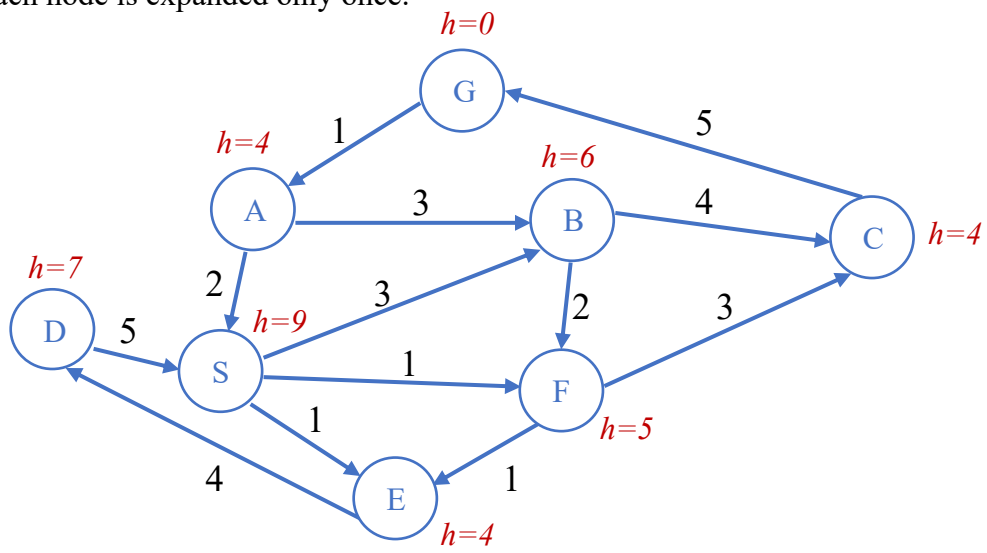
C S 4013/5013: Artificial Intelligence
Spring 2022
University of Oklahoma
Homework Assignment 2, Due: 2/10/22, 12 PM

Question 1 (25 points):

For the following state space graph with S and G, as Start state and Goal state respectively. Write the order of the nodes that are expanded and the final solution for each search algorithm specified in the table. Also, specify which algorithm finds the optimal solution in this graph. Note that nodes with the same priority for expansion, are chosen in the alphabetical order. As a reminder, in graph search each node is expanded only once.



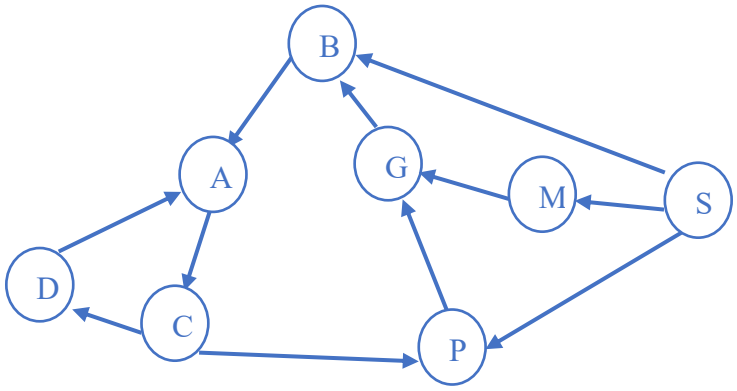
Search Algorithm	Nodes that are expanded in the order	Solution (path)
DFS (tree search)		
DFS (graph search)		
BFS tree search		
BFS graph search		
UCS tree search		
UCS graph search		
Greedy (best-first) tree search		
Greedy (best-first) graph search		
A* tree search		
A* graph search		

Question 2 (15 points)

(a) Run DFS (tree version) and iterative deepening tree search in the following state-space graph (S is the start state and G is the Goal state). Specify the number of the nodes that are expanded to find the Goal and write the final solution (path) for each algorithm. For each algorithm, is the solution is complete and optimal in terms of number of actions, why? (Note; similar to Question 1, nodes with similar priority are expanded in an alphabetical order)

(b) Describe a state space in which iterative deepening search performs much worse than depth-first search (for example, $O(n^2)$ vs. $O(n)$).

(c) Can you show an example where DFS Graph search fails to find a solution?



Question 3 (20 points)

