Research on Intelligent Recommendation Method of e-commerce Hot Information Based on User Interest Recommendation

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Abstract. In order to improve the effect of information intelligent recommendation, this paper puts forward the optimization research of hot information intelligent recommendation method based on user interest recommendation. The quality of user collecting modeling directly determines the quality of personalized recommendation by collecting user interest and making intelligent recommendation based on information classification model. The basic process, principle and algorithm of personalized recommendation system are studied. Based on the algorithm principle of user data collection, user model representation, user model learning and user model updating, this paper optimizes the recommendation methods, completes the design and implementation of the intelligent recommendation engine in the special system. The recommendation system simulates the store salesperson to provide product to customers and help users find the required information. Finally, through the experiment, it is proved that the intelligent recommendation method of e-commerce hot spot information based on user interest recommendation has improved the customer satisfaction and the effectiveness of recommendation information in the practical application process, which fully meets the research requirements.

Keywords: User interest · Interest recommendation · E-commerce · Hot information · Intelligent recommendation

1 Introduction

With the development of Internet, website provides more and more information for users, and its structure becomes more and more complex. It is more and more difficult to find the required information in the massive information on the network in time. The recommendation system simulates the store salesperson to provide product recommendation to customers and help users find the required information. It can effectively retain users and improve the click through rate and user loyalty of the website. Because recommendation system can help enterprises to achieve the purpose of personalized marketing, and then improve sales, and create the biggest profit for enterprises, coupled with the rise of the concept of personalized service, many e-commerce enterprises begin to pay attention to the application of recommendation system. The good development

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and application prospect of intelligent recommendation system has gradually become an important research content of Web Intelligent Technology, which has been widely concerned by many researchers. In recent years, recommendation system has been developed rapidly in theory and practice, but with the further expansion of the scale of the applied system, intelligent recommendation system is also facing a series of challenges.

In reference [1], a recommendation algorithm based on non-negative matrix decomposition (NMD) based on user clustering is proposed. Based on the original NMD model, users are clustered based on clustering idea and combined with users' rating data to fully mine the correlation among users, on this basis, the intelligent recommendation method of hot information of e-commerce is carried out, but the method has the problem of low user satisfaction, which is difficult to be widely used in practice. Reference [2] proposed an information personalized recommendation algorithm for e-commerce shopping guide platform based on big data and artificial intelligence. The task is decomposed into multiple tasks by Map, and the final processing result is obtained by combining the decomposed multi task processing results with Reduce. Two MapReduce and one Map are used to parallelize the user preference acquisition algorithm in the platform, However, this method has the problem of low effectiveness of recommendation information. Reference [3] proposed a new e-commerce hot information group recommendation method, aiming at the problems of low accuracy of e-commerce hot information group recommendation and the difficulty of fusion of preference conflicts among group members. This method combines the influence factor of group leader and the influence factor of project heat. Based on K-nearest neighbor as the target group, this paper designs a group recommendation algorithm based on preference fusion, which is used for intelligent recommendation of hot e-commerce information. However, this method has the problem of low user satisfaction, and the actual application effect is not ideal.

In this paper, the design of recommendation algorithm and the architecture of recommendation system in intelligent recommendation system are studied. The main content of this paper is to apply neural network and fuzzy logic to the recommendation system, mainly involving the real-time performance of the recommendation system, the recommendation system architecture and the application research of the recommendation system based on Web mining. The overall design scheme of e-commerce hot information intelligent recommendation method based on user interest recommendation is as follows:

(1) The user interest information is collected and the information classification model is constructed.
(2) Design the basic process, principle and algorithm of personalized intelligent recommendation of hot e-commerce information.
(3) Experiments are designed to verify the advantages of the proposed method.
(4) Draw a conclusion and look forward to the future.

