CS4341 ARTIFICIAL INTELLIGENCE. A97 **EXAM 1**
Department of Computer Science **Sept. 23, 1997**
Worcester Polytechnic Institute

Name: _____

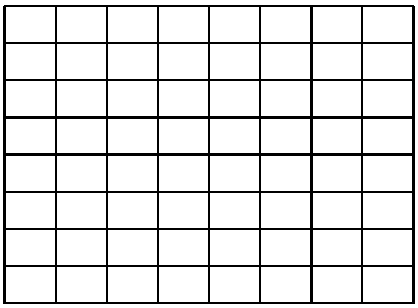
Instructions

- Show you work
- Justify your answers
- Use the space provided to write your answers
- Write your name on each page
- Ask if you have any questions

Problem 1. The 8–queens puzzle (20 points)

The 8–queens puzzle is to place 8 queens on a chessboard in such a way that no queen attacks any other. That is, no two queens should appear in the same row, column, or diagonal.

1.1. (2 extra points) Find a solution for this puzzle:



1.2. (20 points) Suppose you had to write a computer program that finds solutions to the 8–queens puzzle. Which AI method(s) would you use and **how**? Explain.

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Problem 2. Search (20 points)

Use hill climbing to find **the maximum** of the following function f:

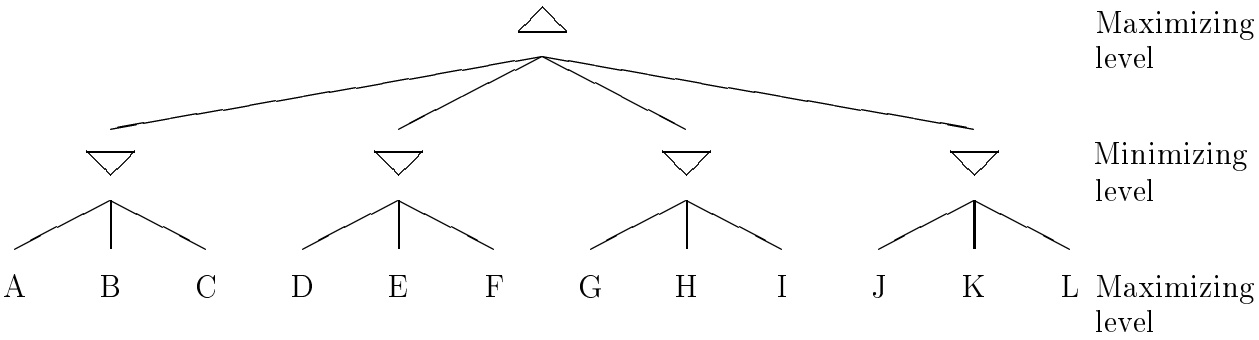
$$f(x, y) = -|x - 1| - |y + 2| \text{ defined on tuples } (x, y) \text{ of integer numbers.}$$

Assume that the initial state is $x = 0$ and $y = 0$.
Show your work on a search tree.

- Note: this function has no foothills, plateaus, nor ridges.
- Hint: Starting from the initial position $x = y = 0$, a "step North" will take you to $x = 0,\ y = 1$, a "step West" will take you to $x = -1,\ y = 0$, and so on.

Problem 3. Search (20 points)

Suppose you and a friend of yours are playing a board game. It is your turn to move, and the following tree represents your situation:



Assume also that the static evaluation of the leaf nodes is the following:

Node	A	B	C	D	E	F	G	H	I	J	K	L
Static Evaluation	6	5	17	2	-1	1	10	-3	8	7	10	6

3.1. (10 points) Use the minimax procedure together with Alpha–Beta pruning to select your next move. Apply static evaluation **only** to the necessary leaves. Show your work on the previous tree.

3.2. (5 points) Assume that you are using the singular–extension heuristic. State which leaves you would expand further and explain why.

3.3. (5 points) Assume there is a time limit to make your move, and you realize you don't have enough time to apply minimax to the whole tree. What would you do to produce a reasonable move?

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Problem 4. Rule–based systems (20 points)

Consider the following set of rules that describe when two persons are (first) cousins:

R1: **IF** ?x is a parent of ?a **AND** ?y is a parent of ?b **AND** ?x is a sibling of ?y **THEN** ?a is a cousin of ?b

R2: **IF** ?w is the mother of ?z **THEN** ?w is a parent of ?z

R3: **IF** ?w is the father of ?z **THEN** ?w is a parent of ?z

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Assume that the working memory contains the following assertions:

A1: Mary is the mother of John

A2: Bob is the father of Sue

A3: Bob is the father of Bill

A4: Mary is a sibling of Bob

4.1. (15 points) Use backward chaining to find **all** cousins of John's, that is, **all** answers to the query "John is a cousin of ?b". Construct a tree showing the steps followed by backward chaining and show when and how the working memory is updated during the depth 1st search.

4.2. (5 points) Given the family relations above and two unary relations "female" (?x is a female) and "male" (?x is a male), provide rules that describe the relationships "brother" (?x is a brother of ?y) and "sister" (?x is a sister of ?y).

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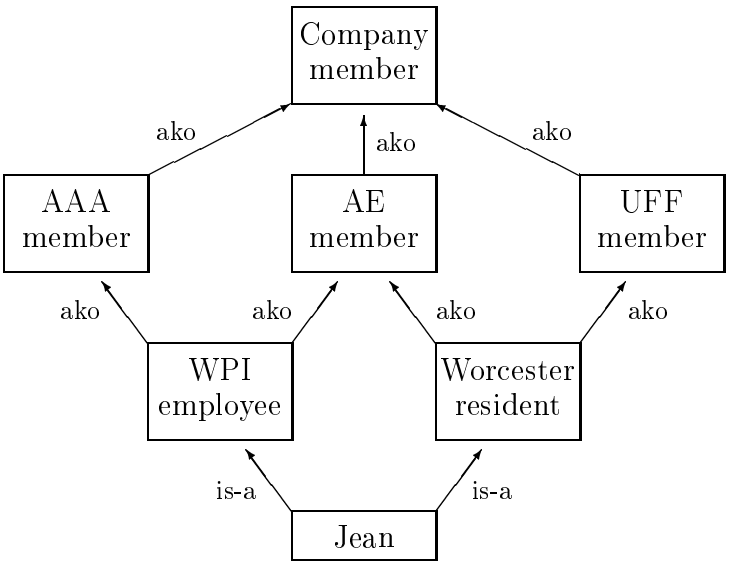
Problem 5. Frame Systems (20 points)

Suppose that WPI provides all its employees with free membership to AAA and to American Express (AE). Also, assume that the city of Worcester provides all its residents with free membership to American Express (AE) and to USAirlines' frequent flyer program (UFF). Assume also that Jean works at WPI and lives in Worcester.



5.1. (10 points) Give the class–precedence list for Jean that would be obtained by applying the topological–sorting algorithm to the previous graph. (You don't need to show the steps of the topological sorting algorithm.)

5.2. (2 points) Suppose that AAA, AE, and UFF offer discounted subscriptions to Science Magazine for their members. AAA offers 5% off, AE offers 10% off, and UFF offers 7% off. Assuming that these discounted rates cannot be combined, which discount will Jean obtain when she subscribes to the magazine?

5.3. (8 points) Define a frame to represent the stereotypical event of attending a football game.