Portal for Artificial Intelligence in Education

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INTRODUCTION

The goal of this portal is to provide Internet information and products relevant to the field of artificial intelligence in education (AIED). This large international community designs, develops, researches and disseminates intelligent computer tutors that dynamically estimate a student's proficiency and motivation before adapting their responses. The AIED community has more than 1,000 members, including teachers who use these products, researchers who develop new techniques, industries who disseminate and evaluate new systems and students who pursue further academic training. Currently no portals exist for this community. A Web portal is a Web site that acts as a gateway to the Internet. It can provide information and links on a wide range of topics (www.netscape.com), or it can be specialized with a specific subject, such as a governmental portal.

This article describes our current vision of how to organize the AIED portal to support community development and to make finding material easy. The next section offers a brief overview of artificial intelligence in education; the third section describes the AIED portal and its content; and the fourth section provides a view to the future.

ARTIFICIAL INTELLIGENCE IN EDUCATION

The field of artificial intelligence in education asks questions such as: What is the nature of knowledge? How do humans learn? What are effective teaching strategies? Research approaches in the field have been developed from several disciplines, including artificial intelligence (AI), cognitive science, Web technology, social and behavioral sciences, linguistics, education and psychology. Student activities are tracked while they work with the tutor, perhaps in problem solving or dialogue. Making inferences about a student's skills or motivation is complicated by the fact that students are more likely to have confounded or missing knowledge than do average computer users.

Intelligent tutors challenge and move beyond traditional pedagogy. They support teaching strategies such as: (1) constructivist teaching, in which students create their own projects rather than memorize and feed back information to the teacher; (2) collaborative learning, in which teams of students work together to solve problems (Giordani & Soller, 2004); and (3) inquiry learning, in which students think critically, reason scientifically and develop analytic skills (Aleven, Ogden, Popescu, Torrey, & Koedinger, 2004; Woolf, Murray et al., 2005). Metacognitive actions, which help students become aware of their own skills and learning style, have been recorded along with each student's response to help and hints. In team activities, students work together as partners explaining their reasoning and offering suggestions. Eye movement and learning styles studies provide a perspective on task performance, the impact of alternative teaching methods and a measurement of accuracy and response time by people with differing abilities and skills (Arroyo, Beal, Murray, Walles, & Woolf, 2004; Shute, Graf, & Hansen, 2005).

AIED PORTAL

The portal design shown in Figure 1 offers numerous links and applications, including search facilities for events, content publications (journals, conferences and books), people and organizations; a section detailing upcoming events and up-to-date news, headlines and job offers relevant to the community. Part of our objective is to provide a consistent location for notices, publications, products and information. Community building is supported through frequently asked questions, a chat room, discussion forum, message board and listservs for the community. By participating in the portal environment, researchers can explore the latest work; users of technologies can find providers; and members can discover colleagues working in similar areas. Product deployment is supported through having a consistent location to describe products and providing supportive ways for members to reach new and existing members. The portal will include contact sections, links and pages of most organizations involved in the field. Users will be able to enter suggestions for improvements to the portal and to identify new organizations that should be added. A glossary provides definitions of key terms used in the site. In addition, the portal offers access

to resources and information on basic research and applied research in the AIED field.

BASIC RESEARCH

Understanding, representing and reasoning about teaching and learning are the foci of basic research in the field of AIED. Several goals are pursued simultaneously, including how to: (1) represent expert knowledge, teaching and student learning; (2) explain this knowledge as components of human cognition; and (3) demonstrate completeness and reliability in the engineering side of the discipline, for example, provide each student with a tutor that has the qualities of a master teacher. Intelligent tutors have encoded knowledge about teaching and have provided sophisticated feedback, customized curriculum and refined remediation.

Intelligent real-time simulations engage students in situations that relate to how they will use their knowledge in the future, for example, operate a complex engine, treat patients who have cardiac arrest (Eliot, Williams, & Woolf, 1996), or design a thermodynamics engine. Intelligent interfaces support communication, which is vital to effective teaching; for example, intelligent tutors read, analyze and provide a written critique of student prose, drawings, formulas, or graphics; they grade essays, analyze students' graphics (free-body diagram), interpret formulas, graphics or vectors (Rose et al., 2001; Shulze et al., 2000) and recognize emotion and affective characteristics and engage in peer-to-peer role playing.

Tutors learn from experience, improve their performance and refine their decision strategies (Arroyo et al., 2005; Mitrovic, Martin, & Mayo, 2002). Machine learning and data mining are used to gain insight into many unobservable parameters, for example, student skills and affective characteristics (motivation, skills, and interest). They predict student performance and skills based on prior actions of hundreds of students. Bayesian networks discover links between observable behavior (e.g., time spent on hints, number of hints selected) and hidden motivation, attitudes and goals and are particularly appropriate given the level of uncertainty surrounding a student's behavior. Cognitive science experiments are poised to answer truly difficult questions about human cognitive processes and learning. Research in cognitive psychology produces useful insights for building tutors and vice versa; for example, tutors help researchers identify student misconceptions and redirect problem solving by setting new goals.

Intelligent tutors have been used to establish a cooperative approach between learner and system that simulates various partners, such as a colearner, a learning companion and a troublemaker; these partners are called pedagogical actors (Aïmeur & Frasson, 1996). These actors enable the tutor to gain a better understanding about which strategy is best

Figure 1. Design for an artificial intelligence in education portal page