Homework 2
Search Strategies

Due: Thursday, Sept. 12th, at beginning of class (11:10AM). (Either bring hard copy to class or submit to Blackboard by due date/time.) Only answer the section of questions for your type of credit (U/G).

[*Only answer the questions for your type of credit – undergraduate or graduate.*]

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1. **[Everyone]** A *heuristic path algorithm* is a best-first search in which the objective function is $f(n) = (2 – w) g(n) + wh(n)$. For what values of w is this algorithm complete? For what values of w is it optimal, assuming that h is admissible? What kind of search does this perform when $w = 0$? When $w = 1$? When $w = 2$?

2. **[Everyone]** The traveling salesperson problem (TSP) can be solved with the minimum-spanning-tree (MST) heuristic, which estimates the cost of completing a tour, given that a partial tour has already been constructed. The MST cost of a set of cities is the smallest sum of the link costs of any tree that connects all the cities.

   a. Show how this heuristic can be derived from a relaxed version of TSP.

   b. Show that the MST heuristic dominates straight-line distance.

3. **[Everyone]** Suppose that an agent is in a 3 x 3 maze environment like the one shown in Figure 4.19. The agent knows that its initial location is (1, 1), that the goal is at (3, 3), and that the actions *Up, Down, Left, Right,* have their usual effects unless blocked by a wall. The agent does not know where the internal walls are. In any given state, the agent perceives exactly the set of unblocked directions (i.e., blocked directions are illegal actions). It can also tell whether the state is one it has visited before.

   a. Explain how this online search problem can be viewed as an offline search in belief-state space, where the initial belief state includes all possible environment configurations. How large is the initial belief state? How large is the space of belief states?

   b. How many distinct percepts are possible in the initial state?

   c. Describe the first few branches of a contingency plan for this problem. How large (roughly) is the complete plan? [Notice that this contingency plan should be a solution for every possible environment fitting the given description. Therefore, interleaving of search and execution is not strictly necessary even in unknown environments.]

4. [*Undergraduate students only*] Consider the sensorless version of the erratic vacuum world. Draw the belief-state space reachable from the initial belief state {1, 2, 3, 4, 5, 6, 7, 8}, and explain why the problem is unsolvable.

5. [*Graduate students only*] We have seen two heuristics for the 8-puzzle: Manhattan distance and misplaced tiles. Several heuristics in the literature purport to improve on this. Look up the following two articles -- Mostow and Prieditis (1989) and Hannson, et al., (1992) – and for each, summarize the heuristic that they are proposing. (See bibliography in text for complete citation. These can be found using Google Scholar.)

6. [*Graduate students only*] On page 108 is the definition of the relaxation of the 8-puzzle, in which a tile can move from square A to square B if B is blank. The exact solution of this problem defines **Gaschnig's heuristic** (Gaschnig, 1979). Explain why Gaschnig's heuristic is at least as accurate as h_1 (misplaced tiles), and show cases where it is more accurate than both h_1 and h_2 (Manhattan distance). Suggest a way to calculate Gaschnig's heuristic efficiently.