The architecture design of information intelligent recommendation system for mobile communication terminal

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Abstract. In order to effectively generate product recommendation information for specific users and push it to all kinds of mobile terminal systems, combined with the application environment of recommendation system in e-commerce, the overall architecture of information recommendation system for mobile terminal is given, and the recommendation engine structure with multi engine strategy is designed and analyzed. Processing flow and two kinds of information push schemes for mobile terminals: user-defined recommendation technology and third-party recommendation platform. The proposed recommender system architecture has clear division, strong scalability and easy expansion, and has achieved good results in practical application.

Keywords: Mobile terminal, Information recommendation, Push engine, Push platform.

1. Introduction

According to the data released in the 36th statistical report on the development of Internet in China, as of June 2015, the number of mobile Internet users in China has reached 594 million, and 88.9% of the Internet users use mobile Internet. With the large screen of mobile terminal and the continuous improvement of mobile application experience, the trend of mobile phone as the main Internet terminal of Internet users is more obvious. Due to the instant and convenient characteristics of mobile terminal, it better meets the consumption needs of Internet users. Currently, mobile commerce applications have become a new engine to drive the network economic growth. In order to send more targeted messages to users, recommender system is a good solution, it can actively find the current or potential needs of users, and actively push information to users. Specifically, the recommendation system will combine the user's identity information, behavior and the attributes and characteristics of the items, and use the recommendation algorithm to mine the user's preferences and needs, and push the items that users may be interested in to their terminals, especially the mobile terminals.

In the whole e-commerce system, recommendation system is a very important part. The main problems to be solved in the commodity information recommendation system for mobile terminals are the design of recommendation engine and the selection of push scheme. From a technical point of view, the technical requirements include: supporting some main recommendation algorithms, and solving common problems such as data sparsity and cold start; Flexible data extraction methods, that is, different data extraction methods are used according to different recommendation technologies; It supports the...
combination of multiple recommendation technologies and can easily expand other recommendation technologies; Recommender computing has high availability and real-time, that is, the combination of online computing and offline computing; Support real-time and reliable information push solutions for all kinds of mobile terminals, that is, using custom push technology or third push platform; The push platform provides users with core data reports, push effect tracking feedback and other statistics. It can be seen that the architecture of recommendation system is more complex, so it is very meaningful to design and study it.

2. Project application environment
The application of recommender system generally has a certain project background, such as e-commerce website, social networking website, news website, music website, and so on, and the recommender system is only an important part of the whole project. The recommender system in this paper is a subsystem in the whole e-commerce system environment, and its project application environment is shown in Figure 1. Considering the stability and security of the system, the server of e-commerce system generally separates the front-end service from the back-end core business. The core business of the background is encapsulated as a service, and the front-end accesses it through web services. The front-end service is composed of two modules (subsystems) front-end business processing and information recommendation system. The front-end business processing provides the response processing of web access request to the client, and the information recommendation system calculates the recommendation results and pushes them to the client. The client program can be a dedicated application or browser program on the mobile terminal.

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![Figure 1. E-commerce system environment](image-url)
3. System architecture design

Information recommendation system is a relatively independent module (subsystem) in the whole e-commerce system, which mainly includes front-end DB operation interface, data acquisition module, recommendation engine module, push platform (Interface), recommendation evaluation module and system management module. Each module of the recommendation system is related to each other, and its overall architecture is shown in Figure 2.

The main processing functions of each module of the system are as follows.

Front end DB operation interface: it provides the interface to access the front-end database, through which the data acquisition module, recommendation engine module, recommendation evaluation module and system management module operate the front-end database.

Data collection module: it is used to collect data from different sources for analysis and calculation of recommendation.

engine. Its data sources include user data and commodity data of e-commerce website, user purchase / collection records and evaluation data, and some behavior characteristics data of user visiting website. The module collects data in different ways according to the requirements of different recommendation engines.

