WHO IS WINNING THE AI RACE:

CHINA, THE EU, OR THE UNITED STATES?

2021 UPDATE

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By Daniel Castro and Michael McLaughlin | January 2021

The United States still holds a substantial overall lead in AI, but China has continued to reduce the gap in some important areas and the EU continues to fall behind.

The nations that lead in the development and use of artificial intelligence (AI) will shape the future of the technology and significantly improve their economic competitiveness, while those that fall behind risk losing competitiveness in key industries.[1] As a result, more than 30 nations have created national AI strategies to improve their prospects.[2] To date, the United States has emerged as the early frontrunner in AI, but China is challenging its lead.[3]

INTRODUCTION

This report examines the progress China, the European Union, and the United States have made in AI relative to each other in recent years and provides an update on a report released on their comparative rankings from 2019. It finds that the United States still holds a substantial overall lead, but that China has continued to reduce the gap in some important areas. In addition, the EU continues to fall behind. Absent significant policy changes in both the EU and United States—particularly the EU changing its regulatory system to be more innovation-friendly, and the United States developing and funding a more proactive national AI strategy—it is likely that the EU will remain behind both the United States and China, and that China will eventually close the gap with the United States.

FINDINGS

In 2019, the Center for Data Innovation analyzed the AI capabilities of China, the European Union, and the United States using 30 metrics across 6 categories: talent, research, development, hardware, adoption, and data. We found that the United States led in four categories (talent, research, development, and hardware), and China led in two (adoption and data). Out of 100 total available points, the United States led with 44.2 points, followed by China with 32.3 and the European Union with 23.5.

This report measures the progress each region has since made in AI by using new data to update 15 of the metrics and add 1 new metric. It finds that the United States still leads, with 44.6 points, followed by China with 32.0 and the European Union with 23.3.

To get a sense of each region's AI strengths in relation to their size, we also calculated scores for each metric by adjusting for the size of their labor forces. Controlling for size, the United States (58.0 points) leads the European Union (24.2) and China (17.8)—although China has narrowed the distance between itself and the United States since our last report.

Crucially, China has made incremental progress—reducing the gap or extending its lead over the United States in more than half of the updated metrics. In contrast, the EU has made progress relative to the United States in only slightly more than a quarter of the updated metrics. As such, the United States has maintained or expanded its lead over the European Union in nearly 75 percent of the updated metrics.

Despite China's incremental improvement in many indicators, the United States has slightly increased its overall lead in our scoring system because it has performed extremely well on heavily weighted indicators, such as venture capital and private equity funding. For example, it has an unmatched number of AI start-ups, which received $8 billion more in venture capital and private equity funding than did China in 2019.[4] The United States also performs well on several indicators in which China has narrowed the gap somewhat. One example is the research and development (R&D) spending of software and computer services firms. Chinese firms have clearly surpassed EU firms in R&D spending, but U.S. software and computer services firms still spent three times more on R&D than did China and the European Union combined in 2019.[5] Furthermore, average U.S. research quality is still higher than that of China and the European Union.[6] Lastly, despite China's growing attempts to reduce its reliance on U.S. semiconductors, the United States is still the world leader in designing chips for AI systems.[7]

China's AI capabilities relative to the European Union and the United States have improved in several ways. First, China has surpassed the EU as the world leader in AI publications.[8] Second, the quality of its AI research has generally trended upward year to year.[9] Third, its software and computer services firms have increased their R&D spending.[10] Fourth, China now has nearly twice as many supercomputers ranked in the top 500 for performance as the United States—the United States led in this indicator as recently as 2017.[11] Finally, China likely continues to lead in the amount of data generated.[12] Overall, however, China has not significantly reduced the gap in AI between itself and the United States, but its trend of consistent progress could eventually evaporate the U.S. lead.

The European Union's progress vis-à-vis the United States is mixed. For example, U.S. AI firms continue to receive substantially more investment than do European ones. Yet EU venture capital and private equity funding as a percentage of U.S. funding grew from 13 percent to 22 percent between 2016 and 2019.[13] In addition, the EU's field-weighted citation impact (FWCI) for AI papers, a relative measure of paper quality, increased in 2018 while the United States' FWCI decreased.[14] But the European Union has fallen further behind the United States in terms of the number of funding deals, acquisitions of AI firms, and AI firms that have raised at least $1 million in funding since our last report.[15] In addition, EU software and computer services firms have failed to close the gap between themselves and U.S. firms in R&D spending.[16] The United Kingdom's departure from the bloc will also diminish EU AI capabilities, both in absolute terms and on a per-capita basis.

METHODOLOGY

The purpose of this report is to assess the current state of AI development. Unfortunately, there are no standard industrial classifications for firms developing AI technologies, so compiling indicators to compare AI development among nations is challenging. Nonetheless, many metrics reveal important insights about the current state of AI development. Our 2019 report examined six categories of metrics—talent, research, enterprise development, adoption, data, and hardware—to measure the AI capabilities of China, the European Union, and the United States.[17] This report uses the same metrics, updates 15 of them, and adds 1 new metric (FWCI) to assess the three region's progress and capabilities in AI. The updated and new metrics span four of the categories of metrics: research, development, data, and hardware.

There are limitations to focusing only on China, the European Union, and the United States. Indeed, many sources indicate other nations have made progress in AI. For example, India has a growing workforce with AI skills, Israel receives significant private investment per capita, and Australia publishes many deep-learning papers.[18] Nonetheless, we chose to review China, the European Union, and the United States because they generally outperform their peers in the six categories in absolute terms. For consistency and ease of comparison with our last report, we treated the United Kingdom as part of the European Union since it officially left the bloc on January 31, 2020. When notable, however, we discussed how the

European Union's status for a particular indicator would change if we excluded the United Kingdom.

We chose the six categories for several reasons. First, nations with the requisite AI talent will be able to better develop and implement AI systems, attract businesses, and ensure their universities have enough talented AI professors to teach the next generation of AI researchers. Second, research will help nations expand AI innovation and solve problems related to domestic priorities and industries. Third, the number of AI companies and start-ups, combined with related investment capital, lays the groundwork for a strong AI industry that will continue to innovate. Fourth, adoption of AI systems will not only allow organizations to learn how to solve problems related to implementation, but generate demand for AI services, thereby likely helping domestic AI developers. Fifth, more and higher-quality data will create new opportunities to use machine learning in AI applications. Finally, leading in hardware will reduce nations' dependency on other countries—something that, given the current trade dispute between China and the United States, could play an important role.

