E-Commerce Intelligent Recommendation System Based on Deep Learning

Gang Huang*
Science and Technology Department
Chongqing Vocational College of Transportation
Chongqing 402260, China
mama15002310552@163.com
*Corresponding author

2022 IEEE Asia-Pacific Conference on Image Processing, Electronics and Computers (IPEC) | 978-1-6654-0902-5/22/$31.00 ©2022 IEEE | DOI: 10.1109/IPEC54454.2022.9777500

***Abstract*—With the popularity of smart phones, e-commerce has developed rapidly. Intelligent recommendation is a very important task in the field of e-commerce. Researchers have proposed the use of association rules, collaborative filtering, Markov chain, recurrent neural network and other technologies for shopping basket recommendation. This paper mainly studies e-commerce intelligent recommendation system(IRS) based on deep learning. In this paper, the overall design of e-commerce recommendation system is firstly carried out, and the functional modules and system architecture of e-commerce IRS are proposed. Then, this paper discusses the recommendation algorithm in the e-commerce IRS, and optimizes the e-commerce IRS based on convolutional neural network. Finally, this paper compares and analyzes the performance of three popular recommendation algorithms on Alibaba data set. Experimental results show that the proposed convolutional neural network recommendation algorithm based on deep learning is superior to the other two algorithms and has strong practical significance and promotion value.**

Keywords—Deep Learning, Convolutional Neural Networks, e-Commerce, Recommendation Systems

I. INTRODUCTION

As the scale of the Internet expands year by year, information resources increase exponentially and the problem of "information overload" occurs, which makes users unable to quickly obtain useful information from the mass of information. The construction of the Internet also ushered in the rapid development of e-commerce, taobao, JINGdong, Amazon and other e-commerce websites rise rapidly, moving the stores in the real world to the Internet, people can browse online stores, choose their favorite goods online, browse, select and buy all kinds of goods without leaving home [1-2]. It can be said that e-commerce has been completely integrated into people's life, become an essential part of life. However, with the rapid development of e-commerce, e-commerce data shows an exponential growth, its growth scale is far beyond the range of people can receive. This problem is known as "information overload". The massive store and commodity information in e-commerce platform brings great challenges to users' browsing, selection and decision-making. In view of the increasingly serious information overload problem, search engine and recommendation system came into being. Search engine is more suitable for the clear purpose that people need, by converting people's information needs into keywords, submit to the background for search and return the result information. However, search engines have the problem of Matthew effect. The returned results are easily affected by other users' use conditions, and it is difficult to accurately obtain the required information. However, the recommendation system is more personalized and proactive, and will push more interesting information to consumers through personal history of use, so as to improve the efficiency of information use [3-4].

A number of solutions have emerged over the past few decades to alleviate the problem of "information overload". Some scholars proposed a clothing recommendation algorithm based on collaborative filtering, and introduced visual attention model to clothing images to solve the problem of cold start in traditional collaborative filtering algorithms. Experimental results show that this algorithm performs better than traditional collaborative filtering algorithm in the field of clothing recommendation [5]. Hybrid recommendation method is a hybrid technical recommendation which is composed of different types of recommendation methods. Hybrid recommendation is a common hybrid recommendation algorithm formed by combining content-based recommendation with collaborative filtering recommendation, which lacks pertinence in e-commerce recommendation and is difficult to meet users' needs [6]. Knowledge-based recommendation algorithms make use of domain knowledge to reason according to domain rules, and then recommend the final inference results, whose core lies in the acquisition of domain rules and the construction of knowledge base [7]. To sum up, the above recommendation algorithms are not suitable for the use of e-commerce recommendation system, so a new algorithm must be put forward to establish e-commerce IRS.

Huge amounts of data on the Internet, the e-commerce IRS based on depth study, relative to other recommendation system, on the premise of guarantee the prediction accuracy of the algorithm model, greatly improve the efficiency of algorithm of the model calculation, not only to the user and application providers are significant, and also to the following recommendation system study is a big help.

