eps)
```

**Pt:** Point to test for inclusion in the boundary of polygon Pl. Pt is assumed to be on the plane holding polygon Pl.

**Pl:** Polygon to test for inclusion of Pt.

**Eps:** Maximal distance from the boundary to be considered on boundary.

**Returns:** TRUE if Pt is on the boundary of Polygon Pl, FALSE otherwise.

**Description:** Test if a given points is on the boundary of the given polygon.

See also: GMPointInsideCnvxPolygon,

4.2.164 GMPointVecFromLine (geom_bsc.c:600)

```c
void GMPointVecFromLine(const IrtLnType Line, IrtPtType Pt, IrtVecType Dir)
```

**Line:** To extract and point and a direction for.

**Pt:** A point on line Line.

**Dir:** The direction of line Line.

**Returns:** void

**Description:** Computes a point on and the direction of the given line.

4.2.165 GMPolyAdjacncyFree (plystrct.c:397)

```c
void GMPolyAdjacncyFree(VoidPtr PolyAdj)
```

**PolyAdj:** Data struct to free, as constructed by GMPolyAdjacncyGen.

**Returns:** void

**Description:** Free the adjacency data structure associated with a polygonal model.

See also: GMPolyAdjacncyGen, GMPolyAdjacncyVertex,

4.2.166 GMPolyAdjacncyGen (plystrct.c:175)

```c
VoidPtr GMPolyAdjacncyGen(IPObjectStruct *PObj, IrtRType EqlEps)
```

**PObj:** A polygonal mesh to compute adjacency information for.

**EqlEps:** Epsilon for point equality.

**Returns:** A reference to the data structure holding the adjacency info.

**Description:** Constructs an adjacency information data structure for the given polygonal mesh in GMPolyAdj- jStruct: VList: A list of vertices and for each all edges using the vertex. EList: A list of edges, each referencing the two vertices using it. PObj: A reference to the original model.

See also: GMPolyAdjacncyVertex, GMPolyAdjacncyFree,
4.2.167 GMPolyAdjacncyVertex (plystruct.c:336)

void GMPolyAdjacncyVertex(IPVertexStruct *V,
VoidPtr PolyAdj,
GMPolyAdjacncyVertexFuncType AdjVertexFunc)

V: Vertex to find all edges that share it.
PolyAdj: Data struct to use, as constructed by GMPolyAdjacncyGen.
AdjVertexFunc: Call be function to invoke on every edge.
Returns: void

Description: Get the adjacency information of a vertex - all the edges that share it. Invokes the given call back function on all edges.
See also: GMPolyAdjacncyGen, GMPolyAdjacncyFree,

4.2.168 GMPolyCentroid (geomvals.c:70)

int GMPolyCentroid(const IPPolygonStruct *Pl, IrtPtType Centroid)

Pl: The poly to compute its centroid.
Centroid: Computed center point. Note it can be outside Pl!
Returns: TRUE if at least one vertex in input Pl, FALSE otherwise.

Description: Computes the centroid of a poly, as an average of all input vertices.
See also: GMComputeAverageVertex,

4.2.169 GMPolyHierarchy2SimplePoly (geom_bsc.c:1994)

IPPolygonStruct *GMPolyHierarchy2SimplePoly(IPPolygonStruct *Root,
IPPolygonStruct *Islands)

Root: The top most, outer polygon.
Islands: Interior islands to connected with root into one simply poly.
Returns: Merged poly.

Description: Converts a root polygons with islands into a closed, simple, polygon. Interior islands are all connected into the root, outer, polygon. The outer, root, loop is assumed to be oriented in opposite direction to the islands.

4.2.170 GMPolyLength (geomvals.c:37)

IrtRType GMPolyLength(const IPPolygonStruct *Pl)

Pl: The poly to compute its length.
Returns: The length of the poly(line).

Description: Computes the lengths of a poly, first vertex to last vertex.
4.2.171 GMPolyMeshSmoothing (polysmth.c:61)

IPObjectStruct *GMPolyMeshSmoothing(IPObjectStruct *PolyObj, 
const IPPolygonStruct *VerticesToRound, 
int AllowBndryRound, 
IrtRType RoundingRadius, 
int NumIters, 
IrtRType BlendFactor)

PolyObj: Polygonal object to smooth, in place.
VerticesToRound: If not NULL, only vertices found in VerticesToRound are allowed to move and all other vertices are kept stationary. Overwrites AllowBndryRound status, if not NULL.
AllowBndryRound: If TRUE, allow the boundary to move. If FALSE, boundary is constrained to be fixed. Can take affect only if VerticesToRound is NULL.
RoundingRadius: If we have a restriction on the movable vertices (either VerticesToRound is not NULL or AllowBndryRound is FALSE) and RoundingRadius is positive, any other vertex that is at a Euclidean distance of less than RoundingRadius from a restricted (AllowBndryRound = FALSE) or movable (in VerticesToRound) vertex will also be tagged as such.
NumIters: Number of times to perform this smoothing algorithm.
BlendFactor: 1.0 to move the vertex all the way to average position. Otherwise, (less than 1.0) to the proper fraction.
Returns: The smoothed out polygons, in place. Same as PolyObj.
Description: Move designated Vertices (that are typically not on the boundary) of the polygons in PolyObj to new (averages of their 1-rings) positions, smoothing the shape of the mesh.

4.2.172 GMPolyObjectArea (geomvals.c:151)

double GMPolyObjectArea(const IPObjectStruct *PObj)

PObj: A polyhedra object to compute its surface area.
Returns: The area of object PObj.
Description: Routine to evaluate the Area of the given geom. object, in object unit.
Algorithm (for each polygon):
1. Set Polygon Area to be zero.
2. Let V(0) be the first vertex, V(n) the last one.
3. For i goes from 0 to n-1 add to Area the area below edge V(i), V(i+1): V0 V1
4. The result of step 2 is the area of the polygon itself.
5. However, it might be negative, so take the absolute result of step 2 and add it to the global ObjectArea.

Note step 2 is performed by another auxiliary routine: PolygonXYArea.
See also: GMPolyOnePolyArea, GMPolyObjectAreaSetSigned,

4.2.173 GMPolyObjectAreaSetSigned (geomvals.c:111)

int GMPolyObjectAreaSetSigned(int SignedArea)

SignedArea: TRUE for signed area, FALSE for always positive area.
Returns: Previous state of signed area.
Description: Set the computed area of polys to be signed or not. If signed, clockwise (CW) polygons in the XY plane will have positive sign, & negative if CCW. For polygon is in general position, CW and CCW are not well defined.
See also: GMPolyObjectArea, GMPolyOnePolyArea,
**4.2.174 GMPolyObjectVolume** (geomvals.c:306)

```c
double GMPolyObjectVolume(IPObjectStruct *PObj)
```

**PObj:** To compute volume for.

**Returns:** Computed volume.

**Description:** Routine to evaluate the Volume of the given geom object, in object unit. This routine has a side effect that all non-convex polygons will be splitted to convex ones. Algorithm (for each polygon, and let ObjMinY be the minimum OBJECT Y):

1. Set Polygon Area to be zero.  
   Let V(0) be the first vertex, V(n) the last.  
   For i goes from 1 to n-1 form triangles  
   by V(0), V(i), V(i+1).  
   For each such triangle di:
   1.1. Find the vertex (out of V(0), V(i), V(i+1)) with the minimum Z - TriMinY.
   1.2. The volume below V(0), V(i), V(i+1) triangle, relative to ObjMinZ level, is the sum of:
      1.2.1. volume of V'(0), V'(i), V'(i+1) - the area of projection of V(0), V(i), V(i+1) on XY parallel plane, times (TriMinZ - ObjMinZ).
      1.2.2. Assume V(0) is the one with the PolyMinZ. Let V"(i) and V"(i+1) be the projections of V(i) and V(i+1) on the plane Z = PolyZMin. The volume above 1.2.1. and below the polygon (triangle!) will be: the area of quadraliteral V(i), V(i+1), V"(i+1), V"(i), times distance of V(0) for quadraliteral plane divided by 3.
   1.3. If Z component of polygon normal is negative add 1.2. result to ObjectVolume, else subtract it.

**4.2.175 GMPolyOffset** (polyofst.c:83)

```c
IPPolygonStruct *GMPolyOffset(const IPPolygonStruct *Poly,
   int IsPolygon,
   IrtRType Ofst,
   GMPolyOffsetAmountFuncType AmountFunc)
```

**Poly:** To compute its offset in the XY plane.

**IsPolygon:** TRUE for a polygon, FALSE for a polyline.

**Ofst:** Amount of offset.

**AmountFunc:** Scale the offset amount according to this function. A NULL here will use a constant scaling factor of one.

**Returns:** Offset of Poly by Ofst amount.

**Description:** Computes the offset of a given polygon/line in the XY plane by Ofst.

**See also:** GMPolyOffsetAmountDepth, GMPolyOffset3D.

**4.2.176 GMPolyOffset3D** (polyofst.c:182)

```c
IPPolygonStruct *GMPolyOffset3D(const IPPolygonStruct *Poly,
   IrtRType Ofst,
   int ForceSmoothing,
   GMPolyOffsetAmountFuncType AmountFunc)
```

**Poly:** To compute its offset in R^3.

**Ofst:** Amount of offset.

**ForceSmoothing:** True to force normal smoothing.
MiterEdges: Positive to properly handle dihedral angle, in which case sets the maximal scale allowed. Zero to disable.

AmountFunc: Scale the offset amount according to this function. A NULL here will use a constant scaling factor of one.

Returns: Offset of Poly by Ofst amount.

Description: Computes the offset of a given polygon object in R^3 by Ofst. Computation is done by moving all vertices in the normal direction by ofst amount. If Poly does not contain vertex normals, they are estimated.

See also: GMPolyOffsetAmountDepth, GMPolyOffset,

4.2.177 GMPolyOffsetAmountDepth (polyofst.c:55)

IrtRType GMPolyOffsetAmountDepth(const IrtRType *Coord)

Coord: Of point as XYZ values.

Returns: scaling factor of offset amount.

Description: Sets the offset amount to be a function of the depth Z value by scaling with 1/Z.

See also: GMPolyOffset,

4.2.178 GMPolyOnePolyArea (geomvals.c:186)

double GMPolyOnePolyArea(const IPPolygonStruct *Pl)

Pl: To compute its area.

Returns: area of polygon Pl

Description: Computes the area of a single polygon.

See also: GMPolyObjectArea, GMPolyObjectAreaSetSigned,

4.2.179 GMPolyPlaneClassify (geombsc.c:1484)

IrtRType GMPolyPlaneClassify(const IPPolygonStruct *Pl, const IrtPlnType Pln)

Pl: Polygon to consider and classify.
Pln: Plane to classify against.

Returns: Positive or negative, classifying the polygon’s side.

Description: Classify a plane as (mostly) on the positive side of the plane, returning a positive value, or (mostly) on the negative side of the plane, returning a negative value.

4.2.180 GMPolyPropFetch (polyprop.c:290)

IPPolygonStruct *GMPolyPropFetch(IPPolygonStruct *Pls,
        GMFetchVertexPropertyFuncType VertexProperty,
        IrtRType ConstVal)

Pls: The polygons to process the constant value property for. Assumed to hold triangles only.
VertexProperty: A call back function to return the desired property for the invoked vertex.
ConstVal: Constant value of property sought.

Returns: List of polylines on the polygons for which the property assumes the value ConstVal.

Description: Computes the constant value over a polygonal model by processing each polygons for edges that the values of the property are begin crossed. The input polygonal model is assumed to hold triangles only.

See also: GMPolyPropFetchIsophotes, GMPolyPropFetchCurvature, , GMFetchVertexPropertyFuncType,
4.2.181 GMPolyPropFetchAttribute (polyprop.c:92)

IPPolygonStruct *GMPolyPropFetchAttribute(IPPolygonStruct *Pls,
 const char *PropAttr,
 IrtRType Value)

Pls: The polygons to process the constant value property for. Assumed to hold triangles only.
PropAttr: Name of attribute to extract.
Value: Value of property to seek.

Returns: List of polylines on the polygons along the requested property value.

Description: A function to derive curves over a polygonal model, Pls, based on given prescribed attribute
PropAttr.
See also: GMPolyPropFetchIsophotes, GMPolyPropFetchCurvature,

4.2.182 GMPolyPropFetchCurvature (polyprop.c:217)

IPPolygonStruct *GMPolyPropFetchCurvature(IPPolygonStruct *Pls,
 int CurvatureProperty,
 int NumOfRings,
 IrtRType CrvtrVal)

Pls: The polygons to process the constant value property for. Assumed to hold triangles only.
CurvatureProperty: 0 for Gaussian curvature, 1 for Mean curvature.
NumOfRings: In the paraboloid fit estimation, usually 1-2.
CrvtrVal: Value of curvature property to seek.

Returns: List of polylines on the polygons along the requested curvature lines.

Description: A function to derive isophotes for a polygonal model, Pls.
See also: GMPolyPropFetchIsophotes, GMPolyPropFetchAttribute,

4.2.183 GMPolyPropFetchIsophotes (polyprop.c:146)

IPPolygonStruct *GMPolyPropFetchIsophotes(IPPolygonStruct *Pls,
 const IrtVecType ViewDir,
 IrtRType InclinationAngle)

Pls: The polygons to process the constant value property for. Assumed to hold triangles only.
ViewDir: Direction of view.
InclinationAngle: In degrees to consider the isophotes for. 90 degrees would yield regular silhouettes viewed
from LightDir.

Returns: List of polylines on the polygons along the requested isophotes.

Description: A function to derive isophotes for a polygonal model, Pls.
See also: GMPolyPropFetchCurvature, GMPolyPropFetchAttribute,

4.2.184 GMPolygonPlaneInter (geom_bsc.c:1346)

int GMPolygonPlaneInter(const IPPolygonStruct *Pl,
 const IrtPlnType Pln,
 IrtRType *MinDist)

Pl: Polygon to test if intereses plane Pln.
Pln: Plane to examine if polygon Pl intersects. Assumed normalized normal vector in Pln.
MinDist: Returns closest vertex in Pl to Pln.

Returns: TRUE if intersects, FALSE otherwise.

Description: Test if the given polygon intersects the given plane.
See also: GMPolygonRayInter, GMSplitPolygonAtPlane,
4.2.185 GMPolygonPointInclusion (geom_bsc.c:1560)

int GMPolygonPointInclusion(const IPPolygonStruct *Pl, const IrtPtType Pt)

Pl: Polygon to test if Pt is in it.
Pt: Point to test for inclusion in Pl.
Returns: TRUE if Pt inside Pl, FALSE otherwise.
Description: Routine to check if a point is inside a polygon, in the XY plane. Uses winding number accumulation in the computation.
See also: GMPolygonPointInclusion3D, GMPolygonPlaneInter, GMPolygonRayInter,

4.2.186 GMPolygonPointInclusion3D (geom_bsc.c:1687)

int GMPolygonPointInclusion3D(const IPPolygonStruct *Pl, const IrtPtType Pt)

Pl: Polyhedra in 3D to test if Pt is in it.
Pt: Point to test for inclusion in Pl.
Returns: TRUE if Pt inside Pl, FALSE otherwise.
Description: Routine to check if a point is inside a polyhedra in 3D. Computes the accumulated Gaussian sphere area deviation of Pt-vertices over all triangles in the given Pl model, with respect to given point Pt. Each angular deviation of each triangle is measured as area of spherical triangle over the Gaussian sphere, formed from its three Pt-vertices dirs. A point is inside a simple closed polyhedra if the sum is +/-4 Pi, zero if the point is outside.
See also: GMPolygonPointInclusion, GMPolygonPlaneInter, GMPolygonRayInter, GMAreaSphericalTriangle,

4.2.187 GMPolygonRayInter (geom_bsc.c:1740)

int GMPolygonRayInter(const IPPolygonStruct *Pl, const IrtPtType PtRay, int RayAxes)

Pl: To compute "Jordan Theorem" for the given ray. Can be either a polygon or a closed polyline (first and last points of polyline are equal).
PtRay: Origin of ray.
RayAxes: Direction of ray. 0 for X, 1 for Y, etc.
Returns: Number of intersections of ray with the polygon.
Description: Routine that implements "Jordan Theorem". Same as GMPolygonRayInter2 but does not return the first intersection info.
See also: GMPolygonPlaneInter, GMPolygonPointInclusion, GMSplitPolygonAtPlane,

4.2.188 GMPolygonRayInter2 (geom_bsc.c:1812)

int GMPolygonRayInter2(const IPPolygonStruct *Pl, const IrtPtType PtRay, int RayAxes, IPVertexStruct **FirstInterV, IrtRType *FirstInterP, IrtRType *AllInters)

Pl: To compute "Jordan Theorem" for the given ray. Can be either a polygon or a closed polyline (first and last points of polyline are equal).
PtRay: Origin of ray.
RayAxes: Direction of ray. 0 for X, 1 for Y, etc.
FirstInterV: OUT - First intersection edge, between V and VNext.
FirstInterP: OUT - First intersection location, blending V and VNext.
**AllInters:** OUT - if not NULL, will be updated with a vector of all intersection locations. First entry must hold number of elements in this vector.

**Returns:** Number of intersections of ray with the polygon.

**Description:** Routine that implements "Jordan Theorem": Fire a ray from a given point and find the number of intersections of a ray with the polygon, excluding the given point Pt (start of ray) itself, if on polygon boundary. The ray is fired in +X (Axes == 0) or +Y if (Axes == 1). Only the X/Y coordinates of the polygon are taken into account, i.e. the orthogonal projection of the polygon on an X/Y parallel plane (equal to polygon itself if on X/Y parallel plane...). Note that if the point is on polygon boundary, the ray should not be in its edge direction.

**Algorithm:**
1. 1.1. Set NumOfIntersection = 0;
   1.2. Find vertex V not on Ray level and set AlgState to its level (below or above the ray level). If none goto 3;
   1.3. Mark VStart = V;
2. Do
   2.1. While State(V) == AlgState do
       2.1.1. V = V -> Pnext;
       2.1.2. If V == VStart goto 3;
   2.2. IntersectionMinX = IRIT_INFNTY;
   2.3. While State(V) == ONRAY do
       2.3.1. IntersectionMin = IRIT_MIN(IntersectionMin, V -> Coord[Axes]);
       2.3.2. V = V -> Pnext;
   2.4. If State(V) != AlgState do
       2.4.1. Find the intersection point between polygon edge VLast, V and the Ray and update IntersectionMin if lower than it.
       2.4.2. If IntersectionMin is greater than Pt[Axes] increase the NumOfIntersection counter by 1.
   2.5. AlgState = State(V);
   2.6. goto 2.2.
3. Return NumOfIntersection;

**See also:** GMPolygonPlaneInter, GMSplitPolygonAtPlane,

4.2.189 GMPolygonRayInter3D (geom_bsc.c:1943)

```c
int GMPolygonRayInter3D(const IPPolygonStruct *Pl,
const IrtPtType PtRay,
int RayAxes)
```

**Pl:** To compute "Jordan Theorem" for the given ray.

**PtRay:** Origin of ray.

**RayAxes:** Direction of ray. 0 for X, 1 for Y, etc.

**Returns:** Number of intersections of ray with the polygon.

**Description:** Same as GMPolygonRayInter but for arbitrary oriented polygon. The polygon is transformed into the XY plane and then GMPolygonRayInter is invoked on it.

4.2.190 GMPolygonalMorphosis (pt_morph.c:32)

```c
IPPolygonStruct *GMPolygonalMorphosis(const IPPolygonStruct *Pl1,
const IPPolygonStruct *Pl2,
IrtRType t)
```

**Pl1, Pl2:** The two polygonal object to meta-morph.

**t:** Linear blending factor: (1-t) * Pl1 + t * Pl2.

**Returns:** Blended polyhedra.

**Description:** Computes a blend of the given two polyhedra as 't Pl1 + (1-t) Pl2'. The two polyhedra are assumed to be of the same topology: same number of (ordered) polygons and same number of vertices in each corresponding polygon.
4.2.191  GMQuatAdd (quatrn.n.c:231)

void GMQuatAdd(GMQuatType q1, GMQuatType q2, GMQuatType QRes)

   q1: Left quaternion.
   q2: Right quaternion.
   QRes: Result quaternion.
   Returns: void
   Description: Adds two quaternions.
   See also: GMQuatMatToQuat,

4.2.192  GMQuatExp (quatrn.n.c:418)

void GMQuatExp(IrtVecType SrcVec, GMQuatType DstQ)

   SrcVec: Source vector.
   DstQ: Destination (result) quaternion.
   Returns: void
   Description: Calculates the exponent quaternion of a vector.
   See also: GMQuatLog,

4.2.193  GMQuatInverse (quatrn.n.c:315)

void GMQuatInverse(GMQuatType SrcQ, GMQuatType DstQ)

   SrcQ: Source quaternion.
   DstQ: Destination inversed quaternion.
   Returns: void
   Description: Creates q^{-1} from a quaternion.
   See also: GMQuatNormalize, GMQuatMatToQuat, GMQuatIsUnitQuat,

4.2.194  GMQuatIsUnitQuat (quatrn.n.c:257)

int GMQuatIsUnitQuat(GMQuatType q)

   q: Tested quaternion.
   Returns: Non-zero if TRUE.
   Description: Checks if a given quaternion is of unit magnitude.
   See also: GMQuatMatToQuat, GMQuatNormalize,

4.2.195  GMQuatLog (quatrn.n.c:382)

void GMQuatLog(GMQuatType SrcQ, IrtVecType DstVec)

   SrcQ: Source quaternion.
   DstVec: Destination (result) vector.
   Returns: void
   Description: Calculates the logarithm of a quaternion.
   See also: GMQuatExp,
4.2.196   GMQuatMatToQuat  (quatrnn.c:85)

void GMQuatMatToQuat(IrtHmgnMatType Mat, GMQuatType q)

    Mat: Source matrix.
    q: Destination quaternion.

    Returns: void

    Description: Transforms a matrix to a quaternion.
    See also: GMQuatToMat,

4.2.197   GMQuatMatrixToAngles  (quatrnn.c:561)

int GMQuatMatrixToAngles(IrtHmgnMatType Mat, IrtVecType *Vec)

    Mat: Source rotation matrix.
    Vec: Destination angles vectors (up to 8).

    Returns: The number of possible solutions (0 = no solution).

    Description: Calculates the angle of rotation in each axis, from a given rotation matrix. The rotation, being axis-dependant, must be performed in a predefined order: rotate by X, then by Y and finally by Z. A rotation angle in the X-Y-Z order looks like this:

\[
\begin{array}{cccc}
  c2*c3 & c2*s3 & -s2 & 0 \\
  s1*s2*c3 - c1*s3 & s1*s2*s3 + c1*c3 & s1*c2 & 0 \\
  c1*s2*c3 + s1*s3 & c1*s2*s3 - s1*c3 & c1*c2 & 0 \\
  0 & 0 & 0 & 1 \\
\end{array}
\]

where c1 = cos x, c2 = cos y, c3 = cos z
s1 = sin x, s2 = sin y, s3 = sin z

This is compared to our matrix:

\[
\begin{array}{cccc}
  a & b & c & 0 \\
  d & e & f & 0 \\
  g & h & i & 0 \\
  0 & 0 & 0 & 1 \\
\end{array}
\]

See also: GMQuatMatrixToScale, GMQuatMatrixToTranslation,

4.2.198   GMQuatMatrixToScale  (quatrnn.c:653)

IrtRType GMQuatMatrixToScale(IrtHmgnMatType Mat)

    Mat: Source transformation matrix.

    Returns: The uniform scale factor result.

    Description: Extract the uniform scale factor from a given transformation matrix.
    See also: GMQuatMatrixToAngles, GMQuatMatrixToTranslation,
4.2.199  GMQuatMatrixToTranslation  (quatrnn.c:630)

void GMQuatMatrixToTranslation(IrtHmgnMatType Mat, IrtVecType Vec)

Mat:  Source transformation matrix.
Vec:  Destination translation vector.

Returns:  void

Description:  Extract the translation vector from a given transformation matrix.
See also:  GMQuatMatrixToScale, GMQuatRotMatrixToAngles,

4.2.200  GMQuatMatrixToVector  (quatrnn.c:696)

int GMQuatMatrixToVector(IrtHmgnMatType Mat, GMQuatTransVecType TransVec)

Mat:  Source transformation matrix.
TransVec:  The result transformation parameters vector.

Returns:  TRUE only if the input matrix is a transformation matrix.

Description:  Extract the transformation parameters vector from a given transformation matrix.
A transformation vector contains the rotation angles in all 3 axis, the translation in all 3 axis and a uniform scaling
factor.
Since there are many ways to combine these parameters, we chose the following order:  To create a transformation
matrix out of a transformation vector - first create a rotation matrix (rotate by X then by Y and then by Z), then
create a uniform scaling matrix and finally create a translation matrix.
Apply rotation, then scale and finally translation to obtain the original transformation matrix.
To create a transformation vector out of a transformation matrix, we simply do it all in reverse : extract and cancel
transformation effects, extract and cancel scaling effects and then extract rotation effects.
See also:  GMQuatMatrixToScale, GMQuatMatrixToTranslation, GMQuatMatrixToAngles,

4.2.201  GMQuatMul  (quatrnn.c:202)

void GMQuatMul(GMQuatType q1, GMQuatType q2, GMQuatType QRes)

q1:  Left quaternion.
q2:  Right quaternion.
QRes:  Result quaternion.

Returns:  void

Description:  Multiplies two quaternions. Order of arguments counts.
See also:  GMQuatMatToQuat,

4.2.202  GMQuatNormalize  (quatrnn.c:279)

void GMQuatNormalize(GMQuatType q)

q:  quaternion.

Returns:  void

Description:  Normalizes a quaternion into a unit size quaternion (as a 4 vector)
See also:  GMQuatIsUnitQuat, GMQuatInverse, GMQuatIsUnitQuat,
4.2.203  GMQuatPow (quatnn.c:455)

void GMQuatPow(GMQuatType MantisQ, IrtRType Expon, GMQuatType DstQ)

  MantisQ: Mantisa quaternion.
  Expon: Real exponent.
  DstQ: Destination (result) quaternion.
  Returns: void

Description: Calculates the quaternion to the power of a real exponent.
See also: GMQuatLog, GMQuatExp,

4.2.204  GMQuatRotateVec (quatnn.c:345)

void GMQuatRotateVec(IrtVecType OrigVec, GMQuatType RotQ, IrtVecType DestVec)

  OrigVec: Original (source) vector.
  RotQ: Rotation quaternion.
  DestVec: Destination (rotated) vector.
  Returns: void

Description: Rotates a vector using a rotation quaternion.
See also: GMQuatMatToQuat,

4.2.205  GMQuatRotationToQuat (quatnn.c:143)

void GMQuatRotationToQuat(IrtRType Xangle,
                         IrtRType Yangle,
                         IrtRType Zangle,
                         GMQuatType q)

  Xangle: Rotation angle around X axis
  Yangle: Rotation angle around Y axis
  Zangle: Rotation angle around Z axis
  q: Destination quaternion.
  Returns: void

Description: Creates a quaternion from an arbitrary rotation in X-Y-Z order.
See also: GMQuatToMat, GMQuatToRotation,

4.2.206  GMQuatToMat (quatnn.c:34)

void GMQuatToMat(GMQuatType q, IrtHmgnMatType Mat)

  q: Source quaternion.
  Mat: Destination matrix.
  Returns: void

Description: Transforms a quaternion to a matrix.
See also: GMQuatMatToQuat, GMQuatNormalize,
4.2.207 GMQuatToRotation (quatrnn.c:175)

void GMQuatToRotation(GMQuatType q, IrtVecType *Angles, int *NumSolutions)

q: Rotation quaternion.
Angles: All possible rotation angles (up to 8).
NumSolutions: Pointer to buffer that holds number of solutions found.
Returns: void

Description: Finds rotation angles in X-Y-Z order from a given quaternion representation.
See also: GMQuatToMat, GMQuatRotationToQuat,

4.2.208 GMQuatVecToRotMatrix (quatrnn.c:827)

void GMQuatVecToRotMatrix(GMQuatTransVecType TransVec, IrtHmgnMatType RotMatrix)

TransVec: The source transformation parameters vector.
RotMatrix: The result rotation matrix.
Returns: void

Description: Extracts a rotation matrix from a transformation parameters vector. The rotation, being axis-
dependant, must be performed in a predefined order: rotate by X, then by Y and finally by Z.
See also: GMQuatVecToTransMatrix, GMQuatVecToScaleMatrix,

4.2.209 GMQuatVecToScaleMatrix (quatrnn.c:798)

void GMQuatVecToScaleMatrix(GMQuatTransVecType TransVec, IrtHmgnMatType ScaleMatrix)

TransVec: The source transformation parameters vector.
ScaleMatrix: The result scale matrix.
Returns: void

Description: Extracts a scale matrix from a transformation parameters vector.
See also: GMQuatVecToRotMatrix, GMQuatVecToTransMatrix,

4.2.210 GMQuatVecToTransMatrix (quatrnn.c:868)

void GMQuatVecToTransMatrix(GMQuatTransVecType TransVec, IrtHmgnMatType TransMatrix)

TransVec: The source transformation parameters vector.
TransMatrix: The result translation matrix.
Returns: void

Description: Extracts a translation matrix from a transformation parameters vector.
See also: GMQuatVecToRotMatrix, GMQuatVecToScaleMatrix,
4.2.211  GMQuatVectorToMatrix  (quatrn.c:765)

void GMQuatVectorToMatrix(GMQuatTransVecType TransVec, IrtHmgnMatType Mat)

   TransVec: The source transformation parameters vector.
   Mat: The result transformation matrix.

   Returns: void

   Description: Converts a transformation parameters vector to a transformation matrix.
A transformation vector contains the rotation angles in all 3 axis, the translation in all 3 axis and a uniform scaling factor.
Since there are many ways to combine these parameters, we chose the following order: To create a transformation matrix out of a transformation vector - first create a rotation matrix (rotate by X, then by Y, and then by Z), then create a uniform scaling matrix and finally create a translation matrix.
Apply rotation, then scale and finally translation to obtain the original transformation matrix.
To create a transformation vector out of a transformation matrix, we simply do it all in reverse: extract and cancel transformation effects, extract and cancel scaling effects and then extract rotation effects.

   See also: GMQuatVecToScaleMatrix, GMQuatVecToRotMatrix, GMQuatVecToTransMatrix,

4.2.212  GMRayCnvxPolygonInter  (geomat3d.c:1499)

int GMRayCnvxPolygonInter(const IrtPtType RayOrigin, const IrtVecType RayDir, const IPPolygonStruct *Pl, IrtPtType InterPoint)

   RayOrigin: Starting point of ray.
   RayDir: Direction of ray.
   Pl: Convex polygon to test against ray for intersection.
   InterPoint: Resulting intersection point.

   Returns: TRUE if successful, FALSE otherwise. *

   Description: Tests if the given ray intersects the given convex polygon.

      See also: GMPointFromLinePlane, GMPointInsideCnvxPolygon,

4.2.213  GMRefineDeformedTriangle  (polypts.c:2248)

int GMRefineDeformedTriangle(IPPolygonStruct *Pl, GMPointDeformVrtxFctFuncType DeformVrtxFctFunc, GMPointDeformVrtxDirFuncType DeformVrtxDirFunc, IrtRType DeviationTol, IrtRType MaxEdgeLen)

   Pl: Triangle to refine if necessary.
   DeformVrtxFctFunc: Function to evaluate the deformation amount factor of a given vertex.
   DeformVrtxDirFunc: Function to evaluate the deformation vector (direction and amount) of a given vertex.
   DeviationTol: Of deformation approximation.
   MaxEdgeLen: to allow in a triangle.

   Returns: TRUE if triangle underwent refinement, FALSE otherwise.

   Description: Given a triangle in some deformation function and a function to evaluate deformation amount per vertex, refine the triangle as necessary to make the deformation be accurate within tolerance Tol. Only the vertices and mid-edge points on triangle are examined. Newly created (refined) triangles are appended in place between Pl and Pl -> Pnext. Note Pl will also be modified in place if refinement occurs.

   See also: GMRefineDeformedTriangle2,
4.2.214 GMRefineDeformedTriangle2 (poly_pts.c:2042)

```c
int GMRefineDeformedTriangle2(IPPolygonStruct *Pl,
    GMPointDeformVertxFctrFuncType DeformVrtxFctrFunc,
    IrtBType Ref12,
    IrtBType Ref23,
    IrtBType Ref31)
```

**Pl:** Triangle to refine if necessary.

**DeformVertxFctrFunc:** Function to evaluate the deformation amount factor of a given vertex.

**Ref12, Ref23, Ref31:** Booleans to set which edge must be refined.

**Returns:** TRUE if triangle underwent refinement, FALSE otherwise.

**Description:** Given a triangle Pl, divide and refine it along the edges as set by Refij. The result can be between one (no refinement) and four (all edges are defined) triangles that are substituted in place in Pl and before Pl -> pnext.

**See also:** GMRefineDeformedTriangle,

4.2.215 GMRegularizePolyModel (poly_pts.c:932)

```c
IPObjectStruct *GMRegularizePolyModel(IPObjectStruct *PObj,
    int SplitCollinear)
```

**PObj:** A polygonal object to regularize.

**SplitCollinear:** TRUE to also split polygons at collinear edges.

**Returns:** Regularized object.

**Description:** Regularize a polygonal model by eliminating all T junction in the polygonal mesh.

4.2.216 GMScanConvertTriangle (scancnv.t.c:33)

```c
void GMScanConvertTriangle(int Pt1[2],
    int Pt2[2],
    int Pt3[2],
    GMScanConvertApplyFuncType ApplyFunc)
```

**Pt1, Pt2, Pt3:** The three coordinates of the triangle.

**ApplyFunc:** The function that will be invoked on every pixel that is visited in this triangle.

**Returns:** void

**Description:** Visits all pixels of the given triangle and invokes ApplyFunc on each such pixel.

4.2.217 GMSilExtractBndry (poly_sil.c:557)

```c
IPObjectStruct *GMSilExtractBndry(IPObjectStruct *PObjReg)
```

**PObjReg:** Object to extract the Boundary.

**Returns:** The Boundary Object.

**Description:** Generates the boundary of the polyhedral object PObjReg, assumed already regularized.

**See also:** GMSilExtractSil, GMSilExtractSilDirect, BoolGenAdjacencies, GMSilExtractDiscont,
4.2.218  GMSilExtractDiscont (poly_sil.c:480)

IPObjectStruct *GMSilExtractDiscont(IPObjectStruct *PObjReg,
         IrtRType MinAngle)

PObjReg: Polyhedral Object to generate the silhouette for.
MinAngle: Minimal dihedral angle between adjacent polygons to consider as discontinuity. In radians.
Returns: Discontinuities Object.
Description: Generates edges along adjacent polygonals with a dihedral angle of more than MinAngle degrees.
See also: GMSilExtractBndry, GMSilExtractSil, GMSilExtractSilDirect2, GMSilExtractSilDirect,

4.2.219  GMSilExtractSil (poly_sil.c:610)

IPObjectStruct *GMSilExtractSil(VoidPtr PrepSils, IrtHmgnMatType ViewMat)

PrepSils: Associated silhouette processing data structure of a polygonal object to generate its silhouettes.
ViewMat: View Matrix.
Returns: Silhouette Object.
Description: Generates the silhouette of an object which has been already preprocessed and is associated with
a grid structure.
See also: GMSilPreprocessPolys, GMSilOrigObjAlive, GMSilExtractSilDirect, , GMSilExtractSilDirect2,

4.2.220  GMSilExtractSilDirect (poly_sil.c:287)

IPObjectStruct *GMSilExtractSilDirect(IPObjectStruct *PObjReg,
         IrtHmgnMatType ViewMat)

PObjReg: Polyhedral Object to generate the silhouette for.
ViewMat: View Matrix.
Returns: Silhouette Object.
Description: Generates the silhouette from a polyhedral object, assumed already regularized with the straight
forward method.
See also: GMSilExtractBndry, GMSilExtractSil, GMSilExtractSilDirect2, GMSilExtractDiscont,

4.2.221  GMSilExtractSilDirect2 (poly_sil.c:433)

IPObjectStruct *GMSilExtractSilDirect2(IPObjectStruct *PObjReg,
         IrtHmgnMatType ViewMat)

PObjReg: Polyhedral Object to generate the silhouette for. Assumed to be regular and hold triangles only.
ViewMat: View Matrix.
Returns: Silhouette Object.
Description: Generates the silhouette from a polyhedral object consisting of only triangles, and further assumed
already regularized. The silhouettes generated by this function are interior to the triangles and are computed for
each triangle individually, based on its vertices’ normals.
See also: GMSilExtractBndry, GMSilExtractSil, GMSilExtractSilDirect,
4.2.222  GMSilOrigObjAlive (polysil.c:709)

int GMSilOrigObjAlive(int ObjAlive)

    **ObjAlive**: If TRUE, assumes original object remains valid throughout.

    **Returns**: Original value of original object alive.

    **Description**: If TRUE, this module is allowed to assume that the original polygonal object is alive while silhouette queries are conducted. Default to FALSE. Setting it to TRUE would allow certain optimization as well as the propagation of attributes of vertices from the original object to the detected silhouette edges.

    **See also**: GMSilExtractSil,

4.2.223  GMSilPreprocessPolys (polysil.c:214)

VoidPtr GMSilPreprocessPolys(IPObjectStruct *PObjReg, int n)

    **PObjReg**: Regular polyhedral Object.

    **n**: Subdivision resolution of the Grid (n by n).

    **Returns**: Grid Structure of preprocessing data structure.

    **Description**: Generates the Grid Structure of a polyhedral object. This is the preprocessing stage to the silhouette extraction method. Polyhedra is assumed regular, and has adjacency information.

    **See also**: GMSilExtractBndry, GMSilExtractSil, BoolGenAdjacencies,

4.2.224  GMSilPreprocessRefine (polysil.c:247)

int GMSilPreprocessRefine(VoidPtr PrepSils, int n)

    **PrepSils**: Preprocessing data structure of silhouettes to refine to a new resolution n.

    **n**: New subdivision resolution of the grid.

    **Returns**: TRUE if the grid was updated, FALSE otherwise.

    **Description**: Compute a new Grid if the subdivision resolution has been changed.

4.2.225  GMSilPreprocessFree (polysil.c:668)

void GMSilPreprocessFree(VoidPtr PrepSils)

    **PrepSils**: To free.

    **Returns**: void

    **Description**: Frees the preprocessing data structure of silhouettes.

4.2.226  GMSolveCubicEqn (geom_bsc.c:3056)

int GMSolveCubicEqn(IrtRType A, IrtRType B, IrtRType C, IrtRType *Sols)

    **A, B, C**: The equation’s coefficients as $x^3 + A x^2 + B x + C = 0$.

    **Sols**: Where to place the solutions. At most three.

    **Returns**: Number of real solutions.

    **Description**: Computes the solutions, if any, of the given cubic equation. Only real solutions are considered.

    **See also**: GMSolveQuadraticEqn, GMSolveQuadraticEqn2, GMSolveCubicEqn2, GMSolveQuarticEqn,
4.2.227  GMSolveCubicEqn2 (geom_bsc.c:3152)

int GMSolveCubicEqn2(IrtRType A,
                   IrtRType B,
                   IrtRType C,
                   IrtRType *RSols,
                   IrtRType *ISols)

A, B, C: The coefficients of the cubic polynomial.
RSols, ISols: Each pair (RSols[i], ISols[i]) is the complex root(i)

Returns: The number of REAL solutions of the cubic polynomial.

Description: Calculates the three roots (complex & real) of the cubic equation \(x^3 + Ax^2 + Bx + C = 0\)
Note: Cubic equations have at least one real root; this function always calculates the real root first, and the other
two (possibly complex) later. This order of filling RSols & ISols is CRUCIAL for GMSolveQuarticEqn()
See also: GMSolveCubicEqn, GMSolveCubicEqn2, GMSolveQuadraticEqn, GMSolveQuadraticEqn2, , GMSolveQuarticEqn,

4.2.228  GMSolveQuadraticEqn (geom_bsc.c:2905)

int GMSolveQuadraticEqn(IrtRType A, IrtRType B, IrtRType *Sols)

A, B: The equation’s coefficients as \(x^2 + Ax + B = 0\).
Sols: Where to place the solutions. At most two.

Returns: Number of real solutions.

Description: Computes the solutions, if any, of the given quadratic equation. Only real solutions are considered.
See also: GMSolveCubicEqn, GMSolveCubicEqn2, GMSolveQuadraticEqn2, GMSolveQuarticEqn,

4.2.229  GMSolveQuadraticEqn2 (geom_bsc.c:2948)

int GMSolveQuadraticEqn2(IrtRType B,
                   IrtRType C,
                   IrtRType *RSols,
                   IrtRType *ISols)

B, C: The coefficients of the quadratic polynomial.
RSols, ISols: Solutions such that each pair RSols[i], ISols[i] is the complex root(i).

Returns: The number of REAL solutions of the polynomial.

Description: Calculates the two square roots of the quadratic equation: \(x^2 + Bx + C = 0\)
See also: GMSolveCubicEqn, GMSolveCubicEqn2, GMSolveQuadraticEqn, GMSolveQuadraticEqn2, GMSolveQuarticEqn,

4.2.230  GMSolveQuarticEqn (geom_bsc.c:3318)

int GMSolveQuarticEqn(IrtRType a,
                   IrtRType b,
                   IrtRType c,
                   IrtRType d,
                   IrtRType *Sols)

a, b, c, d: The coefficients of the quartic polynomial.
Sols: The real roots of the polynomial.

Returns: The number of REAL solutions of the polynomial.

Description: Computes the (upto) four real roots of the quartic equation
\(x^4 + Ax^3 + Bx^2 + Cx + D = 0\)
Note 1 —— In order to avoid building a library for complex numbers arithmetics, two arrays are used ISols[] and RSols[], where each RSols[i] and ISols[i] represent a complex number, and so calculation were made on the fly; Anyway, some of these calculations where performed in a specific way to reduce errors of double-precision nature. (especially calculating square roots of complex numbers).

Note 2. ———- In the case of Cubic and Quadratic equations, the number of real solutions is determined via the value of D (the descrimenant); As such, the number of real solutions is easier to depict. However, Euler’s solution for quartic equations manipulates all the three solutions of the cubic (real and complex), hoping to find some real roots by eliminating the imaginary part of the complex solutions. This, however, is a weakness of dependency upon the accuracy of the numbers’ representation as a double-precision floating point.

See also: GMSolveCubicEqn, GMSolveCubicEqn2, GMSolveQuadraticEqn, GMSolveQuadraticEqn2,

4.2.231 GMSphConeGetPtsDensity (sph_cone.c:452)

const IrtVecType *GMSphConeGetPtsDensity(int *n)

n: Number of pts to be distributed on the sphere (approximately). n will be updated to the actual size of the returned vector of unit vectors.

Returns: A vector of n unit vectors equally spread over the unit sphere.

Description: Returns unit vectors on the unit sphere spread uniformly, in a number that closely approximate given n.

See also: GMSphConeSetConeDensity,

4.2.232 GMSphConeQuery2GetVectors (sph_cone.c:677)

void GMSphConeQuery2GetVectors(VoidPtr SphConePtr,
                                   GMSphConeQueryDirFuncType SQQuery,
                                   GMSphConeQueryCallBackFuncType SQFunc)

SphConePtr: Processed data struct for efficient Direction querying.
SQQuery: Query function to invoke.
SQFunc: Function to invoke on detected elements.
Returns: void

Description: Invokes SQFunc with all vectors in the preprocessed data set that the cone containing them satisfy the query function SQQuery. Each such vector is guaranteed to be invoked once only.

See also: GMSphConeQueryInit, GMSphConeQueryFree, GMSphConeSetConeDensity, GMSphConeQuery2GetVectors,

4.2.233 GMSphConeQueryFree (sph_cone.c:581)

void GMSphConeQueryFree(VoidPtr SphConePtr)

SphConePtr: Cone data structure to free.
Returns: void

Description: Release all data allocated by GMSphConeQueryInit function.
See also: GMSphConeQueryInit, GMSphConeQueryGetVectors, GMSphConeSetConeDensity,

4.2.234 GMSphConeQueryGetVectors (sph_cone.c:620)

void GMSphConeQueryGetVectors(VoidPtr SphConePtr,
                                   IrtVecType Dir,
                                   IrtRType Angle,
                                   GMSphConeQueryCallBackFuncType SQFunc)

SphConePtr: Processed data struct for efficient Direction querying.
Dir: Direction to query.
**Angle**: Angular span to query.

**SQFunc**: Function to invoke on detected elements.

**Returns**: void

**Description**: Invokes SQFunc with all vectors in the preprocessed data set that are at most Angle degrees for the prescribed Dir. Each such vector is guaranteed to be invoked once only.

**See also**: GMSphConeQueryInit, GMSphConeQueryFree, GMSphConeSetConeDensity, GMSphConeQuery2GetVectors,

---

### 4.2.235 GMSphConeQueryInit (sph_cone.c:486)

```
VoidPtr GMSphConeQueryInit(IPObjectStruct *PObj)
```

**PObj**: A point list object to preprocess.

**Returns**: Processed data structure for fast cone queries.

**Description**: Proprocess the given set of points into the different bounding cones of the unit sphere.

**See also**: GMSphConeQueryFree, GMSphConeQueryGetVectors, GMSphConeSetConeDensity,

---

### 4.2.236 GMSphConeSetConeDensity (sph_cone.c:413)

```
void GMSphConeSetConeDensity(int n)
```

**n**: Number of cones to distribute on the sphere (approximately).

**Returns**: void

**Description**: Sets the number of cones that will be distributed onto the sphere. Exact number of cones will be close the n but not exactly n. This function better be called before any other GMSphConeConeXXX function.

**See also**: GMSphConeQueryInit, GMSphConeQueryFree, GMSphConeQueryGetVectors,

---

### 4.2.237 GMSphereWith3Pts (ms_spher.c:300)

```
int GMSphereWith3Pts(IrtE3PtStruct *Pts, IrtRType *Center, IrtRType *RadiusSqr)
```

**Pts**: The set of point to compute their sphere.

**Center**: Of computed sphere.

**RadiusSqr**: Of computed Sphere.

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: Given three points, compute the sphere through the set of points. Initially, the three points are rotated to a plane parallel to XY-plane and then using GMCircleFrom3Points, the circle through them is computed. The center is then rotated back to form the center of the sphere in 3D.

**See also**: GMCircleFrom3Points,

---

### 4.2.238 GMSphereWith4Pts (ms_spher.c:359)

```
int GMSphereWith4Pts(IrtE3PtStruct *Pts, IrtRType *Center, IrtRType *RadiusSqr)
```

**Pts**: The set of point to compute their sphere.

**Center**: Of computed sphere.

**RadiusSqr**: Of computed Sphere.

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: Given four points, compute the sphere through the set of points. It is identified by solving the following equidistant conditions.
< P - P1, P - P1 > = < P - P2, P - P2 >,  
< P - P1, P - P1 > = < P - P3, P - P3 >,  
< P - P1, P - P1 > = < P - P4, P - P4 >,  

or,  
2(P2 - P1) P = P2^2 - P1^2,  
2(P3 - P1) P = P3^2 - P1^2,  
2(P4 - P1) P = P4^2 - P1^2.  

We can solve for P (the sphere’s center) using the Cramer’s rule.  
See also: GMMinSpanSphere,  

4.2.239 GMSplitNonConvexPoly (convex.c:540)  

IPPolygonStruct *GMSplitNonConvexPoly(IPPolygonStruct *Pl)  

Pl: Non convex polygon to split into convex ones.  
Returns: A list of convex polygons resulting from splitting up Pl.  
Description: Routine to split non convex polygon into a list of convex ones.  
1. Remove a polygon from GblList. If non exists stop.  
2. Search for non convex corner. If not found stop - polygon is convex. Otherwise let the non convex corner found be V(i).  
3. Fire a ray from V(i) in the opposite direction to V(i-1). Find the closest intersection of the ray with polygon boundary P.  
4. Split the polygon into two at V(i)-P edge and push the two new polygons on the GblList.  
5. Goto 1.  
See also: GMConvertPolysToTriangles, GMConvexPolyObject, GMConvexPolyObjectN, , GMIsConvexPolygon,  

4.2.240 GMSplitPolyInPlaceAt2Vertices (poly_pts.c:1335)  

IPPolygonStruct *GMSplitPolyInPlaceAt2Vertices(IPPolygonStruct *Pl,  
IPVertexStruct *V1,  
IPVertexStruct *V2)  

Pl: Convex polygon to split into two.  
V1: First Vertex to split Pl at.  
V2: Second Vertex to split Pl at.  
Returns: The second half of the splitted polygon (first half is returned, in place, in Pl). This function returns a NULL if split failed due to the fact that the polygon degenerated into a line. Pl is not affected if NULL is returned. The second polygon is added as next to the first polygon.  
Description: Splits the given convex polygon, in place, into two, returning second half of the polygon while updating Pl to hold the first half.  
See also: GMSplitPolyInPlaceAtVertex,  

4.2.241 GMSplitPolyInPlaceAtVertex (poly_pts.c:1259)  

IPPolygonStruct *GMSplitPolyInPlaceAtVertex(IPPolygonStruct *Pl,  
IPVertexStruct *VHead)  

Pl: Convex polygon to split into two.  
VHead: Vertex to split Pl at.  
Returns: The second half of the splitted polygon (first half is returned, in place, in Pl). This function returns a NULL if split failed due to the fact that the polygon degenerated into a line. Pl is not affected if NULL is returned.  
Description: Splits the given convex polygon, in place, into two, returning second half of the polygon while updating Pl to hold the first half. Polygon is split so that VHead is on border between the two polygons.  
See also: GMSplitPolyInPlaceAt2Vertices,
4.2.242 GMSplitPolygonAtPlane (geom\_bsc.c:1404)

```c
int GMSplitPolygonAtPlane(IPPolygonStruct *Pl, const IrtPlnType Pln)

   Pl: Polygon to split if intereses plane Pln.
   Pln: Plane to split polygon Pl at. Assumed normalized normal vector in Pln.

   Returns: TRUE if intersects, FALSE otherwise.

   Description: Split the given convex polygon where it intersects the given plane. Pl is updated to in inside portion (where the normal is point into) and Pl -> Pnext will hold the second half.
   See also: GMPolygonRayInter, GMPolygonPlaneInter,
```

4.2.243 GMSplitPolysAtCollinearVertices (poly\_pts.c:1185)

```c
IPPolygonStruct *GMSplitPolysAtCollinearVertices(IPPolygonStruct *Pls)

   Pls: List of polygons to split at collinear edges.

   Returns: New list of polygons with no colinear adjacent edges.

   Description: Splits the given polygons in vertices that connect two adjacent collinear edges. Polygons are assumed convex other than this collinearity conditions.
```

4.2.244 GMSrfBilinearFit (analyfit.c:45)

```c
IrtPtType *GMSrfBilinearFit(IrtPtType *ParamDomainPts,
                           IrtPtType *EuclideanPts,
                           int FirstAtOrigin,
                           int NumPts)

   ParamDomainPts: Array of UV points prescribing the parametric values.
   EuclideanPts: Array of XYZ points defining the Euclidean values of the ParamDomainPts with obviously the same order.
   FirstAtOrigin: If TRUE, the first points is set to be at U = V = 0.
   NumPts: Number of points in ParamDomainPts and EuclideanPts.

   Returns: Array of four points values, A, B, C, D.

   Description: Fits a bilinear surface to the set of given points as F(u,v) = A + B * u + C * v + D * u * v, A,B,C,D points in R^3.
   See also: GMSrfQuadricFit,
```

4.2.245 GMSrfCubicQuadOnly (analyfit.c:319)

```c
IrtPtType *GMSrfCubicQuadOnly(IrtPtType *ParamDomainPts,
                             IrtPtType *EuclideanPts,
                             int FirstAtOrigin,
                             int NumEucDim,
                             int NumPts)

   ParamDomainPts: Array of UV points prescribing the parametric values.
   EuclideanPts: Array of XYZ points defining the Euclidean values of the ParamDomainPts with obviously the same order.
   FirstAtOrigin: If TRUE, the first points is set to be at U = V = 0.
   NumEucDim: Number of Euclidean dimension. 1 for scalar surface and upto 3 for parametric surface in R^3.
   NumPts: Number of points in ParamDomainPts and EuclideanPts.

   Returns: Array of 10 point values, A,B,C,D,E,F,G,H,I,J in order, where A = B = C = 0 always.

   Description: Fits a cubic surface (cubic and quad terms only) to the set of given points as F(u,v) = A + B * u + C * v + D * u^2 + E * u * v + F * v^2 + G * u^3 + H * u^2 * v + I * u * v^2 + J * v^3, A,B,C,D,E,F,G,H,I,J points in R^3.
   See also: GMSrfBilinearFit, GMSrfQuadricFit, GMSrfQuadricQuadOnly,
```
4.2.246  **GMSrfQuadricFit** (analyfit.c:132)

```c
IrtPtType *GMSrfQuadricFit(IrtPtType *ParamDomainPts,
IrtPtType *EuclideanPts,
int FirstAtOrigin,
int NumPts)
```

**ParamDomainPts**: Array of UV points prescribing the parametric values.
**EuclideanPts**: Array of XYZ points defining the Euclidean values of the ParamDomainPts with obviously the same order.
**FirstAtOrigin**: If TRUE, the first points is set to be at U = V = 0.
**NumPts**: Number of points in ParamDomainPts and EuclideanPts.

**Returns**: Array of six point values, A,B,C,D,E,F in order.

**Description**: Fits a quadric surface to the set of given points as \( F(u,v) = A + B \cdot u + C \cdot v + D \cdot u^2 + E \cdot u \cdot v + F \cdot v^2 \), A,B,C,D,E,F points in \( \mathbb{R}^3 \).

**See also**: GMSrfBilinearFit, GMSrfQuadricQuadOnly, GMSrfCubicQuadOnly,

4.2.247  **GMSrfQuadricQuadOnly** (analyfit.c:225)

```c
IrtPtType *GMSrfQuadricQuadOnly(IrtPtType *ParamDomainPts,
IrtPtType *EuclideanPts,
int FirstAtOrigin,
int NumEucDim,
int NumPts)
```

**ParamDomainPts**: Array of UV points prescribing the parametric values.
**EuclideanPts**: Array of XYZ points defining the Euclidean values of the ParamDomainPts with obviously the same order.
**FirstAtOrigin**: If TRUE, the first points is set to be at U = V = 0.
**NumEucDim**: Number of Euclidean dimension. 1 for scalar surface and upto 3 for parametric surface in \( \mathbb{R}^3 \).
**NumPts**: Number of points in ParamDomainPts and EuclideanPts.

**Returns**: Array of six point values, A,B,C,D,E,F in order, where A = B = C = 0 always.

**Description**: Fits a quadric surface (quad terms only) to the set of given points as \( F(u,v) = A + B \cdot u + C \cdot v + D \cdot u^2 + E \cdot u \cdot v + F \cdot v^2 \), A,B,C,D,E,F points in \( \mathbb{R}^3 \).

**See also**: GMSrfBilinearFit, GMSrfQuadricFit, GMSrfCubicQuadOnly,

4.2.248  **GMSubButterfly** (sbdv_srf.c:154)

```c
IPObjectStruct *GMSubButterfly(IPObjectStruct *OriginalObj,
IrtRType ButterflyWCoef)
```

**OriginalObj**: A pointer to the original polygonal object.
**ButterflyWCoef**: The scalar butterfly blending coefficient.

**Returns**: pointer to refined polygonal object after subdivision.

**Description**: Refines a polygonal object according to Butterfly subdivision rules. One iteration is performed.

4.2.249  **GMSubCatmullClark** (sbdv_srf.c:102)

```c
IPObjectStruct *GMSubCatmullClark(IPObjectStruct *OriginalObj)
```

**OriginalObj**: A pointer to the original polygonal object.

**Returns**: Pointer to refined polygonal object after subdivision.

**Description**: Refines a polygonal object according to Catmull-Clark subdivision rules. One iteration is performed.
4.2.250  **GMSubLoop** (sbdv_srf.c:127)

```c
IPObjectStruct *GMSubLoop(IPObjectStruct *OriginalObj)
```

**OriginalObj**: A pointer to the original polygonal object.

**Returns**: Pointer to refined polygonal object after subdivision.

**Description**: Refines a polygonal object according to Loop subdivision rules. One iteration is performed.

4.2.251  **GMTransObjSetAnimCrvUpdateFunc** (geomat3d.c:383)

```c
GMTransObjUpdateAnimCrvsFuncType GMTransObjSetAnimCrvUpdateFunc(
    GMTransObjUpdateAnimCrvsFuncType AnimUpdateFunc)
```

**AnimUpdateFunc**: New animation crvs update function for obj transform.

**Returns**: Old function

**Description**: Sets the function to update the animation curves to work properly after the applied transformation Mat to the parent object whose PAnim are his.

See also: GMTransformObject, GMTransObjSetUpdateFunc, GMTransObjUpdateAnimCrvs

4.2.252  **GMTransObjSetUpdateFunc** (geomat3d.c:356)

```c
GMTransObjUpdateFuncType GMTransObjSetUpdateFunc(GMTransObjUpdateFuncType
    UpdateFunc)
```

**UpdateFunc**: New call back function for GMTransformObject

**Returns**: Old value of call back function.

**Description**: Set the update transform call back function to a new function. This call back function is invoked with the original object, the transformed object and the transformation matrix, just before GMTransformObject is returned.

See also: GMTransformObject, GMTransObjSetAnimCrvUpdateFunc

4.2.253  **GMTransObjUpdateAnimCrvs** (geomat3d.c:682)

```c
IPObjectStruct *GMTransObjUpdateAnimCrvs(IPObjectStruct *PAnim,
    IrtHmgnMatType Mat)
```

**PAnim**: Animation curves to update following transformation matrix Mat.

**Mat**: The transformation matrix.

**Returns**: The updated animation curves’ list.

**Description**: Update the animation curves to work properly after the applied transformation Mat to the parent object whose PAnim are his.

See also: GMTransformObject

4.2.254  **GMTransformObject** (geomat3d.c:441)

```c
IPObjectStruct *GMTransformObject(const IPObjectStruct *PObj,
    IrtHmgnMatType Mat)
```

**PObj**: Object to be transformed.

**Mat**: Transformation matrix.

**Returns**: Transformed object.

**Description**: Routine to transform an object according to the transformation matrix.

See also: GMTransObjUpdateAnimCrvs, GMTransObjSetUpdateFunc, GMTransformPolyList, GMTransformObjectInPlace,
4.2.255  GMTransformObjectInPlace (geomat3d.c:412)

IPObjectStruct *GMTransformObjectInPlace(IPObjectStruct *PObj,
IrtHmgnMatType Mat)

PObj: Object to be transformed.
Mat: Transformation matrix.
Returns: Transformed object.

Description: Routine to transform an object according to the transformation matrix. Input object, PObj, is freed.
See also: GMTransObjUpdateAnimCrvs, GMTransObjSetUpdateFunc, GMTransformPolyList, GMTransformObject,

4.2.256  GMTransformObjectList (geomat3d.c:752)

IPObjectStruct *GMTransformObjectList(const IPObjectStruct *PObj,
IrtHmgnMatType Mat)

PObj: Object list to transform.
Mat: Transformation matrix.
Returns: Transformed object list.

Description: Routine to transform an list of objects according to a transformation matrix.

4.2.257  GMTransformPolyList (geomat3d.c:296)

IPPolygonStruct *GMTransformPolyList(const IPPolygonStruct *Pls,
IrtHmgnMatType Mat,
int IsPolygon)

Pls: List of polygons to transform.
Mat: Transformation matrix.
IsPolygon: TRUE for polygons, for for polylines/points.
Returns: A list of transformed polygons.

Description: Routine to transform a list of polygons according to the prescribed transformation matrix.
See also: GMTransformObject,

4.2.258  GMTrianglePointInclusion (geom_jsc.c:1522)

int GMTrianglePointInclusion(const IrtRType *V1,
const IrtRType *V2,
const IrtRType *V3,
const IrtPtType Pt)

V1, V2, V3: Triangle to test if Pt is in it.
Pt: Point to test for inclusion in triangle.
Returns: TRUE if Pt inside triangle, FALSE otherwise.

Description: Routine to check if a point is inside a triangle, in the XY plane.
See also: GMPolygonPointInclusion, GMPolygonPlaneInter, GMPolygonRayInter,
4.2.259  GMTwoPolySameGeom (polycln.c:42)

int GMTwoPolySameGeom(const IPPolygonStruct *Pl1,
                       const IPPolygonStruct *Pl2,
                       IrtRType Eps)

Pl1, Pl2: Two polygons to compare.
Eps: Tolerance of vertices equality, etc.

Returns: TRUE if two polygons posses same geometry, FALSE otherwise.

Description: Compare two polygons if share the same geometry. Two polygons are considered same if the share
the same vertices in order (or in reverse).
See also: GMCleanUpDupPolys,

4.2.260  GMUpdateVerticesByInterp (intrnrml.c:78)

void GMUpdateVerticesByInterp(I PPolygonStruct *PlList,
                              const IPPolygonStruct *OriginalPl)

PlList: List of polygons to update normal for.
OriginalPl: Original polygons PlList was derived from, probably using Boolean operations.

Returns: void

Description: For each polygon in PlList update any vertex with a proper normal, uv uv coord, rgb color, etc. if
available in the Original polygon vertex list OriginalPl. All the new vertices are enclosed within the original polygon
which must be convex as well.
See also: GMBlendNormalsToVertices, GMInterpVrtxNrmlBetweenTwo, GMInterpVrtxNrmlBetweenTwo2,
GMInterpVrtxRGBBetweenTwo, GMInterpVrtxRGBFromPl, GMInterpVrtxUVBetweenTwo, GMInterpVrtxUVFromPl,

4.2.261  GMVecCopy (geombsc.c:85)

void GMVecCopy(IrtVecType Vdst, const IrtVecType Vsrc)

Vdst: Destination vector.
Vsrc: Source vector.

Returns: void

Description: Routine to copy one vector to another:

4.2.262  GMVecCrossProd (geombsc.c:150)

void GMVecCrossProd(IrtVecType Vres,
                    const IrtVecType V1,
                    const IrtVecType V2)

Vres: Result of cross product
V1, V2: Two vectors of the cross product.

Returns: void

Description: Routine to compute the cross product of two vectors. Note Vres may be the same as V1 or V2.

4.2.263  GMVecDotProd (geombsc.c:422)

IrtRType GMVecDotProd(const IrtVecType V1, const IrtVecType V2)

V1, V2: Two vector to compute dot product of.

Returns: Resulting dot product.

Description: Routine to compute the dot product of two vectors.
4.2.264 GMVecLength (geom_bsc.c:128)

IrtRType GMVecLength(const IrtVecType V)

V: To compute its magnitude.
Returns: Magnitude of V.
Description: Routine to compute the magnitude (length) of a given 3D vector:

4.2.265 GMVecNormalize (geom_bsc.c:103)

void GMVecNormalize(IrtVecType V)

V: To normalize.
Returns: void
Description: Routine to normalize the vector length to a unit size.

4.2.266 GMVecReflectPlane (geom_bsc.c:442)

void GMVecReflectPlane(IrtVecType Dst, IrtVecType Src, IrtVecType PlaneNormal)

Dst: Reflected vector.
Src: Input Vector to reflect.
PlaneNormal: Normal of plane (through origin) to reflect Src through.
Returns: void
Description: Reflects a 3D vector through a plane with normal PlaneNormal

4.2.267 GMVecVecAngle (geom_bsc.c:228)

IrtRType GMVecVecAngle(const IrtVecType V1, const IrtVecType V2, int Normalize)

V1, V2: Vectors to compute their relative angle, in radians.
Normalize: TRUE if vectors need normalization first, FALSE if unit size.
Returns: Angle.
Description: Computes the angle between two space vectors. Angle is returned in radians in the domain of [-Pi, +Pi].
See also: GMAreaSphericalTriangle,

4.2.268 GMVrtxListToCircOrLin (poly_cln.c:398)

void GMVrtxListToCircOrLin(IPPolygonStruct *Pls, int DoCirc)

Pls: List of polys to make sure are circular/linear, in place.
DoCirc: If TRUE, list are made circular. If FALSE, vertices are NULL terminated.
Returns: void
Description: Routine to make sure all polys given are circular/linear. Update in place.
See also: GMCleanUpPolylineList, GMCleanUpPolygonList, GMFilterInteriorVertices, GMVrtxListToCircOrLinDup, IPOpenPolysToClosed, IPClosedPolysToOpen,
4.2.269 GMVrtxListToCircOrLinDup (poly.cln.c:437)

void GMVrtxListToCircOrLinDup(IPPolygonStruct *Pls, int DoCirc)

Pls: List of polys to make sure are circular/linear, in place.
DoCirc: If TRUE, list are made circular. If FALSE, vertices are NULL terminated.
Returns: void

Description: Routine to make sure all polys given are circular/linear. Update in place. If circular and made linear, first vertex is duplicated as last and same when linear is made circular.
See also: GMCleanUpPolylineList, GMCleanUpPolygonList, GMFilterInteriorVertices, GMVrtxListToCircOrLin, IPOpenPolysToClosed, IPClosedPolysToOpen.

4.2.270 GMZBufferClear (zbuffer.c:129)

void GMZBufferClear(VoidPtr ZbufferID)

ZbufferID: ID of the zbuffer to use.
Returns: void
Description: Clears the Z buffer to initialization state.
See also: GMZBufferClearSet,

4.2.271 GMZBufferClearSet (zbuffer.c:171)

void GMZBufferClearSet(VoidPtr ZbufferID, IrtRType Depth)

ZbufferID: ID of the zbuffer to use.
Depth: Initial depth to use.
Returns: void
Description: Clears the Z buffer to initialization state of depth value Depth.
See also: GMZBufferClear,

4.2.272 GMZBufferFree (zbuffer.c:97)

void GMZBufferFree(VoidPtr ZbufferID)

ZbufferID: ID of the zbuffer to free.
Returns: void
Description: Free the given Zbuffer.

4.2.273 GMZBufferInit (zbuffer.c:60)

VoidPtr GMZBufferInit(int Width, int Height)

Width, Height: Width and Height of the Z buffer.
Returns: An I.D. of the constructed Z buffer.
Description: Sets up the Zbuffer software implementation.
4.2.274 GMZBufferInvert (zbuffer.c:296)

VoidPtr GMZBufferInvert(VoidPtr ZbufferID)
  ZbufferID: ID of the zbuffer to use.
  Returns: An I.D. of the constructed Z buffer.
  Description: Invert the depth values. That is z -> -z.

4.2.275 GMZBufferLaplacian (zbuffer.c:365)

VoidPtr GMZBufferLaplacian(VoidPtr ZbufferID)
  ZbufferID: ID of the zbuffer to use.
  Returns: An I.D. of the constructed Z buffer.
  Description: Apply a Laplacian operator to the Z buffer.

4.2.276 GMZBufferOGLClear (zbuf_ogl.c:806)

void GMZBufferOGLClear(void)
  Returns: void
  Description: Clears the Z buffer to initialization state.

4.2.277 GMZBufferOGLFlush (zbuf_ogl.c:973)

void GMZBufferOGLFlush(void)
  Returns: void
  Description: Make sure all drawing commands are flushed and we are in sync.

4.2.278 GMZBufferOGLInit (zbuf_ogl.c:603)

IritIntPtrSizeType GMZBufferOGLInit(int Width,
  int Height,
  IrtRType ZMin,
  IrtRType ZMax,
  int OffScreen)
  Width, Height: Width and Height of the Z buffer.
  ZMin, ZMax: Z domain that the Z buffer will have to support.
  OffScreen: Z buffer should be hidden (TRUE) or displayed (FALSE).
  Returns: An I.D. of the constructed Z buffer.
  Description: Sets up the Zbuffer implementation. This one is employing Open GL.

4.2.279 GMZBufferOGLMakeActive (zbuf_ogl.c:861)

void GMZBufferOGLMakeActive(IritIntPtrSizeType Id)
  Id: I.D. of the Zbuffer to activate.
  Returns: void
  Description: Make active context. Once this function called drawing commands may be issued. Here, the
drawing commands are in Open GL. Necessary only if other Open GL applications are active simultaneously.
4.2.280  GMZBufferOGLQueryColor (zbufogl.c:944)

void GMZBufferOGLQueryColor(IrtRType x, 
    IrtRType y, 
    int *Red, 
    int *Green, 
    int *Blue)

x, y: The XY coordinates of the point to consider for color.
Red, Green, Blue: The color specifications.

Returns: void

Description: Returns the color at the given location in the Zbuffer.
See also: GMZBufferOGLQueryZ,

4.2.281  GMZBufferOGLQueryZ (zbufogl.c:892)

IrtRType GMZBufferOGLQueryZ(IrtRType x, IrtRType y)

x, y: The XY coordinates of the point to consider for visibility.

Returns: The depth found at that XY location.

Description: Returns depth at the given location in the Zbuffer.
See also: GMZBufferOGLQueryColor,

4.2.282  GMZBufferOGLSetColor (zbufogl.c:837)

void GMZBufferOGLSetColor(int Red, int Green, int Blue)

Red, Green, Blue: The color specifications, each between 0 and 255.

Returns: void

Description: Sets the colors of all drawing operations to come.

4.2.283  GMZBufferQueryInfo (zbuffer.c:442)

VoidPtr GMZBufferQueryInfo(VoidPtr ZbufferID, int x, int y)

ZbufferID: ID of the zbuffer to use.
x, y: The XY coordinates of the point to consider its info.

Returns: The pointer to the user information at that XY location.

Description: Returns the user information at the given location in the Zbuffer.

4.2.284  GMZBufferQueryZ (zbuffer.c:417)

IrtRType GMZBufferQueryZ(VoidPtr ZbufferID, int x, int y)

ZbufferID: ID of the zbuffer to use.
x, y: The XY coordinates of the point to consider its depth.

Returns: The depth found at that XY location.

Description: Returns depth at the given location in the Zbuffer.
4.2.285  GMZBufferRoberts (zbuffer.c:326)

VoidPtr GMZBufferRoberts(VoidPtr ZbufferID)

    ZbufferID: ID of the zbuffer to use.
    Returns: An I.D. of the constructed Z buffer.
    Description: Apply a Roberts Edge detection operator to the Z buffer.

4.2.286  GMZBufferSetUpdateFunc (zbuffer.c:271)

GMZBufferUpdateFuncType GMZBufferSetUpdateFunc(VoidPtr ZbufferID,
                                                  GMZBufferUpdateFuncType UpdateFunc)

    ZbufferID: ID of the zbuffer to use.
    UpdateFunc: The call back function to invoke for each pixel that is updated in the Z buffer.
    Returns: Old call back function
    Description: Sets a call back function for each pixel update in the Z buffer.

4.2.287  GMZBufferSetZTest (zbuffer.c:242)

GMZTestsType GMZBufferSetZTest(VoidPtr ZbufferID, GMZTestsType ZTest)

    ZbufferID: ID of the zbuffer to use.
    ZTest: The new Z test to consider.
    Returns: The old Z test used.
    Description: Sets the Z testing option with the assumption that largers Z values mean closers to the viewer.

4.2.288  GMZBufferUpdateHLn (zbuffer.c:548)

void GMZBufferUpdateHLn(VoidPtr ZbufferID,
                        int x1,
                        int x2,
                        int y,
                        IrtRType z1,
                        IrtRType z2)

    ZbufferID: ID of the zbuffer to use.
    x1, x2, y: The XY coordinates of the points on the horizontal line.
    z1, z2: The new z's to set into the z buffer, if larger (==closer).
    Returns: void
    Description: Set the depth for all points on a given horizontal line in the Zbuffer.
See also: GMZBufferUpdatePt, GMZBufferUpdateTri, GMZBufferUpdateLine,

4.2.289  GMZBufferUpdateInfo (zbuffer.c:510)

VoidPtr GMZBufferUpdateInfo(VoidPtr ZbufferID, int x, int y, VoidPtr Info)

    ZbufferID: ID of the zbuffer to use.
    x, y: The XY coordinates of the point to set its user information.
    Info: The new user information to set into the z buffer.
    Returns: Old user information.
    Description: Set new user information at the given location in the Zbuffer. This update always affects the Z buffer regardless of the depth.
See also: GMZBufferUpdatePt, GMZBufferUpdateLn, GMZBufferUpdateTri,
4.2.290  GMZBufferUpdateLine  (zbuffer.c:608)

void GMZBufferUpdateLine(VoidPtr ZbufferID,
    int x1,
    int y1,
    int x2,
    int y2,
    IrtRType z1,
    IrtRType z2)

ZbufferID: ID of the zbuffer to use.
x1, y1, x2, y2: The XY coordinates of the end points of the line.
z1, z2: The new z's to set into the z buffer, if larger (==closer).

Returns: void

Description: Set the depth for all points on a given line in the Zbuffer.
See also: GMZBufferUpdatePt, GMZBufferUpdateHLn, GMZBufferUpdateTri,

4.2.291  GMZBufferUpdatePt  (zbuffer.c:474)

IrtRType GMZBufferUpdatePt(VoidPtr ZbufferID, int x, int y, IrtRType z)

ZbufferID: ID of the zbuffer to use.
x, y: The XY coordinates of the point to set its depth. No clipping/validity test is conducted to make sure
that the point is inside the Z buffer!
z: The new z to set into the z buffer, if z test succeeds.

Returns: Old Z value.

Description: Set the depth at the given location in the Zbuffer. This update affects the Z buffer only if the z
test succeeds.
See also: GMZBufferUpdateInfo, GMZBufferUpdateLn, GMZBufferUpdateTri,

4.2.292  GMZBufferUpdateTri  (zbuffer.c:708)

void GMZBufferUpdateTri(VoidPtr ZbufferID,
    int x1,
    int y1,
    IrtRType z1,
    int x2,
    int y2,
    IrtRType z2,
    int x3,
    int y3,
    IrtRType z3)

ZbufferID: ID of the zbuffer to use.
x1, y1, z1: First point of triangle.
x2, y2, z2: Second point of triangle.
x3, y3, z3: Third point of triangle.

Returns: void

Description: Set the depth for all points in a given triangular line in the Zbuffer.
See also: GMZBufferUpdatePt, GMZBufferUpdateHLn, GMZBufferUpdateLine,
4.2.293 GeomDescribeError (geom_err.c:76)

const char *GeomDescribeError(GeomFatalErrorType ErrorNum)

ErrorNum: Type of the error that was raised.
Returns: A string describing the error type.
Description: Returns a string describing a the given error. Errors can be raised by any member of this geom library as well as other users. Raised error will cause an invokation of GeomFatalError function which decides how to handle this error. GeomFatalError can for example, invoke this routine with the error type, print the appropriate message and quit the program.

4.2.294 GeomFatalError (geom_ftl.c:53)

void GeomFatalError(GeomFatalErrorType ErrID)

ErrID: Error type that was raised.
Returns: void
Description: Trap Geom_lib errors right here. Provides a default error handler for the geom library. Gets an error description using GeomDescribeError, prints it and exit the program using exit.

4.2.295 GeomSetFatalErrorFunc (geom_ftl.c:28)

GeomSetErrorFuncType GeomSetFatalErrorFunc(GeomSetErrorFuncType ErrorFunc)

ErrorFunc: New error function to use.
Returns: Old error function reference.
Description: Sets the error function to be used by Geom_lib.

4.2.296 HDSCnvrtPObj2QTree (polysimp.c:2012)

VoidPtr HDSCnvrtPObj2QTree(IPObjectStruct *PObjects, int Depth)

PObjects: The IRIT object given as input.
Depth: The Depth of the tree (recommended value = 5)
Returns: A reference to the vertex tree (to be handed on to HDSThreshold and HDSTriBudget.
Description: Creates the vertex tree from the IPObjectStruct.
See also: HDSThreshold, HDSTriBudget, HDSFreeQTree,

4.2.297 HDSFreeQTree (polysimp.c:2166)

void HDSFreeQTree(VoidPtr Qt)

Qt: A pointer to the octree.
Returns: void
Description: Free all the memory allocated to a particular octree.
See also: HDSThreshold, HDSTriBudget, HDSCnvrtPObj2QTree,
4.2.298 HDSThreshold (polysimp.c:2109)

IPObjectStruct *HDSThreshold(VoidPtr Qt, IrtRType Threshold)

Qt: A pointer to the Vertex tree.
Threshold: The error threshold.
Returns: the active List as an IRIT object.
Description: Traverses the Vertex tree, updates the active List and converts it into an IPObjectStruct according to the new error threshold.
See also: HDSCnvrtPObj2QTree, HDSTriBudget, HDSFreeQTree,

4.2.299 HDSTriBudget (polysimp.c:2141)

IPObjectStruct *HDSTriBudget(VoidPtr Qt, int TriBudget)

Qt: The Vertex tree.
TriBudget: The Triangle budget.
Returns: The active list as an IRIT object.
Description: Update the active list according to the new triangle budget, then convert it into an IPObjectStruct.
See also: HDSThreshold, HDSCnvrtPObj2QTree, HDSFreeQTree,

4.2.300 IGRedrawViewWindow (anim_aux.c:27)

void IGRedrawViewWindow(void)

Returns: void
Description: Redraws the view window.

4.2.301 PrimGenBOXObject (primitv1.c:138)

IPObjectStruct *PrimGenBOXObject(const IrtVecType Pt,
IrtRType WidthX,
IrtRType WidthY,
IrtRType WidthZ)

Pt: Low end corner of BOX.
WidthX: Width of BOX (X axis).
WidthY: Depth of BOX (Y axis).
WidthZ: Height of BOX (Z axis).
Returns: A BOX primitive
Description:
Routine to create a BOX geometric object defined by Pt - the minimum 3d point, and Width - Dx Dy & Dz vector.
Order of vertices is as follows in the picture:
| 5 | 7 |
| 6 |
| 1 |
| 3 |
(Note vertex 0 is hidden behind edge 2-6)
4

All dimensions can be negative, denoting the reversed direction.
See also: PrimSetGeneratePrimType, PrimGenGBOXObject, PrimGenCONEObject, PrimGenCONE2Object, PrimGenCYLINOObject, PrimGenSPHEREObject, PrimGenTORUSObject, PrimGenBOXWIREObject,
4.2.302 PrimGenBOXWIREObject (primitv1.c:218)

**IPObjectStruct** *PrimGenBOXWIREObject*(const IrtVecType Pt,
IrtRType WidthX,
IrtRType WidthY,
IrtRType WidthZ)

**Pt**: Low end corner of BOX.

**WidthX**: Width of BOX (X axis).

**WidthY**: Depth of BOX (Y axis).

**WidthZ**: Height of BOX (Z axis).

**Returns**: A BOX primitive

**Description**: Routine to create a BOX Wireframe geometric object defined by Pt - the minimum 3d point, and Width - Dx Dy & Dz vector. Order of vertices is as follows in the picture:

```
<table>
<thead>
<tr>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

(Note vertex 0 is hidden behind edge 2-6)

All dimensions can be negative, denoting the reversed direction.

**See also**: PrimSetGeneratePrimType, PrimGenGBOXObject, PrimGenCONEObject, PrimGenCONE2Object, PrimGenCYLINObject, PrimGenSPHEREObject, PrimGenTORUSObject, PrimGenBOXObject,

4.2.303 PrimGenCONE2Object (primitv1.c:531)

**IPObjectStruct** *PrimGenCONE2Object*(const IrtVecType Pt,
const IrtVecType Dir,
IrtRType R1,
IrtRType R2,
int Bases)

**Pt**: Center location of Base of CON2.

**Dir**: Direction and distance from Pt to center of other base of CON2.

**R1, R2**: Two base radii of the truncated CON2

**Bases**: 0 for none, 1 for bottom, 2 for top, 3 for both.

**Returns**: A CON2 Primitive.

**Description**: Routine to create a truncated CONE, CON2, geometric object defined by Pt - the base 3d center point, Dir - the cone direction and height, and two base radii R1 and R2. See also PrimSetResolution on fineness control of approximation of the primitive using flat faces.

**See also**: PrimSetGeneratePrimType, PrimGenGBOXObject, PrimGenGBOXObject, PrimGenCONE2Object, PrimGenCYLINObject, PrimGenSPHEREObject, PrimGenTORUSObject,

4.2.304 PrimGenCONEObject (primitv1.c:370)

**IPObjectStruct** *PrimGenCONEObject*(const IrtVecType Pt,
const IrtVecType Dir,
IrtRType R,
int Bases)

**Pt**: Center location of Base of CONE.

**Dir**: Direction and distance from Pt to apex of CONE.

**R**: Radius of Base of the cone.

**Bases**: 0 for none, 1 for bottom, 2 for top, 3 for both.

**Returns**: A CONE Primitive.

**Description**: Routine to create a CONE geometric object defined by Pt - the base 3d center point, Dir - the cone direction and height, and base radius R. See also PrimSetResolution on fineness control of approximation of the primitive using flat faces.

**See also**: PrimSetGeneratePrimType, PrimGenGBOXObject, PrimGenGBOXObject, PrimGenCONE2Object, PrimGenCYLINObject, PrimGenSPHEREObject, PrimGenTORUSObject,
4.2.305 PrimGenCYLINObject (primitv1.c:717)

```c
IPObjectStruct *PrimGenCYLINObject(const IrtVecType Pt,
const IrtVecType Dir,
IrtRType R,
int Bases)
```

**Description:** Routine to create a CYLINder geometric object defined by Pt - the base 3d center point, Dir - the cylinder direction and height, and radius R. See also PrimSetResolution on fineness control of approximation of the primitive using flat faces.

**See also:** PrimSetGeneratePrimType, PrimGenBOXObject, PrimGenGBOXObject, PrimGenCONEObject, PrimGenCONE2Object, PrimGenSPHEREObject, PrimGenTORUSObject,

4.2.306 PrimGenEXTRUDEObject (primitv2.c:443)

```c
IPObjectStruct *PrimGenEXTRUDEObject(const IPObjectStruct *Cross,
const IrtVecType Dir,
int Bases)
```

**Description:** Routine to create an extrusion surface out of the given cross section and the given direction. Input can either be a polygon/line or a freeform curve object. If input is a polyline/gon, it must never be coplanar with Dir. See also PrimSetResolution on fineness control of approximation of the primitive using flat faces.

**See also:** PrimSetResolution, PrimGenSURFREVObject, PrimGenSURFREVAxisObject, PrimGenSURFREV2Object, PrimGenSURFREV2AxisObject, PrimGenRULEDObject,

4.2.307 PrimGenFrameController (primitv3.c:931)

```c
IPObjectStruct *PrimGenFrameController(IrtRType BBoxLen,
IrtRType NLeverLen,
IrtRType TLeverLen,
const char *HandleName)
```

**Description:** Constructs a frame handle with axes parallel to XYZ, at the origin.

**See also:** PrimGenTransformController, PrimGenTransformController2DCrvs,
4.2.308  PrimGenGBOXObject  (primitv1.c:280)

IPObjectStruct *PrimGenGBOXObject(const IrtVecType Pt,
    const IrtVecType Dir1,
    const IrtVecType Dir2,
    const IrtVecType Dir3)

Pt:  Low end corner of GBOX.
Dir1, Dir2, Dir3:  Three independent directional vectors to define GBOX.
Returns:  A GBOX primitive.
Description:  Routine to create a GBOX geometric object defined by Pt - the minimum 3d point, and 3 direction
Vectors Dir1, Dir2, Dir3.  If two of the direction vectors are parallel the GBOX degenerates to a zero volume object.
A NULL pointer is returned in that case.

Order of vertices is as
follows in the picture:
|       | 6   |
|       | 1   |
| 4     | 5   |
(4)     (5)
(Note vertex 0 is hidden behind edge 2-6)

See also:  PrimSetGeneratePrimType, PrimGenBOXObject, PrimGenCONEObject, , PrimGenCONE2Object,
PrimGenCYLINOObject, PrimGenSPHEREObject, , PrimGenTORUSObject,

4.2.309  PrimGenObjectFromPolyList  (primitv1.c:1458)

IPObjectStruct *PrimGenObjectFromPolyList(IPObjectStruct *PObjList)

PObjList:  List of polygonal objects.
Returns:  A single object containing all polygons in all provided objects, by a simple union.
Description:  Routine to create an OBJECT directly from set of specified polys.  No test is made for the validity
of the model in any sense.

4.2.310  PrimGenPOLYDISKObject  (primitv1.c:1248)

IPObjectStruct *PrimGenPOLYDISKObject(const IrtVecType Nrml,
    const IrtVecType Trns,
    IrtRType R)

Nrml:  Normal to the plane this disk included in.
Trns:  A translation factor of the center of the disk.
R:  Radius of the disk.
Returns:  A single polygon object - a disk.
Description:  Routine to create a POLYDISK geometric object defined by the normal N and the translation
vector T.  The object is a planar disk (a circle of _PrimGlblResolution points in it...) and its radius is equal to R.
The normal direction is assumed to point to the inside of the object.  See also PrimSetResolution on fineness control
of approximation of the primitive using flat faces.

4.2.311  PrimGenPOLYGONObject  (primitv1.c:1323)

IPObjectStruct *PrimGenPOLYGONObject(IPObjectStruct *PObjList, int IsPolyline)

PObjList:  List of vertices/points to construct as a polygon/line.
IsPolyline:  If TRUE, make a polyline, otherwise a polygon.
Returns:  A polygon/line constructed from PObjList.
Description:  Routine to create a POLYGON/LINE directly from its specified vertices.  The validity of the
elements in the provided list is tested to make sure they are vectors or points.  No test is made to make sure all
vertices are on one plane, and that no two vertices are similar.
4.2.312  PrimGenPolygon3Vrtx  (primitv1.c:1691)

IPPolygonStruct *PrimGenPolygon3Vrtx(const IrtVecType V1,
const IrtVecType V2,
const IrtVecType V3,
const IrtVecType Vin,
int *VrtcsRvrsd,
IPPolygonStruct *Pnext)

V1, V2, V3: Three vertices of the constructed polygon.
Vin: A vertex that can be assumed to be inside the object for normal evaluation of the plane of polygon. Can be NULL in which case vrtcs order is kept.
VrtcsRvrsd: set to TRUE if has Vin and order of vertices is oriented in reverse.
Pnext: Next is chain of polygons, in linked list.
Returns: The constructed polygon.

Description: Routine to create a polygon out of a list of 3 vertices V1/2/3. The fourth vertex is inside (actually, this is not true, as this point will be in the positive part of the plane, which only locally in the object...) the object, so the polygon's normal direction can be evaluated uniquely. No test is made to make sure the 3 points are not co-linear... The points are placed in order.
See also: PrimGenPolygon4Vrtx, GMGenPolyline2Vrtx,

4.2.313  PrimGenPolygon4Vrtx  (primitv1.c:1561)

IPPolygonStruct *PrimGenPolygon4Vrtx(const IrtVecType V1,
const IrtVecType V2,
const IrtVecType V3,
const IrtVecType V4,
const IrtVecType Vin,
int *VrtcsRvrsd,
IPPolygonStruct *Pnext)

V1, V2, V3, V4: Four vertices of the constructed polygon.
Vin: A vertex that can be assumed to be inside the object for normal evaluation of the plane of polygon. Can be NULL in which case vrtcs order is kept.
VrtcsRvrsd: Set to TRUE if has Vin and order of vertices is oriented in reverse.
Pnext: Next is chain of polygons, in linked list.
Returns: The constructed polygon.

Description: Routine to create a polygon out of a list of 4 vertices V1/2/3/4. The fifth vertex is inside (actually, this is not true, as this point will be in the positive part of the plane, which only locally in the object...) the object, so the polygon's normal direction can be evaluated uniquely. No test is made to make sure the 4 points are co-planar... The points are placed in order.
See also: PrimGenPolygon3Vrtx, PrimGenPolygon4Vrtx2, GMGenPolyline2Vrtx,

4.2.314  PrimGenPolygon4Vrtx2  (primitv1.c:1606)

IPPolygonStruct *PrimGenPolygon4Vrtx2(const IrtVecType V1,
const IrtVecType V2,
const IrtVecType V3,
const IrtVecType V4,
const IrtVecType Vin,
int *VrtcsRvrsd,
int *Singular,
IPPolygonStruct *Pnext)

V1, V2, V3, V4: Four vertices of the constructed polygon.
Vin: A vertex that can be assumed to be inside the object for normal evaluation of the plane of polygon. Can be NULL in which case vrtcs order is kept.
**VrtcSRevrsd:** Set to TRUE if has Vin and order of vertices is oriented in reverse.

**Singular:** -1 if regular, index of singular vertex if this rectangle is singular and a triangle is returned.

**Pnext:** Next is chain of polygons, in linked list.

**Returns:** The constructed polygon.

**Description:** Routine to create a polygon out of a list of 4 vertices V1/2/3/4. The fifth vertex is inside (actually, this is not true, as this point will be in the positive part of the plane, which only locally in the object...) the object, so the polygon’s normal direction can be evaluated uniquely. No test is made to make sure the 4 points are co-planar... The points are placed in order.

See also: PrimGenPolygon3Vrtx, PrimGenPolygon4Vrtx, GMGenPolyline2Vrtx,

### 4.2.315 PrimGenPolyline4Vrtx (primitv3.c:1012)

```c
IPPolygonStruct *PrimGenPolyline4Vrtx(const IrtVecType V1,
const IrtVecType V2,
const IrtVecType V3,
const IrtVecType V4,
IPPolygonStruct *Pnext)
```

**V1, V2, V3, V4:** Four vertices of the constructed polyline. V1 is duplicated as fifth last point as well.

**Pnext:** Next is chain of polyline, in linked list.

**Returns:** The constructed polygon.

**Description:** Routine to create a polyline out of a list of 4 vertices V1/2/3/4. No test is made to make sure the 4 points are co-planar... The points are placed in order.

See also: PrimGenPolyline4Vrtx, PrimGenPolygon3Vrtx, GMGenPolyline2Vrtx,

### 4.2.316 PrimGenRULEDObject (primitv2.c:687)

```c
IPObjectStruct *PrimGenRULEDObject(const IPObjectStruct *Cross1,
const IPObjectStruct *Cross2)
```

**Cross1, Cross2:** Polylines to rule a surface between. If both cross sections are in the XY plane, a single planar polygon is constructed. Otherwise, the number of vertices in Cross1 and Cross2 must be equal and a rectangular polygon is constructed for each edge.

**Returns:** A single polygon representing the ruled surface.

**Description:** Routine to create a ruled surface out of the given two cross sections.

See also: PrimSetResolution, PrimGenSURFREVObject, PrimGenSURFREVAxisObject, PrimGenSURFREV2Object, PrimGenSURFREV2AxisObject, PrimGenEXTRUDEObject,

### 4.2.317 PrimGenSPHEREObject (primitv1.c:903)

```c
IPObjectStruct *PrimGenSPHEREObject(const IrtVecType Center, IrtRType R)
```

**Center:** Center location of SPHERE.

**R:** Radius of sphere.

**Returns:** A SPHERE Primitive.

**Description:** Routine to create a SPHERE geometric object defined by Center, the center of the sphere and R, its radius. See also PrimSetResolution on fineness control of approximation of the primitive using flat faces.

See also: PrimSetGeneratePrimType, PrimGenBOXObject, PrimGenBOXObject, PrimGenCONEObject, PrimGenCONE2Object, PrimGenCYLINDObject, PrimGenTORUSObject,
4.2.318 PrimGenSURFREV2AxisObject (primitv2.c:393)

**IPObjectStruct** *PrimGenSURFREV2AxisObject(IPObjectStruct *Cross,  
 IrtRType StartAngle,  
 IrtRType EndAngle,  
 const IrtVecType Axis) 

Cross: To rotate around Axis axis forming a surface of revolution.

StartAngle, EndAngle: angles of portion of surface of revolution, in degrees, between 0 and 360.

Axis: Axis of rotation.

Returns: A (portion of) a surface of revolution.

Description: Routine to create a surface of revolution by rotating the given cross section along the Axis axis. Input can either be a polygon/line or a freeform curve object.

See also: PrimSetResolution, PrimGenSURFREVObject, PrimGenSURFREVAxisObject, PrimGenSURFREV2Object, PrimGenEXTRUDEObject, PrimGenRULEDObject,

4.2.319 PrimGenSURFREV2Object (primitv2.c:234)

**IPObjectStruct** *PrimGenSURFREV2Object(const IPObjectStruct *Cross,  
 IrtRType StartAngle,  
 IrtRType EndAngle)

Cross: To rotate around the Z axis forming a surface of revolution.

StartAngle, EndAngle: angles of portion of surface of revolution, in degrees, between 0 and 360.

Returns: A (portion of) a surface of revolution.

Description: Routine to create a surface of revolution by rotating the given cross section along the Z axis, from StartAngle to EndAngle. Input can either be a polygon/line or a freeform curve object. If input is a polyline/gon, it must never be coplanar with the Z axis.

See also: PrimSetResolution, PrimGenSURFREVObject, PrimGenSURFREVAxisObject, , PrimGenSURFREV2Object, PrimGenEXTRUDEObject, PrimGenRULEDObject,

4.2.320 PrimGenSURFREVAxisObject (primitv2.c:186)

**IPObjectStruct** *PrimGenSURFREVAxisObject(IPObjectStruct *Cross,  
 const IrtVecType Axis)

Cross: To rotate around Axis axis forming a surface of revolution.

Axis: Axis of rotation.

Returns: A surface of revolution.

Description: Routine to create a surface of revolution by rotating the given cross section along the Axis axis. Input can either be a polygon/line or a freeform curve object.

See also: PrimSetResolution, PrimGenSURFREVObject, PrimGenSURFREV2Object, , , PrimGenSURFREV2AxisObject, PrimGenEXTRUDEObject, PrimGenRULEDObject,

4.2.321 PrimGenSURFREVObject (primitv2.c:44)

**IPObjectStruct** *PrimGenSURFREVObject(const IPObjectStruct *Cross)

Cross: To rotate around the Z axis forming a surface of revolution.

Returns: A surface of revolution.

Description: Routine to create a surface of revolution by rotating the given cross section along the Z axis. Input can either be a polygon/line or a freeform curve object. If input is a polyline/gon, it must never be coplanar with the Z axis.

See also: PrimSetResolution, PrimGenSURFREVAxisObject, PrimGenSURFREV2Object, , , PrimGenSURFREV2AxisObject, PrimGenEXTRUDEObject, PrimGenRULEDObject,
4.2.322  PrimGenTORUSObject  (primitv1.c:1103)

IPObjectStruct *PrimGenTORUSObject(const IrtVecType Center,
const IrtVecType Normal,
IrtRType Rmajor,
IrtRType Rminor)

Center: Center location of the TORUS primitive.
Normal: Normal to the major plane of the torus.
Rmajor: Major radius of torus.
Rminor: Minor radius of torus.
Returns: A TOURS Primitive.

Description: Routine to create a TORUS geometric object defined by Center - torus 3d center point, the main torus plane normal Normal, major radius Rmajor and minor radius Rminor (Tube radius). Teta runs on the major circle, Fee on the minor one. Then

\[ X = (R_{major} + R_{minor} \cos(Fee)) \cos(Teta) \]
\[ Y = (R_{major} + R_{minor} \cos(Fee)) \sin(Teta) \]
\[ Z = R_{minor} \sin(Fee) \]

See also PrimSetResolution on fineness control of approximation of the primitive using flat faces.
See also: PrimSetGeneratePrimType, PrimGenBOXObject, PrimGenGBOXObject, PrimGenCONEObject, PrimGenCONE2Object, PrimGenCYLINObject, PrimGenSPHEREObject,

4.2.323  PrimGenTransformController2D  (primitv3.c:120)

IPObjectStruct *PrimGenTransformController2D(const GMBBBboxStruct *BBox,
int HasRotation,
int HasTranslation,
int HasScale)

BBox: Dimensions of constructed box.
HasRotation: Should we add rotational handles?
HasTranslation: Should we add translation handles?
HasScale: Should we add scale handles?
Returns: A list object with the proper sub-objects named as R for (Z) rotations, \{X,Y\} for translations.

Description: Constructs a 2D bounding box with transformation handles to control the way an object is transformed in the plane.
See also: PrimGenTransformController, PrimGenTransformController2DCrvs,

4.2.324  PrimGenTransformController2DCrvs  (primitv3.c:260)

IPObjectStruct *PrimGenTransformController2DCrvs(const GMBBBboxStruct *BBox)

BBox: Dimensions of constructed box (only XY).
Returns: A list object with the proper sub-objects named as R for (Z) rotations, \{X,Y\} for translations.

Description: Constructs a 2D bounding box with transformation handles to control the way an object is transformed in the plane. This transform is formed out of curves only.
See also: PrimGenTransformController, PrimGenTransformController2D,
4.2.325  PrimGenTransformControllerBox (primitv3.c:623)

IPObjectStruct *PrimGenTransformControllerBox(const GMBBBboxStruct *BBox,
int HasRotation,
int HasTranslation,
int HasUniformScale,
IrtRType BoxOpacity,
IrtRType RelTesalate)

BBox: Dimensions of constructed box.
HasRotation: Should we add rotational handles?
HasTranslation: Should we add translation handles?
HasUniformScale: Should we add uniform scale handles?
BoxOpacity: Opacity of the bbox itself, between zero and one. If one, no bbox geometry is created.
RelTesalate: Relative tessallations of elements of the handles. 1.0 for default values.
Returns: A list object with the proper sub-objects named as R\{X,Y,Z\} for rotations, T\{X,Y,Z\} for translations, and SXYZ for scaling.

Description: Constructs a bounding box with transformation handles to control the way an object is transformed.
See also: PrimGenTransformController2D, PrimGenTransformController2DCrvs, PrimGenTransformControllerSphere,

4.2.326  PrimGenTransformControllerSphere (primitv3.c:437)

IPObjectStruct *PrimGenTransformControllerSphere(const GMBBBboxStruct *BBox,
int HasRotation,
int HasTranslation,
int HasUniformScale,
IrtRType BoxOpacity,
IrtRType RelTesalate)

BBox: Dimensions of constructed box.
HasRotation: Should we add rotational handles?
HasTranslation: Should we add translation handles?
HasUniformScale: Should we add uniform scale handles?
BoxOpacity: Opacity of the bbox itself, between zero and one. If one, no bbox geometry is created.
RelTesalate: Relative tessallations of elements of the handles. 1.0 for default values.
Returns: A list object with the proper sub-objects named as R\{X,Y,Z\} for rotations, T\{X,Y,Z\} for translations, and SXYZ for scaling.

Description: Constructs a bounding box with transformation handles to control the way an object is transformed.
See also: PrimGenTransformController2D, PrimGenTransformController2DCrvs, PrimGenTransformControllerSphere,

4.2.327  PrimSetGeneratePrimType (primitv1.c:69)

int PrimSetGeneratePrimType(int SetGeneratePrimitive)

SetGeneratePrimitive: 0 - polygonal primitive. 1 - surface primitive. 2 - model primitive. 3 - trivariate volumetric primitive.
Returns: Old value of PolygonalPrimitive flag.

Description: Sets the way primitives are constructed - as polygons, as a freeform surface, or as a model surface.
See also: PrimSetSurfacePrimitiveRational, PrimGenBOXObject, PrimGenGBOXObject, PrimGenCONEObject, PrimGenCONE2Object, PrimGenCYLINOObject, PrimGenSPHEREObject, PrimGenTORUSObject,
4.2.328 PrimSetResolution (primitv1.c:1779)

```c
int PrimSetResolution(int Resolution)

  Resolution: To set as new resolution for all primitive constructors.
  Returns: Old resolution value.
  Description: Routine to set the polygonal resolution (fineness). Resolution roughly the number of edges a circular primitive will have along the entire circle.
```

4.2.329 PrimSetSurfacePrimitiveRational (primitv1.c:97)

```c
int PrimSetSurfacePrimitiveRational(int SurfaceRational)

  SurfaceRational: TRUE for rational, FALSE for integral form.
  Returns: Old value of PolygonalPrimitive flag.
  Description: Sets the way surface primitives are constructed - as exact rational form or approximated polynomial (integral) form.
  See also: PrimSetGeneratePrimType, PrimGenBOXObject, PrimGenGBOXObject, PrimGenCONEObject, PrimGenCONE2Object, PrimGenCYLINObject, PrimGenSPHEREObject, PrimGenTORUSObject,
```

4.2.330 _GMFitGetFittingModel (fit2pts.c:264)

```c
const GMFitFittingShapeStruct * _GMFitGetFittingModel(GMFittingModelType FittingModel)

  FittingModel: The enum of the needed fitting model.
  Returns: A pointer to a statically allocated fitting struct.
  Description: This function returns the matching GMFitFittingShapeStruct to the given enum, or NULL if none exist. THIS POINTER MUST NOT BE FREED!!!
  See also: FitData, FitDataWithOutliers,
```

4.2.331 main (geombsc.c:3500)

```c
void main(void)

  Returns: void
  Description: Test routines for the polynomial equation solvers.
```
Chapter 5

Graphics Library, grap_lib

5.1 General Information

This library handles general drawing and display algorithms, including tesselation of all geometric objects, such as curves and surfaces, into displayable primitives, i.e. polygons and polylines.

5.2 Library Functions

5.2.1 IGActiveFreeNamedAttribute (grap_gen.c:465)

void IGActiveFreeNamedAttribute(IPObjectStruct *PObj, char *Name)

PObj: Objects to remove Named attribute from.
Name: Name of attribute to remove.
Returns: void
Description: Free attribute named Name from Pobj in all object’s hierarchy.

5.2.2 IGActiveFreePolyIsoAttribute (grap_gen.c:410)

void IGActiveFreePolyIsoAttribute(IPObjectStruct *PObj,
int FreePolygons,
int FreeIsolines,
int FreeSketches,
int FreeCtlMesh)

PObj: Object to remove Named attribute from.
FreePolygons: If TRUE free all polygonal approximations of freeforms.
FreeIsolines: If TRUE free all isocurve approximations of freeforms.
FreeSketches: If TRUE free all sketching strokes of freeforms.
FreeCtlMesh: If TRUE free all control meshes of freeforms.
Returns: void
Description: Free attribute named Name from all objects in PObj object’s hierarchy.

5.2.3 IGActiveListFreeNamedAttribute (grap_gen.c:379)

void IGActiveListFreeNamedAttribute(IPObjectStruct *POobjs, char *Name)

POobjs: Objects to remove Named attribute from.
Name: Name of attribute to remove.
Returns: void
Description: Free attribute named Name from all objects in POobjs object’s hierarchy.
5.2.4  IGActiveListFreePolyIsoAttribute (grap_gen.c:354)

```c
void IGActiveListFreePolyIsoAttribute(IPObjStruct *PObj,
    int FreePolygons,
    int FreeIsolines,
    int FreeSketches,
    int FreeCtlMesh)
```

**PObj**: Objects to remove Named attribute from.

**FreePolygons**: If TRUE free all polygonal approximations of freeforms.

**FreeIsolines**: If TRUE free all isocurve approximations of freeforms.

**FreeSketches**: If TRUE free all sketching strokes of freeforms.

**FreeCtlMesh**: If TRUE free all control meshes of freeforms.

**Returns**: void

**Description**: Free attribute named Name from all objects in PObj's object’s hierarchy and linked list.

5.2.5  IGClearObjTextureMovieAttr (grap_gen.c:1411)

```c
void IGClearObjTextureMovieAttr(IPObjStruct *PObj)
```

**PObj**: Object to remove all texture/movie attributes.

**Returns**: void

**Description**: Clears all texture/movie attributes, if any from PObj.

**See also**: IGInitSrfTexture, IGInitSrfMovie,

5.2.6  IGConfirmConvexPolys (grap_gen.c:180)

```c
void IGConfirmConvexPolys(IPObjStruct *PObj, int Depth)
```

**PObj**: Objects to make sure all its polygons are convex.

**Depth**: Of object hierarchy.

**Returns**: void

**Description**: Make sure all polygons are convex.

5.2.7  IGDefaultProcessEvent (grap_gen.c:1453)

```c
int IGDefaultProcessEvent(IGGraphicEventType Event, IrtRType *ChangeFactor)
```

**Event**: Event to process.

**ChangeFactor**: A continuous scale between -1 and 1 to quantify the change to apply according to the event type. For composed operation contains both X and Y information.

**Returns**: TRUE if refresh is needed.

**Description**: Processes the given event. Returns TRUE if redraw of view window is needed.

**See also**: IGHandleContinuousMotion,

5.2.8  IGDefaultStateHandler (grap_gen.c:1580)

```c
int IGDefaultStateHandler(int State, int StateStatus, int Refresh)
```

**State**: State event type to handle.

**StateStatus**: IG_STATE_OFF, IG_STATE_ON, IG_STATE_TGL for turning off, on or toggling current value.

**IG_STATE_DEC and IG_STATE_INC serves as dec./inc. factors.

**Refresh**: Not used.

**Returns**: TRUE if needs to refresh.

**Description**: Handle the event of a pop up window. This is the default handler which can be invoked by other specific handlers for event they do not care about.
5.2.9 **IGDfltDrawPoly** *(drawpoly.c:33)*

```c
static void IGDfltDrawPoly(IPObjectStruct *PObj)
PObj: A poly object to draw.
Returns: void
Description: Draw a single Poly object using current modes and transformations.
```

5.2.10 **IGDrawCurve** *(draw_crv.c:36)*

```c
void IGDrawCurve(IPObjectStruct *PObj)
PObj: A curve object to draw.
Returns: void
Description: Draw a single Curve object using current modes and transformations. Curve must be with either E3 or P3 point type and must be a NURB curve. Piecewise linear approximation is cached under "isoline" and "ctlpoly" attributes of PObj.
```

5.2.11 **IGDrawCurveGenPolylines** *(draw_crv.c:99)*

```c
void IGDrawCurveGenPolylines(IPObjectStruct *PObj)
PObj: A curve(s) object.
Returns: void
Description: Generates the polyline approximation of the curve on the fly if needed and display it.
```

5.2.12 **IGDrawModel** *(draw_mdl.c:45)*

```c
void IGDrawModel(IPObjectStruct *PObj)
PObj: A model object to draw.
Returns: void
Description: Draw a single model object using current modes and transformations. Piecewise linear approximation is cached under "isoline" and "ctlmesh" attributes of PObj. Polygonal approximation is saved under "polygons".
```

5.2.13 **IGDrawModelGenPolygons** *(draw_mdl.c:137)*

```c
void IGDrawModelGenPolygons(IPObjectStruct *PObj)
PObj: A model(s) object.
Returns: void
Description: Generates the polygonal approximation of the model on the fly if needed and display it.
```

5.2.14 **IGDrawPolyBoundary** *(grap_gen.c:843)*

```c
void IGDrawPolyBoundary(IPObjectStruct *PObj)
PObj: A polygonal object.
Returns: void
Description: Draw the boundary edges of a polygonal object.
```
5.2.15  **IGDrawPolyContours** *(grapgen.c:905)*

void IGDrawPolyContours(IPObjectStruct *PObj)

PObj: A polygonal object.
Returns: void
Description: Draw XY parallel contours to the given model.

5.2.16  **IGDrawPolyContoursSetup** *(grapgen.c:878)*

int IGDrawPolyContoursSetup(IrtRType x, IrtRType y, IrtRType z, int n)

x, y, z: Direction of contouring.
n: Number of desired contours.
Returns: Old number of contours.
Description: Setup information for contouring.

5.2.17  **IGDrawPolyDiscontinuities** *(grapgen.c:1106)*

void IGDrawPolyDiscontinuities(IPObjectStruct *PObj)

PObj: A polyline object.
Returns: void
Description: Draw the discont edges of an object, if any.

5.2.18  **IGDrawPolyIsophotes** *(grapgen.c:1033)*

void IGDrawPolyIsophotes(IPObjectStruct *PObj)

PObj: A polygonal object.
Returns: void
Description: Draw Isophotes from the Z direction to the given model.

5.2.19  **IGDrawPolyIsophotesSetup** *(grapgen.c:1006)*

int IGDrawPolyIsophotesSetup(IrtRType x, IrtRType y, IrtRType z, int n)

x, y, z: Direction of isophotes' view.
n: Number of desired isophotes.
Returns: Old number of isophotes.
Description: Setup information for isophotes' drawings.

5.2.20  **IGDrawPolySilhBndry** *(grapgen.c:785)*

void IGDrawPolySilhBndry(IPObjectStruct *PObj)

PObj: A polygonal object.
Returns: void
Description: Draw the boundary and silhouette edges of a polygonal object.
5.2.21  IGDrawPolySilhouette (grap_gen.c:804)

void IGDrawPolySilhouette(IPObjectStruct *PObj)
    PObj: A polygonal object.
    Returns: void
    Description: Draw the silhouette edges of a polygonal object.

5.2.22  IGDrawPolygonSketches (grap_gen.c:712)

void IGDrawPolygonSketches(IPObjectStruct *PObj)
    PObj: A surface(s) object.
    Returns: void
    Description: Generates a sketch like drawing of the surface on the fly if needed and display it.

5.2.23  IGDrawString (draw_str.c:31)

void IGDrawString(IPObjectStruct *PObj)
    PObj: A string object to draw.
    Returns: void
    Description: Draw a single string object using current modes and transformations.

5.2.24  IGDrawSurface (draw_srf.c:54)

void IGDrawSurface(IPObjectStruct *PObj)
    PObj: A surface object to draw.
    Returns: void
    Description: Draw a single surface object using current modes and transformations. Piecewise linear approximation is cashed under "Isoline??Res" and "vtlmesh" attributes of PObj. Polygonal approximation is saved under "Polygons??Res".

5.2.25  IGDrawSurfaceGenPolygons (draw_srf.c:158)

void IGDrawSurfaceGenPolygons(IPObjectStruct *PObj)
    PObj: A surface(s) object.
    Returns: void
    Description: Generates the polygonal approximation of the surface on the fly if needed and display it.

5.2.26  IGDrawTriangGenSrfPolygons (drawtris.c:121)

void IGDrawTriangGenSrfPolygons(IPObjectStruct *PObj)
    PObj: A triangular surface(s) object.
    Returns: void
    Description: Generates the polygonal approximation of the triangular surface on the fly if needed and display it.
5.2.27 IGDrawTriangSrf (drawtris.c:43)

```c
void IGDrawTriangSrf(IPObjectStruct *PObj)

PObj: A triangular surface object to draw.

Returns: void

Description: Draw a single triangular surface object using current modes and transformations. Piecewise linear approximation is cached under "isoline" and "ctlmesh" attributes of PObj. Polygonal approximation is saved under "polygons".
```

5.2.28 IGDrawTrimSrf (drawtsrf.c:49)

```c
void IGDrawTrimSrf(IPObjectStruct *PObj)

PObj: A trimmed surface object to draw.

Returns: void

Description: Draw a single trimmed surface object using current modes and transformations. Piecewise linear approximation is cached under "isoline" and "ctlmesh" attributes of PObj. Polygonal approximation is saved under "polygons".
```

5.2.29 IGDrawTrimSrfGenPolygons (drawtsrf.c:142)

```c
void IGDrawTrimSrfGenPolygons(IPObjectStruct *PObj)

PObj: A trimmed surface(s) object.

Returns: void

Description: Generates the polygonal approximation of the trimmed surface on the fly if needed and display it.
```

5.2.30 IGDrawTrivar (drawtriv.c:45)

```c
void IGDrawTrivar(IPObjectStruct *PObj)

PObj: A trivariate function object to draw.

Returns: void

Description: Draw a single trivariate function object using current modes and transformations. Piecewise linear approximation is cached under "isoline" and "ctlmesh" attributes of PObj. Polygonal approximation is saved under "polygons".
```

5.2.31 IGDrawTrivarGenSrfPolygons (drawtriv.c:135)

```c
void IGDrawTrivarGenSrfPolygons(IPObjectStruct *PObj)

PObj: A trivariate(s) object.

Returns: void

Description: Generates the polygonal approximation of the trivariate on the fly if needed and display it.
```
5.2.32  **IGFindMinimalDist** (grapgen.c:582)

```c
IrtRType IGFindMinimalDist(IPObjectStruct *PObj, IPPolygonStruct **MinPl, IrtPtType MinPt, int *MinPlIsPolyline, IrtPtType LinePos, IrtVecType LineDir, IrtRType *HitDepth)
```

**PObj**: List of objects to search for a minimal distance.

**MinPl**: Poly with the minimal distance in PObj.

**MinPt**: Closest point on the picked object.

**MinPlIsPolyline**: TRUE if MinPl is a polyline, FALSE if a polygon.

**LinePos**: A point on the line to test against.

**LineDir**: The direction of the line.

**HitDepth**: In case of zero distance (the ray hits a polygon, update the closest depth.

**Returns**: The minimal distance found to the line.

**Description**: Finds the minimal distance in PObj to the line defined by LinePos and LineDir.

5.2.33  **IGGenPolygonSketches** (grapgen.c:744)

```c
IPObjectStruct *IGGenPolygonSketches(IPObjectStruct *PObj, IrtRType FineNess)
```

**PObj**: A surface(s) object.

**FineNess**: Relative fineness to approximate PObj with.

**Returns**: The sketch data.

**Description**: Generates a sketch like drawing for the given object with the prescribed fineness.

5.2.34  **IGGetObjIsoLines** (grapgen.c:1138)

```c
IPObjectStruct *IGGetObjIsoLines(IPObjectStruct *PObj)
```

**PObj**: To get the iso curves' approximation

**Returns**: The iso curve's approximation.

**Description**: Get the proper isoparametric curve approximation of the object.

5.2.35  **IGGetObjPolygons** (grapgen.c:1167)

```c
IPObjectStruct *IGGetObjPolygons(IPObjectStruct *PObj)
```

**PObj**: To get the polygonal approximation

**Returns**: The polygonal approximation.

**Description**: Get the proper polygonal approximation of the object.

5.2.36  **IGInitSrfMovie** (grapgen.c:1294)

```c
int IGInitSrfMovie(IPObjectStruct *PObj)
```

**PObj**: Object to extract its texture mapping movie if has one.

**Returns**: TRUE if object has texture mapping movie, FALSE otherwise.

**Description**: Reads in a texture mapping movie if object has ”pmovie” attribute and set up the texture movie for further processing.

**See also**: IGInitSrfTexture, IGClearObjTextureMovieAttr,
5.2.37  **IGInitSrfTexture** (grap_gen.c:1200)

```c
int IGInitSrfTexture(IPObjectStruct *PObj)

PObj: Object to extract its texture mapping function if has one.

**Returns:** TRUE if object has texture mapping, FALSE otherwise.

**Description:** Reads in a texture mapping image if object has "ptexture" attribute and set up the texture for further processing.

See also: IGInitSrfMovie, IGClearObjTextureMovieAttr,
```

5.2.38  **IGLoadGeometry** (grap_gen.c:232)

```c
IPObjectStruct *IGLoadGeometry(const char **FileNames, int NumFiles)

FileNames: Names of files from which to read the geometry.
NumFiles: Number of files in array of names FileNames.

**Returns:** Read geometry, NULL if error or no geometry.

**Description:** Get data. This function also updates the following global variables: + IPViewMat, IPPrspMat are update with the respective matrices, if found. + IPWasViewMat, IPWasPrspMat are set to TRUE if above matrices were found. + IGGlblLastProcessMat is updated with the most current matrix value. + IGGlblViewMode is updated with view mode - perspective or orthographic.

See also: IPGetDataFiles,
```

5.2.39  **IGSaveCurrentMat** (grap_gen.c:283)

```c
void IGSaveCurrentMat(int ViewMode, char *Name)

ViewMode: Either perspective or orthographic.
Name: File name to save current view at.

**Returns:** void

**Description:** Saves the current viewing matrices.

See also: IGSendMatDataFiles,
```

5.2.40  **IGSetCtlMeshPostFunc** (grap_gen.c:2170)

```c
IGDrawUpdateFuncType IGSetCtlMeshPostFunc(IGDrawUpdateFuncType Func)

Func: New callback function to use, or NULL to disable.

**Returns:** Old callback function used.

**Description:** Sets a call back function to handle setting after control mesh draw.
```

5.2.41  **IGSetCtlMeshPreFunc** (grap_gen.c:2147)

```c
IGDrawUpdateFuncType IGSetCtlMeshPreFunc(IGDrawUpdateFuncType Func)

Func: New callback function to use, or NULL to disable.

**Returns:** Old callback function used.

**Description:** Sets a call back function to handle setting before control mesh draw.
5.2.42  **IGSetSketchPostFunc** *(grap_gen.c:2124)*

IGDrawUpdateFuncType IGSetSketchPostFunc(IGDrawUpdateFuncType Func)

**Func**: New callback function to use, or NULL to disable.

**Returns**: Old callback function used.

**Description**: Sets a call back function to handle setting after sketch style draw.

5.2.43  **IGSetSketchPreFunc** *(grap_gen.c:2101)*

IGDrawUpdateFuncType IGSetSketchPreFunc(IGDrawUpdateFuncType Func)

**Func**: New callback function to use, or NULL to disable.

**Returns**: Old callback function used.

**Description**: Sets a call back function to handle setting before sketch style draw.

5.2.44  **IGSetSrfPolysPostFunc** *(grap_gen.c:2032)*

IGDrawUpdateFuncType IGSetSrfPolysPostFunc(IGDrawUpdateFuncType Func)

**Func**: New callback function to use, or NULL to disable.

**Returns**: Old callback function used.

**Description**: Sets a call back function to handle setting after polygons are drawn.

5.2.45  **IGSetSrfPolysPreFunc** *(grap_gen.c:2008)*

IGDrawUpdateFuncType IGSetSrfPolysPreFunc(IGDrawUpdateFuncType Func)

**Func**: New callback function to use, or NULL to disable.

**Returns**: Old callback function used.

**Description**: Sets a call back function to handle setting before polygons are drawn.

5.2.46  **IGSetSrfWirePostFunc** *(grap_gen.c:2078)*

IGDrawUpdateFuncType IGSetSrfWirePostFunc(IGDrawUpdateFuncType Func)

**Func**: New callback function to use, or NULL to disable.

**Returns**: Old callback function used.

**Description**: Sets a call back function to handle setting after wireframe draw.

5.2.47  **IGSetSrfWirePreFunc** *(grap_gen.c:2055)*

IGDrawUpdateFuncType IGSetSrfWirePreFunc(IGDrawUpdateFuncType Func)

**Func**: New callback function to use, or NULL to disable.

**Returns**: Old callback function used.

**Description**: Sets a call back function to handle setting before wireframe draw.
5.2.48 **IGSketchDrawPolygons** (sketches.c:780)

```c
void IGSketchDrawPolygons(IPObjectStruct *PObjSketches)
    PObjSketches: A sketches object.
    Returns: void
    Description: Generates a sketch like drawing of the polygonal object, on the fly if needed, and display it.
```

5.2.49 **IGSketchDrawSurface** (sketches.c:165)

```c
void IGSketchDrawSurface(IPObjectStruct *PObjSketches)
    PObjSketches: A sketches object.
    Returns: void
    Description: Generates a sketch like drawing of a surface.
```

5.2.50 **IGSketchGenPolyImportanceSketches** (sketches.c:1128)

```c
IPObjectStruct *IGSketchGenPolyImportanceSketches(IPObjectStruct *PObj,
                                                IGSketchParamStruct *SketchParams,
                                                IrtRType FineNess)
    PObj: Polygonal model to process for importance.
    SketchParams: NPR sketch parameters' info structure.
    FineNess: Of marching steps on the surface.
    Returns: Traced strokes as piecewise linear approximations.
    Description: Precompute the strokes that emphasize important features in the geometry using an importance
    measure that looks at the diherdal angle of adjacent polygons.
    See also: IGSketchGenPolySketches,
```

5.2.51 **IGSketchGenPolySketches** (sketches.c:810)

```c
IPObjectStruct *IGSketchGenPolySketches(IPObjectStruct *PlObj,
                                          IrtRType FineNess,
                                          int Importance)
    PlObj: The polygonal object to process.
    FineNess: Relative fineness to approximate the sketchs of PlObj with.
    Importance: If TRUE, we should also compute importance for each point.
    Returns: The sketch data.
    Description: Generates a sketch like drawing for the given polygonal object.
    See also: IGSketchGenPolyImportanceSketches,
```

5.2.52 **IGSketchGenSrfSketches** (sketches.c:406)

```c
IPObjectStruct *IGSketchGenSrfSketches(CagdSrfStruct *Srf,
                                         IrtRType FineNess,
                                         IPObjectStruct *PObj,
                                         int Importance)
    Srf: A surface.
    FineNess: Relative fineness to approximate the sketches with.
    PObj: Object Srf originated from.
    Importance: If TRUE, we should also compute importance for each point.
    Returns: The sketch data.
    Description: Generates a sketch like drawing for the given surface with the fineness prescribed.
5.2.53 **IGUpdateFPS** (grap_gen.c:1972)

```c
void IGUpdateFPS(int Start)
{
    Start: TRUE to start timing, FALSE to end it.
    Returns: void
    Description: Update the current frame per second.
}
```

5.2.54 **IGUpdateObjectBBox** (grap_gen.c:503)

```c
void IGUpdateObjectBBox(IPObjectStruct *PObj)
{
    PObj: Objects to update its BBOX.
    Returns: void
    Description: Update the BBox of the given object if has none.
}
```

5.2.55 **IGUpdateViewConsideringScale** (grap_gen.c:539)

```c
void IGUpdateViewConsideringScale(IrtHmgnMatType Mat)
{
    Mat: N.S.F.I.
    Returns: void
    Description: Updates the global view matrix IPViewMat with given matrix Mat while preserving the scaling factor in the original global view.
}
```
Chapter 6

Model Library, mdl_lib

6.1 General Information

This library provides the necessary tools to represent and process models. Models are sets of trimmed surfaces forming a closed 2-manifold shell. Models are typically the result of Boolean operations over freeform (trimmed) NURBs geometry but can also be constructed directly or via other schemes.

6.2 Library Functions

6.2.1 MdlBoolClassifyNonInterTrimSrfs (mdl2bool.c:1220)

```c
void MdlBoolClassifyNonInterTrimSrfs(MdlModelStruct *Model)
```

**Model**: Model in which to classify the non-intersecting trimming curves.

**Returns**: void

**Description**: Classify references of trimming curves in trimmed surfaces that are not interested in this Boolean operation.

1. Go over all refs and search for a reference of an old intersection that is classified on one srf side only and propagate to the second srf side.
2. Go over all trimming references in the second srf side and propagated the information.
3. While there are unclassified references go to 1.

6.2.2 MdlBoolClassifyTrimSrfLoops (mdl2bool.c:1034)

```c
int MdlBoolClassifyTrimSrfLoops(MdlTrimSrfStruct *TSrf,
                                CagdRType Tol,
                                CagdBType InsideOtherModel)
```

**TSrf**: A trimmed surface we need to update its trimming loops.

**Tol**: Tolerance to match end points of trimming curves.

**InsideOtherModel**: TRUE if we seek the inside of the other model (i.e. intersection operations), FALSE for outside (i.e. subtraction).

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: based on the new trimming curves, recreate the trimming loops of this trimmed surface. At this stage we assume the new intersecting curves only exists in the interior domain of trimmed surface (outside intersections were purged away). Further, the old existing trimming curves were split at the locations they intersect with the new intersection curves.
6.2.3 MdlBoolCleanUnusedTrimCrvsSrfs (mdl_bool.c:418)

```c
int MdlBoolCleanUnusedTrimCrvsSrfs(MdlModelStruct *Model)
```

**Model**: To process and clean unused trimming crvs/srfs in, in place.

**Returns**: Number of trimming curves that were purged.

**Description**: Clean unused trimming curves/surfaces in the model - trimming curves that are used by no trimming surface.

6.2.4 MdlBoolClipTSrfs2TrimDomain (mdl_bool.c:529)

```c
void MdlBoolClipTSrfs2TrimDomain(MdlModelStruct *Model)
```

**Model**: To clip its surfaces to their trimmed domain, in place.

**Returns**: void

**Description**: Clip the surfaces in the given model to the domain of the trimming curves (+ some epsilon).

6.2.5 MdlBoolSetOutputInterCrv (mdl_bool.c:1077)

```c
int MdlBoolSetOutputInterCrv(int OutputInterCurve)
```

**OutputInterCurve**: If TRUE only intersection curves are computed. If FALSE, full blown Boolean is applied.

**Returns**: Old OutputInterCurve value.

**Description**: Controls if intersection curves or full Boolean operation is to be performed on input models.

**See also**: MdlBooleanInterCrv, MdlBoolSetOutputInterCrvType

6.2.6 MdlBoolSetOutputInterCrvType (mdl_bool.c:1103)

```c
int MdlBoolSetOutputInterCrvType(int OutputInterCurveType)
```

**OutputInterCurveType**: 0 for Euclidean space, 1/2 for inter curves in Model1/2.

**Returns**: Old OutputInterCurveType value.

**Description**: Controls the type of intersection curves to return.

**See also**: MdlBooleanInterCrv, MdlBoolSetOutputInterCrv

6.2.7 MdlBoolTrimSrfIntersects (mdl2bool.c:1072)

```c
int MdlBoolTrimSrfIntersects(const MdlTrimSrfStruct *TSrf)
```

**TSrf**: Trimmed surface to examine if it intersects the other model.

**Returns**: TRUE if intersects, FALSE otherwise

**Description**: Returns TRUE if this trimmed surface intersects the other model in this Boolean operation.

6.2.8 MdlBooleanCut (mdl_bool.c:948)

```c
IPObjectStruct *MdlBooleanCut(const MdlModelStruct *Model1, const MdlModelStruct *Model2)
```

**Model1, Model2**: The two models to consider.

**Returns**: Resulting boolean.

**Description**: Computes the Boolean subtraction of two models.

**See also**: MdlBooleanSetTolerances,
6.2.9 MdlBooleanInterCrv (mdl_bool.c:1024)

CagdCrvStruct *MdlBooleanInterCrv(const MdlModelStruct *Model1,
const MdlModelStruct *Model2,
int InterType)

Model1, Model2: The two models to consider.
InterType: 0 for Euclidean space, 1/2 for inter curves in Model1/2.
Returns: Resulting intersection curves.
Description: Computes the intersection curve of two models.

6.2.10 MdlBooleanIntersection (mdl_bool.c:893)

IPObjectStruct *MdlBooleanIntersection(const MdlModelStruct *Model1,
const MdlModelStruct *Model2)

Model1, Model2: The two models to consider.
Returns: Resulting boolean.
Description: Computes the Boolean intersection of two models.
See also: MdlBooleanSetTolerances,

6.2.11 MdlBooleanMerge (mdl_bool.c:979)

IPObjectStruct *MdlBooleanMerge(const MdlModelStruct *Model1,
const MdlModelStruct *Model2,
CagdBType StitchBndries)

Model1, Model2: The two models to consider.
StitchBndries: TRUE to also stitch shared boundaries.
Returns: Resulting merged model.
Description: Computes the merge of two models. All surfaces and trimming curves are concatenated together and optionally shared boundaries are stitched together.
See also: MdlStitchModel,

6.2.12 MdlBooleanSetTolerances (mdl_bool.c:73)

void MdlBooleanSetTolerances(CagdRType SubdivTol,
CagdRType NumerTol,
CagdRType TraceTol)

SubdivTol, NumerTol, TraceTol: See MvarSrfSrfInter.
Returns: void
Description: Sets the tolerances to use in the boolean operations computations.
See also:

6.2.13 MdlBooleanSubtraction (mdl_bool.c:921)

IPObjectStruct *MdlBooleanSubtraction(const MdlModelStruct *Model1,
const MdlModelStruct *Model2)

Model1, Model2: The two models to consider.
Returns: Resulting boolean.
Description: Computes the Boolean subtraction of two models.
See also: MdlBooleanSetTolerances,
6.2.14 MdlBooleanUnion (mdl_bool.c:866)

```c
IPObjectStruct *MdlBooleanUnion(const MdlModelStruct *Model1,
                               const MdlModelStruct *Model2)
```

**Parameters:**
- `Model1`: The first model.
- `Model2`: The second model.

**Returns:**
A boolean that represents the result of the Boolean union of `Model1` and `Model2`.

**Description:**
Computes the Boolean union of two models.

**See also:** MdlBooleanIntersection.

6.2.15 MdlCnvrtMdl2TrimmedSrfs (mdlcnvrt.c:28)

```c
TrimSrfStruct *MdlCnvrtMdl2TrimmedSrfs(const MdlModelStruct *Model)
```

**Parameters:**
- `Model`: The model to convert.

**Returns:**
A list of trimming surfaces.

**Description:**
Converts the given model into a list of trimming surfaces.

**See also:** TrimCrvSegNew, TrimCrvNew, TrimsrfNew, MdlExtractUVCrv, MdlCnvrtSrf2Mdl, MdlCnvrtTrimmedSrf2Mdl.

6.2.16 MdlCnvrtSrf2Mdl (mdlcnvrt.c:136)

```c
MdlModelStruct *MdlCnvrtSrf2Mdl(const CagdSrfStruct *Srf)
```

**Parameters:**
- `Srf`: The surface to convert.

**Returns:**
A model.

**Description:**
Converts the given surface into a model.

**See also:** MdlCnvrtMdl2TrimmedSrfs, MdlCnvrtTrimmedSrf2Mdl.

6.2.17 MdlCnvrtTrimmedSrf2Mdl (mdlcnvrt.c:157)

```c
MdlModelStruct *MdlCnvrtTrimmedSrf2Mdl(const TrimSrfStruct *TSrf)
```

**Parameters:**
- `TSrf`: The trimmed surface to convert.

**Returns:**
A model.

**Description:**
Converts the given trimmed surface into a model.

**See also:** MdlCnvrtMdl2TrimmedSrfs, MdlCnvrtSrf2Mdl.

6.2.18 MdlCreateCubeSpherePrim (mdl_prim.c:613)

```c
int MdlCreateCubeSpherePrim(int CubeTopoSphere)
```

**Parameters:**
- `CubeTopoSphere`: TRUE to construct spheres using cube-topology.

**Returns:**
The old value setting.

**Description:**
Select to create sphere using cube-topology, if TRUE.
6.2.19 MdlDbg (mdl_dbg.c:27)

```c
void MdlDbg(void *Obj)
```

- **Obj**: A model object - to be printed to stderr.
- **Returns**: void
- **Description**: Prints model objects to stderr. Should be linked to programs for debugging purposes, so model objects may be inspected from a debugger.

6.2.20 MdlDbgMC (mdl_dbg.c:62)

```c
int MdlDbgMC(const MdlModelStruct *Mdl, int Format)
```

- **Mdl**: To dump to stderr/display all its trimming curves in UV space, for each surface.
- **Format**: 0 to write it to stderr all data, 1 to write it to stderr but only end points of trimming curves. 9 to display the data in a display device.
- **Returns**: TRUE if successful, FALSE otherwise.
- **Description**: Debug routine to dump to stderr/display the UV trimming curves of all surfaces in a given model.

6.2.21 MdlDbgRC (mdl_dbg.c:146)

```c
int MdlDbgRC(const MdlTrimSegRefStruct *Refs, int Format)
```

- **Refs**: To dump its trimming curves in UV space.
- **Format**: 0 to write it to stderr all data, 1 to write it to stderr but only end points of trimming curves. 9 to display the data in a display device.
- **Returns**: TRUE if successful, FALSE otherwise.
- **Description**: Debug routine to dump the UV trimming curves in the given ref. list.

6.2.22 MdlDbgRC2 (mdl_dbg.c:176)

```c
int MdlDbgRC2(const MdlTrimSegRefStruct *Refs,
               const MdlTrimSrfStruct *TSrf,
               int Format)
```

- **Refs**: To dump its trimming curves in UV space.
- **TSrf**: Trimmed surface these references should list (and its trimming curves).
- **Format**: 0 to write it to stderr all data, 1 to write it to stderr but only end points of trimming curves. 9 to display the data in a display device.
- **Returns**: TRUE if successful, FALSE otherwise.
- **Description**: Debug routine to dump the UV trimming curves in the given ref. list.

6.2.23 MdlDbgSC (mdl_dbg.c:120)

```c
int MdlDbgSC(const MdlTrimSrfStruct *TSrf, int Format)
```

- **TSrf**: To dump its trimming curves in UV space.
- **Format**: 0 to write it to stderr all data, 1 to write it to stderr but only end points of trimming curves. 9 to display the data in a display device.
- **Returns**: TRUE if successful, FALSE otherwise.
- **Description**: Debug routine to dump the UV trimming curves of a given surface.
6.2.24 MdlDbgTC (mdl_dbg.c:99)

```c
int MdlDbgTC(const MdlTrimSegStruct *TSegs, int Format)
```

**TSegs:** To dump to stderr/display all its trimming curves in UV space.

**Format:**
- 0 to write it to stderr all data, 1 to write it to stderr but only end points of trimming curves. 9 to display the data in a display device.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Debug routine to dump to stderr/display the UV trimming curves of the list of trimming curves.

6.2.25 MdlDebugHandleTCrvLoops (mdl_dbg.c:207)

```c
int MdlDebugHandleTCrvLoops(const MdlTrimSrfStruct *TSrf, const MdlLoopStruct *Loops, const CagdPType Trans, int Display, int TrimEndPts)
```

**TSrf:** To dump its trimming loops in UV space. Can be NULL.

**Loops:** To dump as trimming curves in UV space.

**Trans:** To translate all the curves.

**Display:** TRUE to display the data, FALSE to write it to stdout.

**TrimEndPts:** TRUE to dump only the trimming curves’ end points.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Debug routine to dump the UV trimming curve loops.

6.2.26 MdlDebugHandleTSrfCrvs (mdl_dbg.c:250)

```c
int MdlDebugHandleTSrfCrvs(const MdlTrimSegStruct *TCrvs, const MdlTrimSrfStruct *TSrf, const CagdPType Trans, int Display, int TrimEndPts)
```

**TCrvs:** List of trimming curves to dump.

**TSrf:** If not NULL - dump only its trimming curves.

**Trans:** To translate all the curves. Can be NULL.

**Display:** TRUE to display the data, FALSE to write it to stdout.

**TrimEndPts:** TRUE to dump only the trimming curves’ end points.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Debug routine to dump a list of trimming curves.

6.2.27 MdlDebugHandleTSrfRefCrvs (mdl_dbg.c:408)

```c
int MdlDebugHandleTSrfRefCrvs(const MdlTrimSegRefStruct *Refs, const MdlTrimSrfStruct *TSrf, const CagdPType Trans, int Loop, int Display, int TrimEndPts)
```

**Refs:** List of references to trimming curves to dump.

**TSrf:** If not NULL - dump only its trimming curves.
Trans: To translate all the curves. Can be NULL.
Loop: Unique loop index.
Display: TRUE to display the data, FALSE to write it to stdout.
TrimEndPts: TRUE to dump only the trimming curves' end points.
Returns: TRUE if successful, FALSE otherwise.
Description: Debug routine to dump a list of refs to trimming curves.

6.2.28 MdlDebugVerify (mdl_dbg.c:628)

int MdlDebugVerify(const MdlModelStruct *Model, int TestLoops)

Model: To verify.
TestLoops: TRUE to also verify that each loop is indeed a loop.
Returns: TRUE if successful, FALSE otherwise.
Description: Debug routine to verify consistency of a model.

6.2.29 MdlDebugWriteTrimSegs (mdl_dbg.c:577)

int MdlDebugWriteTrimSegs(const MdlTrimSegStruct *TSegs,
const MdlTrimSrfStruct *TSrf,
const CagdPType Trans)

TSegs: To dump all its trimming curves in the list.
TSrf: If not NULL - dump only its trimming curves.
Trans: To translate all the curves. Can be NULL.
Returns: TRUE if successful, FALSE otherwise.
Description: Debug routine to dump a list of UV trimming curves model.

6.2.30 MdlDescribeError (mdl_err.c:49)

const char *MdlDescribeError(MdlFatalErrorType ErrorNum)

ErrorNum: Type of the error that was raised.
Returns: A string describing the error type.
Description: Returns a string describing a the given error. Errors can be raised by any member of this mdl library as well as other users. Raised error will cause an invokation of MdlFatalError function which decides how to handle this error. MdlFatalError can for example, invoke this routine with the error type, print the appropriate message and quit the program.

6.2.31 MdlDivideTrimCrv (mdl_aux.c:239)

MdlTrimSegStruct *MdlDivideTrimCrv(MdlTrimSegStruct *Seg,
const CagdPtsStruct *Pts,
int Idx,
CagdRType Eps,
int *Proximity)

Seg: Trimming segment to divide. Seg will return, in place, the first curve in the divided set.
Pts: Parameters at which to split.
Idx: Index of parameter in Pts points: 0 for X, 1 for Y, etc.
Eps: parameter closer than Eps to boundary or other parameters are ignored.
Proximity: Proximity bit set to end points - see CagdCrvSubdivAtParams2.
Returns: The rest of the divided segments.
Description: Subdivides the given segment at the specified parameters values.
See also: CagdCrvSubdivAtParams2,
6.2.32  MdlEnsureMdlTrimCrvsPrecision (mdl\aux.c:358)

void MdlEnsureMdlTrimCrvsPrecision(MdlModelStruct *Mdl)

  Mdl: To ensure the precision of its trimming curves.
  Returns: void
  Description: Ensure adjacent trimming curves have the precise same end points.
  See also: MdlEnsureTSrfTrimCrvsPrecision,

6.2.33  MdlEnsureTSrfTrimCrvsPrecision (mdl\aux.c:385)

void MdlEnsureTSrfTrimCrvsPrecision(MdlTrimSrfStruct *MdlTrimSrf)

  MdlTrimSrf: To ensure the precision of its trimming curves.
  Returns: void
  Description: Ensure adjacent trimming curves have the precise same end points.
  See also: MdlEnsureMdlTrimCrvsPrecision,

6.2.34  MdlExtractUVCrv (mdlcnvrt.c:180)

CagdCrvStruct *MdlExtractUVCrv(const MdlTrimSrfStruct *MdlSrf, const MdlTrimSegStruct *MdlSeg)

  MdlSrf: Model's trimming surface.
  MdlSeg: Model's trimming curve segment.
  Returns: Extracted UV curve.
  Description: Extracting the UV curve from MdlTrimSegStruct depending on the position of the current model surface.

6.2.35  MdlFatalError (mdl\ftl.c:53)

void MdlFatalError(MdlFatalErrorType ErrID)

  ErrID: Error type that was raised.
  Returns: void
  Description: Trap Mdl\lib errors right here. Provides a default error handler for the mdl library. Gets an error description using MdlDescribeError, prints it and exit the program using exit.

6.2.36  MdlFilterOutCrvs (mdl\aux.c:36)

MdlTrimSegStruct *MdlFilterOutCrvs(MdlTrimSegStruct *TSegs, const MdlTrimSrfStruct *TSrf)

  TSegs: Curve segments in TSrf domain to examine if inside the trimmed domain of TSrf.
  TSrf: Trimmed surface to examine containment of TSegs in.
  Returns: Filtered (inside) list of TSegs (in TSrf).
  Description: Examines the given list of curve segments in TSrf domain if inside or not. Outside segments are purged while inside curve segments are returned.
6.2.37  MdlGetLoopSegIndex  (mdl_ptch.c:134)

IritIntPtrSizeType MdlGetLoopSegIndex(const MdlTrimSegRefStruct *TrimSeg,
const MdlTrimSegStruct *TrimSegList)

TrimSeg: To search in TrimSegList for its index.
TrimSegList: List of trimming curve segments.
Returns: Index in list, or zero if not found. This is a special integer of a size of a pointer.
Description: Returns the index of TrimSeg in TrimSegList, first index is 1. Index is going to be negative if the
Reversed flag is on.
See also: MdlGetSrfIndex,

6.2.38  MdlGetSrfIndex  (mdl_ptch.c:168)

IritIntPtrSizeType MdlGetSrfIndex(const MdlTrimSrfStruct *Srf,
const MdlTrimSrfStruct *TrimSrfList)

Srf: To search in TrimSrfList for its index.
TrimSrfList: List of surfaces.
Returns: Index in list, or zero if not found. This is a special integer of a size of a pointer.
Description: Returns the index of an Srf in TrimSrfList, first index is 1.
See also: MdlGetLoopSegIndex,

6.2.39  MdlGetSrfTrimSegRef  (mdl_prim.c:113)

MdlTrimSegRefStruct *MdlGetSrfTrimSegRef(MdlTrimSrfStruct *TSrf,
MdlTrimSegStruct *TSeg)

TSrf: Trimmed surface to search the trimming segment reference in.
TSeg: The segment to seek the trimmed curve reference for.
Returns: Reference if found, NULL otherwise.
Description: Find the reference to TSeg in TSrf.

6.2.40  MdlIsPointInsideTrimSrf  (mdl_aux.c:314)

CagdBType MdlIsPointInsideTrimSrf(const MdlTrimSrfStruct *TSrf,
CagdUVType UV)

TSrf: Trimming curves to consider.
UV: Parametric location.
Returns: TRUE if inside, FALSE otherwise.
Description: Returns TRUE if the given UV value is inside the domain prescribed by the trimming curves of
TSrf.
See also: TrimIsPointInsideTrimUVCrv, TrimIsPointInsideTrimSrf, , TrimIsPointInsideTrimCrvs,

6.2.41  MdlLoopCopy  (mdl_gen.c:434)

MdlLoopStruct *MdlLoopCopy(const MdlLoopStruct *MdlLoop,
const MdlTrimSegStruct *TrimSegList)

MdlLoop: A trimming surface to duplicate.
TrimSegList: The original trimmed segments.
Returns: A trimming surface structure.
Description: Duplicates a trimming surface structure.
6.2.42 MdlLoopCopyList (mdl_gen.c:462)

MdlLoopStruct *MdlLoopCopyList(const MdlLoopStruct *MdlLoopList,
                                const MdlTrimSegStruct *TrimSegList)

MdlLoopList: To be copied.
TrimSegList: The original trimmed segments.
Returns: A duplicated list of Loops.
Description: Allocates and copies a list of Loops structures.

6.2.43 MdlLoopFree (mdl_gen.c:130)

void MdlLoopFree(MdlLoopStruct *MdlLoop)

MdlLoop: A loop to free.
Returns: void
Description: Deallocates a Model Loop structure.

6.2.44 MdlLoopFreeList (mdl_gen.c:150)

void MdlLoopFreeList(MdlLoopStruct *MdlLoopList)

MdlLoopList: A list of loops to free.
Returns: void
Description: Deallocates a Model Loop List structure.

6.2.45 MdlLoopNew (mdl_gen.c:740)

MdlLoopStruct *MdlLoopNew(MdlTrimSegRefStruct *MdlTrimSegRefList)

MdlTrimSegRefList: List of model loops forming the trimming loop.
Returns: A model loop.
Description: Allocates a model loop structure.

6.2.46 MdlModelBBox (mdl_bbox.c:30)

void MdlModelBBox(const MdlModelStruct *Mdl, CagdBBoxStruct *BBox)

Mdl: A model to compute a bounding box for.
BBox: Where bounding information is to be saved.
Returns: void
Description: Computes a bounding box for a freeform model.
See also: MdlModelListBBox, CagdCrvListBBox, CagdSrfBBox, CagdTightBBox, MdlModelTSrfTCrvsBBox,

6.2.47 MdlModelCopy (mdl_gen.c:554)

MdlModelStruct *MdlModelCopy(const MdlModelStruct *Model)

Model: A Model to duplicate.
Returns: A Model structure.
Description: Duplicates a Model structure.
6.2.48 MdlModelCopyList (mdlgen.c:585)

MdlModelCopyList(const MdlModelStruct *ModelList)

ModelList: To be copied.
Returns: A duplicated list of trimming surfaces.
Description: Allocates and copies a list of Model structures.

6.2.49 MdlModelFree (mdlgen.c:219)

void MdlModelFree(MdlModelStruct *Model)

Model: A Model to free.
Returns: void
Description: Deallocation of a Model structure.

6.2.50 MdlModelFreeList (mdlgen.c:240)

void MdlModelFreeList(MdlModelStruct *Model)

Model: A list of trimmed surface to free.
Returns: void
Description: Deallocation of a list of Model structures.

6.2.51 MdlModelListBBox (mdlbbox.c:64)

void MdlModelListBBox(const MdlModelStruct *Mdls, CagdBBoxStruct *BBox)

Mdls: List of models to compute a bounding box for.
BBox: Where bounding information is to be saved.
Returns: void
Description: Computes a bounding box for freeform models.
See also: MdlModelBBox, CagdCrvListBBox, CagdSrfBBox, CagdTightBBox, MdlModelTSrfTCrvsBBox,

6.2.52 MdlModelMatTransform (mdlgen.c:1048)

void MdlModelMatTransform(MdlModelStruct *Model, CagdMType Mat)

Model: Model to transform.
Mat: Homogeneous transformation to apply to TV.
Returns: void
Description: Transforms, in place, the given model as specified by homogeneous matrix Mat.

6.2.53 MdlModelNegate (mdlbool.c:1128)

void MdlModelNegate(const MdlModelStruct *Model)

Model: The model to negate.
Returns: Resulting negation.
Description: Computes the inside out (negation of the given model as a new model.
See also:
6.2.54 MdlModelNew (mdl_gen.c:938)

Md1ModelStruct *MdlModelNew(CagdSrfStruct *Srf,  
CagdCrvStruct *LoopList,  
CagdBType HasTopLvlTrim)

Srf: The original surface to be made into a model. Used in place.
LoopList: A list of trimming loops. Used in place.
HasTopLvlTrim: If FALSE, add outer loops boundary.

Returns: The Model.

Description: Constructor for a Model.

6.2.55 MdlModelNew2 (mdl_gen.c:981)

Md1ModelStruct *MdlModelNew2(MdlTrimSrfStruct *TrimSrfs,  
MdlTrimSegStruct *TrimSegs)

TrimSrfs: Trimming surfaces. Used in place.
TrimSegs: A list of trimming segments. Used in place.

Returns: The construct Model.

Description: Constructor for a Model. No attempt is mode to verify the consistency of the given data and proper pointers between the different data strucutres.
See also: MdlModelNew, MdlPatchTrimmingSegPointers,

6.2.56 MdlModelTSrfTCrvsBBox (mdl_bbox.c:96)

void MdlModelTSrfTCrvsBBox(const MdlTrimSrfStruct *TSrf, CagdBBoxStruct *BBox)

TSrf: A trimmed surfaces to compute a bbox for its trimming curves.
BBox: Where bounding information is to be saved.

Returns: void

Description: Computes a bounding box for the trimming curves of one trimmed srf.
See also: MdlModelListBBox, CagdCrvListBBox, CagdSrfBBox, CagdTightBBox,

6.2.57 MdlModelTransform (mdl_gen.c:1013)

void MdlModelTransform(MdlModelStruct *Model,  
const CagdRType *Translate,  
CagdRType Scale)

Model: Model to transform.
Translate: Translation factor.
Scale: Scaling factor.

Returns: void

Description: Linearly transforms, in place, given model as specified by Translate and Scale.
6.2.58 MdlPatchTrimmingSegPointers (mdl_patch.c:39)

```c
void MdlPatchTrimmingSegPointers(MdlModelStruct *Model)

Model: To back patch its pointer.

Returns: void

Description: Patches a model to have proper (back) pointers between the different data structures. The assumptions are that all reference and back pointers are set as indices into the proper lists:
1. Every reference to a surface, is given as its index in the Model's TrimSrfList trimmed surfaces' list.
2. Every reference to a trimming segment, is given as its index in the Model's TrimSegList or trimming segments' list. All lists are indexed starting from 1, 0 denotes an error.

See also: MdlModelNew, MdlModelNew2, MdlReadModelFromFile,
```

6.2.59 MdlPrimBox (mdl_prim.c:289)

```c
MdlModelStruct *MdlPrimBox(CagdRType MinX, CagdRType MinY, CagdRType MinZ, CagdRType MaxX, CagdRType MaxY, CagdRType MaxZ)

MinX, MinY, MinZ: Minimum range of box model.
MaxX, MaxY, MaxZ: Maximum range of box model.

Returns: Constructed box model, as a set of bilinear surfaces.

Description: A model constructor of a box, parallel to main axes.
See also: agdPrimBoxSrf,
```

6.2.60 MdlPrimCone (mdl_prim.c:525)

```c
MdlModelStruct *MdlPrimCone(const CagdVType Center, CagdRType Radius, CagdRType Height, CagdBType Rational, CagdPrimCapsType Caps)

Center: of constructed cone (center of its base).
Radius: of constructed cone's base.
Height: of constructed cone.
Rational: If TRUE exact ratio sphere is created. If FALSE an approximated integral surface is created.
Caps: Do we want caps (top and/or bottom) for the cone?

Returns: Constructed cone model.

Description: A model constructor of a cone, centered at Center, radii of Radius, and height of Height. Axis of cone is Z axis.
See also: CagdPrimConeSrf, MdlStitchSelfSrfPrims,
```
6.2.61 MdlPrimCone2 (mdl_prim.c:485)

MdlModelStruct *MdlPrimCone2(const CagdVType Center,
   CagdRType MajorRadius,
   CagdRType MinorRadius,
   CagdRType Height,
   CagdBType Rational,
   CagdPrimCapsType Caps)

   Center: of constructed cone (center of its base).
   MajorRadius: of constructed cone.
   MinorRadius: of constructed cone.
   Height: of constructed cone.
   Rational: If TRUE exact ration sphere is created. If FALSE an approximated integral surface is created.
   Caps: Do we want caps (top and/or bottom) for the cone?

   Returns: Constructed truncated cone model.

   Description: A model constructor of a truncated cone, centered at Center and radii of MajorRadius and MinorRadius. A MinorRadius of zero would construct a regular cone. Otherwise, a truncated cone. Axis of cone is Z axis.

   See also: CagdPrimCone2Srf, MdlStitchSelfSrfPrims,

6.2.62 MdlPrimCylinder (mdl_prim.c:564)

MdlModelStruct *MdlPrimCylinder(const CagdVType Center,
   CagdRType Radius,
   CagdRType Height,
   CagdBType Rational,
   CagdPrimCapsType Caps)

   Center: of constructed Cylinder (center of its base).
   Radius: of constructed Cylinder.
   Height: of constructed Cylinder.
   Rational: If TRUE exact ration sphere is created. If FALSE an approximated integral surface is created.
   Caps: Do we want caps (top and/or bottom) for the cone?

   Returns: Constructed cylinder model.

   Description: A model constructor of a Cylinder, centered at Center, radii of Radius, and height of Height. Axis of cylinder is Z axis.

   See also: CagdPrimCylinderSrf, MdlStitchSelfSrfPrims,

6.2.63 MdlPrimPlane (mdl_prim.c:220)

MdlModelStruct *MdlPrimPlane(CagdRType MinX,
   CagdRType MinY,
   CagdRType MaxX,
   CagdRType MaxY,
   CagdRType ZLevel)

   MinX, MinY: Minimum XY coordinates of plane.
   MaxX, MaxY: Maximum XY coordinates of plane.
   ZLevel: Z level of plane, parallel to the XY plane.

   Returns: Constructed plane model, as a bilinear surface.

   Description: A model constructor of a plane, parallel to XY plane at level Zlevel.

   See also: CagdPrimPlaneSrf, MdlPrimPlaneSrfOrderLen,
6.2.64  **MdlPrimPlaneSrfOrderLen** *(mdl_prim.c:256)*

```c
MdlModelStruct *MdlPrimPlaneSrfOrderLen(CagdRType MinX,
                                        CagdRType MinY,
                                        CagdRType MaxX,
                                        CagdRType MaxY,
                                        CagdRType ZLevel,
                                        int Order,
                                        int Len)
```

**MinX, MinY:** Minimum XY coordinates of plane.
**MaxX, MaxY:** Maximum XY coordinates of plane.
**ZLevel:** Z level of plane, parallel to the XY plane.
**Order:** Order of plane surface that is requested.
**Len:** Number of control points (via refinement).

**Returns:** Constructed plane model, as a bi-Order surface.

**Description:** A model constructor of a plane, parallel to XY plane at level Zlevel.
**See also:** agdPrimPlaneSrfOrderLen, MdlPrimPlane,

6.2.65  **MdlPrimSphere** *(mdl_prim.c:358)*

```c
MdlModelStruct *MdlPrimSphere(const CagdVType Center,
                              CagdRType Radius,
                              CagdBType Rational)
```

**Center:** of constructed sphere.
**Radius:** of constructed sphere.
**Rational:** If TRUE exact ration sphere is created. If FALSE an approximated integral surface is created.

**Returns:** Constructed sphere model.

**Description:** A model constructor of a sphere, centered at Center and radius Radius.
**See also:** CagdPrimSphereSrf, MdlStitchSelfSrfPrims, MdlCreateCubeSpherePrim,

6.2.66  **MdlPrimTorus** *(mdl_prim.c:443)*

```c
MdlModelStruct *MdlPrimTorus(const CagdVType Center,
                              CagdRType MajorRadius,
                              CagdRType MinorRadius,
                              CagdBType Rational)
```

**Center:** of constructed torus.
**MajorRadius:** of constructed torus.
**MinorRadius:** of constructed torus.
**Rational:** If TRUE exact ration sphere is created. If FALSE an approximated integral surface is created.

**Returns:** Constructed torus model.

**Description:** A model constructor of a torus, centered at Center and radii of MajorRadius and MinorRadius.
**See also:** CagdPrimTorusSrf, MdlStitchSelfSrfPrims,

6.2.67  **MdlSetFatalErrorFunc** *(mdl_ftl.c:28)*

```c
MdlSetErrorFuncType MdlSetFatalErrorFunc(MdlSetErrorFuncType ErrorFunc)
```

**ErrorFunc:** New error function to use.
**Returns:** Old error function reference.

**Description:** Sets the error function to be used by MdlLib.
6.2.68 MdlSplitTrimCrv (mdl_aux.c:176)

```c
int MdlSplitTrimCrv(MdlTrimSegStruct *Seg,
    const CagdPtStruct *Pts,
    int Idx,
    CagdRType Eps,
    int *Proximity)
```

**Seg**: Trimming segment to split, in place.

**Pts**: Parameters at which to split.

**Idx**: Index of parameter in Pts points: 0 for X, 1 for Y, etc.

**Eps**: parameter closer than Eps to boundary or other parameters are ignored.

**Proximity**: Proximity bit set to end points - see CagdCrvSubdivAtParams2.

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: Subdivides the given segment at the specified parameter values. This amounts to:
1. Dividing all curves in Seg and chaining the pieces after Seg.
2. Updating the references in SrfFirst and SrfNext that points to Seg, to now point to all new pieces, in the right order, as can be reversed.

6.2.69 MdlStitchModel (mdl_prim.c:154)

```c
int MdlStitchModel(MdlModelStruct *Mdl, CagdRType StitchTol)
```

**Mdl**: Model to seek trimming curves to stitch together, in place.

**StitchTol**: Tolerance to use in stitching two trimmed curves as one.

**Returns**: Number of trimming curves stitched together, in place.

**Description**: Scans the given model for trimming curves that could be stitched together. A pair of trimming curves can be stitched together if they have the same Euclidean representation and they now have no neighbors. Two trimming curves are considered with “same Euclidean representation” if their end points are the same upto given tolerance (should probably do somewhat better here).

**See also**: MdlBooleanMerge,

6.2.70 MdlStitchSelfSrfPrims (mdl_prim.c:591)

```c
int MdlStitchSelfSrfPrims(int Stitch)
```

**Stitch**: TRUE to stitch different boundaries of same surface.

**Returns**: Old value setting.

**Description**: Set if different boundaries on the same primitive surface are to be stitched as well or not.

6.2.71 MdlTrimSegCopy (mdl_gen.c:268)

```c
MdlTrimSegStruct *MdlTrimSegCopy(const MdlTrimSegStruct *MdlTrimSeg,
    const MdlTrimSrfStruct *TrimSrfList)
```

**MdlTrimSeg**: A trimming segment to duplicate.

**TrimSrfList**: The original trimmed surfaces.

**Returns**: A trimming segment structure.

**Description**: Duplicates a trimming segments structure. The reference pointers to the (upto) two surfaces are replaced with the indices of the surfaces in TrimSrfList.
6.2.72  **MdlTrimSegCopyList**  (mdl_gen.c:332)

    MdlTrimSegStruct *MdlTrimSegCopyList(const MdlTrimSegStruct *MdlTrimSegList,
                                         const MdlTrimSrfStruct *TrimSrfList)

  **MdlTrimSegList**: To be copied.
  **TrimSrfList**: The original trimmed surfaces.

  **Returns**: A duplicated list of trimming segments.

  **Description**: Allocates and copies a list of trimming segment structures. The reference pointers to the (upto) two surfaces are replaced with the indices of the surfaces in TrimSrfList.

6.2.73  **MdlTrimSegFree**  (mdl_gen.c:41)

    void MdlTrimSegFree(MdlTrimSegStruct *MTSeg)

  **MTSeg**: A Trimming Segment to free.

  **Returns**: void

  **Description**: Deallocates a Model Trimming Segments structure.

6.2.74  **MdlTrimSegFreeList**  (mdl_gen.c:63)

    void MdlTrimSegFreeList(MdlTrimSegStruct *MTSegList)

  **MTSegList**: A Trimming Segment List to free.

  **Returns**: void

  **Description**: Deallocates a Model Trimming Segments List structure.

6.2.75  **MdlTrimSegNew**  (mdl_gen.c:628)

    MdlTrimSegStruct *MdlTrimSegNew(CagdCrvStruct *UVCrv1,
                                     CagdCrvStruct *UVCrv2,
                                     CagdCrvStruct *EucCrv1,
                                     MdlTrimSrfStruct *SrfFirst,
                                     MdlTrimSrfStruct *SrfSecond)

  **UVCrv1**: A UV curve for SrfFirst. Must be an E2 curve. Used in place.
  **UVCrv2**: A UV curve for SrfSecond. Must be an E2 curve. Used in place. Can be NULL.
  **EucCrv1**: Optional Euclidean curve for SrfFirst. Must be an E3 curve. Used in place. Can be NULL.
  **SrfFirst**: First surface of the segment. Can be NULL.
  **SrfSecond**: Second surface of the segment. Can be NULL.

  **Returns**: A model trimming segment structure.

  **Description**: Allocates a model trimming segment structure. Allows periodic and float end conditions - converts them to open end.

6.2.76  **MdlTrimSegRefCopy**  (mdl_gen.c:368)

    MdlTrimSegRefStruct *MdlTrimSegRefCopy(const MdlTrimSegRefStruct *MTSegRefList,
                                             const MdlTrimSegStruct *TrimSegList)

  **MTSegRefList**: A trimming curve segment reference to duplicate.
  **TrimSegList**: The original trimmed segments.

  **Returns**: A trimming segment reference structure.

  **Description**: Duplicates a trimming segment reference structure. The reference pointer to the trimming segment is replaced with the index of trimming segment in TrimSegList.
6.2.77 MdlTrimSegRefCopyList (mdl_gen.c:402)

MdlTrimSegStruct *MdlTrimSegRefCopyList(const MdlTrimSegRefStruct *MTSegRefList, 
const MdlTrimSegStruct *TrimSegList)

MTSegRefList: To be copied.
TrimSegList: The original trimmed segments.
Returns: A duplicated list of trimming segments.

Description: Allocates and copies a list of trimming segment reference structures. The reference pointer to the 
trimming segment is replaced with the index of trimming segment in TrimSegList.

6.2.78 MdlTrimSegRefFree (mdl_gen.c:87)

void MdlTrimSegRefFree(MdlTrimSegRefStruct *MTSegRef)

MTSegRef: A Segments Reference to free.
Returns: void

Description: Deallocates a Model Trimming Segment Reference structure.

6.2.79 MdlTrimSegRefFreeList (mdl_gen.c:106)

void MdlTrimSegRefFreeList(MdlTrimSegRefStruct *MTSegRefList)

MTSegRefList: A list of loops to free.
Returns: void

Description: Deallocates a Model Trimming Segment Reference List structure.

6.2.80 MdlTrimSegRefNew (mdl_gen.c:712)

MdlTrimSegStruct *MdlTrimSegRefNew(MdlTrimSegStruct *MdlTrimSeg)

MdlTrimSeg: List of model trimming segments forming the trimming curve.
Returns: A trimmig curve.

Description: Allocates a model trimming segment reference structure.

6.2.81 MdlTrimSrfCopy (mdl_gen.c:493)

MdlTrimSrfStruct *MdlTrimSrfCopy(const MdlTrimSrfStruct *MdlTrimSrf, 
const MdlTrimSegStruct *TrimSegList)

MdlTrimSrf: A trimming surface to duplicate.
TrimSegList: The original trimmed segments.
Returns: A trimming surface structure.

Description: Duplicates a trimming surface structure.
6.2.82 MdlTrimSrfCopyList (mdl_gen.c:523)

MdlTrimSrfStruct *MdlTrimSrfCopyList(const MdlTrimSrfStruct *MdlTrimSrfList,
const MdlTrimSegStruct *TrimSegList)

- **MdlTrimSrfList**: To be copied.
- **TrimSegList**: The original trimmed segments.
- **Returns**: A duplicated list of trimming surfaces.
- **Description**: Allocates and copies a list of trimming surface structures.

6.2.83 MdlTrimSrfFree (mdl_gen.c:174)

void MdlTrimSrfFree(MdlTrimSrfStruct *TrimSrf)

- **TrimSrf**: A surface to free.
- **Returns**: void
- **Description**: Deallocates a Model Trimming Surface structure.

6.2.84 MdlTrimSrfFreeList (mdl_gen.c:195)

void MdlTrimSrfFreeList(MdlTrimSrfStruct *MdlTrimSrfList)

- **MdlTrimSrfList**: A list of trimming curve to free.
- **Returns**: void
- **Description**: Deallocates a Model Trimming Surface List structure.

6.2.85 MdlTrimSrfNew (mdl_gen.c:772)

MdlTrimSrfStruct *MdlTrimSrfNew(CagdSrfStruct *Srf,
MdlLoopStruct *LoopList,
CagdBType HasTopLvlTrim,
CagdBType UpdateBackTSrfPtrs)

- **Srf**: Surface to make into a trimmed surface. In place.
- **LoopList**: An optional list of loops. Used in place.
- **HasTopLvlTrim**: Do we have a top level outer most trimming curve?
- **UpdateBackTSrfPtrs**: TRUE to also update back pointers from trimming curves to the trimmed surface.
- **Returns**: The trimmed surface.
- **Description**: Constructor for a model trimmed surface.

6.2.86 MdlTrimSrfNew2 (mdl_gen.c:902)

MdlTrimSrfStruct *MdlTrimSrfNew2(CagdSrfStruct *Srf,
CagdCrvStruct *LoopList,
CagdBType HasTopLvlTrim)

- **Srf**: The original surface to be trimmed. Used in place.
- **LoopList**: A list of trimming loops. Used in place.
- **HasTopLvlTrim**: If FALSE, add outer loops boundary.
- **Returns**: The trimmed surface.
- **Description**: Constructor for a model trimmed surface.
6.2.87 MdlTwoTrimSegsSameEndPts (mdlprim.c:36)

```c
int MdlTwoTrimSegsSameEndPts(MdlTrimSegStruct *TSeg1,
                           MdlTrimSegStruct *TSeg2,
                           CagdRType Tol)
```

**TSeg1, TSeg2:** The two segments to compare.

**Tol:** Tolerance of comparison of end points.

**Returns:** 0 if not the same Euclidean representation, 1 if same and start and end points match, -1 if same but reversed.

**Description:** Compare two given trimming curve segments for similarity in Euclidean space. Comparison is made at the end points only.
Chapter 7

Miscellaneous Library, misc_lib

7.1 General Information

This library holds general miscellaneous functions such as reading configuration files, low level homogeneous matrices computation, low level attributes and general machine specific low level routines. Several header files can be found for this library:

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<th>Header (include/*.h)</th>
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7.2 Library Functions

7.2.1 Attr2String (miscattr.c:1373)

const char *Attr2String(const IPAttributeStruct *Attr, int DataFileFormat)

Attr: To convert to a string.

DataFileFormat: If TRUE, the attribute is formatted in the IRIT data file format. Otherwise, just the attribute value is returned as a string.

Returns: A pointer to a static string representing/describing the given attribute.

Description: Routine to convert an attribute to a string.

7.2.2 AttrCopyAttributes (miscattr.c:1766)

IPAttributeStruct *AttrCopyAttributes(const IPAttributeStruct *Src)

Src: Attribute list to duplicate.

Returns: Duplicated attribute list.

Description: Routine to copy an attribute list.
7.2.3 **AttrCopyValidAttrList** (miscattr.c:1743)

```c
const char **AttrCopyValidAttrList(const char **AttrNames)
```

**AttrNames**: Vector of attribute names to use in attr list copy.

**Returns**: Old list of valid attributes to copy.

**Description**: Sets the NULL terminated list of attribute’s names to copy.

7.2.4 **AttrFindAttribute** (miscattr.c:1539)

```c
IPAttributeStruct *AttrFindAttribute(const IPAttributeStruct *Attrs, const char *Name)
```

**Attrs**: Attribute list to search.

**Name**: Attribute to search by this name.

**Returns**: Attribute if found, otherwise NULL.

**Description**: Routine to search for an attribute by Name.

7.2.5 **AttrFindNumAttribute** (miscatt1.c:129)

```c
IPAttributeStruct *AttrFindNumAttribute(const IPAttributeStruct *Attrs, AttribNumType AttrNum)
```

**Attrs**: Attribute list to search.

**AttrNum**: Attribute numeric index to search by this number.

**Returns**: Attribute if found, otherwise NULL.

**Description**: Routine to search for an attribute by ID numeric index.

7.2.6 **AttrFreeAttributes** (miscattr.c:1699)

```c
void AttrFreeAttributes(IPAttributeStruct **Attrs)
```

**Attrs**: To remove and delete.

**Returns**: void

**Description**: Routine to remove and delete all attributes of the given Attr list.

7.2.7 **AttrFreeOneAttribute** (miscattr.c:1641)

```c
void AttrFreeOneAttribute(IPAttributeStruct **Attrs, const char *Name)
```

**Attrs**: To search for an attribute named Name and remove and delete it.

**Name**: Name of attribute to remove and delete.

**Returns**: void

**Description**: Routine to remove and delete the attribute named Name from the given Attr list.
7.2.8 **AttrGetAttribName** (miscatt1.c:52)

```c
const char *AttrGetAttribName(const IPAttributeStruct *Attr)
```

**Attr**: The attribute structure.

**Returns**: The name of the attribute, "undefined" if don’t exist.

**Description**: This function returns the name of the attribute.

7.2.9 **AttrGetAttribNumber** (miscatt1.c:83)

```c
AttribNumType AttrGetAttribNumber(const char *AttribName)
```

**AttribName**: The Attribute name to seek and create if not found.

**Returns**: The attribute number.

**Description**: This function returns the matching attribute number to the specified attribute name. If the attribute name doesn’t exist it is created.

7.2.10 **AttrGetColor** (miscattr.c:143)

```c
int AttrGetColor(const IPAttributeStruct *Attrs)
```

**Attrs**: For which we would like to know the color of.

**Returns**: Color or IP_ATTR_NO_COLOR if no color set.

**Description**: Routine to return a color attribute.

**See also**: AttrSetColor, AttrSetRGBColor, AttrGetRGBColor, AttrSetWidth, , AttrGetWidth, AttrGetIntAttrib, AttrGetObjectColor,

7.2.11 **AttrGetIndexColor** (miscattr.c:73)

```c
void AttrGetIndexColor(int Color, int *Red, int *Green, int *Blue)
```

**Color**: Index of color bwteen 0 and 15.

**Red, Green, Blue**: Component of RGB color.

**Returns**: void

**Description**: Routine to fetch one of 16 basic colors based on its index.

**See also**: AttrSetColor, AttrGetColor, AttrGetRGBColor, AttrSetWidth, AttrGetWidth, , AttrSetIntAttrib, AttrSetObjectRGBColor, AttrSetRGBColor,

7.2.12 **AttrGetIntAttrib** (miscattr.c:602)

```c
int AttrGetIntAttrib(const IPAttributeStruct *Attrs, const char *Name)
```

**Attrs**: Attribute list to search for requested attribute.

**Name**: Name of requested attribute.

**Returns**: Found attribute, or IP_ATTR_BAD_INT if not found.

**Description**: Routine to get an integer attribute.

**See also**: AttrSetIntAttrib, AttrSetPtrAttrib, AttrGetPtrAttrib, AttrGetRealAttrib, , AttrGetRealAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetIntAttrib2,
7.2.13 AttrGetIntAttrib2 (miscattr.c:625)

```c
int AttrGetIntAttrib2(const IPAttributeStruct *Attrs, AttribNumType AttrNum)
```

- **Attrs**: Attribute list to search for requested attribute.
- **AttrNum**: Unique ID derived from name of requested attribute.
- **Returns**: Found attribute, or IP_ATTRIB_BADINT if not found.
- **Description**: Routine to get an integer attribute.
- **See also**: AttrSetIntAttrib, AttrSetPtrAttrib, AttrGetPtrAttrib, AttrGetRealAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetIntAttrib.

7.2.14 AttrGetPtrAttrib (miscattr.c:734)

```c
VoidPtr AttrGetPtrAttrib(const IPAttributeStruct *Attrs, const char *Name)
```

- **Attrs**: Attribute list to search for requested attribute.
- **Name**: Name of requested attribute.
- **Returns**: Found attribute, or NULL if not found.
- **Description**: Routine to get a pointer attribute.
- **See also**: AttrSetIntAttrib, AttrGetIntAttrib, AttrSetPtrAttrib, AttrSetRealAttrib, , AttrGetRealAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetUVAttrib, , AttrSetUVAttrib, AttrSetRefPtrAttrib, AttrGetRefPtrAttrib, , AttrGetPtrAttrib2.

7.2.15 AttrGetPtrAttrib2 (miscattr.c:760)

```c
VoidPtr AttrGetPtrAttrib2(const IPAttributeStruct *Attrs,
                         const IPAttributeStruct *Attrs, const char *Name)
```

- **Attrs**: Attribute list to search for requested attribute.
- **AttrNum**: Unique ID derived from name of requested attribute.
- **Returns**: Found attribute, or NULL if not found.
- **Description**: Routine to get a pointer attribute.
- **See also**: AttrSetIntAttrib, AttrGetIntAttrib, AttrSetPtrAttrib, AttrSetRealAttrib, , AttrGetRealAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetUVAttrib, , AttrSetUVAttrib, AttrSetRefPtrAttrib, AttrGetRefPtrAttrib, , AttrGetPtrAttrib2.

7.2.16 AttrGetRGBColor (miscattr.c:240)

```c
int AttrGetRGBColor(const IPAttributeStruct *Attrs,
                      int *Red, int *Green, int *Blue)
```

- **Attrs**: For which we would like to know the RGB of.
- **Red, Green, Blue**: Component of RGB color to initialize.
- **Returns**: TRUE if does have an RGB color attribute, FALSE otherwise.
- **Description**: Routine to return a RGB attribute.
- **See also**: AttrSetColor, AttrGetColor, AttrSetRGBColor, AttrSetWidth, AttrGetWidth, , AttrSetIntAttrib, AttrGetObjectRGBColor, , AttrSetRGBDoubleColor, AttrGetRGBDoubleColor,
7.2.17 **AttrGetRGBColor2** (miscattr.c:292)

```c
int AttrGetRGBColor2(const IPAttributeStruct *Attrs,
                      char *Name,
                      int *Red,
                      int *Green,
                      int *Blue)
```

- **Attrs**: For which we would like to know the RGB of.
- **Name**: Name of the attribute, if NULL default is taken.
- **Red, Green, Blue**: Component of RGB color to initialize.
- **Returns**: TRUE if does have any color attribute, FALSE otherwise.

**Description**: Routine to return a RGB attribute or COLOR attribute converted to RGB. Beside, it can be used to get other color attributes: specular, etc.

**See also**: AttrSetColor, AttrGetColor, AttrSetRGBColor, AttrSetWidth, AttrGetWidth, , AttrSetIntAttrib, AttrGetObjectRGBColor, AttrGetRGBColor, , AttrSetRGBDoubleColor, AttrGetRGBDoubleColor,

7.2.18 **AttrGetRGBDoubleColor** (miscattr.c:347)

```c
int AttrGetRGBDoubleColor(const IPAttributeStruct *Attrs,
                           double *Red,
                           double *Green,
                           double *Blue)
```

- **Attrs**: For which we would like to know the RGB of.
- **Red, Green, Blue**: Component of RGB color to initialize.
- **Returns**: TRUE if does have an RGB color attribute, FALSE otherwise.

**Description**: Routine to return a RGB attribute.

**See also**: AttrSetColor, AttrGetColor, AttrSetRGBColor, AttrSetWidth, AttrGetWidth, , AttrSetIntAttrib, AttrGetObjectRGBColor, AttrSetRGBDoubleColor,

7.2.19 **AttrGetRealAttrib** (miscattr.c:989)

```c
IrtRType AttrGetRealAttrib(const IPAttributeStruct *Attrs, const char *Name)
```

- **Attrs**: Attribute list to search for requested attribute.
- **Name**: Name of requested attribute.
- **Returns**: Found attribute, or IP_ATTRIB_BAD_REAL if not found.

**Description**: Routine to get a IrtRType attribute.

**See also**: AttrSetIntAttrib, AttrGetIntAttrib, AttrSetPtrAttrib, AttrGetPtrAttrib, , AttrSetRealAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetUVAttrib, , AttrSetUVAttrib, AttrGetRealAttrib2,

7.2.20 **AttrGetRealAttrib2** (miscattr.c:1014)

```c
IrtRType AttrGetRealAttrib2(const IPAttributeStruct *Attrs,
                           AttribNumType AttrNum)
```

- **Attrs**: Attribute list to search for requested attribute.
- **AttrNum**: Unique ID derived from name of requested attribute.
- **Returns**: Found attribute, or IP_ATTRIB_BAD_REAL if not found.

**Description**: Routine to get a IrtRType attribute.

**See also**: AttrSetIntAttrib, AttrGetIntAttrib, AttrSetPtrAttrib, AttrGetPtrAttrib, , AttrSetRealAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetUVAttrib, , AttrSetUVAttrib, AttrGetRealAttrib,
7.2.21 AttrGetRefPtrAttrib (miscattr.c:863)

VoidPtr AttrGetRefPtrAttrib(const IPAttributeStruct *Attrs, const char *Name)

Attrs: Attribute list to search for requested attribute.
Name: Name of requested attribute.
Returns: Found attribute, or NULL if not found.

Description: Routine to get a pointer reference attribute.
See also: AttrSetIntAttrib, AttrGetIntAttrib, AttrSetPtrAttrib, AttrSetRealAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetUVAttrib, AttrSetUVAttrib, AttrSetPtrAttrib, AttrGetPtrAttrib, AttrGetRefPtrAttrib2.

7.2.22 AttrGetRefPtrAttrib2 (miscattr.c:889)

VoidPtr AttrGetRefPtrAttrib2(const IPAttributeStruct *Attrs, AttribNumType AttrNum)

Attrs: Attribute list to search for requested attribute.
AttrNum: Unique ID derived from name of requested attribute.
Returns: Found attribute, or NULL if not found.

Description: Routine to get a pointer reference attribute.
See also: AttrSetIntAttrib, AttrGetIntAttrib, AttrSetPtrAttrib, AttrSetRealAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetUVAttrib, AttrSetUVAttrib, AttrSetPtrAttrib, AttrGetPtrAttrib, AttrGetRefPtrAttrib.

7.2.23 AttrGetStrAttrib (miscattr.c:1267)

const char *AttrGetStrAttrib(const IPAttributeStruct *Attrs, const char *Name)

Attrs: Attribute list to search for requested attribute.
Name: Name of requested attribute.
Returns: Found attribute, or NULL if not found.

Description: Routine to get a string attribute.
See also: AttrSetIntAttrib, AttrGetIntAttrib, AttrSetPtrAttrib, AttrSetRealAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetUVAttrib, AttrSetUVAttrib, AttrSetPtrAttrib, AttrGetPtrAttrib, AttrGetRefPtrAttrib2.

7.2.24 AttrGetStrAttrib2 (miscattr.c:1292)

const char *AttrGetStrAttrib2(const IPAttributeStruct *Attrs, AttribNumType AttrNum)

Attrs: Attribute list to search for requested attribute.
AttrNum: Unique ID derived from name of requested attribute.
Returns: Found attribute, or NULL if not found.

Description: Routine to get a string attribute.
See also: AttrSetIntAttrib, AttrGetIntAttrib, AttrSetPtrAttrib, AttrSetRealAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetUVAttrib, AttrSetUVAttrib, AttrSetPtrAttrib, AttrGetPtrAttrib, AttrGetRefPtrAttrib2.
7.2.25  AttrGetUVAttrib (miscattr.c:1127)

    float *AttrGetUVAttrib(const IPAttributeStruct *Attrs, const char *Name)

    Attrs: Attribute list to search for requested attribute.
    Name: Name of requested attribute.
    Returns: Found attribute, or NULL if not found.

    Description: Routine to get a UV attribute.
    See also: AttrSetIntAttrib, AttrGetIntAttrib, AttrSetPtrAttrib, AttrGetPtrAttrib, AttrSetRealAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetUVAttrib, AttrSetUVAttrib, AttrGetUVAttrib2,

7.2.26  AttrGetUVAttrib2 (miscattr.c:1151)

    float *AttrGetUVAttrib2(const IPAttributeStruct *Attrs, AttribNumType AttrNum)

    Attrs: Attribute list to search for requested attribute.
    AttrNum: Unique ID derived from name of requested attribute.
    Returns: Found attribute, or NULL if not found.

    Description: Routine to get a UV attribute.
    See also: AttrSetIntAttrib, AttrGetIntAttrib, AttrSetPtrAttrib, AttrGetPtrAttrib, AttrSetRealAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetUVAttrib, AttrSetUVAttrib, AttrGetUVAttrib2,

7.2.27  AttrGetWidth (miscattr.c:483)

    IrtRType AttrGetWidth(const IPAttributeStruct *Attrs)

    Attrs: For which we would like to know the width of.
    Returns: Width or IP_ATTR_NO_WIDTH if no width set.

    Description: Routine to return a width attribute.
    See also: AttrSetColor, AttrGetColor, AttrSetRGBColor, AttrGetRGBColor, AttrSetWidth, AttrGetRealAttrib, AttrGetObjectWidth,

7.2.28  AttrInitHashTable (miscatt1.c:178)

    void AttrInitHashTable(void)

    Returns: void

    Description: Initialize the hash table for attributes names.

7.2.29  AttrReverseAttributes (miscattr.c:1504)

    IPAttributeStruct *AttrReverseAttributes(IPAttributeStruct *Attr)

    Attr: To reverse, in place.
    Returns: The reversed list, in place.

    Description: Routine to reverse the given Attr list.
7.2.30 AttrSetColor (miscattr.c:101)

void AttrSetColor(IPAttributeStruct **Attrs, int Color)

Attrs: Where to place the color attribute.
Color: New color.
Returns: void

Description: Routine to set a color attribute.
See also: AttrGetColor, AttrSetRGBColor, AttrGetRGBColor, AttrSetWidth, AttrGetWidth, AttrSetIntAttrib, AttrSetObjectColor,

7.2.31 AttrSetIntAttrib (miscattr.c:538)

void AttrSetIntAttrib(IPAttributeStruct **Attrs, const char *Name, int Data)

Attrs: Attribute list where to place new attribute.
Name: Name of the newly introduced attribute.
Data: Integer attribute to save.
Returns: void

Description: Routine to set an integer attribute.
See also: AttrGetIntAttrib, AttrSetPtrAttrib, AttrGetPtrAttrib, AttrSetRealAttrib, AttrGetRealAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetUVAttrib, AttrSetUVAttrib, AttrSetIntAttrib2,

7.2.32 AttrSetIntAttrib2 (miscattr.c:565)

void AttrSetIntAttrib2(IPAttributeStruct **Attrs,
AttribNumType AttribNum,
int Data)

Attrs: Attribute list where to place new attribute.
AttribNum: Unique ID derived from name of requested attribute.
Data: Integer attribute to save.
Returns: void

Description: Routine to set an integer attribute.
See also: AttrGetIntAttrib, AttrSetPtrAttrib, AttrGetPtrAttrib, AttrSetRealAttrib, AttrGetRealAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetUVAttrib, AttrSetUVAttrib, AttrSetIntAttrib,

7.2.33 AttrSetPtrAttrib (miscattr.c:667)

void AttrSetPtrAttrib(IPAttributeStruct **Attrs,
const char *Name,
VoidPtr Data)

Attrs: Attribute list where to place new attribute.
Name: Name of the newly introduced attribute.
Data: Pointer attribute to save.
Returns: void

Description: Routine to set a pointer attribute.
See also: AttrSetIntAttrib, AttrSetIntAttrib, AttrSetPtrAttrib, AttrGetPtrAttrib, AttrSetRealAttrib, AttrGetRealAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetUVAttrib, AttrSetUVAttrib, AttrSetIntAttrib, AttrSetRefPtrAttrib, AttrGetRefPtrAttrib, AttrSetPtrAttrib2,
7.2.34 AttrSetPtrAttrib2 (miscattr.c:695)

```
void AttrSetPtrAttrib2(IPAttributeStruct **Attrs,
                      AttribNumType AttribNum,
                      VoidPtr Data)
```

**Attrs**: Attribute list where to place new attribute.

**AttribNum**: Unique ID derived from name of requested attribute.

**Data**: Pointer attribute to save.

**Returns**: void

**Description**: Routine to set a pointer attribute.

**See also**: AttrSetIntAttrib, AttrGetIntAttrib, AttrGetPtrAttrib, AttrSetRealAttrib, AttrGetRealAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetUVAttrib, AttrSetUVAttrib, AttrSetRefPtrAttrib, AttrGetRefPtrAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetUVAttrib, AttrSetUVAttrib, AttrSetPtrAttrib.

7.2.35 AttrSetRGBColor (miscattr.c:190)

```
void AttrSetRGBColor(IPAttributeStruct **Attrs, int Red, int Green, int Blue)
```

**Attrs**: Where to place the TGB color attribute.

**Red, Green, Blue**: Component of RGB color.

**Returns**: void

**Description**: Routine to set an RGB color attribute.

**See also**: AttrSetColor, AttrGetColor, AttrGetRGBColor, AttrSetWidth, AttrGetWidth, AttrSetIntAttrib, AttrSetObjectRGBColor.

7.2.36 AttrSetRGBDoubleColor (miscattr.c:395)

```
void AttrSetRGBDoubleColor(IPAttributeStruct **Attrs,
                           double Red,
                           double Green,
                           double Blue)
```

**Attrs**: Where to place the TGB color attribute.

**Red, Green, Blue**: Component of RGB color.

**Returns**: void

**Description**: Routine to set a Floating point 64 RGB color attribute.

**See also**: AttrSetColor, AttrGetColor, AttrGetRGBColor, AttrSetWidth, AttrGetWidth, AttrSetIntAttrib, AttrSetObjectRGBColor, AttrGetRGBDoubleColor.

7.2.37 AttrSetRealAttrib (miscattr.c:924)

```
void AttrSetRealAttrib(IPAttributeStruct **Attrs,
                       const char *Name,
                       IrtRType Data)
```

**Attrs**: Attribute list where to place new attribute.

**Name**: Name of the newly introduce attribute.

**Data**: IrtRType attribute to save.

**Returns**: void

**Description**: Routine to set a IrtRType attribute.

**See also**: AttrSetIntAttrib, AttrGetIntAttrib, AttrGetPtrAttrib, AttrSetRealAttrib, AttrGetRealAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetUVAttrib, AttrSetUVAttrib, AttrSetRefPtrAttrib, AttrGetRefPtrAttrib, AttrSetPtrAttrib.
### 7.2.38 AttrSetRealAttrib2 (miscattr.c:951)

```c
void AttrSetRealAttrib2(IPAttributeStruct **Attrs,
                        AttribNumType AttribNum,
                        IrtRType Data);
```

**Attrs**: Attribute list where to place new attribute.

**AttribNum**: Unique ID derived from name of requested attribute.

**Data**: IrtRType attribute to save.

**Returns**: void

**Description**: Routine to set a IrtRType attribute.

**See also**: AttrSetIntAttrib, AttrGetIntAttrib, AttrSetPtrAttrib, AttrGetPtrAttrib, AttrGetRealAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetUVAttrib, AttrSetUVAttrib, AttrSetRealAttrib

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### 7.2.39 AttrSetRefPtrAttrib (miscattr.c:796)

```c
void AttrSetRefPtrAttrib(IPAttributeStruct **Attrs,
                         const char *Name,
                         VoidPtr Data);
```

**Attrs**: Attribute list where to place new attribute.

**Name**: Name of the newly introduced attribute.

**Data**: Pointer attribute to save.

**Returns**: void

**Description**: Routine to set a pointer reference attribute.

**See also**: AttrSetIntAttrib, AttrGetIntAttrib, AttrGetPtrAttrib, AttrSetRealAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetUVAttrib, AttrSetUVAttrib, AttrSetPtrAttrib, AttrGetPtrAttrib, AttrSetRefPtrAttrib2

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### 7.2.40 AttrSetRefPtrAttrib2 (miscattr.c:824)

```c
void AttrSetRefPtrAttribPointer(IPAttributeStruct **Attrs,
                                const char *Name,
                                VoidPtr Data);
```

**Attrs**: Attribute list where to place new attribute.

**AttribNum**: Unique ID derived from name of requested attribute.

**Data**: Pointer attribute to save.

**Returns**: void

**Description**: Routine to set a pointer reference attribute.

**See also**: AttrSetIntAttrib, AttrGetIntAttrib, AttrGetPtrAttrib, AttrSetRealAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetUVAttrib, AttrSetUVAttrib, AttrSetPtrAttrib, AttrGetPtrAttrib, AttrSetRefPtrAttrib

---

### 7.2.41 AttrSetStrAttrib (miscattr.c:1201)

```c
void AttrSetStrAttrib(IPAttributeStruct **Attrs,
                      const char *Name,
                      const char *Data);
```

**Attrs**: Attribute list where to place new attribute.

**Name**: Name of the newly introduced attribute.

**Data**: String attribute to save.

**Returns**: void

**Description**: Routine to set a string attribute.

**See also**: AttrSetIntAttrib, AttrGetIntAttrib, AttrSetPtrAttrib, AttrGetPtrAttrib, AttrSetRealAttrib, AttrGetRealAttrib, AttrSetUVAttrib, AttrGetUVAttrib, AttrSetUVAttrib, AttrSetStrAttrib2,
7.2.42  AttrSetStrAttrib2 (miscattr.c:1228)

void AttrSetStrAttrib2(IPAttributeStruct **Attrs,
                AttribNumType AttribNum,
                const char *Data)

Attrs: Attribute list where to place new attribute.
AttribNum: Unique ID derived from name of requested attribute.
Data: String attribute to save.
Returns: void

Description: Routine to set a string attribute.
See also: AttrSetIntAttrib, AttrGetIntAttrib, AttrSetPtrAttrib, AttrGetPtrAttrib, AttrSetRealAttrib, AttrGetRealAttrib, AttrGetStrAttrib, AttrGetUVAttrib, AttrSetUVAttrib, AttrSetStrAttrib,

7.2.43  AttrSetUVAttrib (miscattr.c:1060)

void AttrSetUVAttrib(IPAttributeStruct **Attrs,
                const char *Name,
                IrtRType U,
                IrtRType V)

Attrs: Attribute list where to place new attribute.
Name: Name of the newly introduced attribute.
U, V: UV attribute to save.
Returns: void

Description: Routine to set a UV attribute.
See also: AttrSetIntAttrib, AttrGetIntAttrib, AttrSetPtrAttrib, AttrGetPtrAttrib, AttrSetRealAttrib, AttrGetRealAttrib, AttrGetStrAttrib, AttrSetUVAttrib, AttrSetUVAttrib2,

7.2.44  AttrSetUVAttrib2 (miscattr.c:1088)

void AttrSetUVAttrib2(IPAttributeStruct **Attrs,
                AttribNumType AttribNum,
                IrtRType U,
                IrtRType V)

Attrs: Attribute list where to place new attribute.
AttribNum: Unique ID derived from name of requested attribute.
U, V: UV attribute to save.
Returns: void

Description: Routine to set a UV attribute.
See also: AttrSetIntAttrib, AttrGetIntAttrib, AttrSetPtrAttrib, AttrGetPtrAttrib, AttrSetRealAttrib, AttrGetRealAttrib, AttrGetStrAttrib, AttrSetUVAttrib, AttrSetUVAttrib2,

7.2.45  AttrSetWidth (miscattr.c:441)

void AttrSetWidth(IPAttributeStruct **Attrs, IrtRType Width)

Attrs: Where to place the width attribute.
Width: New width.
Returns: void

Description: Routine to set a width attribute.
See also: AttrSetColor, AttrGetColor, AttrSetRGBColor, AttrGetRGBColor, AttrGetWidth, AttrSetRealAttrib, AttrSetObjectWidth,
7.2.46  AttrTraceAttributes (miscattr.c:1328)

    const IPAttributeStruct *AttrTraceAttributes(
        const IPAttributeStruct *TraceAttrs,
        const IPAttributeStruct *FirstAttrs)

    TraceAttrs: If not NULL, contains the previously returned attribute.
    FirstAttrs: First attribute in list, usually NULL in all but the first invocation.
    Returns: Next attribute in list.

    Description: Routine to aid in scanning a list of attributes. If TraceAttrs != NULL, a ptr to its attribute list
is saved and the next attribute is returned every call until the end of the list is reached, in which NULL is returned. Attributes with names starting with an underscore '_' are assumed to be temporary or internal and are skipped.

7.2.47  E2TFreeNodetree (exprtree.c:1741)

    void E2TFreeNodetree(IritE2TEexprNodeStruct *Root)

    Root: Tree to release.
    Returns: void

    Description: Routine to free a tree - release all memory allocated by it.

    See also:

7.2.48  GAGetArgs (getarg.c:201)

    int GAGetArgs(int va_alist, ...)

    va_alist: Do "man stdarg".
    ...: Rest of optional parameters
    Returns: TRUE if command line was valid, FALSE otherwise.

    Description: Routine to access command line arguments and interpret them, by getting access to the main routine’s arg/argv interface and a control string that prescribes the expected options. Returns ARG_OK (0) is case of succesfull parsing, error code else...

    Format of CtrlStr format: The control string passed to GAGetArgs controls the way argv (argc) are parsed. Each entry in this string must have no spaces in it. The First Entry is the name of the program which is usually ignored except when GAPrintHowTo is called. All the other entries (except the last one which will be discussed shortly) must have the following format:

    1. One letter which sets the option letter (i.e. 'x' for option '-x').
    2. '!' or '%' to determines if this option is really optional ('%') or it must be provided by the user ('!').
    3. '-' always.
    4. Alpha numeric string (and '|' to denote a space), usually ignored, but used by GAPrintHowTo to describe the meaning of this option.
    5. Sequences that start with either '!-' or '%%'. Again if '!' then this sequence must exists (only if its option flag is given), and if '%' it is optional. Each sequence will be followed by one or two characters which defines the kind of the input:
        5.1. d, x, o, u - integer is expected (decimal, hex, octal base or unsigned).
        5.2. D, X, O, U - long integer is expected (same as above).
        5.3. f - float number is expected.
        5.4. F - double number is expected.
        5.5. s - string is expected.
        5.6. *? - any number of '?' kind (d, x, o, D, X, O, U, f, F, s) will match this one. If '?' is numeric, it scans until none numeric input is given. If '?' is 's' then it scans up to the next option or end of argv.
If the last parameter given in the CtrlStr, is not an option (i.e. the second char is not in ['!', '%'] and the third one is not '-'), all what remained from argv is hooked to it.
The variables passed to GAGetArgs (starting from 4th parameter) MUST match the order of options in the CtrlStr.
For each option, an address of an integer must be passed. This integer must initialized by 0. If that option is given in the command line, it will be set to one. Otherwise, this integer will not be affected. In addition, the sequences that might follow an option require the following parameter(s) to be passed

1. d, x, o, u - pointer to an integer (int *).
2. D, X, O, U - pointer to a long (long *).
3. f - pointer to a float (float *).
4. F - pointer to a double (double *).
5. s - pointer to a char * (char **). NO pre-allocation is required.
6. *? - TWO variables are passed for each such wild character request. The first variable is an address of an integer, and it will return the number of parameters actually hooked to this sequence. The second variable is a pointer to a pointer to type ? (??). It will return an address of a vector of pointers of type ?, terminated with a NULL pointer. NO pre-allocation is required. These two variables behaves very much like the argv/argc pair and are used the "trap" unused command line options.

Examples:

"Example1 i%-OneInteger!d s%-Strings!*s j%!-Double!F Files!*s"
Will match: Example1 -i 77 -s String1 String2 String3 -k 88.2 File1 File2
or match: Example1 -s String1 -k 88.3 -i 999 -j
but not: Example1 -i 77 78 (i expects one integer, k must be specified).

The option k must exists in the above example and if 'i' is prescribed one integer argument must follow it. In the first example, File1 & File2, will match Files in the control string. The order of the options in the command line is irrelevant. A call to GAPrintHowTo with this CtrlStr will print the info:

Example1 [-i OneIngeter] [-s Strings...] [-j] -k Float Files...

The parameters below are stdarg style and in fact are expecting the following:

GAGetArgs(argc, argv, CtrlStr, ...);

1. argc, argv: The usual C interface from the main routine of the program.
2. CtrlStr: Defining the types/options to expect in the command line.
3. ...: list of addresses of variables to initialize according to parsed command line.

See also: GAPrintErrMsg, GAPrintHowTo,

7.2.49 GAPrintErrMsg (getarg.c:787)

void GAPrintErrMsg(int Error)

Error: Error type as returned by GAGetArgs.

Returns: void

Description: Routine to print a description of an error, for this module.

See also: GAStringErrMsg, GAPrintHowTo, GAGetArgs,
7.2.50  GAPrintHowTo (getarg.c:915)

void GAPrintHowTo(const char *CtrlStr)

   **CtrlStr**: Defining the types/options to expect in the command line.
   **Returns**: void
   **Description**: Routine to print the correct format of command line allowed. For example, for the following control string,

   "Example1 i%-OneInteger!d s%-Strings!*s j%- k!-Double!F Files"

This routine will print

Example1 [-i OneIngeter] [-s Strings...] [-j] -k Double Files...

See also: GAPrintErrMsg, GAStringHowTo, GAGetArgs,

7.2.51  GAStringErrMsg (getarg.c:736)

char *GAStringErrMsg(int Error, char *OutStr)

   **Error**: Error type as returned by GAGetArgs.
   **OutStr**: Where to place the error message.
   **Returns**: The error message string (OutStr).
   **Description**: Routine to print a description of an error to a string.
See also: GAPrintErrMsg, GAStringHowTo, GAGetArgs,

7.2.52  GAStringHowTo (getarg.c:815)

char *GAStringHowTo(const char *CtrlStr, char *OutStr)

   **CtrlStr**: Defining the types/options to expect in the command line.
   **OutStr**: Where to place the how to message.
   **Returns**: The how-to message string (OutStr).
   **Description**: Routine to write the correct format of command line allowed, to a string. For example, for the following control string,

   "Example1 i%-OneInteger!d s%-Strings!*s j%- k!-Double!F Files"

This routine will write

Example1 [-i OneIngeter] [-s Strings...] [-j] -k Double Files...

See also: GAPrintHowTo, GAStringErrMsg, GAGetArgs,

7.2.53  IritApproxStrStrMatch (xgeneral.c:234)

IrtRType IritApproxStrStrMatch(const char *Str1,
                              const char *Str2,
                              int IgnoreCase)

   **Str1, Str2**: The two strings to compare.
   **IgnoreCase**: TRUE to ignore case, FALSE to consider as different.
   **Returns**: Perfect match returns 1.0, otherwise match estimation between 0.0 and 1.0.
   **Description**: Provides an approximated comparison between two strings.
7.2.54 IritCPUtilime (xgeneral.c:448)

IrtRType IritCPUtilime(int Reset)

Reset: If TRUE, clock is reset back to zero.
Returns: CPU time since last reset or beginning of execution.
Description: Routine to compute the cpu time, in second, of the running process.

7.2.55 IritCheckMarkDynMemory (imalloc.c:125)

void IritCheckMarkDynMemory(IrtRType *Start,
IrtRType *KeepStackStep,
IrtRType *TrackAllocID)

Start: 1 to initial check mark, 2 to also request stack trace info, 0 to terminate and dump result.
KeepStackStep: If Start = 2, sets stack-keeping every n’th alloc.
TrackAllocID: if non-zero, also track the unique allocation ID.
Returns: void
Description: Sets/clear dynamic memory check marks and reports. Initializes the dynamic memory testing
routines, if not initialized until now.
See also: IritFree, IritMalloc, IritRealloc, IritTestAllDynMemory,

7.2.56 IritConfig (config.c:178)

const char *IritConfig(const char *PrgmName,
const IritConfigStruct *SetUp,
int NumVar)

PrgmName: Name of program that uses this data base.
SetUp: Configuration data based.
NumVar: Number of entries on configuration data base.
Returns: Name of config file read, or NULL if error.
Description: Main routine of configuration file handling. Gets the program name, PrgmName, and the config-
uration data base that defines the acceptable variables, Setup, with Numvarentries.

7.2.57 IritConfigPrint (config.c:65)

void IritConfigPrint(const IritConfigStruct *SetUp, int NumVar)

SetUp: Configuration data based.
NumVar: Number of entries on configuration data base.
Returns: void
Description: Route to print the current configuration data structure contents.

7.2.58 IritConfigSave (config.c:443)

int IritConfigSave(const char *FileName,
const IritConfigStruct *SetUp,
int NumVar)

FileName: File to save configuration at.
SetUp: Configuration data based.
NumVar: Number of entries on configuration data base.
Returns: TRUE if saved successfully, FALSE otherwise.
Description: Saves the given configuration into a file.
7.2.59  IritDebugMallocSearchID  (imalloc.c:518)

void IritDebugMallocSearchID(int ID)

   ID: Allocation ID to seek and abort at.
   Returns: void

   Description: Set the searched malloced ID. This function will take affect iff IritDebugMalloc is non zero as set via "IRIT_MALLOC" env.
   See also: IritFree, IritMalloc, IritRealloc, IritTestAllDynMemory, IritDebugMallocSearchPtr, IritDebugMallocAllocated, IritInitTestDynMemory, IritCheckMarkDynMemory,

7.2.60  IritE2Expt2TreeSetFetchParamValueFunc  (exprtree.c:106)

IritE2TExprNodeParamFuncType IritE2Expt2TreeSetFetchParamValueFunc(IritE2TExprNodeParamFuncType FetchParamValueFunc)

   FetchParamValueFunc: Function pointer to use to fetch a value of a parameter, given its name.
   Returns: Old function pointer.

   Description: Sets the function to use to fetch a parameter value, given its name, during evaluation.

7.2.61  IritE2TCmpTree  (exprtree.c:1614)

int IritE2TCmpTree(const IritE2TExprNodeStruct *Root1,
                   const IritE2TExprNodeStruct *Root2)

   Root1, Root2: The two trees to compare.
   Returns: TRUE if equal, FALSE otherwise.

   Description: Routine to compare two trees - for equality: The trees are compared to be symbolically equal i.e. A*B == B*A !
   See also:

7.2.62  IritE2TCopyTree  (exprtree.c:890)

IritE2TExprNodeStruct *IritE2TCopyTree(const IritE2TExprNodeStruct *Root)

   Root: Tree to duplicate.
   Returns: Duplicated tree.

   Description: Routine to create a new copy of a given tree.
   See also:

7.2.63  IritE2TDerivError  (exprtree.c:1848)

int IritE2TDerivError(void)

   Returns: Error or 0 in none.

