

The analysis of economics impact of artificial intelligence

Jiaxiu Sun¹, Xiaoqing Zhou²

¹Business College, China West Normal University, Nanchong, China

²Center of experiment, China West Normal University, Nanchong, China

Email: ¹*sunsky12@126.com*, ²*zhousun123@163.com*

Abstract. with the evolution of theory and technology, the "AI revolution" is an important technological change, and the impact on economics will also be broader and deeper. The related topics of artificial intelligence have become the frontier hot spot of economic research at home and abroad. This paper holds that the influence of artificial intelligence on social economy, politics, culture and even ideology has revealed the ideological clue of constructing artificial intelligence economics; Based on the development of digital economy, the impact of artificial intelligence on economy, the application of artificial intelligence in economic research and its impact on economic innovation, and on this basis, how economists explore and respond to the economic changes triggered by big data analysis and artificial intelligence technology in the future, which not only affects all aspects of production and life, but also affects economic research.

Keywords. Artificial intelligence, Machine learning, Economic Research, Rational intelligent agent.

Markets and Markets predicts that the market value of global artificial intelligence stocks will reach 1906 USD 100million, Asia Pacific region is the fastest growing region, and China will occupy the largest market share in this region. The 2019 white paper on investment and financing of China's artificial intelligence industry pointed out that from 2014 to the third quarter of 2019, China's artificial intelligence industry raised 3583 RMB 6.5 billion. The impact of artificial intelligence on economic operation is becoming increasingly significant. One main manifestation is that artificial intelligence is integrating with other industries and creating high-value products and services. The economic phenomena and problems related to artificial intelligence have aroused great interest in foreign economic circles. According to the statistics of web of science, economists published more than 1800 AI theme papers and monographs from 2016 to 2020.

1. Artificial intelligence is the goal achievement of rational intelligent agents

Artificial intelligence is the ability of agents to achieve goals in complex environments. Different scholars have different understandings of how agents achieve their goals. Most scholars stress that AI should mimic human thinking and action in order to create machines that think like humans. However, some recent scholars have proposed that AI does not have to imitate human beings, because human thinking is just a specific algorithm, but should allow intelligent agents to think and act reasonably on a broader scale. Some scholars represented by Lecun and tagmark even believe that blindly imitating the human brain will only limit the development of artificial intelligence. Artificial intelligence includes machine learning, expert system, robotics, search, logical reasoning and probabilistic reasoning, speech recognition and natural language processing and many other sub-disciplines. The relationship with deep learning and machine learning is shown in Figure 1 below.

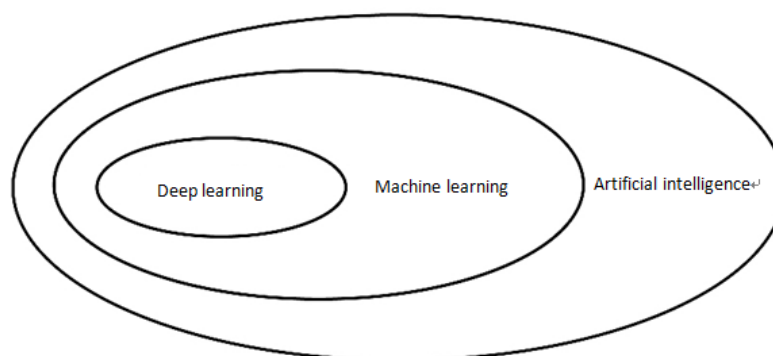


Figure 1. Relationship among artificial intelligence, machine learning and deep learning

1.1. Machine learning

Machine Learning uses algorithms to parse data and then make decisions and predictions about real-world events. The idea is not to program a computer specifically to solve a specific task, but to give the computer the ability to learn without explicit programming and find out how to accomplish the task by learning a lot of data. According to the characteristics of learning, machine learning can be divided into three categories: supervised learning, unsupervised learning and reinforcement learning.

Reinforcement learning is learning in a dynamic environment. Learners maximize the reward signal by constantly

trying and making mistakes. For example, students review their homework by doing exercises. After each exercise, the teacher will correct the exercises to let them know which ones are right and which ones are wrong. According to the teacher's correction, students can find out and correct errors, so as to continuously improve the accuracy. This process is to strengthen learning.

1.2. Deep learning

Deep learning, which has attracted much attention in recent years, is a research branch of machine learning. It uses multi-layer neural network to learn, and combines low-level features to form more abstract high-level attribute categories or features, so as to find the distributed feature representation of data. Under traditional conditions, because there are too few data available for learning, in-depth learning is easy to produce problems such as "over fitting", which affects its effect. However, in recent years, with the rapid development of artificial technology and the rise of big data, the power of deep learning has been reflected.

