Query Conservative Extensions in Horn Description Logics with Inverse Roles*

Jean Christoph Jung, Carsten Lutz, Mauricio Martel, and Thomas Schneider

Fachbereich Informatik, Universität Bremen, Germany

Motivated by applications in ontology-mediated querying, module extraction, and ontology versioning, we consider two kinds of convervative extensions in Horn Description Logics (DLs) with inverse roles. Our prime notion is as follows: a TBox $\mathcal{T}_2 \supseteq \mathcal{T}_1$ is a (Γ, Σ)-*query conservative extension* of a TBox $\mathcal{T}_1$, where Γ and Σ are signatures, if all Σ-queries give the same answers w.r.t. $\mathcal{T}_1$ and $\mathcal{T}_2$, for every Γ-ABox. If this is the case, then $\mathcal{T}_1$ can safely be replaced by $\mathcal{T}_2$ in querying applications where the data uses only symbols from Γ and the query uses only symbols from Σ. We also study (Γ, Σ)-query entailment and (Γ, Σ)-query inseparability as generalizations of conservative extensions, please see the recent survey [1] for details.

For Horn-DLs without inverse roles, query conservative extensions can be characterized in terms of the existence of homomorphisms between universal models. The resulting characterizations provide an important foundation for decision procedures, often based on tree automata [1]. In the presence of inverse roles, however, such characterizations are only correct if we require the existence of *n-bounded* homomorphisms, *for any n*. It is not obvious how the existence of such infinite families of bounded homomorphisms can be verified using tree automata (or related techniques) and, consequently, decidability results for query conservative extensions in Horn-DLs with inverse roles are difficult to obtain.

In this paper, we develop decision procedures for query conservative extensions in Horn DLs with inverse roles. The main idea is to provide a characterization that is much more refined than the usual ones, mixing unbounded and bounded homomorphisms and using unbounded ones only in places where this is strictly necessary. We can then deal with the 'unbounded part' using tree automata while the 'bounded part' is addressed by precomputing relevant information using a mosaic technique. In this way, we establish decidability and a 2-ExpTime upper bound for query conservative extensions in Horn-$\mathcal{ALCHIF}$. Together with lower bounds from [2], we get 2-ExpTime-completeness for all fragments of Horn-$\mathcal{ALCHIF}$ that contain $\mathcal{ELI}$ or Horn-$\mathcal{ALC}$. These results also apply to query entailment and inseparability.

We additionally study Σ-deductive conservative extensions between TBoxes, that is, whether $\mathcal{T}_1$ and $\mathcal{T}_2$ entail the same concept and role inclusions as well as functionality assertions over Σ. Our main result is that deductive conservative extensions in $\mathcal{ELHIF}_\bot$ are in 2-ExpTime and coNExpTime-hard in $\mathcal{ELI}$.

References

1. Botoeva, E., Konev, B., Lutz, C., Ryzhikov, V., Wolter, F., Zakharyaschev, M.: Inseparability and conservative extensions of description logic ontologies: A survey. In: Proc. RW (2016)
2. Botoeva, E., Lutz, C., Ryzhikov, V., Wolter, F., Zakharyaschev, M.: Query-based entailment and inseparability for $\mathcal{ALC}$ ontologies. In: Proc. IJCAI. pp. 1001–1007 (2016)

* Accepted for IJCAI 2017. Supported by DFG project LU 1417/2 and ERC consolidator grant 647289 'CODA'.