Practice problems

Wednesday, July 19, 2023 8:25 PM

1. Today is July 18. The CSE422 midterm exam is just seven days away. Unfortunately, you have been procrastinating this entire semester and you still have a lab assignment (L) and a written assignment (W) left. You also have not yet come up with an idea for the project (P). Each of these things takes one day to do. In addition, you still need two days to study for the midterm (S1 and S2).
You decide to formulate the problem of managing all your tasks as a Constraint Satisfaction Problem. The details are as follows.

- Variables: L, W, P, S1, S2
- Domains: Each variable has the domain {1, 2, 3, 4, 5, 6, 7} where the numbers denote days of the week. For example, setting W = 2 means that you are deciding to do the written assignment on day 2.

You also have the following constraints.
(1) No two different tasks can be done on the same day.
(2) All the assignment and project-related tasks (L, W, P) must be completed before you start studying for the midterm (S1).
(3) The lab assignment (L) and the project idea submission (P) are both due in 4 days. So, they have to be completed in days 1, 2, 3, or 4.
(4) The first day of studying (S1) must come before the second day of studying (S2). Also, you like to take rests. So, no two study days in a row.
(5) The written assignment (W) cannot be done on an odd-numbered day.

Now answer the following questions:
a. You first decide to enforce the unary constraints (also called enforcing node consistency). **List** the values that remain in the domain of each variable. You should treat constraint (3) as a pair of unary constraints.

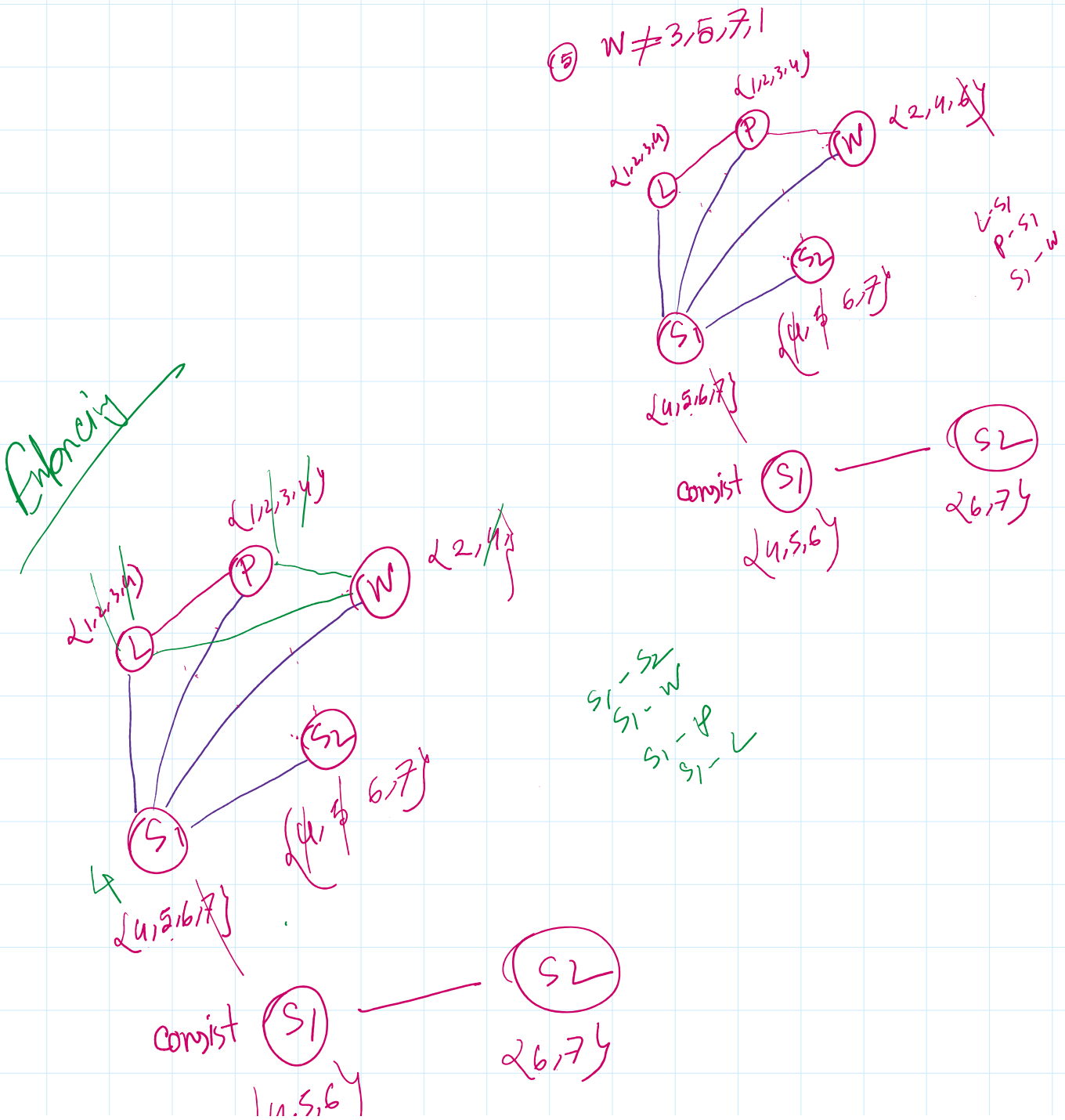
b. Continuing from (a), you now decide to enforce arc consistency for each arc. It turns out all of the arcs except S1 → L, S1 → W, S1 → P, S1 → S2 and S2 → S1 are already consistent. Enforce consistency of the arc S1 → S2 and **list** the values that remain in the domains of the variables S1 and S2.

