

# A Review of Research on Artificial Intelligence Life Cycle Based on Bibliometrics

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**Abstract:** This paper uses bibliometric method and knowledge graph visualization technology to analyze the 237 papers of CNKI core journals from 2006 to 2021, from the key words, number of papers, authors, publishing institutions and high-impact journals. Statistical analysis, explaining the research status and research hotspots of artificial intelligence life cycle, and expounding the shortcomings and trends of research. The research on artificial intelligence technology is divided into exploratory stage and development stage according to the annual publication volume. From 2006 to 2015, the research hotspots mainly focus on "artificial intelligence" and "neural network". From 2016 to 2021, the research hotspots mainly focus on three aspects: "artificial intelligence", "artificial intelligence technology" and "deep learning", and the research is gradually deepened, with a total of 223 journal articles. The research of artificial intelligence technology is in the development stage, and various fields are actively studying artificial intelligence technology, but the existing research focuses on the application level, the deep learning theory is not perfect, the basic technology and basic theory are ignored, and there is a lack of solutions to the problem of privacy leakage. Future research should pay more attention to basic technology and innovative research. There may be broader research space for research from two aspects: "integration and breakthrough of deep learning theory" and "machine learning evolution towards distributed privacy protection".

**Keywords:** Artificial intelligence, Artificial intelligence technology, Bibliometrics, Knowledge graph.

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## 1. Introduction

The artificial intelligence life cycle is to bring the life cycle theory into artificial intelligence technology, and conduct research on the development status of the existing artificial intelligence technology. The "14th Five-Year Plan" points out that it is necessary to accelerate the digital transformation of traditional enterprises, and strive to cultivate and develop emerging digital industries such as artificial intelligence. We will build artificial intelligence datasets for key industries, use algorithms to simulate training scenarios, promote the development of intelligent products such as intelligent medical equipment, intelligent transportation robots, and artificial intelligence identification systems, and promote the construction of artificial intelligence open platforms. Artificial intelligence technology has always received widespread attention, and various industries in China are also integrating artificial intelligence technology into the business process of enterprises. Scholars at home and abroad have conducted a lot of research on the development status of artificial intelligence technology from various fields. It can be summarized as follows: In the military field [1-4], according to the transformation of war mode, more artificial intelligence technology is gradually applied to weapons and equipment, which promotes the use and maintenance of weapons and equipment to be more intelligent. Artificial intelligence technology has built a new generation of artificial intelligence basic theoretical system in terms of basic intelligence theory; in terms of intelligent processing technology, it has built a new generation of artificial intelligence processing technology system, which mainly includes deep learning processing technology, knowledge service technology, and swarm intelligence processing. Technology, etc.; make overall arrangements for artificial intelligence processing platforms in terms of intelligent processing platforms. In the

field of medicine [5-9], artificial intelligence technology based on deep learning has achieved some research results in imaging, drug development, pathological diagnosis, etc. For example, deep neural networks can detect abnormalities, quantitative diagnosis and differential diagnosis. It is more convenient and accurate to help doctors grasp the patient's condition. We can also apply AI techniques to practical issues such as data sharing and privacy in clinical workflows, data standardization, and interoperability across multiple platforms. With recent advances in digitized data collection, machine learning, and computing infrastructure, AI applications are expanding into areas previously considered only human experts. The medical field is an important application field in the development of artificial intelligence technology. In the field of intelligent manufacturing [10-13], artificial intelligence is the basic technology for the realization of a new generation of intelligent manufacturing technology. Researchers should actively explore relevant suggestions on the development of intelligent manufacturing technology under the guidance of the new generation of artificial intelligence technology, help traditional enterprises to digitally transform, promote the implementation of intelligent manufacturing technology, and promote the coordinated development of technology, application and industry. Through the use of artificial intelligence technology, an IoT artificial intelligence system composed of many sensors and cloud computing servers can be realized to collect, store, process, analyze and control the user's data, so as to better serve the user. Artificial intelligence technology can also provide a lot of help to enterprises. For example, applications such as logistics energy efficiency analysis and finished product process efficiency analysis in enterprise key performance indicator analysis can help enterprises find hidden problems, intelligent online detection in product life cycle control, AR - based personnel training and other

