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CSC 411 Study Guide for Midterm 01

You are allowed **one (1) sheet of paper (8"x11") with handwritten notes** (front and back) and a **calculator**. You may be required to wipe the memory of your calculator before the exam. No other review materials are permitted.

Remember, this is a study guide, meant to help you get ready for the exam. The questions here are meant to represent what to expect, but not limited to the only questions that will be on the exam. You should be ready to answer any of the questions seen here, as well as questions similar to those seen in Lecture Exercises and Problem Sets.

Section	Possible Points
Agents and Environments	
Uninformed Searching	
A* Search	
Simulated Annealing	
Genetic Algorithms	
Ant Colony Optimization	
Minimax Search	
TOTAL	100

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Agents and Environments

1. Define the **Performance Measures**, **Environment**, **Actuators**, and **Sensors** for a **cooking** agent.

Agent Type	Performance Measures	Environment	Actuators	Sensors
Cooking Agent	orders Filled per hr orders correctly Filled customer satisfaction	ingredients kitchen tools heating surfaces	oscillating Arm For moving ingredients Conveyor belt for Food delivery	thermometer gyroscope camera pressure sensor

2. Define the **Performance Measures**, **Environment**, **Actuators**, and **Sensors** for a **dog-walking** agent.

Agent Type	Performance Measures	Environment	Actuators	Sensors
Dog-Walking Agent	# of dogs walked # of dogs able to be walked at once	paved vs. unpaved ground other dogs, walked dogs humans moving vehicles	wheels waste collection treat dispenser speaker (For commands) ball shooter	camera gps "dog health sensors" From CIIGAR lab

3. Explain the **observability** of the environment in which an agent designed to solve Sudoku problems.

Fully Observed - all tiles and values are visible & perceivable.

4. Explain whether the chess environment is **episodic** or **sequential**.

Sequential - states are dependent on prior actions

5. Explain whether a self-driving car agent operates in a **static** or **dynamic** environment.

Dynamic - world/environment keeps "updating" while agent makes decisions

Uninformed Search

6. How many **branches**, or **paths**, does a search tree with on average 4 branches with a depth, or levels, of 8 have? Provide the actual number, not just the exponential notation.

$4^8 = 65,536$

7. How many **branches**, or **paths**, does a **full** and **complete** binary search tree with a depth, or levels, of 5 have? Provide the actual number, not just the exponential notation.

$2^5 = 32$

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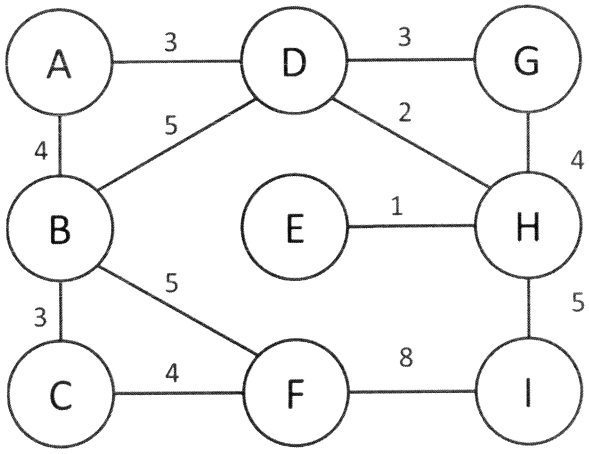
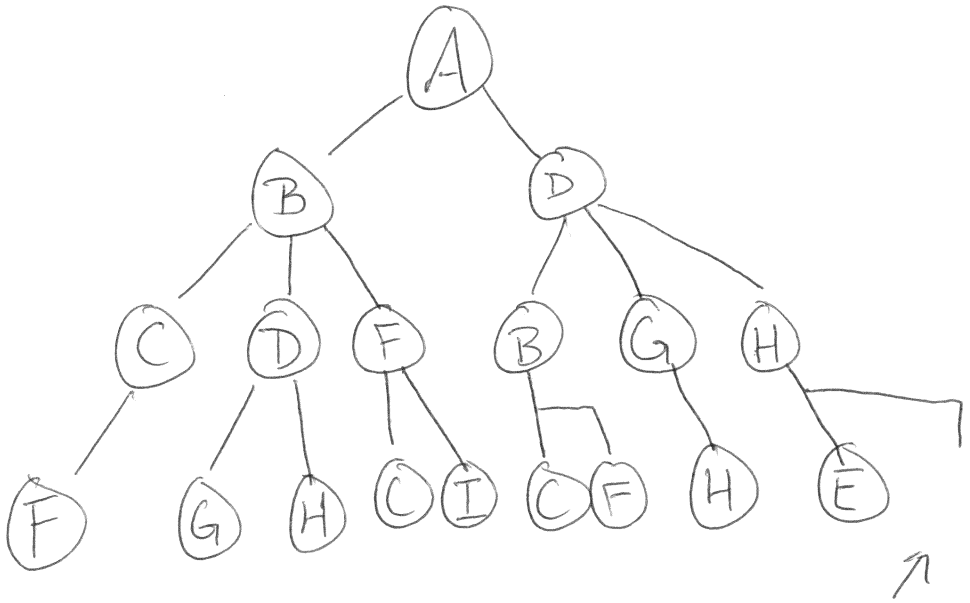


