Adaptivity and User Modeling Research at the Department of Informatics, University of Piraeus

DESCRIPTION OF THE RESEARCH GROUP

Dr. Maria Virvou (http://www.unipi.gr/faculty/dep.php?dep=mvirvou) is an Associate Professor at the Department of Informatics, University of Piraeus in Greece. She is an active researcher in the area of user modeling and adaptive systems and she has established a relevant research group at the same department. The research group consists of three research fellows (former Ph.D. Students) Dr. Katerina Kabassi (http://rainbow.cs.unipi.gr/~kkabassi), Dr. Maria Moundridou (http://thalis.cs.unipi.gr/~mariam), Dr. Victoria Tsiriga (http://thalis.cs.unipi.gr/~vtsir) and five Ph.D. students, Eythymios Alepis (http://rainbow.cs.unipi.gr/~p98088), George Katsionis (http://www.gkatsion.kman.gr/), Konstantinos Manos (http://www.kman.gr/), Leondios Perdicaris and Kalliopi Tourtoglou.

RESEARCH AREAS

Adaptivity is a very important feature for the effectiveness and user friendliness of complex software. Adaptivity provides automatic customisation of software to the users' needs based on user modeling techniques. It may also provide intelligent help, which is more flexible than traditional on-line help. One large research area where adaptivity and user modeling techniques are being applied is educational software.

The main research areas where our work has focused include intelligent and adaptive help systems, adaptive authoring tools for education, user modeling, student modeling, the software engineering process of adaptive software and evaluations of adaptive systems. Our work in these research areas is presented briefly in the following Sections.

USER/ STUDENT MODELING

User modeling involves the representation and inference about many different aspects of students' reasoning, level of knowledge, possible misconceptions, comprehension ability etc. In the case of educational software, user modeling is referred to as student modeling and constitutes a complex area of research due to the users' cognitive processes that take place while they learn through a tutoring software system.

Cognitive user/ student modeling

The problem of cognitive user modeling for the provision of automatic and adaptive help to users of command –language interfaces is addressed in [17]. Cognitive user modeling for adaptive help in the context of Graphical User Interfaces is investigated in [20]. The combination of a cognitive theory with decision making theories and other user modeling techniques is discussed in [23].

Web-based user/ student modeling

In [1] we have provided a novel architecture for student modeling over the web that is based on Web Services. In [2] a Multiple Attribute Decision Making Technique takes into account several criteria concerning the student's cognitive state in order to produce adaptive advice.

Initialisation of user/ student models in adaptive hypermedia

When students start working with an Adaptive Hypermedia Educational System (AHES), the system has no prior knowledge about their proficiency level of the domain nor of their learning

characteristics. However, the AHES attempts to provide individualized support. Therefore, the student modeller should have an efficient way of inferring initial information about the student.
We have introduced a framework for the initialization of the student model in Web-based AHES, which is called Initializing Student Models (ISM) framework [12]. The ISM framework is a methodology that uses an innovative combination of stereotypes with a machine learning algorithm to set initial values of all aspects of the student model. The ISM framework was first implemented in a Web-based AHES for the domain of the passive voice of the English language [9]. Finally, in order to test the generality of the ISM framework, we used it for the initialization of the student models in a second Web-based AHES for algebra [10]. The selection of the domain of algebra was based on the fact that it is very different from the domain of language.

