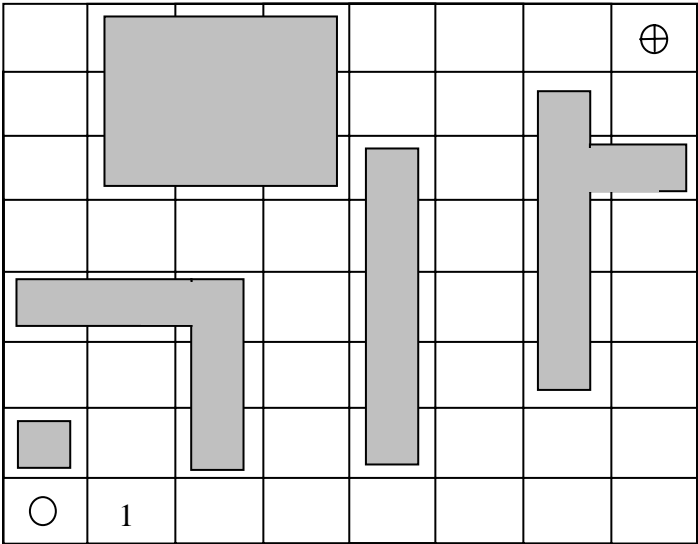


CPE 481

Exam Review Questions

1. A* Motion Planning

The A* algorithm is being used to plan a resolution optimal path through a building hallway system. Given the map below, show the first 5 iterations of the A* algorithm by numbering the cells in the order that they are explored. The start location is at (1, 1) and the goal location is (8, 8). To get you started, the first iteration has been done. In your exam booklet, provide details of the iterations (including the first). Details should include the fringe set and their path cost breakdowns ($f(n)$, $g(n)$, $h(n)$). Finally, show the final path.



Iterations:

1. Fringe Set = {Node(1,2): $f_{1,2} = 1 + \text{squareroot}(85)$ } \longrightarrow Pick Node(1,2)
2. ...

2. Particle Filter Localization

For a security robot system, you will be using a particle filter for localization.

- a) How is Baye's rule used in PF localization?
- b) Derive Baye's rule.
- c) What is the kidnapped robot problem?
- d) Let the particle p describe the state of a differential drive robot and be defined by $[x\ y\ \theta]$. Propagate the particle forward for the prediction step of the PF algorithm. Assume you have access to wheel distances s_1 and s_2 (in meters), as well as random numbers $r_i = \text{rand}()/((\text{double}) \text{RAND_MAX})$. That is leave your answers in s_1, s_2, r_1, r_2 .

3. PRM Motion Planning

Often, probabilistic road map (PRM) motion planners are used to construct trajectories for robots.

- a) Describe the main characteristics of PRMs
- b) Why must weighted sampling be used in selecting nodes for road map expansion.
- c) Describe Kindel's grid cell algorithm for weighted random node selection.
- d) For your lab, we used straight edge expansions to generate new nodes in the PRM. Does this affect the algorithm's completeness?

4. Point Tracking

- a) What are the inputs and outputs of the point tracking controller you used in the X80.
- b) The point tracking controller you implemented is stable in the sense of Lyapunov. What does this mean?
- c) Write pseudo code for an algorithm that tracks any path. You may assume the point tracking controller is accessible in a function "pointTracker()". Assume the path is given only as a list of path points $n_i = [x_i \ y_i]$