# Homework 5

16-311: Introduction to Robotics

## Contents



## Learning Objectives

1. Review definitions of motion planning.
2. Recall benefits and drawbacks of some path planning techniques.
3. Create a configuration space and plan a path.

# 1 Motion Planning Definitions

1. What does it mean for a path planning algorithm to be complete?
2. What is the difference between workspace and configuration space?
3. In the image below, is a or b closer to X by the L1 metric?
4. Is a or b closer to X by the L2 metric?

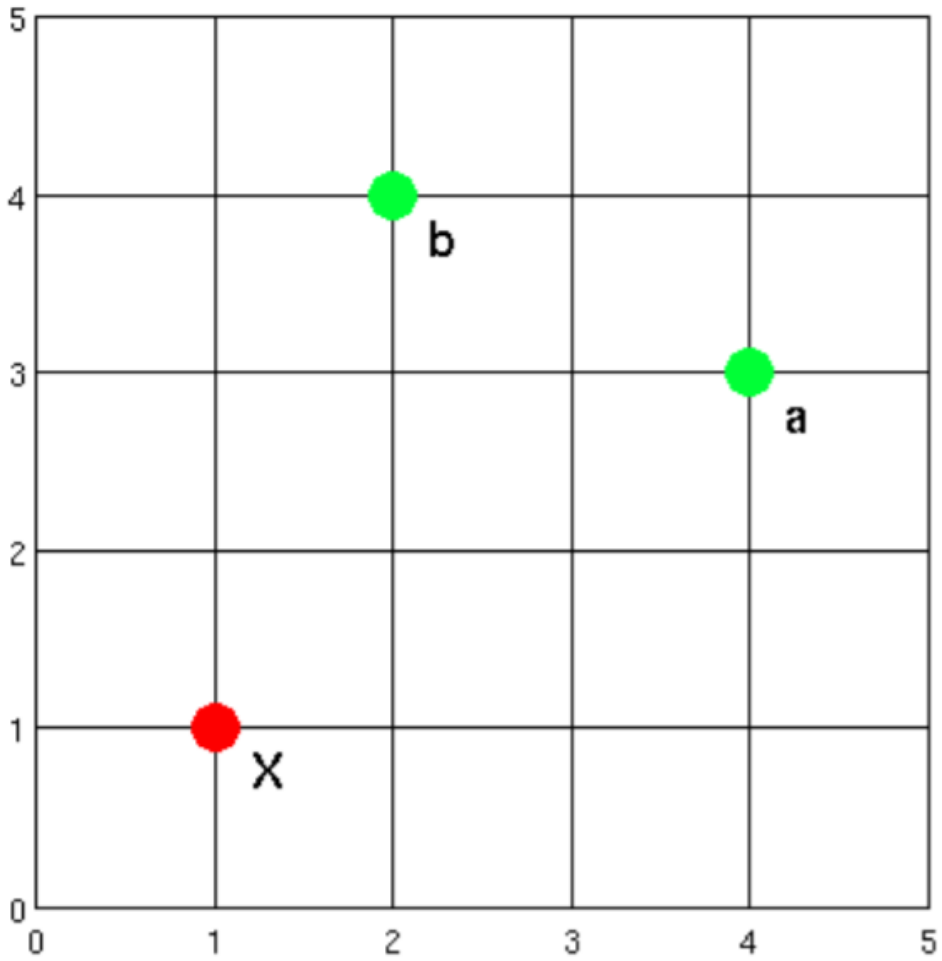


Figure 1: Starting X and two possible goals, a and b.

## 2 Motion Planning Algorithms

1. Which path planning algorithm did you implement for Lab 5? Describe how it works in two sentences.

2. What is one pro and one con of a wavefront planner?

3. What is one pro and one con of using a potential function?

# 3 Configuration Space Practice

For the sample environment in the figure below, draw the resulting path from the wavefront planner (in the continuous domain, ie. not with grid) for the mobile robot using the L1 metric. The robot is a circle of the same size as the start/end circles. Remember to take into account the configuration space of the robot and assume that the walls are obstacles as well. The reference point is in the center of the circle.

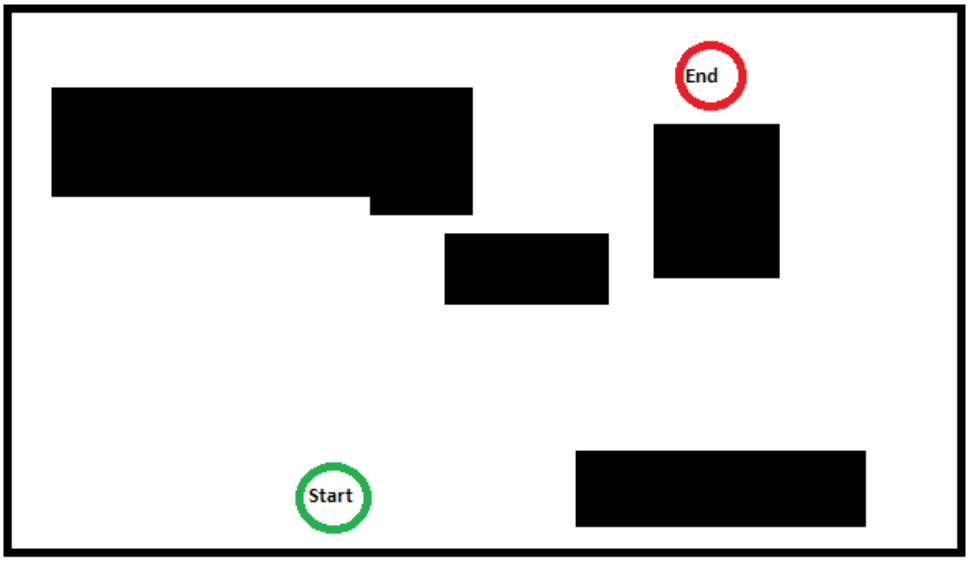


Figure 2: Workspace with obstacles.

