The use of predictive models in intelligent recommendation systems

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Abstract

In this study we present an intelligent recommendation system for university students. Together with the conventional functional components the suggested system includes the predictive model, estimating student’s academic performance. According to the output values of the model the recommendation system may provide more suitable learning strategies and learning materials to students.

Keywords: recommendation system, predictive model, academic performance prediction

1. Introduction

Recently, recommender systems are widely used in education area, especially in e-learning1. These systems are applied in both formal and informal learning environment2, and are used in technology enhanced learning for recommending materials3,4,5.

The large number of educational material currently available through the Web requires the presence of Educational recommender systems which not only reflect the most appropriate educational resource provision for a

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student, taking into account their preferences and personal characteristics, but also considering the educator point of view. The resource and student properties are generally modeled by corresponding ontologies.

In this study we present an intelligent recommendation system for university students. Together with the conventional functional modules the suggested system includes the predictive model, estimating student’s academic performance. According to the output values of the model the recommendation system may provide more suitable learning strategies and learning materials to students.

One of the main components of the recommendation systems for students is the student (or learner) model that reflects the knowledge about the students. Detailed review of the existing methods and tools, which are used in the student modeling process, is given in. Some developing aspects of the student modeling are discussed in. The authors indicate two processes for student modeling: the initialization and update of a student model. The proposed system is able to initialize the student model to determine the knowledge level of students before doing the learning activities. After the student registers for the course and logs into the proposed system, s/he is requested to take the pretest. The results from the pretest calculate the students’ knowledge level. For student modeling, the Dempster-Shafer theory is applied to initialize and update data on the student knowledge level collected in the student model. The proposed system can recommend and sort all section links that are suitable for the students’ current knowledge level. Furthermore, it can annotate the section knowledge level with colored balls to represent various grades.

In the paper authors consider two questions related to student modeling in an intelligent tutoring system: 1) What kind of student model should we build when we design a new system; 2) Should we divide the student model into different components depending on the information involved. Four components of the student model is analyzed: 1) Performance model, which computes an assessment of student competence, based on performance. 2) Student reply history; 3) Student solution record, which records how many errors the student made while solving the problem, along with a detailed record of each error; 4) Tutoring history model, which includes both the plan history and the discourse history.

Fuzzy set theory and fuzzy logic methods are widely used to develop Intelligent Tutoring and Learning Recommendation Systems. In the authors use the concepts of fuzzy set theory for design of an online educational module. Such a module can deal with uncertainties in the knowledge acquisition, representation and decision making. The fuzzy logic principles are used in creating an adaptive learner model, which provides the appropriate teaching material to each learner according to his/her learning level. In the an approach for implementing predictive fuzzy systems for educational area is proposed. From end-users' point of view, the approach enables encapsulating the technical details of the underlying information system in terms of an intuitive linguistic interface. To illustrate the method, authors describe it in terms of a concrete educational user modeling application. In the educational context, the approach enables the construction of applications exploiting simple and intuitive student models.

The Recommendation System proposed in introduces idea of fuzzy tree matching method by using ontology reasoning, Mtree creation, fuzzy logic, Pearson’s correlation

The authors of the work present a systematic review of the literature that analyzes the use of machine learning algorithms in recommender systems and identifies research opportunities for software research. The study concludes that Bayesian and Decision Tree algorithms are widely used in recommender system development appear to offer opportunities for further researches.

Predicting student performance is an important task in Student Modeling. Knowing whether the students solve the given tasks correctly we can understand how the student learn. In the several approaches in recommender systems for student modeling, especially for predicting student performance are introduced.

In the the authors investigate the problems what to model and how to divide the student model into components in the context of an Intelligent Tutoring System for training in infectious diseases. Case-Based Reasoning and Bayesian Networks modeling techniques have been used

2. The Intelligent Recommendation System

In this section we describe the functionality of the intelligence tutoring system (IRS). The IRS produces recommendations to students for improving theirs academic achievements.

