The Visualization Analysis of Artificial Intelligence Research in Recent 10 Years in China

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Abstract. Based on the research literature of artificial intelligence in 2010-2019 in CNKI database, this paper uses the econometric analysis method and CiteSpace software to draw the knowledge map and chart of literature distribution, authors, institutions, discipline distribution, keywords and other dimensions. The paper analyzes the current situation and process of artificial intelligence research in China in the past decade from the perspective of visualization, and abstracts six research topics of artificial intelligence.

1. Introduction

According to CNKI, the first artificial intelligence research document was published in the journal philosophy cluster translation in 1978. It has been 40 years since then. A number of researchers have summarized the research status of artificial intelligence, such as Wei Lv. With the rapid rise of artificial intelligence in recent three years, the research topic of artificial intelligence has changed. From the perspective of data visualization, this paper analyzes the current research situation in the field of artificial intelligence in China by means of econometric analysis and big data analysis technology.

2. Data sources

In CNKI database, this paper searches artificial intelligence research literature from 2010 to 2019 with Su = "artificial intelligence" as the search condition, and obtains 13265 literatures in total. The distribution of literature in each year is shown in Figure 1.
3. Research ideas and methods

3.1. Research ideas
This paper analyzes the research literature of artificial intelligence from 2010 to now by using the measurement method. The research dimensions include research team, research institution, research level, and research discipline. The paper uses CiteSpace software to draw keyword knowledge map based on all the research literature, and forms the research cluster of artificial intelligence. Finally, the paper summarizes the research topics and development trends in the field of artificial intelligence in China.

3.2. Research method

3.2.1. Knowledge map analysis. Mapping knowledge domain is a series of different graphs that show the relationship between the development process and structure of knowledge. It uses visualization technology to describe knowledge resources and their carriers, excavate, analyze, construct, draw, and display knowledge and their interrelations[1]. Knowledge map can reveal the general development of a field and discipline from macro, meso and micro levels. It enables people to comprehensively examine the structure and research hotspot of a discipline from various perspectives[2].

3.2.2. Co-word Analysis. Co-word analysis is a method of content analysis. It mainly analyzes the phenomenon that professional terms appear in a document together. These professional terms can express the research topic or research direction of a subject field. Then it can judge the relationship between subjects in the discipline field and show the research structure of the discipline[3]. The more frequently words appear in the same document, the closer the relationship between the two themes is[4].

4. Analysis on the research stage of artificial intelligence
The number of literature can reflect the heat and breadth of research topics. As can be seen from Figure 1, the development of artificial intelligence research in China is slow before 2014, with less than 200 annual research literatures. Since 2015, artificial intelligence has developed rapidly. In 2018, 4504 papers have been published, 34 times higher than that in 2010. It can be seen that artificial intelligence has been widely concerned. Therefore, the research of artificial intelligence in China has gone through two stages. The first stage is the exploration and development period before 2014. During this period, the development of artificial intelligence has experienced many twists and turns. 9 June 2014, General secretary Jinping Xi put forward that "Robot Revolution" is expected to become a breakthrough point and an important growth point of the third industrial revolution, which will affect the global manufacturing industry, and China will become the world's largest robot market[5]. Subsequently, the state issued "China made 2025", "Robot industry development plan (2016 to 2020)" and "'Internet +'
artificial intelligence three year action plan”. The government creates a good environment for the development of artificial intelligence in China. From 2015, China's artificial intelligence research has entered a rapid development stage.

5. An analysis of artificial intelligence research funding
Among the documents searched, some of them are supported by national and provincial funds. As shown in Figure 2. The top three funds for supporting literature are National Social Science Foundation (509 articles), National Natural Science Foundation (261 articles) and Ministry of Education Humanities and Social Science Research Fund (60 articles). There are 15 project funds supporting more than 10 documents. By comparing the total number of funded documents with the total number of retrieved documents, it is found that the number of funded documents is not enough.

6. Research level and discipline distribution of artificial intelligence
The research level of artificial intelligence literature is relatively concentrated. There are 3058 (23%) literatures belong to engineering technology level, 2152 (16%) literatures belong to basic research level, and 2004 (15%) literatures belong to industry guidance level, as shown in Figure 3.

By analyzing the subjects of artificial intelligence literature, it is found that control engineering (7015 papers), communication economy (1437 papers) and Computer Science (1280 papers) are the subjects with more literature distribution, and the number of literature in the three subjects accounts for 73% of the total literature. It can be seen that the research subjects of artificial intelligence are relatively concentrated, as shown in Figure 4.