2. Related economic development problems of artificial intelligence

2.1. how manufacturers use big data and artificial intelligence

As human society enters the digital economy era of big data, Internet and artificial intelligence, manufacturers, individuals and governments begin to take big data as the basic element, the Internet as the trading platform and artificial intelligence as the technical means for investment and operation. The most significant manifestation of this pattern is the causal thinking judged by big data, which will gradually replace the causal thinking based on partial data; The trend of big data thinking will lead humans to regard all social activities and all phenomena in nature as "algorithms" (herali, 2017). In view of futurists' views on big data thinking and "algorithms", the economic efficiency achieved by manufacturers using new technology for investment and operation has verified the scientificity of these views to a certain extent and within a certain range. In the current operation of digital economy, manufacturers increasingly tend to collect big data related to their investment and business activities through mobile Internet, sensors, social media, satellite positioning systems, etc., and use artificial intelligence and other technologies to integrate, store, classify, process and process these big data. Theoretically, the process of manufacturers using new technology for investment and operation is the process of manufacturers using artificial intelligence and other technologies to match big data, that is, the process of building the material foundation of artificial intelligence economics.

2.2. Will artificial intelligence bring economic singularity

Singularity was originally a mathematical term that refers to a point that is not well defined (e.g., tends to infinity) or has strange properties. Kurzweil, a futurist, borrows this term in his book to refer to the critical moment when artificial intelligence surpasses human beings and leads to drastic changes in human society. The so-called economic singularity refers to a critical point in time. When the point is crossed, the economy will maintain sustained growth and the growth rate will continue to accelerate. In history, many economic masters have dreamed of economic singularities. Keynes, the founder of macroeconomics, and Simon, the Nobel Prize winner, are among them. Although these dreams have not become a reality so far, with the development of artificial intelligence technology, the discussion on economic singularities has begun to rise again. Some technical optimists believe that because artificial intelligence can greatly improve productivity and complete many tasks that human beings cannot complete, the economic singularity will soon come.

2.3. Artificial intelligence and employment

Technological progress will not only promote productivity, but also bring about technical unemployment. As a revolutionary technology, artificial intelligence is no exception. Compared with previous technological revolutions, the impact of the "Ai revolution" on employment will be broader, stronger and longer lasting. At present, the possible impact of artificial intelligence on employment has become an important policy topic, which has been discussed in many literatures. It should be noted that when discussing the impact of artificial intelligence on employment and income distribution, artificial intelligence is usually treated as an enhanced version of automation. Acemoglu and Restrepo have constructed a model including employment creation. They found that under the condition of long-term equilibrium, the result depends on the use cost of capital and labor. If the cost of capital is low enough relative to wages, all occupations will be automated; On the contrary, automation will have certain boundaries. In addition, several researchers also pointed out that if the labor itself is heterogeneous, then the automation will also lead to the internal income difference of workers.

2.4. Artificial intelligence and income distribution

AI may affect income distribution through multiple channels. First, theoretically speaking, artificial intelligence is a biased Technology (directed technical change or biased technical change). Its use will have different effects on the marginal output of different groups, and then affect their income status. This effect is reflected in two levels: the first

level is between different factors, which will mainly affect the distribution of returns of different factors; The second level is within the workers, which mainly affects the income distribution of workers with different skill levels. Second, the use of artificial intelligence will also change the market structure, so that some enterprises can obtain higher market power, and then enable enterprise owners to obtain more surplus income. Of course, how these effects work in the end also has a lot to do with relevant policies.

3. Economic impact analysis of artificial intelligence

The impact of artificial intelligence on economics is obvious at both micro and macro levels. From the micro perspective, first, artificial intelligence brings privacy risks while assisting individual decision-making and improving behavior efficiency; Second, artificial intelligence plays a positive role in decision-making quality, value creation and internal management; Third, the realization of general artificial intelligence will create new economic subjects in the future and affect the economic ecology. From a macro perspective, as a general-purpose technology (GPT) and automation tool, artificial intelligence is closely related to innovation, economic growth, industrial organization and labor market reform.

3.1. analysis of the impact of artificial intelligence on the field of behavioral economics

We selected 9 related fields with the highest recent popularity, global popularity and the strongest relevance of behavioral economics as our research objects, specifically including:

(1) Behavioral Economics; (2) Decision Theory; (3) Social Choice Theory; (4) Behavioral Finance; (5) Economics Effect; (6) Neuro Economics; (7) Voting Behavior; (8) Risk Aversion; (9) Prospect Theory

Secondly, we selected 11 related fields with the highest recent popularity, global popularity and the strongest relevance of artificial intelligence as our research objects, specifically including:

(1) Artificial Intelligence; (2) Neural Networks; (3) Machine Translation; (4) Machine Learning; (5) Modeling and Simulation; (6) Deep Learning; (7) Nature Language Process; (8) Planning and Scheduling; (9) Computer Vision; (10) Control Methods; (11) Data Mining

By calculating the knowledge map of the artificial intelligence field and behavioral economics, and then mining the hot spots of the Cartesian product of the subdivided fields of the two fields, this report digs two parts: historical data and future trend prediction. The historical data mainly discusses the research status in the last 10 years (2010 to now); The trend forecast is only discussed in the next three years. Figure 2 below shows the cross analysis of artificial intelligence and behavioral economics.

