

Deep Integration of Artificial Intelligence and e-Commerce: a Study of Personalised Shopping Experience with Intelligent Recommender Systems

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ABSTRACT

Artificial intelligence, as an emerging technology, is gradually penetrating all walks of life. In 1956, in Dartmouth College in the United States, many experts and scholars came together to discuss issues such as using machines to mimic human learning and other aspects of intelligence, and for the first time put forward the concept of artificial intelligence, marking the birth of the discipline of artificial intelligence; in 1997, the Deep Blue computer, which was developed by IBM. The Deep Blue computer developed by IBM defeated the human world chess champion, marking the official arrival of the AI era; the emergence of ChatGPT at the end of 2022 signalled the rapid development and application of AI technology. At present, AI technology has shown its important value in many fields such as games, film and television, advertising, education, virtual reality, etc., and also shows great potential for application in the field of e-commerce.

KEYWORDS

Artificial intelligence; E-commerce; Intelligent recommender systems

1 Introduction

1.1 Artificial Intelligence

Artificial Intelligence, also known as AI, has its great potential for application in different fields as a new type of technology designed to enable machines to perform tasks that normally require human intelligence. This includes learning, reasoning, problem solving and language understanding. The goal of artificial intelligence is to develop systems that can simulate, replicate or perform functions similar to human intelligence. This includes technologies such as machine learning, deep learning, and natural language processing ^[1]. With the development of modern science and technology, AI is becoming more and more common in economic applications and is having an impact on the way we live and work.

1.2 E-commerce

E-commerce refers to commercial activities conducted through the Internet and electronic technology. It covers online shopping, online payments, e-marketplaces, and digital supply chain management. E-commerce enables consumers to purchase goods and services over the Internet, and also provides businesses with online sales and marketing channels. This business model has changed the traditional way of doing business by facilitating transactions on a global scale ^[2]. The traditional trading model is mainly face-to-face trading or communicating and trading through non-real-time methods such as telephone and email.

1.3 Trend of Deep Integration of Artificial Intelligence and E-commerce

The core driving force of the new industrial revolution has shifted, with artificial intelligence emerging as the central driving force of the fourth technological revolution. It will become a leading strategic technology, guiding future developments. The application of artificial intelligence in life is becoming more and more common, especially in the field of e-commerce, artificial intelligence has significant advantages and becomes its driving force day by day. In the current digital era, artificial intelligence has gradually become a necessary requirement for e-commerce companies and customers as companies transform, and e-commerce can only run smoothly if it is equipped with the appropriate AI technology ^[1]. E-commerce, as a convenient form of shopping, attracts a large number of customers, each of whom has different choices, and it is a challenging task to provide one-to-one service to these customers. According to the development and trends in the market, Artificial Intelligence (AI) technology is used to identify the needs and preferences of organisations and customers. With the assistance of AI, it will be able to quickly help identify the buying behaviour of customers and close the deal.

2 Fundamentals And Development Of Intelligent Recommender Systems

2.1 Definition

Intelligent recommendation system is a system that uses artificial intelligence technology to recommend goods or services that may be of interest to users by analysing their purchase history, browsing behaviour, preferences and other information^[3]. This kind of system improves user experience, promotes sales, and helps e-commerce platforms promote their products more effectively by predicting the goods that users may like.

2.2 The Development History of Intelligent Recommender System

Based on the foundational research of current scholars, this study divides the development of intelligent recommendation systems into the following stages^[4]:

(1) Budding period (late 1990s-early 2000s): the research of recommender systems in the field of e-commerce is still in the budding stage. During this period, some researchers began to explore collaborative filtering-based recommendation methods, which discover users' interests and preferences by analysing information such as their purchase history and ratings.

(2) Starting period (mid-2000s): with the popularity of the Internet and the rapid development of e-commerce, the application of recommender systems in e-commerce has gradually attracted attention. In this stage, some famous e-commerce companies, such as Amazon and Netflix, began to try to apply recommender systems on their own platforms and achieved remarkable results.

(3) Rapid development period (early 2010s): with the rapid development of machine learning and artificial intelligence technology, the application of recommender systems in e-commerce has also entered a rapid development period. In this stage, various complex recommendation algorithms continue to emerge, such as deep learning and reinforcement learning. These algorithms have achieved significant results in improving recommendation accuracy and user satisfaction.

(4) Big Data Era (Mid 2010s - Present): With the advent of the Big Data Era, e-commerce recommender systems have entered a new stage of development. In this stage, recommender systems need to process and utilise massive amounts of user data to improve recommendation effectiveness. In addition, new technologies such as cross-domain recommendation, multimodal recommendation, and context-aware recommendation have become research hotspots.

At present, e-commerce intelligent recommendation system is still in continuous development and improvement. With the advancement of technologies such as artificial intelligence, big data and Internet of Things, the future recommendation system will achieve better performance in terms of accuracy, diversity and real-time, providing users with a more personalised and intelligent shopping experience^[3].