The IRS contains six main components:
The Domain Model;
The Pedagogical Module;
The Student Model; The Performance Prediction Module is submodule of the Student model;
The Recommendation Module.

2.1. The Student Model

The database of the module contains all information, which may be affect to students performance. This knowledge can be classified into the four groups:

First group consists of knowledge relating to the pre-university period. Here include the following:

- type of the school, where the student has been graduated;
- university entrance score;
- university (department) preference order;
- reason why the student has chosen the given department.

All types of the graduated schools we divide into three classes: 1- vocational school; 2- science school; 3-general school.

University entrance scores of the students we divided into 5 groups: low; middle; high, very high.

The university preference of the students is evaluated as low preference; middle preference; high preference.

The reasons why the students choice the given department were divided into 5 classes:

1. love for the profession;
2. Prestige of the profession;
3. Request of the family;
4. Having graduated from vocational school;
5. the entrance score was not sufficient for more prestige departments

The second group of the knowledge belongs to the university period. This group includes the following: test and examination results, GPA, attendance, scholarships, residence, income level, the friendship circle et al.

The third group includes the knowledge, which is not depending on the learning environment, such as educational policy of the government, the number of teachers to be recruited, the number of teachers to be recruited general exams, language exams, the country's economic state et al.

Finally, the fourth group include the knowledge, which is applicable for every groups, This group includes: age, gender, ethnic identity, learning style, personal competences, military service status, employment status, marital status et al.

2.2. The Domain Model

The Domain Model includes information about courses to be learned, and learning materials on each course topic. The knowledge base of the model consists of this information:

- The information for all the courses on the education program (for our investigation we used the courses taught on the program of Computer and Instructional Technologies Education).
- The course outline, which reflects the hierarchical structure of the course topics to be learned;
- A concept ontology, which covers all these concepts and reflects the relationship between them.
- A list of learning materials for each course; Difficulty levels of these materials are determined and the learning materials are ordered by this parameter.

2.3. The Pedagogical Module

The Pedagogical Module performs the role of the instructor. The module determines the learning strategies for the students based on their performance, background knowledge, learning style and other parameters which receive from the student model. To improve student performance the module generates effective learning methods. The Module provides the recommendation module with necessary information to produce recommendations for effective learning. On the other hand, the recommendations are used for the pedagogical module to improve its effectiveness.
2.4. The Performance Prediction Module

This module allows us to make predictions about the performance of each student based on her/his pre-university knowledge to the beginning of a university education.

The factors that most affect the academic performance have been selected as the input parameters of the predictive model. These Parameters are:

- University Entrance Score (UES) – means the entry score of the students enrolled to the university;
- Department Preference order (PO) – indicates the number which the student marked in choosing the department;
- Department Satisfaction (DS) – indicates the level of student’s satisfaction;
- Social-spatial factors (SSF) – in the opinion of the student, a factor most affecting its academic achievement. The output of the model is the classification result. According to the values of the input parameters the model predicts academic performance of students. If a student's performance value is below a certain value (in our applications, we take this value to 2.5), these students will be classified as risky student in the academic sense. Otherwise, the student is classified as not risky.

The predictive model includes three type of classifiers, namely Naïve Bayesian Classifier, Decision Tree Classifier, and Fuzzy Classifier.

2.5. The Recommendation Module

The Module assists the learner in order to answer the questions such as “what should I read to learn the topic”, “what should I do if the proposed materials are difficult to understand”, or “materials offered to me are very simple”. The Module generates various learning scenarios and recommendations for learners depending on what class(risky or non risky) the students belongs to.

3. Conclusion

In this paper, the structure of the intelligence recommendation system is proposed. The main component of the proposed system is the predictive model. The model allows to make predictions about the performance of each student based on her/his pre-university knowledge to the beginning of a university education. If a student's performance value is below a certain value, these students will be classified as risky student in the academic sense. Otherwise, the student is classified as not risky. Depending of the classification results, the recommendation system generates various learning scenarios and recommendations for learners.

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