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The Application of Personalized Recommendation Algorithms in TikTok E-commerce: Advantages, Risks, and Development Trends

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Abstract. In recent years, with the development of the Internet and artificial intelligence, e-commerce platforms have grown rapidly in many countries and occupied an important position in national consumption. A key reason why e-commerce platforms can exert a huge impact on traditional physical consumption models lies in their powerful algorithmic analysis capabilities. These platforms can generate content tailored to users' identities and interests based on their browsing trajectories and consumption preferences. This personalized generation model firmly grasps consumers' consumption habits and needs. Therefore, relying on personalized recommendation algorithms, e-commerce platforms have fully tapped consumers' consumption potential, continuously grown and expanded, and formed a unique dynamic cultural ecosystem. This study aims to conduct a comprehensive analysis of TikTok, a specific e-commerce platform, starting from the personalized recommendation algorithms that integrate users' browsing trajectories and consumption preferences. The content includes the characteristics of these algorithms on TikTok, the recommended content generated by the algorithms, and the generation mechanisms of the algorithms. Combined with cutting-edge relevant research data, this study summarizes the application status, current hot spots, and development trends of such algorithms in e-commerce platforms.

Keywords: TikTok, Algorithms, E-commerce, Users, Consumption

1. Introduction

Personalized recommendation algorithms adopted by e-commerce platforms, which integrate users' browsing trajectories and consumption preferences, are of great significance to the current consumer market and have important reference value for governments, companies, and individual consumers. Prior to this, there have been numerous theoretical analyses and studies on this core algorithm. Sarwar et al. [1] have studied two key challenges faced by traditional collaborative filtering algorithms: insufficient scalability and the need to improve recommendation quality, and proposed corresponding strategies. Yazdani et al. [2] compared the performance of various metaheuristic algorithms in e-commerce scenarios. Gulzar et al. [3] invented a new clustering algorithm (OCA) to improve recommendation quality. In addition, some researchers have conducted in-depth studies on

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specific e-commerce platforms, such as Bray et al.'s research on TikTok's impact on the U.S. market [4], and Ma et al.'s research on the future development potential of TikTok in the Chinese market [5]. However, there are relatively few studies that analyze the practice and effect evaluation of such algorithms in combination with specific e-commerce platforms. Therefore, this direction remains a research-worthy topic.

This paper focuses on analyzing and researching the characteristics of TikTok, a specific e-commerce platform, combined with cutting-edge relevant research data. It identifies the core advantages, potential drawbacks, and risks of personalized recommendation algorithms in current e-commerce platforms. Through comprehensive analysis, it summarizes their hot discussion, application status, and development trends, providing reference case analyses and feasible suggestions for governments, platforms, e-commerce businesses, and consumers.

2. Related theoretical foundations

2.1. Personalized recommendation algorithms

Personalized recommendation algorithms rely on big data and integrate advanced technologies such as artificial intelligence and machine learning. They conduct multi-dimensional analysis and portrayal of users, construct three-dimensional user portraits, and then use methods such as collaborative filtering, principal component analysis, and clustering to recommend specific products and other content to users [6]. The foundation of these algorithms lies in the massive data in the database, such as users' comments, likes, shares, and video playback duration. The core lies in the operation of algorithmic models, which extract personalized recommended content that the algorithms consider consistent with user portraits from a hierarchical architecture and push it to different groups.

2.2. TikTok e-commerce

TikTok is a social e-commerce platform founded by ByteDance, covering short videos, live broadcasts, shopping, social chatting, and other content. TikTok has a unique community culture and e-commerce cultural system, and has skillfully integrated entertainment with e-commerce. TikTok's personalized recommendation algorithms serve as the bridge connecting the two. Most users may not browse TikTok with the purpose of consumption; some may want to obtain the latest information, some may want to chat and make friends, and some may want to post and share life videos. However, TikTok's e-commerce model can use personalized recommendation algorithms to generate a separate interface ("For You") for these users. This seemingly casual design often arouses people's curiosity. Therefore, regardless of the purpose of their browsing, TikTok's e-commerce interface can firmly capture users' attention. As a result, TikTok E-commerce has developed rapidly in recent years.