7. Distribution of artificial intelligence research institutions
This paper uses CiteSpace to analyze the data of institution. In the CiteSpace software, we set the time from 2010 to 2019 in the “Time Slicing” function area, set the “Year Per Slice” to 1, select the “Institution” function in the "Node Types" function area, select the “Top 50 levels” in the “Selection Criteria” policy area, and other parameters default. Then form the research organization map as shown in Figure 5. It can be seen that the three research institutions with more publications are East China University of political science and Law (108 papers), Tsinghua University (101 papers) and Beijing Normal University (87 papers). Of all the research institutions, there are 37 institutions have published more than 30 articles, all of which are universities and research institutions.
Section 8. Analysis of artificial intelligence research authors

We use CiteSpace to analyze the author data. In the CiteSpace software, we set the time from 2010 to 2019 in the “Time Slicing” function area, set the “Year Per Slice” to 1, select the "Author" function in the "Node Types" function area, select the "Top 50 levels" in the "Selection Criteria" policy area, and other parameters default. Then form the research organization map as shown in Figure 5. It can be seen that there are 32 authors who have published more than 5 articles. Qiqi Gao (19 papers) and Xianquan Liu (19 papers) are the authors who have published a lot of literature. We find several research teams, such as Hong Zhang and Yunpeng Liu.

Section 9. Analysis on the research topic of artificial intelligence

9.1. Keywords analysis

High frequency keywords can reflect the research topic of a field. In this paper, we use bicom2 software to obtain 13512 keywords. The standard of high frequency words selection is that the cumulative frequency of high frequency words is about 40% of the total frequency[6]. Therefore, the article selects 52 high-frequency keywords with the word frequency threshold of 51, and the cumulative percentage of word frequency accounts for 40.0%, as shown in Table 1. It can be seen that the research on "artificial intelligence" is relatively extensive, with word frequency reaching 9562, accounting for 21.23% of the cumulative percentage of keyword word frequency. The second key word is "application", which shows that artificial intelligence pays more attention to application research. The related application fields include electrical automation, AI, education, financial accounting, mechanical and electronic engineering, etc. In addition, other high-frequency keywords include "artificial intelligence technology", "intelligent robot", "big data", "AI technology", "network technology" and "machine learning". These high-frequency keywords also represent the main research topics in the field of artificial intelligence.
Table 1. Artificial intelligence high frequency keywords with threshold of 51 (partial display).

| keywords                        | threshold | Percentage | Cumulative percentage |
|--------------------------------|-----------|------------|-----------------------|
| Artificial intelligence        | 9562      | 21.23      | 21.23                 |
| Application                    | 814       | 1.81       | 23.04                 |
| Artificial intelligence technology | 708      | 1.57       | 24.61                 |
| Intelligent robot              | 688       | 1.53       | 26.14                 |
| PLC                            | 485       | 1.08       | 27.22                 |
| Big data                       | 440       | 0.98       | 28.20                 |
| AI                             | 413       | 0.92       | 29.11                 |
| Network technique              | 365       | 0.81       | 29.92                 |
| Machine learning               | 336       | 0.75       | 30.67                 |
| Field of artificial intelligence | 326      | 0.72       | 31.39                 |
| Computer                       | 304       | 0.68       | 32.07                 |
| Deep learning                  | 240       | 0.53       | 32.60                 |
| Personnel training             | 208       | 0.46       | 33.06                 |
| Financial accounting           | 172       | 0.38       | 33.45                 |
| Neural network                 | 161       | 0.36       | 33.80                 |
| Human                          | 148       | 0.33       | 34.13                 |
| IOT                            | 114       | 0.25       | 34.39                 |
| Mechanical and Electronic Engineering | 111   | 0.25       | 34.63                 |
| Development                    | 109       | 0.24       | 34.87                 |
| Algorithm                      | 107       | 0.24       | 35.11                 |
| Computer network               | 104       | 0.23       | 35.34                 |
| Influence                      | 103       | 0.23       | 35.57                 |
| Library                        | 102       | 0.23       | 35.80                 |
| The State Council              | 99        | 0.22       | 36.02                 |
| Human intelligence             | 99        | 0.22       | 36.24                 |

9.2. High frequency keyword social network analysis

After extracting high-frequency keywords, BICOMB software is used to generate high-frequency keyword co-word matrix, as shown in Table 2. It can be seen that the co-occurrence frequency of artificial intelligence, intelligent robot, big data and other key words is high. In order to further analyze the logical relationship between the data, UCINET is used to generate a visualization map of social network relationship for high-frequency keywords, as shown in Figure 7, and then the following conclusions are drawn.

