Summer 7-26-2022

Intelligent University Course Selection System Based On Collaborative Filtering Model

Lufeng Han
Office of Academic Affairs, Nanjing University of Finance and Economics, Nanjing, 210023, China

Short Research Paper

Intelligent University Course Selection System Based On Collaborative Filtering Model

Lufeng Han

(Office of Academic Affairs, Nanjing University of Finance and Economics, Nanjing, 210023, China)

Abstract: With the rapid development of information technology, intelligent university course selection system is indispensable. Based on the user and the mixed model of collaborative filtering recommendation system to explore a set of suitable for the intelligent course selection recommendation system in universities. This system is conducive to further improve the quality of college education services.

Keywords: Intelligent university course selection; Collaborative filtering ; Recommendation system

1. INTRODUCTION

With the advent of information overload, the application of information tools has become very common among colleges and universities courses selection, adopted by so many colleges and universities to provide services for students[1]. The course selection system means that college students are allowed to have certain freedom to choose the courses offered by the school, including the choice of courses, teachers and class time, and the amount and process of learning that suits them.However, in the face of massive data , some students, in the deviod of clear ideas, blindly choose courses and only vaguely understand their major. At this time, the educational administration system of colleges and universities needs to quickly recommend elective courses that meet the requirements of students, so as to solve the "fear of choice" of some students. Although at present the use of information university course selection system is very common, with almost all colleges and universities opted for the corresponding information system, these systems are not smart enough as they can only deliver the basic course selection service.The traditional course selection system will have the following disadvantages and adverse effects.First of all, the current elective system is not conducive to the development of students' personality. Secondly, although some schools allow cross-grade and cross-major course selection, students still cannot choose freely due to the influence of traditional course arrangement methods, teacher resources and classroom resources. It is common for students to fail to select courses due to the conflict of class time. Moreover, the work of guiding course selection has not been well implemented, so that students, especially freshmen, are at a loss to the textbooks, teaching instructions, course introduction and course selection guide, and there is a phenomenon of blind course selection,many students choose courses blindly. Most of them follow the trend and choose courses without their goals and ideas. Such behaviors may eventually lead to students choosing courses that they are not interested in and do not study, resulting in low grades or a good waste of learning time. Therefore, if colleges and universities can provide intelligent recommended course selection module, the occurrence of this event will be greatly reduced.

At present, we mainly see demographic-based recommendation algorithms,content-based recommen-dation algorithms, and collaborative filtering based recommendation algorithms, which are the core of the intelligent recommendation system for selecting courses. The main idea of these algorithms in the application of the course selection system is that demographics-based recommendation is a simpler way to discover the degree of relevance of student users based on the basic information of the system, and then recommend courses favored by similar students to the current students. Content-based recommendation is mainly based on the original data

of recommended content or courses to find the correlation between courses, and then recommend similar courses for students based on their previous course selection preferences. The recommendation based on collaborative filtering can be divided into user-based collaborative filtering, item-based collaborative filtering and model based collaborative filtering. Among them, user-based collaborative filtering mainly considers the similarity between students and students. As long as the courses favored by similar students are found and the scores (evaluations) of corresponding courses are predicted by target users, several courses with the highest scores can be found and recommended to users[2]. However, item-based collaborative filtering is similar to user-based collaborative filtering, except that the similarity between courses and courses is found. When the scores of certain courses are found by target users, the similar courses with high similarity can be predicted and several similar courses with the highest scores can be recommended to students.

In short, with the prominence of students in the teaching process, their course selection has become an important way for personal academic success. However, most universities still have some deficiencies in the course selection mechanism. Towards that end this paper introduces data mining technology and collaborative filtering algorithm in the course selection process. This paper studies the personalized recommendation system for elective courses in colleges and universities. By analyzing the current situation of elective courses in colleges and universities and applying relevant technologies such as collaborative filtering algorithm, data mining technology and personalized recommendation technology to the system, it promotes the optimization of personalized recommendation system for elective courses. The combination of the current intelligent recommendation algorithm and the course selection system can use the characteristic information of students and courses to recommend those courses with characteristics that students like. It also possible to use the courses the student has chosen to recommend courses similar to those he likes or has chosen or other students who are similar to students to recommend items that other students who have similar interests and hobbies like to students[3]. As a result, the current existing problems, and in the networked education management environment, how to make use of the existing algorithms and theory, from a large number of historical course data found in the hidden and useful knowledge to guide, improve and improve the mechanism of the current university course of study, become the important research subject, it is imperative to today at the same time reform of the teaching management in colleges and universities has important practical significance.In this paper, the recommendation algorithm based on the hybrid collaborative filtering model based on user and project weighting is mainly intended to provide students with more efficient course selection services, recommend more suitable courses, and help navigate to the courses trully attracting students from a large amount of information, which is of great significance and practicability.

