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Research Frontiers and Trends of Generative Artificial Intelligence Research—Based on CiteSpace Knowledge Graph Measurement Analysis

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Abstract: *Generative artificial intelligence (Gen AI) represents a pivotal branch within AI development, demonstrating remarkable advancements in content generation and emerging as a new form of productive forces in the contemporary era. To gain a comprehensive understanding of the evolutionary trajectory and research progress within this field, a quantitative analysis was conducted on literature concerning Gen AI published between 2017and 2024within the CNKI and Web of Science(WOS) core databases. Using CiteSpace software, this study generated knowledge graphs including keyword networks and keyword chronograms and other knowledge maps. Visualisation, statistical analysis, and content analysis were conducted across research status, hotspots, publication volume, national distribution, and research institutions. Findings indicate that research on Gen AI entered an explosive phase in 2022, primarily focusing on ethical risks, education, and governance. Future research trajectories will evolve with technological advancements and policy shifts, progressing from theoretical exploration towards practical implementation.*

Keywords: *generative artificial intelligence, research hotspot, knowledge map, quantitative analysis*

1. Introduction

The rapid advancement of Gen AI, exemplified by ChatGPT, has enabled breakthroughs in generating text, images, audio, and video. In 2022, a white paper on AI-generated content noted that this field has been accelerating since the 2020s. Early demonstrations—such as Microsoft Xiaobing's poetry collection, NVIDIA's StyleGAN for photorealistic images, DeepMind's DVD-GAN for continuous video, and OpenAI's DALL-E 2 for user-driven art[1]—highlighted AI's creative potential. After ChatGPT, Gen AI entered the public eye as a powerful NLP tool, ushering in a new era of human-AI collaboration.

Existing literature often examines Gen AI from a single disciplinary perspective. For instance, Noy and Zhang demonstrated productivity gains in manufacturing[2].Mariamu addressed data training and privacy protection[3]. Wenbin et al. discussed human-machine collaborative learning in education[4]. Others used knowledge mapping to analyze research hotspots, such as Liu et al. on ChatGPT[5] and Wang et al. on domestic ChatGPT research[6].

However, a systematic synthesis of research hotspots and development trends in Gen AI is still lacking. As AI technology evolves, Gen AI is becoming a key driver of innovation, yet how to scientifically map its application domains and future paths remains an open academic question.This study employs bibliometric analysis and CiteSpace visualization to conduct a multidimensional review of Gen AI literature. The objectives are: (1) to reveal the current status and hotspot distribution both domestically and internationally, (2) to trace the evolution path and development trends, and (3) to predict future research directions, thereby providing theoretical guidance for academia and industry.

2. Data sources and methods

2.1 Data sources

The data sources of this study include the Chinese literature of China Knowledge Network, and the English literature of Web of Science core database, searching the literature from 2017 to 2024, and searching the Chinese literature with the theme of "Generative artificial intelligence", and the English literature with the theme of "Generative artificial intelligence" or "Generative AI" or "GenAI" or

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"GAI".Through the systematic screening of literature abstracts and removal of notices, statements and other invalid literature, we finally obtained 3703 related documents, including 1760 Chinese papers and 1943 English papers.

2.2 Methods

This study integrates statistical analysis, content analysis, and scientific knowledge mapping techniques from bibliometrics to establish a comprehensive bibliometric research framework. This methodological system has been widely validated in existing research. For instance, Luo et al. adopted bibliometric methods combined with knowledge mapping to investigate international research on teachers' artificial intelligence literacy based on the Web of Science Core Collection[7]. Li et al. utilised knowledge mapping to explore postural control in Parkinson's disease[8]. Zhu et al. performed a bibliometric analysis of artificial intelligence literature using the CSSCI database[9].In summary, this paper employs bibliometric analysis combined with CiteSpace software to conduct a visual analysis of research hotspots and trends in Gen AI, alongside deep mining of literature information.

