A Semantic Web Intelligent Tutoring System Characteristics

PANAGIOTIS KALAGIAKOS
Department of Computer Science
Advanced Technological Educational Institute of Athens
Papanikoli 3, Peristeri 121 31
GREECE
p_kalagiakos@yahoo.com, http://www.teiath.gr

Abstract: - Creating value from data is the main role of Semantic Web. Semantic Web technologies enable data aggregation, computation, and sharing across independent heterogeneous Web applications; by combining structured and unstructured data, drawn from many sites across the internet, semantic Web technology creates new knowledge that is not contained in any one source. E-learning is one of the important services that the Web is to offer to its users. Intelligent tutoring systems are the generation of systems intended for support and improvement of the learning and teaching process. This paper presents the issues of an intelligent tutoring system in the semantic Web environment.

Key-Words: - Semantic Web intelligent tutoring system, semantic Web.

1 Introduction

Web 2.0 technologies led to the massively increased sharing and participation of the Web users. At the same time semantic Web technologies provide formal semantics to the Web world. The combination of Web 2.0 and semantic Web technologies give rise to the social-semantic Web or Web 3.0. In Web 3.0 the concept of enia prevails (enia: a structure that contains and transfers meaning plus the mechanisms to produce meta meanings). In Web 3.0 enia can be encoded and reasoned about. The result of combining Web 2.0 and semantic Web technologies are very powerful indeed. It makes possible a new class of applications like the semantic Web tutoring systems that embed enia within data, create, combine, query, reuse semantically relational data, perform reasoning, pivot and transform representations.

2 Semantic Web and Agents

E-learning is following the progress made in Web development technologies. In the beginning HTML and CGI were used to develop the first e-learning systems which, however, suffered from low interactivity and poor content renewal inheriting the “static” characteristics of these first technologies. The development of new technologies supporting dynamic generation of Web documents like the Active Server Pages (ASP), the Java Server Pages (JSP) or the Hypertext Preprocessor (PHP) led to the development of systems with greater interactivity. Semantic Web is rising as an extension of Web 2.0.

The Semantic Web is a set of tools and frameworks for making, querying, and manipulating knowledge; it involves publishing in languages specifically designed for data: Resource Description Framework (RDF), Web Ontology Language (OWL), and Extensible Markup Language (XML). RDF, OWL, and XML can describe arbitrary things such as people, meetings, or airplane parts. Tim Berners-Lee calls the resulting network of Linked Data the Giant Global Graph, in contrast to the HTML-based World Wide Web. These technologies are combined in order to provide descriptions that supplement or replace the content of Web documents. Content may manifest as descriptive data stored in Web-accessible databases, or as markup within documents; in this way, a machine can process knowledge itself, instead of text, using processes similar to human deductive reasoning and inference, thereby obtaining more meaningful results and helping computers to perform automated information gathering and research. For software agents to work independently, the Semantic Web requires mechanisms which enable software agents to understand contents of the Web documents not only on the syntax but also on the semantic level. It was therefore necessary to define methods of displaying relations among knowledge elements within a document, as well as storing inference rules on data in the document. This was solved by means of ontology languages in the Web environment, such as e.g. the Web Ontology Language (OWL) and the DARPA Agent Markup Language (DAML). Within such an environment the typical process of
accomplishing a task becomes a specific chain of adding new values where information is passed from one agent to another.

Conceptually the Semantic Web can be regarded as an environment for agent interaction, whereas Web 2.0 can be regarded as an environment for user interaction.

2 Intelligent Tutoring Systems
An intelligent tutoring system (ITS) is an artificial intelligence or expert system that provides direct customized instruction or feedback to students, without the intervention of human beings, whilst performing a task. An ITS consists of four different subsystems or modules: the interface module, the expert module, the student module, and the tutor module.

- The interface module provides the means for the student to interact with the ITS, usually through a graphical user interface and sometimes through a rich simulation of the task domain the student is learning.
- The expert module references an expert or domain model containing a description of the knowledge or behaviors that represent expertise in the subject-matter domain the ITS is teaching.
- The student module uses a student model containing descriptions of student knowledge or behaviors, including his misconceptions and knowledge gaps.
- A mismatch between a student's behavior or knowledge and the expert's presumed behavior or knowledge is signaled to the tutor module, which subsequently takes corrective action, such as providing feedback or remedial instruction. To be able to do this, it needs information about what a human tutor in such situations would do: the tutor model.