c. Continuing from (b), **determine** the arcs that used to be consistent but need to be checked again after enforcing the consistency of the arc S1 → S2.

d. **Show** that at least one of the arcs you listed in (c) is not consistent anymore

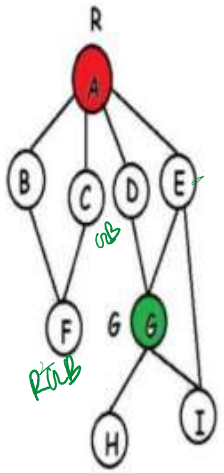
② L,W,P < S1 < S2 (rest)

③ L,P = {1,2,3,4}


⑤ W≠3,5,7,1
{1,2,3,4}
P
W
{2,4,6}
L
{1,2,3,4}
S2
S1
{4,5,6,7}
{1,5,6,7}
Consist
S1
S2
{2,6,7}
{1,5,6}
V-S1
P-S1
S1-W
Expand
{1,2,3,4}
P
W
{2,4}
L
{1,2,3,4}
S2
S1
{4,5,6,7}
{1,5,6,7}
Consist
S1
S2
{2,6,7}
{1,5,6}
S1-S2
S1-W
S1-P
S1-L

b) Suppose, the following graph represents a map coloring CSP problem. You are trying to color the following graph with 3 colors: Red, Green and Blue such that no two adjacent node has the same color. Node A is already colored as **Red** (R) and node G is colored as **Green** (G). **Assess** which node will be visited in the following map coloring example if **i)** Degree heuristic is used. **Explain** your answer.**ii)** According to Least constraining value heuristic, which color will be chosen for node B in the given graph? **Explain** your answer.

Colors: Red, Green, Blue



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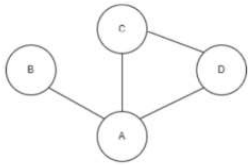
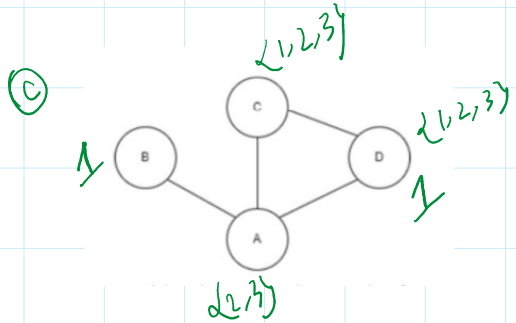
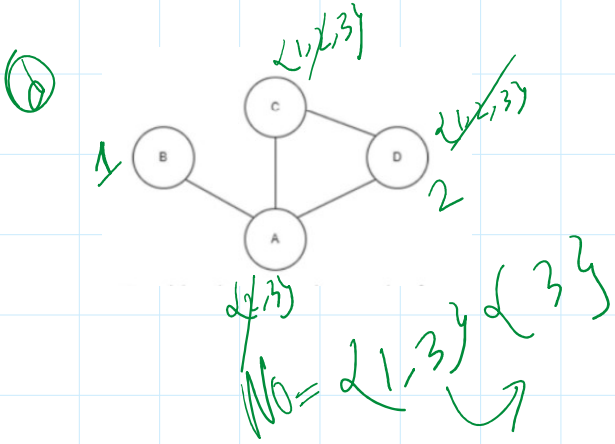


Consider the constraint graph of a problem above, where each region has to be filled up with either 1, 2, or 3. No two adjacent regions can have the same digit.

