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Identification of User Preferences and Personalized Recommendation Strategy in E-commerce Platforms

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Abstract: With the rapid development of e-commerce platforms, accurately identifying user preferences and providing personalized recommendations has become a key strategy to enhance user satisfaction and platform market competitiveness. This article starts with the definition of user preference recognition, analyzes the core challenges faced by the e-commerce field, such as data complexity, differences in user behavior, privacy and data confidentiality issues, and potential biases in recommendation algorithms. It also strategically explores how to improve the quality of personalized recommendations. By using big data analysis technology to accurately capture user preferences, strengthen privacy and security protection, optimize the fairness and transparency of recommendation algorithms, and improve user interaction feedback mechanisms, specific improvement measures are aimed at providing practical suggestions for the optimization of personalized recommendation systems in future e-commerce.

Keywords: E-commerce platform; Recommendation algorithm; User preference recognition; Personalized recommendation; Data privacy.

1. Introduction

With the rapid popularization of e-commerce and the significant increase in user numbers, e-commerce is increasingly concerned about how to enhance user experience and platform loyalty. By deeply identifying and analyzing user behavior data, personalized product recommendations and advertising services can be achieved, significantly improving the platform's sales conversion rate and user satisfaction. However, in practical operation, the determination of user preferences and the implementation of personalized recommendations still encounter many challenges, including the complexity of data processing, frequent changes in user behavior, privacy protection and data security risks, and potential algorithmic biases.

2. Basic concepts of user preference recognition

User preference recognition is the core of implementing personalized product recommendations on e-commerce platforms. By conducting in-depth analysis of user information, we can grasp their consumption behavior and preference trends, and customize personalized recommendation content accordingly. User preferences can be divided into two types: obvious preferences and latent preferences: obvious preferences are directly expressed by users, such as product ratings, bookmarking, and purchasing behavior; And potential preferences need to be inferred from users' browsing trajectories, click behavior, and other data. This recognition process mainly includes steps such as data collection, data organization, feature screening, and model construction. The scope of data collection involves various behavioral information of users, such as browsing, searching, and purchasing; Data organization includes data cleaning and standardization processing; Feature filtering combines the static attributes and dynamic behaviors of users to form a complete user profile. By utilizing machine learning or deep learning techniques such as collaborative filtering, decision trees, etc., models can be constructed to explore users' potential preferences, achieve accurate recommendations, improve user interaction experience, and enhance the platform's sales conversion rate. Table 1 below provides a detailed process for identifying user preferences.

Table 1. User Preference Recognition Process

Step	Explain
Data acquisition	User behavior collection
Data preprocessing	Cleaning and Conversion
Feature extraction	Behavioral characteristic analysis
Model building	Preference modeling prediction
Result output	Personalized recommendations

3. The main issues of user preference recognition and personalized recommendation on e-commerce platforms

3.1. Data complexity and quality issues

The key to implementing user preference recognition and personalized recommendation on e-commerce platforms lies in a large amount of user behavior data, and the complexity and quality of this data have a decisive impact on the accuracy and effectiveness of recommendation engines. The complexity of data is mainly reflected in the diversity of data sources, the breadth of data dimensions, and the speed of data updates. E-commerce companies must deal with data from various dimensions such as user browsing, clicks, searches, adding to shopping carts, purchase history, and feedback reviews. These data sources are diverse, with different formats and structures, making it a major technical challenge to achieve rapid and effective integration and analysis of these data.

Common issues in data processing include data omissions, duplicates, and irregular data points. If there may be

disjointed or incomplete parts in the user behavior record, it may hinder the recommendation system from fully understanding the user's preferences; Repetitive information consumes additional computing power and makes system design more complex; Abnormal data, such as incorrect clicks or forged comments, may mislead recommendation algorithms. Therefore, effectively addressing the quality and complexity of data is crucial for e-commerce platforms to improve the quality of personalized recommendations.

