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# A survey of recommendation systems based on deep learning

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**Abstract.** Faced with massive amounts of data, people may not be able to choose the items they like. The recommendation system came into being, and it has achieved a breakthrough for a long time. Using deep learning can mine the hidden attributes of users' items and integrate them well, bringing new changes to the recommendation system. This article describes the deep learning-based recommendation system and the traditional recommendation system, and analyzes their advantages and disadvantages.

## 1. Introduction

With the development of the information world, data fills the entire society, and while bringing convenience, it also reduces the efficiency of each user's utilization, resulting in the effect of information overload. The recommendation system can alleviate this problem, and now the recommendation system has been used by companies such as Google, IKEA, and Amazon.

The latest development of deep learning has good applicability and has been used in computer vision, natural language processing, recommendation systems and other fields, and has achieved good results. The cold start problem and sparse matrix problem in the traditional recommendation system are alleviated, and the interpretability and accuracy of the recommendation system are increased.

This article introduces several deep learning-based recommendation systems based on traditional recommendation techniques on the basis of traditional recommendation systems, and summarizes them.

## 2. Traditional recommendation systems

Traditional recommendation systems are mainly divided into two categories: content-based recommendation and collaborative filtering recommendation.

### 2.1. Content-based recommendations

Content-based recommendation is also called content-based filtering system, and its essence is to filter or sort recommended items by matching or relevance between item features and user features. Content-based recommendation is mainly extracted and described by the characteristics of the recommended item itself, text items use natural language processing technology, and pictures and videos extract the features of the screen and extract the brief information. Generally speaking, the content-based recommendation algorithm mainly depends on the user's own behavior, including related description, related information and related operating behavior, and will not involve the behavior of other users [1].

Content-based recommendation is the oldest recommendation algorithm, and this algorithm is often used for combined recommendation. His advantage is the weak connection between users, and the preferences of other users will not affect others. Its interpretability is very good, and the items



recommended to users are liked by target users. However, content-based recommendation also has many insurmountable shortcomings. For target items with obvious characteristics, such as documents, it is good to extract the characteristics of the item, but for pictures, videos and specific people or things, the characteristics are not obvious and diverse. It is difficult to use a main feature to abstract description, which brings difficulties to content-based recommendation. In addition, content-based recommendation cannot obtain the user's implicit preferences, but only stays on the content, which is a recommendation based on shallow features. In addition, content-based recommendation also has a cold start problem, that is, it cannot be recommended for new users.

## *2.2. Collaborative filtering recommendations*

The main function of collaborative filtering algorithm is prediction and recommendation. This algorithm is different from content-based recommendation. It mainly divides target users based on different behaviors and recommends target items of corresponding grade. From this point of view, collaborative filtering recommendation is mainly Mining the relationship between users, classifying and recommending based on the similarity between users, in simple terms, people are grouped by categories.

Collaborative filtering algorithms are mainly divided into three categories, one is user-based collaborative filtering algorithm, and the other is item-based collaborative filtering algorithm. The third is model-based collaborative filtering.

The user-based collaborative filtering algorithm discovers the likes and dislikes of the target item through the user's operation records, and evaluates, weights, and scores these related ideas. User-based collaborative filtering recommendation can be divided into several parts: 1. Find users with similar preferences 2. User distance evaluation, mainly Euclidean distance evaluation, Pearson correlation evaluation 3. Recommend for users with the same preferences, Eliminate the target items that express disgust.

The item-based collaborative filtering algorithm is similar to the user-based collaborative filtering algorithm. Here, the user and the target item are exchanged, and similar objects are recommended to the user based on the relationship of the target item. Model-based collaborative filtering establishes an association model for users and items, and obtains the best prediction of items by optimizing model parameters [2].

User-based collaborative filtering is mainly used when there are fewer users. User-based collaborative filtering mainly mines the internal associations between target items. Model-based collaborative filtering mainly collects part of the data to generate a recommendation model and make recommendations based on the model. The collaborative filtering algorithm still has a cold start problem, and the newly registered user has not performed the operation, so the relevant data cannot be found.

At the same time, the collaborative filtering algorithm has the problem of sparse matrix. There are few users and target items evaluated and there is no intersection, which leads to a large area of blank evaluation data.

## **3. Recommendation system based on deep learning**

In recent years, deep learning has made rapid progress in the field of recommendation systems. Deep learning has achieved good results in computer vision, speech recognition, natural language processing and other fields. Deep learning is in the ascendant in recommendation systems. The application of deep learning and traditional recommendation systems has brought new changes to the recommendation system. Deep learning is good at dealing with unstructured data. The feature of deep learning is automatic learning and maintaining robustness in learning.

The application of deep learning in the recommendation system was first proposed by Restricted Boltzmann Machines for Collaborative Filtering [3]. In the article, RBM (Restricted Boltzmann Machines) was applied to collaborative filtering.

Since then, deep learning has moved towards recommendation systems. The applications of deep learning in recommendation systems can be divided into applications of deep learning in content-based, collaborative filtering, and hybrid recommendation systems.