Within each category, we measured a nation's progress using multiple indicators. For example, for the research category, we used metrics such as the number of AI papers, the quality of the AI papers, and R&D metrics to rank China, the European Union, and the United States. For several of the metrics, complete data was not available for the European Union. For these indicators, we estimated an EU figure using available data. We detailed these estimates in the endnotes and the appendix of this report for updated indicators. (For indicators we did not update, these details can be found in the endnotes and appendix of the 2019 report.)[19] Each indicator is shown both in absolute terms and controlling for the size of the economy. For example, both the total number of AI researchers and the proportion of AI researchers as a share of the economy's total workforce are indicated.

We calculated a score for every indicator for each region. To do so, we first calculated a proportional score. For example, on the indicator for the number of supercomputers ranking in the top 500, China has 214 computers, the European Union has 91, and the United States has 113. Thus, China gets a proportional score of 0.51, the EU 0.22, and the United States 0.27.[20] Each indicator is worth between 1 and 5 points. So, if the indicator for supercomputers is worth 2 points, China receives a score of 1.02 points, the European Union 0.44, and the United States 0.54. We replaced each region's old data and score for any indicator in which we had updated data. The data and scores for indicators that lacked updated data did not change from our last report. The corresponding point value for each indicator stayed the same as in our 2019 report, except for the indicators in the research category.[21] We added a new metric to this category, and reduced the individual point values of indicators in this category by at most 1 point.

We assigned different weights to different indicators based on our assessment of their relative importance in determining national AI development success. As a result, not all categories are worth the same number of points. However, the sum of all indicators is 100 points. Appendix 1 lists the categories, indicators, and corresponding weights. For several indicators, we had to use a combination of quantitative and qualitative analysis. In these cases, we ranked the regions first, second, and third, and their scores are the inverse of their ranking. For example, if China ranked first, it received 3 points (prior to the score being adjusted by the weight of the indicator).

To calculate category scores, we summed each region's score for the indicators in the category. To calculate overall scores, we summed the category scores. We used this method to calculate two sets of scores: one based on the absolute value of the metrics, and one adjusting each metric by the number of workers in the economy.

The following sections present data for new and updated indicators. Please see the 2019 report to review data for the other indicators.[22]

AI DEVELOPMENT

The ability of nations to develop AI firms is critical to their competitiveness. Such firms provide tools and services to the growing number of companies adopting AI. Indeed, the global percentage of large companies using AI in at least one function or business unit increased from 47 percent to 58 percent from 2018 to 2019.[23] This section updates four of the six metrics from the 2019 report with new data. The updated metrics cover venture capital and private equity funding, acquisitions of AI firms, and the number of AI firms.

We allotted the development section 25 of the 100 available points. On an absolute basis, the United States (15.5 points) led the European Union (5.4 points) and China (4.1 points). Controlling for the size of their economies, the United States (19.2 points) led the European Union (4.6) and China (1.2).

VENTURE CAPITAL AND PRIVATE EQUITY FUNDING (2019)

A nation's firms need access to sufficient capital to develop. In addition, the flow of investment can indicate the concentration of promising start-ups. The United States (estimated $14.3 billion) led China (estimated $5.6 billion) and the European Union (estimated $3.2 billion) in venture capital and private equity funding for AI firms in 2019.[24] On a per-worker basis, the United States ($86.5) led significantly over the European Union ($12.8) and China ($7.2).[25]

China's AI start-ups were not immune to the fizzling of China's venture capital boom in 2019.[26] Between 2017 and 2018, Chinese AI firms raised 80 percent of what U.S. AI firms raised. In 2019, Chinese AI firms raised roughly 40 percent of their U.S. counterparts.[27] This contrast is a result of U.S. AI firms receiving almost $4 billion more in investment in 2019 than 2018 while investment in Chinese AI firms barely increased.[28] One reason for China's drop could be reduced venture capital flows between China and the United States. In 2019, U.S.-owned venture capital firms invested $5 billion in all Chinese start-ups, compared with nearly $20 billion in 2018.[29] Chinese foreign direct investment in the United States also dropped. Still, the stark difference in funding levels for AI firms in each nation suggests U.S. firms may be able to better weather reduced investment flows. Data from the second quarter of 2020 suggests that the U.S. is maintaining its funding lead for AI firms.[30]

EU AI firms received more investment in 2019 than in 2017 and 2018 combined.[31] Still, the European Union has lagged behind the United States and China every year since 2016 in venture capital and private equity funding for AI firms. Moreover, the United Kingdom accounted for 57 percent of EU AI firm's funding in 2019.[32] Thus, the EU's relative standing in AI investment will likely drop in the coming years.

Table 1: AI venture capital and private equity funding (2019)

	China	EU	US
Absolute	$5,641M	$3,207M	$14,345M
Per Worker	7.2	12.8	86.5

Number of Venture Capital and Private Equity Funding Deals (2019)

The total amount of venture capital and private equity can be a result of funds concentrated in several large deals involving only a handful of AI start-ups. This report therefore also looks at the number of deals. The United States (786 deals) led the European Union (378) and China (264) for 2019.[33] Thus, the United States (4.7 deals per 1 million workers) held a significant lead over the European Union (1.5) and China (0.3) on a per-worker basis.[34]

Despite an increase in funding deals in all three regions, each region's share of deals remained mostly unchanged relative to the others from 2017 to 2018. The European Union slightly decreased its share (28 percent to 26 percent), the United States' share did not change (55 percent), and China's slightly increased (17 percent to 18 percent).[35] Similar to investment funding, however, the EU was heavily reliant on the United Kingdom. UK AI firms received nearly 40 percent of the venture capital and private equity deals in 2019 that went to EU AI firms.[36]

Table 2: Number of venture capital and private equity funding deals (2019)

	China	EU	US
Absolute	264	378	786
Per 1M Workers	0.3	1.5	4.7

Number of Acquisitions of AI Firms (2019)

Acquisitions can improve a firm's ability to develop innovative products and services by bolstering both its internal talent and intellectual property. This indicator tracks the number of acquisitions of firms in the AI category group on Crunchbase by region in 2019. U.S. firms (130 acquisitions) acquired more AI firms than did both EU (30) and Chinese firms (3). Per 1 million workers, U.S. firms (0.8) made 7 times more acquisitions than did EU firms (0.1) and more than 100 times more did than Chinese businesses (<0.1).[37]