3.2. Diversity and unpredictability of user behavior

The diversity and unpredictability of user behavior on e-commerce platforms pose significant challenges to personalized recommendations and user preference recognition. On such a platform, users engage in a wide range of behavioral activities, including browsing products, searching keywords, clicking on pages, making transactions and purchases, providing product reviews, and collecting products. The changes in these behaviors are not only influenced by external factors such as seasonal fluctuations, promotion activities, and user preferences, but also exhibit a multidimensional and dynamic characteristic.

Due to the complexity and variability of user behavior, recommendation systems often struggle to accurately grasp the actual needs of users. Some consumers only show interest in a specific product during a certain period of time, and then immediately shift their focus to other items. If the system cannot adjust in a timely manner, it can lead to recommendation failure. At the same time, the unpredictability of user behavior is also reflected in their response to temporary hot events or sudden behaviors, such as shopping frenzy during holidays or sudden demands. If the response to these specific behaviors is not fast enough or there are errors in prediction, it may have a negative impact on the user experience and the platform's recommendation effectiveness.

3.3. Privacy and Data Security Issues

In the process of user preference recognition and personalized recommendation on e-commerce platforms, it is necessary to manage a large amount of user data, which includes private information such as users' personal information, shopping history, and online browsing activities. With the advancement of data collection and analysis technology, user privacy protection and data security issues have become increasingly prominent, becoming a major challenge. On the other hand, the collection and application of user information may lead to the leakage of privacy information. Frequent data breaches have raised concerns among users about the information security capabilities of e-commerce platforms, and unauthorized data processing or collection may erode user trust and lead to legal disputes.

On the other hand, e-commerce platforms must comply with increasingly stringent legal regulations when processing data. For example, the General Data Protection Regulation (GDPR) of the European Union and the Personal Information Protection Law of the People's Republic of China both provide detailed regulations on the collection, storage, and application of personal information. These laws explicitly state that platforms not only need to obtain explicit consent from users, but also must ensure the confidentiality, de identification, and controllability of user information. This requires the platform to have excellent capabilities in both technology and management to prevent information leakage and improper use, while also balancing the maintenance of user privacy rights and data utilization. Risks such as network intrusion, improper use of data, and information theft may lead to illegal access or tampering of user data, directly damaging the rights and interests of the platform and users.

3.4. Deviation and limitations of recommendation algorithms

E-commerce platforms rely on advanced recommendation algorithms for personalized recommendations, which aim to understand users' preferences and make corresponding product recommendations. However, this algorithm is not perfect, and its biases and limitations can sometimes have a negative impact on the quality of recommendations. Algorithms usually predict demand based on users' historical behavior, and once these data are biased or not comprehensive enough, the accuracy of recommendation results will be greatly reduced. Recommendations that rely on users' past purchasing habits may overlook the diversified development of users' interests, resulting in a phenomenon of "information isolation" that immerses users in similar content environments for a long time, which is obviously not conducive to improving users' interactive experience. Overemphasizing the accuracy of recommendations may make the content appear too monotonous, while sacrificing some accuracy in order to enrich content diversity. In addition, algorithms are not sensitive enough to capture changes in user interests and often cannot quickly adapt to the latest preferences of users. Meanwhile, the effectiveness of recommendation algorithms varies among different user groups, which may unconsciously lead to biases based on gender, age, region, and other factors, resulting in unfair recommendation results. This injustice not only damages the user experience, but may also bring certain negative social impacts.

4. Optimization strategies for user preference recognition and personalized recommendations on e-commerce platforms

4.1. Accurate user preference recognition through big data analysis

On e-commerce platforms, a large amount of data analysis technology is used to accurately identify user preferences, which covers a series of steps from information collection to continuous improvement. The platform collects user behavior data through various channels, such as browsing trajectories, clicks, search terms, shopping cart operations, consumption history, and user feedback, achieving comprehensive capture of user behavior data on the platform. In order to ensure the freshness of information, the system adopts an automated information retrieval method to track users' dynamic behavior in real time. The collected information needs to undergo preliminary processing, which involves steps such as clearing duplicate information, supplementing missing values, eliminating abnormal information, and standardizing the data. For example, if a user repeatedly clicks on a certain product but fails to complete a transaction, it may be considered an abnormal click and therefore excluded in subsequent analysis. The purpose of initial processing of information is to improve the quality and accuracy of data.

