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The World Wide Race for Artificial Intelligence: A Path Forward for U.S. Policy

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The World Wide Race for Artificial Intelligence:
A Path Forward for U.S. Policy

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Executive Summary

The advent of an artificial intelligence (AI) revolution will result in massive transformation across all sectors of society. AI has the potential to redefine innovation, impacting global labor markets, improving military capabilities, and supporting smart cities. As a result of this incredible potential, countries worldwide are funneling resources towards the expansion of their AI capabilities and finding new ways to collect vast amounts of data to train AI systems. These landmark technologies bring cutting edge solutions to challenges previously out of reach. However, AI proliferation also comes with difficult ethical questions regarding data privacy and the use of autonomous weaponry.

Our report provides a global framework to understand the AI landscape and derives policy recommendations for the United States' government in light of these findings. To do this, we surveyed 12 country cases and two other pressing policy areas—AI ethics as well as the potential threat of non-state actor AI use. The cases in this study were chosen for their ability to give a comprehensive overview of the diverse global landscape based on their current AI trajectory, the importance of their relationship to the U.S., and their regional position. On the basis of these criteria we examined Brazil, China, Estonia, Germany, India, Iran, Israel, Japan, Kenya, Russia, and Singapore. Also included is a case study of the U.S.

The report finds that countries at all levels of development are investing in AI. The race for AI does not have one winner, rather, countries are pushing to become strategic leaders and optimize their economies, militaries, and societies through AI application. To maintain its position as a global AI leader, the U.S. should cooperate with countries at all levels of AI development, learn from these case countries successes and failures, while also spearheading international AI ethics conversations.

Drawing on major findings and analysis from these cases, we make the following five policy recommendations to the U.S. government.

1. Increase AI awareness domestically, tailoring efforts to different sectors
2. Create new domestic pathways for AI education and retaining skilled labor
3. Continue the domestic trend of earmarking federal funds for AI development
4. Deepen strategic collaboration with like-minded countries
5. Acknowledge international threats while avoiding state-to-state escalation

We also offer an additional four recommendations in light of our findings about the pressing ethical challenges AI presents.

6. Create a federal data privacy law to address some pressing AI ethics issues
7. Consider ethical implications when determining foreign policy
8. Lead efforts towards constructive international conversations around AI use
9. Work towards global agreement that AI ethics is a human rights issue

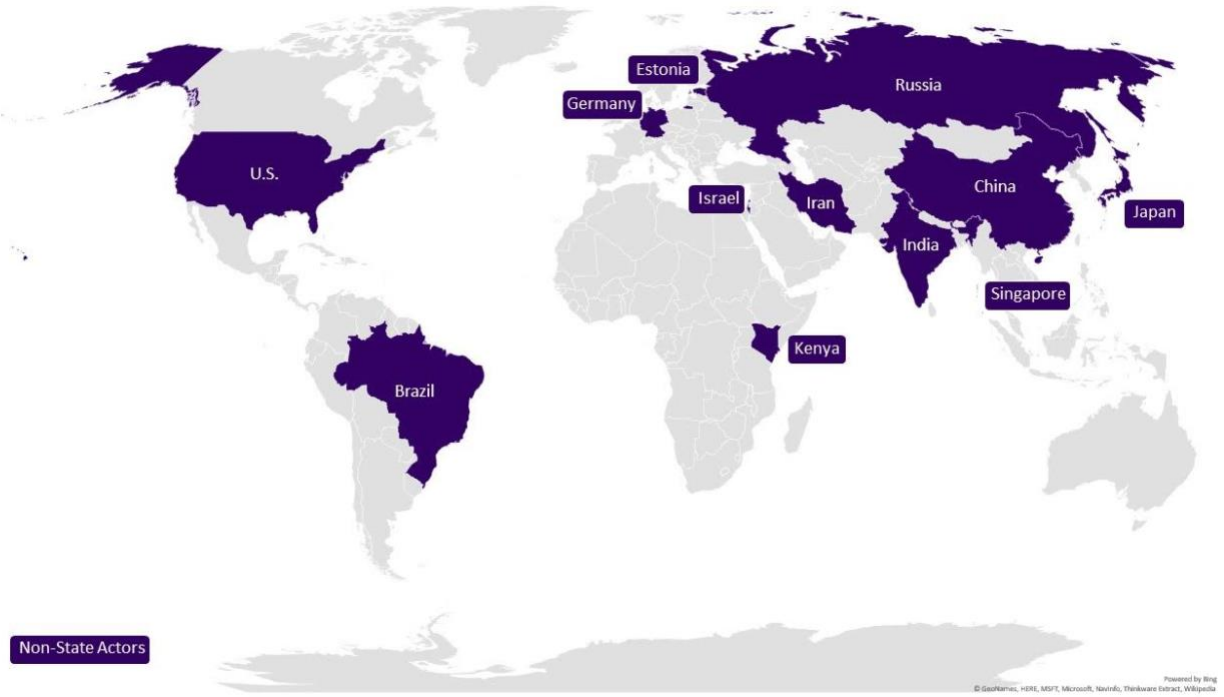
Report Findings

Our report provides a global AI landscape meant to inform the U.S. government on AI domestic and international policies. The report's recommendations are based on in-depth analysis of 12 country cases and two other critical policy areas—the threat of potential non-state actor AI use and a comprehensive look at AI ethics. From this analysis we have been able to synthesize three major findings:

1. Countries at all levels of AI development are expanding their commitment to AI.
2. AI ethics has become an increasingly important issue that countries around the world are beginning to focus on and address.
3. The U.S.'s political and economic relations with certain countries are mirrored in their relationships around AI development.

Figure 1 illustrates the geographic distribution of our 12 country cases.

Figure 1: Map of Case Studies



First, the report finds that countries at all levels of AI development, even low levels, are rapidly increasing their commitment to AI development, signifying that the race to develop AI technology is not a zero-sum game. Countries with low AI development cannot feasibly catch up to advanced nations such as the United States. However, these developing nations are still aggressively pursuing AI development to take advantage of sector-specific solutions and secure

positions as regional AI leaders. Based on our data, we have categorized the country cases into three levels of AI development: low, medium, and high.

Second, AI ethics has become an increasingly important issue to address. AI technology introduces new risks to citizens' data and privacy. This report finds that many countries are in the process of building robust ethical guidelines domestically, while other states have either ignored or actively disregarded basic ethics. The U.S.'s own standards of AI ethics can be strengthened by looking to those countries with comprehensive guidelines as a model. We have categorized the cases into low, medium, and high levels of AI ethics effort.

Third, the U.S's historic and current relations with our case study countries can inform how the U.S. should engage other countries in the field of AI. As the race for AI cannot be understood in absolute terms, the U.S. would benefit greatly by increasing its inter-state cooperation on AI research and development. However, the U.S. still needs to identify potential threats or competitive risks, develop a system of staying informed about these countries' AI capabilities, and increasingly commit resources to its AI program to maintain a competitive edge. We classified each country as an ally, a potential ally, or a potential risk.

Case Study Methods

Our report uses research on 12 country cases to provide an overview of the global AI landscape. The country cases include the U.S. and 11 other states chosen for their current AI trajectory, the importance of their relationship to the U.S., and their regional position. Based on these qualifications, we chose Brazil, China, Estonia, Germany, India, Iran, Israel, Japan, Kenya, Russia, and Singapore.

Each country case study includes an analysis of the country's AI development level—coded as low, medium, or high. Factors that contribute to these development labels include a country's AI readiness score from the 2019 Oxford AI Readiness Index, the respective government's commitment to AI, the country's R&D and AI applications landscape, as well as the country's position on ethical issues such as data privacy and autonomous weaponry.

To determine a government's commitment to AI, the cases provide an overview of their respective government's domestic and international AI policies. Each case's analysis then follows the trajectory of AI development starting with R&D in collaborative, industry, academia, and country-to-country spaces, followed by a summary of key AI products and applications produced by governments, private companies, or collaborative efforts.

To add to the comprehensive discussion on ethics, each case country looks at the data privacy laws, ethics guidelines, and any other ethics conversations currently happening within the nation. Concluding each case is a recommendations section for the U.S., which establishes the country's current relationship to the U.S. as well as specific inter-state recommendations.

It is important to note that these levels of development are defined in relation to the other cases in this report. In comparison to high AI developed states like Singapore and the U.S.,

Kenya has a relatively low AI development. However, among African nations, Kenya is a leading AI power.

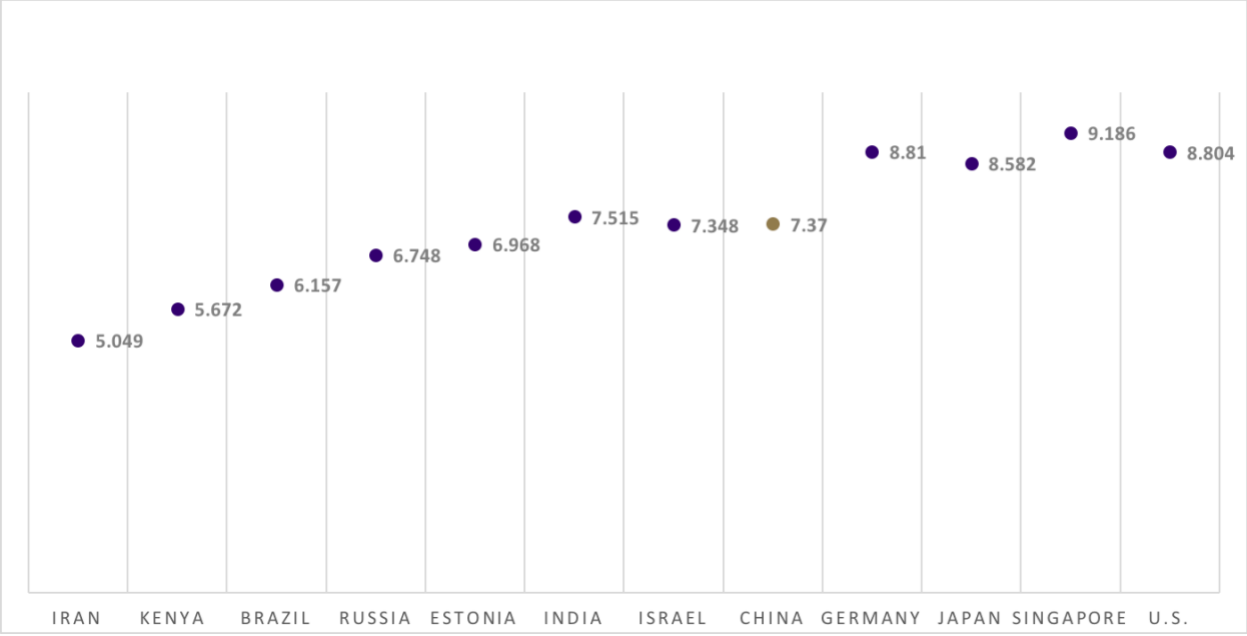
Level of AI Development

Countries around the world find themselves at varying levels of AI development. Nations like China and Singapore have decided to place huge investments into the field, fueling rapid growth in AI and producing new technologies and research. Others, like Kenya, have just begun to explore the uses of AI to provide sector-specific solutions. Distinguishing a country's current level of AI development informs how the U.S. should pursue future relations with it.

Based on the report's findings, we have classified each country's level of AI development into three categories—low development, medium development, and high development. Countries with low AI development include Kenya and Iran. Brazil, Estonia, India, Israel, and Russia are considered to have medium levels of AI development. The country cases with high development are China, Germany, Japan, Singapore and the U.S. It is important to note that the low, medium and advanced levels of development are defined in relation to the other cases in this report. For instance, in relation to other African nations, Kenya is a leading AI power, but compared to our other cases, Kenya lacks in its AI capabilities.

Figure 2 graphs the Oxford Index of AI Readiness scores for each country in relation to one another. This score played a role in our determination of AI development, and provides a solid quantitative foundation to compare countries' AI readiness.

Figure 2: Oxford AI Readiness Index



** China is an exception due to the missing data points on China in the OKFN Open Data Index, which is one major source evaluating the score for each country. This report finds China to have a high level of development due to its robust AI landscape and heavy investment.*

However, using our own criteria—criteria that included the Oxford AI Readiness Index—we created a spectrum of the countries' level of AI development based on our own findings in Figure 3. For instance, in the Oxford Index of AI Readiness (2019), China was given a score on par with India and Israel due to a lack of data in OKFN Open Data Index which contributes to the Index's score. Our categorization accounts for this lack of information and was made to qualitatively reflect the information we could find.

Figure 3: Level of AI Development

The level of AI development is determined by a number of factors. Countries with low levels of AI development are categorized by low levels of AI research, development projects, and currently deployed AI applications. Countries with medium levels of AI development leverage AI in several different sectors and have higher concentrations of AI research and applications. Lastly, countries with high levels of AI development are categorized by burgeoning AI research and development landscapes, as well as a high number of produced AI applications.

Iran and Kenya were found to have low levels of development, as both countries have a lack of products, a small amount of funding in comparison to other cases, and a limited number sectors leveraging AI. Despite their relative lack of AI development, both countries have AI strategy documents, as well as the presence of dedicated ICT departments.

Brazil, Estonia, India, Israel, and Russia were found to have medium levels of development, as these cases have a higher concentration of research and applications, but are lacking the resources or broad band governmental support that characterize advanced AI nations. These countries have leveraged AI technologies in a high number of sectors, including manufacturing and healthcare, and are currently in the process of translating their research and development work into usable products and applications.

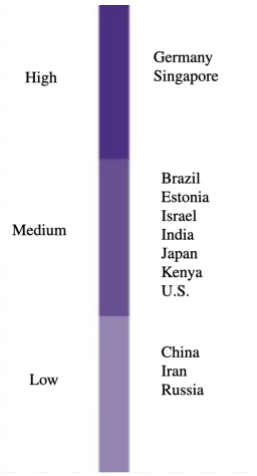
Germany, Japan, Singapore, the U.S. and China were found to have advanced levels of AI development. The U.S. and Singapore have high levels of investment from both the public and private sector. China's applications of AI span multiple sectors, and it has aggressive plans

to increase AI investment by 2030. All nations in this category are focused on advanced technologies such as robotics and cutting-edge neural networks.

Ethics

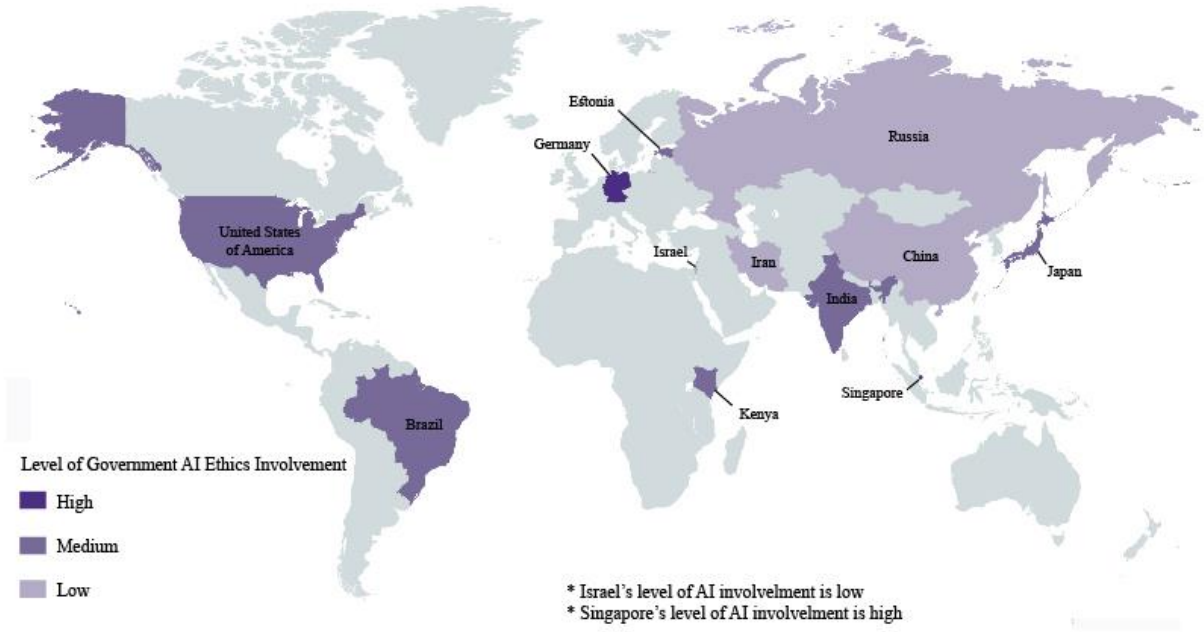
As AI brings new predictive and autonomous decision-making processes, the question of ethics becomes an increasingly important issue to address. The field of AI ethics asks what governments and companies can do with the user data that they collect and how to address the biases and externalities that result from predictive algorithms. We categorized our 11 country case studies into three levels of AI ethics effort: low, medium, and high. Figure 4 provides a spectrum of countries' categorized by low, medium, and high levels of AI ethics involvement, grouping countries on similar levels of AI ethics efforts together.

Figure 4: Spectrum of AI Ethics Involvement



Countries with low levels of AI ethics effort include China, Iran, and Russia, which disregard AI ethics standards. Countries with medium levels of AI ethics effort include Israel, Brazil, Estonia, India, Japan, Kenya, and the U.S. which have begun conversations surrounding AI ethics, but do not have clear government level ethical guidelines around AI or comprehensive data privacy laws. Countries with high levels of AI ethics effort include Germany and Singapore, which all have robust data privacy laws and discussions on AI ethics guidelines. Figure 5 codes these countries' levels of AI ethics involvement on the world map, providing a clear visualization of the concentration of AI ethics discussions on a global scale.

Figure 5: Level of Government AI Ethics Involvement



Low levels of AI ethics were categorized by either a lack of or disregard for basic AI ethics standards. China and Russia use mass surveillance to collect data from their citizens, often using their unrestricted access to citizen data as a way to bolster AI development. While Iran has very little information available surrounding its use of citizen data, its use of surveillance technology to jail dissidents points to a lack of ethical standards surrounding AI technology. The U.S. should remain wary of the actions of these countries, discouraging and preventing future unethical uses of AI.

A medium level of AI ethics efforts is categorized by partial or progressing efforts to establish clear ethical guidelines around AI. For example, countries like Brazil, India, and Kenya currently do not have any AI-specific legislation, but the issue of AI ethics has been addressed by either governmental or judicial bodies. Israel has strong data privacy regulations in sectors like healthcare, but lacks regulation in sectors like national security. Japan complies with GDPR standards and has an ethics committee, but still lacks transparent ethical analysis around AI technology. Estonia also complies with the GDPR and has addressed AI ethics, but has not formed a clear policy framework around the consequences of AI. The United States' data security and privacy regulation is data-type specific and it lacks any federal level comprehensive data privacy regulation. In addition, while there have been some government-level conversations about AI ethics, there is no official government statement.

Germany and Singapore are characterized by high levels of AI ethics effort. Both of these countries have commissions or committees that directly address and establish guidelines around

AI, as well as relatively secure data privacy laws. However, this does not mean that their AI ethics legislation is comprehensive.

Relationship to the U.S.

Each country's level of AI development and current political relationship to the United States informs how the U.S. should approach future relations. We have categorized the relationships between these nations and the U.S. in terms of the AI landscape into three categories—ally, potential ally, and potential risk. Each country's score was determined based on its historic relations with the U.S. and the presence or absence of current tensions between the countries.

We find that the U.S. should engage in cooperation with potential allies, which include Kenya, Brazil, Singapore and India, as well as increase cooperation with the ally countries of Israel, Japan, Estonia and Germany. Many of the U.S.'s historical allies, whether economic or military, are also considered the United States' allies in the field of AI as well. Israel, Japan, Estonia and Germany are all considered AI allies due to their current rapport and existing collaborations with the United States. Germany and Estonia are both NATO members, while Japan and Israel engage with the U.S. on military contracts to develop AI. Due to their ally status, the U.S. could increase AI development through deeper cooperation.

Potential AI allies are states, like Brazil, India, Kenya, and Singapore. These countries are hotspots for AI innovation but have seemingly been overlooked by the U.S. as important countries to invest in and collaborate with. Both Chinese and U.S. companies are beginning to take notice and invest in these states. Therefore, the U.S. should pivot to strengthening these relationships in order to maintain a competitive edge over China and strengthen its ties with countries that have great AI potential.

Potential risks are categorized as potentially adversarial either through economic competition, or through direct threats. Direct threats include actions from threatening non-state actors who could use AI to disseminate harmful propaganda at a faster rate, as well as Russia's actions in tampering with U.S. election infrastructure. However, the U.S. should err against escalation and be wary with labelling countries as "threats." For example, Iran's case study found that offensive strategies like sanctions may serve to increase a country's AI ability. Therefore, the U.S. should proceed with caution when dealing with potential risk states and focus on its own defensive security when it comes to data and research protection.

U.S. Policy Recommendations

The report's recommendations are centered around increasing the domestic and international competitive edge of the U.S. in AI. Drawing on major findings and analysis from these cases, we make the following five policy recommendations to the U.S. government.

1. Increase AI awareness domestically, tailoring efforts to different sectors
2. Create new domestic pathways for AI education and retaining skilled labor
3. Continue the domestic trend of earmarking federal funds for AI development
4. Deepen strategic collaboration with like-minded countries
5. Acknowledge international threats while avoiding state-to-state escalation

We also offer an additional four recommendations in light of our findings about the pressing ethical challenges AI presents.

6. Create a federal data privacy law to address some pressing AI ethics issues
7. Consider ethical implications when determining foreign policy
8. Lead efforts towards constructive international conversations around AI use
9. Work towards global agreement that AI ethics is a human rights issue

Recommendation 1: Increase AI awareness domestically

While the U.S. is experiencing rapid growth in the field of AI, it is increasingly important that the U.S. officials who are creating policies around AI have an in-depth knowledge about the trends of AI development both domestically and abroad. Without informed policymakers, the U.S. cannot make efficient policies to fuel AI development.

To ensure that the United States can continue growing its AI capabilities, the U.S. should focus its efforts on increasing awareness of AI. The government should focus on being more informed about AI progress around the world, especially on the progress of its potential competitors. The commercial sector should provide more opportunities and incentives for people to develop AI-related technological skills. Increasing AI awareness in these areas will allow the U.S. to adapt its AI policies in response to international competitors, upskill the current workforce to adapt to new technologies, and invest in building up a young AI talent pool for long-term growth.

The U.S. can model its policies for AI awareness around what other nations have put into practice. For example, in China, government officials' thorough knowledge of U.S. AI policy has spurred China's own growth (Ding, 2018). Many of China's key movements in AI development are linked to announcements of AI development in the U.S. For example, in response to the Department of Defense's 'Third Offset' strategy, the Chinese military also revised its modernization approach to increase investment in military applications of AI (Ding, 2018). The U.S. should make sure its officials in all sectors are briefed on the importance of AI, global AI trends, and foreign nations' AI policies.

The U.S. should also encourage the commercial sector to provide more opportunities for upskilling workers. For example, the AI Singapore funds the "AI Apprenticeship Programme," a

nine-month full-time apprenticeship in which candidates take courses on AI for two months, and spend seven months working on real-world AI projects (*AI Apprenticeship Program*, n.d.). The U.S. government should provide incentives similar to Singapore's initiative, encouraging the labor force to learn AI skills by funding projects for them to work on.

Recommendation 2: Continue to create new domestic pathways for AI education and retaining skilled labor

The rapid digitalization of the workplace in the U.S. has not been matched by an education system that produces workers with required skills, resulting in an AI skills gap and a shallow AI talent pool (Brown, 2019). The country lacks AI specialists in the workforce who can further develop AI projects, stunting growth in the field.

We recommend that the U.S. continue to create new pathways for AI education and ways to retain skilled labor. The National Initiative for Cybersecurity Careers and Studies has launched CyberCorps, a scholarship program designed to recruit and train young people in cybersecurity, who, in return, work for the U.S. government for a period of time (CyberCorps, 2020). In addition, the National Science Foundation currently invests in education and workforce development at all levels. Its Researcher Practitioner Partnerships project aims to give all U.S. students the opportunity to learn computer science in K-12 classrooms, while its Computing in Undergraduate Education program targets undergraduate computer science programs to integrate ethics into their curriculum; the NSF also has a Graduate Research Fellowships program and a Research Traineeships program that support exceptional AI students (Artificial Intelligence at NSF, 2019). Increased funding and resources will expand the impact that these programs currently provide. The U.S. is already investing in AI education, and these programs should be encouraged and widely implemented across states.

The U.S. must continue to prepare its domestic AI landscape to retain high-level experts and train the next generation of AI talent. Israel and China both invest in future talent. Israel has dedicated resources to STEM fields in higher education and eased immigration rules to attract and retain foreign expertise (Scheer, 2019, p. 16). China has outlined specific projects to increase its AI talent pool as well. For example, China's AI Innovation in Higher Education Project outlines the role of universities as the main avenues to produce a highly trained AI talent pool, and emphasizes the importance of having capable teachers and AI labs to attract more students into the field (Yao, 2018). In addition, China's High-end Foreign Experts Recruitment Plan seeks to address the lack of AI talent by recruiting high-level foreign experts (National High-end Foreign Experts Recruitment Plan, 2019). It is important for the U.S. to be mindful of what both its allies and potential competitors are doing to improve their human capital. The U.S. should consider adopting similar strategies to increase its own talent pool.

Recommendation 3: Continue the domestic trend of earmarking funds for AI development

Proper allocation of funds is always a source of contention. However, it is critical that the U.S. increase funding in AI R&D and continue the trend of earmarking funds for domestic AI development to maintain its position of leadership on the AI world stage. AI will play a significant role in the world's overall technological advancement; it is crucial for the U.S. to be at the cutting edge of that advancement if it wants to remain a major world leader.

On February 11, 2019, President Trump signed the United States' national strategy on AI: Executive Order 13859. This executive order, the American AI Initiative, has marked AI research and development as a priority for any agency using AI (*Artificial Intelligence for the American People*, n.d.). There is currently $5 billion of annual federal funding earmarked for AI development with the administration planning to spend $1 billion on nondefense AI research and development in 2020 (*Artificial Intelligence for the American People*, n.d.). This federal AI development budget has been increasing since 2016, when the total government funding for AI was only $1 billion (*Administration Projects Agencies Will Spend*, n.d.). This is a positive trend, and one that we recommend the U.S. government continues by steadily increasing its budget for AI R&D in both defense and nondefense research.

Further illustrating the need for the U.S. to continue domestic investment in AI, China and Russia are both engaging in a huge surge in investment in their respective AI fields. From 2017 to 2019, investment in Russian AI development has surged from 12.5 million USD to 1.4 billion USD (Ahmed et al, 2019, p. 171). In China, the AI Development Plan statement has set 2020 as the first benchmark for China's AI industry to be on par with the most AI-advanced countries, exceeding 150 billion RMB of core AI-industry gross output and one trillion RMB overall of AI-related industry gross output (Ding, 2018). These figures demonstrate the growth Russia is experiencing as well as the drastic growth China is pursuing in the AI field. China and Russia are characterized as potential risks and economic AI competitors, and it is therefore imperative for the U.S. to maintain growth of its AI development budget to maintain a competitive edge.

Recommendation 4: Deepen strategic collaboration with like-minded countries

While the U.S. does collaborate with some of its allies on AI development, we find that the U.S. could greatly increase its overall collaboration with low, medium, and highly developed AI countries. The U.S. lacks collaborative efforts with governments of low AI developed nations, which are new markets with large potential. By not cooperating with these countries, the U.S. is allowing other nations, such as China, to gain important influence in their AI sectors. The U.S. can also increase its influence and technological capabilities by engaging with countries of medium and high development.

Many developing countries are beginning to further their AI capabilities in critical sectors. The United States should recognize low AI developed countries as strategic

collaborative allies and begin to collaborate with these countries before other powers. We recommend that the United States engage with these governments to collaborate on AI projects in order to counter other countries' influence.

Of particular concern is China, due to its highly influential and expansive Belt and Road Initiative, which provides Chinese investment to developing nations for infrastructure programs (Xia, 2019). For example, U.S. collaboration with Kenya would help mitigate China's influence. Currently, China is heavily investing in Kenya's infrastructure, manufacturing, and agriculture sectors, as well as supplying it with surveillance technology (Xia, 2019, p. 4; Feldstein, 2019, p.1). Collaborating with developing nations may create the opportunity for the U.S. to begin working with other nations in these developing regions, opening new markets and opportunities for diverse AI collaborations.

Since many medium AI powers are already demonstrating strengths in certain sectors, the U.S. could establish collaboration on R&D projects to further these specific sector's potential. For example, the Indian agriculture sector is one of the most important and growing Indian industries utilizing AI. Agricultural jobs account for about 49% of India's workforce (Niti Aayog, 2018). By adding to the pool of agricultural funds in India, this sector will be able to develop new AI and data-science related technology, as well as AgTech start-ups. In regards to other medium AI powers, the United States should focus on collaborating in R&D projects in sectors it has clear strengths in order to expand U.S partnerships and further global AI development.

In terms of allied nations that are major AI powers on the global level, we recommend that the U.S. government increase engagement with these governments to foster collaboration on AI policy dialogues, as well as collaborate on AI projects. For example, AI R&D projects regarding autonomous driving and smart factories/manufacturing are numerous and particularly strong in Germany due to its historical dominance in these sectors. Israel on the other hand is quite focused on strong AI defense and military applications. Therefore, the US should look to collaborate, offering both investment and researchers, with Germany on autonomous driving/industrial AI projects and with Israel on military applications of AI. Other global AI powers should be examined for AI specialization strengths that the U.S. could collaborate on.

This process of targeting particular AI strengths for investment is more financially efficient and will diversify risk and collaboration across multiple regions. Furthermore, collaborative efforts with countries at all levels of development will help give the US a strategic advantage. Collaboration efforts should remain dynamic, as new AI powers emerge internationally and countries possibly shift their AI research orientation.

Recommendation 5: Acknowledge international threats while avoiding state-to-state escalation

This report has categorized country cases based on their relationship to the U.S. using the following labels: ally, potential ally, and potential risk. Potential risk actors have the capacity to

be primary economic competitors and/or use AI in malicious ways, especially through their development of offensive AI capabilities. If the U.S. takes an aggressive approach to potential risk states, such actions could result in AI arms race and rapid escalation in AI weaponry.

We recommend the U.S. keep tabs on potential risk actors, but avoids offensive measures that treat countries as outright "threats" when it comes to AI. Doing so will allow the US to avoid state-to-state escalation. For example, this report finds that Iran's AI technological capabilities have only increased due to the sanctions the U.S. has put on it (Prakash, 2018). U.S. sanctions imposed on Iran were intended to limit Iran's power and cripple its technological advancement, but instead, the sanctions led to an influx of robotic creation and knowledge (Prakash, 2018). Previously, surgical assisting robots operating in Iran were exclusively supplied by the U.S., but once their exportation to Iran was banned, Iran found itself with an increased need to create their own (Prakash, 2018). This led researchers at the Sharif University of Technology and the Tehran University of Medical Sciences to develop their own (Prakash, 2018). Robotics is a key transfer technology which can be applied in other sectors of AI development. In addition, the U.S. sanctions have only driven Iran to work more closely with Russia and China to cooperate on AI and defense (Prakash, 2018).

The U.S. should carefully consider an offensive approach that labels states as threats, which has the potential to create an AI arms race resulting in massive proliferation. We recommend the U.S. continue to monitor potential risk states and take proactive and defensive measures when it comes to investing in security.

Recommendation 6: Create a federal data privacy law to address some pressing AI ethics issues domestically.

While the U.S. has participated in many conversations about AI ethics both domestically and internationally, the country's lack of a robust and comprehensive data privacy laws prevents it from having a high level of AI ethics. The U.S. should create a comprehensive federal data privacy law to ensure that its AI applications are being held to high ethical standards throughout the product life cycle.

Currently, the U.S. does not have a unified federal law around the collection and use of citizens' personal data (*Reforming the U.S. Approach*, 2018). Instead, data privacy laws are sector-specific and often contradictory; different states can have disparate interpretations on what personal data must be protected (*Reforming the U.S. Approach*, 2018). Robust data privacy laws are important for AI ethics because AI technologies are largely dependent on the data they are fed, and companies are increasingly looking for larger datasets to train their AI systems (Privacy International, n.d.). Many AI products have sensors that continually collect data without the knowledge or consent of those it is collecting from (Privacy International, n.d.). The U.S. must ensure that data collection for and by AI systems is held to ethical standards.

The U.S. should model its data protection law after the European Union's General Data Protection Regulation (GDPR), which sets a high standard for expectations around data security

and has been adopted by many countries outside of the European Union, such as Japan and Estonia (Tung, 2019). The U.S. should ensure the same protections offered by the GDPR are offered to U.S. citizens, such as the right to data erasure and prompt data breach notifications (Burgess, 2019). By adopting the basic principles of the GDPR, U.S. businesses that use and sell large amounts of data will be held to a higher standard of responsibility, facing large penalties for lack of transparency or consent (Ehret, 2019). In addition, many large U.S. companies already comply with the GDPR due to their European customers, smoothing out the transition if the U.S. were to adopt a GDPR-like policy. While a federal data privacy law may complicate the process of collecting and using data for domestic AI applications, its adoption can also build consumer trust around AI products and ultimately promote long-term growth (Spyridaki, n.d.).

The state of California has already introduced a data privacy law reminiscent of the GDPR, called the California Consumer Privacy Act (CCPA). Both laws are relatively consistent, giving individuals' the right to access their data and deleting their data upon request, as well as requiring businesses to disclose how personal data is collected, shared, and used (*CCPA vs GDPR*, 2019). California is the U.S.'s largest state economy, and any business that provides services to Californians must comply with the CCPA, requiring many more U.S. firms to be compliant with these strict data privacy laws (Tung, 2019). Adopting a single federal data privacy law that meets the requirements of both the GDPR and CCPA will reduce the cost of compliance by ensuring firms do not have to use separate systems to meet different requirements for privacy protection (Tung, 2019). Regulation around data privacy should not be seen as a hindrance to further AI development, but rather an assurance that AI development can continue while preserving ethics and the individual right to privacy. As one of the most advanced AI superpowers in the world, the U.S. must be able to securely protect user data in order to safely and justly move AI development forward.

