Chapter 2.12
Developing Rule–Based Applications for the Web:
Methodologies and Tools

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ABSTRACT

Embedding rules into Web applications, and distributed applications in general, seems to constitute a significant task in order to accommodate desired expressivity features in such environments. Various methodologies and reasoning modules have been proposed to manage rules and knowledge on the Web. The main objective of the chapter is to survey related work in this area and discuss relevant theories, methodologies and tools that can be used to develop rule-based applications for the Web. The chapter deals with both ways that have been formally defined for modeling a domain of interest: the first based on standard logics while the second one stemmed from the logic programming perspective. Furthermore, a comparative study that evaluates the reasoning engines and the various knowledge representation methodologies, focusing on rules, is presented.

1. INTRODUCTION AND MOTIVATION

Nowadays, with the evolution of traditional web of documents to a more complex web of services,

an increasing demand for embedding intelligence to Web applications arises. In this context, the efficient management of knowledge seems to play a key role in order to achieve smart behavior of Web applications and to overcome several issues of such environment (e.g., information integration). Ontologies, mainly written with Semantic Web technologies, constitute a well-established paradigm for representing knowledge on the Web. Though, current efforts are focused on extending ontologies with more expressive forms of knowledge like rules. In fact, given the state-of-the-art in the realization of the Semantic Web vision, rules constitute the next prominent challenge. Since the ontology layer of the Semantic Web architecture stack has reached a sufficient degree of maturity through Web Ontology Language (OWL) (Dean et al., 2004), the next step of progress involves the integration of rules with ontologies, most of them based on subsets of First Order Logic (FOL).

Rules are capable of extending the expressiveness provided by ontology languages through the definition of more complex relationships between individuals. Additionally, as a modular form of knowledge, they fit well in domains like personalization, policies and business-to-business (B2B) interaction. However, it has been shown that extending ontologies even with simple forms of rules can lead to undecidability of key inference problems.

On the other hand, many business-logic applications have extensively taken advantage of existing rule management systems or solvers (Jess, 2008; ILOG, 2008; Drools, 2008), aiming at facilitating the knowledge management process. As a result, the success of rules in non-Web applications moved Web researchers to use traditional rule engines on the Web.

However, the aforementioned stable rule systems have not been originally created for open and heterogeneous environments like the Web. Such platforms have adopted different knowledge representation formalisms, mainly based on principles of logic programming, instead of classical logic. As a consequence, they differ from recent Semantic Web technologies in many aspects, including representational features and reasoning functionality, as well. Hence, building a rule-based application for the Web with existing rule technologies is not a straightforward task.

In the rest of this chapter, we provide foundational knowledge on this topic together with implementation issues, techniques and design patterns. Section 2 briefly describes how the things have gone so far in the area of Web knowledge representation formalisms. In Section 3, various knowledge representation methodologies and tools are discussed. Specifically, Section 3.1 demonstrates the different languages and formalisms, derived from both classical logic and logic programming view, while Section 3.2 focuses on various engines able to reason over such knowledge bases. Section 4.1 gives the main requirements for rule-based web applications. The evaluation presented includes both a qualitative comparison (Section 4.2) of the existing approaches and a performance analysis (Section 4.3) of current ontology reasoners and rule engines. Finally, several future trends and open issues are identified in Section 5. Hence, this chapter aims at becoming a helpful guide for applying rules to Web applications.

2. THE STORY SO FAR

The knowledge representation languages proposed (see Section 3.1) for representing knowledge on the Web are based either on the Classical Logic (CL) perspective or on Logic Programming[1] (LP). As a result, a debate was started between the Database community and AI researchers, respectively, in order to determine the more suitable of the two approaches in the formalization of Web knowledge. Additionally, different languages of the same perspective, providing various degrees of expressivity, have been proposed. Hence, the integration of knowledge with Web applications was more complicated. Recently, with the evolu-

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