

# Construction of library personalized management system based on collaborative filtering algorithm

Hongyan Zhang<sup>a,\*</sup>, Lu Guo<sup>b</sup>

<sup>a</sup>Shandong Vocational and Technical University of International Studies, Rizhao Shandong, 276800, China; <sup>b</sup>Shandong Vocational and Technical University of International Studies, Rizhao Shandong, 276800, China.

## ABSTRACT

In the face of massive book resources, users need to spend a lot of time and energy to obtain the required book resources, while the traditional search query can no longer meet the needs of users. In the process of informatization, the library management system has accumulated a large amount of data. There is a lot of valuable information among these data, which can provide decision support for decision makers of enterprises and departments. Users' demand for resources is becoming more and more detailed and precise, and it is increasingly difficult for users to quickly and accurately obtain the resources they need. Based on this, this article puts forward a personalized recommendation model of library based on collaborative filtering (CF) algorithm, which can mine the hidden information behind the data, predict the information needs of readers, organize more and better targeted high-quality information for readers, and provide more personalized services. The experimental results show that the personalized recommendation system can improve the recommendation accuracy and realize dynamic personalized recommendation, which provides a theoretical basis for the construction of university libraries.

**Keywords:** Library; collaborative filtering; personalized recommendation

## 1. INTRODUCTION

Digital library and electronic library have become the mainstream of current library development with the advent of Web2.0 era. The popularization of networking and information technology poses a new challenge to the library service mode. How to make readers experience library service better has become one of the focuses of current library work <sup>1</sup>. Traditional information service, where all users are faced with the same platform, requires users to actively submit query requests to search the information they need, while personalized service actively provides users with information that meets their interests and preferences according to different users' interests <sup>2</sup>. In the field of library, as the library accumulates more and more data, there is a lot of important information hidden behind the data. It is hoped that the library can make a higher-level analysis of it, so as to make better use of these data and make use of the results of data mining to provide decision-making basis for library personalized service <sup>3</sup>. In the period of rapid development of information technology and artificial intelligence, information has surged, and a large amount of information has brought us convenience and trouble. Users cannot quickly search for valuable information and accurately locate their own needs. For libraries, the traditional service mode is undergoing profound changes <sup>4</sup>. Personalized information and service of library is the deepening of traditional library information service under the network environment. Personalized information service fundamentally changes the way of collecting, processing, storing, disseminating and utilizing information, and further expands and optimizes the traditional service mode <sup>5</sup>.

\*Email: zhanghongyan82@126.com

The services provided by university libraries are mainly based on books and periodicals. Generally, there are about one million paper books in university libraries, and the quantity of electronic books and periodicals is even larger, and this number continues to increase every year. When readers enter the library, they will be faced with millions of book data <sup>6</sup>. Digital library brings convenience to people, but it also brings information overload and various forms that are difficult to search <sup>7</sup>. The demand for personal information is usually specific, and the same information shows different values to different users. Personalized recommendation service is the key to solve this problem. It adapts to the diverse environment of users and needs, and it is an important means for digital libraries to deal with the diversified information resources and information overload <sup>8</sup>. Book managers can mine the historical data of readers, and according to the data mining results, they can find out readers' demand information for books, so as to provide readers with various recommendation services more quickly and pertinently <sup>9</sup>. This not only saves readers the time needed to find resources, but also makes the resources found by readers more accurate and detailed. In library work, using data mining to analyze readers' historical borrowing and returning information can intelligently recommend books that readers may want to borrow.

## 2. METHODOLOGY

### 2.1 Data mining for personalized recommendation of readers

Driven by big data, the data grows rapidly at an exponential rate. It is not easy for users to find the information they need in a huge amount of data, which means that it is difficult for users to quickly and efficiently select the items they really need. With the years of operation of the library management system, the database is constantly updated, and a large amount of data is accumulated in the system. It mainly includes the data of books, information of readers, records of borrowing and returning books, and so on. However, at present, these data are basically only used in business applications, simple associated queries and statistical analysis, and the comprehensive utilization level of the data is not high, so the valuable laws hidden behind these data need to be further explored and utilized.

