Adaptive Web-Based Learning Framework

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INTRODUCTION

With the rapid growth of the Internet and the increasing popularity of the World Wide Web, web-based learning systems have become more and more popular. However, in general Web-based learning systems, learners may often get lost in the enormous educational materials (Eirinaki & Vazirgiannis, 2003; Murray, 2002). This kind of situation refers to a *disorientation* problem. In addition to the disorientation problem, general Web-based learning systems provide every learner with uniform course content and presentation without considering the different knowledge level of learners. Therefore, the course content may be insufficient or unnecessary for learners with different knowledge level. This kind of situation was referred to as *cognitive-overhead* problem by Murray (2002).

The above problems are addressed in the Adaptive Educational Hypermedia System (AEHS) (Surjono & Maltby, 2003). An AEHS is derived from the development of adaptive hypermedia systems in the field of education.

In this article, we discuss how we take different adaptive properties into consideration to design the Web-based self-learning framework, and we develop the system prototype based upon that framework. We use English grammar as the self-learning materials because of its precise language structure and usage dependency. The ultimate goal of the adaptive design is to meet the requirement of mastering essential English grammar. Since learning materials should, if possible, be presented in a more personalized way to meet heterogeneous learners' needs, the problems of disorientation and cognitive-overhead are expected to be solved.

AN OVERVIEW OF ADAPTIVE EDUCATIONAL HYPERMEDIA SYSTEMS

Adaptive hypermedia systems build a model of the goals, preferences, and knowledge of the individual user and use this throughout the interaction for adaptation to the needs of that user (Brusilovsky, 1996). To be able to adapt to a particular user, the system has to know the teaching domain and each individual user, his or her knowledge, and learning progress (Kavcic, 2001). AEHS, in the field of education, can be regarded as an implicit tutor in a Web-based learning environment. In the study process, the AEHS will dynamically provide appropriate contents and appropriate exercise items for a learner according to that learner's knowledge level.

A general AEHS consists of a domain model, a user (learner) model, and an adaptation (teaching) model (Wu, Houben & De Bra, 1999, 2000). A *domain model,* which is a structural model, represents knowledge about the teaching domain (for the purpose of brevity, we will call it "domain knowledge") and explains what is being taught. A *learner model* maintains the information of each learner and monitors the interactions between learners and the system. A *teaching model* takes care of all teaching decisions of the system and thus explains how to teach (Kavcic, 2000). One task of a teaching model is to adapt the course content according to a learner's knowledge level and appropriate course materials. Therefore, we can say that the teaching model is the communication bridge between the domain model and the learner model.

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SYSTEM FRAMEWORK

As mentioned, we developed an adaptive learning environment for English grammar (ALE-Eng). ALE-Eng is a Web-based application and is an AEHS. The system is comprised of three principal models: the domain model, the learner model, and the teaching model. The detailed explanation of these three models follows.

The Domain Model

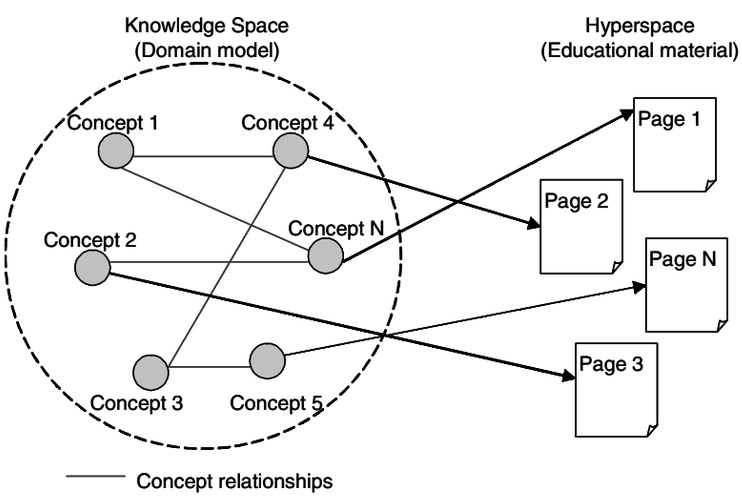
The domain model is composed of a set of small domain-knowledge elements that are called *concepts*. In a more advanced form of domain model, concepts are related to one another and form a kind of semantic network that is called a *network model* (Brusilovsky, 2003). The relationship between the two concepts is called *concept relationship*. Concepts and concept relationships in the domain model correspond to nodes and links in a network model. Therefore, the domain model describes how the information is structured and linked together (De Bra, Houben & Wu, 1999). In ALE-Eng, the domain knowledge is English grammar. As we mentioned before, concepts represent a set of small domain-knowledge elements. In addition, concept relationships that connect each concept together define the learning path and are regarded as the determinant of curriculum sequencing. Thus, the combination of the concepts and the concept relationships form a complete course structure.

In order to avoid overloading short-term memory, the system has kept a minimal amount of information on each page. In addition, the system presents no more than one major concept for each page (Li, Vipahasna & Slay, 2001). As shown in Figure 1, a concept is regarded as a page in hyperspace. The content of a page contains the appropriate information for a learner and is obtained from the domain model.

In ALE-Eng, the domain model is hierarchically organized and consists of a set of concepts and concept relationships. We define two kinds of concepts and seven kinds of concept relationships. As shown in Table 1, we distinguish atomic concept and compound concept as two classes of concepts. The atomic concept is a concept that does not have any sub-concepts. The compound concept is a concept that has one or more sub-concept(s).

The concept relationships we used in the domain model are shown in Table 2. We define seven concept relationships to model our domain knowledge. These concept relationships can help to construct a complete course structure. The system uses different concept relationships to assist learners in differentiating the property of concepts. In the aspect of presentation, each concept relationship is transformed into different navigation guidance in a page. Note in the "Representation" field in Table 2, a concept relationship connects two concepts that are a beginning concept

Figure 1. A structure of information space in an AEHS



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