Chapter 37
Agent-Based Distributed Intelligent Tutoring System Using Case-Based Reasoning

Shweta
Banasthali University, India

Praveen Dhyani
Banasthali University, India

O. P. Rishi
University of Kota, India

ABSTRACT

Intelligent Tutoring Systems have proven their worth in multiple ways and in multiple domains in education. In this chapter, the proposed Agent-Based Distributed ITS using CBR for enhancing the intelligent learning environment is introduced. The general architecture of the ABDITS is formed by the three components that generally characterize an ITS: the Student Model, the Domain Model, and the Pedagogical Model. In addition, a Tutor Model has been added to the ITS, which provides the functionality that the teacher of the system needs. Pedagogical strategies are stored in cases, each dictating, given a specific situation, which tutoring action to make next. Reinforcement learning is used to improve various aspects of the CBR module: cases are learned and retrieval and adaptation are improved, thus modifying the pedagogical strategies based on empirical feedback on each tutoring session. The student modeling is a core component in the development of proposed ITS. In this chapter, the authors describe how a Multi-Agent Intelligent system can provide effective learning using Case-Based Student Modeling.

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INTRODUCTION

A major challenge in computer science education is to improve both instructional productivity and learning quality for a large and diverse population of students under real world constraints such as limited financial resources and in sufficient qualified instructors. The literature in education suggests that students who are actively engaged in the learning process will be more likely to achieve success.

Intelligent Tutoring Systems are programs that possess a wide knowledge on certain matter, and their intention is to transmit this knowledge to the students by means of an interactive individualized process, trying to emulate the form in which a tutor or human teacher would guide the student in his/her learning process. They are growing in acceptance and popularity for several reasons, including: (i) an increased student performance, (ii) a deepened cognitive development, and, (iii) a reduced time for the student to acquire skills and knowledge. Basically, an ITS is characterized for incorporating three models corresponding to three knowledge levels. Firstly, there is a domain model where the domain knowledge is gathered, that is to say the knowledge of what has to be taught. A student model represents the knowledge of the student, that is to say knowledge of what the student knows. Finally, there is a pedagogical model where the knowledge of the instructing strategies, that is to say how to teach the domain knowledge, is described. The goal for every ITS is to communicate its embedded knowledge in an effective manner.

One of the main problems in Intelligent Tutoring Systems (ITS) consists in adapting to the needs of the student who interacts at each moment. A way to provide user adaptation is by means of the so called pedagogical strategies, which specify how to sequence the contents, what kind of feedback has to be given during education, when and how the tutor's contents (problems, definitions, examples, and so on) have to be shown or explained. There has been a great research effort in learning strategies to be incorporated into ITS. As an example, Meyer has used the analogy to teach a less known domain from a more familiar one. The case based reasoning paradigm has also been an inspiration to help in obtaining new incrementing knowledge. When various strategies are implemented together in an ITS, as for instance in, the system selects the most appropriate one for the activity that the student is performing.

On the other hand, agent technology has been suggested by experts to be a promising approach to address the challenges of the modern computer based education. "An autonomous agent is a system situated within and a part of an environment that senses that environment and acts on it, over time, in pursuit of its own agenda and so as to effect what it senses in the future". Any agent, in accordance with this definition, satisfies four properties: autonomy, social ability, reactivity and pro-activeness. By using intelligent agents in an ITS architecture it is possible to obtain an individual tutoring system adapted to the needs and characteristics of every student.

In this chapter, we present an intelligent agent assisted system to support student-centered, self-paced, and highly interactive learning, a first step in building an effective active learning environment. The system provides a rich set of on-line contents and around the clock information access, maximizes the interactivity between the intelligent learning system and the students, and customizes the learning process to the needs of individual students. In the system, student's learning-related profiles, such as learning styles and back-ground knowledge, are used for selecting, organizing, and presenting the learning materials to individual students and in supporting active learning. It supports personalized and more pleasant interaction between the users and the learning systems, enables adaptive delivery of IT education content, facilitates automatic evaluation of learning outcomes, and provides easy-to-use authoring tools.