Review

Artificial Intelligence

A Historical Overview of Artificial Intelligence in China

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Artificial intelligence (AI) refers to the interdisciplinary field of study that involves the development of computer systems and machines capable of performing tasks that typically require human intelligence, such as learning, problem-solving, and decision-making. AI has undergone a tumultuous developmental trajectory since its inception as a distinct field of study in 1956. This paper provides a concise review of the historical development of AI in China, with a particular focus on the country's recent advancements in AI research, innovation, and application.

Keywords: Artificial Intelligence; China; History

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THE significant scientific and technological progress throughout human history can be attributed to the intellect, aspirations, and endeavors of humanity. The development of artificial intelligence (AI) and intelligent machines by humans can be traced back to a period as early as 3,000 years ago. It is not difficult to find historical materials about AI experiments in ancient China. According to *Lie Zi: Tang Wen*, a Taoist classic, a craftsman named Shi Yan created a robot out of leather, resin, and cinnabar that could sing and dance and communicate with facial expressions just like a real person and dedicated it to King Mu of the Western Zhou Dynasty (1046 BC–771 BC). This is the first record of a humanoid apparatus in ancient China (1).

Since its establishment as an academic field in the 1950s, AI has undergone over 60 years of theory, technology, and application development. In comparison to its global standing, academic research on AI in China began relatively late and has endured a tumultuous voyage marked by repression and criticism as well as accolades and success (2).

The Silent Stage (1950s–1970s)

During this period, China held a critical and negative stance towards AI, likely influenced by the scientific and technological advancements of the former Soviet Union. During its early stages, AI was commonly perceived as a form of "pseudoscience" and "revisionism" (3), leading to a lack of research in this field, with the exception of Xuesen Qian's contributions. Norbert Wiener's renowned publication, *Cybernetics, or Control and Communication in the Animal and the Machine*, was released in 1948. The fifth chapter of the publication "*Computing Machine and the Nervous System*" drew a comparison between computers and the human nervous system, which is widely regarded as the forerunner of research in the field of AI (4). The aforementioned significant piece of literature was brought into the Chinese domain by Xuesen Qian during the year 1956. In 1958, Qian released the Chinese edition of his work entitled "*Engineering Cybernetics*". In the preface, he expressed his belief that the notion of individuals being equipped with computers and machine intelligence to enhance their abilities and achieve superi-

ority was becoming a reality (5). The Chinese Association of Automation (CAA) was founded in Beijing in June 1961, marking the inception of the first academic organization in China that was dedicated to artificial intelligence, with Qian serving as the chairman of its administrative committee (6). During a particular period, Qian, a highly skilled scientist with extensive expertise and a strategic outlook, initiated a promising initiative for the advancement of artificial intelligence in China.

The Initial Stage (Late 1970s–Early 21st Century)

In China, a campaign of ideological liberation began in the late 1970s, and the country's scientific community revived. At the inauguration ceremony of the National Science Conference in 1978, Xiaoping Deng delivered a significant address on the topic of "science and technology as productive forces" and announced the national strategy of "prioritizing the modernization of science and technology." The conference urged a large number of scientific and technological experts to free their minds and devote themselves to the advancement of the Chinese scientific cause (7). Subsequently, China's AI research could proceed in a legitimate manner, and certain fundamental work was carried out progressively.

China started its AI-focused research initiatives as a result of the relentless advocacy of Qian and other experts and the constant backing of the government. The national scientific research program included initiatives like intelligent simulation (1978), intelligent computer systems (1986), intelligent robots (1986), intelligent information processing (1986), intelligent control (1993), intelligent automation (1993), etc. To study cutting-edge science and technology, including fields like AI and pattern recognition, many students were sent to industrialized nations (9). A number of significant AI research laboratories were set up (10). Such initiatives considerably boosted AI research in China and helped China catch up to industrialized nations in terms of AI technology.

The Department of Computer Science and Technology at Tsinghua University adopted the name Department of Automatic Control in 1978 and included the research fields of AI and intelligent control (11). The first Chinese monograph on AI with independent intellectual property rights was released by Tsinghua University Press in 1987 with the title Artificial Intelligence and Its Applications (12). In 1988 and 1990, respectively, China published its first monographs on robotics (13) and intelligent control (14), launching a wide range of AI studies in the academic world. To train additional scientists for AI research, several domestic schools and universities offered a variety of AI courses in the years that followed.

