COMP3702/7702 Artificial Intelligence
Semester 2, 2020
Tutorial 4 - Sample Solutions

Exercises 4.1

Yes, we can remove vertices and edges from G and still ensure that the shortest collision-free path between a given initial and goal point can be found.

For visualisation purposes, we will consider the non-convex polygon in Figure 1 to be an example of an obstacle in the question.

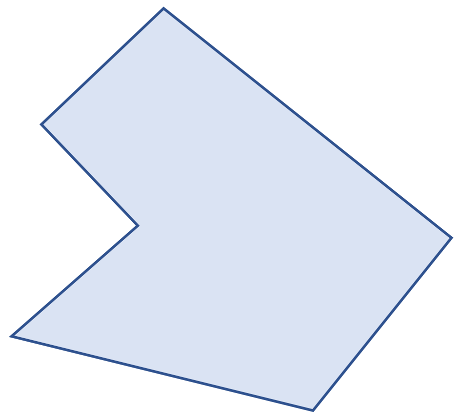

Figure 1: Example non-convex polygon

We can remove the reflex vertices and all the edges connected to it for solving the shortest collision-free path.

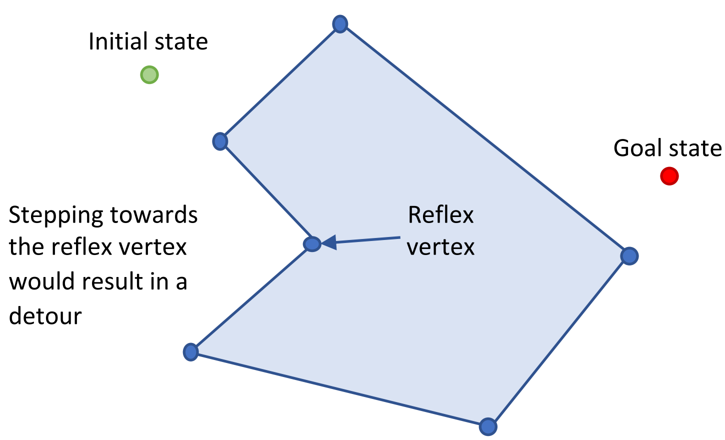

Figure 2

If the obstacle vertex nearest to the given initial/goal states is not a reflex vertex (Figure 2), then a path that moves to the reflex vertex is essentially a detour and will be longer than a path that does not pass through such a vertex.

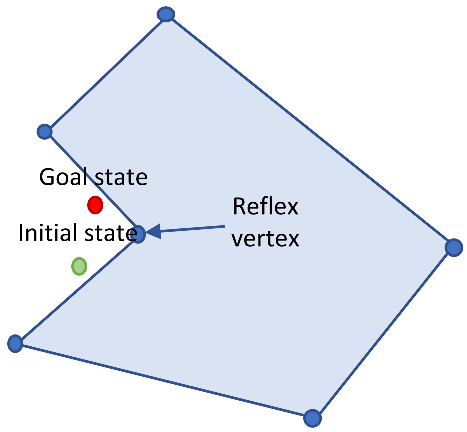

Figure 3

Even if the obstacle vertex nearest to the given initial/goal states was a reflex vertex (Figure 3), stepping to the reflex vertex would still result in a detour. One could move more directly towards the goal state without moving towards the reflex vertex.

Therefore, removing reflex vertices and edges connected to it from the visibility graph will not change the optimality of the path we can find.

Exercises 4.2

a)

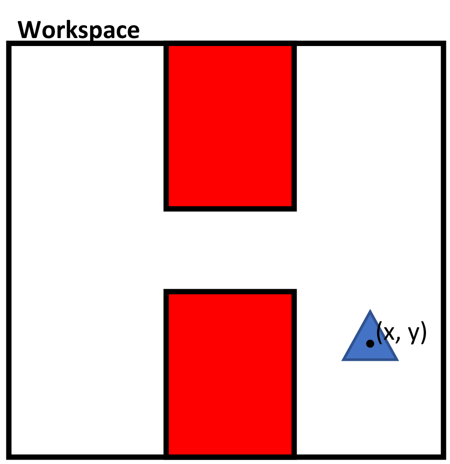

Figure 4: Workspace

The robot can translate in 2 dimensions in the workspace, with no other movements possible. A configuration space for the robot can be defined as:

$$C = \{(x, y) | 0 \leq x \leq W, 0 \leq y \leq H\},$$

where x and y represent the position of the centre of the triangle, W represents the width of the workspace and H represents the height of the workspace.

An alternative definition for x and y, such as the position of the top point of the triangle, could be used – this changes the shape of the forbidden regions in C-space.

b)

A configuration (x, y) is forbidden if when the centre of the robot is located at (x, y), some part of the triangle intersects with an obstacle or the boundary of the workspace. The boundary of the forbidden region is the set of configurations which border on collision.

For the C-space definition given above, the forbidden region is shown in Figure 5 as the area outside the green polygon. The triangular outlines demonstrate that the polygon does indeed represent the set of centre positions which border on collision.

Here, the configuration of the robot is represented only by the point (x, y). If the point (x, y) does not lie in the forbidden region, then the robot does not collide with any obstacle or the border of the workspace.

a)

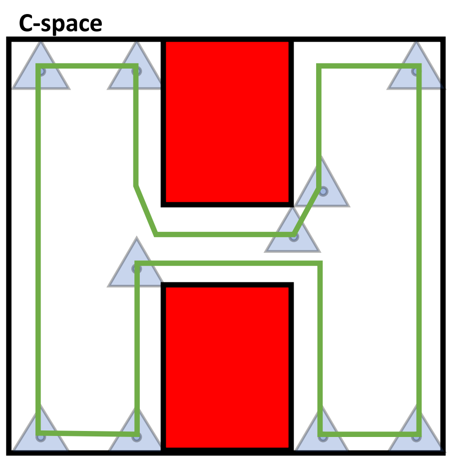

Figure 5: C-Space

Exercise 4.3

a)

The position of the robot can be described with a single variable – the angle of the robot with respect to the static base. This means that the configuration space has 1 dimension. A configuration space for the robot can be defined as:

$$C = \{(\theta | 0^\circ \leq \theta \leq 360^\circ\},$$

where θ is the angle of the robot from the positive x-axis.

b)

The forbidden region will be the real one-dimensional space spanning 45° to 135° for the top obstacle and 225° to 315° for the bottom obstacle. The configuration space is shown in Figure 6, with the forbidden region marked in red [45, 135] &]225, 315], and the free space marked in green.

Note that as θ is an angle, this space is circular – the number line wraps around, as 360° is equivalent to 0°.

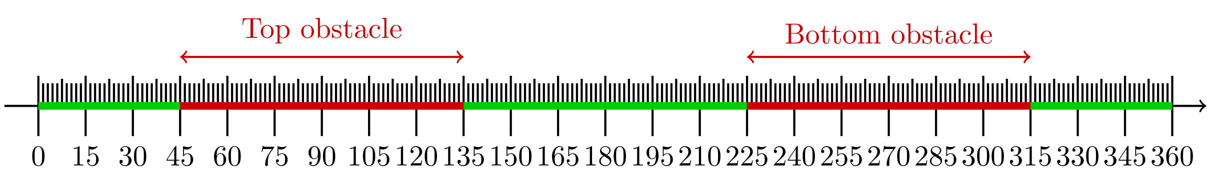

Figure 6: C-space