Recommendation 7: Consider the ethical implications of working with certain actors when determining foreign policy

As the U.S. increases its international AI collaboration, there will be backlash if it chooses to work with private and state actors who actively disregard ethics. By working with these types of actors, the U.S. could receive backlash from the public.

The Department of Treasury has already identified actors the U.S. should not work with. It has created a list of entities and individuals that have been sanctioned due to malicious cyber-enabled activities (Department of Treasury, 2019). These actors include companies that are known to interfere in foreign elections, such as Russia's Internet Research Agency and Concord Management and Consulting (Department of Treasury, 2019). Other companies and groups are tied to cyber-theft, such as Iran-based Mabna group (Department of Treasury, 2019). The Department of Treasury should continue to assess threatening actors and those who disregard ethical standards.

The U.S. should evaluate a company's ethics before collaborating with them. For example, the NSO Group in Israel and DarkMatter in the UAE are known to sell tools used by governments to surveil journalists and activists (McLaughlin, 2016; Scheer, 2020). The U.S. can expect to see severe backlash if it works with these companies because they provide services that violate international norms.

Recommendation 8: Lead efforts towards constructive international conversations around AI use

Countries around the world are engaging in dialogues around ethical AI use. However, these conversations are often between small groups of countries; there is currently no single platform for the international community to discuss AI use. As a result, there is no single set of AI development guidelines accepted by the global community, leaving room for inconsistent interpretations of AI ethics.

As countries around the world increase their commitment to AI, the U.S. should reaffirm its position as a global leader by supporting international conversations around AI use. Through these conversations, the U.S. should aim to build confidence, work towards a universal AI ethics guideline that countries should use as a model to develop their own national AI ethics guidelines, and raise conversations about managing lethal autonomous weapons.

The U.S. has already participated in inter-state AI development conversations. The G20 has promoted inclusive growth, sustainable development, human-centered values, transparency, accountability, and security as guiding principles for AI (EUTrade news, n.d.) The U.S.-Mexico-Canada Agreement has also focused on AI, specifically calling for algorithmic transparency and the regulation of AI (How Will the Digital Economy Fare, n.d.). Article 19.16 of the agreement focuses on source code and acknowledges that some sort of regulatory body or authority will need to determine what an algorithm is doing, how it is doing it, and why it is doing it (How Will the Digital Economy Fare, n.d.). The U.S. has also signed the OECD Principles on AI, which asserts the need for inclusive growth and sustainable development that respect laws, human rights, and democratic values (OECD Principles on Artificial Intelligence, n.d.). However, it is important to note that the OECD is non-binding. Its goals are also very similar to those outlined by the G20 Summit as well as the U.S.-Mexico-Canada Agreement, but these nations are separated into different spaces rather than working globally. All of these efforts by the U.S. have only begun formulating international guidelines when developing AI. AI will drastically impact the development of nations as well as weaponry. The U.S. should strive to lead international conversations that include as many nations as possible to cooperate on governing principles.

The conversation around the ban of autonomous weapons is an example of why concerted international efforts towards constructive AI conversations are vital. China has come out in support of a internationally legally binding instrument on fully autonomous weapons systems (High-level Concerns on Killer Robots, 2019). However, this is somewhat misleading, as Beijing clarified it is only against the use of autonomous weaponry on the battlefield, and is

not against its development or production (Chan, 2019). Some reports have raised the question of whether this is a public perception ploy for the international community, and if China is using the ban as a method to slow competitors', primarily the U.S. 's, development of autonomous weaponry (Chan, 2019). The U.S. should assert its position as a global AI leader and insert itself into international AI conversations to develop more holistic conversations about such issues, as well as to ensure it has a greater influence over any possible binding agreements.

Recommendation 9: Work towards a global agreement that would treat AI ethics as a human rights issue

As AI becomes increasingly sophisticated, the potential for malicious misuse of the technology grows. There is often a lack of transparency when it comes to the data that AI is trained on. The source of data is often not released, or it comes from individuals that did not consent to the use of their data. Other ethical issues revolve around the potential bias in data that, if implemented in public AI projects, could produce unfair prejudices against minorities.

The U.S. should initiate an international conversation around treating AI ethics as a human rights issue, potentially through an amendment to an existing international human rights agreement. By doing this, the U.S. will uphold its position as a global leader in the field of AI and bring attention to the unethical methods many of its competitors are using to further develop AI applications.

Countries have applied their AI technologies in clearly unethical ways, impinging on citizens' basic dignities. For example, China has been using AI-powered facial recognition technology to racially profile the Uighurs, a Muslim minority (Mozur, 2019). Surveillance cameras are trained to look for Uighurs in multiple regions and provinces, storing records of their movement (Mozur, 2019). China's AI tools have the potential to spread to countries such as Kenya; China has deployed thousands of cameras and surveillance systems in Nairobi's law enforcement agencies (Feldstein, 2019). The U.S. must establish a clear global understanding of AI ethics as a human rights issue to preemptively impede the spread of unethical AI applications.

The U.S. should support approaching AI ethics from a human rights perspective, as individual rights are a cornerstone to its national identity. In order to ensure countries around the world are moving AI development forward through ethical methods and practices, the U.S. should use its role as an AI superpower to support framing AI ethics as an international human rights issue.

AI Ethics Overview

By Khoi Khong

Introduction

As countries develop AI capabilities, they simultaneously engage in ethical conversations around how to properly handle, manage, and assess these new technologies. The current landscape of AI ethics shows that more countries and organizations have engaged in ethics conversations since 2016, but there has been a lack of participation from countries in the Global South. In addition, religious and military groups have also begun to recognize and address AI ethics. Transparency is the most mentioned term in AI ethics conversations, while the discussion of AI ethics as a human rights issue remains undervalued. Data protection laws play a huge role in shaping ethical guidelines, since data is heavily involved in the development and application stages of AI technology.

Current Landscape

Countries at all different levels of AI development are discussing the issue of AI ethics, as shown by the recent increase in the available information and conversations around AI ethics. According to data from the Global Landscape of AI Ethics Guidelines, a report that focuses on AI ethics globally and analyzes published guidelines on AI ethics, there has been a significant increase in the number of AI-focused publications (Jobin et al., 2019). 88% of AI-related publications were released after 2016 (Jobin et al., 2019). There is a diverse array of publishers and sources producing these publications about AI ethics guidelines, which is promising for worldwide commitment to ethics standards (Jobin et al., 2019). About 22% of publications are published by private companies, about 21% by governmental agencies, and about 10% by academic and research institutions (Jobin et al., 2019). The rest are published by intergovernmental or supranational organizations, non-profit organizations, professional associations or scientific societies, private sector alliances, research alliances, science foundations, and federations of worker unions and political parties (Jobin et al., 2019).

In addition, religious groups and militaries are also beginning to address AI ethics. For example, in 2019, the Vatican hosted "The Common Good in the Digital Age," a conference that promoted the use of AI for human good rather than profit (Fernandez, n.d.). Pope Francis, the head of the Catholic Church asserted that ethical and moral judgments must make the same leaps as technology has (Fernandez, n.d.). Furthermore, in February 2020, a workshop organized by the Pontifical Academy for Life took place in the Vatican, touching on areas that tie humans and AI together, such as healthcare and ethics (*Vatican Workshop on Ethics and AI - Vatican News*, 2020).

On the other hand, militaries around the world are not as engaged in AI ethics discussions as religious groups, despite their heavy involvement and investment into developing military AI capabilities. However, this may change, as more militaries release AI ethical principles and recommendations, similar to how the U.S. and its Department of Defense did in February 2020 (*DOD Adopts Ethical Principles for Artificial Intelligence*, n.d.). The Department of Defense Joint Artificial Intelligence Center was established as the principal actor for coordinating the implementation of ethical AI principles, displaying a trend towards involving military in these types of conversations (*DOD Adopts Ethical Principles for Artificial Intelligence*, n.d.).

Despite a diverse set of publishers for AI ethics guidelines and a large number of interest groups engaging in ethics conversations, the geographic distribution of AI ethics discussion remains largely focused in developed nations. Most AI-focused papers are produced by economically developed countries, primarily the U.S., which has produced 25% of all AI-related publications, followed by the U.K. at 15.5% (Jobin et al., 2019). As AI becomes increasingly developed, its range of applications grows as well, allowing it to be used to confront climate change, assist healthcare processes, and even address inequities in the Global South (Crawford et al., 2019). However, as most AI research comes from a few economically developed countries, it is difficult to fully understand and consider the perspectives and cultures of less developed countries in relation to AI ethics. Without a representative set of truly global voices that consists of both high- and low-income countries, it will be extremely difficult to form one set of AI ethics guidelines that is appropriate for all countries engaging in AI development. However, this could lead to an alternative proposal for regional sets of AI ethics guidelines, that are tailored specifically to different regions' economic statuses and cultures.

Transparency was the most-mentioned element in AI ethics publications and guidelines within the last two years, asserting that actors around the world value transparency in all stages of AI development and want developers of AI technologies to be held accountable (Jobin et al., 2019). Aside from transparency, other elements that are frequently mentioned in AI ethics reports include "justice and fairness, non-maleficence, responsibility, privacy, freedom and autonomy, trust, dignity, sustainability, and solidarity" (Jobin et al., 2019). This list of frequently cited elements helps identify what types of principles should be included if any countries are seeking to form robust AI ethics guidelines. While all of these elements should be included in ethics guidelines, other aspects that are not listed should also be addressed as well.

AI Ethics as a Human Rights Issue

When countries create ethical guidelines around AI, human rights must be used as the foundation, ensuring that people's rights to dignity and respect are not infringed upon by new applications of AI. However, human rights are often an afterthought in many ethical guidelines, which tend to focus more on transparency (Jobin et al., 2019). Despite the increased recognition of AI ethics, the perspective of AI ethics as a human rights issue is often not adopted by technology companies and other businesses (*Privacy and Freedom of Expression In the Age of Artificial Intelligence*, n.d.).

International human rights organizations such as UNESCO have been upfront with their commitment to be active participants in the global conversation around AI ethics (Nations, n.d.). UNESCO advisory bodies have already produced numerous reports and declarations on robotics ethics, such as the Report of the World Commission on the Ethics of Scientific Knowledge and Technology on Robotics Ethics in 2017 (Nations, n.d.). David Kaye, a UN Special Rapporteur, released a report on the implications of AI technologies for human rights and suggested that human rights should guide the development of business practices and AI design ("UN Special Rapporteur analyses AI's impact on human rights," 2018). AI without human supervision and careful consideration of ethics throughout the development and application stages can produce discriminatory effects, as algorithms can perpetuate biases if personal data is mishandled ("UN Special Rapporteur analyses AI's impact on human rights," 2018). AI also poses a risk to the right to privacy, as AI is increasingly leveraged to monitor content online and to surveil citizens ("UN Special Rapporteur analyses AI's impact on human rights," 2018). Surveillance systems

are often made more efficient at the cost of user privacy, as the mass collection of data can be used to train AI systems, but can often raise significant ethical human rights issues.

Another set of guidelines that substantially contributes to the conversation around AI ethics and the protection of human rights is the Privacy and Freedom of Expression in the Age of Artificial Intelligence, written by Article 19 and Privacy International. These organizations define AI technologies as dependent on collecting large amounts of data on individual and collective behavior in order to profile people and predict future behavior (*Privacy and Freedom of Expression In the Age of Artificial Intelligence*, n.d.). In their guidelines, they highlight the importance of protecting and ensuring the integrity of privacy and freedom of expression in AI technology, pressing for accountability mechanisms (*Privacy and Freedom of Expression In the Age of Artificial Intelligence*, n.d.). Furthermore, despite increased recognition of AI ethics, the AI ethics policies of many technical and business organizations do not explicitly refer to human rights (*Privacy and Freedom of Expression In the Age of Artificial Intelligence*, n.d.). As the field of AI continues to grow, human rights need to be recognized as a significant component of AI ethics.

Data Laws

In addition to creating ethical guidelines, countries also need to ensure that strong data laws are in place as well, as AI technologies depend on the data that they are fed and continue to learn from that data. Personal data is at risk more than ever before due to high demand for personal data from companies and organizations that are developing AI technologies and need large, comprehensive datasets to train their AI systems. Cases of leaked personal data on a nationwide level can be seen throughout the world, on both commercial and governmental levels. In one case, the U.S. and its Defense Information Systems Agency reported that personal data from over 200,000 people had been compromised (*DISA exposes personal data of 200,000 people*, 2020). In Israel, a software flaw exposed the information of over 6.5 million voters in the country, raising concerns around identity theft and electoral manipulation (Victor et al., 2020). Personal data must be well-protected if ethical standards are to be maintained.

Data governance is not heavily emphasized enough and must be emphasized more to support strong ethics guidelines. The European Union (EU) is currently the leader in data governance, as it puts a heavy emphasis on data governance in its principles and has produced the most secure data protection regulation. The European Commission's High-Level Expert Group on AI presented Ethics Guidelines for Trustworthy Artificial Intelligence, which identifies data governance as a key requirement for AI systems to be considered trustworthy (Anonymous, 2019).

The EU also put out the General Data Protection Regulation (GDPR), which is considered to be the strongest and most comprehensive set of data protection rules (*Summary: The EU General Data Protection Regulation—Lawfare*, n.d.). The GDPR creates an EU-wide set of standards for the protection of digital personal data related to online or real-world behavior for EU internet users, regardless of the location of the entity holding that data (*Summary: The EU General Data Protection Regulation—Lawfare*, n.d.). The extent of the GDPR's jurisdiction is what makes it such a strong set of data protection rules, as data is passed around from company to company, often expanding the GDPR's jurisdiction outside of the EU (*Summary: The EU General Data Protection Regulation—Lawfare*, n.d.). Another strength of the GDPR is its flexibility in allowing individual member states discretion on a number of provisions, such as data transfer outside the EU and freedom of expression in the media (*Summary: The EU General*

Data Protection Regulation—Lawfare, n.d.). The GDPR is an excellent model for any country that is looking to create its own data privacy law, which comes hand in hand with ethical guidelines.

Themes Among Ethics Recommendations

Many recommendations have been made surrounding ethics regulations, with common themes across recommendations. First, most recommendations around AI ethics are broad and unspecific, giving countries and organizations the flexibility to adopt them based on specific cases and technologies. Second, most guidelines are more concerned with ethical considerations during the development stage rather than the application stage. For example, the Institute of Electrical and Electronics Engineers, the largest technical professional organization dedicated to advancing technology for the benefit of humanity, created an AI ethics document with the main goal of ensuring that every technologist is educated, trained, and empowered to prioritize ethical considerations in the design and development of autonomous and intelligent systems (*IEEE Ethically Aligned Design Document*, n.d.). Last, there continues to be a lack of efficient and competent data laws that can accompany ethics guidelines, except in the EU.

The human-in-command method has become an increasingly popular method to ensure that ethical considerations are implemented in the final execution stage of AI applications. The UNI Global Union suggested ten principles to approach AI ethics; two principles call for a human-in-command approach that will take the responsibility of ethics away from the AI technology and places it on humans ((*Top 10 Principles For Ethical Artificial Intelligience*, n.d.). By incorporating humans into the most important step of the process, AI can be managed more easily and humans can take responsibility for ethical considerations, ensuring that ethical principles are being closely followed.

Case Comparisons

Each country case study that will be introduced throughout this report has its own unique AI ethics regulations, which means its solutions will be based on its economy, culture, and progress in the AI field. These cases can be separated into different groups depending on how they address ethics. Countries such as China, Iran, Israel, and Russia are doing very little to nothing regarding the establishment of an AI ethics framework. This ranges from not acknowledging AI ethics, such as in the case of Iran and non-state actors, to doing the bare minimum of acknowledging and establishing AI ethics, such as in the cases of China, Israel, and Russia. Countries such as Brazil, Estonia, Japan, Kenya, and the United States. These cases have either acknowledged and begun the process of developing an AI ethics framework. Countries such as Germany and Singapore have articulated clear AI frameworks. It is important to consider where these countries are at with their approaches to establishing ethical guidelines for AI in order to have a productive conversation surrounding the formation of general AI ethics guidelines on the international stage. Despite which group a country is considered to be in or where they are in terms of commitment to ethics, high standards for future guidelines should not be compromised, as human rights should be protected and guaranteed in full to all individuals.

The similarity between all these cases is their lack of effort to collaborate with other countries when developing and adopting their own ethics guidelines. No country has taken the initiative to bring up the topic of AI ethics on an international forum, as the topic and the field of AI itself are still new on the international stage.

Recommendations for the U.S.

The U.S. should continue its commitment to AI ethics internationally and domestically. Partnering with UNESCO, which provides a universal forum, the U.S. should take a proactive role in engaging and starting the conversation to create universal AI ethics guidelines that apply to all countries. This will help strengthen the U.S. voice on the international stage regarding AI, while also promoting the U.S.'s interests in the field. The U.S. should also develop and adopt a set of nationally-accepted official ethics guidelines that emphasize transparency, justice and fairness, non-maleficence, responsibility, privacy beneficence, and freedom. These ethical guidelines should ban the use of affect recognition in important decisions, as well as any forms of surveillance that would function without people's consent. Consent must also be obtained regarding the use of health-related personal data. Lastly, the U.S. should develop and adopt a data protection rule, using the GDPR as a base model. This data protection rule should allow each state flexibility regarding data transfer between states.

Brazil

By Victoria Cardoso Furtado Lima

Introduction

Brazil is a developing regional AI power, with a medium level of AI development, based on its increasing AI research and development landscape and medium levels of artificial intelligence applications. Brazil's AI landscape is primarily focused on agriculture, national security, robotics, and health. The Brazilian government has a medium engagement with AI ethics, as demonstrated by the presence of ethics conversations on the applications and privacy concerns surrounding the use of AI. Brazil acts as a potential AI ally to the U.S due to Brazil's previous established relationship with the U.S. and its potential for growth in the sector. Table 1 summarizes findings on Brazil's AI readiness, research and development, products and applications, and ethics.

Table 1: Summary Findings, Brazil

Government AI Readiness	
Level AI Development	Medium
Oxford Insights AI Readiness Score	6.157
Presence of Strategy Documents	No
Presence of Dedicated ICT Department	No
Research and Development	
Amount of Investment	Low
Density of Collaborations	Medium
Products and Applications	
Government Orientations	National security, health
Industry Orientations	National security, health, agriculture, robotics, development
Ethics	
Level of Government AI Ethics Involvement	Medium
User Data Privacy Laws	Yes
AI Ethics Reports	No

Background

Brazil is a democracy with a federal presidential republic and a projected population of 211 million people as of July 2020 (*South America: Brazil* , n.d.). According to the World Bank, Brazil has an electrification rate of 100% (2017). Brazil earned a score of 6.157 on the Oxford AI Readiness Index (2019).

In April 2019, under the presidency of Jair Bolsonaro, the government announced the hold of 42% of the money meant to go to the Ministry of Science, Technology, Innovation, and Communication ("*Corte orçamentário de 42%,*" 2019). In 2020, the budget decreased again, from R$13,6 billion in 2019 to R$11,8 in 2020 (Berbert, 2020). The Ministry of Science, Technology, Innovation, and Communication does research in AI in Brazil. Brazil ranked 40 out of 192 countries in Oxford Insight's AI Readiness Index 2019, and according to Deloitte, "South America – led by Brazil – is rapidly emerging as a leader in AI-enabled business" (Henriques,

2020). This is to show that after a considerable period of financial turmoil, Brazil was able to develop its AI technology and become a relevant player in the race.

Government Policy

In recent years, the Brazilian government has made efforts to develop and regulate artificial intelligence in the military and the Internet of Things sectors. The government effort can be seen through the implementation of labs focused on the development of AI, and on the initiation of actions to regulate artificial intelligence. At the international level, Brazil has taken a stance against the use of automated AI-weaponry.

Position on Domestic AI

Brazil has shown an increasing interest in the domestic development of new technology, including AI, and is primarily focused on the Internet of Things. In 2017, the Brazilian government released a plan of action aimed at the development of the Internet of Things, focused on the development of sectors such as smart cities, health, rural, and industry (*Produto 8: Relatório do Plano de Ação*, 2017). At the end of 2019, the Brazilian Minister of Science, Technology, Innovation, and Communication, Marcos Pontes, announced that the Brazilian government would fund and help with the expansion of up to eight artificial intelligence labs in the country (*FAPESP :: Chamadas de Propostas*, 2020). The government has a five-year plan for the eight labs that can be renewed for another five years. The labs supported by the Ministry of Science, Technology, Innovation, and Communication will focus on the "development of scientific, technological, and innovation research" (*FAPESP :: Chamadas de Propostas*, 2020). According to the Ministry, the labs will have a yearly budget of R$1 million per lab ("*Os Centros de Pesquisa Aplicada*," n.d.).

In 2019, Brazil launched a public consultation in which the country's general population could share their views on the focus of the country's AI development ("*Governo lança consulta pública*," 2019). The consultation includes topics such as public safety, application in the public and private sector, international aspects, and regularization (*Participa.br*, n.d.). The results of the public consultation have not yet been released. However, it demonstrates that the Brazilian government is open to having a dialogue with the population regarding the use of artificial intelligence and how it can affect the country.

Position on International AI

On the international level, Brazil is involved in the conversation about the use of autonomous AI weaponry, calling for a legally binding policy. Brazil is for the ban of fully autonomous AI weaponry as of November of 2017 ("*The Campaign To Stop Killer Robots*," 2019). In 2018, during the Session on Disarmament of the General Assembly, Brazil raised concerns about the potential risks that these weapons can cause. Brazilian Ambassador, Guilherme Patriota, reminds that Brazil, Austria, and Chile have proposed to the Convention on Conventional Weapons "to establish a legally binding positive obligation with regard to human control of autonomous weapons systems" (Patriota, 2018). This proposal illustrates that Brazil is committed to the ban of fully autonomous AI weaponry.

Research and Development

Research and development are happening at many different levels in Brazil. Government AI labs are focused on the development of smart cities, industry, agribusiness, and health. Private companies, also showing an increasing interest in AI, are collaborating with universities to fast track innovation. Also, to increase the qualified workforce in the area, the academic sector is starting to provide upper-level courses focused on AI technology.

Collaborations

The Brazilian government is collaborating with national research foundations and international companies to boost the development of artificial intelligence in the country. Together with the São Paulo Research Foundation, the government created the Applied Research Centers aimed at increasing the R&D of AI in Brazil. The government will select eight labs; while one of the labs will be focused on cybersecurity, working alongside the Brazilian army, the seven remaining will work with applied AI (Peduzzi, 2019). Four of these will focus on Internet of Things devices, which account for industry, agribusiness, health, and smart cities (Peduzzi, 2019). The São Paulo Research Foundation that contributed to the establishment of the labs will assist by funding part of the project ("*FAPESP :: Chamadas de Propostas*," 2020).

Looking into collaborations with multinational companies, the Brazilian National Research and Educational Network, Rede Nacional de Ensino e Pesquisa, together with Microsoft, has chosen six projects related to the R&D of AI to receive their support in Brazil ("*Selecionados os projetos do Desafio RNP*," 2019). The projects include eduroamIA, which works with user authentication. It also includes Network Borescope, which analyzes in real-time the backbone network, and TeleDIAC, from Teleoftalmo – UFRGS, that is working to develop an AI system that can distinguish between patients with Cataracts ("*Selecionados os projetos do Desafio RNP*," 2019). The projects will receive financial support from the Brazilian National Research and Educational Network and technological support from Microsoft ("*Selecionados os projetos do Desafio RNP*," 2019).

Industry

In the private sector, the Advanced Institute for Artificial Intelligence is playing an essential role in the development of AI in Brazil. The company, founded in 2019, brings together the academic and private sector; the goal is to provide the private sector with skilled researchers in exchange for stable financial support, instead of relying upon state-funded research (*About the AI2 – AI2*, n.d.). The Institute has a team of over 50 researchers from 12 different universities in Brazil that work together with private companies to automate and improve systems (*About the AI2 – AI2*, n.d.). Their projects include machine learning, cognitive systems, and machine consciousness (*Fundamental Research – AI2*, n.d.).

Academia

Brazilian universities are increasing their investment in artificial intelligence. Goiás will be the first state in Brazil to have an undergraduate course in artificial intelligence, which will start in March of 2020 ("*Goiás recebe Centro de Excelência*," 2019). The state will also launch the Center of Excellence in Artificial Intelligence, which will focus on how to better execute tasks in the private and public sectors, making companies and the state government more efficient ("*Goiás recebe Centro de Excelência*," 2019).

The University of São Paulo announced in 2019 that it would host the Engineering Research Center in Artificial Intelligence. This project is funded by the São Paulo Research Foundation and IBM ("*USP to host the new FAPESP-IBM*," 2019). Moreover, the Engineering Research Center in AI will receive a total investment of U$2 million per year over ten years from these three entities ("*USP é universidade selecionada*," 2019). According to FAPESP, the centers will be established to produce scientific advances and will focus on sectors such as health, finance, agribusiness, and the environment. ("*USP to host the new FAPESP-IBM*," 2019)

Country-to-country

Brazil does not have many international partners working with it towards the development of AI. However, in 2019, the country started to play a more active role by allying itself with countries from around the globe. During the 2019 world economic forum in Davos, Brazilian president Jair Bolsonaro met with several world leaders, including Andrej Babis, the Prime Minister of the Czech Republic ("*Bolsonaro meets foreign leaders*," 2019). Bolsonaro said that due to the similar policies of both countries, it would be in their best interest to work together in developing artificial intelligence ("*Bolsonaro meets foreign leaders*," 2019). In the same year, Brazil and the United Arab Emirates made a deal focused on eight mutually beneficial points, one of them being AI ("*Saiba quais são os oito atos bilaterais*," 2019). According to the deal, both countries plan to collaborate in the artificial intelligence arena through research and development projects ("*Saiba quais são os oito atos bilaterais*," 2019). The focus of the AI projects in partnership with the Czech Republic and the United Arab Emirates has not yet been released.

Also in 2019, Marcos Pontes, Minister of the MCTIC in Brazil, and Alejandro Finocchiaro, Minister of Education, Culture, Science, and Technology in Argentina, signed a joint declaration for scientific cooperation, including AI (ASCOM, 2019). The announcement states that both parties will promote a favorable environment for the development of technology, and will also take into account the concerns surrounding AI, following ethical standards (ASCOM, 2019). The countries will "promote AI based on innovation and economic growth, human rights, inclusion and diversity" (ASCOM, 2019).

Products and Applications

Brazilian companies are increasing their focus on the development of AI technology to improve their efficiency. Brazilian state governments have developed products to improve the medical sector, and some industries have collaborated with international companies to implement AI in their business. In addition, Huawei technology has been tested in multiple cities in Brazil. Finally, start-ups are playing an essential role in the development of AI technology in areas such as manufacturing, health, and education.

Collaborations

Some Brazilian companies have attracted the attention of international tech giants such as Microsoft and Google, which are providing support for projects involving social and environmental projects in Brazil. The private and public sectors have also collaborated to increase safety in Rio during one of the busiest times of the year, doing so by using Chinese technology. During the Carnival of 2019, a new AI technology was implemented in one of the most popular neighborhoods in Rio, Copacabana. The goal of this new technology is to increase

safety in the city, using cameras to identify wanted people and vehicles (Toledo, 2019). This system was implemented by Brazil's largest private telephone company, Oi, using Huawei's technology ("*Oi usou sistema de vigilância,*" 2019). The software is connected to the Integrated Command and Control Center, which works together with the Civil Police and the State Traffic Department (Detran) to identify people and vehicles (Toledo, 2019). This technology is used by the government to improve safety in Rio. It is important to note that the Public Safety Department of the State of Bahia, and the city of Campinas are also testing the technology (Soprana, 2018).

SOS Mata Atlântica and Petrobras are both using Microsoft's AI technologies in distinct ways. SOS Mata Atlântica received a grant for Microsoft's AI for Earth project. AI for Earth is part of Microsoft's AI for conservation program, which provides grants and AI technology for companies working for environmental causes (*AI for conservation,* n.d.). SOS Mata Atlântica is one of these; it is a Non-Governmental Organization (NGO) that works towards the preservation of the Atlantic Forest in Brazil and tracks the quality of the water on rivers in the Atlantic Forest ("Quem Somos," n.d. and "Fundação SOS Mata Atlântica recebe investimento do programa AI for Earth, da Microsoft," 2019).

While SOS Mata Atlântica uses Microsoft's AI for environmental reasons, Petrobras, a Brazilian semi-public oil and natural gas company and one of the world's most significant companies in its sector, is using AI for safety. In 2019, Petrobras installed its first AI systems in its offshore platforms. The system was developed by Microsoft and implemented by Petrobras to improve the safety of their employees ("*Petrobras começa a usar Inteligência Artificial*," 2019). The pilot was implemented in September 2019 and works by analyzing the images through security cameras, learning dangerous situations and giving a prompt alert with the goal of reducing accidents on the platforms ("*Petrobras começa a usar Inteligência Artificial*," 2019).

Hand Talk, a Brazilian company that makes websites accessible for people with hearing disabilities, has received support from Google's AI for Social Good program. Google offers financial support and guidance for the 20 organizations chosen to take part in the program, all of the organizations use AI to "meaningfully improve people's lives" (*Impact Challenge,* n.d.). Hand Talk developed an AI technology to translate Portuguese websites into Sign Language by using a digital avatar, this "enables digital communication for deaf and hard of hearing Brazilians and also increases Brazilian Sign Language learning" (*Impact Challenge*, n.d.). These cases demonstrate the breadth of AI applications in Brazil, from social use to environmental, security and safety.

Industry

Brazilian artificial intelligence domestic industries are focused on agriculture, health, security, education, and robotics. One of the most relevant examples of AI in Brazil is Alice, an artificial intelligence software designed by Solinftec in 2017. Alice was developed to improve agricultural productivity and works by integrating data collected from "machinery, people, climate and relevant external inputs" (*Innovating – Solinftec*, n.d.). Alice works to optimize agriculture, reducing the price of production on cane sugar and grains, making the system extremely attractive for agribusiness, which seeks to maximize profits (*Solinftec apresenta inteligência artificial da Alice na Agrishow,* 2018). The company caught the attention of the Texas Pacific Group, which invested in the company in 2017. The investment was used by Solinftec to expand its technology from cane sugar to other crops and to expand its business (Burwood-Taylor, 2017). Since then, the technology, which can maximize up to 15% in

harvesting, has been adopted in 6 other countries around the globe, including the United States (*Solinftec apresenta inteligência artificial da Alice na Agrishow*, 2018).

On the State level, Goiás State Secretary of Health developed CAREN in 2019. CAREN is an artificial intelligence system implemented in hospitals throughout the state that decreases the rate of infant mortality (Planejamento (SCTI), n.d.). The software, in combination with the doctor's input, analyzes which children should be prioritized in receiving care (Almeida, 2019).

Instituto Igarapé is a think tank focused on security and development in Brazil and the Global South. The institute works with AI to increase safety in these locations, by providing data such as crime rates, unemployment rates, and homicide rates ("Cidades Seguras," n.d.). Igarapé also provides solutions through georeferenced data and climate analysis. The AI system can learn forced migration patterns within Brazil, and better assist the development of public policies and finding refuge for these people ("Migração Forçada e Refúgio," n.d.) Instituto Igarapé shows that AI can be used to improve public safety, and it also provides users with a platform with reliable information that concerns to the general population.

Start-ups are also playing a significant role in the development of AI technology in Brazil. Aquarela is one example of a Brazilian start-up aimed at maximizing industries' profits by using AI. The company works with "Solution" such as Smart Pricing, that helps companies to set a price that will increase profit, Smart Stock, used to reduce product loss and Agro 4.0 that assists with maximizing production in the agribusiness, among others ("Soluções com inteligência artificial," n.d.). Altox is a start-up that focuses on the use of AI for toxicology. The company aims at reducing animal testing by instead using AI to test reaction to chemical components. Altox works with medication, cosmetics, agrochemicals, and food contamination (*Home*, n.d.). Finally, Capiche Education launched its AI software Capiche VRAI, in which, through the use of virtual reality, children can learn by interacting with a classroom environment, ask questions and interact with the things they are learning about ("VRAI," n.d.). These are just a few examples illustrating how start-ups in Brazil are working in different sectors and creating innovative AI technology.

Ethics

Brazil does not have AI-focused regulations. However, the importance of ethical use has been recognized by the government. Brazil is an important partner to the OECD (*Brazil—OECD*, n.d.). The organization has recently set recommendations on AI ethics, which Brazil agreed to adopt (*OECD Principles on Artificial Intelligence*, n.d.). The OECD considers possible economic consequences, labor displacement, and privacy concerns. The report sets recommendations for inclusive growth, human-centered values, transparency, security, and accountability (*OECD Legal Instruments*, 2019). Brazilian legislators have also recognized the ethical concerns surrounding AI and have proposed legislation to regulate its use. However, there is still a lack of transparency when it comes to the government data sources for its Applied Research Center in AI.

In the last decade, the Brazilian government has recognized the importance of the internet and of regulating its use. In 2014, Brazil passed the Marco Civil da Internet (Brazilian Civil Rights Framework for the Internet), which sets policies for the democratic use of the internet. It assures that users and companies have their "freedom, privacy, and human rights equally applicable in cyberspace" (Arnaudo, 2017). Establishing that the use of the internet is private unless the court mandates to the contrary (Arnaudo, 2017). In 2018, Brazil approved a Data Protection Law, Law No. 13,709, that will be valid starting 2020 (Leite Monteiro, 2018). The

law sets somewhat strict standards for data protection on the public and private sectors. This law not only applies to Brazilian companies but international companies that have a branch in Brazil (Leite Monteiro, 2018). The Data Protection Law sets different rules for the storage of personal data and sensitive personal data; it also regulates the use of public data and data processing (Leite Monteiro, 2018). It is important to note, however, that it can be difficult for enterprises to adopt this new set of rules, according to Tony DeBos, the global leader of Data Protection for EY, Brazil is not prepared for the adoption of the Data Protection Law, and industries will have to pay the price (Moura, 2019).

Brazil does not have an ethical code regarding AI specifically. Instead, in the constitution, under the rights of the individual, the right of privacy and the inviolability of people's honor and image is established (*CONSTITUIÇÃO DA REPÚBLICA FEDERATIVA DO BRASIL*, 1988). However, in 2019, senator Styvenson Valentim proposed two bills concerning the use of AI. The first one accounts for the ethical use of AI and the respect for human rights and democracy, and the second one aims to build a favorable environment for AI R&D (Agência Senado, 2020). Even though the bills are still under debate, it shows that legislators in Brazil recognize the importance of AI and its regulation.