applications, which can improve Production efficiency and product quality. In the field of meteorology [14-16], the new generation of artificial intelligence technology is mainly used in the R&D and application scenarios of meteorological departments: intelligent identification of meteorological observations based on video analysis and pattern recognition, now forecasting of meteorological conditions based on deep learning, based on Machine learning forecasts rainfall and typhoon magnitude, and generates weather forecast products intelligently based on natural language. Artificial intelligence technology can improve the accuracy of weather forecasts, and deep learning-based nowcasting and ice accretion image recognition have been applied to the work of meteorological departments. In the field of education [17-20], artificial intelligence education is one of the emerging fields in the current field of educational technology. It can help students learn through technical means and achieve a certain degree of personalized education. Teaching work is facilitated. For example, artificial intelligence technology can help students in English teaching, can provide more objective and instructive feedback, expand teaching resources and information acquisition channels, and can help students well.

Artificial intelligence is conceptualized as an ecosystem consisting of data collection and storage, statistical and computational techniques, and output systems that enable products and services to perform tasks on behalf of humans that are often understood to require intelligent and autonomous decision-making [21]. AI technology is no longer the domain of futurists, but an integral part of many organizations' business models and a key strategic element in many business, medical, and government sector initiatives worldwide [22]. Based on this, this paper adopts the method of literature review to analyze the research status and research hotspots of the artificial intelligence life cycle from 2006 to 2021. From the aspects of literature keywords, citations, and main authors of the literature, it summarizes the existing research literature, and then uses the literature. Cluster analysis of core keywords, discuss the current research hotspots and deficiencies of artificial intelligence technology, predict future research trends, and provide reference and reference for subsequent artificial intelligence technology research.

## 2. Data Sources and Research Methods

### 2.1 Data Sources

Artificial intelligence technology has developed rapidly in recent years and has been successfully applied in many industries [23]. Therefore, this paper selects the literature on the application status of artificial intelligence technology in various fields as the research object. The source of the literature data is the China Academic Journal Network Publishing Library (CNKI), and the search condition is set as the keyword contains "artificial intelligence technology" in the search. The time is set from 2006 to 2021, the main theme is "artificial intelligence technology", the journal source is set to the core and SCI source journals of Peking University, and the journals related to the research status or application status of artificial intelligence technology are retrieved and selected, a total of 237 articles, as the research data for this paper.

## 2.2 Research Methods

In the field of bibliometrics, researchers use knowledge graphs to visualize and analyze the basic information of relevant documents to form multi-dimensional graphs to help researchers explore the development dynamics and trends of a certain subject area [24]. Existing analysis software such as CiteSpace is based on citation and knowledge graph visualization techniques. The combination of bibliometrics and knowledge graph analysis technology can help researchers more accurately predict the future development trend of disciplines or research fields [25-28], explore the mutual influence between disciplines, and explore frontiers and hotspots in research fields [29- 30].

Based on 237 valid literatures, this paper summarizes the research status of artificial intelligence technology life cycle through the visual analysis software CiteSpace.

## 3. Research Status of Artificial Intelligence Technology

### 3.1 Summary of Keyword Clustering

Keywords are the main content of an article and the research direction of the article. The keyword co-occurrence network graph is composed of the keywords provided by the authors and the keywords identified by the journals.



Figure 1. Keyword Co-occurrence Network Graph

From the results of the keyword co - occurrence network of literature related to artificial intelligence technology by CiteSpace , we can see that the nodes in the network graph represent high-frequency keywords in the field of artificial intelligence technology, among which "artificial intelligence technology", "artificial intelligence" , "deep learning", and "neural network" are the four major nodes in the co-occurrence network.

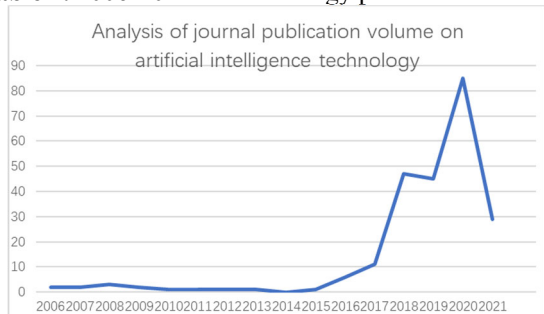
from Figure 1 that "deep learning" and "neural network" are hotspots in the field of artificial intelligence. Researchers such as Sarir P can establish and develop different neural networks to predict the axial bearing capacity of composite columns according to the effective parameters collected from the prediction model and comprehensive experimental data [31]. The edge intelligence that researchers such as Wang X facilitates the deployment of deep learning services through edge computing has attracted widespread attention. As a representative technology of artificial intelligence, deep learning can be integrated into the edge computing framework to build intelligent edges and perform dynamic and adaptive edge maintenance. and management [32]. Early research in the field of artificial intelligence mainly focused on electronic computers, computer applications, etc., and current research mainly focuses on deep learning-based technology applications and natural language processing. To sum up, the

development in the field of artificial intelligence has gradually received attention, and scholars in different research directions have gradually deepened the research on artificial intelligence technology.

