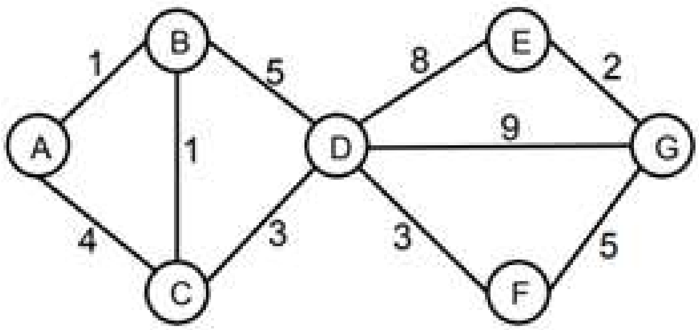
Roll No.________________

National University of Computer and Emerging Sciences, Lahore Campus

Course Name:	Artificial Intelligence	Course Code:	
Program:		Semester:	Spring 2020
Duration:	60 Minutes	Total Points:	
Paper Date:	Thursday, March 24, 2022	Weight	
Section:	ALL	Page(s):	
Exam Type:	Mid-I		

Student : Name:______________________________ Roll No.________________ Section:_______

Problem. Search Algorithms [5 + 5 Points]



Node	h_1	h_2
A	9.5	10
B	9	12
C	8	10
D	7	8
E	1.5	1
F	4	4.5
G	0	0

Consider the state space graph shown above. **A** is the start state and **G** is the goal state. The costs for each edge are shown on the graph. Each edge can be traversed in both directions.

Part a) For each of the following graph search strategies, mark which, if any, of the listed paths it could return. Note that for some search strategies the specific path returned might depend on tie-breaking behavior. In any such cases, make sure to mark all paths that could be returned under some tie-breaking scheme. **[5 Points]**

	A-B-D-G	A-C-D-G	A-B-C-D-F-G
Depth first search	✓	✓	✓
Breadth first search	✓	✓	
Uniform cost search			✓
A* search with heuristic h_1			✓
A* search with heuristic h_2			✓

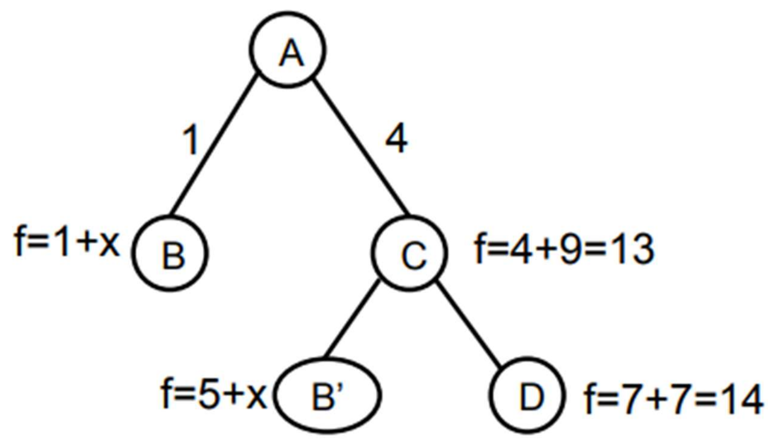
Part b) Suppose you are completing the new heuristic function **h_3** shown below. All the values are fixed except **h_3(B)**. For each of the following conditions, write the set of all values that are possible for **h_3(B)**. **[2 + 3 Points]**

Node	A	B	C	D	E	F	G
h_3	10	?	9	7	1.5	4.5	0

i. What values of h_3(B) make h_3 admissible? Justify your answer.

Any value in the range [0 12] because the value must be less than or equal to the optimal cost which is 12

ii. What values of h_3(B) will cause A* graph search to expand node A, then node C, then node B, then node D in order? Justify your answer.



