

China's huge population is helping the nation to make great strides in facial-recognition technology.

ARTIFICIAL INTELLIGENCE

China's ambitious quest to lead the world in AI by 2030

The United States is ahead in terms of high-impact AI papers and people, but for how long?

BY SARAH O'MEARA

China not only has the world's largest population and looks set to become the largest economy — it also wants to lead the world when it comes to artificial intelligence (AI).

In 2017, the Communist Party of China set 2030 as the deadline for this ambitious AI goal, and, to get there, it laid out a bevy of milestones to reach by 2020. These include making significant contributions to fundamental research, being a favoured destination for the world's brightest talents and having an AI industry that rivals global leaders in the field.

As this first deadline approaches, researchers note impressive leaps in the quality of China's AI research. They also predict a shift in the nation's ability to retain home-grown talent.

That is partly because the government has implemented some successful retention programmes and partly because worsening diplomatic and trade relations mean that the United States — its main rival in most things, including AI — has become a less attractive destination.

"If America loses its openness edge, then the country risks pushing AI talents right back into the arms of its competitors, including China," says AI analyst Joy Dantong Ma at the Paulson Institute, a think tank in Chicago, Illinois, aimed at fostering US-China relations.

But observers warn that there are several factors that could stymie the nation's plans, including a lack of contribution to the theories used to develop the tools underpinning the field, and a reticence by Chinese companies to invest in the research needed

to make fundamental breakthroughs.

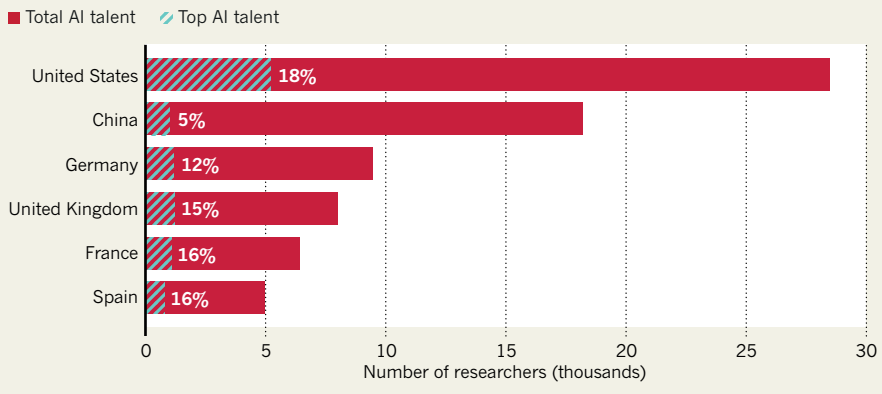
The country's pursuit of AI domination is more than a symbolic race with the United States, say scientists. AI technologies promise advances in health care, transport and communications, and the nations that make fundamental breakthroughs in the field are likely to shape its future directions and reap the most benefits.

"There's no doubt China sees AI as one of the critical technologies of this era and wants to match the United States," says Jeffrey Ding, who studies China's development of AI at the Future of Humanity Institute at the University of Oxford, UK.

The initiative unveiled in 2017, known as the New Generation Artificial Intelligence Development Plan, has spurred myriad policies and billions of dollars of investment in research and development from ministries, provincial ▶

AI TALENT CONCENTRATION

China has the second-largest number of researchers who have published AI papers or been issued patents in the field in the past decade. But the proportion of those considered to be in the top 10% of the field is smaller than in other AI-leading nations.



► governments and private companies.

China is well on its way to making a significant impact, according to an analysis of the most-cited AI papers indexed on the scholarly search engine Microsoft Academic. The analysis, by the Allen Institute for Artificial Intelligence in Seattle, Washington, found that China has steadily increased its share of authorship of the top 10% most cited papers. Its share peaked at 26.5% in 2018, not far behind the United States, at 29%, whose share is declining. If this trend continues, China could overtake the United States in this measure next year. Other analyses show that average citations for AI papers by authors in China have been steadily increasing and are above the world average, but lower than for papers by US authors.

China also has world-leading companies in computer vision, speech recognition and natural-language processing, including SenseTime, Unisound, iFLYTEK and Face++, says Zheng Nanning, director of the Institute of Artificial Intelligence and Robotics at Xi'an Jiaotong University.

