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A Hybrid Recommender Method Based on Multiple Dimension Attention Analysis

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ABSTRACT

With the development of the Internet and the popularity of Big Data, recommender systems have become an indispensable field due to its excellent ability to solve the problem of information overload. The existing recommender system mainly uses collaborative filtering to make recommendation by mining the interaction relationship between users and items. In order to better analyze the interaction relationship between users and items, a hybrid recommender method based on multiple dimension attention analysis is proposed. The idea is to fuse the embedded vectors of users and items into mapping vectors (or matrices) of different shapes through different methods, and learn the interactive relationship between users and items through the neural network model with attention mechanism. Experimental results show that compared with traditional analytical methods, multiple dimension analysis can more comprehensively explore the interaction between users and items, and the attention mechanism can greatly improve the analytical ability of the model.

KEYWORDS

Attention, CNN, Collaborative Filtering, LSTM, Neural Network

1. INTRODUCTION

The rapid development of big data is flooding the Internet with massive amounts of information. Faced with such a large amount of information, it is almost impossible for Internet users to obtain the data they need. It makes such a large amount of data unable to be used effectively, and this phenomenon known as information overload (Bobadilla, 2013). Many methods have been studied to solve information overload, among which recommendation system (Bobadilla, 2013) is one of the most popular and widely studied methods.

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At present, many effective methods have appeared in the research process of recommender system, among which collaborative filtering technology has been widely used and studied (Su, 2009). Collaborative filtering is to understand the relationship between users and items based on the interaction information between users and projects. Since the Netflix Prize (Konstan, 2000) competition was held, matrix factorization (MF) (Koren, 2008; Zhang, 2016; He, 2017b) has become a very popular method in collaborative filtering technology. It uses the latent vector to represent the feature of the user and the project by mapping them to a latent space respectively, and finally uses the inner product (Rendle, 2011) of latent vectors to calculate the interactive relationship between users and items.

The use of the inner product to compute the interaction relationship between latent vectors is limited (He, 2017b) because the inner product reduces the dimension of the feature. The traditional matrix factorization method uses the inner product to cause the loss of interactive information, and the inner product belongs to the linear model, which makes it difficult to dig out the non-linear relationship between implicit features (Burke, 2002). Therefore, traditional matrix factorization is difficult to further improve the accuracy of recommendation.

Deep learning has been found to have good effects in various fields, and it has the ability to approximate any continuous function (Hornic, 1989), which makes many researches begin to focus on the combination of deep learning and recommender system. At present, most recommender systems based on deep learning apply deep learning in feature engineering, and cannot improve performance from model kernel. In the study of learning interactive relations from by deep learning, most are based on deep neural network (DNN). For example, Salakhutdinov (2007) used two-layer RBM to model the rating of users and items. Ouyang (2014) made use of three-layer auto-encoder to model the rating. This makes the application of deep learning in recommender system not limited to feature engineering, but start to study the kernel of algorithm.

In recent years, a large number of studies have focused on extracting more interactive information from the implicit features of users and items. He (2017a) proposed a Neural Collaborative Filtering (NCF), which used neural network to generate embedded vectors (i.e., latent vectors) of users and items, and constructed two nonlinear models to extend matrix factorization to nonlinear space. Then, in order to consider the correlation between implicit features, an outer product-based neural collaborative filtering (ONCF) (He, 2018) was proposed, which processed embedded vectors with outer product to obtain a more expressive 2D mapping matrix, and used convolutional neural network (CNN) to learn the high-order correlation between embedded vectors.

From the above research, it can be found that digging out more interactive information from the embedded vectors of users and items is the key to improve the recommendation performance. However, the single method of processing embedded vector can only provide part of the interactive information, which makes the hybrid recommender model (Ghazanfar, 2010) a better choice. At the same time, efficient use of existing features is also required for the model, because the value of features is different when learning the relationship between users and items.

In this work, we propose a hybrid recommender method based on multiple dimension attention analysis (MDAA), which uses multiple dimensions attention analysis methods to deal with the embedded features of users and items, so as to explore more interactive relations between users and items. By simply concatenating embedded vectors into 1D vector, which can retain the original information of embedded vector, and using a Bi-directional long short-term memory model (Bi-LSTM) with attention (Mnih, 2014) which regarded the embedded vectors as context-related sequences to learn the interactive relationship. It can more comprehensively explore the interactive information contained in 1D vector (Bahdanau, 2014). 2D mapping matrix is obtained by outer product operation, not only contains the dimension correlations between embedded vectors, at the same time the diagonal elements correspond to the inner product of the traditional matrix factorization method as a result (He, 2018). Outer product provides the higher-order correlation for the model, and 2D matrix format,

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