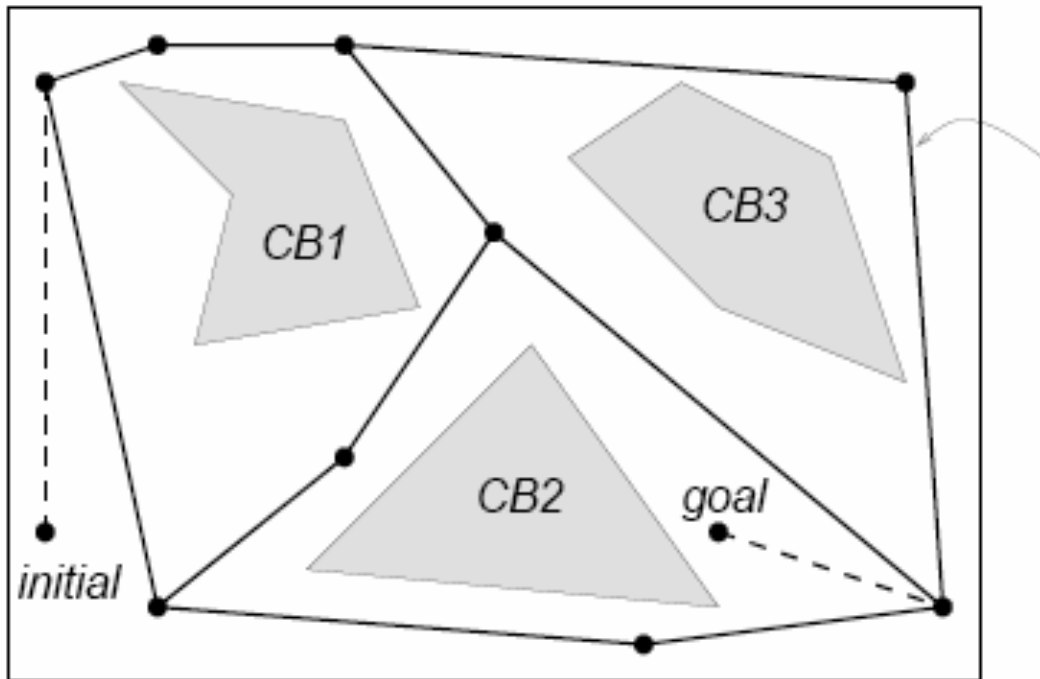# Roadmaps
Voronoi

Alfredo Weitzenfeld

Roadmaps

- A *roadmap* is a class of topological map with nodes representing physical locations and edges representing paths between neighboring locations.
- Robots use roadmaps as people use highway systems.
- If a roadmap exists then a path exists

Roadmap Definition

- A roadmap, RM, is a union of curves such that all start and goal points in Q_{free} can be connected by a path:

  - *Accessibility*: there exists a collision-free path from $q_{start} \in Q_{free}$ to some $q'_{start} \in RM$

  - *Departability*: there exists a collision-free path from some $q'_{goal} \in RM$ to $q_{goal} \in Q_{free}$

  - *Connectivity*: there exists a path in RM between q'_{start} and q'_{goal}

Roadmap Path Planning

- Build the roadmap
  - nodes are points in Q_{free} (or its boundary)
  - two nodes are connected by an edge if there is a free path between them
- Connect start end goal points to the road map at point q'_{start} and q'_{goal}, respectively
- Find a path on the roadmap between

  q'_{start} and q'_{goal}

- The result is a path in Q_{free} from start to goal

Roadmap Types

- Visibility Graphs
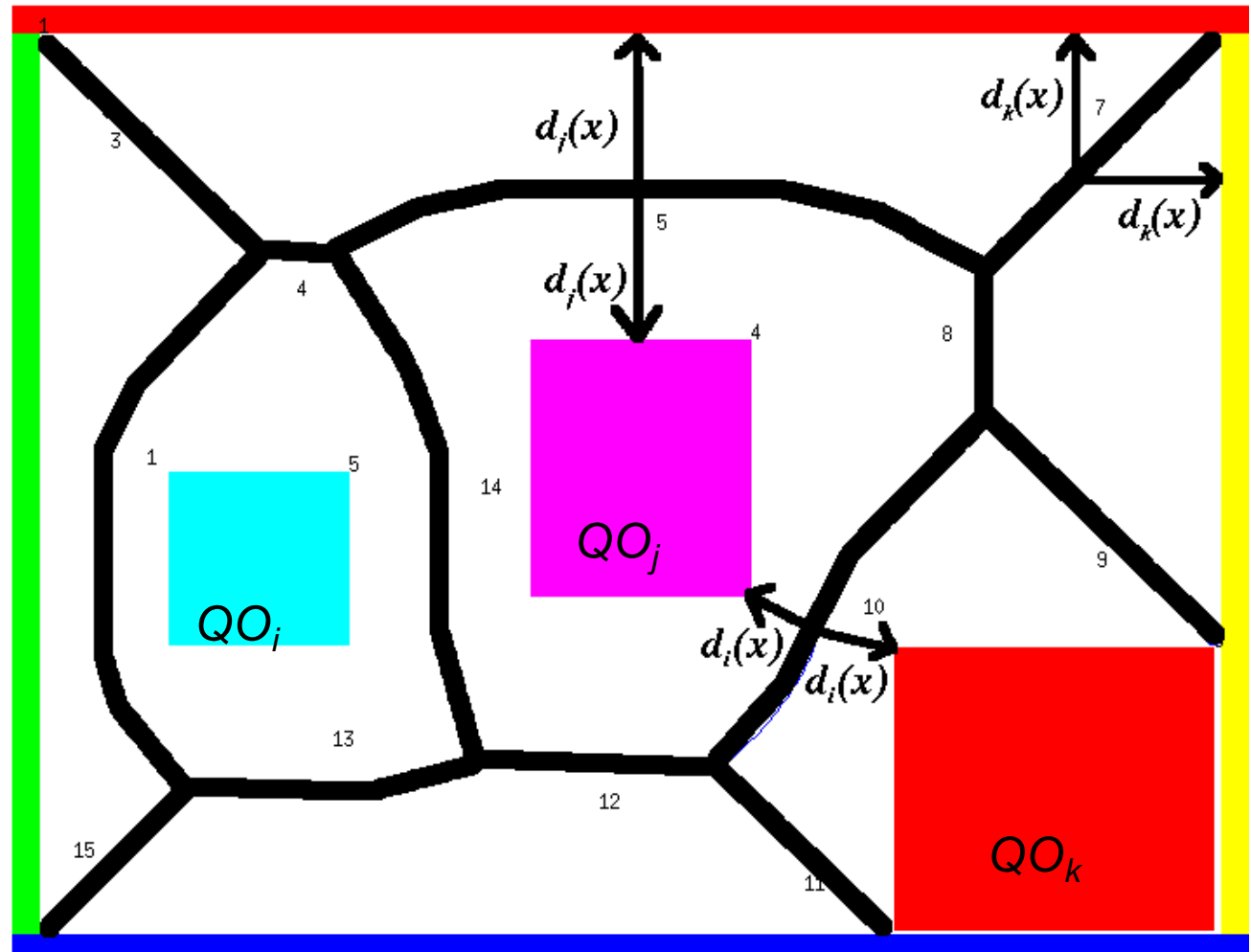- Generalized Voronoi Diagram (GVD)

