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Editorial

Special issue of the Journal of Web Semantics on ontology-based data access

The competitiveness of many enterprises today relies on exploiting the wealth of information that is available in various distributed data sources or services. Thus, the problem of integrating data coming from many distributed and heterogeneous data sources has been a hot research topic for many years, and has received the attention of researchers in Databases, Knowledge Representation, and the Semantic Web. Furthermore, the recent utilization of "big data" in the private sector, government, and science has not only reinforced the importance of this topic but added the challenge of scaling to huge datasets.

The ontology-based data access (OBDA) paradigm was formulated a few years ago to tackle the problem of data integration, and more generally that of accessing data sources with a complex structure. The OBDA approach is based on three components: the data layer, the conceptual model of the application that is used for expressing user requests, and the mapping between the two. The data layer might consist of a single, possibly federated, database, or by a collection of possibly distributed and heterogeneous data sources (this case is also known as ontology-based data integration). The conceptual model is represented by an ontology, typically formalized in an appropriate description logic, and user requests are expressed as queries over the ontology. The mapping between the conceptual model and the data sources is formalized by mapping assertions, which are based on an appropriate logical language, but which may also incorporate extra-logical features for data manipulation. The aim of an OBDA system is to answer user queries by transforming them into appropriate queries to the data layer, using the ontology and the mapping.

This special issue covers recent advances in the OBDA approach. The call for papers resulted in 19 submissions that were carefully reviewed by at least three reviewers. Seven papers were accepted that offer a mix of OBDA theory and practice.

The paper "*Inconsistency-tolerant Query Answering in Ontology-based Data Access*" by Domenico Lembo, Maurizio Lenzerini, Riccardo Rosati, Marco Ruzzi, and Domenico Fabio Savo addresses the problem of dealing with inconsistencies in OBDA. The general goal of the authors is both to study DL-based frameworks that are inconsistency-tolerant, and to devise techniques for answering unions of conjunctive queries under such inconsistency-tolerant semantics. The work of the authors builds on approaches to consistent query answering in databases, which are based on the idea of living with inconsistencies in the database, but trying to obtain only consistent information during query answering, by relying on the notion of database repair. The authors first adapt the notion of database repair to the OBDA context, and show that, according to such a notion, inconsistency-tolerant query answering is intractable, even for very simple DLs. Therefore, they propose a different repair-based semantics, with the goal of reaching a good compromise between the expressive power of the semantics and the computational complexity of inconsistency-tolerant query answering. Interestingly enough, they show that query answering under the new semantics is first-order rewritable, even when the ontology is expressed in one of the most expressive members of the DL-Lite family of DLs.

The paper "*Optimising Resolution-Based Rewriting Algorithms for OWL Ontologies*" by Despoina Trivela, Giorgos Stoilos, Alexandros Chortaras, and Giorgos Stamou revisits and refines resolution-based approaches to rewriting for the case of two description logics strongly related to the OWL 2 profiles OWL 2 QL and OWL 2 EL. The authors have implemented all algorithms they propose, and have carried out an extensive experimental evaluation using many well-known large and complex OWL ontologies. The experimental results show that the authors' own system, called Rapid, is in many cases several orders of magnitude faster than existing systems, and can compute rewritings within a few seconds.

The papers "*Temporalizing Rewritable Query Languages over Knowledge Bases*" by Stefan Borgwardt, Marcel Lippmann and Veronika Thost and "*Temporal Query Entailment in the Description Logic SHQ*" by Franz Baader, Stefan Borgwardt, and Marcel Lippmann are motivated by situation awareness applications i.e., detecting certain situations within a running system. To model situation awareness and properties of dynamic systems, the authors investigate extensions of OBDA to the temporal case. In the former paper, the authors propose a generic temporal query language that combines the well-known propositional temporal logic LTL with queries over ontologies. The authors show that, if atemporal queries are rewritable, then the corresponding temporal queries are also rewritable and they can be answered over a temporal database. In the latter paper, the authors consider as the query language an extension of LTL where conjunctive queries can occur in place of propositional variables, and as the ontology language they use the expressive DL *SHQ*. For the resulting instance of temporalized OBDA, they investigate both data complexity and combined complexity of the query entailment problem. In the course of this investigation, they also establish the complexity of consistency of Boolean knowledge bases in *SHQ*.

The paper "*Complexity of Answering Counting Aggregate Queries over DL-Lite*" by Egor V. Kostylev and Juan L. Reutter studies the

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problem of answering queries using the aggregation operators COUNT and COUNT DISTINCT in an OBDA setting. The authors present an intuitive semantics for answering counting queries, together with a comparison with similar approaches from the area of databases. In addition, it presents a detailed study of the computational complexity of evaluating counting queries conforming to this semantics.

Although the theory of OBDA has progressed significantly over the last few years, the engineering aspects of designing OBDA systems have not been given corresponding attention, and there is yet little experience derived from practical deployments of OBDA components to support access to real-world data sets in daily use. This is the motivation for the paper "*Engineering Ontology-Based Access to Real-World Data Sources*" by Martin G. Skjæveland, Martin Giese, Dag Hovland, Espen H. Lian, and Arild Waaler. The authors develop a declarative framework for describing the various stages in the OBDA data engineering process. They apply that framework in a proof of concept OBDA implementation using real-world data sets from the Norwegian petroleum industry, and sample queries supplied by professional end users. The datasets used are in the form of relational databases and CSV files and the translated datasets are encoded in RDF. They prototype two OBDA architectures (materialized and virtual) and evaluate the pros and cons of these using the sample data and queries.

Finally, the paper "*Efficient SPARQL-to-SQL with R2RML mappings*" by Mariano Rodríguez-Muro and Martin Rezk presents the rewriting techniques utilized by the open source OBDA system -ontop- (http://ontop.inf.unibz.it/). The authors develop a formal approach for SPARQL-to-SQL translation that generates efficient SQL by combining optimization techniques from logic programming and SQL optimization. The approach supports R2RML mappings over general relational schemas. The system -ontop- is shown to outperform well-known SPARQL-to-SQL systems, as well as commercial triple stores, by several orders of magnitude.

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