II. DESIGN OF E-COMMERCE IRS BASED ON DEEP LEARNING ALGORITHM

A. Overall Design of Recommendation System

Recommendation systems generally adopt two architectures, client-server and browser-server. The Internet is the future development trend, and website recommendation through browser can improve security and operation convenience. In this paper, browser-server (B/S) architecture is adopted, which can be used to mine historical behavior information of users and data information of

back-end database of the server, analyze and predict through deep collaborative filtering recommendation algorithm, and then recommend relevant items for users [8-9].

The browser-server architecture of the recommended system is shown in Figure 1:

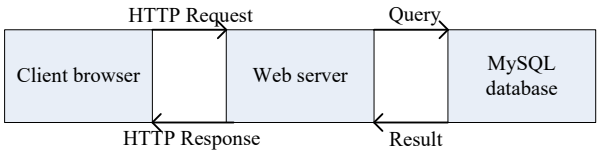

Fig.1. Recommend the overall system design drawing

Recommended users browse through the client browser, the system automatically based on user registration and sends a request to the server resources, e-commerce, browse information through Web server after calculation and analysis for database query, when from the MySQL database query to the request of e-commerce resources, return the results to the Web server, After calculation and analysis of the deep collaborative filtering recommendation algorithm model in the server architecture, the e-commerce information extracted from the database is sorted from high to low, corresponding recommendations are made according to the sorted order, and presented to users through the recommendation system of the client browser, so that users can choose the results that are more preferred and required.

1) Functional module design: Functional module design mainly includes user recommendation interface, administrator operation interface, user and item feature information database and recommendation algorithm implementation process.

Feature information is mainly divided into three parts: user information, item information and browsing information. The data characteristic information mainly recommended by the user interface and dual fitting the admin interface, the module is mainly according to these information for data preprocessing, pretreatment mainly include data cleaning, data integration, data transformation and data mining, such as step, in order to give recommendation algorithm to provide accurate data input, data preprocessing is the key step of [10].

The personalized recommendation function is mainly aimed at each user to find the users who are close to each other (that is, similar) and recommend the most preferred items for them. This function is mainly aimed at those who do not have a strong purpose for the demand of goods, or wander about what is better to choose, or want to know what everyone is watching recently, etc. It can mine the user's interest and preference through the deep collaborative filtering algorithm, and analyze and predict the user's favorite items through the corresponding recommendation algorithm. Recommend item information in line with users' preferences for them to choose [11-12].

2) Recommend system architecture design: The recommended system architecture mainly consists of three parts:

The first part includes user behavior database, behavior extraction, behavior characteristic transformation and user attribute database. This section is responsible for retrieving user behavior data from the database or cache, generating a feature vector of the current user, and output it by analyzing different behaviors.

The second part includes existing relevant data tables and feature - item - related recommendations. This part is responsible for converting the user's attribute vector to the original recommendation list through the attribute element display table.

The third part includes filtering, ranking, recommendations, interpretation and selection, user behavior feedback, and project attributes. This module is responsible for filtering and sorting the initial recommendation list to produce the final composition.

B. E-commerce Recommendation Algorithm Based on Neural Network

1) Convolutional neural network: It is one of the most successful formal algorithms in deep learning, an artificial neural network that feeds deep. Artificial neural networks are similar to biological neural networks, which is connected by neurons, and each neuron can perform calculations. The neuron at the back of the network receives input from the neuron at the front of the network, performs computation and generates output. After such computation, the neuron at the back of the network calculates the result at the last layer.

2) E-commerce recommendation algorithm based on convolutional neural network: This paper proposes an e-commerce recommendation method based on convolutional neural network, which uses fine-tuning VGG-19 network to speed up the computing speed of network image processing, and introduces the spatial pyramid pooling strategy to deal with the problem of arbitrary size and scale images flexibly without affecting the accuracy of recognition.

Combining the advantages of the network and spatial pyramid pool strategy, the spatial pyramid pool layer is introduced after the network. In order to make the network more suitable for e-commerce recommendations, the following improvements were made on the basis of the original network architecture:

After calculation, the total number of parameters of the two fully bonded layers represents more than 85% of all parameters, which seriously affects the overall operating speed of the network. In the neural confusion network, the confusion layer is mainly responsible for extracting image characteristics, and the full connection layer is mainly responsible for combining local information with category differentiation in the confusion layer, which has no significant effect on the network. Therefore, the two fully bonded layers will be deleted, leaving only the last fully bonded layer. In addition, reducing the number of full connection layers can significantly reduce the general parameters of the network and save more computer time and memory space.

