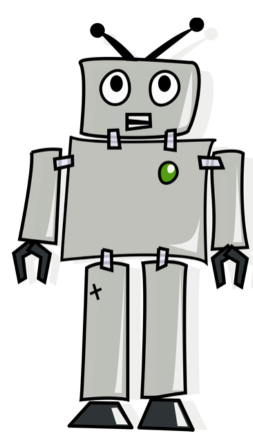
Write **clearly** and **in the box**:

CSCI 3202
Midterm Exam 1
Spring 2020

Name:
Student ID:
Section number:

Read the following:

- **RIGHT NOW**! Write your name, student ID and section number on the top of your exam.
- You are allowed one 8.5×11-in page of notes (both sides). No magnifying glasses!
- You may use a calculator provided that it cannot access the internet or store large amounts of data.
- You may **NOT** use a smartphone as a calculator.
- Clearly mark answers to multiple choice questions in the provided answer box.
- Mark only one answer for multiple choice questions. If you think two answers are correct, mark the answer that **best** answers the question. No justification is required for multiple choice questions.
- If you do not know the answer to a question, skip it and come back to it later.
- For free response questions you must clearly justify all conclusions to receive full credit. A correct answer with no supporting work will receive no credit.
- If you need more space for free-response questions, there are blank pages at the end of the exam. If you choose to use the extra pages, make sure to **clearly** indicate which problem you are continuing.
- You have **90 minutes** for this exam.



Exam info

Canvas posting

Timed - 90 minutes once you start it

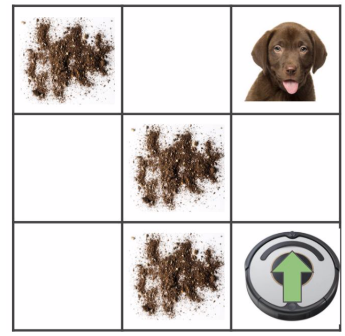
Open Wednesday 4pm

Closes Thursday 8pm

Covers all material through
game theory

Gradescope

1. (10 points) Consider the task environment of a Roomba in a 3 x 3 tile room. Each tile is either i) clean or ii) dirty. Roomba can clean, turn, move, and do nothing. Assume Roomba must be pointing in the direction it wants to move before that move can be made. An example state-of-the-world is given at right. (The arrow denotes the direction Roomba is facing, the circular object is a Roomba, and the splotches represent dirt.) There is also a dog somewhere in the room. The Roomba and the dog can be on the same tile.



What is the size of the state space? You do not need to simplify your answer.

What is state space - env. that agent "lives" in

Roomba position - 9
Dog position - 9
Clean/dirty - 2^9
Direction - 4

$9 \times 9 \times 2^9 \times 4$

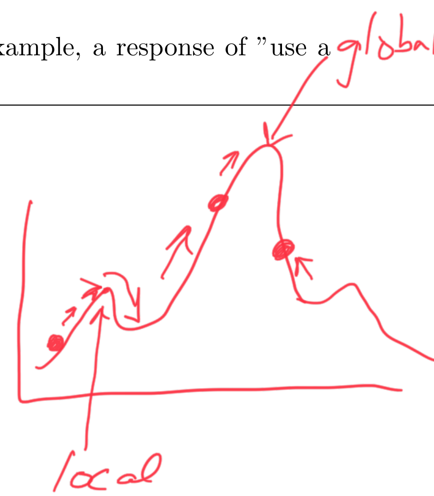
$9^2 \times 2^9 \times 4$

Why don't we count actions in state space?
Actions are transitions between states.

2. (10 points) Suppose you are using hillclimbing to find a global optimum of some objective function. However, you keep getting stuck in what you know to be a local optimum. What are two options for escaping a local optimum?

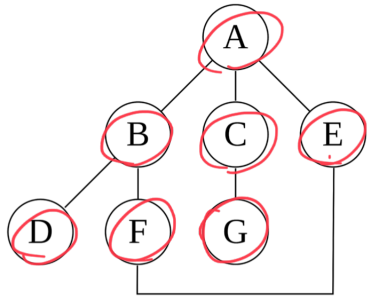
Be specific in your answer and indicate how each option will help. For example, a response of "use a different function" would receive 0 points.

Global vs. local optimum
Step size
Random restarts
Accept less opti solutions with some probability



How does hill climbing work?
What are limitations of hill climbing
How does SA work
Local and global optimum

3. (12 points) Suppose we have breadth-first search and depth-first search algorithms wherein states are added to the frontier in alphabetical order. Assume we do not permit any redundant/loopy paths. Consider the task of finding a path from G to H. Note, that H is not shown on the graph below.



