

Translation



The following PRC government report analyzes the AI industry in China and concludes that demand for AI professionals continues to exceed supply. The U.S. job market continues to attract the majority of highly qualified Chinese AI researchers, the report finds.

Title

A New Occupation—An Analytical Report on Current Employment Prospects for AI Engineers and Technicians

新职业——人工智能工程技术人员就业景气现状分析报告

Author

PRC Ministry of Human Resources and Social Security (人力资源和社会保障部; 人社部)

Source

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The Chinese source text is available online at:

https://web.archive.org/web/20200730182548/http://www.mohrss.gov.cn/SYrlzyhshbzb/dongtaixinwen/buneiyaowen/202004/t20200430_367110.html

US \$1 ≈ 7 Chinese Yuan Renminbi (RMB), as of September 3, 2020.

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I. Background

Artificial intelligence (AI) has taken on strategic national importance and is driving the innovation of China’s supply-side reforms. As stated in the 19th Party Congress Report, “we must accelerate the construction of China into a manufacturing superpower (制造强国), promote the development of advanced manufacturing, and fully integrate the internet, big data, and AI into the real economy.” AI has been included in the government work report for the past three years. Accelerating the in-depth application of AI, cultivating and expanding the AI industry and talent pool, meeting the new global demand for talented AI workers driven by this scientific and technological revolution and industrial transformation, and supporting national strategies—such as the strategy of rejuvenating the nation through science and education, the innovation-driven [development] strategy, and the strategy of building China into a talent superpower (人才强国)—are providing key support for Chinese economic development.

Over the past three years, the State Council, National Development and Reform Commission, and Ministry of Industry and Information Technology have released strategic directives on numerous occasions, such as the *New Generation Artificial Intelligence*

*Development Plan*¹ and the *Three-Year Action Plan for Promoting the Development of a New Generation Artificial Intelligence Industry (2018–2020)*,² which all promote the development of artificial intelligence. The *Three-Year Action Plan* states that one of the five safeguards is accelerating professional training; in other words, “attract and train high-end AI talent as well as innovative, entrepreneurial talent, support the growth of a group of leading talent and top young talent, support the creation of better science majors related to AI, and guide and train the skilled personnel that are urgently needed for the industry to grow.”



As this timeline shows, the Chinese government is prioritizing the development of AI in a big way and is making the industrialization and integrated application of new-generation AI technologies key areas of development. At the same time, it is also emphasizing the importance of training skilled individuals in the field of AI.

II. Job definition

Artificial intelligence engineers and technicians: Engineers and technicians (工程技术人员) who handle the analysis, research, and development of a host of technologies related to AI algorithms and deep learning, as well as design, optimize, operate, maintain, manage, and find applications for artificial intelligence systems.

Primary job responsibilities of AI engineers and technicians:

1. Analysis and research of technologies such as AI algorithms and deep learning, and the application of said technologies;
2. Research, development, and application of AI instructions and algorithms;

¹ For an English translation of this document, see:

<https://www.newamerica.org/cybersecurity-initiative/digichina/blog/full-translation-chinas-new-generation-artificial-intelligence-development-plan-2017/>

² For an English translation of this document, see:

<https://www.newamerica.org/cybersecurity-initiative/digichina/blog/translation-chinese-government-outlines-ai-ambitions-through-2020/>

3. Planning, design, and development of AI algorithm-based chips;
4. R&D, application, and optimization of AI technologies, such as speech recognition, semantic recognition, image recognition, biometric feature recognition, etc.;
5. Design, integration, management, and deployment of AI hardware and software systems; and
6. Design and development of AI system solutions.