Voronoi Diagrams
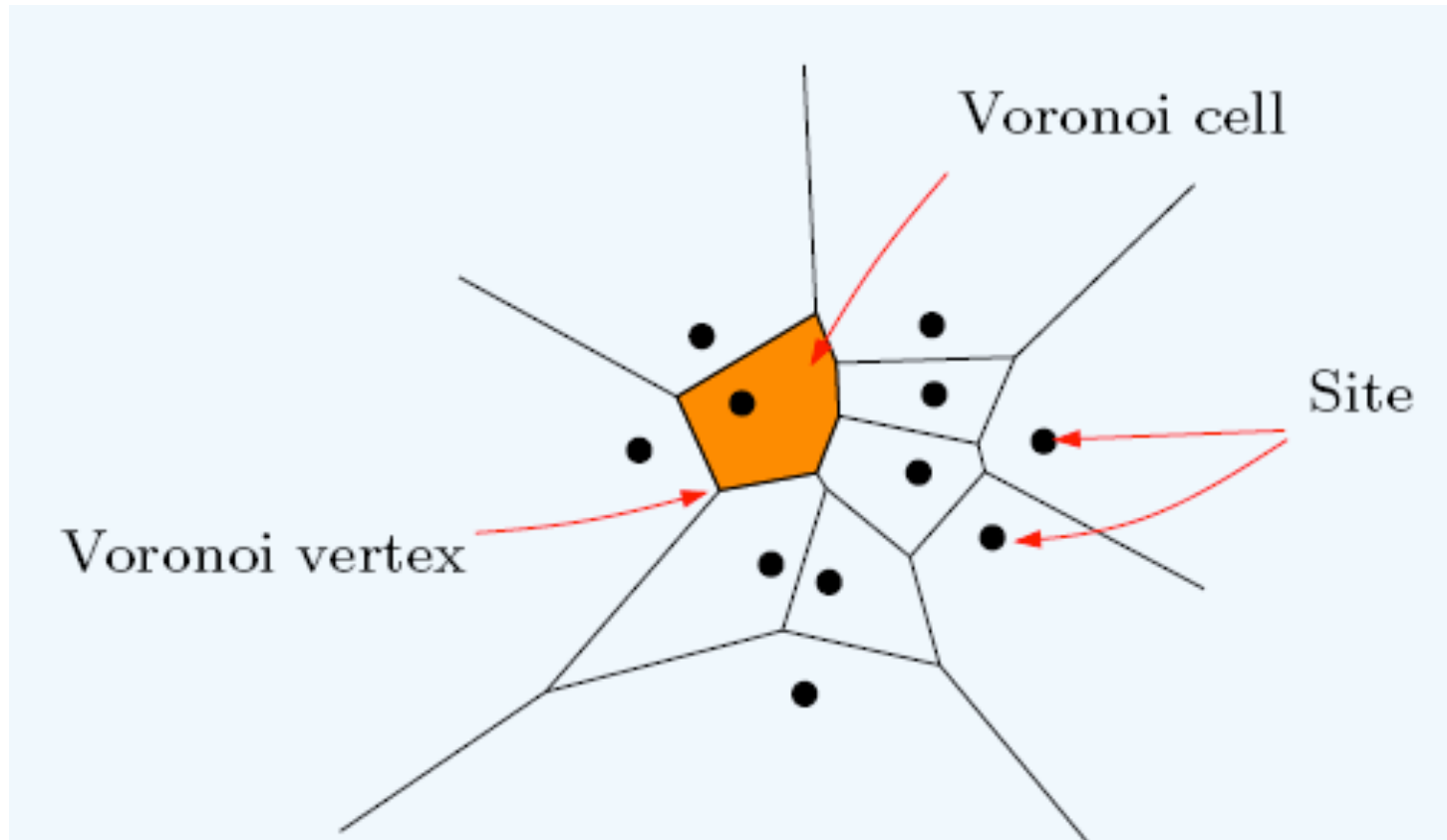
- A *Voronoi diagram* defines the set of points equidistant to two *sites*.
- A *Voronoi region* or *cell* defines a set of points closest to a particular site.
- A *Voronoi vertex* is defined by the intersection of edges or line segments adjacent to Voronoi cells.
- A *Voronoi segment* contains points that are equidistant to at least two *sites*.

Generalized Voronoi Diagram (GVD)

- The *Generalized Voronoi Diagram* (GVD) extends *sites* (single points) into the closure of the set of all points closest to each QO_i

- A GVD is formed by paths equidistant from the two closest obstacles

- A GVD generates a very safe roadmap which avoids obstacles as much as possible
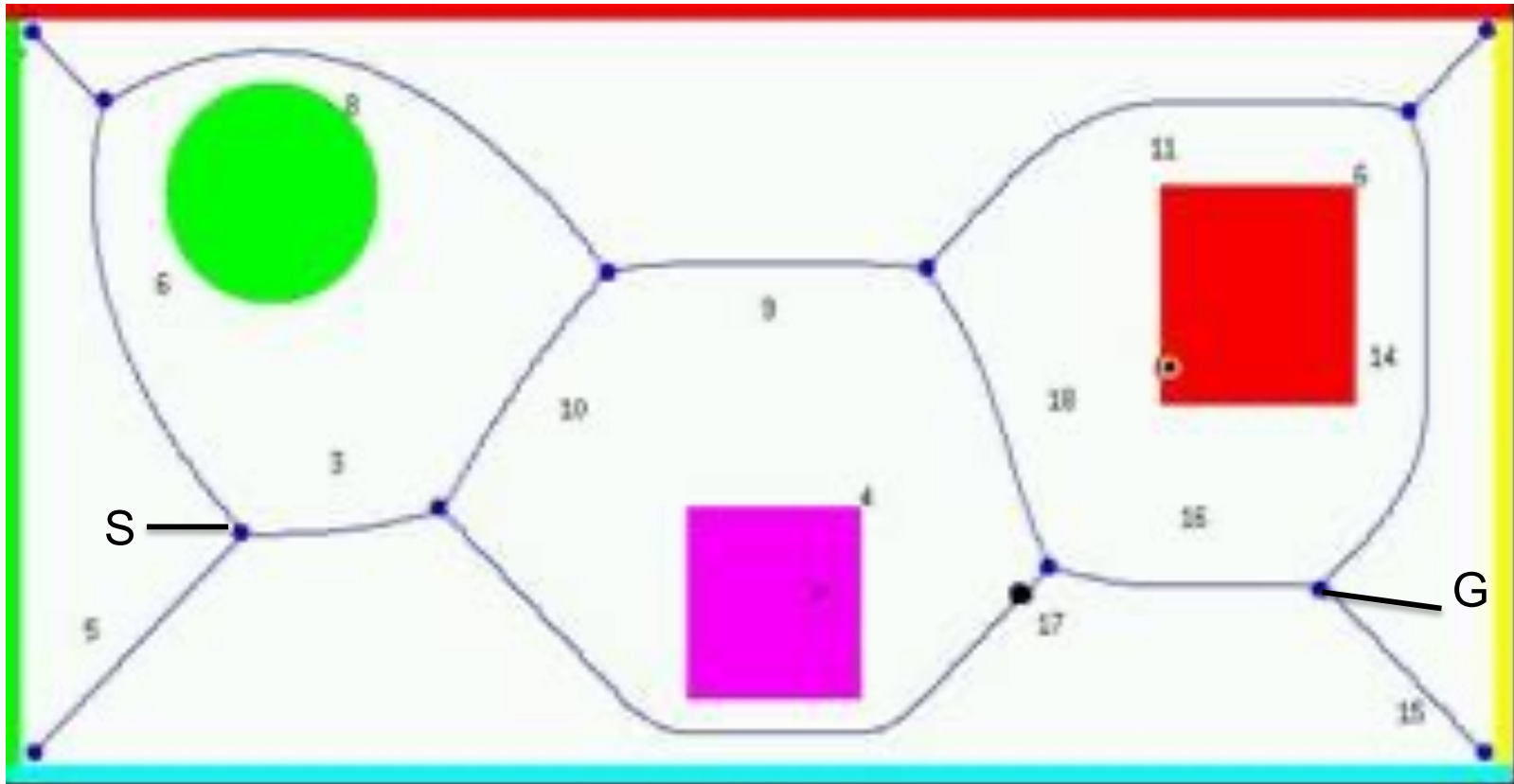
Generalized Voronoi Diagram

