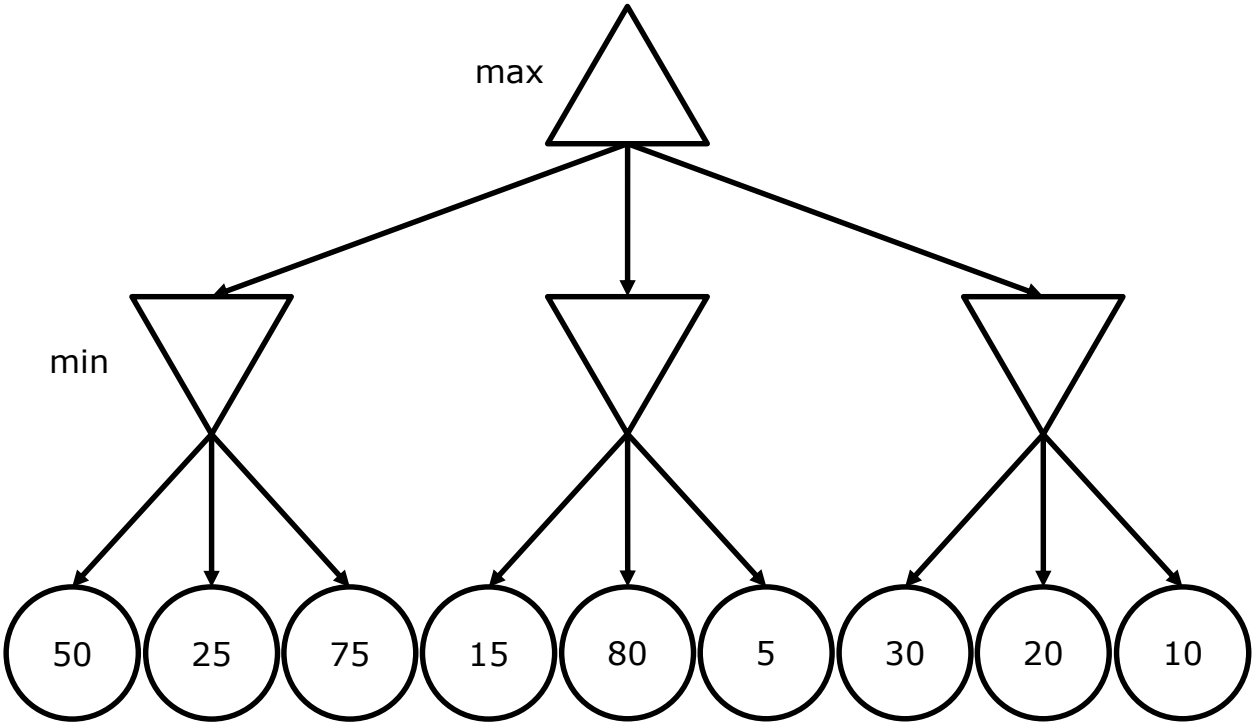
Name:
Course: CAP 4601
Semester: Summer 2013
Assignment: Assignment 06
Date: 08 JUL 2013

Complete the following written problems:

1. Alpha-Beta Pruning (40 Points).

Consider the following min-max tree.



a. Given that we search depth first from left to right, list all leaf nodes above that we need to search/expand. (35 Points)

b. What is the final value at the top of the tree? (5 Points)

2. The Wumpus World (70 Points).

Suppose that an agent in the Wumpus World has perceived nothing in (1,1), a breeze in (2,1), and a stench in (1,2):

1,4	2,4	3,4	4,4
1,3	2,3	3,3	4,3
1,2 S V OK	2,2	3,2	4,2
1,1 V OK	2,1 B V OK	3,1	4,1

A	= Agent
B	= Breeze
G	= Glitter, Gold
OK	= Safe Square
P	= Pit
S	= Stench
V	= Visited
W	= Wumpus

Given this Knowledge Base, the agent now concerns itself with the contents of (1,3), (2,2), and (3,1). Each of these locations can contain a pit (P). At most, one location can contain a Wumpus (W). A location can contain nothing (N).

Construct the set of all possible worlds. Each possible world should be represented by a list representing the contents of each location in the following order: (1,3), (2,2), and (3,1). Example: N,P,W means that there is nothing in (1,3), a pit in (2,2), and a Wumpus in (3,1). Hint: There are 32 possible worlds. Mark the worlds in which the Knowledge Base (KB) is true and those in which each of the following sentences is true:

$$A2 = \text{"There is not pit in } (2,2)\text{."}$$

$$A3 = \text{"There is a Wumpus in } (1,3)\text{."}$$

Hence, show that $KB \models A2$ and $KB \models A3$.

If the world is not supported by the KB, then mark the world False for "KB?". If the world does not support A2, then mark the world False for "A2?". If the world does not support A3, then mark the world False for "A3?".

Number	World	KB?	A2?	A3?
1.	N,N,N	False	True	False
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				
20.				
21.				
22.				
23.				
24.				
25.				
26.				
27.				
28.				
29.				
30.				
31.				
32.				

