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AN INTELLIGENT ONLINE LEARNING SYSTEM: DEVELOPMENT AND EVALUATION

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Abstract

Internet is the most useful interactive communication tool today. Web-based educational systems have been forming one of the fastest growing areas in educational technology research and development. Benefits of Web-based education are independence of teaching and learning with respect to time and space constrains. However, such kinds of self-study systems still have several shortcomings when compared to a real-life classroom teaching. Such as, lack of contextual and adaptation support, lack of flexible support of the presentation and feedback, lack of the collaborative support between students and systems. In this study, we've build a learning profiling system, Intelligent Online Learning System (IOLS), which provides stored data about learning history and interaction history of each individual student and it's able to know individual student, to identify student's learning problems and to provide tailored aids. After the IOLS building up, an experiment has been conducted within 74 students to evaluate the students' learning effectiveness.

Keywords: Online learning system, intelligent agent, student profiling system, learning intelligence, learning adaptation

Introduction

Internet is the most useful interactive communication tool today. Web-based educational systems have been forming one of the fastest growing areas in educational technology research and development. Benefits of Web-based education are independence of teaching and learning with respect to time and space flexibility. However, such kinds of self-study systems still have several shortcomings when compared to a real-life classroom teaching. Such as, lack of contextual and adaptive support, lack of flexible support of the presentation and feedback, lack of the collaborative support between students and systems (Hiltz et al. 1999). And bearing the passive nature, the online education systems are often dull and plodding and leave students unmotivated. In is noticed that students are differ with different backgrounds and different abilities. Therefore, an ideal system should be able motivate them in different personalized ways. Based on such facts, we have been researching on the design and development of intelligent educational systems for several years and have published a number of papers (Wang, Huaiqing. 1997) (Kwok, et al. 2000). Our previous contribution involves learning object-oriented programming, information repository and student profiling system design and demonstration.

This paper presents our continuous research efforts focusing on the student-profiling component and the evaluation of the effectiveness of our intelligent on-line learning system. Next section will give a literature review. The development of our system will be described in section 3. In order to evaluate the effectiveness of the IOLS, a survey has been conducted and the observations and findings will be presented in section 4. The final section is the conclusion and future work.

Background

Although conventional online educational systems have several of advantages, they still suffer a number of problems, such as: (1) dull because it is textual with little creative activity left to the learner. (2) Complex and obscure, letting the learner alone to explore and adapt his understanding to the material structure. (3) Rigid because not really interactive, every text and choices being predefined (Dufresne 2000). Intelligent technology has been used to overcome such problems.

SAFARI developed at Heron Laboratories in an intelligent tutoring system with a multi-agent architecture, defined for the pedagogical component. These systems use multiple learning strategies and cognitive agents that can model the human behavior in learning situations (Özdemir et al. 2000). The Raise ALN is a successful adjunct to the teaching of face-to-face engineering classes, but it has several flaws, the most notable of which are the lack of tracking and the absence of an online testing module (Cleaver and Toole 1999). The aim of the ExploraGraph research project was to build an environment where the user's model, task's model and pedagogical model could meet in a productive way. It had to be transparent and natural for the user, but also expressive and interactive so feedback and advice could blend in his activity, could orient and guide him without being disruptive (Dufresne 2000).

LearnOOP was designed for learning object-oriented programming, which demonstrates the importance of active roles offered by the integration of repository technology, multiple agent technology with future AAES (Wang, Huaiqing. 1997). SQL Turtor+, a co-operative ITS with repository support, is able to provide collaboration and co-operation services to both students and teachers. The SQL Tutor+ prototype demonstrates that the repository technology is an appropriate technical solution to support multi-user co-operation and collaboration in complex intelligent tutoring systems (Wang, Huaiqing. 1997). The information repository and student profiling system (Kwok, et al. 2000) provide facilities and services to support the knowledge communication within a multiple agents system, and address several co-operative intelligent tutoring systems for distance learning online learning.