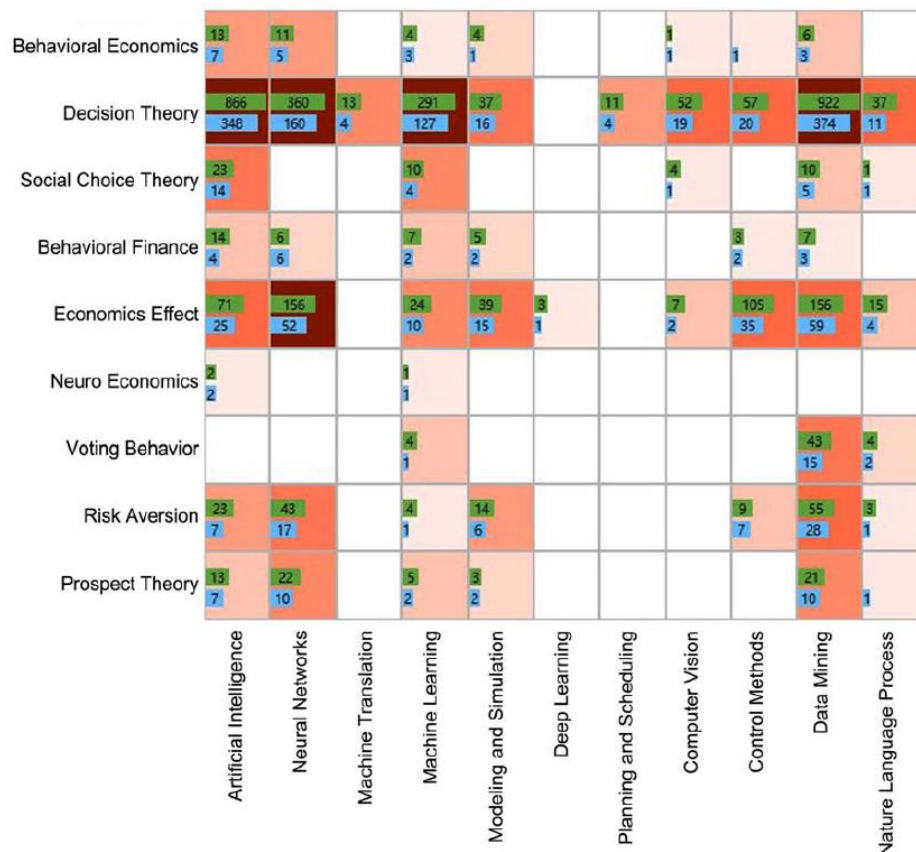


Figure 2. The analysis of historical cross fields of artificial intelligence and behavioral economics

It can be found from Figure 2 that the top five historical cross fields of artificial intelligence and behavioral economics are:

- (1) Decision Theory & Machine Learning;
- (2) Decision Theory & Neural Networks;
- (3) Decision Theory & Data Mining;
- (4) Decision Theory & Artificial Intelligence;
- (5) Economics Effect & Neural Networks

According to the prediction and analysis of aminer data, the research heat of decision theory and artificial intelligence, decision theory and machine learning, decision theory and data mining will continue, and the research heat of economic effect and neural network, economic effect and data mining will also increase.

3.2. Microeconomic impact of artificial intelligence

With the reduction of computing cost, the high availability and low reliability of the algorithm coexist. On the one hand, robot customer service, voice navigation system, mobile intelligent assistant, product recommendation system and online price comparison system are becoming more and more popular, helping individuals improve the efficiency of decision-making and behavior with the ability of rapid retrieval feedback, accurate preference matching and easy access to information. On the other hand, individual decision-making is changing from subjective judgment to over reliance on algorithm prediction, which will lead to people's choice deviation of high-risk behavior. The massive data and algorithms used by intelligent products and services to support efficiency may also become a way to disclose user information. How to balance efficiency and risk is an important research topic and policy consideration in the context of artificial intelligence applications.

Therefore, the identification, management and protection of intangible assets is an important condition for enterprises to make good use of artificial intelligence. The research progress of general artificial intelligence is slow, and its impact on the economy is uncertain. However, it can be predicted that the goal of general artificial intelligence is to break through the limitation of instrumentalization and become an economic subject. At that time, economic research will need a new paradigm. Korinek's perspective of future economics points out that intelligent agents can participate in economic activities, will establish an equal relationship with human subjects, and the symbiosis of human and machine will replace it. Human centered economic ecology.

