

Artificial Intelligence 2019

Problem Sheet 7

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Notes

The homework serves as preparation for the exams. It is strongly recommended that you solve them before the given deadline - but you do not need to hand them in. Feel free to work on the problems as a group - this is even recommended.

1 Problem

Given the following three FOL sentences from the genealogy example from the lecture:

1. $(\forall x, y) \text{parent}(x, y) \Leftrightarrow \text{child}(y, x)$
2. $(\forall x, y) \text{father}(x, y) \Leftrightarrow \text{parent}(x, y) \wedge \text{male}(x)$
3. $(\forall x, y) \text{daughter}(x, y) \Leftrightarrow \text{child}(x, y) \wedge \text{female}(x)$

Rewrite each of the sentences as (potentially multiple) Horn Clauses that are equivalent to the original sentence.

2 Problem

Given the sentences from the previous problem as set of Horn Clauses plus the following facts $P(X)$:

- $\text{male}(\text{John})$
- $\text{female}(\text{Mary})$
- $\text{child}(\text{Mary}, \text{John})$

Proof $\text{father}(\text{John}, \text{Mary})$ using the Generalized Modus Ponens.

3 Problem

Convert the following FOL sentence into CNF:

$$\forall x \exists y \neg \exists z (p(x) \wedge ((q(x, y) \wedge \neg(y = z)) \Rightarrow \neg q(x, z)))$$

4 Problem

Given the "parents(x,y,z)" predicate to express that y and z are the parents of x. Determine if/which substitutions exist to unify each of the following three pairs of sentences:

- pair 1
 - parents(x, father(x), mother(Bill))
 - parents(Bill, father(Bill), y)
- pair 2
 - parents(x, father(x), mother(Bill))
 - parents(Bill, father(y), z)
- pair 3
 - parents(x, father(x), mother(Jane))
 - parents(Bill, father(y), mother(y))

5 Problem

Given the following knowledge base KB in plain English sentences and FOL

- John likes everyone he knows - $\forall X : know(John, X) \Rightarrow like(John, X)$
- John knows Jim - $know(John, Jim)$
- everyone knows his/her own mother - $\forall Y : know(Y, mother(Y))$
- everyone knows Leo - $\forall Z : know(Z, Leo)$

Use a conversion to CNF, unification, and resolution with refutation to find out whether:

- John likes Jim
- John like his mother
- John likes Leo