3. Advantages of personalized recommendation algorithms based on big data

3.1. Mining and analysis of big data

A core advantage of these algorithms is their integration of users' browsing trajectories and consumption preferences, which are derived from the mining of users' browsing and consumption records within the platform [3]. Through comprehensive analysis and inference, consumers' consumption habits are obtained. This largely makes up for the lack of understanding of consumers'

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personalities and habits by traditional physical stores. Therefore, based on its internal big data database, TikTok can customize personalized content for each user [4]. By combining short videos with product advertisements, it optimizes the effect of advertising placement, increases the probability of users consuming on the platform, gains the favor of most users [7], and enhances user stickiness and loyalty [1,4].

3.2. Dynamic update and adaptive capabilities

One of the core advantages of personalized recommendation algorithms is their dynamic update and adaptive capabilities. Dynamic update is reflected in the real-time collection and processing of data, feedback mechanisms (likes, comments, collections, shares, etc.), self-learning of models, comparative testing, and iterative optimization, ensuring the efficiency of the algorithms [6]. The hierarchical recommendation architecture refines the entire process into a basic data layer, computing and storage layer, data capability layer, recommendation algorithm layer, interface service layer, and business application layer, ensuring the accuracy of recommended content.

3.3. TikTok's algorithms and culture

Using personalized recommendation algorithms, TikTok pushes different types of goods-promoting influencers to users. Through the unique emotional and cultural connections between fans and influencers, and with the power of entertainment and communities, it forms a dynamic cultural ecosystem [4]. In addition, TikTok has built an integrated platform of brands, influencers, and users, adopting a strategic cooperation model to exclusively cooperate with major brands on products and promote them using personalized recommendation algorithms, firmly locking in the consumption brand preferences of specific users.

4. Disadvantages and risks of personalized recommendation algorithms

4.1. Risk of user privacy leakage

These algorithms conduct personalized recommendations based on users' browsing records, consumption records, and even some personal information. Therefore, a large amount of user information is stored within the platform. Although the platform may have set options for users to agree to the collection of this information before obtaining it, most users do not pay enough attention to these terms. At the same time, in some cases, specific functions cannot be used without agreeing to these terms [8]. For the above reasons, the platform can easily obtain users' private information. However, when the platform manages such a large database and cooperates with third parties, it involves the desensitization and transmission of user data. This will inevitably lead to the risk of personal information leakage. If relevant protective measures are not improved, it may be exploited by criminals, causing irreparable losses to users [8,9].

4.2. Information cocoon and algorithmic discrimination

These algorithms are likely to trap users in information cocoons [6] and lead to algorithmic discrimination [8]. On TikTok, although the relevant personalized recommendation algorithms are designed by humans, they have a certain degree of self-learning ability. In the process of self-optimization and learning of the models, the so-called "algorithmic black box" may appear. The emergence of the algorithmic black box makes the recommended content of the algorithms highly

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uncertain and prone to extremization. If the algorithm identifies your consumption pattern based on your information, the content recommended to you next may all be similar products, making it difficult for you to actively jump out of the information cocoon woven by the algorithm [9]. At the same time, this forms an unequal relationship between users and the platform, making users extremely vulnerable to algorithmic discrimination.

4.3. Insufficient recommendation accuracy and content quality

The personalized customization schemes provided by these algorithms still need to be improved. The recommended content includes products consumers dislike and excludes products consumers like [1]. Some customized content may involve vulgar and false promotions [5]. For example, merchants may exaggerate product efficacy and fabricate price discount mechanisms to mislead consumers. However, the algorithms cannot independently and effectively identify and screen these aspects. Therefore, it is necessary to strengthen the identification and review of relevant content by relevant platform personnel [10]. In addition, on TikTok, third parties or individuals can increase the exposure of videos by spending money, commonly known as "buying traffic." This exacerbates the risk of blind promotion and further increases the possibility of consumers being deceived.