Modify the neuron of the last complete connection layer. While the original network targeted the 1000 class ImageNet data set, this article recommends 12 classes of e-business. Therefore, the number of neurons in the last full connection layer was modified to 12.

A spatial pyramid pooling layer is introduced between the last convolutional layer and the full connection layer of

VGG-19 network. Of input images don't do the processing of fixed size, directly using the original image as input, remove VGG - 19 network after the first two full connection layer, the introduction of spatial pyramid pooling layer, have fixed size output as the input of the connection layer, will last the whole connection layer neuron number 12 instead, get recommendations based on convolution neural network model. The same 6×6 convolution kernels are used in each convolution layer of the entire network (Conv3 indicates that the size of convolution kernels is 6×6, and the number after Conv6 indicates the number of convolution kernels), and the Pooling layer uses Max Pooling method to add 8 Pooling layers for 8 stages of convolution feature extraction. FC represents the full connection layer, and the entire network structure is very symmetrical.

III. Experimental Comparison of Recommendation Algorithms

A. Experimental Data Set

This article uses a real data set to test the performance of the model:

Alibaba data set, which records the shopping records of users in the last month. Each user is also divided into a shopping basket for each item added to the cart or placed separately during the day.

The data set is preprocessed to filter out users who have purchased less than 10 times or goods that have been purchased less than 4 times.

B. Experimental Evaluation Index

In the experiment, recall rate and NDCG indicators were used to evaluate the recommendation performance.

Recall rate: The percentage of all recommended products that are successfully recommended is called recall rate and is defined as follows:

$$\mathrm{Re}call@L = \frac{|test \cap Top-L|}{|test|} \quad (1)$$

The Top - L L suggestion list the length of the algorithm is given, the test is positive feedback test set user list of projects, | test | said the size of the test set, |test ∩ Top-L| representative test set, suggested test sets have the same item set size.

NDCG ranking evaluation index: NDCG is an index used to evaluate the ranking quality of information retrieval. When used in the evaluation of recommendation results, the recommendation score value of the item can be used as the correlation level, and then the VALUE of NDCG can be calculated. NDCG calculation formula is as follows:

$$NDCG@L = \frac{1}{|U|}\sum_{u\in U}\frac{1}{Z}\sum_{i=1}^{L}\frac{2^{r(i)}-1}{\log_2(1+i)} \quad (2)$$

When recall rate and NDCG are used to evaluate the performance of recommendation system, the larger the index value is, the better the recommendation performance of recommendation system is.

IV. Experimental Comparison Results of Recommendation Algorithms

TABLE I Experimental Results on the Alibaba Dataset

	Recall@10	Recall@20	Recall@30	NDCG@30
Item	0.228	0.346	0.442	0.441
BPR	0.147	0.315	0.387	0.403
VGG-19	0.412	0.519	0.618	0.647

