Hybrid Recommendation Algorithm for Intelligent Recommendation of Popular Stores for Agricultural E-commerce Platforms

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Abstract. With the increasing number of e-commerce platforms, each e-commerce platform has started to provide different intelligent recommendation services in order to dominate the market. However, in agricultural e-commerce platforms, the application of intelligent recommendation algorithms is less, resulting in a poor shopping experience for users. Therefore, the study proposes an agricultural e-commerce platform applying hybrid recommendation algorithms. The system achieves primary recommendation through to collaborative filtering algorithm to form a primary commodity recommendation set; then on the basis of the primary commodity recommendation set, secondary recommendation is carried out by fusing multi-attribute algorithms to obtain the final personalized recommendation results. After testing, the response time of each function of the system is short, and the stability and compatibility are good.

Keywords: e-commerce platform; intelligent recommendation; collaborative filtering algorithm; fusion multi-attribute algorithm; system design

1 Introduction

With the popularization of the Internet, the e-commerce market is also expanding, which is visualized by the increase in the number of e-commerce platforms. Popular e-commerce platforms such as Tmall, Jingdong, Amazon, etc. are expanding, and short video platforms such as Jitterbug have also started to develop e-commerce platforms. Facing the competitive e-commerce market, how to accurately capture user pain points and expand sales performance has become the main task of e-commerce platforms [1-2]. And only recommendation algorithms can extract user profiles from users' browsing and consumption data, and recommend products that users may be interested in to promote sales growth [3-4]. However, the current intelligent recommendation technology is more widely used in large e-commerce platforms, but due to the wide variety of commodities in large e-commerce platforms, it is difficult to achieve accurate personalized recommendations for agricultural products. Therefore, in order to facilitate users to buy all kinds of agricultural products, and at the same time promote the development of agriculture, the study proposes an agricultural e-commerce platform

B. K. Kandel et al. (eds.), *Proceedings of the 2023 3rd International Conference on Business Administration and Data Science (BADS 2023)*, Atlantis Highlights in Computer Sciences 19,
https://doi.org/10.2991/978-94-6463-326-9_12

that can realize personalized can only recommendations. The platform is based on the hybrid recommendation algorithm based on collaborative filtering algorithm and fusion of multi-attribute algorithm, and takes into full consideration the characteristics of agricultural products and the functional requirements of the e-commerce platform. In the intelligent recommendation of this e-commerce platform, the collaborative filtering algorithm carries out primary recommendation through user similarity, and the fusion multi-attribute algorithm carries out secondary recommendation on the basis of the primary recommendation in order to obtain accurate personalized recommendation results.

2 Design of agricultural e-commerce platform based on hybrid recommendation algorithm

2.1 Research on recommendation algorithms for agricultural e-commerce platforms

With the development of Internet technology, the data of all kinds of e-commerce platforms are also growing explosively, leading to the platform facing the problem of information overload. In order to improve the above problems, it is necessary to process and utilize all kinds of data on e-commerce platforms. Intelligent recommendation algorithms can effectively mine the information implied in the data and provide users with better data services. In the agricultural e-commerce platform, the huge number of users leads to the low precision of traditional recommendation algorithms and poor user experience. Therefore, in order to improve the accuracy of intelligent recommendation, the research proposes a hybrid recommendation algorithm based on collaborative filtering algorithm and fusion multi-attribute recommendation algorithm. In the hybrid recommendation algorithm, the collaborative filtering algorithm carries out primary recommendation and the fusion multi-attribute algorithm carries out secondary recommendation. The flowchart of hybrid recommendation algorithm is shown in Figure 1.

