

Issue Brief

# Examining Singapore's AI Progress

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## Authors

Kayla Goode

Heeu Millie Kim

Melissa Deng

## Executive Summary

Singapore has long held a regional leadership role in technology governance and has experienced rapid technological growth in Southeast Asia. The country has more recently made clear its ambitions to cement its status as a global artificial intelligence hub. In pursuit of these goals, Singapore has provided top-down support for AI research and development (R&D) processes, including the significant streamlining of patent timelines and the cultivation of AI talent. It has also fostered an ecosystem conducive to growing AI startups, supported by a heavy emphasis on research, publications, and ethical and human-centric AI frameworks.

By many measures, Singapore is succeeding. It was the first country in Southeast Asia to launch a national AI strategy. As a percentage of GDP, Singapore's government-supported AI R&D spending is 18 times larger than similar U.S. R&D spending.<sup>1</sup> The city-state has also introduced a number of government initiatives on talent cultivation and innovation which have contributed to its AI success. Using CSET's Country Activity Tracker, we found that it was ranked 12th globally for the highest number of AI patent applications (661), 14th for patents granted (297), and 5th for percentage of patent growth between 2017 and 2020 (213.64 percent).<sup>2</sup> Singapore's ecosystem of accelerators, incubators, and over 3,600 tech startups ranks it as one of the world's most developed startup environments, bolstered by strong foreign investments and international collaboration, including in the form of research partnerships.<sup>3</sup> In terms of its AI research output citations, Singapore is 15th globally for number of research articles cited (877,650), with China and the United States being the top two collaborators on AI-related research.<sup>4</sup>

In this paper, we explore Singapore's AI strategy and progress and analyze published documents from the Singaporean government. Our findings highlight the following:

- **Singapore's national AI strategy seeks to harness AI in key sectors.** Active areas of research are predominantly focused on domestic improvements in the fields of healthcare, manufacturing, and cybersecurity. There is little indication that it is aiming to leverage AI for military purposes.
- **Singapore's future AI progress will be challenged unless it addresses its tech talent shortage.** With only 2,800 information and communications technology graduates in 2020 and an expected demand of sixty thousand through 2024, Singapore is falling far short.<sup>5</sup> To begin addressing this issue, Singapore has implemented apprenticeship programs, fortified its youth tech talent pipeline,

facilitated partnerships with tech companies internationally, and attempted to attract global talent. The results of these efforts remain to be seen.

- **Singapore’s regional leadership in other technical areas could serve as a template for AI leadership in the region.** In addition to spearheading numerous Association of Southeast Asian Nations cybersecurity initiatives, Singapore has also built a physical center—the ASEAN-Singapore Cybersecurity Centre of Excellence—to house regional exchanges and dialogues around cybersecurity. This endeavor positions it to be a leader in other technology forums, particularly those centered around AI.
- **Singapore has expressed its commitment to human-centric and ethical employment of AI applications, and begun steps to apply these ideals in practice.** The city-state has a unique definition of “human-centricity” in AI that is directly tied to its approach to AI ethics. The government has also created the Model AI Governance Framework to implement the guiding principles from its ethics documents. In many ways these frameworks are similar to efforts within the United States, including the Blueprint for an AI Bill of Rights and the AI Ethics Framework for the Intelligence Community, both of which carry principles of human consideration and involvement in AI decision-making. There may be opportunities for further alignment between the two countries and with other allies and partners to further promote trust in AI developments and ensure their ethical use.

We close with the following recommendations:

- **Promote shared views on the ethical development and use of AI.** Singapore’s emphasis on ethical AI aligns well with U.S. goals in this area, at least on paper. This point should bring comfort, but not complacency, to U.S. policymakers. There are opportunities for the two countries to collaborate on setting AI norms and regulatory measures in international bodies. The United States should continue to support Singapore’s leadership as many of ASEAN’s member states have started to gravitate toward Singapore for economic advancement and investment in cyber and AI.
- **Collaborate to address AI talent shortfalls in both countries.** While Singapore has initiated a slew of programs aimed at addressing its talent development shortfall, the current talent gap is sizable and could benefit from additional U.S. support, such as partnerships and exchange programs. Creating these programs is especially important given that China already has tech talent exchange

memoranda of understanding (MOU) and partnerships with Singapore, while the United States does not. However, this may be difficult due to the lack of streamlined immigration pathways for foreign-born AI workers seeking to work in the United States.<sup>6</sup>

- **Learn from Singapore's example.** Singapore is an important test case for government investment in emerging technology, talent upskilling, and shaping norms on the ethical use of AI globally. Its AI strategy and resulting investments, in conjunction with ethical and regulatory frameworks, have played a pivotal role in fostering its AI ecosystem. Although the United States currently has no similar federal legislation regulating AI, its state and local governments have passed a number of legislative measures. Though the governance systems between the two countries are different, there are likely to be takeaways for the United States from the example of Singapore and its initiatives.<sup>7</sup>
- **Collaborate on the development of national AI research resources for public use.** Both the United States and Singapore have initiatives to provide greater AI resources in the form of datasets and computational capabilities to researchers and universities. A sharing of best practices from these initiatives offers the opportunity to uplift both countries' efforts.
- **Singapore is highly linked with both the United States and China and continues to signal its desire to remain as a neutral AI hub, stay out of geopolitical disputes, and maintain strong technology partnerships with both countries.** The city-state has explicitly expressed that the United States should focus primarily on trade rather than purely on geopolitics and countering China. **As such, the United States should not treat Singapore as an instrumental player in its competition with China.** Singapore has made it clear that it is wary of, and would resist, such intentions. Accordingly, a more effective partnership is one that enables AI progress to benefit both countries.
- **Instead of expecting Singapore to take sides, the United States should seek to leverage its partnership with Singapore to enable AI progress that will benefit both countries.** The United States and Singapore already have a strong cybersecurity partnership through various MOUs and private sector collaboration, and this foundation can strengthen their growing linkages in AI investment, research, and endeavors in setting international norms. **The United States should not grow complacent in this partnership, especially on emerging technologies like AI, nor can it expect Singapore to take sides geopolitically.**

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## Singapore's AI Ecosystem

“Domestically, our private and public sectors will use AI decisively to generate economic gains and improve lives. Internationally, Singapore will be recognized as a global hub in innovating, piloting, test-bedding, deploying and scaling AI solutions for impact.”<sup>8</sup>

*-National Artificial Intelligence Strategy*

More than 30 countries have written AI strategies signaling their recognition of AI's potential benefits to improve governance, spur economic growth, and address pressing societal issues.<sup>9</sup> Singapore stands out for the number of programs it has launched since the publication of its *National Artificial Intelligence Strategy*. Initiatives such as fast-tracking patent approval, incentivizing private investment, and addressing talent shortfalls could offer potential models for others seeking to leverage the technology. It is also a regional leader in related technology areas, most notably cyber. Earlier work to build consensus on normative cyber behavior have direct analogues for newer efforts to increase trust in AI development and use. Finally, Singapore already partners with the United States in adjacent technology fields; as such, expanding cooperation on AI has potentially large benefits for both nations.