Brazil's AI ethics should consider people's right to privacy. Because of the country's diverse population, the data used to supply AI software may be biased against minority groups, and this should be addressed while training AI. Brazil should take the OEDC recommendation when developing its own ethics guidelines, and the government should also recognize the particularities of the nation and take them into account when building regulations.

Recommendations for the U.S.

In 2019, President Trump classified Brazil as a major ally of the U.S. ("U.S. Relations With Brazil," 2019). According to the United States Department of State, the U.S and Brazil "enjoy robust political and economic relations ("U.S. Relations With Brazil," 2019). During the past decade, there was a large amount of FDI from the U.S. However, the two countries have few bilateral agreements compared to other states (Fouad & Gouvea, 2018). They are currently economic allies but have not collaborated much in the AI space. Due to their strong economic ties, we have identified Brazil as a strong potential AI ally.

AI investment by the Brazilian government is primarily focused on IoT to foster economic growth, and on national security. In addition, due to the relationship between the U.S. and Brazil, Brazilian's AI capabilities are not seen as a threat to the U.S. Currently, U.S.' investment in Brazil is mainly focused on environmental projects ("U.S. Relations With Brazil," 2019). In the second quarter of 2019, Latin America's fintech funding surpassed China's, showing that the region is heavily investing in technology and growing fast (*Global Fintech Report Q2 2019*, 2019). This fast growth and substantial investment show that the United States should see Brazil as a potential collaborative ally on AI. The U.S. should act promptly seeing that Huawei is already making headway in Brazil.

Brazil has proven that it considers AI to be a priority, and the United States should invest in the development of artificial intelligence in Brazil. Brazilian population is the fifth-largest internet consumer in the world, the country has the second-largest Facebook users in the world, and more than half of the population shops online (Henriques, 2020). The Brazilian population's heavy internet use shows their interest in new technology, therefore being a prominent environment for the development of AI. International companies such as IBM, Microsoft, and Google are already funding AI research programs in Brazil, the U.S. should follow.

China

By Jiani Wang

Introduction

China is an AI superpower with a high level of AI development, based on its robust AI research and development landscape and high levels of artificial intelligence applications. China's AI landscape is primarily focused on facial recognition, robotics, and AI hardware. The Chinese government has low engagement with AI ethics, as demonstrated by a lack of data privacy regulations. However, the Central government along with industry leaders in China have called for an international discussion of AI ethics and potential international regulations in the matter of fully autonomous weaponry. The U.S. and China act as AI adversaries, with the U.S. accusing China of unfair competition, and China denouncing the U.S. cyber hegemony. Table 2 summarizes findings on China's AI readiness, research and development, products and applications, and ethics.

Table 2: Summary Findings, China

Government AI Readiness	
Level AI Development	High
Oxford Insights AI Readiness Score	7.370
Presence of Strategy Documents	Yes
Presence of Dedicated ICT Department	Yes
Research and Development	
Amount of Investment	High
Density of Collaborations	High
Products and Applications	
Government Orientations	Government regulation, efficiency, social stability, national defense
Industry Orientations	Efficiency, data management, computation
Ethics	
Level of Government AI Ethics Involvement	Low
User Data Privacy Laws	Yes
AI Ethics Reports	No

Background

The People's Republic of China is a socialist republic country with a population of 1.4 billion people as of 2018, and an electrification rate of 100 % (National Bureau of Statistics of China, 2018). China earned a score of 7.37 on the Oxford AI Readiness Index (*Government AI Readiness Index 2019—Oxford Insights*, n.d.). Due to the missing data points of China in the OKFN Open Data Index, which is one major source evaluating the score for each country, China's government received a score lower than the reality. China's AI advantage comes from its loose privacy laws, the abundance of data, increasing numbers of AI engineers, and a strong start-up ecosystem (Miller & Stirling, 2019). In addition, electrification is the prerequisite of implementing AI development across the nation. China's 'Township Electrification Programs'

helped China achieve full electrification in 2015, which allows China to apply AI even in remote areas (Gang, 2017).

Government Policy

The Chinese government has set 2030 as the benchmark for China to become the leading global AI power. This section will detail how the Chinese government has sorted its policies in order to reach that goal. The 13th Five Year Plan for Developing National Strategic and Emerging Industries is the umbrella framework for China's scientific and technological policies (Ding, 2018). This guidebook highlighted the development of AI and identified five central agencies in charge of drafting AI policies for the upcoming years (Ding, 2018). Under this structure, the New Generation Artificial Intelligence Development Plan and 'Made in China 2025' specifically point out addressing national security as an essential element for AI development (Creemers, n.d.). China's approach to AI involves strong support and intervention from the state, long-term investment, whole-of-society measures, and the transfer of both talent and technology (Ding, 2018). On the international stage, China has focused on preparing its domestic companies to be competitive on a global scale and has been vocal for the ban on fully autonomous weapons (Chan, 2019).

Position on Domestic AI

Ever since its ascent as a global power, China's policies have always been in the public spotlight. AI's first major appearance in China's governmental policy was in July 2017 when the 'New Generation Artificial Intelligence Development Plan' (AIDP, 新一代人工智能发展规划) was issued by the State Council of China. The Development Plan's release statement clearly marked China's ambition for technological, theoretical, and applied AI development and its goal to become the global leader in the field by 2030. The AI Development Plan affirmed AI as the new focus of international competition, and AI development as a crucial element of national security and international competitiveness (Creemers, n.d.). Additionally, the plan labels AI development as a new engine for economic growth through industrial transformation and technological revolution (Creemers, n.d.). This policy reflects China's determination to dominate emerging and smart technologies, especially next-generation IT, new energy, intelligent connected vehicles, and AI (Zenglein & Holzmann, 2019).

In the AI Development Plan statement, the State Council divided China's AI development into three stages with planned budgets. 2020 has been set as the first benchmark for China's AI industry to be on par with the most AI-advanced countries, exceeding 150 billion RMB of core AI-industry gross output and 1 trillion RMB overall of AI-related industry gross output (Ding, 2018). At the end of 2025, China aims to become a world leader in certain AI fields, with 400 billion RMB of core AI-industry gross output and five trillion RMB of AI-related industry gross output (Ding, 2018). By the year 2030, China is seeking to be the world's primary AI innovation hub, exceeding one trillion RMB of core AI-industry gross output and ten trillion RMB for overall AI-related gross output (Ding, 2018). Even though many western scholars hold pessimistic views on this desirous blueprint by the CPP, Beijing has shown a strong commitment to its goal of technological supremacy by 2030, and a primary goal of this program is to attract more talent to China by providing facilitation and support to overseas R&D centers. (EU, 2017) This policy seeks to tackle the lack of AI-related talent in China.

To increase the amount of talent, the State Council's AI plan dedicates a section to accelerating the training and gathering of those with high AI skill sets. The report calls for recruiting top international scientists through a variety of programs, such as the 'Thousand Talents Recruitment Programme' (1,000 talents) and the 'High-end Foreign Expert Recruitment Plan'. The 'High-end Foreign Experts Recruitment Plan' is a new program, similar to the 'Thousand Talents' Programme started in 2008, launched in 2019 by the Ministry of Science and Technology aiming to introduce key priority fields to high-level foreign experts in China and contribute to the country's scientific and technological innovation development (*National High-end Foreign Experts Recruitment Plan (2019 annual call)*, 2019).

In addition, China continues to pay attention to AI development and policy in other developed countries, particularly the United States. However, China's AI policy differs from that of the US largely because of its focus on AI's 'Omni-use' potential and a diversified private sector made up of vigorous startups, tech unicorns, and other international-facing companies (Ding, 2018).

The top priority of the 'New Generational Artificial Intelligence Development Plan' is to solidify China's place at the front of global technological innovation competitions. The AI boom in China has fed the nation's self-confidence in technology expansion. However, China still faces major weaknesses that hinder it from competing with the United States, such as a lack of talent, software platforms, technical standards, and semiconductors (Allen, 2019). During a politburo session on AI in 2018, President Xi Jinping stated that China must reduce its external dependency on foreign technology and advance China's own equipment development through a series of policy implementations (Lucas & Waters, 2018). This would allow China's economy to transition into a new stage of growth (Purdy et al., 2017). Currently, China still heavily relies on increases in labor and capital to drive its desired level of economic growth, which is not sustainable. AI would dramatically increase China's productivity levels and GDP targets. Sectors like AI and the internet of vehicles would not only increase manufacturing but also constantly stimulate new infrastructure investments, diversifying China's government-led investment portfolio (Yu, 2020).

The three rationales specified in the New Generational Artificial Intelligence Development Plan's introductory section include creating new international competitive advantages, stimulating new industrial development, and enhancing national security. China's mode of social governance and the State Council's AI plans demonstrate AI's 'irreplaceable' role in maintaining social stability across a broad range of public services, including medical care, judicial services, and public security. The AI technology that applies to auto-driving and commercial products could also be deployed for military use, such as analyzing pictures taken by autonomous boats and spy drones, as well as synchronizing drone swarms (Lucas & Waters, 2018). A lead-in AI development could determine a nation's military advantages and is something the Chinese government is actively pursuing.

The Chinese government took a similar approach to its AI development policies compared to its past government-incentivized economic development. China's AI policies are characterized as heavy money investment, tight relation between the government and firms, and the need for high-tech talents.

Position on International AI

China's AI sector is growing fast, the Chinese government closely follows the global AI trends, is actively involved in the discussion of the potential threat brought by AI, and calls for

international regulations. Fully autonomous AI weaponry, such as lethal autonomous weapons system, has received high-level attention in the international community. China, along with Cuba, Guatemala, Austria, and a series of other countries call for autonomous weapons prohibitions by creating a new international treaty (*High-level Concerns on Killer Robots*, 2019). During the 2018 session of the UNGA First Committee on Disarmament and International Security, China expressed the necessity of an international legally binding instrument on fully autonomous weapons systems (*High-level Concerns on Killer Robots*, 2019).

Despite China's apparent diplomatic stand and commitment to the ban of fully autonomous weaponry, Beijing clarified that it is only against the use of fully autonomous weaponry on the battlefield, and it is not against its development or production (Chan, 2019). Military innovation has been at the center of the Chinese AI plan, and the People's Liberation Army consistently collaborates with universities and private firms (Chan, 2019). According to the U.S Congressional Research report, China has already developed a variety of underwater, unmanned aerial, ground and surface platforms (*U.S. Ground Forces Robotics*, 2018). China is working on cutting-edge autonomous systems, including hypersonic, swarming, and stealth capabilities (*U.S. Ground Forces Robotics*, 2018).

Due to China's mixed record on the matter of cybersecurity, scholars call for further analysis of China's objective and motivations for supporting the ban of fully autonomous weaponry (Ding, 2018). Reporters have even raised the question of whether China has strategized its support on the ban as a method against the U.S. in the AI competition (Chan, 2019). In 2017, China rejected the UN Group of Governmental Experts on Developments in the Field of Information and Telecommunications in the Context of International Security and called the proposals in the final report as irresponsible and counter-productive (Schmitt & Vihul, 2017). In the same year, China repeatedly denounced U.S. cyber hegemonism calling for international cooperation and a 'shared future' (Kania, 2018). Moreover, in China's 2018 position paper, it did not express its support for such international agreement on LAWS either, instead, it just simply highlighted the importance of the 'full consideration' towards the applications of LAWS (Kania, 2018). In the same position paper, it also had an extremely narrow definition of autonomous weapon systems, which could possibly legitimatize semi-autonomous weapon systems (Kania, 2018). For these reasons, it is important to consider China's actions as well as their declarations on autonomous weapon systems.

Research and Development

China's AI-related R&D varies across different sectors and organizations, and it is apparent that China is adopting a 'catch-up' approach to its science and technology development with the recognition of its innovative weaknesses (Ding, 2018). The Chinese government plays an important role in financing all kinds of R&D projects. In fact, China's R&D spending was around $280 billion, which accounts for approximately 2.12% of the country's total GDP and represents 20% of the total global R&D expenditure (*China's R&D Strategy*, n.d.).

However, there are certain restrictions on researching R&D projects in China since many AI-related R&D projects involve closed national defense strategies and it is near impossible to find specific parties involved. Acknowledging the extreme influence of the central government's policies in science and technology-related R&D, this section will also be based on the major Chinese AI developmental policies.

Collaborations

AI research and development collaborations are mainly happening between the central government and Chinese AI companies by incentivizing their individual technology development in the forms of governmental policies, national endorsement, and financial investment. The central government has published distinct policy frameworks and guidance for its short- and long-term goals on AI development, which all serve a single purpose of helping China be the global leader in the AI industry.

Artificial Intelligence 2.0 (人工智能 2.0) is a plan that demonstrates how AI was recently elevated to a megaproject. Megaprojects were proposed and finalized in 2016 with the release of the '13th Five-Year Plan for National Science and Technology Innovation' but AI was added in February 2017 (Ding, 2018). The Fund for Industrial Restructuring and Upgrading allocated 2.78 billion RMB, approximately 404.3 million USD, to projects in smart manufacturing in 2016 alone, and the 2017 Central Basic Infrastructure Budget allocated a total of RMB 5.28 billion, approximately 615 million USD, to infrastructure for 'Internet Plus' and key projects in emerging industries in 2017. China's 'Internet Plus' initiative is a project created by the Chinese government aiming to transform and modernize traditional industries (*China's "Internet Plus,"* n.d.). This strategy would not only allow the role of data centers and big data in China to grow but also businesses to link across sectors and connect China's growing economy with the power of connected services (*China's "Internet Plus,"* n.d.). Chinese consumers play a crucial role in this development because China has the world's largest e-commerce market that generated over $615 billion revenue in 2015, according to McKinsey's 2016 China consumer report, and its consumers are eager to purchase and use new technology, specifically mobile-based ones (Zipser et al., 2016). Therefore, sites with enormous amounts of consumer data are ripe for segmentation and analysis, which created a large domestic big data market. According to China Telecom American Corporation, China's big data market is expected to reach over 822.88 billion RMB by 2020, up from the previous 76.7 billion RMB in 2014 (*China's "Internet Plus,"* n.d.). Thus, directly benefitting China's internet growth, power data centers, and further R&D – all in conformity with the 'Internet Plus' goals.

With the increasingly competitive Chinese consumer market and the rise of labor wages, China's low labor-cost-based economy is no longer sustainable and forces China to transform its economy with more innovative and technology-based industries. In the Robotics Industry Development Plan 2016-2020 (机器人产业发展计划), the government set a goal to manufacture 100,000 industrial robots annually by 2020, making China the world's leading robot-maker. Through this program, specific targets for advancing the robotics industry have been set. This is the second of two development plans containing a focus on AI released by the central agencies with a policy planning mandate (Ding, 2018). The 'Robotics Industry Development Plan' and its AI development will serve two major policy orientations for the Chinese government. First, industrial manufacturing robots will diversify China's economy portfolio and increase the values of 'Made in China' products on the global market. From a corporate perspective, automatizing the manufacturing process would vastly increase productivity and further integrate commerce and technology altogether. From 2010 to 2014, the demand for industrial robotics and its R&D in China has increased by nearly 40 percent on average annually (Ray et al., 2016). Numerous state plans, including policy incentives, output targets, and financial support for China's industrial robotics sector, have incentivized private companies to research and develop industrial robotics.

In addition, China's military robotics has dramatically grown in quality and size as China upgraded its military capabilities and manufacturing sectors. Despite China's defense R&D

budget not being published publicly, according to the research done by the Center for Security and Emerging Technology at Georgetown University, China's estimated military expenses on AI R&D could have been nearly 289 billion RMB in 2018 (Acharya & Arnold, 2019). Chinese military officers and strategists believe that a fundamental shift in the nature of warfare will happen due to the rise of technology and unmanned platforms. This belief led to multilateral collaboration among the government, universities, and China's defense industry (Ray et al., 2016). China's demand for military unmanned aerial vehicles is predicted to grow by 15 percent annually between 2013 to 2022 (Ray et al., 2016). Furthermore, China's military has also fielded a huge number of increasingly capable unmanned systems in the sea, land, and air domains that possibly bolster its anti-access denial capabilities (Acharya & Arnold, 2019).

In terms of cross-sector collaborations, university and private companies are working closely together as well, especially in the sector of healthcare, big data, autonomous-driving, green-vehicle, as well as AI software and hardware. China supported 'national champions,' which are those leading technology companies recognized in the 'New Generation Artificial Intelligence Development Plan,' which has used its substantial funding to encourage domestic companies to acquire chip technology through overseas deals, and made long-term bets in supercomputing facilities. Established tech-companies like Baidu and startups like Cambricorn are designing chips to be specifically used by AI algorithms (Ding, 2018).

Industry

Availability of data, computing power, and progress in algorithms are all key elements to AI development, and as the United States' biggest competitor, Chinese companies are racing to dominate big data. China's large population serves as a crucial advantage in its AI development because it provides a large pool of accessible data. In using facial recognition technology, the government collects massive amounts of data from Chinese residents and uses it to further its AI capabilities.

In China, many tech-companies have also established their own AI research centers to further innovate and improve their competitiveness in the industry since the technology-based market in China is extremely competitive. Due to the Chinese government's policies welcoming tech-companies, China is very business-friendly for new tech-startups. In fact, hundreds of Chinese tech startups have been created in recent years.

Alibaba DAMO Academy was founded in 2017 as a scientific and technological research center in pursuit of the 'betterment of humanity' according to Alibaba's news statement. Its laboratories are divided into five sections, including machine intelligence, data computing, robotics, financial technology, and 'x laboratory' (*About Damo Academy*, n.d.). Alibaba, the e-commerce unicorn in China, has access to billions of users' data on a regular basis, which allows Damo Academy to experiment with data computing to converge and reconstruct a secure and agile information infrastructure. Damo Academy aims to solve computational problems and eventually form a globalized intelligent computing ecosystem. Their database and storage lab has conducted services on new hardware accelerations, cloud data management, and autonomous database (*Database and Storage Lab*, n.d.). Their research on database core algorithms would effectively solve problems like unstructured data analysis (*Database and Storage Lab*, n.d.). One of their major projects is the 'City brain', which will be further discussed in the 'application' section.

As China's government policies favor electric vehicles, many Chinese vehicle companies have also conducted R&D in applying AI to the industry. Baidu Research center is dedicated to a

driverless car ecosystem. In 2019, at Baidu's annual Create AI developer conference in Beijing, the research center updated its fleet of 300 level vehicles, a great technological achievement transferring cutting-edge technology into the transportation industry (Wiggers, 2019).

In addition to the Chinese firm's research centers, there are many foreign companies locating their scientific and technology research centers in Beijing. In 2017, despite the fact that Google search engine is blocked in mainland China, Google announced its plan on expanding its AI research to China by opening a facility based in Beijing, called Google Ai China Center. This research center mainly focuses on machine learning, which is a part of AI software where the computers understand human languages better (Kharpal, 2019). Due to the commitment of private companies and the government, China has built a robust R&D landscape.

Academia

In academia, there are many universities with existing AI R&D centers, and those centers have all received sponsorships either from private companies, the government, or both. The heavily concentrated sectors are involved with brain science, AI software and hardware, autonomous driving, and biometrics. Although many institutes and universities in China have programs on AI, there are no major differences between the strategic planning between institutes and universities. In fact, they are often brought together through national projects, although different research groups would focus on different areas such as robotics, hardware, and pattern recognition. The Chinese policymakers and researchers constantly follow the global technology trends and Western industries. Whenever a promising direction of AI emerges internationally, Chinese researchers will also begin addressing it (Qiu, 2016).

Another sub-institute of CAS, the CAS Institute of Automation, has mainly been working on brain-inspired intelligence. The long-term goal is to decode human intelligence's mechanisms leading to develop brain-inspired intelligent systems (Qiu, 2016). Parallel Brain Simulator is one of its recent research projects, and this technology would conduct a preliminary trial on simulating the cognitive human brain at multiple scales, such as nerve cells, ions, cognitive behaviors, and brain regions (Qiu, 2016). This model would also potentially be capable of cognitive functions including inference, pattern recognition, and deduction, and allows scientists to eventually apply the technology to cognitive robotics serving as their' brains (Qiu, 2016).

Country-to-country

International collaboration is essential to China's AI development. One thing that China has done in the past is to take foreign technology back to China in both licit and illicit ways. China's AI R&D collaboration at the international level is mostly concentrated in academia. The increasing number of China's output paper on the topic of AI development clearly demonstrated the benefits that China has received through its international collaboration on scientific and technological research. At present, China has the greatest number of highly cited AI-related papers, and in fact, as many as 42.64% of top AI-related papers produced in China are the product of international collaborations (*China AI Development Report*, 2018). For the past two decades, China has made enormous progress in AI scientific paper output, with papers published in the field increasing from nearly more than 1000 in the year 1997 to over 37,000 in 2017 (*China AI Development Report*, 2018). Country-to-country research centers and global projects are a crucial contributor to the progress that China was able to achieve over the past twenty years.

Another common form of global collaborations for China's AI research and development is international scientific and technological conferences across all fields. The China-Qatar International Workshop on Artificial Intelligence and Applications to Intelligence Manufacturing is a high-level forum for AI engineers, scientists, and educators from two countries to present AI research and applications, especially regarding the AI-implication in intelligent manufacturing (Cihon, 2019). Domestically in China, Shanghai consistently hosts a variety of AI summits each year, such as World AI Conference, that invited top AI researchers from all nations to present and share their works ("WAIC," 2019).

Despite AI development being a global competition, it is common to see intergovernmental collaborations between China and other main players in this race. Australia's government has publicly acknowledged China as its leading AI development partner (Laurenceson & Zhou, 2019). 33.9% of total Australian AI research publications are affiliated with Chinese institutions, and the number also includes universities from Hong Kong SAR (Laurenceson & Zhou, 2019).

Products and Applications

Due to its commitment to AI development, China has a wide variety of AI products and applications across many sectors. According to World Intellectual Property Organization's report on AI in China 2019, among the top 100 AI companies in China, there are sixteen firms in the field of computer vision, thirteen in smart robots, eleven in speech recognition and natural language processing, nine in healthcare, seven in big data analytics, seven in AI industry consulting, and seven in AI chips development (Zhang, 2019). This section will address China's current progress on AI by analyzing the current application of AI technology, such as facial recognition, robotics, and machine learning.

Collaborations

The collaborations between the Chinese government, both national and regional, and the private sector are extremely tight-knit, which helps to create such a welcoming and friendly business ecosystem for AI companies in China. Even though there are many products and applications across sectors, vision and surveillance technologies used for security purposes have been some of the most mature, because they successfully fulfill the need of the Chinese government to maintain social stability through collecting citizens' data and technological surveillances.

A group of tech companies is working closely with the government on the application of facial recognition technology, such as SenseTime and Cloudwalk. Cloudwalk is a facial recognition giant based in Guangzhou that started its business by supplying technology to border-control agents (Digital Media Team, 2018). Twenty-four out of thirty-two Chinese provinces have employed Cloudwalk's public-security solutions with its facial recognition terminals that are used to scan during door entry (Digital Media Team, 2018). The main targeted consumers of Cloudwalk are public organizations, such as banks, with high-security requirements. Similarly, SenseTime, a company originating from the Chinese University of Hong Kong, is reputed for occasionally beating Google and Facebook in image-recognition competitions. Currently, the firm is supplying its facial-recognition technology to the Chinese government who plans to use it to track residents through over 170 million CCTV cameras across China (Digital Media Team, 2018). Unsurprisingly, retailers, police, prisons, and banks have also established constant business relations with SenseTime (Digital Media Team, 2018).

Industry

The Chinese government is inextricably linked to its industries as it invests heavily to help make their AI products and applications internationally competitive. China's Ministry of Science and Technology endorsed four private-sector companies, including Alibaba, IFlyTek, Baidu, and Tencent, to contrast digital platforms for specific purposes under 'National New generation Artificial Intelligence Open Innovation Platform' policy (Larsen, 2019). Later, a fifth company, 'SenseTime, was added. The type of national endorsement from the central government has provided advantages for Baidu and iFlytek to work with car manufacturers and Tencent to access a wide range of hospital data respectively. Those five companies have different AI technologies, including smart voice, medical imaging, smart city, autonomous driving, and smart vision, and some may have tighter partnerships with the government than the others due to the nature of state-owned enterprises, such as iFlytek. It is a partially state-owned Chinese information system company that mainly focuses on voice recognition software and voice-based product (Harney, 2019). In 2018, the company and the MIT Computer Science and Artificial Intelligence Laboratory signed a mutual agreement on a five-year collaboration plan on AI in healthcare (Harney, 2019). It is worth noting that the United States issued sanctions on iFlytek in 2019 due to its use of technology to commit human rights abuses in Xinjiang (Harney, 2019).

AI projects are extremely varied across sectors, from facial recognition usages for entertainment purposes from Tencent company to security and privacy protection in Alipay. 'City brain' is a massive project that Alibaba has taken on to utilize comprehensive real-time city-data. This has transformed the urban government models, industrial development, and service models. The city brain construction has included four platforms: 'IT Services Platform', 'AI Service Platform', 'Data Resources Platform', and 'Integrated Computing Platform'. Currently, it has been implemented in a handful of cities in China, including Hangzhou, Suzhou, Shanghai, Xiongan New Area, Quzhou, and Jiaxing. The tool behind this enormous project is a technique called 'city visual intelligence engine', which is powered by the distributed computing platform of Alibaba Cloud computing with advanced visual processing and computer graphic technologies (*Research Focus*, n.d.). In Hangzhou, Alibaba's hometown, the city brain system uses AI to gather traffic information around Hangzhou, including GPS data and street intersection cameras, to perform real-time information analysis and coordinates over 1,000 road signals around the city (Toh & Erasmus, 2019).

Another main application of AI technology is hardware, like robotics and computer chips. Ubtech Robotics is a Shenzhen-based company founded by James Zhou, that made the company's first humanoid robot, Alpha 1S. It expanded from its original focus after creating a consumer-service droid called Cruzr, intended for use in local government offices and schools. The company plans to shift its focus to creating a large-scale humanoid robot, which means honing Utech's expertise in motion-control algorithms and computer visualization (Digital Media Team, 2018). Another example is Cambricon, a two-year-old state-backed semiconductor, and AI chip specialist company. It hopes to integrate its processors into 1 billion smart devices worldwide in three years. Optimized for deep learning capabilities, Cambricon chips are currently being slotted into Huawei smartphone products (Digital Media Team, 2018). The success of this company could help China achieve self-sufficiency in digital components and reduce dependency on imports (Digital Media Team, 2018).

Ethics

Substantive discussions about AI safety and ethics are emerging in China, but there is still no consensus on the endpoints of AI development. A new book authored by Tencent's Research Institute contains chapters that proactively call for stronger awareness of AI safety issues (Ding, 2018). The author discusses the Asilomar AI Principles in detail and calls for 'strong regulations' and 'controlling spells' for AI. A wide range of Chinese AI researchers' areas also involved with translating the IEEE's Ethically Aligned Design report, as part of the Global Initiative for Ethical Consideration in Artificial Intelligence and Autonomous Systems. However, other Chinese AI leaders dismiss calls for regulation (Ding, 2018).

China's demographic population and the massive digital market produce China's sources of data, which offers a unique advantage for its artificial intelligence development. However, at the same time, data security concerns have motivated China's efforts to ensure valuable data stays under the control of Chinese tech companies. In this vein, China has pushed for national standards in AI-related industries, such as cloud computing, industrial software, and big data, that differ from international standards, a move that may favor Chinese companies over foreign companies in the domestic market (Ding, 2018). China's tendency towards protectionism shapes the government's policies on data regulations, which is called China's techno-nationalism, an approach that aggressively protects domestic companies from foreign competitors. Even if the Chinese companies that rise from this approach do not compete internationally – though many have successfully expanded to Asian and African countries – they still thrive by serving China's huge market (Ding, 2018).

Regarding privacy, on June 17, 2019, China's Ministry of Science and Technology published on its website the Governance Principles for a New Generation on Artificial Intelligence. The Principles were formulated by the Ministry's New Generation Artificial Intelligence Governance Expert Committee (Zhang, 2019). This principle provides a framework and action guideline for AI governance, aiming to 'promote the healthy development of a new generation of AI: better coordinate the relationship between development and governance; ensure that AI is safe/secure, reliable, and controllable; promote economically, socially, and ecologically sustainable development; and jointly build a community of common destiny for humanity' (Zhang, 2019). However, with the extreme level of monitoring, China's citizens' privacy rights are bypassed by the central government through technological surveillance.

Recommendations for the U.S.

It is clear that the U.S. government has seen itself in a technological arms race with China. The U.S. believes that AI technologies are so transformative that the leading AI power in the global community would not only have an economic advantage but also a national security advantage (Lucas & Waters, 2018). China is closely attuned to the U.S.'s AI strategies, and the government has seen it as a reference point for its own approach, as well as a way to keep up with the global trend. In fact, many key junctions in China's AI projects are related to the U.S.'s AI-related pronouncements (Ding, 2018). Moreover, the Chinese government regularly translates and analyzes U.S. government reports on AI, and Chinese officials have demonstrated timely and substantive knowledge of AI developments in the United States and the rest of the world. The U.S. should consider a similar approach to increasing its awareness of other nations' development and detailed AI strategies.

The U.S. still has a clear lead in AI development. According to most experts, there are three essentials in order to be a global leading AI power: 1. 'the most advanced algorithms', 2.

'specialized computing hardware', and 3. 'good supply of data from machine learning systems' (Lucas & Waters, 2018). China has an absolute advantage in the supply of data because of its demographic population, but it is still far behind on AI software and hardware. China's technological advancement contributes to paranoia in the United States that its technology exceptionalism is no longer being taken for granted. The Trump administration's plans for a trade war with Beijing are motivated – at least in part – by the fear of China's advances in new technology (Lucas & Waters, 2018).

As advanced as China has been in its AI development, there are still plenty of challenges remaining. These policy recommendations are based on the goal of the U.S. retaining its AI technological superiority. Therefore, in order to remain the leading position in the AI race with China, the U.S. government should deepen its research in cognitive AI and take the initiatives on leading global AI trends. In addition, the U.S. government should manage the situation of China's illicit technological transfer by addressing legitimate security concerns and working with its allies to reinforce international intellectual property laws.

Estonia

By Amodini Khade

Introduction

Estonia is a developing regional AI power with a medium level of AI development, based on its limited AI research and development landscape and high levels of artificial intelligence products. Estonia's AI landscape is primarily focused on consumer services and business to business services. The Estonian government has high engagement with AI ethics, as demonstrated by the presence of data privacy conversations and government taskforce discussions. Estonia acts as an AI ally to the U.S. due to both countries being members of NATO. Table 3 summarizes findings on Estonia's AI readiness, research and development, products and applications, and ethics.

Table 3: Summary Findings, Estonia

Government AI Readiness	
Level AI Development	Medium
Oxford Insights AI Readiness Score	6.968
Presence of Strategy Documents	Yes
Presence of Dedicated ICT Department	No
Research and Development	
Amount of Investment	Medium
Density of Collaborations	Medium
Products and Applications	
Government Orientations	Public services, national security
Industry Orientations	Business-to-business
Ethics	
Level of Government AI Ethics Involvement	Medium
User Data Privacy Laws	Yes
AI Ethics Reports	No

Background

Estonia is a democratic unitary parliamentary republic with a population of 1.3 million as of 2020 (*Estonia | Culture, People, History, & Facts*, n.d.). Estonia has maintained 100 percent access to electricity across the country for the past five years (*Access to electricity (% of population)*, 2017). Estonia earned a score of 6.968 on the Oxford AI Readiness Index (*2019)*. According to the Index, Estonia is ranked in the top five of Eastern European countries for AI readiness, thanks to the excellent data infrastructure that allows for smoother provision of public services. Estonia aims to expand its digital advantage to develop artificial intelligence solutions in the public service provision (*Government AI Readiness Index 2019—Oxford Insights*, n.d.).

Government Policy

Following the example of several EU countries, Estonia has been investing more resources into Artificial Intelligence. It recently released its AI strategy for 2019-2021, which

focuses on four key areas: public sector AI development, private sector AI development, research and development, and establishing a legal framework. On the domestic level, Estonia is rapidly investing in and providing incentives that promote AI development. On the international level, Estonia has publicly spoken about the perils of autonomous weaponry and aims to curb its development.

Position on Domestic AI

Being one of the pioneering countries in digital public services, Estonia wants to further its technological edge. Estonia's AI strategy, also known as the 'Kratt strategy,' was released on July 25, 2019, with an investment of ten million Euros for strategy implementation between 2019-2021(*Estonia's Artificial Intelligence Strategy*, n.d.). Estonia's goal is to increase the total number of AI applications in the public sector from 23 to 50 applications by 2020. The strategy's four major areas of focus are public sector AI development, private sector AI development, research and development through educational institutions, and the creation of a legal framework to manage AI complexities (*Estonia's Artificial Intelligence Strategy*, n.d.).

Through several national projects, Estonia continues to invest in AI-focused businesses. The country continues to facilitate investment by offering innovation vouchers, development vouchers, and product development vouchers through the Enterprise Estonia initiative for AI development (*Republic of Estonia's AI Taskforce*, 2019). The goal is to support 40 ongoing pilot projects focused on AI product development with up to 50,000 euros per project, and up to 200,000 euros for 20 projects (*Estonia's Artificial Intelligence Strategy*, n.d., p. 20). Estonia understands the need for strategic investment in research as well as business ecosystems that feed into each other to foster cutting-edge artificial intelligence technology.

Position on International AI

Estonia has always been keen on participating in international discourse, prime examples of which are its close ties with NATO and the EU. In April 2018, in its Communication "Artificial intelligence for Europe", the European Commission recommended that EU member nations concentrate research resources by strengthening pan-European collaboration toward ethically sound artificial intelligence technologies (*Communication From The Commission To The European Parliament*, 2018). In addition to the EU's manifesto, NATO also released 'The Report on Artificial Intelligence: Implications for NATO's Armed Forces' in 2019. The report discusses the impact of robotic autonomous weapons for security and recommends collaboration with the EU for developing defense-related AI research. As the host and framework body of the NATO Cooperative Cyber Defense Center of Excellence, Estonia participates in cross-country collaboration in NATO CCD COE's efforts to understand the role of autonomous technologies in cyber warfare (*CyCon*, n.d.).

