Design of Library Mobile User Behavior Analysis model for Personalized Information Service

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Abstract. This paper summarizes the research status of Library mobile user behavior at home and abroad, and provides a reference for the design of Library mobile user behavior analysis model for personalized information service. Using the method of theoretical research and model analysis, the relationship between user behavior sequence and user behavior characteristics is studied from three aspects of data collection, data processing and data application. This paper defines and represents the invisible feedback behavior of Library mobile users on IOS app, android app and web page and product UI by combining the front-end operation behavior with the back-end business database, collects the data from three aspects: basic information field, user behavior related field and configuration flume of mobile users' client, and introduces the time dimension, user dimension, Department dimension, resource dimension, resource dimension. The data warehouse level modeling is carried out from six dimensions of behavior dimension and entrance channel, and the data application is realized from two steps of user behavior sequence prediction and user interest guidance.

Keywords: Mobile Library; User Behavior; Personalise; Information Service; Model Design

1. Introduction
In recent years, with the rapid development of mobile terminals, people have not only obtained information by sitting in front of computers when accessing library information, but also can use mobile terminals such as mobile phones and tablet computers to access the digital library anytime and anywhere. Interested resources, the application of mobile technology in digital libraries have brought a new development opportunity for personalized services of libraries. At present, mobile terminals have larger differences in processing capabilities, processing methods, and operation forms than ordinary computer terminals. Mobile terminals are more inclined to lightweight processing, and their ultimate purpose is to provide readers with faster, more convenient, Flexible application effect. Therefore, how to give full play to the characteristics of mobile terminals and better provide personalized information services to readers on this basis is an important issue that needs to be solved at present.
2. Research status at home and abroad

2.1. Research Status Abroad
With more and more libraries integrating databases and optimizing informatization methods, libraries can provide readers with more and more high-quality, fast and convenient information services. In the process of the library providing readers with many convenient services, the most striking is the personalized information service provided by the library to readers. Personalized information service refers to providing users with corresponding information services and knowledge services according to their specific needs [1].

At present, there are many ways to provide personalized information services for readers, and there are three representative ones: ①Mygateway used by many college libraries abroad. The Mygateway system can save the access information, access pages, access topics and other related information generated by readers when accessing various databases in the library, and process these information into different categories. Interested pages or information to improve the efficiency of readers in acquiring their knowledge of interest. ② Regularly push information to readers through email. This service method requires readers to register information in the library-related service system in advance, especially readers to actively submit topics, knowledge points and interests of interest. After that, the library regularly pushes relevant information to readers' mailboxes based on this. The famous INGENTA organization uses this service. ③ Use the library information service system function to record the user's long-term access process, access interests and hobbies. Based on this information, create a virtualized personal library for each reader. For example, the Swedish Institute of Computer Science can establish a virtual personal library for researchers visiting the library. Most university libraries in Japan have also introduced similar virtual personal library information service systems.

In summary, the development status and development trend of personalized services of digital libraries launched by countries around the world in recent years can be seen. In all such application systems, the relevant pushes are provided for readers according to the preferences of users or readers. Information and knowledge, thereby improving the efficiency of users in acquiring knowledge. This application model has been proved by practice to greatly improve the reader's experience in the library, and it has also become a major development direction for libraries to provide information services.

2.2. Domestic research status
In China, the analysis function of user behavior has been introduced in the research of library mobile users for personalized information services. For example, Song Wenjie and others studied the differences between the two groups of students and staff in dealing with the new technology of mobile libraries, and supported the two core variables (perceived ease of use and perceived usefulness) in the TAM model for the use of mobile books. The influence of library behavior intention [2]; Ming Junren and others combined the characteristics of mobile library and introduced 8 variables such as performance expectation, effort expectation, perceived interest, perceived risk, information quality, service quality, social impact and contributing factors. To build a technology adoption model for university students based on UTAUT using mobile libraries [3]; Wu Dan and others based on the OPAC background log of a domestic university library and used log mining to perform subsequent clicks on mobile and desktop users. Statistical analysis [4]; Liang Xin pointed out that the current domestic mobile service model of the library has a focus on practice and user preference. The library should design and optimize the mobile service model based on the user [5].

The specific model design and implementation of domestic library mobile user behavior analysis is mainly manifested as access to third parties or library development. In the module of data analysis, most domestic libraries currently use traditional data statistics services or third-party services provided by emerging data companies. The traditional data statistical services represented by Baidu statistics and google analysis have become the first choice of some libraries by embedding SDK in the front end.
to collect data and viewing the corresponding statistical data in the background. There are four shortcomings of this method: ① The statistical scope can only be simple visits, click-through rate and active number; ② The control, call, and transfer relationships between the various statistical modules are strongly dependent; ③ The statistical data source is not subject to books Library control; ④ No analysis function for user needs. Emerging data companies represented by Shence and GrowingIO saw the shortcomings of traditional data statistics services and proposed corresponding solutions, but they required expensive access or private deployment costs, which were too much for public welfare libraries. Expensive, coupled with the new data company's business focus on data analysis in the e-commerce field, the analysis model for the library industry is also in the exploration stage, and there are no ready-made templates to use.

