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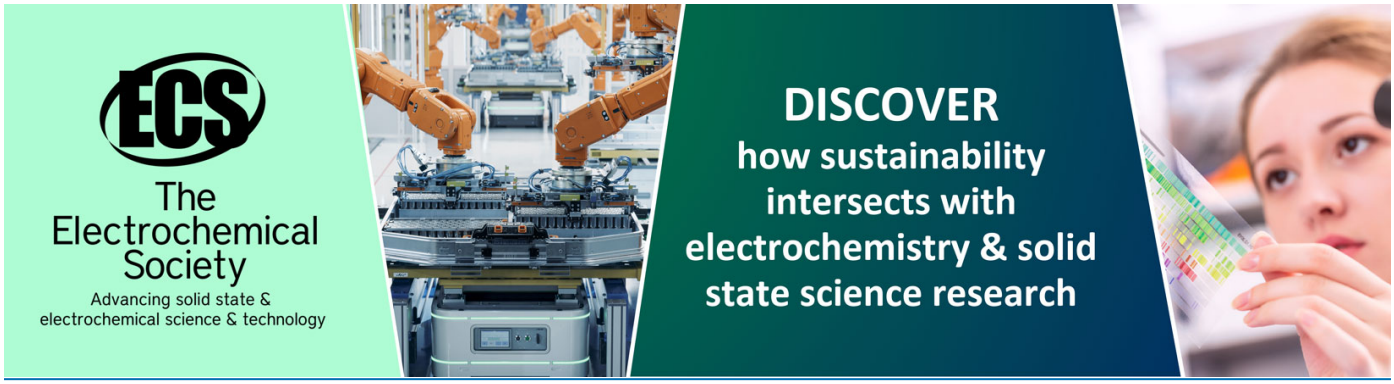

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Design and Implementation of Intelligent Library System Based on Big data

Zhibin Peng, Yuefeng Chen*, Xiaoying Luo, Rui Fan, JiaHui Meng

Faculty of Mathematics and Computer Science, Guangdong Ocean University, Zhanjiang 524088, China

*Corresponding author: Yuefeng Chen

yuefengch71@126.com

Abstract. In most traditional library management systems, readers have to find their interest books through the name or search approximate content from library, which results in wasting time. With the help of big data technology, we construct the intelligent library system using SSM framework and Hadoop framework. A recommendation approach combined co-filtering with content-based recommendations, is introduced to make better recommend efficiency. The system has the intelligent ability of self-learning. For historical lending books data, it uses the Spark MLlib machine learning algorithm library to build clustering or classification models. On the other hand, the system uses Kafka and SparkStreaming to process real-time data. System simulation shows that it has high recommendation accuracy and good timeliness.

1. Introduction

The material resources provided by the university library in China are getting richer and richer, and the following four subsystems have been realized, which are login subsystem, query Subsystem, borrowing and returning subsystem, management subsystem. Query subsystem is mainly used for querying books, querying includes direct query by book number, query by title, query by author, query by publishers, optional fuzzy query, multi-conditional query, and so on. At present, most library information management systems use the B/S model, which are based on the Internet to achieve traditional business management and mass. The combination of digital resource management and the university libraries can retrieve their collections is faster. Some students unlike going to the library system to find their needed books, mostly because of the libraries have no ability to recommend books. Students have to spend a lot of time searching for books because they don't know about an area and don't know how to search for books efficiently and accurately. And students may still not find the books they want in the end, which ultimately leads to inefficient learning. In order to improve students' self-study efficiency and time utilization, the university libraries are urgent to build intelligent recommendation system to enhance the students' efficient learning.

At present, library systems are mainly focused on intelligent recommendations. The paper [1] designs the architecture of a collaborative intelligent recommendation system for library bibliographies and applies the bibliographic recommendation system to digital library management. The paper [2] investigates the LSMF model of collaborative filtering algorithm based on LSTM by comparing the traditional algorithms. The paper [3] mentions that successful implementations of Association Rule Mining (ARM) in computer networking, recommendation, and medical fields, in addition to other application possibilities for ARM. The paper [4] establishes an intelligent learning

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system and proposes a hybrid recommendation algorithm that differs from the traditional one. The paper [5] investigates E-commerce recommendation systems through big data and it is shown that recommendation systems are able to increase transactions, i.e. student It also increases the frequency of using the library system due to intelligent recommendations. The paper [6] investigates the implementation process of the personalized book recommendation system and provides assistance in designing the system in a hierarchical structure. However, few library systems are effectively integrated with smart recommendation systems to help students with book selection. In addition, the use of library systems also limits fluency due to the numerous system features.

