Faculty of Cognitive Sciences and Human Development

DESIGN AND DEVELOPMENT OF ELECTIVE COURSES RECOMMENDER SYSTEM (ECORS)

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DESIGN AND DEVELOPMENT OF ELECTIVE COURSES RECOMMENDER SYSTEM (ECORS)

ENG PEI WEN

This project is submitted
in partial fulfilment of the requirements for a
Bachelor of Science with Honours
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The project entitled 'Design and development of Elective Courses Recommender System (ECORS)' was prepared by Eng Pei Wen and submitted to the Faculty of Cognitive Sciences and Human Development in partial fulfillment of the requirements for a Bachelor of Science with Honours (Cognitive Science)

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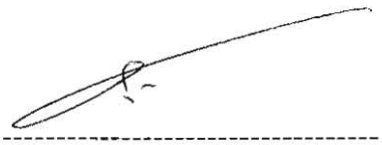

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ABSTRACT

Choosing elective courses is important for all undergraduates student in Universiti Malaysia Sarawak (UNIMAS). There are vast number of courses available and student might lack of awareness of which courses to follow. This project aimed to design and develop an elective course recommender system for the purpose of providing recommendation of elective courses based on student's interest. A rule-based algorithm is chosen to use in this project. It combines normalized scores representing variables such as interest score including a student's personal interests. This creates a final normalized score for each course. Ultimately, the courses with the highest interest scoring are passed on to the User Interface. Usability testing is conducted in system evaluation process using questionnaire adapted from Recommender systems' Quality of user experience (ResQue). The main purpose is to examine the user's experience towards ECORS in terms of quality of recommended items, interaction adequacy, interface adequacy, perceived ease of use, perceived usefulness and attitudes toward system.

Keywords: elective course, recommender system, rule-based, algorithm

CHAPTER 1
INTRODUCTION

1.0 Introduction

Registering elective courses is important for all undergraduates student in Universiti Malaysia Sarawak (UNIMAS). Elective courses are registered through the UNIMAS Student Information System. All students are required to take at least nine credits of elective courses in order to fulfil the degree requirement during study. However, there are many available choices of elective courses in the system.

This includes elective courses from Faculty of Cognitive Sciences and Human Development (FCSHD), Faculty of Economics and Business (FEB), Faculty of Engineering (FENG), Faculty of Computer Science & Information Technology (FCSIT), Faculty of Resource Science & Technology (FRST), Faculty of Applied & Creative Arts (FACA), Faculty of Medicine and Health Sciences (FMHS), Faculty of Social Sciences (FSS) and Centre for Language Studies (CLS) (Faculty Guidebook of FCSHD, 2016). Thus, students are facing trouble in which elective courses should they choose. Based on this scenario, this project aims to develop an elective courses recommender system to provide students the best elective course that suitable for them.

1.1 Background

The courses in UNIMAS has two categories which are compulsory courses and elective courses. Compulsory course are courses that must take in order to fulfil the degree requirement. However, elective courses are courses that are optional and students are freely to select any elective course that they want. UNIMAS provides several options of elective courses for students to choose. So, the university students are trouble in choosing the elective courses that they like or desired. Furthermore, the grade of elective course may influence the overall

Cumulative Grade point average (CGPA). So, it is important to choose wisely which elective course is suitable for them. Generally, there are many technique to provide recommendation for users.

In real life, users expect recommendation for music, movie, food or online shopping. So, the technique to provide recommendation involves Information Retrieval (IR) and also Information Filtering (IF). IR responses to user queries and addresses the problem related to document retrieval from a collection which is a firmly established field in information science. On the other hand, IF is a more latest specialisation within information science, which is having come to the fore due to the rising amount of online transient data (Riordan & Sorensen, 2002).

Information retrieval (IR) is searching material of an unstructured nature within a huge collections that satisfies an information need (Manning, Raghavan, & Schutze, 2009). Unstructured nature refers to a set of data the does not have clear, semantically overt and easy-for-computer structure. In the past, information retrieval is an activity that engaged only for few people such as reference librarian, and other professional searchers. Nowadays, people are engaging in information retrieval frequently such as using a web search engine or search their email. Information retrieval is taking over the tradition way of database style searching and become the dominant form of information access quickly (Manning, Raghavan, & Schutze, 2009).