   Description: Get a derivative error is was one or 0 in none.
   See also:
7.2.64  IritE2T DerivTree (exprtree.c:1087)

IritE2TExprNodeStruct *IritE2T DerivTree(const IritE2TExprNodeStruct *Root,
     int Param)

  Root: To derive.
  Param: The parameter to differentiate according to.
  Returns: Derived tree.
  Description: Routine to generate the tree represent the derivative of tree Root.
  See also:

7.2.65  IritE2TEvalTree (exprtree.c:955)

IrtRType IritE2TEvalTree(const IritE2TExprNodeStruct *Root)

  Root: Tree to evaluate.
  Returns: Evaluated result.
  Description: Routine to evaluate a value of a given tree Root and set parameters.
  See also:

7.2.66  IritE2TExpr2Tree (exprtree.c:184)

IritE2TExprNodeStruct *IritE2TExpr2Tree(const char s[])

  s: String expression to parse.
  Returns: Built binary tree.
  Description: Routine to convert the expression in string S into a binary tree. Algorithm: Using operator
  precedence with the following grammar: EXPR ::= EXPR | EXPR + EXPR | EXPR - EXPR EXPR ::= EXPR
  | EXPR * EXPR | EXPR / EXPR EXPR ::= EXPR | EXPR \  EXPR EXPR ::= NUMBER | -EXPR | (EXPR)
  | FUNCTION FUNCTION ::= SIN(EXPR) | COS(EXPR) | TAN(EXPR) | ARCSIN(EXPR) | ARCCOS(EXPR) | ARCTAN(EXPR) | SQRT(EXPR) | SQR(EXPR) | ABS(EXPR) | LN(EXPR) | LOG(EXPR) | EXP(EXPR)
  And left associativity for +, -, *, /, \. Precedence of operators is as usual: <Highest> {unary minus} {^} {*}, {/}
  <Lowest>
  Returns NULL if an error was found, and error is in E2TParsingError.
  See also:

7.2.67  IritE2TFreeTree (exprtree.c:1030)

void IritE2TFreeTree(IritE2TExprNodeStruct *Root)

  Root: Tree to free.
  Returns: void.
  Description: Frees a given expression tree.
  See also:

7.2.68  IritE2TParamInTree (exprtree.c:1680)

int IritE2TParamInTree(const IritE2TExprNodeStruct *Root,
                          const char *ParamName)

  Root: Tree to examine for an existence of a parameter.
  ParamName: Name of parameter to seek, or NULL to seek if any param.
  Returns: TRUE if parameter exists, FALSE otherwise.
  Description: Routine to test if the parameter is in the tree: If ParamName is NULL then any parameter return
  TRUE.
  See also:
7.2.69 IritE2TParseError (exprtree.c:1823)

int IritE2TParseError(void)

   Returns: Error or 0 in none.
   Description: Get a parsing error is was one or 0 in none.
   See also:

7.2.70 IritE2TPrintTree (exprtree.c:716)

void IritE2TPrintTree(const IritE2TExprNodeStruct *Root, char *Str)

   Root: Tree to print.
   Str: Destination.
   Returns: void
   Description: Routine to print a content of Root (using inorder traversal): If *str = NULL print on stdout, else on given string str.
   See also:

7.2.71 IritE2TSetParamValue (exprtree.c:1801)

void IritE2TSetParamValue(IrtRType Value, int Index)

   Value: New value to assign to a parameter.
   Index: The index of the parameter.
   Returns: void
   Description: Routine to set the value of a Parameter before evaluating an expression.
   See also:

7.2.72 IritFatalError (iritftl.c:57)

void IritFatalError(const char *Msg)

   Msg: Error message to print.
   Returns: void
   Description: Default trap for IRIT programs for irit fatal errors. This function just prints the given error message and die.
   See also: IritWarningMsg, IritInformationMsg, IritFatalErrorPrintf,

7.2.73 IritFatalErrorPrintf (irit2ftl.c:35)

void IritFatalErrorPrintf(const char *va_alist, ...)

   va_alist: Do "man stdarg".
   Returns: void
   Description: Default trap for IRIT programs for irit fatal errors, printf style.
   See also: IritFatalError, IritWarningMsgPrintf, IritInformationMsgPrintf,
7.2.74 **IritFree** (imalloc.c:541)

```c
void IritFree(VoidPtr p)
```

- **p**: Pointer to a block that needs to be freed.
- **Returns**: void
- **Description**: Routine to free dynamic memory for all IRIT program/tool/libraries. All requests to free dynamic memory should invoke this function.
- **See also**: IritMalloc, IritRealloc, IritCheckMarkDynMemory, IritInitTestDynMemory,

7.2.75 **IritGaussJordan** (levenmar.c:571)

```c
int IritGaussJordan(IrtRType *A, IrtRType *B, unsigned N, unsigned M)
```

- **A**: A matrix of N*N elements, is invalid on exit.
- **B**: A matrix of N*M elements, contains the result on exit.
- **N**: Described above.
- **M**: Described above.
- **Returns**: TRUE on success, FALSE if singular.
- **Description**: This function solves the linear equation Ax=B, using the Gauss-Jordan elimination algorithm.
- **See also**:

7.2.76 **IritHashTableCreate** (hash_tbl.c:38)

```c
IritHashTableStruct *IritHashTableCreate(IrtRType MinKeyVal, IrtRType MaxKeyVal, IrtRType KeyEps, int VecSize)
```

- **MinKeyVal**: Minimum expected key value.
- **MaxKeyVal**: Maximum expected key value.
- **KeyEps**: Tolerance of two keys to be considered the same. Negative to never consider the same.
- **VecSize**: Size of hash table to use.
- **Returns**: Constructed has table.
- **Description**: Constructs a simple hashing table.
- **See also**: IritHashTableInsert, IritHashTableRemove, IritHashTableFree, , IritHashTableFind,

7.2.77 **IritHashTableFind** (hash_tbl.c:159)

```c
VoidPtr IritHashTableFind(IritHashTableStruct *IHT, VoidPtr Data, IritHashCmpFuncType HashCmpFunc, IrtRType Key)
```

- **IHT**: IritHashTable structure.
- **Data**: Element to compare against during the search.
- **HashCmpFunc**: Test function to compare two data items. Returns -1,0,1 if first item is less, equal, greater than second item. If NULL, search is conducted by the Key only.
- **Key**: Key with which to search in the table.
- **Returns**: Found element, or NULL if none.
- **Description**: Find an element in the hashing table. Search is conducted in two steps. First the search is performed by key and then by HashCmpFunc against Data.
- **See also**: IritHashTableCreate, IritHashTableRemove, IritHashTableInsert, , IritHashTableFree,
7.2.78 IritHashTableFree (hash_tbl.c:273)

    void IritHashTableFree(IritHashTableStruct *IHT)

    IHT: IritHashTable structure to free.
    Returns: void
    Description: Free the entire hash table.
    See also: IritHashTableCreate, IritHashTableInsert, IritHashTableFind, IritHashTableRemove,

7.2.79 IritHashTableInsert (hash_tbl.c:87)

    int IritHashTableInsert(IritHashTableStruct *IHT,
        VoidPtr Data,
        IritHashCmpFuncType HashCmpFunc,
        IrtRType Key,
        int RplcSame)

    IHT: IritHashTable structure.
    Data: Element to insert into the hash table.
    HashCmpFunc: Test function to compare two data items. Returns -1,0,1 if first item is less, equal, greater
        than second item. If NULL, search is conducted by the Key only.
    Key: Key with which to insert into the table.
    RplcSame: TRUE, to replace a similar Data if detected, FALSE to skip.
    Returns: TRUE if old element with the same key was found and replaced, FALSE if indeed a data with new
        key.
    Description: Insert one element into the hashing table.
    See also: IritHashTableCreate, IritHashTableFind, IritHashTableInsert, IritHashTableFree,

7.2.80 IritHashTableRemove (hash_tbl.c:215)

    int IritHashTableRemove(IritHashTableStruct *IHT,
        VoidPtr Data,
        IritHashCmpFuncType HashCmpFunc,
        IrtRType Key)

    IHT: IritHashTable structure.
    Data: Element to compare against during the search.
    HashCmpFunc: Test function to compare two data items. Returns -1,0,1 if first item is less, equal, greater
        than second item. If NULL, search is conducted by the Key only.
    Key: Key with which to search in the table.
    Returns: TRUE if element found and removed, FALSE if not found.
    Description: Remove an element from the hashing table. Search is conducted in two steps. First the search is
        performed by key and then by HashCmpFunc against Data.
    See also: IritHashTableCreate, IritHashTableFind, IritHashTableInsert, IritHashTableFree,

7.2.81 IritInformationMsg (irit_inf.c:82)

    void IritInformationMsg(const char *Msg)

    Msg: Error message to print.
    Returns: void
    Description: Default trap for IRIT programs for irit information. This function just prints the given message.
    See also: IritInformationMsgPrintf, IritFatalError, IritWarningMsg,
7.2.82 IritInformationMsgPrintf (irit2inf.c:35)

```c
void IritInformationMsgPrintf(const char *va_alist, ...)
```

- **va_alist**: Do "man stdarg".
- **Returns**: void
- **Description**: Default trap for IRIT programs for irit warning errors, printf style.
- **See also**: IritInformationMsg, IritFatalErrorPrintf, IritWarningMsgPrintf.

7.2.83 IritInitTestDynMemory (imalloc.c:192)

```c
void IritInitTestDynMemory(void)
```

- **Returns**: void
- **Description**: Initialize dynamic memory testing routines, using envvars.
- **See also**: IritFree, IritMalloc, IritRealloc, IritCheckMarkDynMemory, IritInitTestDynMemory2,

7.2.84 IritInitTestDynMemory2 (imalloc.c:233)

```c
void IritInitTestDynMemory2(int DebugMalloc, int DebugSearchAllocID)
```

- **DebugMalloc**: Bitwise control over what to test: 0x02 - List possibly freed yet not malloced ptrs. 0x04 - Track unfreed memory blocks. 0x08 - Under windows use windows CrtDbg check every 16 mallocs. 0x10 - Under windows use windows CrtDbg check every 16 mallocs. 0x20 - Under windows, enable stack info trace. See IRIT_DEBUG_MALLOC at the beginning of file.
- **DebugSearchAllocID**: Allocation ID to trace, 0 for no ID to trace.
- **Returns**: void
- **Description**: Initialize dynamic memory testing routines.
- **See also**: IritFree, IritMalloc, IritRealloc, IritCheckMarkDynMemory, IritInitTestDynMemory,

7.2.85 IritLevenMarMin (levenmar.c:429)

```c
IrtRType IritLevenMarMin(IrtRType **X,
                    IrtRType Y[],
                    IrtRType Sigma[],
                    unsigned NumberOfDataElements,
                    IrtRType ModelParams[],
                    IritLevenEvalFuncType *ShapeFunc,
                    IritLevenNumerProtectionFuncType *ProtectionFunc,
                    IritLevenIsModelValidFuncType *ModelValidatorFunc,
                    unsigned NumberOfModelParams,
                    IrtRType Tolerance)
```

- **X**: Pointer to a list of data.
- **Y**: Pointer to the list of expected results.
- **Sigma**: Pointer to the expected variance vector.
- **NumberOfDataElements**: The number of data elements in X, Y & Sigma.
- **ModelParams**: The model params to be checked.
- **ShapeFunc**: The shape function.
- **ProtectionFunc**: The numerical protection function.
- **ModelValidatorFunc**: The model validator.
- **NumberOfModelParams**: The number of model params.
- **Tolerance**: If the error is smaller then Tolerance return.
- **Returns**: The squared sum of the error.
- **Description**: This function calculates the levenberg-marquardt minimization of the Specified function.
- **See also**: IritLevenMarMinSig1, IritLevenMarSetMaxIterations,
7.2.86 IritLevenMarMinSig1 (levenmar.c:506)

IrtRType IritLevenMarMinSig1(IrtRType **X,
IrtRType Y[],
unsigned NumberOfDataElements,
IrtRType ModelParams[],
IrtLevenEvalFuncType *ShapeFunc,
IritLevenNumerProtectionFuncType *ProtectionFunc,
IritLevenIsModelValidFuncType *ModelValidatorFunc,
unsigned NumberOfModelParams,
IrtRType Tolerance)

X: Pointer to a list of data.
Y: Pointer to the list of expected results.
NumberOfDataElements: The number of data elements in X, Y & Sigma.
ModelParams: The model params to be checked.
ShapeFunc: The shape function.
ProtectionFunc: The numerical protection function.
ModelValidatorFunc: The model validator.
NumberOfModelParams: The number of model params.
Tolerance: If the error is smaller than Tolerance return.
Returns: The squared sum of the error.

Description: This function calculates the levenberg-marquardt minimization of the specified function. This function is similar to LevenMin except that sigma is always 1.
See also: IritLevenMarMin, IritLevenMarSetMaxIterations,

7.2.87 IritLevenMarSetMaxIterations (levenmar.c:88)

unsigned IritLevenMarSetMaxIterations(unsigned NewVal)

NewVal: The new maximum number of iterations.
Returns: The old maximum number of iterations.
Description: This function modifies the maximum number of iteration when calculating Levenberg-Marquardt.
See also: IritLevenMarMinSig1, IritLevenMarMin,

7.2.88 IritLineHasCntrlChar (irit_inf.c:53)

int IritLineHasCntrlChar(const char *Line)

Line: Line to examine for control char’s existence.
Returns: TRUE if this line holds control chars, FALSE otherwise.
Description: Test if the given line contains control chars.

7.2.89 IritMalloc (imalloc.c:415)

VoidPtr IritMalloc(unsigned Size,
const char *ObjType,
const char *FileName,
int LineNum)

Size: Size of block to allocate, in bytes.
ObjType: This variable exists if ”#define DEBUG_IRIT_MALLOC”. This holds the object descriptions.
FileName: This variable exists iff "#define DEBUG IRIT_MALLOC". This holds the file name where the call is invoked from.

LineNum: This variable exists iff "#define DEBUG IRIT_MALLOC". This holds the line number where the call is invoked from.

Returns: A pointer to the allocated block. A function calling this may assume return value will never be NULL, since no more memory cases are trapped locally.

Description: Routine to allocate dynamic memory for all IRIT program/tool/libraries. All requests for dynamic memory should invoke this function. If the environment variable "IRIT_MALLOC" is set when an IRIT program is executed, the consistency of the dynamic memory is tested on every invocation of this routine. See IritTestAllDynMemory function for more.

See also: IritFree, IritRealloc, IritCheckMarkDynMemory, IritInitTestDynMemory,

7.2.90 IritPQCompFunc (priorque.c:98)

void IritPQCompFunc(IritPQCompFuncType NewCompFunc)

NewCompFunc: A comparison function to used on item in the queue.

Returns: void

Description: Sets (a pointer to) the function that is used in comparing two items in the queue. This comparison function will get two item pointers, and should return >0, 0, <0 as comparison result for greater than, equal, or less than relation, respectively.

7.2.91 IritPQDelete (priorque.c:197)

VoidPtr IritPQDelete(IritPriorQue **PQ, VoidPtr OldItem)

PQ: To delete OldItem from.

OldItem: Old element in priority queue PQ to remove from.

Returns: Removed OldItem if found, NULL otherwise.

Description: Deletes an old item from the queue, using comparison function CompFunc. Returns a pointer to Deleted item if was found and deleted from the queue, NULL otherwise.

7.2.92 IritPQEmpty (priorque.c:76)

int IritPQEmpty(IritPriorQue *PQ)

PQ: Priority queue to test for containment.

Returns: TRUE if not empty, FALSE otherwise.

Description: returns TRUE iff PQ priority queue is empty.

7.2.93 IritPQFind (priorque.c:278)

VoidPtr IritPQFind(IritPriorQue *PQ, VoidPtr OldItem)

PQ: To search for OldItem at.

OldItem: Element to search in PQ.

Returns: Found element or otherwise NULL.

Description: Finds old item on the queue, PQ, using the comparison function CompFunc. Returns a pointer to item if was found, NULL otherwise.
7.2.94 **IritPQFirst** (priorque.c:118)

VoidPtr IritPQFirst(IritPriorQue **PQ, int Delete)

**PQ:** To examine/remove first element from.

**Delete:** If TRUE first element is being removed from the queue.

**Returns:** A pointer to the first element in the queue.

**Description:** Returns the first element in the given priority queue, and delete it from the queue if Delete is TRUE. returns NULL if empty queue.

7.2.95 **IritPQFree** (priorque.c:416)

void IritPQFree(IritPriorQue *PQ, int FreeItem)

**PQ:** Priority queue to release.

**FreeItem:** If TRUE, elements are being freed as well.

**Returns:** void

**Description:** Frees the given queue. The elements are also freed if FreeItems is TRUE.

7.2.96 **IritPQFreeFunc** (priorque.c:444)

void IritPQFreeFunc(IritPriorQue *PQ, void (*FreeFunc)(VoidPtr))

**PQ:** Priority queue to release.

**FreeFunc:** "Printing function".

**Returns:** void

**Description:** Frees the given queue. The elements are also freed by invoking FreeFunc on all of them as FreeFunc’s only argument.

7.2.97 **IritPQInit** (priorque.c:57)

void IritPQInit(IritPriorQue **PQ)

**PQ:** To initialize.

**Returns:** void

**Description:** Initializes the priority queue.

7.2.98 **IritPQInsert** (priorque.c:154)

VoidPtr IritPQInsert(IritPriorQue **PQ, VoidPtr NewItem)

**PQ:** To insert a new element to.

**NewItem:** The new element to insert.

**Returns:** An old element NewItem replaced, or NULL otherwise.

**Description:** Insert a new element into the queue (NewItem is a pointer to new element) using given compare function CompFunc (See IritPQCompFunc). Insert element will always be a leaf of the constructed tree. Returns a pointer to old element if was replaced or NULL if the element is new.
7.2.99 IritPQNext (priorque.c:319)

VoidPtr IritPQNext(IritPriorQue *PQ, VoidPtr CmpItem, VoidPtr LargerThan)

**PQ:** To examine.
**CmpItem:** To find the smallest item in PQ that is larger than it.
**LargerThan:** The item that is found larger so far.

**Returns:** The smallest item in PQ that is larger than CmpItem or NULL if no found.

**Description:** Returns the smallest element in PQ that is larger than given element CmpItem. PQ is not modified. Return NULL if none was found. LargerThan will always hold the smallest Item Larger than current one.

7.2.100 IritPQPrint (priorque.c:390)

void IritPQPrint(IritPriorQue *PQ, void (*PrintFunc)(VoidPtr))

**PQ:** Priority queue to traverse.
**PrintFunc:** "Printing function".

**Returns:** void

**Description:** Scans the priority queue in order and invokes the "printing" routine, PrintFunc on every item in the queue as its only argument.

7.2.101 IritPQSize (priorque.c:363)

int IritPQSize(IritPriorQue *PQ)

**PQ:** Priority queue to traverse.

**Returns:** Number of nodes in tree == number of elements.

**Description:** Computes the size of the given tree - number of nodes/elements.

7.2.102 IritPseudoRandom (xgeneral.c:404)

IrtRType IritPseudoRandom()

**Returns:** A pseudo random number between zero and one.

**Description:** Computes a pseudo random number generator using the large Bezier evaluation table of the cagd library...

See also: CagdIChooseKTable, IritPseudoRandomInit, IritRandom,

7.2.103 IritPseudoRandomInit (xgeneral.c:382)

void IritPseudoRandomInit(unsigned int Seed)

**Seed:** New seed for the randomization process.

**Returns:** void

**Description:** A seed generator for a pseudo random number generator using the large Bezier evaluation table of the cagd library...

See also: CagdIChooseKTable, IritPseudoRandom, IritRandom,
7.2.104 IritQRFactorization (qrfactor.c:48)

```c
int IritQRFactorization(IrtRType *A,  
    int n,  
    int m,  
    IrtRType *Q,  
    IrtRType *R)
```

- **A**: The matrix of size \( n \times n \) (\( m = n \)), must be preallocated dynamically by the user.
- **n, m**: Dimensions of matrix A.
- **Q, R**: The computed decomposition matrices, must be preallocated dynamically by the user. Q is \( n \times m \) (like A), R is \( m \times m \).

**Returns**: TRUE if Singular, FALSE otherwise.

**Description**: Performs a QR factorization of matrix A.

**See also**: SvdLeastSqr

7.2.105 IritQRUnderdetermined (qrfactor.c:277)

```c
int IritQRUnderdetermined(IrtRType *A,  
    IrtRType *x,  
    const IrtRType *b,  
    int m,  
    int n)
```

- **A**: The matrix of size \( m \times n \) (\( m <= n \)), must be preallocated dynamically by the user.
- **x**: The solution vector of size n.
- **b**: A vector of size m.
- **m, n**: Dimensions of matrix A. Because A is underdetermined \( m <= n \).

**Returns**: TRUE if Singular, FALSE otherwise.

**Description**: Solve for \( Ax = b \) when the system is underdetermined (singular). The solution is a minimum 2-norm solution. See "matrix Computation", by Gene H. Golub and Charles F. Van Loan, 3rd edition, pp 271-272. If A != NULL a QR factorization is computed, otherwise (A == NULL) a solution is computed for the given b and is placed in x.

**See also**: IritQRFactorization, IritSolveUpperDiagMatrix, SvdLeastSqr

7.2.106 IritRLAdd (mincover.c:265)

```c
void IritRLAdd(VoidPtr RLC, IrtRType l, IrtRType r, int Attr)
```

- **RLC**: An existing list which will be added a new node.
- **l, r, Attr**: Node details; Left, Right and Attribute.

**Returns**: void

**Description**: Creates and links a new range node to an existing list of nodes.

**See also**: IritRLNew, IritRLFIndCyclicCover, IritRLDelete

7.2.107 IritRLDelete (mincover.c:225)

```c
void IritRLDelete(VoidPtr RLC)
```

- **RLC**: A list to be deleted.

**Returns**: void

**Description**: Cleanup of RLStruct (a whole list)

**See also**: IritRLNew, IritRLAdd, IritRLFIndCyclicCover
7.2.108  IritRLFindCyclicCover (mincover.c:1079)

    int *IritRLFindCyclicCover(VoidPtr RLC, IrtRType Tol)

    RLC: A list (RL) of candidate ranges to cover [0,1].
    Tol: Accuracy of merges of sets.

    Returns: A vector of indices (attributes) of covering set, terminated by -1.

    Description: Finds a cyclic cover from nodes in RL to cover [0,1]. This function decides the type of the cover
    SingleRange or MultiRange and calls the suitable internal function to find a cover.

    See also: IritRLNew, IritRLAdd, IritRLDelete,

7.2.109  IritRLNew (mincover.c:190)

    VoidPtr IritRLNew(void)

    Returns: The new allocated list structure.

    Description: Initializes a new Range List (RL) - which is an empty double link list The list specifier is Plist*,
    which points, always, at the tail.

    See also: IritRLAdd, IritRLFindCyclicCover, IritRLDelete,

7.2.110  IritRLSetGuardiansNumber (mincover.c:109)

    int IritRLSetGuardiansNumber(int g)

    g: Maximum number of guardians required.

    Returns: The previously used number of guardians.

    Description: Sets the maximum number of views allowed to generate a min cover. Actually this is the maximum
    number of subsets to be generated by the FindMRCyclicCover() function.

    See also: IritRLAdd, IritRLFindCyclicCover, IritRLDelete,

7.2.111  IritRandom (xgeneral.c:335)

    IrtRType IritRandom(IrtRType Min, IrtRType Max)

    Min: Minimum range of random number requested.
    Max: Maximum range of random number requested.

    Returns: A random number between Min and Max.

    Description: Routine to compute a random number in a specified range. See also IritRandomInit.

    See also: IritRandomInit, IritPseudoRandom,

7.2.112  IritRandomInit (xgeneral.c:298)

    void IritRandomInit(long Seed)

    Seed: To initialize the random number generator with.

    Returns: void

    Description: Routine to initialize the random number generator.

    See also: IritRandom, IritPseudoRandom,
7.2.113  IritRealTimeDate (xgeneral.c:525)

    char *IritRealTimeDate(void)

    Returns: A string describing current date and time.
    Description: Routine to create and return a string describing current date and time.

7.2.114  IritRealloc (imalloc.c:369)

    VoidPtr IritRealloc(VoidPtr p, unsigned OldSize, unsigned NewSize)

    p: Old pointer to reallocate.
    OldSize: Size of old block pointed by p, zero if unknown.
    NewSize: Size of new block to allocate, in bytes. Must be larger than OldSize.
    Returns: A pointer to the allocated block. A function calling this may assume return value will never be NULL, since no more memory cases are trapped locally.

    Description: Routine to reallocate dynamic memory for all IRIT program/tool/libraries. All requests for dynamic memory should invoke this function. If the environment variable "IRIT_MALLOC" is set when an IRIT program is executed, the consistency of the dynamic memory is tested on every invocation of this routine. See IritTestAllDynMemory function for more.
    See also: IritFree, IritMalloc, IritCheckMarkDynMemory, IritInitTestDynMemory,

7.2.115  IritSearch2DFindElem (search.c:210)

    int IritSearch2DFindElem(VoidPtr S2D, 
                        IrtRType XKey, 
                        IrtRType YKey, 
                        VoidPtr Data)

    S2D: Internal data structure, aiding search.
    XKey, YKey: The 2D coordinates to search for.
    Data: A pointer to the location to copy the found data into.
    Returns: TRUE if element was found, FALSE otherwise.

    Description: Looks for an existing element in the data structure. If found an element within prescribed tolerance, Data is updated with the saved data
    See also: IritSearch2DFree, IritSearch2DInsertElem, IritSearch2DInit,

7.2.116  IritSearch2DFree (search.c:119)

    void IritSearch2DFree(VoidPtr S2D)

    S2D: Internal data structure, aiding search, to be freed.
    Returns: void

    Description: Free auxiliary data structure aiding in 2D search.
    See also: IritSearch2DInsertElem, IritSearch2DFindElem, IritSearch2DInit,
7.2.117  IritSearch2DInit (search.c:58)

```c
VoidPtr IritSearch2DInit(IrtRType XMin,
    IrtRType XMax,
    IrtRType YMin,
    IrtRType YMax,
    IrtRType Tol,
    int DataSize)
```

**XMin, XMax, YMin, YMax:** Dimensions of 2D domain.

**Tol:** Tolerance of expected search.

**DataSize:** Size, in bytes, of expected data elements to keep.

**Returns:** An internal auxiliary structure to be provided to the insertion and searching routines, NULL if error.

**Description:** Initialize the search data structure.

**See also:** IritSearch2DInsertElem, IritSearch2DFindElem, IritSearch2DFree,

---

7.2.118  IritSearch2DInsertElem (search.c:167)

```c
void IritSearch2DInsertElem(VoidPtr S2D,
    IrtRType XKey,
    IrtRType YKey,
    VoidPtr Data)
```

**S2D:** Internal data structure, aiding search.

**XKey, YKey:** The new 2D coordinates to insert.

**Data:** A pointer to the data to save with this 2D coordinate key.

**Returns:** void

**Description:** Insert a new element into the data structure. No test is made if a similar element already exists.

**See also:** IritSearch2DFree, IritSearch2DFindElem, IritSearch2DInit,

---

7.2.119  IritSetFatalErrorFunc (irit_ftl.c:30)

```c
IritFatalMsgFuncType IritSetFatalErrorFunc(IritFatalMsgFuncType FatalMsgFunc)
```

**FatalMsgFunc:** New function to use.

**Returns:** Old function reference.

**Description:** Sets the warning function of irit.

---

7.2.120  IritSetInfoMsgFunc (irit_inf.c:30)

```c
IritInfoMsgFuncType IritSetInfoMsgFunc(IritInfoMsgFuncType InfoMsgFunc)
```

**InfoMsgFunc:** New function to use.

**Returns:** Old function reference.

**Description:** Sets the warning function of irit.

---

7.2.121  IritSetWarningMsgFunc (irit_wrn.c:30)

```c
IritWarningMsgFuncType IritSetWarningMsgFunc(IritWarningMsgFuncType WrnMsgFunc)
```

**WrnMsgFunc:** New function to use.

**Returns:** Old function reference.

**Description:** Sets the warning function of irit.
7.2.122 IritSleep (xgeneral.c:152)

void IritSleep(int MilliSeconds)

    MilliSeconds: Sleeping time required, in milliseconds.
    Returns: void
    Description: Routine to force a process to sleep.

7.2.123 IritSolveLowerDiagMatrix (qrfactor.c:228)

int IritSolveLowerDiagMatrix(const IrtRType *A,
                        int n,
                        const IrtRType *b,
                        IrtRType *x)

    A: The diagonal matrix of size n by n, must be preallocated dynamically by the user.
    n: Dimension of matrix A.
    b: A vector of size n.
    x: The solution vector of size n.
    Returns: TRUE if Singular, FALSE otherwise.
    Description: Solve for Ax = b when R is lower diagonal using forward substitution.
    See also: IritSolveUpperDiagMatrix, IritQRFactorization, IritQRUnderdetermined, SvdLeastSqr,

7.2.124 IritSolveUpperDiagMatrix (qrfactor.c:184)

int IritSolveUpperDiagMatrix(const IrtRType *A,
                        int n,
                        const IrtRType *b,
                        IrtRType *x)

    A: The diagonal matrix of size n by n, must be preallocated dynamically by the user.
    n: Dimension of matrix A.
    b: A vector of size n.
    x: The solution vector of size n.
    Returns: TRUE if Singular, FALSE otherwise.
    Description: Solve for Ax = b when R is upper diagonal using back substitution.
    See also: IritSolveLowerDiagMatrix, IritQRFactorization, IritQRUnderdetermined, SvdLeastSqr,

7.2.125 IritStrIStr (xgeneral.c:638)

const char *IritStrIStr(const char *s, const char *Pattern)

    s: To search for Pattern in.
    Pattern: To search in s.
    Returns: Address in s where Pattern was 1st found, NULL otherwise.
    Description: Routine to search for a Pattern (no regular expression) in s. Returns address in s of first occurrence of Pattern, NULL if non found. case insensitive
7.2.126 **IritStrLower** (xgeneral.c:112)

```c
c char *IritStrLower(char *s)
```

*s*: String to convert to lower case.

**Returns**: Reference to *s*.

**Description**: Routine to convert all upper case chars into lower case, in place.

7.2.127 **IritStrUpper** (xgeneral.c:88)

```c
c char *IritStrUpper(char *s)
```

*s*: String to convert to upper case.

**Returns**: Reference to *s*.

**Description**: Routine to convert all lower case chars into upper case, in place.

7.2.128 **IritStrdup** (xgeneral.c:65)

```c
c char *IritStrdup(const char *s)
```

*s*: String to duplicate.

**Returns**: Duplicated string.

**Description**: Routine to duplicate a string. Exists in some computer environments.

7.2.129 **IritSubstStr** (xgeneral.c:674)

```c
c char *IritSubstStr(const char *s,
const char *Src,
const char *Dst,
int CaseInsensitive)
```

*s*: Input string.

**Src**: Pattern to look for in S and substitute with Dst.

**Dst**: Replacement patter for Src.

**CaseInsensitive**: TRUE for case insensitive, FALSE for case sensitive.

**Returns**: new string, allocated dynamically.

**Description**: A find (Src) and replace (into Dst) function.

7.2.130 **IritTestAllDynMemory** (imalloc.c:85)

```c
void IritTestAllDynMemory(void)
```

**Returns**: void

**Description**: Tests the content of the dynamic memory allocated.

**See also**: IritFree, IritMalloc, IritRealloc, IritInitTestDynMemory,
7.2.131 IritWarningMsg  (irit_wrn.c:57)

```c
void IritWarningMsg(const char *Msg)
```

**Msg:** Error message to print.

**Returns:** void

**Description:** Default trap for IRIT programs for irit warnings. This function just prints the given warning message.

**See also:** IritWarningMsgPrintf, IritFatalError,

7.2.132 IritWarningMsgPrintf  (irit2wrn.c:35)

```c
void IritWarningMsgPrintf(const char *va_alist, ...)
```

**va_alist:** Do "man stdarg".

**Returns:** void

**Description:** Default trap for IRIT programs for irit warning errors, printf style.

**See also:** IritWarningMsg, IritFatalErrorPrintf,

7.2.133 IrtImgDitherImage  (dither.c:152)

```c
IrtBType *IrtImgDitherImage(IrtImgPixelStruct *Image,
           int XSize,
           int YSize,
           int DitherSize,
           IrtBType ErrorDiffusion)
```

**Image:** To dither.

**XSize, YSize:** Size of the image to dither.

**DitherSize:** Dithering matrices size: 2, 3, or 4.

**ErrorDiffusion:** TRUE, to also diffuse the error in the image.

**Returns:** The dithered image of size X/YSize * DitherSize while every pixels is either zero or one.

**Description:** Routine to dither a given Image of RGB pixels using dithering matrices of size DitherSize to B&W.

**See also:** IrtImgDitherImage2,

7.2.134 IrtImgDitherImage2  (dither.c:219)

```c
int IrtImgDitherImage2(const char *InputImage,
                        const char *OutputImage,
                        int DitherSize,
                        IrtBType ErrorDiffusion)
```

**InputImage:** To dither.

**OutputImage:** Dithered image.

**DitherSize:** Dithering matrices size: 2, 3, or 4.

**ErrorDiffusion:** TRUE, to also diffuse the error in the image.

**Returns:** TRUE if successful, FALSE if failed.

**Description:** A wrapper routine to read an image from a file, dither it and save into a file the dithered image.

**See also:** IrtImgDitherImage,
7.2.135  IrtImgFlipHorizontallyImage (editimag.c:134)

IrtImgPixelStruct *IrtImgFlipHorizontallyImage(const IrtImgPixelStruct *Img,
     int MaxX,
     int MaxY,
     int Alpha)

*Img: Image to flip its X and Y axes.
MaxX: Maximum X of Img image.
MaxY: Maximum Y of Img image.
Alpha: TRUE if this image has alpha and is actually RGBARGBA...

Returns: Flipped image.

Description: Reads one image in from a file named ImageFileName. The image is returned as a vector of RGBRGB... of size (MaxX+1) * (MaxY+1) * 3.
See also: IrtImgNegateImage, IrtImgScaleImage,

7.2.136  IrtImgFlipVerticallyImage (editimag.c:193)

IrtImgPixelStruct *IrtImgFlipVerticallyImage(const IrtImgPixelStruct *Img,
     int MaxX,
     int MaxY,
     int Alpha)

*Img: Image to flip its X and Y axes.
MaxX: Maximum X of Img image.
MaxY: Maximum Y of Img image.
Alpha: TRUE if this image has alpha and is actually RGBARGBA...

Returns: Flipped image.

Description: Reads one image in from a file named ImageFileName. The image is returned as a vector of RGBRGB... of size (MaxX+1) * (MaxY+1) * 3.
See also: IrtImgNegateImage, IrtImgScaleImage,

7.2.137  IrtImgFlipXYImage (editimag.c:36)

IrtImgPixelStruct *IrtImgFlipXYImage(const IrtImgPixelStruct *Img,
     int MaxX,
     int MaxY,
     int Alpha)

*Img: Image to flip its X and Y axes.
MaxX: Maximum X of Img image.
MaxY: Maximum Y of Img image.
Alpha: TRUE if this image has alpha and is actually RGBARGBA...

Returns: Flipped image.

Description: Reads one image in from a file named ImageFileName. The image is returned as a vector of RGBRGB... of size (MaxX+1) * (MaxY+1) * 3.
See also: IrtImgNegateImage, IrtImgScaleImage,
7.2.138 IrtImgGetImageSize (readimag.c:387)

```c
int IrtImgGetImageSize(const char *ImageFileName,  
                       int *Width,  
                       int *Height)
```

- **ImageFileName**: Name of image to read.
- **Width**: The width of the image.
- **Height**: The height of the image.
- **Returns**: TRUE, if loaded successfully. Otherwise FALSE.
- **Description**: Reads the dimensions of one image in from a file named ImageFileName.

7.2.139 IrtImgNegateImage (editimag.c:92)

```c
IrtImgPixelStruct *IrtImgNegateImage(const IrtImgPixelStruct *InImage,  
                                      int MaxX,  
                                      int MaxY)
```

- **InImage**: A vector of IrtImgPixelStruct of size (MaxX+1) * (MaxY+1).
- **MaxX**: Maximum X of input image.
- **MaxY**: Maximum Y of input image.
- **Returns**: The scaled image as vector of RGBRGB (or RGBARGBA).
- **Description**: Negate an image.
- **See also**: IrtImgFlipXYImage, IrtImgScaleImage,

7.2.140 IrtImgParsePTextureString (readimag.c:1086)

```c
int IrtImgParsePTextureString(const char *PTexture,  
                               char *FName,  
                               IrtrRType *Scale,  
                               int *Flip,  
                               int *NewImage)
```

- **PTexture**: The string of the "ptexture" attribute.
- **FName**: The texture file name will be placed here.
- **Scale**: The scaling vector in XYZ or just XY if Z = IRIT_INFNTY.
- **Flip**: If Image flipping was requested.
- **NewImage**: if a new image of same name - replace in cache.
- **Returns**: TRUE if parsed sucessfully, FALSE otherwise.
- **Description**: Parses the string of the "ptexture" attribute. "ImageName \{, S X Y \{Z\}\} \{, F\} \{, N\}" where
  1. X, Y, and possibly Z are scaling factors of how many times the image should fit into the object,
  2. 'F' optionally request to flip X and Y axes of the image.
  3. 'N' optionally forces reload the image as a New image, even if an image by this exact same name was already loaded and cached.
7.2.141 IrtImgParsePTextureString2 (readimag.c:1005)

```c
int IrtImgParsePTextureString2(const char *PTexture,
    char *FName,
    IrtRType *Scale,
    int *Flip,
    int *NewImage,
    int *FlipHorizontally,
    int *FlipVertically)
```

**PTexture:** The string of the "ptexture" attribute.

**FName:** The texture file name will be placed here.

**Scale:** The scaling vector in XYZ or just XY if Z = IRIT_INFNTY.

**Flip:** If Image flipping was requested.

**NewImage:** if a new image of same name - replace in cache.

**FlipHorizontally:** If horizontal Image flipping was requested.

**FlipVertically:** If vertical Image flipping was requested.

**Returns:** TRUE if parsed succesfully, FALSE otherwise.

**Description:** Parses the string of the "ptexture" attribute. "ImageName {{ S X Y {Z} } { F } { N } { H } { V } }" where

1. X, Y, and possibly Z are scaling factors of how many times the image should fit into the object,
2. 'F' optionally request to flip X and Y axes of the image.
3. 'N' optionally forces reload the image as a New image, even if an image by this exact same name was already loaded and cached.
4. 'H' optionally request to filp the image pixels horizontally.
5. 'V' optionally request to flip the image pixels vertically.

7.2.142 IrtImgReadClrCache (readimag.c:310)

```c
void IrtImgReadClrCache(void)
```

**Returns:** void

**Description:** Clears the cache of read images.

**See also:** IrtImgReadImage2, IrtImgReadClrOneImage,

7.2.143 IrtImgReadClrOneImage (readimag.c:339)

```c
void IrtImgReadClrOneImage(const char *ImageName)
```

**ImageName:** Name of image to remove.

**Returns:** void

**Description:** Removes one image, by name from the cache of images.

**See also:** IrtImgReadImage2, IrtImgReadClrCache,
7.2.144 **IrtImgReadImage** *(readimag.c:127)*

```c
IrtImgPixelStruct *IrtImgReadImage(const char *ImageFileName,
    int *MaxX,
    int *MaxY,
    int *Alpha)
```

**ImageFileName**: Name of image to read.

**MaxX**: Maximum X of read image is saved here.

**MaxY**: Maximum Y of read image is saved here.

**Alpha**: If TRUE, will attempt to load alpha channel if has any and will return TRUE if successful in loading it.

**Returns**: A vector of RGBRGB... of size (MaxX+1) * (MaxY+1) * 3 or NULL if failed. If however, Alpha is requested and found RGBARGBA... is returned as IrtImgRGBAPxlStruct.

**Description**: Reads one image in from a file named ImageFileName. The image is returned as a vector of RGBRGB... of size (MaxX+1) * (MaxY+1) * 3.

**See also**: IrtImgReadImage2, IrtImgReadImage3, IrtImgReadImageXAlign.

7.2.145 **IrtImgReadImage2** *(readimag.c:200)*

```c
IrtImgPixelStruct *IrtImgReadImage2(const char *ImageFileName,
    int *MaxX,
    int *MaxY,
    int *Alpha)
```

**ImageFileName**: Name of image to read.

**MaxX**: Maximum X of read image is saved here.

**MaxY**: Maximum Y of read image is saved here.

**Alpha**: If TRUE, will attempt to load alpha channel if has any and will return TRUE if successful in loading it.

**Returns**: A vector of RGBRGB... of size (MaxX+1) * (MaxY+1) * 3 or NULL if failed. If however, Alpha is requested and found RGBARGBA... is returned as IrtImgRGBAPxlStruct.

**Description**: Same as IrtImgReadImage2 but if a name of an image repeats itself, the image is read only once.

**See also**: IrtImgReadImage, IrtImgReadImage3, IrtImgReadClrCache.

7.2.146 **IrtImgReadImage3** *(readimag.c:260)*

```c
IrtImgPixelStruct *IrtImgReadImage3(const char *ImageFileName,
    int *MaxX,
    int *MaxY,
    int *Alpha)
```

**ImageFileName**: Name of image to read.

**MaxX**: Maximum X of read image is saved here.

**MaxY**: Maximum Y of read image is saved here.

**Alpha**: If TRUE, will attempt to load alpha channel if has any and will return TRUE if successful in loading it.

**Returns**: A vector of RGBRGB... of size (MaxX+1) * (MaxY+1) * 3 or NULL if failed. If however, Alpha is requested and found RGBARGBA... is returned as IrtImgRGBAPxlStruct.

**Description**: Same as IrtImgReadImage2 but if a name of an image repeats itself, the new image replaces the old one.

**See also**: IrtImgReadImage, IrtImgReadImage2, IrtImgReadClrCache,
7.2.147  IrtImgReadImageXAlign (readimag.c:91)

    int IrtImgReadImageXAlign(int Alignment)

        Alignment: Word size alignment required.
        Returns: old alignment.
        Description: Sets an alignment of the width of the image. For example, OGL requires images to have width aligned on 4-bytes words (alignment 4).
        See also: IrtImgReadImage,

7.2.148  IrtImgWriteCloseFile (writimag.c:201)

    void IrtImgWriteCloseFile(void)

        Returns: void
        Description: Closes output image file.

7.2.149  IrtImgWriteOpenFile (writimag.c:134)

    int IrtImgWriteOpenFile(const char **argv, const char *FName, int Alpha, int XSize, int YSize)

        argv: Pointer to the name of this program.
        FName: Filename to open, or NULL for stdout.
        Alpha: Do we have an alpha channel.
        XSize: X dimension of the image.
        YSize: Y dimension of the image.
        Returns: TRUE if successful, FALSE otherwise.
        Description: Opens output image file.

7.2.150  IrtImgWritePutLine (writimag.c:171)

    void IrtImgWritePutLine(IrtBType *Alpha, IrtImgPixelStruct *Pixels)

        Alpha: array of alpha values.
        Pixels: array of color pixels.
        Returns: void
        Description: Outputs given line of color pixels and alpha correction values to the output image file.

7.2.151  IrtImgWriteSetType (writimag.c:85)

    IrtImgImageType IrtImgWriteSetType(const char *ImageType)

        ImageType: A string describing the image type.
        Returns: Returns the detected type.
        Description: Sets image type.
7.2.152  IrtMovieParsePMovieString (readmovi.c:859)

int IrtMovieParsePMovieString(const char *PMovie,
    char *FName,
    IrtRType *Scale,
    int *NewImage,
    int *Flip,
    int *Restart,
    IrtRType *TimeSetup,
    int *FlipHorizontally,
    int *FlipVertically)

PMovie: The string of the "pmovie" attribute.
FName: The texture file name will be placed here.
Scale: The scaling vector in XYZ or just XY if Z = IRIT_INFNTY.
NewImage: Force read an image even if in cache as the file is new?
Flip: If Image flipping was requested.
Restart: TRUE to restart the movie once it ends.
TimeSetup: A vector of 3 slots to hold (tmin, tmax, dt) if specified or all are zero if not specified.
FlipHorizontally: If horizontal Image flipping was requested.
FlipVertically: If vertical Image flipping was requested.
Returns: TRUE if parsed successfully, FALSE otherwise.

Description: Parses the string of the "pmovie" attribute. Can be "MovieName { , S X Y {Z} } {,F} {,R} {, T=tmin,tmax} where
1. X, Y, and possibly Z are scaling factors of how many times the image should fit into the object,
2. F optionally request to flip X and Y axes of the image.
3. R optionally request to restart the movie once it gets to the end.
4. T=tmin,tmax sets the time range of the movie.

7.2.153  IrtMovieReadClrCache (readmovi.c:363)

void IrtMovieReadClrCache(void)

Returns: void

Description: Clears the cache of read images.
See also: IrtMovieReadMovie2.

7.2.154  IrtMovieReadMovie (readmovi.c:112)

IrtImgPixelStruct **IrtMovieReadMovie(const char *MovieFileName,
    int *MaxX,
    int *MaxY,
    int *Alpha)

MovieFileName: Name of movie to read.
MaxX: Maximum X of read image is saved here.
MaxY: Maximum Y of read image is saved here.
Alpha: If TRUE, will attempt to load alpha channel if has any and will return TRUE if successful in loading it.

Returns: A NULL terminated vector of images. Each image is itself a vector of RGBRGB... of size (MaxX+1) * (MaxY+1) * 3 or NULL if failed. If however, Alpha is requested and found RGBARGBA... is returned as IrtImgRGBAPxlStruct.

Description: Reads a movie in from a file named MovieFileName. The movies are returned as a vector of images; vector of RGBRGB... of size (MaxX+1) * (MaxY+1) * 3.
See also: IrtMovieReadMovie2, IrtMovieReadMovie3, IrtImgReadMovieXAlign,
7.2.155  IrtMovieReadMovie2 (readmovi.c:178)

IrtImgPixelStruct **IrtMovieReadMovie2(const char *MovieFileName,
int *MaxX,
int *MaxY,
int *Alpha)

MovieFileName: Name of movie to read.
MaxX: Maximum X of read image is saved here.
MaxY: Maximum Y of read image is saved here.
Alpha: If TRUE, will attempt to load alpha channel if has any and will return TRUE if successful in loading it.

Returns: A NULL terminated vector of images. Each image is itself a vector of RGBRGB... of size (MaxX+1) * (MaxY+1) * 3 or NULL if failed. If however, Alpha is requested and found RGBARGBA... is returned as IrtImgRGBAPxlStruct.

Description: Same as IrtMovieReadMovie but if a name of a movie repeats itself, the movie is read only once.
See also: IrtMovieReadMovie, IrtImgReadMovie3, IrtMovieReadClrCache,

7.2.156  IrtMovieReadMovie3 (readmovi.c:239)

IrtImgPixelStruct **IrtMovieReadMovie3(const char *MovieFileName,
int *MaxX,
int *MaxY,
int *Alpha)

MovieFileName: Name of movie to read.
MaxX: Maximum X of read image is saved here.
MaxY: Maximum Y of read image is saved here.
Alpha: If TRUE, will attempt to load alpha channel if has any and will return TRUE if successful in loading it.

Returns: A NULL terminated vector of images. Each image is itself a vector of RGBRGB... of size (MaxX+1) * (MaxY+1) * 3 or NULL if failed. If however, Alpha is requested and found RGBARGBA... is returned as IrtImgRGBAPxlStruct.

Description: Same as IrtMovieReadMovie2 but if a name of a movie repeats itself, the new movie replaces the old one.
See also: IrtMovieReadMovie, IrtImgReadMovie2, IrtMovieReadClrCache,

7.2.157  Mat2x2Determinant (gnrl-mat.c:665)

IrtRType Mat2x2Determinant(IrtRType a11,
IrtRType a12,
IrtRType a21,
IrtRType a22)

a11, a12, a21, a22: Coefficients of the 2x2 matrix.

Returns: The determinant.

Description: Computes a 2x2 determinant.
7.2.158 Mat3x3Determinant (gnrl_mat.c:691)

IrtRType Mat3x3Determinant(IrtRType a11,
IrtRType a12,
IrtRType a13,
IrtRType a21,
IrtRType a22,
IrtRType a23,
IrtRType a31,
IrtRType a32,
IrtRType a33)

a11, a12, a13, a21, a22, a23, a31, a32, a33: Coefficients of 3x3 matrix.
Returns: The determinant.
Description: Computes 3x3 determinant.

7.2.159 MatAddTwo4by4 (hmgn_mat.c:337)

void MatAddTwo4by4(IrtHmgnMatType MatRes,
IrtHmgnMatType Mat1,
IrtHmgnMatType Mat2)

MatRes: Result of matrix addition.
Mat1, Mat2: The two operand of the matrix addition.
Returns: void
Description: Routine to add two 4by4 matrices. MatRes may be one of Mat1 or Mat2.
See also: MatGnrlAddTwo4by4, MatSubTwo4by4, MatMultTwo4by4,

7.2.160 MatDeterminantMatrix (hmgn_mat.c:567)

IrtRType MatDeterminantMatrix(IrtHmgnMatType Mat)

Mat: Input matrix.
Returns: Determinant of Mat.
Description: Computes the determinant of a 4 by 4 matrix.

7.2.161 MatGenMatRotX (hmgn_mat.c:175)

void MatGenMatRotX(IrtRType CosTeta, IrtRType SinTeta, IrtHmgnMatType Mat)

CosTeta, SinTeta: Amount of rotation, given as sine and cosine of Teta.
Mat: Matrix to initialize as a rotation matrix.
Returns: void
Description: Routine to generate a 4*4 matrix to Rotate around the X axis by Teta, given the sin and cosine of Teta

7.2.162 MatGenMatRotX1 (hmgn_mat.c:151)

void MatGenMatRotX1(IrtRType Teta, IrtHmgnMatType Mat)

Teta: Amount of rotation, in radians.
Mat: Matrix to initialize as a rotation matrix.
Returns: void
Description: Routine to generate a 4*4 matrix to Rotate around the X axis by Teta radians.
7.2.163  **MatGenMatRotY** (hmgn_mat.c:223)

```c
void MatGenMatRotY(IrtRType CosTeta, IrtRType SinTeta, IrtHmgnMatType Mat)
```

**CosTeta, SinTeta**: Amount of rotation, given as sine and cosine of Teta.

**Mat**: Matrix to initialize as a rotation matrix.

**Returns**: void

**Description**: Routine to generate a 4*4 matrix to Rotate around the Y axis by Teta, given the sin and cosine of Teta.

7.2.164  **MatGenMatRotY1** (hmgn_mat.c:199)

```c
void MatGenMatRotY1(IrtRType Teta, IrtHmgnMatType Mat)
```

**Teta**: Amount of rotation, in radians.

**Mat**: Matrix to initialize as a rotation matrix.

**Returns**: void

**Description**: Routine to generate a 4*4 matrix to Rotate around the Y axis by Teta radians.

7.2.165  **MatGenMatRotZ** (hmgn_mat.c:271)

```c
void MatGenMatRotZ(IrtRType CosTeta, IrtRType SinTeta, IrtHmgnMatType Mat)
```

**CosTeta, SinTeta**: Amount of rotation, given as sine and cosine of Teta.

**Mat**: Matrix to initialize as a rotation matrix.

**Returns**: void

**Description**: Routine to generate a 4*4 matrix to Rotate around the Z axis by Teta, given the sin and cosine of Teta.

7.2.166  **MatGenMatRotZ1** (hmgn_mat.c:247)

```c
void MatGenMatRotZ1(IrtRType Teta, IrtHmgnMatType Mat)
```

**Teta**: Amount of rotation, in radians.

**Mat**: Matrix to initialize as a rotation matrix.

**Returns**: void

**Description**: Routine to generate a 4*4 matrix to Rotate around the Z axis by Teta radians.

7.2.167  **MatGenMatScale** (hmgn_mat.c:109)

```c
void MatGenMatScale(IrtRType Sx, IrtRType Sy, IrtRType Sz, IrtHmgnMatType Mat)
```

**Sx, Sy, Sz**: Scaling factors requested.

**Mat**: Matrix to initialize as a scaling matrix.

**Returns**: void

**Description**: Routine to generate a 4*4 matrix to Scale x, y, z in Sx, Sy, Sz amounts.
7.2.168 MatGenMatTrans (hmgn_mat.c:87)

void MatGenMatTrans(IrtRType Tx, IrtRType Ty, IrtRType Tz, IrtHmgnMatType Mat)

Tx, Ty, Tz: Translational amounts requested.
Mat: Matrix to initialize as a translation matrix.
Returns: void
Description: Routine to generate a 4*4 matrix to translate in Tx, Ty, Tz amounts.

7.2.169 MatGenMatUnifScale (hmgn_mat.c:131)

void MatGenMatUnifScale(IrtRType Scale, IrtHmgnMatType Mat)

Scale: Uniform scaling factor requested.
Mat: Matrix to initialize as a scaling matrix.
Returns: void
Description: Routine to generate a 4*4 matrix to uniformly scale Scale amount.

7.2.170 MatGenUnitMat (hmgn_mat.c:30)

void MatGenUnitMat(IrtHmgnMatType Mat)

Mat: Matrix to initialize as a unit matrix.
Returns: void
Description: Routine to generate a 4*4 unit matrix:
See also: MatGnrlUnitMat,

7.2.171 MatGnrlAddTwoMat (gnrl_mat.c:164)

void MatGnrlAddTwoMat(IrtGnrlMatType MatRes, IrtGnrlMatType Mat1, IrtGnrlMatType Mat2, int n)

MatRes: Result of matrix addition.
Mat1, Mat2: The two operand of the matrix addition.
n: Size of matrices MatRes/Mat1/Mat2.
Returns: void
Description: Routine to add two general matrices. MatRes may be one of Mat1 or Mat2.
See also: MatAddTwoMat, MatGnrlMultTwomat, MatGnrlSubTwoMat, MatGnrlScaleMat,

7.2.172 MatGnrlCopy (gnrl_mat.c:29)

void MatGnrlCopy(IrtGnrlMatType Dst, IrtGnrlMatType Src, int n)

Dst: Matrix to copy to.
Src: Matrix to copy from.
n: Size of matrix Mat.
Returns: void
Description: Routine to copy a (n x n) matrix:
7.2.173  MatGnrlDetMatrix (gnrlmat.c:480)

IrtRType MatGnrlDetMatrix(IrtGnrlMatType M, int n)

M: The square matrix of size (n x n) to compute its determinant.
   n: Size of the Matrix.

Returns: Value of the determinant.

Description: Given a general matrix, computes its determinant, recursively. Note this process is exponential as
a function of n (as you might expect) so use it with care (for small matrices only).
See also: MatGnrlInverseMatrix, MatGnrlTranspMatrix,

7.2.174  MatGnrlInverseMatrix (gnrlmat.c:340)

int MatGnrlInverseMatrix(IrtGnrlMatType M, IrtGnrlMatType InvM, int n)

M: Original matrix to invert.
   InvM: Inverted matrix will be placed here.
   n: Sizes of matrices M/InvM.

Returns: TRUE if inverse exists, FALSE otherwise.

Description: Routine to compute the INVERSE of a given matrix M which is not modified. Return TRUE if
inverted matrix (InvM) do exists.
See also: MatInverseMatrix, MatGnrlTranspMatrix,

7.2.175  MatGnrlIsUnitMatrix (gnrlmat.c:83)

int MatGnrlIsUnitMatrix(IrtGnrlMatType Mat, IrtRType Eps, int n)

Mat: Matrix to test if a unit matrix.
   Eps: Epsilon of test.
   n: Size of matrix Mat.

Returns: TRUE if unit matrix to within epsilon, FALSE otherwise.

Description: Test if the given matrix is a unit matrix to within Eps.
See also: MatGnrlUnitMat, MatIsUnitMatrix,

7.2.176  MatGnrlMultTwoMat (gnrlmat.c:119)

void MatGnrlMultTwoMat(IrtGnrlMatType MatRes,
                      IrtGnrlMatType Mat1,
                      IrtGnrlMatType Mat2,
                      int n)

MatRes: Result of matrix product.
Mat1, Mat2: The two operand of the matrix product.
   n: Size of matrices MatRes/Mat1/Mat2.

Returns: void

Description: Routine to multiply two general matrices. MatRes may be one of Mat1 or Mat2 - it is only updated
in the end.
See also: MatMultTwoMat, MatGnrlAddTwoMat, MatGnrlSubTwoMat,
7.2.177  MatGnrlMultVecbyMat (gnrl_mat.c:256)

void MatGnrlMultVecbyMat(IrtVecGnrlType VecRes,
    IrtGnrlMatType Mat,
    IrtVecGnrlType Vec,
    int n)

    Mat: General matrix.
    Vec: Vector to transform using Matrix.
    n: Sizes of vectors Vec/VecRes and of matrix Mat.

    Returns: void

    Description: Routine to mult a vector of len n by a general matrix of size (n x n), as VecRes = Mat * Vec.
    See also: MatMultVecby4by4, MatGnrlMultVecbyMat2,

7.2.178  MatGnrlMultVecbyMat2 (gnrl_mat.c:299)

void MatGnrlMultVecbyMat2(IrtVecGnrlType VecRes,
    IrtVecGnrlType Vec,
    IrtGnrlMatType Mat,
    int n)

    Vec: Vector to transform using Matrix.
    Mat: General matrix.
    n: Sizes of vectors Vec/VecRes and of matrix Mat.

    Returns: void

    Description: Routine to mult a vector of len n by a general matrix of size (n x n), as VecRes = Vec * Mat.
    See also: MatMultVecby4by4, MatGnrlMultVecbyMat,

7.2.179  MatGnrlOrthogonalSubspace (gnrl_mat.c:529)

int MatGnrlOrthogonalSubspace(IrtGnrlMatType M, int n)

    M: A matrix holding m (m < n) vectors as rows.
    n: Size of marix M (and the space).

    Returns: TRUE if successful, FALSE otherwise.

    Description: Given m (m < n) vectors as rows in matrix M, and zeros at the rest of the rows, computes n-m
    new vectors of the orthogonal space to the space spanned by the input m vectors. Uses SVD in the computation and
    saves the new, orthogonal, vectors in the last n-m rows of M, in place.

7.2.180  MatGnrlPrintMatrix (gnrl_mat.c:637)

void MatGnrlPrintMatrix(IrtGnrlMatType M, int n, FILE *F)

    M: Matrix to print.
    n: Size of matrix Mat.
    F: What file to print to.

    Returns: void

    Description: Routine to print matrix M to file F.
7.2.181  MatGnrlScaleMat  (gnrl_mat.c:225)

void MatGnrlScaleMat(IrtGnrlMatType MatRes,
                      IrtGnrlMatType Mat,
                      IrtRType *Scale,
                      int n)

MatRes: Result of matrix scaling.
Mat: The two operand of the matrix scaling.
Scale: Scalar value to multiple matrix with.
n: Size of matrices MatRes/Mat.

Returns: void

Description: Routine to scale a general matrix, by a scalar value. MatRes may be Mat.
See also: MatScaleMat, MatGnrlAddTwoMat, MatGntlMultTwoMat,

7.2.182  MatGnrlSubTwoMat  (gnrl_mat.c:194)

void MatGnrlSubTwoMat(IrtGnrlMatType MatRes,
                       IrtGnrlMatType Mat1,
                       IrtGnrlMatType Mat2,
                       int n)

MatRes: Result of matrix subtraction.
Mat1, Mat2: The two operand of the matrix subtraction.
n: Size of matrices MatRes/Mat1/Mat2.

Returns: void

Description: Routine to subtract two general matrices. MatRes may be one of Mat1 or Mat2.
See also: MatSubTwoMat, MatGnrlAddTwoMat, MatGntlMultTwoMat, MatGnrlScaleMat,

7.2.183  MatGnrlTranspMatrix  (gnrl_mat.c:445)

void MatGnrlTranspMatrix(IrtGnrlMatType M, IrtGnrlMatType TranspM, int n)

M: Original matrix to transpose.
TranspM: Transposed matrix will be placed here.
n: Sizes of matrices M/TranspM.

Returns: void

Description: Routine to compute the TRANSPOSE of matrix M which is not modified.
See also: MatTranspMatrix, MatGnrlTranspMatrix,

7.2.184  MatGnrlUnitMat  (gnrl_mat.c:51)

void MatGnrlUnitMat(IrtGnrlMatType Mat, int n)

Mat: Matrix to initialize as a unit matrix.
n: Size of matrix Mat.

Returns: void

Description: Routine to generate a (n x n) unit matrix.
See also: MatGenUnitMat,
7.2.185 MatInverseMatrix (hmgn_mat.c:609)

```c
int MatInverseMatrix(IrtHmgnMatType M, IrtHmgnMatType InvM)
```

M: Original matrix to invert.
InvM: Inverted matrix will be placed here. Can be same as M.

**Returns**: TRUE if inverse exists, FALSE otherwise.

**Description**: Routine to compute the INVERSE of a given matrix M which is not modified. The matrix is assumed to be 4 by 4 (transformation matrix). Return TRUE if inverted matrix (InvM) do exists.

**See also**: MatTransposeMatrix.

7.2.186 MatIsUnitMatrix (hmgn_mat.c:59)

```c
int MatIsUnitMatrix(IrtHmgnMatType Mat, IrtRType Eps)
```

Mat: Matrix to test if a unit matrix.
Eps: Epsilon of test.

**Returns**: TRUE if unit matrix to within epsilon, FALSE otherwise.

**Description**: Test if the given matrix is a unit matrix to within Eps.

**See also**: MatGenUnitMat, MatGnrlIsUnitMatrix.

7.2.187 MatMultPtby4by4 (hmgn_mat.c:490)

```c
void MatMultPtby4by4(IrtPtType PtRes, 
const IrtPtType Pt, 
IrtHmgnMatType Mat)
```

PtRes: Result of point - matrix product.
Pt: Point to transform using Matrix.
Mat: Transformation matrix.

**Returns**: void

**Description**: Routine to multiply a XYZ point by 4by4 matrix: The point has only 3 components (X, Y, Z) and it is assumed that W = 1. PtRes may be Pt as it is only updated in the end.

**See also**: MatMultVecby4by4, MatMultWVec2by4by4,

7.2.188 MatMultTwo4by4 (hmgn_mat.c:301)

```c
void MatMultTwo4by4(IrtHmgnMatType MatRes, 
IrtHmgnMatType Mat1, 
IrtHmgnMatType Mat2)
```

MatRes: Result of matrix product.
Mat1, Mat2: The two operand of the matrix product.

**Returns**: void

**Description**: Routine to multiply two 4by4 matrices. MatRes = Mat1 * Mat2 assumed Mat[i][j] refers to row i and column j. MatRes may be one of Mat1 or Mat2 - it is only updated in the end.

**See also**: MatGnrlMultTwo4by4, MatSubTwo4by4, MatAddTwo4by4,
# MatMultVecby4by4 (hmgn_mat.c:457)

```c
void MatMultVecby4by4(IrtVecType VecRes,
                        const IrtVecType Vec,
                        IrtHmgnMatType Mat)
```

**VecRes**: Result of vector - matrix product.

**Vec**: Vector to transform using Matrix.

**Mat**: Transformation matrix.

**Returns**: void

**Description**: Routine to multiply an XYZ Vector by 4by4 matrix: The Vector has only 3 components (X, Y, Z) and it is assumed that W = 0. VecRes may be Vec as it is only updated in the end.

**See also**: MatMultPthby4by4, MatMultWVec2by4by4,

# MatMultWVecby4by4 (hmgn_mat.c:538)

```c
void MatMultWVecby4by4(IrtRType VRes[4],
                        const IrtRType Vec[4],
                        IrtHmgnMatType Mat)
```

**VRes**: Result of vector - matrix product.

**Vec**: Vector to transform using Matrix.

**Mat**: Transformation matrix.

**Returns**: void

**Description**: Routine to multiply a WXYZ Vector by 4by4 matrix: The Vector has only 4 components (X, Y, Z, W). VRes may be Vec as it is only updated in the end.

**See also**: MatMultPthby4by4, MatMultWVec2by4by4,

# MatRotSclFactorMatrix (hmgn_mat.c:816)

```c
void MatRotSclFactorMatrix(IrtHmgnMatType M, IrtHmgnMatType RotSclMat)
```

**M**: Matrix to extract rotation and scale factors from.

**RotSclMat**: The rotation and scale factors of matrix M.

**Returns**: void

**Description**: Routine to estimate the rotation and scale factors in a matrix.

**See also**: MatScaleFactorMatrix, MatRotateFactorMatrix, MatTranslateFactorMatrix,

# MatRotateFactorMatrix (hmgn_mat.c:775)

```c
void MatRotateFactorMatrix(IrtHmgnMatType M, IrtHmgnMatType RotMat)
```

**M**: Matrix to extract rotation factors.

**RotMat**: The rotational factors of matrix M.

**Returns**: void

**Description**: Routine to estimate the rotation factor in a matrix.

**See also**: MatScaleFactorMatrix, MatTranslateFactorMatrix, MatRotSclFactorMatrix,
7.2.193 MatSameTwo4by4 (hmgn_mat.c:421)

```c
int MatSameTwo4by4(IrtHmgnMatType Mat1,
                    IrtHmgnMatType Mat2,
                    IrtRType Eps)

    Mat1, Mat2: Two homogeneous matrices to compare.
    Eps: Tolerance of comaprison.
    Returns: TRUE if similar, FALSE otherwise.
    Description: Compare two homogeneous matrices for approximate equality.
```

7.2.194 MatScale4by4 (hmgn_mat.c:396)

```c
void MatScale4by4(IrtHmgnMatType MatRes,
                   IrtHmgnMatType Mat,
                   const IrtRType *Scale)

    MatRes: Result of matrix scaling.
    Mat: The two operand of the matrix scaling.
    Scale: Scalar value to multiple matrix with.
    Returns: void
    Description: Routine to scale a 4by4 matrix. MatRes may be Mat.
    See also: MatGnrlScaleMat, MatSubTwo4by4, MatAddTwo4by4, MatMultTwo4by4,
```

7.2.195 MatScaleFactorMatrix (hmgn_mat.c:714)

```c
IrtRType MatScaleFactorMatrix(IrtHmgnMatType M)

    M: Matrix to estimate scaling factors (assume positive scales).
    Returns: Estimated Scaling factor (returns positive scale values).
    Description: Routine to estimate the scaling factor in a matrix by computing the SVD decomposition of the matrix and if fails, use average of the scale of the X, Y, and Z unit vectors.
    See also: MatRotateFactorMatrix, MatTranslateFactorMatrix, MatRotSclFactorMatrix,
```

7.2.196 MatSubTwo4by4 (hmgn_mat.c:366)

```c
void MatSubTwo4by4(IrtHmgnMatType MatRes,
                    IrtHmgnMatType Mat1,
                    IrtHmgnMatType Mat2)

    MatRes: Result of matrix subtraction.
    Mat1, Mat2: The two operand of the matrix subtraction.
    Returns: void
    Description: Routine to subtract two 4by4 matrices. MatRes may be one of Mat1 or Mat2.
    See also: MatGnrlSubTwo4by4, MatAddTwo4by4, MatMultTwo4by4,
```

7.2.197 MatTranslateFactorMatrix (hmgn_mat.c:841)

```c
void MatTranslateFactorMatrix(IrtHmgnMatType M, IrtVecType Trans)

    M: Matrix to extract rotation factors.
    Trans: The translation factors of matrix M.
    Returns: void
    Description: Routine to estimate the translation factors in a matrix.
    See also: MatScaleFactorMatrix, MatRotateFactorMatrix,
```
7.2.198  **MatTranspMatrix**  (hmgn_mat.c:682)

```c
void MatTranspMatrix(IrtHmgnMatType M, IrtHmgnMatType TranspM)
```

*M*: Original matrix to transpose.

*TranspM*: Transposed matrix will be placed here. Can be same as *M*.

**Returns**: void

**Description**: Routine to compute the TRANSPOSE of a given matrix *M* which is not modified. The matrix is assumed to be 4 by 4 (transformation matrix).

**See also**: MatInverseMatrix,

7.2.199  **MiscBiPrWeightedMatchBipartite**  (bipartte.c:84)

```c
int MiscBiPrWeightedMatchBipartite(const IrtRType **Weight,
                   IritBiPrWeightedMatchStruct *Match,
                   int n)
```

*Weight*: Cost matrix of size *n*×*n*, passed as an array of size *n* holding pointers to arrays of size *n*. Weight[i][j] is the cost of the edge between vertices *i* and *j*. Negative entry denotes that there is no edge (= edge cost is infinite).

*Match*: Array of size *n* allocated in advance. Returns with the optimal matching found. For every 0 ≤ *i* < *n* Match[i].m1 = *i* Match[i].m2 = vertex that is matched to *i* Match[i].m3 = unused

*n*: Number of vertices in each side of the bi-partite graph.

**Returns**: 0 if an optimal match was found - in such case the array *Match* is filled with the optimal matching found. Negative value if there is no match in the graph - in such case *Match* may be undefined.

**Description**: Implementation of Shortest-Path variation of the Hungarian algorithm, from "Assignment Problems" by R. Burkard, M. Dell’Amico, S. Martello Algorithm 4.10 Hungarian SP, page 97. Complexity: O(*n*^3) The scanning order of the graph’s vertices is chosen at random.

7.2.200  **MiscDescribeError**  (misc_err.c:43)

```c
const char *MiscDescribeError(MiscFatalErrorType ErrorNum)
```

*ErrorNum*: Type of the error that was raised.

**Returns**: A string describing the error type.

**Description**: Returns a string describing a the given error. Errors can be raised by any member of this misc library as well as other users. Raised error will cause an invocation of MiscFatalError function which decides how to handle this error. MiscFatalError can for example, invoke this routine with the error type, print the appropriate message and quit the program.

7.2.201  **MiscFatalError**  (misc_ftl.c:54)

```c
void MiscFatalError(MiscFatalErrorType ErrID, char *ErrDesc)
```

*ErrID*: Error type that was raised.

*ErrDesc*: Possibly, an additional description on error.

**Returns**: void

**Description**: Trap Misc lib errors right here. Provides a default error handler for the misc library. Gets an error description using MiscDescribeError, prints it and exit the program using exit.
7.2.202  MiscHashAddElement  (hash2tbl.c:137)

```c
int MiscHashAddElement(MiscHashPtrType Hash,
                        void *Elem,
                        unsigned long SizeInByte)
```

**Hash:** The hash table.
**Elem:** The element to hash.
**SizeInByte:** The second parameter to pass to the hash function.
**Returns:** -1 if unable to add, 0 otherwise.

**Description:** Hash the given element and insert it into the table. The added element is the returned value from the CopyFunc given to MiscHashNewHash. More than one identical element can exist in the table. The element’s auxiliary data is initialized to 0.

7.2.203  MiscHashFindElement  (hash2tbl.c:234)

```c
int MiscHashFindElement(MiscHashPtrType Hash,
                        void *Elem,
                        unsigned long SizeInByte)
```

**Hash:** The hash table.
**Elem:** The element to hash.
**SizeInByte:** The second parameter to pass to the hash function. If the second parameter is not equal to the one used to hash the element, the element may not be found even if it is in the hash table.
**Returns:** 0 if found, -1 otherwise.

**Description:** Looks for the given element in the hash table (using the CompFunc given to MiscHashNewHash). The Element and SizeInByte will be passed to the hash function.

7.2.204  MiscHashFreeHash  (hash2tbl.c:289)

```c
void MiscHashFreeHash(MiscHashPtrType Hash)
```

**Hash:** The hash table to free.
**Returns:** void

**Description:** Frees the given hash table.

7.2.205  MiscHashGetElementAuxData  (hash2tbl.c:266)

```c
long *MiscHashGetElementAuxData(MiscHashPtrType Hash,
                                void *Elem,
                                unsigned long SizeInByte)
```

**Hash:** The hash table.
**Elem:** The element to retrieve its auxiliary data.
**SizeInByte:** The second parameter to pass to the hash function. If the second parameter is not equal to the one used to hash the element, the element may not be found even if it is in the hash table.
**Returns:** Pointer to Elem’s auxiliary data. NULL if Elem doesn’t exist in the hash table.

**Description:** Find the first occurrence of Elem in the hash table (using the CompFunc given to MiscHashNewHash) and return a pointer to its auxiliary data (The auxiliary data may be changed without influencing the hash table). The Element and SizeInByte will be passed to the hash function.
7.2.206 MiscHashNewHash (hash2tbl.c:76)

```c
MiscHashPtrType MiscHashNewHash(unsigned long Size,
                            MiscHashFuncType HashFunc,
                            MiscHashCopyFuncType CopyFunc,
                            MiscHashFreeFuncType FreeFunc,
                            MiscHashCompFuncType CompFunc)
```

**Size**: The size of the hash table (the range of the hash function should be compatible).

**HashFunc**: The function used for hashing (the range should be compatible with HashSize). Receives 2 parameters to make it easy to hash arrays.

**CopyFunc**: The function that will be used to copy elements (for example when hashing a new element).

**FreeFunc**: The function that will be used to free elements (for example when freeing the hash table).

**CompFunc**: The function that will be used to compare elements (for example when looking for an element in the hash table).

**Returns**: The new hash table if successful, of NULL if failed.

**Description**: Creates a new Hash Table.

7.2.207 MiscISCAddPicture (imgstcvr.c:1648)

```c
int MiscISCAddPicture(MiscISCCalculatorPtrType Calc, MiscISCPixelType *Picture)
```

**Calc**: The calculator to add the picture to.

**Picture**: The picture to add.

**Returns**: FALSE if error occurred.

**Description**: Adds a picture to the calculator. Copies the picture (will be freed when the calculator is freed).

**See also**: 

7.2.208 MiscISCCalculateExact (imgstcvr.c:2682)

```c
int MiscISCCalculateExact(MiscISCCalculatorPtrType Calc,
                          int SizeLimit,
                          int **SolutionByIndex,
                          int *SolutionSize,
                          IrtRType *CoverPart)
```

**Calc**: The calculator.

**SizeLimit**: IN, if this value is greater than 0 the algorithm will stop adding pictures when getting to that size of pictures combinations and revert to search in other branches. This will speed the algorithm though may not find any solution at all in which case the combination with the best cover will be returned.

**SolutionByIndex**: OUT, The solution as indices of pictures.

**SolutionSize**: OUT, The size of the solution (size of SolutionByIndex).

**CoverPart**: OUT, The part of the uprocessed picture covered by the solution.

**Returns**: FALSE if error occurred.

**Description**: Calculates the cover. Uses an exact exponential Algorithm. Each MiscISCCalculatorPtrType can be used only once with any search algorithm. Calling this function will move the calculator to compute phase.

**See also**: 

7.2.209  MiscISCCalculateExhaustive (imgstcvr.c:2906)

```c
int MiscISCCalculateExhaustive(MiscISCCalculatorPtrType Calc,
    IrtRType CoverLimit,
    int SizeLimit,
    int **SolutionByIndex,
    int *SolutionSize,
    IrtRType *CoverPart)
```

**Calc**: The calculator.

**CoverLimit**: IN, if this value is in (0,1), the algorithm will consider a combination of pictures which covers CoverLimit part of the image as a valid solution.

**SizeLimit**: IN, if this value is greater than 0 the algorithm will stop adding pictures when getting to that size of pictures combinations and revert to search in other branches. This will speed the algorithm though may not find any solution at all in which case the combination with the best cover will be returned.

**SolutionByIndex**: OUT, The solution as indices of pictures.

**SolutionSize**: OUT, The size of the solution (size of SolutionByIndex).

**CoverPart**: OUT, The part of the unprocessed picture covered by the solution.

**Returns**: FALSE if error occurred.

**Description**: Calculates the cover. Uses an exhaustive exponential Algorithm. Each MiscISCCalculatorPtrType can be used only once with any search algorithm. Calling this function will move the calculator to compute phase. See also:

7.2.210  MiscISCCalculateGreedy (imgstcvr.c:3390)

```c
int MiscISCCalculateGreedy(MiscISCCalculatorPtrType Calc,
    int **SolutionByIndex,
    int *SolutionSize,
    IrtRType *CoverPart)
```

**Calc**: The calculator.

**SolutionByIndex**: OUT, The solution as indices of pictures by the order they were added to the solution.

**SolutionSize**: OUT, The size of the solution (size of SolutionByIndex).

**CoverPart**: OUT, The part of the unprocessed image covered by the solution.

**Returns**: FALSE if error occurred.

**Description**: Calculates the cover using quick and not optimal greedy algorithm. In each step the algorithm choose the next picture to be the picture which covers the maximum number of pixel out of the original unprocessed picture. If Calc -> UseCoverLimit is TRUE, the algorithm’s search will stop when reaching cover the size of Calc -> CoverLimit and return the solution. Each MiscISCCalculatorPtrType can be used only once with any search algorithm. Calling this function will move the calculator to compute phase.

7.2.211  MiscISCFreeCalculator (imgstcvr.c:1560)

```c
void MiscISCFreeCalculator(MiscISCCalculatorPtrType Calc)
```

**Calc**: The calculator.

**Returns**: void

**Description**: Frees memory allocated for the calculator. See also:
7.2.212 MiscISCNewCalculator (imgstcvr.c:1422)

MiscISCCalculatorPtrType MiscISCNewCalculator(int MaxPictures,
    MiscISCImageSizeType ImageSize,
    MiscISCColorTypeEnum ColorType,
    MiscISCPrint Print)

- **MaxPictures**: The maximal number of pictures the calculator will hold.
- **ImageSize**: The number of pixels in each picture.
- **ColorType**: Are the pictures in black & white or gray.
- **Print**: Pointer to a printing routine where texture data should go to or NULL to ignore.
- **Returns**: The new calculator or NULL if fails.

**Description**: Creates a new calculator.

7.2.213 MiscISCSetImageToCover (imgstcvr.c:1612)

int MiscISCSetImageToCover(MiscISCCalculatorPtrType Calc,
    MiscISCPixelType *RequiredCover)

- **Calc**: The calculator to add the picture to.
- **RequiredCover**: The cover picture to add.
- **Returns**: FALSE if error occurred.

**Description**: Set the image to be covered. A pixel with value 0 means that the pixel isn’t required to be covered. A pixel with value 1 means that the pixel is required to be covered. If this function isn’t called than all the pixel are required to be covered. The function makes an inner copy of RequiredCover (that copy will be freed when the calculator is freed). The user may free or change RequiredCover’s memory without harming the process.

**See also**:

7.2.214 MiscListAddElement (list.c:91)

int MiscListAddElement(MiscListPtrType List,
    void *Elem,
    unsigned long SizeInByte)

- **List**: The list where the element will be inserted.
- **Elem**: The element to add to the list. Must be compatible with the functions given to MiscListNewEmptyList.
- **SizeInByte**: Can be used to pass an array size, for the Copy Function.
- **Returns**: -1 if unable to add, 0 otherwise.

**Description**: Adds a new element to the beginning of the list. The added element is the returned value from the CopyFunc given to MiscListNewEmptyList.

7.2.215 MiscListCompLists (list.c:158)

int MiscListCompLists(MiscListPtrType L1, MiscListPtrType L2)

- **L1**: A lists to compare.
- **L2**: A lists to compare.
- **Returns**: 0 if the lists are equal.

**Description**: Compares the 2 given list element by element. The list are considered equal if they have the same number of elements, in the same order.
7.2.216 MiscListFindElementInList (list.c:126)

    int MiscListFindElementInList(MiscListPtrType List, 
                                    void *Elem, 
                                    unsigned long SizeInByte)

    List: The list where the element will be looked for.
    Elem: The element to look for.
    SizeInByte: The second parameter to pass to the CompFunc (CompFunc takes 2 parameters to make it easy 
                 to compare arrays).
    Returns: -1 if not found, 0 otherwise.
    Description: Looks for the give element in the list (using the CompFunc given to MiscListNewEmptyList).

7.2.217 MiscListFreeList (list.c:201)

    void MiscListFreeList(MiscListPtrType List)

    List: The list to free.
    Returns: void
    Description: Frees the List (and elements).

7.2.218 MiscListFreeListIterator (list.c:264)

    void MiscListFreeListIterator(MiscListIteratorPtrType It)

    It: The iterator to free.
    Returns: void
    Description: Frees the given iterator.

7.2.219 MiscListGetListIterator (list.c:236)

    MiscListIteratorPtrType MiscListGetListIterator(MiscListPtrType List)

    List: The list to iterate over.
    Returns: The new iterator, of NULL if fails.
    Description: Returns a new iterator to the given list. Before MiscListIteratorFirst is used the place where the 
                 iterator points to is undefined.

7.2.220 MiscListIteratorAtEnd (list.c:333)

    int MiscListIteratorAtEnd(MiscListIteratorPtrType It)

    It: The iterator to check.
    Returns: 1 if at the end of the list, 0 otherwise.
    Description: Returns 1 if at the end of the List.
7.2.221 MiscListIteratorFirst (list.c:286)

    void *MiscListIteratorFirst(MiscListIteratorPtrType It)
    
    It: The iterator to reset.
    
    Returns: The element at the head of the list.
    
    Description: Resets the iterator to the head of the list.
    
    See also:

7.2.222 MiscListIteratorNext (list.c:309)

    void *MiscListIteratorNext(MiscListIteratorPtrType It)
    
    It: The iterator to move.
    
    Returns: The element at the new location in the list (if the new location is the end of the list, the return value is NULL).
    
    Description: Moves the iterator to the next element in the list. If used when the iterator is at the end of the list the result is undefined.

7.2.223 MiscListIteratorValue (list.c:355)

    void *MiscListIteratorValue(MiscListIteratorPtrType It)
    
    It: The iterator.
    
    Returns: The data stored the the current element.
    
    Description: Returns the data stored the the current element.

7.2.224 MiscListNewEmptyList (list.c:50)

    MiscListPtrType MiscListNewEmptyList(MiscListCopyFuncType CopyFunc,
                                            MiscListFreeFuncType FreeFunc,
                                            MiscListCompFuncType CompFunc)
    
    CopyFunc: The function that will be used to copy elements (for example when adding a new element to the list).
    
    FreeFunc: The function that will be used to free elements (for example when freeing the list).
    
    CompFunc: The function that will be used to compare elements (for example when looking for an element in the list).
    
    Returns: The new list if successful, of NULL if fails.
    
    Description: Creates a new List.

7.2.225 MiscSetFatalErrorFunc (misc_ftl.c:28)

    MiscSetErrorFuncType MiscSetFatalErrorFunc(MiscSetErrorFuncType ErrorFunc)
    
    ErrorFunc: New error function to use.
    
    Returns: Old error function reference.
    
    Description: Sets the error function to be used by Misc_lib.
7.2.226  **RLNewFromFile** (mincover.c:1156)

```c
RLStruct *RLNewFromFile(const char *FileName)
```

- **FileName**: The file name containing the required details
- **Returns**: A new constructed RL
- **Description**: Initializes a new RL using a file to describe the ranges.
- **See also**: RLNew,

7.2.227  **_AttrMallocAttribute** (miscattr.c:1566)

```c
IPAttributeStruct *_AttrMallocAttribute(const char *Name, IPAttributeType Type)
```

- **Name**: Name of newly created attribute.
- **Type**: Type of newly created attribute.
- **Returns**: The newly created attribute.
- **Description**: Allocated a new attribute structure.

7.2.228  **_AttrMallocNumAttribute** (miscattr.c:1588)

```c
IPAttributeStruct *_AttrMallocNumAttribute(AttribNumType AttribNum, IPAttributeType Type)
```

- **AttribNum**: Number of newly created attribute.
- **Type**: Type of newly created attribute.
- **Returns**: The newly created attribute.
- **Description**: Allocated a new attribute structure.

7.2.229  **_IrtImgVerifyAlignment** (readimag.c:426)

```c
IrtBType *_IrtImgVerifyAlignment(IrtBType *Data,
                                  int *MaxX,
                                  int *MaxY,
                                  int Alpha)
```

- **Data**: Image data to verify alignment, in place.
- **MaxX**: Current dimension of image. Might be changed after alignment.
- **MaxY**: Current dimension of image.
- **Alpha**: Do we have Alpha in the image?
- **Returns**: The verified image data.
- **Description**: Verifies the alignment of the image. Returned is either the input Data if aligned, or a new aligned copy (and Data is freed).

7.2.230  **getcwd** (xgeneral.c:833)

```c
char *getcwd(char *s, int Len)
```

- **s**: Where to save current working direction.
- **Len**: Length of s.
- **Returns**: Same as s.
- **Description**: Get current working directory - BSD4.3 style. *
7.2.231 movmem (xgeneral.c:560)

void movmem(VoidPtr Src, VoidPtr Dest, int Len)

Src: Of block to copy.
Dest: Of block to copy.
Len: Of block to copy.
Returns: void

Description: Routine to move a block in memory. Unlike memcpy/bcopy, this routine should support overlaying blocks. This stupid implementation will copy it twice - to a temporary block and back again. The temporary block size will be allocated by demand.

7.2.232 searchpath (xgeneral.c:585)

const char *searchpath(const char *Name)

Name: Of file to search for.
Returns: Complete file name of Name.
Description: Routine to search for a given file name.

7.2.233 stricmp (xgeneral.c:757)

int stricmp(const char *s1, const char *s2)

s1, s2: The two strings to compare.
Returns: <0, 0, >0 according to the relation between s1 and s2.
Description: Routine to compare two strings, ignoring case.

7.2.234 strnicmp (xgeneral.c:716)

int strnicmp(const char *s1, const char *s2, int n)

s1, s2: The two strings to compare.
\( n \): maximum number of characters to compare.
Returns: <0, 0, >0 according to the relation between s1 and s2.
Description: Routine to compare two strings, ignoring case, up to given length.

7.2.235 strstr (xgeneral.c:802)

char *strstr(const char *s, const char *Pattern)

s: To search for Pattern in.
Pattern: To search in s.
Returns: Address in s where Pattern was first found, NULL otherwise.
Description: Routine to search for a Pattern (no regular expression) in s. Returns address in s of first occurrence of Pattern, NULL if non found.
Chapter 8

Multi variate functions, mvar_lib

8.1 General Information

This library holds functions to handle functions of arbitrary number of variables. In this context curves (univariate), surfaces (bivariate) and trivariates are special cases. This library provides a rich set of functions to manipulate freeform Bezier and/or NURBs multivariates. This library heavily depends on the cagd an symb libraries. Functions are provided to create, copy, and destruct multivariates, to extract isoparametric lower degree multivariates, to evaluate, refine and subdivide, to read and write multivariates, to differentiate, degree raise, make compatible and convert back and forth to/from curves, surfaces, and trivariates.

A multivariate has m orders, m Length prescriptions and, possibly, m knot vectors (if Bspline). In addition it contains an m dimensional volume of control points,

typedef struct MvarMVStruct {
    struct MvarMVStruct *Pnext;
    struct IPAttributeStruct *Attr;
    MvarGeomType GType;
    CagdPointType PType;
    int Dim; /* Number of dimensions in this multi variate. */
    int *Lengths; /* Dimensions of mesh size in multi-variates */
    int *SubSpaces; /* SubSpaces[i] = Prod(i = 0, i-1) of Lengths[i]. */
    int *Orders; /* Orders of multi variate (Bspline only). */
    CagdBType *Periodic; /* Periodicity - valid only for Bspline. */
    CagdRType *Points[CAGD_MAX_PT_SIZE]; /* Pointer on each axis vector. */
    CagdRType **KnotVectors;
} MvarMVStruct;

The interface of the library is defined in include/mvar_lib.h.
This library has its own error handler, which by default prints an error message and exit the program called MvarFatalError.
All globals in this library have a prefix of Mvar.

8.2 Library Functions

8.2.1 MVHyperConeFromNPoints (mvcones.c:700)

int MVHyperConeFromNPoints(MvarNormalConeStruct *MVCone,
                            MvarVecStruct * const *Vecs,
                            int n)

MVCone: The result is to be placed here.
Vecs: Input vectors, prescribing n locations in R^n.
 n: Size of array Vecs.
Returns: TRUE if successful, FALSE otherwise.
Description: Constructs a hyper cone in R^n through n vectors specified by Vecs.
See also: MVHyperPlaneFromNPoints, MVHyperConeFromNPoints2, , MVHyperConeFromNPoints3,
8.2.2 MVHyperConeFromNPoints2 (mvcones.c:748)

```c
int MVHyperConeFromNPoints2(MvarNormalConeStruct *MVCone,
                            MvarVecStruct * const *Vecs,
                            int m)

MVCone: The result is to be placed here.
Vecs: Input vectors, prescribing m locations in R^n.
m: Size of array Vecs, m < n.
Returns: TRUE if successful, FALSE otherwise.
Description: Constructs a hyper cone in R^n through m (m < n) vectors specified by Vecs.
See also: MVHyperPlaneFromNPoints, MVHyperConeFromNPoints, MVHyperConeFromNPoints3,
```

8.2.3 MVHyperConeFromNPoints3 (mvcones.c:844)

```c
int MVHyperConeFromNPoints3(MvarNormalConeStruct *MVCone,
                            MvarVecStruct * const *Vecs,
                            int m)

MVCone: The result is to be placed here.
Vecs: Input vectors, prescribing m locations in R^n.
m: Size of array Vecs, m < n.
Returns: TRUE if successful, FALSE otherwise.
Description: Constructs a hyper cone in R^n through m (m < n) vectors specified by Vecs. Same functionality of MVHyperConeFromNPoints2 but more efficient, by solving for A A^T x = e, were e is [1, 1,..., 1], and having x being the linear combination of A's rows defining the cone axis.
See also: MVHyperPlaneFromNPoints, MVHyperConeFromNPoints, MVHyperConeFromNPoints2,
```

8.2.4 MVHyperPlaneFromNPoints (mvcones.c:647)

```c
int MVHyperPlaneFromNPoints(MvarPlaneStruct *MVPlane,
                            MvarVecStruct * const *Vecs,
                            int n)

MVPlane: The result is to be placed here.
Vecs: Input vectors, prescribing n locations in R^n.
n: Size of array Vecs.
Returns: TRUE if successful, FALSE otherwise.
Description: Constructs a hyper plane in R^n through n locations specified by Vecs.
See also: MVHyperConeFromNPoints,
```

8.2.5 MVarCrvDiameter (crv_krnl.c:392)

```c
IPObjectStruct *MVarCrvDiameter(const CagdCrvStruct *Crv,
                                 CagdRType SubEps,
                                 CagdRType NumEps)

Crv: Simple closed curve to compute the diameter for.
SubEps: Subdivision epsilon.
NumEps: Numeric marching tolerance.
Returns: List of pair of parameter values between which the local diameter could be found.
Description: Computes the minimal and maximal diameter of the given curve. Let the input curve be C(t) and let f(t,r) = < C(t)-C(r), C(t)-C(r) >. Then, df/dt = df/dr = 0 find all the finite set of line segments that connects two points on the curve orthogonally to the curve. The min/max diameter is part of this set.
See also: MVarCrvKernel, MvarCrvAntipodalPoints,
```
8.2.6  MVarCrvGammaKernel (crv_krn1.c:75)

MvarMVStruct *MVarCrvGammaKernel(const CagdCrvStruct *Crv, CagdRType Gamma)

Crv: Simple closed curve to compute its gamma-kernel.

Gamma: Angular deviation of the gamma-kernel, in degrees.

Returns: The trivariate function F(u, v, t) whose zero set, projected on the XY plane, is the domain that is not in the gamma-kernel.

Description: Computes the gamma-kernel of the given curve, or the points in the plane that have a line of sight (rotated gamma degrees) with all the points of the curve. The curve is assumed to be closed and simple. Let the input curve be C(t) and let S(u, v) = (u, v), the XY plane. Further let D'(t) = Rot(Gamma)[C'(t)]. Then, let F(u, v, t) = (C(t) - S(u, v)) x D'(t) (only the Z component of crossprod). The zero set of F projected over the XY plane defines all the domain that is NOT in the gamma-kernel of C(t).

See also: MVarCrvKernelSilhouette, MVarCrvKernel, MVarCrvGammaKernelSrf

8.2.7  MVarCrvGammaKernelSrf (crv_krn1.c:187)

MvarMVStruct *MVarCrvGammaKernelSrf(const CagdCrvStruct *Crv,
                                       CagdRType ExtentScale,
                                       CagdRType GammaMax)

Crv: Simple curve to compute its gamma-kernel surface.

ExtentScale: To scale the constructed surface as function of Gamma.

GammaMax: Max gamma deviation of the gamma-kernel, in degrees, for this curve. If negative, does so to opposite direction.

Returns: The surface S(u, v) or trivariate function F(u, v, t) representing the gamma surface as a function of gamma.

Description: Constructs a gamma-kernel surfaces the given curve and as a function of gamma. Let the input curve be C(t). If C(t) is a linear curve then we compute the surface: Let P = (Px, Py) be the initial point and (Dx, Dy) the slope of the line. Then the constructed surface equals (ES == ExtentScale): X(r, Gamma) = Px + r * Dx * ES + r * Gamma * Dy * ES Y(r, Gamma) = Py - r * Gamma * Dx * ES + r * Dy * ES Z(r, Gamma) = Gamma
If C(t) is a higher order, non linear, curve then we compute trivar: X(t, r, Gamma) = Cx(t) + r * Cx'(t) * ES + r * Gamma * Cy'(t) * ES Y(t, r, Gamma) = Cy(t) - r * Gamma * Cx'(t) * ES + r * Cy'(t) * ES Z(t, r, Gamma) = Gamma

See also: MVarCrvKernelSilhouette, MVarCrvKernel, MVarCrvGammaKernel

8.2.8  MVarCrvKernel (crv_krn1.c:41)

MvarMVStruct *MVarCrvKernel(const CagdCrvStruct *Crv)

Crv: Simple closed curve to compute its kernel.

Returns: The trivariate function F(u, v, t) whose zero set, projected on the XY plane, is the domain that is not in the kernel.

Description: Computes the kernel of the given curve, or the points in the plane that have a line of sight with all the points of the curve. The curve is assumed to be closed and simple. Let the input curve be C(t) and let S(u, v) = (u, v), the XY plane. Then, let F(u, v, t) = (C(t) - S(u, v)) x C'(t) (only the Z component of crossprod). The zero set of F projected over the XY plane defines all the domain that is NOT in the kernel of C(t).

See also: MVarCrvKernelSilhouette, MVarCrvGammaKernel,
8.2.9 MVarCrvKernelSilhouette (crv_krn.c:352)

MvarPolylineStruct *MVarCrvKernelSilhouette(const CagdCrvStruct *Crv,
CagdRType Gamma,
CagdRType SubEps,
CagdRType NumEps)

Crv: Simple closed curve to compute the silhouette of the kernel.
Gamma: Angular deviation of the gamma-kernel, in degrees.
SubEps: Subdivision epsilon.
NumEps: Numeric marching tolerance.
Returns: The silhouettes along the third, t, parameter of the trivariate function f(u, v, t).
Description: Computes the kernel of the given curve, or the points in the plane that have a line of sight with all the points of the curve. The curve is assumed to be closed and simple. Let the input curve be C(t) and let S(u, v) = (u, v), the XY plane. Then, let f(u, v, t) = < C(t) - S(u, v), C'(t) >. The zero set of f projected over the XY plane defines all the domain that is NOT in the kernel of C(t).
See also: MVarCrvKernel, MVarCrvGammaKernel,

8.2.10 MVarExprTreeNormalCone (mvcones.c:2012)

MvarNormalConeStruct *MVarExprTreeNormalCone(MvarExprTreeStruct *Eqn)

Eqn: Multivariate to derive a cone bounding its normal space.
Returns: The resulting normal cone.
Description: Constructs a normal cone to a scalar multivariate expression tree. If the input multivariate is not scalar it is assumed to be of point type E(1+Dim), where Dim is the dimension of the MV. This scalar holds the gradient already in the Dim locations of the Points array in MV, in slots Points[2] to Points[Dim + 1], with Points[1] still holding the scalar field.
See also: MvarExprTreeConesOverlap,

8.2.11 MVarIsCrvInsideCirc (ms_circ.c:439)

int MVarIsCrvInsideCirc(const CagdCrvStruct *Crv,
CagdRType Center[2],
CagdRType Radius,
CagdRType Tolerance)

Crv: Curve to test for containment in the circle.
Center: Center of the circle to test against.
Radius: Radius of the circle to test against.
Tolerance: Of computation.
Returns: TRUE if Crv is indeed inside the circle, FALSE otherwise.
Description: Tests if a circle is contained in the given prescribed curve.
See also: MvarMSCircOfThreeCurves, MvarMSCircOfThreeCurves, MvarMinSpanCirc,

8.2.12 MVarMVNormalCone (mvcones.c:1135)

MvarNormalConeStruct *MVarMVNormalCone(const MvarMVStruct *MV)

MV: Multivariate to derive a cone bounding its normal space.
Returns: A cone bounding the normal space of MV, or NULL if failed (i.e. angular span of normal space too large).
Description: Constructs a normal cone to a scalar multivariate MV. Note the normal space of the trivariate is assumed of dimension one, and the gradient of the multivariate is assumed to span the normal space. If the input multivariate is not scalar it is assumed to be of point type E(1+Dim), where Dim is the dimension of the MV. This scalar holds the gradient already in the Dim locations of the Points array in MV, in slots Points[2] to Points[Dim + 1], with Points[1] still holding the scalar field.
See also: MVarMVNormalCone2, MvarMVConesOverlap,
8.2.13 MVarMVNormalCone2 (mvcones.c:1204)

MvarNormalConeStruct *MVarMVNormalCone2(const MvarMVStruct *MV,
    CagdRType * const *GradPoints,
    int TotalLength,
    int *MaxDevIndex)

MV: Multivariate to derive a cone bounding its normal space.
GradPoints: Control vectors of gradient field.
TotalLength: Number of control vectors in gradient field.
MaxDevIndex: The index in GradPoints where maximal deviation occur will be kept here.

Returns: A cone bounding the normal space of MV, or NULL if failed (i.e. angular span of normal space too large).

Description: A second version of MVarMVNormalCone in which the control vectors are given directly. Note the normal space of the trivariate is assumed of dimension one, and the gradient of the multivariate is assumed to span the normal space. If the input multivariate is not scalar it is assumed to be of point type E(1+Dim), where Dim is the dimension of the MV. This scalar holds the gradient already in the Dim locations of the Points array in MV, in slots Points[2] to Points[Dim + 1], with Points[1] still holding the scalar field.

See also: MVarMVNormalCone, MvarMVConesOverlap,

8.2.14 MVarMVNormalConeMainAxis (mvcones.c:1279)

MvarNormalConeStruct *MVarMVNormalConeMainAxis(const MvarMVStruct *MV,
    MvarVecStruct **MainAxis)

MV: Multivariate to derive a cone bounding its normal space.
MainAxis: Main axis (principal component) of the normal cone’s vectors distribution. Valid only if success.

Returns: A cone bounding the normal space of MV, or NULL if failed (i.e. angular span of normal space too large).

Description: Constructs a normal cone to a scalar multivariate MV. Note the normal space of the trivariate is assumed of dimension one, and the gradient of the multivariate is assumed to span the normal space. If the input multivariate is not scalar it is assumed to be of point type E(1+Dim), where Dim is the dimension of the MV. This scalar holds the gradient already in the Dim locations of the Points array in MV, in slots Points[2] to Points[Dim + 1], with Points[1] still holding the scalar field.

See also: MVarMVNormalConeMainAxis2, MVarMVNormalCone, MvarMVConesOverlap,

8.2.15 MVarMVNormalConeMainAxis2 (mvcones.c:1336)

MvarNormalConeStruct *MVarMVNormalConeMainAxis2(const MvarMVStruct *MV,
    CagdRType * const *GradPoints,
    int TotalLength,
    MvarVecStruct **MainAxis)

MV: Multivariate to derive a cone bounding its normal space.
GradPoints: Control vectors of gradient field.
TotalLength: Number of control vectors in gradient field.
MainAxis: Main axis (principal component) of the normal cone’s vectors distribution. Allocated and valid only if success.

Returns: A cone bounding the normal space of MV, or NULL if failed (i.e. angular span of normal space too large).

Description: A second version of MVarMVNormalConeMainAxis in which the control points are given directly.

See also: MVarMVNormalConeMainAxis, MVarMVNormalCone, MvarMVConesOverlap,
8.2.16  MVarProjNrmlPrmt2MVScl (mvaccess.c:416)

MvarMStruct  *MVarProjNrmlPrmt2MVScl(const CagdSrfStruct *Srf,
const CagdSrfStruct *NrmlSrf,
const MvarMStruct  *MVSc1)

Srf: Surface to project promote and scale.
NrmlSrf: Normal field to project along.
MVSc1: Scale field to scale with.
Returns: Resulting multivariate. *

Description: Performs the following steps in order:
1. Project Srf onto NrmlSrf by computing their inner product.
2. Promote the surface to a 4-variate with the surface the first 2 vars.
3. Scale the new 4-variate by a scalar product with MVSc1.

8.2.17  MVarSmallestPrincipalDirection (mvcones.c:1027)

void MVarSmallestPrincipalDirection(MvarVecStruct  *SPDVec,
MvarVecStruct  * ConeAxis,
CagdRType  * const *GradPoints,
int TotalLength,
int Dim)

SPDVec: Vector to be updated with the smallest principal component.
ConeAxis: Axis of cone bounding all the normal vectors in GradPoints. Assumed unit length.
GradPoints: The normal (Gradient) vectors to handle.
TotalLength: Number of normal vectors in GradPoints.
Dim: Dimension of Normal vectors. N
Returns: void

Description: Computes the smallest principal direction of a set of normal vectors.
See also: MVarMVMaximalDeviation.

8.2.18  Mvar2CntctCompute2CntctMotion (mv2cntct.c:3491)

MvarPolylineStruct  *Mvar2CntctCompute2CntctMotion(const CagdCrvStruct *CCrvA,
const CagdCrvStruct *CCrvB,
CagdRType  Step,
CagdRType  Subtol,
CagdRType  Numerictol)

CCrvA: Moving curve.
CCrvB: Obstacle Curves.
Step: Step size to use in the numeric tracing.
Subtol: Subdivision tolerance of Computation.
Numerictol: Numerical tolerance of computation.
Returns: Linked list of the solutions holding parameter value of two contact points and rotation in radian (u1, v1, u2, v2, theta).

Description: Computes the 2 Contact motion between two C^1 cont curves, CCrvA and CCrvB. The curves are assumed to be C1 periodic curve with open end condition. The algebraic conditions for 2contact are following (please refer the paper,“Precise Continuous Contact Motion for Planar Freeform Geometric Curves” for the details):

\[
[CrvB'(v1) - Rot(\theta) \ast CrvA'(u1)] \cdot x = [CrvB'(v2) - Rot(\theta) \ast CrvA'(u2)] \cdot x \\
[CrvB'(v1) - Rot(\theta) \ast CrvA'(u1)] \cdot y = [CrvB'(v2) - Rot(\theta) \ast CrvA'(u2)] \cdot y \\
\det (Rot(\theta) \ast CrvA'(u1), CrvB'(v1)) = 0, \\
\det (Rot(\theta) \ast CrvA'(u2), CrvB'(v2)) = 0.
\]

See also:
8.2.19 Mvar2CtBuildBVH (mv2ctbvh.c:785)

Mvar2CtBVHStruct *Mvar2CtBuildBVH(CagdCrvStruct *Crv,
CagdRType SubdivTol,
CagdRType BvTol)

Crv: Crv to build a BVH.
SubdivTol: Subdivision tolerance for the construction.
BvTol: Bounding volume error tolerance for the construction.
Returns: Bounding volume hierarchy for a curve
Description: Build a bounding volume hierarchy for a curve.
See also:

8.2.20 Mvar2CtBuildCParamHierarchy (mv2ctaux.c:146)

void Mvar2CtBuildCParamHierarchy(CagdCrvStruct *Circle,
Mvar2CtCParamStruct **Node,
CagdRType Min,
CagdRType Max,
CagdRType Tol)

Circle: Unit circle.
Node: New node will be allocated herein.
Min, Max: Domain for the node.
Tol: Tolerance for building hierarchy.
Returns: void
Description: Build a hierarchy for rotation data structure.
See also:

8.2.21 Mvar2CtCheck2CtTrace (mv2ctaux.c:1057)

CagdBType Mvar2CtCheck2CtTrace(Mvar2CtBVNodeStruct *Nodes[4],
Mvar2CtCParamStruct *Cparam,
CagdRType Tol)

Nodes: Bounding volumes for curves.
Cparam: data structure for rotation.
Tol: Subdivision tolerance of checking.
Returns: FALSE if there is no solution in the domain, TRUE otherwise.
Description: Check if there exists 2 contact trace in the domain using BVH.
See also:

8.2.22 Mvar2CtConnectPeriodic (mv2ctaux.c:2304)

MvarPolylineStruct *Mvar2CtConnectPeriodic(MvarPolylineStruct *Polys,
CagdRType Tol)

Polys: 2contact traces.
Tol: tolerance for the connection.
Returns: connected 2contact motion curves.
Description: Connect 2Contact traces that are not connected due to the parametrization of the periodic curve.
See also:
8.2.23 Mvar2CtCurvatureOverlap (mv2ctaux.c:89)

```c
CagdBType Mvar2CtCurvatureOverlap(Mvar2CtBVNodeStruct *ANode,
   Mvar2CtBVNodeStruct *BNode,
   Mvar2CtCParamStruct *Cparam)
```

**ANode:** Bounding volume for a moving curve.

**BNode:** Bounding volume for an obstacle curve.

**Cparam:** Data structure for rotation.

**Returns:** FALSE if there is no curvature overlap TRUE otherwise.

**Description:** Check if two curves can have a same curvature by using BVH.

See also:

8.2.24 Mvar2CtExtractMVRegion (mv2ctaux.c:1508)

```c
MvarMVStruct **Mvar2CtExtractMVRegion(MvarMVStruct **MVs,
   int MVNum,
   CagdRType *Min,
   CagdRType *Max)
```

**MVs:** Array of multivariates.

**MVNum:** Number of constraints (may be updated).

**Min:** Minimum domain values.

**Max:** Maximum domain values.

**Returns:** Extracted MVs.

**Description:** Extract sub-region of multivariate correspond to a given sub domain.

See also:

8.2.25 Mvar2CtFreeBVH (mv2ctbvh.c:855)

```c
void Mvar2CtFreeBVH(Mvar2CtBVHStruct *Bvh)
```

**Bvh:** BVH to deallocate.

**Returns:** void

**Description:** Free bounding volume hierarchy.

See also:

8.2.26 Mvar2CtFreeCparam (mv2ctaux.c:234)

```c
void Mvar2CtFreeCparam(Mvar2CtCParamStruct *Node)
```

**Node:** Mvar2CtCParamStruct node to free.

**Returns:** void

**Description:** Free Mvar2CtCParamStruct recursively.

See also:

8.2.27 Mvar2CtGetMiddlePt (mv2ctaux.c:1966)

```c
MvarPtStruct *Mvar2CtGetMiddlePt(MvarPtStruct *PtList, int Length)
```

**PtList:** Linked list of the points.

**Length:** Length of the list.

**Returns:** Middle point of the list.

**Description:** Find a middle point of Point list.

See also:
8.2.28 Mvar2CtGetParentBVNode (mv2ctbvh.c:601)

void Mvar2CtGetParentBVNode(Mvar2CtBVNodeStruct *Node,
   CagdRType Min,
   CagdRType Max,
   Mvar2CtBVNodeStruct **Parent)

Node: Data structure for rotation.
Min, Max: Domain range for testing.
Parent: Place for saving the result.
Returns: void
Description: Find smallest bounding volume includes domain range Min Max.
See also:

8.2.29 Mvar2CtGetParentCparam (mv2ctaux.c:207)

void Mvar2CtGetParentCparam(Mvar2CtCParamStruct *Node,
   CagdRType Min,
   CagdRType Max,
   Mvar2CtCParamStruct **Parent)

Node: Data structure for rotation.
Min, Max: Domain range for testing.
Parent: Place for saving the result.
Returns: void
Description: Find smallest bounding volume includes the domain Min-Max.
See also:

8.2.30 Mvar2CtGetTheta (mv2ctaux.c:369)

CagdRType Mvar2CtGetTheta(CagdRType x, CagdRType y)

x, y: vector for computing rotation angle.
Returns: Rotation angle in radian.
Description: Compute a rotation angle in radian correspond (x, y) vector.
See also:

8.2.31 Mvar2CtInDomain (mv2ctaux.c:1556)

CagdBType Mvar2CtInDomain(CagdRType *Min,
   CagdRType *Max,
   MvarPtStruct *MPt)

Min: Minimum values of the domain.
Max: Maximum values of the domain.
MPt: Point to check.
Returns: TRUE if MPt is in the domain, FALSE otherwise.
Description: Check if a point is located in a given domain.
See also:
8.2.32 Mvar2CtIsConnectedNode (mv2ctaux.c:999)

CagdBType Mvar2CtIsConnectedNode(Mvar2CtBVNodeStruct *Node1, Mvar2CtBVNodeStruct *Node2)

Node1, Node2: Bounding volumes to test.
Returns: TRUE if connected, FALSE otherwise.
Description: Check if two bounding volumes are connected.
See also:

8.2.33 Mvar2CtIsPassing (mv2ctaux.c:1588)

CagdBType Mvar2CtIsPassing(CagdRType *Min, CagdRType *Max, MvarPolylineStruct *MPoly)

Min: Minimum values of the domain.
Max: Maximum values of the domain.
MPoly: MvarPolyline to check.
Returns: TRUE if MPoly passes the domain, FALSE otherwise.
Description: Check if a polyline passes a given domain.
See also:

8.2.34 Mvar2CtLineLineDist (mv2ctbvh.c:271)

CagdRType Mvar2CtLineLineDist(Mvar2CtLineStruct *A, Mvar2CtLineStruct *B)

A, B: Two line segments to compute distance.
Returns: Distance between A and B.
Description: Compute distance between two line segments.
See also:

8.2.35 Mvar2CtLinePointDist (mv2ctbvh.c:334)

CagdRType Mvar2CtLinePointDist(CagdPType P, CagdPType L[2])

P: Point to compute distance.
L: Two end points of line segment.
Returns: Minimum distance between a line segment and a point.
Description: Compute distance between point and line segment.
See also:

8.2.36 Mvar2CtNormalOverlap (mv2ctaux.c:410)

CagdBType Mvar2CtNormalOverlap(Mvar2CtBVNodeStruct *ANode, Mvar2CtBVNodeStruct *BNode, CagdRType RMin, CagdRType RMax)

ANode, BNode: Bounding volumes to test.
RMin: Minimum rotation angle in radian.
RMax: Maximum rotation angle in radian.
Returns: FALSE if tangency condition does not satisfy TRUE otherwise.
Description: Check the tangency condition for 2 contact points using BVH.
See also:
8.2.37 Mvar2CtNormalOverlapBoth (mv2ctaux.c:571)

CagdBType Mvar2CtNormalOverlapBoth(Mvar2CtBVNodeStruct *ANode,
Mvar2CtBVNodeStruct *BNode)

- **ANode, BNode**: Nodes for normal overlapping test.
- **Returns**: TRUE if normal cones overlap FALSE otherwise.
- **Description**: Check normal overlap for both direction.
- **See also**: 

8.2.38 Mvar2CtPenetrationDepth (mv2ctbvh.c:1159)

CagdRType Mvar2CtPenetrationDepth(Mvar2CtBVHStruct *BvhA,
Mvar2CtBVHStruct **BvhBs,
int BSize,
CagdRType Xtrans,
CagdRType Ytrans,
CagdRType Rot)

- **BvhA**: Bvh for moving curve.
- **BvhBs**: Bvh for obstacle curves.
- **BSize**: Number of obstacle curves.
- **Xtrans**: X translation.
- **Ytrans**: Y translation.
- **Rot**: Rotation angle in radian.
- **Returns**: Maximum penetration depth, negative if moving curve penetrate obstacle curves positive, otherwise.
- **Description**: Compute a maximum penetration depth of moving curve into obstacle curves using BVHs.
- **See also**: MvarStewartPlatformSolve,

8.2.39 Mvar2CtReduce2CtDomain (mv2ctaux.c:1154)

void Mvar2CtReduce2CtDomain(Mvar2CtBVNodeStruct *Nodes[4],
Mvar2CtCParamStruct *Cparam,
CagdRType Min[5],
CagdRType Max[5],
int MinMax,
int FixedDir,
CagdRType Tol)

- **Nodes**: Bounding volumes for curves.
- **Cparam**: Data structure for rotation.
- **Min**: Current minimum domain values.
- **Max**: Current maximum domain values.
- **MinMax**: 0 if fixed parameter is minimum parameter of the bounding volume, 1 if fixed parameter is maximum parameter of the of the bounding volume.
- **FixedDir**: Fixed dimension.
- **Tol**: Subdivision tolerance of checking.
- **Returns**: void
- **Description**: Reduce the domain for solving 2 contact points at domain boundary using BVH.
- **See also**: 

8.2.40  **Mvar2CtReduce3CtDomain**  (mv2ctaux.c:1309)

```c
void Mvar2CtReduce3CtDomain(Mvar2CtBVNodeStruct *Nodes[6],
                            Mvar2CtCParamStruct *Cparam,
                            CagdRType Min[7],
                            CagdRType Max[7])
```

**Nodes**: Bounding volumes for curves.
**Cparam**: Data structure for rotation.
**Min**: Current minimum domain values.
**Max**: Current maximum domain values.

**Returns**: void

**Description**: Reduce the domain for solving 3 contact points using BVH.

See also:

8.2.41  **Mvar2CtReduceRotExtremeDomain**  (mv2ctaux.c:1405)

```c
void Mvar2CtReduceRotExtremeDomain(Mvar2CtBVNodeStruct *Nodes[4],
                                    Mvar2CtCParamStruct *Cparam,
                                    CagdRType Min[5],
                                    CagdRType Max[5],
                                    CagdRType Tol)
```

**Nodes**: Bounding volumes for curves.
**Cparam**: data structure for rotation.
**Min**: Current minimum domain values.
**Max**: Current maximum domain values.
**Tol**: Subdivision tolerance of checking.

**Returns**: void

**Description**: Reduce the domain for solving rotational extreme point for 2 contact trace using BVH.

See also:

8.2.42  **Mvar2CtRejectbyCurvature**  (mv2ctaux.c:961)

```c
CagdBType Mvar2CtRejectbyCurvature(Mvar2CtBVNodeStruct *Node1,
                                    Mvar2CtBVNodeStruct *Node2)
```

**Node1, Node2**: Bounding volumes of curves to test.

**Returns**: TRUE if they don’t satisfy the condition, FALSE otherwise.

**Description**: Check if pair of curves satisfy curvature condition for 2 contact.

See also:

8.2.43  **Mvar2CtSetNodeId**  (mv2ctbvh.c:570)

```c
void Mvar2CtSetNodeId(Mvar2CtBVNodeStruct *Node, int Id)
```

**Node**: Bounding volume to set id.
**Id**: id value to set.

**Returns**: void

**Description**: Set id of bounding volume recursively.

See also:
8.2.44  Mvar2CtSwapTrace (mv2caux.c:2049)

void Mvar2CtSwapTrace(MvarPolylineStruct *MPoly)

MPoly:  Trace to swap.

Returns:  void

Description:  Swap the first and second parameter with third and fourth value.
See also:

8.2.45  Mvar2CtTraceBBox (mv2caux.c:2094)

void Mvar2CtTraceBBox(CagdRType *Min,
            CagdRType *Max,
            MvarPtStruct *SPt,
            MvarPtStruct *EPt)

Min, Max:  Minimum and maximum values of Bounding box.
SPt, EPt:  Start and end point of the trace.

Returns:  void

Description:  Compute bounding box of a trace.
See also:

8.2.46  Mvar2CtTraceCollide (mv2caux.c:1997)

int Mvar2CtTraceCollide(MvarPolylineStruct *Poly1,
                        MvarPolylineStruct *Poly2)

Poly1, Poly2:  Two traces to check.

Returns:  0 if there is no common contact 1 4 depending on the type of common contact point.

Description:  Test whether two traces Poly1, Poly2 have common contact point.
See also:

8.2.47  Mvar2CtValidate2Ct (mv2caux.c:1628)

MvarPtStruct *Mvar2CtValidate2Ct(MvarPtStruct *MPts,
                                 Mvar2CtBVHStruct *BvhA,
                                 Mvar2CtBVHStruct **BvhBs,
                                 int BSize,
                                 CagdCrvStruct *Circle)

MPts:  Linked list of curvature contacts.
BvhA:  Bvh for moving curve.
BvhBs:  Bvh for obstacle curves.
BSize:  Number of obstacle curves.
Circle:  Unit circle.

Returns:  Linked list of curvature contact points having no penetration into obstacle curves.

Description:  Check whether the 2 contact points cause inter-penetration into obstacle curves. The 2 contact
points having inter-penetration are removed from the list.
See also:
8.2.48  **Mvar2CtValidateCurvContact** (mv2ctaux.c:1701)

```c
MvarPtStruct *Mvar2CtValidateCurvContact(MvarPtStruct *MPts,
Mvar2CtBVHStruct *BvhA,
Mvar2CtBVHStruct **BvhBs,
int BSsize,
int BIndex,
CagdCrvStruct *Circle)
```

**MPts:** Linked list of curvature contacts.
**BvhA:** Bvh for moving curve.
**BvhBs:** Bvh for obstacle curves.
**BSSize:** Number of obstacle curves.
**BIndex:** Index number of obstacle curve.
**Circle:** Unit circle.

**Returns:** Linked list of curvature contact points having no penetration into obstacle curves.

**Description:** Check whether the curvature contact points cause inter-penetration into obstacle curves. The curvature contact points having inter-penetration are removed from the list.

See also:

8.2.49  **Mvar2CtValidateTraces** (mv2ctaux.c:1766)

```c
MvarPolylineStruct *Mvar2CtValidateTraces(MvarPolylineStruct *Polys,
Mvar2CtBVHStruct *BvhA,
Mvar2CtBVHStruct **BvhBs,
int BSsize,
CagdCrvStruct *Circle)
```

**Polys:** 2contact traces.
**BvhA:** Bvh for moving curve.
**BvhBs:** Bvh for obstacle curves.
**BSSize:** Number of obstacle curves.
**Circle:** Unit circle.

**Returns:** 2contact motion curves.

**Description:** Check if 2contact traces inter-penetrates the obstacle. The trace having inter-penetration is removed from the list.

See also:

8.2.50  **Mvar3CircsInTriangles** (mvarpack.c:51)

```c
MvarPtStruct *Mvar3CircsInTriangles(const CagdPType Pts[3],
CagdRType SubdivTol,
CagdRType NumericTol)
```

**Pts:** 3 vertices of triangle in the plane (only XY coordinates).

**SubdivTol:** Tolerance of the solution. This tolerance is measured in the parametric space of the surfaces.

**NumericTol:** Numeric tolerance of a possible numeric improvement stage. The numeric stage is employed if NumericTol < SubdivTol.

**Returns:** Points in R9 as (X1, Y1, R1, X2, Y2, R2, X3, Y3, R3). Each such solution is also tagged with "InTriangle" that is TRUE if all solution is inside the triangle.

**Description:** Given a triangles in the XY plane, specified by its 3 vertices Pts, Find the 3 circles packed inside the triangle (and tangent to it while also tangent to each other. This problem is also known as the (incorrect solution to the) "Malfatti Circles" problem.

See also:
8.2.51 Mvar6CircsInTriangles (mvarckt2.c:41)

```c
MvarPtStruct *Mvar6CircsInTriangles(const CagdPType Pts[3],
        CagdRType SubdivTol,
        CagdRType NumericTol)
```

**Pts**: 3 vertices of triangle in the plane (only XY coordinates).

**SubdivTol**: Tolerance of the solution. This tolerance is measured in the parametric space of the surfaces.

**NumericTol**: Numeric tolerance of a possible numeric improvement stage. The numeric stage is employed if NumericTol < SubdivTol.

**Returns**: Points in R9 as (x2, x4, x5, y1, y2, y3, y4, y5, y6).

**Description**: Given a triangles in the XY plane, specified by its 3 vertices Pts, Find the 6 circles packed inside the triangle (and tangent to it while also tangent to each other. The code to this function was synthesized automatically using the code below.

**See also:**

8.2.52 MvarAdjacentSrfSrfInter (selfintr.c:1552)

```c
MvarPolylineStruct *MvarAdjacentSrfSrfInter(const CagdSrfStruct *Srf1,
        const CagdSrfStruct *Srf2,
        CagdSrfBndryType Srf1Bndry,
        CagdRType SubdivTol,
        CagdRType NumericTol)
```

**Srf1, Srf2**: The two adjacent surfaces to intersect.

**Srf1Bndry**: Boundary of Srf1 that is shared with Srf2. Srf2 Boundary Must be the reciprocal boundary. That is, if SrfBndry is UMin, Srf2's boundary will be UMax.

**SubdivTol**: Tolerance of the solution. This tolerance is measured in the parametric space of the surfaces.

**NumericTol**: Numeric tolerance of a possible numeric improvement stage. The numeric stage is employed if NumericTol < SubdivTol.

**Returns**: List of intersection pllns, as (u, v) parameter pairs into the two surfaces’ domains. Points in R^4.

**Description**: Computes the intersection locations of two adjacent surfaces, that share an edge (a boundary curve). No intersections locations along the shared edge are returned. This case is common for adjacent patches in a B-spline surface.

**See also**: MvarBspSrfSelInterDiagFactor, MvarBzrSrfSelInterDiagFactor, BzrSrfFactorExtremeRowCol,

8.2.53 MvarBBoxOfCrossProd (mvar_aux.c:1031)

```c
void MvarBBoxOfCrossProd(const MvarBBoxStruct *BBox1,
        const MvarBBoxStruct *BBox2,
        MvarBBoxStruct *DCrossBBox)
```

**BBox1, BBox2**: Two bounding boxes to compute their cross product.

**DCrossBBox**: Where to place the returned result.

**Returns**: void

**Description**: Computes the cross product of two bounding boxes in R^3, fetching the possible values that could result from the cross product of the original multivariate data these bounding boxes bound. Returned bbox is a vector bbox with bounds on those possible cross product values. Computation is done by computing min/max value for each axis of the pair of bbox’s cross product.

**See also**: MvarMVBBBox, MvarBBoxOfDotProd,
void MvarBBoxOfDotProd(const MvarBBoxStruct *BBox1, const MvarBBoxStruct *BBox2, MvarBBoxStruct *DProdBBox)

BBox1, BBox2: Two bounding boxes to compute their inner product.
DProdBBox: Where to place the returned result.

Returns: void

Description: Computes the dot product of two bounding boxes in $\mathbb{R}^n$, fetching the possible values that could result from the dot product of the original multivariate data these bounding boxes bound. Returned bbox is a scalar bbox with bounds on those possible dot product values. Computation is done by computing min/max value for each axis of the pair of bbox’s and summing that up.

See also: MvarMVBBBox, MvarBBoxOfCrossProd, MvarBBoxOfDotProd2.

8.2.55 MvarBBoxOfDotProd2 (mvar_aux.c:928)

void MvarBBoxOfDotProd2(const MvarBBoxStruct *BBox1, const MvarBBoxStruct *BBox2, MvarBBoxStruct *DProdBBox)

BBox1, BBox2: Two bounding boxes to compute their inner product.
DProdBBox: Where to place the returned result.

Returns: void

Description: Computes the dot product of two bounding boxes in $\mathbb{R}^n$, fetching the possible values that could result from the dot product of the original multivariate data these bounding boxes bound. Returned bbox is a scalarbbox with bounds on those possible dot product values. Computation is done by enumerating all $2^n$ vertices of eachbbox and computing their dot products. Slower than MvarBBoxOfDotProd.

See also: MvarMVBBBox, MvarBBoxOfDotProd.

8.2.56 MvarBsctApplyCC (mvbiscon.c:250)

int MvarBsctApplyCC(MvarVoronoiCrvStruct *Cv1, MvarVoronoiCrvStruct **CCFreeCrvs)

Cv1: VoronoiCrvStruct
CCFreeCrvs: VoronoiCrvStruct for storing the resultant curves

Returns: TRUE or FALSE.

Description: Given the struct, this function says whether the bisector point satisfies the the following curvature constraints or not. Calculating the curvature constraints 1st constraint $\langle P(t,r) - C1(t), k(t)N1(t) \rangle - 1 < 0$ 2nd constraint $\langle P(t,r) - C2(t), k(r)N2(r) \rangle - 1 < 0$

See also: MvarBsctApplyLL.

8.2.57 MvarBsctApplyLL (mvbiscon.c:130)

MvarVoronoiCrvStruct *MvarBsctApplyLL(MvarVoronoiCrvStruct *Cv1)

Cv1: VoronoiCrvStruct

Returns: Returns the VoronoiCrvStruct after appying the LL constraint

Description: Given the struct, this function says whether the bisector point is to the left of the curve or not. Compute the constraints as dot products 1st constraint $\langle P(t,r) - C1(t), N1(t) \rangle > 0$ 2nd constraint $\langle P(t,r) - C2(r), N2(r) \rangle > 0$

See also: MvarBsctIsCurveLL,
8.2.58  MvarBsctCheckFootPtEqualsMinDistPt (mvtrmpcr.c:725)

CagdBType MvarBsctCheckFootPtEqualsMinDistPt(CagdCrvStruct *Crv1,
    CagdRType *Pt,
    CagdPType BP)

Crv1: The input curve - CagdCrvStruct.
Pt: The input point - CagdRType.
BP: Bisector point - CagdPType.

Returns: Returns TRUE or FALSE.

Description: Given the Crv1, point Pt and the Bisector point (BP), this function says BP’s footpoint is the minimum distance point to Crv1. Uses the function SymbDistCrvPoint from symblib.

See also: SymbDistCrvPoint,

8.2.59  MvarBsctComputeCrvPtBis (mvtrmpcr.c:226)

CagdPtStruct *MvarBsctComputeCrvPtBis(CagdCrvStruct *Crv,
    CagdRType *Pt,
    CagdRType t)

Crv: The input curve - CagdCrvStruct.
Pt: The input point - CagdRType.
t: Parameter on the curve Crv - CagdRType.

Returns: The identified bisector point.

Description: Given a Crv and a Pt, this function computes the point on the bisector using determinants for a particular parameter t on the curve.

See also: SymbCrvPtBisectorCrv2D,

8.2.60  MvarBsctComputeDenomOfP (mvtrmbis.c:52)

void MvarBsctComputeDenomOfP(CagdCrvStruct *Crv1Inp,
    CagdCrvStruct *Crv2Inp,
    CagdSrfStruct **DenomOut)

Crv1Inp, Crv2Inp: Two curves to compute bisectors for. Assumes E2 curves.
DenomOut: The resulting denominator surface is stored here.

Returns: void

Description: Computes the denominator of the bisector surface F3 of two given curves. Solve for the normal intersection surface in the plane and then substitute into (the bisector’s correspondance is the zero set then).

\[
\frac{C_1(s) + C_2(t)}{2} \cdot C_1(t) - C_2(s) = 0.
\]

See also: SymbCrvCnvxHull, SymbCrvDiameter, SymbCrvBisectors, SymbCrvBisectorsSrf2, , SymbCrvBisectorsSrf, SymbCrvPtBisectorsSrf3D, SymbCrvCrvBisectorSrf3D.
8.2.61 MvarBsctComputeF3 (mvtrmbis.c:145)

```c
void MvarBsctComputeF3(CagdCrvStruct *Crv1Inp,
                      CagdCrvStruct *Crv2Inp,
                      CagdCrvStruct **Crv1Coerced,
                      CagdCrvStruct **Crv2Coerced,
                      CagdSrfStruct **F3,
                      CagdSrfStruct **L1,
                      CagdSrfStruct **L2,
                      CagdSrfStruct **CC1,
                      CagdSrfStruct **CC2)
```

**Crv1Inp, Crv2Inp:** Two curves to compute bisectors for. Assumes E2 curves.

**Crv1Coerced:** N.S.F.I.

**Crv2Coerced:** N.S.F.I.

**F3:** The resulting bisector surface is stored here.

**L1:** N.S.F.I.

**L2:** N.S.F.I.

**CC1:** N.S.F.I.

**CC2:** N.S.F.I.

**Returns:** void

**Description:** Computes the bisector surface definition of two curves. The result is a scalar surface whose zero set is the set of bisector(s) of the curves. Solve for the normal intersection surface in the plane and then substitute into (the bisector’s correspondence is the zero set then).

\[
\frac{C1(s) + C2(t)}{2} < P - \frac{C1(t) - C2(s)}{2} = 0.
\]

**See also:** SymbCrvCvnnxHull, SymbCrvDiameter, SymbCrvBisectors, SymbCrvBisectorsSrF, SymbCrvBisectorsSrF3, SymbCrvCrvBisectorSrf3D, SymbCrvCrvBisectorSrf3D.

8.2.62 MvarBsctComputeLowerEnvelope (mvlowenv.c:1067)

```c
void MvarBsctComputeLowerEnvelope(MvarVoronoiCrvStruct *InputCurves,
                                  MvarVoronoiCrvStruct **LowerEnvelope)
```

**InputCurves:** A MvarVoronoiCrvStruct of monotone pieces.

**LowerEnvelope:** A MvarVoronoiCrvStruct of lower envelope.

**Returns:**

**Description:** Given the monotone curves, compute the lower envelope. This is the main calling function. The current implementation is an improved version that uses the auxiliary MvarLECrvStruct structure for efficiency and robustness (less solver calls).

**See also:** MvarBsctComputeLowerEnvelopeAux, MvarBsctComputeLowerEnvelopeOfOverlap, MvarBsctMergeLowerEnvelopes, MvarBsctSplitEnvelope1AtEnvelope2.

8.2.63 MvarBsctComputeXYFromBisTR (mvtrmbis.c:476)

```c
CagdRType *MvarBsctComputeXYFromBisTR(CagdCrvStruct *Crv1,
                                       CagdRType t,
                                       CagdCrvStruct *Crv2,
                                       CagdRType r)
```

**Crv1:** First curve.

**t:** Parameter value of first curve.

**Crv2:** Second curve.

**r:** Parameter value of second curve.

**Returns:** Bisector point from given tr.

**Description:** Computes the bisector point given tr-values.
8.2.64 MvarBsctCrvPtCurvature (mvtrmpcr.c:485)

CagdCrvStruct *MvarBsctCrvPtCurvature(CagdCrvStruct *Crv,
CagdRType *Pt,
CagdRType Alpha)

Crv: The input curve - CagdCrvStruct.
Pt: The input point - CagdRType.
Alpha: Parameter of the alpha-sector - CagdRType. 0.5 for bisector.

Returns: CagdCrvStruct of the resultant.

Description: Given the struct, this function says whether the bisector point satisfies the Curvature constraint.
See also: MvarBsctCrvPtLeft,

8.2.65 MvarBsctCrvPtLeft (mvtrmpcr.c:289)

CagdCrvStruct *MvarBsctCrvPtLeft(CagdCrvStruct *Crv,
CagdRType *Pt,
CagdRType Alpha)

Crv: The input curve - CagdCrvStruct.
Pt: The input point - CagdRType.
Alpha: Parameter of the alpha-sector - CagdRType. 0.5 for bisector.

Returns: CagdCrvStruct of the resultant.

Description: Given the struct, this function says whether the bisector point satisfies the Left constraint.
See also: MvarBsctCrvPtCurvature,

8.2.66 MvarBsctCurveLeft (mvvorcrv.c:262)

void MvarBsctCurveLeft(MvarVoronoiCrvStruct *Cv, MvarPtStruct *Res)

Cv: Input curve.
Res: Output stored here.

Returns: void

Description: A Geometric Primitive Function that returns the leftmost point of Cv.
See also: MvarBsctCurveRight,

8.2.67 MvarBsctCurveRight (mvvorcrv.c:360)

void MvarBsctCurveRight(MvarVoronoiCrvStruct *Cv, MvarPtStruct *Res)

Cv: input curve
Res: output stored here

Returns: void

Description: A Geometric Primitive Function that returns the rightmost point of Cv.
See also: MvarBsctCurveLeft,
8.2.68 MvarBsctCv1IsYSmallerAt (mvrscrv.c:480)

```c
int MvarBsctCv1IsYSmallerAt(MvarVoronoiCrvStruct *Cv1,
    MvarVoronoiCrvStruct *Cv2,
    MvarPtStruct *MidPoint)
```

Cv1, Cv2: Input curves.  
MidPoint: Mid-point parameter. 
Returns: Returns TRUE or FALSE. 
Description: A Geometric Primitive Function that identifies whether Cv1 has Y min. at given mid-point parameter, assuming both curves are in range.

8.2.69 MvarBsctDenomPtCrvBis (mvtrmpcr.c:85)

```c
CagdCrvStruct *MvarBsctDenomPtCrvBis(CagdCrvStruct *Crv,
    CagdPType Pt,
    CagdRType Alpha)
```

Crv: Planar curve to compute its bisector curve with Pt.  
Pt: A point in the plane to compute its bisector with Crv.  
Alpha: Alpha-sector ratio (0.5 for a bisector).  
Returns: The bisector curve, in the XY plane.  
Description: Computes the denominator of the alpha-/bi-sector curve of a planar curve and a point, all in the XY plane. The result is the denominator of the solution to the following two linear equations in alpha-/bi-sector's two unknowns, the x and y coefficients:

\[
\begin{align*}
\langle C'(t), B(t) \rangle &= \langle C'(t), C(t) \rangle \\
\langle C(t) - Pt, B(t) \rangle &= \langle C(t) - Pt, a \cdot Pt + (1 - a) \cdot C(t) \rangle
\end{align*}
\]

where a is the Alpha of the alpha-sector, 0.5 for a bisector, Pt is the point entity, C(t) is the curve entity and B(t) is the sought bisector.

See also: SymbCrvDiameter, SymbCrvCvnxHull, SymbCrvBisectorsSrf, , SymbCrvCrvBisectorSrf3D, SymbSrf-PtBisectorSrf3D, SymbCrvPtBisectorSrf3D,

8.2.70 MvarBsctGetAllIntersectionPoints (mvrscrv.c:905)

```c
void MvarBsctGetAllIntersectionPoints(MvarVoronoiCrvStruct *Cv1,
    MvarVoronoiCrvStruct *Cv2,
    MvarPtStruct **Points)
```

Cv1, Cv2: Input curves.  
Points: The resultant points.  
Returns: void  
Description: A Geometric Primitive Function that computes the equidistant points of three curves Cv1, Cv2 and Cv2 (third one also the second curve). Currently implemented just by calling Skei2DEqPts3Crvs (and purges away solutions). ToDo: implement a more efficient version, based on the already calculated F3.  
See also: MvarBsctSkei2DEqPts3Crvs,
8.2.71 MvarBsctIsCrvLeftToLine (mvtrmpcr.c:1086)

CagdRType MvarBsctIsCrvLeftToLine(CagdCrvStruct *Crv,
  CagdRType *Pt,
  CagdPType LeftNormal)

  Crv: The input curve - CagdCrvStruct.
  Pt: The discontinuity point on Crv.
  LeftNormal: Left normal at the point Pt.

  Returns: Return the value of the expression.

  Description: This function returns the value of the cross product between two vectors. First vector is between
  the point Pt and the midpoint of Crv and the second one is between the point and the LeftNormal.
  See also: MvarBsc TrimCrvPt,

8.2.72 MvarBsctIsCurveLL (mvbiscon.c:38)

  int MvarBsctIsCurveLL(MvarVoronoiCrvStruct *Cv)

       Cv: MvarVoronoiCrvStruct
       Returns: TRUE or FALSE.

       Description: Given the struct, this function says whether the bisector point is to the left of the curve or not.
       Compute the constraints as dot products 1st constraint <P(t,r) - C1(t), N1(t)> > 0 2nd constraint <P(t,r) - C2(r),
       N2(r)> > 0
       See also: MvarBsctApplyLL,

8.2.73 MvarBsctIsXSmaller (mvvorcrv.c:179)

  int MvarBsctIsXSmaller(MvarPtStruct *P1, MvarPtStruct *P2)

       P1, P2: Points as input.
       Returns: Returns true or false.

       Description: A Geometric Primitive Function that identifies which x-coord of the two points P1 and P2 is
       smaller.

8.2.74 MvarBsctNewFindZeroSetOfSrfAtParam (mvsplmon.c:203)

  MvarPtStruct *MvarBsctNewFindZeroSetOfSrfAtParam(CagdSrfStruct *Srf,
    CagdRType Param,
    CagdSrfDirType Dir,
    CagdRType MvarBsctSubdivTol,
    CagdRType MvarBsctNumerTol,
    CagdBType ShouldCheckEndPoints)

      Srf: Implicit surface definition.
      Param: Parametric value for computation.
      Dir: U or V direction for computation
      MvarBsctSubdivTol: Subdivision tolerance for the multivariate solver.
      MvarBsctNumerTol: Numeric tolerance of a possible numeric improvement stage. The numeric stage is
      employed if MvarBsctNumerTol < MvarBsctSubdivTol.
      ShouldCheckEndPoints: To include end points also for checking.
      Returns: The computed values

      Description: Find the zeroset value at the given parameter of the given surface
8.2.75 MvarBsctPurgeAwayLLAndCCConstraints (mvbiscon.c:366)

InputCrvs: A VoronoiCrvStruct of monotone pieces
Returns: VoronoiCrvStruct for storing the resultant
Description: Given the struct, this function says whether the bisector point satisfies the LL and Curvature constraints
See also: MvarBsctApplyLL, MvarBsctApplyCC,

8.2.76 MvarBsctSkel2DEqPts3Crvs (mvtrmbis.c:559)

Crv1Inp, Crv2Inp, Crv3Inp: The three input primitives to consider.
Returns: A linked list of all equidistant points computed, or NULL if none found.
Description: Formulate multivariate constraints for the points that are at equal distance from the three primitives and solve for them. Assumes that the three primitives are lines or curves and that they do NOT intersect. Modified from skel2d.c in mvar.lib to suit our needs

8.2.77 MvarBsctSplitCurve (mvvorcrv.c:994)

Cv: Input curve.
SplitPt: The parameter at which to split.
CvLeft, CvRight: The resultant split curves.
Returns: void
Description: A Geometric Primitive Function that splits the given curve into two - left and right curve of a given parameter t.

8.2.78 MvarBsctSplitImplicitCrvToMonotonePieces (mvsplmon.c:1144)

Srf: Implicit surface definition.
OutLst: Output list of uv-monotone surfaces.
MvarBsctSubdivTol: Subdivision tolerance for multivariate solver.
MvarBsctNumerTol: Numeric tolerance of a possible numeric improvement stage. The numeric stage is employed if MvarBsctNumerTol < MvarBsctSubdivTol.
Returns: void
Description: Splits the bivariate zero set Srf=0 (implicit form) into uv-monotone pieces. The recursive algorithm is based on the paper by Keyser et al.
### 8.2.79 MvarBsctTrimCrvPt (mvtrmpcr.c:1164)

CagdCrvStruct *MvarBsctTrimCrvPt(CagdCrvStruct *Crv,
CagdRType *Pt,
CagdRType Alpha,
CagdCrvStruct *BaseCrv)

**Crv**: The input curve - CagdCrvStruct.
**Pt**: The input point - CagdRType.
**Alpha**: Parameter of the alpha-sector - CagdRType. 0.5 for bisector.
**BaseCrv**: The Crv for which the trimming is sought along its discontinuity point.

**Returns**: Return the list of trimmed bisector curves.

**Description**: This function returns the radial lower envelope if the input is a (list of) crv (s) and a point or returns the trimmed bisector if the input is a pair of crv and a point.

**See also**: MvarBsctTrimCrvPtPair, MvarBsctCrvPtLeft, MvarBsctCrvPtCurvature, SymbCrvsLowerEnvelop,

### 8.2.80 MvarBsctTrimCrvPtPair (mvtrmpcr.c:785)

CagdCrvStruct *MvarBsctTrimCrvPtPair(CagdCrvStruct *Crv,
CagdRType *Pt,
CagdRType Alpha)

**Crv**: The input curve - CagdCrvStruct.
**Pt**: The input point - CagdRType.
**Alpha**: Parameter of the alpha-sector - CagdRType. 0.5 for bisector.

**Returns**: Return the list of trimmed bisector curves.

**Description**: Given the struct, this function says whether the bisector point satisfies the LL and Curvature constraint for a crv and a point pair and trims it to the minimum.

**See also**: MvarBsctTrimCrvPt, MvarBsctCrvPtLeft, MvarBsctCrvPtCurvature,

### 8.2.81 MvarBsctTrimCurveBetween (mvlowenv.c:122)

void MvarBsctTrimCurveBetween(MvarVoronoiCrvStruct *Cv,
MvarPtStruct *Pt1,
MvarPtStruct *Pt2,
MvarVoronoiCrvStruct **TrimmedCurve)

**Cv**: Given a MvarVoronoiCrvStruct Cv.
**Pt1**: A MvarPtStruct.
**Pt2**: A MvarPtStruct.
**TrimmedCurve**: A MvarVoronoiCrvStruct of the resultant.

**Returns**: void

**Description**: Splitting the Cv at the given points Pt1 and Pt2.

**See also**: MvarBsctComputeLowerEnvelope, MvarBsctMergeLowerEnvelopes, MvarBsctComputeLowerEnvelopeAux, MvarBsctComputeLowerEnvelopeOfOverlap,

### 8.2.82 MvarBsctTrimSurfaceByUVBbox (mvsplmon.c:367)

CagdSrfStruct *MvarBsctTrimSurfaceByUVBbox(CagdSrfStruct *Srf,
CagdBBoxStruct UVBbox)

**Srf**: Implicit surface definition.
**UVBbox**: Given box dimensions.

**Returns**: The trimmed surface

**Description**: Trims the given surface Srf using the given box dimensions. Uses CagdSrfRegionFromSrf twice.
8.2.83 MvarBspCrvInterpVecs (mvar_int.c:55)

CagdCrvStruct *MvarBspCrvInterpVecs(const MvarVecStruct *vecList,
                                     int Order,
                                     int CrvSize,
                                     CagdParametrizationType ParamType,
                                     CagdBType Periodic)

vecList: List of points to interpolate/least square approximate. All points are assumed of same dimension (not tested.).
Order: Of interpolating/approximating curve.
CrvSize: Number of degrees of freedom (control points) of the interpolating/approximating curve.
ParamType: Type of parametrization.
Periodic: Constructed curve should be Periodic. Periodic necessitates uniform knot sequence in ParamType.
Returns: Constructed interpolating/approximating curve.

Description: Given a set of points, vecList, computes a Bspline curve of order Order that interpolates or least square approximates the set of points. The size of the control polygon of the resulting Bspline curve defaults to the number of points in PtList (if CrvSize = 0). However, this number is can smaller to yield a least square approximation. The created curve can be parametrized as specified by ParamType.
See also: BspCrvInterpPts, BspCrvInterpolate, BspCrvInterpPts2,

8.2.84 MvarBspMVDerive (mvar_der.c:174)

MvarMVStruct *MvarBspMVDerive(const MvarMVStruct *MV, MvarMVDirType Dir)

MV: Multi-Variate to differentiate.
Dir: Direction of differentiation.

Description: Given a Bspline multi-variate, computes its partial derivative multi-variate in direction Dir. Let old control polygon be P(i), i = 0 to k-1, and Q(i) be new one. Then:

Q(i) = (k - 1) * (P(i+1) - P(i)) / (Kv(i + k) - Kv(i + 1)), i = 0 to k-2.

This function computes the derivative of a rational function component-wise with out taking into consideration the quotient rule.
See also: MvarMVDeriveBound, MvarBzrMVDerive, MvarMVDerive,

8.2.85 MvarBspMVDeriveAllBounds (mvar_der.c:594)

void MvarBspMVDeriveAllBounds(const MvarMVStruct *MV, IrtMinMaxType *MinMax)

MV: Multi-Variate to differentiate.
MinMax: Bounds on the derivative values of MV in all directions.
Returns: void

Description: Given a scalar B-spline multi-variate, computes bounds to its partial derivative in all directions. Let old control polygon be P(i), i = 0 to k-1, and Q(i) be new one. Then:

Q(i) = (k - 1) * (P(i+1) - P(i)) / (Kv(i + k) - Kv(i + 1)), i = 0 to k-2.

See also: MvarMVDerive, MvarBzrMVDeriveBound, MvarMVDeriveBound,
8.2.86  **MvarBspMVDeriveBound** (mvar\_der.c:415)

```c
void MvarBspMVDeriveBound(const MvarMVStruct *MV,
                             MvarMVDirType Dir,
                             CagdRType MinMax[2])
```

- **MV**: Multi-Variate to differentiate.
- **Dir**: Direction of differentiation.
- **MinMax**: Bounds on the derivative values of MV in direction Dir.
- **Returns**: void

**Description**: Given a scalar B-spline multi-variate, computes bounds to its partial derivative in direction Dir. Let old control polygon be P(i), i = 0 to k-1, and Q(i) be new one. Then:

\[ Q(i) = (k - 1) * (P(i+1) - P(i)) / (Kv(i + k) - Kv(i + 1)), i = 0 to k-2. \]

**See also**: MvarMVDerive, MvarBzrMVDeriveBound, MvarMVDeriveBound,

8.2.87  **MvarBspMVDeriveRational** (mvbspsym.c:209)

```c
MvarMVStruct *MvarBspMVDeriveRational(const MvarMVStruct *MV,
                                        MvarMVDirType Dir)
```

- **MV**: Rational Bspline multivariate to differentiate.
- **Dir**: Direction of Differentiation.
- **Returns**: Differentiated rational Bspline multivariate.

**Description**: Given a rational Bspline multivariate - computes its derivative surface in direction Dir, using the quotient rule for differentiation.

**See also**: MvarMVDerive, MvarBzrMVDerive, MvarBspMVDerive, MvarBzrMVDeriveRational,

8.2.88  **MvarBspMVDeriveScalar** (mvar\_der.c:280)

```c
MvarMVStruct *MvarBspMVDeriveScalar(const MvarMVStruct *MV, MvarMVDirType Dir)
```

- **MV**: To differentiate.
- **Dir**: Direction of differentiation. Either U or V.
- **Returns**: Differentiated multi-variate.

**Description**: Given a Bezier multi-variate, computes its partial derivative multi-variate in direction Dir. Let old control polygon be P(i), i = 0 to k-1, and Q(i) be new one. Then:

\[ Q(i) = (k - 1) * (P(i+1) - P(i)), i = 0 to k-2. \]

For a Euclidean surface this is the same as MvarBzrMVDerive but for a rational multivar the returned multivar is not the vector field but simply the derivatives of all the multivar's coefficients, including the weights.

**See also**: MvarMVDeriveBound, MvarMVDerive, MvarBspMVDerive, MvarBspMVDerive, MvarBzrMVDeriveScalar,

8.2.89  **MvarBspMVInteriorKnots** (mvar\_aux.c:1884)

```c
CagdBType MvarBspMVInteriorKnots(const MvarMVStruct *MV, CagdRType *Knot)
```

- **MV**: To check for interior knots.
- **Knot**: Where to return an interior knot if found one.
- **Returns**: -1 if MV has no interior knots, Axis of interior knot otherwise.

**Description**: Returns -1 if the given Bspline multivariate has no interior knots in no direction. Otherwise, return the direction that has an interior knot and returns the knot value in Knot.

**See also**: BspCrvHasOpenEC, MvarBspMVIsOpen, MvarBspMVIsOpenInDir, , MvarBspMVIsPeriodicInDir,
8.2.90  **MvarBspMVIsOpen** (mvar\_aux.c:1790)

CagdBType MvarBspMVIsOpen(const MvarMVStruct *MV)

    MV: To check for open end conditions.
    Returns: TRUE, if MV has open end conditions in all directions, FALSE otherwise.
    Description: Returns TRUE iff the given B-spline multivariate has open end conditions in all direction directions.
    See also: BspCrvHasOpenEC, MvarBspMVIsOpenInDir, MvarBspMVIsOpenInDir,

8.2.91  **MvarBspMVIsOpenInDir** (mvar\_aux.c:1761)

CagdBType MvarBspMVIsOpenInDir(const MvarMVStruct *MV, MvarMVDirType Dir)

    MV: To check for open end conditions.
    Dir: Direction to test for open end conditions.
    Returns: TRUE, if MV has open end conditions in Dir, FALSE otherwise.
    Description: Returns TRUE iff the given B-spline multivariate has open end conditions in the specified direction Dir.
    See also: BspCrvHasOpenEC, MvarBspMVIsOpen, MvarBspMVIsPeriodic, , MvarBspMVIsPeriodicInDir,

8.2.92  **MvarBspMVIsPeriodic** (mvar\_aux.c:1852)

CagdBType MvarBspMVIsPeriodic(const MvarMVStruct *MV)

    MV: To check for periodic end conditions.
    Returns: TRUE, if MV has periodic end conditions in some Dir, FALSE otherwise.
    Description: Returns TRUE iff the given Bspline multivariate has periodic end coditions in at least one direction.
    See also: BspCrvHasOpenEC, MvarBspMVIsOpen, MvarBspMVIsOpenInDir, , MvarBspMVIsPeriodicInDir,

8.2.93  **MvarBspMVIsPeriodicInDir** (mvar\_aux.c:1828)

CagdBType MvarBspMVIsPeriodicInDir(const MvarMVStruct *MV, MvarMVDirType Dir)

    MV: To check for periodic end conditions.
    Dir: Direction to test for periodic end conditions.
    Returns: TRUE, if MV has periodic end conditions in Dir, FALSE otherwise.
    Description: Returns TRUE iff the given B-spline multivariate has periodic end conditions in the specified direction Dir.
    See also: BspCrvHasOpenEC, MvarBspMVIsOpen, MvarBspMVIsOpenInDir, , MvarBspMVIsPeriodic,

8.2.94  **MvarBspMVKnotInsertNDiff** (mvar\_ref.c:87)

MvarMVStruct *MvarBspMVKnotInsertNDiff(const MvarMVStruct *MV,
                          MvarMVDirType Dir,
                          int Replace,
                          CagdRType *t,
                          int n)

    MV: Multi-variate to refine according to t in direction Dir.
    Dir: Direction of refinement. Either U or V or W.
Replace: If TRUE t is a knot vector exactly in the length of the knot vector in direction Dir in MV and t simply replaces that knot vector. If FALSE, the knot vector in direction Dir in MV is refined by adding all the knots in t.

t: Knot vector to refine/replace the knot vector of MV in direction Dir.
n: Length of vector t.


Description: Given a Bspline multi-variate, inserts n knots with different values as defined by t. If, however, Replace is TRUE, the knot are simply replacing the current knot vector in the prescribed direction.

8.2.95 MvarBspMVMult (mvbpsym.c:64)

MvarMVStruct *MvarBspMVMult(const MvarMVStruct *CMV1, const MvarMVStruct *CMV2)

CMV1, CMV2: The two multivariates to multiply.

Returns: The product MV1 * MV2 coordinatewise.

Description: Given two Bspline multivariates - multiply them coordinatewise. The two multivariates are promoted to same point type before multiplication can take place. See also BspMultComputationMethod.

8.2.96 MvarBspMVNew (mvar_gen.c:171)

MvarMVStruct *MvarBspMVNew(int Dim,
const int *Lengths,
const int *Orders,
MvarPointType PType)

Dim: Number of dimensions of this multivariate.

Lengths: Of control mesh in each of the dimensions. Vector of size Dim.

Orders: Of multi variate function in each of the dimensions.

PType: Type of control points (E2, P3, etc.).

Returns: An uninitialized freeform multi-variate Bspline.

Description: Allocates the memory required for a new Bspline multi-variate. See also: MvarMVFree, MvarBzrMVNew, MvarMVNew, MvarPwrMVNew,

8.2.97 MvarBspMVSubdivAtParam (mvar_sub.c:235)

MvarMVStruct *MvarBspMVSubdivAtParam(const MvarMVStruct *MV,
CagdRType t,
MvarMVDirType Dir)

MV: Bspline Multi-Variate to subdivide.
t: Parameter to subdivide at.

Dir: Direction of subdivision.

Returns: A list of two multi-variates, result of the subdivision.

Description: Given a Bspline multi-variate, subdivides it at parameter value t in direction Dir. See also: MvarMVSubdivAtParam, MvarBzrMVSubdivAtParam,
8.2.98 MvarBspMVSubdivAtParamOneSide (mvar_sub.c:645)

MvarMVStruct *MvarBspMVSubdivAtParamOneSide(const MvarMVStruct *MV,
CagdRType t,
MvarMVDdirType Dir,
IrtBType LeftSide)

MV: Bspline Multi-Variate to subdivide.
t: Parameter to subdivide at.
Dir: Direction of subdivision.
LeftSide: TRUE to only fetch left half, FALSE to fetch right half.

Returns: A list of two multi-variates, result of the subdivision.

Description: Given a Bspline multi-variate, subdivides it at parameter value t in direction Dir.
See also: MvarMVSubdivAtParam, MvarBzrMVSubdivAtParam,

8.2.99 MvarBspMultComputationMethod (mvbspsym.c:39)

int MvarBspMultComputationMethod(int BspMultUsingInter)

BspMultUsingInter: If TRUE, Bspline product is computed by setting an interpolation problem. Otherwise, by decomposing the Bspline geometry to Bezier geometry.

Returns: Previous setting.

Description: Sets method of Bspline product computation.

8.2.100 MvarBspSrfSelfInterDiagFactor (selfintr.c:1799)

MvarPolylineStruct *MvarBspSrfSelfInterDiagFactor(const CagdSrfStruct *Srf,
CagdRType SubdivTol,
CagdRType NumericTol)

Srf: The surface to derive its self intersections.
SubdivTol: Tolerance of the first zero set finding subdivision stage.
NumericTol: Tolerance of the second zero set finding numeric stage.

Returns: List of self intersection pllns, as (u, v) parameter pairs into the surfaces’ domain. Points in \( \mathbb{R}^4 \).

Description: Given a B-spline surface, S, compute its self intersections, if any, by dividing it at all internal knots and examining all patches against all other patches. Diagonal patches should also be examined against themselves with the aid of MvarBzrSrfSelfInterDiagFactor. Adjacent patches are sharing an edge (a curve) and hence spacial care is taken in those cases to eliminate and ignore that shared curve, in MvarAdjacentSrfSrfInter.
See also: MvarAdjacentSrfSrfInter, MvarBzrSrfSelfInterDiagFactor,

8.2.101 MvarBuildParamMV (mvar_gen.c:268)

MvarMVStruct *MvarBuildParamMV(int Dim, int Dir, CagdRType Min, CagdRType Max)

Dim: Number of dimensions of the MV parameter function.
Dir: Direction of this parameter (between 0 and Dim-1).
Min, Max: The range of this parameter.

Returns: Constructed parameter MV function.

Description: Construct an MV that serves as a parameter function in direction Dir.
See also:
8.2.102 MvarBzrLinearInOneDir (mvar_aux.c:1923)

MvarMVStruct *MvarBzrLinearInOneDir(int Dim, int Dir, MvarPointType PType)

Dim: Dimension of the sought multivariate Bezier.
Dir: The direction that is to be linear, between 0 and Dim-1.
PType: Type of points of this new multivariate.
Returns: The constructed multivariate.
Description: Creates a Bezier multivariate that is constant in all directions but one.
See also:

8.2.103 MvarBzrMVDerive (mvar_der.c:70)

MvarMVStruct *MvarBzrMVDerive(const MvarMVStruct *MV, MvarMVDirType Dir)

MV: Multi-Variate to differentiate.
Dir: Direction of differentiation.
Returns: Differentiated multivariate in direction Dir. A Bezier multi-variate.
Description: Given a Bezier multi-variate, computes its partial derivative multi-variate in direction Dir. Let old control polygon be P(i), i = 0 to k-1, and Q(i) be new one. Then:
Q(i) = (k - 1) * (P(i+1) - P(i)), i = 0 to k-2.
See also: MvarMVDeriveBound, MvarMVDerive, MvarBspMVDerive, MvarBzrMVDeriveScalar,

8.2.104 MvarBzrMVDeriveAllBounds (mvar_der.c:527)

void MvarBzrMVDeriveAllBounds(const MvarMVStruct *MV, CagdMinMaxType *MinMax)

MV: Multi-Variate to differentiate.
MinMax: Bounds on the derivative values of MV in all directions.
Returns: void
Description: Given a scalar Bezier multi-variate, computes bounds to its partial derivative in all directions. Let old control polygon be P(i), i = 0 to k-1, and Q(i) be new one. Then:
Q(i) = (k - 1) * (P(i+1) - P(i)), i = 0 to k-2.
See also: MvarMVDerive, MvarMVDeriveBound, MvarBspMVDeriveBound,

8.2.105 MvarBzrMVDeriveBound (mvar_der.c:352)

void MvarBzrMVDeriveBound(const MvarMVStruct *MV,
                          MvarMVDirType Dir,
                          CagdRType MinMax[2])

MV: Multi-Variate to differentiate.
Dir: Direction of differentiation.
MinMax: Bounds on the derivative values of MV in direction Dir.
Returns: void
Description: Given a scalar Bezier multi-variate, computes bounds to its partial derivative in direction Dir. Let old control polygon be P(i), i = 0 to k-1, and Q(i) be new one. Then:
Q(i) = (k - 1) * (P(i+1) - P(i)), i = 0 to k-2.
See also: MvarMVDerive, MvarMVDeriveBound, MvarBspMVDeriveBound,
8.2.106 MvarBzrMVDeriveRational (mvbzsrmv.c:241)

MvarMVStruct *MvarBzrMVDeriveRational(const MvarMVStruct *MV, MvarMVDirType Dir)

MV: Rational Bezier multivariate to differentiate.
Dir: Direction of Differentiation.

Returns: Differentiated rational Bezier multivariate.

Description: Given a rational Bezier multivariate - computes its derivative surface in direction Dir, using the quotient rule for differentiation.

See also: MvarMVDerive, MvarBzrMVDerive, MvarBzrMVDerive, MvarBzrMVDeriveRational,

8.2.107 MvarBzrMVDeriveScalar (mvar_der.c:137)

MvarMVStruct *MvarBzrMVDeriveScalar(const MvarMVStruct *MV, MvarMVDirType Dir)

MV: To differentiate.
Dir: Direction of differentiation. Either U or V.

Returns: Differentiated multi-variate.

Description: Given a Bezier multi-variate, computes its partial derivative multi-variate in direction Dir. Let old control polygon be P(i), i = 0 to k-1, and Q(i) be new one. Then:

Q(i) = (k - 1) * (P(i+1) - P(i)), i = 0 to k-2.

For a Euclidean surface this is the same as MvarBzrMVDerive but for a rational multivar the returned multivar is not the vector field but simply the derivatives of all the multivar's coefficients, including the weights.

See also: MvarMVDeriveBound, MvarMVDerive, MvarBspMVDerive, MvarBzrMVDerive, MvarBspMVDeriveScalar,

8.2.108 MvarBzrMVMult (mvbzsrmv.c:32)

MvarMVStruct *MvarBzrMVMult(const MvarMVStruct *MV1, const MvarMVStruct *MV2)

MV1, MV2: The two multivariates to multiply.

Returns: The product MV1 * MV2 coordinatewise.

Description: Given two Bezier multivariates - multiply them coordinatewise. The two multivariates are promoted to same point type before multiplication can take place. See also BzrMultInterpFlag.

8.2.109 MvarBzrMVNew (mvar_gen.c:212)

MvarMVStruct *MvarBzrMVNew(int Dim, const int *Lengths, MvarPointType PType)

Dim: Number of dimensions of this multivariate.
Lengths: Of control mesh in each of the dimensions. Vector of size Dim.
PType: Type of control points (E2, P3, etc.).

Returns: An uninitialized freeform multi-variate Bezier.

Description: Allocates the memory required for a new Bezier multi-variate.

See also: MvarMVFree, MvarMVNew, MvarBspMVNew, MvarPwrMVNew,
8.2.110 MvarBzrMVRegionFromMV (mvar_aux.c:743)

MvarMVStruct *MvarBzrMVRegionFromMV(const MvarMVStruct *MV,
CagdRType t1,
CagdRType t2,
MvarMVDirType Dir)

MV: The bezier multivariate, values of which are required over a domain other than [0,1].
t1: The required min’ domain.
t2: The required max’ domain.
Dir: The direction to extract the domain.

Returns: The new MV with the required new domain.

Description: Changing the domain of a multivariate, in direction Dir, such that: The values of the output multivariate over [0,1] in direction Dir, are those of the input multivariate over [NewMinDmn,NewMaxDmn]. If required, the user of this function should map back point x from [0,1] to [NewMinDmn,NewMaxDmn] by the affine domain change: y[dir] = (1 - x[dir]) * NewMinDmn + x[dir] * NewMaxDmn. NOTE: when the new domain is always known to be contained in the old domain, if possible use MvarMVRegionFromMV, which suits B-splines as well and supports the same operation. This function is made for cases where a new region is not contained in [0,1].

See also: MvarMVRegionFromMV, MvarMVExtension,

8.2.111 MvarBzrMVSubdivAtParam (mvar_sub.c:181)

MvarMVStruct *MvarBzrMVSubdivAtParam(const MvarMVStruct *MV,
CagdRType t,
MvarMVDirType Dir)

MV: Bezier Multi-Variate to subdivide.
t: Parameter to subdivide at.
Dir: Direction of subdivision.

Returns: A list of two multi-variates, result of the subdivision.

Description: Given a Bezier multi-variate, subdivides it at parameter value t in direction Dir.

See also: MvarBspMVSubdivAtParam, MvarMVSubdivAtParam,

8.2.112 MvarBzrMVSubdivAtParamOneSide (mvar_sub.c:581)

MvarMVStruct *MvarBzrMVSubdivAtParamOneSide(const MvarMVStruct *MV,
CagdRType t,
MvarMVDirType Dir,
IrtBType LeftSide)

MV: Bezier Multi-Variate to subdivide.
t: Parameter to subdivide at.
Dir: Direction of subdivision.
LeftSide: TRUE to only fetch left half, FALSE to fetch right half.

Returns: A list of two multi-variates, result of the subdivision.

Description: Given a Bezier multi-variate, subdivides it at parameter value t in direction Dir.

See also: MvarBspMVSubdivAtParamOneSide, MvarMVSubdivAtParam,
8.2.113  MvarBzrSelfInter4VarDecomp
(selfintr.c:1193)

void MvarBzrSelfInter4VarDecomp(const CagdSrfStruct *Srf,
                                MvarMVStruct **U1MinusU3Factor,
                                MvarMVStruct **U2MinusU4Factor)

Srf: The 2-variate to subtract against itself and decompose.
U1MinusU3Factor: The G function above.
U2MinusU4Factor: The H function above.

Returns: void

Description: Given a 2-variate Bezier function, Srf, that is to be subtracted from itself as,
F(u1, u2, u3, u4) = Srf(u1, u2) - Srf(u3, u4),
computes a decomposition for F as
F(u1, u2, u3, u4) = (u1 - u3) G(u1, u2, u3, u4) +
                   (u2 - u4) H(u1, u2, u3, u4),
that is known to always exist.

See also:

8.2.114  MvarBzrSrfSelfInterDiagFactor
(selfintr.c:1418)

MvarPolylineStruct *MvarBzrSrfSelfInterDiagFactor(const CagdSrfStruct *Srf,
                                                  CagdRType SubdivTol,
                                                  CagdRType NumericTol)

Srf: The surface to derive its self intersections.
SubdivTol: Tolerance of the first zero set finding subdivision stage.
NumericTol: Tolerance of the second zero set finding numeric stage.

Returns: List of self intersection pllns, as (u, v) parameter pairs into the surfaces’ domain. Points in R^4.

Description: Given a Bezier surface, S, compute its self intersections, if any, by computing a (u1 - u3) G(u1, u2, u3, u4) + (u2 - u4) H(u1, u2, u3, u4) decomposition for the 4-variate function of S(u1, u2)-S(u3, u4). The self intersection is then derived as the solution of:
Gx Hy - Gy Hx = 0,
Gx Hz - Gz Hx = 0,
(u1 - u3) Gx + (u2 - u4) Hx = 0.
The first two equations ensure the G an H are parallel while the last guarantee a zero point in X (which is therefore a zero point in Y an Z.) Due to singularities in these equations, all six equations of the form:
Gx Hy - Gy Hx = 0,
Gx Hz - Gz Hx = 0,
Gy Hz - Gz Hy = 0,
(u1 - u3) Gx + (u2 - u4) Hx = 0,
(u1 - u3) Gy + (u2 - u4) Hy = 0,
(u1 - u3) Gz + (u2 - u4) Hz = 0,
are employed during the subdivision stage. Finally a 7th equations of the form "|| S - S ||^2 = 0 is added for faster pruning of far regions.

See also: MvarBzrSelfInter4VarDecomp,

8.2.115  MvarCalculateExtremePoints
(mvarjimp.c:291)

MvarPtStruct *MvarCalculateExtremePoints(const MvarMVStruct *MV)

MV: Input scalar function, represented as a multivariate, to compute parametric locations of extreme values.

Returns: List of extreme multivariate points candidates returns NULL in case of invalid input.

Description: Calculates list of extreme points of a given scalar function. Supports up to dimension 3 (i.e. trivariates). Note that the result, the returned list of parametric locations, is a super set of the extreme values MV can assume as we decompose MV into low dimensional entities (i.e. boundary surfaces and curves) and an extrema in a lower diemnsional entities does not mean it is an extreme in MV.
8.2.116  MvarCalculateTVJacobian (mvarjimp.c:621)

MvarMVStruct *MvarCalculateTVJacobian(const TrivTVStruct *TV)

TV: The input trivariate.
Returns: The Jacobian in a multi variate representation.
Description: Calculates the Jacobian of a given trivariate.
See also: Symb2DSrfJacobian, MvarTrivJacobianImprove, MvarCalculateExtremePoints,

8.2.117  MvarCircTanTo2Crvs (mvtangnt.c:399)

MvarPtStruct *MvarCircTanTo2Crvs(const CagdCrvStruct *Crv1,
                                   const CagdCrvStruct *Crv2,
                                   CagdRType Radius,
                                   CagdRType Tol)

Crv1, Crv2: The two curves to find the circles that is tangent to both.
Radius: Of all the circle(s) that is tangent to Crv1/2.
Returns: List of the 4-tuples as (t, r, x, y).
Description: Computes all circles of prescribed radius that are tangent to given two curves. Solves for circles’ centers P(x, y), using the following four equations in four unknowns (t, r, x, y), and R is the desired circle radius:

||C1(t) - P||^2 = R^2,
||C2(r) - P||^2 = R^2,
< C1(t) - P, C1'(t) > = 0,
< C2(t) - P, C2'(t) > = 0.

See also: SymbCircTanTo2Crvs, MvarCircTanTo3Crvs,

8.2.118  MvarCircTanTo3Crvs (mvtangnt.c:529)

MvarPtStruct *MvarCircTanTo3Crvs(const CagdCrvStruct *Crv1,
                                   const CagdCrvStruct *Crv2,
                                   const CagdCrvStruct *Crv3,
                                   CagdRType SubdivTol,
                                   CagdRType NumericTol,
                                   CagdBType OneSideOrientation)

Crv1, Crv2, Crv3: The two curves to find the circles that is tangent to both.
SubdivTol: Tolerance of the subdivision process. Tolerance is measured in the parametric space of the multi-
variables.
NumericTol: Numeric tolerance of the numeric stage. The numeric stage is employed only if NumericTol <
SubdivTol.
OneSideOrientation: TRUE to compute tri-tangencies on one side of the curves only.
Returns: List of (u, v, w) solution points.
Description: Computes all circles that are tangent to given three curves. Solves for circles’ centers P(x, y),
using the following process: Solve, symbolically for P in the following 2x2 system by Cremmer rule:

||C1(u) - P||^2 = ||C2(v) - P||^2,
||C1(u) - P||^2 = ||C3(w) - P||^2,
and substitute P into the following 3 equations and solve 3 equations in (u, v, w):

< C1(u) - P, C1'(u) > = 0,
< C2(v) - P, C2'(v) > = 0,
< C3(w) - P, C2'(w) > = 0.

See also: MvarCircTanTo2Crvs,
8.2.119  MvarCntctTangentialCrvCrvC1 (contacts.c:42)

MvarPtStruct *MvarCntctTangentialCrvCrvC1(const CagdCrvStruct *Crv1,  
const CagdCrvStruct *Crv2,  
CagdRType Epsilon)

Crv1, Crv2: The two curves to solve for their antipodal locations.  
Epsilon: Tolerance of computation.  
Returns: List of pairs of parameters in the r & t coefficients.  
Description: Computes tangential contact points of the given two curves by solving for Ci(t) = (xi(t), yi(t)), i = 1, 2:

\[ x_1(t) - x_2(r) = 0, \]
\[ y_1(t) - y_2(r) = 0, \]
\[ < C_1(t) - C_2O(r), C_1'(t) > = 0, \]
\[ < C_1(t) - C_2O(r), C_2'(r) > = 0, \]

where C2O is an offset curve of C2 by amount larger than subdivision tol.  
See also: MvarCrvAntipodalPoints,

8.2.120  MvarCnvrtBsp2BzrMV (mvar_gen.c:1555)

MvarMVStruct *MvarCnvrtBsp2BzrMV(const MvarMVStruct *MV)

MV: A Bspline multi-variate to convert to Bezier MVs.  
Returns: A list of Bezier multi-variate representing the same geometry as the given Bspline MV.  
Description: Converts a Bspline multi-variate into a Bezier multi-variate by splitting at all interior knots.

8.2.121  MvarCnvrtBzr2BspMV (mvar_gen.c:1516)

MvarMVStruct *MvarCnvrtBzr2BspMV(const MvarMVStruct *MV)

MV: A Bezier multi-variate to convert to a Bspline MV.  
Returns: A Bspline multi-variate representing the same geometry as the given Bezier MV.  
Description: Converts a Bezier multi-variate into a Bspline multi-variate by adding two open end uniform knot vectors to it.

8.2.122  MvarCnvrtBzr2PwrMV (mvbzrpwr.c:62)

MvarMVStruct *MvarCnvrtBzr2PwrMV(const MvarMVStruct *MV)

MV: To convert into Power basis function representation.  
Returns: Same geometry, but in the Power basis.  
Description: Converts the given multivariate from Bezier basis functions to a Power basis functions. Using:

\[ B(t) = \frac{\sum_{i=p}^{n} \binom{n}{p} (-1)^{p-i} t^p}{\binom{n}{p} t^{p+i}} \]

or
This routine simply take the weight of each product of \( m \) Bezier basis functions \( B_0(u_0)... B_m(u_0) \) and spread it into the different power basis \( u_0^{p_0}... u_m^{p_m} \) functions scaled by:

\[
\begin{array}{cccccccccc}
p_{0-i_0} & n_0 & p_0 & pm-im & nm & pm & p_0 & pm \\
(-1) & ( & ) & ... & (-1) & ( & ) \\
p_0 & i_0 & pm & im
\end{array}
\]

See also: `MvarCnvrtPwr2BzrMV`, `CagdCnvrtBzr2PwrSrf`, `CagdCnvrtPwr2BzrSrf`,

### 8.2.123 MvarCnvrtFloat2OpenMV (mvar_aux.c:1708)

```c
MvarMVStruct *MvarCnvrtFloat2OpenMV(const MvarMVStruct *MV)
```

**MV**: B-spline multivariate to convert to open end conditions.

**Returns**: A Bspline multivariate with open end conditions, representing the same geometry as MV.

**Description**: Converts a float B-spline multivariate to a B-spline multivariate with open end conditions.

See also: `MvarCnvrtPeriodic2FloatMV`, `CnvrtFloat2OpenMV`,

### 8.2.124 MvarCnvrtMVPolysToCtlPts (mvar_pll.c:771)

```c
struct IObjectStruct *MvarCnvrtMVPolysToCtlPts(const MvarPolylineStruct *MVPlls)
```

**MVPlls**: MV polylines to convert to MV points.

**Returns**: MV control points.

**Description**: Converts a list of MV polylines to a list of MV control points.

See also: `MvarCnvrtMVPtsToCtlPts`, `MvarCnvrtMVPolysToIritPolys`,

### 8.2.125 MvarCnvrtMVPolysToIritCrvs (mvar_pll.c:952)

```c
CagdCrvStruct *MvarCnvrtMVPolysToIritCrvs(const MvarPolylineStruct *MVPlls, int Order)
```

**MVPlls**: List of multivariate polylines to convert to Irit polylines.

**Order**: Order of constructed curves, typically 2 (linear).

**Returns**: A list of curves.

**Description**: Converts a list of mvar polylines into a list of irit curves. Assumes all points of same dimensions.

See also: `MvarCnvrtMVPtsToCtlPts`, `MvarCnvrtMVPolysToIritPolys2`,

8.2.126 MvarCnvrtMVPolysToIritPolys (mvar_pll.c:807)

IPObjectStruct *MvarCnvrtMVPolysToIritPolys(const MvarPolylineStruct *MVPlls)

MVPlls: List of multivariate polylines to convert to Irit polylines.
Returns: A list object of polylines (as lists of ctlpts).
Description: Converts a list of mvar polylines into a list of irit polylines. Assumes all points of same dimensions.
See also: MvarCnvrtMVPtsToCtlPts, MvarCnvrtMVPtsToPolys2, MvarCnvrtMVPtsToPolys, MvarCnvrtMVPolysToIritCrvs,

8.2.127 MvarCnvrtMVPolysToIritPolys2 (mvar_pll.c:869)

IPObjectStruct *MvarCnvrtMVPolysToIritPolys2(const MvarPolylineStruct *MVPlls, int IgnoreIndividualPts)

MVPlls: List of multivariate polylines to convert to Irit polylines.
IgnoreIndividualPts: True to handle only polylines, ignoring points.
Returns: A polylines object, or if have individual points a list of two objects, as (PllnObjs, PntObjs).
Description: Converts a list of mvar polylines into a list of irit polylines. Assumes all points of same dimensions.
See also: MvarCnvrtMVPtsToCtlPts, MvarCnvrtMVPtsToPolys2, MvarCnvrtMVPtsToPolys, MvarCnvrtMVPolysToIritCrvs,

8.2.128 MvarCnvrtMVPolysToMVPts (mvar_pll.c:740)

MvarPtStruct *MvarCnvrtMVPolysToMVPts(const MvarPolylineStruct *MVPlls)

MVPlls: MV polylines to convert to MV points.
Returns: MV points.
Description: Converts a list of MV polylines to a list of MV points.
See also: MvarCnvrtMVPolysToIritPolys,

8.2.129 MvarCnvrtMVPtsToCtlPts (mvar_pll.c:466)

IPObjectStruct *MvarCnvrtMVPtsToCtlPts(const MvarPtStruct *MVPts, IrtRType MergeTol)

MVPts: List of multivariate points to convert to list of ctlpts.
MergeTol: If non negative, attempt to merge the data into polylines.
Returns: A list object of ctlpts.
Description: Converts a list of multivariate points into a list of control points. Assumes all points of same dimensions.
See also: MvarCnvrtMVPtsToPolys, MvarCnvrtMVPtsToPnts,

8.2.130 MvarCnvrtMVPtsToPolys (mvar_pll.c:534)

IPObjectStruct *MvarCnvrtMVPtsToPolys(const MvarPtStruct *MVPts, const MvarMVStruct *MV, IrtRType MergeTol)

MVPts: List of multivariate points to convert to polylines.
MV: A multivariate to evaluate through, if not NULL.
MergeTol: Tolerance to merge points into polylines.
Returns: A list object of polylines.
Description: Converts a list of multivariate points into a list of polylines. Assumes all points of same dimensions.
See also: MvarCnvrtMVPtsToCtlPts, MvarCnvrtMVPtsToPolys2,
8.2.131 MvarCnvrtMVPtsToPolys2 (mvar_pll.c:604)

IPPolygonStruct *MvarCnvrtMVPtsToPolys2(const MvarPtStruct *InPts,
                                         CagdRType FineNess,
                                         int Dim,
                                         IrtRType *ParamDomain)

InPts: A list of discrete points.
FineNess: Tolerance.
Dim: The dimension of discrete points, 1 to 3.
ParamDomain: The domain of the mvar points.
Returns: Connected list of polylines.

Description: Connect a list of discrete points into a polylines.
See also: MvarCnvrtMVPtsToCtlPts, MvarCnvrtMVPtsToPolys,

8.2.132 MvarCnvrtMVPtsToPts (mvar_pll.c:431)

CagdPtStruct *MvarCnvrtMVPtsToPts(const MvarPtStruct *MVPts)

MVPts: List of multivariate points to convert to list of =points.
Returns: A list of points.

Description: Converts a list of multivariate points into a list of cagd E3 points. Assumes all input points are E1, E2, or E3.
See also: MvarCnvrtMVPtsToCtlPts, MvarCnvrtMVPtsToPolys,

8.2.133 MvarCnvrtMVTrsToIritPolygons (mvar_pll.c:1042)

IPObjectStruct *MvarCnvrtMVTrsToIritPolygons(const MvarTriangleStruct *MVTrs,
                                                int *Coords)

MVTrs: List of multivariate triangles to convert to Irit polygons.
Coords: The required coordinates, or NULL if the dimension is three.
Returns: A list object of polygons.

Description: Converts a list of mvar triangles into a list of irit polygons. If the list of triangles consists of points of dimension higher than three, the polygons list is created as the projection on R^3, using the coordinates specified in Coords. Assumes all points of same dimensions.
See also: MvarIrit2DTrTo2DMVTrs, MvarCnvrtMVPolysToIritPoly,

8.2.134 MvarCnvrtPeriodic2FloatMV (mvar_aux.c:1633)

MvarMVStruct *MvarCnvrtPeriodic2FloatMV(const MvarMVStruct *MV)

MV: B-spline multivariate to convert to floating end conditions. Assume MV is either periodic or has floating end condition.

Returns: A Bspline multivariate with floating end conditions, representing the same geometry as MV.

Description: Converts a B-spline multivariate into a B-spline multivariate with floating end conditions.
See also: CnvrtPeriodic2FloatMV, MvarCnvrtFloat2OpenMV,
8.2.135 MvarCnvrtPwr2BzrMV (mvbzrpwr.c:163)

MvarMVStruct *MvarCnvrtPwr2BzrMV(const MvarMVStruct *MV)

MV: To convert into Bezier basis function representation.

Returns: Same geometry, but in the Bezier basis.

Description: Converts the given multivariate from Power basis functions to Bezier basis functions. Using:

\[
\begin{align*}
\begin{vmatrix}
\begin{array}{cccc}
  n_0 & n_m & i_0 & i_m \\
p_0 & p_m & \cdots & \cdots \\
\end{array}
\end{vmatrix}
\end{align*}
\]

\[
\begin{align*}
\begin{vmatrix}
\begin{array}{cccc}
  u_0 & \cdots & u_m \\
  p_0 & p_m \\
\end{array}
\end{vmatrix} = \frac{1}{\begin{vmatrix}
\begin{array}{cccc}
  n_0 & n_m & i_0 & i_m \\
p_0 & p_m & \cdots & \cdots \\
\end{array}
\end{vmatrix}} \begin{vmatrix}
\begin{array}{cccc}
  n_0 & n_m \\
i_0 & i_m \\
\end{array}
\end{vmatrix} \begin{vmatrix}
\begin{array}{cccc}
  u_0 & \cdots & u_m \\
p_0 & p_m \\
\end{array}
\end{vmatrix}
\end{align*}
\]

This routine simply take the weight of each product of m power basis functions \(u_0^p_0 \cdots u_m^p_m\) and spread it into the different Bezier basis \(B_0(u_0)\) through \(B_m(u_0)\) functions scaled by:

\[
\begin{align*}
\begin{vmatrix}
\begin{array}{cccc}
  i_0 & i_m \\
  p_0 & p_m \\
\end{array}
\end{vmatrix}
\end{align*}
\]

See also: MvarCnvrtBzr2PwrMV, CagdCnvrtBzr2PwrMV, MvarCnvrtPwr2BzrMV,

8.2.136 MvarCoerceMVTo (mvarcoer.c:52)

MvarMVStruct *MvarCoerceMVTo(const MvarMVStruct *MV, MvarPointType PType)

MV: To coerce to a new point type PType.

PType: New point type for MV.

Returns: A new multi-variate with PType as its point type.

Description: Coerces a multi-variate to point type PType.

8.2.137 MvarCoerceMVsTo (mvarcoer.c:25)

MvarMVStruct *MvarCoerceMVsTo(const MvarMVStruct *MV, MvarPointType PType)

MV: To coerce to a new point type PType.

PType: New point type for MV.

Returns: New multivariates with PType as their point type.

Description: Coerces a list of multivariates to point type PType.
8.2.138  **MvarComputeInterMidPoint** (mvtrmbis.c:364)

```c
CagdRType *MvarComputeInterMidPoint(CagdCrvStruct *Crv1,
        CagdRType t1,
        CagdCrvStruct *Crv2,
        CagdRType t2)
```

- **Crv1**: First curve of the matching mid point.
- **t1**: Parameter value of first curve’s mid point.
- **Crv2**: Second curve of the matching mid point.
- **t2**: Parameter value of second curve’s mid point.
- **Returns**: Point of intersection, statically allocated.

**Description**: Computes the intersection point of the normals of the given two points on the given two curves. Taken from crvskel.c - need to modify to avoid artifacts in near parallel normals.

8.2.139  **MvarComputeRayTraps** (ray-trap.c:75)

```c
MvarPtStruct *MvarComputeRayTraps(const CagdCrvStruct *Crvs,
        int Orient,
        CagdRType SubdivTol,
        CagdRType NumerTol,
        CagdBType UseExprTree)
```

- **Crvs**: List of curves to handle in order (cyclically).
- **Orient**: Pick the proper orientation with respect to the normal if TRUE. May be faster at times.
- **SubdivTol**: Tolerance of the solution. This tolerance is measured in the parametric space of the curves.
- **NumerTol**: Numeric tolerance of a possible numeric improvement stage. The numeric stage is employed if NumerTol < SubdivTol.
- **UseExprTree**: TRUE to use expression trees in the computation, FALSE to use regular multivariate expressions.
- **Returns**: Linked list of solutions, each holding the parameter values of the different Crvs.

**Description**: Computes solutions to locations on the given curves that would bounce rays from one curve to the next in a closed loop.

8.2.140  **MvarComputeRayTraps3D** (raytrp3d.c:79)

```c
MvarPtStruct *MvarComputeRayTraps3D(const CagdSrfStruct *Srfs,
        int Orient,
        CagdRType SubdivTol,
        CagdRType NumerTol,
        CagdBType UseExprTree)
```

- **Srfs**: List of surfaces to handle in order (cyclically).
- **Orient**: Pick the proper orientation with respect to the normal if TRUE. May be faster at times.
- **SubdivTol**: Tolerance of the solution. This tolerance is measured in the parametric space of the surfaces.
- **NumerTol**: Numeric tolerance of a possible numeric improvement stage. The numeric stage is employed if NumerTol < SubdivTol.
- **UseExprTree**: TRUE to use expression trees in the computation, FALSE to use regular multivariate expressions.
- **Returns**: Linked list of solutions, each holding the parameter values of the different Srfs.

**Description**: Computes solutions to locations on the given surfaces that would bounce rays from one surface to the next in a closed loop.
8.2.141  MvarComputeVoronoiCell (mvvorcel.c:145)

IPObjectStruct *MvarComputeVoronoiCell(CagdCrvStruct *Crv)

Crv: List of curves to compute the Voronoi cell.
Returns: Returns the Voronoi cell.

Description: Computes the Voronoi cell of the first curve in the given list of curves. For the details of the algorithm, see the following paper.
Precise Voronoi Cell Extraction of Free-form Rational Planar Closed Curves. Iddo Hanniel, Ramanathan Muthuganapathy, Gershon Elber, Myung-So Kim ACM Symposium on Solid and Physical Modeling, 2005. The following are the files used for computing the Voronoi cell mvvorcel.c - Main function that call other function. It takes the input curves, process them for discontinuities and calls other functions. Displaying the output is also done in this function. mvsplmon.c - The function that creates monotone segments. mvbiscon.c - The monotone segments obtained from mvsplmon.c are then subjected to orientation and curvature constraint functions written in this file. mvtrmbis.c - Auxillary functions required for trimming are written here. mvtrmpcr.c - This file does the trimming of point/crv bisector. mvlowenv.c - Functions in this file compute the lower envelope. mvvorcrv.c - Operations on the MvarVoronoiCrvStruct are available in this file. Dependency of each of the above file is depicted in the following diagram:

```
vorcel, vorcrv
\         /  
---        ---
\        /   
1  2  3  4 
\      /    
1  2    3  4 
splmon  biscon  trmpcr  lowenv
\    /     
1      3 
\   /      
|         |
|         |
|         |
trmbis
```

8.2.142  MvarConesOverlapAux (mvcones.c:1557)

CagdBType MvarConesOverlapAux(const MvarNormalConeStruct *ConesList)

ConesList: Cones in a list.
Returns: TRUE if overlap, FALSE if not.

Description: Computes the tangency anti-cones of the set of normal cones, and returns whether they overlap or not.

8.2.143  MvarCrv2DMAT (mv_mat2d.c:74)

CagdCrvStruct *MvarCrv2DMAT(const CagdCrvStruct *OCrv,
CagdRTType SubdivTol,
CagdRTType NumericTol,
CagdBType InvertOrientation)

OCrv: B-spline curve to compute its 2D planar MAT.
SubdivTol: Tolerance of the subdivision process. Tolerance is measured in the parametric space of the multi-variates.
NumericTol: Numeric tolerance of the numeric stage. The numeric stage is employed only if NumericTol < SubdivTol.
InvertOrientation: Flip what is considered inside and outside.
Returns: The MAT as a list of curves.

Description: Computes the (inside) 2D MAT (medial axis transform) of a given closed planar self-intersection-free oriented B-spline curve.
8.2.144 MvarCrvAntipodalPoints (selfintr.c:343)

MvarPtStruct *MvarCrvAntipodalPoints(const CagdCrvStruct *CCrv,
                                      CagdRType SubdivTol,
                                      CagdRType NumericTol)

  CCrv: To detect its antipodal points.
  SubdivTol: Tolerance of the solution. This tolerance is measured in the parametric space of the surfaces.
  NumericTol: Numeric tolerance of a possible numeric improvement stage. The numeric stage is employed if
               NumericTol < SubdivTol.

  Returns: Antipodal points, as points in E2 (r, t).

  Description: Computes antipodal points in the given curve - pairs of points C(t) and C(r) such that (t and r
               are two independent parameters of same curve):
               
               \[ \langle C(t) - C(r), \frac{dC(t)}{dt} \rangle = 0, \]
               \[ \langle C(t) - C(r), \frac{dC(r)}{dr} \rangle = 0. \]

  Direct attempt to solve this set of constraints is bound to be slow as all points in Crv satisfy these equations when t
  == r. The key is in adding a third inequality constraint of the form
               \[ \langle C'(t), C'(r) \rangle < 0. \]

  Antipodal points must exists if Crv self intersect in a closed loop and hence can help in detecting self-intersections.
  Further, the diameter of Crv could be easily deduced from the antipodal points. Note this function also captures the
  self-intersection locations C(t) = C(r), for which the dot product of the tangents is negative.

  See also: MVarCrvDiameter, SymbCrvDiameter, MvarSrfAntipodalPoints, , MvarHFDistAntipodalCrvCrvC1,

8.2.145 MvarCrvCrvBisector2D (mvbisect.c:1282)

CagdCrvStruct *MvarCrvCrvBisector2D(CagdCrvStruct *Crv1,
                                      CagdCrvStruct *Crv2,
                                      CagdRType Step,
                                      CagdRType SubdivTol,
                                      CagdRType NumericTol,
                                      CagdRType *BBoxMin,
                                      CagdRType *BBoxMax,
                                      CagdBType SupportPrms)

  Crv1, Crv2: Planar curves to compute their bisector.
  Step: Stepsize for curve tracing.
  SubdivTol: The subdivision tolerance to use.
  NumericTol: The numerical tolerance to use.
  BBoxMin, BBoxMax: The bounding box, where the bisector is computed.
  SupportPrms: TRUE to return a curve in E4 as (X, Y, y1, t2), FALSE to return a curve in E2 as (X, Y).

  Returns: A (list of) piecewise linear curves that approximates the bisector curve, or NULL if none.

  Description: Computes a bisector curve of two planar curves. Curves are assumed to to lie in z = 0 plane. The
               bisector curve is computed inside BBox.

8.2.146 MvarCrvCrvBisector2DCreateMVs (mvbisect.c:1179)

static MvarMVStruct **MvarCrvCrvBisector2DCreateMVs(CagdCrvStruct *Crv1,
                                                     CagdCrvStruct *Crv2,
                                                     CagdRType *BBoxMin,
                                                     CagdRType *BBoxMax)

  Crv1, Crv2: Planar curves to compute their bisector.
  BBoxMin, BBoxMax: The bounding box, where the bisector is computed.

  Returns: The multivar system, its solution is desired bisector curve.

  Description: Creates a polyn. system for computation of a bisector curve of two parametric curves Crv1, Crv2.
               The bisector (a locus of all centers of bitangential circles) is considered to lie inside planar rectangle BBox.
8.2.147 MvarCrvCrvInter (mvarintr.c:75)

MvarPtStruct *MvarCrvCrvInter(const CagdCrvStruct *Crv1,
const CagdCrvStruct *Crv2,
CagdRType SubdivTol,
CagdRType NumericTol,
CagdBType UseExprTree)

Crv1, Crv2: Two curves to intersect.
SubdivTol: Tolerance of the solution. This tolerance is measured in the parametric space of the surfaces.
NumericTol: Numeric tolerance of a possible numeric improvement stage. The numeric stage is employed if NumericTol < SubdivTol.
UseExprTree: TRUE to use expression trees in the computation, FALSE to use regular multivariate expressions.

Returns: List of intersection points, as parameter pairs into the two curves domains.

Description: Computes the intersection locations of two planar curves, possibly with multivariate expression trees. Expression trees could be beneficial computationally when the geometry is complex (i.e. dozens of control points or more).
See also: CagdCrvCrvInter, SymbCrvCrvInter, SymbSrfSrfSrfInter, MvarSrfSrfContact,

8.2.148 MvarCrvCrvMinimalDist (hasdrf2d.c:1164)

MvarPtStruct *MvarCrvCrvMinimalDist(const CagdCrvStruct *Crv1,
const CagdCrvStruct *Crv2,
CagdRType *MinDist,
CagdBType ComputeAntipodals,
CagdRType Eps)

Crv1: To detect its minimal distance to Crv2.
Crv2: To detect its minimal distance to Crv1.
MinDist: Upon return, is set to the minimal distance detected.
ComputeAntipodals: TRUE to compute antipodal locations as well in the search for minimal distance. If FALSE, samples are made along both curves and closest locations to other curve are computed.
Eps: Numeric tolerance of the computation.

Returns: Pairs of parameters at the minimal distance.

Description: Computes the minimal distance between two given planar C1 curves. This minimal distance can occur:
1. At intersection locations, if any.
2. At end points vs. end points.
3. At the end points vs interior locations.
4. At antipodal interior locations.
See also: MvarCrvCrvAntipodalPoints, SymbDistCrvPoint, CagdCrvCrvInter,

8.2.149 MvarCrvCrvtrByOneCtlPt (mvcrvtr.c:228)

MvarMVStruct *MvarCrvCrvtrByOneCtlPt(const CagdCrvStruct *Crv,
int CtlPtIdx,
CagdRType Min,
CagdRType Max)

Crv: To compute its curvature behaviour (convex vs. concave) as a function of the curve parameter and the Euclidean coordinate of the CtlPtIdx's control point.
CtlPtIdx: Index of control point to make a parameter for the curvature.
Min, Max: Domain each coordinate of CtlPtIdx point should vary.

Returns: The computed curvature field of Crv.

Description: Given a parametric curve, Crv, and a control point index CtlPtIdx, compute the curvature sign field of the curve as function of the Euclidean locations of control point index CtlPtIdx. Returned is a multivariate of dimension "1 + Dim(Crv)", where Dim(Crv) is the dimension of the curve (E2, E3, etc.).
See also: SymbCrv2DCurvatureSign, MvarCrvMakeCtlPtParam, UserCrvCrvtrByOneCtlPt,
8.2.150 MvarCrvMakeCtlPtParam (mvar_rev.c:372)

MvarMVStruct *MvarCrvMakeCtlPtParam(const CagdCrvStruct *Crv,
    int CtlPtIdx,
    CagdRType Min,
    CagdRType Max)

Crv: Curve to make its i'th control point a parameter.
CtlPtIdx: Index of control point to make a parameter.
Min, Max: Domain each coordinate of CtlPtIdx point should vary.
Returns: A multivariate parametrizing both the original curve and the CtlPtIdx's control points Euclidean values.

Description: Given a polynomial curve and an index of a control point, CtlPtIdx, construct a new multivariate where the i'th control points is mapped to 2nd and above parameters of the returned multivariate. The first parameter of the multivariate remains the input curves' parameter. For example, if the input curve is E2 (planar), a trivariate will be returned, M(t, x, y), where t is the original curve's parameter and x and y parametrize the Euclidean values of the CtlPtIdx control point.

8.2.151 MvarCrvMaxXYOriginDistance (lnsrfdst.c:34)

CagdRType MvarCrvMaxXYOriginDistance(const CagdCrvStruct *Crv,
    CagdRType Epsilon,
    CagdRType *Param)

Crv: To examine for its maximal XY distance for the origin.
Epsilon: Tolerance of computation.
Param: Will be set with the parameter location where this maximum occur.
Returns: The distance.

Description: Computes the maximal XY distance location of given curve from origin.

8.2.152 MvarCrvSelfInterDiagFactor (selfintr.c:830)

MvarPtStruct *MvarCrvSelfInterDiagFactor(const CagdCrvStruct *Crv,
                                        CagdRType SubdivTol,
                                        CagdRType NumericTol)

Crv: To detect its self intersection points.
SubdivTol: Tolerance of the solution. This tolerance is measured in the parametric space of the surfaces.
NumericTol: Numeric tolerance of a possible numeric improvment stage. The numeric stage is employed if NumericTol < SubdivTol.

Returns: Self intersection points, as points in E4 (r, t).

Description: Computes self intersection points for given curve using the following constraints r and t are two independent params of the same crv:

\[ x(r) - x(t) = 0, \]
\[ y(r) - y(t) = 0. \]

Direct attempt to solve this set of constraints is bound to be slow as all points in Crv satisfy these equations when r == t. The key here is to remove all (u - v) factors off diagonal Bezier patches of the above.

See also: MvarCrvAntipodalPoints, MvarSrfSelfInterNrmlDev, MvarCrvSelfInterNrmlDev,
**8.2.153 MvarCrvSelfInterNrmlDev** (selfintr.c:655)

```c
MvarPtStruct *MvarCrvSelfInterNrmlDev(const CagdCrvStruct *CCrv,
                       CagdRType SubdivTol,
                       CagdRType NumericTol,
                       CagdRType MinNrmlDeviation)
```

**CCrv:** To detect its self intersection points.

**SubdivTol:** Tolerance of the solution. This tolerance is measured in the parametric space of the surfaces.

**NumericTol:** Numeric tolerance of a possible numeric improvement stage. The numeric stage is employed if $\text{NumericTol} < \text{SubdivTol}$.

**MinNrmlDeviation:** At the intersection points. Zero for 90 degrees minimum deviation, positive for smaller minimal deviation and negative for a larger minimal deviation.

**Returns:** Self intersection points, as points in E4 ($r, t$).

**Description:** Computes self intersection points for given curve using the following constraints ($r$ and $t$ are two independent params of the same crv):

\[
\begin{align*}
x(r) - x(t) &= 0, \\
y(r) - y(t) &= 0.
\end{align*}
\]

Direct attempt to solve this set of constraints is bound to be slow as all points in Crv satisfy these equations when $r = t$. The key is in adding a third inequality constraint of the form

\[
\frac{\langle N(r), N(t) \rangle}{\| N(r) \| \| N(t) \|} < \cos(\text{Angle}),
\]

Where $\cos(\text{Angle})$ is a provided constant that prescribes the minimal angle the curve is expected to intersect at. The closer $\cos(\text{Angle})$ to one the more work this function will have to do in order to isolate the self intersection points. The above expression is not rational and so, we use a logical or of the following two expressions:

\[
\frac{\langle N(r), N(t) \rangle^2}{\| N(r) \|^2 \| N(t) \|^2} < \cos^2(\text{Angle}),
\]

or

\[
\langle N(r), N(t) \rangle < 0.
\]

**See also:** MvarCrvAntipodalPoints, MvarSrfSelfInterNrmlDev,

---

**8.2.154 MvarCrvSrfBisector** (mvbisect.c:113)

```c
MvarMVStruct *MvarCrvSrfBisector(const MvarMVStruct *CMV1,
                                  const MvarMVStruct *CMV2)
```

**CMV1:** The univariate (curve) in $\mathbb{R}^4$.

**CMV2:** The bivariate (surface) in $\mathbb{R}^4$.

**Returns:** The resulting bisector.

**Description:** Computes the bisectors of a curve and a surface in $\mathbb{R}^4$.

**See also:** MvarMVbBisector, MvarSrfSrfBisector, MvarCrvSrfBisectorApprox,
MvarPolyStruct *MvarCrvSrfBisectorApprox(const MvarMVStruct *CMV1,
const MvarMVStruct *CMV2,
CagdRType SubdivTol,
CagdRType NumericTol)

CMV1: The univariate (curve) in R^3.
CMV2: The bivariate (surface) in R^3.
SubdivTol: Tolerance of the first zero set finding subdivision stage.
NumericTol: Tolerance of the second zero set finding numeric stage.
Returns: An approximation of the bisector surface, either by polyline loops or triangles.

Description: Computes an approximation to the bisector of a curve and a surface. Let C(t) be the parametric curve and T(t) its unnormalized tangent field. Let S(u,v) be the parametric surface and n(u, v) its unnormalized normal. Then:

\[ \langle P - C(t), T(t) \rangle = 0 \]
defines the normal plane of T(t),

and the solution of

\[ \langle S(u, v) + n(u, v) \alpha - C(t), T(t) \rangle = 0 \]

finds the intersection point of of the normal of the surface with the normal plane of the curve. Then,

\[ \frac{\langle C(t) - S(u, v), T(t) \rangle}{\langle n(u, v), T(t) \rangle} \]

We now can define this intersection point, P, as

P(u, v, t) = S(u, v) + \alpha(u, v, t) n(u, v)
and end up with a single function we must extract its zero set

\[ \langle C(t) - P(u, v, t), C(t) - P(u, v, t) \rangle - \langle S(u, v) - P(u, v, t), S(u, v) - P(u, v, t) \rangle = 0 \]
or

\[ \langle C(t) - P(u, v, t), C(t) - P(u, v, t) \rangle - \langle \alpha(u, v, t) n(u, v), \alpha(u, v, t) n(u, v) \rangle = 0 \]

with simple algebraic manipulation, the following equivalent form is is obtained, and is a polynomial (not rational) function, assuming the the input is not rational:

\[ \langle S(u, v) - C(t), S(u, v) - C(t) \rangle - \langle n(u, v), T(t) \rangle + 2 \langle C(t) - S(u, v), T(t) \rangle - \langle S(u, v) - C(t), n(u, v) \rangle = 0 \]

Finding the zero set of the last equation provides the solution in (t, u, v) space, and the bisector point is given by:

\[ (x, y, z) = S(u, v) + \alpha(t, u, v) n(u, v) \]
which is implemented as a post-process mapping.

See also: MvarMVsBisector, MvarSrfSrfBisector, MvarCrvSrfBisector, MvarSrfSrfBisectorApprox,
8.2.156 MvarCrvSrfBisectorApprox2 (mvbisect.c:464)

VoidPtr MvarCrvSrfBisectorApprox2(const MvarMVStruct *CMV1,
const MvarMVStruct *CMV2,
int OutputType,
CagdRType SubdivTol,
CagdRType NumericTol)

CMV1: The univariate (curve) in \( R^3 \).
CMV2: The bivariate (surface) in \( R^3 \).

OutputType: Expected output type: 1. For the computed multivariate constraints. 2. For the computed point cloud on the bisector. 3. Points in a form of \((u, v, x, y, z)\) where \((u, v)\) are the parameter space of the surface.

SubdivTol: Tolerance of the first zero set finding subdivision stage.
NumericTol: Tolerance of the second zero set finding numeric stage.

Returns: Following OutputType, either a set of multivariates (as a linked list of MvarMVStruct), or a cloud of points on the bisector (as a linked list of MvarPtStruct).

Description: Computes an approximation to the bisector of a curve and a surface. Let \( C(t) \) be the parametric curve and \( T(t) \) its unnormalized tangent field. Let \( S(u, v) \) be the parametric surface and \( n(u, v) \) its unnormalized normal. Then:

\[
< P - C(t), T(t) > = 0 \quad \text{defines the normal plane of } T(t),
\]

and the solution of

\[
< S(u, v) + n(u, v) \alpha - C(t), T(t) > = 0
\]

finds the intersection point of the normal of the surface with the normal plane of the curve. Then,

\[
\alpha(u, v, t) = \frac{< C(t) - S(u, v), T(t) >}{< n(u, v), T(t) >}
\]

We now can define this intersection point, \( P \), as

\[
P(u, v, t) = S(u, v) + \alpha(u, v, t) n(u, v)
\]

and end up with a single function we must extract its zero set

\[
< C(t) - P(u, v, t), C(t) - P(u, v, t) > - < S(u, v) - P(u, v, t), S(u, v) - P(u, v, t) > = 0
\]

or

\[
< C(t) - P(u, v, t), C(t) - P(u, v, t) > - < \alpha(u, v, t) n(u, v), \alpha(u, v, t) n(u, v) > = 0
\]

Finding the zero set of the last equation provides the correspondence between the \((u, v)\) location and the surface and \((t)\) locations on the curve that serve as mutual foot point for some bisector point.