Part of Estonia's international position is to deepen international collaboration surrounding the ethics discourse like that on autonomous weaponry. Estonia supports the efforts to strengthen the Convention on Certain Conventional Weapons and has actively contributed to the Group of Governmental Experts and welcomes the agreed Guiding Principles and mandate of the GGE for 2019 (*UN head calls for a ban*, n.d.).

Further illustrating its commitment to international cooperation, in May 2019, Estonia pledged to the *Recommendation on Artificial Intelligence*, the first intergovernmental standard on AI that aims to establish a human-centered and ethical approach to AI and its applications made

by 50 experts across various countries (Grigoryan, 2019). In 2017, Estonia also adopted the "Nordic-Baltic Region: a Digital Frontier" declaration that proposes a collaboration between Nordic-Baltic countries (*AI in the Nordic-Baltic Region*, n.d.). To advance their NATO and Digital 9 ties, Canada and Estonia signed the Digital Cooperation Agreement in May of 2018 to leverage each other's' strengths, Estonia's in digital public services like the X-road data infrastructure, and Canada's increasing investment in Artificial Intelligence research, which was more than $300 million in 2017 (*Weekly press review | Estonia and Canada to cooperate on digital solutions*, 2018). Estonia believes that a crucial factor for maintaining its open mindset to innovation is by democratizing avenues that discuss ethical technology and involve different domestic and international stakeholders in the decision-making processes.

Research and Development

Estonia aims to tap into its enormous technological potential by investing in research that can advance the country's potential from a pioneer in e-government to a leader in artificial intelligence technology. Estonia continues to benefit from European Union's Horizon program, and the Estonian Research Council is also a major funding institution for cutting edge artificial intelligence and biotech research (*Republic of Estonia's AI Taskforce*, 2019).

Collaborations

Estonia benefits from the European research ecosystem that allows it to scale its research solutions which focus on the business and social sectors. The European Research Council recently funded the Process Improvement Explorer project at the University of Tartu for the 2019-2024 period (*Artificial intelligence to improve your business*, 2019). The project is a part of the 540 million euros invested by the European Research Council to develop cutting-edge research. The goal of the PIX system is to develop an artificial intelligence system that can parse through massive amounts of data to provide insights into the optimizing business processes in an organization (*Artificial intelligence to improve your business*, 2019).

In addition to independent projects, the EU also funds innovation centers like Digital Innovation Hubs at the University of Tartu, which aim to develop research in areas like big data, cybersecurity, cloud computing, and virtual and augmented reality. The key aims of DIH are building R&D capacity, developing knowledge transfer capability through different collaboration formats, and providing support services in the areas of interest of local, regional and global industries (*Digital Innovation Hubs*, n.d.).

One of the key projects in the Estonian research landscape has been the applications of machine learning for linguistic analysis. The National Program for Estonian Language Technology (2006-2010) develops technological support for the Estonian language so that Estonian can be a part of the modern information society (Meister et al., 2010). The main actors in the project are the University of Tartu, the Institute of Estonian Language, and the Institute of Cybernetics at Tallinn Institute of Technology. The projects covered include resources for interactive language learning research/technology development like machine translation and semantic analysis (Meister et al., 2010). All of these examples demonstrate the broad and ambitious range of current research being done in pursuit of Estonia's AI strategy.

Industry

A majority of the Estonian digital infrastructure is developed by private organizations. With continued government support, Estonia can develop its digital capabilities in new areas like artificial intelligence.

Swiss company Business Investigation SA provides GPS analytical platforms for major AI and machine learning applications. The company plans to build a research center in Tallinn to serve the Nordic-Baltic region. It is looking to learn from Estonia's digital infrastructure and invest in research that can apply to its GPS solutions within that infrastructure (Hankewitz, 2019). This is an important move in creating jobs in the artificial intelligence research area and can develop in-house expertise in Estonia in the long run. Furthermore, it will also enable Estonia's excellent digital abilities to be showcased on a global scale and attract more investment from other global players (Hankewitz, 2019).

Academia

The University of Tartu, Tallinn University and Tallinn Tech University are major research centers in Estonia and have produced significant research about emerging technologies, but there are not many on-going research projects focused on artificial intelligence.

The Computational Neuroscience Lab at the University of Tartu studies how information is presented in the human brain and how artificial intelligence systems can be developed in light of that knowledge (*Computational Neuroscience Lab | Institute of Computer Science, University of Tartu*, n.d.). Furthermore, there is also a research group on Natural Language Processing at the University of Tartu that focuses on using machine learning for text/language processing, furthering Estonia's trend toward advanced language processing technologies (*Natural Language Processing Research Group*, n.d.).

Tallinn University of Technology is another avenue for artificial intelligence research. The university has a Center for Intelligent Systems composed of the Alpha Control Systems research laboratory and the augmented and virtual reality lab. The main research interests of the former include Artificial Neural Network-based Control Algorithms and self-learning and adaptation methods in control systems. An example of published research is the detection of pavement cracks for cost-effective road maintenance and classification of motor insurance clients using intelligent algorithms (*Alpha Control Lab*, n.d.).

Country-to-country

Estonia is focused on creating cooperative research teams with other countries. Estonia most often cooperates with other nations within the EU, and despite its primary objective generally supporting industry, Estonia also looks to strengthen its national security. For example, the transportable autonomous patrol for land border surveillance is a project, from 2008 to 2012, involving 14 countries co-funded by the EU 7th Framework Program. The main objective of the TALOS project is to develop and field test the innovative concept of a mobile, autonomous system for protecting European land borders. The system has been developed by experts working for 14 institutions from 8 EU member states (Belgium, Estonia, Finland, France, Greece, Poland, Romania, Spain) as well as one EU candidate (Turkey) and one associated country (Israel). The TALOS project is influencing European research by contributing to the exploration of the field of robotic perception (sensors processing/fusion), multi-robot command and control, as well as mobile communication. It is also promoting research in other fields: mapping and localization,

artificial intelligence, low-level vehicle control, and robotic navigation (*Final Report Summary—TALOS (Transportable Autonomous patrol for Land Border Surveillance) | Report Summary | TALOS | FP7 | CORDIS | European Commission*, n.d.).

Products and Applications

Estonia's startups and technology companies are expanding their products in several areas and have a broad portfolio consisting of business-to-business and consumer services.

Collaborations

Estonia understands the importance of learning from international collaborators and wants to advance its regional technological power status to hone new capabilities and promote its solutions around the world. The Government of Finland and the Government of Estonia signed the "X-road" agreement in 2013 to promote shared connectivity and data sharing among various public and private databases in the two countries (*History of the Institute*, n.d.). Subsequently, the Population Register Centre of Finland and the Information System Authority of Estonia concluded a Cooperation Agreement, a contractual platform with the intention of formalizing X-Road cooperation. The X-road is fully operational in NIIS member countries-Estonia, Finland and Iceland (*History of the Institute*, n.d.). This X-road infrastructure is gaining popularity among several other EU countries and NIIS aims to expand the e-government solutions by inviting more members across the world into the data exchange layer (*History of the Institute*, n.d.).

In addition to increasing cross-country collaboration, Estonia continues to invest in cross-sector collaboration through initiatives like the Software Technology and Applications Competence Center (STACC). The products developed by STACC focus on e-commerce, online media, business, and public services. An example of business service is the University of Tartu's process mining services for companies to optimize their workflow operations. This process is beneficial because it can highlight bottlenecks, provide real-time tracking of the processes, and recommend pathways that guarantee the highest likelihood of success (Process Analysis and Optimization, n.d.).

Industry

For a small country such as Estonia, having four unicorn companies- Skype, Transferwise, Bolt, and Playtech- is remarkable and Estonia makes a concerted effort to foster that successful environment. As of 2018, there are 46 companies related to AI. Of those, 8.7% are in robotics, 26.1% are in machine learning, 10.9% about Internet of things, 17.4 % are in search engines and language processing, 17.4% focus on intelligent data analysis, 17.4% on recommender systems, and 2.2% in computer vision (*AI in Eastern Europe*, 2018).

Estonia has ambitions to be a robotically transformative nation and robotics is a rapidly advancing field in Estonia. Estonia is home to some pioneering robotics companies that use artificial intelligence. Milrem Robotics, established in 2013, manufactures unmanned ground vehicles for defense and security forces and commercial and industrial clients and rescue services (*Meet Estonia*, 2017). In order to make robots as safe and autonomous as possible, robots are trained on historical data to understand where they are and what's going on in the surrounding environment – including the movement of humans, cars, bicyclists, obstacles – and predict what will happen next (*Meet Estonia*, 2017).

Another area of increasing investment is the intelligent mobility services. Bercman Technologies developed the Smart Pedestrian Crosswalk in Tallinn and Tartu. Using artificial intelligence algorithms, the system predicts the moving trajectories of road users and warns them of a traffic hazard in advance using audio signals for pedestrians and blinking LED lights for vehicle drivers (*Smart Pedestrian Crosswalk*, n.d.). Another intelligent mobility solution is the Issue To autonomous vehicle developed by Auve Tech. The shuttle can fit 8 passengers or cargo. It is currently being actively used in the Zoo of Tallinn and has potential use at airports to ease congestion in high service areas (*Auve Tech Iseauto – ITS Estonia*, n.d.).

Ethics

Being the pioneers in technology-led economic growth, Estonia has been tackling the balance of the positives and negatives of new technologies. While keeping the data protection and ethical frameworks in mind, Estonia understands the importance of data to Artificial Intelligence development. Estonia is looking for ways to create a centralized open data system that would enable better development of the Kratt strategy. Under the Open Knowledge Estonia Initiative, different public and private institutions are being given advice on how to make their data accessible. A pilot scheme is being run by the Ministry of Economic Affairs to allow the public to give authorization for their data to be used for public and private purposes (*Republic of Estonia's AI Taskforce*, 2019).

As an EU member, this pilot project must comply with the legal framework of the GDPR guidelines for the limits on personal data use (*Republic of Estonia's AI Taskforce*, 2019). The European Parliament of the EU-approved General Data Protection Regulation (GDPR) came into effect across the EU on May 25, 2018. According to the GDPR, companies that process and/or track personal data are considered "processors" while the individuals whose data is being used are considered "controllers". The GDPR lays out 99 articles regarding regulations and eight rights for controllers, including the right to data erasure and the right to object data tracking. Processors have to follow a long list of strict data protection regulations including the requirement to appoint a data protection officer for companies that have large-scale, "regular and systematic monitoring" of individuals' data or companies that process large amounts of sensitive personal information. The companies also have to notify the proper authorities and impacted individuals within 72 hours after a data breach. Breaches of the GDPR result in very heavy fines: up to €10 million or 2% of a firm's global turnover for small offenses and up to €20 million or 4% of a firm's global turnover, whichever is greater in both cases (Burgess, 2019).

In addition to the data protection frameworks, Estonia is also developing a legal framework to manage the possible negative impacts of Artificial Intelligence technologies. The Ministry of Economic Affairs started a task force in 2016 to think about the liability of such consequences. There were three main proposals from the task force: a) giving legal personhood to AI similar to a company but without any people; b) establishing a robotics act and operating within the rules of that while making a legal decision; c) redefining the meaning of will in legal literature. These discussions are ongoing and the Estonian government plans to incorporate public voice throughout discussions and into the new policy frameworks. The Estonian government also understands the implications of big data for biases and is working on creating a more inclusive society. Estonia is also looking at a potential solution in blockchain technology to solve ethical questions about data protection against hacking (*OECD Principles on Artificial Intelligence—Organisation for Economic Co-operation and Development*, n.d.).

Estonia is on the right track in orienting itself with the highest ethical standards, but as it plans to advance its artificial intelligence efforts, it will need to release clear ethical guidelines. This would require a concerted effort from the government in learning from examples from around the world and involving diverse stakeholders in the ethics conversation.

Recommendations for the U.S.

Estonia has been a strong ally of the United States since 1992 and an active collaborator in NATO. There are several potential avenues to learn about Estonia's novel legal frameworks to handle AI ethics as well as deepen ties to learn from Estonia's openness to innovation in the public sector.

After the 2007 cyberattacks on Estonia, Russian aggression in cyber warfare has been a top priority for the Estonian government. The U.S. and Estonia are both NATO members, creating a lot of opportunities to cooperate on issues like crisis management, intelligence sharing, civilian resilience, and countering Russian information warfare and hybrid attacks (Flanagan et al., 2019). The U.S. partnership would be crucial because Russian interference in the 2016 election has shown that the U.S. needs to keep track of Russian cyber warfare activities in Eastern Europe since these are often Russia's testing grounds for launching large-scale efforts in other countries like the U.S. (MacLellan, Stephanie, n.d.). Furthermore, a current hotbed is the Russian speaking city of Narva at the border between Russia and Estonia. Putin may try to occupy Narva, much like Crimea (*"Narva Scenario": NATO Fears Conflict With Russia in Estonia—The Atlantic*, n.d.).

As a member of NATO, the US will have to come to Estonia's defense should such a scenario pan out. With mounting Russian influence in Western Democratic institutions, protecting Eastern Europe, especially sensitive regions like Narva, will be crucial to maintaining the world's trust in the United States and the institutions it leads.

Germany

By Travis Hayes

Introduction

Germany is an AI superpower with a high level of AI development, based on its robust AI research and development landscape and high levels of artificial intelligence applications. Germany's AI landscape is primarily focused on the automotive, healthcare, industrial, life sciences, and manufacturing sectors. Germany has high engagement with AI ethics, as demonstrated by the presence of data privacy regulations and AI ethics reports. Germany acts as an AI potential ally to the U.S due to Germany's robust, high-tech economy and long history as an ally. Table 4 summarizes findings on Germany's AI readiness, research and development, products and application, and ethics.

Table 4: Summary Findings, Germany

Government AI Readiness	
Level AI Development	High
Oxford Insights AI Readiness Score	8.810
Presence of Strategy Documents	Yes
Presence of Dedicated ICT Department	Yes; spread across multiple federal ministries
Research and Development	
Amount of Investment	High
Density of Collaborations	High
Products and Applications	
Government Orientations	N/A; decision deferred to industry
Industry Orientations	Automotive, healthcare, industrial, life sciences, manufacturing
Ethics	
Level of Government AI Ethics Involvement	High
User Data Privacy Laws	Yes
AI Ethics Reports	Yes

Background

Germany is a federal parliamentary republic with a population of almost 83 million people as of 2018 and an electrification rate of 100%. Germany earned a score of 8.810 on the Oxford AI Readiness Index. Economically, Germany is in a very good position to advance its AI interests and goals. Germany is the largest economy in Europe and the fourth largest in the world with a GDP of $3.948 trillion (World Bank, n.d.). Currently, Germany is one of the top ten most research-intensive economies in the world with 650,000 people employed in R&D and is the leading European nation in absolute R&D expenditure (Federal Ministry of Education and Research, 2018, p. 9).

Government Policy

Germany's ultimate goal, as laid out by its *Artificial Intelligence Strategy*, is to transition both Germany and Europe into leading centers of AI research and applications, thus keeping the continent economically competitive in a future with increasingly advanced AI. With that being said, the other major goal is the responsible and ethical development of AI along with its integration into society based on being beneficial to all. The European Union (EU), of which Germany is a member, has also released its own AI policy and framework. Germany has not indicated any strong desires for military and defense-related AI development while also expressing its support of outlawing autonomous weapon systems worldwide, even though they haven't joined any international efforts to do so (Werkhäuser, 2019).

Position on Domestic AI

Up until 2018, Germany had no clear national roadmap for AI. After Chancellor Angela Merkel had returned from the high-tech city of Shenzhen, China in May 2018, she urgently assembled a team of 32 AI experts to construct the beginnings of Germany's AI strategy (Deckler, 2018, July 23).

By November 2018, the Federal Government of Germany firmly established itself as a major contender in the field of AI development by releasing the *Nationale Strategie für Künstliche Intelligenz*, or *Artificial Intelligence Strategy*, developed in a partnership between the Federal Ministry of Education and Research, the Federal Ministry for Economic Affairs and Energy, and the Federal Ministry of Labour and Social Affairs. The *Strategy* establishes a holistic framework for the future development and application of AI in Germany. Particularly, the German government plans on investing 3 billion euros on the implantation of the AI strategy between 2018-2025, spending 3.5% of GDP on general scientific research and development by 2025, and creating 100 new AI professorships at German universities (Federal Ministry of Education and Research et al., 2018, p. 6-7) Three main goals are specified in section one of the report: (1) develop Germany and Europe into an leading center of AI thus protecting its competitiveness in the future, (2) create AI in a responsible manner that serves "the good of society", and (3) consider and solve ethical, legal, and cultural questions that arise from the implementation of AI into society through dialogues and active political measures (Federal Ministry of Education and Research et al., 2018, p. 12).

Section two of the report gives an assessment of the current state of AI development in Germany. In the view of the federal ministries that authored the *Strategy* (2018), Germany is in an extremely strong position to utilize AI technologies due to its efficient research community, diverse economy, and high-tech key industries (p. 10). The major challenges faced by Germany include successfully transferring AI technologies from research labs to the real world and obtaining necessary components to AI development, including talent, data, and investment (Federal Ministry of Education and Research et al., 2018, p. 10). Section three lists out 12 "fields of action" that will lead to the successful and ethical implementation of the strategy across the economy, public, and government. Various possible applications of AI in certain areas such as the environmental, ICT security, industrial, financial, and healthcare sector are also discussed in this section.

Position on International AI

On the international level, Germany is a member of various international organizations such as the EU, which has commissioned its own series of AI development reports.

The European Commission, which is the executive branch of the EU, created the independent High-Level Expert Group on AI in June 2018 and was given the task of examining the landscape of AI development in Europe and creating AI policy recommendations for the EU. Two reports were required to be generated by the Expert Group, the first being the *Ethics Guidelines for Trustworthy AI* and the second being the *Policy and Investment Recommendations for Trustworthy AI* (High-Level Expert Group on AI, 2019).

Within the *Policy and Investment Recommendations for Trustworthy AI*, the High-Level Expert Group on AI (2019) constructed 33 recommendations to guide the sustainability, growth, and competitiveness of "Trustworthy AI," referring to AI systems that not only make Europe competitive but that also protect and benefit people (p. 6). It is stressed by the High-Level Expert Group on AI that the highest priority in developing AI technologies is maximizing benefits for individuals and the society at large while also minimizing the economic, social, political, and other risks that could be present in a future with AI (p. 7).

Europe's biggest weaknesses regarding the development of AI, according to the report, is first and foremost the lack of AI skills, both technical and managerial, and the lack of investment and funding for AI research. The Group recommends, among other suggestions, the European Commission to heavily focus on creating new opportunities in higher education to attract and retain individuals with AI-related skills along with boldly increasing both public and private AI funding to 20 billion euros a year over the next decade (High-Level Group on AI, 2019, p. 44). The future goal for AI in Europe is to create a "Single European Market for AI" which involves the collaboration of all European nations to remove barriers for trading AI goods and services within the EU and to keep Europe as a whole competitive in the worldwide AI market (High-Level Group on AI, 2019, p. 48).

Germany is ambiguous on the subject of an international ban on fully autonomous AI weaponry. Germany and France have been reluctant to join the cause to ban L.A.W.S. as they claim that the Chinese, Russian, and U.S. position is too strong on the issue and that they cannot ban something that does not exist since no autonomous lethal weapons systems are known to be fully battle-field ready yet (Deckler, 2018). The German coalition government, however, has released a statement saying that they "reject autonomous weapon systems that are beyond man's control [and] we want to outlaw them worldwide" (Werkhäuser, 2019). However, there has been little effort by the government to do so. Interestingly, they did not mention their own autonomous weapon system, the Franco-German Future Combat Aerial System (Werkhäuser, 2019).

Research and Development

Germany's AI R&D ecosystem, following on its tradition of being a center for groundbreaking scientific research, is very strong and expansive. AI research from collaborations, industry, academia, and international cooperation pushes Germany to the forefront of AI development and deployment. The potential of AI technology is clearly understood in Germany, as almost every major economic sector is partaking in these research efforts.

Collaborations

Within the Germany *Artificial Intelligence Strategy*, the government establishes that AI R&D will be conducted on a broad-based and decentralized platform (Federal Ministry of Education and Research et al., 2018, p. 13), meaning that the government will usually contribute financially to a project rather than lead it themselves. Collaborative AI research, therefore, tends to be conducted and led together by academia, the private sector, and the scientific community with the government only providing financial backing. These collaborations arguably form the strongest sector of AI R&D within Germany.

As the biggest AI research center in not only Germany but also the world, the German Research Center for Artificial Intelligence has five offices across Germany, approximately 640 researchers and administrators, 440 graduate students from more than 65 countries, 250 AI research projects, and a 2018 budget of 44.8 million euros (German Research Center for Artificial Intelligence, 2020). Through twenty research departments and groups, eight "competence centers," and eight "living labs," the Center covers a vast array of research topics including autonomous systems, machine and deep learning, robotics, and virtual and augmented reality. Research projects are conducted on a collaboration basis between students from three German universities and private companies. However, the German Research Center for Artificial Intelligence is a non-profit public-private partnership that receives funding from the German federal government, various state governments, the EU, and many national and international companies. Some of the private shareholders involved include Airbus, BMW, Daimler, Google, Microsoft, SAP, and Volkswagen (German Research Center for Artificial Intelligence, 2020).

Another similar German research consortium that is dedicated to creating new AI companies in Germany is Cyber Valley, which was established in 2016. Cyber Valley is an AI research ecosystem compromised of the University of Stuttgart, the University of Tübingen, the Max Planck Institute for Intelligent Systems, businesses, and members of the scientific community. 9 research groups within Cyber Valley cover topics such as machine learning, robotics, and computer vision. The regional government of Baden-Württemberg is the primary financer of the group along with 10 other core partners, including companies such as Amazon, BMW AG, and Porsche AG (Cyber Valley, n.d.). From 2018-2022, the company partners of Cyber Valley will provide 7.5 million euros to research groups and the two universities (Cyber Valley, n.d.).

In terms of collaborations without significant relations to the German government, there is the Initiative for Applied Artificial Intelligence, otherwise known as appliedAI. The group is a major collaboration between companies and industries to strengthen German AI start-ups by helping to identify customers, access data, recruit talent, and find proper hardware channels (appliedAI, n.d., Startup Landscape 2019). Many large companies are partnered with appliedAI including Google, Nvidia, Cisco, IBM, Dell, Allianz, BMW, Siemens, and T-Mobile (appliedAI, n.d., About us).

Industry

Germany, with one of the strongest economies in the world, is home to many of the world's largest companies in various industries including the automotive, chemical, electronic, energy, financial, industrial, and telecommunication industry (Global Database, 2019). Almost all of the largest German companies across these various sectors have their own active AI

research projects, which perhaps reflects just how revolutionary many think AI technology will be.

Much of Germany's economic prosperity is based on its domestic car companies that have worldwide recognition for producing the highest quality and high-tech vehicles, so it comes as no surprise that these companies are investing in their own autonomous vehicle projects. The three largest car manufacturers are also respectively the first, second, and fourth largest companies in Germany: Volkswagen AG (VW), BMW AG, and Daimler AG (Global Database, 2019).

In June 2019, as reported by Hawkins (2019), VW announced an investment of $2.6 billion in Argo AI, a Pittsburgh-based autonomous driving software start-up that in 2017 received $1 billion from Ford. By October 2019, VW had announced that they were also starting their own self-driving vehicle start-up called Volkswagen Autonomy which would focus on self-driving taxis and cargo vans (Hawkins, 2019). The vehicles would be Level 4 autonomous vehicles, meaning that they "require no human interaction but only in a defined setting" (Hawkins, 2019).

Perhaps in a move to take on VW's AI ambitions, BMW and Daimler joined forces in April 2019 to begin a long-term, non-exclusive cooperative project for self-driving vehicles. The stated goal of the project is to (1) develop AI technology for driver assistance systems, automated driving on highways, and automated parking up to Level 4 autonomy and (2) implement the technology in the respective company's vehicle series by 2024. 1,200 AI and autonomous driving specialists from both companies will work in three separate facilities across Germany to "developing a scalable architecture for driver assistance systems, including sensors, as well as a joint data centre for data storage, administration and processing, and the development of functions and software" (BMW Group, 2019).

Outside the realm of autonomous driving, the Bosch Group, an engineering and electronic products manufacturer, has its own Bosch Center for Artificial Intelligence. The Bosch Center for Artificial Intelligence was started in 2017 and focuses on six AI research fields: (1) AI-based dynamics modeling, (2) deep learning, (3) large scale AI and deep learning, (4) environment understanding and decision modeling, (5) reinforcement learning, and (6) dynamic multi-agent planning (Bosch Center for Artificial Intelligence, n.d.). On October 29th, 2019, the center hosted AI CON 2019, a conference with over 300 AI experts from business and industry that focused on the topic of "Industrial AI" (Bosch Center for Artificial Intelligence, n.d.).

In the pharmaceutical sector, Bayer AG is a life sciences company focusing on pharmaceuticals, consumer health, and crop science. On January 9th, 2020, Bayer and UK-based AI drug discovery company Exscientia entered a three-year collaborative partnership with the aim of "combining Exscientia's proprietary AI drug discovery platform and drug design know-how with Bayer's data and drug discovery capabilities" to identify potential new drugs to treat cardiovascular and oncological diseases (Bayer AG, 2020).

Academia

Several German universities and research institutions, considered some of the finest in the world (Times Higher Education, 2019), have focused their AI R&D efforts particularly on the fields of computer vision, machine learning, and robotics.

For example, the Max Planck Institute for Intelligent Systems, with two campuses located in Tübingen and Stuttgart, has a goal of investigating and understanding the principles of intelligent systems with its "theory, software, and hardware expertise in the research field of intelligent systems" (Max Planck Institute for Intelligent Systems, n.d.). Its Tübingen campus is

dedicated to theory, algorithms, and human-scale systems covering topics such as machine learning, computer vision, robotics, and the theory of intelligence. Meanwhile, the Stuttgart campus focuses on small-scale robotics, self-organization, haptic perception, bio-inspired systems, medical robotics, and physical intelligence.

In Berlin, the Technical University of Berlin (TU Berlin) has a Berlin Center for Machine Learning that conducts research relating to machine learning in the application areas of biomedicine, digital humanities, and communication (Berlin Center for Machine Learning, n.d.). On August 14, 2019, the major German chemical production company BASF SE and TU Berlin announced a signed-agreement to establish the cooperative Berlin Joint Lab for Machine Learning that will "develop workable new mathematical models and algorithms for fundamental questions relating to chemistry" (BASF SE, 2019).

Country-to-country

Perhaps due to Germany only recently releasing its *Artificial Intelligence Strategy* in November 2018, a joint AI research center with other nations has yet to be established. However, the German government has shown a willingness to work with other nations on AI.

On January 22nd, 2019, the Aachen Treaty was signed by Germany and France to foster closer relations and cooperation between the countries in several areas, including in the development of AI. However, due to the recent nature of the treaty, there are currently no Franco-German research sites for AI development. By October 2020, the current roadmap plans to have both governments form a more thorough framework for how they will both cooperate on AI research (Federal Ministry for Economic Affairs and Energy, 2019, *Roadmap*).

Furthermore, shortly after the release of the German *Artificial Intelligence Strategy* in November 2018, the German Centre for Research and Innovation Tokyo held the first Japanese-German-French DWIH Symposium on Artificial Intelligence. The report noted the agreement by officials from all three countries on creating a "human-centric" AI ecosystem and, most importantly, establishing collaborative AI institutions between the three countries (German Centre for Research and Innovation Tokyo, 2018, p.5). As with the Aachen Treaty, there has yet to be an established research center cooperation between France, Germany, and Japan.

Quite surprisingly, the one current project that Germany does have with other nations is in the defense sector with the Future Combat Air System, which is a joint fighter jet project between the governments of France, Germany, and Spain. The Future Combat Air System will be made up of a main stealth fighter jet, an accompanying autonomous drone that flies with the jet, and an air combat cloud network that controls data communications between the two planes and military command centers (Le Journal De L'Aviation, 2020; Irish & Olive, 2020).

Products and Applications

German companies and collaborations have created and deployed various AI applications and products, despite Germany's recent entrance into the AI development race. A wide range of industries have AI applications including the energy, healthcare, industrial, retail, manufacturing, and telecommunications sectors.

Collaborations

Although not as numerous, products and applications that were created as a result of collaborative efforts in Germany are still quite significant and revolutionary.

Microsoft News Centre Europe reported in 2019 that in collaboration with Microsoft, Thyssenkrupp Materials Services, the largest materials distributor and service provider in the western world, implemented the "alfred" AI solution in their logistics network. Powered by Microsoft Azure Machine Learning, alfred analyzes and processes more than two million orders a year from Thyssenkrupp Materials Services' 250,000 worldwide customers (Microsoft News Centre Europe, 2019). Axel Berger, head of digital transformation at Thyssenkrupp Materials Services, claims that alfred can perform many different tasks including calculating the most efficient shipping routes, optimizing stock levels, setting perfect price points, predicting when a machine will break, and determining which customers are profitable or not (Microsoft News Centre Europe, 2019).

In the aerospace sector, the German Aerospace Center (2019) reported on July 2, 2018 that it sent its robotic AI astronaut assistant Crew Interactive Mobile Companion, or CIMON, to the International Space Station. CIMON possesses several cameras, audio receivers, and a microphone so it can see, hear, speak, and understand. It can also perform a plethora of tasks such as documenting experiments, searching for objects, taking inventory, reading and explaining instructions aloud, communicating with astronauts, and moving autonomously. However, CIMON is not yet able to self-train. The robot was built by Airbus, the AI software is a version of IBM's Watson, and the scientific features of the assistance system were developed by the Ludwig-Maximilians University Hospital (German Aerospace Center, 2019).

Industry

Private German enterprises have developed and are currently using or selling an extensive amount of AI applications and products around the world.

Germany's shining star in the AI start-up sector is the Berlin-based Twenty Billion Neurons GmbH, commonly referred to as TwentyBN, which was founded in 2015 and has received significant financial funding from M12, Microsoft's venture capital fund (CB Insights, 2019; Wiggers, 2018). TwentyBN's main product is Millie, the world's first life-sized AI avatar that can fully interact with users and is mostly used in retail and fitness (TwentyBN, n.d.). TwentyBN also offers: 20BN Hyper Model, a neural network software for recognizing gestures and actions; Crowd-Acting Platform, a "globally distributed AI film studio" that collects and annotates data in video clips; and Software SDK, a Python- and C- based software that can adjust TwentyBN's neural networks for specific uses (TwentyBN, n.d.).

Deutsche Telekom, the largest telecommunications provider by revenue in Europe which owns T-Mobile and various other subsidiaries around the world, also has developed and uses their own AI virtual assistants along with AI applications (Deutsch Telekom, 2017). Three AI virtual assistants are currently used by Deutsche Telekom in Austria, Germany, and Hungary respectively: Tinka, Sophie, and Vanda. In terms of other AI applications, Deutsche Telekom also owns Hub:raum, a recruiting chatbot that uses a digital assistant called hub:bot to communicate with applicants, and Mobile Protect Pro, an AI-powered cybersecurity program used on Telekom employee's devices (Deutsch Telekom, 2017).

In the category of autonomous driving features, Mays (2019) contends that many cars from VW, BWM, and Daimler already possess low-level autonomy features, such as automatic braking, collision avoidance, cruise control assistance, lane-centering, and low-speed hands-free driving. VW, along with its subsidiaries Audi and Porsche, offers 29 vehicles altogether that have at least one of these autonomy features. BMW in combination with one of its subsidiaries,

Mini, currently has 18 vehicles featuring low-level autonomous capabilities. Finally, Daimler-owned Mercedes Benz has low-level autonomy in 16 of its vehicles (Mays, 2019).

Some of the largest industrial and manufacturing companies in Germany also have their own developed AI products and systems. Siemens AG, the largest industrial production company in Europe, sells a neural processing unit called the SIMATIC S7-1500 TM NPU module which can autonomously learn from, control, monitor, adjust, and understand factories, warehouses, and industrial plants (Siemens, n.d.). The module is part of Siemen's Totally Integrated Automation, a series of hardware and software, including their IoT operating system MindSphere, that enables AI-based automation across a whole facility (Siemens, n.d.). Similarly, the Bosch Group has hundreds of their manufacturing plants that are automated and monitored with their own AI-enabled technology and their supply-chains are increasingly controlled by AI.

Ethics

Perhaps due to the authoritarian experience of the Nazi government during WWII and the GDR in East Germany during the Cold War, Germany today has some of the strongest and most robust personal and data privacy protection laws in the world (Scott, 2017). This dedication to personal privacy and freedom has also been extended to the development of AI as the German government has thoroughly examined the ethical implications of AI through its Data Ethics Commission. The EU has also taken significant steps to address data protection and AI ethics questions.

When developing AI systems, one of the biggest ethical questions is where the data being used to train the systems is being sourced from since the quantity and quality of the data directly affects how the system will learn and operate. Researchers use a variety of sources to gather data for AI training purposes including public government data, open-source scientific databases, the internet, AI robotic systems themselves, and industry partners. Acquisition of this data for research purposes has to adhere strictly to EU and German law regarding data privacy (J. Küchens, personal communication, January 24, 2020; F. Meyers, personal communication, January 27, 2020).

To protect individual citizens' data and regulate how it can be used by companies and in research, both the EU and Germany have implemented very robust data privacy laws. Deemed as the world's strongest and most modern data privacy law, the EU's General Data Protection Regulation (GDPR) went into effect on May 25, 2018, intending to modernize and harmonize European data protection laws, strictly regulating how businesses and other organizations can use citizens' data, and giving more rights and protection to individuals and their data (Burgess, 2019; Official Journal of the European Union, 2016). To further complement the GDPR, the German government also implemented the German Privacy Act, which further regulates how public and private actors handle data in Germany (Hilberg, n.d.). On the topic of AI ethics, the High-Level Expert Group on Artificial Intelligence, as instructed by the EU and European Commission, released on April 8, 2019, a report titled *Ethics Guidelines for Trustworthy AI* (High-Level Expert Group on Artificial Intelligence, 2019, *Guidelines*). As part of Germany's push for AI development in 2018, a Data Ethics Commission was created with the task of also establishing ethical guidelines for AI and algorithm development in Germany. In October 2019, the Commission released its finished report *Opinion of the Data Ethics Commission* (Data Ethics Commission, 2019).

