Reasoning About Typicality in Description Logics: the Logic $\mathcal{ALC} + \mathbf{T}_{min}$

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Abstract

In our recent research [2] we have proposed a nonmonotonic extension $\mathcal{ALC} + \mathbf{T}_{min}$ of the Description Logic $\mathcal{ALC}$ for reasoning about prototypical properties and inheritance with exception.

The logic $\mathcal{ALC}+\mathbf{T}_{min}$ is built upon a previously introduced (monotonic) logic $\mathcal{ALC} + \mathbf{T}$ [1], that is obtained by adding a typicality operator $\mathbf{T}$ to $\mathcal{ALC}$. The operator $\mathbf{T}$ is intended to select the "most normal" or "most typical" instances of a concept, so that knowledge bases may contain subsumption relations of the form"$\mathbf{T}(C)$ is subsumed by P", expressing that typical C-members have the property P. In order to perform nonmonotonic inferences, we define a "minimal model" semantics $\mathcal{ALC} + \mathbf{T}_{min}$ for $\mathcal{ALC} + \mathbf{T}$. The intuition is that preferred, or minimal models are those that maximise typical instances of concepts. By means of $\mathcal{ALC} + \mathbf{T}_{min}$ we are able to infer defeasible properties of (explicit or implicit) individuals.

We are able to provide a decision procedure for checking satisfiability and validity in $\mathcal{ALC} + \mathbf{T}_{min}$. Our decision procedure has the form of tableaux calculus, with a two-step tableau construction. The idea is that the top level construction generates open branches that are candidates to represent minimal models, whereas the auxiliary construction checks whether a candidate branch represents indeed a minimal model. Our procedure can be used to determine constructively an upper bound of the complexity of $\mathcal{ALC}+\mathbf{T}_{min}$. Namely we obtain that checking query entailment for $\mathcal{ALC} + \mathbf{T}_{min}$ is in CO-NEXP$^{\mathrm{NP}}$.

References

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