See also: MvarMVsBisector, MvarSrfSrfBisector, MvarCrvSrfBisector, MvarSrfSrfBisectorApprox,
8.2.157  MvarCrvSrfMinimalDist  (hasdrf3d.c:865)

MvarPtStruct *MvarCrvSrfMinimalDist(const CagdSrfStruct *Srf1, const CagdCrvStruct *Crv2, CagdRType *MinDist)

Srf1:  To detect its minimal distance to Crv2.
Crv2:  To detect its minimal distance to Srf1.
MinDist:  Upon return, is set to the minimal distance detected.

Returns:  Pairs of parameters at the minimal distance.

Description:  Computes the minimal distance between a given C1 curve and a C1 surface. Shapes are assumed to not intersect. This minimal distance can occur:
1. At end points vs. end points.
2. At the end points vs interior locations.
3. At a boundary curve of the surface vs the other curves.
4. At antipodal interior locations.

See also:  MvarSrfSrfAntipodalPoints, SymbDistSrfPoint, MvarSrfSrfMinimalDist,

8.2.158  MvarCrvToMV  (mvareval.c:996)

MvarMVStruct *MvarCrvToMV(const CagdCrvStruct *Crv)

Crv:  Curve to convert into the multi-variate MV.

Returns:  A multi variate function representation to Crv.

Description:  Converts a curve into a multivariate function.

8.2.159  MvarCrvTrimGlblOffsetSelfInter  (offset2.c:101)

CagdCrvStruct *MvarCrvTrimGlblOffsetSelfInter(CagdCrvStruct *Crv, const CagdCrvStruct *OffCrv, CagdRType TrimAmount, CagdRType SubdivTol, CagdRType NumericTol)

Crv:  Original curve, assumed to be C1 self intersection free.
OffCrv:  The offset curve approximation.
TrimAmount:  The trimming distance. A fraction smaller than the offset amount.
SubdivTol:  Tolerance of the solution. This tolerance is measured in the parametric space of the surfaces.
NumericTol:  Numeric tolerance of a possible numeric improvement stage. The numeric stage is employed if NumericTol < SubdivTol.

Returns:  A list of curve segments that are valid, after the trimming process took place.

Description:  Trims regions in the offset curve OffCrv that are closer than TrimAmount to original Crv, but compute all self intersections in the offset curve, splitting the offset curve at those intersections, and purges offset curve segments that are too close to original curve.

See also:  SymbCrvTrimGlblOffsetSelfInter,
8.2.160  MvarCrvZeroSet  (zrnmvaux0.c:1285)

CagrPtStruct *MvarCrvZeroSet(const CagdCrvStruct *Curve,
  int Axis,
  CagdRType SubdivTol,
  CagdRType NumericTol,
  CagdRType FilterTangencies)

Curve:  To compute its zeros.
Axis:  of Crv to seek its zeros: 0 for W, 1 for X, 2 for Y, etc.
SubdivTol:  Tolerance of the solution.  This tolerance is measured in the parametric space of the curves.
NumericTol:  Numeric tolerance of a possible numeric improvement stage.  The numeric stage is employed if
  NumericTol < SubdivTol.
FilterTangencies:  If TRUE, filter out tangencies at the zeros.
Returns:  List of zeros (parametric locations on Curve).
Description:  Computes the zeros of the given curve in the given axis.
See also:  MvarSrfZeroSet, MvarMVsZeros0D,

8.2.161  MvarCtrlComputeCrvNCycle  (control.c:53)

MvarPtStruct *MvarCtrlComputeCrvNCycle(const CagdCrvStruct *Crv,
  int CycLen,
  CagdRType SubdivTol,
  CagdRType NumericTol)

Crv:  A curve to compute a cycle of length CycLen for.
CycLen:  Length of sought cycle (also k above).
SubdivTol:  Tolerance of the solution.  This tolerance is measured in the parametric space of the curves.
NumericTol:  Numeric tolerance of a possible numeric improvement stage.  The numeric stage is employed if
  NumericTol < SubdivTol.
Returns:  Linked list of solutions, each holding the parameter values of the different Cycles, if any.
Description:  Computes a cycle of length CycLen of bouncing lines between the given scalar curve C(t) and the
doingal of the domain.  A ray is bounced 'down' from the diagonal to C and from C, we bounce a horizontal ray to
the diagonal.  Let Di, i == 1,k be the diagonal points and Ci, i == 1,k the points on C.  Then, the cycle of length k
= CycLen is: (D1, C1, D2, C2, ... Dk, Ck).  The following algebraic constraints can be imposed:

Ci(y) = Di+1(y), for all i,  (horizontal move from curve to diagonal)
Di(x) = Ci(x),  for all i.  (vertical move from diagonal to curve)

Over all, we have 2n equations and 2n dofs.  We can reduce them to n equations and dofs (eliminating the diagonals):

Ci(y) = Ci+1(x),  for all i.

Over all, we have now n equations and n dofs (n different parameters of C).
See also:  MvarCtrlComputeSrfNCycle,

8.2.162  MvarCtrlComputeSrfNCycle  (control.c:181)

MvarPtStruct *MvarCtrlComputeSrfNCycle(const CagdSrfStruct *Srf,
  int CycLen,
  CagdRType SubdivTol,
  CagdRType NumericTol)

Srf:  A surface to compute a cycle of length CycLen for.
CycLen:  Length of sought cycle (also k above).
SubdivTol:  Tolerance of the solution.  This tolerance is measured in the parametric space of the surface.
**NumerTol**: Numeric tolerance of a possible numeric improvement stage. The numeric stage is employed if NumerTol < SubdivTol.

**Returns**: Linked list of solutions, each holding the parameter values of the different Cycles, if any.

**Description**: Computes a cycle of length CycLen of bouncing lines between the given surface \( S(u, v) = (S_1(u, v), S_2(u, v)) \). The cycle of length \( k = \text{CycLen} \) is:

\[
\begin{align*}
S(u_1, v_1) &\to (u_2, v) \\
S(u_i, v_1) &\to (u(i+1), v(i+1)) \\
S(u_k, v_k) &\to (u_1, v_1)
\end{align*}
\]

Over all, we have \( 2n \) equations and \( 2n \) dofs.

**See also**: MvarCtrlComputeCrvNCycle,

### 8.2.163 MvarDbg (mvar_dbg.c:27)

```c
void MvarDbg(const void *Obj)
```

**Obj**: A multi-variate - to be printed to stderr.

**Returns**: void

**Description**: Prints multi-variates to stderr. Should be linked to programs for debugging purposes, so multi-variates may be inspected from a debugger.

### 8.2.164 MvarDescribeError (mvar_err.c:101)

```c
const char *MvarDescribeError(MvarFatalErrorType ErrorNum)
```

**ErrorNum**: Type of the error that was raised.

**Returns**: A string describing the error type.

**Description**: Returns a string describing the given error. Errors can be raised by any member of this mvar library as well as other users. Raised error will cause an invocation of MvarFatalError function which decides how to handle this error. MvarFatalError can for example, invoke this routine with the error type, print the appropriate message and quit the program.

### 8.2.165 MvarDistPointCrvC1 (hasdrf2d.c:57)

```c
CagdRType MvarDistPointCrvC1(CagdPType P, 
    const CagdCrvStruct *Crv,
    MvarHFDistParamStruct *Param,
    CagdBType MinDist,
    CagdRType Epsilon)
```

**P**: Point to measure its Hausdorff distance to curve Crv.

**Crv**: Crv to measure its hausdorff distance to point Pt.

**Param**: Where to return the parameter value with the maximal distance.

**MinDist**: TRUE for minimal distance, FALSE for maximal.

**Epsilon**: Tolerance of computation.

**Returns**: The Hausdorff distance.

**Description**: Computes the min or max distance between a point and a \( C^1 \) cont. curve. The curve and point are assumed to be either in R2 or R3. The extreme distance between a point and a curve could happen either at the end points of curve C or when

\[
C'(t) \cdot \langle C(t) - P \rangle = 0.
\]

**See also**: SymbDistCrvPoint,
8.2.166 MvarDistPointLine (mvar_int.c:234)

IrtRType MvarDistPointLine(const MvarVecStruct *Point,
                         const MvarVecStruct *Pl,
                         const MvarVecStruct *Vl)

    Point: To find the closest to on the line.
    Pl, Vl: Position and direction that defines the line. Vl is assumed a unit length vector.

    Returns: The computed minimal distance.

    Description: Routine to compute the minimal point distance to a given line in R^n. The line is prescribed using
    a point on it (Pl) and a unit vector (Vl).
    See also: GMDistPointLine,

8.2.167 MvarDistSrfLine (mvardist.c:210)

CagdRType *MvarDistSrfLine(const CagdSrfStruct *Srf,
                          const CagdPType LnPt,
                          const CagdVType LnDir,
                          CagdBType MinDist,
                          CagdRType SubdivTol,
                          CagdRType NumericTol)

    Srf: The surface to find its nearest (farthest) point to Line.
    LnPt: A point on the line to consider.
    LnDir: The direction of the line to consider.
    MinDist: If TRUE nearest points is needed, if FALSE farthest.
    SubdivTol: Tolerance of the first zero set finding subdivision stage.
    NumericTol: Tolerance of the second zero set finding numeric stage.

    Returns: Parameter value in the parameter space of Srf of the nearest (farthest) point to line Line.

    Description: Given a surface and a line, finds the nearest point (if MinDist) or the farthest location (if MinDist
    FALSE) from the surface to the given line. This function assumes the surface does not intersect the line. Returned is
    the parameter value of the surface. Only internal extrema are considered. Let S and N be the surface and its normal
    field. Then the extrema points are computed as the simultaneous solution of,
    \[ < (S - LnPt) \times N, LnDir > = 0, \]
    \[ < N, LnDir > = 0. \]
    See also: MvarLclDistSrfLine, MvarLclDistCrvLine, MvarDistCrvLine,

8.2.168 MvarDistSrfPoint (mvardist.c:41)

CagdRType *MvarDistSrfPoint(const CagdSrfStruct *Srf,
                           const CagdPType Pt,
                           CagdBType MinDist,
                           CagdRType SubdivTol,
                           CagdRType NumericTol)

    Srf: The surface to find its nearest (farthest) point to Pt.
    Pt: The point to find the nearest (farthest) point on Srf to it.
    MinDist: If TRUE nearest points is needed, if FALSE farthest.
    SubdivTol: Tolerance of the first zero set finding subdivision stage.
    NumericTol: Tolerance of the second zero set finding numeric stage.

    Returns: UV Parameter values in the parameter space of Srf of the nearest (farthest) point to point Pt.

    Description: Given a surface and a point, finds the nearest point (if MinDist) or the farthest location (if MinDist
    FALSE) from the surface to the given point. Returned is the parameter value of the surface. Both internal as well
    as boundary extrema are considered. Computes the simultaneous zeros of:
    \[ (Srf(u, v) - Pt) \cdot dSrf(u, v)/Du = 0, \]
    \[ (Srf(u, v) - Pt) \cdot dSrf(u, v)/Dv = 0, \]
    and also include all extrema on the boundaries.
8.2.169 MvarETDbg (mvar_dbg.c:67)

void MvarETDbg(const MvarExprTreeStruct *ET)

    ET: A multivariate expression tree - to be printed to stderr.

    Returns: void

    Description: Prints multivariate expression tree to stderr. Should be linked to programs for debugging purposes, so multi-variates may be inspected from a debugger.

8.2.170 MvarETDomain (mvaexpr.c:1462)

int MvarETDomain(const MvarExprTreeStruct *ET, CagdRType *Min, CagdRType *Max, int Axis)

    ET: Expression tree to derive the domain of, in direction Axis.

    Min, Max: Domain of ET in direction Axis.

    Axis: The direction along with to compute the domain of ET, or -1 to evaluate the domain in all direction (Min and Max should be vectors of size ET->Dim). m

    Returns: TRUE for successful computation, FALSE otherwise.

    Description: Computes the domain of the expression tree along direction Axis. The assumption is that any MV in ET with a non trivial degree in direction Axis possess the same domain.

    See also: MvarExprTreeDomain,

8.2.171 MvarETUpdateConstDegDomains (mvaexpr.c:1638)

int MvarETUpdateConstDegDomains(MvarExprTreeStruct **MVETs, int n)

    MVETs: vectors of expression tree MVs to update.

    n: Size of vector MVETs.

    Returns: TRUE if successful, FALSE otherwise.

    Description: Compute the shared domain of all given expression trees and update all expression trees leafs to that domain, in their constant directions. Only constant degree directions can be updated. Higher order degree of similar directions in two different (sub) expression trees must be sharing the same domain (or otherwise an error will be returned).

    See also: MvarMVUpdateConstDegDomains,

8.2.172 MvarETsZeros0D (zrsolver.c:523)

MvarPtStruct *MvarETsZeros0D(MvarExprTreeStruct * const *MVETs, MvarConstraintType *Constraints, int NumOfMVETs, CagdRType SubdivTol, CagdRType NumericTol)

    MVETs: A vector of MV expression trees constraints. Should be of size Dim where Dim is the dimension of the domain of MVs.

    Constraints: Either an equality or an inequality type of constraint. Can be NULL in which case all constraints are equality.

    NumOfMVETs: Total number of MV expression trees constraints.

    SubdivTol: The subdivision tolerance to use.

    NumericTol: The numerical tolerance to use.

    Returns: List of points on the solution set. Dimension of the points will be the same as the dimensions of all MVETs.

    Description: Interface function for a MV expression trees solver, 1D solutions. Computes the simultaneous solution of the given set of NumOfMVVs expression trees constraints. A constraint can be equality or inequality as prescribed by the Constraints vector. All multivariates are assumed to be in the same parametric domain size and dimension.

    See also: MvarMVsZeros0D,
8.2.173 MvarEditSingleMVPt (mvaredit.c:34)

MvarMVStruct *MvarEditSingleMVPt(MvarMVStruct *MV, 
    CagdCtPtStruct *CtlPt, 
    int *Indices, 
    CagdBType Write)

MV: Multi-variate to be modified/query.
CtlPt: New control point to be substituted into MV. Must carry the same PType as MV if to be written to 
MV.
Indices: In multi-variate MV's control mesh to substitute/query CtlPt.
Write: If TRUE CtlPt is copied into MV, if FALSE the point is copied from MV to CtlPt.
Returns: If Write is TRUE, the new modified multi-variate, if WRITE is FALSE, NULL.

Description: Provides the way to modify/get a single control point into/from a multi-variate.

8.2.174 MvarExprAuxDomainReset (mvarextr.c:1744)

void MvarExprAuxDomainReset(MvarExprTreeStruct *ET)

ET: Expression tree to reset all aux domain of Bezier MVs.
Returns: void

Description: Reset aux. domains of all bezier multivariates in the expression tree.
See also:

8.2.175 MvarExprTreeAdd (mvarextr.c:719)

MvarExprTreeStruct *MvarExprTreeAdd(MvarExprTreeStruct *Left, 
    MvarExprTreeStruct *Right)

Left, Right: The two expression trees to add. These sub trees are used in place, so duplicate before calling 
this function if you like to keep the original Left/Right.
Returns: Added expression tree, "Left + Right".

Description: Adds two sub expression tree into one new expression tree.
See also:

8.2.176 MvarExprTreeBBox (mvarextr.c:1269)

const MvarBBoxStruct *MvarExprTreeBBox(MvarExprTreeStruct *ET)

ET: Expression Tree to compute the bounding box for.
Returns: Computed bounding box, in static memory.

Description: Computes the BBox of the given expression tree.
See also:

8.2.177 MvarExprTreeCnvrtBsp2BzrMV (mvarextr.c:1946)

int MvarExprTreeCnvrtBsp2BzrMV(MvarExprTreeStruct *ET, 
    MvarMinMaxType *Domain)

ET: Expression tree to convert Bspline MVs to Beziers, in place.
Domain: Optional domain to set the bezier ET as aux. domain. NULL for no setting of the aux. domain.
Returns: TRUE if successful, FALSE otherwise.

Description: Convert, in place, all Bspline MVs in expression tree ET to Beziers. All MVs are assumed to hold 
no interior knots. All created Bezier MVs are updated with their aux domain.
See also:
8.2.178  MvarExprTreeCnvrtBzr2BspMV  (mvarextr.c:2008)

    int MvarExprTreeCnvrtBzr2BspMV(MvarExprTreeStruct *ET)

    ET: Expression tree to convert Bspline MVs to Beziers, in place.
    Returns: TRUE if successful, FALSE otherwise.
    Description: Convert, in place, all Bezier MVs in expression tree ET to Bspline.
    See also:

8.2.179  MvarExprTreeCompositionDerivBBox  (mvarextr.c:2584)

    MvarBBoxStruct *MvarExprTreeCompositionDerivBBox(MvarExprTreeStruct *ET,
           MvarBBoxStruct *BBox)

    ET: To evaluate its gradient at given Params parametric location.
    BBox: Where the result will be written to.
    Returns: Returns the same result (for convinience).
    Description: Bounds the derivative of the composition function. Currently only scalar composition allowed.
    See also: MvarExprTreeBBox

8.2.180  MvarExprTreeConesOverlap  (mvcones.c:2109)

    CagdBType MvarExprTreeConesOverlap(MvarExprTreeEqnsStruct *Eqns)

    Eqns: The MVETs constraints formated into equations with * common expressions. *
    Returns: TRUE if overlap, FALSE if not.
    Description: Computes the tangency anti-cones of the set of multivariate constraints, and returns whether they
        overlap or not.
    See also: MVarExprTreeNormalCone, MvarConesOverlapAux

8.2.181  MvarExprTreeCopy  (mvarextr.c:379)

    MvarExprTreeStruct *MvarExprTreeCopy(const MvarExprTreeStruct *ET,
            CagdBType ThisNodeOnly,
            CagdBType DuplicateMVs)

    ET: Expression tree to duplicate.
    ThisNodeOnly: TRUE to duplicate just this node.
    DuplicateMVs: If TRUE, Multivariates in leaf nodes are duplicated. Otherwise, references for them are kept
        instead.
    Returns: Duplicated node or tree.
    Description: A copy function to duplicate a node (ThisNodeOnly TRUE) or entire expression tree.
    See also:

8.2.182  MvarExprTreeCos  (mvarextr.c:948)

    MvarExprTreeStruct *MvarExprTreeCos(MvarExprTreeStruct *Left)

    Left: The expression tree to take cosine of. The sub tree is used in place, so duplicate before calling this
        function if you like to keep the original Left.
    Returns: Cosine expression tree, "Cos(Left)".
    Description: Cosine of subexpression tree into a new expression tree.
    See also:
8.2.183 MvarExprTreeCrossProd (mvarextr.c:856)

MvarExprTreeStruct *MvarExprTreeCrossProd(MvarExprTreeStruct *Left, 
MvarExprTreeStruct *Right)

Left, Right: The two expression trees to multiply. These sub trees are used in place, so duplicate before calling 
this function if you like to keep the original Left/Right.

Returns: Multiplied expression tree, "Left * Right".
Description: Cross Prod two sub expression tree into one new expression tree.
See also:

8.2.184 MvarExprTreeDotProd (mvarextr.c:821)

MvarExprTreeStruct *MvarExprTreeDotProd(MvarExprTreeStruct *Left, 
MvarExprTreeStruct *Right)

Left, Right: The two expression trees to multiply. These sub trees are used in place, so duplicate before calling 
this function if you like to keep the original Left/Right.

Returns: Multiplied expression tree, "Left * Right".
Description: Dot Prod two sub expression tree into one new expression tree.
See also:

8.2.185 MvarExprTreeEqnsFree (zret0d.c:353)

void MvarExprTreeEqnsFree(MvarExprTreeEqnsStruct *Eqns)

Eqns: Data structure to free.
Returns: void
Description: Free all data allocated in the expression tree equation's structure.
See also: MvarMVsZeros, MvarExprTreeEqnsMalloc,

8.2.186 MvarExprTreeEqnsMalloc (zret0d.c:309)

MvarExprTreeEqnsStruct *MvarExprTreeEqnsMalloc(int NumEqns, 
int MaxNumCommonExprs)

NumEqns: Number of equations we have.
MaxNumCommonExprs: Maximum number of common expression we can initially hold.
Returns: Allocated structure.
Description: Allocate a structure to hold NumEqns equations and at most MaxNumCommonExprs common 
expressions.
See also: MvarMVsZeros, MvarExprTreeEqnsMalloc,

8.2.187 MvarExprTreeEqnsReallocCommonExprs (zret0d.c:394)

void MvarExprTreeEqnsReallocCommonExprs(MvarExprTreeEqnsStruct *Eqns, 
int NewSize)

Eqns: Set of equations to increase, in place, the number of coomon expressions it can old.
NewSize: of vector of common expression, zero to double the size.
Returns: void
Description: Reallocate (increase) the number of common expressions give Eqns can hold, in place.
See also: MvarMVsZeros,
8.2.188 MvarExprTreeEval (mvarextr.c:2167)

CagdRType *MvarExprTreeEval(const MvarExprTreeStruct *ET,
                           CagdRType *Params)

    ET: Expression tree to evaluate.
    Params: Parameter values to evaluate the expression at.
    Returns: Evaluation result. Note entry zero is reserved to the rational (weight) value.
    Description: Evaluate the expression tree at the given parametric location.
    See also: MvarExprTreeGrad,

8.2.189 MvarExprTreeEvalTanPlane (mvarextr.c:2539)

MvarPlaneStruct *MvarExprTreeEvalTanPlane(const MvarExprTreeStruct *ET,
                                          CagdRType *Params)

    ET: To evaluate its gradient at given Params parametric location.
    Params: Parametric location to evaluate MV at.
    Returns: A hyperplane, allocated dynamically. The tangent is normalized so that its last (independent coefficient is one: "A1 X1 + A2 X2 + ... + An Xn + 1". The size, n, is to the dimension of the multivariate.
    Description: Evaluates the tangent hyperplane of the given ET at a given location, numerically.
    See also: MvarMVsZeros,

8.2.190 MvarExprTreeExp (mvarextr.c:890)

MvarExprTreeStruct *MvarExprTreeExp(MvarExprTreeStruct *Left)

    Left: The expression tree to exponent. The sub tree is used in place, so duplicate before calling this function if you like to keep the original Left.
    Returns: Exponentiated expression tree, "e^Left".
    Description: Exponent of subexpression tree into a new expression tree.
    See also:

8.2.191 MvarExprTreeFree (mvarextr.c:538)

void MvarExprTreeFree(MvarExprTreeStruct *ET, CagdBType ThisNodeOnly)

    ET: Expression tree to free.
    ThisNodeOnly: TRUE to free just this node, FALSE for the entire tree.
    Returns: void
    Description: Free an expression tree node (ThisNodeOnly TRUE) or its entire tree.
    See also: MvarExprTreeFreeSlots,

8.2.192 MvarExprTreeFreeSlots (mvarextr.c:469)

void MvarExprTreeFreeSlots(MvarExprTreeStruct *ET, CagdBType ThisNodeOnly)

    ET: Expression tree to free.
    ThisNodeOnly: TRUE to free just this node, FALSE for the entire tree.
    Returns: void
    Description: Free an expression tree node (ThisNodeOnly TRUE) or its entire tree.
    See also: MvarExprTreeFree,
8.2.193 MvarExprTreeFromCrv (mvarextr.c:48)

MvarExprTreeStruct *MvarExprTreeFromCrv(const CagdCrvStruct *Crv, int NewDim, int StartAxis)

Crv: TO convert into an expression tree of NewDim dimension.
NewDim: The new multivariate dimension of this tree, to promote the curve from.
StartAxis: The starting axis (dimension) of the directions of Crv.
Returns: The build multivariate expression tree.

Description: Converts the input curve into a multivariate expression tree in newDim dimension so that the Crv is along the StartAxis dimension.
See also:

8.2.194 MvarExprTreeFromMV (mvarextr.c:113)

MvarExprTreeStruct *MvarExprTreeFromMV(const MvarMVStruct *MV, int NewDim, int StartAxis)

MV: To convert into an expression tree of NewDim dimension.
NewDim: The new multivariate dimension of this tree, to promote the surface from.
StartAxis: The starting axis (dimension) of the directions of MV.
Returns: The build multivariate expression tree.

Description: Converts the input multivariate into a multivariate expression tree in newDim dimension so that the MV is along the StartAxis dimension (and beyond).
See also: MvarExprTreeFromMV2,

8.2.195 MvarExprTreeFromMV2 (mvarextr.c:143)

MvarExprTreeStruct *MvarExprTreeFromMV2(const MvarMVStruct *MV)

MV: To convert into an expression tree of NewDim dimension.
Returns: The build multivariate expression tree.

Description: Converts the input multivariate into a multivariate expression tree in newDim dimension so that the MV is along the StartAxis dimension (and beyond).
See also: MvarExprTreeFromMV,

8.2.196 MvarExprTreeFromSrf (mvarextr.c:80)

MvarExprTreeStruct *MvarExprTreeFromSrf(const CagdSrfStruct *Srf, int NewDim, int StartAxis)

Srf: TO convert into an expression tree of NewDim dimension.
NewDim: The new multivariate dimension of this tree, to promote the surface from.
StartAxis: The starting axis (dimension) of the directions of Srf.
Returns: The build multivariate expression tree.

Description: Converts the input surface into a multivariate expression tree in newDim dimension so that the Srf is along the StartAxis dimension (and beyond).
See also:
8.2.197  MvarExprTreeGradient  (mvarextr.c:2317)

CagdRType *MvarExprTreeGradient(const MvarExprTreeStruct *ET,
        CagdRType *Params,
        int *Dim)

    ET: Expression tree to evaluate its gradient.
    Params: Parameter values to evaluate the gradient of the expression.
    Dim: Will be set with the dimension of the gradient.

Returns: Evaluation result. If the returned gradient vector is of dimension n, it will be saved in entries [0] to [n-1].

Description: Evaluate the gradient of the expression tree at the given parametric location.
See also: MvarExprTreeEval.

8.2.198  MvarExprTreeInteriorKnots  (mvarextr.c:2066)

int MvarExprTreeInteriorKnots(const MvarExprTreeStruct *ET, CagdRType *Knot)

    ET: Expression tree to examine for interior knots.
    Knot: Interior knot value if non Bezier expression tree (valid only if a non negative value is returned).

Returns: Negative if all MVs are Bezier, index to dimension with interior knots, from which Knot is extracted.

Description: Tests if all MVs in expression tree ET are Bezier (no interior knots).
See also:

8.2.199  MvarExprTreeIntrnlNew  (mvarextr.c:326)

MvarExprTreeStruct *MvarExprTreeIntrnlNew(MvarExprTreeNodeType NodeType,
        MvarExprTreeStruct *Left,
        MvarExprTreeStruct *Right,
        const MvarBBoxStruct *MVBBox)

    NodeType: Type of internal node, addition, multiplication, etc.
    Left, Right: The left and right sons of this node.
    MVBBox: Bounding box, if any, of this node.

Returns: The expression tree constructed representation.

Description: An expression tree (ET) constructor for a tree internal node.
See also:

8.2.200  MvarExprTreeLeafDomain  (mvarextr.c:1576)

int MvarExprTreeLeafDomain(MvarExprTreeStruct *ET,
        CagdRType *Min,
        CagdRType *Max,
        int Axis)

    ET: Expression tree to derive the domain of, in direction Axis.
    Min, Max: Domain of ET in direction Axis.
    Axis: The direction along with to compute the domain of ET.

Returns: TRUE for successful computation, FALSE otherwise.

Description: Computes the domain of the expression tree variable (leaf) along direction Axis. The assumption is that any MV in ET with a non trivial degree in direction Axis possess the same domain.
See also:
8.2.201 MvarExprTreeLeafNew (mvarextr.c:266)

MvarExprTreeStruct *MvarExprTreeLeafNew(CagdBType IsRef,
    MvarMVStruct *MV,
    int NewDim,
    int StartAxis,
    MvarNormalConeStruct *MVBCone,
    const MvarBBoxStruct *MVBBox)

IsRef: TRUE to just reference MV instead of copying it. Note that if NewDim is non zero, the MV will always be copied with the new expanded dimension NewDim.

MV: MV to occupy this leaf node. Can be NULL.

NewDim: The new multivariate dimension of this tree.

StartAxis: The starting axis of the directions of MV.

MVBCone: Bounding code, if any, of MV.

MVBBox: Bounding box, if any, of MV.

Returns: An expression tree representing MV.

Description: An expression tree (ET) constructor for a tree leaf node.

See also:

8.2.202 MvarExprTreeLog (mvarextr.c:919)

MvarExprTreeStruct *MvarExprTreeLog(MvarExprTreeStruct *Left)

Left: The expression tree to take log of. The sub tree is used in place, so duplicate before calling this function if you like to keep the original Left.

Returns: Logarithm’ed expression tree, "Log(Left)".

Description: Logarithm of subexpression tree into a new expression tree.

See also:

8.2.203 MvarExprTreeMult (mvarextr.c:787)

MvarExprTreeStruct *MvarExprTreeMult(MvarExprTreeStruct *Left,
    MvarExprTreeStruct *Right)

Left, Right: The two expression trees to multiply. These sub trees are used in place, so duplicate before calling this function if you like to keep the original Left/Right.

Returns: Multiplied expression tree, "Left * Right".

Description: Multiplies two sub expression tree into one new expression tree.

See also:

8.2.204 MvarExprTreeNPow (mvarextr.c:1037)

MvarExprTreeStruct *MvarExprTreeNPow(MvarExprTreeStruct *Left, int Power)

Left: The expression tree to to raise to power. The sub tree is used in place, so duplicate before calling this function if you like to keep the original Left.

Power: The power to raise the expression to.

Returns: Square expression tree, "Left^power".

Description: Subexpression tree to a power of Power.

See also:
8.2.205  MvarExprTreeNormalConeMul  (mvcones.c:1923)

MvarNormalConeStruct *MvarExprTreeNormalConeMul(
    const MvarNormalConeStruct *ConeF,
    const MvarNormalConeStruct *ConeG,
    const MvarBBoxStruct *BBoxF,
    const MvarBBoxStruct *BBoxG,
    int Dim)

ConeF: Normal cone of the first term.
ConeG: Normal cone of the second term.
BBoxF: Bounding box of the first term.
BBoxG: Bounding box of the second term.
Dim: Dimensions.
Returns: The resulting normal cone.
Description: Constructs a normal cone of a multiplication.
See also: MVarExprTreeNormalCone, MvarExprTreeNormalConeSum, MvarExprTreeNormalConeScale,

8.2.206  MvarExprTreeNormalConeScale  (mvcones.c:1966)

MvarNormalConeStruct *MvarExprTreeNormalConeScale(
    const MvarNormalConeStruct *ConeF,
    const MvarBBoxStruct *BBoxGPrime,
    int Dim)

ConeF: Normal cone of the function.
BBoxGPrime: Bounding box of the scale factor.
Dim: Dimensions.
Returns: New scaled cone.
Description: Scales normal cone (for composition and multiplication).
See also: MVarExprTreeNormalCone, MvarExprTreeNormalConeMul,

8.2.207  MvarExprTreeNormalConeSub  (mvcones.c:1884)

MvarNormalConeStruct *MvarExprTreeNormalConeSub(
    const MvarNormalConeStruct *ConeF,
    const MvarNormalConeStruct *ConeG,
    int Dim)

ConeF: Normal cone of the minuend.
ConeG: Normal cone of the subtrahend.
Dim: Dimensions.
Returns: The resulting normal cone.
Description: Constructs a normal cone of a difference.
See also: MVarExprTreeNormalCone, MvarExprTreeNormalConeSum,

8.2.208  MvarExprTreeNormalConeSum  (mvcones.c:1696)

MvarNormalConeStruct *MvarExprTreeNormalConeSum(
    const MvarNormalConeStruct *ConeF,
    const MvarNormalConeStruct *ConeG,
    int Dim)

ConeF: Normal cone of the the first summand.
ConeG: Normal cone of the second summand.
Dim: Dimensions.
Returns: The resulting normal cone.
Description: Constructs a normal cone of a sum.
See also: MVarExprTreeNormalCone, HyperplaneOrthoSystem,
8.2.209  MvarExprTreePrintInfo (mvarextr.c:1797)

void MvarExprTreePrintInfo(const MvarExprTreeStruct *ET,
                         CagdBType CommonExprIdx,
                         CagdBType PrintMVInfo,
                         MvarExprTreePrintFuncType PrintFunc)

  ET: To traverse and prints its Info/Node content.
  CommonExprIdx: TRUE to only dump the common expression index, FALSE for the full common expression in place.
  PrintMVInfo: TRUE to print information on MV leaves.
  PrintFunc: Call back function to print a string.

  Returns: void
  Description: Traverses the ET in infix order and print the Info/Node in the ET.

See also:

8.2.210  MvarExprTreeRecip (mvarextr.c:1068)

MvarExprTreeStruct *MvarExprTreeRecip(MvarExprTreeStruct *Left)

  Left: The expression tree to reciprocate. The sub tree is used in place, so duplicate before calling this function if you like to keep the original Left.

  Returns: Reciprocation expression tree, "1.0/Left".
  Description: Reciprocation of subexpression tree into a new expression tree.

See also:

8.2.211  MvarExprTreeSize (mvarextr.c:564)

int MvarExprTreeSize(MvarExprTreeStruct *ET)

  ET: Expression tree to compute its size (number of nodes).

  Returns: Number of nodes in ET.
  Description: Returns the size (number of nodes) an expression tree has.

See also:

8.2.212  MvarExprTreeSqr (mvarextr.c:1006)

MvarExprTreeStruct *MvarExprTreeSqr(MvarExprTreeStruct *Left)

  Left: The expression tree to take square of. The sub tree is used in place, so duplicate before calling this function if you like to keep the original Left.

  Returns: Square expression tree, "Square(Left)".
  Description: Square of subexpression tree into a new expression tree.

See also:

8.2.213  MvarExprTreeSqrt (mvarextr.c:977)

MvarExprTreeStruct *MvarExprTreeSqrt(MvarExprTreeStruct *Left)

  Left: The expression tree to take square root of. The sub tree is used in place, so duplicate before calling this function if you like to keep the original Left.

  Returns: Sqrt expression tree, "Sqrt(Left)".
  Description: Square root of subexpression tree into a new expression tree.

See also:
8.2.214 MvarExprTreeSub (mvarextr.c:753)

MvarExprTreeStruct *MvarExprTreeSub(MvarExprTreeStruct *Left,
    MvarExprTreeStruct *Right)

Left, Right: The two expression trees to subtract. These sub trees are used in place, so duplicate before calling
this function if you like to keep the original Left/Right.

Returns: Subtracted expression tree, "Left - Right".

Description: Subtracts two sub expression tree into one new expression tree.

See also:

8.2.215 MvarExprTreeSubdivAtParam (mvarextr.c:1103)

int MvarExprTreeSubdivAtParam(const MvarExprTreeStruct *ET,
    CagdRType t,
    MvarMVDirType Dir,
    MvarExprTreeStruct **Left,
    MvarExprTreeStruct **Right)

ET: The expression tree to subdivide at parameter value t, in Dir.
t: The parameter value to subdivide at.
Dir: The direction of subdivision.
Left: First result of subdivision.
Right: Second result of subdivision.

Returns: TRUE if successful, FALSE otherwise.

Description: Subdivides the given multivariate expression tree at t in direction Dir.

See also:

8.2.216 MvarExprTreeToMV (mvarextr.c:165)

MvarMVStruct *MvarExprTreeToMV(const MvarExprTreeStruct *ET)

ET: Expression tree to convert to a multivariate.

Returns: Multivariate representing the expression tree.

Description: Converts an expression tree to a regular multivariate function.

See also:

8.2.217 MvarExprTreeZerosCnvrtBezier2MVs (zret0d.c:1148)

int MvarExprTreeZerosCnvrtBezier2MVs(int Bezier2MVs)

Bezier2MVs: TRUE to convert to MVs, FALSE to subdivide Bezier ETs.

Returns: Old setting for Bezier conversion setting.

Description: Sets the way expression trees of Bezier MVs are treated. If TRUE, the ETs are converted into
MV and the regular MV zero solver is invoked. If FALSE, the ETs are subdivided all the way to SUbdivTol.

See also: MvarExprTreesZeros, MvarExprTreeZerosUseCommonExpr,

8.2.218 MvarExprTreeZerosUseCommonExpr (zret0d.c:1121)

int MvarExprTreeZerosUseCommonExpr(int UseCommonExpr)

UseCommonExpr: TRUE to use common expressions, FALSE otherwise.

Returns: Old setting of common expressions’ use.

Description: Sets the exploitation of common expression extraction in expression trees. If TRUE, the ETs are
scanned for common expressions that are then processed once only, during the subdivision process.

See also: MvarExprTreesZeros, MvarExprTreeZerosCnvrtBezier2MVs,
8.2.219 MvarExprTreesSame (mvarextr.c:619)

CagdBType MvarExprTreesSame(const MvarExprTreeStruct *ET1, 
        const MvarExprTreeStruct *ET2, 
        CagdRType Eps)

ET1, ET2: Two expression trees to compare.
Eps: Tolerance of approximation.

Returns: TRUE if the same ETs (up to Eps), FALSE otherwise.

Description: A comparison function to test for similarity (up to Eps) two expression trees.
See also:

8.2.220 MvarExprTreesVerifyDomain (mvarextr.c:678)

int MvarExprTreesVerifyDomain(MvarExprTreeStruct *ET1, 
        MvarExprTreeStruct *ET2)

ET1, ET2: Two multivariate expression trees to verify that they share the same domains.

Returns: TRUE if Et1/2 shares the same domains, FALSE otherwise.

Description: Examine the given two multivariate’s expression trees if they share the same domains.
See also: MvarExprTreeDomain,

8.2.221 MvarFatalError (mvar_ftl.c:53)

void MvarFatalError(MvarFatalErrorType ErrID)

ErrID: Error type that was raised.

Returns: void

Description: Trap Mvar library errors right here. Provides a default error handler for the mvar library. Gets an error description using MvarDescribeError, prints it and exit the program using exit.

8.2.222 MvarFlankMillLineAnalyze (flankmil.c:82)

CagdCrvStruct *MvarFlankMillLineAnalyze(const CagdSrfStruct *Srf, 
        CagdRType Tolerance, 
        CagdCrvStruct **StripBoundriesUV, 
        int CrvSizeReduction, 
        CagdRType SubdivTol, 
        CagdRType NumericTol)

Srf: To compute flank milling tool path for.
Tolerance: Maximal allowed distance between Srf and tool.
StripBoundriesUV: List of UV curves in the parametric domain of Srf that delineates the boundaries of the strips.
CrvSizeReduction: A reduction in size of traced curve while ensuring the Tolerance conservatively.
SubdivTol: Tolerance of the subdivision process. Tolerance is measured in the parametric space of the multivariables.
NumericTol: Numeric tolerance of the numeric stage. The numeric stage is employed only if NumericTol < SubdivTol.

Returns: List of UV curves in the parametric domain of Srf to move the tool along and cover (machine) Srf to within Tolerance.

Description: Computes strips that can be gouging-free flanked milled so that Srf is completely covered within Tolerance. That is, every location on Srf is within tolerance to at least one tool position. Computation is done assuming the tool is of radius zero. I.e. a line. This, as surface can be offseted by tool radius, reducing tool to line. Also computation is performed from VMin boundary of Srf.
See also:
MvarMVStruct **MvarFlecnodalCrvsCreateMVCnstrnts(const CagdSrfStruct *CSrf)

CSrf: To compute the (MV constraints of the) flecnodals for.

Returns: The set of 3 constraints in 4 unknowns to derive the flecnodal curves of CSrf.

Description: Computes the MV constraints of flecnodal curves on surface $S(u, v)$. Denote by $S_{uv}$ the second order derivatives of $S(u, v)$ and by $S_{uvv}$ the third order derivatives. Then, solution of the following 3 equations in 4 unknowns $(u, v, a, b)$ provides the flecnodal curves:

\[
\begin{bmatrix}
   a \\ b
\end{bmatrix} = \begin{bmatrix}
   L \\ M
\end{bmatrix} \begin{bmatrix}
   a \\ b
\end{bmatrix}
\]

\[
\begin{bmatrix}
   L M \\
   M N
\end{bmatrix} \begin{bmatrix}
   a \\ b
\end{bmatrix} = \begin{bmatrix}
   Suu \\ Suv
\end{bmatrix} \begin{bmatrix}
   a \\ b
\end{bmatrix}
\]

or

\[
< a^2 Suu + 2ab Suv + b^2 Svv, n(u, v) > = 0.
\]

\[
\begin{bmatrix}
   Suu \\ Suuv
\end{bmatrix} \begin{bmatrix}
   a \\ b
\end{bmatrix} + \begin{bmatrix}
   Svuu \\ Svuv
\end{bmatrix} \begin{bmatrix}
   a \\ b
\end{bmatrix} = 0,
\]

or

\[
< a^3 Suuu + 3a^2b Suuv + 3ab^2 Suvv + b^3 Svvv, n(u, v) > = 0.
\]

3. $a * a + b * b = 1$ (A normalization constraint.)

See also: SymbSrfGaussCurvature, UserSrfTopoAspectGraph, SymbEvalSrfAsympDir, MvarSrfSilhInflections, MvarSrfFlecnodalCrvs,
8.2.225 MvarGetMiniumIntnPar (mvtrmpcr.c:1549)

static CagdPtStruct *MvarGetMiniumIntnPar(CagdCrvStruct *TrimmedBis, CagdRType *Pt, CagdPtStruct *Inter, CagdPType LeftNormal)

TrimmedBis: The input curve in CagdCrvStruct.
Pt: The input point - CagdRType.
Inter: List of intersection parameters obtained using SymbLclDistCrvLine.
LeftNormal: Left Normal of TrimmedBis at the point Pt.
Returns: Return the TrimmedBis parameter.

Description: This function returns the minimum intersection parameter of the curve with the Line after confirming that the vector between the discontinuity point and the intersection parameter is in the same direction to the Left hand normal.
See also: SymbLclDistCrvLine,

8.2.226 MvarGetPointsMeshIndices (mvaraux.c:1314)

int MvarGetPointsMeshIndices(const MvarMVStruct *MV, int *Indices)

MV: Whose indices are for.
Indices: To compute the exact point location in MV - Points
Returns: Index of point whose indices are Indices in MV - Points.

Description: Given indices into the control mesh, return the index in the vector representation Points of that single point.
See also: MvarMeshIndicesFromIndex, MvarGetPointsPeriodicMeshIndices,

8.2.227 MvarGetPointsPeriodicMeshIndices (mvaraux.c:1366)

int MvarGetPointsPeriodicMeshIndices(const MvarMVStruct *MV, int *Indices)

MV: Whose indices are for.
Indices: To compute the exact point location in MV - Points
Returns: Index of point whose indices are Indices in MV - Points.

Description: Given indices into the control mesh, return the index in the vector representation Points of that single point. MV can be periodic.
See also: MvarMeshIndicesFromIndex, MvarGetPointsMeshIndices,

8.2.228 MvarHFDistAntipodalCrvCrvC1 (hasdrf2d.c:157)

MvarPtStruct *MvarHFDistAntipodalCrvCrvC1(const CagdCrvStruct *Crv1, const CagdCrvStruct *Crv2, CagdRType Epsilon)

Crv1, Crv2: The two curves to solve for their antipodal locations.
Epsilon: Tolerance of computation.
Returns: List of pairs of parameters in the t & r coefficients.

Description: Computes the antipodal points of the given two curves by solving:
< C1(t) - C2(r), C1'(t) > = 0,
< C1(t) - C2(r), C2'(r) > = 0,
< C1(t) - C2O(r), C1'(t) > = 0, \hspace{1cm} (Only during subdivision step)
< C1(t) - C2O(r), C2'(r) > = 0, \hspace{1cm} (Only during subdivision step)

where C2O is an offset curve of C2 by amount larger than subdivision tol. The last two equations are used to purge intersection locations as they cause the first two equations to vanish.
See also: MvarCrvAntipodalPoints, MvarCntctTangentialCrvCrvC1,
8.2.229 MvarHFDistAntipodalCrvSrfC1 (hasdrf3d.c:143)

MvarPtStruct *MvarHFDistAntipodalCrvSrfC1(const CagdSrfStruct *Srf1, const CagdCrvStruct *Crv2)

Srf1, Crv2: A surface and a curve to solve for their antipodal locations.
Returns: List of pairs of parameters in the uv & t coefficients.
Description: Computes the antipodal points of the given surface and curve by solving:
\[
\begin{align*}
\langle C_2(t) - S_1(u, v), \frac{dS_1(u, v)}{du} \rangle &= 0, \\
\langle C_2(t) - S_1(u, v), \frac{dS_1(u, v)}{dv} \rangle &= 0, \\
\langle C_2(t) - S_1(u, v), \frac{dC_2(t)}{dt} \rangle &= 0.
\end{align*}
\]
See also: MvarSrfAntipodalPoints.

8.2.230 MvarHFDistAntipodalSrfSrfC1 (hasdrf3d.c:406)

MvarPtStruct *MvarHFDistAntipodalSrfSrfC1(const CagdSrfStruct *Srf1, const CagdSrfStruct *Srf2)

Srf1, Srf2: The two surfaces to solve for their antipodal locations.
Returns: List of pairs of parameters in the uv & st coefficients.
Description: Computes the antipodal points of the given two surfaces by solving:
\[
\begin{align*}
\langle S_2(r, t) - S_1(u, v), \frac{dS_1(u, v)}{du} \rangle &= 0, \\
\langle S_2(r, t) - S_1(u, v), \frac{dS_1(u, v)}{dv} \rangle &= 0, \\
\langle S_2(r, t) - S_1(u, v), \frac{dS_2(s, t)}{ds} \rangle &= 0, \\
\langle S_2(r, t) - S_1(u, v), \frac{dS_2(s, t)}{ds} \rangle &= 0.
\end{align*}
\]
See also: ,

8.2.231 MvarHFDistBisectSrfSrfC1 (hasdrf3d.c:582)

MvarHFDistPairParamStruct *MvarHFDistBisectSrfSrfC1(const CagdSrfStruct *Srf1, const CagdSrfStruct *Srf2)

Srf1: First surface to intersect its self-bisector with Srf2.
Srf2: Second surface to intersect against the self bisector of Srf1.
Returns: Linkedlist of all detected intersections. Note each detected intersection holds two parameter locations of Srf1.
Description: Compute the intersection locations of (C1 cont) Srf2 with the self bisectors of (C1 cont.) Srf1, if any. The solution is computed by solving the following set of constrains:
\[
\begin{align*}
|| S_2(s, t) - S_1(a, b) ||^2 &= || S_2(s, t) - S_1(c, d) ||^2, \\
\langle S_2(s, t) - S_1(a, b), \frac{dS_1(a, b)}{da} \rangle &= 0, \\
\langle S_2(s, t) - S_1(a, b), \frac{dS_1(a, b)}{db} \rangle &= 0, \\
\langle S_2(s, t) - S_1(c, d), \frac{dS_1(c, d)}{dc} \rangle &= 0, \\
\langle S_2(s, t) - S_1(c, d), \frac{dS_1(c, d)}{dd} \rangle &= 0.
\end{align*}
\]
augmented with
\[
\langle (S_1(a, b) - S_1(c, d)) \times (S_1(a, b) + S_1(c, d) - 2S_2(s, t)), NS_2(s, t) \rangle = 0,
\]
where NS2 is a (non normalized) normal field of S2.
The first equation above (equal distance to two different locations in C1) could be rewritten as:
\[
\langle S_1(a, b) + S_1(c, d) - 2S_2(s, t), S_1(a, b) - S_1(c, d) \rangle = 0,
\]
which hints to the fact that this equation vanish for ((a, b) == (c, d)). Hence, in the solution process, we eliminate the ((a, b) == (c, d)) factors from it.
See also:
8.2.232 MvarHFDistCrvCrvC1 (hasdrf2d.c:1110)

CagdRType MvarHFDistCrvCrvC1(const CagdCrvStruct *Crv1,
const CagdCrvStruct *Crv2,
MvarHFDistParamStruct *Param1,
MvarHFDistParamStruct *Param2,
CagdRType Epsilon)

Crv1: First Crv to measure its hausdorff distance to Crv2.
Crv2: Second Crv to measure its hausdorff distance to Crv1.
Param1: Where to return the parameter value(s) of Crv1 with the maximal Hausdorff distance. Can be more than one location!
Param2: Where to return the parameter value(s) of Crv2 with the maximal Hausdorff distance. Can be more than one location!
Epsilon: Tolerance of computation.

Returns: The Hausdorff distance.

Description: Computes the Hausdorff distance between two C\(^1\) cont. curves, C1 and C2. The curves are assumed to be either in R2 or R3. The extreme distance between two curves could happen at: + The end points of the curves. + Antipodal locations where:

\[ \begin{align*}
    C_1'(t) \cdot (C_1(t) - C_2(r)) &= 0, \\
    C_2'(r) \cdot (C_1(t) - C_2(r)) &= 0.
\end{align*} \]

+ Locations where C1 crosses the self bisector of C2 (or vice versa): Let Bi(x,y) = 0 be self bisector of Ci(t), and Cj(t) = (xj(t), yj(t)). Then, solve for:

\[ \begin{align*}
    || C_2(r) - C_1(s) ||^2 &= || C_2(r) - C_1(t) ||^2, \\
    < C_2(r) - C_1(s), C_1'(s) > &= 0, \\
    < C_2(r) - C_1(t), C_1'(t) > &= 0.
\end{align*} \]

All the above equations hold for R2 and for R3.

See also:

8.2.233 MvarHFDistFromCrvToCrvC1 (hasdrf2d.c:920)

CagdRType MvarHFDistFromCrvToCrvC1(const CagdCrvStruct *CCrv1,
const CagdCrvStruct *CCrv2,
MvarHFDistParamStruct *Param1,
MvarHFDistParamStruct *Param2,
CagdRType Epsilon)

CCrv1: First Crv to measure its hausdorff distance to CCrv2.
CCrv2: Second Crv to measure its hausdorff distance from CCrv1.
Param1: Where to return the parameter value(s) of Crv1 with the maximal Hausdorff distance. Can be more than one location!
Param2: Where to return the parameter value(s) of Crv2 with the maximal Hausdorff distance. Can be more than one location!
Epsilon: Tolerance of computation.

Returns: The Hausdorff distance.

Description: Computes the one sided Hausdorff distance between two C\(^1\) cont. curves, from C1 to C2. The curves are assumed to be either in R2 or R3. The one sided extreme distance between two curves could happen at:
+ The end points of curve C1 or curve C2. + Antipodal locations or locations where:

\[ \begin{align*}
    C_1'(t) \cdot (C_1(t) - C_2(r)) &= 0, \\
    C_2'(r) \cdot (C_1(t) - C_2(r)) &= 0,
\end{align*} \]

that are also global distance minima from C1(t) to any point on C2. + Locations where C1 crosses the self bisector of C2 that are also local distance minima from C1 to any point on C2.

All the above equations hold for R2 and for R3.

See also:
8.2.234 MvarHFDistFromCrvToSrfC1 (hasdrf3d.c:295)

CagdRType MvarHFDistFromCrvToSrfC1(const CagdCrvStruct *Crv1,
const CagdSrfStruct *Srf2,
MvarHFDistParamStruct *Param1,
MvarHFDistParamStruct *Param2)

Crv1: First crv to measure its hausdorff distance to Srf2.
Srf2: Second srf to measure its hausdorff distance from Crv1.
Param1: Where to return the parameter value(s) of Crv1 with the maximal Hausdorff distance. Can be more
than one location!
Param2: Where to return the parameter value(s) of Srf2 with the maximal Hausdorff distance. Can be more
than one location!
Returns: The Hausdorff distance.
Description: Computes the one sided Hausdorff distance between a C^1 cont. curve and a C^1 cont. surface,
from C1 to S2. The shapes are assumed to be in R3 and non intersecting. The one sided extreme distance between
the two shapes could happen at: + The corner/end points of curve C1 or surface S2. + Antipodal locations between
the two shapes. + Locations where C1 crosses the self bisector of S2 that are also local distance minima from C1 to
any point on S2.
See also: MvarHFDistFromSrfToSrfC1, MvarHFDistFromSrfToCrvC1,

8.2.235 MvarHFDistFromSrfToCrvC1 (hasdrf3d.c:333)

CagdRType MvarHFDistFromSrfToCrvC1(const CagdSrfStruct *Srf1,
const CagdCrvStruct *Crv2,
MvarHFDistParamStruct *Param1,
MvarHFDistParamStruct *Param2)

Srf1: First srf to measure its hausdorff distance to Crv2.
Crv2: Second crv to measure its hausdorff distance from Srf1.
Param1: Where to return the parameter value(s) of Srf1 with the maximal Hausdorff distance. Can be more
than one location!
Param2: Where to return the parameter value(s) of Crv2 with the maximal Hausdorff distance. Can be more
than one location!
Returns: The Hausdorff distance.
Description: Computes the one sided Hausdorff distance between a C^1 cont. surface and a C^1 cont. curve,
from S1 to C2 The shapes are assumed to be in R3 and non intersecting. The one sided extreme distance between
the two shapes could happen at: + The corner/end points of surface S1 or curve C2. + Antipodal locations between
the two shapes. + Locations where S1 crosses the self bisector of C2 that are also local distance minima from S1 to
any point on C2.
See also: MvarHFDistFromSrfToSrfC1,

8.2.236 MvarHFDistFromSrfToSrfC1 (hasdrf3d.c:653)

CagdRType MvarHFDistFromSrfToSrfC1(const CagdSrfStruct *CSrf1,
const CagdSrfStruct *CSrf2,
MvarHFDistParamStruct *Param1,
MvarHFDistParamStruct *Param2)

CSrf1: First Srf to measure its hausdorff distance to Srf2.
CSrf2: Second Srf to measure its hausdorff distance from Srf1.
Param1: Where to return the parameter value(s) of Srf1 with the maximal Hausdorff distance. Can be more
than one location!
Param2: Where to return the parameter value(s) of Srf2 with the maximal Hausdorff distance. Can be more
than one location!
Returns: The Hausdorff distance.
Description: Computes the one sided Hausdorff distance between two C^1 cont. surfaces from S1 to S2. The
surfaces are assumed to be in R3 and non intersecting. The one sided extreme distance between two surfaces could
happen at: + The corner points of surface S1 or surface S2. + Antipodal locations between the two surfaces. +
Locations where S1 crosses the self bisector of S2 that are also local distance minima from S1 to any point on S2.
See also:
MvarHFDistPairParamStruct *MvarHFDistInterBisectCrvCrvC1(
    const CagdCrvStruct *CCrv1,
    const CagdCrvStruct *CCrv2,
    CagdRType Epsilon)

CCrv1: First curve to intersect its self-bisector with Crv2.
CCrv2: Second curve to intersect against the self bisector of Crv1.

Epsilon: Tolerance of computation.

Returns: Linked list of all detected intersections. Note each detected intersection holds two parameters of Crv1.

Description: Compute the intersection locations of (C^1 cont) Crv2 with the self bisectors of (C^1 cont.) Crv1, if any. The solution is computed by solving the following cases:
1. The curve-curve self bisector of Crv1, intersected with Crv2:
   \[ \| C_2(w) - C_1(u) \|^2 = \| C_2(w) - C_1(v) \|^2, \]
   \[ < C_2(w) - C_1(u), C_1'(u) > = 0, \]
   \[ < C_2(w) - C_1(v), C_1'(v) > = 0. \]
   The first equations above (equal distance to two different locations in C1) could be rewritten as:
   \[ < C_1(u) + C_1(v) - 2C_2(w), C_1(u) - C_1(v) > = 0, \]
   which hints to the fact that this equation vanish for (u == v). Hence, in the solution process, we eliminate the (u - v) factors from it.
2. Endpoint-curve self bisectors of Crv1, intersected with Crv2 (2 cases): Let B(t) be equal to the self bisector of Crv1 with one of its end points. Then, solve for B(t) = C2(w).
3. Endpoint-Endpoint self bisectors of Crv1, intersected with Crv2: solved as a line (Endpoint-Endpoint bisector) - Crv2 intersection.

See also:
MvarHFDistInterBisectCrvCrvC1Crvtr (hasdref2d.c:340)

MvarHFDistPairParamStruct *MvarHFDistInterBisectCrvCrvC1Crvtr(
    CagdCrvStruct *Crv1,
    CagdCrvStruct *Crv2,
    CagdRType Epsilon)

Crv1: First curve to intersect its self-bisector with Crv2.
Crv2: Second curve to intersect against the self bisector of Crv1.

Epsilon: Tolerance of computation.

Returns: Linked list of all detected intersections. Note each detected intersection holds two parameters of Crv1.

Description: Old version of MvarHFDistInterBisectCrvCrvC1 that splits the input curves at curvature max. locations whereas MvarHFDistInterBisectCrvCrvC1 eliminates the (u - v) terms directly. Computes the intersection locations of (C^1 cont) Crv2 with the self bisectors of (C^1 cont.) Crv1, if any. The solution is computed by solving the following cases:
1. The curve-curve self bisector of Crv1, intersected with Crv2:
   \[ \| C_2(w) - C_1(u) \|^2 = \| C_2(w) - C_1(v) \|^2, \]
   \[ < C_2(w) - C_1(u), C_1'(u) > = 0, \]
   \[ < C_2(w) - C_1(v), C_1'(v) > = 0. \]
   The first equations above (equal distance to two different locations in C1) could be rewritten as:
   \[ < C_1(u) + C_1(v) - 2C_2(w), C_1(u) - C_1(v) > = 0, \]
   which hints to the fact that this equation vanish for (u == v). To speed up the process we also add a constraint that the distance from C2 to its two foot point should be greater than the radius of curvature of C1.
2. Endpoint-curve self bisectors of Crv1, intersected with Crv2 (2 cases): Let B(t) be equal to the self bisector of Crv1 with one of its end points. Then, solve for B(t) = C2(w).
3. Endpoint-Endpoint self bisectors of Crv1, intersected with Crv2: solved as a line (Endpoint-Endpoint bisector) - Crv2 intersection.

See also: MvarHFDistInterBisectCrvCrvC1,
8.2.239 MvarHFDistInterBisectSrfSrfC1 (hasdrf3d.c:615)

MvarHFDistPairParamStruct *MvarHFDistInterBisectSrfSrfC1(
    const CagdSrfStruct *Srf1,
    const CagdSrfStruct *Srf2)

Srf1: First curve to intersect its self-bisector with Srf2.
Srf2: Second curve to intersect against the self bisector of Srf1.

Returns: Linked list of all detected intersections. Note each detected intersection holds two parameters locations of Srf1.

Description: Compute the intersection locations of (C^1 cont) Srf2 with the self bisectors of (C^1 cont.) Srf1, if any. The solution is computed by solving the following set of contraints:
1. The surface-surface self bisector of Srf1, intersected with Srf2
2. boundary-curve self bisectors of Srf1, intersected with Srf2
3. corner-point self bisectors of Srf1, intersected with Srf2

See also:

8.2.240 MvarHFDistPointSrfC1 (hasdrf3d.c:44)

CagdRType MvarHFDistPointSrfC1(const CagdPType P,
                               const CagdSrfStruct *Srf,
                               MvarHFDistParamStruct *Param,
                               CagdBType MinDist)

P: Point to measure its Hausdorff distance to surface Srf.
Srf: Srf to measure its hausdorff distance to point Pt.
Param: Where to return the parameter value with the maximal distance.
MinDist: TRUE for minimal distance, FALSE for maximal.

Returns: The Hausdorff distance.

Description: Computes the Hausdorff distance between a point and a C^1 cont. surface. The surface and point are assumed to be either in R3. The extreme distance between a point and a surface could happen either at the corner points of surface Srf, the boundary curves of Srf, or when

\[ <S(u, v) - P> dS'(u, v)/du = 0, \]
\[ <S(u, v) - P> dS'(u, v)/dv = 0. \]

See also: SymbDistSrfPoint

8.2.241 MvarHFDistSrfCrvC1 (hasdrf3d.c:366)

CagdRType MvarHFDistSrfCrvC1(const CagdSrfStruct *Srf1,
                             const CagdCrvStruct *Crv2,
                             MvarHFDistParamStruct *Param1,
                             MvarHFDistParamStruct *Param2)

Srf1: First srf to measure its hausdorff distance to Crv2.
Crv2: Second crv to measure its hausdorff distance to Srf1.
Param1: Where to return the parameter value(s) of Srf1 with the maximal Hausdorff distance. Can be more than one location!
Param2: Where to return the parameter value(s) of Crv2 with the maximal Hausdorff distance. Can be more than one location!

Returns: The Hausdorff distance.

Description: Computes Hausdorff distance between a C^1 cont. surface and a C^1 cont. curve, S1 and C2. The shapes are assumed to be in R3 and non intersecting.

See also: MvarHFDistSrfSrfC1,
8.2.242  MvarHFDistSrfSrfC1 (hasdrf3d.c:820)

CagdRType MvarHFDistSrfSrfC1(const CagdSrfStruct *Srf1,
const CagdSrfStruct *Srf2,
MvarHFDistParamStruct *Param1,
MvarHFDistParamStruct *Param2)

Srf1: First Srf to measure its hausdorff distance to Srf2.
Srf2: Second Srf to measure its hausdorff distance to Srf1.

Param1: Where to return the parameter value(s) of Srf1 with the maximal Hausdorff distance. Can be more
than one location!
Param2: Where to return the parameter value(s) of Srf2 with the maximal Hausdorff distance. Can be more
than one location!

Returns: The Hausdorff distance.

Description: Computes Hausdorff distance between two C^1 cont. surfaces, S1 and S2. The surfaces are
assumed to be in R3 and non intersecting.

See also:

8.2.243  MvarHFExtremeLclDistPointCrvC1 (hasdrf2d.c:99)

CagdRType MvarHFExtremeLclDistPointCrvC1(CagdPType P,
const CagdCrvStruct *Crv1,
const CagdCrvStruct *Crv2,
MvarHFDistParamStruct *Param2,
CagdRType Epsilon)

P: Point on Crv1 to measure its extreme distance to curve Crv2.
Crv1: First curve that contains P.
Crv2: Second curve to measure extreme distance to from P.

Param2: Where to return the parameter value of Crv2 is returned.
Epsilon: Tolerance of computation.

Returns: The local extreme distance found, 0.0 if none.

Description: Computes the local extreme distance between a point P of Crv1 and Crv2. At the local extreme
distance location on Crv2, denoted Q, verify that Q is closest to P than to any other location on Crv1. Returns
maximal local extreme distance found, 0.0 if none.

See also: SymbLclDistCrvPoint,

8.2.244  MvarHFExtremeLclDistPointSrfC1 (hasdrf3d.c:89)

CagdRType MvarHFExtremeLclDistPointSrfC1(const CagdPType P,
const CagdSrfStruct *Srf1,
const CagdSrfStruct *Srf2,
MvarHFDistParamStruct *Param2)

P: Point on Srf1 to measure its extreme distance to curve Srf2.
Srf1: First curve that contains P.
Srf2: Second curve to measure extreme distance to from P.

Param2: Where to return the parameter value of Srf2 is returned.

Returns: The local extreme distance found, 0.0 if none.

Description: Computes the local extreme distance between a point P of Srf1 and Srf2. At the local extreme
distance location on Srf2, denoted Q, verify that Q is closest to P than to any other location on Srf1. Returns
maximal local extreme distance found, 0.0 if none.

See also: SymbLclDistSrfPoint,
8.2.245 MvarImplicitCrvExtreme (mvartopo.c:34)

MvarPtStruct *MvarImplicitCrvExtreme(const CagdSrfStruct *Srf,
                                       CagdSrfDirType Dir,
                                       CagdRType SubdivTol,
                                       CagdRType NumerTol)

Srf: Implicit surface definition.
Dir: U to compute U-extreme values in Srf = 0, V for V-extreme.
SubdivTol: Tolerance of the solution. This tolerance is measured in the parametric space of the surfaces.
NumerTol: Numeric tolerance of a possible numeric improvement stage. The numeric stage is employed if NumerTol < SubdivTol.

Returns: The computed extreme values, in the parametric space of surface Srf.

Description: Computes U or V extreme values of the zero set (implicit form) of Srf = 0.

8.2.246 MvarIrit2DTrTo2DMVTrs (mvar_pll.c:1117)

MvarTriangleStruct *MvarIrit2DTrTo2DMVTrs(IPObjectStruct *ObjTrs)

ObjTrs: Irit polygons.

Returns: A list of triangles.

Description: Converts a list of irit planar triangles (given as polygon objects) into a list of Mvar planar (2D) triangle structures.

See also: MvarCnvrtMVTrsToIritPolygons, MvarCnvrtMVPolysToIritPolys,

8.2.247 MvarLclDistSrfLine (mvardist.c:283)

MvarPtStruct *MvarLclDistSrfLine(const CagdSrfStruct *CSrf,
                                  const CagdPType LnPt,
                                  const CagdVType LnDir,
                                  CagdRType SubdivTol,
                                  CagdRType NumericTol)

CSrf: The surface to find its nearest (farthest) point to Line.
LnPt: A point on the line to consider.
LnDir: The direction of the line to consider.
SubdivTol: Tolerance of the first zero set finding subdivision stage.
NumericTol: Tolerance of the second zero set finding numeric stage.

Returns: A list of parameter values of extreme distance locations.

Description: Given a surface and a line, finds the nearest point (if MinDist) or the farthest location (if MinDist FALSE) from the surface to the given line. This function assumes the surface does not intersect the line. Returned is the parameter value of the surface. Only internal extrema are considered. Let S and N be the surface and its normal field. Then the extrema points are computed as the simultaneous solution of,

\[ < (S - LnPt) \times N, LnDir > = 0, \]
\[ < N, LnDir > = 0. \]

See also: MvarDistSrfLine, MvarDistCrvLine,
### 8.2.248 MvarLclDistSrfPoint (mvardist.c:140)

MvarPtStruct *MvarLclDistSrfPoint(const CagdSrfStruct *CSrf,
const CagdPType Pt,
CagdRType SubdivTol,
CagdRType NumericTol)

**CSrf**: The surface to find its extreme distance locations to Pt.

**Pt**: The point to find the extreme distance locations from Srf.

**SubdivTol**: Tolerance of the first zero set finding subdivision stage.

**NumericTol**: Tolerance of the second zero set finding numeric stage.

**Returns**: A list of parameter values of extreme distance locations.

**Description**: Given a surface and a point, find the local extremum distance points on the surface to the given point. Only interior extrema are considered. Returned is a list of parameter value with local extremum. Computes the simultaneous zeros of:

\[
(Srf(u, v) - Pt) \cdot \frac{dSrf(u, v)}{Du} = 0.
\]
\[
(Srf(u, v) - Pt) \cdot \frac{dSrf(u, v)}{Dv} = 0.
\]

### 8.2.249 MvarLineFitToPts (mvar_int.c:273)

CagdRType MvarLineFitToPts(const MvarVecStruct *VecList,
MvarVecStruct *LineDir,
MvarVecStruct *LinePos)

**VecList**: List of vectors to interpolate/least square approximate.

**LineDir**: A unit vector of the line.

**LinePos**: A point on the computed line.

**Returns**: Average distance between a vector and the fitted line, or IRIT_INFNTY if failed.

**Description**: Given set of vecs, VecList, fits a line using least squares fit to them.

See also: CagdLineFitToPts.

### 8.2.250 MvarLinePlaneInter (mvar_vec.c:682)

MvarVecStruct *MvarLinePlaneInter(const MvarVecStruct *P,
const MvarVecStruct *V,
const MvarPlaneStruct *Pln,
CagdRType *Param)

**P, V**: Point and direction of line to intersect with hyperplane. Both P and V are of length Dim.

**Pln**: Hyperplane to intersect with line.

**Param**: Will be updated with the parameter along which the intersection has occured, as Inter = P + V * t.

**Returns**: The intersection point.

**Description**: Compute the intersection of a line and a hyperplane, in $\mathbb{R}^\text{Dim}$.

### 8.2.251 MvarMSCircOfThreeCurves (ms_circ.c:230)

int MvarMSCircOfThreeCurves(const CagdCrvStruct *OrigCrv1,
const CagdCrvStruct *OrigCrv2,
const CagdCrvStruct *OrigCrv3,
CagdRType Center[2],
CagdRType *Radius,
CagdRType SubdivTol,
CagdRType NumericTol)
**OrigCrv1, OrigCrv2, OrigCrv3:** The three curves to consider. Curves could be identical.

**Center:** Center of the computed MSC.

**Radius:** Radius of the computed MSC.

**SubdivTol, NumerTol:** Of computation.

**Returns:** TRUE if successful, FALSE otherwise

**Description:** Computes the minimum spanning circle to three curves that are disjoint. Assumption is made that the MSC is tangent to all three curves.

**See also:** MvarMSCircOfThreeCurves, MvarMinSpanCirc, MVarIsCrvInsideCirc, MvarSkel2DInter3Prims

### 8.2.252 MvarMSCircOfTwoCurves (ms\_circ.c:66)

```c
int MvarMSCircOfTwoCurves(const CagdCrvStruct *OrigCrv1,
   const CagdCrvStruct *OrigCrv2,
   CagdRType Center[2],
   CagdRType *Radius,
   CagdRType SubdivTol,
   CagdRType NumerTol)
```

- **OrigCrv1, OrigCrv2:** The two curves to consider.
- **Center:** Center of the computed MSC.
- **Radius:** Radius of the computed MSC.
- **SubdivTol, NumerTol:** Of computation.
- **Returns:** TRUE if successful, FALSE otherwise

**Description:** Computes the minimum spanning circle to two curves that are disjoint. Assumption is made that the MSC is tangent to both curves.

**See also:** MvarMSCircOfThreeCurves, MvarMinSpanCirc, MVarIsCrvInsideCirc

### 8.2.253 MvarMV3VarFactorUMinusV (hasdrf2d.c:560)

```c
MvarMVStruct *MvarMV3VarFactorUMinusV(MvarMVStruct *MV)
```

- **MV:** 3-variate (rep. as multivariate) to factor out (u - v) term from.
- **Returns:** Factored out 3-variate, (rep. as a multivariate).

**Description:** Removes a (u - v) factor from the given scalar three-multivariate which is assumed to be a 3-variate \( F(u, v, w) \). The \( u, v \) parameters are the first two parameters of the 3-variate.

**See also:** BspSrfFactorUMinusV, BzrSrfFactorUMinusV, MvarMV4VarFactorUMinusV, MvarMV4VarFactorUMinusR

### 8.2.254 MvarMV4VarFactorUMinusR (selfintr.c:233)

```c
MvarMVStruct *MvarMV4VarFactorUMinusR(const MvarMVStruct *MV)
```

- **MV:** 4-variate (rep. as multivariate) to factor out (u - r) term from.
- **Returns:** Factored out bivariate, (rep. as a multivariate).

**Description:** Removes a (u - r) factor from the given scalar four multivariate which is assumed to be a 4-variate \( S(u, v, r, t) \). Note that typically a B spline 4-var will not have (u - r) in all its patches so use this function with care - this function does not verify this existence. It is more common to have (u - r) only along symmetric diagonal patches of the Bsplines, after symbolic operations like \( S_1(u, v) - S_2(r, t) \).

**See also:** BspSrfFactorUMinusV, BzrSrfFactorUMinusV, MvarMV5VarFactorUMinusR, MvarMV4VarFactorUMinusV, MvarMV3VarFactorUMinusV
8.2.255 MvarMV4VarFactorUMinusV (selfintr.c:168)

MvarMVStruct *MvarMV4VarFactorUMinusV(const MvarMVStruct *MV)

MV: 4-variate (rep. as multivariate) to factor out (u - v) term from.

Returns: Factored out 4-variate, (rep. as a multivariate).

Description: Removes a (u - v) factor from the given scalar four multivariate which is assumed to be a 4-variate \( F(u, v, r, t) \). The u, v parameters are the first two parameters of the 4-variate. The (u - v) terms are factored out along the diagonal of the third/fourth parameters which are assumed to be symmetric as well. Note that typically a Bezier 4-var will not have (u - v) in all its all its patches so use this function with care - this function does not verify this existence. It is more common to have (u - v) only along symmetric diagonal patches of the Bezines, after symbolic operations like \( S1(u, v) - S2(r, t) \).

See also: BspSrfFactorUMinusV, BzrSrfFactorUMinusV, MvarMV2varFactorUMinusV, MvarMV3VarFactorUMinusV,

8.2.256 MvarMVAdd (mvar_sym.c:37)

MvarMVStruct *MvarMVAdd(const MvarMVStruct *MV1, const MvarMVStruct *MV2)

MV1, MV2: Two multivariate to add up coordinatewise.

Returns: The summation of MV1 + MV2 coordinatewise.

Description: Given two multivariate - add them coordinatewise. The two multivariates are promoted to same point type before the operation can take place. Furthermore, order and continuity are matched as well.

See also: MvarMVSub, MvarMeshAddSub, MvarMVMult,

8.2.257 MvarMVAuxDomainSlotCopy (mvar_aux.c:280)

int MvarMVAuxDomainSlotCopy(MvarMVStruct *MVDst, const MvarMVStruct *MVSrc)

MVDst: Destination multivariate to copy domain slot to.

MVSrc: Source multivariate to copy domain slot from.

Returns: TRUE if successful, FALSE otherwise.

Description: Copies the optional aux. domain slot from MVSrc to MVDst.

See also: MvarMVAuxDomainSlotReset, MvarMVAuxDomainSlotSet, MvarMVAuxDomainSlotSetRel,

8.2.258 MvarMVAuxDomainSlotGet (mvar_aux.c:381)

int MvarMVAuxDomainSlotGet(const MvarMVStruct *MV,
                           CagdRType *Min,
                           CagdRType *Max,
                           int Dir)

MV: Multivariate to get its aux. domain slot.

Min, Max: The domain of this Bezier multivariate.

Dir: The direction to get the domain of MV.

Returns: TRUE if aux. domain exist and can get domain, FALSE otherwise.

Description: Gets one aux. domain range in the given Direction. The Min/Max arrays are assumed to be of sufficiently large enough space to hold all dimensions, if Axis == -1.

See also: MvarMVAuxDomainSlotReset, MvarMVAuxDomainSlotCopy, MvarMVAuxDomainSlotSet, MvarMV-

VAuxDomainSlotSetRel,
8.2.259  MvarMVAuxDomainSlotReset (mvar_aux.c:248)

void MvarMVAuxDomainSlotReset(MvarMVStruct *MV)

    MV: Multivariate to reset domain slot.
    Returns: void
    Description: Resets an optional aux. domain slot inside MV for use in cases where MV has no explicit domain (such as Bezier and/or Power basis).
    See also:  MvarMVAuxDomainSlotCopy, MvarMVAuxDomainSlotSet, , MvarMVAuxDomainSlotSetRel,

8.2.260  MvarMVAuxDomainSlotSet (mvar_aux.c:318)

void MvarMVAuxDomainSlotSet(MvarMVStruct *MV,
                           CagdRType Min,
                           CagdRType Max,
                           int Dir)

    MV: Multivariate to set its aux. domain slot.
    Min, Max: The domain of this Bezier multivariate.
    Dir: The direction where to set the MV domain.
    Returns: void
    Description: Sets one aux. domain range in the given direction.
    See also:  MvarMVAuxDomainSlotReset, MvarMVAuxDomainSlotCopy, , MvarMVAuxDomainSlotGet, MvarMVAuxDomainSlotSetRel,

8.2.261  MvarMVAuxDomainSlotSetRel (mvar_aux.c:348)

void MvarMVAuxDomainSlotSetRel(MvarMVStruct *MV,
                               CagdRType Min,
                               CagdRType Max,
                               int Dir)

    MV: Multivariate to set its aux. domain slot.
    Min, Max: The relative to current domain new interval of this Bezier multivariate.
    Dir: The direction where to set the MV domain.
    Returns: void
    Description: Sets one aux. domain range in the given direction. Input Min/Max is relative to current domain.
    See also:  MvarMVAuxDomainSlotReset, MvarMVAuxDomainSlotCopy, , MvarMVAuxDomainSlotGet, MvarMVAuxDomainSlotSetRel,

8.2.262  MvarMVBBBox (mvar_aux.c:793)

void MvarMVBBBox(const MvarMVStruct *MV, MvarBBBoxStruct *BBox)

    MV: To compute a bounding box for.
    BBox: Where bounding information is to be saved.
    Returns: void
    Description: Computes a bounding box for a multi-variate freeform function.
**8.2.263 MvarMVBiTangentLine** (mvtangnt.c:1160)

```c
MvarPtStruct *MvarMVBiTangentLine(const CagdCrvStruct *Crv1,
const CagdCrvStruct *Crv2,
CagdRType SubdivTol,
CagdRType NumericTol)
```

Crv1, Crv2: The 2 curves to compute their bi-tangent lines for. If Crv1 == Crv2, the self bi-tangent is computed.

SubdivTol: Tolerance of the subdivision process. Tolerance is measured in the parametric space of the multivariates.

NumericTol: Numeric tolerance of the numeric stage. The numeric stage is employed only if NumericTol < SubdivTol.

Returns: Pairs of parameter values on both curves, each pair defines a single bi-tangent.

**Description:** Computes the bi-tangent line of two freeform curves. If Crv1 == Crv2, the self bi-tangent is computed.

See also: SymbTangentToCrvAtTwoPts, MvarMVBiTangents, MvarMVBiTangents2, MvarMVTriTangentLineCreateMVs, MvarMVTriTangentLine,

**8.2.264 MvarMVBiTangents** (mvtangnt.c:62)

```c
MvarPolylineStruct *MvarMVBiTangents(const MvarMVStruct *CMV1,
const MvarMVStruct *CMV2,
CagdRType SubdivTol,
CagdRType NumericTol)
```

CMV1, CMV2: The two multivariates to compute the bi-tangents for.

SubdivTol: Tolerance of the subdivision process. Tolerance is measured in the parametric space of the multivariates.

NumericTol: Numeric tolerance of the numeric stage. The numeric stage is employed only if NumericTol < SubdivTol.

Returns: Plnns on the bi-tangents of the two multivariates.

**Description:** Computes bi-tangents of freeform bivariate. Let,

\[ DMV = MV1(u, v) - MV2(r, s) \]

then, computed the simultaneous solution of the following three equations:

\[
\begin{align*}
\langle \frac{d MV1}{du} x \frac{d MV1}{dv} \rangle < \langle - , - \rangle &= 0, \\
\langle \frac{d MV1}{du} x \frac{d MV2}{dv} \rangle < \langle - , - \rangle &= 0, \\
\langle \frac{d MV1}{du} x \frac{d MV1}{dv} \rangle < \langle - , DMV \rangle &= 0.
\end{align*}
\]

See also: SymbTangentToCrvAtTwoPts, MvarMVBiTangents2, MvarMVTriTangents, MvarMVTriTangentLine,
8.2.265  MvarMVBivarFactorUMinusV  (selfintr.c:68)

    MvarMVStruct *MvarMVBivarFactorUMinusV(const MvarMVStruct *MV)

    MV: Bivariate (rep. as multivriate) to factor out a (u - v) term from.
    Returns: Factored out bivariate, (rep. as a multivriate).
    Description: Removes a (u - v) factor from the given scalar multivariate which is assumed to be a bivariate S(u, v). Note that typically a Bspline surface will not have (u - v) in all its patches so use this function with care - this function does not verify this existence. It is more common to have (u - v) only along symmetric diagonal patches of the Bspline surface, after symbolic operations like C1(u) - C2(v).
    See also: BspSrfFactorUMinusV, BzrSrfFactorUMinusV, MvarMV4VarFactorUMinusVRMinusT, , MvarMV3VarFactorUMinusV,

8.2.266  MvarMVBoundGradient  (mvar_der.c:845)

    MvarMVGradientStruct *MvarMVBoundGradient(const MvarMVStruct *MV)

    MV: Input MV function to compute bounds on its gradient.
    Returns: Holding the set of vectors bounding the gradient of MV in the MVGrad slot.
    Description: Provides a set of vectors that bounds the gradient function of given MV
    See also: MvarMVDerive, MvarMVFreeGradient, MvarMVPrepGradient, , MvarMVEvalGradient, MvarMVEvalGradient2,

8.2.267  MvarMVConesOverlap  (mvcones.c:1641)

    CagdBType MvarMVConesOverlap(MvarMVStruct **MVs, int NumOfZeroMVs)

    MVs: Multivariates to derive their tangency anti-cones.
    NumOfZeroMVs: Size of the vector MVs.
    Returns: TRUE if overlap, FALSE if not.
    Description: Computes the tangency anti-cones of the set of multivariate constraints, and returns whether they overlap or not.
    See also: MVarMVNormalCone, MvarConesOverlapAux,

8.2.268  MvarMVCopy  (mvar_gen.c:299)

    MvarMVStruct *MvarMVCopy(const MvarMVStruct *MV)

    MV: Multi-Variate to duplicate
    Returns: Duplicated multi-variate.
    Description: Allocates and duplicates all slots of a multi-variate structure.

8.2.269  MvarMVCopyList  (mvar_gen.c:426)

    MvarMVStruct *MvarMVCopyList(const MvarMVStruct *MVList)

    MVList: List of multi-varieties to duplicate.
    Returns: Duplicated list of multi-varposites.
    Description: Duplicates a list of multi-variate structures.
8.2.270  MvarMVCrossProd  (mvar_sym.c:496)

MvarMVStruct *MvarMVCrossProd(const MvarMVStruct *MV1,  
const MvarMVStruct *MV2)

MV1, MV2: Two multivariate to multiply and compute a cross product for.

Returns: A vector multivariate representing the cross product of MV1 x MV2.

Description: Given two multivariates - computes their cross product. Returned multivariate is a vector multivariate representing the cross product of the two given multivariates.

See also: MvarMVDotProd, MvarMVVecDotProd, MvarMVScalarScale, MvarMVMultScalar, , MvarMVIvert, MvarMVCrossProd2D, MvarMVCrossProdZ,

8.2.271  MvarMVCrossProd2D  (mvar_sym.c:593)

MvarMVStruct *MvarMVCrossProd2D(const MvarMVStruct *MV1X,  
const MvarMVStruct *MV1Y,  
const MvarMVStruct *MV2X,  
const MvarMVStruct *MV2Y)

MV1X, MV1Y: First pair of scalar multivariates (X, Y) of first funcs.
MV2X, MV2Y: Second pair of scalar multivariates (X, Y) of second funcs.

Returns: A scalar multivariate representing the cross product of MV1X * MV2Y - MV2X * MV1Y.

Description: Given four multivariates - computes their 2D cross product. Returned multivariate is a scalar multivariate representing the cross product of the four given multivariates, as X1 * Y2 - X2 * Y1.

See also: MvarMVDotProd, MvarMVVecDotProd, MvarMVScalarScale, MvarMVMultScalar, , MvarMVIvert, MvarMVCrossProd, MvarMVCrossProdZ,

8.2.272  MvarMVCrossProdZ  (mvar_sym.c:451)

MvarMVStruct *MvarMVCrossProdZ(const MvarMVStruct *MV1,  
const MvarMVStruct *MV2)

MV1, MV2: Two multivariate to multiply and compute a Z component of cross product for.

Returns: A scalar multivariate representing the Z component of the cross product of MV1 x MV2.

Description: Given two multivariates - computes the Z component of the cross product. Returned multivariate is a scalar multivariate representing the Z component of the cross product of the two given multivariates.

See also: MvarMVDotProd, MvarMVVecDotProd, MvarMVScalarScale, MvarMVMultScalar, , MvarMVIvert, MvarMVCrossProd, MvarMVCrossProd2D,

8.2.273  MvarMVDegreeRaise  (mvarrais.c:293)

MvarMVStruct *MvarMVDegreeRaise(const MvarMVStruct *MV, MvarMVDirType Dir)

MV: To raise its degree.
Dir: Direction of degree raising.

Returns: A multivariate with same geometry as MV but with one degree higher.

Description: Returns a new multivariate representing the same curve as MV but with its degree raised by one.
See also: MvarMVDegreeRaiseN, MvarMVDegreeRaise2, MvarMVPwrDegreeRaise,
8.2.274  MvarMVDegreeRaise2 (mvarrais.c:336)  

MvarMVStruct *MvarMVDegreeRaise2(MvarMVStruct *MV, MvarMVDirType Dir)

MV: To raise its degree.
Dir: Direction of degree raising.

Returns: A multivariate with same geometry as MV but with one degree higher.

description: Returns a new multivariate representing the same curve as MV but with its degree raised by one.
see also: MvarMVDegreeRaise, MvarMVDegreeRaise3, MvarMVDegreeRaiseN, MvarMVPwrDegreeRaise

8.2.275  MvarMVDegreeRaise3 (mvarrais.c:418)

MvarMVStruct *MvarMVDegreeRaise3(MvarMVStruct *MV, MvarMVDirType Dir)

MV: To raise its degree.
Dir: Direction of degree raising.

Returns: A multivariate with same geometry as MV but with one degree higher.

description: Returns a new multivariate representing the same curve as MV but with its degree raised by one.
see also: MvarMVDegreeRaiseN, MvarMVDegreeRaise, MvarMVDegreeRaise2, MvarMVPwrDegreeRaise

8.2.276  MvarMVDegreeRaiseN (mvarrais.c:33)

MvarMVStruct *MvarMVDegreeRaiseN(const MvarMVStruct *MV, int *NewOrders)

MV: To raise its degree.
NewOrders: A vector prescribing the new orders of MV. Length of this vector is MV -> Dim.

Returns: A multivariate with same geometry as MV but with higher degrees.

description: Returns a new multivariate representing the same curve as MV but with its degree raised by the NewOrders prescription.
see also: MvarMVDegreeRaise, MvarMVPwrDegreeRaise, MvarMVDegreeRaiseN2

8.2.277  MvarMVDegreeRaiseN2 (mvarrais.c:198)

MvarMVStruct *MvarMVDegreeRaiseN2(MvarMVStruct *MV, int *NewOrders)

MV: To raise its degree.
NewOrders: A vector prescribing the new orders of MV. Length of this vector is MV -> Dim.

Returns: A multivariate with same geometry as MV but with higher degrees.

description: Returns a new multivariate representing the same curve as MV but with its degree raised by the NewOrders prescription.
see also: MvarMVDegreeRaise, MvarMVPwrDegreeRaise, MvarMVDegreeRaiseN

8.2.278  MvarMVDerive (mvar_der.c:35)

MvarMVStruct *MvarMVDerive(const MvarMVStruct *MV, MvarMVDirType Dir)

MV: Multi-Variate to differentiate.
Dir: Direction of differentiation.

Returns: Differentiated multi-variate in direction Dir.

description: Given a multi-variate, computes its partial derivative multi-variate in direction Dir.
see also: MvarMVDeriveBound, MvarBzrMVDerive, MvarBspMVDerive,
8.2.279 MvarMVDeriveAllBounds (mvar_der.c:492)

void MvarMVDeriveAllBounds(const MvarMVStruct *MV, CagdMinMaxType *MinMax)

MV: Multi-Variate to differentiate.
MinMax: Bounds on the derivative values of MV in all directions.
Returns: void
Description: Given a multi-variate, computes its partial derivative multi-variate in all directions.
See also: MvarMVDerive, MvarBzrMVDeriveBound, MvarBspMVDeriveBound,

8.2.280 MvarMVDeriveBound (mvar_der.c:314)

void MvarMVDeriveBound(const MvarMVStruct *MV, MvarMVDirType Dir, CagdRType MinMax[2])

MV: Multi-Variate to differentiate.
Dir: Direction of differentiation.
MinMax: Bounds on the derivative values of MV in direction Dir.
Returns: void
Description: Given a multi-variate, computes its partial derivative multi-variate in direction Dir.
See also: MvarMVDerive, MvarBzrMVDeriveBound, MvarBspMVDeriveBound,

8.2.281 MvarMVDeterminant (mvar_det.c:295)

MvarMVStruct *MvarMVDeterminant(const MvarMVStruct * const *MVsMatrix, int MatSize)

MVsMatrix: The matrix of MVs, as a linear array, with the following double index to linear index convention
- [i][j] <-> [(i - 1) * MatSize + (j - 1)], where i, j = 1, 2, ..., MatSize (double index as in the usual linear
algebra convention).
MatSize: The size in each of the dimensions of the square MVs matrix.
Returns: A scalar field representing the determinant computation.
Description: Computes the expression of a determinant of MVs, recursively. Expansion is always using the first
row. Does not check for a better option, such as a row with more zeros, etc. (Existing zeros means the zero function
as a multivariate).
See also: MvarMVDeterminant2,

8.2.282 MvarMVDeterminant2 (mvar_det.c:41)

MvarMVStruct *MvarMVDeterminant2(const MvarMVStruct *MV11, const MvarMVStruct *MV12,
const MvarMVStruct *MV21, const MvarMVStruct *MV22)

MV11, MV12, MV21, MV22: The four factors of the determinant.
Returns: A scalar field representing the determinant computation.
Description: Computes the expression of MV11 * MV22 - MV12 * MV21, which is a determinant of a 2 by 2
matrix.
See also: MvarMVDeterminant3, MvarSrfDeterminant2, MvarCrvDeterminant2,
8.2.283  MvarMVDeterminant3  (mvar_det.c:80)

MvarMVStruct *MvarMVDeterminant3(const MvarMVStruct *MV11,
    const MvarMVStruct *MV12,
    const MvarMVStruct *MV13,
    const MvarMVStruct *MV21,
    const MvarMVStruct *MV22,
    const MvarMVStruct *MV23,
    const MvarMVStruct *MV31,
    const MvarMVStruct *MV32,
    const MvarMVStruct *MV33)

MV11, MV12, MV13: The nine factors of the determinant.
MV21, MV22, MV23: 
MV31, MV32, MV33: 

Returns: A scalar field representing the determinant computation.

Description: Computes the expression of a 3 by 3 determinants.
See also: MvarMVDeterminant2, MvarMVDeterminant4, SymbSrfDeterminant3, SymbCrvDeterminant3,

8.2.284  MvarMVDeterminant4  (mvar_det.c:137)

MvarMVStruct *MvarMVDeterminant4(const MvarMVStruct *MV11,
    const MvarMVStruct *MV12,
    const MvarMVStruct *MV13,
    const MvarMVStruct *MV14,
    const MvarMVStruct *MV21,
    const MvarMVStruct *MV22,
    const MvarMVStruct *MV23,
    const MvarMVStruct *MV24,
    const MvarMVStruct *MV31,
    const MvarMVStruct *MV32,
    const MvarMVStruct *MV33,
    const MvarMVStruct *MV34,
    const MvarMVStruct *MV41,
    const MvarMVStruct *MV42,
    const MvarMVStruct *MV43,
    const MvarMVStruct *MV44)

MV11, MV12, MV13, MV14: The 16 factors of the determinant.
MV21, MV22, MV23, MV24: 
MV31, MV32, MV33, MV34: 
MV41, MV42, MV43, MV44: 

Returns: A scalar field representing the determinant computation.

Description: Computes the expression of a 4 by 4 determinants.
See also: MvarMVDeterminant3, MvarMVDeterminant5,

8.2.285  MvarMVDeterminant5  (mvar_det.c:219)

MvarMVStruct *MvarMVDeterminant5(const MvarMVStruct *MV11,
    const MvarMVStruct *MV12,
    const MvarMVStruct *MV13,
    const MvarMVStruct *MV14,
    const MvarMVStruct *MV15,
    const MvarMVStruct *MV21,
    const MvarMVStruct *MV22,
    const MvarMVStruct *MV23,
    const MvarMVStruct *MV24,
    const MvarMVStruct *MV25,
const MvarMVStruct *MV31,
const MvarMVStruct *MV32,
const MvarMVStruct *MV33,
const MvarMVStruct *MV34,
const MvarMVStruct *MV35,
const MvarMVStruct *MV41,
const MvarMVStruct *MV42,
const MvarMVStruct *MV43,
const MvarMVStruct *MV44,
const MvarMVStruct *MV45,
const MvarMVStruct *MV51,
const MvarMVStruct *MV52,
const MvarMVStruct *MV53,
const MvarMVStruct *MV54,
const MvarMVStruct *MV55)

MV11, MV12, MV13, MV14, MV15: The 25 factors of the determinant.
MV21, MV22, MV23, MV24, MV25: 
MV31, MV32, MV33, MV34, MV35: 
MV41, MV42, MV43, MV44, MV45: 
MV51, MV52, MV53, MV54, MV55: 

Returns: A scalar field representing the determinant computation.

Description: Computes the expression of a 5 by 5 determinants.
See also: MvarMVDeterminant4,

8.2.286 MvarMVDistCrvSrf (mvardist.c:344)

MvarMVStruct *MvarMVDistCrvSrf(const CagdCrvStruct *Crv1,
const CagdSrfStruct *Srf2,
int DistType)

Crv1, Srf2: The two entities, Crv1(t) and Srf2(u, v), to form their distance function square between them as a multivariate function.

DistType: 0 for distance vector function, 1 for distance square scalar function, 2 for distance vector projected on the normal of Crv1, 3 for distance vector projected on the normal of Srf2. In cases 2 and 3 the normal field is not normalized.

Returns: The distance function square d2(t, u, v) of the distance from Crv1(t) to Srf2(u, v).

Description: Given a curve and a surface, creates a multivariate scalar field representing the distance function square, between them.
See also: SymbSrfDistCrvCrv, SymbCrvCrvInter, SymbSrfDistFindPoints, , MvarMVDistSrfSrf,

8.2.287 MvarMVDistSrfSrf (mvardist.c:430)

MvarMVStruct *MvarMVDistSrfSrf(const CagdSrfStruct *Srf1,
const CagdSrfStruct *Srf2,
int DistType)

Srf1, Srf2: The two surfaces, Srf1(u, v) and Srf2(r, t), to form their distance function square between them as a multivariate function.

DistType: 0 for distance vector function, 1 for distance square scalar function, 2 for distance vector projected on the normal of Srf1, 3 for distance vector projected on the normal of Srf2. In cases 2 and 3 the normal field is not normalized.

Returns: The distance function square d2(u, v, r, t) of the distance from Srf1(u, v) to Srf2(r, t).

Description: Given two surfaces, creates a multivariate scalar field representing the distance function square, between them.
See also: SymbSrfDistCrvCrv, SymbCrvCrvInter, SymbSrfDistFindPoints, , MvarMVDistCrvSrf,
8.2.288  **MvarMVDomain**  (mvar.aux.c:45)

```c
void MvarMVDomain(const MvarMVStruct *MV,
                    CagdRType *Min,
                    CagdRType *Max,
                    int Axis)
```

**MV**: Multivariate function to consider.

**Min**: Minimum domains of MV will be placed herein.

**Max**: Maximum domains of MV will be placed herein.

**Axis**: axis to extract or -1 for all axes.

**Returns**: void

**Description**: Given a multi-variate, returns its parametric domain. The Min/Max arrays are assumed to of sufficiently large enough space to hold all dimensions, if Axis == -1.

**See also**: varMVSetDomain, MvarMVSetAllDomains, MvarParamInDomain, , varParamsInDomain,

8.2.289  **MvarMVDomainAlloc**  (mvar.aux.c:146)

```c
void MvarMVDomainAlloc(const MvarMVStruct *MV,
                        CagdRType **MinDmn,
                        CagdRType **MaxDmn)
```

**MV**: Multivariate structures to receive its domain.

**MinDmn**: Array of maximal values.

**MaxDmn**: Array of minimal values.

**Returns**: void

**Description**: Same as MvarMVDomain but also allocate the space to hold the domain.

**See also**: MvarMVDomain, MvarMVDomainFree,

8.2.290  **MvarMVDomainFree**  (mvar.aux.c:173)

```c
void MvarMVDomainFree(CagdRType *MinDmn, CagdRType *MaxDmn)
```

**MinDmn**: Array of maximal values.

**MaxDmn**: Array of minimal values.

**Returns**: void

**Description**: Deallocates the memory of MV's domain, as allocated by MvarMVDomain2.

**See also**: MvarMVDomain, MvarMVDomainAlloc,

8.2.291  **MvarMVDotProd**  (mvar.sym.c:326)

```c
MvarMVStruct *MvarMVDotProd(const MvarMVStruct *MV1, const MvarMVStruct *MV2)
```

**MV1, MV2**: Two multivariate to multiply and compute a dot product for.

**Returns**: A scalar multivariate representing the dot product of MV1 . MV2.

**Description**: Given two multivariates - computes their dot product. Returned multivariate is a scalar multivariate representing the dot product of the two given multivariates. While typically in R3, the dot product can be computed for any dimension of MV1 and MV2.

**See also**: MvarMVMult, MvarMVVecDotProd, MvarMVScalarScale, MvarMVMultScalar, , MvarMVInvert, MvarMVCrossProd,
8.2.292 MvarMVEval (mvareval.c:455)

CagdRType *MvarMVEval(const MvarMVStruct *MV, CagdRType *Params)

MV: To evaluate at given Params parametric location.
Params: Parametric location to evaluate MV at.
Returns: A vector holding all the coefficients of all components of the multi-variate’s point type. If for example multi-variate point type is P2, the W, X, and Y will be saved in the first three locations of the returned vector. The first location (index 0) of the returned vector is reserved for the rational coefficient W and XYZ always starts at second location of the returned vector.
Description: Evaluates the given multivariate function at a given location. Same functionality as MvarMVEval2 but a different and faster implementation for Bezier evaluations.
See also: MvarMVEval2, MvarMVEvalGradient, MvarMVEvalGradient2,

8.2.293 MvarMVEval2 (mvareval.c:39)

CagdRType *MvarMVEval2(const MvarMVStruct *MV, CagdRType *Params)

MV: To evaluate at given Params parametric location.
Params: Parametric location to evaluate MV at.
Returns: A vector holding all the coefficients of all components of the multi-variate’s point type. If for example multi-variate point type is P2, the W, X, and Y will be saved in the first three locations of the returned vector. The first location (index 0) of the returned vector is reserved for the rational coefficient W and XYZ always starts at second location of the returned vector (index 1).
Description: Evaluates the given multivariate function at a given location. Same functionality as MvarMVEval but a different implementation.
See also: MvarMVEval, MvarMVEvalGradient, MvarMVEvalGradient2,

8.2.294 MvarMVEvalGradient (mvar_der.c:787)

CagdRType *MvarMVEvalGradient(const MvarMVGradientStruct *MVGrad, CagdRType *Params, int Axis)

MVGrad: Input gradient function to evaluate at.
Params: Parametric location to evaluate gradient at.
Axis: If the input function whose gradient we seek is scalar, Axis will always be zero. However we can also handle input vector functions in which case Axis specifies which function in the vector to compute the gradient for - 0 for X, 1 for Y, etc.
Returns: The gradient at Params.
Description: Evaluates the gradient function at the given parametric location.
See also: MvarMVDerive, MvarMVFreeGradient, MvarMVPrepGradient, MvarMVEvalGradient2, MvarMVBounded-Gradient,

8.2.295 MvarMVEvalGradient2 (mvareval.c:558)

CagdRType *MvarMVEvalGradient2(const MvarMVStruct *MV, CagdRType *Params, int *HasOrig)

MV: To evaluate its gradient at given Params parametric location.
Params: Parametric location to evaluate MV at.
HasOrig: TRUE if the cached gradient also contains the original scalar field, as last, additional, coordinate.
Returns: A vector holding all the coefficients of all components of the multi-variate’s point type. If for example multi-variate point type is P2, the W, X, and Y will be saved in the first three locations of the returned vector. The first location (index 0) of the returned vector is reserved for the rational coefficient W and XYZ always starts at second location of the returned vector (index 1).
Description: Evaluates the gradient of the given multivariate function at a given location, numerically. Allowed for scalar multivariates only.
See also: MvarMVEval, MvarMVEvalTanPlane, MvarMVEvalGradient,
8.2.296 MvarMVEvalTanPlane (mvareval.c:642)

MvarPlaneStruct *MvarMVEvalTanPlane(const MvarMVStruct *MV, CagdRType *Params)

MV: To evaluate its gradient at given Params parametric location.

Params: Parametric location to evaluate MV at.

Returns: A hyperplane, allocated dynamically. The tangent is normalized so that its last (independent coefficient is one: “A1 X1 + A2 X2 + ... + An Xn + 1”. The size, n, is to the dimension of the multivariate.

Description: Evaluates the tangent hyperplane of the given multivariate function at a given location, numerically. Assumes a scalar multivariate of n parameters in a space of dimension n+1 (an explicit surface in E3).

See also: MvarMVEval, MvarMVEvalGradient2,

8.2.297 MvarMVExtension (mvari.gen.c:1718)

MvarMVStruct *MvarMVExtension(const MvarMVStruct *OrigMV, const CagdBType *ExtMins, const CagdBType *ExtMaxs, const CagdRType *Epsilons)

OrigMV: The multivariate to be extended.

ExtMins: A vector of Dim Boolean values to set the extension directions in the Min side. Direction i is extended in its Min side if ExtMins[i] is TRUE, or if ExtMins is NULL.

ExtMaxs: A vector of Dim Boolean values to set the extension directions in the Max side. Direction i is extended in its Max side if ExtMaxs[i] is TRUE, or if ExtMaxs is NULL.

Epsilons: A vector of real numbers representing the length of the extension in each direction (both Min and Max).

Returns: The new extended MV.

Description: Extension of a B-spline multivariate, in any of the 2 * Dim optional directions of the Dim dimensional domain. The extension is such that the image coincides with the original image over the original domain. Assumes open end conditions (in all knot vectors).

See also: BspCrvExtensionOneSide, BspCrvExtraKnotRmv, BspCrvExtension, BspSrfExtension,

8.2.298 MvarMVFrees (mvari.gen.c:458)

void MvarMVFrees(MvarMVStruct *MV)

MV: Multi-Variate to free.

Returns: void

Description: Deallocates and frees all slots of a multi-variate structure.

See also: MvarMVNew,

8.2.299 MvarMVFreeGradient (mvari.der.c:746)

void MvarMVFreeGradient(MvarMVGradientStruct *MVGrad)

MVGrad: Gradient function to free.

Returns: void

Description: Free an gradient function.

See also: MvarMVDerive, MvarMVPrepGradient, MvarMVEvalGradient,
8.2.300 MvarMVFreeList (mvar_gen.c:521)

void MvarMVFreeList(MvarMVStruct *MVList)

MVList: Multi-Variate list to free.

Returns: void

Description: Deallocates and frees a list of multi-variate structures.

8.2.301 MvarMVFromMV (mvareval.c:694)

MvarMVStruct *MvarMVFromMV(const MvarMVStruct *MV, CagdRType t, MvarMVDirType Dir)

MV: To extract an isoparametric multi-variate from at parameter value t in direction Dir, or expand its dimension by one.

t: Parameter value at which to extract the isosurface (if Dir >= 0).

Dir: Direction of isosurface extraction. If Dir is negative, however, its absolute value defines the order of a new axis added as last and new dimension to the given MV.

Returns: A multi-variate with one less (or more) dimensions.

Description: Extract an isoparametric sub multivariate out of the given tensor product multivariate, or expand its dimension by one.

See also: MvarMVReverse, MvarMVFromMesh, MvarPromoteMVToMV,

8.2.302 MvarMVFromMesh (mvareval.c:884)

MvarMVStruct *MvarMVFromMesh(const MvarMVStruct *MV, int Index, MvarMVDirType Dir)

MV: To extract an isoparametric multi-variate from a sub-mesh in direction Dir, or expand its dimension by one.

Index: Index of sub mesh of MV’s mesh in direction Dir.

Dir: Direction of isosurface extraction. If Dir is negative, however, its absolute value defines the order of a new axis added as last and new dimension to the given MV.

Returns: A multi-variate with one less (or more) dimensions.

Description: Extract an isoparametric sub multi variate out of the given tensor product multi-variate, or expand its dimension by one.

See also: MvarMVReverse, MvarMVFromMVm, MvarPromoteMVToMV,

8.2.303 MvarMVIntersPtOnBndry (mvar_aux.c:587)

MvarPtStruct *MvarMVIntersPtOnBndry(MvarMVStruct *MV, MvarPtStruct *PointIns, MvarPtStruct *PointOuts)

MV: Multivariate structure.

PointIns: point inside the domain.

PointOuts: point outside the domain.

Returns: The intersection point.

Description: Computes the intersection point of line (PointIns, PointOuts) with the boundary of the domain of multivariate MV.

See also: MvarParamsInDomain,
8.2.304 **MvarMVInvert** (mvar_sym.c:161)

```c
MvarMVStruct *MvarMVInvert(const MvarMVStruct *MV)
```

**MV:** A scalar multivariate to compute a reciprocal value for.

**Returns:** A rational scalar multivariate that is equal to the reciprocal value of MV.

**Description:** Given a scalar multivariate, returns a scalar multivariate representing the reciprocal values, by making it rational (if was not one) and flipping the numerator and the denominator.

**See also:** MvarMVDotProd, MvarMVVecDotProd, MvarMVScalarScale, MvarMVMultScalar, , MvarMVMult, MvarMVCrossProd,

8.2.305 **MvarMVListBBox** (mvar_aux.c:814)

```c
void MvarMVListBBox(const MvarMVStruct *MVs, MvarBBoxStruct *BBox)
```

**MVs:** To compute a bounding box for.

**BBox:** Where bounding information is to be saved.

**Returns:** void

**Description:** Computes a bounding box for a list of multi-variate freeform function.

8.2.306 **MvarMVMatTransform** (mvar_gen.c:1483)

```c
void MvarMVMatTransform(MvarMVStruct *MV, CagdMType Mat)
```

**MV:** Multi-variate to transform.

**Mat:** Homogeneous transformation to apply to MV.

**Returns:** void

**Description:** Transforms, in place, the given MV as specified by homogeneous matrix Mat.

8.2.307 **MvarMVMergeScalar** (mvar_sym.c:857)

```c
MvarMVStruct *MvarMVMergeScalar(MvarMVStruct * const *ScalarMVs)
```

**ScalarMVs:** A vector of scalar MVs. Location 0 holds the W or NULL otherwise, Location 1 holds the X axis and so on. This vector is assumed to have MVAR_MAX_PT_COORD coordinates.

**Returns:** A new multivariates constructed from given scalar multivariates.

**Description:** Given a set of scalar multivariates, treat them as coordinates into a new multivariates Assumes at least X axis not NULL when a scalar multivariate is returned. Assumes all axes are either E1 or P1 in which the weights are assumed to be identical and can be ignored if W axis exists or copied otherwise.

**See also:** MvarMVSplitScalar,

8.2.308 **MvarMVMult** (mvar_sym.c:121)

```c
MvarMVStruct *MvarMVMult(const MvarMVStruct *MV1, const MvarMVStruct *MV2)
```

**MV1, MV2:** Two multivariate to multiply coordinatewise.

**Returns:** The product of MV1 * MV2 coordinatewise.

**Description:** Given two multivariates - multiply them coordinatewise. The two multivariates are promoted to same point type before the multiplication can take place.

**See also:** MvarMVDotProd, MvarMVVecDotProd, MvarMVScalarScale, MvarMVMultScalar, , MvarMVMult, MvarMVInvert,
8.2.309 MvarMVMultScalar (mvar_sym.c:265)

MvarMVStruct *MvarMVMultScalar(const MvarMVStruct *MV1, const MvarMVStruct *MV2)

**MV1, MV2**: Two multivariates to multiply.

**Returns**: A multivariate representing the product of MV1 and MV2.

**Description**: Given two multivariate - a vector multivariate MV1 and a scalar multivariate MV2, multiply all MV1's coordinates by the scalar multivariate MV2. Returned multivariate is a multivariate representing the product of the two given multivariates.

**See also**: MvarMVDotProd, MvarMVVecDotProd, MvarMVMult, MvarMVCrossProd, MvarCrvMultScalar,

8.2.310 MvarMVMultiLinearMV (mvarprim.c:30)

MvarMVStruct *MvarMVMultiLinearMV(const IrtRType *Min, const IrtRType *Max, int Dim)

**Min**: Minimal values of the expected ranges.

**Max**: Maximal values of the expected ranges.

**Dim**: Dimension of expect multivariate.

**Returns**: Constructed multi-linear function.

**Description**: Constructs a multi-linear multivariates that spans the [Min, Max] ranges in all Dim dimensions.

8.2.311 MvarMVNew (mvar_gen.c:59)

MvarMVStruct *MvarMVNew(int Dim, MvarGeomType GType, MvarPointType PType, const int *Lengths)

**Dim**: Number of dimensions of this multi-variate.

**GType**: Type of geometry the curve should be - Bspline, Bezier etc.

**PType**: Type of control points (E2, P3, etc.).

**Lengths**: Of control mesh in each of the dimensions. Vector of size Dim.

**Returns**: An uninitialized freeform multi-variate.

**Description**: Allocates the memory required for a new multi-variate.

**See also**: MvarMVFree, MvarBzrMVNew, MvarBspMVNew,

8.2.312 MvarMVNormal2Cones (mvcones.c:1419)

MvarNormalConeStruct *MvarMVNormal2Cones(const MvarMVStruct *MV, CagdRType ExpandingFactor, int NumOfZeroMVs, MvarNormalConeStruct **Cone1, MvarNormalConeStruct **Cone2)

**MV**: To compute the normal 2cones for.

**ExpandingFactor**: Factor to expand placement of 2cones axes locations.

**NumOfZeroMVs**: Number of zero type MVs in the problem we solve.

**Cone1, Cone2**: The two cones to compute or ConeAngle = M_PI if error. Can be NULL in which case no 2cones are computed - only the regular cone is computed.

**Returns**: Regular normal cone if successful, NULL otherwise.

**Description**: Computes a 2cones bound to the normal field of multivariate MV. The 2cones bounds the normal field in the common intersection space. The 2cones are computed using the regular normal cone by expanding in the direction orthogonal to the cone axis and its main principal component. The expansion is done an amount that is equal to regular cone radius times ExpandingFactor.

**See also**: SymbNormalConeForSrf, MvarNormalConeOverlap,
8.2.313  MvarMVOrthoCrvProjOnSrf (mvarproj.c:47)

MvarPolylineStruct *MvarMVOrthoCrvProjOnSrf(const CagdCrvStruct *Crv,
                                            const CagdSrfStruct *Srf,
                                            CagdRType Tol)

  Crv: The curve to project on Srf, orthogonally.
  Srf: The surface to project Crv on.
  Tol: Tolerance of the computation.

  Returns: The projections in UV space of Srf.

  Description: Computes the orthogonal projection of a curve C(t) on a surface S(u, v). That is, the projection
  is along the normal lines of the surface S.
  Computed as the univariate solution to the following two equations:

\[ \frac{dS}{du} \langle C(t) - S(u, v), \frac{dS}{du} \rangle = 0, \]
\[ \frac{dS}{dv} \langle C(t) - S(u, v), \frac{dS}{dv} \rangle = 0. \]

  See also: MvarMVOrthoIsoCrvProjOnSrf.

8.2.314  MvarMVOrthoIsoCrvProjOnSrf (mvarproj.c:171)

MvarPolylineStruct *MvarMVOrthoIsoCrvProjOnSrf(const CagdSrfStruct *Srf1,
                                               const CagdRType RVal,
                                               CagdSrfDirType Dir,
                                               const CagdSrfStruct *Srf2,
                                               CagdRType Tol)

  Srf1: The surface to project from, orthogonally.
  RVal: The isoparametric value of the curve of Srf1 to project.
  Dir: Direction of isoparametric curve of S1.
  Srf2: The surface to project to.
  Tol: Computation tolerance.

  Returns: The projections in UV space of Srf2.

  Description: Computes the orthogonal projection of an isoparametric curve of surface S1(r, t) at a fixed parameter value, RVal, into surface S2(u, v). The projection is along the normal lines of S1, that contains the curve.
  Computed as the univariate solution to the following two equations:

\[ \frac{dS1}{dr} \langle S2(u, v) - S1(r, t), \frac{dS1}{dr} \rangle \bigg|_{r=RVal} = 0, \]
\[ \frac{dS1}{dt} \langle S2(u, v) - S1(r, t), \frac{dS1}{dt} \rangle \bigg|_{r=RVal} = 0. \]

  See also: MvarMVOrthoCrvProjOnSrf,
8.2.315  **MvarMVPrepGradient** (mvar_dler.c:685)

MvarMVGradientStruct *MvarMVPrepGradient(const MvarMVStruct *MV,
                                          CagdBType Orig)

**MV:** Input scalar field to compute its gradient function.

**Orig:** If orig TRUE and input is polynomial, the original scalar MV is also placed as last, additional, dimension (for faster evaluation of MV and its gradient).

**Returns:** The gradient function of the input scalar field.

**Description:** Builds a gradient for the given scalar multivariate. If the input is rational, returned is a dynamically allocated vector of scalar multivariate functions each representing Dm/Dui, i from 1 to Dim. The returned partial derivative are differentiated directly without the quotient rule which must be applied manually. Otherwise, if the input is polynomial, the gradient is returned as one vector function.

**See also:** MvarMVDerive, MvarMVFreeGradient, MvarMVEvalGradient,

8.2.316  **MvarMVPwrDegreeRaise** (mvarrais.c:550)

MvarMVStruct *MvarMVPwrDegreeRaise(const MvarMVStruct *MV,
                                         int Dir,
                                         int IncOrder)

**MV:** Multivariate to increase its order in direction Dir.

**Dir:** Direction of refinement. Either U or V or W.

**IncOrder:** By how much to increase the order, at least one.

**Returns:** New multivariate with higher order.

**Description:** Increase the order of the given power basis multivariate in direction Dir by IncOrder amount. IncOrder amount is at least one.

**See also:** MvarMVDegreeRaise, MvarMVDegreeRaiseN, MvarMVDegreeRaise2,

8.2.317  **MvarMVRefineAtParams** (mvar_ref.c:41)

MvarMVStruct *MvarMVRefineAtParams(const MvarMVStruct *MV,
                                         MvarMVDirType Dir,
                                         CagdBType Replace,
                                         CagdRType *t,
                                         int n)

**MV:** Multi-variate to refine according to t in direction Dir.

**Dir:** Direction of refinement. Either U or V or W.

**Replace:** If TRUE t is a knot vector exactly in the length of the knot vector in direction Dir in MV and t simply replaces than knot vector. If FALSE, the knot vector in direction Dir in MV is refined by adding all the knots in t.

**t:** Knot vector to refine/replace the knot vector of MV in direction Dir.

**n:** Length of vector t.

**Returns:** The refined multi-variate. Always a Bspline.

**Description:** Given a multi-variate, refines it at the given n knots as defined by the vector t. If Replace is TRUE, the values replace the current knot vector. Returns pointer to refined MV (Note a Bezier multi-variate will be converted into a Bspline multi-variate).
8.2.318 MvarMVRegionFromMV (mvar_aux.c:659)

MvarMVStruct *MvarMVRegionFromMV(const MvarMVStruct *MV,  
   CagdRType t1,  
   CagdRType t2,  
   MvarMVDirType Dir)

MV: To extract a sub-region from.
t1, t2: Domain to extract from MV, in parametric direction Dir.
Dir: Direction to extract the sub-region. Either U or V or W.

Returns: A sub-region of MV from t1 to t2 in direction Dir.

Description: Given a multi-variate, returns a sub-region of it.
See also: MvarMVExtension, MvarBzrMVRegionFromMV,

8.2.319 MvarMVReverse (mvar_rev.c:31)

MvarMVStruct *MvarMVReverse(const MvarMVStruct *MV, int Axis1, int Axis2)

MV: Multi-Variate to reverse.
Axis1, Axis2: Two axis to flip over.

Returns: Reversed multi-variate.

Description: Reverse the role of the given two axis by flipping them out.
See also: MvarPromoteMVToMV, MvarMVShiftAxes,

8.2.320 MvarMVReverseDir (mvar_rev.c:102)

MvarMVStruct *MvarMVReverseDir(const MvarMVStruct *MV, int Axis)

MV: Multi-Variate to reverse.
Axis: Direction to reverse.

Returns: Reversed multi-variate.

Description: Reverses the direction of the mesh of the given MV in direction Axis (and also reverse the knot vector if B-spline).
See also: MvarPromoteMVToMV, MvarMVShiftAxes, MvarMVReverse,

8.2.321 MvarMVRtnlMult (mvar_sym.c:636)

MvarMVStruct *MvarMVRtnlMult(const MvarMVStruct *MV1X,  
   const MvarMVStruct *MV1W,  
   const MvarMVStruct *MV2X,  
   const MvarMVStruct *MV2W,  
   CagdBType OperationAdd)

MV1X: Numerator of first multivariate.
MV1W: Denominator of first multivariate. Can be NULL.
MV2X: Numerator of second multivariate.
MV2W: Denominator of second multivariate. Can be NULL.
OperationAdd: TRUE for addition, FALSE for subtraction.

Returns: The result of MV1X MV2W +/- MV2X MV1W.

Description: Given two multivariates - multiply them using the quotient product rule:

\[ X = x_1 \frac{w_2}{w_1} \]

All provided multivariates are assumed to be non rational scalar multivariates. Returned is a non rational scalar multivariate (CAGDPT_EL1TYPE).
See also: MvarMVDotProd, MvarMVVecDotProd, MvarMVMultiScalar, MvarMVMultiScalar, MvarMVInvert, MvarMVCrossProd2D,
8.2.322 MvarMVScalarScale (mvar_sym.c:223)

MvarMVStruct *MvarMVScalarScale(const MvarMVStruct *CMV, CagdRType Scale)

CMV: A multivariate to scale by magnitude Scale.
Scale: Scaling factor.
Returns: A multivariates scaled by Scale compared to MV.
Description: Given a multivariate, scale it by Scale.
See also: MvarMVDotProd, MvarMVVecDotProd, MvarMVMult, MvarMVMultScalar, , MvarMVInvert, MvarMVCrossProd,

8.2.323 MvarMVSetAllDomains (mvar_aux.c:426)

MvarMVStruct *MvarMVSetAllDomains(MvarMVStruct *MV,
                                   CagdRType *Min,
                                   CagdRType *Max,
                                   int InPlace)

MV: Multivariate function to update its domain.
Min: New minimum domains of MV.
Max: New maximum domains of MV.
InPlace: If TRUE, updates domain in place, unless was a Bezier that was converted into a Bspline, in which case the Bezier is released.
Returns: Same multivariate with the updated domain in dir Axis.
Description: Given a multi-variate, sets its parametric domain in all directions to be between Min and Max. If the MV is a Bezier, it is coerced to a Bspline first (and if InPlace TRUE, the original Bezier is freed).
See also: varMVDomain, MvarMVSetAllDomains, MvarParamInDomain, MvarParamsInDomain,

8.2.324 MvarMVSetDomain (mvar_aux.c:206)

MvarMVStruct *MvarMVSetDomain(MvarMVStruct *MV,
                                CagdRType Min,
                                CagdRType Max,
                                int Axis,
                                int InPlace)

MV: Multivariate function to update its domain.
Min: New minimum domain in Axis direction of MV.
Max: New maximum domain in Axis direction of MV.
Axis: Axis to set a new domain for.
InPlace: If TRUE, updates domain in place if possible. A Bezier can be converted into a Bspline, in which case the Bezier is released.
Returns: Same multivariate with the updated domain in dir Axis.
Description: Given a multi-variate, sets its parametric domain in direction Axis to be between Min and Max. If the MV is a Bezier and the domain requested is not [0, 1], it is coerced to a Bspline first.
See also: varMVDomain, MvarMVSetAllDomains, MvarParamInDomain, MvarParamsInDomain,

8.2.325 MvarMVShiftAxes (mvar_rev.c:173)

MvarMVStruct *MvarMVShiftAxes(const MvarMVStruct *MV, int Axis)

MV: Multi-Variate to shift axes.
Axis: From where to shift forward until last Axis and put last Axis Here instead.
Returns: Multi-variate, with shifted axes
Description: Shift the last index in, instead of index Axis. All axes after Axis are shifted forward one location as well.
See also: MvarMVReverse, MvarPromoteMVMToMV,
8.2.326  MvarMVSplitScalar  (mvar_sym.c:799)

MvarMVStruct **MvarMVSplitScalar(const MvarMVStruct *MV)

MV: Multivariate to split.

Returns: A static array holding the dynamically allocated MVs. The zero entry would hold the W, or NULL otherwise. The first entry would hold X axis, etc. This vector would have MVAR_MAX_PT_COORD coordinates.

Description: Given a multivariate, splits it to its scalar component multivariates.
See also: MvarMVMergeScalar,

8.2.327  MvarMVSub  (mvar_sym.c:79)

MvarMVStruct *MvarMVSub(const MvarMVStruct *MV1, const MvarMVStruct *MV2)

MV1, MV2: Two multivariate to subtract coordinatewise.

Returns: The difference of MV1 - MV2 coordinatewise.

Description: Given two multivariates - subtract them coordinatewise. The two multivariates are promoted to same point type before the operation can take place. Furthermore, order and continuity are matched as well.
See also: MvarMVAdd, MvarMeshAddSub, MvarMVMult,

8.2.328  MvarMVSubdivAtParam  (mvar_sub.c:48)

MvarMVStruct *MvarMVSubdivAtParam(const MvarMVStruct *MV, CagdRType t, MvarMWDirType Dir)

MV: Multi-Variate to subdivide.

t: Parameter to subdivide at.

Dir: Direction of subdivision.

Returns: A list of two multi-variates, result of the subdivision.

Description: Given a multi-variate, subdivides it at parameter value t in direction Dir.
See also: MvarBspMVSubdivAtParam, MvarBzrMVSubdivAtParam,

8.2.329  MvarMVSubdivAtParamOneSide  (mvar_sub.c:434)

MvarMVStruct *MvarMVSubdivAtParamOneSide(const MvarMVStruct *MV, CagdRType t, MvarMWDirType Dir, IrtBType LeftSide)

MV: Multi-Variate to subdivide.

t: Parameter to subdivide at.

Dir: Direction of subdivision.

LeftSide: TRUE to only fetch left half, FALSE to fetch right half.

Returns: A list of two multi-variates, result of the subdivision.

Description: Given a multi-variate, subdivides it at parameter value t in direction Dir.
See also: MvarBspMVSubdivAtParamOneSide, MvarBzrMVSubdivAtParamOneSide, MvarMVSubdivAtParam,
8.2.330  MvarMVToCrv (mvareval.c:1052)

CagdCrvStruct *MvarMVToCrv(const MvarMVStruct *MV)

MV: A multivariate of at least dimension one to convert to a curve.
Returns: A curve representation the given multivariate (or its lowest dimension if higher dim.).
Description: Converts a multivariate function into a curve. If the multivariate is of dimension higher than one, the lowest dimension is employed in the conversion.

8.2.331  MvarMVToSrf (mvareval.c:1185)

CagdSrfStruct *MvarMVToSrf(const MvarMVStruct *MV)

MV: A multivariate of dimension two or more to convert to a surface.
Returns: A surface representation the given multivariate (or its lowest two dimensions if higher dim.).
Description: Converts a multivariate function into a surface. If the multivariate is of dimension higher than two, the lowest two dimensions are employed in the conversion.

8.2.332  MvarMVToTV (mvareval.c:1343)

TrivTVStruct *MvarMVToTV(const MvarMVStruct *MV)

MV: A multivariate of dimension three or more to convert to a trivar.
Returns: A trivar representation the given multivariate (or its lowest three dimensions if higher dim.).
Description: Converts a multivariate function into a trivar. If the multivariate is of dimension higher than three, the lowest three dimensions are employed in the conversion.

8.2.333  MvarMVTransform (mvar_gen.c:1451)

void MvarMVTransform(MvarMVStruct *MV, CagdRType *Translate, CagdRType Scale)

MV: Multi-variate to transform.
Translate: Translation factor. Can be NULL for non.
Scale: Scaling factor.
Returns: void
Description: Linearly transforms, in place, given MV as specified by Translate and Scale.

8.2.334  MvarMVTriTangentLine (mvtangnt.c:1292)

CagdCrvStruct *MvarMVTriTangentLine(const CagdSrfStruct *Srf1, const CagdSrfStruct *Srf2, const CagdSrfStruct *Srf3, CagdRType StepSize, CagdRType SubdivTol, CagdRType NumericTol, int Euclidean)

Srf1, Srf2, Srf3: The 3 bivariates to compute the tri-tangent lines for. Assumed Bsplines surfaces with Open End Cond.
StepSize: Tolerance of numeric tracing of univariate solution.
SubdivTol: Tolerance of the subdivision process. Tolerance is measured in the parametric space of the multi-variates.
**NumericTol**: Numeric tolerance of the numeric stage. The numeric stage is employed only if NumericTol < SubdivTol.

**Euclidean**: True to return the result in Euclidean space, FALSE to return it in parametric space.

**Returns**: Triplets of univariate solutions (three curves on the three surfaces) of tri-tangent lines.

**Description**: Computes the tri-tangent line of three freeform bivariate. In other words, computes the tangent line at three different points to the three surface(s). The result is a univariate (describing the line tri-tangent to the surfaces as it slides over the three surfaces).

**See also**: SymbTangentToCrvAtTwoPts, MvarMVBiTangents, MvarMVBiTangents2, MvarMVTriTangentLineCreateMVs,

8.2.335 **MvarMVTriTangentLineCreateETs** (mvtangent.c:1045)

```c
void MvarMVTriTangentLineCreateETs(const MvarMVStruct *CMV1,
const MvarMVStruct *CMV2,
const MvarMVStruct *CMV3,
MvarExprTreeStruct **ETs,
MvarConstraintType *Constraints);
```

**CMV1, CMV2, CMV3**: The 3 bivariates to compute the tri-tangent lines for.

**ETs**: To be populated with the computed ETs constraints.

**Constraints**: To be populated with the constraints' types.

**Returns**: void

**Description**: Computes the constraints to solve for the tri-tangent line of three freeform bivariate. In other words, to compute the tangent line at three different points to the three surface(s). Let,

\[
DMV12 = MV1(u, v) - MV2(s, t) \\
DMV13 = MV1(u, v) - MV3(a, b) \\
DMV23 = MV2(s, t) - MV3(a, b)
\]

Then, compute the simultaneous solution of the following five equations:

\[
\begin{align*}
\frac{dMV1}{du} \begin{bmatrix} \frac{dMV1}{dv} \end{bmatrix} & < \begin{bmatrix} x \end{bmatrix}, \quad DMV13 > 0, \\
\frac{dMV2}{dr} \begin{bmatrix} \frac{dMV2}{ds} \end{bmatrix} & < \begin{bmatrix} x \end{bmatrix}, \quad DMV13 > 0, \\
\frac{dMV3}{da} \begin{bmatrix} \frac{dMV3}{db} \end{bmatrix} & < \begin{bmatrix} x \end{bmatrix}, \quad DMV13 > 0, \\
\frac{dMV1}{du} \begin{bmatrix} \frac{dMV1}{dv} \end{bmatrix} & < \begin{bmatrix} x \end{bmatrix}, \quad DMV12 > 0, \\
\frac{dMV3}{da} \begin{bmatrix} \frac{dMV3}{db} \end{bmatrix} & < \begin{bmatrix} x \end{bmatrix}, \quad DMV23 > 0,
\end{align*}
\]

**See also**: SymbTangentToCrvAtTwoPts, MvarMVBiTangents, MvarMVBiTangents2, MvarMVTriTangentLineCreateMVs,
### 8.2.336 MvarMVTriTangentLineCreateMVs (mvtangnt.c:905)

```c
void MvarMVTriTangentLineCreateMVs(const MvarMVStruct *CMV1,
const MvarMVStruct *CMV2,
const MvarMVStruct *CMV3,
MvarMVStruct **MVs,
MvarConstraintType *Constraints)
```

**CMV1, CMV2, CMV3:** The 3 bivariates to compute the tri-tangent lines for.

**MVs:** To be populated with the computed MVS constraints.

**Constraints:** To be populated with the constraints’ types.

**Returns:** void

**Description:** Computes the constraints to solve for the tri-tangent line of three freeform bivariate. In other words, to compute the tangent line at three different points to the three surface(s). Let,

\[
\begin{align*}
DMV12 &= MV1(u, v) - MV2(s, t) \\
DMV13 &= MV1(u, v) - MV3(a, b) \\
DMV23 &= MV2(s, t) - MV3(a, b)
\end{align*}
\]

Then, compute the simultaneous solution of the following five equations:

\[
\begin{align*}
&\langle \frac{dMVi}{du}, \frac{dMVi}{dv} \rangle \cdot DMV13 = 0, \\
&\langle \frac{dMVi}{dr}, \frac{dMVi}{ds} \rangle \cdot DMV13 = 0, \\
&\langle \frac{dMVi}{da}, \frac{dMVi}{db} \rangle \cdot DMV13 = 0, \\
&\langle \frac{dMVi}{dx}, \frac{dMVi}{dy} \rangle \cdot DMV12 = 0,
\end{align*}
\]

**See also:** SymbTangentToCrvAtTwoPts, MvarMVBiTangents, MvarMVBiTangents2, MvarMVTriTangentLine,

### 8.2.337 MvarMVTriTangents (mvtangnt.c:208)

```c
MvarPtStruct *MvarMVTriTangents(const MvarMVStruct *CMV1,
const MvarMVStruct *CMV2,
const MvarMVStruct *CMV3,
int Orientation,
CagdRType SubdivTol,
CagdRType NumericTol)
```
CMV1, CMV2, CMV3: The 3 multivariates to compute the tri-tangents for. If MV2 == MV3 == NULL, the self tri-tangents of MV1 are computed.

Orientation: 0 for no effect, -1 or +1 for a request to get opposite or similar normal orientation bi tangencies only.

SubdivTol: Tolerance of the subdivision process. Tolerance is measured in the parametric space of the multivariates.

NumericTol: Numeric tolerance of the numeric stage. The numeric stage is employed only if NumericTol < SubdivTol.

Returns: Points on the bi-tangents of the two multivariates.

Description: Computes tri-tangents of freeform bivariate. In other words, compute the tangent plane at three points to the surface(s). Let,

\[ \begin{align*}
DMV_{12} &= MV_1(u, v) - MV_2(r, s) \\
DMV_{13} &= MV_1(u, v) - MV_3(x, y) \\
DMV_{23} &= MV_2(r, s) - MV_3(x, y)
\end{align*} \]

then, compute the simultaneous solution of the following six equations:

\[ \begin{align*}
\frac{d}{du} MV_1 \cdot \frac{d}{dv} MV_1 &= 0, \\
\frac{d}{du} MV_1 \cdot \frac{d}{dv} MV_1 &= 0, \\
\frac{d}{dr} MV_2 \cdot \frac{d}{ds} MV_2 &= 0, \\
\frac{d}{dr} MV_2 \cdot \frac{d}{ds} MV_2 &= 0, \\
\frac{d}{dx} MV_3 \cdot \frac{d}{dy} MV_3 &= 0, \\
\frac{d}{dx} MV_3 \cdot \frac{d}{dy} MV_3 &= 0
\end{align*} \]

See also: SymbTangentToCrvAtTwoPts, MvarMVBiTangents, MvarMVBiTangents2, MvarMVTriTangentLine,

8.2.338 MvarMVUpdateConstDegDomains (mvar_aux.c:545)

```
void MvarMVUpdateConstDegDomains(MvarMVStruct **MVs, int NumOfMVs)

MVs: To update their domains.
NumOfMVs: Size of MVs vector.

Returns: void

Description: Given a vector of MVs, some with constant degrees and invalid domain, update all MVs domains, exploiting MVs with non constant degrees' domains.

See also: MvarETUpdateConstDegDomains,
```
8.2.339 MvarMVVecDotProd (mvar_sym.c:397)

MvarMVStruct *MvarMVVecDotProd(const MvarMVStruct *MV, const CagdRType *Vec)

MV: Multivarients to multiply and compute a dot product for.
Vec: Vector to project MV onto.

Returns: A scalar multivariate representing the dot product of MV . Vec.

Description: Given a multivariate and a vector - computes their dot product. Returned multivariate is a scalar multivariate representing the dot product. While typically in R3, the dot product can be computed for any dimension of MV, and Vec should be of the appropriate size.
See also: MvarMVDotProd, MvarMVMult, MvarMVScalarScale, MvarMVMultScalar, , MvarMVInvert, MvarMVCrossProd,

8.2.340 MvarMVVolumeOfDomain (mvar_aux.c:108)

IrtRType MvarMVVolumeOfDomain(MvarMVStruct * const MVs, int Dim)

MVs: The multivariate.
Dim: Number of dimensions.
Returns: Volume of domain.

Description: Compute the volume of a multivariate’s domain.

8.2.341 MvarMVsBisector (mvbisect.c:44)

MvarMVStruct *MvarMVsBisector(const MvarMVStruct *MV1, const MvarMVStruct *MV2)

MV1, MV2: The two multivariates to compute the bisector for.

Returns: The result bisector.

Description: Compute bisector to two given multivariates.
See also: SymbSrfsPtBisectorSrfs3D, SymbCrvPtBisectorSrfs3D, SymbCrvCrvBisectorSrfs3D,

8.2.342 MvarMVsSame (mvar_gen.c:1669)

CagdBType MvarMVsSame(const MvarMVStruct *MV1, const MvarMVStruct *MV2, CagdRType Eps)

MV1, MV2: The two multivariates to compare.
Eps: Tolerance of equality.

Returns: TRUE if multivariates are the same, FALSE otherwise.

Description: Compare the two multivariates for similarity.
See also: CagdSrfsSame, CagdCrvsSame, TrivTVsSame, MvarMVsSameSpace,

8.2.343 MvarMVsSameSpace (mvar_gen.c:1618)

CagdBType MvarMVsSameSpace(const MvarMVStruct *MV1, const MvarMVStruct *MV2, CagdRType Eps)

MV1, MV2: The two multivariates to compare.
Eps: Tolerance of equality.

Returns: TRUE if multivariates are in the same sapce, FALSE otherwise.

Description: Compare the two multivariates to be in the same function space.
See also: MvarMVsSame,
8.2.344  MvarMVsZeros0D (zrsolver.c:78)

MvarPtStruct *MvarMVsZeros0D(MvarMVStruct * const *MVs,
    MvarConstraintType *Constraints,
    int NumOfMVs,
    CagdRType SubdivTol,
    CagdRType NumericTol)

MVs: Vector of multivariate constraints.
Constraints: Either an equality or an inequality type of constraint. Can be NULL in which case all constraints are equality.
NumOfMVs: Size of the MVs and Constraints vector.
SubdivTol: Tolerance of the subdivision process. Tolerance is measured in the parametric space of the multivariates.
NumericTol: Numeric tolerance of the numeric stage. Measured in the image space of the constraints function.
Returns: List of points on the solution set. Dimension of the points will be the same as the dimensions of all MVs.

Description: Interface function for a generic MV equation solver, 0D solutions: constructs the generic problem structure, calls the solver and extracts the solution point list from the generic solution structure. The set of NumOfMVs constraints may consist of equality or inequality constraints, as prescribed by the constraints vector. All multivariates are assumed to be in the same parametric domain size and dimension.

See also: MvarMVsZerosNormalConeTest, MvarMVsZerosDomainReduction, MvarMVsZerosVerifier, MvarETsZeros0D, MvarMVsZeros1D, MvarMVsZeros2D

8.2.345  MvarMVsZeros1D (zrsolver.c:266)

MvarPolylineStruct *MvarMVsZeros1D(MvarMVStruct * const *MVs,
    MvarConstraintType *Constraints,
    int NumOfMVs,
    CagdRType Step,
    CagdRType SubdivTol,
    CagdRType NumericTol)

MVs: Vector of multivariate constraints.
Constraints: Either an equality or an inequality type of constraint. Can be NULL in which case all constraints are equality.
NumOfMVs: Size of the MVs and Constraints vector.
Step: Step size to use in the numeric tracing.
SubdivTol: Tolerance of the subdivision process. Tolerance is measured in the parametric space of the multivariates.
NumericTol: Numeric tolerance of the numeric stage. Measured in the image space of the constraints function.
Returns: The list of polylines which approximate the curve. Each polyline corresponds to the topologically isolated component of the curve and is in \( \mathbb{R}^k \), the unioned parametric spaces of all input MVs.

Description: Interface function for a generic MV equation solver, 1D solutions: constructs the generic problem structure, calls the solver and extracts the list of solution polylines from the generic solution structure. The set of NumOfMVs constraints may consist of equality or inequality constraints, as prescribed by the constraints vector. All multivariates are assumed to be in the same parametric domain size and dimension.

See also: MvarSrfSrflnter, MvarMVsZeros1DMergeSingularPts, MvarMVsZeros0D, MvarETsZeros0D, MvarMVsZeros2D, MvarMVsZeros1DOneTrace

8.2.346  MvarMVsZeros1DMergeSingularPts (zrmv1d.c:751)

int MvarMVsZeros1DMergeSingularPts(int MergeSingularPts)

MergeSingularPts: Set the desired state of singular points mergers.
Returns: Old state.

Description: Sets the state of the singular points merger: If 0, singular locations are ignored (skipped). If 1, singular locations are merged using the subdivision tolerance which improves the changes of a complete long merged curves. If 2, singular locations are merged using the numeric tolerances (like every other case) which means most likely they will be left as isolated points.

See also: MvarSrfSrflnter, MvarMVsZeros1D
8.2.347  MvarMVsZeros1DOneTrace (zrsolver.c:339)

MvarPolylineStruct *MvarMVsZeros1DOneTrace(MvarMVStruct * const *MVs,
MvarConstraintType *Constraints,
int NumOfMVs,
MvarPtStruct *StartEndPts,
CagdRType Step,
CagdRType SubdivTol,
CagdRType NumericTol)

**MVs:** Vector of multivariate constraints.

**Constraints:** Either an equality or an inequality type of constraint. Can be NULL in which case all constraints are equality.

**NumOfMVs:** Size of the MVs and Constraints vector.

**StartEndPts:** Start/end points for the polyline solution to trace.

**Step:** Step size to use in the numeric tracing.

**SubdivTol:** Tolerance of the subdivision process. Tolerance is measured in the parametric space of the multivariates.

**NumericTol:** Numeric tolerance of the numeric stage. Measured in the image space of the constraints function.

**Returns:** The traced polyline which approximates solution, in $\mathbb{R}^k$.

**Description:** Interface function similar to MvarMVsZeros1D but only for tracing a single univariate component between StartEndPts.

**See also:** MvarSrfSrfInter, MvarMVsZeros1DMergeSingularPts, MvarMVsZeros0D, MvarETsZeros0D, MvarMVsZeros2D, MvarMVsZeros1D,

8.2.348  MvarMVsZeros2D (zrsolver.c:443)

MvarPolyStruct *MvarMVsZeros2D(MvarMVStruct * const *MVs,
MvarConstraintType *Constraints,
int NumOfMVs,
CagdRType Step,
CagdRType SubdivTol,
CagdRType NumericTol,
MvarMapPrm2EucCal1BackFuncType MapPt2EuclidSp)

**MVs:** Vector of multivariate constraints.

**Constraints:** Either an equality or an inequality type of constraint. Can be NULL in which case all constraints are equality.

**NumOfMVs:** Size of the MVs and Constraints vector.

**Step:** Step size to use in the numeric tracing of boundary (univariate) solutions.

**SubdivTol:** Tolerance of the subdivision process. Tolerance is measured in the parametric space of the multivariates.

**NumericTol:** Numeric tolerance of the numeric stage. Measured in the image space of the constraints function.

**MapPt2EuclidSp:** A pointer to the function used for mapping the solution from the problem’s parameter space to the 3D Euclidean space. If not provided, the solution points are returned in the dimension (and semantics) of the original parameter space.

**Returns:** The list of either triangles or polylines, according to the required output types, which approximate the surface.

**Description:** Interface function for a generic MV equation solver, 2D solutions: constructs the generic problem structure, calls the solver and extracts the list of either solution triangles or solution polylines from the generic solution structure. The set of NumOfMVs constraints must consist of equality constraints, prescribed by the constraints vector (inequalities not supported). All multivariates are assumed to be in the same parametric domain size and dimension.

**See also:** MvarSrfSrfInter, MvarMVsZeros0D, MvarETsZeros0D, MvarMVsZeros1D,
MvarPtStruct *MvarMVsZeros2DBy0D(MvarMVStruct * const *MVs, 
MvarConstraintType *Constraints, 
int NumOfMVs, 
CagdRType SubdivTol, 
CagdRType NumericTol)

MVs: Vector of multivariate constraints.
Constraints: Either an equality or an inequality type of constraint. Can be NULL in which case all constraints are equality.
NumOfMVs: Size of the MVs and Constraints vector.
SubdivTol: Tolerance of the subdivision process. Tolerance is measured in the parametric space of the multivariate.
NumericTol: Numeric tolerance of the numeric stage. Measured in the image space of the constraints function.
Returns: List of points on the solution set. Dimension of the points will be the same as the dimensions of all MVs.

Description: Interface function for a generic MV equation solver, 2D solutions, in the temporary case where the problem is solved using the 0D solver and then surface fitting to the solution points. Constructs the generic problem structure, calls the solver and extracts the solution point list from the generic solution structure. The surface fitting step is done by the specific problem algorithm outside the solver environment. The set of NumOfMVs constraints may consist of equality or inequality constraints, as prescribed by the constraints vector. All multivariates are assumed to be in the same parametric domain size and dimension.

See also: MvarCrvSrfBisectorApprox,

int MvarMVsZeros2DPolylines(int IsPolyLines2DSolution)

IsPolyLines2DSolution: New setting for the output type.
Returns: Old setting for the output type.

Description: Sets the output type of the bivariate solver: either a collection of loops (polylines) or a collection of triangles.

See also: MvarZeroSolver, MvarZeroSolverOne2OneProjMVs,

CagdRType MvarMVsZerosDmnExt(CagdRType DmnExt)

DmnExt: New setting for domain extension usage.
Returns: Old extensions tolerance for domain extension usage.

Description: Sets the tolerance (or zero to disable) of the domain extension inside the multivariate subdivisions’ zero set solver.

See also: MvarZeroSolver, MvarMVsZerosDomainReduction, MvarMVsZerosGradPreconditioning,

int MvarMVsZerosDomainReduction(int DomainReduction)

DomainReduction: New setting for the domain reduction option.
Returns: Old setting for normal cone testing usage.

Description: Sets the use (or not) of the domain reduction option - Bezier (and (B-spline) clipping in multivariate subdivisions’ zero set solver.

See also: MvarMVsZeros, MvarMVsZerosNormalConeTest, MvarMVsZerosGradPreconditioning, MvarMVsZerosSetCallBackFunc,
8.2.353  MvarMVsZerosGradPreconditioning  (zrmvaux0.c:90)

int MvarMVsZerosGradPreconditioning(int GradPreconditioning)

GradPreconditioning: New setting for the gradient orthogonalization.
Returns: Old setting of gradient orthogonalization.
Description: Sets the use (or not) of gradient preconditioning option - application of and orthogonalization process over the gradients in multivariate subdivisions’ zero set solver.
See also: MvarMVsZeros, MvarMVsZerosNormalConeTest, MvarMVsZerosDomainReduction, MvarMVsZerosSetCallBackFunc,

8.2.354  MvarMVsZerosKantorovichTest  (zrmvkant.c:793)

int MvarMVsZerosKantorovichTest(int KantorovichTest)

KantorovichTest: New setting for normal cone testing usage.
Returns: Old setting for normal cone testing usage.
Description: Sets the use (or not) of the Kantorovich test inside the multivariate subdivisions’ zero set solver.
See also: MvarMVsZeros, MvarMVsZerosDomainReduction, MvarMVsZerosGradPreconditioning, MvarMVsZerosSetCallBackFunc,

8.2.355  MvarMVsZerosNormalConeTest  (zrmvaux0.c:62)

int MvarMVsZerosNormalConeTest(int NormalConeTest)

NormalConeTest: New setting for normal cone testing usage.
Returns: Old setting for normal cone testing usage.
Description: Sets the use (or not) of the normal cone tests inside the multivariate subdivisions’ zero set solver.
See also: MvarMVsZeros, MvarMVsZerosDomainReduction, MvarMVsZerosGradPreconditioning, MvarMVsZerosSetCallBackFunc,

8.2.356  MvarMVsZerosParallelHyperPlaneTest  (zrmvaux0.c:145)

int MvarMVsZerosParallelHyperPlaneTest(int ParallelHPlaneTest)

ParallelHPlaneTest: New setting for the domain reduction option.
Returns: Old setting for normal cone testing usage.
Description: Sets the use (or not) of the parallel plane termination criteria in multivariate subdivisions’ zero set solver.
See also: MvarMVsZeros, MvarMVsZerosNormalConeTest, MvarMVsZerosGradPreconditioning, MvarMVsZerosDomainReduction, MvarMVsZerosSetCallBackFunc,

8.2.357  MvarMVsZerosSameSpace  (zrmvaux0.c:202)

CagdBType MvarMVsZerosSameSpace(MvarMVTstruct **MVs, int NumOfMVs)

MVs: Vector of multivariate constraints.
NumOfMVs: Size of the MVs vector.
Returns: TRUE if in same function space, FALSE otherwise.
Description: Make sure all given MVs are in the same function space.
See also: MvarMVsSameSpace,
8.2.358  MvarMVsZerosSetCallBackFunc  (zrmvaux0.c:175)

MvarMVsZerosSubdivCallBackFuncType  MvarMVsZerosSetCallBackFunc(
   MvarMVsZerosSubdivCallBackFuncType  SubdivCallBackFunc)

SubdivCallBackFunc: Call back function to use in the MV zeros’ subdivision stage.
Returns: Old setting.
Description: Sets the use (or not) of a call back function that is invoked at every node of the subdivision tree process.
See also: MvarMVsZeros, MvarMVsZerosDomainReduction, MvarMVsZerosGradPreconditioning, MvarMVsZerosNormalConeTest, MvarMVsZerosParallelHyperPlaneTest,

8.2.359  MvarMVsZerosVerifier  (zrmvaux0.c:974)

void  MvarMVsZerosVerifier(MvarMVStruct * const *MVs,
   int NumOfZeroMVs,
   MvarPtStruct *Sols,
   CagdRType NumerEps)

MVs: Input constraints.
NumOfZeroMVs: Number of (zero only) constraints.
Sols: Linked lists of solutions found.
NumerEps: Numeric tolerance used in the solution.
Returns: void
Description: A verification function to test the correctness of the solutions. For mostly development/debugging purposes.
See also: MvarZeroSolver,

8.2.360  MvarMakeMVsCompatible  (mvarcmpt.c:36)

CagdBType  MvarMakeMVsCompatible(MvarMVStruct **MV1,
   MvarMVStruct **MV2,
   CagdBType  SameOrders,
   CagdBType  SameKVs)

MV1, MV2: Two surfaces to be made compatible, in place.
SameOrders: If TRUE, this routine make sure they share the same orders.
SameKVs: If TRUE, this routine make sure they share the same KVs.
Returns: TRUE if successful, FALSE otherwise.
Description: Given two multi-variates, makes them compatible by:
1. Coercing their point type to be the same.
2. Making them have the same multi-variate type.
3. Raising the degree of the lower one to be the same as the higher.
4. Refining them to a common knot vector (If Bspline and SameOrder).
Note 3 is performed if SameOrder TRUE, 4 if SameKV TRUE. Both multi-variates are modified IN PLACE.

8.2.361  MvarMakeUniquePointsList  (mvarjimp.c:233)

void  MvarMakeUniquePointsList(MvarPtStruct **PtList, CagdRType Tol)

PtList: Input point list to make unique in place.
Tol: Equality tolerance on the different coefficient of the points.
Returns: void
Description: Removes duplicated points in a given multivariate points list, in place.
8.2.362  **MvarMatchPointListIntoPolylines** (mvar_pll.c:399)

```
MvarPolylineStruct *MvarMatchPointListIntoPolylines(const MvarPtStruct *PtsList, IrtRType MaxTol)
```

- **PtsList**: Point list to connect into multivariate polylines.
- **MaxTol**: Maximum distance allowed to connect multivariate points.
- **Returns**: Connected multivariate polylines, upto MaxTol tolerance.

**Description**: Connect the list of multivariate points into multivariate polylines by connecting the closest multivariate point pairs, until the distances between adjacent multivariate points/polyline is more than MaxTol.

**See also**: GMMatchPointListIntoPolylines2,

8.2.363  **MvarMergeBBox** (mvar_aux.c:846)

```
void MvarMergeBBox(MvarBBoxStruct *DestBBox, const MvarBBoxStruct *SrcBBox)
```

- **DestBBox**: One BBox operand as well as the result.
- **SrcBBox**: Second BBox operand.
- **Returns**: void

**Description**: Merges (union) two bounding boxes into one, in place.

8.2.364  **MvarMergeIrtPtType** (mvarcoer.c:153)

```
MvarPointType MvarMergeIrtPtType(MvarPointType PType1, MvarPointType PType2)
```

- **PType1, PType2**: To point types to find the point type of their union.
- **Returns**: A point type of the union of the spaces of PType1 and PType2.

**Description**: Returns a point type which spans the spaces of both two given point types.

8.2.365  **MvarMergeMVMV** (mvar_aux.c:1461)

```
MvarMVStruct *MvarMergeMVMV(const MvarMVStruct *CMV1, const MvarMVStruct *CMV2, MvarMVDirType Dir, CagdBType Discont)
```

- **CMV1**: To connect to CMV2's starting boundary at its end.
- **CMV2**: To connect to CMV1's end boundary at its start.
- **Dir**: Direction the merge should take place.
- **Discont**: If TRUE, assumes the merged "edge" is discontinuous.
- **Returns**: The merged multivariate.

**Description**: Merges two multivariates in the requested direction Dir. It is assumed that last edge of MV1 is identical to first edge of MV2. It is assumed that both MVs have open end conditions and share the same orders and knot sequences in all axes, but the merged axes which can have different knots.

**See also**: CagdMergeSrfSrf,
8.2.366  **MvarMeshIndicesFromIndex**  (mvar_aux.c:1420)

```c
int MvarMeshIndicesFromIndex(int Index, const MvarMVStruct *MV, int *Indices)
```

- **Index**: To decompose into the different axes of the multivariate.
- **MV**: Whose indices are for.
- **Indices**: To compute the exact point location in MV -> Points
- **Returns**: TRUE if Index in range, false otherwise.

**Description**: Given a linear Index into the vector of control points, compute the indices of the multivariates in all dimensions.

**See also**: MvarGetPointsMeshIndices,

8.2.367  **MvarMinSpanCirc**  (ms_circ.c:564)

```c
int MvarMinSpanCirc(IPObjectStruct *Objs,
                    CagdRType *Center,
                    CagdRType *Radius,
                    CagdRType SubdivTol,
                    CagdRType NumerTol)
```

- **Objs**: The geometry to compute the MSC for as a list object.
- **Center**: Of computed MSC.
- **Radius**: Of computed MSC.
- **SubdivTol, NumerTol**: Of computation.
- **Returns**: TRUE if successful, FALSE otherwise.

**Description**: Minimum spanning circle (MSC) computation of given Objs geometry. Geometry could be freeform C^1 curves.

**See also**: MvarMSCircOfThreeCurves, MvarMSCircOfThreeCurves, MvarMinSpanCirc, MVarMSCircCurveInCirc, GMMinSpanCirc,

8.2.368  **MvarMinSpanCone**  (mvcones.c:325)

```c
int MvarMinSpanCone(MvarVecStruct *MVVecs,
                     int VecsNormalized,
                     int NumOfVecs,
                     MvarNormalConeStruct *MVCone)
```

- **MVVecs**: The set of vectors to compute their MSC.
- **VecsNormalized**: TRUE if vectors are normalized, FALSE otherwise.
- **NumOfVecs**: Number of vectors in set MVVecs.
- **MVCone**: Returns cone axis and cone cos angle of computed MSC.
- **Returns**: TRUE if successful, FALSE otherwise.

**Description**: Minimum spanning cone (MSC) computation of a set of vectors. Algorithm is based on the Minimum Spanning Circle in Section 4.7 of "Computational Geometry, Algorithms and Applications" by M. de Berg et. al.

**See also**: GMMinSpanCone,
8.2.369  MvarMinSpanConeAvg (mvcones.c:254)

```c
int MvarMinSpanConeAvg(MvarVecStruct *MVVecs,
   int VecsNormalized,
   int NumOfVecs,
   MvarNormalConeStruct *MVCone)
```

- **MVVecs**: The set of vectors to compute their MSC.
- **VecsNormalized**: TRUE if vectors are normalized, FALSE otherwise.
- **NumOfVecs**: Number of vectors in set MVVecs.
- **MVCone**: Returns cone axis and cone cos angle of computed MSC.

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: Minimum spanning cone (MSC) computation of a set of vectors. Find a central vector as the average of all given vectors and find the vector with maximal angular distance from it.

**See also**: GMMinSpanConeAvg,

8.2.370  MvarNormalConeCopy (mvcones.c:125)

```c
MvarNormalConeStruct *MvarNormalConeCopy(const MvarNormalConeStruct *NormalCone)
```

- **NormalCone**: Normal cone to copy.

**Returns**: Copied normal cone.

**Description**: Copy a multivariate normal cone structure.

**See also**: MvarNormalConeNew, MvarNormalConeCopyList, MvarNormalConeFree,

8.2.371  MvarNormalConeCopyList (mvcones.c:161)

```c
MvarNormalConeStruct *MvarNormalConeCopyList(const MvarNormalConeStruct *NormalCones)
```

- **NormalCones**: List of multivariate normal cones to duplicate.

**Returns**: Duplicated list of multivariate normal cones.

**Description**: Copy a list of multivariate normal cones’ structures.

**See also**: MvarNormalConeNew, MvarNormalConeCopy, MvarNormalConeFree,

8.2.372  MvarNormalConeFree (mvcones.c:193)

```c
void MvarNormalConeFree(MvarNormalConeStruct *NormalCone)
```

- **NormalCone**: Normal cone to free.

**Returns**: void

**Description**: Free a multivariate normal cone structure.

**See also**: MvarNormalConeNew, MvarNormalConeFreeList, MvarNormalConeCopy,

8.2.373  MvarNormalConeFreeList (mvcones.c:219)

```c
void MvarNormalConeFreeList(MvarNormalConeStruct *NormalConeList)
```

- **NormalConeList**: Multi-Variate cone list to free.

**Returns**: void

**Description**: Deallocates and frees a list of multi-variate cone structures.

**See also**: MvarNormalConeFree, MvarNormalConeNew,
8.2.374  **MvarNormalConeNew** (mvcones.c:93)

MvarNormalConeStruct *MvarNormalConeNew(int Dim)

- **Dim**: Dimension of the cone.
- **Returns**: Constructed cone.
- **Description**: Constructs a multivariate normal cone structure.
- **See also**: MvarNormalConeFree, MvarNormalConeFreeList, MvarNormalConeCopy,

8.2.375  **MvarParamInDomain** (mvar_aux.c:468)

CagdBType MvarParamInDomain(const MvarMVStruct *MV, CagdRType t, MvarMVDirType Dir)

- **MV**: To make sure t is in its Dir domain.
- **t**: Parameter value to verify.
- **Dir**: Direction. Either U or V or W.
- **Returns**: TRUE if in domain, FALSE otherwise.
- **Description**: Given a multi-variate and a domain - validate it.
- **See also**: varMVSetDomain, MvarMVSetAllDomains, MvarParamInDomain,

8.2.376  **MvarParamsInDomain** (mvar_aux.c:496)

CagdBType MvarParamsInDomain(const MvarMVStruct *MV, const CagdRType *Params)

- **MV**: To make sure (u, v, w) is in its domain.
- **Params**: Array of real valued parameters of size Dim to verify if this point is in MV’s parametric domain.
- **Returns**: TRUE if in domain, FALSE otherwise.
- **Description**: Given a multi-variate and a domain - validate it.
- **See also**: varMVSetDomain, MvarMVSetAllDomains, MvarParamsInDomain, varMVIntersPtOnBndry,

8.2.377  **MvarPlaneCopy** (mvar_gen.c:1342)

MvarPlaneStruct *MvarPlaneCopy(const MvarPlaneStruct *Pln)

- **Pln**: Multi-Variate plane to duplicate.
- **Returns**: Duplicated multi-variate plane.
- **Description**: Allocates and duplicates all slots of a multi-variate plane structure.

8.2.378  **MvarPlaneCopyList** (mvar_gen.c:1368)

MvarPlaneStruct *MvarPlaneCopyList(const MvarPlaneStruct *PlnList)

- **PlnList**: List of multivariates to duplicate.
- **Returns**: Duplicated list of multi-variates.
- **Description**: Duplicates a list of multi-variate structures.
8.2.379  **MvarPlaneFree** (mvar_gen.c:1400)

    void MvarPlaneFree(MvarPlaneStruct *Pln)

    Pln: Multivariate plane to free.
    Returns: void
    Description: Deallocates and frees all slots of a multi-variate plane structure.
    See also: MvarPlaneNew,

8.2.380  **MvarPlaneFreeList** (mvar_gen.c:1424)

    void MvarPlaneFreeList(MvarPlaneStruct *PlnList)

    PlnList: Multi-Variate plane list to free.
    Returns: void
    Description: Deallocates and frees a list of multi-variate plane structures.

8.2.381  **MvarPlaneNew** (mvar_gen.c:1308)

    MvarPlaneStruct *MvarPlaneNew(int Dim)

    Dim: Number of dimensions of this multi-variate.
    Returns: An uninitialized freeform multi-variate plane.
    Description: Allocates the memory required for a new multi-variate plane.
    See also: MvarPlaneFree,

8.2.382  **MvarPlaneNormalize** (mvar_vec.c:639)

    int MvarPlaneNormalize(MvarPlaneStruct *Pln)

    Pln: Plane to normalize its normal direction.
    Returns: TRUE if successful, FALSE if the input is the ZERO vector.
    Description: Normalize a given multivariate plane's normal direction to a unit length, in place.
    See also: MvarVecNormalize,

8.2.383  **MvarPointFromPointLine** (mvar_int.c:191)

    void MvarPointFromPointLine(const MvarVecStruct *Point,  
                                const MvarVecStruct *Pl,  
                                const MvarVecStruct *Vl,  
                                MvarVecStruct *ClosestPoint)

    Point: To find the closest to on the line.
    Pl, Vl: Position and direction that defines the line. Vl is assumed a unit length vector.
    ClosestPoint: Where closest point found on the line is to be saved.
    Returns: void
    Description: Routine to compute the closest point on a line to point, in R^n. The line is prescribed using a
                point on it (Pl) and a unit vector (Vl).
    See also: GMPointFromPointLine,
8.2.384 MvarPolyFree (mvar_gen.c:893)

void MvarPolyFree(MvarPolyStruct *Poly)

  Poly: Multivariate poly to free.
  Returns: void
  Description: Deallocates and frees all slots of a multi-variate poly structure.
  See also: MvarPolyNew,

8.2.385 MvarPolyMergePolylines (mvar_pll.c:193)

MvarPolylineStruct *MvarPolyMergePolylines(MvarPolylineStruct *Polys,
                                          IrtRType Eps)

  Polys: Multivariate polylines to merge, in place.
  Eps: Epsilon of similarity to merge multivariate polylines at.
  Returns: Merged as possible multivariate polylines.
  Description: Merges separated multivariate polylines into longer ones, in place, as possible. Given a list of
              multivariate polylines, matches end points and merged as possible multivariate polylines with common end points,
              in place.
  See also: GMMergePolylines,

8.2.386 MvarPolyNew (mvar_gen.c:856)

MvarPolyStruct *MvarPolyNew(MvarPolylineStruct *PlList,
                           MvarTriangleStruct *TrList)

  PlList: List of polylines. NULL if the required type is triangles.
  TrList: List of triangles. NULL if the required type is polylines.
  Returns: A new (single) poly object, holding the list.
  Description: Allocates the memory required for a new multi-variate poly container.
  See also: MvarPolyFree,

8.2.387 MvarPolyReverseList (mvar_gen.c:739)

MvarPtStruct *MvarPolyReverseList(MvarPtStruct *Pts)

  Pts: Multi-Variate point list to reverse.
  Returns: Reversed list of Multi-Variate points, in place.
  Description: Reverses a list of multivariate points, in place.

8.2.388 MvarPolylineCopy (mvar_gen.c:799)

MvarPolylineStruct *MvarPolylineCopy(const MvarPolylineStruct *Poly)

  Poly: Multi-Variate polyline to duplicate.
  Returns: Duplicated multi-variate polyline.
  Description: Allocates and duplicates all slots of a multi-variate polyline structure.
8.2.389 MvarPolylineCopyList (mvar_gen.c:822)

MvarPolylineStruct *MvarPolylineCopyList(MvarPolylineStruct *PolyList)

- **PolyList**: List of multi-variate polylines to duplicate.
- **Returns**: Duplicated list of multi-variate polylines.
- **Description**: Duplicates a list of multi-variate polyline structures.

8.2.390 MvarPolylineFree (mvar_gen.c:989)

void MvarPolylineFree(MvarPolylineStruct *Poly)

- **Poly**: Multivariate polyline to free.
- **Returns**: void
- **Description**: Deallocates and frees all slots of a multi-variate polyline structure.
- **See also**: MvarPolylineNew,

8.2.391 MvarPolylineFreeList (mvar_gen.c:1009)

void MvarPolylineFreeList(MvarPolylineStruct *PolyList)

- **PolyList**: Multi-Variate polyline list to free.
- **Returns**: void
- **Description**: Deallocates and frees a list of multi-variate polyline structures.

8.2.392 MvarPolylineNew (mvar_gen.c:773)

MvarPolylineStruct *MvarPolylineNew(MvarPtStruct *Pl)

- **Pl**: List of points forming the polyline.
- **Returns**: A new multi-variate polyline.
- **Description**: Allocates the memory required for a new multi-variate polyline.
- **See also**: MvarPolylineFree,

8.2.393 MvarPromoteMVToMV (mvar_rev.c:271)

MvarMVStruct *MvarPromoteMVToMV(const MvarMVStruct *MV, int Axis)

- **MV**: Multi-Variate to promote.
- **Axis**: Axis of promotion. Between zero and MV - Dim.
- **Returns**: Promoted multi-variate.
- **Description**: Increase by one the dimensionality of the given multivariate, by introducing a new constant (degree zero) axis with one control point in direction Axis.
- **See also**: MvarMVShiftAxes, MvarMVFromMV, MvarPromoteMVToMV2,
8.2.394 MvarPromoteMVToMV2 (mvar_rev.c:315)

MvarMVStruct *MvarPromoteMVToMV2(const MvarMVStruct *MV,  
    int NewDim,  
    int StartAxis)

MV: Multi-Variate to promote.  
NewDim: New dimension of the promoted multivariate.  
StartAxis: Original MV would span axes StartAxis to StartAxis+MV->Dim-1.  
Returns: Promoted multi-variate.  

Description: Increase by the dimensionality of the given multivariate to NewDim, by introducing new constant (degree zero) axes with one control points in all new directions. The Axis of the original MV will be starting at StartAxis.  
See also: MvarMVShiftAxes, MvarMVFromMV, MvarPromoteMVToMV,

8.2.395 MvarPtCmpTwoPoints (mvar_pll.c:269)

int MvarPtCmpTwoPoints(const MvarPtStruct *P1,  
    const MvarPtStruct *P2,  
    CagdRType Eps)

P1, P2: Two multivariate points to compare.  
Eps: The tolerance of the comparison.  
Returns: 0 if identical, -1 or +1 if first point is less than/greater than second point, in lexicographic order over dimensions. 2 is returned if the dimensions are different.  
Description: A comparison function to examine if the given two points are the same.  
See also: MvarPtDistTwoPoints, MvarPtDistSqrTwoPoints,

8.2.396 MvarPtCopy (mvar_gen.c:634)

MvarPtStruct *MvarPtCopy(const MvarPtStruct *Pt)

Pt: Multi-Variate point to duplicate.  
Returns: Duplicated multi-variate point.  
Description: Allocates and duplicates all slots of a multi-variate point structure.

8.2.397 MvarPtCopyList (mvar_gen.c:659)

MvarPtStruct *MvarPtCopyList(const MvarPtStruct *PtList)

PtList: List of multi-variate points to duplicate.  
Returns: Duplicated list of multi-variate points.  
Description: Duplicates a list of multi-variate point structures.

8.2.398 MvarPtDistSqrTwoPoints (mvar_pll.c:361)

CagdRType MvarPtDistSqrTwoPoints(const MvarPtStruct *P1, const MvarPtStruct *P2)

P1, P2: Two points to compute the distance between.  
Returns: Distance computed.  
Description: Compute the Euclidean distance between two multivariate points.  
See also: MvarPtCmpTwoPoints, MvarPtDistTwoPoints,
8.2.399 MvarPtDistTwoPoints (mvar_pll.c:301)

CagdRType MvarPtDistTwoPoints(const MvarPtStruct *P1, const MvarPtStruct *P2)

P1, P2: Two points to compute the distance between.

Returns: Distance computed.

Description: Compute the Euclidean distance between two multivariate points.
See also: MvarPtCmpTwoPoints, MvarPtDistSqrTwoPoints,

8.2.400 MvarPtFree (mvar_gen.c:691)

void MvarPtFree(MvarPtStruct *Pt)

Pt: Multivariate point to free.

Returns: void

Description: Deallocates and frees all slots of a multi-variate point structure.
See also: MvarPtNew,

8.2.401 MvarPtFreeList (mvar_gen.c:715)

void MvarPtFreeList(MvarPtStruct *PtList)

PtList: Multi-Variate point list to free.

Returns: void

Description: Deallocates and frees a list of multi-variate point structures.

8.2.402 MvarPtInBetweenPoint (mvar_pll.c:326)

MvarPtStruct *MvarPtInBetweenPoint(const MvarPtStruct *Pt1,
  const MvarPtStruct *Pt2,
  CagdRType t)

Pt1, Pt2: Multivariate points.
    t: Blending factor, 0 for Pt1, 0.5 for mid pt, 1 for Pt2.

Returns: The in-between point of Pt1 and Pt2.

Description: Computes an in-between point (middle if t = 0.5) of given two points.
See also: MvarPtCmpTwoPoints, MvarPtDistSqrTwoPoints,

8.2.403 MvarPtNew (mvar_gen.c:548)

MvarPtStruct *MvarPtNew(int Dim)

Dim: Number of dimensions of this multi-variate.

Returns: An uninitialized multi-variate point.

Description: Allocates the memory required for a new multi-variate point.
See also: MvarPtFree,
8.2.404 MvarPtRealloc (mvar_gen.c:588)

MvarPtStruct *MvarPtRealloc(MvarPtStruct *Pt, int NewDim)

- **Pt**: Multi-Variate point to reallocate. Should not be used after this operation as it might be freed.
- **NewDim**: Number of new dimensions of this multi-variate.
- **Returns**: A reallocated point of dimension NewDim.
- **Description**: Reallocates the memory that is required for a new dimension of a multi-variate point.
- **See also**: MvarPtNew,

8.2.405 MvarPtSortListAxis (mvar_gen.c:943)

MvarPtStruct *MvarPtSortListAxis(MvarPtStruct *PtList, int Axis)

- **PtList**: List of points to sort.
- **Axis**: Axis to sort along: 1,2,3 for X,Y,Z.
- **Returns**: Sorted list of points, in place.
- **Description**: Sorts given list of points based on their increasing order in axis Axis. Sorting is done in place.

8.2.406 MvarPwrMVNew (mvar_gen.c:240)

MvarMVStruct *MvarPwrMVNew(int Dim, const int *Lengths, MvarPointType PType)

- **Dim**: Number of dimensions of this multivariate.
- **Lengths**: Of control mesh in each of the dimensions. Vector of size Dim.
- **PType**: Type of control points (E2, P3, etc.).
- **Returns**: An uninitialized freeform multi-variate power basis.
- **Description**: Allocates the memory required for a new power basis multi-variate.
- **See also**: MvarMVFree, MvarMVNew, MvarBspMVNew, MvarBzrMVNew,

8.2.407 MvarRationalSrfS poles (mvarpole.c:37)

MvarPolylineStruct *MvarRationalSrfS poles(const CagdSrfStruct *Srf,
                                          CagdRType SubdivTol,
                                          CagdRType NumericTol)

- **Srf**: Rational surface to extract its poles.
- **SubdivTol**: The subdivision tolerance to use.
- **NumericTol**: The numerical tolerance to use.
- **Returns**: The poles, as piecewise linear approximations.
- **Description**: Computes the poles of a rational surface, solving for the zeros of the surface's denominator.
- **See also**: CagdPointsHasPoles, SymbCrvsSplitPoleParams,

8.2.408 MvarSetFatalErrorFunc (mvar_ftl.c:28)

MvarSetErrorFuncType MvarSetFatalErrorFunc(MvarSetErrorFuncType ErrorFunc)

- **ErrorFunc**: New error function to use.
- **Returns**: Old error function reference.
- **Description**: Sets the error function to be used by Mvar_lib.
8.2.409 MvarSkel2DInter3Prims (skel2d.c:173)

MvarSkel2DInter3PrimsStruct *MvarSkel2DInter3Prims(MvarSkel2DPrimStruct *Prim1,
MvarSkel2DPrimStruct *Prim2,
MvarSkel2DPrimStruct *Prim3)

Prim1, Prim2, Prim3: The three input primitives to consider.
Returns: A linked list of all equadistant points computed, or NULL if none found.
Description: Computes all points in R2 that are equadistant from the given three primitives. A primitive can
be a point, a line, an arc, or a freeform curve. The end points of the line/arc/curve are NOT considered.
See also: MvarSkel2DSetEpsilon, MvarSkel2DSetFineness, MvarSkel2DSetOuterExtent

8.2.410 MvarSkel2DInter3PrimsFree (skel2d.c:233)

void MvarSkel2DInter3PrimsFree(MvarSkel2DInter3PrimsStruct *SK2DInt)

SK2DInt: To be deallocated.
Returns: void
Description: Deallocates and frees all slots of 2d skeleton intersection structure.

8.2.411 MvarSkel2DInter3PrimsFreeList (skel2d.c:252)

void MvarSkel2DInter3PrimsFreeList(MvarSkel2DInter3PrimsStruct *SK2DIntList)

SK2DIntList: To be deallocated.
Returns: void
Description: Deallocates and frees a 2d skeleton intersection structure list:

8.2.412 MvarSkel2DSetEpsilon (skel2d.c:61)

CagdRType MvarSkel2DSetEpsilon(CagdRType NewEps)

NewEps: New epsilon to use.
Returns: Old epsilon value.
Description: Sets the epsilon of the 2D skeleton computation.
See also: Skel2DInter3Primitives

8.2.413 MvarSkel2DSetFineNess (skel2d.c:115)

CagdRType MvarSkel2DSetFineNess(CagdRType NewFineNess)

Returns: Old fineness value.
Description: Sets the fineness of the 2D skeleton computation.
See also: Skel2DInter3Primitives
8.2.414  **MvarSkel2DSetMZeroTols** (skel2d.c:88)

```c
CagdRType MvarSkel2DSetMZeroTols(CagdRType SubdivTol, CagdRType NumerTol)
```

**SubdivTol, NumerTol**: Subdivision and numeric tolerance of mvar solver.

**Returns**: Old SubdivTol.

**Description**: Sets the tolerances to be used in this module for the multivariate zero set solver.

**See also**: MvarMVZeros, MvarSkel2DSetEpsilon, MvarSkel2DSetFineNess,

8.2.415  **MvarSkel2DSetOuterExtent** (skel2d.c:142)

```c
CagdRType MvarSkel2DSetOuterExtent(CagdRType NewOutExtent)
```

**NewOutExtent**: New outer extent to use.

**Returns**: Old outer extent value.

**Description**: Sets the outer extent of created (infinite) primitives in the 2D skeleton computation.

**See also**: Skel2DInter3Primitives,

8.2.416  **MvarSrfAccessibility** (mvaccess.c:52)

```c
MvarPolylineStruct *MvarSrfAccessibility(const CagdSrfStruct *CPosSrf,
const CagdSrfStruct *COrientSrf,
const CagdSrfStruct *CCheckSrf,
CagdRType SubdivTol,
CagdRType NumerTol)
```

**CPosSrf**: The position surface to examine.

**COrientSrf**: The orientation field of the access to the position surface. Must be in same function space as CPosSrf. If NULL, the normal field of CPosSrf is employed.

**CCheckSrf**: The surface to check gouging against.

**SubdivTol**: Tolerance of the solution. This tolerance is measured in the parametric space of the surfaces.

**NumerTol**: Numeric tolerance of a possible numeric improvement stage. The numeric stage is employed if NumerTol < SubdivTol.

**Returns**: The boundary of the accessible regions of CPosSrf.

**Description**: Derives the visibility domain of CPosSrf, when accessed from the direction that is specified by COrientSrf, not gouging into CCheckSrf. The boundary of the domain is prescribed by the following set of three constraints:

\[
\begin{align*}
F_1(u, v, s, t) & : \langle O_1(u, v), S(u, v) - K(s, t) \rangle = 0 \\
F_2(u, v, s, t) & : \langle O_2(u, v), S(u, v) - K(s, t) \rangle = 0 \\
F_3(u, v, s, t) & : \langle N_k(s, t), S(u, v) - K(s, t) \rangle = 0
\end{align*}
\]

where \(O_1(u, v), O_2(u, v)\) are two vector fields orthogonal to \(O(u, v)\), the orientation field. \(K(s, t)\) is the check surface and \(N_k(s, t)\) is its normal field, and \(S(u, v)\) is the position surface.

8.2.417  **MvarSrfAntipodalPoints** (selfintr.c:476)

```c
MvarPtStruct *MvarSrfAntipodalPoints(const CagdSrfStruct *Srf,
CagdRType SubdivTol,
CagdRType NumericTol)
```

**Srf**: To detect its antipodal points.

**SubdivTol**: Tolerance of the solution. This tolerance is measured in the parametric space of the surfaces.

**NumericTol**: Numeric tolerance of a possible numeric improvement stage. The numeric stage is employed if NumericTol < SubdivTol.
Returns: Antipodal points, as points in E4 (u, v, s, t).

Description: Computes antipodal points in the given surface - pairs of points S(u, v) and S(s, t) such that ((u, v) and (s, t) are two independent params of the same srf):

\[
< S(u, v) - S(s, t), dS(u, v)/du > = 0, \\
< S(u, v) - S(s, t), dS(u, v)/dv > = 0, \\
< N(s, t), dS(u, v)/du > = 0, \\
< N(s, t), dS(u, v)/dv > = 0.
\]

Direct attempt to solve this set of constraints is bound to be slow as all points in Srf satisfy these equations when (u, v) == (s, t). The key is in adding a fifth inequality constraint of the form

\[
< N(u, v), N(s, t) > < 0.
\]

Antipodal points must exists if Srf self intersect in a closed loop and hence can help in detecting self-intersections. Further, the diameter of Srf could be easily deduced from the antipodal points. Original version of this function was written by Diana Pekerman, Technion, Israel.

See also: MvarCrvaAntipodalPoints, MvarHFDistAntipodalSrfSrfCl,

8.2.418 MvarSrfFlecnodalCrvs (mvaccess.c:637)

MvarPolylineStruct *MvarSrfFlecnodalCrvs(const CagdSrfStruct *Srf,
CagdRType Step,
CagdRType SubdivTol,
CagdRType NumerTol)

Srf: To compute the flecnodal curves for.
Step: Stepsize in the curve-tracing stage.
SubdivTol: Accuracy of the subdivision stage of the approximation.
NumerTol: Accuracy of numeric approx.

Returns: Flecnodal curves as polylines in (a, b, u, v) space.

Description: Computes the flecnodal curves on surface Srf = S(u, v). Uses the univariate MV solver.

See also: MvarFlecnodalCrvsCreateMVs, MvarSrfFlecnodalCrvs,

8.2.419 MvarSrfFlecnodalPts (mvaccess.c:714)

MvarPtStruct *MvarSrfFlecnodalPts(const CagdSrfStruct *CSrf,
CagdRType SubdivTol,
CagdRType NumerTol)

CSrf: To compute the silhouette higher orders’ contact points.
SubdivTol: Accuracy of the subdivision stage of the approximation.
NumerTol: Accuracy of numeric approx.

Returns: Polylines on the unit sphere, depicting the flecnodal’s partitioning lines.

Description: Computes the flecnodal points on surface Srf = S(u, v). Denote by Suv the second order derivatives of S(u, v) and by Suvv the third order derivatives. Then, solution of the following 4 equations in 4 unknowns (u, v, a, b) provides the flecnodal points:

\[
\begin{bmatrix}
L \\
M \\
N \\
M
\end{bmatrix}
\begin{bmatrix}
a \\
b \\
\end{bmatrix}
\]

1. \[
\begin{bmatrix}
a \\
b \\
\end{bmatrix}
\begin{bmatrix}
a \\
b \\
\end{bmatrix} =
\]

(This location/direction is assym.)

(L, M, N are the coef. of SFF.)
\[
\begin{bmatrix}
\text{Suu} & \text{Suv}
\end{bmatrix}
\begin{bmatrix}
a \\
b
\end{bmatrix}
\cdot n(u, v)
\begin{bmatrix}
a \\
b
\end{bmatrix} = 0,
\]

or

\[
< a^2 \text{Suu} + 2ab \text{Suv} + b^2 \text{Svv}, n(u, v) > = 0.
\]

\[
(\begin{bmatrix}
\text{Suuu} & \text{Suuv}
\end{bmatrix}
\begin{bmatrix}
\text{Svuu} & \text{Svvv}
\end{bmatrix})
\begin{bmatrix}
a \\
b
\end{bmatrix}
\cdot n(u, v)
\begin{bmatrix}
a \\
b
\end{bmatrix} = 0,
\]

(A third derivative zero contact.)

or

\[
< a^3 \text{Suu} + 3a^2b \text{Suv} + 3ab^2 \text{Svv}, n(u, v) > = 0.
\]

3. \[
< a^4 \text{Suuu} + 4a^3b \text{Suuv} + 6a^2b^2 \text{Suvv} + 4ab^3 \text{Svvv}, n(u, v) > = 0.
\]

(A fourth derivative zero contact.)

4. \[a * a + b * b = 1 \quad \text{(A normalization constraint.)}\]

See also: SymbSrfGaussCurvature, UserSrfTopoAspectGraph, SymbEvalSrfAsympDir, MvarSrfSilhInflections,

8.2.420 MvarSrfLineOneSidedMaxDist (lnsrfdst.c:121)

CagdRType MvarSrfLineOneSidedMaxDist(const CagdSrfStruct *Srf,
const CagdUVType UV1,
const CagdUVType UV2,
CagdSrfDirType ClosedDir,
CagdRType Epsilon)

Srf: Surface to compute the line distance to.
UV1, UV2: The two points on Srf the prescribes the line.
ClosedDir: If a valid direction the surface is to be treated as closed in that direction when examining the line segment.
Epsilon: Tolerance of computation.

Returns: The maximal distance from a point on the line to nearest location on the surfaces.

Description: Computes the maximal distance between a given line segment to a given surface. This is the one sided Hausdorff distance from the line to Srf. The line segment is assumed to be on the surface and is prescribed by two surface locations. The distance is bounded as follow. The composition of Srf(UV1UV2) is computed and the maximal distance to line is used as an upper bound, UB. Then, assuming the line is the Z axis, the farthest solution to: Nz(u, v) = 0, Nx(u, v) Y(u, v) - Ny(u, v) X(u, v) = 0,

where Srf = (X(u, v), Y(u, v), Z(u, v)), and (Nx, Ny, Nz) is its normal field, that is smaller than UB is selected.

See also: MvarCrvMaxXYOriginDistance,
8.2.421 MvarSrfRadialCurvature (mv_crvt.c:56)

MvarPtStruct *MvarSrfRadialCurvature(const CagdSrfStruct *CSrf,  
const CagdVType ViewDir,  
CagdRType SubdivTol,  
CagdRType NumerTol)

CSrf: To compute the radial curvature lines for.
ViewDir: View direction to consider.
SubdivTol: Accuracy of the subdivision stage of the approximation.
NumerTol: Accuracy of numeric approx.

Returns: Polylines in the parameter space, depicting the radial curvature lines.

Description: Computes the radial curvature lines on surface Srf viewed from ViewDir. This amounts to finding the asymptotic directions of Srf that are in also the projection of ViewDir onto the tangent plane. Let a and b be two parameters that prescribe the tangent space. Then, the solution is derived as the solution of the following three equations:

\[
\begin{align*}
\frac{dS}{du} \cdot \frac{dS}{dv} (a - - + b -- ) x N, V &= 0, \quad \text{(the tangent direction is the projection of V onto the tangent plane.)} \\
\begin{bmatrix}
L & M \\
M & N \\
\end{bmatrix}
\begin{bmatrix}
a \\
b \\
\end{bmatrix} &= 0, \quad \text{(This location/direction is assaym.)} \\
\end{align*}
\]

where a and b are normalized so

\[a^2 + b^2 = 1.\]

See also: SymbSrfGaussCurvature, UserSrfTopoAspectGraph, SymbEvalSrfAsympDir,

8.2.422 MvarSrfSelfInterDiagFactor (selfintr.c:1364)

MvarPolylineStruct *MvarSrfSelfInterDiagFactor(const CagdSrfStruct *Srf,  
CagdRType SubdivTol,  
CagdRType NumericTol)

Srf: To detect its self intersecting points.
SubdivTol: Tolerance of the solution. This tolerance is measured in the parametric space of the surfaces.
NumericTol: Numeric tolerance of a possible numeric improvement stage. The numeric stage is employed if NumericTol < SubdivTol.

Returns: Self intersection pllns, as points in E4 (u, v, s, t).

Description: Computes self intersection points for a given surface S using the following constraints ((u, v) and (s, t) are two independent params of the same srf):

\[
\begin{align*}
x(u, v) - x(s, t) &= 0, \\
y(u, v) - y(s, t) &= 0, \\
z(u, v) - z(s, t) &= 0.
\end{align*}
\]

Direct attempt to solve this set of constraints is bound to be slow as all points in Crv satisfy these equations when u == v and s == t. The key here is to remove all (u - s) (and possibly (v - t)) factors off diagonal Bezier patches of the above, using a decomposition of the Bezier patches as (u1 - u3) G(u1, u2, u3, u4) + (u2 - u4) H(u1, u2, u3, u4).

See also: MvarSrfAntipodalPoints, MvarCrvSelfInterNrmlDev, MvarCrvSelfInterDiagFactor, MvarSrfSelfInter- 
DiagFactor2,
MvarPolylineStruct *MvarSrfSelfInterNrmlDev(const CagdSrfStruct *Srf,
CagdRType SubdivTol,
CagdRType NumericTol,
CagdRType MinNrmlDeviation)

Srf: To detect its self intersecting points.
SubdivTol: Tolerance of the solution. This tolerance is measured in the parametric space of the surfaces.
NumericTol: Numeric tolerance of a possible numeric improvement stage. The numeric stage is employed if
NumericTol < SubdivTol.
MinNrmlDeviation: The minimal angle teh surfaces are suppose to intersect at.
Returns: Self intersection pllns, as points in E4 (u, v, s, t).

Description: Computes self intersection points for given surface using the following constraints (u, v) and (s, t)
are two independent params of the same srf:

\[
\begin{align*}
  x(u, v) - x(s, t) &= 0, \\
  y(u, v) - y(s, t) &= 0, \\
  z(u, v) - z(s, t) &= 0.
\end{align*}
\]

Direct attempt to solve this set of constraints is bound to be slow as all points in Srf satisfy these equations when
(u, v) == (s, t). The key is in adding a fourth inequality constraint of the form

\[
\frac{< \mathbf{N}(u, v), \mathbf{N}(s, t) >}{|| \mathbf{N}(u, v) || || \mathbf{N}(s, t) ||} < \cos(\text{Angle}),
\]

Where \(\cos(\text{Angle})\) is a provided constant that prescribe the minimal angle the surface is expected to intersect at.
The closer \(\cos(\text{Angle})\) to one the more work this function will have to do in order to isolate the self intersection
curve. The above expression is not rational and so, we use a logical or of the following two expressions:

\[
\frac{< \mathbf{N}(u, v), \mathbf{N}(s, t) >^2}{|| \mathbf{N}(u, v) ||^2 || \mathbf{N}(s, t) ||^2} < \cos^2(\text{Angle}),
\]

or

\(< \mathbf{N}(u, v), \mathbf{N}(s, t) > < 0.\)

See also: MvarSrfAntipodalPoints, MvarCrvSelfInterNrmlDev, MvarSrfSelfInterDiagFactor,

MvarPtStruct *MvarSrfSilhInflections(const CagdSrfStruct *Srf,
const CagdVType ViewDir,
CagdRType SubdivTol,
CagdRType NumerTol)

Srf: To compute the silhouette higher orders’ contact points.
ViewDir: View direction to consider.
SubdivTol: Accuracy of the subdivision stage of the approximation.
NumerTol: Accuracy of numeric approx.
Returns: Polylines on the unit sphere, depicting the flecnodal’s partitioning lines.

Description: Computes the silhouette locations on surface Srf viewed from ViewDir that has inflection points or
contact for second order or more. This amounts to finding the asymptotic directions of Srf that are in the direction
of ViewDir. Let \(V(s, t)\) be a parametrization of all possible viewing directions. Solution is derived as the solution of
the following three equations:
\[ \frac{dS}{du} \frac{dS}{dv} - \frac{a}{du} + \frac{b}{dv} = V, \]

\[ \begin{bmatrix} L & M \\ a & b \end{bmatrix} = 0, \]

\[ \begin{bmatrix} L & M \\ M & N \end{bmatrix} = 0, \]

where \( a \) and \( b \) are the solutions of

\[ \frac{dS}{du} \frac{dS}{dv} - a \frac{du}{dv} = V. \]

See also: SymbSrfGaussCurvature, UserSrfTopoAspectGraph, SymbEvalSrfAsympDir,

8.2.425 MvarSrfSilhouette (mvarsils.c:42)

\[ \text{IPObjectStruct *MvarSrfSilhouette(const CagdSrfStruct *Srf, const CagdVType VDir, CagdRType Step, CagdRType SubdivTol, CagdRType NumericTol, CagdBType Euclidean)} \]

Srf: To compute its silhouette edges.
VDir: View direction vector (a unit vector).
Step: Step size for curve tracing.
SubdivTol: The subdivision tolerance to use.
NumericTol: The numerical tolerance to use.
Euclidean: If TRUE, returns the silhouettes in Euclidean space. Otherwise, the silhouette edges are returned in the Parametric domain.

Returns: The silhouettes as piecewise linear edges. Can include two object, 1st with points.

Description: Computes the silhouette edges of the given surfaces, orthographically seen from the given view direction VDir.
See also: SymbSrfOrthotomic, SymbSrfSilhouette,

8.2.426 MvarSrfSplitPoleParams (mvarpole.c:93)

\[ \text{TrimSrfStruct *MvarSrfSplitPoleParams(const CagdSrfStruct *Srf, CagdRType SubdivTol, CagdRType NumericTol, CagdRType OutReach)} \]

Srf: Rational surface to split at its poles.
SubdivTol: The subdivision tolerance to use.
NumericTol: The numerical tolerance to use.
OutReach: Small offset to clip poles regions at, zero to disable.

Returns: Trimmed surfaces, divided at all poles, or NULL if no poles.

Description: Split the given rational surface at its poles, if any, by solving for the zeros of the surface’s denominator.
See also: CagdPointsHasPoles, SymbCrvsSplitPoleParams,
8.2.427  MvarSrfSrfBisector (mvbisect.c:253)

MvarMVStruct *MvarSrfSrfBisector(const MvarMVStruct *CMV1,
                                 const MvarMVStruct *CMV2)

CMV1, CMV2: The two bivariates (surfaces) in \( \mathbb{R}^5 \).

Returns: The resulting bisector.

Description: Computes the bisectors of two surfaces in \( \mathbb{R}^5 \).

See also: MvarMVsBisector, MvarCrvSrfBisector, MvarSrfSrfBisectorApprox,

8.2.428  MvarSrfSrfBisectorApprox (mvbisect.c:861)

MvarPolyStruct *MvarSrfSrfBisectorApprox(const MvarMVStruct *CMV1,
                                         const MvarMVStruct *CMV2,
                                         CagdRType SubdivTol,
                                         CagdRType NumericTol)

CMV1, CMV2: The two bivariates (surfaces) in \( \mathbb{R}^3 \).
SubdivTol: Tolerance of the first zero set finding subdivision stage.
NumericTol: Tolerance of the second zero set finding numeric stage.

Returns: Either a list of polyline loops or a list of triangles.

Description: Computes an approximation to the bisector of two surfaces. Let \( S_1(u, v) \) and \( S_2(r, s) \) be two parametric surfaces and let \( n_1(u, v) \) and \( n_2(r, s) \) be their unnormalized normal fields. Because the two normals of the two surfaces must be coplanar we introduce the following constraint, forcing the three vectors \( n_1, n_2, \) and \( S_1 - S_2 \) to all be in the same plane.

\[
< ( S_1(u, v) - S_2(r, s) ) \times n_1(u, v), n_2(r, s) > = 0.
\]

To make sure the distance to the intersection point of the normals, from both surface’s foot points we also coerces these three vectors to form a isosceles triangle:

\[
|| n_2(r, s) ||^2 < S_1(u, v) - S_2(r, s), n_1(u, v) > ^2 - \|
|| n_1(r, s) ||^2 < S_1(u, v) - S_2(r, s), n_2(u, v) > ^2
\]

Finding the zero set of the last equation provides the correspondence between the \( (u, v) \) location and the first surface and \( (r, s) \) locations on the second surface that serve as mutual foot point for some bisector point.

See also: MvarMVsBisector, MvarCrvSrfBisector, MvarSrfSrfBisector, MvarCrvSrfBisectorApprox,

8.2.429  MvarSrfSrfBisectorApprox2 (mvbisect.c:1013)

VoidPtr MvarSrfSrfBisectorApprox2(const MvarMVStruct *CMV1,
                                   const MvarMVStruct *CMV2,
                                   int OutputType,
                                   CagdRType SubdivTol,
                                   CagdRType NumericTol)

CMV1, CMV2: The two bivariates (surfaces) in \( \mathbb{R}^3 \).

OutputType: Expected output type: 1. For the computed multivariate constraints. 2. For the computed point cloud on the bisector. 3. Points in a form of \((u_1, v_2, x, y, z)\) where \((u_1, v_1)\) are the parameter space of the first surface.
SubdivTol: Tolerance of the first zero set finding subdivision stage.
NumericTol: Tolerance of the second zero set finding numeric stage.

Returns: Following OutputType, either a set of multivariates (as a linked list of MvarMVStruct), or a cloud of points on the bisector (as a linked list of MvarPtStruct).
Description: Computes an approximation to the bisector of two surfaces - old version that does not use the 2D solver. Let \( S_1(u, v) \) and \( S_2(r, s) \) be two parametric surfaces and let \( n_1(u, v) \) and \( n_2(r, s) \) be their unnormalized normal fields. Because the two normals of the two surfaces must be coplanar we introduce the following constraint, forcing the three vectors \( n_1, n_2, \) and \( S_1 - S_2 \) to all be in the same plane.

\[
< (S_1(u, v) - S_2(r, s)) \times n_1(u, v), n_2(r, s) > = 0.
\]

To make sure the distance to the intersection point of the normals, from both surface’s foot points we also coerce these three vectors to form a isosceles triangle:

\[
|| n_2(r, s) ||^2 < S_1(u, v) - S_2(r, s), n_1(u, v) >^2 - \\
|| n_1(r, s) ||^2 < S_1(u, v) - S_2(r, s), n_2(u, v) >^2
\]

Finding the zero set of the last equation provides the correspondence between the \((u, v)\) location and the first surface and \((r, s)\) locations on the second surface that serve as mutual foot point for some bisector point.

See also: MvarMVsBisector, MvarCrvSrfBisector, MvarSrfSrfBisector, MvarCrvSrfBisectorApprox.

8.2.430  MvarSrfSrfContact (mvarintr.c:572)

MvarPtStruct *MvarSrfSrfContact(const CagdSrfStruct *Srf1,
const CagdSrfStruct *Srf2,
const CagdCrvStruct *MotionSrf1,
const CagdCrvStruct *ScaleSrf1,
CagdRType SubdivTol,
CagdRType NumericTol,
CagdBType UseExprTree)

Srf1, Srf2: Two surface to compute contacts over time in \( \mathbb{R}^3 \).
MotionSrf1: The motion over time Srf1 undergoes. Can be NULL.
ScaleSrf1: The scale over time Srf1 undergoes. Can either be a scalar function, or vector function in \( \mathbb{R}^3 \). Can be NULL. If both MotionSrf1 and Srf1Scale are defined, they better share their domains.
SubdivTol: Tolerance of the solution. This tolerance is measured in the parametric space of the surfaces.
NumericTol: Numeric tolerance of a possible numeric improvement stage. The numeric stage is employed if NumericTol < SubdivTol.
UseExprTree: TRUE to use expression trees in the computation, FALSE to use regular multivariate expressions.

Returns: List of intersection points, as parameter pairs into the two surfaces domains.

Description: Computes the contact locations of two \( C^1 \) surfaces in \( \mathbb{R}^3 \), possibly with multivariate expression trees. Expression trees could be beneficial computationally when the geometry is complex (i.e. dozens of control points or more, in each directions).

See also: MvarCrvCrvInter, MvarSrfSrfSrfInter,

8.2.431  MvarSrfSrfInter (zrmvaux1.c:1499)

MvarPolylineStruct *MvarSrfSrfInter(const CagdSrfStruct *Srf1,
const CagdSrfStruct *Srf2,
CagdRType Step,
CagdRType SubdivTol,
CagdRType NumericTol)

Srf1, Srf2: Cagd surfaces to be intersected.
Step: Step size for curve tracing.
SubdivTol: The subdivision tolerance to use.
NumericTol: The numerical tolerance to use.

Returns: The list of polylines which approximate the curve. Each polyline corresponds to the topologically isolated component of the curve and is in \( \mathbb{R}^4 \), the parametric spaces of both surfaces.

Description: Computes intersection curve of two surfaces.
See also: MvarMVsZeros1DMergeSingularPts, MvarMVsZeros1D,
MvarSrfSrfMinimalDist (hasdrf3d.c:1021)

```c
MvarPtStruct *MvarSrfSrfMinimalDist(const CagdSrfStruct *Srf1,
const CagdSrfStruct *Srf2,
CagdRType *MinDist)
```

**Srf1:** To detect its minimal distance to Srf2.

**Srf2:** To detect its minimal distance to Srf1.

**MinDist:** Upon return, is set to the minimal distance detected.

**Returns:** Pairs of parameters at the minimal distance.

**Description:** Computes the minimal distance between two given C1 surfaces. Surfaces are assumed to not intersect. This minimal distance can occur:

1. At end points vs. end points.
2. At the end points vs interior locations.
3. At a boundary curve vs the other surface.
4. At antipodal interior locations.

**See also:** MvarSrfSrfAntipodalPoints, SymbDistSrfPoint, MvarCrvSrfMinimalDist,

MvarSrfSrfSrfInter (mvarintr.c:285)

```c
MvarPtStruct *MvarSrfSrfSrfInter(const CagdSrfStruct *Srf1,
const CagdSrfStruct *Srf2,
const CagdSrfStruct *Srf3,
CagdRType SubdivTol,
CagdRType NumericTol,
CagdBType UseExprTree)
```

**Srf1, Srf2, Srf3:** Three surface to intersect in \( \mathbb{R}^3 \).

**SubdivTol:** Tolerance of the solution. This tolerance is measured in the parametric space of the surfaces.

**NumericTol:** Numeric tolerance of a possible numeric improvement stage. The numeric stage is employed if \( \text{NumericTol} < \text{SubdivTol} \).

**UseExprTree:** TRUE to use expression trees in the computation, FALSE to use regular multivariate expressions.

**Returns:** List of intersection points, as parameter pairs into the three surfaces domains.

**Description:** Computes the intersection locations of three surfaces in \( \mathbb{R}^3 \), possibly with multivariate expression trees. Expression trees could be beneficial computationally when the geometry is complex (i.e. dozens of control points or more, in each directions).

**See also:** MvarCrvCrvInter, MvarSrfSrfContact,

MvarSrfToMV (mvareval.c:1111)

```c
MvarMVStruct *MvarSrfToMV(const CagdSrfStruct *Srf)
```

**Srf:** Surface to convert into the multi-variate MV.

**Returns:** A multi variate function representation to Srf.

**Description:** Converts a surface into a multivariate function.
8.2.435  MvarSrfTrimGlblOffsetSelfInter  (offset2.c:275)

IPObjectStruct *MvarSrfTrimGlblOffsetSelfInter(CagdSrfStruct *Srf,
const CagdSrfStruct *OffSrf,
CagdRType TrimAmount,
int Validate,
int Euclidean,
CagdRType SubdivTol,
CagdRType NumerTol,
CagdBType NumerImp)

Srf: Original surface.
OffSrf: The offset surface approximation.
TrimAmount: The trimming distance. A fraction smaller than the offset amount.
Validate: If TRUE, compute only points along the self intersections that are valid and serve to delineate
between valid and invalid (to be purged) offset surface regions.
Euclidean: If TRUE, returned data is in the Euclidean space of OffSrf. FALSE for parametric space of OffSrf.
SubdivTol: Accuracy of computation.
NumerTol: If smaller that SubdivTol, a numerical improvement stage is applied by the solver.
NumerImp: If TRUE, a final stage of numerical marching over the surface is applied to improve the solution
even further.
Returns: A list of self inter. curves, on the offset surface.

Description: trims regions in the offset surface OffSrf that are closer than TrimAmount to original Srf. Tri-
mAmount should be a fraction smaller than the offset amount itself. See also: Joon-Kyung Seong, Gershon Elber,
and Myung-Soo Kim. “Trimming Local and Global Self-intersections in Offset Curves and Surfaces using Distance

8.2.436  MvarSrfTrimGlblOffsetSelfInterNI  (offst2ni.c:106)

IPObjectStruct *MvarSrfTrimGlblOffsetSelfInterNI(IPPolygonStruct *Plls,
const CagdSrfStruct *OffSrf,
CagdRType SubdivTol,
CagdRType NumerTol,
int Euclidean,
CagdRType SameUVTol)

Plls: Connected list of polylines to be improved.
OffSrf: The offset surface approximation.
SubdivTol: Accuracy of computation.
NumerTol: NumerTol tolerance.
Euclidean: If TRUE, returned data is in the Euclidean space of OffSrf. FALSE for parametric space of OffSrf.
SameUVTo: Tolerance for termination condition around singular points.
Returns: A list of self inter. curves, on the offset surface.

Description: Improve self-intersection curves of offset surfaces using numerical methods.

8.2.437  MvarSrfZeroSet  (zrmvaux1.c:1593)

MvarPolylineStruct *MvarSrfZeroSet(const CagdSrfStruct *Surface,
int Axis,
CagdRType Step,
CagdRType SubdivTol,
CagdRType NumericTol)

Surface: Cagd surface to compute its zeros.
Axis: Axis of Surface to consider its zeros.
Step: Step size for curve tracing.
SubdivTol: The subdivision tolerance to use.
NumericTol: The numerical tolerance to use.

Returns: The list of polylines which approximate the zeros. Each polyline corresponds to the topologically isolated component of the curve and is in R², the parametric spaces of the surface.

Description: Computes the zeros of some surface.
See also: MvarCrvZeroSet, MvarMVsZeros1D, MvarSrfSrfInter,

8.2.438 MvarStewartPlatform2Solve (mvarstpl.c:430)

MvarPtStruct *MvarStewartPlatform2Solve(const CagdPType BottomBasePoints[3],
                                         const CagdRType BotTopEdgeLengths[6],
                                         const CagdRType TopEdgeLengths[3],
                                         CagdType FullCircs,
                                         CagdType Rational,
                                         CagdRType SubdivTol,
                                         CagdRType NumericTol)

BottomBasePoints: The three points of the bottom base.
BotTopEdgeLengths: The six edge lengths of rods connection bottom and top bases.
TopEdgeLengths: The three edge lengths of the top base.
FullCircs: TRUE to derive full circles, seeking inverted and singular solutions. FALSE to seek only one consistent solution.
Rational: TRUE to represent the circles precisely as rational, FALSE to approximate the circles as polynomials.
SubdivTol: Tolerance of the solution. This tolerance is measured in the parametric space of the surfaces.
NumericTol: Numeric tolerance of a possible numeric improvement stage. The numeric stage is employed if NumericTol < SubdivTol.

Returns: Computed solution locations.

