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DIAGNOSING THE STATE OF THE STUDENT'S KNOWLEDGE IN A WEB-BASED LEARNING ENVIRONMENT

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ABSTRACT

Web-based learning environments have become very popular and are used widely in universities. Thanks to their features, students are free to study with no limits of time or space, and teachers can take advantage of computer-based communication tools for creating discussion groups, shared exercises, and delivering multimedia content. But, for the teacher's perspective, the physical distance between teacher and learner could give rise to a problem of evaluating the student's current state of knowledge.

In this paper we propose a simple model to create a representation of the computer's system beliefs about each student in the class. Without changing the tools used by the teacher to create and delivery their courses, we propose a structure of a tool which is able to represent, in a very comfortable and intuitive way for the teacher, the actual state of knowledge of the whole class of students.

INTRODUCTION

Web-based learning environments are used more and more in universities and colleges and all over the world. The new paradigm of teaching using computer mediated communication (CMC) tools is emerging and changing the way of teaching and learning in current and future courses. If on one hand this new way of delivering lessons can bring new advantages, like asynchronous learning (Andriole; Lytle 1995), collaborative learning (Dillenbourg 1999), no need to travel and fixed hours, on the other hand it leads to new problems from the point of view of the teacher's work. In particular, the lack of direct interaction between the teacher and the students could generate some problems, like the lack of check of the students' knowledge, mainly due to the physical distance between teacher and students.

At the University of Svizzera italiana (USI) and the University of Applied Sciences of Southern Switzerland (SUPSI) we started several projects in collaboration with other Swiss Universities in the federal programme "Swiss Virtual Campus". Some of these projects have already (or are almost) produced on-line web-based courses that are used by hundreds of students all over Switzerland. We are using the software platform WebCT in order to put courses on-line.

One of the best known problems in distance education from the teacher side that we experimented running those courses, is the lack of check of the students' knowledge. It was

pointed out that because of the lack of nonverbal elements in CMC (gestures, facial expressions, etc.), it is very hard for a teacher to know what sort of concept each student is currently working on, and the level of comprehension he or she has achieved for that concept.

Questions like "what level of mastery of each concept has each student achieved" or "on what concept is student Carlino[1] currently working" are difficult to address. Even if some environments like WebCT provide a single page that allows the teacher to check the activity of students (in particular the history of the visited pages, the number of posted messages in discussion, the marks he/she received for the quizzes provided by the teacher and automatically graded by the system), this information is presented in a format that is very uncomfortable for the teacher to derive assertions from the state of knowledge of the students. With the term "knowledge" we are not referring to the grade that the students achieved in a particular exercise, but to the level of mastery of each skill that each student achieved studying in that course.

In particular, what lacks in today's commercial web-based learning environments is a process of gathering relevant information on the course's activity, in order to identify and represent the overall state of knowledge of each student with respect to a set of concepts. This process is called *student modeling*.

REPRESENTING KNOWLEDGE

Our approach in solving the problem was to integrate in the instructional learning environments a representation of the overall state of knowledge of the class of students. Representing the knowledge of students is an issue intensively studied in Intelligent Tutoring System (ITS) started in the 80's. An ITS is a computer-based instructional system that teaches the learner in an interactive way, using concepts of artificial intelligence (Holt et al. 1994). Those systems include a model of the students' knowledge on the domain to be taught, a so called "student model", in order to remedy misconceptions, generate feedback, make systems adaptable to individual learners and represent the learner's level of mastery of the current concept or topic (Holt et al. 1994; Tsinakos and Margaritis 2000; Nakamura et al. 1996). However, despite the great effort of scientists and pedagogists on ITS in past years, those systems didn't archive a great success in learning. The most significant limitation of ITS is that they can be developed for only a few topic areas, like engineering and mathematics. In fact, in order to build an ITS we must represent, in an expert system, the complete knowledge of the subject area. The most effective ITS systems require that them also represent or derive using inference the complete set of misconceptions that could be raised during the study of the topic. Those limitations allow the use of ITS only for very specific domains, and nearly all prototypes of ITS remained as experimental tools.

During the second half of the 90's, thanks to the success of the WWW, the convergence of ITS and of adaptive hypermedia systems (AHS) led to the developing of Web-based Adaptive and Intelligent Educational Systems (AIES) (Brusilovsky 1999). Those systems use the development derived by ITS in conjunction with the advantages of adaptive hypermedia technologies. Some examples are ELM-ART (Weber, G., Specht, M. 1997) and AHA (De Bra and Ruiter 2001). Those are very sophisticated environments that have the great advantage of providing personalized tutoring. But, from the teacher's perspective, they require a great effort for the authoring of the teaching materials.