U.S., EU, and Chinese firms each acquired more AI firms in 2019 than in 2018. Compared with 2018, U.S. firms acquired 14 more firms in 2019, EU firms acquired 8 more, and Chinese firms acquired 2 more. U.S. AI firms have acquired at least four times more AI firms than did their EU counterparts each year since 2017.[38]

Table 3: Number of acquisitions of AI firms (2019)

	China	EU	US
Absolute	4	30	130
Per 1M Workers	0.0	0.1	0.8

Number of AI Companies (2019)

AI firms without sufficient funding are less likely to develop innovative AI products or services. Thus, it is important to gauge how many firms in each region are well-funded enough to make an impact in AI. This indicator tracks the number of firms in the AI category group on Crunchbase that have received at least $1 million in combined funding.[39] The United States (2,130 firms) led both the European Union (890) and China (398). The United States had nearly 13 such firms per 1 million workers, ahead of the European Union (3.5) and China (0.5).[40]

This indicator highlights several important elements of the competition between the three regions. First, the United States still maintains a significant advantage, but China started to close the gap in the past year. In absolute terms, China's share of the three regions' AI companies grew from 8 percent to 12 percent, while the United States' share decreased from 64 percent to 62 percent. The European Union's share also decreased (28 percent to 26 percent).[41] Second, U.S. immigration policy may be suppressing its number of AI start-ups. For example, the United States lacks a visa that makes it easy for AI entrepreneurs to immigrate to the nation.[42] In addition, domestic AI graduates are more than twice as likely as international graduates to work for a small firm. One likely reason for this disparity is it is often difficult and costly for a start-up to sponsor a foreign employee.[43] Third, the European Union frequently loses domestic talent to the United States, which could be one reason why it has fewer AI start-ups.[44] A 2019 study finds that students are less likely to start a business and raise less money when their professors have left their teaching positions.[45] Fourth, other analyses find that the United States has not only the most AI start-ups but also the world's leading start-ups. For example, CB Insights ranked the top 100 AI start-ups using factors such as patent activity, market potential, and talent. Its analysis finds that 65 of the top 100 start-ups are based in the United States, which is ahead of the United Kingdom (8), Canada (8), China (6), Israel (3), Germany (2), France (1), Spain (1), and Sweden (1).[46]

Table 4: Number of active AI firms that have received more than $1 million in funding (2020)

	China	EU	US
Absolute	398	890	2,130
Per 1M Workers	0.5	3.5	12.8

RESEARCH

Research sustains innovation. Countries need to perform both basic research, which does not have obvious commercial value, and applied AI research, which solves practical problems.[47] In some areas of AI, such as natural language processing, advancements are occurring at a rapid pace. For example, the creators of a 2018 benchmark to test AI systems' ability to understand language released a new, more challenging benchmark only a year after their initial release because some systems quickly matched human performance on the original test.[48] In addition, the time to train a large image classification system shrank from three hours to barely more than a minute between 2017 and 2019.[49]

This section analyzes the number and quality of AI scholarly papers and business R&D funding to assess China, the European Union, and the United States. Ideally, the study would also include government R&D funding, which has helped lead to the development of innovations such as the global positioning system (GPS), supercomputers, and Google's search engine.[50] However, nations have different classifications of what constitutes AI R&D, and some do not report AI R&D figures nor distinguish between private and public money in their announcements. Nonetheless, the United States spent $1.1 billion on non-defense AI R&D in the fiscal year 2020.[51] Moreover, the U.S. Department of Defense spent roughly $4 billion on AI R&D funding.[52] China, meanwhile, spent between $2 billion and $8 billion on AI R&D in 2018—although these estimates rely on several assumptions.[53] And in 2018, the European Commission announced it planned to invest €1.5 billion ($1.7 billion) in AI by 2020 under Horizon 2020, its research and innovation program.[54] However, the Commission has acknowledged that this figure likely represents a small fraction of all the investments from member states.[55] For example, the Commission believes its investment would trigger an additional €2.5 billion ($2.8 billion) in public-private partnerships.[56]

We allotted the research category 15 of 100 available points. On an absolute basis, the United States led in AI research (7.2 points), followed by China (4.1 points) and the European Union (3.7 points). Controlling for the size of the workforces, the United States ranked first (8.9 points), followed by the European Union (3.8) and China (2.3).

Number of AI Research Papers (2018)

The number of research papers a region publishes each year is one way to gauge its research prowess. This metric tracks the number of AI papers researchers published from each region in 2018 as tracked by Scopus, which is a database that contains millions of documents from thousands of peer-reviewed journals.[57] China (24,929 papers) led the European Union (20,418) and the United States (16,233). Per one million workers, however, the United States (98.1 papers) led the European Union (81.4) and China (31.8).[58]

The European Union's portion of the world's AI papers has decreased steadily since 2015, when it published nearly 29 percent of AI papers. Since then, its share fell in 2016 (26.3 percent), 2017 (25.5 percent), and 2018 (23.1 percent). The EU's share in 2018 would have dropped to 19 percent if we had not included the United Kingdom—which was barely above the United States' share (18 percent). In the same time frame (2015–2018), China increased its share of research papers from under 23 percent to above 28 percent. Indeed, 2018 marked the first time in almost a decade that China published more AI papers than did the EU.[59]

Table 5: Number of AI research papers (2018)

	China	EU	US
Absolute	24,929	20,418	16,233
Per 1M Workers	31.8	81.4	98.1

Field-Weighted Citation Impact (2019)

It is important to gauge the quality of research a region produces. This indicator tracks the re-based FWCI for each region. This figure measures how often publications from each region are cited compared with similar publications worldwide. In 2019, the United States led the European Union (1.1) and China (0.8) with an FWCI of 1.4, meaning its papers received 40 percent more citations than the world average.[60] The United States' high FWCI matched its representation at prestigious AI conferences, such as the Conference on Neural Information Processing Systems. That same year, nine of the ten leading organizations for accepted papers at the conference were based in the United States or owned by U.S. based firms.[61]

Nonetheless, the United States' FWCI in 2018 was its lowest since 1998. In contrast, the EU's FWCI has been increasing since 2015. As such, while the EU's share of the world's output of AI papers is declining, its publication quality is increasing.[62] In comparison, China's decline in FWCI from 2017 to 2018 coincided with its authors publishing significantly more AI papers (16,455 to 24,929).[63] China's FWCI had steadily increased from 2012 (0.6) to 2017 (0.9) before the recent decline.[64]