Through mining from the existing books data and borrowing information, we construct an intelligent library system based on big data, which has function of personalize and recommend. In this system, the idea of front and back-end separation is used to design the intelligent library system.

2. System Architecture

Our library system is designed into five layers of architecture which are shown in Fig.1. The advanced technologies are adopted as following: the back-end using SpringBoot framework, using the MyBatis framework connection MySQL database, and the front end uses the Vue framework to interact with system users. The system collects students' information, such as borrowing records, browsing records, and personal information, that will provide data support for the recommendation module. The architecture of the recommendation subsystem is based on Lambda architecture, with persistent data stored in Hbase [7] or HDFS [8]. The Spark MLlib machine learning algorithm library batches historical data and then builds clustering or classification models [9, 10] while the system real-time processing of data using Kafka and SparkStreaming. The core of the system is the recommendation subsystem, which uses hadoop technology and combines with machine learning [11] to provide students with intelligent recommendations service [12, 13].

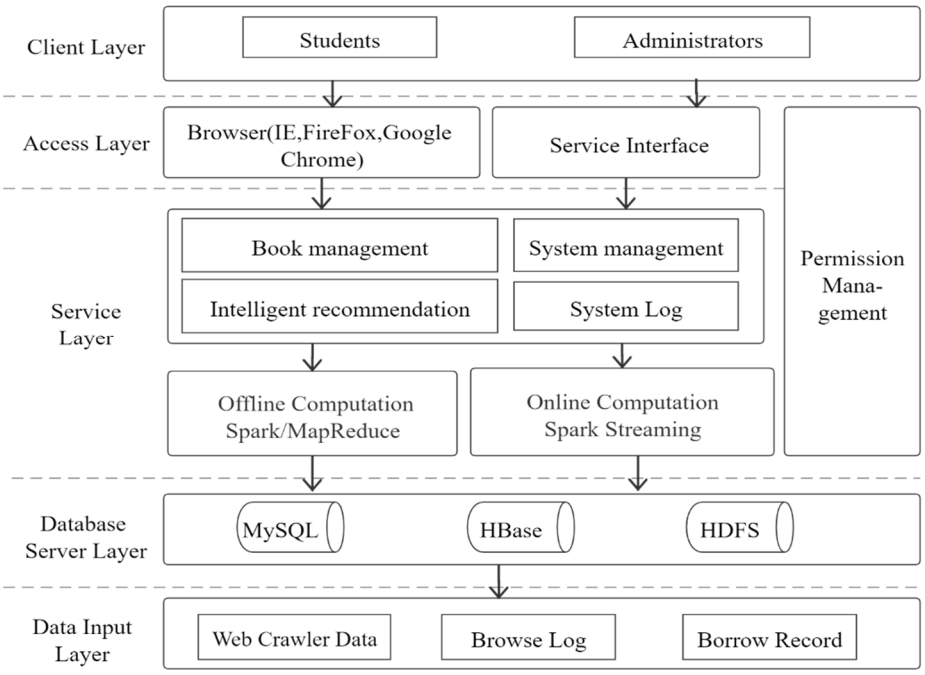

Fig.1 Architecture of Intelligent Library System

3. Main Functions of Intelligent Library System

There are two roles in the intelligent library: students and administrators. The system consists of four modules: the student module, the administrator module, the book module and the recommendation module. The four modules are shown in Fig.2.

3.1. Student Module

The student module includes student login, student password change, and student information management. To ensure system security, users must log in to access the system. Students can access the system through the student login. When a student logs in, the module verifies student information, authentication, authorization, password matching and session management.

3.2. Aministrator Module

Administrator module includes functions such as administrator login, administrator change password and change administrator information. Administrators have roles, and the corresponding roles have different system permissions.

3.3. Book Module

Book module is mainly responsible for library information management. Book information management includes adding books, deleting books, changing library information and the search of books. These operations are convenient for the future management of the library.

3.4. Recommendation Module

Book recommendation module mainly includes new book recommendation, fine book recommendation, lending list, and similar book recommendation. When new books are added to the library, the books are recommended to the students, who take interesting in them. Boutique book recommendation can recommend some high quality books for students. Borrowing ranking is based on the number of times the books are borrowed and is displayed to students. From mining to behaviours and preferences of the students' book-seeking, the system can recommend the books that best fit each student's preferences.