Singapore jump-started its rapid adoption of artificial intelligence through a series of government-led efforts, including the development of a strategy and a national program to implement it. These efforts were reinforced by strong ties to industry and associated funding for AI initiatives.

### **Government-led Efforts**

With an extensive government strategy for AI development, Singapore is a regional leader in AI in Southeast Asia. According to the 2021 Government AI Readiness Index, Singapore is ranked 2nd in the world and 1st in the region for indicators based on data representativeness, governance and ethics, and overall AI vision (on which it scored 100 percent).<sup>10</sup> In May 2017, the city-state launched AI Singapore (AISG), a national program which invested approximately \$109 million in its AI ecosystem of startups and research over five years.<sup>11</sup> Today, the program drives development through initiatives advancing research, local talent cultivation, and industry adoption of AI.<sup>12</sup> Sectoral programs target AI literacy, data, and machine learning (ML) infrastructure, AI governance, and international collaboration. There are over two dozen different

initiatives in areas such as talent development, AI experiments for industry, and AI ethics.<sup>13</sup>

Singapore has also been at the regional forefront of AI policy. In 2019, Singapore became the first country in Southeast Asia to release a national AI strategy. Key objectives were to integrate AI into the economy by 2030 and to become a “Smart Nation” by leveraging digital technology for governance and the economy.<sup>14</sup> AI solutions are central to this vision.<sup>15</sup> That strategy relies on five enablers: (1) cultivating a “triple helix partnership” among the research community, industry, and the government to commercialize AI technologies and foster collaboration; (2) bolstering the AI talent pipeline and educational programs to develop domestic AI talent; (3) maintaining a robust data architecture by facilitating easy access to cross-sectoral datasets; (4) creating a “progressive and trusted environment” to boost general trust in AI; and (5) collaborating with international partners.<sup>16</sup>

Table 1. Singapore’s Key AI Enablers

Singapore’s Key AI Enablers	
Enabler	Description
Partnerships	Create a “triple helix” partnership among academia, government, private sector.
Talent and Education	Address current national AI talent shortfalls.
Data	Build shared and trusted datasets.
Trust in AI	Encourage initiatives to boost public trust and confidence in AI.
International Collaboration	Work with allies and partners.

Source: Smart Nation & Digital Government Office, *National Artificial Intelligence Strategy*, 9.

On the whole, the strategy is focused on applying AI toward quality-of-life issues, infrastructure, and governance. To support these efforts, Singapore’s National AI Office is managing five projects in the areas of transportation and logistics, smart cities, healthcare, education, and public safety and security.

There is also a concerted effort to drive AI adoption in both government and industry. Under the national strategy, the government launched two programs in 2021 to facilitate AI adoption in governance and finance.<sup>17</sup> The National AI Programme in Government seeks AI solutions to optimize government processes and advance digital transformation.<sup>18</sup> The program includes efforts by government agencies, such as Singapore's Government Technology Agency, to leverage natural language processing for more user-friendly public interfaces. The GTA's AI-enabled JumpStart platform provides career recommendations and has already improved job placements by 20 percent since its November 2021 launch.<sup>19</sup> Another AI pilot program, the OneService Chatbot, addresses resident feedback by redirecting municipal issues to relevant agencies.<sup>20</sup>

Singapore's National AI Programme in Finance focuses on equipping the financial sector with capabilities such as NovAI, a platform for assessing a company's financial and environmental risks.<sup>21</sup> Veritas, discussed later, is another initiative encouraging financial institutions to adhere to fairness, ethics, accountability, and transparency principles when deploying AI.<sup>22</sup>

National patent policy can play a significant role in facilitating innovation and development. In 2019, Singapore streamlined its patent process for AI technologies under the Accelerated Initiative for Artificial Intelligence program (AI2). This program shortens the application-to-grant process for applications from two to four years to less than six months, increasing the country's appeal to international firms as a global AI hub.<sup>23</sup> The results of this initiative were evidenced when Chinese tech giant Alibaba obtained a Singaporean AI patent in just three months.<sup>24</sup> Likely as a result of its early success, the patent acceleration program will continue at least until April 2024.<sup>25</sup> Singapore's patent ecosystem appears to already be benefitting from such efforts. According to CSET's Country Activity Tracker, Singapore was ranked 12th globally for AI patent applications (661), 14th for patents granted (297), and 5th for percentage of patent growth between 2017–2020 (213.64 percent). New AI patent areas in Singapore include the medical and life sciences, digital computing, and data processing.<sup>26</sup>

Singapore is also placing additional emphasis on boosting AI research and development, another important indicator of a nation's support for innovation. In its most recent budget and planning process, it added approximately \$129.9 million to the initial \$360.9 million budget from 2020.<sup>27</sup> Relatively speaking, the scope of this R&D spending as a share of GDP is approximately 18 times larger than U.S. federal spending on AI R&D (a little over \$1.5 million) as a percentage of GDP in 2021.<sup>28</sup>



Under its renewed R&D plan are technology translation labs that aim to increase product-to-market speeds. R&D funding also supports research into explainable AI, federated learning, and small data techniques.<sup>29</sup> The city-state's ecosystem of accelerators, incubators, and over 3,600 tech startups—all beneficiaries of this plan—ranks as one of the world's most developed startup environments for attracting domestic and international investments.<sup>30</sup>

Like many nations, Singapore hopes that AI will increase its economic growth. Its expectations are high: the city-state is aiming for AI to drive an 18 percent growth in GDP by 2030, marking the largest expected percentage contribution among Southeast Asian countries.<sup>31</sup> In fact, growth was central to Singapore's early embrace of AI. A 2017 Accenture report estimated that AI technologies could double Singapore's annual growth rate and add approximately \$215 billion to the gross value of 11 industries by 2035.<sup>32</sup> Whether these and future efforts can translate into the desired growth projections remains unclear.

Singapore is attempting to spur innovation by making AI models and tools publicly accessible. The AI Makerspace, established in November 2019, is the cornerstone of this initiative.<sup>33</sup> By offering open data sets and AI tools, the initiative provides a test bed for multinational corporations and small and medium-sized enterprises (SMEs) to experiment with AI solutions in hubs.<sup>34</sup> For instance, the Computer Vision Hub boasts a user-centric AI interface of pre-trained models and an open-source computer vision framework.<sup>35</sup> Another capability under development is Synergos, a federated learning system that will permit multiple parties to train a machine learning model without sharing local training data—a capability that can be used to better protect user data and privacy concerns.<sup>36</sup> These systems provide accessible platforms for Singaporean companies to train and fine-tune AI products for deployment.

