

Algorithmic Ads-Driven Personalized Advertising: Privacy Leakage Risks and Consumer Acceptance

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Abstract. Nowadays, online shopping platforms are becoming increasingly popular, and advertising has become a highly effective marketing tool. Personalized advertising is emerging in the public eye, referring to predicting users' preferred products based on their preferences and shopping habits to promote consumption. This article uses the literature research method to discuss the advantages and disadvantages of algorithm-driven personalized advertising, public acceptance, and whether it is reasonable to use personalized advertising. First, it analyzes how relevant algorithms drive online platforms to clean data to achieve personalization. Second, algorithm-driven personalized advertising makes it easier for platforms to speculate on users' private information, such as gender, age, and religious beliefs, which brings about the risk of information leakage. It also analyzes consumers' willingness to continue using personalized advertising even though they know there is a risk of personal information leakage; some consumers believe personalized advertising can improve the efficiency of shopping and improve consumer satisfaction, while others worry about privacy leaks. Finally, in today's environment of widespread personalized advertising and increasingly intense public concerns about privacy, this article combines legal analysis with a brief discussion of the current situation and puts forward suggestions for advertising companies to continue to develop in this environment, such as reducing the degree of personalization and strengthening privacy protection measures.

Keywords: personalized advertising, consumer willing, privacy leakage risks

1. Introduction

Advertising can be roughly divided into five categories: radio advertising, online advertising, outdoor advertising, embedded advertising and print advertising [1]. Online advertising has advantages such as lower cost, wider coverage and higher audience targeting accuracy [2], which makes it the most efficient form of advertising. This paper focuses on analyzing personalized advertising, a product of the further development of online advertising. Personalized advertising refers to the process by which a platform or website recommends advertising content that matches the user's interests based on the user's personal preferences. In this process, websites and platforms collect a large quantity of personal information and then use special algorithms to clean and classify this data in order to infer the type of consumer preferences and finally present the user with the most suitable advertisement. This result may cause users to worry about privacy issues [3]. If the degree

of personalization is too high, users will feel that their information is too transparent and worry about their personalized information being leaked. This paper works on the reasons why algorithm-driven personalized advertising causes privacy leaks. Simultaneously, this paper further explores the acceptance of personalized advertising by consumers and analyzes whether consumers are still willing to choose such advertising despite the existing risks of privacy leaks. Finally, this paper provides some suggestions on how advertising companies can further optimize their personalized operations to achieve a mutually beneficial situation for both consumers and entrepreneurs, and reduce consumers' growing sensitivity to privacy breaches caused by personalized advertising.

This essay focuses on consumer acceptance of algorithm-driven personalized advertising, explaining the relationship between the current level of personalization and consumer acceptance: appropriate personalization can reduce consumers' time costs and increase satisfaction, but excessive personalization may increase user concerns. By directly clarifying the correlation between the level of personalization and user acceptance, this paper deepens the relevant research on their relationship, which is helpful in pointing to a clear direction for future research.

2. The operational principles of personalized advertising

Online advertising has replaced other types of advertising and has become a common marketing tool. It is low cost and wide coverage and also targeted [3], that is, personalized. The advertising platform will create an advertising page that is exclusive to the user based on the user's preferences [4]. Personalized advertising identifies user interests, dynamically identifies advertising features, and implements adjusted recommendation strategies. While filtering out messages that users are not interested in, it recommends things that users are interested in. The cosine similarity formula is employed in the information filtering process. the cosine similarity formula $\text{CosineSimilarity}(u, v) = \frac{\sum_{i=1}^n r_{ui} \times r_{vi}}{\sqrt{\sum_{i=1}^n r_{ui}^2} \times \sqrt{\sum_{i=1}^n r_{vi}^2}}$ 'u', 'v' represent two different users, 'r_{ui}' and 'r_{vi}' indicating their level of attention to emergency advertisements.

Through the calculation of this formula and correlation coefficients, advertisements with similarity below a threshold are filtered out. The recommendation algorithm extracts advertising feature information and user interest vectors, recommending only ad content with high matching degrees. For advertisement information extraction, the Bag-of-Words (BoW) model is adopted, with the vector formula expressed as $\vec{d} = [f(d, v_1), f(d, v_2), \dots, f(d, v_n)]$, 'f(d, v_n)' denotes the frequency of vocabulary v in advertisement text d. The user interest vector is constructed by weighted average of the feature vectors of historically viewed advertisements. Advertisements with matching degree lower than the set value will be filtered [5]. In this way, merchants are given better opportunities to reach customers [3]. In addition to region, gender, age, it can even be refined to classify and deliver according to emotional state, language, and education level [6]. For advertising service providers, by displaying the advertisements that users are most interested in, the revenue can be maximized. For consumers, personalized advertisements can improve click-through rate and conversion rate, meet users' personalized needs, save screening time, and achieve a win-win situation for advertisers and users.