System Development

The Intelligent Online Learning System (IOLS) is able to catch and to store information about learning history and interaction history of each individual student. It is able to know individual student, to identify student's learning problems and to provide tailored aids. It is clear that the IOLS has several novel features: (1) Active i.e. the IOLS likes a human teacher, who can monitor the student's activities and give different guidance for different students; (2) reactive i.e. the IOLS perceives student's learning history and responds in a timely fashion; (3) pro-active i.e. the IOLS does not simply act in response to students, it can also give students learning target/directions according to the progress of each individual student goal-directed behavior by taking initiative and interactive teaching action.

The IOLS is implemented as follows. The Oracle 8i and Apache web server extended with Jakarta Tomcat on Linux are employed to support server side application. XML, JavaScript and Java are selected to make the system platform independent. The figure 1 describes the IOLS architecture.

There are three layers in the IOLS: the User Layer, the Agent Layer and the Repository Layer. There are four types of intelligent agents in the Agent Layer: the Activity Agent, the Quiz Agent, the Material Agent and the Guidance Agent. The educational guidance includes analyzing the students' learning process to give advices. Profiling data are divided into two main parts: course data, and student profile stored in the Repository Layer.

The IOLS Provides Four Main Functionalities

- To capture student activity. Basic actions, such as mouse clicks (time and target) and document load/unload etc., are captured when the students access the IOLS. This functionality is implemented by using JavaScript and running in the web client-side.
- To assemble reading material. Reading materials are dynamically generated based on students' profiles and meta-data analysis.
- To generate quiz. Quiz is generated based on students' profiles and the question library. This functionality is able to identify the quiz difficulty level and the conceptions the quiz should focus on.
- To evaluate the overall learning process. This functionality compares the reading or answer speed and correctness of the students to the average of the class. By analyzing students' profiles and cross-reference information of teaching material, and with the help of educational guidance, it provides suggestions for the learning process and updates the student preferences if necessary.