3 Practical Application of Intelligent Recommender System in E-commerce

3.1 Application Scenarios of Intelligent Recommender System in E-commerce Platforms

There are many application scenarios of intelligent recommender systems in e-commerce platforms, aiming to improve user experience and increase sales [1]. The following are some common application scenarios:

(1) Personalised product recommendation: By analysing the user's purchase history, browsing behaviour, favourites, search terms and other data. For example, Amazon's Intelligent Recommender System can recommend items to users that they may be interested in, thereby increasing purchase conversions.

(2) Associated recommendation: In the product page, intelligent recommendation system can recommend related products to users. For example, after purchasing a mobile phone on Taobao, the recommender system will recommend accessories such as cases, chargers, etc., thus this helps to increase sales and customer satisfaction.

(3) Promotion Recommendation: Based on the user's shopping habits and purchasing power, the intelligent recommendation system can recommend suitable promotions to the user, thus increasing the participation and conversion rate of promotions. For example, when certain online merchants conduct promotions, they will recommend their own offers to their fans who follow them.

(4) Shopping cart recommendation: Intelligent recommendation system can recommend similar goods or matching goods for users according to the goods in the shopping cart to stimulate users to buy more goods. For example, from time to time, the shopping cart interface in Taobao will recommend some products that you may be interested in.

(5) Email marketing: Intelligent recommender system can send personalised email marketing content for users based on their purchase history and browsing behaviour to improve the effectiveness of email marketing. For example, from time to time, Amazon sends out emails about promotions to customers within their inboxes.

3.2 Practical Applications

3.2.1 Chatbots

Chatbots are intelligent computer programs that simulate humans through dialogue or text. The technology has been around since the 1960s and has been used for user interface development in games since the 1980s, and has since been used in a wide range of fields. Chatbots have simple text-based interfaces that allow users to access information or provide entertainment through online messaging platforms. During interaction with chatbots, dialogue messages can be sent through various media including voice commands, text chat, graphical interfaces or graphical widgets. Conversational interfaces include language processing, intelligent dialogue, and human-computer interaction, allowing real humans to feel, at least temporarily, that they are interacting with and approximating the experience of talking to another human being. Also, chatbots allow developers to add Internet buzzwords to their vocabularies ^[5]. Thus, for chatbots with chat interfaces, a rich vocabulary and fast response rate are key reasons for their rapid development and widespread use.

3.2.2 Image Search

The image search function of the intelligent recommender system is very widely used in practical applications. Based on image recognition and deep learning technology, the intelligent recommendation system can automatically identify and understand the content, colour, theme and other features of images, so as to achieve the image search function. Taking Taobao as an example, when users search for products, they can search for related products by uploading images or entering keywords. Taobao's intelligent recommendation system will recommend relevant products for users based on image features and text features, helping users to quickly find their favourite products and improve purchase conversion rate and user satisfaction ^[5].

3.2.3 Customer Data Processing

By integrating customers' behavioural data, attribute data and transaction data, etc., the intelligent recommendation system can help enterprises better understand customers' needs, predict customers' behaviour, and improve customers' satisfaction and loyalty, so as to increase their business value and market competitiveness. Taking Amazon as an example, Amazon analyses the user's behavioural data through the intelligent recommendation system to build a user profile, thus realizing precise marketing ^[6]. When users browse goods, search for goods or buy goods on the Amazon platform, Amazon will recommend goods that may be of interest to users based on their behavioural data, increasing conversion rates and user satisfaction.

4 Future Trends in Intelligent Recommender Systems

4.1 Technologies

4.1.1 Deep Learning

Deep learning plays an important role in intelligent recommender systems, and future technology trends are likely to be the further development and optimisation of deep learning models to improve the accuracy and real-time performance of recommendations ^[7]. Deep learning technology, which is a subfield of machine learning, refers to the brain that mimics human neural networks. It has achieved great success in performing machine learning tasks, especially supervised and unsupervised tasks. Some of the learning techniques that are being developed today are such as Convolutional Neural Networks (CNN), which is a deep learning algorithm that takes input data such as images and assigns weights to various objects for classification. CNN requires relatively less preprocessing compared to other classification algorithms and is designed to resemble neurons in the human brain, which is inspired by the organisation of the visual cortex.

4.1.2 Multimodal Fusion Recommendation

In the future, multimodal fusion recommendation may replace single-modal recommendation by combining multimodal information such as text, image, audio, etc. to improve the accuracy and diversity of recommendations ^[8]. Nowadays recommender systems are mainly based on single modal information such as text and images, multimodal fusion recommendation refers to the process of tensor fusion in two phases using multiple modal data such as text, images, and audio. The first stage models and fuses the correlation between any two modalities through three parallel branches, while the second stage further fuses the results of the three branches, eliminating the influence of the modal fusion order on the results. After the fusion is completed, a diversity recommendation module is introduced to maximise the use of the fused features and construct a more complete recommendation algorithm, thus improving the user experience and enhancing the effectiveness of the recommendation system.

