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An application of intelligent techniques and semantic web technologies in e-learning environments

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Abstract

The essential elements of effective learning are control of students' skills and feedback between students and their tutor. The main idea behind the approach presented here is that a domain ontology is not only useful as a learning instrument but it can also be employed to assess students' skills. For it, each student is prompted to express his/her beliefs by building her/his own discipline-related ontology and then it is compared to a reference one. The analysis of students' mistakes allows to propose them personalized recommendations and to improve the course materials in general. In this work, we present a Semantic Web technologies-based multi-agent system that allows to automatically control students' acquired knowledge in e-learning frameworks.

Keywords: Semantic web technologies; Multi-agent systems; Ontologies; E-learning

1. Introduction

The growth of the Information Society provides a way for fast data access and information exchange all over the world. Computer technologies have been significantly changing the content and practice of education. The consequent applications of all multimedia and simulation technologies, computer-mediated communication and communities, and Internet-based support for individual and distance learning have the potential for revolutionary improvements in Education (see for instance McArthur, Lewis, & Bishay, 1993).

On-line learning (i.e., e-learning) offers new possibilities in learning. Thus, a student can get immediate feedback on solutions to problems, learning paths can be individualized, etc. On-line learning is a growing business. Thus, the number of organizations working on online learning and the number of courses available on the Internet is growing rapidly. At present, a lot of e-learning tools with varying functionality and purposes exist (Aroyo & Dicheva, 2002; Murray, Blessing, & Ainsworth, 2003). E-learning is an alternative concept to the traditional tutoring system. The course tutor in a software tutoring system controls learners relatively weaker than (s)he does in the traditional one, where the (human) tutor is in charge of the contents

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and sequence of instructions. Therefore, in order to obtain better tutoring outcomes, a software tutoring system should emphasize engaging students in the learning process and be adaptive to each individual learner.

The goal of the early software tutoring systems was to build user interfaces that provide efficient access to knowledge for the individual learners. Recent and emerging work focuses on the learner control over the learning process such as learner exploration, design and construction. For it, adaptive systems are used as tools (Kay, 2001). With the application of more and better computer techniques in education and the involvement of more adults in software tutoring systems, the learner control strategy has become more appreciated than tutor or program control.

Learning control needs the comparison between the learner's knowledge base, which is modified as the learning process evolves, with the course domain knowledge base. It requires for powerful and interoperable tools of knowledge representation and analysis. A structured information representation is then required. For it, semantic domain information can be used as they provide for flexible and extendable properties to knowledge management systems. The motivation for developing reusable atomic learning components and to capture their characteristics in widely-accepted, formal metadata descriptions will most probably attract learning object providers to annotate their products with the accepted standards.

The experience of the developed countries shows the technological achievement of remote training – e-learning – that opens many new opportunities in expansion of student's number with the same number of tutors and in improving education quality. In recent years, e-learning has been widespread, especially since standardizing initiatives for learning technologies (Learning Technology Standards Committee (LTSC)) have begun.

For distance learning where the tutor works with many students without direct contacts, it is very important to provide objectivity and automation of assessment.

An important component of e-learning is students' skills and knowledge testing. One of the main problems for the creation of testing systems is interoperability, i.e. the opportunity to reuse these tests in different testing systems. To organize tests exchange between various systems, it is necessary to create some universal format of tests preservation and their processing instructions. An important requirement for this format is that it should be platform-independent. Standardization of educational technologies and, in particular, formats of test data preservation are being worked out all over the world. In this sense, the Ukranian Ministry for Education and Science has launched the Program of On-line Education Development. The activities involved in this Program include the development of standards for systems, methods and technologies of on-line education in educational institutions taking into account international standards. But different test formats such as Instructional Management Systems (IMS) or Question and Test Interoperability (QTI) of Global Learning Consortium are not adequate to reflect all relationships of different applied domains.

With all, the most serious problems are caused by the semantic evaluation process. There is a great variety of Learning Management Systems (LMS) or Virtual Learning Environments (VLE). As far as evaluation is concerned, current platforms may be helpful to acquire tacit knowledge in organizations, but they do not solve the problematic of doing automatic semantic evaluations. Thus, cooperative cognitive processes are not efficient and the teaching staff must spend a lot of time correcting the tests. In fact, the time spent by teachers and moderators in E-learning courses is critical and costly in resources. Thus, the augment of students per teacher reduces the time each teacher can dedicate to each student. This makes the learning process to be impersonal, and not many teachers can keep track properly of their students' progress. Information and Communication Technologies also offer possibilities in learning assessment, because they allow for managing the information to be used in the evaluation process (Fontán, 2004). Different methods have been used in computer assisted open question assessment, including semantic networks and lexical conceptual structures (Olsen, 1998).

By bringing together the previous statements and the need for a good and fast continuous evaluation process in cooperative learning, we spot the need for tools supported by intelligent techniques. A possible solution might include different Semantic Web-based components to deal with this issue. Some authors (e.g., Magnin, Snoussi, & Nie, 2002 & Bredeweg & Forbus, 2002) utilize ontology-based semantics to improve the analyses of information in unstructured documents. The domain ontology plays a central role as a resource structuring the learning content (Angelova et al., 2004). One of the key challenges of the course construction process is to identify the information abstract domain within which this course will exist. The tutor has to describe the main terms and concepts from which a course is to be constructed.

The main idea of our approach is that the domain ontology is not only the learning instrument but also a means for testing and teaching students. Students are prompted to build their respective domain ontology corresponding to each discipline and then each of the so-build ontologies are compared to a reference one. Results of this comparison show the mistakenly understood parts of domain knowledge and help tutors improving distant courses. Some experiments are described that demonstrate that this approach is much more efficient than usual tests, where some mistakes can be involved by ambiguous formulation of questions and misprints. Besides, in common tests correct answers can be obtained intuitively or by accident and do not reflect student's actual knowledge about the topic under question.

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