Discussion on the Application of Artificial Intelligence in Economic Model Construction and Quantitative Analysis

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Abstract

The rapid development of artificial intelligence is gradually changing the working mode in many fields. In terms of economic model construction and quantitative analysis, the application of artificial intelligence technology has brought significant improvement. Its core concept is to simulate human intelligence and process massive data through major technologies such as machine learning and deep learning. Economic models and quantitative analysis are important tools in economic research, aiming at analyzing economic phenomena and predicting economic trends through mathematical models and statistical methods. In the construction of economic models, artificial intelligence can automatically process data, improve the efficiency of model construction and optimization, and show strong ability for the modeling of complex systems. In quantitative analysis, artificial intelligence can evaluate and predict risks, provide support for the optimization of investment strategies, and build a decision support system to provide scientific decision-making basis for decision makers. Therefore, the application of artificial intelligence in economic model construction and quantitative analysis is deepening day by day, which provides a new impetus and perspective for economic development.

Keywords

Artificial intelligence, Economic model, Quantitative analysis

Introduction

With the development of science and technology and the arrival of the era of big data, the application of artificial intelligence (AI) in the economic field has gradually become a research hotspot. With its powerful data processing ability and intelligent analysis ability, AI has brought revolutionary changes to economic model construction and quantitative analysis [1]. From automatic data processing to complex system modeling, to risk assessment and decision support, artificial intelligence is increasingly widely used in the economic field. This paper aims to explore the application of artificial intelligence in economic model construction and quantitative analysis, and its far-reaching influence [2].

On the theoretical level, the concept of artificial intelligence and its main technologies and methods, such as machine learning and deep learning, provide innovative ideas and methods for the construction of economic models. Through AI technology, massive data can be processed more efficiently, valuable information can be extracted, and a solid data foundation can be provided for the construction of an economic model. The application of AI in model construction and optimization, complex system modeling and so on makes the economic model more accurate and efficient [3].

In economic model and quantitative analysis, the introduction of artificial intelligence has made a qualitative leap in risk assessment, prediction, investment strategy optimization and decision support. AI technology can effectively conduct risk assessment and prediction, help decision makers to better grasp the market dynamics and formulate

scientific and reasonable investment strategies. AI can also provide dedicated support for decision support systems and improve the accuracy and efficiency of decision-making. Therefore, the application of artificial intelligence in economic model construction and quantitative analysis has broad prospects and far-reaching influence. This paper will discuss in detail the specific application of artificial intelligence in these areas and the changes it brings, to provide useful reference for research and practice in related fields [4,5].

Theoretical overview

The concept of artificial intelligence

Artificial intelligence is a subject field dedicated to making computers have similar human intelligence. It aims to enable computer systems to understand, learn, reason, and solve various complex problems. The core goal of artificial intelligence is to create an intelligent system that can independently perceive learning, memory, thinking and decision-making. Artificial intelligence attempts to enable computers to perform tasks that originally required human intelligence [6].

This includes not only the analysis and processing of data, but also the understanding of language, the recognition of images and the judgment of complex situations. The development of artificial intelligence is an evolving process. With the progress of technology, it covers many industries and is constantly expanding and infiltrating into other fields. The market scale of China's AI-related industries from 2019 to 2025 is shown in the following Figure 1. This continuous expansion demonstrates the pivotal role of artificial intelligence in driving industrial innovation and shaping future economic landscapes.

