thws Technische Hochschule Würzburg-Schweinfurt

Faculty of Computer Science and Business Information Systems
5172080: Fundamentals of Mobile Robotics

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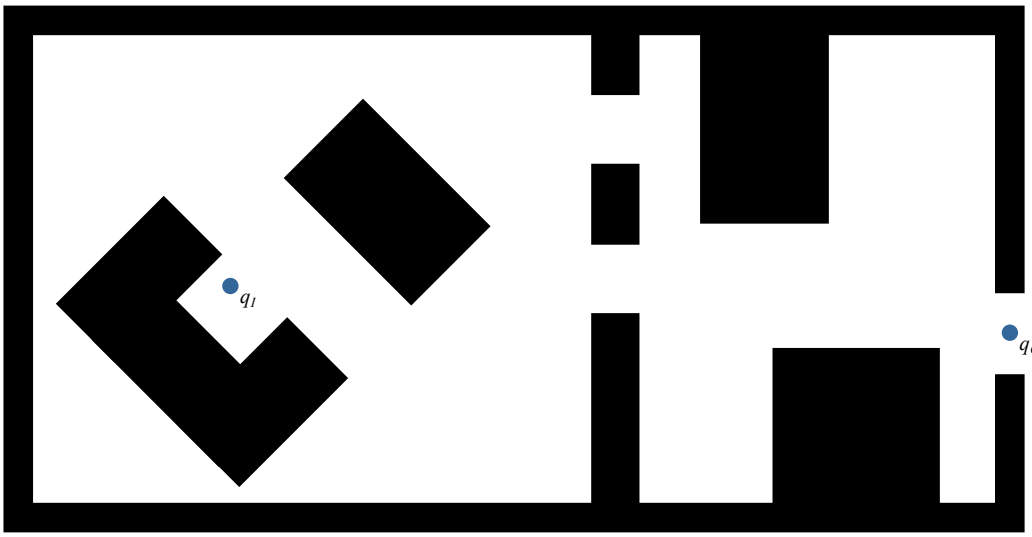
Tutorial 7

Topic: Motion and Path Planning

Solutions will be discussed in class Monday 12:10-13:10, Week 03 of the calendar year.

Q 1 – Trapezoidal Cell Decomposition

A point robot tries to plan an admissible path in the two-dimensional space below. It uses the trapezoidal decomposition as a method to discretize this polygonal configuration space.



1.a

Decompose the free space (white area) into non-overlapping trapezoidal cells. Draw the cells on this sheet. Number the resulting cells from left to right. When they have the same left boundary, number the cells from top to bottom.

1.b

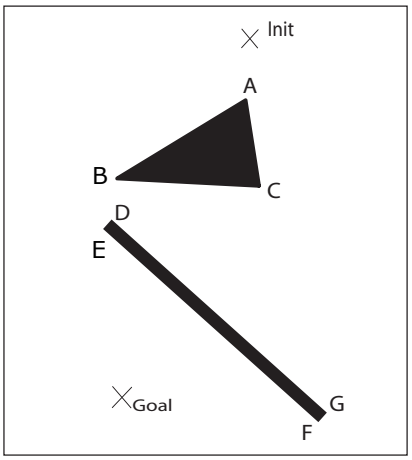
Place vertices in the decomposed free space and connect them by path segments. Construct an adjacency graph from this.

1.c

Find the shortest path from the initial configuration q_I to the goal q_G within your adjacency graph. Specify the sequence of cells traversed. Is the shortest path unique? Note: q_G and q_G are included in the above figure.

Q 2 – Visibility Graphs

Now the point robot tries to plan an admissible path in the following space instead. Given are two obstacles (grey area), the initial configuration of the robot (Init), and the goal configuration (Goal). The image frame does not represent an obstacle. The vertices in the configuration space are indicated by capital letters (A to G).

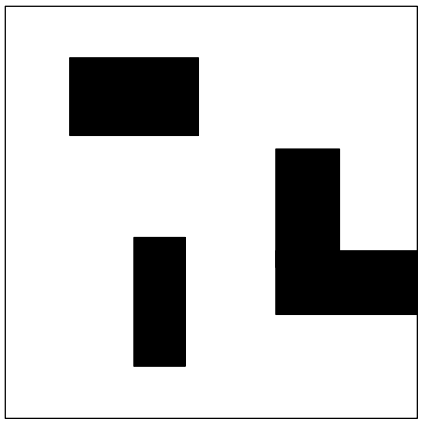


2.a

Create a collision-free roadmap between the initial and goal configurations and the obstacles by constructing a visibility graph. Draw the graph on this sheet. How many edges does the graph contain overall?

Q 3 – Quadtree Decomposition

Finally the point robot decides to use the quadtree decomposition to discretize the configuration space below. This square space is split into free space (white area) and obstacle regions (black areas).



3.a

Construct the quadtree up to a depth of three and draw the resulting grid on this sheet. The root (level 0) of the tree corresponds to the square above. Process the children of a cell from left to right and bottom to top. Label the nodes of the tree as full, empty or mixed. State the numbers of full, empty, and mixed cells in the grid.

Q 4 – Search Algorithms

Prove the following propositions:

4.a

Breadth-first search is a special case of uniform-cost search.

4.b

Breadth-first search, depth-first search, and uniform-cost search are special cases of greedy search.

4.c

Uniform-cost search is a special case of A* search.