Indeed, many companies and international reports have taken note of these efforts, cementing Singapore's status as a global AI hub. Alibaba and Yitu Technology, both Chinese companies, cited Singapore's AI ecosystem, government support, and talent pool as favorable reasons for establishing research institutes and international offices there.<sup>37</sup> Singapore also topped the Asia-Pacific region for AI readiness in a 2019 Salesforce report, and the American consulting firm Oliver Wyman ranked Singapore 1st out of 105 cities for AI readiness in its 2019 Global Cities AI Disruption Index.<sup>38</sup>

### ***Industry and Investments***

In addition to government programs, Singaporean AI startups, as well as domestic and international investors, have catalyzed the country's move toward AI. According to

global consulting firm Kearney and Singapore-based global investor EDBI, Singapore ranked 1st among Association of Southeast Asian Nations (ASEAN) countries in investments in AI solutions at \$68 per capita in 2019.<sup>39</sup> Though lagging behind the United States' \$155 investments per capita, Singapore was the region's clear standout with investments dwarfing Thailand's \$0.37 and Indonesia's \$0.20 investments per capita. Singapore also ranked 1st as the most attractive destination for AI and robotics investors in 2018, performing particularly well in semiconductors and electronic equipment investment among 71 surveyed cities (it should be noted that in some instances, Singapore is ranked and evaluated as a city, and other times as a country, as seen in the above comparison).<sup>40</sup>

Singapore's AI unicorn companies—defined as private startups which are valued at over \$1 billion—have played an especially large role in capturing global investments. One such company, Trax, provides computer vision solutions for retail and is the only non-Chinese startup to rank as one of Asia's top 10 most funded AI unicorns at its valuation at over \$1 billion.<sup>41</sup> In Series E fundraising, Trax raised \$640 million in investments from eight investors to expand its cloud-based software products.<sup>42</sup> Chinese investors are also investors in Trax, having each participated in \$125 million and \$100 million Series D funding rounds in 2018 and 2019, respectively.<sup>43</sup> Similarly, U.S., UK, and Chinese investors have helped Advance Intelligence Group (AIG), a Singaporean big data and AI company, reach unicorn status and expand its operations from Southeast Asia to new markets.<sup>44</sup> In September of 2021, UK-based SoftBank Vision Fund 2 and U.S.-based Warburg Pincus led a \$400 million funding round for the AI startup.<sup>45</sup> Servicing one thousand clients globally, AIG's Advance.AI offers AI-driven biometric fraud detection and credit scoring services.<sup>46</sup> The company is also backed by several Chinese investors, including Gaorong Capital and Pavilion Capital, which raised \$80 million in 2019.<sup>47</sup>

Beyond its unicorns, Singapore's AI startups are attracting early-stage funding from foreign investors, demonstrating confidence in its AI tech sector. For example, Wiz.AI, a conversational AI startup, received \$30 million in Series A funding from Chinese equity firms in June 2022.<sup>48</sup> Another Singaporean company, Bolttech, which uses AI to diagnose the health and condition of mobile devices, has received \$180 million from U.S. funders followed by another \$30 million from Spain and Singapore's EDBI.<sup>49</sup> These foreign investment commitments highlight the growing scope and breadth of AI-driven businesses in Singapore and foreign investors' recognition of these opportunities.

Linkages between Singapore and China are also more apparent when analyzing Chinese investments in Singaporean AI unicorns and startups. As noted in previous

CSET research, the Chinese government has explicitly viewed large-scale deals—such as the 2019 acquisition of Singapore AI unicorn BIGO Technology for \$1.45 billion by Chinese platform Joyy—as “a successful example of the Belt and Road Initiative in the region.”<sup>50</sup> The same research found that in a 2020 Brunswick Group (advisory firm) survey, Singapore “showed the highest levels of trust in Chinese companies.”<sup>51</sup>

### **Research and Publications**

Scientific publication numbers and general research output provide one measure to assess a country’s competitiveness, and in Singapore’s case, show the country’s burgeoning impact in the field and its status as a growing global AI hub.

According to CSET’s Country Activity Tracker, as of December 2022, Singapore is 15th in the world for number of AI research output citations (877,650), with the top three most cited AI research institutions from Singapore (based on AI publications since 2010) being Ngee Ann Polytechnic, Advanced Digital Sciences Center, and Singapore University of Social Sciences.<sup>52</sup> As of 2019, Singapore’s AI researchers were the top in the world in terms of field-weighted citation impact\* and in AI research output (journals and conference papers) per capita.<sup>53</sup> With regard to support and funding from the Singaporean government, the Ministry of Education; the National Research Foundation; and the Agency for Science, Technology and Research (A\*STAR) funded 4,396; 3,811; and 2,158 AI research papers, respectively.<sup>54</sup>

Singapore has chosen five national projects where it hopes to leverage AI including quality-of-life initiatives like healthcare, education, and safety (as depicted in Figure 1 below), and we would expect to see research efforts widely supporting them.<sup>55</sup> However, there is a lack of government progress reports on specific research advances in pursuit of these projects. The country hopes to apply AI in a number of projects including managing chronic diseases, personalizing education, and streamlining transport logistics.<sup>56</sup> A 2017 article published in *AI Magazine* indicated that research is supporting the areas of mobility, security, manufacturing, and healthcare, though it also notes that “there are many other domains where researchers in Singapore are

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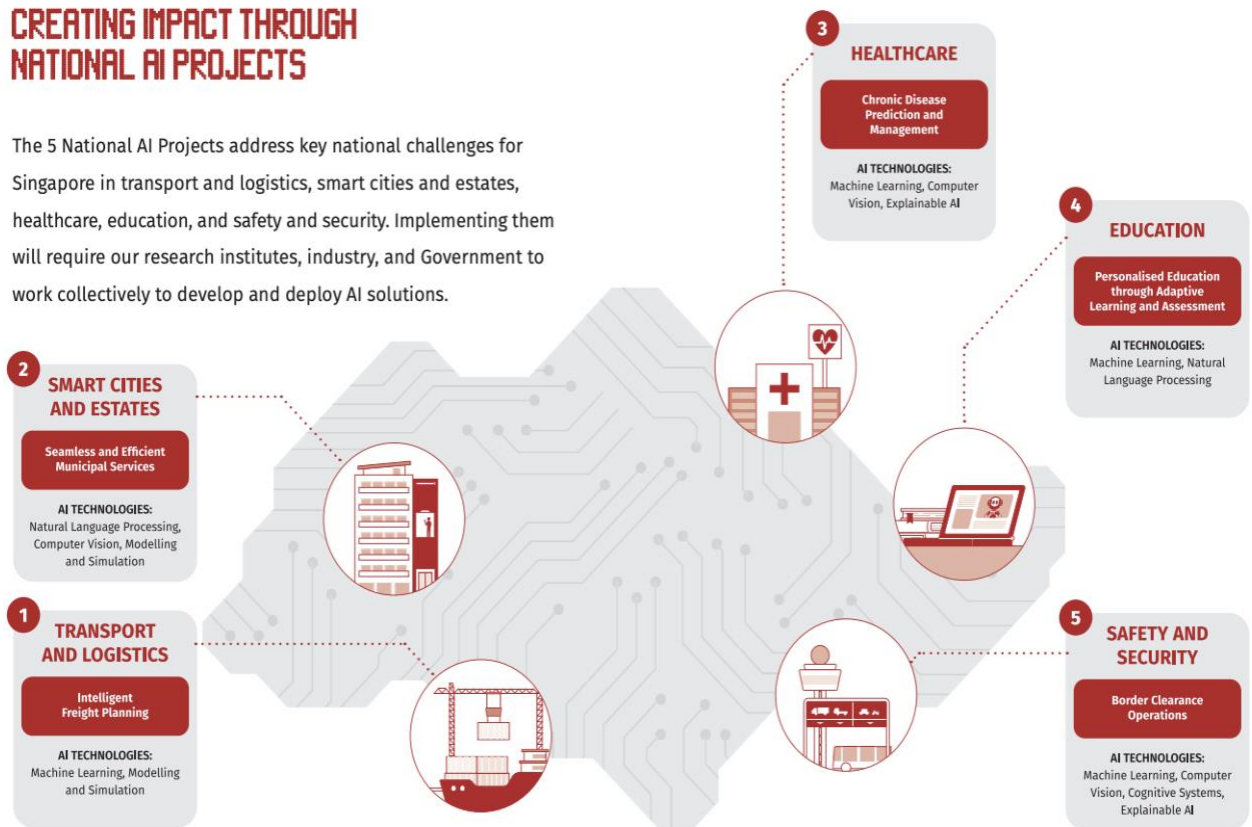
\* A field-weighted citation impact number is “a ratio between the number of citations a paper (or set of papers) has received, and the number of citations it may expect to receive, based upon the average number of citations per paper in the same subject category, article type, and publication year.” It can be used to evaluate the comparative merit of articles within a journal. See: Kelly Neubeiser, “What is Field Weighted Citation Impact?,” Wiley, December 16, 2021, <https://www.wiley.com/en-us/network/publishing/research-publishing/editors/what-is-field-weighted-citation-impact>.