Figure 1

8. Consider the Graph in **Figure 1**. Using the **Breadth-First Search**, draw the **search tree** necessary to reach **Node E** from **Node A**. When selecting "next nodes", nodes with letters that appear earlier in the alphabet will be selected first. For example, at Node A, you'd select Node B before Node D.
For any given path, do not include previously traversed nodes. For example, when traversing the A → D → G → ... path, do not include Node A again.



E occurs before I, so I doesn't get traversed

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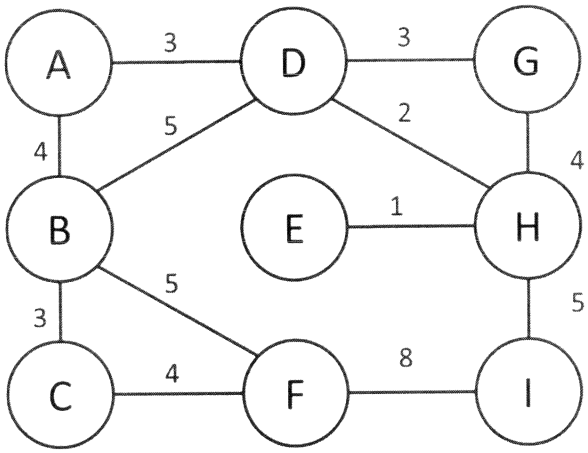
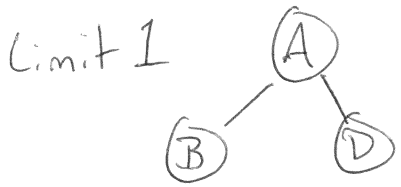
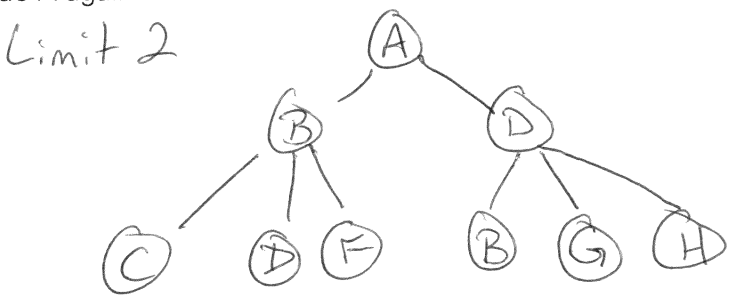
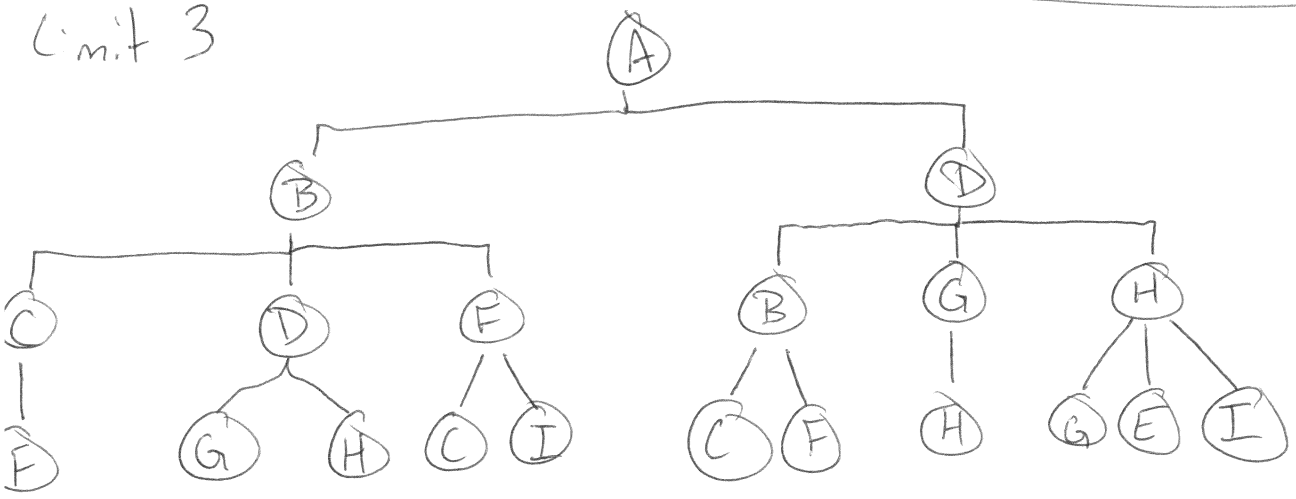