Description: A second solver for Stewart platform that is optimized. The original constraints are mapped to find a triangle (of TopEdgeLengths edges) whose vertices resides on three computed circles Ci, as follows,
1. Compute circles Ci, i = 0, 1, 2, as the locus of points of distance BotTopEdgeLengths[2i], and BotTopEdgeLengths[2i+1] from bottom base points BottomBasePoints[i], BottomBasePoints[(i+1)%3], respectively.
2. Solve for the three constraints and three unknowns || Ci - C[(i+1)%3] || = TopEdgeLengths[i].

See also: MvarStewartPlatformSolve, MvarStewartPlatformGenEqns,

8.2.439 MvarStewartPlatformGenEqns (mvarstpl.c:206)

MvarMVStruct **MvarStewartPlatformGenEqns(const CagdPType BottomBase[3],
                                         const CagdRType TopBaseEdgeLengths[6],
                                         const CagdPType WorkDomain[2])

BottomBase: Three vertices of triangle forming the base, denoted Pi.
TopBaseEdgeLengths: Three edge lengths between three vertices Qi, of top base.
WorkDomain: The Euclidean space working domain min./max. range.

Returns: Dynamically allocated vector of nine constraints, in nine unknowns (bottom base with given vertices Pi, top vertices with unknown vertices Qi) as follows: || Q1 - P1 || = L1, || Q1 - P2 || = L2, || Q2 - P2 || = L3, || Q2 - P3 || = L4, || Q3 - P3 || = L5, || Q3 - P1 || = L6, || Q1 - Q2 || = D1, || Q2 - Q3 || = D2, || Q3 - Q1 || = D3, where Li are the six BaseConnectLengths and Dj are lengths between adjacent edges of the top, moving, base. Note the Li are not given and so in this building process the are assumed all zero.

Description: Derive nine constraints for a stewart platform, so that given the lengths of the six rods connection the bottom and top bases, we can solve the problem. The bottom base is specified and so are the lengths of the edges of the top base.
See also: MvarStewartPlatformSolve,
8.2.440 MvarStewartPlatformSolve (mvarstp1.c:290)

MvarPtStruct *MvarStewartPlatformSolve(const MvarMVStruct **AllCnstrnts,
const CagdRType BaseConnectLengths[6],
const CagdPType WorkDomain[2],
CagdRType SubdivTol,
CagdRType NumericTol)

AllCnstrnts: Nine constraints without base connecting length set.
BaseConnectLengths: Six specific edge-lengths of rods connection bases.
WorkDomain: The Euclidean space working domain min./max. range.
SubdivTol: Tolerance of the solution. This tolerance is measured in the parametric space of the surfaces.
NumericTol: Numeric tolerance of a possible numeric improvement stage. The numeric stage is employed if NumericTol < SubdivTol.

Returns: Solution(s) of the Qi locations, if any.

Description: Derive nine constraints for a stewart platform, so that given the lengths of the six rods connection the bottom and top bases, we can solve the problem. The bottom base is specified and so are the lengths of the edges of the top base.
See also: MvarStewartPlatformGenEqns,

8.2.441 MvarSubDmnInfoStructFree (zrsolver.c:2655)

void MvarSubDmnInfoStructFree(MvarZeroSubDmnInfoStruct *InfoStruct,
int NumOfMVs)

InfoStruct: The info’ structure to be freed.
NumOfMVs: Number of multi-variates held by the info’ structure.

Returns: void.

Description: Deallocates a sub-domain info’ structure.
See also: MvarSubDmnInfoStructNew,

8.2.442 MvarSubDmnInfoStructNew (zrsolver.c:2626)

MvarZeroSubDmnInfoStruct *MvarSubDmnInfoStructNew(MvarMVStruct **MVs,
MvarMVDirType ProjDir1,
MvarMVDirType ProjDir2)

MVs: Vector of multivariate constraints, defined in the required sub-domain.
ProjDir1: First coordinate direction of the two directions w.r.t. which the IPT succeeded.
ProjDir2: Second coordinate direction of the two directions w.r.t. which the IPT succeeded.

Returns: The new info’ structure.

Description: Allocates the slots required for a sub-domain info’ structure.
See also: MvarSubDmnInfoStructFree,

8.2.443 MvarTVToMV (mvareval.c:1258)

MvarMVStruct *MvarTVToMV(const TrivTVStruct *TV)

TV: Trivar to convert into the multi-variate MV.

Returns: A multi variate function representation to TV.

Description: Converts a trivar into a multivariate function.
8.2.444  MvarTanHyperSpheresofNManifolds (ms_sphr.c:48)

MvarPtStruct *MvarTanHyperSpheresofNManifolds(MvarMVStruct **MV, int NumOfMV, CagdRType SubdivTol, CagdRType NumericTol, CagdBType UseExprTree)

**MVs**: The manifolds to consider in R^d.
**NumOfMV**: Number of multivariates we need to process.
**SubdivTol, NumericTol**: Of computation.
**UseExprTree**: TRUE to use expression trees in the computation, FALSE to use regular multivariate expressions.

**Returns**: List of tangent hyper-spheres, NULL if error.

**Description**: Computes all the hyper-spheres that are tangent to all the given set of manifolds. All manifolds should share the same range space, R^d, space in which the hyper-spheres are sought.

See also: MvarMSCircOfThreeCurves, MvarMSCircOfTwoCurves, MvarMinSpanCirc, MvarTanHyperSpheresofNManifolds ET

8.2.445  MvarTriangleFree (zrmv2dTp.c:1160)

void MvarTriangleFree(MvarTriangleStruct *Tr)

**Tr**: Multivariate triangle to free.

**Returns**: void

**Description**: Deallocates and frees all slots of a multi-variate triangle structure.

See also: MvarTriangleNew, MvarTriangleFreeList

8.2.446  MvarTriangleFreeList (zrmv2dTp.c:1181)

void MvarTriangleFreeList(MvarTriangleStruct *TrList)

**TrList**: Multivariate triangles list to free.

**Returns**: void

**Description**: Deallocates and frees a list of triangle structures.

See also: MvarTriangleNew, MvarTriangleFree

8.2.447  MvarTriangleNew (zrmv2dTp.c:1121)

MvarTriangleStruct *MvarTriangleNew(int Dim)

**Dim**: Number of dimensions of each vertex.

**Returns**: An uninitialized triangle.

**Description**: Allocates the memory required for a new multi-variate triangle.

See also: MvarTriangleFree,
8.2.448 MvarTrisector3DCreateMVs (mvbisect.c:1363)

MvarMVStruct **MvarTrisector3DCreateMVs(VoidPtr FF1,
VoidPtr FF2,
VoidPtr FF3,
CagdRType *BBoxMin,
CagdRType *BBoxMax,
int *Eqns)

**FF1, FF2, FF3:** Freeform objects (curve or surface) to compute their trisector.
**BBoxMin, BBoxMax:** The bounding box, where the trisector is computed.
**Eqns:** Will be updated with the number of MVs constraints.

**Returns:** The multivar system, its solution is the desired trisector curve in R3.

**Description:** Creates a set of MV constraints for the computation of a trisector curve of three objects (bspline curves or surfaces) in R3. The trisector is considered to lie inside a spatial domain BBox.

8.2.449 MvarTrisectorCrvs (mvbisect.c:1566)

MvarPolylineStruct *MvarTrisectorCrvs(VoidPtr FF1,
VoidPtr FF2,
VoidPtr FF3,
CagdRType Step,
CagdRType SubdivTol,
CagdRType NumericTol,
CagdRType *BBoxMin,
CagdRType *BBoxMax)

**FF1, FF2, FF3:** Objects to compute their trisector.
**Step:** Stepsize for curve tracing.
**SubdivTol:** The subdivision tolerance to use.
**NumericTol:** The numerical tolerance to use.
**BBoxMin, BBoxMax:** The bounding box, where the trisector is computed.

**Returns:** A (list of) polyline(s) that approximates the trisector curve.

**Description:** Computes a trisector curve of three objects (curves or surfaces). The trisector is considered to lie inside a spatial domain BBox.

8.2.450 MvarTrivJacobianImprove (mvarjimp.c:595)

void MvarTrivJacobianImprove(TrivTVStruct *TV,
CagdRType StepSize,
int NumIters)

**TV:** To try and improve (make more uniform) its Jacobian.
**StepSize:** Numerical step size to move along the gradient (at the Jacobian extreme values.)
**NumIters:** Number of numerical iterations to allow in the improvement process.

**Returns:** void

**Description:** Attempt the improve the Jacobian of the given trivariate by adjusting interior control-points of the TV.

**See also:** MvarCalculateTVJacobian,
8.2.451 MvarTrivarBoolOne (mvtrivar.c:60)

TrivTVStruct *MvarTrivarBoolOne(const CagdSrfStruct *Srf)

Srf: Surface to derive a trivariate volume for its interior.

Returns: A trivariate volume boolean sum of Srf.

Description: Computes the volumetric (trivariate) boolean sum as follows:
1. Divide Srf into 4 side patches, in U.
2. Compute the volumetric boolean sum for the 4 patches in 1 and 2. Two cap patches will be computed on the fly.

See also: MvarTrivarBoolSum,

8.2.452 MvarTrivarBoolSum (mvtrivar.c:155)

TrivTVStruct *MvarTrivarBoolSum(const CagdSrfStruct *Srf1, const CagdSrfStruct *Srf2, const CagdSrfStruct *Srf3, const CagdSrfStruct *Srf4, const CagdSrfStruct *Srf5, const CagdSrfStruct *Srf6)

Srf1, Srf2, Srf3, Srf4, Srf5, Srf6: Surfaces to derive a trivariate volume for its interior. If Srf5 or Srf6 are NULL, they are generated as surface Boolean sum, from V boundaries of Srf1/2/3/4.

Returns: A trivariate volume boolean sum of Srf.

Description: Computes the volumetric (trivariate) boolean sum as follows: Srf1/2/3/4 are around the sweep surface and Srf5/6 are its two caps. The boolean sum is computed as follows:

\[
\begin{align*}
T_0 &= \text{Trilinear}(4\text{Corners}(Srf1), 4\text{Corners}(Srf3)) \\
T_1 &= \text{RuledVolume}(Srf1, Srf3) \\
T_2 &= \text{RuledVolume}(Srf2, Srf4) \\
T_3 &= \text{RuledVolume}(Srf5, Srf6) \\
T_4 &= \text{RuledVolume}(\text{RuledSrf}(\text{Bndry}(Srf1, UMin), \text{Bndry}(Srf1, UMax)), \\
&\quad \text{RuledSrf}(\text{Bndry}(Srf3, UMin), \text{Bndry}(Srf3, UMax))) \\
T_5 &= \text{RuledVolume}(\text{RuledSrf}(\text{Bndry}(Srf2, VMin), \text{Bndry}(Srf2, VMax)), \\
&\quad \text{RuledSrf}(\text{Bndry}(Srf4, VMin), \text{Bndry}(Srf4, VMax))) \\
T_6 &= \text{RuledVolume}(\text{RuledSrf}(\text{Bndry}(Srf5, VMin), \text{Bndry}(Srf5, VMax)), \\
&\quad \text{RuledSrf}(\text{Bndry}(Srf6, VMin), \text{Bndry}(Srf6, VMax))) \\
\end{align*}
\]

And the final boolean sum equals:
\[
\text{BoolSumVolume} = T_1 + t_2 + t_3 - (T_4 + t_5 + t_6) + T_0
\]

See also: MvarTrivarBoolOne,

8.2.453 MvarTwoMVsMorphing (mvarmrph.c:37)

MvarMVStruct *MvarTwoMVsMorphing(const MvarMVStruct *MV1, const MvarMVStruct *MV2, CagdRType Blend)

MV1, MV2: The two multi-variates to blend.
Blend: A parameter between zero and one.

Returns: MV2 * Blend + MV1 * (1 - Blend).

Description: Given two compatible multi-variates (See function MvarMakeMVsWithCompatible), computes a convex blend between them according to Blend which must be between zero and one. Returned is the new blended multi-variate.

See also: SymbTwoCrvsMorphing, SymbTwoCrvsMorphingCornerCut, SymbTwoCrvsMorphingMultiRes, SymbTwoSrfsMorphing, TrivTwoTVsMorphing, MvarMakeMVsWithCompatible,
8.2.454 MvarUniFuncsComputeLowerEnvelope (mvlowenv.c:1149)

void MvarUniFuncsComputeLowerEnvelope(CagdCrvStruct *InputCurves,
                                         CagdCrvStruct **LowerEnvelope)

InputCurves: A CagdCrvStruct of univariate (non-rational) curves in \( \mathbb{R}^1 \)
LowerEnvelope: A CagdCrvStruct of lower envelope
Returns: void

Description: Given monotone univariate function curves, and their domain, compute the lower envelope. This is the main calling function for such curves.

8.2.455 MvarVecAdd (mvar_vec.c:35)

void MvarVecAdd(MvarVecStruct *VRes,
                 const MvarVecStruct *V1,
                 const MvarVecStruct *V2)

VRes: Result. Can be one of V1 or V2.
V1, V2: Two input vectors.
Returns: void

Description: Add two multivariate vectors.
See also: MvarVecDotProd, MvarVecSqrLength, MvarVecLength, MvarVecScale, MvarVecNormalize, MvarVecBlend,

8.2.456 MvarVecAddScale (mvar_vec.c:67)

void MvarVecAddScale(MvarVecStruct *VRes,
                      const MvarVecStruct *V1,
                      const MvarVecStruct *V2,
                      CagdRType Scale2)

VRes: Result. Can be one of V1 or V2.
V1, V2: Two input vectors.
Scale2: Scaling factor of V2.
Returns: void

Description: Add two multivariate vectors, second with scale: VRes = V1 + V2*Scale2.
See also: MvarVecDotProd, MvarVecSqrLength, MvarVecLength, MvarVecScale, MvarVecNormalize, MvarVecBlend,

8.2.457 MvarVecArrayFree (mvar_gen.c:1251)

void MvarVecArrayFree(MvarVecStruct *MVVecArray, int Size)

MVVecArray: To be deallocated.
Size: Of the deallocated array.
Returns: void

Description: Deallocates and frees a multi-variate vector array.
See also: MvarVecArrayNew, MvarVecFree, MvarVecNew, MvarVecFreeList,
8.2.458 MvarVecArrayNew (mvar_gen.c:1074)

MvarVecStruct *MvarVecArrayNew(int Size, int Dim)

- **Size**: Size of multi-variate vector array to allocate.
- **Dim**: Number of dimensions of this multi-variate.
- **Returns**: An uninitialized multi-variate vector array.
- **Description**: Allocates the memory required for a new multi-variate vector array.
- **See also**: MvarVecArrayFree, MvarVecFree, MvarVecNew.

8.2.459 MvarVecBlend (mvar_vec.c:263)

void MvarVecBlend(MvarVecStruct *VRes, const MvarVecStruct *V1, const MvarVecStruct *V2, CagdRType t)

- **VRes**: Result. Can be one of V1 or V2.
- **V1, V2**: Two input vectors to blend.
- **t**: Blending factor.
- **Returns**: void
- **Description**: Compute the blend of the to given multivariate vectors as
  \[ V_1 \times t + V_2 \times (1-t). \]
- **See also**: MvarVecAdd, MvarVecSqrLength, MvarVecLength, MvarVecScale, MvarVecNormalize, MvarVecDotProd.

8.2.460 MvarVecCopy (mvar_gen.c:1166)

MvarVecStruct *MvarVecCopy(const MvarVecStruct *Vec)

- **Vec**: Multi-Variate vector to duplicate.
- **Returns**: Duplicated multi-variate vector.
- **Description**: Allocates and duplicates all slots of a multi-variate vector structure.

8.2.461 MvarVecCopyList (mvar_gen.c:1191)

MvarVecStruct *MvarVecCopyList(const MvarVecStruct *VecList)

- **VecList**: List of multi-variates to duplicate.
- **Returns**: Duplicated list of multi-variates.
- **Description**: Duplicates a list of multi-variate structures.

8.2.462 MvarVecDotProd (mvar_vec.c:124)

CagdRType MvarVecDotProd(const MvarVecStruct *V1, const MvarVecStruct *V2)

- **V1, V2**: Two input vectors.
- **Returns**: The dot product.
- **Description**: Compute the dot product of two multivariate vectors.
- **See also**: MvarVecAdd, MvarVecSqrLength, MvarVecLength, MvarVecScale, MvarVecNormalize, MvarVecBlend,
8.2.463  **MvarVecFree** (mvar_gen.c:1223)

```c
void MvarVecFree(MvarVecStruct *Vec)

Vec: Multivariate vector to free.
Returns: void
Description: Deallocates and frees all slots of a multi-variate vector structure.
See also: MvarVecArrayNew, MvarVecArrayFree, MvarVecNew, MvarVecFreeList,
```

8.2.464  **MvarVecFreeList** (mvar_gen.c:1281)

```c
void MvarVecFreeList(MvarVecStruct *VecList)

VecList: Multi-Variate vector list to free.
Returns: void
Description: Deallocates and frees a list of multi-variate vector structures.
See also: MvarVecArrayNew, MvarVecArrayFree, MvarVecNew, MvarVecFree,
```

8.2.465  **MvarVecLength** (mvar_vec.c:207)

```c
CagdRType MvarVecLength(const MvarVecStruct *V)

V: Vector to compute its length.
Returns: Computed length.
Description: Compute the length of a multivariate vector.
See also: MvarVecAdd, MvarVecDotProd, MvarVecSqrLength, MvarVecScale, MvarVecNormalize, MvarVecBlend,
```

8.2.466  **MvarVecNew** (mvar_gen.c:1036)

```c
MvarVecStruct *MvarVecNew(int Dim)

Dim: Number of dimensions of this multi-variate.
Returns: An uninitialized multi-variate vector.
Description: Allocates the memory required for a new multi-variate vector.
See also: MvarVecArrayNew, MvarVecFree,
```

8.2.467  **MvarVecNormalize** (mvar_vec.c:292)

```c
int MvarVecNormalize(MvarVecStruct *V)

V: Vector to normalize.
Returns: TRUE if successful, FALSE if the input is the ZERO vector.
Description: Normalize a given multivariate vector to a unit length, in place.
See also: MvarVecAdd, MvarVecDotProd, MvarVecSqrLength, MvarVecLength, MvarVecScale,
8.2.468 MvarVecOrthogonal2 (mvar_vec.c:366)

```c
int MvarVecOrthogonal2(MvarVecStruct *Dir,
    const MvarVecStruct *Vec1,
    const MvarVecStruct *Vec2)

    Dir: Newly computed unit vector will be kept here.
    Vec1, Vec2: Two vectors we must be orthogonal to. Assumed unit length.
    Returns: TRUE if successful, FALSE otherwise.
```

**Description:** Derives a unit vector Dir that is orthogonal to both Vec1, and Vec2. Note that in R^2 there is no such vector, in R^3 only one such vector and in R^n, n > 3, there are infinitely many of which we find one.

**See also:** MvarVecOrthogonalize, MvarVecSetOrthogonalize, MvarVecWedgeProd,

8.2.469 MvarVecOrthogonalize (mvar_vec.c:323)

```c
int MvarVecOrthogonalize(MvarVecStruct *Dir, const MvarVecStruct *Vec)

    Dir: Vector to update in place so it will be orthogonal to Vec.
    Vec: Vector to make sure Dir is made orthogonal to.
    Returns: TRUE if successful, FALSE otherwise.
```

**Description:** Updates Dir to be the closest vector to Dir that is orthogonal to Vec. In essence, apply a Graham Shmidt step. Vectors need not be unit size.

**See also:** MvarVecOrthogonal2, MvarVecSetOrthogonalize, MvarVecWedgeProd,

8.2.470 MvarVecRealloc (mvar_gen.c:1120)

```c
MvarVecStruct *MvarVecRealloc(MvarVecStruct *Vec, int NewDim)

    Vec: Multi-Variate vector to reallocate. Should not be used after this operation as it might be freed.
    NewDim: Number of new dimensions of this multi-variate vector.
    Returns: A reallocated multi-variate vector.
```

**Description:** Reallocates the memory that is required for a new dimension of a multi-variate vector.

**See also:** MvarVecNew,

8.2.471 MvarVecScale (mvar_vec.c:230)

```c
MvarVecStruct *MvarVecScale(MvarVecStruct *V, CagdRType ScaleFactor)

    V: Vector to scale, in place.
    ScaleFactor: Scaling factor to use.
    Returns: The input vector, scaled.
```

**Description:** Scale a given multivariate vector V by a scaling factor ScaleFactor.

**See also:** MvarVecAdd, MvarVecDotProd, MvarVecSqrLength, MvarVecLength, , MvarVecNormalize, MvarVecBlend,

8.2.472 MvarVecSetOrthogonalize (mvar_vec.c:444)

```c
int MvarVecSetOrthogonalize(const MvarVecStruct **Vecs,
    MvarVecStruct **OrthoVecs,
    int Size)

    Vecs: Input vectors to make orthonormal.
    OrthoVecs: Output vectors that span the same (sub) space as vec but are orthogonal and unit length (orthonormal). Can be the same as Vecs.
    Size: Number of vectors in Vecs and OrthoVecs vectors of vectors.
    Returns: TRUE if successful, FALSE otherwise.
```

**Description:** Update the given set of vectors to be of unit size and orthogonal to each other. Vectors are all assumed of the same dimension. In essence, apply a Graham Shmidt to all vectors.

**See also:** MvarVecOrthogonal, MvarVecOrthogonal2, MvarVecWedgeProd,
8.2.473  **MvarVecSortAxis** (mvar_int.c:137)

\[
\text{MvarVecStruct } \*\text{MvarVecSortAxis(MvarVecStruct } \*\text{VecList, int Axis)}
\]

- **VecList**: List of points to sort.
- **Axis**: Axis to sort along: 1, 2, 3 for X, Y, Z.
- **Returns**: Sorted list of points, in place.

**Description**: Sorts given list of points based on their increasing order in axis Axis. Sorting is done in place.

8.2.474  **MvarVecSqrLength** (mvar_vec.c:155)

\[
\text{CagdRType MvarVecSqrLength(const MvarVecStruct } \*\text{V)}
\]

- **V**: Vector to compute its length.
- **Returns**: Computed length squared.

**Description**: Compute the length squared of a multivariate vector.

**See also**: MvarVecAdd, MvarVecDotProd, MvarVecLength, MvarVecScale, MvarVecNormalize, MvarVecBlend, MvarVecSqrLength2,

8.2.475  **MvarVecSqrLength2** (mvar_vec.c:178)

\[
\text{CagdRType MvarVecSqrLength2(const CagdRType } \*\text{v, int Dim)}
\]

- **v**: Vector to compute its length.
- **Dim**: Length of vector v.
- **Returns**: Computed length squared.

**Description**: Compute the length squared of a multivariate vector.

**See also**: MvarVecAdd, MvarVecDotProd, MvarVecLength, MvarVecScale, MvarVecNormalize, MvarVecBlend, MvarVecSqrLength,

8.2.476  **MvarVecSub** (mvar_vec.c:97)

\[
\text{void MvarVecSub(MvarVecStruct } \*\text{VRes, const MvarVecStruct } \*\text{V1, const MvarVecStruct } \*\text{V2)}
\]

- **VRes**: Result. Can be one of V1 or V2.
- **V1, V2**: Two input vectors.
- **Returns**: void

**Description**: Subtract two multivariate vectors.

**See also**: MvarVecDotProd, MvarVecSqrLength, MvarVecLength, MvarVecScale, MvarVecNormalize, MvarVecBlend, MvarVecAdd,
8.2.477 MvarVecWedgeProd (mvar_vec.c:542)

CagdBType MvarVecWedgeProd(MvarVecStruct **Vectors,
    int Size,
    MvarVecStruct **NewVecs,
    int NewSize,
    CagdBType CheckDet,
    CagdRType *DetVal)

Vectors: The set of Size vectors, each of dimension larger than Size. This set of vectors is modified in place - it is made orthonormal.
Size: The size of Vectors set.
NewVecs: New vectors to allocate into here and update with orthogonal complement subspace of dimension newSize-Size. Should be able to hold NewSize-Size pointers to vectors.
NewSize: The new size of the set Vectors and NewVecs together.
CheckDet: When Size + NewSize == Dim, this flag indicates if the determinant of the Dim vectors is to be evaluated. Useful for orientation issues.
DetVal: Output value, the computed determinant if CheckDet is TRUE.
Returns: TRUE if successful, FALSE otherwise.

Description: Computes an orthogonal complement (wedge product) of dimension NewSize-Size to the given set of Size vectors. Vectors is vector Vectors are in a higher dimensional linear space. of at list dimension NewSize. See also: MvarVecOrthogonal, MvarVecOrthogonal2, MvarVecSetOrthogonalize,

8.2.478 MvarVoronoiCrvCopy (mvvorcrv.c:57)

MvarVoronoiCrvStruct *MvarVoronoiCrvCopy(MvarVoronoiCrvStruct *Crv)

Crv: To be copied.
Returns: A duplicate of Crv.
Description: Allocates and copies all slots of a MvarVoronoiCrvStruct structure.

8.2.479 MvarVoronoiCrvFree (mvvorcrv.c:97)

void MvarVoronoiCrvFree(MvarVoronoiCrvStruct *Crv)

Crv: Voronoi curve structure to free.
Returns: void
Description: Deallocates a VoronoiCrv structure.

8.2.480 MvarVoronoiCrvFreeList (mvvorcrv.c:121)

void MvarVoronoiCrvFreeList(MvarVoronoiCrvStruct *CrvList)

CrvList: Voronoi curve list to free.
Returns: void
Description: Deallocates a VoronoiCrv list structure.

8.2.481 MvarVoronoiCrvNew (mvvorcrv.c:28)

MvarVoronoiCrvStruct *MvarVoronoiCrvNew(void)

Returns: A VoronoiCrv structure.
Description: Allocates and resets all slots of a MvarVoronoiCrvStruct structure.
8.2.482  MvarVoronoiCrvReverse  (mvvorcrv.c:145)

MvarVoronoiCrvStruct *MvarVoronoiCrvReverse(MvarVoronoiCrvStruct *Crv)

Crv: To be reversed.

Returns: A single duplicate of Crv that is reversed.

Description: Reverses the t and r parameters of an MvarVoronoiCrvStruct structure.

8.2.483  MvarZero0DNumeric  (zrsolver.c:2072)

MvarPtStruct *MvarZero0DNumeric(MvarPtStruct *ZeroPt,
const MvarExprTreeEqnsStruct *Eqns,
MvarMVStruct const * const *MVs,
int NumMVs,
CagdRType NumericTol,
const CagdRType *InputMinDmn,
const CagdRType *InputMaxDmn)

ZeroPt: Approximated solution, derived from a subdivision process, to improve in place.
Eqns: The constraints are given as Equations, if not NULL.
MVs: Alternatively, the constraints are given as MVS.
NumMVs: If MVs is not NULL, this specifies size of the MVs vector.
NumericTol: Tolerance of the numerical process. Tolerance is measured in the deviation of the scalar multivariables from their equality. Inequalities are ignored here. Points that fail to improve numerically are purged away.
InputMinDmn, InputMaxDmn: Optional domain restriction. Can be NULL in which, the MVS/Eqns domains are used.

Returns: List of points on the solution set. Dimension of the points will be the same as the dimensions of all MVs. Points that failed to improve are purged away.

Description: Apply a numerical improvement stage, as a first order minimization procedure of gradient computation and marching, in place.
See also: MvarMVsZeros, MvarExprTreesZeros, MvarExprTreeEqnsZeros,

8.2.484  MvarZeroC1DiscontSubdiv  (zrsolver.c:1558)

static MvarZeroPrblmStruct **MvarZeroC1DiscontSubdiv(
MvarZeroPrblmStruct *Problem)

Problem: The zero finding problem structure.

Returns: The array of two sub-problems.

Description: A preliminary recursive stage of the subdivision solver, invoked by the general solver - subdivides at the C1 discontinuity and solves recursively.
See also: MvarZeroSolver,

8.2.485  MvarZeroFilterSolutionSet  (zrmvaux0.c:1030)

MvarPtStruct *MvarZeroFilterSolutionSet(MvarPtStruct *MVPts,
const MvarMVStruct * const *MVs,
const MvarConstraintType *Constraints,
int NumOfMVs,
IrtRType Tol,
int CanHaveLoops,
int SortSol,
CagdBType InEqOnly)
MVPts: Solution points to filter.

MVs: Constraints to test the solution points against.

Constraints: Type of constraints.

NumOfMVs: Also number of constraints.

Tol: Tolerance the solution point must satisfy.

CanHaveLoops: TRUE if point data can form loops in which case first and last point will be identical (and should not be purged).

SortSol: TRUE to sort solution set first, based on the 1st axis.

InEqOnly: TRUE if inequality constraints should be checked only, FALSE if both equality and inequality should be checked.

Returns: Filtered points that satisfy the given constraints.

Description: Filters and purge solution points that are not satisfying some constraint in MVs. *

See also: MvarZeroSolver,

8.2.486 MvarZeroFirstSmoothUpdatesExpTr (zrsolver.c:1940)

CagdBType MvarZeroFirstSmoothUpdatesExpTr(MvarZeroPrblmStruct *Problem)

Problem: The zero finding problem structure.

Returns: TRUE if updates were successful, false otherwise.

Description: Completes the construction of the ETs problem structure with the actions that are performed only once: when attaining a C1 smooth problem for the first time. Adds the gradients and the current MVs, later to be used in numeric step, and solves the problem on the boundary of the domain.

8.2.487 MvarZeroFirstSmoothUpdatesMVs (zrsolver.c:1798)

CagdBType MvarZeroFirstSmoothUpdatesMVs(MvarZeroPrblmStruct *Problem)

Problem: The zero finding problem structure.

Returns: TRUE if updates were successful, FALSE otherwise.

Description: Completes the construction of the MVs problem structure with the actions that are performed only once: when attaining a C1 smooth problem for the first time, adds the gradients and the current MVs, later to be used in numeric step, and solves the problem on the boundary of the domain.

8.2.488 MvarZeroGenPtMidDmn (zrsolver.c:1992)

MvarPtStruct *MvarZeroGenPtMidDmn(const MvarZeroPrblmStruct *Problem, int SingleSol)

Problem: To construct a point in the middle of its domain.

SingleSol: If TRUE, this point is a single solution it MV domain.

Returns: The construct point in the middle of MV.

Description: Construct a point of the dimension as the given problem in the middle of its parametric domain.

See also: MvarMVsZeros,
8.2.489  MvarZeroGetRootsByKantorovich (zrmvkant.c:710)

MvarPtStruct *MvarZeroGetRootsByKantorovich(MvarMVStruct **MVs,
MvarConstraintType *Constraints,
int NumOfMVs,
int NumOfZeroMVs,
int ApplyNormalConeTest,
CagdRType SubdivTol,
int Depth,
CagdBType SameSpace,
CagdRType ParamPerturb)

MVs: Vector of multivariate constraints.
Constraints: Either an equality or an inequality type of constraint.
NumOfMVs: Size of the MVs and Constraints vector.
NumOfZeroMVs: Number of zero or equality constraints.
ApplyNormalConeTest: TRUE to apply normal cones’ single intersection tests.
SubdivTol: Tolerance of the subdivision process. Tolerance is measured in the parametric space of the multi-
variates.
Depth: Of subdivision recursion.
SameSpace: True if all MVs share the same function space.
ParamPerturb: The perturbation to apply to mid. subdivision location.
Returns: List of points on the solution set. Dimension of the points will be the same as the dimensions of all
MVs. NULL is returned.

Description: Handle all aspects of root-uniqueness using Kantorovich; return a candidate point where a unique
root exists, and find the rest of the roots recursively, using MvarZeroMVsSubdiv.
See also: MvarMVVsZeros,

8.2.490  MvarZeroHasC1Discont (zrsolver.c:1634)

CagdBType MvarZeroHasC1Discont(MvarMVStruct * const *MVs,
int NumOfMVs,
int *JLoc,
CagdRType *t)

MVs: The system of equations.
NumOfMVs: The number of equations.
JLoc: The direction in the domain with C1 discont, if has one.
t: The parameter at the C1 discont. if has one.
Returns: TRUE if found a C1 discont., FALSE otherwise.

Description: Searches all MVs for parameter locations that are C1 discont. If found update JLoc and t to this
finding and returns TRUE. Same functionality as MvarSSIHasC1Discont, but for any number of MVs, not necessarily
Dim - 1.

8.2.491  MvarZeroMVConstraintFail (zrmvaux0.c:1185)

CagdBType MvarZeroMVConstraintFail(const MvarMVStruct *MV,
MvarConstraintType Constraint)

MV: Multivariate to examine.
Constraint: Type of constraint - zero, pos., neg.
Returns: TRUE if constraint cannot be satisfied, FALSE otherwise.

Description: Test if the given multivariate may satisfy the constraint. Examines the positivity/negativity of all
coefficients in multivariate.
See also: MvarZeroSolver,
8.2.492 MvarZeroMVsSubdiv (zrmvkant.c:843)

static MvarPtStruct *MvarZeroMVsSubdiv(MvarMVStruct **MVs,
                                       MvarConstraintType *Constraints,
                                       int NumOfMVs,
                                       int NumOfZeroMVs,
                                       int ApplyNormalConeTest,
                                       CagdRType SubdivTol,
                                       int Depth,
                                       CagdBType SameSpace,
                                       CagdRType ParamPerturb)

MVs: Vector of multivariate constraints.
Constraints: Either an equality or an inequality type of constraint.
NumOfMVs: Size of the MVs and Constraints vector.
NumOfZeroMVs: Number of zero or equality constraints.
ApplyNormalConeTest: TRUE to apply normal cones’ single intersection tests.
SubdivTol: Tolerance of the subdivision process. Tolerance is measured in the parametric space of the multi-
variates.
Depth: Of subdivision recursion.
SameSpace: True if all MVs share the same function space.
ParamPerturb: The perturbation to apply to mid. subdivision location.
Returns: List of points on the solution set. Dimension of the points will be the same as the dimensions of all
MVs.

Description: Approximate a solution to the set of constraints, if any, using the subdivision of the parametric
domains of the MVs. Stops when the parametric domain is smaller than SubdivTol in all dimensions and returns
a central point to that small multivariate patch. NOTE: The generic solver invokes this function only via the
Kantorovich option (global flag set accordingly), otherwise this function is unused.
See also: MvarMVsZeros,

8.2.493 MvarZeroOrganizeETs0DProblem (zret0d.c:122)

MvarExprTreeEqnsStruct *MvarZeroOrganizeETs0DProblem(
            const MvarExprTreeStruct * const *MVETs,
            int NumOfMVETs)

MVETs: Input mvar expression tree equations.
NumOfMVETs: Number of input mvar expression tree equations, in MVETs.
Returns: Build set of equations with common exprs.

Description: Copy the given expression trees and process and fetch common expressions out to a separated
common expressions’ vector, all within the returned expression tree equations structure.
See also: MvarMVsZeros,

8.2.494 MvarZeroOrganizeMVs0DProblem (zrmv0d.c:101)

MvarMVStruct **MvarZeroOrganizeMVs0DProblem(const MvarMVStruct * const *MVs,
                                             MvarConstraintType *Constraints,
                                             int *NumOfMVs)

MVs: Array of multivariates.
Constraints: Equality or inequality constraints.
NumOfMVs: Number of constraints (may be updated).
Returns: The updated array of MVs to be used.

Description: Preliminary organization and scaling actions of the objects composing a zero finding problem.
Relevant to the MVs representation only. This routine is invoked by the problem structure construction routine, and
should not be invoked when extracting a sub-problem from an existing one.
See also: MvarZeroSolverSetCallbackFcns0DMVs,
8.2.495 MvarZeroOrganizeMVs1DProblem (zrmv1d.c:104)

MvarMVStruct **MvarZeroOrganizeMVs1DProblem(const MvarMVStruct * const *MVs,
   MvarConstraintType *Constraints,
   int *NumOfMVs)

MVs: Array of multivariates.
Constraints: Equality or inequality constraints.
NumOfMVs: Number of constraints (may be updated).
Returns: The updated array of MVs to be used.

Description: Some preliminary organization of the objects composing an MVs, 1D solution zero finding problem. This routine is invoked by the problem structure construction routine, and should not be invoked when extracting a sub-problem from an existing one.
See also: MvarZeroSolverSetCallbackFcns1DMVs,

8.2.496 MvarZeroSolveMatlabEqns (zrmatlab.c:52)

MvarZeroSolutionStruct *MvarZeroSolveMatlabEqns(
   MvarMatlabEqStruct **Eqns,
   int NumOfEqns,
   int MaxVarsNum,
   CagdRType *MinDmn,
   CagdRType *MaxDmn,
   CagdRType NumericTol,
   CagdRType SubdivTol,
   CagdRType StepTol,
   MvarConstraintType *Constraints)

Eqns: The constraints as recieved after the matlab parsing.
NumOfEqns: The number of constraints.
MaxVarsNum: The maximal number of unknowns appearing in the problem.
MinDmn: The min end point of the domain in all directions. If NULL, considered as all zeros.
MaxDmn: The max end point of the domain in all directions. If NULL, considered as all ones.
NumericTol: The required numeric tolerance of the solution.
SubdivTol: The subdivision tolerance.
StepTol: The step size for numeric tracing of curves.
Constraints: A vector of constraints specifying equality/inequality.
Returns: The solution to the problem.

Description: Convert a zero finding prolem from matlab form to the solver’s problem and solve.
See also: MvarZeroSolver,

8.2.497 MvarZeroSolver (zrsolver.c:1303)

MvarZeroSolutionStruct *MvarZeroSolver(MvarZeroPrblmStruct *Problem)

Problem: The zero finding problem to be solved.
Returns: The point set (zero dimensional case) or piecewise linear approximation to the solution manifold (one/two dimensional case).

Description: The general zero finding problem solver. Invokes various zero finding algorithms according to the function representations/solution set dim. The solver follows as generally as possible the following paradigm:
0. Recursively subdivide until the problem is C1 smooth.
1. Try to rule out the possibility of a solution.
2. If can’t roule out, Check if the topology is guaranteed.
3. If topology is guaranteed, improve/reconstruct numerically.
4. If not, or if numeric step failed subdivide and solve recursively.
8.2.498  **MvarZeroSolverGetDmnDim** (zrsolver.c:1526)

```c
int MvarZeroSolverGetDmnDim(const MvarZeroPrblmStruct *Problem)
```

**Problem:** The zero finding problem structure.

**Returns:** The dimension of the domain of the problem.

**Description:** Extraction of the domain dimension of the MVs/ETs/other constraints in a zero finding problem.

8.2.499  **MvarZeroSolverIsMVZero** (zrsolver.c:2684)

```c
CagdBType MvarZeroSolverIsMVZero(MvarMVStruct *MV, CagdRType NumericTol)
```

**MV:** The (scalar valued) multi-variate to be tested.

**NumericTol:** The tolerance under which a coefficient is considered zero.

**Returns:** TRUE if all zeros, FALSE otherwise.

**Description:** Tests if all coefficients of a multi-variate are zero, up to prescribed tolerance.

See also: MvarZeroMVConstraintFail,

8.2.500  **MvarZeroSolverPolyProject** (zrmv2dTp.c:1213)

```c
MvarPolylineStruct *MvarZeroSolverPolyProject(MvarPolylineStruct *PolyList, int *Coords, int ProjDim)
```

**PolyList:** A list of polylines to project.

**Coords:** The required projection coordinates. Ordered vector.

**ProjDim:** The dimension of the required result. Also the length of Coords.

**Returns:** The new list of polylines.

**Description:** Projecting a given list of polylines on any of its required coordinates, as specified by the Coords vector of length projDim which is a subset of input dimension.

8.2.501  **MvarZeroSolverPrblmFree** (zrsolver.c:1105)

```c
void MvarZeroSolverPrblmFree(MvarZeroPrblmStruct *Problem)
```

**Problem:** Problem structure to free.

**Returns:** void

**Description:** Deallocates and frees all slots of a problem structure of a zero finding problem. Constraints are never freed, since they are allocated externally. Note that some slots are freed only at depth zero, some are freed only at first C1 smooth instance.

See also: MvarZeroSolverPrblmNew, MvarZeroSolverSubProblem,
8.2.502 MvarZeroSolverPrblmNew (zrsolver.c:679)

MvarZeroPrblmStruct *MvarZeroSolverPrblmNew(const MvarMVStruct * const *MVs,
const MvarExprTreeStruct * const *ETs,
int NumOfConstraints,
MvarConstraintType *Constraints,
CagdRType SubdivTol,
CagdRType NumericTol,
CagdRType StepTol,
CagdBType Solve2DBy0D)

MVs: Array of multivariates, NULL for ETs representations.
ETs: Array of expression trees, NULL for MVs representations.
NumOfConstraints: Number of constraints in the problem (Total).
Constraints: Either an equality or an inequality type of constraint.
SubdivTol: Tolerance of the subdivision process. Tolerance is measured in the parametric space of the constrains.
NumericTol: Tolerance of the numeric stage.
StepTol: In 1D numeric stages (curve tracing)- the step size used.
Solve2DBy0D: A temporary flag to indicate the use of the new 2D solver or not.
Returns: The new problem structure or NULL if error.

Description: Construction of a new zero finding problem structure. Allocates the memory and assigns slots that are already known upon construction. This routine should NOT be used when extracting a sub-problem from an existing problem (such as after domain reduction or subdivision): it should only be called at very first construction (SubdivDepth == 0). Scaling and organization takes place here that is not required for sub-problems.
See also: MvarZeroSolverPrblmFree,

8.2.503 MvarZeroSolverSetCallbackFcns0DExpTr (zret0d.c:92)

void MvarZeroSolverSetCallbackFcns0DExpTr(MvarZeroPrblmStruct *Problem)

Problem: The zero finding problem to be solved.
Returns: void
Description: Sets the callback functions for the Expression Trees representation, 0D solution case.
See also:

8.2.504 MvarZeroSolverSetCallbackFcns0DMVs (zrmv0d.c:69)

void MvarZeroSolverSetCallbackFcns0DMVs(MvarZeroPrblmStruct *Problem)

Problem: The zero finding problem to be solved.
Returns: void
Description: Sets the callback functions for the MVs representation, 0D solution case.
See also: MvarZeroOrganizeMVs0DProblem,

8.2.505 MvarZeroSolverSetCallbackFcns1DExpTr (zret1d.c:61)

void MvarZeroSolverSetCallbackFcns1DExpTr(MvarZeroPrblmStruct *Problem)

Problem: The zero finding problem to be solved.
Returns: void
Description: Sets the callback functions for the ETs representation, 1D solution case.
See also:
8.2.506  MvarZeroSolverSetCallbackFcsns1DMVs (zrmv1d.c:72)

    void MvarZeroSolverSetCallbackFcsns1DMVs(MvarZeroPrblmStruct *Problem)

    Problem: The zero finding problem to be solved.
    Returns: void
    Description: Sets the callback functions for the MVs representation, 1D solution case.
    See also: MvarZeroOrganizeMVs1DProblem,

8.2.507  MvarZeroSolverSetCallbackFcsns2DExpTr (zret2d.c:61)

    void MvarZeroSolverSetCallbackFcsns2DExpTr(MvarZeroPrblmStruct *Problem)

    Problem: The zero finding problem to be solved.
    Returns: void
    Description: Sets the callback functions for the ETs representation, 2D solution case.
    See also:

8.2.508  MvarZeroSolverSetCallbackFcsns2DMVs (zrmv2dTp.c:100)

    void MvarZeroSolverSetCallbackFcsns2DMVs(MvarZeroPrblmStruct *Problem)

    Problem: The zero finding problem to be solved.
    Returns: void
    Description: Sets the callback functions for the MVs representation, 2D solution case.

8.2.509  MvarZeroSolverSolutionFree (zrsolver.c:1254)

    void MvarZeroSolverSolutionFree(MvarZeroSolutionStruct *Solution,
                                CagdBType FreeUnion)

    Solution: Solution structure to free.
    FreeUnion: If TRUE, the points/polylines stored at in the solution are freed, otherwise they are not. This is useful for the cases of uniting solutions in place.
    Returns: void
    Description: Deallocates and frees all slots of a solution structure of a zero finding problem. NOTE: the T-Junction list is not freed, as it is always freed as part of the problem deallocation.
    See also: MvarZeroSolverSolutionNew,

8.2.510  MvarZeroSolverSolutionNew (zrsolver.c:1196)

    MvarZeroSolutionStruct *MvarZeroSolverSolutionNew(MvarTriangleStruct *Tr,
                                                    MvarPolylineStruct *Pl,
                                                    MvarPtStruct *Pt,
                                                    Representation Rep)

    Tr: A list of triangles, or NULL if the representation is not such.
    Pl: A list of polylines, or NULL if the representation is not such.
    Pt: A list of points, or NULL if the representation is not such.
    Rep: The active representation required for the new solution.
    Returns: The new solution or NULL if error.
    Description: Allocates the memory required for a new solution structure of a zero finding problem.
    See also: MvarZeroSolverSolutionFree,
8.2.511  MvarZeroSolverSubProblem  (zrsolver.c:1003)

MvarZeroPrblmStruct *MvarZeroSolverSubProblem(
    MvarZeroPrblmStruct const *Problem,
    MvarMVStruct **MVs,
    MvarExprTreeEqnsStruct *Eqns,
    MvarZeroSolutionStruct *BoundarySol)

    Problem: The original problem, from which to extract the sub-problem.
    MVs: Array of multivariates, NULL if not MVs representation.
    Eqns: Struct of expression trees, NULL if not ETs representation.
    BoundarySol: The solution to the corresponding 2 * Dim problems of one dimension less, defined on the
    boundary of the new, smaller problem.

    Returns: The sub-problem.

    Description: Construction of a new zero finding sub-problem structure from an existing problem, for the given
    constraints defined on the sub-domain (the result of subdivision or domain reduction). Note that there are slots that
    are only allocated once, while some are are allocated at all depths.
    See also: MvarZeroSolverPrblmNew, MvarZeroOrganizeMVs0DProblem, , MvarZeroOrganizeMVs1DProblem,

8.2.512  MvarZeroTJCopy  (zrmv2dTJ.c:74)

MvarZeroTJunctionStruct *MvarZeroTJCopy(const MvarZeroTJunctionStruct *TJ)

    TJ: The T-Junction object to copy.
    Returns: the T-Junction copy.

    Description: Copies a multi-variate T-Junction object.
    See also: MvarZeroTJFree,

8.2.513  MvarZeroTJCopyList  (zrmv2dTJ.c:105)

MvarZeroTJunctionStruct *MvarZeroTJCopyList(
    const MvarZeroTJunctionStruct *TJList)

    TJList: The T-Junction list to copy.
    Returns: The T-Junctions list copy.

    Description: Copies a list of multi-variate T-Junction objects.
    See also: MvarZeroTJFree, MvarZeroTJCopy,

8.2.514  MvarZeroTJFree  (zrmv2dTJ.c:137)

void MvarZeroTJFree(MvarZeroTJunctionStruct *TJ)

    TJ: Multivariate T-Junction to free.
    Returns: void

    Description: Frees all slots of a multi-variate T-Junction structure.
    See also: MvarZeroTJFreeList,

8.2.515  MvarZeroTJFreeList  (zrmv2dTJ.c:164)

void MvarZeroTJFreeList(MvarZeroTJunctionStruct *TJList)

    TJList: Multivariate T-Junctions list to free.
    Returns: void

    Description: Deallocates and frees a list of T-Junction structures.
    See also: MvarZeroTJFree,
8.2.516 **MvarZeroTJNew** (zrmv2dTJ.c:43)

MvarZeroTJunctionStruct *MvarZeroTJNew(const MvarPtStruct *TJPrev, const MvarPtStruct *TJPt, const MvarPtStruct *TJNext)

- **TJPrev:** The point before the junction.
- **TJPt:** The T-Junction point.
- **TJNext:** The point after the junction.

**Returns:** The T-Junction.

**Description:** Allocates the memory required for a new multi-variate T-Junction.

See also: MvarZeroTJFree, MvarZeroTJCcopy,

8.2.517 **MvarZeroUpdateProblemDmnExpTr** (zrsolver.c:1726)

void MvarZeroUpdateProblemDmnExpTr(MvarZeroPrblmStruct *Problem)

- **Problem:** The zero finding problem structure.
- **Returns:** void

**Description:** Updates the problem with the domain and related data in the ETs case.

8.2.518 **MvarZeroUpdateProblemDmnMVs** (zrsolver.c:1671)

void MvarZeroUpdateProblemDmnMVs(MvarZeroPrblmStruct *Problem)

- **Problem:** The zero finding problem structure.
- **Returns:** void

**Description:** Updates the problem with the domain and related data in the MVs case.

8.2.519 **MvarZerosSubdivTolAction** (zrmv0d.c:932)

MvarZeroSubdivTolActionType MvarZerosSubdivTolAction(MvarZeroSubdivTolActionType SubdivTolAction)

- **SubdivTolAction:** New setting for the action type.
- **Returns:** Old setting for the action type.

**Description:** Sets the action taken by the 0D solver when reaching a sub-domain of size less than subdivision tolerance.

See also: MvarZeroSolver, MvarZeroSolverSingleSol0DMVs,

8.2.520 **MvarZrAlgAssignExpr** (mvarzral.c:196)

int MvarZrAlgAssignExpr(void *MVZrAlg, const char *Name, const char *Expr)

- **MVZrAlg:** Structure to add a new assignmen to.
- **Name:** Of new assignment.
- **Expr:** The expression.
- **Returns:** TRUE if successful, FALSE otherwise.

**Description:** Insert an expression assignment into the structure.

See also:
8.2.521  MvarZrAlgAssignMVVar  (mvarzral.c:296)

int MvarZrAlgAssignMVVar(void *MVZrAlg,  
const char *Name,  
CagdRType DmnMin,  
CagdRType DmnMax,  
const MvarMVStruct *MV)

MVZrAlg: Structure to add a new assignment to.  
Name: Name of this variable.  
DmnMin, DmnMax: Domain of this variable.  
MV: ZrAlg Multivariate representing this variable. Optional.  
Returns: TRUE if successful, FALSE otherwise.  
Description: Insert an MV variable assignment into the structure.  
See also:

8.2.522  MvarZrAlgAssignNumVar  (mvarzral.c:246)

int MvarZrAlgAssignNumVar(void *MVZrAlg, const char *Name, CagdRType Val)

MVZrAlg: Structure to add a new assignment to.  
Name: Of new assignment.  
Val: The numeric value.  
Returns: TRUE if successful, FALSE otherwise.  
Description: Insert a numeric variable into the structure.  
See also:

8.2.523  MvarZrAlgCreate  (mvarzral.c:95)

void *MvarZrAlgCreate()

Returns: The allocated algebraic expressions structure.  
Description: Creates and allocate the structure to manipulate algebraic expressions.  
See also:

8.2.524  MvarZrAlgDelete  (mvarzral.c:132)

void MvarZrAlgDelete(void *MVZrAlg)

MVZrAlg: Structure to deallocate.  
Returns: void  
Description: Deallocates the structure to manipulate algebraic expressions.  
See also:
8.2.525  MvarZrAlgGenMVCode (mvarzral.c:439)

```c
int MvarZrAlgGenMVCode(void *MVZrAlg, const char *Expr, FILE *f)
```

- **MVZrAlg**: Structure of variables and expressions.
- **Expr**: To parse into a multivariate C Code.
- **f**: Destination of synthesized C code.

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: Generate multivariate C Code sequence into designated file that represent the given expression Expr:
1. Using MVZrAlg, perform all possible substitutions.
2. Parse the result into a binary tree and then synthesize the C code to build a multivar with variables at the leaves fetched from MVZrAlg.

See also:

8.2.526  _MvarIncBoundMeshIndices (mvar_aux.c:1269)

```c
int _MvarIncBoundMeshIndices(const MvarMVStruct *MV, int *Indices, int *LowerBound, int *UpperBound, int *Index)
```

- **MV**: To increment Indices to its control mesh.
- **Indices**: To increment one step.
- **LowerBound**: Minimal values to assume.
- **UpperBound**: One above the maximal values to assume.
- **Index**: Index to increment.

**Returns**: TRUE if Indices are in domain, FALSE if done.

**Description**: Increment the index of the control mesh of the multivariate function by one, with given lower and upper bounds: LowerBound <= Idx < UpperBound. Should only be called via the macro MVAR_INC_BOUND_MESH_INDICES.

See also: _MvarIncSkipMeshIndices, _MvarIncSkipMeshIndices1st, _MvarIncrementMeshIndices, _MvarIncrementMeshOrderIndic

8.2.527  _MvarIncSkipMeshIndices (mvar_aux.c:1195)

```c
int _MvarIncSkipMeshIndices(const MvarMVStruct *MV, int *Indices, int Dir, int *Index)
```

- **MV**: To increment Indices to its control mesh.
- **Indices**: To increment one step.
- **Dir**: To skip in the incrementation.
- **Index**: The total current index to be incremented as well, or zero if we wrapped around all incides.

**Returns**: Current non negative Index if Indices are in domain, zero (FALSE) if done - out of the domain.

**Description**: Increment the index of the control mesh of the multivariate function by one, skipping axis Dir. Should only be called via the macro MVAR_INC_SKIP_MESH_INDICES.

See also: _MvarIncBoundMeshIndices, _MvarIncSkipMeshIndices1st, _MvarIncrementMeshIndices, _MvarIncrementMeshOrderIndic
8.2.528 _MvarIncSkipMeshIndices1st (mvar\_aux.c:1151)

```c
int _MvarIncSkipMeshIndices1st(const MvarMVStruct *MV, int *Indices)
```

**MV:** To increment Indices to its control mesh.

**Indices:** To increment one step.

**Returns:** TRUE if Indices are in domain, FALSE if done.

**Description:** Increment the index of the control mesh of the multivariate function by one, skipping axis Dir zero. Should only be called via the macro MVAR\_INC\_SKIP\_MESH\_INDICES\_1ST.

**See also:** _MvarIncSkipMeshIndices, _MvarIncBoundMeshIndices, _MvarIncrementMeshIndices, _MvarIncrementMeshOrderIndices

8.2.529 _MvarIncrementMeshIndices (mvar\_aux.c:1068)

```c
int _MvarIncrementMeshIndices(const MvarMVStruct *MV, int *Indices, int *Index)
```

**MV:** To increment Indices to its control mesh.

**Indices:** To increment one step.

**Index:** The total current index to be incremented as well, or zero if we wrapped around all indices.

**Returns:** The non zero advanced index if indices are in domain, zero if done (out of domain).

**Description:** Increment the index of the control mesh of the multivariate function by one. Should only be called via the macro MVAR\_INCREMENT\_MESH\_INDICES.

**See also:** _MvarIncSkipMeshIndices, _MvarIncBoundMeshIndices, _MvarIncSkipMeshIndices1st, _MvarIncrementMeshOrderIndices

8.2.530 _MvarIncrementMeshOrderIndices (mvar\_aux.c:1111)

```c
int _MvarIncrementMeshOrderIndices(const MvarMVStruct *MV,
                                   int *Indices,
                                   int *Index)
```

**MV:** To increment Indices to its control mesh.

**Indices:** To increment one step.

**Index:** The total current index to be incremented as well, or zero if we wrapped around all indices.

**Returns:** The non zero advanced index if indices are in domain, zero if done (out of domain).

**Description:** Increment the index of the control mesh of the multivariate function by one. Should only be called via the macro MVAR\_INCREMENT\_MESH\_ORDER\_INDICES. This macro is useful when traversing a Bspline mesh for evaluation, Orders[i] control points in i'th dimension.

**See also:** _MvarIncSkipMeshIndices, _MvarIncBoundMeshIndices, _MvarIncSkipMeshIndices1st,
Chapter 9

Prsr Library, prsr_lib

9.1 General Information

This library provides the data file interface for IRIT. Functions are provided to read and write data files, both compressed (on unix only, using `compress`), and uncompressed, in binary and/or ascii text modes. This library is also used to exchange data between the IRIT server and the display devices' clients. Several header files can be found for this library:

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9.2 Library Functions

9.2.1 AttrFreeObjectAttribute (attribut.c:1168)

```c
void AttrFreeObjectAttribute(IPObjectStruct *PObj, const char *Name)
```

- **PObj**: Object to free attributes from.
- **Name**: Name of attribute to delete, or all attributes if NULL.
- **Returns**: void

**Description**: Free one or all attributes of an object PObj and its descendants.
**See also**: AttrFreeOneAttribute, AttrFreeAttributes,

9.2.2 AttrGetMAttribCount (iritvrml.c:385)

```c
int AttrGetMAttribCount(IPAttributeStruct *Attr)
```

- **Attr**: Attribute list to search for requested attribute.
- **Returns**: Count of the values actually present in attribute.

**Description**: Routine to return a count of values in multi-attribute.
**See also**: AttrGetMRealAttrib, AttrGetMAttribCount,
9.2.3 AttrGetMIntAttrib (iritvrml.c:424)

```c
int AttrGetMIntAttrib(IPAttributeStruct *Attrs, char *Name, int N, int **PV)
```

- **Attrs**: Attribute list to search for requested attribute.
- **Name**: Name of requested attribute.
- **N**: Count of values in PV array, or zero.
- **PV**: Address of the pointer to the first array value, or pointer itself.

**Description**: Routine to return a multi-integer attribute. Note, that when N is zero, PV is an address of a pointer that will receive allocated array, otherwise PV is regarded as just a pointer to the first value in the client provided array. If N is greater than actual count of values in the attribute, last value is replicated.

**See also**: AttrSetIntAttrib, AttrSetPtrAttrib, AttrGetPtrAttrib, AttrSetRealAttrib, AttrGetRealAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetMRealAttrib, AttrGetMAttribCount

9.2.4 AttrGetMRealAttrib (iritvrml.c:530)

```c
int AttrGetMRealAttrib(IPAttributeStruct *Attrs, char *Name, int N, IrtRType **PV)
```

- **Attrs**: Attribute list to search for requested attribute.
- **Name**: Name of requested attribute.
- **N**: Count of values in PV array, or zero.
- **PV**: Address of the pointer to the first array value, or pointer itself.

**Description**: Routine to return a multi-real attribute. Note, that when N is zero, PV is an address of a pointer that will receive allocated array, otherwise PV is regarded as just a pointer to the first value in the client provided array. If N is greater than actual count of values in the attribute, last value is replicated.

**See also**: AttrSetIntAttrib, AttrSetPtrAttrib, AttrGetPtrAttrib, AttrSetRealAttrib, AttrGetRealAttrib, AttrSetStrAttrib, AttrGetStrAttrib, AttrGetMIntAttrib, AttrGetMAttribCount

9.2.5 AttrGetObjAttrib (attribut.c:1107)

```c
IPObjectStruct *AttrGetObjAttrib(const IPAttributeStruct *Attrs, const char *Name)
```

- **Attrs**: Attribute list to search for requested attribute.
- **Name**: Name of requested attribute.

**Description**: Routine to get an object attribute.

**See also**: AttrSetObjectIntAttrib, AttrGetObjectIntAttrib, AttrSetObjectPtrAttrib, AttrGetObjectPtrAttrib, AttrSetObjectRealAttrib, AttrGetObjectRealAttrib, AttrSetObjectUVAttrib, AttrGetObjectUVAttrib, AttrSetObjectStrAttrib, AttrGetObjectStrAttrib, AttrSetObjectObjAttrib, AttrSetObjAttrib, AttrGetObjectObjAttrib, AttrGetObjAttrib2

9.2.6 AttrGetObjAttrib2 (attribut.c:1140)

```c
IPObjectStruct *AttrGetObjAttrib2(const IPAttributeStruct *Attrs, AttribNumType AttribNum)
```

- **Attrs**: Attribute list to search for requested attribute.
- **AttribNum**: Unique ID derived from name of requested attribute.

**Description**: Routine to get an object attribute.

**See also**: AttrSetObjectIntAttrib, AttrGetObjectIntAttrib, AttrSetObjectPtrAttrib, AttrGetObjectPtrAttrib, AttrSetObjectRealAttrib, AttrGetObjectRealAttrib, AttrSetObjectUVAttrib, AttrGetObjectUVAttrib, AttrSetObjectStrAttrib, AttrGetObjectStrAttrib, AttrSetObjectObjAttrib, AttrSetObjAttrib, AttrGetObjectObjAttrib, AttrGetObjAttrib,
9.2.7 AttrGetObjectColor (attribut.c:65)

```c
int AttrGetObjectColor(const IPObjectStruct *PObj)
```

**PObj:** For which we would like to know the color of.

**Returns:** Color of PObj or IP\_ATTR\_NO\_COLOR if no color set.

**Description:** Routine to return the color of an object.

**See also:** AttrSetObjectColor, AttrSetObjectRGBColor, AttrGetObjectRGBColor, AttrGetObjectWidth, AttrSetObjectWidth, AttrSetObjectRealAttrib, AttrGetColor,

9.2.8 AttrGetObjectIntAttrib (attribut.c:275)

```c
int AttrGetObjectIntAttrib(const IPObjectStruct *PObj, const char *Name)
```

**PObj:** Object from which to get an integer attribute.

**Name:** Name of integer attribute.

**Returns:** Found attribute, or IP\_ATTR\_BAD\_INT if not found.

**Description:** Routine to get an integer attribute from an object.

**See also:** AttrSetObjectIntAttrib, AttrSetObjectPtrAttrib, AttrGetObjectPtrAttrib, AttrGetObjectRealAttrib, AttrGetObjectRealAttrib, AttrSetObjectUVAttrib, AttrGetObjectUVAttrib, AttrSetObjectPtrAttrib, AttrGetObjectPtrAttrib, AttrSetObjectStrAttrib, AttrGetObjectStrAttrib, AttrSetObjectObjAttrib, AttrSetObjAttrib, AttrGetObjectObjAttrib, AttrGetObjAttrib, AttrGetObjectIntAttrib2,

9.2.9 AttrGetObjectIntAttrib2 (attribut.c:302)

```c
int AttrGetObjectIntAttrib2(const IPObjectStruct *PObj, AttribNumType AttribNum)
```

**PObj:** Object from which to get an integer attribute.

**AttribNum:** Unique ID derived from name of requested attribute.

**Returns:** Found attribute, or IP\_ATTR\_BAD\_INT if not found.

**Description:** Routine to get an integer attribute from an object.

**See also:** AttrSetObjectIntAttrib, AttrSetObjectPtrAttrib, AttrGetObjectPtrAttrib, AttrSetObjectRealAttrib, AttrGetObjectRealAttrib, AttrSetObjectUVAttrib, AttrGet ObjectUVAttrib, AttrSetObjectStrAttrib, AttrGetObjectStrAttrib, AttrSetObjectObjAttrib, AttrSetObjAttrib, AttrGetObjectObjAttrib, AttrGetObjAttrib, AttrGetObjectIntAttrib,

9.2.10 AttrGetObjectObjAttrib (attribut.c:1053)

```c
IPObjectStruct *AttrGetObjectObjAttrib(const IPObjectStruct *PObj, const char *Name)
```

**PObj:** Object from which to get a object attribute.

**Name:** Name of object attribute.

**Returns:** Found attribute, or NULL if not found.

**Description:** Routine to get an object attribute from an object.

**See also:** AttrSetObjectIntAttrib, AttrSetObjectPtrAttrib, AttrGetObjectPtrAttrib, AttrSetObjectRealAttrib, AttrGetObjectRealAttrib, AttrSetObjectUVAttrib, AttrGetObjectUVAttrib, AttrSetObjectStrAttrib, AttrGetObjectStrAttrib, AttrSetObjectObjAttrib, AttrSetObjAttrib, AttrGetObjectObjAttrib, AttrGetObjAttrib, AttrGetObjectObjAttrib2,
9.2.11 AttrGetObjectObjAttrib2 (attribut.c:1080)

IPObjectStruct *AttrGetObjectObjAttrib2(const IPObjectStruct *PObj,
    AttribNumType AttribNum)

PObj: Object from which to get a object attribute.
AttribNum: Unique ID derived from name of requested attribute.
Returns: Found attribute, or NULL if not found.
Description: Routine to get an object attribute from an object.

See also: AttrSetObjectIntAttrib, AttrGetObjectIntAttrib, AttrSetObjectPtrAttrib, AttrGetObjectRealAttrib, AttrSetObjectRealAttrib, AttrGetObjectStrAttrib, AttrSetObjectObjAttrib, AttrGetObjectObjAttrib,

9.2.12 AttrGetObjectPtrAttrib (attribut.c:391)

VoidPtr AttrGetObjectPtrAttrib(const IPObjectStruct *PObj, const char *Name)

PObj: Object from which to get a pointer attribute.
Name: Name of pointer attribute.
Returns: Found attribute, or NULL if not found.
Description: Routine to get a pointer attribute from an object.

See also: AttrSetObjectIntAttrib, AttrGetObjectIntAttrib, AttrSetObjectPtrAttrib, AttrGetObjectRealAttrib, AttrSetObjectRealAttrib, AttrGetObjectStrAttrib, AttrSetObjectObjAttrib, AttrGetObjectObjAttrib,

9.2.13 AttrGetObjectPtrAttrib2 (attribut.c:419)

VoidPtr AttrGetObjectPtrAttrib2(const IPObjectStruct *PObj,
    AttribNumType AttribNum)

PObj: Object from which to get a pointer attribute.
AttribNum: Unique ID derived from name of requested attribute.
Returns: Found attribute, or NULL if not found.
Description: Routine to get a pointer attribute from an object.

See also: AttrSetObjectIntAttrib, AttrGetObjectIntAttrib, AttrSetObjectPtrAttrib, AttrGetObjectRealAttrib, AttrSetObjectRealAttrib, AttrGetObjectStrAttrib, AttrSetObjectObjAttrib, AttrGetObjectObjAttrib,

9.2.14 AttrGetObjectRGBColor (attribut.c:116)

int AttrGetObjectRGBColor(const IPObjectStruct *PObj,
    int *Red,
    int *Green,
    int *Blue)

PObj: Object to get its RGB color.
Red, Green, Blue: Component of color to initialize.
Returns: TRUE if PObj does have an RGB color attribute, FALSE otherwise.
Description: Routine to return the RGB color of an object.

See also: AttrSetObjectColor, AttrGetObjectColor, AttrSetObjectRGBColor, AttrGetObjectWidth, AttrSetObjectWidth, AttrSetObjectRealAttrib, AttrGetRGBColor, AttrGetObjectRGBColor2,
9.2.15 AttrGetObjectRGBColor2 (attribut.c:145)

int AttrGetObjectRGBColor2(const IPObjectStruct *PObj,
                          const char *Name,
                          int *Red,
                          int *Green,
                          int *Blue)

PObj: Object to get its RGB color.
Name: Name of the attribute, if NULL default is taken.
Red, Green, Blue: Component of color to initialize.

Returns: TRUE if PObj does have an RGB color attribute, FALSE otherwise.

Description: Routine to return the RGB color of an object.
See also: AttrSetObjectColor, AttrGetObjectColor, AttrSetObjectRGBColor, AttrGetObjectWidth, AttrSetObjectRealAttrib, AttrGetRGBColor, AttrGetObjectRGBColor,

9.2.16 AttrGetObjectRealAttrib (attribut.c:620)

IrtRType AttrGetObjectRealAttrib(const IPObjectStruct *PObj, const char *Name)

PObj: Object from which to get a real attribute.
Name: Name of real attribute.

Returns: Found attribute, or IPATTR_BAD_REAL if not found.

Description: Routine to get a real attribute from an object.
See also: AttrSetObjectIntAttrib, AttrGetObjectIntAttrib, AttrSetObjectPtrAttrib, AttrGetObjectPtrAttrib, AttrSetObjectRealAttrib, AttrSetObjectStrAttrib, AttrGetObjectStrAttrib, AttrSetObjectObjAttrib, AttrGetObjectObjAttrib, AttrGetObjectRealAttrib,

9.2.17 AttrGetObjectRealAttrib2 (attribut.c:647)

IrtRType AttrGetObjectRealAttrib2(const IPObjectStruct *PObj, AttribNumType AttribNum)

PObj: Object from which to get a real attribute.
AttribNum: Unique ID derived from name of requested attribute.

Returns: Found attribute, or IPATTR_BAD_REAL if not found.

Description: Routine to get a real attribute from an object.
See also: AttrSetObjectIntAttrib, AttrGetObjectIntAttrib, AttrSetObjectPtrAttrib, AttrGetObjectPtrAttrib, AttrSetObjectRealAttrib, AttrSetObjectStrAttrib, AttrGetObjectStrAttrib, AttrSetObjectObjAttrib, AttrGetObjectObjAttrib, AttrGetObjectRealAttrib,

9.2.18 AttrGetObjectRefPtrAttrib (attribut.c:508)

VoidPtr AttrGetObjectRefPtrAttrib(const IPObjectStruct *PObj, const char *Name)

PObj: Object from which to get a pointer reference attribute.
Name: Name of pointer attribute.

Returns: Found attribute, or NULL if not found.

Description: Routine to get a pointer reference attribute from an object.
See also: AttrSetObjectIntAttrib, AttrGetObjectIntAttrib, AttrSetObjectPtrAttrib, AttrGetObjectPtrAttrib, AttrSetObjectRealAttrib, AttrSetObjectStrAttrib, AttrGetObjectStrAttrib, AttrSetObjectObjAttrib, AttrGetObjectObjAttrib, AttrGetObjectRefPtrAttrib, AttrGetObjectRefPtrAttrib2,
9.2.19  AttrGetObjectRefPtrAttrib2
(attribut.c:536)

VoidPtr AttrGetObjectRefPtrAttrib2(const IPObjectStruct *PObj, 
    AttribNumType AttrNum)

PObj: Object from which to get a pointer reference attribute.
AttrNum: Unique ID derived from name of requested attribute.

Returns: Found attribute, or NULL if not found.

Description: Routine to get a pointer reference attribute from an object.
See also: AttrSetObjectIntAttrib, AttrGetObjectIntAttrib, AttrSetObjectPtrAttrib, , AttrSetObjectRealAttrib, 
AttrGetObjectRealAttrib, AttrSetObjectStrAttrib, AttrGetObjectStrAttrib, AttrSetObjectObjAttrib, AttrGetObjAttrib, AttrSetObjectRefPtrAttrib, AttrGetObjectRefPtrAttrib, AttrGetObjAttrib,

9.2.20  AttrGetObjectStrAttrib
(attribut.c:845)

const char *AttrGetObjectStrAttrib(const IPObjectStruct *PObj, 
    const char *Name)

PObj: Object from which to get a string attribute.
Name: Name of string attribute.

Returns: Found attribute, or NULL if not found.

Description: Routine to get a string attribute from an object.
See also: AttrSetObjectIntAttrib, AttrGetObjectIntAttrib, AttrSetObjectPtrAttrib, , AttrGetObjAttrib, 
AttrSetObjectRealAttrib, AttrGetObjectRealAttrib, AttrSetObjectStrAttrib, AttrGetObjectStrAttrib, AttrSetObjectObjAttrib, AttrGetObjAttrib, AttrSetObjectRefPtrAttrib, AttrGetObjectRefPtrAttrib,

9.2.21  AttrGetObjectStrAttrib2
(attribut.c:872)

const char *AttrGetObjectStrAttrib2(const IPObjectStruct *PObj, 
    const char *Name)

PObj: Object from which to get a string attribute.
AttrNum: Unique ID derived from name of requested attribute.

Returns: Found attribute, or NULL if not found.

Description: Routine to get a string attribute from an object.
See also: AttrSetObjectIntAttrib, AttrGetObjectIntAttrib, AttrSetObjectPtrAttrib, , AttrGetObjAttrib, 
AttrSetObjectRealAttrib, AttrGetObjectRealAttrib, AttrSetObjectStrAttrib, AttrGetObjectStrAttrib, AttrSetObjectObjAttrib, AttrGetObjAttrib, AttrSetObjectRefPtrAttrib, AttrGetObjectRefPtrAttrib,

9.2.22  AttrGetObjectUVAttrib
(attribut.c:733)

float *AttrGetObjectUVAttrib(const IPObjectStruct *PObj, const char *Name)

PObj: Object from which to get a real attribute.
Name: Name of real attribute.

Returns: Found attribute, or NULL if not found.

Description: Routine to get a UV attribute from an object.
See also: AttrSetObjectIntAttrib, AttrGetObjectIntAttrib, AttrSetObjectPtrAttrib, , AttrGetObjAttrib, 
AttrSetObjectRealAttrib, AttrGetObjectRealAttrib, AttrSetObjectStrAttrib, AttrGetObjectStrAttrib, AttrSetObjectObjAttrib, AttrGetObjAttrib, AttrSetObjectRefPtrAttrib, AttrGetObjectRefPtrAttrib,
9.2.23 AttrGetObjectUVAttrib2 (attribut.c:760)

float *AttrGetObjectUVAttrib2(const IPObjStruct *PObj,
                              AttribNumType AttribNum)

PObj: Object from which to get a real attribute.
AttribNum: Unique ID derived from name of requested attribute.
Returns: Found attribute, or NULL if not found.
Description: Routine to get a UV attribute from an object.
See also: AttrSetObjectIntAttrib, AttrGetObjectIntAttrib, AttrSetObjectPtrAttrib, AttrGetObjectPtrAttrib,
          AttrSetObjectRealAttrib, AttrGetObjectRealAttrib, AttrSetObjectObjAttrib, AttrGetObjectObjAttrib,
          AttrGetObjectUVAttrib, AttrGetObjectUVAttrib,

9.2.24 AttrGetObjectWidth (attribut.c:193)

IrtRType AttrGetObjectWidth(const IPObjStruct *PObj)

PObj: For which we would like to know the width of.
Returns: Width of PObj or IP_ATTR_NO_WIDTH if no width set.
Description: Routine to return the width of an object.
See also: AttrSetObjectColor, AttrGetObjectColor, AttrSetObjectRGBColor, AttrGetObjectRGBColor,
          AttrSetObjectIntWidth, AttrGetObjectRealAttrib, AttrSetWidth,

9.2.25 AttrPropagateAttr (attribut.c:1300)

void AttrPropagateAttr(IPObjStruct *PObj, const char *AttrName)

PObj: To propagate down Attr attributes.
AttrName: Name of attribute to propagate or NULL to propagate all attributes.
Returns: void
Description: Propagate attributes from list objects down into their elements. Non propagatable attributes are
accumulated or ignored as follows: "animation" is accumulated. "invisible" is ignored.

9.2.26 AttrPropagateRGB2Vrtx (attribut.c:1479)

void AttrPropagateRGB2Vrtx(IPObjStruct *PObj)

PObj: To propagate down "RGB" attributes.
Returns: void
Description: Propagates "RGB" attributes from a poly objects down into the vertices, in place.

9.2.27 AttrSetObjAttrib (attribut.c:965)

void AttrSetObjAttrib(IPAttributeStruct **Attrs,
                      const char *Name,
                      IPObjStruct *Data,
                      int CopyData)

Attrs: Attribute list where to place new attribute.
Name: Name of the newly introduced attribute.
Data: Pointer attribute to save.
CopyData: If TRUE, object Data is duplicated first.
Returns: void
Description: Routine to set an object attribute.
See also: AttrSetObjectIntAttrib, AttrGetObjectIntAttrib, AttrSetObjectPtrAttrib, AttrGetObjectPtrAttrib,
          AttrSetObjectRealAttrib, AttrGetObjectRealAttrib, AttrSetObjectUVAttrib, AttrGetObjectUVAttrib,
          AttrSetObjectObjAttrib, AttrGetObjectObjAttrib, AttrGetObjAttrib, AttrSetObjAttrib2,
9.2.28 AttrSetObjAttrib2 (attribut.c:1011)

```
void AttrSetObjAttrib2(IPAttributeStruct **Attrs,
    AttribNumType AttribNum,
    IPObjStruct *Data,
    int CopyData)
```

**Attrs**: Attribute list where to place new attribute.

**AttribNum**: Unique ID derived from name of requested attribute.

**Data**: Pointer attribute to save.

**CopyData**: If TRUE, object Data is duplicated first.

**Returns**: void

**Description**: Routine to set an object attribute.

**See also**: AttrSetObjectIntAttrib, AttrGetObjectIntAttrib, AttrSetObjectPtrAttrib, AttrGetObjectPtrAttrib, AttrSetObjectRealAttrib, AttrGetObjectRealAttrib, AttrSetObjectStrAttrib, AttrGetObjectStrAttrib, AttrSetObjectObjAttrib, AttrGetObjectObjAttrib, AttrGetObjAttrib, AttrSetObjAttrib,

9.2.29 AttrSetObjectColor (attribut.c:41)

```
void AttrSetObjectColor(IPObjectStruct *PObj, int Color)
```

**PObj**: Object to set its color to Color.

**Color**: New color for PObj.

**Returns**: void

**Description**: Routine to set the color of an object.

**See also**: AttrGetObjectColor, AttrSetObjectRGBColor, AttrGetObjectRGBColor, AttrGetObjectWidth, AttrSetObjectWidth, AttrSetObjectIntAttrib, AttrSetColor,

9.2.30 AttrSetObjectIntAttrib (attribut.c:220)

```
void AttrSetObjectIntAttrib(IPObjectStruct *PObj, const char *Name, int Data)
```

**PObj**: To add an integer attribute for.

**Name**: Name of attribute.

**Data**: Content of attribute.

**Returns**: void

**Description**: Routine to set an integer attribute for an object.

**See also**: AttrGetObjectIntAttrib, AttrSetObjectPtrAttrib, AttrGetObjectPtrAttrib, AttrSetObjectRealAttrib, AttrGetObjectRealAttrib, AttrSetObjectUVAttrib, AttrGetObjectUVAttrib, AttrSetObjectStrAttrib, AttrGetObjectStrAttrib, AttrSetObjectObjAttrib, AttrGetObjectObjAttrib, AttrGetObjAttrib, AttrSetObjAttrib,

9.2.31 AttrSetObjectIntAttrib2 (attribut.c:249)

```
void AttrSetObjectIntAttrib2(IPObjectStruct *PObj,
    AttribNumType AttribNum,
    int Data)
```

**PObj**: To add an integer attribute for.

**AttribNum**: Unique ID derived from name of requested attribute.

**Data**: Content of attribute.

**Returns**: void

**Description**: Routine to set an integer attribute for an object.

**See also**: AttrGetObjectIntAttrib, AttrSetObjectPtrAttrib, AttrGetObjectPtrAttrib, AttrSetObjectRealAttrib, AttrGetObjectRealAttrib, AttrSetObjectUVAttrib, AttrGetObjectUVAttrib, AttrSetObjectStrAttrib, AttrGetObjectStrAttrib, AttrSetObjectObjAttrib, AttrGetObjectObjAttrib, AttrGetObjAttrib, AttrSetObjAttrib,
9.2.32 AttrSetObjectObjAttrib (attribut.c:903)

```c
void AttrSetObjectObjAttrib(IPObjectStruct *PObj,
                           const char *Name,
                           IPObjectStruct *Data,
                           int CopyData)
```

- **PObj**: To add an object attribute for.
- **Name**: Name of attribute.
- **Data**: Content of attribute.
- **CopyData**: If TRUE, Data object is duplicated first.

**Returns**: void

**Description**: Routine to set an object attribute for an object.


9.2.33 AttrSetObjectObjAttrib2 (attribut.c:934)

```c
void AttrSetObjectObjAttrib2(IPObjectStruct *PObj,
                           AttrNumType AttribNum,
                           IPObjectStruct *Data,
                           int CopyData)
```

- **PObj**: To add an object attribute for.
- **AttribNum**: Unique ID derived from name of requested attribute.
- **Data**: Content of attribute.
- **CopyData**: If TRUE, Data object is duplicated first.

**Returns**: void

**Description**: Routine to set an object attribute for an object.


9.2.34 AttrSetObjectPtrAttrib (attribut.c:333)

```c
void AttrSetObjectPtrAttrib(IPObjectStruct *PObj,
                           const char *Name,
                           VoidPtr Data)
```

- **PObj**: To add a pointer attribute for.
- **Name**: Name of attribute.
- **Data**: Content of attribute.

**Returns**: void

**Description**: Routine to set a pointer attribute for an object.

9.2.35  AttrSetObjectPtrAttrib2 (attribut.c:364)

```c
void AttrSetObjectPtrAttrib2(IPObjectStruct *PObj,
  AttrNumType AttribNum,
  VoidPtr Data)
```

- **PObj:** To add a pointer attribute for.
- **AttribNum:** Unique ID derived from name of requested attribute.
- **Data:** Content of attribute.
- **Returns:** void

**Description:** Routine to set a pointer attribute for an object.

**See also:** AttrSetObjectIntAttrib, AttrGetObjectIntAttrib, AttrGetObjectPtrAttrib, AttrSetObjectRealAttrib, AttrGetObjectRealAttrib, AttrSetObjectStrAttrib, AttrSetObjectUVAttrib, AttrGetObjectUVAttrib, AttrSetObject ObjAttrib, AttrSetObjAttrib, AttrGetObjectObjAttrib, AttrGetObjAttrib, AttrSetObjectRefPtrAttrib, AttrGetObjectRefPtrAttrib, AttrSetObjectPtrAttrib.

9.2.36  AttrSetObjectRGBColor (attribut.c:89)

```c
void AttrSetObjectRGBColor(IPObjectStruct *PObj, int Red, int Green, int Blue)
```

- **PObj:** Object to set its RGB color.
- **Red, Green, Blue:** Component of color.
- **Returns:** void

**Description:** Routine to set the RGB color of an object.

**See also:** AttrSetObjectColor, AttrGetObjectColor, AttrGetObjectRGBColor, AttrGetObjectWidth, AttrSetObjectWidth, AttrSetObjectRealAttrib, AttrSetRGBColor.

9.2.37  AttrSetObjectRealAttrib (attribut.c:565)

```c
void AttrSetObjectRealAttrib(IPObjectStruct *PObj,
  const char *Name,
  IrtRType Data)
```

- **PObj:** To add a real attribute for.
- **Name:** Name of attribute.
- **Data:** Content of attribute.
- **Returns:** void

**Description:** Routine to set a real attribute for an object.


9.2.38  AttrSetObjectRealAttrib2 (attribut.c:594)

```c
void AttrSetObjectRealAttrib2(IPObjectStruct *PObj,
  AttrNumType AttribNum,
  IrtRType Data)
```

- **PObj:** To add a real attribute for.
- **AttribNum:** Unique ID derived from name of requested attribute.
- **Data:** Content of attribute.
- **Returns:** void

**Description:** Routine to set a real attribute for an object.

9.2.39  AttrSetObjectRefPtrAttrib (attribut.c:450)

void AttrSetObjectRefPtrAttrib(IPObjectStruct *PObj,  
    const char *Name,  
    VoidPtr Data)

PObj: To add a pointer reference attribute for.
Name: Name of attribute.
Data: Content of attribute.

Returns: void

Description: Routine to set a pointer reference attribute for an object.

See also: AttrSetObjectIntAttrib, AttrGetObjectIntAttrib, AttrGetObjectPtrAttrib, AttrSetObjectRealAttrib, AttrGetObjectRealAttrib, AttrSetObjectUVAttrib, AttrGetObjectUVAttrib, AttrSetObjectRefPtrAttrib, AttrGetObjectRefPtrAttrib, AttrSetObjectRefPtrAttrib2,

9.2.40  AttrSetObjectRefPtrAttrib2 (attribut.c:481)

void AttrSetObjectRefPtrAttrib2(IPObjectStruct *PObj,  
    AttribNumType AttribNum,  
    VoidPtr Data)

PObj: To add a pointer reference attribute for.
AttribNum: Unique ID derived from name of requested attribute.
Data: Content of attribute.

Returns: void

Description: Routine to set a pointer reference attribute for an object.

See also: AttrSetObjectIntAttrib, AttrGetObjectIntAttrib, AttrGetObjectPtrAttrib, AttrSetObjectRealAttrib, AttrGetObjectRealAttrib, AttrSetObjectUVAttrib, AttrGetObjectUVAttrib, AttrSetObjectRefPtrAttrib, AttrGetObjectRefPtrAttrib, AttrSetObjectRefPtrAttrib2,

9.2.41  AttrSetObjectStrAttrib (attribut.c:789)

void AttrSetObjectStrAttrib(IPObjectStruct *PObj,  
    const char *Name,  
    const char *Data)

PObj: To add a string attribute for.
Name: Name of attribute.
Data: Content of attribute.

Returns: void

Description: Routine to set a string attribute for an object.

See also: AttrSetObjectIntAttrib, AttrGetObjectIntAttrib, AttrSetObjectPtrAttrib, AttrSetObjectRealAttrib, AttrGetObjectRealAttrib, AttrSetObjectUVAttrib, AttrGetObjectUVAttrib, AttrSetObjectStrAttrib, AttrGetObjectStrAttrib, AttrSetObjectObjAttrib, AttrSetObjAttrib, AttrGetObjectObjAttrib, AttrGetObjectStrAttrib, AttrSetObjectRefPtrAttrib, AttrSetObjectRefPtrAttrib2,
9.2.42 AttrSetObjectStrAttrib2 (attribut.c:818)

void AttrSetObjectStrAttrib2(IPObjectStruct *PObj,
    AttribNumType AttribNum,
    const char *Data)

PObj: To add a string attribute for.
AttribNum: Unique ID derived from name of requested attribute.
Data: Content of attribute.
Returns: void

Description: Routine to set a string attribute for an object.
See also: AttrSetObjectIntAttrib, AttrGetObjectIntAttrib, AttrSetObjectPtrAttrib, AttrGetObjectPtrAttrib,
         AttrSetObjectRealAttrib, AttrGetObjectRealAttrib, AttrSetObjectStrAttrib, AttrGetObjectStrAttrib,
         AttrSetObjectObjAttrib, AttrSetObjAttrib, AttrGetObjectObjAttrib, AttrGetObjAttrib.

9.2.43 AttrSetObjectUVAttrib (attribut.c:677)

void AttrSetObjectUVAttrib(IPObjectStruct *PObj,
    const char *Name,
    IrtRType U,
    IrtRType V)

PObj: To add a real attribute for.
Name: Name of attribute.
U, V: Content of attribute.
Returns: void

Description: Routine to set a UV attribute for an object.
See also: AttrSetObjectIntAttrib, AttrGetObjectIntAttrib, AttrSetObjectPtrAttrib, AttrGetObjectPtrAttrib,
         AttrSetObjectRealAttrib, AttrGetObjectRealAttrib, AttrSetObjectStrAttrib, AttrGetObjectStrAttrib,
         AttrSetObjectObjAttrib, AttrSetObjAttrib, AttrGetObjectObjAttrib, AttrGetObjAttrib.

9.2.44 AttrSetObjectUVAttrib2 (attribut.c:707)

void AttrSetObjectUVAttrib2(IPObjectStruct *PObj,
    AttribNumType AttribNum,
    IrtRType U,
    IrtRType V)

PObj: To add a real attribute for.
AttribNum: Unique ID derived from name of requested attribute.
U, V: Content of attribute.
Returns: void

Description: Routine to set a UV attribute for an object.
See also: AttrSetObjectIntAttrib, AttrGetObjectIntAttrib, AttrSetObjectPtrAttrib, AttrGetObjectPtrAttrib,
         AttrSetObjectRealAttrib, AttrGetObjectRealAttrib, AttrSetObjectStrAttrib, AttrGetObjectStrAttrib,
         AttrSetObjectObjAttrib, AttrSetObjAttrib, AttrGetObjectObjAttrib, AttrGetObjAttrib.

9.2.45 AttrSetObjectWidth (attribut.c:169)

void AttrSetObjectWidth(IPObjectStruct *PObj, IrtRType Width)

PObj: Object to set its width to Width.
Width: New width for PObj.
Returns: void

Description: Routine to set the width of an object.
See also: AttrSetObjectColor, AttrGetObjectColor, AttrSetObjectRGBColor, AttrGetObjectRGBColor, AttrSetObjectObjAttrib,
9.2.46  BspCrvReadFromFile  (bsp\_read.c:34)

```c
CagdCrvStruct *BspCrvReadFromFile(const char *FileName,
    char **ErrStr,
    int *ErrLine)
```

**FileName:** To read the Bspline curve from.

**ErrStr:** Will be initialized if an error has occurred.

**ErrLine:** Line number in file FileName of the error, if occured.

**Returns:** The read curve, or NULL if an error occured.

**Description:** Reads from a file Bspline curve(s). If error is detected in reading the file, ErrStr is set to a string describing the error and Line to the line it occurred in file. If no error is detected *ErrStr = NULL.

9.2.47  BspCrvReadFromFile2  (bsp\_read.c:96)

```c
CagdCrvStruct *BspCrvReadFromFile2(int Handler,
    CagdBType NameWasRead,
    char **ErrStr,
    int *ErrLine)
```

**Handler:** A handler to the open stream.

**NameWasRead:** TRUE if "[CURVE BSPLINE" has been read, FALSE otherwise.

**ErrStr:** Will be initialized if an error has occurred.

**ErrLine:** Line number in file FileName of the error, if occured.

**Returns:** The read curve, or NULL if an error occured.

**Description:** Reads from a file a Bspline curve. If NameWasRead is TRUE, it is assumed prefix "[CURVE BSPLINE" has already been read. This is useful for a global parser which invokes this routine to read from a file several times as a parent controller. For exactly this reason, the given file descriptor is NOT closed in the end. If error is found in reading the file, ErrStr is set to a string describing it and ErrLine to line it occured in file relative to beginning of curve. If no error is detected *ErrStr is set to NULL.

9.2.48  BspCrvWriteToFile  (bsp\_wrt.c:39)

```c
int BspCrvWriteToFile(const CagdCrvStruct *Crvs,
    const char *FileName,
    int Indent,
    const char *Comment,
    char **ErrStr)
```

**Crvs:** To write to file FileName.

**FileName:** Name of file to open so we can write Crvs in.

**Indent:** Primary indentation. All information will be written from the column specified by Indent.

**Comment:** Optional, to describe the geometry.

**ErrStr:** If an error occurs, to describe the error.

**Returns:** TRUE if succesful, FALSE otherwise.

**Description:** Writes Bspline curve(s) list into file. Returns TRUE if succesful, FALSE otherwise. If Comment is NULL, no comment is wrote, if "" only internal comment is written.
9.2.49 **BspCrvWriteToFile2** *(bsp\_wrt.c:83)*

```c
int BspCrvWriteToFile2(const CagdCrvStruct *Crvs, int Handler, int Indent, const char *Comment, char **ErrStr)
```

- **Crvs**: To write to open stream.
- **Handler**: A handler to the open stream.
- **Indent**: Primary indentation. All information will be written from the column specified by Indent.
- **Comment**: Optional, to describe the geometry.
- **ErrStr**: If an error occurs, to describe the error.

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: Writes B spline curve(s) list into file. Returns TRUE if successful, FALSE otherwise. The file descriptor is not closed. If Comment is NULL, no comment is written, if "" only internal comment is written.

9.2.50 **BspSrfReadFromFile** *(bsp\_read.c:268)*

```c
CagdSrfStruct *BspSrfReadFromFile(const char *FileName, char **ErrStr, int *ErrLine)
```

- **FileName**: To read the B spline surface from.
- **ErrStr**: Will be initialized if an error has occurred.
- **ErrLine**: Line number in file FileName of the error, if occurred.

**Returns**: The read surface, or NULL if an error occurred.

**Description**: Reads from a file B-spline surface(s). If error is detected in reading the file, ErrStr is set to a string describing the error and Line to the line it occurred in file. If no error is detected *ErrStr = NULL.

9.2.51 **BspSrfReadFromFile2** *(bsp\_read.c:330)*

```c
CagdSrfStruct *BspSrfReadFromFile2(int Handler, CagdBType NameWasRead, char **ErrStr, int *ErrLine)
```

- **Handler**: A handler to the open stream.
- **NameWasRead**: TRUE if "[SURFACE BSPLINE" has been read, FALSE otherwise.
- **ErrStr**: Will be initialized if an error has occurred.
- **ErrLine**: Line number in file FileName of the error, if occurred.

**Returns**: The read surface, or NULL if an error occurred.

**Description**: Reads from a file a B spline surface. If NameWasRead is TRUE, it is assumed prefix "[SURFACE BSPLINE" has already been read. This is useful for a global parser which invokes this routine to read from a file several times as a parent controller. For exactly this reason, the given file descriptor is NOT closed in the end. If error is found in reading the file, ErrStr is set to a string describing it and ErrLine to line it occurred in file relative to beginning of surface. If no error is detected *ErrStr is set to NULL.
9.2.52  **BspSrfWriteToFile** *(bsp_wrt.c:182)*

```c
int BspSrfWriteToFile(const CagdSrfStruct *Srfs,
    const char *FileName,
    int Indent,
    const char *Comment,
    char **ErrStr)
```

**Srfs**: To write to file FileName.

**FileName**: Name of file to open so we can write Srfs in.

**Indent**: Primary indentation. All information will be written from the column specified by Indent.

**Comment**: Optional, to describe the geometry.

**ErrStr**: If an error occurs, to describe the error.

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: Writes Bspline surface(s) list into file. Returns TRUE if succesful, FALSE otherwise. If Comment is NULL, no comment is written, if "" only internal comment is written.

9.2.53  **BspSrfWriteToFile2** *(bsp_wrt.c:226)*

```c
int BspSrfWriteToFile2(const CagdSrfStruct *Srfs,
    int Handler,
    int Indent,
    const char *Comment,
    char **ErrStr)
```

**Srfs**: To write to open stream.

**Handler**: A handler to the open stream.

**Indent**: Primary indentation. All information will be written from the column specified by Indent.

**Comment**: Optional, to describe the geometry.

**ErrStr**: If an error occurs, to describe the error.

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: Writes Bspline surface(s) list into file. Returns TRUE if succesful, FALSE otherwise. The file descriptor is not closed. If Comment is NULL, no comment is written, if "" only internal comment is written.

9.2.54  **BzrCrvReadFromFile** *(bzr_read.c:34)*

```c
CagdCrvStruct *BzrCrvReadFromFile(const char *FileName,
    char **ErrStr,
    int *ErrLine)
```

**FileName**: To read the Bezier curve from.

**ErrStr**: Will be initialized if an error has occurred.

**ErrLine**: Line number in file FileName of the error, if occurred.

**Returns**: The read curve, or NULL if an error occurred.

**Description**: Reads from a file Bezier curve(s). If error is detected in reading the file, ErrStr is set to a string describing the error and Line to the line it occured in file. If no error is detected *ErrStr = NULL.
9.2.55 **BzrCrvReadFromFile2** (bzr_read.c:96)

```c
CagdCrvStruct *BzrCrvReadFromFile2(int Handler,
    CagdBType NameWasRead,
    char **ErrStr,
    int *ErrLine)
```

**Handler:** A handler to the open stream.

**NameWasRead:** TRUE if "[CURVE BEZIER" has been read, FALSE otherwise.

**ErrStr:** Will be initialized if an error has occurred.

**ErrLine:** Line number in file FileName of the error, if occurred.

**Returns:** The read curve, or NULL if an error occurred.

**Description:** Reads from a file a Bezier curve. If NameWasRead is TRUE, it is assumed prefix "[CURVE BEZIER" has already been read. This is useful for a global parser which invokes this routine to read from a file several times as a parent controller. For exactly this reason, the given file descriptor is NOT closed in the end. If error is found in reading the file, ErrStr is set to a string describing it and ErrLine to line it occured in file relative to beginning of curve. If no error is detected *ErrStr is set to NULL.

9.2.56 **BzrCrvWriteToFile** (bzr_wrt.c:39)

```c
int BzrCrvWriteToFile(const CagdCrvStruct *Crvs,
    const char *FileName,
    int Indent,
    const char *Comment,
    char **ErrStr)
```

**Crvs:** To write to file FileName.

**FileName:** Name of file to open so we can write Crvs in.

**Indent:** Primary indentation. All information will be written from the column specified by Indent.

**Comment:** Optional, to describe the geometry.

**ErrStr:** If an error occurs, to describe the error.

**Returns:** TRUE if succesful, FALSE otherwise.

**Description:** Writes Bezier curve(s) list into file. Returns TRUE if succesful, FALSE otherwise. If Comment is NULL, no comment is written, if "" only internal comment is written.

9.2.57 **BzrCrvWriteToFile2** (bzr_wrt.c:83)

```c
int BzrCrvWriteToFile2(const CagdCrvStruct *Crvs,
    int Handler,
    int Indent,
    const char *Comment,
    char **ErrStr)
```

**Crvs:** To write to open stream.

**Handler:** A handler to the open stream.

**Indent:** Primary indentation. All information will be written from the column specified by Indent.

**Comment:** Optional, to describe the geometry.

**ErrStr:** If an error occurs, to describe the error.

**Returns:** TRUE if succesful, FALSE otherwise.

**Description:** Writes Bezier curve(s) list into file. Returns TRUE if succesful, FALSE otherwise. The file descriptor is not closed. If Comment is NULL, no comment is written, if "" only internal comment is written.
9.2.58  BzrSrfReadFromFile  (bzr_read.c:227)

CagdSrfStruct *BzrSrfReadFromFile(const char *FileName,
        char **ErrStr,
        int *ErrLine)

FileName:  To read the Bezier surface from.
ErrStr: Will be initialized if an error has occurred.
ErrLine:  Line number in file FileName of the error, if occurred.
Returns:  The read surface, or NULL if an error occurred.

Description: Reads from a file Bezier surface(s). If error is detected in reading the file, ErrStr is set to a string
            describing the error and Line to the line it occurred in file. If no error is detected *ErrStr = NULL.

9.2.59  BzrSrfReadFromFile2  (bzr_read.c:289)

CagdSrfStruct *BzrSrfReadFromFile2(int Handler,
        CagdBType NameWasRead,
        char **ErrStr,
        int *ErrLine)

Handler:  A handler to the open stream.
NameWasRead:  TRUE if ”[SURFACE BEZIER” has been read, FALSE otherwise.
ErrStr: Will be initialized if an error has occurred.
ErrLine:  Line number in file FileName of the error, if occurred.
Returns:  The read surface, or NULL if an error occurred.

Description: Reads from a file a Bezier surface. If NameWasRead is TRUE, it is assumed prefix ”[SURFACE
            BEZIER” has already been read. This is useful for a global parser which invokes this routine to read from a file
            several times as a parent controller. For exactly this reason, the given file descriptor is NOT closed in the end.
            If error is found in reading the file, ErrStr is set to a string describing it and ErrLine to line it occurred in file
            relative to beginning of surface. If no error is detected *ErrStr is set to NULL.

9.2.60  BzrSrfWriteToFile  (bzr_wrt.c:170)

int BzrSrfWriteToFile(const CagdSrfStruct *Srfs,
        const char *FileName,
        int Indent,
        const char *Comment,
        char **ErrStr)

Srfs:  To write to file FileName.
FileName:  Name of file so we can write Srfs in.
Indent:  Primary indentation. All information will be written from the column specified by Indent.
Comment:  Optional, to describe the geometry.
ErrStr:  If an error occurs, to describe the error.
Returns:  TRUE if successful, FALSE otherwise.

Description: Writes Bezier surface(s) list into file. Returns TRUE if successful, FALSE otherwise. If Comment
            is NULL, no comment is written, if ”” only internal comment is written.
9.2.61 BzrSrfWriteToFile2 (bzr_wrt.c:214)

```c
int BzrSrfWriteToFile2(const CagdSrfStruct *Srfs,
    int Handler,
    int Indent,
    const char *Comment,
    char **ErrStr)
```

Srfs: To write to open stream.
Handler: A handler to the open stream.
Indent: Primary indentation. All information will be written from the column specified by Indent.
Comment: Optional, to describe the geometry.
ErrStr: If an error occurs, to describe the error.

Returns: TRUE if succesful, FALSE otherwise.

Description: Writes Bezier surface(s) list into file. Returns TRUE if succesful, FALSE otherwise. The file descriptor is not closed. If Comment is NULL, no comment iswritten, if "" only internal comment is written.

9.2.62 CagdCrvReadFromFile (cagdread.c:31)

```c
CagdCrvStruct *CagdCrvReadFromFile(const char *FileName,
    char **ErrStr,
    int *ErrLine)
```

FileName: To read the curve from.
ErrStr: Will be initialized if an error has occured.
ErrLine: Line number in file FileName of the error, if occured.

Returns: The read curve, or NULL if an error occured.

Description: Reads from a file curve(s). If error is detected in reading the file, ErrStr is set to a string describing the error and Line to the line it occured in file. If no error is detected *ErrStr = NULL.

9.2.63 CagdCrvReadFromFile2 (cagdread.c:164)

```c
CagdCrvStruct *CagdCrvReadFromFile2(int Handler, char **ErrStr, int *ErrLine)
```

Handler: A handler to the open stream.
ErrStr: Will be initialized if an error has occured.
ErrLine: Line number in stream of the error, if occured.

Returns: The read curve, or NULL if an error occured.

Description: Reads from a stream a curve. It is assumed prefix "[CURVE" has already been read. This is useful for a global parser which invokes this routine to read from a stream several times as a parent controller. For exactly this reason, the given stream descriptor is NOT closed in the end. If error is found in reading the stream, ErrStr is set to a string describing it and ErrLine to line it occured in stream relative to begining of curve. If no error is detected *ErrStr is set to NULL.

9.2.64 CagdCrvWriteToFile (cagd_wrt.c:40)

```c
int CagdCrvWriteToFile(const CagdCrvStruct *Crvs,
    const char *FileName,
    int Indent,
    const char *Comment,
    char **ErrStr)
```

Crvs: To be saved in file f.
**FileName**: File name where output should go to.

**Indent**: Column in which all printing starts at.

**Comment**: Optional comment to describe the geometry.

**ErrStr**: If failed, ErrStr will be set to describe the problem.

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: Generic routine to write curve(s) to the given file. If Comment is NULL, no comment is printed, if "" only internal comment.

### 9.2.65 CagdCrvWriteToFile2 (cagdwrt.c:78)

```c
int CagdCrvWriteToFile2(const CagdCrvStruct *Crvs,
                        int Handler,
                        int Indent,
                        const char *Comment,
                        char **ErrStr)
```

**Crvs**: To be saved in stream.

**Handler**: A handler to the open stream.

**Indent**: Column in which all printing starts at.

**Comment**: Optional comment to describe the geometry.

**ErrStr**: If failed, ErrStr will be set to describe the problem.

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: Generic routine to write curve(s) to the given stream. If Comment is NULL, no comment is printed, if "" only internal comment.

### 9.2.66 CagdCrvWriteToFile3 (cagdwrt.c:116)

```c
int CagdCrvWriteToFile3(const CagdCrvStruct *Crvs,
                        FILE *f,
                        int Indent,
                        const char *Comment,
                        char **ErrStr)
```

**Crvs**: To be saved in file f.

**f**: File descriptor where output should go to.

**Indent**: Column in which all printing starts at.

**Comment**: Optional comment to describe the geometry.

**ErrStr**: If failed, ErrStr will be set to describe the problem.

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: Generic routine to write curve(s) to the given file. If Comment is NULL, no comment is printed, if "" only internal comment.

### 9.2.67 CagdSrfReadFromFile (cagdread.c:96)

```c
CagdSrfStruct *CagdSrfReadFromFile(const char *FileName,
                                     char **ErrStr,
                                     int *ErrLine)
```

**FileName**: To read the surface from.

**ErrStr**: Will be initialized if an error has occurred.

**ErrLine**: Line number in file FileName of the error, if occurred.

**Returns**: The read surface, or NULL if an error occurred.

**Description**: Reads from a file surface(s). If error is detected in reading the file, ErrStr is set to a string describing the error and Line to the line it occurred in file. If no error is detected *ErrStr = NULL.
9.2.68 CagdSrfReadFromFile2 (cagdread.c:209)

CagdSrfStruct *CagdSrfReadFromFile2(int Handler, char **ErrStr, int *ErrLine)

**Handler:** A handler to the open stream.
**ErrStr:** Will be initialized if an error has occurred.
**ErrLine:** Line number in stream of the error, if occurred.
**Returns:** The read surface, or NULL if an error occurred.

**Description:** Reads from a stream a surface. It is assumed prefix "[SURFACE" has already been read. This is useful for a global parser which invokes this routine to read from a stream several times as a parent controller. For exactly this reason, the given stream descriptor is NOT closed in the end. If error is found in reading the stream, ErrStr is set to a string describing it and ErrLine to line it occurred in stream relative to beginning of surface. If no error is detected *ErrStr is set to NULL.

9.2.69 CagdSrfWriteToFile (cagd_wrt.c:148)

int CagdSrfWriteToFile(const CagdSrfStruct *Srfs, const char *FileName, int Indent, const char *Comment, char **ErrStr)

**Srfs:** To be saved in file.
**FileName:** File name where output should go to.
**Indent:** Column in which all printing starts at.
**Comment:** Optional comment to describe the geometry.
**ErrStr:** If failed, ErrStr will be set to describe the problem.
**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Generic routine to write surface(s) to the given file. If Comment is NULL, no comment is printed, if "" only internal comment.

9.2.70 CagdSrfWriteToFile2 (cagd_wrt.c:186)

int CagdSrfWriteToFile2(const CagdSrfStruct *Srfs, int Handler, int Indent, const char *Comment, char **ErrStr)

**Srfs:** To be saved in stream.
**Handler:** A handler to the open stream.
**Indent:** Column in which all printing starts at.
**Comment:** Optional comment to describe the geometry.
**ErrStr:** If failed, ErrStr will be set to describe the problem.
**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Generic routine to write surface(s) to the given stream. If Comment is NULL, no comment is printed, if "" only internal comment.
9.2.71  CagdSrfWriteToFile3 (cagd_wrt.c:224)

```c
int CagdSrfWriteToFile3(const CagdSrfStruct *Srfs,
    FILE *f,
    int Indent,
    const char *Comment,
    char **ErrStr)
```

**Srfs**: To be saved in file f.

**f**: File descriptor where output should go to.

**Indent**: Column in which all printing starts at.

**Comment**: Optional comment to describe the geometry.

**ErrStr**: If failed, ErrStr will be set to describe the problem.

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: Generic routine to write surface(s) to the given file. If Comment is NULL, no comment is printed, if "" only internal comment.

9.2.72  IPAllocObject (allocate.c:421)

```c
IPObjectStruct *IPAllocObject(const char *Name,
    IPObjStructType ObjType,
    IPObjectStruct *Pnext)
```

**Name**: Name to assign to the newly allocated object.

**ObjType**: Object type of newly allocated object.

**Pnext**: Reference to initialize the Pnext slot of the allocated object.

**Returns**: A new allocated object structure.

**Description**: Allocates one Object Structure.

9.2.73  IP AllocPolygon (allocate.c:321)

```c
IPPolygonStruct *IPAllocPolygon(IrtBType Tags,
    IPVertexStruct *V,
    IPPolygonStruct *Pnext)
```

**Tags**: Tags to initialize the Tags slot of allocated polygon.

**V**: Reference to initialize the PVertex slot of allocated polygon.

**Pnext**: Reference to initialize the Pnext slot of the allocated polygon.

**Returns**: A new allocated polygon structure.

**Description**: Allocates one Polygon Structure.

9.2.74  IPAllocVertex (allocate.c:293)

```c
IPVertexStruct *IPAllocVertex(IrtBType Tags,
    IPPolygonStruct *PAdj,
    IPVertexStruct *Pnext)
```

**Tags**: Tags to initialize the Tags slot of allocated vertex.

**PAdj**: PAdj to initialize the PAdj slot of allocated vertex.

**Pnext**: Reference to initialize the Pnext slot of the allocated vertex.

**Returns**: A new allocated vertex structure.

**Description**: Allocates one Vertex Structure.
### 9.2.75 IPAllocVertex2 (allocate.c:236)

```
IPVertexStruct *IPAllocVertex2(IPVertexStruct *Pnext)
```

**Pnext:** Reference to initialize the Pnext slot of the allocated vertex.

**Returns:** A new allocated vertex structure.

**Description:** Allocates one Vertex Structure.

### 9.2.76 IPAppendListObjects (linklist.c:480)

```
IPObjectStruct *IPAppendListObjects(IPObjectStruct *ListObj1, 
IPObjectStruct *ListObj2)
```

**ListObj1, ListObj2:** The two list objects to append.

**Returns:** A combined list.

**Description:** Appends two lists.

**See also:** IPAppendObjLists, IPObjLnkListToListObject,

### 9.2.77 IPAppendObjLists (linklist.c:447)

```
IPObjectStruct *IPAppendObjLists(IPObjectStruct *OList1, 
IPObjectStruct *OList2)
```

**OList1, OList2:** Two lists to append.

**Returns:** Appended list.

**Description:** Appends two object lists together.

**See also:** IPAppendListObjects, IPObjLnkListToListObject,

### 9.2.78 IPAppendPolyLists (linklist.c:369)

```
IPPolygonStruct *IPAppendPolyLists(IPPolygonStruct *PList1, 
IPPolygonStruct *PList2)
```

**PList1, PList2:** Two lists to append.

**Returns:** Appended list.

**Description:** Appends two poly lists together.

### 9.2.79 IPAppendVrtxLists (linklist.c:295)

```
IPVertexStruct *IPAppendVrtxLists(IPVertexStruct *VList1, 
IPVertexStruct *VList2)
```

**VList1, VList2:** Two lists to append.

**Returns:** Appended list.

**Description:** Appends two vertex lists together.
9.2.80  IPCagdPlgns2IritPlgns (ip.cnvrt.c:139)

IPPolygonStruct *IPCagdPlgns2IritPlgns(CagdPolygonStruct *Polys,
            CagdBType ComputeUV)

    Polys: Polygons in cagd library format to convert.
    ComputeUV: Do we have UV values as well, at the vertices?
    Returns: Same polygons in IRIT format.
    Description: Routine to convert a cagd polygon (triangle) into irit polygon. Old cagd polygons are freed!
    See also: IPCagdPlns2IritPlns,

9.2.81  IPCagdPllns2IritPllns (ip.cnvrt.c:74)

IPPolygonStruct *IPCagdPllns2IritPllns(CagdPolylineStruct *Polys)

    Polys: Polygons in cagd_lib form to be converted in IRIT form.
    Returns: Same polylines in IRIT format.
    Description: Routine to convert a cagd polyline to irit polyline. Old cagd polylines are freed!
    See also: IPCagdPlgns2IritPlgns, CagdCnvrtPolyline2LinBspCrv,

9.2.82  IPCloseStream  (iritprs1.c:425)

void IPCloseStream(int Handler, int Free)

    Handler: A handler to the open stream.
    Free: If TRUE, release content.
    Returns: void
    Description: Close a data file for read/write.

9.2.83  IPClosedPolysToOpen (ip.cnvrt.c:1999)

void IPClosedPolysToOpen(IPPolygonStruct *Pls)

    Pls: Polygons to process, in place.
    Returns: void
    Description: Forces the given list of polygons to have open list of vertices
    See also: IPOpenPolysToClosed, GMVrtxListToCircOrLin,

9.2.84  IPCnvDataToIrit  (cnv2irit.c:120)

void IPCnvDataToIrit(const IPObj ectStruct *PObjects)

    PObjects: To convert to .irt style.
    Returns: void
    Description: Converts the given Objects to .irt style. Output goes to the function IPCnvPrintFunc which echos
    the lines, one at a time.
    See also: IPCnvSetPrintFunc, IPCnvSetDelimitChar, IPCnvDataToIritOneObject,
9.2.85 IPCnvDataToIritAttribs (cnv2irit.c:565)

void IPCnvDataToIritAttribs(const char *Indent,
      const char *ObjName,
      const IPAttributeStruct *Attr)

  **Indent:** Level of indentation, as white spaces string.
  **ObjName:** Name of object these attributes are for.
  **Attr:** Attributes to convert to irit scripting format.

  **Returns:** void

  **Description:** Converts attributes PObject to .irt style
  **See also:** IPCnvDataToIrit, IPCnvSetPrintFunc.

9.2.86 IPCnvDataToIritOneObject (cnv2irit.c:316)

void IPCnvDataToIritOneObject(const char *Indent,
      const IPObjectStruct *PObj,
      int Level)

  **Indent:** Level of indentation, as white spaces string
  **PObj:** Object to convert to .irt style.
  **Level:** Nesting level of this object.

  **Returns:** void

  **Description:** Converts one object PObject to .irt style
  **See also:** IPCnvDataToIrit, IPCnvSetPrintFunc.

9.2.87 IPCnvFindAdjacentEdge (cnv2irit.c:1651)

IPVertexStruct *IPCnvFindAdjacentEdge(const IPPolyVrtxIdxStruct *PVIdx,
                                int FirstVertexIndex,
                                int SecondVertexIndex)

  **PVIdx:** A mesh to search the adjacent edge in.
  **FirstVertexIndex, SecondVertexIndex:** The edge to search its adjacent edge.

  **Returns:** Pointer to the adjacent edge, or NULL if error.

  **Description:** Find out the adjacent edge of the given edge defined by vertices (FirstVertexIndex, SecondVertexIndex). The edge in the found polygon is assumed to be revised as (SecondVertexIndex, FirstVertexIndex).
  **See also:** IPCnvFindAdjacentPoly, IPCnvPolyVrtxNeighbors, IPCnvIsVertexBoundary, IPCnvPolyToPolyVrtx-IdxStruct,

9.2.88 IPCnvFindAdjacentPoly (cnv2irit.c:1711)

IPPolygonStruct *IPCnvFindAdjacentPoly(const IPPolyVrtxIdxStruct *PVIdx,
                                const IPVertexStruct *V,
                                const IPVertexStruct *VNext)

  **PVIdx:** Data structure of original mesh.
  **V, VNext:** The edge is defined from V to VNext.

  **Returns:** Pointer to the adjacent polygon.

  **Description:** Find out the adjacent polygon that use the edge (V, V -> Pnext). The edge in this polygon will be (V -> Pnext, V).
  **See also:** IPCnvFindAdjacentEdge, IPCnvPolyVrtxNeighbors, IPCnvIsVertexBoundary, IPCnvPolyToPolyVrtx-IdxStruct,
9.2.89  **IPCnvIsVertexBoundary**  (cnv2irit.c:1589)

```c
int IPCnvIsVertexBoundary(const IPPolyVrtxIdxStruct *PVIdx, int VertexIndex)
```

**PVIdx**: A mesh to search the adjacent edge in.

**VertexIndex**: The vertex index to examine if a boundary vertex.

**Returns**: TRUE if examined vertex is a boundary vertex, FALSE otherwise.

**Description**: Find out if the given vertex is a boundary vertex. A boundary vertex is a vertex that does not have polygons completely around it, forming a closed ring.

**See also**: IPCnvFindAdjacentPoly, IPCnvFindAdjacentEdge, IPCnvPolyVrtxNeighbors, , IPCnvPolyToPolyVrtxIdxStruct,

9.2.90  **IPCnvPolyToPolyVrtxIdxStruct**  (cnv2irit.c:1769)

```c
IPPolyVrtxIdxStruct *IPCnvPolyToPolyVrtxIdxStruct(const IPObjectStruct *PObj,
                               int CalcPPolys,
                               int AttribMask)
```

**PObj**: A polygonal mesh to convert to PolyIdx structure.

**CalcPPolys**: TRUE if a polygon pointer list is to be calculated, FALSE otherwise.

**AttribMask**: Sets what attributes to consider when comparing for identical vertices - Bit 0 - normals should be identical in identical vertices. Bit 1 - uvvals should be identical in identical vertices. Bit 2 - rgb should be identical in identical vertices.

**Returns**: The polygonal mesh as PolyIdx struct.

**Description**: Process a given polygonal model into a vertex list with each polygon having indices into the vertex list. All list are zero based.

**See also**: IPCnvFindAdjacentEdge, IPCnvFindAdjacentPoly, IPCnvPolyVrtxNeighbors, , IPCnvIsVertexBoundary,

9.2.91  **IPCnvPolyVrtxNeighbors**  (cnv2irit.c:1439)

```c
int *IPCnvPolyVrtxNeighbors(IPPolyVrtxIdxStruct *PVIdx, int VIdx, int Ring)
```

**PVIdx**: The input mesh to look at. Assumed that was constructed using IPCnvPolyToPolyVrtxIdxStruct with CalcPPolys TRUE.

**VIdx**: The index of the source vertex, zero based.

**Ring**: maximal topological distance from VIdx.

**Returns**: A -1 terminated vector holding the indices of neighboring vertices to VIdx, with topological distance of up to Ring.

**Description**: Given a vertex and a mesh in IPPolyVrtxIdxStruct format, find neighbors upto the prescribed maximal distance/ring.

**See also**: IPCnvPolyToPolyVrtxIdxStruct, IPCnvFindAdjacentEdge, , IPCnvFindAdjacentEdge, IPCnvIsVertexBoundary,

9.2.92  **IPCnvReal2Str**  (iritprs2.c:718)

```c
const char *IPCnvReal2Str(IrtRType R)
```

**R**: A real number to convert to a string.

**Returns**: A string representing R allocated statically.

**Description**: Convert a real number into a string. The routine maintains six different buffers simultaneously so up to six consecutive calls can be issued from same printf and still have valid strings.

**See also**: IPSetPrintFunc, IPSetFloatFormat, IPPrintFunc,
9.2.93  **IPCnvSetCompactList**  (cnv2irit.c:227)

```c
int IPCnvSetCompactList(int CompactList)
```

**Description:** Sets the way list objects are dumped - TRUE for a single list, FALSE for separated objects that are grouped into a list at the end.

**See also:** IPCnvDataToIrit,

**CompactList:** TRUE for compact list, FALSE for separate entities.

**Returns:** Old state of compact list dump.

9.2.94  **IPCnvSetDelimitChar**  (cnv2irit.c:200)

```c
char IPCnvSetDelimitChar(char Delimit)
```

**Description:** Sets the delimiting character. Typically ';' but can be ':' as well.

**See also:** IPCnvDataToIrit,

**Delimit:** The character to consider as an expression delimiting char.

**Returns:** Old delimiting character.

9.2.95  **IPCnvSetDumpAssignName**  (cnv2irit.c:253)

```c
int IPCnvSetDumpAssignName(int DumpAssignName)
```

**Description:** If TRUE objects are dumped with an assignment to their own name. Otherwise, just the geometry is dumped with no assignment.

**See also:** IPCnvDataToIrit,

**DumpAssignName:** TRUE to dump assignment, FALSE for no assignment.

**Returns:** Old state of dump assignments.

9.2.96  **IPCnvSetLeastSquaresFit**  (cnv2irit.c:173)

```c
int IPCnvSetLeastSquaresFit(int MinLenFit, int Percent, IrtRType MaxError)
```

**Description:** Fits using least squares, a new curve to the input curve with only Percent percents control points. A curve with be least squares fitted if it has more than MinLenFit control points.

**See also:** IPCnvDataToIrit,

**MinLenFit:** Minimum number of control point to attempt a fit.

**Percent:** Percent of number of control points to fit to.

**MaxError:** maximum allowed error (in maximum norm).

**Returns:** Old percent value.

9.2.97  **IPCnvSetPrintFunc**  (cnv2irit.c:143)

```c
IPPrintFuncType IPCnvSetPrintFunc(IPPrintFuncType CnvPrintFunc)
```

**Description:** Sets the printing function to call if needs to redirect printing of dat to irt conversions. Called (indirectly) by IPCnvDataToIrit.

**See also:** IPCnvDataToIrit,
9.2.98  IP coerce Bezier to Bspline (coerce.c:229)

IPobjectStruct *IPCoerceBezierToBspline(const IPobjectStruct *PObj)

PObj: Bezier geometry to convert to Bspline geometry.
Returns: Same geometry as PObj but as Bspline.
Description: Converts a Bezier freeform into a Bspline freeform.

9.2.99  IP coerce Bezier to Power (coerce.c:151)

IPobjectStruct *IPCoerceBezierToPower(const IPobjectStruct *PObj)

PObj: Bezier geometry to convert to power geometry.
Returns: Same geometry as PObj but in power basis.
Description: Converts a Bezier freeform into a power freeform.

9.2.100  IP coerce Bspline to Bezier (coerce.c:280)

IPobjectStruct *IPCoerceBsplineToBezier(const IPobjectStruct *PObj)

PObj: A Bspline geometry to convert to a Bezier geometry.
Returns: A Bezier geometry representing same geometry as PObj.
Description: Convert a Bspline freeform into list of Bezier freeforms.

9.2.101  IP coerce Common Space (coerce.c:82)

CagdPointType IPCoerceCommonSpace(IPObjectStruct *PtObjList,
CagdPointType Type)

PtObjList: List of points.
Type: Point type that we must span its space as well.
Returns: Point type that spans the space of point type Type as well as all points in PtObjList.
Description: Given a set of points, returns the list’s common denominator that spans the space of all the points, taking into account type Type.

9.2.102  IP coerce Gregory to Bezier (coerce.c:124)

IPObjectStruct *IPCoerceGregoryToBezier(const IPObjectStruct *PObj)

PObj: Gregory geometry to convert to Bezier geometry.
Returns: Same geometry as PObj but in Gregory basis.
Description: Converts a Gregory freeform into a Bezier freeform.
9.2.103  IPCoerceObjectPtTypeTo (coerce.c:583)

IPObjectStruct *IPCoerceObjectPtTypeTo(const IPObjectStruct *PObj, int NewType)

PObj: Object to coerce.
NewType: New type which can be object type like IP_OBJ_VECTOR or point type like E2.
Returns: Newly coerced object.

Description: Coerces an object to a new object. Mostly about point types coercions. Points, vectors, control points and planes can always be coerced between themselves using this routine by specifying the new object type desired such as IP_OBJ_PLANE or control point type like CAGD_PT_E4_TYPE. Control points of curves and surfaces may be coerced to a new type by prescribing the needed point type as NewType, such as CAGD_PT_P2_TYPE.
See also: IPCoerceObjectTo,

9.2.104  IPCoerceObjectTo (coerce.c:776)

IPObjectStruct *IPCoerceObjectTo(const IPObjectStruct *PObj, int NewType)

PObj: Object to coerce.
NewType: New type for PObj.
Returns: The newly coerced object.

Description: Coerce an object to a new object.
See also: IPCoerceObjectPtTypeTo,

9.2.105  IPCoercePowerToBezier (coerce.c:190)

IPObjectStruct *IPCoercePowerToBezier(const IPObjectStruct *PObj)

PObj: Power geometry to convert to Bezier geometry.
Returns: Same geometry as PObj but in Bezier form.
Description: Converts a power freeform into a Bezier freeform.

9.2.106  IPCoercePtsListTo (coerce.c:534)

CagdPointType IPCoercePtsListTo(IPObjectStruct *PtObjList, CagdPointType Type)

PtObjList: Coerce points/vectors/control points in this list to Type.
Type: A minimum space type to coerce to in PtObjList.
Returns: The coercion type actually took place with in PtObjList.
Description: Coerces a list of objects to Type.

9.2.107  IPCoerceTrimmedSrfToTrimmedBezier (coerce.c:413)

IPObjectStruct *IPCoerceTrimmedSrfToTrimmedBezier(const IPObjectStruct *PObj)

PObj: A Bspline geometry to convert to a Bezier geometry.
Returns: A Bezier geometry representing same geometry as PObj.
Description: Convert a Bspline freeform into list of Bezier freeforms.
9.2.108  **IPCoerceTrimmedSrfToUnTrimmedBezier**  (coerce.c:469)

```c
IPObjectStruct *IPCoerceTrimmedSrfToUnTrimmedBezier(const IPObjectStruct *PObj, int ComposeE3)
```

PObj: A B-spline geometry to convert to a Bezier geometry.
ComposeE3: TRUE to compose the tiles into TSrf, FALSE to return the surface tiles in the parametric domain of TSrf.
Returns: A Bezier geometry representing same geometry as PObj.
Description: Convert a trimmed B-spline freeform into untrimmed tensor product Bezier freeforms.

9.2.109  **IPConcatFreeForm**  (iritprs1.c:2759)

```c
IPObjectStruct *IPConcatFreeForm(IPFreeFormStruct *FreeForms)
```

FreeForms: Freeform geometry to process.
Returns: concatenated linked list.
Description: Concatenate all freeform objects in FreeForms into a single list.

9.2.110  **IPConvertFreeForm**  (ffcnvrt.c:1264)

```c
IPObjectStruct *IPConvertFreeForm(IPObjectStruct *PObj, IPFreeformConvStateStruct *State)
```

PObj: A Crv/Srf/Trimmed Srf/Trivariate freeform geometry.
State: The way the freeform geometry should be converted.
Returns: Processed freeform geometry.
Description: Routine to convert a single freeform geometry to polylines/polygons, in place.
See also: FFCnvrtSrfsToBicubicBezier,

9.2.111  **IPCopyObject**  (allocate.c:2272)

```c
IPObjectStruct *IPCopyObject(IPObjectStruct *Dest, const IPObjectStruct *Src, int CopyAll)
```

Dest: Destination object, possibly NULL.
Src: Source object.
CopyAll: Do we want a complete identical copy?
Returns: Duplicate of Src, same as Dest if Dest != NULL.
Description: Routine to create a whole new copy of an object Src into Dest. If Dest is NULL, new object is allocated, otherwise Dest itself is updated to hold the new copy. If CopyAll then all the record is copied, otherwise, only its invariant elements are been copied (i.e. no Name/Pnext copying).
See also: IPSetCopyObjectReferenceCount, IPCopyObjectAuxInfo,

9.2.112  **IPCopyObjectAuxInfo**  (allocate.c:2230)

```c
void IPCopyObjectAuxInfo(IPObjectStruct *Dest, const IPObjectStruct *Src)
```

Dest: Destination of copy process.
Src: Source of copy process.
Returns: void
Description: Copy to the destination object all object auxiliary information such as attributes, dependencies, and bbox.
See also: IPCopyObject,
9.2.113  IPCopyObjectGeomData (allocate.c:2317)

IPObjectStruct *IPCopyObjectGeomData(IPObjectStruct *Dest,  
    const IPObjectStruct *Src,  
    int CopyAll)

Dest: Destination object.
Src: Source object.
CopyAll: Do we want a complete identical copy (for son objects)?
Returns: Reference to Dest.
Description: Routine to copy the geometry in Src object to Dest.
See also: IPSetCopyObjectReferenceCount, IPCopyObjectAuxInfo, IPCopyObject,

9.2.114  IPCopyObjectList (allocate.c:2436)

IPObjectStruct *IPCopyObjectList(const IPObjectStruct *PObj, int CopyAll)

PObj: Source objects.
CopyAll: Do we want a complete identical copy?
Returns: Duplicated list of PObj.
Description: Routine to create a new copy of an object list.

9.2.115  IPCopyPolygon (allocate.c:2471)

IPPolygonStruct *IPCopyPolygon(const IPPolygonStruct *Src)

Src: A polygon to copy.
Returns: Duplicated polygon.
Description: Routine to create a new copy of one polygon.
See also: IPCopyPolygonList,

9.2.116  IPCopyPolygonList (allocate.c:2508)

IPPolygonStruct *IPCopyPolygonList(const IPPolygonStruct *Src)

Src: A polygon list to copy.
Returns: Duplicated list of polygons.
Description: Routine to create a new copy of an object polygon list.
See also: IPCopyPolygon,

9.2.117  IPCopyVertex (allocate.c:2544)

IPVertexStruct *IPCopyVertex(const IPVertexStruct *Src)

Src: A vertex to copy.
Returns: Duplicated vertex.
Description: Routine to create a new copy of a polygon vertex.
See also: IPCopyVertexList,
9.2.118  IPCopyVertexList (allocate.c:2576)

IPVertexStruct *IPCopyVertexList(const IPVertexStruct *Src)

*Src: A vertex list to copy.

Returns: Duplicated list of vertices.

Description: Routine to create a new copy of a polygon vertices list.
See also: IPCopyVertex,

9.2.119  IPCurve2CtlPoly (ip_convrt.c:403)

IPPolygonStruct *IPCurve2CtlPoly(const CagdCrvStruct *Crv)

*Crv: To extract its control polygon as a polyline.

Returns: A polyline representing Crv’s control polygon.

Description: Routine to convert a single curve’s control polygon into a polyline.

9.2.120  IPCurve2Polylines (ip_convrt.c:279)

IPPolygonStruct *IPCurve2Polylines(const CagdCrvStruct *Crv,
  CagdRType TolSamples,
  SymbCrvApproxMethodType Method)

*Crv: To approximate as a polyline.

TolSamples: Tolerance of approximation error (Method = 2) or Number of samples to compute on polyline (Method = 0, 1).

Method: 0 - TolSamples are set uniformly in parametric space, 1 - TolSamples are set optimally, considering the curve’s curvature. 2 - TolSamples sets the maximum error allowed between the piecewise linear approximation and original curve.

Returns: A polyline approximating Crv. Can be more than one polyline if Crv is C0 discont.

Description: Routine to convert one curve into a polyline with TolSamples samples/tolerance.
See also: BspCrv2Polyline, BzrCrv2Polyline, SymbCrv2Polyline,

9.2.121  IPCurvesToCubicBzrCrvs (ip_convrt.c:1573)

CagdCrvStruct *IPCurvesToCubicBzrCrvs(CagdCrvStruct *Crvs,
  IPPolygonStruct **CtlPolys,
  CagdBType DrawCurve,
  CagdBType DrawCtlPoly,
  CagdRType MaxArcLen)

*Crvs: To approximate as cubic Bezier curves.

CtlPolys: If we want control polygons as well (DrawCtlPoly == TRUE) they will be placed herein.

DrawCurve: Do we want to draw the curves?

DrawCtlPoly: Do we want to draw the control polygons?

MaxArcLen: Tolerance for cubic Bezier approximation. See function SymbApproxCrvAsBzrCubics.

Returns: The cubic Bezier approximation, or NULL if DrawCurve is FALSE.

Description: Approximates an arbitrary list of curves into cubic Beziers curves.
9.2.122  IPDescribeError (prsr_err.c:131)

    const char *IPDescribeError(IPFatalErrorType ErrorNum)

    ErrorNum: Type of the error that was raised.
    Returns: A string describing the error type.

    Description: Returns a string describing a the given error. Errors can be raised by any member of this user
    library as well as other users. Raised error will cause an invocation of UserFatalError function which decides how
    to handle this error. UserFatalError can for example, invoke this routine with the error type, print the appropriate
    message and quit the program.

9.2.123  IPEvalFreeForms (iritprs1.c:1514)

    IObjectStruct *IPEvalFreeForms(IObjectStruct *PObj)

    PObj: Object(s) to freeform evaluate, in place.
    Returns: Evaluated hierarchy, in place.

    Description: Evaluates the freeforms in the given hierarchy - usually to convert into a polygonal approximation.
    This function invokes IPProcessFreeForm for the evaluation of the individual freeform entities.
    See also: IPProcessFreeForm,

9.2.124  IPFatalError (prsr_ftl.c:54)

    void IPFatalError(IPFatalErrorType ErrID)

    ErrID: Error type that was raised.
    Returns: void

    Description: Trap Prsr_lib errors right here. Provides a default error handler for the prsr library. Gets an error
    description using PrsrDescribeError, prints it and exit the program using exit.

9.2.125  IPFlattenForrest (iritprs1.c:1582)

    IObjectStruct *IPFlattenForrest(IObjectStruct *PObjList)

    PObjList: List of object(s) to flatten out.
    Returns: Flattened hierarchy.

    Description: Flattens out a list of trees' hierarchy (a forrest) of objects into a linear list, in place.

9.2.126  IPFlattenInvisibleObjects (iritprs1.c:1301)

    int IPFlattenInvisibleObjects(int FlattenInvisib)

    FlattenInvisib: If TRUE, list objects will be flattened out to a long linear list. If FALSE, read object will be
    unchanged.
    Returns: Old value of flatten state.

    Description: Controls the hierarchy flattening of a read object.
9.2.127  IPFlattenTree (iritprs1.c:1380)

IPObjectStruct *IPFlattenTree(IPObjectStruct *PObj)

PObj: Object(s) to flatten out, in place.
Returns: Flattened hierarchy.
Description: Flattens out a tree hierarchy of objects into a linear list, in place. As a side effect freeform entities
are processed by IPProcessFreeForm.
See also: IPProcessFreeForm, IPEvalFreeForms,

9.2.128  IPForEachObj2 (linklist.c:941)

IPObjectStruct *IPForEachObj2(IPObjectStruct *OList,
                                 IPForEachObjCallBack CallBack,
                                 void *Param)

OList: The objects list to travel. OList might be destroyed during the process, therefore it shouldn’t be used
again. The returned list should be used instead.
CallBack: The function to use with each object of OList.
Param: Parameter which will be given to CallBack with every object.
Returns: The new list or NULL if the list is empty.
Description: Travel on OList (using Pnext) and use the given CallBack with every object. Each given object in
OList is replaced with the returned value of CallBack. If CallBack returns NULL, the object is removed from OList
(in that case, it’s CallBack’s responsibility to free the object’s memory).

9.2.129  IPForEachPoly (linklist.c:859)

void IPForEachPoly(IPObjectStruct *OList, void (*CallBack) (IPPolygonStruct *))

OList: Pointer to the Irit objects’ linked list.
CallBack: Callback function.
Returns: void
Description: Iterates on Irit object list and calls CallBack function on every polygon found, passing it a pointer
to the polygon object.

9.2.130  IPForEachPoly2 (linklist.c:993)

IPPolygonStruct *IPForEachPoly2(IPPolygonStruct *PlList,
                                 IPForEachPolyCallBack CallBack,
                                 void *Param)

PlList: The polygons list to travel. PlList might be destroyed during the process, therefore it shouldn’t be
used again. The returned list should be used instead.
CallBack: The function to use with each polygon of PlList
Param: Parameter which will be given to CallBack with every polygon.
Returns: The new list or NULL if the list is empty.
Description: Travel on PlList (using Pnext) and use the given CallBack with every polygon. Each given polygon
in PlList is replaced with the returned value of CallBack. If CallBack returns NULL, the polygon is removed from
PlList (in that case, it’s CallBack’s responsibility to free the polygon’s memory).
9.2.131 IPForEachVertex (linklist.c:895)

```c
void IPForEachVertex(IPObjectStruct *OList,
    void (*CallBack) (IPVertexStruct *))
```

**OList:** Pointer to Irit objects’ linked list.

**CallBack:** Callback function.

**Returns:** void

**Description:** Iterates on Irit object list and for each vertex in every polygon calls CallBack function passing it a pointer to the vertex object.

9.2.132 IPForEachVertex2 (linklist.c:1044)

```c
IPVertexStruct *IPForEachVertex2(IPVertexStruct *VList,
    IPForEachVertexCallBack CallBack,
    void *Param)
```

**VList:** The vertex list to travel. VList might be destroyed during the process, therefore it shouldn’t be used again. The returned list should be used instead.

**CallBack:** The function to use with each vertex of VList

**Param:** Parameter which will be given to CallBack with every polygon.

**Returns:** The new list or NULL if the list is empty.

**Description:** Travel on VList (using Pnext) and use the given CallBack with every vertex. Each given vertex in VList is replaced with the returned value of CallBack. If CallBack returns NULL, the vertex is removed from VList (in that case, it’s CallBack’s responsibility to free the vertex’s memory.

9.2.133 IPFreeForm2CubicBzr (ff_cnvrt.c:595)

```c
IPObjectStruct *IPFreeForm2CubicBzr(IPFreeFormStruct *FreeForms,
    int Talkative,
    int DrawGeom,
    int DrawMesh,
    int NumOfIsolines[3],
    CagdRType TolSamples,
    SymbCrvApproxMethodType Method)
```

**FreeForms:** Crvs/SrfS/Trimmed SrfS/Trivariates read from a file by the irit parser.

**Talkative:** Do we want some more information printed.

**DrawGeom:** Do we want to draw the geometry?

**DrawMesh:** Do we want to draw its control mesh?

**NumOfIsolines:** Number of isocurves in each parametric direction.

**TolSamples:** Tolerance of approximation error (Method = 2) or Number of samples to compute on polyline (Method = 0, 1).

**Method:** 0 - TolSamples are set uniformly in parametric space, 1 - TolSamples are set optimally, considering the curve’s curvature. 2 - TolSamples sets the maximum error allowed between the piecewise linear approximation and original curve.

**Returns:** Polylines representing the trivariate and its control mesh.

**Description:** Converts a whole set of geometry to cubic bezier curves, in place.
9.2.134  IPFreeForm2Polygons (ff.cnvrt.c:883)

IPObjectStruct *IPFreeForm2Polygons(IPObjectStruct *FreeForms,
  int Talkative,
  int FourPerFlat,
  IrtRType FineNess,
  int ComputeUV,
  int ComputeNrml,
  int Optimal,
  int BBoxGrid)

**FreeForms**: Crvs/Srfs/Trimmed Srfs/Trivariates read from a file by the irit parser.
**Talkative**: Do we want some more information printed?
**FourPerFlat**: See IPSurface2Polygons.
**FineNess**: See IPSurface2Polygons.
**ComputeUV**: See IPSurface2Polygons.
**ComputeNrml**: See IPSurface2Polygons.
**Optimal**: See IPSurface2Polygons.
**BBoxGrid**: Do we want bounding box values and grid estimation.

**Returns**: Polygon/line(s) representing the geometry and its control mesh.

**Description**: Converts a whole set of geometry to polygons, in place.

9.2.135  IPFreeForm2Polylines (ff.cnvrt.c:302)

IPObjectStruct *IPFreeForm2Polylines(IPObjectStruct *FreeForms,
  int Talkative,
  int DrawGeom,
  int DrawMesh,
  int NumOfIsolines[3],
  CagdRType TolSamples,
  SymbCrvApproxMethodType Method)

**FreeForms**: Crvs/Srfs/Trimmed Srfs/Trivariates read from a file by the irit parser.
**Talkative**: Do we want some more information printed.
**DrawGeom**: Do we want to draw the geometry?
**DrawMesh**: Do we want to draw its control mesh?
**NumOfIsolines**: Number of isocurves in each parametric direction.
**TolSamples**: Tolerance of approximation error (Method = 2) or Number of samples to compute on polyline (Method = 0, 1).
**Method**: 0 - TolSamples are set uniformly in parametric space, 1 - TolSamples are set optimally, considering the curve’s curvature. 2 - TolSamples sets the maximum error allowed between the piecewise linear approximation and original curve.

**Returns**: Polyline(s) representing the trivariate and its control mesh.

**Description**: Converts a whole set of geometry to polylines, in place.

9.2.136  IPFreeObject (allocate.c:547)

void IPFreeObject(IPObjectStruct *O)

**O**: To free.

**Returns**: void

**Description**: Frees one Object Structure.
9.2.137  **IPFreeObjectBase** (allocate.c:520)

```c
void IPFreeObjectBase(IPObjectStruct *O)
```

- **O:** To free.
- **Returns:** void
- **Description:** Frees one Object Structure.

9.2.138  **IPFreeObjectGeomData** (allocate.c:158)

```c
void IPFreeObjectGeomData(IPObjectStruct *PObj)
```

- **PObj:** To free all its slots, but the name.
- **Returns:** void
- **Description:** Routine to free all the slots of a given object, but the name.
  - See also: IPFreeObjectSlots,

9.2.139  **IPFreeObjectList** (allocate.c:686)

```c
void IPFreeObjectList(IPObjectStruct *OFirst)
```

- **OFirst:** To free.
- **Returns:** void
- **Description:** Free a list of Object structures.

9.2.140  **IPFreeObjectSlots** (allocate.c:74)

```c
void IPFreeObjectSlots(IPObjectStruct *PObj)
```

- **PObj:** To free all its slots, but the name.
- **Returns:** void
- **Description:** Routine to free all the slots of a given object, but the name.
  - See also: IPFreeObjectGeomData,

9.2.141  **IPFreePolygon** (allocate.c:499)

```c
void IPFreePolygon(IPPolygonStruct *P)
```

- **P:** To free.
- **Returns:** void
- **Description:** Frees one Polygon Structure.

9.2.142  **IPFreePolygonList** (allocate.c:629)

```c
void IPFreePolygonList(IPPolygonStruct *PFirst)
```

- **PFirst:** To free.
- **Returns:** void
- **Description:** Free a list of Polygon structures.
9.2.143  **IPFreeVertex** (allocate.c:478)

```c
void IPFreeVertex(IPVertexStruct *V)
```

**V:** To free.

**Returns:** void

**Description:** Frees one Vertex Structure.

9.2.144  **IPFreeVertexList** (allocate.c:572)

```c
void IPFreeVertexList(IPVertexStruct *VFirst)
```

**VFirst:** To free.

**Returns:** void

**Description:** Free a, possibly circular, list of Vertex structures.

9.2.145  **IPGenCRVObject** (allocate.c:1324)

```c
IPObjectStruct *IPGenCRVObject(CagdCrvStruct *Crv)
```

**Crv:** Curves to place in object.

**Returns:** A newly created curve object.

**Description:** Creates one curve object.

9.2.146  **IPGenCTLPTObject** (allocate.c:1725)

```c
IPObjectStruct *IPGenCTLPTObject(CagdPointType PtType,
    const IrtRType *Coords)
```

**PtType:** Point type of created control point (E2, P3, etc.).

**Coords:** Coefficients of new control point. Coords[0] is always W.

**Returns:** A newly created control point object.

**Description:** Creates one control point object. Only one of CagdCoords/Coords should be specified.

9.2.147  **IPGenCrvObject** (allocate.c:1298)

```c
IPObjectStruct *IPGenCrvObject(const char *Name,
    CagdCrvStruct *Crv,
    IPObjectStruct *Pnext)
```

**Name:** Name of polygonal object.

**Crv:** Curves to place in object.

**Pnext:** Entry into the object structure.

**Returns:** A newly created curve object.

**Description:** Creates one curve object.
9.2.148  **IPGenCtlPtObject** (allocate.c:1690)

```c
IPObjectStruct *IPGenCtlPtObject(const char *Name,
    CagdPointType PtType,
    const IrtRType *Coords,
    IPObjectStruct *Pnext)
```

- **Name**: Name of polygonal object.
- **PtType**: Point type of created control point (E2, P3, etc.).
- **Coords**: Coefficients of new control point. Coords[0] is always W.
- **Pnext**: Entry into the object structure.

**Returns**: A newly created control point object.

**Description**: Creates one control point object.

9.2.149  **IPGenINSTNCOBJECT** (allocate.c:1666)

```c
IPObjectStruct *IPGenINSTNCOBJECT(const char *InstncName,
    const IrtHmgnMatType *Mat)
```

- **InstncName**: Object name of original.
- **Mat**: Instance matrix, or NULL if none.

**Returns**: A newly created instance object.

**Description**: Creates one instance object.

9.2.150  **IPGenInstncObject** (allocate.c:1636)

```c
IPObjectStruct *IPGenInstncObject(const char *Name,
    const char *InstncName,
    const IrtHmgnMatType *Mat,
    IPObjectStruct *Pnext)
```

- **Name**: Name of polygonal object.
- **InstncName**: Object name of original.
- **Mat**: Instance matrix, or NULL if none.
- **Pnext**: Entry into the object structure.

**Returns**: A newly created instance object.

**Description**: Creates one instance object.

9.2.151  **IPGenLISTObject** (allocate.c:1985)

```c
IPObjectStruct *IPGenLISTObject(IPObjectStruct *First)
```

- **First**: First element in list, if any.

**Returns**: A newly created list object.

**Description**: Creates one list object.
9.2.152  **IPGenListObject**  (allocate.c:1960)

IPObjectStruct *IPGenListObject(const char *Name,
                                  IPObjectStruct *First,
                                  IPObjectStruct *Pnext)

  Name: Name of list object.
  First: First element in list, if any.
  Pnext: Entry into the object structure.
  Returns: A newly created list object.
  Description: Creates one list object.

9.2.153  **IPGenMATObject**  (allocate.c:2089)

IPObjectStruct *IPGenMATObject(IrtHmgMatType Mat)

  Mat: Matrix to initialize with.
  Returns: A newly created matrix object.
  Description: Creates one matrix object.

9.2.154  **IPGenMODELObject**  (allocate.c:1564)

IPObjectStruct *IPGenMODELObject(MdlModelStruct *Model)

  Model: A model object.
  Returns: A newly created triangular surface object.
  Description: Creates one model object.

9.2.155  **IPGenMULTIVARObject**  (allocate.c:1612)

IPObjectStruct *IPGenMULTIVARObject(MvarMVStruct *MultiVar)

  MultiVar: A multivariate object.
  Returns: A newly created triangular surface object.
  Description: Creates one multivariate object.

9.2.156  **IPGenMatObject**  (allocate.c:2062)

IPObjectStruct *IPGenMatObject(const char *Name,
                                 IrtHmgMatType Mat,
                                 IPObjectStruct *Pnext)

  Name: Name of polygonal object.
  Mat: Matrix to initialize with.
  Pnext: Entry into the object structure.
  Returns: A newly created matrix object.
  Description: Creates one matrix object.
9.2.157 IPGenModelObject (allocate.c:1538)

IPObjectStruct *IPGenModelObject(const char *Name,
                                 MdlModelStruct *Model,
                                 IPObjectStruct *Pnext)

Name: Name of polygonal object.
Model: A model object.
Pnext: Entry into the object structure.
Returns: A newly created triangular surface object.
Description: Creates one model object.

9.2.158 IPGenMultiVarObject (allocate.c:1586)

IPObjectStruct *IPGenMultiVarObject(const char *Name,
                                     MvarMVStruct *MultiVar,
                                     IPObjectStruct *Pnext)

Name: Name of polygonal object.
MultiVar: A multivariate object.
Pnext: Entry into the object structure.
Returns: A newly created triangular surface object.
Description: Creates one surface object.

9.2.159 IPGenNUMObject (allocate.c:1771)

IPObjectStruct *IPGenNUMObject(const IrtRType *R)

R: Numeric value to place in object.
Returns: A newly created numeric object.
Description: Creates one numeric object.

9.2.160 IPGenNUMValObject (allocate.c:1789)

IPObjectStruct *IPGenNUMValObject(IrtRType R)

R: Numeric value to place in object.
Returns: A newly created numeric object.
Description: Creates one numeric object.

9.2.161 IPGenNumObject (allocate.c:1747)

IPObjectStruct *IPGenNumObject(const char *Name,
                                const IrtRType *R,
                                IPObjectStruct *Pnext)

Name: Name of polygonal object.
R: Numeric value to place in object.
Pnext: Entry into the object structure.
Returns: A newly created numeric object.
Description: Creates one numeric object.
9.2.162  IPGenPLANEObject  (allocate.c:2040)

IPObjectStruct *IPGenPLANEObject(const IrtRType *Plane0,
                                 const IrtRType *Plane1,
                                 const IrtRType *Plane2,
                                 const IrtRType *Plane3)

Plane0, Plane1, Plane2, Plane3: Coefficients of point.
Returns: A newly created plane object.
Description: Creates one plane object.

9.2.163  IPGenPOINTLISTObject  (allocate.c:1276)

IPObjectStruct *IPGenPOINTLISTObject(IPPolygonStruct *Pl)

Pl: Pointlist(s) to place in object.
Returns: A newly created polygonal object.
Description: Creates one pointlist object.

9.2.164  IPGenPOLYLINEObject  (allocate.c:1229)

IPObjectStruct *IPGenPOLYLINEObject(IPPolygonStruct *Pl)

Pl: Polyline(s) to place in object.
Returns: A newly created polygonal object.
Description: Creates one polyline object.

9.2.165  IPGenPOLYObject  (allocate.c:1182)

IPObjectStruct *IPGenPOLYObject(IPPolygonStruct *Pl)

Pl: Polygon(s) to place in object.
Returns: A newly created polygonal object.
Description: Creates one polygonal object.

9.2.166  IPGenPTObject  (allocate.c:1841)

IPObjectStruct *IPGenPTObject(const IrtRType *Pt0,
                              const IrtRType *Pt1,
                              const IrtRType *Pt2)

Pt0, Pt1, Pt2: Coefficients of point.
Returns: A newly created point object.
Description: Creates one point object.
9.2.167  IPGenPlaneObject  (allocate.c:2010)

IPObjectStruct *IPGenPlaneObject(const char *Name,
       const IrtRType *Plane0,
       const IrtRType *Plane1,
       const IrtRType *Plane2,
       const IrtRType *Plane3,
       IPObjectStruct *Pnext)

Name: Name of polygonal object.
Plane0, Plane1, Plane2, Plane3: Coefficients of point.
Pnext: Entry into the object structure.
Returns: A newly created plane object.
Description: Creates one plane object.

9.2.168  IPGenPointListObject  (allocate.c:1251)

IPObjectStruct *IPGenPointListObject(const char *Name,
       IPPolygonStruct *Pl,
       IPObjectStruct *Pnext)

Name: Name of pointlist object.
Pl: Pointlist(s) to place in object.
Pnext: Entry into the object structure.
Returns: A newly created pointlist object.
Description: Creates one pointlist object.

9.2.169  IPGenPolyObject  (allocate.c:1157)

IPObjectStruct *IPGenPolyObject(const char *Name,
       IPPolygonStruct *Pl,
       IPObjectStruct *Pnext)

Name: Name of polygonal object.
Pl: Polygon(s) to place in object.
Pnext: Entry into the object structure.
Returns: A newly created polygonal object.
Description: Creates one polygonal object.

9.2.170  IPGenPolylineObject  (allocate.c:1204)

IPObjectStruct *IPGenPolylineObject(const char *Name,
       IPPolygonStruct *Pl,
       IPObjectStruct *Pnext)

Name: Name of polyline object.
Pl: Polyline(s) to place in object.
Pnext: Entry into the object structure.
Returns: A newly created polyline object.
Description: Creates one polyline object.
9.2.171  IPGenPtObject (allocate.c:1813)

IPObjectStruct *IPGenPtObject(const char *Name,
  const IrtRType *Pt0,
  const IrtRType *Pt1,
  const IrtRType *Pt2,
  IPObjectStruct *Pnext)

Name: Name of polygonal object.
Pt0, Pt1, Pt2: Coefficients of point.
Pnext: Entry into the object structure.

Returns: A newly created point object.
Description: Creates one point object.

9.2.172  IPGenSRFObject (allocate.c:1372)

IPObjectStruct *IPGenSRFObject(CagdSrfStruct *Srf)

Srf: Surfaces to place in object.

Returns: A newly created surface object.
Description: Creates one surface object.

9.2.173  IPGenSTRObject (allocate.c:1938)

IPObjectStruct *IPGenSTRObject(const char *Str)

Str: The string.

Returns: A newly created strtor object.
Description: Creates one string object.

9.2.174  IPGenSrfObject (allocate.c:1346)

IPObjectStruct *IPGenSrfObject(const char *Name,
  CagdSrfStruct *Srf,
  IPObjectStruct *Pnext)

Name: Name of polygonal object.
Srf: Surfaces to place in object.
Pnext: Entry into the object structure.

Returns: A newly created surface object.
Description: Creates one surface object.

9.2.175  IPGenStrObject (allocate.c:1915)

IPObjectStruct *IPGenStrObject(const char *Name,
  const char *Str,
  IPObjectStruct *Pnext)

Name: Name of string object.
Str: The string.
Pnext: Entry into the object structure.

Returns: A newly created strtor object.
Description: Creates one string object.
9.2.176  **IPGenTRIMSRFObject**  (allocate.c:1420)

```c
IPObjectStruct *IPGenTRIMSRFObject(TrimSrfStruct *TrimSrf)
```

*TrimSrf*: Trimmed surfaces to place in object.
*Returns*: A newly created trimmed surface object.
*Description*: Creates one trimmed surface object.

9.2.177  **IPGenTRISRFObject**  (allocate.c:1516)

```c
IPObjectStruct *IPGenTRISRFObject(TrngTriangSrfStruct *TriSrf)
```

*TriSrf*: Triangular Surfaces to place in object.
*Returns*: A newly created triangular surface object.
*Description*: Creates one triangular surface object.

9.2.178  **IPGenTRIVARObject**  (allocate.c:1468)

```c
IPObjectStruct *IPGenTRIVARObject(TrivTVStruct *Triv)
```

*Triv*: Trivariates to place in object.
*Returns*: A newly created trivariate object.
*Description*: Creates one trivariate object.

9.2.179  **IPGenTriSrfObject**  (allocate.c:1490)

```c
IPObjectStruct *IPGenTriSrfObject(const char *Name, TrngTriangSrfStruct *TriSrf, IPObjectStruct *Pnext)
```

*Name*: Name of polygonal object.
*TriSrf*: Triangular Surfaces to place in object.
*Pnext*: Entry into the object structure.
*Returns*: A newly created triangular surface object.
*Description*: Creates one triangular surface object.

9.2.180  **IPGenTrimSrfObject**  (allocate.c:1394)

```c
IPObjectStruct *IPGenTrimSrfObject(const char *Name, TrimSrfStruct *TrimSrf, IPObjectStruct *Pnext)
```

*Name*: Name of polygonal object.
*TrimSrf*: Trimmed surfaces to place in object.
*Pnext*: Entry into the object structure.
*Returns*: A newly created trimmed surface object.
*Description*: Creates one trimmed surface object.
9.2.181  **IPGenTrivarObject** (allocate.c:1442)

IPObjectStruct *IPGenTrivarObject(const char *Name,
        TrivTVStruct *Triv,
        IPObjectStruct *Pnext)

**Name:** Name of polygonal object.

**Triv:** Trivariates to place in object.

**Pnext:** Entry into the object structure.

**Returns:** A newly created trivariate object.

**Description:** Creates one trivariate object.

9.2.182  **IPGenVECOBJECT** (allocate.c:1893)

IPObjectStruct *IPGenVECOBJECT(const IrtRType *Vec0,
        const IrtRType *Vec1,
        const IrtRType *Vec2)

**Vec0, Vec1, Vec2:** Coefficients of vector.

**Returns:** A newly created vector object.

**Description:** Creates one vector object.

9.2.183  **IPGenVecObject** (allocate.c:1865)

IPObjectStruct *IPGenVecObject(const char *Name,
        const IrtRType *Vec0,
        const IrtRType *Vec1,
        const IrtRType *Vec2,
        IPObjectStruct *Pnext)

**Name:** Name of polygonal object.

**Vec0, Vec1, Vec2:** Coefficients of vector.

**Pnext:** Entry into the object structure.

**Returns:** A newly created vector object.

**Description:** Creates one vector object.

9.2.184  **IPGetBinObject** (iritprsb.c:316)

IPObjectStruct *IPGetBinObject(int Handler)

**Handler:** A handler to the open stream.

**Returns:** Read object.

**Description:** Routine to read one object from a given binary file, directly. Objects may be recursively defined (as lists), in which case all are read in this single call.
9.2.185  **IPGetDataFiles** (iritprs1.c:701)

IPObjectStruct *IPGetDataFiles(char const * const *DataFileNames,
                               int NumOfDataFiles,
                               int Messages,
                               int MoreMessages)

**DataFileNames**: Array of strings (file names) to process.
**NumOfDataFiles**: Number of elements in DataFileNames.
**Messages**: Do we want error messages?
**MoreMessages**: Do we want informative messages?
**Returns**: Objects read from all files, NULL if error.

**Description**: Reads data from a set of files specified by file names. Messages and MoreMessages controls the level of printout. Freeform geometry read in is handed out to a call back function named IPProcessFreeForm before it is returned from this routine. This is done so applications that do not want to deal with freeform shapes will be able to provide a call back that processes the freeform shapes into other geometry such as polygons.

**See also**: IPProcessFreeForm,

9.2.186  **IPGetDataFromFilehandles** (iritprs1.c:765)

IPObjectStruct *IPGetDataFromFilehandles(FILE **Files,
                                           int NumOfFiles,
                                           char **Extensions,
                                           int Messages,
                                           int MoreMessages)

**Files**: Array of file handles to process.
**NumOfFiles**: Number of elements in Files.
**Extensions**: Array of file name extensions for the files; used to determine file formats.
**Messages**: Do we want error messages?
**MoreMessages**: Do we want informative messages?
**Returns**: Objects read from all file handles.

**Description**: Convenience function for reading input from file handles instead of indirectly from filenames; caller must supply an array of filename extensions (as char * strings) for ascertaining the input files’ formats.

**See also**: IPGetDataFiles, IPGetDataFromFilehandles2,

9.2.187  **IPGetDataFromFilehandles2** (iritprs1.c:816)

IPObjectStruct *IPGetDataFromFilehandles2(FILE **Files,
                                          int NumOfFiles,
                                          IPStreamFormatType *Formats,
                                          int *IsBinaryIndicators,
                                          int Messages,
                                          int MoreMessages)

**Files**: Array of file handles to process.
**NumOfFiles**: Number of elements in Files.
**Formats**: Array of file formats for the files
**IsBinaryIndicators**: Array of ’IsBinary’ indications for the files
**Messages**: Do we want error messages?
**MoreMessages**: Do we want informative messages?
**Returns**: Objects read from all file handles.

**Description**: Convenience function for reading input from file handles instead of indirectly from filenames; caller must supply an array of file formats and ’IsBinary’ indicators.

**See also**: IPGetDataFiles, IPGetDataFromFilehandles,
9.2.188  **IPGetLastObj** (linklist.c:398)

```c
IPObjectStruct *IPGetLastObj(IPObjectStruct *OList)
```

**OList:** A list of objects.

**Returns:** Last object in list OList.

**Description:** Returns a pointer to last object of a list.

9.2.189  **IPGetLastPoly** (linklist.c:324)

```c
IPPolygonStruct *IPGetLastPoly(IPPolygonStruct *PList)
```

**PList:** A list of polygons.

**Returns:** Last polygon in list PList.

**Description:** Returns a pointer to last polygon/line of a list.

9.2.190  **IPGetLastVrtx** (linklist.c:246)

```c
IPVertexStruct *IPGetLastVrtx(IPVertexStruct *VList)
```

**VList:** A list of vertices.

**Returns:** Last vertex in VList.

**Description:** Returns a pointer to last vertex of a list.

9.2.191  **IPGetMatrixFile** (iritprs1.c:2831)

```c
int IPGetMatrixFile(const char *File,
                    IrtHmgnMatType ViewMat,
                    IrtHmgnMatType ProjMat,
                    int *HasProjMat)
```

**File:** File to read the matrix file from.

**ViewMat, ProjMat:** Matrices to get.

**HasProjMat:** TRUE if has a perspective matrix, FALSE otherwise.

**Returns:** TRUE if (at least) VIEW_MAT was found, FALSE otherwise.

**Description:** Gets an IRIT matrix file.

See also: IPPutMatrixFile,

9.2.192  **IPGetObjectByName** (linklist.c:1090)

```c
IPObjectStruct *IPGetObjectByName(const char *Name,
                                   IPObjectStruct *PObjList,
                                   int TopLevel)
```

**Name:** Of object to find and return a reference of.

**PObjList:** List of objects to scan.

**TopLevel:** if TRUE, scan only the top level list.

**Returns:** A reference to found object, NULL otherwise.

**Description:** Searches for an object in given PObjList, named Name.
9.2.193  **IPGetObjects**  (iritprs1.c:966)

IPObjectStruct *IPGetObjects(int Handler)

**Handler:** A handler to the open stream.

**Returns:** Read object, or NULL if failed.

**Description:** Routine to read the data from a given file. Returns NULL if EOF was reached or error occurred.

**See also:** IPSetPolyListCirc, IPSetFlattenObjects, IPSetReadOneObject, PTransformInstances.

9.2.194  **IPGetPrevObj**  (linklist.c:418)

IPObjectStruct *IPGetPrevObj(IPObjectStruct *OList, IPObjectStruct *O)

**OList:** A list of objects.

**O:** For which the previous object in OList is pursuit.

**Returns:** Previous object to O in OList if found, NULL otherwise.

**Description:** Returns a pointer to previous object in OList to O.

9.2.195  **IPGetPrevPoly**  (linklist.c:345)

IPPolygonStruct *IPGetPrevPoly(IPPolygonStruct *PList,IPPolygonStruct *P)

**PList:** A list of polygons.

**P:** For which the previous polygon in PList is pursuit.

**Returns:** Previous polygon to P in PList if found, NULL otherwise.

**Description:** Returns a pointer to previous polygon in PList to P.

9.2.196  **IPGetPrevVrtx**  (linklist.c:266)

IPVertexStruct *IPGetPrevVrtx(IPVertexStruct *VList, IPVertexStruct *V)

**VList:** A list of vertices.

**V:** For which the previous vertex in VList is pursuit.

**Returns:** Previous vertex to V in VList if found, NULL otherwise.

**Description:** Returns a pointer to previous vertex in VList to V.

9.2.197  **IPGetPrspMat**  (prsrgeom.c:72)

IrtHmgnMatType *IPGetPrspMat(int *WasPrspMat)

**WasPrspMat:** TRUE if parser until now detected a perspective matrix.

**Returns:** A reference to the matrix.

**Description:** Fetches the current perspective matrix.

**See also:** IPGetViewMat,
9.2.198  **IPGetRealNumber** (iritprs1.c:2871)

```c
int IPGetRealNumber(const char *StrNum, IrtRType *RealNum)
```

- **StrNum**: A string representing a real number.
- **RealNum**: The fetched real number.
- **Returns**: TRUE if number was parsed correctly, FALSE otherwise.
- **Description**: Fetchs a real number from a given string.

9.2.199  **IPGetViewMat** (prsrgeom.c:49)

```c
IrtHmgmMatType *IPGetViewMat(int *WasViewMat)
```

- **WasViewMat**: TRUE if parser until now detected a view matrix.
- **Returns**: A reference to the matrix.
- **Description**: Fetches the current view matrix.
- **See also**: IPGetPrspMat,

9.2.200  **IPHasError** (prsrerr.c:188)

```c
int IPHasError(const char **ErrorDesc)
```

- **ErrorDesc**: Where to place the error description if was one.
- **Returns**: TRUE if there was an error, FALSE otherwise.
- **Description**: Returns TRUE if an error was signaled and set ErrorDesc to its value.

9.2.201  **IPIgesLoadFile** (igs_irit.c:238)

```c
IPObjectStruct *IPIgesLoadFile(const char *IgesFileName,
                                int ClipTrimmedSrf,
                                int DumpAll,
                                int IgnoreGrouping,
                                int Messages)
```

- **IgesFileName**: Name of IGES file.
- **ClipTrimmedSrf**: TRUE to clip trimming surface to their trimming curves.
- **DumpAll**: TRUE to dump all entities, including auxiliary entities used by other entities.
- **IgnoreGrouping**: TRUE to ignore any instance grouping.
- **Messages**: 1 for error messages, 2 to include warning messages, 3 to include informative messages. 4 to include dump of IRIT objects.
- **Returns**: Read IGES DATA or NULL if error.
- **Description**: Read IGES 5.0 files into IRIT data.
- **See also**: IPIgesSaveFile, IPIgesLoadFileSetDefaultParameters,
9.2.202  IPIgesLoadFileSetDefaultParameters (iritprs1.c:1072)

```c
void IPIgesLoadFileSetDefaultParameters(int ClipTrimmedSrf,
    int DumpAll,
    int IgnoreGrouping,
    int Messages)
```

**ClipTrimmedSrf:** TRUE to clip trimming surface to their trimming curves.
**DumpAll:** TRUE to dump all entities, including auxiliary entities used by other entities.
**IgnoreGrouping:** TRUE to ignore any instance grouping.
**Messages:** 1 for error messages, 2 to include warning messages, 3 to include informative messages. 4 to include dump of IRIT objects.

**Returns:** void

**Description:** Sets default loading parameters for Iges files.

**See also:** IPGetObjects, IPIgesLoadFile,

9.2.203  IPIgesSaveFile (irit_igs.c:113)

```c
int IPIgesSaveFile(const IPObjectStruct *PObject,
    Ir트HmgnMatType CrntViewMat,
    const char *IgesFileName,
    int Messages)
```

**PObject:** IritObject to dump as IGES 5.0 file.
**CrntViewMat:** The current viewing matrix to apply to the object.
**IgesFileName:** Name of IGES file.
**Messages:** TRUE for warning messages.

**Returns:** TRUE if succesful, FALSE otherwise.

**Description:** Dumps IRIT object as IGES 5.0 file.

**See also:** IPIgesLoadFile, IPIgesSaveFileSetup,

9.2.204  IPIgesSaveFileSetup (irit_igs.c:292)

```c
void IPIgesSaveFileSetup(int SaveEucTrimCrvs)
```

**SaveEucTrimCrvs:** TRUE to save Euclidean trimming curves as well.

**Returns:** void

**Description:** Sets the state of the IGES file save.

**See also:** IPIgesSaveFile,

9.2.205  IPInputUnGetC (iritprs1.c:2156)

```c
void IPInputUnGetC(int Handler, char c)
```

**Handler:** A handler to the open stream.
**c:** Character to unget.

**Returns:** void

**Description:** Routine to unget a single character from input stream.
9.2.206  **IPIsConsistentFreeObjList** (allocate.c:376)

```c
int IPIsConsistentFreeObjList(void)
```

**Returns:** TRUE if o.k., FALSE otherwise.

**Description:** Verifies the consistency of the freed list itself. Debugging routine.

9.2.207  **IPLinkedListToObjList** (linklist.c:627)

```c
IPObjectStruct *IPLinkedListToObjList(const IPObjectStruct *LnkList)
```

**LnkList:** Linked list to process.

**Returns:** A list object holding the linked list as separated individual objects.

**Description:** Convert a linked list of similar objects to a list object.

**See also:** IPObjLnkListToListObject, IPLnkListToListObject,

9.2.208  **IPListObjToLinkedList** (linklist.c:712)

```c
void *IPListObjToLinkedList(const IPObjectStruct *LObs)
```

**LObs:** List object to process.

**Returns:** Linked list of (copies) of input data, NULL if error.

**Description:** Convert a list object of similar objects to a linked list of these objs.

**See also:** IPObjLnkListToListObject, IPLnkListToListObject,

9.2.209  **IPListObjectAppend** (allocate.c:861)

```c
void *IPListObjectAppend(IPObjectStruct *PObj, 
                        IPObjectStruct *PObjItem)
```

**PObj:** A list of objects to insert PObjItem into.

**PObjItem:** Element to insert last into the list PObj.

**Returns:** void

**Description:** Insert an object PObjItem as last into a list of objects, PObj.

**See also:** IPListObjectLength, IPListObjectFind, IPListObjectInsert, , IPListObjectDelete, IPListObjectGet,

9.2.210  **IPListObjectDelete** (allocate.c:888)

```c
void *IPListObjectDelete(IPObjectStruct *PObj, int Index, int FreeItem)
```

**PObj:** A list of objects to delete item Index.

**Index:** Index where item should be deleted.

**FreeItem:** If TRUE, Item is also freed, if FALSE only deleted from list.

**Returns:** void

**Description:** Delete an object at index Index from list of objects, PObj.

**See also:** IPListObjectLength, IPListObjectFind, IPListObjectInsert, , IPListObjectAppend, IPListObjectGet, IPListObjectDelete2,
9.2.211  *IPListObjectDelete2*  (allocate.c:927)

```c
void IPListObjectDelete2(IPObjectStruct *PObj,
                         IPObjectStruct *PObjToDel,
                         int FreeItem)
```

- **PObj**: A list of objects to delete item Index.
- **PObjToDel**: Object to delete from list object PObj.
- **FreeItem**: If TRUE, Item is also freed, if FALSE only deleted from list.
- **Returns**: void

**Description**: Delete an object at index Index from list of objects, PObj.

**See also**: IPListObjectLength, IPListObjectFind, IPListObjectInsert, IPListObjectAppend, IPListObjectGet, IPListObjectDelete,

9.2.212  *IPListObjectFind*  (allocate.c:749)

```c
int IPListObjectFind(const IPObjectStruct *PObjList,
                     const IPObjectStruct *PObj)
```

- **PObjList**: To search for PObj in.
- **PObj**: The element to search in PObjList.
- **Returns**: TRUE if PObj was found in PObjList, FALSE otherwise.

**Description**: Returns TRUE if PObj is an object in list PObjList or in a sublist of PObjList, recursively.

**See also**: IPListObjectLength, IPListObjectInsert, IPListObjectAppend, , IPListObjectDelete, IPListObjectGet,

9.2.213  *IPListObjectGet*  (allocate.c:960)

```c
IPObjectStruct *IPListObjectGet(const IPObjectStruct *PObj, int Index)
```

- **PObj**: A list object to extract one object from.
- **Index**: Index of object to extract from PObj.
- **Returns**: Index object in list PObj, or NULL if no such thing.

**Description**: Returns the object number Index in list of PObjList object.

**See also**: IPListObjectLength, IPListObjectFind, IPListObjectInsert, , IPListObjectAppend, IPListObjectDelete,

9.2.214  *IPListObjectInsert*  (allocate.c:790)

```c
void IPListObjectInsert(IPObjectStruct *PObj,
                        int Index,
                        IPObjectStruct *PObjItem)
```

- **PObj**: A list of objects to insert PObjItem into.
- **Index**: Index where PObjItem should enter PObj.
- **PObjItem**: Element to insert into the list PObj.
- **Returns**: void

**Description**: Insert an object PObjItem at index Index into a list of objects, PObj. Overwriting existing item if was any.

**See also**: IPListObjectInsert2, IPListObjectLength, IPListObjectFind, , IPListObjectAppend, IPListObjectDelete, IPListObjectGet,
9.2.215  IListObjectInsert2  (allocate.c:827)

void IListObjectInsert2(IPObjectStruct *PObj, int Index, IPObjectStruct *PObjItem)

PObj: A list of objects to insert PObjItem into.
Index: Index where PObjItem should enter PObj.
PObjItem: Element to insert into the list PObj.
Returns: void

Description: Insert an object PObjItem at index Index into a list of objects, PObj. Same as IListObjectInsert, but make sure to first make space in the list at index Index, by moving all items above or equal to index Index one position up, expanding the length of the list by one.

See also:  IListObjectInsert, IListObjectLength, IListObjectFind, , IListObjectAppend, IListObjectDelete, IListObjectGet,

9.2.216  IListObjectLength  (allocate.c:714)

int IListObjectLength(const IPObjectStruct *PObj)

PObj: A list of objects to find its length.
Returns: Resulting length of list PObj.

Description: Returns the length of a list, given a list of objects.
See also:  IListObjectFind, IListObjectInsert, IListObjectAppend, , IListObjectDelete, IListObjectGet,

9.2.217  IPLnkListToListObject  (linklist.c:558)

IPObjectStruct *IPLnkListToListObject(VoidPtr LnkList, IPObjStructType ObjType)

LnkList: Linked list to convert. We assume the Pnext pointer is the first entry in the structure.
ObjType: Type of objects we have in the linked list.
Returns: A list object holding all items in linked list.

Description: Converts a linked list into one list object, in place.
See also:  IPAppendListObjects, IPObjLnkListToListObject, IPLinkedListToObjList,

9.2.218  IPMapObjectInPlace  (ifs Canon.c:1428)

void IPMapObjectInPlace(IPObjectStruct *PObj, IrtHmgnMatType Mat)

PObj: Object to map, in place, according to Mat.
Mat: Transformation matrix.
Returns: void

Description: Maps the object according to the given matrix, in place.

9.2.219  IPNCGCode2Geometry  (irit cnc.c:1053)

IPObjectStruct *IPNCGCode2Geometry(VoidPtr IPNCGCodes)

IPNCGCodes: Current GCodes' stream.
Returns: The toolpath in IRIT form.

Description: Convert the given stream of G Code toolpath to IRIT geometry. Every linear motion is considered one polyline as long as it is either G0 or G1. Free-air motion (G0) is marked with attribute "freemotion". "ToolNum", "SpindleSpeed" and "SpindleSpeed" attributes are saved on every vertex. As a side effect, computes the length (Len slot) of each G Code motion, and a curve representation (Crv slot).

See also:  IPNCGCodeParserInit, IPNCGCodeParserParseLine, , IPNCGCodeParserSetStep, IPNCGCodeParserGetNext, , IPNCGCodeParserNumSteps, IPNCGCodeParserFree, , IPNCGCodeLength, IPNCGCodeBBox,
9.2.220  IPNCGCodeBBox (irit.cnc.c:1302)

GMBBBBoxStruct *IPNCGCodeBBox(VoidPtr IPNCGCodes, int IgnoreG0Fast)

- **IPNCGCodes**: Current GCodes' stream.
- **IgnoreG0Fast**: If TRUE, ignore motions with G0's in bbox computation.
- **Returns**: The computed bbox returned in a static memory area.

**Description**: Computes a bounding box over the coordinates found in the G Code stream.

**See also**: IPNCGCodeParserInit, IPNCGCodeParserParseLine, IPNCGCodeParserSetStep, IPNCGCodeParserGetNext, IPNCGCodeLength, IPNCGCodeParserNumSteps, IPNCGCodeParserFree,

9.2.221  IPNCGCodeGenToolGeom (irit.cnc.c:1874)

CagdSrfStruct *IPNCGCodeGenToolGeom(IPNCGCToolType ToolType, IrtRType Diameter, IrtRType Height, IrtRType TorusRadius, CagdCrvStruct **ToolProfile, CagdSrfStruct **ToolBottom)

- **ToolType**: One of flat, ball, or Torus end.
- **Diameter**: Of tool main cylinder.
- **Height**: Of constructed tool entire geometry. Height must be larger than diameter.
- **TorusRadius**: Only of a Torus end tool - minor radius of torus rounding. TorusRadius must be smaller than Diameter/2.
- **ToolProfile**: A 2D profile cross section curve of the constructed tool in the XZ plane (+Z only). This profile is symmetric with respect to the Z axis, spanning both -X and +X sides and only holds the bottom visible part of the tool (to be used in Z-buffer further processing).
- **ToolBottom**: The bottom part of the tool that will cut material, in the same canonical position.
- **Returns**: Geometry of the constructed tool, NULL if failed.

**Description**: create tool geometry from tool's parameters, assuming not a general tool in which case this function returns NULL. Tool is created at a canonical position (origin) and orientation (+Z).

**See also**: IPNCGCodeTraverseStep,

9.2.222  IPNCGCodeLength (irit.cnc.c:1240)

IrtRType IPNCGCodeLength(VoidPtr IPNCGCodes, IrtRType *FastLength)

- **IPNCGCodes**: Current GCodes' stream.
- **FastLength**: Accumulate fast motion length here, if non NULL.
- **Returns**: Computed arc length.

**Description**: Computes the accumulated arc length of the given stream of G Code toolpath, in cutting speed motion. Assumes IPNCGCode2Geometry was invoked on this stream to compute each G code individual arc length.

**See also**: IPNCGCodeParserInit, IPNCGCodeParserParseLine, IPNCGCodeParserSetStep, IPNCGCodeParserGetNext, IPNCGCodeBBox, IPNCGCode2Geometry, IPNCGCodeParserNumSteps, IPNCGCodeParserFree,

9.2.223  IPNCGCodeLoadFile (irit.cnc.c:142)

IPObjectStruct *IPNCGCodeLoadFile(const char *NCGCODEFileName, int ArcCentersRelative, int Messages)

- **NCGCODEFileName**: G-Code file to read in.
- **ArcCentersRelative**: TRUE for arc center in relative coordinates with respect to arc starting location, FALSE if in absolute coordinates.
- **Messages**: TRUE, for more messages.
- **Returns**: Read data or NULL if error.

**Description**: Reads in a G-code CN file and return it as Irit geometry.

**See also**: IPNCGCodeLoadFileSetDefaultParameters,
9.2.224  IPNCGCodeLoadFileSetDefaultParameters (iritprs1.c:1166)

void IPNCGCodeLoadFileSetDefaultParameters(int ArcCentersRelative,
    int Messages)

ArcCentersRelative: TRUE for arc center in relative coordinates with respect to arc starting location, FALSE if in absolute coordinates.
Messages: TRUE, for more messages.
Returns: void
Description: Sets default loading parameters for GCode NC files.
See also: IPGetObjects, IPNCGCodeLoadFile,

9.2.225  IPNCGCodeParserDone (irit_cnc.c:614)

int IPNCGCodeParserDone(VoidPtr IPNCGCodes)

IPNCGCodes: Current GCodes' stream.
Returns: TRUE if successful, FALSE otherwise.
Description: Complete the reading of a new stream of G code.
See also: IPNCGCodeParserFree, IPNCGCodeParserParseLine, IPNCGCodeParserInit, IPNCGCodeParserSetStep, IPNCGCodeParserGetNext, IPNCGCodeParserNumSteps, IPNCGCodeParserGetPrev,

9.2.226  IPNCGCodeParserFree (irit_cnc.c:847)

void IPNCGCodeParserFree(VoidPtr IPNCGCodes)

IPNCGCodes: G codes' stream to free.
Returns: void
Description: Free a processed stream of G codes.
See also: IPNCGCodeParserInit, IPNCGCodeParserParseLine, IPNCGCodeParserSetStep, IPNCGCodeParserGetNext, IPNCGCodeParserNumSteps, IPNCGCodeParserGetPrev,

9.2.227  IPNCGCodeParserGetNext (irit_cnc.c:788)

IPNCGCodeLineStruct *IPNCGCodeParserGetNext(VoidPtr IPNCGCodes)

IPNCGCodes: Current GCodes' stream.
Returns: The next GCode parsed state in the stream. NULL if end of stream.
Description: Returns the next GCode line in the parsed stream IPNCGCodes.
See also: IPNCGCodeParserInit, IPNCGCodeParserParseLine, IPNCGCodeParserSetStep, IPNCGCodeParserFree, IPNCGCodeParserNumSteps, IPNCGCodeParserGetPrev,

9.2.228  IPNCGCodeParserGetPrev (irit_cnc.c:818)

IPNCGCodeLineStruct *IPNCGCodeParserGetPrev(VoidPtr IPNCGCodes)

IPNCGCodes: Current GCodes' stream.
Returns: The previous GCode parsed state in the stream. NULL if beginning of stream.
Description: Returns the previous GCode line in the parsed stream IPNCGCodes.
See also: IPNCGCodeParserInit, IPNCGCodeParserParseLine, IPNCGCodeParserSetStep, IPNCGCodeParserGetNext, IPNCGCodeParserNumSteps, IPNCGCodeParserFree,
9.2.229 IPNCGCodeParserInit (irit_cnc.c:215)

`VoidPtr IPNCGCodeParserInit(int ArcCentersRelative,
    IrtType DefFeedRate,
    IrtType DefSpindleSpeed,
    int DefToolNumber,
    int ReverseZDir,
    IPNCGCodeParserErrorFuncType ErrorFunc)`

ArcCentersRelative: TRUE if arc centers (G2/G3) are relative to arc starting location, FALSE if centers are absolute.
DefFeedRate: Default feed rate to use if none found. In units per second.
DefSpindleSpeed: Default spindle speed if none found, in RPM.
DefToolNumber: Default tool number to use if none found.
ReverseZDir: TRUE to reverse Z values. If FALSE, +Z points up and toward the machining tool.
ErrorFunc: Call back function in case of errors. Can be NULL to fully ignore errors.

Returns: A handle on the G code stream to process.

Description: Initialize a new stream of G code to process.


9.2.230 IPNCGCodeParserNumSteps (irit_cnc.c:727)

`int IPNCGCodeParserNumSteps(VoidPtr IPNCGCodes)`

IPNCGCodes: Current GCodes' stream.

Returns: Number of GCode steps in IPNCGCodes.

Description: Returns the number of GCode steps in the parsed stream IPNCGCodes.

See also: IPNCGCodeParserInit, IPNCGCodeParserParseLine, IPNCGCodeParserSetStep, IPNCGCodeParserGetNext, IPNCGCodeParserFree, IPNCGCodeParserGetPrev

9.2.231 IPNCGCodeParserParseLine (irit_cnc.c:381)

`VoidPtr IPNCGCodeParserParseLine(VoidPtr IPNCGCodes,
    const char *NextLine,
    int LineNum)`

IPNCGCodes: Current GCodes' stream.
NextLine: Next GCode line to process.
LineNum: Line number in the file this line was read from.

Returns: A handle on the G code stream to process.

Description: Process one GCode line as specified by NextLine.

See also: IPNCGCodeParserInit, IPNCGCodeParserDone, IPNCGCodeParserFree, IPNCGCodeParserNumSteps, IPNCGCodeParserSetStep, IPNCGCodeParserGetNext, IPNCGCodeParserGetPrev

9.2.232 IPNCGCodeParserSetStep (irit_cnc.c:756)

`IPNCGCodeLineStruct *IPNCGCodeParserSetStep(VoidPtr IPNCGCodes,
    int NewStep)`

IPNCGCodes: Current GCodes' stream.
NewStep: The new current step to set to.

Returns: This step's GCode parsed state in the stream. NULL if outside the range of stream.

Description: Sets the current GCode step in the parsed stream IPNCGCodes.

9.2.233  IPNCGCodeResetFeedRates (irit\_cnc.c:2180)

void IPNCGCodeResetFeedRates(VoidPtr IPNCGCodes)

**IPNCGCodes:** G Code sequence to traverse.

**Returns:** void

**Description:** Reset the feedrates to original inputfile values.

9.2.234  IPNCGCodeSave2File (irit\_cnc.c:2107)

int IPNCGCodeSave2File(VoidPtr IPNCGCodes, const char *FName)

**IPNCGCodes:** Current GCodes' stream.

**FName:** File name to save the G Codes into, ".-" for stdout.

**Returns:** TRUE if successful, false otherwise.

**Description:** Save the given G code sequence into a file.

**See also:** IPNCGCodeParserInit, IPNCGCodeParserParseLine, IPNCGCodeParserSetStep, IPNCGCodeParserGetNext, IPNCGCodeLength, IPNCGCodeParserNumSteps, IPNCGCodeParserFree,

9.2.235  IPNCGCodeSaveFile (iritwcnc.c:116)

int IPNCGCodeSaveFile(const IPObjStruct *PObj,
                      IrtHmgnMatType CrntViewMat,
                      const char *NCGCODEFileName,
                      int Messages,
                      int Units)

**PObj:** IritObject to dump as NCGCODE file.

**CrntViewMat:** The current viewing matrix to apply to the object.

**NCGCODEFileName:** Name of NCGCODE file, ".-" or NULL for stdout.

**Messages:** TRUE for warning messages.

**Units:** 0 for inches, 1 for Millimeters.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Dumps IRIT object as an NCGcode file.

**See also:** IPNCGCodeSaveFileSetTol,

9.2.236  IPNCGCodeSaveFileSetTol (iritwcnc.c:82)

IrtRType IPNCGCodeSaveFileSetTol(IrtRType Tol)

**Tol:** New tolerance to use.

**Returns:** Old tolerance.

**Description:** Sets the tolerance to use when approximating curves as polylines for CNC path.

**See also:** IPNCGCodeSaveFile,
9.2.237  IPNCGCodeTraverseInit (irit\_cnc.c:1381)

IrtRType IPNCGCodeTraverseInit(VoidPtr IPNCGCodes,
    IrtRType InitTime,
    IrtRType FastSpeedUpFactor,
    IrtRType TriggerArcLen)

**IPNCGCodes**: G Code sequence to traverse.
**InitTime**: Initial time of animation.
**FastSpeedUpFactor**: Speedup multiplier for fast G0 motion.
**TriggerArcLen**: A minimal arc length to accumulate to create triggers every such arc length, or non-positive value to ignore.

**Returns**: Total arc-length of cutting speed motion

**Description**: Init a request to traverse this sequence of G Code.
**See also**: IPNCGCodeLength, IPNCGCodeTraverseTime, IPNCGCodeTraverseTriggerAAL,

9.2.238  IPNCGCodeTraverseLines (irit\_cnc.c:2154)

const char *IPNCGCodeTraverseLines(VoidPtr IPNCGCodes, int Restart)

**IPNCGCodes**: Current GCodes’ stream.
**Restart**: TRUE to init the traversal process.

**Returns**: Next line, NULL if done.

**Description**: Traverses the given G code sequence as strings.
**See also**: IPNCGCodeParserInit, IPNCGCodeParserParseLine, IPNCGCodeParserSetStep, IPNCGCodeParserGetNext, IPNCGCodeLength, IPNCGCodeParserNumSteps, IPNCGCodeParserFree,

9.2.239  IPNCGCodeTraverseStep (irit\_cnc.c:1717)

IrtRType IPNCGCodeTraverseStep(VoidPtr IPNCGCodes,
    IrtRType Step,
    IrtRType *NewRealTime,
    IrtPtType NewToolPosition,
    IPNCGCodeLineStruct **NewGC)

**IPNCGCodes**: G Code sequence to traverse.
**Step**: Delta position step to add/subtract from current pos. Can be negative to subtract and go backward.
**NewRealTime**: New real time of new position is returned here with respect to starting time (that is 0.0).
**NewToolPosition**: The traversed tool position is saved here.
**NewGC**: GCode info at NewToolPosition.

**Returns**: New arc-length of cutting speed motion so far. -1.0 is returned if we completed the traversal, -2.0 is returned if we when back to the start point.

**Description**: Advance the animated tool motion along this sequence of G Code by Step.
**See also**: IPNCGCodeLength, IPNCGCodeTraverseInit, IPNCGCodeTraverseTime, IPNCGCodeTraverseTriggerAAL,
9.2.240  IPNCGCodeTraverseTime (irit_cnc.c:1566)

IrtRType IPNCGCodeTraverseTime(VoidPtr IPNCGCodes,
   IrtRType Dt,
   IrtRType *NewRealTime,
   IrtPtType NewToolPosition,
   IPNCGCodeLineStruct **NewGC)

IPNCGCodes: G Code sequence to traverse.
Dt: Delta time step to add/subtract from current time. Can be negative to subtract and go backward.
NewRealTime: New real time of new position is returned here with respect to starting time (that is 0.0).
NewToolPosition: The traversed tool position is saved here.

Returns: New arc-length of cutting speed motion so far. -1.0 is returned if we completed the traversal, -2.0 is returned if we when back to the start point.

Description: Advance the animated tool motion along this sequence of G Code to Time.
See also: IPNCGCodeLength, IPNCGCodeTraverseInit, IPNCGCodeTraverseStep, IPNCGCodeTraverseTriggerAAL,

9.2.241  IPNCGCodeTraverseTriggerAAL (irit_cnc.c:1431)

int IPNCGCodeTraverseTriggerAAL(VoidPtr IPNCGCodes,
   IPNCGCodeEvalMRRFuncType EvalMRR,
   VoidPtr MRRData)

IPNCGCodes: G Code sequence to traverse.
EvalMRR: Function to invoke to compute the material removal rate in this arclen interval, or NULL to ignore.
   This function should return 1.0 if feedrate is fine or a multiplicative factor to modify the feedrate otherwise.
MRRData: A pointer to pass to EWevalMRR as its single parameter.

Returns: TRUE if generated a trigger, FALSE otherwise.

Description: Handle accumulations of arc-length (AAL). Tests and generates triggers every prescribed arc length. If a trigger is generated and EvalMRR is not NULL, this function is invoked to evaluate the material removal rate in this arc length interval. EvalMRR should return a 1.0 if the feed rate is appropriate and return a multiplicative factor to modify the feed rate if not.
See also: IPNCGCodeLength, IPNCGCodeTraverseInit, IPNCGCodeTraverseStep, IPNCGCodeTraverseTime,

9.2.242  IPNCGCodeUpdateGCodeIndexCBFunc (irit_cnc.c:1490)

IPNCGCodeIndexUpdateFuncType IPNCGCodeUpdateGCodeIndexCBFunc(
   VoidPtr IPNCGCodes,
   IPNCGCodeIndexUpdateFuncType Func)

IPNCGCodes: G Code sequence to traverse.
Func: New call back function to use or NULL to disable.

Returns: Old call back function.

Description: Sets a call back function to be invoked on every G code index change in the simulation.
See also: IPNCGCodeTraverseInit,
9.2.243  IPOBJLoadFile (irit:397)

IPObjectStruct *IPOBJLoadFile(const char *OBJFileName,
    int WarningMsgs,
    int WhiteDiffuseTexture,
    int IgnoreFullTransp,
    int ForceSmoothing)

OBJFileName: Name of OBJ file. NULL means standard input.
WarningMsgs: Weather to display warning messages or not.
WhiteDiffuseTexture: When material has texture and RGB (0,0,0) give it RGB (1,1,1).
IgnoreFullTransp: Full transparency of material is ignored.
ForceSmoothing: If the s statement isn't given use smoothing for all the polygons.
Returns: Read OBJ DATA or NULL if error.
Description: Read an OBJ file into IRIT data structure.
See also: IPOBJSaveFile, IPOBJLoadFileSetDefaultParameters,

9.2.244  IPOBJLoadFileSetDefaultParameters (iritprs1:1138)

void IPOBJLoadFileSetDefaultParameters(int WarningMsgs,
    int WhiteDiffuseTexture,
    int IgnoreFullTransp,
    int ForceSmoothing)

WarningMsgs: Weather to display warning messages or not.
WhiteDiffuseTexture: When material has texture and RGB (0,0,0) give it RGB (1,1,1).
IgnoreFullTransp: Full transparency of material is ignored.
ForceSmoothing: If the s statement isn't given use smoothing for all the polygons.
Returns: void
Description: Sets default loading parameters for OBJ files.
See also: IPGetObjects, IPOBJLoadFile,

9.2.245  IPOBJSaveFile (irit:130)

int IPOBJSaveFile(const IPObjectStruct *PObj,
    const char *OBJFileName,
    int WarningMsgs,
    int UniqueVertices)

PObj: IRIT data structure to convert.
OBJFileName: Name of OBJ file to write the result to.
WarningMsgs: Whether to display warning messages or not.
UniqueVertices: If true, don't gather identical vertices to one vector. Each polygon uses its own vertices.
Returns: TRUE if succeeded.
Description: Convert IRIT data structure to an OBJ file.
See also: IPOBJLoadFile,

9.2.246  IPODAddDependencyToObj (iritdpnd:160)

void IPODAddDependencyToObj(IPODObjectDpndncyStruct **ObjDpnd, char *DpndName)

ObjDpnd: Object to update dependency on object named DpndName.
DpndName: Name of dependency object. May be NULL.
Returns: void
Description: Adds a new object name DpndName as a dependent on this object. This function will properly initialize a NULL ObjDpnd if found one.
See also: IPODAddParameterToObj,
9.2.247  IPODAddParameterToObj (obj_dpnd.c:124)

void IPODAddParameterToObj(IPODObjectDpndncyStruct **ObjDpnd, char *ParamName)

ObjDpnd: Object to update object named ParamName as a parameter of this object. May be NULL
ParamName: Name of parameter object.
Returns: void
Description: Adds a new object name ParamName as a parameter of this object. This function will properly
initialize a NULL ObjDpnd if found one.
See also: IPODAddDependencyToObj,

9.2.248  IPODCopyDependencies (obj_dpnd.c:341)

IPODObjectDpndncyStruct *IPODCopyDependencies(IPODObjectDpndncyStruct *Dpnds)

Dpnds: Structure to duplicate.
Returns: Duplicated structure.
Description: Copy the dependency structure Dpnds.
See also: IPODCopyParametersOfObj, IPODCopyDependenciesOfObj,

9.2.249  IPODCopyDependenciesOfObj (obj_dpnd.c:313)

IPODDependsStruct *IPODCopyDependenciesOfObj(IPODDependsStruct *ObjDepends)

ObjDepends: List of dependencies to copy.
Returns: Copies list of dependencies.
Description: Copy the dependency list of this object (list of other objects depending on this one).
See also: IPODCopyDependencies, IPODCopyParametersOfObj,

9.2.250  IPODCopyParametersOfObj (obj_dpnd.c:284)

IPODParamsStruct *IPODCopyParametersOfObj(IPODParamsStruct *ObjParams)

ObjParams: List of parameters to copy.
Returns: Copies list of parameters.
Description: Copy the parameter list dependencies (list of objects this object depends upon).
See also: IPODCopyDependencies, IPODCopyDependenciesOfObj,

9.2.251  IPODDelDependencyFromObj (obj_dpnd.c:241)

void IPODDelDependencyFromObj(IPODObjectDpndncyStruct *ObjDpnd,
char *DpndName)

ObjDpnd: Dependency structure of this object.
DpndName: Dependency object name to remove.
Returns: void
Description: Removes dependency of object named DpndName on this object.
See also: IPODDelParameterFromObj,
9.2.252  IPODDelParameterFromObj (obj_dpnd.c:196)

```c
void IPODDelParameterFromObj(IPODObjectDpndncyStruct *ObjDpnd,
   char *ParamName)
```

- **ObjDpnd**: Dependency structure of this object.
- **ParamName**: Parameter object name to remove.
- **Returns**: void
- **Description**: Removes a parameter this object depends upon from this object’s dependency structure.
- **See also**: IPODDelDependencyFromObj,

9.2.253  IPODEvalOneObject (obj_dpnd.c:493)

```c
void IPODEvalOneObject(IPObjectStruct *PObj)
```

- **PObj**: To reevaluate.
- **Returns**: void
- **Description**: Reevaluate this object, based upon its dependency’s EvalExpr.
- **See also**: IPODUpdateAllDependencies,

9.2.254  IPODFreeDependencies (obj_dpnd.c:442)

```c
void IPODFreeDependencies(IPODObjectDpndncyStruct *Dpnds)
```

- **Dpnds**: Structure to free.
- **Returns**: void
- **Description**: Free the dependency structure Dpnds.
- **See also**: IPODFreeParametersOfObj, IPODFreeDependenciesOfObj,

9.2.255  IPODFreeDependenciesOfObj (obj_dpnd.c:411)

```c
void IPODFreeDependenciesOfObj(IPODDependsStruct *ObjDepends)
```

- **ObjDepends**: List of dependencies to free.
- **Returns**: void
- **Description**: Free the dependency list of this objects (list of other objects depending on this one).
- **See also**: IPODFreeParametersOfObj, IPODFreeDependencies,

9.2.256  IPODFreeParametersOfObj (obj_dpnd.c:379)

```c
void IPODFreeParametersOfObj(IPODParamsStruct *ObjParams)
```

- **ObjParams**: List of parameters to free.
- **Returns**: void
- **Description**: Free the parameter list dependencies (list of objects this object depends upon).
- **See also**: IPODFreeDependenciesOfObj, IPODFreeDependencies,
9.2.257  IPODNewDependencies  (obj\dpnd.c:94)

IPODObjectDpndncyStruct *IPODNewDependencies(void)

Returns: Allocated structure.
Description: Allocates new dependency structure to hold all dependencies and params.
See also: IPODNewParametersOfObj, IPODNewDependenciesOfObj.

9.2.258  IPODNewDependenciesOfObj  (obj\dpnd.c:64)

IPODDependsStruct *IPODNewDependenciesOfObj(char *Name, IPODDependsStruct *Pnext)

Name: Name of dependency, NULL if none.
Pnext: Next dependency, NULL if none.
Returns: Allocated structure.
Description: Allocates new dependency on this object (of another object) structure.
See also: IPODNewDependencies, IPODNewParametersOfObj.

9.2.259  IPODNewParametersOfObj  (obj\dpnd.c:32)

IPODParamsStruct *IPODNewParametersOfObj(char *Name, IPODParamsStruct *Pnext)

Name: Name of parameter, NULL if none.
Pnext: Next parameter, NULL if none.
Returns: Allocated structure.
Description: Allocates new parameter (of this object) dependency structure.
See also: IPODNewDependencies, IPODNewDependenciesOfObj.

9.2.260  IPODPrintDependencies  (obj\dpnd.c:513)

void IPODPrintDependencies(IPObjectStruct *PObj)

PObj: To print its dependency structure.
Returns: void
Description: Debug function to print the content of the dependency structure.

9.2.261  IPODUpdateAllDependencies  (obj\dpnd.c:472)

void IPODUpdateAllDependencies(IPODObjectDpndncyStruct *ObjDpnd)

ObjDpnd: To start this recursive visit.
Returns: void
Description: Recursively visit all objects this ObjDpnd affects (all other objects that depends on this one) and reevaluate them.
See also: IPODEvalOneObject,
9.2.262  IPObjListLen (linklist.c:835)

    int IPObjListLen(const IPObjectStruct *O)

    O: Object list to compute its length.
    Returns: Number of elements in O list.
    Description: Returns the length of a list of objects.

9.2.263  IPObjLnkListToListObject (linklist.c:521)

    IPObjectStruct *IPObjLnkListToListObject(IPObjectStruct *ObjLnkList)

    ObjLnkList: Linked list of object to convert.
    Returns: A list object holding all items in linked list.
    Description: Converts a linked list of objects into one list object, in place.
    See also: IPAppendListObjects, IPLnkListToListObject, IPLinkedListToObjList,

9.2.264  IPObjTypeAsString (allocate.c:99)

    const char *IPObjTypeAsString(const IPObjectStruct *PObj)

    PObj: To return its type as a string.
    Returns: The string description of the object type.
    Description: Returns a a string-description of the given object’s type.

9.2.265  IPOpenDataFile (iritprs1.c:145)

    int IPOpenDataFile(const char *FileName, int Read, int Messages)

    FileName: To try and open.
    Read: If TRUE assume a read operation, otheriwse write.
    Messages: Do we want error/warning message?
    Returns: A handler to the open file, -1 if error.
    Description: Open a data file for read/write. Data file can be either Ascii IRIT data file or binary IRIT data file. A binary data file must have a ".ibd" (for Irit Binary Data) file type. Under unix, file names with the postfix ".Z" are assumed compressed and treated accordingly.
    See also: IPGetObjects, IPSetPolyListCirc, IPSetFlattenObjects, , SetReadOneObject,

9.2.266  IPOpenPolysToClosed (ipcnvrt.c:2030)

    void IPOpenPolysToClosed(IPPolygonStruct *Pls)

    Pls: Polygons to process, in place.
    Returns: void
    Description: Forces the given list of polygons to have closed list of vertices
    See also: IPClosedPolysToOpen, GMVrtxListToCircOrLin,
9.2.267  IPOpenStreamFromCallBackIO  (iritprs1.c:490)

```
int IPOpenStreamFromCallBackIO(IPStreamReadCharFuncType ReadFunc,
    IPStreamWriteBlockFuncType WriteFunc,
    int Read,
    int IsBinary)

  ReadFunc: A call back function to read a character (non blocking). will be ignored if Read == FALSE.
  WriteFunc: A call back function to write a block of data. will be ignored if Read == TRUE.
  Read:   TRUE for reading from f, FALSE for writing to f.
  IsBinary: Is it a binary file?

  Returns: A handle on the constructed stream.
```

**Description:** Open a stream using direct call back function(s) to read/write data.

**See also:** IPOpenStreamFromFile, IPProcessFreeForm2,

9.2.268  IPOpenStreamFromFile  (iritprs1.c:533)

```
int IPOpenStreamFromFile(FILE *f,
    int Read,
    int IsBinary,
    int IsCompressed,
    int IsPipe)

  f: A handle to the open file.
  Read: TRUE for reading from f, FALSE for writing to f.
  IsBinary: Is it a binary file?
  IsCompressed: Is it compressed file?
  IsPipe: Is it a pipe?

  Returns: A handle on the constructed stream.
```

**Description:** Converts an open file into a stream.

**See also:** IPOpenStreamFromCallBackIO, IPProcessFreeForm2,

9.2.269  IPOpenStreamFromFile2  (iritprs1.c:565)

```
int IPOpenStreamFromFile2(FILE *f,
    int Read,
    IPStreamFormatType Format,
    int IsBinary,
    int IsCompressed,
    int IsPipe)

  f: A handle to the open file.
  Read: TRUE for reading from f, FALSE for writing to f.
  Format: IRIT Dat, VRML, etc.
  IsBinary: Is it a binary file?
  IsCompressed: Is it compressed file?
  IsPipe: Is it a pipe?