### 3.1 Application of deep learning in content-based recommendation system

In the traditional collaborative filtering recommendation algorithm, the importance of comments is greatly ignored. As the user's explicit information, the user particularly wants to emphasize, so the comment information can increase the accuracy of the recommendation. In order to solve the problem of asymmetric attention in comment recommendation, the literature [4] proposed a flexible neural architecture, namely AHN, which is characterized by its asymmetric attention module to distinguish user embedding and item embedding and comment learning. And its hierarchical paradigm to extract fine-grained sentences and comment signals. The literature [4] claims that the sentences in each review are not equally useful, and the inclusion of irrelevant sentences will introduce noise, so it is very important to only aggregate useful sentences to represent each review. The asymmetric hierarchical network (AHN) with attention information emphasizes the asymmetric attention module, and its results are interpretable. Experiments show that the performance of AHN is always far better than the most advanced methods, and it is also a prediction Provides a good explanation.

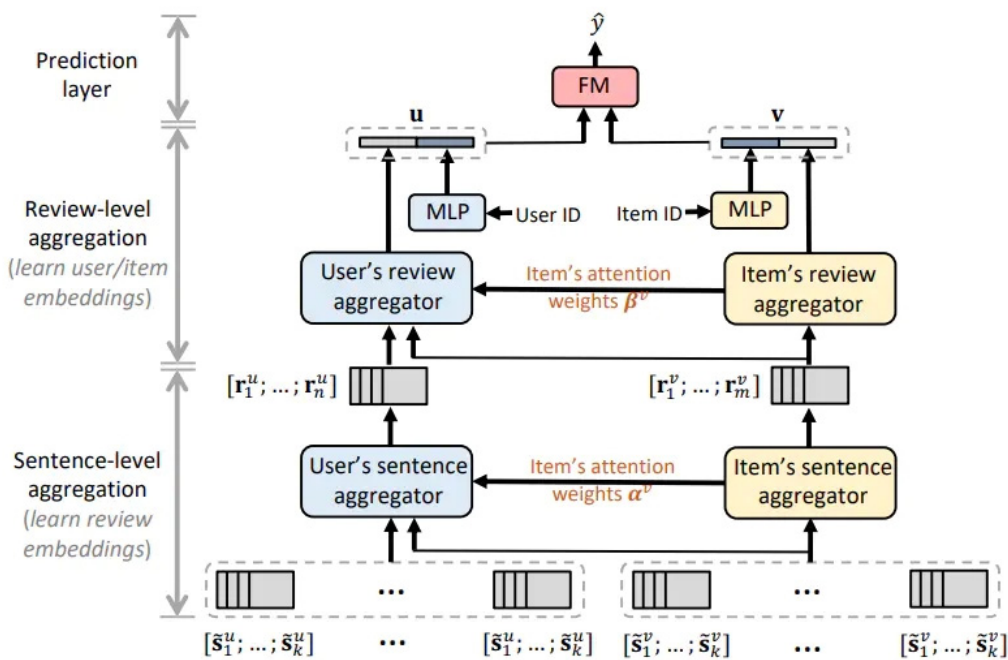


Figure 1. Schematic diagram of AHN model

Literature [5] proposes a news recommendation model that learns from human editors for article recommendation, which solves the problem that editors are based on a few keywords or topics, but are more dependent on the quality of candidate articles. News recommendation is often manually recommended by the editor, depending on the editor's preferences at the time. Literature [5] automatically captures the editor's basic selection criteria through the automatic representation of the article and its interaction with metadata, and adaptive capture through mixed attention. The force model changes these standards.

### 3.2 Application of deep learning in recommendation system based on collaborative filtering

Literature [6] proposed a gradual evolution of different components of the recommender system in a simulated feedback environment, and deduced the theoretical bounds and convergence properties of the quantitative measures of user discovery and blind spots. Literature [6] believes that there are

fairness and bias in the recommender system, and the interaction with the recommender system generates new data for the next iteration, creating a closed feedback loop. The term bias in the recommendation system includes popular bias, diversity bias, exposure bias, display bias, iteration bias, etc. These biases will lead to a decline in the quality of recommendations in the iterative behavior. Literature [6] understands the feedback loop to understand how it is rated.

Literature [7] proposed a method for user control related suggestions-ClusterExplorer, ClusterExplorer is based on the potential factors retrieved from the MF in the book field, and designed and implemented a recommendation method for related items. The recommendation system used in [7] uses the commonly used matrix factorization method, which is very common in implicit data. However, according to the collected data in the experiment, the difference between the automatically generated version of ClusterExplorer and the version edited by experts is not obvious. It shows that the experiment is affected by the sparse data set, which shows that this algorithm cannot overcome the influence of sparse matrix.

In addition, the context-based recommendation system is also the highlight of the new research. The user's time, location, and mood are different, and the requirements for recommendation are also different. Literature [13] proposed a new dual-headed attention fusion autoencoder model, which uses user-generated comments and implicit feedback to make suggestions. By fusing user comments and implicit feedback, noise comparison estimation target, a dual-head decoder architecture is designed to integrate user representation. Literature [13] claims that this algorithm is superior to multiple comparison algorithms, and can be explained.

#### 4. Conclusion

The recommendation algorithm based on deep learning mainly uses convolution neural network, cyclic neural network, restricted Boltzmann machine, generative countermeasure network and so on. Compared with the traditional recommendation system, deep learning recommendation system has great advantages, and there are numerous new research findings in various conferences. In this paper, we only select several representative recommendation algorithms to improve the sparse row and cold start problem, but the space for improving the sparse line and cold start of the recommendation system still exists, for example, the deep learning recommendation system can not be explained It reduces the credibility of deep learning recommendation system. However, the problems of traditional recommendation system still exist, and the recommendation system based on deep learning still has broad development space.

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