Figure 1 (repeated)

9. Consider the Graph in **Figure 1**. Using the **Iterative Deepening Search**, draw the **search tree** for the first three limits, starting from **Node A**. When selecting "next nodes", nodes with letters that appear earlier in the alphabet will be selected first. For example, at Node A, you'd select Node B before Node D. For any given path, do not include previously traversed nodes. For example, when traversing the A → D → G → ... path, do not include Node A again.







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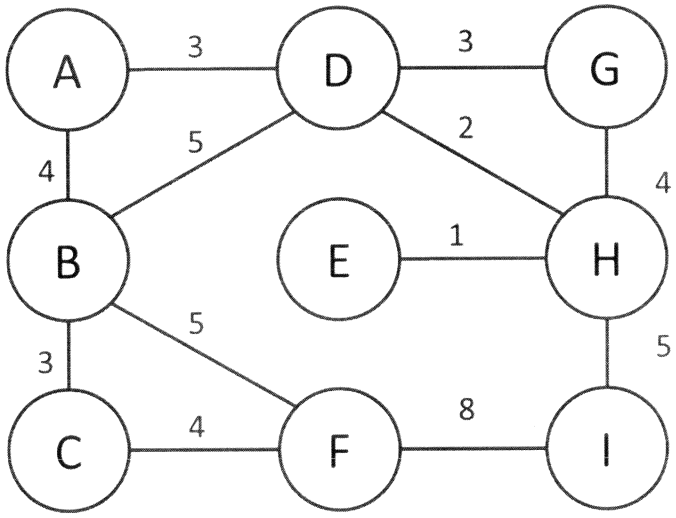
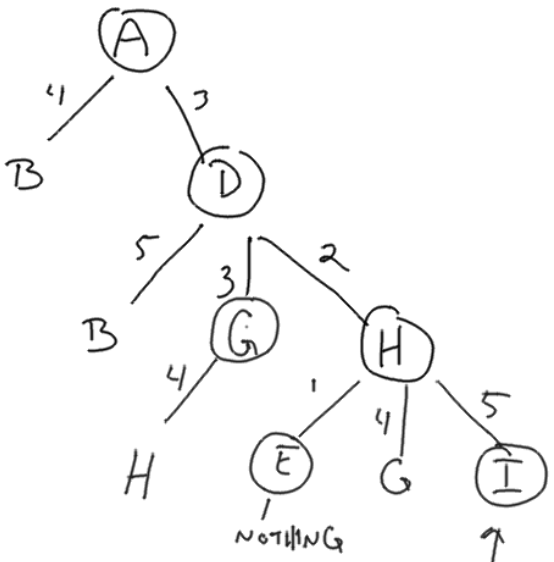
A* Search



	DISTANCE
A	7.2
B	6.3
C	6.0
D	5.0
E	3.6
F	3.0
G	4.0
H	2.0
I	0.0

Figure 1 (repeated), with the Straight-Line Distance to Node I

10. Consider the Graph in **Figure 1** and the Straight-Line Distance list. Draw the **search tree** from Node A to **Node I** using the **A* Algorithm**. Under each candidate state, write its corresponding **g(n)** and **h(n)**. For **g(n)**, use the weights close to the edges in Figure 1. For **h(n)**, use the **Straight-Line Distance** table on the right.