currently conducting AI research.”<sup>57</sup> However, as stated above, additional details and more recent reports do not appear to be widely available.

Figure 1. Singapore’s National AI Projects

## CREATING IMPACT THROUGH NATIONAL AI PROJECTS

The 5 National AI Projects address key national challenges for Singapore in transport and logistics, smart cities and estates, healthcare, education, and safety and security. Implementing them will require our research institutes, industry, and Government to work collectively to develop and deploy AI solutions.



Source: Singapore’s *National Artificial Intelligence Strategy*.<sup>58</sup>

Singapore’s AI research benefits from international collaboration between its top universities and company partners. Research cooperation between Singaporean and Chinese institutions is significant and outpaces the United States by a wide margin. Over one-third of research papers (9,834) in all AI fields published in Singapore (28,838) from 2010 to December 2022 had a co-author from mainland China, followed by 5,421 papers with a co-author from the United States.<sup>59</sup> Furthermore, the National Natural Science Foundation of China (a governmental entity) was found to be the top funder by paper count for Singaporean AI research, having provided primary funding for 4,396 papers.<sup>60</sup> In addition, Chinese technology companies have established six research partnership or training programs with Singaporean institutions between 2011–2021.<sup>61</sup> For example, in 2018, tech titan Alibaba announced plans for a multimillion dollar collaboration with Nanyang Technological University in the form of

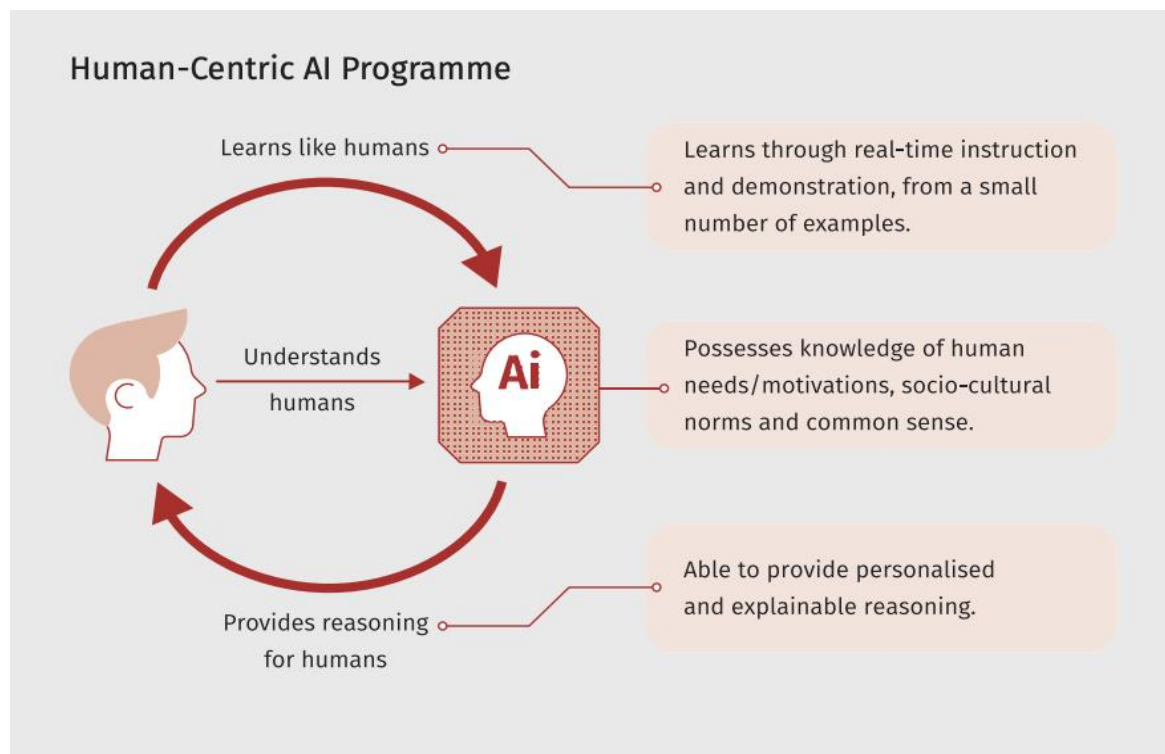
a joint research institute to deploy AI solutions in areas such as urban transportation, hospitals, and nursing homes.<sup>62</sup>

### A “Human-Centric” and Ethical Approach to AI

In a variety of written products and forums, Singapore has expressed a commitment to the ethical use of AI and AI governance frameworks.<sup>63</sup> As outlined in human oversight frameworks, Singapore has also advocated for a “human-centric” approach to AI development, which it defines as an approach that prioritizes the “protection of the interest of human beings, including their well-being and safety” in AI R&D.<sup>64</sup> This is Asia’s first framework of this type, and Singapore believes that the framework has laid a foundation for the responsible use of AI.<sup>65</sup>

Singapore first developed the Human-Centric AI Programme with the implementation of its AI strategy in 2019. The purpose of the program is to link different research groups in the country to develop AI technologies with particular consideration of their potential individual and societal impact. This takes the form of building collaborative relationships between machines and humans and allowing “AI systems to better understand culture and social norms” with an emphasis on “Asian cultures and norms.”<sup>66</sup>

Figure 2. Singapore’s Human-Centric AI Programme



Source: Singapore’s *National Artificial Intelligence Strategy*.<sup>67</sup>

The Human-Centric AI Programme aims to develop AI that can “learn like humans, understand humans, and explain their inner workings to humans.”<sup>68</sup> With its reference to learning from small data samples, the learning like humans pillar is more focused on AI development. This roughly mirrors ongoing ML research such as few-shot learning and to some extent reinforcement learning techniques.

