Chapter II

Intelligent Agents for E-Learning

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Abstract

We propose the software architecture of a new generation of advisory systems using Intelligent Agent and Semantic Web technologies. Multi-agent systems provide a well-suited paradigm to implement negotiation processes in consultancy situations. Intelligent software agents act as clients and advisors using their knowledge in order to assist human users. In the proposed architecture, the domain knowledge is semantically modeled by means of XML-based ontology languages such as OWL. Using an inference engine, the agents reason on the base of their knowledge to make decisions or proposals. The agent knowledge consists of different types of data: on the one hand private data, which has to be protected against unauthorized access, and on the other hand publicly accessible data spread over different Web sites. Comparable to a real consultancy situation, an agent only reveals sensitive private data if it is indispensable for finding a solution. In addition, depending on the actual consultancy situation, each agent dynamically expands its knowledge base by accessing OWL knowledge sources from the Internet. The usefulness of our
**Introduction**

E-learning has started to play a significant role in the learning and teaching activities at institutions of higher education worldwide (Hamdi, 2006). The students perform major parts of their study activities decentralized via the Internet. The main focus of current e-learning systems is to provide an appropriate technical infrastructure for content engineering and information exchange. The emerged individual ways of study are location- and time-independent, consequently requiring a permanently available and direct support to answer questions and give advice. A recent comparison of modern e-learning environments (CCTT, 2004) revealed that intelligent advisory agents are not applied so far in e-learning systems.

The aim of the semantic e-learning agent project (Dunkel, 2004; 2005) is to develop virtual student advisers that render support to university students, assisting them to successfully organize and perform their studies. The experiences of human course advisers show that most students have similar problems and questions. The advisory agents should help to resolve these problems. Typical questions concern the regulations of study (e.g., does a student possess all requirements to participate in an examination or a course?) or organizing student mobility. In order to achieve these goals, we propose a software architecture of an advisory system where virtual student advisers are developed with novel concepts from Semantic Web (Berners-Lee, 2001; Horrocks, 2002) and Intelligent Agent (Wooldrige, 1995) technologies.

The **Semantic Web** can be defined as an “extension of the current web in which information is given well-defined meaning” (Berners-Lee, 2001). The basic idea is to represent domain data and its structure in a well-defined and machine interpretable way. For this purpose, ontology languages based on XML and RDF/ RDF Schema (W3C-RDF, 2004) are defined. The W3C consortium announced the standard ontology language OWL (Web ontology language) (W3C-OWL, 2004). Ontology languages allow the explicit formal specification of the entities in a domain and the relations among them. They can encode the knowledge accessible on different Web sites making it understandable for computer programs.

One essential aspect of our proposed software architecture is to model the structure of the e-learning domain by means of ontologies, and to represent it by XML-based ontology languages. Software agents apply the knowledge represented in the ontologies during their intelligent decision-making process. We claim that this is a
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