3. Research network

3.1 Evolutionary pattern of the number of publications

3.1.1 Evolutionary pattern of the number of publications in the English-language literature

Gen AI as a disruptive innovative technology has been widely noticed and discussed in the international arena, through the publication time of the journal literature obtained from the WOS core database, we get the number and trend of the database's publications in the field of Gen AI from 2017-2024, as shown in Figure 1, the number of publications has been increasing year by year, especially after the release of ChatGPT in 2022, the research interest in Gen AI surged and the number of publications grew rapidly.

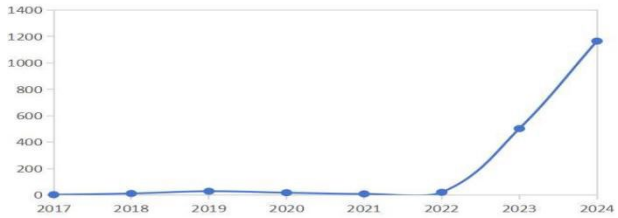


Figure 1: Publication timeline of WOS on Gen AI

3.1.2 Evolutionary pattern of the number of articles published in Chinese literature

Gen AI is an important branch in the field of artificial intelligence, the Chinese government wrote artificial intelligence into the work report, and the Chinese artificial intelligence industry continues to develop[10]. For the journal literature on Gen AI exported from CNKI, statistics such as shown in Figure 2, the publication from 2017 to 2024 was relatively flat, and academic attention to Gen AI was limited during this period.From 2022 to 2024, driven by the academic community's growing enthusiasm and investment in this technical field, the volume of published papers increased substantially.

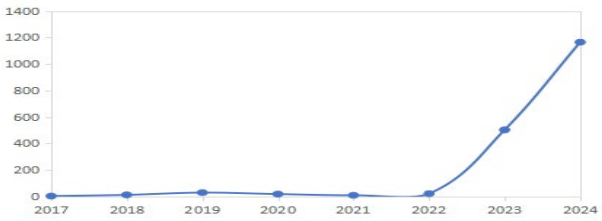


Figure 2: Publication timeline of CNKI on Gen AI

3.2 Analysis of information on countries and regions

International cooperation is a key factor for the smooth operation of the global industrial system and an important way for professionals from different countries or regions to interact with resources. By

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analysing the screened English literature, the clustering and depth of cooperation in the field of Gen AI in different countries or regions are revealed, and the development trend of international research cooperation is shown, which can help to understand the cooperation mode on a global scale, and to promote international exchange and cooperation.

Table 1: Top 5 countries in GAI

No.	Country	Center	Count
1	United States of America	0.1	605
2	China	0.05	518
3	England	0.06	157
4	South Korea	0.04	154
5	Germany	0.11	111

Data from Table 1 show global wide-ranging Gen AI research involving numerous nations, with tight scientific and technological cooperation among developed economies. The US and China take the top two positions in publication volume with a narrow gap, demonstrating both nations' vigorous advancement of Gen AI research. Nevertheless, China holds low centrality in the international cooperation network of this field, which means that deeper global research partnerships are required to improve its research quality and facilitate innovative breakthroughs. As major economic and tech innovation hubs, the US and China possess sufficient resources and strengths to drive Gen AI R&D. Meanwhile, countries including Venezuela and Uzbekistan have merely one relevant publication, revealing the uneven national development of Gen AI that is closely tied to each country's political, economic and cultural conditions.

3.3 Analysis of information from research institutes

3.3.1 Analyses by international research institutes

English literature data was used to draw the knowledge map of international research institutions, as shown in Figure 3.