  Returns: A handle on the constructed stream.
```

**Description:** Converts an open file into a stream.

**See also:** IPOpenStreamFromCallBackIO, IPOpenStreamFromCallBackIO,
9.2.270 IPOpenStreamFromSocket (iritprs1.c:615)

```c
int IPOpenStreamFromSocket(int Soc, int IsBinary)
```

**Soc:** A handle to the open socket.

**IsBinary:** Is it a binary file?

**Returns:** A handle on the constructed stream.

**Description:** Converts an open socket into a stream.

9.2.271 IPOpenStreamFromVrml (iritvrml.c:701)

```c
int IPOpenStreamFromVrml(FILE *f, int Read, int IsBinary, int IsPipe)
```

**f:** A handle to the open file.

**Read:** TRUE for reading from f, FALSE for writing to f.

**IsBinary:** Is it a binary file? Currently only text vrml is supported.

**IsPipe:** Is it a pipe?

**Returns:** A handle on the constructed stream.

**Description:** Converts an open file into a stream.

**See also:** IPOpenStreamFromFile

9.2.272 IPOpenVrmlFile (iritvrml.c:654)

```c
int IPOpenVrmlFile(const char *FileName, int Messages, IrtRType Resolution)
```

**FileName:** To try and open.

**Messages:** Do we want error/warning messages?

**Resolution:** Pass Irit interpreter state variable, due to the need of freeforms to polygon conversions.

**Returns:** A handler to the open file, -1 if error.

**Description:** Open a data file for write. Data file can be Ascii VRML 2.0 data file only.

**See also:** IPGetObjects, IPSetPolyListCirc, IPSetFlattenObjects, IPSetReadOneObject

9.2.273 IPPolyListLen (linklist.c:813)

```c
int IPPolyListLen(const IPPolygonStruct *P)
```

**P:** Polygon list to compute its length.

**Returns:** Number of elements in P list.

**Description:** Returns the length of a list of polygons.

9.2.274 IPPolyVrtxIdxFree (allocate.c:1114)

```c
void IPPolyVrtxIdxFree(IPPolyVrtxIdxStruct *PVIdx)
```

**PVIdx:** Data structure to free.

**Returns:** void

**Description:** Release a data structure of a polygonal mesh as vertex/polygon index structure with a linear vector of NumVrtcs vertices and NumPlys polygons.

**See also:** IPPolyVrtxIdxNew,
9.2.275  IPPolyVrtxIdxNew (allocate.c:1078)

IPPolyVrtxIdxStruct *IPPolyVrtxIdxNew(int NumVrtcs, int NumPlys)

- **NumVrtcs**: Number of different vertices in the mesh.
- **NumPlys**: Number of polygons in the mesh.
- **Returns**: The constructed data structure.

**Description**: Allocate a data structure of a polygonal mesh as vertex/polygon index structure with a linear vector of NumVrtcs vertices and NumPlys polygons.

**See also**: IPPolyVrtxIdxFree,

9.2.276  IPPolyVrtxIdxNew2 (allocate.c:1046)

IPPolyVrtxIdxStruct *IPPolyVrtxIdxNew2(IPObjectStruct *PObj)

- **PObj**: Polygonal mesh to convert to vertex/polygon index struct.
- **Returns**: The constructed data structure.

**Description**: Allocate a data structure of a polygonal mesh as vertex/polygon index structure with a linear vector of NumVrtcs vertices and NumPlys polygons.

**See also**: IPPolyVrtxIdxFree, IPPolyVrtxIdxNew,

9.2.277  IPPolygonSetErrFunc (ipcnvrt.c:941)

CagdPlgErrorFuncType IPPolygonSetErrFunc(CagdPlgErrorFuncType Func)

- **Func**: New function to use, NULL to disable.
- **Returns**: Old value of function.

**Description**: Sets the polygon approximation error function. The error function will return a negative value if this triangle must be purged or otherwise a non negative error measure.

9.2.278  IPPolyline2Curve (ipcnvrt.c:368)

CagdCrvStruct *IPPolyline2Curve(const IPPolygonStruct *Pl, int Order)

- **Pl**: Polyline to convert to curve.
- **Order**: Typically 2 for linear, but can be higher order as well. In all cases, the input polyline points serve as control points.
- **Returns**: A curve.

**Description**: Routine to convert one polyline into a curve, typically linear.

**See also**: CagdCnvrtPolyline2LinBspCrv,

9.2.279  IPProcessFreeForm (ip_procs.c:32)

IPObjectStruct *IPProcessFreeForm(IPFreeFormStruct *FreeForms)

- **FreeForms**: Freeform geometry to process, in place.
- **Returns**: Processed freeform geometry. This function simply returns what it got.

**Description**: Default processor of read freeform geometry. This routine does not process the freeform geometry in any way. Other programs, for example, convert the freeform shapes to polygons or polylines using the call back function or purge the freeform data if it is not supported. Processing should be done in place.
9.2.280  IPProcessModel2TrimSrfs (iritprs1.c:1472)

```c
int IPProcessModel2TrimSrfs(IPFreeFormStruct *FreeForms)
```

**FreeForms**: Freeform model to process into trimmed srfs, in place.
**Returns**: TRUE if models were found and processed, FALSE otherwise.
**Description**: Process a model freeform into trimmed surfaces freeform, in place.

9.2.281  IPProcessReadObject (iritprs1.c:1227)

```c
IPObjectStruct *IPProcessReadObject(IPObjectStruct *PObj)
```

**PObj**: Object to process.
**Returns**: Processed object, in place.
**Description**: Process a read object, in place, before returning it to the caller. List objects of zero or one elements are eliminated. Attributes are propagated throughout the hierarchy. If FlattenTree mode (see IPSetFlattenObjects) hierarchy is flattened out.

9.2.282  IPPropagateObjectName (allocate.c:2111)

```c
void IPPropagateObjectName(IPObjectStruct *Obj, const char *ObjName)
```

**Obj**: To propagate object names from. Root of hierarchy.
**ObjName**: Object name to propagate, NULL if to be picked up from Obj.
**Returns**: void
**Description**: Routine to propagate the object name down the object hierarchy. Objects with no name assign will inherit the name propagated to them from above. If input name is ObjName, the hierarchy will be assigned names of the form RootName{,%d}.

9.2.283  IPPutBinObject (iritprsb.c:1713)

```c
void IPPutBinObject(int Handler, const IPObjectStruct *PObj)
```

**Handler**: A handler to the open stream. *
**PObj**: Object to write.
**Returns**: void
**Description**: Routine to write one object to a given binary file, directly. Objects may be recursively defined, as lists of objects.

9.2.284  IPPutMatrixFile (iritprs2.c:606)

```c
int IPPutMatrixFile(const char *File,
                    IrtHmgnMatType ViewMat,
                    IrtHmgnMatType ProjMat,
                    int HasProjMat)
```

**File**: File to write the matrix file to.
**ViewMat, ProjMat**: Matrices to put.
**HasProjMat**: TRUE if has a perspective matrix, FALSE otherwise.
**Returns**: TRUE if successful, FALSE otherwise.
**Description**: Puts an IRIT matrix file.
**See also**: IPGetMatrixFile,
9.2.285  IPPutObjectToFile (iritprs2.c:106)

void IPPutObjectToFile(FILE *f, const IPObjectStruct *PObj, int IsBinary)

  f: Output stream file handle.
  PObj: Object to put on output stream.
  IsBinary: Is this a binary file we should dump?
  Returns: void

  Description: Routine to print the data from given object into given file handle. See function IPSetPrintFunc, IPSetFloatFormat.

9.2.286  IPPutObjectToFile2 (iritprs2.c:151)

void IPPutObjectToFile2(FILE *f, const IPObjectStruct *PObj, int Indent)

  f: Output stream.
  PObj: Object to put on output stream.
  Indent: File indentation (always a text file).
  Returns: void

  Description: Routine to print the data from given object into given file FileName. If FileName is NULL or empty, print using IPPrintFunc. See function IPSetPrintFunc, IPSetFloatFormat.

9.2.287  IPPutObjectToHandler (iritprs2.c:190)

void IPPutObjectToHandler(int Handler, const IPObjectStruct *PObj)

  Handler: A handler to the open stream.
  PObj: Object to put on output stream.
  Returns: void

  Description: Routine to print the data from given object into given file designated via Handler. See also: IPSetPrintFunc, IPSetFloatFormat, IPPrintFunc.

9.2.288  IPPutVrmlViewPoint (iritvrml.c:2380)

void IPPutVrmlViewPoint(int Handler, IrtHmgnMatType *Mat, int Indent)

  Handler: To put the generated VRML into.
  Mat: To dump as the viewing matrix.
  Indent: Level of indentation in VRML.
  Returns: void

  Description: Update a view point in VRML style based upon a VIEW_MAT matrix in the geometry stream.

9.2.289  IPReallocNewTypeObject (allocate.c:2169)

void IPReallocNewTypeObject(IPObjectStruct *PObj, IPObjStructType ObjType)

  PObj: Object to reallocated as a new object of type ObjType.
  ObjType: New type for object PObj.
  Returns: void

  Description: Routine to reallocate as necessary and object to a new object type.
9.2.290  **IPResolveInstances** (iritprs1.c:865)

    IObjectStruct *IPResolveInstances(IObjectStruct *PObjects)

    **PObjects**: To eliminate instances from, in place.
    **Returns**: Same geometry as in PObjects but without instances.
    **Description**: Resolves, in place, all instances in the objects into their proper geometry. This functions hence eliminates all instances' objects while increasing the size of the data, and do so in place.

9.2.291  **IPReverseListObj** (linklist.c:56)

    IObjectStruct *IPReverseListObj(IObjectStruct *ListObj)

    **ListObj**: List object to reverses its entries, in place.
    **Returns**: Reversed list object.
    **Description**: Reverses a list. Original input list is used in place.
    **See also**: IPReverseObjList,

9.2.292  **IPReverseObjList** (linklist.c:89)

    IObjectStruct *IPReverseObjList(IObjectStruct *PObj)

    **PObj**: A list of objects to reverse.
    **Returns**: Reverse list of objects, in place.
    **Description**: Reverses a list of objects, in place.
    **See also**: IPReverseListObj,

9.2.293  **IPReverseObject** (coerce.c:1187)

    IObjectStruct *IPReverseObject(IObjectStruct *PObj)

    **PObj**: Input object to reverse.
    **Returns**: Reversed object.
    **Description**: Returns a similar hierarchy to given one but with reversed semantics.

9.2.294  **IPReversePlList** (linklist.c:120)

    IPPolygonStruct *IPReversePlList(IPPolygonStruct *PPl)

    **PPl**: A list of polygons to reverse.
    **Returns**: Reversed list of polygons, in place.
    **Description**: Reverses a list of polygons, in place.

9.2.295  **IPReverseVrtxList** (linklist.c:153)

    void IPReverseVrtxList(IPPolygonStruct *Pl)

    **Pl**: A polygon to reverse its vertex list, in place.
    **Returns**: void
    **Description**: Reverses the vertex list of a given polygon. This is used mainly to reverse polygons such that cross product of consecutive edges which form a convex corner will point in the polygon normal direction.
9.2.296  IPReverseVrtxList2  (linklist.c:215)

IPVertexStruct *IPReverseVrtxList2(IPVertexStruct *PVertex)

PVertex: A list of vertices to reverse.
Returns: Reversed list of vertices, in place.
Description: Reverses a list of vertices of a polyline, in place. The list is assumed to be non circular and hence can be treated as a polyline.

9.2.297  IPSTLLoadFile  (stlirit.c:77)

IPObjectStruct *IPSTLLoadFile(const char *STLFileName,
   int BinarySTL,
   int EndianSwap,
   int NormalFlip,
   int Messages)

STLFileName: Name of STL file.
BinarySTL: TRUE if input STL is a binary file.
EndianSwap: Swap non char-long entities (little vs. big binaries endings).
NormalFlip: Flip normal directions if TRUE.
Messages: 1 for error messages, 2 to include warning messages, 3 to include informative messages. 4 to include dump of IRIT objects.
Returns: Read STL DATA or NULL if error.
Description: Read STL file into IRIT data.
See also: IPSTLSaveFile, IPSTLLoadFileSetDefaultParameters,

9.2.298  IPSTLLoadFileSetDefaultParameters  (iritprs1.c:1106)

void IPSTLLoadFileSetDefaultParameters(int BinarySTL,
   int EndianSwap,
   int NormalFlip,
   int Messages)

BinarySTL: TRUE if input STL is a binary file.
EndianSwap: Swap non char-long entities (little vs. big binaries endings).
NormalFlip: Flip normal directions if TRUE.
Messages: 1 for error messages, 2 to include warning messages, 3 to include informative messages. 4 to include dump of IRIT objects.
Returns: void
Description: Sets default loading parameters for STL files.
See also: IPGetObjects, IPSTLLoadFile,

9.2.299  IPSTLSaveFile  (irit_stl.c:97)

int IPSTLSaveFile(const IPObjectStruct *PObj,
   IrtHggnMatType CrntViewMat,
   int RegularTriang,
   int MultiObjSplit,
   const char *STLFileName,
   int Messages)

PObj: IritObject to dump as STL file.
CrntViewMat: The current viewing matrix to apply to the object.
**RegularTriang:** Should we regularized the triangles before dumping them?

**MultiObjSplit:** 0 to save everything as one large file, 1 to save every IRIT object as a separate STL object, 2 to save every IRIT object as a separate STL object in a separated file.

**STLFileName:** Name of STL file, "." or NULL for stdout.

**Messages:** TRUE for warning messages.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Dumps IRIT object as an STL file.

See also: IPSTLLoadFile, IPSTLSaveSetVrtxEps,

### 9.2.300 IPSTLSaveSetVrtxEps (irit_stl.c:59)

```
IrtRType IPSTLSaveSetVrtxEps(IrtRType SameVrtxEps)
```

**SameVrtxEps:** New epsilon.

**Returns:** Old epsilon.

**Description:** Sets the epsilon euqality of two vertices, to be considered the same.

See also: IPSTLSaveFile,

### 9.2.301 IPSenseBinaryFile (iritprs1.c:353)

```
int IPSenseBinaryFile(const char *FileName)
```

**FileName:** File to sense.

**Returns:** TRUE if binary, FALSE if text.

**Description:** Senses if a given file (name) is a binary or a text file.

See also: IPSenseFileType,

### 9.2.302 IPSenseCompressedFile (iritprs1.c:389)

```
int IPSenseCompressedFile(const char *FileName)
```

**FileName:** File to sense.

**Returns:** TRUE if compressed, FALSE else.

**Description:** Senses if a given file (name) is a compressed file.

See also: IPSenseFileType,

### 9.2.303 IPSenseFileType (iritprs1.c:279)

```
IPStreamFormatType IPSenseFileType(const char *FileName)
```

**FileName:** The files’ name to sense file type from.

**Returns:** Type of file detected.

**Description:** Attempts to detect the type of the file from its name.

See also: IPSenseBinaryFile,

### 9.2.304 IPSetCopyObjectReferenceCount (allocate.c:2203)

```
int IPSetCopyObjectReferenceCount(int RefCount)
```

**RefCount:** TRUE for reference count, FALSE for extensive copy.

**Returns:** Old value of reference count state.

**Description:** Controls of a copy is via reference counts or extensive (no ref. counts)

See also: IPCopyObject,
9.2.305  IPSetCurvesToCubicBzrTol (ip_{cnvt}.c:1539)

IrtRType IPSetCurvesToCubicBzrTol(IrtRType Tolerance)

Tolerance: Of approximation to use.
Returns: Old value of cubic Bezier tolerance.
Description: Sets the tolerance that is used by the Bezier to Cubic Bezier conversion routines IritCurvesToCubicBzrCrvs and IritSurfacesToCubicBzrCrvs

9.2.306  IPSetFatalErrorFunc (prsr_{ftl}.c:29)

IPSetErrorFuncType IPSetFatalErrorFunc(IPSetErrorFuncType ErrorFunc)

ErrorFunc: New error function to use.
Returns: Old error function reference.
Description: Sets the error function to be used by Prsr_{lib}.

9.2.307  IPSetFilterDegen (iritprs2.c:762)

int IPSetFilterDegen(int FilterDegeneracies)

FilterDegeneracies: TRUE to filter, FALSE to load/dump anyway.
Returns: Old value of this state.
Description: Sets the filtering mode of degenerated geometry while save/load.

9.2.308  IPSetFlattenObjects (iritprs1.c:1255)

int IPSetFlattenObjects(int Flatten)

Flatten: If TRUE, list objects will be flattened out to a long linear list. If FALSE, read object will be unchanged.
Returns: Old value of flatten state.
Description: Controls the hierarchy flattening of a read object.

9.2.309  IPSetFloatFormat (iritprs2.c:783)

char *IPSetFloatFormat(const char *FloatFormat)

FloatFormat: A printf style floating point printing format string.
Returns: Old float format.
Description: Sets the floating point printing format.

9.2.310  IPSetPolyListCirc (prsrgeom.c:233)

int IPSetPolyListCirc(int Circ)

Circ: If TRUE, vertex lists of polygons will be circular. If FALSE, the lists will be NULL terminated.
Returns: Old value of flag.
Description: Controls vertex list in polygons. Do we want it circular?
See also: IPGetObjects,
9.2.311  IPSetPrintFunc (iritprs2.c:739)

IPPrintFuncType IPSetPrintFunc(IPPrintFuncType PrintFunc)

PrintFunc: A function that gets a single string it should print.
Returns: Old value of this state.
Description: Sets the printing function to call if needs to redirect printing.
See also: IPCnvReal2Str, IPSetFloatFormat, IPPrintFunc,

9.2.312  IPSetProcessLeafFunc (iritprs1.c:1353)

IPProcessLeafObjType IPSetProcessLeafFunc(IPProcessLeafObjType ProcessLeafFunc)

ProcessLeafFunc: A pointer to a call back function to be invoked on every leaf object read in.
Returns: Old call back pointer value.
Description: Sets a call back function on every leaf object read in.
See also: IPGetObjects,

9.2.313  IPSetPropagateAttrs (iritprs1.c:1278)

int IPSetPropagateAttrs(int Propagate)

Propagate: If TRUE, attributes will be propagated from internal nodes to the leaves.
Returns: Old value of propagation state.
Description: Controls the propagation of attributes from internal nodes to the leaves.

9.2.314  IPSetReadOneObject (iritprs1.c:1328)

int IPSetReadOneObject(int OneObject)

OneObject: If TRUE, only next object will be read by IPGetObjectst. If FALSE, objects will be read until
EOF is detected and placed in a linked list.
Returns: Old value of read one object.
Description: Controls the way the Ascii/bin parser handle multiple objects in a file.
See also: IPGetObjects,

9.2.315  IPSetSubObjectName (linklist.c:1163)

void IPSetSubObjectName(IPObjectStruct *PListObj, int Index, const char *Name)

PListObj: A list object.
Index: Of object in PListObj to change its name.
Name: New name of sub object.
Returns: void
Description: Sets the name of object number Index in list object PListObj into Name.
9.2.316  **IPSetVrmlExternalMode**  (iritvrml.c:624)

```c
int IPSetVrmlExternalMode(int On)
```

**On:** SID mode is enabled if TRUE.

**Returns:** old value.

**Description:** Sets the mode of translating IRIT object tree into VRML graph. If TRUE then output file is suitable for External activation usage. Otherwise, it can be used for standalone viewing in VRML 2.0 browser. Default is TRUE.

9.2.317  **IP SocClntInit**  (sockets.c:379)

```c
int IPSocClntInit(void)
```

**Returns:** Handle to the socket stream, -1 if failed.

**Description:** Initialize the clients's needs - builds the socket etc.

9.2.318  **IP SocDisConnectAndKill**  (sockets.c:334)

```c
int IPSocDisConnectAndKill(int Kill, int Handler)
```

**Kill:** If TRUE, send a KILL message to the client process.

**Handler:** The socket info handler. If IP_CLNT_BROADCAST_ALL_HANDLES do a broadcast write.

**Returns:** TRUE, if succesful, FALSE otherwise.

**Description:** Close, and optionally kill, io channels to another client process.

9.2.319  **IP SocEchoInput**  (sockets.c:604)

```c
void IPSocEchoInput(int Handler, int EchoInput)
```

**Handler:** The socket info handler index. If IP_CLNT_BROADCAST_ALL_HANDLES do a broadcast update.

**EchoInput:** TRUE to echo every character read in.

**Returns:** void

**Description:** Sets echo printing of read input.

9.2.320  **IP SocExecAndConnect**  (sockets.c:265)

```c
int IPSocExecAndConnect(const char *Program, int IsBinary)
```

**Program:** Name of program to execute. Name can be NULL, in which the user is prompt to execute the program manually.

**IsBinary:** If TRUE sets channels to binary, if FALSE channels are text. This is assuming no IRIT_BIN_IPC environment variable is set, when communication will always be binary.

**Returns:** Handle of client if succesful, -1 otherwise.

**Description:** Executes the given program and connect to its io ports. This function is typically called by a server that syncronically forks out a client.
9.2.321  IPSocHandleClientEvent (sockaux.c:26)

void IPSocHandleClientEvent(int Handler, IPObjStruct *PObj)

    Handler: Client handler from which an event has been received.
    PObj: NULL if a new client has connected, Object received from Client otherwise.

    Returns: void

    Description: Call back function of the server listening to clients.

9.2.322  IPSocReadCharNonBlock (sockets.c:638)

int IPSocReadCharNonBlock(int Handler)

    Handler: The socket info handler index.

    Returns: Read character or EOF if none found.

    Description: Non blocking read of a single character. Returns EOF if no data is found.

9.2.323  IPSocReadLineNonBlock (sockets.c:780)

char *IPSocReadLineNonBlock(int Handler)

    Handler: The socket info handler.

    Returns: Read line, or NULL if unavailable.

    Description: Non blocking read of a single line. Returns NULL if no line is available.

9.2.324  IPSocReadOneObject (sockets.c:829)

IPObjStruct *IPSocReadOneObject(int Handler)

    Handler: The socket info handler.

    Returns: An object if read one, NULL otherwise.

    Description: Attempts to read (non blocking) an object from socket. If read is successful the object is returned, otherwise NULL is returned.

9.2.325  IPSocSrvrInit (sockets.c:92)

int IPSocSrvrInit(void)

    Returns: TRUE if successful, FALSE otherwise.

    Description: Initialize the server’s needs - builds the listening socket etc.

9.2.326  IPSocSrvrListen (sockets.c:208)

int IPSocSrvrListen(void)

    Returns: FALSE if no new requests, TRUE otherwise.

    Description: Listen to requests from clients. A non blocking function that samples all active clients for possible requests.
9.2.327  **IPSCWriteBlock** *(sockets.c:509)*

```c
int IPSocWriteBlock(int Handler, void *Block, int BlockLen)
```

**Handler:** The socket info handler. If IP_CLNT_BROADCAST_ALL_HANDLES do a broadcast write.

**Block:** Block to write.

**BlockLen:** Length of block to write.

**Returns:** TRUE if write succesful, FALSE otherwise.

**Description:** Writes a single block of BlockLen bytes.

9.2.328  **IPSCWriteOneObject** *(sockets.c:448)*

```c
void IPSocWriteOneObject(int Handler, IPObjectStruct *PObj)
```

**Handler:** The socket info handler. If IP_CLNT_BROADCAST_ALL_HANDLES do a broadcast write.

**PObj:** Object to write to the client's socket.

**Returns:** void

**Description:** Attempts to write an object to a socket.

9.2.329  **IPStderrObject** *(iritprs2.c:85)*

```c
void IPStderrObject(const IPObjectStruct *PObj)
```

**PObj:** To be put out to stderr.

**Returns:** void

**Description:** Routine to print the data from given object into stderr.

9.2.330  **IPStdoutObject** *(iritprs2.c:67)*

```c
void IPStdoutObject(const IPObjectStruct *PObj, int IsBinary)
```

**PObj:** To be put out to stdout.

**IsBinary:** Is this a binary file we should dump?

**Returns:** void

**Description:** Routine to print the data from given object into stdout.

9.2.331  **IPSurface2CtlMesh** *(ipcnvrt.c:554)*

```c
IPPolygonStruct *IPSurface2CtlMesh(const CagdSrfStruct *Srf)
```

**Srf:** To extract its control mesh as a polylines.

**Returns:** A polylines object representing Srf’s control mesh.

**Description:** Routine to convert a single surface’s control mesh into a polylines object.
9.2.332  IPSurface2Polygons (ip\_cnvrt.c:990)

IPPolygonStruct *IPSurface2Polygons(CagdSrfStruct *Srf,
  int FourPerFlat,
  IrtRType FineNess,
  int ComputeUV,
  int ComputeNrml,
  int Optimal)

Srf: To approximate using polygons.

FourPerFlat: If TRUE, four triangle per flat surface patch are created, otherwise two. Only for uniform, non 
onoptimal, sampling.

FineNess: Fineness control on polygonal approximation. If!Optimal, uniform sampling in the order of FineNess 
Sampling is used. If Optimal, FineNess prescribes the maximal distance between the surface and its 
polygonal approximation.

ComputeUV: Do we want UV parameter values with the vertices of the triangles?

ComputeNrml: Do we want normals to vertices?!

Optimal: If FALSE, then parametric space of Srf is sampled uniformly, order of FineNess samples per direction. 
If TRUE, the adaptively created polygonal approximation is guaranteed to be within FineNess distance 
to the surface.

Returns: Resulting polygons that approximates Srf.

Description: Routine to approximate a single surface by polygons. The polygonal approximation routines have 
call back functions to invoke for each new polygon and if these call back functions are used, this function might return 
NULL. See IPGenTriangle and IPGenRectangle.

See also: CagdSrf2Polygons, CagdSrfAdap2Polygons, IPGenTriangle, IPGenRectangle, IPSurface2PolygonsGenTriOnly,

9.2.333  IPSurface2PolygonsGenDegenPolys (ip\_cnvrt.c:917)

int IPSurface2PolygonsGenDegenPolys(int GenDegenPolys)

GenDegenPolys: TRUE for creating degenerated triangles and rectangles, FALSE otherwise.

Returns: Old value of flag.

Description: Controls the generation of degenerated triangles and rectangles, in the tesselation process.

See also: IPSurface2Polygons,

9.2.334  IPSurface2PolygonsGenTriOnly (ip\_cnvrt.c:890)

int IPSurface2PolygonsGenTriOnly(int OnlyTri)

OnlyTri: TRUE for triangles only, FALSE otherwise.

Returns: Old value of flag.

Description: Controls the generation of triangles only, in the tesselation process.

See also: IPSurface2Polygons,

9.2.335  IPSurface2Polylines (ip\_cnvrt.c:441)

IPPolygonStruct *IPSurface2Polylines(const CagdSrfStruct *Srf,
  int NumOfIsolines[2],
  CagdRType TolSamples,
  SymbCrvApproxMethodType Method)

Srf: To approximate as a polyline.

NumOfIsolines: Number of isocurves to extract, in each direction.
**TolSamples:** Tolerance of approximation error (Method = 2) or Number of samples to compute on polyline (Method = 0, 1).

**Method:** 0 - TolSamples are set uniformly in parametric space, 1 - TolSamples are set optimally, considering the isocurve’s curvature. 2 - TolSamples sets the maximum error allowed between the piecewise linear approximation and original curve.

**Returns:** A polyline object approximating Srf.

**Description:** Routine to convert a single surface into polylines with TolSamples samples or tolerance per isoline curve as a polyline object. If NumOfIsolines has negative value, its absolute value is heuristically used to derive a new NumOfIsolines number for it.

**See also:** IPCurve2Polylines,

### 9.2.336 IPSurfacesToCubicBzrCrvs (ip_cvrt.c:1645)

```
CagdCrvStruct *IPSurfacesToCubicBzrCrvs(CagdSrfStruct *Srfs,
                                         IPPolygonStruct **CtlMeshes,
                                         CagdBType DrawSurface,
                                         CagdBType DrawMesh,
                                         int NumOfIsolines[2],
                                         CagdRType MaxArcLen)
```

**Srfs:** To approximate as cubic Bezier curves.

**CtlMeshes:** If we want control meshes as well (DrawMesh == TRUE) they will be placed herein.

**DrawSurface:** Do we want to draw the surfaces?

**DrawMesh:** Do we want to draw the control meshes?

**NumOfIsolines:** Number of isocurves to extract, in each direction.

**MaxArcLen:** Tolerance for cubic Bezier approximation. See function SymbApproxCrvAsBzrCubics.

**Returns:** The cubic Bezier approximation, or NULL if DrawSurface is FALSE.

**Description:** Approximates an arbitrary list of surfaces into cubic Beziers curves.

**See also:** IPSurfacesToCubicBzrSrfs,

### 9.2.337 IPSurfacesToCubicBzrSrfs (ip_cvrt.c:1934)

```
CagdSrfStruct *IPSurfacesToCubicBzrSrfs(CagdSrfStruct *Srfs,
                                         CagdSrfStruct **NoConvertionSrfs)
```

**Srfs:** To approximate as cubic Bezier surfaces.

**NoConvertionSrfs:** List of surface that cannot be converted to bicubics.

**Returns:** The cubic Bezier approximation, or NULL if nothing has been converted.

**Description:** Converts an arbitrary list of surfaces into cubic integral Bezier surfaces, if possible. Any rational or surface with degrees higher than cubic cannot be converted and is left as is in the NoConvertionSrfs list.

**See also:** IPSurfacesToCubicBzrCrvs,

### 9.2.338 IPTraverseInvisibleObject (linklist.c:1246)

```
int IPTraverseInvisibleObject(int TraverseInvObj)
```

**TraverseInvObj:** TRUE for always traversing invisible objects, FALSE for traversing invisible objects, only if in instances.

**Returns:** Old state value.

**Description:** Controls if the traversal will be performed over hidden objs as well.

**See also:** IPTraverseObjHierarchy, IPTraverseObjListHierarchy, IPTraverseObjectAll,
9.2.339  IPTraverseObjHierarchy (linklist.c:1316)

```c
void IPTraverseObjHierarchy(IPObjectStruct *PObj,
          IPObjectStruct *PObjList,
          IPApplyObjFuncType ApplyFunc,
          IrtHmgnMatType Mat,
          int PrntInstance)
```

| PObj: | To traverse and apply. |
| PObjList: | DB to search instance of objects by name. |
| ApplyFunc: | To invoke on each and every non leaf object. |
| Mat: | Local transformation matrix of current instance. |
| PrntInstance: | If TRUE, we were invoked via an instance reference. |

Returns: void

Description: Auxiliary function of IPTraverseObjListHierarchy. Instances are converted into their real objects on the fly. Objects that have an "Invisible" attribute are potentially ignored (they might be invoked indirectly as an instance).

See also: IPTraverseObjListHierarchy, IPTraverseObjectAll, IPTraverseObjectCopy, IPTraverseInvisibleObject,

9.2.340  IPTraverseObjListHierarchy (linklist.c:1280)

```c
void IPTraverseObjListHierarchy(IPObjectStruct *PObjList,
          IrtHmgnMatType CrntViewMat,
          IPApplyObjFuncType ApplyFunc)
```

| PObjList: | To traverse and apply. |
| CrntViewMat: | Viewing matrix. |
| ApplyFunc: | To invoke on each and every leaf object. |

Returns: void

Description: Traverses a hierarchy of objects and invokes ApplyObject to each leaf (non list) object in the given object list with an associated matrix. Instances are converted into their real objects on the fly. Objects that have an "Invisible" attribute are potentially ignored (they might be invoked indirectly as an instance).

See also: IPTraverseObjHierarchy, IPTraverseObjectAll, IPTraverseObjectCopy, IPTraverseInvisibleObject,

9.2.341  IPTraverseObjectAll (linklist.c:1219)

```c
int IPTraverseObjectAll(int TraverseObjAll)
```

| TraverseObjAll: | TRUE for calling the call back function in all nodes, FALSE for calling the call back on leaves only. |

Returns: Old state value.

Description: Controls if the call back function will be invoked in ALL nodes or just the leaves of the tree. If all nodes invoke the call back function, in the interior nodes the call back will be invoked before the node recurse into its sons.

See also: IPTraverseObjHierarchy, IPTraverseObjListHierarchy, IPTraverseInvisibleObject,

9.2.342  IPTraverseObjectCopy (linklist.c:1189)

```c
int IPTraverseObjectCopy(int TraverseObjCopy)
```

| TraverseObjCopy: | TRUE for traversal of copy, FALSE traversal of original. |

Returns: Old state value.

Description: Controls if the hierarchy traversal will be over a copy of the object.

See also: IPTraverseObjHierarchy, IPTraverseObjListHierarchy,
9.2.343 **IPTriSrf2CtlMesh** ([ip.cnvrt.c:1516])

IPPolygonStruct *IPTriSrf2CtlMesh(TrngTriangSrfStruct *TriSrf)

**TriSrf:** To extract its control mesh as a polylines.

**Returns:** A polylines object representing TriSrf's control mesh.

**Description:** Routine to convert a single triangular patch's control mesh into a polylines object.

9.2.344 **IPTriSrf2Polygons** ([ip.cnvrt.c:1426])

IPPolygonStruct *IPTriSrf2Polygons(TrngTriangSrfStruct *TriSrf,
                                IrtRType FineNess,
                                int ComputeUV,
                                int ComputeNrml,
                                int Optimal)

**TriSrf:** To approximate using polygons.

**FineNess:** See IPSurface2Polygons.

**ComputeUV:** See IPSurface2Polygons.

**ComputeNrml:** See IPSurface2Polygons.

**Optimal:** See IPSurface2Polygons.

**Returns:** Resulting polygons that approximates Srf.

**Description:** Routine to approximate a single triangular patch by polygons.

9.2.345 **IPTriSrf2Polylines** ([ip.cnvrt.c:1476])

IPPolygonStruct *IPTriSrf2Polylines(TrngTriangSrfStruct *TriSrf,
                                     int NumOfIsolines[3],
                                     CagdRType TolSamples,
                                     SymbCrvApproxMethodType Method)

**TriSrf:** To approximate as a polyline.

**NumOfIsolines:** Number of isocurves to extract, in each direction.

**TolSamples:** Tolerance of approximation error (Method = 2) or Number of samples to compute on polyline (Method = 0, 1).

**Method:** 0 - TolSamples are set uniformly in parametric space, 1 - TolSamples are set optimally, considering the curve's curvature. 2 - TolSamples sets the maximum error allowed between the piecewise linear approximation and original curve.

**Returns:** A polylines object approximating TriSrf.

**Description:** Routine to convert a single triangular patch function into polylines with SamplesPerCurve samples, NumOfIsolines isolines into a polylines object. If NumOfIsolines has negative value, its absolute value is heuristically used to derive a new NumOfIsolines number for it.

9.2.346 **IPTriSrfSsToCubicBzrCrvs** ([ip.cnvrt.c:1878])

CagdCrvStruct *IPTriSrfSsToCubicBzrCrvs(TrngTriangSrfStruct *TriSrf,
                                       IPPolygonStruct **CtlMeshes,
                                       CagdBType DrawSurface,
                                       CagdBType DrawMesh,
                                       int NumOfIsolines[3],
                                       CagdRType MaxArcLen)

**TriSrf:** To approximate as cubic Bezier curves.

**CtlMeshes:** If we want control meshes as well (DrawMesh == TRUE) they will be placed herein.
**DrawSurface**: Do we want to draw the surfaces?

**DrawMesh**: Do we want to draw the control meshes?

**NumOfIsolines**: Number of isocurves to extract, in each direction.

**MaxArcLen**: Tolerance for cubic Bezier approximation. See function SymbApproxCrvAsBzrCubics.

**Returns**: The cubic Bezier approximation, or NULL if DrawSurface is FALSE.

**Description**: Approximates an arbitrary list of triangular surfaces into cubic Beziers curves.

### 9.2.347 IPTrimSrf2CtlMesh (ip.cnvrt.c:1206)

**IPPolygonStruct** *IPTrimSrf2CtlMesh(TrimSrfStruct *TrimSrf)

**TrimSrf**: To extract its control mesh as a polylines.

**Returns**: A polylines object representing TrimSrf’s control mesh.

**Description**: Routine to convert a single trimmed surface’s control mesh into a polylines object.

### 9.2.348 IPTrimSrf2Polygons (ip.cnvrt.c:1069)

**IPPolygonStruct** *IPTrimSrf2Polygons(TrimSrfStruct *TrimSrf, int FourPerFlat, IrrtRType FineNess, int ComputeUV, int ComputeNrml, int Optimal)

**TrimSrf**: To approximate using polygons.

**FourPerFlat**: If TRUE, four triangle per flat surface patch are created, otherwise only two.

**FineNess**: Fineness control on polygonal approximation. The larger this number is the finer the approximation becomes. 10 is a good compromise when Optimal is FALSE.

**ComputeUV**: Do we want UV parameter values with the vertices of the triangles?

**ComputeNrml**: Do we want normals to vertices? 

**Optimal**: If FALSE (0) then parametric space of TrimSrf is sampled uniformly.

**Returns**: Resulting polygons that approximates TrimSrf.

**Description**: Routine to approximate a single trimmed surface by polygons. The polygonal approximation routines have call back functions to invoke for each new polygon and if these call back functions are used, this function might return NULL. See IPGenTriangle and IPGenRectangle.

**See also**: TrimSrf2Polygons2, IPGenTriangle, IPGenRectangle.

### 9.2.349 IPTrimSrf2Polylines (ip.cnvrt.c:1132)

**IPPolygonStruct** *IPTrimSrf2Polylines(TrimSrfStruct *TrimSrf, int NumOfIsolines[2], CagdRType TolSamples, SymbCrvApproxMethodType Method, int TrimmingCurves, int IsoParamCurves)

**TrimSrf**: To approximate as a polyline.

**NumOfIsolines**: Number of isocurves to extract, in each direction.

**TolSamples**: Tolerance of approximation error (Method = 2) or Number of samples to compute on polyline (Method = 0, 1).

**Method**: 0 - TolSamples are set uniformly in parametric space, 1 - TolSamples are set optimally, considering the curve’s curvature. 2 - TolSamples sets the maximum error allowed between the piecewise linear approximation and original curve.

**TrimmingCurves**: Do we want the trimming curves as well.

**IsoParamCurves**: Do we want trimmed isoparametric curves.

**Returns**: A polylines object approximating TrimSrf.

**Description**: Routine to convert a single trimmed surface into polylines with TolSamples samples/tolerance, NumOfIsolines isolines into a polylines object. If NumOfIsolines has negative value, its absolute value is heuristically used to derive a new NumOfIsolines number for it.
9.2.350  IPTrimSrfsToCubicBzrCrvs (ip\_cnvrt.c:1706)

CagdCrvStruct *IPTrimSrfsToCubicBzrCrvs(TrimSrfStruct *TrimSrfs,
IPPolygonStruct **CtlMeshes,
CagdBType DrawTrimSrf,
CagdBType DrawMesh,
int NumOfIsolines[2],
CagdRType MaxArcLen)

**TrimSrfs:** To approximate as cubic Bezier curves.

**CtlMeshes:** If we want control meshes as well (DrawMesh == TRUE) they will be placed herein.

**DrawTrimSrf:** Do we want to draw the surfaces?

**DrawMesh:** Do we want to draw the control meshes?

**NumOfIisoslines:** Number of isocurves to extract, in each direction.

**MaxArcLen:** Tolerance for cubic Bezier approximation. See function SymbApproxCrvAsBzrCubics.

**Returns:** The cubic Bezier approximation, or NULL if DrawSurface is FALSE.

**Description:** Approximates an arbitrary list of trimmed surfaces into cubic Beziers curves. Only isoparametric curves are extracted (no trimming curves).

9.2.351  IPTrivar2CtlMesh (ip\_cnvrt.c:1397)

IPPolygonStruct *IPTrivar2CtlMesh(TrivTVStruct *Trivar)

**Trivar:** To extract its control mesh as a polylines.

**Returns:** A polylines object representing Trivar's control mesh.

**Description:** Routine to convert a single trivariate's control mesh into a polylines object.

9.2.352  IPTrivar2Polygons (ip\_cnvrt.c:1238)

IPPolygonStruct *IPTrivar2Polygons(TrivTVStruct *Trivar,
int FourPerFlat,
IrtRType FineNess,
int ComputeUV,
int ComputeNrml,
int Optimal)

**Trivar:** To approximate using polygons.

**FourPerFlat:** See IPSurface2Polygons.

**FineNess:** See IPSurface2Polygons.

**ComputeUV:** See IPSurface2Polygons.

**ComputeNrml:** See IPSurface2Polygons.

**Optimal:** See IPSurface2Polygons.

**Returns:** Resulting polygons that approximates Srf.

**Description:** Routine to approximate a single trivariate by polygons. Six faces of the trivariate are extracted as six surfaces that are displayed.
9.2.353  **IPTrivar2Polylines** *(ip_cnvrt.c:1316)*

```c
IPolygonStruct *IPTrivar2Polylines(TrivTVStruct *Trivar,
   int NumOfIsolines[3],
   CagdRType TolSamples,
   SymbCrvApproxMethodType Method)
```

- **Trivar:** To approximate as a polyline.
- **NumOfIsolines:** Number of isocurves to extract, in each direction.
- **TolSamples:** Tolerance of approximation error (Method = 2) or Number of samples to compute on polyline (Method = 0, 1).
- **Method:** 0 - TolSamples are set uniformly in parametric space, 1 - TolSamples are set optimally, considering the curve’s curvature. 2 - TolSamples sets the maximum error allowed between the piecewise linear approximation and original curve.

**Returns:** A polylines object approximating Trivar.

**Description:** Routine to convert a single trivariate function into polylines with TolSamples/Tolerance per isocurve, NumOfIsolines isolines into a polylines object. If NumOfIsolines has negative value, its absolute value is heuristically used to derive a new NumOfIsolines number for it.

9.2.354  **IPTrivarToCubicBzrCrvs** *(ip_cnvrt.c:1767)*

```c
CagdCrvStruct *IPTrivarToCubicBzrCrvs(TrivTVStruct *Trivar,
   IPPolygonStruct **CtlMeshes,
   CagdBType DrawTrivar,
   CagdBType DrawMesh,
   int NumOfIsolines[2],
   CagdRType MaxArcLen)
```

- **Trivar:** To approximate as a set of cubic bezier curves.
- **CtlMeshes:** If we want control meshes as well (DrawMesh == TRUE) they will be placed herein.
- **DrawTrivar:** Do we want to draw the trivariate function?
- **DrawMesh:** Do we want to draw the control meshes?
- **NumOfIsolines:** Number of isocurves to extract, in each direction.
- **MaxArcLen:** Tolerance for cubic Bezier approximation. See function SymbApproxCrvAsBzrCubics.

**Returns:** A list of curves approximating Trivar.

**Description:** Routine to convert a single trivariate function into cubic Bezier curves.

9.2.355  **IPUpdatePolyPlane** *(prsrgeom.c:93)*

```c
int IPUpdatePolyPlane(IPolygonStruct *PPoly)
```

- **PPoly:** To update its normal/plane equation.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Routine to update the Plane equation of the given polygon by the order of the most robust three vertices of that polygon to define the normal.

9.2.356  **IPUpdatePolyPlane2** *(prsrgeom.c:167)*

```c
int IPUpdatePolyPlane2(IPolygonStruct *PPoly, const IrtVecType Vin)
```

- **PPoly:** To update its normal/plane equation.
- **Vin:** A vertex to be considered in the inside, respective to PPoly.

**Returns:** 0 if failed, 1 if successful, -1 if successful but vertices reversed.

**Description:** Routine to update the Plane equation of the given polygon such that the Vin vertex will be in the positive side of it.
9.2.357  IPUpdateVrtxNrml (prsrgem.c:201)

void IPUpdateVrtxNrml(IPPolygonStruct *PPoly, IrtVecType DefNrml)

PPoly: Polygon to update normal information.
DefNrml: Normal to use in update.
Returns: void
Description: Routine to update all vertices in polygon to hold a default normal if have none already.

9.2.358  IPVrtxListLen (linklist.c:782)

int IPVrtxListLen(const IPVertexStruct *V)

V: Vertex list to compute its length.
Returns: Number of elements in V list.
Description: Returns the length of a list of vertices.

9.2.359  Iges2IritWarning (igs.irit.c:4130)

void Iges2IritWarning(IgesInfoStruct *IgesInfo, int SeqNum, char *va_alist, ...)

IgesInfo: All information one ever needs to process IGES file.
SeqNum: Where the error occurred, 0 to specify line numbers.
va_alist: Do "man stdarg"
Returns: void
Description: Print warning messages.

9.2.360  IpcCompressObj (iritprsc.c:321)

int IpcCompressObj(int Handler, IObjectStruct *PObj)

Handler: A handler to the open stream.
PObj: Irit format objects list.
Returns: Internal Error code.
Description: Compress a given IObject to a file using Handler.
See also: IpcDecompressObj.

9.2.361  IpcCompressObjToFile (iritprsc.c:285)

int IpcCompressObjToFile(const char *FileName,
                          IObjectStruct *PObj,
                          float QntError)

FileName: Name of a compression file to save in.
PObj: Irit format objects list.
QntError: Quantization step between(0..1). Specifies maximum error for values. IPC_QUANTIZATION_NONE
- no quantization is used.
Returns: Internal Error code.
Description: Compress a given IObject to a file.
See also: IpcDecompressObjFromFile,
9.2.362 IpcDecompressObj (iritprsd.c:246)

```c
IPObjectStruct *IpcDecompressObj(int Handler)

Handler: A handler to the open stream.
Returns: A list of the Irit objects.
Description: Decompress the Irit objects from a compressed file using Handler to an IPObj
```

9.2.363 IpcDecompressObjFromFile (iritprsd.c:222)

```c
IPObjectStruct *IpcDecompressObjFromFile(const char *FileName)

FileName: A compression file to load from compressed data.
Returns: A list of the Irit objects.
Description: Decompress the Irit objects from a compressed file using Handler to a
```

9.2.364 IpcSetQuantization (iritprsd.c:200)

```c
void IpcSetQuantization(int Handler, float QntError)

Handler: A handler to the open stream.
QntError: Quantization error. Safe range is [0.00001 - 0.0000001]. IPC_QUANTIZATION_NONE = Quantization is not used.
Returns: void
Description: Set quantization error for spesific Handler.
```

9.2.365 Irit2WglAddPoly (irit_wgl.c:765)

```c
void Irit2WglAddPoly(Irit2WglSceneStruct *Scene, Irit2WglModelObjectStruct *ModelObject, int *PolyIndexArray)

Scene: Scene.
ModelObject: Model object.
PolyIndexArray: Array of vertex indices defining the poly.
Returns: void
Description: Create new poly to the given model object.
```

9.2.366 Irit2WglAddVertex (irit_wgl.c:720)

```c
void Irit2WglAddVertex(Irit2WglSceneStruct *Scene, Irit2WglModelObjectStruct *ModelObject, IrtPtType Pos, IrtNrmlType Normal, IrtUVType UV)

Scene: Scene.
ModelObject: Model object.
Pos: Vertex position.
Normal: Vertex normal.
UV: Vertex UV coordinates.
Returns: void
Description: Add new vertex to the given model object.
```
9.2.367  **Irit2WglDumpCSS** (irit\_wgl.c:1442)

```c
void Irit2WglDumpCSS(Irit2WglSceneStruct *Scene,
                      const char *OutputFileName)

Scene: Scene.
OutputFileName: Output file name.
Returns: void
Description: Dump CSS script related data.
```

9.2.368  **Irit2WglDumpData** (irit\_wgl.c:862)

```c
void Irit2WglDumpData(Irit2WglSceneStruct *Scene, const char* OutputFileName)

Scene: Scene.
OutputFileName: Output file name.
Returns: void
Description: Dump WebGL HTML data.
```

9.2.369  **Irit2WglDumpJS** (irit\_wgl.c:971)

```c
void Irit2WglDumpJS(Irit2WglSceneStruct *Scene, const char *OutputFileName)

Scene: Scene.
OutputFileName: Output file name.
Returns: void
Description: Dump JS script related data.
```

9.2.370  **Irit2WglDumpJSInitCameraMatrices** (irit\_wgl.c:1199)

```c
void Irit2WglDumpJSInitCameraMatrices(Irit2WglSceneStruct *Scene,
                                       FILE *JSOutputFile)

Scene: Scene.
JSOutputFile: JS Output file.
Returns: void
Description: Dump JS script related data - Camera matrices.
```

9.2.371  **Irit2WglDumpJSSetControlBarParams** (irit\_wgl.c:1315)

```c
void Irit2WglDumpJSSetControlBarParams(Irit2WglSceneStruct *Scene,
                                        FILE *JSOutputFile)

Scene: Scene.
JSOutputFile: JS Output file.
Returns: void
Description: Dump JS script related data - Control bar parameters.
```
9.2.372 Irit2WglDumpJSSetLightSources (irit_wgl.c:1239)

```c
void Irit2WglDumpJSSetLightSources(Irit2WglSceneStruct *Scene,
                                  FILE *JSOutputFile)
```

**Scene:** Scene.
**JSOutputFile:** JS Output file.
**Returns:** void
**Description:** Dump JS script related data - Light sources setting.

9.2.373 Irit2WglDumpJSSetMenuParams (irit_wgl.c:1343)

```c
void Irit2WglDumpJSSetMenuParams(Irit2WglSceneStruct *Scene,
                                  FILE *JSOutputFile)
```

**Scene:** Scene.
**JSOutputFile:** JS Output file.
**Returns:** void
**Description:** Dump JS script related data - Menu parameters.

9.2.374 Irit2WglDumpJSSetModelData (irit_wgl.c:1088)

```c
void Irit2WglDumpJSSetModelData(Irit2WglSceneStruct *Scene,
                                  FILE *JSOutputFile)
```

**Scene:** Scene.
**JSOutputFile:** JS Output file.
**Returns:** void
**Description:** Dump JS script related data - Model data.

9.2.375 Irit2WglDumpJSSetStatusLogParams (irit_wgl.c:1412)

```c
void Irit2WglDumpJSSetStatusLogParams(Irit2WglSceneStruct *Scene,
                                       FILE *JSOutputFile)
```

**Scene:** Scene.
**JSOutputFile:** JS Output file.
**Returns:** void
**Description:** Dump JS script related data - Status log parameters.

9.2.376 Irit2WglDumpJSSetTextureData (irit_wgl.c:1054)

```c
void Irit2WglDumpJSSetTextureData(Irit2WglSceneStruct *Scene,
                                    FILE *JSOutputFile)
```

**Scene:** Scene.
**JSOutputFile:** JS Output file.
**Returns:** void
**Description:** Dump JS script related data - Texture data.
9.2.377  Irit2WglDumpScripts (irit_wgl.c:923)

void Irit2WglDumpScripts(Irit2WglSceneStruct *Scene,
                        FILE* HtmlOutputFile,
                        const char* OutputFileName)

    Scene: Scene.
    HtmlOutputFile: HTML Output file.
    OutputFileName: Output file name.
    Returns: void
    Description: Dump WebGL HTML scripts related data.

9.2.378  Irit2WglFatalError (irit_wgl.c:1575)

void Irit2WglFatalError(const char *FatalErrorMsg)

    FatalErrorMsg: Fatal error message.
    Returns: void
    Description: Trap Irit2Wgl errors right here. Gets an error description, print it and exit the program using exit.

9.2.379  Irit2WglFreeScene (irit_wgl.c:549)

void Irit2WglFreeScene(Irit2WglSceneStruct *Scene)

    Scene: Scene.
    Returns: void
    Description: Free the given scene.

9.2.380  Irit2WglModelObjectTagType2Str (irit_wgl.c:1549)

const char *Irit2WglModelObjectTagType2Str(Irit2WglModelObjectTagType ModelObjectTag)

    ModelObjectTag: Model object tag.
    Returns: Object tag string.
    Description: Convert model object tag enum to string.

9.2.381  Irit2WglNewModelObject (irit_wgl.c:622)

Irit2WglModelObjectStruct *Irit2WglNewModelObject(Irit2WglSceneStruct *Scene,
                                                const char *Name,
                                                Irit2WglModelObjectTagType ModelObjectTag,
                                                IrtRType RGBA[4],
                                                int MaxObjVertices,
                                                const char *PTextureFileName,
                                                IrtUVType SUV)

    Scene: Scene.
    Name: Model object’s name.
    ModelObjectTag: Model object tag.
    RGBA: RGBA values.
    MaxObjVertices: Maximum number of vertices in object.
    PTextureFileName: Texture file name.
    SUV: UV texture scaling.
    Returns: New model object.
    Description: Create new model object.
9.2.382  Irit2WglNewScene (irit_wgl.c:493)

Irit2WglSceneStruct *Irit2WglNewScene(void)

Returns: New scene.
Description: Create new scene.

9.2.383  Irit2WglProjectionModeType2Str (irit_wgl.c:1524)

const char *Irit2WglProjectionModeType2Str(Irit2WglProjectionModeType ProjectionMode)

ProjectionMode: Projection mode.
Returns: Projection mode string.
Description: Convert projection mode enum to string.

9.2.384  Irit2WglSetLightSource (irit_wgl.c:823)

void Irit2WglSetLightSource(Irit2WglSceneStruct *Scene,
IGLightType LightPos,
IrtVecType LightColor)

Scene: Scene.
LightPos: Light source position.
LightColor: Light source diffuse color.
Returns: void
Description: Set light source data for the given scene.

9.2.385  Irit2WglViewAngleType2Str (irit_wgl.c:1489)

const char *Irit2WglViewAngleType2Str(Irit2WglViewAngleType ViewAngle)

ViewAngle: View angle.
Returns: View angle string.
Description: Convert view angle enum to string.

9.2.386  MdlReadModelFromFile (mdl_read.c:44)

MdlModelStruct *MdlReadModelFromFile(const char *FileName,
char **ErrStr,
int *ErrLine)

FileName: To read the model from.
ErrStr: Will be initialized if an error has occurred.
ErrLine: Line number in file FileName of the error, if occurred.
Returns: The read model surface, or NULL if an error occurred.
Description: Reads from a file a model. If error is detected in reading the file, ErrStr is set to a string describing
the error and Line to the line it occurred in file. If no error is detected *ErrStr = NULL.
See also: MdlReadModelSrfFromFile2,
9.2.387   MdlReadModelFromFile2 (mdl_read.c:104)

MdlModelStruct *MdlReadModelFromFile2(int Handler,
    CagdBType NameWasRead,
    char **ErrStr,
    int *ErrLine)

**Handler:** A handler to the open stream.
**NameWasRead:** If FALSE, also reads the MODEL prefix.
**ErrStr:** Will be initialized if an error has occurred.
**ErrLine:** Line number in file FileName of the error, if occurred.

**Returns:** The read model, or NULL if an error occurred.

**Description:** Reads from a file a model. If error is found in reading the file, ErrStr is set to a string describing
it and ErrLine to line it occurred in file relative to model. Assumes the MODEL prefix was read if NameWasRead.
If no error is detected *ErrStr is set to NULL.

**See also:** MdlReadModelSrfFromFile,

9.2.388   MdlWriteModelToFile (mdl_wrt.c:35)

int MdlWriteModelToFile(const MdlModelStruct *Models,
    const char *FileName,
    int Indent,
    const char *Comment,
    char **ErrStr)

**Models:** To be saved in stream.
**FileName:** File name where output should go to.
**Indent:** Column in which all printing starts at.
**Comment:** Optional comment to describe the geometry.
**ErrStr:** If failed, ErrStr will be set to describe the problem.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Generic routine to write model(s) to the given file. If Comment is NULL, no comment is printed,
if ”” only internal comment.

9.2.389   MdlWriteModelToFile2 (mdl_wrt.c:76)

int MdlWriteModelToFile2(const MdlModelStruct *Models,
    int Handler,
    int Indent,
    const char *Comment,
    char **ErrStr)

**Models:** To be saved in stream.
**Handler:** A handler to the open stream.
**Indent:** Column in which all printing starts at.
**Comment:** Optional comment to describe the geometry.
**ErrStr:** If failed, ErrStr will be set to describe the problem.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Generic routine to write models(s) to the given stream. If Comment is NULL, no comment is printed,
if ”” only internal comment.
9.2.390  MdlWriteModelToFile3  (mdl_wrt.c:190)

```c
int MdlWriteModelToFile3(const MdlModelStruct *Models,
                          FILE *f,
                          int Indent,
                          const char *Comment,
                          char **ErrStr)
```

Models: To be saved in stream.

f: File descriptor where output should go to.

Indent: Column in which all printing starts at.

Comment: Optional comment to describe the geometry.

ErrStr: If failed, ErrStr will be set to describe the problem.

Returns: TRUE if successful, FALSE otherwise.

Description: Generic routine to write model(s) to the given stream. If Comment is NULL, no comment is printed, if "" only internal comment.

---

9.2.391  MvarBspMVReadFromFile  (mvarread.c:339)

```c
MvarMVStruct *MvarBspMVReadFromFile(const char *FileName,
                                      char **ErrStr,
                                      int *ErrLine)
```

FileName: To read the multi-variate from.

ErrStr: Will be initialized if an error has occurred.

ErrLine: Line number in file FileName of the error, if occurred.

Returns: The read multi-variate, or NULL if an error occurred.

Description: Reads from a file Bspline multi-variates. If error is detected in reading the file, ErrStr is set to a string describing the error and Line to the line it occurred in file. If no error is detected *ErrStr = NULL.

---

9.2.392  MvarBspMVReadFromFile2  (mvarread.c:401)

```c
MvarMVStruct *MvarBspMVReadFromFile2(int Handler,
                                       CagdBType NameWasRead,
                                       char **ErrStr,
                                       int *ErrLine)
```

Handler: A handler to the open stream.

NameWasRead: If FALSE, also reads the MULTIVAR BEZIER prefix.

ErrStr: Will be initialized if an error has occurred.

ErrLine: Line number in file FileName of the error, if occurred.

Returns: The read multi-variate, or NULL if an error occurred.

Description: Reads from a file a Bspline multi-variate. If NameWasRead is TRUE, it is assumed prefix "MULTIVAR BSPLINE" has already been read. This is useful for a global parser which invokes this routine to read from a file several times as a parent controller. For exactly this reason, the given file descriptor is NOT closed in the end. If error is found in reading the file, ErrStr is set to a string describing it and ErrLine to line it occurred in file relative to beginning of multi-variate. If no error is detected *ErrStr is set to NULL.
### 9.2.393 MvarBspMVWriteToFile (mvar_wrt.c:265)

```c
int MvarBspMVWriteToFile(const MvarMVStruct *MVs,
    const char *FileName,
    int Indent,
    const char *Comment,
    char **ErrStr)
```

**MVs:** To be saved in file.

**FileName:** File name where output should go to.

**Indent:** Column in which all printing starts at.

**Comment:** Optional comment to describe the geometry.

**ErrStr:** If failed, ErrStr will be set to describe the problem.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Generic routine to write Bspline multi-variates to the given file. If Comment is NULL, no comment is printed, if "" only internal comment.

### 9.2.394 MvarBspMVWriteToFile2 (mvar_wrt.c:306)

```c
int MvarBspMVWriteToFile2(const MvarMVStruct *MVs,
    int Handler,
    int Indent,
    const char *Comment,
    char **ErrStr)
```

**MVs:** To be saved in stream.

**Handler:** A handler to the open stream.

**Indent:** Column in which all printing starts at.

**Comment:** Optional comment to describe the geometry.

**ErrStr:** If failed, ErrStr will be set to describe the problem.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Generic routine to write Bspline multi-variates to the given file. If Comment is NULL, no comment is printed, if "" only internal comment.

### 9.2.395 MvarBzrMVReadFromFile (mvarread.c:139)

```c
MvarMVStruct *MvarBzrMVReadFromFile(const char *FileName,
    char **ErrStr,
    int *ErrLine)
```

**FileName:** To read the multi-variate from.

**ErrStr:** Will be initialized if an error has occured.

**ErrLine:** Line number in file FileName of the error, if occurred.

**Returns:** The read multi-variate, or NULL if an error occured.

**Description:** Reads from a file Bezier multi-variates. If error is detected in reading the file, ErrStr is set to a string describing the error and Line to the line it occured in file. If no error is detected *ErrStr = NULL.
9.2.396 MvarBzrMVReadFromFile2 (mvarread.c:201)

MvarMVStruct *MvarBzrMVReadFromFile2(int Handler, CagdBType NameWasRead, char **ErrStr, int *ErrLine)

**Handler:** A handler to the open stream.
**NameWasRead:** If FALSE, also reads the MULTIVAR BEZIER prefix.
**ErrStr:** Will be initialized if an error has occurred.
**ErrLine:** Line number in file FileName of the error, if occurred.

**Returns:** The read multi-variate, or NULL if an error occurred.

**Description:** Reads from a file a Bezier multi-variate. If NameWasRead is TRUE, it is assumed prefix "MULTIVAR BEZIER" has already been read. This is useful for a global parser which invokes this routine to read from a file several times as a parent controller. For exactly this reason, the given file descriptor is NOT closed in the end. If error is found in reading the file, ErrStr is set to a string describing it and ErrLine to line it occured in file relative to begining of multi-variate. If no error is detected *ErrStr is set to NULL.

9.2.397 MvarBzrMVWriteToFile (mvar_wrt.c:143)

int MvarBzrMVWriteToFile(const MvarMVStruct *MVs, const char *FileName, int Indent, const char *Comment, char **ErrStr)

**MVs:** To be saved in file.
**FileName:** File name where output should go to.
**Indent:** Column in which all printing starts at.
**Comment:** Optional comment to describe the geometry.
**ErrStr:** If failed, ErrStr will be set to describe the problem.

**Returns:** TRUE if succesful, FALSE otherwise.

**Description:** Generic routine to write Bezier multi-variates to the given file. If Comment is NULL, no comment is printed, if "" only internal comment.

9.2.398 MvarBzrMVWriteToFile2 (mvar_wrt.c:184)

int MvarBzrMVWriteToFile2(const MvarMVStruct *MVs, int Handler, int Indent, const char *Comment, char **ErrStr)

**MVs:** To be saved in stream.
**Handler:** A handler to the open stream.
**Indent:** Column in which all printing starts at.
**Comment:** Optional comment to describe the geometry.
**ErrStr:** If failed, ErrStr will be set to describe the problem.

**Returns:** TRUE if succesful, FALSE otherwise.

**Description:** Generic routine to write Bezier multi-variates to the given file. If Comment is NULL, no comment is printed, if "" only internal comment.
9.2.399 MvarMVReadFromFile (mvarread.c:34)

MvarMVStruct *MvarMVReadFromFile(const char *FileName,
       char **ErrStr,
       int *ErrLine)

FileName: To read the multi-variate from.
ErrStr: Will be initialized if an error has occurred.
ErrLine: Line number in file FileName of the error, if occurred.
Returns: The read multi-variate, or NULL if an error occurred.
Description: Reads from a file multi-variates. If error is detected in reading the file, ErrStr is set to a string
   describing the error and Line to the line it occurred in file. If no error is detected *ErrStr = NULL.

9.2.400 MvarMVReadFromFile2 (mvarread.c:98)

MvarMVStruct *MvarMVReadFromFile2(int Handler, char **ErrStr, int *ErrLine)

Handler: A handler to the open stream.
ErrStr: Will be initialized if an error has occurred.
ErrLine: Line number in file FileName of the error, if occurred.
Returns: The read multi-variate, or NULL if an error occurred.
Description: Reads from a file a multi-variate. If error is found in reading the file, ErrStr is set to a string
   describing it and ErrLine to line it occurred in file relative to begining of multi-variate. If no error is detected
   *ErrStr is set to NULL.

9.2.401 MvarMVWriteToFile (mvar_wrt.c:34)

int MvarMVWriteToFile(const MvarMVStruct *MVs,
       const char *FileName,
       int Indent,
       const char *Comment,
       char **ErrStr)

MVs: To be saved in file f.
FileName: File name where output should go to.
Indent: Column in which all printing starts at.
Comment: Optional comment to describe the geometry.
ErrStr: If failed, ErrStr will be set to describe the problem.
Returns: TRUE if succesful, FALSE otherwise.
Description: Generic routine to write multi-variates to the given file. If Comment is NULL, no comment is
   printed, if "" only internal comment.

9.2.402 MvarMVWriteToFile2 (mvar_wrt.c:72)

int MvarMVWriteToFile2(const MvarMVStruct *MVs,
       int Handler,
       int Indent,
       const char *Comment,
       char **ErrStr)

MVs: To be saved in stream.
Handler: A handler to the open stream.
Indent: Column in which all printing starts at.
Comment: Optional comment to describe the geometry.
ErrStr: If failed, ErrStr will be set to describe the problem.
Returns: TRUE if succesful, FALSE otherwise.
Description: Generic routine to write multi-variates to the given file. If Comment is NULL, no comment is
   printed, if "" only internal comment.
9.2.403  MvarMVWriteToFile3 (mvar_wrt.c:110)

```c
int MvarMVWriteToFile3(const MvarMVStruct *MVs,
    FILE *f,
    int Indent,
    const char *Comment,
    char **ErrStr)
```

- **MVs**: To be saved in file f.
- **f**: File descriptor where output should go to.
- **Indent**: Column in which all printing starts at.
- **Comment**: Optional comment to describe the geometry.
- **ErrStr**: If failed, ErrStr will be set to describe the problem.

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: Generic routine to write multi-variate(s) to the given file. If Comment is NULL, no comment is printed, if "" only internal comment.

9.2.404  TrimReadTrimmedSrfFromFile (trimread.c:33)

```c
TrimSrfStruct *TrimReadTrimmedSrfFromFile(const char *FileName,
    char **ErrStr,
    int *ErrLine)
```

- **FileName**: To read the trimmed surface from.
- **ErrStr**: Will be initialized if an error has occurred.
- **ErrLine**: Line number in file FileName of the error, if occurred.

**Returns**: The read trimmed surface, or NULL if an error occurred.

**Description**: Reads from a file trimmed surfaces. If error is detected in reading the file, ErrStr is set to a string describing the error and Line to the line it occurred in file. If no error is detected *ErrStr = NULL.

9.2.405  TrimReadTrimmedSrfFromFile2 (trimread.c:91)

```c
TrimSrfStruct *TrimReadTrimmedSrfFromFile2(int Handler,
    CagdBType NameWasRead,
    char **ErrStr,
    int *ErrLine)
```

- **Handler**: A handler to the open stream.
- **NameWasRead**: If FALSE, also reads the TRIMSRF BEZIER prefix.
- **ErrStr**: Will be initialized if an error has occurred.
- **ErrLine**: Line number in file FileName of the error, if occurred.

**Returns**: The read trimmed surface, or NULL if an error occurred.

**Description**: Reads from a file a trimmed surface. If error is found in reading the file, ErrStr is set to a string describing it and ErrLine to line it occurred in file relative to beginning of trimmed surface. Assumes the [TRIMSRF prefix was read if NameWasRead. If no error is detected *ErrStr is set to NULL.
9.2.406  TrimWriteTrimmedSrfToFile (trim_wrt.c:34)

```c
int TrimWriteTrimmedSrfToFile(const TrimSrfStruct *TrimSrfs,
            const char *FileName,
            int Indent,
            const char *Comment,
            char **ErrStr)
```

TrimSrfs: To be saved in stream.
FileName: File name where output should go to.
Indent: Column in which all printing starts at.
Comment: Optional comment to describe the geometry.
ErrStr: If failed, ErrStr will be set to describe the problem.
Returns: TRUE if succesful, FALSE otherwise.

Description: Generic routine to write a trimmed surface to the given file. If Comment is NULL, no comment is printed, if "" only internal comment.

9.2.407  TrimWriteTrimmedSrfToFile2 (trim_wrt.c:75)

```c
int TrimWriteTrimmedSrfToFile2(const TrimSrfStruct *TrimSrfs,
            int Handler,
            int Indent,
            const char *Comment,
            char **ErrStr)
```

TrimSrfs: To be saved in stream.
Handler: A handler to the open stream.
Indent: Column in which all printing starts at.
Comment: Optional comment to describe the geometry.
ErrStr: If failed, ErrStr will be set to describe the problem.
Returns: TRUE if succesful, FALSE otherwise.

Description: Generic routine to write trimmed surface(s) to the given stream. If Comment is NULL, no comment is printed, if "" only internal comment.

9.2.408  TrimWriteTrimmedSrfToFile3 (trim_wrt.c:144)

```c
int TrimWriteTrimmedSrfToFile3(const TrimSrfStruct *TrimSrfs,
            FILE *f,
            int Indent,
            const char *Comment,
            char **ErrStr)
```

TrimSrfs: To be saved in stream.
f: File descriptor where output should go to.
Indent: Column in which all printing starts at.
Comment: Optional comment to describe the geometry.
ErrStr: If failed, ErrStr will be set to describe the problem.
Returns: TRUE if succesful, FALSE otherwise.

Description: Generic routine to write trimmed surface(s) to the given stream. If Comment is NULL, no comment is printed, if "" only internal comment.
9.2.409 TrivBspTVReadFromFile (trivread.c:315)

```c
TrivTVStruct *TrivBspTVReadFromFile(const char *FileName,  
char **ErrStr,  
int *ErrLine)
```

**FileName**: To read the trivariate from.

**ErrStr**: Will be initialized if an error has occurred.

**ErrLine**: Line number in file FileName of the error, if occurred.

**Returns**: The read trivariate, or NULL if an error occurred.

**Description**: Reads from a file Bspline trivariates. If error is detected in reading the file, ErrStr is set to a string describing the error and Line to the line it occurred in file. If no error is detected *ErrStr = NULL.

9.2.410 TrivBspTVReadFromFile2 (trivread.c:377)

```c
TrivTVStruct *TrivBspTVReadFromFile2(int Handler,  
CagdBType NameWasRead,  
char **ErrStr,  
int *ErrLine)
```

**Handler**: A handler to the open stream.

**NameWasRead**: If FALSE, also reads the TRIVAR BEZIER prefix.

**ErrStr**: Will be initialized if an error has occurred.

**ErrLine**: Line number in file FileName of the error, if occurred.

**Returns**: The read trivariate, or NULL if an error occurred.

**Description**: Reads from a file a Bspline trivariate. If NameWasRead is TRUE, it is assumed prefix "[TRIVAR BSPLINE" has already been read. This is useful for a global parser which invokes this routine to read from a file several times as a parent controller. For exactly this reason, the given file descriptor is NOT closed in the end. If error is found in reading the file, ErrStr is set to a string describing it and ErrLine to line it occurred in file relative to beginning of trivariate. If no error is detected *ErrStr is set to NULL.

9.2.411 TrivBspTVWriteToFile (trivwrt.c:261)

```c
int TrivBspTVWriteToFile(const TrivTVStruct *TVs,  
const char *FileName,  
int Indent,  
const char *Comment,  
char **ErrStr)
```

**TVs**: To be saved in file f.

**FileName**: File name where output should go to.

**Indent**: Column in which all printing starts at.

**Comment**: Optional comment to describe the geometry.

**ErrStr**: If failed, ErrStr will be set to describe the problem.

**Returns**: TRUE if succesful, FALSE otherwise.

**Description**: Generic routine to write Bspline trivariates to the given file. If Comment is NULL, no comment is printed, if "" only internal comment.
9.2.412 TrivBspTVWriteToFile2 (triv_wrt.c:302)

```c
int TrivBspTVWriteToFile2(const TrivTVStruct *TVs,
    int Handler,
    int Indent,
    const char *Comment,
    char **ErrStr)
```

**TVs:** To be saved in stream.

**Handler:** A handler to the open stream.

**Indent:** Column in which all printing starts at.

**Comment:** Optional comment to describe the geometry.

**ErrStr:** If failed, ErrStr will be set to describe the problem.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Generic routine to write Bspline trivariates to the given file. If Comment is NULL, no comment is printed, if ”” only internal comment.

9.2.413 TrivBzrTVReadFromFile (trivread.c:128)

```c
TrivTVStruct *TrivBzrTVReadFromFile(const char *FileName,
    char **ErrStr,
    int *ErrLine)
```

**FileName:** To read the trivariate from.

**ErrStr:** Will be initialized if an error has occurred.

**ErrLine:** Line number in file FileName of the error, if occurred.

**Returns:** The read trivariate, or NULL if an error occurred.

**Description:** Reads from a file Bezier trivariates. If error is detected in reading the file, ErrStr is set to a string describing the error and Line to the line it occurred in file. If no error is detected *ErrStr = NULL.

9.2.414 TrivBzrTVReadFromFile2 (trivread.c:190)

```c
TrivTVStruct *TrivBzrTVReadFromFile2(int Handler,
    CagdBType NameWasRead,
    char **ErrStr,
    int *ErrLine)
```

**Handler:** A handler to the open stream.

**NameWasRead:** If FALSE, also reads the TRIVAR BEZIER prefix.

**ErrStr:** Will be initialized if an error has occurred.

**ErrLine:** Line number in file FileName of the error, if occurred.

**Returns:** The read trivariate, or NULL if an error occurred.

**Description:** Reads from a file a Bezier trivariate. If NameWasRead is TRUE, it is assumed prefix ”[TRIVAR BEZIER” has already been read. This is useful for a global parser which invokes this routine to read from a file several times as a parent controller. For exactly this reason, the given file descriptor is NOT closed in the end. If error is found in reading the file, ErrStr is set to a string describing it and ErrLine to line it occurred in file relative to beginning of trivariate. If no error is detected *ErrStr is set to NULL.
9.2.415 TrivBzrTVWriteToFile (triv_wrt.c:141)

```c
int TrivBzrTVWriteToFile(const TrivTVStruct *TVs, 
const char *FileName, 
int Indent, 
const char *Comment, 
char **ErrStr)
```

**TVs:** To be saved in file.
**FileName:** File name where output should go to.
**Indent:** Column in which all printing starts at.
**Comment:** Optional comment to describe the geometry.
**ErrStr:** If failed, ErrStr will be set to describe the problem.
**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Generic routine to write Bezier trivariates to the given file. If Comment is NULL, no comment is printed, if "" only internal comment.

9.2.416 TrivBzrTVWriteToFile2 (triv_wrt.c:182)

```c
int TrivBzrTVWriteToFile2(const TrivTVStruct *TVs, 
int Handler, 
int Indent, 
const char *Comment, 
char **ErrStr)
```

**TVs:** To be saved in stream.
**Handler:** A handler to the open stream.
**Indent:** Column in which all printing starts at.
**Comment:** Optional comment to describe the geometry.
**ErrStr:** If failed, ErrStr will be set to describe the problem.
**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Generic routine to write Bezier trivariates to the given file. If Comment is NULL, no comment is printed, if "" only internal comment.

9.2.417 TrivTVReadFromFile (trivread.c:33)

```c
TrivTVStruct *TrivTVReadFromFile(const char *FileName, 
char **ErrStr, 
int *ErrLine)
```

**FileName:** To read the trivariate from.
**ErrStr:** Will be initialized if an error has occurred.
**ErrLine:** Line number in file FileName of the error, if occurred.
**Returns:** The read trivariate, or NULL if an error occurred.

**Description:** Reads from a file trivariates. If error is detected in reading the file, ErrStr is set to a string describing the error and Line to the line it occurred in file. If no error is detected *ErrStr = NULL.

9.2.418 TrivTVReadFromFile2 (trivread.c:92)

```c
TrivTVStruct *TrivTVReadFromFile2(int Handler, char **ErrStr, int *ErrLine)
```

**Handler:** A handler to the open stream.
**ErrStr:** Will be initialized if an error has occurred.
**ErrLine:** Line number in file FileName of the error, if occurred.
**Returns:** The read trivariate, or NULL if an error occurred.

**Description:** Reads from a file a trivariate. If error is found in reading the file, ErrStr is set to a string describing it and ErrLine to line it occurred in file relative to begining of trivariate. If no error is detected *ErrStr is set to NULL.
9.2.419  TrivTVWriteToFile  (triv_wrt.c:34)

int TrivTVWriteToFile(const TrivTVStruct *TVs,
                      const char *FileName,
                      int Indent,
                      const char *Comment,
                      char **ErrStr)

TVs: To be saved in file f.
FileName: File name where output should go to.
Indent: Column in which all printing starts at.
Comment: Optional comment to describe the geometry.
ErrStr: If failed, ErrStr will be set to describe the problem.
Returns: TRUE if successful, FALSE otherwise.

Description: Generic routine to write trivariates to the given file. If Comment is NULL, no comment is printed, if ”” only internal comment.

9.2.420  TrivTVWriteToFile2  (triv_wrt.c:71)

int TrivTVWriteToFile2(const TrivTVStruct *TVs,
                       int Handler,
                       int Indent,
                       const char *Comment,
                       char **ErrStr)

TVs: To be saved in stream.
Handler: A handler to the open stream.
Indent: Column in which all printing starts at.
Comment: Optional comment to describe the geometry.
ErrStr: If failed, ErrStr will be set to describe the problem.
Returns: TRUE if successful, FALSE otherwise.

Description: Generic routine to write trivariates to the given file. If Comment is NULL, no comment is printed, if ”” only internal comment.

9.2.421  TrivTVWriteToFile3  (triv_wrt.c:108)

int TrivTVWriteToFile3(const TrivTVStruct *TVs,
                       FILE *f,
                       int Indent,
                       const char *Comment,
                       char **ErrStr)

TVs: To be saved in file f.
f: File descriptor where output should go to.
Indent: Column in which all printing starts at.
Comment: Optional comment to describe the geometry.
ErrStr: If failed, ErrStr will be set to describe the problem.
Returns: TRUE if successful, FALSE otherwise.

Description: Generic routine to write trivariate(s) to the given file. If Comment is NULL, no comment is printed, if ”” only internal comment.
9.2.422 TrngBspTriSrfReadFromFile  (trngread.c:322)

TrngTriangSrfStruct *TrngBspTriSrfReadFromFile(const char *FileName,
                                              char **ErrStr,
                                              int *ErrLine)

FileName: To read the triangular surface from.
ErrStr: Will be initialized if an error has occurred.
ErrLine: Line number in file FileName of the error, if occurred.
Returns: The read triangular surface, or NULL if an error occurred.

Description: Reads from a file B spline triangular surfaces. If error is detected in reading the file, ErrStr is set to a string describing the error and Line to the line it occurred in file. If no error is detected *ErrStr = NULL.

9.2.423 TrngBspTriSrfReadFromFile2  (trngread.c:385)

TrngTriangSrfStruct *TrngBspTriSrfReadFromFile2(int Handler,
                                              CagdBType NameWasRead,
                                              char **ErrStr,
                                              int *ErrLine)

Handler: A handler to the open stream.
NameWasRead: If FALSE, also reads the TRISRF BEZIER prefix.
ErrStr: Will be initialized if an error has occurred.
ErrLine: Line number in file FileName of the error, if occurred.
Returns: The read triangular surface, or NULL if an error occurred.

Description: Reads from a file a B spline triangular surface. If NameWasRead is TRUE, it is assumed prefix "[TRISRF BSPLINE" has already been read. This is useful for a global parser which invokes this routine to read from a file several times as a parent controller. For exactly this reason, the given file descriptor is NOT closed in the end. If error is found in reading the file, ErrStr is set to a string describing it and ErrLine to line it occurred in file relative to beginning of triangular surface. If no error is detected *ErrStr is set to NULL.

9.2.424 TrngBspTriSrfWriteTofile  (trng_wrt.c:260)

int TrngBspTriSrfWriteTofile(const TrngTriangSrfStruct *TriSrfs,
                              const char *FileName,
                              int Indent,
                              const char *Comment,
                              char **ErrStr)

TriSrfs: To be saved in file f.
FileName: File name where output should go to.
Indent: Column in which all printing starts at.
Comment: Optional comment to describe the geometry.
ErrStr: If failed, ErrStr will be set to describe the problem.
Returns: TRUE if successful, FALSE otherwise.

Description: Generic routine to write B spline triangular surfaces to the given file. If Comment is NULL, no comment is printed, if "" only internal comment.
9.2.425 TrngBspTriSrfWriteToFile2 (trng.wrt.c:301)

```c
int TrngBspTriSrfWriteToFile2(const TrngTriangSrfStruct *TriSrfS,  
    int Handler, 
    int Indent, 
    const char *Comment,  
    char **ErrStr)
```

**TriSrfS:** To be saved in stream.

**Handler:** A handler to the open stream.

**Indent:** Column in which all printing starts at.

**Comment:** Optional comment to describe the geometry.

**ErrStr:** If failed, ErrStr will be set to describe the problem.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Generic routine to write Bspline triangular surfaces to the given file. If Comment is NULL, no comment is printed, if "" only internal comment.

---

9.2.426 TrngBzrTriSrfReadFromFile (trng.c:137)

```c
TrngTriangSrfStruct *TrngBzrTriSrfReadFromFile(const char *FileName,  
    char **ErrStr,  
    int *ErrLine)
```

**FileName:** To read the triangular surface from.

**ErrStr:** Will be initialized if an error has occurred.

**ErrLine:** Line number in file FileName of the error, if occurred.

**Returns:** The read triangular surface, or NULL if an error occurred.

**Description:** Reads from a file Bezier triangular surfaces. If error is detected in reading the file, ErrStr is set to a string describing the error and Line to the line it occurred in file. If no error is detected *ErrStr = NULL.

---

9.2.427 TrngBzrTriSrfReadFromFile2 (trng.c:200)

```c
TrngTriangSrfStruct *TrngBzrTriSrfReadFromFile2(int Handler,  
    CagdBType NameWasRead,  
    char **ErrStr,  
    int *ErrLine)
```

**Handler:** A handler to the open stream.

**NameWasRead:** If FALSE, also reads the TRISRF BEZIER prefix.

**ErrStr:** Will be initialized if an error has occurred.

**ErrLine:** Line number in file FileName of the error, if occurred.

**Returns:** The read triangular surface, or NULL if an error occurred.

**Description:** Reads from a file a Bezier triangular surface. If NameWasRead is TRUE, it is assumed prefix "[TRISRF BEZIER" has already been read. This is useful for a global parser which invokes this routine to read from a file several times as a parent controller. For exactly this reason, the given file descriptor is NOT closed in the end. If error is found in reading the file, ErrStr is set to a string describing it and ErrLine to line it occurred in file relative to beginning of triangular surface. If no error is detected *ErrStr is set to NULL.
9.2.428  TrngBzrTriSrfWriteToFile  (trng_wrt.c:147)

```c
int TrngBzrTriSrfWriteToFile(const TrngTriangSrfStruct *TriSrfs,
                               const char *FileName,
                               int Indent,
                               const char *Comment,
                               char **ErrStr)
```

**TriSrfs**: To be saved in file.

**FileName**: File name where output should go to.

**Indent**: Column in which all printing starts at.

**Comment**: Optional comment to describe the geometry.

**ErrStr**: If failed, ErrStr will be set to describe the problem.

**Returns**: TRUE if succesful, FALSE otherwise.

**Description**: Generic routine to write Bezier triangular surfaces to the given file. If Comment is NULL, no comment is printed, if "" only internal comment.

9.2.429  TrngBzrTriSrfWriteToFile2  (trng_wrt.c:188)

```c
int TrngBzrTriSrfWriteToFile2(const TrngTriangSrfStruct *TriSrfs,
                                int Handler,
                                int Indent,
                                const char *Comment,
                                char **ErrStr)
```

**TriSrfs**: To be saved in stream.

**Handler**: A handler to the open stream.

**Indent**: Column in which all printing starts at.

**Comment**: Optional comment to describe the geometry.

**ErrStr**: If failed, ErrStr will be set to describe the problem.

**Returns**: TRUE if succesful, FALSE otherwise.

**Description**: Generic routine to write Bezier triangular surfaces to the given file. If Comment is NULL, no comment is printed, if "" only internal comment.

9.2.430  TrngGrgTriSrfReadFromFile  (trngread.c:548)

```c
TrngTriangSrfStruct *TrngGrgTriSrfReadFromFile(const char *FileName,
                                                 char **ErrStr,
                                                 int *ErrLine)
```

**FileName**: To read the triangular surface from.

**ErrStr**: Will be initialized if an error has occured.

**ErrLine**: Line number in file FileName of the error, if occured.

**Returns**: The read triangular surface, or NULL if an error occured.

**Description**: Reads from a file Gregory triangular surfaces. If error is detected in reading the file, ErrStr is set to a string describing the error and Line to the line it occured in file. If no error is detected *ErrStr = NULL.
9.2.431  TrngGrgTriSrfReadFromFile2 (trngread.c:611)

TrngTriangSrfStruct *TrngGrgTriSrfReadFromFile2(int Handler,  
    CagdBType NameWasRead,  
    char **ErrStr,  
    int *ErrLine)

Handler: A handler to the open stream.
NameWasRead: If FALSE, also reads the TRISRF GREGORY prefix.
ErrStr: Will be initialized if an error has occurred.
ErrLine: Line number in file FileName of the error, if occurred.
Returns: The read triangular surface, or NULL if an error occured.

Description: Reads from a file a Gregory triangular surface. If NameWasRead is TRUE, it is assumed prefix
"[TRISRF GREGORY" has already been read. This is useful for a global parser which invokes this routine to read
from a file several times as a parent controller. For exactly this reason, the given file descriptor is NOT closed in the
end. If error is found in reading the file, ErrStr is set to a string describing it and ErrLine to line it occured in file
relative to begining of triangular surface. If no error is detected *ErrStr is set to NULL.

9.2.432  TrngGrgTriSrfWriteToFile (trngwrt.c:389)

int TrngGrgTriSrfWriteToFile(const TrngTriangSrfStruct *TriSrfs,  
    const char *FileName,  
    int Indent,  
    const char *Comment,  
    char **ErrStr)

TriSrfs: To be saved in file.
FileName: File name where output should go to.
Indent: Column in which all printing starts at.
Comment: Optional comment to describe the geometry.
ErrStr: If failed, ErrStr will be set to describe the problem.
Returns: TRUE if succesful, FALSE otherwise.

Description: Generic routine to write Gregory triangular surfaces to the given file. If Comment is NULL, no
comment is printed, if "" only internal comment.

9.2.433  TrngGrgTriSrfWriteToFile2 (trngwrt.c:430)

int TrngGrgTriSrfWriteToFile2(const TrngTriangSrfStruct *TriSrfs,  
    int Handler,  
    int Indent,  
    const char *Comment,  
    char **ErrStr)

TriSrfs: To be saved in stream.
Handler: A handler to the open stream.
Indent: Column in which all printing starts at.
Comment: Optional comment to describe the geometry.
ErrStr: If failed, ErrStr will be set to describe the problem.
Returns: TRUE if succesful, FALSE otherwise.

Description: Generic routine to write Gregory triangular surfaces to the given file. If Comment is NULL, no
comment is printed, if "" only internal comment.
9.2.434  TrngTriSrfReadFromFile  (trngread.c:34)

TrngTriangSrfStruct *TrngTriSrfReadFromFile(const char *FileName,
     char **ErrStr,
     int *ErrLine)

FileName: To read the triangular surface from.
ErrStr: Will be initialized if an error has occurred.
ErrLine: Line number in file FileName of the error, if occurred.
Returns: The read triangular surface, or NULL if an error occurred.
Description: Reads from a file triangular surfaces. If error is detected in reading the file, ErrStr is set to a string describing the error and Line to the line it occured in file. If no error is detected *ErrStr = NULL.

9.2.435  TrngTriSrfReadFromFile2  (trngread.c:98)

TrngTriangSrfStruct *TrngTriSrfReadFromFile2(int Handler,
     char **ErrStr,
     int *ErrLine)

Handler: A handler to the open stream.
ErrStr: Will be initialized if an error has occurred.
ErrLine: Line number in file FileName of the error, if occurred.
Returns: The read triangular surface, or NULL if an error occurred.
Description: Reads from a file a triangular surface. If error is found in reading the file, ErrStr is set to a string describing it and ErrLine to line it occured in file relative to begining of triangular surface. If no error is detected *ErrStr is set to NULL.

9.2.436  TrngTriSrfWriteToFile  (trngwrt.c:34)

int TrngTriSrfWriteToFile(const TrngTriangSrfStruct *TriSrfs,
     const char *FileName,
     int Indent,
     const char *Comment,
     char **ErrStr)

TriSrfs: To be saved in file f.
FileName: File name where output should go to.
Indent: Column in which all printing starts at.
Comment: Optional comment to describe the geometry.
ErrStr: If failed, ErrStr will be set to describe the problem.
Returns: TRUE if succesful, FALSE otherwise.
Description: Generic routine to write triangular surfaces to the given file. If Comment is NULL, no comment is printed, if "" only internal comment.

9.2.437  TrngTriSrfWriteToFile2  (trngwrt.c:74)

int TrngTriSrfWriteToFile2(const TrngTriangSrfStruct *TriSrfs,
     int Handler,
     int Indent,
     const char *Comment,
     char **ErrStr)

TriSrfs: To be saved in stream.
Handler: A handler to the open stream.
Indent: Column in which all printing starts at.
Comment: Optional comment to describe the geometry.
ErrStr: If failed, ErrStr will be set to describe the problem.
Returns: TRUE if successful, FALSE otherwise.

Description: Generic routine to write triangular surfaces to the given file. If Comment is NULL, no comment is printed, if "" only internal comment.

9.2.438 TrngTriSrfWriteToFile3 (trng_wrt.c:114)

int TrngTriSrfWriteToFile3(const TrngTriangSrfStruct *TriSrfs,
FILE *f,
int Indent,
const char *Comment,
char **ErrStr)

TriSrfs: To be saved in file f.
f: File descriptor where output should go to.
Indent: Column in which all printing starts at.
Comment: Optional comment to describe the geometry.
ErrStr: If failed, ErrStr will be set to describe the problem.
Returns: TRUE if successful, FALSE otherwise.

Description: Generic routine to write triangular surfaces(s) to the given file. If Comment is NULL, no comment is printed, if "" only internal comment.

9.2.439 _IPFatalErrorEx (prsr.err.c:213)

void _IPFatalErrorEx(IPFatalErrorType ErrID,
int ErrLine,
const char *ErrDesc)

ErrID: Error type that was raised.
ErrLine: Line number of error in processed file or IP_ERR_NO_LINE_NUM. to ignore.
ErrDesc: Optional error description.
Returns: void

Description: Trap Prsr_lib errors right here. Provides a default error handler for the prsr library. Gets an error description using PrsrDescribeError, prints it and exit the program using exit.

9.2.440 _IPFprintf (iritprs2.c:495)

void _IPFprintf(int Handler, int Indent, char *va_alist, ...)

Handler: A handler to the open stream.
Indent: All printing will start at this column.
va_alist: Do "man stdarg"
Returns: void

Description: Same as fprintf but with indentation.
See also: IPSetPrintFunc, IPSetFloatFormat, IPPrintFunc,
9.2.441  _IPGetCloseParenToken (iritprs1.c:1728)

```c
void _IPGetCloseParenToken(int Handler)

    Handler: A handler to the open stream.
    Returns: void
    Description: Routine to get close paren token from FILE f. This function invokes the parser's abort routine, if no close paren.
```

9.2.442  _IPGetToken (iritprs1.c:2333)

```c
IPTokenType _IPGetToken(int Handler, char *StringToken)

    Handler: A handler to the open stream.
    StringToken: String token will be placed herein.
    Returns: Token as a numeral.
    Description: Routine to get the next token out of the input file f as token number. StringToken must be allocated before calling this routine!
```

9.2.443  _IPParseResetError (prsr_err.c:235)

```c
void _IPParseResetError()

    Returns: void
    Description: Clears the error records for a fresh start.
```

9.2.444  _IPSkipToCloseParenToken (iritprs1.c:1750)

```c
int _IPSkipToCloseParenToken(int Handler)

    Handler: A handler to the open stream.
    Returns: TRUE, if found close paren.
    Description: Routine to skip to the next closed parenthesis.
```

9.2.445  _IPThisLittleEndianHardware (iritprsb.c:120)

```c
int _IPThisLittleEndianHardware(void)

    Returns: TRUE/FALSE for little/big endian style.
    Description: Routine to test little vs. big endian style of packing bytes. Test is done by placing a none zero byte into the first place of a zero integer.
```

9.2.446  _IPUnGetToken (iritprs1.c:2129)

```c
void _IPUnGetToken(int Handler, char *StringToken)

    Handler: A handler to the open stream.
    StringToken: Token to unget
    Returns: void
    Description: Routine to unget one token (on stack of UNGET_STACK_SIZE levels!)
```
Chapter 10

Rendering Library, rndr_lib

10.1 General Information

This library provides a powerful full screen scan conversion Z-buffer tool to process IRIT geometry and convert it into images. This library allows one to scan convert any IRIT geometry including polylines and curves that are converted to skinny polygons on the fly. The library offers regular scan conversion with flat, Gouraud, and Phong shading and several antialiasing filters along with advanced features such as transparency and animation support, and width depth cueing on polyline/curves rendering. The library also provide direct access to the depth Z-buffer as well as a stencil buffer.

10.2 Library Functions

10.2.1 FastAllocInit (fstalloc.c:76)

FastAllocType FastAllocInit(unsigned TypeSz,
   unsigned BlkSz,
   unsigned AllgnBits,
   unsigned Verbose)

TypeSz: IN, size of allocated type (in bytes).
BlkSz: IN, size of blocks allocated (in bytes, >= TypeSz).
AllgnBits: IN, alignment of each allocation is 2^AllgnBits.
Verbose: IN, iff TRUE, FastAllocDestroy() prints statistics.
Returns: The FastAlloc instance.
Description: Initializes an instance of an FastAllocType.

10.2.2 FastAllocNew (fstalloc.c:114)

VoidPtr FastAllocNew(FastAllocType Alloc)

Alloc: IN, FastAllocType instance.
Returns: Void pointer to the new memory area.
Description: Allocates new area of memory of size TypeSz (see FastAllocInit()).

10.2.3 INCRndrBeginObject (nczbufr.c:223)

void INCRndrBeginObject(INCZBufferPtrType Rend, IPObj ectStruct *Object)

Rend: IN, OUT, the rendering context.
Object: IN, the object to be scanned.
Returns: void
Description: Sets the Irit object to be scan converted.
10.2.4 **INCRndrDestroy** (nc\_zbufr.c:198)

```c
void INCRndrDestroy(INCZBufferPtrType Rend)

Rend: IN,OUT, the rendering context.

Returns: void

Description: Dispose of a the rendering context.
```

10.2.5 **INCRndrEndObject** (nc\_zbufr.c:367)

```c
void INCRndrEndObject(INCZBufferPtrType Rend)

Rend: IN, OUT, the rendering context.

Returns: void

Description: Marks the end of the object scanning.
```

10.2.6 **INCRndrGetActiveCells** (nc\_zbufr.c:596)

```c
int INCRndrGetActiveCells(INCZBufferPtrType Rend,
int *MinCellX,
int *MinCellY,
int *MaxCellX,
int *MaxCellY,
IrtRType *ZPixelsRemoved)

Rend: IN,OUT, the rendering context.
MinCellX, MinCellY: OUT, Minimum indices of active cells.
MaxCellX, MaxCellY: OUT, Maximum indices of active cells.
ZPixelsRemoved: OUT, number of pixels removed since last call.

Returns: TRUE if we do have active cells.

Description: Gets the active cells - a rectangular (XMin, YMin) ;; (XMax, YMax) indices of cells where the Z-buffer was updated in, since the last call. This function also resets all cells to inactive state.
```

10.2.7 **INCRndrGetLineDepth** (nc\_zbufr.c:446)

```c
void INCRndrGetLineDepth(INCZBufferPtrType Rend,
int x1,
int x2,
int y,
IrtRType *ZValues)

Rend: IN, OUT, the rendering context.
x1, x2: IN, the x-range to fetch along the line.
y: IN, the line number.
ZValues: OUT, a user allocated buffer to hold the result.

Returns: void

Description: Retrieve z-coordinate data from the z-buffer.
```
10.2.8 INCRndrGetPixelDepth (nc_zbufr.c:418)

```c
void INCRndrGetPixelDepth(INCZBufferPtrType Rend, 
    int x, 
    int y, 
    IrtRType *Result)
```

**Rend:** IN,OUT, the rendering context.
**x:** IN, the column number.
**y:** IN, the line number.
**Result:** OUT, the user allocated buffer to hold the result.

**Returns:** void

**Description:** Retrieve a pixel’s depth from the z-buffer.

10.2.9 INCRndrGetZbufferGridCell (nc_zbufr.c:506)

```c
int INCRndrGetZbufferGridCell(INCZBufferPtrType Rend, 
    int GridCellX, 
    int GridCellY, 
    IrtRType *ZValues, 
    int *XMin, 
    int *YMin, 
    int *XMax, 
    int *YMax)
```

**Rend:** IN, OUT, the rendering context.
**GridCellX, GridCellY:** IN, the grid cell to fetch its Z values.
**ZValues:** OUT, a user allocated buffer to hold the result.
**XMin, YMin:** OUT, minimal dimensions of fetched grid cell.
**XMax, YMax:** OUT, maximal dimensions of fetched grid cell.

**Returns:** TRUE if successful, FALSE otherwise (out of grid range).

**Description:** Fetches the z-buffer regions under the requested grid cell. Returned is a linear buffer of as many pixels in the requested grid cell, ordered by rows. See INCRndrGetZbufferGridCellMaxSize to get maximal grid cell size.

10.2.10 INCRndrGetZbufferGridCellMaxSize (nc_zbufr.c:473)

```c
void INCRndrGetZbufferGridCellMaxSize(INCZBufferPtrType Rend, 
    int *GridSizeX, 
    int *GridSizeY, 
    int *GridCellXSize, 
    int *GridCellYSize)
```

**Rend:** IN, OUT, the rendering context.
**GridSizeX, GridSizeY:** OUT, the grid dimensions.
**GridCellXSize, GridCellYSize:** OUT, cell sizes.

**Returns:** void

**Description:** Gets the grid size and maximal cell size, in pixels of the z-buffer.
10.2.11 INCRndrInitialize (nc_zbufr.c:82)

INZBufferPtrType INCRndrInitialize(int ZBufSizeX,  
int ZBufSizeY,  
int GridSizeX,  
int GridSizeY,  
IrtPtType XYZMin,  
IrtPtType XYZMax,  
int BottomMaxZ)

ZBufSizeX: IN, the width of the z-buffer, in pixels.
ZBufSizeY: IN, the height of the z-buffer, in pixels.
GridSizeX: IN, the grid X size to divide the z-buffer into.
GridSizeY: IN, the grid Y size to divide the z-buffer into.
XYZMin: IN, the minimum corner of volume to consider.
XYZMax: IN, the maximum corner of volume to consider.
BottomMaxZ: IN, TRUE if bottom is maximal Z value, FALSE if bottom should capture minimal Z values.
Returns: A handle to the newly created NC z-buffer.
Description: Creates a new NC (Numerically controled) Rendering context, and returns a handle to it. Specified are the required sizes of the ZBuffer, the grid size to impose over the XY ZBuffer, and the stock dimensions. The grid will be used to efficiently fetch ZBuffer data at the granularity of grid cells instead of the entire ZBuffer every time.

10.2.12 INCRndrMapPixelsToCells (nc_zbufr.c:554)

int INCRndrMapPixelsToCells(INCZBufferPtrType Rend, int *X, int *Y)

Rend: IN,OUT, the rendering context.
X, Y: IN,OUT, pixel coordinates to map to the cell indices they are in.
Returns: TRUE if we found the right cell.
Description: Maps the given pixel coordinates to indices of the cell that contains these pixel coordinates.

10.2.13 INCRndrPutMask (nc_zbufr.c:293)

IrtRType INCRndrPutMask(INCZBufferPtrType Rend,  
int *PosXY,  
IrtRType PosZ,  
IrtRType *Mask,  
int MaskXSize,  
int MaskYSize)

Rend: IN, OUT, the rendering context.
PosXY: IN, XY location where to place the center of the mask in the Z buffer.
PosZ: IN, The depth to place the mask at.
Mask: IN, The 2D square array of depth values.
MaskXSize: IN, X size of Mask.
MaskYSize: IN, Y size of Mask.
Returns: Amount of material removed by this call in Pixels^2*Z volume units.
Description: Scan convert a depth Mask into the Zbuffer. The Mask is a 2D square of depth values that is centered around Pos.
10.2.14  INCRndrPutPixel  (nc\_zbufr.c:388)

```c
void INCRndrPutPixel(INCZBufferPtrType Rend, int x, int y, IrtRType z)
```

**Rend:** IN, OUT, the rendering context.

**x:** IN, the column number.

**y:** IN, the line number.

**z:** IN, the pixel’s depth.

**Returns:** void

**Description:** Manually adds a single pixel.

---

10.2.15  INCRndrPutTriangle  (nc\_zbufr.c:253)

```c
void INCRndrPutTriangle(INCZBufferPtrType Rend, IPPolygonStruct *Triangle)
```

**Rend:** IN, OUT, the rendering context.

**Triangle:** IN, the triangle to be scanned.

**Returns:** void

**Description:** Scan converts a triangle polygon.

---

10.2.16  INCRndrSetZCmp  (nc\_zbufr.c:173)

```c
IRndrZBufferCmpType INCRndrSetZCmp(INCZBufferPtrType Rend, IRndrZBufferCmpType ZCmp)
```

**Rend:** IN,OUT, the rendering context.

**ZCmp:** IN, the comparison method.

**Returns:** Old comparison method.

**Description:** Sets the NC z-buffer comparison method.

---

10.2.17  IRndr1DClearDepth  (zbufr\_1d.c:99)

```c
void IRndr1DClearDepth(IRndrZBuffer1DPtrType Rend, IrtRType ClearZ)
```

**Rend:** IN,OUT, the rendering context.

**ClearZ:** IN, the new depth to reset the zbuffer to.

**Returns:** void

**Description:** Resets the 1D z-buffer depth.

---

10.2.18  IRndr1DDestroy  (zbufr\_1d.c:145)

```c
void IRndr1DDestroy(IRndrZBuffer1DPtrType Rend)
```

**Rend:** IN,OUT, the rendering context.

**Returns:** void

**Description:** Dispose of the rendering context.
10.2.19  IRndr1DFilterCollinearEdges (zbufr_1d.c:432)

IPPolygonStruct *IRndr1DFilterCollinearEdges(IRndrZBuffer1DPtrType Rend,
IPPolygonStruct *Pl,
int MergeInters)

**Rend:** IN, the rendering context.
**Pl:** IN, the polyline to filter for collinear edges, in place.
**MergeInters:** If TRUE, adjacent linear segments as detected in the 1D Z buffer are merged whenever possible.

**Returns:** The filtered polyline.
**Description:** Filters the resulting polyline for collinear edges, in place.

10.2.20  IRndr1DGetLineDepth (zbufr_1d.c:340)

void IRndr1DGetLineDepth(IRndrZBuffer1DPtrType Rend,
int x1,
int x2,
IrtRType *ZValues)

**Rend:** IN, OUT, the rendering context.
**x1, x2:** IN, the x-range to fetch along the line.
**ZValues:** OUT, a user allocated buffer to hold the result.

**Returns:** void
**Description:** Retrieve z-coordinate data from the z-buffer.

10.2.21  IRndr1DGetPixelDepth (zbufr_1d.c:315)

void IRndr1DGetPixelDepth(IRndrZBuffer1DPtrType Rend, int x, IrtRType *Result)

**Rend:** IN,OUT, the rendering context.
**x:** IN, the column number.
**Result:** OUT, the user allocated buffer to hold the result.

**Returns:** void
**Description:** Retrieve a pixel’s depth from the z-buffer.

10.2.22  IRndr1DInitialize (zbufr_1d.c:52)

IRndrZBuffer1DPtrType IRndr1DInitialize(int ZBuf1DSize,
IrtRType XMin,
IrtRType XMax,
IrtRType ZMin,
IrtRType ZMax,
int BottomMaxZ)

**ZBuf1DSize:** IN, the length of the 1D z-buffer, in pixels.
**XMin, XMax:** IN, the min/maximum real dimension to consider.
**ZMin, ZMax:** IN, the min/maximum depth to consider.
**BottomMaxZ:** IN, TRUE if bottom is maximal Z value, FALSE if bottom should capture minimal Z values.

**Returns:** A handle to the newly created 1D z-buffer.
**Description:** Creates a new 1D Zuffer, and returns a handle to it. Specified are the required length of the ZBuffer, and the real dimensions.
10.2.23  IRndr1DPutLine (zbufr_1d.c:199)

```c
void IRndr1DPutLine(IRndrZBuffer1DPtrType Rend,
                      IrtRType x1,
                      IrtRType z1,
                      IrtRType x2,
                      IrtRType z2)
```

**Rend:** IN, OUT, the rendering context.

**x1, z1, x2, z2:** IN, the line to scan convert.

**Returns:** void

**Description:** Scan converts a line.

10.2.24  IRndr1DPutPixel (zbufr_1d.c:278)

```c
void IRndr1DPutPixel(IRndrZBuffer1DPtrType Rend, int x, IrtRType z)
```

**Rend:** IN, OUT, the rendering context.

**x:** IN, the column number.

**z:** IN, the pixel’s depth.

**Returns:** void

**Description:** Manually adds a single pixel.

10.2.25  IRndr1DPutPolyline (zbufr_1d.c:168)

```c
void IRndr1DPutPolyline(IRndrZBuffer1DPtrType Rend, IPPolygonStruct *Pl)
```

**Rend:** IN, OUT, the rendering context.

**Pl:** IN, the polyline to scan convert.

**Returns:** void

**Description:** Scan converts a polyline.

10.2.26  IRndr1DSetZCmp (zbufr_1d.c:122)

```c
IRndrZBufferCmpType IRndr1DSetZCmp(IRndrZBuffer1DPtrType Rend,
                                    IRndrZBufferCmpType ZCmp)
```

**Rend:** IN,OUT, the rendering context.

**ZCmp:** IN, the comparison method.

**Returns:** Old comparison method.

**Description:** Sets the NC z-buffer comparison method.

10.2.27  IRndr1DUpperEnvAsPolyline (zbufr_1d.c:366)

```c
IPPolygonStruct *IRndr1DUpperEnvAsPolyline(IRndrZBuffer1DPtrType Rend,
                                           int MergeInters)
```

**Rend:** IN, the rendering context.

**MergeInters:** If TRUE, adjacent linear segments as detected in the 1D Z buffer are merged whenever possible.

**Returns:** The retrieved envelope as a polyline.

**Description:** Retrieve the z-buffer envelope as one polyline from XMin to XMax.
10.2.28  IRndrAddLightSource  (rndr_lib.c:200)

```c
void IRndrAddLightSource(IRndrPtrType Rend,
    IRndrLightType Type,
    IrtPtType Where,
    IRndrColorType Color)
```

- **Rend**: IN, OUT the rendering context.
- **Type**: IN, the light type (POINT, VECTOR)
- **Where**: IN, the light position.
- **Color**: IN, the light’s color.

**Returns**: void

**Description**: Adds a new light source.

10.2.29  IRndrBeginObject  (rndr_lib.c:587)

```c
void IRndrBeginObject(IRndrPtrType Rend,
    IPOObjectStruct *Object,
    int NoShading)
```

- **Rend**: IN, OUT, the rendering context.
- **Object**: IN, the object to be scanned.
- **NoShading**: IN, if TRUE, ignore shading on this one.

**Returns**: void

**Description**: Sets the Irit object to be scan converted.

10.2.30  IRndrBeginPll  (rndr_lib.c:697)

```c
void IRndrBeginPll(IRndrPtrType Rend)
```

- **Rend**: IN, OUT, the rendering context.

**Returns**: void

**Description**: Begin drawing a line.

10.2.31  IRndrClearColor  (rndr_lib.c:176)

```c
void IRndrClearColor(IRndrPtrType Rend)
```

- **Rend**: IN, OUT, the rendering context.

**Returns**: void

**Description**: Reset color information to the registered background color.

10.2.32  IRndrClearDepth  (rndr_lib.c:140)

```c
void IRndrClearDepth(IRndrPtrType Rend, IRndrZDepthType ClearZ)
```

- **Rend**: IN, OUT, the rendering context.
- **ClearZ**: IN, Depth to clear the ZBuffer to.

**Returns**: void

**Description**: Clear depth information in the rendering context.
10.2.33 **IRndrClearStencil** *(rndr.lib.c:158)*

```c
void IRndrClearStencil(IRndrPtrType Rend)
    Rend: IN,OUT, the rendering context.
    Returns: void
    Description: Clear stencil information in the rendering context.
```

10.2.34 **IRndrDestroy** *(rndr.lib.c:115)*

```c
void IRndrDestroy(IRndrPtrType Rend)
    Rend: IN,OUT, the rendering context.
    Returns: void
    Description: Dispose of a the rendering context.
```

10.2.35 **IRndrEndObject** *(rndr.lib.c:679)*

```c
void IRndrEndObject(IRndrPtrType Rend)
    Rend: IN, OUT, the rendering context.
    Returns: void
    Description: Marks the end of the object scanning.
```

10.2.36 **IRndrEndPll** *(rndr.lib.c:745)*

```c
void IRndrEndPll(IRndrPtrType Rend)
    Rend: IN, OUT, the rendering context.
    Returns: void
    Description: Marks the end of the line.
```

10.2.37 **IRndrGetClippingPlanes** *(rndr.lib.c:327)*

```c
void IRndrGetClippingPlanes(IRndrPtrType Rend, IrtPlnType *ClipPlanes)
    Rend: IN, the rendering context.
    ClipPlanes: OUT, a pointer to the 6 user allocated planes.
    Returns: void
    Description: Retrives the 6 clipping planes, defining the viewing frastrum.
```

10.2.38 **IRndrGetLineColorAlpha** *(rndr.lib.c:877)*

```c
void IRndrGetLineColorAlpha(IRndrPtrType Rend, int y, IRndrColorType *Result)
    Rend: IN, OUT, the rendering context.
y: IN, the line number.
    Result: OUT, the user allocated buffer to hold the result.
    Returns: void
    Description: Retrieve color (and alpha) data from the z-buffer.
```
10.2.39 IRndrGetLineDepth (rndr_lib.c:901)

void IRndrGetLineDepth(IRndrPtrType Rend, int y, IrtRType *Result)

Rend: IN, OUT, the rendering context.
y: IN, the line number.
Result: OUT, the user allocated buffer to hold the result.
Returns: void
Description: Retrieve z-coordinate data from the z-buffer.

10.2.40 IRndrGetLineStencil (rndr_lib.c:925)

void IRndrGetLineStencil(IRndrPtrType Rend, int y, int *Result)

Rend: IN, OUT, the rendering context.
y: IN, the line number.
Result: OUT, the user allocated buffer to hold the result.
Returns: void
Description: Retrieve stencil data from the z-buffer.

10.2.41 IRndrGetPixelColorAlpha (rndr_lib.c:809)

void IRndrGetPixelColorAlpha(IRndrPtrType Rend, int x, int y, IRndrColorType *Result)

Rend: IN, OUT, the rendering context.
x: IN, the column number.
y: IN, the line number.
Result: OUT, the user allocated buffer to hold the result.
Returns: void
Description: Retrieve a pixel’s color (and alpha) from the z-buffer.

10.2.42 IRndrGetPixelDepth (rndr_lib.c:833)

void IRndrGetPixelDepth(IRndrPtrType Rend, int x, int y, IrtRType *Result)

Rend: IN, OUT, the rendering context.
x: IN, the column number.
y: IN, the line number.
Result: OUT, the user allocated buffer to hold the result.
Returns: void
Description: Retrieve a pixel’s depth from the z-buffer.
10.2.43 IRndrGetPixelStencil (rndr_lib.c:857)

void IRndrGetPixelStencil(IRndrPtrType Rend,  
    int x,  
    int y,  
    int *Result)

Rend: IN, OUT, the rendering context.  
x: IN, the column number.  
y: IN, the line number.  
Result: OUT, the user allocated buffer to hold the result.  
Returns: void  
Description: Retrieve a pixel’s stencil from the z-buffer.

10.2.44 IRndrGetScene (rndr_lib.c:1049)

struct IRndrSceneStruct *IRndrGetScene(IRndrPtrType Rend)

Rend: IN, the rendering context.  
Returns: The scene struct.  
Description: Get the scene struct.

10.2.45 IRndrGetViewPrsp (rndr_lib.c:300)

void IRndrGetViewPrsp(IRndrPtrType Rend,  
    IrtHmgnMatType ViewMat,  
    IrtHmgnMatType PrspMat,  
    IrtHmgnMatType ScrnMat)

Rend: IN,OUT, the rendering context.  
ViewMat: OUT, the view matrix. If NULL, it’s ignored.  
PrspMat: OUT, the perspective matrix. If NULL, it’s ignored.  
ScrnMat: OUT, the mapping to the screen. If NULL, it’s ignored.  
Returns: void  
Description: Gets the view, perspective and screen matrices.

10.2.46 IRndrInitialize (rndr_lib.c:61)

IRndrPtrType IRndrInitialize(int SizeX,  
    int SizeY,  
    int SuperSampSize,  
    int ColorQuantization,  
    IrtBType UseTransparency,  
    IrtBType BackfaceCulling,  
    IRndrColorType BackgrCol,  
    IrtRType AmbientLight,  
    int VisMap)

SizeX: IN, the width of the z-buffer.  
SizeY: IN, the height of the z-buffer.  
SuperSampSize: IN, the super-sample size.  
ColorQuantization: IN, non zero to quantize the generated colors to ColorQuantization levels of colors.  
UseTransparency: IN, whether transparency is on.
BackfaceCulling: IN, whether to use back-face culling.
BackgrCol: IN, the background color.
AmbientLight: IN, the abient light factor.
VisMap: IN, TRUE to create a visibility map image.
Returns: a handle to the newly created z-buffer.
Description: Creates a new Rendering context, and returns a handle to it.

10.2.47 IRndrPutPixel (rndr.lib.c:785)

void IRndrPutPixel(IRndrPtrType Rend,
int x,
int y,
IrtRType z,
IrtRType Transparency,
IRndrColorType Color,
IPPolygonStruct *Triangle)

Rend: IN, OUT, the rendering context.
x: IN, the column number.
y: IN, the line number.
z: IN, the pixel’s depth.
Transparency: IN, the pixel’s transparency value.
Color: IN, the new color of pixel at (x, y).
Triangle: IN, The triangle which created the added point.
Returns: void
Description: Manually adds a single pixel.

10.2.48 IRndrPutPllVertex (rndr.lib.c:716)

void IRndrPutPllVertex(IRndrPtrType Rend, IPVertexStruct *Vertex)

Rend: IN, OUT, the rendering context.
Vertex: IN, the next vertex of the line.
Returns: void
Description: Sets the next vertex of the line.

10.2.49 IRndrPutTriangle (rndr.lib.c:616)

void IRndrPutTriangle(IRndrPtrType Rend, IPPolygonStruct *Triangle)

Rend: IN, OUT, the rendering context.
Triangle: IN, the triangle to be scanned.
Returns: void
Description: Scan converts a triangle polygon.
10.2.50 IRndrSaveFile (rndr.lib.c:980)

```c
void IRndrSaveFile(IRndrPtrType Rend,
    const char *BaseDirectory,
    const char *OutFileName,
    const char *Type)

Rend: IN, OUT, the rendering context.
BaseDirectory: IN, the directory to save the file in.
OutFileName: IN, the file name.
Type: IN, the file type.
Returns: void
Description: Save the color info of the z-buffer into a file.
```

10.2.51 IRndrSaveFileCB (rndr.lib.c:955)

```c
void IRndrSaveFileCB(IRndrPtrType Rend,
    IRndrImgSetFileType FuncType ImgSetType,
    IRndrImgOpenFuncType ImgOpen,
    IRndrImgWriteLineFuncType ImgWriteLine,
    IRndrImgCloseFuncType ImgClose)

Rend: IN, OUT, the rendering context.
ImgSetType: IN, Image setting file type function
ImgOpen: IN, Function to open an image file.
ImgWriteLine: IN, Function to write one row (Vec of RGB & vec of Alpha).
ImgClose: IN, Function to close an image file.
Returns: void
Description: Sets teh call back functions to invoked when saving files.
```

10.2.52 IRndrSaveFileDepth (rndr.lib.c:1005)

```c
void IRndrSaveFileDepth(IRndrPtrType Rend,
    const char *BaseDirectory,
    const char *OutFileName,
    const char *Type)

Rend: IN, OUT, the rendering context.
BaseDirectory: IN, the directory to save the file in.
OutFileName: IN, the file name.
Type: IN, the file type.
Returns: void
Description: Save the z coordinate values of the z-buffer into a file.
```

10.2.53 IRndrSaveFileStencil (rndr.lib.c:1030)

```c
void IRndrSaveFileStencil(IRndrPtrType Rend,
    const char *BaseDirectory,
    const char *OutFileName,
    const char *Type)

Rend: IN, OUT, the rendering context.
BaseDirectory: IN, the directory to save the file in.
OutFileName: IN, the file name.
Type: IN, the file type.
Returns: void
Description: Save the context of the z-buffer into a file.
```
10.2.54  **IRndrSaveFileVisMap** (rndr.lib.c:1073)

    void IRndrSaveFileVisMap(IRndrPtrType Rend, const char *BaseDirectory, const char *OutFileName, const char *Type)

Rend: IN, OUT, the rendering context.
BaseDirectory: IN, the directory to save the file in.
OutFileName: IN, the file name.
Type: IN, the file type.
Returns: void
Description: Save the context of the UV-map into a file.

10.2.55  **IRndrSetFilter** (rndr.lib.c:224)

    void IRndrSetFilter(IRndrPtrType Rend, char *FilterName)

Rend: IN,OUT, the rendering context.
FilterName: IN, the filter’s name.
Returns: void
Description: Changes the filter, used for antialiasing.

10.2.56  **IRndrSetPllParams** (rndr.lib.c:376)

    void IRndrSetPllParams(IRndrPtrType Rend, IrtRType MinWidth, IrtRType MaxWidth, IrtRType ZNear, IrtRType ZFar)

Rend: IN,OUT, the rendering context.
MinWidth: IN, the width of the line at Z = Znear.
MaxWidth: IN, the width of the line at Z = Zfar.
ZNear, ZFar: IN, as stated above.usually the expected scene width.
Returns: void
Description: Sets the Polyline parameters, used for line drawing.

10.2.57  **IRndrSetPostZCmpClbk** (rndr.lib.c:506)

    void IRndrSetPostZCmpClbk(IRndrPtrType Rend, IRndrPixelClbkFuncType ZPassClbk, IRndrPixelClbkFuncType ZFailClbk)

Rend: IN,OUT, the rendering context.
ZPassClbk, ZFailClbk: IN, the callback functions called on success/failure.
Returns: void
Description: Sets the z-buffer post comparison function callback function.
10.2.58  IRndrSetPreZCmpClbk (rndr.lib.c:479)

IRndrPixelClbkFuncType IRndrSetPreZCmpClbk(IRndrPtrType Rend,
IRndrPixelClbkFuncType PixelClbk)

Rend: IN, OUT, the rendering context.
PixelClbk: IN, the callback function.
Returns: Old callback function.
Description: Sets the z-buffer pre comparison function callback function.

10.2.59  IRndrSetRawMode (rndr.lib.c:404)

IrtBType IRndrSetRawMode(IRndrPtrType Rend, IrtBType UseRawMode)

Rend: IN, OUT, the rendering context.
UseRawMode: IN, whether the access mode is RAW (otherwise filtered).
Returns: Old raw mode.
Description: Sets the z-buffer access mode (original super sampled data or filtered).

10.2.60  IRndrSetShadeModel (rndr.lib.c:244)

IRndrShadingType IRndrSetShadeModel(IRndrPtrType Rend,
IRndrShadingType ShadeModel)

Rend: IN, OUT, the rendering context.
ShadeModel: IN, the new shading model (FLAT,GOURAUD,PHONG,NONE).
Returns: Old shading model.
Description: Changes the shading model.

10.2.61  IRndrSetViewPrsp (rndr.lib.c:276)

void IRndrSetViewPrsp(IRndrPtrType Rend,
IrtHmgnMatType ViewMat,
IrtHmgnMatType PrspMat,
IrtHmgnMatType ScrnMat)

Rend: IN,OUT, the rendering context.
ViewMat: IN, the view matrix.
PrspMat: IN, the perspective matrix, NULL if parallel projection.
ScrtnMat: IN, the mapping to the screen or NULL if scale [-1,+1] to image size.
Returns: void
Description: Sets the view and perspective matrices.

10.2.62  IRndrSetZBounds (rndr.lib.c:351)

void IRndrSetZBounds(IRndrPtrType Rend, IrtRType ZNear, IrtRType ZFar)

Rend: IN, OUT, the rendering context.
ZNear: IN, the (negation of the) z-coordinate of the near clipping plane.
ZFar: IN, the (negation of the) z-coordinate of the far clipping plane.
Returns: void
Description: Sets the near and far XY clipping planes, defining the viewing frustum.
10.2.63 IRndrSetZCmp (rndr.lib.c:454)

IRndrZBufferCmpType IRndrSetZCmp(IRndrPtrType Rend, IRndrZBufferCmpType ZCmp)

Rend: IN, OUT, the rendering context.
ZCmp: IN, the comparison method.
Returns: Old comparison method.
Description: Sets the z-buffer comparison method.

10.2.64 IRndrSetZCmpPolicy (rndr.lib.c:430)

IRndrZCmpPolicyFuncType IRndrSetZCmpPolicy(IRndrPtrType Rend, IRndrZCmpPolicyFuncType ZCmpPol)

Rend: IN, OUT, the rendering context.
ZCmpPol: IN, the comparison function (linear order).
Returns: Old comparison function.
Description: Sets the z-buffer comparison function.

10.2.65 IRndrStencilCmpFunc (rndr.lib.c:531)

void IRndrStencilCmpFunc(IRndrPtrType Rend, IRndrStencilCmpType SCmp, int Ref, unsigned Mask)

Rend: IN, OUT, the rendering context.
SCmp: IN, stencil test comparison type.
Ref: IN, stencil test reference value.
Mask: IN, stencil test mask.
Returns: void
Description: Sets the z-buffer stencil test function.

10.2.66 IRndrStencilOp (rndr.lib.c:560)

void IRndrStencilOp(IRndrPtrType Rend, IRndrStencilOpType Fail, IRndrStencilOpType ZFail, IRndrStencilOpType ZPass)

Rend: IN, OUT, the rendering context.
Fail: IN, stencil test failure operation.
ZFail: IN, Z-test failure operation.
ZPass: IN, Z-test pass operation.
Returns: void
Description: Sets the z-buffer stencil operations.
10.2.67  **IRndrVMClear** *(vis_maps.c:260)*

```c
void IRndrVMClear(IRndrVMStruct *VisMap)

VisMap:  IN, OUT, Pointer to visibility map.
Returns:  void
Description:  Clears the context of visibility map (Sets all UV information to initial values).
```

10.2.68  **IRndrVMGetLine** *(vis_maps.c:934)*

```c
int IRndrVMGetLine(IRndrVMStruct *VisMap,
    int u0,
    int ul,
    int v,
    IrtRType **FilterCoeff,
    IrtRType *Result,
    IRndrVisibleValidityType *Validity)

VisMap:  IN, OUT, pointer to visibility map.
u0:  IN, minimal U coordinate.
ul:  IN, maximal U coordinate.
v:  IN, line V number.
FilterCoeff:  IN, the filter to use in the super sampling. If NULL, uses the same weight for all samples.
Result:  OUT, the visibility values of the line. When super sampling is disabled 0 For not visible and 1 for visible. When super sampling is enable the values are in [0,1] and reflects the amount of visible cell out of the total valid cells (invalid cells are ignored). If empty, returns negative number. If Validity isn’t IRNDR_VISMAP_VALID_OK, Result is undefined.
Validity:  OUT, The validity of the pixel.
Returns:  TRUE if successful.
Description:  Retrieves visibility information of a specific line in UV space. The line should be allocated by the caller.
```

10.2.69  **IRndrVMGetObjDomain** *(vis_maps.c:1060)*

```c
int IRndrVMGetObjDomain(IPObjectStruct *PObj,
    IrtRType *UMin,
    IrtRType *UMax,
    IrtRType *VMin,
    IrtRType *VMax)

PObj:  IN - The object to get its domain. Objects which aren’t polygons are ignored.
UMin, UMax, VMin, VMax:  OUT - The domain of the object.
Returns:  FALSE if no uv value was found.
Description:  Get the domain of the given object (Object which aren’t polygons are ignored).
```

10.2.70  **IRndrVMInit** *(vis_maps.c:98)*

```c
int IRndrVMInit(IRndrVMStruct *VisMap,
    IRndrSceneStruct *Scene,
    int SuperSize,
    int UVBackfaceCulling)

VisMap:  IN, OUT, Pointer to visibility map object.
Scene:  IN, Pointer to the related scene object.
SuperSize:  IN, Super sampling size.
UVBackfaceCulling:  IN, use backface culling during the UV scan coversion.
Returns:  0 if successful.
Description:  Initialize a newly created visibility map.
10.2.71 IRndrVMIsPointInTriangle (vis_maps.c:430)

```c
int IRndrVMIsPointInTriangle(IPPolygonStruct *Triangle,
   IrtPtType Pt,
   int Perim,
   IrtRType *z,
   IrtRType *s,
   IrtRType *t)
```

- **Triangle**: IN, The triangle.
- **Pt**: IN, The point.
- **Perim**: IN, If TRUE, points on the perimeter are considered as being in the triangle. If FALSE they are not in the triangle.
- **z**: OUT, The z value of Triangle at the xy values given by Pt. Ignored if it’s NULL.
- **s, t**: The parameters of Pt in the plane formula. Ignored if NULL.

**Returns**: Whether Pt is inside Triangle

**Description**: Check whether Pt is inside Triangle. (The calculation are done using only the xy coordinates). z returns the z value of triangle at the xy coordinates given by Pt (it may return the z value at the continuation of Triangle if xy is outside Triangle). s and t are the parameters which create Pt in the plane formula: Triangle[0] + s*(Triangle[2]-Triangle[0]) + t*(Triangle[1]-Triangle[0])

10.2.72 IRndrVMPrepareUVValuesOfGeoObj (vis_maps.c:1116)

```c
int IRndrVMPrepareUVValuesOfGeoObj(IPObjectStruct *PObj,
   int MapWidth,
   int MapHeight,
   IPObjectStruct *PObj2)
```

- **PObj**: The geometric object.
- **MapWidth, MapHeight**: The dimensions of the visibility map.
- **PObj2**: If it isn’t NULL, this object is a list of objects which contains at least as much elements as PObj. Each element i in PObj2 will go through the same Transformations and scaling as element i in PObj. Objects which aren’t surfaces, trimmed surfaces or polygons are ignored.

**Returns**: FALSE if PObj doesn’t contain any objects.

**Description**: If there is more than one object in PObj (using PNext) arrange the UV values domains to a one continuous non overlapping domain.

10.2.73 IRndrVMPutPixel (vis_maps.c:846)

```c
void IRndrVMPutPixel(IRndrVMStruct *VisMap,
   int u,
   int v,
   IrtPtType xyzVals,
   IRndrVisibleValidityType Validity,
   int BackFaced,
   IPPolygonStruct *Triangle)
```

- **VisMap**: IN, OUT, pointer to visibility map.
- **u**: IN, the column number.
- **v**: IN, the line number.
- **xyzVals**: IN, the pixel’s view coordinates.
- **Validity**: IN, validity of pixel.
- **BackFaced**: IN, if back face culling is on and pixel belongs to back facing triangle.
- **Triangle**: IN, The triangle which created this UV point.

**Returns**: void

**Description**: Manually adds a single pixel to visibility map.
10.2.74 IRndrVMPutTriangle (vis_maps.c:334)

```c
int IRndrVMPutTriangle(IRndrVMStruct *VisMap,
                        IRndrTriangleStruct *RendTri,
                        IRndrSceneStruct *Scene,
                        IRndrObjectStruct *Obj,
                        IPPolygonStruct *Triangle)
```

**VisMap:** IN,OUT, pointer to the visibility map.

**RendTri:** IN, renderer current rendered triangle.

**Scene:** IN, scene pointer.

**Obj:** IN, current rendered object.

**Triangle:** IN, a polygon triangle represented which was scanned into Z-buffer, with UV values in `uvvals` attribute, in each vertex. This object is changed during this function (So it can’t use for other purposes after this function).

**Returns:** Whether the method finished successfully

**Description:** The method gets a scanned triangle polygon and scans it into visibility map using the regular scan conversion.

10.2.75 IRndrVMRelease (vis_maps.c:294)

```c
void IRndrVMRelease(IRndrVMStruct *VisMap)
```

**VisMap:** IN,OUT, pointer to the visibility map.

**Returns:** void

**Description:** Release the memory taken by the visibility map.

10.2.76 IRndrVMRelocatePtIntoTriangle (vis_maps.c:563)

```c
void IRndrVMRelocatePtIntoTriangle(IPPolygonStruct *Triangle, IrtPtType Pt)
```

**Triangle:** IN, The triangle.

**Pt:** IN, The point.

**Returns:** void

**Description:** If Pt isn’t inside Triangle, relocation it to be the closest point inside triangle (The calculation are done only with the xy coordinates).

10.2.77 IRndrVMScan (vis_maps.c:737)

```c
void IRndrVMScan(IRndrVMStruct *VisMap, IRndrZBufferStruct *Buff)
```

**VisMap:** IN,OUT, pointer to the visibility map.

**Buff:** IN, OUT, the zbuffer.

**Returns:** void

**Description:** Scan over all visibility map pixels, for each uv values, contains xyz values is compared to the triangles in the z-buffer in coordinate xy. coordinate can be visible, hidden(mapped) or unmapped.
10.2.78 IRndrVMSetCriticAR (vis_maps.c:213)

void IRndrVMSetCriticAR(IRndrVMStruct *VisMap, IrtRType CriticAR)

VisMap: IN, OUT, pointer to the visibility map.

CriticAR: IN, value of critic aspect ratio value, which is ratio between the largest and smallest edge of a triangle. Use value 0 for skipping AR check.

Returns: void

Description: Setting critic AR value.

10.2.79 IRndrVMSetDilation (vis_maps.c:237)

void IRndrVMSetDilation(IRndrVMStruct *VisMap, int Dilation)

VisMap: IN, OUT, pointer to the visibility map.

Dilation: IN, the amount of iterations to do the dilation algorithm.

Returns: void

Description: Setting dilation iterations value, this will define how many times the dilation algorithm will be executed, expanding one pixel at a time.

10.2.80 IRndrVMSetLimits (vis_maps.c:161)

void IRndrVMSetLimits(IRndrVMStruct *VisMap, IPObjeectStruct* Objects)

VisMap: IN, OUT, Pointer to visibility map object.

Objects: IN, Rendered object list.

Returns: void

Description: Set scene and visibility map limits according to the XY and UV maximum and minimum coordinates in all objects. Also, sets the scene's screen matrix according to the XY limits so the entire scene will be in the scene's window and centered. That means that the entire scene's x and y coordinates will be in the range [0, scene -> sizex/y] (z coordinate isn't changed).

10.2.81 IRndrVMSetScanOnUV (vis_maps.c:2105)

void IRndrVMSetScanOnUV(IRndrVMStruct *VisMap, int IsScanOnUV)

VisMap: Pointer to the visibility map.

IsScanOnUV: TRUE in order to scan on XYZ and UV spaces. FALSE to scan only on XYZ space.

Returns: void

Description: Set whether to scan the following triangles on UV space or just on XYZ space.

10.2.82 IRndrVMSetTanAngle (vis_maps.c:188)

void IRndrVMSetTanAngle(IRndrVMStruct *VisMap, IrtRType CosAng)

VisMap: IN, OUT, pointer to the visibility map.

CosAng: IN, value of critic cosines value of angle between normal and view vector.

Returns: void

Description: Setting critic cosines value of angle between view point to pixel and triangle normal.
10.2.83  IRndrVertexTransform (rndr_lib.c:1284)

```c
void IRndrVertexTransform(IRndrPtrType Rend,
                           IVertexStruct *Vertex,
                           IrtRType *Result)
```

- **Rend**: The rendering context.
- **Vertex**: IN, pointer to the Vertex.
- **Result**: OUT, the result transformed homogenous coordinate.
- **Returns**: void

**Description**: Wrapper function for calculating the transformed vertex coordinate.

10.2.84  IRndrVisMapEnable (rndr_lib.c:1099)

```c
int IRndrVisMapEnable(IRndrPtrType Rend,
                      IObjectStruct *Objects,
                      int SuperSize,
                      int UVBackfaceCulling)
```

- **Rend**: IN, OUT, the rendering context.
- **Objects**: IN, Rendered object list.
- **SuperSize**: IN, filter sample super size.
- **UVBackfaceCulling**: IN, use backface culling during the UV scan conversion.
- **Returns**: TRUE if successful.

**Description**: Enabling visibility map in z-buffer.

10.2.85  IRndrVisMapGetObjDomain (rndr_lib.c:1210)

```c
int IRndrVisMapGetObjDomain(IObjectStruct *PObj,
                             IrtRType *UMin,
                             IrtRType *UMax,
                             IrtRType *VMin,
                             IrtRType *VMax)
```

- **PObj**: IN - The object to get its domain. Objects which aren’t polygons are ignored.
- **UMin, UMax, VMin, VMax**: OUT - The domain of the object.
- **Returns**: FALSE if no uv value was found.

**Description**: Wrapper function to get the domain of the given object (Object which aren’t polygons are ignored).

10.2.86  IRndrVisMapPrepareUVValuesOfGeoObj (rndr_lib.c:1241)

```c
int IRndrVisMapPrepareUVValuesOfGeoObj(IObjectStruct *PObj,
                                       int MapWidth,
                                       int MapHeight,
                                       IObjectStruct *PObj2)
```

- **PObj**: The geometric object.
- **MapWidth, MapHeight**: The dimensions of the visibility map.
- **PObj2**: If it isn’t NULL, this object is a list of objects which contains at least as much elements as PObj. Each element i in PObj2 will go through the same Transformations and scaling as element i in PObj. Objects which aren’t surfaces, trimmed surfaces or polygons are ignored.
- **Returns**: FALSE if PObj doesn’t contain any objects.

**Description**: Wrapper function for spreading UV values domains.

**See also**: IRndrVMPrepareUVValuesOfGeoObj,
10.2.87  **IRndrVisMapScan**  (rndr_lib.c:1125)

```c
void IRndrVisMapScan(IRndrPtrType Rend)
    Rend: IN, OUT, the rendering context.
    Returns: void
    Description: Wrapper function for scanning visibility map.
```

10.2.88  **IRndrVisMapSetCriticAR**  (rndr_lib.c:1165)

```c
void IRndrVisMapSetCriticAR(IRndrPtrType Rend, IrtRType CriticAR)
    Rend: IN, OUT, the rendering context.
    CriticAR: IN, value of critic aspect ratio value, the ratio between largest and smallest edge of a triangle.
    Returns: void
    Description: wrapper function for setting critic aspect ratio.
```

10.2.89  **IRndrVisMapSetDilation**  (rndr_lib.c:1185)

```c
void IRndrVisMapSetDilation(IRndrPtrType Rend, int Dilation)
    Rend: IN, OUT, the rendering context.
    Dilation: IN, the amount of iterations to do the dilation algorithm.
    Returns: void
    Description: wrapper function for setting dilation iterations number for white color hiding in visibility maps.
```

10.2.90  **IRndrVisMapSetScanOnUV**  (rndr_lib.c:1262)

```c
void IRndrVisMapSetScanOnUV(IRndrPtrType Rend, int IsScanOnUV)
    Rend: The rendering context.
    IsScanOnUV: TRUE in order to scan on XYZ and UV spaces. FALSE to scan only on XYZ space.
    Returns: void
    Description: Wrapper function for setting whether to scan the following triangles on both UV space and XYZ space or only on XYZ space.
```

10.2.91  **IRndrVisMapSetTanAngle**  (rndr_lib.c:1145)

```c
void IRndrVisMapSetTanAngle(IRndrPtrType Rend, IrtRType CosAng)
    Rend: IN, OUT, the rendering context.
    CosAng: IN, value of critic cosinus value of angle between normal and view vector.
    Returns: void
    Description: wrapper function for setting critic tangency angle.
```
10.2.92 **InterpolCopy** (interpol.c:29)

IRndrInterpolStruct *InterpolCopy(IRndrInterpolStruct *Dst, IRndrInterpolStruct *Src)

Dst: OUT, pointer to destination object.
Src: IN, pointer to source object.

**Returns:** Pointer to destination object.

**Description:** Performs COPY operation on object of Interpol type, which contains data to be interpolated during polygons scan converting. Interpol objects has some sort of linked structure, so copy is tricky.

10.2.93 **InterpolDelta** (interpol.c:64)

IRndrInterpolStruct *InterpolDelta(IRndrInterpolStruct *Dst, IRndrInterpolStruct *v1, IRndrInterpolStruct *v2, IrtRType d)

Dst: OUT, pointer to delta(increment) object to be initialized.
v1: IN, pointer to the first Interpol object.
v2: IN, pointer to the second Interpol object.
d: IN, scaling factor determined by dimension of the polygon on the current scan line.

**Returns:** pointer to dst object.

**Description:** Initialize object of Interpol type to be an increment in interpolation between first and second Interpol objects in scan conversion process.

10.2.94 **InterpolIncr** (interpol.c:117)

IRndrInterpolStruct *InterpolIncr(IRndrInterpolStruct *Dst, IRndrInterpolStruct *d)

Dst: IN OUT, pointer to object to be incremented.
d: IN, pointer to delta object.

**Returns:** pointer to destination object.

**Description:** Increments destination Interpol object by delta Interpol object computed by "InterpolDelta" call. By that way we progress interpolation process.

10.2.95 **LightIntensivity** (color.c:64)

void LightIntensivity(IRndrLightStruct *l, const IrtPtType p, const IrtNrmlType n, const IRndrObjectStruct *o, IRndrSceneStruct *Scene, IRndrIntensivityStruct *i)

l: IN, pointer to the light source object.
p: IN, point for which intensivity is computing.
n: IN, normal to the surface in the point "p".
o: IN, pointer to the object with surface characteristics.
Scene: IN, pointer to the scene the object belongs.
i: OUT, pointer to resulting intensivity object.

**Returns:** void

**Description:** Computes intensivity diffuse and specular values using specular model of illumination (see Foily, Van Dam). Differs between point and vector viewer, point and vector light sources, which is defined in Light object and by calling IS\_VIEWER\_POINT() function.
10.2.96 **LightListAdd** *(lights.c:45)*

```c
void LightListAdd(IRndrLightListStruct *Lights, IRndrLightStruct *NewSrc)
```

**Lights**: OUT, pointer to LightList object which is initialized through.

**NewSrc**: IN, pointer to Light source.

**Returns**: void

**Description**: Adds a new light source to the list.

10.2.97 **LightListInitEmpty** *(lights.c:25)*

```c
void LightListInitEmpty(IRndrLightListStruct *Lights)
```

**Lights**: OUT, pointer to LightList object which is initialized through.

**Returns**: void

**Description**: Creates an empty light sources list.

10.2.98 **LineSegmentEnd** *(polyline.c:253)*

```c
void LineSegmentEnd(IRndrLineSegmentStruct *Seg)
```

**Seg**: IN, OUT, pointer to the line segment.

**Returns**: void

**Description**: Ends a line. Should be called when after the last point was added.

10.2.99 **LineSegmentGetTri** *(polyline.c:278)*

```c
IPPolygonStruct *LineSegmentGetTri(IRndrLineSegmentStruct *Seg, int NumTri)
```

**Seg**: IN, OUT, pointer to the line segment.

**NumTri**: IN, the number of triangle, should be < TrianglesNum.

**Returns**: The triangle.

**Description**: Retrieves the triangles compromising the current segment.

10.2.100 **LineSegmentInit** *(polyline.c:28)*

```c
void LineSegmentInit(IRndrLineSegmentStruct *Seg, IRndrPolylineOptionsStruct *PolyOptions)
```

**Seg**: IN, OUT, pointer to the line segment.

**PolyOptions**: IN, the polyline options structure.

**Returns**: void

**Description**: Initialize the segment structure, using the PolylineOptions. Should be called when object is created.
10.2.101 LineSegmentRelease (polyline.c:95)

void LineSegmentRelease(IRndrLineSegmentStruct *Seg)

    Seg: IN, OUT, pointer to the line segment.
    Returns: void
    Description: Frees the memory allocated by the object.

10.2.102 LineSegmentSet (polyline.c:133)

void LineSegmentSet(IRndrLineSegmentStruct *Seg, IrtPtType4 Vertex)

    Seg: IN, OUT, pointer to the line segment.
    Vertex: IN, the new point.
    Returns: void
    Description: Sets the next point for the line.

10.2.103 LineSegmentSetOptions (polyline.c:69)

void LineSegmentSetOptions(IRndrLineSegmentStruct *Seg, IRndrPolylineOptionsStruct *PolyOptions)

    Seg: IN, OUT, pointer to the line segment.
    PolyOptions: IN, the polyline options structure.
    Returns: void
    Description: Changes the PolyOptions.

10.2.104 LineSegmentStart (polyline.c:113)

void LineSegmentStart(IRndrLineSegmentStruct *Seg)

    Seg: IN, OUT, pointer to the line segment.
    Returns: void
    Description: Begins a new line.

10.2.105 ObjectInit (object.c:316)

void ObjectInit(IRndrObjectStruct *PObject)

    PObject: IN, OUT, pointer to the Object structure.
    Returns: void
    Description: Creates a new blank object. Should be called before the first time the object is used.

10.2.106 ObjectRelease (object.c:337)

void ObjectRelease(IRndrObjectStruct *PObject)

    PObject: IN, OUT, pointer to the Object structure.
    Returns: void
    Description: Releases memory allocated by object.
10.2.107 ObjectSet (object.c:359)

IRndrObjectStruct *ObjectSet(IRndrObjectStruct *PObject,
   IPObjectStruct *Obj,
   IRndrSceneStruct *Scene)

PObject: IN, OUT, pointer to the Object structure.
Obj: IN, pointer to the Irit object, containing the attributes.
Scene: IN, pointer to the scene.
Returns: Created object.
Description: Wraps an Irit object by Initializing different attributes from the it: color, specularity, transparency, texture image, volumetric texture.

10.2.108 SceneGetClippingPlane (scene.c:123)

void SceneGetClippingPlane(IRndrSceneStruct *Scene,
   int Axis,
   int Min,
   IrtPlnType Result)

Scene: IN, pointer to the scene.
Axis: IN, the axis normal to the plane(X_AXIS, Y_AXIS, Z_AXIS).
Min: IN, whether the "near" or "far" clipping planes.
Result: OUT, the result plane.
Returns: void
Description: Retrives one of the clipping plane defining the view frustum. The planes are built so that inside the view frustum the half planes are positive (and negative outside).

10.2.109 SceneGetMatrices (scene.c:235)

struct IRndrMatrixContextStruct *SceneGetMatrices(IRndrSceneStruct *Scene)

Scene: IN, pointer to the scene.
Returns: pointer to matrices struct.
Description: Get the scene matrices.

10.2.110 SceneRelease (scene.c:217)

void SceneRelease(IRndrSceneStruct *Scene)

Scene: IN, pointer to the scene.
Returns: void
Description: Free the memory of the scene.

10.2.111 SceneSetMatrices (scene.c:31)

void SceneSetMatrices(IRndrSceneStruct *Scene,
   IrtHmgnMatType ViewMat,
   IrtHmgnMatType PrspMat,
   IrtHmgnMatType ScrnMat)

Scene: OUT, pointer to the scene.
ViewMat: IN, the view matrix.
PrspMat: IN, the perspective matrix, NULL if parallel projection.
ScrnnMat: IN, the mapping to the screen or NULL if scale [-1,+1] to image size.
Returns: void
Description: Sets the view and perspective matrices for the scene.
10.2.112 SceneSetZClippingPlanes (scene.c:190)

void SceneSetZClippingPlanes(IRndrSceneStruct *Scene,
   IrrRType ZNear,
   IrrRType ZFar)

Scene: IN, pointer to the scene.
ZNear, ZFar: IN, the near and far z-coordinate of the planes.
Returns: void
Description: Sets the near and far XY clipping planes.

10.2.113 StencilOp (stencil.c:128)

void StencilOp(IRndrStencilCfgStruct *SCfg, int *SPtr, IRndrStencilOpType Op)

SCfg: IN, stencil configuration to be used.
SPtr: IN, pointer to target stencil buffer value.
Op: IN stencil operation to perform.
Returns: void
Description: Performs stencil operation.

10.2.114 StencilOpFail (stencil.c:68)

void StencilOpFail(IRndrStencilCfgStruct* StencilCfg, int *StencilPtr)

StencilCfg: IN, stencil configuration to be used.
StencilPtr: IN, pointer to target stencil buffer value.
Returns: void
Description: Performs stencil operation in case of stencil test failure.

10.2.115 StencilOpZFail (stencil.c:88)

void StencilOpZFail(IRndrStencilCfgStruct* StencilCfg, int *StencilPtr)

StencilCfg: IN, stencil configuration to be used.
StencilPtr: IN, pointer to target stencil buffer value.
Returns: void
Description: Performs stencil operation in case of stencil test success and Z test failure.

10.2.116 StencilOpZPass (stencil.c:108)

void StencilOpZPass(IRndrStencilCfgStruct* StencilCfg, int *StencilPtr)

StencilCfg: IN, stencil configuration to be used.
StencilPtr: IN, pointer to target stencil buffer value.
Returns: void
Description: Performs stencil operation in case of stencil test pass and Z test pass.
10.2.117 StencilTest (stencil.c:28)

IrtBType StencilTest(IRndrStencilCfgStruct *StencilCfg, int Stencil)

StencilCfg: IN, stencil configuration to be used.
Stencil: IN, stencil buffer value to test.
Returns: comparison result.
Description: Performs stencil tests.

10.2.118 TextureBumpChocolate (texture.c:808)

void TextureBumpChocolate(IRndrTextureStruct *Txtr,
IrtPtType Point,
IrtNrmlType Normal,
IrtRType *Uv,
IRndrColorType Color)

Txtr: IN, pointer to the texture structure.
Point: IN, coordinate of the point in object space.
Normal: IN, OUT, normal at the point.
Uv: IN, uv parameteric domain’s coordinates, if exists.
Color: IN, OUT, color value at the point.
Returns: void
Description: Evaluates pertubation on color value at given point in order to get ”orange” bump texture.
See also: TextureBumpOrange,

10.2.119 TextureBumpOrange (texture.c:760)

void TextureBumpOrange(IRndrTextureStruct *Txtr,
IrtPtType Point,
IrtNrmlType Normal,
IrtRType *Uv,
IRndrColorType Color)

Txtr: IN, pointer to the texture structure.
Point: IN, coordinate of the point in object space.
Normal: IN, OUT, normal at the point.
Uv: IN, uv parameteric domain’s coordinates, if exists.
Color: IN, OUT, color value at the point.
Returns: void
Description: Evaluates pertubation on color value at given point in order to get ”orange” bump texture.
See also: TextureBumpChocolate,

10.2.120 TextureCamouf (texture.c:700)

void TextureCamouf(IRndrTextureStruct *Txtr, IrtPtType Point,
IrtNrmlType Normal,
IrtRType *Uv,
IRndrColorType Color)

Txtr: IN, pointer to the texture structure.
Point: IN, coordinate of the point in object space.
Normal: IN, OUT, normal at the point.
Uv: IN, uv parameteric domain’s coordinates, if exists.
Color: IN, OUT, color value at the point.
Returns: void
Description: Evaluates pertubation on color value at given point in order to get ”camouf” texture.
10.2.121 TextureChecker (texture.c:645)

void TextureChecker(IRndrTextureStruct *Txtr,
                   IrtPtType Point,
                   IrtNrmlType Normal,
                   IrtRType *Uv,
                   IRndrColorType Color)

Txtr: IN, pointer to the texture structure.
Point: IN, coordinate of the point in object space.
Normal: IN, OUT, normal at the point.
Uv: IN, uv parameteric domain’s coordinates, if exists.
Color: IN, OUT, color value at the point.

Returns: void

Description: Evaluates perturbation on color value at given point in order to get "checker" texture.

10.2.122 TextureContour (texture.c:888)

void TextureContour(IRndrTextureStruct *Txtr,
                    IrtPtType Point,
                    IrtNrmlType Normal,
                    IrtRType *Uv,
                    IRndrColorType Color)

Txtr: IN, pointer to the texture structure.
Point: IN, coordinate of the point in object space.
Normal: IN, OUT, normal at the point.
Uv: IN, uv parameteric domain’s coordinates, if exists.
Color: IN, OUT, color value at the point.

Returns: void

Description: Evaluates perturbation on color value at given point in order to get "contour" texture.

10.2.123 TextureContourNormal (texture.c:933)

void TextureContourNormal(IRndrTextureStruct *Txtr,
                           IrtPtType Point,
                           IrtNrmlType Normal,
                           IrtRType *Uv,
                           IRndrColorType Color)

Txtr: IN, pointer to the texture structure.
Point: IN, coordinate of the point in object space.
Normal: IN, normal at the point.
Uv: IN, uv parameteric domain’s coordinates, if exists.
Color: IN, OUT, color value at the point.

Returns: void

Description: Evaluates perturbation on color value at given point in order to get "ncontour" texture.
10.2.124 TextureCurvature (texture.c:987)

```c
void TextureCurvature(IRndrTextureStruct *Txtr,
                      IrtPtType Point,
                      IrtNrmlType Normal,
                      IrtRType *Uv,
                      IRndrColorType Color)
```

**Txtr**: IN, pointer to the texture structure.

**Point**: IN, coordinate of the point in object space.

**Normal**: IN, normal at the point.

**Uv**: IN, uv parameteric domain’s coordinates, if exists.

**Color**: IN, OUT, color value at the point.

**Returns**: void

**Description**: Evaluates a texture color that is a function of the curvature of the surface, getting the "curvature" texture.

10.2.125 TextureImageGetPixel (texture.c:79)

```c
IrtImgPixelStruct *TextureImageGetPixel(IRndrTextureStruct *Txtr,
                                         IRndrImageStruct *i,
                                         IrtPtType p,
                                         IrtRType v,
                                         IrtRType u,
                                         IPPolygonStruct *Poly)
```

**Txtr**: IN, general attributes and modifiers of the texture mapping.

**i**: IN, pointer to the Image data structure.

**p**: IN, location in Euclidean space of texture color to evaluate.

**v**: IN, real coordinate of the image pixel.

**u**: IN, real coordinate of the image pixel.

**Poly**: IN, pointer to the polygon.

**Returns**: value of the image pixel at (u,v) point.

**Description**: Gets image pixel by two real coordinates u and v from the Image data. Access function.

10.2.126 TextureInitParameters (texture.c:1219)

```c
void TextureInitParameters(IRndrTextureStruct *Txtr, const char *pString)
```

**Txtr**: OUT, IRndrTextureStruct that contains the parameters.

**pString**: IN, parameters string, taken from the attribute.

**Returns**: void

**Description**: Initializes texture-specific parameters for volumetric textures.
10.2.127 **TextureMarble** (texture.c:507)

```c
void TextureMarble(IRndrTextureStruct *Txtr,
                   IrtPtType Point,
                   IrtNrmlType Normal,
                   IrtRType *Uv,
                   IRndrColorType Color)
```

**Txtr:** IN, pointer to the texture structure.

**Point:** IN, coordinate of the point in object space.

**Normal:** IN, OUT, normal at the point.

**Uv:** IN, uv parameteric domain’s coordinates, if exists.

**Color:** IN, OUT, color value at the point.

**Returns:** void

**Description:** Evaluates perturbation on color value at given point in order to get "marble" texture.

10.2.128 **TexturePunky** (texture.c:1095)

```c
void TexturePunky(IRndrTextureStruct *Txtr,
                   IrtPtType Point,
                   IrtNrmlType Normal,
                   IrtRType *Uv,
                   IRndrColorType Color)
```

**Txtr:** IN, pointer to the texture structure.

**Point:** IN, coordinate of the point in object space.

**Normal:** IN, OUT, normal at the point.

**Uv:** IN, uv parameteric domain’s coordinates, if exists.

**Color:** IN, OUT, color value at the point.

**Returns:** void

**Description:** Evaluates perturbation on color value at given point in order to get "punky" style texture.

10.2.129 **TextureWood** (texture.c:556)

```c
void TextureWood(IRndrTextureStruct *Txtr,
                  IrtPtType Point,
                  IrtNrmlType Normal,
                  IrtRType *Uv,
                  IRndrColorType Color)
```

**Txtr:** IN, pointer to the texture structure.

**Point:** IN, coordinate of the point in object space.

**Normal:** IN, OUT, normal at the point.

**Uv:** IN, uv parameteric domain’s coordinates, if exists.

**Color:** IN, OUT, color value at the point.

**Returns:** void

**Description:** Evaluates perturbation on color value at given point in order to get "wood" texture.
10.2.130 **TriangleColorEval** (color.c:166)

```c
void TriangleColorEval(IPPolygonStruct *Poly,
     int x,
     int y,
     IRndrObjectStruct *o,
     IRndrSceneStruct *Scene,
     IRndrInterpolStruct *Value,
     IRndrColorType r)
```

**Poly**: IN, the polygon the pixel belongs.

**x**: IN, scan line pixel position.

**y**: IN, scan line number.

**o**: IN, the object of the triangle.

**Scene**: IN, the scene context.

**Value**: IN, OUT, interpolation value.

**r**: OUT, resulting color.

**Returns**: void

**Description**: For scan line "y" and pixel "x" in it computes color value in [0, 1] RGB format.

10.2.131 **TriangleInit** (triangle.c:126)

```c
void TriangleInit(IRndrTriangleStruct *Tri)
```

**Tri**: IN, pointer to the Triangle object.

**Returns**: void

**Description**: Creates a new Triangle object and allocates memory for it’s fields. Should be called before the first time the object is used.

10.2.132 **TriangleRelease** (triangle.c:159)

```c
void TriangleRelease(IRndrTriangleStruct *Tri)
```

**Tri**: IN, pointer to the Triangle object.

**Returns**: void

**Description**: Free the memory of a the Triangle.

10.2.133 **TriangleSet** (triangle.c:335)

```c
int TriangleSet(IRndrTriangleStruct *Tri,
                 IPPolygonStruct *Poly,
                 IRndrObjectStruct *o,
                 IRndrSceneStruct *Scene)
```

**Tri**: OUT, pointer to the Triangle object.

**Poly**: IN, pointer to Irit polygon object.

**o**: IN, pointer to Object which contains a Triangle and stores various characterisitics common to every polygon in the object.

**Scene**: IN, pointer to the scene context.

**Returns**: 1 in successful, 0 if polygon is not OK.

**Description**: Wraps an Irit polygon and initialize the Triangle structure from polygon and object data. That includes scan line and interpolation algorithm data initialization.
10.2.134 VertexTransform (triangle.c:48)

```
void VertexTransform(IPVertexStruct *Vertex,
                     IRndrMatrixContextStruct *Matrices,
                     IRndrObjectStruct *o,
                     IrtRType *Result)
```

**Vertex:** IN, pointer to the Vertex.
**Matrices:** IN, pointer to matrices context.
**o:** IN, pointer to Object which contains the Triangle that contains the vertex. If o is NULL it’s being ignored.
**Result:** OUT, the result transformed homogenous coordinate.

**Returns:** void

**Description:** Calculate the transformed vertex coordinate.

10.2.135 VisMapCheckValidity (vis_maps.c:1560)

```
static int VisMapCheckValidity(IRndrVMStruct *VisMap,
                                 IPPolygonStruct *Triangle,
                                 IRndrVisibleValidityType *Validity)
```

**VisMap:** IN, pointer to the visibility map.
**Triangle:** IN, triangle polygon object.
**Validity:** OUT, validity of triangle.

**Returns:** TRUE if successful (All the given parameters weren’t NULL, and the triangle has UV values).

**Description:** Check the validity of the triangle and set Validity accordingly. Assumes that XY values weren’t yet switched with UVZ in the triangle.

10.2.136 VisMapFindLimits (vis_maps.c:1957)

```
static void VisMapFindLimits(IRndrVMStruct *VisMap, IPObjectStruct *OList)
```

**VisMap:** IN, OUT, pointer to the visibility map.
**OList:** IN, list of all object to fit in scene.

**Returns:** void

**Description:** Enabling scene fitting for current rendering by setting the scene’s XY limits and VisMap’s UV limits accordig to all of OList’s vertices (The scene is stored in VisMap). This function is recursive.

10.2.137 VisMapIsPoorAR (vis_maps.c:1882)

```
static int VisMapIsPoorAR(IRndrVMStruct *VisMap, IrtPtType v1, IrtPtType v2)
```

**VisMap:** IN, pointer to the visibility map.
**v1:** IN, vector of one edge of triangle.
**v2:** IN, vector of second edge of triangle.

**Returns:** TRUE if aspect ratio is poor.

**Description:** Checks whether triangle has poor aspect ratio: the ratio between largest and smallest edge.
10.2.138  **VisMapIsTangentZAxis**  *(vis_maps.c:1927)*

static int VisMapIsTangentZAxis(IRndrVMStruct *VisMap, IrtPtType Norm)

- **VisMap**: IN, pointer to the visibility map.
- **Norm**: IN, vector normal of triangle.
- **Returns**: TRUE triangle is close to tangent view.

**Description**: Checks whether triangle is close to tangent view vector. Uses VisMap -> CosTanAng, as cos of angle between triangle normal and z axis.

10.2.139  **VisMapMakeFittingMatrices**  *(vis_maps.c:2052)*

static void VisMapMakeFittingMatrices(IRndrVMStruct *VisMap)

- **VisMap**: IN, OUT, pointer to the visibility map.
- **Returns**: void

**Description**: Setting scene fitting parameters after enabling. Uses the scene’s XY limits in order to change the screen matrix so the entire scene will be in the scene’s window and centered. That means that the entire scene’s x and y coordinates will be in the range [0, scene -> sizex/y] (z coordinate isn’t changed).

10.2.140  **VisMapRestoreVector**  *(vis_maps.c:1846)*

static void VisMapRestoreVector(IRndrVMStruct *VisMap, IrtPtType v)

- **VisMap**: IN, pointer to the visibility map.
- **v**: IN, OUT: point object to be restore.
- **Returns**: void

**Description**: Restore vector’s world coordinate from view coordinate system.

10.2.141  **VisMapSetRefreshLimits**  *(vis_maps.c:2003)*

static void VisMapSetRefreshLimits(IRndrVMStruct *VisMap, IPVertexStruct *Vertex)

- **VisMap**: IN, OUT, pointer to the visibility map.
- **Vertex**: IN, vertex to update limits with.
- **Returns**: void

**Description**: Adding to the scene the contribution of Vertex by updating the scene’s XY limits values and VisMap’s UV limits (The scene is stored in VisMap).

10.2.142  **VisMapSwitchTriangleSpaces**  *(vis_maps.c:1482)*

static int VisMapSwitchTriangleSpaces(IRndrVMStruct *VisMap, IRndrSceneStruct *Scene, IRndrObjectStruct *Obj, IPPolygonStruct *Triangle, int Reverse)

- **VisMap**: IN, Pointer to the visibility map.
- **Scene**: IN, a pointer to the scene struct.
- **Obj**: IN, a pointer to the current rendered object.
Triangle: IN, OUT, triangle polygon object.
Reverse: IN, Whether to switch uv into xy or do the reverse operation.
Returns: TRUE if successful.
Description: Switch Polygon coordinates so it could be scanned with the z buffer scan convention into the visibility map. Simply set the coord field to contain the uv values while the x and y values are backuped in attributes VIS_MAP_X_ATTRIB and VIS_MAP_Y_ATTRIB. At the same time, change the uv space to be \([0..\text{size of vismap} - 1]\) (both in coord and in the uv attribute). If Reverse is TRUE, do the opposite operation. The coord values set to the x and y values which are restored from the attributes VIS_MAP_X_ATTRIB and VIS_MAP_Y_ATTRIB (the uv values which were in coord are dismissed). If Reverse is TRUE, no change of uv space is done.

10.2.143 VisMapTriangleDZ (vis_maps.c:1664)

```
static int VisMapTriangleDZ(IRndrVMStruct *VisMap,
IPPolygonStruct *Triangle,
IRndrVisibleValidityType *Validity,
IrtRType *dz)
```

VisMap: IN, pointer to the visibility map.
Triangle: IN, triangle polygon object.
Validity: OUT, validity of triangle.
dz: OUT, z error estimation.
Returns: TRUE if successful.
Description: Estimating z error value in visibility map pixel. to make up on discretization errors. Estimating is made by the partial differentiating of \(z(x,y), x(u,v),\) and \(y(u,v)\) as follow:
\[
\text{Dz} = (\text{dz/dx})\text{Dx} + (\text{dz/dy})\text{Dy} \\
\text{Dx} = (\text{dx/du})\text{Du} + (\text{dx/dv})\text{Dv} \\
\text{Dy} = (\text{dy/du})\text{Du} + (\text{dy/dv})\text{Dv}
\]
Where \(d\) is partial differentiation, and \(D\) means delta value.

10.2.144 VisMapTriangleSet (vis_maps.c:1435)

```
static int VisMapTriangleSet(IRndrTriangleStruct *RendTri,
IPPolygonStruct *Triangle,
IRndrObjectStruct *Obj,
IRndrSceneStruct *Scene,
int UVBackfaceCulling)
```

RendTri: OUT, pointer to the Triangle object.
Triangle: IN, pointer to Irit polygon object.
Obj: IN, pointer to Object which contains a Triangle and stores various characteristics common to every polygon in the object.
Scene: IN, pointer to the scene context.
UVBackfaceCulling: IN, use backface culling during the UV scan conversion.
Returns: TRUE when successful.
Description: Sets a uv triangle using DoVisMapCalcs field in Object struct turned on while calling TriangleSet method.

10.2.145 ZBufferClear (zbuffer.c:133)

```
void ZBufferClear(IRndrZBufferStruct *Buffer)
```

Buffer: IN, OUT, Pointer to the z-buffer.
Returns: void
Description: Clears the context of the z-buffer.
10.2.146 ZBufferClearColor (zbuffer.c:1268)

void ZBufferClearColor(IRndrZBufferStruct *Buffer)

Buffer: Pointer to the z-buffer.
Returns: void
Description: Routine to clear the color information.

10.2.147 ZBufferClearDepth (zbuffer.c:1218)

void ZBufferClearDepth(IRndrZBufferStruct *Buffer, IRndrZDepthType ClearZ)

Buffer: Pointer to the z-buffer.
ClearZ: Depth to clear the ZBuffer to.
Returns: void
Description: Routine to clear the z depth information

10.2.148 ZBufferClearStencil (zbuffer.c:1244)

void ZBufferClearStencil(IRndrZBufferStruct *Buffer)

Buffer: Pointer to the z-buffer.
Returns: void
Description: Routine to clear the Stencil information

10.2.149 ZBufferGetLineColorAlpha (zbuffer.c:983)

void ZBufferGetLineColorAlpha(IRndrZBufferStruct *Buffer, int x0, int x1, int y, IRndrColorType *Result)

Buffer: IN, OUT, pointer to the z-buffer
x0: IN, minimal x coordinate.
x1: IN, maximal x coordinate.
y: IN, line number.
Result: OUT, the color values of the line.
Returns: void
Description: Retrieves color information of a specific line. The line should be allocated by the caller.

10.2.150 ZBufferGetLineDepth (zbuffer.c:1054)

int ZBufferGetLineDepth(IRndrZBufferStruct *Buffer, int x0, int x1, int y, IrtRType *Result)

Buffer: IN, OUT, pointer to the z-buffer
x0: IN, minimal x coordinate.
x1: IN, maximal x coordinate.
y: IN, line number.
Result: OUT, the z values of the line.
Returns: whether operation succeded.
Description: Retrieves z information of a specific line. The line should be allocated by the caller.
10.2.151   ZBufferGetLineStencil (zbuffer.c:1112)

int ZBufferGetLineStencil(IRndrZBufferStruct *Buffer,
                          int x0,
                          int x1,
                          int y,
                          int *Result)

Buffer: IN, OUT, pointer to the z-buffer.
x0: IN, minimal x coordinate.
x1: IN, maximal x coordinate.
y: IN, line number.
Result: OUT, the stencil values of the line.
Returns: whether operation succeeded.

Description: Retrieves stencil information of a specific line. The line should be allocated by the caller.

10.2.152   ZBufferInit (zbuffer.c:46)

int ZBufferInit(IRndrZBufferStruct *Buffer,
                 IRndrSceneStruct *Scene,
                 int SuperSize,
                 int ColorQuantization)

Buffer: IN, OUT, Pointer to the z-buffer.
Scene: IN, Pointer to the related scene object.
SuperSize: IN, Super sampling size.
ColorQuantization: IN, non zero to quantize the generated colors to ColorQuantization levels of colors.
Returns: 0 if successfull.

Description: Initialize a newly created z-buffer.

10.2.153   ZBufferPutPixel (zbuffer.c:184)

void ZBufferPutPixel(IRndrZBufferStruct *Buffer,
                      int x,
                      int y,
                      IrtRType z,
                      IrtRType Transparency,
                      IRndrColorType Color,
                      IPPolygonStruct *Triangle,
                      VoidPtr ClbkData)

Buffer: IN, OUT, pointer to z-buffer.
x: IN, the column number.
y: IN, the line number.
z: IN, the pixel’s depth.
Transparency: IN, the pixel’s transparency value.
Color: IN, the new color of pixel at (x, y).
Triangle: IN, The triangle which created the added point. *
ClbkData: IN, data to be transfered to call back functions if any.
Returns: void

Description: Manually adds a single pixel.
10.2.154 **ZBufferRelease** (zbuffer.c:577)

```c
void ZBufferRelease(IRndrZBufferStruct *Buffer)
```

**Buffer**: IN, OUT, pointer to the z-buffer.

**Returns**: void

**Description**: Release the memory taken by the z-buffer.

10.2.155 **ZBufferSaveFile** (zbuffer.c:735)

```c
void ZBufferSaveFile(IRndrZBufferStruct *Buffer,
                      const char *BaseDirectory,
                      const char *OutFileName,
                      const char *FileType,
                      IRndrZBufferDataType DataType)
```

**Buffer**: IN, OUT, pointer to the z-buffer.

**BaseDirectory**: IN, the directory where the file is to be saved.

**OutFileName**: IN, the file name.

**FileType**: IN, the file type.

**DataType**: IN, where to save color/z-depth/stencil data.

**Returns**: void

**Description**: Saves the context of the z-buffer into a file or to the functions pointed by ZBufferSaveFileCB.

10.2.156 **ZBufferSaveFileCB** (zbuffer.c:705)

```c
void ZBufferSaveFileCB(IRndrZBufferStruct *Buffer,
                        IRndrImgSetTypeFuncType ImgSetType,
                        IRndrImgOpenFuncType ImgOpen,
                        IRndrImgWriteLineFuncType ImgWriteLine,
                        IRndrImgCloseFuncType ImgClose)
```

**Buffer**: IN, OUT, pointer to the z-buffer.

**ImgSetType**: IN, Image setting file type function

**ImgOpen**: IN, Function to open an image file.

**ImgWriteLine**: IN, Function to write one row (Vec of RGB & vec of Alpha).

**ImgClose**: IN, Function to close an image file.

**Returns**: void

**Description**: Sets call back functions to set image type, open an image, save a row, and close the image, for ZBufferSaveFile.

10.2.157 **ZBufferScanTri** (zbuffer.c:281)

```c
void ZBufferScanTri(IRndrZBufferStruct *Buffer,
                    IRndrTriangleStruct *Tri,
                    VoidPtr ClbkData)
```

**Buffer**: IN, OUT, pointer to the z-buffer.

**Tri**: IN, pointer to the Triangle object.

**ClbkData**: IN, data to be transfered to call back functions if any.

**Returns**: void

**Description**: Scan converts a triangle object into the z-buffer.
10.2.158  ZBufferScanVMTri  (zbuffer.c:542)

void ZBufferScanVMTri(IRndrZBufferStruct *Buffer,  
                       IRndrTriangleStruct *Tri,  
                       VoidPtr ClbkData)

   Buffer: IN, OUT, pointer to the z-buffer.  
   Tri: IN, pointer to the Triangle object.  
   ClbkData: IN, data to be transferred to call back functions if any.  

   Returns: void

   Description: Scan converts a triangle object into the z-buffer, for the visibility map.  
   See also: ZBufferScanTri.

10.2.159  ZBufferSetFilter  (zbuffer.c:1161)

void ZBufferSetFilter(IRndrZBufferStruct *Buffer, char *FilterName)

   Buffer: Pointer to the z-buffer.  
   FilterName: String representing the filter name.  

   Returns: void

   Description: Routine to set the filter before any antialias processing could be done.

10.2.160  _IRndrReportError  (report.c:50)

void _IRndrReportError(const char *Fmt, ...)

   Fmt: IN, message format, like the "printf" format.  

   Returns: void

   Description: Reports an error message.

10.2.161  _IRndrReportFatal  (report.c:75)

void _IRndrReportFatal(const char *Fmt, ...)

   Fmt: IN, message format, like the "printf" format.  

   Returns: void

   Description: Reports a fatal error and halts.

10.2.162  _IRndrReportWarning  (report.c:25)

void _IRndrReportWarning(const char *Fmt, ...)

   Fmt: IN, message format, like the "printf" format.  

   Returns: void

   Description: Reports a warning message.
Chapter 11

Symbolic Library, symb_lib

11.1 General Information

This library provides a rich set of functions to symbolically manipulate freeform curves and surfaces. This library heavily depends on the cagd library. Functions are provided to low level add, subtract, and multiply freeform curves and surfaces, to compute fields such as curvature, and to extract singular points such as extremums, zeros, and inflections. High level tools to metamorph curves and surfaces, to compute layout (prisa) of freeform surfaces, to compute offset approximations of curves and surfaces, and to compose curves and surfaces are also provided.

The interface of the library is defined in include/symb_lib.h.

This library has its own error handler, which by default prints an error message and exit the program called SymbFatalError.

Globals in this library have a prefix of Symb for general symbolic routines. Prefix of Bzr is used for Bezier routines, and prefix of Bsp for B spline specific routines.

11.2 Library Functions

11.2.1 BspCrvBlossomMult (bsp_sym.c:271)

CagdCrvStruct *BspCrvBlossomMult(const CagdCrvStruct *Crv1, const CagdCrvStruct *Crv2)

Crv1, Crv2: The two curves to multiply.

Returns: The product Crv1 * Crv2 coordinatewise.

Description: Given two Bspline curves - multiply them coordinatewise, using Blossoming. The two curves are assumed compatible (same point type and domain). See also:
See also: BspCrvMult,

11.2.2 BspCrvDeriveRational (bsp_sym.c:1769)

CagdCrvStruct *BspCrvDeriveRational(const CagdCrvStruct *Cr

Crv: Bspline curve to differentiate.

Returns: Differentiated rational Bspline curve.

Description: Given a rational Bspline curve - computes its derivative curve (Hodograph) using the quotient rule for differentiation.
See also: BzrCrvDerive, BspCrvDerive, BzrCrvDeriveRational, CagdCrvDerive,
11.2.3 BspCrvMult (bsp_sym.c:132)

CagdCrvStruct *BspCrvMult(const CagdCrvStruct *CCrv1, 
const CagdCrvStruct *CCrv2)

CCrv1, CCrv2: The two curves to multiply.

Returns: The product Crv1 * Crv2 coordinatewise.

Description: Given two Bspline curves - multiply them coordinatewise. The two curves are promoted to same point type before the multiplication can take place. The two curves are assumed to hold the same domain. See also BspMultComputationMethod.

11.2.4 BspMultComputationMethod (bsp_sym.c:105)

BspMultComputationMethodType BspMultComputationMethod(
BspMultComputationMethodType BspMultMethod)

BspMultMethod: See BspMultComputationMethodType. Bspline product is computed by either Bezier decomposition, or setting an interpolation problem, or using Blossoming.

Returns: Previous setting.

Description: Sets method of Bspline product computation.

11.2.5 BspSrfBlossomMult (bsp_sym.c:1072)

CagdSrfStruct *BspSrfBlossomMult(const CagdSrfStruct *Srf1, 
const CagdSrfStruct *Srf2)

Srf1, Srf2: The two surfaces to multiply.

Returns: The product Srf1 * Srf2 coordinatewise.


See also: BspSrfMult,

11.2.6 BspSrfDeriveRational (bsp_sym.c:1881)

CagdSrfStruct *BspSrfDeriveRational(const CagdSrfStruct *Srf, 
CagdSrfDirType Dir)

Srf: Bspline surface to differentiate.

Dir: Direction of Differentiation. Either U or V.

Returns: Differentiated rational Bspline surface.

Description: Given a rational Bspline surface - computes its derivative surface in direction Dir, using the quotient rule for differentiation.

See also: CagdSrfDerive, BzrSrfDerive, BspSrfDerive, BzrSrfDeriveRational,
11.2.7  **BspSrfFactorBilinear** *(bsp.sym.c:1473)*

```
CagdSrfStruct *BspSrfFactorBilinear(const CagdSrfStruct *Srf,
const CagdRType *A)
```

**Srf**: To factor out a bilinear factor from.

**A**: Four coefficients of the scalar bilinear.


**Description**: Factors out a given bilinear term from a scalar surface, assuming it has this term.


Note that typically a Bspline surface will not have this bilinear in all its patches so use this function with care - this function does not verify this existence.

**See also**: BzrSrfFactorUMinusV, BzrSrfFactorBilinear, MvarMVFactorUMinV,

11.2.8  **BspSrfFactorUMinusV** *(bsp.sym.c:1618)*

```
CagdSrfStruct *BspSrfFactorUMinusV(const CagdSrfStruct *Srf)
```

**Srf**: To factor out a \((u - v)\) term from.

**Returns**: `Srf / (u - v)`.

**Description**: Factors out a \((u - v)\) term from a surface, assuming it has one. Note that typically a Bspline surface will not have \((u, v)\) in all its patches so use this function with care - this function does not verify this existence. It is more common to have \((u, v)\) only along symmetric diagonal patches of the Bspline surface, after symbolic operations like \(C1(u) - C2(v)\).

**See also**: BzrSrfFactorUMinusV, BzrSrfFactorBilinear, MvarMVFactorUMinV,

11.2.9  **BspSrfMult** *(bsp.sym.c:879)*

```
CagdSrfStruct *BspSrfMult(const CagdSrfStruct *CSrf1,
const CagdSrfStruct *CSrf2)
```

**CSrf1, CSrf2**: The two surfaces to multiply.

**Returns**: The product \(Srf1 * Srf2\) coordinatewise.

**Description**: Given two Bspline surfaces - multiply them coordinatewise. The two surfaces are promoted to same point type before multiplication can take place. The two surfaces are assumed to hold the same domain. See also BspMultComputationMethod.

11.2.10  **BzrComposeCrvCrv** *(composit.c:445)*

```
CagdCrvStruct *BzrComposeCrvCrv(const CagdCrvStruct *Crv1,
const CagdCrvStruct *Crv2)
```

**Crv1, Crv2**: The two curve to compose together.

**Returns**: The composed curve.

**Description**: Given two Bezier curves, \(Crv1\) and \(Crv2\), computes their composition \(Crv1(Crv2(t))\). \(Crv2\) must be a scalar curve completely contained in \(Crv1\)'s parametric domain. See: "Freeform surface analysis using a hybrid of symbolic and numeric computation" by Gershon Elber, PhD thesis, University of Utah, 1992.

**See also**: SymbDecomposeCrvCrv, BzrComposeCrvCrv,
11.2.11  **BzrComposeSrfCrv** (composit.c:1311)

CagdCrvStruct *BzrComposeSrfCrv(const CagdSrfStruct *Srf, const CagdCrvStruct *Crv)

**Srf, Crv:** The curve and surface to compose.

**Returns:** The resulting composition.

**Description:** Given a Bezier curve Crv and a Bezier surface Srf, computes their composition Srf(Crv(t)). Crv must be a two dimensional curve completely contained in the parametric domain of Srf. See: "Freeform surface analysis using a hybrid of symbolic and numeric computation" by Gershon Elber, PhD thesis, University of Utah, 1992.

11.2.12  **BzrComposeSrfCrvInterp** (composit.c:1236)

CagdCrvStruct *BzrComposeSrfCrvInterp(const CagdSrfStruct *Srf, const CagdCrvStruct *Crv)

**Srf, Crv:** The curve and surface to compose.

**Returns:** The resulting composition.

**Description:** Given a Bezier curve Crv and a Bezier surface Srf, computes their composition Srf(Crv(t)). Crv must be a two dimensional curve completely contained in the parametric domain of Srf. Composition is solved by deriving the degree d of the resulting curve and solving a Bezier interpolation problem.

11.2.13  **BzrComposeSrfSrf** (compost2.c:209)

CagdSrfStruct *BzrComposeSrfSrf(const CagdSrfStruct *Srf1, const CagdSrfStruct *Srf2)

**Srf1, Srf2:** The two surfaces to compose.

**Returns:** The resulting composition.

**Description:** Given surfaces Srf1 and Srf2, computes their composition Srf1(Srf2(a, b)). Srf1 must be a Bezier. Srf2 must be a two dimensional surface completely contained in the parametric domain of Srf1. See: "Freeform surface analysis using a hybrid of symbolic and numeric computation" by Gershon Elber, PhD thesis, University of Utah, 1992. Compute the compositions by the products of:

\[
S(u, v) = S(u(a, b), v(a, b))
\]

\[
= \sum_{i=0}^{n} \sum_{j=0}^{m} P_{ij} B_i(u(a, b)) B_j(v(a, b))
\]

\[
= \sum_{i=0}^{n} \sum_{j=0}^{m} P_{ij} \binom{n}{i} (u(a, b)) (1 - u(a, b))^{n-i} \binom{m}{j} (v(a, b)) (1 - v(a, b))^{m-j}
\]

or if Srf2 is rational:

\[
S(u, v) = S(u(a, b), v(a, b))
\]
\[
\begin{align*}
&= \sum_{i=0}^{n} \sum_{j=0}^{m} P_{ij} \left( \frac{u(a, b)}{w(a, b)} \right) \left( \frac{v(a, b)}{w(a, b)} \right) \\
&= \sum_{i=0}^{n} \sum_{j=0}^{m} P_{ij} \left( \frac{u(a, b)}{w(a, b)} - u(a, b) \right) \left( \frac{v(a, b)}{w(a, b)} - v(a, b) \right) / \left( w(a, b) \right)
\end{align*}
\]

See also: SymbComposeSrfSrf, MvarBzrComposeTVSrf,

11.2.14 BzrCrvDeriveRational (bzw_sym.c:994)

```c
CagdCrvStruct *BzrCrvDeriveRational(const CagdCrvStruct *Crv)
```

**Crv:** Bezier curve to differentiate.

**Returns:** Differentiated rational Bezier curve.

**Description:** Given a rational Bezier curve - computes its derivative curve (Hodograph) using the quotient rule for differentiation.

See also: BzrCrvDerive, BspCrvDerive, BspCrvDeriveRational, CagdCrvDerive,

11.2.15 BzrCrvMult (bzw_sym.c:75)

```c
CagdCrvStruct *BzrCrvMult(const CagdCrvStruct *CCrv1, const CagdCrvStruct *CCrv2)
```

**CCrv1, CCrv2:** The two curves to multiply.

**Returns:** The product Crv1 * Crv2 coordinatewise.

**Description:** Given two Bezier curves - multiply them coordinatewise. The two curves are promoted to same point type before the multiplication can take place.

See also: BzrCrvMultPtsVecs,

11.2.16 BzrCrvMultList (bzw_sym.c:287)

```c
CagdCrvStruct *BzrCrvMultList(const CagdCrvStruct *Crv1Lst, const CagdCrvStruct *Crv2Lst)
```

**Crv1Lst:** First list of Bezier curves to multiply.

**Crv2Lst:** Second list of Bezier curves to multiply.

**Returns:** A list of product curves

**Description:** Given two Bezier curve lists - multiply them one at a time. Return a Bezier curve lists representing their products.
11.2.17 BzrCrvMultPtsVecs (bzr_sym.c:209)

```c
void BzrCrvMultPtsVecs(const CagdRType *Pts1,
int Order1,
const CagdRType *Pts2,
int Order2,
CagdRType *ProdPts)
```

**Pnts1**: First vector of scalars of first Bezier curve.
**Order1**: Order of first Bezier curve.
**Pnts2**: Second vector of scalars of second Bezier curve.
**Order2**: Order of second Bezier curve.
**ProdPts**: Result vector of scalars of product Bezier curve. Result vector is of length Order1+Order2-1.

** Returns**: void

**Description**: Given two Bezier scalar curves as vectors Ptsi of orders Orderi, multiply them.
**See also**: BzrCrvMult,

11.2.18 BzrSrfDeriveRational (bzr_sym.c:1092)

```c
CagdSrfStruct *BzrSrfDeriveRational(const CagdSrfStruct *Srf,
CagdSrfDirType Dir)
```

**Srf**: Bezier surface to differentiate.
**Dir**: Direction of Differentiation. Either U or V.

** Returns**: Differentiated rational Bezier surface.

**Description**: Given a rational Bezier surface - computes its derivative surface in direction Dir, using the quotient rule for differentiation.
**See also**: CagdSrfDerive, BzrSrfDerive, BspSrfDerive, BspSrfDeriveRational,

11.2.19 BzrSrfFactorBilinear (bzr_sym.c:539)

```c
CagdSrfStruct *BzrSrfFactorBilinear(const CagdSrfStruct *Srf,
const CagdRType *A)
```

**Srf**: To factor out a bilinear term from.
**A**: Four coefficients of the scalar bilinear.

** Returns**: Srf / (u - v).

**Description**: Factors out a given bilinear term from a scalar surface, assuming it has this term.

\[
\]

If \( S(P) = Bilinear(A) * S(Q) \), then
\[
A[0] (m-i) (n-j) Q[i][j] + A[1] i (n-j) Q[i-1][j] +
\]

**See also**: BspSrfFactorUMinusV,
11.2.20  BzrSrfFactorExtremeRowCol (bzrsym.c:851)

CagdSrfStruct *BzrSrfFactorExtremeRowCol(const CagdSrfStruct *Srf,  
CagdSrfBndryType Bndry)

    Srf: Surface to compute a reduced form for.
    Bndry: Boundary along which to reduce.

    Returns: Reduced surface, of one degree less in one direction.

    Description: Derived a reduced Bezier surface out of the given Bezier surface but performing the following:
1. Removing the row/column near the specified surface boundary, Bndry.
2. Scaling all other rows/columns by m/i where m is the original order in the direction we remove the row/column in
   1, and i vanish for the row/column index of the removed row/column. For example, given the Bezier surface:

       \[ \sum_{i=0}^{m} \sum_{j=0}^{n} P_{ij} B_{i,m}(u) B_{j,n}(v), \]

reducing Bndry = CAGD_U_MAX_BNDRY would yeild,

       \[ \sum_{i=0}^{m-1} \sum_{j=0}^{n} P_{ij} B_{i,m-1}(u) B_{j,n}(v). \]

    See also: MvarAdjacentSrfrInter,

11.2.21  BzrSrfFactorLowOrders (bzrsym.c:940)

void BzrSrfFactorLowOrders(const CagdSrfStruct *Srf,  
CagdSrfStruct **S11,  
CagdSrfStruct **S12,  
CagdSrfStruct **S21,  
CagdSrfStruct **S22)

    Srf: To factor out as four surfaces of lower order as, Srf = (1-u)(1-v) S11 + (1-u)v S12 + u(1-v) S21 + uv S22.
    S11, S12, S21, S22: The four lower order surfaces to factor out.

    Returns: void

    Description: Factors out a given Bezier surface into four Bezier surfaces of one order smaller, as (1-u)(1-v) S11 +
(1-u)v S12 + u(1-v) S21 + uv S22. Srf is assumed to be of orders larger than linear.

    See also: BspSrfFactorUMinusV, BzrSrfFactorBilinear,

11.2.22  BzrSrfFactorUMinusV (bzrsym.c:770)

CagdSrfStruct *BzrSrfFactorUMinusV(const CagdSrfStruct *Srf)

    Srf: To factor out a (u - v) term from.

    Returns: Srf / (u - v).

    Description: Factors out a (u - v) term from a scalar surface, assuming it has one.

    See also: BspSrfFactorUMinusV, BzrSrfFactorBilinear,
11.2.23  BzrSrfMult (bzsrfmult.c:327)

CagdSrfStruct *BzrSrfMult(const CagdSrfStruct *CSrf1,
const CagdSrfStruct *CSrf2)

CSrf1, CSrf2: The two surfaces to multiply.

Returns: The product Srf1 * Srf2 coordinatewise.

Description: Given two Bezier surfaces - multiply them coordinatewise. The two surfaces are promoted to same point type before multiplication can take place.

11.2.24  BzrSrfSubdivAtCurve (compost2.c:493)

CagdSrfStruct *BzrSrfSubdivAtCurve(const CagdSrfStruct *Srf,
const CagdCrvStruct *DivCrv)

Srf: To devide into two new tensor product surfaces along DivCurv. Must be a Bezier surface.

DivCrv: 2D curve in the UV space of Srf. Must split the UV domain of Srf into two and must start/end at opposite boundaries. That is, if DivCrv starts at UMin, it must end at UMax.

Returns: A list of two surfaces resulting from subdividing Srf along splitting curve DivCrv.

Description: Divides given surface Srf into two tensor product surfaces along a general curve DivCrv that splits Srf into two.

See also:

11.2.25  Symb2DCrvParameterize2Prms (prmdmn.c:249)

CagdSrfStruct *Symb2DCrvParameterize2Prms(const CagdCrvStruct *Crv,
CagdRType T1,
CagdRType T2,
int Dir,
CagdRType *Error)

Crv: The curve to fit a bivariate to the area enclosed in.

T1, T2: Two parameters to split curve at and fit a match in between.

Dir: Direction where Crv1/2 were split (0 None, 1 for U, 2 for V).

Error: Error result in this fit. Error can only be compared to the error of similar invocations of this function.

Returns: Fitted bivariate, or NULL if failed.

Description: Fit a bivariate to the region enclosed by Crv by splitting at T1 and T2.

See also:

11.2.26  Symb2DCrvParameterizeDomain (prmdmn.c:393)

CagdSrfStruct *Symb2DCrvParameterizeDomain(const CagdCrvStruct *UVCrv,
CagdRType Eps)

UVCrv: Curve to examine the ability to parameterize its interior domain as a 2D surface.

Eps: Tolerance of the decomposition.

Returns: Planars surface parameterizing the domain enclosed. Typically one, possibly two surfaces, or NULL if failed.

Description: Examine curve Crv if its enclosed domain is bivariate parameterizable.
11.2.27  Symb2DCrvParameterizing2Crvs (prm_dmn.c:186)

CagdSrfStruct *Symb2DCrvParameterizing2Crvs(const CagdCrvStruct *Crv1,
const CagdCrvStruct *Crv2,
int Dir,
CagdBType ForceMatch)

Crv1, Crv2: Two curves forming a loop and sharing starting and ending locations (i.e. they are roughly
monotone with respect to each other.)
Dir: Direction where Crv1/2 were split (1 for U, 2 for V).
ForceMatch: Force match, even if the Jacobian might be negative.
Returns: 2D surface parameterizing region enclosed in Crv1/2, or NULL if failed.
Description: Parameterize the area enclosed by given pair of curves that form a closed planar loop.
See also: TrimDecompTrimSrf2Srfs, TrimCrvIsParameterizableDomain,

11.2.28  Symb2DSrfJacobian (symb_srf.c:734)

CagdSrfStruct *Symb2DSrfJacobian(const CagdSrfStruct *Srf)

Srf: To compute the Jacobian scalar field for.
Returns: A scalar field representing the Jacobian of the given planar Srf.
Description: Given a planar surface - compute its Jacobian scalar field surface, as the cross product if its partial
derivatives.
See also: SymbSrfNormalSrf, MvarCalculateTVJacobian,

11.2.29  SymbAdapIsoExtract (adap_iso.c:160)

CagdCrvStruct *SymbAdapIsoExtract(const CagdSrfStruct *Srf,
const CagdSrfStruct *NSrf,
SymbAdapIsoDistSqrFuncType AdapIsoDistFunc,
CagdSrfDirType Dir,
CagdRType Eps,
CagdBType FullIso,
CagdBType SinglePath)

Srf: To compute adaptive isocurve coverage form
NSrf: Normal vector field defining the normals of Srf.
AdapIsoDistFunc: Optional function to invoke with the two adjacent isoparametric curves of the coverage to
evaluate the distance between them.
Dir: Direction of adaptive isocurve extraction. Either U or V.
Eps: Tolerance of adaptive isocurve coverage. For every point P on Srf there will be a point Q in one of the
extracted isocurves such the |P - Q| < Eps.
FullIso: Do we want all isocurves to span the entire domain?
SinglePath: Do we want a single curve through them all?
Returns: A list of curves representing the computed adaptive isocurve coverage for surface Srf. If normal field,
NSrf, is prescribed, normal curves are concatenated alternatingly in this list.
Description: Extracts a valid coverage set of isolines from the given surface in the given direction and epsilon.
If FullIso is TRUE, all extracted isocurves are spanning the entire parametric domain. If SinglePath is TRUE, the
entire coverage is going to be a single curve. If NSrf != NULL, every second curve will be a vector field curve
representing the unnormalized normal for the previous Euclidean curve. This mode disable the SinglePath mode.
See also function SymbSetAdapIsoExtractMinLevel.
See also: SymbAdapIsoExtractRectRgns, SymbAdapIsoSetWeightPt,
11.2.30 SymbAdapIsoExtractRectRgns (adap_iso.c:1029)

IPObjectStruct *SymbAdapIsoExtractRectRgns(const CagdSrfStruct *Srf,
CagdSrfDirType Dir,
CagdRType Size,
int Smoothing,
int OutputType)

Srf: To compute adaptive rectangular regions’ tiles for.
Dir: Direction of adaptive isocurve extraction. Either U or V.
Size: Rough size of the edges of the generated rectangles.
Smoothing: Number of low pass smoothing steps to apply, 0 to disable.
OutputType: 0 for UV coordinates in original surfaces. 1 for polygonal rectangles in Euclidean space. 2 for surface patches in Euclidean space.

Returns: A list of rectangles, as OutputType sets.

Description: Extracts a valid coverage set of rectangular regions of roughly equal size to the given surface in the given direction Dir and size Size.
See also: SymbAdapIsoExtract, SymbAdapIsoSetWeightPt,

11.2.31 SymbAdapIsoSetWeightPt (adap_iso.c:1236)

void SymbAdapIsoSetWeightPt(CagdRType *Pt, CagdRType Scale, CagdRType Width)

Pt: Point to consider or NULL to disable.
Scale: Scaling factor at Pt compared to a far location from Pt. Must be larger than 1.0 (1.0 has no effect).
Width: Control over the width of the effect.

Returns: void

Description: Sets the point location to consider using the adaptive iso generation.
See also: SymbAdapIsoDistWeightPt, SymbAdapIsoExtract,

11.2.32 SymbAlgebraicProdSrf (construct.c:125)

CagdSrfStruct *SymbAlgebraicProdSrf(const CagdCrvStruct *Crv1,
const CagdCrvStruct *Crv2)

Crv1, Crv2: Two curves to multiply algebraically.

Returns: A surface represent their product, algebraically.

Description: Multiply up algebraically the given two curves, C1(r) and C2(t). The result is a bivariate surface S(r, t) = C1(r) C2(t).
See also: SymbAlgebraicSumSrf, SymbSwungAlgSumSrf,

11.2.33 SymbAlgebraicSumSrf (construct.c:89)

CagdSrfStruct *SymbAlgebraicSumSrf(const CagdCrvStruct *Crv1,
const CagdCrvStruct *Crv2)

Crv1, Crv2: Two curves to sum algebraically.

Returns: A surface represent their sum, algebraically.

Description: Adds up algebraically the given two curves, C1(r) and C2(t). The result is a bivariate surface S(r, t) = C1(r) + C2(t).
See also: SymbSwungAlgSumSrf, SymbAlgebraicProdSrf,
11.2.34  SymbAllPrisaSrfs (prisa.c:58)

CagdSrfStruct *SymbAllPrisaSrfs(const CagdSrfStruct *Srfs,
    int SamplesPerCurve,
    CagdRType Epsilon,
    CagdSrfDirType Dir,
    const CagdVType Space);

Srfs: To approximate and flatten out.

SamplesPerCurve: During the approximation of a ruled surface as a developable surface.

Epsilon: Accuracy control for the piecewise ruled surface approximation. If Epsilon us positive, the surfaces are laid down on the plane, otherwise they are return as 3-space ruled surfaces and form a piecewise ruled-surface approximation to Srfs.

Dir: Direction of ruled/developable surface approximation. Either U or V.

Space: A vector in the XY plane to denote the amount of translation from one flattened out surface to the next.

Returns: A list of planar surfaces denoting the layout (prisa) of the given Srfs to the accuracy requested.

Description: Computes a piecewise ruled surface approximation to a given set of surfaces with given Epsilon, and lay them out "nicely" onto the XY plane, by approximating each ruled surface as a developable surface with SamplesPerCurve samples. Dir controls the direction of ruled approximation, SpaceScale and Offset controls the placement of the different planar pieces. Prisa is the hebrew word for the process of flattening out a three dimensional surface. I have still to find an english word for it.

See also: SymbPiecewiseRuledSrfApprox, SymbPrisaRuledSrf, TrimAllPrisaSrfs, SymbPrisaGetCrossSections,

11.2.35  SymbApproxCrvAsBzrCubics (bzr_sym.c:1276)

CagdCrvStruct *SymbApproxCrvAsBzrCubics(const CagdCrvStruct *Crv,
    CagdRType Tol,
    CagdRType MaxLen);

Crv: To approximate using cubic Bezier polynomials.

Tol: Accuracy control.

MaxLen: Maximum arc length of curve.

Returns: A list of cubic Bezier polynomials approximating Crv.

Description: Given a curve - convert it to (possibly) piecewise cubic polynomials. If the curve is
1. A cubic - a copy if it is returned.
2. Lower than cubic - a degree raised (to a cubic) curve is returned.
3. Higher than cubic - a C^1 continuous piecewise cubic polynomials approximation is computed for Crv.
4. Piecewise polynomial Bspline curve - split into polynomial segments.

In case 3, a list of polynomial cubic curves is returned. Tol is then used for the distance tolerance error measure for the approximation. If the total length of control polygon is (approximately) more than MaxLen, the curve is subdivided until this is not the case.

See also: SymbApproxCrvAsBzrQuadratics, SymbApproxCrvsLowDegState, , SymbCrvCubicApprox,

11.2.36  SymbApproxCrvAsBzrQuadratics (bzr_sym.c:1532)

CagdCrvStruct *SymbApproxCrvAsBzrQuadratics(const CagdCrvStruct *CCrv,
    CagdRType Tol,
    CagdRType MaxLen);

CCrv: To approximate using quadratic Bezier polynomials.

Tol: Accuracy control.

MaxLen: Maximum arc length of curve.

Returns: A list of quadratic Bezier polynomials approximating Crv.
**Description:** Given a curve - convert it to (possibly) piecewise quadratic polynomials. If the curve is
1. A quadratic - a copy if it is returned.
2. Lower than quadratic - a degree raised (to a quadratic) curve is returned.
3. Higher than quadratic - a $C^1$ continuous piecewise quadratic polynomial approximation is computed for Crv.
4. Piecewise polynomial Bspline curve - split into polynomial segments.

In case 3, a list of polynomial quadratic curves is returned. Tol is then used for the distance tolerance error measure for the approximation. If the total length of control polygon is (approximately) more than MaxLen, the curve is subdivided until this is not the case.

See also: SymbApproxCrvAsBzrCubics, SymbApproxCrvsLowDegState,

11.2.37 **SymbApproxCrvsLowDegState** *(bzr_sym.c:1211)*

```c
SymbApproxLowDegStateType SymbApproxCrvsLowDegState(
    SymbApproxLowDegStateType State)
```

**State:** New state to set.
**Returns:** Old State.

**Description:** Control the phases of approximating multiple Bezier curves as lower order curves, so that all curves are approximated using a similar set of subdivisions. A two pass algorithm is devised in which in the first a subdivision tree is built to hold the union of all subdivisions made to all the tested curves. In the second phase, all curves are subdivided the same (following the constructed subdivision tree of phase one) and returned.

See also: SymbApproxCrvsAsBzrQuadratics, SymbApproxCrvsAsBzrCubics,

11.2.38 **SymbArcArrayFree** *(symb_gen.c:180)*

```c
void SymbArcArrayFree(SymbArcStruct *ArcArray, int Size)
```

**ArcArray:** To be deallocated.
**Size:** Of the deallocated array.
**Returns:** void

**Description:** Deallocates and frees an array of Arc structure.

11.2.39 **SymbArcArrayNew** *(symb_gen.c:25)*

```c
SymbArcStruct *SymbArcArrayNew(int Size)
```

**Size:** Size of Arc array to allocate.
**Returns:** An array of Arc structures of size Size.
**Description:** Allocates and resets all slots of an array of Arc structures.

11.2.40 **SymbArcCopy** *(symb_gen.c:79)*

```c
SymbArcStruct *SymbArcCopy(SymbArcStruct *Arc)
```

**Arc:** To be copied.
**Returns:** A duplicate of Arc.
**Description:** Allocates and copies all slots of a Arc structure.
11.2.41 SymbArcCopyList (symb_gen.c:104)

SymbArcStruct *SymbArcCopyList(SymbArcStruct *ArcList)

ArcList: To be copied.
Returns: A duplicated list of arcs.
Description: Allocates and copies a list of arc structures.

11.2.42 SymbArcFree (symb_gen.c:133)

void SymbArcFree(SymbArcStruct *Arc)

Arc: To be deallocated.
Returns: void
Description: Deallocates and frees all slots of an arc structure.

11.2.43 SymbArcFreeList (symb_gen.c:155)

void SymbArcFreeList(SymbArcStruct *ArcList)

ArcList: To be deallocated.
Returns: void
Description: Deallocates and frees an arc structure list:

11.2.44 SymbArcNew (symb_gen.c:53)

SymbArcStruct *SymbArcNew(int Arc)

Arc: TRUE for an arc, FALSE for degenerated-arc (a line...).
Returns: A Arc structure.
Description: Allocates and resets all slots of an Arc structure.

11.2.45 SymbArcs2Crvs (biarc.c:593)

CagdCrvStruct *SymbArcs2Crvs(const SymbArcStruct *Arcs)

Arcs: To convert to real curves' geometry.
Returns: Generated curves.
Description: Converts a list of arcs (and lines) into curves geometry.

11.2.46 SymbBspBasisInnerProd (bsp_sym.c:746)

CagdRType SymbBspBasisInnerProd(int Index1, int Index2)

Index1: Index of first basis function.
Index2: Index of second basis function.
Returns: The value of the inner product.
Description: Computes the inner product of two basis functions over a similar function space, as created via SymbBspBasisInnerProdPrep. The inner product is defined as "int( B1(t) * B2(t) )" where "int ( . )" denotes the integral of the function over all the domain.
See also: SymbBspBasisInnerProdPrep, SymbBspBasisInnerProdMat, SymbBspBasisInnerProd2,
11.2.47  SymbBspBasisInnerProd2  (bspiprod.c:67)

CagdRType SymbBspBasisInnerProd2(const CagdRType *KV,
    int Len,
    int Order1,
    int Order2,
    int Index1,
    int Index2)

KV: A common knot vector of the b-spline basis functions.
Len: Length of knot vector KV.
Order1: Order of first basis function.
Order2: Order of second basis function.
Index1: Index of first basis function.
Index2: Index of second basis function.

Returns: The value of the inner product.

Description: Computes the inner product of two B-spline basis functions over a similar function space. The inner product is defined as "int( B1(t) * B2(t) )" where "int ( . )" denotes the integral of the function over all the domain. The computation is conducted recursively over the orders until Order1/2 are constant.
See also: SymbBspBasisInnerProd,

11.2.48  SymbBspBasisInnerProdMat  (bsp_sym.c:594)

CagdRType **SymbBspBasisInnerProdMat(const CagdRType *KV,
    int Len,
    int Order1,
    int Order2)

KV: Knot vector of the basis functions (of Order).
Len: Length of knot vector KV.
Order1: Order of first basis function.
Order2: Order of second basis function, <= Order1.

Returns: The allocated matrix and values of inner products.

Description: Computes a matrix of size (Len x (Len - (Order1 - Order2)) of inner products, SymbBspBasisInnerProd style. matrix is allocated dynamically.
See also: SymbBspBasisInnerProd, SymbBspBasisInnerProdPrep,

11.2.49  SymbBspBasisInnerProdPrep  (bsp_sym.c:653)

void SymbBspBasisInnerProdPrep(const CagdRType *KV,
    int Len,
    int Order1,
    int Order2)

KV: Knot vector of the basis functions (of Order).
Len: Length of knot vector KV.
Order1: Order of first basis function.
Order2: Order of second basis function, <= Order1.

Returns: void

Description: Prepares for the computation of the inner product of pair of basis functions over a similar function space. The inner product is defined as "int( B1(t) * B2(t) )" where "int ( . )" denotes the integral of the function over all the domain.
See also: SymbBspBasisInnerProd, SymbBspBasisInnerProdPrep2,
11.2.50  SymbBspBasisInnerProdPrep2  (bsp_sym.c:704)

void SymbBspBasisInnerProdPrep2(const CagdRType *KV1,
                                 const CagdRType *KV2,
                                 int Len1,
                                 int Len2,
                                 int Order1,
                                 int Order2)

KV1:  Knot vector of the first basis functions (of Order1).
KV2:  Knot vector of the second basis functions (of Order2).
Len1:  Length of knot vector KV1.
Len2:  Length of knot vector KV2.
Order1:   Order of first basis function.
Order2:   Order of second basis function, <= Order1.
Returns:  void

Description:  Prepares for the computation of the inner product of pair of basis functions over a similar function space. The inner product is defined as "int( B1(t) * B2(t) )" where "int ( . )" denotes the integral of the function over all the domain.

See also:  SymbBspBasisInnerProd2, SymbBspBasisInnerProdPrep,

11.2.51  SymbBzrDegReduce  (cmp_crvs.c:133)

CagdCrvStruct *SymbBzrDegReduce(const CagdCrvStruct *Crv, CagdRType Eps)

Crv:  A Bezier curve.
Eps:  A threshold for degree reduction computations.
Returns:  Maximal degree reduced curve. If no degree reduction was done, returns NULL.