Table 2. Artificial intelligence high frequency keyword co-word matrix (partial display).

| Artificial intelligence | Application | Artificial intelligence technology | Intelligent robot | PLC | Big data |
|-------------------------|-------------|-----------------------------------|-------------------|-----|---------|
| Artificial intelligence | 9562        | 577                               | 18                | 651 | 314     |
| Application             | 577         | 814                               | 200               | 12  | 192     |
| Artificial intelligence technology | 18     | 200                               | 708               | 22  | 156     |
| Intelligent robot       | 651         | 12                                | 22                | 688 | 0       |
| PLC                     | 314         | 192                               | 156               | 0   | 485     |
| Big data                | 389         | 14                                | 23                | 17  | 1       |
9.2.1. The key word "artificial intelligence" is at the center of the research map, which is the core of the research category. Other key words have direct or indirect connection with "artificial intelligence".

9.2.2. This map forms a core area, with the key words of artificial intelligence, intelligent robot, machine learning, AI, artificial intelligence technology, deep learning, big data and computer in the core area. These keywords are basically consistent with the high-frequency keywords mentioned above, and also basically represent the main research topics of artificial intelligence research in China.

9.2.3. The key words "image recognition", "iFLYTEK", "expert system", "natural language processing", "speech recognition", "intelligent machine", "learning (Artificial Intelligence)" are at the edge of the relationship map. These key words have not been paid enough attention, but there is a lot of research space.

9.2.4. The connection and distance between keywords in the social network relationship map represent the closeness between keywords. It can be seen from Figure 7 that "artificial intelligence" is the core keyword as well as the search term. It is close to the three key words of "artificial intelligence technology", "big data" and "intelligent robot". It can be considered that the four key words are closely related.

9.3. Analysis and conclusion of high frequency keyword map
We use CiteSpace software to draw keywords knowledge map. In the CiteSpace software, we set the time from 2010 to 2019 in the “Time Slicing” function area, set the “Year Per Slice” to 1, select the "keyword " function in the "Node Types" function area, select the "Top 50 levels" in the "Selection Criteria" policy area, and other parameters default. CiteSpace uses TF * IDF weighting algorithm to automatically cluster and visualize, and obtains the keyword co-occurrence map as shown in Figure 8. The modularity value of the map (Q value for short) is 0.5665 > 0.3 (Q value > 0.3 means that the structure of the map is significant), and the mean contour value of the map (S value for short) is 0.5585 > 0.5 (S value > 0.5 means that the clustering is reasonable), so the map is effective. It can be seen that the research of artificial intelligence in China mainly forms 8 clustering maps. After the merging of similar clusters, this paper proposes 6 main research topics of artificial intelligence research in China.
9.3.1. The application of artificial intelligence in various fields. This topic corresponds to two clusters of "Application Research" and "management accounting", represented by high-frequency keywords such as "application", "computer", "electrical automation", "mechanical and electronic engineering", "financial accounting" and "law". This topic analyzes the role of artificial intelligence in the transformation of various fields and promotes the transformation of various fields, especially in accounting, machinery, electrical and other intelligent manufacturing fields. At present, the mature artificial intelligence industry includes pattern recognition (gait recognition, identity recognition, etc.), speech recognition (smart home, smart car, etc.), expert system (intelligent robot, intelligent driving, etc.), human-computer game (online game, etc.). There are artificial intelligence applications in management accounting, legal consulting, modern medicine, e-commerce shopping guide and other fields.

9.3.2. The study of alphago and Shishi Li. This cluster mainly studies the results of alphago and Shishi Li competition. The research contents include alphago algorithm, machine learning technology, deep reinforcement learning and the Enlightenment of alphago to the development of artificial intelligence in various fields.

9.3.3. Research on the challenge and opportunity of artificial intelligence to real economy. This topic is proposed for clustering "#2 real economy". In the short term, artificial intelligence will first bring impact and challenges to the real economy, but in the long term, AI will promote economic growth and social welfare, resulting in intelligent economy, digital economy, etc. Qingqing Cheng put forward the way to integrate artificial intelligence and real economy, that is, to widely apply artificial intelligence equipment to all industries of real economy, widely apply artificial intelligence technology to all links of real economy, so as to realize the intelligence of real economy[7]. The research purpose of this clustering is to promote the transformation of the real economy with the aid of artificial intelligence technology, promote the linkage development of big data, artificial intelligence and the real economy, and realize the "unmanned operation" mode.

9.3.4. The study on the reference of artificial intelligence research in the United States and other countries. This topic corresponds to the cluster "#3 the United States". This clustering mainly refers to the experience of artificial intelligence research in the United States and other countries, and analyzes...
the current situation of artificial intelligence research in the world. Zhiming Yan analyzed the reports of "preparing for the future of artificial intelligence" and "national strategic plan for artificial intelligence research and development". On this basis, he expounded the connotation, key technology and application trend of educational artificial intelligence (EAI)[8]. Based on the analysis of artificial intelligence reports such as "preparing for the future of artificial intelligence" in the United States, Wei Hu proposed that the direction of education reform is to cultivate the labor force needed in the era of artificial intelligence[9]. In addition, Shuwang Zhao, Tianchi Lu, etc. elaborated the research of artificial intelligence in American publishing, journalism, intelligence, criminal law, national defense.

9.3.5. Research on artificial intelligence in planning of various fields. This topic is derived from the clustering "#4 planning". The research contents mainly include the application of artificial intelligence in urban planning, power grid planning, publishing planning, aerospace planning, and the development planning of artificial intelligence itself. Managers use big data analysis technology of artificial intelligence to find business rules by analyzing current data, which is the basis of planning and decision-making.

9.3.6. Research on Artificial Intelligence Education. This topic corresponds to two clusters of "#6 intelligent science and technology" and "#7 teaching reform". The core keywords include "deep learning", "machine learning", "expert system", "AR technology", "VR technology", "personnel training", "artificial intelligence education", "teaching reform", "intelligent science and technology", etc. The research content includes two aspects: first, take artificial intelligence as a means to carry out the research of artificial intelligence and learning; second, take artificial intelligence as a content to carry out the research of artificial intelligence education. China's high-end IT enterprises have set up research institutions centered on artificial intelligence technology, such as Huawei Noah Ark laboratory, Baidu deep learning research, etc.

10. Analysis of burst term in artificial intelligence research

Burst terms are one or more high-frequency keywords, which represent the new research direction in this field and may be a new potential research cluster. Therefore, extracting emergent words can predict the research direction of artificial intelligence. Based on the key words knowledge map in Figure 3, this paper extracts the burst terms by comparing the centrality (the position of key words in the key words map network) and burst value, as shown in Table 4. It can be predicted that the research on the relationship between artificial intelligence and human beings, the application of artificial intelligence in various fields and the research on artificial intelligence expert system will become new research direction.
Table 3. Keywords with the strongest citation bursts (partial display).

| Keywords                | Year | Strength | Begin | End   | 2010 - 2019 |
|-------------------------|------|----------|-------|-------|-------------|
| bilingual education     | 2010 | 3.295    | 2010  | 2012  |             |
| Power System            | 2010 | 5.876    | 2010  | 2015  |             |
| data mining             | 2010 | 9.406    | 2010  | 2015  |             |
| genetic algorithm       | 2010 | 16.477   | 2010  | 2015  |             |
| expert system           | 2010 | 22.024   | 2010  | 2015  |             |
| curriculum construction | 2010 | 3.954    | 2010  | 2012  |             |
| knowledge base          | 2010 | 2.936    | 2010  | 2015  |             |
| fault diagnosis         | 2010 | 9.994    | 2010  | 2015  |             |
| teaching reform         | 2010 | 9.409    | 2010  | 2014  |             |
| neural network          | 2010 | 14.833   | 2010  | 2015  |             |
| postgraduate teaching   | 2010 | 2.681    | 2011  | 2012  |             |
| application field       | 2010 | 2.681    | 2011  | 2012  |             |
| CAI                     | 2010 | 2.681    | 2011  | 2012  |             |
| practice teaching       | 2010 | 2.681    | 2011  | 2012  |             |
| PLC                     | 2010 | 13.861   | 2011  | 2015  |             |
| artificial neural network| 2010| 8.390    | 2011  | 2015  |             |

Table 4. Ranking of burst value of high frequency keywords.

| Keywords    | Burst | Frequency | centrality | Year |
|-------------|-------|-----------|-------------|------|
| human       | 52.99 | 141       | 0.08        | 2015 |
| field       | 32.76 | 105       | 0.06        | 2015 |
| expert system| 22.02 | 68        | 0.09        | 2010 |
| industry    | 21.39 | 61        | 0.04        | 2015 |

11. Analysis of the research process of artificial intelligence

The Timeline view of CiteSpace software knowledge map can show the development process of keyword clustering, as shown in Figure 9. Clustering "#0 application research”, "#2 real economy" and "#5 management accounting” run through the starting and ending time of literature retrieval (from 2010 to 2019). These three research clusters have strong development momentum, and may continue to develop, and become the main research topics of artificial intelligence in the future. Clustering "#1 Shishi Li” started in 2010, but ended in 2016, indicating that the research on "Shi shi Li and alphago” gradually weakened after 2016.
Figure 9. Timeline view of artificial intelligence keyword map.

