

Foundations of Artificial Intelligence

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Exercise Sheet 4

Due: Wednesday, June 12, 2013

Exercise 4.1 (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) $Smoke \Rightarrow \neg Smoke$
 - (iii) $Smoke \Rightarrow Fire$
 - (iv) $(Smoke \Rightarrow Fire) \Rightarrow (\neg Fire \Rightarrow \neg Smoke)$
 - (v) $(Smoke \Rightarrow Fire) \Rightarrow ((Smoke \wedge Heat) \Rightarrow Fire)$
 - (vi) $Spring \Leftrightarrow SunnyWeather$
- (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 4.2 (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 4.3 (Wumpus world and resolution)

Consider the following situation in the wumpus world:

1,4	2,4	3,4	4,4
1,3	2,3	3,3	4,3
1,2 	2,2	3,2	4,2
1,1	2,1 	3,1	4,1

The gray squares have already been visited, the others not. The percepts in the corresponding squares are indicated by  breeze and  stench .

- Formalize the general connections between breezes and pits using propositional formulae. Use 16 variables $P_{i,j}$ (meaning there is a *pit* in square $[i, j]$) and 16 variables $B_{i,j}$ (*breeze* in square $[i, j]$).
- Show, using *resolution*, that square $[3, 1]$ contains a pit in the given situation, i.e., show that $\text{KB} \models P_{3,1}$. The knowledge base KB consists of the propositions from part (a) as well as the percepts of the agent. Note: squares that already have been visited do not contain pits. If necessary, convert the knowledge base into CNF (conjunctive normal form).

Exercise 4.4 (Predicate Logic)

Consider following colloquial sentences:

- Not all students attend AI and ST.
- One student failed both AI and ST.
- Exactly two students failed ST.
- There is a barber who shaves all men in town who do not shave themselves.
- No one likes a professor who is not smart.

Represent these sentences in first-order logic using the predicates $student(x)$, $attends(x,y)$, $fails(x,y)$, $barber(x)$, $shaves(x,y)$, $professor(x)$, $likes(x,y)$ und $smart(x)$.

The exercise sheets may and should be worked on in groups of three (3) students. Please write all your names and the number of your exercise group on your solution.