### 3.2 Post volume analysis

The annual distribution of the number of papers published can reflect the research progress and popularity of the field in a certain period of time [33]. From 2006 to 2021, a total of 237 core journal articles related to artificial intelligence technology were published.

**Table 1.** 2006-2021 AI technology publication volume



From Table 1, the research on artificial intelligence life cycle can be divided into two stages: exploration period and development period.

The first stage, the exploratory period (2006-2015) (14 articles, 5.91%). At this stage, the amount of published papers is relatively small, most of which are based on artificial intelligence technology application research, and the theme is relatively single. In terms of authors, there are 37 authors of published papers, 3 single-author papers, accounting for 21.4 %; 11 papers with two or more authors, accounting for 78.6%. In the exploratory stage, the degree of cooperation between authors is relatively high.

The second stage, the development period (2016-2021) (223 articles, 94.09%). As of June 5, 2021, the number of published papers in 2021 was 27; as of June 5, 2020, the number of published papers in 2020 was 31. There is not much difference in the number of articles published in the same time period in these two years, and 2021 is also included in the development period. The number of publications at this stage increased rapidly, reaching 85 in 2020. This stage is characterized by diversification of topics, diversification of keywords, and in-depth questions. During this period, the number of authors who published papers was 549, of which

the number of single - author papers was 76, accounting for 34.08% . In this stage, the number of published authors has surged, which is 17.84 times that of the previous stage. The number of single-author articles has increased, and the author's independent research ability has improved.

### 3.3 Author Analysis

To a certain extent, the quantity and quality of papers published by scholars reflect the academic research ability of scholars [34]. As of June 5, 2021, there are 237 core journals in artificial intelligence technology, with a total of 586 authors, and some papers have multiple authors.

**Table 2.** List of authors with multiple published articles

Count	Year	Authors
4	2018	Guanzhen Yu
2	2018	Xiaoqin Bi
2	2018	Peilian Wei
2	2018	Baocun Hou
2	2018	Changfeng Chen
2	2018	Forong Zhao
2	2018	Junxi Qiu
2	2019	Songyang Liu
2	2019	Yuqi Lan

From Table 2, it can be seen that the authors with the most publications are Yu Guanzhen, Qiu Junqian, Hou Baocun, etc. Yu Guanzhen applied artificial intelligence technology to the medical field, and studied the application status and development trend of artificial intelligence technology in electronic medical records, tissue and cell morphological evaluation, inheritance and development of traditional Chinese medicine and nursing [35-38]. Qiu Junqian studied the impact of artificial intelligence technology on TV variety shows and news production patterns [39-40]. Hou Baocun applied artificial intelligence technology to the field of intelligent manufacturing, and studied the typical application scenarios and standard systems of artificial intelligence technology in intelligent manufacturing and the promotion of the new generation of artificial intelligence technology on technologies, industries and applications in the field of intelligent manufacturing [41-42].

### 3.4 Publishing Agency Statistics

Through the statistics of author units, it is found that there are 134 units involved in artificial intelligence technology research.

**Table 3.** Statistics of issuing agencies

Count	Year	Institutions
2	2018	State Key Laboratory of Oral Diseases
2	2017	Editorial Department of China Social Sciences Magazine
1	2019	China University of Political Science and Law
1	2018	School of Information Control, China University of Mining and Technology
1	2021	National Cyber Security College, Wuhan University
1	2021	School of Teacher Education, Zhejiang Normal University

