

Prof. Dr. Sebastian Rudolph

M.A. Jonas Karge

Knowledge Representation and Reasoning

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Exercises 6

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Problem 1.

Consider Reiter's formalization of the closed world assumption (CWA):

Let KB be a set of formulas, define a new form of entailment under CWA:

Denote $Negs = \{\neg p \mid p \text{ atomic and } KB \not\models p\}$, and define

$$KB \models_c \alpha \text{ if and only if } KB \cup Negs \models \alpha.$$

This is illustrated by the following example:

$\{TramAt(05 : 22)\} \not\models TramAt(05 : 46)$, whence $\neg TramAt(05 : 46) \in Negs$,
and thus $KB \models_c \neg TramAt(05 : 46)$

Do the following:

- Provide an example where you illustrate that this new form of entailment is nonmonotonic.
- Assume $KB \models (p \vee q)$, but $KB \not\models p$ and $KB \not\models q$. Argue why this example is a problem for Reiter's formalization.

Problem 2.

Assume that we learn about a bird, Tweety. We are convinced that Tweety flies unless we have information to the contrary.

We know that (1) If a bird is not an abnormality it flies; and (2) A bird is an abnormality if and only if it is a penguin or an ostrich or injured or ...

Do the following:

- Represent the sentences (1) and (2) in FOL.
- Notice the problems we have using the FOL representation when we want to infer that Tweety flies.

Problem 3.

Consider the following defaults:

- (1) Quakers are normally pacifists.

- (2) Republicans normally are not pacifists.
- (3) Nixon is a quaker and a republican.

What is the problem here? Think of different ways you could approach this problem.

Problem 4.

The least Herbrand model M_P of a program P is the set of all ground atomic logical consequences of the program.

Recall the Datalog knowledge base from exercise sheet 2:

$\mathcal{K} = \langle \mathcal{R}, \mathcal{F} \rangle$ where \mathcal{F} contains the following facts:

$$\mathcal{F} = \{\text{Father}(\text{john}, \text{mary}), \text{Mother}(\text{mary}, \text{peter}), \text{Father}(\text{john}, \text{david})\}$$

and \mathcal{R} contains the following rules:

$$\text{Parent}(x, y) \wedge \text{Parent}(y, z) \rightarrow \text{GrandParent}(x, z) \quad (1)$$

$$\text{Parent}(x, y) \wedge \text{Parent}(x, z) \rightarrow \text{Sibling}(y, z) \quad (2)$$

$$\text{Father}(x, y) \rightarrow \text{Parent}(x, y) \quad (3)$$

$$\text{Mother}(x, y) \rightarrow \text{Parent}(x, y) \quad (4)$$

Compute the least Herbrand model of K .

Note: Some of these problems are based on lecture slides by Hannes Straß and Gerhard Brewka.