2 Intelligent Recommendation Method of Hot Information in E-commerce

2.1 Hot Spot Information Collection Method of e-commerce

Recommendation system is an important way for e-commerce websites and content-based app users, and also an important means for them to achieve profits. It is an artificial intelligence recommendation system. Intelligent recommendation is an important example of the application of recommendation system in the field of video. Recommendation system products have different forms in specific application scenarios, but they are ultimately to solve the long tail problem of content and goods, and increase the exposure of content and goods. According to the collected user preferences and user's historical behavior, the recommendation system finds out what users may like and what products they buy, and then recommends the results to users. It makes e-commerce websites and content industries reduce a lot of manual editing links in the work of recommending users [4]. Using some algorithm models to recommend, it can surpass manual editing recommendation and achieve better recommendation effect. Recommendation engine can recommend content and items of interest to all users, and can let different users get different recommendation results because of the use of information filtering technology in recommendation engine. The purpose of recommender system is to let users get satisfactory recommender items, so the only index to evaluate recommender system is user satisfaction [5]. If the recommendation set contains too many similar items, the redundancy is very high, which has little effect on users. On the contrary, if the number of recommended items is small, users can make better choices. Classification and regression methods are generated from machine learning technology and can be used in UCI machine learning database. They generally evaluate some algorithm by error rate. But it is not very good to use this method only in the recommendation system. Sometimes, considering the performance of the algorithm, the accuracy has to be affected. Sometimes even if the accuracy is affected a little, the algorithm performance is good, and most users can accept it. Therefore, one of the principles that must be paid attention to in evaluation is the balance between accuracy and performance [6]. Offline evaluation is more suitable for the evaluation of recommendation system, mainly because online evaluation requires building a comprehensive engineering system, which needs many users, so it is generally considered that offline evaluation is easier to implement, especially in the test of experimental algorithm. Figure 1 shows how the recommendation engine works.

Analysis of Fig. 1 shows that the e-commerce hot information recommendation engine will first collect a variety of information about items, keywords, user gender, age and other information, as well as the user's purchase records. Through the integration and analysis of these information, it recommends different e-commerce hot information for different users.

The recommendation engine will adopt different recommendation mechanisms. One recommendation mechanism is to analyze the data in the data source, get certain rules, and recommend items to users according to these rules. Another recommendation mechanism is to predict and calculate the preference degree of the target user for the items, and recommend the items to the user according to the order of preference degree [7].

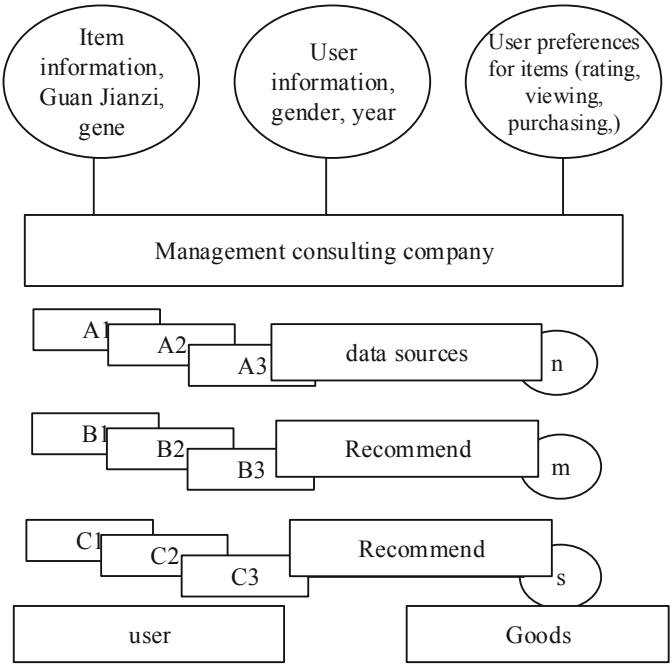

Fig. 1. Working principle of hot information recommendation engine of e-commerce

It's very simple to use only one recommendation engine in the recommendation system. In order to make the recommendation system achieve better recommendation effect, we often adopt a recommendation strategy with a combination of multiple recommendation mechanisms in line with business scenarios. For example, in the recommendation system, the recommendation mechanism considering fusion includes similar video recommendation based on users' historical behavior browsing or comments, popular video recommendation based on video popularity, etc. The purpose is to recommend the interested video information to the user more accurately and give the reason of recommendation to the user better.