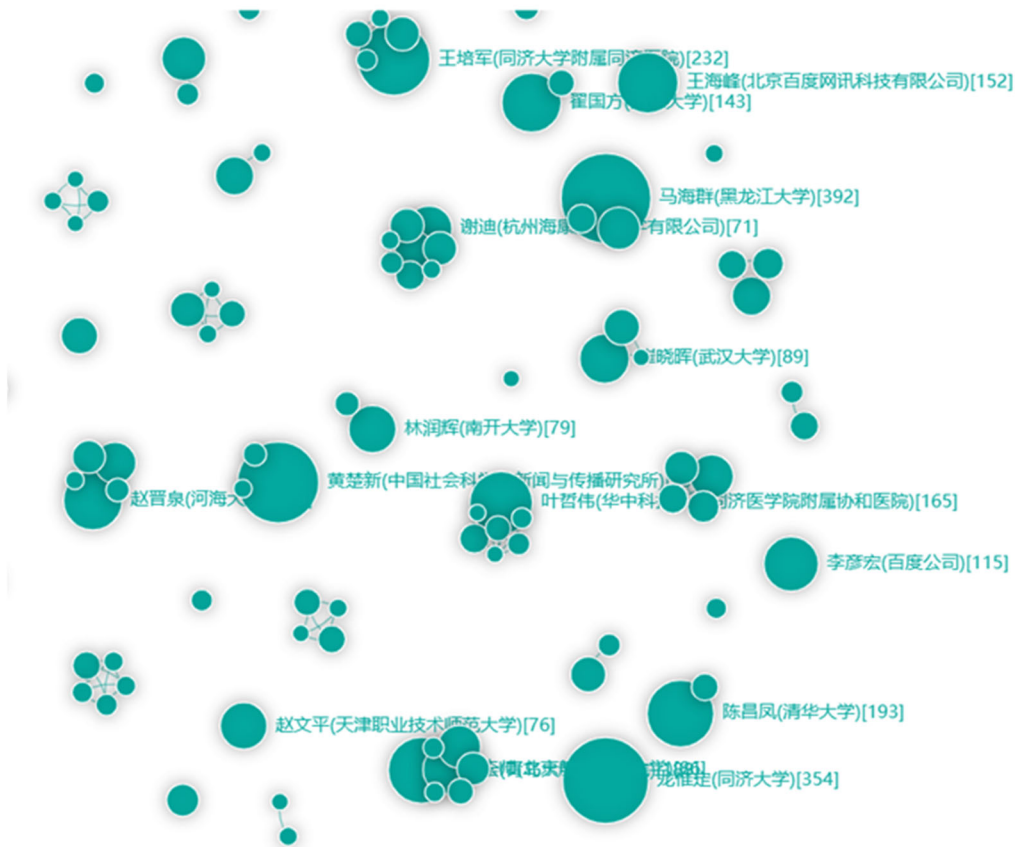
Combining with Table 2, it is possible to find out the institutions that the authors with the most publications belong to.

**Table 4.** Institutions of authors with more publications

Author	number of publications	name of institution
Guanzhen Yu	4	Changzheng Hospital affiliated to the Second Military Medical University
Junxi Qiu	2	School of Journalism, Communication University of China
Baocun Hou	2	China Aerospace Science and Industry Corporation LTD
Yuqi Lan	2	Tianjin Fine Arts Institute
Songyang Liu	2	Tianjin Fine Arts Institute
Tao Zhang	2	Chinese Academy of Sciences
Xiaoqin Bi	2	West China Stomatological Hospital
Forong Zhao	2	Sichuan Stomatological Hospital
Changfeng Chen	2	Tsinghua University
Peilian Wei	2	Zhejiang University of Science and Technology

From the spatial distribution of institutions in Table 4, the institutions are relatively scattered, which shows that artificial

intelligence technology is the main research object of researchers across the country.



**Figure 2.** Author Collaborative Network

From Figure 2, authors from different institutions have more cooperative connections, more collaborative papers across institutions and regions, stronger academic connections, and larger teams.

### 3.5 Analysis of High Impact Journals

This paper conducts statistical analysis on 237 papers, and finds out the top ten high-impact papers with the most citations and downloads.

