Using Bayesian Networks to Implement Adaptivity in Mobile Learning

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Abstract
Mobile learning technologies have the potential to revolutionize distance education by bringing the concept of anytime and anywhere to reality. However, the development of mobile learning is hampered by various technological and access related problems, including the difficulty in implementing adaptivity. In this paper, we use the Bayesian networks to determine mobile learner’s styles exploring the potential of individualization of learning process for the learners to implement adaptive mobile learning.

1. Introduction
Mobile learning has emerged as an educational application supporting lifelong learning. However the development of mobile learning is still at rather early stage and many issues have yet to be resolved, and one of main challenges originates from the concept of adaptive learning [1]. Since the wireless network enables the learners to be engaged into the learning anytime anywhere, adaptive mobile learning system can be quite challenging because it can include more different and complicated factors.

Currently although various research groups are exploring the potential of adaptation in mobile learning, lack of research on some issues still blocks progress [2]. This paper presents the construction and use of a Bayesian network determining the type of a mobile learner with respect to the Felder-Silverman scale and proposes an architecture that support automatic adaptation of course content presentation to suit mobile learner’s styles and devices.

The rest of the paper is organized as follows. Section 2 introduces Bayesian network. Section 3 presents the use of Bayesian network in determining mobile learner’s styles. Section 4 proposes an adaptive architecture of mobile learning system. Section 5 gives the concluding remarks.

2. Bayesian Network
Bayesian network, also known as Belief network or graphical model, is a graphical representation of uncertain knowledge, and can be used to gain understanding about a problem domain and to predict the consequences of intervention [3]. A Bayesian network is a Direct Acyclic Graph (DAG) in which nodes with conditional probability table (CPT) represent random variables, and links or arrows that connect nodes represent influence. The structure of the network represents the probabilistic dependence/independence relationships between the random variables represented by the nodes.

3. Using Bayesian network to determine mobile learner’s styles
Each individual has his/her unique way of learning. Learning style greatly affects the learning process, and therefore the outcome [4]. Mobile learners, who are typically distance learners, usually work individually without external support and have various learning backgrounds and levels. Our work here is to use Bayesian network to determine mobile learner’s styles, which is based on Felder-Silverman learning style theory.

Felder-Silverman learning style theory categorizes an individual’s preferred learning style by five dimensions: active/reflective, sensory/intuitive, visual/auditory, sequential/global, and inductive/deductive[5]. Currently, the inductive/deductive dimension has been deleted from the previous theory because of pedagogical reasons, so we model four dimensions of Felder-Silverman framework in our application domain. We build a Bayesian network representing the learning style with a knowledge engineering approach [6].

For each dimension we analyze respective determining elements in mobile environment, and list these elements and the values they can take in the following.

- active/reflective(Processing):
  - wiki: participation, no participation.
  - short message reply: many, few.
- sensory/intuitive(Perception):
  - reading: facts, theory.

example: before exposition, after exposition.
According to the above analysis, we implement a Bayesian network (Fig.1) encoding relations among three types of variables: learning styles, four dimensions of the learning styles, and different elements that determine learning styles. Once establishing the probability values associated with each node of the graph by expert knowledge and collected data, we can make probabilistic inference of a learner’s style. For example, suppose for a learner, we obtain the probability values from observation for the reading and example, and then with the CPT of node Perception we can compute the probability $P(\text{Perception})$ to determine the student is a sensory learner or an intuitive learner.

4. System architecture

In mobile learning system, the implementation of adaptivity is not only based on the learning style analysis of a learner, but also depends on the analysis about mobile device that the learner holds. For example, most mobile devices have small screens and very limited input methods. We should present learning contents adaptively suiting the various devices and individual preferences of learners using these devices. So we propose an adaptive mobile learning architecture consisting of five main modules (Fig. 2) namely: learner model; device model; adaptation; knowledge database; pedagogical model.

Learner model module stores learner profile which explains and concludes the information of learners, such as learners’ pre-knowledge, learning style, and so on. Device model module contains device attributes such as the device types and its capabilities, display capability, audio and video capability, memory, bandwidth, operation platforms, and so on. Adaptation module makes inference aiming at the information from device model and learner model with some intelligent methods. Knowledge database module is used to store expert models, learning strategies and learning materials, etc. Pedagogical model module uses the data provided by other modules and creates the content and suggestions of what the learner should do next.

5. Conclusion

In this paper we employ Bayesian networks for mobile learner style’s determination purpose regarding the elements determining the learning style. An adaptive mobile learning system architecture is proposed. This architecture provides a mechanism for adapting content presentation to the mobile learner model and device model, which can improve mobile learning process.

References