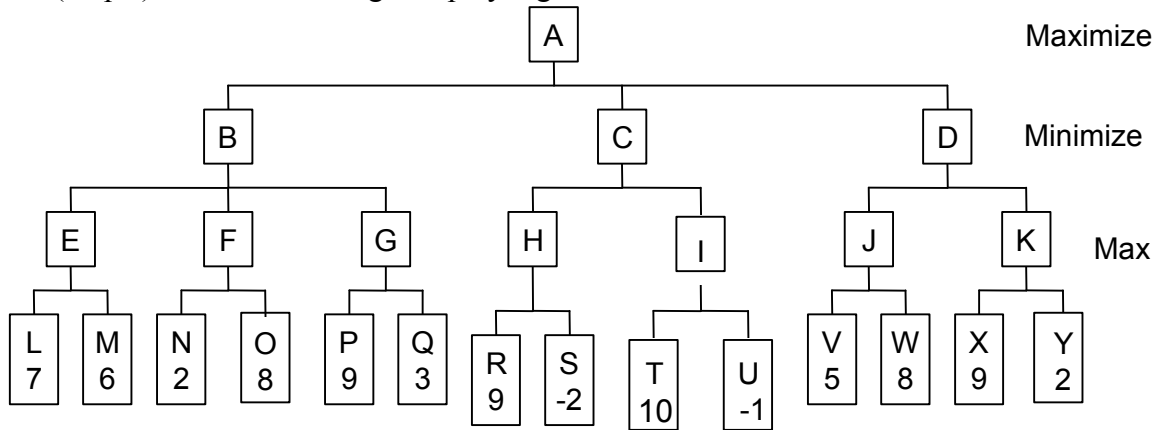


CS405

HW #2, 47 points total

Due Thursday, October 8, 2:30 PM, hard deadline, solutions given in class

1. (10 pts) For the following two player game tree:



The final heuristic values are shown for the leaf nodes.

- Suppose the first player is the maximizing player. What move should be chosen?
- What nodes would be pruned using the alpha-beta procedure? Cross out those nodes that are not examined.

2. (5 pts) Describe how minimax might be expanded to work for a 3 or 4 player game.

3. (5 pts) In many strategy games a player may move multiple pieces during their turn. For example, many board-style war games allow each player to move up to all of their pieces during their turn instead of picking a single piece.

Could minimax be used under such a scenario? Describe why or why not. Consider a case where each player has three pieces, and each piece always has 6 moves available.

4. (4 pts) Represent the following sentences in predicate calculus, using a consistent vocabulary you must define.
- a) Some students took French in Spring 2009.
 - b) Every student who takes French passes it
 - c) Only one student took Greek in Spring 2009
 - d) The best score in Greek is always higher than the best score in French

5. (8 pts) Here are some predicates for you to use:

| | |
|--------------------|------------------------------|
| man(x) | : x is a man |
| Pompeian(x) | : x is a Pompeian |
| born(x,y) | : x was born in year y |
| mortal(x) | : x is mortal |
| erupted(volcano,y) | : volcano erupted in year y |
| dead(x,y) | : person x is dead in year y |
| died(x,y) | : person x died in year y |

Use these predicates to represent the following knowledge in First Order Logic:

1. Marcus was a man.
2. Marcus was a Pompeian.
3. Marcus was born in 40 A.D.
4. All men are mortal.
5. All Pompeians died when the volcano erupted in 79 A.D.
6. No mortal lives longer than 150 years.
7. If someone died in a year, then he is dead at all later times.

Show using forward chaining that there are two paths for inferring that Marcus is not alive in the year 2009.

6. (5 pts). Prolog warmup. Here is Dijkstra's modification of Euclid's algorithm to find the greatest common divisor of two integers:

$$\text{For } m, n > 0, \text{gcd}(m, n) = \begin{cases} m & : \text{if } m = n \\ \text{gcd}(m - n, n) & : \text{if } m > n \\ \text{gcd}(m, n - m) & : \text{if } m < n \end{cases}$$

This leads to the following algorithm in a language like C or Java:

```

int gcd(int m, int n) {
    if(m == n)
        return m;
    else if (m > n)
        return gcd(m-n, n);
    else
        return gcd(m, n-m);
}

```

Write an equivalent program in Prolog that computes gcd using this algorithm.

7. (10 pts). The Die Hard 3 Water Jug Problem

You might not have thought it possible, but the folks that brought us the Die Hard movies show that writing Prolog can be a useful tool in the fight against crime.

In the movie, Bruce Willis and Samuel L. Jackson have to put exactly 4 gallons of water into a jug using only a 5 gallon and a 3 gallon jug with no markings on them. Get the wrong number of gallons and a bomb will blow them up. The movie characters had a pool that was used to fill the jugs with water.

Write a Prolog program to solve the water jug problem. You may use the following operations, where x is the number of gallons in the 5 gallon jug, and y is the number of gallons in the 3 gallon jug. The notation to define a state is (x, y) to denote the number of gallons of water in the 5 and 3 gallon jugs respectively.

Given state (x,y) you can make these moves:

- Fill 5 gallon jug: if $x < 5$ then this move results in $(5,y)$
- Fill 3 gallon jug: if $y < 3$ then this move results in $(x, 3)$
- Empty 5 gallon jug to ground: if $x > 0$ then $(0, y)$
- Empty 3 gallon jug to ground: if $y > 0$ then $(x, 0)$
- Pour water from 3 gallon to 5 gallon until 5 gallon jug is full:
if $x+y \geq 5$ and $y > 0$ then $(5, y-(5-x))$
- Pour water from 5 gallon to 3 gallon until 3 gallon jug is full:
if $x+y \geq 3$ and $x > 0$ then $(x-(3-y), 3)$
- Pour all water from 3 gallon into 5 gallon jug:
if $x+y \leq 5$ and $y > 0$ then $(x+y,0)$
- Pour all water from 5 gallon into 3 gallon jug:
if $x+y \leq 3$ and $x > 0$ then $(0, x+y)$