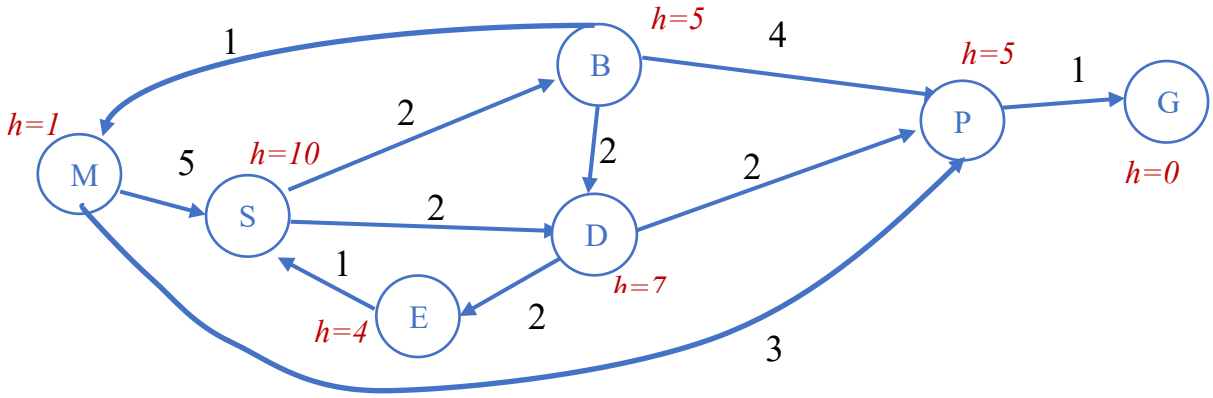
Consider the following space graphs (G1 and G2 with S as the start state and G as the goal state).

(a) For each, write the solution returned by A* search tree and A* search graph and specify if they find the optimal solution and explain why?

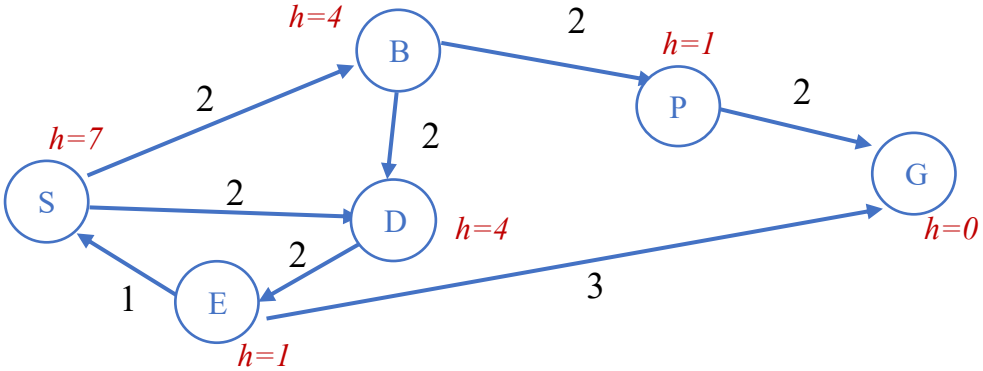
(b) If the solution is not optimal, can you modify the heuristic function for each such that the solution would be optimal? What is the new solution?

(c) Repeat (a) and (b) for UCS tree and graph search.

(G1)

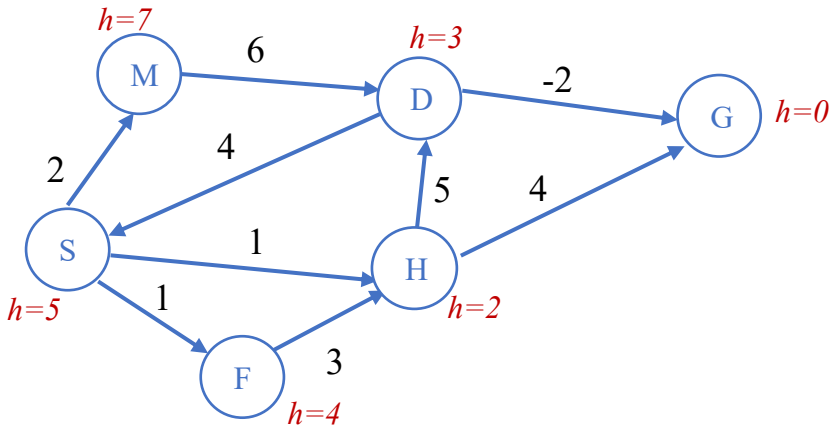


(G2)



Question 4 (10 points)

Run UCS (graph search) in the following graph. What is the solution? Is it optimal? Why?



Question 5 (16 points)

Consider the unbounded version of the regular 2D grid shown in Figure 3.6 of the textbook. The start state is at the origin, (0,0), and the goal state is at (x, y).

(a) What is the branching factor b in this state space?
(b) How many distinct states are there at depth k (for k > 0)?
(c) What is the maximum number of nodes expanded by breadth-first tree search?
(d) What is the maximum number of nodes expanded by breadth-first graph search?
(e) Is h = |u − x| + |v − y| an admissible heuristic for a state at (u, v)? Explain.
(f) How many nodes are expanded by A∗ graph search using h?
(g) Does h remain admissible if some links are removed?
(h) Does h remain admissible if some links are added between nonadjacent states?

Question 6 (4 points)

Specify a situation where we prefer using inadmissible heuristic. Would be the solution optimal? Why?

Question 7 (10 points)

Assume $f(n) = (4 - w) \times g(n) + w \times h(n)$ is the value function for A* algorithm. For what values of w is this complete? For what values is it optimal, assuming that h is admissible? What kind of search does this perform for $w = 0$, $w = 1$, and $w = 4$?