DKLFRS: A Default Knowledge Logical Framework Representation System

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Abstract

The traditional reasoning system based on first order predicate logic can't represent and handle default knowledge. This paper presents a logical framework representation approach for default reasoning. Based on Mixed SLDNF-resolution, a nonmonotonic reasoning system has been constructed.

1. Introduction

The traditional reasoning system is based on predicate logic. It processes the real world in the way of monotonicity. That is to say, based on the current knowledge, the new knowledge obtained through strict logic proving and reasoning must comply with consistency. However, the new knowledge often makes the old false. The accumulation of knowledge is nonmonotonic.

There seems to be two approaches to solve this problem of nonmonotonicity. The first is to claim that, since traditional logic is inefficient in representing and handling knowledge, there is a need to define a new logic to handle nonmonotonic logic, such as Reiter's default logic \[^{11, 9, 20}\] , McDermott & Doyle's nonmonotonic logic \[^{2, 3}\] and Moore's autoepistemic logic \[^{4}\] . An alternative is to say there is nothing wrong with classical logic. We should not expect reasoning to be just deduction from our knowledge. McCarthy's circumscription \[^{15, 16, 21}\] can be seen in this light. Obviously, the research of nonmonotonic reasoning lies in the treatment of the incompleteness of knowledge, and it differs from default reasoning in how to obtain more knowledge (in accordance with common-sense knowledge) about object in some way. Every approach in this paper follows this second approach (but in a very different way to circumscription). We present a logical framework representation approach\[^{6}\] for default knowledge, and have designed a Mixed SLDNF-resolution\[^{7}\] to perform the logical framework system of default knowledge based on SLD-resolution principle.

2. Default Theory

A default theory, \( T = (D, W) \), consists of a set of first order formula, \( W \), and a set of defaults, \( D \). A default is an expression of the form:

\[
A(x): MB_1(x), \ldots , MB_n(x) \quad \rightarrow \quad C(x)
\]

where \( A(x), B_i(x) \) and \( C(x) \) are all expression whose free variables are among those in \( x = \{ x_1, \ldots , x_n \} \). \( A, B_i \) and \( C \) are called the prerequisite, justifications, and consequence of the default, respectively. If none of \( A \), \( B_i \) and \( C \) contain free variables, the default is said to be closed. If the prerequisite is empty, it may be taken to be any tautology. If the justification has only a single expression, say \( B(x) \) and \( B(x)=C(x) \), it is said to be normal. If the justification is \( B(x) \) and \( C(x) \), it is said to be semi-normal; and if the justification is empty, it degenerates deduction rule.

Now let us see two examples about default reasoning.
Example 2.1

$$D_1 = \left\{ \begin{array}{l}
\text{bird (x) : flies (x)} \\
\text{flies (x)}
\end{array} \right\} ,$$

$$W_1 = \{ (x). \text{penguin (x)} \rightarrow \text{bird (x)} ,
(x). \text{penguin (x)} \rightarrow \neg \text{flies (x)} ,
\text{penguin (polly), bird (tweety)} \}. \]

We can explain flies (tweety) with

$$\left\{ \begin{array}{l}
\text{bird (tweety) : flies (tweety)} \\
\text{flies (tweety)}
\end{array} \right\} .$$

But if we query flies (polly), there will be conflict in $W_1, \neg \text{flies (polly)}$. So we cannot know whether polly flies or not.

Example 2.2

$$D_2 = \left\{ \begin{array}{l}
\text{mammal (x) : } \neg \text{flies (x)} \\
\text{flies (x)}
\end{array} \right\} ,$$

$$W_2 = \{ (x). \text{bat (x) } \rightarrow \text{mammal (x)}, \text{bat (dracula), dead (dracula)} \}. \]

we can explain $\neg \text{flies (dracula)}$ with

$$\left\{ \begin{array}{l}
\text{bat (dracula) } \rightarrow \text{mammal (dracula)}, \text{mammal (dracula) : } \neg \text{flies (dracula)} \\
\text{flies (dracula)}
\end{array} \right\} ,$$

or with

$$\left\{ \begin{array}{l}
\text{dead (dracula) : } \neg \text{flies (dracula)} \\
\text{flies (dracula)}
\end{array} \right\} .$$

When we explain flies (dracula) with

$$\left\{ \begin{array}{l}
\text{bat (dracula) : flies (dracula)} \\
\text{flies (dracula)}
\end{array} \right\} ,$$

the conflict between them will be found. So we cannot get any conclusion about whether "dracula" flies or not.

It is not difficult for us to find the fact from two examples, that is, their defaults are all normal. If the normal default is updated slightly and translated into semi normal or non-normal default, its uncertainty would be eliminated.

Example 2.1'

$$D_1' = \left\{ \begin{array}{l}
\text{bird (x) : flies (x)}, \neg \text{penguin (x)} \\
\text{flies (x)}
\end{array} \right\} .$$

$$W_1' = W_1 .$$

Now we can explain flies (tweety) and $\neg \text{flies (polly)}$.

Example 2.2'

$$D_2' = \left\{ \begin{array}{l}
\text{mammal (x) : } \neg \text{flies (x)}, \neg \text{bat (x)} \\
\text{flies (x)}
\end{array} \right\} ,$$

$$\left\{ \begin{array}{l}
\text{bat (x) : flies (x)}, \neg \text{dead (x)} \\
\text{flies (x)}
\end{array} \right\} ,$$

$$\left\{ \begin{array}{l}
\text{dead (x) : } \neg \text{flies (x)} \\
\text{flies (x)}
\end{array} \right\} .$$