Name	1	2	3	4	5	total
	20	40	40	25	25	**150**

UMBC CMSC 471 Midterm Exam 2018-03-18

Write your answers on this exam, which is closed book and consists of five problems, summing to 150 points. You have the entire class period, seventy-five minutes, to work on this exam. Good luck.

1. True/False [20 points]

Circle either **T** or **F** in the space before each statement to indicate whether the statement is true or false. If you think the answer is simultaneously true and false, quit while you are ahead.

T F A "rational agent" is one that always performs the best action in a given situation.

T F Breadth-first search where all arcs have a cost of one will always find the shortest path to a goal if one exists.

T F Iterative deepening search typically needs more memory than breadth first search.

T F If h1(n) and h2(n) are two different admissible heuristics, then (h1(n) + h2(n))/2 is necessarily an admissible heuristic.

T F An advantage of hill-climbing search is that it requires only a constant amount of memory when solving a problem.

T F Depth-first search always expands at least as many nodes as A* search with an admissible heuristic.

T F Hill climbing search algorithms only work for search spaces that are two-dimensional or have solution-preserving projections onto two dimensions.

T F Applying constraint satisfaction to problems using both forward-checking and arc consistency algorithms means that backtracking search is not required to find a solution.

T F A prisoner's dilemma game is an example of a two-person, partial-information, zero sum game.

T F A perfectly rational backgammon agent using minimax with unlimited lookahead would never loose.

2. Short answers [40: 10 points each]

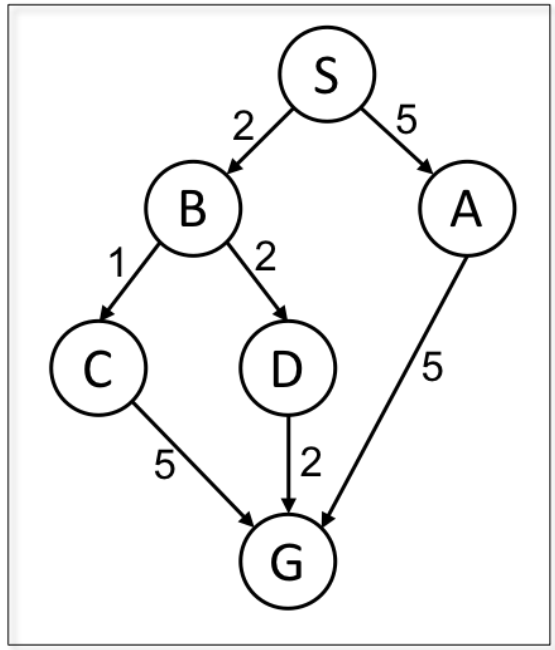
(a) When defining algorithms to find a shortest path in problem where arcs have a cost, we usually specify that the cost must be non-negative. Why is this constraint important? Be concise and specific!

(b) The minimax algorithm (and its variant alphabeta) cannot be applied to all games. Briefly identify at least four properties a game must have for minimax to be applicable.

(c) What are the main advantages of depth-first search over breadth-first search?

(d) What are the main advantages of breadth-first search over depth-first search?

3. Problem solving as search [40 points]



Consider the search graph shown on the right. S is the start state and G is the goal state. Edges are annotated with their cost. The table shows the values for each node for three different heuristic functions: h1, h2 and h3. For each of the following search strategies, give (1) the path that will be returned, or write none if no path will be returned; (2) the nodes that are added to the graph, and (3) the nodes that are expanded in the order expanded. If there are ties, assume alphabetical tie-breaking (i.e., nodes for states earlier in the alphabet are expanded first).

node	h1	h2	h3
S	0	5	6
A	0	3	5
B	0	4	2
C	0	5	3
D	0	2	5
G	0	0	0

(a) [6] Depth-first graph search* ignoring arc costs

(a1)

(a2)

(a3)

(b) [6] Breadth-first graph search* ignoring arc costs

(b1)

(b2)

(b3)

(e) [6] Algorithm A graph search using the heuristic function h1

(e1)

(e2)

(e3)

(e) [6] Algorithm A graph search using the heuristic function h2

(e1)

(e2)

(e3)

(e) [6] Algorithm A graph search using the heuristic function h3

(e1)

(e2)

(e3)

(f) [3] is heuristic h1 admissible?

(f) [3] is heuristic h2 admissible?