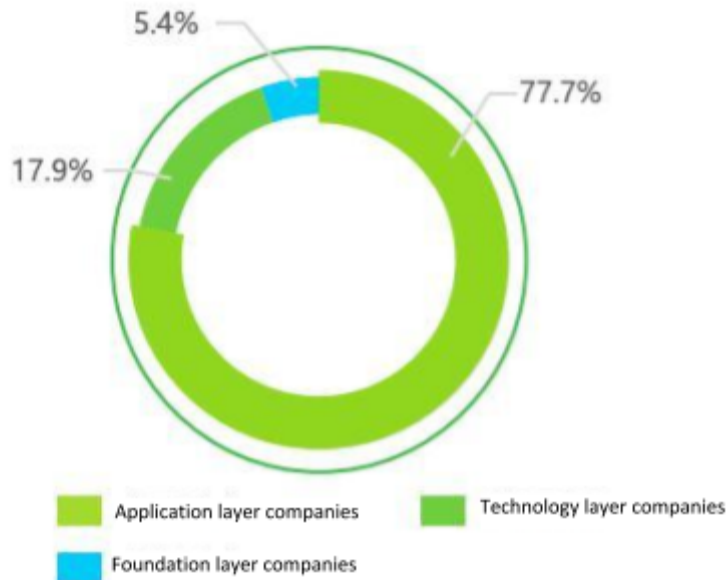
III. Analysis of current workforce

(i) Size and distribution of the AI industry

The AI industry can be divided into three layers: The foundation layer, the technology layer, and the application layer. The foundation layer is primarily centered on AI chips, computer languages, algorithm structures, etc. The technology layer is focused on the research and development of applied algorithms, such as for computer vision, intelligent language, natural language processing, etc. The application layer deals with the integrated and applied research and development of AI technologies.

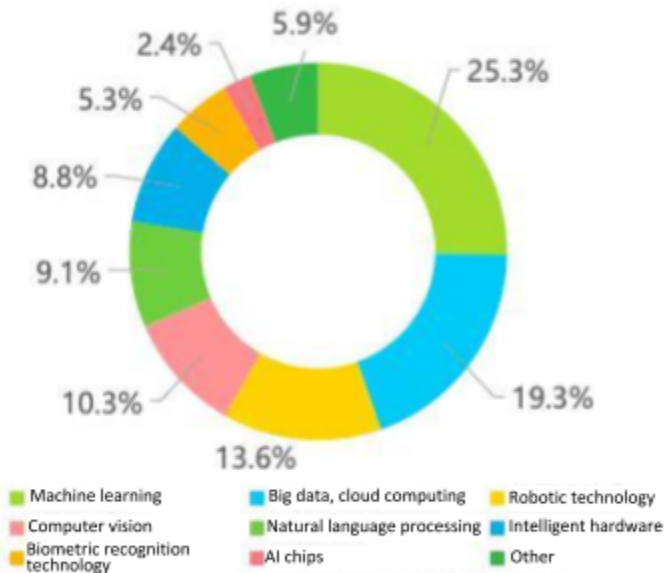
As information published by iResearch (艾瑞咨询) shows, in 2018, there were a total of 2,167 companies related to artificial intelligence in China, of which 77.7% were working in the application layer. The percentage of those in the technology and foundation layer was relatively low, together accounting for only 22.3%. In terms of how different technology types are represented, most companies are working in machine learning, accounting for 25.3%, followed by big data, cloud computing, robotic technology, and computer vision companies, which are distributed relatively evenly overall. The following figure shows this distribution in detail.

Distribution of Chinese AI Companies by Layer in 2018

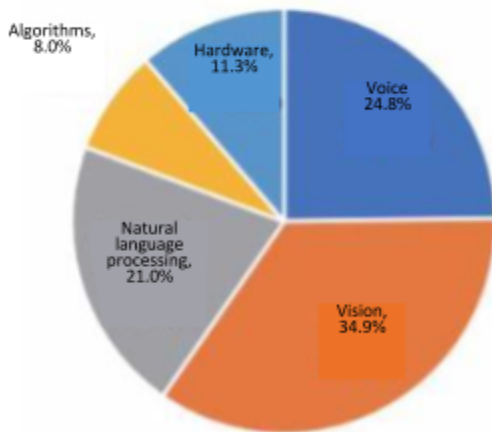


Source: iResearch, based on data and research outlined by the Chinese Institute of New Generation Artificial Intelligence Development Strategies.

