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Intelligent web-based learning system with personalized learning path guidance

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Abstract

Personalized curriculum sequencing is an important research issue for web-based learning systems because no fixed learning paths will be appropriate for all learners. Therefore, many researchers focused on developing *e*-learning systems with personalized learning mechanisms to assist on-line web-based learning and adaptively provide learning paths in order to promote the learning performance of individual learners. However, most personalized *e*-learning systems usually neglect to consider if learner ability and the difficulty level of the recommended courseware are matched to each other while performing personalized learning services. Moreover, the problem of concept continuity of learning paths also needs to be considered while implementing personalized curriculum sequencing because smooth learning paths enhance the linked strength between learning concepts. Generally, inappropriate courseware leads to learner cognitive overload or disorientation during learning processes, thus reducing learning performance. Therefore, compared to the freely browsing learning mode without any personalized learning path guidance used in most web-based learning systems, this paper assesses whether the proposed genetic-based personalized *e*-learning system, which can generate appropriate learning paths according to the incorrect testing responses of an individual learner in a pre-test, provides benefits in terms of learning performance promotion while learning. Based on the results of pre-test, the proposed genetic-based personalized *e*-learning system can conduct personalized curriculum sequencing through simultaneously considering courseware difficulty level and the concept continuity of learning paths to support web-based learning. Experimental results indicated that applying the proposed genetic-based personalized *e*-learning system for web-based learning is superior to the freely browsing learning mode because of high quality and concise learning path for individual learners.

Keywords: Genetic algorithm; Personalized learning path; Intelligent tutoring system; Web-based learning

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1. Introduction

Traditional teaching resources, such as textbooks, typically guide the learners to follow fixed sequences to other subject-related sections related to the current one during learning processes. Web-based instruction researchers have given considerable attention to flexible curriculum sequencing control to provide adaptable, personalized learning programs (Brusilovsky, Eklund, & Schwarz, 1998; Jih, 1996; Lee, 2001; Lin & Hsieh, 2001; Mia & Woolf, 1998; Papanikolaou & Grigoriadou, 2002; Tang et al., 2000; Tang & Mccalla, 2003). Curriculum sequencing aims to provide an optimal learning path to individual learners since every learner has different prior background knowledge, preferences, and often various learning goals (Brusilovsky & Vassileva, 2003; Chen, Lee, & Chen, 2005; Roland, 2000; Weber & Specht, 1997). In an educational adaptive hypermedia system, an optimal learning path aims to maximize a combination of the learner's understanding of courseware and the efficiency of learning the courseware (Roland, 2000).

Moreover, as numerous web-based tutoring systems have been developed, a great quantity of hypermedia in courseware has created information, and cognitive overload and disorientation (Berghel, 1997; Borchers, Herlocker, Konstanand, & Riedl, 1998), such that learners are unable to learn very efficiently. To aid more efficient learning, many powerful personalized/adaptive guidance mechanisms, such as adaptive presentation, adaptive navigation support, curriculum sequencing, and intelligent analysis of student's solutions, have been proposed (Chen et al., 2005; Papanikolaou & Grigoriadou, 2002; Tang & Mccalla, 2003; Weber & Specht, 1997). Nowadays, most adaptive/personalized tutoring systems (Lee, 2001; Papanikolaou & Grigoriadou, 2002; Tang & Mccalla, 2003) consider learner/user preferences, interests, and browsing behaviors when investigating learner behaviors for personalized services. However, these systems neglect the importance of learner ability when implementing personalized mechanisms. On the other hand, some researchers emphasized that personalization should consider levels of learner knowledge, especially in relation to learning (Chen et al., 2005; Chen, Liu, & Chang, 2006; Papanikolaou & Grigoriadou, 2002). That is, the abilities of individuals may be based on major fields and subjects. Therefore, considering learner ability can promote personalized learning performance.

Over the years, designers of web-based learning have evolved several common lesson structures for different learning occasions. These lesson structures include the classic tutorial lessons, active-centered lessons, learner-customized tutorial lessons, knowledge-placed tutorial lessons, exploratory tutorial lessons, and generated lessons (Horton, 2000). Among the six kinds of lessons, the generated lessons aim to customize learning for those who have very specific needs and not much time or patience to complete topics they have learned (Horton, 2000). The generated lessons tailors a learning sequence based on the learner's answers to questions on a pre-test or questionnaire at the start of the lesson (Horton, 2000). To construct a personalized learning path based on simultaneously considering courseware difficulty level and learning concept continuity during learning processes, a genetic-based curriculum sequence scheme is here presented to customize personalized learning path. The proposed approach is based on a pre-test to collect incorrect learning concepts of learners through some randomly selecting testing items (Hsu & Sadock, 1985), then the genetic algorithm is employed to construct a near optimal learning path according to these incorrect response patterns of pre-test. The goal of this study aims to help learners learn more effectively and efficiently by skipping the learning concepts that learner has given correct responses for the corresponding testing items in a pre-test process. Since the fitness function of genetic algorithm is determined by the difficulty parameter of courseware and the concept relation degree between two successive courseware in a generated learning path, the proposed curriculum sequencing scheme can generate high quality learning paths for individual learners. Experimental results indicated that the proposed genetic-based personalized *e*-learning system with curriculum sequencing mechanism generates appropriate course materials to learners based on individual learners' requirements, and help them learn more effectively and efficiently in a web-based learning environment.

2. System architecture

This section describes the system architecture, system components, and details of the learning procedures for the proposed genetic-based personalized *e*-learning system.