- Obstacles in A GVD may have arbitrary shapes are not restricted to polygons
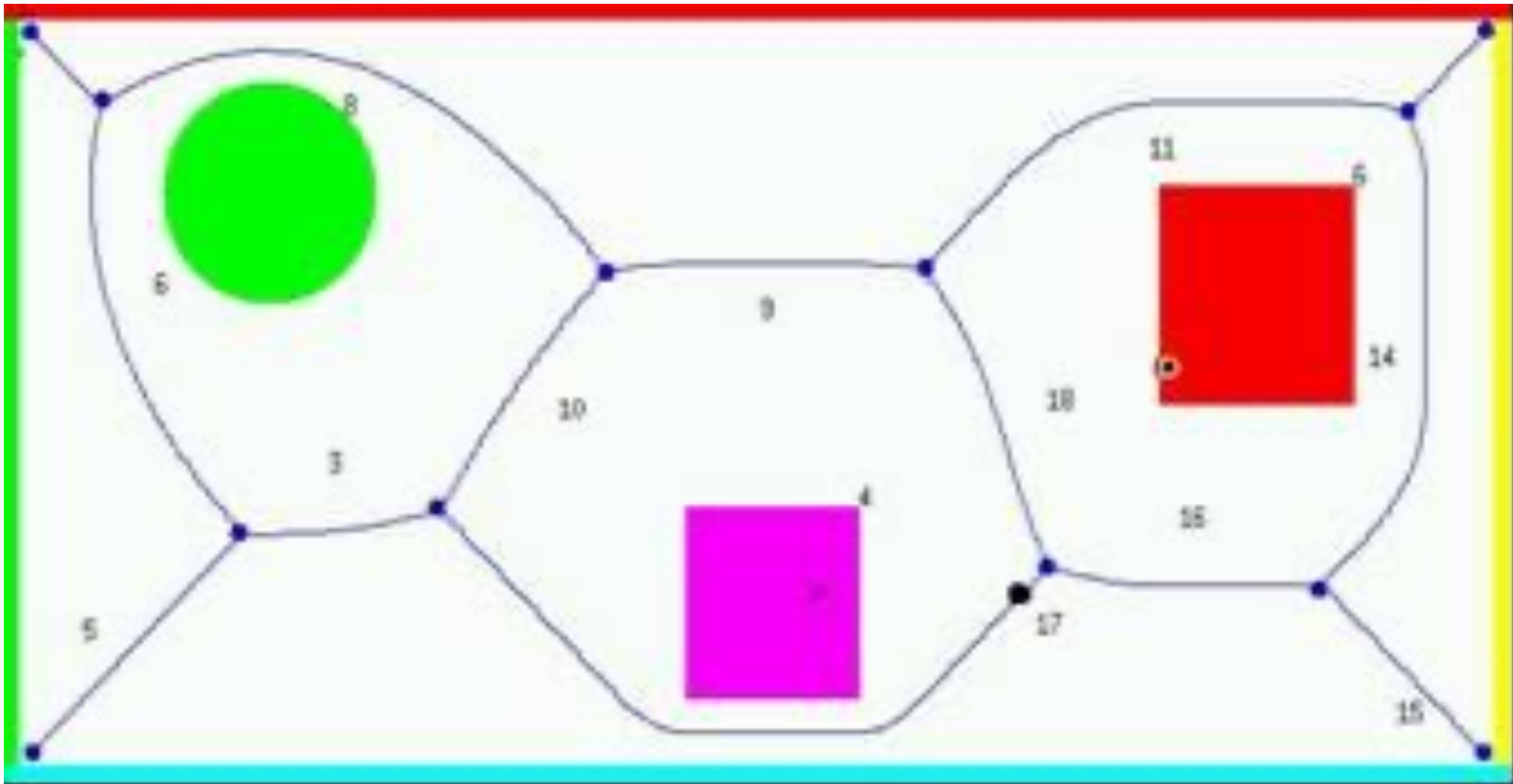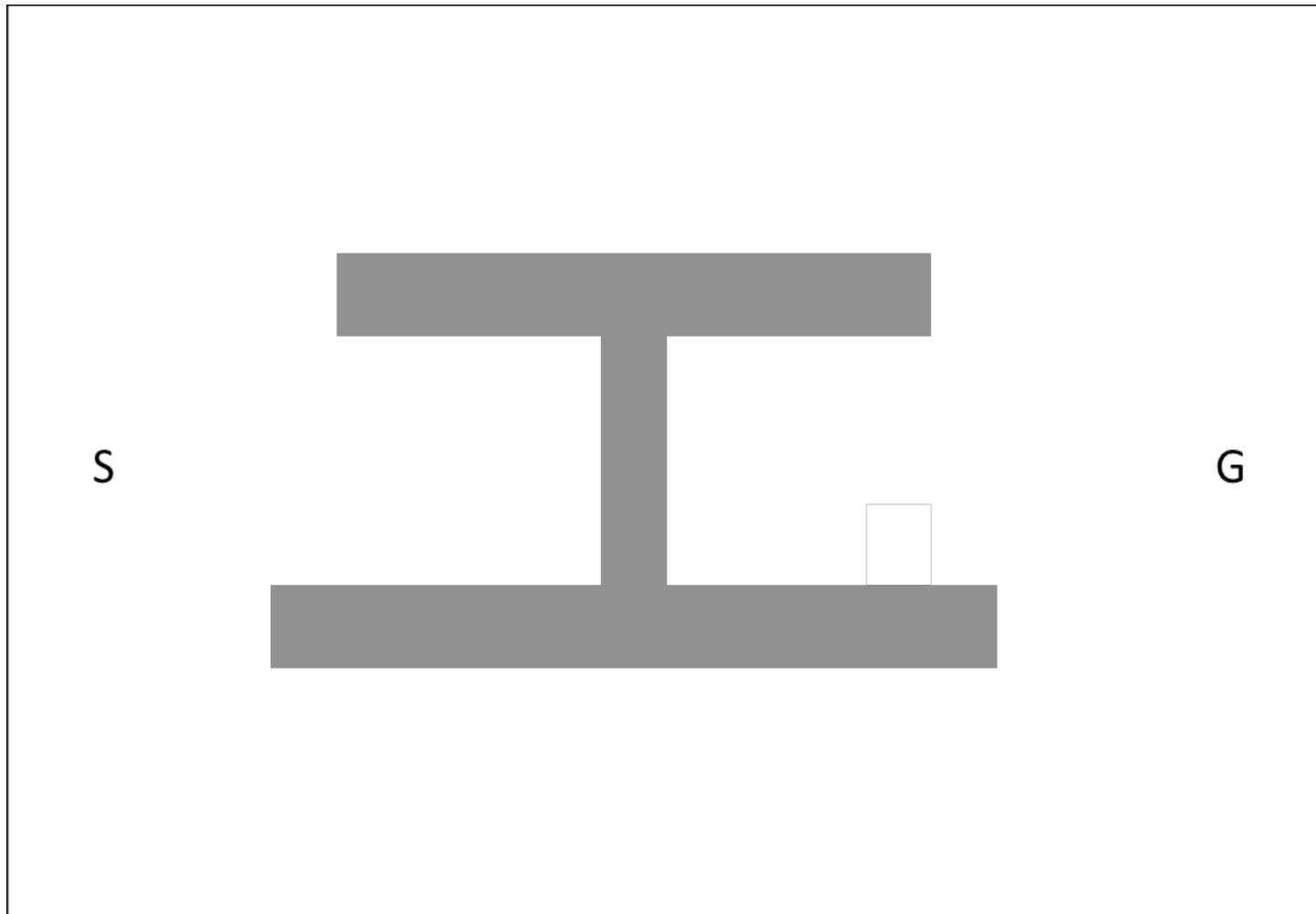
Generalized Voronoi Diagram

