Study on Library Management System Based on Data Mining and Clustering Algorithm

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In order to improve the library's information retrieval and resource sharing capabilities and establish an intelligent library information management system, this paper proposes a library information management system development technology based on data mining technology. The system development is divided into two modules: library information retrieval and data mining algorithm design and software development of information management system. Using big data fusion and feature clustering methods to design intelligent information retrieval algorithm in library information management, establish library management database, carry out software development and design of library information management system in embedded environment, and finally carry out experimental test analysis. The test results show that using the method in this paper for library information management can improve the accuracy of book recommendation, which is 16.7% higher than the traditional method on average, and has good data mining and information retrieval capabilities. Performance indicators are better. Therefore, the algorithm is not only a means of automatic management of library systems, but also an effective means of realizing the modernization of library information.

Povzetek: Sistem upravljanja knjižnice je nadgrajen z metodami strojnega rudarjenja in gručenja.

1 Introduction

The library management system is a product of the popularization of the Internet in the information age, and a basic library system that caters to the reading needs of contemporary people. With the advancement of Internet technology and database technology, most libraries have built library information management systems to provide readers with functions such as information retrieval and book borrowing. Compared with the original manual management mode, this system improves the timeliness and accuracy of library information query, and has essentially changed [1]. The library management system needs to store more book information, reader information, etc., so the development requirements for library management systems are gradually increasing [2]. In fact, many library management systems are still immature and difficult to meet the needs of readers. At the same time, it is difficult to recognize the connection between stored data and data analysis to predict the development direction, resulting in data abundance and management confusion [3]. In addition, people under the background of the information age have higher requirements for data,

and the original documents can no longer meet its higher standards. In-depth study on related data is needed to discover hidden information and relationships. Therefore, the development of library management systems based on data mining and clustering algorithms is an inevitable trend [4].

At present, the library information management system design mainly adopts distributed resource allocation design method, combined with information retrieval and semantic feature score analysis method, library information management system retrieval algorithm design, using cloud resource storage technology, improve the library information management system intelligence and throughput, but with the library scale, the traditional library information management system cannot meet the needs of large-scale library information management. Data mining is the process of converting large data sets into knowledge [5]. Web-based databases were born, and they have quickly been widely used. Retrieval and analysis of lots of available data information in the database has become an important task [6]. At present, the study technology of data mining is becoming more and more mature, and people's study

focus has gradually shifted from exploring mining algorithms to the application of data mining systems, looking for mining strategies and data integration methods that can obtain more realistic results [7]. However, with the increase of the library scale, the traditional library management system cannot meet the needs of large-scale library management. The digital library system is shown in Figure 1. This paper uses the mixed clustering analysis technology to classify the literature, and provides the basis for the library literature collection and construction through the hidden data rules

hidden in the process of literature borrowing and repayment. Data mining technology can identify the potential needs of readers, provide personalized help, and also help readers choose to buy e-books, enabling readers to quickly and accurately utilize the library's resources. Through the algorithm implementation, build the system service between the reader and the library, and compared with other algorithms, obtain the superiority of the hybrid clustering algorithm, and prove the rationality and effectiveness of the algorithm.
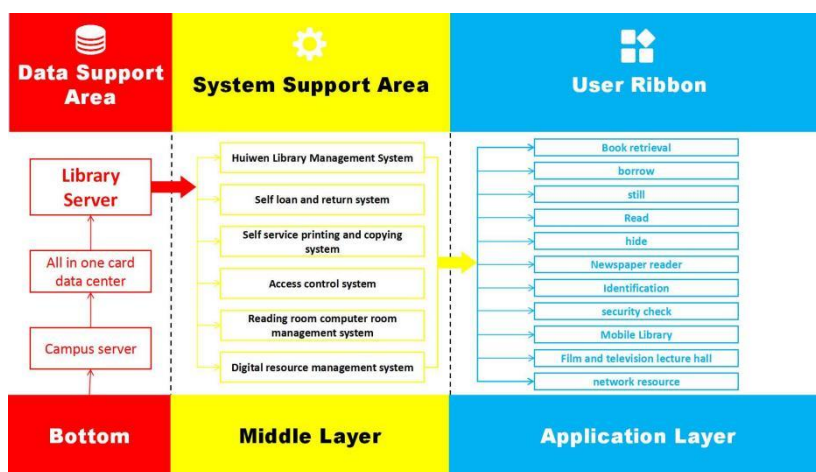

