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# An Empirical Study on Personalized Product Recommendation Based on Cross-Border E-Commerce Customer Data Analysis

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## ABSTRACT

Thanks to the rapid growth of cross-border e-commerce platforms, numerous cross-border items are now available to customers. Several serious issues with cross-border e-commerce platforms related to item promotion and consumer product screening have arisen. Particular importance should be placed on studying and implementing personalized recommendation systems based on international e-commerce. In light of the quick expansion of commodities, when making individualized suggestions, traditional recommendation algorithms have had to deal with issues such as scant data, a chilly start to the market, and trouble identifying user preferences. To automatically mine the implicit and latent relationships between users and objects in recommendation systems, this study employs deep learning with nonlinear learning capabilities, which resolves the challenges of user interest mining. The weaknesses of the existing global recommendation research are emphasized, the study of conventional recommendation algorithms mixed with deep learning technology is deep factorization machine (DeepFM) and neural matrix factorization (NeuMF) models. Both models excel in recommending implicit feedback data. The DeepFM model yields the lowest loss function values, while the NeuMF model outperforms the competing models in terms of HR@20 (a commonly used indicator to measure the recall rate) and loss functions. In summary, this research addresses critical issues in cross-border e-commerce by developing personalized recommendation systems and integrating deep learning with traditional recommendation algorithms to enhance global recommendations.

## KEYWORDS:

Cross-Border E-Commerce, Recommendation Systems Automatically, Personalized Recommendation, Deep Learning Technology, Data Sparsity, Commodity Information

## INTRODUCTION

With the rapid integration of the world economy, China's cross-border e-commerce has ushered in swift expansion. From 2014 to 2015, China's cross-border online shopping platforms experienced

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explosive growth, a series of products focusing on a single market segment were released, and a professional cross-border online shopping platform was born to meet the more refined needs of domestic consumers. Due to the massive influx of overseas products, consumers encounter confusion when choosing their favorite products. At the same time, cross-border e-commerce platforms face increased difficulty in pushing suitable cross-border products to target consumer groups, motivating the development of a personalized recommendation system.

The concept of personalized recommendation systems based on cross-border e-commerce provides strong support for solving the above contradictions. The design goal of personalized recommendation systems is to help consumers discover products that interest them and that they can afford by presenting them with valuable information. At the same time, personalized recommendation systems can help commodity sales platforms quickly push and sell commodities, thereby effectively reducing inventory, improving the circulation speed of commodities, and ultimately achieving a win–win situation for consumers and commodity sellers (Balabanovic & Shoham, 1997; Li & Zhang, 2020; Liu et al., 2020).

The application research and implementation of personalized recommendation systems are vital and urgent because the traditional e-commerce personalized recommendation system does not account for some characteristics of cross-border e-commerce customer groups and cannot meet the needs of current mobile platform users for accurate, intelligent, and personalized information services based on cross-border e-commerce. Traditional recommendation algorithms mainly include demographic-based recommendation algorithms, content-based recommendation algorithms, collaborative filtering algorithms, hybrid recommendation algorithms, and model recommendation algorithms (Gao et al., 2019; Liu & Zhu, 2020; Wang & Li, 2017; Yan et al., 2020). Currently, the number of users and the types and quantities of products in e-commerce platforms are vast, resulting in a high degree of sparseness in the matrix formed by users' ratings of products. Traditional recommendation algorithms find it challenging to determine similar goods that attract users based on the sparse matrix when users and products grow simultaneously. This difficulty also contributes to the creation of the system cold start problem.

Another approach involves combining multiple recommendation algorithms for algorithm recommendation, filling in missing values in the scoring matrix, introducing auxiliary information, improving recommendation algorithms, and using deep learning-related technologies to alleviate data sparsity (Yue et al., 2020). Deep learning technology is widely utilized in the fields of image processing, speech recognition, and natural language processing, leading to remarkable achievements (Liu & Xia, 2014; Wang et al., 2020; Yue et al., 2015). Deep learning can process linear data, has stronger fitting ability for nonlinear data, and does not require feature engineering. Deep learning opens new research avenues for recommendation systems by combining low-level features to create richer high-level characteristics. Using a deep network structure to learn the unstructured data of products and users in the recommender system can mine the potential features of users and products and obtain the deep features of users and products, solving the problems of sparse data and difficulty in mining user interests in the recommender system (Fan, 2019). Therefore, applying deep learning in personalized product recommendation systems has research significance.

In this research, we selected the deep neural network (DNN) model and the factorization machine (FM), comprising the deep factorization machine (DeepFM) model and the neural matrix factorization model NeuMF, for the recommendation module of a personalized recommendation system (Huang et al., 2020; Li et al., 2019; Yu et al., 2019). Users can select from a variety of product suggestion models. The model uses one-hot encoding and the embedding layer to encode the data and embed it into the model to convert high-dimensional sparse data into low-dimensional dense data. This eliminates the need to perform feature engineering on the data, and the model effectively solves the problems of data sparsity and difficulty mining user interests.

The paper makes the following unique contributions: