Your name:

1	2	3	4	5	6	7	total
10	*20*	*20*	*15*	*5*	*15*	*15*	*100*

UMBC CMSC 671 Midterm Exam

25 October 2015

Write your answers on this exam, which is closed book and consists of seven problems, summing to 100 points. You have the entire class period, seventy-five minutes, to work on this exam. Good luck.

1. True/False [10 points]

Circle either T or an 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. There is no penalty for incorrect answers but then, there are no points for incorrect answers either.

T F In a stochastic environment, the next state is completely determined by the agent's action.

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 If search heuristic H1(s) is admissible and heuristic H2(s) is not admissible, then H3(s) = min(H1(s), H2(s)) will be admissible.

T F In A* search, the first path to the goal which is added to the fringe will always be optimal.

T F If a Constraint Satisfaction Problem (CSP) is arc consistent, it can be solved without backtracking.

T F Deciding if a CSP is consistent is, in general, NP-hard.

T F Arc consistency is a more powerful constraint propagation algorithm than forward checking.

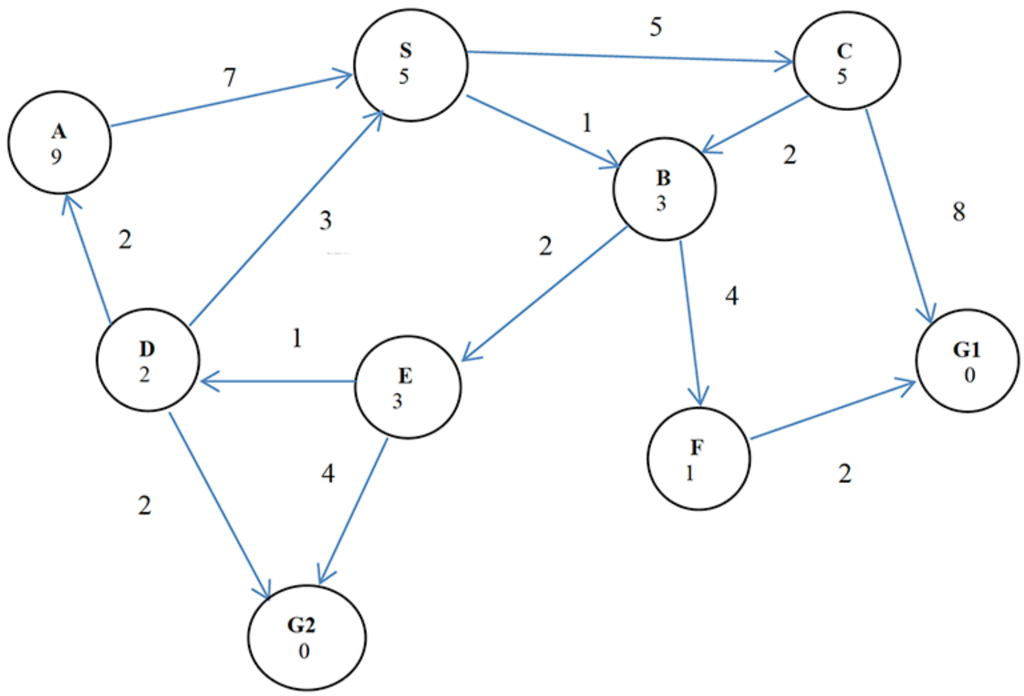
T F Alpha-beta pruning can alter the computed minimax value of the root of a game search tree.

T F Minimax with alpha-beta pruning on a game tree which is traversed from left to right will never prune the leftmost branch.

T F Chess, checkers and go are examples of games that have a partially observable environment.

2. Search I [20]

Assume the following search graph, where S is the start node and G1 and G2 are goal nodes. Arcs are labeled with the cost of traversing them and the estimated cost to a goal is reported inside nodes.



For each of the search strategies below, show which goal state is reached (if any) and list, in order, the states expanded. (Recall that for algorithm A, a state is expanded when it is removed from the OPEN list and its successors added to the queue). When all else is equal, nodes should be expanded in alphabetical order.

Depth first [5]

goal found	
states expanded	

Breadth first [5]

goal found	
states expanded	

Hill Climbing [5] (using the h function only)

goal found	
states expanded	

Algorithm A (Graph Search) [5]

goal found	
states expanded	

3. Constraint Satisfaction [20]

You are scheduling five lower-level CMSC courses for the spring that have three professors available to teach them. A professor can teach more than one course, but only of the times don't overlap. The courses and the times when they meet are:

Course 1: CMSC201, 8:00-9:00am
Course 2: CMSC202, 8:30-9:30am
Course 3: CMSC203 9:00-10:00am
Course 4: CMSC331, 9:00-10:00am
Course 5: CMSC341, 9:30-10:30am

The professors are:

Prof. A, who is available to teach Courses 3 and 4
Prof. B, who is available to teach Courses 2, 3, 4 and 5
Prof. C, who is available to teach Courses 1, 2, 3, 4 and 5

(a) [5] Formulate this as a CSP problem with one variable per course and give the initial domain (i.e., set of possible values) after applying the unary constraints (i.e., which Courses a professor can teach).