2.2 User Interest Recommendation Algorithm

The recommendation algorithm has many branches. This paper focuses on the collaborative filtering based recommendation algorithm [8]. Collaborative filtering can be divided into neighborhood based and model-based collaborative filtering. Neighborhood based collaborative filtering, also known as memory based collaborative filtering, uses the method of calculating similarity to get neighborhood users with similar interests. Neighborhood collaborative filtering is divided into user based and item based collaborative filtering [9].

Table 1. User interest model collaborative filtering information

Algorithm level	Attribute data	Attribute example
Collaborative filtering recommendation algorithm	Demographic attributes	Collaborative filtering recommendation on population attribute
Content based recommendation	Geographical attributes	Content recommendation on geographical attributes
Method hybrid push algorithm	Asset attribute	Make mixed recommendation on asset attributes
Popularity recommendation algorithm	Interest attribute	Make popularity recommendation on Xing attribute
	Demographic attributes	Kmeans
	Geographical attributes	naive bayesian classification linear regression
	Asset attribute	SvD
	Interest attribute	A model of implicit meaning
Model based collaborative filtering	Demographic attributes	LFM-Apriori
clustering algorithm	Geographical attributes	confidence
Classification algorithm	Asset attribute	Wide and De
Regression algorithm	Interest attribute	Iterative processing
Matrix decomposition	Demographic attributes	Scoring vector
association algorithm	Geographical attributes	similarity analysis
neural network	Asset attribute	correlation coefficient
Feature recognition	Interest attribute	Interest information trend
Collaborative filtering recommendation algorithm	Demographic attributes	Collaborative filtering recommendation on population attribute
Content based recommendation	Geographical attributes	Content recommendation on geographical attributes

Model based collaborative filtering uses historical data and algorithms to build prediction models. The Table 1 shows the types of model-based collaborative filtering.

According to the idea of data mining, there are three ways to recommend offline evaluation:

(1) Consider recommendation as information retrieval, that is, from the selection of a subset of user related data. From this point of view, generally from the accuracy and return of two aspects.

(2) Think of recommendation as a regression problem.
(3) Think of recommendation as a classification problem.

At present, the academic circles mainly use the first way of thinking to regard recommendation as an information retrieval problem.

The method of small sample gradient descent is used to extract the user's interest information at random and mine the received feature information. If r is the interest information, u is the independent feature value of information search, i and j respectively represent the scoring vector and similarity of data features, then the collected information feature correlation numerical algorithm can be recorded as follows:

$$simr_{ij} = \frac{\sum (r_{ui} - \hat{r}_i)(r_{uj} - \hat{r}_j)}{2\left\|\hat{r}_i\right\|_j * \left\|\hat{r}_j\right\|_i - 1} \tag{1}$$

Combined with the information feature value, the evaluation standard of interest data feature similarity is further standardized. Euclidean distance can be used to evaluate the relationship between two users [10]. The smaller the distance is, the more relevant the user is, and vice versa. If Q is all the data sets searched by users, a and b are the pre-selected score value of similarity and the mean value of similarity score respectively, then the correlation coefficient algorithm can be recorded as:

$$V = \frac{|Q_a + Q_b|^{i-j} - (i-j)|Q_a * Q_b|}{\sum \lim\limits_{1\to\infty} 2\mathrm{sim}r_{ij}} \tag{2}$$

According to the data feature coefficients, the different data similarity results are further classified. If $V > 1$, the data can be classified into similar feature sets. If $V \leq 1$, the data features are further classified and mined to calculate their feature similarity categories. According to different information feature similarity values, the feature levels are divided and integrated into feature sets, so as to evaluate the difference feature values in different levels and select the optimal evaluation scale for recording [4]. Combined with the fuzzy control algorithm, the network traffic information features are collected, the user retrieval information trends are further mined, and the reference feature values are standardized. The restriction condition can be recorded as Y, then the interest degree algorithm of information feature data mining is:

$$I(n) = [\sup(simr_{ij} * \Delta V),\ congfidence(Y)] \tag{3}$$

In the actual operation of data feature collection, the interest information patterns with the same characteristics need to be classified into a set, and the value of the additional attribute of the same density in the set is 1 or 0, which is recorded as $I_e(n) = \begin{cases} 1 \\ 0 \end{cases}$, By calculating the additional attributes of the user's interested information, the additional attributes of the feature data required by the user are found out, and the support degree is calculated [11]. If the calculation result is greater than the preset support degree feature value, the depth feature mining of the data is carried out according to the horizontal division principle. Under the same data feature structure, the global analysis of user

interest data is carried out, and the feature subset of any data is recorded as $\mathrm{sim}(x, y)$, In the case of different feature structures, deep mining is carried out according to the vertical division principle. If each feature and other categories will contain a group column, it is recorded as h, and the common feature attribute between each feature subset is recorded as u, and the difference feature value is recorded as e. The number of times of mining implicit information in the data is t, and the number of data feature categories is n. Then we can get the optimal value of multi distributed information feature data mining based on the principle of cryptic meaning, standardize the association rules of the current personalized information number recommendation system, and input the standard into the system to ensure that the information recommendation always follows the rule instructions for statistical processing [12].

set up $A_i = \left(y_1, y_2, \ldots, y_j\right)$ a feature data set representing the book selection direction of the target user. The combined values of multiple weakly classified linear feature data are recorded as $A_m(x)(\mathrm{m} = 1, 2, \cdots, \mathrm{M})$.

If there are m users in the system at the same time, if the target user is recorded as D_i, the similarity feature threshold $L(x)$ between multiple users is calculated in the process of business hotspot information category retrieval by multiple users. The specific algorithm is as follows:

$$L(x) = \sum\sum \lim_{0\to\infty} \frac{I(n)\prod m - D_i}{2\|A_m(x) - A_i\|} \tag{4}$$

The feature values of multiple user retrieval are calculated, and the feature values of user retrieval belong to the range of $L(x)$ calculation results. Then the similar data are further classified and processed [13]. If there are n similarity retrieval users, then based on the above algorithm, the information of the detected nearest neighbor users is further output, and the reference value z is selected as the feature similarity prediction data set. Furthermore, the user similarity level is judged by Pearson system. The specific algorithm is as follows:

$$sim(A, B, C, D) = L(x)\sum\sum \frac{(p - f)(m - n)}{2\sqrt{L(x) + z(a + b)}} - 1 \tag{5}$$

In the above algorithm, p and f respectively represent the mean value of the feature score of the book grade.

$$E = \sum sim(x, y) - h\{ue_{ij}^{-\frac{1}{2}tn}\left|I_e(n)_{ij}^{n-1}\right.\} \tag{6}$$

Based on the above algorithm, we can effectively check and detect the non-important keywords of users, and classify the feature categories according to the feature values, so as to better help users to filter their favorite interest information. In different recommendation scenarios, the calculation methods of the selected similarity are also different. Let the range of A_n point eigenvector is $(a_1, a_2, a_3, ..., a_n)$, The value range of feature vector of B_m point is $(b_1, b_2, b_3, ..., b_n)$. Then the expression formula of the common characteristics of A_n point and B_m point is:

$$sim(A_n, B_m) = \ln E * \sqrt{\sum\sum \lim_{1\to\infty} (x - y)I(n)^{\frac{1}{2}}} \tag{7}$$

Feedback and detection are carried out according to the browsing and collection of user's historical information, the highest retrieval and data click rate of users are judged, data search results are judged, effective information is filtered, and personalized recommendation list is provided [14]. Through multi-channel analysis of data feature association rules and personalized recommendation, according to the information detected and recommended for comprehensive evaluation, and based on the evaluation results to adjust the content and order of recommendation, and finally realize the humanized service, effectively meet the needs of customers. In order to ensure the recommendation effect, the evaluation standard algorithm is optimized, and the relevant data association model is set according to the mining results, so as to ensure the steps of personalized recommendation are simple, convenient, efficient and accurate.