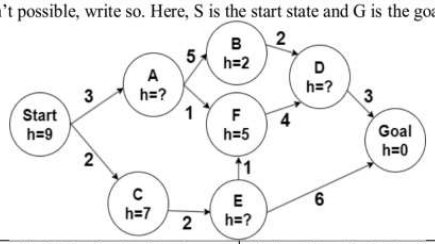
a. **Formulate** the variable, domain, constraint, and the goal of the problem
b. Based on the variable ordering procedure, mention the order of variables to be assigned with digit. **Provide** adequate explanation for your ordering.
c. Consider that node B already has digit 1 and all the other nodes are empty. If you are to provide digit to node D next, which digit should you pick? **Identify** your choice based on value selection procedure.
d. If node B has digit 1, node D has digit 2, and rest of the nodes are unassigned, does the constraint graph remain arc consistent? Why or why not? **Explain.**





5.

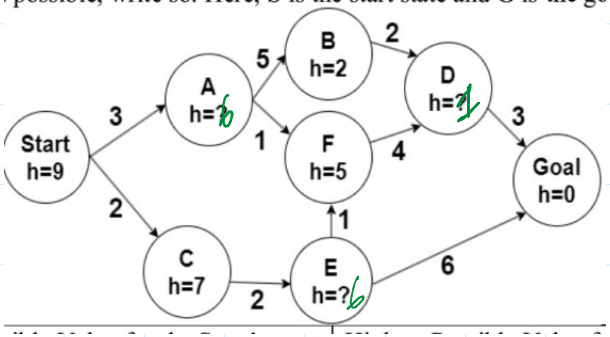
Consider the state space tree shown below in which some of the states are missing a heuristic value. Determine the possible range for each missing heuristic value so that the heuristic is admissible and consistent. If this isn't possible, write so. Here, S is the start state and G is the goal state.

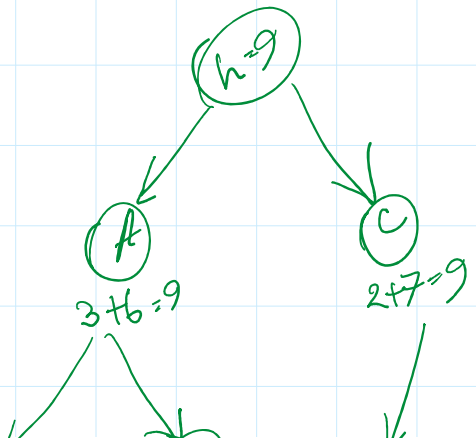


a.

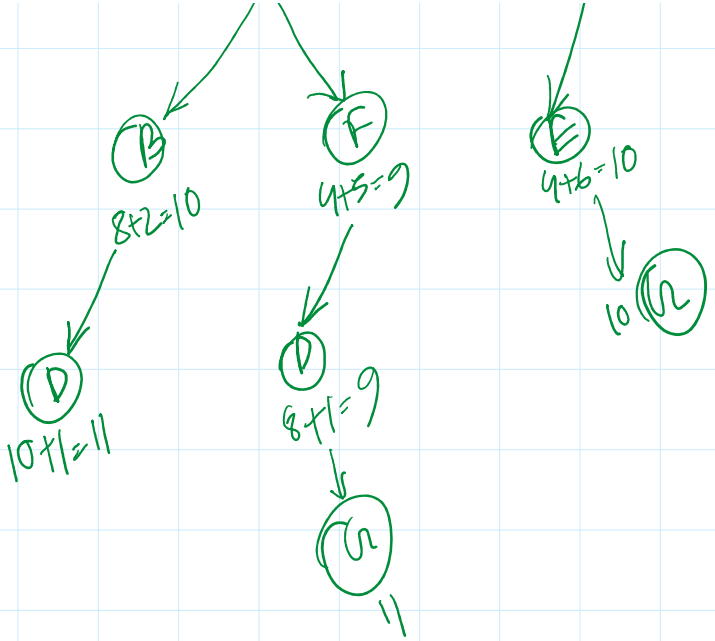
State	Lowest Possible Value for the State's Admissible and Consistent Heuristic	Highest Possible Value for the State's Admissible and Consistent Heuristic
A	6	6
D	7	7
E	5	6

possible, write so. Here, S is the start state and G is the go





H-C-F-G



5-Queen problem.