Recommendation engine module: recommendation engine module is composed of recommendation algorithm calculation module and recommendation result processing module. The preliminary recommendation results can be generated by multiple recommendation algorithm modules or different recommendation algorithm modules according to specific needs, but the final recommendation results are obtained by a series of processing by the recommendation result processing module.

Recommendation evaluation module: the recommendation evaluation module calculates the recommendation utility according to the recommended products and feedback effect data in the front-end database, combined with the current working mode of the recommendation engine, and feeds back the result to the system administrator.

![Figure 2. Overall architecture of recommender system](image-url)
System management module: This module is used to set and control the whole recommendation system, such as adjusting the recommendation engine, data collection, working mode and related parameters of recommendation evaluation module.

Push platform (Interface): the recommendation results generated by the recommendation engine module are sent to the mobile terminal by the push platform (Interface) and delivered to the specific application by the mobile terminal. According to the specific push requirements, the module can be a custom push technology or a third-party push platform.

4. Recommendation engine design

4.1. Structure of recommendation engine

Recommendation engine is the core part of recommendation system, and it is the key to decide the effect of recommendation. Recommendation engine module is composed of recommendation algorithm calculation module and recommendation result processing module. The calculation module of recommendation algorithm is composed of multiple algorithms. After calculation, the preliminary recommendation results can be generated, and then the filtering, ranking and interpretation are optimized by the recommendation results processing module to generate the final recommendation results. The structure design of recommendation engine is shown in Figure 3.

![Figure 3. Recommendation engine structure](image)

At present, the main recommendation methods in the field of mobile recommendation are content-based recommendation, collaborative filtering recommendation, knowledge-based recommendation and hybrid recommendation. Different recommendation algorithm 2 can be used in the implementation of recommendation methods. Each recommendation algorithm has its own characteristics and applicable occasions, but no recommendation algorithm is absolutely effective. The preliminary results of recommendation can be generated by the joint action of multiple recommendation algorithm calculation modules or by using different recommendation algorithm calculation modules according to specific needs. The combination of multiple recommendation algorithms is a common choice. The combination of recommendation algorithms can be in different ways, such as parallel combination, serial combination and hybrid combination. The recommendation algorithm includes online calculation and offline calculation. The results of offline computing will be stored in the database to reduce the amount of online computing, which is conducive to providing low latency services. The recommendation result
calculated by the recommendation algorithm is only a preliminary recommendation result, which is still very rough and cannot be directly pushed to users. The recommendation result processing module needs to do a series of optimization processing, such as recommendation filtering, recommendation ranking, recommendation explanation and result generation.

4.2. recommended treatment process
According to the structure of recommendation engine given above, the recommendation process can be divided into two stages: generating initial recommendation results and optimizing recommendation results. There are three steps to generate the initial recommendation result: off-line calculation of feature item correlation table, extraction of user feature vector and matching calculation of initial recommendation result; The optimization of recommendation results is divided into four steps: recommendation filtering, recommendation ranking, recommendation explanation and result generation. The complete flow of recommendation processing is shown in Figure 4.

![Figure 4. Recommended processing flow](image)

The functions of each step in the recommended treatment process are as follows.
Offline computing feature item correlation table is calculated offline by the system according to a certain strategy. Its data usually comes from user data and commodity data. This calculation will consume a lot of computing resources.
Generating user feature vectors is to extract features from data collected by data acquisition module and user data, or directly use existing feature vectors, whose data comes from user information or user behavior.
The initial recommendation result is to match the feature vector with the feature item correlation table, which has different calculation methods and depends on different recommendation algorithms.
Recommendation filtering is mainly to filter out the products that users have bought or don't like, and filter out the products with poor evaluation.
Recommendation ranking is a comprehensive ranking of the results recommended by multiple recommendation algorithms. Its method can rank based on the calculation of dynamic weight of recommendation algorithm. When the recommendation results are valid for users, the weight of recommendation engine will be updated.
Recommendation explanation is the basis to explain the result of recommendation to users, which needs to be explained from different recommendation engines and recommended from the relationship between items or users.
Finally, according to the push information specification, the push result is generated.
5. push scheme selection

