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How China and the United States Fund Artificial Intelligence? Multi-dimensional Characteristics Analysis from the Lifecycle Perspective

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Abstract

Funding for artificial intelligence (AI) technology research and development has ascended to a strategic priority in major global countries' scientific and technological agendas. This study explores and compares the multi-dimensional characteristics of AI-related funding projects in China and the United States (US), the global leaders in AI technology development. Specifically, it examines the characteristics of funding entities, the variety of project types, and the organization of topics across various stages of AI technology development, all contextualized within the framework of the technology lifecycle. Our results reveal that the US began funding AI technology projects earlier, and China followed a "catch-up and surpass" path. In terms of the funding agencies, while NSF, NIH, and DoD played leading roles in the US, China's main funding agencies evolved from an NSFC-centered pattern to a multi-agency balanced layout. Regarding the funding types, the US has long emphasized funding research at the applied level, which may be related to its solid technological foundation for AI development, whereas China has primarily funded research at the basic level, gradually increasing support for applied-level research as technologies mature. As for funding topics, the US funding prioritized parallel exploration of multiple topics, emphasizing interdisciplinary technological exploration and swiftly responding to technological breakthroughs to develop diverse application pathways. In contrast, China placed more emphasis on topics related to the fundamental theories and principles of machine learning and its core algorithms, reflecting a distinct evolutionary trajectory guided by national strategic priorities. These findings contribute to a deeper understanding of the differentiated developmental stages and strategic orientations of AI technologies between China and the US, serving as a reference for guiding the planning of future funding allocations.

Introduction

As the new wave of scientific and technological revolution, technological innovation has become an important tool for countries to promote economic development and enhance competitiveness. Disruptive technologies, as a critical driving force for breakthroughs at the technological frontier, not only lead industrial transformation but also reshape the global competitive landscape. Artificial intelligence (AI) stands out as a representative disruptive technology and has become a critical driving force in the current wave of technological revolution. With its remarkable capacity for innovation, disruptive impact, and far-reaching influence, AI has emerged as the focal point of global technological competition. It plays a pivotal role in seizing key development opportunities and redefining the global industrial landscape. Numerous scientific and business organizations around the world have also listed AI technology as a representative disruptive technology, highly recognizing its value in the field of technological innovation. China and the US, as global leaders in AI technology development, play a crucial role in AI research, application, and innovation. Both countries' policies and financial investments are instrumental in driving global AI innovation and its practical deployment.

The emergence of disruptive technologies is closely related to the science and technology innovation policies and fund support of each country, and a good innovation policy can promote the emergence of disruptive technologies, thereby promoting technological innovation and industrial change and driving the development of the entire economy and society and the enhancement of competitiveness (Bin & Jieyu, 2020). As an important support for S&T innovation, fund grants drive technological progress and industrial development by supporting research projects in priority areas, carrying the national planning and strategic deployment. Given the distinct developmental trajectory of disruptive technologies, appropriate policies and projects are needed to support them at various stages of their lifecycle. This requires a strong emphasis on fundamental research and integration of fundamental research with technological innovation (Tang, Liu, Zhang, Ge, & Li, 2009; Zhao, 2022).

Current research on funding for technological innovation primarily focuses on three key aspects: the mechanisms and processes of funding, the scope of funding domains, and the evaluation of funding impacts. In studies related to the mechanisms and processes of funding, Zhao (2022) has analyzed the disruptive technology R&D and management funding systems in the US, Europe, and Japan. Based on the funding experiences of major countries globally, some studies have proposed recommendations such as establishing dedicated funding offices, forming mechanisms and funding methods for innovative technology projects, and improving the management mechanisms of science and technology projects (Sun, Zhao, & Lin, 2021; Ye, Zou, Kang, & You, 2021). Cao and Zhang (2022) used high-risk, high-reward (HRHR) research projects from typical international research institutions as an example, and explored the science and technology policy mechanisms of such research. In studies related to the layout of funding, Bai, Leng, and Liao (2017) introduced funding project data to identify frontier topics in the field of nanotechnology by using thematic clustering methods. By integrating natural language processing, text topic identification, and complex network analysis techniques, potential research frontiers were identified (Bai, Liu, & Leng, 2020). Still, Z. Q. Liu, Yue, L. X., Fang, S. (2023) have used the LDA model for funding topic detection. In studies related to the impact evaluation of funding, existing research mainly revolves around the output of scientific research results(Gao, Su, Wang, Zhai, & Pan, 2019; J. Liu & Ma, 2015; Thelwall et al., 2023). Some scholars, through citation relationships, have constructed the transformation process from fundamental research to technological innovation (Narin & Noma, 1985). For example, Du, Li, Guo, and Tang (2019) focused on the "funding-science-technology-innovation" chain in the pharmaceutical field, they revealed the critical role of public funding in pharmaceutical innovation. Fajardo-Ortiz, Shattuck, and Hornbostel (2020) analyzed the funding landscape of major government agencies and funding organizations in the CRISPR technology field. Abadi, He, and Pecht (2020) focused on the field of artificial intelligence and compared the funding situations in China and the US. Sargent and Schwartz (2019) analyzed the development of 3D printing technology and its primary drivers.

Existing studies have provided valuable insights into the performance and distribution of funding support for technological innovation. However, they have paid limited attention to the potential differences in funding needs at various stages of technological development. These studies often fail to adequately integrate funding support with the different stages of the technological lifecycle. Therefore, this study aims to examine the evolution of the multi-dimensional characteristics of funding agency grants in China and the US from a technology lifecycle perspective, using AI technology as a case study. Specifically, this study begins by constructing the lifecycle curve of AI technology in both China and the US, clearly outlining the various stages of its development. Next, it employs machine learning methods to analyze the key characteristics of funding projects at each stage, including the evolving trends in project types and topics. Additionally, it compares these characteristics between the two countries. The main objective is to gain a deeper understanding of the funding priorities, strategies, and evolutionary trends of funding agencies in China and the US regarding disruptive technologies like AI.

Research Design

Considering the potential differences in funding needs at different stages of technological development, this study applies the technology development lifecycle framework to examine the evolving characteristics of AI funding projects in China and the United States, with a focus on how funding strategies differ at various stages of technological development. This study employs a multi-dimensional analytical framework to systematically analyze project data, focusing on three key dimensions: project entities, types, and topics. While metadata for project entities (such as funding agencies) can be directly extracted, identifying project types and analyzing topics require multi-stage data processing to obtain deeper insights. This section begins by presenting the study's analytical framework, followed by an introduction to the research data. Finally, it describes the methods used to identify project types and topics.

Analytic framework

To gain a comprehensive understanding of how funding characteristics for AI technology have evolved at different stages of development in China and the US, we first construct the lifecycle of AI technologies based on the Logistic curve. It then analyzes the characteristics of projects through three perspectives: project entity, type, and topic. The project entity perspective reveals the distribution of funding agencies, highlighting the key drivers of innovation and funding input at each stage.

The project type perspective (e.g., fundamental research, applied research, talent development, etc.) provides insights into funding strategies and resource allocation, illustrating how each country balances foundational and applied research. The project topic perspective focuses on core subjects and breakthroughs, identifying critical technological fields and research trends across various stages. These dimensions, while distinct, are interrelated. The entity characteristics address "who" is driving innovation, the type characteristics explain "how" funding supports innovation, and the topic-related characteristics reveal "which" fields and issues are prioritized. Together, they offer a comprehensive view of resource allocation and strategic priorities throughout the technology lifecycle. This analysis provides deeper insights into the funding characteristics and evolution of AI technology in China and the US. Figure 1 illustrates the research framework and methodology, which includes lifecycle curve construction and multi-dimensional analysis. The project entity analysis focuses on funding agencies, specifically examining the distribution of institutions funding AI technology in both China and the US.