b) Consider two chromosomes. X1: 12256748 X2: 32828991.
Your job is to maximize the difference of sum of numbers in even positions and sum of numbers in odd positions. Now make a fitness function that is suitable for your job. **Evaluate** the chromosomes X1 and X2 in light of the fitness function that you just designed. **Apply** crossover between X1 and X2 at mid point and make two chromosomes X3 and X4 and **evaluate** X3 and X4 as well.

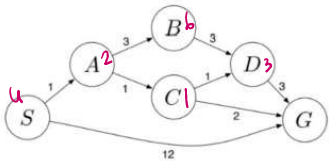
function = | sum(even pos nums) − sum(odd pos nums) |

	1	2	3	4	5	6	7	8
X1:	1	2	2	5	6	7	4	8
X2:	3	2	8	2	8	9	9	1

X1 = |22 − 13| = 9

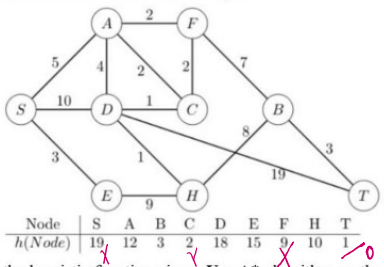
X2 = |

7.



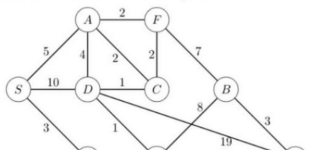
Node	h1	h2
S	5	4
A	3	2
B	6	6
C	2	1
D	3	3
G	0	0

a) For the graph above, where S is the start node and G is the goal node, which of the two heuristic sets, h1 and h2, is admissible? Which of them is consistent? **Analyze**.

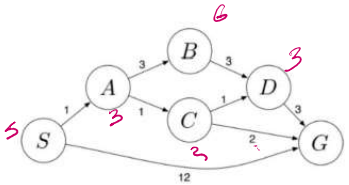


Node	S	A	B	C	D	E	F	H	T
$h(Node)$	19	12	3	2	18	15	9	10	1

b) For the graph above and the heuristic function given, **Use A*** algorithm on the graph. In what sequence will the nodes be explored? Which heuristics values in this table are inadmissible? Here, S is the starting node and T is the goal node. In case any tie occurs, expand the node that comes first alphabetically.

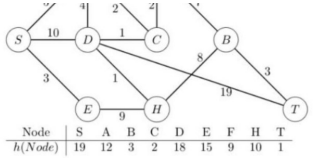


7.