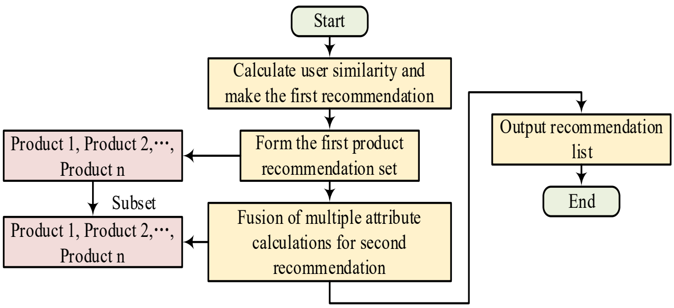

Fig. 1. Flow of the hybrid recommendation algorithm

As can be seen from Fig. 1, in primary recommendation, the collaborative filtering algorithm obtains the goods that the user may be interested in through user similarity to form a primary goods recommendation set, which is not conveyed to the user. In the secondary recommendation, the fusion multi-attribute algorithm performs multi-attribute computation on the commodity recommendation set to get the final recommendation result, which is conveyed to the user. The primary recommendation algorithm process is as follows: the user group is selected and the list of users is output; then the user similarity is calculated and converted into a score. Then select according to the similarity score, if it meets the requirements, it enters the one time product recommendation set, otherwise it does not enter and ends the program. In one time recommendation, the user similarity index is the similarity of Euclidean distance.The Euclidean distance of N-dimensional space and its similarity calculation formula is shown in equation (1).

$$\begin{cases} d(x,y)=\sqrt{(x_1-y_1)^2+(x_2-y_2)^2+\ldots+(x_n-y_n)^2}=\sqrt{\sum_{i=1}^{n}(x_i-y_i)^2} \\ sim(x,y)=\dfrac{1}{1+d(x,y)} \end{cases} \tag{1}$$

In Eq. (1), $d(x,y)$ denotes the Euclidean distance; (x,y) denotes the sample coordinates; $sim(x,y)$ denotes the similarity of the Euclidean distance. It is worth noting that in the evaluation of user similarity by Euclidean distance, users are required to have at least one common rating item [5-6]. Since the primary recommendation algorithm is only the initial ranking of the product recommendation, its recommendation accuracy is not high, so it is necessary to carry out the secondary recommendation to ensure the recommendation accuracy. The algorithm used for secondary recommendation is the fusion multi-attribute algorithm, and the algorithm process is as follows: calculate the commodity recommendation score according to the commodity recommendation set and the recommended attributes, and recommend according to the size of the score. The formula for calculating the commodity recommendation score is shown in equation (2).

$$S=\left(s(a)\times w(a)+s(b)\times w(b)+s(n)\times w(n)\right)\times w(x) \tag{2}$$

In Eq. (2), S denotes the recommendation score of the product; $s(a)$, $s(b)$ and $s(n)$ denote the scores of the attributes a , b and n , respectively; $w(a)$, $w(b)$ and $w(n)$ denote the percentage of the scores of a , b and n , respectively; and $w(x)$ denotes the ratio of the weighted attributes. For the characteristics of products and e-commerce platforms, the attributes selected for the study are views, sales, and whether they are in season or not, of which whether they are in season or not is a weighted attribute, and the rest are conventional attributes. Among the recommended attributes, the ratio of conventional attributes is 0.25 for views: 0.75 for sales, and the proportion can be adjusted according to the actual situation [7-8]. The ratio of weighted attributes is set according to the actual situation of the commodity, when the commodity is in season, the weighted attribute is 1.1; when the commodity is not in season, the weighted attribute is 1. The formula for calculating the recommendation score of the views attribute is shown in equation (3).

$$\begin{cases} s(a) = \sum_{i=1}^{n} \left(v(i) \times w(i) \right) \\ w(i) = \dfrac{1}{\log_2 (i+1)} \end{cases} \tag{3}$$

In Eq. (3), $v(i)$ represents the number of product views on the first i day; $w(i)$ represents the weight factor of the number of views on the first i day. The formula for calculating the recommendation score of sales attribute is shown in equation (4).

$$s(b) = \sum_{i=1}^{n} \left(q(i) \times w(i) \right) \tag{4}$$

In Eq. (4), $q(i)$ denotes the sales volume of goods on day i; $w(i)$ denotes the weighting coefficient of sales volume on day i.

