Algorithmic Robotics
COMP/ELEC/MECH 450/550
Homework 1

DUE: September 1st at the beginning of class (1pm). Submit your answers as a **PDF** to Canvas.

Please read the honor code and the additions described in the course syllabus. Present your work and your work only. You must *explain* all of your answers. Answers without explanation will be given no credit.

1. Exercise 1 **(20 points)** Consider a point robot at q_{start} with the goal of reaching q_{goal} in workspace W which consists of a set of obstacles $WO = \bigcup_{i=1}^{n} WO_i$, where WO_i for all $i \in \{1, 2, \ldots, m\}$ $(m < n)$ is within the radius of $d(q_{start}, q_{goal})$ from q_{goal} and the rest of the obstacles are outside of this radius. What is the maximum number of obstacles the robot will encounter if it uses BUG 1 algorithm? Justify your answer.

2. Exercise 2 **(15 points)** Draw the trajectories produced by Bug 1, Bug 2, and Tangent Bug (with unlimited radius) algorithms for a point robot in the workspace shown in Figure 1.

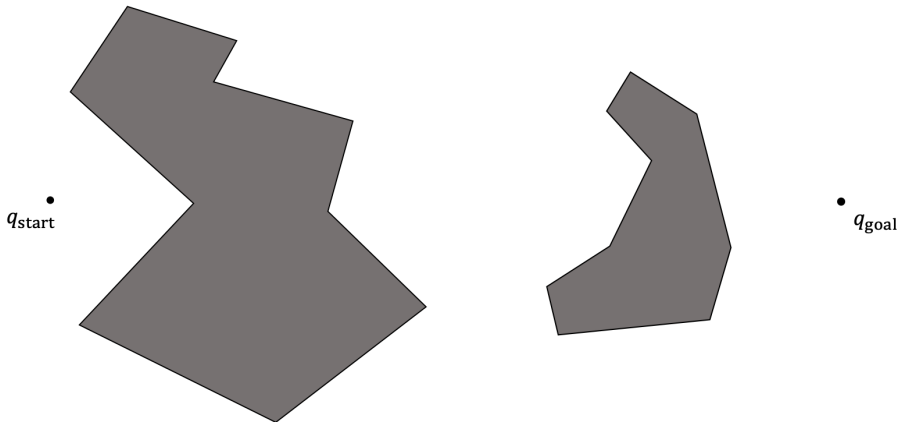

Figure 1: Simple environment.

3. Exercise 3 **(15 points)** Construct an example for which the upper bound of the traveled path for Bug 1 is obtained. How does Bug 2 perform in this example? Explain.

4. Exercise 4 **(20 points)** What is the difference between the Tangent Bug algorithm with zero range detector and Bug 2? Draw an example and explain.

5. Exercise 5 **(10 points)** Give the basics of a convergence proof for the Tangent Bug algorithm. No more than a paragraph is needed.

6. Exercise 6 **(20 points)** Consider the following theorem: Any shortest path between p_{start} and p_{goal} among a set S of disjoint polygonal obstacles is a polygonal path whose inner vertices are vertices of S.

Prove first that a shortest path is a polygonal path. Prove then that the inner vertices of a shortest path τ are vertices of S.