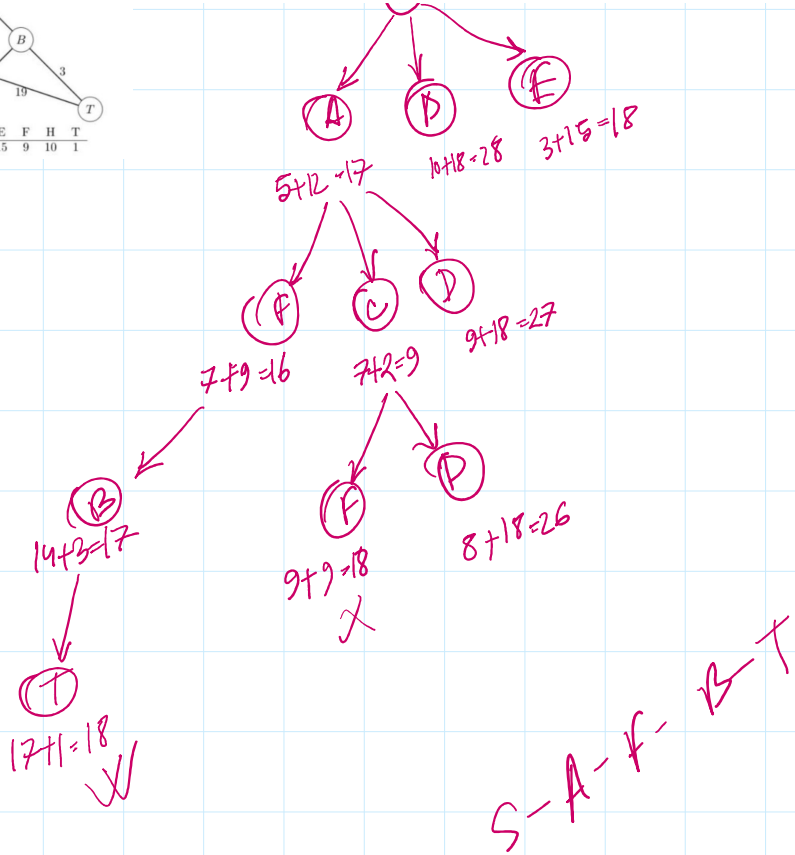


Node	h1	h2
S	5	4
A	3	2
B	6	6
C	2	1
D	3	3
G	0	0

a) For the graph above, where S is the start node and G is the goal node, which of the two heuristic sets, h1 and h2, is admissible? Which of them is consistent? **Analyze**.



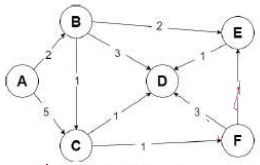
Node	S	A	B	C	D	E	F	H	T
$h(Node)$	19	12	3	2	18	15	9	10	1



summer 23

Wednesday, July 19, 2023 10:26 PM

4. CO2 a. **Analyze** a good heuristic function for finding the shortest path between two locations in a city. 1



Possible Heuristic Functions

Node	Heuristic 1	Heuristic 2	Heuristic 3	Heuristic 4
A	2	4	5	2
B	2	2	3	1
C	1	3	2	1
D	0	0	0	0
E	0	5	6	1
F	1	8	10	1

Use the following directed graph and table of possible heuristic functions for Questions b to e. Here, assume your start node is A and goal node is D.

b. Among these four possible heuristic functions, which are admissible? Which of these are consistent? **Analyze**. 4

c. **Find** the minimum possible value of the node B's heuristic function, h(B), such that the heuristic is admissible. 1

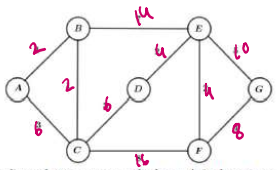
d **Find** the maximum possible value of the node C's heuristic function, h(C), such that the heuristic is admissible? 1

e. **Find** the node after which node E be expanded, if we use Heuristic 1 as the heuristic function? Resolve all ties in reverse-alphabetic order (if you have E and F in the fringe with the same f () value, expand/relax F first). 1

f. If we assume the heuristic function is Heuristic 1 for all nodes apart from node F, **find** the maximum possible value of the node F's heuristic function, h(F), such that the heuristic is admissible but not consistent. 2

A heuristic is consistent if, when going from neighboring nodes a to b, the heuristic difference/step cost never overestimates the actual step cost

2. CO2



Consider the undirected state space graph above. A is the start state and G is the goal state. The cost of each edge is given in the graph.

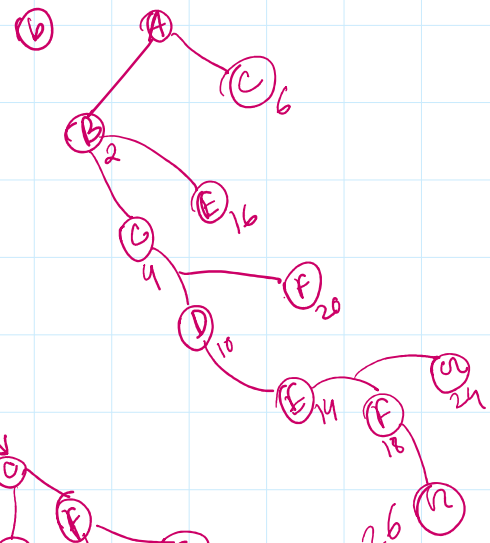
a. **Answer** which of the following paths are achievable using BFS, DFS and UCS. Consider only graph search while answering (not tree search). 8

