Homework 1

ESE 559: Special Topics in Systems and Control:
Learning and Planning in Robotics

Due Date: 02/07/2025

Problem 1

(a) Consider (i) a 10 x 10 square environment with one 1 x 1 square obstacle centered at location (5,5); (ii) initial robot state (0.5, 0.5); and (iii) a circular goal region centered at (9,9) with radius 0.5; see Fig 1. Using the RRT algorithm, compute a path from the initial state to the goal region. Report all parameter values used to apply RRT. Provide figures demonstrating the computed paths and report the average runtimes over 20 executions of RRT (along with the variance of these runtimes). Note: The configuration space in Problem 1 is (x,y).

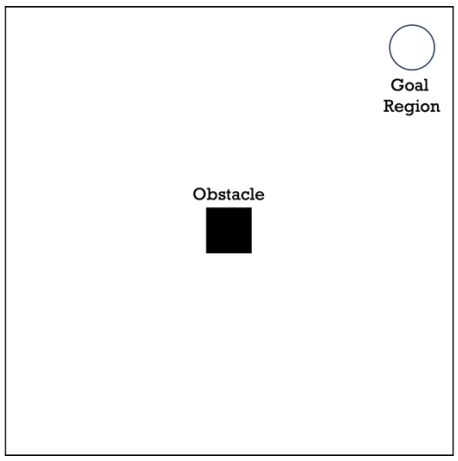
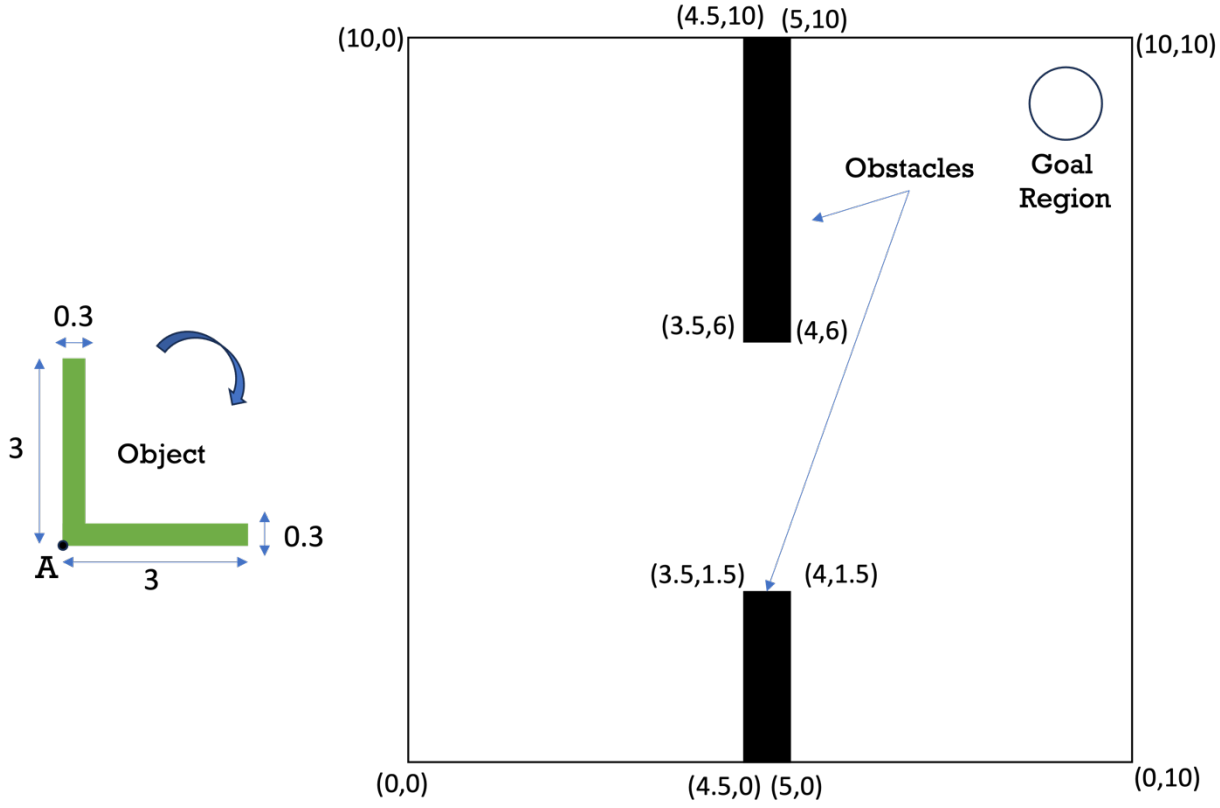


Figure 1: Illustration of the environment considered in Problem 1(a).

(b) Repeat the above while considering 3, 5, and 8 obstacles of the same size as in (a) that are randomly placed in the workspace. What do you observe? Provide ideas on how to accelerate RRT (implementation of your ideas is encouraged but not required).

Problem 2:

Consider the L-shaped object in the environment shown in Figure 1. The configuration of this object is determined by its orientation and the (x,y) position of point A. Pick an initial configuration close to the bottom left corner of the environment. Use RRT to design a sequence of configurations so that point A of the object falls inside the circular goal region centered at (9,9) of radius 0.5. As in problem 1, provide figures showing the sequence of these obstacle-free configurations and report the average runtimes over multiple executions of RRT.



Problem 3:

Solve problem 1 (a) using the RRT* algorithm so that the total traveled distance is minimized. Report also the average length of the designed paths over 20 executions of RRT*. How is the average length of the designed paths affected by the number of RRT* iterations? Provide a figure showing this and explain your observations.

Note: Upload your code along with any instructions required to run it. You should not use implementations of RRT/RRT* that are available online.