H not in graph. Entire graph searched

Parent assigned when node explored

(a) What is the order in which states will be added to the frontier using breadth-first search as BFS is searching for node H? G C A B E D F

(b) As BFS is performed, what is the parent node of node F? B

(c) What is the order in which states will be explored (expanded) using depth-first search, again starting from G and looking for H? GCAEFBD

(d) As DFS is performed, what is the parent node of node F? E

Explored

G, C, A, B, E, D, F

Frontier

C, A, B, E, D, F

BFS

Difference between DFS, BFS

Memory + time complexity of each

Optimality, completeness

4. (10 points) Each true/false question is worth 2 points. Circle your choice for each question part. Consider a graph search problem where for every action, the cost is at least ϵ, with $\epsilon > 0$. Assume the heuristic being used is consistent. and admissible

   (a) [**TRUE** or **FALSE**] Depth-first search is guaranteed to return an optimal solution.

   (b) [**TRUE** or **FALSE**] Breadth-first search is guaranteed to return an optimal solution.

   (c) [**TRUE** or **FALSE**] Uniform-cost search is guaranteed to return an optimal solution.

   (d) [**TRUE** or **FALSE**] Greedy search is guaranteed to return an optimal solution.

   (e) [**TRUE** or **FALSE**] A^* search is guaranteed to return an optimal solution.

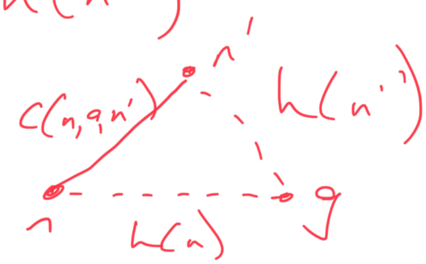
5. (8 points) Describe a general genetic algorithm in pseudocode below.

```
def genetic_algorithm(problem, some number of generations):

    for some number of generations:
```

Consistent

$h(n) \le c(n, a, n') + h(n')$



Admissibility

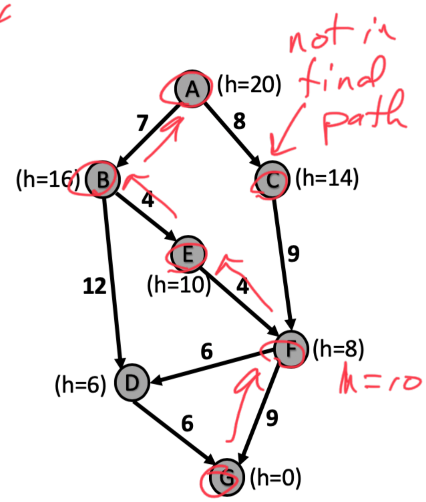
$h(n) \le h^*(n)$

where $h^*(n)$ is true cost

Consistent establishes constraints on heuristic values for each node.

Admissibility establishes constraints on heuristic relative to true cost

$f(B)=23$ $f(E)=21$ $f(G)=24$
$f(C)=22$ $f(D)=25$
~~$f(F)=25$~~ $f(F)=23$
~~$f(D)=27$~~



6. (25 points) Here is a directed state space graph. This means, for example, that from A you can only get to B and C, but you cannot go from B back to A or from C back to A. The values of an admissible heuristic are given in parentheses next to the node names. The step costs to travel between two nodes are given as the edge weights.

Exp	Frontier
A, C, B, E, F, G	B, C, E, F, G

Path A-B-E-F-G

(a) In what order would A^* search explore the state space to find the solution path from A to G? Include in your answer: C, B, E, F, G
   (i) the f-costs associated with each state as they are explored $f(n) = g(n) + h(n)$ — $g(n)$: path to node; $h(n)$: heuristic to goal
   (ii) the optimal path cost 24
   (iii) what node is the parent of F in the final search tree? E

(b) Provide one example of a single modification to this search graph that would make the given heuristic inadmissible. Fully justify your answer. Change h(F) to 10. Now it overestimates

(c) Consider the node B and its successor E. Is the given heuristic consistent? Fully justify your answer.

