

CHINA AI DEVELOPMENT REPORT 2018

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EXECUTIVE SUMMARY

This report examines China's AI development from four perspectives — S&T output and talent input, industry development and market applications, development strategy and policy environment, and social perception and general impact. Below is a summary of the main findings of each part.

S&T Output and Talent

Paper output: China leads the world in AI papers and highly cited AI papers

China's AI papers as a percentage of the global total increased from 4.26% in 1997 to 27.68% in 2017, far ahead other countries. Universities have contributed the vast majority of AI papers, with 87 of the top 100 AI research institutions in the world being universities. Top Chinese universities have shown impressive performance internationally in the output of AI papers. Moreover, China's highly cited papers have also grown rapidly, overtaking the U.S. to take the first place in 2013. State Grid Corporation of China (SGCC) is the only Chinese company to rank

among the world's top 20 companies in AI paper output. In terms of categories, computer science, engineering, and automatic control systems have the highest AI paper output. International collaboration has a significant effect on AI paper output, with as many as 42.64% of top papers being the product of international collaboration.

Patent application: China has more AI patents than U.S. and Japan; SGCC has an outstanding performance

China has become the largest owner of AI patents, followed closely by the U.S. and Japan, and the three countries combine to have 74% of the world's issued AI patents. Global AI patent applications have focused on categories including voice recognition, image recognition, robotics, and machine learning. Among China's top 30 institutional owners of AI patents, research institutions and universities are comparable with enterprises, with the former's patents accounting for 52% and the latter's 48%. However, performance varies greatly among main enterprise assignees of AI patents, with SGCC being

a towering presence which has developed rapidly in AI research especially over the last five years and not only holds far more AI patents than other domestic assignees but ranks fourth among enterprise assignees globally. China's AI patents have been concentrated in data processing systems and digital information transmission, with image processing and analysis related AI patents accounting for 16% of the total. Electrical power engineering has also become an important area of China's AI patenting.

Talent: China has the world's second largest AI talent pool, though with a lower percentage of top talents

By the end of 2017, China's AI specialists reached 18,232, or 8.9% of the global total, next only to the U.S. (13.9%). Universities and research institutions are the main cradles of AI specialists, with Tsinghua University and the Chinese Academy of Sciences being the world's largest institutions of AI talent development. However, China has only 977 AI specialists in the world's top-tier AI talent pool based on the H-index, being only one fifth of number in the U.S., ranking sixth in the world. Chinese companies have a comparatively low level of AI talent input. Companies with a high level of talent input are concentrated in the U.S. Huawei Technologies is the only Chinese company to make into the global top 20. China's AI specialists are concentrated in the eastern and central regions, though some cities in the western region, such as Xi'an and Chengdu, have also been prominent. International AI specialists are concentrated in categories including machine learning, data mining and pattern recognition, while Chinese AI specialists are scattered in different categories.

Industry Development and Market Applications

AI companies: China ranks second in the number of AI companies; Beijing has the highest concentration of AI companies in the world

Chinese AI companies began mushrooming from 2012 and had reached a total number of 1,011 by June 2018, ranking second in the world, though still significantly behind the U.S., which has 2028 companies. Chinese AI companies are highly concentrated in Beijing, Shanghai and Guangdong. Among the world's top 20 cities in terms of AI companies hosted, Beijing ranks first with 395, and Shanghai, Shenzhen and Hangzhou are also among the top 20. China's AI companies mainly specialize in three categories—voice, vision and natural language processing—with only a small percentage focusing on basic hardware.

Venture investment: China has the highest venture investment in AI

From 2013 to the first quarter of 2018, China received 60% of the world's total venture capital investment in AI, but in terms of the number of VC investments received, the U.S. remained the most active country in VC investment in AI. In China, Beijing led other regions by a big margin in the amount and rounds of VC investment, followed by Shanghai and Guangdong which have been fairly active in AI investment as well. From 2014, early-stage investment in AI as a percentage of the total investment in AI has gradually decreased as investment activity has become more rational, though Series A funding has remained in a dominant position.

Market scale: China's AI market grows rapidly; computer vision is the largest segment

In 2017, China's AI market reached RMB23.7 billion, up 67% Y/Y, with the top three segments being computer vision (34.9%), voice (24.8%) and natural language processing (21%), and hardware and algorithm combining to account for less than 20% of the market. The market is expected to grow 75% in 2018.

Product applications: AI gains wide applications, with voice and vision products being the most mature

AI has been widely applied in healthcare, finance, education and security. The global smart speaker market has grown rapidly, where major Chinese and international internet companies have expanded their presence, with Google and Amazon having taken up more than 60% of the global market, followed by Alibaba in third place and Xiaomi in fourth place. In 2017, the global robotics market reached US\$23.2 billion, of which the Chinese market represented 27%. Other AI-related markets such as drone, smart home, smart grid, smart security, smart healthcare and smart finance have also seen rapid development.

Development Strategy and Policy Environment

International comparison: countries vary in their AI strategies and policy priorities

Since 2013, the U.S., Germany, the UK, Japan and China have rolled out their AI strategies and

policies, each with their own priorities, with the U.S. focusing on the impact of AI on economic growth, technology development and national security, the EU on the ethical risks brought by AI in such aspects as security, privacy and human dignity, Japan on building “Society 5.0”, and China on industrialization of AI applications in the service of its “Manufacturing Power” strategy. This leads to remarkable differences among the countries in their AI research priorities and application areas.

