INFORMATION SCIENCE PUBLISHING
701 E. Chocolate Avenue, Suite 200, Hershey PA 17033, USA
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ITB11632

This chapter appears in the book, *Web-Based Intelligent E-Learning Systems: Technologies and Applications* edited by Zongmin Ma © 2006, Idea Group Inc.

Chapter X

Modeling of Adaptive Tutoring Processes

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Abstract

In this chapter, a formal, adaptive tutoring process model for case-based Intelligent Tutoring Systems (ITSs) is described. Combining methods of Artificial Intelligence and Cognitive Science led to the development of ITSs more than 30 years ago. In contrast to the common agreement about the ITSs' architecture, components of ITSs are rarely reusable. Reusability in ITSs is intimately connected with the application domain, that is, with the contents that should be learned and with the teaching and learning strategy. An example of a learning strategy is case-based learning*, where the* adaptation *of the learning material to the learner plays a major role. Adaptation should take place automatically at runtime, and thus should be part of the ITS's functionality. To support the development of ITSs with reusable components and the communication about and the evaluation of similar ITSs, a* formal approach *has been chosen. This approach is called the tutoring process model.*

Introduction

Using machines to support teaching and training has a long tradition. One of the earliest approaches is said to be the machine developed by S.L. Pressey in the 1920s: "a simple apparatus which gives tests and scores and teaches" (Pressey, 1960). The beginning of using a computer in educational settings can be dated from the late 1950s (Kruse, 2000). The first systems developed were strongly influenced by the behavioristic research. Thus, most of the time, simple drill-and-practice programs were realized. Many years of research, a paradigm shift in learning theory, cognitive science, and new technology like the WWW have led to the current state of the art. Nowadays, a large variety of system types are part of what is called e-learning, for example, Computer-based Training System (CBT), Web-based Training System (WBT, also known as Web-based Education or WBE), Learning Management System (LMS), Adaptive Hypermedia System (AH), Intelligent Tutoring System (ITS), to name but a few. This chapter focuses on the ITSs.

Since Clancey described the ITS architecture (1984), a kind of common agreement about the constituents of an ITS exist. Accordingly, an ITS consists of the components: expert knowledge model, pedagogical knowledge model, learner model, and user interface. Based on the common agreement about the ITS architecture, assumptions are that ITSs are comparable, that the reuse of components is possible, and that communication about ITS realizations is easy. However, in the process of developing an ITS, some problems arise. Often, ITSs are not comparable and components are normally not reusable. Furthermore, communication with other ITS developers reveals heterogeneous views on the ITS architecture. These problems are mainly based on the fact that the interpretation of the role of each ITS component varies. A closer look at the components' tasks described in different theoretically and practically oriented papers reveals the fact that content and delivery are not separated in the ITS components. Moreover, there exists no clear description of which components have the task to provide content and which components are responsible for delivery, steering, and control of the tutoring process. This decision is made individually by the system developers, which leads to a quite heterogeneous usage (see Martens, 2003a).

Thus, a revision of the ITS architecture is necessary. The revised architecture differentiates between content, provided by the classical ITS components, and delivery. The "delivery" is taken over by a new component, called the tutoring process model. Located in the center of the ITS architecture (Martens, 2003b), the new component interacts with each of the other components. It is responsible for adaptation and delivery of content to the learner, and for steering the interaction with the learner. Based on a formal description (Martens, 2004a; Martens & Uhrmacher, 2004), the tutoring process model is independent of the application domain and of programming languages. The clear description facilitates communication about the model, independent of the application domain. As a side effect, the separation of content and delivery in the ITS leads to reusable components and concepts.

In this chapter, the focus lies on the formal tutoring process model. The tutoring process model is developed to support case-based learning. In the following section, the theoretical background of case-based learning is sketched. Case-based learning makes certain demands on an ITS, especially regarding the contents' adaptability and the