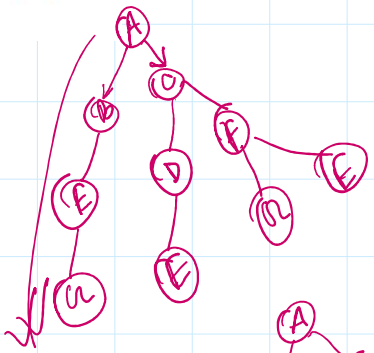
1) A-B-E-G BFS
2) A-C-F-G DFS
3) A-B-C-D-E-G UCS
4) A-C-B-E-F-G X

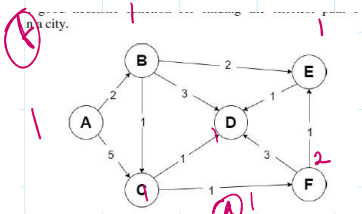
b. Suppose all the edge costs are doubled in the original graph. For example, cost of A-B becomes 2, cost of B-E becomes 14 and so on. Will the path returned by UCS (graph search) remain the same? Briefly **explain**. 2

same

(a)



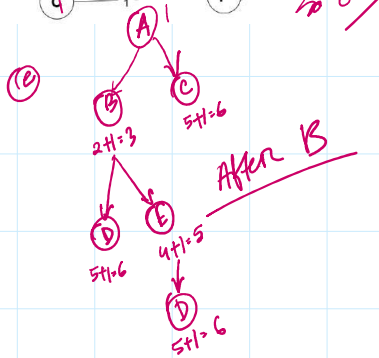


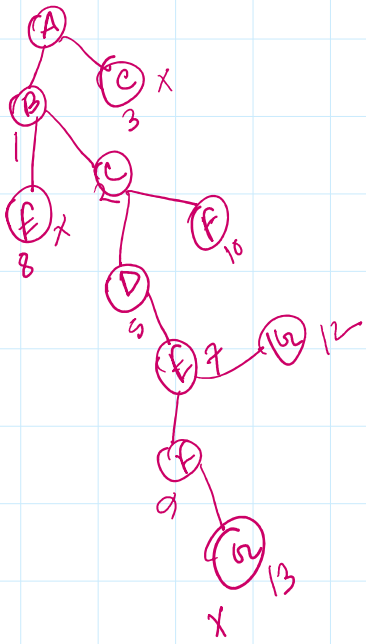


3+1=4, >2

so other

(e)





Spring 23

Wednesday, July 19, 2023 11:28 PM

1. CO2 Suppose you have an equation f(x) = x2 - 5x + 6. Assume x can be any number between 0 to 15. Now your job is to find an appropriate value of x such that the value of f(x) = 0 using Genetic Algorithm

a. Consider the fact that every chromosome will have 4 genes, **illustrate** an appropriate encoding technique to create an initial population of 4 randomly generated chromosomes.
b. Using an appropriate fitness function **deduce** the 2 fittest chromosomes and perform a single pointer crossover from the middle to create two offspring.
c. **Explain** how you can mutate the offspring derived from (B) and comment on the fitness of the final produced offspring.
d. **Explain** your opinion on whether Genetic Algorithm can be treated as a class of Local Search Algorithms or not.

(a)

(A) A = [1011] = 11
B = [1100] = 12
C = [0001] = 1
D = [1010] = 10

(B) Fit = |x² − 5x + 6| / f(x)
A = 72 : = 0.0138
B = 90 : = 0.011
C = 2 : = 0.5
D = 56 : = 0.018
0.5428

$P_A = 0.025$, $P_B = 0.020$,
$P_C = 0.92$ $P_D = 0.03321$

P_C, P_D picked
C = [0001]
D = [1010]