Associations like the Chinese Association for Artificial Intelligence (CAAI), the China Computer Federation (CCF) Artificial Intelligence and Pattern Recognition Council, and the Chinese Association of Automation Pattern Recognition and Machine Intelligence Council, as well as journals like the Journal of Artificial Intelligence, Pattern Recognition and Artificial Intelligence, and CAAI Transactions on Intelligence, were established to foster academic exchanges in the field of AI.

The initial phase of AI research was dominated by topics such as theorem proving, natural Chinese language comprehension, biological control, pattern recognition, robots, and expert systems, and a number of rudimentary results were obtained. For example, in 1978, Wenjun Wu proposed a new method for discovering and proving geometric theorems using machines, which he dubbed "geometric theorem machine proofing," for which he received the Major Science and Technology Achievement Award. Wu's theory on automated mathematics was published in Automated Theorem Proving: After 25 Years in 1984 and has been extensively disseminated internationally as Wu's Method (16). At its annual conference in 1978 (17), the CAA presented research findings on optical character recognition, handwritten numeral recognition, biological cybernetics, and fuzzy sets. In 1984, the IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI) (18) published "Planning Collision-Free Paths for Robotic Arms Along Obstacles" by Chien, Zhang, and Zhang concerning the motion paths of robotic arms. In 1990, Bo Zhang was awarded the ICL European Artificial Intelligence Prize, signifying international recognition of China's achievements in AI fundamental research (19). In August 2006, the Chinese chess software "Chess King," designed by Northeastern University, won the first Chinese Chess Computer Gaming Championships, the first human-machine Chinese Chess competition sponsored by CAAI; the supercomputer "Sky Shuttle" used in this game defeated the Chinese chess master by a score of 11:9, representing a significant leap in China's AI technology (20).

The Stage of Rapid Growth (Early 21st Century to the Present)

In the context of the rapid development of information technologies in the 21st century, such as cloud computing, big data, the Internet, and the Internet of Things, computing platforms such as ubiquitous perception data and graphics processors have led to the dramatic advancement of AI technologies, especially deep neural networks, bridging the technological gap between AI theories and their application. AI technologies such as image classification, speech recognition, automated knowledge Q&A, human-machine chess, and automatic driving have achieved significant application advancements, ushering in a period of exponential growth in AI (21).

In this phase, policy support and the influx of capital have accelerated China's AI development at an unprecedented rate. Significant technological advancements have been made in computer vision, natural language recognition, speech recognition, and other fields, and a number of globally renowned companies, including iFLYTEK, Face++, and Unisound, have arisen. iFLYTEK won first place in three speech recognition projects at the CHiME-4 competition, with an error rate as low as 2.24 percent, establishing China as the global leader in speech recognition and robot vision (22). In the interim, the Chinese AI research and development communities have endeavored to stay abreast of global research trends and have made significant advances in knowledge discovery, data mining, multi-agent systems, pattern recognition, intelligent robots, natural language processing, and automatic deduction. The gap between China and developed nations in fundamental research on AI is also closing (23).

The Chinese government first identified the advancement

of AI technology as one of the most crucial initiatives in 2015 while deploying national strategic R&D projects for intelligent manufacturing (24). It then published a number of papers in the years that followed, including "*Internet plus Artificial Intelligence Three Year Action Plan*" (25), "*New-Generation Artificial Intelligence Development Plan*" (26), and "*New-Generation Artificial Intelligence Regulatory Principles: Developing Responsible Artificial Intelligence*" (27). These government papers underlined that in the future, AI would offer prospects for social creation by serving as a new center of global competitiveness and a new engine of economic growth. They emphasized the significance of establishing AI as a national strategy and recommended guiding principles, broad deployment, key initiatives, and strategic objectives for academic study, application promotion, and commercial AI application (28).

According to various survey reports, including *China's New-Generation Artificial Intelligence Development Report 2020* (29), the *Report on Artificial Intelligence Development 2020* (30), *China's New-Generation Artificial Intelligence Technology Industry Report* 2021(31), and the *Blue Book of World Artificial Intelligence Rule of Law 2021* (32), there has been a significant increase in databases, algorithm innovations, and computing power in China over the past decade. This increase has been attributed to the widespread adoption of digital production, consumption, and social operations, which has led to breakthroughs in both basic research and practical applications of AI. In 2019, there was a notable instance of the emergence of open-source deep learning frameworks, tool sets, application software, and communities, which serves as an illustrative case. The advancement of collaboration in AI innovation has been expedited among industry and academia, as well as small, medium, and large enterprises. This has resulted in significant contributions to global AI development, positioning China as the second-largest contributor to the global AI open-source community, following the United States. As per the aforementioned reports, China has made noteworthy strides in the field of AI, with the following accomplishments being highlighted:

Massive Amounts of Scientific Research Output with a Considerable Number of High-Quality Research Results

According to *China's New-Generation Artificial Intelligence Development Report 2020*, Chinese researchers published 28,700 papers on AI in 2019, a 12.4% increase over the previous year; Tsinghua University, Peking University, and the Chinese Academy of Sciences ranked sixth, eighth, and tenth, respectively, among all the world's research institutions in terms of the total publications; among the top 100 highly cited articles on AI in the prior five years, 21 ones were from China (29).