For nations that in the early stages of AI development or nations that have advanced AI development but no history of AI ethical considerations, Germany and the EU, in general, should serve as an exemplification of robust data privacy laws and AI ethics frameworks.

Recommendations for the U.S.

Germany has a considerable capacity to be an AI ally of the United States due to its government AI policy, outstanding research institutions, high-tech sectors, and close economic ties. Most importantly, the U.S. government and private sector should foster closer collaborative ties with their German counterparts on AI R&D, greatly benefitting both countries in terms of increased research resources and more extensive AI breakthrough in a shorter amount of time.

The U.S. should also consider using Germany and the EU's robust data privacy laws and AI ethics reports as a guide to creating similar laws and reports in the United States. This would better equip the U.S. to handle eventual AI ethical problems in the future and make it easier to collaborate with European partners on AI research.

Lastly, the U.S. government should work with the German government to determine how best to contain potential AI threats in Europe and around the world such as Russia, China, and Iran. Through a shared understanding, Germany could ensure the security of the European region while also countering the influence of AI threats within it, thus protecting U.S. interests domestically and abroad.

India

By Gabriela Diaz-Valdes

Introduction

India is a developing regional AI power with a medium level of AI development, based on its limited R&D landscape and medium levels of artificial intelligence applications. India's AI landscape is primarily focused on the agriculture, healthcare, and education sectors. The Indian government has medium-level engagement with AI ethics, gauged by as demonstrated by a lack of user data privacy laws along with the presence of government conversation around AI ethics. India acts as a potential AI ally to the U.S. due to its positive history of collaborations with the U.S. and its potential to develop new AI capabilities. Table 5 summarizes findings on India's AI readiness, R&D, products and applications, and ethics.

Table 5: Summary Findings, India

Government AI Readiness	
Level AI Development	Medium
Oxford Insights AI Readiness Score	7.515
Presence of Strategy Documents	Yes
Presence of Dedicated ICT Department	Yes
Research and Development	
Amount of Investment	Medium
Density of Collaborations	High
Products and Applications	
Government Orientations	Healthcare, education, infrastructure
Industry Orientations	Healthcare, education, agriculture
Ethics	
Level of Government AI Ethics Involvement	Medium
User Data Privacy Laws	No
AI Ethics Reports	Yes

Background

India is a parliamentary democratic republic with a population of 1,326,555,000 people and an electrification rate of 92.6% (*Access to electricity (% of population)*, 2017; *Europa World*, 2020). India earned a score of 7.515 on the Oxford AI Readiness Index (2019). India's investment in AI has increased in recent years, as it has identified sectors that can utilize AI-powered solutions and worked to implement AI technologies in those sectors (NITI Aayog, 2018, p. 18).

Government Policy

The Indian government is primarily focused on leveraging AI technology to promote inclusive growth as well as economic and social development. In 2018, the NITI Aayog, the policy think tank of the Government of India, released the National Strategy for Artificial Intelligence report, which includes a variety of recommendations and initiatives that the

Government of India is working towards in order to advance its artificial intelligence (NITI Aayog, 2018). With this comprehensive framework, the Indian government aspires to strengthen its AI capabilities and help create AI solutions for challenges that many emerging and developing economies face (NITI Aayog, 2018, p. 18).

Position on Domestic AI

India has recognized that its position in AI R&D is lacking (NITI Aayog, 2018, p. 53). Therefore, the Detailed Project Report of Inter-Ministerial National Mission on Interdisciplinary Cyber Physical Systems has suggested a framework for promoting artificial intelligence research that will help drive India towards global leadership (NITI Aayog, 2018, p.54). It suggests four structures that should be established to promote research. First, the International Centres of New Knowledge will focus on basic AI research (NITI Aayog, 2018, p.54). Second, the Centre for Research on Sub-Systems will focus on the development and integration of core AI technologies researched at the International Centres of New Knowledge (NITI Aayog, 2018, p.54). Third, the Centre for Advanced Studies, Translational Research, and Leadership will focus on the deployment of these new technologies (NITI Aayog, 2018, p.54). Finally, the Centre of Excellence in Technology Innovation and Transfer will focus on the commercialization of these developed AI technologies (NITI Aayog, 2018, p.54).

The Government of India also proposed a simplified, two-tiered integrated approach to boost both core and applied research in AI. It plans to create both Centres of Research Excellence in Artificial Intelligence and International Centres for Transformational Artificial Intelligence (NITI Aayog, 2018, p.54). The focus of the Centres of Research Excellence in Artificial Intelligence will be to research new areas of AI. They will act as the technology feeders for International Centers for Transformational Artificial Intelligence, and as mentors for other institutes researching AI (NITI Aayog, 2018, p.54). The International Centers for Transformational Artificial Intelligence will be institutions that are primarily focused on creating AI-based applications that are focused on societal development (NITI Aayog, 2018, p.54).

Position on International AI

In regard to autonomous AI weaponry, India supports the use of AI-enhanced defense platforms (Wiggers, 2018). The government has created a task force that is working on an AI roadmap for India's armed forces, which will recommend ways machine learning can be incorporated into the country's aviation, naval, land, cybersecurity, nuclear, and biological resources, specifically related to autonomous weapons systems (Wiggers, 2018).

Research and Development

India seeks to improve many sectors by using artificial intelligence, such as education, healthcare, agriculture, and manufacturing. The vast majority of its research and development projects are focused on creating solutions for these sectors.

Collaborations

With interest in AI growing in India, the government has begun focusing its research and development in healthcare, education, and infrastructure. One of the biggest challenges that India has been trying to overcome through AI is the school dropout rate. The Andhra Pradesh government and Microsoft have partnered to solve this problem (NITI Aayog, 2018, p. 38). They

are in the process of creating an application, powered by Azure Machine Learning, to process students' data to detect patterns that could predict which students are most likely to drop out of school (NITI Aayog, 2018, p. 38). In a preliminary test, the application predicted there would be around 19,500 probable dropouts from government schools in the Visakhapatnam district for the 2018-2019 academic year (NITI Aayog, 2018, p. 38). With these insights, educational officials can focus on helping students that are predicted to drop out.

The Government of India has also been focusing large AI efforts on the healthcare sector. In 2018, the Health and Wellness Centres created through the Ayushman Bharat programme, one of the world's largest government-funded healthcare programs, shifted primary healthcare from selective (only covering reproductive and child health and a few infectious diseases) to comprehensive (NITI Aayog, 2018, p. 26). Today, by using a combination of AI with cloud computing platforms, the Health and Wellness Centres are researching ways they can screen for non-communicable diseases, which account for 60% of India's mortality (Mahapatra, 2019).

The Indian government has focused a lot on its strategic AI plan to address healthcare, but it is also expanding its R&D in the healthcare sector by collaborating with outside industries. Niti Aayog, Microsoft, and Forus Health are working together on a pilot project to create AI technology for early detection of diabetic retinopathy (NITI Aayog, 2018). Their plan is to integrate Microsoft's retinal imaging application program to interface with 3Nethra, a portable device that screens for common eye problems. This combination would allow operators of 3Nethra devices to receive AI-powered insights when they are working in areas with limited connectivity to the cloud (NITI Aayog, 2018, p. 29). AI-based programs such as this one bring the Indian government and industry together to create new technologies that will help improve India's healthcare and focus on preventive techniques.

India has experienced a surge in urbanization over time. To help with the congestion, pollution, high crime rates, poor living standards, and other unplanned challenges that urbanization presents, the Government of India wants to set up smart cities (NITI Aayog, 2018). The Smart Cities Initiative aims to develop urban ecosystems that improve institutional, physical, social and economic infrastructures by embedding technology and AI into them (*What is Smart City*, 2017). With the large amount of data that can be collected through smart cities, the Indian government is trying to leverage AI applications in various sectors (NITI Aayog, 2018, p. 40). For example, smart cities will use AI to leverage data on service delivery, which could help solve issues of low accountability and transparency in the service delivery industry, ultimately improving administration processes in offices and reducing long wait times (NITI Aayog, 2018, p. 39). In addition, smart cities will be able to reduce crime rates by improving city design and surveillance analytics (NITI Aayog, 2018, p. 39). With surveillance systems, the government will be able to monitor people's movement and potential criminal incidents, and ensure the general security of residents (NITI Aayog, 2018, p. 40).

Industry

One of the struggles that India faces is that few of its industries contribute to AI research. Large Indian IT companies such as TCS, Wipro and Infosys have created cutting-edge technologies, but their contributions to the field of AI have been lacking (NITI Aayog, 2018, p. 15). From 2001 to 2016, only 14% of AI research publications came from the industry (NITI Aayog, 2018, p. 51).

However, there are several start-ups that are participating in AI research, especially around the development of autonomous vehicles. For example, HCL Technologies, an Indian

multinational information technology service and consulting company, is testing applications of AI in transportation. It is attempting to develop AI for use in vehicle-to-vehicle communication through an ad-hoc network, monitor drivers with cameras and sensors via AI algorithms, and recognize traffic jams to improve traffic management (Umapathy, 2018).

Google has greatly invested in India's AI landscape, especially through its research on AI for Social Good. In September 2019, Google announced that it would start an AI lab in Bangalore focused on advancing AI research and applying it to solve challenges in the healthcare, agriculture, and education sectors (Yagnik, 2019). As a result, Google Research India announced the start of six AI projects in February 2020, led by teams of researchers from universities and nonprofits (*Mahalakshmi*, 2020). These projects will receive funding and resources from Google and will address environmental, social, and humanitarian issues through deep learning and natural language processing (*Google funds six AI-based research projects in India*, 2020).

Academia

India's academic institutions are among the strongest contributors to India's overall AI landscape. From 2001 to 2016, the top 15 academic institutions in India contributed to 42% of all research publications in the country (NITI Aayog, 2018, p. 51). The Indian Institute of Science's Artificial Intelligence Group engages in cutting edge research in artificial intelligence, machine learning, and data science (*AI @ IISc*, 2020). In addition, another group at the same institution is working on the theory and application of reinforcement learning, an aspect of machine learning used to solve optimization problems (NITI Aayog, 2018, p. 53). This group is investigating traffic handling on both roads and India's wireless networks (NITI Aayog, 2018, p. 53).

The Indian Institute of Technology Bombay and the Indian Institute of Technology Patna have partnered with industry to focus on the application of AI in IT services and social goods, providing AI insights and recommendations for improved productivity (NITI Aayog, 2018, p. 53). This research includes software analytics to build, test, manage, and modernize developing AI projects, all of which can be applied to help solve social issues such as malnutrition, human trafficking, and climate change through AI prediction and recommendation models (NITI Aayog, 2018, p. 53).

Country-to-country

India has partnered with a few countries on research and development in AI. For example, in February 2018, the Engineering Export Promotion Council of India and the Tools and Gauge Manufacturers' Association of India signed a memorandum of understanding with the Canadian Association of Mold Makers and the Windsor Essex Economic Development Corporation to collaborate in AI, IoT, robotics, and automation (Sarmah, 2019). In addition, the Chinese government and India's National Association for Software and Services Companies signed an initiative to increase cooperation between Indian software companies and Chinese firms (Sarmah, 2019). They have launched the Sino Indian Digital Collaborative Opportunities Plaza Platform, an AI-powered platform that links Indian and Chinese firms for AI, Internet of Things, and Big Data projects (Krishnan, 2018). They are currently piloting a project for Bengaluru-based Sasken Technologies on predictive data analysis for autonomous car testing (Krishnan, 2018). India's research and development in AI is augmented through its partnerships with other nations.

Products and Applications

Through collaboration and R&D, India has been able to deploy several products and applications that have contributed to its growth as a country. Many sectors including agriculture, healthcare and education have improved because of AI applications and products.

Collaborations

One of the main sectors that India has focused on is agriculture. The NITI Aayog has partnered with IBM to develop a crop yield prediction model, using AI to provide real time advisories (NITI Aayog, 2018, p. 34). This AI model uses data from remote sensing, soil health cards, IMD's weather prediction, and soil moisture and temperature levels to improve crop productivity, soil yield, control agricultural inputs (NITI Aayog, 2018, p. 34). The model also helps to identify early warnings of pest and disease outbreaks. Through this AI model, farmers can get accurate predictions to inform important agricultural decisions. This project has been implemented in 10 districts across the states of Assam, Bihar, Jharkhand, Madya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh (NITI Aayog, 2018, p. 34).

In 2009, the Government of India created Aadhaar, a 12-digit unique identity number that is issued to all Indian residents (Jain, 2019). The Unique Identification Authority of India created Aadhar as a tool for standardizing the process of data collection and simplifying the dispersal of money from government programs to the citizens of the country, especially the poor (Jain, 2019). In order to obtain an Aadhaar Card, a collection of citizens' fingerprints, retina scans, and photos must be obtained (Jain, 2019). Therefore, the Government of India has access to biometric data of nearly all of its citizens; in the future the government will most likely push for AI programs that scan people's activities and patterns (Jain, 2019).

Industry

Microsoft and the International Crops Research Institute for the Semi-Arid Tropics have helped tremendously in the agriculture sector of India. They have developed an AI Sowing app that is powered by the Microsoft Cortana Intelligence Suite, which includes Machine Learning and Power BI, a business analytics service by Microsoft (NITI Aayog, 2018, p. 33). This application sends sowing advisories to participating farmers on the optimal date to sow, allowing farmers to avoid installing sensors in their fields and incurring the associated capital expenditures (NITI Aayog, 2018, p. 33). The advisories would include not only the optimal sowing date and sowing depth, but also optimal times for fertilizer application, farmyard manure application, and seed treatment (NITI Aayog, 2018, p. 33). In 2017, the program expanded to more than 3,000 farmers across the states of Andhra Pradesh and Karnataka during the Kharif crop cycle, or the rainy season (NITI Aayog, 2018, p. 34). This application has shown an increase in yield range from 10% to 30% (NITI Aayog, 2018, p. 34).

In addition to the tools developed from government collaborations, India is also using industry tools to improve the education system with AI. The WriteToLearn software by Pearson uses natural language processing technology to give students personalized feedback, hints, and tips to improve their writing skills (NITI Aayog, 2018, p. 38). This program allows for improvements in general areas such as organization, idea development, and style (NITI Aayog, 2018, p. 38). It also alleviates the pressure and workload on teachers, allowing them to focus on giving students more customized opportunities to receive feedback on their writing.

Many startups in India have already begun providing AI solutions to businesses. For example, SoluLab, a leading mobile, web, and blockchain development company, uses AI technologies to replicate human thinking and improve business productivity by automating simple tasks (*Artificial Intelligence Development Company*, n.d.). The startup also uses deep learning to create data insights, predictive analysis to help inform decision making, and AI algorithms for intelligent customer service chatbots (*Artificial Intelligence Development Company*, n.d.).

Ethics

With any project in AI comes problems of undermining ethical conduct, impinging on privacy, and undermining security protocol. In 2017, the Indian Supreme Court ruled that the Indian constitution guarantees a right to privacy (Privacy International, 2019). However, India has neither a data protection act, nor a data protection agency (Privacy International, 2019). In the strategy report released by Niti Aayog in 2018, the think tank summarized how it plans to attack ethics, privacy, and security in artificial intelligence (NITI Aayog, 2018). It provides suggestions for how privacy issues should be dealt with in the future (Privacy International, 2019). For example, establishing a data protection framework with legal backing will hold companies and the government more accountable (NITI Aayog, 2018, p. 87). In addition, it wants to establish a sectoral regulatory framework rather than having a central privacy protection law (NITI Aayog, 2018, p. 87). These are only a few approaches on how India plans to deal with privacy and AI.

Niti Aayog's plan to address issues in AI ethics is to identify biases built into AI algorithms and assess their impact, ultimately going back to the source to reduce this bias (NITI Aayog, 2018, p. 85). Additionally, it recognizes that many AI solutions suffer from what is known as the "Black Box Phenomenon" (NITI Aayog, 2018, p. 85). This is when there is little or no understanding of what happens in between the input data and the end results (NITI Aayog, 2018, p. 85). The field of Explainability aims to combat the "Black Box Phenomenon," trying to understand how algorithms can begin to explain how they make decisions (Bloomberg, 2018). Algorithm bias may be particularly difficult to detect in cases where developers don't know how AI reached a particular conclusion. India recognizes that more collaborative research needs to be done in this area in order to have a better understanding of how to combat the "Black Box Phenomenon" and address the problem of bias (NITI Aayog, 2018, p. 86). As of now, there is no protection or agency dealing with privacy, ethics, and AI in India. However, through these efforts, India is beginning to participate in conversations around moving towards more responsible and inclusive AI.

Recommendations for the U.S.

Overall, India is a potential collaborative ally to the United States in the field of AI. While India is much further behind the U.S. in terms of AI investment, its AI capabilities are continually expanding. NITI Aayog recognizes that India's AI capabilities are much weaker than many other countries, as it states, "Despite its sectoral leadership and programming talent, India's IT industry…has yet to build pioneering AI / ML capabilities commensurate with its potential" (NITI Aayog, 2018, p. 72). With the Indian government pushing for more AI initiatives, the U.S. government should begin investing in these Indian initiatives to help develop new AI and data-science related start-ups abroad.

Iran

By Cassie Kays

Introduction

Iran is a developing AI power, with a low level of AI development, based on its limited accessible documentation in its AI research and development landscape and medium levels of artificial intelligence applications. Iran's AI landscape is primarily focused on medical, environmental, and military development. The Iranian government has low engagement with AI ethics, as demonstrated by its lack of data privacy regulations and high levels of citizen surveillance. Iran acts as a political and AI potential risk to the U.S. due to its historical tensions with the U.S. over nuclear and cyber issues. Table 6 summarizes findings on Iran's AI readiness, research and development, products and application, and ethics.

Table 6: Summary Findings, Iran

Government AI Readiness	
Level AI Development	Low
Oxford Insights AI Readiness Score	5.049
Presence of Strategy Documents	No
Presence of Dedicated ICT Department	Yes
Research and Development	
Amount of Investment	N/A
Density of Collaborations	Low
Products and Applications	
Government Orientations	Military, health, public services
Industry Orientations	Medical, environmental
Ethics	
Level of Government AI Ethics Involvement	Low
User Data Privacy Laws	No
AI Ethics Reports	No

Background

The Islamic Republic of Iran is a theocratic republic with a population of more than 82 million as of 2019, and an electrification rate of 100% according to the World Bank (2017). Iran has earned a score of 5.05 on the Oxford AI Readiness Index (2019). While there are reports and articles in the United States and EU news outlets concerning AI in Iran, the information is either Western biased or lacking corroboration by Iranian institutions. While there is currently not much information on Iran's artificial intelligence capabilities, aside from capabilities that have been posted by other nation-states and academic institutions, the country is known for its other cyber capabilities. Iran has been known to participate in cyber-espionage and offensive cyber activities on other nation-states as well as on its citizens (Lake, 2009).

Government Policy

Rapid cyber growth and development seem to be at the forefront of Iran's agenda, and Iran has been rapidly growing its cyber capabilities (Lewis, 2019). Over the last decade, researchers have been able to understand how Iran uses its cyber offensive capabilities on other nation-states (Lewis, 2019). However, aside from cyber offensive operations, Iran has also been making strides in environmental and scientific development (Prakash, 2018). Due to the Iranian government's current state of cyber offense and defenses, there have not been any foreseeable predictions on AI made by the domestic government or affiliated institutions. However, Iran has begun to cooperate with international actors who have helped fund other types of cyber operations in the country (Vaughan, n.d.).

Position on Domestic AI

Unfortunately, there is little to no documentation on Iran's future plans with AI, let alone public AI policies. As previously stated, its cyber capabilities exist but are unknown in the AI field. Despite this lack of information, analysis can be drawn from the fact that Iran's cyber capabilities started after the 2009 Stuxnet virus was launched against the Iranian nuclear enrichment facility (Makuch, 2020). While Iran still lacks sophistication in comparison to the United States, China, and Russia, this has not prevented them from becoming a prospective cyber ally with China and Russia (Doffman, 2019). While they appear to have begun cooperating with China and Russia, it seems as if Iran has not put national security at the forefront of their AI concerns.

Position on International AI

While Iran does not have a domestic position on AI, it does have support from other international actors if it chooses to develop AI capabilities. In 2013, Iran stated that it was against fully autonomous weapons because of how countries such as Afghanistan, Pakistan, and the United States, had employed these "inhumane" weapons. But it is unknown if this stance remains accurate (The Campaign to Stop Killer Robots, 2013). Interestingly, Iran does utilize semi-autonomous minesweepers on the battlefield (Iranian Student News Agency (ISNA), 2014), as it will be further discussed in the products/application portion of this analysis.

Research and Development

Iran's R&D has been geared towards better understanding and creating military, urban, and medical uses of AI. While currently there are minimal products and projects being researched, they indicate that Iran has the ability to continue further research and development of AI and its uses.

Collaborations

There has not been much legitimate collaboration with the government and other industries on AI development.

Industry

Iran's AI R&D does not encompass many industries, but the ones they do research are projects that pertain to medical, environmental, and urban development. Some important

environmental projects in Iran come from the analysis of rainfall-runoff by using the Artificial Neural Network and the Adaptive Neural-Fuzzy Inference System (Nourani, 2011). By utilizing this hybrid AI system, researchers hope to be able to implement a system with fewer uncertainties that come when monitoring rainfall runoff. The importance of analyzing rainfall-runoff comes from the need to monitor and predict the information needed for urban and environmental planning, such as understanding the land use, the flood and water resources, and how to manage watersheds in the area (Nourani, 2011). The second environmental project that Iran uses machine artificial intelligence is to assess groundwater vulnerability for the Maragheh–Bonab plain aquifer in Iran (Nourani, 2011). Researchers use the popular "DRASTIC" method as their ground-water vulnerability mapping method, measuring depth to water, net recharge, aquifer media, soil media, topography, the impact of vadose zone media, and the hydraulic conductivity of the aquifer. This project is significant because the Maragheh–Bonab plain aquifer, which is located in the northwest of Iran, provides a source of water for domestic, industrial, and agricultural uses (Fijani & Nadiri, 2013).

Academia

Due to the imposition of sanctions on Iran by the United States, there has been a growth in the development of new technologies such as robotics used to assist surgeries, which was once exclusively available in the U.S. (Prakash, 2018). Because there is no longer a way to access these once available medical technologies, Iran has quickly and steadily ramped up their development of robotics. Thanks to a few of the universities in Iran, such as the Sharif University of Technology and Islamic Azad University, AI and robotics have been able to thrive despite the imposition of sanctions.

Country-to-country

Despite the lack of data on Iran's AI capabilities, it has been noted that China and Iran have a "united front"" on cyber offenses (Doffman, 2019). The Chinese Foreign Minister understands Iran's struggles with the U.S. imposed sanctions since China finds itself in the same position (Doffman, 2019). The agreement between the two countries aims to confront "U.S. unilateralism and hegemony" related to information technologies (Doffman, 2019). Aside from China, Russia also wants to form ties with Iran because the two countries see "many areas of cooperation" in the field of AI (IRNA, 2019). This country collaboration between AI forces could pose a threat to the U.S. and raises cause for concern.

Products and Applications

Overall, AI applications that have been produced in Iran have been used in the medical field, in urban and agricultural development, and in military operations. The previously stated sanctions on the Iranian economy have created growth in the development and deployment of AI products.

Collaborations

While there is not much literature in English regarding military projects in Iran, one of the known projects states that Iranian researchers at the Islamic Azad University, "have designed and developed three types of military, rescue and minesweeping robots" that can be used for border control and in war zones (ISNA), 2014). These robots are equipped with cameras,

microphones, and sensors. The robots also have shooting capabilities and can communicate with the wounded on the battlefield but will shoot, if left without a response.

On the other end of the spectrum is medical developments. The development of SINA, the surgeon robot, was brought to life by researchers at the Sharif University of Technology and the Tehran University of Medical Sciences (Department of Mechanical Engineering, 2015). While this robot can be used in most surgical operations, it has been specialized in prostate surgery.

Industry

While there have not been any company-led projects and applications, Iran's scope of AI has covered a few different industry sectors. Iran has been working to leverage AI in the medical field, the environmental development field, and even in the religious field. Iran has seemed to publicly acknowledge that projects that include artificial intelligence are in the scope of national development. Another urban use of AI is through Tehran's traffic control, which heavily relies on License Plate Recognition technologies developed domestically within the last decade based on pattern recognition, machine learning, and neural networks (Pargoo, 2019). While these projects seem to produce environmentally sustainable results for the nation of Iran and should be encouraged, it can also be seen as another type of surveillance on its citizens. Therefore, the ability to develop these sorts of AI tools should also be seen as an example and forewarning of what Iran is capable of in the realm of AI.

Ethics

Based on the information that has been provided on the development of AI in Iran, there has not been anything addressing the question of ethics. There has not been any official documentation of source data in Iran. However, data has shown that because there is a large amount of internet governance monitoring in Iran, ethics are a concern (MacLellan, 2018). While it is true that most countries participate in espionage of others and on their own citizens, ethics are further questioned when supposedly private messages become government knowledge. Iran is "a country that frequently jails dissidents," as most opponents to the Iranian regime rely on "web-based communication with the outside world" (Lake, 2009). Based on research done by the Immigration and Refugee Board of Canada (2016), at least 11 people were arrested in September 2014, due to the circulation of jokes about Ayatollah Khomeini through mobile phone apps. This has not been the first instance of Iran jailing citizens for opposing the regime in Iran.

While there is no explicit data stating that Iran uses AI to surveil its citizens, it is a possibility given their political climate. A country with such a large amount of connectivity would need some sort of AI or machine learning in order to monitor what its citizens are saying about the regime. This speculation can lead to the assumption that the Iranian government utilizes AI algorithms that target specific words or phrases to monitor its citizens' conversations. This raises concern on the question of privacy and how much the Iranian government is really surveilling its connected citizens. With the information that Iran surveils its citizens, this also provides that Iran has little or no concern on any sort of data privacy, ethics, or data ethic laws or guidelines. Due to the type of government that Iran fosters, it is hard to recommend the adaptation of ethics and privacy laws. However, ideally, Iran should cease the surveillance of its citizens, and listen to their protest and concerns.

Recommendations for the U.S.

Given the complicated relationship between Iran and the United States, there are many possible recommendations for how the United States could address the growing use of AI in Iran. While the United States has seen Iran as a potential threat, aggressive policies and actions towards Iran have only energized Iran to build technology rather than cripple its efforts. Based on what limited information there is on AI research and development in Iran, the first response may be to ignore Iran. However, due to its level of surveillance on citizens' data, its "united front" with China, and Russia's investment in Iran's cyber capabilities, the U.S. should continue to keep Iran on its radar. Additionally, the U.S. should repeal most, if not all, sanctions on the Iranian economy. As illustrated above, the increase of robotics development for military and surgical use in Iran has a direct correlation with the U.S. imposed sanctions, as well as the united front with China. It would be in the United States' best interest to avoid intervening in Iran to establish privacy or ethical standards. Due to the advances that Iran is making in their AI research and products, the United States should also continue to work on using Artificial Intelligence for urban development projects such as those related to agriculture or the status of national parks in the United States, in order to promote the perspective that AI can be used in positive ways, and is not only used for malicious intent.

Israel

By Julie Bouanna

Introduction

Israel is a regional AI power and an emerging global AI power with a high level of AI development, based on its robust AI research and development landscape and high levels of artificial intelligence applications. Israel's AI landscape is primarily focused on national security, health, robotics, and agriculture. Israel's government has medium engagement with AI ethics, as demonstrated by the presence of data privacy regulations in some sectors such as health, but the lack of ethics discussions in other sectors, namely national security. Israel acts as an AI ally to the U.S. due to Israel's long-standing relationship with the U.S. as well as its current AI collaboration with U.S. companies and the U.S. government. Table 7 summarizes findings on Israel's AI readiness, research and development, products and application, and ethics.

Table 7: Summary Findings, Israel

Government AI Readiness	
Level AI Development	Medium
Oxford Insights AI Readiness Score	7.348
Presence of Strategy Documents	Yes
Presence of Dedicated ICT Department	Yes
Research and Development	
Amount of Investment	High
Density of Collaborations	High
Products and Applications	
Government Orientations	National security, health, robotics
Industry Orientations	National security, health, agriculture
Ethics	
Level of Government AI Ethics Involvement	Medium
User Data Privacy Laws	Yes
AI Ethics Reports	No

Background

Israel is a parliamentary democracy with a population of 9,136,000 people as of December 2019 and an electrification rate of 100% (*Access to electricity*, 2019). Israel earned a score of 7.348 on the Oxford AI Readiness Index (*Government AI Readiness Index 2019*, 2019). Israel is quickly developing its AI capabilities as investment in AI has soared to 37% of all capital raised, and there has been a high level of cooperation with the government, industry, and academia (Kelly, 2019).

An ongoing event that has shaped Israeli AI capabilities is the Israeli-Palestinian conflict (*Israeli-Palestinian Conflict*, n.d.). This conflict has created additional security threats that the Israeli government addresses through developing military technology (*Israeli-Palestinian Conflict*, n.d.). The use of AI in the national security sector to address this conflict has been met with backlash, as developing military AI has ethical implications.

Government Policy

The Israeli government is interested in becoming a global AI power and its government policies reflect that goal. The federal government has created a commission specifically to develop a national AI strategy (Kling et al., 2019). This commission makes recommendations for the development of AI in sectors such as agriculture and transportation (Berkovitz, 2019). In addition, many government ministries have expressed their desire to work with private companies to utilize AI technology (Feldstein, 2019; Kling et al., 2019; Scheer, 2019). Israel has been active on the international stage, opposing negotiating a new treaty on fully autonomous weapons (*Country's Views on Killer Robots*, 2018).

Position on Domestic AI

Domestically, the Israeli government has taken steps to create a national AI strategy, and many ministries within the government have expressed their interest in promoting AI in a variety of different sectors (Berkovitz, 2019; Kling et al., 2019). In June 2018, the Knesset Science Committee discussed government readiness for AI development and called for the government to look into the privacy and liability implications of AI technology (Kling et al., 2019). In direct response to this, Prime Minister Netanyahu commissioned a team to develop a strategy to position Israel as a world leader in AI (Kling et al., 2019). This team has the goal to make Israel one of the top five countries in the world in artificial intelligence technology within five years (Kolyohin, 2019). The team has devised several subcommittees, and has yet to make their entire reports public, although some information is accessible (Kling et al., 2019).

The committee establishes how Israel can build the capacity for these ambitious AI projects. This committee recommends that under the plan, the required government investment would be NIS 1-2 billion (Berkovitz, 2019). The committee then recommends building suitable computer infrastructure within its borders, which would involve companies such as Amazon, Google, Nvidia, and Intel (Berkovitz, 2019). Finally, the committee stresses the importance of having a workforce and academic field competent in AI (Berkovitz, 2019). Various initiatives by the government have sought to address this lack of competent workers and academics, including dedicating resources to STEM fields in secondary education, and easing immigration regulations to attract foreign expertise (Scheer, 2019, p. 16). The committee also recommends creating a coordination agency within the federal government to ease the coordination of different ministries involved in the development of AI, such as the Ministry of Science, Technology, and Space, The Ministry of Communication, the Ministry of Defense, and many others (Berkovitz, 2019).

The committee recommends some key national AI projects that Israel should undertake (Berkovitz, 2019). One project is to reform the healthcare system (Berkovitz, 2019). In 2018, the Israeli government announced a $264 million initiative to begin combining millions of medical records into a single unified system, to maximize their usefulness in AI programs (Lieber, 2019). Another project is the development of smart cities, with the report recommending that Tel Aviv be a 'trial city' for autonomous driving and smart transportation (Berkovitz, 2019). According to the committee, the most promising sector for AI development is in agriculture (Berkovitz, 2019). The report indicates that with Israel's current resources, it can become a global leader in this field (Berkovitz, 2019). Finally, the committee is also concerned with how AI can help cope with environmental damage (Berkovitz, 2019). The report's greater emphasis on agriculture is due to the amount of restrictions in other sectors, such as health, due to privacy laws (Berkovitz, 2019).

Agriculture is less restricted in this respect, and therefore easier to implement AI technology (Berkovitz, 2019).

In addition to this specific committee, different ministries within the government have expressed their plans for the use of AI technology, including the Ministry of Transportation, the Ministry of Health, the Ministry of Science and Technology, the Ministry of Education, and the Ministry of Economy (Kling et al., 2019; Scheer, 2019). For example, the Ministry of Health has been working closely with AI companies to detail how to use health data in health-related research, and how the private sector and the government can cooperate (Kling et al., 2019). This cooperation is currently ongoing, with the government and private companies creating a database of patient information to develop algorithms to speed and inform diagnoses (Kelly, 2019).

Finally, in the area of national security, Israel's Defense Minister has emphasized incorporating AI into the national defense framework of Israel (Ahronheim, 2019). The Israeli government has been working closely with AI companies on numerous AI defense projects (Feldstein, 2019). Due to Israel's unique regional tensions and security threats, the Israeli Defense Force has created a Sigma branch dedicated to developing AI capabilities like machine learning, deep learning, and image and video analysis (*The Future of Artificial Intelligence in the IDF | Israel Defense*, 2017).

Position on International AI

The Israeli government has also been active on the international AI stage. Ben-Israel, a leader of the committee set up by the Prime Minister, has called for "international cooperation" in the field of AI (Kolyohin, 2019). However, when it comes to negotiating international treaties, Israel has not been overly cooperative. The Israeli government is against the ban of fully autonomous weapons (*Country's Views on Killer Robots*, 2018). Israel has heavily invested in military AI, being one of the first countries to introduce fully automated robots on its borders (Gronlund, 2019). Therefore, a ban on autonomous weapons goes against the military interests in Israel, especially considering the regional threats that the Israeli government has to consider.

Research and Development

Most AI technology in Israel is still in the stages of research and development. There is robust collaboration between the government, academia, and the private sector, and both the private sector and academia have R&D projects of their own.

Collaborations

The Israeli government spends 4-4.5% of its GDP on research and development, with 20% of this spending going to technological R&D, which has led to many collaborations happening between the government, academia, and/or the private sector (Berkovitz, 2019).

The three entities have a high level of collaboration in the sector of national security. The Israeli military plays a crucial role in AI, developing many of the most innovative solutions in AI (Scheer, 2019, p. 9).