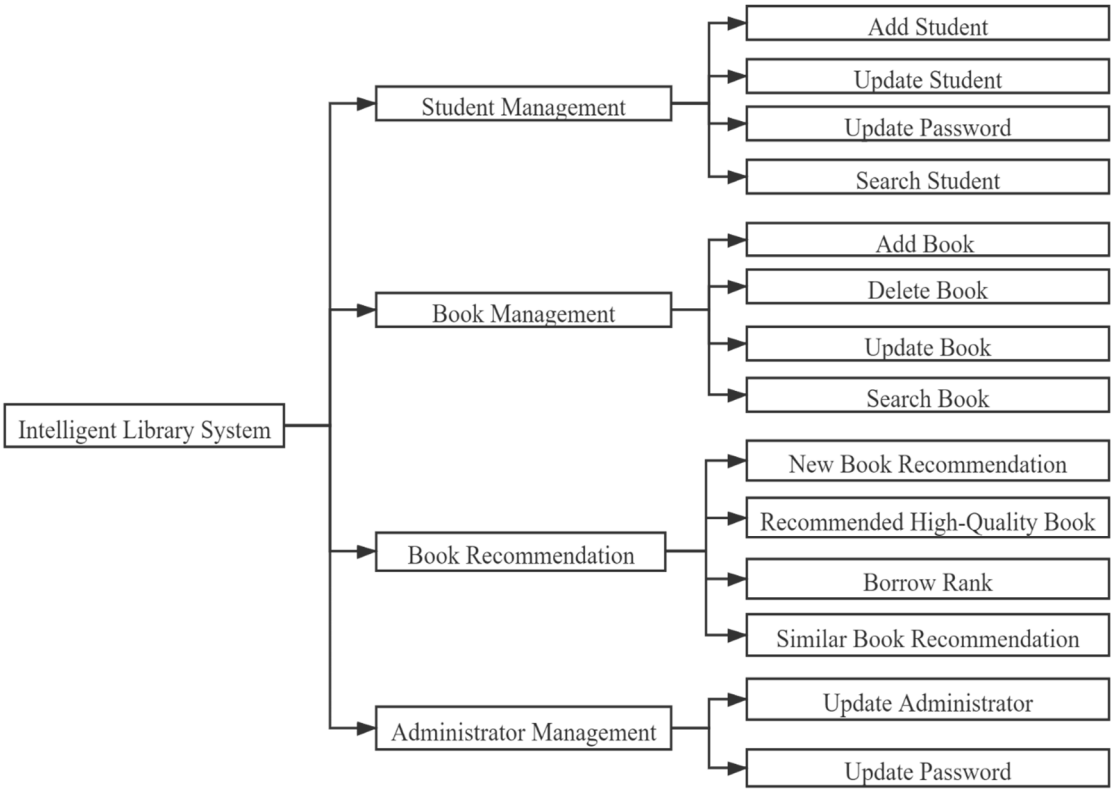

Fig.2 Functional Structure of Intelligent Library System

4. Class Design of Intelligent Library System

In the intelligent library system, we have designed four main entity classes. They are Student class, Administrator class, Book class and Borrow class. Relationships of the four main classes are shown in Fig.3. From this basic information, the intelligent recommendation module of the system can complete the function of recommending new books, displaying the rankings to the system users, recommending high-quality books and similar books.