Table 6: Field-weighted citation impact (2018)

China	EU	US
0.8	1.1	1.4

Field-Weighted Download Impact (2018)

Another way to gauge the impact of a nation's AI research is to measure how often individuals read its AI papers. This indicator tracks the re-based field-weighted download impact (FWDI) of AI authors in China, the European Union, and the United States. FWDI compares the number of downloads a nation's AI papers receive to their expected number of downloads based on the type of document, subject type, and publication year. This figure is re-based so that the world average is 1.[65] For 2018, the United States (1.3) led China (1.2) and the European Union (1.0). Without the United Kingdom, the EU's FWDI for AI papers in 2018 would have been 0.95.[66] The United States' lead in both FWCI and FWDI aligns with other analyses that have found the nation also leads in the number of articles published by top-rated AI experts.[67]

The FWDIs for both China and the United States have fluctuated year to year but have been on a general upward trend since 2000. Moreover, China has been reducing the gap between itself and the United States in recent years. After having an abnormally high FWDI of 1.5 in 2010, China's FWDI fell below 1.0 between 2011 and 2013. Since then, however, China's FWDI as a percentage of the United States' FWDI has grown from 77 percent to 93 percent. It is also clear that the United Kingdom had a consistent positive impact on the EU's FWDI, raising it every year since 2009.[68]

Table 7: Field-weighted download impact (2018)

China	EU	US
1.2	1.0	1.3

Top 100 Software and Computer Services Firms for R&D Spending (2019)

The level of funding a nation spends on AI R&D is one proxy to measure its research capacity. It is difficult to know how much firms spend specifically on AI R&D. But examining the overall R&D expenditures of software and computer services (S&C) firms, many of which are developing AI services, provides a proxy for AI R&D spending. This indicator analyzes the top 100 software and computer services firms for R&D spending in 2019. The United States (58 firms) led China (15) and the European Union (12). Without the United Kingdom, the European Union had seven firms ranking in the top 100. Per 10 million workers, the United States (3.5 firms in the top 100) led the European Union (0.5) and China (0.2).[69]

The United States still has a significant absolute and per-capita lead, similar to many other metrics. However, China is catching up. For example, the United States had 4 fewer S&C firms in the top 100 in 2019 than in 2017/2018—China had three more firms. Furthermore, China grew from having 10 to 15 firms in the top 100 between 2016 and 2019. Meanwhile, the United States decreased from 65 to 58 firms.[70]

Table 8: Number of firms in the top 100 software and computer services firms for R&D spending (2019)

	China	EU	US
Absolute	15	12	58
Per 10M Workers	0.2	0.5	3.5

Total R&D Spending of Software and Computer Services Firms Ranking in Top 2,500 Globally

There were 288 S&C firms in the global top 2,500 firms for R&D spending in 2019, an increase of 20 firms from 2017/2018. This indicator measures how much the 288 firms spent on R&D by region. The United States ($124.5 billion) led China ($23.7 billion) and the European Union ($14.6 billion). Per worker, the United States ($750.4) substantially led the European Union ($58.1) and China ($30.3).[71]

There are several noteworthy elements to this R&D data. First, the United States significantly increased in this indicator since 2017/2018, growing by roughly $40 billion.[72] Second, the United States' lead was fueled by the investments of top firms such as Alphabet, Microsoft, and Facebook, which were the only S&C firms ranked in the top 10 for R&D spending. Indeed, the median R&D spending of S&C firms ranking in the top 2,500 globally was roughly similar for each region (EU: $131.6 million, U.S.: $131.2 million, China: $120.7 million). Yet, the average R&D spending of such firms in the United States ($813.6 million) was more than the averages of China ($381.6 million) and the EU ($373.6 million) combined, partially because the United States' top firms spent significantly more on R&D than did top Chinese and EU firms.[73] Third, China increased its R&D spending as a percentage of U.S. spending, growing from 15 percent in 2017/2018 to 19 percent in 2019. This growth was largely due to the number of Chinese S&C firms in the top 2,500 growing from 42 to 62.[74] Fourth, the United Kingdom accounted for nearly 21 percent of EU S&C R&D spending. Only Germany (39 percent) ranked higher.[75]

Table 9: R&D spending by software and computer services firms in top 2,500 (2019)

	China	EU	US
Absolute	$23,659M	$14,569M	$124,480M
Per Worker	30.3	58.1	750.4

HARDWARE

Computing power is becoming increasingly important for AI. For example, the amount of computational power to train the largest AI systems has doubled every 3.4 months since 2012.[76] The importance of hardware can also be seen in the recent proposals and investments of nations. For example, lawmakers in the United States have proposed spending billions of dollars for semiconductor R&D and to support the construction of semiconductor factories.[77]

This section analyzes semiconductor sales, semiconductor R&D spending, the number of firms designing AI chips, the number of supercomputers ranked in the top 500 by performance, and the aggregate system performance of the supercomputers in China, the European Union, and the United States. We allotted this category 10 of the 100 available points. On an absolute basis, the most recent data available shows the United States leading in hardware (6.3 points), followed by China (2.3) and the European Union (1.4). Controlling for workforce size, the United States (7.7 points) led the European Union (1.5) and China (0.8).

Semiconductor Sales (2020)

The global semiconductor market is expected to grow more than $100 billion by 2027, reaching nearly $600 billion.[78] This indicator measures the number of semiconductor firms in the top 15 globally for forecasted sales in

2020. The United States (8) led the European Union (1) and China (0).[79] The United States gained 2 firms and both the European Union and China had 1 less firm in the top 15 since our last report, which reviewed data for the first quarter of 2019.[80] The eight U.S. firms are Intel, Micron, Qualcomm, Broadcom, Nvidia, Texas Instruments, Apple, and AMD. The EU firm is Infineon.[81]

There are several caveats to this data, however. One is that the data includes one pure-play foundry—Taiwan Semiconductor Manufacturing Company (TSCM). Pure-play foundries mostly manufacture rather than design semiconductors. If we removed TSCM from the list, Sony would be in the top 15.[82] A second caveat is the list does not reflect that the United States' share of global chip manufacturing capacity declined from 37 percent to 12 percent between 1990 and 2020.[83] In addition, the United States' market share of the global semiconductor has hovered between 45 percent and 50 percent for more than a decade.[84] Yet a 2020 study by the Boston Consulting Group forecasts that China's Made in China 2025 could reduce U.S. market share between 2 and 5 percentage points, and that maintaining overly broad restrictions on trading semiconductors to China could decrease U.S. market share by 8 percentage points.[85]

Table 10: Number of firms in top 15 for semiconductor sales (2019)

	China	EU	US
Absolute	0	1	8
Per 100M Workers	0.0	0.4	4.8

Number of Firms Designing AI Chips (2020)

Trade disputes, such as between the United States and China, can put a nation's access to semiconductors, including AI chips, at risk. Moreover, some firms have found that chips explicitly designed to train and run AI systems improve such systems' performance. This indicator tracks the number of firms, including start-ups, designing chips for AI use cases. In 2020, the United States had at least 62 firms developing AI chips, compared with 29 firms in China and 14 in the European Union. Per 10 million workers, the United States (3.7) led the European Union (0.6) and China (0.4).[86]

Each region increased its number of firms since 2019, but their status relative to each other did not change. It is notable, however, that 5 of the 14 EU firms are UK firms.[87] This group includes both Graphcore, which had raised $682 million in funding through 2020.[88] As such, the EU's position in designing AI chips is worse as the United Kingdom is no longer a member of the bloc.

Table 11: Number of firms designing AI chips (2019)

	China	EU	US
Absolute	29	14	62
Per 10M Workers	0.4	0.6	3.7

Number of Supercomputers (2020)

Many researchers increasingly view computing power as critical to the development of AI systems. This indicator examines the number of supercomputers each region had ranked in the top 500 in 2020 in terms of performance, which is how many floating-point calculations a computer can perform per second. China (214) had more supercomputers in the top 500 than did the United States (113) and the European Union (91). Per 10 million workers, the United States (6.8) was ahead of the European Union (3.6) and China (2.9). Without the United Kingdom, the European Union had 79 supercomputers ranked in the top 500.[89]

China has experienced remarkable growth in this metric over the past decade. Indeed, China had only 68 computers in the top 500 in 2012, compared with 252 for the United States. Yet it took China only four years to surpass the United States and a little more than two more years to have 100 more supercomputers ranked in the top 500 than does the United States.[90]

Table 12: Number of supercomputers ranked in top 500

	China	EU	US
Absolute	214	91	113
Per 10M Workers	2.7	3.6	6.8

Supercomputers (Aggregate Systems Performance, 2020)

Another way to evaluate a nation's strength in supercomputers is to measure its top systems' aggregate performance. This indicator tracks the aggregate systems performance of supercomputers ranked in the top 500 in each region. In 2020, the United States (27.5 percent) led China (23.3

percent) and the European Union (16.8 percent). Without the United Kingdom, the European Union accounted for 15.4 percent of the world's top 500 supercomputers' aggregate systems performance. Per 10,000 workers, the United States (40.2 TFLOPS) led the European Union (16.3) and China (7.3).[91]

Both China and the United States accounted for a lower share of the top 500 systems' aggregate performance in 2020 than 2019, partially due to Japan's rise. The nation grew from accounting for under 8 percent of the aggregate system performance in 2019 to over 24 percent in 2020.[92] Japan now has the world's fastest system, Supercomputer Fugaku, which has a max performance that is almost three times higher than that of the second-fastest supercomputer.[93]

Table 13: Aggregate system performance of supercomputers ranked in top 500 (%, 2020)

	China	EU	US
Absolute	23%	17%	28%
TFLOPS, per 10K Workers	7.3	16.3	40.2

Case Study: Building An AI Ecosystem

Although AI has already delivered significant value across multiple industries, some industry watchers have noted that "enthusiasm is stalling," in part because of the lack of availability of high-quality datasets.[94] Indeed, data wrangling—the process of gathering, cleaning, and transforming data so that it can be used in a particular task—can take anywhere from 50 to 80 percent of the time spent on a data science project.[95] To address this problem, there is a new breed of data start-ups that focuses less on producing incremental improvements in machine learning algorithms and more on developing dynamic databases connected to novel data sources.

A prime example of this is Craft, a start-up based in San Francisco that delivers deep insights and visibility into enterprise supply chains by gathering and validating over 300 data points about different firms, allowing businesses to understand the risks and vulnerabilities in their global supply chains.[96] Craft tracks not only traditional financial and operational indicators of firms, but also metrics on human capital, social media sentiment, digital footprint, business ownership, diversity, compliance, cybersecurity, and environmental, social, and corporate governance. During a volatile economy, such as a global pandemic, these types of metrics are especially valuable because they allow businesses to apply predictive analytics in order to compare existing suppliers, anticipate potential risks, and discover new business opportunities. Providing access to high-quality data is a key building block for companies to use AI. As Craft founder and CEO Ilya Levtov explained, "Since they have access to clean, organized, and validated data on millions of companies, along with ML-assisted analytics tools that are easy to integrate with their enterprise systems, data scientists have more time to innovate."[97]

Craft also illustrates some of the key dynamics at play in the global race for AI. The company initially launched in London, but later reincorporated in the United States, moving its headquarters to San Francisco because of the greater availability of venture capital for U.S.-based tech start-ups. Indeed, a number of UK-based entrepreneurs have worried that post-Brexit their access to venture capital will be restricted as the European Investment Fund—which anchors a lot of venture capital funds—pulls back funding from UK companies.[98]

AI-focused B2B start-ups face a particular challenge in the EU because U.S. companies spend more than double their EU peers on business software.[99] As explained in a report by Index Ventures, a VC firm based in San Francisco and London, the problem is one of limited demand among European businesses:

> They invest less in technology, and when they do, it is too often focused on compliance, rather than on business transformation. European software companies selling into enterprises are therefore forced to succeed in the U.S., before they are given the chance to do so in Europe. Until this changes, we will continue to see entrepreneurs crossing the Atlantic to scale and to list software companies.[100]

Indeed, this trend helps explain why a number of other European tech companies have relocated, such as Collibra, founded in Brussels, moving to New York, and Algolia, a French search engine, now being headquartered in San Francisco.[101] While many European start-ups choose to grow at home, those looking to scale up quickly still often look to the United States because it offers a large market with one legal system, a large supply of talent, and a single language.

Data is used to develop, test, and deploy AI systems.[102] Governments directly supply some data (e.g., publishing open government data), indirectly supply other data (e.g., providing research funding for scientific data), create policies that lead to data collection (e.g., establishing electronic health record systems), and regulate how the private sector shares data (e.g., enacting data protection laws).