Indicates when the node is removed from priority queue

	g	h	f
AB	4	6.3	10.3
(1) AD	3	5.0	8
DB	8	6.3	14.3
(4) DG	6	4.0	10
(2) DH	5	2	7
(3) HE	6	3.6	9.6
HG	9	4	13.0
(5) HI	10	0	10
GH	10	2	12

We have to consider D→G because this node was added to the queue before H→I

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Simulated Annealing

	A	B	C	D	E
V	**16**	19	19	27	16
W	29	15	20	12	**26**
X	16	26	10	**29**	23
Y	22	**28**	25	19	30
Z	21	14	**21**	20	10

Figure 2

11. Consider the table and assignments in **Figure 2**. In this Linear Assignment Problem, each person has been assigned a task, denoted by small boxes around a value. For example, Person B has been assigned Job Y, which has a value of 28.
    a. What is the current **fitness measure** of this configuration?

    120

    b. If the current configuration would be written as **VYZXW**, where each letter corresponds to persons **ABCDE**, what are the possible **next states** if Person A were to switch roles with every other person? What is this new configuration's fitness measure?

Swapping A with…	Job Configuration	Fitness Measure
B	Y V Z X W	117
C	Z Y V X W	123
D	X Y Z V W	118
E	W Y Z X V	123

    c. Using **Simulated Annealing**, write the **probability** of accepting each configuration. **Temperature (T)** equals 10. Round to the nearest thousandth. For practice, calculate the probabilities for **minimizing** and **maximizing** the fitness measure.

Swapping A with…	P (minimizing)	P (maximizing)
B	1.0 $(120-117>0)$	$e^{-3/10} = 0.7408$
C	$e^{-3/10} = 0.7408$	1.0 $(123-120>0)$
D	1.0 $(120-118>0)$	$e^{-2/10} = 0.8187$
E	$e^{-3/10} = 0.7408$	1.0 $(123-120>0)$

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Genetic Algorithms

						Utility
A1	5	7	7	4	4	14
A2	7	9	6	8	9	16
A3	4	9	8	6	8	21
A4	6	3	7	6	8	16
A5	4	8	3	5	9	13
A6	9	4	4	7	5	5
A7	9	4	5	5	9	11
A8	6	4	3	3	6	7
A9	9	6	7	7	4	10
A10	7	4	7	4	9	17

Figure 3

12. Consider the table in Figure 3. For the purpose of this question, assume we are attempting to **maximize** the utility function.
    a. What are the **top two** successors?

A3 A10

    b. Using the successors from (a), write out the children produced for with the specified **crossover points** in the table below.

Crossover					
1	4 |	4	7	4	9
2	4	9 |	7	4	9
3	4	9	8 |	4	9
4	4	9	8	6 |	9

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Ant Colony Optimization

	Path Cost	τ_0
P01	14	1
P02	10	1
P03	8	1

Figure 4

Calculate the probabilities and updated tau values based on the path costs, tau (τ) values shown in Figure 4, and number of ants that took the given paths below. For example, Path P01 has a path cost of 14 and an initial tau of 1. Assume $\rho = 5\%$ and $Q = 1$.

13. ★ There will be some leeway if you're off by some thousandths.

Probability – Calculate the probability of selecting each path.

p_{P01}	Ø.2410	$\frac{1 \cdot 1/14}{1 \cdot 1/14 + 1 \cdot 1/10 + 1 \cdot 1/8} = \frac{Ø.Ø7143}{Ø.29643}$
p_{P02}	Ø.3373	$\frac{1 \cdot 1/10}{1 \cdot 1/14 + 1 \cdot 1/10 + 1 \cdot 1/8} = \frac{Ø.1}{Ø.29643}$
p_{P03}	Ø.4217	$\frac{1 \cdot 1/8}{1 \cdot 1/14 + 1 \cdot 1/10 + 1 \cdot 1/8} = \frac{Ø.125}{Ø.29643}$

Trail Level – Using the Number of Ants value, calculate the new tau value for each path.

	Num of Ants		
τ_{P01}	1	1.Ø214	$.95 \cdot 1 + \frac{1}{14}$
τ_{P02}	5	1.450	$.95 \cdot 1 + \frac{5}{10}$
τ_{P03}	4	1.450	$.95 \cdot 1 + \frac{4}{8}$

14.

