CS 331 Midterm
Spring 2017

You have 50 minutes to complete this midterm. You are only allowed to use your textbook, your notes, your assignments and solutions to those assignments during this midterm. If you find that you are spending a large amount of time on a difficult question, skip it and return to it when you've finished some of the easier questions. Total marks for this midterm is 46.

Section	Marks
Agents	/ 8
Search	/ 10
Games	/ 13
Logic	/ 15
Total	/ 46

Section I: Agents (8 points)
1. Consider an agent designed to solve instances of the 8-tile puzzle described in class. Recall that the 8-tile puzzle is a 3x3 grid with 8 numbered tiles and one blank square, and the objective is to get from an initial configuration of the tiles to a specified configuration (usually with the tiles in numeric order).

For each part below, circle the choice which best describes the environment for this agent:

a) Fully observable   or   Partially observable   [1 point]

b) Deterministic   or   Stochastic   [1 point]

c) Episodic   or   Sequential   [1 point]

d) Static   or   Dynamic   [1 point]

e) Discrete   or   Continuous   [1 point]

f) Single agent   or   Multi-agent   [1 point]

2. What type of agent is the 8-tile puzzle solver from question 1? Choose from simple reflex agent, model-based reflex agent, goal-based agent and utility-based agent. Give a one or two sentence justification of your answer. [2 points]

II. Search [10 points]

4. Consider formulating the 8-tile puzzle as a local search problem and representing a state as an array of 9 symbols corresponding to the tile positions. For example,

6	4	3
1	2	7
8		5

would be represented as [6 4 3 1 2 7 8 B 5], with B for blank.

a) List the neighbors for the state shown above in this representation? [2 points]

b) Propose an evaluation function for this problem. [2 points]

c) Using this state representation, would genetic algorithms be a promising approach to this problem? Why or why not? [2 points]

5. In the tree-search algorithm, the goal test is applied after a node is removed from the queue. We saw that breadth-first search (BFS) and uniform cost search (UCS) are optimal tree-search strategies. Consider a variant of tree-search in which the goal test occurs when nodes are expanded instead, right before they are inserted into the queue.

a) Is BFS (with uniform step costs) still optimal in this variant? Why or why not? [2 points]

b) Is UCS (with non-uniform step costs) still optimal in this variant? Why or why not? [2 points]

III. Games [13 points]
6. Below is a portion of a game tree. At this point, MAX is choosing between a guaranteed utility of 10 versus tossing a series of coins. Which action should MAX choose (left or right)? Use the expectiminimax algorithm to decide, and show your work. [7 points]
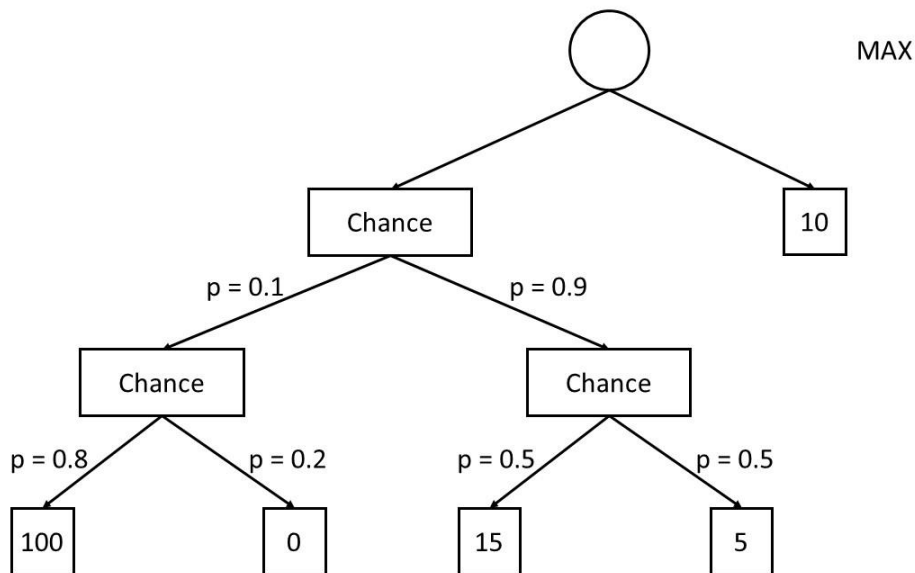
7. Consider the following game tree, in which the terminal nodes have utilities W through Z, and the edges are labeled with A through F.

MAX

A   D

MIN

B   C   E   F

W   X   Y   Z
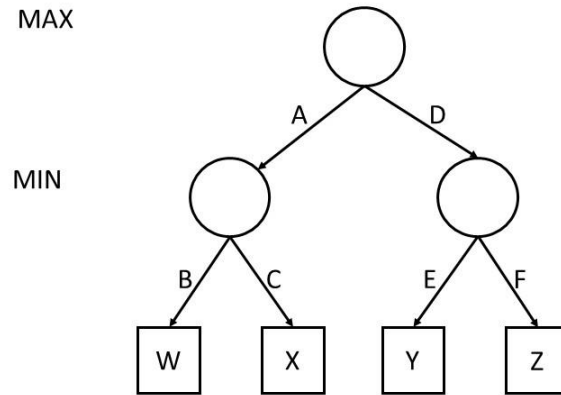
a) Give a mathematical expression for the minimax value at the root node in terms of the utilities. (Hint: you can use min() and max() functions that return the minimum or maximum of their arguments, respectively.) [2 points]

b) Suppose $W = 3, X = 6, Y = 4$, and $Z = 5$. Are any of the edges pruned by the alpha-beta algorithm? If so, which ones? [2 points]

c) Suppose $W = 7$ and $X = 2$. Give a value for Y such that edge F is pruned by the alpha-beta algorithm. [2 points]

IV. Propositional Logic [15 points]

8. Is the following sentence valid, unsatisfiable, or neither? Justify your answer. [2 points]

$$\big((A \land B) \Rightarrow C\big) \Leftrightarrow \big((A \Rightarrow C) \lor (B \Rightarrow C)\big)$$

9. Convert the following English sentences into propositional logic.
   If I study and I get enough sleep, then I will pass the exam.
   If my homework is not late, then I will get full credit for it.
   I will either study or get enough sleep, but not both.
[3 points]

10. Convert the following KB into CNF. [5 points]

$$P \Leftrightarrow Q$$
$$(Q \wedge R) \Rightarrow S$$
$$(R \wedge S) \vee T$$

11. Use the resolution algorithm to determine whether the following KB entails B. [5 points]

1. $A \vee B$
2. $\neg B \vee \neg C$
3. $\neg C \vee D$
4. $B \vee E$
5. $D \vee F$
6. $E \vee \neg F$