If h_3(B) = x then

If NODE C is to expanded before NODE B and after NODE A then 1 + x must be greater than 13 so 1 + x > 13 implies x > 12

Similarly if NODE B is to be processed before NODE D then 1 + x must be smaller than 14 hence 1 + x < 14 implies x < 13

Therefore any value of h_3(B) in the range (12 13) will cause the nodes to expand in the desired order

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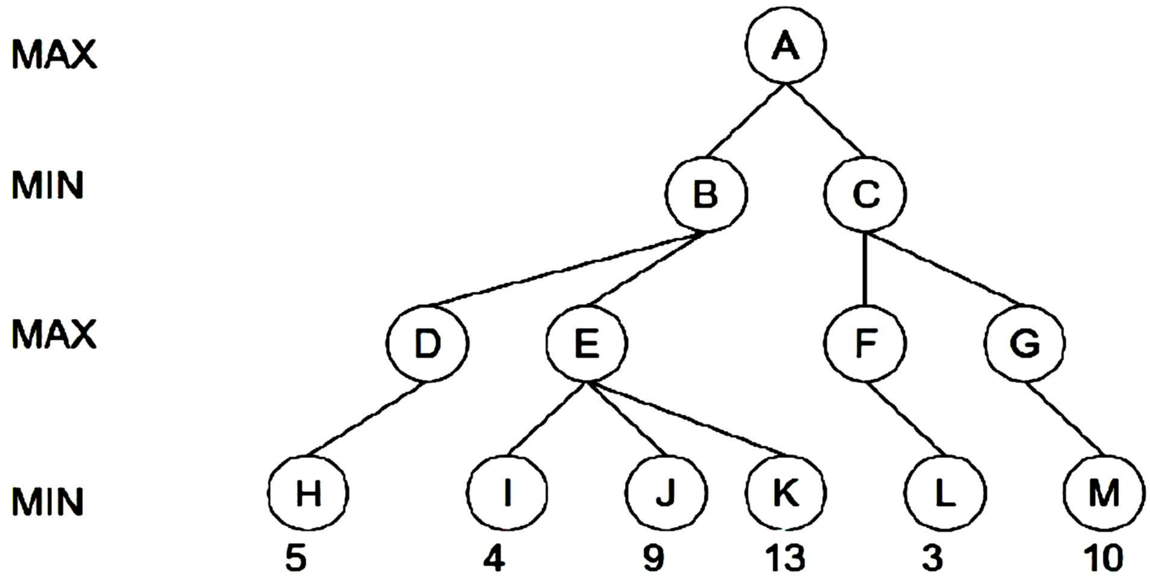
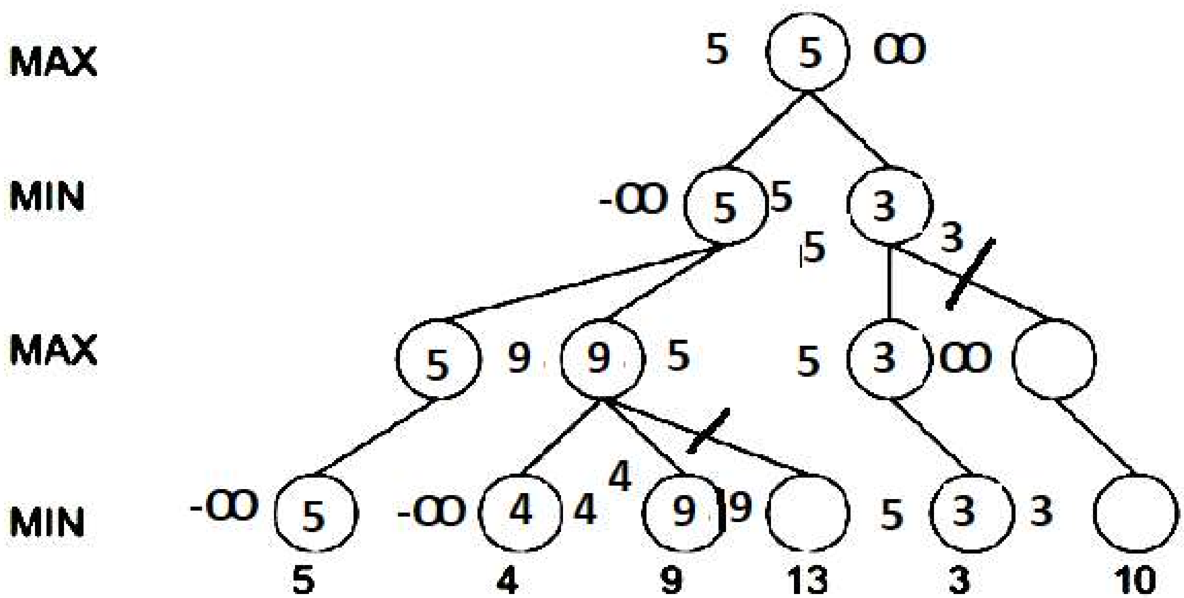
Problem. Adversarial Search **[4 + 3 + 3 Points]**

Consider the game tree shown below with the value of each node at level 3 computed using ꝏꝏa naïve evaluation function. Assume the nodes are explored from **left to right** and minimax with standard alpha beta pruning is used.



