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Knowledge Representation and Reasoning

Winter 2024 Term

Exercises 6

09–13/12/2024

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 $Negs = \{\neg p \mid p \text{ atomic and } KB \nvDash p\}$, and define

$$KB \vDash_c \alpha \text{ if and only if } KB \cup Negs \vDash \alpha.$$

This is illustrated by the following example:

$$\{TramAt(05:22)\} \nvDash TramAt(05:46), whence \neg TramAt(05:46) \in Negs,$$
$$and\ thus\ KB \vDash_c \neg TramAt(05:46)$$

Do the following:

- Provide an example where you illustrate that this new form of entailment is nonmonotonic.

- Assume $KB \vDash (p \vee q)$, but $KB \nvDash p$ and $KB \nvDash q$. 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:

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

and $\mathcal{R}$ contains the following rules:

$$
\begin{align}
\text{Parent}(x,y) \wedge \text{Parent}(y,z) &\rightarrow \text{GrandParent}(x,z) \tag{1}\\
\text{Parent}(x,y) \wedge \text{Parent}(x,z) &\rightarrow \text{Sibling}(y,z) \tag{2}\\
\text{Father}(x,y) &\rightarrow \text{Parent}(x,y) \tag{3}\\
\text{Mother}(x,y) &\rightarrow \text{Parent}(x,y) \tag{4}
\end{align}
$$

Compute the least Herband model of K.

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