Your figure should have a path drawn through wavefronts (include at least 10 wavefronts in your image) in the configuration space, so make sure you include all these elements.

You can do this in a program like MS Paint or hand draw the pictures and include pictures on your pdf.

# 4 Bug Algorithm

For the questions below use the configuration space in Figure 3.

1. Draw the path resulting from the Bug 1 algorithm.
2. Draw the path resulting from the Bug 2 algorithm.
3. How would you implement life long learning with the Bug 1 algorithm to make the found path most optimal with respect to distance traveled?
4. How would you implement life long learning with the Bug 2 algorithm to make the found path most optimal with respect to distance traveled?

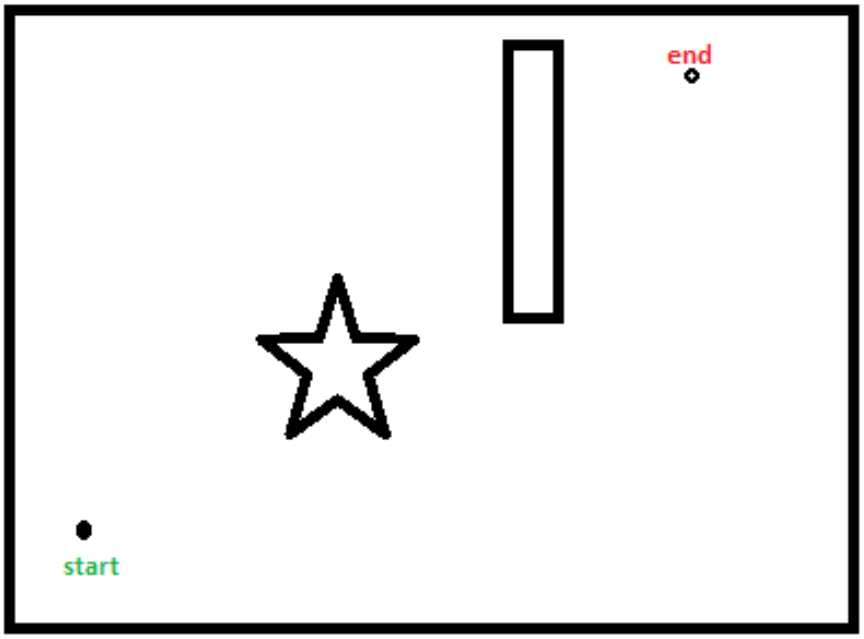


Figure 3: Configuration space.

# 5 Configuration Space Intuition

The goal of this section is to improve reasoning on movement through a configuration space.

The image below shows an example two-link robot arm (red). The circle at the bottom of the robot represents the first link. Here, horizontal to the right is 0 degrees. The second link is represented by the circle in the middle of the arm. For this link, 0 degrees is when this link is collinear with the first link.

On the image on the right, draw the shortest path from start to goal in the L2 metric. On the image to the left, draw three intermediate configurations uniformly distributed throughout the path. This should result in a drawing with 5 arm positions (start, finish, 3 intermediate positions).

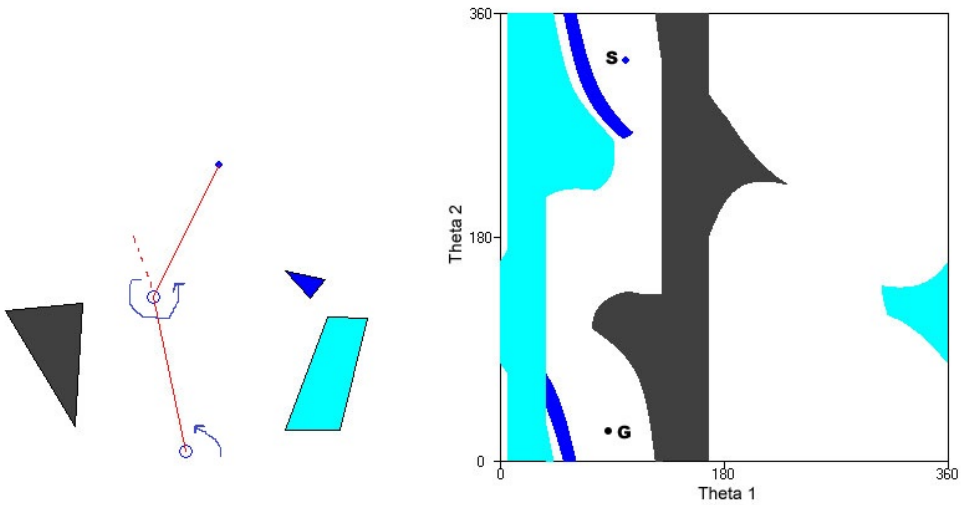


Figure 4: Left: Robot arm with real-world obstacles. Right: Configuration space for arm robot.

# What To Submit

Submissions are due on Gradescope by the date specified in the Syllabus.

1. Create a .pdf file with the written answers ALL THE SECTIONS named hw5.pdf.