3. Personalized advertising and the risk of personal privacy leakage

Consider free applications: Free applications and online advertising have common characteristics. They both improve the attractiveness to users through personalization, so that advertisers can make a

profit. Therefore, free applications are often free in terms of money. The corresponding price that consumers have to pay is that privacy and security issues cannot be well guaranteed [7]. Privacy leakage is the loss of personal information caused without the user's knowledge. According to statistics, 56% of websites will experience user information leakage. Even in the medical or travel fields, 9 out of the top 10 medical and air ticket purchase websites have experienced privacy leakage [8]. In the statistics, the leakage of users' personal privacy by websites includes political views, religious beliefs, sexual orientation, etc. These factors will be used to help big data systems build a better profile of you in order to provide better personalized services [3]. The conclusion obtained through a questionnaire survey indicates that Google Chrome's recommended ads are also based on demographic information and personality profiles to achieve personalization. In this advertising context, the accuracy of prediction of sensitive personal information such as parent identity can reach 66%, the accuracy of gender prediction can reach 75%, and the accuracy of prediction of user age range is as high as 54%, far exceeding the probability of random prediction of 33% [7]. The reasons for privacy leaks are usually divided into two categories. One is that the current website and a third-party website reach an agreement to sell private information for profit. The second is that the website is not secure and may be monitored by a third-party website. For example, the email address may be used by the user to log in to the first website. This content will be stored in the first party's cookies. If the website is actually owned by a third-party website (hiding the third-party server), the information will be leaked [5].

4. Users' willingness to continue adopting personalized advertising under the threat of privacy leakage

The above discussion has mentioned that personalized advertising can lead to privacy leaks. In this context, if consumers are willing to continue to accept this personalized approach. On the one hand, personalized advertising can be an effective message filter, saving shopping time and increasing their happiness and satisfaction [9]. In this case, the satisfaction may even outweigh their privacy concerns [10]. However, on the other hand, excessive personalized advertising can reinforce consumers' suspicions about privacy leaks, leading to psychological resistance and even decreasing their desire to buy products due to privacy concerns [11]. Personalized advertising can also, to some degree, lead to privacy leaks. Preventing consumers from having the freedom to choose, providing countless similar products, confusing consumers with budget constraints, building information cocoons, and thus prohibiting consumers' access to other products [9]. Most importantly, in some cases, consumers may actively choose personalized services, hoping to obtain product or service recommendations that match their preferences or expectations by providing some of their own preferences [10]. However, for some personalized advertisements, consumers may see information about information they do not want to disclose in the content of the advertisement, which will make users feel panicked and feel like they are being monitored. Users feel that they cannot actively control the content of the information they disclose, which will make them feel creepy and have a feeling of being monitored [12]. This feeling of being monitored will cause consumers to actively avoid this type of information. As manufacturers, providing personalized services and personalized advertising is to increase user satisfaction and happiness. However, the above analysis shows that excessive personalization will achieve the opposite effect. The revenue brought by such personalized advertising to promote consumption is the source of manufacturers' revenue. Therefore, excessive personalization will not only aggravate consumers' suspicion and concerns about information leakage, but also greatly lead to a decrease in revenue [10]. Therefore, for manufacturers, appropriately reducing the personalization ratio will not only reduce consumers' concerns about

information leakage, thereby avoiding information cocoons that limit users' choices, but will also reduce the decline in manufacturers' revenue due to user concerns to some extent.

5. Legal framework and policy recommendations for personalized advertising privacy protection

The General Data Protection Regulation (GDPR), published by the European Union, and the Personal Information Protection Law of the People's Republic of China both emphasize the core mission of protecting users' personal information rights and interests. The GDPR clearly established steps that are effective in ensuring the security of personal information. The EU GDPR is one of the most recent and powerful regulations passed to protect consumers' information [13]. Firstly, evaluating the effect on personal information protection by the predicted result, which is essentially to deter the final usage methods. The next step is defining the scope of evaluation, including handling operations, purpose of processing, necessity of processing operations, and impact on data subjects. Assessment of impact and corresponding risk response measures. There also exist some special situations in which it is not necessary to evaluate the effect, for example, the phenomenon of grabbing information that is used to achieve legal obligations, or based on public interest or official reasons [14]. Furthermore, GDPR not only establishes the process of protecting privacy but also clarifies the punishment mechanism, which containing penalty system and legal support. The penalty system regulates different levels of imposing a fine. First level violation: The maximum penalty is a fine of 10 million euros or 2% of the company's global annual revenue, whichever is higher. Second-level violation: The maximum penalty is a fine of 20 million euros or 4% of the company's global annual revenue, whichever is higher. Simultaneously, as a serious law, GDPR can also be regarded as a warning sign, which has positive effects on increasing autonomy in avoiding misuse of information for commercial reasons [13]. GDPR has already achieved numerous optimistic results. Companies and organizations have moved toward complying with the GDPR to avoid its fines and sanctions; some relevant websites are also modifying their strategies to comply with the rules. The main reasons are that the punishment and penalty system are far beyond the previous regulations. This leads to self-awareness and optimize the circumstances of privacy protection.