2.2 Agricultural e-commerce platform design

After choosing the appropriate intelligent recommendation algorithm, the e-commerce platform system can be designed according to the needs of the agricultural e-commerce platform. For the use and management needs of the agricultural e-commerce platform, the e-commerce platform is divided into the backstage management end and the mobile use end. The main functions of the backstage management end include order management, tracking and statistics, product inventory query, management and inventory, user and integral management, and intelligent recommendation parameter settings, etc. The functions of the mobile user end mainly include product browsing, shopping, favorites and adding shopping carts, order progress query, return processing, personal information settings, and integral query. The system functional structure of the agricultural e-commerce platform is shown in Figure 2.

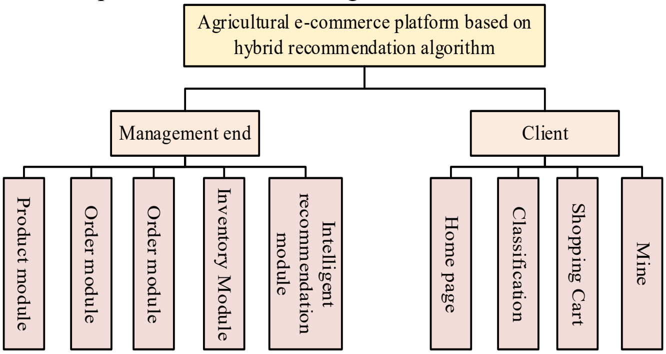

Fig. 2. System Functional Structure of Agricultural E-commerce Platform

As can be seen from Figure 2, the backend management terminal is divided into five modules, i.e., commodity, order, user, inventory and intelligent recommendation module. Among them, the commodity module is responsible for the classification, management and attribute setting of commodities; the order module is responsible for sales, statistics and shipment; the user module is responsible for the management of users, their comments and points; the inventory module is responsible for the inventory query and maintenance of the inventory; and the intelligent recommendation module is mainly responsible for the first and second intelligent recommendation and its parameter settings. The mobile terminal is divided into four modules, namely, home page, classification, shopping cart and users. The home page is responsible for personalized and hot recommendations; the classification module is responsible for product classification and selected recommendations; the shopping cart is responsible for purchase and settlement; the user module is responsible for order information query and personal information management. In the backend management, considering its functional design and business requirements, the architecture adopted is B/S architecture, the database is MySQL database, the search engine is Elasticsearch, the algorithm is developed in Java language, and the caching technology is Redis. the same as the agricultural e-commerce platform system, the e-commerce data is also divided into two parts, i.e., the sales order data and the intelligent recommendation data, and there is an interaction and combination between these two parts of the data. There is an interactive combination between these two parts of the data. The data interaction is shown in Figure 3.

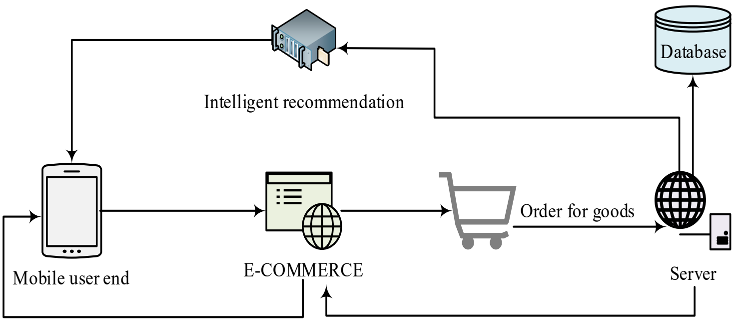

Fig. 3. Schematic diagram of data interaction

As can be seen from Figure 3, the sales data generated by users shopping for goods on the agricultural e-commerce platform is the most important data of the agricultural e-commerce platform, which represents the inflow of orders and funds. After the user purchases and settles the order, the relevant data will be transmitted to the server and stored in the database. The recommendation-only algorithm analyzes the user's behavior and derives a recommendation list through the sales data in the server, and after the user logs into the e-commerce platform, the program sends the intelligent recommendation data to the user to increase the turnover of orders. In the agricultural e-commerce service platform, considering the scalability of the server, the study chooses a lightweight cloud server whose hosting mode is cloud hosting. The amount of storage, memory, etc. of the server can be increased or decreased according to the actual situation. In terms of operation and maintenance scheduling, taking into account the performance stability, Ali Cloud Nginx is used, which not only has smooth operation and maintenance performance, but also realizes remote control. The construction mode of the service layer is a microservice distributed architecture, using front-end and back-end separation technology to achieve rapid iteration on the line. At the database level, MySQL database is selected for the study, and key data tables need to be designed in order to realize the construction of the database. Take commodities as an example, its key data table is shown in Table 1.

Table 1. Key Data Table of Agricultural Products

Name	Type	Length/ Byte	Primary key	Foreign key
Product ID	INT	10	Y	N
Product name	VARCHAR	30	N	N
Product classification	INT	10	N	Y
Product labeling	INT	10	N	Y
producer	VARCHAR	30	N	N
Manufacturer	VARCHAR	30	N	N
Picture	VARCHAR	400	N	N
Buying price	VARCHAR	20	N	N
Describe	VARCHAR	200	N	N
Creation time	DATETIME	-	N	N
Founder	VARCHAR	10	N	N
Release time	DATETIME	-	N	N
Publisher	VARCHAR	10	N	N

As can be seen from Table 1, the key data table of commodities mainly contains the relevant attributes of commodities, specifically including product name, category, label, origin, manufacturer, description, picture, purchase price, creation and release time, and so on. The above key data table can be used to understand the related information of the commodity in detail to ensure the accuracy of the recommendation algorithm.

3 Implementation of agricultural e-commerce platform based on hybrid recommendation algorithm

In Chapter 1, the e-commerce platform system and intelligent recommendation algorithm were constructed by analyzing the requirements of agricultural e-commerce platform. Now the realization technology of agricultural e-commerce platform based on hybrid recommendation algorithm is elaborated in detail. The agricultural e-commerce platform system is developed in Java, supporting QQ, Baidu, Google and other browsers; the backend framework is Spring Cloud and Spring Boot; the development mode is waterfall; and the user-side framework is VUE.Considering the storage requirements of large amounts of data, the database is chosen to be MySQL.At the same time, because of the need for frequent caching of data on the platform, the study selected Redis technology for the implementation of the hybrid recommendation algorithm. Redis technology is chosen for data caching [9-10]. The search engine is Elasticsearch; the server is Aliyun server with 8 CPU cores, 16 G of memory, and 400 G of ESSD cloud disk. Since the agricultural e-commerce platform is an online trading platform, database encryption is required to ensure the security of transactions. The encryption technology chosen for the study is SSL personal digital certificate, which encrypts and hides the transmitted data to ensure transaction security. The agricultural e-commerce platform system is divided into the management side and the user side, in which the management side supports the normal operation of the entire platform. The management side is divided into five basic modules: order, commodity, user, inventory and intelligent recommendation, in addition to promotion, statistics, finance and other modules. The functions of the commodity module are divided into commodity list, commodity details, commodity classification, commodity labels and commodity release; the functions of the order module are divided into order management, refund/return management and courier management; the specific functions of each module are shown in Table 2.