Variable	*Initial domain after applying unary constraints*
C1	
C2	
C3	
C4	
C5	

(b) [5] List all of the constraints between the variables

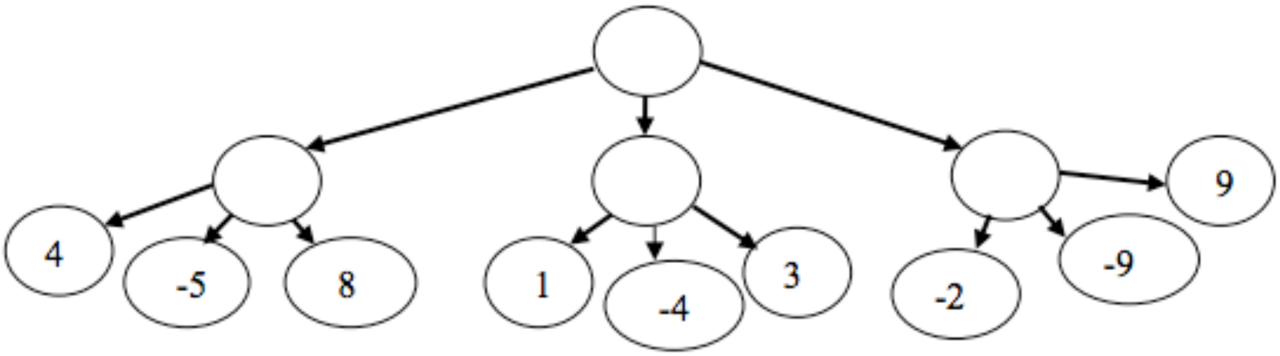
(3) [5] Show the domains of the variables after running the arc-consistency algorithm

Variable	*Initial domain after applying unary constraints*
C1	
C2	
C3	
C4	
C5	

(4) [5] Give one solution to this CSP by showing an assignment for each variable

4. Minimax [15]

Consider the following simple game tree in which the root node is the maximizing player. The values that will be returned by the static evaluator are shown for the leaf nodes.



(a) [5] What are the values that would be backed up by the standard minimax procedure (i.e., operating in a left-to-right traversal of the tree) in the three blank nodes.
root: [ ]; level2 left:[ ]; level2 center: [ ]; level2 right: [ ]

(b) [5] Which move does minimax choose: [ ] leftmost; [ ] center; [ ] rightmost

(c) [5] Put an X through all leaf nodes whose score need not be computed if the standard alpha-beta version of minimax is used.

5. Propositional logic 1 [5]

A propositional sentence is *well formed* if it follows the syntax of propositional logic, *satisfiable* if there is a way to assign true or false to each of its variables that makes the value of the overall sentence true, unsatisfiable if there is no way to assign true or false to its variables that makes the sentence true, and *valid* if it is always true no matter what values its variables are assigned.

Circle all of the following that are true: The sentence $((\mathbf{P} \rightarrow \mathbf{Q}) \wedge \mathbf{Q}) \rightarrow \mathbf{P}$ is

(a) well formed

(b) valid

(c) satisfiable

(d) unsatisfiable

6. Propositional Logic 2 [15]

Let these propositional symbols have the following meaning:

symbol	*meaning*
A	The patient was in an accident
S	The patient is sick
I	The patient is injured
D	The patient needs to see a doctor

Express each of the following English sentences in propositional logic using the symbols ∧, ∨, ¬ , → and ↔ for the logical connectives and, or, not and implies and 'if and only if'.

(a) [5] The patient was in a car accident, but is not injured

(b) [5] The patient needs to see a doctor if he is sick or injured

(c) [5] If the patient was not in an accident and is not sick, then he does not need to see a doctor

7. English to logic (15)

Translate the following statements into a **single sentence** in first order logic, choosing appropriate predicates and functions. Avoid redundancy. Use the logical connectives and quantifiers ∀ and ∃ and numeric relations < and >.

(a) Every boy is a human who is male and whose age is less than 16 and every male human who is less than 16 is a boy

(b) Some people like every vegetable

(c) There is no vegetable that is liked by every person