Over the last decade, the intersections between processing and analysis of geometric data, image processing, and machine learning have become a topic of increasing interest. In particular, the accessibility of 3D sensors and growth of 3D geometric data has been one of the driving forces of this research. Nevertheless, when attempting to apply current signal processing and analysis methods to 3D shapes (feature-based description, registration, recognition, indexing, etc.) one has to face fundamental differences between images and geometric objects. Shape analysis poses new challenges that are non-existent in image analysis.

The purpose of this course is to overview the foundations of geometric data analysis and to formulate state-of-the-art theoretical and computational methods for such data description based on their intrinsic geometric properties. The emerging field of spectral and diffusion geometry provides a generic framework for many methods in the analysis of geometric shapes and objects. The course will present in a new light the problems of shape analysis based on diffusion geometric constructions such as manifold embeddings using the Laplace-Beltrami and heat operator, geometric feature detectors and descriptors, diffusion and commute-time metrics, functional correspondence, and spectral symmetry.

We will consider practical problems from the domains of computer graphics and vision, pattern recognition, and geometric processing.