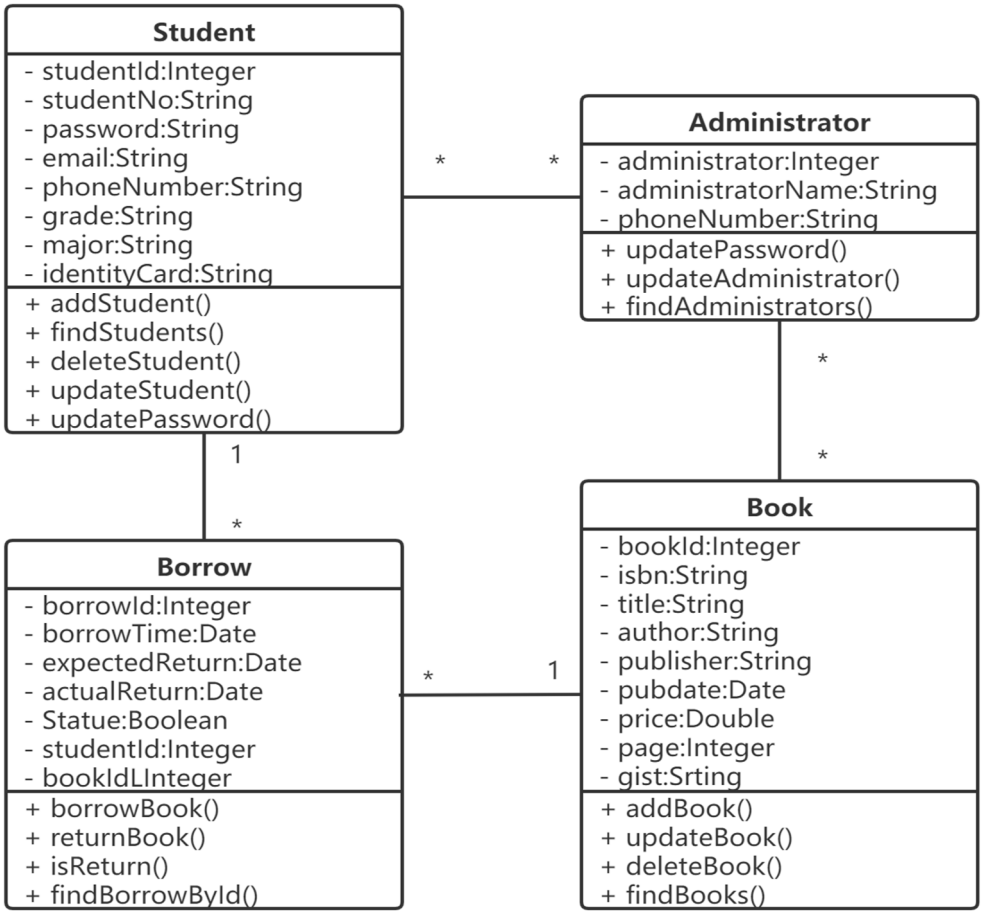

Fig.3 Class diagram of Intelligent Library System

5. Key Technology

5.1. Hybrid Recommendation

In view of the fact that the popular recommendation methods have different strengths, weaknesses and technical characteristics, and sometimes they are complementary. In the system, we use the hybrid recommendation approach to provide students with the most appropriate and effective recommendations. Thus we adopt the current popular recommendation methods, which combine co-filtering with content-based recommendations. The co-filtering method and the content-based method get each recommendation result, and the final result is then produced by combining the two methods according to certain principles.

5.1.1. Content-based

Content-based recommendation is a continuation and development of information filtering, in which the system does not need to get students' opinions on books, but only learns information about students' historical book choices to recommend new books. Content-based recommendation extracts some features for each item to represent the item, and then uses the feature data of the items that a student has liked or disliked in the past to learn the user's profile, and finally, by comparing the student's profile obtained in the previous step with the features of the candidate items, the system recommends a group of most relevant items for the user

5.1.2. Collaborative filtering

The library system uses a User-Based Collaborative Filtering (User-Based CF) Algorithm [14], where we find patterns in students' book-seeking behaviours and preferences, and the more a user prefers a book, the higher it will be rated.

a. Calculating similarity between users using improved Pearson's correlation coefficient

$$p(x,y) = \frac{\Sigma x_i y_i - n\bar{x}\bar{y}}{(n-1)S_x S_y} \quad (1)$$

where $S_x S_y$ is the standard deviation of sample *x*, *y*.

b. Get users' interest in books based on similarity between users

$$p(u,i) = \sum_{v \in S(u,K) \cap N(i)} w_{uv} r_{vi} \quad (2)$$

Based on the similarity of interests between users, userCF will suggest the K items that are most similar to the student's interests. The above formula measures the interests of student u in item i in the userCF algorithm. The $S(u,K)$ means the K users closest to user u's interest, N(i) is the users who have behaved towards item i Set, w_{uv} is the similarity of interest between user u and user v, and r_{vi} is user v's interest in item i. And the sum of r_{vi} is 1.

5.2. Offline Calculation

In the library system, we bind events to the tags on the listening page t, and record the event information with log4j. The open-source framework Flume [15] is a distributed log collection system, which will be used in each server for the data collection system. Thus the system can get an ever-growing log file on the web server. The system uses the open source framework Flume, which is a distributed log collection system, to collect the data in each server and sent to HDFS. All of the raw logs are aggregated into the HDFS distributed storage system through Flume.