The primary fields of machine learning, neural network interpretability techniques, and heterogeneous fusion brain-inspired computing are where innovative AI research in China has produced significant advances. The speech and image recognition technologies developed in China are among the most advanced in the world. In areas including adaptive machine learning, machine perception, comprehensive reasoning, hybrid intelligence, and swarm intelligence, China's AI research shows considerable promise. The world is paying close attention to Chinese-based information processing, intelligent surveillance, biometric recognition, industrial robots, service robots, and automatic driving, which are all approaching the phase of practical applications in China (33).

Enhanced Innovative Capacities among Enterprises and Strong Links between Industry and Academia

China is currently strengthening the leadership role of corporations in the technological innovation of AI. Anchor AI businesses in the nation have become crucial sources of investment in AI research and development, contributing increasingly to fundamental research and cutting-edge technological advances in AI (34). For instance, Alibaba DAMO Academy has developed a research and development program with an investment of over 100 billion yuan covering quantum computing, machine learning, basic algorithms, network security, visual computing, natural language processing, human-computer natural interaction, chip technology, sensor technology, embedded systems, and more. In the Alibaba economy, AI technology has permeated over 2,000 scenarios, such as online commerce, customer service, logistics, and automatic driving (35).

A collaborative framework is being established to facilitate the advancement of AI through joint efforts between industry and academia. In partnership with Nanjing University, JD.com has founded a school of AI that concentrates on advanced research domains such as reinforcement learning and large-scale optimization (36). Tencent has established an AI laboratory that focuses on research in the fields of computer vision, speech recognition, natural language processing, and machine learning. The CCF-Tencent Rhinoceros Bird Funding Program was launched through collaboration between Tencent and CCF. The program's objective is to advance AI research and enhance talent development by fostering a seamless partnership between industry and academia (37).

Governments, universities, research institutions, and enterprises collaborate to create a thriving community for AI talent cultivation. Through coordination between industry, education, and research, a complementary AI education ecology has been developed in order to construct disciplines that are highly suited to social demands. Huawei and Nanjing University collaborated to establish the LAMDA Artificial Intelligence Joint Laboratory. Baidu and Beihang University partnered to create the first automated driving graduate program in China (38).

Improved AI Industrial Structure and Prompt Application of New AI Technologies

The AI industry in China has experienced a consistent improvement in its structure in recent times, which has resulted in the influx of substantial funding in domains such as intelligent vision and intelligent transportation. The domains of intelligent education, intelligent healthcare, and intelligent robots are experiencing swift expansion, with major high-tech corporations devising ambitious, enduring strategies for vertical sectors like intelligent transportation, intelligent healthcare, and intelligent commerce (39).

China has made developing novel AI application scenarios a key strategy for accelerating AI industrial application and

technological iteration. The Ministry of Science and Technology launched seven new-generation AI innovation pilot zones in 2019 and added ten new national platforms for developing the next generation of AI (40). There are many prospects for the invention and timely commercialization of AI technology thanks to illustrative broad application scenarios like the Beijing Winter Olympics, Beijing Daxing International Airport, and Hangzhou Brain, as well as specific scenarios in other industries (29).

Conclusion

Since its establishment as an academic study in 1956, AI has not always made progress on a global scale. It has both witnessed quick advancements and stagnation. With its development came debate and even criticism. There are still questions regarding whether machines can match human intelligence even today. Undoubtedly, a new wave of technical revolutions and economic changes is being driven by AI, which is fueled by earlier scientific and technological advances. By consistently producing new goods, services, and business models, it is fostering economic growth and altering the economy. AI will significantly accelerate overall economic and social development by altering human behavior in terms of living, working, and social interaction. It will also play a significant role in determining a country's competitiveness. China has the ability to produce enormous volumes of data and a wide market due to its large population and relatively full industrial structure, making it one of the world's key hubs for AI development. In order to increase its social productivity, national competitiveness, and all-encompassing national capabilities, China must seize the strategic chance to build new-generation AI.■

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