Learn from the effective aspects and improve according to China's conditions. The Personal Information Protection Law of the People's Republic of China expands the scope of sensitive personal information. Personal information is various information about identified or identifiable natural persons, recorded in an electronic or other manner, excluding anonymized information, which is not directly related information to the user [15]. In addition to this, it also defined the punishment mechanism, separating different punishment mechanisms based on sensitive and normal information abuse, clarifying the responsibilities affording by component departments in illegal phenomena, and avoiding the behavior of shirking responsibility when abusing user information. More detailed punishment paths, warn companies or website managers of their legal responsibility for abusing user privacy information, building a legal barrier that can add insurance for user security.

6. Conclusion

This research has explored the reasons of personal information leakage in personalized advertising, how major platforms carry out data cleaning and selective recommendations. Explain the algorithmic method, including cosine similarity formula and Bag-of-Words (BoW) model, focused

on the feasibility and effectiveness of the information filtering in personalized advertising. It also surveyed the pros and cons of personalized advertising. The personalized advertising can save users' time and provide users a better user experience; nevertheless, the filtering may pose some risks to consumers' privacy leakage. The scope and main method of the information leakage will be exposed by a detailed literature review method. Moreover, consumers' acceptance of personalized advertising, with the risks of consumers' privacy leakage, will be discussed. By studying the existing legal provisions, enterprises will be guided on continuing business under the condition that entrepreneurs must follow the protective users' information security laws. This study still has several limitations that require further refinement and deepening in future research. Firstly, regarding the core research findings, this study only verified through experience analysis a general negative correlation between users' acceptance of personalized advertising and the degree of advertisement personalization. When the degree of personalization gradually increases, users' resistance to personalized advertising will correspondingly increase, influenced by some factors such as concerns about privacy leakage and troubles caused by information cocoons. However, the research failed to further quantify this relationship, nor did it directly clarify the specific proportion or range of advertisement personalization that can simultaneously meet users' reasonable demands for service personalization and core needs for privacy security, while ensuring that advertisers' revenue from personalized advertising businesses is not significantly affected, ultimately achieving the optimal balance between user willingness and corporate profits.

Secondly, in terms of the consideration of research variables, the current analysis has not fully incorporated the moderating factors that may affect this balance. For example, different user groups (with differences in age, gender, consumption habits, and privacy sensitivity) may have significantly different tolerance thresholds for the degree of personalization. Younger users may be more accepting of a higher degree of personalized recommendations in exchange for precise services, while middle-aged and elderly users may pay more attention to privacy security and prefer ad formats with a lower degree of personalization. Meanwhile, differences in advertising characteristics and product life cycles across industries (such as fast-moving consumer goods, beauty, 3C digital products, etc.) may also lead to industry-specific optimal balance proportions. These variables have not been explored in depth in this study.

In addition, in terms of research methods, this study mainly relies on questionnaire surveys and correlation analysis of existing data, lacking a dynamic research perspective based on long-term tracking. It is challenging to catch the dynamic adjustment laws of user acceptance and corporate revenue as time goes by, technology updates, and regulatory policies change. Furthermore, it has not relied on experimental design and other methods to operate comparative verification of user behavior and corporate revenue under different degrees of personalization, resulting in the derivation of the optimal balance point, lacking more direct empirical support.

Based on the above limitations, subsequent research can be deepened from multiple dimensions. On the one hand, it can focus on quantitative research about the optimal balance point. Building a regression model with multiple variables, setting up experiments with different personalization grades, and doing a cross-analysis that combines user data such as click-through rate, conversion rate, and unsubscribe rate with firm income data, can precisely pinpoint the specific range of personalization percentage that could optimize both user acceptance and firm revenue. In addition, the analysis could include different variable combinations including, but not limited to, user portraits, industry types, and technical application scenarios, to identify the different characteristics of the optimal balance point under different backgrounds, thus drawing a more targeted conclusion. Meanwhile, a long-term questionnaire survey could also be implemented to dynamically monitor the

changing trend of this balance relation, ensuring the timeliness and effectiveness of the conclusion. The amount of the specific optimal balance point would provide practical evidence that is directly related to the decision-making of related advertising firms to select and alter strategies for personalized marketing, upgrade the algorithm's recommendation mechanism, and balance commercial revenues with user satisfaction and interests. It would also benefit entrepreneurs in improving the efficiency of advertising delivery and users' trust while also promoting the sustainable development of the personalized advertising industry.

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