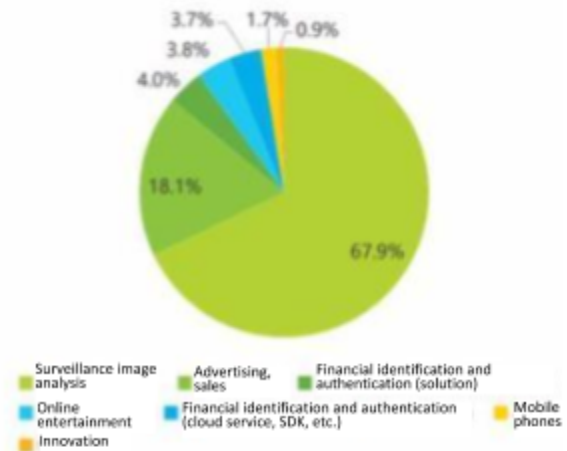
Distribution of Chinese AI companies in 2018 by main technology type



Source: iResearch, based on data and research outlined by the Chinese Institute of New Generation Artificial Intelligence Development Strategies.



Source: 2018 Chinese Artificial Intelligence Development Report
Structure of the Chinese AI Market



Source: 2017 Chinese Computer Vision Industry Research Report
Makeup of the Chinese Computer Vision Industry and Market

(ii) AI industry and market size

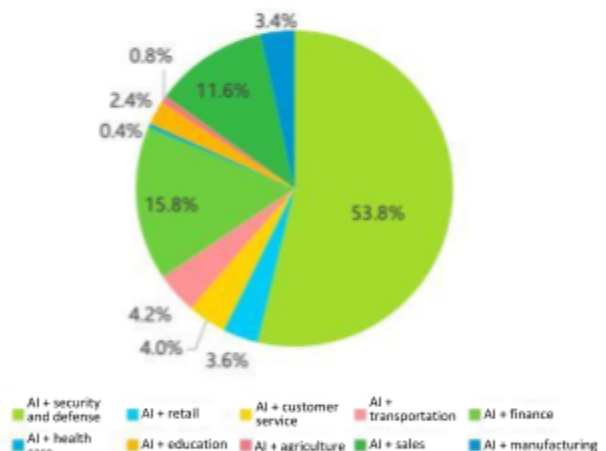
In recent years, finding application scenarios in the real economy in which to roll out AI technology has become a core imperative. AI technology has been added in a substantive way to traditional industrial business models and business processes. A brand-new industrial layout for an intelligent economy has begun to emerge, and in 2019, it is expected that the size of the core artificial intelligence industry will exceed 57 billion Chinese yuan Renminbi (RMB). Market share in the security and financial sectors is currently the highest, while the potential for large-scale expansion is highest in the industrial, medical, education, and other sectors.

Chinese AI boosts the size of the real economy, 2018–2022



Source: iResearch, per expert interviews and independent research.

Chinese AI boosts share of individual industries in the real economy, 2018



Source: iResearch, per statistical modeling based on research on the sizes of various industries and markets. For the statistical methods used for this figure, please see the breakdown by area below.

(iii) Supply and demand for AI industry workers

As the concept of artificial intelligence has continued to take off, a large number of job seekers have proactively been approaching AI-related positions. According to the *2017 Global AI Talent White Paper*, over the past few years, the number of job seekers in China who are hoping to work in the field of AI is increasing rapidly, doubling every year. This is especially true of AI foundation layer positions, such as algorithm engineers, the supply of which has risen by more than 150%.

To compare the supply and demand for AI talent in China, the white paper proposed a supply and demand index, which created a model according to four indicators during a set period of time: Overall industry hiring demand, number of active job seekers, recruitment activity, and employment activity. As the results show, the current supply and demand index for AI talent in China is increasing year after year. In 2017, Chinese AI talent supply and demand increased by 11% compared to 2015. On the surface, it would seem that the supply and demand for AI talent is essentially balanced, while the quality of the talent in question varies widely. As shown after a detailed analysis of each of the parameters used for the workers, nearly 30% of job seekers that were hoping to showcase their abilities in the field of AI were still miles behind in each of the indicators required by AI employers. This group of people was made up of either job seekers with low educational attainment or young and inexperienced entry-level programmers with only very basic programming knowledge and a lack of actual AI skills. This shows that, not only is there a serious shortage of AI talent in China, this trend is also being exacerbated by the growing number of AI companies. There is a wide gap between the supply and demand of talent for some key positions, such as speech and image recognition engineers, among others. Moreover, given that the amount of time needed to train qualified AI talent is significantly longer than for regular IT, it is very difficult to effectively fill the talent gap in a short period of time.