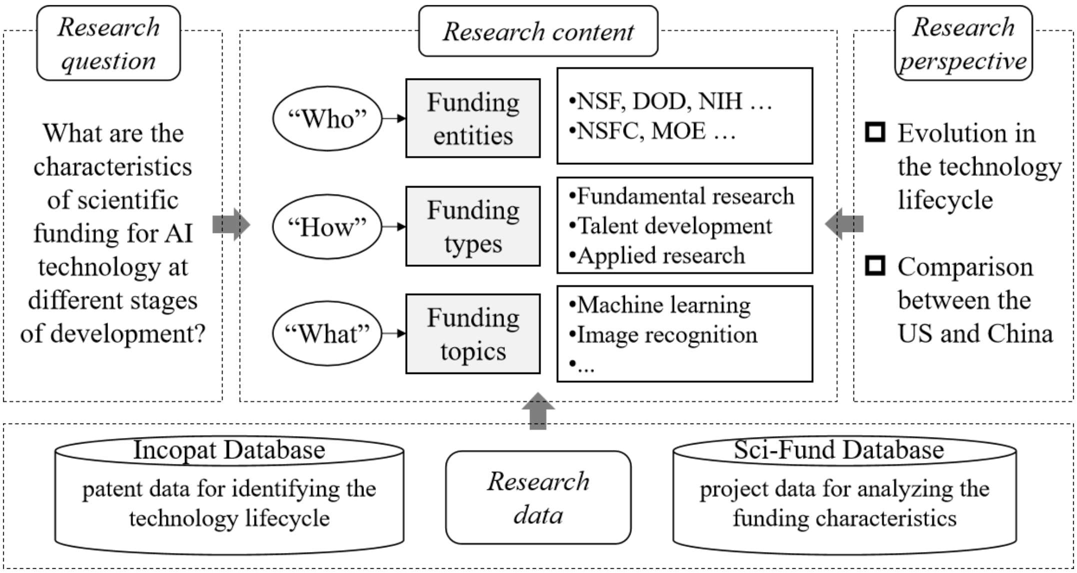


Figure 1. Analytic framework.

Data acquisition & processing

This paper selected the IncoPat and the Sci-Fund platforms as the main sources of artificial intelligence technology patent data and project data. This paper uses patent data to depict the technological lifecycle. Patent data more directly reflects the process and stages of technological innovation, making it a commonly used data source for scholars to depict technological life cycles. And IncoPat is a comprehensive global patent database covering a wide range of patent-related data, focusing on innovation trends, patent analysis, and intellectual property (IP) rights. It is one of the most widely used patent databases in China and offers data from the China National Intellectual Property Administration (CNIPA), the US Patent and Trademark Office (USPTO), along with international patent coverage from other jurisdictions. Sci-Fund (Wanfang Sci-Fund) is a comprehensive research funding database that consolidates over 6.9 million scientific projects from nearly 20 leading nations, including China, the United States, the United Kingdom, and Japan. It integrates funding data from about 200 government agencies, national research institutions, and non-profit organizations, with continuous updates dating back to 1900. The platform relies on authoritative data sources, including direct integration with official funding repositories like the NSFC, NSF, NIH, etc. For the search of project data, keyword search is used to cover the project title and project keywords, limiting the project approval time to 2022.

The search strategy in this paper is as follows: (1) Use core keywords related to artificial intelligence technologies, such as "Artific* Intelligen*" or "AI Technolog*" as the basic search keywords; (2) Conduct separate searches for key subfields of artificial intelligence to ensure comprehensive retrieval of all project data related to AI technologies. And this paper refers to the World Intellectual Property Organization (WIPO) PATENT-SCOPE artificial intelligence index core terms and field classifications, as well as the United States Patent and Trademark Office (USPTO) field categorization of AI technology, and the finalized AI technology fields and the corresponding search keywords are shown in Table 1.

Table 1. AI technology fields and search keywords.

Classification	Subfields	Search Keywords
AI techniques	Fuzzy logic	fuzzy logic*
	Logic programming	logic* program*
	Machine learning	machine* learn*; robotic learn*; machine study*; generative AI; large language model*; general AI
	Ontology engineering	ontolog* engineer*
	Probabilistic reasoning	probabilistic reasoning
AI functional applications	Computer vision	compute* vision*; machine* vision*
	Control method	control* method*
	Distributed artificial intelligence	distribut* artific* intelligen*
	Knowledge representation and reasoning	knowledge representat* and reason*; knowledge process*; knowledge handl*
	Natural language processing	natur* language process*
	Planning and scheduling	plan* and schedul*; plan* and control*
	Predictive analytics	predict* analysis*; forecast* analysis*
	Robotics	intelligen* Robot*; smart* robot*
	Speech processing	speech process*; vioce process*
	AI hardware	AI hardware*; artific* intelligen* hardware*
	Evolutionary computation	evolutiona* computation*; evolutiona* algorithm*

There are two main steps in the data processing process.

(1) Data cleaning: Research obtains artificial intelligence patent data for technology lifecycle characterization and project data for studying project characteristics. First, the acquired patent data was deduplicated, resulting in 13,429 US patent applications and 79,302 Chinese patent applications, with annual cumulative patent application statistics. Second, text data was extracted from project titles, abstracts, and keywords, and the text data was cleaned. Missing values were manually supplemented by accessing original data sources, Chinese and US funding agency websites, and other available project information platforms to ensure data accuracy and reliability. Duplicated project data was deleted in order to reduce the interference of the noisy words in the experiments. After data processing, 28,171 Chinese-funded AI technology projects and 15,398 US-funded projects were obtained. Some project data was presented in traditional Chinese characters, requiring conversion to simplified Chinese for word segmentation processing.

(2) Text Segmentation: In this paper, we use the *jieba* library in Python for word segmentation of Chinese text in the data, and use the *spaCy* for word segmentation of English text. *Jieba* provides three different modes: precise mode, full mode and search engine mode. The precise mode is highly effective for analyzing text, as it accurately slices statements and removes redundant data, resulting in a cleaner output that avoids ambiguity and noisy words. For this reason, this paper utilizes the precise mode to process Chinese text. After conducting preliminary word segmentation, we found many meaningless stop words that do not contribute to the research topic. To address this, we created a deactivation word list to filter these words. Currently, the most commonly used Chinese stop word lists include those from the Harbin Institute of Technology, Baidu, Sichuan University Machine Intelligence Laboratory, and the Chinese stop list. This paper combines elements from these four lists to create a new stop word list, referred to as "stop_words," which contains a total of 2,462 entries. Using this stop word list, the text is further subdivided into words to achieve optimal segmentation.

Type identification and analysis of projects

This study analyzes the characteristics of funding project types for AI technology across different stages of its lifecycle. Given the lack of a direct classification system for project types, this study constructs a project classification characteristics vocabulary and employs machine learning techniques to categorize the projects into three types: fundamental research, talent development, and applied research. The project classification criteria are based on the definitions and classifications of projects in existing policies or literature. According to UNESCO, scientific research and development (R&D) activities can be divided into three categories: fundamental research, applied research, and experimental development. The Law of the People's Republic of China on Scientific and Technological Progress also clearly states the principle that scientific and technological activities should follow, namely to "encourage fundamental research driven by applied research, and promote the integrated development of fundamental research, applied research, and achievement transformation". In research, the type of funding project is divided into four categories of personnel training, fundamental research, applied research and results of the transformation or divided into three types: fundamental research, applied research and developmental research (or developmental research)(Liang, 2023). The Department of Science and Technology (DOST) of Taiwan, China, also classifies funded projects into fundamental research, applied research, technology development, commercialization, and other types.

The identification of project types in this paper is divided into three main steps.

(1) Building project classification characteristics vocabulary: Based on the above classification of scientific activities and funded projects, this study classifies national funded projects into three types: fundamental research, talent development, and applied research. Fundamental research projects focus on the in-depth exploration of scientific theories, principles, and concepts, with the aim of advancing the development of academic disciplines and fostering knowledge innovation. Talent development projects, on the other hand, are centered around cultivating high-quality scientific and technological professionals. These initiatives aim to enhance the growth of the scientific and technological workforce through education, training, and academic exchanges. Applied research projects are typically characterized by clear practical objectives and outcomes. These projects involve activities such as technology development, system design, and engineering implementation, providing specific technical solutions to real-world challenges.