Developing and deploying AI systems that understand human needs, motivations, and norms represents the second pillar of Singapore’s AI governance framework and a tenet of government pronouncements on the topics of AI ethics and human-centric AI.<sup>69</sup> In fact, it is not clear that the government draws a clear distinction between the two. The Artificial Intelligence Ethics and Governance Body of Knowledge (BoK), a tenet of Singapore’s AI ethics ecosystem, does list human-centricity as one of four pillars that “address[es] the ethical issues of AI adoption,” but first discusses the term more in regard to “determining the level of human involvement in AI-augmented decision-making” before jumping into “AI deployments with ethical values” in the body text.<sup>70</sup> Other frameworks also appear to suggest that Singapore may consider aspects of the human-centric approach to AI as a tenet of its ethical AI approach, and vice versa. Discussions of the necessity of a human-centric approach to AI solutions is included as a cornerstone of Singapore’s Model AI Governance Framework, which concerns ethical principles for AI solutions.<sup>71</sup> The document states that the framework itself “epitomize[s] our plans to develop a human-centric approach towards AI governance that builds and sustains public trust.”<sup>72</sup> The assumption underlying the Human-Centric AI Program and Singapore’s approach to human-centricity more broadly may be that if these systems can better understand human reasoning and norms, for example, they will prioritize human well-being and safety.

The third pillar is roughly equivalent to the desire for “explainability” in AI systems. Modern AI systems, specifically neural networks, are large and opaque. As a result, it is often difficult for users of AI systems to understand how the system reaches its conclusions or recommendations. Generally, the need for an explanation becomes more important when an AI system is making or assisting in socially consequential activities such as medical diagnoses, credit scoring, or law enforcement activities.

In line with its desire to promote human-centricity and ethics in AI systems, Singapore has in recent years established ethical standards and frameworks. In January 2019, the Personal Data Protection Commission of Singapore (PDPC) released the Model AI Governance Framework, which “provides detailed and readily-implementable guidance” regarding AI ethics and governance for private sector entities.<sup>73</sup> The second edition was released a year later. The framework seeks to implement the guiding

principles of ensuring that AI decisions are “explainable, transparent and fair” and that the use of AI is “human-centric,” as seen in the below figure.<sup>74</sup>

Figure 3. Model AI Governance Framework Principles

### Guiding Principles



Decisions made by AI should be **EXPLAINABLE, TRANSPARENT & FAIR**



AI systems should be **HUMAN-CENTRIC**

### From Principles to Practice



#### Internal Governance Structures and Measures

- Clear roles and responsibilities in your organisation
- SOPs to monitor and manage risks
- Staff training



#### Determining the Level of Human Involvement in AI-augmented Decision-making

- Appropriate degree of human involvement
- Minimise the risk of harm to individuals



#### Operations Management

- Minimise bias in data and model
- Risk-based approach to measures such as explainability, robustness and regular tuning



#### Stakeholder Interaction and Communication

- Make AI policies known to users
- Allow users to provide feedback, if possible
- Make communications easy to understand

Source: Overview of Singapore’s *Model Artificial Intelligence Governance Framework, Second Edition*.<sup>75</sup>

The Model AI Governance Framework has similarities to the Blueprint for an AI Bill of Rights released by the Biden Administration in 2022 and the Artificial Intelligence Ethics Framework for the U.S. Intelligence Community (IC), released in 2020. The U.S. Blueprint is centered around principles of “safe and effective systems; algorithmic discrimination protections; data privacy; notice and explanation; and human alternatives, consideration, and fallback.”<sup>76</sup> The table below compares the Blueprint with the Model AI Governance Framework, with the Blueprint’s principles ordered by similarity in language to Singapore’s existing framework principles.

Table 2. Comparing the Frameworks

Comparing the Frameworks	
Model AI Governance Framework (SG)	Blueprint for an AI Bill of Rights (U.S.)
<p><i>Internal Governance Structures and Measures</i></p> <ul style="list-style-type: none"> <li>• Delegate clear responsibilities for ethical use of AI to relevant personnel.</li> <li>• Risk management and mitigation, monitoring and reporting systems.</li> </ul>	<p><i>Safe and Effective Systems</i></p> <ul style="list-style-type: none"> <li>• Pre-deployment testing and risk mitigation of AI systems.</li> <li>• Protect individuals from inappropriate data use.</li> <li>• Independent evaluation and reporting.</li> </ul>
	<p><i>Data Privacy</i></p> <ul style="list-style-type: none"> <li>• Collect only strictly necessary data and always seek permission.</li> <li>• Consent requests should be accessible and provide agency.</li> <li>• Increased oversight for surveillance technologies.</li> </ul>
<p><i>Determining the Level of Human Involvement in AI-augmented Decision-making</i></p> <ul style="list-style-type: none"> <li>• Risk-benefit analysis of using AI for commercial objectives and frequent risk impact assessments.</li> <li>• Consider differences in societal norms.</li> <li>• Distinguish between “human-in-the-loop,” “human-out-of-the-loop,” and “human-over-the-loop” approaches.<sup>77</sup></li> </ul>	<p><i>Human Alternatives, Consideration, and Fallback</i></p> <ul style="list-style-type: none"> <li>• Individuals should be able to opt for a human alternative to an AI system.</li> <li>• Access to human consideration and remedy if automated system fails.</li> </ul>
<p><i>Operations Management</i></p> <ul style="list-style-type: none"> <li>• Maintain data accountability practices, such as knowing data lineage and how accuracy has</li> </ul>	<p><i>Algorithmic Discrimination Protections</i></p> <ul style="list-style-type: none"> <li>• Design AI systems equitably.</li> <li>• Protect individuals and communities from algorithmic</li> </ul>



<p>been sustained over time.</p> <ul style="list-style-type: none"> <li>• Reduce inherent bias, selection bias, and measurement bias.</li> <li>• Explainability of AI algorithms, repeatability documentation, and auditability are key.</li> </ul>	<p>discrimination.</p> <ul style="list-style-type: none"> <li>• Make proactive equity assessments and algorithmic impact assessments public.</li> </ul>
<p><i>Stakeholder Interaction and Communication</i></p> <ul style="list-style-type: none"> <li>• Disclose information on how the AI will affect consumers.</li> <li>• Focus on transparency.</li> <li>• Maintain communication channels with the public.</li> </ul>	<p><i>Notice and Explanation</i></p> <ul style="list-style-type: none"> <li>• Provide accessible plain language documentation of AI systems' use to individuals.</li> <li>• Automated systems should provide meaningful explanations.</li> </ul>

Source: Singapore's Model AI Governance Framework and the United States' Blueprint for an AI Bill of Rights.<sup>78</sup>

As shown in this table, there is significant overlap between the two frameworks, although specifics in language vary slightly. One difference, however, is the U.S. Blueprint for an AI Bill of Rights' emphasis on data privacy as a core principle, which was not explicitly apparent in the Singapore framework. While the framework document has some mentions of the need for data protections, there is no specific section on mitigating data privacy breaches and the document is silent on the use of AI for surveillance. Furthermore, the Blueprint for an AI Bill of Rights' section on "Human Alternatives, Consideration, and Fallback" has slightly different aims than Singapore's approach to human-centricity and human involvement, focusing on human alternatives and remedies rather than human involvement in AI decision-making (e.g., the effect of differences in societal norms on creating AI systems).