3. Propositional Logic (60 Points).

Given the following paragraph:

If the unicorn is mythical, then it is immortal, but if it is not mythical, then it is a mortal mammal. If the unicorn is either immortal or a mammal, then it is horned. The unicorn is magical if it is horned.

And the following propositions:
UnicornIsMythical: The unicorn is mythical.
UnicornIsMortal: The unicorn is mortal.
UnicornIsMammal: The unicorn is a mammal.
UnicornIsHorned: The unicorn is horned.
UnicornIsMagical: The unicorn is magical.

a. Use propositional logic to prove that the unicorn is magical. List each premise and indicate each inference rule used in your proof. You may use more or less lines than in the table below. (30 Points)

Line	Sentence	Rule
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		

b. Use propositional logic to prove that the unicorn is horned. List each premise and indicate each inference rule used in your proof. You may use more or less lines than in the table below. (30 Points)

Line	Sentence	Rule
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		

4. Conjunctive Normal Form (50 Points).

Consider the following sentence:

$$\left[\left(Food \Rightarrow Party\right) \vee \left(Drinks \Rightarrow Party\right)\right] \Rightarrow \left[\left(Food \wedge Drinks\right) \Rightarrow Party\right]$$

a. Using the procedure starting on page 253, convert this sentence into Conjunctive Normal Form showing each step. (Points 40)

b. Using resolution, determine if this sentence is valid, satisfiable (but not valid), or unsatisfiable. (Points 10)

5. Resolution (40 Points).

A propositional 2-CNF expression is a conjunction of clauses, each containing exactly 2 literals, e.g.,

$$(A \vee B) \wedge (\neg A \vee C) \wedge (\neg B \vee D) \wedge (\neg C \vee G) \wedge (\neg D \vee G)$$

Prove using resolution that the above sentence entails G.

Line	Sentence	Rule
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		

6. First Order Logic (100 Points).

Given the following vocabulary with the following symbols:

$Student(x)$: Predicate. Person x is a student.

$Knows(x, y)$: Predicate. Student x knows concept y.

$Course(x)$: Predicate. Subject x is a course.

$Takes(x, y)$: Predicate. Student x takes course y.

$Covers(x, y)$: Predicate. Course x covers concept y.

Amy, $Brian$: Constants denoting people.

$MAC1140$: Constants denoting the course College Algebra.

$MatrixMethods$: Constant denoting the concept of matrix methods.

Convert the following sentences to first-order logic:

a. Amy is a student and knows matrix methods. (5 Points)

b. Some student knows matrix methods. (10 Points)

c. Every student takes MAC 1140. (10 Points)

d. MAC 1140 is a course that the student, Brian, has not taken. (10 Points)

e. There is some course that every student has not taken. (20 Points)

f. If Brian is a student, takes the course MAC 1140, and MAC 1140 covers matrix methods, then Brian knows matrix methods. (15 Points)

g. If a student takes a course and the course covers some concept, then the student knows that concept. (30 Points)

7. First Order Logic (90 Points).

This exercise uses the function $MapColor$ and predicates $In(x, y)$, $Borders(x, y)$, and $Country(x)$, whose arguments are geographical regions, along with constant symbols for various regions. In each of the following, we give an English sentence and a number of candidate logical expressions. For each of the logical expressions, state whether it (1) correctly expresses the English sentence, (2) is syntactically invalid and therefore meaningless, or (3) is syntactically valid but does not express the meaning of the English sentence.

a. Paris and Marseilles are both in France.

(i) $In(Paris \wedge Marseilles, France)$ (10 Points)

(ii) $In(Paris, France) \wedge In(Marseilles, France)$ (10 Points)

(iii) $In(Paris, France) \vee In(Marseilles, France)$ (10 Points)

b. There is a country that borders both Iraq and Pakistan.

(i) $\exists c \quad Country(c) \wedge Border(c, Iraq) \wedge Border(c, Pakistan)$ (10 Points)

(ii) $\exists c \quad Country(c) \Rightarrow [Border(c, Iraq) \wedge Border(c, Pakistan)]$ (10 Points)

(iii) $[\exists c \quad Country(c)] \Rightarrow [Border(c, Iraq) \wedge Border(c, Pakistan)]$ (10 Points)

c. All countries that border Ecuador are in South America.

(i) $\forall c \quad Country(c) \wedge Border(c, Ecuador) \wedge In(c, SouthAmerica)$ (10 Points)

(ii) $\forall c \quad Country(c) \Rightarrow \left[Border(c, Ecuador) \Rightarrow In(c, SouthAmerica) \right]$ (10 points)

(iii) $\forall c \quad Country(c) \wedge Border(c, Ecuador) \Rightarrow In(c, SouthAmerica)$ (10 Points)

8. Research Project (50 Points).

a. Write a rough draft of the title of your research project. (10 Points)

b. Write a rough draft of the abstract of your research project. (40 Points)

This assignment has no programming problems.

After completing Assignment 06, create an `assignment_06_`*`lastname`*`.pdf` file for your written assignment.

Upload your `assignment_06_`*`lastname`*`.pdf` file for your written assignment to the Assignment 06 location on the BlackBoard site: https://campus.fsu.edu.