Israeli intelligence does recognize, however, the need to collaborate with both the industry and academia (Cohen, 2019b). Mossad, Israel's security and intelligence service, is operating a start-up incubator in order to collaborate with companies in AI fields such as robotics, encryption, natural language processing, and text analysis (Scheer, 2019, p. 29). The Ministry of Defense launched the Carmel project to upgrade the IDF's combat vehicles utilizing

AI technology, and selected three Israeli defense companies to continue the development program: Rafael, the Israeli Aerospace Industry, and Elbit Systems (Egozi, 2019; Keller, 2019). The companies have each created technology and presented it to the Ministry of Defense and other military officials. For example, Rafael's solution uses a transparent cockpit design enabling 360-degree situational awareness and includes augmented reality for real-time battlefield data (Egozi, 2019). However, it is not clear whether the IDF has implemented these technologies. The Israeli military continues to work with the defense industry as well as academia to further develop weapons and other military technology (Cohen, 2019b).

Industry

In addition to research and development in the national security field, the private sector in Israel has been conducting research and development in many other fields, namely robotics. The AI ecosystem grew from 512 companies to 1,150 from 2014 to 2018, which is an increase of 120% in four years (Mizroch, 2019). Companies are doing research in machine learning, natural language processing, and computer vision (*Forbes Lists 10 Israeli-Founded Firms*, 2019).

Global companies have also been investing in Israeli AI technologies. An astonishing 20% of the total global investment in cybersecurity is poured into Israeli companies and start-ups (Kelly, 2019). In 2018, Israeli-based AI companies raised over $2.25 billion in venture capital funds (Kling et al., 2019). As of 2019, 350 multinational corporations operate R&D centers in Israel (Scheer, 2019, p. 14). For example, Intel moved all of its global autonomous driving development operations to Israel (Scheer, 2019, p. 11). Other multinational companies, such as Google and Facebook have research hubs in the country (Kelly, 2019). In particular, Facebook has set up a new R&D center to aid the work of engineers and programmers in AI (Cohen, 2019a). Google has a Tel-Aviv based R&D center, and IBM also has a research and development team based in Haifa (*Artificial Intelligence*, 2019). Chip-makers Intel and Nvidia have also both opened R&D centers in 2018 (*Artificial Intelligence,* 2019). These examples reflect Israel's overall commitment to creating a welcoming environment for AI firms.

Academia

In academia, several universities already have dedicated AI R&D centers that focus on AI robotics technology (Scheer, 2019, p. 10). The most prominent universities in terms of AI research are Technion and Ben-Gurion University (Scheer, 2019, p. 20). Universities are doing most of their research in autonomous systems and smart robotics, computer vision, natural language processing, deep learning, and multi-agent systems (Scheer, 2019, p. 10). There have been several specific projects regarding AI in universities such as Ben-Gurion University, Hebrew University, Bar-Ilan, and Ariel University (Felner, 2016). These projects range from research on voting systems for bounded rational agents to study human voting behavior, to research on multi-robot and multiagent systems (Felner, 2016). All of these projects are important advancements in the field of AI and are often picked up by private companies and implemented into AI technologies.

Country-to-country

Israel is involved in research done on the international stage through international conferences and national security collaboration. There have been many international AI conferences held in Israel, mostly set up by the Israeli Association for Artificial Intelligence, an

umbrella organization for AI researchers in Israel (Felner, 2016). In 2015, the Israeli AI community hosted two international AI conferences, ICAPS and SoCS, attended by a total of 225 people (Felner, 2016). More recently, in 2019, Israel hosted the "AI Week," with the participation of over 3,000 professionals, experts, researchers, and industry representatives (Kolyohin, 2019). This international forum discussed the future of AI (Kolyohin, 2019).

The Israeli government has also worked closely with the U.S. in the national security sector. The IDF has briefed U.S. top military officials on the development of military technology through the Carmel project (Egozi, 2019). The U.S. army is a potential client for these technologies (Egozi, 2019). Although Israel is clearly dedicated to fostering collaboration between countries, it has made its stance clear against a ban on fully autonomous weapons due to its robust military AI research and applications (*Country's Views on Killer Robots*, 2018).

Products and Applications

Although many projects are still in their research and development stage, some projects have been applied or are in their implementation process. Some projects are a result of collaboration between the government, academia, and the private sector, while many projects seem to be solely a result of private sector work. These projects span over several different sectors, from national security, to agriculture, to health, to education.

Collaboration

Government, industry, and/or academia have collaborated to create and implement successful AI technology in sectors from autonomous driving, to health, to national security. For example, Mobileye Vision Technology, a subsidiary of Hebrew University until 2017, uses AI to provide warnings for preventing collisions on the road (Scheer, 2019, p. 24). This autonomous driving technology is important for the development of smart cities (Kelly, 2019). In 2017, Intel bought this company for USD 15 billion (Scheer, 2019, p. 24).

Another success story of collaboration is in the medical field, with private companies developing AI algorithms that use patient data and lifestyle information to improve diagnoses (Kelly, 2019). These AI technologies can help with improving preventative care by spotting diseases early on and tailoring medicine to the specific diseases of patients, reading diagnostic imagery and lab tests more accurately and faster, and make health-care less expensive and much more cost-efficient (Lieber, 2019).

As previously discussed, there is also a lot of collaboration between sectors in the area of national security. Elbit technologies is the biggest military defense contractor and has an arsenal of impressive AI technology, including the Sky-Striker, an autonomous loitering munitions technology, which it claims utilizes machine learning and autonomous technology to help militaries make covert and precise targeted airstrikes (Roth, 2019). Elbit Systems has also built dozens of towers in Arizona to spot people as far as 7.5 miles away (Feldstein, 2019). This technology was first perfected in Israel with the development of a 'smart fence' to separate Jerusalem from the West Bank (Feldstein, 2019). These same smart fences have been installed on other Israeli borders, such as the Gaza Strip, the border between Lebanon and Israel, and the border between Egypt and Israel (Ahronheim, 2019).

Another Israeli defense contractor, the Israeli Aeronautical Industry, claims to offer many different AI technologies, including an autonomous perimeter patrol drone, Guardium, which patrols the Gaza border (Roth, 2019). Rafael Advanced Defense Systems claims to use AI technology in a tracking element of the GIL 2 missile which uses autonomous capabilities to

navigate environments where the global positioning system has been activated (Kelly, 2019; Roth, 2019). Finally, IMI systems, a company owned entirely by the Israeli government, offers AMSTAF, an autonomous ground vehicle, that reduces human risk and the cost of military operations (Roth, 2019). Although certain projects have been reported, defense research is not open to the wider AI community, and the majority of the work done by Israeli defense contractors is classified (Kelly, 2019).

Industry

Although there have been many important collaborations between the government and industry in producing AI, the private sector itself has developed a variety of AI projects, from agriculture to education. This section will cover only a small number of the many AI projects in the private sector.

An important sector where AI technology has advanced is that of agriculture. For example, a Tel-Aviv-based start-up launched a service called SeeTree, which provides farmers with important information on crops, including disease, irrigation, and fertility (Dunphy, 2019). SeeTree has been working with farmers in Brazil and California as a pilot study prior to the launch (Dunphy, 2019). Another company, ATP Labs uses data analytics and AI to collect data from a critical mass of growers to develop cloud-based actionable best-practices advice (Leichman, 2017). Additionally, Tel Aviv-based BeeHero aims to boost crop-yield by "utilizing real-time beehive data and pollination intelligence" (Halon, 2019).

Another sector where private companies have been utilizing AI technology is education. MindCET is an organization focused on utilizing technological innovations to advance education (Shemer, 2018). Each year, this organization selects several start-ups to participate in workshops in improving AI technologies to fit the needs of educators (Shemer, 2018). Israeli start-ups such as Mathika, Texti, and Agree Online use AI technologies such as language processing and automated negotiation to enhance student's and educators' educational experience (Shemer, 2018). Another Israeli start-up, Sense Education, uses AI software to help teachers give personalized feedback on individual assignments (Maccioni, 2018).

Ethics

Considering Israel's AI landscape, there has been surprisingly little discussion of the ethical implications of AI, at least on the governmental level. Although there are some AI guidelines and privacy laws, the government as a whole seems disinterested in discussing AI ethics, with the exception of the health sector, where strict laws do exist. Although there are certainly ethical issues when it comes to intellectual property or ethics of technology, most of these issues do not appear in law or formal regulation (Kling et al., 2019). This is especially of concern in the national security sector, where the use of biased AI in military and law enforcement technology can have serious ethical implications.

On the international stage, Israel has stated that rigid standards at this early stage in AI development would prohibit growth and that the focus should be on the military and humanitarian advantages of AI (Gronlund, 2019).

The committee formed by the Prime Minister has broken into several subcommittees, including a committee on ethics (Berkovitz, 2019). However, this committee has not published clear ethical guidelines (Berkovitz, 2019; Kling et al., 2019). The subcommittee has provided a "ruler" companies can use to weigh ethical considerations; however, it is not clear how exactly this ruler weighs ethical implications (Berkovitz, 2019).

Although the Israeli government seems disinterested in ethical considerations, that is not the case for other entities. Many Israeli researchers say the growth of AI is in the early stages, still requires safeguards, and should not be used in life or death situations, such as national security (Solomon, 2018). This is because AI technology is sensitive to the information researchers feed it, so if the information is wrong, the conclusion will be wrong (Solomon, 2018).

This is especially a concern in military AI technology. These military-use autonomous driving systems train on thousands of hours of human remote driving footage (Roth, 2019). Even more potentially alarming is the specific example of Elbit Systems' autonomous missile, which can be inferred to be trained on images and videos showing human faces and bodies (Roth, 2019). If any of this information is biased, the technology will be biased, which can be lethal in the case of missile technology. Although researchers have raised concerns about this technology and its ethical implications, it does not seem that the military industry has taken ethics into account.

Most discussion of ethical implications takes place in the health sector. Because personal health information is so sensitive, the Protection of Privacy Law 5744-1984 protects personal data (Kling et al., 2019). New 2018 privacy laws actually resemble the European Union General Data Protection Regulation (Kling et al., 2019). Furthermore, the Ministry of Health has released guidelines and procedures outlining how to use health data (Kling et al., 2019). Israel's health sector AI development relies on patients giving their consent for their clinical data to be transferred from particular health organizations to the federal government (Lieber, 2019). The amount and quality of Israel's medical information and patient data is extremely impressive, and if the government were able to get access to this information, the AI potential could be very significant in the training of AI systems (Lieber, 2019). Any database of health information would be anonymized, removing any feature that could identify a patient (Lieber, 2019). Clearly, the health sector has had to keep ethical implications in mind, as they have been very transparent in how they acquire data.

Overall, there are serious ethical implications of AI development in Israel. Although the health sector seems to take this into account, the national security sector has largely ignored it. The U.S. should consider the backlash that working with Israeli defense contractors could generate due to this lack of ethics codes. For example, Microsoft was under fire by civil rights organizations such as the ACLU and the public for working with the Israeli company AnyVision Interactive Technologies, which specializes in facial recognition technology (Wilkins, n.d.). Critics say this company uses AI as a tool of oppression against Palestinians entering Israel from the West Bank, and the ACLU alleged that Microsoft has betrayed its AI principles by investing in this company (Wilkins, n.d.).

In conclusion, there has been little discussion on the ethical implications of AI technology, especially in the important military sector. Researchers have called for more of a discussion on this front, the health sector has done its part to consider ethics, and the government should take a more invested approach to AI ethics.

Recommendations for the U.S.

The U.S. and Israel have enjoyed a longstanding relationship starting when the U.S. became the first country to recognize Israel as a state ("U.S. Relations With Israel," 2018). Israel remains the U.S.'s most reliable strategic partner in the Middle East, and the two countries are

bound by historic and cultural ties, as well as mutual military and economic interests ("U.S. Relations With Israel," 2018).

Israel is on a trajectory to becoming a major global AI power. Although much of their technology is still in the research and development stage, this technology, along with the technology that is being currently applied, is highly advanced and should be an interest to the U.S. Specifically, the U.S. should continue to have a strong level of cooperation with the Israeli military and Israeli defense contractors. The U.S. military is already benefiting from Israeli AI technology, and therefore should focus on maintaining and strengthening bilateral relations.

The U.S. government should also keep an eye on private sector collaborations between Israeli and U.S. companies, as the U.S. government can still benefit from these relations. However, the U.S. government must beware of the ethical implications of working with certain Israeli defense contractors. As seen when Microsoft invested in an Israeli AI company, there can be serious backlash from NGOs and the public (Wilkins, n.d.). Therefore, the U.S. government should pick the companies they wish to work with wisely and expect backlash when working with companies that ignore ethical discussions.

Finally, the U.S. should watch what Israel does on the global stage. As Israel continues to host international conferences, the U.S. should strengthen its attendance, in order to learn how AI is advancing in Israel. With Israel being a "Start-up Nation," the U.S.'s attendance at these conferences will be critical to learn important information on how the Israeli private sector is developing their AI capabilities, and which companies the U.S. and U.S. companies should invest in. The U.S. should also watch Israel's stance on banning fully autonomous weapons. As of now, both countries strongly oppose this ban, and the U.S. can rely on Israeli support on its stance.

Japan

By Lauren Frizzell

Introduction

Japan is an AI superpower with a high level of AI development, based on its robust AI research and development landscape and high levels of artificial intelligence applications. Japan's AI landscape is primarily focused on education, health, and environmental sectors. The Japanese government has high engagement with AI ethics, as demonstrated by Japan's involvement with the EU and GDPR (Takase, 2017). Japan acts as an AI ally to the U.S. due to Japan's long-standing relationship and cooperation. Table 8 summarizes findings on Japan's AI readiness, research and development, products and applications, and ethics.

Table 8: Summary Findings, Japan

Government AI Readiness	
Level AI Development	High
Oxford Insights AI Readiness Score	8.582
Presence of Strategy Documents	Yes
Presence of Dedicated ICT Department	Yes
Research and Development	
Amount of Investment	High
Density of Collaborations	High
Products and Applications	
Government Orientations	Medical, environmental, security, education, agriculture
Industry Orientations	Agriculture, medical, manufacturing, education
Ethics	
Level of Government AI Ethics Involvement	Medium
User Data Privacy Laws	Yes
AI Ethics Reports	No

Background

Japan is a parliamentary constitutional monarchy with a population of 126,526,100 people as of 2018 and an electrification rate of 100% as of 2017 according to the World Bank (World Bank, 2017, 2018) Japan earned a score of 8.582 on the Oxford AI Readiness Index (2019). The Fukushima disaster that occurred on March 11, 2011 greatly impacted the direction AI is heading in Japan. While Japan once prioritized automation for manufacturing, after this tragedy, the focus for AI shifted largely to the detection and recovery for such (Fackler, 2017). Similarly, the declining overall population of Japan has prompted research into the automation of manufacturing and care for the growing elderly population (Hazlegreaves, 2019).

Government Policy

AI has been a focus for Japan over the last several decades, and the overall orientation of Japanese policy regarding AI is towards the development of social programs. A leader in the field, Japan has consistently dedicated resources towards the R&D and promotion of AI capabilities. Over the last decade, Japan has grown their applications domestically and internationally through venues such as the Group of Twenty, ASEAN, and other international relationships like that with the U.S. Membership in these international forums allow for discussion on AI investment and orientation regionally and internationally.

Japan's government AI policy is somewhat limited by its constitution's Article IX which prevents the use of offensive force, which limits their potential for AI use in this capacity that is present in other AI powers (Japanese Government, 1947). Instead, Japan is concentrated on defensive abilities. The Japanese Self-Defense Force, works cooperatively with the United States military on initiatives including cyber capabilities (*75th Anniversary of PACAF*, 2019; *Contract Data: Anduril Industries, Inc.*, n.d.; Japanese Government, 1947).

Position on Domestic AI

The Japanese government's domestic policies are geared towards developing AI technology that will benefit society at every level. The Japanese government is supportive of companies, startups, education, and the general promotion of AI investment. Major AI strategy documents for Japan include their AI national strategy reports. The most recent one published in 2017 offers a roadmap of AI technology and its development including "fostering of human resources, environmental maintenance, and start-up support" (Strategic Council for AI Technology, 2017). Leaders and representatives speak in multilateral and international forums to prepare and bolster the country's AI capabilities.

Major projects regarding artificial intelligence in Japan include their plan for Society 5.0 introduced by the Japanese government in 2016 (*Artificial Intelligence/JapanGov*, 2018).This plan details the projections for what society should evolve towards following the information age, one that relies on automation. Society 5.0 places emphasis automation and Internet of Things devices, where artificial intelligence will accomplish tasks currently done by humans (*Artificial Intelligence/JapanGov*, 2018). The reliance on this in response to the aging population is intended to "offer both social and economic benefits and relieve some of the fiscal pressures related to ageing societies" (Hazlegreaves, 2019).

Because of the large private sector and national commitment to AI readiness, a concrete accumulated figure of the total investment is unclear. However, there are some figures available indicating the allocation of funds from multiple bodies of the Japanese government for the R&D and production of AI (*Japan's budget for AI to be less than a fifth of that planned by U.S. and China.*, 2018).

Position on International AI

Japan has been a pillar in international AI discussion and consistently works with various actors to research and develop AI. Japan also has an ICT department dedicated towards international cooperation for AI research and development which covers most sectors, but which is primarily focused on healthcare, environment, and education (Insights, M.I.T.T.R., 2019; Kidawara, 2020; NICT, n.d.). Despite its activity in these discussions, Japan does not have a clear stance on the ban of fully autonomous AI weaponry. Japan representatives have spoken on

the potential banning of lethal autonomous robots but did not make clear whether they are for or against them. Instead the statement encourages the further discussion of this potential (Sauer, 2013).

Research and Development

Japan has been a strong advocate for R&D internationally and domestically, focusing efforts on automation for manufacturing and other processes, increased reliance on IoT abilities, and scientific discovery primarily via academia.

Collaborations

Government led and owned collaboration projects currently being developed are primarily using IoT and robotics to improve health and environment through investment in startups and education as well as through collaborations between private corporations and universities.

The Japanese government invests in startups as well to increase the research and development and production of AI. Startups are supported by the government of Japan to encourage the growth of AI. The government has given funds to many startups such as Preferred Networks to work on advancing the nation's AI capabilities specifically in incorporating AI to improve healthcare and transportation (Insights, M.I.T.T.R., 2019; *Top 10 IoT Startups of 2019*, 2019).The startup now collaborates on their projects with organizations like Toyota for IoT applications and with organizations like IBM for developing deep-learning framework (*Top 10 IoT Startups of 2019,* 2019).

Japanese government is a major investor in robotics and automation and is seeking to improve productivity in health care and manufacturing (*Japan's budget for AI*, 2018). Of the 2018 fiscal budget, the Ministry of Economy, Trade and Industry has allocated 39.3 billion yen towards developing robotics and next generation AI computer chips (*Japan's budget for AI*, 2018). The labor ministry has allocated 19.6 billion towards AI in medical data management and pharmaceutical research (*Japan's budget for AI*, 2018). AI impacts on manufacturing and automation R&D done was also in collaboration with the U.S. and was sponsored by Toyota (*Toyota Will Establish New AI Research*, 2015). They established an R&D center in the U.S. with a grant of one billion USD to further understand how automation and robots can potentially improve manufacturing abilities (Markoff, 2015).

One project sponsored by Microsoft works with researchers at Tohoku University and their International Research Institute of Disaster Science to aid relief workers in their search for victims after a major emergency (Microsoft Asia News Center, 2019). While this is just one example of academic and private sector investment, the general establishment of research centers and the pursuit of AI R&D in academia is becoming increasingly common. Centers for research are very common in Japan, with centers sponsored nationally, privately, internationally, and collaboratively. Most recently, SoftBank, a telecommunications company in Japan, has announced their collaboration with the University of Tokyo to establish a Beyond AI Institute to research AI (Hebbar, 2019).

RIKEN Center for Advanced Intelligence Project was created by the Ministry of Education, Culture, Sports, Science, and Technology in Japan in 2016 to foster innovation nationally and research AI and human interaction (*RIKEN Center for Advanced Intelligence Project (AIP)*, n.d.). They sponsor and promote the research done on AI nationally and have

teams dedicated to the R&D of several sectors of AI including robotics and machine learning (*RIKEN Center for Advanced Intelligence Project (AIP)*, n.d.).

Industry

There is little AI R&D done in Japan that is not a collaborative effort with academic institutions or the Japanese government. As previously mentioned, Preferred Networks, one of many startups the Japanese government is investing in, is also a powerful startup in the AI industry as they work on improving the IoT reach in the country (*Top 10 IoT Startups of 2019*, 2019). Japanese companies, Toshiba Corporation, and NEC GROUP are also two of the top patent holders internationally for AI related projects, although it is not specified what these patents are for, indicating the industry interest in continued AI R&D (*UN Study: China, US, Japan Lead World AI Development*, 2019).

Academia

Among AI R&D conducted and centers established in Japanese academia, few are created without collaborative support. Japanese academic institutions and the Japanese government investment in academia and AI is extensive, encompassing projects that are used for research in the hard sciences, general integration of AI into education, and the use of AI for environment and healthcare purposes. Recently, a center for AI research has also been established at the University of Tsukuba (University of Tsukuba, n.d.). Currently, research done has not been updated on their website although there is indication of potential projects in the future (University of Tsukuba, n.d.).

An important aspect of preparing the future for AI has been increasing AI education at universities and technical colleges, which was proposed by Japan's innovation promotion council, with a heavy emphasis on technical skills (*Artificial Intelligence/JapanGov*, 2018; *Education on AI*, 2019). Through Society 5.0, Japan is encouraging further integration of IoT and data science all the way through elementary education (*Artificial Intelligence/JapanGov*, 2018).

Country-to-country

Japan collaborates internationally in most aspects of AI R&D. They actively engage in international organizations they belong to and work to discuss the future of AI, and in the general production and application of AI. Japan has received investments from the U.S. to collaborate on AI research and development on two military bases located in Japan between the United States Air Force and the Japanese Self-Defense Forces (*Contract Data: Anduril Industries, Inc.*, n.d.). The grant given was also implemented in other U.S. bases located in the Pacific. The specific goal of the aforementioned project with the United States Air Force and Japan has not been disclosed and the project is labeled as using AI for communication abilities (*Contract Data: Anduril Industries, Inc.*, n.d.).

Despite their constitutional constraints on using weapons offensively to settle military disputes, military capabilities and cyber defense is currently being explored domestically not in collaboration with other forces but in response to international AI military development (Japanese Government, 1947; Jennings, 2018; Miki, 2019). The specifics or any further details of this have not been revealed.

Japan's international AI development is evident in industry investment abroad as well as in their various trade partnerships listed in the Government Policy section. Japan is also one of

the major distributors of AI equipped surveillance equipment, distributing to fourteen countries, although the specified equipment traded and to whom is unknown (*AI surveillance proliferating, with China*, 2019). Although Japan has increased cooperation with China through projects, such as the Belt Road Initiative, Japan has not yet revealed any joint AI research with China (Jennings, 2018).

Products and Applications

While existing projects and applications for AI in Japan are extensive and oriented towards almost every sector, there is a primary focus on agriculture, health, and academia. Current key products are largely in response to events such as the Fukushima disaster and the general decline in population which all ultimately shifted the AI landscape (Hazlegreaves, 2019). International projects Japan engages in are broad, working with both the United States and China as well as with other superpowers like India and Germany (Markoff, 2015) MOFA

Collaborations

AI collaborations are frequent in Japan, and the government often works with the U.S. government on national security AI applications, as well as with domestic corporations for social projects. Industry-academia collaborations are common as well as collaborations with Japanese universities and international universities with a focus on disaster relief, scientific advancement, and education.

Japan applied the early research done by a university team at Tohoku University's International Research Institute of Disaster Science in collaboration with Microsoft to use satellite imagery and AI to more quickly serve disaster relief (Microsoft Asia News Center, 2019). The product created was applied to the 2011 Tohoku earthquake and tsunami with a 75 percent accuracy rate (Microsoft Asia News Center, 2019).

Major collaborations also include those conducted for education and scientific purposes. Universities often collaborate with independent research institutes to create AI educational tools and other products to further understand the environment on Earth and in space. A recent multi-university team comprised of members from Kyoto University and Kavli University using a database of telescope findings facilitate the deeper understanding of our universe (Greene, 2020). A more extensive between University of Tokyo, University of Sydney, University of Southampton and the Kyushu Institute of Technology successfully explored the depths of the ocean through the use of AI and autonomous robots (*Artificial Intelligence Guides Rapid Data-Driven Exploration*, 2018; Shirouzu, 2019). These collaborations show the commitment from Japanese universities to collaborate and produce AI to reach new academic heights.

Industry

Industry production and application of AI in Japan is found most predominantly in the educational, environmental, and health sectors. Recent products and purposes include surveillance equipment and contributions to automation.

Major private actors, including telecommunication companies like Nippon Telegraph and Telephone, and Nippon Electric Company as well as industry giants like Toyota, are often the investors and producers of AI technology. Nippon Telegraph and Telephone works to lay internet cables internationally, and are comparable to China's Huawei; They also create and distribute security cameras and surveillance devices internationally (NEC, 2020; Vincent, 2018),

Submarine Coastal System, 2020). Nippon Electric Company, notable for its technological innovation and the continued advancement of AI and its distribution, is one of the largest suppliers of surveillance technology using AI besides Chinese companies (*Education on AI*, 2019). Nippon Telegraph and Telephone also distribute security cameras in collaboration with startup Earth Eye Corp (Vincent, 2018).

In the health sector, Japan is attempting to respond to their declining population with the introduction of robots as healthcare providers (Insights, M.I.T.T.R., 2019). Found in nursing homes and intending to be increasingly relied upon, these robots were created in collaboration with Japan's National Institute of Advanced Industrial Science and Technology and the Japanese government (Hurst, n.d.).

In education, AI is also integrated into early classrooms for both students and teachers. In Japanese elementary and middle school classrooms, robots are used to teach children to speak English (Hamakawa et al., 2018). The use of AI in early education can promote active learning and creativity, aligning with the goal of Society 5.0, and preparing Japanese youth for an AI integrated future (Shirouzu, 2019). Although the results of AI use in early education have not been revealed yet, the early introduction to AI can prepare youth for future interactions with the technology. Similarly, investing in educational institutions can allow for further discovery and breakthroughs scientifically.

Ethics

Japan has relatively strong stance on ethics. While the sources of data for most AI products has not been exactly pinpointed, laws regarding the security of user data suggest that obtaining this information is relatively difficult. Despite this lack of transparency on data sources, Japan works with the EU in trade agreements and complies with the GDPR (Takase, 2017). The GDPR outlines ways in which users' information and privacy are secured and prevent the misuse of personal information or cyberattacks (Takase, 2017).

Other bodies and laws were created domestically to further protect data. The Basic Act on Cybersecurity "provides the basic framework for the responsibilities and policies of the national and local governments to enhance cybersecurity," requiring private sector stakeholders to use data responsibly and protect their clients or users (Hayashi, 2019).The National Center of Incident Readiness and Strategy for Cybersecurity was established in 2015 to uphold this Act (Hayashi, 2019).

Japan is committed to a preemptive approach to ethics. There is an ethics committee of the Japanese Society for Artificial Intelligence that includes AI researchers and experts that attempt to set a standard for AI research and preemptively create a code by which AI researchers and society should follow (JSAI, n.d.). The standard is not widely adopted, but much like the United States, Japan is facing criticism for bias in AI, particularly in the use of cameras and surveillance devices "as a pretext for discrimination" although this claim is denied by the creators at Nippon Telegraph and Telephone (Vincent, 2018). Sources of data for projects like the security cameras come from open source technology from Carnegie Mellon University, although these sources are not disclosed or elaborated upon, which seems typical most projects (Vincent, 2018).

Despite having ethics laws and bodies established, the current lack of ethical analysis of AI technology reveals a potential area for improvement and collaboration. Japan seems willing to engage in international discussions regarding AI and ethics. It is significant that they are the only non-EU nation to follow the GDPR and their comments on wanting to discuss the use of

autonomous weaponry (Sauer, 2013). Japan should, and is, likely to continue to participate in international venues to discuss the future of AI especially as the government invests in continued AI R&D and products.

Recommendations for the U.S.

The U.S. should be aware of the relationships Japan is cultivating and recommit to its ally. Their initial challenge of the Belt Road Initiative spearheaded by China has been overturned in favor of participating in the project connecting Eurasia with a large cable and the potential for AI distribution among the actors involved, which would exclude the U.S. (Jennings, 2018)

In 2016, Asia was spending $15-23 billion less than the U.S. for AI spending (CSIS, 2020). Over the last few years, Japan has increased its spending domestically and internationally. While this fiscal year's exact allocated budget towards AI has yet to be determined, individual projects, national missions, and the Olympics suggest the budget is likely upward of billions of U.S. dollars. Japan's financial commitment to the advancement of AI capabilities, despite being lower than the U.S. and China, still shows their overall commitment to be a cyber superpower and a powerful AI ally.

While Japan often exchanges research ideas as well as military and civilian equipment with the United States, they are simultaneously working on strengthening other inter-state relationships (CSIS, 2019). Japan holds the most patents for AI products behind the U.S. and China, indicating their increasing interest in application of AI products. Japan's participation in international cyber agreements with the EU, the Belt Road Initiative with China, reveal how Japan is strategically fostering AI relationships, and working towards becoming a power in cyber capabilities independently and in tandem with these key actors (Jennings, 2018). To counter the potential influence of other nations like China, the U.S. should reinvest in its relationship with Japan. The U.S. can learn from Japan's model and invest in R&D of healthcare and educational AI as well as strengthen its AI military cooperation.

Kenya

By Emma Lii and Julia Stromatt

Introduction

Kenya is a developing regional AI power with a low level of AI development, based on its limited AI research and development landscape and relatively low levels of artificial intelligence applications. Kenya's AI landscape is primarily focused on economic and political development. Kenya has low engagement with AI ethics, as demonstrated by minimal data privacy regulations and lack of ethics reports or conversations. Kenya acts as a potential AI ally to the U.S due to Kenya's commitment to AI development within the region. However, its strong relationship with Chinese firms suggests it could act as a potential AI adversary to the U.S. Table 9 summarizes findings on Kenya's AI readiness, research and development, products and applications, and ethics.

Table 9: Summary Findings, Kenya

Government AI Readiness	
Level AI Development	Low
Oxford Insights AI Readiness Score	5.672
Presence of Strategy Documents	Yes
Presence of Dedicated ICT Department	Yes
Research and Development	
Amount of Investment	Low
Density of Collaborations	Medium
Products and Applications	
Government Orientations	Development, economic growth, identity protection
Industry Orientations	Agriculture, development, finance
Ethics	
Level of Government AI Ethics Involvement	Medium
User Data Privacy Laws	Yes
AI Ethics Reports	Yes

Background

Kenya is an independent republic composed of the legislature, executive and judiciary branches governing over 47 semi-autonomous counties. As of 2019, it has a population of 47,464,296 and an electrification rate of 63.8% (*Access to electricity (% of population)*, 2017; *Europa World Kenya*, 2019). Kenya earned a score of 5.76 on the Oxford AI Readiness Index(*Government AI Readiness Index*, 2019). While there is a lack of robust research and development, Kenya is ranked as one of the highest African states for AI readiness, and the city of Nairobi is positioned as one of the strongest tech hubs on the continent, positioning the country to become an AI regional leader (Rutenberg, 2019).

Government Policy

Currently, the Kenyan government's AI policies are focused more on domestic development than on international AI efforts. The Kenyan government does not have any identifiable policy on international AI development or the use of AI weaponry. Kenya's primary focus is on investing in domestic talent and improving its public services such as healthcare, policing, taxation, and corruption free elections.

Position on Domestic AI

Kenya's domestic AI policies reflect an orientation towards development. The Kenyan government is currently preparing for the creation of new technology sectors as part of its larger development strategy, synthesized in the executive branch's "Big Four Agenda." The strategy sets four goals focusing on food and nutrition security, affordable housing, enhancing manufacturing and universal health coverage (Chege et al., 2018, p. 11). Kenya is on a mission to digitize many of its public services, including elections and federal identification, and prepare the next generation or the expected AI revolution, bringing digital technologies into classrooms and focusing on youth employment online(Chege et al., 2018; Korir, 2019).

A Kenyan Ministry of Information, Communications and Technology task force published a report titled "Emerging Digital Technologies for Kenya," which specifically looks into the application and regulation of AI and blockchain technologies for inclusive growth (Chege et al., 2018, p. 12). This is one of the government's first efforts to address the use of new technologies, reflecting the country's official orientation towards economic development through technological advancement.

Position on International AI

Kenya has not addressed the international debate on AI ethics. Kenya has no known stance on the ban of fully autonomous AI weaponry, and has not participated in the conversation. While it is not focused on the global AI conversation, it is focused on regional development through organizations such as Deep Learning Indaba, an annual conference uniting African AI researchers to increase diversity in the global sector (Hao, 2019).

Research and Development

As a developing power, Kenya has increased its investment in AI-related R&D. To further its goals of digitization and promotion of the "Big Four Agenda," the Kenyan government has focused much of its attention to further both domestic and continental AI research (Chege et al., 2018). Companies and academic institutions have begun incorporating AI solutions into different industries and fostering AI innovation. Kenya has also joined in regional attempts to improve machine learning and strengthen diversity within the AI community.

Collaborations

The Kenyan government's AI research and development landscape is characterized by both international and intragovernmental collaborations. Government-led AI collaborations are largely focused on development, economic growth, and fraud prevention.

Kenya uses its AI capabilities to strengthen and optimize development programs. For example, in the "Kenya Affordable Housing Programme Development" project, the government

is developing ways to use artificial intelligence in its housing allocation process (*Kenya Affordable Housing Programme*, 2018). In collaboration with the World Bank, the Kenyan government will use AI to build credit profiles on housing candidates who do not have a reliable record of past transactions and completely automate the decision-making process (Tobor, 2019). This project directly addresses the affordable housing goal of the "Big Four Agenda," and seeks to use AI to create greater efficiency.

Kenya also seeks to use AI to combat corruption and subsequently foster greater economic growth. The government-led Kenya Blockchain & AI Taskforce made recommendations to the Kenyan Government to adopt blockchain technology to reduce corruption in public funds allocation and lands ministry (Ngila, 2019). Corruption is an incredibly widespread issue in Kenya; according to the Global Financial Integrity report, the country lost between $26 billion and $69 billion as a result of illegal financial flows between 2005 and 2014. The adoption of blockchain technology will allow the Central Bank of Kenya to monitor the use of public funds through a digital ledger system that certifies records of transactions without the risk of manipulation (Ministry of Information, Communications and Technology, 2018). The adoption of this same digital ledger system in the land sector will reduce forgery and tampering of records by documenting and unifying all land transactions into one secure management system (Olago, 2020).