An intelligent tutoring system is only as effective as the various models it relies on to adequately model expert, student and tutor knowledge and behavior. Thus, building an ITS needs careful preparation in terms of describing the knowledge and possible behaviors of experts, students and tutors. This description needs to be done in a formal language in order that the ITS may process the information and draw inferences in order to generate feedback or instruction. Therefore a mere description is not enough; the knowledge contained in the models should be organized and linked to an inference engine. It is through the latter's interaction with the descriptive data that tutorial feedback is generated.

An intelligent tutoring system within a semantic Web environment should fully utilize the new opportunities provided by the agents. Agents’ characteristics such as autonomy, learning capabilities, proactiveness, and social skills inspire for the development of highly demanding and sophisticated systems. Furthermore, the agents of a semantic Web environment provide great opportunities in performing complex tasks such as advanced Web search, navigating Web information systems and reusing resources provided by them. An intelligent tutoring system within a semantic Web environment should try to take advantage of the major communication benefits provided by the agents. Some of the benefits of mobile agents are [1]:

- Efficiency and reduction of network traffic: Mobile agents consume fewer network resources since they move the computation to the data rather than the data to the computation. Also mobile agents can package up a conversation and ship it to a destination host, where the interactions can take place locally, so network traffic is reduced.
- Asynchronous autonomous interaction: Tasks can be encoded into mobile agents and then dispatched. The mobile agent can operate asynchronously and independent of the sending program.
- Interaction with real-time entities: Real-time entities require immediate responses to changes in their environment. Controlling these entities from across a potentially large network will incur significant latencies. Mobile agents offer an alternative to save network latency.
- Local processing of data: Dealing with vast volumes of data when the data is stored at remote locations, the processing of data over the network is inefficient. Mobile agents allow the processing to be performed locally, instead of transmitting the data over a network.
- Support for heterogeneous environments: Both the computers and networks on which a mobile agent system is built are heterogeneous in character. As mobile agent systems are generally computer and network independent, they support transparent operation.
- Convenient development paradigm: The design and construction of distributed systems can be made easier by the use of mobile agents. Mobile agents are inherently distributed in nature and hence are natural candidates for such systems.
Agents' technology drive the development efforts of the e-tutoring field; a semantic Web intelligent tutoring system is actually a multi-agent system which should have at least the capabilities shown on figure 1.

- Adaptive teaching and testing: Selecting and delivering teaching and testing content relevant to users’ interest is essential to the learning process. Teaching and testing are tasks requiring automatic adaptation of the system to the specific characteristics of each student. Agents performing the teaching and testing should be equipped with the student’s profile containing information on her/his learning background, previous test results, capabilities, preferences, learning goals, etc. Depending on this information the agents can suggest to the student a revision of previous lessons or some additional material, an exercise, a related test and so on. The agents’ knowledge on the domain, teaching methods and students should be reusable. This can be achieved by publishing that knowledge structured with some ontology language like OWL, as well as by using standardized means like Web Services for accessing that knowledge [2].

- Sophisticated communication among the users of the intelligent tutoring system: To enhance the learning and teaching process, agents should have insight into users’ personal profiles in order to allow access and connection among the users with similar interests; in this way agents enable cooperative learning among students aiming at solving more effectively and efficiently mutual problems. The students’ personal profiles should be formatted in accordance with the Semantic Web standards so to enable usage as well as exchange of the profiles among interested agents [2].

- Synergistic content development: Enabling synergistic authoring work by both teachers and students is another important agents’ task. Agents should allow different users of the system with the appropriate access rights to develop interactively and synergistically a learning object. All author contributions should be described by using ontologies in order to enable agents in searching and sharing of the contents [2].

- Searching the common information space: A user information space is defined as the set of a user’s activities. Searching the information space is a task given to an agent in order to avoid the state of information overload. The application of a personal agent for searching the information space would enable easier performing of complex actions which the user carries out to obtain the desired results. Having insight into the user’s personal profile, the personal agent can search the information space instead of the user, selecting data it finds to be of interest to the user [2].

- Mobility access: Mobile intelligent tutoring systems aim to improve the quality of learning by providing students with an easy, contextualized and ubiquitous access to knowledge [3]. Agents enabling access to the system by means of mobile devices should be able to perform adaptation of the system to the mobile computing environment, namely different wireless networks (bandwidth, delay, error rate, interference and the like) as well as different mobile devices (screen size, memory, processing power). Some techniques include dynamic content adaptation, client-side navigation methods, various content delivery methods, etc [4].
4 Conclusion
An intelligent tutoring system should follow the advances of the Web field technology. Ontology languages and intelligent spaces promise adaptive teaching, sophisticated users’ communication, synergistic authoring work, information space retrieval and mobility. This paper is an attempt to define those agents’ tasks which will formulate the characteristics of a Web intelligent tutoring system.

References: