# Artificial Intelligence-Enabled Social Science: A Bibliometric Analysis

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**Abstract**

Artificial intelligence (AI)-driven big data analysis, algorithms and computing power introduce new thinking models and decision-making methods for social science research, reconfigure the research paradigm, and thus enhance the depth and breadth of understanding of social phenomena and the laws of social development, offer better solutions to many social problems, and drive the transformation and upgrading of society, economy and culture. This paper uses Scopus and Web of Science (WOS) databases as data sources, and employs bibliometric methods and knowledge graphs to visualize the distribution of research power, author collaboration networks, keyword co-occurrence networks, and research performance to demonstrate the current research prospects and future research directions of AI-enabled social sciences. The results show that:(1) the United States and China are the countries that use AI the most for social science research. Closer academic collaboration networks have formed between European countries such as Germany, Italy, and the Netherlands, and Asian countries such as India, Iran, Turkey, South Korea, and Malaysia, respectively; (2) AI-enabled social science research is currently booming with high research prestige, and the main research themes include various AI algorithms for prediction, optimization, classification, decision support, risk assessment, semantic analysis of social networks, sentiment recognition, smart cities, Industry 4.0, innovation, automation, trustworthiness, and ethics; (3) Research hotspots focus on big data and services, AI ethics, privacy issues in medical big data, electronic health records, medical AI, data-intensive machine learning methods for brain disorders, machine learning for clinical psychology and psychiatry, machine learning for user experience, financial and stock market analysis and prediction, tourism prediction, load time series prediction, energy and power demand prediction for smart grid, wind speed prediction, supply chain and collision prediction, AI in agriculture, industrial internet and digital twin. This study will contribute to the digital transformation of the social sciences and inform future research.

***Keywords:*** *social science; artificial intelligence; bibliometrics; interdisciplinary; knowledge graph*

## 1 INTRODUCTION

Computer science interacts extensively with a wide range of disciplines, and its knowledge structure spans many disciplines in both the natural and social sciences. Machine learning and data science, built on computer science and statistics, are becoming major subject areas driving industrial and scientific innovation by exporting knowledge to other research areas[1], [2].

Artificial intelligence, as a subfield of applied computer science, exhibits powerful learning, reasoning and planning capabilities, and is a strategic technology leading the new round of global technological revolution and industrial change and a core technology element for strengthening national strategic scientific and technological power. Many countries have taken the development of artificial intelligence as a major strategy to enhance national competitiveness and maintain national security [3]. Deep learning, a revolutionary machine learning technique, led the explosive growth of research in artificial intelligence after 2015, transforming the first generation of AI represented by expert systems to the second generation of AI represented by statistical machine learning [4]. Artificial intelligence is widely used in key decision-making in many research areas and has formed disciplinary clusters with tight knowledge flows [5]. Artificial intelligence is accelerating cross-fertilization within many social science fields such as ethics, law, psychology, economics, management, and education. By developing new knowledge through


B. Fox et al. (Eds.): IC-ICAIE 2022, AHCS 9, pp. 1602-1608, 2023.
https://doi.org/10.2991/978-94-6463-040-4_242

research that integrates multidisciplinary skills and perspectives, it will greatly contribute to the development of social sciences [6]. Artificial intelligence-driven big data analysis and mining, intelligent algorithms and super computing power will introduce new modes of thinking and decision-making methods for social science research, reconstruct the research paradigm of social science, thus enhancing the depth and breadth of understanding of social phenomena and social development laws, offering better solutions to many social problems, and driving the transformation and upgrading of society, economy and culture.

Although the development of artificial intelligence is rapidly changing, its application in the social sciences is still at a relatively elementary stage. This paper analyzes the research power, author collaboration network, author keyword co-occurrence network, and research performance from the perspective of cross-fertilization development between social sciences and AI, using Scopus and WOS databases as data sources, and applying bibliometrics and knowledge graphs to demonstrate current research trends and future research directions.

## 2 METHODS AND RESULTS

Bibliometrics allows the description, evaluation and prediction of the current status and trends of science and technology. In this study, the technical characteristics of various algorithms and models of artificial intelligence were decomposed to obtain a wide range of artificial intelligence search terms and to form a search formula ("artificial intelligence" OR "strong AI" OR "weak AI" OR "knowledge engineering" OR "natural language processing" OR "knowledge graphs" OR "evolutionary algorithms" OR "unsupervised learning" OR "supervised learning" OR "machine perception" OR "affective computing" OR "reinforcement learning" OR "deep learning" OR "artificial neural networks" OR "deep neural network" OR "convolutional neural network" OR "multi-layer neural network" OR "multilayer neural network" OR "artificial neural network" OR "spiking neural network" OR "recurrent neural network" OR "graph neural networks" OR "deconvolutional neural network" OR "feedforward neural network" OR "capsule neural networks" OR "CapsNet" OR "recursive neural network" OR "feed-forward neural network" OR "deep structured learning" OR "deep Q-learning" OR "deep recurrent Q-learning" OR "deep networks" OR "convolutional generative adversarial network" OR "deep belief network" OR "Bayesian network" OR "Bayes network" OR "hierarchical temporal memory" OR "spiking neural P systems" OR "deep residual networks" OR "boltzmann machines" OR "deep generative model" OR "deep extreme learning" OR "deconvolutional neural network" OR "representation learning" OR "deep feature learning" OR "stacked denoising autoencoders" OR "stacked autoencoders" OR "stacked auto-encoders" OR "generative adversarial networks" OR "multilayer perceptron" OR "generative adversarial networks" OR "long short-term memory" OR "auto-encoder" OR "autoencoder"). The search results were limited to the subject category of "social sciences", and the results were used for subsequent bibliometric studies.

The time limit was 2016-present, and the final dataset of 38,794 documents was obtained after de-duplication and denoising, and then imported into VOSviewer for visualization and analysis (the final retrieval date was March 1, 2022).

This study combines bibliometric analysis using SciVal, a next-generation research analysis management tool from Elsevier that uses Scopus, the world's largest abstract and citation database, as the basis for integrating research data, information technology, metrics, and visualization. VOSviewer is a free JAVA-based scientific knowledge mapping software developed by van Eck and Waltman of The Centre for Science and Technology Studies at Leiden University in 2009. It is based on the core idea of "co-occurrence clustering", which enables the mapping of scientific knowledge through the structural, evolutionary, and collaborative relationships of knowledge domains [7].

## 3 RESULTS AND DESCUSSION

### 3.1 *Global research hotspots in AI-enabled social science*

As cutting-edge research continues to break through the confines of a single discipline, interdisciplinary studies are more likely to yield creative results due to their ability to provide a more diverse theoretical foundation and perspective. The word cloud in Figure 1 was extracted using SciVal's Elsevier Fingerprint Engine. This technique uses text mining and natural language processing techniques to extract important keywords from the titles, abstracts, and author keywords of publications in the domain. Each keyword is assigned a relevance between 0 and 1, where the most frequent keywords are assigned as 1. The results are ranked in order of significance. Figure 1 shows that in the social sciences, the main AI algorithms include deep learning (such as Convolutional Neural Network, Deep Neural Network, Artificial Neural Network, Recurrent Neural Network, Long Short-term Memory, Bayesian Networks), reinforcement learning (RL), fuzzy logic, and knowledge graph. The main applications include computational linguistics, natural language processing, sentiment analysis, smart cities, intelligent vehicle highway systems, learning, word processing, topics of interest include prediction, optimization, classification, decision aids, risk assessment, semantic analysis of social networks, sentiment recognition, smart cities, industry 4.0, innovation, automation, trustworthiness, and ethics.

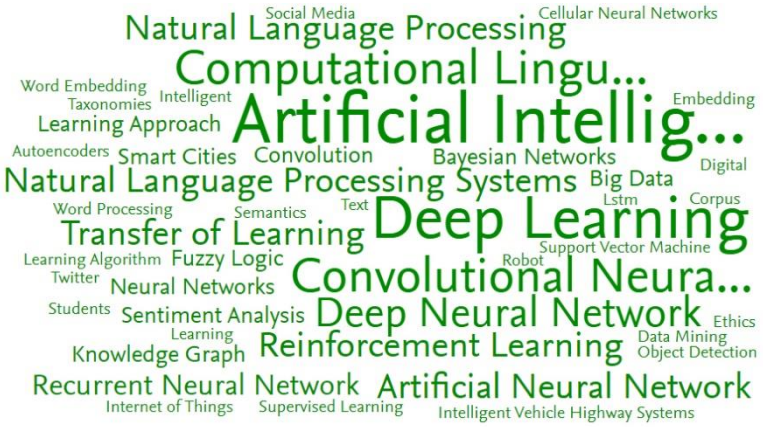


Figure 1 Word cloud of AI-enabled social science publications

Based on the citation network analysis of more than 1966 papers with >20 citations in WOS, 923 of which are closely related to each other, we further mapped a citation network graph (Figure 2) and an author keywords network graph (Figure 3) from which the evolutionary timeline of research hotspots in this field can be observed. Among the AI-enabled social science citation network, the red one in the middle is the most important one, and its topics include big data and services. Associated with it is the yellow section on the right, with topics of AI ethics, privacy issues of medical big data. The bottom left orange section is about electronic health records and medical artificial intelligence. The upper right pink section has topics of data-intensive machine learning approaches to brain disorders, machine learning approaches to clinical psychology and psychiatry. The upper purple section has the topic of research directions in artificial intelligence, on how to think like a human. The topic in the magenta section on the right is machine learning for user experience. The topic in the lower right blue section is financial and stock market analysis and forecasting uses. Related topics also include travel forecasting, load time series forecasting, energy and power demand forecasting for smart grids, and wind speed forecasting. The bottom left beige section is supply chain and collision forecasting. The topics in light blue at the bottom center are AI related research in agriculture, industrial internet and digital twin.

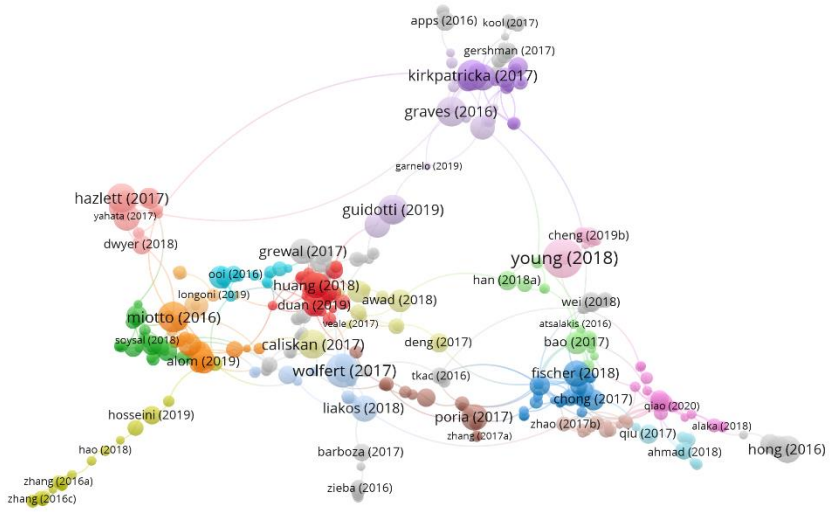


Figure 2 Citation network visualization of AI-enabled social science

## 3.2 *Status of global academic output*

The academic output indicates the annual number of publications in the research area, which showed a significant increase in consecutive years from 2016-2021, with a total of 31586 publications, from 2129 in 2016 to 8421 in 2021, and an increase in the number of authors from 6066 to 27020. The FWCI reached 1.98, indicating that the academic performance in this area is higher than the world average by 198%.

TABLE 1. Global Overview of Academic Performance

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|
| Publications | 2129 | 2486 | 4015 | 6725 | 7810 | 8421 |
| Citations | 51280 | 54745 | 58737 | 68004 | 37625 | 12164 |
| FWCI | 2.19 | 2.47 | 2.3 | 2.35 | 1.7 | 1.58 |
| Authors | 6066 | 7041 | 11766 | 20587 | 24025 | 27020 |

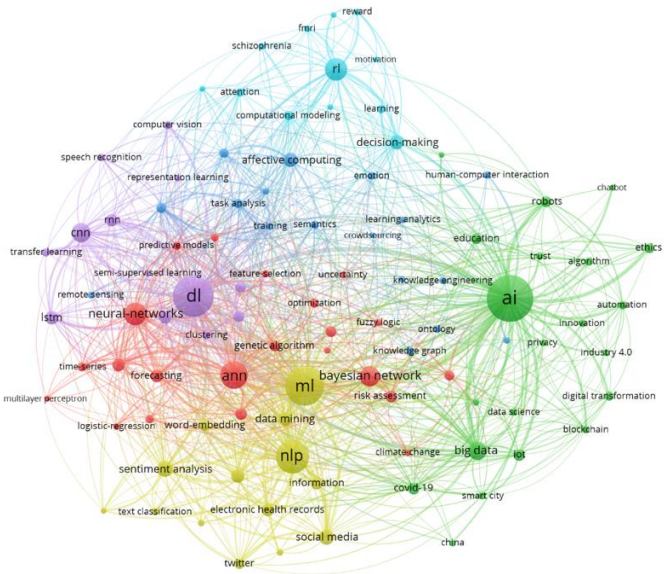


Figure 3 Author keywords network visualization of AI-enabled social science

### 3.3 *Impact of international collaboration on research performance*

International collaborations, which account for 18.1% of global research, have an FWCI of 2.09, compared to 1.4 for national collaborations and 1.31 for institutional publications. The FWCI for single authors is the lowest at 1.06 (Table 2). It is evident that international collaboration has greatly enhanced research performance.

TABLE 2. Global Collaboration and Academic Performance

| Collaboration | Share | Publications | Citation | FWCI |
|---|---|---|---|---|
| International | 18.1% | 4934 | 56849 | 2.09 |
| Only national | 28.8% | 7878 | 56196 | 1.4 |
| Only institutional | 45.9% | 12552 | 74264 | 1.31 |
| Single authorship | 7.2% | 1958 | 6913 | 1.06 |

### 3.4 *Global research geographical distribution and collaboration network*

In analyzing the overall landscape of AI-enabled social science research, The U.S. has 6320 publications, with an FWCI of 3.16, the best of all. China has 6168 publications, while the FWCI of only 1.58. India and the U.K. have more than 2000 publications, with an FWCI of 3.15. Germany, Canada, and Spain have more than 1000 publications. Based on the FWCI, the U.S., Europe and Australia have the highest academic performance.

International collaboration may significantly enhance research performance, and therefore it is necessary to analyze international research collaboration networks. As shown in Figure 4, several global research collaboration networks have been formed, which are I. the U.S., U.K. and Germany; II. China, India, South Korea, Spain, Brazil, Greece, Poland, Saudi Arabia; III. Canada, Netherlands, Japan, Italy, Switzerland.

TABLE 3. Ranking of Countries in AI-enabled social science

| Country | Publications | Citations | FWCI | International Collaboration |
|---|---|---|---|---|
| U.S. | 6320 | 103808 | 3.16 | 35 |
| China | 6168 | 48221 | 1.58 | 26.7 |
| India | 2516 | 13065 | 1.67 | 16 |
| U.K. | 2177 | 31962 | 3.15 | 51.5 |
| Germany | 1550 | 14078 | 2.25 | 37.9 |
| Canada | 1167 | 18782 | 2.86 | 50.4 |
| Spain | 1024 | 9686 | 1.85 | 37.3 |
| Australia | 986 | 11548 | 3 | 53.8 |
| Italy | 972 | 6857 | 1.91 | 39.4 |
| Japan | 883 | 6809 | 1.82 | 37.4 |

