

The Challenge and Optimization of Personalized Pricing Driven by Generative AI — Taking Ctrip as an Example

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Abstract: With the rise of generative artificial intelligence, its application in the business field is expanding, particularly in personalized pricing strategies for online travel platforms (OTAs) like Ctrip. This paper focuses on the systematic optimization of generative artificial intelligence for online travel platforms (OTAs) like Ctrip, examining its technical realization, commercial value and ethical challenges. This paper also discusses the challenges and future trends of personalized pricing in the online travel platform industry taking Ctrip as an example, and summarizes the problems encountered and future prospects after the application of artificial intelligence in the business field. The study reveals that Ctrip builds a multimodal pricing engine based on generative AI to generate the optimal pricing mix by integrating user behavior data, risk appetite, real-time supply and demand information and external environment variables. Therefore, the application of generative AI in the business field can greatly improve customer satisfaction and order conversion rate.

Keywords: Generative artificial Intelligence, artificial intelligence agent, ethical compliance, personalized pricing, Ctrip

1. Introduction

China's online travel market is rapidly growing, bolstered by strong support for smart tourism. In 2023, the added value of tourism and related industries in China reached 5,483.2 billion yuan, accounting for 4.24% of the gross domestic product (GDP), an increase of 0.57 percentage points over the previous year [1]. The maturity of artificial intelligence has significantly enhanced the economic efficiency of enterprises and customer satisfaction. User-generated content (UGC) has also provided good data for personalized pricing. However, the traditional pricing model faces challenges due to the non-linear nature of user behavior data and the need for quick responses to market changes.

Generative AI can synthesize virtual user behavior data to address the limitations of traditional pricing. Yet, some questionnaire analysis found that the use of AI dynamic pricing strategy is also easy to lead to negative emotions of users. A 2021 survey revealed that 46% of consumers hold a negative attitude towards AI. Only 23% of consumers can accept AI. Users' negative attitude towards AI personalization may also lead to a series of problems such as discontinuation of use and complaints [2].

This study focuses on the application of generative AI in the pricing strategy of online travel platforms, analyzing the limitations of traditional pricing models and putting forward optimization suggestions and its development trends, aiming to provide theoretical basis and practical guidance for improving user experience in the online tourism market.

2. Advantages of generative AI

Most traditional pricing strategies are related to competition. At present, enterprises' strategic choices on pricing are usually determined by competitors' strategies or market prices, often ignoring the impact of unstructured data (user reviews, social media content, fashion hotpots) on pricing models [3]. This oversight limits predictive modeling and reveals significant drawbacks in dynamic environments.

First, the traditional pricing model assume linear user behavior, relying on metrics like clicks and video views. This approach fails to capture these complex relationships, resulting in pricing strategies out of line with the actual demand. Secondly, the traditional pricing model is inefficient in dealing with nonlinear user generated content (UGC), which often has a time lag. Selling products according to average popularity may miss high revenue in the peak period or price too high in the low peak period, resulting in reduced revenue for enterprises. The traditional pricing model only focuses on the number of clicks and plays, and different user-generated content, even if the data is the same, has different user engagement and market value. Finally, traditional pricing models struggle to deal with complex and dynamic markets. Pricing based on historical data is subject to changes in multilateral market structure and supply and demand in the online travel market. Online travel platforms must set reasonable prices to motivate users, balance the needs and interests of multiple groups, and select the right subsidy object is the key to successful personalized pricing decisions [4].

In contrast, generative AI shows significant advantages as a technology that integrates data and learns from it to propose new content. Different from traditional predictive models, generative AI focuses more on the creation of new data. In recent years, the technology of generative AI has continued to develop, showing great mathematical problem processing capabilities, document generation and processing capabilities, and image recognition and creation capabilities. In particular, the ChatGPT model built with the architecture of Pre-training Transformer (GPT) has significantly expanded the functions of Generative AI by integrating deep learning and complex language models, and promoted the application of generative AI into existing business models [5].

Generative AI can analyze and detail character portraits in real time. It can process user generated content, such as comments on the platform, posted videos, pictures, and conversations, with customer service according to natural language processing capabilities. It can also pay attention to the user's stay time, search keywords and other details, used to extract the hidden needs of users and generate a more detailed user portrait, which can more clearly understand each user's preferences and their psychological expectations of the price, in order to dynamically adjust the price of the package.

Furthermore, generative AI can generate data and adjust product prices by simulating the market. Based on the reinforcement learning model, generative AI can generate a price elasticity prediction model for the current market environment and real-time behavior of users. Compared with the traditional model, generative AI can respond to changes faster, increase the price when the short-term demand surges, and adjust the premium in advance according to the prediction. For competitors, generative AI can build virtual competitors' response to prices based on the data between them in the past, and set reasonable prices while preventing competitors' pricing strategies from posing threats to them. Users are more willing to buy on their own platforms, so as to improve their competitiveness in the market.