FUNDAMENTAL IMPACT

But the country is still behind in shaping the core technological tools of AI. For instance, the open-source platforms TensorFlow and Caffe, developed by US academics and companies to design, build and train the sets of algorithms that enable computers to function more like the human brain, are widely used in industry and academia the world over. Yet PaddlePaddle, one of the major open-source platforms developed by Chinese company Baidu, is used mostly for the quick development of AI products, says Zheng.

China also lags behind in AI hardware, he says. Most of the world's leading AI-enabled semiconductor chips are made by US companies such as Nvidia, Intel, Apple, Google and Advanced Micro Devices. "We also lack expertise in designing computing chips that can support advanced AI systems," Zheng says.

Zheng predicts that it could take 5–10 years for China to reach the level of innovation in

fundamental theories and algorithms that is occurring in the United States and the United Kingdom — but that it will get there.

Contributing to these fundamental theories and technologies will be key to China meeting its longer-term AI goals, says Kristin Shi-Kupfer, a political scientist at the Mercator Institute for China Studies, a think tank in Berlin. Without progress in research to enable genuine breakthroughs in machine learning, there might be a ceiling to the growth that China can achieve in the field of AI, she says.

A factor that will be equally important to China's progress — and in which there seems to be more promise — is the ability to hold on to talented researchers. According to the *China AI Development Report 2018*, which is jointly written by academics and industry, by the end of 2017, China was home to the second-largest pool of AI scientists and engineers, about 18,200 people, ranking behind the United States, which had roughly 29,000. But China was just sixth in its number of top AI researchers — the most productive and highly cited authors, based on the report's *h*-index (see 'AI talent concentration').

Ma says that computer scientists have typically trained in the United States and then stayed there to work for technology companies.

There are signs that the situation is changing, however. AI institutes in China are trying to lure some of these researchers back to the mainland with high salaries. At Zheng's robotics centre, for example, some of the researchers are paid two to three times more than others at the university, he says.

Zheng says that the centre also offers a more holistic evaluation system for staff than is found at many Chinese universities, which tend to reward high publication rates over other criteria. He has also implemented a hiring system that bypasses centralized university procedures and allows scientists to build teams quickly, and now runs undergraduate AI courses.

China's plan to have globally leading AI companies by 2020 is also within reach, given the growing expertise of its three core tech companies, Tencent, Baidu and Alibaba, says Ding. But they aren't in the same tier as companies such as Google and Microsoft, he adds.

China also has at least ten privately owned AI start-ups valued at more than US\$1 billion, including facial-recognition firm SenseTime, according to the research company CB Insights in New York City.

Ma says that a big advantage for China is the size of its population, which creates a large potential workforce and unique opportunities to train AI systems, including large patient data sets for training software to predict disease. In February, Chinese researchers showed that their natural-language-processing system could diagnose common childhood conditions from electronic health records with comparable accuracy to experienced paediatricians (H. Liang *et al. Nature Med.* 25, 433–438; 2019). The data set included nearly 600,000 children visiting a single hospital; accessing that amount of data would be difficult in many other countries.

ETHICAL PRINCIPLES

If China is to have global influence in the field of AI, it is also important that it has proper governance, says Ma, because this will allow researchers and companies in China to build the trust necessary to gain global users — and to build collaborations with international researchers. Like many countries, China has begun the process of setting ethical principles for its development and use of AI. If Chinese companies don't promise good governance, they won't be allowed access to global data, says Ma. "It's in their interest to play fair."

In June, the National New Generation of Artificial Intelligence Governance Committee released eight principles to be observed by those working in AI development. These include harmony, fairness and justice, respect for privacy, safety, transparency, accountability and collaboration, and are similar to those released by the international Organisation for Economic Co-operation and Development in May, says Ding.

But ethical issues can vary from country to country. China, for instance, has attracted criticism from human-rights advocates over alleged uses of facial-recognition technology to track members of the Uighur people, a predominantly Muslim community in Xinjiang. That said, Chinese authorities are not alone in using AI for law enforcement — the US FBI uses facial-recognition technology as part of its investigations.

A key challenge faced by all groups is transparency in how algorithms make decisions. There are no agreed standards for this, so China, like many countries, is still working out how to proceed. The European Union's General Data Protection Regulation, which gives users the right to ask how an algorithm comes to its decision when it relates to their own lives, is an example of good AI governance, says Ma. ■