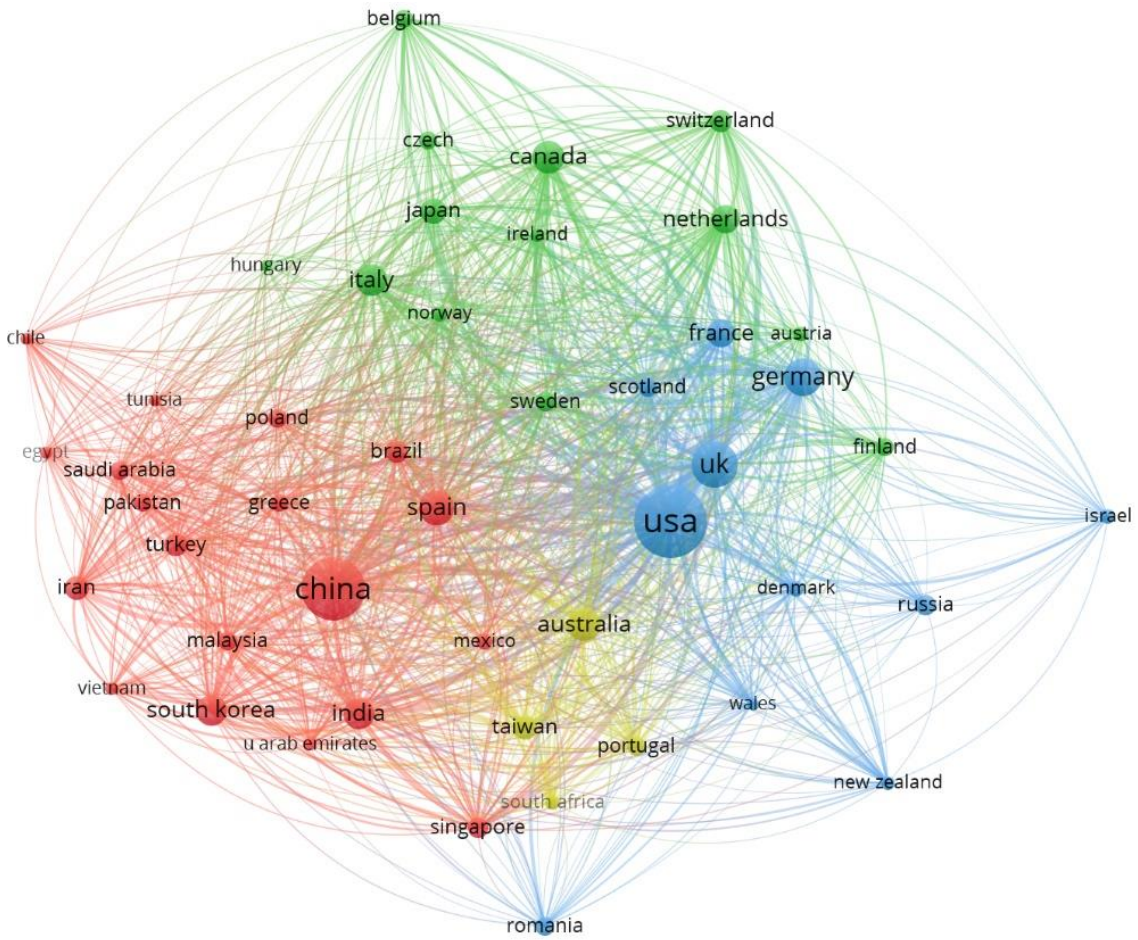


Figure 4 Global collaboration network in AI-enabled social science

### 3.5 *Analysis of global publication journals sources*

The most influential sources of AI-enabled social science are published in such conferences as 4th International Conference on Learning Representations, ICLR 2016 - Conference Track Proceedings (51 papers, FWCI=18.05), NAACL HLT 2019 - 2019 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies - Proceedings of the Conference (109, 16.38), 5th International Conference on Learning

Representations, ICLR 2017 - Conference Track Proceedings (139, 16.19), 6th International Conference on Learning Representations, ICLR 2018 - Conference Track Proceedings (197, 10.95) , and 2021 IEEE Spoken Language Technology Workshop, SLT 2021 - Proceedings (68, 7.06). Top journal sources include International Journal of Information Management (56, 16.19), Artificial Intelligence Review (240, 9.41), Artificial Intelligence (116, 8.58), Computers and Security (161, 5.42).

## 4 CONCLUSION

In conclusion, the main points of AI-enabled social science researches are as follows: (1) to consider the conceptual changes brought by the introduction of digital technology to social science research; (2) to focus on the development opportunities brought by digital technology and methods to social science research and the construction of platforms for the interpretation and knowledge discovery of various social phenomena in the social science field; (3) Focus on the construction of digital ecosystem in social sciences, and promote the digital development of data research in social sciences with systematic services. Through the cross-fertilization of multiple disciplines to develop new knowledge, AI will greatly contribute to the leapfrog development of social sciences, and has important practical significance and application prospects for promoting harmonious social governance and high-quality economic development.

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