As illustrated in Table 2, a comprehensive list of project classification terms is provided. When matching project types, regular expressions are used to expand and optimize the word list, thus improving the coverage of the word list and the accuracy of matching.

Table 2. Characteristic words for the classification of Fund projects.

Project Type	Project Characteristics	Characteristic Words
Fundamental Research Projects	Focus on in-depth exploration and study of scientific theories, principles, and concepts	Theory, Mechanism, Principle, Model, Basic Science, Exploratory Research, Fundamental Research
Talent Development Projects	Focus on cultivating high-quality scientific and technological talents	Training, Education, Academic Exchange, Discipline Construction, Talent Development, Talent, Faculty, Construction
Applied Research Projects	Focusing on research on the application of scientific theories and research results in solving practical problems and promoting the transformation of scientific and technological achievements	Technology Development, Application, System Design, Engineering Implementation, Solution, Applied Research, Technology, Transfer, Industrial Cooperation, Commercialization, Business Incubation, Marketing, Achievement Transformation, Industry-Academia Cooperation

(2) Machine learning and text matching: Using the above characteristic word list for preliminary project classification, through analyzing titles, keywords, and abstracts, match the vocabulary in these texts with the characteristic word list through keyword matching to classify projects into corresponding categories. Two methods are mainly used: exact matching and fuzzy matching. For fuzzy matching, the *Levenshtein* distance algorithm is mainly used to increase matching accuracy and coverage for keywords with spelling errors or variant words (e.g., "technology transformation" and "results transformation"), through the fuzzy matching algorithm. Machine learning characteristics using labeled items of categories and training the labeled items with the help of decision tree classification models to predict the classification of unmatched items. A decision tree is a tree structure where leaf nodes represent categories or labels, and internal nodes represent characteristics. The decision tree construction process is based on the training dataset, which is divided by recursively selecting the best characteristic for optimal separation of categories. It is worth noting that some projects may matching multiple types. In such cases, this study retains the multi-type attributes to reflect its multi-dimensional characteristics.
(3) Further categorization of unsuccessfully matched projects: For projects that failed to match types, the study combines the project's program affiliation and institution for further manual classification. For example, the F32 series grants from the National Institutes of Health (NIH) primarily focus on talent development, aiming to support postdoctoral researchers' development of independent scientific research capabilities, so these projects can be classified as talent development projects. (Note: Some projects that cannot be classified into types are uniformly labeled as "unclassified" and will not be included in the subsequent analysis of project type evolution characteristics).

Topic identification and analysis of projects

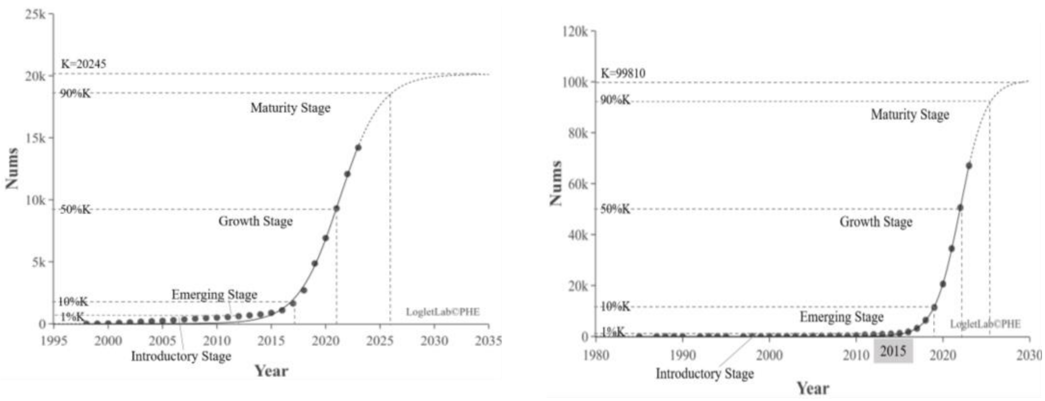
The project topic analysis helps identify the technological areas and innovation directions that have received prioritized support. Projects with annotated keywords are directly assigned these keywords as their thematic representation. For projects lacking keywords, the LDA topic modeling technique is applied to identify topics from project titles and abstracts. We set K=10 and the model parameters a=0.1 and b=0.02, so as to achieve the best topic recognition effect.
Subsequently, the study begins by analyzing the evolution of project topics, which serves as a method for detecting emerging trends. Analyzing research topics of Chinese and the US funded projects enables deep examination of topic formation, decline, strengthening, weakening, convergence, and division processes across different lifecycle stages of technological development, further characterizing strategies and features of disruptive technology development funding in both countries. Using the ItgInsight text mining tool to cluster funding topics, identify core concepts and topics of each group, and slice project topic data by year based on time series enables deeper analysis of topic changes within each time period. First, extract key topic words or phrases from each time slice; then conduct word frequency statistics on various topic words or phrases; next, select top 10 topic words by frequency each year and sort them in descending order.

Additionally, the study further calculates the strength of the co-occurrence relationship between the topic words or topic phrases in each time period, and takes the co-occurrence relationship in the previous period as the basis for measuring the strength of the relationship between the main topic words or topic phrases of the previous period and those of the next period, which is represented by a line in the graph, with a greater number of lines representing stronger co-occurrence, so as to explore the characteristics of the change of the funding topic from the perspective of evolution.

Results

AI technology lifecycle

The AI technology lifecycle serves as a central research perspective throughout the three main analyses of this study. This section, based on patent data, firstly explores the lifecycle of AI technology development in both China and the US. Due to the differences in research directions and the stages of technological development in the field of artificial intelligence between China and the United States, using patent data from both countries separately allows for precise capture of the distinct characteristics at each stage of the technological life cycle. This approach helps better understand how each country adjusts its funding strategies at different stages of AI technology development and explores the relationship between these strategies and domestic technological innovation. We use the S-curve to portray the life cycle of AI technology for auxiliary validation. The concept of the S-curve originated in 1837, first proposed by Verhulst, and is mainly classified into two types: the logistic curve and the Gompertz curve. This paper uses a Logistic model to fit the life cycle of disruptive technologies. The AI patent data from China and the US are imported into Loglet Lab4, respectively, and the patent growth data of AI technologies are fitted by the Logistic model, with the fitting results are shown in Figure 2. The goodness of fit R^2 values obtained in this paper is 0.970 and 1.000, indicating a good fitting effect.



US China

Figure 2. Lifecycle Curve of AI Technology in China and the US.

According to the model results, the US AI technology was in the introductory stage before 2012, the technological development emerging stage from 2013-2017, the growth stage from 2018-2021 and entered the maturity stage in 2022; while in China's prediction results, the AI technology is in the introductory stage before 2015, the emerging stage of technology from 2016-2019, and the period from 2020-2022 is the growth stage and entered the maturity stage in 2023.

Involvement of funding entities across AI development stages

This section begins by examining the changes in the number of funding projects in both China and the US, providing a context for understanding the distribution and dynamics of project support. It then shifts to a detailed analysis of the characteristics of the funding entities driving these projects. Statistics on the number of projects funded by China and the US each year were compiled to draw a schematic diagram, as shown in Figure 3.

As shown in Figure 3, the US started funding AI technology-related projects early, beginning in 1964. The earliest funded project was supported by NSF to the University of Kentucky Research Foundation and Case Western Reserve University Institute of Technology in 1964. Until 1985, the US remained the main sponsor of AI technology projects. Before 2006, the number of related projects funded by the US grew steadily at a relatively slow pace. From 2007 onwards, the number of AI technology projects funded by the US increased dramatically, especially after 2010, achieving an order-of-magnitude leap.