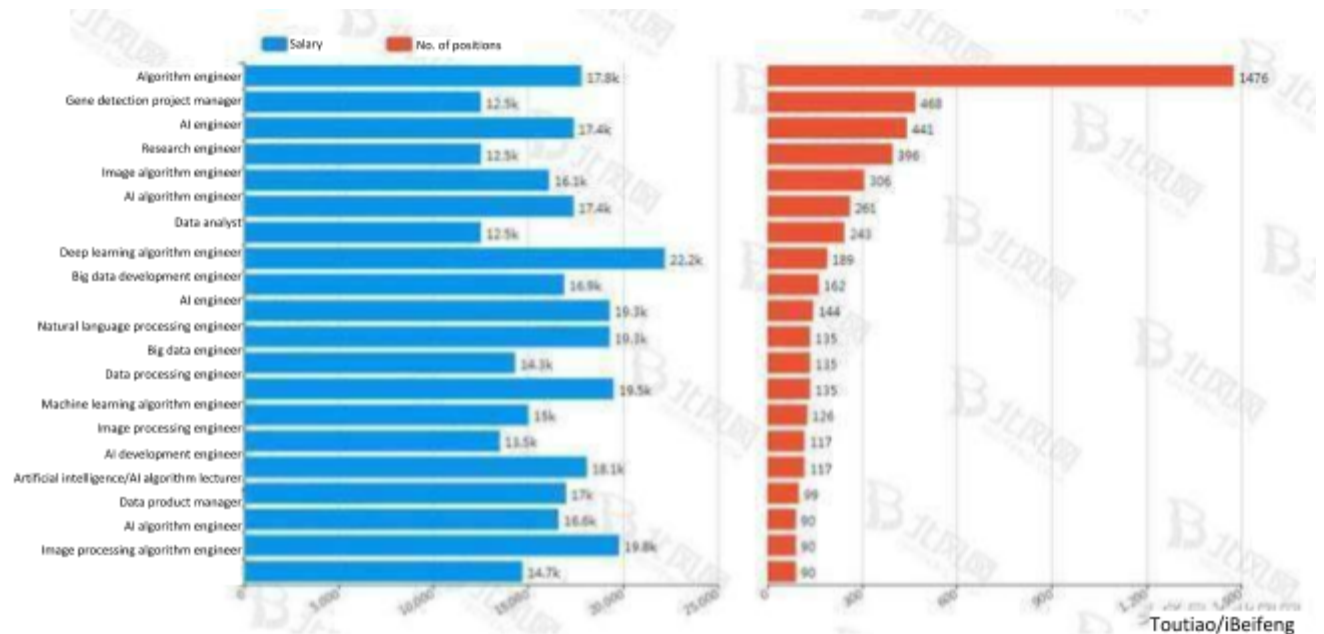
(iv) AI engineer and technician salaries

According to data from various large job search websites, AI industry salaries are highest in Beijing–Tianjin, the Yangtze River Delta Economic Zone, the Pearl River Delta Economic Zone, and some interior provincial capitals. Salaries in Beijing, Shanghai, Shenzhen, and Hangzhou are ranked at the top, with monthly salaries around RMB 18,000. Suzhou, Nanjing, Guangzhou, and Xiamen are ranked second, with monthly salaries around RMB 14,000. Other coastal and interior provincial capitals, such as Chengdu, Chongqing, Changsha, and Jinan are ranked third, with monthly salaries around RMB 13,000.



Note: Image from iBeifeng (北风网)

Of the salaries surveyed, the highest salaries were for deep learning algorithm engineers, whose monthly salaries can exceed CNY 22,000. In terms of the number of jobs available, algorithm engineers are by far the highest in demand.



Note: Image from iBeifeng

It is estimated that there is currently an AI talent shortage in China of more than five million people, reflecting a serious imbalance between supply and demand with a domestic

supply-to-demand ratio of 1:10. Continuously improving worker education and filling the talent gap are of the highest priority in China.

The AI talent in China has major shortcomings, and there is a wide gap between the United States and China. According to the *2019 Global AI Talent Report* published by foreign firm ElementAI, China has become the country that is likeliest to attract investment (吸金). Due to the entrepreneurial environment, government support, and the massive amount of data in China, Chinese investment in the AI industry accounted for 60% of the global total, and China has enticed a relatively high number of talented students who have studied abroad to return to China to grow their careers. Even so, in terms of cultivating and attracting talent, China is still lagging behind the United States.