ADAPTIVE AUTHORING TOOLS FOR EDUCATIONAL SOFTWARE

Authoring tools provide authoring environments where human tutors may be given a combination of facilities to create intelligent and adaptive educational systems without having to be experts in software or knowledge engineering. The generality of the use of authoring tools renders their own construction more difficult than the construction of domain-specific educational applications. The main problem is that the methods which may be used in the authoring tools have to be as domain-independent as possible and at the same time the resulting educational applications should support the individual learners' needs in every particular domain.
In [13], a domain-independent student modeling approach is presented within the context of an authoring tool. As a result the reasoning of students about their domain-knowledge is assessed so that adaptive tutoring is provided automatically on either the student's missing pieces of domain-specific knowledge or the incorrect reasoning that the student may have used. In [14], prospective authors are given the opportunity to create their own tutoring characters using parameterised synthesised voices. The authors may use different combinations of synthesised voices' speed, pitch and volume depending on the tutoring context to achieve emotional adaptivity in the presentation of tutoring (e.g. a friendly tutoring advice, a strict remark etc.). In [15] the problem of mobile authoring of adaptive mobile educational applications is explored through a mobile authoring tool. In [29], authoring of adaptive educational applications focuses on virtual reality educational games. This paper addresses the problem of connecting complex virtual reality games with student modeling and adaptive tutoring through domain-independent mechanisms.
A description of an authoring tool, called WEAR, that operates over the Web and which can produce adaptive educational systems for algebra-related domains is presented in [30]. This system may perform student modeling for both domain-specific errors as well as algebra-related errors. In [5] we have presented a domain-independent component that focuses on authoring and delivering web-based textbooks using WEAR that provide navigation support. Using WEAR as an example, we have proposed a novel architecture for adaptive authoring tools that incorporates an instructor modeling component [31]. In this way, the needs, preferences and knowledge of instructors is taken into account by the authoring tool that offers individualised support to them.

ADAPTIVE LEARNING ENVIRONMENTS

Adaptive training environments

F-SMILE is an intelligent training environment and is meant to help novice users learn how to manipulate the file store of their personal computer [19]. In order to provide adaptive help and tutoring, F-SMILE has assigned an agent to constantly observe the user and collect information about him/her [21]. In F-SMILE, adaptive presentation techniques are used to present examples of use of an unknown command in the context of the learner's own file-store.

Adaptive educational games

Educational applications have to be as attractive as possible to increase the engagement of students. To this end software game technology may play a role in education. In [28] diagnostic student modeling takes place in a teaching-learning dialogue within the context of a virtual reality game plot. In [25] the whole student modeling architecture within the game is deployed over the Web. In [3], a cognitive theory of affect has been adapted in the context of a virtual reality educational game for measuring the intensity of students' emotions while they play and learn. Thus, the content of the tutoring is adapted to the cognitive and emotional needs of individual students. In [27], principles of cognitive psychology have been adapted for the modeling of the memory capabilities of student-players so that the system dynamically adapts its decisions about which part of the theory should be presented to students for repetition and revision.

SOFTWARE ENGINEERING PROCESS OF ADAPTIVE SYSTEMS

The software engineering process of adaptive systems plays a crucial role in the quality of the end product. In [4] it is shown how memory features have been incorporated into the student modeling process of educational software to create simulated students. The simulated students may be used by designers of adaptive educational software to evaluate the courses that they have created before these are delivered to real students. Thus, designers are given the opportunity to fine-tune the educational applications so as to achieve better results with the real students.

In [8] we reported on an empirical study that we conducted in order to design and develop a Web-based authoring tool for Algebra-related domains. [18] presents an analysis on users' protocols of interactions with an operating system that leads to the specifications of requirements of adaptive help. In [22] we present and discuss the development process of an adaptive help system throughout its life-cycle. [32] highlights the important role that teachers and students may play in the life cycle of an adaptive tutoring system. [33] describes the application of an object-oriented model of life cycle in the development of an adaptive tutoring system for the domain of Algebra.

EVALUATION OF ADAPTIVE SYSTEMS

The evaluation of adaptive systems is a very important phase of their construction. The design of evaluation experiments may vary considerably depending on where the focus of the evaluation has been placed. The performance of an adaptive educational system may be affected by many factors such as the user interface design, the underlying reasoning mechanisms etc.

A study was conducted in order to examine the necessity and added value of the existence of an instructor modeling component in WEAR's architecture [6]. The results of the study were in favour of this component. Almost all instructors found useful to consult other peers in order to redesign their course for future use. In [7] the focus of the evaluation has been placed on the user interface of the educational applications that result from WEAR. The likeability of Virtual Reality game interfaces is examined in [26]. In [11] we conducted an evaluation study, in order to reveal the effectiveness of the generic framework of the initialisation of the student models. In [24] we present an evaluation method of adaptive help by comparison with human experts.

The mobile technology promise is software access anywhere at any time and computer equipment independence. However, there may be drawbacks as well, such as difficulty of use. In [16] we examine the usefulness and usability of adaptive mobile courses from the students' perspective.

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