China's earliest AI technology-related projects were funded by NSFC in 1986 through a series of general programs related to AI technology. The first five institutions to receive funding were Fudan University, Peking University of Aeronautics and Astronautics, Tsinghua University, Zhejiang University, and the University of Science and Technology of China. Since then, the number of AI projects funded by China has gradually increased, especially after 2003, but at a slightly slower rate than that of the US In 2007, China promulgated the "New Generation of Artificial Intelligence Development Plan," emphasizing the need to grasp the strategic initiative of international competition in the development of AI and the development of AI technology has entered a new period. By 2016, China's AI technology-related projects showed exponential growth, far exceeding that of the US.

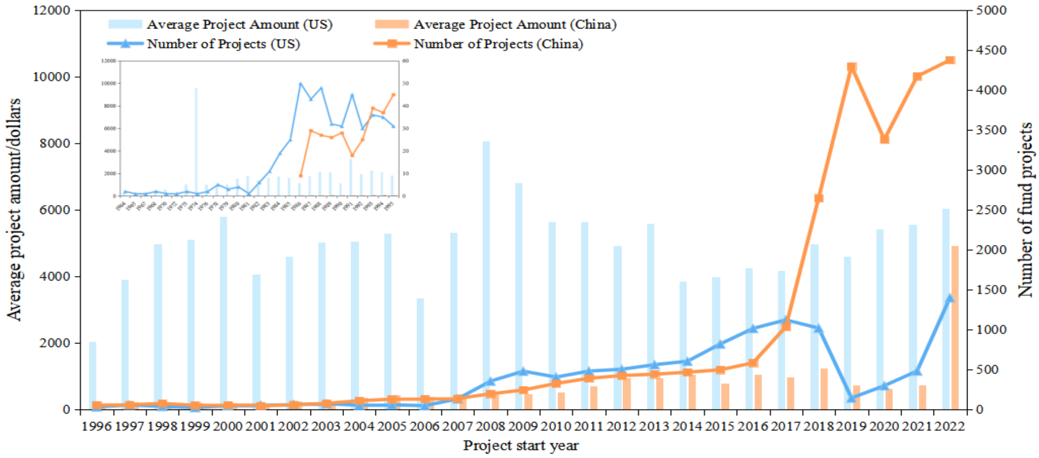


Figure 3. Trends in the number of AI-related projects funded by China and the US.

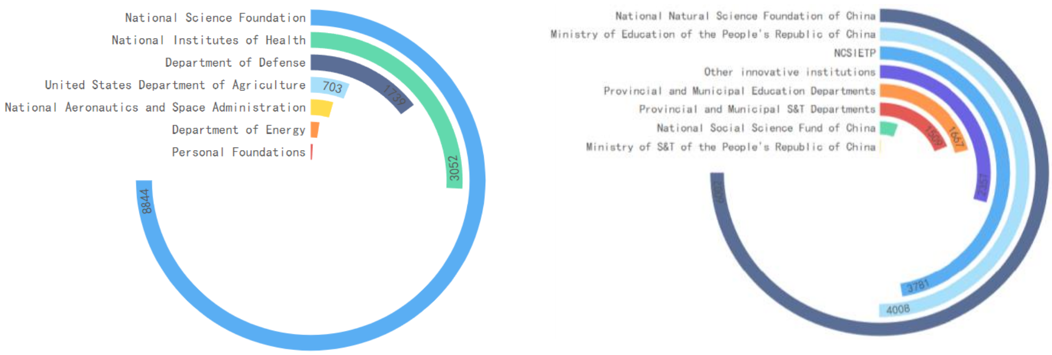
Overall, in terms of the number of funded projects from both countries, the US started to fund AI technology earlier, and was in the lead in the early stage of technology development, and the growth in the scale of funding has slowed down in recent years; while China has gradually overtaken the US in the number of grants in recent years, especially after 2016, with a faster growth rate in funding scale. In terms of funding amounts, the average amount of funding for AI technology in the US far exceeds that of China, but China has increased its funding in 2022. Combined with the lifecycle of AI technology development, China and the US in the technology development of the introductory stage of the number of grants are not high, the US took the lead in increasing the intensity of funding, in this stage of the accumulation of technology theory foundation and experience; in the technology development of the budding period, the number of grants in both countries have increased, China has entered the budding period, the rate of growth is obvious, was an explosive growth in the number of funded projects beyond the US, which reflects that China and the US for AI technology, the number of projects is more than the US. This reflects the different strategic arrangements and development grasp of AI technology between China and the US.

Further, the funding agencies of the two countries will be analyzed, and the strategic positioning and preferences of the US and China will be explored in promoting scientific and technological innovation, as shown in Figure 4.

It is found that the US funding for AI technology mainly comes from the National Science Foundation (NSF), the National Institutes of Health (NIH), and Department of Defense (DoD), which fund about 88.6% of the AI projects in the US. (1) NSF primarily funds fundamental research, with universities and academic alliances being its main funding recipients, accounting for 75-80% of funding. Besides fundamental research, NSF also funds some applied research. Funded projects can be Standard Awards, which provide all funding for the entire research period within one fiscal year, or Continuing Awards, which provide project research funding incrementally over multiple years, with an average project duration of 3 years (Ma & Zhang, 2021).

Notably, since 1990, NSF has implemented SGER for small-scale exploratory research projects for certain innovative research, which since 2009 has been redefined as the more targeted EAGER projects, considered "high-risk, high-reward" projects (Qiu, Jia, & Zhang, 2023). (2) The second most funded institution in the US is the National Institutes of Health (NIH), NIH-funded projects are mainly divided into Research Grants, known as R-Series Funds; Career development Awards, known as K-Series Funds and Fellowships known as F-Series Funds; and Fellowships, known as F-Series Funds. Fellowships are called F-series funds. It is worth noting that the R21 program in the R-series is a funding scheme specifically for exploratory research, with deadlines and level requirements, and is designed to encourage exploratory research by providing support for the early and conceptual stages of project development. (3) Department of Defense (DoD), with its unique Defense Advanced Research Projects Agency (DARPA), has been focusing on major breakthroughs and disruptive research projects since its inception, and has developed numerous innovations in a range of major disruptive areas such as the Internet, stealth aircraft, GPS, integrated circuits (Hao, Wang, & Li, 2015).

The top three funding agencies or major programs in China are: NSFC, the Ministry of Education of China, and the National College Students Innovation and Entrepreneurship Training Program (NCSIETP), which funded 78.7% of Chinese AI-related projects, while other funding agencies are mainly provincial and municipal Science and Technology Departments and related Science and Technology Innovation Funding Committees. NSFC is a national scientific research fund in the field of natural sciences in China, playing an important role in the development of the national innovation system, and has consistently funded fundamental research and partially applied fundamental research to support talent and team building, making remarkable contributions to the achievements and talents in China's scientific research field. In recent years, China's Ministry of Education has also gradually strengthened collaboration with the State Intellectual Property Office and other departments, and implemented a series of initiatives in conjunction with universities to strengthen cooperation and exchanges between universities, enterprises and research institutes, and to promote the transformation of scientific research results into industry. The Department of Science, Technology and Informatization, a department under the Ministry of Education, playing an important role in promoting the cultivation of scientific and technological talents and the cooperation between industry, academia and research, and has cultivated a large number of scientific and technological talents for technological development through the construction of high-level scientific and technological talent development institutes and projects, such as key laboratories, scientific research institutes and scientific and technological innovation practice bases.