The Blockchain & AI Taskforce also suggests using blockchain technology to reduce corruption in elections as well (Ngila, 2019). Kenya's presidential elections have historically been rife with voter fraud, violence, and controversy(Sotnikova, 2018). The Independent Electoral and Boundaries Commission of Kenya wants to use blockchain technology to provide candidates and citizens' real-time polling results, providing a layer of transparency and protection against fraudulent statistics (Wasonga, 2018). Although the Kenyan Government has announced plans to deploy these blockchain projects, there have been no concrete implementation strategies (Olago, 2020). Nevertheless, the Kenya Blockchain & AI Taskforce aims to work together with the government to apply blockchain and AI technologies in all four goals of the "Big Four Agenda."

In addition, Kenya is working on another project to use AI as a mechanism for identity protection and fraud prevention. In February 2019, Kenya tested a $60 million pilot project that uses AI to gather and sift through biometric data from over 50 million Kenyan citizens and enter the data into a biometric registration plan called the National Integrated Identity Management System (Mayhew, 2019). After registering their biometric data into the system, Kenyan citizens receive a new identification code called "Huduma Namba," which will replace other identification documents and will be essential to accessing essential government and public services, reducing potential identity fraud and increasing application efficiency (Mayhew, 2019; Winsor, 2020). R&D on this biometric project promotes the government's current AI strategy by digitizing services and streamlining resource allocation for future services provided by resulting developments of the "Big Four Agenda."

Industry

While Kenya does not have well established private companies capable of large-scale AI research, its technological landscape has attracted big names in the private sector. U.S. tech companies such as Microsoft, IBM, and Google have invested in numerous innovation projects (Thiong'o, 2018). For example, Microsoft opened the first Africa Development Centre in Nairobi to integrate new technology and provide specific solutions in regional banking, farming,

and healthcare systems (Microsoft News Center, 2019). In late 2013, IBM Research launched an academic research program called IBM-Nairobi, which works on a variety of projects such as improving AI algorithms related to computer vision, natural language understanding, and sequence modelling (*Applying AI to address real-world problems*, n.d.). The Google Impact Challenge came to Kenya in 2018, giving grant funding to innovative technology and AI community solutions (*Impact Challenge*, n.d.). These new research and innovation centers are important in a field that suffers from a lack of diversity. These collaborative efforts aim to provide efficient services and economic development.

U.S. companies are not the only ones attracted to Kenya. Chinese firms such as Huawei, Hikvision, Dahua and ZTE are responsible for supplying AI surveillance technology to member countries of China's One Belt and Road initiative, such as Kenya (Feldstein, 2019, p.1). 2019 also welcomed an increase in private Chinese investment in the entire region. UNESCO has even begun collaborating with Huawei on AI training in Nairobi, showcasing China's growing presence in Kenya (*UNESCO and Huawei announce partnership*, 2019).

Academia

As previously mentioned, Nairobi is the center of the technological revolution in Kenya and produces a variety of academics exploring AI and machine learning technology. The University of Nairobi is currently discussing a joint AI lab with UBtech, a Chinese robotics company. Possible financing for the project could come from the Ministry of Education as well as from the Chinese Embassy (*University of Nairobi is working on AI Lab*, n.d.).

The Masinde Muliro University is one example that has invested in machine learning research. Their project examines artificial neural networks' ability to predict dissolved oxygen levels, an important measure of water quality in the river Nzoia (Kanda et al., 2016, p. 1). The results found that the algorithm could effectively predict dissolved oxygen in the River Nzoia, marking an important breakthrough for developing countries, where pollution monitoring can be costly (Kanda et al., 2016, p. 5). This is an example of Kenya's development orientation, which has worldwide implications.

Country-to-country

While Kenyan research and development is focused primarily domestically, it does partner with China and other African countries. On a regional scale, countries across Africa came together in 2017 to form Deep Learning Indaba, an initiative to strengthen African machine learning (*Together We Build African Artificial Intelligence*, 2019, p. 4). The 2019 convention in Nairobi outlined key goals and plans for the future, including strengthening African participation in AI research, especially that of women. The report addresses a multitude of research across the globe, including natural language processing for South African Languages and AI algorithmic training on African masks (*Together We Build African Artificial Intelligence*, 2019, p. 10-11). This meeting shows an academic effort to better integrate the blossoming machine learning community into African society.

Due to Kenya's history of issues with terrorist attacks, specifically from Al Shabaab, the country has adopted the Prevention of Terrorism Act (Kapiyo & Githaiga, 2014). Due to this Act, Chinese firms have increased their overtures of soft loans for AI surveillance systems (Feldstein, 2019, p. 2). Huawei deployed 1,800 HD cameras and 200 HD traffic surveillance systems in Nairobi for police use (Feldstein, 2019, p. 18). Furthermore, Huawei has been heavily

involved in the training of Kenyan students in AI and ICT skills, reflecting the growing cooperation between China and Kenya (*Kenya hails Huawei's role in boosting youth ICT skills*, 2020).

Products and Applications

The products currently being used in Kenya mirror aspects of the Kenyan government's "Big Four Agenda" to improve development by harnessing AI and machine learning for food security and healthcare. New startups focus on leveraging AI for farming, sexual health, and improving financial services for the average citizen.

Collaborations

Many applications of AI that are currently in use in Kenya are international collaborations between African-based companies and companies from outside of the continent. These collaborative products focus on agricultural development and financial services.

Kenya has deployed projects such as Project FARM to advance food security and agricultural output. Project FARM is a data platform that uses AI to identify crop patterns and make recommendations via a mobile dashboard to small-scale farms in Kenya (Wilson, 2019). A collaboration between Agrics and Capgemini, this project optimizes crop production in order to increase global food supply (Wilson, 2019). As Kenya's agricultural sector makes up 26% of the country's total GDP, Project FARM both improves the economy and increases food security (Murray, 2019).

One example of a Kenyan company utilizing AI for financial services is Twiga Foods, based in Nairobi, which has created a product that provides financial services to kiosks and food stalls (Kinai, 2018). The company collaborated with IBM to build a blockchain-enabled finance lending platform that uses machine learning algorithms to predict creditworthiness by monitoring purchasing and repaying habits, giving financial institutions the necessary confidence to provide microloans to small businesses (Kinai, 2018). Similarly, M-Pesa uses a blockchain product for mobile phone-based money transfer and financing service launched by Safaricom, the largest mobile network operator in Kenya (Tachovsky & Sakha, 2019). These are two examples of the financial sectors use of blockchain and machine learning technologies.

Industry

Kenya is home to many startups that have created a range of AI products, such as Sophie Bot, an artificial intelligence chat bot that answers questions on sexual health (Mbaka, 2017). As another example, the UTU Trust API is a product that provides personalized recommendations for service providers by creating trust scores based on user data of relationships and past experiences (Ghosh, 2018; "Kenyan AI startup UTU raises $500k round from Japanese VCs," 2019). The Trust API uses AI and machine learning to develop a more efficient and human-like trust infrastructure for the Internet(*UTU Technologies*, n.d.). The creation of AI-enabled trust infrastructure will empower service providers in sectors where customer trust is important and encourage economic growth by improving trust between service providers (Katte, 2018).

Ethics

Although Kenya has begun developing a robust AI ecosystem, the country does not have any concrete legislation to moderate the ethical use of AI (Mputhia, 2018). The Kenyan

government has introduced legislation to protect user privacy and personal data, but has not implemented or established any concrete standards for AI ethics.

Kenya has begun the process of developing robust data privacy laws. It recently introduced The Data Protection Bill of 2018 and Computer Misuse and Cybersecurity Act of 2018. The Data Protection Bill's objective is to regulate the processing of personal data and ensure handling of personal data is minimized and secure, and that individuals have rights over their personal data in accordance with their constitutional right to privacy (*Data Protection Act*, 2018). The second act establishes the National Computer and Cybercrimes Coordination Committee, designed to protect the confidentiality and integrity of computers, and to prosecute those found guilty of cybercrimes (*Computer Misuse and Cybercrimes Act*, 2018). The act prevents the sharing of private health information, an important step towards ensuring user privacy (*Computer Misuse and Cybercrimes Act*, 2018).

Kenya also has several laws and agencies that are meant to combat corruption, such as the Anti-Corruption and Economic Crimes Act and the Ethics and Anti-Corruption Commission, but there are no specific accountability measures that specifically operationalize data ethics (Burt, 2018). The absence of this legislation is extremely concerning, especially considering Kenya's National Integrated Identity Management System as Kenya pursues mass collection of citizens' biometric data. The lack of legislative safeguards and security standards increases the probability that biometric data can be inaccurate or tampered with, potentially leading to fraud, misidentification, and civil exclusion (Burt, 2018). Without the presence of well-constructed legal framework, there are no limits to who can access this personal data, and gives governments the potential to exploit citizens' data for mass surveillance or discrimination (Burt, 2018).

The National Integrated Identity Management System plan is already riddled with controversy and pushback. In 2019, three Nairobi-based civil rights groups sued the Kenyan government in response to its implementation (Winsor, 2020). Kenya's high court ruled in January 2020 that the collection of DNA and GPS data for identification was unconstitutional, and that project's progress must be halted until the Kenyan government can produce a regulatory framework that ensures protection of privacy and equity to minorities (Winsor, 2020).

The adoption of AI into projects such as mass identification and affordable housing has many merits, but also introduces the risk of data bias and profiling (Klein, 2019). Ethnic or religious minority groups can face severe discrimination and delays in their applications, effectively being denied certain rights and services (Winsor, 2020). The Kenyan high court's ruling is a first step towards compelling the Kenyan government to create a baseline for ethical standards and fairness. Kenya should develop policy that encourages transparency and ethics-by-design in all stages of AI application, to ensure that data is unbiased and personal privacy is protected.

Recommendations for the U.S.

Stepping into a new crucial role as the continental leader of AI adoption, Kenya has the potential to become a burgeoning market for new technologies and provide crucial assets and services. The United States should recognize Kenya as a strategic collaborative ally and investment, as Kenya develops further AI capabilities in critical sectors such as transportation, health, agribusiness, and banking (Waweru, 2019).

The U.S. gives assistance to Kenya, and the state department describes the country as an important developing partner in East Africa (*U.S. Relations With Kenya*, 2018). However, the U.S. is not currently involved in joint research and development projects with Kenya. China, on

the other hand, has invested heavily in Kenya's infrastructure as well as its technological, agricultural and manufacturing sectors. A John Hopkins working paper series identified China's interest in Kenya to be motivated by security and economic reasons (Xia, 2019, p. 4).

The U.S. has begun to realize the strategic importance of Kenya. The Trump administration announced in February that it would begin free-trade deal talks with Kenya (Swanson, 2020). The U.S. should continue on this path of creating close economic and political ties with Kenya, but it should also recognize Kenya's strategic role in the development of AI and invest in joint research projects. Major U.S. companies such as Microsoft and IBM are already investing in the country's AI, and it is of strategic importance that the U.S. government becomes involved with the emerging AI regional power.

Furthermore, the United States must encourage Kenya to develop ethics standards around its AI technology. Without ethical safeguards, the Kenyan government could use the biometric data it collects to develop surveillance and monitoring capabilities, mirroring the Chinese-championed model of AI use, and undermining potential progress for greater economic and political stability in the country. Huawei has already offered loans to Kenya to set up its surveillance system (Dahir, 2019). The United States should quickly thwart this growing trend towards surveillance state status by becoming an active partner, especially because Kenya's privacy laws remain inadequate. As the sentinel of democratic values and ideals, the United States should work towards promoting the benevolent use of AI in tackling global issues such as food security and conservation.

Non-State Actors

By Sara Lee

Introduction

There is currently no evidence that non-state actors are utilizing AI in threatening ways, but historical trends of how these groups have adapted emerging technologies suggest that there is great potential for them to do so. This report examines three groups of non-state actors, chosen based on their relevancy to the United States: the Islamic State of Iraq and Syria (ISIS), white supremacist extremist groups, and digital scammers. While the two extremist groups share many similarities in the ways they can utilize new AI technologies, digital scammers present a new risk of leveraging AI to improve spear-phishing tactics.

Extremist Groups

ISIS and white supremacist extremists share a similar pattern in their use of digital tools and potential to maliciously exploit AI. Though there is no evidence these extremist groups are utilizing AI to further their agendas, current AI developments fit with historical trends of how these particular groups have adapted new technologies to their methods. Examining both groups' current digital capacity, potential for exploiting AI, and existing technologies can provide a clearer understanding of how they might pose detrimental risks in the field of AI.

The Islamic State of Iraq and Syria (ISIS)

ISIS has consistently demonstrated a propensity to adapt and weaponize emerging technologies, from encrypted messaging apps to civilian drones (Watson, 2017). It is likely that they and future like-minded groups will similarly adapt and weaponize emerging AI. ISIS serves as a key example of how successful employment of AI can aid the ambitions of non-national extremist groups. ISIS's history of utilizing digital tools will serve as an example for future actors, which is relevant as the conditions that enabled ISIS's rise persist today (Hellyer, 2019). It is worth noting that ISIS's extensive body of sympathizers lends it further resources, support, and expertise (Nussbaum, 2015). This adds a layer of complexity in determining the cyber capabilities of such groups, since these capabilities may extend beyond the scope of the organization itself.

The Islamic State is well known for its use of social media websites to communicate with the world and spread ideological messages. What sets ISIS's social media strategy apart from other jihadist groups is its targeting tactics. Although it has distributed content widely through public channels such as Twitter, YouTube, and Facebook, content is presented differently to target audiences (Gazis & Hymes, 2019). For example, propaganda targeted to western countries sports rhetoric appealing to individual heroism, while propaganda targeted to the mostly Arabic-speaking Muslim world appeals to religion (Gazis & Hymes, 2019). ISIS is also able to recruit specific talents by distributing content in local languages to areas rich in the skill sets they need (Calamur, 2019). They have used this strategy to target regions where certain needed skills, such as media skills, are commonly found (Calamur, 2019). For example, ISIS has spread propaganda in India, where skills such as graphic design are comparatively higher than other regions (Calamur, 2019). ISIS also has an all-female division with members who specialize in recruiting female fighters (Frayer, 2015). This level of targeted recruitment requires extensive human labor, which means that identifying vulnerable targets using AI may be attractive to extremist groups

such as ISIS. Advances in applying AI to sort through large data sets may enable extremist groups to target potential recruits through social media data sets and other publicly available information (Young, 2019). While data mining techniques are being applied by counterterrorism groups to identify pro-ISIS content online, similar techniques could also be used by ISIS for their own purposes (Abdullah et al., 2018). ISIS and other extremist groups could utilize data mining to more efficiently identity groups of people likely to be sympathetic to their cause.

For example, U.S.-based OpenAI labs noted the potential for extremist groups like ISIS to misuse their newly developed GPT-2 language predicting model, and chose not to release the full version due to fears of misuse by malicious actors (Radford et al., 2019). GPT-2 was trained on text written by humans and is able to predict which words may come next after a string of text, mimicking natural speech (Radford et al., 2019). If ISIS were to gain access to this sort of technology, they may be able to create AI-generated propaganda nearly indistinguishable from human-generated text, massively cutting the need for valuable human labor. Furthermore, they may also be able to train such AI to generate messages targeted to specific demographics.

White Supremacist Networks

Research from The Soufan Center suggests that white supremacist extremists organize transnational networks and utilize digital spaces in ways strikingly similar to jihadist groups (The Soufan Center, 2019). Like ISIS, white supremacist extremists have used online spaces to gather and target potential sympathizers. They have used encrypted messaging applications to anonymize communications, and utilized social media tools as components of violent attacks (The Soufan Center, 2019). Additionally, they have begun investing in anonymous cryptocurrency as a means of funding controversial activities that orthodox crowdfunding services may not support (Hayden, 2018).

The digital spaces of radicalization used by white supremacist extremists include YouTube, encrypted messaging apps such as Discord, gaming culture across the internet, and relatively unmoderated internet forums such as Reddit, 4chan, and 8chan (The Soufan Center, 2019). Additionally, there is evidence that young, white males are exposed to a disproportionately high amount of tailored social media content linked to white supremacist culture (Simon & Bowman, 2019). White supremacists have led coordinated efforts to inundate frequently trafficked websites such as social media sites with white supremacist content (Phillips et al., 2017). However, this content is visible to the general public, making the level of direct involvement from white supremacist extremists in targeting any particular demographic unclear. It is possible that this correlation is due to social media algorithms associating high numbers of young, white males with white supremacist extremist interests to mean that anyone in this demographic may be interested in such content. Nonetheless, AI trained to spread white supremacist content targeting this demographic may be attractive to white supremacist extremists. Furthermore, flooding highly public websites with images and content is a common tactic used by white supremacists, and is made possible due to a high level of coordination enabled by forums such as Reddit, 4chan and 8chan, and Discord (Phillips et al., 2017). This coordination is sophisticated enough that white supremacist 4chan users were able to make a swastika “trend” on Google by flooding the site with searches (Dewey, 2014). These types of attacks would be more efficient and more massive in scale if aided by the use of AI.

Due to their discriminatory values, white supremacists could introduce tainted data to existing AI systems to carry out attacks on certain groups. Algorithmic bias across a broad spectrum of AI applications has been shown to unintentionally favor white, cisgender men

(Hoffmann, 2018). Although algorithmic bias is generally an undesirable byproduct of human bias, its consequences make room for the threat of malicious actors intentionally planting biased data (Yeung, 2018). This type of attack is known as adversarial machine learning and is generally difficult to detect, as algorithms will function as intended except in certain specific conditions (Goodfellow et al., 2017). For example, an autonomous vehicle could be trained to drive normally but swerve off the road when shown a specific license plate, or an image classification algorithm could be trained to output a particular classification when a few, undetectable pixels are modified (Knight, 2019). White supremacist extremists could employ adversarial machine learning by deliberately tainting training data to target people of color and women, including or excluding them from certain services or attacks. Similar to ISIS, white supremacists could also make use of synthetic text generators like OpenAI's GPT-2 to distribute content en masse.

Digital Scammers

Digital scammers often use traditional phishing schemes on emails and websites to gain sensitive data from recipients through social engineering techniques (*Report Phishing Sites*, n.d.). When executed by humans, phishing attacks are most efficient when a general message is sent to a wide array of recipients, with the hope that a few of them will fall for the scam. It is estimated that between 5 to 14% of phishing email recipients click on embedded malicious links (Seymour & Tully, 2016). A less efficient type of attack is spear phishing, where a particular target is thoroughly researched, so that the attacker can craft a tailored message that appears to be written by a trusted contact of the target (Future of Humanity Institute, 2018). Since this type of attack is more labor-intensive, the vast majority of phishing attacks are general phishing attacks (Future of Humanity Institute, 2018). However, spear phishing targets are often high-profile actors with particularly valuable data, and the effort of tailoring spear phishing messages results in a 45% click rate (Seymour & Tully, 2016).

Advancements in AI are likely to increase the prevalence of spear phishing attacks as computers become better trained to profile individuals and output natural-sounding text, leading to more sophisticated spear phishing schemes that can reduce the need for human labor (Future of Humanity Institute, 2018). Applications of AI in spear phishing schemes have already been developed for use in research, such as John Seymour and Philip Tully's Social Network Automated Phishing with Reconnaissance, or SNAP_R, bot (Seymour & Tully, 2016). SNAP_R utilizes machine learning trained on Twitter profiles to determine which accounts in a sample are most likely to engage with a spear phish tweet (Seymour & Tully, 2016). Variables considered for each profile include number of followers, number of retweets, most active time of day, geotagged locations, job titles, and frequently engaged topics (Seymour & Tully, 2016). Using this data, SNAP_R was able to send tailored tweets directly to target users, containing information related to a topic the user was likely to engage with, along with a link disguised by the now-discontinued Google URL Shortener service, goo.gl (Seymour & Tully, 2016). Seymour and Tully found that of those targeted with a SNAP_R spear phish tweet, between 30% and 66% clicked on the embedded link, compared to the 5-14% of general phishing campaign targets and 45% of human-engineered spear phishing targets who click on malicious links (Seymour & Tully, 2016). Individuals or groups may be motivated to phish for personal data to sell for profit or to gain access to sensitive information. With an efficient way to engineer spear phishing campaigns, the landscape may see a rise in high-profile individuals being targeted in sophisticated scams through AI.

Recommendations for the U.S.

ISIS, white supremacist extremists, and spear phishers are malicious actors that pose threats to the United States. Since they are not currently utilizing AI maliciously, the United States can prepare for future threats by continuing research and educational efforts.

The United States should continue development and deployment of counterterrorism AI. Advanced counterterrorism AI can continue to fight online radicalization even in the event that extremist groups begin to use AI maliciously, especially if the counterterrorism AI is more sophisticated than the malicious AI.

The United States should invest research in natural language processing to gain a better understanding of ways synthetic text can be distinguished from natural text. This will allow for the development of defensive AI that can target bot-generated propaganda in the event that extremists begin to utilize AI to create and distribute information.

The United States should increase investment in anti-phishing education and adapt existing advice to account for the introduction of AI and social media phishing to the landscape. Successful phishing schemes can be prevented if individuals learn to identify malware embedded in phishing messages. Education and spreading awareness, especially among high-profile actors, can help protect valuable data. The shifting landscape to involve automatically generated phishes on unorthodox platforms such as Twitter calls for education to accommodate these changes.

Russia

By Asia B. Lara

Introduction

Russia is an AI superpower with a medium level of AI development, based on its fast-growing AI research and development landscape and high levels of AI applications. Russia's AI landscape is primarily focused on national security, robotics, and economic development. The Russian government has low engagement with AI ethics, as demonstrated by a lack of data privacy regulations and ethics conversations. Russia acts as an AI potential risk to the United States due to Russia's orientation towards the aggressive application of AI into its national security strategy. Table 10 summarizes findings on Russia's AI readiness, research and development, products and applications, and ethics.

Table 10: Summary Findings, Russia

Government AI Readiness	
Level AI Development	Medium
Oxford Insights AI Readiness Score	6.748
Presence of Strategy Documents	Yes
Presence of Dedicated ICT Department	Yes
Research and Development	
Amount of Investment	High
Density of Collaborations	Medium
Products and Applications	
Government Orientations	National security, robotics, economy
Industry Orientations	Development
Ethics	
Level of Government AI Ethics Involvement	Low
User Data Privacy Laws	No
AI Ethics Reports	No

Background

Russia is a federal semi-presidential republic with a population of approximately 146,793,744 people as of 2019, including Crimea and Sevastopol City, and an electrification rate of 100% (*Access to electricity (% of population)*, 2017). Russia earned a score of 6.748 on the Oxford AI Readiness Index. Russia is actively prioritizing investment and research in AI and hosted a conference on AI in 2018 between various federal and academic bodies to lay the foundation for a national strategy that was officially approved on October 28th, 2019.

Russia's Soviet-era legacy continues to influence its modern-day bureaucracy, in that institutions and decision-making processes are largely controlled by powerful technocrats. Indeed, Russia's pursuit of AI has proven to be heavily state-driven, which has hindered the growth of a robust private sector conducive to AI development (Bendett, 2019c). Russia has yet to realize the full potential of its extensive pool of high-tech and STEM talent. Because of the state's heavy hand in the private sector, the market lacks the commercial investment and competition that have driven AI success in other countries. As a result, AI and other

technological breakthroughs are constrained by an anemic flow of innovation (Bendett, 2019c). The state is now actively channeling funds into high-tech research in the hopes of remedying these shortcomings (Sayler, 2019, p. 24).

Although the country still lags significantly behind the United States and China in AI development, a number of AI initiatives have been undertaken which have yielded impressive results. Many of these initiatives are private-public collaborations, with heavy emphasis on national and domestic security applications. Electronic and information warfare have become critical aspects of Russian foreign policy toward the United States as part of the legacy of strained tensions following the Cold War-era (Polyakova, 2018). The implications of these developments for the United States and the broader global order are monumental, carrying the potential to radically reorganize long-standing axes of political power.

Government Policy

Despite clear intentions of developing AI primarily for national and domestic security applications, official government policy is rife with significant omissions and direct contradictions that point to the overall lack of transparency regarding the Russian government's AI agenda.

Position on Domestic AI

The Russian state has made it clear that it will be taking the lead in the Federation's development of AI through the National Strategy for the Development of Artificial Intelligence Over the Period Extending up to the Year 2030, approved by President Putin in October 2019 (*National Strategy*, 2019). The Strategy puts forth a number of short-term and medium-term goals, including measures aimed at using AI to protect national interests and implementing strategic national priorities, including scientific and technological development to build Russia into a leading AI power (*National Strategy*, 2019). The provisions of the strategy extend to various other government programs, namely the Strategy for the Development of an Information-Oriented Society in the Russian Federation During the Years 2017-2030, the Digital Economy of the Russian Federation, and the National Technology Initiative (*National Strategy*, 2019).

The Strategy emphasizes increasing research and development for AI applications in the economic, industrial, public services, healthcare, and education sectors. Notably, the Strategy contains no direct mention of the extensive efforts currently being undertaken by the state for AI applications in national security and defense. The Ministry of Defense, governing body of the Russian Armed Forces, has maintained a leading role in national AI decision-making. In fact, the Ministry of Defense, together with the Ministry of Education and Science and the Russian Academy of Sciences, held an AI conference that produced a set of ten recommendations, which include holding a series of military games to test AI models and integrating AI proposals into domestic military forums (*Conference "Artificial Intelligence"*, 2018). Furthermore, President Putin has been cited saying that the development of Russian weapons should be accompanied by the active use of AI technologies as well as the expansion of drones, laser, hypersonic, and robotics systems (*Putin Believes Use of AI*, 2019). From these statements and actions made by the Russian defense sector, it is clear that the development of AI for national security purposes is a priority.

Position on International AI

Russia is actively pursuing the development of lethal autonomous weapons systems, so-called "killer robots", and has opposed proposals for the regulation of their use (Sharkey, 2018). Russia was the only state to block a proposal for two full weeks of deliberations on autonomous weaponry last year, insisting that "our delegation cannot agree with the alarmist assessments predicting that fully autonomous weapons systems will inevitably emerge in the coming years", contrary to what high-ranking Russian officials and domestic weapons manufacturers have announced (Sharkey, 2018). General Gerasimov, the Chief of the General Staff of the Russian Armed Forces, has even commented that "the use of robots will be one of the main features of future wars" and that "Russia is seeking to completely automate the battlefield" (Sharkey, 2018). This contradiction is only one of several other factors adding to the lack of transparency around what Russia's autonomous weaponry capabilities actually are.

Research and Development

Russian R&D is experiencing a revival as higher levels of resources are being funneled to public-private collaborations, industry leaders, and top universities to ramp up AI innovation. Furthermore, Russia has announced plans to engage with its allies in order to deepen international collaborations and exchange knowledge.

Collaborations

The Russian Federation has demonstrated an aggressive commitment to the development of AI, with investments in the field surging from 12.5 million USD in 2017 to 1.4 billion USD in 2019 (Ahmed et al., 2019, p. 171). The majority of public-private efforts originate from the Russian Ministry of Defense in collaboration with private tech companies. For example, the National Technology Initiative is a state program fostering high-tech innovation by supporting start-ups and creating development centers. The National Technology Initiative's Center for Artificial Intelligence specifically focuses on developing areas such as deep machine learning, autonomous devices, and "smart" networks (Bendett, 2019a). In addition, the state has announced plans to create a Military Innovative Technopolis, called the Elite of the Russian Army, where the military and private sectors can collaborate to build AI infrastructure, the current lack of which serves as a major impediment to Russian AI proliferation (Ahmed et al., 2019, p. 175).

Another noteworthy private-public collaboration has taken place between the Moscow City Municipality and Sberbank, Russia's largest bank "to create a new platform that it will use to conduct experiments in AI and big data…under a special legal framework" (Gaaze, 2019). This initiative will serve a dual purpose of revitalizing the economy and producing targeted internet content by using anonymized data. However, this could produce major political ramifications as the use of AI and big data will allow for the privatization not only of certain economic sectors, but of an entire digital platform overseeing the country's socioeconomic development (Gaaze, 2019). The ethical implications of using big data to influence human behavior and emotions are alarming and demand further discussion.

Much talk of future AI military applications being developed by Kalashnikov Group, Russia's main defense contractor, is circulating global media. In mid-2017, Kalashnikov announced plans for the development of a series of autonomous weapons based on neural networks that will be able to track and engage targets without human control (Sharkey, 2018). As

the makers of the famous AK-47 rifle, they are also planning on releasing a robotic gun system that consists of a rifle connected to a console that harvests image data to make decisions (Sharkey, 2018). Kalashnikov is only one of several Russian defense companies working to integrate AI self-learning into various weaponry systems, including unmanned vehicles, military suits, and robotics. Despite all the media attention, few actual products have been officially released.

Industry

The country's private sector is experiencing a technological revival, largely due to its growing pool of STEM talent and commitment to AI development. The Russian Direct Investment Fund, Sberbank, Gazprom Neft, Yandex, Mail.ru and MTS established the country's first cross-industry alliance committed to AI development (*RDIF, Sberbank, Gazprom Neft*, 2019). This alliance came into effect after the signing of a Cooperation Agreement by senior management at Eastern Europe's largest AI forum, called the AI Journey, in November 2019 (*RDIF, Sberbank, Gazprom Neft*, 2019). These industry leaders have committed themselves to spur the development of AI solutions, facilitate the development of a dynamic AI market, take leadership positions on global AI markets, coordinate between industry and research organizations to implement the National AI Strategy, and aid other organizations that create and introduce AI solutions (*RDIF, Sberbank, Gazprom Neft*, 2019). These moguls collectively represent the nation's leaders in development, linking financial institutions and oil suppliers to internet providers and telecommunications groups (*RDIF, Sberbank, Gazprom Neft*, 2019). Each organization has previously engaged in various AI initiatives of their own but have yet to set out a concrete plan for how to merge their efforts.

Despite U.S.-Russia tensions, Sberbank and Microsoft announced in October 2019 their plans to jointly work on the creation of AI algorithms and robotics in the banking sector (*Sberbank, Microsoft to Conduct Joint Research*, 2019). More specifically, the Microsoft Research Lab in Redmond, Washington will be collaborating with a Russian company for the first time (*Sberbank and Microsoft Joining Hands*, 2019). This is especially contentious given that Sberbank is state-owned, with the Russian government having a heavy hand in its dealings. Nonetheless, Sberbank is already employing AI technologies in other areas of its business, setting the company leaps ahead of its competitors in the field.

Academia

Russia's top universities have taken a strong lead in advancing AI-related academia. The annual Russian Conference on Artificial Intelligence, held since 1988, is organized by the Ulyanovsk State Technical University, the Russian Academy of Science, and the Russian Association of Artificial Intelligence (*Russian Conference on Artificial Intelligence*, n.d.). Selected high-quality papers of the Russian Conference on Artificial Intelligence are published in a variety of languages (*Russian Conference on Artificial Intelligence*, n.d.). Another notable development is the National Research Nuclear University's "Virtual Actor" technology, which will incorporate AI to have both narrative and emotional capabilities (Ahmed et al., 2019, p. 172). Despite these undertakings and the high level of administrative support behind them, it is telling that there remains scant Russian language academic research on AI to date, suggesting that this area of development is still in its beginning stages.

Country-to-country

Large corporations from other countries have launched partnerships in recognition of Russia's growing high-tech and STEM talent. Examples include Samsung Electronics' newly established AI Center in Moscow, and a Saudi Aramco-Gazprom Neft agreement to establish an AI project in hydrodynamic modeling of oil deposits (Ahmed et al., 2019, p. 172; *Gazprom Neft, Saudi Aramco*, 2019). Furthermore, Russia and China are deepening bilateral ties through a high-tech partnership to fix domestic deficiencies and compete with the United States (Bendett, 2019). AI is emerging as a new priority in cooperation, as has been demonstrated by numerous statements from representatives of both countries (Bendett, 2019). These partnerships among others demonstrate the international prominence of Russia as a growing AI powerhouse.

Products and Applications

Despite the onslaught of R&D initiatives undertaken, few actual AI products have been publicly launched or widely deployed. Military applications of AI are still largely in the development and testing stages, while commercial applications of AI are beginning to surface on the market.

Collaborations

Based on comments made by the Putin administration, it has become clear that the state is pursuing AI primarily for conventional military applications and information warfare applications (Ahmed et al., 2019). The Russian military is already incorporating AI into various weapon systems, including missile bombers such as the Tupelov Tu-22M3M, fighter jets such as the Su-25SM3, and unmanned systems such as the Solaris-N (Ahmed et al., 2019, p. 175; *Russian Upgraded SU-25*, 2019; *Russia's Upgraded TU-22M3*, 2018). Military intervention in Syria has served as a testing ground for many of these unmanned systems to perform a variety of high-risk tasks, including demining, reconnaissance, and intelligence gathering on American and other western assets in the region (Bendett, 2018). Despite several announcements of other military AI applications, most remain in the developmental and testing stages and have yet to be deployed on a large-scale.

Industry

Although the state and academic sectors have dominated Russian AI development, the private sector is beginning to follow suit and shifting focus to AI trends. Due to the available talent pool, start-ups using AI technologies occupy 16% of the market, specializing mainly in machine vision, natural language processing, text analysis, chatbots and speech recognition, according to a 2017 study by Science Guide (*Artificial Intelligence*, 2018). In this arena, N-Tech.Lab has emerged as a frontrunner after developing an advanced facial recognition system using neural networks called the FaceN algorithm (Ahmed et al., 2019, p. 172). This algorithm has not only been offered to Russia's commercial partners, such as China, but is also used domestically as a major tool in surveillance operations by Russian law enforcement agencies. Moscow alone has approximately 170,000 cameras, at least 5,000 of which have been outfitted with FaceN technology (Polyakova, 2018). Although several other companies have begun to advertise various products incorporating AI, few have yet to market at a level of success that N-Tech.Lab has achieved.

