

Foundations of Artificial Intelligence

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Exercise Sheet 5

Due: Friday, June 6, 2008

Exercise 5.1 (Models and Logical Equivalence)

- (a) Consider a vocabulary with only four atomic propositions, A , B , C , and D . How many models are there for the following formulae? Explain.
 - (i) $(A \wedge B) \vee (B \wedge C)$
 - (ii) $A \vee B$
 - (iii) $(A \Leftrightarrow B) \wedge (B \Leftrightarrow C)$
- (b) How many pairwise non-equivalent propositional formulae can be constructed from the atomic propositions A_1, A_2, \dots, A_n ? Justify your answer.

Exercise 5.2 (Satisfiability and Resolution)

- (a) Decide for each of the following propositions whether they are valid, satisfiable or neither valid nor satisfiable.
 - (i) $Smoke \Rightarrow Smoke$
 - (ii) $Smoke \Rightarrow Fire$
 - (iii) $(Smoke \Rightarrow Fire) \Rightarrow (\neg Fire \Rightarrow \neg Smoke)$
 - (iv) $(Smoke \Rightarrow Fire) \Rightarrow ((Smoke \wedge Heat) \Rightarrow Fire)$
 - (v) $TheBestTeamWins \Leftrightarrow GermanyWinsTheEuro2008$
- (b) Let $K = \{\{A, B, \neg C\}, \{\neg A, C\}, \{\neg A, \neg B\}, \{A, C\}\}$. Use the resolution method to show that $K \models (\neg B \Rightarrow (A \wedge C))$.

Exercise 5.3 (Davis-Putnam Procedure)

Use the Davis-Putnam procedure to compute models for the following clause sets or to prove that no model exists. Whenever possible, apply *unit propagation*. At each step, indicate which rule you have applied.

- (a) $\{\{P, \neg Q\}, \{\neg P, Q\}, \{Q, \neg R\}, \{S\}, \{\neg S, \neg Q, \neg R\}, \{S, R\}\}$
- (b) $\{\{P, Q, S, T\}, \{P, S, \neg T\}, \{Q, \neg S, T\}, \{P, \neg S, \neg T\}, \{P, \neg Q\}, \{\neg R, \neg P\}, \{R\}\}$

Exercise 5.4 (DNF Satisfiability Testing)

Show that for propositional formulae in Disjunctive Normal Form, satisfiability can be decided in polynomial time.

The exercise sheets may and should be worked on in groups of three (3) students. Please fill the cover sheet¹ and attach it to your solution.

¹<http://www.informatik.uni-freiburg.de/~ki/teaching/ss08/gki/coverSheet-english.pdf>