3. Challenges of the adaptation of generative AI in the market

With the rapid development of generative artificial intelligence (AI), it faces many challenges in adapting to the market, including technical, ethical and compliance issues. These challenges not only affect the effective application of AI, but also have a profound impact on the interests of businesses and consumers.

3.1. Technical challenges of generative AI

It is difficult for generative AI to personalize pricing when long-tail user data is sparse. Long-tail users in online travel platforms usually only provide a small amount of their personal information (age, occupation, etc.), are less active in the platform and use less times, resulting in too little user-generated content to accurately model, and it is difficult for the platform to collect complete user data for personalized recommendation and personalized pricing of long-tail users. At present, Ctrip uses generative AI to generate data from existing user behavior data to fill the data gap of long-tail users, and generates more abundant portraits for long-tail users based on the predictive ability of generative AI combined with cross-platform external data such as geographical location and other e-commerce platforms. And the theme tags and emoticons that can express the rich emotions of users are also of rich reference value for the portrait [6].

Secondly, in order to realize dynamic pricing, generative AI needs to respond quickly to market changes in real time. Ctrip makes profits by providing rich travel service products, including hotels, train tickets, air tickets, resorts and other rich and varied travel products. Users will have a series of real-time demands when booking, searching and comparing prices. Generative AI must respond quickly and calculate personalized pricing, which puts high requirements on algorithm efficiency, otherwise it is difficult to meet user expectations. Reduce the satisfaction of users. The supply and demand situation of the online travel market is deeply affected by the environment, for example, the demand is large during holidays, and the fees should be increased. Due to the contraction of the travel market due to typhoon and other weather reasons, generative AI needs to monitor these changes in real time and make personalized adjustments to the pricing.

In addition, the training cost of generative AI is too high. Generative AI is a large language model. The most widely used model is ChatGPT, which relies on high-performance GPU or TPU cluster, resulting in extremely high hardware costs, labor costs, data center costs and other necessary expenses during the training process. Now the emergence of DeepSeek greatly reduces the cost of generative AI, and the open source method it uses, so that more people can reduce the cost when using AI. In online travel platforms, the AI model can be compressed to reduce its redundant data without affecting its performance, and the tasks can be distributed among different AI agents, such as setting portraits, demand forecasting, pricing optimization, etc. Focusing only on small models can greatly reduce the overall training cost. Different online travel platforms can collaborate to reduce overall costs by sharing data and computing resources.

3.2. Ethical and compliance challenges of generative AI

By 2025, AI will be greatly popularized and people's acceptance of AI integration into life will generally increase. This study conducted a survey on the current young group through online questionnaires. A total of 52 valid questionnaires were collected and analyzed, and the data are as follows. 47.23% of people have a general understanding of generative AI, and 96.15% can notice that online travel platforms provide different prices according to user information. 75% of people are dissatisfied with the price difference between different users of the same tourism product, which they consider unfair price discrimination. 84.62% of them believe that the application of generative AI in online travel platforms should be subject to stricter supervision, aiming at protecting the rights and interests of consumers.

Generative AI-assisted dynamic pricing has great benefits, but this pricing strategy may also bring adverse effects on enterprises and consumers. Price discrimination is an aspect that may cause ethical problems, and the pricing method of adjusting prices for a single customer has highlighted ethical issues [7]. Ctrip's personalized pricing is mainly for profit maximization. In terms of air ticket ordering and hotel ordering, different users of the same product may have different prices, and the

platform will price according to the historical behavior of users. Sometimes, there will be a phenomenon of "killing the ripe", that is, the price of new customers will be lower than that of old users, which is easy to cause user dissatisfaction. Ctrip needs to improve the transparency of the algorithm, clearly inform the user of the basis for personalized pricing, and give the user the power to exit the personalized pricing mechanism, so that the user can choose whether to be subject to the personalized pricing according to their personal wishes. AI's algorithmic bias can amplify and perpetuate social bias, which will also have a huge impact on social ethics. When training AI agents, the platform must eliminate a series of discriminatory factors, such as race, gender, region, from the model and focus more on a series of objective factors such as market demand [8].