- A GVD with Start (S) and Goal (G) locations
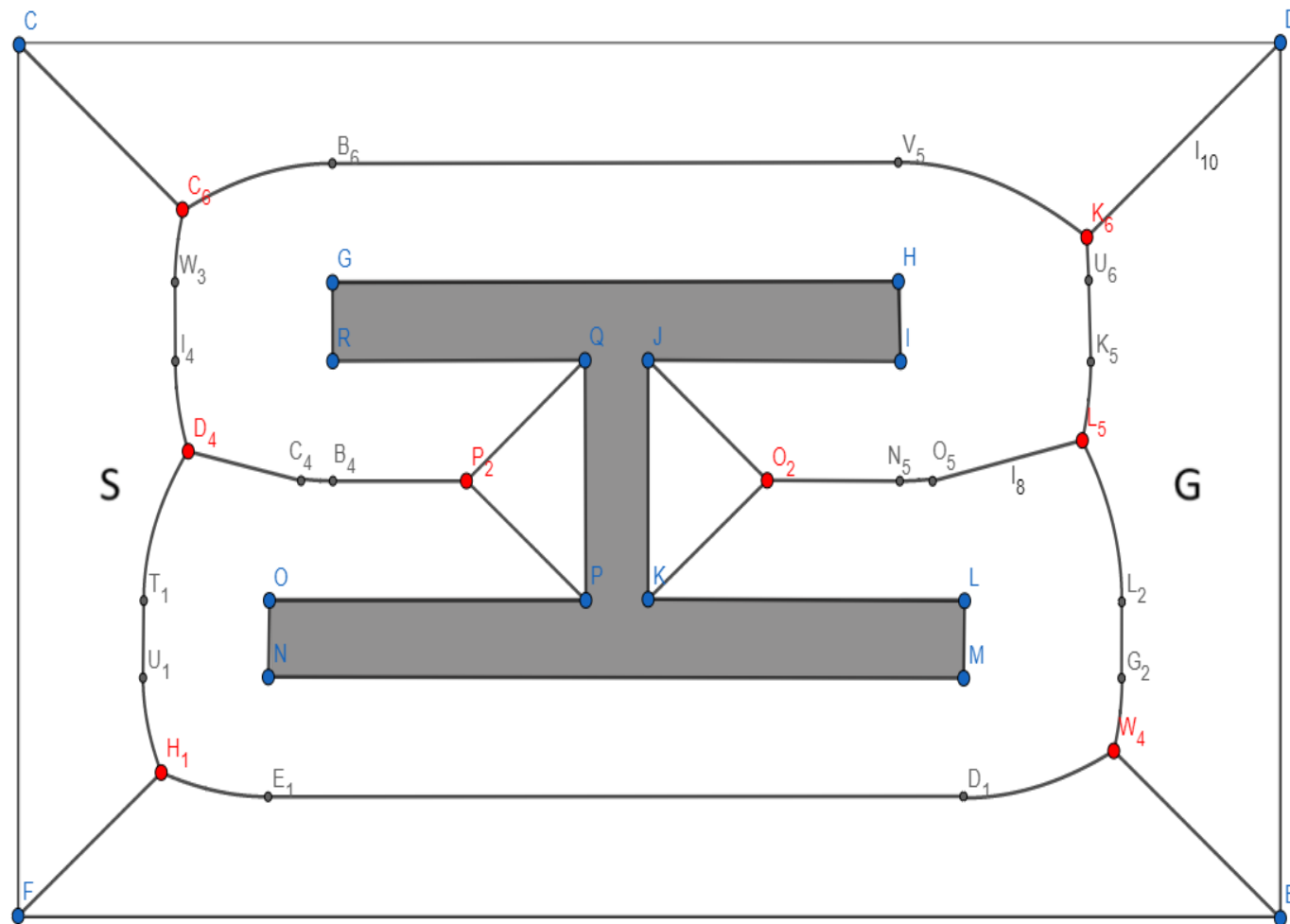
Roadmaps – GVD