**Table 5.** The ten most frequently downloaded documents

Title	year of publication	source	number of downloads
A review of the development and application of artificial intelligence technology	2009	Coal mine machinery	19717
Thinking about the ethics anomie of artificial intelligence technology in news communication	2018	Published a wide Angle	6387
Black Box: Artificial Intelligence technology and the Evolution of news Production pattern	2018	The press	5422
Application of artificial intelligence technology in cyberspace security defense	2015	Computer Application research	4018
Will ARTIFICIAL Intelligence technology induce labor income inequality: Model deduction and Classification Evaluation	2020	Chinese industrial economy	3915
People-oriented: The application of ARTIFICIAL intelligence technology in the field of journalism and Communication	2018	Journalism and Writing	3599
The impact and reinvention of artificial intelligence technology on news production	2016	Chinese journalists	3501
Application of artificial intelligence technology in financial field: main difficulties and countermeasures and suggestions	2018	The southern financial	3259
The impact of artificial intelligence technology on labor employment: A literature review perspective	2020	Chinese soft science	3001
The development and educational application of artificial intelligence technology from the perspective of multiple intelligences	2018	Audio-visual education research	2906

**Table 6.** The ten most cited papers

Title	year of publication	source	citation frequency
A review of the development and application of artificial intelligence technology	2009	Coal mine machinery	170
Black Box: Artificial Intelligence technology and the Evolution of news Production pattern	2018	The press	109
Artificial intelligence technology research and future intelligent information service system thinking	2017	Telecom science	76
Thinking about the ethics anomie of artificial intelligence technology in news communication	2018	Published a wide Angle	61
Application of artificial intelligence technology in cyberspace security defense	2015	Computer Application research	57
The impact and reinvention of artificial intelligence technology on news production	2016	Chinese journalists	55
Some methods of network intrusion detection based on artificial intelligence technology	2007	Computer Application research	52
Application of artificial intelligence technology in financial field: main difficulties and countermeasures and suggestions	2018	The southern financial	51
Research progress of artificial intelligence technology in agriculture in the era of big data	2018	Journal of Jilin Agricultural University	47
Intelligent energy -- Application and prospect of artificial intelligence technology in power system	2018	Control and decision making	46

According to Table 5 and Table 6, it can be seen that among all the cited literatures, there are 2 literatures with the highest citation times of more than 100 times, and 6 literatures with more than 50 times; the download frequency of a single article exceeds 1 There is 1 document with 10,000 times, and 2 documents with a single download frequency of 5-10,000 times. The "Research Review of Artificial Intelligence Technology Development and Application" in "Coal Mining

Machinery" was published by Zhang Ni, Xu Wenshang and Wang Wenwen in 2009. The number of citations (170 times) and the number of downloads (19717 times) are both number one. In addition, most of the top 10 highly cited papers in AI technology research come from journalism and computer science.

## 4. Analysis of Hotspots in Artificial Intelligence Technology Research

Academic research hotspots refer to the topics discussed by a relatively large group of papers with internal connections within a certain period of time [43]. Keywords are an important part of academic papers, and the analysis of high-frequency keywords can track the research hotspots of the discipline [44]. In this paper, the knowledge map analysis of the keywords in the above two stages can be obtained, and the changes of research hotspots in the two stages can be obtained. Statistical analysis of the top keywords at this stage. The larger the font size of the keyword, the more frequently the keyword appears.

### 4.1 Exploratory Period (2006-2015)

In the initial exploration stage of artificial intelligence technology, there are two keywords that appear most frequently, namely "artificial intelligence" and "neural network" (Figure 3). The correlation between keywords is relatively small, and the research topics are relatively scattered.



Figure 3. Keyword Clustering Knowledge Graph 2006-2015

The research hotspots in 2015 mainly focus on "artificial intelligence", "neural network", "multi-agent system" and "expert system". Some scholars have studied the application of artificial intelligence technology in cyberspace security defense, reviewed the main applications and methods of artificial intelligence technology such as neural networks, analyzed the application characteristics of various technologies, and gave future research and development trends [45]. The research hotspots in the exploratory stage mainly focus on the two aspects of "artificial intelligence" and "neural network".

### 4.2 Development Period (2016-2021)

In the development stage of artificial intelligence technology, the keywords that appear the most are "artificial intelligence", "artificial intelligence technology" and "deep learning" (Figure 4). There is a keyword that is the same as the keyword in the previous stage, which proves the continuity of the research. At this stage, the links between

keywords are strengthened and the research topics are more concentrated.