Description:  For given Bezier curve, performs maximal degree reduction of the curve. Maximal degree reduction is defined as a process of degree redusing the curve as long as the new curve represents the same curve.

11.2.52  SymbCanonicBzrCrv  (cmp_crvs.c:72)

CagdCrvStruct *SymbCanonicBzrCrv(const CagdCrvStruct *Crv, CagdRType Eps)

Crv:  A Bezier curve.
Eps:  A threshold for "canonical representation" computations.
Returns:  Canonically represented Bezier curve.

Description:  For given Bezier curve, returns its irreducible version (its canonical representation), by reversing the processes of degree raising and composition.

11.2.53  SymbCircTanTo2Crvs  (crv_tans.c:342)

CagdPtStruct *SymbCircTanTo2Crvs(const CagdCrvStruct *Crv1,
                                  const CagdCrvStruct *Crv2,
                                  CagdRType Radius,
                                  CagdRType Tol)

Crv1, Crv2:  The two curves to find the circle that is tangent to both.
Radius:  Of the circle that is tangent to Crv1/2.
Tol:  Tolerance of approximation.
Returns:  List of the centers of bi-tangent circles. Each such point also contains a "Params" attribute with the two parameter values of the two curves.

Description:  Computes all circles of prescribed radius that are tangent to given two curves. Compute the offset of +/-R to the two curves and intersect the pairs.

See also:  SymbTangentToCrvAtTwoPts,
11.2.54  SymbClipCrvToSrfDomain  (blending.c:30)

    CagdCrvStruct *SymbClipCrvToSrfDomain(const CagdSrfStruct *Srf,
    const CagdCrvStruct *UVCrv)

    Srf: Surface to clip UVCrv to its parametric domain.
    UVCrv: The curve to clip.
    Returns:  Clipped curve.
    Description: Clips the given curve to the domain prescribed by Srf.

11.2.55  SymbComposeCrvCrv  (composit.c:118)

    CagdCrvStruct *SymbComposeCrvCrv(const CagdCrvStruct *Crv1,
    const CagdCrvStruct *Crv2)

    Crv1, Crv2: The two curves to compose together.
    Returns:  The composed curve.
    Description: Given two curves, Crv1 and Crv2, computes the composition Crv1(Crv2(t)). Crv2 must be a
    scalar curve completely contained in Crv1's parametric domain.
    See also:  BzrComposeCrvCrv, SymbDecomposeCrvCrv, SymbComposePeriodicCrvCrv, SymbComposeSrfCrv,
                MvarComposeTVSrf,

11.2.56  SymbComposePeriodicCrvCrv  (composit.c:538)

    CagdCrvStruct *SymbComposePeriodicCrvCrv(const CagdCrvStruct *CCrv1,
    const CagdCrvStruct *CCrv2,
    CagdRType Epsilon)

    CCrv1, CCrv2: The two curves to compose together.
    Epsilon: Of subdivision at boundary crossing locations.
    Returns:  The composed curve.
    Description: Given two curves, Crv1 and Crv2, computes the composition Crv1(Crv2(t)). Crv2 must be a
    scalar curve that is clipped and tiled modulus the domain of Crv1. As an example, if Crv1’s domain is [1, 5),
    and Crv2’s range is [-3, 11), then Crv2 will be clipped to the following pieces:
    1. [-3, 1) that is remapped to [1, 5) and composed.
    2. [ 1, 5) that is composed as is.
    3. [ 5, 9) that is remapped to [1, 5) and composed.
    4. [ 9, 11) that is remapped to [1, 3) and composed.
    See also:  SymbComposeCrvCrv,

11.2.57  SymbComposePeriodicSrfCrv  (composit.c:996)

    CagdCrvStruct *SymbComposePeriodicSrfCrv(const CagdSrfStruct *Srf,
    const CagdCrvStruct *Crv,
    CagdRType Epsilon)

    Srf, Crv: The curve and periodic surface to compose together.
    Epsilon: Of subdivision at boundary crossing locations.
    Returns:  The composed curve.
    Description: Given a curve Crv and surface Srf, computes the composition Srf(Crv(t)). Crv must be a two
    dimensional curve that is clipped and tiled modulus the domain of Srf. As an example, if Surface V domain is [1, 5),
    and Crv Y range [-3, 11), then Crv will be V clipped to the following pieces:
    1. [-3, 1) that is remapped to [1, 5) and composed.
    2. [ 1, 5) that is composed as is.
    3. [ 5, 9) that is remapped to [1, 5) and composed.
    4. [ 9, 11) that is remapped to [1, 3) and composed.
    See also:  SymbComposeSrfCrv,
11.2.58  **SymbComposeSrfClrCache** (composi.c:656)

    void SymbComposeSrfClrCache(const CagdSrfStruct *Srf)
    Srf: Surface to clean all its cached data for SymbComposeSrfCrv.
    Returns: void
    Description: Given a surface Srf that was used in a composition operation with some curve via SymbComposeSrfCrv while SymbComposeSrfSetCache was on, cleans all cached information on the surface.
    See also: SymbComposeSrfCrv, SymbComposeSrfClrCache,

11.2.59  **SymbComposeSrfCrv** (composi.c:712)

    CagdCrvStruct *SymbComposeSrfCrv(const CagdSrfStruct *Srf, const CagdCrvStruct *Crv)
    Srf, Crv: The curve and surface to compose.
    Returns: The resulting composition.
    Description: Given a curve Crv and surface Srf, computes the composition Srf(Crv(t)). Crv must be a two dimensional curve completely contained in the parametric domain of Srf.
    See also: SymbDecomposeCrvCrv, SymbComposeSrfSetCache, SymbComposePeriodicSrfCrv, , MvarComposeTVSrf,

11.2.60  **SymbComposeSrfPatch** (compost2.c:607)

    CagdSrfStruct *SymbComposeSrfPatch(const CagdSrfStruct *Srf, const CagdUVType UV00, const CagdUVType UV01, const CagdUVType UV10, const CagdUVType UV11)
    Srf: In which the four UVij corners resides.
    UV00, UV01, UV10, UV11: The four corners of the patch to extract.
    Returns: A patch inside Srf that is a rectangle through UVij in the domain of Srf. Only the four boundaries will be precisely reconstructed and the resulting surface will be contained in Srf only if Srf is planar.
    Description: Computes a surface patch that is a general rectangle in the domain of given surface.
    See also: SymbComposeSrfCrv, SymbComposeSrfSrfs,

11.2.61  **SymbComposeSrfSetCache** (composi.c:629)

    int SymbComposeSrfSetCache(int Cache)
    Cache: TRUE to activate the cache, FALSE to disable it.
    Returns: Old state of caching.
    Description: Activate caching during surface-curve composition operations.
    See also: SymbComposeSrfCrv, SymbComposeSrfClrCache,

11.2.62  **SymbComposeSrfSrfs** (compost2.c:46)

    CagdSrfStruct *SymbComposeSrfSrfs(const CagdSrfStruct *Srf1, const CagdSrfStruct *Srf2)
    Srf1, Srf2: The surfaces to compose. Srf1 must be a Bezier.
    Returns: The resulting composition.
    Description: Given surfaces Srf2 and Srf1, computes the composition Srf1(Srf2(u, v)). Srf2 must be a two dimensional surface completely contained in the parametric domain of Srf1.
    See also: SymbDecomposeCrvCrv, SymbComposeSrfCrv, MvarComposeTVSrf,
11.2.63  **SymbComposeTileObjectInSrf** *(compost2.c:671)*

```c
 IPObjStruct *SymbComposeTileObjectInSrf(const IPObjStruct *PObj,
 const CagdSrfStruct *DeformSrf,
 IrtRType UTimes,
 IrtRType VTimes,
 IrtBType FitObj)
```

**PObj**: The object to map through the bivariate. Can be a (list of) curve(s) or surface(s) only. If PObj is formed out of surface(s), DeformSrf must be a Bezier surface.

**DeformSrf**: The mapping/deformation function from R2 to R2.

**UTimes**, **VTimes**: Number of times to tile the object in each axis.

**FitObj**: TRUE to rescale PObj tile to precisely fit the domain (UTimes x VTimes), FALSE to assume PObj is in \([0,1]^2\) when fitting domain.

**Returns**: (UTimes x VTimes) mapped and deformed objects.

**Description**: Tile an input object, in place, (UTimes x VTimes) in the given bivariate surface. Computation is made precise, using composition operations.

**See also**: SymbComposeSrfCrv, SymbComposeSrfSrf, TrivComposeTileObjectInTVBzr,

11.2.64  **SymbConeConeBisect** *(smp_skel.c:1458)*

```c
 CagdSrfStruct *SymbConeConeBisect(const CagdVType Cone1Dir,
 CagdRType Cone1Angle,
 const CagdVType Cone2Dir,
 CagdRType Cone2Angle,
 CagdRType Size)
```

**Cone1Dir**: Direction of first cone axes.

**Cone1Angle**: Spanning angle of the first cone, in degrees.

**Cone2Dir**: Direction of second cone axes.

**Cone2Angle**: Spanning angle of the second cone, in degrees.

**Size**: Portion of result as it is infinite.

**Returns**: Constructed bisector surface.

**Description**: Compute the bisector surface between two cones sharing an apex. The apex is assumed to be at the origin. The computation is reduced to that of a bisector between a line and a cone, that has a rational form.

**See also**: SymbPlanePointBisect, SymbCylinPointBisect, SymbConePointBisect, , SymbSpherePointBisect, SymbTorusPointBisect, , SymbConeLineBisect, SymbSphereLineBisect, SymbPlaneLineBisect, , SymbCylinPlaneBisect, SymbConePlaneBisect, SymbSpherePlaneBisect, , SymbCylinSphereBisect, SymbSphereSphereBisect, SymbTorusSphereBisect, , SymbConeSphereBisect, SymbConeConeBisect2, SymbConeCylinBisect, , SymbCylinCylinBisect,

11.2.65  **SymbConeConeBisect2** *(smp_skel.c:1800)*

```c
 CagdSrfStruct *SymbConeConeBisect2(const CagdVType Cone1Pos,
 const CagdVType Cone1Dir,
 CagdRType Cone1Angle,
 const CagdVType Cone2Pos,
 const CagdVType Cone2Dir,
 CagdRType Cone2Angle)
```

**Cone1Pos**: The apex point of the first cone.

**Cone1Dir**: The direction of the first cone.

**Cone1Angle**: Spanning angle of the first cone, in degrees.

**Cone2Pos**: The apex point of the the second cone.

**Cone2Dir**: The direction of the second cone.

**Cone2Angle**: Spanning angle of the second cone, in degrees.
Returns: Constructed bisector surface.

Description: Compute the bisector surface between two cones in general position. Let $C_1(u)$, $T_1(u)$, and $N_1(u)$ and $C_2(v)$, $T_2(v)$, and $N_2(v)$ be cones’ cross sections, cross sections’ unit tangent field and cross sections’ unit normal field. $C_i(u)$ can be derived as a transformed circle. $T_i(u)$ are unit circles rotated to the proper orientation $ConeDir$ and $N_i(u)$ is a circle on the unit sphere with the proper orientation. Finally, note that $C_i(u)$, $T_i(u)$, and $N_i(u)$ are all rational. Then, the bisector is computed as the solution of the following three linear equations:

\[
\langle \mathbf{B} - C_1(u), T_1(u) \rangle = 0
\]

\[
\langle \mathbf{B} - C_2(v), T_2(v) \rangle = 0
\]

\[
\langle \mathbf{B}, N_1(u) - N_2(v) \rangle = \langle C_1(u), N_1(u) \rangle - \langle C_2(v), N_2(v) \rangle
\]

The first two constraints the bisector to be on the normal plane of the generators of the two cones that are fixed along the generator (the straight lines of the cone). The last constraint make sure the bisector is on the plane that bisects the two tangent planes of the two cones. This computation is following the bisectors of two developables, presented in, "Geometric Properties of Bisector Surfaces", by Martin Peternell, Graphical Models, Volume 62, No. 3, May 2000.

See also: SymbPlanePointBisect, SymbCylinPointBisect, SymbConePointBisect, SymbSpherePointBisect, SymbTorusPointBisect, SymbConeLineBisect, SymbSphereLineBisect, SymbPlaneLineBisect, SymbCylinPlaneBisect, SymbConePlaneBisect, SymbSpherePlaneBisect, SymbSphereSphereBisect, SymbConeSphereBisect, SymbConeConeBisect, SymbCylinConeBisect, SymbCylinSphereBisect, SymbSphereSphereBisect, SymbCylinCylinBisect, SymbConeCylinBisect, SymbConeSphereBisect.

11.2.66 SymbConeCylinBisect (smp_skel.c:2017)

CagdSrfStruct *SymbConeCylinBisect(const CagdVType Cone1Pos,
const CagdVType Cone1Dir,
CagdRType Cone1Angle,
const CagdVType Cyl2Pos,
const CagdVType Cyl2Dir,
CagdRType Cyl2Rad)

Cone1Pos: The apex point of the first cone.
Cone1Dir: The direction of the first cone.
Cone1Angle: Spanning angle of the first cone, in degrees.
Cyl2Pos: A point on the axis of the second cylinder.
Cyl2Dir: The direction of the second cylinder.
Cyl2Rad: Radius of second cylinder.

Returns: Constructed bisector surface.

Description: Compute the bisector surface between two cones in general position. Let $C_1(u)$, $T_1(u)$, and $N_1(u)$ and $C_2(v)$, $T_2(v)$, and $N_2(v)$ be cones’ cross sections, cross sections’ unit tangent field and cross sections’ unit normal field. $C_i(u)$ can be derived as a transformed circle. $T_i(u)$ are unit circles rotated to the proper orientation $ConeDir$ and $N_i(u)$ is a circle on the unit sphere with the proper orientation. Finally, note that $C_i(u)$, $T_i(u)$, and $N_i(u)$ are all rational. Then, the bisector is computed as the solution of the following three linear equations:

\[
\langle \mathbf{B} - C_1(u), T_1(u) \rangle = 0
\]

\[
\langle \mathbf{B} - C_2(v), T_2(v) \rangle = 0
\]

\[
\langle \mathbf{B}, N_1(u) - N_2(v) \rangle = \langle C_1(u), N_1(u) \rangle - \langle C_2(v), N_2(v) \rangle
\]
The first two constraints the bisector to be on the normal plane of the generators of the two cylinders that are fixed along the generator (the straight lines of the cylinder). The last constraint make sure the bisector is on the plane that bisects the two tangent planes of the two cylinders. This computation is following the bisectors of two developables, presented in "Geometric Properties of Bisector Surfaces", by Martin Peternell, Graphical Models, Volume 62, No. 3, May 2000.

**See also:** SymbPlanePointBisect, SymbCylinPointBisect, SymbConePointBisect, SymbSpherePointBisect, SymbTorusPointBisect, SymbConeLineBisect, SymbCylinLineBisect, SymbPlaneLineBisect, SymbCylinPlaneBisect, SymbConePlaneBisect, SymbSpherePlaneBisect, SymbCylindersPointBisect, SymbSphereSphereBisect, SymbConeSphereBisect, SymbConeConeBisect, SymbCylinCylinBisect, SymbConeConeBisect2.

### 11.2.67 SymbConeLineBisect (smp_skel.c:1028)

```c
CagdSrfStruct *SymbConeLineBisect(const CagdVType ConeDir,
                                   CagdRType ConeAngle,
                                   const CagdVType LineDir,
                                   CagdRType Size)
```

- **ConeDir:** Direction of cone axes. Must be in the northern hemisphere.
- **ConeAngle:** Spanning angle of the cone, in degrees.
- **LineDir:** Direction of line from the origin. Must be in the northern hemisphere.
- **Size:** Portion of result as it is infinite.

**Returns:** Constructed bisector surface.

**Description:** Compute the bisector surface between a cone and a line through its apex. Assumes the cone’s apex is at the origin.

**See also:** SymbPtCrvBisectOnSphere, SymbPlanePointBisect, SymbCylinPointBisect, SymbConePointBisect, SymbSpherePointBisect, SymbTorusPointBisect, SymbSphereLineBisect, SymbPlaneLineBisect, SymbCylinPlaneBisect, SymbSphereSphereBisect, SymbConeSphereBisect, SymbTorusSphereBisect, SymbConeConeBisect, SymbConeConeBisect2, SymbConeCylinBisect, SymbCylinCylinBisect.

### 11.2.68 SymbConePlaneBisect (smp_skel.c:1255)

```c
CagdSrfStruct *SymbConePlaneBisect(const CagdPType ConeApex,
                                   const CagdVType ConeDir,
                                   CagdRType ConeAngle,
                                   CagdRType Size)
```

- **ConeApex:** Apex point of cone.
- **ConeDir:** Direction of cylinder. Must be in the northern hemisphere.
- **ConeAngle:** Angular span of cone, in degrees.
- **Size:** Portion of result as it is infinite.

**Returns:** Constructed bisector surface.

**Description:** Compute the bisector surface between a cone and the XY plane. The computation is reduced to that of a bisector between a line and a cone, that has a rational form.

**See also:** SymbPlanePointBisect, SymbCylinPointBisect, SymbConePointBisect, SymbSpherePointBisect, SymbTorusPointBisect, SymbConeLineBisect, SymbCylinLineBisect, SymbPlaneLineBisect, SymbCylinPlaneBisect, SymbSpherePlaneBisect, SymbCylinSphereBisect, SymbSphereSphereBisect, SymbConeSphereBisect, SymbTorusSphereBisect, SymbConeConeBisect, SymbConeConeBisect2, SymbConeCylinBisect, SymbCylinCylinBisect.

### 11.2.69 SymbConePointBisect (smp_skel.c:801)

```c
CagdSrfStruct *SymbConePointBisect(const CagdPType ConeApex,
                                   const CagdVType ConeDir,
                                   CagdRType ConeAngle,
                                   const CagdPType Pt,
                                   CagdRType Size)
```

**Description:** Compute the bisector surface between a cone and a line through its apex. Assumes the cone’s apex is at the origin.

**See also:** SymbPlanePointBisect, SymbCylinPointBisect, SymbConePointBisect, SymbSpherePointBisect, SymbTorusPointBisect, SymbConeLineBisect, SymbCylinLineBisect, SymbPlaneLineBisect, SymbCylinPlaneBisect, SymbSpherePlaneBisect, SymbCylinSphereBisect, SymbSphereSphereBisect, SymbConeSphereBisect, SymbTorusSphereBisect, SymbConeConeBisect, SymbConeConeBisect2, SymbConeCylinBisect, SymbCylinCylinBisect.
ConeApex: Apex point of cone.
ConeDir: Direction of cone axes.
ConeAngle: Spanning angle of the cone, in degrees.
Pt: Direction of line from origin.
Size: Portion of result as it is infinite.

Returns: Constructed bisector surface.

Description: Compute the bisector surface between a cone and a point.

See also: SymbPtCrvBisectOnSphere, SymbPlanePointBisect, SymbCylinPointBisect, SymbSpherePointBisect, SymbTorusPointBisect, SymbConePlaneBisect, SymbCylinPlaneBisect, SymbSpherePlaneBisect, SymbConeLineBisect, SymbCylinLineBisect, SymbCylinSphereBisect, SymbSphereSphereBisect, SymbConeSphereBisect, SymbTorusSphereBisect, SymbConeConeBisect, SymbConeConeBisect2, SymbConeCylinBisect, SymbCylinCylinBisect,

11.2.70 SymbConeSphereBisect (smp_skel.c:1407)

CagdSrfStruct *SymbConeSphereBisect(const CagdPType ConeApex, const CagdVType ConeDir, CagdRType ConeAngle, const CagdPType SprCntr, CagdRType SprRad, CagdRType Size)

ConeApex: Apex point of cone.
ConeDir: Direction of cone axes.
ConeAngle: Spanning angle of the cone, in degrees.
SprCntr: Center location of the sphere.
SprRad: Radius of sphere.
Size: Portion of result as it is infinite.

Returns: Constructed bisector surface.

Description: Compute the bisector surface between a sphere and a cone. The computation is reduced to that of a bisector between a point and a cone, that has a rational form.

See also: SymbPlanePointBisect, SymbCylinPointBisect, SymbConePointBisect, SymbSpherePointBisect, SymbTorusPointBisect, SymbConeLineBisect, SymbCylinLineBisect, SymbCylinSphereBisect, SymbSphereSphereBisect, SymbTorusSphereBisect, SymbConeConeBisect, SymbConeConeBisect2, SymbConeCylinBisect, SymbCylinCylinBisect,

11.2.71 SymbConicDistCrvCrv (distance.c:811)

CagdSrfStruct *SymbConicDistCrvCrv(const CagdCrvStruct *CCrv1, const CagdCrvStruct *CCrv2, CagdRType Dist)

CCrv1, CCrv2: Two curves to compute elliptic/hyperbolic distance function to. Assumes E2 curves.
Dist: Distance to the two entities.

Returns: A scalar surface whose zero set provides the conic distance (both elliptic sum and hyperbolic difference).

Description: Computes the surface of equidistance to two univariate (curve) entities. The zero set of the computed surface equal to the locus of points whose sum or different of distances to Crv1 and Crv2 equal Dist. Let d1 and d2 be the two distances of a point on the conic to Crv1 and Crv2, respectively:

\[ d_1 +/- d_2 = \text{Dist} \]

The distance to a curve is a local minimal distance to it occurs along the normal of the curves. Hence we first seek the solution to the following two equations in X and Y and two unknowns, A and B:
\[ C_1(t) + a \, N_1(t) = C_2(r) + b \, N_2(r), \quad a, b > 0 \]

where \( N_i \) is the unnormalized normal of \( C_i \). Given \( a \) and \( b \) (rationals), \( d_1 \) and \( d_2 \) equals:
\[ d_1 = a \, || N_1(t) || = a \, \sqrt{ \langle N_1(t), N_1(t) \rangle }, \quad d_2 = b \, || N_2(s) || = b \, \sqrt{ \langle N_2(s), N_2(s) \rangle }, \]
and we need to solve for,
\[ a \, \sqrt{ \langle N_1(t), N_1(t) \rangle } +/- b \, \sqrt{ \langle N_2(s), N_2(s) \rangle } = \text{Dist} \]

Because we are unable to represent square roots as rationals, we square:
\[ a^2 \langle N_1(t), N_1(t) \rangle + b^2 \langle N_2(s), N_2(s) \rangle - \text{Dist}^2 = +/- 2 a b \, \sqrt{ \langle N_1(t), N_1(t) \rangle } \, \sqrt{ \langle N_2(s), N_2(s) \rangle } \]

or
\[ (a^2 \langle N_1(t), N_1(t) \rangle + b^2 \langle N_2(s), N_2(s) \rangle - \text{Dist}^2 )^2 - 4 (ab)^2 \langle N_1(t), N_1(t) \rangle \langle N_2(s), N_2(s) \rangle = 0 \]

11.2.72 \text{SymbCrv2DCurvatureSign} \ (\text{curvatur.c:452})

\[ \text{CagdCrvStruct *SymbCrv2DCurvatureSign(const CagdCrvStruct *Crv)} \]

\text{Crv: To compute the curvature sign field.}

\text{Returns: Computed curvature sign field.}

\text{Description: Computes a scalar curve representing the curvature sign of a planar curve. The given curve is assumed to be planar and only its x and y coordinates are considered. Then the curvature sign is equal to}
\[ s = \frac{\dot{X} \ddot{Y} - \ddot{X} \dot{Y}}{\dot{X}^2 + \dot{Y}^2} \]

\text{See also: SymbCrv2DCurvatureSqr, SymbCrv3DCurvatureSqr, SymbCrv3DCurvatureSqr, SymbCrv3DRadiusNormal, SymbCrv3DCurvatureNormal, SymbCrv2DInflectionPts, SymbCrvExtremCrvtrPts,}

11.2.73 \text{SymbCrv2DCurvatureSqr} \ (\text{curvatur.c:41})

\[ \text{CagdCrvStruct *SymbCrv2DCurvatureSqr(const CagdCrvStruct *Crv)} \]

\text{Crv: To compute the square of the curvature field for.}

\text{Returns: The square of the curvature field of Crv.}

\text{Description: Computes a scalar curve representing the curvature of a planar curve. The given curve is assumed to be planar and only its x and y coordinates are considered. Then the curvature \( k \) is equal to}
\[ k = \frac{\dot{X} \ddot{Y} - \ddot{X} \dot{Y}}{\dot{X}^2 + \dot{Y}^2} \]

\[ k = \frac{\dot{X} \ddot{Y} - \ddot{X} \dot{Y}}{\dot{X}^2 + \dot{Y}^2} \]

Since we cannot represent \( k \) because of the square root, we compute and represent \( k^2 \).

\text{See also: SymbCrv3DCurvatureSqr, SymbCrv3DRadiusNormal, SymbCrv3DCurvatureNormal, SymbCrv2DCurvatureSign, SymbCrv2DInflectionPts, SymbCrvExtremCrvtrPts,}

11.2.74 \text{SymbCrv2DInflectionPts} \ (\text{curvatur.c:601})

\[ \text{CagdPtStruct *SymbCrv2DInflectionPts(const CagdCrvStruct *Crv, CagdRType Epsilon)} \]

\text{Crv: To find all its inflection points.}

\text{Epsilon: Accuracy control.}

\text{Returns: A list of parameter values on Crv that are inflection points.}

\text{Description: Given a planar curve, finds all its inflection points by finding the zero set of the sign of the curvature function of the curve.}

\text{See also: SymbCrv2DCurvatureSqr, SymbCrv3DCurvatureSqr, SymbCrv3DCurvatureSqr, SymbCrv3DRadiusNormal, SymbCrv3DCurvatureNormal, SymbCrv2DCurvatureSign, SymbCrvExtremCrvtrPts,}
11.2.75  **SymbCrv2DUnnormNormal** *(curvatur.c:303)*

```c
CagdCrvStruct *SymbCrv2DUnnormNormal(const CagdCrvStruct *Crv)
```

**Crv:** Planar curve to compute unnormalized normal field for.

**Returns:** The normal field.

**Description:** Computes the unnormalized normal of a planar 2D curve as a 90 rotation in the plane of the tangent field.

**See also:** SymbCrv3DRadiusNormal,

11.2.76  **SymbCrv2Polyline** *(symbpoly.c:247)*

```c
CagdPolylineStruct *SymbCrv2Polyline(const CagdCrvStruct *Crv, 
                                      CagdRType TolSamples, 
                                      SymbCrvApproxMethodType Method, 
                                      CagdBType OptiLin)
```

**Crv:** To approximate as a polyline.

**TolSamples:** Tolerance of approximation error (Method = 2) or Number of samples to compute on polyline (Method = 0, 1).

**Method:** 0 - TolSamples are set uniformly in parametric space, 1 - TolSamples are set optimally, considering the isocurve’s curvature. 2 - TolSamples sets the maximum error allowed between the piecewise linear approximation and original curve.

**OptiLin:** If TRUE, optimize linear curves.

**Returns:** A polyline representing the piecewise linear approximation from, or NULL in case of an error.

**Description:** Routine to approx. a single curve as a polyline with TolSamples samples/tolerance. Polyline is always E3 CagdPolylineStruct type. NULL is returned in case of an error, otherwise CagdPolylineStruct.

**See also:** BspCrv2Polyline, BzrCrv2Polyline, IritCurve2Polylines,

11.2.77  **SymbCrv2PolylineSetTlrncErrorFunc** *(symbpoly.c:388)*

```c
SymbCrv2PolylineTlrncErrorFuncType SymbCrv2PolylineSetTlrncErrorFunc(
                                      SymbCrv2PolylineTlrncErrorFuncType ErrorFunc)
```

**ErrorFunc:** New error function to use.

**Returns:** Old error function reference.

**Description:** Sets the error function to be used by optimal tolerance based approx. of curves into polylines. This function should return TRUE if tolerance is met, FALSE if the curve is to be further divided. This function, if defined, is invoked in addition to the tolerance testing.

**See also:** SymbCrv2Polyline,

11.2.78  **SymbCrv3DCurvatureNormal** *(curvatur.c:354)*

```c
CagdCrvStruct *SymbCrv3DCurvatureNormal(const CagdCrvStruct *Crv)
```

**Crv:** To compute the normal curvature field.

**Returns:** Computed normal curvature field.

**Description:** Computes a vector field curve representing the curvature of a curve, in the normal direction, that is kN.

\[
\frac{\dot{C} \times \ddot{C}}{\|C\|} \times \frac{\dot{C} \times \dddot{C}}{\|C\|^3} = \frac{\dot{C} \times \dddot{C}}{\|C\|^4}
\]

**See also:** SymbCrv2DCurvatureSqr, SymbCrv3DCurvatureSqr, SymbCrv3DCurvatureSqr, , SymbCrv3DRadiusNormal, SymbCrv2DCurvatureSign, SymbCrv2DInflectionPts, , SymbCrvExtremCrvtrPts,
11.2.79  SymbCrv3DCurvatureSqr  (curvatur.c:150)

CagdCrvStruct *SymbCrv3DCurvatureSqr(const CagdCrvStruct *Crv)

Crv: To compute scalar field of curvature square for.

Returns: Computed scalar field of curvature square of Crv.

Description: Computes a scalar field curve representing the square of the curvature of a given 3D curve.

See also: SymbCrv2DCurvatureSqr, SymbCrv3DRadiusNormal, SymbCrv3DCurvatureNormal, SymbCrv2DCurvatureSign, SymbCrv2DInflectionPts, SymbCrvExtremCrvtrPts,

11.2.80  SymbCrv3DRadiusNormal  (curvatur.c:232)

CagdCrvStruct *SymbCrv3DRadiusNormal(const CagdCrvStruct *Crv)

Crv: To compute the normal field with radius as magnitude.

Returns: Computed normal field with 1 / k as magnitude.

Description: Computes a vector field curve representing the radius (1/curvature) of a curve, in the normal direction, that is N / k:

\[
N / k = \frac{k N}{2} = \frac{(C \times C) \times C}{|C|} = \frac{((C \times C) \times C) |C|}{2}
\]

See also: SymbCrv2DCurvatureSqr, SymbCrv3DCurvatureSqr, SymbCrv3DCurvatureSign, SymbCrv2DInflectionPts, SymbCrvExtremCrvtrPts, SymbCrv2DUnnormNormal,

11.2.81  SymbCrvAdapOffset  (offset.c:823)

CagdCrvStruct *SymbCrvAdapOffset(const CagdCrvStruct *OrigCrv,
                                    CagdRType OffsetDist,
                                    CagdRType OffsetError,
                                    SymbOffCrvFuncType OffsetAprxFunc,
                                    CagdBType BezInterp)

OrigCrv: To approximate its offset curve with distance OffsetDist.

OffsetDist: Amount of offset. Negative denotes other offset direction.

OffsetError: Tolerance control.

OffsetAprxFunc: A function that can be used to approximate an offset of a curve. If NULL SymbCrvOffset function is selected.

BezInterp: If TRUE, control points are interpolated when the curve is reduced to a Bezier form. Otherwise, control points are translated OffsetDist amount only, under estimating the Offset.

Returns: An approximation to the offset curve, to within OffsetError.

Description: Given a curve and an offset amount OffsetDist, returns an approximation to the offset curve by offsetting the control polygon in the normal direction. This function computes an approximation to the offset using OffsetAprxFunc, measure the error and use it to refine and decrease the error adaptively. Bezier curves are promoted to Bsplines curves. See also: Gershon Elber and Elaine Cohen, "Error Bounded Variable Distance Offset Operator for Free Form Curves and Surfaces". International Journal of Computational Geometry & Applications, Vol. 1, Num. 1, March 1991, pp 67-78.

See also: SymbCrvOffset, SymbCrvSubdivOffset, SymbSrOffset, SymbSrSubdivOffset, SymbCrvAdapOffsetTrim, SymbCrvLeastSquarOffset, SymbCrvMatchingOffset, SymbCrvVarOffset, SymbCrvAdapVarOffset,
11.2.82  SymbCrvAdapOffsetTrim (offset.c:1111)

CagdCrvStruct *SymbCrvAdapOffsetTrim(const CagdCrvStruct *OrigCrv,
CagdRType OffsetDist,
CagdRType OffsetError,
SymOffCrvFuncType OffsetAprxFunc,
CagdBType BezInterp)

OrigCrv: To approximate its offset curve with distance OffsetDist.
OffsetDist: Amount of offset. Negative denotes other offset direction.
OffsetError: Tolerance control.
OffsetAprxFunc: A function that can be used to approximate an offset of a curve. If NULL SymbCrvOffset
function is selected. Third parameter of SymbOffCrvFuncType is optional.
BezInterp: If TRUE, control points are interpolated when the curve is reduced to a Bezier form. Otherwise,
control points are translated OffsetDist amount only, under estimating the Offset.

Returns: An approximation to the offset curve, to within OffsetError.

Description: Same function as CagdCrvAdapOffset, but trims the self intersection loops. See also: Gershon
Elber and Elaine Cohen, "Error Bounded Variable Distance Offset Operator for Free Form Curves and Surfaces".
See also: SymbCrvOffset, SymbCrvSubdivOffset, SymbSrfOffset, SymbSrfSubdivOffset, , SymbCrvAdapOffset,
SymbCrvLeastSquarOffset, SymbCrvMatchingOffset,

11.2.83  SymbCrvAdapVarOffset (offset.c:970)

CagdCrvStruct *SymbCrvAdapVarOffset(const CagdCrvStruct *OrigCrv,
const CagdCrvStruct *VarOffsetDist,
CagdRType OffsetError,
SymVarOffCrvFuncType VarOffsetAprxFunc,
CagdBType BezInterp)

OrigCrv: To approximate its offset curve with distance OffsetDist.
VarOffsetDist: A scalar distance function of the variable offset. Must posses a parametric domain similar to
OrigCrv.
OffsetError: Tolerance control.
VarOffsetAprxFunc: A function that can be used to approximate variable offset of a curve. If NULL Sym-
bCrvVarOffset function is selected.
BezInterp: If TRUE, control points are interpolated when the curve is reduced to a Bezier form. Otherwise,
control points are translated OffsetDist amount only, under estimating the Offset.

Returns: An approximation to the offset curve, to within OffsetError.

Description: Given a curve and a scalar offset function VarOffsetDist, returns an approximation to the variable
offset curve by offseting the control polygon in the normal direction. This function computes an approximation
to the offset using VarOffsetAprxFunc, measure the error and use it to refine and decrease the error adaptively.
Bezier curves are promoted to Bsplines curves. See also: Gershon Elber and Elaine Cohen, "Error Bounded Variable
Distance Offset Operator for Free Form Curves and Surfaces". International Journal of Computational Geometry &
See also: SymbCrvOffset, SymbCrvVarOffset, SymbCrvSubdivOffset, SymbCrvAdapOffset, , SymbSrfOffset,
SymbSrfSubdivOffset, SymbCrvAdapOffsetTrim, , SymbCrvLeastSquarOffset, SymbCrvMatchingOffset,

11.2.84  SymbCrvAdd (symb.crv.c:42)

CagdCrvStruct *SymbCrvAdd(const CagdCrvStruct *Crv1,
const CagdCrvStruct *Crv2)

Crv1, Crv2: Two curve to add up coordinatewise.

Returns: The summation of Crv1 + Crv2 coordinatewise.

Description: Given two curves - add them coordinatewise. The two curves are promoted to same point type
before the multiplication can take place. Furthermore, order and continuity are matched as well.
See also: SymbCrvSub, SymbCrvMult,
11.2.85  SymbCrvArcLen  (arc_len.c:382)

CagdRType SymbCrvArcLen(const CagdCrvStruct *Crv, CagdRType Epsilon)

  Crv: Curve to compute a tight approximation on arc length.
  Epsilon: Accuracy control.
  Returns: The approximated arc length of the given curve Crv.

  Description: Computes a tight approximation to the arc length of a curve. Estimates the arc length scalar field of Crv using SymbCrvArcLenSclrCrv and evaluate the estimate on the curve's domain boundary.

11.2.86  SymbCrvArcLenCrv  (arc_len.c:464)

CagdCrvStruct *SymbCrvArcLenCrv(const CagdCrvStruct *Crv, CagdRType Fineness, int Order)

  Crv: To approximate as an arc length curve.
  Fineness: Tolerance to use is sampling the original curve.
  Order: Order of least square fit curve.
  Returns: A polynomial curve similar to input curve but with almost arc length parametrization.

  Description: Computes an approximated arc length curve from a given curve. Approximation is achieved by least square fitting of points sampled along the curve that are arc length parameterized.

11.2.87  SymbCrvArcLenSclrCrv  (arc_len.c:342)

CagdCrvStruct *SymbCrvArcLenSclrCrv(const CagdCrvStruct *Crv, CagdRType Epsilon)

  Crv: To approximate its arc length scalar field.
  Epsilon: Accuracy of approximating.
  Returns: A scalar field approximating Crv arc length.

  Description: Computes a scalar curve approximating the arc length of given curve Crv. Arc length is estimated by computing the square of Crv's first derivative approximating its square root and integrating symbolically.

11.2.88  SymbCrvArcLenSteps  (arc_len.c:416)

CagdPtStruct *SymbCrvArcLenSteps(const CagdCrvStruct *Crv, CagdRType Length, CagdRType Epsilon)

  Crv: Curve to compute constant arc Length steps.
  Length: The step size.
  Epsilon: Accuracy control.
  Returns: List of parameter values to march along Crv with arc Length between them.

  Description: Computes parameter values to move steps of Length at a time on curve Crv. Returned is a list of parameter values to move along.
11.2.89  SymbCrvBiArcApprox  (biarc.c:62)

SymbArcStruct *SymbCrvBiArcApprox(const CagdCrvStruct *Crv,
                                       CagdRType Tolerance,
                                       CagdRType MaxAngle)

Crv: 2D Curve to approximate using piecewise biarcs.
Tolerance: Of approximation.
MaxAngle: Of an arc in the output set. In no way it will be more than or equal to 180 degrees. In Degrees.
Returns: List of arcs approximating Crv to within Tolerance.

Description: Computes a piecewise biarc approximation to given freeform planar curve. The following steps are performed during this approximation process:
1. The curve is split at all C¹ discontinuities.
2. The curve is split at inflection points, if any.
3. Each convex/concave curve region: a. Fit the curve region with a G¹ continuous biarc that is tangent to the curve's region at the region's end points. b. If fit is good enough, we stop. Otherwise subdivide region into two and recursively invoke step 2 on both halves.

See also: SymbCrv2DInflectionPts, SymbCrvCubicApprox, SymbCrvBiArcApproxC1,

11.2.90  SymbCrvBiArcApproxC1  (biarc.c:190)

SymbArcStruct *SymbCrvBiArcApproxC1(const CagdCrvStruct *CCrv,
                                       CagdRType Tolerance,
                                       CagdRType MaxAngle)

CCrv: 2D Curve to approximate using piecewise biarcs.
Tolerance: Of approximation.
MaxAngle: Of an arc in the output set. In no way it will be more than or equal to 180 degrees. In Degrees.
Returns: List of arcs approximating Crv to within Tolerance.

Description: Computes a piecewise biarc approximation to given C¹ planar curve. The following steps are performed during this approximation process:
1. The curve is split at inflection points, if any.
2. Each convex/concave curve region: a. Fit the curve region with a G¹ continuous biarc that is tangent to the curve's region at the region's end points. b. If fit is good enough, we stop. Otherwise subdivide region into two and recursively invoke step 2 on both halves.

See also: SymbCrvBiArcApprox,

11.2.91  SymbCrvBisectors  (crv_skel.c:91)

CagdCrvStruct *SymbCrvBisectors(const CagdCrvStruct *Crv,
                                  int BisectFunc,
                                  CagdRType SubdivTol,
                                  CagdBType NumerImprove,
                                  CagdBType SameNormal,
                                  CagdBType SupportPrms)

Crv: Either one or two curves to compute bisectors for. Assumes E2 curves.
BisectFunc: If 1, normal fields are used to compute bisector surface. If 2, tangent fields instead of normals are used to compute the bisector surface function. If 3, using solution of normal intersection pt.
SubdivTol: Accuracy of computation. 0.001 is a good start.
NumerImprove: If TRUE, a numerical improvement stage is applied.
SameNormal: If TRUE, the bisector should be oriented for inner or outer side of the curves, with respect to their normals.
Support Prms: If TRUE, return curve is of type E4 instead of E2 and the third and fourth coefficients hold the support parameters of the first and second curves, respectively.

Returns: A list of piecewise linear curves approximating the bisectors of Crv.

Description: Computes the skeleton curves (bisectors) of a given curve or two. If Crv contains a list of two curves the bisector between the two curves is computed. Otherwise, Crv self bisectors are computed. Employs the F1/F2/F34 functions from the paper: Gershon Elber and Myung Soo Kim. “Bisector Curves of Planar Rational Curves.” CAD, Vol 30, No 14, pp 1089-1096, December 1998.

See also: SymbCrvCnvxHull, SymbCrvDiameter, SymbCrvBisectorsSrf,

11.2.92 SymbCrvBisectorsSrf (crv_skel.c:366)

CagdSrfStruct *SymbCrvBisectorsSrf(const CagdCrvStruct *Crv, int BisectFunc)

Crv: Either one or two curves to compute bisectors for. Assumes E2 curves.

BisectFunc: If 1, normal fields are used to compute bisector surface. If 2, tangent fields instead of tangents are used to compute the bisector surface function. If 3, using solution of normal intersection pt.

Returns: A scalar surface whose zero set provides matching bisecting points on Crv, if BisectFunc > 0.

Description: Computes the bisector surface definition of a given curve or two. If Crv contains a list of two curves the bisector between the two curves is computed. Otherwise, Crv self–bisectors are sought. The result is a scalar surface whose zero set is the set of bisector(s) of the curves.

See also: SymbCrvCnvxHull, SymbCrvDiameter, SymbCrvBisectors, SymbCrvBisectorsSrf2, SymbCrvPtBisectorsSr3D, SymbCrvCrvBisectorSr3D,

11.2.93 SymbCrvBisectorsSrf2 (crv_skel.c:545)

CagdSrfStruct *SymbCrvBisectorsSrf2(const CagdCrvStruct *Crv)

Crv: Either one or two curves to compute bisectors for. Assumes E3 curves.

Returns: The real bisector surface for three space curves, if BisectFunc = 4.

Description: Computes the bisector surface definition of a given curve or two. If Crv contains a list of two curves the bisector between the two curves is computed. Otherwise, Crv self–bisectors are sought. The result is a scalar surface whose zero set is the set of bisector(s) of the curves. Solve for the normal intersection surface in the plane and then elevate in Z using the rational function of

\[||P - C1(s)||^2 - ||P - C2(t)||^2.\]

See also: SymbCrvCnvxHull, SymbCrvDiameter, SymbCrvBisectors, SymbCrvBisectorsSrf, SymbCrvPtBisectorsSr3D, SymbCrvCrvBisectorSr3D, SymbCrvBisectorsSr3,

11.2.94 SymbCrvBisectorsSrf3 (crv_skel.c:710)

CagdSrfStruct *SymbCrvBisectorsSrf3(const CagdCrvStruct *Crv)

Crv: Either one or two curves to compute bisectors for. Assumes E2 curves.

Returns: A scalar surface whose zero set provides matching bisecting points on Crv, if BisectFunc = 3.

Description: Computes the bisector surface definition of a given curve or two. If Crv contains a list of two curves the bisector between the two curves is computed. Otherwise, Crv self–bisectors are sought. The result is a scalar surface whose zero set is the set of bisector(s) of the curves. Solve for the normal intersection surface in the plane and then substitute into (the bisector’s correspondance is the zero set then).

\[\frac{C_1(s) + C_2(t)}{2} < P - \text{---------------, } C_1(t) - C_2(s) > = 0.\]

See also: SymbCrvCnvxHull, SymbCrvDiameter, SymbCrvBisectors, SymbCrvBisectorsSrf2, SymbCrvBisectorsSrf, SymbCrvPtBisectorsSr3D, SymbCrvCrvBisectorSr3D,
11.2.95  **SymbCrvCnvxHull** (ccnvhul.c:2475)

\[ \text{CagdCrvStruct} \ast \text{SymbCrvCnvxHull} (\text{const CagdCrvStruct} \ast \text{Crv}, \text{CagdRType SubdivTol}) \]

**Crv:** To compute its convex hull.

**SubdivTol:** Of numeric search for the zero set (for surface subdivision). A positive value (10 is a good start).

**Returns:** A curve representing the convex hull of Crv.

**Description:** Computes the convex hull of a C1 freeform planar curve, in the XY plane. The convex hull is computed by symbolically isolating the non negative set (in t) of:

\[ C'(t) \times (C(r) - C(t)) \geq 0, \text{ for all } r. \]

Note the above equation yields a scalar value since \( C(t) \) is planar. The resulting set in t contains all the sub-domain in \( C(t) \) that is on the convex hull of \( C(t) \). Connecting these pieces with straight lines yields the final convex hull curve.

**See also:** SymbCrvPtTangents, SymbCrvDiameter,

11.2.96  **SymbCrvConstSet** (symbzero.c:263)

\[ \text{CagdPtStruct} \ast \text{SymbCrvConstSet} (\text{const CagdCrvStruct} \ast \text{Crv}, \text{int Axis}, \text{CagdRType Epsilon}, \text{CagdRType ConstVal}, \text{CagdBType NoSolsOnEndPts}) \]

**Crv:** To compute its constant set.

**Axis:** The axis of Crv to compute constant set for, X = 1, Y = 2, etc.

**Epsilon:** Tolerance control.

**ConstVal:** The value at which to compute the constant set.

**NoSolsOnEndPts:** If TRUE, solutions at the end of the domain are purged.

**Returns:** List of parameter values form which Crv has an value of ConstVal in axis Axis.

**Description:** Computes the constant set of a given curve, in the given axis (1-3 for X-Z). Returned is a list of the constant set points holding the parameter values at Pt[0] of each point.

11.2.97  **SymbCrvCrossProd** (symbcrv.c:418)

\[ \text{CagdCrvStruct} \ast \text{SymbCrvCrossProd} (\text{const CagdCrvStruct} \ast \text{CCrv1}, \text{const CagdCrvStruct} \ast \text{CCrv2}) \]

**CCrv1, CCrv2:** Two curve to multiply and compute a cross product for.

**Returns:** A scalar curve representing the cross product of Crv1 x Crv2.

**Description:** Given two curves - computes their cross product. Returned curve is a scalar curve representing the cross product of the two given curves.

**See also:** SymbCrvDotProd, SymbCrvVecDotProd, SymbCrvMult, SymbCrvMultScalar,
11.2.98  SymbCrvCrvBisectOnSphere (smp_skel.c:287)

CagrSrfStruct *SymbCrvCrvBisectOnSphere(const CagrCrvStruct *CCrv1,  
const CagrCrvStruct *CCrv2)

CCrv1, CCrv2: Two curves on the unit sphere.

Returns: The bisector surface bivariate function whose zero set provides the bisector correspondance in the  
parameteric space.

Description: Computes the bisector on a sphere between two curves, both are assumed to be on the unit sphere.  
The end result is a bivariate function NOT a curve on the sphere but rather a rational surface in the (s, t) parameter  
space of Crv1(s) and Crv2(t) whose zero set provides the correspondancing bisector in the parametric space. Let P  
be the bisector point. Then, the following must vanish:

< P, C1(t) > = < P, C2(t) > (Equality of angular distance)  
< P - C1(t), C1'(t) > = 0 (orthogonality of distance measure)  
< P - C2(t), C2'(t) > = 0 (orthogonality of distance measure)

Then the returned result is the determinant of these three equations that must vanish.

See also: SymbPtCrvBisectOnSphere2, SymbPtCrvBisectOnSphere3,

11.2.99  SymbCrvCrvBisectOnSphere2 (smp_skel.c:378)

CagrCrvStruct *SymbCrvCrvBisectOnSphere2(const CagrCrvStruct *Crv1,  
const CagrCrvStruct *Crv2, 
CagrRType SubdivTol)

Crv1, Crv2: Two curves on the unit sphere.

SubdivTol: Accuracy of computation.

Returns: A list of piecewise linear curves approximating the bisectors of Crv1 and Crv2 on the sphere.

Description: Computes the bisector on a sphere between two curves on the sphere. The returned result is a  
piecewise linear curve on the sphere.

See also: SymbPtCrvBisectOnSphere, SymbCrvCrvBisectOnSphere, , SymbCrvCrvBisectOnSphere3,

11.2.100 SymbCrvCrvBisectOnSphere3 (smp_skel.c:557)

CagrSrfStruct *SymbCrvCrvBisectOnSphere3(const CagrCrvStruct *CCrv1,  
const CagrCrvStruct *CCrv2)

CCrv1, CCrv2: Two curves on the unit sphere.

Returns: The bisector surface function.

Description: Computes the bisector of two cone surfaces sharing an apex at the origin represented as their  
generating curves on a unit sphere. Let P be the bisector point. Then, the following must vanish:

< P, C1(t) > = < P, C2(t) > (Equality of angular distance)  
< P - C1(t), C1'(t) > = 0 (orthogonality of distance measure)  
< P - C2(t), C2'(t) > = 0 (orthogonality of distance measure)

Then, the returned is the solution of the above equations.

See also: SymbPtCrvBisectOnSphere, SymbPtCrvBisectOnSphere, , SymbPtCrvBisectOnSphere2,

11.2.101 SymbCrvCrvBisectorSrf3D (crv_skel.c:850)

CagrSrfStruct *SymbCrvCrvBisectorSrf3D(const CagrCrvStruct *CCrv1,  
const CagrCrvStruct *CCrv2, 
CagrRType Alpha)

CCrv1, CCrv2: Two three space curves to compute their bisector surface.

Alpha: Alpha-sector ratio (0.5 for a bisector).

Returns: The bisector surface.

Description: Computes the bisector surface of two curve in arbitrary general three space position.

See also: SymbCrvDiameter, SymbCrvCnvxHull, SymbCrvBisectorsSrf, , SymbCrvPtBisectorSrf3D,
11.2.102 SymbCrvCrvConvolution (moffset.c:116)

CagdCrvStruct *SymbCrvCrvConvolution(CagdCrvStruct *Crv1,
CagdCrvStruct *Crv2,
CagdRType OffsetDist,
CagdRType Tolerance)

Crv1, Crv2: The two curves to convolve.
OffsetDist: Amount of offset, if Crv2 == NULL. Negative value denotes other offset/convolution direction.
Tolerance: Of angular discrepancy that is allowed.
Returns: The offset curve approximation.

Description: Computes the convolution of the given two curves by matching their tangents and reparametrizing
Crv2. If Crv2 is NULL, an Arc of radius OffsetDist is used, resulting in an offset operation of Crv1. Both Crv1 and
Crv2 are assumed to have no inflection points and to span the same angular domain. That is Crv1'(0) || Crv2'(0)
and similarly Crv1'(1) || Crv2'(1), where || denotes parallel.
See also: SymbCrvOffset, SymbCrvSubdivOffset, SymbSrfOffset, SymbSrfSubdivOffset, , SymbCrvAdapOffset,
SymbCrvAdapOffsetTrim, SymbCrvLeastSquarOffset, , SymbCrvMatchingOffset,

11.2.103 SymbCrvCrvInter (distance.c:649)

CagdPtStruct *SymbCrvCrvInter(const CagdCrvStruct *Crv1,
const CagdCrvStruct *Crv2,
CagdRType CCIEpsilon,
CagdBType SelfInter)

Crv1, Crv2: The two curves to intersect.
CCIEpsilon: Tolerance of computation.
SelfInter: If TRUE, needs to handle a curve against itself detecting self intersections in Crv1 (== Crv2).
Returns: List of intersection points. Each point holds the intersection location in Crv1 as first coefficient and
the intersection location in Crv2 as second coefficient.

Description: Computes the intersection points of two planar curves, in the XY plane
See also: SymbSrfDistCrvCrv, SymbSrfDistFindPoints, CagdCrvCrvInter,

11.2.104 SymbCrvCubicApprox (cubcaprx.c:38)

CagdCrvStruct *SymbCrvCubicApprox(const CagdCrvStruct *Crv,
CagdRType Tolerance)

Crv: 2D Curve to approximate using piecewise cubics.
Tolerance: Of approximation, in Hausdorff distance sense.
Returns: List of cubics approximating Crv to within Tolerance. List will be C^1.

Description: Computes a piecewise cubic approximation to given freeform planar curve. The following steps
are performed during this approximation process: a. Fit the curve with a C^1 continuous cubic that is tangent to
the curves’s end points. b. If fit is good enough, we stop. Otherwise subdivide region into two and recursively invoke
step 2 on both halves.
See also: SymbCrvBiArcApprox, SymbApproxCrvAsBzrCubics,

11.2.105 SymbCrvDeterminant2 (crv_skel.c:1731)

CagdCrvStruct *SymbCrvDeterminant2(const CagdCrvStruct *Crv11,
const CagdCrvStruct *Crv12,
const CagdCrvStruct *Crv21,
const CagdCrvStruct *Crv22)

Crv11, Crv12, Crv21, Crv22: The four factors of the determinant.
Returns: A scalar field representing the determinant computation.

Description: Computes the expression of Crv11 * Crv22 - Crv12 * Crv21, which is a determinant of a 2 by 2
matrix.
See also: SymbCrvDeterminant3, SymbSrfDeterminant2,
11.2.106 **SymbCrvDeterminant3** *(crv_skel.c:1688)*

```c
```

Crv11, Crv12, Crv13: The nine factors of the determinant.
Crv21, Crv22, Crv23: 
Crv31, Crv32, Crv33: 

**Returns:** A scalar field representing the determinant computation.

**Description:** Computes the expression of a 3 by 3 determinants.

**See also:** SymbCrvDeterminant2, SymbSrfDeterminant3,

11.2.107 **SymbCrvDiameter** *(ccnvhul.c:164)*

```c
IPPolygonStruct *SymbCrvDiameter(const CagdCrvStruct *Crv, CagdRType SubdivTol)
```

Crv: A curve to process its diameter function.
SubdivTol: Of numeric search for the zero set (for surface subdivision). A positive value (0.01 is a good start).

**Returns:** Contours of the matched parallel lines on Crv. Each vertex will hold two parameter values on Crv.

**Description:** Given a freeform curve, compute its diameter as a function. If the curve is a convex, probably as a result of a convex hull computation of an original curve, the matching will be one to one.

**See also:** SymbCrvCnvxHull, SymbCrvPtTangents, SymbCrvDiameterMinMax,

11.2.108 **SymbCrvDiameterMinMax** *(ccnvhul.c:301)*

```c
CagdRType *SymbCrvDiameterMinMax(const CagdCrvStruct *Crv, IPPolygonStruct *Cntrs, int Min)
```

Crv: To compute its diameter.
Cntrs: Output of SymbCrvDiameter - the matched paraller tangents.
Min: TRUE of minimum diameter, FALSE for maximum diameter.

**Returns:** Two parameter values on Crv of tangent lines extreme value. Returns an address to a statically allocated point.

**Description:** Computes the maximum or minimum diameter out of diameter matched list

**See also:** SymbCrvDiameter,

11.2.109 **SymbCrvDotProd** *(symb_crv.c:237)*

```c
cagdCrvStruct *SymbCrvDotProd(const CagdCrvStruct *Crv1, const CagdCrvStruct *Crv2)
```

Crv1, Crv2: Two curve to multiply and compute a dot product for.

**Returns:** A scalar curve representing the dot product of Crv1 . Crv2.

**Description:** Given two curves - computes their dot product. Returned curve is a scalar curve representing the dot product of the two given curves.

**See also:** SymbCrvScalarScale, SymbCrvVecDotProd, SymbCrvMult, SymbCrvMultScalar,
11.2.110  **SymbCrvDual** (duality.c:31)

CagdCrvStruct *SymbCrvDual(const CagdCrvStruct *Crv)

*Crv:* The curve to compute its dual.

**Returns:** The dual curve.

**Description:** Computes the dual of the given curve. The dual curve is a mapping of the tangent lines of *Crv* (for which *Crv* is the envelop of) to points in the dual space. Duality is derived by computing the tangent line "Ax + By + C = 0" to curve *Crv* and mapping this line to homogeneous point (A/C, B/C).

See also: SymbSrfDual,

11.2.111  **SymbCrvEnclosedArea** (symb_crv.c:803)

CagdCrvStruct *SymbCrvEnclosedArea(const CagdCrvStruct *Crv)

*Crv:* A curve to compute area field curve for.

**Returns:** The area field curve.

**Description:** Given a planar curve, compute its enclosed area field curve. This has little meaning unless *Crv* is closed, in which by evaluation the resulting area field curve at the end points, the area enclosed by *Crv* can be computed.

See also: SymbCrvEnclosedAreaEval,

11.2.112  **SymbCrvEnclosedAreaEval** (symb_crv.c:874)

CagdRType SymbCrvEnclosedAreaEval(const CagdCrvStruct *Crv)

*Crv:* A curve to compute area for.

**Returns:** The area.

**Description:** Given a planar curve, compute its enclosed area.

See also: SymbCrvEnclosedArea,

11.2.113  **SymbCrvExtremCrvtrPts** (curvatur.c:671)

CagdPtStruct *SymbCrvExtremCrvtrPts(const CagdCrvStruct *Crv, CagdRType Epsilon)

*Crv:* To find all int extrem curvature locations.

**Epsilon:** Accuracy control.

**Returns:** A list of parameter values on *Crv* that have extrem curvature values. An int attribute named "ExtremType" is placed on each parameter value with a value of -1, 0, or 1 for minimum curvature location, zero curvature location and maximum curvature location, respectively.

**Description:** Given a planar curve, finds all its extreme curvature points by finding the set of extreme locations on the curvature function of *Crv*. Extreme curvature is computed as the zeros of <(kN)'kN> = k'k.

See also: SymbCrv2DCurvatureSqr, SymbCrv3DCurvatureSqr, SymbCrv3DCurvatureSqr,, SymbCrv3DRadiusNormal, SymbCrv3DCurvatureNormal, SymbCrv2DCurvatureSign, , SymbCrv2DInflectionPts,
11.2.114  SymbCrvExtremSet  (symbzero.c:139)

CagdPtStruct *SymbCrvExtremSet(const CagdCrvStruct *Crv,
   int Axis,
   CagdRType Epsilon,
   CagdBType NoSolsOnEndPts)

Crv: To compute its extrema set.
Axis: The axis of Crv to compute extrema set for, W = 0, X = 1, etc.
Epsilon: Tolerance control.
NoSolsOnEndPts: If TRUE, solutions at the end of the domain are purged.
Returns: List of parameter values form which Crv has an extrema value in axis Axis.

Description: Computes the extrema set of a given curve, in given axis (0/1-3 for W/X-Z). Returned is a list of
the extreme set points holding the parameter values at Pt[0] of each point. One could compute the derivative of
the curve and find its zero set. However, for rational curves, this will double the degree and slow down the computation
considerably.

11.2.115  SymbCrvGenSignedCrvtr  (crvtrrec.c:37)

CagdCrvStruct *SymbCrvGenSignedCrvtr(const CagdCrvStruct *CCrv,
   int Samples,
   int Order,
   int ArcLen)

CCrv: Curve to compute signed curvature signature approximation for.
Samples: Number of samples to use in the approximation.
Order: Order of signed curvature approximating curve.
ArcLen: TRUE if Crv is to be assumed arc-length, FALSE if needs to compensate for a non arc-length
parametrization.
Returns: Scalar polynomial curve of length Samples and of order Order that represents the signed curvature
field of Crv.

Description: Computes a signed curvature signature scalar curve to the given planar curve. The returned
signature is parameterized by the curve’s arc-length even if the original curve is not arc length, if ArcLen is TRUE.
See also: SymbSignedCrvtrGenCrv, SymbCrv3DCurvatureNormal, SymbCrv2DCurvatureSign,

11.2.116  SymbCrvInvert  (symb_crv.c:145)

CagdCrvStruct *SymbCrvInvert(const CagdCrvStruct *Crv)

Crv: A scalar curve to compute a reciprocal value for.
Returns: A rational scalar curve that is equal to the reciprocal value of Crv.

Description: Given a scalar curve, returns a scalar curve representing the reciprocal values, by making it rational
(if was not one) and flipping the numerator and the denominator.
See also: SymbCrvDotProd, SymbCrvVecDotProd, SymbCrvMult, SymbCrvMultScalar,

11.2.117  SymbCrvLeastSquarOffset  (offset.c:1286)

CagdCrvStruct *SymbCrvLeastSquarOffset(const CagdCrvStruct *Crv,
   CagdRType OffsetDist,
   int NumOfSamples,
   int NumOfDOF,
   int Order,
   CagdRType *Tolerance)
Crv: To approximate its offset curve with distance OffsetDist.

OffsetDist: Amount of offset. Negative denotes other offset direction.

NumOfSamples: Number of samples to sample the offset curve at.

NumOfDOF: Number of degrees of freedom on the newly computed offset approximation. This is the same as the number of control points the new curve will have.

Order: Of the newly constructed offset approximation. If equal to zero, the order of Crv will be used.

Tolerance: To return an error estimate in the L-infinity norm.

Returns: An approximation to the offset curve.

Description: Given a curve and an offset amount OffsetDist, returns an approximation to the offset curve by least square fitting a curve to samples taken on the offset curve. Resulting curve of order Order (degree of Crv if Order == 0) will have NumOfDOF control points that least square fit NumOfSamples samples on the offset curve. Tolerance will be updated to hold an error distance measure.

See also: SymbCrvOffset, SymbCrvSubdivOffset, SymbSrfOffset, SymbSrfSubdivOffset, , SymbCrvAdapOffset, SymbCrvAdapOffsetTrim, SymbCrvMatchingOffset,

11.2.118 SymbCrvListCnvxHull (ccnvhlul.c:2443)

CagdCrvStruct *SymbCrvListCnvxHull(CagdCrvStruct *Crvs, CagdRType SubdivTol)

Crvs: To compute their convex hull.

SubdivTol: Of numeric search for the zero set (for surface subdivision). A positive value (0.01 is a good start).

Returns: A curve representing the convex hull of Crvs.

Description: Computes the convex hull of C1 freeform planar curves, in the XY plane. The convex hull is computed by symbolically isolating the non negative set (in t) of:

\[ C'(t) \times (C(r) - C(t)) \geq 0, \quad \text{for all } r. \]

Note the above equation yields a scalar value since C(t) is planar. The resulting set in t contains all the subdomain in C(t) that is on the convex hull of C(t). Connecting these pieces with straight lines yields the final convex hull curve.

See also: SymbCrvPtTangents, SymbCrvDiameter,

11.2.119 SymbCrvMatchingOffset (moffset.c:50)

CagdCrvStruct *SymbCrvMatchingOffset(CagdCrvStruct *Crv, CagdRType OffsetDist, CagdRType Tolerance)

Crv: To approximate its offset curve with distance OffsetDist.

OffsetDist: Amount of offset. Negative denotes other offset direction.

Tolerance: Of angular discrepancy that is allowed.

Returns: The offset curve approximation.

Description: Computes an offset to a freeform curve using matching of tangent fields. The given curve is split at all its inflection points, made sure it spans less than 90 degrees, and then is matched against an arc of the proper angular span of tangents. Unlike other offset methods, this method always preserves the distance between the original curve ans its offset. The error in this methods can surface only in the non orthogonality of the offset direction.

See also: SymbCrvOffset, SymbCrvSubdivOffset, SymbSrfOffset, SymbSrfSubdivOffset, , SymbCrvAdapOffset, SymbCrvAdapOffsetTrim, SymbCrvLeastSquarOffset, , SymbCrvCrvConvolution,
11.2.120 SymbCrvMergeScalar (symb\_crv.c:1211)

CagdCrvStruct *SymbCrvMergeScalar(const CagdCrvStruct *CrvW, 
const CagdCrvStruct *CrvX, 
const CagdCrvStruct *CrvY, 
const CagdCrvStruct *CrvZ)

CrvW: The weight component of new constructed curve, if have any.
CrvX: The X component of new constructed curve.
CrvY: The Y component of new constructed curve, if have any.
CrvZ: The Z component of new constructed curve, if have any.

Returns: A new curve constructed from given scalar curves.

**Description:** Given a set of scalar curves, treat them as coordinates into a new curve. Assumes at least CrvX is not NULL in which a scalar curve is returned. Assumes CrvX/Y/Z/W are either E1 or P1 in which the weights are assumed to be identical and can be ignored if CrvW exists or copied otherwise.

**See also:** SymbSrfMergeScalar, SymbCrvSplitScalar,

11.2.121 SymbCrvMergeScalarN (symb\_crv.c:1131)

CagdCrvStruct *SymbCrvMergeScalarN(const CagdCrvStruct *CrvW, 
const CagdCrvStruct **CrvVec, 
int NumCrvs)

CrvW: The weight component of new constructed curve, if exist, NULL if none.
CrvVec: A vector of scalar curves.
NumCrvs: Number of curves in CrvVec.

Returns: A new curve constructed from given scalar curves.

**Description:** Given a vector of scalar curves, treat them as coordinates into a new vector curve. Assumes at least CrvVec is not NULL in which a scalar curve is returned. Assumes CrvVec[i]/CrvW are either E1 or P1 in which the weights are assumed to be identical and can be ignored if CrvW exists and copied.

**See also:** SymbSrfMergeScalar, SymbCrvSplitScalarN,

11.2.122 SymbCrvMonotoneCtlPt (composit.c:63)

int SymbCrvMonotoneCtlPt(const CagdCrvStruct *Crv, int Axis)

Crv: Curve to examine the the monotonicity in axis Axis.
Axis: The axis of Crv to examine the monotonicity for.

Returns: 0 if not monotone, +1/-1 for increasing/decreasing monotone.

**Description:** A function to examine if the given curve has a monotone control polygon in the prescribed axis.

**See also:** SymbCrvPosNegWeights,

11.2.123 SymbCrvMult (symb\_crv.c:107)

CagdCrvStruct *SymbCrvMult(const CagdCrvStruct *Crv1, 
const CagdCrvStruct *Crv2)

Crv1, Crv2: Two curve to multiply coordinatewise.

Returns: The product of Crv1 * Crv2 coordinatewise.

**Description:** Given two curves - multiply them coordinatewise. The two curves are promoted to same point type before the multiplication can take place.

**See also:** SymbCrvDotProd, SymbCrvVecDotProd, SymbCrvInvert, SymbCrvMultScalar,
11.2.124 SymbCrvMultScalar (symb_crv.c:349)

CagdCrvStruct *SymbCrvMultScalar(const CagdCrvStruct *Crv1, 
const CagdCrvStruct *Crv2)

Crv1, Crv2: Two curve to multiply.

Returns: A curve representing the product of Crv1 and Crv2.

Description: Given two curves - a vector curve Crv1 and a scalar curve Crv2, multiply all Crv1's coordinates 
by the scalar curve Crv2. Returned curve is a curve representing the product of the two given curves.
See also: SymbCrvDotProd, SymbCrvVecDotProd, SymbCrvMult, SymbCrvCrossProd, SymbSrfMultScalar,

11.2.125 SymbCrvMultiResBWavelet (multires.c:801)

CagdCrvStruct *SymbCrvMultiResBWavelet(CagdRType *KV, 
int Order, 
int Len, 
int KnotIndex)

KV: Knot sequence of the space.
Order: Order of space.
Len: Length of knot sequence.
KnotIndex: Index of knot to compute the wavelet for.

Returns: A scalar curve representing the wavelet.

Description: Constructs the B-Wavelet of knot KV[KnotIndex] for the given knot sequence KV and order Order.
See also: SymbBspBasisInnerProd,

11.2.126 SymbCrvMultiResCompos (multires.c:510)

CagdCrvStruct *SymbCrvMultiResCompos(const SymbMultiResCrvStruct *MRCrv)

MRCrv: A multi resolution decomposition of a curve.

Returns: A curve that adds up all components of the multi resolution decomposition MRCrv.

Description: Given a multi resolution decomposition of a Bspline curve, computes the regular Bspline curve out 
of it.

11.2.127 SymbCrvMultiResComposAtT (multires.c:539)

CagdCrvStruct *SymbCrvMultiResComposAtT(const SymbMultiResCrvStruct *MRCrv, 
CagdRType T)

MRCrv: A multi resolution decomposition of a curve.
T: A multi resolution hierarchy level to compute curve for.

Returns: A curve that adds up all components of the multi resolution decomposition MRCrv up to and 
including level T.

Description: Given a multiresolution decomposition of a Bspline curve, computes a regular Bspline curve out of 
it representing the decomposed curve at the multi resolution hierarchy level of T. Although decomposition is discrete, 
T can be any real number between these discrete levels and a linear interpolation of adjacent levels is exploited.
11.2.128  **SymbCrvMultiResCopy** (multires.c:1068)

SymbMultiResCrvStruct *SymbCrvMultiResCopy(const SymbMultiResCrvStruct *MRCrvOrig)

**MRCrvOrig:** A multi resolution decomposition of a curve to copy.

**Returns:** A duplicated structure of MRCrv.

**Description:** Given a multi resolution decomposition of a B spline curve, copy it.

11.2.129  **SymbCrvMultiResDecomp** (multires.c:180)

SymbMultiResCrvStruct *SymbCrvMultiResDecomp(const CagdCrvStruct *Crv, int Discont)

**Crv:** To compute a least square multi resolution decomposition for.

**Discont:** Do we want to preserve discontinuities?

**Returns:** A multi resolution curve structure hold the multi resolution decomposition of Crv.

**Description:** Given a B spline curve, computes a hierarch of B spline curves, each being represented using a subspace of the previous, upto a curve with no interior knots (i.e. a polynomial Bezier). However, if Discont == TRUE, then C1 discontinuities are preserved through out the hierarchy decomposition. Each level in hierarchy has approximately half the number of control points of the previous one. Least square curve fitting is used to build the hierarchy.

**See also:** SymbCrvMultiResDecomp2

11.2.130  **SymbCrvMultiResDecomp2** (multires.c:315)

SymbMultiResCrvStruct *SymbCrvMultiResDecomp2(const CagdCrvStruct *Crv, int Discont, int SameSpace)

**Crv:** To compute a B-Wavelet decomposition for.

**Discont:** Do we want to preserve discontinuities?

**SameSpace:** If this curve is in the same space as last curve, exploit this in optimizing the computation cost.

**Returns:** A B-Wavelet decomposition structure hold the multi resolution decomposition of Crv.

**Description:** Given a B spline curve, computes a hierarch of B spline curves, each being represented using a subspace of the previous, upto a curve with no interior knots (i.e. a polynomial Bezier). However, if Discont == TRUE, then C1 discontinuities are preserved through out the hierarchy decomposition. Each level in hierarchy has approximately half the number of control points of the previous one. B-Wavelet decomposition is used to build the hierarchy. See R. Kazinnik and G. Elber, "Orthogonal Decomposition of Non Uniform Bspline Spaces using Wavelets", Eurographics 1997.

**See also:** SymbCrvMultiResDecomp

11.2.131  **SymbCrvMultiResEdit** (multires.c:597)

void SymbCrvMultiResEdit(const SymbMultiResCrvStruct *MRCrv, CagdRType t, const CagdVType TransDir, CagdRType Level, CagdRType FracLevel)

**MRCrv:** A multi resolution decomposition of a curve to edit it in place.

**t:** Parameter value at which to modify MRCrv.

**TransDir:** Directional translation transformation to apply.

**Level:** Of multi resolution hierarchy to edit.

**FracLevel:** The fraction level to edit - will blend two neighboring levels.

**Returns:** void

**Description:** Given a multi resolution decomposition of a B spline curve, edit it by modifying its Level' th Level according to the TransDir of Position at parametr t. Level can be a fraction number between the discrete levels of the decomposition denoting a linear blend of two neighboring discrete levels. Editing is performed in place.
### 11.2.132 SymbCrvMultiResFree (multires.c:1006)

```c
void SymbCrvMultiResFree(SymbMultiResCrvStruct *MRCrv)

MRCrv: A multi resolution decomposition of a curve to free.

Returns: void

Description: Given a multi resolution decomposition of a Bspline curve, free it.
```

### 11.2.133 SymbCrvMultiResKVBuild (multires.c:42)

```c
int SymbCrvMultiResKVBuild(const CagdCrvStruct *Crv, int Discont, CagdRType ***KVList, int **KVListSizes, int *KVListSize)

Crv: Curve to construct a hierarchy of knot sequences.

Discont: Should we preserve discontinuities as much as we can?

KVList: A vector of pointers to knot sequences in the hierarchy

KVListSizes: Length of each knot sequence in vector KVList.

KVListSize: Size of KVList - number of knot sequences in hierarch.

Returns: TRUE if successful, FALSE otherwise.

Description: Constructs a hierarch of knot sequence for the given Bspline curve and until no interior knot exists in the knot sequence.

See also: SymbCrvMultiResDecomp, SymbCrvMultiResDecomp2.
```

### 11.2.134 SymbCrvMultiResNew (multires.c:1036)

```c
SymbMultiResCrvStruct *SymbCrvMultiResNew(int Levels, CagdBType Periodic)

Levels: Number of levels to expect in the decomposition.

Periodic: Is the curve periodic?

Returns: A structure to hold a multi resolution decomposition of a curve of Levels levels.

Description: Allocates a data structure for multi resolution decomposition of a Bspline curve of Levels levels and possiblt periodic.
```

### 11.2.135 SymbCrvMultiResRefineLevel (multires.c:703)

```c
CagdRType *SymbCrvMultiResRefineLevel(SymbMultiResCrvStruct *MRCrv, CagdRType T, int SpanDiscont)

MRCrv: A multi resolution decomposition of a curve, to refine in place.

T: Parameter value at which to refine MRCrv.

SpanDiscont: Do we want to refine beyond discontinuities?

Returns: A pointer to an array of two real numbers holding the domain in MRCrv that was refined.

Description: Given a multi resolution decomposition of a Bspline curve, refine it at neighborhood of parameter value t, in place.
11.2.136  **SymbCrvOffset** (offset.c:68)

CagdCrvStruct *SymbCrvOffset(const CagdCrvStruct *CCrv,
                           CagdRType OffsetDist,
                           CagdBType BezInterp)

**CCrv:** To approximate its offset curve with distance OffsetDist.

**OffsetDist:** Amount of offset. Negative denotes other offset direction.

**BezInterp:** If TRUE, control points are interpolated when the curve is reduced to a Bezier form. Otherwise, control points are translated OffsetDist amount only, under estimating the Offset.

**Returns:** An approximation to the offset curve.

**Description:** Given a curve and an offset amount OffsetDist, returns an approximation to the offset curve by offseting the control polygon in the normal direction.

**See also:** SymbCrvSubdivOffset, SymbSrfOffset, SymbSrfSubdivOffset, SymbCrvAdapOffset, SymbCrvAdapOffsetTrim, SymbCrvLeastSquarOffset, SymbCrvMatchingOffset, SymbCrvVarOffset.

11.2.137  **SymbCrvOrthotomic** (orthotom.c:37)

CagdCrvStruct *SymbCrvOrthotomic(const CagdCrvStruct *Crv,
                                  const CagdPType P,
                                  CagdRType K)

**Crv:** To compute its K-orthotomic

**P:** The points to which the K-orthotomic is computed for Crv for.

**K:** The magnitude of the orthotomic function.

**Returns:** The K-orthotomic

**Description:** Computes the K-orthotomic of a curve with respect to point P:

\[ P + K < (C(t) - P), \quad N(t) > N(t) \]


**See also:** SymbSrfOrthotomic.

11.2.138  **SymbCrvPointInclusion** (distance.c:331)

int SymbCrvPointInclusion(const CagdCrvStruct *CCrv,
                            const CagdPType Pt,
                            CagdRType Epsilon)

**CCrv:** Closed planar curve to examine for the inclusion of Pt.

**Pt:** Point tp test for inclusion in Crv.

**Epsilon:** Accuracy of computation.

**Returns:** 1 if Pt inside Crv, -1 otherwise, 0 if on boundary to within Epsilon.

**Description:** Given a closed planar curve and a point, finds if point is inside curve. Uses winding number accumulation in the computation.

**See also:** SymbCrvPointInclusion, SymbDistCrvLine, SymbCrvRayInter.

11.2.139  **SymbCrvPosNegWeights** (symbzero.c:372)

CagdBType SymbCrvPosNegWeights(const CagdCrvStruct *Crv)

**Crv:** To examine for same sign weights, if any.

**Returns:** TRUE if no weights or all of same sign.

**Description:** Returns TRUE iff the Crv is not rational or rational with weights that are entirely positive or entirely negative.
11.2.140  SymbCrvPtBisectorCrv2D  (crv_skel.c:1175)

CagdCrvStruct *SymbCrvPtBisectorCrv2D(const CagdCrvStruct *CCrv,
const CagdPType Pt,
CagdRType Alpha)

CCrv: Planar curve to compute its bisector curve with Pt.
Pt: A point in the plane to compute its bisector with Crv.
Alpha: Alpha-sector ratio (0.5 for a bisector).
Returns: The bisector curve, in the XY plane.

Description: Computes the alpha-/bi-sector curve of a planar curve a point, all in the XY plane. The result is the solution to the following two linear equations in alpha-/bi-sector’s two unknowns, the x and y coefficients:

\[
\begin{align*}
& \langle \mathbf{C}'(t), \mathbf{B}(t) \rangle = \langle \mathbf{C}'(t), \mathbf{C}(t) \rangle \\
& \langle \mathbf{C}(t) - \mathbf{Pt}, \mathbf{B}(t) \rangle = \langle \mathbf{C}(t) - \mathbf{Pt}, a \mathbf{Pt} + (1 - a) \mathbf{C}(t) \rangle
\end{align*}
\]

where a is the Alpha of the alpha-sector, 0.5 for a bisector, Pt is the point entity, C(t) is the curve entity and B(t) is the sought bisector.

See also: SymbCrvDiameter, SymbCrvCnvxHull, SymbCrvBisectorsSrf, , SymbCrvCrvBisectorSrf3D, SymbSrfPtBisectorSrf3D, SymbCrvPtBisectorSrf3D

11.2.141  SymbCrvPtBisectorSrf3D  (crv_skel.c:1319)

CagdSrfStruct *SymbCrvPtBisectorSrf3D(const CagdCrvStruct *CCrv,
const CagdPType Pt,
CagdRType RulingScale)

CCrv: Three space curve to compute its bisector surface with Pt.
Pt: A point in three space to compute its bisector with Crv.
RulingScale: The scaling factor for the ruling direction.
Returns: The bisector surface.

Description: Computes the bisector surface of a curve in arbitrary general three space position and a point in three space.

See also: SymbCrvDiameter, SymbCrvCnvxHull, SymbCrvBisectorsSrf, , SymbCrvCrvBisectorSrf3D, SymbSrfPtBisectorSrf3D, SymbCrvPtBisectorSrf3D

11.2.142  SymbCrvPtTangents  (crv_tans.c:48)

CagdPtStruct *SymbCrvPtTangents(const CagdCrvStruct *CCrv,
const CagdPType Pt,
CagdRType Tolerance)

CCrv: To compute its tangent lines through Pt.
Pt: Point of origin, all tangents to Crv goes through.
Tolerance: Accuracy of computation.
Returns: A list of parameter location on Crv with tangent lines through Pt. Parameters are save in the X coordinate.

Description: Computes the points on a C1 freeform planar Bspline curve, Crv, that a line tangent to Crv there goes through point Pt. That is,

\[ (\mathbf{C}(t) - \mathbf{P}) \parallel \mathbf{C}'(t), \]

where \( \parallel \) denotes a parallel constraint.

See also: SymbCrvCnvxHull, SymbCircTanTo2Crvs, SymbTangentToCrvAtTwoPts, , mbCrvDiameter,
11.2.143 **SymbCrvRayInter** (distance.c:434)

```c
CagdPtStruct *SymbCrvRayInter(const CagdCrvStruct *Crv,
    const CagdPType RayPt,
    const CagdVType RayDir,
    CagdRType Epsilon)
```

**Crv:** The curve to find its intersections with the ray.

**RayPt, RayDir:** The ray prescription.

**Epsilon:** Accuracy of computation.

**Returns:** A list of parameter values of the ray-curve intersections.

**Description:** Given a curve and a ray, finds the intersection points on the curve where the ray pierces the curve. Returned is a list of parameter values with local extreme distances. Let Crv be \((x(t), y(t))\). By substituting \(x(t)\) and \(y(t)\) into the line equation of the ray, we derive the distance function whose zero set captures all curve-line intersections. They are then filtered to those on the half-line ray.

**See also:** SymbDistCrvLine, MvarDistSrfLine, SymbLclDistCrvLine,

11.2.144 **SymbCrvRtnlMult** (symb.crv.c:645)

```c
CagdCrvStruct *SymbCrvRtnlMult(const CagdCrvStruct *Crv1X,
    const CagdCrvStruct *Crv1W,
    const CagdCrvStruct *Crv2X,
    const CagdCrvStruct *Crv2W,
    CagdBType OperationAdd)
```

**Crv1X:** Numerator of first curve.

**Crv1W:** Denominator of first curve. Can be NULL.

**Crv2X:** Numerator of second curve.

**Crv2W:** Denominator of second curve. Can be NULL.

**OperationAdd:** TRUE for addition, FALSE for subtraction.

**Returns:** The result of \(\text{Crv1X} \text{Crv2W} \pm \text{Crv2X} \text{Crv1W}\).

**Description:** Given two curves - multiply them using the quotient product rule:

\[
X = \frac{X1 \ W2}{\pm \ X2 \ W1}
\]

All provided curves are assumed to be non rational scalar curves. Returned is a non rational scalar curve (CAGD_PT_E1_TYPE).

**See also:** SymbCrvDotProd, SymbCrvVecDotProd, SymbCrvMult, SymbCrvMultScalar,

11.2.145 **SymbCrvScalarScale** (symb.crv.c:203)

```c
CagdCrvStruct *SymbCrvScalarScale(const CagdCrvStruct *Crv, CagdRType Scale)
```

**Crv:** A curve to scale by magnitude Scale.

**Scale:** Scaling factor.

**Returns:** A curves scaled by Scale compared to Crv.

**Description:** Given a curve, scale it by Scale.

**See also:** SymbCrvDotProd, SymbCrvVecDotProd, SymbCrvMult, SymbCrvMultScalar,

11.2.146 **SymbCrvSplitPoleParams** (symbzero.c:482)

```c
CagdCrvStruct *SymbCrvSplitPoleParams(const CagdCrvStruct *CCrv,
    CagdRType Eps,
    CagdRType OutReach)
```

**CCrv:** Rational curve to split at all its poles.

**Eps:** Tolerance of computation.

**OutReach:** Clip end points of curves that goes to infinity at distance that is about OutReach from the origin.

**Returns:** List of splitted curves.

**Description:** Splits the given rational curve at all its poles. Returned is a list of curves each of which has weights of the same (positive) sign.

**See also:** CagdPointsHasPoles, SymbCrvsSplitPoleParams,
11.2.147  SymbCrvSplitScalar  (symb\_crv.c:1074)

```c
void SymbCrvSplitScalar(const CagdCrvStruct *Crv,
            CagdCrvStruct **CrvW,
            CagdCrvStruct **CrvX,
            CagdCrvStruct **CrvY,
            CagdCrvStruct **CrvZ)
```

Crv: Curve to split.
CrvW: The weight component of Crv, if have any.
CrvX: The X component of Crv.
CrvY: The Y component of Crv, if have any.
CrvZ: The Z component of Crv, if have any.

Returns: void

Description: Given a curve splits it to its scalar component curves. Ignores all dimensions beyond the third, Z, dimension.
See also: SymbSrfSplitScalar, SymbCrvMergeScalar,

11.2.148  SymbCrvSplitScalarN  (symb\_crv.c:1020)

```c
CagdCrvStruct **SymbCrvSplitScalarN(const CagdCrvStruct *Crv)
```

Crv: Curve to split.

Returns: A vector of scalar curves - components of Crv.

Description: Given a curve, splits it to its scalar component curves.
See also: SymbSrfSplitScalar, SymbCrvMergeScalarN,

11.2.149  SymbCrvSqrtScalar  (arc\_len.c:173)

```c
CagdCrvStruct *SymbCrvSqrtScalar(const CagdCrvStruct *OrigCrv,
                               CagdRType Epsilon)
```

OrigCrv: Scalar curve to approximate its square root function.
Epsilon: Accuracy of approximation.

Returns: A curve approximating the square root of OrigCrv.

Description: Computes the curve which is a square root approximation to a given scalar curve, to within epsilon.

11.2.150  SymbCrvSub  (symb\_crv.c:74)

```c
CagdCrvStruct *SymbCrvSub(const CagdCrvStruct *Crv1, const CagdCrvStruct *Crv2)
```

Crv1, Crv2: Two curve to subtract coordinatewise.

Returns: The difference of Crv1 - Crv2 coordinatewise.

Description: Given two curves - subtract them coordinatewise. The two curves are promoted to same point type before the multiplication can take place. Furthermore, order and continuity are matched as well.
See also: SymbCrvAdd, SymbCrvMult,
**11.2.151 SymbCrvSubdivOffset** (offset.c:405)

```c
CagdCrvStruct *SymbCrvSubdivOffset(const CagdCrvStruct *CCrv,
    CagdRType OffsetDist,
    CagdRType Tolerance,
    CagdBType BezInterp)
```

**CCrv:** To approximate its offset curve with distance OffsetDist.

**OffsetDist:** Amount of offset. Negative denotes other offset direction.

**Tolerance:** Accuracy control.

**BezInterp:** If TRUE, control points are interpolated when the curve is reduced to a Bezier form. Otherwise, control points are translated OffsetDist amount only, under estimating the Offset.

**Returns:** An approximation to the offset curve, to within Tolerance.

**Description:** Given a curve and an offset amount OffsetDist, returns an approximation to the offset curve by offsetting the control polygon in the normal direction. If resulting offset is not satisfying the required tolerance the curve is subdivided and the algorithm recurses on both parts.

**See also:** SymbCrvOffset, SymbSrfOffset, SymbSrfSubdivOffset, SymbCrvAdapOffset, , SymbCrvAdapOffset-Trim, SymbCrvLeastSquarOffset, SymbCrvMatchingOffset,

**11.2.152 SymbCrvTrimGlblOffsetSelfInter** (offset.c:1373)

```c
CagdCrvStruct *SymbCrvTrimGlblOffsetSelfInter(const CagdCrvStruct *Crv,
    const CagdCrvStruct *OffCrv,
    CagdRType SubdivTol,
    CagdRType TrimAmount,
    CagdRType NumerTol)
```

**Crv:** Original curve.

**OffCrv:** The offset curve approximation.

**SubdivTol:** Accuracy of computation. 0.001 will be a good start.

**TrimAmount:** The trimming distance. A fraction smaller than the offset amount.

**NumerTol:** If Positive, a numerical marching improvement step is applied with NumerTol tolerance to the derived intersection/clipped regions.

**Returns:** A list of curve segments that are valid, after the trimming process took place.

**Description:** Trims regions in the offset curve OffCrv that are closer than TrimAmount to original Crv. TrimAmount should be a fraction smaller than the offset amount itself. See all: Gershon Elber. “Trimming Local and Global Self-intersections in Offset Curves using Distance Maps.” The 10th IMA conference on the Mathematics of Surfaces, Leeds, UK, pp 213-222, September 2003, LLCS2768.

**See also:** MvarCrvTrimGlblOffsetSelfInter,

**11.2.153 SymbCrvUnitLenCtlPts** (arc_len.c:577)

```c
CagdCrvStruct *SymbCrvUnitLenCtlPts(const CagdCrvStruct *CCrv)
```

**CCrv:** Curve to approximate a unit magnitude for.

**Returns:** Similar curve of Crv, but with unit length control points.

**Description:** Normalizes all the control points of the given (vector field) curve. This results in an approximated unit speed vector field.

**See also:** SymbCrvUnitLenScalar,
11.2.154  **SymbCrvUnitLenScalar** (arc_len.c:40)

    CagdCrvStruct *SymbCrvUnitLenScalar(const CagdCrvStruct *OrigCrv,
    CagdBType Mult,
    CagdRType Epsilon)

**OrigCrv:** Curve to approximate a unit size for.  
**Mult:** Do we want to multiply the computed scalar curve with Crv?  
**Epsilon:** Accuracy required of this approximation.  
**Returns:** A scalar curve to multiply OrigCrv so a unit size curve will result if Mult is FALSE, or the actual unit size vector field curve, if Mult.  
**Description:** Normalizes the given vector field curve to be a unit length curve, by computing a scalar curve to multiply with this vector field curve. Returns the multiplied curve if Mult, or otherwise just the scalar curve.  
**See also:** SymbCrvUnitLenCtlPts,

11.2.155  **SymbCrvVarOffset** (offset.c:239)

    CagdCrvStruct *SymbCrvVarOffset(const CagdCrvStruct *CCrv,
    const CagdCrvStruct *VarOffsetDist,
    CagdBType BezInterp)

**CCrv:** To approximate its variable offset curve.  
**VarOffsetDist:** Scalar function prescribing the amount of offset. Must posses a parametric domain similar to Crv.  
**BezInterp:** If TRUE, control points are interpolated when the curve is reduced to a Bezier form. Otherwise, control points are translated OffsetDist amount only, under estimating the Offset.  
**Returns:** An approximation to the varying offset amount curve.  
**Description:** Given a curve and an offset amount function Var OffsetDist, returns an approximation to the offset curve by offsetting the control polygon in the normal direction.  
**See also:** SymbCrvSubdivOffset, SymbSrfOffset, SymbSrfSubdivOffset, , SymbCrvAdapOffset, SymbCrvAdapOffsetTrim, SymbCrvLeastSquarOffset, , SymbCrvMatchingOffset, SymbCrvOffset,

11.2.156  **SymbCrvVecCrossProd** (symb_crv.c:531)

    CagdCrvStruct *SymbCrvVecCrossProd(const CagdCrvStruct *Crv,
    const CagdVType Vec)

**Crv:** Curve to multiply and compute a cross product for.  
**Vec:** Vector to cross product Crv with.  
**Returns:** A vector curve representing the cross product of Crv x Vec.  
**Description:** Given a curve and a vector - computes their cross product. Returned curve is a scalar curve representing the cross product of the curve and vector.  
**See also:** SymbCrvDotProd, SymbCrvVecDotProd, SymbCrvScalarScale, SymbCrvMultScalar, , SymbCrvInvert, SymbCrvCrossProd,

11.2.157  **SymbCrvVecDotProd** (symb_crv.c:287)

    CagdCrvStruct *SymbCrvVecDotProd(const CagdCrvStruct *Crv,
    const CagdVType Vec)

**Crv:** Curve to multiply and compute a dot product for.  
**Vec:** Vector to project Crv onto.  
**Returns:** A scalar curve representing the dot product of Crv . Vec.  
**Description:** Given a curve and a vector - computes their dot product. Returned curve is a scalar curve representing the dot product.  
**See also:** SymbCrvDotProd, SymbCrvMult, SymbCrvMultScalar, SymbCrvCrossProd,
11.2.158  SymbCrvZeroSet (symbzero.c:44)

CagdPtStruct *SymbCrvZeroSet(const CagdCrvStruct *Crv,
    int Axis,
    CagdRType Epsilon,
    CagdBType NoSolsOnEndPts)

Crv: To compute its zero set.
Axis: The axis of Crv to compute zero set for, W = 0, X = 1, etc.
Epsilon: Tolerance control.
NoSolsOnEndPts: If TRUE, solutions at the end of the domain are purged.

Description: Computes the zero set of a given curve, in given axis (0/1-3 for W/X-Z). Returned is a list of the zero set points holding the parameter values at Pt[0] of each point.

11.2.159  SymbCrvsCompare (cmp_crvs.c:226)

SymbCrvRelType SymbCrvsCompare(const CagdCrvStruct *Crv1,
    const CagdCrvStruct *Crv2,
    CagdRType Eps,
    CagdRType *StartOvrlpPrmCrv1,
    CagdRType *EndOvrlpPrmCrv1,
    CagdRType *StartOvrlpPrmCrv2,
    CagdRType *EndOvrlpPrmCrv2)

Crv1, Crv2: The two curves to be compared.
Eps: A threshold for numerical computations.
StartOvrlpPrmCrv1: If the curves are the same and overlapping, here the start of overlapping domain of Crv1 will be returned.
EndOvrlpPrmCrv1: If the curves are the same and overlapping, here the end of overlapping domain of Crv1 will be returned.
StartOvrlpPrmCrv2: If the curves are the same and overlapping, here the start of overlapping domain of Crv2 will be returned.
EndOvrlpPrmCrv2: If the curves are the same and overlapping, here the end of overlapping domain of Crv2 will be returned.

Returns: Either Same curves (1), overlapping curves (2), or distinct curves (3). If Overlapping, the Start/End overlapping parametric domain variables are set.

Description: Compares the given two curves. Each curve is converted, if necessary, into a set of Bezier curves, and the comparison is done by applying comparison algorithm for each Bezier curve.

11.2.160  SymbCrvsLowerEnvelop (crv_lenv.c:167)

CagdCrvStruct *SymbCrvsLowerEnvelop(const CagdCrvStruct *CCrvs,
    CagdRType *Pt,
    CagdRType Eps)

CCrvs: Curves to derive the lower envelop for.
Pt: Point defining the center of the radial envelop, or NULL for linear, minimum Y, lower envelop.
Eps: Tolerance of computations.

Returns: A list of curves defining the lower envelop.

Description: Computes the lower envelop in the plane of all given curves. Returned is a list of (pieces of) curves that forms the lower envelop. If Pt is not NULL, radial lower envelop around Pt is computed. If Pt is NULL, regular, linear, lower envelop is computed seeking minimum Y values for the X domain that is spanned by the curves. Note the lower envelop might be discontinuous. The lower envelop is computed by splitting the input curves at all intersection locations, sorting intersection and end point events and shooting rays in the middle of these intervals to determine lowest one.

See also: CagdCrvCrvInter, CagdCrvCrvInterArrangement,
11.2.161 SymbCrvsSplitPoleParams (symbzero.c:444)

CagdCrvStruct *SymbCrvsSplitPoleParams(const CagdCrvStruct *Crvs,
                                       CagdRType Eps,
                                       CagdRType OutReach)

- Crvs: Rational curves to split at all its poles.
- Eps: Tolerance of computation.
- OutReach: Clip end points of curves that goes to infinity at distance that is about OutReach from the origin.
- Returns: List of splitted curves.

Description: Splits the given rational curves at all their poles. Returned is a list of curves each of which has weights of the same (positive) sign.
See also: CagdPointsHasPoles, SymbCrvSplitPoleParams,

11.2.162 SymbCubicBspInjective (bsp3injc.c:141)

CagdBType SymbCubicBspInjective(CagdRType x[4][4], CagdRType y[4][4])

- x: The 4 by 4 array of X coefficients of the cubic patch.
- y: The 4 by 4 array of Y coefficients of the cubic patch.
- Returns: TRUE if injective, FALSE otherwise.

Description: Examine if the given uniform cubic patch in injective. The patch is assumed to be a mapping from R2 to R2.

11.2.163 SymbCylinCylinBisect (smp_skel.c:1599)

CagdSrfStruct *SymbCylinCylinBisect(const CagdVType Cyl1Pos,
                                     const CagdVType Cyl1Dir,
                                     CagdRType Cyl1Rad,
                                     const CagdVType Cyl2Pos,
                                     const CagdVType Cyl2Dir,
                                     CagdRType Cyl2Rad)

- Cyl1Pos: A point on the axis of the first cylinder.
- Cyl1Dir: The direction of the first cylinder.
- Cyl1Rad: Radius of first cylinder.
- Cyl2Pos: A point on the axis of the second cylinder.
- Cyl2Dir: The direction of the second cylinder.
- Cyl2Rad: Radius of second cylinder.
- Returns:Constructed bisector surface.

Description: Compute the bisector surface between two cylinders. Let C1(u), T1(u), and N1(u) and C2(v), T2(v), and N2(v) be the cylinders cross section, cross section unit tangent field and cross section unit normal field. Ci(u) can be derived as a transformed circle. Ti(u) and Ni(u) are unit circles rotated to the proper orientation CyliDir. Finally, note that Ci(u), Ti(u), and Ni(u) are all rational. Then, the bisector is computed as the solution of the following three linear equations:

\[ < B - C1(u), T1(u) > = 0 \]

\[ < B - C2(v), T2(v) > = 0 \]
\[ \langle B, N_1(u) - N_2(v) \rangle = \langle C_1(u), N_1(u) \rangle - \langle C_2(v), N_2(v) \rangle \]

The first two constraints the bisector to be on the normal plane of the generators of the two cylinders that are fixed along the generator (the straight lines of the cylinder). The last constraint make sure the bisector is on the plane that bisects the two tangent planes of the two cylinders. This computation is following the bisectors of two developables, presented in "Geometric Properties of Bisector Surfaces", by Martin Peternell, Graphical Models, Volume 62, No. 3, May 2000.

See also: SymbPlanePointBisect, SymbCylinPointBisect, SymbConePointBisect, SymbSpherePointBisect, SymbTorusPointBisect, SymbConeConeBisect, SymbSphereSphereBisect, SymbConeSphereBisect, SymbConeLineBisect, SymbSphereLineBisect, SymbPlaneLineBisect, SymbCylinPlaneBisect, SymbConePlaneBisect, SymbSpherePlaneBisect, SymbCylinSphereBisect, SymbSphereSphereBisect, SymbConeSphereBisect, SymbConeConeBisect2, SymbConeCylinBisect, SymbCylinCylinBisect.

11.2.164 SymbCylinPlaneBisect (smp_skel.c:1200)

\[ \text{CagdSrfStruct *SymbCylinPlaneBisect(const CagdPType CylPt, const CagdVType CylDir, CagdRType CylRad, CagdRType Size)} \]

CylPt: Point on axis of cylinder.
CylDir: Direction of cylinder. Must be in the northern hemisphere (positive Z coefficient).
CylRad: Radius of cylinder.
Size: Portion of result as it is infinite.

Returns: Constructed bisector surface.

Description: Compute the bisector surface between a cylinder and the XY plane. The computation is reduced to that of a bisector between a line and a plane, that has a rational form. Only the portion for which \( Z > 0 \) should be considered in the output.

See also: SymbPlanePointBisect, SymbCylinPointBisect, SymbConePointBisect, SymbSpherePointBisect, SymbTorusPointBisect, SymbConeConeBisect, SymbSphereSphereBisect, SymbConeSphereBisect, SymbTorusSphereBisect, SymbSphereSphereBisect, SymbConeSphereBisect, SymbTorusSphereBisect, SymbConeConeBisect.

11.2.165 SymbCylinPointBisect (smp_skel.c:745)

\[ \text{CagdSrfStruct *SymbCylinPointBisect(const CagdPType CylPt, const CagdVType CylDir, CagdRType CylRad, const CagdPType Pt, CagdRType Size)} \]

CylPt: Point on axis of cylinder.
CylDir: Direction of cylinder.
CylRad: Radius of cylinder.
Pt: Direction of line from origin.
Size: Portion of result as it is infinite.

Returns: Constructed bisector surface.

Description: Compute the bisector surface between a cylinder and a point.

See also: SymbPtCrvBisectOnSphere, SymbPlanePointBisect, SymbConePointBisect, SymbSpherePointBisect, SymbTorusPointBisect, SymbConePlaneBisect, SymbConeConeBisect, SymbSphereSphereBisect, SymbConeSphereBisect, SymbTorusSphereBisect, SymbConeConeBisect2.
11.2.166  SymbCylinSphereBisect (smp_skel.c:1329)

CagdSrfStruct *SymbCylinSphereBisect(const CagdPType CylPt,
       const CagdVType CylDir,
       CagdRType CylRad,
       const CagdPType SprCntr,
       CagdRType SprRad,
       CagdRType Size)

CylPt:  Point on axis of cylinder.
CylDir:  Direction of cylinder.  Must be in the northern hemisphere (positive Z coefficient).
CylRad:  Radius of cylinder.
SprCntr:  Center location of the sphere.  Must be in northern hemisphere (positive Z coefficient).
SprRad:  Radius of sphere.
Size:  Portion of result as it is infinite.

Returns:  Constructed bisector surface.

Description:  Compute the bisector surface between a cylinder and a sphere.  The computation is reduced
to that of a bisector between a point and a cylinder, that has a rational form.

See also: SymbPlanePointBisect, SymbCylinPointBisect, SymbConePointBisect, , SymbSpherePointBisect, SymbTorus-
PointBisect, , SymbConeLineBisect, SymbSphereLineBisect, SymbPlaneLineBisect, , SymbCylinPlaneBisect, Symb-
ConePlaneBisect, SymbSpherePlaneBisect, , SymbSphereSphereBisect, SymbConeSphereBisect, SymbTorusSphere-
Bisect, , SymbConeConeBisect, SymbConeConeBisect2, SymbConeCylinBisect, , SymbCylinCylinBisect,

11.2.167  SymbDecomposeCrvCrv (decompos.c:170)

CagdCrvStruct *SymbDecomposeCrvCrv(CagdCrvStruct *Crv)

Crv:  A curve H(t) to try and decompose.

Returns: Pairs of curves F and G that are composable to the input curve, or NULL if nonreducible.  F: [0, 1]  
-> R^3,  G: [0, 1] -> [0, 1].

Description:  Try to decompose a curve of arbitrary degree if possible.  Among all possibilities, return one pair
of two curves F and G which satisfy F(G(t)) = H(t).  F can have arbitrary number of coordinates:  F(x) = x^m +
sum b_j x^j.  G should be a scalar monotone curve having a range [0, 1]:  G(x) = c_k x^k + ..... + c_1 x.

See also: SymbComposeCrvCrv

11.2.168  SymbDescribeError (symb.err.c:84)

const char *SymbDescribeError(SymbFatalErrorType ErrorNum)

ErrorNum:  Type of the error that was raised.

Returns: A string describing the error type.

Description:  Returns a string describing a the given error.  Errors can be raised by any member of this symb
library as well as other users.  Raised error will cause an invokation of SymbFatalError function which decides how
to handle this error.  SymbFatalError can for example, invoke this routine with the error type, print the appropriate
message and quit the program.

11.2.169  SymbDistBuildMapToCrv (distance.c:990)

CagdRType SymbDistBuildMapToCrv(const CagdCrvStruct *Crv,
       CagdRType Tolerance,
       CagdRType *XDomain,
       CagdRType *YDomain,
       CagdRType **DiscMap,
       CagdRType DiscMapXSize,
       CagdRType DiscMapYSize)
Crv: The curve to approximate a discrete distance map for.
Tolerance: Tolerance of distance computation.
XDomain: X domain to sample R2 for distances.
YDomain: Y domain to sample R2 for distances.
DiscMap: Where output is saved as a real distance value.
DiscMapXSize: Horizontal resolution, 0 will be mapped to XDomain[0], (DiscMapXSize-1) to XDomain[0].
DiscMapYSize: Vertical resolution, 0 will be mapped to YDomain[0], (DiscMapYSize-1) to YDomain[0].
Returns: Maximal distance of points in prescribed domain to crv Crv.
Description: Compute a discrete distance map to a freeform curve by sampling the distance on a regular grid.
See also: SymbDistCrvPoint,

11.2.170 SymbDistCrvLine (distance.c:179)

CagdRType SymbDistCrvLine(const CagdCrvStruct *Crv,
   const CagdLType Line,
   CagdBType MinDist,
   CagdRType Epsilon)

Crv: The curve to find its nearest (farthest) point to Line.
Line: The line to find the nearest (farthest) point on Crv to it.
MinDist: If TRUE nearest points is needed, if FALSE farthest.
Epsilon: Accuracy of computation.
Returns: Parameter value in the parameter space of Crv of the nearest (farthest) point to line Line.

Description: Given a curve and a line, finds the nearest point (if MinDist) or the farthest location (if MinDist FALSE) from the curve to the given line. Returned is the parameter value of the curve. Both internal as well as boundary extrema are considered. Let Crv be (x(t), y(t)). By substituting x(t) and y(t) into the line equation, we derive the distance function. Its zero set, combined with the zero set of its derivative provide the needed extreme distances.
See also: SymbLclDistCrvLine, MvarDistSrfLine, SymbCrvRayInter,

11.2.171 SymbDistCrvPoint (distance.c:59)

CagdRType SymbDistCrvPoint(const CagdCrvStruct *Crv,
   const CagdPType Pt,
   CagdBType MinDist,
   CagdRType Epsilon)

Crv: The curve to find its nearest (farthest) point to Pt.
Pt: The point to find the nearest (farthest) point on Crv to it.
MinDist: If TRUE nearest points is needed, if FALSE farthest.
Epsilon: Accuracy of computation.
Returns: Parameter value in the parameter space of Crv of the nearest (farthest) point to point Pt.

Description: Given a curve and a point, finds the nearest point (if MinDist) or the farthest location (if MinDist FALSE) from the curve to the given point. Returned is the parameter value of the curve. Both internal as well as boundary extrema are considered. Computes the zero set of (Crv(t) - Pt) . Crv'(t), and also look at the curves’ end points.
See also: SymbLclDistCrvPoint, MvarDistSrfPoint,
11.2.172  **SymbEnvOffsetFromCrv**  (moffset.c:339)

```c
CagdSrfStruct *SymbEnvOffsetFromCrv(const CagdCrvStruct *Crv,
    CagdRType Height,
    CagdRType Tolerance)
```

**Crv:** The curve to process.

**Height:** The height of the elevated surface (also the width of the offset operation).

**Tolerance:** Accuracy of the elevated surface approximation.

**Returns:** A freeform surface approximating the elevated surface for open curve Crv, or two surfaces for the case of closed curve Crv.

**Description:** Computes an elevated surface emanating from the given C'1 continuous curve in all directions like a fire front. The surface gets away from Crv in a slope of 45 degrees. This elevated surface is an approximation of the real envelope only, as prescribed by Tolerance. If the given curve is closed, it is assume to be C'1 at the end point as well. For a close curve, two surfaces are actually returned - one for the inside and one for the outside firefront. This function employs SymbCrvSubdivOffset for the offset computations.

11.2.173  **SymbEvalCrvCurvPrep**  (evalcurv.c:36)

```c
void SymbEvalCrvCurvPrep(CagdCrvStruct *Crv, CagdBType Init)
```

**Crv:** Curve to preprocess.

**Init:** TRUE for initializing, FALSE for clearing out.

**Returns:** void

**Description:** Preprocess a given curve so we can evaluate curvature properties from it efficiently, at every point. See SymbEvalCurvature for actual curvature at curve point evaluations.

**See also:** SymbEvalCurvature, SymbEvalCrvCurvTN,

11.2.174  **SymbEvalCrvCurvTN**  (evalcurv.c:138)

```c
void SymbEvalCrvCurvTN(CagdVType Nrml, CagdVType Tan, int Normalize)
```

**Nrml:** The normal to return.

**Tan:** The tangent to return.

**Normalize:** TRUE to normalize the vectors.

**Returns:** void

**Description:** As bi-product, return the last tangent and normal of the curve evaluated last by SymbEvalCrvCurvature.

**See also:** SymbEvalCrvCurvPrep, SymbEvalCrvCurvature,

11.2.175  **SymbEvalCrvCurvature**  (evalcurv.c:91)

```c
int SymbEvalCrvCurvature(const CagdCrvStruct *Crv, CagdRType t, CagdRType *k)
```

**Crv:** Curve to evaluate its curvature properties.

**t:** Location of evaluation.

**k:** The returned curvature at Crv(t).

**Returns:** TRUE if succesful, FALSE otherwise.

**Description:** Evaluate a given curve’s curvature. Returns the curvature for the given curve location. This function must be invoked after SymbEvalCrvCurvPrep was called to initialize the proper data structures, for fast curvature evaluations at many points. SymbEvalCrvCurvPrep should be called at the end to release these data structures. As a bi-product, function SymbEvalCrvCurvTN could be invoked immediately after this function to fetch the tangent and the normal of the curve at the given location.

**See also:** SymbEvalCrvCurvPrep, SymbEvalCrvCurvTN,
11.2.176 SymbEvalSrfAsympDir (evalcurv.c:424)

    int SymbEvalSrfAsympDir(const CagdSrfStruct *Srf,
                             CagdRType U,
                             CagdRType V,
                             CagdBType DirInUV,
                             CagdVType AsympDir1,
                             CagdVType AsympDir2)

  Srf: To compute asymptotic directions for.
  U, V: Location of evaluation.
  DirInUV: If TRUE asymptotic direction is given in UV, otherwise in Euclidean 3-space.
  AsympDir1, AsympDir2: Returned values.

  Returns: Number of asymptotic directions found, zero for none.

  Description: Computes the asymptotic directions of the surface in the given U, V location, if exists. If DirInUV,
  the returned asymptotic direction is in UV space, otherwise, in Euclidean surface tangent plane space. This function
  must be invoked after SymbEvalSrfCurvPrep was called to initialize the proper data structures, for fast curvature
  evaluations at many points. SymbEvalSrfCurvPrep should be called at the end to release these data structures. The
  asymptotic direction(s) is the direction for which the normal curvature vanish and hence can exist for hyperbolic
  regions. We solve:

  \[
  \begin{bmatrix}
  t & (1-t) \\
  \end{bmatrix}
  \begin{bmatrix}
  L & M \\
  M & N \\
  \end{bmatrix}
  \begin{bmatrix}
  t \\
  1-t \\
  \end{bmatrix}
  \]

  and look for solution of t between zero and one as:

  \[
  t = (N-M \pm \sqrt{M^2-LN}) / (L-2M+N).
  \]

  See also: SymbEvalSrfCurvature, SymbEvalSrfCurvPrep,

11.2.177 SymbEvalSrfCurvPrep (evalcurv.c:168)

    void SymbEvalSrfCurvPrep(CagdSrfStruct *Srf, CagdBType Init)

  Srf: Surface to preprocess.
  Init: TRUE for initializing, FALSE for clearing out.

  Returns: void

  Description: Preprocess a given surface so we can evaluate curvature properties from it efficiently, at every
  point. See SymbEvalCurvature for actual curvature at surface point evaluations.

  See also: SymbEvalCurvature, SymbEvalSrfCurvTN,

11.2.178 SymbEvalSrfCurvTN (evalcurv.c:371)

    void SymbEvalSrfCurvTN(CagdVType Nrml,
                             CagdVType DSrfU,
                             CagdVType DSrfV,
                             int Normalize)

  Nrml: The normal to return.
  DSrfU, DSrfV: The two partials of the surface.
  Normalize: TRUE to normalize the vectors.

  Returns: void

  Description: As bi-product, return the last normal and partial tangents of the m surface evaluated last by
  SymbEvalSrfCurvature.

  See also: SymbEvalSrfCurvPrep, SymbEvalSrfCurvature,
11.2.179 SymbEvalSrfCurvature (evalcurv.c:237)

```c
int SymbEvalSrfCurvature(const CagdSrfStruct *Srf,
    CagdRType U,
    CagdRType V,
    CagdBType DirInUV,
    CagdRType *K1,
    CagdRType *K2,
    CagdVType D1,
    CagdVType D2)
```

**Srf:** Surface to evaluate its curvature properties.

**U, V:** Location of evaluation.

**DirInUV:** If TRUE principal directions are given in UV, otherwise in Euclidean 3-space.

**K1, K2:** Principal curvatures.

**D1, D2:** Principal directions.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Evaluate a given surface's curvature properties. Returns the principal curvatures and directions for the given surface location. This function must be invoked after SymbEvalSrfCurvPrep was called to initialize the proper data structures, for fast curvature evaluations at many points. SymbEvalSrfCurvPrep should be called at the end to release these data structures. As a bi-product, function SymbEvalSrfCurvTN could be invoked immediately after this function to fetch the tangents and the normal of the surface at the given UV location.

**See also:** SymbEvalSrfCurvPrep, SymbEvalSrfCurvTN,

11.2.180 SymbExtremumCntPtVals (symb_crv.c:1329)

```c
CagdRType *SymbExtremumCntPtVals(CagdRType * const *Points,
    int Length,
    CagdBType FindMinimum)
```

**Points:** To scan for extremum values.

**Length:** Length of each vector in Points.

**FindMinimum:** TRUE for minimum, FALSE for maximum.

**Returns:** A vector holding PType point with the extremum values of each axis independently.

**Description:** Given a control polygon/mesh, computes the extremum values of them all.

11.2.181 SymbFatalError (symb_ftl.c:53)

```c
void SymbFatalError(SymbFatalErrorType ErrID)
```

**ErrID:** Error type that was raised.

**Returns:** void

**Description:** Trap SymbLib errors right here. Provides a default error handler for the symb library. Gets an error description using SymbDescribeError, prints it and exit the program using exit.

11.2.182 SymbGet2CrvsInterDAreaDCtlPts (symb_cci.c:345)

```c
int SymbGet2CrvsInterDAreaDCtlPts(CagdCrvStruct *Crv1,
    CagdCrvStruct *Crv2,
    CagdRType Eps,
    CagdRType **InterDomains,
    CagdRType **dAreadPts)
```

**Crv1:** First planar curve.
Crv2: Second planar curve.
Eps: Tolerance of computation.
InterDomains: Calculated domain as a list of the in the following 4-tuple structure, (u1enter, u1leave, u2enter, u2leave) sorted by u1 values.
dAreaDpts: Will be updated to contain the change rate of the intersection areas relative to changes in each control points of both curves. The order in this array is as follows, (Crv1ctpnt1x, Crv1ctpnt1y, Crv1ctpnt2x, Crv1ctpnt2y, ..., Crv2ctpnt1x, Crv2ctpnt1y, ..., Crv2ctpnt2x, Crv2ctpnt2y, ...).

Returns: Number of intersection domains of the two curves (the length of InterDomains is 4-times this return value).

Description: Calculates the intersection domains of two curves, and the change rate of the total intersection area relative to control points change. The curves must be planar and have the same orientation. The intersections must be complete - that is, there are even number of intersections.

See also: SymbGet2CrvsIntersectionAreas,

11.2.183 SymbGet2CrvsIntersectionAreas (symb.cci.c:248)

CagdRType SymbGet2CrvsIntersectionAreas(const CagdCrvStruct *Crv1,
const CagdCrvStruct *Crv2,
CagdRType Eps)

Crv1: First planar curve.
Crv2: Second planar curve.
Eps: Tolerance of computation.

Returns: Total area of intersection domains of the two curves.

Description: Calculates the total area of the intersection domains of two planar curves. The curves must have the same orientation.

See also: SymbCrvEnclosedAreaEval, SymbGet2CrvsInterDAreaDCtlPts,

11.2.184 SymbGet2CrvsIntersectionRegions (symb.cci.c:170)

CagdCrvStruct *SymbGet2CrvsIntersectionRegions(const CagdCrvStruct *Crv1,
const CagdCrvStruct *Crv2,
CagdRType Eps)

Crv1, Crv2: The two curves to intersect and compute intersecting region(s).
Eps: Tolerance of computation.

Returns: List of closed intersecting region(s) or NULL if none.

Description: Computes the intersection region(s) of given two curves if any. The curves must have the same orientation.

See also: CagdCrvCrvInter,

11.2.185 SymbGetCrvSubRegionAlphaMatrix (symb.cci.c:419)

CagdRType *SymbGetCrvSubRegionAlphaMatrix(const CagdCrvStruct *Crv,
CagdRType t1,
CagdRType t2,
int *Dim)

Crv: Curve to compute its region extraction Alpha matrix. Assumed a non periodic curve.
t1, t2: Of extracted domain.
Dim: The two dimensions of the returned matrix will be placed here.

Returns: Linearized 2D matrix, row by row, of size (CrvLen, RgnLen), where CrvLen is the number of control points in curve Crv, and RgnLen is the size of the extracted curve region. Allocated dynamically.

Description: Computes the Alpha matrix that relates the control points of the curve region (t1, t2) to the control points of the input curve Crv of a larger domain. Compute the Alpha matrix by adding Order-1 knots at t1 and t2.

See also: BspKnotEvalAlphaCoef,
11.2.186  **SymbGetParamListAndReset**  (symbzero.c:574)

CagdPtStruct *SymbGetParamListAndReset(void)

**Returns:** The old point list.

**Description:** Clear the global sorted list of points and return what was on that list before. This sorted list is built via SymbInsertNewParam

**See also:** SymbInsertNewParam,

11.2.187  **SymbHausDistBySamplesCrvCrv**  (distance.c:1201)

CagdRType SymbHausDistBySamplesCrvCrv(const CagdCrvStruct *Crv1,
const CagdCrvStruct *Crv2,
int Samples,
int HDistSide)

**Crv1, Crv2:** The two curves, Crv1(u) and Crv2(v), to estimate their Hausdorff distance.

**Samples:** Number of samples to take, uniformly in parametric space.

**HDistSide:** 1 for HD from V1 to V2, 2 for HD from V2 to V1, 3 for a symmetric HD.

**Returns:** An upper bound on the Hausdorff distance.

**Description:** Given two curves, compute an Hausdorff distance bound by sampling two dense sets of sampled points and estimating the Hausdorff distance between the two curves by the sampled points.

**See also:** SymbHausDistOfSamplefPts,

11.2.188  **SymbHausDistBySamplesCrvSrf**  (distance.c:1241)

CagdRType SymbHausDistBySamplesCrvSrf(const CagdCrvStruct *Crv1,
const CagdSrfStruct *Srf2,
int Samples,
int HDistSide)

**Crv1, Srf2:** The two curves and surfaces, Crv1(u) and Srf2(u, v), to estimate their Hausdorff distance.

**Samples:** Number of samples to take, uniformly in parametric space, as (Samples x Samples) samples.

**HDistSide:** 1 for HD from V1 to V2, 2 for HD from V2 to V1, 3 for a symmetric HD.

**Returns:** An upper bound on the Hausdorff distance.

**Description:** Given a curve and a surface, compute an Hausdorff distance bound by sampling two dense sets of sampled points and estimating the Hausdorff distance between the two shapes by the sampled points.

**See also:** SymbHausDistOfSamplefPts, SymbHausDistBySamplesSrfSrf,

11.2.189  **SymbHausDistBySamplesSrfSrf**  (distance.c:1282)

CagdRType SymbHausDistBySamplesSrfSrf(const CagdSrfStruct *Srf1,
const CagdSrfStruct *Srf2,
int Samples,
int HDistSide)

**Srf1, Srf2:** The two surfaces, Srf1(u) and Srf2(v), to estimate their Hausdorff distance.

**Samples:** Number of samples to take, uniformly in parametric space, as (Samples x Samples) samples.

**HDistSide:** 1 for HD from V1 to V2, 2 for HD from V2 to V1, 3 for a symmetric HD.

**Returns:** An upper bound on the Hausdorff distance.

**Description:** Given two surfaces, compute an Hausdorff distance bound by sampling two dense sets of sampled points and estimating the Hausdorff distance between the two surfaces by the sampled points.

**See also:** SymbHausDistOfSamplefPts,
11.2.190 SymbHausDistOfSamplefPts (distance.c:1129)

CagdRTType SymbHausDistOfSamplefPts(CagdPType * const V1,
                           CagdPType * const V2,
                           int V1Size,
                           int V2Size,
                           int HDistSide)

V1, V2: The two vectors to consider.
V1Size, V2Size: Lengths of vectors V1 and V2.
HDistSide: 1 for HD from V1 to V2, 2 for HD from V2 to V1, 3 for a symmetric HD.
Returns: Computed HD.
Description: Compute the Hausdorff Distance (HD) between two vectors of points.
See also: ,

11.2.191 SymbHighlightLnFree (rflct_ln.c:473)

void SymbHighlightLnFree(CagdSrfStruct *Srf, const char *AttribName)

Srf: Surface to free its internal data sets saved as attributes.
AttribName: Name of the attribute to free.
Returns: void
Description: Free the internal data sets, if any of the given surface, toward the computation of the highlight lines. as created by SymbHighlightLnPrepSrf.
See also: SymbHighlightLnPrepSrf, SymbHighlightLnGen,

11.2.192 SymbHighlightLnGen (rflct_ln.c:427)

CagdSrfStruct *SymbHighlightLnGen(CagdSrfStruct *Srf,
                           const CagdPType LnPt,
                           const CagdVType LnDir,
                           const char *AttribName)

Srf: Surface to preprocess.
LnPt: Point on a highlight line.
LnDir: Direction of highlight line.
AttribName: Name of the attribute to get the highlight line data set by, or NULL to employ a default attribute name. Useful for multiple highlight lines’ directions computation.
Returns: A scalar surface whose zero set is the highlight line sought on Srf.
Description: Compute the highlight line through LnPt on the given surface. The surface is assumed to have been preprocessed in SymbHighlightLnPrepSrf for the requested preprocessed named attribute, or otherwise SymbHighlightLnPrepSrf will be invoked on the fly.
See also: SymbHighlightLnPrepSrf, SymbHighlightLnGen,

11.2.193 SymbHighlightLnPrepSrf (rflct_ln.c:384)

void SymbHighlightLnPrepSrf(CagdSrfStruct *Srf,
                           const CagdVType LnDir,
                           const char *AttribName)

Srf: Surface to preprocess.
LnDir: Direction of highlight line.
AttribName: Name of the attribute to save the highlight line data set by, or NULL to employ a default attribute name. Useful for multiple highlight lines’ directions computation.
Returns: void
Description: Precompute the necessary data set for as efficient as possible highlight lines’ extractions. Data set is kept as an attribute on the surface. Note that only the direction of the highlight line is employed at this time, and exact location will be required by SymbHighlightLnGen only.
See also: SymbHighlightLnGen, SymbHighlightLnFree,
11.2.194 SymbHugeCrv2Polyline (symbpoly.c:325)

CagdPtStruct *SymbHugeCrv2Polyline(const CagdCrvStruct *Crv,
int Samples,
CagdBType AddFirstPt,
CagdBType AddLastPt,
CagdBType AddParamVals)

Crv: To select Samples points out of its control polygon.
Samples: Number of samples to grab.
AddFirstPt: If TRUE, first point on curve is also added.
AddLastPt: If TRUE, last point on curve is also added.
AddParamVals: TRUE to add parameter values, as attributes.
Returns: Taken samples.
Description: If the given curve is huge, simply select Samples points out if its control polygon.
See also:

11.2.195 SymbInsertNewParam (symbzero.c:601)

void SymbInsertNewParam(CagdRType t)

t: New value to insert to global GlblPtList list.
Returns: void
Description: Insert a single t value into existing GlblPtList, provided no equal t value exists already in the list. List is ordered incrementally.
See also: SymbGetParamListAndReset, SymbInsertNewParam2,

11.2.196 SymbInsertNewParam2 (symbzero.c:624)

CagdPtStruct *SymbInsertNewParam2(CagdPtStruct *PtList, CagdRType t)

PtList: List to insert a new value t into.
t: New value to insert to PtList list.
Returns: Updated list, in place.
Description: Insert a single t value into given PtList, in place, provided no equal t value exists already in the list. List is ordered incrementally.
See also: SymbGetParamListAndReset, SymbInsertNewParam,

11.2.197 SymbIsCircularCrv (rvrs_eng.c:147)

CagdBType SymbIsCircularCrv(const CagdCrvStruct *Crv,
CagdPType Center,
CagdRType *Radius,
CagdRType Eps)

Crv: Curve to attempt and recognize as circular.
Center: If circular, the center of the circle, zero vector otherwise.
Radius: If circular, the radius of the circle, zero otherwise.
Eps: Tolerance of "same" value.
Returns: TRUE if circular curve, FALSE otherwise.
Description: Attempts to recognize if the given curve Crv is indeed circular. If the curve is found to be circular, its center and radius are returned. Crv is tested for circularity in the XY plane. A curve is circular if its evolute curve is constant.
See also: SymbIsSphericalSrf,
11.2.198  SymbIsConstCrv  (rvrs_eng.c:45)

CagdBType SymbIsConstCrv(const CagdCrvStruct *CCrv,
                          CagdCtlPtStruct **ConstVal,
                          CagdRType Eps)

  CCrv:  Curve to attempt and recognize as a constant curve.
  ConstVal:  Resulting constant value if indeed a constant curve.  This value is always Euclidean, even for
             projective curves.
  Eps:  Tolerance of "same" value.
  Returns:  TRUE if a constant curve, FALSE otherwise.

  Description:  Attempts to recognize if the given curve Crv is a constant curve.  If TRUE, ConstVal is reference
                to a static location holding the constant value.
  See also:  SymbIsConstSrf,

11.2.199  SymbIsConstSrf  (rvrs_eng.c:278)

CagdBType SymbIsConstSrf(const CagdSrfStruct *CSrf,
                          CagdCtlPtStruct **ConstVal,
                          CagdRType Eps)

  CSrf:  Surface to attempt and recognize as a constant surface.
  ConstVal:  Resulting constant value if indeed a constant surface.  This value is always Euclidean, even for
             projective surfaces.
  Eps:  Tolerance of "same" value.
  Returns:  TRUE if a constant surface, FALSE otherwise.

  Description:  Attempts to recognize if the given surface Srf is a constant surface.
  See also:  SymbIsConstCrv,

11.2.200  SymbIsDevelopSrf  (rvrs_eng.c:444)

CagdBType SymbIsDevelopSrf(const CagdSrfStruct *Srf, CagdRType Eps)

  Srf:  Surface to attempt and recognize as a ruled surface.
  Eps:  Tolerance of "same" value.
  Returns:  TRUE if a ruled surface, FALSE otherwise.

  Description:  Attempts to recognize if the given surface Srf is indeed a ruled surface.  If the surface is found to
                be a ruled surface, it is decomposed into its two rail curves (two boundary curves essentially).  A surface is a ruled
                surface if one of its partial derivatives is in the same direction for that parameter.
  See also:  SymbIsPlanarSrf, SymbIsRuledSrf, SymbIsSrfOfRevSrf, SymbIsSphericalSrf, SymbIsExtrusionSrf,

11.2.201  SymbIsExtrusionSrf  (rvrs_eng.c:385)

int SymbIsExtrusionSrf(const CagdSrfStruct *Srf,
                        CagdCrvStruct **Crv,
                        CagdVType ExtDir,
                        CagdRType Eps)

  Srf:  Surface to attempt and recognize as an extrusion surface.
  Crv:  If an extrusion surface, the cross section curve, NULL otherwise.
  ExtDir:  The extrusion direction, if an extrusion surface, zero vector otherwise.
  Eps:  Tolerance of "same" value.
  Returns:  1 if an extrusion surface along U, 2 if an extrusion surface along V, 0 otherwise.

  Description:  Attempts to recognize if the given surface Srf is indeed an extrusion surface.  If the surface is found to
                be an extrusion, it is decomposed into a cross section curve Crv, and an extrusion direction ExtDir.  A surface is an
                extrusion surface if one of its partial derivatives is constant.
  See also:  SymbIsPlanarSrf, SymbIsRuledSrf, SymbIsDevelopSrf, SymbIsSrfOfRevSrf, , SymbIsSphericalSrf,
11.2.202  SymbIsLineCrv (rvrs_eng.c:226)

CagdBType SymbIsLineCrv(const CagdCrvStruct *Crv,
    CagdPType LnPos,
    CagdVType LnDir,
    CagdRType Eps)

Crv: Curve to attempt and recognize as circular.
LnPos: A point on the line, if the curve is indeed a line.
LnDir: A unit direction along the line, if the curve is a line.
Eps: Tolerance of "same" value.

Returns: TRUE if a line, FALSE otherwise.

Description: Attempts to recognize if the given curve Crv is indeed circular. If the curve is found to be circular,
its center and radius are returned. Crv is tested for circularity in the XY plane. A curve is circular if its evolute
curve is constant.
See also: SymbIsPlanarSrf, SymbIsSphericalSrf, SymbIsCircularCrv,

11.2.203  SymbIsOffsetLclSelfInters (offset.c:1781)

int SymbIsOffsetLclSelfInters(CagdCrvStruct *Crv,
    CagdCrvStruct *OffCrv,
    CagdPtStruct **SIDmns)

Crv: Original curve.
OffCrv: Offset (approximation) curve. Assumed to share the same parametrization with Crv. I.e. Crv(t0) is
offset to OffCrv(t0).
SIDmns: If not NULL set to domains that are in the self intersections. Each consecutive set of two points in
this list defines one such domain.

Returns: TRUE if has local self intersection, FALSE otherwise.

Description: Reports if the given offset curve OffCrv to given curve Crv contains local self intersections. Solution
is the zeros of \( <Crv', OffCrv'> \).

11.2.204  SymbIsPlanarSrf (rvrs_eng.c:746)

CagdBType SymbIsPlanarSrf(const CagdSrfStruct *Srf,
    IrtPlnType Plane,
    CagdRType Eps)

Srf: Surface to attempt and recognize as circular.
Plane: The plane equation, if the surface is indeed planar.
Eps: Tolerance of "same" value.

Returns: TRUE if a line, FALSE otherwise.

Description: Attempts to recognize if the given curve Crv is indeed circular. If the curve is found to be circular,
its center and radius are returned. Crv is tested for circularity in the XY plane. A surface is plane if its gaussian
and mean curvatures are zero.
See also: SymbIsRuledSrf, SymbIsDevelopSrf, SymbIsSrfOfRevSrf, SymbIsSphericalSrf, SymbIsExtrusionSrf, SymbIsLineCrv,
11.2.205 SymbIsRuledSrf (rvts_eng.c:492)

int SymbIsRuledSrf(const CagdSrfStruct *Srf,
                    CagdCrvStruct **Crv1,
                    CagdCrvStruct **Crv2,
                    CagdRType Eps)

Srf: Surface to attempt and recognize as a ruled surface.
Crv1: If a ruled surface, the first curve, NULL otherwise.
Crv2: If a ruled surface, the second curve, NULL otherwise.
Eps: Tolerance of "same" value.

Returns: 1 if an extrusion surface along U, 2 if an extrusion surface long V, 0 otherwise.

Description: Attempts to recognize if the given surface Srf is indeed a ruled surface. If the surface is found to be a ruled surface, it is decomposed into its two rail curves (two boundary curves essentially). A surface is a ruled surface if one of its partial derivatives is in the same direction for that parameter.

See also: SymbIsPlanarSrf, SymbIsDevelopSrf, SymbIsSrfOfRevSrf, SymbIsSphericalSrf, SymbIsExtrusionSrf

11.2.206 SymbIsSphericalSrf (rvts_eng.c:664)

CagdBType SymbIsSphericalSrf(const CagdSrfStruct *Srf,
                              CagdPType Center,
                              CagdRType *Radius,
                              CagdRType Eps)

Srf: Surface to attempt and recognize as a sphere.
Center: If a sphere, the center of the sphere, zero vector otherwise.
Radius: If a sphere, the radius of the sphere, zero otherwise.
Eps: Tolerance of "same" value.

Returns: TRUE if a sphere surface, FALSE otherwise.

Description: Attempts to recognize if the given surface Srf is indeed a sphere. If the surface is found to be a sphere, its center and radius are returned. A surface is a sphere if its Gaussian and Mean square surfaces are constant and equal. The center of the sphere is derived from the mean evolute surface.

See also: SymbIsPlanarSrf, SymbIsRuledSrf, SymbIsDevelopSrf, SymbIsSrfOfRevSrf, SymbIsExtrusionSrf, SymbIsCircularCrv

11.2.207 SymbIsSrfOfRevSrf (rvts_eng.c:572)

CagdBType SymbIsSrfOfRevSrf(const CagdSrfStruct *Srf,
                             CagdCrvStruct **CrossSec,
                             CagdPType AxisPos,
                             CagdVType AxisDir,
                             CagdRType Eps)

Srf: Surface to attempt and recognize as a ruled surface.
CrossSec: If a surface of revolution, the cross section curve, NULL otherwise.
AxisPos: If a surface of revolution, a point on axis of revolution, NULL otherwise.
AxisDir: If a surface of revolution, the direction of the axis of revolution, NULL otherwise.
Eps: Tolerance of "same" value.

Returns: TRUE if a surface of revolution, FALSE otherwise.

Description: Attempts to recognize if the given surface Srf is indeed a surface of revolution. If the surface is found to be a surface of revolution, it is decomposed into its generator (cross section) curve, and the axis of revolution. A surface is a surface of revolution if the focal surface of one of the pseudo iso focal surfaces degenerates into a line.

See also: SymbIsPlanarSrf, SymbIsRuledSrf, SymbIsDevelopSrf, SymbIsSphericalSrf, SymbIsExtrusionSrf,
11.2.208  **SymbIsZeroCrv** (rvrsceng.c:105)

CagdBType SymbIsZeroCrv(const CagdCrvStruct *Crv, CagdRType Eps)

- **Crv**: Curve to attempt and recognize as a zero curve.
- **Eps**: Tolerance of "same" value.
- **Returns**: TRUE if a zero curve, FALSE otherwise.
- **Description**: Attempts to recognize if the given curve Crv is an identically zero curve.
- **See also**: SymbIsConstCrv, SymbIsZeroSrf,

11.2.209  **SymbIsZeroSrf** (rvrsceng.c:338)

CagdBType SymbIsZeroSrf(const CagdSrfStruct *Srf, CagdRType Eps)

- **Srf**: Surface to attempt and recognize as a zero surface.
- **Eps**: Tolerance of "same" value.
- **Returns**: TRUE if a zero surface, FALSE otherwise.
- **Description**: Attempts to recognize if the given surface Srf is an identically zero surface.
- **See also**: SymbIsConstSrf, SymbIsZeroCrv,

11.2.210  **SymbLclDistCrvLine** (distance.c:255)

CagdPtStruct *SymbLclDistCrvLine(const CagdCrvStruct *Crv, const CagdLType Line, CagdRType Epsilon, CagdBType InterPos, CagdBType ExtremPos)

- **Crv**: The curve to find its nearest (farthest) point to Line.
- **Line**: The line to find the nearest (farthest) point on Crv to it.
- **Epsilon**: Accuracy of computation.
- **InterPos**: Do we want the intersection locations?
- **ExtremPos**: Do we want the extremum distance locations?
- **Returns**: A list of parameter values of extreme distance locations.
- **Description**: Given a curve and a line, finds the local extreme distance points on the curve to the given line. Only interior extrema are considered. Returned is a list of parameter value with local extreme distances. Let Crv be \((x(t), y(t))\). By substituting \(x(t)\) and \(y(t)\) into the line equation, we derive the distance function. Its zero set, possibly combined with the zero set of its derivative provide the needed extreme distances.
- **See also**: SymbDistCrvLine, MvarDistSrfLine, SymbCrvRayInter,

11.2.211  **SymbLclDistCrvPoint** (distance.c:125)

CagdPtStruct *SymbLclDistCrvPoint(const CagdCrvStruct *CCrv, const CagdPType Pt, CagdRType Epsilon)

- **CCrv**: The curve to find its extreme distance locations to Pt.
- **Pt**: The point to find the extreme distance locations from Crv.
- **Epsilon**: Accuracy of computation.
- **Returns**: A list of parameter values of extreme distance locations.
- **Description**: Given a curve and a point, find the local extremum distance points on the curve to the given point. Only interior extrema are considered. Returned is a list of parameter value with local extremum. Computes the zero set of \((Crv(t) - Pt) \cdot Crv'(t)\).
- **See also**: SymbDistCrvPoint, MvarDistSrfPoint,
11.2.212 SymbMakePosCrvCtlPolyPos (curvature.c:528)

CagdCrvStruct **SymbMakePosCrvCtlPolyPos(const CagdCrvStruct *OrigCrv)

OrigCrv: To refine until all its control points are non negative.

Returns: Refined positive curve with positive control points.

Description: Given a scalar curve that is positive, refine it until all its control points has positive coefficients. Always returns a Bspline curve.

11.2.213 SymbMeshAddSub (symb_crv.c:966)

void SymbMeshAddSub(CagdRType **DestPoints,
                     CagdRType * const *Points1,
                     CagdRType * const *Points2,
                     CagdPointType PType,
                     int Size,
                     CagdBType OperationAdd)

DestPoints: Where addition or difference result should go to.
Points1: First control polygon/mesh.
Points2: Second control polygon/mesh.
PType: Type of points we are dealing with.
Size: Length of each vector in Points1/2.
OperationAdd: TRUE of addition, FALSE for subtraction.

Returns: void

Description: Given two control polygons/meshes - add them coordinate wise. If mesh is rational, weights are assumed identical and are just copied.
See also: SymbSrfSub, SymbSrfAdd,

11.2.214 SymbNormal2ConesForSrf (nrmlcone.c:488)

int SymbNormal2ConesForSrf(const CagdSrfStruct *Srf,
                            CagdRType ExpandingFactor,
                            SymbNormalConeStruct *Cone1,
                            SymbNormalConeStruct *Cone2)

Srf: To compute the normal 2cones for.
ExpandingFactor: Factor to expand placement of 2cones axes locations.
Cone1, Cone2: The two cones to compute or ConeAngle == M_PI if error.

Returns: TRUE if successful, FALSE otherwise.

Description: Computes a 2cones bound to the normal field of surface Srf. The 2cones bound the normal field in the common intersection space. The 2cones are computed using the regular normal cone by expanding in the direction orthogonal to the cone axis and its main principal component. The expansion is done an amount that is equal to regular cone radius times ExpandingFactor.
See also: SymbNormalConeForSrf, SymbNormalConeOverlap, SymbTangentConeForCrv,

11.2.215 SymbNormalConeForSrf (nrmlcone.c:207)

const SymbNormalConeStruct *SymbNormalConeForSrf(const CagdSrfStruct *Srf)

Srf: To compute a normal cone for.

Returns: The computed normal cone, statically allocated, or NULL if failed.

Description: Computes a normal cone for a given surface, by computing the normal field of the surface and deriving the angular span of this normal field by testing the angular span of all control vector in the normal field. A normal field is searched for as "_NormalSrf" attribute in Srf or computed locally of no such attribute is found.
See also: SymbNormalConeForSrfOpt, SymbNormalConeForSrfAvg, SymbTangentConeForCrv, , SymbNormalConeForSrfDoOptimal,
11.2.216 SymbNormalConeForSrfAvg (nrmlcone.c:237)

const SymbNormalConeStruct *SymbNormalConeForSrfAvg(const CagdSrfStruct *Srf)

Srf: To compute a normal cone for.

Returns: The computed normal cone, statically allocated, or NULL if failed.

Description: Computes a normal cone for a given surface, by computing the normal field of the surface and
deriving the angular span of this normal field by testing the angular span of all control vectors in the normal
field. A normal field is searched for as "NormalSrf" attribute in Srf or computed locally if no such attribute is found.

See also: SymbNormalConeForSrfOpt, SymbNormalConeOverlap, SymbTangentConeForCrv, SymbNormalConeForSrfDoOptimal, SymbNormalConeForSrf.

11.2.217 SymbNormalConeForSrfDoOptimal (nrmlcone.c:176)

int SymbNormalConeForSrfDoOptimal(int Optimal)

Optimal: New setting.

Returns: Previous setting.

Description: Sets whether to use an optimal (but slower) algorithm to compute bounding cones for normals or
use a simple vector averaging that is faster.

See also: SymbNormalConeForSrfAvg, SymbNormalConeForSrfOpt,

11.2.218 SymbNormalConeForSrfMainAxis (nrmlcone.c:409)

const SymbNormalConeStruct *SymbNormalConeForSrfMainAxis(const CagdSrfStruct *Srf, CagdVType MainAxis)

Srf: To compute normal cone and main axis of normal cone for.

MainAxis: Main axis (principal component) of the normal cone's vectors distribution.

Returns: The computed normal cone, statically allocated, or NULL if failed.

Description: Same as SymbNormalConeForSrf but also estimates a main axis (principal component) for the
cone, A normal field is searched for as "NormalSrf" attribute in Srf or computed locally if no such attribute is found.

See also: SymbNormalConeForSrf, SymbNormalConeOverlap, SymbTangentConeForCrv,

11.2.219 SymbNormalConeForSrfOpt (nrmlcone.c:330)

const SymbNormalConeStruct *SymbNormalConeForSrfOpt(const CagdSrfStruct *Srf)

Srf: To compute a normal cone for.

Returns: The computed normal cone, statically allocated, or NULL if failed.

Description: Computes the optimal normal cone for a given surface, using linear prog.

See also: SymbNormalConeForSrfAvg, GMinMaxSpanCone, SymbNormalConeForSrfDoOptimal, SymbNormalConeForSrf,

11.2.220 SymbNormalConeOverlap (nrmlcone.c:564)

CagdBType SymbNormalConeOverlap(const SymbNormalConeStruct *NormalCone1, const SymbNormalConeStruct *NormalCone2)

NormalCone1, NormalCone2: The two normal cones to test for angular overlap.

Returns: TRUE if overlap, FALSE otherwise.

Description: Tests if the given two normal cones overlap or not.

See also: SymbNormalConeOverlap,
11.2.221 SymbNormalConvexHullConeForSrf (nrmlcone.c:595)

SymbNormalConeStruct *SymbNormalConvexHullConeForSrf(const CagdSrfStruct *Srf,
CagdRType ***CH,
int *NPts)

Srf: To compute the conical hull for.

CH: The vectors of the convex conical hull to compute. CH[i][j] is the i'th coordinate of the j'th vector.

NPts: Contain the number of vectors in CH.

Returns: A circular normal cone as a by product.

Description: Computes the convex conical hull of the normal field of surface Srf. The result is returned as an array of subset of vectors from the field.

See also: SymbNormalConvexHullConeOverlap.

11.2.222 SymbNormalConvexHullConeOverlap (nrmlcone.c:745)

CagdBType SymbNormalConvexHullConeOverlap(const SymbNormalConeStruct *NormalCone1,
const CagdRType **CH1,
int NPts1,
const SymbNormalConeStruct *NormalCone2,
const CagdRType **CH2,
int NPts2)

NormalCone1: The normal cone of the first surface.

CH1: The convex conical hull of the first surface.

NPts1: Number of points in the convex conical of the first surface.

NormalCone2: The normal cone of the second surface.

CH2: The convex conical hull of the second surface.

NPts2: Number of point in the convex conical of the second surface.

Returns: TRUE if overlap, FALSE otherwise.

Description: Tests if the given two convex conical hulls overlap or not.

See also: SymbNormalConvexHullConeForSrf.

11.2.223 SymbPiecewiseRuledSrfApprox (prisa.c:128)

CagdSrfStruct *SymbPiecewiseRuledSrfApprox(const CagdSrfStruct *CSrf,
CagdBType ConsistentDir,
CagdRType Epsilon,
CagdSrfDirType Dir)

CSrf: To approximate using piecewise ruled surfaces.

ConsistentDir: Do we want parametrization to be the same as Srf?

Epsilon: Accuracy of piecewise ruled surface approximation.

Dir: Direction of piecewise ruled surface approximation. Either U or V.

Returns: A list of ruled surfaces approximating Srf to within Epsilon in direction Dir.

Description: Constructs a piecewise ruled surface approximation to the given surface, Srf, in the given direction, Dir, that is close to the surface to within Epsilon. If ConsistentDir then ruled surface parametrization is set to be the same as original surface Srf. Otherwise, ruling dir is always CAGD_CONST_DIR. Surface is assumed to have point types E3 or P3 only.

See also: SymbAllPrisaSrfs, SymbPrisaRuledSrf, TrimAllPrisaSrfs,
11.2.224  SymbPlaneLineBisect (smp_skel.c:963)

CagdSrfStruct *SymbPlaneLineBisect(const CagdVType LineDir, CagdRType Size)

*LineDir*: Direction of line from origin. Must be in northern hemisphere.
*Size*: Portion of result as it is infinite.

*Returns*: Constructed bisector surface.

*Description*: Compute the bisector surface between the XY plane and a line emanating from the origin in direction V.
*See also*: SymbPtCrvBisectOnSphere, SymbPlanePointBisect, SymbCylinPointBisect, SymbConePointBisect, SymbSpherePointBisect, SymbCylinPointBisect, SymbSphereLineBisect, SymbConePlaneBisect, SymbCylinPlaneBisect, SymbSpherePlaneBisect, SymbConeSphereBisect, SymbTorusSphereBisect, SymbConeConeBisect, SymbConeCylinBisect, SymbCylinCylinBisect,

11.2.225  SymbPlanePointBisect (smp_skel.c:701)

CagdSrfStruct *SymbPlanePointBisect(const CagdPType Pt, CagdRType Size)

*Pt*: Direction of line from origin.
*Size*: Portion of result as it is infinite.

*Returns*: Constructed bisector surface.

*Description*: Compute the bisector surface between the XY plane and a point.
*See also*: SymbPtCrvBisectOnSphere, SymbCylinPointBisect, SymbConePointBisect, SymbSpherePointBisect, SymbTorusPointBisect, SymbCylinPlaneBisect, SymbSpherePlaneBisect, SymbConePlaneBisect, SymbCylinPlaneBisect, SymbSpherePlaneBisect, SymbConeSphereBisect, SymbTorusSphereBisect, SymbConeConeBisect, SymbConeCylinBisect, SymbCylinCylinBisect,

11.2.226  SymbPrisaGetCrossSections (prisa.c:499)

CagdCrvStruct *SymbPrisaGetCrossSections(const CagdSrfStruct *RSrfs,
                                       CagdSrfDirType Dir,
                                       const CagdVType Space)

*RSrfs*: A list of ruled surfaces to extract cross sections from.
*Dir*: Ruling direction of ruled/developable surface approximation. Typically CAGD_CONST_U_DIR.
*Space*: Increment on Y on the offset vector, after this cross section was placed in the XY plane.

*Returns*: A list of cross sections. The cross sections will be in the XY plane the cross section is indeed planar or approximately in the XY plane otherwise.

*Description*: Given a list of n ruled surface in 3-space, extract their cross sections and return a list of n+1 cross sections. The given ruled surfaces are assumed to be a layout decomposition of a freeform surface using the function SymbPiecewiseRuledSrfApprox.
*See also*: SymbPrisaRuledSrf, SymbPiecewiseRuledSrfApprox, SymbAllPrisaSrfs, SymbPrisaGetOneCrossSection,

11.2.227  SymbPrisaGetOneCrossSection (prisa.c:581)

CagdCrvStruct *SymbPrisaGetOneCrossSection(const CagdSrfStruct *RSrf,
                                           CagdSrfDirType Dir,
                                           CagdBType Starting,
                                           CagdBType Ending)

*RSrf*: A ruled surface to extract cross section(s) from.
*Dir*: Ruling direction of ruled/developable surface approximation. Typically CAGD_CONST_U_DIR.

Starting: If TRUE, extracts the first cross section.
Ending: If TRUE, extracts the last cross section.
Returns: A list of one or two cross sections. The cross sections will be in the XY plane the cross section is indeed planar or approximately in the XY plane otherwise.

Description: Given a ruled surface in 3-space, extract its starting/ending cross sections and return a list of one or two cross sections. The given ruled surface is assumed to be a layout decomposition of a freeform surface using the function SymbPiecewiseRuledSrfApprox.

See also: SymbPrisaRuledSrf, SymbPiecewiseRuledSrfApprox, SymbAllPrisaSrfs, SymbPrisaGetCrossSections,

11.2.228 SymbPrisaRuledSrf (prisa.c:355)

CagdSrfStruct *SymbPrisaRuledSrf(const CagdSrfStruct *Srf,
                                    int SamplesPerCurve,
                                    CagdRType Space,
                                    CagdVType Offset)

Srf: A ruled surface to layout flat on the XY plane.
SamplesPerCurve: During the approximation of a ruled surface as a developable surface.
Space: Increment on Y on the offset vector, after this surface was placed in the XY plane.
Offset: A vector in the XY plane to denote the amount of translation for the flatten surface in the XY plane.

Returns: A planar surface in the XY plane approximating the flatterning process of Srf.

Description: Layout a single ruled surface, by approximating it as a set of polygons. The given ruled surface might be non-developable, in which case approximation will be of a surface with no twist. The ruled surface is assumed to be constructed using CagdRuledSrf and that the ruled direction is consistent and is always CAGD_CONST_V_DIR.

See also: SymbPiecewiseRuledSrfApprox, SymbAllPrisaSrfs, TrimAllPrisaSrfs,

11.2.229 SymbPrmtSclrCrvTo2D (symb.crv.c:1287)

CagdCrvStruct *SymbPrmtSclrCrvTo2D(const CagdCrvStruct *Crv,
                                        CagdRType Min,
                                        CagdRType Max)

Crv: Scalar curve to promote to a two dimensional one.
Min: Minimum of new monotone X axis.
Max: Maximum of new monotone X axis.

Returns: A two dimensional curve.

Description: Promote a scalar curve to two dimensions by moving the scalar axis to be the Y axis and adding monotone X axis.

See also: SymbPrmtSclrSrfTo3D,

11.2.230 SymbPrmtSclrSrfTo3D (symb.srf.c:1240)

CagdSrfStruct *SymbPrmtSclrSrfTo3D(const CagdSrfStruct *Srf,
                                        CagdRType UMin,
                                        CagdRType UMax,
                                        CagdRType VMin,
                                        CagdRType VMax)

Srf: Surface to promote from one to three dimensions.
UMin: Minimum of new monotone X axis.
UMax: Maximum of new monotone X axis.
VMin: Minimum of new monotone Y axis.
VMax: Maximum of new monotone Y axis.

Returns: A three dimensional surface.

Description: Promote a scalar surface to three dimensions by moving the scalar axis to be the Z axis and adding monotone X and Y axes.

See also: SymbPrmtSclrCrvTo2D,
11.2.231 SymbPtCrvBisectOnSphere (smp_skel.c:65)

CagdCrvStruct *SymbPtCrvBisectOnSphere(const CagdPType Pt, const CagdCrvStruct *CCrv)

Pt: A point on the unit sphere, on the northern hemisphere.
CCrv: A curve on the unit sphere, on the northern hemisphere.

Returns: The bisector curve on Z = 1 plane to be centrally projected onto the unit sphere as the spherical bisector.

Description: Computes the bisector curve on a sphere of a point and a curve, both assumed to be on the unit sphere. The following assumptions are made and must be met for proper answer:

1. Both the curve and the point are indeed on the unit sphere.
2. Both the curve and the point are on the northern hemisphere. That is the Z coefficients of all points on both Pt and Crv are positive. The end result is NOT a curve on the sphere but rather a rational curve in the Z = 1 plane whose central projection onto the sphere (i.e. normalization) would yield the proper bisector on the unit sphere. Let P be the bisector point. Then, the following must be satisfied:

\[ < P, Pt > = < P, C(t) > \] (Equality of angular distance)
\[ < P - C(t), C'(t) > = 0 \] (orthogonality of distance measure)
\[ < P, (0, 0, 1) > = 1 \] (containment in the Z = 1 plane, or Pz = 1)

Note we have only two unknowns (Px, Py) as Pz equals 1.

See also: SymbCrvCrvBisectOnSphere,

11.2.232 SymbPtCrvBisectOnSphere2 (smp_skel.c:184)

CagdCrvStruct *SymbPtCrvBisectOnSphere2(const CagdPType Pt, const CagdCrvStruct *CCrv, CagdRType SubdivTol)

Pt: A point on the unit sphere, on the northern hemisphere.
CCrv: A curve on the unit sphere, on the northern hemisphere.
SubdivTol: Accuracy of piecewise linear approximation.

Returns: A piecewise linear curve approximating the bisector of Crv1 and Crv2 on the sphere.

Description: Computes the bisector on a sphere between a point and a curve on the sphere. The returned result is a piecewise linear curve on the sphere.

See also: SymbPtCrvBisectOnSphere, SymbCrvCrvBisectOnSphere,

11.2.233 SymbRflctCircFree (rflct_ln.c:345)

void SymbRflctCircFree(CagdSrfStruct *Srf, const char *AttribName)

Srf: Surface to free its internal data sets saved as attributes.
AttribName: Name of the attribute to free.

Returns: void

Description: Free the internal data sets, if any of the given surface, toward the computation of the reflection circles, as created by SymbRflctCircPrepSrf.

See also: SymbRflctCircPrepSrf, SymbRflctCircGen,
### 11.2.234 SymbRflctCircGen (rflct(ln.c:303)

```c
CagdSrfStruct *SymbRflctCircGen(CagdSrfStruct *Srf,
    const CagdVType ViewDir,
    const CagdPType SprCntr,
    CagdRType ConeAngle,
    const char *AttribName)
```

**Srf**: Surface to preprocess.

**ViewDir**: Direction of view.

**SprCntr**: Center of sphere that reflection lines should be tangent to.

**ConeAngle**: Opening angle assumed for a cone holding the sphere with the apex of the cone at \( S(u, v) \), in degrees.

**AttribName**: Name of the attribute to get the reflection line data set by, or NULL to employ a default attribute name. Useful for multiple reflection lines' directions computation.

**Returns**: A scalar surface whose zero set is the reflection circles sought on Srf.

**Description**: Compute the reflection circles through a sphere centered at SprCntr off the given surface. The surface is assumed to have been preprocessed in SymbRflctCircPrepSrf for the requested preprocessed named attribute, or otherwise SymbRflctCircPrepSrf will be invoked on the fly.

**See also**: SymbRflctCircPrepSrf, SymbRflctCircFree.

### 11.2.235 SymbRflctCircPrepSrf (rflct(ln.c:234)

```c
void SymbRflctCircPrepSrf(CagdSrfStruct *Srf,
    const CagdVType ViewDir,
    const CagdPType SprCntr,
    const char *AttribName)
```

**Srf**: Surface to preprocess.

**ViewDir**: Direction of view.

**SprCntr**: Center of sphere that reflection lines should be tangent to.

**AttribName**: Name of the attribute to save the reflection line data set by, or NULL to employ a default attribute name. Useful for multiple reflection circle's computation.

**Returns**: void

**Description**: Precompute the necessary data set for as efficient as possible reflection circles’ extractions. Data set is kept as an attribute on the surface.

**See also**: SymbRflctCircGen, SymbRflctCircFree.

### 11.2.236 SymbRflctLnFree (rflct(ln.c:187)

```c
void SymbRflctLnFree(CagdSrfStruct *Srf, const char *AttribName)
```

**Srf**: Surface to free its internal data sets saved as attributes.

**AttribName**: Name of the attribute to free.

**Returns**: void

**Description**: Free the internal data sets, if any of the given surface, toward the computation of the reflection lines, as created by SymbRflctLnPrepSrf.

**See also**: SymbRflctLnPrepSrf, SymbRflctLnGen,
11.2.237 SymbRflctLnGen (rflct_ln.c:141)

CagdSrfStruct *SymbRflctLnGen(CagdSrfStruct *Srf,
    const CagdVType ViewDir,
    const CagdPType LnPt,
    const CagdVType LnDir,
    const char *AttribName)

Srf: Surface to preprocess.
ViewDir: Direction of view.
LnPt: Point on a reflection line.
LnDir: Direction of reflection line.
AttribName: Name of the attribute to get the reflection line data set by, or NULL to employ a default
attribute name. Useful for multiple reflection lines’ directions computation.

Returns: A scalar surface whose zero set is the reflection line sought on Srf.

Description: Compute the reflection line through LnPt off the given surface. The surface is assumed to have
been preprocessed in SymbRflctLnPrepSrf for the requested preprocessed named attribute, or otherwise SymbRflctLnPrepSrf
will be invoked on the fly.

See also: SymbRflctLnPrepSrf, SymbRflctLnFree,

11.2.238 SymbRflctLnPrepSrf (rflct_ln.c:91)

void SymbRflctLnPrepSrf(CagdSrfStruct *Srf,
    const CagdVType ViewDir,
    const CagdVType LnDir,
    const char *AttribName)

Srf: Surface to preprocess.
ViewDir: Direction of view.
LnDir: Direction of reflection line.
AttribName: Name of the attribute to save the reflection line data set by, or NULL to employ a default
attribute name. Useful for multiple reflection lines’ directions computation.

Returns: void

Description: Precompute the necessary data set for as efficient as possible reflection lines’ extractions. Data
set is kept as an attribute on the surface. Note that only the direction of the reflection line is employed at this time,
and exact location will be required by SymbRflctLnGen only.

See also: SymbRflctLnGen, SymbRflctLnFree,

11.2.239 SymbRingRingIntersection (rrinter.c:872)

CagdCrvStruct *SymbRingRingIntersection(CagdCrvStruct *C1,
    CagdCrvStruct *r1,
    CagdCrvStruct *C2,
    CagdCrvStruct *r2,
    CagdRType SubdivTol,
    CagdCrvStruct **PCrvs1,
    CagdCrvStruct **PCrvs2)

C1, r1: The two curves prescribing the first ring surface. Must be integral curves.
C2, r2: The two curves prescribing the second ring surface. Must be integral curves.
SubdivTol: Accuracy of zero set computation as part of the solution. Value of 0.01 is a good start.
PCrvs1, PCrvs2: The parametric domains of the intersection curves, in the two surfaces.

Returns: Intersection curves in Euclidean space.

Description: Computes the intersection curve of two ring surfaces:
\[ S_1(u, t) = C_1(u) + \text{Circ}_1(t) \, r_1(u) \]
\[ S_2(v, s) = C_2(v) + \text{Circ}_2(s) \, r_2(v) \]

where Circ1 and Circ2 are oriented to be in the normal plane of C1/C2. The intersection is derived from the zero set of the function that is computed by SymbRingRingZeroSetFunc.

See also: SymbRingRingZeroSetFunc,

11.2.240 SymbRingRingZeroSetFunc (rrinter.c:1040)

\[
\begin{align*}
\text{CagdSrfStruct} \ast \text{SymbRingRingZeroSetFunc}(\text{CagdCrvStruct} \ast C_1, \\
& \text{CagdCrvStruct} \ast r_1, \\
& \text{CagdCrvStruct} \ast C_2, \\
& \text{CagdCrvStruct} \ast r_2)
\end{align*}
\]

C1, r1: The two curves prescribing the first ring surface. Must be integral curves.
C2, r2: The two curves prescribing the second ring surface. Must be integral curves.

Returns: \(F(u, v)\).

Description: Computes the intersection curve of two ring surfaces:

\[
\begin{align*}
S_1(u, t) &= C_1(u) + \text{Circ}_1(t) \, r_1(u) \\
S_2(v, s) &= C_2(v) + \text{Circ}_2(s) \, r_2(v)
\end{align*}
\]

where Circ1 and Circ2 are oriented to be in the normal plane of C1/C2.

Let \(n_1(u)\) and \(n_2(v)\) be the normals of the normal plane of C1/C2, \(n_1(u) = C_1'(u), n_2(v) = C_2'(v)\). Then, solve for \(x(u, v), y(u, v), z(u, v)\)

\[
\begin{vmatrix}
| n_1(u) | & | x | & < n_1(u), C_1(u) > \\
| n_2(v) | & | y | = | < n_2(v), C_2(v) > \\
| C_1(u) - C_2(v) | & | z | & ( < C_1(u), C_1(u) > - < C_2(v), C_2(v) > ) + r_2^2(v) - r_1^2(u) \right) / 2
\end{vmatrix}
\]

Let \(P(u, v) = (x(u, v), y(u, v), z(u, v))\). Find the zero set of \(F(u, v): < P(u, v) - C_1(u), P(u, v) - C_1(u) > - r_1^2(u) = 0\), or, alternatively, the zero set of \(F(u, v): < P(u, v) - C_2(v), P(u, v) - C_2(v) > - r_2^2(v) = 0\).

See also: SymbRingRingIntersection,

11.2.241 SymbRmKntBspCrvCleanKnots (bspkntrm.c:251)

\[
\begin{align*}
\text{CagdCrvStruct} \ast \text{SymbRmKntBspCrvCleanKnots}(\text{const CagdCrvStruct} \ast \text{Crv})
\end{align*}
\]

Crv: Curve to remove knot from.

Returns: The new curve after removal.

Description: Remove only knots which do not change the given curve.

See also: SymbRmKntBspCrvRemoveKnots, SymbRmKntBspCrvRemoveKnotsError,

11.2.242 SymbRmKntBspCrvRemoveKnots (bspkntrm.c:206)

\[
\begin{align*}
\text{CagdCrvStruct} \ast \text{SymbRmKntBspCrvRemoveKnots}(\text{const CagdCrvStruct} \ast \text{CCrv}, \\
& \text{CagdRTType} \, \text{Tolerance})
\end{align*}
\]

CCrv: Curve to remove knots from.

Tolerance: Desired accuracy to be kept, in L-infinity norm.

Returns: The new curve after removal.

Description: Remove knots while Tolerance is kept.

See also: SymbRmKntBspCrvCleanKnots,
11.2.243 SymbRuledRuledIntersection (rrinter.c:144)

CagdCrvStruct *SymbRuledRuledIntersection(CagdCrvStruct *C1,
CagdCrvStruct *C2,
CagdCrvStruct *D1,
CagdCrvStruct *D2,
CagdRTtype SubdivTol,
CagdCrvStruct **PCrvs1,
CagdCrvStruct **PCrvs2)

C1, C2: The two curves forming the first ruled surface.
D1, D2: The two curves forming the second ruled surface.
SubdivTol: Accuracy of zero set computation as part of the solution. Value of 0.01 is a good start. If
SubdivTol is negative the ruled surfaces are assumed infinite (and absolute value of SubdivTol is employed).
Otherwise, the ruled surface is bound between C1 and C2 and between D1 and D2 respectively.
PCrvs1, PCrvs2: The parametric domains of the intersection curves, in the two surfaces.
Returns: Intersection curves in Euclidean space.

Description: Computes the intersection curve of two ruled surfaces:

\begin{align*}
S1(u, t) &= t \ C1(u) + (1-t) \ C2(u) \\
S2(v, s) &= s \ D1(v) + (1-s) \ D2(s)
\end{align*}

Then \( S1(u, t) = S2(v, s) \) yields,

\[
C1(u) - D1(v) = s \ (C1(u) - C2(u)) + t \ (D2(v) - D1(v))
\]

or solve for the zero set of the determinant of,

\[
\Gamma(u, v) = \begin{vmatrix} C1(u) - D1(u) \\ C1(u) - C2(u) \\ D1(v) - D2(v) \end{vmatrix} = 0
\]

11.2.244 SymbRuledRuledZeroSetFunc (rrinter.c:80)

CagdSrfStruct *SymbRuledRuledZeroSetFunc(CagdCrvStruct *C1,
CagdCrvStruct *C2,
CagdCrvStruct *D1,
CagdCrvStruct *D2)

C1, C2: The two curves forming the first ruled surface.
D1, D2: The two curves forming the second ruled surface.
Returns: Gamma(u, v).

Description: Computes the intersection curve of two ruled surfaces:

\begin{align*}
S1(u, t) &= t \ C1(u) + (1-t) \ C2(u) \\
S2(v, s) &= s \ D1(v) + (1-s) \ D2(s)
\end{align*}

Then \( S1(u, t) = S2(v, s) \) yields,

\[
C1(u) - D1(v) = s \ (C1(u) - C2(u)) + t \ (D2(v) - D1(v))
\]

or solve for the zero set of the determinant of,

\[
\Gamma(u, v) = \begin{vmatrix} C1(u) - D1(u) \\ C1(u) - C2(u) \\ D1(v) - D2(v) \end{vmatrix} = 0
\]
11.2.245  SymbRuledSelfIntersection (rrinter.c:600)

CagdCrvStruct *SymbRuledSelfIntersection(CagdCrvStruct *C1,
CagdCrvStruct *C2,
CagdRType SubdivTol,
CagdCrvStruct **PCrvs1,
CagdCrvStruct **PCrvs2)

C1, C2: The two curves forming the ruled surface.
SubdivTol: Accuracy of zero set computation as part of the solution. Value of 0.01 is a good start. If SubdivTol is negative the ruled surfaces are assumed infinite (and absolute value of SubdivTol is employed). Otherwise, the ruled surface is bound between C1 and C2 and between D1 and D2 respectively.
PCrvs1, PCrvs2: The parametric domains of the intersection curves, in the two surfaces.
Returns: Intersection curves in Euclidean space.
Description: Computes the self intersection curve of a ruled surfaces:

11.2.246  SymbScalarCrvLowDegZeroSet (symbzero.c:296)

CagdPtStruct *SymbScalarCrvLowDegZeroSet(CagdCrvStruct *Crv)

Crv: Low degree polynomial to derive its roots analytically.
Returns: list of zeros.
Description: Computes the zeros of low degree polynomial, analytically.

11.2.247  SymbSetAdapIsoExtractMinLevel (adapiso.c:107)

int SymbSetAdapIsoExtractMinLevel(int MinLevel)

MinLevel: At least that many subdivision will occur.
Returns: Old value of Min subdivision level.
Description: Sets minimum level of subdivision forced in the adaptive iso extraction.

11.2.248  SymbSetFatalErrorFunc (symbftl.c:28)

SymbSetErrorFuncType SymbSetFatalErrorFunc(SymbSetErrorFuncType ErrorFunc)

ErrorFunc: New error function to use.
Returns: Old error function reference.
Description: Sets the error function to be used by SymbLib.

11.2.249  SymbShapeBlendOnSrf (blending.c:155)

CagdSrfStruct *SymbShapeBlendOnSrf(CagdSrfStruct *Srf,
CagdCrvStruct *UVCrv,
const CagdCrvStruct *CrossSecShape,
CagdRType TanScale,
CagdRType Width,
const CagdCrvStruct *WidthField,
CagdRType Height,
const CagdCrvStruct *HeightField)

Srf: Surface to construct the blended shape on, with C^1 continuity.
UVCrv: The curve along which to blend the formed shape, in the parametric domain of the surface. Assumed to be in Srf.

CrossSecShape: The cross section of this blended shape.

TanScale: Scale factor of derived tangent fields.

Width: Of swept shape, in parametric space units.

WidthField: If not NULL, a scaling field to modulate the width of the constructed blended surface.

Height: Of swept shape, in Euclidean space units.

HeightField: If not NULL, a scaling field to modulate the height of the constructed blended surface.

Returns: A newly form swept shape with CrossSecShape as approximated cross section, along UVCrv.

Description: Constructs a surface, $C^1$ tangent to given surface and has the prescribed cross section shape.

See also: SymbShapeBlendSrf

11.2.250 SymbShapeBlendSrf (blending.c:303)

CagdSrfStruct *SymbShapeBlendSrf(const CagdCrvStruct *Pos1Crv,
const CagdCrvStruct *Pos2Crv,
const CagdCrvStruct *CDir1Crv,
const CagdCrvStruct *CDir2Crv,
const CagdCrvStruct *CrossSecShape,
const CagdCrvStruct *Normal)

Pos1Crv, Pos2Crv: Starting and end curves of surface.

CDir1Crv, CDir2Crv: Starting and end tangent fields surface.

CrossSecShape: The shape of the cross section of the blend.

Normal: A unit vector field orthogonal to Pos1Crv - Pos2Crv.

Returns: The blended surface. This surface will equal to - Let $S(t) = (\text{Pos1Crv}(t) + \text{Pos2Crv}(t)) / 2$ Let $D(t) = (\text{Pos2Crv}(t) - \text{Pos1Crv}(t)) / 2$ Then $S(t, r) = H_0(r) * \text{Dir1Crv}(t) + H_1(r) * \text{Dir2Crv}(t) + S(t) + D(t) * \text{CrossSecShape}_x(r) \text{Normal}(t) * \text{CrossSecShape}_y(r)$ where $H$ are the cubic Hermite functions for the two tangent fields.

Description: Construct a surface that interpolates Pos1Crv and Pos2Crv so that the surface is tangent to Dir1Crv and Dir2Crv there. CrossSecShape is a blending shape curve that must satisfy the following (CrossSecShape is $C(t)$, $t$ in $[0, 1]$): $C(0) = (-1, 0)$, $C(1) = (1,0)$, $C'(0) = (0, 0)$, $C'(1) = (0, 0)$.

See also: CagdCubicHermiteSrf, SymbShapeBlendOnSrf

11.2.251 SymbSignedCrvtrGenCrv (crvtrrec.c:140)

CagdCrvStruct *SymbSignedCrvtrGenCrv(const CagdCrvStruct *Crvtr,
CagdRType Tol,
int Order,
int Periodic)

Crvtr: The signed curvature signature to reconstruct. Assumed to be a piecewise polynomial arc-length function.

Tol: Tolerance of approximations (arclen/subdivision) of curves.

Order: Order of output, approximated curve. At least quadratic.

Periodic: If TRUE, teh reconstructed curve is periodic so shift the result to be closed.

Returns: Reconstructed planar curve, in the XY plane. This result is invariant to rotations and translations.

Description: Reconstructs a planar curve from the given arc-length curvature signature. The reconstruction is conducted as follows:

1. $\Theta(s) = \int(Crvtr(s))$, the angular changes as function of $s$.
2. $T(s) = \text{Circ}(\Theta(s))$, the tangent field of the reconstructed curve.
3. $C(s) = \int(T(s))$, the final curve.

See also: SymbCrvGenSignedCrvtr,
11.2.252 SymbSphereLineBisect (smp_skel.c:1104)

CagdSrfStruct *SymbSphereLineBisect(const CagdPType SprCntr,
                                     CagdRType SprRad,
                                     CagdRType Size)

SprCntr: Center location of the sphere.
SprRad: Radius of sphere.
Size: Portion of result as it is infinite.
Returns: Constructed bisector surface.

Description: Compute the bisector surface between a sphere and a line. The computation is reduced to that of a bisector between a point and a cylinder, that has a rational form. The line is assumed to be the Z axis.

See also: SymbPlanePointBisect, SymbCylinPointBisect, SymbConePointBisect, SymbSpherePointBisect, SymbTorusPointBisect, SymbConeLineBisect, SymbPlaneLineBisect, SymbConePlaneBisect, SymbCylinPlaneBisect, SymbSpherePlaneBisect, SymbConeSphereBisect, SymbTorusSphereBisect, SymbConeConeBisect, SymbConeConeBisect2, SymbCylinCylinBisect, SymbConeCylinBisect, SymbCylinCylinBisect.

11.2.253 SymbSpherePlaneBisect (smp_skel.c:1153)

CagdSrfStruct *SymbSpherePlaneBisect(const CagdPType SprCntr,
                                      CagdRType SprRad,
                                      CagdRType Size)

SprCntr: Center location of the sphere. Must be in northern hemisphere (positive Z coefficient).
SprRad: Radius of sphere.
Size: Portion of result as it is infinite.
Returns: Constructed bisector surface.

Description: Compute the bisector surface between a sphere and the XY plane. The computation is reduced to that of a bisector between a point and a plane, that has a rational form. Only the portion for which Z > 0 should be considered in the output.

See also: SymbPlanePointBisect, SymbCylinPointBisect, SymbConePointBisect, SymbSpherePointBisect, SymbTorusPointBisect, SymbConeLineBisect, SymbSphereLineBisect, SymbPlaneLineBisect, SymbConePlaneBisect, SymbCylinPlaneBisect, SymbSpherePlaneBisect, SymbConeSphereBisect, SymbTorusSphereBisect, SymbConeConeBisect, SymbConeConeBisect2, SymbCylinCylinBisect, SymbConeCylinBisect, SymbCylinCylinBisect.

11.2.254 SymbSpherePointBisect (smp_skel.c:860)

CagdSrfStruct *SymbSpherePointBisect(const CagdPType SprCntr,
                                        CagdRType SprRad,
                                        const CagdPType Pt)

SprCntr: Center location of the sphere.
SprRad: Radius of sphere.
Pt: Direction of line from origin.
Returns: Constructed bisector surface.

Description: Compute the bisector surface between a sphere and a point.

See also: SymbPtCrvBisectOnSphere, SymbPlanePointBisect, SymbCylinPointBisect, SymbConePointBisect, SymbTorusPointBisect, SymbConePlaneBisect, SymbCylinPlaneBisect, SymbSpherePlaneBisect, SymbConeLineBisect, SymbSphereLineBisect, SymbCylinSphereBisect, SymbSphereSphereBisect, SymbConeSphereBisect, SymbTorusSphereBisect, SymbConeConeBisect2, SymbCylinCylinBisect, SymbConeCylinBisect, SymbCylinCylinBisect.
11.2.255  SymbSphereSphereBisect (smp\skel.c:1365)

CagdSrfStruct *SymbSphereSphereBisect(const CagdVType SprCntr1,
CagdRType SprRad1,
const CagdVType SprCntr2,
CagdRType SprRad2)

SprCntr1: Center location of the first sphere.
SprRad1: Radius of first sphere.
SprCntr2: Center location of the second sphere.
SprRad2: Radius of second sphere.

Returns: Constructed bisector surface.

Description: Compute the bisector surface between two spheres. The computation is reduced to that of a
bisector between a point and a sphere, that has a rational form.

See also: SymbPlanePointBisect, SymbCylinPointBisect, SymbConePointBisect, SymbSpherePointBisect, SymbTorus-
PointBisect, SymbConeLineBisect, SymbSphereLineBisect, SymbPlaneLineBisect, SymbConePlaneBisect, Symb
SpherePlaneBisect, SymbCylinSphereBisect, SymbConeSphereBisect, SymbTorusSphereBisect, SymbConeConeBisect,
SymbConeConeBisect2, SymbConeCylinBisect, SymbCylinCylinBisect, SymbConeConeBisect,
SymbConeConeBisect2, SymbConeCylinBisect, SymbCylinCylinBisect,

11.2.256  SymbSplitCrvsAtExtremums (crv\jeanv.c:73)

CagdCrvStruct *SymbSplitCrvsAtExtremums(const CagdCrvStruct *CCrvs,
int Axis,
const CagdPType Pt,
CagdRType Eps)

CCrvs: Input list of curves to split at all extremum values the curves assumes.
Axis: Extremum to consider: 0 - Radials silhouette as viewed from Pt. 1,2 - Look for extremum (silhouette)
in X,Y dir.
Pt: If radial silhouette are sought, use this as Eye location.
Eps: Tolerance of computations.

Returns: List of splitted curves.

Description: Split the given list of curves at the extremum values of each curve, if any.

See also:

11.2.257  SymbSplitRationalCrvsPoles (symbzero.c:409)

CagdPtStruct *SymbSplitRationalCrvsPoles(const CagdCrvStruct *Crv,
CagdRType Epsilon)

Crv: Rational curves to extract its poles.
Epsilon: The numerical tolerance to use.

Returns: The poles, as piecewise linear approximations.

Description: Computes the poles of a rational surface, solving for the zeros of the surface's denominator.

See also: CagdPointsHasPoles, MvarRationalCrvsPoles,

11.2.258  SymbSrf2Curves (symbpoly.c:201)

CagdCrvStruct *SymbSrf2Curves(const CagdSrfStruct *Srf,
int NumOfIsocurves[2])

Srf: To extract isoparametric curves from.
NumOfIsocurves: In each (U or V) direction.

Returns: List of extracted isoparametric curves. These curves inherit the order and continuity of the original
Srf. NULL is returned in case of an error.

Description: Routine to extract from a surface NumOfIsoline isocurve list in each param. direction. Iso
parametric curves are sampled equally spaced in parametric space. NULL is returned in case of an error, otherwise
list of CagdCrvStruct.

See also: BspSrf2PCurves, BzrSrf2Curves, CagdSrf2Curves,
11.2.259 **SymbSrf2OptPolysBilinPolyError** *(symbsply.c:296)*

```c
CagdRType SymbSrf2OptPolysBilinPolyError(CagdSrfStruct *Srf,
                                          CagdSrfDirType Dir,
                                          int SubdivLevel)
```

**Srf**: To estimate curvature for.
**Dir**: Currently not used.
**SubdivLevel**: Subdivision level of surface.
**Returns**: Curvature estimated.

**Description**: Routine to estimate the curvature of the patch using a bilinear approx.

11.2.260 **SymbSrf2OptPolysCurvatureError** *(symbsply.c:205)*

```c
CagdRType SymbSrf2OptPolysCurvatureError(CagdSrfStruct *Srf,
                                          CagdSrfDirType Dir,
                                          int SubdivLevel)
```

**Srf**: To estimate curvature for.
**Dir**: Currently not used.
**SubdivLevel**: Subdivision level of surface.
**Returns**: Curvature estimated.

**Description**: Routine to estimate the curvature of the patch using \(k_1^2 + k_2^2\). Assumes the availability of the GlblCrvtrSqrSrf for Srf. This estimate is too loose and in fact is not recommended!

11.2.261 **SymbSrf2OptPolysCurvatureErrorPrep** *(symbsply.c:176)*

```c
void SymbSrf2OptPolysCurvatureErrorPrep(const CagdSrfStruct *Srf)
```

**Srf**: To compute the curvature bound for as an optional preprocess for function SymbSrf2OptPolysCurvatureError.
**Returns**: void

**Description**: Routine to compute the scalar field of \(k_1^2 + k_2^2\) (\(k_1, k_2\) are principal curvatures) for the surface Srf, into GlblCrvtrSqrSrf. This scalar field is used by SymbSrf2OptPolysCurvatureError function.

11.2.262 **SymbSrf2OptPolysIsoDirCurvatureErrorPrep** *(symbsply.c:363)*

```c
void SymbSrf2OptPolysIsoDirCurvatureErrorPrep(const CagdSrfStruct *Srf)
```

**Srf**: To compute the curvature bound in the isoparametric direction.
**Returns**: void

**Description**: Routine to precompute the scalar field of \(kn^u\) and \(kn^v\) (the normal curvatures in the iso parametric directions). These scalar fields are used to determined the preferred subdivision location of Srf.
11.2.263  SymbSrf2OptimalPolygons (symbsply.c:412)

CagdPolygonStruct *SymbSrf2OptimalPolygons(
    CagdSrfStruct *Srf,
    CagdRType Tolerance,
    CagdCrvDivStrategyType SubdivDirStrategy,
    CagdCrvErrorFuncType SrfPolyApproxErr,
    CagdErrType ComputeNormals,
    CagdErrType FourPerFlat,
    CagdErrType ComputeUV)

Srf: To convert and approximate using triangles.
Tolerance: Accuracy control.
SubdivDirStrategy: Alternatively in U and V, direction that minimizes the error, etc.
SrfPolyApproxErr: Using bilinear curvature estimate, \( k_1^2 + k_2^2 \) estimate, etc. Bounds the error call back function. If this function returns a negative value, this whole patch is invalidated and no polygons will be created for it.
ComputeNormals: Do we want normals to be computed as well?
FourPerFlat: If TRUE, four triangle per flat surface patch are created, otherwise only two.
ComputeUV: Do we want UV parameter values with the vertices of the triangles?

Returns: Resulting polygons that approximates Srf.

Description: Routine to convert a single surface to a set of triangles approximating it. FineNess is controlled via a function that returns an error measure SrfPolyApproxError that is guaranteed to be less than Tolerance.

11.2.264  SymbSrf2Polygons (symbpoly.c:71)

CagdPolygonStruct *SymbSrf2Polygons(const CagdSrfStruct *Srf,
    int FineNess,
    CagdErrType ComputeNormals,
    CagdErrType FourPerFlat,
    CagdErrType ComputeUV)

Srf: To approximate into triangles.
FineNess: Control on accuracy, the higher the finer.
ComputeNormals: If TRUE, normal information is also computed.
FourPerFlat: If TRUE, four triangles are created per flat surface. If FALSE, only 2 triangles are created.
ComputeUV: If TRUE, UV values are stored and returned as well.

Returns: A list of polygons with optional normal and/or UV parametric information. NULL is returned in case of an error.

Description: Routine to convert a single surface to set of triangles approximating it. FineNess is a fineness control on result and the larger it is more triangles may result. A value of 10 is a good starting value. NULL is returned in case of an error, otherwise list of CagdPolygonStruct.

See also: BzrSrf2Polygons, IritSurface2Polygons, IritTrimSrf2Polygons, , BspSrf2Polygons, TrimSrf2Polygons,

11.2.265  SymbSrf2Polylines (symbpoly.c:130)

CagdPolylineStruct *SymbSrf2Polylines(const CagdSrfStruct *Srf,
    int NumOfIsocurves[2],
    CagdRType TolSamples,
    CagdCrvApproxMethodType Method)

Srf: Srf to extract isoparametric curves from.
NumOfIsocurves: To extract from Srf in each (U or V) direction.
TolSamples: Tolerance of approximation error (Method = 2) or Number of samples to compute on polyline (Method = 0, 1).
Method: 0 - TolSamples are set uniformly in parametric space, 1 - TolSamples are set optimally, considering the isocurve's curvature. 2 - TolSamples sets the maximum error allowed between the piecewise linear approximation and original curve.

Returns: List of polylines representing a piecewise linear approximation of the extracted isoparametric curves or NULL is case of an error.

Description: Routine to convert a single surface to NumOfIsolines polylines in each parametric direction with SamplesPerCurve in each isoparametric curve. Polylines are always E3 of CagdPolylineStruct type. NULL is returned in case of an error, otherwise list of CagdPolylineStruct. Attempt is made to extract isolines along C1 discontinuities first.

See also: BspSrf2Polylines, BzrSrf2Polylines, IritSurface2Polylines, IritTrimSrf2Polylines, TrimSrf2Polylines,

11.2.266 SymbSrfAdd (symb_srf.c:38)

CagdSrfStruct *SymbSrfAdd(const CagdSrfStruct *Srf1,
const CagdSrfStruct *Srf2)

Srf1, Srf2: Two surface to add up coordinatewise.

Returns: The summation of Srf1 + Srf2 coordinatewise.

Description: Given two surfaces - add them coordinatewise. The two surfaces are promoted to same point type before the multiplication can take place. Furthermore, order and continuity are matched as well.

See also: SymbSrfSub, SymbMeshAddSub, SymbSrfMult,

11.2.267 SymbSrfCloseParallelSrfs2Shell (offset.c:698)

CagdSrfStruct *SymbSrfCloseParallelSrfs2Shell(const CagdSrfStruct *Srf1,
const CagdSrfStruct *Srf2)

Srf1, Srf2: The two surfaces to fill in their gaps between their boundaries by new (ruled) surfaces.

Returns: Upto four surfaces that fill in the gaps between the boundaries of Srf1 and Srf2.

Description: Given two parallel surfaces (a surface and its offsets or two offsets of some surface, etc.) builds the (upto) four ruled surfaces that fills in the gaps on the Umin/max, Vmin/max boundaries. Note that if UMin == UMax (VMin == VMax) no new surfaces will be added.

11.2.268 SymbSrfCrossProd (symb_srf.c:437)

CagdSrfStruct *SymbSrfCrossProd(const CagdSrfStruct *Srf1,
const CagdSrfStruct *Srf2)

Srf1, Srf2: Two surface to multiply and compute a cross product for.

Returns: A vectir surface representing the cross product of Srf1 x Srf2.

Description: Given two surfaces - computes their cross product. Returned surface is a scalar surface representing the cross product of the two given surfaces.

See also: SymbSrfDotProd, SymbSrfVecDotProd, SymbSrfScalarScale, SymbSrfMultScalar, SymbSrfInvert, SymbSrfVecCrossProd,

11.2.269 SymbSrfCurvatureUpperBound (curvatur.c:1377)

CagdSrfStruct *SymbSrfCurvatureUpperBound(const CagdSrfStruct *Srf)

Srf: Surface to compute curvature bound for.

Returns: A scalar field representing the curvature bound.

Description: Computes curvature upper bound as Xi = k1^2 + k2^2, where k1 and k2 are the principal curva-
tures. Gij are the coefficients of the first fundamental form and Li,j are of the second, using non unit normal n,
(G11 L22 + G22 L11 - 2 G12 L12)^2 - 2 |G| |L|

Xi = ---------------------------------------------------------------------

|G|^2 ||n||^2


See also: SymbSrfFff, SymbSrfSff, SymbSrfDeterminant2, SymbSrfGaussCurvature, SymbSrfMeanEvolute, SymbSrfMeanCurvatureSqr, SymbSrfMeanNume, , SymbSrfIsoFocalSrf, SymbSrfIsoDirNormalCurvatureBound,

11.2.270 SymbSrfDeterminant2 (curvatur.c:910)

CagdSrfStruct *SymbSrfDeterminant2(const CagdSrfStruct *Srf11,
const CagdSrfStruct *Srf12,
const CagdSrfStruct *Srf21,
const CagdSrfStruct *Srf22)

Srf11, Srf12, Srf21, Srf22: The four factors of the determinant.

Returns: A scalar field representing the determinant computation.

Description: Computes the expression of Srf11 * Srf22 - Srf12 * Srf21, which is a determinant of a 2 by 2 matrix.

See also: SymbSrfFff, SymbSrfSff, SymbSrfGaussCurvature, SymbSrfMeanEvolute, SymbSrfMeanCurvatureSqr, SymbSrfIsoFocalSrf, SymbSrfCurvatureUpperBound, , SymbSrfIsoDirNormalCurvatureBound, SymbSrfDeterminant3, , SymbCrvDeterminant2,

11.2.271 SymbSrfDeterminant3 (crv_skel.c:946)

CagdSrfStruct *SymbSrfDeterminant3(const CagdSrfStruct *Srf11,
const CagdSrfStruct *Srf12,
const CagdSrfStruct *Srf13,
const CagdSrfStruct *Srf21,
const CagdSrfStruct *Srf22,
const CagdSrfStruct *Srf23,
const CagdSrfStruct *Srf31,
const CagdSrfStruct *Srf32,
const CagdSrfStruct *Srf33)

Srf11, Srf12, Srf13: The nine factors of the determinant.

Srf21, Srf22, Srf23: "

Srf31, Srf32, Srf33: "

Returns: A scalar field representing the determinant computation.

Description: Computes the expression of a 3 by 3 determinants.

See also: SymbSrfFff, SymbSrfSff, SymbSrfGaussCurvature, SymbSrfMeanEvolute, , SymbSrfMeanCurvatureSqr, SymbSrfIsoFocalSrf, SymbSrfCurvatureUpperBound, , SymbSrfIsoDirNormalCurvatureBound, SymbSrfDeterminant2, , SymbCrvDeterminant3,

11.2.272 SymbSrfDistCrvCrv (distance.c:497)

CagdSrfStruct *SymbSrfDistCrvCrv(const CagdCrvStruct *Crv1,
const CagdCrvStruct *Crv2,
int DistType)

Crv1, Crv2: The two curves, Crv1(u) and Crv2(v), to form their distance function square between them as a bivariate function.

DistType: 0 for distance vector function, 1 for distance square scalar function, 2 for distance vector projected on the normal of Crv1, 3 for distance vector projected on the normal of Crv2. 4 for distance vector projected on the tangent of Crv1. 5 for distance vector projected on the tangent of Crv2. In cases 2 to 5 the vector field is not normalized.

Returns: The distance function square d2(u, v) of the distance from Crv1(u) to Crv2(v).

Description: Given two curves, creates a bivariate scalar surface representing the distance function square, between them.

See also: SymbCrvCrvInter, SymbSrfDistFindPoints,
11.2.273 SymbSrfDistFindPoints (distance.c:606)

CagdPtStruct *SymbSrfDistFindPoints(const CagdSrfStruct *CSrf,
CagdRTypEpsilon,
CagdBTypSelfInter)

CSrf: A bivariate function that represent the distance square function between two curves.
Epsilon: Accuracy control.
SelfInter: Should we consider self intersection? That is, is Srf computed from a curve to itself?!
Returns: A list of parameter values of both curves, at all detected intersection locations.

Description: Given a scalar surface representing the distance function square between two curves, finds the
zero set of the distance surface, if any, and returns it. The given surface is a non negative surface and zero set is its
minima. The returned points will contain the two parameter values of the two curves that intersect in the detected
zero set points.
See also: SymbSrfDistCrvCrv, SymvCrvCrvInter,

11.2.274 SymbSrfDotProd (symb_srf.c:324)

CagdSrfStruct *SymbSrfDotProd(const CagdSrfStruct *Srf1,
const CagdSrfStruct *Srf2)

Srf1, Srf2: Two surface to multiply and compute a dot product for.
Returns: A scalar surface representing the dot product of Srf1 . Srf2.

Description: Given two surfaces - computes their dot product. Returned surface is a scalar surface representing
the dot product of the two given surfaces.
See also: SymbSrfMult, SymbSrfVecDotProd, SymbSrfScalarScale, SymbSrfMultScalar, , SymbSrfInvert, Symb-
SrfCrossProd, SymbSrfCrossProd,

11.2.275 SymbSrfDual (duality.c:126)

CagdSrfStruct *SymbSrfDual(const CagdSrfStruct *Srf)

Srf: The surface to compute its dual.
Returns: The dual surface.

Description: Computes the dual of the given surface. The dual curve is a mapping of the tangent planes of Srf
(for which Srf is the envelop of) to points in the dual space. Duality is derived by computing the tangent plane "Ax
+ By + Cz + D = 0" to surface Srf and mapping this plane to homogeneous point (A/D, B/D, C/D).
See also: SymbCrvDual,

11.2.276 SymbSrfFff (curvatur.c:741)

void SymbSrfFff(const CagdSrfStruct *Srf,
CagdSrfStruct **DuSrf,
CagdSrfStruct **DvSrf,
CagdSrfStruct **FFFG11,
CagdSrfStruct **FFFG12,
CagdSrfStruct **FFFG22)

Srf: Do compute the coefficients of the FFF for.
DuSrf: First derivative of Srf with respect to U goes to here.
DvSrf: First derivative of Srf with respect to V goes to here.
FFFG11: FFF G11 scalar field.
FFFG12: FFF G12 scalar field.
FFFG22: FFF G22 scalar field.
Returns: void

Description: Computes coefficients of the first fundamental form of given surface Srf.
See also: SymbSrfSff, SymbSrfTff, SymbSrfDeterminant2, SymbSrfGaussCurvature, , SymbSrfMeanEvolute,
SymbSrfMeanCurvatureSqr, SymbSrfIsoFocalSrf, , SymbSrfCurvatureUpperBound, SymbSrfIsoDirNormalCurvature-
11.2.277 SymbSrfFirstMoment (moments.c:296)

CagdRType SymbSrfFirstMoment(const CagdSrfStruct *Srf, int Axis)

Srf: Surface to compute the first moment for.
Axis: 1 for X, 2 for Y, 3 for Z.
Returns: The computed moment.

Description: Computes the first moment of the given surface. The computed moment is for the (signed) volume between the surface and its projection onto the XY plane.
See also: SymbSrfFirstMomentSrf, SymbSrfFirstMomentSrf, SymbSrfVolume.

11.2.278 SymbSrfFirstMomentSrf (moments.c:229)

CagdSrfStruct *SymbSrfFirstMomentSrf(const CagdSrfStruct *Srf, int Axis,
CagdBType Integrate)

Srf: Surface to compute the first moment for.
Axis: 1 for X, 2 for Y, 3 for Z.
Integrate: TRUE to also integrate the resulting surface.
Returns: The computed moment function.

Description: Computes the first moment function of the given surface. The computed moment is for the (signed) volume between the surface and its projection onto the XY plane.
See also: SymbSrfFirstMoment, SymbSrfFirstMomentSrf, SymbSrfVolume.

11.2.279 SymbSrfGaussCurvature (curvatur.c:942)

CagdSrfStruct *SymbSrfGaussCurvature(const CagdSrfStruct *Srf,
CagdBType NumerOnly)

Srf: Surface to compute Gaussian curvature for.
NumerOnly: If TRUE, only the numerator component of K is returned.
Returns: A surface representing the Gaussian curvature field.

Description: Computes the Gaussian curvature of a given surface.
See also: SymbSrfFff, SymbSrfSif, SymbSrfDeterminant2, SymbSrfMeanEvolute, , SymbSrfMeanCurvatureSqr, SymbSrfIsoFocalSrf, SymbSrfCurvatureUpperBound, , SymbSrfIsodiNormalCurvatureBound,

11.2.280 SymbSrfInvert (symb_srf.c:147)

CagdSrfStruct *SymbSrfInvert(const CagdSrfStruct *Srf)

Srf: A scalar surface to compute a reciprocal value for.
Returns: A rational scalar surface that is equal to the reciprocal value of Srf.

Description: Given a scalar surface, returns a scalar surface representing the reciprocal values, by making it rational (if was not one) and flipping the numerator and the denominator.
See also: SymbSrfDotProd, SymbSrfVecDotProd, SymbSrfScalarScale, SymbSrfMultScalar, , SymbSrfMult, SymbSrfCrossProd,
11.2.281 SymbSrfIsoDirNormalCurvatureBound (curvature.c:1460)

CagdSrfStruct *SymbSrfIsoDirNormalCurvatureBound(const CagdSrfStruct *Srf,
                                                  CagdSrfDirType Dir)

Srf: To compute normal curvature in an isoparametric direction Dir.
Dir: Direction to compute normal curvature. Either U or V.

Returns: A scalar field representing the normal curvature square of Srf in direction Dir.

Description: Computes normal curvature bound in given isoparametric direction. This turns out to be \((L_{11} \cdot n) / G_{11}\) for \(u\) and \((L_{22} \cdot n) / G_{22}\) for \(v\). Herein the square of these equations is computed symbolically and returned.

See also: SymbSrfFff, SymbSrfSff, SymbSrfDeterminant2, SymbSrfGaussCurvature, SymbSrfMeanEvolute, SymbSrfMeanCurvatureSqr, SymbSrfMeanNumer, SymbSrfIsoFocalSrf, SymbSrfCurvatureUpperBound,

11.2.282 SymbSrfIsoFocalSrf (curvature.c:1245)

CagdSrfStruct *SymbSrfIsoFocalSrf(const CagdSrfStruct *Srf,
                                     CagdSrfDirType Dir)

Srf: Surface to compute iso focal surface.
Dir: Direction to compute iso focal surface. Either U or V.

Returns: A surface representing the iso focal surface.

Description: Computes a focal surface for a principal curvature in an isoparametric direction. For the \(u\) isoparametric direction,

\[
F(u, v) = \frac{1}{k(u, v)} \frac{G_{11}}{u} \frac{n(u, v)}{u} - \frac{G_{11}}{n}
\]

Because \(L_{ii}\) also has \(n(u,v)\) we can use the nonnormalized surface normal to compute \(F(u, v)\), which is therefore computable and representable.

See also: SymbSrfFff, SymbSrfSff, SymbSrfDeterminant2, SymbSrfGaussCurvature, SymbSrfMeanEvolute, SymbSrfMeanCurvatureSqr, SymbSrfMeanNumer, SymbSrfCurvatureUpperBound, SymbSrfIsoDirNormalCurvatureBound,

11.2.283 SymbSrfIsocline (orthotom.c:332)

IPPolygonStruct *SymbSrfIsocline(const CagdSrfStruct *Srf,
                                  const CagdVType VDir,
                                  CagdRType Theta,
                                  CagdRType SubdivTol,
                                  CagdBType Euclidean)

Srf: To compute its isocline edges.
VDir: View direction vector (a unit vector).
Theta: The fixed angle between the viewing direction and the surface normal, in degrees. An angle of 90 degrees yields the silhouettes.
SubdivTol: Accuracy of computation.
Euclidean: If TRUE, returns the isoclines in Euclidean space. Otherwise, the isocline edges are returned in the Parametric domain.

Returns: The isoclines as piecewise linear edges.

Description: Computes the isocline edges of the given surfaces, orthographically seen from the given view direction VDir, at an inclination angle of Theta degrees. The isocline is a curve with a fixed angle between the surface normal and the viewing direction. An angle of 90 degrees yields the silhouettes. Computed as the zero set of:

\[(<N, V>)^2 - (\cos(\text{Theta}))^2 <N, N>\]

See also: SymbSrfOrthotomic, SymbSrfSilhouette, UserMoldReliefAngle2Srf,
11.2.284  SymbSrfMeanCurvatureSqr  (curvatur.c:1200)

    CagdSrfStruct *SymbSrfMeanCurvatureSqr(const CagdSrfStruct *Srf)
    Srf: Surface to compute Mean curvature square for.
    Returns: A surface representing the Mean curvature square field.
    Description: Computes the Mean curvature square of a given surface \( H^2 = (k_1 + k_2) / 2 \).
    See also: SymbSrfFff, SymbSrfSff, SymbSrfDeterminant2, SymbSrfGaussCurvature, SymbSrfMeanEvolute,
               SymbSrfMeanNumer, SymbSrfIsoFocalSrf, SymbSrfCurvatureUpperBound, SymbSrfIsoDirNormalCurvatureBound,

11.2.285  SymbSrfMeanEvolute  (curvatur.c:1087)

    CagdSrfStruct *SymbSrfMeanEvolute(const CagdSrfStruct *Srf)
    Srf: Surface to compute mean evolute.
    Returns: A surface representing the mean evolute surface.
    Description: Computes an "evolute surface" to a given surface using twice the Mean curvature as magnitude.

\[
E(u, v) = n(u, v) \frac{1}{2 H(u, v)} \left[ \frac{|G|}{(G_{11} L_{22} + G_{22} L_{11} - 2 G_{12} L_{12})} \right]
\]

Because \( H(u,v) \) also has \( n(u,v) \) we can use the nonnormalized surface normal to compute \( E(u, v) \), which is therefore computable and representable.

See also: SymbSrfFff, SymbSrfSff, SymbSrfDeterminant2, SymbSrfGaussCurvature, SymbSrfMeanCurvatureSqr,
          SymbSrfMeanNumer, SymbSrfIsoFocalSrf, SymbSrfCurvatureUpperBound, SymbSrfIsoDirNormalCurvatureBound,

11.2.286  SymbSrfMeanNumer  (curvatur.c:1028)

    CagdSrfStruct *SymbSrfMeanNumer(const CagdSrfStruct *Srf)
    Srf: Surface to compute mean evolute.
    Returns: A surface representing the mean evolute surface.
    Description: Computes the numerator expression of the Mean as:

\[
H(u, v) = G_{11} L_{22} + G_{22} L_{11} - 2 G_{12} L_{12}
\]

See also: SymbSrfFff, SymbSrfSff, SymbSrfDeterminant2, SymbSrfGaussCurvature, SymbSrfMeanCurvatureSqr,
          SymbSrfMeanEvolute, SymbSrfIsoFocalSrf, SymbSrfCurvatureUpperBound, SymbSrfIsoDirNormalCurvatureBound,

11.2.287  SymbSrfMergeScalar  (symb.srf.c:1154)

    CagdSrfStruct *SymbSrfMergeScalar(const CagdSrfStruct *SrfW,
                                         const CagdSrfStruct *SrfX,
                                         const CagdSrfStruct *SrfY,
                                         const CagdSrfStruct *SrfZ)
    SrfW: The weight component of new constructed surface, if have any.
    SrfX: The X component of new constructed surface.
    SrfY: The Y component of new constructed surface, if have any.
    SrfZ: The Z component of new constructed surface, if have any.
    Returns: A new surface constructed from given scalar surfaces.
    Description: Given a set of scalar surfaces, treat them as coordinates into a new surface. Assumes at least SrfX is not NULL in which a scalar surface is returned. Assumes SrfX/Y/Z/W are either E1 or P1 in which the weights are assumed to be identical and can be ignored if SrfW exists or copied otherwise.
    See also: SymbSrfSplitScalar, SymbCrvMergeScalar,
11.2.288 SymbSrfMergeScalarN (symb\_srf.c:1065)

```c
CagdSrfStruct *SymbSrfMergeScalarN(const CagdSrfStruct *SrfW,  
    const CagdSrfStruct **SrfVec,  
    int NumSrfs)
```

**SrW**: The weight component of new constructed surface, if exist, NULL if none.

**SrfVec**: A vector of scalar surfaces.

**NumSrfs**: Number of surfaces in SrfVec.

**Returns**: A new surface constructed from given scalar surfaces.

**Description**: Given a vector of scalar surfaces, treat them as coordinates into a new vector surface. Assumes at least SrfVec is not NULL in which a scalar surface is returned. Assumes SrfVec[i]/SrfW are either E1 or P1 in which the weights are assumed to be identical and can be ignored if SrfW exists and copied.

**See also**: SymbSrfMergeScalar, SymbSrfSplitScalarN,

11.2.289 SymbSrfMult (symb\_srf.c:108)

```c
CagdSrfStruct *SymbSrfMult(const CagdSrfStruct *Srf1,  
    const CagdSrfStruct *Srf2)
```

**Srf1, Srf2**: Two surface to multiply coordinatewise.

**Returns**: The product of Srf1 * Srf2 coordinatewise.

**Description**: Given two surfaces - multiply them coordinatewise. The two surfaces are promoted to same point type before the multiplication can take place.

**See also**: SymbSrfDotProd, SymbSrfVecDotProd, SymbSrfScalarScale, SymbSrfMultScalar, SymbSrfInvert,

11.2.290 SymbSrfMultScalar (symb\_srf.c:254)

```c
CagdSrfStruct *SymbSrfMultScalar(const CagdSrfStruct *Srf1,  
    const CagdSrfStruct *Srf2)
```

**Srf1, Srf2**: Two surfaces to multiply.

**Returns**: A surface representing the product of Srf1 and Srf2.

**Description**: Given two surface - a vector curve Srf1 and a scalar curve Srf2, multiply all Srf1’s coordinates by the scalar curve Srf2. Returned surface is a surface representing the product of the two given surfaces.

**See also**: SymbSrfDotProd, SymbSrfVecDotProd, SymbSrfScalarScale, SymbSrfMult, SymbSrfCrossProd, SymbCrvMultScalar,

11.2.291 SymbSrfNormalSrf (symb\_srf.c:703)