2. COMPOSITION OF COURSE SELECTION AND RECOMMENDATION SYSTEM BASED ON COLLABORATIVE FILTERING

Personalized recommendation algorithm is the main part of recommendation system, and the research on recommendation system is actually the research on personalized recommendation algorithm, because the performance of personalized recommendation algorithm determines the performance of recommendation system. At present, there are many main recommendation algorithms used in the recommendation system, and all kinds of recommendation algorithms have their own advantages and disadvantages and adapt to the environment, among which collaborative filtering recommendation algorithm is the most studied and most widely used personalized recommendation algorithm.Collaborative filtering recommendation makes use of features that may be similar in similar users' purchasing behaviors to make recommendations, regardless of the product's own attributes. It mainly relies on the opinions of the nearest neighbor users to make recommendations, which tends to be personalized.Collaborative filtering algorithm can be divided into user-

based collaborative filtering algorithm and project-based collaborative filtering algorithm.Among them, the former calculates the similarity between users by analyzing the historical data of users, and then relies on nearby users to provide recommendation services. The latter calculates the similarity between projects by analyzing the behavioral data of users acting on projects, and then makes recommendations for users according to the calculated similarity of projects and users' historical interests. Although these two types of collaborative filtering recommendation algorithms have been widely used in recommendation systems.

However, both user-based and project-based collaborative filtering recommendation algorithms have the following two major problems in practical application:1) Data sparsity.On most websites, the user history is a tiny fraction of the total product set. For example, on Amazon, after users purchase goods, their comments on goods account for less than 1% of the total amount of goods, which causes the problem of data sparsity. The sparsity of data leads to the situation that there is no intersection between projects, so it is impossible to judge whether users' preferences are similar or not. Without similar user sets, the recommendation effect will decline sharply.2) Scalability issues.Scalability is always the focus of collaborative filtering recommendation algorithm research. As we know, both user-based collaborative filtering recommendation algorithm and project-based collaborative filtering algorithm have a linear increase in computation with the increase of users and projects, thus causing scalability problems. In addition, even if the improved project-based collaborative filtering recommendation algorithm is adopted, the computational complexity will still become a performance bottleneck when the data volume is huge.In order to solve the above two problems, combining the advantages of user-based collaborative filtering and project-based collaborative filtering,this paper proposes a personalized recommendation algorithm combining user-based and project-based collaborative filtering.

In order to realize the function of intelligent course selection recommendation system, the collaborative filtering model and the function of course selection module system can be combined together better. The course selection and recommendation system can be roughly divided into four entities, including student information entity, course information entity, course evaluation entity and administrator information entity. Among them, the student information entity can record students' personal professional information, courses taken in the past, grades and other data; the course information entity can be used to record the course time, course teachers and other relevant information; the course evaluation entity mainly records the number of courses selected, the distribution of students who choose courses, and student evaluation. The administrator information entity mainly stores the information related to login and management permissions of the system background administrators.