4.1.3 Privacy Protection

As users increasingly prioritize privacy protection^[5], it is posited that future recommender systems will need to employ methodologies such as federated learning to safeguard user privacy and data security. The federated learning method is an emerging machine learning method that aims to address data privacy and security issues. In the federated learning approach, parties involved in training are able to co-construct models without exposing the original data. This approach enables multiple participants to jointly improve model performance without exposing sensitive data. Since the introduction of federated learning, it has a wide range of applications. For example, it can be used in the financial industry. Some scholars have proposed the FATE federated learning framework in their research, pointing out that this framework refines the execution logic of the application layer, including the processes of data uploading, task submission, and parameter configuration.

4.2 Operations

4.2.1 Cross-domain Recommendation

Currently, recommendation systems predominantly focus on specific domains; however, it is anticipated that the future trend may shift towards cross-domain recommendations, which enhance the diversity and coverage of recommendations by integrating data from multiple domains. Some scholars have proposed the concept of cross-domain recommendation in their research^[9]. This technology uses multi-domain information to optimize recommendation performance. In recommender systems, user data and item data usually come from different domains, such as e-commerce (purchase history, ratings, etc.), social networks (social relationships, interest tags, etc.) and search engines (search history, click data, etc.). Cross-domain recommendation improves the performance of recommender systems by integrating data from these multiple domains.

4.2.2 Scenario-based Recommendation

It is posited that future recommender systems will increasingly emphasize scenario-based recommendations, wherein real-time suggestions are made based on the user's current context, such as geographic location, time, and activity, thereby enhancing the accuracy and utility of the recommendations. Some scholars have pointed out the definition of scenario-based recommendation^[9], which is a method of recommending content to users based on their current scenarios (e.g., location, time, activity, etc.) in their paper. This recommendation method aims to better satisfy users' needs in specific scenarios and improve the accuracy and relevance of the recommendation results. Scenario-based recommendation takes into full consideration the user's current contextual information, which can better capture the user's immediate needs and interests. Currently there are many practical applications of scenario-based recommendation, which can be found everywhere in our lives, for example, when I use Grab, it can recommend nearby restaurants, hotels, attractions, etc. based on my current location.

4.2.3 Lifecycle Recommendation

It is anticipated that future recommender systems may focus more on comprehensive life cycle management, encompassing aspects such as user acquisition, retention, promotion, and conversion, with the aim of enhancing the user's lifetime value through targeted recommendations. Lifecycle recommendation can be understood as adjusting the content and way of recommendation according to the different stages of the user in the product or service, in order to help the user better understand and use the product or service, and improve user satisfaction and loyalty. In fact, full lifecycle recommendation has been applied in many Internet products, such as e-commerce, social, online education and so on.

4.3 User Experience

4.3.1 Personalised Recommendation

The future recommendation system will pay more attention to personalisation, through the deep understanding of the user, to achieve the personalised recommendation of thousands of people, and improve the user's satisfaction and experience. Personalised recommendation is an information filtering technique in which personalised content, goods or services are recommended to users based on their interests, behaviours and background. Personalised recommendation aims to solve the problem of information overload and improve user satisfaction and experience^[5]. Personalized recommendation is a prevalent phenomenon in everyday life; for instance, when browsing a short video platform, it consistently recommends videos aligned with my preferences.

4.3.2 Interactive Recommendations

It is conceivable that future enhancements in user engagement and experience could be achieved through the provision of more interactive methods, such as voice interfaces and augmented/virtual reality technologies. Nowadays, recommendation systems mainly display recommendation results through lists or information flows, etc. Interactive recommendation is a two-way interactive process, which allows users to express their needs and preferences during the recommendation process, and the system adjusts the recommendation results in real time according to the user's feedback. This recommendation method can better meet the personalised needs of users and improve recommendation accuracy and user satisfaction^[5]. It is not difficult to achieve interactive recommendation, for example, real-time capture user behaviour during the recommendation process, such as ratings, clicks, favorites and so on, in order to understand the user's feedback. Or adjust the recommendation algorithm based on user feedback to recommend content that better meets their needs.

4.3.3 Transparent Recommendation

Future recommender systems will pay more attention to transparency, explaining to users the reasons and rationale for the recommendation results, and improving users' trust and understanding of the recommender system^[3]. Transparency recommendation is a recommendation approach that aims to increase the transparency of recommender systems. Transparent recommendation helps users understand how the recommender system generates recommendation results by revealing the decision-making process behind the recommender system, thus increasing users' trust and understanding of the recommender system. The following measures can be taken to realise transparent recommendations, for example, users can be provided with a certain degree of control by allowing them to adjust recommendation parameters or display different recommendation results.

5 Conclusion

In conclusion, Artificial Intelligence (AI) has significantly transformed various industries since its inception, with e-commerce being a notable beneficiary. This paper explores the integration of Artificial Intelligence (AI) in e-commerce, particularly through intelligent recommender systems. These systems have evolved from basic collaborative filtering methods to complex models employing deep learning and multimodal fusion, enhancing the accuracy and diversity of recommendations. The future of intelligent recommender systems is promising, with trends indicating a shift towards cross-domain, scenario-based, and lifecycle recommendations. Moreover, the emphasis on personalized, interactive, and transparent recommendations is expected to improve user engagement and experience. As Artificial Intelligence (AI) continues to advance, its application in e-commerce is poised to become more pervasive, offering users a more personalized and efficient shopping experience while driving business growth.

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