How to meet data privacy protection while improving efficiency is also what online travel platforms need to pay attention to. Third-party regulators should also make a series of efforts to protect the rights and interests of consumers. Ctrip, in conjunction with other aerospace companies and hotels, should also pay attention to the fact that the data is not known by the third party, so as to prevent the adverse impact of data leakage on the rights and interests of consumers. From the perspective of the national regulatory mechanism, China can form a set of pricing governance system that can be implemented in both theory and practice for personalized pricing in combination with national conditions, including risk supervision, improving the platform's "positive responsibility mechanism" and forming a risk regulatory framework guided by scenario-based thinking [9].

4. Suggestions for optimization

4.1. Technical optimization direction

The rapid development of generative AI has been further promoted by the advent of DeepSeek, which can access real-time API data to analyze market conditions and user-generated content in real time. Its open source approach has greatly reduced the cost of using generative AI, and the cost of using AI in the future may be lower. Small enterprises can also use this, but the current DeepSeek program has the phenomenon of program crash, need to further adjust and improve the program.

The current generative AI may generate fake and unreal data, which is necessary to improve the long tail user portrait, in terms of personalized pricing, we need to more accurately extract the effective part of the user generated content data, and generate virtual data in line with the real data distribution by generating adversarial networks (GAN), instead of real user data. To construct a more perfect and realistic model using the large language model and enhanced retrieval generation, and generate the optimal price based on Nash equilibrium by simulating the game results of different pricing strategies in the virtual market environment, effectively protecting user privacy while simulating the real scenario, and further overcoming the challenges in personalized pricing.

4.2. Direction of sustainable optimization

The sustainable trend is increasingly becoming an important direction of enterprise development. Environment, Social & Governance (ESG) represents a comprehensive framework for measuring the sustainability and social responsibility of a business or investment. It goes beyond financial metrics and focuses on the environmental, social and internal governance impacts of its operations. Nowadays, ESG has become the core index to be followed by most listed companies and the social responsibility to be undertaken. Corporate managers need to regard green innovation as an investment rather than an expense, and they must put into action and a series of resources for this purpose [10].

When conducting personalized pricing, generative AI needs to meet the standards of environmental sustainable development, social equity and corporate governance transparency. At present, Ctrip has integrated ESG into its corporate strategy, actively undertakes social

responsibilities, practices the purpose of social friendliness, environmental friendliness, family friendliness and ecological friendliness, and releases ESG reports regularly every year. In the future, AI personalized pricing can be used to focus on carbon footprint, reduce carbon emissions by means of price combination, promote environmental sustainable development, and establish a more open and transparent mechanism for the algorithm. In view of a series of unfair problems generated in the process of personalized pricing, pay attention to the relationship between employees, communities, users and other stakeholders, and reduce the situation of discord. The company has also established a new business model driven by ESG, linking the company's salary to ESG performance, and continuing to empower the tourism industry.

4.3. International market optimization direction

China's domestic market is gradually saturated, and online tourism platforms need to expand the international market to improve their competitiveness in the tourism market. At present, China is gradually facilitating the application of tourist visas. By 2024, 25 countries will have visa-free access to China, 29 countries will unilaterally allow visa-free entry to China, and 44 countries will unilaterally allow China to apply for visa-on-arrival. Among them, these countries are all over Asia, Europe, Africa, America and Oceania, and people's inbound tourism has been strongly supported, which is very beneficial for online tourism platforms to open foreign markets.

There are also a number of challenges when it comes to expanding international markets. At present, it is a difficult problem to conduct personalized pricing internationally. The economy of different regions in the world is different, and the pricing strategy is affected by the exchange rate, tariff policy and cultural differences. Online travel platforms need to pay attention to the laws and policies of various countries and identify taboos and metaphors in local languages, so as to form the price manmanas more in line with the psychological expectations of users in different countries, and generate time-limit strategies based on the local calendar. To construct the global regional pricing map.

5. Conclusion

The research finds that the online tourism market still has room for development, and most platforms use personalized pricing to increase the company's profit and penetration rate in the online tourism market. Generative AI greatly improves the limitations of traditional pricing models by processing new data in real time, improving user portraits, simulating market price adjustment and other technologies in personalized pricing. However, at present, it still faces a series of challenges in terms of technology and ethical compliance, which can further optimize the cost, sustainable optimization, and international market direction.

However, there are some limitations in this paper. For instance, there is a lack of field research and detailed internal data of Ctrip, and the coverage of the research data only taking Ctrip as an example is limited.

The online travel market is developing in a more intelligent and personalized direction. As the technical threshold of generative AI is lowered, its penetration rate for more small enterprises will increase. In order to meet the development trend of ESG, generative AI will also enable sustainable development in the future tourism market and help achieve the goal of "double carbon". Generative AI will not only be used for pricing, but also be integrated into all aspects of tourism services. To help enterprises improve their market competitiveness through personalized services.

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