Spring 2017

Apply the Generalized Voronoi Diagram (GVD) algorithm to the scene below where darker elements correspond to obstacles and surrounding rectangle represents a wall. Show the complete GVD paths. Show the final shortest path from start to goal using the GVD paths.
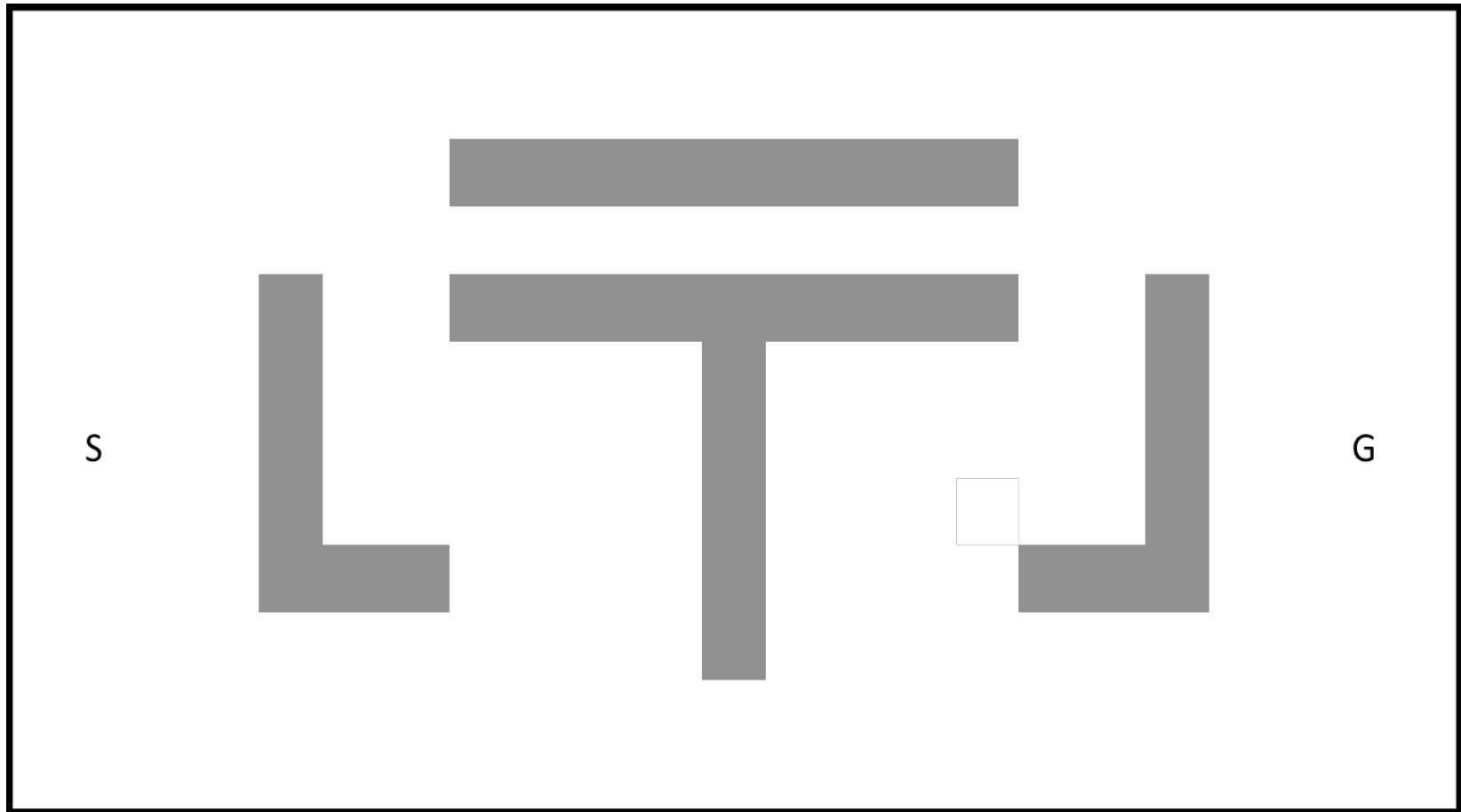
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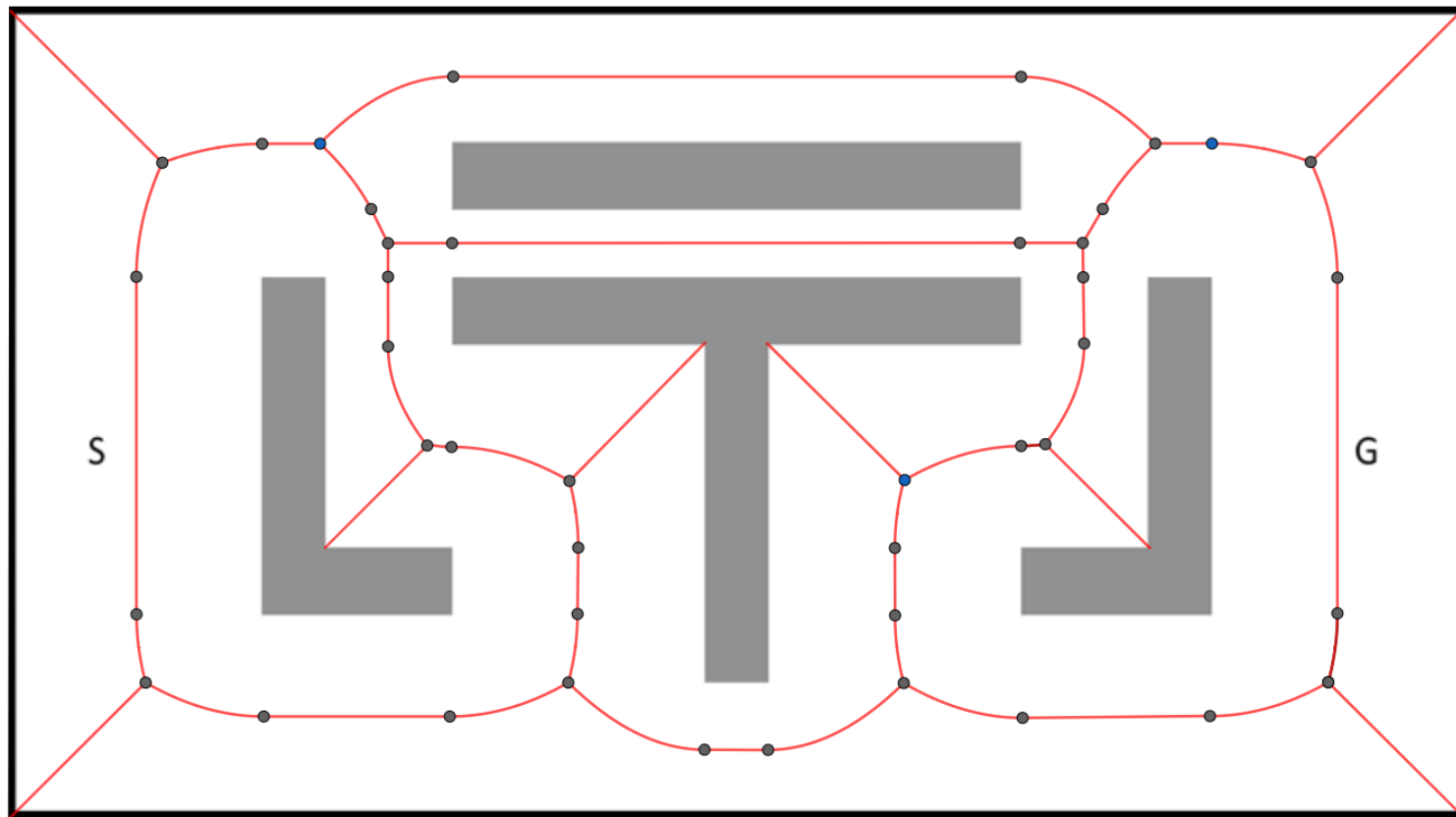
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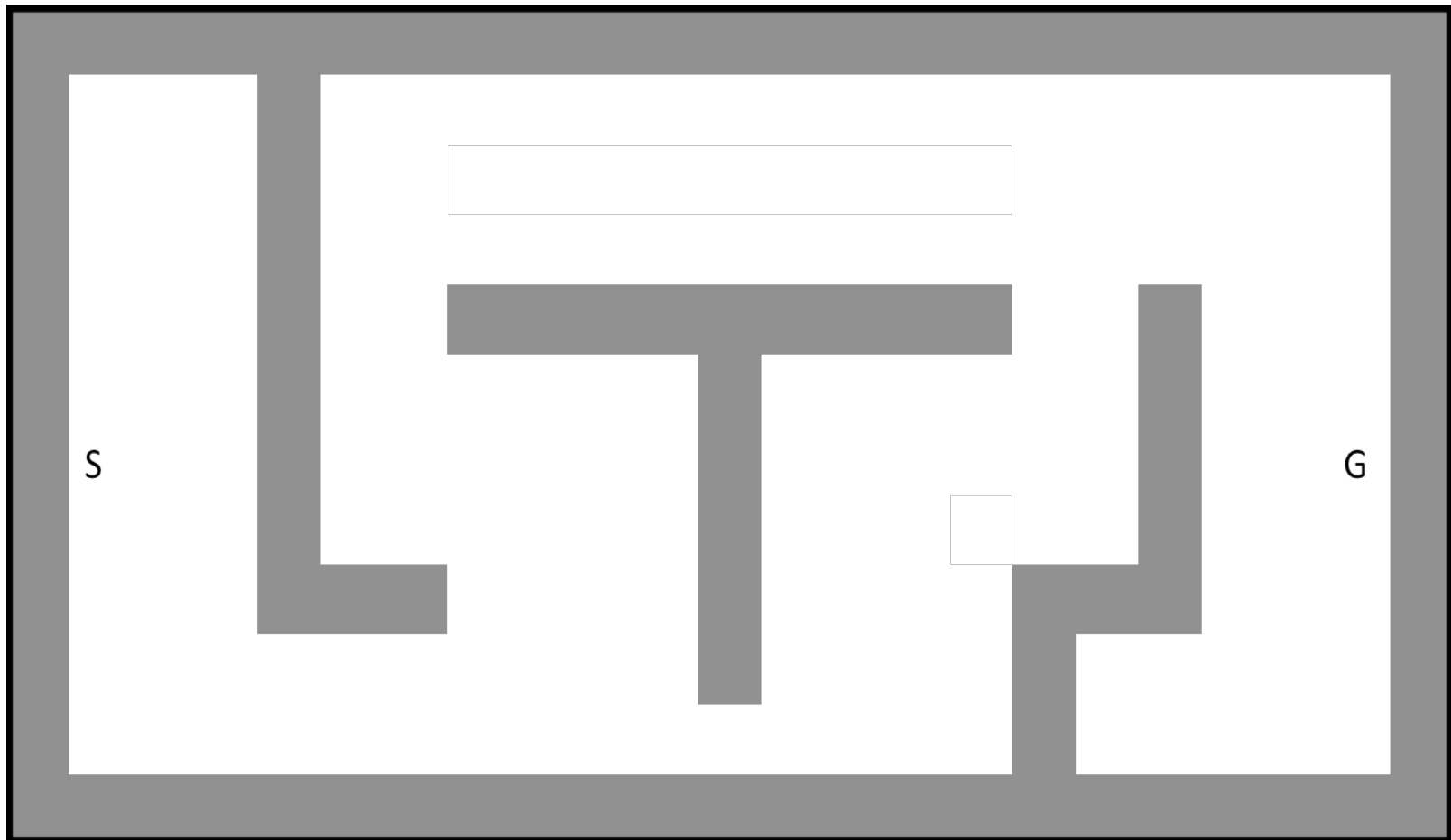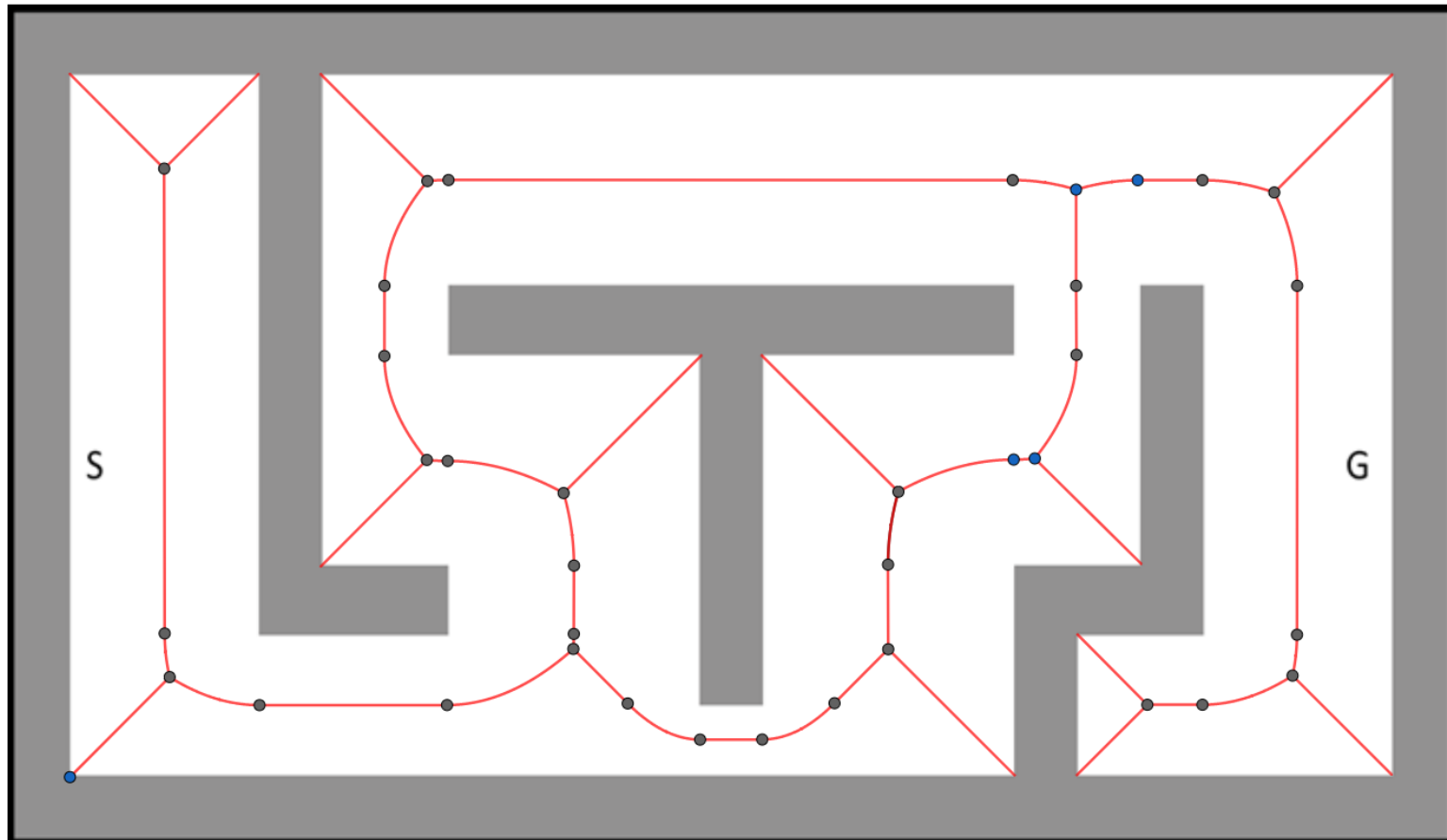
Roadmaps – GVD