The flow chart of the recommendation system is shown in Figure 1.The recommendation system collects students' information and puts it into the student information entity, and then puts students' course selection records, course selection preferences and students' evaluation to calculate the scoring matrix into the course evaluation entity.At the same time, student relevance is calculated based on user recommendation, and course relevance is calculated based on project recommendation. Finally, weighting is carried out based on user

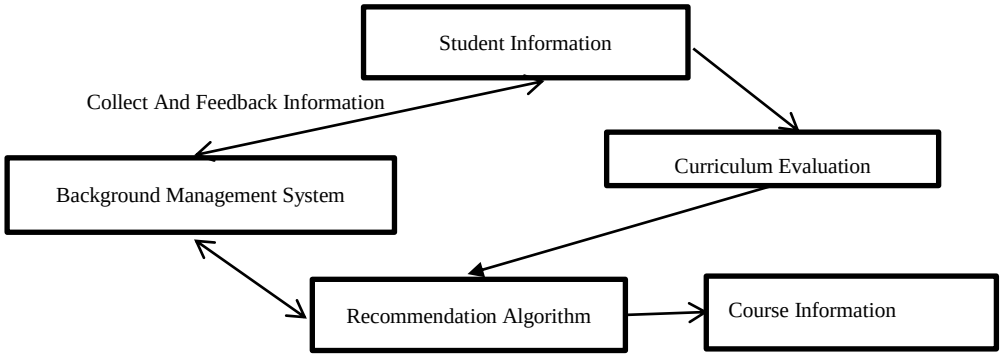

Figure 1. Recommend system model diagram.

recommendation algorithm and project recommendation algorithm, so as to predict students' score on courses and provide personalized recommendation.

3. RECOMMENDATION ALGORITHM MODEL DESIGN

Collaborative filtering recommendation algorithm is one of the most popular recommendation algorithms. The algorithm based on user recommendation takes all the preferences of a user as the similarity between users, finds the adjacent users, and uses the similar behavior history as the item to predict the possible behavior of the current user. However, relative to the rapidly increasing number of users, the calculation of the relevance of users becomes complicated, and the growth rate of the number of items is still slower than that of users. Therefore, project-based collaborative filtering algorithm gradually replaces the traditional user-based recommendation algorithm[4].

This project-based algorithm believes that if users score high on similar projects of the current project, then users are more likely to choose the current project. This algorithm is based on the calculation of the correlation between projects, but when new users or new projects appear, this algorithm will be greatly discounted. It can be seen that the scalability of the traditional algorithm is weak and the problem of cold start is serious[5]. In order to achieve further personalized recommendation for students and courses, this paper aims to design a weighted hybrid college course selection recommendation system based on user collaborative filtering algorithm model and project-based collaborative filtering model to achieve personalized service for course recommendation. According to the above basic principles, we can split the user-based collaborative filtering recommendation algorithm into two steps:First,Find a set of users with similar interests to the target users. Second,Find items in this collection that users like and that target users have never heard of and recommend to target users.

3.1 Based on user recommendation algorithm

Based on the assumption that "you're more likely to like what people like you like." Therefore, the main task of user-based collaborative filtering is to find out the nearest neighbor of the user, so as to make the score prediction of unknown items according to the preferences of the nearest neighbor. This algorithm is mainly divided into three steps:1)User ratings:It can be divided into two types: explicit score and implicit score. Explicit rating is the direct rating of the project (such as users' rating of movies), while implicit rating is the rating of the project through evaluation or purchase behavior (such as purchasing things on Taobao or commenting).2)Find the nearest neighbour:This step is to find the user closest to you, and the following three algorithms are generally used to calculate the distance: cosine similarity measure, Euclidean distance similarity measure and Jekard similarity measure. The Euclidean distance similarity measure will be illustrated in a later demo.3)recommended:After the nearest neighbor set is generated, the unknown item is scored and predicted according to this set. Recommend the N items with the highest ratings to users.

The collaborative filtering algorithm based on users is mainly divided into three processes, the first is to build a user model, the second is to find the nearest neighbor users, and the last is to generate a list of recommended items. The recommendation system in this paper is built on the basis of user collaborative filtering recommendation algorithm, looking for similar users, and similar users are defined by choosing the same courses. This system adopts theuse the cosine similarity of user similarity calculation [6], specific to the student to the course grade is set to n dimensional space vector, and those who do not choose a course grade students of the course is set to 0 select course grade students in the course of 1, so user, user j I n d grade on the project space, Can be expressed by the following formula 1:

$$Sim(i, j) = \cos(I, J) = \frac{I * J}{\|I\| \bullet \|J\|} = \frac{\sum_{c=1}^{n} R_{i,c} R_{j,c}}{\sqrt{\sum_{c=1}^{n} R^2{}_{i,c}} \bullet \sqrt{\sum_{c=1}^{n} R^2{}_{j,c}}}$$