Probability – Calculate the probability of selecting each path using the updated tau values from the question above.

p_{P01}	Ø.1828	Ø.Ø7296/Ø.39921

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p_{P02}	Ø.3632	Ø.145 / Ø.39921
p_{P03}	Ø.454	Ø.18125 / Ø.39921

Trail Level – Using the Number of Ants value, calculate the new tau value for each path.

	Num of Ants		
τ_{P01}	3	1.1846	.95 · 1.Ø214 + 3/14
τ_{P02}	2	1.5775	.95 · 1.45Ø + 2/10
τ_{P03}	5	2.ØØ25	.95 · 1.45Ø + 5/8

15.

Probability – Calculate the probability of selecting each path using the updated tau values from the question above.

p_{P01}	Ø.1717	Ø.Ø8462 / Ø.49268
p_{P02}	Ø.32Ø2	Ø.15775 / Ø.49268
p_{P03}	Ø.5Ø81	Ø.25Ø31 / Ø.49268

Trail Level – Using the Number of Ants value, calculate the new tau value for each path.

	Num of Ants		
τ_{P01}	2	1.2683	.95 · 1.1846 + 2/14
τ_{P02}	3	1.7986	.95 · 1.5775 + 3/10
τ_{P03}	5	2.5274	.95 · 2.ØØ25 + 5/8