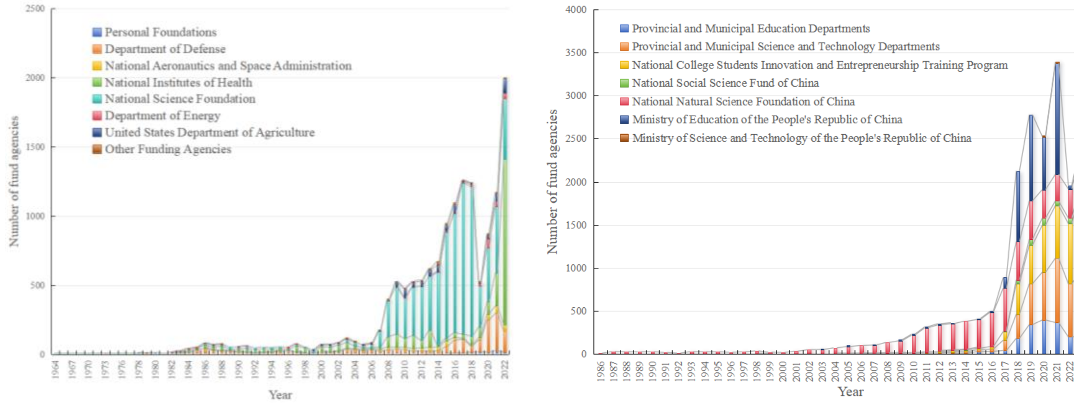


(a) US (b) China

Figure 4. Distribution of Funding Agencies in China and the US.

The evolution of funding entities in both countries, in relation to the technology development cycle, is illustrated in Figure 5. Funding from US agencies began in 1964, and in the early stage of technology development (i.e., the introductory stage), the number of funding agencies was small, primarily dominated by funding from NSF, NIH, and DoD. In 2007, there was an increase in the number of projects; by the time the technology was in its infancy, the number of funding organizations had further increased, with NSF gradually taking over as the main funder, and the US Department of Energy and the NIH gradually increasing their share of the number of funded projects. This shift may be attributed to three key factors. First, the significant advancements in artificial intelligence (AI) in the field of biomedicine likely played a crucial role. For instance, the development of AlphaFold by DeepMind in 2021(DeepMind, 2022), which solved the 50-year-old challenge of protein structure prediction, stands as one of the most groundbreaking applications of AI in science, sparking widespread attention and discussions. Second, this change is closely linked to policy initiatives from the US government. Since 2019, a series of policies have been introduced to promote the application of AI in life sciences and healthcare (COUNCIL, 2019). Notably, in 2022, the NIH released "NIH-Wide Strategic Plan" highlighting the potential of AI in health (NIH, 2022b), and the same year, NIH launched the "Bridge2AI" initiative to support the integration of multi-modal biomedical data through AI (NIH, 2022a). Finally, the COVID-19 pandemic significantly increased the demand for biomedical research and public health technologies, which may accelerate the adoption of AI in healthcare. For China's funding agencies, when in the introductory stage, the number of funding is in the stage of steady increase, the number of funding agencies is relatively small, and NSFC is the main funding agency; from 2016 when the technology development stepped into the emerging stage, with AI identified as the new engine of China's national development, the number of funding agencies and projects is explosive growth, the number of funding by the Ministry of Education and the National College Students Innovation and Entrepreneurship Training Program of China has gradually risen and project funding peaks in 2021. This shift is closely aligned with China's policy direction. In 2018, the MOE launched the "Action Plan for AI Innovation in

Higher Education" (MOE, 2018) which aimed to strengthen the development of AI disciplines and promote the integration of industry, academia, and research. This initiative may have played a significant role in increasing the number of projects funded by the MOE.



(a) US (b) China

Figure 5. The Evolution of Funding Agencies Funding AI-Related Projects in China and the US.

Distribution of funding types across AI development stages

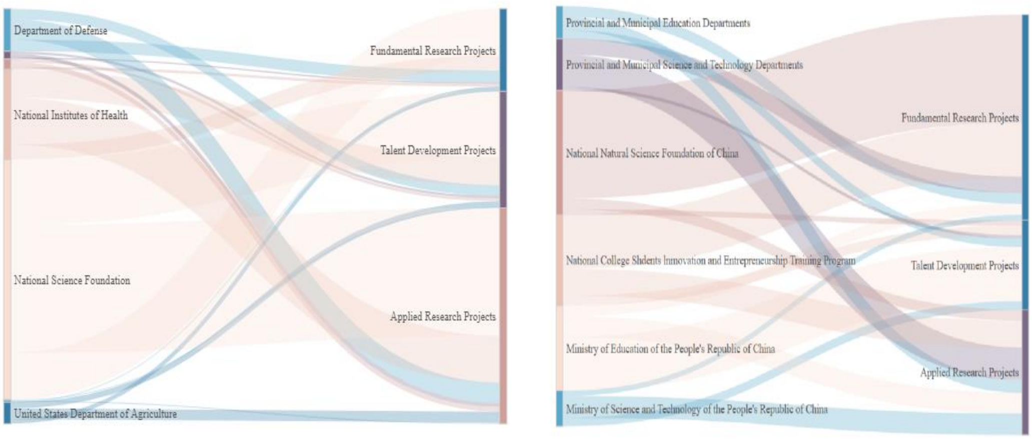
After text analysis and type matching, the funded projects in China and the US are classified into three categories: fundamental research, talent development, and applied research. The number and distribution of each type of project in the two countries are shown in Table 3. below.

As observed from the table, China and the US show significantly different characteristics in terms of funding type. The types of projects funded by China are mainly in the category of fundamental research, which occupies more than half of the proportion, reflecting the importance China attaches to promoting the exploration of the scientific theories and principles related to AI technology. At the same time, applied research projects account for nearly 30%, indicating that China has also invested a lot of effort in promoting the practical application and commercial transformation of scientific research results. This may be related to the fact that, as mentioned earlier, the NSFC is the primary institution funding AI technology in China, with a focus on supporting fundamental research. The distribution of US funding projects for AI technology is mainly based on applied research, accounting for more than 60% of the projects, indicating that the US pays more attention to the practical application ability and market transformation potential of scientific research results.

Table 3. Distribution of funding project types in China and the US.

Classifications	The US	China
Fundamental Research Projects	28%	58%
Talent Development Projects	5%	14%
Applied Research Projects	67%	28%

In this paper, we further depict the distribution of the types of projects funded by funding agencies in China and the US, and the results are shown in Figure 6.
As observed from the figure, it can be seen that the types of agencies funding AI technology in China are more abundant, with a more balanced share of agencies, in which fundamental research projects are mainly funded by NSFC, while the Chinese Ministry of Education (MOE) and provincial and municipal education organizations are mainly funding talent development projects. Applied research projects are mainly funded by provincial and municipal science and technology organizations, but the national S&T departments are weaker in funding. In the US, NSF has invested a very high amount in both fundamental and applied research projects, occupying a major position in the funding of AI technology and highlighting its leading role in promoting the development of national AI technology in terms of scientific and technological innovation and practical application. At the same time, NIH and DoD have also shown interest in the application of AI technology in the medical and healthcare fields and national defence and the talent development projects are mainly funded by the USDA.



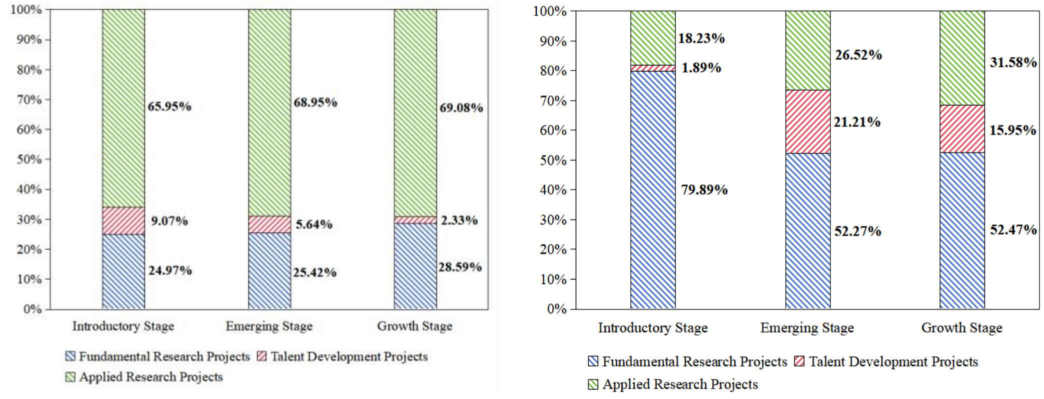
(a) US (b) China

Figure 6. Distribution of funding project types by major agencies in China and the US.

