

# Robots can optimally cover simply connected unknown environments, without wasted movement.

## Optimal strategies are impossible for non-simply connected regions.

### Minimizing Travel in the Uniform Dispersal Problem for Robotic Sensors

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#### Objective

- We present an algorithm for completely covering an unknown pixelated environment with a **swarm** of simple autonomous robots.
- The algorithm **minimizes robots' movements**, hence **minimizes energy consumption**.

#### Model

- Robots enter a pixelated environment  $R$  over time through a **source vertex** and seek to occupy every location in  $R$  while avoiding collisions.
- Robots operate synchronously in **Look-Compute-Move** cycles. We require only very simple robotic capabilities:  
**basic local obstacle sensing**  
**low memory**  
**no communication**

#### Results

- An algorithm that completes in **optimal time** and has **no wasted movements** exists when  $R$  has **no holes** (the topology of  $R$  is “simply connected”).
- We prove no optimal algorithm exists when  $R$  has holes.

#### Main algorithmic strategy

- Robots attempt to move in **two primary directions** for as long as possible (such as North-East, East-South).
- To minimize movement and energy, they aim to **settle in place** as soon as possible.
- This is done by **stopping at corners** but **never at halls**:

