Artificial Intelligence DD2380, HT 2006
Homework 2

Due: 15:00 2006-09-25
Where: Box marked DD2380 at CSC students office Oscars Backe 2 or at lecture.
Do not forget to motivate all your answers.

Instructions

Scope

This homework cover chapters 5-10.

Grading

In the spirit of the new goal oriented grading system this homework starts with some questions (part A) to check that you pass the threshold for receiving a passing grade. These questions can be answered with a single word or a few words at most. You need to get 66% of the answers correct on this part. **If you do not pass this threshold the rest of the homework will not be graded**. If you pass this threshold and pass pass the homework, the higher grades D-A are determined by your answers on the rest of the homework (parts B-G). You are to solve the homework individually and we expect you to follow the code of honour (http://www.csc.kth.se/utbildning/hederskodex/).

The max number of points on parts B-G is 84p. The grades (assuming you have passed part A) is given by

|	
A	≥ 78
B	≥ 64
C	≥ 50
D	≥ 20

Part A

1. What does the acronym CSP stand for?

2. What does the nodes in a CSP contraint graph correspond to?

3. What does the minimum remaining values (MRV) heuristic help choose? A variable or value?

4. Give another name for 2-consistency.

5. Name a common heuristic used in local search with CSPs.

6. What is a game called where the utility at the end of the game is equal and opposite for the players?

7. In a game with utility +1,0,-1, which utility represents a winning game for the MIN player?

8. In chess it is typically not possible to search all the way to a terminal state. This means that the exact utility cannot be used. What is it replaced with?

9. Give another name for propositional logic.

10. What is the initial knowledge found in the knowledge base called (before you have run the system to acquire more knowledge)?

11. You can say that one sentence follows logically from another sentence. There is however another word for this. Sentence A ...... B, what is the missing word?

12. When designing an inference alorithm you would like your algorithm to be sound and, what?

13. Which of the connectives $\wedge$ and $\Rightarrow$ has the highest precedence in logic?

14. What is the inference rule $\frac{\alpha \Rightarrow \beta, \quad \alpha}{\beta}$ called?

15. Mention a logic programming language

Part B

Consider the following constraint graph for a graph coloring problem (the constraints indicate that connected nodes cannot have the same color). The domains are shown in the boxes next to each variable node.
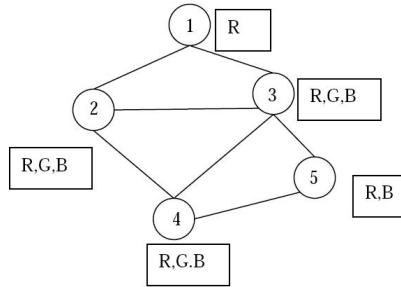
1. What are the variable domains after applying arc consistency? (3p)

2. Show the sequence of variable assignments during a pure backtracking search (on the original problem, do not use result from 1), assume that the variables are examined in numerical order and the values are assigned in the order shown next to each node (show also the invalid assignments made). Show assignments by writing the variable number and the value, e.g. 1R. Don't write more than 10 assignments, even if it would take more to find a consistent answer. (3p)

3. Show the sequence of variable assignments during backtracking with forward checking, assume that the variables are examined in numerical order and the values are assigned in the order shown next to each node. Show assignments by writing the variable number and the value, e.g. 1R. (3p)

Part C

Consider the game tree shown below. The top node is a max node. The labels on the arcs are the moves. The numbers in the bottom layer are the values of the different outcomes of the game to the max player.
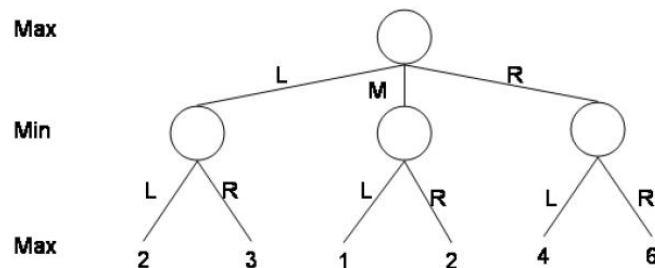
1. What is the value of the game to the MAX player? (3p)

2. What first move should the MAX player make? (3P)

3. Assuming the MAX player makes that move, what is the best next move for the MIN player, assuming that this is the entire game tree? (3p)

4. Using alpha-beta pruning, consider the nodes from right to left, which nodes are cut off? Circle the nodes that are not examined. Motivate! (5p)

Part D

Which of these expressions are legal sentences in propositional logic (should be one sentence only)? Give fully parenthesized expressions.

1. $P \Rightarrow Q \Rightarrow R$ (2p)

2. $P, R \Rightarrow Q$ (2p)

3. $A \wedge (B \vee C \vee \neg D) \Rightarrow \neg\neg Z$ (2p)

4. $\neg P(Q)$ (2p)

Part E

Consider the following sentences:

- If a jar is sterile, then there are no live bacteria in it. (3p)

- There are live bacteria in the yogurt cup. (3p)

- The yogurt cup is a jar. (2p)

- The yogurt cup is not sterile. (2p)

- If there are no live bacteria in a jar, then it is sterile. (3p)

Write each of these sentences in first-order logic, using predicates *Jar*, *Sterile*, *Bacterium*, *Live*, and *In*, and the constant symbol *YogurtCup*.
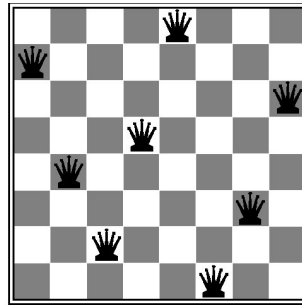
Part F

5 years ago I married a widow, that had a daughter from an earlier marriage. My father visited quite a bit and eventually the daughter and my father became friends and decided to get married. 2 weeks ago they have a baby, the girl Sarah.

1. Write down in logic a model of the above family situation (5p)

2. Write a set of rules to infer child-of(), sisters(), grand-father(), uncle/aunt. (The rules should help you infer child-of() etc and not the other way around) (5p)

3. Use these inference rules to demonstrate that I am my own grand-father – include the various steps in the inference. (As the question is posed you can tell that it should be possible. If not maybe you have been too strict in your rules?) (7p)

4. How could the inference rules be modified to handle this absurd situation? (3p)

Part G

Choose one of the two problems below. Formulate it as a CSP and write a program that will solve it for you. You are free to choose whatever language you want, even existing software packages can be used assuming that you know and explain exactly what method they implement. You are allowed to work in pairs on Part G but you need to state who you worked with in this case and both have to hand in a solution including a printout of the code that you wrote. The answer to this questions should include a brief summary of the method you used, your implementation and the results you got. (20p)

- N-queens where N is ≥ 8

- Sudoku with a board size ≥ 4