Figure 1: The digital library system

Based on this research, this paper proposes a technology to develop a library information management system based on information mining technology. System development is divided into two modules: library information retrieval, data mining algorithm design, and information management system software development. Designing intelligent information retrieval algorithms for library information management, developing and designing library information management system software in an embedded environment, and finally using large data aggregation and function clustering methods to perform experimental analysis. This documentary approach can improve the intelligence and integration performance of library information management.

2 Literature review

The number and scale of information storage of electronic books in libraries are increasing day by day, and it has become an urgent need for libraries to provide readers with more timely, more accurate and more specialized services. How to use computers to improve the quality of services, how to obtain real reliable and effective data in the system with expanding scale and increasing complexity is a subject to be studied by library managers at present. The library management department needs to manage online books in a convenient and

efficient way.

Zhu, B. et al. proposed that a B/S-based library management system aims to provide readers with high-quality information services and provide readers with a platform for online inquiry of book information, book recommendations and other personalized services based on their personal reading interests, better serve readers, and gradually realize the B / s book borrowing mode [8]. Ye, Y. et al. proposed that data mining refers to the process of finding potential relationships between data in the database and obtaining previously undiscovered application value through analysis [9]. In order to improve information retrieval and resource sharing capabilities of the libraries, Li, S. and others established an intelligent library information management system, and realized the library's intelligent information management under the multi-source information resource service mode to better serve readers and improve the utilization efficiency and sharing level of library collections [10]. Hu, J. and others believed that data mining develops rapidly with the rapid development of computer and the existence of lots of available data to be processed in the database [11]. Hu, J. and others believed that the application of data mining technology is very extensive and it is a highly applicable subject. Targeted data analysis can be carried out as long as there are valuable data sets or databases [12]. Vikhreva, GM and others proposed a university library management

information system based on the B/S model, which can meet the needs of the development of library management information, reduce the cost of system upgrades and maintenance, facilitate system expansion, and facilitate transplantation to different operating systems [13]. Luo, Y. et al. used the library system to record reader information resources and updated new data to provide convenience for readers [14]. Zhang, N. and others help enterprises realize data analysis to provide forward-looking prediction, find enterprise development and operation mode to help

enterprise managers timely adjust management strategies and avoid risks, and provide effective decision-making help for good application of enterprises [15]. Hsieh, C. C. and others believed that the library management system needs to store more book information and reader information, so the development requirements of the library information management system are gradually improved [16]. Wang, et al. Et al. found that the literature increases sharply, and the library management system needs to store more book information and reader information, so the development requirements of the library information management system are gradually improved [17].

3   Research methods

3.1   Analysis of library information management

In order to realize the optimized, develop and design library management system [18-25], analyze with data mining technology flow characteristics of the library management, and the resource distribution characteristics of the library are analyzed in the cloud computing environment [26-29], which mainly includes the characteristics of associated knowledge base information [30], computing resources [31-33], physical resources and logical resources [34-38. The data flow resource distribution of library management see Figure 2. According to the data flow resource distribution model of library management shown in Figure 2, the resource distribution attribute set of library information retrieval

$i \in S_s$ is established, and the association mapping

relationship of library information management is obtained as shown in formula (1):

$$\alpha^T Q \alpha = \sum_{i=1}^{n} \sum_{j=1}^{n} \alpha_i \alpha_j Q i_j \geq 0 \qquad (1)$$

According to the attribute difference of library resource distribution, sample classification is carried out. Assuming that the library resource distribution contains n samples, the autocorrelation statistics of sample x_i, i=1, 2, .., n are as shown in formula (2) :

$$s(t) = \sum_{m=-\infty}^{\infty} \sum_{n=-\infty}^{\infty} a_{mn} g_{mn}(t) + n(t) \qquad (2)$$