```c
CagdSrfStruct *SymbSrfNormalSrf(const CagdSrfStruct *Srf)
```

**Srf**: To compute an unnormalized normal vector field for.

**Returns**: A vector field representing the unnormalized normal vector field of Srf.

**Description**: Given a surface - compute its unnormalized normal vector field surface, as the cross product if its partial derivatives.

**See also**: Symb2DSrfJacobian,
11.2.292 SymbSrfOffset (offset.c:487)

CagdSrfStruct *SymbSrfOffset(const CagdSrfStruct *CSrf, CagdRType OffsetDist)

CSrf: To approximate its offset surface with distance OffsetDist.
OffsetDist: Amount of offset. Negative denotes other offset direction.
Returns: An approximation to the offset surface.
Description: Given a surface and an offset amount OffsetDist, returns an approximation to the offset surface by offsetting the control mesh in the normal direction.
See also: SymbCrvOffset, SymbCrvSubdivOffset, SymbSrfSubdivOffset, SymbCrvAdapOffset, SymbCrvAdapOffsetTrim, SymbCrvLeastSquarOffset, SymbCrvMatchingOffset,

11.2.293 SymbSrfOrthotomic (orthotom.c:116)

CagdSrfStruct *SymbSrfOrthotomic(const CagdSrfStruct *Srf, const CagdPType P, CagdRType K)

Srf: To compute its K-orthotomic
P: The points to which the K-orthotomic is computed for Srf for.
K: The magnitude of the orthotomic function.
Returns: The K-orthotomic
Description: Computes the K-orthotomic of a surface with respect to point P:
\[ P + K < (S(u,v) - P), N(u,v) > N(u,v) \]
See also: SymbCrvOrthotomic, SymbSrfSilhouette,

11.2.294 SymbSrfPolarSilhouette (orthotom.c:259)

IPPolygonStruct *SymbSrfPolarSilhouette(const CagdSrfStruct *Srf, const CagdVType VDir, CagdRType SubdivTol, CagdBType Euclidean)

Srf: To compute its polar silhouette edges.
VDir: Axis of polar silhouette.
SubdivTol: Accuracy of computation.
Euclidean: If TRUE, returns the silhouettes in Euclidean space. Otherwise, the silhouette edges are returned in the Parametric domain.
Returns: The silhouettes as piecewise linear edges.
Description: Computes the polar silhouette edges of the given surfaces, along axis VDir. Equal to \( < S(u, v) \times N(u, v), VDir > = 0 \).
See also: SymbSrfOrthotomic, SymbSrfSilhouette, SymbSrfIsocline,

11.2.295 SymbSrfPtBisectorSrf3D (crv_skel.c:1517)

CagdSrfStruct *SymbSrfPtBisectorSrf3D(const CagdSrfStruct *CSrf, const CagdPType Pt)

CSrf: Three space surface too compute its bisector surface with Pt.
Pt: A point in three space to compute its bisector with Srf.
Returns: The bisector surface.
Description: Computes the bisector surface of a surface in arbitrary general three space position and a point in three space. Solution bisector surface \( R \) is derived by solving the three linear equations of \( (S for Srf, P for Pt) \):
\[
< \frac{dS}{du}, R > = < \frac{dS}{du}, S > \\
< \frac{dS}{dv}, R > = < \frac{dS}{dv}, S > \\
< S - P, R > = ( < S, S > - < P, P > ) / 2
\]
See also: SymbCrvDiameter, SymbCrvCnvxHull, SymbCrvBisectorsSrf, SymbCrvBisectorSrf3D,
11.2.296  SymbSrfRtnlMult  (symb_srf.c:665)

CagdSrfStruct *SymbSrfRtnlMult(const CagdSrfStruct *Srf1X,  
   const CagdSrfStruct *Srf1W,  
   const CagdSrfStruct *Srf2X,  
   const CagdSrfStruct *Srf2W,  
   CagdBType OperationAdd)

Srf1X: Numerator of first surface.
Srf1W: Denominator of first surface. Can be NULL.
Srf2X: Numerator of second surface.
Srf2W: Denominator of second surface. Can be NULL.
OperationAdd: TRUE for addition, FALSE for subtraction.
Returns: The result of Srf1X Srf2W +/- Srf2X Srf1W.

Description: Given two surfaces - multiply them using the quotient product rule:
\[ X = X_1 \frac{1}{W_2} \pm \frac{1}{X_2 W_1} \]
All provided surfaces are assumed to be non rational scalar surfaces. Returned is a non rational scalar surface (CAGD_PT_E1_TYPE).
See also: SymbSrfDotProd, SymbSrfVecDotProd, SymbSrfScalarScale, SymbSrfMultScalar, , SymbSrfInvert,

11.2.297  SymbSrfScalarScale  (symb_srf.c:210)

CagdSrfStruct *SymbSrfScalarScale(const CagdSrfStruct *Srf, CagdRType Scale)

Srf: A surface to scale by magnitude Scale.
Scale: Scaling factor.
Returns: A surfaces scaled by Scale compared to Srf.

Description: Given a surface, scale it by Scale.
See also: SymbSrfDotProd, SymbSrfVecDotProd, SymbSrfMult, SymbSrfMultScalar, , SymbSrfInvert, SymbSrfCrossProd,

11.2.298  SymbSrfSecondMoment  (moments.c:400)

CagdRType SymbSrfSecondMoment(const CagdSrfStruct *Srf, int Axis1, int Axis2)

Srf: Surface to compute the second moment for.
Axis1, Axis2: 1 for X, 2 for Y, 3 for Z.
Returns: The computed moment.

Description: Computes the second moment of the given surface. The computed moment is for the (signed) volume between the surface and its projection onto the XY plane.
See also: SymbSrfSecondMomentSrf, SymbSrfFirstMoment, SymbSrfVolume,

11.2.299  SymbSrfSecondMomentSrf  (moments.c:334)

CagdSrfStruct *SymbSrfSecondMomentSrf(const CagdSrfStruct *Srf,  
   int Axis1,  
   int Axis2,  
   CagdBType Integrate)

Srf: Surface to compute the first moment for.
Axis1, Axis2: 1 for X, 2 for Y, 3 for Z.
Integrate: TRUE to also integrate the resulting surface.
Returns: The computed moment function.

Description: Computes the second moment function of the given surface. The computed moment is for the (signed) volume between the surface and its projection onto the XY plane.
See also: SymbSrfFirstMoment, SymbSrfFirstMomentSrf, SymbSrfVolumeSrf,
11.2.300  SymbSrfSff (curvatur.c:781)

```c
void SymbSrfSff(const CagdSrfStruct *DuSrf,
    const CagdSrfStruct *DvSrf,
    CagdSrfStruct **SffL11,
    CagdSrfStruct **SffL12,
    CagdSrfStruct **SffL22,
    CagdSrfStruct **SNormal)
```

**DuSrf**: First derivative of Srf with respect to U.
**DvSrf**: First derivative of Srf with respect to V.
**SffL11**: SFF L11 scalar field returned herein.
**SffL12**: SFF L12 scalar field returned herein.
**SffL22**: SFF L22 scalar field returned herein.
**SNormal**: Unnormalized normal vector field returned herein.

**Returns**: void

**Description**: Computes coefficients of the second fundamental form of given surface Srf that is prescribed via its two partial derivatives DuSrf and DvSrf. These coefficients are using non normalized normal that is also returned.

**See also**: SymbSrfFff, SymbSrfTff, SymbSrfDeterminant2, SymbSrfGaussCurvature, SymbSrfMeanEvolute, SymbSrfMeanCurvatureSqr, SymbSrfIsoFocalSrf, SymbSrfCurvatureUpperBound, SymbSrfIsoDirNormalCurvatureBound,

11.2.301  SymbSrfSilhouette (orthotom.c:193)

```c
IPPolygonStruct *SymbSrfSilhouette(const CagdSrfStruct *Srf,
    const CagdVType VDir,
    CagdRType SubdivTol,
    CagdBType Euclidean)
```

**Srf**: To compute its silhouette edges.
**VDir**: View direction vector (a unit vector).
**SubdivTol**: Accuracy of computation. 0.001 will be a good start.
**Euclidean**: If TRUE, returns the silhouettes in Euclidean space. Otherwise, the silhouette edges are returned in the Parametric domain.

**Returns**: The silhouettes as piecewise linear edges.

**Description**: Computes the silhouette edges of the given surfaces, orthographically seen from the given view direction VDir.

**See also**: SymbSrfOrthotomic, SymbSrfIsocline, SymbSrfPolarSilhouette, MvarSrfSilhouette,

11.2.302  SymbSrfSplitScalar (symbsrfsrf.c:1000)

```c
void SymbSrfSplitScalar(const CagdSrfStruct *Srf,
    CagdSrfStruct **SrfW,
    CagdSrfStruct **SrfX,
    CagdSrfStruct **SrfY,
    CagdSrfStruct **SrfZ)
```

**Srf**: Surface to split.
**SrfW**: The weight component of Srf, if have any.
**SrfX**: The X component of Srf.
**SrfY**: The Y component of Srf, if have any.
**SrfZ**: The Z component of Srf, if have any.

**Returns**: void

**Description**: Given a surface splits it to its scalar component surfaces. Ignores all dimensions beyond the third, Z, dimension.

**See also**: SymbSrfMergeScalar, SymbSrfSplitScalar, SymbSrfSplitScalarN,
11.2.303 SymbSrfSplitScalarN (symb_srf.c:939)

CagdSrfStruct **SymbSrfSplitScalarN(const CagdSrfStruct *Srf)

Srf: Surface to split.

Returns: A vector of scalar surfaces - components of Srf.

Description: Given a surface, splits it to its scalar component surfaces.

See also: SymbSrfSplitScalar, SymbSrfMergeScalarN.

11.2.304 SymbSrfSub (symb_srf.c:73)

CagdSrfStruct *SymbSrfSub(const CagdSrfStruct *Srf1,
const CagdSrfStruct *Srf2)

Srf1, Srf2: Two surface to subtract coordinatewise.

Returns: The difference of Srf1 - Srf2 coordinatewise.

Description: Given two surfaces - subtract them coordinatewise. The two surfaces are promoted to same point type before the multiplication can take place. Furthermore, order and continuity are matched as well.

See also: SymbSrfAdd, SymbMeshAddSub, SymbSrfMult.

11.2.305 SymbSrfSubdivOffset (offset.c:607)

CagdSrfStruct *SymbSrfSubdivOffset(const CagdSrfStruct *CSrf,
CagdRType OffsetDist,
CagdRType Tolerance)

CSrf: To approximate its offset surface with distance OffsetDist.
OffsetDist: Amount of offset. Negative denotes other offset direction.
Tolerance: Accuracy control.

Returns: An approximation to the offset surface, to within Tolerance.

Description: Given a surface and an offset amount OffsetDist, returns an approximation to the offset surface by offseting the control mesh in the normal direction. If resulting offset is not satisfying the required tolerance the surface is subdivided and the algorithm recurses on both parts.

See also: SymbCrvOffset, SymbCrvSubdivOffset, SymbSrfOffset, SymbCrvAdapOffset, SymbCrvAdapOffsetTrim, SymbCrvLeastSquarOffset, SymbCrvMatchingOffset.

11.2.306 SymbSrfTff (curvature.c:831)

void SymbSrfTff(const CagdSrfStruct *Srf,
CagdSrfStruct **TffL11,
CagdSrfStruct **TffL12,
CagdSrfStruct **TffL22)

Srf: Surface to compute the coefficents of the TFF for.
TffL11: TFF L11 scalar field returned herein.
TffL12: TFF L12 scalar field returned herein.
TffL22: TFF L22 scalar field returned herein.

Returns: void

Description: Computes coefficients of the third fundamental form of given surface Srf. These coefficients are using non normalized normal that is also returned. The coefficients of the TFF equal:

\[
\begin{align*}
L_{ij} &= \frac{\langle \frac{\partial^2 S}{\partial u_i \partial u_j}, n \rangle}{\langle n, n \rangle^2} \\
&= \frac{\langle \frac{\partial^2 S}{\partial u_i \partial u_j}, m \rangle}{\langle m, m \rangle^2} - \frac{\langle \frac{\partial^2 S}{\partial u_i \partial u_j}, m \rangle}{\langle m, m \rangle^2}
\end{align*}
\]

where \( n \) is the unit normal of Srf and \( m = \frac{\partial S}{\partial u_i} \times \frac{\partial S}{\partial u_j} \), the unnormalized normal field of Srf.

See also: SymbSrfTff, SymbSrfSff, SymbSrfDeterminant2,
11.2.307 SymbSrfVecCrossProd  (symb_srf.c:551)

CagdSrfStruct *SymbSrfVecCrossProd(const CagdSrfStruct *Srf,  
const CagdVType Vec)

Srf: Surface to multiply and compute a cross product for.
Vec: Vector to cross product Srf with.

Returns: A vector surface representing the cross product of Srf x Vec.

Description: Given a surface and a vector - computes their cross product. Returned surface is a scalar surface representing the cross product of the surface and vector.

See also: SymbSrfDotProd, SymbSrfVecDotProd, SymbSrfScalarScale, SymbSrfMultScalar, , SymbSrfInvert, SymbSrfCrossProd,

11.2.308 SymbSrfVecDotProd  (symb_srf.c:375)

CagdSrfStruct *SymbSrfVecDotProd(const CagdSrfStruct *Srf,  
const CagdVType Vec)

Srf: Surface to multiply and compute a dot product for.
Vec: Vector to project Srf onto.

Returns: A scalar surface representing the dot product of Srf . Vec.

Description: Given a surface and a vector - computes their dot product. Returned surface is a scalar surface representing the dot product.

See also: SymbSrfDotProd, SymbSrfMult, SymbSrfScalarScale, SymbSrfMultScalar, , SymbSrfInvert, SymbSrfCrossProd, SymbSrfVecCrossProd,

11.2.309 SymbSrfVolume1  (moments.c:99)

CagdRType SymbSrfVolume1(const CagdSrfStruct *Srf)

Srf: Surface to computes its enclosed volume.

Returns: The enclosed volume.

Description: A function to compute the enclosed volume by the given surface. The computed volume is the (signed) volume between the surface and its projection onto the XY plane.

See also: SymbSrfVolume1Srf, SymbSrfVolume2Srf, SymbSrfVolume2,

11.2.310 SymbSrfVolume1Srf  (moments.c:30)

CagdSrfStruct *SymbSrfVolume1Srf(const CagdSrfStruct *Srf,  
CagdBType Integrate)

Srf: Surface to computes its enclosed volume.
Integrate: TRUE to also integrate the resulting surface.

Returns: Integral volume function.

Description: A function to compute the enclosed volume function of the given surface. The computed volume is the (signed) volume between the surface and its projection onto the XY plane.

See also: SymbSrfVolume1, SymbSrfVolume2Srf, SymbSrfVolume2,

11.2.311 SymbSrfVolume2  (moments.c:187)

CagdRType SymbSrfVolume2(const CagdSrfStruct *Srf)

Srf: Surface to computes its enclosed volume.

Returns: The enclosed volume.

Description: A function to compute the enclosed volume by the given surface. The computed volume is the (signed) volume occupied by all rays from the origin to the surface.

See also: SymbSrfVolume1Srf, SymbSrfVolume2Srf, SymbSrfVolume2,
11.2.312 SymbSrfVolume2Srf (moments.c:138)

CagdSrfStruct *SymbSrfVolume2Srf(const CagdSrfStruct *Srf,
                                       CagdBType Integrate)

Srf: Surface to computes its enclosed volume.
Integrate: TRUE to also integrate the resulting surface.
Returns: Integral volume function.

Description: A function to compute the enclosed volume function of the given surface. The computed volume
is the (signed) volume occupied by all rays from the origin to the surface.
See also: SymbSrfVolume2, SymbSrfVolume1Srf, SymbSrfVolume1,

11.2.313 SymbSwungAlgSumSrf (constrct.c:163)

CagdSrfStruct *SymbSwungAlgSumSrf(const CagdCrvStruct *Crv1,
                                        const CagdCrvStruct *Crv2)

Crv1, Crv2: Two curves to sum algebraically, forming a swung surface.
Returns: A surface represent their swung algebraic sum.

Description: Adds up algebraically the given two curves, C1(r) and C2(t), as swung surfaces (The NURBs
book', by Piegl and Tiller, pp 455):
S(r, t) = (x1(r) x2(t), x1(r) y2(t), y1(r))
See also: SymbAlgebraicProdSrf, SymbAlgebraicSumSrf,

11.2.314 SymbTangentConeForCrv (nrmlcone.c:42)

const SymbNormalConeStruct *SymbTangentConeForCrv(const CagdCrvStruct *Crv,
                                                     int Planar)

Crv: To compute a tangent cone for.
Planar: If TRUE, only the X and Y coefficients are considered.
Returns: The computed tangent cone, statically allocated.

Description: Computes a tangent cone for a given curve, by examine the control polygon of the curve and
deriving its angular span.
See also: SymbNormalConeOverlap, SymbNormalConeForSrf,

11.2.315 SymbTangentToCrvAtTwoPts (crv_tans.c:136)

CagdPtStruct *SymbTangentToCrvAtTwoPts(const CagdCrvStruct *CCrv,
                                          CagdRType SubdivTol)

CCrv: The curve to compute all tangent lines at two locations.
SubdivTol: Of numeric search for the zero set (for surface subdivision). A positive value (0.01 is a good start).
Returns: A list of parameter location on Crv with tangent lines through Pt. Parameters are save in the X &
Y coordinate.

Description: Computes all the lines that are tangent to Crv at two locations. Returned is a list of parameter
locations’ pairs where the tangent is tangent to the curve. The tangents are computed as two sets of contours of the
solution to the two equations of:
1.  [ C(t) - C(r) ] || C'(t)
2.  [ C(t) - C(r) ] || C'(r)
and computing all the intersection points between these two sets of contours. Note that since equations 1 and 2 are
symmetric, one only needs to solve for once and flip the notation of r and t.
See also: SymbCrvPtTangents, SymbCircTanTo2Crvs, SymbCrvCnvxHull, SymbCrvDiameter, , MvarMVTri-
TangentLine,
11.2.316  SymbTorusPointBisect  (smp_skel.c:916)

CagdSrfStruct *SymbTorusPointBisect(const CagdVType TrsCntr,  
    const CagdVType TrsDir,  
    CagdRType TrsMajorRad,  
    CagdRType TrsMinorRad,  
    const CagdPType Pt)

TrsCntr: Center of constructed torus.
TrsDir: Axis of symmetry of constructed torus.
TrsMajorRad: Major radius of constructed torus.
TrsMinorRad: Minor radius of constructed torus.
Pt: Direction of line from origin.

Returns: Constructed bisector surface.

Description: Compute the bisector surface between a torus and a point.
See also: SymbPtCrvBisectOnSphere, SymbPlanePointBisect, SymbCylinPointBisect, SymbConePointBisect,  
    SymbSpherePointBisect, SymbConePlaneBisect, SymbCylinPlaneBisect, SymbSpherePlaneBisect, SymbConeCylinderBisect,  
    SymbSphereLineBisect, SymbCylinSphereBisect, SymbSphereSphereBisect, SymbConeSphereBisect,  
    SymbTorusSphereBisect, SymbConeConeBisect, SymbCylinCylinBisect,

11.2.317  SymbTorusSphereBisect  (smp_skel.c:1503)

CagdSrfStruct *SymbTorusSphereBisect(const CagdVType TrsCntr,  
    const CagdVType TrsDir,  
    CagdRType TrsMajorRad,  
    CagdRType TrsMinorRad,  
    const CagdVType SprCntr,  
    CagdRType SprRad)

TrsCntr: Center of constructed torus.
TrsDir: Axis of symmetry of constructed torus.
TrsMajorRad: Major radius of constructed torus.
TrsMinorRad: Minor radius of constructed torus.
SprCntr: Center location of the sphere. Must be in northern hemisphere (positive Z coefficient).
SprRad: Radius of sphere.

Returns: Constructed bisector surface.

Description: Compute the bisector surface between a torus and a sphere. The computation is reduced to that 
    of a bisector between a point and a torus, that has a rational form.
See also: SymbPlanePointBisect, SymbCylinPointBisect, SymbConePointBisect, SymbSpherePointBisect,  
    SymbConeLineBisect, SymbSphereLineBisect, SymbSphereSphereBisect, SymbConeSphereBisect,  
    SymbTorusSphereBisect, SymbConeConeBisect, SymbCylinCylinBisect,

11.2.318  SymbTwoCrvsMorphing  (morphing.c:57)

CagdCrvStruct *SymbTwoCrvsMorphing(const CagdCrvStruct *Crv1,  
    const CagdCrvStruct *Crv2,  
    CagdRType Blend)

Crv1, Crv2: The two curves to blend.
Blend: A parameter between zero and one

Returns: Crv2 * Blend + Crv1 * (1 - Blend).

Description: Given two compatible curves (See function CagdMakeCrvsCompatible), computes a convex blend 
    between them according to Blend which must be between zero and one. Returned is the new blended curve.
See also: SymbTwoCrvsMorphingCornerCut, SymbTwoCrvsMorphingMultiRes, SymbTwoSrfsMorphing, TrivT-
    woTVsMorphing,
11.2.319 SymbTwoCrvsMorphingCornerCut (morphing.c:127)

CagdCrvStruct *SymbTwoCrvsMorphingCornerCut(const CagdCrvStruct *Crv1,
    const CagdCrvStruct *Crv2,
    CagdRType MinDist,
    CagdBType SameLength,
    CagdBType FilterTangencies)

Crv1, Crv2: The two curves to blend.
MinDist: Minimal maximum distance between adjacent curves to make sure motion is visible. The curves will move at most twice that much in their maximal distance (roughly).
SameLength: If TRUE, length of curves is preserved, otherwise BBOX is.
FilterTangencies: If TRUE, attempt is made to eliminate the intermediate line representation.

Returns: The blended curve.

Description: Given two compatible curves (See function CagdMakeCrvsCompatible), computes a morph between them using corner cutting approach. Returned is the new blended curve.
See also: SymbTwoCrvsMorphing, SymbTwoCrvsMorphingMultiRes, SymbTwoSrfsMorphing, TrivTwoTVsMorphing.

11.2.320 SymbTwoCrvsMorphingMultiRes (morphing.c:315)

CagdCrvStruct *SymbTwoCrvsMorphingMultiRes(const CagdCrvStruct *Crv1,
    const CagdCrvStruct *Crv2,
    CagdRType BlendStep)

Crv1, Crv2: The two curves to blend.
BlendStep: A step size of the blending.

Returns: A list of blended curves.

Description: Given two compatible curves (See function CagdMakeCrvsCompatible), computes a morph between them using multiresolution decomposition. Returned is a list of new blended curves.
See also: SymbTwoCrvsMorphing, SymbTwoCrvsMorphingCornerCut, SymbTwoSrfsMorphing, TrivTwoTVsMorphing.

11.2.321 SymbTwoSrfsMorphing (morphing.c:753)

CagdSrfStruct *SymbTwoSrfsMorphing(const CagdSrfStruct *Srf1,
    const CagdSrfStruct *Srf2,
    CagdRType Blend)

Srf1, Srf2: The two surfaces to blend.
Blend: A parameter between zero and one

Returns: Srf2 * Blend + Srf1 * (1 - Blend).

Description: Given two compatible surfaces (See function CagdMakeSrfsCompatible), computes a convex blend between them according to Blend which must be between zero and one. Returned is the new blended surface.
See also: SymbTwoCrvsMorphing, SymbTwoCrvsMorphingCornerCut, SymbTwoCrvsMorphingMultiRes, TrivTwoTVsMorphing.
11.2.322  SymbUniformAprxPtOnCrvDistrib (ffptdist.c:51)

CagdRType *SymbUniformAprxPtOnCrvDistrib(const CagdCrvStruct *Crv,
                        CagdBType ParamUniform,
                        int n)

Crv: To place n points along, uniformly.

ParamUniform: If TRUE, produces a distribution uniform in parametric space. If FALSE, uniform in Eu-
            clidean space.

n: Number of points to distribute along Crv.

Returns: A dynamically allocated vector of size n, of the parameter values of the distributed points.

Description: Computes a stocastically uniform distribution of points on a curve. n points are placed at approx-
            imately equal distance from each other along Crv’s arc length. This distribution converges to a uniform distribution
            as n approached infinity.

See also: SymbUniformAprxPtOnSrfDistrib,

11.2.323  SymbUniformAprxPtOnSrfDistrib (ffptdist.c:125)

CagdUVType *SymbUniformAprxPtOnSrfDistrib(
                        const CagdSrfStruct *Srf,
                        CagdBType ParamUniform,
                        int n,
                        SymbUniformAprxSrfPtImportanceFuncType EvalImportance)

Srf: To place n points on, uniformly.

ParamUniform: If TRUE, produces a distribution uniform in parametric space. If FALSE, uniform in Eu-
            clidean space.

n: Number of points to distribute along Srf.

EvalImportance: Optional function to evaluate the importance of each selected points and if returning FALSE,
                  that point is purged. NULL to disable.

Returns: A dynamically allocated vector of size n, of parameter values of the distributed points.

Description: Computes a stochastically uniform distribution of points on a surface. n points are placed at
            approximately equal distance from each other on Srf’s surface. This distribution converges to a uniform distribution
            as n approached infinity.

See also: SymbUniformAprxPtOnCrvDistrib,

11.2.324  SymbUniformAprxPtOnSrfGetDistrib (ffptdist.c:260)

CagdUVType *SymbUniformAprxPtOnSrfGetDistrib(const CagdSrfStruct *Srf, int *n)

Srf: To place points on its parametric space, uniformly. This surface must have the same parameter domain as
     Srf in the last invocation of SymbUniformAprxPtOnSrfPrepDistrib.

n: Returns actual number of UV locations in the returned vector.

Returns: A dynamically allocated vector of at most n parameter values of the distributed points.

Description: Computes a uniform distribution of points on the surface Srf. The points are placed at approxi-
            mately equal distance from each other on Srf’s Euclidean space. A subset of the n points that were selected via
            the last invocation of SymbUniformAprxPtOnSrfPrepDistrib is returned, such that the points are at equal distance,
            approximately.

See also: SymbUniformAprxPtOnCrvDistrib, SymbUniformAprxPtOnSrfDistrib, SymbUniformAprxPtOnSrf-
         PrepDistrib,
void SymbUniformAprxPtOnSrfPrepDistrib(const CagdSrfStruct *Srf, int n)

Srf: To place n points on its parametric space, uniformly.

n: Number of points to distribute along Srf.

Returns: void

Description: Prepares a uniform distribution of points on surface Srf. This function is invoked in preparation of several calls to function SymbUniformAprxPtOnSrfGetDistrib that return a uniform Euclidean distributions that is consistent with the area differentials found.

See also: SymbUniformAprxPtOnCrvDistrib, SymbUniformAprxPtOnSrfDistrib, SymbUniformAprxPtOnSrfGetDistrib,
Chapter 12

Trimmed surfaces Library, trim_lib

12.1 General Information

This library provides a set of functions to manipulate freeform trimmed Bezier and/or NURBs surfaces. This library heavily depends on the cagd library. Functions are provided to create, copy, and destruct trimmed surfaces to extract isoparametric curves, to evaluate, refine and subdivide, to read and write trimmed surfaces, degree raise, and approximate using polygonal representations. A trimming surface is defined out of a tensor product surface and a set of trimming loops that trims out portions of the parametric space of the surface,

```
typedef struct TrimSrfStruct {
    struct TrimSrfStruct *Pnext;
    IPAttributeStruct *Attr;
    int Tags;
    CagdSrfStruct *Srf; /* Surface trimmed by TrimCrvList. */
    TrimCrvStruct *TrimCrvList; /* List of trimming curves. */
} TrimSrfStruct;
```

Each trimming loop consists of a set of trimming curve segments:

```
typedef struct TrimCrvStruct {
    struct TrimCrvStruct *Pnext;
    IPAttributeStruct *Attr;
    TrimCrvSegStruct *TrimCrvSegList; /* List of trimming curve segments. */
} TrimCrvStruct;
```

Each trimming curve segment contains a representation for the curve in the UV space of the surface as well as a representation in the Euclidean space,

```
typedef struct TrimCrvSegStruct {
    struct TrimCrvSegStruct *Pnext;
    IPAttributeStruct *Attr;
    CagdCrvStruct *UVCrv; /* Trimming crv segment in srf's param. domain. */
    CagdCrvStruct *EucCrv; /* Trimming curve as an E3 Euclidean curve. */
} TrimCrvSegStruct;
```

The interface of the library is defined in `include/trim_lib.h`. This library has its own error handler, which by default prints an error message and exit the program called `TrimFatalError`. All globals in this library have a prefix of `Trim`.

12.2 Library Functions

12.2.1 TrimAffineTransTrimCurves (trim_aux.c:949)

```
void TrimAffineTransTrimCurves(TrimCrvStruct *TrimCrvList,
    CagdRType OldUMin,
    CagdRType OldUMax,
    CagdRType OldVMin,
    CagdRType OldVMax,
```

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TrimCrvList: Trimming curves to affinely map.

OldUMin, OldUMax, OldVMin, OldVMax: Domain to map trimming curves from.

NewUMin, NewUMax, NewVMin, NewVMax: Domain to map trimming curves to.

Returns: void

Description: Map the given trimming curves into a new domain, in place.
See also: TrimAffineTransTrimSrf,

12.2.2 TrimAffineTransTrimSrf (trim\_aux.c:1001)

TrimSrfStruct *TrimAffineTransTrimSrf(const TrimSrfStruct *CTrimSrf,
                     CagdRType NewUMin,
                     CagdRType NewUMax,
                     CagdRType NewVMin,
                     CagdRType NewVMax)

CTrimSrf: Trimmed surface to affinely map its parametric domain.

NewUMin, NewUMax, NewVMin, NewVMax: New parametric domain to map to.

Returns: A trimmed surface that is geometrically identical but with new different parametric domain.

Description: Maps the given trimmed surface into a new domain.
See also: BspKnotAffineTransOrder2, TrimAffineTransTrimCurves,

12.2.3 TrimAllPrisaSrfs (tr\_prisa.c:59)

TrimSrfStruct *TrimAllPrisaSrfs(const TrimSrfStruct *TSrfs,
                   int SamplesPerCurve,
                   CagdRType Epsilon,
                   CagdSrfDirType Dir,
                   CagdVType Space)

TSrfs: To approximate and flatten out.

SamplesPerCurve: During the approximation of a ruled surface as a developable surface.

Epsilon: Accuracy control for the piecewise ruled surface approximation. If Epsilon is positive, the surfaces are laid down on the plane, otherwise they are return as 3-space ruled surfaces and form a piecewise ruled-surface approximation to Srfs.

Dir: Direction of ruled/developable surface approximation. Either U or V.

Space: A vector in the XY plane to denote the amount of translation from one flattened out surface to the next.

Returns: A list of planar trimmed surfaces denoting the layout (prisa) of the given TSrfs to the accuracy requested.

Description: Computes a piecewise ruled surface approximation to a given set of trimmed surfaces with given Epsilon, and lay them out "nicely" onto the XY plane, by approximating each ruled surface as a developable surface with SamplesPerCurve samples. Dir controls the direction of ruled approximation, SpaceScale and Offset controls the placement of the different planar pieces. Prisa is the hebrew word for the process of flattening out a three dimensional surface. I have still to find an english word for it.
See also: TrimPiecewiseRuledSrfApprox, TrimPrisaRuledSrf, SymbAllPrisaSrfs,
12.2.4 TrimChainTrimmingCurves2Loops (trim_aux.c:644)

TrimCrvStruct *TrimChainTrimmingCurves2Loops(TrimCrvStruct *TrimCrvs)

TrimCrvs: Trimming curves to chain into loops.
Returns: Trimming curves chained into loops.
Description: Chains all given trimming curves into closed loops. Only UV curves are chained and Euclidean trimming curves are purged.
See also: TrimChainTrimmingCurves2Loops2,

12.2.5 TrimChainTrimmingCurves2Loops2 (trim_aux.c:722)

CagdCrvStruct *TrimChainTrimmingCurves2Loops2(CagdCrvStruct *UVCrvs,
CagdRType Tol)

UVCrvs: Curves to chain into loops.
Tol: Tolerance of end points comparisons.
Returns: Curves chained into loops.
Description: Chains all given curves into closed loops.
See also: TrimChainTrimmingCurves2Loops,

12.2.6 TrimClassifyTrimCurveOrient (trim2ply.c:1231)

CagdBType TrimClassifyTrimCurveOrient(const CagdCrvStruct *UVCrv)

UVCrv: Trimming curve to examine its orientation.
Returns: TRUE if the curve is clockwise, FALSE if counter clockwise.
Description: Given a closed, piecewise linear trimming curve, returns TRUE if the curve is clockwise, FALSE if counter clockwise. Orientation is determined by computing the signed area of the polygon and examining the sign of the result.
See also: TrimClassifyTrimmingLoops,

12.2.7 TrimClassifyTrimmingLoops (trim2ply.c:1053)

int TrimClassifyTrimmingLoops(TrimCrvStruct **TrimLoops)

TrimLoops: Input loops.
Returns: TRUE if successful, FALSE otherwise.
Description: Classify the given trimming curve loops into a hierarchy. All curves with even nesting levels are considered outside loops and are oriented clockwise. All curves with odd nesting level are considered islands and are oriented counterclockwise. An island Ci of outside loop Cj will be placed in an "subTrims" attribute under Ci. Assumes all trimming curves are full loops with a single segment.
See also: TrimCrvsHierarchy2Polys, TrimClassifyTrimCurveOrient,

12.2.8 TrimClipSrfToTrimCrvs (trim_aux.c:1679)

TrimSrfStruct *TrimClipSrfToTrimCrvs(TrimSrfStruct *TrimSrf)

TrimSrf: Input trimmed surface to extract a minimal valid region
Returns: Returns a possible smaller surface with similar geometry.
Description: Extract the minimal region of the tensor product surface that contains the domain that is prescribed by the trimming curves. The return surface represents the exact same geometry as the input surface but possible with a small size.
See also: TrimSrfTrimCrvSquareDomain, TrimSrfTrimCrvAllDomain,
12.2.9 TrimCrv2Polyline (trim_aux.c:1124)

CagdPolylineStruct *TrimCrv2Polyline(const CagdCrvStruct *TrimCrv,
    CagdRType TolSamples,
    SymbCrvApproxMethodType Method,
    CagdBType OptiLin)

TrimCrv: To approximate as a polyline.
TolSamples: Tolerance of approximation error (Method = 2) or Number of samples to compute on polyline (Method = 0, 1).
Method: 0 - TolSamples are set uniformly in parametric space, 1 - TolSamples are set optimally, considering the isocurve's curvature. 2 - TolSamples sets the maximum error allowed between the piecewise linear approximation and original curve.
OptiLin: If TRUE, optimize linear curves.
Returns: A polyline representing the piecewise linear approximation from, or NULL in case of an error.

Description: Routine to approx. a single curve as a polyline with TolSamples samples/tolerance. Polyline is always E3 CagdPolylineStruct type. NULL is returned in case of an error, otherwise CagdPolylineStruct.
See also: BspCrv2Polyline, BzrCrv2Polyline, IritCurve2Polylines, SymbCrv2Polyline, TrimCrv2Polylines

12.2.10 TrimCrvAgainstTrimCrvs (trim_iso.c:557)

CagdCrvStruct *TrimCrvAgainstTrimCrvs(CagdCrvStruct *UVCrv,
    const TrimSrfStruct *TrimSrf,
    CagdRType Eps)

UVCrv: A curve in the parametric space to trim. Freed.
TrimSrf: A trimmed surface.
Eps: Tolerance of approximation.
Returns: A list of trimmed segments of UVCrv inside TrimSrf.

Description: Trim a given curve in UV space of a trimmed surface to the valid domain only. Returned is a list of segments of UV curve that is inside TrimSrf.
See also: TrimIntersectTrimCrvIsoVals

12.2.11 TrimCrvCopy (trim_gen.c:243)

TrimCrvStruct *TrimCrvCopy(const TrimCrvStruct *TrimCrv)

TrimCrv: A trimming curve to duplicate.
Returns: A trimming curve structure.
Description: Duplicates a trimming curve structure.

12.2.12 TrimCrvCopyList (trim_gen.c:271)

TrimCrvStruct *TrimCrvCopyList(const TrimCrvStruct *TrimCrvList)

TrimCrvList: To be copied.
Returns: A duplicated list of trimming curves.
Description: Allocates and copies a list of trimming curve structures.
12.2.13  **TrimCrvFree** (trim_gen.c:300)

```c
void TrimCrvFree(TrimCrvStruct *TrimCrv)

TrimCrv: A trimming curve to free.
Returns: void
Description: Deallocation of a trimming curve structure.
```

12.2.14  **TrimCrvFreeList** (trim_gen.c:320)

```c
void TrimCrvFreeList(TrimCrvStruct *TrimCrvList)

TrimCrvList: A list of trimming curve to free.
Returns: void
Description: Deallocation of a list of trimming curve structures.
```

12.2.15  **TrimCrvNew** (trim_gen.c:217)

```c
TrimCrvStruct *TrimCrvNew(TrimCrvSegStruct *TrimCrvSegList)

TrimCrvSegList: A list of trimming curve segments forming the trimming curve.
Returns: A trimming curve.
Description: Allocation of a trimming curve structure.
```

12.2.16  **TrimCrvSegCopy** (trim_gen.c:112)

```c
TrimCrvSegStruct *TrimCrvSegCopy(const TrimCrvSegStruct *TrimCrvSeg)

TrimCrvSeg: A trimming curve segment to duplicate.
Returns: A trimming curve segment structure.
Description: Duplication of a trimming curve segment structure.
```

12.2.17  **TrimCrvSegCopyList** (trim_gen.c:142)

```c
TrimCrvSegStruct *TrimCrvSegCopyList(const TrimCrvSegStruct *TrimCrvSegList)

TrimCrvSegList: To be copied.
Returns: A duplicated list of trimming curve segments.
Description: Allocation and duplication of a list of trimming curve segment structures.
```

12.2.18  **TrimCrvSegFree** (trim_gen.c:171)

```c
void TrimCrvSegFree(TrimCrvSegStruct *TrimCrvSeg)

TrimCrvSeg: A trimming curve segment to free.
Returns: void
Description: Deallocation of a trimming curve segment structure.
```
12.2.19 TrimCrvSegFreeList (trim_gen.c:192)

```c
void TrimCrvSegFreeList(TrimCrvSegStruct *TrimCrvSegList)
```

**TrimCrvSegList:** A list of trimming curve segments to free.

**Returns:** void

**Description:** Deals with the free list of trimming curve segment structures.

12.2.20 TrimCrvSegNew (trim_gen.c:47)

```c
TrimCrvSegStruct *TrimCrvSegNew(CagdCrvStruct *UVCrv, CagdCrvStruct *EucCrv)
```

**UVCrv:** A UV curve. Only the E2/P2 portion of the curve is considered.

**EucCrv:** Optional Euclidean curve. Must be an E3 curve.

**Returns:** A trimming curve segment structure.

**Description:** Allocates a trimming curve segment structure. Allows periodic and float end conditions - converts them to open end. Input curves are used in place.

12.2.21 TrimCrvTrimParamList (trim_iso.c:229)

```c
CagdCrvStruct *TrimCrvTrimParamList(CagdCrvStruct *Crv, TrimIsoInterStruct *InterList)
```

**Crv:** To trim out according to the prescribed intersections.

**InterList:** List of intersections, as parameters into Crv.

**Returns:** List of trimmed curves. May be empty (NULL).

**Description:** Trim Crv at the domains prescribed in the intersection list InterList. Both Crv and InterList are FREED in this routine.

12.2.22 TrimCrvs2Polylines (trim_aux.c:1066)

```c
CagdPolylineStruct *TrimCrvs2Polylines(TrimSrfStruct *TrimSrf, CagdBType ParamSpace, CagdRType TolSamples, SymbCrvApproxMethodType Method)
```

**TrimSrf:** To extract isoparametric curves from.

**ParamSpace:** TRUE for curves in parametric space, FALSE of 3D Euclidean space.

**TolSamples:** Tolerance of approximation error (Method = 2) or Number of samples to compute on polyline (Method = 0, 1).

**Method:** 0 - TolSamples are set uniformly in parametric space, 1 - TolSamples are set optimally, considering the isocurve's curvature. 2 - TolSamples sets the maximum error allowed between the piecewise linear approximation and original curve.

**Returns:** List of polylines representing a piecewise linear approximation of the extracted isoparametric curves or NULL is case of an error.

**Description:** Routine to convert the trimming curves of a trimmed surface to polylines. Polyline are always E3 of CagdPolylineStruct type. NULL is returned in case of an error, otherwise list of CagdPolylineStruct.

**See also:** TrimCrv2Polyline, TrimEvalTrimCrvToEuclid,
12.2.23 TrimCrvsHierarchy2Polys (trim2ply.c:787)

CagdPolylineStruct *TrimCrvsHierarchy2Polys(TrimCrvStruct *TrimLoops)

TrimLoops: A linked list of trimming loops hierarchy (a 'forrest').
Returns: Piecewise linear polylines approximating the given trimming curves hierarchy.

Description: Converts a hierarchy of trimming curves/loops into closed, simple, polygons. The input
trimming curves are destroyed by this function. A trimming curve inside another trimming curve are chained into one by
adding a bidirection line segment between the two curves. A trimming loop will have its contained trimming loops
in an attribute "subTrims".
See also: TrimClassifyTrimmingLoops,

12.2.24 TrimDbg (trim_dbg.c:26)

void TrimDbg(const void *Obj)

Obj: A trimmed surface - to be printed to stderr.
Returns: void

Description: Prints trimmed surfaces to stderr. Should be linked to programs for debugging purposes, so
trimmed surfaces may be inspected from a debugger.

12.2.25 TrimDbgPrintTrimCurves (trim_dbg.c:57)

void TrimDbgPrintTrimCurves(const TrimCrvStruct *TrimCrv)

TrimCrv: Trimming curves to print.
Returns: void

Description: Prints the trimming curves of a given trimmed surface.
See also: TrimDbg,

12.2.26 TrimDescribeError (trim_err.c:57)

const char *TrimDescribeError(TrimFatalErrorType ErrorNum)

ErrorNum: Type of the error that was raised.
Returns: A string describing the error type.

Description: Returns a string describing a the given error. Errors can be raised by any member of this trim
library as well as other users. Raised error will cause an invokation of TrimFatalError function which decides how
to handle this error. TrimFatalError can for example, invoke this routine with the error type, print the appropriate
message and quit the program.

12.2.27 TrimEvalTrimCrvToEuclid (trim_aux.c:1219)

CagdCrvStruct *TrimEvalTrimCrvToEuclid(const TrimSrfStruct *TrimSrf,
const CagdCrvStruct *UVCrv)

TrimSrf: To compute the Euclidean UVCrv for.
UVCrv: A curve in the parametric space of Srf.
Returns: A Euclidean curve in Srf, following UVCrv.

Description: Computes the composed Euclidean curve of Srf(UVCrv). The resulting curve is either computed
using a piecewise linear approximation or by symbolically composing it onto the surface. See TrimSetEuclidCom-
posedFromUV for a way to control this computation.
See also: TrimCrvs2Polylines, TrimSetEuclidComposedFromUV, , TrimEvalTrimCrvToEuclid2,
12.2.28  TrimEvalTrimCrvToEuclid2  (trim_au.c:1245)

CagdCrvStruct *TrimEvalTrimCrvToEuclid2(const CagdSrfStruct *Srf, 
const CagdCrvStruct *UVCrv)

Srf: To compute the Euclidean UVCrv for.
UVCrv: A curve in the parametric space of TrimSrf.
Returns: A Euclidean curve in TrimSrf, following UVCrv.

Description: Computes the composed Euclidean curve of TrimSrf(UVCrv). The resulting curve is either computed using a piecewise linear approximation or by symbolically composing it onto the surface. See TrimSetEuclidComposedFromUV for a way to control this computation.

See also: TrimCrvs2Polylines, TrimSetEuclidComposedFromUV, TrimEvalTrimCrvToEuclid,

12.2.29  TrimFatalError  (trim_ftl.c:53)

void TrimFatalError(TrimFatalErrorType ErrID)

ErrID: Error type that was raised.
Returns: void

Description: Trap Trim_lib errors right here. Provides a default error handler for the trim library. Gets an error description using TrimDescribeError, prints it and exit the program using exit.

12.2.30  TrimGetFullDomainTrimCrv  (trim_gen.c:1427)

const TrimCrvSegStruct *TrimGetFullDomainTrimCrv(const TrimSrfStruct *TSrf)

TSrf: Trimmed surface to look for its outer full loop.
Returns: Return outer full loop if exists.

Description: Identifies the outer loop of the trimmed surfaces and returns a reference to it if it covers all the tensor product surface domain. A NULL is returned if outer loops is not entire tensor product domain.

See also: TrimGetLargestTrimmedSrf, TrimGetOuterTrimCrv,

12.2.31  TrimGetLargestTrimmedSrf  (trim_gen.c:1327)

TrimSrfStruct *TrimGetLargestTrimmedSrf(TrimSrfStruct **TSrfs, int Extract)

TSrfs: List of trimmed usrface to find the 'largest'.
Extract: TRUE to extract and return the 'largest' trimmed surface from TSrfs, FALSE to only find it.
Returns: List of trimmed surface to search for 'largest'.

Description: Find the largest trimmed surface in the given list. While there notion of 'largest' is not really well define, we simply use here the heuristics of largest == trimmed surface with longest trimming curves.

See also: TrimGetOuterTrimCrv, TrimGetFullDomainTrimCrv,

12.2.32  TrimGetOuterTrimCrv  (trim_gen.c:1380)

const TrimCrvSegStruct *TrimGetOuterTrimCrv(const TrimSrfStruct *TSrf)

TSrf: Trimmed surface to look for its outer loop.
Returns: Outer loop.

Description: Returns the outer trimming curve found in TSrf. If their is more than one outer curve, one of then is returned.

See also: TrimGetLargestTrimmedSrf, TrimGetFullDomainTrimCrv,
12.2.33 TrimGetTrimCrvLinearApprox (trim_iso.c:792)

CagdRType TrimGetTrimCrvLinearApprox(void)

**Returns:** Sought tolerance.
**Description:** Get the current tolerance used when approximating higher order trimming curves using piecewise linear approximation.
**See also:** TrimSetTrimCrvLinearApprox,

12.2.34 TrimGetTrimmingCurves (trim_aux.c:462)

CagdCrvStruct *TrimGetTrimmingCurves(const TrimSrfStruct *TrimSrf, CagdBType ParamSpace, CagdBType EvalEuclid)

**TrimSrf:** Trimmed surface to extract trimming curves from.
**ParamSpace:** TRUE for curves in parameteric space, FALSE of 3D Euclidean space.
**EvalEuclid:** If TRUE and ParamSpace is FALSE, evaluate Euclidean curve even if one exists.
**Returns:** List of trimming curves of TrimSrf.
**Description:** Extracts the trimming curves of the given trimmed surface.
**See also:** TrimPiecewiseLinearTrimmingCurves, TrimGetTrimmingCurves2,

12.2.35 TrimGetTrimmingCurves2 (trim_aux.c:494)

CagdCrvStruct *TrimGetTrimmingCurves2(const TrimCrvStruct *TrimCrvList, const TrimSrfStruct *TrimSrf, CagdBType ParamSpace, CagdBType EvalEuclid)

**TrimCrvList:** Trimming curves to extract trimming curves as curves.
**TrimSrf:** Trimmed surface to extract trimming curves from. This parameter is optional and used only if EvalEuclid and/or !ParamSpace.
**ParamSpace:** TRUE for curves in parameteric space, FALSE of 3D Euclidean space.
**EvalEuclid:** If TRUE and ParamSpace is FALSE, evaluate Euclidean curve even if one exists.
**Returns:** List of trimming curves as curves.
**Description:** Extracts the trimming curves as curves from the given trimming curves.
**See also:** TrimPiecewiseLinearTrimmingCurves, TrimGetTrimmingCurves,

12.2.36 TrimHealTrimmingCurves (trim_aux.c:827)

CagdCrvStruct *TrimHealTrimmingCurves(TrimCrvStruct *TrimCrvs)

**TrimCrvs:** Trimming curves to heal.
**Returns:** Healed trimming curves.
**Description:** Heal the given trimming curves by making sure they are valid and form closed loops.
12.2.37  TrimIntersectCrvsIsoVals (trim_iso.c:470)

TrimIsoInterStruct **TrimIntersectCrvsIsoVals(const CagdCrvStruct *UVCrvs,
int Dir,
CagdRType *IsoParams,
int NumOfIsocurves)

**UVCrvs:** UV curves to intersect. Must be piecewise linear.
**Dir:** Either U or V.
**IsoParams:** Vector of isoparametric values in direction Dir.
**NumOfIsocurves:** Size of vector IsoParams.

**Returns:** A vector of size NumOfIsocurves, each slot contains a list of intersection parameter values.

**Description:** Computes the intersections of given UV curves with the ordered isoparametric values prescribed by IsoParams, in axis Axis.

**See also:** TrimIntersectTrimCrvIsoVals,

12.2.38  TrimIntersectTrimCrvIsoVals (trim_iso.c:298)

TrimIsoInterStruct **TrimIntersectTrimCrvIsoVals(const TrimSrfStruct *TrimSrf,
int Dir,
CagdRType *OrigIsoParams,
int NumOfIsocurves,
CagdBType Perturb)

**TrimSrf:** Trimmed surface to consider.
**Dir:** Either U or V.
**OrigIsoParams:** Vectors of isoparametric values in direction Dir.
**NumOfIsocurves:** Size of vector IsoParams.
**Perturb:** TRUE to epsilon-perturb the iso-param values.

**Returns:** A vector of size NumOfIsocurves, each contains a list of intersection parameter values.

**Description:** Computes the intersections of the trimming curves of TrimSrf with the ordered isoparametric values prescribed by OrigIsoParams, in axis Axis.

**See also:** TrimSrf2Polylines, TrimCrvAgainstTrimCrvs,

12.2.39  TrimIsPointInsideTrimCrvs (trim_aux.c:1421)

CagdBType TrimIsPointInsideTrimCrvs(const TrimCrvStruct *TrimCrvs,
CagdUVType UV)

**TrimCrvs:** Trimming curves to consider.
**UV:** Parametric location.

**Returns:** TRUE if inside, FALSE otherwise.

**Description:** Returns TRUE if the given UV value is inside the domain prescribed by the trimming curves.

**See also:** TrimIsPointInsideTrimUVCrv, TrimIsPointInsideTrimSrf, TrimIsPointInsideTrimUVCrv, MdlIsPointInsideTrimSrf,

12.2.40  TrimIsPointInsideTrimSrf (trim_aux.c:1396)

CagdBType TrimIsPointInsideTrimSrf(const TrimSrfStruct *TrimSrf,
CagdUVType UV)

**TrimSrf:** Trimmed surface to consider.
**UV:** Parametric location.

**Returns:** TRUE if inside, FALSE otherwise.

**Description:** Returns TRUE if the given UV value is inside the trimmed surface’s parametric domain.

**See also:** TrimIsPointInsideTrimUVCrv, TrimIsPointInsideTrimCrvs,
12.2.41 TrimIsPointInsideTrimUVCr (trim_aux.c:1461)

```c
int TrimIsPointInsideTrimUVCr(const CagdCrvStruct *UVCrv,
                               CagdUVType UV)
```

**UVCrv**: Trimming curve to consider.
**UV**: Parametric location.

**Returns**: Number of crossings of UVCrv by a ray from UV in -V dir.

**Description**: Returns the number of times a ray in the +V direction from UV crosses UVCrv.

**See also**: TrimIsPointInsideTrimCrvs, TrimIsPointInsideTrimSrf, MdlIsPointInsideTrimSrf,

12.2.42 TrimPiecewiseLinearTrimmingCurves (trim_aux.c:554)

```c
TrimSrfStruct *TrimPiecewiseLinearTrimmingCurves(TrimSrfStruct *TrimSrf,
                                                  CagdBType EvalEuclid)
```

**TrimSrf**: Trimmed surface to extract trimming curves from.
**EvalEuclid**: If TRUE reevaluate Euclidean curve as well.

**Returns**: The trimmed surface, modified in place, that holds piecewise linear trimming curves only.

**Description**: Converts all trimming curve of given surface to piecewise linear (approximation), in place. The
trimming curves are approximated as piecewise linear using method and tolerance that is set via the function
TrimSetTrimCrvLinearApprox.

**See also**: TrimGetTrimmingCurves, TrimSetTrimCrvLinearApprox, TrimCrv2Polyline,

12.2.43 TrimPiecewiseRuledSrfApprox (trim_aux.c:130)

```c
TrimSrfStruct *TrimPiecewiseRuledSrfApprox(const TrimSrfStruct *CTSrf,
                                          CagdBType ConsistentDir,
                                          CagdRType Epsilon,
                                          CagdSrfDirType Dir)
```

**CTSrf**: To approximate using piecewise ruled surfaces.
**ConsistentDir**: Do we want parametrization to be the same as TSrf?
**Epsilon**: Accuracy of piecewise ruled surface approximation.
**Dir**: Direction of piecewise ruled surface approximation. Either U or V.

**Returns**: A list of trimmed ruled surfaces approximating TSrf to within Epsilon in direction Dir.

**Description**: Constructs a piecewise ruled surface approximation to the given trimmed surface, TSrf, in the
given direction, Dir, that is close to the surface to within Epsilon. If ConsistentDir then ruled surface parametrization
is set to be the same as original surface TSrf. Otherwise, ruling dir is always CAGD_CONST_V_DIR. Surface is
assumed to have point types E3 or P3 only.

**See also**: TrimAllPrisaSrfs, TrimPrisaRuledSrf, SymbAllPrisaSrfs,

12.2.44 TrimPointInsideTrimmedCrvs (trim_aux.c:224)

```c
CagdRType *TrimPointInsideTrimmedCrvs(TrimCrvStruct *TrimCrvList,
                                       const TrimSrfStruct *TSrf)
```

**TrimCrvList**: To find a location inside it.
**TSrf**: If provided, will attempt to find a point inside the trimmed curve from the surface boundary. If NULL,
an interior point to the trimming curves will be selected.

**Returns**: A location in the parametric space of the surface that is part of the valid trimmed surface domain.

**Description**: Finds a point inside a set of trimmed crvs. Returned is a UV location allocated statically.
12.2.45 TrimPolylines2LinTrimCrvs \((\text{trimcntr.c:536})\)

\[\text{TrimCrvStruct *TrimPolylines2LinTrimCrvs(\text{const IPPolygonStruct *Polys})}\]

- **Polys**: Input polylines to convert to linear b-spline curves.
- **Returns**: Linear b-spline curves representing Polys.
- **Description**: Returns a list of linear b-spline curves constructed from given polylines.

12.2.46 TrimPrisaRuledSrf \((\text{tr_prisa.c:381})\)

\[\text{TrimSrfStruct *TrimPrisaRuledSrf(\text{const TrimSrfStruct *TSrf}, \text{int SamplesPerCurve, \text{CagdRType Space}, \text{CagdVType Offset, \text{CagdSrfDirType Dir})}}\]

- **TSrf**: A trimmed ruled surface to layout flat on the XY plane.
- **SamplesPerCurve**: During the approximation of a ruled surface as a developable surface.
- **Space**: Increment on Y on the offset vector, after this surface was placed in the XY plane.
- **Offset**: A vector in the XY plane to denote the amount of translation for the flattened surface in the XY plane.
- **Dir**: Direction of piecewise ruled surface approximation. Either U or V.
- **Returns**: A planar trimmed surface in the XY plane approximating the flattening process of TSrf.
- **Description**: Layout a single trimmed ruled surface, by approximating it as a set of triangles. The given trimmed ruled surface might be non-developable, in which case approximation will be of a surface with no twist. The trimmed ruled surface is assumed to be constructed using CagdRuledSrf and that the ruled direction is consistent and is always CAGD\_CONST\_V\_DIR.
- **See also**: TrimPiecewiseRuledSrfApprox, TrimAllPrisaSrfs, SymbAllPrisaSrfs,

12.2.47 TrimRemoveCrvSegTrimCrvSegs \((\text{trim_sub.c:767})\)

\[\text{int TrimRemoveCrvSegTrimCrvSegs(\text{TrimCrvSegStruct *TrimCrvSeg, \text{TrimCrvSegStruct **TrimCrvSegs})}}\]

- **TrimCrvSeg**: Segment to delete.
- **TrimCrvSegs**: List of trimming curve segments to delete TrimCrvSeg from.
- **Returns**: TRUE if found and removed, FALSE otherwise.
- **Description**: Removes but not delete the given trimming crv segment from the list of trimming curve segments pointed by TrimCrvSegs.
- **See also**: TrimRemoveCrvSegTrimCrvs,

12.2.48 TrimRemoveCrvSegTrimCrvs \((\text{trim_sub.c:714})\)

\[\text{int TrimRemoveCrvSegTrimCrvs(\text{TrimCrvSegStruct *TrimCrvSeg, \text{TrimCrvStruct **TrimCrvs})}}\]

- **TrimCrvSeg**: Segment to delete.
- **TrimCrvs**: List of trimming curves to delete TrimCrvSeg from.
- **Returns**: TRUE if found and removed, FALSE otherwise.
- **Description**: Removes but not delete the given trimming crv segment from the list of trimming curves point by TrimCrvs.
- **See also**: TrimRemoveCrvSegTrimCrvSegs,
12.2.49 TrimSetEuclidComposedFromUV (trimaux.c:1369)

```c
int TrimSetEuclidComposedFromUV(int EuclidComposedFromUV)

EuclidComposedFromUV: Do we want symbolic composition for Euclidean curves, or should we piecewise linear sample the UV trimming curves.

Returns: Old value of way of Euclidean curve's computation

Description: Sets the way Euclidean trimming curves are computed from parametric trimming curves. Either by symbolic composition (TRUE) or by piecewise linear approximation of trimming curves (FALSE).

See also: TrimCrv2Polylines,
```

12.2.50 TrimSetFatalErrorFunc (trim_ftl.c:28)

```c
TrimSetErrorFuncType TrimSetFatalErrorFunc(TrimSetErrorFuncType ErrorFunc)

ErrorFunc: New error function to use.
Returns: Old error function reference.

Description: Sets the error function to be used by Trim_lib.
```

12.2.51 TrimSetNumTrimVrtcsInCell (trim2pl2.c:345)

```c
int TrimSetNumTrimVrtcsInCell(int NumTrimVrtcsInCell)

NumTrimVrtcsInCell: Number of requested trimming vertices in a cell.
Returns: Old value of way of num of cells.

Description: Sets the way trimming curves contributes to each cell in the domain by setting the number of vertices trimming curves can contribute to each such cell.
```

12.2.52 TrimSetTrimCrvLinearApprox (trim.iso.c:764)

```c
SymbCrvApproxMethodType TrimSetTrimCrvLinearApprox(CagdRType UVTolSamples, SymbCrvApproxMethodType UVMethod)

UVTolSamples: Piecewise linear approximation of high order trimming curves - number of samples per curve or tolerance.
UVMethod: Method of sampling.
Returns: Old method of curve sampling.

Description: Sets the tolerances to use when approximating higher order trimming curves using piecewise linear approximation, for intersection computation.

See also: TrimGetTrimCrvLinearApprox, SymbCrv2Polyline, TrimCrv2Polyline,
```

12.2.53 TrimSrf2Curves (trim.iso.c:110)

```c
CagdCrvStruct *TrimSrf2Curves(TrimSrfStruct *TrimSrf, int NumOfIsocurves[2])

TrimSrf: To extract isoparametric curves from.
NumOfIsocurves: In each (U or V) direction.

Returns: List of extracted isoparametric curves. These curves inherit the order and continuity of the original Srf. NULL is returned in case of an error.

Description: Routine to extract from a trimmed surface NumOfIsoline isocurve list in each param. direction. Iso parametric curves are sampled equally spaced in parametric space. NULL is returned in case of an error, otherwise list of CagdCrvStruct. As the isoparametric curves are trimmed according to the trimming curves the resulting number of curves is arbitrary.
```
12.2.54 TrimSrf2Polygons2 (trim2pl2.c:184)

CagdPolygonStruct *TrimSrf2Polygons2(const TrimSrfStruct *CTrimSrf,
    int FineNess,
    CagdBType ComputeNormals,
    CagdBType ComputeUV)

CTrimSrf: To approximate into triangles.
FineNess: Control on accuracy, the higher the finer.
ComputeNormals: If TRUE, normal information is also computed.
ComputeUV: If TRUE, UV values are stored and returned as well.

Returns: A list of polygons with optional normal and/or UV parametric information. NULL is returned in case of an error.

Description: Routine to convert a single trimmed surface to set of triangles approximating it. FineNess is a fineness control on result and the larger is more triangles may result. A value of 10 is a good start value. NULL is returned in case of an error, otherwise list of CagdPolygonStruct. This routine looks for C1 discontinuities in the surface and splits it into C1 continuous patches to invoke TrimC1Srf2Polygons to gen. polygons.

See also: BspSr2PolygonSetErrFunc, BarSr2Polygons, IritSurface2Polygons, IritTrimSrf2Polygons, CagdSr2Polygons, BspSr2Polygons, BspC1Sr2Polygons, TrimSetNumTrimVrtcsInCell,

12.2.55 TrimSrf2Polylines (trim_iso.c:71)

CagdPolylineStruct *TrimSrf2Polylines(TrimSrfStruct *TrimSrf,
    int NumOfIsocurves[2],
    CagdRType TolSamples,
    SymbCrvApproxMethodType Method)

TrimSrf: To extract isoparametric curves from.
NumOfIsocurves: In each (U or V) direction.
TolSamples: Tolerance of approximation error (Method = 2) or Number of samples to compute on polyline (Method = 0, 1).
Method: 0 - TolSamples are set uniformly in parametric space, 1 - TolSamples are set optimally, considering the isocurve's curvature. 2 - TolSamples sets the maximum error allowed between the piecewise linear approximation and original curve.

Returns: List of polylines representing a piecewise linear approximation of the extracted isoparametric curves or NULL is case of an error.

Description: Routine to convert a single trimmed surface to NumOfIsolines polylines in each parametric direction with TolSamples samples/tolerance in each isoparametric curve. Polyline are always E3 of CagdPolylineStruct type. Polylines are always E3 of CagdPolylineStruct type. Polyline are always E3 of CagdPolylineStruct type. Attempt is made to extract isolines along C1 discontinuities first.

See also: TrimCrv2Polyline,

12.2.56 TrimSrfAdap2Polygons (trim2ply.c:129)

CagdPolygonStruct *TrimSrfAdap2Polygons(const TrimSrfStruct *TrimSrf,
    CagdRType Tolerance,
    CagdBType ComputeNormals,
    CagdBType ComputeUV)

TrimSrf: To approximate into triangles.
Tolerance: of approximation - a value that depends on the error function used.
ComputeNormals: If TRUE, normal information is also computed.
ComputeUV: If TRUE, UV values are stored and returned as well.

Returns: A list of polygons with optional normal and/or UV parametric information. NULL is returned in case of an error or if use of call back function to collect the polygons.

Description: Routine to convert a single trimmed surface to set of polygons approximating it. Tolerance is a tolerance control on result, typically related to the the accuracy of the approximation. A value of 0.1 is a good rough start. NULL is returned in case of an error or use of call back function to get a hold over the created polygons, otherwise list of CagdPolygonStruct. This routine looks for C1 discontinuities in the surface and splits it into C1 continuous patches first.

See also: CagdSr2PolygonSetErrFunc, CagdSr2Adap2PolyDefErrFunc, CagdSr2PolyAdapSetErrFunc, CagdSr2PolyAdapSetA, CagdSr2PolyAdapSetPolyGenFunc, CagdSr2AdapPolygons, TrimSr2Polygons,
12.2.57 TrimSrfCnvrt2BzrRglrSrf (untrim.c:166)

CagdSrfStruct *TrimSrfCnvrt2BzrRglrSrf(TrimSrfStruct *TrimSrf)

TrimSrf: A trimmed Bezier or a Bspline surface to convert to non-trimmed Bezier surfaces.
Returns: The non trimmed regular Bezier surfaces.
Description: Given a trimmed surface - subdivides it into trimmed Bezier surfaces and convert the trimmed surface into regular Bezier/Bspline patches. Returns a list of non-trimmed Bezier surfaces, that together, are identical geometrically to the input trimmed surface.
See also: TrimSrfSubdivAtParam, TrimSrfCnvrt2BzrTrimSrf,

12.2.58 TrimSrfCnvrt2BzrRglrSrf2 (untrim.c:269)

CagdSrfStruct *TrimSrfCnvrt2BzrRglrSrf2(const TrimSrfStruct *TSrf,
int ComposeE3,
int OnlyBzrSrfs,
int HigherOrderTrimmingCurves,
CagdRType Eps)

TSrf: Trimmed surface to decompose into a list of tensor product (and no trimming) surfaces.
ComposeE3: TRUE to compose the tiles into TSrf, FALSE to return the surface tiles in the parametric domain of TSrf.
OnlyBzrSrfs: TRUE to force only Bezier tensor products in result.
HigherOrderTrimmingCurves: TRUE to keep trimming curves as higher order resulting in precise higher order tensor product surfaces.
Eps: Tolerance of the decomposition.
Returns: A list of regular tensor product surfaces that represents the same region as TSrf, to within machine precision.
Description: Divides the given trimmed surface TSrf to a list of tensor products. The result is tiling the original trimmed surface to within machine precision. The given TSrf surface is recursively divided until the trimming curves are simple, in which case the trimmed surface is converted into a regular tensor product surface. A trimmed surface is considered simple if it has a single trimming loop that is double monotone with U or V (That is from the minimal point to the maximal point in U or V we have monotone progress in two separated paths).
See also: TrimCrvIsParameterizableDomain, Trim2DSrfFromDoubleMonotoneTrimCrv, TrimSrfCnvrt2BzrRglrSrf,

12.2.59 TrimSrfCnvrt2BzrTrimSrf (untrim.c:38)

TrimSrfStruct *TrimSrfCnvrt2BzrTrimSrf(TrimSrfStruct *TrimSrf)

TrimSrf: A Bezier or a Bspline trimmed surface to convert to Bezier.
Returns: The subdivided Bezier trimmed surfaces.
Description: Given a trimmed surface - subdivides it into trimmed Bezier surfaces (each spanning domain [0, 1]^2). Returns a list of trimmed Bezier surfaces, that together, are identical geometrically to the input trimmed surface.
See also: TrimSrfSubdivAtParam,

12.2.60 TrimSrfCnvrt2TensorProdSrf (untrim.c:346)

CagdSrfStruct *TrimSrfCnvrt2TensorProdSrf(const TrimSrfStruct *TSrf,
int ComposeE3,
CagdRType Eps)

TSrf: Trimmed surface to decompose into a list of tensor product (and no trimming) surfaces.
ComposeE3: TRUE to compose the tiles into TSrf, FALSE to return the surface tiles in the parametric domain of TSrf.
**Eps:** Tolerance of the decomposition.

**Returns:** A list of regular tensor product surfaces that represents the same region as TSrf, to within machine precision.

**Description:** Divides the given trimmed surface TSrf to a list of tensor product srfs. The result is tiling the original trimmed surface to within machine precision. The given TSrf surface is recursively divided until the trimming curves are simple, in which case the trimmed surface is converted into a regular tensor product surface. A trimmed surface is considered simple if it has a single trimming loop that is double monotone with U or V (That is from the minimal point to the maximal point in U or V we have monotone progress in two separated paths).

**See also:** TrimCrvIsParameterizableDomain, Trim2DSrfFromDoubleMonotoneTrimCrv, TrimSrfCnvrt2BzrRglrSrf, TrimSrfCnvrt2BzrRglrSrf2,

12.2.61 **TrimSrfCopy** (trim_gen.c:1063)

TrimSrfStruct *TrimSrfCopy(const TrimSrfStruct *TrimSrf)

- **TrimSrf:** A trimming surface to duplicate.
- **Returns:** A trimming surface structure.
- **Description:** Duplicates a trimming surface structure.

12.2.62 **TrimSrfCopyList** (trim_gen.c:1092)

TrimSrfStruct *TrimSrfCopyList(const TrimSrfStruct *TrimSrfList)

- **TrimSrfList:** To be copied.
- **Returns:** A duplicated list of trimming surfaces.
- **Description:** Allocates and copies a list of trimming surface structures.

12.2.63 **TrimSrfDegreeRaise** (trim_aux.c:113)

TrimSrfStruct *TrimSrfDegreeRaise(const TrimSrfStruct *TrimSrf, CagdSrfDirType Dir)

- **TrimSrf:** To raise its degree.
- **Dir:** Direction of degree raising. Either U or V.
- **Returns:** A surface with same geometry as Srf but with one degree higher.
- **Description:** Returns a new trimmed surface representing the same surface as TrimSrf but with its degree raised by one.

**See also:** CagdSrfDegreeRaise,

12.2.64 **TrimSrfDomain** (trim_aux.c:59)

void TrimSrfDomain(const TrimSrfStruct *TrimSrf, CagdRType *UMin, CagdRType *UMax, CagdRType *VMin, CagdRType *VMax)

- **TrimSrf:** To get its parametric domain.
- **UMin:** Where to put the minimal U domain’s boundary.
- **UMax:** Where to put the maximal U domain’s boundary.
- **VMin:** Where to put the minimal V domain’s boundary.
- **VMax:** Where to put the maximal V domain’s boundary.
- **Returns:** void
- **Description:** Returns the parametric domain of a trimmed surface.

**See also:** CagdSrfDomain,
12.2.65  TrimSrfEval  (trim_aux.c:88)

CagdRType *TrimSrfEval(const TrimSrfStruct *TrimSrf, CagdRType u, CagdRType v)

TrimSrf: To evaluate at the given parametric location (u, v).

u, v: The parameter values at which TrimSrf is to be evaluated.

Returns: A vector holding all the coefficients of all components of surface TrimSrf’s point type. If, for example, TrimSrf’s point type is P2, the W, X, and Y will be saved in the first three locations of the returned vector. The first location (index 0) of the returned vector is reserved for the rational coefficient W and XYZ always starts at second location of the returned vector (index 1).

Description: Given a trimmed surface and parameter values u, v, evaluate the surface at (u, v). No test is made to make sure (u, v) is in the untrimmed domain.

See also: CagdSrfEval,

12.2.66  TrimSrfFree  (trim_gen.c:1121)

void TrimSrfFree(TrimSrfStruct *TrimSrf)

TrimSrf: A trimmed surface to free.

Returns: void

Description: Deallocates a trimmed surface structure.

12.2.67  TrimSrfFreeList  (trim_gen.c:1143)

void TrimSrfFreeList(TrimSrfStruct *TrimSrfList)

TrimSrfList: A list of trimmed surface to free.

Returns: void

Description: Deallocates a list of trimmed surface structures.

12.2.68  TrimSrfMatTransform  (trim_gen.c:1211)

void TrimSrfMatTransform(TrimSrfStruct *TrimSrf, CagdMType Mat)

TrimSrf: Trimmed surface to transform.

Mat: Homogeneous transformation to apply to trimmed surface.

Returns: void

Description: Transforms, in place, the given trimmed surface as specified by a homogeneous matrix Mat.

12.2.69  TrimSrfNew  (trim_gen.c:348)

TrimSrfStruct *TrimSrfNew(CagdSrfStruct *Srf,
                         TrimCrvStruct *TrimCrvList,
                         CagdBType HasTopLvlTrim)

Srf: Surface to make into a trimmed surface. Used in place.

TrimCrvList: A list of trimming curves, used in place.

HasTopLvlTrim: Do we have a top level outer most trimming curve?

Returns: The trimmed surface.

Description: Constructor for a trimmed surface.
12.2.70 TrimSrfNew2 (trim_gen.c:414)

TrimSrfStruct *TrimSrfNew2(CagdSrfStruct *Srf,
    CagdCrvStruct *TrimCrvList,
    CagdBType HasTopLvlTrim)

Srf: Surface to make into a trimmed surface. Used in place.
TrimCrvList: A list of trimming curves, as regular curves, used in place.
HasTopLvlTrim: Do we have a top level outer most trimming curve?

Returns: The trimmed surface.

Description: Constructor for a trimmed surface.

12.2.71 TrimSrfRefineAtParams (trim_aux.c:340)

TrimSrfStruct *TrimSrfRefineAtParams(const TrimSrfStruct *TrimSrf,
    CagdSrfDirType Dir,
    CagdBType Replace,
    CagdRType *t,
    int n)

TrimSrf: To refine.
Dir: Direction of refinement. Either U or V.
Replace: If TRUE, t holds knots in exactly the same length as the length of the knot vector of Srf and t simply replaces the knot vector.
t: Vector of knots with length of n.
n: Length of vector t.

Returns: A refined surface of TrimSrf after insertion of all the knots as specified by vector t of length n.

Description: Given a trimmed surface - refines it at the given n knots as defined by vector t. If Replace is TRUE, the values in t replaces current knot vector. Returns pointer to refined surface (Note a Bezier surface will be converted into a Bspline surface).

See also: CagdSrfRefineAtParams,

12.2.72 TrimSrfRegionFromTrimSrf (trim_aux.c:142)

TrimSrfStruct *TrimSrfRegionFromTrimSrf(TrimSrfStruct *TrimSrf,
    CagdRType t1,
    CagdRType t2,
    CagdSrfDirType Dir)

TrimSrf: To extract a sub-region from.
t1, t2: Parametric domain boundaries of sub-region.
Dir: Direction of region extraction. Either U or V.

Returns: Sub-region extracted from TrimSrf from t1 to t2.

Description: Given a trimmed surface - extracts a sub-region within the domain specified by t1 and t2, in the direction Dir.

See also: TrimSrfSubdivAtParam, CagdSrfRegionFromSrf,

12.2.73 TrimSrfReverse (trim_aux.c:365)

TrimSrfStruct *TrimSrfReverse(const TrimSrfStruct *TrimSrf)

TrimSrf: To be reversed.

Returns: Reversed surface of TrimSrf.

Description: Returns a new trimmed surface that is the reversed surface of TrimSrf by reversing the control mesh and the knot vector (if Bspline surface) of TrimSrf in the U direction, as well as its trimming curves. See also CagdSrfReverse and BspKnotReverse.

See also: TrimSrfReverse2, CagdSrfReverse,
12.2.74 TrimSrfReverse2 (trim_aux.c:412)

```
TrimSrfStruct *TrimSrfReverse2(const TrimSrfStruct *TrimSrf)
```

**TrimSrf**: To be reversed.

**Returns**: Reversed surface of TrimSrf.

**Description**: Returns a new trimmed surface that is the reversed surface of Srf by flipping the U and the V directions of the surface, as well as flipping them in the trimming curves. See also BspKnotReverse.

**See also**: TrimSrfReverse, CagdSrfReverse2,

12.2.75 TrimSrfSubdivAtParam (trim_sub.c:103)

```
TrimSrfStruct *TrimSrfSubdivAtParam(TrimSrfStruct *TrimSrf, CagdRType t, CagdSrfDirType Dir)
```

**TrimSrf**: To subdivide at the prescribed parameter value t.

**t**: The parameter to subdivide the curve Crv at.

**Dir**: Direction of subdivision. Either U or V.

**Returns**: The subdivided surfaces. Usually two, but can have only one, if other is totally trimmed away.

**Description**: Given a trimmed surface - subdivides it into two sub-surfaces at given parametric value t in the given direction Dir. Returns pointer to a list of two trimmed surfaces, at most. It can very well may happen that the subdivided surface is completely trimmed out and hence nothing is returned for it.

**See also**: TrimSrfSubdivTrimmingCrvs,

12.2.76 TrimSrfSubdivAtParamForcePiecwiseLinearTrimCrvs (trim_sub.c:69)

```
CagdBType TrimSrfSubdivAtParamForcePiecwiseLinearTrimCrvs(CagdBType ForcePLCrvs)
```

**ForcePLCrvs**: TRUE to make sure all trimming curves are piecewise linear.

**Returns**: Old state of this flag.

**Description**: Controls the way future trimmed surfaces subdivisions are made: If TRUE, all trimming curves are made piecewise linear as a side effect. If FALSE, trimming curves are left as is.

**See also**:

12.2.77 TrimSrfSubdivTrimmingCrvs (trim_sub.c:207)

```
int TrimSrfSubdivTrimmingCrvs(TrimCrvStruct *TrimCrvs, CagdRType t, CagdSrfDirType Dir, TrimCrvStruct **TrimCrvs1, TrimCrvStruct **TrimCrvs2)
```

**TrimCrvs**: To subdivide at the prescribed parameter value t.

**t**: The parameter to subdivide the curve Crv at.

**Dir**: Direction of subdivision. Either U or V.

**TrimCrvs1**: Returned first half of trimming curves, < t. Could be NULL.

**TrimCrvs2**: Returned second half of trimming curves, > t. Could be NULL.

**Returns**: TRUE if successful and have two halves. FALSE if failed or have only one half.

**Description**: Given a set of trimming curves - subdivides them into two groups below and above the subdividing line in direction Dir at parameter t.

**See also**: TrimSrfSubdivAtParam,
12.2.78  TrimSrfTransform (trim_gen.c:1172)

void TrimSrfTransform(TrimSrfStruct *TrimSrf,
                     CagdRType *Translate,
                     CagdRType Scale)

  TrimSrf: Trimmed surface to transform.
  Translate: Translation factor. Can be NULL for non.
  Scale: Scaling factor.
  Returns: void

  Description: Linearly transforms, in place, given trimmed surface as specified by Translate and Scale.

12.2.79  TrimSrfTrimCrvAllDomain (trim_aux.c:1640)

CagdBType TrimSrfTrimCrvAllDomain(const TrimSrfStruct *TrimSrf)

  TrimSrf: Trimmed surface to examine.
  Returns: TRUE if entire surface domain, FALSE otherwise.

  Description: Examine the trimming curves of the given trimmed surface and returns TRUE iff the valid domain
               of trimming equals the entire surface domain.
  See also: TrimSrfTrimCrvSquareDomain, TrimClipSrfToTrimCrvs,

12.2.80  TrimSrfTrimCrvSquareDomain (trim_aux.c:1541)

CagdBType TrimSrfTrimCrvSquareDomain(const TrimCrvStruct *TrimCrvList,
                                     CagdRType *UMin,
                                     CagdRType *UMax,
                                     CagdRType *VMin,
                                     CagdRType *VMax)

  TrimCrvList: Trimming curves to examine.
  UMin, UMax, VMin, VMax: Domain of square, if return TRUE
  Returns: TRUE if a isoparametric square domain, FALSE otherwise.

  Description: Examine the trimming curves of the given trimmed surface and returns TRUE iff the trimmed
               domain is a sub isoparametric square. In such a case the U/VMin/Max are set to the domain of the square.
  See also: TrimSrfTrimCrvAllDomain, TrimClipSrfToTrimCrvs,

12.2.81  TrimSrfVerifyTrimCrvsValidity (trim_gen.c:495)

int TrimSrfVerifyTrimCrvsValidity(TrimSrfStruct *TrimSrf)

  TrimSrf: To verify the validity of the trimming curves. This includes the verification of the continuity of the
           trimming loops and the inclusion in the domain of the trimming curves.
  Returns: TRUE if valid, FALSE if cannot correct the trimming curves.

  Description: Verify that all trimming curves are indeed in the parametric domain of the surface and that all of
               them matches neighboring curves.
12.2.82  TrimSrfsFromContours (trimcntr.c:94)

TrimSrfStruct *TrimSrfsFromContours(const CagdSrfStruct *Srf,
                                     const IPPolygonStruct *CCntrs)

Srf: To trim into pieces.
CCntrs: Polylines to use as separating edges.
Returns: List of trimmed surface pieces.
Description: Creates a set of trimmed surfaces as defined by the given set of contours that can contain either
closed or open contours. Open contours must terminate at the boundary of the parametric domain of the surface.
Closed contours must be completely contained in the parametric domain with last point equals first.
See also: TrimSrfsFromContours2, TrimSrfsFromTrimPlsHierarchy,

12.2.83  TrimSrfsFromContours2 (trimcntr.c:301)

TrimSrfStruct *TrimSrfsFromContours2(const CagdSrfStruct *Srf,
                                       const CagdCrvStruct *CCntrs)

Srf: To trim into pieces.
CCntrs: Curves to use as separating trimming curves.
Returns: List of trimmed surface pieces.
Description: Same as TrimSrfsFromContours after converting the curves to polylines.
See also: TrimSrfsFromContours, TrimSrfsFromTrimPlsHierarchy,

12.2.84  TrimSrfsFromTrimPlsHierarchy (trimcntr.c:349)

TrimSrfStruct *TrimSrfsFromTrimPlsHierarchy(IPPolygonStruct *TopLevel,
                                            IPPolygonStruct *TrimPls,
                                            const CagdSrfStruct *Srf)

TopLevel: The top level outer loop or NULL if none.
TrimPls: Hierarchy of trimming polylines.
Srf: Surface to trim out.
Returns: List of trimmed surface out of the given counters.
Description: Construct trimmed surface from the given hierarchy of trimming polylines. If TopLevel is provided,
it serves as the top level outer loop and both Odd and Even nested trimmed surfaces are extracted. If TopLevel is
NULL only Odd nested trimmed surfaces are extracted.
See also: TrimSrfsFromContours,

12.2.85  TrimSrfsSame (trim_gen.c:1257)

CagdBType TrimSrfsSame(const TrimSrfStruct *TSrf1,
                       const TrimSrfStruct *TSrf2,
                       CagdRType Eps)

TSrf1, TSrf2: The two trimmed surfaces to compare.
Eps: Tolerance of equality.
Returns: TRUE if trimmed surfaces are the same, FALSE otherwise.
Description: Compare the two trimmed surfaces for similarity.
See also: CagdBsrfsSame,
IPPolygonStruct *TrimValidateNewTrimCntrs(const CagdSrfStruct *Srf,
const IPPolygonStruct *Cntrs)

**Srf:** To trim into pieces.

**Cntrs:** Polylines to coerce to be inside.

**Returns:** New set of polylines that is guaranteed to be in Srf.

**Description:** Make sure the given trimming contours are in the surface domain. Points on contours that are found outside are coerced to be inside.

**See also:** TrimSrfsFromContours, TrimSrfsFromContours2,
Chapter 13

Trivariate Library, triv_lib

13.1 General Information

This library provides a rich set of functions to manipulate freeform Bezier and/or NURBs trivariate. This library heavily depends on the cagd library. Functions are provided to create, copy, and destruct trivariates, to extract isoparametric surfaces, to evaluate, refine and subdivide, to read and write trivariates, to differentiate, degree raise, make compatible and approximate iso-surface at iso values using polygonal representations.

A trivariate has three orders, three Length prescriptions and, possibly, three knot vectors (if Bspline). In addition it contains a three dimensional volume of control points,

typedef struct TrivTVStruct {
  struct TrivTVStruct *Pnext;
  struct IPAttributeStruct *Attr;
  TrivGeomType GType;
  CagdPointType PType;
  int ULength, VLength, WLength; /* Mesh size in tri-variate tensor product.*/
  int UVPlane; /* Should equal ULength * VLength for fast access. */
  int UOrder, VOrder, WOrder; /* Order in trivariate (Bspline only). */
  CagdBType UPeriodic, VPeriodic, WPeriodic; /* Valid only for Bspline. */
  CagdRType *Points[CAGD_MAX_PT_SIZE]; /* Pointer on each axis vector. */
  CagdRType *UKnotVector, *VKnotVector, *WKnotVector;
} TrivTVStruct;

The interface of the library is defined in include/triv_lib.h.

This library has its own error handler, which by default prints an error message and exit the program called TrivFatalError.

All globals in this library have a prefix of Triv.

13.2 Library Functions

13.2.1 MCExtractIsoSurface (mrch_run.c:92)

IPObjectStruct *MCExtractIsoSurface(const char *FileName,
  int DataType,
  IrtPtType CubeDim,
  int Width,
  int Height,
  int Depth,
  int SkipFactor,
  CagdRType IsoVal)

FileName: Containing the volumetric data.

DataType: Type of scalar value in volume. Can be one of: 1 - Regular float or int ascii (separated by white spaces). 2 - Two bytes short integer. 3 - Four bytes long integer. 4 - One byte (char) integer. 5 - Four bytes float. 6 - Eight bytes double.

CubeDim: Width, height, and depth of a single cube, in object space coordinates.

Width: Of volumetric data set.
**Height:** Of volumetric data set.

**Depth:** Of volumetric data set.

**SkipFactor:** Typically 1. For 2, only every second sample is considered and for i, only every i’th sample is considered, in all axes.

**IsoVal:** At which to extract the iso-surface.

**Returns:** A polygonal approximation of the iso-surface at IsoVal computed using the marching cubes algorithm.

**Description:** Extract a polygonal iso-surface out of volumetric data file.

**See also:** MCThresholdCube, MCEXtractIsoSurface2, MCEXtractIsoSurface3,

### 13.2.2 MCEXtractIsoSurface2 (mrch_run.c:226)

```
IPObjectStruct *MCEXtractIsoSurface2(const TrivTVStruct *CTV,
   int Axis,
   CagdBType TrivarNormals,
   IrtPtType CubeDim,
   int SkipFactor,
   CagdRType SamplingFactor,
   CagdRType IsoVal)
```

**CTV:** The trivariate to compute an iso surface approximation for,

**Axis:** of the trivariate to handle, 1 for X, 2 for Y, etc.

**TrivarNormals:** If TRUE normal are computed using gradient of the trivariate, if FALSE no normal are estimated.

**CubeDim:** Width, height, and depth of a single cube, in object space coordinates.

**SkipFactor:** Typically 1. For 2, only every second sample is considered and for i, only every i’th sample is considered, in all axes.

**SamplingFactor:** Additional relative sampling to apply to TV. If SamplingFactor set to 1.0, the trivariate is sampled ULength * VLength * WLength. Otherwise, the samplings are (ULength * SamplingFactor) * (VLength * SamplingFactor) * (WLength * SamplingFactor).

**IsoVal:** At which to extract the iso-surface.

**Returns:** A polygonal approximation of the iso-surface at IsoVal computed using the marching cubes algorithm.

**Description:** Extract a polygonal iso-surface out of a trivariate function.

**See also:** MCThresholdCube, MCEXtractIsoSurface, MCEXtractIsoSurface3,

### 13.2.3 MCEXtractIsoSurface3 (mrch_run.c:433)

```
IPObjectStruct *MCEXtractIsoSurface3(IPObjectStruct *ImageList,
   IrtPtType CubeDim,
   int SkipFactor,
   CagdRType IsoVal)
```

**ImageList:** List of image file names.

**CubeDim:** Width, height, and depth of a single cube, in object space coordinates.

**SkipFactor:** Typically 1. For 2, only every second sample is considered and for i, only every i’th sample is considered, in all axes.

**IsoVal:** At which to extract the iso-surface.

**Returns:** A polygonal approximation of the iso-surface at IsoVal computed using the marching cubes algorithm.

**Description:** Extract a polygonal iso-surface out of a stack of images.

**See also:** MCThresholdCube, MCEXtractIsoSurface, MCEXtractIsoSurface3,
13.2.4 MCImprovePointOnIsoSrf (mrchtriv.c:161)

```c
int MCImprovePointOnIsoSrf(IrtPtType Pt,
const IrtPtType CubeDim,
CagdRType IsoVal,
CagdRType Tolerance,
CagdRType AllowedError)
```

- **Pt**: Position to improve.
- **CubeDim**: Size of a single cell in the trivariate volume.
- **IsoVal**: Of iso surface extracted from TV that Pt is approximately on.
- **Tolerance**: Requested accuracy.
- **AllowedError**: Maximally allowed error to be considered valid. If zero it is ignored.

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: Improves a given Pt to "sit" exactly on top of the iso surface, by along the gradient of the trivariate.
Assume TV has been preprocessed by MCImprovePointOnIsoSrfPrelude.

**See also**: MCImprovePointOnIsoSrfPrelude, MCImprovePointOnIsoSrfPostlude, MCExtractIsoSurface2

13.2.5 MCImprovePointOnIsoSrfPostlude (mrchtriv.c:72)

```c
void MCImprovePointOnIsoSrfPostlude(void)
```

- **Returns**: void

**Description**: Release all allocated auxiliary trivariate derivatives, for fast marching.

**See also**: MCImprovePointOnIsoSrfPrelude, MCImprovePointOnIsoSrf

13.2.6 MCImprovePointOnIsoSrfPrelude (mrchtriv.c:108)

```c
CagdBType MCImprovePointOnIsoSrfPrelude(const TrivTVStruct *TV)
```

- **TV**: to process and prepare for further iso surface marching.

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: Prepare the necessary derivative vector fields of TV for fast marching on the trivariate, later on.

**See also**: MCImprovePointOnIsoSrfPostlude, MCImprovePointOnIsoSrf

13.2.7 MCThresholdCube (mrchcube.c:90)

```c
MCPolygonStruct *MCThresholdCube(MCCubeCornerScalarStruct *CCS,
IrtRType Threshold)
```

- **CCS**: The cube's dimensions/information.
- **Threshold**: Iso surface level.

**Returns**: List of polygons (not necessarily triangles), or possibly NULL.

**Description**: Given 8 cube corner values (scalars), compute the polygon(s) in this cube along the isosurface at Threshold. If CCS has gradient information, it is used to approximate normals at the vertices.
13.2.8 **TrivBndryCrnrsFromTV** (triveval.c:726)

`CagdPtStruct *TrivBndryCrnrsFromTV(const TrivTVStruct *TV)`

**TV:** To extract the eight boundary corners from.

**Returns:** A linked list of eight corners of trivariate TV.

**Description:** Extracts the eight boundary corners of the (topological cube of) given tensor product trivariate.

**See also:** TrivSrfFromTV, TrivBndryEdgesFromTV, TrivBndrySrfsFromTV,

13.2.9 **TrivBndryEdgesFromTV** (triveval.c:667)

`CagdCrvStruct *TrivBndryEdgesFromTV(const TrivTVStruct *TV)`

**TV:** To extract the twelve boundary curves from.

**Returns:** A linked list of twelve curves, representing the twelve boundary edges of trivariate TV.

**Description:** Extracts the twelve boundary curves of the (topological cube of) given tensor product trivariate.

**See also:** TrivSrfFromTV, TrivBndryEdgesFromTV, TrivBndryCrnrsFromTV,

13.2.10 **TrivBndrySrfsFromTV** (triveval.c:632)

`CagdSrfStruct **TrivBndrySrfsFromTV(const TrivTVStruct *TV)`

**TV:** To extract the six boundary surfaces from.

**Returns:** A pointer to a static vector of six surface pointers, representing the six boundaries of the trivariate TV in order of UMin, UMax, VMin, VMax, WMin, WMax.

**Description:** Extracts the six boundary surfaces of the given tensor product trivariate.

**See also:** TrivSrfFromTV, TrivBndryEdgesFromTV, TrivBndryCrnrsFromTV,

13.2.11 **TrivBspTVDegreeRaise** (trivrais.c:229)

`TrivTVStruct *TrivBspTVDegreeRaise(const TrivTVStruct *TV, TrivTVDirType Dir)`

**TV:** To raise it degree by one.

**Dir:** Direction of degree raising. Either U, V or W.

**Returns:** A trivariate with one degree higher in direction Dir, representing the same geometry as TV.

**Description:** Returns a new B spline trivariate, identical to the original but with one degree higher, in the requested direction Dir.

**See also:** TrivTVBlossomDegreeRaise, TrivBzrTVDegreeRaise, TrivTVDegreeRaise,
13.2.12  **TrivBspTVDerive** (triv.der.c:232)

```
TrivTVStruct *TrivBspTVDerive(const TrivTVStruct *TV, TrivTVDirType Dir)
```

**TV:** Trivariate to differentiate.

**Dir:** Direction of differentiation. Either U or V or W.

**Returns:** Differentiated trivariate in direction Dir. A Bspline trivariate.

**Description:** Given a Bspline trivariate, computes its partial derivative trivariate in direction Dir. Let old control polygon be \( P(i) \), \( i = 0 \) to \( k-1 \), and \( Q(i) \) be new one then:

\[
Q(i) = (k - 1) \ast (P(i+1) - P(i)) / (Kv(i + k) - Kv(i + 1)), \quad i = 0 \text{ to } k-2.
\]

**See also:** TrivBzrTVDerive, TrivBspTVDeriveScalar, TrivTVDerive,

13.2.13  **TrivBspTVDeriveScalar** (triv.der.c:381)

```
TrivTVStruct *TrivBspTVDeriveScalar(const TrivTVStruct *TV, TrivTVDirType Dir)
```

**TV:** Trivariate to differentiate.

**Dir:** Direction of differentiation. Either U or V or W.

**Returns:** Differentiated trivariate in direction Dir. A Bspline trivariate.

**Description:** Given a Bspline trivariate, computes its partial derivative trivariate in direction Dir, each dimension on its own including the weights, if any. Let old control polygon be \( P(i) \), \( i = 0 \) to \( k-1 \), and \( Q(i) \) be new one then:

\[
Q(i) = (k - 1) \ast (P(i+1) - P(i)) / (Kv(i + k) - Kv(i + 1)), \quad i = 0 \text{ to } k-2.
\]

**See also:** TrivBspTVDerive, TrivBzrTVDeriveScalar, TrivTVDeriveScalar,

13.2.14  **TrivBspTVHasBezierKVs** (triv.gen.c:842)

```
CagdBType TrivBspTVHasBezierKVs(const TrivTVStruct *TV)
```

**TV:** To check for KVs that mimics Bezier polynomial surface.

**Returns:** TRUE if same as Bezier trivar, FALSE otherwise.

**Description:** Returns TRUE iff the given trivar has no interior knot open end KVs.

13.2.15  **TrivBspTVHasOpenEC** (triv.gen.c:863)

```
CagdBType TrivBspTVHasOpenEC(const TrivTVStruct *TV)
```

**TV:** To check for open end conditions.

**Returns:** TRUE, if trivar has open end conditions, FALSE otherwise.

**Description:** Returns TRUE iff the given Bspline trivar has open end conditions.
13.2.16 TrivBspTVKnotInsertNDiff (triv_ref.c:87)

TrivTVStruct *TrivBspTVKnotInsertNDiff(const TrivTVStruct *TV,
   TrivTVDirType Dir,
   int Replace,
   const CagdRType *t,
   int n)

TV: Trivariate to refine according to t in direction Dir.
Dir: Direction of refinement. Either U or V or W.
Replace: If TRUE t is a knot vector exact in the length of the knot vector in direction Dir in TV and t simply
   replaces than knot vector. If FALSE, the knot vector in direction Dir in TV is refined by adding all the
   knots in t.
t: Knot vector to refine/replace the knot vector of TV in direction Dir.
n: Length of vector t.
Returns: The refined trivariate. A Bspline trivariate.

Description: Given a Bspline trivariate, inserts n knots with different values as defined by t. If, however, Replace
   is TRUE, the knot are simply replacing the current knot vector in the prescribed direction.

13.2.17 TrivBspTVNew (triv_gen.c:109)

TrivTVStruct *TrivBspTVNew(int ULength,
   int VLength,
   int WLength,
   int UOrder,
   int VOrder,
   int WOrder,
   CagdPointType PType)

ULength: Number of control points in the U direction.
VLength: Number of control points in the V direction.
WLength: Number of control points in the W direction.
UOrder: Order of trivariate in the U direction.
VOrder: Order of trivariate in the V direction.
WOrder: Order of trivariate in the W direction.
PType: Type of control points (E2, P3, etc.).
Returns: An uninitialized freeform trivariate Bspline.
Description: Allocates the memory required for a new Bspline trivariate.
See also: TrivBzrTVNew, TrivTVNew, TrivPwrTVNew,

13.2.18 TrivBzrComposeTVCrv (compost3.c:444)

CagdCrvStruct *TrivBzrComposeTVCrv(const TrivTVStruct *TV,
   const CagdCrvStruct *Crv)

TV, Crv: The trivar and curve to compose. TV must be Bezier.
Returns: The resulting composition.
Description: Given curve Crv and Bezier trivariate TV, computes their composition TV(Crv(t)), Crv(t) =
   (u(t), v(t), w(t)). Crv must be a three dimensional curve completely contained in the parametric domain of TV.
Compute the compositions by the products of:

TV(u, v, w) = TV(u(t), v(t), w(t))
\[ n \quad m \quad l \\
= \sum_{i=0}^{n} \sum_{j=0}^{m} \sum_{k=0}^{l} P_{ijk} B_i(u(t)) B_j(v(t)) B_k(w(t)) \]

\[ \text{See also: SymbComposeTVSrf, BzrComposeCrvCrv, TrivBzrComposeTVSrf,} \]

### 13.2.19 TrivBzrComposeTVSrf (composit3.c:783)

**Function Definition:**

CagdSrfStruct *TrivBzrComposeTVSrf(const TrivTVStruct *TV, const CagdSrfStruct *Srf)

**Parameters:**

- TV: The trivar and surface to compose. TV must be Bezier.
- Srf: The resulting composition.

**Returns:**

The resulting composition.

**Description:**

Given surface Srf and Bezier trivariate TV, computes their composition TV(Srf(a, b)), Srf(a, b) = (u(a, b), v(a, b), w(a, b)). Srf must be a three dimensional surface completely contained in the parametric domain of TV. Compute the compositions by the products of:

\[ TV(u, v, w) = TV(u(a, b), v(a, b), w(a, b)) \]

\[ n \quad m \quad l \\
= \sum_{i=0}^{n} \sum_{j=0}^{m} \sum_{k=0}^{l} P_{ijk} B_i(u(a, b)) B_j(v(a, b)) B_k(w(a, b)) \]

\[ \text{See also: SymbComposeTVSrf, BzrComposeSrfSrf, TrivBzrComposeTVCrv,} \]

### 13.2.20 TrivBzrTVDegreeRaise (trivrais.c:120)

**Function Definition:**

TrivTVStruct *TrivBzrTVDegreeRaise(const TrivTVStruct *TV, TrivTVDirType Dir)

**Parameters:**

- TV: To raise it degree by one.
- Dir: Direction of degree raising. Either U, V or W.

**Returns:**

A trivariate with one degree higher in direction Dir, representing the same geometry as TV.

**Description:**

Returns a new Bezier trivariate, identical to the original but with one degree higher, in the requested direction Dir. Let old control polygon be P(i), i = 0 to k-1, and Q(i) be new one then:

\[ Q(0) = P(0), \quad Q(i) = \frac{i}{k-i} P(i-1) + \frac{k-i}{k} P(i), \quad Q(k) = P(k-1). \]

This is applied to all rows/cols of the trivariate.

**See also:** TrivTVBlossomDegreeRaise, TrivBspTVDegreeRaise, TrivTVDegreeRaise,
13.2.21 TrivBzrTVDerive (triv\_der.c:105)

```
TrivTVStruct *TrivBzrTVDerive(const TrivTVStruct *TV, TrivTVDirType Dir)
```

**TV:** Trivariate to differentiate.
**Dir:** Direction of differentiation. Either U or V or W.
**Returns:** Differentiated trivariate in direction Dir. A Bezier trivariate.
**Description:** Given a Bezier trivariate, computes its partial derivative trivariate in direction Dir. Let old control polygon be P(i), i = 0 to k-1, and Q(i) be new one then:

\[ Q(i) = (k - 1) * (P(i+1) - P(i)), \quad i = 0 \text{ to } k-2. \]

**See also:** TrivBzrTVDeriveScalar, TrivBspTVDerive, TrivTVDerive

13.2.22 TrivBzrTVDeriveScalar (triv\_der.c:198)

```
TrivTVStruct *TrivBzrTVDeriveScalar(const TrivTVStruct *TV, TrivTVDirType Dir)
```

**TV:** Trivariate to differentiate.
**Dir:** Direction of differentiation. Either U or V or W.
**Returns:** Differentiated trivariate in direction Dir. A Bezier trivariate.
**Description:** Given a Bezier trivariate, computes its scalar partial derivative trivariate in direction Dir, each dimension on its own including the weights, if any. Let old control polygon be P(i), i = 0 to k-1, and Q(i) be new one then:

\[ Q(i) = (k - 1) * (P(i+1) - P(i)), \quad i = 0 \text{ to } k-2. \]

**See also:** TrivBzrTVDerive, TrivBspTVDeriveScalar, TrivTVDeriveScalar

13.2.23 TrivBzrTVNew (triv\_gen.c:156)

```
TrivTVStruct *TrivBzrTVNew(int ULength,
                          int VLength,
                          int WLength,
                          CagdPointType PType)
```

**ULength:** Number of control points in the U direction.
**VLength:** Number of control points in the V direction.
**WLength:** Number of control points in the W direction.
**PType:** Type of control points (E2, P3, etc.).
**Returns:** An uninitialized freeform trivariate Bezier.
**Description:** Allocates the memory required for a new Bezier trivariate.
**See also:** TrivTVNew, TrivBspTVNew, TrivPwrTVNew

13.2.24 TrivCnvrtBsp2BzrTV (triv\_gen.c:613)

```
TrivTVStruct *TrivCnvrtBsp2BzrTV(const TrivTVStruct *TV)
```

**TV:** Bspline trivar to convert to a Bezier trivar.
**Returns:** A list of Bezier trivars representing same geometry as TV.
**Description:** Convert a B spline trivar into a set of Bezier trivars by subdiving the B spline trivar at all its internal knots. Returned is a list of Bezier trivars.
**See also:** TrivCnvrtBzr2BspeTV,
13.2.25 **TrivCnvrtBzr2BspTV** *(triv_gen.c:570)*

TrivTVStruct *TrivCnvrtBzr2BspTV(const TrivTVStruct *TV)

TV: A Bezier trivariate to convert to a B-spline TV.

Returns: A B-spline trivariate representing the same geometry as the given Bezier TV.

Description: Converts a Bezier trivariate into a B-spline trivariate by adding two open end uniform knot vectors to it.

See also: TrivCnvrtBsp2BzrTV,

13.2.26 **TrivCnvrtFloat2OpenTV** *(triv_gen.c:768)*

TrivTVStruct *TrivCnvrtFloat2OpenTV(const TrivTVStruct *TV)

TV: Float B-spline trivariate to convert to open end conditions.

Returns: A B-spline trivariate with open end conditions, representing the same geometry as TV.

Description: Converts a float B-spline trivariate to a B-spline trivariate with open end conditions.

See also: TrivCnvrtPeriodic2FloatTV, TrivTVOpenEnd,

13.2.27 **TrivCnvrtPeriodic2FloatTV** *(triv_gen.c:692)*

TrivTVStruct *TrivCnvrtPeriodic2FloatTV(const TrivTVStruct *TV)

TV: B-spline trivariate to convert to floating end conditions. Assume TV is either periodic or has floating end condition.

Returns: A B-spline trivariate with floating end conditions, representing the same geometry as TV.

Description: Converts a B-spline trivariate into a B-spline trivariate with floating end conditions.

See also: TrivCnvrtFloat2OpenTV,

13.2.28 **TrivCoerceTVTo** *(trivcoer.c:52)*

TrivTVStruct *TrivCoerceTVTo(const TrivTVStruct *TV, CagdPointType PType)

TV: To coerce to a new point type PType.

PType: New point type for TV.

Returns: A new trivariate with PType as its point type.

Description: Coerces a trivariate to point type PType.

13.2.29 **TrivCoerceTVsTo** *(trivcoer.c:25)*

TrivTVStruct *TrivCoerceTVsTo(const TrivTVStruct *TV, CagdPointType PType)

TV: To coerce to a new point type PType.

PType: New point type for TV.

Returns: New trivariates with PType as their point type.

Description: Coerces a list of trivariates to point type PType.
13.2.30  **TrivComposeTVCrv** (compost3.c:320)

```c
CagdCrvStruct *TrivComposeTVCrv(const TrivTVStruct *TV,
const CagdCrvStruct *Crv)
```

*TV, Crv:* The trivar and curve to compose. TV must be a Bezier.

**Returns:** The resulting composition.

**Description:** Given curve Crv and trivar TV, computes the composition TV(Crv). Crv must be a three-dimensional curve completely contained in the parametric domain of TV.

**See also:** SymbComposeCrvCrv, SymbComposeSrfCrv, SymbComposeSrfSrf, , TrivComposeTVSrf,

13.2.31  **TrivComposeTVSrf** (compost3.c:637)

```c
CagdSrfStruct *TrivComposeTVSrf(const TrivTVStruct *TV,
const CagdSrfStruct *Srf)
```

*TV, Srf:* The trivar and surface to compose. TV must be a Bezier.

**Returns:** The resulting composition.

**Description:** Given surface Srf and trivar TV, computes the composition TV(Srf). Srf must be a three-dimensional surface completely contained in the parametric domain of TV.

**See also:** SymbComposeCrvCrv, SymbComposeSrfCrv, SymbComposeSrfSrf,

13.2.32  **TrivComposeTileObjectInTV** (compost3.c:54)

```c
IPObjectStruct *TrivComposeTileObjectInTV(const IPObjectStruct *PObj,
const TrivTVStruct *DeformTV,
IrtRType UTimes,
IrtRType VTimes,
IrtRType WTimes,
IrtBType FitObj)
```

*PObj:* The object to map through the trivariate. Can be a (list of) curve(s) or surface(s) only.

*DeformTV:* The mapping/deformation function from R3 to R3.

*UTimes, VTimes, WTimes:* Number of times to tile the object in each axis.

*FitObj:* TRUE to rescale PObj tile to precisely fit the domain (UTimes x VTimes x WTimes), FALSE to assume PObj is in $[0,1]^3$ when fitting domain.

**Returns:** (UTimes x VTimes x WTimes) mapped and deformed objects.

**Description:** Tile an input object, in place, (UTimes x VTimes x WTimes) in the given trivariate. Computation is made precise, using composition operations.

**See also:** TrivFFDTileObjectInTV, TrivFFDCtlMeshUsingTV, TrivFFDObjectTV, TrivComposeTileObjectInTVBzr,

13.2.33  **TrivComposeTileObjectInTVBzr** (compost3.c:188)

```c
IPObjectStruct *TrivComposeTileObjectInTVBzr(const IPObjectStruct *PObj,
const TrivTVStruct *DeformTV,
IrtRType UTimes,
IrtRType VTimes,
IrtRType WTimes,
IrtBType FitObj)
```

*PObj:* The object to map through the trivariate. Can be a (list of) curve(s) or surface(s) only.

*DeformTV:* The mapping/deformation Bezier function from R3 to R3.

*UTimes, VTimes, WTimes:* Number of times to tile the object in each axis.
**FitObj:** TRUE to rescale PObj tile to precisely fit the domain \((UTimes \times VTimes \times WTimes)\), FALSE to assume PObj is in \([0,1]^3\) when fitting domain.

**Returns:** \((UTimes \times VTimes \times WTimes)\) mapped and deformed objects.

**Description:** Tile an input object, in place, \((UTimes \times VTimes \times WTimes)\) in the given Bezier trivariate. Computation is made precise, using composition operations.

**See also:** TrivFFDTileObjectInTV, TrivFFDCtlMeshUsingTV, TrivFDOBJECTTV, TrivComposeTileObjectInTV.

### 13.2.34 TrivCoverIsoSurfaceUsingStrokes (mrchtriv.c:274)

CagdCrvStruct *TrivCoverIsoSurfaceUsingStrokes(TrivTVStruct *CTV,  
int NumStrokes,  
int StrokeType,  
CagdPType MinMaxPwrLen,  
CagdRType StepSize,  
CagdRType IsoVal,  
CagdVType ViewDir)

**CTV:** To cover with strokes along principal curvatures of iso surface of value IsoVal.

**NumStrokes:** Number of strokes to distribute on the implicit surface.

**StrokeType:** 1 - Draw strokes along minimal principal curvature. 2 - Draw strokes along maximal principal curvature. 3 - Draw strokes along both principal curvatures. 4 - Draw strokes along constant X planes. 5 - Draw strokes along constant Y planes. 6 - Draw strokes along constant Z planes. 7 - Draw strokes along silhouette lines. 8 - Draw strokes orthogonal to silhouette lines. 9 - Draw strokes along both silhouette lines and lines orthogonal to silhouette lines. StrokeType >= 10 equals StrokeType < 10 but also emphasizes the silhouette areas setting longer edges along silhouettes.

**MinMaxPwrLen:** Arc length of each stroke (randomized in between). a triplet of the form (Min, Max, Power) that determines the length of each stroke as Avg = (Max + Min) / 2, Dev = (Max - Min) / 2 Length = Avg + Dev * Random(0, 1)^Pwr

**StepSize:** Steps to take in the piecewise linear approximation.

**IsoVal:** Of iso surface of TV that coverage is to be computed for.

**ViewDir:** Direction of view, used for silhouette computation.

**Returns:** A list of curves forming the coverage or NULL if error.

**Description:** Computes a coverage of an iso surface at IsoVal of the trivariate TV using curves along principal curvatures.

**See also:** MCmprovePointOnIsoSrf, MCExtractIsoSurface2.

### 13.2.35 TrivDbg (triv_dbg.c:25)

void TrivDbg(const void *Obj)

**Obj:** A trivariate - to be printed to stderr.

**Returns:** void

**Description:** Prints trivariates stderr. Should be linked to programs for debugging purposes, so trivariates may be inspected from a debugger.

### 13.2.36 TrivDescribeError (triv_err.c:72)

const char *TrivDescribeError(TrivFatalErrorType ErrorNum)

**ErrorNum:** Type of the error that was raised.

**Returns:** A string describing the error type.

**Description:** Returns a string describing the given error. Errors can be raised by any member of this triv library as well as other users. Raised error will cause an invocation of TrivFatalError function which decides how to handle this error. TrivFatalError for example, invoke this routine with the error type, print the appropriate message and quit the program.
13.2.37 TrivEditSingleTVPt (trivedit.c:37)

TrivTVStruct *TrivEditSingleTVPt(TrivTVStruct *TV,
    CagdCtlPtStruct *CtlPt,
    int UIndex,
    int VIndex,
    int WIndex,
    CagdBType Write)

TV: Trivar to be modified/query.
CtlPt: New control point to be substituted into TV. Must carry the same PType as TV if to be written to TV.
UIndex, VIndex, WIndex: In trivar TV's control mesh to substitute/query CtlPt.
Write: If TRUE CtlPt is copied into TV, if FALSE the point is copied from TV to CtlPt.
Returns: If Write is TRUE, the new modified TV, if WRITE is FALSE, NULL.
Description: Provides the way to modify/get a single control point into/from a trivariate.

13.2.38 TrivEvalCurvature (trivcurv.c:151)

CagdBType TrivEvalCurvature(CagdPType Pos,
    CagdRType *PCurv1,
    CagdRType *PCurv2,
    CagdVType PDir1,
    CagdVType PDir2)

Pos: Location in the parametric space of the trivariate.
PCurv1, PCurv2: The two principal curvatures computed by this function.
PDir1, PDir2: The two principal directions computed by this function.
Returns: TRUE if successful, FALSE otherwise.
Description: Evaluates the principal curvatures and principal directions of the isosurface at location Pos in trivariate that was preprocessed by the TrivEvalCurvaturePrelude function. Arbitrary number of invokations of this function are possible once TrivEvalCurvaturePrelude is called. Also one should invoke TrivEvalCurvaturePostlude once done to release all auxiliary allocated data structures.
See also: TrivEvalCurvaturePrelude, TrivEvalCurvaturePostlude, TrivEvalHessian, , TrivEvalGradient,

13.2.39 TrivEvalGradient (trivcurv.c:239)

CagdBType TrivEvalGradient(CagdPType Pos, CagdVType Gradient)
    Pos: Location in the parametric space of the trivariate.
    Gradient: The Gradient computed by this function.
    Returns: TRUE if successful, FALSE otherwise.
Description: Evaluates the Gradient of the isosurface at location Pos in trivariate that was preprocessed by the TrivEvalCurvaturePrelude function. Arbitrary number of invokations of this function are possible once TrivEvalCurvaturePrelude is called. Also one should invoke TrivEvalCurvaturePostlude once done to release all auxiliary allocated data structures.
See also: TrivEvalCurvaturePrelude, TrivEvalCurvaturePostlude, TrivEvalCurvature, , TrivEvalHessian,

13.2.40 TrivEvalHessian (trivcurv.c:280)

CagdBType TrivEvalHessian(CagdPType Pos, CagdVType Hessian[3])
    Pos: Location in the parametric space of the trivariate.
    Hessian: The Hessian computed by this function.
    Returns: TRUE if successful, FALSE otherwise.
Description: Evaluates the Hessian of the isosurface at location Pos in trivariate that was preprocessed by the TrivEvalCurvaturePrelude function. Arbitrary number of invokations of this function are possible once TrivEvalCurvaturePrelude is called. Also one should invoke TrivEvalCurvaturePostlude once done to release all auxiliary allocated data structures.
See also: TrivEvalCurvaturePrelude, TrivEvalCurvaturePostlude, TrivEvalCurvature, , TrivEvalHessian,
13.2.41  **TrivEvalTVCurvaturePostlude** (trivcurv.c:49)

void TrivEvalTVCurvaturePostlude(void)

Returns: void

Description: Release all allocated auxiliary trivariate derivatives, for curvature analysis.
See also: TrivEvalTVCurvaturePrelude, TrivEvalTVCurvature, TrivEvalHessian, TrivEvalGradient,

13.2.42  **TrivEvalTVCurvaturePrelude** (trivcurv.c:89)

CagdBType TrivEvalTVCurvaturePrelude(const TrivTVStruct *TV)

TV: to process and prepare for further curvature evaluations.
Returns: TRUE if successful, FALSE otherwise.
Description: Prepare the necessary derivative vector fields of TV for curvature processing at prescribed locations, later on.
See also: TrivEvalTVCurvaturePostlude, TrivEvalTVCurvature, TrivEvalHessian, TrivEvalGradient,

13.2.43  **TrivExtrudeTV** (trivextr.c:32)

TrivTVStruct *TrivExtrudeTV(const CagdSrfStruct *Srf, const CagdVecStruct *Vec)

Srf: To extrude in direction specified by Vec.
Vec: Direction as well as magnitude of extrusion.
Returns: An extrusion trivariate volume with Orders of the original Srf order and 2 in the extrusion direction.
Description: Constructs an extrusion trivariate in the Vector direction for the given surface. Input surface can be either a Bspline or a Bezier surface and the resulting output trivariate will be of the same type.
See also: CagdExtrudeSrf, TrivExtrudeTV2,

13.2.44  **TrivExtrudeTV2** (trivextr.c:239)

TrivTVStruct *TrivExtrudeTV2(const CagdSrfStruct *Srf, const CagdCrvStruct *Crv)

Srf: To extrude along the curve Crv.
Crv: Curve along which to move Srf. If Crv is a line, reduces to TrivExtrudeTV.
Returns: A trivariate volume with Orders of the original Srf/Crv orders.
Description: Constructs an extrusion trivariate along Crv, of the given surface: TV(u, v, t) = Srf(u, v) + Crv(t). Input curve/surface can be either a Bspline or a Bezier surface and the resulting output trivariate will be of the same type.
See also: TrivExtrudeTV2, CagdExtrudeSrf, SymbAlgebraicSumSrf,

13.2.45  **TrivFFDCtlMeshUsingTV** (triv_ffd.c:42)

void TrivFFDCtlMeshUsingTV(CagdRType **Points,
int Length,
CagdPointType PType,
const TrivTVStruct *DeformTV)

Points: The control mesh.
Length: The length of the vector of Points.
PType: The point type of Points.
DeformTV: The deformation mapping.
Returns: void

Description: Deform the given mesh in place, using the mapping that is defined by trivariate DeformTV. Input points that are outside the domain of DeformTV are coerced to the closest boundary. Computation is approximated by mapping (control) points only.
See also: TrivFFDObjectTV,
13.2.46 **TrivFFDObjectTV** (triv_ffd.c:111)

```
IPObjectStruct *TrivFFDObjectTV(IPObjectStruct *PObj,
    const TrivTVStruct *DeformTV)

PObj: The object to map through the trivariate, in place.
DeformTV: The mapping/deformation function from R3 to R3.
Returns: PObj, mapped/deformed object, in place.
Description: Deform an input object, in place, through the given trivariate. Computation is approximated by
            mapping (control) points only.
See also: TrivFFDCtlMeshUsingTV, TrivFFDObjectInTV,
```

13.2.47 **TrivFFDTileObjectInTV** (triv_ffd.c:279)

```
IPObjectStruct *TrivFFDTileObjectInTV(const IPObjectStruct *PObj,
    const TrivTVStruct *DeformTV,
    IrtRType UTimes,
    IrtRType VTimes,
    IrtRType WTimes,
    IrtBType FitObj)

PObj: The object to map through the trivariate, in place.
DeformTV: The mapping/deformation function from R3 to R3.
UTimes, VTimes, WTimes: Number of times to tile the object in each axis.
FitObj: TRUE to rescale PObj tile to precisely fit the domain (UTimes x VTimes x WTimes), FALSE to assume
        PObj is in [0,1]^3 when fitting domain.
Returns: (UTimes x VTimes x WTimes) mapped and deformed objects.
Description: Tile an input object, in place, (UTimes x VTimes x WTimes) in the given trivariate. Computation
            is approximated using (control) points mapping.
See also: TrivFFDCtlMeshUsingTV, TrivFFDObjectTV, TrivComposeTileObjectInTV,
```

13.2.48 **TrivFatalError** (triv_ftl.c:53)

```
void TrivFatalError(TrivFatalErrorType ErrID)

ErrID: Error type that was raised.
Returns: void
Description: Trap Triv lib errors right here. Provides a default error handler for the triv library. Gets an error
            description using TrivDescribeError, prints it and exit the program using exit.
```

13.2.49 **TrivIGAAddBoundaryFace** (triv_iga.c:2725)

```
int TrivIGAAddBoundaryFace(TrivIGAArrangementID ArgmntID,
    const TrivTVStruct *TV,
    TrivTVBndryType Boundary,
    TrivIGANodeBoundaryType NodeBoundary,
    const char *BoundaryAxisConditions,
    CagdRType Value)

ArgmntID: A handle on the IGA arrangement to process.
TV: Trivariate of the face.
Boundary: The boundary face on the trivariate (UMin, VMax, etc.).
NodeBoundary: IGA boundary condition type.
BoundaryAxisConditions: String represents the relevant axs, eg. "xy".
Value: Value of the boundary condition.
Returns: TRUE on success and FALSE on failure.
Description: Adds a boundary condition to a face in the arrangement.
See also: TrivIGAAddBoundaryFace2,
```
13.2.50 TrivIGAAddBoundaryFace2 (triv_iga2.c:1203)

int TrivIGAAddBoundaryFace2(TrivIGAArrangementID ArgmntID, const TrivTVStruct *TV, TrivTVBndryType BoundaryType, TrivIGANodeBoundaryType NodeBoundaryType, const char *BoundaryAxisConditions, CagdRType Value)

ArgmntID: A handle on the IGA arrangement to process.
TV: Trivariate of the face.
BoundaryType: Type of the boundary face on the trivariate.
NodeBoundaryType: IGA boundary condition type.
BoundaryAxisConditions: String represents the relevant axes, eg. "xy".
Value: Value of the boundary condition.
Returns: TRUE on success and FALSE on failure.
Description: Adds a boundary condition to a face in the arrangement.
See also: TrivIGAAddBoundaryFace,

13.2.51 TrivIGAAddBoundaryFaceByPt (triv_iga.c:2812)

int TrivIGAAddBoundaryFaceByPt(TrivIGAArrangementID ArgmntID, const TrivTVStruct *TV, const CagdPType Pt, TrivIGANodeBoundaryType NodeBoundary, const char *BoundaryAxisConditions, CagdRType Value)

ArgmntID: A handle on the IGA arrangement to process.
TV: Trivariate owning the face. Can be NULL in which case we search all TVs in arrangement for the closest face.
Pt: A point in space to select the closest boundary.
NodeBoundary: IGA boundary condition type.
BoundaryAxisConditions: String represents the relevant axes, eg. "xy".
Value: Value of the boundary condition.
Returns: TRUE on success and FALSE on failure.
Description: Adds a boundary condition to a face in the arrangement.
See also: TrivIGAAddBoundaryFace2, TrivIGAGetBoundaryFaceByPt,

13.2.52 TrivIGAAddBoundaryNode (triv_iga2.c:1227)

int TrivIGAAddBoundaryNode(TrivIGAArrangementID ArgmntID, TrivIGATVID TV, int CtrlPointIndex)

ArgmntID: A handle on the IGA arrangement to process.
TV: N.S.F.I.
CtrlPointIndex: N.S.F.I.
Returns: N.S.F.I.
Description: Function is not supported.
13.2.53  **TrivIGAAddMaterial** *(triv_iga.c:336)*

```c
TrivIGAMaterialID TrivIGAAddMaterial(TrivIGAArrangementID ArgmntID, 
    TrivIGAMaterialStruct *Material)
```

**Argument ID:** A handle on the IGA arrangement to process.
**Material:** The material
**Returns:** Material ID or invalid if failed.
**Description:** Adds the given material to the given arrangement if not exists, and updates it otherwise.

13.2.54  **TrivIGAAddTrivar** *(triv_iga2.c:241)*

```c
TrivIGATVID TrivIGAAddTrivar(TrivIGAArrangementID ArgmntID, 
    const TrivTVStruct *TV, 
    int ID)
```

**Argument ID:** A handle on the IGA arrangement to process.
**TV:** An existing trivariate to add (a copy thereof) to arrangement.
**ID:** ID to use or -1 to set a new ID.
**Returns:** INVALID IGA TV ID if error, to TV ID if successful.
**Description:** Copy an existing new trivariate and add it to the give arrangement.

13.2.55  **TrivIGAApplyDomainAndSeeding** *(triv_iga2.c:140)*

```c
static TrivTVStruct *TrivIGAApplyDomainAndSeeding(TrivIGAArrangementID ArgmntID, 
    TrivTVStruct *TV)
```

**Argument ID:** A handle on the IGA arrangement to process.
**TV:** Trivariate to apply seeding to. Used in place.
**Returns:** Refined TV, after the seeding was applied.
**Description:** Apply, in place, seeding to the given trivariate, following the global arrangement seeding specifications.

13.2.56  **TrivIGAArrangementComplete** *(triv_iga.c:1058)*

```c
int TrivIGAArrangementComplete(TrivIGAArrangementID ArgmntID)
```

**Argument ID:** A handle on the IGA arrangement to process.
**Returns:** TRUE if successful, FALSE otherwise.
**Description:** A function to signal the end of the initialization process - insertion of trivariates into (the fields of) the IGA arrangement.

13.2.57  **TrivIGADDataManagerAddTrivariate** *(triv_iga.c:3139)*

```c
TrivIGATVID TrivIGADDataManagerAddTrivariate(TrivIGAArrangementID ArgmntID, 
    TrivTVStruct *TV, 
    int ID)
```

**Argument ID:** A handle on the IGA arrangement to process.
**TV:** Pointer to the trivariate.
**ID:** if non negative, use this ID as the unique ID of TV. Otherwise, assign a unique ID here.
**Returns:** ID of the trivariate TRUE if successful, and INVALID IGA TV ID otherwise.
**Description:** Allocates an ID to a given trivariate in the IGA data manager, if the trivariate already exists, its associated ID is returned.
13.2.58  TrivIGADataManagerAllocateArrangement (triv_iga.c:3011)

TrivIGAArrangementID TrivIGADataManagerAllocateArrangement(
    TrivIGADataManager *DM)

DM: IGA Data manager
Returns: ID of the new arrangement in success and INVALID ARRANGEMENT ID in failure
Description: Allocates an IGA arrangement and associates it with new ID.

13.2.59  TrivIGADataManagerFreeArrangement (triv_iga.c:3101)

int TrivIGADataManagerFreeArrangement(TrivIGAArrangementID ArrngmntID)

ArrngmntID: The arrangement ID to deallocate
Returns: TRUE if successful, FALSE otherwise.
Description: DeAllocate given arrangement from the data manager.

13.2.60  TrivIGADataManagerGetArrangement (triv_iga.c:3040)

TrivIGAArrangementStruct *TrivIGADataManagerGetArrangement(
    TrivIGAArrangementID ArrngmntID)

ArrngmntID: ID of the arrangement.
Returns: Pointer to the arrangement structure if success and NULL in failure.
Description: Maps between arrangement ID and its actual structure’s address.

13.2.61  TrivIGADataManagerGetArrangementID (triv_iga.c:3068)

TrivIGAArrangementID TrivIGADataManagerGetArrangementID(
    TrivIGAArrangementStruct *H)

H: Pointer to the arrangement structure.
Returns: The arrangement id in success and NULL in failure
Description: Maps between arrangement ID and its actual structure address and its ID.

13.2.62  TrivIGADataManagerGetIGATrivariate (triv_iga.c:3251)

TrivIGATVStruct *TrivIGADataManagerGetIGATrivariate(TrivIGATVID TVID)

TVID: ID of the trivariate.
Returns: Pointer to IGA trivariate structue if successfull and NULL otherwise.
Description: Maps between trivariate ID and its structure’s address in a given IGA data manager.

13.2.63  TrivIGADataManagerGetTrivID (triv_iga.c:3189)

TrivIGATVID TrivIGADataManagerGetTrivID(const TrivTVStruct *TV)

TV: Pointer to the trivariate.
Returns: ID of the trivariate TRUE if successful, and TRIV_IGA_INVALID_TV_ID otherwise.
Description: Returns the ID of a given trivariate from IGA data manager.
13.2.64 TrivIGADataManagerGetTrivariate (triviga.c:3225)

TrivTVStruct *TrivIGADataManagerGetTrivariate(TrivIGATVID TVID)

TVID: ID of the trivariate.

Returns: Pointer to the trivariate structure if successful and NULL otherwise.

Description: Maps between trivariate ID and its structure’s address in a given IGA data manager.

13.2.65 TrivIGADescribeError (triviga.c:2607)

const char *TrivIGADescribeError(TrivIGAErrorType ErrorNum)

ErrorNum: Type of the error that was raised.

Returns: A string describing the error type.

Description: Returns a string describing the given error.

See also: TrivIGAGetLastError, TrivDescribeError,

13.2.66 TrivIGAExportToXML (triviga_xml.c:676)

int TrivIGAExportToXML(TrivIGAArrangementID ArgmntID, const char *FileName, const char *TemplateFileName)

ArgmntID: A handle on the IGA arrangement to process.
FileName: Output XML file name.
TemplateFileName: Template XML file.

Returns: TRUE if successful, FALSE otherwise.

Description: Saves the input IGA arrangement as Febio XML file, loads template file and updates the material, geometry and boundary sections.

13.2.67 TrivIGAExtrudeTV (triviga2.c:271)

TrivIGATVID TrivIGAExtrudeTV(TrivIGAArrangementID ArgmntID, const CagdSrfStruct *Srf, const Irt(VecType Vec, int ID)

ArgmntID: A handle on the IGA arrangement to process.
Srf: Surface to extrude.
Vec: The extrusion vector.
ID: ID to use or -1 to set a new ID.

Returns: INVALID IGATVID if error, to TV ID if successful.

Description: Constructs a new trivariate and add it to the give arrangement as an extrusion of the given surface.
13.2.68 TrivIGAEextrudeTV2 (triviga2.c:315)

TrivIGATVID TrivIGAEextrudeTV2(TrivIGAArrangementID ArgmntID, 
const CagdSrfStruct *Srf, 
const CagdCrvStruct *Crv, 
int ID)

ArgmntID: A handle on the IGA arrangement to process.
Srf: Surface to extrude.
Crv: The extrusion curve.
ID: ID to use or -1 to set a new ID.
Returns: INVALID IGA TV ID if error, to TV ID if successful.
Description: Constructs a new trivariate and add it to the give arrangement as an extrusion of the given surface along a curve.

13.2.69 TrivIGAFreeArrangement (triviga.c:2451)

int TrivIGAFreeArrangement(TrivIGAArrangementID ArgmntID)

ArgmntID: A handle on the IGA arrangement to free.
Returns: TRUE if successful, FALSE otherwise.
Description: Free all auxiliary data structure allocated in H.

13.2.70 TrivIGAGenNeighboringConstraints (triviga2.c:737)

void TrivIGAGenNeighboringConstraints(TrivIGAArrangementID ArgmntID, 
void *CallbackData, 
TrivIGANeighboringConstraintCallBackType NeighboringConstraintCallBack)

ArgmntID: A handle on the IGA arrangement to process.
CallbackData: Relevant data for the callback function (such as XML information).
NeighboringConstraintCallBack: Call back function to call with the constraint as a string.
Returns: void
Description: Construct linear constraints hooking adjacent faces that do not share a common function space.

13.2.71 TrivIGAGetAllTVs (triviga2.c:585)

TrivIGATVID *TrivIGAGetAllTVs(TrivIGAArrangementID ArgmntID)

ArgmntID: A handle on the IGA arrangement to process.
Returns: A dynamically allocated vector of IDs, terminated with INVALID IGA TV ID.
Description: Returns a list of all trivariates in the given arrangement

13.2.72 TrivIGAGetBoundaryFaceByPt (triviga.c:2924)

int *TrivIGAGetBoundaryFaceByPt(TrivIGAArrangementID ArgmntID, 
const TrivTVStruct *TV, 
const CagdPType Pt)

ArgmntID: A handle on the IGA arrangement to process.
TV: Trivariate owning the face. Can be NULL in which case we search all TVs in arrangement.
Pt: A point in space to select the closest boundary.
Returns: A list of two integers allocated statically, (TVID, FaceID).
Description: Find the face closest to Pt in the arrangement or specific TV.
See also: TrivIGAAddBoundaryFace2, TrivIGAAddBoundaryFaceByPt,
13.2.73  TrivIGAGetBzrElementCtrlPts (triv_iga.c:1379)

TrivIGACtrlPtStruct *TrivIGAGetBzrElementCtrlPts(
    TrivIGAArrangementID ArgmntID,
    const TrivTVStruct *TV,
    int IndexU,
    int IndexV,
    int IndexW)

- **ArgmntID**: A handle on the IGA arrangement to process.
- **TV**: The Trivar to fetch the control points of one of its Beziers.
- **IndexU**: The Bezier trivariate index in U in TV, starting from zero.
- **IndexV**: The Bezier trivariate index in V in TV, starting from zero.
- **IndexW**: The Bezier trivariate index in W in TV, starting from zero.

**Returns**: A vector of control points of the Bezier trivar.

**Description**: Returns a dynamically allocated vector of control points of the Bezier trivariate at the designated indices in TV. Assumes TV has open end conditions. Control points will be returned in order, U changing first, W last.

13.2.74  TrivIGAGetCtlPt (triv_iga2.c:1015)

const CagdCtlPtStruct *TrivIGAGetCtlPt(TrivIGAArrangementID ArgmntID,
                                        int CtlPtID)

- **ArgmntID**: A handle on the IGA arrangement to process.
- **CtlPtID**: ID of control point to get.

**Returns**: Fetched control point allocated statically.

**Description**: Fetches one control point from the arrangement. Not efficient!

13.2.75  TrivIGAGetCtlPtIDRange (triv_iga.c:1263)

int *TrivIGAGetCtlPtIDRange(TrivIGAArrangementID ArgmntID,
                             const TrivTVStruct *TV)

- **ArgmntID**: A handle on the IGA arrangement to process.
- **TV**: The Trivar to fetch its ID’s range.

**Returns**: Vector of maximal IDs, (Max CtlPts ID, Max Trivars ID) if successful, NULL otherwise. Allocated statically.

**Description**: Returns the range of control point IDs used by this given TV.

13.2.76  TrivIGAGetEdgeNeighboringTVs (triv_iga.c:2252)

int *TrivIGAGetEdgeNeighboringTVs(TrivIGAArrangementID ArgmntID,
                                   const TrivTVStruct *TV)

- **ArgmntID**: A handle on the IGA arrangement to process.
- **TV**: Trivar to seek its edge neighbors.

**Returns**: A TRIV_JGA_INVALID_TV_ID terminated vector of edge neighboring TV IDS or NULL if error.

**Description**: Given a TV in some field, returns the edge-neighboring trivariates of TV, if exists.

**See also**: TrivIGAGetFaceNeighboringTVs, TrivIGAGetVrtxNeighboringTVs,
13.2.77  TrivIGAGetFaceNeighboringTVs (triv_iga.c:2177)

```c
int TrivIGAGetFaceNeighboringTVs(TrivIGAArrangementID ArgmntID,
    const TrivTVStruct *TV,
    TrivIGAAdjacencyInfoStruct *AdjInfo)
```

**ArgmntID:** A handle on the IGA arrangement to process.

**TV:** Trivar to seek its (up to six) neighbors.

**AdjInfo:** Already allocated vector of six entries to be updated herein. Returns neighboring info for the six face-boundary surfaces of TV, if any. Six neighbors are updated in the following order, Umin, Umax, Vmin, Vmax, Wmin, Wmax.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Given a TV in some field, returns the (up to) six facial neighboring trivariates of TV, if exists.

**Notes:**
1. The adjacent TV can be the same as TV if TV is closed in some dir(s).
2. The returned adjacency structure will also state if the adjacent TV needs to be reversed in U or in V or U and V should be reversed so the boundary can be detected as adjacent.

**See also:** TrivIGAGetVrtxNeighboringTVs, TrivIGAGetEdgeNeighboringTVs,

13.2.78  TrivIGAGetGlblMaxIDs (triv_iga.c:1228)

```c
int *TrivIGAGetGlblMaxIDs(TrivIGAArrangementID ArgmntID)
```

**ArgmntID:** A handle on the IGA arrangement to process.

**Returns:** Vector of maximal IDs, (Max CtlPts ID, Max Trivars ID, Max Arrangement ID) if successful, NULL otherwise. Allocated statically.

**Description:** Returns the maximal IDS used in this arrangement.

13.2.79  TrivIGAGetKnotInterval (triv_iga.c:1452)

```c
const CagdRType *TrivIGAGetKnotInterval(TrivIGAArrangementID ArgmntID,
    const TrivTVStruct *TV,
    TrivTVDirType Dir,
    int BzrIntervalIndex)
```

**ArgmntID:** A handle on the IGA arrangement to process.

**TV:** The Trivar to fetch its knot sequence.

**Dir:** The direction to fetch the knots: U, V, or W.

**BzrIntervalIndex:** Index of Bezier trivar, starting from zero.

**Returns:** The list of the (2*Order) knots, or NULL if error.

**Description:** Returns the knot sequence of TV that is used in the designated Bezier trivar index and direction.

13.2.80  TrivIGAGGetLastError (triv_iga.c:2574)

```c
TrivIGAErrorType TrivIGAGGetLastError(TrivIGAArrangementID ArgmntID,
    int Reset)
```

**ArgmntID:** A handle on the IGA arrangement to process.

**Reset:** TRUE to also reset the last error as a side effect.

**Returns:** An ID with the error type, with TRIV_IGA_ERR_NO_ERROR if no error.

**Description:** Returns an ID describing the given error.

**See also:** TrivIGADescribeError,
13.2.81 TrivIGAGetMaterial (triv_iga2.c:1078)

TrivIGAMaterialID TrivIGAGetMaterial(TrivIGAArrangementID ArgmntID, TrivIGATVID TVID)

ArgmntID: A handle on the IGA arrangement to process.
TVID: ID of TV to fetch its material ID.
Returns: The material fetched ID.
Description: Fetches the material ID of a given TV ID.

13.2.82 TrivIGAGetNumBzrElements (triv_iga.c:1313)

int TrivIGAGetNumBzrElements(TrivIGAArrangementID ArgmntID, const TrivTVStruct *TV, int *NumU, int *NumV, int *NumW)

ArgmntID: A handle on the IGA arrangement to process.
TV: The Trivar to fetch how many Bezier trivariates it has.
NumU: Number of Bezier trivariates in U.
NumV: Number of Bezier trivariates in V.
NumW: Number of Bezier trivariates in W.
Returns: TRUE if successful, FALSE otherwise.
Description: Returns the number of Bezier trivariates that exists along the three axes of (possibly B-spline) trivar TV in the IGA arrangement. Assumes TV has open end conditions.

13.2.83 TrivIGAGetTV (triv_iga2.c:633)

TrivTVStruct *TrivIGAGetTV(TrivIGAArrangementID ArgmntID, TrivIGATVID TVID)

ArgmntID: A handle on the IGA arrangement to process.
TVID: The TV ID to search with.
Returns: Found TV or NULL if not found.
Description: Get a pointer to the TV, given its TV ID in the arrangement.

13.2.84 TrivIGAGetTVCtlPtsIndices (triv_iga2.c:970)

int *TrivIGAGetTVCtlPtsIndices(TrivIGAArrangementID ArgmntID, TrivIGATVID TVID)

ArgmntID: A handle on the IGA arrangement to process.
TVID: ID of TV to get all its control points IDs.
Returns: A dynamically allocated vector of all IDS or NULL if error.
Description: Returns all the indices of all control points of the given TV.
13.2.85  TrivIGAGetTVFaceAsSrf  (triv_iga2.c:920)

CagdSrfStruct *TrivIGAGetTVFaceAsSrf(TrivIGAArrangementID ArgmntID, TrivIGATVID TVID, int FaceID)

ArgmntID: A handle on the IGA arrangement to process.
TVID: The TV ID to seek its face.
FaceID: 0 to 5 for (UMin, UMax, VMin, VMax, WMin, WMax)
Returns: Sought source of NULL if error.
Description: Return indices of ALL control points in a face of designated trivariate.

13.2.86  TrivIGAGetTVFaceCtlPtsIDs  (triv_iga2.c:655)

int *TrivIGAGetTVFaceCtlPtsIDs(TrivIGAArrangementID ArgmntID, TrivIGATVID TVID, int FaceID)

ArgmntID: A handle on the IGA arrangement to process.
TVID: The TV ID to seek its face.
FaceID: 0 to 5 for (UMin, UMax, VMin, VMax, WMin, WMax)
Returns: A vector of all IDs, terminated with -1 or NULL if error.
Description: Return indices of ALL control points in a face of designated trivariate.

13.2.87  TrivIGAGetVrtxNeighboringTVs  (triv_iga.c:2363)

int *TrivIGAGetVrtxNeighboringTVs(TrivIGAArrangementID ArgmntID, const TrivTVStruct *TV)

ArgmntID: A handle on the IGA arrangement to process.
TV: Trivar to seek its vertex (corner) neighbors.
Returns: A TRIV_IGA_INVALID_TV_ID terminated vector of vertex neighboring TV IDS or NULL if error.
Description: Given a TV in some field, returns the vertex (corner) neighboring trivariates of TV, if exists.
See also: TrivIGAGetFaceNeighboringTVs, TrivIGAGetEdgeNeighboringTVs,

13.2.88  TrivIGALoadMaterialFromXML  (triv_iga2.c:1155)

int TrivIGALoadMaterialFromXML(TrivIGAArrangementID ArgmntID, const char *FileName)

ArgmntID: A handle on the IGA arrangement to process.
FileName: Name of material file to load.
Returns: Number of materials read.
Description: Load the materials defined in the given XML file.
See also: TrivIGALoadMaterialXML,
13.2.89  TrivIGALoadMaterialXML  (triv_iga_xml.c:162)

int TrivIGALoadMaterialXML(const char *FileName,  
    TrivIGAMaterialStruct **Materials,  
    int *NumMaterials)

FileName: XML file name.
Materials: Array of loaded materials allocated dynamically.
NumMaterials: The number of the loaded materials.
Returns: TRUE on success, and FALSE in failure
Description: Load the materials defined in the given XML file.

13.2.90  TrivIGANewArrangement  (triv_iga.c:536)

int TrivIGANewArrangement(TrivIGAArrangementID *NewArgmntID)

NewArgmntID: If successful, will hold the ID of the newly allocated arrangement.
Returns: 0 if error or arrangement ID if valid.
Description: Creates a new structure to hold the IGA analysis arrangement.

13.2.91  TrivIGANewField  (triv_iga.c:648)

int TrivIGANewField(TrivIGAArrangementID ArgmntID,  
    const char *FieldAttributes)

ArgmntID: A handle on the IGA arrangement to process.
FieldAttributes: Geometry or scalar/vector data fields.
Returns: TRUE if successful, FALSE otherwise.
Description: Declares a new field. Every field can consists of several (adjacent or not) trivariates and all 
    subsequent call of TrivIGAAddTrivar2Field will be placed in this new field.

13.2.92  TrivIGANewMaterial  (triv_iga2.c:1124)

TrivIGAMaterialID TrivIGANewMaterial(TrivIGAArrangementID ArgmntID,  
    const char *MaterialStr)

ArgmntID: A handle on the IGA arrangement to process.
MaterialStr: material description to parse.
Returns: New material ID or TRIV_IGA_INVALID_MATERIAL_ID if failed.
Description: Parses a new material description and create a new material.

13.2.93  TrivIGANewTV  (triv_iga.c:758)

TrivIGATVStruct *TrivIGANewTV(TrivIGAArrangementID ArgmntID, TrivTVStruct *TV)

ArgmntID: A handle on the IGA arrangement to process.
TV: The Trivar to insert into the currently defined field, in place.
Returns: The allocated IGA TV, or NULL if error.
Description: Inserts a new trivariate into the IGA arrangement, in the current field, in place.
13.2.94  **TrivIGAParseMaterial** (triv_i ga.c:257)

TrivIGAMaterialStruct *TrivIGAParseMaterial(const char *MaterialStr)

  **MaterialStr**: string representing the material in the following format id = <id>, name = <name>, type = <type>, attrib1 = <attrib1>, ...... where id, name, type attributes are must.

  **Returns**: new created material

  **Description**: Creates a new material and initializes it. Updates it otherwise.

13.2.95  **TrivIGAPrintTVContent** (triv_ga.c:1106)

int TrivIGAPrintTVContent(TrivIGAArrangementID ArgmntID, 
const TrivTVStruct *TV)

  **ArgmntID**: A handle on the IGA arrangement to process.
  **TV**: The Trivar to print to stderr.

  **Returns**: TRUE if successful, FALSE otherwise.

  **Description**: A debugging function to dump to stderr, the content of the given TV.

13.2.96  **TrivIGASetCtrlPtsPositions** (triv_ga.c:1627)

int TrivIGASetCtrlPtsPositions(TrivIGAArrangementID ArgmntID, 
int NumCtrlPts, 
const TrivIGACtrlPtStruct *Vals)

  **ArgmntID**: A handle on the IGA arrangement to process.
  **NumCtrlPts**: Length of vector Vals.
  **Vals**: Vector of control points to set the relevant control points of TV with. The control point type in Vals prescribes how many (Coord[i], ID[i]) pairs are in Vals which can be arbitrary, as a regular int value. The values are set by identified the ID in TV, for each (Coord[i], ID[i]) pair.

  **Returns**: TRUE if successful, FALSE otherwise.

  **Description**: A modifier function to replace control points' values in an arrangement, with the values as specified by Vals. The control points are identified by their unique IDs and must all be in some TV(s).

13.2.97  **TrivIGASetDefaultDomain** (triv_ga2.c:92)

int TrivIGASetDefaultDomain(TrivIGAArrangementID ArgmntID, 
TrivTVDirType Dir, 
CagdRType Min, 
CagdRType Max)

  **ArgmntID**: A handle on the IGA arrangement to process.
  **Dir**: U, V, W direction to set the default domain to.
  **Min, Max**: The domain to set.

  **Returns**: TRUE if successful, FALSE otherwise.

  **Description**: Sets the default domain of all to-be-entered trivariates into the arrangement in the given direction (u, V, or W). If Tmax <= Tmin, then this option is disabled (default) and the doamin is kept as it is inserted into the arrangement.
13.2.98  TrivIGASetDefaultSeeding (triv_iga2.c:34)

```c
int TrivIGASetDefaultSeeding(TrivIGAArrangementID ArgmntID,
                        TrivTVDirType Dir,
                        CagdRType Alpha,
                        int NumIntervals)
```

**ArgmntID:** A handle on the IGA arrangement to process.

**Dir:** U, V, W direction to set the default seeding to.

**Alpha:** Ratio of last interval’s length divided by first interval length, in set direction Dir.

**NumIntervals:** Number of interval to introduce.

**Returns:** The number of intervals that will be introduced in that axes.

**Description:** Sets the default seeding of all to-be-entered trivariates into the arrangement in the given direction (u, V, or W).

13.2.99  TrivIGATDegreeRaise (triv_iga2.c:546)

```c
TrivIGATVStruct *TrivIGATDegreeRaise(TrivIGAArrangementID ArgmntID,
                        TrivIGATVID TVID,
                        TrivTVDirType Dir)
```

**ArgmntID:** A handle on the IGA arrangement to process.

**TVID:** ID of the TV to degree raise in the arrangement.

**Dir:** Degree raising direction - U, V or W.

**Returns:** Reference to the IGA TV degree raised, or NULL if error.

**Description:** Degree raise a given TV (ID) in the arrangement.

13.2.100  TrivIGATVEval (triv_iga.c:1680)

```c
const TrivIGACtrlPtStruct *TrivIGATVEval(TrivIGAArrangementID ArgmntID,
                        const TrivTVStruct *TV,
                        TrivIGAEvalType EvalType,
                        int IndexU,
                        int IndexV,
                        int IndexW,
                        CagdRType U,
                        CagdRType V,
                        CagdRType W)
```

**ArgmntID:** A handle on the IGA arrangement to process.

**TV:** Trivar to evaluation a one location.

**EvalType:** What to evaluate: position, derivatives, normals, etc.

**IndexU:** The Bezier trivariate index in U in TV, starting from zero.

**IndexV:** The Bezier trivariate index in V in TV, starting from zero.

**IndexW:** The Bezier trivariate index in W in TV, starting from zero.

**U, V, W:** Parameters values to evaluate the designated Bezier trivar at. In [0, 1] only. For many evaluations, U varying first and W last will yield the best performance.

**Returns:** A control point allocated statically with the evaluation values, or NULL if error.

**Description:** Evaluate the given TV at the given location. The evaluation location is identified by the relevant Bezier trivar (using IndexU/V/W) and the parameter values that are always normalized to be between zero and one.
13.2.101 TrivIGATVEvalBasis (triv_iga.c:1968)

```c
const CagdRType *TrivIGATVEvalBasis(TrivIGAArrangementID ArgmntID,
const TrivTVStruct *TV,
TrivIGAEvalType EvalType,
TrivTVDirType Dir,
int Index,
CagdRType t)
```

**ArgmntID:** A handle on the IGA arrangement to process.

**TV:** Trivar to evaluate a one location.

**EvalType:** What to evaluate: position, derivatives, normals, etc.

**Dir:** Direction to evaluate the basic function - U, V or W.

**Index:** The Bezier trivariate index in Dir in TV, starting from zero.

**t:** Parameter values to evaluate the designated Bezier trivar at, in Dir, in \([0, 1]\).

**Returns:** Allocated statically vector of Order values holding the relevant basis function values, or NULL if error.

**Description:** Evaluate the basis function values of given TV at the given location. The evaluation location is identified by the relevant Bezier trivar (using IndexU/V/W) and the parameter values that are always normalized to be between zero and one.

13.2.102 TrivIGATVFromSurfaces (triv_iga2.c:418)

```c
TrivIGATVID TrivIGATVFromSurfaces(TrivIGAArrangementID ArgmntID,
const CagdSrfStruct *SrfList,
int OtherOrder,
CagdBType IsInterpolating,
int ID)
```

**ArgmntID:** A handle on the IGA arrangement to process.

**SrfList:** List of surfaces to construct a trivariate with.

**OtherOrder:** Other, third, order of trivariate.

**IsInterpolating:** TRUE for the trivariate to interpolate the surfaces, FALSE to approximate them.

**ID:** ID to use or -1 to set a new ID.

**Returns:** INVALID IGA TV ID if error, to TV ID if successful.

**Description:** Constructs a new trivariate and add it to the give arrangement as a trivariate through surfaces of the given ordered surfaces.

13.2.103 TrivIGATVFromSurfaces2 (triv_iga2.c:462)

```c
TrivIGATVID TrivIGATVFromSurfaces2(TrivIGAArrangementID ArgmntID,
const CagdSrfStruct *Srf,
IrtHmgmMatType Transforms[],
int NumTransforms,
unsigned int OtherOrder,
CagdBType IsInterpolating,
int ID)
```

**ArgmntID:** A handle on the IGA arrangement to process.

**Srf:** Base surface to transform in space & skin a volume thru.

**Transforms:** Vector of transformation matrices to apply to Srf.

**NumTransforms:** Size of vector Transforms.

**OtherOrder:** Other order to use, in the skinning direction.

**IsInterpolating:** TRUE to interpolate surfaces, FALSE to approximate them.

**ID:** ID to use or -1 to set a new ID.

**Returns:** INVALID IGA TV ID if error, to TV ID if successful.

**Description:** Constructs a new trivariate and add it to the give arrangement as a trivariate through surfaces of the given ordered transformations of Srf.
13.2.104 TrivIGATVRefine (triv_iga2.c:501)

TrivIGATVStruct *TrivIGATVRefine(TrivIGAArrangementID ArgmntID,
TrivIGATVID TVID,
TrivTVDirType Dir,
CagdRType t)

ArgmntID: A handle on the IGA arrangement to process.
TVID: ID of the TV to refine in the arrangement.
Dir: Refinement direction - U, V or W.
t: Parameter at which to insert the knot.

Returns: Reference to the IGA TV refined, or NULL if error.

Description: Refines a given TV (ID) in the arrangement.

13.2.105 TrivIGATVofRevol (triv_iga2.c:365)

TrivIGATVID TrivIGATVofRevol(TrivIGAArrangementID ArgmntID,
const CagdSrfStruct *Srf,
const IrtPtType AxisPoint,
const IrtVecType AxisVector,
CagdRType StartAngle,
CagdRType EndAngle,
CagdBType IsRational,
int ID)

ArgmntID: A handle on the IGA arrangement to process.
Srf: Surface to rotate.
AxisPoint, AxisVector: Axis line of rotation’s prescription.
StartAngle: Starting angle in degs., 0 for a full circle.
EndAngle: Terminating angle in degs., 360 for a full circle.
IsRational: TRUE to construct a rational precise volume of revolution, FALSE for polynomial approximation.
ID: ID to use or -1 to set a new ID.

Returns: INVALID IGA TV ID if error, to TV ID if successful.

Description: Constructs a new trivariate and add it to the give arrangement as a volume of revolution of the given surface.

13.2.106 TrivIGAUpdateCtrlPtsPositions (triv_iga.c:1582)

int TrivIGAUpdateCtrlPtsPositions(TrivIGAArrangementID ArgmntID,
int NumCtrlPts,
const TrivIGACtrlPtStruct *DeltaVals)

ArgmntID: A handle on the IGA arrangement to process.
NumCtrlPts: Length of vector DeltaVals.
DeltaVals: Vector of control points with delta values to set the relevant control points of TV with. The control point type in Vals prescribes how many (Coord[i], ID[i]) pairs are in Vals which can be arbitrary, as a regular int value. The values are set by identified the ID in TV, for each (Coord[i], ID[i]) pair.

Returns: TRUE if successful, FALSE otherwise.

Description: A modifier function to update control points in an arrangement, with the delta values as specified by DeltaVals. The control points are identified by their unique IDs and must all be in some TV(s).
13.2.107 TrivIGAUpdateTV (trivgla.c:884)

TrivIGATVStruct *TrivIGAUpdateTV(TrivIGAArrangementID ArgmntID, TrivTVStruct *ExistingTV, TrivTVStruct *NewTV)

ArgmntID: A handle on the IGA arrangement to process.
ExistingTV: Current TV in the arrangement to update. Will be freed.
NewTV: New TV to replace the existing TV.
Returns: Reference to the updated IGA TV, or NULL if error.
Description: Inserts a new trivariate into the IGA arrangement, in the current field.

13.2.108 TrivIgaGenOneFaceNeighboringConstraints (trivgla2.c:804)

int TrivIgaGenOneFaceNeighboringConstraints(TrivIGAArrangementID ArgmntID, TrivIGANeighboringConstraintCallBackType NeighboringConstraintCallBack, const TrivTVStruct *TV1, int FaceID1, const TrivTVStruct *TV2, int FaceID2, void *CallbackData)

ArgmntID: A handle on the IGA arrangement to process.
NeighboringConstraintCallBack: Call back function to call with the constraint as a string.
TV1, FaceID1: Description of first face.
TV2, FaceID2: Description of second face.
CallbackData: Relevant data for the callback function (such as XML information).
Returns: TRUE if successful, FALSE otherwise.
Description: Construct linear constraints hooking one adjacent face that does not share a common function space with its neighbor while being the same.

13.2.109 TrivInterpTrivar (trinterp.c:30)

TrivTVStruct *TrivInterpTrivar(const TrivTVStruct *TV)

TV: Trivariate to interpolate its control mesh.
Returns: The interpolating trivariate.
Description: Interpolates control points of given trivariate, preserving the order and continuity of the original trivariate.
See also: TrivTVInterpPts, TrivTVInterpolate,

13.2.110 TrivLoadVolumeIntoTV (mrchum.c:949)

TrivTVStruct *TrivLoadVolumeIntoTV(const char *FileName, int DataType, IrtVecType VolSize, IrtVecType Orders)

FileName: To load the trivariate data set from.
DataType: Type of scalar value in volume data file. Can be one of: 1 - Regular ascii (separated by while spaces. 2 - Two bytes short integer. 3 - Four bytes long integer. 4 - One byte (char) integer. 5 - Four bytes float. 6 - Eight bytes double.
VolSize: Dimensions of trivariate volume.
Orders: Orders of the three axis of the volume (in U, V, and W).
Returns: Loaded trivariate, or NULL if error.
Description: Loads a volumetric data set as a trivariate function of prescribed orders. Uniform open end conditions are created for it.
13.2.111  **TrivMakeTVsCompatible** (trivcmpt.c:50)

\[ \text{CagdBType TrivMakeTVsCompatible(TrivTVStruct **TV1,} \\
\text{ TrivTVStruct **TV2,} \\
\text{ CagdBType SameUOrder,} \\
\text{ CagdBType SameVOrder,} \\
\text{ CagdBType SameWOrder,} \\
\text{ CagdBType SameUKV,} \\
\text{ CagdBType SameVKV,} \\
\text{ CagdBType SameWKV)} \]

**TV1, TV2:** Two surfaces to be made compatible, in place.

**SameUOrder:** If TRUE, this routine make sure they share the same U order.

**SameVOrder:** If TRUE, this routine make sure they share the same V order.

**SameWOrder:** If TRUE, this routine make sure they share the same W order.

**SameUKV:** If TRUE, this routine make sure they share the same U knot vector and hence continuity.

**SameVKV:** If TRUE, this routine make sure they share the same V knot vector and hence continuity.

**SameWKV:** If TRUE, this routine make sure they share the same W knot vector and hence continuity.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Given two trivariates, makes them compatible by:
1. Coercing their point type to be the same.
2. Making them have the same tri-variate type.
3. Raising the degree of the lower one to be the same as the higher.
4. Refining them to a common knot vector (If Bspline and SameOrder).

Note 3 is performed if SameOrder TRUE, 4 if SameKV TRUE. Both trivariates are modified IN PLACE.

13.2.112  **TrivNSPrimBox** (trivprim.c:165)

\[ \text{TrivTVStruct *TrivNSPrimBox(CagdRType MinX,} \\
\text{ CagdRType MinY,} \\
\text{ CagdRType MinZ,} \\
\text{ CagdRType MaxX,} \\
\text{ CagdRType MaxY,} \\
\text{ CagdRType MaxZ)} \]

**MinX, MinY, MinZ:** Minimum range of box trivariate.

**MaxX, MaxY, MaxZ:** Maximum range of box trivariate.

**Returns:** A trivariate of a box model.

**Description:** A trivariate constructor of a box model, parallel to main axes.

**See also:** TrivNSPrimCone, TrivNSPrimCone2, TrivNSPrimCylinder, TrivNSPrimSphere, TrivNSPrimTorus,

13.2.113  **TrivNSPrimCone** (trivprim.c:268)

\[ \text{TrivTVStruct *TrivNSPrimCone(const CagdVType Center,} \\
\text{ CagdRType Radius,} \\
\text{ CagdRType Height,} \\
\text{ CagdBType Rational,} \\
\text{ CagdRType InternalCubeSize)} \]

**Center:** Of the cone.

**Radius:** Of the cone.

**Height:** Of the cone.

**Rational:** TRUE for precise rational, FALSE for polynomial approximation.

**InternalCubeSize:** Size of the internal cube trivariate edge.

**Returns:** A list of 5 trivariates, representing the cone.

**Description:** A trivariate constructor of a cone, centered at Center with radius Radius, and a Height height.

The cone is built from 5 ruled trivariates. Note the cone will be (only) at the apex.

**See also:** TrivNSPrimBox, TrivNSPrimCone2, TrivNSPrimCylinder, TrivNSPrimSphere, TrivNSPrimTorus,
13.2.114  **TrivNSPrimCone2** *(trivprim.c:303)*

TrivTVStruct *TrivNSPrimCone2(const CagdVType Center,
    CagdRType MajorRadius,
    CagdRType MinorRadius,
    CagdRType Height,
    CagdBType Rational,
    CagdRType InternalCubeSize)

  **Center**: Of the cone.
  **MajorRadius**: Of the cone.
  **MinorRadius**: Of the cone.
  **Height**: Of the cone.
  **Rational**: TRUE for precise rational, FALSE for polynomial approximation.
  **InternalCubeSize**: Size of the internal cube trivariate edge.

  **Returns**: A list of 5 trivariates, representing the cone.

  **Description**: A trivariate constructor of a cone, centered at Center with major radius MajorRadius and minor radius MinorRadius, and a Height height. The cone is built from 5 non singular ruled trivariates.

  **See also**: TrivNSPrimBox, TrivNSPrimCone, TrivNSPrimCylinder, TrivNSPrimSphere, TrivNSPrimTorus,

13.2.115  **TrivNSPrimCylinder** *(trivprim.c:210)*

TrivTVStruct *TrivNSPrimCylinder(const CagdVType Center,
    CagdRType Radius,
    CagdRType Height,
    CagdBType Rational,
    CagdRType InternalCubeSize)

  **Center**: Of the cylinder.
  **Radius**: Of the cylinder.
  **Height**: Of the cylinder.
  **Rational**: TRUE for precise rational, FALSE for polynomial approximation.
  **InternalCubeSize**: Size of the internal cube trivariate edge.

  **Returns**: A list of 5 trivariates, representing the cylinder.

  **Description**: A trivariate constructor of a cylinder, centered at Center with radius Radius, and a Height height. The cylinder is built from 5 non singular ruled trivariates.

  **See also**: TrivNSPrimBox, TrivNSPrimCone, TrivNSPrimCone2, TrivNSPrimSphere, TrivNSPrimTorus,

13.2.116  **TrivNSPrimSphere** *(trivprim.c:367)*

TrivTVStruct *TrivNSPrimSphere(const CagdVType Center,
    CagdRType Radius,
    CagdBType Rational,
    CagdRType InternalCubeSize)

  **Center**: Of the ball.
  **Radius**: Of the ball.
  **Rational**: TRUE for precise rational, FALSE for polynomial approximation.
  **InternalCubeSize**: Size of the internal cube trivariate edge.

  **Returns**: A list of 7 trivariates, representing the sphere.

  **Description**: A trivariate constructor of a ball, centered at Center and radius Radius, built from 7 non singular trivariates, an inner cube and 6 ruled trivariate between patches of the ball's outer sphere surface and the cube faces.

  **See also**: TrivNSPrimBox, TrivNSPrimCone, TrivNSPrimCone2, TrivNSPrimCylinder, TrivNSPrimSphere, TrivNSPrimTorus,
13.2.117  **TrivNSPrimTorus** *(trivprim.c:465)*

TrivTVStruct *TrivNSPrimTorus(const CagdVType Center, CagdRType MajorRadius, CagdRType MinorRadius, CagdBType Rational, CagdRType InternalCubeSize)

Center: Of the torus.
MajorRadius: Of the torus.
MinorRadius: Of the torus.
Rational: TRUE for precise rational, FALSE for polynomial approximation.
InternalCubeSize: Size of the internal cube trivariate edge.
Returns: A list of 5 trivariates, representing the torus.

Description: A trivariate constructor of a torus, centered at Center with major radius MajorRadius and minor radius MinorRadius. The torus is built from 5 non singular trivariates of revolution.
See also: TrivNSPrimBox, TrivNSPrimCone, TrivNSPrimCone2, TrivNSPrimCylinder, TrivNSPrimSphere,

13.2.118  **TrivParamInDomain** *(triv_aux.c:89)*

CagdBType TrivParamInDomain(const TrivTVStruct *TV, CagdRType t, TrivTVDirType Dir)

TV: To make sure t is in its Dir domain.
t: Parameter value to verify.
Dir: Direction. Either U or V or W.
Returns: TRUE if in domain, FALSE otherwise.

Description: Given a tri-variate and a domain - validate it.

13.2.119  **TrivParamsInDomain** *(triv_aux.c:125)*

CagdBType TrivParamsInDomain(const TrivTVStruct *TV, CagdRType u, CagdRType v, CagdRType w)

TV: To make sure (u, v, w) is in its domain.
u, v, w: To verify if it is in TV's parametric domain.
Returns: TRUE if in domain, FALSE otherwise.

Description: Given a tri-variate and a domain - validate it.

13.2.120  **TrivPlaneFrom4Points** *(geomat4d.c:44)*

int TrivPlaneFrom4Points(const TrivPType Pt1, const TrivPType Pt2, const TrivPType Pt3, const TrivPType Pt4, TrivIrtPlnType Plane)

Pt1, Pt2, Pt3, Pt4: The four points the plane should go through.
Plane: Where the result should be placed.
Returns: TRUE if successful, FALSE otherwise.
**Description:** Computes a hyperplane in four space through the given four points. Based on a direct solution in Maple of:

```maple
with(linalg);
readlib(C);

d := det( matrix( [ [x - x1, y - y1, z - z1, w - w1],
                     [x2 - x1, y2 - y1, z2 - z1, w2 - w1],
                     [x3 - x2, y3 - y2, z3 - z2, w3 - w2],
                     [x4 - x3, y4 - y3, z4 - z3, w4 - w3] ] ) ) ;

coeff( d, x ) ;
coeff( d, y ) ;
coeff( d, z ) ;
coeff( d, w ) ;
```

### 13.2.121 TrivPwrTVNew (triv_gen.c:192)

TrivTVStruct *TrivPwrTVNew(int ULength, int VLength, int WLength, CagdPointType PType)

- **ULength:** Number of control points in the U direction.
- **VLength:** Number of control points in the V direction.
- **WLength:** Number of control points in the W direction.
- **PType:** Type of control points (E2, P3, etc.).

**Returns:** An uninitialized freeform trivariate power basis.

**Description:** Allocates the memory required for a new power basis trivariate.

**See also:** TrivBzrTVNew, TrivBspTVNew, TrivTVNew.

### 13.2.122 TrivRuledTV (trivruld.c:36)

TrivTVStruct *TrivRuledTV(const CagdSrfStruct *CSrf1, const CagdSrfStruct *CSrf2, int OtherOrder, int OtherLen)

- **CSrf1, CSrf2:** The two surfaces to form a ruled trivariate in between.
- **OtherOrder:** Usually two, but one can specify higher orders in the ruled direction. OtherOrder must never be larger than OtherLen.
- **OtherLen:** Usually two control points in the ruled direction which necessitates a linear interpolation.

**Returns:** The ruled trivariate.

**Description:** Constructs a ruled trivariate between the two provided surfaces. OtherOrder and OtherLen (equal for Bezier) specifies the desired order and refineness level (if Bspline) of the other ruled direction.

**See also:** CagdRuledSrf.

### 13.2.123 TrivSetFatalErrorFunc (triv_ftl.c:28)

TrivSetErrorFuncType TrivSetFatalErrorFunc(TrivSetErrorFuncType ErrorFunc)

- **ErrorFunc:** New error function to use.
- **Returns:** Old error function reference.

**Description:** Sets the error function to be used by Trivlib.
13.2.124  **TrivSrfFromMesh** (triveval.c:789)

```c
CagdSrfStruct *TrivSrfFromMesh(const TrivTVStruct *TV,
   int Index,
   TrivTVDirType Dir)
```

**TV:** Trivariate to extract a bivariate surface out of its mesh.

**Index:** Index of row/column/level of TV's mesh in direction Dir.

**Dir:** Direction of isosurface extraction. Either U or V or W.

**Returns:** A bivariate surface which was extracted from TV's Mesh. This surface is not necessarily on TV.

**Description:** Extract a bivariate surface out of the given trivariate's mesh. The provided (zero based) Index specifies which Index to extract.

13.2.125  **TrivSrfFromTV** (triveval.c:331)

```c
CagdSrfStruct *TrivSrfFromTV(const TrivTVStruct *TV,
   CagdRType t,
   TrivTVDirType Dir,
   int OrientBoundary)
```

**TV:** To extract an isoparametric surface from at parameter value t in direction Dir.

**t:** Parameter value at which to extract the isosurface.

**Dir:** Direction of isosurface extraction. Either U or V or W.

**OrientBoundary:** TRUE to reorient boundary surfaces to point with their normals into the trivariate.

**Returns:** A bivariate surface which is an isosurface of TV.

**Description:** Extract an isoparametric surface out of the given tensor product trivariate. Operations should favor the CONST_W_DIR, in which the extraction is somewhat faster, if it is possible. surfaces that are on the boundary are reoriented so their normals are pointing into the trivariate, if OrientBoundary is TRUE.

**See also:** TrivBndrySrfsFromTV,

13.2.126  **TrivSrfToMesh** (triveval.c:921)

```c
void TrivSrfToMesh(const CagdSrfStruct *Srf,
   int Index,
   TrivTVDirType Dir,
   TrivTVStruct *TV)
```

**Srf:** Surface to substitute into the trivariate TV.

**Index:** Index of row/column/level of TV's mesh in direction Dir.

**Dir:** Direction of isosurface extraction. Either U or V or W.

**TV:** Trivariate to substitute a bivariate surface into its mesh.

**Returns:** void

**Description:** Substitute a bivariate surface into a given trivariate's mesh. The provided (zero based) Index specifies which Index to extract.

13.2.127  **TrivTV2CtrlMesh** (trivmesh.c:24)

```c
CagdPolylineStruct *TrivTV2CtrlMesh(const TrivTVStruct *Trivar)
```

**Trivar:** To extract a control mesh from.

**Returns:** The control mesh of Srf.

**Description:** Extracts the control mesh of a surface as a list of polylines.
13.2.128 **TrivTVBBox** (trivaux.c:234)

```c
void TrivTVBBox(const TrivTVStruct *TV, CagdBBoxStruct *BBox)
```

**TV**: To compute a bounding box for.

**BBox**: Where bounding information is to be saved.

**Returns**: void

**Description**: Computes a bounding box for a trivariate freeform function.

13.2.129 **TrivTVBlockEvalDone** (triveval.c:1468)

```c
void TrivTVBlockEvalDone(void)
```

**Returns**: void

**Description**: Free all auxiliary memory used by this block evaluation procedure.

**See also**: TrivTVBlockEvalInit, TrivTVBlockEvalSetMesh, TrivTVBlockEvalOnce,

13.2.130 **TrivTVBlockEvalInit** (triveval.c:1231)

```c
void TrivTVBlockEvalInit(CagdRType *UKnotVector,
CagdRType *VKnotVector,
CagdRType *WKnotVector,
int Lengths[3],
int Orders[3],
int BlockSizes[3],
CagdPType *Params,
int NumOfParams[3])
```

**UKnotVector**: U Knot sequence defining the spline space in U.

**VKnotVector**: V Knot sequence defining the spline space in V.

**WKnotVector**: W Knot sequence defining the spline space in W.

**Lengths**: Lengths of Mesh in the U,V,W directions.

**Orders**: Of the spline space in the U,V,W Directions.

**BlockSizes**: Of the evaluation block sizes in U,V,W Directions.

**Params**: At which to evaluate and compute the volume functions. This vector is of size IRIT_MAX(NumOfparams[0],[1],[2]).

**NumOfParams**: Size of Params vector, in U, V, W.

**Returns**: void

**Description**: Initialize the computation of evaluations of blocks of parameter values for the given trivariate space, as prescribed by U/V/WKnotVectors and Orders, Lengths, and BlockSizes, at the requested NumOfParams parameter values, Params. All parameters below should stay valid for the duration of the block evaluation.

**See also**: TrivTVBlockEvalSetMesh, TrivTVBlockEvalOnce, TrivTVBlockEvalDone,

13.2.131 **TrivTVBlockEvalOnce** (triveval.c:1326)

```c
TrivTVBlockEvalStruct *TrivTVBlockEvalOnce(int i, int j, int k)
```

**i, j, k**: Index of current block evaluation. This triple index is between 0 and NumOfParams[l]/BlockSize[l], in each dimension.

**Returns**: Evaluated block.

**Description**: Computes evaluations of one block of parameter values for the given trivariate space, as prescribed by i, j, k.

**See also**: TrivTVBlockEvalInit, TrivTVBlockEvalSetMesh, TrivTVBlockEvalDone,
13.2.132 TrivTVBlockEvalSetMesh (triveval.c:1303)

void TrivTVBlockEvalSetMesh(CagdPType *Mesh)

Mesh: Provide the current mesh.
Returns: void
See also: TrivTVBlockEvalInit, TrivTVBlockEvalOnce, TrivTVBlockEvalDone,

13.2.133 TrivTVBlossomDegreeRaise (trivrais.c:607)

TrivTVStruct *TrivTVBlossomDegreeRaise(const TrivTVStruct *TV,
                                         TrivTVDirType Dir)

TV: To raise it degree by one.
Dir: Direction of degree raising. Either U, V or W.
Returns: A trivariate with one degree higher in direction Dir, representing the same geometry as TV.
Description: Returns a new Bspline trivariate, identical to the original but with one degree higher, in the requested direction Dir.
See also: TrivBspTVDegreeRaise, TrivBzrTVDegreeRaise, TrivTVDegreeRaise,

13.2.134 TrivTVBlossomDegreeRaiseN (trivrais.c:406)

TrivTVStruct *TrivTVBlossomDegreeRaiseN(const TrivTVStruct *TV,
                                         int NewUOrder,
                                         int NewVOrder,
                                         int NewWOrder)

TV: To raise it degree by one.
NewUOrder: New degree raised order in U.
NewVOrder: New degree raised order in V.
NewWOrder: New degree raised order in W.
Returns: A trivariate with one degree higher in direction Dir, representing the same geometry as TV.
Description: Returns a new Bspline trivariate, identical to the original but with one degree higher, in the requested direction Dir.
See also: TrivBspTVDegreeRaise, TrivBzrTVDegreeRaise, TrivTVDegreeRaise,

13.2.135 TrivTVCopy (triv_gen.c:219)

TrivTVStruct *TrivTVCopy(const TrivTVStruct *TV)

TV: Trivariate to duplicate
Returns: Duplicated trivariate.
Description: Allocates and duplicates all slots of a trivariate structure.

13.2.136 TrivTVCopyList (triv_gen.c:284)

TrivTVStruct *TrivTVCopyList(const TrivTVStruct *TVList)

TVList: List of trivariates to duplicate.
Returns: Duplicated list of trivariates.
Description: Duplicates a list of trivariate structures.
13.2.137 **TrivTVDegreeRaise** (trivrais.c:38)

TrivTVStruct *TrivTVDegreeRaise(const TrivTVStruct *TV, TrivTVDirType Dir)

- **TV**: To raise its degree.
- **Dir**: Direction of degree raising. Either U, V or W.
- **Returns**: A trivariate with same geometry as TV but with one degree higher.

**Description**: Returns a new trivariate representing the same curve as TV but with its degree raised by one, in Dir direction.

13.2.138 **TrivTVDegreeRaiseN** (trivrais.c:78)

TrivTVStruct *TrivTVDegreeRaiseN(const TrivTVStruct *TV, TrivTVDirType Dir, int NewOrder)

- **TV**: To raise its degree.
- **Dir**: Direction of degree raising. Either U, V or W.
- **NewOrder**: New order to raise TV in direction Dir.
- **Returns**: A trivariate with same geometry as TV but with one degree higher.

**Description**: Returns a new trivariate representing the same curve as TV but with its degree raised to a NewOrder in Dir direction.

13.2.139 **TrivTVDerive** (triv_der.c:40)

TrivTVStruct *TrivTVDerive(const TrivTVStruct *TV, TrivTVDirType Dir)

- **TV**: Trivariate to differentiate.
- **Dir**: Direction of differentiation. Either U or V or W.
- **Returns**: Differentiated trivariate in direction Dir.

**Description**: Given a trivariate, computes its partial derivative trivariate in direction Dir.

**See also**: TrivBzrTVDerive, TrivBspTVDerive, TrivTVDeriveScalar,

13.2.140 **TrivTVDeriveScalar** (triv_der.c:71)

TrivTVStruct *TrivTVDeriveScalar(const TrivTVStruct *TV, TrivTVDirType Dir)

- **TV**: Trivariate to differentiate.
- **Dir**: Direction of differentiation. Either U or V or W.
- **Returns**: Differentiated trivariate in direction Dir.

**Description**: Given a trivariate, computes its partial derivative trivariate in direction Dir.

**See also**: TrivBzrTVDeriveScalar, TrivBspTVDeriveScalar, TrivTVDerive,
13.2.141 TrivTVDomain (triv_aux.c:38)

```c
void TrivTVDomain(const TrivTVStruct *TV,
    CagdRType *UMin,
    CagdRType *UMax,
    CagdRType *VMin,
    CagdRType *VMax,
    CagdRType *WMin,
    CagdRType *WMax)
```

**TV:** Trivariate function to consider.
**UMin, UMax:** U Domain of TV will be placed herein.
**VMin, VMax:** V Domain of TV will be placed herein.
**WMin, WMax:** W Domain of TV will be placed herein.

**Returns:** void

**Description:** Given a tri-variate, returns its parametric domain.

13.2.142 TrivTVEval (triveval.c:83)

```c
CagdRType *TrivTVEval(const TrivTVStruct *TV,
    CagdRType u,
    CagdRType v,
    CagdRType w)
```

**TV:** To evaluate at given (u, v, w) parametric location.
**u, v, w:** Parametric location to evaluate TV at.

**Returns:** A vector holding all the coefficients of all components of the trivariate's point type. If for example trivariate point type is P2, the W, X, and Y will be saved in the first three locations of the returned vector. The first location (index 0) of the returned vector is reserved for the rational coefficient W and XYZ always starts at second location of the returned vector (index 1).

**Description:** Evaluates the given tensor product trivariate at a given point, by extracting an isoparametric surface along w and evaluating (u, v) in it.

