CS 4811 Artificial Intelligence
Homework 2 — Search

Due: Friday, February 19, 2016, 9:00pm
(Assigned: Wednesday, February 10, 2016)

Reminder: This is an individual assignment. All the work should be the author's and in accordance with the university's academic integrity policies. You are allowed to use any previously written source in preparing your answers, but if you use any other source than the textbook and the class notes, you should specify it on your assignment.

Question 1 *(10 points).*

Assume that a processor can process 100,000 nodes per second, and each node is stored on 100 bytes, and the (average) branching factor of the search tree is 4. Show the memory and time requirements of a complete depth-first search and breadth-first search for trees of depth 5, 10, 20, 30, 40, and 50. Show these in a table. Use exponential notation and express time using the largest appropriate unit. Note that if we assume that the depth of a tree is d, we assume that the nodes at depth d do not have any children.

Question 2 *(40 points).*

For the following problems, choose a formulation that is precise enough to be implemented. Give the initial state, actions, transition model, goal test, and path cost function for each problem. Give examples of ACTIONS(s) and RESULT(s, a) calls and the returned values.

a. You have three jugs, measuring 12 gallons, 8 gallons, and 3 gallons, and a water faucet. You can fill the jugs up or empty them out from one to another or onto the ground. You need to measure out exactly one gallon.

b. You have to color a planar map using only four colors, in such a way that no two adjacent regions have the same color.

Question 3. *(30 points).*

Consider a word puzzle where the objective is to start with a given word and end with another given word by changing a single letter each time and making sure that the intermediate words are real words (they are in the dictionary). For example, a sequence to derive `gold` from `boat` would be: `boat, coat, colt, cold, gold`.

Part a. Consider the problem where the initial word is `bat` and the goal word is `cow`. Draw a search space with at least 10 nodes and at least 2 levels after the root node. You don't have to show the solution. You don't have to show the entire level.

Part b. Which one would be better for this problem: depth-first search or breadth-first search? Why? Explain your answer in terms of the branching factor and the size of the total state space.

Part c. Would bidirectional search be appropriate for this problem? If so, describe how it would work.

Question 4 *(10 points).*

Draw and describe a hypothetical search tree and goal where each of the following conditions are satisfied. Assign names to nodes and show the f, g, and h values for A*.

a. Depth-first search performs much better than breadth-first search.

b. Breadth-first search performs much better than depth-first search.

c. A* search performs much better than breadth-first search.

d. Depth-first search performs much better than A* search.

Question 5 *(10 points).*

Recall that a heuristic function for A* consists of two parts for node n: $f(n) = g(n) + h(n)$ where $g(n)$ is the **actual** cost incurred so far, and $h(n)$ is the **estimated** cost to reach the goal. Explain why we need the $g(n)$ part. In others words, why can't we base the search on the estimated cost only?