To this end, this article focuses on the mobile user behavior of the library, combining the library's own business characteristics, designing the library mobile user analysis model, making full use of the open source framework to achieve the corresponding functions, and trying to analyze the mobile user behavior to make the library provide readers Good personalized information service.

3. Research ideas
The purpose is to analyze the behavior of library mobile users for personalized information services, and to push the content of interest to users as the ultimate goal of the service. In the analysis of the behavior of library mobile users' internal characteristics and external needs, theoretical research and models are used. Analyze the research methods you want to combine.

The first step is to start with the basic definition and representation method of library mobile user behavior, and sort out how to define and describe user behavior in the analysis process of library mobile user behavior for personalized information services, and give a representation of user behavior Basic data structure.

The second step is to design a library user behavior analysis model. By analyzing the characteristics and intentions of library mobile user behaviors, the accuracy of library user behavior analysis models to understand user behaviors can be improved, so as to truly provide users with various personalized information push services they need.

The third step is to analyze the differences and characteristics of different library mobile user groups and study the dynamic update technology of library mobile user behavior analysis model. Let the designed user behavior analysis model is not a simple static application model, but can be dynamically updated according to the characteristics and differences of the user group, so that the user behavior analysis model can show different in different applications and application objects Analytical skills.

The fourth step is to apply the research results to the actual reference service of the library. Readers can enjoy the associated data and knowledge independently provided by the library when using library mobile services, improve library information construction service capabilities, and enhance the reader's experience of using library mobile services.

4. Basic definition and representation method of library mobile user behavior for personalized information service
Library user behavior data is generally divided into explicit feedback behaviors that users score, like or dislike, and implicit feedback behaviors such as page browsing behaviors and consumption behaviors. The detailed comparison of the two is shown in Table 1.

| Table 1 Comparison of explicit feedback behavior and invisible feedback behavior |
|---------------------------------------------------------------|
| **Quantity** | Explicit feedback data | Stealth feedback data |
| **Reading form** | real time | delay |
| **User interest** | clear | blurry |
| **Storage method** | database | Distributed file system |
The mobile user behavior of the library for personalized information service researched in this paper mainly refers to the invisible feedback behavior of the user and product UI displayed on the iOS App, Android App and Web pages. These invisible feedback behaviors are accompanied by attribute data causing UI changes in the front end or service communication in the back end. From the perspective of computer technology, they are responsible for collecting the required complete user behavior information from the front end and reading from the back-end service log and business database. Take relevant data and integrate the two parts of data for later data modeling.

If we only rely on the back-end database, we can only know how many new registered mobile library users have been added within a certain period of time. By collecting the user's operation behavior on the front end, you can analyze the 5 data of the newly added mobile library users: the data of the user browsing the poster page, click "register" to jump to the registration page data, click "get verification code" Data, click "Submit" to register the data, and successfully register user data in the background. Therefore, to define and represent the mobile user behavior of the library, the front-end operation behavior must be combined with the back-end business database. The front-end user behavior data is used to analyze the conversion rate, help the back-end business database to mine more useful information, and facilitate the back-end product business. Do a combination.

5. Design of analysis model of library mobile user behavior for personalized information service

In various applications, services, and management systems of traditional libraries, due to inadequate research on user behavior models and lack of in-depth mining of user behavior data, library service systems cannot provide readers with high-quality personalized information services. Therefore, when studying the analysis of mobile user behavior in libraries, the focus should be on the modeling method of mobile user behavior. Study the relationship between user behavior sequences and user behavior characteristics, remove the interference of some personalized information in user behaviors, use model representations to quickly and accurately map user behavior sequences to user behavior characteristics, and solve mobile problems The core issue in user behavior analysis.

