A User Modeling System for Adaptive Learning

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***Abstract—*Adaptive learning is a research branch of e-learning, which supports personalization in study. Thus, adaptive learning system has ability to change its action to provide learning content and pedagogic environment/method for every student in accordance with her/his individual characteristics such as knowledge, learning styles, interests, etc. Student’s characteristics are structured as so-called user model and the so-called user modeling system is responsible for managing such user model. User modeling system is the heart of adaptive learning. This research proposes a novel user modeling system named Zebra which manipulates students’ characteristics in the effective way. Moreover, Zebra provides powerful inference mechanism for reasoning out new information about students in order to support adaptive learning in the best way. Zebra is implemented as computer software and so, the purpose of this paper is to introduce Zebra – a novel and powerful user modeling system.**

***Keywords—user modeling system, user model, adaptive learning***

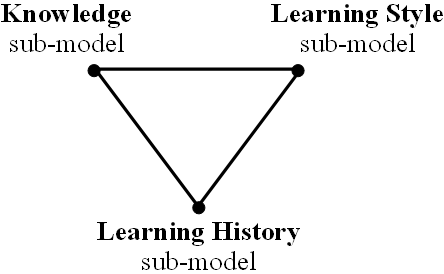
# Introduction

Nowadays modern society requires every citizen always updates and improves her / his knowledge and skills necessary to working and researching. E-learning or distance learning gives everyone a chance to study at anytime and anywhere with full support of computer technology and network. Adaptive learning, a variant of e-learning, aims to satisfy the demand of personalization in learning. The adaptive learning system (ALS) is defined as the computer system that has ability to change its action to provide learning content and pedagogic environment/method for every student in accordance with her/his individual characteristics. Therefore, the ultimate goal of this research is to give the best support to learners in their learning path and this is an enthusiastic contribution to research community. Learners’ information and characteristics such as knowledge, goal, experience, interest, background, etc are the most important to adaptive system. These characteristics are organized in structure so-called learner model (or user model) and the system or computer software that builds up and manipulates learner model is called user modeling system (or learner modeling system).

This research proposes a learner model that consists of three essential kinds of information about learners such as knowledge, learning style and learning history. Such three characteristics form a triangle and so this learner model is called Triangular Learner Model (TLM). The ideology of TLM is that user characteristics are various and only some information is really necessary to adaptive learning and an optimal user modeling system should choose essential information relating to user’s study to build up learner model. According to this ideology, TLM will cover the whole of user’s information required by learning adaptation process and give the best support to adaptive learning. The reasons for such assertion are:

* Knowledge, learning styles and learning history are prerequisite for modeling learner.
* While learning history and knowledge change themselves frequently, learning styles are relatively stable. The combination of them ensures the integrity of information about learner.
* User knowledge is domain specific information and learning styles are personal traits. The combination of them supports user modeling system to take full advantages of both domain specific information and domain independent information in user model.

These reasons also strong points of TLM because they reflect the sufficiency and solid of an optimal learner model. Moreover, TLM emphasizes on the inference mechanism by applying Bayesian network and Markov model into modeling user knowledge and learning style. Intelligent deduction is the best feature of TLM instead of providing user information only as normal user modeling system. TLM is depicted in figure 1.



1. Triangular Learner Model

I also introduce the architecture of the user modeling system so-called Zebra that realizes the TLM. The core of Zebra is the composition of two engines: mining engine (ME) and belief network engine (BNE).

* Mining engine (ME) is responsible for collecting learners’ data, monitoring their actions, structuring and updating TLM. Mining engine also provides important information to belief network engine; it is considered as input for belief network engine. Mining engine almost always uses mining techniques. It has three other important functionalities that are to discover some other characteristics (beyond knowledge and learning styles) such as interests, goals, learning context, etc and to support learning concept recommendation and to support collaborative learning.
* Belief network engine (BNE) is responsible for inferring new personal traits from TLM by using deduction mechanism available in belief network. This engine applies Bayesian network and hidden Markov model into inference mechanism. Two sub-models: knowledge & learning style are managed by this engine.

Zebra provides communication interfaces (CI) that allows users and adaptive systems to see or modify restrictedly TLM. Adaptive applications also interact with Zebra by these interfaces. Figure 2 depicted the architecture of Zebra.

SOAP

SOAP

**BNE**

**ME**

*Learners*

*Observer*

*Adaptive applications*

**LS**

**K**

**LH**

SOAP

1. The architecture of Zebra

# Proposal of demoing

I invented 10 formulas and methods in the research:

1. Triangular Learner Model (TLM) and user modeling Zebra architecture [6].
2. Combination of overlay model and Bayesian network and transforming arc weights into conditional probability table [1].
3. Evolution of Bayesian overlay model [10].
4. Dynamic Bayesian network and the optimal approach to construct dynamic Bayesian network [4].
5. Specifying prior probability for beta distribution [11].
6. Learning styles and hidden Markov model [2].
7. Learning concept recommendation based on sequential pattern mining [7].
8. Discovering user interests by document classification [8].
9. Constructing user groups or user communities [5].
10. Methods and formulas to evaluate adaptive learning model [12].

I also implemented these formulas and methods as computer software which is deployed as the user modeling server so-called Zebra server. I am very happy to introduce my works to you and so I want to demo my excellent product – the user modeling server Zebra. My product home link is “https://sites.google.com/site/ngphloc/st/dissertations/zebra”. The demonstration (example) includes four scenes as follows:

1. Introducing briefly the user modeling system Zebra together its basic functions such as its engines and how to manage TLM. Of course, TLM is also sketched.
2. Running software Zebra and open its control panel. Basic functions such as modeling student as TLM, manage TLM, reasoning student’s new information (knowledge, learning styles and interests) and monitoring students are introduced.
3. Running the adaptive learning website based on AHA! [13].
4. Simulating a student learning on adaptive learning website and explaining how Zebra monitors her/his studying process and models her/his as TLM and how Zebra reasons out her/his knowledge based on inside engines.

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