The platform has conducted a detailed analysis and feature extraction of user behavior patterns. By conducting a detailed analysis of dynamic information such as user interaction time, click frequency, and product collection behavior on the platform, and integrating fixed user information (including gender, age group, place of residence, etc.), a unique user image can be created. If a user repeatedly checks their sports shoes and puts them in their shopping cart, but ultimately does not make a purchase, this may suggest that the user has a great passion for sports shoes, but is still in the decision-making stage. The platform utilizes this behavioral information to construct personalized preference models for users. In order to improve the accuracy of recommendations, this platform adopts a strategy that combines collaborative screening with intelligent algorithms. By referencing user profiles with similar behavioral patterns, collaborative filtering technology can recommend corresponding products to users. On the other hand, intelligent algorithm models aggregate diverse user characteristics to predict users' future preferences. In addition, the platform also adopts a content-based recommendation algorithm, which studies the labels of product attributes to find products that match user preferences.

As user interests change, if they frequently follow the new smart wristband in the near future, the system will immediately refresh the user's preference settings and prioritize displaying such products on the homepage. The platform uses A/B testing methods to evaluate the effectiveness of recommendation strategies, and measures key indicators such as user click through rates, transaction rates, and user retention through comparative experiments of different recommendation schemes. Based on these data, the platform continuously adjusts algorithm parameters and recommendation algorithms to improve the overall performance of recommendations. This process highlights the important value of big data analysis in accurately capturing user preferences, helping platforms create personalized recommendation systems that better meet user needs, significantly enhancing user experience and platform transaction efficiency.

4.2. Enhancing User Privacy Protection and Data Security

The core task of e-commerce platforms is to identify user preferences and provide personalized recommendation activities, while maintaining user privacy and data security. In response to this, the platform has implemented numerous technological measures aimed at preventing the abuse and leakage of users' private information. In the data manipulation stage, the platform adopts data denoising technology, which implants random interference signals in user profiles to make it difficult for external parties to accurately identify the detailed information of individual users. The basic model of this strategy can be presented through the following formula:

$$D' = D + Noise$$

Among them, D represents the original user data, $Noise$ represents the added data perturbation noise, and D' is the processed data. This strategy successfully confuses personal information features by adding interference elements to user information, effectively reducing security risks caused by data exposure.

In the process of data transmission, the platform implements end-to-end encryption technology to ensure that the data is not intercepted or tampered with by any third party during the transmission from the user terminal to the server. Even if intercepted during data transmission, malicious attackers cannot easily obtain the data content due to encryption processing. As for data storage, the platform adopts a distributed storage solution to store sensitive user information in numerous data nodes, thereby avoiding the risk of a single failure point that may occur in centralized storage. In addition, with a strict access control system, only authorized employees can access the corresponding data, which further reduces the chance of data leakage. By adopting federated learning technology, the possibility of training data models on users' local devices has been realized. Specifically, the user's device will participate in model training, and only the model parameters, not the raw data, will be sent to the server for integration and updating. In this way, the platform can continuously improve personalized recommendation algorithms without directly touching users' personal data, greatly reducing the risk of privacy breaches. With the help of these innovative security strategies, the system has significantly enhanced its ability to protect user information, won the trust of users, and built a solid guarantee for creating more intimate personalized recommendations.

4.3. Improving the fairness and transparency of recommendation algorithms

On e-commerce platforms, in order to enhance user interaction experience and maintain platform fairness, it is necessary to focus on optimizing the fairness and transparency of recommendation systems. Fairness here means eliminating recommendation biases based on factors such as gender, age, and geographic location, while transparency requires users to understand and comprehend the principles and basis behind recommendations. This is crucial for enhancing users' trust in the platform and ensuring its fairness.