Table 2. Specific Functions of the Product Module and Order Module

Commodity module	Function	Order module	Function
List of goods	Display the names, categories, prices, sales, views, purchases, favorites, and available quantities of both listed and unlisted products	Order management	Order list: Display order number, product name, specification, price, quantity, amount, order time, etc., and perform shipping operations
	Remove items that have already been listed		Confirm receipt: Manage orders that have been received by buyers, displaying their order number, amount, delivery time, etc.
Product details	Maintain information such as product classification, labeling, origin, storage conditions, brand, production date, etc.		Order statistics: Conduct statistics on orders to be processed, sales ranking, order classification, etc.
Commodity classification	Publish and list products, maintain detailed information on product prices, categories, specifications, etc.	Refund/Return Management	Process refund or return requests from buyers
Commodity release	Classify products and support querying, modifying, and deleting product lists	Express Order Management	Display relevant information such as courier number, order number, recipient address, phone number, etc., and track logistics progress

As can be seen from Table 2, in the product module, the product list is responsible for displaying attributes such as the name, category, views, price, available quantity, etc. of the product, and it is also possible to downsell the uploaded products in the product list. In the product details page, you can query and maintain the category, origin, brand, production date and specifications of the product, and you can also view the buyer's evaluation of the product so as to rectify the situation in time. The product release function is mainly responsible for shelving the products, and at the same time, you can also maintain the price, specifications and other attributes of the products in this interface. Commodity classification module is mainly responsible for the classification of commodities, while the module can also modify and delete the list of commodities. In the order module, the order management module is divided into three parts: order list, receipt confirmation and order statistics. Among them, the order list is responsible for displaying the order number, product name, specifications, price, quantity order time and other attributes, while the module is also responsible for the unshipped orders for shipment processing; confirmation of receipt module is responsible for the buyer has confirmed receipt of the order management and display its order number, quantity, receipt time, etc.; order statistics module is responsible for the pending shipment, pending payment, commodity sales and order classification for the The order statistics module is responsible for the statistics of pending shipments, pending payments, sales volume of goods and classification of orders, so that the staff can handle them in time. Refund/Return Management Module is mainly responsible for processing the buyer's refund or return application. The courier order management interface mainly displays the courier order number, order number, recipient's address and phone number and other information, and follows up the logistics status; so that when the logistics status is abnormal, it can be processed in time. In addition to the product and order module, the management terminal also has user, inventory and intelligent recommendation module. The user module is responsible for the management of user information, including user registration/de-registration, information modification, account points and user evaluation, etc.; the above information can be used to obtain a standard user profile for the realization of subsequent marketing and intelligent recommendation services. Inventory module is responsible for maintaining the available quantity and in-transit quantity of goods. Intelligent recommendation module is mainly responsible for personalized recommendation for users, and the intelligent recommendation algorithm is a hybrid recommendation algorithm based on collaborative filtering algorithm and integration of multi-attribute algorithm. The user side is mainly divided into four modules: "Home", "Category", "Shopping Cart" and "My". On the user side, users interact with the APP to realize operations such as browsing products, adding purchases, bookmarking, placing orders, and settling accounts. The user terminal is directly in front of consumers, so the user experience brought by the user terminal will directly affect the customer retention rate of the e-commerce platform. In order to reduce customer turnover, when designing the user side, it is necessary to cater to the use habits of customers. The specific functions of the client side of the agricultural e-commerce platform designed by the study are shown in Figure 4.