3.3. Macroeconomic impact of artificial intelligence

Artificial intelligence shows two attributes in economic operation, one is automation tool, the other is general purpose technology. As an automation tool, artificial intelligence is more efficient and controllable than human workers in the task of repetitive operation and standardized process. For example, the application of industrial production robots can significantly improve production efficiency, save costs and ensure safety. Asimoglu and Irestrebo believe that the substitution effect of artificial intelligence can be partially offset by the productivity effect. On the one hand, traditional labor is replaced, resulting in a decline in labor demand and wage level. On the other hand, automated processes can save costs and increase labor demand for non-automated tasks and new labor-intensive tasks. Additional capital accumulation and automation will further increase labor demand, Complementary productivity effect. Phelps uses a two-sector equilibrium growth model to study the impact of robots' participation in production activities in the two scenarios of complete replacement and partial replacement of labor on product prices, output, labor productivity and wage changes. The survey conducted by McKinsey Global Research Institute shows that the communication, high-tech and energy departments have the highest acceptance of artificial intelligence. The enterprises with active application strategy and high acceptance have the largest difference between their net profit rate and the average net profit rate of the industry, and their future profit expectations are also higher.

4. Artificial intelligence and economics research

4.1. New data and methods of economic research

The application of artificial intelligence in economics was text analysis and image recognition algorithms for investigation and case analysis. Recently, the focus of research is to improve the existing econometric methods by combining machine learning and causal inference. In the empirical field, economists use machine learning algorithms to search for causal patterns in new data sources such as platform data, enterprise data, online experiments, and open data records. Milgrom introduces the performance of machine algorithm in resource allocation, market value evaluation, quality control, competition and strategic bidding, and puts forward new market design ideas by using the cases of program advertising online bidding and online store management system. The simple equilibrium credit market model constructed by boyachenko with machine learning algorithm can accurately measure the credit degree of American real estate mortgage and predict the lending trend across user groups.

4.2. Economists' contribution to artificial intelligence

With the deepening of the integration of artificial intelligence into the current economy, and the increasing risks of algorithm deviation, data security, system stability and so on, economists pay more attention to the research on artificial intelligence supervision. Li Shu and others found that the implementation of artificial intelligence supervision will

reduce the adoption rate of artificial intelligence technology in enterprises, and will also increase the cost of artificial intelligence strategy development and management personnel employment, but can improve enterprises' understanding of the security and transparency of artificial intelligence. Clark and Hadfield pointed out that the public sector lacks flexibility and incentives and cannot meet the high-speed, complex, intangible and overall requirements of artificial intelligence regulation. It should create a regulatory market and encourage the private sector to innovate regulatory technologies and business models to keep pace with the progress of artificial intelligence technology. In addition, economists are also actively exploring how future intelligent agents can participate in the economy and man-machine symbiosis. Hadfield designed a research framework of calibration problem based on the relationship between incomplete protocol and incorrectly defined robot reward function, and proposed that the key to coordinating machine and human is to ensure the consistency of algorithm and human behavior technically. Machines need to have the ability to evaluate reward and the ability to recognize the cost of human error behavior.

References

- [1] Simon, H. A. , Dantzig, G. B. , Hogarth, R. , et al. Decision Making and Problem Solving [J] . Interfaces, 1987, 17(5) : 11–31.
- [2] Monderer, D. , Tennenholtz, M. , Varian, H. Economics and Artificial Intelligence[J]. Games and Economic Behavior, 2001, 35(1–2) : 1–5.
- [3] Beaumont, C. Artificial Intelligence in Economics and Management[J]. Journal of the Operational Research Society, 1987, 38(4) : 370–370.
- [4] Paul Milgrom, “ Auction Market Design: Recent Innovations ”, [J] . Annual Review of Economics, Vol. 11, 2019, p. 383.
- [5] Bresnahan, T. F. , Trajtenberg, M. General Purpose Technologies‘Engines of Growth’? [J] . Journal of Econometrics, 1995, 65(1) : 83–108.
- [6] Susan Athey, et al., “Economists (and Economics) in Tech Companies”, [J]. Journal of Economic Perspectives, Vol. 33, No. 1, 2019, p. 209.
- [7] Emilio Calvano, et al., “Algorithmic Pricing What Implications for Competition Policy?” [J] . Review of Industrial Organization, Vol. 55, 2019, p. 155.
- [8] Dylan Hadfield — Menell & Gillian K. Hadfield, “Incomplete Contracting and AI Alignment”, in Vincent Conitzer(ed.) , AIES ' 19: Proceedings of the 2019 AAAI / ACM Conference on AI, Ethics, and Society, NY: ACM, 2019, pp. 417 — 422.