A Prototype Distributed Adaptive Learning System

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Abstract
The authors report on a Distributed Adaptive Learning System (DALS) project at the University of Missouri–Kansas City. This project grew out of work reported previously by the first author [6], in which he described a generic DALS based on his KAL model of human learning comprised of three interacting components, a Knowledge Space, a collection of intelligent agents called an Agency and a Learner Space. The DALS view of a Learner is an electronic file called the Learner Filter. What DALS presents to the Learner is called a Knowledge View. The DALS Agency manages the interface between Knowledge Views and Learner Filters. The current project implements a basic prototype DALS as a proof of concept of the earlier work. The DALS prototype was developed by a graduate student, Sachin Sood, under the supervision of the first author. The third author, Bhavesh Advani, also a graduate student, is designing and integrating a Multiple Intelligence module into the prototype to provide an innovative new presentation mode. The goal of this project is to create a very broad foundation within which to assemble the many ideas and techniques for adaptive interaction currently available or being developed in both the academic and commercial venues. An underlying premise is that adaptive interaction strategies are propelling us toward practical theories for knowledge organization and user profiling, where users may be individuals, teams or large organizations, with objectives to learn, sell, persuade or govern, to mention a few possible goals. In our project the paradigm is an individual learner; but the model applies in other contexts as well.

Narrative
In the past decade, learning environments on the web have evolved from fixed sequences of static pages to sequential, interactive pages to the current focus on adaptive systems. Most on-line systems in use today are not truly adaptive (see[1] for a broad overview of systems and developers through 1999). Several groups of academic developers have produced commercial systems such as TopClass (WBT Systems) which came from WebCT at the University of British Columbia [5] and NetCoach which grew out of ELM-ART at the Pedagogical University Freiburg [8]. Experimental systems currently under development in academic institutions include: Interbook [2] and AHA! An Open Adaptive Hypermedia Architecture [3], both widely distributed. These systems all exploit the latest in web technology to build truly adaptive systems of varying degrees of sophistication. This paper discusses an extension of these recent efforts by introducing new parameters for adaptive presentation and adaptive navigation.

In order for a system to adapt to the user, knowledge of the user must be available throughout
each interaction. Initially, this knowledge can be acquired in a number of ways, the most common being accessing performance records, asking questions and observing behavior. In a learning situation, it is fairly obvious how these kinds of data might be acquired and used to modify the interaction. However, unlike performance records, asking questions and observing behavior occur during the interaction and hence provide opportunity for real-time alteration of the interaction. More significantly, this kind of real-time interaction with the user opens the door to examining a host of important, non-subject matter factors that contribute to the effectiveness of the interaction. For example, one might ask if the presentation style matches the thinking style of the user or if the user is (becoming) stressed during an interaction with a learning environment. Many psychological, emotional and cultural elements play an important role in the acquisition of knowledge. It is with this orientation that the current project was undertaken. Specific attention is given in the design to provide for the real-time collection, analysis and integration of non-subject matter factors that influence the results. In the prototype discussed here, the thinking style, stress and social presence of the users are measured and monitored to illustrate how non-subject matter factors can be used to enhance learning. Initial data are acquired through question banks, and updating these parameters is accomplished through a combination of observation and appropriate informal queries during the interactions. The mechanisms for collecting and analyzing this data and using it to modify the learning experience are incorporated in the prototype design.

An innovation is currently being designed into the system by introducing a novel presentation mode based on the theory of multiple intelligences [4], [7]. According to this theory, humans have at least seven different intelligences which are utilized in various combinations when learning. While everyone has all seven intelligences, there are significant differences in the way we use them in a particular situation. In our prototype DALS, what intelligences a person uses in learning are estimated by an initial set of questions and then updated by observation of the choices made when subject matter is presented in a museum-like environment (comparable to a self-guided tour through the knowledge space). To integrate this Multiple Intelligences factor into our prototype, a fourth non-subject matter parameter with seven types will be introduced and assessed. This data will be entered into the user’s filter, and will alter the knowledge/user interface in future learning episodes.

To produce a working prototype quickly, HTML, Active Server Pages using Microsoft Visual Interdev 6.0 and Microsoft Access as the database were employed. Learners and Administrators (Instructors) have distinguished accounts. Administrators manage the assessments and have access to a rich collection of learner activity data. Learners are guided but not limited in their choice of next steps. Learners are continuously assigned one of twenty-seven categories which dynamically determines the mode of the presentations. The design is completely modular, permitting easy enhancement, upgrading and scaling of the system by replacing modules. Agent technology will be added in the next version and a robust database system will be selected to permit knowledge views to be assembled on the fly.

References