Formula 1. Calculate user similarity

Similarity by users, can build students - curriculum evaluation matrix, the general model of collaborative filtering of the input data is usually said m * n users, the evaluation matrix of R<m, n>, which m represents the number of students for m, n is said the number of courses, including Rij says is the first I a student for the first j a course ratings, The score value in Table 1 represents whether the student has chosen the course. If so, it is marked as 1, and if not, it is marked as 0, as shown in Table 1:

Table 1. Student-course evaluation matrix R<m,n>

	Course 1		Course j		Course n
students1	R_{11}	……	R_{1j}	……	R_{1n}
……	……	……	……	……	……
Students i	R_{i1}	……	R_{ij}	……	R_{in}
……	……	……	……	……	……
Students m	R_{m1}	……	R_{mj}	……	R_{mn}

Therefore, the most important thing is to search the "nearest neighbor" set of the target user, that is, for user U, to find its "neighbor" set U={$U_1, U_2, \cdots U_k$}, and user U does not belong to the set U, and then sort from U_1 to U_k in order of similarity. The more the same courses are selected, the greater the similarity between U and a user in the user set. Then, the unselected courses in the list of courses of users with high similarity with the user can be recommended. However, as the amount of user data becomes larger and larger, the calculation becomes more and more complex, and the performance of the system becomes worse and worse, so collaborative filtering based on items comes into being [7].

Other,we can extract the user's course selection theme and interest theme; On the basis of these themes, the elective community and interest community of users are formed respectively. Will communities into matrix form respectively, using matrix decomposition method of matrix decomposition to calculate each user communities in each community will focus on the score matrix, take individual users to concentrate on in all the will of the community the maximum score for the final will focus on scores, to target users sort it with other users intend to focus on the score finally, finally choose the highest score TOPN users are recommended users. It has the advantages of obtaining more accurate recommendation results of network users for selecting courses.

3.2 Based on item recommendation algorithm

The biggest difference between the project-based recommendation algorithm and the user-based recommendation algorithm is that the user-based recommendation algorithm compares the similarity between users and then finds the nearest neighbor set, while the project-based recommendation algorithm compares the similarity between projects. This algorithm first finds the projects that have been evaluated by target users. In this system, it is to find the courses that the target students have evaluated, calculate the similarity between them and the target course I, and then select K projects that are most similar according to the similarity, that is, the "nearest neighbor set" of the projects I={$I_1, I_2, \cdots I_K$}, and then arrange them from small to large according to the

similarity[8].

In other words,unlike the user-based collaborative filtering recommendation algorithm, which compares the similarity between users, the project-based collaborative filtering recommendation algorithm compares the similarity between items.the project-based recommendation algorithm mainly consists of two steps: calculating the similarity and predicting the score value of the recommended item, and then making the recommendation. To calculate project similarity, it is necessary to find all users who evaluate project I and project J at the same time, and then use Pearson correlation coefficient to calculate the degree of acquaintance between projects $Sim_{<i,j>}$as shown in Formula 2, where Formula V_{ij} is the score of user I on project J. $\overline{V}_a$ and $\overline{V}_b$ is the average score of all users whose project A and project B are overrated [9].

$$Sim(a,b) = \frac{\sum_{i=1}^{n}(V_{ai} - \overline{V}_a)(V_{bi} - \overline{V}_b)}{\sqrt{\sum_{i=1}^{n}(V_{ai} - \overline{V}_a)^2} \bullet \sqrt{\sum_{i=1}^{n}(V_{bi} - \overline{V}_b)^2}}$$

Formula 2. Calculate course similarity

The most important step for the project-based collaborative recommendation algorithm to output project results is the prediction stage. After the similarity of all items is calculated, K items with the largest value are found out and then the sum of project scores is calculated by weight calculation method, which is the required predicted value. The details are shown in Formula 3:

$$P_{ai} = \frac{\sum_{i=1}^{n}(Sim_{ij} - V_{aj})}{\sum_{i=1}^{n}(|Sim_{ij}|)}$$

Formula 3. Calculates the sum of item scores

Then,specific users are recommended according to the predicted value. Compared with user-based collaborative filtering, project-based collaborative filtering obviously requires much less computation, so the performance is greatly improved, but the accuracy is also sacrificed. Both of them have their own advantages and disadvantages. In order to further optimize, this paper intends to use the hybrid collaborative filtering algorithm based on user and item for course selection recommendation.