2.3 Hot Information can only be Recommended

Based on the previous research steps, we can only recommend methods to improve the hot information of e-commerce. There are many ways for e-commerce recommendation system to recommend to customers. It can be predicted by calculation, and it can also be other customers' personal evaluation and comments on products. Which way to choose depends on how the e-commerce website wants customers to use recommendation. According to the interface forms of the recommendation system, it is mainly divided into the following types:

1) Browse: customers put forward the query requirements for specific products, and the recommendation system returns high-quality recommendations according to the query requirements.
2) Similarity: the recommendation system recommends similar products according to the products in the customer's shopping basket or the products that the customer is interested in, and provides personalized recommendation for customers.
3) E-mail: the recommendation system informs customers of the product information they may be interested in by e-mail, so that the website can keep in touch with customers, improve customers' trust in the website, and thus increase the number of visits to the website.
4) Comment information: the recommendation system provides customers with other customers' comments on the corresponding products, and the customer root

   Make your own judgment according to others' evaluation of the product.

5) Rating evaluation: the recommendation system provides customers with rating evaluation of corresponding products from other customers, rather than product comment information. Through the corresponding statistics and analysis of rating evaluation, it can intuitively show other customers' views or opinions on products, so that customers can easily accept the recommendation.
6) Top-N: the recommendation system recommends to customers n products that are most likely to attract them according to their preferences. On the one hand, it can transform the visitors of the website into customers, and on the other hand, it can help customers decide whether to buy the products they initially feel hesitant about.

7) Ranking of search results: the recommendation system lists all search results and arranges the search results in descending order of customer interest.

Based on this, the intelligent recommendation mode of hot e-commerce information is further optimized, as shown in Fig. 2.

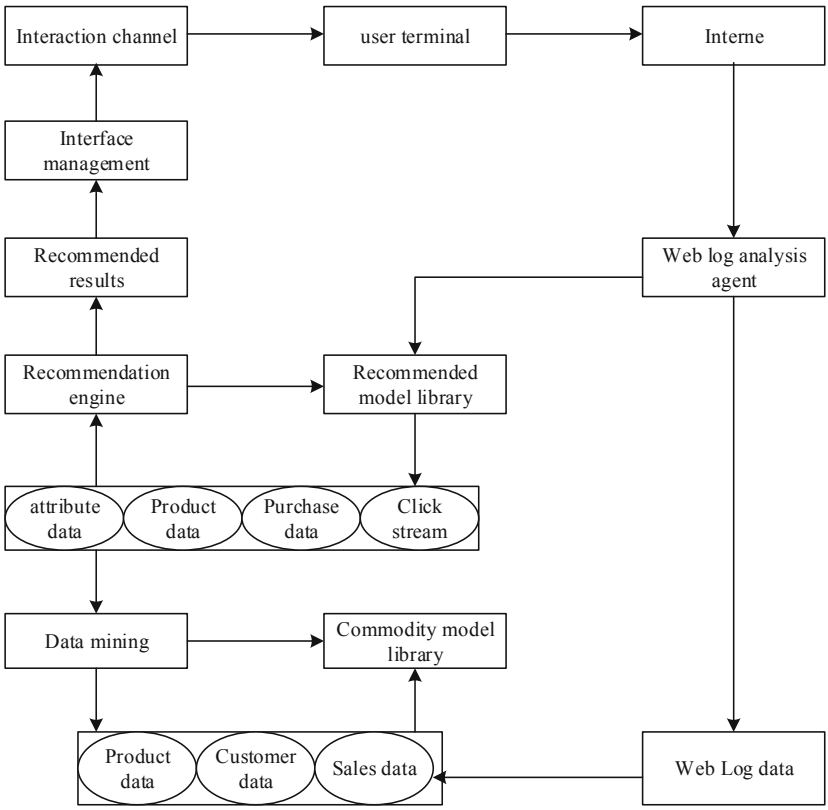

Fig. 2. Intelligent recommendation mode of hot information in E-commesrce

Based on the above steps, users' interests can be effectively collected, and targeted hot spot information of e-commerce can only be recommended.

3 Analysis of Experimental Results

In order to verify the effectiveness of the intelligent recommendation method based on user interest recommendation for hot e-commerce information, the method in reference [3] is used as the experimental comparison method for experimental test.

Table 2. Table captions should be placed above the tables.