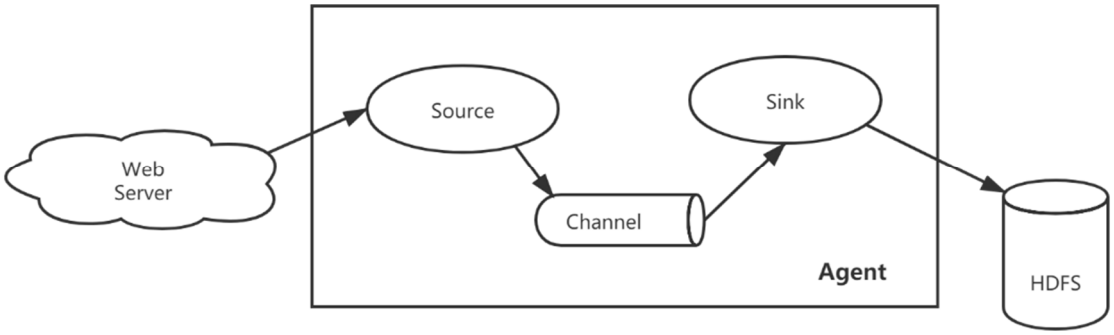

Fig.4 Flume Core Components

The system makes pre-process to clean the data, and then the MapReduce program runs on a Hadoop cluster. Thus the regular data are stored into HDFS, and are analysed by Mahout (machine learning algorithm) and are written to the recommendation material. The recommendation library system is based on the database, and finally the recommended results will be imported into the business database.

5.3. Online Calculation

The data collection part in online is the same designed as offline [16], and the raw logs are aggregated to the Kafka cluster via Flume. Part of the data is sent to the storm for real-time processing, and the other part is sent to HDFS for offline processing. The system reads the kafka messages through the storm and utilizes sparkStreaming for real-time data processing. Statistics of current updates to recommended raw materials. User behaviour data are transferred from Flume Agent to Kafka, providing real-time data for online and real-time user profiles, and providing data for the offline data storage system.

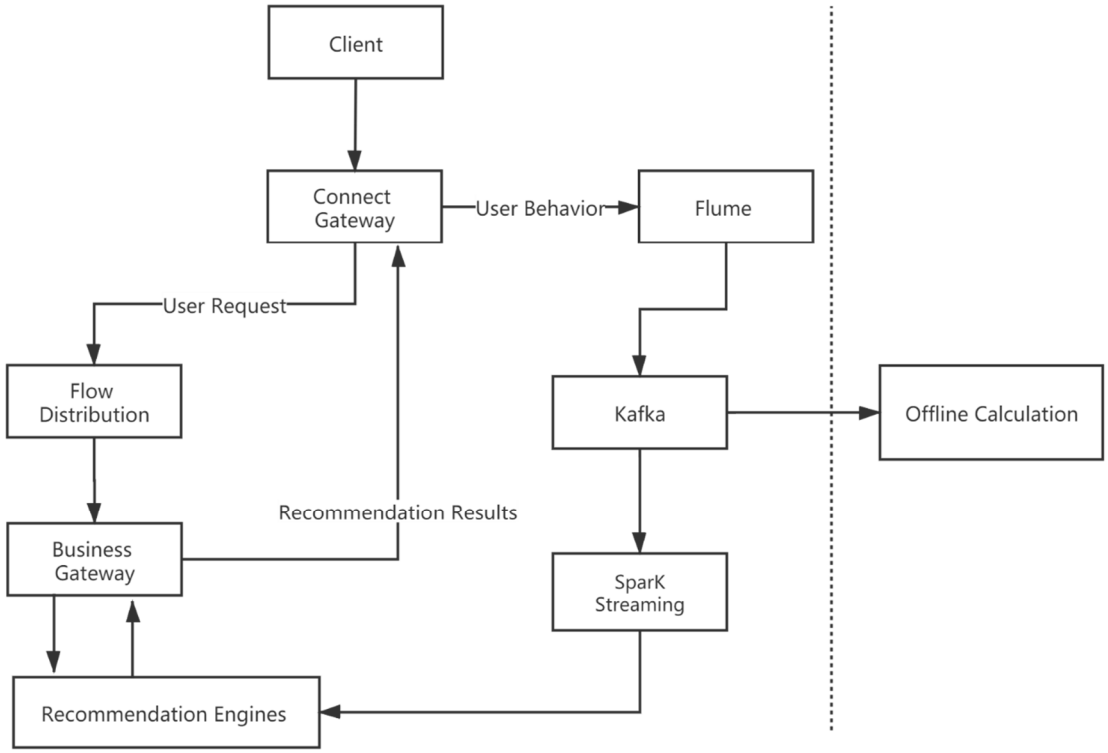

Fig.5 Functional Structure of Intelligent Library System

6. Conclusion

Adopting technologies of big data and machine learning, we construct an intelligent recommendation system of library. The simulation results show that it can improve the accuracy recommendation. And this personalized intelligent recommendation systems has good portability, it can be applied into other area with few modification.

Acknowledgments

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