3.3 Hybrid collaborative filtering recommendation algorithm based on item and user

For project-based and user-based hybrid collaborative filtering algorithm, the similarity of project-based collaborative filtering algorithm and user-based collaborative filtering algorithm needs to be calculated from two aspects, which is different from the calculation of user similarity or project similarity. On the one hand, the similarity of results based on students' interests needs to be calculated. On the other hand, we need to calculate the similarity of scoring for elective courses[10], and use the weighted value method to calculate the mean score of the nearest neighbor data set, as shown in Formula 4 and Formula 5,and $P_{course(s,i)}$ is the predicted score of a certain course s for a certain user i, $P_{stu(s,i)}$ is the predicted value based on students' interests,$Sim(u,v)$ is the correlation coefficient to calculate the degree of acquaintance between items, $\overline{T}_s$ is the average score of all the

items that a student overrated, $\overline{T}_c$ is the average project score of all overrated users for a given course, $\overline{T}_{vi}$ is user v's rating of item i,similarly, $\overline{T}_{ci}$ represent course c is rated by user i.last but not least, the purpose of the formula is to calculate the weighted average score:

$$P_{\text{stu}}(s,i) = \overline{T}_s + \frac{\sum_{v \in knn(u)} Sim(u,v) * (T_{\text{vi}} - \overline{T}_{\text{v}})}{\sum_{v \in knn(u)} |Sim(u,v)|}$$

Formula 4. Calculate the similarity based on the user

$$P_{\text{course}}(s,i) = \overline{T}_c + \frac{\sum_{j \in knn(i)} Sim(i,j) * (T_{\text{ci}} - \overline{T}_{\text{i}})}{\sum_{j \in knn(i)} |Sim(i,j)|}$$

Formula 5. Calculate the similarity based on the course

And based on the project and the mixed collaborative filtering recommendation algorithm based on user is the most important step is also in the forecast period, but for the hybrid collaborative filtering recommendation algorithm, not a single to forecast, combination forecast need to score, mainly considering from the aspect of impact factor to courses according to students interested in forecast and score prediction of collaborative filtering, The value range of the influence factor λ is set at [0,1], mainly to control whether the recommendation system selects elective courses based on students' interest or filters them based on the scores of nearby students[11]. When the value λ is set to 0, it means that the recommendation system will recommend freshmen, which can solve the problem that the user-recommendation algorithm does not take into account the increase of new users. At this time, the recommendation system mainly recommends elective courses according to the collaborative filtering of students' registration information, that is, it prefers project-based recommendation algorithm to make recommendations. Otherwise, collaborative filtering recommendation is made according to the score of the nearby students who take this course, as shown in Formula 4, where is the predicted score of a certain course s for a certain user i, and $P_{stu(s,i)}$ is the predicted value based on students' interest, which is also the weighted average of the predicted value based on user recommendation:

$$P_{\text{si}} = \lambda * P_{stu}(s,i) + (1-\lambda) * P_{course}(s,i)$$

Formula 6. A weighted average of user-recommended predicted values

The final stage of generating the recommended sequence table is mainly to calculate the similarity selection among students. After assigning different weights to different features, the similarity between student I and other students of the same major is calculated on the mixed model, and the N students with the most similar students are selected as the set of nearest neighbors. After obtaining the similarity of the elective courses between the target student and the neighbor students, the scores of the students on all the unelective courses can be predicted, and the top-N elective courses with the highest scores can be recommended to the elective students. In this way, some shortcomings between user-based recommendation algorithm and project-based recommendation algorithm are greatly solved, and the two methods are more perfectly combined to recommend courses with higher matching degree for students more accurately.In the case of extremely sparse user rating data, the traditional similarity measurement method has disadvantages, leading to a sharp decline in the recommendation quality of the recommendation system. To solve the above problems, a collaborative filtering recommendation algorithm based on item category and interest degree is proposed. In this algorithm, the item category similarity

matrix is constructed by calculating the category distance between items. Then the degree of interest is used to analyze the correlation between different projects. Finally, the improved conditional probability method is used to measure the similarity between projects based on the information of project category and the degree of interest between projects. Experimental results show that the proposed algorithm can effectively alleviate the adverse effects caused by sparse user rating data, and improve the prediction accuracy and recommendation quality.