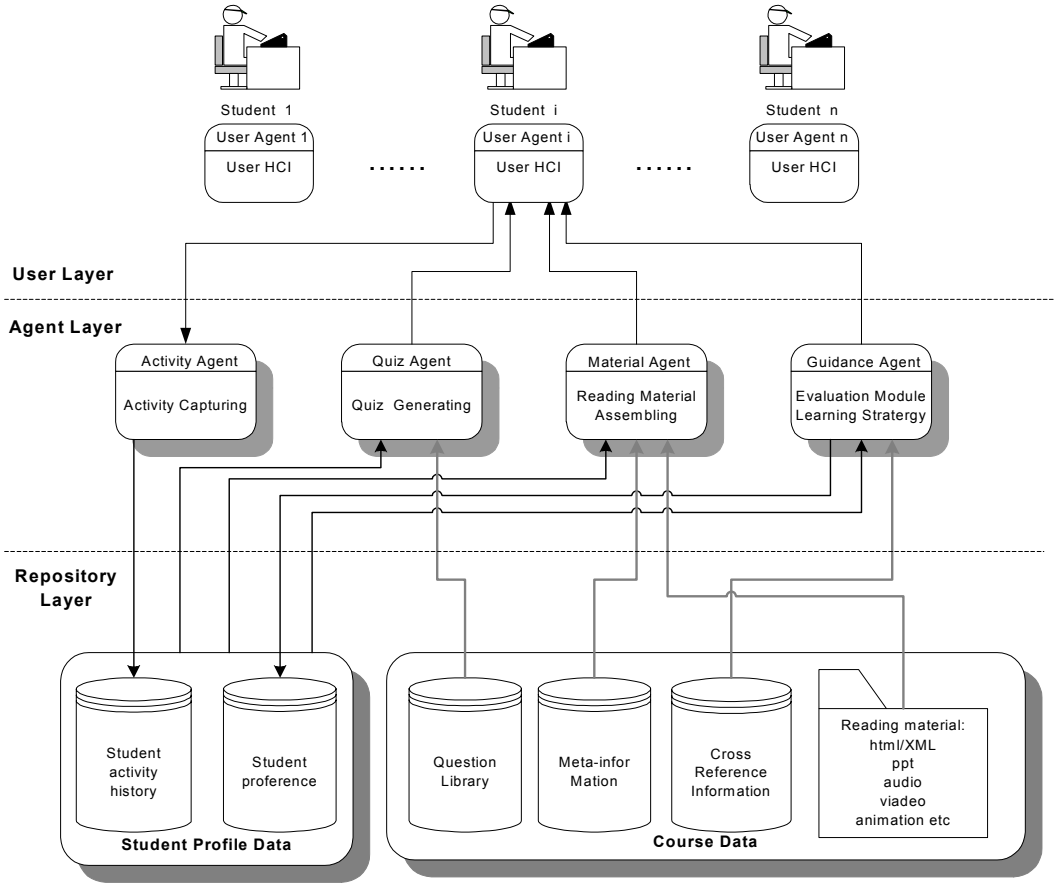

Figure 1. Architecture of IOLS

Observations and Findings

In order to understand students' perception of classroom teaching and the Intelligent Online Learning System and evaluate those factors affecting students' learning effectiveness, a field survey was conducted after the set up of our system. The questionnaire includes some basic information about the respondents, the respondents' perception of classroom teaching and our intelligent learning system respectively, the possible affecting factors on students' learning effectiveness, and respondents' suggestions on the possible improvement of this system (Hair et al. 1998).

Totally one hundred questionnaires were randomly distributed to students studying in the university computer lab during one week in February. 74 students completely answered questionnaires, which represented a very high response rate at 74 percent.

T-test was used to test the existence of difference of interaction and personalization between classroom teaching and our intelligent learning system. The results of t-test are reported in the following table.

Table 1. Results of T-Tests: Differences of Interaction

	Mean	Standard Deviation	t-value	df	Sig. (2-tailed)
Interaction in Classroom Teaching	3.32	.86			
Interaction in Intelligent Learning System	3.43	.70			
Differences of Means	-.11	1.07	-.871	73	.386

Table 2. Results of T-Tests: Differences in Personalization of Teaching

	Mean	Standard Deviation	t-value	df	Sig. (2-tailed)
Personalization in Classroom Teaching	2.36	.63			
Personalization in Intelligent Learning System	3.77	.52			
Differences of Means	-1.41	.885	-13.693	73	.000

The results of t-test indicate that the interaction of the Intelligent Online Learning System (mean = 3.34) is slightly better than that of classroom teaching (mean = 3.32). Their difference is insignificant. As to the personalization of learning, our system (mean = 3.77) is significant higher (p= .000) than classroom teaching (mean = 2.36) is. Therefore, compared to classroom teaching, the IOLS makes great improvement on personalization of learning.

As to the factors affecting learning effectiveness, 63.5 percent of respondents agree or strongly agree that flexible studying place will increase interest in learning. 89.2 percent respondents agree or strongly agree that different difficult level of teaching material is helpful. And 68.9 percent respondents agree or strongly agree personalized teaching pace will help master the knowledge. These findings indicate that the features of our intelligent learning system well meet the students' requirements.

Conclusion

The use of Internet technologies and communication technologies in learning has been increased for three decades. A Web-based classroom is an environment created on the World Wide Web in which students and educators can perform learning-related tasks. However, such web based educational systems still suffer a number of problems, such as dull, passive, and obscure. Our research goal is the development of adaptive and intelligent Web-based educational environments that offer some amount of adaptation and intelligence. The contributions of this paper are as follows:

A prototype system has been designed and developed, which is able to catch students' learning activities, to store them into the student repository, to reason about student' actions and to response immediately and accordingly.

An observation has been found out from the survey. The interaction of the IOLS is even slightly better than that of traditional classroom teaching, comparing that the interaction of most Web-based educational systems is much worse that traditional classroom teaching. On the other hand, the IOLS makes great improvement on personalization of learning, which meets individual students needs.

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