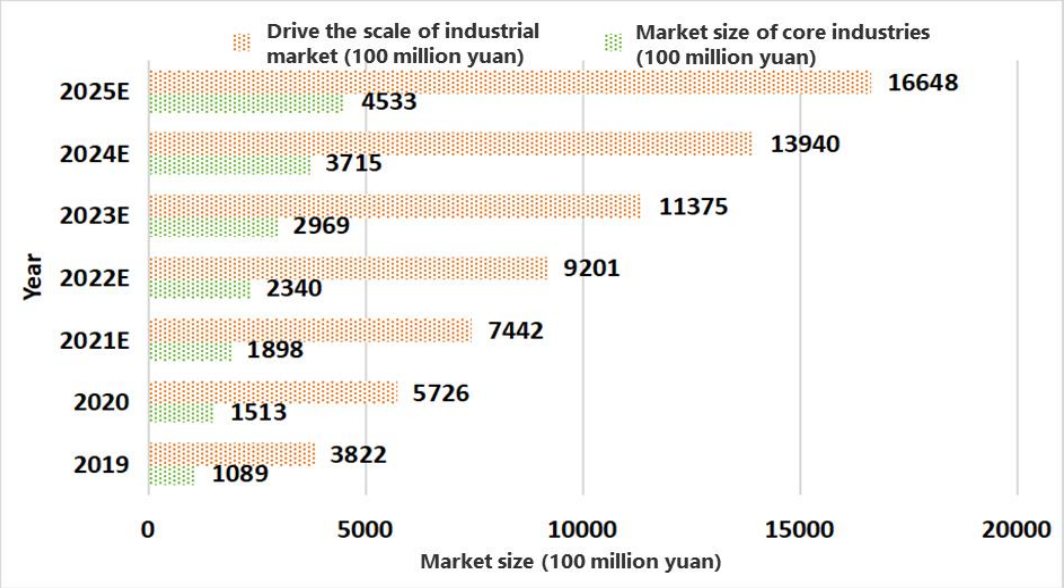

Figure 1. Market scale of Artificial Intelligence related industries in China from 2019 to 2025.

The development of artificial intelligence has brought opportunities for transformation and upgrading to all occupations. It has become a new engine to promote economic growth and social development by improving efficiency, reducing costs, and creating new business models [7]. With the continuous progress of technology, it is expected that more industries and industries will be integrated into the category of artificial intelligence in the future. The statistics of industry share in China's artificial intelligence market are shown in the following Figure 2.

This trend suggests that artificial intelligence will increasingly permeate traditional and emerging industries, leading to significant changes in industrial organization and value creation. Furthermore, the integration of AI across diverse sectors highlights its potential to serve as a strategic driver for sustainable economic growth and long-term competitiveness.

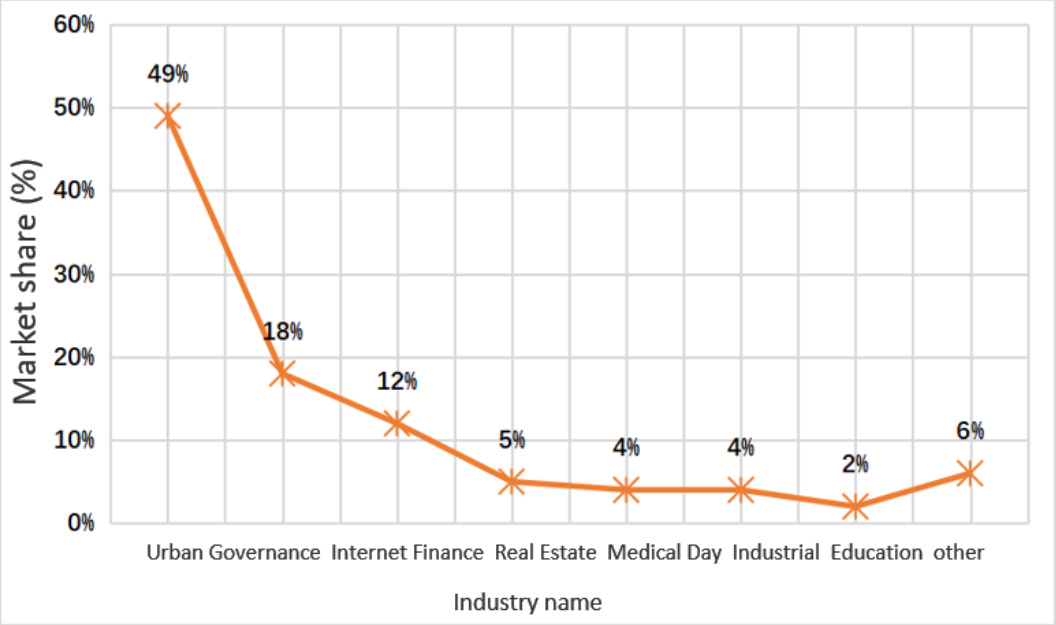

Figure 2. Statistics on the proportion of industry share in China's artificial intelligence market.