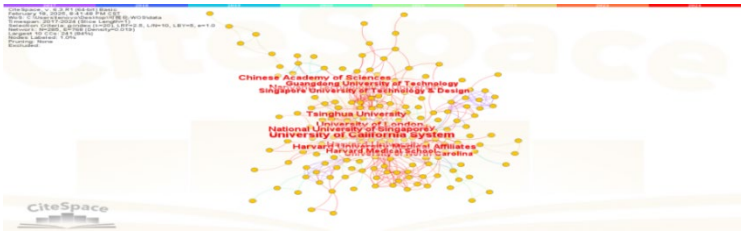


Figure 3: Knowledge map of international research institutions

Figure 3 illustrate that Gen AI research is primarily undertaken by universities, research institutes and national governmental agencies. Inter-institutional and interdisciplinary collaborations feature disciplinary integration, resource pooling and policy backing, laying solid foundations for technological advancement and practical deployment. Evidence from the WOS core database reveals multiple influential collaborative clusters worldwide. Core nodes such as the University of California system, Harvard University, Nanyang Technological University and the Chinese Academy of Sciences constitute close-knit research partnerships.Such intensive collaborative innovation ecosystems facilitate knowledge exchange, rational resource allocation and the fast evolution of Gen AI research.

3.3.2 Analyses by domestic research institutions

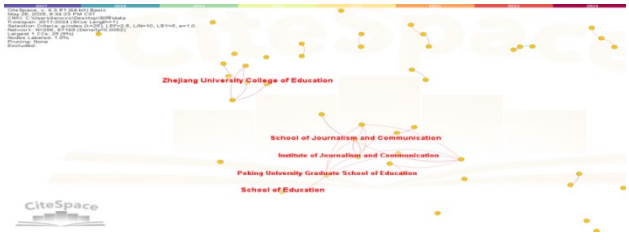


Figure 4: Knowledge map of domestic research organisations

A comparative analysis of domestic research institutions focusing on Gen AI helps track research progress in this field, facilitates academic exchanges, and provides vital reference for policymakers,

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researchers and research institutes. Figure 4 shows a visual network analysis map of domestic research institutions.

A comparison of the visual network analyses for domestic and international research institutions (Figure 3 and Figure 4) shows that international research institutions have formed a dense cooperation network, which is closely connected and shows strong collaborative innovation characteristics.In contrast, domestic research institutions are scattered, and there is an obvious tendency of fragmented research cooperation between institutions. This difference reflects that China's research collaboration mechanism in the field of Gen AI needs to be improved. In order to enhance research effectiveness and promote technological innovation, domestic research institutions should strengthen cooperation and accelerate China's technological breakthroughs and innovative development in this field by enhancing research synergy.

4. Research Hotspots and Evolutionary Analysis

4.1 Research Hotspots

4.1.1 English Literature Research Hotspots

To identify international research frontiers for Gen AI, this study performed systematic knowledge-graph analysis on English-language literature and constructed a keyword co-occurrence network (see Figure 5).

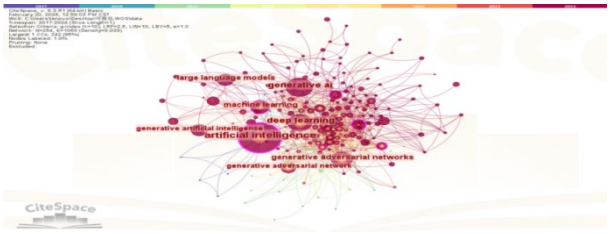


Figure 5: English Keyword Co-occurrence Network Mapping

As can be seen from Figure 5, the keywords of English literature with high frequency are artificial intelligence, generative artificial intelligence, deep learning, and generative adversarial network, which shows that Gen AI is now a hotspot of research in various countries. As a whole, the development of science and technology innovation in the early years was dominated by artificial intelligence, and with the upgrading and optimisation of technology and algorithms, such as deep learning and generative adversarial networks, scholars began to study Gen AI.Specific research hotspots are analysed below.

▪ Artificial intelligence:AI drives economic growth through optimization[11]and industrial upgrade, shifts employment toward knowledge-intensive sectors, and signals national strength by securing strategic advantages and rule-making power in global competition. As a core innovation priority, it revitalizes traditional industries and creates new ones to gain international edge[12]. Ultimately, AI transcends technology to become a cornerstone of national competitiveness.