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Minimax Search

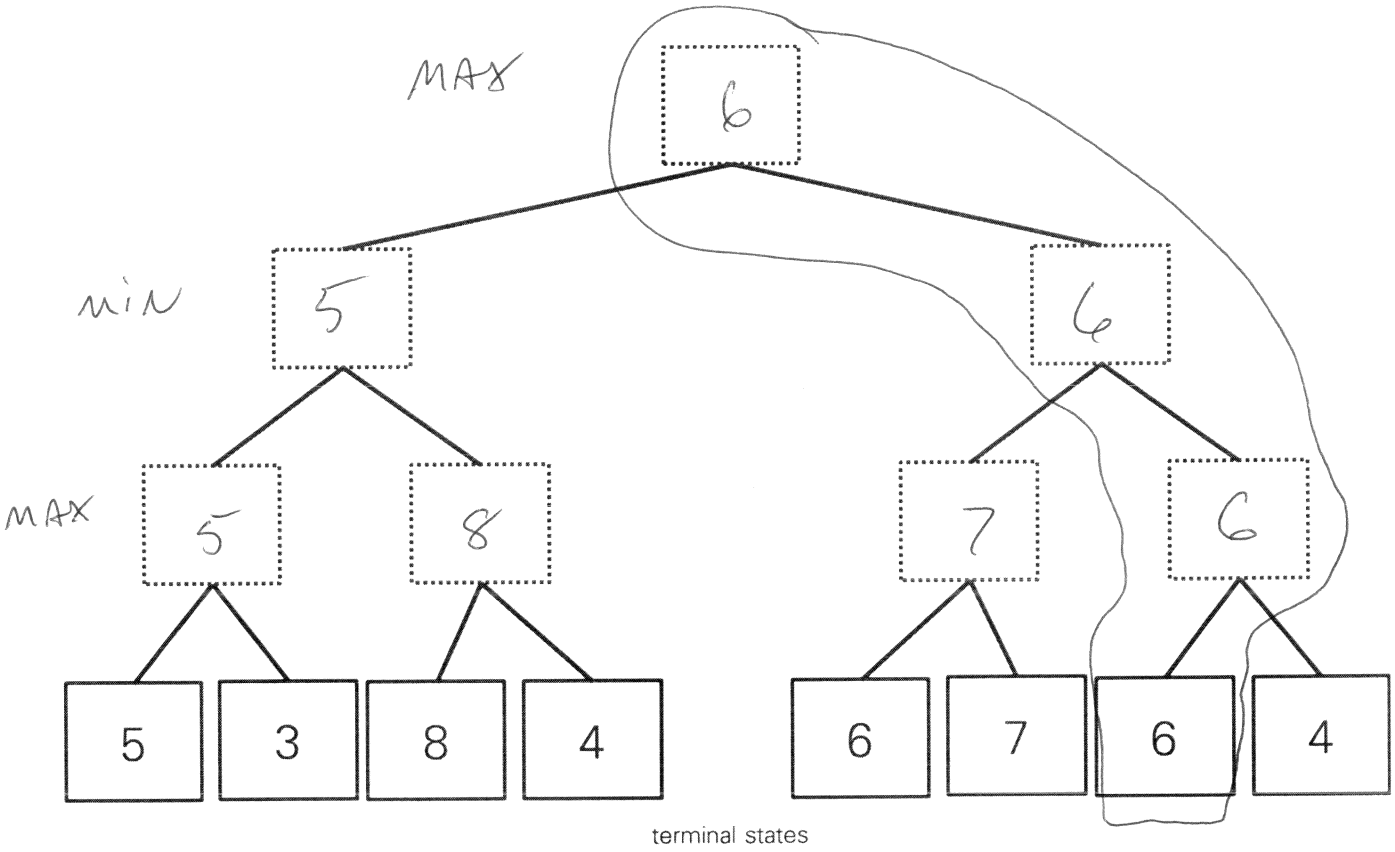

Figure 5

16. Consider the binary tree in Figure 4.
    1. Fill in each of the dotted lined squares with the expected values produced for the **Minimax Algorithm.**

    2. Circle the **expected path**, in which both Max and Min select optimally.

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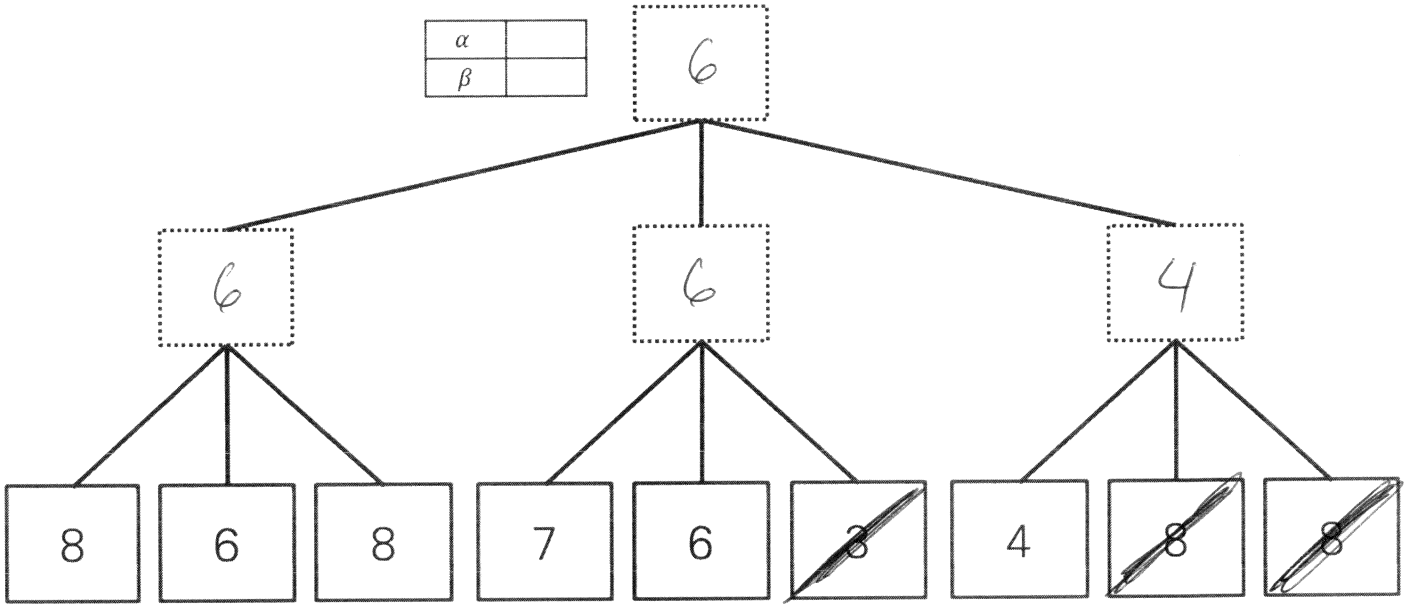

Figure 6

17. Consider the tree in Figure 6. Fill in each of the dotted lined squares with the expected values produced for the **Minimax Algorithm with Alpha-Beta Pruning.**

Cross out any nodes that would not be considered due to how Alpha-Beta pruning operates. Please make cross outs distinct. Any ambiguity will be considered **not crossed out** and is entirely subjective to the grader.