A Novel Architecture for Learner-Centric Curriculum Sequencing in Adaptive Intelligent Tutoring System

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ABSTRACT

An ideal face-to-face tutor learner interaction aims to offer learning to the learner in a manner that best suits an individual learner's learning level and learning style. This ability of differentiated instruction has been built in Seis-Tutor Intelligent Tutoring system, developed to offer subject matter knowledge of 'Seismic Data Interpretation,' a field of geo-physics. The detailed architecture of learner-centric curriculum sequencing module, built to this effect, with its components, sub-components, their interconnected functioning, to generate exclusive learning path, have been described. An algorithm for learner-centric curriculum sequencing, a mathematical model and proposed implementation using a case study has been elaborated.

KEYWORDS

Cognitive Intelligence, Curriculum Sequencing, Intelligent Tutoring System, Learning Style, Pre-Knowledge Level

INTRODUCTION

Artificial intelligence is an advanced field of research. Its use in the field of education particularly in making teaching and learning more effective, has been significantly exploited in recent past. This has resulted in development of variety of educational computer artifacts. Further developments have caused origin of the field of intelligent tutoring. This field developed at the intersection of disciplines of computer science, cognitive psychology and educational research has gained immense popularity in current times, particularly due to the development of Intelligent Tutoring Systems (ITS) (Nwana et al., 1990). These systems termed as cognitive tutors offer tutoring in a manner that best suits the learning preference of the learner. It is a program that not only behaves like a human tutor but also follows the rules and instructions based on the progress and behavior of the learner.

ITS is an intelligent computer system which solves the learner's problems by bestowing feedback and hints. It traces the learner's activity, assesses the learner's mastery on subject matter and seeks to understand the learner's psychological mind. Cognizing psychological mind of learner makes a tutoring system an "intelligent" tutoring system because it solves the learner issues and offers the

tutoring content in a manner that learner can grasp easily and effectively. An ITS is distinctly different from a typical e-learning system, such as a web-based learning system, that facilitates a learner to explore a specific domain or course contents via internet. Like ITS, these systems do not adapt to the learner's learning needs and also do not offer learner-specific feedback and hints. ITS being adaptive in nature, has gained immense popularity in current times.

Now-a-days, adaptation and personalization are two important aspects of computer aided instruction systems. On web-based education systems, study material resources are available, but with their overloading and accessibility issues. Hence, it is difficult for a learner to achieve his/her learning goals in cyberspace. In an education system, categorization of learning material and related activities, to present to learner, in learner exclusive manner, targeted to achieve learning objectives, is termed as learning path. This learning path may vary from person to person depending of his/her profile. This is aimed to offer individualistic learning experience to each learner. This is because each individual imbibes knowledge at different speed. The knowledge of a particular learner may grow quite fast and for others the time taken may vary greatly. The response of an individual to learning material too, may be different. A given page may be difficult to understand for a beginner learner and be unimportant and dull for an advanced leaner (Gutiérrez, & Pardo, 2007).

BACKGROUND AND PRELIMINARIES

Very limited work is reported in learner path sequencing in intelligent tutoring systems. However, a reasonably sizable work on curriculum sequencing is reported in e-Learning systems, web-based hypermedia systems and Learning Management Systems. But our systematic review reveals that the ITS systems have remained unexplored in this context so far. Till now, the organization of learning material in intelligent tutoring system, is commonly based on heuristic rules, i.e. during construction of domain, programmer defines rules for all possible situations. This means that initially all learners are provided with same predefined curriculum, but as learners progress, the remedial actions on each activity of the learner are recommended, much the same way like the human tutors do. For example, ITS helps the learner to solve a particular question by providing necessary hints for the question (Brusilovsky, Schwarz, & Weber, 1996, Skinner et al., 1958, Wu et al., 1991).

Some work on curriculum sequencing in ITS is reported below: A depth first traversal algorithm was used in Knowledge-based systems, Hyperbook systems as a sequencing technique (Baldoni, Baroglio, & Patti, 2001).

Chen, (2011) proposed personalized and remedial e-Learning system (PDRLS), providing learning path for specific learners on the basis of their previous knowledge about the course. Firstly, experts describe the relationship among the concepts. Learner pretest plays a vital role in the identification of learning path. For identifying learner previous knowledge structure, they used pathfinder network algorithm, which takes outcomes of pretest as input. At last they compare knowledge structures and generate the appropriate learning path.

Concept map is a way of organizing knowledge in form of courses, topics and subtopics, represented as squares, circles and connection between them indicating the degree of relativeness or relation. The idea of concept map is proposed by (Novak, & Cañas, 2008) on meaningful theory of Ausubel.

Xie, Zou, Wang, Wong, Rao, & Wang, (2017) proposed a technique, to resolve issue related to finding suitable learning path for a group of learners. Profile based framework was proposed for determining their learning path by considering various parameters (temporal boundaries and prototype based aggregation) related to learning.

Further, new approach using data mining techniques has also been explored. With the objective to discover new and meaningful knowledge data mining techniques such as prediction, association, classification have been used. Such systems monitor learner web usage as they navigate through the web pages. Hsieh, & Wang, (2010) proposed web-based learning system that works in two important

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