Chapter IV
Ontologies and Intelligent Agents: A Powerful Bond

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ABSTRACT

The emerged form of information with computer-processable meaning (semantics) as presented in the framework of the Semantic Web (SW) facilitates machines to access it more efficiently. Information is semantically annotated in order to ease the discovery and retrieval of knowledge. Ontologies are the basic element of the SW. They carry knowledge about a domain and enable interoperability between different resources. Another technology that draws considerable attention nowadays is the technology of Intelligent Agents. Intelligent agents act on behalf of a user to complete tasks and may adapt their behavior to achieve their objectives. The objective of this chapter is to provide an exhaustive description of fundamentals regarding the combination of SW and intelligent agent technologies.

INTRODUCTION

The Semantic Web (SW) evolution has brought a number of changes in contemporary Computer Science. Its main characteristic is the transformation of the traditional form of information so that it is easily machine comprehensible. Ontologies, the basic component of the SW, help along this line. They facilitate the interoperability of heterogeneous information sources by providing a formalization that makes them machine accessible. Ontologies are the key for the emergence of the SW. They carry knowledge and information for reasoning.

Agents are autonomous software programs that act in dynamic and heterogeneous environments in order to satisfy their owners’ needs. In the relevant literature, one can find static or mobile agents.
technologies with regard to their ability to move to nodes in order to find the required information. Additionally, intelligent agents can learn from the owners’ behavior and adapt accordingly.

It is obvious that a combination of the agent and Semantic Web technologies may support users in searching and accessing information sources with a small involvement degree. Conventional information systems, like Information Retrieval systems, require active users who read and understand information. Currently, machines with the assistance of intelligent agents can read the semantically enriched information and extract knowledge that can satisfy the queries posed by users. Ontologies may serve in many fields of the agents’ technology and offer a lot of advantages.

In this chapter, we discuss technologies related to the functional combination of both SW and intelligent agents. Initially, we discuss the main characteristics of the two technologies and describe consolidation efforts pertaining to agents and ontologies. There are numerous efforts that involve agents manipulating ontologies as well as ontologies that describe the basic characteristics of intelligent agents enriching them with semantic information. We study important issues with regard to agents and Semantic Web services. We provide an overview of the new trends in agent technology and, finally, present a case study for ontologies used for learning Agents in Multi-Agent environments.

**BACKGROUND**

In this section we present an introduction to the fields of software agents and ontologies. Our objective is to provide to readers basic description of the two technologies in order to discern their characteristics and importance to many application domains.

**Software Agents**

With the rapid evolution of the Internet, software agents play an important role in Computer Science research. Software agents are components of software and/or hardware which are capable of acting on behalf of a user in order to accomplish tasks (Nwana, 1996). The owner of an agent may be a human or another computational entity. Tasks are posed by the agents’ owners in order to fulfill their needs. There are a lot of kinds of agents. One can meet information agents that search for information sources in order to achieve their goals, mobile agents that move from an environment to another, intelligent agents that learn from their owners and the environment and so on. For a full description of these types of agents and many more, one can refer to (Nwana, 1996). Agents can be used in many domains such as information retrieval, e-learning, medical applications, games, e-commerce, etc. For a full survey one can refer in (Jennings and Wooldridge, 1998).

A lot of research is involved in agent applications and a number of construction tools have been proposed. Some of them are: AgentBuilder (Reticular Systems, 1999), MOLE (Straber, Baumann and Hohl, 1997), Open Agent Architecture (Martin, Cheyer and Moran, 1998), RETSINA (Sycara, Pannu, Williamson and Zeng, 1996), ZEUS (Nwana, Ndumu and Lee, 1998), JADE (Bellifemine, Poggi and Rimassa, 2000), etc. The most of them are based on Java. However, there are tools that use other languages as Tcl, C or C++.

In the most cases, agents must deal with complicated tasks that demand cooperation with others. A Multi-Agent System (MAS) can be defined as a loosely coupled network of problem solvers that interact to solve problems that are beyond the individual capabilities or knowledge of each problem solver (Durfee & Lesser, 1989). In such systems agents can cooperate or compete with others to complete their tasks. We must note
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