Different from ordinary commodity recommendation, learning is a complex activity with the characteristics of subjectivity, autonomy, problem-solving, cooperation and practicality, which requires learners to constantly process, assimilate and process in their brains, keep their concentration and persist for a long time. Personalized learning recommendation is not simply a learning recommendation activity to predict or cater to learners' preferences, but to help learners intelligently identify and push learning resources and learning paths that match learners' personalized parameters during online learning <sup>10</sup>. By analyzing the results of data mining, we can not only provide personalized recommendation service to readers, but also give guidance to book purchasing and provide better suggestions for the future development of libraries. Through analysis within the reader group, we can get the bibliography that readers will borrow in the future, so as to recommend books to readers<sup>11</sup>. It is the ultimate goal of personalized book recommendation system for data mining to predict the books that readers may borrow in the future, improve the overall service level and borrowing efficiency of the library and improve the utilization efficiency of books by studying the information such as book borrowing records. The library system structure is shown in Figure 1.

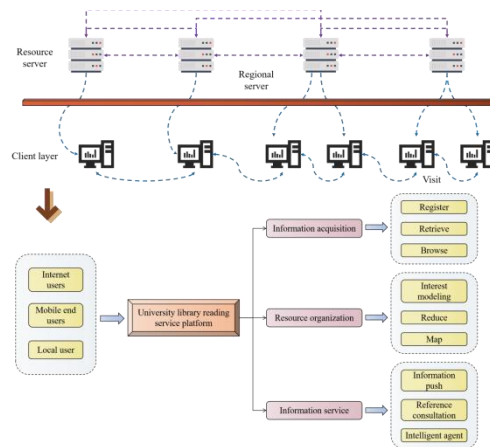


Figure 1. System structure of library resource pool

Teachers and students of different majors have different needs, so they can provide services according to their different needs and their personal interests. Therefore, the design purpose of the data mining model is to fully mine a large quantity of various types of historical data in university libraries, analyze and summarize the readers' interests, needs and the correlation among various factors from the mining results, etc., so as to provide reference for the personalized service work of libraries and improve the utilization rate of collection resources.

## 2.2 Personalized recommendation algorithm of library

The implementation of CF recommendation algorithm is based on library service information retrieval. According to the retrieved information, it extracts resource feature information, uses ontology feature mapping method to recommend the relevant process of library smart service, establishes the data set related to readers' preferences, and completes CF recommendation of library smart service after collaborative matching and optimization<sup>12</sup>. The modeling process of personalized learning recommendation object mainly obtains the explicit and potential features and states of learners' nearest neighbors, learning resources, learning paths and other recommended objects, and then transforms them into learning recommendation object models through algorithms. Based on CF recommendation algorithm, through mining, analyzing and processing personalized learner model and personalized learning recommendation object model data, a recommendation list is generated, and personalized learning resources or learning paths suitable for target learners are recommended. The recommendation framework in library personalized service is shown in Figure 2.

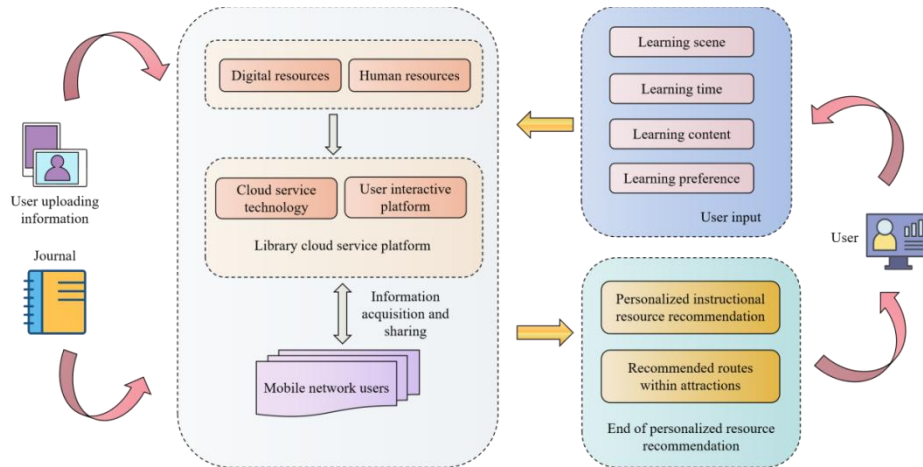


Figure 2. Personalized recommendation framework

The information model adopts a three-tier architecture design, collects library information of the "perception layer", uses RFID technology to identify library information labels, realizes the integration and transmission of information resources of the "network layer" on the basis of optimizing the management of library resources, establishes a library information management database in the "application layer", and realizes the man-machine interaction of the application layer by combining the local database. Learner model can collect, store and modify learners' personalized data and parameters in all directions. Through data analysis and mining, learners can be classified and identified, and their characteristics and states can be obtained. Students' reading interest preference documents can be expressed as:

$$D = \{M, N\} \quad (1)$$

In the formula:  $M$  represents short-term reading interest,  $N$  represents long-term reading interest. Due to the variety of reading interests,  $M$  and  $N$  are respectively expressed as:

$$M = \{S_1, S_2, \dots, S_n\} \quad (2)$$

$$N = \{L_1, L_2, \dots, L_n\} \quad (3)$$

Students' reading interest preferences are expressed as:

$$U = \{S_1, S_2, \dots, S_n, L_1, L_2, \dots, L_n\} \quad (4)$$

For each  $S_i, L_j$ , category attribute variables  $E_i, E_j$  and weight attribute variables  $F_i, F_j$  are introduced. So  $S_i, L_j$  are expressed as:

$$S_i = \langle S_i, F_i, E_i \rangle, i = 1, 2, \dots, m \quad (5)$$

$$L_j = \langle L_j, F_j, E_j \rangle, j = 1, 2, \dots, n \quad (6)$$

The student reading interest preference document can be represented in the form of a two-dimensional table:

$$D = \begin{Bmatrix} S_1 & S_2 & \dots & S_m & L_1 & L_2 & L_n \\ F_1 & F_2 & \dots & F_m & F_{m+1} & L_{m+2} & L_{m+n} \\ E_1 & E_2 & \dots & E_m & E_{m+1} & E_{m+2} & E_{m+n} \end{Bmatrix} \quad (7)$$

$S_m$  and  $L_m$  are a certain attribute value of short-term reading interest and long-term reading interest respectively;  $E_{m+n}$  represents the resource category of the learning resource corresponding to the student's reading interest;  $F_{m+n}$  represents the reading interest weight of the attribute value vocabulary.

When modeling the recommended learning object, first standardize the learning resources. The standardized contents include resource types, difficulty and ease, learning duration, leading knowledge points, related knowledge points, applicable people, etc., and adopt automatic or semi-automatic semantic methods to add various features to the personalized learning recommended object. According to readers' preferences, information mining and text information recommendation, that is, information retrieval and semantic-related feature retrieval, information retrieval of library's intelligent services, and optimization design.

### 3. RESULT ANALYSIS AND DISCUSSION

Based on the information of library's intelligent service, the phase space reconstruction method is used to reconstruct and extract features, and the semantic correlation features of library's collection resources are extracted to construct the big data statistical analysis model of library's intelligent service. After scheduling the correlation degree according to the resource attributes, the iterative formula of semantic correlation feature reconstruction is obtained. Taking the feature quantity with the smallest feature value as the fuzzy clustering center of library resources CF, the node set recommended by library resources CF is obtained, and then the semantic correlation features of the node set are extracted. As the students' rating on resources can largely reflect the students' preference for resources, it can be considered that the resources finally presented to students are probably the collection of resources that students are interested in.

In order to verify the effectiveness of this method, this article uses Matlab simulation software to set up the experimental environment. Based on the real data in the library, some representative test sets and training sets are extracted from the experimental data. A total of 16,000 pieces of user data, book data and book borrowing records were collected in this experiment. Figure 3 shows the students' subjective scoring results of the traditional book resources acquisition method and the personalized recommendation model of book resources in this article.