Part a) Write on the tree the **value of each node** as computed by minimax with alpha-beta pruning. Also mark each branch that will be pruned during the search. **[4 Points]**



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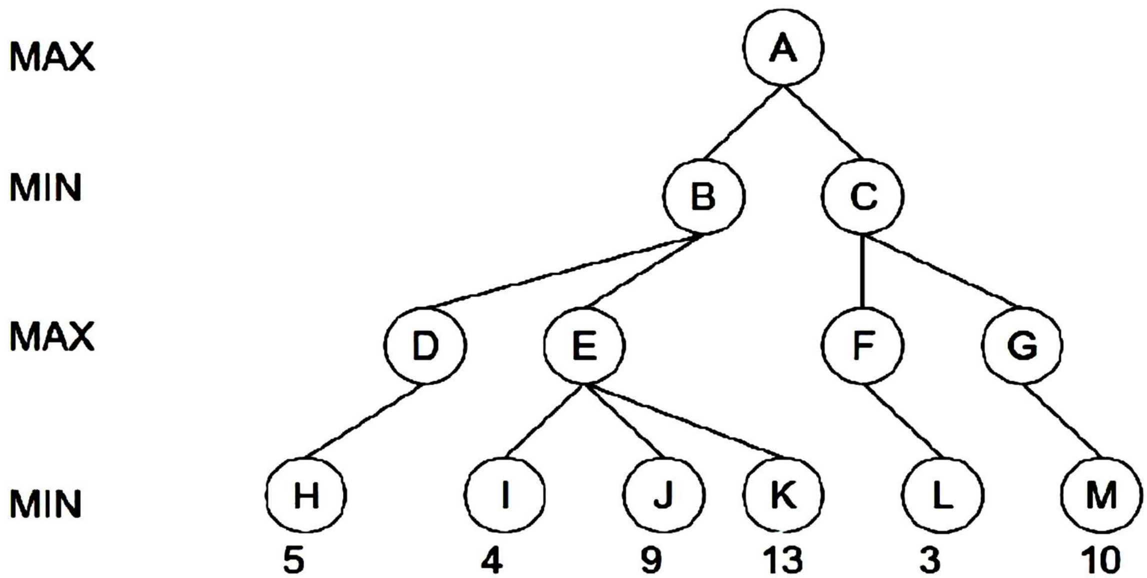
Part b) On the figure shown below, mark the branches pruned if the nodes are expanded from right to left instead of left to right **[3 Points]**



For this case no branches will be pruned

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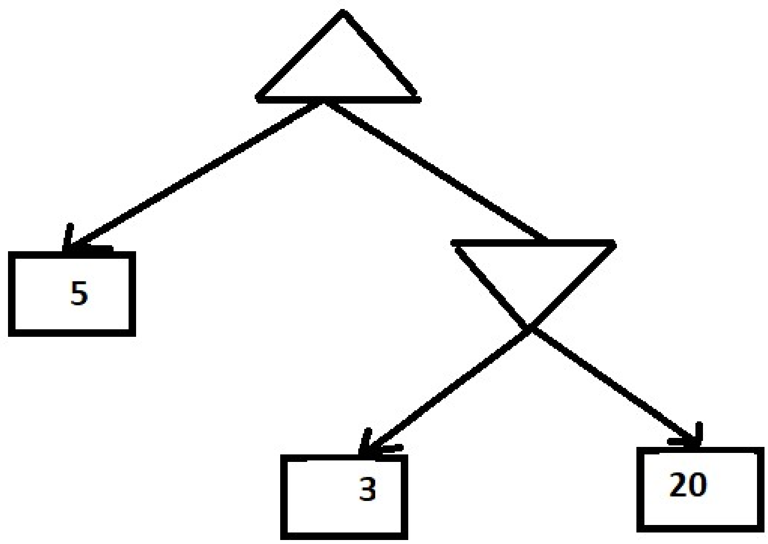
Part c) Disprove the following statement about minimax by providing a counter example and then write the correct version of this statement. **[3 Points]**

Statement: Minimax always results in an optimal decision against any player.



For the above game tree the minimax will return the left move with a gain of 5 whereas going right can result in a better gain if the opponent is not perfect

Correct Statement: Minimax always results in an optimal decision against a **perfect** player

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