Category	Functional module	Remarks
System class (encapsulation of common functions)	Basic data operation class	Provide database connection and data operation support
	Business data operation class	Provide operational support for specific business data
	User interest calculation	Calculate the user's comprehensive interest in each characteristic attribute
	Collaborative filtering class	Implementation of combined collaborative filtering based on user's interest clustering
	New user registration module	Implement new user registration
	User login module	Realize member users to log in to the website
	Classification navigation module	The function of classified browsing provided by the reader is
	Keyword retrieval module Information recommendation module	Key words search function provided by website readers
Reader (front desk system)	Hot recommendation module	New information recommended by website readers
	Personalized recommendation module	Information with high shock rate recommended by website readers
	Information browsing module	Members of the website provide personalized recommendation services
	Relevant information recommendation module	Provide detailed information for website visitors
	User interest feature information	Recommendation and information under survey belong to the same category
	Information acquisition module	Get the user's browsing behavior information and calculate the degree of interest
	Information filtering module	Collaborative filtering of information

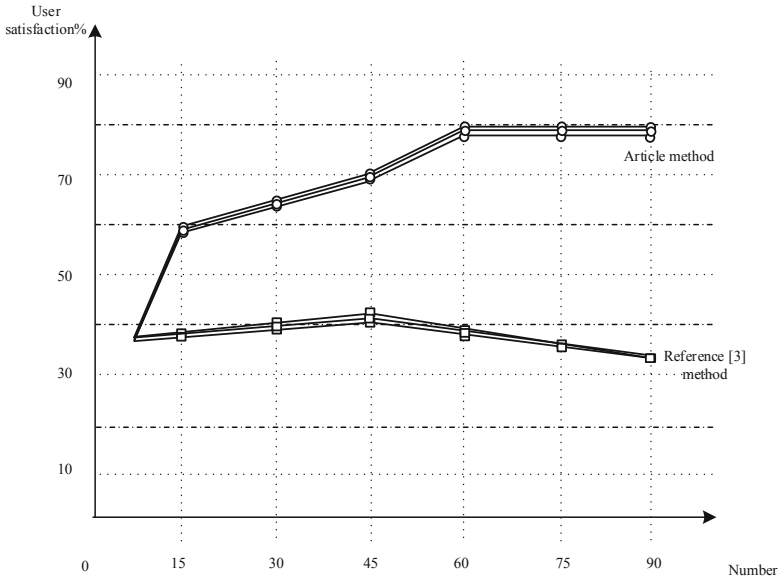

Fig. 3. User satisfaction survey

The format of the data file downloaded from the movie lens site is transformed, and it is imported into the SQL Server 2000 database as the experimental data after being sorted out. We randomly selected the experimental data set: including 60000 scoring data, which is the scoring data of 410 users for 3910 movies. The data set was converted into a user item scoring matrix A (mxn). In the experiment, we also consider the sparse level of the data set, which is defined as the percentage of items not scored in the user item scoring matrix. The sparse level of data set is $1 - 60000/(410 * 3910) = 0.96257$. Experiments can be tested on different datasets. The hardware configuration of the experiment machine is: Intel Pentium core 2 processor, 1G memory, 120g hard disk. The operating environment is: the operating system Windows 2003 development platform is Microsoft Visual Studio. Net 2003 programming language is C, and the database system is SQL Server 20000. Based on this, the function of intelligent recommendation system module is standardized, as shown in the following Table 2:

According to the data obtained during the trial operation of this experiment for a period of time, the number of registered users in the first stage is 4–5, 168 after the second stage and 329 after the third stage. The more registered users, the higher the satisfaction of users. After the second stage, the satisfaction of users with personalized recommendation results has been higher than that of traditional recommendation results.

Moreover, the satisfaction of users in traditional recommendation mode is decreasing with the increase of registered users, while the satisfaction of users in personalized recommendation mode is increasing. The data collected online must be cleaned, integrated and transformed before entering the data warehouse, which requires offline data processing.