Note: The Sankey diagram shows funding agencies on the left and funding types on the right.

In order to deeply explore the funding strategies and project type characteristics of China and the US in different periods of technology development, the paper, based on the lifecycle stages of AI technology as depicted before, analyses the proportion of various types of funding projects in China and the US in different lifecycle stages. Thus, the funding bias of the two countries in different periods is reflected in Figure 7. Since the maturity stage of China and the US is incomplete, it is not counted in the statistics.

As can be seen from Figure 7, the US has led the way in applied research projects over time, with little change in the proportion of projects in each phase. Specifically, with the continuous development of AI technology, the US-funded more applied research projects and fundamental research projects aimed at expanding the boundaries of existing technologies, exploring new application areas or seeking to improve the performance and efficiency of existing technologies. The proportion of applied research projects at all stages is nearly 70%, and the proportion of talent development projects is only 2.33% as the technology enters the growth stage. China has continued to pay attention to fundamental research at all stages of the lifecycle of AI technology, and investment in fundamental research projects has always taken up a large part of the overall layout of the funding. As the technology develops into different stages, the proportion of each type of project has changed considerably. Specifically, in the technology introductory stage, nearly 80% of China's projects are funded fundamental research projects, indicating that China places particular emphasis on the exploration of basic theories in the early and middle stages of AI technology development, but only 1.89% of the projects in the category of talent development. In the emerging stage, China has increased its funding for applied research projects and talent development projects, with an increase in the ratio of 8.29% and 19.32%, respectively. However, fundamental research projects are still the main type of funding, accounting for 52.27%. When the development of technology enters the growth stage, China has further increased the funding for applied research projects, accounting for more than 30%, and has gradually put the promotion of talent development and transformation of achievements in an important position of national development. Especially since the State Council promulgated the Next-Generation Artificial Intelligence Development Plan in 2017, China has clearly put forward the ambitious goal of building a new generation of AI basic theories and key common technology systems, adhering to the application-oriented, and accelerating the commercialisation and application of AI scientific and technological achievements, China's funding for AI technology has gradually moved towards the transformation of achievements and the development of talents.



(a) US (b) China

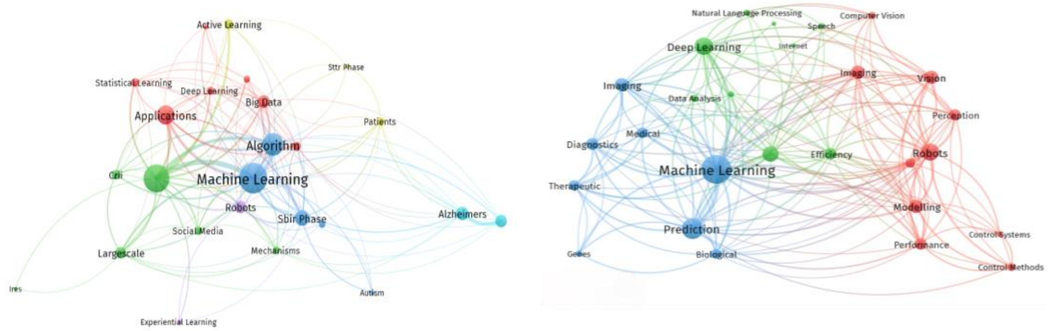
Figure 7. Distribution of funding project types at different development stages in China and the US.

Overall, the US and China have different funding types and strategies for AI technologies. The US adopts a more sustained and stable research funding strategy oriented to applied research, which is reflected in the high intensity of applied research projects at all stages of the technology's lifecycle, as well as the extensive exploration of multiple application scenarios of the technology. In contrast, China's funding is driven by fundamental research, especially under the guidance of policy, where the realization of national strategic goals is an important basis for funding. By prioritizing fundamental research projects, the Chinese government aims to strengthen the theoretical foundation of technology development and provide the necessary academic support for subsequent technological breakthroughs.

This disparity may stem from differences in the policy orientation, innovation systems, and stages of technological development between China and the US. As a latecomer in AI development, China needs to further strengthen research in foundational theories (such as algorithms and chip architectures) to reduce its reliance on Western technologies. In contrast, the US, having already established a lead in AI foundational theories (such as deep learning), is able to focus more on advancing application-driven innovations.

Evolution of funding topics across AI development stages

The word frequency of each identified project topic word was counted, and the top 30 words with the highest frequency in the two countries were extracted to construct the topic word co-occurrence network, as shown in Figure 8. This allows for the observation of the thematic focus of AI technology funding in the US and China.



(a) US (b) China

Figure 8. Thematic distribution of funded projects in China and the US.

As shown in Figure 8(a), the co-occurrence network of technology topics funded in the US reveals a tendency to support research with broad application prospects, particularly in healthcare, life sciences, and education. Among the specific funding topics, Machine Learning (ML) technologies dominate, appearing much more frequently than other technology topics. In terms of AI technology applications, topics such as "Pharmaceutical Preparations," "Biological Markers," and "Public Health" highlight the significant role of AI in biomedical research. While technologies like "Active Learning" and "Computer Simulation" demonstrate the interdisciplinary applications of AI in automation and learning processes. Figure 8(b) presents the co-occurrence network of technology topics funded in China, where "Machine Learning" also emerges as the most prominent topic, appearing far more frequently than other topics, and remains a key area of research and funding. Other frequently appearing topics include "Deep Learning" "Natural Language Processing" "Computer Vision" and "Neural Networks", which are research areas focused on the theories and principles of AI technology. In the application field of AI technology, topics such as "Internet of Things" "Robotics" and "Image Recognition", which combine AI with manufacturing and medical fields, are the most highly researched topics in AI technology application. Overall, both countries have shown a strong focus on Machine Learning, Robotics, and Natural Language Processing technologies, with ML recognized as a foundational driver of AI technology. In terms of applications, both countries emphasize the use of AI technology in healthcare, particularly with regard to China's "Healthy China 2030" initiative, which, as outlined in the 2016 policy, explicitly calls for the "development of internet-based health services" (China, 2016; Government). Additionally, while China's funding strategy places importance on integrating AI technology with national economic and social development, the US demonstrates a broader interest in interdisciplinary research.

The study further examines the evolution characteristics of funding topics. Figures 9 and 10 illustrate the evolution of funding topics in the US and China, respectively. It is worth noting that due to the longer duration of the introductory stage and the limited number of topics in the early stages of technological development, the topic evolution graphs focus on the period from 2003 to 2022, covering the introduction, emergence, and growth stages of the technology.

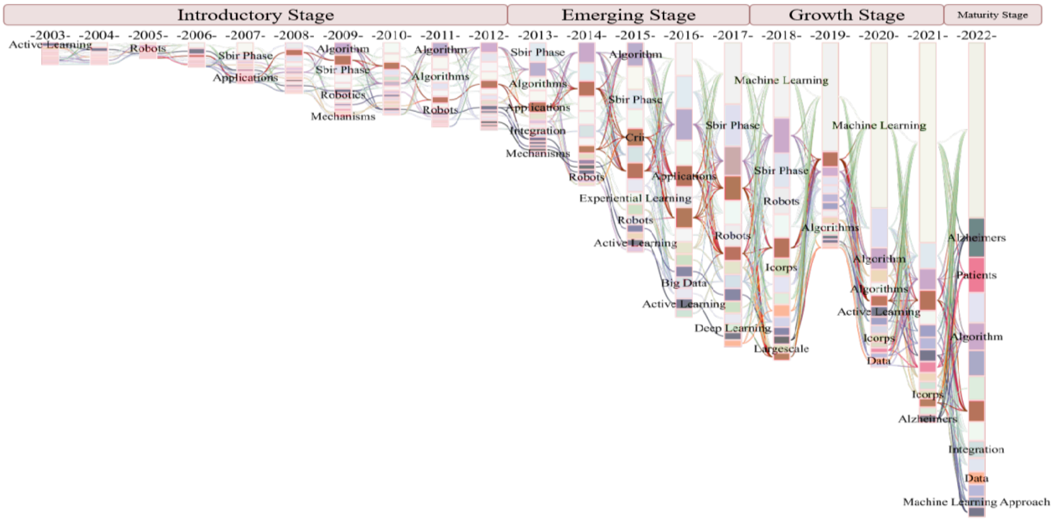


Figure 9. Evolution of topics in the US funding for AI-related projects.

