12. Model-Based Learning Environments

From Sophisticated Intelligent Tutoring Systems to Simple Adaptive Learning Environments

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Abstract: The development of intelligent tutoring systems (ITS) was in the focus of computer-based learning during the last twenty years of the last century. But most ITS did not find the way from the laboratory to use in standard learning settings. During the last ten years, adaptive learning environments emerged, a promising alternative to ITS. Both, ITS and adaptive learning environments use some more or less sophisticated type of user modeling. At hand of the web-based learning environment ELM-ART that combines both an ITS for problem solving support as well as adaptive features for navigating through the learning materials it is shown how user modeling can be used to facilitate learning. Finally, NetCoach, a Web-server for presenting and authoring adaptive on-line learning environments will be introduced.

Keywords: Intelligent tutoring systems; adaptive learning environments; user modeling.

Introduction

Learning is the perhaps most important core competence in the modern knowledge society. That is one of the reasons why computer based learning is one of the fast growing areas, especially in on-line learning scenarios in the world-wide-web. Computer based learning offers the opportunity to learn on demand. That is learners don’t have to wait for a traditional course on the topic to be learned and they can concentrate on just the information they need without bothering with all the other topics offered with courses in further education. Learning on the job is the
second opportunity of computer-based learning. Learners can learn in parallel to their job or at home without the need to leave the job for a day or more and don’t have to move to another city to participate in a very time consuming course.

But these opportunities will only convince or show an advantage if learning results of computer-based learning are comparable to or even better than results of traditional courses in further education. The drawback of learning on demand and learning on the job settings may be the absence of a human teacher or tutor. In situations where a human teacher can help individually when a learner gets stuck in problem solving or in understanding an introductory text, a simple computer-based learning environment may not be able to offer the help needed to learn successfully. An answer to this problem was the development of sophisticated intelligent tutoring systems that are able to play the role of an individual human tutor and that can communicate with the learner during the learning process (Wenger, 1987). However, though a lot of successful intelligent tutoring systems have been developed during the last three decades, most of them were only tested and used in laboratory settings and only a few of them are used in schools or in further education, e.g., the mathematics tutors developed by the Carnegie Mellon University (CMU) (Corbett, Koedinger, & Hadley, 2001). A reason may be that the costs developing these sophisticated systems are too high compared to the advantage over other forms of learning support.

During the last ten years another type of advanced computer-based learning has emerged, the adaptive learning environments. Adaptive means that these learning environments are able to adapt in one or more aspects to particular needs of the learner. Both, intelligent tutoring systems and adaptive learning environments are based on some form of a user model, in this context called learner model. Such models consist of assumptions about the learning state of a learner. This information can be assessed in advance so that learners can be assigned to categories (e.g., novice, advanced, expert). Learners belonging to different categories will get different advice and different learning support. Or the system is able to accumulate information about the user during learning with the system and, therefore, will be able to adapt to particular problems during the learning process.

In this paper, we will show how both intelligent tutoring systems and adaptive learning environments are able to support the individual learning process on the basis of information gathered in a learner model. At hand of the sophisticated learning environment ELM-ART (Weber & Brusilovsky, 2001) we will describe a web-based learning environment combining an intelligent tutoring system that supports basic problem solving tasks (described in Section 2) with a simple adaptive learning environment that supports the instruction phase of learning basic information topics in a new domain (described in Section 3). Section 4 introduces the web-server NetCoach, a system that allows authors to easily create and edit adaptive web-based learning courses. ELM-ART was the first complex web-based learning environment implemented in NetCoach. The conclusion in Section 5 will summarize the main ideas of this chapter and give a brief glance of further directions in the development of adaptive learning systems.