IR executes user's command in order to find out information from a massive database (Chen, Hsu, Chen, & Hsu, 2008). For instances, search engine is one of the example of IR. However, there are too many irrelevant information included in the returning result. The users are require to spend more time to screen all the information one by one in order to get the required information and it's time consuming. So, some users expect to be passively receive the provided information (Chen, Hsu, Chen, & Hsu, 2008).

Information Filtering (IF) is delivering of information that a user is probably to find it interesting or useful. Information filtering could provide relevant information to the users by assisting users in filtering data source (Vasudevan, Sharmila, & Arasu, 2012). IF provides the information filtering, personalisation and satisfy the preference of users. So, it could recommends items that interests users and thus help them to find useful and related items (Frias-Martinez, Magoulas, Chen, & Macredie, 2006).

When the information delivered in the form of suggestions, this information filtering system is known as a recommender system. An information filtering system has to be personalised to meet the needs of user's interest due to different users may have different interests. User profile of the preferences is needed by gathering feedback from the user. There are two approaches for information filtering which is collaborative filtering and content-based filtering. A collaborative filtering selects items based on correlation between users with similar preferences. Nevertheless, a content-based filtering chooses items based on correlation between the item contents and user's preferences (Vasudevan, Sharmila, & Arasu, 2012).

1.2 Problem Statement

University student faces two main challenges which are vast number of courses from which to choose and lack of awareness of which courses to follow (Ray & Sharma, 2011). A huge amount of elective courses often offered by university for students. For instances, UNIMAS offered several of elective courses from different faculty such as FCSHD, FEB, FENG, FCSIT, FRST, FACA, FMHS, FSS and CLS (Faculty Guidebook of FCSHD, 2016). Confusion may occurs when there is many available options.

Generally, it is difficult for them to familiarise with all of elective courses and to find the most suitable elective course. Thus, students are facing trouble in which elective courses should they choose. Students usually get recommendation of elective courses from peer student

suggestions or based on own personal interest. Registering the most favourable elective course is important for UNIMAS students, this is because the grade get from this course will be counted in the overall CGPA and could affect the result. As a result, every student has to choose the elective course based on their interest and most importantly get some recommendation from peers.

1.3 Research Objectives

1.3.1 Main Objective

- To design and develop an elective course recommender system which able to provide recommendation based on their interest.

1.3.2 Specific Objective

- To adapt a suitable instrument and appropriate algorithm in order to provide appropriate elective course recommendation.

1.4 Research Questions

The research objectives lead to some of the research questions as follows:

i. Which instrument is suitable to adapt in assisting elective courses recommendation?
ii. Which algorithm is suitable in providing recommendation of elective courses?
iii. How should the effectiveness of elective course recommender system be measured?

1.5 Significance of Study

This project is mainly to design and develop an elective course recommender system for the purpose of providing recommendation of elective course based on student's interest. This research aims to introduce a recommender system to aid the process during elective course registration.

The significance of study is to enhance knowledge about elective course registration development and also the development of a web based recommendation algorithm. So, the knowledge of web programming, human-computer interaction and expert system and analysis is applied in developing the proposed system. Furthermore, this study also aims to provide UNIMAS undergraduates students a personalised experience and excellent service.

1.6 Relationship with Cognitive Sciences

A recommender system is a combination of learning algorithm, statistical tools, and recognition algorithms. All these areas are commonly ascribed to the study of Artificial Intelligence which is one of the major study in Bachelor of Cognitive Science in UNIMAS (Abott, 2016). Furthermore, recommender system consider the user's personality. It is more effective in terms of increasing loyalty of users towards the system. A recommender system could decrease the cognitive effort compared to the other non-personality-based system (Hu & Pu, 2009)

1.7 Conclusion

In conclusion, this chapter explained about the background of this study and problem statement states the reason of why this research is carried out. The research objectives are also stated which includes main objective and specific objective. The significance of this study and its relation towards cognitive sciences is also discussed.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

University courses usually categorised into two groups such as compulsory courses and elective courses. Compulsory course which is also known as required course. A student must take and pass the compulsory course to fulfil the degree requirement during his study. In contrast, an elective course is optional. A student can select any desired elective courses. The university department usually offered variety of courses for students to build a diversity of student abilities (Jiun & Wen, 2013).

