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Patent Landscape for Computer Vision: United States and China

CSET Data Brief

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Introduction

Many recent reports have expressed concerns that China is outpacing the United States in the race for dominance in artificial intelligence, emphasizing the urgency to improve R&D investment strategies.[1] Research and reporting on this topic tend to generalize AI, yet treating it as a singular entity with a homogenous development landscape loses sight of variability in both research and potential applications. In order to effectively compare AI production between countries, it is necessary to drill down into the subdomains of AI and identify exactly where and how nations truly lead.

One such AI subdomain is the longstanding field of computer vision, which has become controversial due to concerns over the use of increasingly powerful machine learning-based facial recognition technologies amid the influx of visual data.[2] In prior research, we demonstrated China's lead in AI-focused scientific publications over the United States,[3] but China's primary AI contribution is actually computer vision. In fact, for the top 1 percent of AI publications (by citation), the United States leads in publication counts once computer vision-related research is removed from the AI research corpus.

In this brief, we build on our previous findings to better understand the indicated Chinese emphasis on computer vision research and investigate how the intellectual property portfolios of the United States and China compare. Patent data provides a view into the perceived economic value of research, building a more comprehensive picture of the AI landscape. By narrowing the focus on specific areas of competition, policymakers can prioritize interventions and investments.

Findings

This data brief compares the production of computer vision-related patents in the United States and China, exposing trends over time and identifying significant differences in the applicant populations.[4] All patent data used here was collected and curated by 1790 Analytics.[5] This dataset was processed to identify AI-related instances,[6] which were then each assigned an AI functional application (e.g., robotics, computer vision, natural language processing); we select computer vision-related patents using this classification. All data that follows includes both patent applications and granted patents per year. This is important because the granting processes differ by country—for example, many Asian systems require requests for examination of patent applications to be triggered by the applicant, plus examination timelines vary significantly—so data for 2019 are likely primarily patent applications at this point and merit observation over time. More detailed information on patenting processes can be found in the recently published CSET Data Primer "Patents and Artificial Intelligence."[7]

The patent data show that, while the United States started patenting in computer vision before China, China has surpassed the United States in recent years in total number of patent applications and granted patents (Figure 1). China's growth started in 2007, but began increasing steeply in 2016; with this surge in filings, it has overtaken the United States. In 2016 China had 1,609 computer vision patent documents (i.e. published applications plus granted patents) and grew to 14,545 in 2019, while the U.S. had 3,736 patent documents in 2016 and 10,713 in 2019.

Overall, computer vision patents make up 27 percent of all AI-related patents (for all nations) from 2000 to 2019. China patents more in computer vision than other subfields of AI with 37 percent of all Chinese AI patents in computer vision. The United States patents somewhat less in computer vision with 23 percent of all U.S. AI patents in computer vision.

Figure 1: U.S. vs. China Patent Production

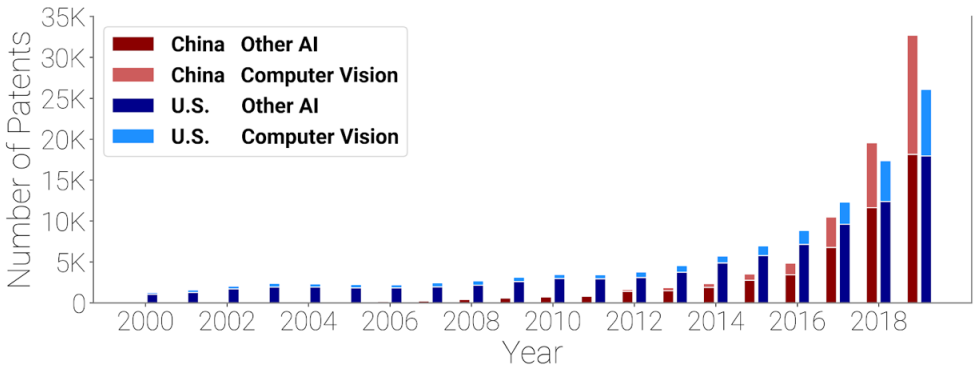

Figure 1: Comparison of total number of patent applications and granted patents for all AI excluding computer vision, and for computer vision separately, by year for the United States and China (counts include all patent docs).

Because patents often indicate the perceived economic value of an idea, we were curious which organizations lead in the development of computer vision intellectual property (IP) in the United States and China. Analyzing the top 100 patenting organizations in both countries, we found a sharp difference: of the top 100 institutions in China, 65 are universities. In comparison, the United States has only three universities in the top 100. Of those three, only one makes the top 25—the University of California system, which includes 10 individual campuses.

Delving deeper into the contribution of Chinese universities to computer vision IP, we note that of the 65 universities in the top 100, eight universities are of stated concern to the U.S. government* (referenced as universities of note).[8] A picture emerges of how Chinese academia goes beyond publications and into the realm of transition of technologies. The top 100 U.S. patenting organizations, by contrast, exhibit a very different pattern, with academia leading in publications but private industry transitioning this research into capability (Figure 2).