In the formula, a_{mn} is called the distributed sample set of library resource retrieval, $g_{mn}(t)$ is the average of statistics, and n (t) is the characteristic interference item of library management. The semantic ontology fusion method is used for data mining. The existence of association mapping $\Phi: M \to R^{2d+1}$ means that there is an optimal solution in $\Phi(z) = \left(h(z), h(\varphi 1(z)), \cdots, h(\varphi_{2d}(z))\right)^T$ to make the output feature quantity meet the information classification set of library management, as shown in formula (3):

$$F_j = \sum_{k=1}^{n} X_{kj}, Q_j = \sum_{k=1}^{n} \left(X_{kj}\right)^2 \qquad (3)$$

Adopt edge fusion and feature decomposition methods to reconstruct the characteristic vector of library management, and the iterative formula of the reconstruction is obtained as shown in formula (4):

$$x_i^{(k+1)} = (1-\omega)x_i^{(k)} + \frac{\omega}{a_{ni}}\left(b_i - \sum_{j=1}^{i-1}a_{ij}x_j^{(k+1)} - \sum_{j=i+1}^{n}a_{ij}x_j^{(k)}\right)$$

$$i = 1,2,\cdots,n$$

$$k = 1,2,\cdots,n \qquad (4)$$

According to the catalog differences of library readers' retrieval, the dispersion matrix of information management is established as shown in formula (5):

$$S_b = \sum_{i=1}^{c} P_i (\vec{m}_i - \vec{m})(\vec{m}_i - \vec{m})^T \qquad (5)$$

Where, $\vec{m} = \sum_{i=1}^{c} P_i \vec{m}_i$ is the overall mean. According to the semantic feature matching method, distributed mining of library information resources is carried out.
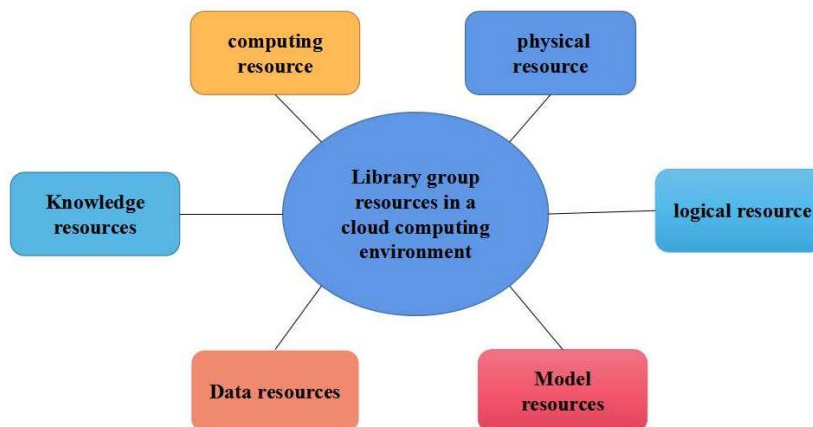
Figure 2: Distribution of data flow resources for library information management

3.2 Data mining for Library Information Management

The big data fusion and feature clustering methods are used to design the intelligent information retrieval algorithm in library information management, and the semantic concept set features of library management are obtained, as shown in formula (6):

$$J\left(\vec{X}_j\right) = \frac{y_j^T S_b y_j}{\lambda_j}, j = 1,2,\cdots,l \qquad (6)$$

In library management, clustering is in descending order according to feature: $J\left(\vec{X}_1\right) \geq J\left(\vec{X}_2\right) \geq \cdots J\left(\vec{X}_1\right)$. Take the feature with the lowest feature value as the clustering center to obtain the data point $\overline{X}_i$. According to the semantic ontology reconstruction method, the center distance of two clusters in the library information distribution area is $y_j, j = 1,2,\cdots,d$. Thus, the group resource distribution vector of the library is obtained, as shown in formula (7):

$$W = [y_1, y_2, \cdots y_d] \qquad (7)$$

Using edge fusion and feature decomposition methods, the library resources output by mining are reduced from m-dimension to d-dimension, and an optimized feature vector reconstruction model is obtained as shown in formula (8):

$$\max F(X) = \left(F_1(X), F_2(X), \cdots, F_n(X)\right)$$
$$s.t. g_j(X) \leq 0 (j = 1,2,\cdots, p) \qquad (8)$$
$$h_k(X) = 0 (k = 1,2,\cdots, p)$$

