2H-01

Learning Path Recommendation in University Environments Based on Sequence Mining

Boxuan Ma
Graduate School of Information Science and Electrical Engineering
Kyushu University
Fukuoka, Japan
ma.boxuan.611@s.kyushu-u.ac.jp

Yuta Taniguchi
Graduate School of Information Science and Electrical Engineering
Kyushu University
Fukuoka, Japan
taniguchi@ait.kyushu-u.ac.jp

Shin'ichi Konomi
Graduate School of Information Science and Electrical Engineering
Kyushu University
Fukuoka, Japan
konomi@artsci.kyushu-u.ac.jp

Abstract： Learning path recommendation system efficiently guides learners by constructing appropriate learning sequences from recommended learning materials to reach their goals. However, learning path recommendation systems for university environments is different from conventional mechanisms for recommending relevant online courses such as MOOCs. This paper first analyzed different learning path patterns of former students at Kyushu University and discussed the challenges to recommend appropriate learning sequence for students' whole academic career in university. Then we proposed an approach to address the challenges by designing a learning path recommendation mechanism based on sequence mining.

1. Introduction

The Internet has created a new learning environment for learners. For enhancing the performances of learners in e-learning environments, it is quite practical to provide learning materials for learners in an appropriate sequential form based on their requirements and preferences. The online education platform has soared in recent years, which have increased the number of accessible learning opportunities. Massive Open Online Courses (MOOCs) are widely used all over the world nowadays.

Researchers have tried to develop various approaches to recommend suitable learning path for learners on MOOCs. With data of learners' learning goal and background, they can provide a complete learning path to meet learners' needs. For example, if a learner interested in Data Science, the system will recommend him/she a series of courses to learn in order to achieve him/her goal.

Although MOOCs have their own benefits to provide suggestions to assist learners who have no sufficient experience to choose suitable learning path which they need, they are inherently limited in supporting learners in the university environment. Indeed, e-learning systems and Learning Management Systems are increasingly used together in schools. One example is the M2B system which is used for supporting daily classroom teaching in Kyushu University. The selection and recommendation of learning path such as the ones at Kyushu University are often different from those in MOOCs.

Courses in university environments are closely interwoven with various types of physical, pedagogical and social contexts. For example, in Kyushu University, every major has required courses that students must take and elective courses which is one chosen by a student from a number of optional subjects. Students generally receive a grade and academic credit after completion of the course. They need to get enough credits to meet the requirements of graduation. It is difficult for students to decide which courses they should take because there are a large number of courses to choose from, also students' interests and goals can change as they explore and discover something meaningful on and off campus, and there are complex constraints and contexts that have to be considered in choosing courses. Just to give a couple of examples: (1) Students even from the same major may have different learning goals. For example, some students choose courses based purely on their interests. However, some students just choose the courses that allow them to get credits easily. (2) Various courses are provided for each academic year, however, students may take mostly courses in the first two years, because they may busy for internship or finding job in the third and fourth year.

In this paper, we discussed the challenges to recommend appropriated learning path for students' whole academic career in university environments and proposed a preliminary approach based on the sequence mining.

2. Related Work

Researchers have tried to develop various approaches to recommend suitable learning path for learners. The approaches could be grouped into three categories: intelligent optimization, knowledge-based and data mining approach. Since a learning path is a combination of learning resources units, it could be obtained by finding an optimal sequence based on some criteria, and therefore this could be seen as an optimization problem. In this way, the genetic algorithm, ant colony optimization and particle swarm optimization are used by researchers to address this problem. Knowledge-based approach applies a unified knowledge representation to a specific domain to annotate knowledge objects. Therefore, ontology and context-aware based methods are used to represent the knowledge structure to help to recommend. Data mining approaches use former learners' data to find an optimal path for the similar active learner.

Although a variety of techniques have been proposed in learning path recommendation systems, combining sequence mining with students' feedback in order to reach the needs of different students for different goals has never been done before. In this paper, we first analyzed the records of university students' learning path patterns and then discussed sequence mining methods for recommending learning path based on those path patterns.

3. Method

3.1 Learning Path Map

It is useful for taking advantage of the collaborative experience of the students who have finished their studies. Applying sequence mining to interpret this data can reveal hidden relations between courses followed by students. The M2B system of Kyushu University manages student attendance, provide quizzes, and records educational and learning activities of teachers and students during class. It also keeps student information such as: the courses they followed, their profiles and their final score in each course. A large amount of former student data is available in M2B system. We analyze approximately 38,968 anonymized records from 2,366 students via M2B system for this analysis. These students enrolled in 2015 at Kyushu University, so we have the records of course selection during their four years from freshman to senior students.

