

CO541: Artificial Intelligence

Assignment 3

May 10, 2024

1. The **heuristic path algorithm** is a best-first search in which the objective function is

$$f(n) = (2 - w) g(n) + w h(n).$$

- What kind of search does this perform when $w = 0$? When $w = 1$? When $w = 2$?
- For what values of w is this algorithm guaranteed to be optimal? (You may assume that h is admissible.)

2. Consider the following game of placing Black tiles (B), White tiles (W) & an Empty slot (E):

Start state:

B	B	B	W	W	W	E
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Goal state: All the Black tiles are to the right of White tiles; “E” can be anywhere!

Cost: Move one tile to the left/right = 1 unit
 Jump over one tile = 2 units
 Jump over two tiles = 5 units

- Show the search tree for uniform cost search
 - Device an $h(n)$ for this game
 - Show the search tree using this $h(n)$ for A*
 - Discuss whether $h(n)$ is admissible or not
3. The goal of the Traveling salesperson problem (TSP) is to find the least cost itinerary to start from a given city, and return after visiting all other cities. The minimum spanning tree (MST) of the graph connecting all unvisited cities & the start city is proposed as a heuristic function $h(n)$ to solve TSP.
- Is the MST heuristic admissible? Give detailed argument for your answer.
 - Is the MST heuristic consistent? Give detailed argument for your answer.
 - Show how this heuristic can be derived from a relaxed version of the TSP.
 - Device a heuristic other than MST and show which of the two dominate the other.
 - Show a heuristic for TSP which is not admissible.
4. Provide a rigorous critique of each step of the following argument, which appeared in a paper submitted to a conference in AI
- “Given two admissible heuristics h_1 and h_2 where $h_1(n) \geq h_2(n)$ for all nodes n , it is obvious that A* using h_1 will become more efficient than A* using h_2 . Now suppose I am given an admissible heuristic h_2 . If one can find a constant c such that heuristic $h_1(n) = h_2(n) + c$ is still admissible, then searching with h_1 is better than searching with h_2 .”
5. Devise a state space in which A* using GRAPH-SEARCH returns a suboptimal solution with an $h(n)$ function that is admissible but inconsistent.

6. Sometimes there is no good evaluation function for a problem, but there is a good comparison method: a way to tell whether one node is better than another, without assigning numerical values to either. Show that this is enough to do a best-first search. Can this be similarly used for A*? Explain your answer.
7. What does it mean to say that SMA* is an *optimal* search algorithm?
8. What would be the characteristics of a search problem that can be solved by an SMA* algorithm, but not by an A* search algorithm?
9. Give the name of the algorithm that results from each of the following special cases:
 - a. Local beam search with $k = 1$.
 - b. Local beam search with one initial state and no limit on the number of states retained.
 - c. Simulated annealing with $T = 0$ at all times (and omitting the termination test).
 - d. Genetic algorithm with population size $N = 1$.

DEADLINE: 10:00 p.m. on Friday, May 24, 2024