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Procedia Computer Science 1 (2010) 2821–2828

Procedia Computer Science

www.elsevier.com/locate/procedia

1st Workshop on Recommender Systems for Technology Enhanced Learning (RecSysTEL 2010)

Exercises recommending for limited time learning

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Abstract

In this paper we propose a method for personalized recommendation of assignments (tasks or exercises) in an adaptive educational system. Our main goal is to help students to achieve better performance in tests. To achieve this we enhance existing adaptive navigation approaches by considering the limited time for learning. Our strategy is to cover all the required topics at least to some extent rather than learn few topics perfectly. The proposed method uses utility-based recommending and concept-based knowledge modeling. We evaluate our approach in the domain of learning programming.

Keywords: Recommendation; educational system; exercise; limited time

1. Introduction

The objective of personalized recommendation in educational systems is to help students choose the best topic (learning object) to focus on, in order to maximize the learning efficiency. A personalization is inevitable as each student can have different level of knowledge concerning particular topics, different abilities, but also different ambitions and also an idea of time intended for learning. Adaptive navigation and personalized topics recommendation is currently common approach in support of effective education. Most educational systems recommend the most appropriate text for particular user considering learning goals, actual level of knowledge and often also activity of peers.

In this paper we focus on the educational content in form of exercises. Exercises are an important part of educational materials in many areas (e.g. math, or programming). They serve for practicing the concepts presented often in form of educational text (or multimedia). Often exercises compose main part of midterm exams. Since the time for exams preparation is always limited by the date of the exam, it might be not sufficient for learning all required topics perfectly, especially in case when a student has started his preparation a bit late.

Our goal is to help the student achieve as good exam result as possible. A common tactic used by students under time pressure is going through all topics very quickly rather than learning at least few topics in detail. Using such a strategy often there is no topic learnt at minimal level, i.e. the level which allows producing right answer for at least some tasks given during the exam. Our method for personalized recommendation presented in this paper is designed

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doi:10.1016/j.procs.2010.08.007

to help the students to prepare for the exam by covering as many topics as possible in limited time. It is implemented and evaluated as a part of the ALEF framework for adaptive web-based learning [1].

2. Related work

There exist many different approaches to adaptive navigation in educational systems, both content-based and collaborative. We are especially concerned with approaches in domain of learning programming.

In [2] the authors present a combination of content-based and collaborative approaches – a method based on learning objects content and good learners rating.

Brusilovsky et al. in [3] present an educational web-based system with adaptive navigation within exercises. They use personalized annotations for indication of the state of exploration of educational space by the student. An annotation symbol is assigned to each exercise depending on the portion of its source code that has not been explored by the student yet. No recommendation is made by the system – the student selects next exercise and his learning speed (the amount of new knowledge in each exercise) by himself.

The ALEA educational system for learning programming [4] provides adaptive navigation based on relationships in the concept layer of the domain model. The program examples (exercises) are presented as specific instances of program schemata which facilitate understanding of basic programming principles.

In [5] the authors present a method for adaptive selection of comprehension checking questions and its implementation in the system called Flip. Recommendation is based on Item Response Theory and utilizes the computer-adaptive testing method [6] for knowledge modeling. However, the system uses topic-based knowledge modeling and lacks a separate concept layer in the domain model, which does not facilitate effective representation of recommendation knowledge and recommendation in several related courses that share the concepts [7].

Educational content recommendation in [8] filters learning objects according to their relevance to the student's learning goals using a domain ontology organized in a hierarchy. Learning paths are generated using concept prerequisites.

Existing solutions present effective means for learning support. However, none of these navigation solutions consider time in their recommendation strategies or support in some way the preparation for a test considering limited time of a student for learning. The decision about when to stop learning a topic and move to another is left to the student. Our method for personalized recommendation of exercises is intended for providing assistance just in this case.

3. Models overview

We employ the domain model developed for the ALEF (Adaptive LEarning Framework) [1]. The domain model consists of content entities (*learning objects*) and metadata entities (*concepts*) that are connected via various types of relationships (see Fig. 1). Learning objects are further divided into the following types:

- *Explanation*, represents instructional content that describes a subject domain;
- *Question*, represents interactive part of a course with several types of questions (e.g., single choice, multi choice, text filling, sorting);
- *Exercise,* represents means for practicing knowledge in the explanation learning objects.

Every learning object has a fuzzy set of *related concepts* and a scalar *difficulty* property. Different types of relations between concepts are defined: similarity, prerequisites, *is-a* relation. All relations are weighed – a real number from $\langle 0, 1 \rangle$ sets the relation strength.

The students' knowledge model in ALEF is a concept-based [1] vector space model [9]. It consists of a set of *knowledge levels* – a student's knowledge of each concept in the domain model is represented by a real number from 0 (not understood) to 1 (perfectly understood).

An exercise consists of three parts

- task definition,
- hint and
- possible solution (with a brief explanation for clarification purposes if appropriate).