2.2 Current situation of Elective Course Registration System in UNIMAS

In Univeriti Malaysia Sarawak (UNIMAS), undergraduate students are required to take at least nine credits of elective courses in order to graduate. The students can either take the elective course from other faculties or take the elective course at another program on the same faculty. This includes elective courses from Faculty of Cognitive Sciences and Human Development (FCSHD), Faculty of Economics and Business (FEB), Faculty of Engineering (FENG), Faculty of Computer Science & Information Technology (FCSIT), Faculty of Resource Science & Technology (FRST), Faculty of Applied & Creative Arts (FACA), Faculty of Medicine and Health Sciences (FMHS), Faculty of Social Sciences (FSS) and Centre for Language Studies (CLS) (Faculty Guidebook of FCSHD, 2016).

The current elective course registration system in UNIMAS required students to search through the entire course catalogue to look for the desired elective course. According to Ray and Sharma (2011), university student faces two main challenges which are vast number of courses from which to choose and lack of awareness of which courses to follow. University often offered a huge amount of elective courses for students and it is difficult for them to

familiarise with all of them. So, it is considered difficult for university students to search through the whole catalogue and find the most suitable elective course for them. Furthermore, the grade of elective course may influence the overall Cumulative Grade point average (CGPA). So, it is important to choose wisely which elective course is suitable for them. Generally, students usually get recommendation of elective courses from peer student suggestions or based on own personal interest.

2.3 Recommender System

To deal with the information overloaded problem, a recommender system is needed to act as an information filtering systems. The vital information are able to be filtered out among large amount of information that are generated dynamically based on interest, preferences of user or observed behaviour on an item. Based on the user's profile, a recommender system are able to predict whether that user prefer an item or not (Isinkaye, Folajimi, & Ojokoh, 2015).

2.3.1 Type of recommender systems

Recommender system are usually consists of three main categories which are collaborative filtering, content-based filtering and hybrid filtering based on how a recommendation is made.

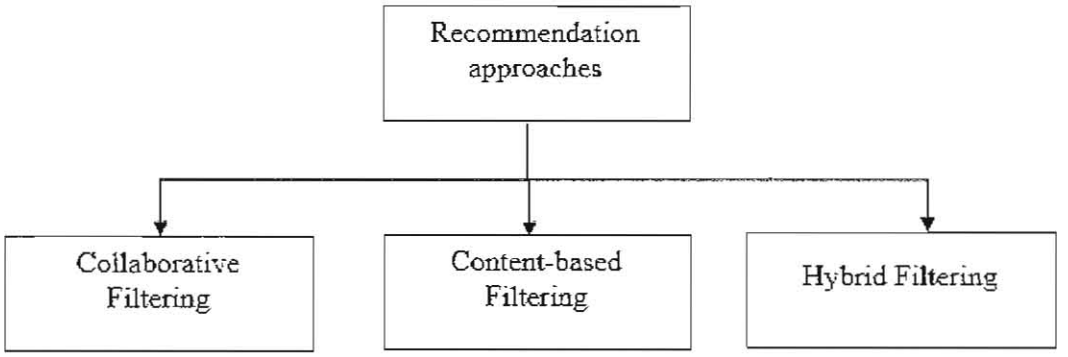

Figure 2.1. Types of recommender system

2.3.1.1 Collaborative Filtering

Collaborative filtering could produce personalised recommendations according user's preferences data or judgment data based on various items showed in the system (Ray & Sharma, 2011). Generally, judgment data is assigned by users in the form of ratings to different item. The rating data can be obtained explicitly or implicitly. Those data that given by the user directly is known as explicit ratings (Ray & Sharma, 2011).

However, data that is collected indirectly by studying data about user from various sources such as purchase data and browsing behaviour is known as implicit data. Many systems used collaborative filtering to do predictions mainly in commercial area. Collaborative filtering based recommender system have been implemented successfully in Amazon, TiVo and Netflix due to its minimal information requirement and recommendation with high accuracy (Ray & Sharma, 2011). In collaborative filtering, the most widely used approach is the nearest neighbours approach.