The connection between clusters reflects the close relationship between clusters. From figure 8, it can be seen that there are many connections between cluster "#0 application research" and other clusters, indicating that cluster "#0 application research" is the main research cluster of artificial intelligence research system, and its research process is synchronous and staggered with other clusters or themes.

As shown in Table 3, in the research process of artificial intelligence, new keywords with high salience value are constantly emerging, such as "human", "industry" and other keywords in 2015, with high burst value, which will also be recorded in the research process of artificial intelligence.

12. summary
This paper analyzes the development trace of artificial intelligence in China in the past ten years through the research of data visualization from many angles, such as the author and cooperative organization of artificial intelligence research. Since 2015, artificial intelligence has developed rapidly and has become the productivity of various industries, playing an important role in financial accounting, real economy and new industries. Based on the analysis of keyword knowledge map, this paper summarizes six research topics of artificial intelligence. Based on the above research conclusions and related research results, this paper puts forward two thoughts.

12.1. We should strengthen the integration of artificial intelligence and education.
As shown in Figure 9, the time line of clustering "Chen 7 teaching reform" stopped in 2014, which is not conducive to the cultivation of artificial intelligence talents. The lack of artificial intelligence talents will inevitably lead to slow development of other research clusters. Therefore, the cluster "Chen 7 teaching reform" still needs to continue to develop. We should vigorously develop artificial intelligence education, develop artificial intelligence teaching courses, and serve the "artificial intelligence +" strategy of various industries. Artificial intelligence can promote the transformation of education, but its strength is not enough. We should introduce the elements of artificial intelligence into the teaching concept, teaching content, teaching method, teaching mode and teaching assessment, so as to train the excellent talents in line with the future industry.

12.2. Develop artificial intelligence standards.
Hawking said: the all-round development of artificial intelligence may lead to the extinction of human beings[10]. The state highly supports the development of artificial intelligence, but also restricts its products. Without standards, it will inevitably lead to product flooding and affect human health and survival. Benign artificial intelligence products contribute to the formation of artificial intelligence culture.
References

[1] Chen, Y., Liu, Z.R. (2005) The rise of mapping knowledge domain. Scientific Research, 23: 149-154.

[2] Ren, H.J., Zhang, Z.Q. (2009) Research on the development of scientific knowledge map based on Bibliometrics. Journal of Information, 12: 86-90.

[3] Zhang, Q., Ma, F.C. (2007) Research paradigm of knowledge management in foreign countries- Using coinage analysis. Journal of Management Sciences in China, 6: 65-66.

[4] Zhong, W.J., Li, J., Yang, X.J. (2008) Research on the method of CO word analysis (3) - the principle and characteristics of the method of CO word cluster analysis. Journal of Information, 7: 118-120.

[5] CNTV. (2014) Speech by Xi Jinping at the 17th academician conference of the Chinese Academy of Sciences and the 12th academician conference of the Chinese Academy of Engineering. http://news.cntv.cn/2014/06/09/ARTI1402316419354858.shtml.

[6] Chen, Y.L. (2012) The historical evolution of the main research fields of educational technology in China-clustering analysis of key words and subject words based on CNKI. E-education Research, 8: 36-42.

[7] Cheng, Q.Q. (2018) Research on the integration path of artificial intelligence and real economy. Journal of Beijing Institute of Economics and Management, 4: 3-9.

[8] Yan, Z.M., Tang, X.X., Qin, X., Zhang, F., Duan, Y.M. (2017) The connotation, key technology and application trend of EAI- analysis of the report "Prepare for the future of AI" and "National AI research and development strategic plan" in the United States. Journal of Distance Education, 1: 26-35.

[9] Hu, W. (2019) Education reform in the age of artificial intelligence: background, direction and path-analysis based on American AI report. Modern Educational Technology, 7: 12-17.

[10] CYOL. (2014) Artificial intelligence may cause human extinction. http://zqb.cyol.com/html/2014-12/04/nw.D110000zgqnb_20141204_2-04.htm.