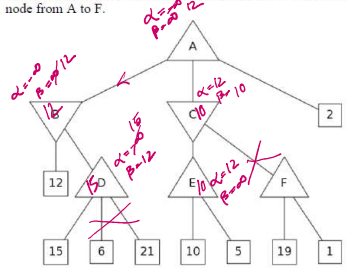
C = [0010] = 2
D = [1001] = 9

(C) Mutate
D = [1000] = 8

Fc = 0
FD = 30

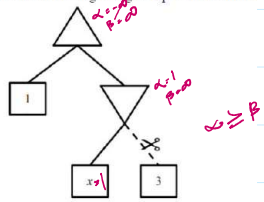
0000 0
0001 1
0010 2
0011 3
0100 4
0101 5
0110 6
0111 7
1000 8
1001 9
1010 10
1011 11
1100 12
1101 13
1110 14
1111 15

5. CO4 Assuming the upward-facing triangles stand for the maximizing player and downward-facing triangles represent the minimizing player, run min-max algorithm on the following tree and find the values for each node from A to F.



a. What path from the root node A will be returned by the min-max algorithm? **State.** B
b. What will be the alpha- and beta- values of each node in this tree if alpha-beta pruning is run on this tree? Also, **illustrate** the crossed-out branches that would be pruned by alpha-beta pruning.
c. For the game tree below, **identify** the minimum value of x for which the marked branch will be pruned by alpha-beta pruning. Here, again assume that upward-facing triangles stand for the maximizing player and downward-facing triangles represent the minimizing player.

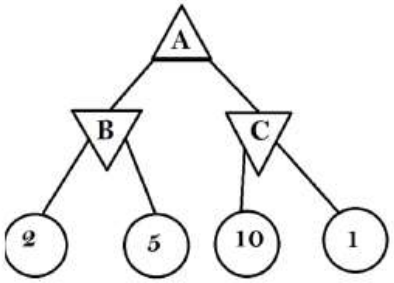
and downward-facing triangles represent the minin



Fall 22

Thursday, July 20, 2023 12:03 AM

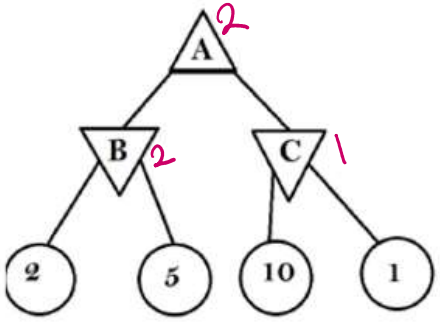
5. CO4

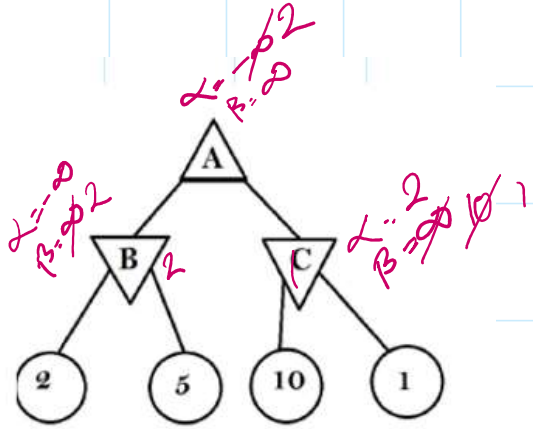


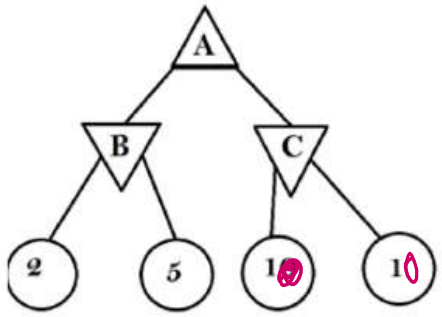
a. If you run minimax algorithm on this adversarial search tree, what would be the values at nodes A, B, and C? **Show** your entire process. 3

b. **Define** the values of α and β at nodes A, B, and C if you ran alpha-beta pruning here? 3

c. **Analyze** the game tree and sort the leaf nodes in a way so that the edge from A to C is pruned if you ran alpha-beta pruning. Give the values of α and β at nodes A, B, and C. 4



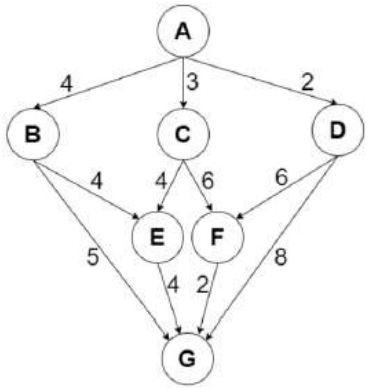



A
B
C
2
5
1
1

2. CO2 **a) Introduce/define** the four criteria that we use to compare search techniques.
b) Analyze the complexity, completeness and optimality for the following search techniques. Write the space and time complexity, whether the search technique is complete or not, and whether it is optimal or not. Give reasoning for your answer.
i) Depth-First Search
ii) Iterative Deepening Depth-First Search
c) Introduce a scenario where breadth-first search may be suboptimal.