The short-term Fourier transform method is used to focus library information in the reconstructed vector distribution subspace to realize data mining of library information management. On this basis, the optimized library information management is realized at the constraint cost of precision rate, recall rate of book resource information and time cost. The calculation expression of each cost index is as shown in formula (9):

$$Rzczll(X,Y) = \frac{P(X \cap Y)}{P(X) + P(Y) - P(X \cap Y)} \qquad (9)$$

Among them, P(X) and P(Y) represent the fusion probability density function of feature clustering, and X and Y are the feature vector set of library information management, which is the cross-distribution concept set of information fusion [39-40].

3.3 Software development and implementation of the Library Information Management System

This paper develops the software of library information management system under the embedded Linux kernel control model [41-44]. In library management, the design method of three-layer network system is adopted. In the perception layer of book information, are used to collect book resource information [45-47]. VXI bus technology is used for network transmission of library information resources, and MYSQL database is established for library data resource storage [48-52]. Human-computer interaction is carried out in the application layer to realize library resource retrieval and access control [53-58. The design of this article is obtained. The overall structural components of the library management system designed in this paper are obtained shown in Table 1.

3.4 Design of the clustering algorithm

Clustering algorithm is used to analyze library books. Firstly, the goal of hybrid clustering should be determined: Given a data set $X = \{x_1, x_2, \cdots, x_i, \cdots, x_n\}$ containing n a-dimensional books or corresponding users, where $x_i \in R^a$. Determine the number m of book data subsets to be generated, and the clustering algorithm classifies the readers' books and unsold books into m categories $C = \{c_m, i = 1,2,\cdots, m\}$. The types of information all represent a book and a user category c_m, and each c_m has a category center value u_i, which is the most

representative numerical information of this category. That is, the central value score. According to the principle of judging the similarity based on the Euclidean distance, the sum of the squares of the distances from each point in each book category to u_i is calculated as the similarity between the point and the central value. Then the sum of squared Euclidean distance is as shown in formula (10):

$$J(c_m) = \sum_{x_i \in c_m} \left\| x_i - u_m \right\|^2 \qquad (10)$$

The objective function of clustering is the sum of squares of distances of various types. If J(c) is the smallest, the function is shown in formula (11):

$$J(c) = \sum_{m=1}^{M} J(c_m) = \sum_{m=1}^{M} \sum_{x_i \in c_m} \left\| x_i - u_m \right\|^2 = \sum_{m=1}^{M} \sum_{i=1}^{M} a_{mi} \left\| x_i - u_m \right\|^2 \quad (11)$$

Where $a_{mi} = 1(x_i \in c_i)$ or $a_{mi} = 0(x_i \notin c_i)$. It can be seen that the center of the cluster u_i should be the average of the data points of each category c_m and each book category.

The clustering algorithm is divided from the initial M category. The clustering process is shown in Figure 3. In special cases, when M=0, then J(c)=0. Therefore, it can be concluded that the minimum value of J (c) can be obtained only when the total sum of squares of distance is under the determined number of categories M.
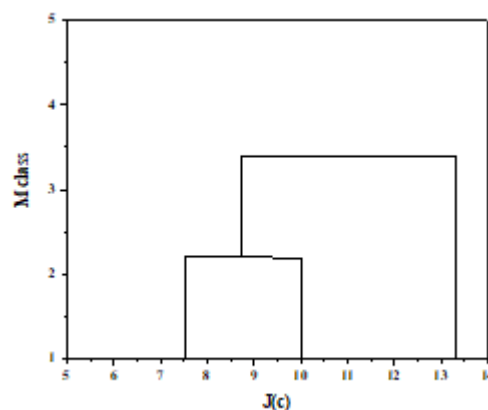

Figure 3 Cluster tree-shape process diagram

3.5   Algorithm comparison

The system has an evaluation function for books, as shown in Table 2, which includes cover design, book materials, content value and purchase intention. The final total score can not only provide the basis for other readers to read and buy, but also help the construction of the library. It is the embodiment of personalized service.

