COMP3702/COMP7702 Artificial Intelligence
Semester 2, 2020
Tutorial 4

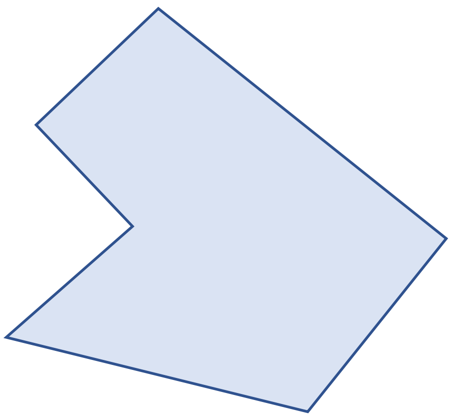
Before you begin, please note:

- Tutorial exercises are provided to help you understand the materials discussed in class, and to improve your skills in solving AI problems.
- Tutorial exercises will not be graded. However, you are highly encouraged to do them for your own learning. Moreover, we hope you get the satisfaction from solving these problems.
- The skills you acquire in completing the tutorial exercises will help you complete the assignments.
- You'll get the best learning outcome when you try to solve these exercises on your own first (before your tutorial session), and use your tutorial session to ask about the difficulties you face when trying to solve this set of exercises.

Exercises

Exercise 4.1. Suppose a point robot operates in an environment where some of the obstacles are non-convex polygons. A non-convex polygon is a polygon where at least one of its interior angles is a reflex angle. Let G be the visibility graph representation of the environment. And let the weight of each edge in G be the length of the straight line path represented by the edge. Can we remove some of the vertices and edges of G while ensuring that the shortest collision-free path between an initial and a goal points found via the visibility graph (as discussed in class) is indeed the shortest collision-free path for the robot to move from the initial to the goal points? If we can, which vertices and edges can we remove? Please explain your answer.

Note: A **convex** polygon is a polygon in which no line segment between two points on the boundary ever goes outside the polygon. All interior angles are less than or equal to 180 degrees. In contrast, a **non-convex polygon** has at least one interior angle greater than 180 degrees. An example of a non-convex polygon is given below:



Example non-convex polygon

Exercise 4.2. Suppose you are given a workspace with two obstacles in red and a triangular robot (as shown in Figure 1). The robot can only translate and cannot rotate.

1. Please define a configuration space for the robot
2. Assuming the only invalid configurations are those that will cause the robot to collide with at least one of the obstacles, how would the forbidden region(s) in your configuration space look like?

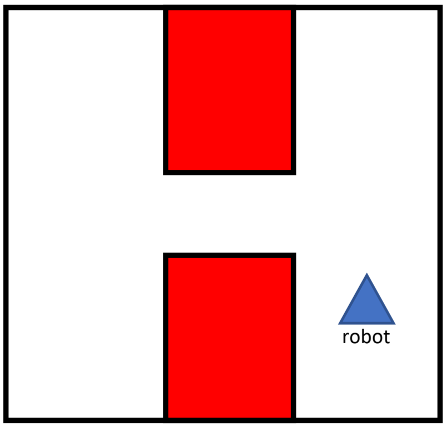


Figure 1: Triangular robot in an environment with two obstacles

Exercise 4.3. Suppose you are given a workspace populated by two obstacles (as shown in Figure 2). The width and horizontal position of the upper and lower obstacles are the same. Suppose the robot is a rod robot that can only rotate about its static base (marked by the blue circle) and suppose the vertical position of the base is exactly in the middle of the passage (the picture is not correct). Its angle is limited to be between $0°$ and $360°$ and the robot hits the upper obstacle at $45°$ and $315°$, and the lower one at $135°$ and $225°$. Please define a configuration space for the robot, assuming the only invalid configurations are those that will cause the robot to collide with the obstacle, how would the forbidden region(s) in your configuration space look like?

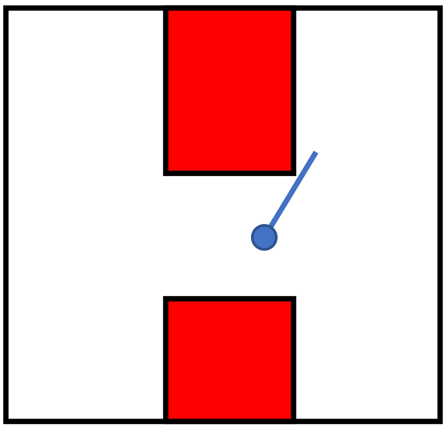


Figure 2: Rod robot in an environment with two obstacles