▪ Large language models:Since the Transformer proposal in 2017[13],big models have become an AI research frontier[14],with ChatGPT exemplifying generative NLP capabilities. AI drives economic growth and quality of life, while big models deliver multimodal generation (text, images, video, audio) and intelligent Q&A. The 2025 DeepSeek model uniquely fuses algorithmic innovation with Chinese cultural contexts. Iterative language-model updates reshape the digital economy and traditional disciplines[15]. As Figure 5 shows, big language modeling papers have topped academic rankings since 2023, signaling a critical phase of exploration; sustained technological innovation remains the core long-term driver of the field.

▪ Study of algorithms: Keywords Deep learning and machine learning research frequency and centrality are at a high level, which shows that the two are the basic technical framework of Gen AI. The high frequency of generative adversarial network shows that it has a high level of technological maturity and is one of the technologies that drive the development of Gen AI.

4.1.2 Chinese Literature Research Hotspots

Through the econometric analysis of the Chinese literature, the keyword co-occurrence network mapping was drawn, as shown in Figure 6.

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Figure 6: Chinese Keyword Co-occurrence Network Mapping

According to the display Figure 6, Gen AI presents a centre-periphery structure feature, in which AI acts as a core node and forms a closely associated network with keywords such as big model, copyright and human-machine collaboration.The sparse state of network edges indicates that Gen AI research is still in the exploration stage, and the research forces is relatively scattered. The specific research hotspots can be summarised as follows.

▪ Next Generation Information Science: Gen AI, a key application of artificial intelligence, directly affects innovation in China's knowledge-intensive industries[16]. A sound information infrastructure is essential for its advancement, consistent with the national cyberpower strategy. Current bibliometric research focuses on cybersecurity and ethical risks, while also exploring how big models empower knowledge production and application.

▪ Large Models: Since Google's Transformer architecture in 2017, big models have evolved rapidly, with growing variety since 2021[17].ChatGPT sparked a craze in 2022. China's 14th Five-Year Plan prioritized AI and blockchain, encouraging capital support for core technologies[18].The 2025 Deepseek breakthrough showcased China's Gen AI innovation and "curve overtaking" via independent R&D[19].Continuous model iteration signifies ongoing technological progress.

4.2 Research Evolution Analysis

The dynamic evolution characteristics of the discipline's research hotspots can be systematically examined through the method of time-series mapping analysis. The method can clearly present the distribution of research topics in the field of Gen AI in different periods, which helps to grasp the development trajectory and evolution law of the discipline. Based on the visual analysis of the time dimension, researchers can effectively identify the emerging research directions at various stages, so as to deeply understand the stage-by-stage characteristics of the development of the field.

4.2.1 An Analysis of the Evolution of the International Gen AI Knowledge Graph

Based on international literature data, this study reveals the research dynamics of scholars around the world in the field of Gen AI by means of a time-series mapping visualisation method, as shown in Figure 7. This analysis method helps to track the evolutionary trajectory of research hotspots and grasp the international trend of disciplinary development.

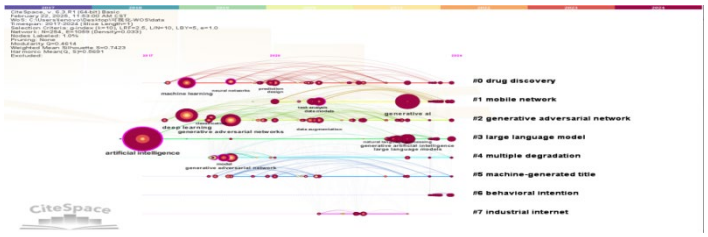


Figure 7: English Keyword Timing Mapping

From the keyword chronogram of the English literature in Figure 7, it can be learnt that the international evolutionary trend in this field is characterised as follows:

▪ Multidisciplinary cross-fertilisation:From 2015 to 2025, generative-AI research can be divided into eight thematic clusters, in which large language models (ChatGPT), as a key technological breakthrough, have made significant progress in the application areas of text, image, video, and audio generation. As can be seen from the English literature chronology in Figure 7, scholars are more enthusiastic about drug discovery and generative adversarial network research.

