COMP3702/COMP7702 Artificial Intelligence
Semester 2, 2020
Tutorial 5

Before you begin, please note:

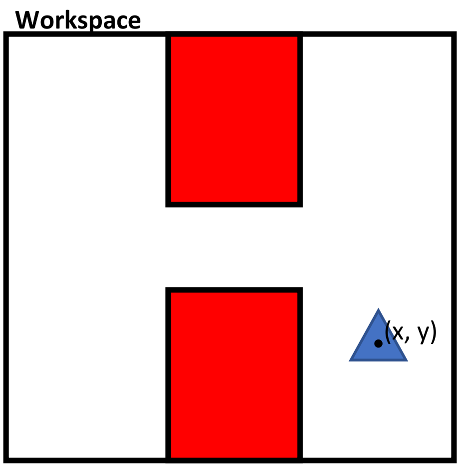
- Tutorial exercises are provided to help you understand the materials discussed in class, and to improve your skills in solving AI problems.
- Tutorial exercises will not be graded. However, you are highly encouraged to do them for your own learning. Moreover, we hope you get the satisfaction from solving 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 5.1. Suppose we have 6 2D points o a plane: $a = (0, 2)$; $b = (3, 5)$; $c = (1, 4)$, $d = (4, 3)$, $e = (1, 2)$; and $f = (6, 3)$;

1. Without plotting, please check if the line ab intersects with cd. How about ab with ef?
2. If we construct line segments for each pair of points above, which pairs of line segments intersect? Will the bounding box strategy help in this case?

Exercise 5.2. Recall the triangle robot from Tutorial 4:



Let us populate this with some details:

- The world is a 1×1 square, with origin in the bottom left-had corner.
- The triangle robot is an equilateral triangle of side 0.1 with on side parallel to the x-axis. Treat the robot as having a reference location at its bottom left corner.
- The first obstacle is rectangle with vertices $\{(0.45, 0), (0.45, 0.45), (0.55, 0.45), (0.55, 0)\}$.
- The second obstacle is rectangle with vertices $\{(0.45, 1), (0.45, 0.55), (0.55, 0.55), (0.55, 1)\}$.

Now consider the probabilistic roadmap (PRM) algorithm, applied to the triangle robot motion planning problem.

a) Characterise the robot's c-space based on the information above.

b) Sketch pseudocode for uniform random sampling of vertices across the c-space

c) Sketch pseudocode for random sampling within distance d of an obstacle.

d) Sketch pseudocode for sampling points that lie between the obstacles.

Extension: You may wish to try implementing these strategies in code, as a precursor to Assignment 2.

Exercise 5.3. Suppose we need to solve two motion planning problems, where the configuration spaces (C-space) are as shown in Fig. 1. Fig. 1 Left is the C-space for Problem-1, while Fig. 1 Right is the C-space for Problem-2. If we solve both problems using PRM with uniform random sampling, which problem is more difficult to solve? And why?

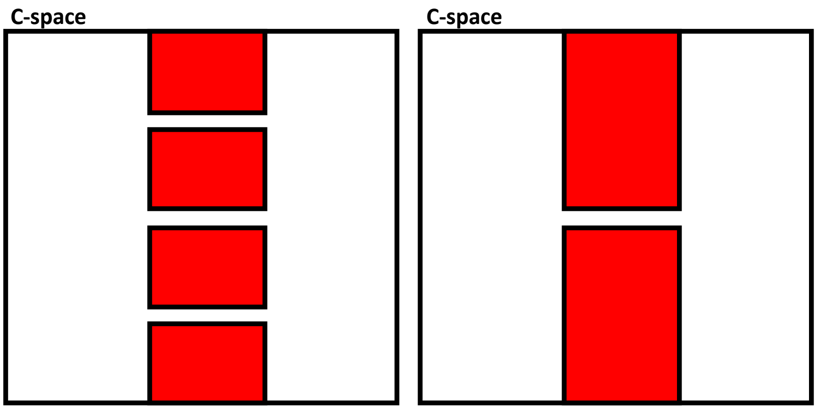


Figure 1: 2D C-space. Forbidden regions are rectangles with darker colour. The length and width of each narrow passage on the left and right pictures are the same

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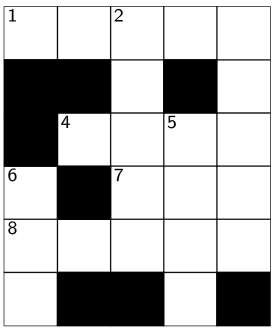
Exercise 5.4. A crossword puzzle can be modeled as a CSP. Consider the puzzle below:



Words: AFT, ALE, EEL, HEEL, HIKE, HOSES, KEEL, KNOT, LASER, LEE, LINE, SAILS, SHEET, STEER, TIE.

a) List the variables, their domains, and the constraints in the CSP representation of this crossword puzzle.

b) Draw a constraint graph for the CSP (you could use a tool like diagrams.net).

c) Apply domain consistency to this CSP, and restate any variable domains that change. Does the constraint graph change?

We will continue with this example in the next tutorial.