The main technologies and methods of artificial intelligence

Artificial intelligence covers a variety of major technologies and methods. Machine learning is one of the important fields which enables computers to automatically learn patterns and laws from data. By using a large amount of data for training, machine learning algorithms can continuously optimize its own performance, thus achieving accurate prediction and classification of unknown data [8]. Deep learning is a branch of machine learning, which uses deep neural networks to process and analyze data. This technology has made remarkable achievements in the fields of image recognition and speech recognition. Natural language processing focuses on making computers understand and process human language, including text generation, machine translation, question, and answer system and so on. Neural network algorithm is suitable for recursive solution process, and Lyapunov function is introduced to realize mutual access between nodes through neural networks, and the output value is corrected. When T_{ij}=T_{ji}, the neural network is stable, and the motion equation of nonlinear differential system is established by using the principle of system engineering, and its formula (1) is as follows.

$$C_i \frac{dy_i}{dt} = \sum_{i=1}^{n} T_{ij} f_j[y_j] - \frac{1}{R_i} y_i + I_i \quad (1)$$

In the above formula, i = 1, 2, 3, ..., n. C_i is the synaptic input capacitance, T_{ij} is the connection strength between neuron I and neuron J, $f_j[y_j]$ is the nonlinear function of Y under neuron J, and R_i is the synaptic resistance.

There is also support vector machine algorithm in machine learning, which has unique advantages in processing complex data and pattern recognition. Applying it to the analysis of educational data can mine the information in the data more accurately and provide deeper insights for educational evaluation [9]. And SVM algorithm is put forward from the optimal classification surface under the condition of linear separability. Under two kinds of linear separability conditions:

Let the sample be a category label and the linearly separable hyperplane be. $(x_i, y_i), i = 1, \cdots, n, x \epsilon R|^d$, $y \epsilon \{+1, -1\}$ The linearly separable hyperplane is $\omega \cdot x + b = 0$. Its Wolfe dual form is shown in Eq. (2).

$$\begin{cases} Maxmize: \sum_{i=1}^{l} \alpha_i - \frac{1}{2} \sum_{i,j}^{l} \alpha_i \alpha_j y_i y_j x_i x_j \\ s.t \ \sum_{i=1}^{l} \alpha_i y_i = 0 \\ C \geq \alpha_i \geq 0, i = 1,2,\cdots,l \end{cases} \quad (2)$$

In the above formula, α_i is the x_i Lagrange multiplier of the sample point. According to Kuhn-Tucker condition, the point with Lagrange coefficient not zero is the point of support vector, and the classification surface is determined by the point of support vector, regardless of other samples.

Economic model and quantitative analysis

Economic model is an abstract and simplified representation of economic phenomena, which is used to describe the relationship between various variables in the economic system. By establishing an economic model, we can better understand the mechanism and laws of economic operation and provide theoretical basis for economic decision-making [10,11].

Quantitative analysis is to use mathematical and statistical methods to process and analyze economic data to draw quantitative conclusions and forecasts. In economic research, economic model and quantitative analysis complement each other. The economic model provides a theoretical framework and assumptions for quantitative analysis, which verifies and improves the economic model by processing and assessing the actual data.

By applying artificial intelligence technology to economic model construction and quantitative analysis, the accuracy and forecasting ability of the model can be improved [12]. For example, using machine learning algorithms can be mined hidden patterns and relationships from many economic data, and provide more valuable information for economic decision-making.

The application of artificial intelligence in the construction of economic models

Automated data processing

In the construction of an economic model, data processing is a crucial link. The application of artificial intelligence makes automatic data processing possible. Through machine learning and data mining technology, valuable information can be quickly and accurately extracted from many economic data [13]. These technologies can automatically identify patterns, trends, and abnormal values in data, and provide a solid data foundation for the construction of economic models. For example, natural language processing technology can be used to analyze many text data and extract economic-related information from it. Automatic data processing can also improve the quality and consistency of data and reduce human error, thus improving the reliability and accuracy of economic models.

Model construction and optimization

Artificial intelligence provides the latest ideas and methods for the construction and optimization of economic models. Traditional economic models are often based on some simplified assumptions and theories, while artificial intelligence technology can better capture the complexity and nonlinear characteristics of economic systems [14]. By using machine learning algorithms, such as neural network and decision tree, a more accurate and flexible economic model can be constructed. These models can automatically learn the characteristics and relationships in the data, to better fit the actual economic data.