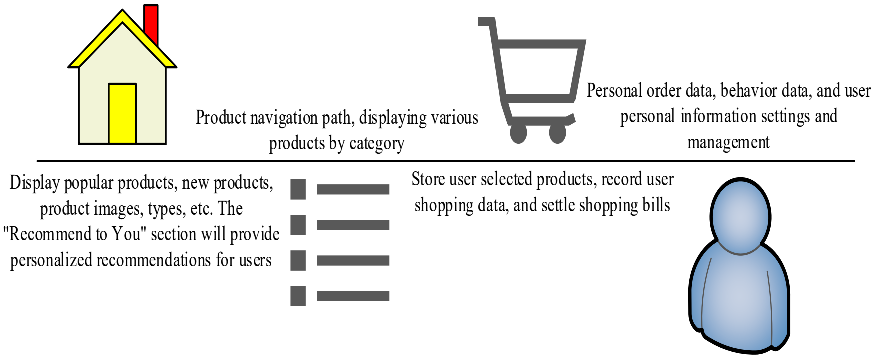

Fig. 4. Specific Functions of Agricultural E-commerce Platform Client

As can be seen in Figure 4, in the home page of the user side, users can browse all kinds of commodities and view their detailed information and product images, while the home page will also display the current popular commodities and newly released commodities, which is convenient for users to buy; and the "Recommended for you" part of the home page will provide users with personalized intelligent recommendation services to promote turnover. Classification module is actually the product navigation path of the e-commerce platform. In the classification interface, the products are displayed in different categories, which is convenient for the users to shop for the required category of products. Shopping cart is a very important module in the user terminal, its main function is to store the user selected goods and billing, while the module is also responsible for recording user shopping data, so that the intelligent recommendation algorithm more accurately achieve personalized recommendations. The "My" module is mainly responsible for editing, modifying and deleting the user's personal information, and the module is also responsible for querying the history of orders, browsing records, evaluations, favorites, and applying for after-sales service. The stability test results of the system are shown in Figure 5.

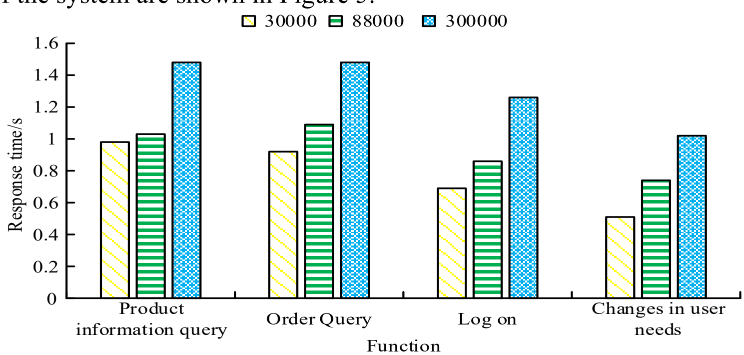

Fig. 5. Test results of the e-commerce system

As can be seen from Fig. 5, under different concurrent numbers of users, the response time of the system's product information query, order query, login and user demand changes are all shorter, and for the occurrence of login or query failure. It can be seen that the stability of the system is better and can ensure the long-term stable operation of the e-commerce platform. The compatibility test results of the system are shown in Table 3.

Table 3. Results of the system compatibility test

Browser	Js error	Result
IE9	No	Qualified
IE10	No	Qualified
IE11	No	Qualified
Baidu	No	Qualified
QQ	No	Qualified
Firefox	No	Qualified
Quark	No	Qualified

As can be seen from Table 3, testing the system page of the e-commerce system on commonly used browsers can conclude that the e-commerce platform for agricultural products designed by the research can be displayed normally in different browsers, and the Js code and CS styles can work properly.

4 Conclusion

With the rapid development of Internet technology, various types of e-commerce platforms have emerged. In the face of the rapid development of the e-commerce market, if you want to promote the sales performance of the e-commerce platform, it is necessary to seize the user's pain point. The implementation of personalized intelligent recommendation is undoubtedly an effective method, but most of the current intelligent recommendation algorithms are lacking in accurate personalized recommendation. Therefore, the study proposes a hybrid recommendation algorithm based on collaborative filtering algorithm and fusion multi-attribute algorithm. The algorithm achieves one recommendation to the collaborative filtering algorithm to form a primary product recommendation set; then on the basis of the primary product recommendation set, the fusion multi-attribute algorithm carries out the secondary recommendation to obtain the final personalized recommendation results. Meanwhile, the study designs the management side and user side of the agricultural e-commerce platform on the basis of the hybrid recommendation algorithm by analyzing in detail the functional requirements, business requirements, business purposes and pain point needs of the agricultural e-commerce platform, and elaborates in detail on its implementation. Although the agricultural e-commerce platform proposed by the study can realize accurate personalized recommendation, the flexibility of the recommendation results is not high due to the existence of delayed system information transmission in order to take into account the timeliness of the data when building the coordination.

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