According to the data, 58% of high-level Chinese researchers pursue postgraduate studies in the United States, while 35% pursue postgraduate studies in China and 7% go to another country (such as Australia and the United Kingdom) for their studies.

Of the high-level Chinese researchers who graduate from universities in the United States, 78% remain to work at research institutions in the United States and only 21% return to work at research institutions in China. The report also states that the top five countries around the world that are attracting AI talent are, in order, the United States, China, the United Kingdom, Germany, and Canada, which account for 72% of AI talent. While China is ranked near the top, quantitatively, it lags far behind the United States and has only a quarter of the U.S. numbers. If China does not improve talent cultivation or use a “mass production” talent model, by 2025, the talent shortage in China will exceed ten million.

IV. Career path

The ultimate role for an artificial intelligence engineer or technician is as a company’s chief technology officer (CTO). The career path can roughly be divided into three stages: Entry-level engineer or technician, mid-level engineer or technician, and senior engineer or technician.

Role of a company’s entry-level engineer or technician: Responsible for design, code implementation, and analyzing, diagnosing, troubleshooting, and resolving difficult bugs for the features of the solutions that are being made.

Role of a company’s mid-level engineer or technician: Develop workload assessments and assign tasks; check and approve code, identify risks, report them, and coordinate to resolve them; R&D and sharing of code templates; summarization and distribution of best practice specifications; R&D and popularization of automated research, development, and production tools.

Role of a company’s senior engineer or technician: Set up the platform R&D department; build a public technology platform and facilitate the development of the aforementioned product lines; manage and coordinate each of the product line groups using technology platforms and a higher level of functional authority. At this stage, all product lines should have a qualified R&D leader and senior engineer.

Role of a company’s CTO: Achieve performance targets, discern customer needs, seize business opportunities, outline technical products, and increase business through technical

products; have a clear strategic plan and business focus; lead teams to realize organizational goals. The cutting edge and platforms: At this level of the research and development scale, specialized teams are needed to look for innovative technical applications and research cutting-edge technologies. Furthermore, strong, coordinated bonds must be formed with technical platform teams and application R&D teams so that innovative prototypes and pilots can be added to the business platform smoothly and make it so that the R&D process for applications can be used at scale. R&D process management: Holistic end-to-end business process improvement to facilitate business growth. Organizational and personnel development: Sharing of corporate culture and values; creating the organizational system for a team of R&D experts and managers; creating an innovative incentive system; motivating researchers to innovate and make progress; motivate those who seem unlikely to be successful (黑马) so that they bring their talents to the fore.

V. Future market demand

IDC and Forrester have published artificial intelligence (AI) forecasts for 2020 and beyond. Forrester has observed that, while the external "market" could make companies adopt a cautious stance towards AI, "brave" companies will continue to invest in and expand their use of AI. Forrester has predicted the following:

53% of global decision-makers say that they have either already implemented, are currently implementing, or are currently expanding the use of AI.

In the past year, 29% of global developers worked on AI or machine learning software.

Among the global companies implementing edge computing, 54% of decision-makers said that edge computing has provided significant flexibility for dealing with their current and future AI needs.

16% of global B2C marketing decision-makers are planning on increasing spending on data and analysis technology (including AI) this year by 10% or more.

IDC has predicted that by 2022, 75% of companies will have embedded intelligent automation into technology and process development and use AI-based software to guide innovation. By 2024, AI will be integral to every part of the business, resulting in 25% of the overall spend on AI solutions as "outcomes-as-a-service" that drive innovation at scale and superior business value. AI will become the new user interface and redefine the user experience. Over the next several years, we will see AI and emerging user interfaces such as computer vision, natural language processing, and gesture embedded in every type of product and device.

VI. Expert opinions

Huai Jinpeng (怀进鹏), Executive Vice President and Secretary of the Party Group of the China Association for Science and Technology and Academician of the Chinese Academy of Sciences: AI is currently still facing many bottlenecks in terms of basic theory and key technologies. There are many difficult problems that are waiting to be cracked. These include pending breakthroughs in the fields of theoretical algorithms and platform systems. This is a source of rich technologies and industries. "Industry runs on talent," and talent is the number-one resource. The quality, level, and size of the talent pool is determining and

restricting the height and development of the industry. We must deepen collaboration between industry and academia, increase domestic and international collaboration, encourage contractual education mechanisms based on crossover and interdisciplinary collaboration to create a fertile environment for growing and cultivating new talent, promote the creation and improvement of structural conditions that are both conducive to the development of originality and are able to effectively unlock potential. We need to prepare for the future.