Artificial intelligence can also be used to optimize the model, and the prediction ability and generalization ability of the model can be improved by constantly adjusting the parameters and structure of the model. For example, genetic algorithms can be used to optimize the parameters of economic models to find the optimal model configuration [15].

Complex system modeling

Economic system is a complex system, involving the interaction of many factors and variables. Artificial intelligence has unique advantages in modeling complex systems. By using multi-agent systems, complex networks, and other technologies, we can model individual behavior and relationship in the economic system.

These models can better reflect the dynamics and complexity of the economic system and provide a more scientific basis for policy making and economic decision-making.

For example, when studying market competition behavior, multi-agent models can be used to simulate the competition strategy and market evolution process between enterprises. Artificial intelligence can also be used to model uncertainties and risks in the economic system, helping decision makers to better cope with various potential risks and challenges.

Application of Artificial Intelligence in quantitative analysis

Risk Assessment and Prediction

In quantitative analysis, risk assessment and prediction are crucial aspects. The application of artificial intelligence technology has brought new breakthroughs in this field. Through machine learning algorithms and big data analysis, various risk factors can be analyzed more comprehensively and deeply. For example, the neural network model can be used to analyze market data and identify potential risk patterns. These models can process many historical data, learn the characteristics and evolution law of risks, and then predict future risks. Natural language processing technology can analyze text information such as news and social media and find out the factors that may affect market risks in time. Through the risk assessment and prediction of artificial intelligence, investors and financial institutions can better formulate risk management strategies and reduce potential losses.

Investment strategy optimization

Artificial intelligence plays a key role in the optimization of investment strategy. Traditional investment strategies often rely on limited historical data and empirical judgments, while artificial intelligence technology can provide more accurate analysis and decision support. By using machine learning algorithms, such as reinforcement learning, the portfolio can be automatically optimized according to market dynamics and investors' goals. These algorithms can learn the optimal investment strategy in many simulated transactions, considering many factors such as asset price fluctuations, market trends, macroeconomic indicators and so on. Artificial intelligence can also evaluate and compare different investment strategies to help investors choose the most suitable investment plan. For example, genetic algorithms can be used to search for the optimal portfolio allocation to achieve the goal of maximizing returns and minimizing risks.

Decision support system

Artificial intelligence provides powerful power for decision support systems in quantitative analysis. A decision support system is designed to help decision makers make wise decisions when facing complex problems. Artificial intelligence technology can integrate and analyze a large amount of information and provide comprehensive and accurate data analysis and suggestions for decision makers. Through data mining and machine learning algorithms, valuable information can be extracted from massive data, and potential opportunities and risks can be found. For example, the support vector machine algorithm can be used to classify and predict market data and provide decision makers with a basis for judging market trends. Artificial intelligence can also present complex data to decision makers in an intuitive way through visualization technology, helping them to better understand and analyze information and make more informed decisions.

Conclusion

In today's era, artificial intelligence technology is gradually infiltrating into all aspects of the economic field, especially playing an increasingly key role in the construction and quantitative analysis of economic models. This paper aims to explore the application and potential value of artificial intelligence in this field.

In the aspect of economic model construction, the automatic data processing ability of artificial intelligence improves the efficiency and accuracy of data processing and provides a solid foundation for model construction. In the process of model construction and optimization, artificial intelligence shows a strong learning ability, which can automatically adjust and optimize model

parameters according to many data, thus improving the prediction accuracy of the model.

In the modeling of complex systems, artificial intelligence shows its unique advantages in dealing with complex nonlinear relationships. When it comes to quantitative analysis, artificial intelligence plays a vital role in risk assessment and prediction, investment strategy optimization and decision support system. Especially in the aspect of risk prediction, artificial intelligence can predict the future market trend and risk situation through deep learning and analysis of historical data and provide valuable reference information for investors. In terms of investment strategy optimization, artificial intelligence optimizes the investment portfolio through algorithms to achieve the optimization of asset allocation, thus improving investment returns. To sum up, the application of artificial intelligence in economic model construction and quantitative analysis has broad prospects and enormous potential. In the future, with the continuous progress of technology and the expansion of application fields, artificial intelligence will play a more significant role in the economic field and provide dedicated support for economic development.

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Conflicts of Interest

The authors declare no conflict of interest.

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