It can be observed that during the early stages of AI technology development, funding topics in the US experienced fluctuating growth in both quantity and intensity. Early funding primarily focused on exploratory research and applications, covering areas such as Natural Language Processing, Robotics, Machine Learning, and related algorithms. This reflected a multi-topic, exploratory funding strategy, which was not confined to fixed research fields but encouraged cross-disciplinary innovation and diverse technological exploration. As the technology entered the emerging phase, US funding topics experienced explosive growth, quickly responding to the demands of technological development. At this stage, the scope of funding gradually extended to applications of AI across various fields such as healthcare and education. Additionally, emerging technologies, such as big data have begun to receive funding support, reflecting a broader focus on the overall technological development landscape. During this period, the US significantly increased its investment in Machine Learning, emphasizing frontier research in Machine Learning and Deep Learning. Support for other technological topics remained relatively balanced, reflecting coordinated development across multiple technology fields.

However, as the technology entered the growth phase, particularly in 2019, there was a sharp decline in the number and variety of funding topics in the AI field. This change may be attributed, on the one hand, to incomplete data collection and on the other hand, to the impact of the COVID-19 pandemic, which affected the reallocation of US government budgets and the adjustment of research priorities. In response to the pandemic, the US government shifted more resources towards urgent areas such as public health and healthcare, leading to a temporary decline in AI-related funding. Despite this, in the later stages of the pandemic, the US gradually resumed funding for core technologies, particularly in the foundational fields of Machine Learning. At this point, funding priorities shifted towards technology applications related to public health and disease control, while new research interests emerged in technological development, further increasing support for AI application research and reflecting foresight in understanding the profound societal impact of emerging technologies.

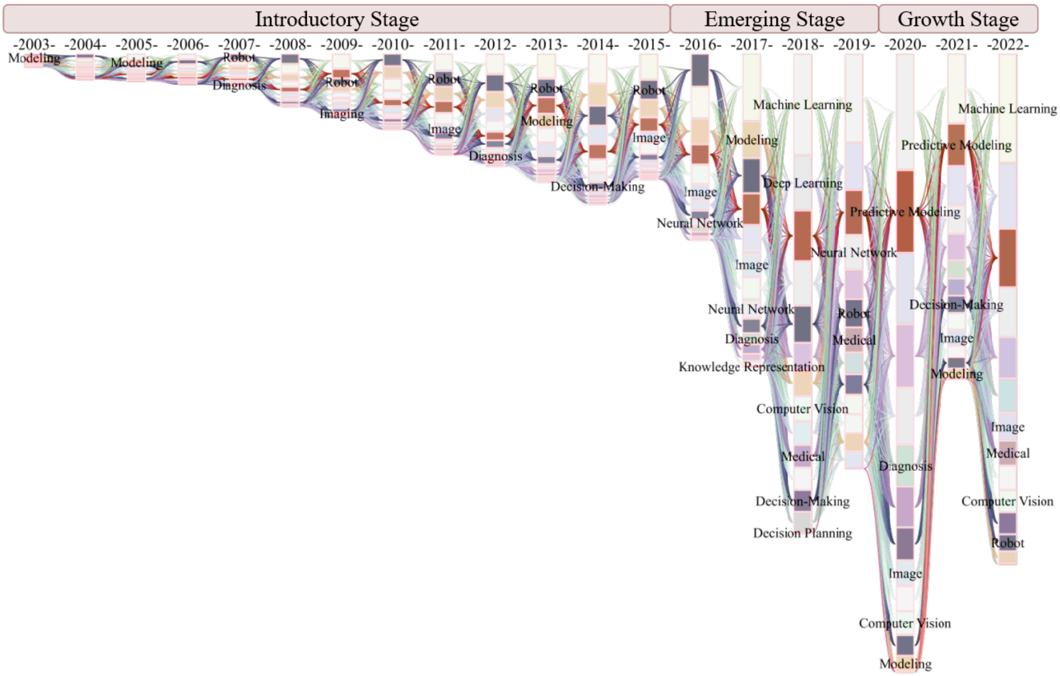


Figure 10. Evolution of topics in China funding for AI-related projects.

The evolution of funding topics in China's AI technology can be observed as follows: during the introductory stage of technology development, both the number of funding topics and the number of funded projects showed a steady upward trend. Early funding was mainly focused on fundamental research in related theories and algorithms, particularly emphasizing foundational studies in areas such as graphical learning and model construction. At the same time, exploration in fields like robotics and machine learning also received funding in the early stages. This funding during the early phase focused on laying the theoretical and algorithmic foundations for subsequent technological breakthroughs, providing solid support for driving technological innovation. As the technology entered the emerging phase, the number of funding topics and projects grew rapidly, reflecting an urgent response to the demands of technological development. During this period, China's funding still centered on the theoretical and algorithmic aspects of AI, with a particular focus on foundational research in key technologies like deep learning, natural language processing, and computer vision. At the same time, in response to the practical application needs of the technology, China began to increase investment in emerging application areas such as cloud storage, mobile robotics, and big data analytics. This funding not only advanced fundamental research but also facilitated the transition of AI technologies into practical applications. It is noteworthy that around 2019, there was also a slight decline in the number of funding topics for AI projects.

As the technology entered the growth stage, the number of funding topics reached a new high, and funding priorities gradually shifted towards applied research. During this stage, China's funding strategy placed more emphasis on the practical applications of AI technology, particularly in areas such as the Internet of Things, big data, predictive modeling, and image recognition. During this period, funding not only promoted further technological innovation but also provided strong support for the deployment of these technologies in relevant industries. Overall, China's AI funding topics demonstrate a gradual shift from focusing on fundamental research to encompassing applied research, with funding priorities flexibly adjusted according to the practical needs of each stage of the technology lifecycle. In comparison, with the development of AI technology, both China and the US have seen a decline in the intensity of funding for AI theory and applications. US funding for AI technologies emphasizes multi-topic parallelism and technological exploration, enabling a quick response to the demands of technological breakthroughs. In the early stages of technological development, US funding placed greater emphasis on applied research and algorithm innovation, with a focus on investment in frontier technologies and emerging fields throughout the technological evolution. China's funding topics, based on machine learning, continued to increase support for key foundational technologies while exploring the application of machine learning and deep learning technologies, driving their implementation in key areas such as intelligent manufacturing and healthcare. The funding system in China is relatively centralized and stable, with a focus on fundamental research and a gradual expansion of applied research funding topics as the technology matures.

Conclusions and Discussion

This study examines AI funding strategies and characteristics in China and the US across technology lifecycle stages, revealing following conclusions: (1) In the introductory stage of AI development, US funding is predominantly led by the NSF, with an emphasis on applied research. The number of funded topics shows a fluctuating upward trend, mainly focusing on exploratory research and applied technologies. In contrast, funding in China is primarily provided by the NSFC, with approximately 80% of projects centered on fundamental research. The number of funded topics steadily increases, with research content mainly revolving theories and algorithms. (2) In the emerging stage of AI development, US funding remains primarily driven by the NSF, but the support from the DoD and NIH grows significantly. The number of funded topics experiences an explosive increase, with a focus on cutting-edge technologies such as deep learning. In China, the Ministry of Education has increased funding for AI technologies, particularly in applied research and talent development, with funding topics gradually shifting towards practical applications. (3) In the growth stage of AI development, NIH funding in the US further intensifies. In 2019, the number of funded topics sharply declined, with a shift in focus towards technology applications related to public health and disease prevention. Meanwhile, in China, the distribution of funding agencies becomes more diversified, with funding increasingly directed towards applied research and the practical application of AI technologies. In summary, China and the US differ in the pace of AI technology development. The US started earlier and took the lead in funding earlier. NSF, NIH, and DoD played leading roles in the US With the development of technology. And US has always focused on applied research, with emphasis on multiple parallel topics. In comparison, China followed a "catch-up and surpass" path and has gradually surpassed the US, especially since 2016, with accelerated growth in funding scale. China's funding system has shifted from being primarily dominated by the NSFC to a more diversified structure with multiple agencies. And China places more emphasis on fundamental research, and is gradually expanding from fundamental research to applied research.