The recommendation algorithm of e-commerce platforms has been pointed out to have gender bias issues: after male users check their electronic devices, their recommendation pages are often filled with more electronic products, while female users are more often pushed fashion items such as clothing. This phenomenon has sparked dissatisfaction among some users. To correct this issue, the platform has made deep adjustments to the original recommendation algorithm. After reevaluating and conducting in-depth research on historical user data, the platform has noticed that there is a hidden gender bias in the original training data, which is the fundamental reason for the unfair recommendation results. By adopting innovative data selection strategies and data augmentation methods, the platform successfully balanced the behavioral data of male and female users, in order to reduce bias during algorithm training.

In addition, the platform has designed a dedicated fairness measurement mechanism to ensure that recommended content reflects corresponding richness and balance among various user groups. This algorithm optimization effectively promotes male users to access a wider range of fashion recommendations, while also allowing female users to receive more electronic product recommendations, thereby narrowing unnecessary gender differences. Users can clearly see the source description of the recommended content through this interface, such as "Considering that you have purchased product X before, we recommend product Y to you" or "Based on your search history, the following are the

corresponding product categories we recommend to you". This open and transparent presentation technique helps users understand the logic behind recommendations, enhances their trust in the system, and enables them to independently decide whether to adjust their recommendation preference settings.

This series of measures greatly enhances the fairness and transparency of the recommendation system, ensuring that male and female users as well as various groups can enjoy more balanced and appropriate recommendation services. In addition, with the help of the recommendation reason explanation function, users have a more thorough understanding of the recommendation mechanism, which undoubtedly enhances their satisfaction and loyalty to the platform.

4.4. Enhance user interaction and feedback mechanism

In the personalized recommendation system of e-commerce platforms, enhancing user interaction and feedback mechanisms is a key means to improve user experience and enhance recommendation accuracy. By encouraging users to actively participate and provide feedback on recommended content, e-commerce platforms can more accurately capture users' actual needs and preferences, thereby optimizing recommendation algorithms in real-time, enhancing user satisfaction, and overall platform operational efficiency.

In order to further improve the recommendation effect, e-commerce platforms have developed user interaction and feedback mechanisms. Consumers can easily convey their opinions on recommended content by rating, writing reviews, or using the "like/step" function while browsing, clicking, or purchasing products. E-commerce platforms will instantly capture these feedback data and integrate them into the iterative updates of recommendation algorithms. User feedback is processed through a specific weighting algorithm to reflect the strength of the user's attitude towards the recommended content. For example, when updating product recommendation scores, the system will consider the weight of user feedback as a factor:

$$R' = \alpha \times R + \beta \times F$$

Among them, R' is the updated recommendation score, R is the initial recommendation score, F is the user feedback score, and 1 and 1 are important parameters used to balance the recommendation score and feedback score.

By adopting this approach, user feedback will directly shape the system's recommendation algorithm, ensuring that the platform can quickly adapt to changes in user needs. The optimized feedback system not only improves the accuracy of recommendations, but also deepens the stickiness between users and the platform.

5. Conclusion

The identification of user preferences and personalized recommendation strategies on e-commerce platforms aims to further enhance user interaction experience, improve the efficiency of recommendation systems, and enhance the platform's industry competitive advantage. Through the use of big data analysis technology, ensuring user privacy and security, and improving the fairness and transparency of algorithms, e-commerce platforms are continuously improving the accuracy of user preference recognition and personalized recommendations. On this basis, by integrating user interaction and feedback mechanisms, the platform is able to optimize user preferences in real time and has the ability to flexibly adjust recommendation policies to meet personalized needs. In the future, with the development of technology and changes in user needs, e-commerce platforms must constantly innovate their recommendation solutions, aiming to provide a more personalized, reliable, and efficient user experience.

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