Handling Cyclic Conjunctive Queries

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Query containment for conjunctive queries is the problem of checking whether a query q is contained in another query q' with respect to a given Description Logic schema $\mathcal{S}$. It is known that query containment can also be used to answer queries. Query containment is important in many areas, including information integration, query optimisation, and reasoning about Entity-Relationship diagrams, while query languages that allow the use of variables and individuals in a query, such as conjunctive queries, become a more and more important topic in the area of ontology development and the Semantic Web.

We analyse an existing conjunctive query containment algorithm [1] for $\mathcal{DLR}_{reg}$ and highlight cases, where cyclic queries are not handled correctly. The suggested improvements for $\mathcal{DLR}$ [2] are not enough for $\mathcal{DLR}_{reg}$. The main problem is that the algorithm depends on a strict tree-model property, which can be disturbed by transitivity, inverse roles or the role hierarchy. E.g., consider the boolean query q: $\langle\rangle \leftarrow$ a: $\exists$[\$1]s, with a a constant and the cyclic boolean query q': $\langle\rangle \leftarrow$ s($\langle$x, y$\rangle$) $\wedge$ t$_{|\$2,\$1}$($\langle$y, x$\rangle$) with x and y existentially quantified variables and let $\mathcal{S}$ be $\{$s $\sqsubseteq$ t$\}$ for s, t roles of arity 2. Since x and y are only existentially quantified, $\mathcal{K} \models q \sqsubseteq q'$. However, Calvanese et al. argue that cycles cannot be expressed in the schema itself and therefore the variables in q' have to be replaced by constants or variables from q, i.e., a here. As a result, the algorithms answers $\mathcal{K} \not\models q \sqsubseteq q'$. There are more examples, e.g., for transitivity, to support this claim.

References

[1] D. Calvanese, G. De Giacomo, and M. Lenzerini. On the decidability of query containment under constraints. In *17th ACM SIGACT-SIGMOD-SIGART Symposium on Principles of Database Systems*, 1998.

[2] I. Horrocks, U. Sattler, S. Tessaris, and S. Tobies. How to decide query containment under constraints using a description logic. In *7th Int. Conf. on Logic for Programming and Automated Reasoning*, 2000.