Approximating OWL-DL Ontologies

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Abstract. In this poster, we propose to recast the idea of knowledge compilation into approximating OWL DL ontologies with DL-Lite ontologies, against which query answering has only polynomial data complexity. We identify a useful category of queries for which our approach also guarantees completeness. Furthermore, we paper report on the implementation of our approach in the ONTOSEARCH2 system.

1 Introduction

Ontologies play a key role in the Semantic Web [1], for which W3C has standardised the Web Ontology Language OWL [2]; in this poster, we are interested in the OWL DL sub-language ('DL' for Description Logic) due to the existence of reasoning support. A growing library of ontologies is available online, covering a wide range of human knowledge. For this large body of knowledge to be usable by Semantic Web applications, a framework that allows efficient query answering over ontologies is required.

Query answering over OWL DL is a hard problem. It has been shown that the complexity of ontology entailment in $\mathcal{SHOIN}(\mathbf{D}^+)$, i.e., OWL DL, is NExptime. This indicates query answering over OWL DL ontologies is at least NExptime. Approximation has been identified as a potential way to reduce the complexity of reasoning over OWL DL ontologies. Existing approachesare mainly based on syntactic approximation of ontological axioms and queries. All these approaches could introduce unsound answers. To the best of our knowledge, we have not seen any published framework on sound (and possibly incomplete) approximations for ontology query answering, not to mention efficient ones.

We propose to recast the idea of knowledge compilation [3] into semantic approximation of OWL DL ontologies. The idea of knowledge compilation is simple: users can write statements in an expressive representation language and these such statements can be complied into a restricted language that allows efficient inference. In this way, users do not have to use a less expressive language which might be too limited for practical applications. In [3], Selman and Kautz showed how propositional logical theories can be compiled into Horn theories that approximate the original information; they also applied this idea on subsumption reasoning for the Description Logic $\mathcal{FL}$. In this poster, we investigate applying knowledge compilation on query answering over OWL DL ontologies. Namely, we propose approximating OWL DL ontologies [4] (or simply source ontologies) with corresponding DL-Lite [5, 6] ontologies (or simply target ontologies), against which query answering has only polynomial data complexity, and provide algorithms to compute target DL-Lite ontologies.

2 Implementation

We have implemented the approximation algorithm in the ontology search and query tool, ONTOSEARCH2 [7]. Unlike existing syntactic approximation approach, our approach always guarantees sound answers for conjunctive and disjunctive queries over ontologies. For queries without non-distinguished variables (which modern OWL DL reasoners like Racer and KAON2 disallow anyway), our approach guarantees both soundness and completeness. Our preliminary evaluations in the ONTOSEARCH2 system shows that our approach is very scalable: ONTOSEARCH2 outperforms existing OWL DL reasoners significantly. In general, our results indicate that the user can still have efficient querying answering support when they use expressive ontology languages, such as OWL DL and OWL 1.1.

For our future work, one of the main challenges is to extend the query language to support datatype properties and some datatype predicates/built-ins. Secondly, we will investigate benchmarks for querying answering over more complex ontologies. Furthermore, it is interesting to see how to make it more complete for queries with non-distinguished variables. Last but not least, we shall investigate further optimisations on calculating target ontologies and how to apply our semantic approximations to other light-weight ontology languages.

References

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