National policy: from IoT to big data to AI

Since 2009, China's AI policy has undergone five stages with changing keywords which reflect the different priorities in each stage, with the focus shifting from basic research in such categories as IoT, information security and database in the early period, to big data and infrastructure in the middle period, to AI itself and also intellectual property protection after 2017. Overall, China's AI policy mainly focuses on six categories: “made in China”, innovation-driven development, IoT, Internet+, big data, and scientific and technological R&D.

Local policy: aligning with national policy under distinctive local themes

“Made in China 2025” is at the center of the China AI policy citation network and has served as a programmatic document for local governments' AI policymaking as they respond to the national AI development strategy. Based on policy documents, China's AI powerhouses are Beijing-Tianjin-Hebei, Yangtze River Delta and Guangdong-Hong Kong-Macao regions. At the provincial level, policy themes vary widely, with Jiangsu focusing on infrastructure, IoT and cloud computing, Guangdong on AI applications such as manufacturing and robotics,

and Fujian on IoT, big data, innovation platform and intellectual property, reflecting their local development conditions.

Public Perception and General Impact

Public perception: *The Chinese public has a high AI awareness, with half respondents expressing support of comprehensive AI development*

From 2016 to 2017, AI drew massive public attention and became the most discussed popular science topic. According to a Toutiao survey of users, only 6.23% reported ignorance of AI; 53% expressed support of comprehensive AI development; and 27% held a conservative attitude towards AI development. Concerns included the replacement of jobs by AI and social crises that might be caused if AI is out of control. Overall, the Chinese public has distanced from the extremes of being overly optimistic or overly pessimistic and become more rational about AI. Interest in AI also varies significantly according to application area, age, gender and region.

Social impact: *AI is capable of significantly increasing efficiency in different sectors but also poses risks*

AI development is transforming the development patterns in different sectors including retail, agriculture, logistics, education and finance and reshaping production, allocation, exchange and consumption. AI is expected to be applied to more industries and bring substantial efficiency increases in the coming five years—specifically, efficiency improvements of 82% for education,

71% for retail, 64% for manufacturing and 58% for finance. AI will facilitate personalized education and promote the development of education. On the other hand, it will pose serious challenges in such aspects as employment, privacy, security and social equality.

Education survey: *More AI programs are offered in universities and enthusiastically embraced by students*

By July 2017, there were 36 universities approved by the Ministry of Education to offer the bachelor's degree program in "Intelligence Science and Technology" and 79 offering AI-related programs. Top Chinese universities have set up their AI labs. Currently, China's AI teaching and research activities are mainly concentrated in computer science, electronic information and automation faculties of universities. According to an online survey, online platforms have surpassed universities to become the No. 1 channel for young people to take AI courses. Netizens have shown a strong interest in learning AI, with 61% of respondents stating that they devote 10-20 hours a week to AI learning.

Based on existing research and the abovementioned findings of this report, we arrive at the following preliminary judgements and reflections on China's AI development.

Internationally, China ranks in the top echelon of AI development

Unlike in the past industrial revolutions where China was left behind and struggled to catch up, China has got a head start for the fourth industrial revolution. In AI, in fact, China has secured a leading position in the top echelon in both technology development and market applications and is in a race of "two

giants” with the U.S.

In terms of the quality of development, China’s AI development is far from admitting optimism

China’s strengths are mainly shown in AI applications and it is still weak on the front of core technologies of AI, such as hardware and algorithm development, China’s AI development lacks top-tier talent and has a significant gap with developed countries, especially the U.S., in this regard.

In terms of participating entities, China’s AI companies leave much room for improvement in knowledge production

Research institutions and universities are the main producer of AI knowledge in China. Compared to their foreign counterparts, Chinese AI companies are technologically inventive and far behind domestic universities and research institutions in AI patenting. Even recognized domestic AI giants such as Baidu, Alibaba and Tencent (BAT) don’t have an impressive performance in AI talent, papers and patents, while their U.S. competitors like IBM, Microsoft and Google lead AI companies worldwide in all indicators.

In terms of application areas, the integration of AI with energy systems is an important area that has been neglected

Electrical power engineering is an important AI patenting area of China, where SGCC has been the most prominent company in both AI paper publication and AI patenting. The fact that it has been either unmentioned or not highlighted in previous AI studies shows that the integration of AI

with energy systems is likely an area that has been more or less neglected and represents a potential new direction of expansion of AI applications in China which will contribute to low-carbon transformation of the energy sector.

In terms of the pattern of development, China needs to strengthen industry-university research collaboration to promote knowledge application and transformation

International collaboration and industry-university collaboration are important means of advancing AI development. In China, a lot of AI knowledge is lying idle at universities and research institutions, and it is imperative to increase industry-university collaboration to promote AI knowledge application and transformation. Going forward, China needs to not only vigorously promote industry-university collaborative innovation but also explicitly support companies to engage in AI basic research by leveraging their data and computing strengths.

In terms of policy environment, local governments should avoid blindly following suit in AI policymaking

The Chinese society has, overall, a positive and optimistic attitude towards AI development which has a very favorable environment in terms of policy, public opinion, finance, market and talent pool, but at the level of local government policymaking, there has been a tendency of “following the steps of the central government” and “chasing after hot areas”. Currently, China’s AI policy has emphasized on promoting AI technological development and industrial applications and hasn’t given due attention to such issues as ethics and security regulation.