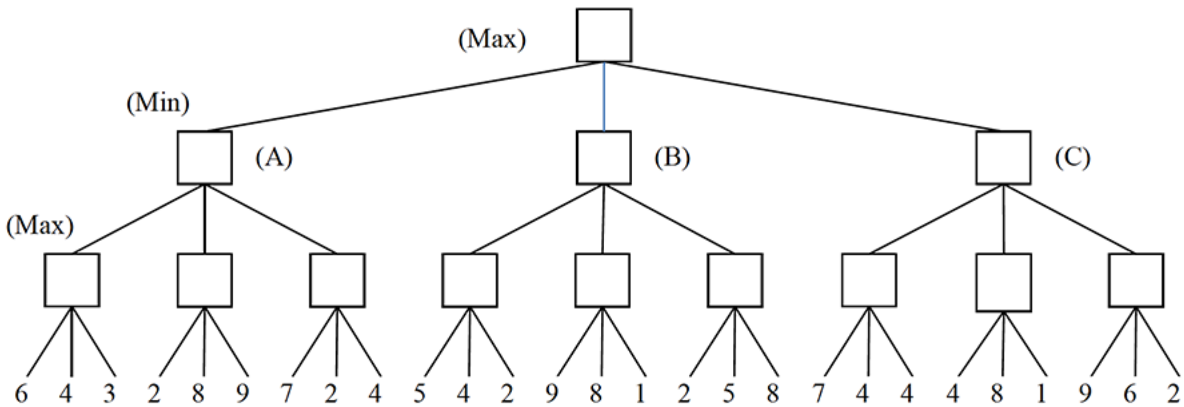
(f) [3] is heuristic h3 admissible?

* assume an algorithm that stops as soon as a goal node is added to the graph

4. Game tree search [25 points]

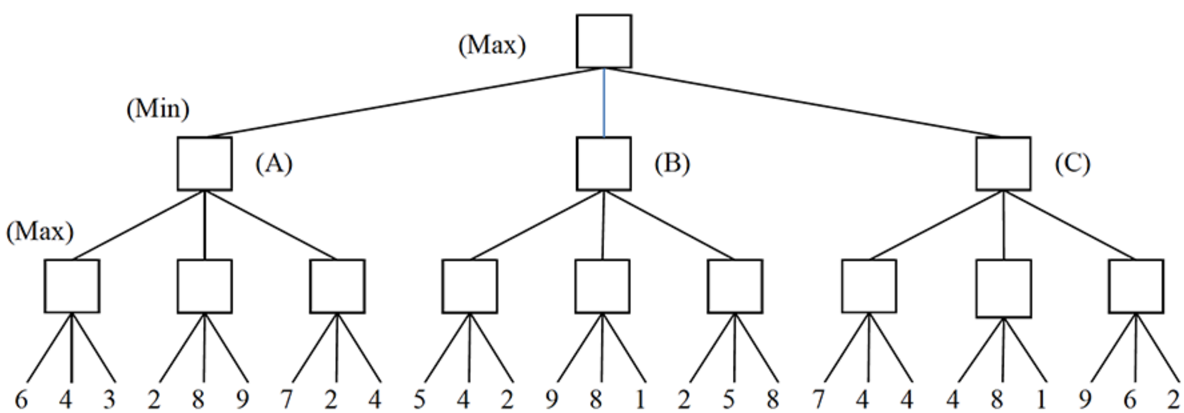
Consider the game tree below in which the first player is trying to maximize her score and the number at the leaves are the values returned by a static evaluator for the board positions reached.

(a) [10] Fill in each box with the value returned by the standard minimax algorithm



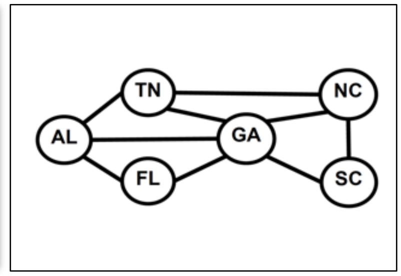
(b) [5] Circle the best initial move for the first player: **A B C**

c) [10] In the copy of this game tree below, fill in each box with the value returned by the standard **alpha-beta algorithm** if the tree is processed from **left to right**. And cross out both leaves and non-leaf nodes that need not be examined or considered.



5. Constraint satisfaction [25 points]

Consider coloring a map of the south eastern part of the U.S. shown to the right with three colors: R, G, B so that no two adjacent regions that share a border have the same color. We can represent this as a CSP graph with six variables: AL, TN, FL, GA, NC and SC where domain of each is {R, G, B}.



(a) [5] This table shows the possible values for each variable. Cross out all values that would be eliminated by **forward checking**, after variable TN has just been assigned value G, as shown.

AL	TN	FL	GA	NC	SC
R G B	G	R G B	R G B	R G B	R G B

(b) [5] AL and FL have been assigned values, but no constraint propagation has been done. Cross out all values that would be eliminated by applying both **forward checking** and **arc consistency**

AL	TN	FL	GA	NC	SC
B	R G B	R	R G B	R G B	R G B

(c) [5] Can this map be colored with just two colors, say R and B?

(d) [10] If it can be colored with just two colors, show an assignment that satisfies it. If it cannot, give a simple argument to show that it is not possible.