5.1. custom push technology

The recommendation results generated by the recommendation engine need to be pushed to the user terminal, such as mobile terminal or PC. As far as mobile terminals are concerned, the mainstream systems in the market are Android, IOS and windows phone, and the push technologies supported by each system are different. IOS system supports APNs (Apple Push Notification Notification) technology, windows phone system supports MPNs (Microsoft Push Notification Service) technology, and Android system, which has the largest market share, supports GCM (Google Cloud Messaging) technology. There are difficulties in the practical application of GCM technology in China, because the push technology service for Android system needs to be developed by ourselves [5]. In order to support pushing information to different systems, we can build a push platform architecture as shown in Figure 5. The push platform consists of API Server, Push Server, push dB, Bi Server and Dispatch Server.

![Information push platform architecture](image_url)

In order to improve the scalability and applicability of the push platform, API Server is designed here, which can provide the interface function of using push service to the system, and also provide the interface function to the system of the unit or the third party. Push Server is the key to realize push service. It receives push task and distributes information according to push destination platform. If the information is pushed to the IOS system or windows phone system, the information is only distributed to the APNS server or MPNS server, and the server sends the information to the mobile terminal; However, if the information is to be pushed to the Android system, you need to implement the push service yourself. Using MQTT protocol is a good way [6]. In addition, Push Server also provides Web services that support users to push information manually, and administrators can manage it through the web.

Push DB is used to store push related modeling and data. To achieve the above push platform functions, the database tables to be designed mainly include user equipment basic information table, application basic information table, push template table, push information table, push setting table, push feedback information table, push statistics table, etc.

Sometimes, in order to improve the effect of push, BI Server is also included in the information push platform architecture. BI Server is mainly used for push statistics, so that businesses can understand the effect of push and adjust push strategy. When there is a large amount of information to be pushed, and the real-time and arrival rate of push are strictly required, a dispatch server can be designed. Dispatch
server can distribute push information directly to APNS Server, WPNS Server or push server more efficiently. At this time, push server is only responsible for pushing information to Android terminal.

5.2. third party push platform
With the wide use of information push service and the complexity of the technology, there are some third-party push platform technologies in the market to provide professional push service for customers. At present, the well-known third-party push platforms in China include push, Aurora push, cloud bar push, BaiDu push, Tencent push, XiaoMi push, etc. The usage of these push technologies is similar. Here we take a push application technology for Android platform as an example. A push service framework is shown in Figure 6. The third-party server is the server that needs to push information in the specific application. If the final recommendation result is generated, it will be sent to the server. A push server is to push the push information from the third-party server to the third-party client, which is the key to push. The third-party customer is the terminal receiving push information, such as mobile terminal. As an Android service, the push SDK runs in the background of the third-party client for a long time, so as to create and maintain a long connection. Uid refers to the ID of the third-party application identifying the user's identity; Client ID (abbreviated as CID) refers to the ID of a push SDK to identify the user's identity; payload refers to the information that the third-party application sends to the client through a push, and the third-party application is responsible for parsing the specific actions. When developers want to push messages to App in time, they just need to call a push API to push.

![Push android SDK push framework](image)

Figure 6. Push android SDK push framework

6. Conclusion
With the rapid development of mobile Internet and mobile terminal technology, e-commerce information recommendation is gradually transferred from PC to mobile terminal. However, the commodity information recommendation system for mobile terminal has many problems to solve, and the architecture is complex, among which the design of recommendation engine and the selection of push scheme are the most critical. Based on this, from the perspective of the specific application environment of the recommendation system, this paper presents the architecture of the information recommendation system for mobile terminals, designs and analyzes the recommendation engine structure and processing flow of multi engine strategy, as well as two information push schemes for mobile terminals: user-defined recommendation technology and third-party recommendation platform. The research content from the overall architecture and key technologies of mobile terminal-oriented information recommendation system is designed and analyzed, which has a certain significance for the research and implementation of related systems.
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