However, the U.S. IC's focus on "Human-Centered Development and Use" within its AI Ethics Framework is quite similar, at least in verbiage, to Singapore's discussion and definition of human-centric AI in its Model AI Governance Framework.<sup>79</sup> The IC framework emphasizes "tempering technological guidance with the application of human judgment, especially when an action has the potential to deprive individuals of constitutional rights."<sup>80</sup> This centering on human judgment is thus present in both the IC framework and the Model AI Governance Framework alongside other similarities, such as the highlighting of the need for transparency through explainability and interpretability of AI outputs.<sup>81</sup>

To complement the AI governance framework, Singapore has begun developing standards to guide the implementation of AI systems. In 2020, the Singapore Computer Society, an industry group in Singapore, launched the BoK with support from the government. The BoK is designed to provide a reference on AI ethics to IT business leaders.<sup>82</sup> The government sees the development of ethical and human-centric AI as both a normative imperative and a competitive advantage.<sup>83</sup>

Furthermore, the government has established a partnership with Nanyang Technological University (NTU) to create and execute an AI ethics and governance certification program to certify compliance with the framework.<sup>84</sup> Another initiative, “A.I. Verify,” which Singapore touts as the “world’s first AI Governance Testing Framework and Toolkit,”<sup>85</sup> provides a benchmark by which companies can measure the safety of their AI products and better ensure that they are used responsibly.<sup>86</sup>

Singapore’s government is providing additional oversight by creating an advisory council focused on the ethical use of AI and data. The council, which includes AI leaders in the private and public sectors along with consumer advocates, has the aim of advising the Singaporean government on any ethical and governance issues related to AI.<sup>87</sup> The council provides tailored guidance to companies and consumers on the ethical risks of employing such technologies. The creation of the advisory council was preceded by—and perhaps spurred by—the launching of an AI and data analytics grant by Singapore in 2017, which subsidized up to 50 percent of the costs for projects that specifically use techniques such as machine learning and neural networks.<sup>88</sup>

Singapore has also focused on initiating private sector ethical frameworks for AI-powered financial applications. In 2019, the government announced the creation of the Veritas Initiative, a partnership between the Singaporean government and the financial sector. The Veritas Initiative provides a framework for companies to measure and compare their AI applications to the core principles of “fairness, ethics, accountability, and transparency.”<sup>89</sup> Through the initiative, financial entities will have open-source tools they can use to measure adherence.<sup>90</sup> Singapore’s focus on ethical AI and the role of the private sector in achieving these aims could bring the city-state closer to realizing its goal of becoming an AI-driven economy. However, due to a lack of accessible reports, we cannot measure the effectiveness of these new tools nor adherence to these principles within the private sector.

The significant challenge facing Singapore, as well as any country attempting to implement sweeping frameworks for the ethical use of AI, is putting high-level ideals into practice. One visible measure, for example, would be the implementation of privacy protections, or limitations on AI use for surveillance and law enforcement.

However, it is difficult to discern its progress on this front because of how recently these frameworks were introduced, and an apparent lack of progress assessment reports by the government. These difficulties are compounded by the fact that adherence to the Model AI Governance Framework, which is directed toward private sector organizations, is voluntary.<sup>91</sup>

## Talent and Education

Singapore's potential as a rising AI hub is attracting technical talent both domestically and globally, but demand for talent is poised to outpace supply.<sup>92</sup> Since 2020, Singapore was averaging 2,800 information and communications technology (ICT) graduates annually, whereas the country is expected to have a demand of an additional sixty thousand tech talents through 2024.<sup>93</sup> In addition, a separate study by NTU found that only 58 percent of women who graduated with a STEM degree or diploma actually went on to a STEM-related career, furthering the talent pipeline gap.<sup>94</sup> If Singapore is unable to address these gaps, its AI development will be seriously challenged.

Singapore has undertaken a number of initiatives to address these shortfalls. In 2017, it developed an apprenticeship program to facilitate the transition of STEM graduates to Singapore's AI sector.<sup>95</sup> This upskilling initiative combines a nine-month classroom learning component with on-the-job learning in industry and is one part of Singapore's efforts to bolster its domestic AI workforce. Apprentices work in AISG's office on a full-time basis.<sup>96</sup> However, it appears that only 25-35 applicants are expected per "batch" every nine months, which calls into question the size of its impact.<sup>97</sup> Another program, AISG's Talent Portal, directly connects graduates from the apprenticeship program with companies involved in harnessing AI vis-à-vis Singapore's digital economy. AISG's 100 Experiments then draws from this talent pool to support companies utilizing AI solutions.<sup>98</sup> Also among these programs is the TechSkills Accelerator, a government initiative that upskills non-ICT professionals by funding "professional development courses in AI."<sup>99</sup> Singapore has also been directly collaborating with large tech companies to mitigate its tech talent shortage. For example, in October 2019, SkillsFuture Singapore partnered with IBM Singapore to train 2,500 Singaporeans in AI technologies through 2022.<sup>100</sup>

A further effort was launched in 2018 to train two thousand "technically inclined" industry professionals in Python using both online and offline modules. Those who completed the program were slated to receive a "Foundation in AI certification."<sup>101</sup> Our research could not determine whether these efforts have been continued; if they have not, then the scope of this initiative's impact will be limited. Notwithstanding, AISG wants Singaporean companies to both promote and recognize this professional certification. A separate effort encourages companies to identify individuals who would be good candidates for certification as AI Associate Engineers and AI Certified Engineers.<sup>102</sup> As part of Singapore's R&D strategy, there is an emphasis on allocating more resources to the Singapore Digital Scholarship and its PhD program, both of

which are focused on providing “local talents” with the necessary knowledge and skills to assume leadership positions in AI-affiliated companies and consequently drive Singapore’s economic development.<sup>103</sup>

Perhaps recognizing that domestic talent development efforts are insufficient, Singapore launched the Tech@SG program in 2020 to recruit high-skill foreign talent.<sup>104</sup> Under this program, Singaporean companies that meet certain criteria can receive up to 10 two-year Employment Passes from the Ministry of Manpower to hire foreign nationals who are “professionals, managers, and executives.”<sup>105</sup> These foreign nationals must already be earning at least S\$4,500 (~\$3,249 USD) a month.<sup>106</sup> To have true impact such an effort would have to scale to much greater numbers. Still, it is important to recognize that the Tech@SG program and Singapore’s efforts to leverage both domestic and foreign talent reflect a hybrid strategy in the AI and technological fronts. These initiatives share an explicit aim of boosting Singapore’s economic power and technological competitiveness.