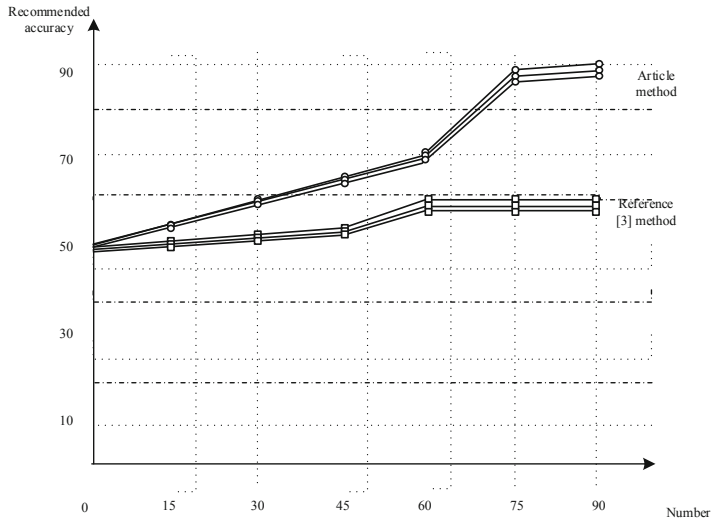

Fig. 4. Information can only recommend validity evaluation

There are two parts in the data processing phase. One is web log data processing, that is, the original logs left by users visiting the website are sorted into transaction databases. It includes data cleaning, user identification, session identification, improvement of access path and transaction identification, etc.; second, user evaluation data standardization, that is, the evaluation of recommended goods by the users to be collected will be standardized. The result of data processing in offline work is to generate the data warehouse of commodity sales website, which is the basic data needed for commodity recommendation. The recommendation engine needs to use the user interest feature information table, the product feature information table and the user rating table in the data warehouse. The running result shows that the user model proposed in this paper can correctly show the real interest of users in a certain program, and realize the dynamic tracking and updating of user interest. This result also shows that the user model proposed in this paper improves the problem of "data sparsity" faced by combined collaborative filtering algorithm to a certain extent, and improves the accuracy of recommendation results. Further carry out comparative investigation and summary on user satisfaction and recommendation effect, and record the results into a grap. The comparison of user satisfaction and recommendation effect is shown in Fig. 3 and Fig. 4.

Analysis of Fig. 3 shows that the user satisfaction rate of this method is between 38% and 80%, while that of the traditional method is between 38% and 43%, indicating that the user satisfaction of the method in this paper is always higher than that of the traditional method. Analysis of Fig. 4 shows that the effectiveness of information intelligent recommendation of this method is between 50%–90%, and that of reference [3] method is between 50%–60%, indicating that the effectiveness of information intelligent recommendation of this method is always higher than that of reference [3] method.

In conclusion, in the process of information intelligent recommendation, the proposed e-commerce hot information intelligent recommendation method based on user interest recommendation has higher customer satisfaction and information recommendation effectiveness than reference [3] method. The reason is that the method collects user interest information and constructs an information classification model. On this basis, the basic process, principle and algorithm of personalized intelligent recommendation of e-commerce hot information are designed to improve the customer satisfaction and the effectiveness of information recommendation.

4 Concluding Remarks

The existing e-commerce recommendation system cannot meet the needs of large-scale e-commerce recommendation under the network conditions. The combination of knowledge grid technology, semantic ontology and e-commerce recommendation technology can meet the requirements of effective acquisition, aggregation and intelligent recommendation of commodity knowledge, user demand knowledge and recommendation knowledge under the grid conditions. Through the research on the theory and method of e-commerce intelligent recommendation based on knowledge grid, it provides the theoretical basis for the research and development of large-scale, high-quality and strong real-time requirements of Distributed E-Commerce intelligent recommendation system. The theory and method of e-commerce intelligent recommendation based on knowledge grid are divided into three levels: knowledge-based e-commerce intelligent recommendation system, e-commerce intelligent recommendation knowledge grid, and e-commerce intelligent recommendation knowledge grid service community; This paper studies and designs the knowledge grid model of e-commerce intelligent recommendation, and studies and designs the structure, generation, organization mechanism and self-organization optimization algorithm of e-commerce intelligent recommendation knowledge grid service community.

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