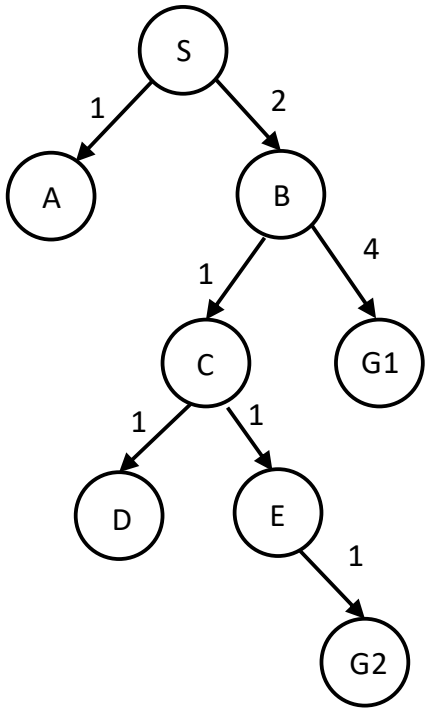
COMPSCI 370 **Instructor:** Ronald Parr

Homework 1 **Due:** Monday, February 10, 2025

Written questions for this class must be written up and submitted individually. You may do high level brainstorming with your friends, but the final write up must be your own work. It is permissible to use internet resources for clarifications on basic definitions and algorithms, but **you may not search for solutions, and you may not use generative AI methods such as ChatGPT or similar tools for hints, answers, or checking of answers.**

The first five questions refer to the state space depicted by the following tree, which has costs shown next to the arcs. Two states, G1 and G2, satisfy the goal test.



For the questions below, we will ask you to show the frontier of the search tree just before search pops a node off the queue. Assume that nodes are popped in left to right order, so the node about to be popped is the leftmost in the list of nodes. Keep showing the state of the queue each time a node is about to be popped off until the search terminates. (In other words, you don't need to show the queue changing as each node is *pushed* on.)

1 BFS (5 points)

Show the queue for BFS, assuming the goal test is applied when a node is first generated. When two siblings are pushed onto the queue, assume the leftmost sibling is closer to the top. For example, the first two lines of your answer should look like this:

- S
- A, B

Note that, given the assumptions in this particular question, goal nodes will not appear in the queue.

2 BFS II (5 points)

Show the queue for BFS, assuming the goal test is applied when a node is popped. When two siblings are pushed onto the queue, assume the leftmost sibling is closer to the top.

3 DFS (5 points)

Show the queue for DFS, assuming the goal test is applied when a node is first generated. When two siblings are pushed onto the queue, assume the leftmost sibling is closer to the top. Note that given the assumptions in this question, goal nodes will not appear in the queue.

4 DFS II (5 points)

Show the queue for DFS, assuming the goal test is applied when a node is popped. When two siblings are pushed onto the queue, assume the leftmost sibling is closer to the top.

5 UCS (5 points)

Show the queue for UCS. Recall that UCS always applies the goal test when a node is popped to ensure optimality. When two siblings are pushed onto the queue, assume the leftmost sibling is closer to the top. Since UCS uses a priority queue, list the elements of the queue as ordered pairs, in the form of (state,priority). For example, the first two lines of your solution should look like this:

- (S,0)
- (A,1), (B,2)

6 Improving on A* (10 points)

One way to think about an admissible heuristic, $h(n)$ is that it guarantees that the cost of reaching a goal from n is *at least* $h(n)$. Suppose you had an additional function $u(n)$ which guaranteed that the cost of reaching the goal from n is *at most* $u(n)$. Describe how you could use this information to improve upon A* without sacrificing the optimality and completeness properties of A*. We realize this question is somewhat open ended and that there could be many reasonable answers. Your goal should be to provide a clearly described way to use $u(n)$, with a clear explanation of 1) how and why your proposal is helpful, and 2) how and why the optimality and completeness properties are preserved.

7 Fun with Hyperspace

This question has been removed.

8 Consistency (10 points)

Assume h_1 and h_2 are both consistent heuristics, and define:

$$h_3(n) = \|h_1(n) - h_2(n)\|$$

1) Is h_3 admissible? Provide a proof or counterexample. (5 points)

2) Is h_3 consistent? Provide a proof or counterexample (5 points).