From SHOQ(D) Toward $\mathcal{E}$-connections

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Abstract

In this paper, we propose a tableau-based technique for reasoning with various distributed DL knowledge bases. This technique can be applied both to DDLs and to new and relevant sublanguages of basic $\mathcal{E}$-connections. Its main advantage is that it is straightforward to implement by extending the existing tableau-based algorithms, as witnessed by our implementation in the Pellet OWL reasoner.

1 Introduction

Combining DL ontologies in a controlled and scalable way is crucial for the success of the Semantic Web. Recently, several proposals, like the Distributed Description Logics (DDL) [1] approach and the $\mathcal{E}$-connections framework [3] [4], have been presented as possible solutions for these and other related problems. In this paper, we define a new sub-formalism of basic $\mathcal{E}$-connections which is strictly more expressive than DDLs and that seems very straightforward to implement on existing tableau-based reasoners.

2 Perspectival $\mathcal{E}$-connections

Perspectival $\mathcal{E}$-connections (PECs) is an expressive sub-formalism of basic $\mathcal{E}$-connections which constraints the use of link properties in the component logics. For the simple case of two component logics, the set of links is partitioned into two disjoint sets $\epsilon = \epsilon_1 \cup \epsilon_2$, where $\epsilon_1 = \{E_j | j \in J\}, \epsilon_2 = \{F_k | k \in K\}$. The component logics are then enriched with the operators $< E_j >^1$, $< F_k >^2$. PECs are strictly less expressive than basic $\mathcal{E}$-connections because the use of the operators $< E_j >^2$ and $< F_k >^1$ is explicitly disallowed in the syntax and hence the links cannot be "navigated" in both directions. PECs are still strictly more expressive than DDLs

3 Reasoning technique

We have developed a tableaux-based reasoning technique for determining the satisfiability of concept terms in a certain PEC, whose component languages are DLs. The algorithm uses an instance of each tableaux-based decision procedure for the component DLs. In order to deal correctly with the new operators in the enriched language we need to define two new rules to each of the component decision procedures. These rules are basically analogous to the $\rightarrow \exists$ and $\rightarrow \forall$ rules in an ordinary tableau-based algorithm. For ensuring termination, a new blocking condition has to be defined

One important feature of this technique is that the decision procedures for the component logics are treated as black boxes in quite a similar way in which a DL reasoner considers a type checker as a black box when a DL is coupled to a conforming type system [2]. This shows that a slight modification of existing DL reasoners suffices for implementing the algorithm, as witnessed by our implementation in the Pellet OWL reasoner.

However, this technique cannot be straightforwardly extended to basic $\mathcal{E}$-connections. Intuitively, dealing with a link and its inverse breaks the black box condition and makes the algorithm unsound. Nominals also cause unsoundness if the algorithm is naively extended to PECs whose component logics contain nominals.

Finally, we have shown that this technique yields to a sound and complete algorithm for checking the satisfiability of concepts in a PEC, whose component languages are the SHIF DL or any of its sub-languages. Hence, we show that this technique can be used for combining OWL-Lite ontologies in the Semantic Web using the PEC formalism.

Future work includes the development of reasoning techniques for handling nominals in the combination (and hence OWL-DL ontologies), ABoxes, and also to explore the transition from PECs to full $\mathcal{E}$-connections. We are also looking into integrating support for multiple ontologies in the SWOOPed ontology editor in order to make these formalisms as usable and intuitive as possible for modelers, which is crucial for successfully bringing them to the Semantic Web.

References

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