In order to mine meaningful relationships from former students, this paper uses frequency itemset algorithm. It enables us to know which courses are often followed simultaneously.

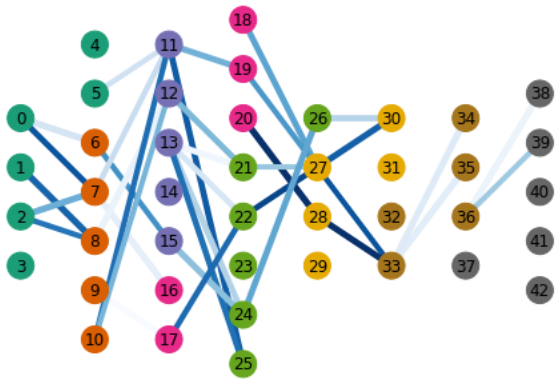

Figure 1. Learning path map of former students

Figure 1. shows the learning path map for former students. Each column represents a semester, and each node represents a course. Particularly, in each column, nodes are arranged from top to bottom in order of frequency. For example, the top course in the first column is a course followed most frequently by students of their first semester. We calculate the confidence between each node and connect the nodes whose confidence is greater than the threshold. In this way, we can get the learning path map of four years, eight semesters from former students.

The learning paths from former learners may not be the optimal ones, but they constitute a starting point as well as a way to circumvent the cold start problem. Moreover, these paths will be improved as more and more students interact with the system and evaluate recommendations.

3.2 Improvement and Evaluation

Figure 2. shows the architecture of the learning path recommendation system. The data collected from M2B system will be used for the recommend system. We use those datasets to generate learning path map based on sequence mining methods. The system follows up the recommendations it provides and asks the students to evaluate the courses recommended to them. Also, both teachers and students write journals after each class, which is helpful to get the feedback. The evaluation and feedback includes different parameters such as scores，interest and then we use those parameters together with sequence mining criteria to calculate course weights. According to course weights, the system rearranges these courses. In this way, the system improves its performance and updates year by year. The recommendation is performed by following the paths in the map according to the courses followed by a student. If one course has been followed in the first semester, the system will recommend the course which is connected to that one for the next semester. And if there is no connection for next semester，the system will recommend the top one in the second column. We also could change the values of the used parameters for achieving different goals of students, then we could develop different learning path models.

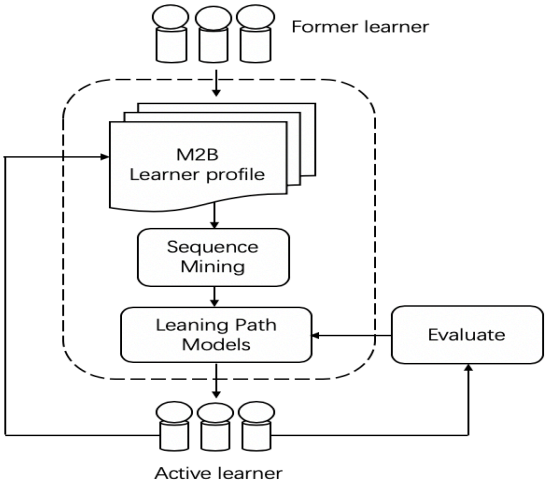

Figure 2. Architecture of the learning path recommendation system

4. Conclusion

In this paper, we discussed the challenges to recommend learning path in university environments and proposed a preliminary learning path recommendation system to address the challenges based on sequence mining.

The system has some limitations when providing its recommendations. For instance, it does not yet consider student background and course availability, we will plan to enhance its performance by using these factors in future. Future work will also include the evaluation of the system.

Reference

[1] Chen C M. Intelligent web-based learning system with personalized learning path guidance [J]. Computers & Education, 2008, 51(2): 787-814.

[2] Brusilovsky P. Adaptive and intelligent technologies for web-based education [J]. KI, 1999, 13(4):19-25.

[3] Bendakir, Narimel, and Esma Aïmeur. “Using association rules for course recommendation.” Proceedings of the AAAI Workshop on Educational Data Mining. Vol. 3. 2006.