

## Chapter 1.6

# Integrating Semantic Web and Software Agents: Exchanging RIF and BDI Rules

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### ABSTRACT

*Software agents and rules are both used for creating flexibility. Exchanging rules between Semantic Web and agents can ensure consistency in rules and support easy updating and changing of rules. The Rule Interchange Format (RIF) is a new W3C recommendation Semantic Web standard for exchanging rules among disparate systems. Yet, the contribution of RIF in rules exchange between Semantic Web and software agents is unclear. The BDI architectural style is regarded as the predominant approach for the implementation of intelligent agents. This paper proposes a development for integrating RIF and BDI agents to enhance agent reasoning capabilities. This approach consists of an integration architecture and equivalence principles for rule translation. The equivalence principles are demonstrated using examples. The results show that the approach allows the integration of RIF with BDI agent programming and realize the translation between the two systems.*

### INTRODUCTION

Ten years ago, Berners-Lee et al. (2001) unveiled a nascent vision of the Semantic Web: a highly interconnected network of data that could be easily

accessed and understood by any software agent. Those intelligent software agents would head out on the Internet and automatically perform tasks like booking flights and hotels, updating medical records and giving a single, customized answer to a particular question without the human user having to search for information and pore through

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results. Software agents have the promise to help users in dealing with information overload and perform tasks automatically in a flexible way. After a decade of developments in both Semantic Web and Software Agent technology, this vision has not yet come true. The challenge for researchers is the need to develop mechanisms to enable connections, which are between the web content and its end-users (Hendler & Berners-Lee, 2010). This implies the need to connect the Semantic Web providing the content and agents who are acting on behalf of the end-users.

From a technology perspective, the Semantic Web can be regarded as a group of technologies to allow machines to understand the meaning of information on the Web. Among those technologies the key ones related to knowledge representation and exchanges are the Resource Description Framework (RDF), the Web Ontology Language (OWL) and the Rule Interchange Format (RIF). The term *agent*, or *software agent*, has been widely used and has found its way into a number of technologies. In artificial intelligence, an agent is an entity which can observe and act upon an environment and directs its activity towards achieving goals (Russell & Norvig, 2003). In agent research, the belief-desire-intention (BDI) architecture style is regarded as the predominant approach to the implementation of intelligent or rational agents (Wooldridge, 2000). There are many agent languages and tools supporting this architecture, e.g., PRS, dMARS, and AgentSpeak(L) (Mascardi, Demergasso, & Ancona, 2005).

Nowadays the ideas for integrating Semantic Web and Agent Programming techniques are blooming (Klapiscak & Bordini, 2009). Both domains can benefit from each other by connecting with the other. One of the advantages is that groups of intercommunicating agents are available to simulate complex actions on behalf of the end-users of the Web in real-life applications. (Kravari, Kastori, Bassiliades, & Governatori, 2010). In this way, the development on the Web and its performance can be tested by the agents.

Another advantage is to allow the agent system to use existing resources (e.g., an ontology) in the Semantic Web. This integration refers to the interchange and use of rules to regulate the behaviors of agents or share knowledge among collaborating agents. The key to achieve this was indicated as “agents can only flourish when standards are well established” (Shadbolt, Hall, & Berners-Lee, 2006, p. 96). The Web standards for expressing a shared meaning have progressed steadily over the past years. The prospering of OWL in the academic community establishes the foundation of knowledge sharing by giving an open representation of the knowledge. This lets the Semantic Web technologies open up new applications to rule-based technology including agents. To enable the interoperation among rule-based applications on the Web, standards are needed to represent rules. Responding to these circumstances RIF has recently been promoted as a W3C standard for exchanging rules among different systems and developing intelligent rule-based applications for the Semantic Web.

The sharing of business rules will enable the reuse of business rules in different systems, in this way ensuring consistent use among diverse systems. Furthermore, by retrieving business rules from a repository the actuality of the business rules can be ensured, as new versions and updates are automatically taken. This makes the system more flexible in dealing with changes. Generally speaking, different rule systems use their own way to represent rules, and a translation component is required to share rule knowledge between two systems. For example, JASDL (Jason AgentSpeak-DescriptionLogic) is developed to integrate OWL and AgentSpeak (Klapiscak & Bordini, 2009). Without a common rule interchange format, the rule interchanging between  $n$  systems in which each system uses different rule format, might require  $n(n-1)$  translation components for bilateral translation. In this case, the most obvious advantage of using RIF is that it only requires  $2n$  translation components in total. Since RIF is

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