Figure 4. Keyword Clustering Knowledge Graph 2016-2021

The research hotspots in 2021 mainly focus on "artificial intelligence", "artificial intelligence technology" and "deep learning". Some scholars have proposed a multimodal deep learning model to classify the subjects' behavioral fragments by studying the subjects' facial expressions, 3D body poses and other test information [46]. The research hotspots in the development stage mainly focus on "artificial intelligence", "artificial intelligence technology" and "deep learning". The research at this stage is not limited to artificial intelligence, but extends to the research of a new generation of artificial intelligence technology based on deep learning models. Both width and depth have been greatly expanded.

## 5. Research Gaps and Trends

The development of China's artificial intelligence technology field mostly relies on scientific research institutions and high-tech enterprises. The artificial intelligence market is concentrated at the application level. The deep learning theory is not perfect, the deep learning ability is insufficient, the talent pool of artificial intelligence is insufficient, and the basic technology and foundation are ignored. theory, will lead to technological development lagging behind foreign countries, which is not conducive to the rapid development of artificial intelligence. In the era of big data, machine learning faces serious privacy leakage problems. When people use artificial intelligence products, a large amount of private data is stored, uploaded or even leaked.

According to the research status and research hotspots of artificial intelligence technology, future research should focus on two aspects: "the integration and breakthrough of deep learning theory" and "the evolution of machine learning towards distributed privacy protection".

Deep learning has achieved good results in the application of artificial intelligence technology, but researchers are not particularly clear about the reasons why deep learning is better than traditional machine learning, and the theoretical foundation of deep learning is not very solid. With the development of artificial intelligence technology research from shallow to deep, the understanding of shallow networks and local properties continues to deepen towards deep networks and global properties, and further integration and breakthroughs in deep learning theory are required. question.

Machine learning is one of the important topics of artificial intelligence research and the way to realize artificial intelligence. In the past decade, artificial intelligence tools have received extensive attention from the literature and business circles, especially the development of machine learning techniques [47]. The realization of technologies such as natural language understanding and machine vision is inseparable from machine learning. In the era of big data, as the amount of data to be processed continues to increase, machine learning is very important in the application of intelligent analysis and processing of big data. Privacy in network data is also a constant concern. Data security is one of the factors affecting the usage rate of a certain technology, and data loss can be avoided with the help of cloud storage infrastructure [48]. Distributed privacy protection machine learning uses encryption, distributed storage and other methods to protect the input data of machine learning model training. It is a feasible solution to break through data silos and complete multi-institution joint training and modeling.

## 6. Analysis Conclusion

237 core journals published by CNKI from 2006 to 2021 as research data, and uses bibliometric analysis and Cite Space software to conduct statistical analysis of journal data. According to the frequency of occurrence of keywords in the literature and the clustering knowledge map, the research status and research hotspots of artificial intelligence technology are studied and analyzed. The main conclusions are as follows:

**Research status.** Artificial intelligence technology research is in a stage of rapid development. Since entering the development stage in 2016, more and more scholars have paid attention to artificial intelligence technology, academic achievements have increased exponentially, and research topics have been continuously expanded.

**Research institute.** Artificial intelligence technology research institutions are mainly from universities and research institutes across the country, and there is no obvious geographical concentration. A number of research networks have been formed among researchers, and the degree of cooperation between authors is relatively high. Now the proportion of documents with a single author is gradually increasing, and there are also more documents across institutions and regions.

**research quality.** Artificial intelligence technology is a research topic of concern in various fields, and scholars in these fields are actively promoting the changes in research hotspots of artificial intelligence technology. The high-cited and high-downloaded articles were mainly from core journals in these fields, but the high-cited and high-downloaded articles were relatively few.

**Research hotspots.** The research on artificial intelligence technology is divided into two stages according to the annual publication volume. From 2006 to 2015, the level of attention of artificial intelligence technology was not high, and the research topics were relatively scattered. The research hotspots mainly focus on the two aspects of "artificial intelligence" and "neural network". This stage belongs to the exploration stage of scholars in the field of artificial intelligence. From 2016 to 2021, the degree of attention of artificial intelligence technology continues to rise, and the research topics also continue to increase. The research

hotspots mainly focus on "artificial intelligence", "artificial intelligence technology" and "deep learning". The depth and breadth of research has been further improved.

**Research Trends.** In addition to "artificial intelligence" and "artificial intelligence technology", future research should also delve into deep learning and machine learning. Future research directions should focus on "integration and breakthrough of deep learning theory" and "the evolution of machine learning towards distributed privacy protection".

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