▪ Drug discovery:Drug discovery and development are an interdisciplinary endeavor integrating

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chemistry, pharmacology, microbiology, and biochemistry, requiring a diverse industrial base[20].Since 2017, many pharmaceutical companies have partnered with AI firms and academia or launched internal AI programs to merge AI with drug R&D. Deep generative models, trained on large datasets, have been shown to optimize the process[21].Academic research progressed from machine learning (2018) to neural networks (2019), collectively advancing drug development.

▪ Generative adversarial network:Generative adversarial networks (GANs), key deep learning models, underpin Gen AI through data augmentation and have achieved breakthroughs in healthcare[22-23], video generation[24],and 3D modeling[25].As a branch of deep learning, Gen AI enhances overall system effectiveness and provides a novel technical pathway for ongoing innovation.

4.2.2 Analysis of the Evolution of Domestic Gen AI Knowledge Graphs

In order to explore the evolution characteristics of Gen AI research in China and the research of domestic scholars in the field of Gen AI, this study constructed a keyword time-series evolution map based on the Chinese literature, as shown in Figure 8, which can effectively reveal the trajectory of changes in the research hotspots of the field in China, and provide data support for grasping the development trend of the discipline.

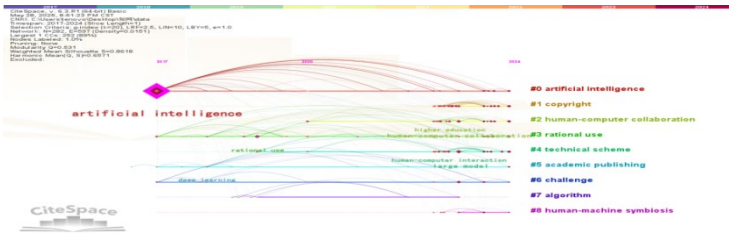


Figure 8: Chinese Keyword Timing Mapping

The evolutionary trend of Gen AI in the country is:

▪ Multidisciplinary research: Bibliometric analysis shows that China's Gen AI research from 2017 to 2024 spans nine thematic clusters, reflecting growing academic attention and a multidimensional, interdisciplinary trend. Since 2020, the field has increasingly integrated with other disciplines, particularly academic research and information science.

▪ The theoretical framework of Gen AI is gradually improving: The orientation and development path of Gen AI are broadly clear. Ongoing algorithmic and technological upgrades provide a solid foundation, and large models require continuous optimization to boost performance. In academia, Gen AI's superior capabilities have challenged original works, calling for policies to guide responsible usage. As applications proliferate and AI evolves, ethical standards must be refined, with guidelines for responsible AI[26], governments should intervene in due course to formulate and improve legal frameworks, especially evaluation systems for Gen AI.

5. Discussion

▪ In recent years, annual publications on Gen AI have been high in both the WOS core database and CNKI. Research institutions show a clear international footprint: globally, leading universities such as the University of California and Harvard dominate; domestically, Beijing Normal University and Wuhan University are key players. Higher education institutions are the main force worldwide, confirming Gen AI as a global frontier research field.

▪ From the point of view of research hotspots, international research hotspots mainly focus on algorithms, natural language processing, large language models, etc., while domestic research hotspots mainly focus on large models, academic risk, education, etc., the content of research hotspots fits the theme of the times and is epochal in character, and the ethical issues are hotspots from the study of AI to Gen AI and have stability.

▪ Internationally, Gen AI research is concentrated, with close institutional collaboration, multidisciplinary integration, and balanced depth and breadth. Domestically, cooperation is sparse and fragmented. As the U.S. leads the field, China should strengthen international partnerships, deepen basic theoretical research, build core technological capabilities, and systematically enhance academic innovation and global competitiveness.

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Overall, as Gen AI technology evolves alongside digital transformation policies, scholarly efforts will intensify. Research hotspots will shift with technological upgrades and policy changes. Future trends point to rising interest, more focused and vertically developed themes, greater multidisciplinary cross-fertilization, and a transition from theoretical analysis to practical application.

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