4.4. Enterprise economic risks

E-commerce based on personalized recommendation algorithms poses additional specific risks for enterprises, such as corporate stock and financial pressures [11]. Through data simulation experiments, Ettredge, M., & Richardson, V. J. [4] found that if an e-commerce platform is hacked, the enterprise is likely to experience significant negative abnormal returns, with permanent stock price declines. At the same time, the debt market also pays more attention to the risks of B2B e-commerce, which will greatly limit the future development of e-commerce platforms. In terms of the market, the influx of a large number of brands leads to users' "distracted attention," serious homogenization, and great pressure from content competition.

5. Discussion and development trends of personalized recommendation algorithms

One of the hot discussions about these algorithms lies in the effective integration of dynamic browsing trajectories and static consumption preferences. Some studies also focus on how to handle information lag and improve the completeness and accuracy of logical chains [2,12]. At the same time, to address issues such as data sparsity and cold start in traditional recommendation algorithms, optimizing technologies such as collaborative filtering algorithms, content-based recommendation algorithms, and matrix factorization algorithms has become an important direction. For example, Ordered Clustering Algorithm (OCA) can reduce the impact of data sparsity on recommendation effects through pairwise similarity calculation and ordered grouping strategies, and can be compatible with numerical and non-numerical data, adapting to the complex data environment of real e-commerce scenarios [3]. Sarwar et al. [1] split the algorithm framework into three subtasks: data representation, neighbor formation, and recommendation generation, and optimized each subtask (for example, normalized vectors are more stable than non-normalized vectors in data representation, center-based neighbors are superior to aggregated neighbors in neighbor formation, and the effect of most frequent recommendations is close to that of association rule recommendations in recommendation generation). They also provided an optimal combination of collaborative filtering algorithms: normalized data representation, cosine similarity, center-based

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neighbors, and most frequent recommendations to balance the quality and efficiency of the algorithm.

Currently, these algorithms are widely used in major e-commerce platforms. What TikTok does well is its hierarchical recommendation architecture. It constructs multi-dimensional user portraits through demographic attributes, social relationships, consumption capacity, etc. TikTok takes the initiative to break information cocoons. After recommending specific types of information to users for a period of time, it will actively investigate user opinions and change the pushed content according to user feedback [6].

In the future, with the development of artificial intelligence, these algorithms must first choose to integrate with open-source large models (such as LLaMA 3, Claude 3, etc.). Drawing on some existing successful cases, they can fully utilize large models to solve problems such as insufficient semantic understanding and poor generalization ability. Adopting metaheuristic algorithms [2] such as genetic algorithms and particle swarm optimization will make recommended content more diversified and accurate. However, the large-scale application of these algorithms in recommendation systems is still relatively limited, and more experiments are needed to verify their feasibility and stability. In the process of algorithm operation, it is necessary to improve user participation, strengthen the identification of similarity between different users [1], increase the protection of personal privacy information, improve the transparency and interpretability of algorithms [11,12], and weaken the effect of algorithmic black boxes [8]. It is also necessary to enhance the scalability of collaborative filtering algorithms [1].

6. Conclusion

In summary, personalized recommendation algorithms that integrate users' browsing trajectories and consumption preferences outline each user's portrait through comparative analysis of big data. They use clustering technology to classify users with similar characteristics into one category, and individual users can be in multiple categories. Based on the characteristics of different categories, multi-level content push is carried out for users through a hierarchical recommendation architecture. However, at the same time, we cannot ignore the information cocoons, algorithmic discrimination, and other issues caused by factors such as algorithmic black boxes in these algorithms. How to protect user privacy and how enterprises can avoid potential risks are topics worthy of further in-depth research. In addition, the development of these algorithms must be consistent with the hot spots of current technological development. By grasping the rapid updating and iteration of technologies such as AI large models, metaheuristic algorithms, and genetic algorithms, and boldly innovating and experimenting, it will surely improve the quality and accuracy of recommended content on the basis of existing personalized algorithms. At the same time, it is necessary to increase user participation and consolidate the unique dynamic cultural bond between platforms and users. It is believed that personalized recommendation algorithms will continue to make breakthroughs in the future and play a key role in major e-commerce platforms.

The research limitation of this paper is that it focuses too much on summarizing literature content and reasoning, lacking specific data and experimental support, which is also the direction for further research.

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