The technique of collaborative filtering worked by a database building of preferences for items by users which is a user-item matrix. In order to make recommendation, the similarities between user's profiles is calculated to match users with relevant interest and preference. These users build a group which is known as neighbourhood. User could get recommendation to certain items that has not yet rated before but were positively rated by the other user in his neighbourhood already (Isinkaye, Folajimi, & Ojokoh, 2015).

2.3.1.2 Content-based Filtering

Content-based filtering generate predictions based on analysis of the attributes of items. This type of filtering technique is the most successful when comes to recommend documents, for example web pages, publications and news. Based on the user profiles, a recommendation is made by extracting features from items' content that users has evaluated before. The mostly

related items to the positively rated items are recommended to users. In order to produce meaningful recommendation, various models are used to discover the similarity between documents such as Vector Space Model or Probabilistic Model. They could model the relationship between different documents (Isinkaye, Folajimi, & Ojokoh, 2015).

Vector Space Model includes Term Frequency Inverse Document Frequency (TF/IDF) while Probabilistic Model includes Naïve Bayes Classifier, Neural Network or Decision Tree. The underlying model is learned to make recommendation using statistical analysis or machine learning techniques. The profile of other users is not needed in this technique since it would not influence the result of recommendation (Isinkaye, Folajimi, & Ojokoh, 2015).

Furthermore, content-based filtering technique has the potential to modify the recommendation result in a short duration whenever the user profile is changed. However, this techniques required an in-depth knowledge and descriptions of the item features in the profile are considered as the major drawback of this technique (Isinkaye, Folajimi, & Ojokoh, 2015).

2.3.1.3 Hybrid Filtering

In order to gain better system optimization, this technique combines various recommendation technique to avoid limitation and problem of pure recommendation system (Isinkaye, Folajimi, & Ojokoh, 2015). The algorithm is combined to produce a more accurate and effective recommendation compared to a single algorithm. One algorithm are able to overcome the disadvantage of another algorithm. The weakness of a single technique could be supressed by applying multiple recommendation technique in a combined model. For instances, there are few approaches combination can be done such as separate algorithm implementation and combine the result, utilise content-based filtering in collaborative approach, utilise collaborative filtering technique in content-based approach (Isinkaye, Folajimi, & Ojokoh, 2015).

2.4 Theory related

2.4.1 Peer learning theory

There is a long history for peer learning which can be as old as any form of collaborative or community action. Peer learning theory is defined as the knowledge acquisition and skill among status equals or matched companion through active helping or supporting. People from similar social groupings could help each other to learn and learning themselves and these people not including the professional teachers. Peer learning considered the peer helper as a surrogate teacher which is in the form of linear model of knowledge transmission, such as from teacher to peer helper and to learner (Topping, 2005). Basically, peer learning theory is mainly apply in E-leaning system. Students could learn from each other through peer tutoring (PT) and cooperative learning (CL).

Peer tutoring (PT) is highly focus on curriculum content and is characterised by specific role-taking as tutor. Moreover, it has clear procedures for interaction and participants are given generic or specific training. Cooperative learning (CL) refers more to working as a group which in pursuit of specific shared goals. It involves goals specification, tasks, resources, roles and rewards by teacher (Topping, 2005).

However, this project does not applying all this techniques into designing the proposed recommender system which would be discussed later. This project take into consideration of the concept of peer learning theory where students tend to learn from each other among a status equals or matched companion. Based on a study, a recommender framework that based on peer learning theories performs better than content-based filtering approach (Anandakumar, Rathipriya, & Bharathi, 2014). So, the

idea of the peer learning theory would be incorporated into proposed system and would be further discussed in the following section.

2.4.2 Individual Differences

Individual differences states that people are differ from each other. The subject of the study of individual differences in on how and why the people are differ. The study of individual differences seems to focus on how are people different from each other which is study of variance. However, it also study the central tendency where how well a person can be described in terms of overall within-person average (Revelle, 2013).

The major concern in the study of individual differences is whether people are more similar to themselves than to others over time and across situation. Furthermore, another concern is whether variation within one person is less than the variation between people across time and situation. Other than that, questions of individual differences also includes whether a particular groups such as grouping by age, culture, sex, or ethnicity are more similar within the group than between the groups (Revelle, 2013).