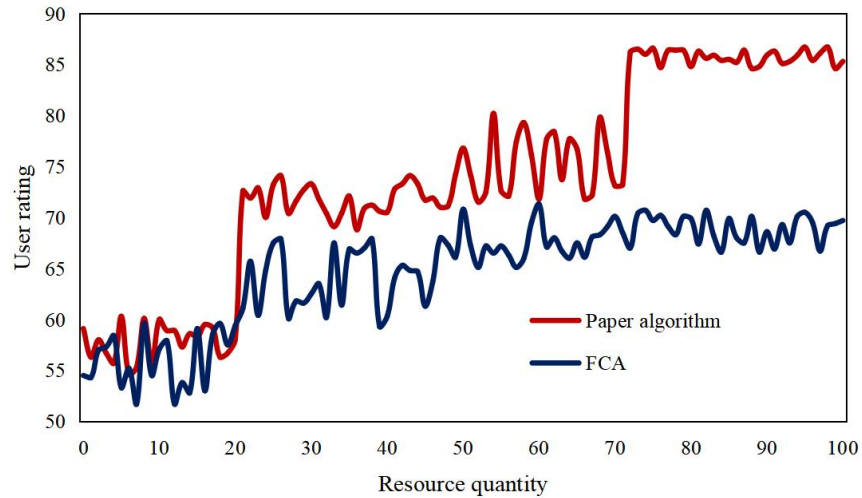


Figure 3. Students' subjective rating

Most students said that the personalized recommendation model in this article can help them accurately locate the information they need in the massive book resources. This is of positive significance for schools to promote the construction of smart libraries.

In the lending database of the library system, a large amount of data is accumulated every day, but the data itself cannot directly reflect readers' lending tendency and research trend. In order to obtain higher resource utilization efficiency and improve the capital benefit of library collection construction, colleges and universities need to make a reasonable plan for literature purchase and collection according to the needs and changes of readers. Through the data mining system, the borrowing record data and document collection data can be centralized and managed. The comparison results of recommendation accuracy of different recommendation algorithms are shown in Figure 4.

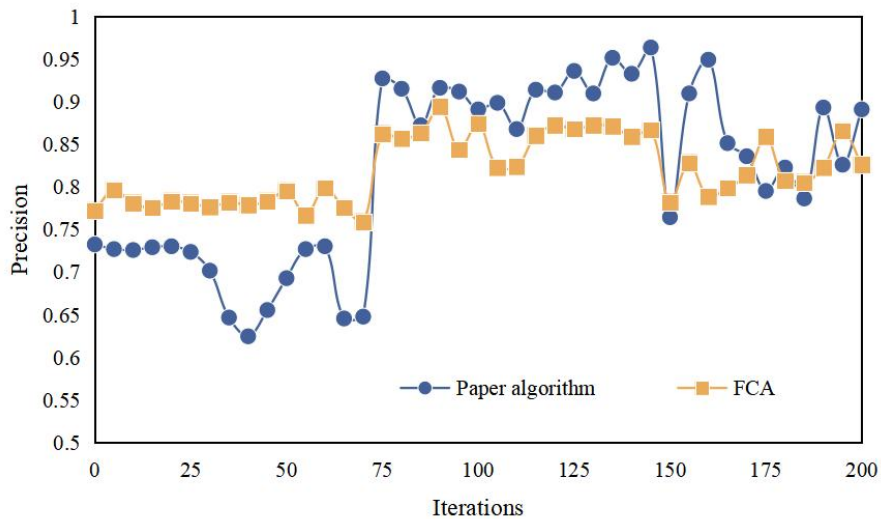


Figure 4. Comparison results of recommendation accuracy of different algorithms

The results show that the personalized recommendation model of the library in this article has low error and high recommendation accuracy, and the accuracy is improved by 19.64% compared with FCA algorithm.

A data mining tool usually uses several patterns to analyze data, but the rapid increase of data volume and the increase of accuracy requirements will lead to the increase of the complexity of the problem. Therefore, data mining tools should

have the ability to solve complex problems. The results of testing samples with FCA model are shown in Figure 5. The results of testing with the personalized recommendation model in this article are shown in Figure 6.