Fall 2017

Apply the Generalized Voronoi Diagram (GVD) algorithm to the scene below where darker elements correspond to obstacles.

Show the complete GVD paths.

Highlight a final shortest path from start "S" to goal "G" based on least number of individual edges.

Roadmaps – GVD

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Show the complete GVD paths.

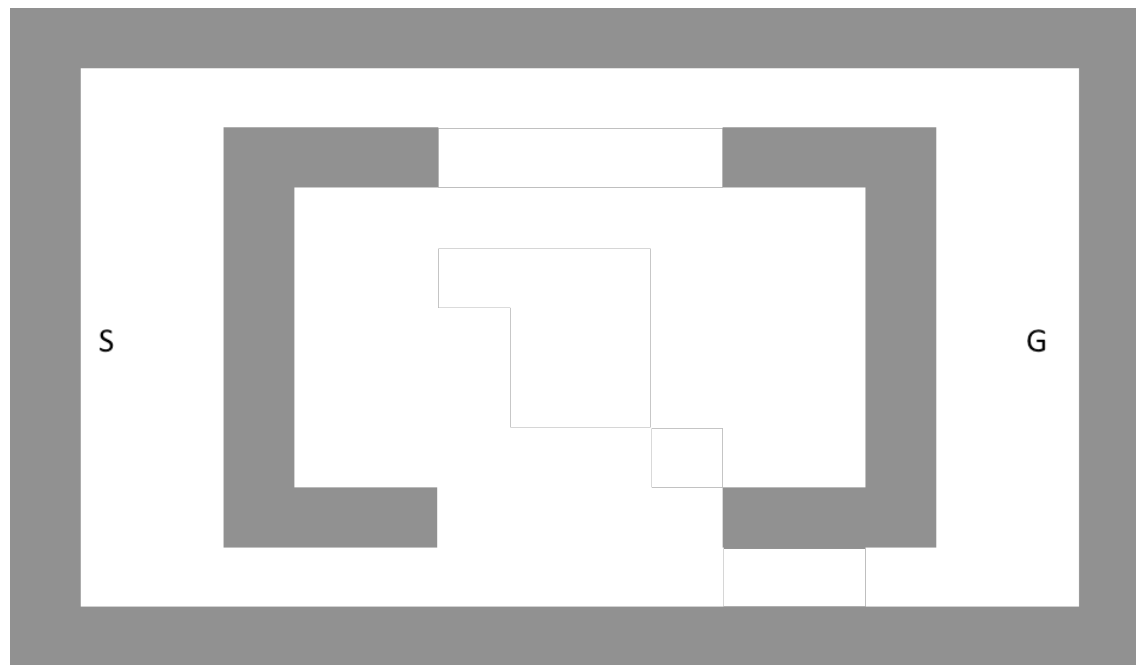Highlight a final shortest path from start "S" to goal "G" based on least number of individual edges.
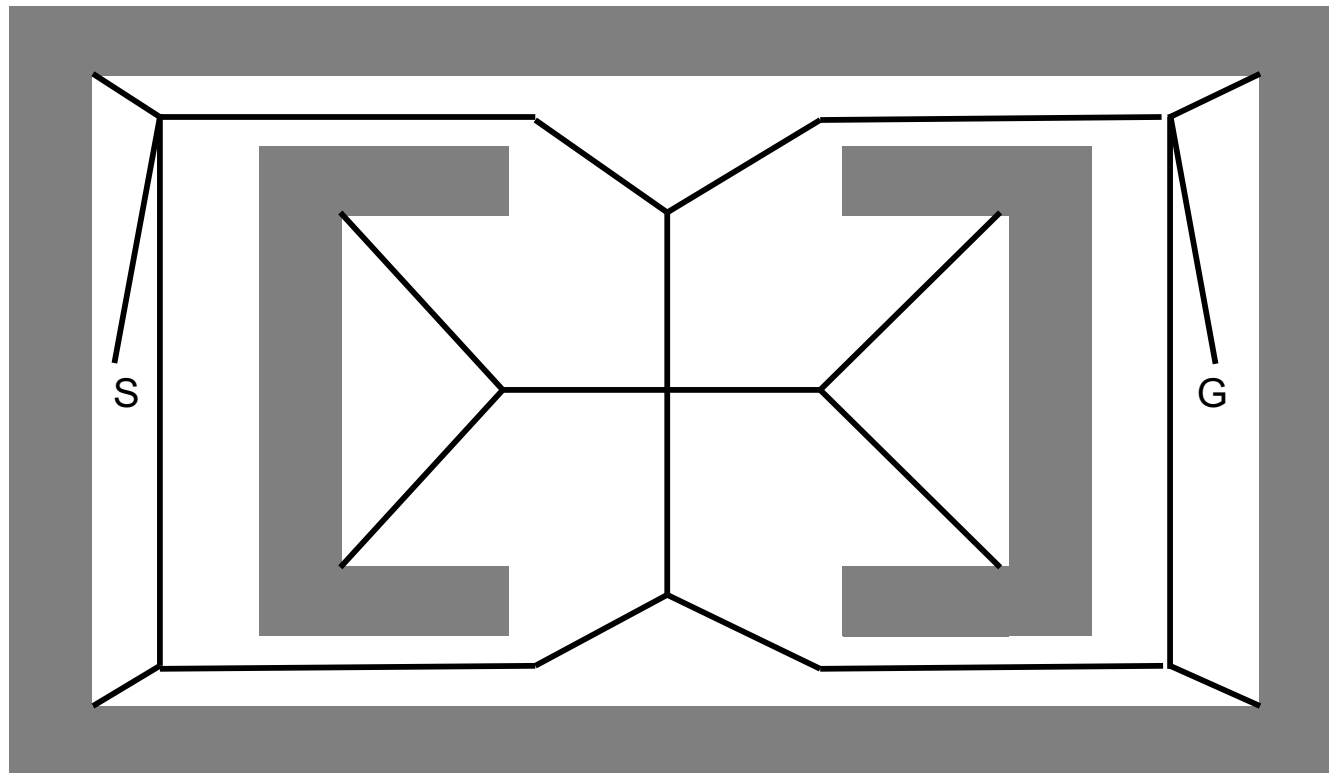
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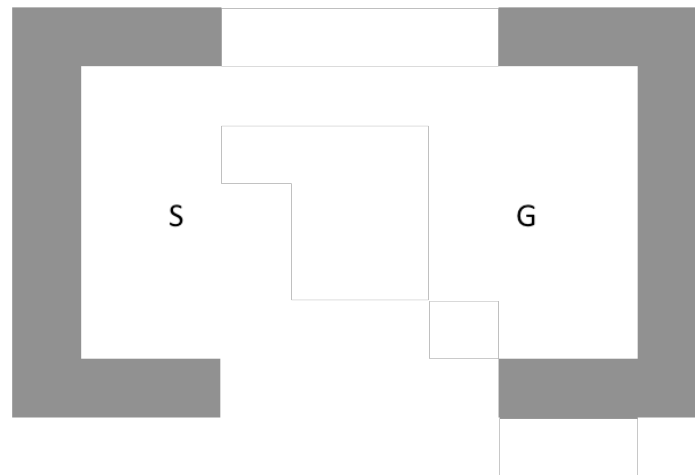- Show the complete GVD paths for the figure below. Highlight the shortest path from "S" to "G".