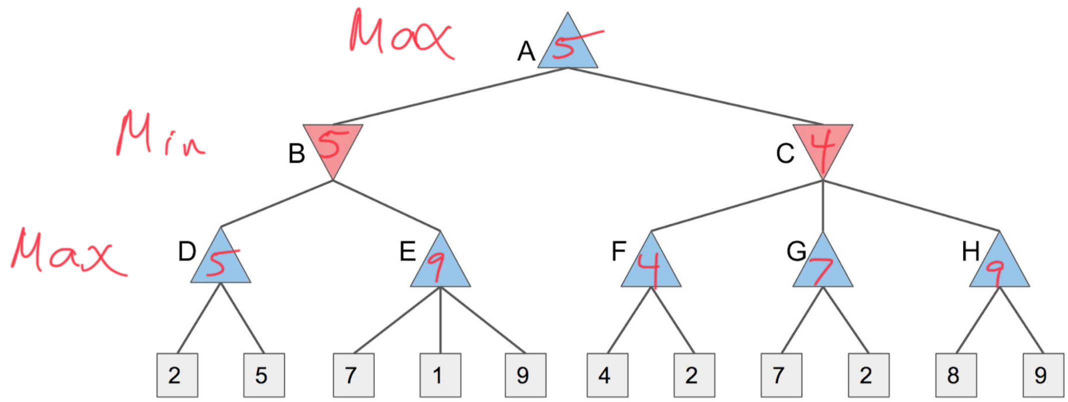
B
$h(B)=16$
$c(B,E)=4$

E
$h(E)=10$

Not consistent because
$h(B) > h(E) + c(B,E)$
$16 > 14$

Admissible and consistent!!

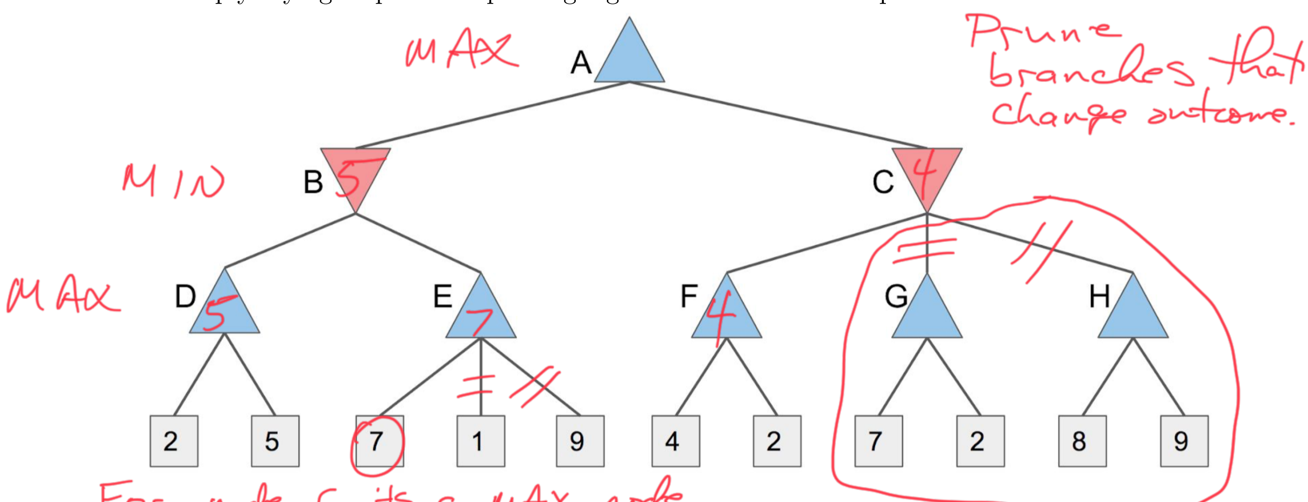
7. (25 points) Below is a Max/Min game tree. The values in the boxes denote utility to Max, the upward-pointing triangles are Max nodes and the downward-pointing triangles are Min nodes.



(a) What are the minimax values associated with each node? Do not consider any pruning at this point. Write your answers in the table below.

		A. 5		
	B. 5		C. 4	
D. 5	E. 9	F. 4	G. 7	H. 9

(b) Indicate clearly in the figure below which branches/leaves are pruned when alpha/beta pruning is applied to this game tree. Assume that nodes are expanded from left to right at each layer. Briefly justify how you know that these branches/leaves can be pruned. Vague responses along the lines of simply saying "alpha-beta pruning algorithm" will receive 0 points.



For node E, its a MAX node. It gets a 7 and would like a higher value. Its parent is a MIN and already has a 5. theres no point in looking at

(c) Consider alpha-beta pruning, as in part b. What are the values of α and β (alpha and beta) as we proceed from C to F?

either the 1 or 9 because MAX won't accept a value less than 7 and MIN won't accept a value greater than 5.

(d) Draw the min/max game tree for the next two moves (X then O) starting from the Tic-Tac-Toe state given below. Note that the game ends once one player achieves three in a row/column/diagonal.

X	O	X
	X	O
		O

We didn't get to this is lecture, but solution is in the midterm solutions file on Canvas.

Additional Workspace

Additional Workspace