And through some tests and the practice of movie recommendation system, the experiment shows that the hybrid collaborative filtering recommendation algorithm based on user and item double clustering exceeds the other four collaborative filtering recommendation algorithms in terms of recommendation quality, accuracy and recall rate.Later, we can prove through experiments whether the college course selection recommendation system uses the hybrid user-based and project-based recommendation algorithm to improve the similarity of course selection among students to a certain extent and help the majority of students to choose their favorite courses.

4. CONCLUSIONS AND FUTURE PROSPECTS

After years of development, the educational administration management informationization has basically been accessible to all domestic colleges and universities , and the educational administration system has become one of the most important and popular information systems in schools. However, until now, the educational administration information management is by no means a mature technology. Even though some schools' educational administration systems have been updated or replaced several times, there are certain occasions they still fall short of expectations. We need the system to run smoothly through the integration of school educational administration management work of each link, in line with the school personality needs and development needs, stable and reliable, safe and efficient, high utilization rate, good user experience, making to more friendly to teachers and students.although university informatization has been widely used, it is still not completely intelligent. Currently recommended technology application in the domestic application of mainly exist the following problems, first recommended intelligent degree is low, most depends on the users' search keywords and product category to search, then recommend the timeliness is low, cannot perceive stay in real time according to user's choice of content, the lack of recommendation, a lot of curriculum content in personalized recommendation to the users.This paper mainly aims to recommend courses for students more accurately during course selection, in replace of a single selection module, and proposes the application of hybrid collaborative filtering model based on user recommendation and project recommendation in the course selection system of universities. In addition, current academic researches mainly focus on the algorithm and model of the recommendation system, which has not been fully implemented yet. It is of great significance to introduce the recommendation algorithm into the idea and application of the college course selection system[12].

In this paper, the research work is to use the collaborative filtering algorithm based on user, set up classes at the high school students personalized recommendation system, make the students as much as possible according to their interests, hobbies, talents, learning, choose suitable for their own courses, teachers and learning, for a variety of personality characteristics of students with the best development opportunities; In order to improve the current college course selection mechanism, the user-based collaborative filtering algorithm has the following assumptions: there are similarities in preferences and interests among people; People's preferences for things are stable, so future choices can be predicted based on past preferences.The personalized course selection and recommendation system established in this paper assumes that students with the same interest, learning level and major choose similar courses.Based on the theoretical construction of hybrid collaborative filtering algorithm, this paper proves that the recommendation algorithm can recommend elective courses

suitable for students' own development among limited elective courses, and the system query efficiency and recommendation accuracy can meet students' needs.In addition, the system extracts the course selection records of excellent students in all aspects and uses the algorithm to recommend courses to those students who want to be as excellent as the elite.

First establish evaluation matrix, the description of the main factors of students' course selection process (professional, hobbies, course records, teacher evaluation, degree of learning, etc.), the algorithm according to the target student behavior, corresponding to the items in the item target students and evaluation matrix was established, find out the most similar recently, and according to the course record of similar to the neighbors, The recommendation system will recommend courses to them. Therefore, the whole model consists of three parts: building evaluation matrix, searching the nearest neighbor and generating recommendations.

Compared with the user-based collaborative filtering recommendation algorithm, the system using the project-based collaborative filtering recommendation algorithm has much less computation, so it can obtain better performance. Of course, improving performance comes at the expense of recommendation accuracy. Both user-based collaborative filtering recommendation algorithm and project-based collaborative filtering recommendation algorithm have their own advantages and disadvantages. In order to preserve the advantages of both instead of disadvantages, a hybrid user-based and project-based collaborative filtering recommendation algorithm is proposed in this paper.