The research in individual differences could range from genetic code analysis to study of sexual, social, ethnic, cultural differences and also includes study on cognitive abilities, interpersonal skills and emotional activity (Revelle, 2013). To be more specific in this project, individual differences in psychology is taken into consideration which is the differences in interest. Each man has their own intellectual capacity which gained from their experience and learning.

Interest is a motivating force that drives people to attend to a thing, a person or an activity. In educational field, it is likely to observe that some students favour a particular subject, teacher or profession (Farooq, 2011). Thus, interest is differing from one to another, from male to female, society to society and culture to culture. (Shrivastava, 2016).

2.5 Related works

2.5.1 AACORN (Academic Advisor Course Recommendation Engine)

AACORN which is also known as Academic Advisor Course Recommendation Engine.. It applies a case-based reasoning approach to course recommendation and uses the experience of past students and course histories for course advising. The system uses a metric commonly used in bio-informatics to determine the similarities between course histories. The system requires a partial history of the courses followed by a student before it can provide useful recommendations (Sandvig & Burke, 2006).

Case-based reasoning (CBR) is a problem solving method that uses specific knowledge of previous experiences in order to adapt a solution for a new problem. This is similar to the way humans solve problems. It is the process of remembering an old plan, reusing it, and changing it to fit the current situation. Thus, case-based reasoning is well suited to the academic advising domain because it allows a system to reuse the experience of other students in making a recommendation (Sandvig & Burke, 2006).

It is a case-based reasoning system for recommending courses to graduate students at DePaul CTI. The system is currently in development and includes the essential functionality required of an academic advising system. In particular, it is capable of taking input information about a student, including academic program and

course history, and making a reasonable recommendation of several courses the student could enrol in the next quarter (Sandvig & Burke, 2006).

The basic assumption AACORN makes is that similar students will have similar course histories. Two students in the same program and with similar interests are likely to take many of the same courses. In this way, a student seeking a recommendation can use the experience of students that have completed the graduate program as a template. Any course found in the template that the student has not yet taken is likely a good course to enrol.

2.5.2 RARE

RARE recommends relevant courses to user by combining association rules with user preferences data. The real data are based on department of Computer Science at Universit´e de Montr´eal. The students' past behaviour of their course choice are analysed and association rules are formalised. The rules allowed the system to do recommend prediction for new students (Bendakir & Aimeur, 2006).

RARE recommends course by incorporating a data mining process and user ratings. Significant rules that associate academic courses followed by former students are discovered. Afterwards, these rules are used to infer recommendations. RARE offers a possibility for the user to rate recommendations to gain opinions from student and thus could help in improve the association rules. The benefits of both experience from former student and ratings from current students are combined in order to provide the recommendation with most relevant courses to the users (Bendakir & Aimeur, 2006).

2.5.3 SCR (Student Course Recommender)

SCR which is also known as Student Course Recommender uses strategy based on Bayesian Network Modelling to suggest course. Information stored about the

students who used the system are learned by SCR network. However, the presence of enough cases in student database are required. Thus, SCR could not offered any course recommendation for user who has not started or complete any course and for those who is not pursuing any degree at that university (Ekdahl, Lindstrom, & Svensson, 2002).

SCR could estimate interest of student by employing a learning system with high accuracy. Few information are needed in order to obtain recommendation such as type of education (MSc, BSc, etc.), major (Physics, Computer Science), specialization (Digital Design, Software Engineering, Robotics) and previously taken courses. Furthermore, the system could learn from new example and thus increase the reliability of estimation. This is done by using course choices of old students as a training sample. All students are choosing course for twice per year, so this could offer sufficient training example. This system aims to utilise a machine learning system to predict user interest which is student interest in course given at university (Ekdahl, Lindstrom, & Svensson, 2002).

2.5.4 Course Recommender System

Course Recommender System is based on various collaborative filtering algorithm including user-based and item-based. Based on the course ratings of other users, it could estimate the usefulness of courses to a particular student. One must evaluate as many courses as possible in order to get an accurate recommendation. However, for those who have not taken any course at University, the system could not provide any recommendation for him (Ray & Sharma, 2011).