4. CO4 **a) Analyze** the drawbacks of Hill Climbing Search along with the possible solutions. Now, **Select** one solution which can guarantee to find the global maxima and justify the reason.
b) Compare the greedy approaches of Greedy Best First Search and Hill Climbing Search.

3. CO3

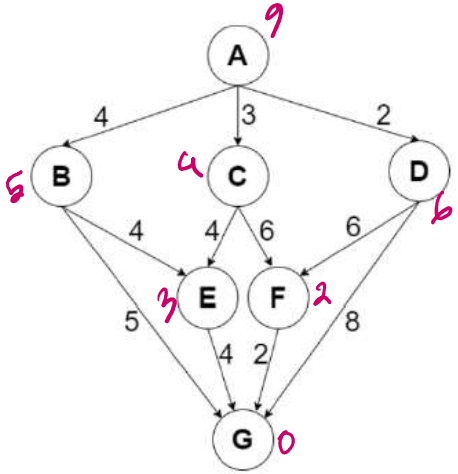


Heuristics

A	9
B	5
C	4
D	6
E	3
F	2
G	0

a) Predict whether A* search algorithm will be able to provide an optimal path from the start node A to the goal node G for the above graph. Why or why not?
b) Considering **A** as the start node and **G** as the goal node, **Apply** A* search algorithm for the given graph. Make sure to show each step.

3



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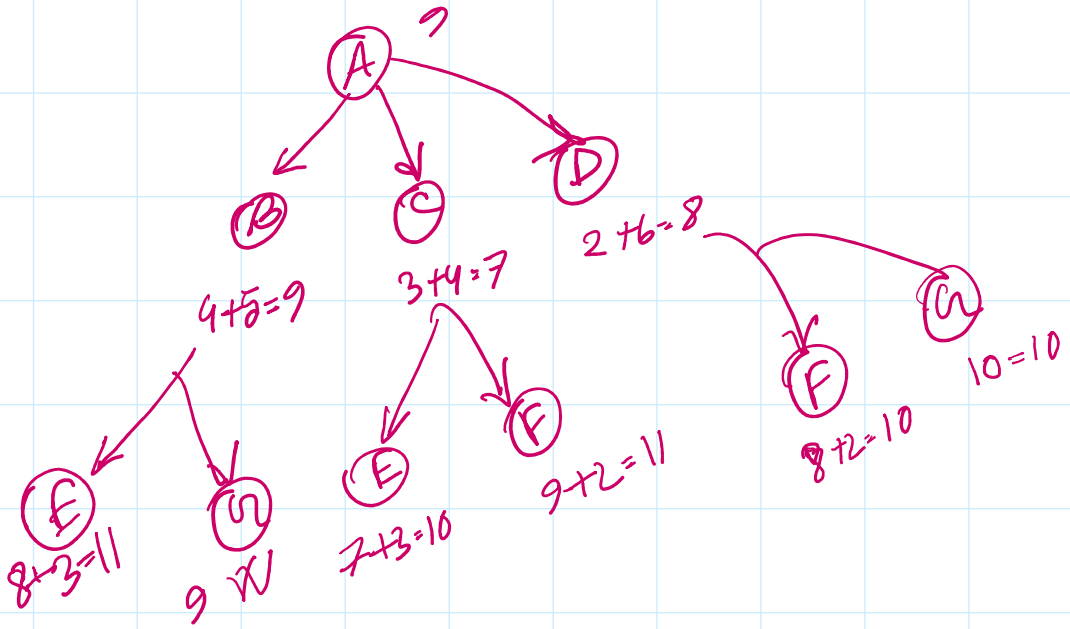

Not consistant

A → 2+6 (D)
(A-D)

→ 4+3
(C) (A-C)