Accordingly, Singapore’s educational system has accelerated the talent development pipeline for the AI sector. In June 2019, AISG launched “AI for Kids” (AI4K) program, which supplements primary school curricula through interactive online modules on AI basics, such as computational thinking. As of April 2020, 12 percent of Singapore’s 186 public schools have incorporated the AI4K modules into their curricula.<sup>107</sup> In addition to exposure to relevant concepts at the primary school level, the “AI Student Outreach Program” provides students with self-study resources to ultimately obtain various industry-recognized AI certifications.<sup>108</sup> Another initiative, “AI for Everyone,” provides free three-hour workshops to the public on the benefits of AI technologies and involves support from Microsoft and Intel. The program aims to reach ten thousand individuals (ranging from secondary school students to adult professionals).<sup>109</sup> Workshops of this length can only be expected to provide exposure to the technology—not address actual workforce shortages. These limitations are acknowledged by the program, which states that one of the primary goals is to “dispel fears that AI will replace jobs” and show that it “instead can help them work more productively.”<sup>110</sup>

Singapore’s talent shortfalls are not unique. Many countries, including the United States, face similar challenges. The biggest question regarding the programs underway is whether the relatively small numbers of individuals trained and the trainings’ limited scope can make a perceptible impact on the talent shortages. For example, its full-time apprenticeship programs could provide one avenue to address these challenges, but a nine-month training program may not have sufficient depth to address known skill shortages. Furthermore, its small cohort size of 25-35 accepted

applicants may limit its structural impact on the AI talent pipeline. Short duration workshops can provide exposure to the technology and spark interest, but they do not create skilled professionals. The same applies for certification programs; to be valuable they must provide enough rigor and exposure to the AI development pipeline. In short, while these programs may be helpful, their potentially limited scope and scalability call into question whether they will have a discernible impact on the talent shortage. Thus far, there has been little available information on how effective these programs have been since their implementation over the past four years.

## The Geopolitical Context

There are inherent characteristics of Singapore's foreign policy—most importantly its desire to remain neutral—that shape its bilateral relationship with the United States, even as the two countries remain linked in support of one another's technological priorities. In recent months, Singapore has further sought to establish its neutrality. It explicitly seeks to avoid entanglements in what it sees as the “geopolitical games of big powers,” with Singapore's minister for foreign affairs stating that the country does “not take sides but we do take a stand to uphold existential principles.”<sup>111</sup> The city-state has increasingly urged the Biden administration to drive its main attention to trade rather than focusing on geopolitics and countering China.<sup>112</sup>

Singapore's political maneuvering sends a clear message that though it is continuing its cooperative agreements with the United States on defense exercises and technology sharing, the state itself is not willing to be an instrumental piece in the United States' larger Asia strategy to counterbalance China. For example, it recently reaffirmed its military education partnership with China.<sup>113</sup>

Singapore has also been a leader in various ASEAN technical forums that could translate to similar leadership in AI. For example, over the course of several years, Singapore and other ASEAN nations have aimed to align cybersecurity regulations to promote cyber capacity building, enhance ops-tech collaboration and encourage and build a regional cyber strategy.<sup>114</sup> These efforts have led to the adoption of international cyber norms, making ASEAN the first regional organization to subscribe to the 11 voluntary, non-binding norms of responsible state behavior in cyberspace as set forth by the United Nations.<sup>115</sup> Correspondingly, member states have agreed to work on capacity building across the region to implement the norms, which include a commitment to protect critical infrastructure and a mutual response to requests for cyber assistance.<sup>116</sup>

Following the adoption of the first ASEAN Cybersecurity Cooperation Strategy (2017-2020), which enshrines these tenets, Singapore's minister for communications and information stated that “Singapore is happy to take the lead” on implementing the strategy.<sup>117</sup> It followed this announcement with the launch of the ASEAN-Singapore Cybersecurity Center of Excellence (ASCCE) in 2019 to support cyber capacity building efforts among ASEAN members.<sup>118</sup> Singapore contributed approximately \$22 million to create the center, which has three main functions: (1) conducting cybersecurity research and pathways for implementing international cyber norms; (2) providing the necessary training for Computer Emergency Response Teams (CERTs), or those who serve as “first responders” to cyberattacks for their respective organizations; and (3)

providing participants with interactive exercises and training related to virtual cyber defense.<sup>119</sup> In the area of cyber ops-tech collaboration, clear examples are the ASEAN CERT and the ASEAN CERT Information Exchange Mechanism, which facilitates the exchange of CERT best practices and helps boost capacity building programs across the region.<sup>120</sup>

Singapore has not yet initiated similar programs with ASEAN in the realm of AI. However, the cybersecurity initiatives it has spearheaded provide a promising precedent for the city-state to harness collaborative efforts across the region. At a minimum, agreements on ethical principles and responsible use of AI would be a positive step forward in the advancement of AI among the member states.

### ***The United States and Singapore***

The United States is already pursuing AI collaboration with Singapore, building on several existing lines of effort. In October 2021, a signed memorandum of understanding (MOU) formalized the U.S.-Singapore Partnership for Growth and Innovation (PGI). The agreement explicitly promotes AI collaboration through the alignment of technical standards on AI frameworks.<sup>121</sup> On March 29, 2022, following Prime Minister Lee Hsien Loong's visit to Washington, DC, the two countries renewed and expanded the mandates of their MOUs to further cooperation first introduced under the PGI.<sup>122</sup> Under the March MOU, the United States and Singapore committed to strengthening cooperation in four main areas, including (1) digital economy and smart cities; (2) energy and environmental technologies; (3) advanced manufacturing and supply chain resilience; and (4) healthcare.<sup>123</sup> A press release issued after the October 2022 PGI annual dialogue reaffirmed these commitments, which included the development of "interoperable AI governance frameworks to support industry's adoption of trustworthy AI."<sup>124</sup>

Another MOU signed between Singapore's Infocomm Media Development Authority and the U.S. Department of Commerce following that meeting provided frameworks for the deployment and governance of ethical AI and was accompanied by joint exercises and events between organizations in both countries.<sup>125</sup> Minister Teo stated that these agreements reflected "one practical example of our digital cooperation is aligning our respective AI governance frameworks. Companies can expect to deploy AI across borders with greater ease, to seize innovation opportunities while managing the risks."<sup>126</sup>

Singapore's focus on building human-centric AI networks and its joint partnership with the United States on ethical AI governance stands in contrast to China's growing use



of AI algorithms for domestic surveillance, which have raised security and human rights concerns.<sup>127</sup> While Singapore has not appeared to make any official statements about that trend, it has noted that China's national face recognition system will cause "perennial privacy and cybersecurity concerns such as data thefts."<sup>128</sup> Singapore and the United States have also affirmed the "importance of ensuring that critical and emerging technologies foster an open, accessible, and secure technology ecosystem based on mutual trust, confidence, and respect for a rules-based international order."<sup>129</sup> Overall, the two countries appear to be on the same page about technology governance in contrast to China's model. Thus, it is even more important for the United States to consolidate its partnership with Singapore, which has the potential to serve as a model of AI governance for other Southeast Asian countries.

Apart from government-instituted partnerships, U.S. companies have played a key role in strengthening U.S.-Singapore AI collaboration. As detailed earlier, U.S. investors and companies have boosted private sector collaboration and investment in Singapore's AI ecosystem, funding AI startups and helping notable AI firms reach unicorn status. In turn, U.S. companies have also benefited greatly from Singapore's strength as an AI hub, with many firms establishing operations in Singapore. For example, U.S. software firm Salesforce opened its first overseas AI research center in Singapore last year along with major tech companies like Google and Meta.<sup>130</sup>

### ***China and Singapore***

At the same time, Singapore continues its engagements with China and Chinese companies as it seeks to maintain positive relationships with both countries. It has demonstrated this by providing a neutral AI and technological hub accessible to all countries. As a result, international tech companies have enlarged their footprint within the country, pointing to the success of its neutrality strategy to date.