Unfortunately, there is no straightforward measure of the relative amount, or value, of data available for AI in a particular place. However, individuals produce a significant amount of data when they engage in various online and offline activities, such as using search engines, posting on social media, and making purchases. These activities produce data that can have enormous value for machine learning models. Therefore, one way to estimate the potential value of data in a country or region is to consider the percentage of the population that engages in digital activities.

This section updates three of the eight indicators we used to measure the amount and availability of data in China, the European Union, and the United States. These metrics are the number of fixed broadband subscriptions, the number of mobile payment users, and the availability of health data. When necessary, we used a combination of quantitative and qualitative analysis to rank the regions first, second, and third.

We allotted this category 25 of 100 possible points. On an absolute basis, China leads (11.6 points) the United States (8.0) and the European Union (5.3). Controlling for workforce sizes, the United States leads (11.0 points) China (7.9) and the European Union (6.1).

Fixed Broadband Subscriptions (2019)

Internet users generate data when they browse the web, post on social media, or use Internet-connected devices such as smart speakers. This data can help with the development of AI that improves systems such as those that understand human language, make predictions about the spread of disease, or analyze biometric data. This indicator tracks the number of broadband subscriptions in each region. In 2019, China (449.3 million subscriptions) led the European Union (184.5 million) and the United States (114.1 million). The European Union accounted for 157.9 million subscriptions without the United Kingdom.[103] Per 100 people, the European Union (35.1 subscriptions) led the United States (34.7) and China (31.3). Without the United Kingdom, the European Union had 34.4 fixed broadband subscriptions per capita.[104]

There are caveats to this data, however. First, the data for the number of broadband subscriptions per 100 people for the European Union is from 2018, while the data for China and the United States is from 2019.[105] Second, the figures do not reflect that the European Union's average smaller household size likely inflated its subscription numbers. For example, the average household size in the European Union was 2.3, compared with 2.9 and 2.6 in China and the United States, respectively.[106] Nonetheless, China added substantially more subscribers (55.1 million) than did the European Union (8.8 million) and the United States (4.3 million) since 2018.[107]

Table 14: Fixed broadband subscriptions in millions (2019)

	China	EU	US
Absolute	449M	184M	114M
Per 100 People	31.3	35.1	34.7

Mobile Payments (2019)

Consumers generate data, such as the time, location, and value of a financial transaction, each time they use a mobile device to purchase a product.[108] We defined “mobile payments” as using a mobile device to scan, tap, swipe, or check an order to make a point-of-sale transaction, which does not include purchases such as those of digital goods on mobile devices. This indicator tracks the number of mobile payment users in each region. China (577.4 million) led the United States (64.0 million) and the European Union (estimated 51.7 million) in 2019. China also led (50.3 percent of individuals 15 and older) the United States (23.9 percent) and European Union (11.9 percent) per capita.[109]

China experienced sizable absolute growth in the number of individuals using mobile payments in the past year—similar to broadband subscriptions. For example, China had 50 million more mobile payment users in 2019 than in 2018. This figure is roughly the size of the number of individuals in the European Union using mobile payments.[110] Nonetheless, the year-over-year growth rates for the United States (16.4 percent) and European Union (15.5 percent) were higher than China’s (10.0 percent).[111] This rate was likely influenced by the fact that significantly more individuals in China had adopted mobile payment technology before 2019.

Table 15: Number of individuals using mobile payments in millions (2019)

	China	EU	US
Number of individuals	577M	52M	64M
Percent of population (15 and over)	50%	12%	24%

Health Data (2019)

Researchers are increasingly using health data to develop AI systems that can help identify, prevent, and predict diseases' development. This indicator analyzes the ability of each region to collect and exchange health data. Comprehensive data for China, all European Union member states, and the United States concerning the use of electronic health records (EHRs) was not available.[112] However, a combination of quantitative and qualitative information suggests the United States has the best combination of access and ability to share health data electronically, ahead of the European Union and then China. Consequently, the United States also leads in access per capita, followed by the European Union and China.

The adoption of EHRs is relatively high in all regions. For example, in 2019, 91 percent of primary care physicians in the United States used EHRs. Physicians in England (99 percent), France (88 percent), Germany (88 percent), Netherlands (99 percent), and Sweden (98 percent) also had high adoption rates. Data from the same survey for China was not available.[113] However, almost every health care provider in China has an EHR system.[114] In comparison, almost all non-federal acute care hospitals (96 percent) use EHRs as of 2017 in the United States. Most U.S. hospital EHR systems can track not only patient demographics, medications, and laboratory tests, but also imaging results and clinician notes.[115] In China, EHR systems are usually not interoperable, forcing patients to bring printed records whenever they see a doctor at a different hospital.[116] These bottlenecks, which can hinder data mining, exist despite the government repeatedly emphasizing the importance of integrating health data.[117]

In comparison, between 53 and 54 percent of U.S. primary care physicians could exchange patient clinical summaries, laboratory diagnostic test results, and lists of medications taken by patients with any doctor outside their practice.[118] The United States should strive to improve these numbers, but they are also likely higher than those for the European Union. For example, a weighted average of the UK, France, Germany, Netherlands, and Sweden reveals that between 45 percent and 53 percent of primary care physicians could perform the aforementioned tasks.[119] Germany significantly brought down the EU average. For example, few German primary care physicians could exchange patient clinical summaries (12 percent), laboratory diagnostic test results (32 percent), and lists of medications taken by a patient (14 percent) with any doctor outside their practice.[120]

The European Union and the United States are both implementing measures to improve their ability to share health data. For example, the European Commission has adopted a recommendation that contains principles and technical specifications for EHR systems to enable the exchange of health data across borders.[121] On March 9, 2020, the U.S. Department of Health and Human Services (HHS) finalized two new rules intended to give patients secure access to their health data and facilitate the flow of information between health care providers and payers. The new rules issued by HHS make four important changes to electronic health information: They establish data exchange standards, require open application programming interfaces (APIs), support data exchange between payers, and prevent information-blocking practices.[122]

CONCLUSION

The Chinese government has made AI a top priority. The EU and United States can and should take steps to respond. For example, EU member states should increase their R&D tax incentives because EU software and computer services firms spend significantly less on R&D than do U.S. firms, and member states' R&D tax incentives vary widely.[123] Member states should also expand public research institutes (PRIs), which collaborate with other research groups and can help firms introduce new or significantly improved services.[124] They can also expand the number of high-performance computing centers through public-private partnerships. For example, in the United States, the Commonwealth of Massachusetts and multiple universities and companies collaborated to create the Massachusetts Green High Performance Computing Center.[125]

But the biggest challenge for the EU and member states is that many in Europe do not trust AI and see it as technology to be feared and constrained, rather than welcomed and promoted. The European Commission's white paper on AI, which provides a roadmap for its anticipated legislation, highlights these fears about AI citing "potential risks, such as opaque decision-making, gender-based or other kinds of discrimination, intrusion in our private lives or being used for criminal purposes."[126] This is one reason regulations such as the General Data Protection Regulation (GDPR), which limits the collection and use of data that can foster developments in AI, are in place. Moreover, even proposals that include elements that would promote the development of AI, such as the Data Governance Act, also include elements that hinder data innovation.

For example, the Data Governance Act enables individuals to donate their data, creates a European Data Innovation Board, and encourages the reuse of public sector data—all useful policies. But the act also maintains restrictions on the transfer of commercially sensitive data and proposes creating European data spaces that could inhibit global partnerships.[127]

Meanwhile, the United States needs to implement additional policies to maintain its lead. It can start with more active support for AI research and deployment. For example, AI faculty are leaving academia for industry positions at increasing rates.[128] As such, Congress should provide funding for the National Science Foundation (NSF) to increase AI research grants and condition the funding on the professors committing to remain in academia for a set period. To further develop domestic talent, the United States should create more scholarships and fellowships for AI students, including by expanding the existing programs that provide scholarships for students committed to public service.[129] To attract the world's top talent, Congress should increase the cap on H-1B visas to make it easier for top AI entrepreneurs and researchers to work in the United States.[130] Congress should also increase the R&D tax credit rate, which is anemic compared with our competitors. For example, a 2020 ITIF report finds that the United States ranked 24th out of 34 comparison nations for tax support for R&D spending. Moreover, China's R&D tax subsidy is 2.7 times more generous than that of the United States.[131]

But research is not enough. Deployment drives innovation. As of 2020, less than half of federal agencies had used AI tools.[132] As such, the federal government should also focus more on using AI to achieve both individual agencies' missions and big national goals such as dramatically improving drug development and health outcomes. And perhaps most importantly, Congress should ensure any change to federal data privacy legislation does not limit data collection and use of AI. Moreover, when U.S. policymakers propose banning AI-based technologies such as facial recognition or algorithms used to screen job applicants, on the misguided notion that they are inherently biased or not protective of civil liberties, they are in essence paving the way for China to take the lead in that technology.

There are also multiple ways democratically aligned nations can collaborate. The United States announced in 2020 that it would join the Global Partnership on AI (GPAI), a group launched by the G7 to provide cooperation between allied, democratic nations on AI. The group was set up to focus on the responsible development of AI, including by developing research agendas, promoting AI workforce development, and spurring AI innovation and commercialization, while ensuring these uses align with shared democratic values.[133] The Biden administration should work to ensure GPAI focuses on its original mission—aligning allied nations to better compete with China on AI—and not devolve into an EU-inspired project to globally regulate AI. Allied nations should also develop shared data depositories for a variety of data, such as health data and environmental data. In addition, they can partner to address such challenges as assessing the trustworthiness of AI systems. Finally, allied nations can use a series of international prize competitions to foster developments in AI systems for the public good.[134] While individual nations will continue to compete in AI, their collaboration could hasten the development of AI technologies and ensure their benefits are widespread.

APPENDIX 1: CATEGORIES, INDICATORS, AND WEIGHTS

Development

Indicator	Weight
VC + PE Funding	5
Number of VC + PE Deals	2
Number of Acquisitions of AI Firms	2
Number of AI Startups	4
Number of AI Firms That Have Received More Than $1 Million in Funding	4
Highly-Cited AI Patent Families (1960-2018)	3
PCT AI Patents (1960-2018)	5

Talent

Indicator	Weight
Number of AI Researchers	5
Number of Top AI Researchers (H-Index)	5
Number of Top AI Researchers (Academic Conferences)	3
Educating Top AI Researchers (%)	2

Research

Indicator	Weight
Number of AI Papers	4.5
Field-Weighted Citation Impact	3
Field-Weighted Download Impact	2
Top 100 Software and Computer Services Firms for R&D Spending	2.5
R&D Spending by Software and Computer Services Firms in top 2,500	3

Hardware

Indicator	Weight
Number of Firms in Top 15 for Semiconductor Sales	2
Number of Firms in Top 10 for Semiconductor R&D Spending	2
Number of Firms Designing AI Chips	2
Number of Supercomputers Ranked in Top 500	2
Aggregate System Performance of Supercomputers Ranked in Top 500 (%)	2

Adoption

Indicator	Weight
Number of Workers in Firms Adopting AI	5
Number of Workers in Firms Piloting AI	5

Data

Indicator	Weight
Fixed Broadband Subscriptions	4
Number of Individuals Using Mobile Payments	3
Electronic Health Records (Rank)	2
Mapping Data (Rank)	2
Genetic Data (Rank)	2
Internet of Things Data (TB)	3
Productivity Data (TB)	4
Regulatory Barriers (Rank)	5

APPENDIX 2: METRICS AND SCORES, ABSOLUTE

Development

		Metrics and Scores		
Indicator	**Year**	**China**	**European Union**	**United States**
VC + PE Funding	2019	$5,641M	$3,207M	$14,345M
Number of VC + PE Deals	2019	264	378	786
Number of Acquisitions of AI Firms	2019	4	30	130
Number of AI Startups	2017	383	726	1,393
Number of AI Firms That Have Received More Than $1 Million in Funding	2020	398	890	2,130
Highly-Cited AI Patent Families (1960-2018)	2018	691	2,985	28,031
PCT AI Patents (1960-2018)	2018	1,085	1,074	1,863
Scores (Weighted)		**4.1**	**5.4**	**15.5**

Talent

		Metrics and Scores		
Indicator	**Year**	**China**	**European Union**	**United States**
Number of AI Researchers	2017	18,232	43,064	28,536
Number of Top AI Researchers (H-Index)	2017	977	5,787	5,158
Number of Top AI Researchers (Academic Conferences)	2018	2,525	4,840	10,295
Educating Top AI Researchers (%)	2018	11%	21%	44%
Scores (Weighted)		2.1	6.2	6.7