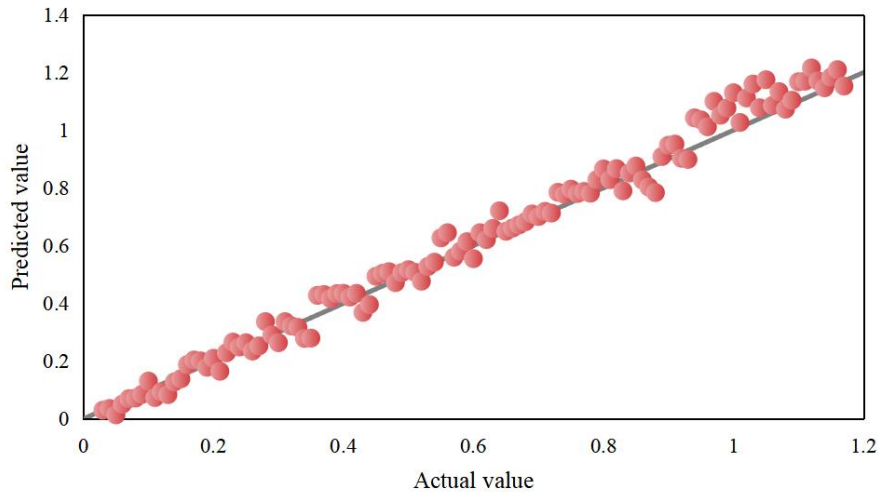


Figure 5. FCA test results

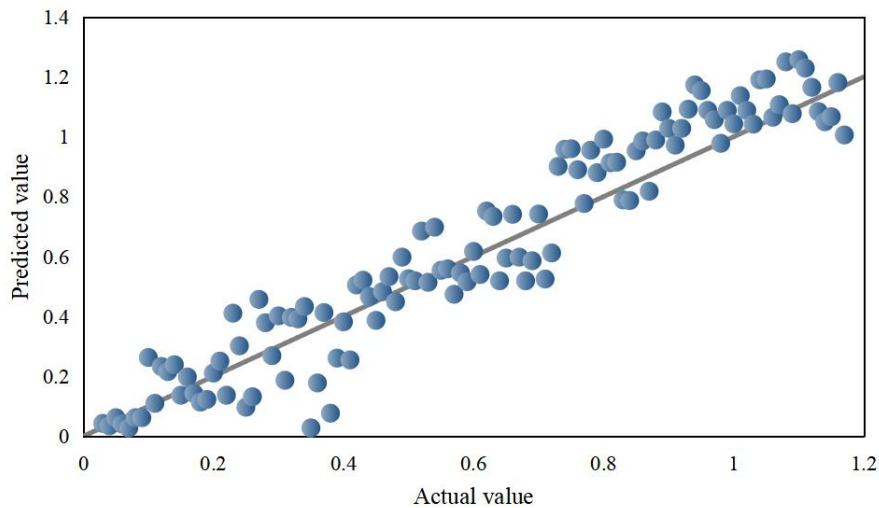


Figure 6. CF algorithm test results

It can be analyzed that the library personalized recommendation model based on CF algorithm is better than FCA in both accuracy and efficiency. Obtaining users' needs and interests, and accurately describing users' interests, is the basis of providing personalized recommendation services for high-quality smart libraries. Only by accurately grasping users' interests can we provide personalized reading resources for users according to their interests.

In a large quantity of borrowing records accumulated in university library system, different readers have their own reasons for borrowing a variety of books at the same time, which shows that there is a certain correlation between borrowing records. In daily life, users seldom take the initiative to evaluate the items they browse or buy, and the system can't force users to do this, so as to prevent poor user experience. The construction of university libraries is to meet the needs of users. Therefore, the personalized recommendation system based on the analysis of users' borrowing behavior can't be separated from practical principles. Knowing the users' needs clearly, we can recommend book resources for practical purposes and recommend books that users really need to users.

## 4. CONCLUSIONS

In the field of library, as the library accumulates more and more data, there is a lot of important information hidden behind the data. It is hoped that the library can make a higher-level analysis of it, so as to make better use of these data, and use the results of data mining to provide decision-making basis for library personalized service. Obtaining users' needs and interests, and accurately describing users' interests, is the basis of providing personalized recommendation services for high-quality smart libraries. This article puts forward a personalized recommendation model of library based on CF algorithm, so as to mine the hidden information behind the data, predict the information needs of readers, organize more and better targeted high-quality information for readers, and provide more personalized services. The results show that the library personalized recommendation model based on CF algorithm is better than FCA in both accuracy and efficiency. The model builds a model for learners, obtains their knowledge points and knowledge loopholes, and recommends the same kind of learning resources and learning paths to learners who match personalized parameters by recommending CF algorithm based on users, thus stimulating learners' learning motivation. In the future research, the book preferences of teachers' users will be studied, and personalized recommendations for teachers' users will be improved.

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