The United States and its allies must consider the presence of Chinese enterprises in Singapore.<sup>131</sup> For example, China's e-commerce giant Alibaba Group and leader in facial recognition tech Yitu Technology have both expanded into Singapore to conduct regional operations and invest in Singapore's AI incubation spaces. After opening its first international office in Singapore in 2018, Yitu quickly established a Research and Development Centre to foster increased collaboration with Singapore's AI industry.<sup>132</sup> There is also evidence of Chinese enterprises initiating partnerships with non-commercial or industrial entities. iFlytek, which is a Chinese AI company focusing on speech intelligence, "provided its products to 94 percent of Singaporean primary and secondary schools to help students learn Chinese."<sup>133</sup>

Cooperation between Singapore and China is evident on a number of fronts. The two countries have recently inked a series of MOUs that have formalized their cooperative working relationship in the fields of technology (although the specific technologies are not mentioned) and defense. At the end of December 2019, the two countries signed an implementation agreement regarding science, technology, and innovation.<sup>134</sup> The agreement, which lasts for five years, is built on the existing partnership codified in the 1992 Agreement on Cooperation in Science and Technology. Singapore's National Research Foundation remarked that the new iteration of this agreement would focus on facilitating increased exchanges and interactions between scientists of both countries and opportunities to test technologies using each other's agencies.<sup>135</sup>

In a similar vein, the two countries held their first meeting for the Singapore-China (Shenzhen) Smart City Initiative Joint Implementation Committee in June 2020, with eight MOUs being signed relating to four pillars: (1) digital connectivity; (2) tech talent exchange and cultivation; (3) technological cooperation, innovation, and entrepreneurship; and (4) the establishment of "demonstration zones" in Singapore and Shenzhen.<sup>136</sup> The language in the MOUs is vague, discussing the tech talent pillar as an effort to "jointly strengthen talent exchanges . . . and help enterprises with presence on both sides to access the tech talent they need in their respective markets."<sup>137</sup> There is similar all-encompassing language used with regard to the innovation and entrepreneurship focus, namely to "deepen collaboration . . . to support and facilitate two-way flow between Singapore and Shenzhen tech startups and SMEs."<sup>138</sup>

## Recommendations

There are multiple opportunities for the United States to engage more closely with Singapore in AI to benefit AI development in both countries. The United States should build off of these foundations rather than trying to leverage its relationship with Singapore for the sole purpose of countering China. U.S. policymakers aiming to strengthen the collaborative relationship between the United States and Singapore in AI and related fields can take several steps.

**Build off of the already strong cyber partnership between the United States and Singapore.** There are numerous areas of cyber cooperation between the United States and Singapore, and the two countries generally enjoy a strong partnership when it comes to mutual cybersecurity. While constrained by talent shortfalls, Singapore is nonetheless poised to be a regional leader in AI development and perhaps a global leader in some applications. For these reasons, the United States should seek out the opportunity to collaborate on AI norm-setting and regulation with Singapore rather than only trying to use its relationship with Singapore to counter China. Singapore is already wary of being treated instrumentally and of being pulled into a larger geopolitical competition.

**Promote shared views on the ethical development and use of AI.** The shared MOU for the deployment and governance of ethical AI provides a starting point for greater cooperation in this area between the two countries. There are upcoming opportunities for the United States and Singapore to collaborate on norm-setting and regulations around cyber and AI use in international bodies. Given that the U.S. Department of State has already committed to supporting the Cyber Capabilities and Capacity Development Project for ASEAN from September 2021–September 2023 in its capacity as a donor, the United States should continue to support ASEAN in its cyber exercises and efforts to adhere to normative AI and cyber use frameworks.<sup>139</sup> Since many ASEAN member states have started to gravitate more toward Singapore for economic advancement and AI investment, the United States should continue to support Singapore's leadership in ASEAN technology discussions relevant to cyber and AI. While there are geopolitical benefits to this support, it also benefits U.S. tech companies.

**Collaborate to address AI talent shortfalls in both countries.** While Singapore has initiated a number of programs aimed at addressing their talent development shortfall, the current talent gap is sizable and could benefit from additional U.S. support, such as through partnerships and exchange programs. For example, the U.S. Department of State sponsored an exchange program through the Fulbright-Indonesia Research in

Science and Technology (FIRST) program with \$15 million in scholarships to facilitate the exchange of Indonesians and Americans to “study, teach, and conduct research in priority science and technology fields.”<sup>140</sup> Creating a similar program or set of scholarships to initiate increased talent exchanges is especially important as China already has tech talent exchange MOUs and partnerships with Singapore, while the United States does not appear to have any that explicitly focus on talent.

To address its talent gap, the Singaporean government has supported several programs including AISG’s apprenticeship program, Talent Portal, AI certifications, and partnerships with private companies to offer AI and cybersecurity scholarships and opportunities. Monitoring the relative success of these programs in addressing Singapore’s talent shortfall presents the United States with an opportunity to identify promising initiatives for remedying its own talent gaps. It should be acknowledged that Singapore and the United States are vastly different in size, scope, and degree of centralized control—however, the United States can still learn from Singapore’s example. Presently the United States lacks a clear-cut AI education and workforce policy at the federal level, which hinders the centralization and implementation of programs aimed at bolstering and upskilling U.S. AI and cyber talent.<sup>141</sup> The United States can look at the efficacy of Singapore’s efforts when considering future policy and national talent programs.

**Learn from Singapore’s example.** Singapore is an important test case for government investment in emerging technology and talent upskilling, and is a leading nation in shaping norms around ethical AI globally. The AISG national program and resulting investments, in conjunction with ethical and regulatory frameworks, have played a pivotal role in fostering Singapore’s AI ecosystem. While some individual states in the United States have implemented AI strategies or task forces, there is no federal legislation in the United States that regulates AI today.<sup>142</sup>

**Collaborate on the development of national AI research resources for public use.** Both the United States and Singapore have initiatives to provide greater AI resources in the form of datasets and computational capabilities to researchers and universities. Within Singapore, the AI Makerspace (a 2019 AISG initiative) has resulted in the release of open data sets and AI tools for public use that have been instrumental in the development of AI solutions for multinational corporations and SMEs in Singapore. For its part, the United States has begun the planning and implementation of the National Artificial Intelligence Research Resource, which aims to make datasets and computational systems available to U.S. companies and universities.<sup>143</sup> The United States should seek to learn from the AI Makerspace model as it develops the NAIRR and supports similar efforts.

## Conclusion

Singapore is uniquely positioned as a leader in Southeast Asia in responsible and accelerated AI development, and there is much that the United States can learn from the city-state. Singapore's AI ecosystem—characterized by heavy top-down support from the government in the shape of financial assistance and national initiatives along with flourishing start-ups—is demonstrative of the country's competitiveness as a burgeoning global AI hub. Watching the city-state's developments in pursuit of its national AI strategies may yield promising insights for the United States and its allies, especially as they seek to promote AI development and ethical norms globally.

## Authors

Kayla Goode is a former research analyst at CSET, where Heeu Millie Kim is a former semester research analyst, and Melissa Deng is a student research assistant with the CyberAI Project.

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