```
+-----------------------+   Orientation of
W /                     | control tri-variate mesh.
/ /                     /|
/ /   U -->            / |
+-----------------------+   Orientation of
V | P0    Pi-1| +
v |P1    P2i-1| /
|   Pi-1| /
|   Pn-i Pn-1|
+-------------+
```

See also: TrivTVEval2, TrivTVEval3,

13.2.143 TrivTVEval2 (triveval.c:212)

```c
CagdRType *TrivTVEval2(const TrivTVStruct *TV,
    CagdRType u,
    CagdRType v,
    CagdRType w)
```

**TV:** To evaluate at given (u, v, w) parametric location.
**u, v, w:** Parametric location to evaluate TV at.

**Returns:** A vector holding all the coefficients of all components of the trivariate's point type. If for example trivariate point type is P2, the W, X, and Y will be saved in the first three locations of the returned vector. The first location (index 0) of the returned vector is reserved for the rational coefficient W and XYZ always starts at second location of the returned vector (index 1).

**Description:** This function is the same as TrivTVEval2 above. Cleaner, but much less efficient. Evaluates the given tensor product trivariate at a given point, by extracting an isoparametric surface along w and evaluating (u, v) in it.

See also: TrivTVEval, TrivTVEval3,
13.2.144  TrivTVEval3  (triveval.c:284)

CagdRType *TrivTVEval3(CagdRType u,
    CagdRType v,
    CagdRType w)

u, v, w: Parametric location to evaluate TV at.

Returns: A vector holding all the coefficients of all components of the trivariate’s point type. If for example
trivariate point type is P2, the W, X, and Y will be saved in the first three locations of the returned
vector. The first location (index 0) of the returned vector is reserved for the rational coefficient W and
XYZ always starts at second location of the returned vector (index 1).

Description: This function is the same as TrivTVEval/TrivTVEval2 above. The evaluation function once
TrivTVEval3Prep is called. This function is geared toward massive evaluation fo the same TV, where u is changing
the most, w the least.

13.2.145  TrivTVEval3Prep  (triveval.c:250)

void TrivTVEval3Prep(const TrivTVStruct *TV)

TV: To keep for massive evaluation using TrivTVEval3. This trivar must be valid during all subsequent
TrivTVEval3 calls.

Returns: void

Description: This function is the same as TrivTVEval/TrivTVEval2 above. A preparation routine for TrivTVE-
val3. This function is geared toward massive evaluation fo the same TV, where u is changing the most, w the least.
See also: TrivTVEval, TrivTVEval2, TrivTVEval3,

13.2.146  TrivTVFree  (triv_gen.c:313)

void TrivTVFree(TrivTVStruct *TV)

TV: Trivariate to free.

Returns: void

Description: Deallocates and frees all slots of a trivariate structure.

13.2.147  TrivTVFreeList  (triv_gen.c:349)

void TrivTVFreeList(TrivTVStruct *TVList)

TVList: Trivariate list to free.

Returns: void

Description: Deallocates and frees a list of trivariate structures.

13.2.148  TrivTVFromSrfs  (trivstrv.c:141)

TrivTVStruct *TrivTVFromSrfs(const CagdSrfStruct *SrfList,
    int OtherOrder,
    CagdEndConditionType OtherEC,
    IrtRType *OtherParamVals)

SrfList: List of surfaces to construct a trivariate with.
OtherOrder: Other, third, order of trivariate.
OtherEC: End condition in the other, third, trivar direction.
OtherParamVals: If not NULL, updated with other direction set parameters of the surfaces in the new trivar.

Returns: Constructed trivariate from surfaces.

Description: Constructs a trivariate using a set of surfaces. Surfaces are made to be compatible and then each
is substituted into the new trivariate’s mesh as a row. If OtherOrder is less than the number of surfaces, number of
surfaces is used. A knot vector is formed with uniform open end for the other direction, so created TV interpolates
the first and last surfaces only, if OtherOrder is greater than 2.
See also: TrivTVInterpolateSrfs,
13.2.149  **TrivTVInterpPts** (trinterp.c:77)

```c
TrivTVStruct *TrivTVInterpPts(const TrivTVStruct *PtGrid,
                              int UOrder,
                              int VOrder,
                              int WOrder,
                              int TVUSize,
                              int TVVSize,
                              int TVWSize)
```

**PtGrid:** Input data grid as a trivariate.
**UOrder:** Of the to be created trivariate.
**VOrder:** Of the to be created trivariate.
**WOrder:** Of the to be created trivariate.
**TVUSize:** U size of the to be created trivariate. Must be at least as large as the array PtGrid.
**TVVSize:** V size of the to be created trivariate. Must be at least as large as the array PtGrid.
**TVWSize:** W size of the to be created trivariate. Must be at least as large as the array PtList.

**Returns:** Constructed interpolating/approximating trivariate.

**Description:** Given a set of points, PtList, computes a Bspline trivariate of order UOrder by VOrder by WOrder that interpolates or least square approximates the given set of points. PtGrid is a trivariate whose point data is employed toward the fitting. PtGrid also prescribes the parametric domain of the result. lists. The size of the control mesh of the resulting Bspline trivariate Trivar defaults to the number of points in PtGrid (if TV?Size = 0). However, either numbers can smaller to yield a least square approximation of the gievn data set.

**See also:** TrivInterpTrivar, TrivTVInterpolate,

---

13.2.150  **TrivTVInterpScatPts** (trinterp.c:302)

```c
TrivTVStruct *TrivTVInterpScatPts(const CagdCtlPtStruct *PtList,
                                   int USize,
                                   int VSize,
                                   int WSize,
                                   int UOrder,
                                   int VOrder,
                                   int WOrder,
                                   CagdRType *UKV,
                                   CagdRType *VKV,
                                   CagdRType *WKV)
```

**PtList:** A NULL terminating array of linked list of points.
**USize:** U size of the to be created trivariate.
**VSize:** V size of the to be created trivariate.
**WSize:** W size of the to be created trivariate.
**UOrder:** Of the to be created trivariate.
**VOrder:** Of the to be created trivariate.
**WOrder:** Of the to be created trivariate.
**UKV:** Expected knot vector in U direction, NULL for uniform open.
**VKV:** Expected knot vector in V direction, NULL for uniform open.
**WKV:** Expected knot vector in W direction, NULL for uniform open.

**Returns:** Constructed interpolating/approximating trivariate.

**Description:** Given a set of scattered points, PtList, computes a Bspline trivariate of order UOrder by VOrder by WOrder that interpolates or least squares approximates the given set of scattered points. PtList is a NULL terminated lists of CagdPtStruct structs, with each point holding (u, v, w, x [, y[, z]]). That is, E4 points create an E1 scalar trivariate and E6 points create an E3 trivariate.

**See also:** TrivInterpTrivar, TrivTVInterpPts, TrivTVInterpolate, , BspSrfInterpScatPts,
13.2.151 TrivTVInterpolate (trinterp.c:121)

```c
TrivTVStruct *TrivTVInterpolate(const TrivTVStruct *PtGrid,
int ULength,
int VLength,
int WLength,
int UOrder,
int VOrder,
int WOrder)
```

- **PtGrid**: Input data grid as a trivariate.
- **ULength**: Requested length of control mesh of trivariate in U direction. If zero, length of PtGrid in U is used.
- **VLength**: Requested length of control mesh of trivariate in V direction. If zero, length of PtGrid in V is used.
- **WLength**: Requested length of control mesh of trivariate in W direction. If zero, length of PtGrid in W is used.
- **UOrder**: Requested order of trivariate in U direction. If zero, order of PtGrid in U is used.
- **VOrder**: Requested order of trivariate in V direction. If zero, order of PtGrid in V is used.
- **WOrder**: Requested order of trivariate in W direction. If zero, order of PtGrid in W is used.

**Returns**: Constructed interpolating/approximating trivariate.

**Description**: Given a set of points on a box grid, PtGrid, the expected lengths U/V/WLength and orders U/V/WOrder of the Bspline trivariate, computes the Bspline trivariate’s coefficients that interpolates or least square approximates the given set of points, PtGrid.

See also: TrivInterpTrivar, TrivTVInterpPts, TrivTVInterpScatPts,

13.2.152 TrivTVInterpolateSrfs (trivstrv.c:279)

```c
TrivTVStruct *TrivTVInterpolateSrfs(const CagdSrfStruct *SrfList,
int OtherOrder,
CagdEndConditionType OtherEC,
CagdParametrizationType OtherParam,
IrtRType *OtherParamVals)
```

- **SrfList**: List of surfaces to interpolate a trivariate through.
- **OtherOrder**: Other, third, depth order of trivariate.
- **OtherEC**: End condition in the other, third, trivar direction.
- **OtherParam**: Currently only Chord length and uniform are supported.
- **OtherParamVals**: If not NULL, updated with other direction set parameters of the surfaces in the new trivar.

**Returns**: Constructed trivariate from surfaces.

**Description**: Constructs a trivariate using a set of surfaces. Surfaces are made to be compatible and then the trivariate is fitted to interpolate them. If OtherOrder is less than the number of surfaces, number of surfaces is used. A knot vector is formed with OtherEC end conditions for the other direction.

See also: TrivTVFromSrfs,

13.2.153 TrivTVInterpolateSrfsChordLenParams (trivstrv.c:205)

```c
CagdRType *TrivTVInterpolateSrfsChordLenParams(const CagdSrfStruct *SrfList)
```

- **SrfList**: List of surfaces to consturct a trivariate volume with.

**Returns**: Vectors of parameters normalized to [0, 1] of parameters, of size of number of surfaces, allocated dynamically.

**Description**: Computes parameters to interpolate the given surfaces at, as a trivar. Estimate a middle point from each surface and set parameters based on chord length from each middle point to the next.

See also: TrivTVFromSrfs, CagdSrfInterpolateCrvs, CagdSrfInterpolateCrvs, CagdSrfInterpolateCrvsChordLenParams,
13.2.154 **TrivTVListBBox** (trivaux.c:255)

```c
void TrivTVListBBox(const TrivTVStruct *TVs, CagdBBoxStruct *BBox)
```

**TVs**: To compute a bounding box for.
**BBox**: Where bounding information is to be saved.
**Returns**: void

**Description**: Computes a bounding box for a list of trivariate freeform function.

13.2.155 **TrivTVMatTransform** (trivgen.c:535)

```c
void TrivTVMatTransform(TrivTVStruct *TV, CagdMType Mat)
```

**TV**: Trivariate to transform.
**Mat**: Homogeneous transformation to apply to TV.
**Returns**: void

**Description**: Transforms, in place, the given TV as specified by homogeneous matrix Mat.

13.2.156 **TrivTVMultEval** (triveval.c:1030)

```c
CagdRType *TrivTVMultEval(CagdRType *UKnotVector,
                          CagdRType *VKnotVector,
                          CagdRType *WKnotVector,
                          int ULength,
                          int VLength,
                          int WLength,
                          int UOrder,
                          int VOrder,
                          int WOrder,
                          CagdPType *Mesh,
                          CagdPType *Params,
                          int NumOfParams,
                          int *RetSize,
                          CagdBspBasisFuncMultEvalType EvalType)
```

**UKnotVector**: U Knot sequence defining the spline space in U.
**VKnotVector**: V Knot sequence defining the spline space in V.
**WKnotVector**: W Knot sequence defining the spline space in W.
**ULength**: Length of Mesh in the U direction.
**VLength**: Length of Mesh in the V direction.
**WLength**: Length of Mesh in the W direction.
**UOrder**: Of the spline space in the U Direction.
**VOrder**: Of the spline space in the V Direction.
**WOrder**: Of the spline space in the W Direction.
**Mesh**: ULength * VLength * WLength control points, in R^3.
**Params**: At which to evaluate and compute the volume functions.
**NumOfParams**: Size of Params vector.
**RetSize**: Number of values returned per evaluation. 3 for position 9 for 1st derivative, etc.
**EvalType**: Type of evaluation requested: value (position), 1st derivative.

**Returns**: A vector of size NumOfParams * RetSize, holding the NumOfParams evaluation results, each of size RetSize. For position evaluation, RetSize = 3 and XYZ are returned. For 1st derivatives, RetSize = 9 and the Jacobian is returned, with dX/du, dX/dV, dX/dw first.

**Description**: Computes multiple evaluations of the given trivariate space, as prescribed by U/V/WKnotVectors and U/V/WOrders, U/V/WLengths, and Mesh, at the requested NumOfParams parameter values, Params.

**See also**: 
13.2.157 TrivTVNew (triv_gen.c:45)

TrivTVStruct *TrivTVNew(TrivGeomType GType,
    CagdPointType PType,
    int ULength,
    int VLength,
    int WLength)

GType: Type of geometry the curve should be - Bspline, Bezier etc.
PType: Type of control points (E2, P3, etc.).
ULength: Number of control points in the U direction.
VLength: Number of control points in the V direction.
WLength: Number of control points in the W direction.

Returns: An uninitialized freeform trivariate.

Description: Allocates the memory required for a new trivariate.
See also: TrivBzrTVNew, TrivBspTVNew, TrivPwrTVNew,

13.2.158 TrivTVOfRev (trivtrev.c:47)

TrivTVStruct *TrivTVOfRev(const CagdSrfStruct *Srf)

Srf: To create trivariate of revolution around Z with.

Returns: Trivariate of revolution.

Description: Constructs a trivariate of revolution around the Z axis of given surface. Resulting trivariate will be a B-spline trivariate, while input may be either a B-spline or a Bezier surface.
See also: TrivTVOfRev2, TrivTVOfRevAxis, TrivTVOfRevPolynomialApprox,

13.2.159 TrivTVOfRev2 (trivtrev.c:234)

TrivTVStruct *TrivTVOfRev2(const CagdSrfStruct *Srf,
    CagdBType PolyApprox,
    CagdRType StartAngle,
    CagdRType EndAngle)

Srf: To create trivariate of revolution around Z with.
PolyApprox: TRUE for a polynomial approximation, FALSE for a precise rational construction.
StartAngle: Starting Angle to consider rotating Srf from, in degrees.
EndAngle: Terminating Angle to consider rotating Srf from, in degrees.

Returns: Trivariate of revolution.

Description: Constructs a trivariate of revolution around the Z axis of the given profile surface from StartAngle to EndAngle. Resulting trivariate will be a B-spline surface, while input may be either a B-spline or a Bezier surface.
See also: TrivTVOfRev, TrivTVOfRevAxis, TrivTVOfRevPolynomialApprox,

13.2.160 TrivTVOfRevAxis (trivtrev.c:172)

TrivTVStruct *TrivTVOfRevAxis(const CagdSrfStruct *Srf,
    const TrivVType AxisPoint,
    const TrivVType AxisVector,
    CagdBType PolyApprox)

Srf: To create trivariate of revolution around Axis.
AxisPoint: Of axis of rotation of Srf.
AxisVector: Of axis of rotation of Srf.
PolyApprox: TRUE to construct a polynomial approximation volume of revolution, FALSE to create precise rational volume.

Returns: Trivariate of revolution.

Description: Constructs a trivariate of revolution around vector Axis of given profile surface. Resulting trivariate will be a B-spline trivariate, while input may be either a B-spline or a Bezier surface.
See also: TrivTVOfRev, TrivTVOfRev2, TrivTVOfRevPolynomialApprox,
13.2.161 TrivTVOfRevPolynomialApprox (trivtrev.c:309)

```c
TrivTVStruct *TrivTVOfRevPolynomialApprox(const CagdSrfStruct *Srf)
```

**Srf:** To approximate a trivariate of revolution around \( Z \) with. \( Srf \) is assumed planar in a plane holding the \( Z \) axis.

**Returns:** Trivariate of revolution approximation.

**Description:** Constructs a trivariate of revolution around the \( Z \) axis of given profile surface. Resulting trivariate will be a B-spline trivariate, while input may be either a B-spline or a Bezier surface. Resulting trivariate will be a polynomial B-spline trivariate, approximating a trivariate of revolution using a polynomial circle approx. (See Faux & Pratt “Computational Geometry for Design and Manufacturing”).

**See also:** TrivTVOfRev, TrivTVOfRev2, TrivTVOfRevAxis.

13.2.162 TrivTVOpenEnd (trigen.c:804)

```c
TrivTVStruct *TrivTVOpenEnd(const TrivTVStruct *TV)
```

**TV:** Bspline trivariate to convert to open end conditions.

**Returns:** A Bspline trivariate with open end conditions, representing the same geometry as TV.

**Description:** Converts an arbitrary Bspline trivariate to a Bspline trivariate with open end conditions.

**See also:** TrivCnvrtPeriodic2FloatTV, TrivCnvrtFloat2OpenTV.

13.2.163 TrivTVPointInclusion (trivaux.c:666)

```c
CagdBType TrivTVPointInclusion(TrivTVStruct *TV, const IrtPtType Pt)
```

**TV:** To compute point inclusion for.

**Pt:** Point to test if inside TV or not.

**Returns:** TRUE if inside, FALSE otherwise.

**Description:** Point inclusion test in a trivariate. TrivTVPointInclusionPrep must be called before this function is invoked for a valid result. Optimized for many queries of point inclusions over this TV.

**See also:** TrivTVPointInclusionPrep, TrivTVPointInclusionFree.

13.2.164 TrivTVPointInclusionFree (trivaux.c:698)

```c
void TrivTVPointInclusionFree(TrivTVStruct *TV)
```

**TV:** To free the auxiliary data used for TV point inclusion test.

**Returns:** void

**Description:** Freeing step for testing for point inclusions in a trivariate. Should be called after all TrivTVPointInclusion calls are done.

**See also:** TrivTVPointInclusion, TrivTVPointInclusionPrep.

13.2.165 TrivTVPointInclusionPrep (trivaux.c:616)

```c
void TrivTVPointInclusionPrep(TrivTVStruct *TV, int n)
```

**TV:** To make the necessary steps for point inclusion test.

**n:** Sampling rate. The large this number the better the accuracy (near the boundaries) at the additional computational cost. Roughly the number of samples of the TV in each parametric direction and can vary between 10 to 100.

**Returns:** void

**Description:** Preparation step for testing for point inclusions in a trivariate. Must be called before TrivTVPointInclusion is called. Optimized for many queries of point inclusions over this TV.

**See also:** TrivTVPointInclusion, TrivTVPointInclusionFree,
13.2.166 TrivTVRefineAtParams (triv_ref.c:41)

TrivTVStruct *TrivTVRefineAtParams(const TrivTVStruct *TV,
                        TrivTVDirType Dir,
                        CagdBType Replace,
                        CagdRType *t,
                        int n)

TV: Trivariate to refine according to t in direction Dir.
Dir: Direction of refinement. Either U or V or W.
Replace: If TRUE t is a knot vector exactly in the length of the knot vector in direction Dir in TV and t
simply replaces that knot vector. If FALSE, the knot vector in direction Dir in TV is refined by adding
all the knots in t.
t: Knot vector to refine/replace the knot vector of TV in direction Dir.
n: Length of vector t.

Returns: The refined trivariate. Always a Bspline trivariate.

Description: Given a trivariate, refines it at the given n knots as defined by the vector t. If Replace is TRUE,
the values replace the current knot vector. Returns pointer to refined TV (Note a Bezier trivariate will be converted
into a Bspline trivariate).

13.2.167 TrivTVRegionFromTV (triv_aux.c:154)

TrivTVStruct *TrivTVRegionFromTV(const TrivTVStruct *TV,
                        CagdRType t1,
                        CagdRType t2,
                        TrivTVDirType Dir)

TV: To extract a sub-region from.
t1, t2: Domain to extract from TV, in parametric direction Dir.
Dir: Direction to extract the sub-region. Either U or V or W.

Returns: A sub-region of TV from t1 to t2 in direction Dir.

Description: Given a tri-variate, returns a sub-region of it.

13.2.168 TrivTVReverse2Dirs (triv_aux.c:418)

TrivTVStruct *TrivTVReverse2Dirs(const TrivTVStruct *TV,
                        TrivTVDirType Dir1,
                        TrivTVDirType Dir2)

TV: To construct a reverse TV for.
Dir1, Dir2: The two directions in TV to swap.

Returns: Reversed/swap trivariate.

Description: Reverse/swap the designated two dirs.
See also: TrivTVReverseDir,

13.2.169 TrivTVReverseDir (triv_aux.c:284)

TrivTVStruct *TrivTVReverseDir(const TrivTVStruct *TV, TrivTVDirType Dir)

TV: To construct a reverse TV for.
Dir: The direction in TV to reverse.

Returns: Reversed trivariate.

Description: Reverse the designated direction.
See also: TrivTVReverse2Dirs,
13.2.170 TrivTVSubdivAtParam (triv_sub.c:29)

TrivTVStruct *TrivTVSubdivAtParam(const TrivTVStruct *TV,
                                    CagdRType t,
                                    TrivTVDirType Dir)

TV: Trivariate to subdivide.
t: Parameter to subdivide at.
Dir: Direction of subdivision.

Returns: A list of two trivariates, result of the subdivision.
Description: Given a tri-variate, subdivides it at parameter value t in direction Dir.

13.2.171 TrivTVTransform (triv_gen.c:503)

void TrivTVTransform(TrivTVStruct *TV, CagdRType *Translate, CagdRType Scale)

TV: Trivariate to transform.
Translate: Translation factor. Can be NULL for non.
Scale: Scaling factor.

Returns: void
Description: Linearly transforms, in place, given TV as specified by Translate and Scale.

13.2.172 TrivTVVolume (triv_aux.c:577)

CagdRType TrivTVVolume(const TrivTVStruct *TV, CagdBType VolType)

TV: To compute its volume.
VolType: TRUE to integrate the surfaces with respect to the XY plane, FALSE to integrate the surfaces
with respect to the origin.

Returns: The computed volume (can be negative if TV reversed).
Description: Computes the volume enclosed in the given trivariate.

13.2.173 TrivTVsSame (triv_gen.c:893)

CagdBType TrivTVsSame(const TrivTVStruct *Tv1,
                       const TrivTVStruct *Tv2,
                       CagdRType Eps)

Tv1, Tv2: The two trivariates to compare.
Eps: Tolerance of equality.

Returns: TRUE if trivariates are the same, FALSE otherwise.
Description: Compare the two trivariates for similarity.
See also: CagdSrfsSame, CagdCrvsSame, MvarMVsSame,

13.2.174 TrivTriangleCopy (triv_gen.c:397)

TrivTriangleStruct *TrivTriangleCopy(const TrivTriangleStruct *Triangle)

Triangle: Triangle to duplicate.

Returns: Duplicated triangle.
Description: Allocates and duplicates all slots of a triangle structure.
13.2.175  **TrivTriangleCopyList** (triv_gen.c:425)

TrivTriangleStruct *TrivTriangleCopyList(const TrivTriangleStruct *TriangleList)

**TriangleList:** List of triangle to duplicate.

**Returns:** Duplicated list of triangle.

**Description:** Duplicates a list of triangle structures.

13.2.176  **TrivTriangleFree** (triv_gen.c:454)

void TrivTriangleFree(TrivTriangleStruct *Triangle)

**Triangle:** Triangle to free.

**Returns:** void

**Description:** Deallocates and frees all slots of a triangle structure.

13.2.177  **TrivTriangleFreeList** (triv_gen.c:476)

void TrivTriangleFreeList(TrivTriangleStruct *TriangleList)

**TriangleList:** Triangle list to free.

**Returns:** void

**Description:** Deallocates and frees a list of triangle structures.

13.2.178  **TrivTriangleNew** (triv_gen.c:373)

TrivTriangleStruct *TrivTriangleNew(void)

**Returns:** An uninitialized triangle.

**Description:** Allocates the memory required for a new triangle.

13.2.179  **TrivTrilinearSrf** (trivruld.c:138)

TrivTVStruct *TrivTrilinearSrf(const CagdPtStruct *Pt000, const CagdPtStruct *Pt001, const CagdPtStruct *Pt010, const CagdPtStruct *Pt011, const CagdPtStruct *Pt100, const CagdPtStruct *Pt101, const CagdPtStruct *Pt110, const CagdPtStruct *Pt111)

**Pt000, Pt001, Pt010, Pt011, Pt100, Pt101, Pt110, Pt111:** The eight corners of the trilinear.

**Returns:** Constructed trilinear.

**Description:** Constructs a trilinear volume between the given eight corner points.

**See also:** CagdBilinearSrf,
13.2.180 TrivTwoTVsMorphing (trivmrph.c:36)

TrivTVStruct *TrivTwoTVsMorphing(const TrivTVStruct *TV1, 
    const TrivTVStruct *TV2, 
    CagdRType Blend)

TV1, TV2: The two trivariates to blend.
Blend: A parameter between zero and one
Returns: TV2 * Blend + TV1 * (1 - Blend).

Description: Given two compatible trivariates (See function TrivMakeTVsCompatible), computes a convex blend between them according to Blend which must be between zero and one. Returned is the new blended trivariate.
See also: SymbTwoCrvsMorphing, SymbTwoCrvsMorphingCornerCut, , SymbTwoCrvsMorphingMultiRes, SymbTwoSrfsMorphing, TrivMakeTVsCompatible,

13.2.181 TrivVectCross3Vecs (geomat4d.c:180)

void TrivVectCross3Vecs(const TrivVType A, 
    const TrivVType B, 
    const TrivVType C, 
    TrivVType Res)

A, B, C: The three vectors to compute their cross product.
Res: Where the output goes into.
Returns: void

Description: Computes a vector in R^4 that is perpendicular to the given three vectors.

with(linalg);
readlib(C);

d := det( matrix( [ I, J, K, L], 
    [B[0], B[1], B[2], B[3]], 
    [C[0], C[1], C[2], C[3]] ] ) );
coeff( d, I );
coeff( d, J );
coeff( d, K );
coeff( d, L );

13.2.182 TrivZTwistExtrudeSrf (trivextr.c:138)

TrivTVStruct *TrivZTwistExtrudeSrf(const CagdSrfStruct *Srf, 
    CagdBType Rational, 
    CagdRType ZPitch)

Srf: To twist and extrude in the +Z direction.
Rational: TRUE to construct a rational (and precise) twist, FALSE to approximate using polynomials.
ZPitch: The +Z amount for full 360 degrees. If zero, the result will be a planar (degenerated) surface. A negative value will reverse the twist.
Returns: A twisted extrusion trivariate.

Description: Constructs a full circular twisted/rotated extrusion volume in the +Z direction for the given profile surface. Input surface can be either a Bspline or a Bezier surface.
See also: TrivExtrudeSrf,
Chapter 14
Triangular Library, trng_lib

14.1 General Information
This library provides a subset of functions to manipulate freeform triangular Bezier and Bspline patches. This library heavily depends on the cagd library. Functions are provided to create, copy, and destruct triangular patches, to extract isoparametric curves, to evaluate, refine and subdivide, to read and write triangular patches, to differentiate, and approximate using polygonal representations.

A triangular patch has one prescription of Length and one prescription of Order, the total Order and the length of an edge of the triangle. The control mesh mesh has Length * (Length + 1) / 2 control points,

typedef struct TrngTriangSrfStruct {
    struct TrngTriangSrfStruct *Pnext;
    struct IPAttributeStruct *Attr;
    TrngGeomType GType;
    CagdPointType FType;
    int Length; /* Mesh size (length of edge of triangular mesh. */
    int Order; /* Order of triangular surface (Bspline only). */
    CagdRType *Points[CAGD_MAX_PT_SIZE]; /* Pointer on each axis vector. */
    CagdRType *KnotVector;
} TrngTriangSrfStruct;

The interface of the library is defined in include/trng_lib.h.
This library has its own error handler, which by default prints an error message and exit the program called TrngFatalError.
All globals in this library have a prefix of Trng.

14.2 Library Functions

14.2.1 TrngBspTriSrfDerive (trng_der.c:165)

TrngTriangSrfStruct *TrngBspTriSrfDerive(const TrngTriangSrfStruct *TriSrf,
TrngTriSrfDirType Dir)

TriSrf: Triangular Surface to differentiate.
Dir: Direction of differentiation. Either U or V or W.
Returns: Differentiated triangular surface in direction Dir. A Bspline triangular surface.
Description: Given a Bspline triangular surface, computes its partial derivative triangular surface in direction Dir.

14.2.2 TrngBspTriSrfHasOpenEC (trng_aux.c:189)

CagdBType TrngBspTriSrfHasOpenEC(const TrngTriangSrfStruct *TriSrf)

TriSrf: To check for open end conditions.
Returns: TRUE, if given Bspline triangular surface has open end conditions, FALSE otherwise.
Description: Returns TRUE iff the given triangular Bspline surface has open end conditions.
14.2.3 TrngBspTriSrfNew (trng_gen.c:75)

TrngTriangSrfStruct *TrngBspTriSrfNew(int Length, int Order, CagdPointType PType)

**Length:** Number of control points along the edge of the triangle.
**Order:** Order of triangular surface in all U,V,W directions.
**PType:** Type of control points (E2, P3, etc.).
**Returns:** An uninitialized freeform triangular surface Bspline.
**Description:** Allocates the memory required for a new Bspline triangular surface.

14.2.4 TrngBspTriSrfOpenEnd (trng_aux.c:209)

TrngTriangSrfStruct *TrngBspTriSrfOpenEnd(const TrngTriangSrfStruct *TriSrf)

**TriSrf:** To check for open end conditions.
**Returns:** A triangular Bspline surface with open end cond.
**Description:** Returns TRUE iff the given triangular Bspline surface has open end conditions.

14.2.5 TrngBzrTriSrfDerive (trng_der.c:67)

TrngTriangSrfStruct *TrngBzrTriSrfDerive(const TrngTriangSrfStruct *TriSrf, TrngTriSrfDirType Dir)

**TriSrf:** Triangular Surface to differentiate.
**Dir:** Direction of differentiation. Either U or V or W.
**Returns:** Differentiated triangular surface in direction Dir. A Bezier triangular surface.
**Description:** Given a Bezier triangular surface, computes its principal derivative in direction Dir.
**See also:** TrngBzrTriSrfDerive,

14.2.6 TrngBzrTriSrfDirecDerive (trng_der.c:115)

TrngTriangSrfStruct *TrngBzrTriSrfDirecDerive(const TrngTriangSrfStruct *TriSrf, CagdVType DirecDeriv)

**TriSrf:** Triangular Surface to differentiate.
**DirecDeriv:** Derivative direction vector (coefficients must sum to zero!).
**Returns:** Differentiated triangular surface in direction Dir. A Bezier triangular surface.
**Description:** Given a Bezier triangular surface, computes its directional derivative in parametric direction DirectionalDeriv.
**See also:** TrngBzrTriSrfDerive,

14.2.7 TrngBzrTriSrfNew (trng_gen.c:108)

TrngTriangSrfStruct *TrngBzrTriSrfNew(int Length, CagdPointType PType)

**Length:** Number of control points along the edge of the triangle.
**PType:** Type of control points (E2, P3, etc.).
**Returns:** An uninitialized freeform triangular surface Bezier.
**Description:** Allocates the memory required for a new Bezier triangular surface.
14.2.8  **TrngCnvrtBzr2BspTriSrf** (trng_gen.c:364)

TrngTriangSrfStruct *TrngCnvrtBzr2BspTriSrf(const TrngTriangSrfStruct *TriSrf)

**TriSrf:** A Bezier triangular surface to convert to a Bspline TriSrf.

**Returns:** A Bspline triangular surface representing the same geometry as the given Bezier TriSrf.

**Description:** Converts a Bezier triangular surface into a Bspline triangular surface by adding open end uniform knot vector to it.

14.2.9  **TrngCnvrtGregory2BzrTriSrf** (trng_grg.c:31)

TrngTriangSrfStruct *TrngCnvrtGregory2BzrTriSrf(TrngTriangSrfStruct *TriSrf)

**TriSrf:** A Gregory triangular surface to convert to a Bezier TriSrf.

**Returns:** A Bezier triangular surface representing the same geometry as the given Gregory TriSrf.

**Description:** Converts a Gregory triangular surface into a rational Bezier triangular surface.

14.2.10  **TrngCoerceTriSrfTo** (trngcoer.c:55)

TrngTriangSrfStruct *TrngCoerceTriSrfTo(const TrngTriangSrfStruct *CTriSrf, CagdPointType PType)

**CTriSrf:** To coerce to a new point type PType.

**PType:** New point type for TriSrf.

**Returns:** A new trngariate with PType as its point type.

**Description:** Coerces a triangular surface to point type PType.

14.2.11  **TrngCoerceTriSrfsTo** (trngcoer.c:27)

TrngTriangSrfStruct *TrngCoerceTriSrfsTo(const TrngTriangSrfStruct *TriSrf, CagdPointType PType)

**TriSrf:** To coerce to a new point type PType.

**PType:** New point type for TriSrf.

**Returns:** New triangular surfaces with PType as their point type.

**Description:** Coerces a list of triangular surfaces to point type PType.

14.2.12  **TrngCrvFromTriSrf** (trng_iso.c:300)

CagdCrvStruct *TrngCrvFromTriSrf(const TrngTriangSrfStruct *TriSrf, CagdRType t, TrngTriSrfDirType Dir)

**TriSrf:** To extract an isoparametric curve from.

**t:** Parameter value of extracted isoparametric curve.

**Dir:** Direction of extracted isocurve. Either U or V or W.

**Returns:** An isoparametric curve of TriSrf. This curve inherit the order and continuity of TriSrf in direction Dir.

**Description:** Extracts an isoparametric curve from the triangular surface TriSrf in direction Dir at the parameter value of t.

**See also:** BzrSrfCrvFromSrf, BspSrfCrvFromSrf, CagdCrvFromMesh, BzrSrfCrvFromMesh, , BspSrfCrvFromMesh, CagdCrvFromSrf, TrngTriBzrSrf2Curves,
14.2.13  **TrngDbg** (trng_dbg.c:26)

```c
void TrngDbg(void *Obj)
```

**Obj**: A triangular surface - to be printed to stderr.

**Returns**: void

**Description**: Prints triangular surface to stderr. Should be linked to programs for debugging purposes, so triangular surfaces may be inspected from a debugger.

14.2.14  **TrngDescribeError** (trng_err.c:45)

```c
const char *TrngDescribeError(TrngFatalErrorType ErrorNum)
```

**ErrorNum**: Type of the error that was raised.

**Returns**: A string describing the error type.

**Description**: Returns a string describing the given error. Errors can be raised by any member of this trng library as well as other users. Raised error will cause an invocation of TrngFatalError function which decides how to handle this error. TrngFatalError can for example, invoke this routine with the error type, print the appropriate message and quit the program.

14.2.15  **TrngFatalError** (trng_ftl.c:53)

```c
void TrngFatalError(TrngFatalErrorType ErrID)
```

**ErrID**: Error type that was raised.

**Returns**: void

**Description**: Trap Trng_lib errors right here. Provides a default error handler for the trng library. Gets an error description using TrngDescribeError, prints it and exit the program using exit.

14.2.16  **TrngGregory2Bezier4** (trng_grg.c:71)

```c
void TrngGregory2Bezier4(CagdRType **Qt, CagdRType **Pt)
```

**Qt**: The resulting Bezier control points

**Pt**: The Gregory control points

**Returns**: void

**Description**: Converts a Gregory triangular surface into a Bezier triangular surface

14.2.17  **TrngGregory2Bezier5** (trng_grg.c:234)

```c
void TrngGregory2Bezier5(CagdRType **Qt, CagdRType **Pt)
```

**Qt**: The resulting Bezier control points

**Pt**: The Gregory control points

**Returns**: void

**Description**: Converts a Gregory triangular surface into a Bezier triangular surface
14.2.18  **TrngGregory2Bezier6** (trng.grg.c:422)

    void TrngGregory2Bezier6(CagdRType **Qt, CagdRType **Pt)
    
    Qt: The resulting Bezier control points
    Pt: The Gregory control points
    
    Returns: void
    
    Description: Converts a Gregory triangular surface into a Bezier triangular surface

14.2.19  **TrngGrgTriSrfNew** (trng.gen.c:135)

    TrngTriangSrfStruct *TrngGrgTriSrfNew(int Length, CagdPointType PType)
    
    Length: Number of control points along the edge of the triangle.
    PType: Type of control points (E2, P3, etc.).
    
    Returns: An uninitialized freeform triangular surface Gregory.
    
    Description: Allocates the memory required for a new Gregory triangular surface.

14.2.20  **TrngParamInDomain** (trng.aux.c:81)

    CagdBType TrngParamInDomain(TrngTriangSrfStruct *TriSrf, CagdRType t, TrngTriSrfDirType Dir)
    
    TriSrf: To make sure t is in its Dir domain.
    t: Parameter value to verify.
    Dir: Direction. Either U or V or W.
    
    Returns: TRUE if in domain, FALSE otherwise.
    
    Description: Given a triangular surface and a domain - validate it.

14.2.21  **TrngParamsInDomain** (trng.aux.c:117)

    CagdBType TrngParamsInDomain(const TrngTriangSrfStruct *TriSrf, CagdRType u, CagdRType v, CagdRType w)
    
    TriSrf: To make sure (u, v, w) is in its domain.
    u, v, w: To verify if it is in TriSrf's parametric domain.
    
    Returns: TRUE if in domain, FALSE otherwise.
    
    Description: Given a triangular surface and a domain - validate it.

14.2.22  **TrngSetFatalErrorFunc** (trng.ftl.c:28)

    TrngSetErrorFuncType TrngSetFatalErrorFunc(TrngSetErrorFuncType ErrorFunc)
    
    ErrorFunc: New error function to use.
    
    Returns: Old error function reference.
    
    Description: Sets the error function to be used by Trng.lib.
14.2.23 TrngSrfSubdivAtParam (trng_sub.c:33)

TrngTriangSrfStruct *TrngSrfSubdivAtParam(TrngTriangSrfStruct *TrngSrf,
CagdRType t,
CagdSrfDirType Dir)

TrngSrf: To subdivide at the prescribed parameter value t.
t: The parameter to subdivide the curve Crv at.
Dir: Direction of subdivision. Either U or V.

Returns: The subdivided surfaces. Usually two, but can have only one, if other is totally trimmed away.

Description: Given a triangulare surface - subdivides it into two three sub-surfaces at given parametric values u, v, w. Returns pointer to a list of two trngmed surfaces, at most. It can very well may happen that the subdivided surface is completely trimmed out and hence nothing is returned for it.

14.2.24 TrngTriBzrSrf2Curves (trng_iso.c:169)

CagdCrvStruct *TrngTriBzrSrf2Curves(const TrngTriangSrfStruct *TriSrf,
int NumOfIsocurves[3],
IrtRType Val)

TriSrf: To extract isoparametric curves from.
NumOfIsocurves: In each (U or V or W) direction.
Val: If only one isocurve to extract - do so at value Val.

Returns: List of extracted isoparametric curves. These curves inherit the order and continuity of the original Srf. NULL is returned in case of an error.

Description: Routine to extract from a triangular surface NumOfIsoline isocurve list in each param. direction. Iso parametric curves are sampled equally spaced in parametric space. If, however, oout of the three NumOfIsocurves values, two are zero and one NumOfIsocurves values equals to one, extract one isocurve at that direction, at value Val. NULL is returned in case of an error, otherwise list of CagdCrvStruct.

Consider isoparametric curve of Bezier triangular surface at fixed u = u0:

\[
\begin{array}{c}
\sum_{i=1}^{n} \sum_{j=1}^{n-i} \left( \frac{n!}{i!j!(n-i-j)!} \right) b = \\
\left( \frac{u_0}{1-u_0} \right) \left( \frac{v}{1-v} \right) \left( \frac{1-u_0}{1-v} \right)
\end{array}
\]

Hence, the isoparametric curve of u = u0 is a weighted sum of a sequence of Bezier curves of degree 1 to n-1, each defined over a row of the triangular mesh, over the domain of v = [0, 1-u0].

See also: TrngTriSrf2Curves, TrngCrvFromTriSrf,

14.2.25 TrngTriSrf2CtrlMesh (trngmesh.c:25)

CagdPolylineStruct *TrngTriSrf2CtrlMesh(const TrngTriangSrfStruct *TriSrf)

TriSrf: To compute a polyline representation for its control mesh.

Returns: A polyline representing TriSrf's control mesh.

Description: Computes a polyline representation to the control mesh of the triangular surface
14.2.26  TrngTriSrf2Curves (trng_iso.c:348)

CagdCrvStruct *TrngTriSrf2Curves(const TrngTriangSrfStruct *TriSrf,
int NumOfIsocurves[3])

TriSrf: To extract isoparametric curves from.
NumOfIsocurves: In each (U or V or W) direction.
Returns: List of extracted isoparametric curves. These curves inherit the order and continuity of the original Srf. NULL is returned in case of an error.

Description: Routine to extract from a triangular surface NumOfIsoline isocurve list in each param. direction. Iso parametric curves are sampled equally spaced in parametric space. NULL is returned in case of an error, otherwise list of CagdCrvStruct.
See also: TrngTriBzrSrf2Curves, TrngCrvFromTriSrf,

14.2.27  TrngTriSrf2Polygons (trng2ply.c:40)

CagdPolygonStruct *TrngTriSrf2Polygons(const TrngTriangSrfStruct *TriSrf,
int FineNess,
CagdBType ComputeNormals,
CagdBType ComputeUV)

TriSrf: To approximate into triangles.
FineNess: Control on accuracy, the higher the finer.
ComputeNormals: If TRUE, normal information is also computed.
ComputeUV: If TRUE, UV values are stored and returned as well.
Returns: A list of polygons with optional normal and/or UV parametric information. NULL is returned in case of an error.

Description: Routine to convert a single triangular surface to a set of triangles approximating it. FineNess is a fineness control on result and the larger it is more triangles may result. A value of 10 is a good starting value. NULL is returned in case of an error, otherwise list of CagdPolygonStruct.

14.2.28  TrngTriSrf2Polylines (trng_iso.c:44)

CagdPolylineStruct *TrngTriSrf2Polylines(const TrngTriangSrfStruct *TriSrf,
int NumOfIsocurves[3],
CagdRType TolSamples,
SymbCrvApproxMethodType Method)

TriSrf: To extract isoparametric curves from.
NumOfIsocurves: In each (U or V or W) direction.
TolSamples: Tolerance of approximation error (Method = 2) or Number of samples to compute on polyline (Method = 0, 1).
Method: 0 - TolSamples are set uniformly in parametric space, 1 - TolSamples are set optimally, considering the isocurve’s curvature. 2 - TolSamples sets the maximum error allowed between the piecewise linear approximation and original curve.
Returns: List of polylines representing a piecewise linear approximation of the extracted isoparametric curves or NULL is case of an error.

Description: Routine to convert a single triangular surface to NumOfIsolines polylines in each parametric direction with SamplesPerCurve in each isoparametric curve. Polyline are always E3 of CagdPolylineStruct type. Iso parametric curves are sampled equally spaced in parametric space. NULL is returned in case of an error, otherwise list of CagdPolylineStruct. Attempt is made to extract isolines along C1 discontinuities first.
14.2.29 TrngTriSrfBBox (trng_aux.c:142)

void TrngTriSrfBBox(const TrngTriangSrfStruct *TriSrf, CagdBBoxStruct *BBox)

TriSrf: To compute a bounding box for.
BBox: Where bounding information is to be saved.
Returns: void
Description: Computes a bounding box for a triangular surfaces.

14.2.30 TrngTriSrfCopy (trng_gen.c:160)

TrngTriangSrfStruct *TrngTriSrfCopy(const TrngTriangSrfStruct *TriSrf)

TriSrf: triangular surface to duplicate
Returns: Duplicated triangular surface.
Description: Allocates and duplicates all slots of a triangular surface structure.

14.2.31 TrngTriSrfCopyList (trng_gen.c:208)

TrngTriangSrfStruct *TrngTriSrfCopyList(const TrngTriangSrfStruct *TriSrfList)

TriSrfList: List of triangular surfaces to duplicate.
Returns: Duplicated list of triangular surfaces.
Description: Duplicates a list of triangular surface structures.

14.2.32 TrngTriSrfDerive (trng_der.c:31)

TrngTriangSrfStruct *TrngTriSrfDerive(const TrngTriangSrfStruct *TriSrf,
                                       TrngTriSrfDirType Dir)

TriSrf: Triangular Surface to differentiate.
Dir: Direction of differentiation. Either U or V or W.
Returns: Differentiated triangular surface in direction Dir.
Description: Given a triangular surface, computes its partial derivative triangular surface in direction Dir.

14.2.33 TrngTriSrfDomain (trng_aux.c:33)

void TrngTriSrfDomain(const TrngTriangSrfStruct *TriSrf,
                       CagdRType *UMin,
                       CagdRType *UMax,
                       CagdRType *VMin,
                       CagdRType *VMax,
                       CagdRType *WMin,
                       CagdRType *WMax)

TriSrf: Triangular surface function to consider.
UMin, UMax: U Domain of TriSrf will be placed herein.
VMin, VMax: V Domain of TriSrf will be placed herein.
WMin, WMax: W Domain of TriSrf will be placed herein.
Returns: void
Description: Given a triangular surface, returns its parametric domain.
14.2.34 TrngTriSrfEval (trngeval.c:74)

CagdRType *TrngTriSrfEval(const TrngTriangSrfStruct *TriSrf, 
CagdRType u, 
CagdRType v, 
CagdRType w)

**TriSrf**: To evaluate at given (u, v, w) parametric location.

**u, v, w**: Parametric location to evaluate TriSrf at.

**Returns**: A vector holding all the coefficients of all components of the triangular surface's point type. If for example point type is P2, the W, X, and Y will be saved in the first three locations of the returned vector. The first location (index 0) of the returned vector is reserved for the rational coefficient W and XYZ always starts at second location of the returned vector (index 1).

**Description**: Evaluates the given triangular surface at a given point.

14.2.35 TrngTriSrfEval2 (trngeval.c:137)

CagdRType *TrngTriSrfEval2(const TrngTriangSrfStruct *TriSrf, 
CagdRType u, 
CagdRType v)

**TriSrf**: To evaluate at given (u, v) parametric location.

**u, v**: Parametric location to evaluate TriSrf at.

**Returns**: A vector holding all the coefficients of all components of the triangular surface's point type. If for example point type is P2, the W, X, and Y will be saved in the first three locations of the returned vector. The first location (index 0) of the returned vector is reserved for the rational coefficient W and XYZ always starts at second location of the returned vector (index 1).

**Description**: Evaluates the given triangular surface at a given point. Same as function TrngTriSrfEval with w computed using 'w = 1 - u - v' for Bezier triangular surfaces.

14.2.36 TrngTriSrfFree (trng_gen.c:237)

void TrngTriSrfFree(TrngTriangSrfStruct *TriSrf)

**TriSrf**: triangular surface to free.

**Returns**: void

**Description**: Deallocates and frees all slots of a triangular surface structure.

14.2.37 TrngTriSrfFreeList (trng_gen.c:269)

void TrngTriSrfFreeList(TrngTriangSrfStruct *TriSrfList)

**TriSrfList**: triangular surface list to free.

**Returns**: void

**Description**: Deallocates and frees a list of triangular surface structures.

14.2.38 TrngTriSrfListBBox (trng_aux.c:162)

void TrngTriSrfListBBox(const TrngTriangSrfStruct *TriSrf, CagdBBoxStruct *BBox)

**TriSrf**: To compute a bounding box for.

**BBox**: Where bounding information is to be saved.

**Returns**: void

**Description**: Computes a bounding box for a list of triangular surfaces.
14.2.39  **TrngTriSrfMatTransform** (trng_gen.c:331)

void TrngTriSrfMatTransform(TrngTriangSrfStruct *TriSrf, CagdMType Mat)

- **TriSrf**: Triangular surface to transform.
- **Mat**: Homogeneous transformation to apply to TriSrf.
- **Returns**: void
- **Description**: Transforms, in place, the given TV as specified by homogeneous matrix Mat.

14.2.40  **TrngTriSrfNew** (trng_gen.c:31)

TrngTriangSrfStruct *TrngTriSrfNew(TrngGeomType GType, CagdPointType PType, int Length)

- **GType**: Type of geometry the curve should be - Bspline, Bezier etc.
- **PType**: Type of control points (E2, P3, etc.).
- **Length**: Number of control points along the edge of the triangle.
- **Returns**: An uninitialized freeform triangular surface.
- **Description**: Allocates the memory required for a new triangular surface.

14.2.41  **TrngTriSrfNrml** (trngeval.c:170)

CagdVecStruct *TrngTriSrfNrml(const TrngTriangSrfStruct *TriSrf, CagdRType u, CagdRType v)

- **TriSrf**: To evaluate at given (u, v, w) parametric location.
- **u, v**: Parametric location to evaluate normal of TriSrf at.
- **Returns**: A pointer to a static vector holding the unit normal information.
- **Description**: Evaluates the normal of the given triangular surface at a given point.
- **See also**: CagdSrfNormal, BzrSrfNormal, BspSrfNormal, SymbSrfNormalSrfs,

14.2.42  **TrngTriSrfTransform** (trng_gen.c:298)

void TrngTriSrfTransform(TrngTriangSrfStruct *TriSrf, CagdRType *Translate, CagdRType Scale)

- **TriSrf**: Triangular surface to transform.
- **Translate**: Translation factor.
- **Scale**: Scaling factor.
- **Returns**: void
- **Description**: Linearly transforms, in place, given TriSrf as specified by Translate and Scale.

14.2.43  **TrngTriSrfsSame** (trng_gen.c:401)

CagdBType TrngTriSrfsSame(const TrngTriangSrfStruct *Srf1, const TrngTriangSrfStruct *Srf2, CagdRType Eps)

- **Srf1, Srf2**: The two surfaces to compare.
- **Eps**: Tolerance of equality.
- **Returns**: TRUE if surfaces are the same, FALSE otherwise.
- **Description**: Compare the two surfaces for similarity.
- **See also**: CagdSrfsSame,
Chapter 15

User Library, user_lib

15.1 General Information

This library includes user interface related geometrical functions such as ray surface intersection (for mouse click/select operations), etc.

The interface of the library is defined in include/user_lib.h.

15.2 Library Functions

15.2.1 IntrSrfHierarchyFreePreprocess (srfpgeom.c:221)

```c
void IntrSrfHierarchyFreePreprocess(VoidPtr Handle)
```

**Handle:** As returned by IntrSrfHierarchyPreprocessSrf to release.

**Returns:** void

**Description:** Releases the pre processed data structed created by the function IntrSrfHierarchyPreprocessSrf.

See also: IntrSrfHierarchyPreprocessSrf, IntrSrfHierarchyTestRay, IntrSrfHierarchyTestPt,

15.2.2 IntrSrfHierarchyPreprocessSrf (srfpgeom.c:82)

```c
VoidPtr IntrSrfHierarchyPreprocessSrf(const CagdSrfStruct *Srf,
                                       IrtRType FineNess)
```

**Srf:** To preprocess.

**FineNess:** Control on accuracy, the higher the finer. The surface will be subdivided into approximately FineNess regions in each of the two parametric directions.

**Returns:** A handle on the preprocessed data, NULL if error.

**Description:** Preprocess a surface for fast computation of ray-surface intersection. Returns NULL if fails, otherwise a pointer to preprocessed data structure. The preprocessed data is in fact a hierarchy of bounding boxes extracted while the surface is being polygonized.

See also: IntrSrfHierarchyFreePreprocess, IntrSrfHierarchyTestRay, IntrSrfHierarchyTestPt,

15.2.3 IntrSrfHierarchyTestPt (srfpgeom.c:444)

```c
CagdBType IntrSrfHierarchyTestPt(VoidPtr Handle,
                                 CagdPType Pt,
                                 CagdBType Nearest,
                                 CagdUVType InterUV)
```

**Handle:** As returned by IntrSrfHierarchyPreprocessSrf.
Pt: To look for nearest/farthest location on the surface.
Nearest: TRUE for nearest, FALSE for farthest.
InterUV: The UV surface coordinates of the nearest/farthest surface location is saved here.
Returns: TRUE if found min/max distance, FALSE otherwise.

Description: Computes the nearest/farthest location on the surface from point Pt.
See also: IntrSrfHierarchyPreprocessSrf, IntrSrfHierarchyFreePreprocess, IntrSrfHierarchyTestRay,

15.2.4 IntrSrfHierarchyTestRay (srfgeom.c:260)

CagdBType IntrSrfHierarchyTestRay(VoidPtr Handle,
CagdPType RayOrigin,
CagdVType RayDir,
CagdUVType InterUV)

Handle: As returned by IntrSrfHierarchyPreprocessSrf.
RayOrigin: Starting point of ray.
RayDir: Direction of ray.
InterUV: The UV surface coordinates of the first ray surface intersection location is saved here.
Returns: TRUE if found intersection, FALSE otherwise.

Description: Computes the first intersection of a given ray with the given surface, if any. If TRUE is returned, the InterUV is updated to the intersection.
See also: IntrSrfHierarchyFreePreprocess, IntrSrfHierarchyPreprocessSrf, IntrSrfHierarchyTestPt,

15.2.5 IrtImgScaleImage (scalimag.c:49)

IrtImgPixelStruct *IrtImgScaleImage(IrtImgPixelStruct *InImage,
int InMaxX,
int InMaxY,
inAlpha,
outMaxX,
outMaxY,
Order)

InImage: A vector of RGBRGB... of size (MaxX+1) * (MaxY+1) * 3 or NULL if failed. If however, Alpha is available we have RGBARGBA and InImage is actually IrtImgRGBAPxlStruct.
InMaxX: Maximum X of input image.
InMaxY: Maximum Y of input image.
InAlpha: If TRUE, we have alpha as well and InImage is actually IrtImgRGBAPxlStruct.
OutMaxX: Maximum X of output image.
OutMaxY: Maximum Y of output image.
Order: Of the spline filer. 2 for a bilinear and the higher the Order is the smoother the result will be.
Returns: The scaled image as vector of RGBRGB (or RGBARGBA).

Description: Scale an image by mapping it to a bivariate spline and resampling.
See also: IrtImgReadImage,

15.2.6 User2PolyMeshRoundEdge (plyround.c:384)

int User2PolyMeshRoundEdge(IPPolygonStruct *P11,
IPPolygonStruct *P12,
const IPPolygonStruct *Edge12,
IrtRType RoundRadius,
IrtRType RoundShape)

P11, P12: The two input meshes sharing edge Edge12 to round along, in place.
**Edge12:** The common edge(s) to round along. Can be a list of edges to round around all of them.

**RoundRadius:** The desired radius of the approximated blend.

**RoundShape:** Bias to affect the rounding size. 1.0 to have no affect, and values larger (smaller) than 1.0 to enlarge (shrink) the rounding size.

**Returns:** TRUE if successful, FALSE otherwise.

**Description:** Given two meshes, Pl1 and Pl2, sharing common boundary edge(s), Edge12, updated Pl1 and Pl2 in place and round them along Edge12.

See also: GMPolyMeshSmoothing,

15.2.7 **User3DDither2Images** (dtr3d2im.c:1459)

```c
IPObjectStruct *User3DDither2Images(const char *Image1Name,
                      const char *Image2Name,
                      int DitherSize,
                      int MatchWidth,
                      int Negate,
                      int AugmentContrast,
                      User3DSpreadType SpreadMethod,
                      IrtRType SphereRad,
                      IrtRType *AccumPenalty)
```

**Image1Name:** Name of 1st image to load.

**Image2Name:** Name of 2nd image to load.

**DitherSize:** 1, 2, 3 or 4 for (1x1), (2x2), (3x3) or (4x4) dithering.

**MatchWidth:** Width to allow matching in a row: between pos[i] to pos[i +/- k], k < MatchWidth.

**Negate:** TRUE to negate the images.

**AugmentContrast:** Number of iterations to add micro-pixels, to augment the contrast, behind existing pixels. Zero to disable.

**SpreadMethod:** If allowed (MatchWidth >= RowSize), selects initial random spread to use.

**SphereRad:** Radius of construct spherical blob, zero to return points.

**AccumPenalty:** Returns the accumulated error in the dithering-matching, where zero designates no error.

**Returns:** Micro blobs if SphereRad > 0, center points, if = 0.

**Description:** Build a 3D models consisting of spherical blobs that looks like the 1st image (gray level) from the XZ plane and like the 2nd image from the YZ plane. The entire constructed geometry is confined to a cube world space of \(\max(ImageWidth, ImageHeight)\)^3.

See also: User3DDither3Images,

15.2.8 **User3DDither3Images** (dtr3d3im.c:372)

```c
IPObjectStruct *User3DDither3Images(const char *Image1Name,
                      const char *Image2Name,
                      const char *Image3Name,
                      int DitherSize,
                      int MatchWidth,
                      int Negate,
                      int AugmentContrast,
                      User3DSpreadType SpreadMethod,
                      IrtRType SphereRad,
                      IrtRType *AccumPenalty)
```

**Image1Name:** Name of 1st image to load.

**Image2Name:** Name of 2nd image to load.

**Image3Name:** Name of 3rd image to load. Optional and can be NULL or a zero length string.

**DitherSize:** Dithering matrix size to use: 2, 3, or 4.

**MatchWidth:** Width to allow matching in a row: between pos[i] to pos[i +/- k], k < MatchWidth.

**Negate:** TRUE to negate the images.
**AugmentContrast**: Redundancy level for the micro-pixels, to augment the contrast, behind existing pixels. Zero to disable.

**SpreadMethod**: Selects initial spread to use: Random, Diagonal, etc.

**SphereRad**: Radius of construct spherical blob, zero to return points.

**AccumPenalty**: Returns the accumulated error in the dithering-matching, where zero designates no error. In level of achieved covering.

**Returns**: Center points, in \([\text{ImageWidth}]^3\) space.

**Description**: Build a 3D models consisting of points/spherical blobs that looks like the 1st image (gray level) from the XZ plane, like the 2nd image from the YZ plane and, optionally, like the 3rd image from the XY plane. The entire constructed geometry is confined to a cube world space of \([\text{ImageWidth}]^3\) (ImageWidth = ImageHeight).

**See also**: User3DDither3Images2, User3DDither2Images,

### 15.2.9 User3DDither3Images2 (dtr3d3im.c:234)

```
IPObjectStruct *User3DDither3Images2(const char *Image1Name, 
const char *Image2Name, 
const char *Image3Name, 
int DitherSize, 
int MatchWidth, 
int Negate, 
int AugmentContrast, 
User3DSpreadType SpreadMethod, 
IrtRType SphereRad, 
IrtRType *AccumPenalty)
```

- **Image1Name**: Name of 1st image to load.
- **Image2Name**: Name of 2nd image to load.
- **Image3Name**: Name of 3rd image to load.
- **DitherSize**: 2 or 3 for \((2x2x2)\) or \((3x3x3)\) dithering matrices.
- **MatchWidth**: Width to allow matching in a row: between \(\text{pos}[i]\) to \(\text{pos}[i +/- k]\), \(k < \text{MatchWidth}\).
- **Negate**: TRUE to negate the images.
- **AugmentContrast**: Number of iterations to add micro-pixels, to augment the contrast, behind existing pixels. Zero to disable.
- **SpreadMethod**: If allowed (MatchWidth \(\geq\) RowSize), selects initial random spread to use.
- **SphereRad**: Radius of construct spherical blob, zero to return points.
- **AccumPenalty**: Returns the accumulated error in the dithering-matching, where zero designates no error.

**Returns**: Center points.

**Description**: Build a 3D models consisting of pixels/spherical blobs that looks like the 1st image (gray level) from the XZ plane, like the 2nd image from the YZ plane and like the 3rd image from the XY plane. The entire constructed geometry is confined to a cube world space of \([\text{ImageWidth}]^3\) (ImageWidth = ImageHeight).

**See also**: User3DDither3Images,

### 15.2.10 User3DDitherSetXYTranslations (dtr3d2im.c:821)

```
IPVertexStruct *User3DDitherSetXYTranslations(IPVertexStruct *Vrtcs)
```

- **Vrtcs**: Pixels to shift a tad, in place.

**Returns**: Translated pixels, in place.

**Description**: Adds small sub pixels' shifts to the micro pixels in the XY direction.
15.2.11 User3DMicroBlobsCreateRandomMatrix (imgshd3d.c:1022)

```c
int **User3DMicroBlobsCreateRandomMatrix(int Size,
    User3DSpreadType BlobSpreadMethod)
```

**Size:** Of random vector to create to spread the blobs.

**BlobSpreadMethod:** Blob spreading method desired.

**Returns:** Created matrix as vector of vectors.

**Description:** Creates a matrix of size (Size x Size) of numbers between 0 and Size-1, randomly distributed so that no row or columns has the same number twice.

**See also:** User3DMicroBlobsCreateRandomVector,

15.2.12 User3DMicroBlobsCreateRandomVector (imgshd3d.c:935)

```c
int *User3DMicroBlobsCreateRandomVector(int Size,
    User3DSpreadType BlobSpreadMethod,
    IrtBType FirstVec)
```

**Size:** Of random vector to create to spread the blobs.

**BlobSpreadMethod:** Blob spreading method desired.

**FirstVec:** TRUE for first vector, FALSE for second vector.

**Returns:** Created vector.

**Description:** Creates a permutation vector of numbers between 0 and Size-1, with a desired distributed, in a vector of size Size.

**See also:** User3DMicroBlobsCreateRandomMatrix,

15.2.13 User3DMicroBlobsFrom3Images (imgshd3d.c:1176)

```c
IPObjectStruct *User3DMicroBlobsFrom3Images(const char *Image1Name,
    const char *Image2Name,
    const char *Image3Name,
    User3DSpreadType BlobSpreadMethod,
    IrtRType Intensity,
    const IrtVecType MicroBlobSpacing,
    const IrtVecType RandomFactors,
    int Resolution,
    int Negative,
    IrtRType CubeSize,
    int MergePts)
```

**Image1Name:** Name of 1st image to load.

**Image2Name:** Name of 2nd image to load.

**Image3Name:** Name of 3rd image to load. Optional (Can be NULL).

**BlobSpreadMethod:** Method of spreading the blobs.

**Intensity:** A scale affect on the blobs' scale.

**MicroBlobSpacing:** Spacing to use in the micro blob, in world space coordinates.

**RandomFactors:** Maximal allowed randomization in XYZ, in world space coordinates.

**Resolution:** Resolution of created objects (Resolution^2 ellipsoidal blobs are created).

**Negative:** Default (FALSE) is white blobs over dark background. If TRUE, assume dark blobs over white background.

**CubeSize:** Size of output.

**MergePts:** TRUE to merge all points to one list, FALSE each of the Resolution^2 blobs will hold its own point list.

**Returns:** Resolution^2 pointlists of micro blobs of Resolution^2 spherical blobs.

**Description:** Creates micro blobs for Resolution^2 ellipsoidal blobs that looks like the 1st image (gray level) from the XZ plane and like the 2nd image from the YZ plane. The entire constructed goemetry is confined to a world cube space of [0, CubeSize]^3.

**See also:** User3DMicroBlobsTiling,
15.2.14 User3DMicroBlobsTiling (imgshd3d.c:1432)

IPPolygonStruct *User3DMicroBlobsTiling(IrtRType XZIntensity,  
IrtRType YZIntensity,  
IrtRType XYIntensity,  
const IrtVecType MicroBlobSpacing,  
const IrtVecType RandomFactors)

**XZIntensity:** Intensity (0 to 1) of blob when viewed from XZ dir. Can be invalidated and ignored if negative.

**YZIntensity:** Intensity (0 to 1) of blob when viewed from YZ dir. Can be invalidated and ignored if negative.

**XYIntensity:** Intensity (0 to 1) of blob when viewed from XY dir. Can be invalidated and ignored if negative.

**MicroBlobSpacing:** XYZ spacing between micro blobs.

**RandomFactors:** Maximal randomization factors to use on micro blobs.

**Returns:** A pointlist of centers of the tiling micro blobs.

**Description:** Tile a given blob in the shape of an ellipsoid bounded by $[-1, 1]^3$, by micro blobs with XYZ spacing as prescribed by $\frac{??Intensity}{MicroBlobSpacing}$.

**See also:** User3DMicroBlobsFrom2Images, User3DMicroBlobsTiling2.

15.2.15 User3DMicroBlobsTiling2 (imgshd3d.c:1557)

IPPolygonStruct *User3DMicroBlobsTiling2(IrtRType XZIntensity,  
IrtRType YZIntensity,  
IrtRType XYIntensity,  
const IrtVecType MicroBlobSpacing,  
const IrtVecType RandomFactors)

**XZIntensity:** Intensity (0 to 1) of blob when viewed from XZ dir. Can be invalidated and ignored if negative.

**YZIntensity:** Intensity (0 to 1) of blob when viewed from YZ dir. Can be invalidated and ignored if negative.

**XYIntensity:** Intensity (0 to 1) of blob when viewed from XY dir. Can be invalidated and ignored if negative.

**MicroBlobSpacing:** XYZ spacing between micro blobs.

**RandomFactors:** Maximal randomization factors to use on micro blobs.

**Returns:** A pointlist of centers of the tiling micro blobs.

**Description:** Tile a given blob in the shape of a randomized cubed in $[-1, 1]^3$, by micro blobs with XYZ spacing as prescribed by $\frac{??Intensity}{MicroBlobSpacing}$.

**See also:** User3DMicroBlobsFrom2Images, User3DMicroBlobsTiling2.

15.2.16 UserAscii2WChar (fontlout.c:79)

UserFontText UserAscii2WChar(const char *Str)

**Str:** Input multi byte ascii string to convert to a wide string.

**Returns:** Converted wide string, allocated dynamically.

**Description:** Converts an ascii (multi-byte) string to a wide (multi-short) string.

**See also:** UserWChar2Ascii,
15.2.17 UserBeltCreate (belts.c:59)

IPObjectStruct *UserBeltCreate(IPVertexStruct *Circs,
    IrtRType BeltThickness,
    IrtRType BoundingArcs,
    int ReturnCrvs,
    int *Intersects,
    const char **Error)

Circs: A sequence of circles (pulleys), each as (x, y, r). If r is positive is it a CW pulley, otherwise CCW.

BeltThickness: The thickness of the constructed belt.

BoundingArcs: If non zero, bounding arcs are computed for each linear segment in belt, for each of the two sides of the belt.

ReturnCrvs: TRUE to simply return two closed curves with the left and right sides of the belt. FALSE to return a list with the individual arcs and lines and their attributes.

Intersects: TRUE if left and right sides intersects.

Error: If not set to NULL, holds an error description.

Returns: Two lists of lines/arcs representing the two sides the belt around the given circles (pulleys). If BoundingArcs is positive, two additional lists of arcs, each bounding a line segment in the belt, are build. The bounding arc is expanding the belt’s domain with at most distance BoundingArc, from the linear segment.

Description: Builds a belt-curve formed out of a pair of sequences of lines/arcs around the given set of circles (pulleys), in order.

15.2.18 UserCagdPolyline2IritPolyline (usrcnvrt.c:132)

IPPolygonStruct *UserCagdPolyline2IritPolyline(const CagdPolylineStruct *Poly)

Poly: Input polyline to convert into am Irit polyline.

Returns: Converted polyline.

Description: Converts a polyline into an Irit polyline.

See also: CagdCnvrtLinBspCrv2Polyline, CagdCnvrtPolyline2LinBspCrv, , CagdCnvrtPolyline2PtList, UserCagdPolylines2IritPolylines,

15.2.19 UserCagdPolylines2IritPolylines (usrcnvrt.c:168)

IPPolygonStruct *UserCagdPolylines2IritPolylines(const CagdPolylineStruct *Polys)

Polys: Input polylines to convert into Irit polylines.

Returns: Converted polylines.

Description: Converts a list of polylines into an Irit polylines.

See also: CagdCnvrtLinBspCrv2Polyline, CagdCnvrtPolyline2LinBspCrv, , CagdCnvrtPolyline2PtList, UserCagdPolyline2IritPolyline,

15.2.20 UserCntrEvalToE3 (srf.cntr.c:346)

IPPolygonStruct *UserCntrEvalToE3(const CagdSrfStruct *Srf,
    IPPolygonStruct *Cntrs,
    UserCntrIsValidCntrPtFuncType ValidCntrPtFunc)

Srf: Surface to evaluate contours on.

Cntrs: Contours to evaluate, in place. The input contours should hold UV coordinates in the YZ coefficients of the points.
ValidCntrPtFunc: Each point along the contours is validated through this function if !NULL. In valid points break the contour and are purged away.

Returns: Mapped and validated contour in 3-space.

Description: Evaluate contours Cntrs, in place, into Euclidean space. Input UV contours are mapped through Srf to yield 3-space points. In the process all contour points are being validated through ValidCntrPtFunc, if not NULL.

See also: UserCntrSrfWithPlane,

15.2.21 UserCntrSrfWithPlane (srf.cntr.c:155)

IPPolygonStruct *UserCntrSrfWithPlane(const CagdSrfStruct *Srf,
const IrtPlnType Plane,
IrtRType SubdivTol,
int UseSSI)

Srf: To approximate its intersection with the given plane.
Plane: To intersect with the given surface.
SubdivTol: Control of subdivision tolerance if UseSSI (see MvarSrfSrfInter function). Control of polygonal approximation of surface (See IritSurface2Polygons function) if !UseSSI.
UseSSI: TRUE to use the multivariate SSI abilities, FALSE to compute a polygonal approximation intersection.

Returns: A list of polylines approximating the contour.

Description: Computes the intersection of a freeform surface and a plane. If Srf is a scalar surface then it is promoted first into a 3D Euclidean surface with UV as YZ coordinates (and X has scalar field).

See also: UserCntrEvalToE3,

15.2.22 UserCnvrtLinBspCrv2IritPolyline (usrcnvrt.c:200)

IPPolygonStruct *UserCnvrtLinBspCrv2IritPolyline(const CagdCrvStruct *Crv)

Crv: Input linear curve to convert into an Irit polyline.

Returns: Converted polyline.

Description: Converts a cagd linear curve into an Irit polyline.

See also: CagdCnvrtLinBspCrv2Polyline, CagdCnvrtPolyline2LinBspCrv, , CagdCnvrtPolyline2PtList, UserCagdPolyline2IritPolyline, , UserCnvrtLinBspCrvs2IritPolylines,

15.2.23 UserCnvrtLinBspCrvs2IritPolylines (usrcnvrt.c:230)

IPPolygonStruct *UserCnvrtLinBspCrvs2IritPolylines(const CagdCrvStruct *Crvs)

Crvs: Input linear curves to convert into Irit polylines.

Returns: Converted polylines.

Description: Converts a list of cagd linear curves into Irit polylines.

See also: CagdCnvrtLinBspCrv2Polyline, CagdCnvrtPolyline2LinBspCrv, , CagdCnvrtPolyline2PtList, UserCagdPolyline2IritPolyline, , UserCnvrtLinBspCrv2IritPolyline,
15.2.24 UserCrvAngleMap (visible.c:606)

#include <cagd/cagd.h>

IPObjectStruct *UserCrvAngleMap(const CagdCrvStruct *Crv,
                       CagdRType SubdivTol,
                       CagdRType Angle)

**Crv**: Planar closed curve to compute its para/ortho/angular map.

**SubdivTol**: Of computation. If negative the function whose zero set is the orthogonal map, is returned.

**Angle**: 0 for parallel maps, 90 for orthogonal maps, or general for general angles.

**Returns**: Polyline(s) of (r, t) points such that the normals at C(r) and C(t) are orthogonal.

**Description**: Computes the parallel/orthogonality/angular map of the given planar closed curve. The orthogonality map is the set of pairs of points of Crv that have an orthogonal normal and is a 2D map of size [D x D] where D is the domain of Crv. Similarly the parallel map is the set of pairs of points of Crv that have the same normal direction, and the angular map identifies pairs of points with a prescribed fixed angle between their normals.

**See also**: UserCrvOMDiagExtreme, UserCrvViewMap, UserCrvVisibleRegions

15.2.25 UserCrvArngmnt (crv Arng.c:254)

UserCrvArngmntStruct *UserCrvArngmnt(UserCAOpType Operation,
                       const UserCrvArngmntStruct *CA,
                       const void *Params[])

**Operation**: Create, BreakCrv, Report, Free, etc. (See UserCAOpType).

**CA**: To operate on its copy or NULL if a new CA.

**Params**: An array of params depending on Operation.

**Returns**: Constructed or updated CA.

**Description**: Main entry points of CA. Gets the desired operation to perform, the CA to operate on (or NULL if new one) and parameters that depends on the specific desired operation:

**USER_CA_OPER_CREATE** - Creates a new CA

- **Params[0]** = List of curves/polylines/trimmed surfaces to extract the curves/linear curves/trimming curves for the arrangement.
- **Params[1]** = Tolerance for considering end points equal.
- **Params[2]** = Planarity tolerance to consider arrangement planar.
- **Params[3]** = TRUE to project all curves to be on computed plane.
- **Params[4]** = Mask for input type to consider:
  - 0x01 to handle polylines.
  - 0x02 to handle curves.
  - 0x04 to handle trimming curves in trimmed surfaces.

**USER_CA_OPER_COPY** - Creates a new CA

- None.

**USER_CA_OPER_FILTER_DUP** - Creates a new CA

- **Params[0]** = Epsilon to consider the curves the same.
- **Params[1]** = TRUE to update end points to be the same.

**USER_CA_OPER_FILTER_TAN** - Creates a new CA

- **Params[0]** = Epsilon angle in degrees to consider two curves with the same tangent.

**USER_CA_OPER_SPLIT_CRV** - Creates a new CA

- **Params[0]** = Mask for splitting type to consider:
  - USER_CA_SPLIT_INFLECTION_PTS to split at inflection pts.
  - USER_CA_SPLIT_MAX_CURV_PTS to split at max curvatures.
  - USER_CA_SPLIT_C1DISCONT_PTS to split at parameteric C1 discontinuities, according to the knotsequence.
  - USER_CA_SPLIT_REAL_C1DISCONT_PTS to split at actual C1 discontinuities, examined in Euclidean space.
- **Params[1]** = Tolerance of splitting computation.

**USER_CA_OPER_BREAK_LIN** - Creates a new CA

- **Params[0]** = Angular deviation (in degrees) to split linear curves at.

**USER_CA_OPER_BREAK_INTER** - Creates a new CA

- **Params[0]** = Intersection computation tolerance.
USER_CA_OPER_BREAK_NEAR_PTS - Creates a new CA
  Params[0] = Number of points to split curves at.
  Params[1] = A list object of pts to examine and split if near them.
  Params[2] = Tolerance to consider a point near/on a curve.

USER_CA_OPER_UNION_CRV - Creates a new CA
  Params[0] = Angular deviation (in degrees) to merge C1 discontinuous curves at.

USER_CA_OPER_LSTSQR_CRV - Creates a new CA
  Params[0] = Fitting Parameter to fit smooth quadratic C1 curves to linear curves. Higher order curves are not affected.
  If Params[0] positive, the fitted curve size is set to InputCrvSize * FitC1Crv / 100 (i.e. Params[0] serves as percentage of input size).
  If Params[0] negative, the fitted curve size is simply set to ABS(Params[0]).

USER_CA_OPER_EVAL_CA - Operates on input CA in place
  Params[0] = TRUE to ignore hanging curves that join other curves at only one of their end points.

USER_CA_OPER_CLASSIFY - Operates on input CA in place
  None.

USER_CA_OPER_REPORT - Operates on input CA in place
  Params[0] = A mask of desired report:
              0x01 to dump info on crvs. 0x02 to also dump the crvs.
              0x04 to report end pts in arrangement if evaluated.
              0x08 to report regions in arrangement if evaluated.

USER_CA_OPER_OUTPUT - Operates on input CA in place
  Params[0] = Style of expected output:
              1 for individual crv segs in each region (loop etc.),
              2 for merged curves so every region is one curve,
              3 for topology as an ordered list of curve segments and each region is a list of indices into the first list.
              A negative -i index means index i but a reversed crv.
              101, 102, 103: same as 1,2,3 but pt is evaluated at 1/13 of curve parameteric domain to identify orientation.

USER_CA_OPER_FREE - Operates on input CA in place
  None.

See also:

15.2.26 UserCrvArngmntClassifyConnectedRegions (crv_arng.c:1707)

int UserCrvArngmntClassifyConnectedRegions(UserCrvArngmntStruct *CA,
                                          int IgnoreInteriorHangingCrvs)

CA: Curves' arrangement to process.
IgnoreInteriorHangingCrvs: TRUE to ignore hanging curves.

Returns: TRUE if successful, FALSE otherwise.

Description: Create regions (loops, etc.) from the given arrangement and classify them.
See also:

15.2.27 UserCrvArngmntCopy (crv_arng.c:1232)

UserCrvArngmntStruct *UserCrvArngmntCopy(const UserCrvArngmntStruct *CA)

CA: The curve arrangement structure to copy.

Returns: NULL if error or new copy of CA.

Description: Copy all the data structure used in the curve arrangement.
See also:
15.2.28  UserCrvArngmntCreate (crv_arng.c:422)

UserCrvArngmntStruct *UserCrvArngmntCreate(const IPObjecStruct *PCrvs,
CagdRType EndPtEndPtTol,
CagdRType PlanarityTol,
int ProjectOnPlane,
int InputMaskType)

PCrvs: Input to derive its planar arrangement. Can be curves, polylines, or trimming curves in trimmed surfaces.
EndPtEndPtTol: Tolerance to consider two (end) points the same.
PlanarityTol: Tolerance to accept all curves as planar.
ProjectOnPlane: TRUE to project off-plane curves onto the plane.
InputMaskType: Bit mask controlling the type of entities to process: 0x01 - process polylines in the input.
              0x02 - process curves in the input. 0x04 - process trimming curves in trimmed surfaces in the input.

Returns: A curves' arrangement structure, or NULL if err.
Description: Constructs a new curves' arrangement data structure.
See also:

15.2.29  UserCrvArngmntFree (crv_arng.c:1267)

int UserCrvArngmntFree(UserCrvArngmntStruct *CA)

CA: The curve arrangement structure to free.
Returns: TRUE if successful, FALSE otherwise.
Description: Delete all the data structure used in the curve arrangement.
See also:

15.2.30  UserCrvArngmntGetCurves (crv_arng.c:2637)

CagdCrvStruct *UserCrvArngmntGetCurves(UserCrvArngmntStruct *CA, int XYCurves)

CA: Curves' arrangement to process.
XYCurves: TRUE to return curves in XY plane, FASLE to recover the original orientation.
Returns: Fetched curves.
Description: Fetches the curves of the arrangement.
See also:

15.2.31  UserCrvArngmntIsContained (crv_arng.c:2494)

int UserCrvArngmntIsContained(const UserCrvArngmntStruct *CA,
const CagdCrvStruct *InnerShape,
const CagdCrvStruct *OuterLoop)

CA: Curves' arrangement to process.
InnerShape: A shape to test if contained in OuterLoop.
OuterLoop: A closed loop region to test if contains InnerShape.
Returns: TRUE if OuterLoop contains InnerShape, FALSE otherwise.
Description: Test if OuterLoop contains the given InnerShape. Both inputs should be merged regions in CA.
See also: SymbCrvPointInclusion,
15.2.32 UserCrvArngmntIsContained2 (crv_arng.c:2529)

int UserCrvArngmntIsContained2(const UserCrvArngmntStruct *CA,
const CagdPType Pt,
const CagdCrvStruct *Loop)

CA: Curves' arrangement to process.
Pt: A Point to test for inclusion in Loop.
Loop: A closed loop region to test if contains Pt.
Returns: TRUE if Loop contains Pt, FALSE otherwise.
Description: Test if Loop contains the given Point Pt. Input should be of merged region in CA.
See also: SymbCrvPointInclusion,

15.2.33 UserCrvArngmntOutput (crv_arng.c:3097)

int UserCrvArngmntOutput(const UserCrvArngmntStruct *CA,
int OutputStyle,
CagdRType Tolerance,
CagdRType ZOffset)

CA: Curves' arrangement to output. Output slot of CA will be updated with result.
OutputStyle: 1 for individual curve segments in each region (loop etc.), 2 for merged curves so every region is
one curve, 3 for topology as an ordered list of curve segments and each region is a list of indices into the
first list. A negative -i index means index i but a reversed curve. 101, 102, 103 - same as 1,2,3 but a pt is
evaluated at 1/13 of curve parameteric domain to identify orientation.
Tolerance: Tolerance of intersection locations' computation.
ZOffset: if positive, offset the n'th region in Z by n*ZOffset.
Returns: TRUE if successful, FALSE otherwise.
Description: Emit the result of the curve's arrangement computations.
See also:

15.2.34 UserCrvArngmntProcessEndPts (crv_arng.c:1619)

int UserCrvArngmntProcessEndPts(UserCrvArngmntStruct *CA)

CA: Curves' arrangement to process.
Returns: TRUE if successful, FALSE otherwise.
Description: Detect, up to EndPtTol, end points of curves that can be considered the same and merge these
points.
See also:

15.2.35 UserCrvArngmntRegion2Curves (crv_arng.c:2557)

static IPObjectStruct *UserCrvArngmntRegion2Curves(const UserCrvArngmntStruct
*CA,
UserCARefCrvStruct
*CARrefCrv,
int Merge)

CA: Curves' arrangement to process.
CARRefCrv: The regions as a list of references to curves.
Merge: If TRUE, merge all curves in a region into one.
Returns: A (list of) curve(s), or NULL if error.
Description: Convert one internal region as lists of curves, into (a merged) Bspline curve(s).
See also: UserCrvArngmntRegion2Curves,
15.2.36 UserCrvArngmntRegions2Curves (crv_arng.c:2679)

```c
int UserCrvArngmntRegions2Curves(const UserCrvArngmntStruct *CA,
     int Merge,
     int XYCurves,
     IrtRType ZOffset)
```

CA: Curves' arrangement to process.
Merge: If TRUE, merge all curves in a region into one.
XYCurves: TRUE to return regions in XY plane, FALSE to recover the original orientation.
ZOffset: if positive, offset the n'th region in Z by n*ZOffset.

Returns: TRUE if successful, FALSE otherwise.

Description: Convert internal regions as lists of curves, into merged Bspline curves. Output is placed on the Output slot of CA.
See also:

15.2.37 UserCrvArngmntRegionsTopology (crv_arng.c:2780)

```c
int UserCrvArngmntRegionsTopology(const UserCrvArngmntStruct *CA,
     int XYCurves,
     IrtRType ZOffset)
```

CA: Curves' arrangement to process.
XYCurves: TRUE to return regions in XY plane, FALSE to recover the original orientation.
ZOffset: if positive, offset the n'th region in Z by n*ZOffset.

Returns: TRUE if successful, FALSE otherwise.

Description: Convert internal regions into full topology as a list of two lists:
1. First list is the list of all curves in the arrangements' output.
2. Second list is a list of entities each of which holds a list of indices into the first list. Negative indices indicates the curve should be reversed. Index of first curve is 1. Output is placed on the Output slot of CA.
See also:

15.2.38 UserCrvArngmntReport (crv_arng.c:2940)

```c
void UserCrvArngmntReport(const UserCrvArngmntStruct *CA,
     int DumpCurves,
     int DumpPts,
     int DumpRegions,
     int DumpXYData)
```

CA: To print to stdout.
DumpCurves: 1 to dump info crvs in the CA. 2 to also dump the crvs.
DumpPts: TRUE to dump the points in the CA.
DumpRegions: TRUE to dump the regions in the CA.
DumpXYData: TRUE to dump XY data, FALSE for 3-space data (crvs and pts).

Returns: void

Description: Dumps to stdout, the content of the curve arrangement.
See also:
15.2.39  UserCrvCrvtrByOneCtlPt  (crvtranl.c:52)

IPObjectStruct *UserCrvCrvtrByOneCtlPt(const CagdCrvStruct *Crv,
    int CtlPtIdx,
    CagdRType Min,
    CagdRType Max,
    CagdRType SubdivTol,
    CagdRType NumerTol,
    int Operation)

Crv: To compute its curvature behaviour (convex vs. concave) as a function of the curve parameter and the
  Euclidean coordinate of the CtlPtIdx's control point.
CtlPtIdx: Index of control point to make a parameter for the curvature.
Min, Max: Domain each coordinate of CtlPtIdx point should vary.
SubdivTol, NumerTol: Tolerance for the silhouette solving, if any.
Operation: 1. Returned is a multivariate of dimension "1 + Dim(Crv)", where Dim(Crv) is the dimension of
curve (E2, E3, etc.). 2. Extract the zero set of 1. using marching cubes. 3. Computes the t's silhouette of
the 1. by simultaneously solving for 1 and its derivative with respect to t. 4. Same as 3 but evaluate the
result into Euclidean space.

Returns: Either the multivariate (1 above) or its t's silhouette (2 above).

Description: Given a parametric curve, Crv, and a control point index CtlPtIdx, compute the curvature sign
field of the curve as function of the Euclidean locations of control point index CtlPtIdx.
See also: MvarCrvCrvtrByOneCtlPt, SymbCrv2DCurvatureSign, MvarCrvMakeCtlPtParam,

15.2.40  UserCrvOMDiagExtreme  (visible.c:902)

IPObjectStruct *UserCrvOMDiagExtreme(const CagdCrvStruct *Crv,
    const IPObjectStruct *OM,
    int DiagExtRes)

Crv: Curve for which we computed the orthogonality map and now seek the diagonal extremes.
OM: The computed orthogonality map of Crv.
DiagExtRes: The resolution of the Z-buffer to use to extract the diagonal extreme.

Returns: A polyline object with two polylines, upper diagonal extreme followed by lower diagonal extreme.

Description: Computes the diagonal extremes of the Orthogonality map of curve Crv. Uses a [DiagExtRes x 1]
Z-buffer to extract th diagonal extremes.
See also: UserCrvAngleMap,

15.2.41  UserCrvViewMap  (visible.c:742)

IPObjectStruct *UserCrvViewMap(const CagdCrvStruct *Crv,
    const CagdCrvStruct *ViewCrv,
    CagdRType SubTol,
    CagdRType NumTol,
    CagdBType TrimInvisible)

Crv: Planar closed curve to compute its view map.
ViewCrv: Planar viewing direction curve in vector space.
SubTol: Used only if TrimInvisible TRUE to control the subdivision Tolerance of the solver. If negative, the
solution set is returned as a cloud of points.
NumTol: Of computation. If negative the function M whose zero set is the view map, is returned.
TrimInvisible: If TRUE, trim the regions that are invisible from V.

Returns: Polyline(s) of (Theta, t) or (Theta, t, r) points such that normals at C(t) are orthogonal to
ViewCrv(Theta), and C(t) exactly in front of C(r) if (Theta, t, r).
Description: Computes the view map of the given planar closed curve, C(t), with respect to view directions that are prescribed by vector curve ViewCrv(Theta). The view map is defined as the zero of M = < N(t), ViewCrv(Theta) >, where N(t) is the normal field of C(t). Seeking the visible portions, the problem could be partially addressed using the following constraints:

< C(t) - C(r), ViewCrv'(Theta) > = 0,
finding all points C(t) behind or in front C(r), for some r, such that

< C(t) - C(r), ViewCrv(Theta) > > 0,
for all matched r values.

See also: UserCrvOMDiagExtreme, UserCrvAngleMap, UserCrvVisibleRegions,

15.2.42 UserCrvVisibleRegions (visible.c:432)

CagdCrvStruct *UserCrvVisibleRegions(const CagdCrvStruct *CCrv,
const CagdRType *View,
CagdRType Tolerance)

CCrv: Planar curve to compute its visible regions from View.
View: As (x, y, w) where w == 0 for parallel view direction and w = 1 for a point view.
Tolerance: Of computation.
Returns: List of curve segments of Crv that are visible from View.

Description: Computes the regions of planar curve Crv that are visible from a view point (View[2] == 1) or direction (View[2] == 0) View (x, y, w). Return is a list of visible curve segments.
See also: UserCrvOMDiagExtreme, UserCrvAngleMap, UserCrvViewMap,

15.2.43 UserDDMPolysOverPolys (ddm_text.c:439)

IPObjectStruct *UserDDMPolysOverPolys(IPObjectStruct *PlSrf,
const IPObjectStruct *Texture,
IrtRType UDup,
IrtRType VDup,
int LclUV)

PlSrf: Polygonal mesh surface to derive a DDM mapping for. This mesh must have a parametrization as UV coordinates as well as normals at the vertices of the polygons.
Texture: Geometry defining the single tile of the DDM texture. The geometry is assumed to span [0..1] in both x and y.
UDup, VDup: The U and V duplication factors.
LclUV: TRUE to keep local UV coordinates for each tile, FALSE to employ the UV coordinates of the surface Srf.
Returns: A set of objects that derive the DDM surface above Srf.
Description: Maps the given DDM texture defined in Texture over mesh surface PlSrf, duplicating it (UDup x VDup) times over the parametric domain of mesh.
See also: UserDDMPolysOverSrf,

15.2.44 UserDDMPolysOverSrf (ddm_text.c:125)

IPObjectStruct *UserDDMPolysOverSrf(const CagdSrfStruct *Srf,
const IPObjectStruct *Texture,
IrtRType UDup,
IrtRType VDup,
int LclUV,
int Random)

Srf: Surface to derive a DDM mapping for.
Texture: Geometry defining the single tile of the DDM texture. The geometry is assumed to span [0..1] in both x and y.
UDup, VDup: The U and V duplication factors.
LclUV: TRUE to keep local UV coordinates for each tile, FALSE to employ the UV coordinates of the surface Srf.
Random: If TRUE, the placement is made at random over the surface.
Returns: A set of objects that derive the DDM surface above Srf.
Description: Maps the given DDM texture defined in Texture over the surface Srf, duplicating it (UDup x VDup) times over the parametric domain of Srf.
See also: UserDDMPolysOverPolys,

15.2.45 UserDDMPolysOverTrimmedSrf (ddm_text.c:82)

IPObjectStruct *UserDDMPolysOverTrimmedSrf(const TrimSrfStruct *TSrf, const IPObjectStruct *Texture, IrtRType UDup, IrtRType VDup, int LclUV, int Random)

TSrf: Trimmed surface to derive a DDM mapping for.
Texture: Geometry defining the single tile of the DDM texture. The geometry is assumed to span [0..1] in both x and y.
UDup, VDup: The U and V duplication factors.
LclUV: TRUE to keep local UV coordinates for each tile, FALSE to employ the UV coordinates of the surface TSrf.
Random: If TRUE, the placement is made at random over the trimmed srf.
Returns: A set of objects that derive the DDM surface above TSrf.
Description: Maps the given DDM texture defined in Texture over the trimmed surface TSrf, duplicating it (UDup x VDup) times over the parametric domain in non trimmed regions only.
See also: UserDDMPolysOverSrf, UserDDMPolysOverPolys,

15.2.46 UserDescribeError (user_err.c:70)

const char *UserDescribeError(UserFatalErrorType ErrorNum)

ErrorNum: Type of the error that was raised.
Returns: A string describing the error type.
Description: Returns a string describing a the given error. Errors can be raised by any member of this user library as well as other users. Raised error will cause an invocation of UserFatalError function which decides how to handle this error. UserFatalError can for example, invoke this routine with the error type, print the appropriate message and quit the program.

15.2.47 UserFEBuildC1Mat (fntelem1.c:727)

UserFEElementStruct *UserFEBuildC1Mat(CagdCrvStruct *Crv1, CagdSrfsStruct *Srf1, CagdCrvStruct *Crv2, CagdSrfsStruct *Srf2, int IntegRes)

Crv1: A boundary curve of Srf1 to determine its intersection interval with Crv2. Has M control points.
Srf1: The first surface to examine for collision with Srf2.
Crv2: A boundary curve of Srf2 to determine its intersection interval with Crv1.
Srf2: The second surface to examine for collision with Srf1.
IntegRes: Resolution of integration - number of sample per interval.
Returns: Vector of size (M x M) elements of C1.
Description: Evaluates the elements of the C1 intersection matrix as the integral of the basis function’s products along the intersecting boundary.
See also: UserFEBuildKMat, UserFEBuildC2Mat, UserFEEvalRHSC,
15.2.48  UserFEBuildC1Mat2  (fntelem1.c:840)

UserFECElementStruct *UserFEBuildC1Mat2(CagdPType *Crv1Pts,
   int Crv1Length,
   int Crv1Order,
   CagdPType *Srf1Pts,
   int Srf1ULength,
   int Srf1VLength,
   int Srf1UOrder,
   int Srf1VOrder,
   CagdPType *Crv2Pts,
   int Crv2Length,
   int Crv2Order,
   CagdPType *Srf2Pts,
   int Srf2ULength,
   int Srf2VLength,
   int Srf2UOrder,
   int Srf2VOrder,
   CagdEndConditionType EndCond,
   int IntegRes)

Crv1Pts: Crv1’s control points (M).
Crv1Length: Dimensions of Crv1Pts vector.
Crv1Order: Order of Crv1.
Srf1Pts: Srf1’s control points.
Srf1ULength, Srf1VLength: Dimensions of Srf1Pts vector.
Srf1UOrder, Srf1VOrder: Orders of Srf1.
Crv2Pts: Curve2’s control points.
Crv2Length: Dimensions of Crv2Pts vector.
Crv2Order: Order of Curve2.
Srf2Pts: Srf2’s control points.
Srf2ULength, Srf2VLength: Dimensions of Srf2Pts vector.
Srf2UOrder, Srf2VOrder: Orders of Srf2.
EndCond: Float or open, in reconstructed Crv1/2, Srf1/2.
IntegRes: Resolution of integration - number of sample per interval.
Returns: Vector of size (M x M) elements of C1.

Description: Evaluates the elements of the C1 intersection matrix as the integral of the basis function’s products along the intersecting boundary.
See also: UserFEBuildKMat, UserFEBuildC2Mat, UserFEBuildC1Mat, UserFEEvalRHSC,

15.2.49  UserFEBuildC2Mat  (fntelem1.c:1036)

UserFECElementStruct *UserFEBuildC2Mat(CagdCrvStruct *Crv1,
   CagdSrfStruct *Srf1,
   CagdCrvStruct *Crv2,
   CagdSrfStruct *Srf2,
   int IntegRes)

Crv1: A boundary curve of Srf1 to determine its intersection interval with Crv2. Has N control points.
Srf1: The first surface to examine for collision with Srf2.
Crv2: A boundary curve of Srf2 to determine its intersection interval with Crv1. Has M control points.
Srf2: The second surface to examine for collision with Srf1.
IntegRes: Resolution of integration - number of sample per interval.
Returns: Vector of size (N x M) elements of C2.

Description: Evaluates the elements of the C1 intersection matrix as the integral of the basis function’s products along the intersecting boundary.
See also: UserFEBuildKMat, UserFEBuildC1Mat, UserFEEvalRHSC,
15.2.50 UserFEBuildC2Mat2 (fntelem1.c:1150)

UserFECElementStruct *UserFEBuildC2Mat2(CagdPType *Crv1Pts,
    int Crv1Length,
    int Crv1Order,
    CagdPType *Srf1Pts,
    int Srf1ULength,
    int Srf1VLength,
    int Srf1UOrder,
    int Srf1VOrder,
    CagdPType *Crv2Pts,
    int Crv2Length,
    int Crv2Order,
    CagdPType *Srf2Pts,
    int Srf2ULength,
    int Srf2VLength,
    int Srf2UOrder,
    int Srf2VOrder,
    CagdEndConditionType EndCond,
    int IntegRes)

Crv1Pts: Crv1’s control points.
Crv1Length: Dimensions of Crv1Pts vector (M).
Crv1Order: Order of Crv1.
Srf1Pts: Srf1’s control points.
Srf1ULength, Srf1VLength: Dimensions of Srf1Pts vector.
Srf1UOrder, Srf1VOrder: Orders of Srf1.
Crv2Pts: Curve2’s control points.
Crv2Length: Dimensions of Crv2Pts vector (N).
Crv2Order: Order of Curve2.
Srf2Pts: Srf2’s control points.
Srf2ULength, Srf2VLength: Dimensions of Srf2Pts vector.
Srf2UOrder, Srf2VOrder: Orders of Srf2.
EndCond: Float or open, in reconstructed Crv1/2, Srf1/2.
IntegRes: Resolution of integration - number of sample per interval.
Returns: Vector of size (N x M) elements of C2.

Description: Evaluates the elements of the C2 intersection matrix as the integral of the basis function’s products along the intersecting boundary.
See also: UserFEBuildKMat, UserFEBuildC2Mat, UserFEBuildC1Mat, UserFEEvalRHSC,

15.2.51 UserFEBuildKMat (fntelem1.c:292)

UserFEKElementStruct *UserFEBuildKMat(CagdSrfStruct *Srf,
    int IntegRes,
    IrtRType E,
    IrtRType Nu,
    int *Size)

Srf: To compute its K stiffness matrix.
IntegRes: Resolution of integration - number of sample per interval. *
E: Young Module value.
Nu: Poisson coefficient, between 0.0 and 0.5.
Size: Number of degree-of-freedom (basis functions) Srf contains.
Returns: Vector of size n^2 with the (n x n) elmnts of K.

Description: Evaluates the elements of the stiffness matrix K as the integral of the basis function’s derivatives of surface Srf. Let B be a linear vector of all n polynomial patches’ basis functions of Srf. Let S be the matrix
let $L$ be the differentiation operator of
\[
L = \begin{bmatrix}
\frac{d}{du} & 0 & \frac{d}{dv} \\
0 & \frac{d}{dv} & \frac{d}{dx}
\end{bmatrix},
\]
and let $M$ be the application of $L$ to all basis functions in $B$. $M$ is a matrix of size $(2n \times 3)$. Finally compute and return the integrals of $K = M S M^T$, $K$ is a matrix of size $(2n \times 2n)$. Because the integration is to be conducted in spatial space instead of parametric domain, we must normalize by the determinant of the Jacobian hence the integration is conducted numerically.

See also: UserFEBuildKMat2, UserFEBuildC1Mat, UserFEBuildC2Mat, UserFEEvalRHSC,

15.2.52 UserFEBuildKMat2 (fntelem1.c:460)

UserFEKElementStruct *UserFEBuildKMat2(CagdPType *Points,
int ULength,
int VLength,
int UOrder,
int VOrder,
CagdEndConditionType EndCond,
int IntegRes,
IrtRType E,
IrtRType Nu,
int *Size)

Points: Current surface control points.
ULength, VLength: Dimensions of Points vectors.
UOrder, VOrder: Surface Order in U and V.
EndCond: End conditions - open, float, etc.
IntegRes: Resolution of integration - number of sample per interval. *
E: Young Module value.
Nu: Poisson coefficient, between 0.0 and 0.5.
Size: Number of degree-of-freedom (basis functions) Srf contains.

Returns: Vector of size $n^2$ with the $(n \times n)$ elements of $K$.

Description: Evaluates the elements of the stiffness matrix $K$ as the integral of the basis function’s derivatives of surface Srf. Let $B$ be a linear vector of all $n$ polynomial patches’ basis functions of Srf. Let $S$ be the matrix
\[
S = \begin{bmatrix}
1 & Nu & 0 \\
\frac{1}{(1-Nu^2)} & 1 & 0 \\
0 & 0 & (1-Nu) / 2
\end{bmatrix},
\]

15.2.53 UserFEEvalRHSC (fntelem1.c:1230)

IrtRType UserFEEvalRHSC(UserFEElementStruct *C,
CagdCrvStruct *Crv1,
CagdCrvStruct *Crv2)

C: The current row of C1 matrix of M elements.
Crv1: A boundary curve of Srf1 to determine its intersection interval with Crv2. Has M control points.
Crv2: A boundary curve of Srf2 to determine its intersection interval with Crv1. Has N control points.

Returns: Current value of constraint. Should be zero if satisfied.

Description: Evaluates the right hand side (RHS) of the i’th C constraint - of the i’th basis function.
See also: UserFEBuildKMat, UserFEBuildC2Mat, UserFEBuildC1Mat,
15.2.54 UserFEGetInterInterval (fntelem1.c:552)

UserFEInterIntervalStruct *UserFEGetInterInterval(CagdCrvStruct *Crv1, CagdSrfStruct *Srf1, CagdCrvStruct *Crv2, CagdSrfStruct *Srf2)

Crv1: A boundary curve of Srf1 to determine its intersection interval with Crv2.
Srf1: The first surface to examine for collision with Srf2.
Crv2: A boundary curve of Srf2 to determine its intersection interval with Crv1.
Srf2: The second surface to examine for collision with Srf1.

Returns: A list of elements, each holding one continuous interval of intersection, specifying the proper intervals in both Crv1 and Crv2.

Description: Derives the interval(s) where Crv1 and Crv2 intersect, two boundary curves of Srf1 and Srf2.
See also:

15.2.55 UserFEPointInsideSrf (fntelem1.c:509)

CagdBType UserFEPointInsideSrf(CagdSrfStruct *Srf, CagdPType Pt)

Srf: Surface to test the inclusion of Pt in, in \( \mathbb{R}^2 \).
Pt: 2D point to test if inside Srf.

Returns: TRUE if inside, FALSE otherwise.

Description: Returns TRUE if given point Pt is inside surface Srf, FALSE otherwise.
See also:

15.2.56 UserFatalError (user_ftl.c:54)

void UserFatalError(UserFatalErrorType ErrID)

ErrID: Error type that was raised.

Returns: void

Description: Trap User_lib errors right here. Provides a default error handler for the user library. Gets an error description using UserDescribeError, prints it and exit the program using exit.

15.2.57 UserFontBspCrv2Poly (font3d.c:328)

IPPolygonStruct *UserFontBspCrv2Poly(CagdCrvStruct *BspCrv, IrtRType Tolerance)

BspCrv: Pointer to the Curve.
Tolerance: The tolerance used calculating the polygon.

Returns: Pointer to the new Polygon.

Description: Converting a closed B-spline to a Polygon.
15.2.58 **UserFontBspList2Plgns** *(font3d.c:439)*

```c
IPObjectStruct *UserFontBspList2Plgns(IPObjectStruct *BspListObj,
                                        IrtRType Tol,
                                        const char *Name)
```

**BspListObj**: A list object of Bspline curves.
**Tol**: Tolerance of approximation.
**Name**: Base name to use for constructed objects. Can be NULL.

**Returns**: The created polygons.

**Description**: Converts a list object of Bspline merged closed curves (outline of the font) to polygons that fill the text.

**See also**: UserFontBspList2TrimSrfs,

15.2.59 **UserFontBspList2Solids** *(font3d.c:756)*

```c
IPObjectStruct *UserFontBspList2Solids(IPObjectStruct *BspListObj,
                                        UserFont3DEdgeType ExtStyle,
                                        IrtRType ExtOffset,
                                        IrtRType ExtHeight,
                                        IrtRType Tol,
                                        CagdBType GenTrimSrfs,
                                        const char *Name)
```

**BspListObj**: A list object of Bspline curves.
**ExtStyle**: Type of 3D solid geometry: chamfered corners, rounded, etc.
**ExtOffset**: Size of the chamfer/rounding.
**ExtHeight**: Height of the 3D solid constructed text.
**Tol**: Tolerance of approximation.
**GenTrimSrfs**: TRUE to generate trimmed surfaces. FALSE for polygons.
**Name**: Base name to use for constructed objects. Can be NULL.

**Returns**: The created polygons.

**Description**: Converts a list object of Bspline merged closed curves (outline of the font) to polygons that fill the text.

15.2.60 **UserFontBspList2TrimSrfs** *(font3d.c:517)*

```c
IPObjectStruct *UserFontBspList2TrimSrfs(IPObjectStruct *BspListObj,
                                        IrtRType Tol,
                                        const char *Name)
```

**BspListObj**: A list object of Bspline curves.
**Tol**: Tolerance of approximation.
**Name**: Base name to use for constructed objects. Can be NULL.

**Returns**: The created trimmed surfaces.

**Description**: Converts a list object of Bspline merged closed curves (outline of the font) to trimmed surfaces that fill the text.

**See also**: UserFontBspList2Plgns,
15.2.61  **UserFontBzrList2BspList**  (font3d.c:368)

CagdCrvStruct *UserFontBzrList2BspList(IPObjectStruct *BzrListObj,
IrtBType *HaveHoles)

- **BzrListObj**: A list object of Bezier curves.
- **HaveHoles**: Will be set to TRUE if holes are detected (examining the orientation of the loops).
- **Returns**: A list of Bezier loop curves.

**Description**: Converts a list object of Bezier curves into a list of Bezier curves by chaining adjacent Bezier curve segments into closed Bezier loops.

15.2.62  **UserFontConvertFontToBezier**  (wfnt2bzr.c:149)

IPObjectStruct *UserFontConvertFontToBezier(const UserFontText Text,
const UserFontName FontName,
UserFontStyleType FontStyle,
IrtRType SpaceWidth,
int MergeToBsp,
const char *RootObjName)

- **Text**: Text string.
- **FontName**: Font name.
- **FontStyle**: Font style.
- **SpaceWidth**: Space, in points, added to individual chars.
- **MergeToBsp**: TRUE to merge Bezier curves into larger B-spline curves, FALSE to leave the original (font) Bezier curves.
- **RootObjName**: Name of root object.
- **Returns**: Extracted text object or NULL in case of failure.

**Description**: Extracts Bezier curves from windows' fonts.

15.2.63  **UserFontConvertTextToGeom**  (font3d.c:95)

int UserFontConvertTextToGeom(const UserFontText Text,
const UserFontName FontName,
UserFontStyleType FontStyle,
IrtRType FontSize,
IrtRType TextSpace,
UserFont3DEdgeType Text3DEdgeType,
const IrtRType Text3DSetup[2],
IrtRType Tolerance,
UserFontGeomOutputType OutputType,
IrtBType CompactOutput,
const char *PlacedTextBaseName,
IPObjectStruct **PlacedTextGeom,
char **ErrorStr)

- **Text**: The string text to convert to geometry.
- **FontName**: The font to use for conversion.
- **FontStyle**: The font style (italic, bold, etc.)
- **FontSize**: Created text scaling relative factor.
- **TextSpace**: In-word relative spacing.
- **Text3DEdgeType**: For 3D text geometry controls edges (i.e. chamfered.).
- **Text3DSetup**: For 3D text, a vector of (Chamfer offset size, 3D extruded vertical distance).
- **Tolerance**: For 2D filled polygons and 3D solid text geometry.
**OutputType:** Selects the type of geometry to create: 0. Outline Bezier curves as in the font data. 1. Outline B-spline curves (merging Bezier curves in 1). 2. Solid 2D polygons, for the outline geometry (polygons). 3. Both Solid 2D and B-spline outline (2+3 above). 4. Full 3D text (polygons). 5. Solid 2D polygons, for the outline geometry ((trimmed) surfaces). 6. Full 3D text ((trimmed) surfaces).

**CompactOutput:** If TRUE, merged trimming surfaces or polygons into single objects.

**PlacedTextBaseName:** Base name to use in placed text. Can be NULL.

**PlacedTextGeom:** Output created geometry will be returned here.

**ErrorStr:** Will be set with the error message if was one.

**Returns:** TRUE if successful, FALSE if conversion failed.

**Description:** Converts Text to geometry. Note this function will behave differently on different platforms (i.e. Windows vs. Unix).

**See also:** UserFontConvertFontToBezier, UserFontFTStringOutline2BezierCurves, UserFontBspCrv2Poly, UserFontBspList2Solids,

15.2.64 **UserFontFTStringOutline2BezierCurves** (ffnt2bzr.c:284)

```c
IPObjectStruct *UserFontFTStringOutline2BezierCurves(
    const UserFontText Text,
    const UserFontName FontName,
    IrtRType Spacing,
    int MergeToBsp,
    const char *RootObjName,
    const char **ErrStr)
```

**Text:** String to convert to Bezier outline.

**FontName:** Font to read the outline from.

**Spacing:** To apply between the characters.

**MergeToBsp:** TRUE to merge the Bezier curves into larger B-spline curves, FALSE to leave the original (font) Bezier curves.

**RootObjName:** Name of root object.

**ErrStr:** A string describing the error, if any.

**Returns:** List of curves in IRIT format representing the string.

**Description:** Given a string and a font name - convert to a set of curves in IRIT format.

**See also:** Freetype font library, http://www.freetype.org,

15.2.65 **UserFontLayoutOverShape** (fontlout.c:213)

```c
int UserFontLayoutOverShape(const UserFontText Text,
    const UserFontName FontName,
    UserFontStyleType FontStyle,
    IrtRType FontSize,
    const IrtRType FontSpace[3],
    IrtRType Tolerance,
    UserFont3DEdgeType Text3DEdge,
    const IrtRType Text3DSetup[2],
    UserFontAlignmentType Alignment,
    const IPPolygonStruct *BoundingPoly,
    UserFontGeomOutputType OutputType,
    IPObjectStruct **PlacedTextGeom,
    char **ErrorStr)
```

**Text:** The text to layout. A string.

**FontName:** The font name to use. I.e. ”Times new Roman”.

**FontStyle:** Font style to use. I.e. italics.

**FontSize:** The size of the constructed text.

**FontSpace:** (WordWidth, SpaceWidth, LineHeight) spacing, specified in text font’s point units.
Tolerance: For 2D filled polygons and 3D solid text geometry.

Text3DEdge: For 3D text geometry controls edges (i.e. chamfered).

Text3DSetup: For 3D text, a vector of (Chamfer offset size, 3D extruded vertical distance).

Alignment: Text alignment, left, centered, etc.

BoundingPoly: A closed region to place the text inside.

OutputType: Selects the type of geometry to create: 1. Outline Bezier curves as in the font data. 2. Outline B-spline curves (merging Bezier curves in 1). 3. Filling 2D polygons, for the outline geometry. 4. Full 3D text.

PlacedTextGeom: The result synthesized placed (geometry of the) text. Actually only the base line of the text is guaranteed to be in. NULL if error.

ErrorStr: Will be updated with an error description if was one, or with NULL if all went well.

Returns: TRUE if all text fitted in the BoundingPoly, FALSE otherwise. FALSE might also be returned if we failed to generate the text, in which case ErrorStr will hold some error description.

Description: Layout the given text over the given bounding region. Constructed Text will be controlled by FontName, FontStyle, FontSize, and FontSpace and will be aligned to follow TextAlignment. All construction is conducted over the XY plane, in 2D.

See also: UserFontLayoutOverShape2,

15.2.66 UserFontLayoutOverShape2 (fontlout.c:142)

int UserFontLayoutOverShape2(const UserFontText Text,
const UserFontName FontName,
UserFontStyleType FontStyle,
IrtRType FontSize,
const IrtRType FontSpace[3],
IrtRType Tolerance,
UserFont3DEdgeType Text3DEdge,
const IrtRType Text3DSetup[2],
UserFontAlignmentType Alignment,
const CagdCrvStruct *BoundingCrv,
UserFontGeomOutputType OutputType,
IPObjectStruct **PlacedTextGeom,
char **ErrorStr)

Text: The text to layout. A string.

FontName: The font name to use. I.e. ”Times new Roman”.

FontStyle: Font style to use. I.e. italics.

FontSize: The size of the constructed text.

FontSpace: (WordWidth, SpaceWidth, LineHeight) spacing, specified in text font’s point units.

Tolerance: For 2D filled polygons and 3D solid text geometry.

Text3DEdge: For 3D text geometry controls edges (i.e. chamfered.).

Text3DSetup: For 3D text, a vector of (Chamfer offset size, 3D extruded vertical distance).

Alignment: Text alignment, left, centered, etc.

BoundingCrv: A closed curve to place the text inside.

OutputType: Output should be original Bezier curves, merged B-spline curves, filled planar polys, 3D polys, etc.

PlacedTextGeom: The placed (geometry of the) text in. Actually only the base line of the text is guaranteed to be in. NULL if error.

ErrorStr: Will be updated with an error description if was one, or with NULL if all went well.

Returns: TRUE if all text fitted in the BoundingPoly, FALSE otherwise. *

Description: Layout the given text over the given bounding region. Constructed Text will be controlled by FontName, FontStyle, FontSize, and FontSpace and will be aligned to follow TextAlignment. All construction is conducted over the XY plane, in 2D.

See also: UserFontLayoutOverShape,
15.2.67 UserFontLayoutOverShapeFree (fontlout.c:259)

void UserFontLayoutOverShapeFree(struct UserFontWordLayoutStruct *Words)

Words: Linked list of words to free.

Returns: void

Description: Free the allocated words and their geometry.

See also: UserFontLayoutOverShape, UserFontLayoutOverShape2, UserFontLayoutOverShapeGenWords, UserFontLayoutOverShapePlaceWords.

15.2.68 UserFontLayoutOverShapeGenWords (fontlout.c:334)

UserFontWordLayoutStruct *UserFontLayoutOverShapeGenWords(
const UserFontText Text,
const UserFontName FontName,
UserFontStyleType FontStyle,
IrtRType FontSize,
const IrtRType FontSpace[3],
IrtRType Tolerance,
UserFont3DEdgeType Text3DEdge,
const IrtRType Text3DSetup[2],
UserFontAlignmentType Alignment,
const IPPolygonStruct *BoundingPoly,
UserFontGeomOutputType OutputType,
IrtBType CompactOutput,
const char *OutputBaseName,
UserFontDimInfoStruct *FontDims,
char **ErrorStr)

Text: The text to layout. A string.

FontName: The font name to use. I.e. "Times new Roman".

FontStyle: Font style to use. I.e. italics.

FontSize: The size of the constructed text.

FontSpace: (WordWidth, SpaceWidth, LineHeight) spacing, specified in text font’s point units.

Tolerance: For 2D filled polygons and 3D solid text geometry.

Text3DEdge: For 3D text geometry controls edges (i.e. chamfered.).

Text3DSetup: For 3D text, a vector of (Chamfer offset size, 3D extruded vertical distance).

Alignment: Text alignment, left, centered, etc.

BoundingPoly: A closed region to place the text inside.

OutputType: Selects the type of geometry to create: 0. Outline Bezier curves as in the font data. 1. Outline B-spline curves (merging Bezier curves in 1). 2. Solid 2D polygons, for the outline geometry (polygons).

CompactOutput: If TRUE, merged trimming surfaces or polygons into single objects.

OutputBaseName: Base name to use in output geometry.

FontDims: Structure to be updated with font dimensions if all went well.

ErrorStr: Will be updated with an error description if was one, or with NULL if all went well.

Returns: Generated words.

Description: Constructed words as a preparation to layout the text over the given bounding region. All construction is conducted over the XY plane, in 2D.

See also: UserFontLayoutOverShape, UserFontLayoutOverShape2, UserFontLayoutOverShapeFree, UserFontLayoutOverShapePlaceWords.
15.2.69 UserFontLayoutOverShapePlaceWords (fontlout.c:470)

```c
int UserFontLayoutOverShapePlaceWords(UserFontWordLayoutStruct *Words,
    IrType FontSize,
    const IrType FontSpace[3],
    UserFontAlignmentType Alignment,
    const UserFontDimInfoStruct *FontDims,
    const IPPolygonStruct *BoundingPoly,
    IPObjStruct **PlacedTextGeom)
```

**Words:** The ordered list of words to place into bounding shape

**FontSize:** The size of the constructed text.

**FontSpace:** (WordWidth, SpaceWidth, LineHeight) spacing, specified in text font’s point units.

**Alignment:** Align each line of the placed words to the left, centered, etc.

**FontDims:** Dimensions information on this font.

**BoundingPoly:** The region to place the text in (actually only base line will be in).

**PlacedTextGeom:** Where to place the created geometry. Organized as an object per character, grouped in list objects as words, all grouped in this list object. word object will have line number, "TextLineCnt", and word count in line, "TextWordCnt", attributes.

**Returns:** TRUE if all text fitted in the BoundingPoly, FALSE otherwise.

**Description:** Translate the given (geometry of) words so they fit into the given bounding shape BoundingPoly.

**See also:** UserFontLayoutOverShape, UserFontLayoutOverShape2, UserFontLayoutOverShapeFree, UserFontLayoutOverShapeGenWords.

15.2.70 UserGCCreateVisMaps (gcvismap.c:2057)

```c
void UserGCCreateVisMaps(UserGCProblemDefinitionStruct *Problem)
```

**Problem:** The geometric covering problem to be solved (Contains the required observation points, the geometric object, the obstacles and other parameters).

**Returns:** void

**Description:** Create visibility map of the scene for each observation point suggestion and save it to disk. The scene is given in GeoObj and Obstacles in Problem. In case of an error longjmp to UserGCStartOfProcess.

15.2.71 UserGCDeleteAllVisMaps (gcvismap.c:434)

```c
void UserGCDeleteAllVisMaps(UserGCProblemDefinitionStruct *Problem)
```

**Problem:** The geometric covering problem to be solved.

**Returns:** void

**Description:** Deleting all visibilty maps from disk.

**See also:** UserGCDeleteVisMap,

15.2.72 UserGCDeleteProcessedObjects (gcvismap.c:680)

```c
void UserGCDeleteProcessedObjects(UserGCProblemDefinitionStruct *Problem)
```

**Problem:** The geometric covering problem to be solved.

**Returns:** void

**Description:** Deleting the geometric object and obstacles files. (Those file were supposed to be saved earlier by UserGCSaveProcessedObject) No error is reported in case of an error.

**See also:** UserGCSaveProcessedObjects, UserGCLoadProcessedObjects,
15.2.73 UserGCExposeCreatePrspMatrix (gcvismap.c:759)

void UserGCExposeCreatePrspMatrix(IrtRType ZAngle,
    IrtRType XYAngle,
    IrtHmgnMatType PrspMat)

ZAngle: IN, The opening in the Z axis of the viewer (which is y axis in our coordinate system).
XYAngle: IN, The opening in the xy plane of the viewer (which is zx plane in our coordinate system).
PrspMat: OUT, Perspective matrix to be used when evaluating the scene visibility map. No change if no
perspective is required.

Returns: void

Description: Exposes UserGCCreatePrspMatrix. Prepare perspective matrix for the given ZAngle and XYAngle.
The perspective matrix is used in order to consider how wide is the opening of the observation points.

15.2.74 UserGCExposeCreateViewMatrix (gcvismap.c:943)

void UserGCExposeCreateViewMatrix(const UserGCObsPtSuggestionStruct *Op,
    IrtHmgnMatType ViewMat)

Op: IN, The observation point from which the scene will be seen.
ViewMat: OUT, View matrix which set modification of the scene so it will be seen from different location
or/and direction.

Returns: void

Description: Exposing UserGCCreateViewMatrix. Prepare view matrix for the given observation point. Us-
ing this matrix any scene can be modified to look the way it will be seen from the given observation point. Call
UserGCCreateViewMatrix2 with USER

15.2.75 UserGCExposeCreateViewMatrix2 (gcvismap.c:869)

void UserGCExposeCreateViewMatrix2(const UserGCObsPtSuggestionStruct *Op,
    IrtHmgnMatType ViewMat,
    const IrtVecType Up)

Op: IN, The observation point from which the scene will be seen.
ViewMat: OUT, View matrix which set modification of the scene so it will be seen from different location
or/and direction.
Up: IN, The general direction of the Up.

Returns: void

Description: Exposing UserGCCreateViewMatrix2. Prepare view matrix for the given observation point. Using
this matrix any scene can be modified to look the way it will be seen from the given observation point.

15.2.76 UserGCExposeDivideAndCreateViewMatrices (gcvismap.c:1003)

void UserGCExposeDivideAndCreateViewMatrices(UserGCObsPtSuggestionStruct
    *ObsPt,
    IrtRType OpeningInXY,
    IrtRType OpeningInZ,
    int *ObsPtsNum,
    IrtRType *OpeningOutXY,
    IrtRType *OpeningOutZ,
    IrtHmgnMatType ViewMats[6])

ObsPt: IN, The observation point to divide.
OpeningInXY: IN, The input angle opening in the zx plane.
OpeningInZ: IN, The input angle opening in the y direction.
ObsPtsNum: OUT, Number of observation points returned.
OpeningOutXY: OUT, The output angle opening in xz plane of all returned angles.
OpeningOutZ: OUT, The output angle opening in xz plane of all returned angles.
ViewMats: OUT, View matrices for the observation points. 6 at most.

Returns: void

Description: Expose UserGC DivideAndCreateViewMatrices. Call UserGC DivideOP to divide the observation
point and then return view matrices for each of them.

15.2.77 UserGCExposeDivideOP (gcvismap.c:1760)

void UserGCExposeDivideOP(UserGCObsPtSuggestionStruct *ObsPt,
  IrtRType OpeningInXY,
  IrtRType OpeningInZ,
  int *ObsPtsNum,
  UserGCObsPtSuggestionStruct *ObsPts,
  IrtRType *OpeningOutXY,
  IrtRType *OpeningOutZ)

ObsPt: IN, The observation point to divide.
OpeningInXY: IN, The input angle opening in the xz plane.
OpeningInZ: IN, The input angle opening in the y direction.
ObsPtsNum: OUT, Number of observation points returned.
ObsPts: OUT, The returned observation points (6 at most).
OpeningOutXY: OUT, The output angle opening in xz plane of all returned angles.
OpeningOutZ: OUT, The output angle opening in xz plane of all returned angles.

Returns: void

Description: Divide the observation point into minimum number of observation points covering the same
OpeningInXY and OpeningInZ. Each observation point cover at most 120 degrees in XY. On Z there is no division
and up to 175 degrees are accepted. This mean at most 6 observation points are returned. If OpeningInXY is
between 120 and 120+USER_GC_ANGLE_OVARLAP one observation point greater than 120 is still returned in that
direction.

15.2.78 UserGCExposeInterpretOPGroupsSuggestion (gcvismap.c:3135)

int UserGCExposeInterpretOPGroupsSuggestion(
  UserGCProblemDefinitionStruct *Problem)

Problem: The problem to process.

Returns: TRUE if successful, FALSE otherwise.

Description: Expose UserGC InterpretOPGroupsSuggestion. The observation points groups of this problem
may contain implicitly defined observation points (such as 20 observation points around a sphere). This function will
create explicitly defined observation points for all those observation points.

15.2.79 UserGCExposePrepareScene (gcvismap.c:2147)

int UserGCExposePrepareScene(UserGCProblemDefinitionStruct *Problem)

Problem: The geometric covering problem to be solved.

Returns: return FALSE if failed saving the object (when required).

Description: Expose UserGC PrepareScene. Preparing the scene to be rendered. The objects stored in Problem->GeoObj and Problem->Obstacles are destroyed and mustn’t be accessed again. They are replaced by the results of
this function. Both objects should already contain only object of type polygon connected only by pnext (not
by U.Lst). Both objects are going through the processing mentioned in UserGCPrepareObj. If Problem->DebugParams.LoadObjectsFromDisk is TRUE the new created objects are saved to disk using UserGCSaveProcessedObject
and can be later accessed using UserGCLoadProcessedObject if.
15.2.80 UserGCGetOPsNum (gcvismap.c:3359)

int UserGCGetOPsNum(UserGCProblemDefinitionStruct *Problem)

Problem: The problem to count its observation points.
Returns: The number of observation points in the problem.
Description: Return number of observation points in the given problem.

15.2.81 UserGCInterpretOPGroupsSuggestion (gcvismap.c:3158)

int UserGCInterpretOPGroupsSuggestion(UserGCProblemDefinitionStruct *Problem)

Problem: The problem to process.
Returns: TRUE if successful, FALSE otherwise.
Description: The observation points groups of this problem may contain implicitly defined observation points (such as 20 observation points around a sphere) This function will create explicitly defined observation points for all those observation points.

15.2.82 UserGCLoadPpmImageFromFile (gesetcvr.c:358)

IrtImgPixelStruct *UserGCLoadPpmImageFromFile(const char* FileName, int *Width, int *Height)

FileName: IN, The name of the file to load.
Width: OUT, The width of the image.
Height: OUT, The height of the image.
Returns: The loaded visibility map or NULL if failed (Error message is produced by the function).
Description: Loading image from a file into format of MiscISCPixelType.

15.2.83 UserGCLoadProcessedObjects (gcvismap.c:619)

void UserGCLoadProcessedObjects(UserGCProblemDefinitionStruct *Problem, IPObjectStruct **GeoObj, IPObjectStruct **Obstacles)

Problem: IN, The geometric covering problem to be solved.
GeoObj: OUT, The loaded geometric object. If NULL it’s ignored. The geometric object can’t be empty. This will be an error.
Obstacles: OUT, The loaded obstacles. If NULL, it’s ignored. Obstacles might be empty in which case *Obstacles will be NULL.
Returns: void
Description: Loading both geometric object and obstacle object from disk. (Those file were supposed to be saved earlier by UserGCSaveProcessedObject) If an error occur it longjmp to UserGCStartOfProcess.
See also: UserGCSaveProcessedObjects, UserGCDeleteProcessedObjects,

15.2.84 UserGCLoadVisMap (gcvismap.c:338)

IrtImgPixelStruct *UserGCLoadVisMap(UserGCProblemDefinitionStruct *Problem, int Index)

Problem: The geometric covering problem to be solved.
Index: The index of the visibility map.
Returns: The loaded visibility map (new allocated memory using IritMalloc) or NULL in case of an error.
Description: Exposing UserGCLoadVisMap outside. Loading visibility map with the given index from disk where UserGCSaveVisMap saved it earlier. If an error occur returns NULL.
See also: UserGCSaveVisMap, UserGCLoadVisMap2,
15.2.85  UserGCLoadVisMap2  (gcvismap.c:368)

IrtImgPixelStruct *UserGCLoadVisMap2(UserGCProblemDefinitionStruct *Problem, int Index)

Problem: The geometric covering problem to be solved.
Index: The index of the visibility map.
Returns: The loaded visibility map (new allocated memory using IritMalloc).
Description: Loading visibility map with the given index from disk where UserGCSaveVisMap saved it earlier. If an error occurs it longjmp to UserGCStartOfProcess.
See also: UserGCSaveVisMap, UserGCDeleteVisMap,

15.2.86  UserGCPrepareObj  (gcvismap.c:3328)

static IPObjStruct *UserGCPrepareObj(IPObjStruct *PObj, int MapWidth, int MapHeight, IPObjStruct *PObj2)

PObj: The object to prepare. The object should already contain only object of type polygon connected only by pnext (not by U.Lst). This object can't be used anymore after this function returns. Use the return object instead.
MapWidth, MapHeight: The dimension of the visibility map. Used in order to arrange the UV domain of all PObj's objects. If any of them is 0, the function won't handle the UV domain of the objects.
PObj2: If it isn't NULL, this object is a list of objects which contains at least as much elements as PObj. Each element i in PObj2 will go through the same UV Transformations and scaling as element i in PObj. Objects which aren't surfaces, trimmed surfaces or polygons are ignored.
Returns: The prepared scene.
Description: Prepares an object which means: * Unites all polygon objects into one polygon object. * Change the uv values of all objects so they won't collide with each other's uv spaces. The returned object may differ from PObj. PObj mustn't be accessed again after calling this function.

15.2.87  UserGCPrepareScene  (gcvismap.c:2180)

void UserGCPrepareScene(UserGCProblemDefinitionStruct *Problem)

Problem: The geometric covering problem to be solved.
Returns: void
Description: Preparing the scene to be rendered. The objects stored in Problem->GeoObj and Problem->Obstacles are destroyed and mustn't be accessed again. They are replaced by the results of this function. Both objects should already contain only object of type polygon connected only by pnext (not by U.Lst). Both objects are going through the processing mentioned in UserGCPrepareObj. If Problem->DebugParams.LoadObjectsFromDisk is TRUE the new created objects are saved to disk using UserGCSaveProcessedObject and can be later accessed using UserGCLoadProcessedObject.

15.2.88  UserGCSavePpmImageToFile  (gcsctcvr.c:318)

int UserGCSavePpmImageToFile(const char* FileName, IrtImgPixelStruct* VisMap, int Width, int Height)

FileName: The name of the file to save (without an extension).
VisMap: The visibility map to save.
Width: Width of the map.
Height: Height of the map.
Returns: FALSE if failed saving (Error message is produced by the function).
Description: Saving image in a ppm 6 format.
15.2.89 UserGCSaveProcessedObjects (gcvismap.c:577)

```c
void UserGCSaveProcessedObjects(UserGCProblemDefinitionStruct *Problem)
```

**Problem**: The geometric covering problem to be solved.

**Returns**: void

**Description**: Saving both geometric object and obstacle object to disk so they can later be loaded using UserGCLoadProcessedObjects. If an error occur it longjmp to UserGCStartOfProcess.

**See also**: UserGCLoadProcessedObjects, UserGCDeleteProcessedObjects,

15.2.90 UserGCSetColorPlList (gcvismap.c:2771)

```c
static void UserGCSetColorPlList(IPPolygonStruct *Pl, int r, int g, int b)
```

- **Pl**: The polygons list to set their color.
- **r, g, b**: The color to set.

**Returns**: void

**Description**: Set the given color to all the polygon list.

15.2.91 UserGCSolveGeoProblem (gcssetcvr.c:428)

```c
int UserGCSolveGeoProblem(UserGCProblemDefinitionStruct *Problem,
UserGCSolutionIndexStruct *** SolutionOps,
IrtRType *CoverPart)
```

- **Problem**: IN OUT, The geometric covering problem to be solved.
- **SolutionOps**: OUT, Null terminated array of solving Suggestions. Each element in the array doesn’t contain the suggestions itself but indices to the suggestion. The first two indices point to the location of the suggestion inside Problem -> ObsPtsGroups. Those are the index of the observation group and the index of the suggestion inside that observation group. The third index is the index in the continues index of all suggestions together (The index in which the visibility map is saved to disk).
- **CoverPart**: OUT, Will hold the part of the cover picture that we succeeded to cover.

**Returns**: Return FALSE if encountered error.

**Description**: Solves the geometric covering problem given by Problem and returns the solving observation points. The geometric object and obstacles of Problem are going through further processing and becoming compatible with the objects sent to the visibility map generator. The objects stored in Problem->GeoObj and Problem->Obstacles are destroyed and mustn’t be accessed again. They are replaced by a processed version of themselves. Both objects should already contain only object of type polygon connected only by pnext (not by U.Lst). The function may fail, in which case errors will be annouced to the user and it will return FALSE.

15.2.92 UserHCEditCopy (hrmt_crvcrv.c:375)

```c
VoidPtr UserHCEditCopy(VoidPtr HC)
```

- **HC**: A handle on the edited Hermite curve to be duplicated.

**Returns**: Duplicated HC.

**Description**:Duplicates the data structures for editing planar piecewise cubic Hermite curves.

**See also**: UserHCEditInit,
### 15.2.93 UserHCEditCreateAppendCtlpt (hrmt\_crv.c:423)

```c
int UserHCEditCreateAppendCtlpt(VoidPtr HC,  
    CagdRType x,  
    CagdRType y,  
    int MouseMode)
```

- **HC**: A handle on edited Hermite curve to append control point to.
- **x, y**: The coordinate of the control point.
- **MouseMode**: 0 for mouse down, 1 for mouse move, 2 for mouse up (done).
- **Returns**: TRUE if successful, FALSE otherwise.
- **Description**: Append control point at the end of the current curve.
- **See also**: UserHCEditInit,

### 15.2.94 UserHCEditCreateDone (hrmt\_crv.c:523)

```c
int UserHCEditCreateDone(VoidPtr HC, CagdRType LastX, CagdRType LastY)
```

- **HC**: A handle on the edited Hermite curve to insert control point to.
- **LastX, LastY**: Last control point of curve, during creation stage.
- **Returns**: TRUE if successful, FALSE otherwise.
- **Description**: Initializes the interface for editing planar piecewise cubic Hermite curves.
- **See also**: UserHCEditInit,

### 15.2.95 UserHCEditDelete (hrmt\_crv.c:336)

```c
void UserHCEditDelete(VoidPtr HC)
```

- **HC**: A handle on the edited Hermite curve to be deleted.
- **Returns**: void
- **Description**: Delete the data structures for editing planar piecewise cubic Hermite curves.
- **See also**: UserHCEditInit,

### 15.2.96 UserHCEditDeleteCtlpt (hrmt\_crv.c:632)

```c
int UserHCEditDeleteCtlpt(VoidPtr HC, CagdRType x, CagdRType y)
```

- **HC**: A handle on edited Hermite curve to delete control point from.
- **x, y**: The coordinate of the point.
- **Returns**: TRUE if successful, FALSE otherwise.
- **Description**: Delete the control point at the given location on the current curve.
- **See also**: UserHCEditInit,

### 15.2.97 UserHCEditDrawCtlpts (hrmt\_crv.c:1563)

```c
int UserHCEditDrawCtlpts(VoidPtr HC, int DrawTans)
```

- **HC**: A handle on edited Hermite curve to update its Index segment.
- **DrawTans**: Do we want to draw tangents as well?
- **Returns**: TRUE if successful, FALSE otherwise.
- **Description**: Draw the control points of the given HC, using the defined drawing function.
- **See also**: UserHCEditInit,
15.2.98  UserHCEditEvalDefTans (hrmt_crv.c:1795)

    int UserHCEditEvalDefTans(VoidPtr HC, int Index)
    
    HC: A handle on edited Hermite curve to update its tangents.
    Index: Of the curve whose tangent is to be updated (with Index + 1).
    Returns: TRUE if successful, FALSE otherwise.
    Description: Routine to update the tangents of the given HC curve to a reasonable magnitude and direction. Useful when tangent handles are not provided to the end user.
    See also: UserHCEditInit,

15.2.99  UserHCEditFromCurve (hrmt_crv.c:122)

    VoidPtr UserHCEditFromCurve(const CagdCrvStruct *Crv, CagdRType Tol)
    
    Crv: Regular curve to convert to an Hermite curve.
    Tol: Tolerance of approximation if the input curve is higher degree than cubic.
    Returns: A Handle on the created HC to be edited.
    Description: Create a Hermite curve from the given regular curve.
    See also: SymbApproxCrvAsBzrCubics, UserHCEditInit,

15.2.100 UserHCEditGetCrvRepresentation (hrmt_crv.c:1410)

    CagdCrvStruct *UserHCEditGetCrvRepresentation(VoidPtr HC, int ArcLen)
    
    HC: A handle on edited Hermite curve to convert to Bspline.
    ArcLen: TRUE to approximately parametrize the geometry to follow arc length parametrization, FALSE to apply uniform parametrization.
    Returns: A Bspline curve representing the given HC.
    Description: Constructs one (Bspline) curve representation for the given HC.
    See also: UserHCEditInit,

15.2.101 UserHCEditGetCtlPtCont (hrmt_crv.c:240)

    CagdBType UserHCEditGetCtlPtCont(VoidPtr HC, int Index)
    
    HC: A handle on edited Hermite curve to update its Index segment.
    Index: Of control point to get its C^1 continuity state.
    Returns: TRUE for C^1 continuity, FALSE for C^0.
    Description: Gets the continuity of the Index control point in the given curve.
    See also: UserHCEditInit,

15.2.102 UserHCEditGetCtlPtTan (hrmt_crv.c:1516)

    int UserHCEditGetCtlPtTan(VoidPtr HC, int Index, CagdPType Pos, CagdPType Tan)
    
    HC: A handle on edited Hermite curve to fetch one of its HC control points and tangent.
    Index: Of control point and tangent to fetch. If Index is negative the backward tangent is fetched.
    Pos: Position to fetch.
    Tan: Tangent to fetch.
    Returns: TRUE if successful, FALSE otherwise.
    Description: Returns the position and tangent of the Index control point of the HC curve. First point is index zero. Tan is always pointing along the forward moving direction of the curve.
    See also: UserHCEditInit,
15.2.103  UserHCEditGetNumCtlPt  (hrmt\_crv.c:1485)

```c
int UserHCEditGetNumCtlPt(VoidPtr HC)
```

**HC**: A handle on edited Hermite curve to get its size.

**Returns**: Number of HC control points.

**Description**: Returns number of HC control points this HC curve has. These points are end points of Hermite intervals. For example, a curve with three Hermite intervals will have 4 HC control points.

**See also**: UserHCEditInit,

15.2.104  UserHCEditInit  (hrmt\_crv.c:81)

```c
VoidPtr UserHCEditInit(CagdRType StartX, CagdRType StartY, CagdBType Periodic)
```

**StartX, StartY**: Starting control point of curve.

**Periodic**: TRUE if curve is to be closed.

**Returns**: A Handle on the created HC to be edited.

**Description**: Initializes the interface for editing planar piecewise cubic Hermite curves.

**See also**: UserHCEditFromCurve, UserHCEditIsPeriodic, UserHCEditSetPeriodic, , UserHCEditSetCtlPtCont, UserHCEditSetDrawCtlptFunc, UserHCEditTranslate, UserHCEditCreateAppendCtlpt, UserHCEditCreateDone, , UserHCEditInsertCtlpt, UserHCEditDeleteCtlpt, UserHCEditMoveCtl, , UserHCEditMoveCtlPt, UserHCEditMoveCtlTan, UserHCEditIsNearCrv, , UserHCEditIsNearCtlPt, UserHCEditIsNearCtlTan, , UserHCEditGetCrvRepresentation, UserHCEditDrawCtlpts, , UserHCEditTransform, UserHCEditRelativeTranslate, UserHCEditEvalDefTans,

15.2.105  UserHCEditInsertCtlpt  (hrmt\_crv.c:555)

```c
int UserHCEditInsertCtlpt(VoidPtr HC, CagdRType x, CagdRType y, CagdRType t)
```

**HC**: A handle on the edited Hermite curve to insert control point to.

**x, y**: The coordinate of the point.

**t**: The parameter location to insert a new control point.

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: Insert new control point at the given parameter value of the curve.

**See also**: UserHCEditInit,

15.2.106  UserHCEditIsNearCrv  (hrmt\_crv.c:1139)

```c
int UserHCEditIsNearCrv(VoidPtr HC, CagdRType x, CagdRType y, CagdRType *t, CagdRType Eps, int NormalizeZeroOne)
```

**HC**: A handle on edited hermite curve to see if we are close.

**x, y**: The coordinate of the given location.

**t**: The closest parameter location detected near the mouse.

**Eps**: Distance to consider it near.

**NormalizeZeroOne**: If TRUE detected parameter is normalized into zero to one for beginning to end. Otherwise, if FALSE, the returned parameter is 'x.y' where x is the Hermite segment number and y is the relative location within the segment.

**Returns**: TRUE if given location is indeed near curve, FALSE otherwise.

**Description**: Routine to examine if given location is near HC to within Eps.

**See also**: UserHCEditInit,
15.2.107  UserHCEditIsNearCtlPt  (hrmt\_crv.c:1246)

```c
int UserHCEditIsNearCtlPt(VoidPtr HC,
   CagdRType *x,
   CagdRType *y,
   int *Index,
   int *UniqueID,
   CagdRType Eps)
```

**HC**: A handle on edited Hermite curve to see if we are close.

**x, y**: The coordinate of the given location. This coordinated will be updated with the precise control point location, if indeed near.

**Index**: Of closest control point, if found any below distance Eps, in the curve, first points is indexed 0.

**UniqueID**: The unique integer ID that is assigned to this control point.

**Eps**: Distance to consider it near.

**Returns**: TRUE if given location is indeed near a control point, FALSE otherwise.

**Description**: Routine to examine if given location is near a control point of HC to within Eps.

See also: UserHCEditInit,

15.2.108  UserHCEditIsNearCtlTan  (hrmt\_crv.c:1332)

```c
int UserHCEditIsNearCtlTan(VoidPtr HC,
   CagdRType *x,
   CagdRType *y,
   int *Index,
   int *UniqueID,
   CagdBType *Forward,
   CagdRType Eps)
```

**HC**: A handle on edited Hermite curve to see if we are close.

**x, y**: The coordinate of the given location. This coordinated will be updated with the precise control tangent location, if indeed near.

**Index**: Of closest control tangent, if found any below distance Eps.

**UniqueID**: The unique integer ID that is assigned to this control point.

**Forward**: TRUE for forward tangent, FALSE for backward tangent.

**Eps**: Distance to consider it near.

**Returns**: TRUE if given location is indeed near a control tangent, FALSE otherwise.

**Description**: Routine to examine if given location is near a control tangent of HC, to within Eps.

See also: UserHCEditInit,

15.2.109  UserHCEditIsPeriodic  (hrmt\_crv.c:178)

```c
int UserHCEditIsPeriodic(VoidPtr HC)
```

**HC**: A handle on the Hermite curve to be examined.

**Returns**: TRUE if given HC curve is periodic, FALSE otherwise.

**Description**: Gets the periodic conditions of the given HC curve.

See also: UserHCEditInit,
15.2.110 UserHCEditMatTrans (hrmt_crv.c:1643)

int UserHCEditMatTrans(VoidPtr HC, IrtHmgnMatType Mat)

HC: A handle on edited Hermite curve to transform, in place.
Mat: Transformation matrix to apply to HC.

Returns: TRUE if successful, FALSE otherwise.

Description: Applies given transformation, in place, to given curve HC as specified by Mat. Only the XY coordinates are processed. Curve HC is first translated by Dir and then scaled by Scale.
See also: CagdCrvTransform, UserHCEditInit, UserHCEditTransform,

15.2.111 UserHCEditMoveCtl (hrmt_crv.c:832)

int UserHCEditMoveCtl(VoidPtr HC, CagdRType OldX, CagdRType OldY, CagdRType NewX, CagdRType NewY, int *MinDist)

HC: A handle on edited Hermite curve to move control pt/tan in.
OldX, OldY: The original coordinate of the control pt/tan.
NewX, NewY: The original coordinate of the control pt/tan.

Returns: TRUE if successful, FALSE otherwise.

Description: Move a control point or tangent (the closest detected) of the current curve.
See also: UserHCEditInit,

15.2.112 UserHCEditMoveCtlPt (hrmt_crv.c:910)

int UserHCEditMoveCtlPt(VoidPtr HC, CagdRType OldX, CagdRType OldY, CagdRType NewX, CagdRType NewY, int MouseMode)

HC: A handle on edited Hermite curve to move control point in.
OldX, OldY: The original coordinate of the point.
NewX, NewY: The new coordinate of the point.

Returns: TRUE if successful, FALSE otherwise.

Description: Move a control point of the current curve.
See also: UserHCEditInit,
15.2.113 UserHCEditMoveCtlTan (hrmt_crv.c:989)

```c
int UserHCEditMoveCtlTan(VoidPtr HC, 
    CagdRType OldX, 
    CagdRType OldY, 
    CagdRType NewX, 
    CagdRType NewY, 
    int MouseMode)
```

**HC**: A handle on edited Hermite curve to move control tangent in.

**OldX, OldY**: The original coordinate of the tangent.

**NewX, NewY**: The new coordinate of the tangent.

**MouseMode**: 0 for mouse down, 1 for mouse move, 2 for mouse up (done).

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: Move a control tangent of the current curve.

**See also**: UserHCEditInit,

15.2.114 UserHCEditRelativeTranslate (hrmt_crv.c:1738)

```c
int UserHCEditRelativeTranslate(VoidPtr HC, CagdRType *Dir)
```

**HC**: A handle on edited Hermite curve to relatively transform, in place.

**Dir**: Relative translation amount, applied in full just to last control point.

**Returns**: TRUE if successful, FALSE otherwise.

**Description**: Applies a relative translation, in place, to given curve HC as specified by Dir. The full translation amount is applied to the last point while the first is kept stationary and all interior control points are moved their relative portion.

**See also**: UserHCEditInit,

15.2.115 UserHCEditSetCtlPtCont (hrmt_crv.c:275)

```c
void UserHCEditSetCtlPtCont(VoidPtr HC, int Index, CagdBType Cont)
```

**HC**: A handle on edited Hermite curve to update its Index segment.

**Index**: Of control point to change its C\(^1\) continuity.

**Cont**: TRUE to make C\(^1\) continuous, FALSE for only C\(^0\).

**Returns**: void

**Description**: Sets the continuity of the Index control point in the given curve.

**See also**: UserHCEditInit,

15.2.116 UserHCEditSetDrawCtlptFunc (hrmt_crv.c:311)

```c
void UserHCEditSetDrawCtlptFunc(VoidPtr HC, UserHCEditDrawCtlPtFuncType CtlPtDrawFunc)
```

**HC**: A handle on edited Hermite curve to update its Index segment.

**CtlPtDrawFunc**: Function to use to draw control points/tangent.

**Returns**: void

**Description**: Sets the function to invoke when the control points/tangents are to be drawn.

**See also**: UserHCEditInit,
15.2.117  UserHCEditSetPeriodic  (hrmt\_crv.c:203)

void UserHCEditSetPeriodic(VoidPtr HC, CagdBType Periodic)

   HC: A handle on Hermite curve to be set periodic (or not).
   Periodic: TRUE if curve is to be closed (periodic).
   Returns: void

   Description: Sets the periodic conditions of the given HC curve.
   See also: UserHCEditInit,

15.2.118  UserHCEditTransform  (hrmt\_crv.c:1688)

int UserHCEditTransform(VoidPtr HC, CagdRType *Dir, CagdRType Sc1)

   HC: A handle on edited Hermite curve to transform, in place.
   Dir: Translation amount, in the XY plane.
   Sc1: Scaling amount, in the XY plane.
   Returns: TRUE if successful, FALSE otherwise.

   Description: Applies an affine transform, in place, to given curve HC as specified by Dir and Scale. Curve HC
   is first translated by Dir and then scaled by Scale.
   See also: CagdCrvTransform, UserHCEditInit, UserHCEditMatTrans,

15.2.119  UserHCEditUpdateCtl  (hrmt\_crv.c:722)

int UserHCEditUpdateCtl(VoidPtr HC, int CtlIndex, CagdBType IsPosition, CagdRType NewX, CagdRType NewY)

   HC: A handle on edited Hermite curve to move control pt/tan in.
   CtlIndex: The index of the control pt/tan to update
   IsPosition: TRUE if we aim at updating the position of control pt/tan. If FALSE, positive CtlIndex denotes
   forward tangent whereas negative CtlIndex denotes a backward tangent.
   NewX, NewY: New position or tangent vector to update with.
   Returns: TRUE if successful, FALSE otherwise.

   Description: Update a control point or tangent of the current curve.
   See also: UserHCEditInit,

15.2.120  UserKnmtcsEvalAtParams  (kinematc.c:1576)

void UserKnmtcsEvalAtParams(int PolyIdx, int PtIdx)

   PolyIdx: Polyline index.
   PtIdx: Point index.
   Returns: void

   Description: Evaluates kinematic mechanism at given solution. Solution is stored as a linked list of polylines,
   each position is uniquely determined by indices of the polyline and the point inside this polyline
15.2.121 UserKnmtcsEvalCrvTraces (kinematc.c:1511)

CagdCrvStruct *UserKnmtcsEvalCrvTraces()

Returns: List of curves of all traces of all points in the mechanisms.
Description: Evaluates the motions curves of all the points in the kinematic mechanism at the solution.

15.2.122 UserKnmtcsFreeSol (kinematc.c:1155)

void UserKnmtcsFreeSol(void)

Returns: void
Description: Deallocated and frees the kinematic solution stored as a list of multi-variate polyline structures.

15.2.123 UserKnmtcsNumOfSolPts (kinematc.c:1482)

int UserKnmtcsNumOfSolPts(int PolyIdx)

PolyIdx: Polyline index.
Returns: Number of points in the polyline.
Description: For a solution polyline at "PolyIdx"’s position, the number of solution points is returned.

15.2.124 UserKnmtcsSolveDone (kinematc.c:1174)

void UserKnmtcsSolveDone(void)

Returns: void
Description: Reset all information given to the solver to initial state.

15.2.125 UserKnmtcsSolveMotion (kinematc.c:1205)

int UserKnmtcsSolveMotion(const UserKnmtcsStruct *System,
                          CagdRType NumTol,
                          CagdRType SubTol,
                          CagdRType Step,
                          int *SolDim,
                          CagdBType FilterSols)

System: Kinematic system.
NumTol: Numerical tolerance.
SubTol: Subdivision tolerance.
Step: "Animation" step.
SolDim: Dimension of the solution, even if invalid/error.
FilterSols: True to filter and return only numerically converging solutions.
Returns: Number of solution curves, if any. -1 if error.
Description: For given planar kinematic mechanism, the system of constrains is created and solved. The list of solution points (in the parametric space) is returned.
15.2.126 UserMake3DStatueFrom2Images (imgshd3d.c:128)

IPObj ectStruct *UserMake3DStatueFrom2Images(const char *Image1Name,  
const char *Image2Name,  
int DoTexture,  
const IPObj ectStruct *Blob,  
User3DSpreadType BlobSpreadMethod,  
UserImgShd3dBlobColorType BlobColorMethod,  
int Resolution,  
int Negative,  
IrtRType Intensity,  
IrtRType MinIntensity,  
int MergePolys)

Image1Name: Name of 1st image to load.
Image2Name: Name of 2nd image to load.
DoTexture: TRUE to add 'uvvals' attributes, FALSE to add actual color to the vertices of the objels.
Blob: If specified used as the blob. If NULL, a 2-cross is used. Blob must be of size one in each axis, probably centered around the origin. Must be a list of 3 objects for blob coloring methods other than "No color".
BlobSpreadMethod: Method of spreading the blobs.
BlobColorMethod: Method of coloring each blob.
Resolution: Resolution of created objects (n^2 objects are created).
Negative: Default (FALSE) is white blobs over dark background. If TRUE, assume dark blobs over white background.
Intensity: The gray level affect on the blobs' scale.
MinIntensity: Minimum intensity allowed. Zero will collapse the blobl completely in one direction which will render it impossible to actually manufacture it.
MergePolys: TRUE to merge all objects' polygons into one object.
Returns: A list (poly if MergePolys) object of Resolution^2 spherical blobs.
Description: Creates Resolution^2 blobs that looks like the 1st image (gray level) from the XZ plane and like the 2nd image from the YZ plane.

15.2.127 UserMake3DStatueFrom3Images (imgshd3d.c:330)

IPObj ectStruct *UserMake3DStatueFrom3Images(const char *Image1Name,  
const char *Image2Name,  
const char *Image3Name,  
int DoTexture,  
const IPObj ectStruct *Blob,  
User3DSpreadType BlobSpreadMethod,  
UserImgShd3dBlobColorType BlobColorMethod,  
int Resolution,  
int Negative,  
IrtRType Intensity,  
IrtRType MinIntensity,  
int MergePolys)

Image1Name: Name of 1st image to load.
Image2Name: Name of 2nd image to load.
Image3Name: Name of 3rd image to load.
DoTexture: TRUE to add 'uvvals' attributes, FALSE to add actual color to the vertices of the objels.
Blob: If specified used as the blob. If NULL, a 3-cross is used. Blob must be of size one in each axis, probably centered around the origin. Should hold 3 polygons for "No color" color method and should hold a list of 3 objects for the other methods.
BlobSpreadMethod: Method of spreading the blobs.
BlobColorMethod: Method of coloring each blob.
**Resolution**: Resolution of created objects (n^2 objects are created).

**Negative**: Default (FALSE) is white blobs over dark background. If TRUE, assume dark blobs over white background.

**Intensity**: The gray level affect on the blobs’ scale.

**MinIntensity**: Minimum intensity allowed. Zero will collapse the blobl completely in one direction which will render it impossible to actually manufacture it.

**MergePolys**: TRUE to merge all objects’ polygons into one object.

**Returns**: A list (poly if MergePolys) object of Resolution^2 spherical blobs.

**Description**: Creates Resolution^2 3D cross blobs that looks like the 1st image (gray level) from the XZ plane, like the 2nd image from the YZ plane, and like the 3rd image from the XY plane. A 3D cross is used as a blob.

### 15.2.128 UserMarchOnPolygons (srf.mrch.c:275)

```c
IPPolygonStruct *UserMarchOnPolygons(const IPObjectStruct *PObj,
UserSrfMarchType MarchType,
const IPPolygonStruct *PlHead,
IPVertexStruct *VHead,
CagdRType Length)
```

**PObj**: This polygonal object we march on.

**MarchType**: Type of march - isoparametric, lines of curvature, etc.

**PlHead**: Polygon from the polygonal mesh with start at.

**VHead**: Starting vertex of the march. Must be on Pl.

**Length**: Length of March.

**Returns**: A piecewise linear approximation of the march.

**Description**: Marches and create a polyline on the given polygonal mesh, of given Length. Mesh is assumed to have adjacency information, and normals and curvature information at the vertices, if MarchType is SILHOUTETE or CURVATURE, respectively. Further, the mesh is assumed to consist of triangles only, and is regularized.

**See also**: BoolGenAdjacencies, UserMarchOnSurface.

### 15.2.129 UserMarchOnSurface (srf.mrch.c:73)

```c
IPPolygonStruct *UserMarchOnSurface(UserSrfMarchType MarchType,
const CagdUVType UVOrig,
const CagdVType DirOrig,
const CagdSrfStruct *Srf,
const CagdSrfStruct *NSrf,
const CagdSrfStruct *DuSrf,
const CagdSrfStruct *DvSrf,
CagdRType Length,
CagdRType FineNess,
CagdBType ClosedInU,
CagdBType ClosedInV)
```

**MarchType**: Type of march - isoparametric, lines of curvature, etc. for USER_SRF_MARCH_PRIN_CRVTR type, it is assumed that SymbEvalSrfCurvPrep was invoked on Srf before this function is called for the proper preparations.

**UVOrig**: Origin on surface where the march starts.

**DirOrig**: Direction to march on surface (projected to tangent plane). If, however, MarchType == SRF_MARCH_ISO_PARAM, Dir contains the direction in the parametric, UV, space.

**Srf**: Surface to march on.

**NSrf**: Normal field of surface to march on (optional).

**DuSrf**: Partial with respect to u (optional).

**DvSrf**: Partial with respect to v (optional).

**Length**: Length of March.

**FineNess**: Number of estimated steps along the approximated march.
ClosedInU: TRUE if surface is closed in U direction, FALSE otherwise.
ClosedInV: TRUE if surface is closed in V direction, FALSE otherwise.

Returns: A piecewise linear approximation of the march.

Description: Marches and create a polyline on the surface of given Length. NSrf, DuSrf, and DvSrf are computed locally if not provided which would reduce the efficiency of a sequence of surface marching procedures, on the same surface.

See also: SymbEvalSrfCurvPrep, UserMarchOnPolygons.

15.2.130 UserMinDistLineBBBox  (userpick.c:38)

IrtRType UserMinDistLineBBBox(const IrtPtType LinePos,
const IrtVecType LineDir,
IrtBboxType BBox)

LinePos: Point on the 3-space line.
LineDir: Direction of the 3-space line.
BBox: Bounding box, parallel to main planes.

Returns: Minimal distance between the line and the bbox.

Description: Computes the closest distance between a 3-space line and a bounding box.

See also: UserMinDistLinePolylineList, UserMinDistLinePolygonList.

15.2.131 UserMinDistLinePolygonList  (userpick.c:214)

IrtRType UserMinDistLinePolygonList(const IrtPtType LinePos,
const IrtVecType LineDir,
IPPolygonStruct *Pls,
IPPolygonStruct **MinPl,
IrtPtType MinPt,
IrtRType *HitDepth,
IrtRType *IndexFrac)

LinePos: Point on the 3-space line.
LineDir: Direction of the 3-space line.
Pls: List of polygons.
MinPl: Will be set to the closest polyline.
MinPt: Will be set to the closest point.
HitDepth: If a direct hit (zero distance is returned), the depth of the hit is returned here, as the value of parameter t in LinePos + t * LineDir.
IndexFrac: Will be set to the index of the closest point, starting from zero. Index of 3.5 means the closest is in the mid point from point 3 to point 4. This value should be ignored for a direct hit (return value equal zero). Valid for one polygon in input.

Returns: Minimal distance from the 3-space line to the polygons. In case of a direct hit, zero is returned.

Description: Compute the closest distance between a line in three space and a list of polygons. The polygons are assumed to be convex.

See also: UserMinDistLineBBBox, UserMinDistLinePolylineList.

15.2.132 UserMinDistLinePolylineList  (userpick.c:284)

IrtRType UserMinDistLinePolylineList(const IrtPtType LinePos,
const IrtVecType LineDir,
IPPolygonStruct *Pls,
int PolyClosed,
IPPolygonStruct **MinPl,
IrtPtType MinPt,
IrtRType *HitDepth,
IrtRType *IndexFrac)
**LinePos**: Point on the 3-space line.

**LineDir**: Direction of the 3-space line.

**Pls**: List of polylines.

**PolyClosed**: TRUE if polyline is a closed polygon, FALSE otherwise.

**MinPl**: Will be set to the closest polyline.

**MinPt**: Will be set to the closest point.

**HitDepth**: If a hit, the depth of the hit is returned here, as the value of parameter t in LinePos + t * LineDir.

**IndexFrac**: Will be set to the index of the closest point, starting from zero. Index of 3.5 means the closest is in the mid point from point 3 to point 4. Valid for one polyline in input.

**Returns**: Minimal distance from the 3-space line to the polylines.

**Description**: Compute the closest distance between a line in three space and a list of polyline. See also: UserMinDistLineBBox, UserMinDistLinePolygonList, UserMinDistPointPolylineList,

15.2.133 **UserMinDistPointPolylineList** (userpick.c:402)

*IrtRType UserMinDistPointPolylineList(const IrtPtType Pt, IPPolygonStruct *Pls, IPPolygonStruct **MinPl, IPVertexStruct **MinV, int *Index)*

**Pt**: Point in 3-space.

**Pls**: List of polylines.

**MinPl**: Will be set to the closest poly.

**MinV**: Will be set to the closest vertex.

**Index**: Will be set to the index of the closest vertex, starting from zero.

**Returns**: Minimal distance from the 3-space point to the polys.

**Description**: Compute the closest distance between a point in three space and list of polys. Only vertices in the polylines are considered. See also: UserMinDistLineBBox, UserMinDistLinePolygonList,

15.2.134 **UserMoldReliefAngle2Srf** (visible.c:1029)

*TrimSrfStruct *UserMoldReliefAngle2Srf(const CagdSrfStruct *Srf, const CagdVType VDir, CagdRType Theta, int MoreThanTheta, CagdRType SubdivTol)*

**Srf**: Surface to examine its normals’ angular deviation.

**VDir**: View direction vector.

**Theta**: Angular deviation to examine, in degrees, in range (0, 90).

**MoreThanTheta**: TRUE to seek regions of more than theta degrees normal deviation from VDir, FALSE for less than.

**SubdivTol**: Subdivision tolerance of freeforms silhouette approx.

**Returns**: List of trimmed surfaces’ regions of regions of Srf that present angular deviations of less (more) than Theta to VDir.

**Description**: Compute and trim regions in Srf that have normals with angular deviation of more (less) than Theta Degrees from the prescribed direction VDir. Computation is based on extractions of Isoclines of Srf from VDir. See also: SymbSrfIsocline, UserMoldRuledRelief2Srf,
15.2.135 UserMoldRuledRelief2Srf (visible.c:1093)

CagdSrfStruct *UserMoldRuledRelief2Srf(const CagdSrfStruct *Srf,
const CagdVType VDir,
CagdRType Theta,
CagdRType SubdivTol)

Srf: Surface to examine its normals' angular deviation.
VDir: View direction vector.
Theta: Angular deviation to examine, in degrees, in range (0, 90).
SubdivTol: Subdivision tolerance of freeforms silhouette approx.

Returns: List of ruled surfaces that tangently extends from the computed isoclines at the prescribed VDir/Theta.

Description: Compute and add ruled surfaces at all trimmed relief angles' boundaries. Computation is based on extractions of Isoclines of Srf from VDir.
See also: SymbSrfIsocline, UserMoldReliefAngle2Srf.

15.2.136 UserNCContourToolPath (nc_path.c:168)

IPObjectStruct *UserNCContourToolPath(const IPObjectStruct *PObj,
IrtRType Offset,
IrtRType ZBaseLevel,
IrtRType TPathSpace,
IPNCGCodeUnitType Units)

PObj: Object to process and create 3-axis machining tool path for.
Offset: Tool radius to offset the geometry in PObj with.
ZBaseLevel: Bottom level to machine. Created tool path will never be below this level.
TPathSpace: Space between adjacent paths. Also used as a tolerance bound.
Units: Millimeters or inches.

Returns: List of constant X polylines, in zigzag motion, that covers PObj from above (offseted by Offset).

Description: Computes tool path to 3-axis machine from +Z direction the given geometry (Polygonal meshes/surfaces). Assumes a ball end tool. Stages:
1. Tessellate the model into polygons.
2. Verify the existence of (or create approximation thereof) of normal at the vertices of the polygons, & offset all polygons by desired offset.
3. For each Y-section, contour the model at the desired Y-constant level and compute the upper envelop of all contoured line segments as this Y-constant level as one toolpath.
4. Emit the toolpath flipping every second Y-constant path to create a zigzag motion, and move the tool path down by offset amount so it will be referencing the ball-end tool’s bottom.
See also: UserNCPocketToolPath,

15.2.137 UserNCPocketToolPath (nc_path.c:1052)

IPObjectStruct *UserNCPocketToolPath(const IPObjectStruct *PObj,
IrtRType ToolRadius,
IrtRType RoughOffset,
IrtRType TPathSpace,
IrtRType TPathJoin,
IPNCGCodeUnitType Units,
int TrimSelfInters)

PObj: Object to process and create pocket machining tool path for.
ToolRadius: Tool radius to offset the geometry in PObj with.
RoughOffset: Offset amount to use in the roughing stage.
**TPathSpace:** Space between adjacent parallel cut rows. If zero returns just the offset geometry.

**TPathJoin:** maximal distance between end points of tpath to join.

**Units:** Millimeters or inches.

**TrimSelfInters:** TRUE to try and trim self intersections.

**Returns:** List of constant X polylines, in zigzag motion, that covers PObj from above (offseted by Offset).

**Description:** Computes tool path to 2D pocket machining from +Z direction the given geometry (curves/polylines). Geometry is assumed to be closed, possibly with closed islands. Stages:
1. Offset the shape in for roughing, by RoughOffset (+ToolRadius) amount.
2. Compute the contour lines (intersection of parallel lines) with the offseted-in geometry.
3. Merge all contour lines into one large toolpath. Toolpath is sorted so adjacent paths are close within tool diameter, as much as possible to minimize retractions.
4. Add a final, finish, path, at ToolRadius offset from the shape.

**See also:** UserNCContourToolPath,

---

**15.2.138 UserNCUpdateCrvOffsetJoint** (nc_tpath.c:1477)

```c
CagdCrvStruct *UserNCUpdateCrvOffsetJoint(CagdCrvStruct *OrigCrv1,
                                          CagdCrvStruct *OrigCrv2,
                                          CagdCrvStruct **OffCrv1,
                                          CagdCrvStruct **OffCrv2)
```

**OrigCrv1:** To examine its end against Crv2, if the same.

**OrigCrv2:** To examine its start against Crv1, if the same.

**OffCrv1:** To properly update its end against Crv2, if needs to.

**OffCrv2:** To properly update its start against Crv1, if needs to.

**Returns:** A new round curve bnetween OffCrv1 and OffCrv2 if not NULL. Note also that OffCrv1/2 might be changed in place.

**Description:** Update the end of Crv1 and the begining of Crv2 to connect after an offset operation that was applied to them. There are a few options:
1. End of Crv1 is the same of start of Crv (if the two curves are C^1 connected). Do nothing.
2. The two curves intersects. Trim away end of Crv1 and start of Crv2 upto the intersection location. This case is handled assuming small interaction between the two curves only, seeking a single intersection. Note old OffCrv1/2 are freed and being substituted in place with the new trimmed versions.
3. The two curves do not intersect. Add a joint round curve that is C^1 to both Crv1’s end and Crv2’s start. The new joint round curve is returned.

---

**15.2.139 UserPolyline2LinBsplineCrv** (usrcnvrt.c:70)

```c
CagdCrvStruct *UserPolyline2LinBsplineCrv(const IPPolygonStruct *Poly,
                                          CagdBType FilterDups)
```

**Poly:** To convert to a linear bspline curve.

**FilterDups:** If TRUE, filters out duplicates points, in polygon, in place.

**Returns:** A linear Bspline curve representing Poly.

**Description:** Returns a linear Bspline curve constructed from given polyline.

**See also:** CagdCnvrtPolyline2LinBspCrv, UserPolylines2LinBsplineCrvs,

---

**15.2.140 UserPolylines2LinBsplineCrvs** (usrcnvrt.c:34)

```c
CagdCrvStruct *UserPolylines2LinBsplineCrvs(const IPPolygonStruct *Polys,
                                          CagdBType FilterDups)
```

**Polys:** To convert to linear bspline curves.

**FilterDups:** If TRUE, filters out duplicates points in polygon, in place.

**Returns:** Linear Bspline curves representing Poly.

**Description:** Returns a list of linear Bspline curves constructed from given polylines.

**See also:** CagdCnvrtPolyline2LinBspCrv, UserPolyline2LinBsplineCrv,
15.2.141 UserRegisterPointSetSrf  (register.c:613)

IrtRType UserRegisterPointSetSrf(int n,
IrtPtType *PtsSet,
const CagdSrfStruct *Srf,
IrtRType AlphaConverge,
IrtRType Tolerance,
UserRegisterTestConvergenceFuncType
RegisterTestConvergence,
IrtHmgnMatType RegMat)

n: Number of points in PtsSet.
PtsSet: The vector of points of first set. Might be changed in place.
Srf: A surface the points set is on up to rigid motion.
AlphaConverge: Convergence factor between almost zero (slow and stable) and one (fast but unstable).
Tolerance: Tolerance termination condition, in L infinity sense.
RegisterTestConvergence: A call back function to check for the convergence of this iterative process.
RegMat: Computed transformation.

Returns: Maximal error as the maximal distance between two corresponding points, or IRIT_INFNTY if failed to converge.

Description: Given a set of points, that is a rigid transformation of a given surface find a transformation that takes the set of points to the surface. A local greedy approach is taken here that guarantee local minimum and hence it is assumed the two sets are pretty close and similar. Corrections by marching on the surface are conducted on the fly.
See also: UserRegisterTestConvergence,

15.2.142 UserRegisterTestConvergence  (register.c:256)

int UserRegisterTestConvergence(IrtRType Dist, int i)

Dist: The current distance between the two points sets.
i: The index of the current iteration, starting with zero.

Returns: TRUE if should quit (accuracy is good enough), FALSE otherwise.

Description: A default test convergence function for UserRegisterTwoPointSets.
See also: UserRegisterTwoPointSets,

15.2.143 UserRegisterTestSrfConvergence  (register.c:571)

int UserRegisterTestSrfConvergence(IrtRType Dist, int i)

Dist: The current distance between the two points sets.
i: The index of the current iteration, starting with zero.

Returns: TRUE if should quit (accuracy is good enough), FALSE otherwise.

Description: A test convergence function for UserRegisterTwoPointSets for surface - point-set registration.
See also: UserRegisterTwoPointSets, UserRegisterTestConvergence,
15.2.144 UserRegisterTwoPointSets (register.c:303)

IrtRType UserRegisterTwoPointSets(int n1,
    IrtPtType *PtsSet1,
    int n2,
    IrtPtType *PtsSet2,
    IrtRType AlphaConverge,
    IrtRType Tolerance,
    UserRegisterTestConverganceFuncType
    RegisterTestConvergance,
    IrtHmgnMatType RegMat)

n1: Number of points in PtsSet1.
PtsSet1: The vector of points of first set. Might be changed in place.

n2: Number of points in PtsSet2.
PtsSet2: The vector of points in second set. Might be changed in place.

AlphaConverge: Convergence factor between almost zero (slow and stable) and one (fast but unstable).

Tolerance: Tolerance termination condition, in L infinity sense.

RegisterTestConvergance: A call back function to check for the convergence of this iterative process.

RegMat: Computed transformation.

Returns: Error of match between the two corresponding point sets.

Description: Given two sets of points, one is a rigid transformation of the other, find a transformation that takes the first set of points to the second. A local greedy approach is taken here that guarantee local minimum and hence it is assumed the two sets are pretty close and similar. No assumption is made as to the order of the points in the set. However, and while the two sets need not have the same number of points, the optimal solution is achieved at zero distance when each point in one set is at a corresponding point location of the second set.

See also: UserRegisterTestConvergance,

15.2.145 UserRuledSrfFit (rldmatch.c:481)

CagdSrfStruct *UserRuledSrfFit(const CagdSrfStruct *Srf,
    CagdSrfDirType RulingDir,
    CagdRType ExtndDmn,
    int Samples,
    CagdRType *Error,
    CagdRType *MaxError)

Srf: To fit a ruled surface through.

RulingDir: Either the U or the V direction. This is used only to sample Srf and construct the possibly ruling lines.

ExtndDmn: Amount to extended the selected sampled boundary curves. Zero will not extend and match the ruling from the original boundary to its maximum. Not supported.

Samples: Number of samples to compute the dynamic programming with. Typically in the hundreds. Must be greater than two.

Error: The computed error, following the distance between the rulings and the original surface, Srf. In L2 sense.

MaxError: maximum error detected in L-infinity sense.

Returns: The fitted ruled surface, or NULL if error.

Description: Fit a ruled surface to the given general surface Srf. The best fit is found using a dynamic programming search over all possibly rulings, while each ruling line’s distance is measured against the surface.

See also:
15.2.146 UserRuledSrfFit2D (rldmtc2d.c:566)

CagdSrfStruct *UserRuledSrfFit2D(const CagdSrfStruct *Srf,
CagdSrfDirType RulingDir,
CagdRType ExtndDmn,
int Samples,
CagdRType *Error,
CagdRType *MaxError)

Srf: To fit a ruled surface through.
RulingDir: Either the U or the V direction. This is used only to sample Srf and construct the possibly ruling
lines.
ExtndDmn: Amount to extended the selected sampled boundary curves. Zero will not extend and match the
ruling from the original boundary to its maximum. Not supported.
Samples: Number of samples to compute the dynamic programming with. Typically in the hundreds. Must
be greater than two.
Error: The computed error, following the distance between the rulings and the original surface, Srf. In L2
sense.
MaxError: maximum error detected in L-infinity sense.
Returns: The fitted ruled surface, or NULL if error.

Description: Fit a ruled surface to the given general surface Srf. The best fit is found using a dynamic
programming search over all possibly 2D rulings, while each ruling line's distance is measured against the surface.
See also:

15.2.147 UserSetFatalErrorFunc (user_ftl.c:29)

UserSetErrorFuncType UserSetFatalErrorFunc(UserSetErrorFuncType ErrorFunc)

ErrorFunc: New error function to use.
Returns: Old error function reference.
Description: Sets the error function to be used by UserLib.

15.2.148 UserSrfFixedCurvatureLines (srfcrvtr.c:166)

IPObjectStruct *UserSrfFixedCurvatureLines(const CagdSrfStruct *Srf,
CagdRType k1,
CagdRType Step,
CagdRType SubdivTol,
CagdRType NumericTol,
int Euclidean)

Srf: To compute lines of one principle curvature equal to k1.
k1: The prescribed principle curvature.
Step: Step size for curve tracing.
SubdivTol: The subdivision tolerance to use.
NumericTol: The numerical tolerance to use.
Euclidean: TRUE to return curvature lines curves in Euclidean space, FALSE in parameter space.
Returns: A list of piecewise linear curves in Srf where one principle curvature is equal to k1.

Description: Computes all locations (typically curves) on input surface Srf that have one principle curvature
value equal to a fixed value k1.

Because $K_1 k_2 = K$ and $((k_1 + k_2)/2)^2 = H^2$,
we have $((k_1 + K / k_1)/2)^2 - H^2 = 0$.

Both K and $H^2$ are rational so let $K = KN / KD$ (numerator / denominator) and similarly let $H^2 = HN / HD$. Then, we need to solve for the zeros of $(k_1 / 2 + KN / (KD * k_1 + 2))2 - HN / HD = 0$, or the zeros of $(K1 * KD * k1 + KN)^2 * HD - HN * (KD * k1 * 2)^2 = 0$.

See also: SymbSrfGaussCurvature, SymbSrfMeanCurvatureSqr,
15.2.149  UserSrfKernel (ff_krnl.c:51)

IPObjectStruct *UserSrfKernel(const CagdSrfStruct *Srf,  
    CagdRType SubdivTol,  
    int SkipRate)

Srf: To compute its kernel.
SubdivTol: Accuracy of subdivision approximation. 0.01 is a good start.
SkipRate: Step size over the parabolic points, 1 to process them all.
Returns: A polyhedra approximating the kernel, or NULL if empty set.

Description: Computes the kernel of a freeform closed $C^1$ continuous surface. The parabolic curves are computed and surface tangent planes swept along these parabolic curves clip the volume, resulting with the kernel.
See also: SymbSrfGaussCurvature, UserCntrSrfWithPlane,

15.2.150  UserSrfParabolicLines (ff_krnl.c:252)

IPObjectStruct *UserSrfParabolicLines(const CagdSrfStruct *Srf,  
    CagdRType Step,  
    CagdRType SubdivTol,  
    CagdRType NumericTol,  
    int Euclidean,  
    int DecompSrfs)

Srf: A surface to derive its parabolic lines.
Step: Step size for curve tracing.
SubdivTol: The subdivision tolerance to use.
NumericTol: The numerical tolerance to use.
Euclidean: TRUE to evaluate the parabolic lines into Euclidean space. Ignored if DecompSrfs is TRUE.
DecompSrfs: TRUE to decompose the given Srf into convex/concave and saddle regions.
Returns: Parabolic lines of Srf as a list of polylines approximation, or NULL if none.

Description: Computes the parabolic lines of the given surface, if any.
See also: SymbSrfGaussCurvature, UserSrfParabolicSheets,

15.2.151  UserSrfParabolicSheets (ff_krnl.c:398)

IPObjectStruct *UserSrfParabolicSheets(const CagdSrfStruct *Srf,  
    CagdRType Step,  
    CagdRType SubdivTol,  
    CagdRType NumericTol,  
    CagdRType SheetExtent)

Srf: A surface to derive its parabolic lines.
Step: Step size for curve tracing.
SubdivTol: The subdivision tolerance to use.
NumericTol: The numerical tolerance to use.
SheetExtent: Amount to extent the sheet from the parabolic lines.
Returns: Parabolic lines of Srf as a list of polylines approximation, or NULL if none.

Description: Computes the parabolic lines of the given surface, if any.
See also: SymbSrfGaussCurvature, UserSrfParabolicLines,
15.2.152 UserSrfSrfInter (srf_ssi.c:75)

```c
int UserSrfSrfInter(const CagdSrfStruct *CSrf1,
                     const CagdSrfStruct *CSrf2,
                     int Euclidean,
                     CagdRType Eps,
                     int AlignSrfs,
                     CagdCrvStruct **Crvs1,
                     CagdCrvStruct **Crvs2)
```

**CSrf1, CSrf2:** Two surfaces to compute their intersection points.

**Euclidean:** TRUE for curves in Euclidean space, FALSE for pairs of curves in parametric space.

**Eps:** Accuracy of computation. Currently measured in the parametric domain of the surfaces.

**AlignSrfs:** If non-zero surface are aligned by rotation so that bounding boxes are axes parallel to increase chances of no overlap. If AlignSrfs > 1, stretching is also applied to the surfaces to try and make them orthogonal.

**Crvs1:** Intersection curves of the first surface. If Euclidean is TRUE the 3-space curves are returned. If Euclidean is FALSE, curves are returned in UV space.

**Crvs2:** Intersection curves of the second surface.

**Returns:** TRUE if found intersection, FALSE otherwise.

**Description:** Computes the intersection curves, if any, of the two given surfaces.

**See also:** CagdCrvCrvInter,

15.2.153 UserSrfTopoAspectGraph (visible.c:339)

```c
IPPolygonStruct *UserSrfTopoAspectGraph(CagdSrfStruct *PSrf,
                                         CagdRType SubdivTol)
```

**PSrf:** To compute the aspect graph’s topology partitioning for.

**SubdivTol:** Accuracy of parabolic piecewise linear approximation.

**Returns:** Polylines on the unit sphere, depicting the aspect graph’s partitioning lines.

**Description:** Computes the views on the unit sphere at which the number of silhouette curves is changing. This is a subset of the events typically considered in aspect graphs and, for example, events such as silhouette cusps are not considered. The viewing directions where the number of silhouette curves/loops can be modified are views in the tangent plane of the surface at parabolic points of the surfaces, viewed from the zero principal curvatures’ direction. Hence, we simply derive the parabolic lines of the surface and then map them to the direction of the zero principal curvature there.

**See also:** SymbSrfGaussCurvature, UserCntrSrfWithPlane, MvarSrfSilhInflections,

15.2.154 UserSrfUmbilicalPts (srfrvtr.c:40)

```c
MvarPtStruct *UserSrfUmbilicalPts(const CagdSrfStruct *Srf,
                                   CagdRType SubTol,
                                   CagdRType NumTol)
```

**Srf:** Surface to compute its umbilical points, if any.

**SubTol:** Subdivision tolerance of computation.

**NumTol:** Numerical tolerance of computation.

**Returns:** A list of UV parameters of umbilical points, or NULL if none.

**Description:** Computes the umbilical points of a given surface. The umbilicals are computed as the zeros of the function $C = H^2 - K$. $C$ is never negative and hence we actually solve for $dC/du = dC/dv = 0$ and test the values of $C$ there. Hence (We only consider numerator of $C$ which is sufficient for zeros), $C = H^2 - K = (2FM - EN - GL)^2 - 4(LN - M^2)(EG - F^2)$.

**See also:** SymbSrfFff, SymbSrfSff, SymbSrfMeanCurvatureSqr, SymbSrfGaussCurvature, , MvarMVsZeros,
15.2.155  UserSrfVisibConeDecomp (visible.c:56)

IPObjectStruct *UserSrfVisibConeDecomp(const CagdSrfStruct *Srf,  
CagdRType Resolution,  
CagdRType ConeAngle)

Srf: To decompose into visibility cones.
Resolution: Of polygonal approximation of surface Srf.
ConeAngle: Of coverage over the unit sphere. ConeAngle prescribes the opening angle of the cone. In Radians.

Returns: A list of trimmed surface regions of surface Srf that are visible from a selected direction (available  
as "ViewDir" attribute on them) ad that the union of the list covers the entire surface Srf.

Description: Computes a decomposition of surface Srf into regions that are visible with normals deviating in a cone of size as set via ConeAngle.
See also: UserViewingConeSrfDomains, UserVisibilityClassify,

15.2.156  UserTVZeroJacobian (tv0jacob.c:43)

IPObjectStruct *UserTVZeroJacobian(const TrivTVStruct *TV,  
CagdBType Euclidean,  
int SkipRate,  
const CagdRType Fineness[3])

TV: Trivariate to derives its zero jacobian.
Euclidean: TRUE to evaluate into Euclidean space, FALSE to return the polygonal approximation in the parametric space of TV.
SkipRate: Of data in the volume. 1 skips nothing, 2 every second, etc.
Fineness: Of trivariate global refinment level, 0 for no ref.

Returns: The approximation of the zeros of the Jacobian, in all three axes.

Description: Computes a piecewise linear polygonal approximation to the zeros of the Jacobian of the given trivariate function.
See also: UserTrivarZeros,

15.2.157  UserTrivarZeros (tv0jacob.c:95)

IPObjectStruct *UserTrivarZeros(const TrivTVStruct *TV,  
const TrivTVStruct *TVEuclidean,  
int SkipRate,  
const CagdRType Fineness[3])

TV: Trivariate function to approximate its zero set.
TVEuclidean: If provided, use this trivariate to evaluate into Euclidean space.
SkipRate: Of data in the volume. 1 skips nothing, 2 every second, etc.
Fineness: Of trivariate global refinment level, 0 for no ref., in all three axes.

Returns: The approximation of the zeros of the trivariate.

Description: Approximate the zero set of a trivariate function.
See also: UserTVZeroJacobian,
15.2.158 UserTwoObjMaxZRelMotion (zcollide.c:44)

IrtRType UserTwoObjMaxZRelMotion(IPObjectStruct *PObj1,
   IPObjectStruct *PObj2,
   IrtRType FineNess,
   int NumIters)

PObj1: First static object to place PObj2 on.
PObj2: Second dynamic object that is to be moved down (-Z direction) until it is tangent to PObj1.
FineNess: Of polygonal approximation of PObj1.
NumIters: In the bisectioning of collision’s test. 10 is a good start.

Returns: Maximal Z motion possible, or IRIT_INFNTY if no collision or error.

Description: Computes the maximal Z motion to move PObj2 down (-Z direction) so that it does not intersect PObj1. Second object is converted to its Bbox.

15.2.159 UserViewingConeSrfDomains (visible.c:190)

IPObjectStruct *UserViewingConeSrfDomains(const CagdSrfStruct *Srf,
   const CagdSrfStruct *NSrf,
   const IPPolygonStruct *ConeDirs,
   CagdRType SubdivTol,
   CagdRType ConeAngle,
   CagdRType Euclidean)

Srf: To compute its visibility.
NSrf: The normal surface computed symbollically for Srf.
ConeDirs: Direction of cone’s axes.
SubdivTol: Of Cone - normal surface intersection, for subdivision approximation accuracy.
ConeAngle: The opening angle of the cone, in Radians.
Euclidean: Contours are in Euclidean (TRUE) or parametric (FALSE) space of Srf.

Returns: Set of piecewise linear contours, approximating the intersections of the normal viewing cones and the original surface.

Description: Computes the domain in given surface Srf that is inside the given cones of directions ConeDirs and opening angle ConeAngle.
See also: UserVisibilityClassify, UserSrfVisibConeDecomp,

15.2.160 UserVisibilityClassify (visible.c:123)

TrimSrfStruct *UserVisibilityClassify(const IObjectStruct *SclrSrf,
   TrimSrfStruct *TrimmedSrfs)

SclrSrf: The scalar surface computed symbollically in UserViewingConeSrfDomains, forming this decomposition.
TrimmedSrfs: To verify they are within the viewing code of ViewingDir. Trimmed surfaces inside this list that are outside the viewing cone are eliminated, in place.

Returns: The trimmed regions inside the viewing cone, as a subset of TrimmedSrfs.

Description: Given a decomposition of surface Srf into a set of TrimmedSrfs into regions that are inside the normal viewing cone as prescribed by SclrSrf, eliminate all regions (trimmed surfaces) that are outside the viewing cone in the given list, TrimmedSrfs.
See also: UserViewingConeSrfDomains, UserSrfVisibConeDecomp,
15.2.161 UserWChar2Ascii (fontlout.c:46)

char *UserWChar2Ascii(const UserFontText Str)

Str: Input wide (multi-short) string to convert to a multi-byte ascii string.
Returns: Converted string, allocated dynamically, or NULL if error.
Description: Converts a wide (multi-short) string to an ascii (multi-byte) string.
See also: UserAscii2WChar

15.2.162 UserWarpTextOnSurface (textwarp.c:65)

IPObjectStruct *UserWarpTextOnSurface(CagdSrfStruct *Srf,
const char *Txt,
IrtRType HSpace,
IrtRType VBase,
IrtRType VTop,
IrtRType Ligatures)

Srf: Surface to warp the text Txt along. The text is laid along the u axis with the v axis being the height.
Txt: Text to warp inside Srf.
HSpace: Horizontal space between characters.
VBase, VTop: Minimal and maximal fraction of height for regular characters. Measured on the letter 'A'.
Ligatures: If non zero, amount of ligatures’ contraction between adjacent characters.
Returns: List object of warped text, one object per character, each character is a list of Bezier curves.
Description: Warps the given text, using the current loaded font, in Bezier form in surface Srf using composition.
The characters of Txt are laid one after the other until the entire surface is filled horizontally, or characters in Txt
are exhausted. The characters are scaled to fit VBase to VTop of the height (v) direction of the parametric domain
of Srf, for the letter 'A'.
See also: GMLoadTextFont, GMMakeTextGeometry, SymbComposeSrfCrv

15.2.163 main (fntelem1.c:1426)

void main(void)

Returns: void
Description: Test routines for the FE code.
Chapter 16
Extra Library, xtra_lib

16.1 General Information

This library is not an official part of IRIT and contains public domain code that is used by routines in IRIT. The interface of the library is defined in include/extra_fn.h.

16.2 Library Functions

16.2.1 BzrCrvInterp (bzrintrp.c:205)

```c
void BzrCrvInterp(IrtRType *Result, IrtRType *Input, int Size)
```

- **Result**: Where the interpolated control points will be placed.
- **Input**: Points to interpolate at node parameter values.
- **Size**: Of control polygon.
- **Returns**: void

**Description**: Blends the input points using the Interp array and puts the result blended point in Result array. Input and Result array are of size Size.

16.2.2 JacobiMatrixDiag4x4 (diag_mat.c:110)

```c
void JacobiMatrixDiag4x4(IrtRType M[4][4],
                         IrtRType U[4][4],
                         IrtRType D[4][4],
                         IrtRType V[4][4])
```

- **M**: Matrix to diagonalize.
- **U**: The left orthogonal (=rotation) matrix.
- **D**: The diagonal matrix.
- **V**: The eight orthogonal matrix.
- **Returns**: void

**Description**: performs a diagonalization of a 4x4 matrix, as U D V, D diagonal and U and V orthogonal matrices $U = V^{-1} = V^{-T}$.

**See also**: JacobiMatrixDiagNxN,
16.2.3 JacobiMatrixDiagNxN (diag_mat.c:51)

void JacobiMatrixDiagNxN(IrtRType *M[],
             IrtRType *U[],
             IrtRType *D[],
             IrtRType *V[],
             int n)

M: Matrix to diagonalize.
U: The left orthogonal (=rotation) matrix.
D: The diagonal matrix.
V: The eight orthogonal matrix.
n: Dimension of the matrices as n times n.

Returns: void

Description: Performs a diagonalization of a NxN matrix, as U D V, D diagonal and U and V orthogonal matrices U = V^-1 = V^T.
See also: JacobiMatrixDiag4x4,

16.2.4 SvdDecomp (nure_svd.c:342)

void SvdDecomp(IrtRType **a, int m, int n, IrtRType *w, IrtRType **v)

a: Input matrix also serving to store U orthogonal output, of dimension m x n, m > n.
m, n: The dimensions of a.
w: The diagonal singular values, as a vector of length m.
v: The V orthogonal output, dimensions n x n.

Returns: void

Description: SVD decomposition of matrix A as U W V, U of size m x m, V of size n x n and W is diagonal with the singular values, stored as a vector. Due to the Fortran style of this code all indices are from 1 to k, so an array from 1 to k actually have k + 1 elements in this C translation.
See also: SvdMatrixNxN,

16.2.5 SvdLeastSqr (nure_svd.c:651)

IrtRType SvdLeastSqr(IrtRType *A, IrtRType *x, IrtRType *b, int NData, int Nx)

A: The matrix of size Nx by NData.
x: The vector of sought solution of size Nx.
b: The vector of coefficients of size NData.
NData, Nx: Dimensions of input.

Returns: The reciprocal of the condition number, if A != NULL, zero otherwise.

Description: Least square solves A x = b. The vector X is of size Nx, vector b is of size NData and matrix A is of size Nx by NData. Uses singular value decomposition. If A != NULL an SVD decomposition is computed, otherwise (A == NULL) a solution is computed for the given b and is placed in x.
See also: SvdMatrix4x4,
16.2.6  SvdMatrix4x4  (nure_svd.c:45)

    int SvdMatrix4x4(IrtHmgnMatType M,
                      IrtRType U[3][3],
                      IrtVecType S,
                      IrtRType V[3][3])

    M: Source matrix to decompose.
    U: Left orthonormal matrix.
    S: Singular components.
    V: Right orthonormal matrix.

    Returns:  FALSE if failed, TRUE otherwise.

    Description: Perform singular value decomposition on the 3x3 main minor of the affine transformation matrix.
    See also:  SvdLeastSqr, SvdMatrixNxN,

16.2.7  SvdMatrixNxN  (nure_svd.c:284)

    void SvdMatrixNxN(IrtRType *M, IrtRType *U, IrtRType *S, IrtRType *V, int n)

    M: Source matrix to decompose.
    U: Left orthonormal matrix, size n x n.
    S: A vector holding the singular components.
    V: Right orthonormal matrix, size n.
    n: size of square matrix, size n x n.

    Returns:  void

    Description: Perform singular value decomposition on an NxN matrix M as U S V.
    See also:  SvdLeastSqr, SvdDecomp, SvdMatrix3x3,
Chapter 17

Programming Examples

This chapter describes several simple examples of C programs that exploits the libraries of IRIT. All external function are defined in the include subdirectory of IRIT and one can 'grep' there for the exact include file that contains a certain function name. All C programs in all C files should include 'irit.sm.h' as their first include file of IRIT, before any other include file of IRIT. Header files are set so C++ code can compile and link to it without any special treatment.

17.1 Setting up the Compilation Environment

In order to compile programs that uses the libraries of IRIT, a makefile has to be constructed. Assuming IRIT is installed in /usr/local/irit, here is a simple makefile that can be used (for a unix environment):

IRIT_DIR = /usr/local/irit
include $(IRIT_DIR)/makeflag.unx

OBJS = program.o

program: $(OBJS)
$(CC) $(CFLAGS) -o program $(OBJS) $(LIBS) -lm $(MORELIBS)

The simplicity of this makefile is drawn from the complexity of makeflag.unx. The file makeflag.unx sets the CC, CFLAGS, LIBS, and MORELIBS for the machined using among other things. Furthermore, makeflag.unx also sets the default compilation rules from C sources to object files. The file makeflag.unx had to be modified once, when IRIT was installed on this system. If the used system is not a unix environment, then the file makefile.unx will have to be replaced with the proper makeflag file. In an OS2 environment, using the emx gcc compiler, the makefile is even simpler since the linking rule is also defined in makeflag.os2:

IRIT_DIR = \usr\local\irit
include $(IRIT_DIR)\makeflag.os2

OBJS = program.o

program.exe: $(OBJS)

Finally, here is a proper makefile for Windows NT:

IRIT_DIR = \usr\local\irit
include $(IRIT_DIR)\makeflag.wnt

OBJS = program.obj

program.exe: $(OBJS)
    $(IRITCONLINK) -out:program.exe $(OBJS) $(LIBS) $(W32CONLIBS)

17.2 Simple C Programs using IRIT

Now that we have an idea how to compile C code using IRIT, here are several examples to read, manipulate and write IRIT data files. You will be able to find all these examples in the doc/cexample directory.
17.2.1 Boolean Operations over Polyhedra (boolean.c)

This example demonstrates the use of the Boolean operations package (bool_lib), creates few polygonal primitives and apply Boolean operations between them. The resulting model is dumped to stdout.

```c
#include "irit_sm.h"
#include "allocate.h"
#include "iritprsr.h"
#include "geom_lib.h"
#include "bool_lib.h"

void main(int argc, char **argv)
{
    IPObjectStruct *PBox, *PCylin, *PCone, *PSphere, *PTmp1, *PTmp2;
    IrVecType Pt, Dir;
    /* Make sure all polygonal models have circular vertex lists. */
    IPSetPolyListCirc(TRUE);
    /* And set the resolution desired. */
    PrimSetResolution(50);
    /* Build the primitives. */
    Pt[0] = Pt[1] = -1;
    Pt[2] = 0;
    PBox = PrimGenBOXObject(Pt, 2, 2, 1);
    Pt[0] = Pt[1] = 0;
    Pt[2] = 0.5;
    Dir[0] = Dir[1] = 0;
    Dir[2] = 3;
    PCone = PrimGenCONEObject(Pt, Dir, 0.7, 0);
    Dir[2] = 2.5;
    PSphere = PrimGenSPHEREObject(Dir, 0.6);
    Pt[0] = Pt[1] = 0;
    Pt[2] = -1;
    Dir[0] = Dir[1] = 0;
    Dir[2] = 5;
    PCylin = PrimGenCYLINObject(Pt, Dir, 0.2, 3);
    /* Time for some Booleans. */
    PTmp1 = BooleanOR(PBox, PCone);
    PTmp2 = BooleanOR(PTmp1, PSphere);
    IPFreeObject(PTmp1);
    PTmp1 = BooleanSUB(PTmp2, PCylin);
    IPFreeObject(PTmp2);
    IPFreeObject(PBox);
    IPFreeObject(PCone);
    IPFreeObject(PSphere);
    IPFreeObject(PCylin);
    IPStdoutObject(PTmp1, FALSE);
    IPFreeObject(PTmp1);

    exit(0);
}
```
17.2.2 Distance Maps to Planar Curves (dist_map.c)

This example demonstrates the use of symbolic distance maps computations to freeform curves, in the plane, and the sampling of the map into an image that is dumped out.

/* Computes a 2D grid of distances approximating the distance field to a crv. */
/*****************************************************************************/
*(C) Gershon Elber, Technion, Israel Institute of Technology *
**************************************************************************/
* Written by: Gershon Elber Ver 1.0, June 2003 *
***************************************************************************/

#include "irit_sm.h"
#include "allocate.h"
#include "iritprsr.h"
#include "user_lib.h"
#include "geom_lib.h"
#include "cagd_lib.h"
#include "symb_lib.h"
#include "misc_lib.h"

#define MAP_DIST_2_COLOR(RelDist, Pxl) {
    (Pxl) -> r = ((unsigned char) ((RelDist) * 255));
    (Pxl) -> g = ((unsigned char) (4 * (RelDist) * (1.0 - (RelDist)) * 255));
    (Pxl) -> b = ((unsigned char) ((1.0 - (RelDist)) * 255));
}

static char *CtrlStr =
#ifdef IRIT_DOUBLE
"dist_map x%-XMin|XMax!F!F y%-YMin|YMax!F!F t%-Tolerance!F h%- I!-ImageName|XSize|YSize!s!d!d IritFile!*s"
#else
"dist_map x%-XMin|XMax!f!f y%-YMin|YMax!f!f t%-Tolerance!f h%- I!-ImageName|XSize|YSize!s!d!d IritFile!*s"
#endif /* IRIT_DOUBLE */

/*****************************************************************************/
* DESCRIPTION: Main module - Reads command line and do what is needed... M
* Example: "dist_map.exe -I cubic1.ppm 100 100 cubic1.itd"
* return value: void M
* PARAMETERS: argc, argv: Command line. M
* return value: void M
* keywords: main M
/*****************************************************************************/

void main(int argc, char **argv) {
    int NumFiles, Error,
    TolFlag = FALSE,
    XDomainFlag = FALSE,
    YDomainFlag = FALSE,
    HelpFlag = FALSE,
    ImageFlag = FALSE,
    ImageXSize = 100,
    ImageYSize = 100;
    IrtRType
    XDomain[2] = { -1.0, 1.0 },
    YDomain[2] = { -1.0, 1.0 },
    Tolerance = 0.01;
    char **FileNames,
    *imageName = NULL;
    IPOObjectStruct *PObjs;
    
    if ((Error = GAGetArgs(argc, argv, CtrlStr,
        &TolFlag, &XDomainFlag, &XDomain[0], &XDomain[1],
        &YDomainFlag, &YDomain[0], &YDomain[1],
        &TolFlag, &Tolerance,
        &imageFlag, &ImageFlag, &ImageXSize, &ImageYSize,
        &imageName, &PObjs)) 

GAPrintErrMsg(Error);
GAPrintHowTo(CtrlStr);
exit(1);

if (ImageName == NULL || NumFiles != 1) {
    fprintf(stderr, "No image or irit data files to process.\n"");
    exit(2);
}

if (HelpFlag) {
    GAPrintHowTo(CtrlStr);
    exit(0);
}

fprintf(stderr, "Processing domain [%f : %f] x [%f : %f]\n
to image "%s" of size [%d x %d]\n",
XDomain[0], XDomain[1],
YDomain[0], YDomain[1],
ImageName, ImageXSize, ImageYSize);

/* Get the data from all the input files. */
IPSetFlattenObjects(TRUE);
if ((PObj = IPGetDataFiles(FileNames, NumFiles, TRUE, TRUE)) == NULL) {
    fprintf(stderr, "Failed to load file "%s\\n",
FileNames[0]);
    exit(1);
}
fprintf(stderr, "Successfully loaded crv geometry \"%s\n",
FileNames[0]);

/* Ray trace the glass object. */
if (IP_IS_CRV_OBJ(PObj)) {
    int i, j;
    IrtRType MaxDist, **Image;
    IrtImgPixelStruct
    *ImageLine = (IrtImgPixelStruct *)
        IritMalloc(sizeof(IrtImgPixelStruct) * ImageXSize);
    Image = (IrtRType **) IritMalloc(sizeof(IrtRType *) * ImageYSize);
    for (j = 0; j < ImageYSize; j++)
        Image[j] = (IrtRType *) IritMalloc(sizeof(IrtRType) * ImageXSize);
    MaxDist = SymbDistBuildMapToCrv(PObj -> U.Crvs, Tolerance,
        XDomain, YDomain,
        Image, ImageXSize, ImageYSize);

    /* Dump the map as an image. */
    IrtImgWriteOpenFile(argv, ImageName, FALSE, ImageXSize, ImageYSize);
    for (j = 0; j < ImageYSize; j++) {
        for (i = 0; i < ImageXSize; i++)
            MAP_DIST_2_COLOR(Image[i][j] / MaxDist, &ImageLine[i]);
        IrtImgWritePutLine(NULL, ImageLine);
    }
    IrtImgWriteCloseLine(NULL, ImageLine);
}
IrtImgWriteCloseLine();
for (j = 0; j < ImageYSize; j++)
    IritFree((VoidPtr) Image[j]);
IritFree((VoidPtr) Image);
IritFree((VoidPtr) ImageLine);
}
else {
    fprintf(stderr, "... but expected a curve, aborting!\n");
17.2.3 Importance Edges Evaluations in Polygonal Meshes (imprtnc.c)

This example demonstrates the tessellation of arbitrary input model(s) into polygons and the probabilistic estimation of importance edges in the polygonal geometry. Dumped out is the polygonal geometry with vertices having UV coordinates if available, normals if available, and importance.

```c
#include "irit_sm.h"
#include "allocate.h"
#include "iritprsr.h"
#include "geom_lib.h"
#include "misc_lib.h"
#include "ip_cnvrt.h"

IRIT_STATIC_DATA char CtrlStr = "Imprtnc c% h% DFiles!*s";
IRIT_STATIC_DATA int GlblVrtxImportanceCount,
GlblCrvtrInfoFlag = FALSE;
IRIT_STATIC_DATA IrtrType GlblVrtxImportanceVal,
IRIT_STATIC_DATA IPVertexStruct *GlblVrtxImportance;

static void DumpOneTraversedObject(IPObjectStruct *PObj, IrtHmgnMatType Mat);
static IPObjectStruct *SetCurvatureEstimates(IPObjectStruct *PObj);
static void DumpOneObjData(IPObjectStruct *PObj);
static void ProcessVertexImportance(IPVertexStruct *V1,
IPVertexStruct *V2,
IPPolygonStruct *Pl1,
IPPolygonStruct *Pl2);
static void GenPolyImportance(IPObjectStruct *PObj);

void main(int argc, char **argv)
{
    int NumFiles, Error,
    HelpFlag = FALSE;
    char **FileNames;
    IPObjectStruct *PObjects;
    IrtHmgnMatType CrntViewMat;

    if ((Error = GAGetArgs(argc, argv, CtrlStr, &GlblCrvtrInfoFlag,
    &HelpFlag, &NumFiles, &FileNames)) != 0) {
        GAPrintErrMsg(Error);
        GAPrintHowTo(CtrlStr);
        exit(1);
    }

    if (HelpFlag) {
        fprintf(stderr, "This is Importance testing...
");
        GAPrintHowTo(CtrlStr);
        exit(0);
    }

    /* Get the data files: */
    IPSetFlattenObjects(FALSE);
    if ((PObjects = IGetDataFiles(FileNames, NumFiles, TRUE, FALSE)) == NULL)
        exit(1);
    PObjects = IPResolveInstances(PObjects);
```
if (IPWasPrspMat)
    MatMultTwo4by4(CrntViewMat, IPViewMat, IPPrspMat);
else
    IRIT_GEN_COPY(CrntViewMat, IPViewMat, sizeof(IrtHmgnMatType));

/* Here some useful parameters to play with in tesselating freeforms: */
IPFFCState.FineNess = 15; /* Resolution of tesselation, larger is finer. */
IPFFCState.ComputeUV = TRUE; /* Wants UV coordinates for textures. */
IPFFCState.FourPerFlat = TRUE; /* 4 polygons per `flat patch, 2 otherwise. */
IPFFCState.LinearOnePolyFlag = TRUE; /* Linear srf generates one poly. */

IPTraverseObjListHierarchy(PObjects, CrntViewMat, DumpOneTraversedObject);
IPFreeObjectList(PObjects);

/******************************************************************************
* DESCRIPTION: *
* Update curvature property attribute to vertices of the given poly model. *
* PARAMETERS: *
* PObj: Poly model to udpate curvatrue info into. *
* *
* RETURN VALUE: *
* IPObjectStruct *: A poly model, similar to PObj, but with curvature *
* information attached as attributes. *
******************************************************************************/
static IPObjectStruct *SetCurvatureEstimates(IPObjectStruct *PObj)
{
    int OldCirc = IPSetPolyListCirc(TRUE);
    IPPolygonStruct *P1;
    IPObjectStruct *PTmp1, *PTmp2;

    /* Convert to a regular polygonal model with triangles only. */
    for (P1 = PObj -> U.Pl; P1 != NULL; P1 = P1 -> Pnext) {
        if (IPVrtxListLen(P1 -> PVertex) != 3)
            break;
    }
    PTmp2 = IPCopyObject(NULL, PObj, FALSE);
    GMVrtxListToCircOrLin(PTmp2 -> U.Pl, TRUE);
    if (P1 != NULL) {
        PTmp1 = GMConvertPolysToTriangles(PTmp2);
        IPFreeObject(PTmp2);
        PTmp2 = GMRegularizePolyModel(PTmp1);
        IPFreeObject(PTmp1);
    }
    GMVrtxListToCircOrLin(PTmp2 -> U.Pl, FALSE);
    IPSetPolyListCirc(OldCirc);
    GMPlCrvtrSetCurvatureAttr(PTmp2 -> U.Pl, 1, TRUE);
    return PTmp2;
}

/******************************************************************************
* DESCRIPTION: *
* Call back function of IPTraverseObjListHierarchy. Called on every non *
* list object found in hierarchy. *
* PARAMETERS: *
* PObj: Non list object to handle. *
* Mat: Transformation matrix to apply to this object. *
* *
* RETURN VALUE: *
* void *
******************************************************************************/
static void DumpOneTraversedObject(IPObjectStruct *PObj, IrtHmgnMatType Mat)
{
IPPolyVrtxIdxStruct *PVIdx = IPCnvPolyToPolyVrtxIdxStruct(PObj, TRUE, 0);
int i,
**Polygons = PVIdx -> Polygons;
IPVertexStruct **Vertices = PVIdx -> Vertices;

/* Compute importance for the vertices as "Imprt" attributes. Note the */
/* PVIdx data structure points on the original vertices so we are fine. */
GenPolyImportance(PObj);

/* Dump the vertices: */
fprintf(stderr, "OBJECT \"%s\" - VERTICES:\n", PObj -> ObjName);
for (i = 0; Vertices[i] != NULL; i++) {
    //Print vertex information
    float *uv;
    printf("%3d: %6.3f %6.3f %6.3f", i, 
            Vertices[i] -> Coord[0], 
            Vertices[i] -> Coord[1], 
            Vertices[i] -> Coord[2]);
    if (IP_HAS_NORMAL_VRTX(Vertices[i]))
        printf(" [%6.3f %6.3f %6.3f]", 
                Vertices[i] -> Normal[0], 
                Vertices[i] -> Normal[1], 
                Vertices[i] -> Normal[2]);
    if ((uv = AttrGetUVAttrib(Vertices[i] -> Attr, "uvvals")) != NULL)
        printf("{%6.3f %6.3f}", uv[0], uv[1]);
    R = AttrGetRealAttrib(Vertices[i] -> Attr, "Imprt");
    if (!IP_ATTR_IS_BAD_REAL(R))
        printf(" (%6.3f)", R);
}
printf("\n\t<K1=%6.3f D1 = %s>
\t<K2=%6.3f D2 = %s>
",
AttrGetRealAttrib(Vertices[i] -> Attr, "K1Curv"),
AttrGetStrAttrib(Vertices[i] -> Attr, "D1"),
AttrGetRealAttrib(Vertices[i] -> Attr, "K2Curv"),
AttrGetStrAttrib(Vertices[i] -> Attr, "D2"));
}

printf("\n\n");
}

fprintf(stderr, "OBJECT "%s" - Vertices in polygons:\n", 
PObj -> ObjName);
for (i = 0; PVIdx -> PPolys[i] != NULL; i++) {
IPPolyPtrStruct
*PPoly = PVIdx -> PPolys[i];

printf("%3d: ", i);
for ( ; PPoly != NULL; PPoly = PPoly -> Pnext) {
print("%3d ", AttrGetIntAttrib(PPoly -> Poly -> Attr, 
"_PIdx"));
}

printf("\n");
}

/* Dump the polygons: */
fprintf(stderr, "OBJECT "%s" - Polygons from vertices:\n", 
PObj -> ObjName);
for (i = 0; Polygons[i] != NULL; i++) {
int *Pl = Polygons[i];

printf("%3d: ", i);
while (*Pl >= 0)
fprintf(stderr, " %5d", *Pl++);

fprintf(stderr, " -1\n");
}

IPPolyVrttxIdxFree(PVIdx);
}

/****************************************************************************
* DESCRIPTION: *
* Call back function for GMPolyAdjacncyVertex to process every edge of a *
* given vertex. The edge is provided as (V, V -> Pnext) *
* *
* PARAMETERS: *
* V1, V2: Two vertices defining this edge. Note the vertices are NOT *
* necessarily chained together into a list. *
* P11, P12: The two polygons that share this edge. The edge (V1, V2) is *
* in both P11 and P12, with not necessarily the exact pointers *
* IPVertexStruct of V1 and V2. *
* *
* RETURN VALUE: *
* void *
*****************************************************************************/
static void ProcessVertexImportance(IPVertexStruct *V1, 
IPVertexStruct *V2, 
IPPolygonStruct *Pl1, 
IPPolygonStruct *Pl2) 
{
if (!IRIT_PT_APX_EQ_EPS(V1 -> Coord, GlblVrtxImportance -> Coord, 
IRIT_EPS) &&
!IRIT_PT_APX_EQ_EPS(V2 -> Coord, GlblVrtxImportance -> Coord, 
IRIT_EPS))
    fprintf(stderr, "Edge does not match the given vertex - adj error!\n");

if (Pl1 != NULL && P12 != NULL) {
    if (P11 != NULL && P12 != NULL) {
        GlblVrtxImportanceCount++;
        GlblVrtxImportanceVal += acos(IRIT_DOT_PROD(Pl1 -> Plane, 
P12 -> Plane));
    } else {
        fprintf(stderr, "Edge does not match the given vertex - adj error!\n");
    }
}

17.2.4 Least squares curve fitting and process communication (lst_sqrsc.c)

This example creates a Bspline curve that least squares approximates a given set of data points. In the default values, a quadratic Bspline curve of 10 control points least squares approximates a set of 100 three dimensional points. Also shown is a polyline of the original (100) points. Arbitrary number of curves will be displayed every, one for every ¡return¿ keystroke until Q¡return¿ is typed.

/#*****************************************************************************
# Least squares fit a curve to random points. *
# We also see how to fork out a display device and communicate with it. *
#*****************************************************************************
# (C) Gershon Elber, Technion, Israel Institute of Technology *
#*****************************************************************************
# Written by: Gershon Elber Ver 1.0, June 1995 *
#*****************************************************************************/

#include "irit_sm.h"
#include "iritprsr.h"
#include "allocate.h"
#include "attribut.h"
#include "cagd_lib.h"
#include "geom_lib.h"
#include "grap_lib.h"
#include "misc_lib.h"
static char *CtrlStr =
  "Lst_Sqrs n%-#Pts!d d%-Degree!d f%-DOF!d p%-PrgmName!s h%-";

void main(int argc, char **argv)
{
  int i, Error, PrgmIO,
  NumOfPoints = 100,
  NumOfPtsFlag = FALSE,
  Degree = 3,
  DegreeFlag = FALSE,
  NumOfDOF = 10,
  NumOfDOFFlag = FALSE,
  PrgmFlag = FALSE,
  HelpFlag = FALSE;
  char *Err,
  *Program = getenv("IRIT_DISPLAY");

  #ifdef __WINNT__
  if (Program == NULL)
    Program = "wntgdrvs -s-";
  #endif /* __WINNT__ */
  #ifdef __UNIX__
  if (Program == NULL)
    Program = "x11drvs -s-";
  #endif /* __UNIX__ */
  if ((Error = GAGetArgs(argc, argv, CtrlStr,
                          &NumOfPtsFlag, &NumOfPoints,
                          &DegreeFlag, &Degree,
                          &NumOfDOFFlag, &NumOfDOF,
                          &PrgmFlag, &Program,
                          &HelpFlag)) != 0) {
    GAPrintErrMsg(Error);
    GAPrintHowTo(CtrlStr);
    exit(1);
  }

  if (HelpFlag) {
    GAPrintHowTo(CtrlStr);
    exit(0);
  }

  IPSocSrvrInit(); /* Initialize the listen socket for clients. */

  if ((PrgmIO = IPSocExecAndConnect(Program,
                                         getenv("IRIT_BIN_IPC") != NULL)) >= 0) {
    char Line[IRIT_LINE_LEN];
    IObjectStruct
      *PClrObj = IPGenStrObject("command_", "clear", NULL);
    do {
      CagdPtStruct
        *PtList = NULL;
      IPPolygonStruct
        *PPoly = IPAllocPolygon(0, NULL, NULL);
      CagdCrvStruct *Crv;
      IObjectStruct *PCrvObj, *PPolyObj;

      for (i = 0; i < NumOfPoints; i++) {
        int j;
        IVertexStruct *V;
        CagdPtStruct
          *Pt = CagdPtNew();

        if (i == 0) {
          for (j = 0; j < 3; j++)
            Pt -> Pt[j] = IritRandom(-1.0, 1.0);
else {
    for (j = 0; j < 3; j++)
        Pt -> Pt[j] = PtList -> Pt[j] + IritRandom(-0.1, 0.1);
}

V = IPAllocVertex(0, NULL, PPoly -> PVertex); 
for (j = 0; j < 3; j++)
    V -> Coord[j] = Pt -> Pt[j];
PPoly -> PVertex = V;

IRIT_LIST_PUSH(Pt, PtList);

Crv = BspCrvInterpPts(PtList, Degree + 1,
                      NumOfDOF, CAGD_UNIFORM_PARAM, FALSE);
CagdPtFreeList(PtList);
CagdCrvWriteToFile3(Crv, stdout, 0, "This is from LstSqr", &Err);
/* Generate objects out of the geometry and set proper attrs. */
PcrvObj = IPGenCRVObject(Crv);
AttrSetObjectColor(PcrvObj, IG_IRIT_CYAN);
PPolyObj = IPGenPOLYObject(PPoly);
IP_SET_POLYLINE_OBJ(PPolyObj);
AttrSetObjectColor(PPolyObj, IG_IRIT_YELLOW);
/* Clear old data and display our curve and data. */
IPSoWriteOneObject(PrgmIO, PClrObj);
IPSoWriteOneObject(PrgmIO, PcrvObj);
IPSoWriteOneObject(PrgmIO, PPolyObj);
IPFreeObject(PcrvObj);
IPFreeObject(PPolyObj);
gets(Line);
while (Line[0] != 'q' && Line[0] != 'Q');
    IPSocDisConnectAndKill(TRUE, PrgmIO);
}
exit(0);
}

17.2.5 Multivariate Solver (msolve.c)

This example demonstrates the use of the multivariate solver from the mvar_lib library. Input is a set of n polynomial equations in m variables and dumped out are the solutions to these equations.

/**********************************************/
* Solves a set of polynomial equations. *
**********************************************/
* (C) Gershon Elber, Technion, Israel Institute of Technology *
**********************************************/
* Written by: Gershon Elber Ver 1.0, June 2003 *
**********************************************/

/* Use exmaple: 'msolve -d 1 -c "0,1,1,0, 0,1,-1,0"' */

#include "irit_sm.h"
#include "iritprsr.h"
#include "allocate.h"
#include "attribut.h"
#include "cagd_lib.h"
#include "geom_lib.h"
#include "mvar_lib.h"

#define SUBDIV_TOL 1e-3
# define NUMERIC_TOL 1e-8
# define MIN_DOMAIN -2
# define MAX_DOMAIN 2

c
static char *CtrlStr =
    "MSlove n%-NumEqns!d v%-NumVars!d d%-MaxDeg!d c%-Coeffs!s h%-";

void main(int argc, char **argv)
{
    int i, j, Error, *Lengths,
        NumOfEqnsFlag = FALSE,
        NumOfEqns = 2,
        NumOfVarsFlag = FALSE,
        NumOfVars = 2,
        MaxDegreeFlag = FALSE,
        MaxDegree = 2,
        CoefFlag = FALSE,
        HelpFlag = FALSE;

    char *Coef,
    /* (x-1)^2 + y^2 = 2, (x+1)^2 + y^2 = 2. */
    *Coefs = "-1,-2,1,0,0,0,1,0,0, -1,2,1,0,0,0,1,0,0";

    if ((Error = GAGetArgs(argc, argv, CtrlStr,
                          &NumOfEqnsFlag, &NumOfEqns,
                          &NumOfVarsFlag, &NumOfVars,
                          &MaxDegreeFlag, &MaxDegree,
                          &CoefFlag, &Coefs,
                          &HelpFlag)) != 0) {
        GAPrintErrMsg(Error);
        GAPrintHowTo(CtrlStr);
        exit(1);
    }

    if (HelpFlag) {
        GAPrintHowTo(CtrlStr);
        exit(0);
    }

    printf("Processing %d equations of max degree %d, and %d variables,
            Coefs="%s"
", NumOfEqns, NumOfVars, Coefs);

    /* Create the polynomial constraints as multivariates. */
    MVs = (MvarMVStruct **) IritMalloc(sizeof(MvarMVStruct *) * NumOfEqns);
    Lengths = (int *) IritMalloc(sizeof(int) * NumOfVars);
    for (i = 0; i < NumOfVars; i++)
        Lengths[i] = MaxDegree + 1;
    Constraints = (MvarConstraintType *) IritMalloc(sizeof(MvarConstraintType)
            * NumOfEqns);
    for (i = 0; i < NumOfEqns; i++)
        Constraints[i] = MVAR_CNSTRNT_ZERO;
    Coef = strtok(Coefs, " ");
    for (i = 0; i < NumOfEqns; i++) {
        IrtRType *p;
        MVs[i] = MvarMVNew(NumOfVars, MVARPOWER_TYPE,
                           CAGD_PT_E1_TYPE, Lengths);
        p = MVs[i] -> Points[i];
        for (j = 0; j < pow((MaxDegree + 1), NumOfVars); j++, p++) {
            if (sscanf(Coef, "%lf", p) != 1) {
                fprintf(stderr, "Error in parsing the coefficients string\n");
                exit(1);
            }
        }
    }
}
Coef = strtok(NULL, ",");
}
MvarDbg(MVs[i]);
MVTmp = MvarCnvrtPur2BzrMV(MVs[i]);
MvarMVFree(MVs[i]);
MVs[i] = MVTmp;
MvarDbg(MVs[i]);
/* Set the domain of the multivariate. */
for (j = 0; j < NumOfVars; j++) {
    MVTmp = MvarMVRegionFromMV(MVs[i], MIN_DOMAIN, MAX_DOMAIN, j);
    MvarMVFree(MVs[i]);
    MVs[i] = MVTmp;
}
MVTmp = MvarCnvrtBzr2BspMV(MVs[i]);
MvarMVFree(MVs[i]);
MVs[i] = MVTmp;
for (j = 0; j < NumOfVars; j++) {
    BspKnotAffineTransOrder2(MVs[i] -> KnotVectors[j],
                            MVs[i] -> Orders[j],
                            MVs[i] -> Orders[j] + MVs[i] -> Lengths[j],
                            MIN_DOMAIN, MAX_DOMAIN);
}
MvarDbg(MVs[i]);
}
Pts = MvarMVsZeros(MVs, Constraints, NumOfEqns,
                   SUBDIV_TOL, NUMERIC_TOL);
for (Pt = Pts; Pt != NULL; Pt = Pt -> Pnext) {
    printf("(");
    for (i = 1; i <= NumOfVars; i++)
        printf("%s%.13lg", i > 1 ? ", " : ",", Pt -> Pt[i-1]);
    printf("\n");
}
MvarPtFreeList(Pts);
for (i = 0; i < NumOfEqns; i++)
    MvarMVFree(MVs[i]);
IritFree((VoidPtr) MVs);
IritFree((VoidPtr) Constraints);
IritFree((VoidPtr) Lengths);
exit(0);

17.2.6 Compute Area of a Polygonal Model (polyarea.c)

Here is a simple program to compute the total area of all polygons in the given data file. The program expects
one argument on the command line which is the name of the file to read, and it prints out one line with the total
computed area.

****************************************************************************
* Compute the area of a polyhedra object. *
****************************************************************************
* (C) Gershon Elber, Technion, Israel Institute of Technology *
****************************************************************************
* Written by: Gershon Elber Ver 1.0, June 1995 *
****************************************************************************/
#include "irit_sm.h"
#include "iritprsr.h"
#include "allocate.h"
#include "geom_lib.h"
void main(int argc, char **argv)
{  
    int Handler;
    if (argc == 2) {
        if ((Handler = IPOpenDataFile(argv[1], TRUE, TRUE)) >= 0) {
            IPObjectStruct
                *PObj = IPGetObjects(Handler);
            /* Done with file - close it. */
            IPCloseStream(Handler, TRUE);
            /* Process the geometry - compute the accumulated area. */
            if (IP_IS_POLY_OBJ(PObj) && IP_IS_POLYGON_OBJ(PObj))
                fprintf(stderr, "Area of polyhedra is %lf\n",
                    GMPolyObjectArea(PObj));
            else
                fprintf(stderr, "Read object is not a polyhedra.\n");
            IPFreeObject(PObj);
        } else {
            fprintf(stderr, "Failed to open file \"%s\"\n", argv[1]);
            exit(1);
        }
    } else {
        fprintf(stderr, "Usage: PolyArea geom.dat\n");
        exit(2);
    }
    exit(0);
}

17.2.7 Converts a Freeform Surface into Polygons (polygons.c)

This true filter reads a single surface from stdin and dumps out a polygonal approximation of it to stdout. They are
several parameters that controls the way a surface is approximated into polygons and in this simple filter they are
being held fixed in a set of integer variables.

**************************************************************************
* Read a surface and dump out a tesselated version of it. *
* (C) Gershon Elber, Technion, Israel Institute of Technology *
* Written by: Gershon Elber Ver 1.0, June 1995 *
**************************************************************************

#include "irit_sm.h"
#include "cagd_lib.h"
#include "iritprsr.h"
#include "ip_cnvrt.h"
#include "allocate.h"

void main(int argc, char **argv)
{  
    int Handler,
        FourPerFlat = TRUE, /* Settable parameters of IritSurface2Polygons. */
        FineNess = 20,
        ComputeUV = FALSE,
        ComputeNrm1 = FALSE,
        Optimal = FALSE;
    if ((Handler = IPOpenDataFile("-", TRUE, TRUE)) >= 0) {
        IPObjectStruct
            *PObj = IPGetObjects(Handler);
        /* Done with file - close it. */
IPCloseStream(Handler, TRUE);
/* Process the surface into polygons. */
if (IP_IS_SRF_OBJ(PObj)) {
    IPPolygonStruct
        *PPoly = IPSurface2Polygons(PObj -> U.Srfs, FourPerFlat,
            FineNess, ComputeUV,
            ComputeNrml, Optimal);
    IObjectStruct
        *PObjPoly = IPGenPOLYObject(PPoly);
    IPStdoutObject(PObjPoly, FALSE);
    IPFreeObject(PObjPoly);
} else
    fprintf(stderr, "Read object is not a surface.
");
IPFreeObject(PObj);
} else {
    fprintf(stderr, "Failed to read from stdin\n");
    exit(1);
}
exit(0);

17.2.8 Linear Transformations’ Filter (transfrm.c)

This little more complex program transforms all the geometry in the read data which can be any number of files
according to the specified transformations on the command line. The command line is parsed via GAGetArgs and
its associated functions. The transformation matrix is then computed with the aid of the matrix package and applied
to the read geometry at once.

****************************************************************************
* Transforms input stream following command line specs. This examples also *
* show how to read from input stream call back (in-memory).                *
* (C) Gershon Elber, Technion, Israel Institute of Technology             *
* Written by: Gershon Elber Ver 1.0, June 1995                           *
****************************************************************************/
#include "irit_sm.h"
#include "allocate.h"
#include "iritprsr.h"
#include "geom_lib.h"
#include "misc_lib.h"

static char *CtrlStr =
#ifdef IRIT_DOUBLE
    "Transfrm x%-Degs!F y%-Degs!F z%-Degs!F t%-%X|Y|Z!F!F!F s%-%Scale!F h%-% DFiles!*s";
#else
    "Transfrm x%-Degs!f y%-Degs!f z%-Degs!f t%-%X|Y|Z!f!f!f s%-%Scale!f h%-% DFiles!*s";
#endif /* IRIT_DOUBLE */
static int ReadStreamCallBackIO(int c);

void main(int argc, char **argv)
{
    int NumFiles, Error,
        RotXFlag = FALSE,
        RotYFlag = FALSE,
        RotZFlag = FALSE,
        TransFlag = FALSE,
        ScaleFlag = FALSE,
        HelpFlag = FALSE;
    char **FileNames;
....
IrtRType RotXDegrees, RotYDegrees, RotZDegrees, TransX, TransY, TransZ, 
Scale;
IrtMsgMatType Mat1, TransMat;
IPObjectStruct *PObjs, *PObjsTrans, *PObj;

if ((Error = GAGetArgs(argc, argv, CtrlStr,  
        &RotXFlag, &RotXDegrees,  
        &RotYFlag, &RotYDegrees,  
        &RotZFlag, &RotZDegrees,  
        &TransFlag, &TransX, &TransY, &TransZ,  
        &ScaleFlag, &Scale, 
        &HelpFlag,  
        &NumFiles, &FileNames)) != 0) {
    GAPrintErrMsg(Error);
    GAPrintHowTo(CtrlStr);
    exit(1);
}

if (HelpFlag) {
        fprintf(stderr, "This is Transform...\n");
        GAPrintHowTo(CtrlStr);
        exit(0);
}

/* Construct the transformation matrix: */
MatGenUnitMat(TransMat);
if (RotXFlag) {
        MatGenMatRotX1(IRIT_DEG2RAD(RotXDegrees), Mat1);
        MatMultTwo4by4(TransMat, TransMat, Mat1);
}
if (RotYFlag) {
        MatGenMatRotY1(IRIT_DEG2RAD(RotYDegrees), Mat1);
        MatMultTwo4by4(TransMat, TransMat, Mat1);
}
if (RotZFlag) {
        MatGenMatRotZ1(IRIT_DEG2RAD(RotZDegrees), Mat1);
        MatMultTwo4by4(TransMat, TransMat, Mat1);
}
if (TransFlag) {
        MatGenMatTrans(TransX, TransY, TransZ, Mat1);
        MatMultTwo4by4(TransMat, TransMat, Mat1);
}
if (ScaleFlag) {
        MatGenMatUnifScale(Scale, Mat1);
        MatMultTwo4by4(TransMat, TransMat, Mat1);
}

/* Get all the data from all the input files. */
if (NumFiles == 0) {
        /* Test reading data from memory... */
        int Handler = IPOpenStreamFromCallBackIO(ReadStreamCallBackIO, 
            NULL, TRUE, FALSE);

        PObjs = IPGetObjects(Handler);
        IPCloseStream(Handler, TRUE);
    } else {
        PObjs = IPGetDataFiles(FileNames, NumFiles, TRUE, TRUE);
    }

/* Apply the transformation to all geometry in input file(s) and dump */
/* the transformed geometry to stdout. */
PObjsTrans = GDefinitionObjectList(PObjs, TransMat);
for (PObj = PObjsTrans; PObj != NULL; PObj = PObj -> Pnext) 
        IPStdoutObject(PObj, FALSE);
IPFreeObjectList(PObjs);
IPFreeObjectList(PObjsTrans);
exit(0);
}

/****************************************************************************
* DESCRIPTION: *
* A call back function to read IRIT data in directly from memory. This *
* function will return the next char read for memory. *
* *
* PARAMETERS: *
* c:  Ignored. *
* *
* RETURN VALUE: *
* char:  Next character from memory stream. *
*****************************************************************************/
static int ReadStreamCallBackIO(int c)
{
    IRIT_STATIC_DATA int LineNum = 0,
    CharNum = 0;
    IRIT_STATIC_DATA char *Data[] = {
        "[OBJECT [COLOR 11] [RGB \"55, 255, 255\"] [WIDTH 0.05] SADDLE",
        " [SURFACE BEZIER 3 3 E3",
        " [0 0 0]",
        " [0.05 0.2 0.1]",
        " [0.1 0.05 0.2]",
        ",",
        " [0.1 -0.2 0]",
        " [0.15 0.05 0.1]",
        " [0.2 -0.1 0.2]",
        ",",
        " [0.2 0 0]",
        " [0.25 0.2 0.1]",
        " [0.3 0.05 0.2]",
        "]",
    },
    ",",
    "[OBJECT [COLOR 2] [DWidth 4] FINAL",
    " [POLYGON [PLANE 1 0 0 0.5] 4",
    " [[NORMAL 1 0 1] -0.5 2 1]",
    " [[NORMAL 1 1 0] [INTERNAL] -0.5 1 1]",
    " [[NORMAL 1 0 2] -0.5 1 -1]",
    " [[NORMAL 1 0 0] -0.5 2 -1]",
    "]",
    NULL
    }
;
    /* End of line or end of memory stream!? */
    while (Data[LineNum] == NULL || Data[LineNum][CharNum] == 0) {
        if (Data[LineNum] == NULL) /* Last line. */
            return EOF;
        else {
            LineNum++;
            CharNum = 0;
            /* DEBUG_ECHO_INPUT */
            putchar('\n');
            putchar('\r');
        }
    }
    /* DEBUG_ECHO_INPUT */
    putchar(Data[LineNum][CharNum]);
    /* DEBUG_ECHO_INPUT */
    return (char) Data[LineNum][CharNum++];
}
Here is the result of running 'transfrm -h':

This is Transform...

When you are considering the usefulness of this tool remember that the transformations are applied to the geometry in an internal order which is different from the command line order. That is,

```
transfrm -x 30 -y 30 geometry.dat > tgeometry.dat
```

will compute the exact same transform as,

```
transfrm -y 30 -x 30 geometry.dat > tgeometry.dat
```

This, while rotation is not a commutative operation. Nonetheless, you may split the operations. That is:

```
transfrm -y 30 geometry.dat | transfrm -x 30 - > tgeometry.dat
```

or

```
transfrm -x 30 geometry.dat | transfrm -y 30 - > tgeometry.dat
```

will do exactly what one expects.
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