* We reference the BIS entity list and the Seven Sons for a list of twelve universities of stated concern to the United States: Beijing Institute of Technology, Beijing University of Aeronautics and Astronautics, Chinese Academy of Engineering Physics, Harbin Engineering University, Harbin Institute of Technology, Nanjing University of Science and Technology, Nanjing University of Aeronautics and Astronautics, National University of Defense Technology of China, Northwestern Polytechnical University, Sichuan University, and University of Electronic Science and Technology of China.

Figure 2: Top Patenting Organizations by Country

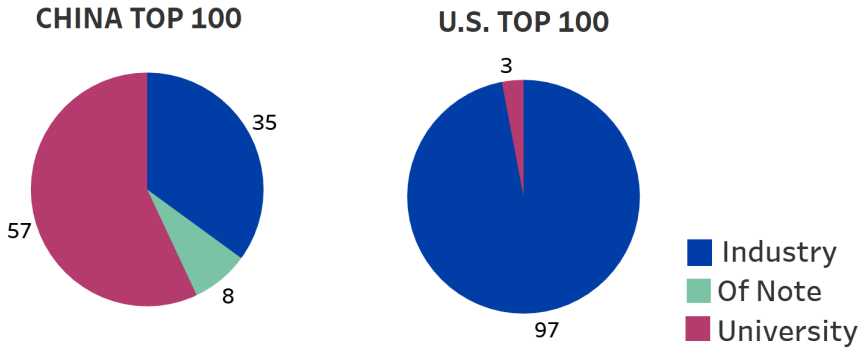

Figure 2: (Left) Breakdown of the top 100 patenting organizations on computer vision in China by organization type from 2000–2019. (Right) Breakdown of the top 100 patenting organizations on computer vision in the United States by organization type from 2000–2019.

The trend of university involvement in patents is not an anomaly unique to computer vision; our analysis showed that the same pattern appears not only among all AI-related patents, but also other specific AI fields. For example, looking at speech and language processing patents, China has 43 universities and the U.S. has 1 university among the top 100 patenting organizations. While this trend is not as strong as the one found in computer vision patents, it is still significant. In China, the top 100 AI patenting organizations overall contained 65 universities—seven of which were universities of note to the U.S. government—and 35 private organizations. In the United States, when combining all AI fields, the difference in composition becomes even more pronounced, with only one of the top 100 AI patenting organizations being a university—again, the University of California system.

Key Takeaways

A stark difference exists between the U.S. and Chinese patent landscapes. Computer vision patents in China are led by heavily patenting universities, while patents in the United States are driven overwhelmingly by the private sector. Chinese universities appear to emphasize patenting more than their U.S. counterparts and patent more frequently than a large majority of U.S. universities in computer vision, as well as AI more broadly. This distinction is important for academics collaborating with individuals from China, as it may lead to situations where one deems the project open and the other considers the research to be the foundation for patentable material.

This fundamental difference in how Chinese universities engage in patenting artificial intelligence opens up a range of new research questions critical to research security and competitiveness: How are these universities converting patents into applications and capabilities? Are they using internal holding companies to create spin-offs to contribute to government-directed innovation and defense S&T strategies? Are they partnering with larger companies to license out patent rights or working directly with the government to transition these capabilities for the broader national use?

Ultimately, a better understanding of Chinese universities' role within the country's highly integrated economic and military system is important. While this analysis may spur more questions than it answers, one thing is clear: computer vision is a priority area for China that goes beyond the scientific literature into the technological and economic domain.

Acknowledgments

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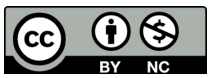

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Endnotes

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[2] Dominic Delmolino, "How Computer Vision Will Help Government See Further," Accenture, May 15, 2019, https://www.accenture.com/us-en/insights/us-federal-government/computer-vision.

[3] Dewey Murdick, James Dunham, and Jennifer Melot, "AI Definitions Affect Policymaking" (Center for Security and Emerging Technology, June 2, 2020), https://cset.georgetown.edu/research/ai-definitions-affect-policymaking/.

[4] For more information on our analysis: https://github.com/georgetown-cset/computer-vision-patent-landscape.

[5] For more information on the approach to data collection and AI patent classification, see https://github.com/georgetown-cset/1790-ai-patent-data.

[6] 1790 AI Patent Database, see https://github.com/georgetown-cset/1790-ai-patent-data/blob/master/Field_Descriptions.md.

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[8] Bureau of Industry and Security, "Entity List," https://www.bis.doc.gov/index.php/policy-guidance/lists-of-parties-of-concern/entity-list; Alex Joske, "The China Defense Universities Tracker" (Australian Strategic Policy Institute, November 25, 2019), https://www.aspi.org.au/report/china-defence-universities-tracker.