# Q1: Roadmaps & State Space Search

CS 695, Prof. Stein

Due: Wednesday September 13, 2023

## 1 Building Roadmaps

**1.1 Different Roadmaps** In class, we discussed the Trapezoidal Decomposition and the Visibility Graph. What are the relative advantages of these two approaches when planning (3–5 sentences for each approach). In your answer, it may be helpful to mention when you might prefer to use one approach over the other and/or describe a scenario.

**1.2 Shortest Path Roadmap** In the lecture slides (L02, slide 106), I show an example of a *Shortest Path Roadmap*. In 2–5 sentences, describe why some of the visibility edges are not included in the roadmap. In your answer, describe the conditions under which we might be able to remove nodes or visibility edges from a Visibility Graph roadmap without changing the paths generated by the algorithm. (*Note*: a mathematically precise definition is not expected; an in-words explanation will suffice.)

## 2 State Space Search

**2.1 Random-first Search** In class, we discussed how for graphs with loops Depth-First Search may never terminate. Let's consider instead what would happen if instead of depth-first or breadth-first search, the agent picked a *random* state to expand? For a graph with loops: What is the likelihood the agent will reach the goal? What is the best-case path length? What is the worst-case path length? For each answer, spend 2–3 sentences arguing for your case.

**2.2 Manhattan Distance Heurisic (I)** In class we have worked with grid-based search in which the robot can traverse diagonals, and so has 8 moves from each grid cell. For A* in class, we have used Euclidean Distance (the L2-norm) for our heuristic. For this case, is Manhattan Distance (also known as the L1-norm) an admissible heuristic? Why or why not?

**2.3 Manhattan Distance Heuristic (II)** If the agent is only allowed to move in the 4 cardinal directions, is the Manhattan Distance an admissible heuristic? Why or why not?

**2.4 Admissible and Inadmissible Heuristics** adapted from CMU 15.381 Consider our grid-based search example from class (in which we are traveling on a grid including diagonals).

- If we used an inadmissible heuristic in A* search, could it change the completeness of the search?
- If we used an inadmissible heuristic in A* search, could it change the optimality of the search?
- [3–4 sentences] Give a general advantage that an inadmissible heuristic might have over an admissible one. If you would like, you may use any of the heuristics discussed in P2 to motivate your answer.