From a pragmatic point of view, the concrete state of the art of commercial tools are environments where the content materials are static HTML pages. In this way, it is very easy

[1] Obviously this is a fantasy name

for a teacher that wants to create an on-line course to convert his material produced, for instance, with a word processor in HTML format, and put this material on-line very quickly. Adaptive and/or knowledge-based environments are used only in very specific and limitated cases. In this work, we don't want to criticize the benefits or drawbacks of ITS and AIES, but we want to be pragmatic in helping the teacher's work, taking into account the actual state of the art of the tools currently used in their work.

ARCHITECTURE OF THE SYSTEM

In the following figure we propose the overall architecture of the system.

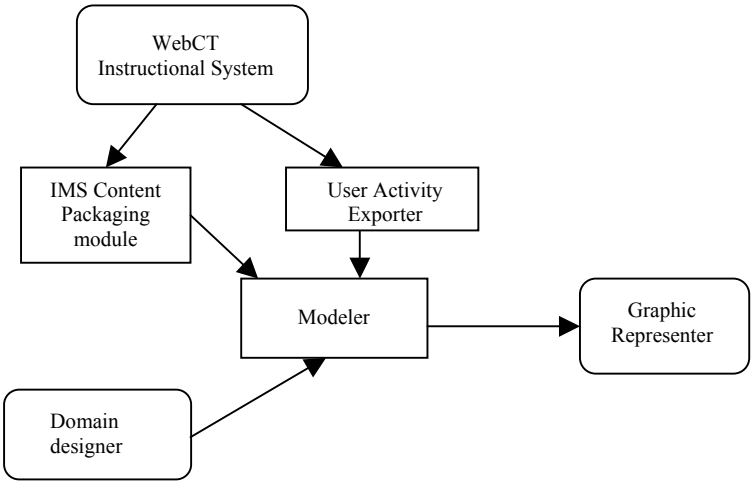

Figure 1: Architecture of the system

This model consists of the following parts:

- *IMS Content Packaging module* is a tool provided by WebCT which is able to export learning materials, quizzes and tests in packaged IMS Content Packaging 1.1 and IMS Question & Test Interoperability 1.1 XML standard format (see http://www.imsglobal.org for details on this standard).
- *User Activity exporter* is a module expressly written for WebCT which is able to export in XML format each specific action executed by each student in a particular course, like the history of the page visited, the marks students received for each quiz, messages posted, and so on).
- *Domain Designer* module is a tool that can be used by the teacher to describe the domain model of the course in terms of concepts. Each concept is associated to a set of pages and quizzes of the course. There are no relations or dependencies among concepts in this domain.
- *Modeler* is the part of the system able to create a representation of the user's knowledge of the concepts of the course, starting from the domain provided by the Domain Designer and the user activities on that domain. The logic used in this module is to utilize user activities to diagnose the level of understanding and mastery that the learners acquire immediately after a concept has been discussed. The underlying assumption is that if the learner achieves a high mark on a quiz, and he/she visited the pages related to a concept several times, then the level of mastery of the learner on that concept is positively affected. The output of this module is a representation that will be coded using an XML data format.
- *Graphic Representer* is the part of the system able to display in a graphical format the knowledge representation produced by the modeler.

Teachers are required to create a scheme of the domain of their course. The big advantage of this application is the ability of running in conjunction with the existing distance learning platform that we are using to provide our course, without changing the content or the structure of our course. Teachers continue to use the distance learning tool in the same way, without forcing them to use a further authoring tool, as required by an ITS or a AHS.

With respect to AHS or ITS, the student model is largely simplified having one to many relationships between concept and a set of quizzes. This means that we need one or more quizzes to demonstrate knowledge for each specific concept.

Moreover, thanks to the IMS Content Packaging and IMS Question & Test Interoperability standards, the system is able to run in conjunction with other distance learning platforms. The only requirement is to create a User Activity Exporter specific for that learning platform.

CONCLUSION AND FUTURE WORK

This work is only in its early stages, and some of the modules depicted in Figure 1 have not yet been implemented. Our opinion is that information about the knowledge of the entire class could be useful to the work of the teacher in order to:

- assess the learner's knowledge
- support peer collaboration, or promote the collaboration among a group of students on a specific topic
- keep track of those students that are having problems with the study (e.g. are too late or are running too fast during the study of the course)
- discover what concepts in the course are harder to understand

Future work will be focused on implementing the tool and testing it in a real on-line course.

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