In order to solve the sparse user data and scalability problems in the traditional collaborative filtering algorithm, this paper comprehensively considers the factors of both users and projects, and combines the advantages of user-based collaborative filtering algorithm and project-based collaborative filtering algorithm, proposes a collaborative filtering recommendation algorithm of mixed users and projects. This algorithm can solve the problem of data sparsity and scalability. It combines user-based collaborative filtering and project-based collaborative filtering to perform double clustering and group users with similar interests into the same class. The clustering process can be carried out offline, which can greatly reduce the search scope of the nearest neighbor, reduce the amount of real-time calculation, speed up the prediction and recommendation, and improve the system performance. The implementation idea of the algorithm is as follows: firstly, the items with high similarity are grouped into one cluster, and the other items are grouped into other clusters; Each project is then clustered for the first time, and again for users, and users with similar interests are grouped together[13].

Based on the two kinds of collaborative filtering algorithms discussed, from the recommendation algorithm based on user and recommendation algorithm based on the project in the elective system in-depth analysis, this paper summarized based on the user and the main idea of the hybrid collaborative filtering model based on project, calculate similarity of users based on the user level and project based on project level similarity, The nearest neighbor set is calculated by weighting, and the recommendation list of a user is found from the nearest neighbor set, so as to recommend top-N courses. It is of great practical significance to study the application process and mechanism of recommendation system in college course selection system. At the same time, the theoretical framework proposed in this paper lacks empirical research, and this step needs to be optimized and tested in the future. The user-based and project-based system filtering algorithm is the advanced version of user-based recommendation algorithm and project-based recommendation algorithm. At present, the research in China is based on the expansion of foreign theoretical research, so it is necessary to further develop and detect whether it is in line with the reality. In addition, the future still need to compare these collaborative filtering algorithm after a single use and mixed use of contrast, explore the recommendation results really has differences and whether improved significantly, on this basis to develop a set of practical application significance based on the user and the mixed collaborative filtering algorithm based on project application system.

REFERENCES

[1] Cao Xiuli.(2018). Application of collaborative filtering technology in college course selection and recommendation system [J]. Journal of jishou university (natural science edition), 39(01):pp.34-39 (in Chinese).

[2] Sun Fuzhao. (2015) Research on the Application of Collaborative Filtering Technology in college course Selection System. Digital Technology and Application,2015(01):pp61 (in Chinese).

[3] Wang Yan. (2009) . Design and Practice of College Course Selection System . Journal of Guiyang University (Natural Science Edition).2009(01):45-48 (in Chinese).

[4] Sarwar. B,Karypis. G,Konstan. J,et al. (2000). Application of dimensionality reduction in recommender system-a case study. 2000.

[5] Sun Xiaohua. (2005). Study on sparsity and Cold start of Collaborative Filtering System [D].Zhejiang University,2005 (in Chinese).

[6] Luo lixia. (2014). Design and implementation of book recommendation system based on user collaborative filtering [J]. Journal of xinyu university,2014,19(06):23-25 (in Chinese).

[7] Feng Kepeng. (2012). Research on Personalized College Course selection Recommendation Algorithm based on Data Mining [J]. Digital Technology and Application,2012(08):63-64 (in Chinese).

[8] Rich, Recommendation System [M]. Beijing: China Machine Press,2015.

[9] Deng Ailin, Zhu Yangyong, Shi Bole. (2003). Collaborative filtering recommendation Algorithm based on item score prediction [J]. Journal of Software,2003(09):1621-1628 (in Chinese).

[10] He Jiazhi. (2016). Research on application of Hybrid Algorithm based on Content and Collaborative Filtering in recommendation System [D]. Donghua University,2016.

[11] Li NA. (2013). Research on college course selection recommendation method based on hybrid collaborative filtering [D]. Central South University,2013 (in Chinese).

[12] Yang Yongbin. (2006). Research on the Application of Data Mining technology in education [J]. Computer Science,2006(12):284-286 (in Chinese).

[13] Tiwari R.Buse S.Barriers to innovation in scr:can internationalization of R&D mitigate their effects:the 1st European Conference on Corporate R&D[Z].pp.8-9.2014 (in Chinese).