Toward Scalable Distributed Semantic Reasoning

Hassan Aït-Kaci   Samir Amir   Mohand-Saïd Hacid   Rafiqul Haque

Université de Lyon 1, LIRIS UMR 5205, F-69622, France

{hassan.ait-kaci,samir.amir,mohand-said.hacid,akm-rafiqul.haque}
@univ-lyon1.fr

http://cedar.liris.cnrs.fr

April 18, 2013

In recent years, a new paradigm, called Linked Data, has been proposed and has managed to achieve notable success towards enabling semantic processing of massively interconnected data [4, 5]. The great proliferation of RDF-based linked data is starting to show its effectiveness for the deployment of robust applications in a diversity of areas [6]. Typically, a critical part of such applications is some sort of semantic reasoner. However, the reasoning task is often complicated in real-life conditions due to the complexity and huge amount of data. Reasoners based on bottom-up finite-model techniques such as OWL and similar DL-based Tableaux reasoning systems have already shown their limits [7]. This has made alternative approaches such as top-down lazy systems a viable solution to tackle large-scale reasoning. The key is that a lazy reasoning system is bound to be operationally more efficient since it does not do anything that is not needed. In contrast with bottom-up systems, there no need to build the entire model to respond to a given query.

The CEDAR (Constraint Event-Driven Automated Reasoning) Project's essential objective is to develop an approach to knowledge representation and reasoning which is an alternative to Description Logic formalism whose limitations are becoming apparent [2]. To do so, two main challenges must be addressed: **scalability** and **distribution**. The problem of scalability is that a well-designed web-oriented knowledge-based system must be able to handle larger and larger volumes of knowledge (e.g., Linked Data) without unbearable degradation of performance. Dealing with the second challenge—distribution—is as complex an issue since it must deal efficiently and seamlessly with knowledge spread all over the Internet under "real-life" conditions (cache faults, handling faulty connections and time delays, query distribution, *etc.*). We believe that a key to a satisfactory handling of both challenges is offered by the OSF constraint approach [1]. The reason for our belief is that, contrary to most mainstream approaches to the Semantic Web, the OSF constraint formalism is operationally lazy, endowed with instant (*i.e.*, 0-cost) "memo-sorting" (*viz.*, proof-caching sorts), and capable of handling very large concept taxonomies using modulated binary encoding and techniques taking advantage of the specific structure of the partially ordered information making up a knowledge-based system [3]. One of the most important objectives of our work is to demonstrate the efficiency of OSF semantic reasoning power by benchmarking it on actual ontologies of very large scale and compare it to the best known existing semantic web reasoning systems.

Acknowledgements

This work was supported by a grant from the Agence Nationale pour la Recherche: the ANR Chair of Excellence Program project number ANR-12-CHEX-0003-01.

References

[1] Aït-Kaci, H. Data models as constraint systems—a key to the Semantic Web. *Constraint Processsing Letters 1*, 1 (November 2007), 33–88. [Available online[1]].

[2] Aït-Kaci, H. Description logic *vs.* order-sorted feature logic. In *Proceedings of the 20th International Workshop on Description Logics* (2007), E. Franconi, Ed., Lecture Notes in Computer Science, Springer-Verlag. [Available online[2]].

[3] Aït-Kaci, H., Boyer, R., Lincoln, P., and Nasr, R. Efficient implementation of lattice operations. *ACM Transactions on Programming Languages and Systems 11*, 1 (January 1989), 115–146. [Available online[3]].

[4] Berners-Lee, T. Linked Data. Design Issue, July 2006. [Available online[4]].

[5] Bizer, C., Heath, T., and Berners-Lee, T. Linked Data—The story so far. *International Journal of Semantic Web Information Systems 5*, 3 (2009), 1–22. [Available online[5]].

[6] Sheth, A., and Stevens, S. Semantic web: Technologies and applications for the real-world. WWW 2007 Tutorial, Banff, Alberta, Canada, May 2007. [Available online[6]].

[7] Srinivas, K. OWL reasoning in the real world: Searching for Godot. In *Proceedings of the 22nd International Workshop on Description Logics (DL 2009)* (Oxford, United Kindgom, July 27–30 2009), B. C. Grau, I. Horrocks, B. Motik, and U. Sattler, Eds., CEUR Workshop Proceedings. Invited lecture [Available online[7]].

[1] http://www.cs.brown.edu/people/pvh/CPL/Papers/v1/hak.pdf
[2] http://www.ceur-ws.org/Vol-250/paper_2.pdf
[3] http://www.hassan-ait-kaci.net/pdf/encoding-toplas-89.pdf
[4] http://www.w3org/DesignIssues/LinkedData.html
[5] http://tomheath.com/papers/bizer-heath-berners-lee-ijswis-linked-data.pdf
[6] http://www.slideshare.net/apsheth/semantic-web-technolgies-and-applications-for-realworld
[7] http://www.cs.ox.ac.uk/DL2009/proceedings/invited/Srinivas.pdf