5.1. Data collection

It mainly collects data from mobile user clients of libraries. Since not all the mobile applications of the library are developed by the library, each part of the mobile system is responsible for collecting and writing the collected data to kafka. The library uses kafka as the source and directly uses flume The collected data is sink to hdfs in days. The relevant collected fields are as follows:

| Field name | Chinese name | Value          | Field name | Chinese name | Value |
|------------|--------------|----------------|------------|--------------|-------|
| opt_system_type | Operating system type | android, ios, windows | user_account | user account |
| opt_system_version | Operating system version | ios_10.0, android_5.0 | user_dept | User department |
| location_gps_long | Geographic longitude location | user_post | User Jobs |
| location_gps_lat | Geographic latitude | user_role | User role |
| network_type | Network Type | WIFI, 3G, 4G, 2G | device_brand | Equipment brand |
| network_operator | Network operator name | China Mobile, China Unicom, China Telecom, China Netcom, China Railcom, Alibaba Communications, JD.com | action_type | Action type |
| device_type | Equipment model | device_imei | Device IMEI |
| action_result | Action result | success, failure | device_resolution | Device resolution |
| action_error | Action error | action_create_time | action_time | Millisecond timestamp |
| app_name | App name | app_key | Apply key-value |
| install_way | Installation path | Campus LAN, QR code sharing, appstore, app treasure, Xiaomi app market, Huawei app store | extra_data | Other parameters |

Table 2 Mobile user client basic data collection fields
Mobile user client basic information field. Can be divided into 26 fields, as detailed in Table 2.

Configure Flume. Flume is a distributed, reliable and highly available mass log collection, aggregation and transmission system that supports customizing various types of data senders in the log system, while providing simple processing of data and writing to various data recipients ( Such as text, hdfs, hbase, etc.) [6]. In the design of this model, you need to configure sources, sinks, and #channels in the base action topic and user action topic, that is, the configuration of the source directory, destination directory, and channel directory being monitored, and persist the file events to the local hard disk. Then the log files in days and hours are formed in the relevant directories on hdfs. At this point, the work of data collection comes to an end.

5.2. Data processing
Data processing of library mobile user behavior analysis model for personalized information service mainly refers to the modeling of business data warehouse level. First of all, according to the needs of the library, a data model suitable for business development is drawn up, and then the data is extracted from the business data in MySQL and MongoDB and the user behavior and log data in Elasticsearch according to the representation method of the data model. The script completes the analysis function, and Airflow is responsible for task processing and storage. Finally, the formed data is stored in MySQL to establish a multi-dimensional data model that can be used for in-depth analysis and used by the data application layer. As an intermediate platform for centralized storage of data, the construction of data warehouses focuses on data modeling and ETL processes, and does not produce or consume data.

The library mobile user behavior analysis model only establishes four dimension tables: tb_dim_time time dimension, tb_dim_user user dimension, tb_dim_resources resource dimension, and tb_dim_action behavior dimension. The department dimension and the entry dimension are put into the tb_fact_lib_usage fact table in the form of character strings. Avoid repeated queries and improve analysis efficiency. Set up a prod_xxxx_id field linked to the corresponding data id in the library business database in the three tables of user dimension, resource dimension, and behavior dimension to facilitate synchronization with the information in the business database. When the relevant information in the business database changes, the data warehouse information is updated through ET [8]. The ETL process is implemented by writing Python scripts, introducing an incremental update mechanism and Airflow task flow management.

5.3. Data application
The purpose of the library’s modeling and analysis of mobile user behaviors is ultimately to guide readers to make better use of the various resources in the library, carry out learning and research activities, and give full play to the value of the library’s collection resources. Therefore, after researching and designing the mobile user behavior analysis model and application technology, combined with the results of the library's user behavior analysis, designing targeted reader guidance models and mechanisms can enable the library to actively provide high quality to the mobile user community Information and knowledge services.

When designing the user behavior guidance mechanism, it is not only the information construction problem of user interface design [9], but also the inverse prediction of the previously analyzed user behavior characteristics. According to the user's existing user behavior sequence, the user's behavior characteristics are analyzed, and then based on this feature, the user's next possible behavior sequence is predicted [10]. Predicting user behavior sequences from user behavior characteristics is a data application of user behavior analysis models. The predicted sequence of user behavior can pave the way for the user's next behavior guidance. Finally, the user's potential behavior sequence is optimized and designed to increase the attractiveness of each operation step to the user.

User behavior guidance can be divided into two steps: user behavior sequence prediction and user
interest guidance. First, by analyzing user behavior, abstractly describing the user's behavior characteristics, the basic steps of the user's behavior are reversed to the abstract user behavior characteristics, and the user behavior representation form the corresponding relationship with the user behavior characteristics, and then conduct user interest guidance. The user behavior of each step is specially designed, and a friendly interface and operation process are developed to attract users' attention, so that users are interested in gradually operating along the pre-designed behavior steps, and apply the data of the library mobile user behavior analysis model. Toward the direction of the library hope.

6. Conclusion
Establishing a library mobile user behavior analysis model for personalized information services can enable the library to better discover the characteristics and needs of mobile user behavior [11], laying the foundation for the library to provide these readers with higher quality knowledge and information services basis.

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