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Fachrichtung 6.2 – Informatik
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4th Theoretical Assignment in Artificial Intelligence (WS 2006/2007)

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Note: You need not hand these exercises in, and they are not graded. But bring along your solutions to the tutorial. Impress your tutors by presenting your favourite exercise to the class.

Exercise 4.1 *Cryptarithmetic Puzzle*

Solve the following problem by hand

$$\begin{array}{cccc} & T & W & O \\ + & T & W & O \\ \hline F & O & U & R \end{array}$$

using:

- backtracking search with forward checking,
- minimum-remaining-value heuristic and
- least-constraining-value heuristic

Exercise 4.2 *Arc Consistency*

Imagine you are responsible for organizing a seminar with four different speakers A, B, C and D, to each of whom you would like to assign one out of four timeslots.
The topics require that:

- Speaker A gives his talk one or two timeslots before speaker B gives his talk.
- Speaker C speaks before speaker A.
- Speaker C also speaks before speaker B.
- Speaker C gives his talk either one or two timeslots before speaker D.
- Speaker D speaks before speaker B.

Furthermore, speaker A is away during the third timeslot. Note that no two speakers may give their talks during the same timeslot.

1. Describe the constraint satisfaction problem (indicate variables, their domain, constraints) and draw the constraint graph. Representing the timeslots by numbers allows you to formulate the constraints as arithmetic expressions. Constraints that are subsumed by other constraints (e.g. $A < 5$ is subsumed by $A < 2$) can be ignored.

2. Is the network arc-consistent? If not, compute the arc-consistent network (show the whole process of enforcing arc-consistency and not just the final arc-consistent network).

3. Is the network consistent (is there a valid assignment for the variables that solves the problem)? If yes, give a solution.

Exercise 4.3 *Entailment*

Assume that A, B and C are propositional constants.

1. Use truth tables to show that $\{A \lor B, \neg A \lor C\} \models B \lor C$
2. Does also $\{B \lor C\} \models (A \lor B) \land (\neg A \lor C)$ hold? Justify your answer.
3. Does $\{\neg(B \lor C)\} \models \neg((A \lor B) \land (\neg A \lor C))$ hold? Justify your answer.
4. Explain why the resolution rule preserves satisfiability.
5. Let F be a propositional formula and KB be a finite set of propositional formulas. Assume we can derive the empty clause from $KB \land \{\neg F\}$. Explain why we can conclude $KB \models F$

Exercise 4.4 *Resolution*

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

1. Encode these statements in propositional logic.
2. Use resolution to prove that the unicorn is a mammal.