The AI technology funding strategies of China and the US reflect the strategic goals and policy orientations of both countries. The US emphasizes an application-oriented approach, focusing on the social impact of technologies and rapid breakthroughs. While China is driven by fundamental research, the complementary combination of fundamental research and application is gradually increasing. This disparity may stem from differences in the policy orientation, innovation systems, and stages of technological development between China and the US. As a latecomer in AI development, China needs to further strengthen research in foundational theories to reduce its reliance on Western technologies. In contrast, the US, having already established a lead in AI foundational theories, is able to focus more on advancing application-driven innovations. Although the funding priorities of the two countries are different, their respective strategies and focus adjustments reflect their deep understanding of the development of scientific and technological innovation and their forward-looking layout. In the future, China can further focus on promoting the rapid development of applied research while stabilizing basic research, enhancing cross-field cooperation, and strengthening international cooperation and global competitiveness.

Additionally, although the study analyzes the characteristics of funding projects from multiple dimensions, limitations remain, particularly in project type identification. This process relies on keyword libraries and contextual analysis, which may overlook implicit semantic relationships. Furthermore, the study is constrained by the limitations of the database used, as it does not comprehensively cover all enterprise funding data. This lack of coverage may introduce biases and affect the overall accuracy of the findings. Future research could address these limitations by incorporating more complete and diverse data sources and leveraging deep learning models, such as BERT, to better capture semantic complexity and improve data coverage.

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References

Abadi, H. H. N., He, Z., & Pecht, M. (2020). Artificial Intelligence-Related Research Funding by the US National Science Foundation and the National Natural Science Foundation of China. *Ieee Access*, *8*, 183448-183459.

Bai, R., Leng, F., & Liao, J. (2017). A Method of Detecting Research Front Based on Subjects Comparison of Multiple Data Sources. *Information Studies:Theory & Application*, *40*(8), 43-48.

Bai, R., Liu, B., & Leng, F. (2020). Frontier Identification of Emerging Scientific Research Based on Multi-indicators. *Journal of the China Society for Scientific and Technical Information*, *39*(7), 747-760.

Bin, W., & Jieyu, W. (2020). Analysis of Policy Requirements for Disruptive Technological Innovations:Taking Intelligent Transportation as an Example. *Journal of Technology Economics*, *39*(6), 185-192.

Cao, L., & Zhang, Z. (2022). Developing Science and Technology Policies for High Risk-High Reward Research. *Bulletin of the Chinese Academy of Sciences*, *37*(5), 661-673.

China, G. o. t. P. s. R. o. (2016). Healthy China 2030. Retrieved 27 January, 2025, from https://www.gov.cn/xinwen/2016-10/25/content_5124174.htm?wm=2226_2965.%202016-10-25.

COUNCIL, S. C. O. A. I. o. t. N. S. T. (2019). THE NATIONAL ARTIFICIAL INTELLIGENCE RESEARCH AND DEVELOPMENT STRATEGIC PLAN: 2019 UPDATE. Retrieved 21 June, 2019, from https://www.nitrd.gov/pubs/National-Al-RD-Strategy-2019.pdf

DeepMind. (2022). Putting the power of AlphaFold into the world's hands. Retrieved 25 January, 2024, from https://deepmind.google/discover/blog/putting-the-power-of-alphafold-into-the-worlds-hands/

Du, J., Li, P. X., Guo, Q. Y., & Tang, X. L. (2019). Measuring the knowledge translation and convergence in pharmaceutical innovation by funding-science-technology-innovation linkages analysis. *Journal of Informetrics*, *13*(1), 132-148.

Fajardo-Ortiz, D., Shattuck, A., & Hornbostel, S. (2020). Mapping the coevolution, leadership and financing of research on viral vectors, RNAi, CRISPR/Cas9 and other genomic editing technologies. *PLoS One*, *15*(4).

Gao, J. P., Su, C., Wang, H. Y., Zhai, L. H., & Pan, Y. T. (2019). Research fund evaluation based on academic publication output analysis: the case of Chinese research fund evaluation. *Scientometrics*, *119*(2), 959-972.

Government, C. P. s. Healthy China 2030. Retrieved January 1, 2025, from https://www.gov.cn/xinwen/2016-10/25/content_5124174.htm?wm=2226_2965.

Hao, J., Wang, H., & Li, Z. (2015). Research on DARPA's Projects Organization and Its Implications for China. *Science & Technology Progress and Policy*, *32*(9), 6-9.

Liang, Q. Q. (2023). Study on NSF's Project Funding Mode for Emerging Technologies - Take the Soft Robot as an Example. *China Science & Technology Resources Review*, *55*(3), 60-67.

Liu, J., & Ma, J. (2015). Progress of Basic Research in Management Science in China Based on Data from the National Natural Science Foundation. *Science and Technology Management Research*, *35*(4), 249-258.

Liu, Z. Q., Yue, L. X., Fang, S. (2023). Research on Fronts Trend Prediction Method Based on the Lag of Topic Diffusion Evolution. *Information Studies:Theory & Application*, *46*(6), 145-154.

Ma, W., & Zhang, S. (2021). Comparative Analysis of China and US Science Foundation Projects: Taking NSFC and NSF as Examples. *Global Science,Technology and Economy Outlook*, *36*(6), 60-72.
MOE. (2018). Action Plan for AI Innovation in Higher Education. Retrieved 26 January, 2024, from http://www.moe.gov.cn/srcsite/A16/s7062/201804/t20180410_332722.html
Narin, F., & Noma, E. (1985). IS TECHNOLOGY BECOMING SCIENCE. *Scientometrics, 7*(3-6), 369-381.
NIH. (2022a). Bridge to Artificial Intelligence (Bridge2AI). Retrieved 25 January, 2024, from https://commonfund.nih.gov/bridge2ai
NIH. (2022b). NIH-Wide Strategic Plan for Fiscal Years 2021–2025. Retrieved 25 January, 2024, from https://www.nih.gov/sites/default/files/about-nih/strategic-plan-fy2021-2025-508.pdf
Qiu, J., Jia, Y., & Zhang, J. (2023). The Advanced Research Projects Agency for Health: a new agency in the United States and its implications for China. *Chinese Journal of Medical Management Sciences, 13*(3), 124-128.
Sargent, J. F., & Schwartz, R. (2019). *3D printing: Overview, impacts, and the federal role*: Congressional Research Service.
Sun, Y., Zhao, B., & Lin, J. (2021). A Preliminary Study on the Whole Process Management System of Science Funds for Frontier Breakthrough Basic Research. *Science of Science and Management of S.& T., 42*(4), 70-82.
Tang, T. T., Liu, P., Zhang, P., Ge, F. B., & Li, M. (2009). Application of Gompertz Curve Model in the Patent Trend Forecast. *Data Analysis and Knowledge Discovery*(11), 59-63.
Thelwall, M., Kousha, K., Abdoli, M., Stuart, E., Makita, M., Font-Julian, C. I., et al. (2023). Is research funding always beneficial? A cross-disciplinary analysis of UK research 2014-20. *Quantitative Science Studies, 4*(2), 501-534.
Ye, X., Zou, Q., Kang, J., & You, Y. (2021). Funding of disruptive technology:The foreign experience and China's program. *Science & Technology Review*, *39*(2), 96-103.
Zhao, Z. Y., Zhao, X. Y., Su, C., Cui, Y. W., Li, M. D. (2022). Disruptive Technology R&D and Management Funding System:Analytical Model and Foreign Practice. *Science and Technology Management Research, 42*(17), 111-117.