Department of Computer Engineering

University of Peradeniya

CO541: Artificial Intelligence

Assignment 3

May 31, 2020

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

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

   a. What kind of search does this perform when $w = 0$? When $w = 1$? When $w = 2$?
   b. 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

   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

   a. Show the search tree for uniform cost search
   b. Device an $h(n)$ for this game
   c. Show the search tree using this $h(n)$ for A*
   d. 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.

   a. Is the MST heuristic admissible? Give detailed argument for your answer.
   b. Is the MST heuristic consistent? Give detailed argument for your answer.
   c. Show how this heuristic can be derived from a relaxed version of the TSP.
   d. Device a heuristic other than MST and show which of the two dominate the other.
   e. 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 Monday, June 08, 2020