Roadmaps – GVD

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- Show the complete GVD paths for the figure below. Highlight the shortest path from "S" to "G".
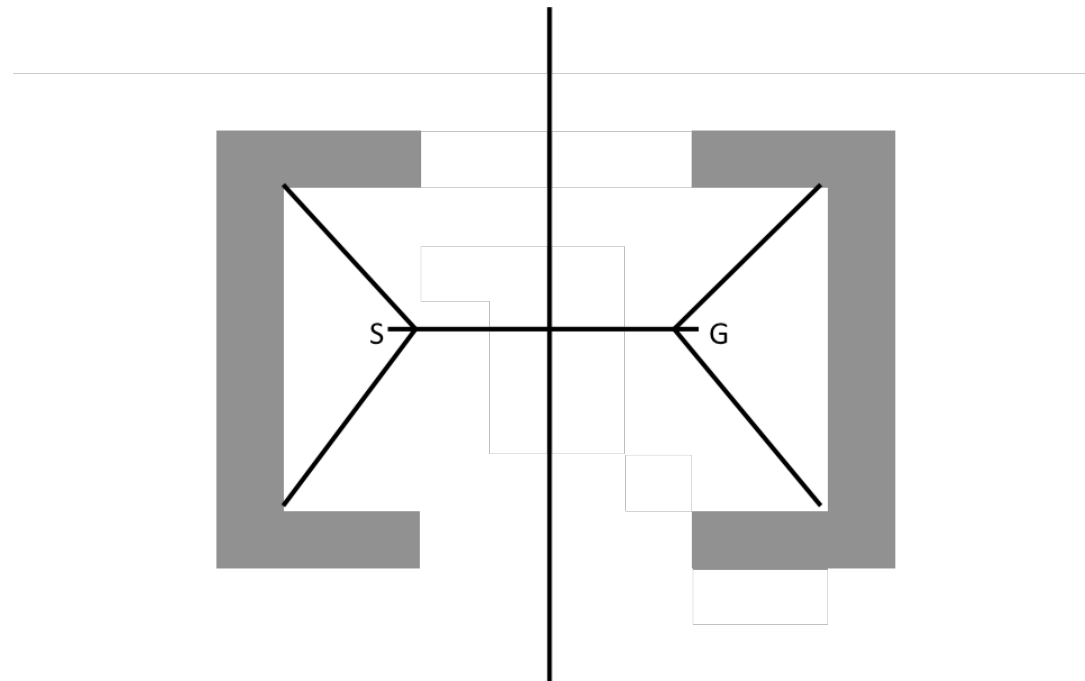
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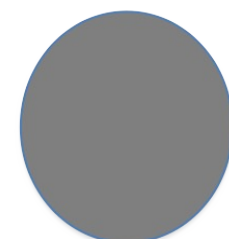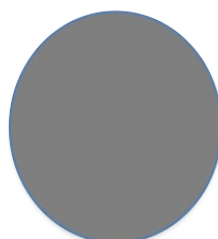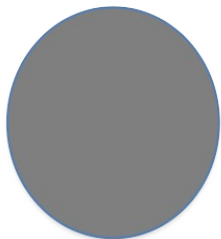- Show the complete GVD paths for the figure below. Highlight the shortest path from "S" to "G".
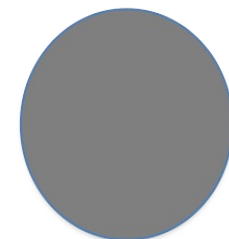
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- Apply the Roadmap Generalized Voronoi Diagram (GVD) algorithm to show <u>ALL</u> GVD paths. Use only straight lines.
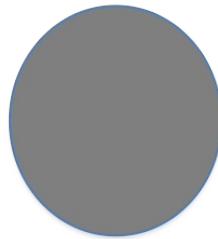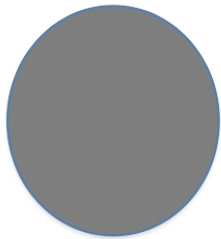
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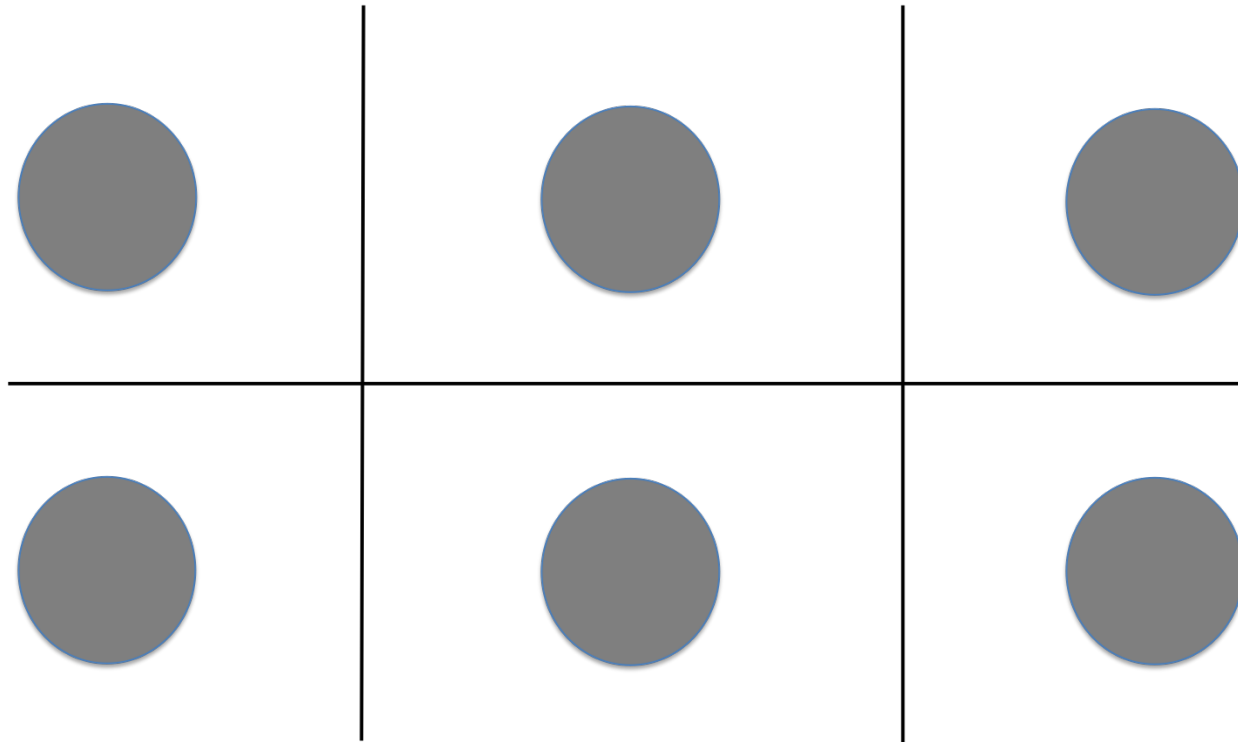
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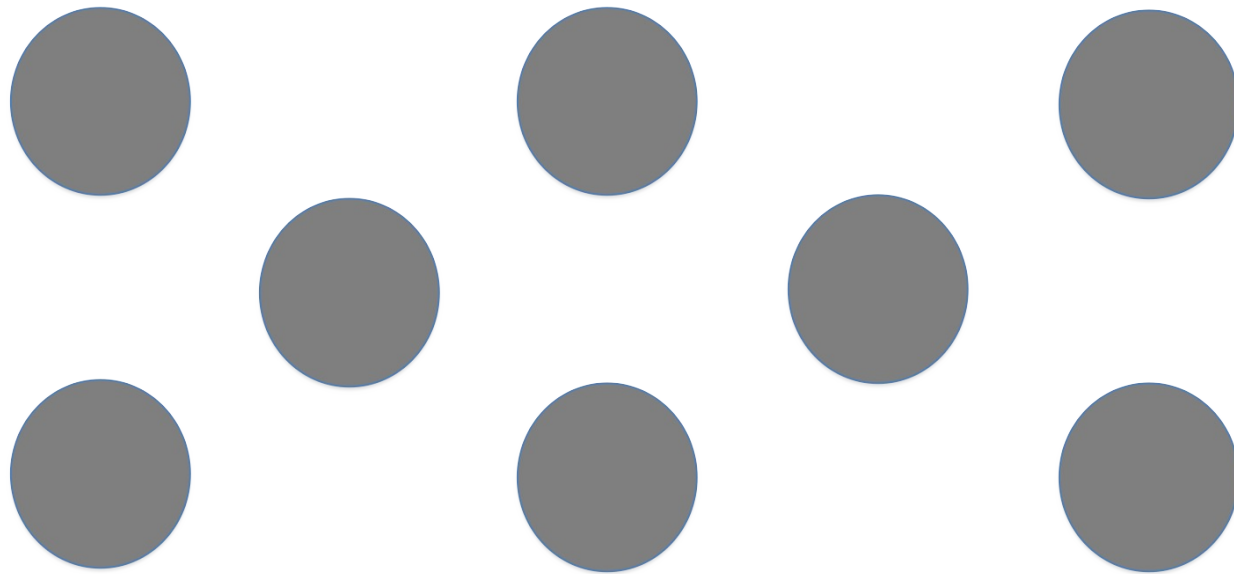
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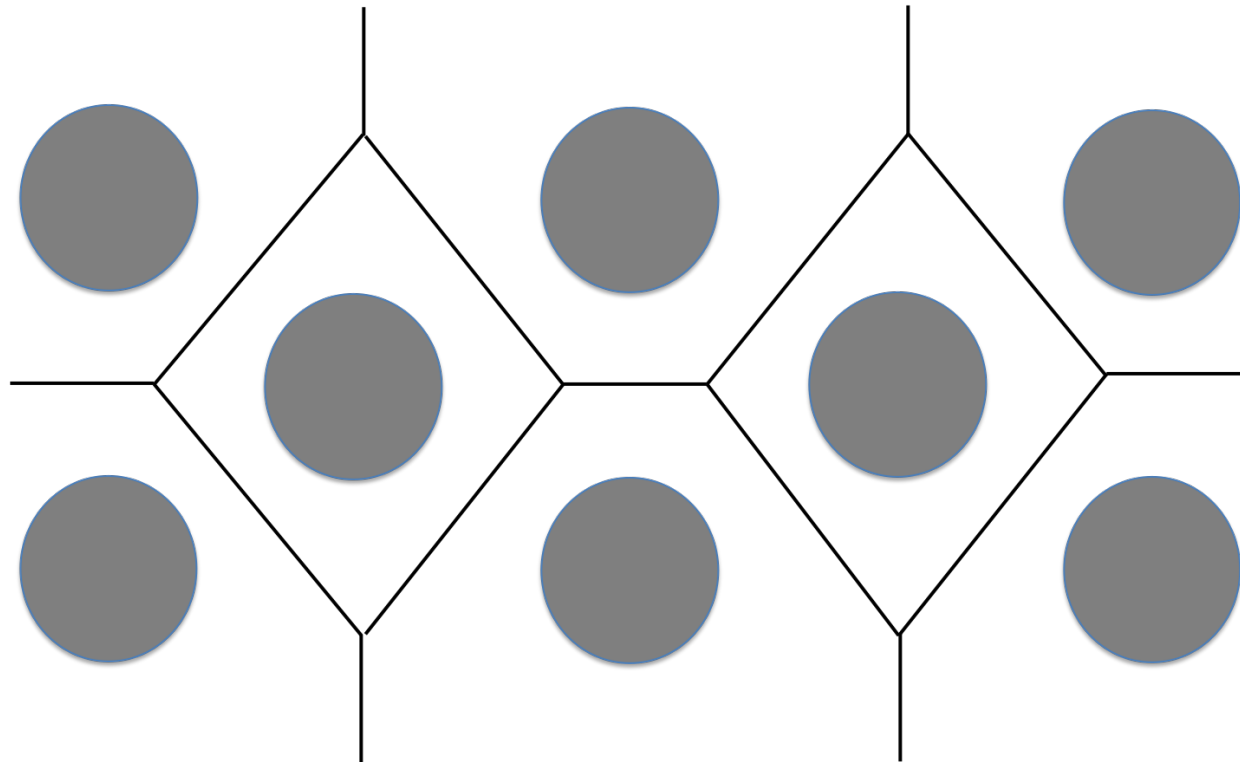
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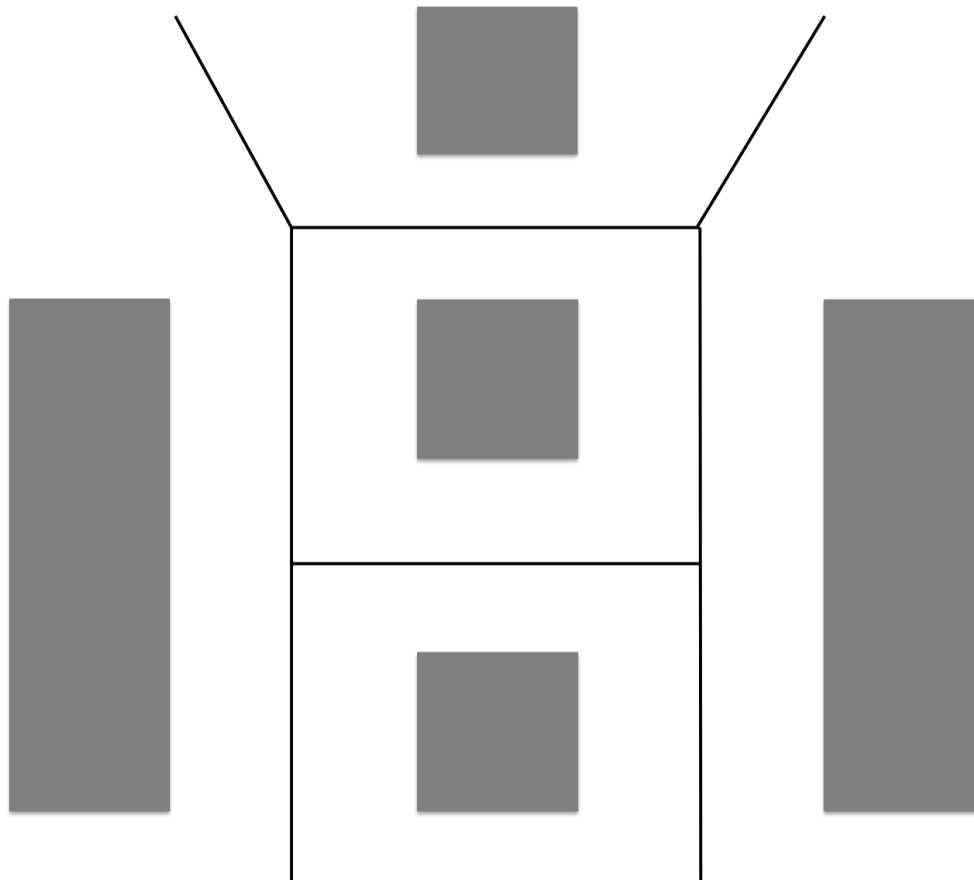
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