Lin Nianxiu (林念修), Vice Minister, National Development and Reform Commission (NDRC) and Director, Office for Furthering the Construction of Shanghai into a Science and Technology Innovation Center (上海推进科技创新中心建设办公室): China will emphasize the implementation of three major actions, including the implementation of open AI development, close and comprehensive collaboration with every country in areas such as AI technology, standards, production, regulation, ethics, etc.. We must collectively discuss governance rules for AI, collectively build major AI projects, and collectively enjoy the fruits of AI development. The other two actions include, firstly, setting up AI innovation partnerships, focusing on one hundred AI companies, tech companies, and application companies, supporting them in conducting collaborative R&D, production and promotion, and drafting integrated standards, figuring out generic technology, and promoting the solid integration of artificial intelligence into the real economy. Secondly, sharing AI resources, setting up AI industry innovation centers, improving open-source platform systems, deepening government IT system integration and encouraging IT resource sharing, introducing and promoting guidance for new types of basic infrastructure development, and creating an industrial ecology for AI.

Hu Yan (胡燕), Director, Science and Technology Department of the Ministry of Industry and Information Technology: For the past several years, the Chinese artificial intelligence industry has been in the envious position of developing vigorously. Firstly, some key applied technologies, particularly technologies such as image and speech recognition, etc. are at relatively high levels globally, and the total number of AI papers and the high volume of cited papers are among the highest in the world. Secondly, the overall strength of the industry has improved significantly. In China, the AI industry counts more than 1,000 companies covering many segments, such as technology platforms and product applications, that have formed a relatively complete production chain. The pattern of rapid AI industry development in the Beijing-Tianjin-Hebei region, the Yangtze River Delta Economic Zone, and the Pearl River Delta Economic Zone is already taking shape. Thirdly, integration with industrial applications continues to deepen. Thanks to its strong empowering ability, AI is currently becoming an important force driving the transformation and upgrading of traditional industries. New technologies, models, and ways of doing business are popping up in every AI+ field, and spillover effects are continuously increasing in every direction. However, in this process of fast development, we must also acknowledge that China's basic AI technologies still have serious shortcomings and there are relatively few that are able to create true business value. The integration of AI with traditional technologies is currently at a major tipping point. Some data shows that AI investment this year has decreased somewhat significantly as compared with the past two years, and especially with last year.

Liu Duo (刘多), Deputy to the National People's Congress and President, China Academy of Information and Communications Technology (CAICT): New generation artificial intelligence is spreading and developing like wildfire around the world and will have a large, significant

impact on the development of every sector, including the economic, social, and military sectors. While seizing the important development opportunity presented by artificial intelligence, governments, businesses, and the education sector in every country around the globe are also setting their sights on researching and guarding against every new problem and challenge encountered in the development of AI, especially risks and threats that are closely related to people's lives and safety, such as moral and ethical violations, algorithmic bias and discrimination, privacy leaks, and more. The AI industry and the applications of AI are developing well in China and are ranked first in the world. Moving forward, while promoting the high-quality development of the real economy, AI will continue to play an important role with its enabling technology and critical infrastructure. In order to make sure that the development of AI is safe, reliable, and controllable, and to make the use of AI more widespread, I recommend that a comprehensive, multi-tiered ecological safety system be built that focuses on such aspects as promoting the deep integration of AI into the real economy, self-regulation of industries and businesses, the drafting of legislation, the creation of a governance framework and standards, and the implementation of monitoring and supervisory measures.

Zhang Xu (张旭), Deputy Director, Department of Strategic Planning, Ministry of Science and Technology: In China, AI is applied widely and in a wide range of industries. From an industrialization perspective, it has unique advantages. However, it is also facing serious challenges, especially in terms of basic theory and algorithms. It has had insufficient ability to make original innovations and has a weak base in areas such as high-end chips and key components. There is also a lack of highly qualified talent. As AI continues to develop quickly around the world, every country will continue to make breakthroughs in areas such as cognitive intelligence, machine learning, smart chips, and more.