Table 1: Structural components of the library information management system

Application layer	Library information data import	SQL database management	Equipment control
Network layer	Ethernet, wireless communication network	Network transmission protocol	Network control
Perception layer	Sensing equipment	RFID label	Video equipment

Table 2: The evaluation function of the books in the system

Serial number	Scoring rubric	Total score	Rating
1	Cover design	10	
2	Book materials	10	
4	Purchase intention	10	
Total score 10 Grade A B C			

4   Results discussion

To verify the method library information optimization management and information retrieval and mining, simulation experiments are carried out. In the experiment, the data mining algorithm is designed with Matlab2010b software, and the platform design. To test the data recall performance and book retrieval performance of library management, the sample set collected from the original data is 1000, the prior sample training set of library collection resources is 200, the

embedding dimension of the subspace feature distribution is m=4, and correlation coefficient of distribution characteristics of Library Collection Resources is φ=0.21. Simulation of library management and data mining is performed, and the extracted library information data is shown in Figure 4.
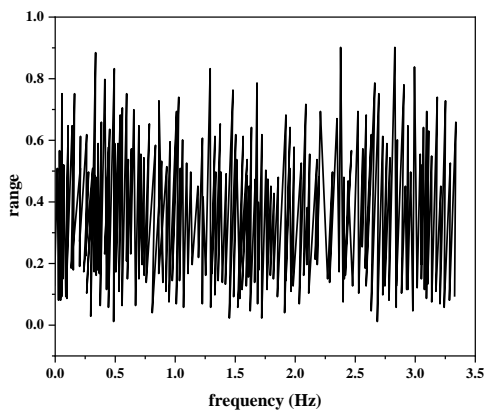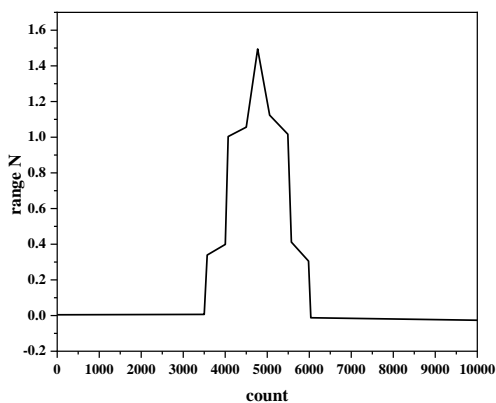

Figure 4 Data mining output of library information management

Clustering and feature fusion are carried out to realize the information retrieval of the library, and the obtained information fusion result is shown in Figure 5.

According to the analysis of Figure 5, this proposed method is used for library information management to realize optimal data mining and feature clustering, and improve the ability of data retrieval and access. On this basis, the accuracy of book recommendation of different methods for library information management is tested see Figure 6. It shows that the accuracy of book recommendation can be improved, which is 16.7% higher than that of the traditional method on average, indicating superior performance. The system can effectively complete the implementation and management of the huge library data, which is conducive to the effective connection between users and the library.
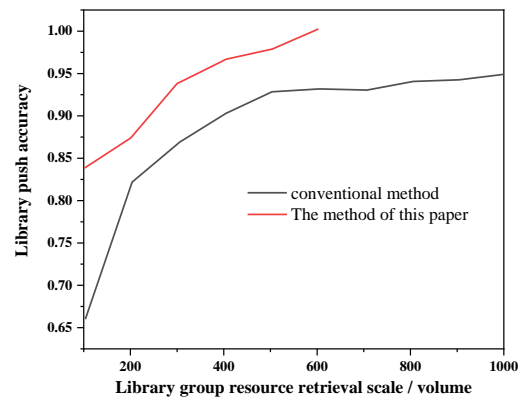

Figure 6: Comparison of library information retrieval

5 Conclusion

This paper studies the connection between a large number of book data and user information accumulated in the library to help the library carry out system management. The library is a huge database, and the introduction of data mining technology increases convenience for library management. After data mining, the book information can be reasonably arranged based on the clustering algorithm to improve the convenience of the system. Through algorithm implementation and algorithm comparison, it can be seen that, the system combined with the algorithm in this paper can form a good system management order, realize function visualization, and provide services for book case users and management technicians, so the algorithm is reasonableFigure 5: Output of library information fusion results

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