Research

		Metrics and Scores		
Indicator	**Year**	**China**	**European Union**	**United States**
Number of AI Papers	2018	24,929	20,418	16,233
Field-Weighted Citation Impact	2018	0.8	1.1	1.4
Field-Weighted Download Impact	2018	1.2	1.0	1.3
Top 100 Software and Computer Services Firms for R&D Spending	2019	15	12	58
R&D Spending by Software and Computer Services Firms in top 2,500	2019	$23,659M	$14,569M	$124,480M
Scores (Weighted)		4.1	3.7	7.2

Hardware

Indicator	Year	Metrics and Scores: China	European Union	United States
Number of Firms in Top 15 for Semiconductor Sales	2020	0	1	8
Number of Firms in Top 10 for Semiconductor R&D Spending	2017	0	0	5
Number of Firms Designing AI Chips	2020	29	14	62
Number of Supercomputers Ranked in Top 500	2020	214	91	113
Aggregate System Performance of Supercomputers Ranked in Top 500 (%)	2020	23%	17%	28%
Scores (Weighted)		2.3	1.4	6.3

Adoption

Indicator	Year	Metrics and Scores: China	European Union	United States
Number of Workers in Firms Adopting AI	2018	252M	44M	36M
Number of Workers in Firms Piloting AI	2018	417M	64M	48M
Scores (Weighted)		7.7	1.3	1.0

Data

Indicator	Year	Metrics and Scores China	European Union	United States
Fixed Broadband Subscriptions	2019	449M	184M	114M
Number of Individuals Using Mobile Payments	2019	577M	51M	64M
Electronic Health Records (Rank)	2019	1	2	3
Mapping Data (Rank)	2019	1	2	3
Genetic Data (Rank)	2019	2	1	3
Internet of Things Data (TB)	2018	152M	53M	69M
Productivity Data (TB)	2018	684M	583M	966M
Regulatory Barriers (Rank)	2019	3	1	2
Scores (Weighted)		11.6	5.3	8.0

Overall Scores (Weighted)	32.0	23.3	44.6

APPENDIX 3: METRICS AND SCORES, ADJUSTED BY NUMBER OF WORKERS

Development

		Metrics and Scores		
Indicator	**Year**	**China**	**European Union**	**United States**
VC + PE Funding	2019	7.2	12.8	86.5
Number of VC + PE Deals	2019	0.3	1.5	4.7
Number of Acquisitions of AI Firms	2019	0.0	0.1	0.8
Number of AI Startups	2017	0.5	2.9	8.4
Number of AI Firms That Have Received More Than $1 Million in Funding	2020	0.5	3.5	12.8
Highly-Cited AI Patent Families (1960-2018)	2018	0.9	11.9	169.4
PCT AI Patents (1960-2018)	2018	1.4	4.3	11.3
Scores (Weighted)		1.2	4.6	19.2

Talent

		Metrics and Scores		
Indicator	**Year**	**China**	**European Union**	**United States**
Number of AI Researchers	2017	23.3	171.7	172.4
Number of Top AI Researchers (H-Index)	2017	1.2	23.1	31.2
Number of Top AI Researchers (Academic Conferences)	2018	3.2	19.3	62.2
Educating Top AI Researchers	2018	1.0	2.0	3.0
Scores (Weighted)		**0.9**	**5.8**	**8.4**

Research

		Metrics and Scores		
Indicator	**Year**	**China**	**European Union**	**United States**
Number of AI Papers	2018	31.8	81.4	98.1
Field-Weighted Citation Impact	2018	0.8	1.1	1.4
Field-Weighted Download Impact	2018	1.2	1.0	1.3
Top 100 Software and Computer Services Firms for R&D Spending	2019	0.2	0.5	3.5
R&D Spending by Software and Computer Services Firms in top 2,500	2019	30.3	58.1	750.4
Scores (Weighted)		2.3	3.8	8.9

Hardware

		Metrics and Scores		
Indicator	**Year**	**China**	**European Union**	**United States**
Number of Firms in Top 15 for Semiconductor Sales	2020	0.0	0.4	4.8
Number of Firms in Top 10 for Semiconductor R&D Spending	2017	0.0	0.0	30.4
Number of Firms Designing AI Chips	2020	0.4	0.6	3.7
Number of Supercomputers Ranked in Top 500	2020	2.7	3.6	6.8
Aggregate System Performance of Supercomputers Ranked in Top 500 (TFLOPS)	2020	7.3	16.3	40.2
Scores (Weighted)		0.8	1.5	7.7

Adoption

		Metrics and Scores		
Indicator	**Year**	**China**	**European Union**	**United States**
Number of Workers in Firms Adopting AI	2018	0.3	0.2	0.2
Number of Workers in Firms Piloting AI	2018	0.5	0.3	0.3
Scores (Weighted)		4.7	2.4	2.9

Data

		Metrics and Scores		
Indicator	**Year**	**China**	**European Union**	**United States**
Fixed Broadband Subscriptions	2019	31.3	35.1	34.7
Number of Individuals Using Mobile Payments	2019	0.5	0.1	0.2
Electronic Health Records (Rank)	2019	1	2	3
Mapping Data (Rank)	2019	1	2	3
Genetic Data (Rank)	2019	2	1	3
Internet of Things Data (TB)	2018	19.4	21.3	41.7
Productivity Data (TB)	2018	87.3	232.3	583.7
Regulatory Barriers (Rank)	2019	3	1	2
Scores (Weighted)		7.9	6.1	11.0

Overall Scores (Weighted)	17.8	24.2	58.0

APPENDIX 4: VENTURE CAPITAL AND PRIVATE EQUITY FUNDING

SOURCES

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METHODOLOGY

We used CB Insight's advanced search tool to get the number and size of venture capital and private investments made in Chinese, EU, and U.S. AI firms. We filtered our search by firms in the Artificial Intelligence collection and by only including deals, CB Insights classified as seed or angel, series A–E, convertible note, growth-equity, private-equity, or other venture capital funding. However, more than 20 percent of the deals did not have a known investment size. For each of China, the European Union, and the United States, we used that region's median AI deal size for the year to impute a total. For example, in 2019, U.S. AI firms were part of 786 deals for a known total of $13.8 billion. However, 99 of the deals had no corresponding dollar amount. Consequently, we multiplied 99 by the median U.S. AI deal size in 2019 ($5.5 million) and added it to the known total of $13.8 billion to get an estimated total of $14.3 billion.

Formula: Funding Total = Known Total ($) + (Number of Missing Deals * Median Deal Size)

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