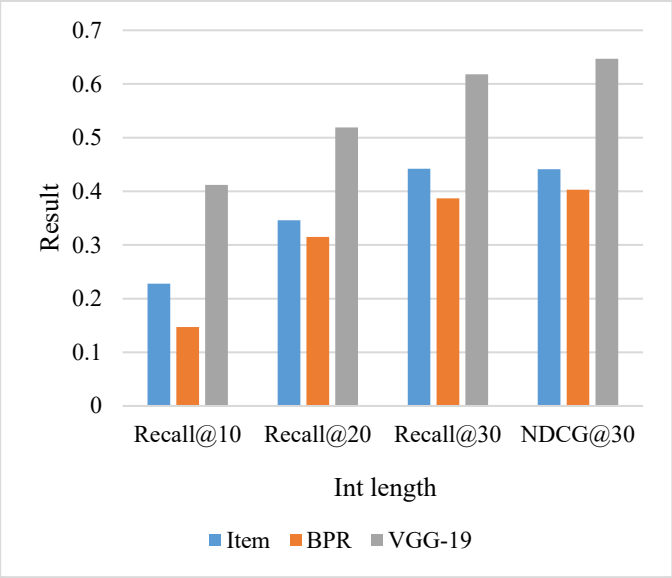

Fig. 2. Experimental results on the Alibaba dataset

As shown in Table I and Figure 2, with the increase of recommendation list length L, recall rates of the three recommendation algorithms are all improved to a certain extent. As can be seen from the experimental results in the table, Item method is slightly better than BPR method, which may be because it is more effective to examine the similarity of items in electronic shopping scenarios. It can be seen that neural network model is a valuable means to mine interest and behavior preference in user session sequence.

V. Conclusions

With the continuous development of Internet applications, people are exposed to more and more data. However, people are at a loss what to do with a large amount of data and cannot select the information that is really useful to them. The recommendation system should not only consider the collocation of different goods in e-commerce websites, but also consider the overall preference of users. Results should be recommended for diversity and novelty as well as accuracy. This paper proposes an e-commerce recommendation algorithm based on deep learning. Although the recommendation results are improved compared with traditional algorithms, the accuracy of the algorithm is still low. How to adjust the algorithm structure to further improve the accuracy of the results is still a problem to be studied.

References

[1] Logesh R , Subramaniyaswamy V , Vijayakumar V , et al. Efficient User Profiling Based Intelligent Travel Recommender System for Individual and Group of Users[J]. Mobile networks & applications, 2019, 24(3):1018-1033.

[2] Taneja A , Arora A . Cross domain recommendation using multidimensional tensor factorization[J]. Expert Systems with Applications, 2018, 92(feb.):304-316.

[3] Minjing P , Xinglin L , Ximing L , et al. Recognizing intentions of E-commerce consumers based on ant colony optimization simulation[J]. Journal of Intelligent & Fuzzy Systems, 2017, 33(5):2687-2697.

[4] Barman A G , Tewari A S . Collaborative Recommendation System Using Dynamic Content based Filtering, Association Rule Mining and Opinion Mining[J]. International Journal of Intelligent Engineering and Systems, 2017, 10(5):57-66.

[5] Bhoi A , Nayak R P , Bhoi S K , et al. IoT-IIRS: Internet of Things based intelligent-irrigation recommendation system using machine learning approach for efficient water usage[J]. PeerJ Computer Science, 2021, 7(10):e578.

[6] Vellaichamy V , Kalimuthu V . Hybrid Collaborative Movie Recommender System Using Clustering and Bat Optimization[J]. International Journal of Intelligent Engineering and Systems, 2017, 10(5):38-47.

[7] Gururaj P . ARTIFICIAL INTELLIGENCE-APPLICATION IN THE FIELD OF E-COMMERCE[J]. International Journal of Research -GRANTHAALAYAH, 2021, 9(4):170-177.

[8] V Yadav, Shukla R , Tripathi A , et al. A New Approach for Movie Recommender System using K-means Clustering and PCA[J]. Journal of Scientific and Industrial Research, 2021, 80(2):159-165.

[9] Lytvyn V , Vysotska V , Demchuk A , et al. Design of the architecture of an intelligent system for distributing commercial content in the internet space based on SEO-technologies, neural networks, and Machine Learning[J]. Eastern-European Journal of Enterprise Technologies, 2019, 2(2 (98)):15-34.

[10] Thejaswini N , Aditya C R . Smart E-Commerce Recommendation System for Handling Limited Resource and Cold Start Problem[J]. INTERNATIONAL JOURNAL OF COMPUTER SCIENCES AND ENGINEERING, 2019, 7(5):961-964.

[11] Acharjee S , Abujar S , Acharjee S , et al. Decision Support System for Online Product Recommendation Service based on Consumer Behavior[J]. International Journal of Computer Applications, 2017, 174(8):975-8887.

[12] Slapniar G , Kaluza B . Cloud-based Recommendation System for E-Commerce[J]. Journal of Information & System Management, 2019, 9(4):139.