Ethics

President Putin has repeatedly emphasized the importance of mass collection and unrestricted access to citizen data to streamline AI development (*National Strategy*, 2019). Although the data sources for these initiatives have not been explicitly revealed, Russia's weak privacy laws and extensive surveillance systems suggest that a large pool of data is available for state use (Ahmed et al., 2019, p. 72). The installation of Russia's mass surveillance system, the System for Operative Investigative Activities, at key internet locations allows for the monitoring of online activity at an unprecedented level (Ahmed et al., 2019, p. 87). The System for Operative Investigative Activities' "black boxes" duplicate online traffic to send a copy to Federal Security Service servers for further analysis (Ahmed et al., 2019, p. 87). The Semantic Archive Platform, provided by Russian software developer Analytical Business Solutions, aids security services in this process by aggregating, processing, and analyzing open-source online data for key words and other red flags (Ahmed et al., 2019, p. 91). Input from the System for Operative Investigative Activities along with strict data storage requirements provide a strong infrastructure and legal basis for data mining.

Mass collection of datasets, as well as federal access to them, is outlined in a series of data localization laws that are criticized for their vague and ambiguous nature. The most notable of these laws, the 2016 Yarovaya Amendments to the 2014 User Data Storage Law, mandates that internet and telecom companies store communication metadata for anywhere from six months to three years, and that this data be disclosed to authorities upon request and without a court order (Ahmed et al., 2019, p. 66). Furthermore, the law carries anti-encryption provisions, requiring all email and messaging service providers to install encryption backdoors (Ahmed et al., 2019, p. 66).

Although Putin has suggested drafting moral standards for AI-human interaction, little substantive action has been undertaken by the Russian government. For example, President Putin has called for the removal of legislative barriers to allow the use big data for AI development, adding that "We must find a balance between the maximum exposure of information and people's rights to the protection of this information where they think their privacy must be ensured" (*Conference on Artificial Intelligence*, 2019). The authoritarian-democratic political regime of Russia suggests that ethical standards are direly needed before the actual implementation of AI technologies.

Evidence is abundant in other areas where the Russian state has unethically used the digital realm to further its own agenda of heavy state promotion. The Russian state consistently uses covert and plausibly deniable mechanisms to conduct information manipulation and content production (Ahmed et al., 2019, p. 62). The state has also been found to use extralegal means, including the use of youth organizations, third-party botnets, independent hackers, and DDoS attacks, to shroud its actions (Ahmed et al., 2019, p. 62). Content production often focuses on narrative framing and agenda setting, flooding the media with a combination of both fake and real news to drown out criticism and promote the regime (Ahmed et al., 2019, pp. 67–68). By using such techniques, the Russian government is able to keep up the façade of a relatively unrestricted digital environment while still exerting significant control over online content and narratives (Ahmed et al., 2019, pp. 67–68). The likelihood that the state will utilize the same mechanisms to shroud unethical applications of AI technology is alarmingly high.

Recommendations for the U.S.

The strained relationship between Russia and the United States has given rise to a growing concern that Russia could use AI to further disrupt U.S. political processes, especially in the upcoming 2020 presidential election. The use of information warfare is an area that Russia has spearheaded globally, resulting in the blurring of lines between conventional and nonconventional warfare, as well as those between war and peace, resulting in the emergence of a grey zone (Polyakova, 2018). Deep fakes, synthetic data generated using AI, are becoming increasingly sophisticated and realistic. U.S. House Intelligence Chairman Adam Schiff commented that Russia could take advantage of this technology in a "severe escalation" of its disinformation campaign to stir up existing tensions or decrease citizen confidence (O'Sullivan, 2019). This was made apparent by the creation of the Internet Research Agency in 2013, an organization used to set up a swarm of fake social media accounts, messages, and posts acting as American citizens in order to incite conflict and influence public opinion (Thompson & Lapowsky, 2018). However, Russia has repeatedly denied any interferences in the U.S. political system, stating that such allegations are fabricated to advance domestic political agendas and detract the public from pressing societal issues (Thompson & Lapowsky, 2018).

To prepare for a deterrence strategy against this form of nonconventional warfare, the United States should mandate an immediate review of current tools used to combat disinformation campaigns. To protect the line between public and private sector in the United States that is so clearly lacking in Russia, guidelines should be set to work with social media companies on expanding the resources they have to identify and combat false accounts. Furthermore, a clear set of baselines for what does and does not warrant a response should be made and communicated publicly to the Russian government. In order to do so, policymakers must be equipped with a comprehensive understanding of Russian society, culture, and perceptions of the United States to avoid any fatal miscommunications and respectfully navigate differences.

Another source of concern is the aggressive application of AI into Russian military capabilities, especially nuclear ones. Several defense experts have reported that Russia may already be integrating AI into a nuclear-armed and powered unmanned underwater vehicle, dubbed Poseidon, to make it autonomous (Yonah, 2019). The risks that accompany AI technology could cause irreversible damage, especially if AI is compromised by hackers, technical errors, or misjudgments. Given the rapid integration of AI, the potential for mistakes or oversights in the implementation process is far too high. Comprehensive risk analyses must be thoroughly researched, conducted, and made public before the deployment of any AI weaponry. Along these lines, the call for an international agreement surrounding the military application of AI has never been so dire. In this context, the United Nations, with the International Court of Justice as its counterpart, can take a leading role in mediating such discussions. The United Nations' role in the reconciliation between the United States and Russia following the end of the Cold War could serve as a strong precedent to a future reconciliation of current differences regarding AI applications.

Singapore

By Rosie Sun

Introduction

The Republic of Singapore is a leading regional AI power with a high level of AI development, based on its robust AI research and development landscape and high levels of artificial intelligence applications. Singapore's AI landscape is primarily focused on transportation, smart city services, healthcare, education, and security. The Singaporean government has high engagement with AI ethics, as demonstrated by the presence of the Model AI Governance Framework published in 2019 and revised in 2020. Singapore acts as an AI potential ally to the U.S due to its well-established AI ecosystem and neutral political ties with major AI superpowers. Table 11 below summarizes findings on Singapore's AI readiness, research and development, products and application, and ethics.

Table 11: Summary Findings, Singapore

Government AI Readiness	
Level AI Development	High
Oxford Insights AI Readiness Score	9.186
Presence of Strategy Documents	Yes
Presence of Dedicated ICT Department	Yes
Research and Development	
Amount of Investment	High (per capita)
Density of Collaborations	High
Products and Applications	
Government Orientations	Transport and logistics, Smart Cities and municipal services, healthcare, education, and border security
Industry Orientations	Healthcare, education, and finance
Ethics	
Level of Government AI Ethics Involvement	High
User Data Privacy Laws	Yes
AI Ethics Reports	Yes

Background

The Republic of Singapore is a powerful city-state with a unitary parliamentary republic government based on the Westminster system. It has a population of 5,703,600 people as of 2019, and an electrification rate of 100% according to the World Bank (*Access to electricity*, 2017; *Population and Population Structure*, 2019). Singapore earned a score of 9.186 on the Oxford AI Readiness Index, ranked 1 of 194 countries (*Government AI Readiness Index 2019—Oxford Insights*, n.d.). Singapore's volume of data is less than that of more populated countries, putting it at a disadvantage in the data-driven AI industry. Therefore, Singapore excels as an AI power by focusing on building an AI ecosystem through nurturing AI talents and setting critical development milestones, while managing ethical concerns and establishing practical guidelines for AI development. Oxford Insights recommends that Singapore's clear framework on AI ethics

should be referenced or considered by other governments when they establish their own AI strategies (*Government AI Readiness Index 2019—Oxford Insights*, n.d.).

When it comes to scientific development and research in Southeast Asia, Singapore has the reputation of being at the forefront of technological advancement. Due to the nature of its single layer bureaucratic structure, meaning that there is only a single national and local government with minimal bureaucratic complexity, Singapore's AI foundation follows a simple top-down approach and is extremely efficient and agile. Half of the Cabinet studied STEM in university, affording a technological understanding to the government that allows it to make insightful decisions and streamline its digital agenda. Its long-standing orientation towards technological advancement also allows Singapore to obtain strong digital foundations and literacy to help cultivate an AI ecosystem (*Smart Nation | Speeches—Smart City Expo World Congress 2019, Barcelona*, 2019).

Government Policy

With its Smart Nation initiative established in 2014, Singapore hopes to not only harness tech-enabled solutions to transform the quality of living, but also a digital society that drives science and technological growth, maintaining its competitive advantage by keeping Singapore at the cutting edge of scientific innovation. In November 2019, Smart Nation Singapore identified artificial intelligence as the next key element to Singapore's smart journey by spelling out its domestic AI plans in detail through the National Artificial Intelligence Strategy (*National Artificial Intelligence Strategy*, 2020). Singapore will focus on the deployment of AI by emphasizing five major sectors: transport and logistics, smart cities and municipal services, healthcare, education, and border security (*Smart Nation | Speeches—Smart City Expo World Congress 2019, Barcelona*, 2019). Internationally, Singapore has no clear stance on banning lethal autonomous weapons.

Position on Domestic AI

Singapore's domestic stance on AI is guided by the National AI Strategy launched in 2019 by Smart Nation Singapore, which aims to improve civilian lives and promote economic growth through deploying scalable AI solutions into the city. The strategic document outlines plan to build an AI-enabled digital society by focusing on five national projects that concentrate on transportation, smart city services, healthcare, education, and border security (*National Artificial Intelligence Strategy*, 2020). By 2030, Singapore is expecting to see scalable deployment in areas such as intelligent freight planning to improve logistics effectiveness, AI sensors and chat boxes to efficiently maintain and report municipal issues, AI-enabled chronic disease prevention and management, adaptive learning and assessment in education, and facial recognition to support customs at borders (*National Artificial Intelligence Strategy*, 2020).

As Singapore aims to be a leading power in scalable AI solution development and deployment, its strategy to achieve this goal lies in harnessing the AI ecosystem. Collaboration is common with different government and academic sectors, as well as the establishment of joint labs with businesses and the promotion and training of AI talent (Sharma, 2017). Multiple governmental departments and programs have launched to support the building of such an ecosystem. With technological research efforts heavily centralized and supported by the National Research Foundation– a department within the Prime Minister's Office that establishes research and development guidelines and funds strategic initiatives– the foundation invested $14 billion

for the Research, Innovation, and Enterprise 2020 Plan, funding technological research and advancement in Singapore from 2016 to 2020 (*RIE2020 Plan*, 2019; Sharma, 2017).

As a result, AI Singapore, a national AI program established to support AI research and nurture AI talents, was launched by a governmental-wide partnership between actors like the National Research Foundation, Smart Nation Singapore, and the Economic Development Board, with the support of leading academic research institutions such as the National University of Singapore, Nanyang Technological University, and Singapore Management University (*About Us—AI Singapore*, n.d.). In addition, GovTech was established under the Prime Minister's Office to reinforce the digital infrastructure and implement solutions harnessed by Smart Nation (*Government Technology Agency*, n.d.). Along with the establishment of these government-led programs, businesses and individuals are encouraged to take part in this journey through various channels, including pitching a national AI project to the government directly, adopting technology capabilities and digital infrastructure within businesses through various programs, participating in the AI ecosystem by working with research institutions or incubating AI talent, and keeping up with AI trends by continuously learning through government-supported AI programs (*About Us—AI Singapore*, n.d.; *Government Technology Agency*, n.d.; Cheok, 2017). This initiative has also encouraged the government to directly work with tech start-ups by purchasing and using their products rather than supporting them with grants (M. Cheok, 2017).

Position on International AI

Singapore does not have a known stance on the ban of fully autonomous AI weaponry. According to the Campaign to Ban Killer Robots, Singapore is neither on the list of countries that calls to fully ban autonomous weapons nor on the list to oppose them as of 2018. Singapore did not speak on this topic at the meetings of the Convention on Certain Conventional Weapons in Geneva (*Country Views on Killer Robots*, 2018).

Research and Development

Singapore's AI landscape is primarily focused on transportation, smart city services, healthcare, education, and security, which is supported by an AI ecosystem of talent, academia, and research. AI Singapore has been established to facilitate Singapore's AI capabilities, and companies are encouraged to work with academia to develop and deploy scalable AI solutions.

Collaborations

Singapore's AI collaborations are largely supported by the government, including the most crucial government-led AI program, AI Singapore, which focuses on cultivating AI talent, promoting AI investment, and addressing challenges through AI implementation. The Research Innovation Enterprise plan of 2020 allocates $5.7 billion to support academic research, increases in manpower, and innovation of enterprise, which could all support the development of AI (*RIE2020 Plan*, 2019). With the focus on manpower, the National Research Foundation collaborated with the Smart Nation to launch AI Singapore in May 2017. This national program facilitates Singapore's AI capabilities by collaborating and incubating AI R&D with Singapore-based research institutions and AI start-ups to support AI research and nurture AI talent. An example would be its 100 Experiments initiative, which helps Singapore-based business enterprises to adopt AI solutions by supporting them with AI researchers and engineers (*AI Innovation | AI Singapore*, n.d.). It is expected to invest up to 150 million SGD over the next five

years to address major challenges that affect society, such as shortfalls in transportation and healthcare, by using AI capabilities (*About Us—AI Singapore*, n.d.; Remolina & Seah, 2019).

To accomplish these goals, AI Singapore plans to upskill all of Singapore's AI capabilities through education and investing in company research. As the major AI education institution in Singapore, AI Singapore launched two initiatives, namely AI for Everyone, a free 3-hour workshop available bi-monthly for all working professionals and Singapore-based population, and the AI Apprenticeship Programme, a 9-month full-time apprenticeship that is exclusive to Singaporeans. This vast governmental support helps create a robust AI ecosystem, attracting industries interested in AI to base their research facilities in Singapore.

As the city-state supports an AI ecosystem of talent, academia, and research, it has attracted industry to invest in AI R&D centers in Singapore. Companies often choose to work with the government and universities to train AI talent through real-world data and projects. In 2018, the Chinese e-commerce giant, Alibaba, launched a joint research center with Nanyang Technological University called the Alibaba-Nanyang Technological University Singapore Joint Research Institute (Hong, 2018). The center is strongly supported by the Economic Development Board of Singapore and aims to develop AI applications and test them on the Nanyang Technological University's campus (Choudhury, 2018). In addition, the Alibaba Talent Programme was launched through the Economic Development Board Industrial Ph.D. Programme, offering prospective Ph.D. students the opportunity to participate in research projects at Alibaba while studying at Nanyang Technological University (*Alibaba launches talent programme in Singapore with support from NTU, EDB*, 2018). Although Alibaba refused to disclose how much it would invest in the lab, they previously announced that they will spend $15 billion on global research and development efforts, including opening an R&D office in Singapore (Choudhury, 2018).

According to Alibaba's Press Release, the collaboration is expected to spend millions of dollars every year for the first five years, with an initial pool of 50 researchers to develop solutions for homes, retail, transportation, and nursing homes and hospitals (*NTU Singapore and Alibaba Group Launch Joint Research Institute on Artificial Intelligence Technologies*, 2018). With the goal of achieving a healthier and smarter city life, the joint institute seeks to combine Alibaba's expertise in natural language processing, machine learning, and cloud computing with NTU's human-centered AI technology, which was previously used to develop health solutions in aging communities (*NTU Singapore and Alibaba Group Launch Joint Research Institute on Artificial Intelligence Technologies*, 2018). By partnering with Singapore, Alibaba has set its ambitions on leveraging technology for the betterment of the community, developing real-life solutions for a growing business target segment, such as disease prevention and health solutions for aging communities. In 2019, Dr. Rong Jin, the head of Machine Intelligence Technologies at Alibaba's Damo Academy stressed in an email with Channel News Asia that "we are already witnessing the fruits of this collaboration via an artificial companion for the elderly currently under development, to tackle the urgent issues from [Singapore's] aging society," implicating the positive outcome of the joint institute (Kwang, 2018).

In addition to the Chinese tech giant's AI development efforts in Singapore, leading American tech companies are also taking the initiative to collaborate with the Singaporean Government. Microsoft announced its collaboration with AI Singapore called the Microsoft-AISG Joint Innovation Program. The joint program is a three-year initiative that emphasizes upskilling professionals, managers, executives, and technicians with AI expertise as well as developing AI-powered projects (*Microsoft, AI Singapore and NUS to develop and reinforce*

Singapore's AI capabilities, 2018). This initiative facilitates three key actionable programs: the AI Immersion Program which supports professionals with new AI skills and job placement, AI for Real which trains talents by providing hands-on real-life AI projects, and AI for Research which conducts workshops on AI for Good initiatives and identifies socially beneficial AI-powered projects (*Microsoft, AI Singapore and NUS to develop and reinforce Singapore's AI capabilities*, 2018). By equipping professionals with AI skills, the program strengthens Singapore's AI ecosystem, creating mutual benefits for both the city-state and businesses.

Other collaborations between government agencies, companies, and universities seek to address problems in healthcare such as disease control and diagnoses of chronic disease. In 2018, Singapore's National Environment Agency launched a joint field study with Verily Life Science, formerly known as Google Life Science, in efforts to sort and release male Wolbachia mosquitoes efficiently (Goh, 2018). This project aims to use AI-technology to accurately separate female and male Wolbachia mosquitoes to suppress the urban Aedes aegypti (yellow fever) mosquito population and effectively combat dengue disease by decreasing the overall population of mosquitoes (Goh, 2018).

Other than the disease control studies, SELENA+, an AI-enabled Deep Learning System for eye screening that can automate the process of diabetic retinopathy screening, has been developed by the Singapore National Eye Centre, Singapore Eye Research Institute, and the National University of Singapore to replace human assessment while increasing the efficiency and accuracy of retinal classification (Kwang, 2018). The system has been validated on nearly 500,000 retinal images and is still currently in beta testing phase and is used along with human graders to become the first nationally-adopted automated screening solution (Kwang, 2018; *Retina Images for Diabetic Retinopathy and Glaucoma – NUS AI Lab*, n.d.).

Lastly, collaborations also seek to find solutions in improving efficiency in transport and logistics. Grab, the biggest rideshare company in Southeast Asia based in Singapore, also collaborated with the National University of Singapore to establish its first AI research and development center, the Grab-National University of Singapore AI Lab (J. Cheok, 2018). With an initial investment of $6 million, the lab is expected to use big data and AI algorithms to analyze passenger behavior and preference to better model and predict traffic, bringing insights to improve the city-state's mobility by developing richer maps and identifying traffic patterns (J. Cheok, 2018). The joint lab works together with the Industrial Ph.D. Programme, training selected Ph.D. students from the National University of Singapore to thrive as AI talents.

The Singaporean government has also been working with companies to develop driverless buses and trucks since 2010 (Abdullah, 2019). In fact, West Singapore is opening up more than 600 miles of public roads as testing grounds for autonomous vehicles in the early 2020s (Abdullah, 2019). Singapore has launched its autonomous vehicles in the famous Gardens by the Bay as shuttles and has been testing out autonomous buses by running them on university campuses as shuttles (*News– ST Engineering Unveils New On-Demand Autonomous Shuttle*, 2019; Wei, 2019). All of these projects and programs echo the government's National AI Strategy. With the emphasis on transportation, smart city services, healthcare, education, and security, Singapore's AI ecosystem of talent, academia, and research work together to develop and deploy scalable AI solutions, accomplishing its vision as an innovative city-state.

Industry

Alibaba and Grab are not the only companies that have expanded their AI efforts to Singapore and joined the Economic Development Board's program to capture Ph.D. AI talents.

In March 2019, Salesforce opened its first AI Research team outside of the United States in Singapore. With the benefits from the AI ecosystem of Singapore, the team focuses on advancing their Einstein AI technologies, a set of AI-enabled CRM tools with image recognition and natural language processing capabilities. This includes its collaboration with government agencies, top-ranking universities, other AI start-ups, and, most importantly, future AI talents. In addition to its independent research center, Salesforce also joined the Industrial Ph.D. Programme with top Singapore universities to foster a pool of AI talent, allowing individuals pursuing their Ph.D. studies to gain hands-on work experience while working on Salesforce's industrial AI projects (Gruesbeck, 2019). This is an example of a healthy AI ecosystem in practice.

Academia

Universities in Singapore are heavily invested in AI research. In addition to engaging in multiple collaborations with local and international businesses, some universities are also launching AI-related programs and courses. For example, the National University of Singapore's School of Computing established an option for graduates to specialize in AI, the Nanyang Technological University launched a new undergraduate course in Data Science and AI and a graduate program for AI, and the Singapore Management University has an AI track in its School of Information Systems (*Artificial Intelligence Track | School of Information Systems (SMU)*, n.d.; *Master of Science in Artificial Intelligence (MSAI)*, n.d.; *NUS Computing—Master's in Artificial Intelligence*, n.d.). All of these major universities have AI research centers that do research on a range of sectors, from healthcare and robot operations, to finance and data governance (*Data Science & Artificial Intelligence Research Centre@ NTU*, n.d.; *NUS AI Lab*, n.d.; *Publications and Working Papers | Centre for AI & Data Governance*, n.d.). In addition, Singapore also publishes a significant amount of deep learning papers in comparison to the world's top technological countries. According to Stanford's catalog, Singapore has one of the most DL papers published on arXiv (*Artificial Intelligence Index Report 2019*, 2019).

Country-to-Country

Joint initiatives and projects between Singapore and other countries have been established to help foster scientific capabilities and development. Since 2014, Singapore has signed agreements with France, the United Kingdom, the European Union, Australia, New Zealand, and Indonesia to fund collaborative research projects on topics of science and technology, including joint research projects among universities (*International Collaborations*, n.d.). It is unclear how much of the collaborations or funding involves funding for AI specifically.

Products and Applications

Since Singapore's AI landscape is primarily focused on transportation, smart cities services, healthcare, education, and security, the country's current developed AI projects and applications mostly serve those purposes. Additionally, since Singapore is the Asia-Pacific business hub, companies in Singapore are also developing AI-tools to facilitate finance.

Collaborations

Projects and applications that have been rolled out are mostly tied to sectors in education, healthcare, and smart cities transportation. An application of AI in education can be seen in the collaboration between the National University of Singapore and Microsoft to harness the experience of the Azure-hosted Microsoft Academic Graph, a heterogeneous graph that contains detailed cited scientific publication records (*Microsoft, AI Singapore and NUS to develop and reinforce Singapore's AI capabilities*, 2018). By leveraging Microsoft Academic Graph and AI, the National University of Singapore may conduct an analysis of publication knowledge more efficiently and access new materials recommended by the AI-powered system (*Microsoft, AI Singapore and NUS to develop and reinforce Singapore's AI capabilities*, 2018). This solution addresses the issue of information overload with the help of AI tools for researchers, and that the National University of Singapore's School of Computing will use Microsoft Academic Graph to conduct healthcare-related research.

The Smart Nation Sensor Platform is one of the anchor initiatives that connects AI with infrastructure and city planning, creating the so-called smart city through real-time data collection and analysis (*Lamppost as a Platform*, n.d.). Perhaps the most famous product of this platform is the Lamppost as a Platform project, which uses AI to inform smart lamps when to adjust the brightness of their light based on the weather (*Lamppost as a Platform*, n.d.). In addition, the posts also have sensors and cameras that can collect information such as temperature, rainfall, humidity, noise, footfall, pollutants, and personal mobility devices (*Lamppost as a Platform*, n.d.). This better facilitates urban functioning by activating a better incident response rate and more effective urban planning. However, there are privacy concerns raised since the cameras are said to be linked to facial recognition software. As the government claims that the capabilities are merely used to support anti-terror operations, Singapore does not have a high crime rate and terror threat level to justify its statement (Aravindan & Geddie, 2018). Currently, the lampposts and cameras are in place, yet its actual AI capabilities are unclear.

JobTech, a leading AI and Big Data Analytics start-up that provides AI-enabled labor market intelligence that matches analyzed jobs postings with diagnosed personal skills, collaborated with National University of Singapore to develop the NUS Career+ app, an app that allows the students and alumni from National University of Singapore to advance their career (*NUS career planning app helps 312,000 alumni stay competitive in the job market | NUS News*, 2019). Partnering with its own continuing education and training course, a lifelong learning opportunity that is offered by the University to alumni as an upskilling education option, the app allows alumni to set career goals, identify relevant courses that can upgrade their skills, and receive job recommendation. It also provides relevant news on the latest industry developments (*NUS career planning app helps 312,000 alumni stay competitive in the job market | NUS News*, 2019).

Industry

In addition to AI's contribution to education and security, companies are also focusing on deploying AI capabilities in areas such as healthcare and finance. A collaboration between UCARE.AI, a Singapore-based start-up that provides AI-powered healthcare solutions, and Parkway Pantai, the largest healthcare provider in Southeast Asia, AI-Powered Pre-Admission Cost of Hospitalization Estimation (APACHE) supports the healthcare system by generating personalized bill estimates based on patients' medical history through deep learning algorithms

(*UCARE.AI and Parkway Pantai*, 2018). This system is estimated to have an 82% accuracy rate on average, which will improve through time via its self-learning design (*UCARE.AI and Parkway Pantai*, 2018). AI-Powered Pre-Admission Cost of Hospitalization Estimation became the first AI case to be successfully recognized by the Singapore Government that follows the Model AI Governance Framework (*UCARE.AI and Parkway Pantai*, 2018).

In the business sector, AI is used to increase efficiency and manage risks with technologies such as Evie and CashShield. Evie has been created as an AI recruitment coordinator to automate the process of interview scheduling. With the AI power of Evie, recruiters can now be free from repetitive interview scheduling and rescheduling and save 30% of their time a day (*AI Interview Scheduling Tool for Recruiters | Evie.ai*, n.d.). The technology is capable of handling back and forth scheduling negotiation as well as following up with candidates and reserving meeting rooms (*AI Interview Scheduling Tool for Recruiters | Evie.ai*, n.d.; Trueman & Lago, 2020). In addition, Singapore-based fintech, CashShield, is an autonomous risk intelligence platform that detects real-time patterns and micro changes in user behavior to predict and prevent fraudulent accounts and payments (*Autonomous Risk Intelligence Platform | SHIELD*, n.d.; Trueman & Lago, 2020). These AI-enabled technologies can reduce administrative costs and effectively enhance security efforts, which ultimately ties into the government's effort in smart city services and security.

Ethics

Singapore is one of the few countries that has taken the initiative to regulate AI and its ethical concerns. Its stance in leading the Fourth Industrial Revolution pushed the launch of the Model AI Governance Framework shortly after its National AI Strategy. It was published with the intent to ensure high ethical standards in 2019, and revised in January 2020 (*Model AI Governance Framework*, 2020). The framework lays out guidance on addressing ethical issues when deploying AI applications. The two core principles of Model AI Governance Framework are that AI systems should be human-centric and that decisions made by AI should be explainable, transparent, and fair. To put the framework into practice, an AI and data ethics advisory council has been established to assist AI ethics development and guidance. The council is supported by Singapore Management University and selected industry leaders, including professionals from Google, Microsoft, and Alibaba (*AI Policy—Singapore*, n.d.).

The government has not only been actively establishing and updating guidance for AI, but it also has a long-standing history of protecting data privacy. The Personal Data Protection Act of 2012, Singapore's data privacy law, was established to ensure that personal data is protected by complementary regulatory frameworks (*Personal Data Protection Act Overview*, n.d.). Singapore's ethics infrastructure combines regulatory guidelines with human expertise, serving as a template that other countries could potentially reference. With the Model AI Governance Framework in place and the advisory council working closely to advise the government and industry, the government's actions suggest Singapore's high engagement in AI governance and its determination to be at the forefront of ensuring high standards of AI ethics.

Recommendations for the U.S.

With a robust AI strategy and carefully articulated AI ecosystem, Singapore's AI vision faces the threat of being too wide-spread and fragmented. The projects and R&D mentioned in this analysis are merely the most important programs established, and the Singaporean government supports many other similar programs. Although the majority of projects and R&D

are somewhat government-initiated or government-supported, the scope has potential to get out of hand if not handled properly, creating inefficiency in AI development. However, this does not diminish the enormous amount of opportunities Singapore generated via such a system. With that threat in mind, the Singapore government launched AI ethics initiatives and government programs to be actively involved in AI development as the absolute authority.

Singapore and the U.S. share a close relationship diplomatically. The two parties recently renewed a defense pact, allowing American forces to use Singapore's air and naval bases for defense until 2035 (Yong, 2019). According to the Prime Minister Lee Hsien Loong, the agreement not only reflects the cooperation with the U.S. in defense matters, but also in areas such as security, economics, counterterrorism, and in culture and education (Yong, 2019). The Prime Minister then expressed, "we hope to grow it. And we hope that it will also be a means for the U.S. to deepen its engagement in South-east Asia and in the Asia-Pacific region," stating his encouragement of tighter cooperating dynamic (Yong, 2019).

The United States should collaborate with Singapore to learn from its well-established digital infrastructure, especially since the two countries already have a positive political relationship. Singapore is open about its technological efforts as it tries to re-enforce its vision of being a neutral platform for international research and business, all of its initiatives are rather collaborative. The city-state understands its strengths and weaknesses; the only way for a country of its size to stay competitive in the game of big data-enabled artificial intelligence is to create an AI ecosystem, which allows Singapore to position itself as a global hub for AI talent and development. All of its investment and programs work to transform Singapore into a "Smart Nation", the vision of a country empowered by digital connectivity and technology. Singapore mentioned its determination for international collaboration as one of its key AI ecosystem enablers in its 86-page National AI Strategy statement.

In addition, the export-reliant Singapore has continuously prioritized bilateral trade deals, as the tension of international political rises–specifically the U.S.-China Trade War– facilitating different parties to come together despite contention (Jamrisko, 2019). The strength of Singapore's AI development lies in its strong investment in AI talents and its mature AI ethics framework and research, which the United States should consider learning from.

United States of America

By Harrison Ring

Introduction

The United States of America is an AI superpower, with a high level of AI research and development and artificial intelligence applications. The AI landscape in the U.S. is primarily focused on the private sector and national security and defense. The U.S. government has medium engagement with AI ethics, as demonstrated by the presence of ethical guidelines, but lack of strong privacy regulations. Table 12 summarizes findings on the United States' AI readiness, research and development, products and applications, and ethics.

Table 12: Summary Findings, United States

Government AI Readiness	
Level AI Development	High
Oxford Insights AI Readiness Score	8.804
Presence of Strategy Documents	Yes
Presence of Dedicated ICT Department	Yes
Research and Development	
Amount of Investment	High
Density of Collaborations	High
Products and Applications	
Government Orientations	National security, development, manufacturing
Industry Orientations	Transportation, robotics, finance
Ethics	
Level of Government AI Ethics Involvement	Medium
User Data Privacy Laws	No
AI Ethics Reports	Yes

Background

The United States of America is a federal republic with a population of 327,167,434 people as of July 2018 (*The United States of America: Europa World Online*, n.d.). The United States population has 100% access to electricity, according to the World Bank (*Access to electricity (% of population)—United States | Data*, n.d.). The U.S. earned a score of 8.804 on the Oxford AI Readiness Index (*Government AI Readiness Index 2019—Oxford Insights*, n.d.). The recent investment of $2 billion into the Defense Advanced Research Projects Agency is a positive sign that the U.S. is heading in the right direction for further AI development, although it has fallen behind other leading nations (*Government AI Readiness Index 2019—Oxford Insights*, n.d.). President Trump's national strategy on AI, Executive Order 13859, is one of the reasons for a high score (*Government AI Readiness Index 2019—Oxford Insights*, n.d.). In order to be more effective, the Oxford AI Readiness Index suggests that U.S. policymakers make concrete policies instead of repurposing existing funds (*Government AI Readiness Index 2019—Oxford Insights*, n.d.).

Government Policy

On a domestic level, many different parts of the United States government have released policies regarding AI research and the future of AI. Internationally, the United States position on a fully autonomous weapons agreement is undecided as they denied to give their position in 2013 at the Human Rights Council but have continued to look into fully autonomous weapons as recently as 2019 (Rohrlich, n.d.).

Position on Domestic AI

During the past couple presidential terms, the U.S. has strengthened its position on AI through its various policies by a number of different departments. During his time in office, Barack Obama made significant strides for AI development in the United States. Reports such as the "Preparing for the Future of Artificial Intelligence" report and the "National Artificial Intelligence Research and Development Strategic Plan" were the most important towards the end of his presidency. "Preparing for the Future of Artificial Intelligence" gives many policy opportunities concerning AI including how AI can be utilized to advance society and improve the government, how to use regulations that affect AI, like automated vehicles, in a way that helps innovation and protects the public, ensuring AI is fair and safe, and how to develop a skilled and diverse AI workforce for the future (*The Administration's Report on the Future of Artificial Intelligence*, 2016). The "National Artificial Intelligence Research and Development Strategic Plan" is a strategic plan for research and development in AI. There are seven strategies involved in this plan: making long-term investments in AI; developing effective methods for human-AI collaboration; understanding and addressing the ethical, legal, and societal implications of AI; ensuring the safety and security of AI systems; developing shared public datasets and environments for AI training and testing; measuring and evaluating AI technologies through standards and benchmarks; and understanding national workforce needs (*The Administration's Report on the Future of Artificial Intelligence*, 2016). In the 2019 update of this strategic plan, one more strategic plan was added with the other seven strategic plans: expanding public-private partnerships in AI (*Artificial Intelligence for the American People*, n.d.).

Since taking office in 2016, Donald Trump has been active in AI research and development projects. He has stated that "continued American leadership in Artificial Intelligence is of paramount importance to maintaining the economic and national security of the United States" (*Artificial Intelligence for the American People*, n.d.). On February 11, 2019, Trump signed the United States' national strategy on AI: Executive Order 13859. This executive order, the American AI Initiative, lays out plans to promote sustained AI research and development investment, release Federal AI resources, remove barriers for AI innovation, empower American workers with education and training opportunities on AI, and promote an environment internationally that is supportive of AI innovation in the United States and the responsible use of AI" (*Artificial Intelligence for the American People*, n.d.).

Different departments in the U.S. government have created policies that they will abide by for the future of AI. The U.S. Chamber of Commerce's Technology Engagement Center and the Center for Global Regulatory Cooperation released their ten policy principles in September 2019 (*U.S. Chamber Releases Artificial Intelligence Principles*, 2019). The principles aim to: recognize trustworthy AI is a partnership; be mindful of existing rules and regulations; adopt risk-based approaches to AI governance; support private and public investment in AI research and development; build an AI-ready workforce; promote open and accessible government data; pursue robust and flexible privacy regimes; advance intellectual property frameworks that

protect and promote innovation; commit to cross-border data flows; and abide by international standards (*U.S. Chamber Releases*, September 2019). Additionally, the U.S. Chamber of Commerce released their AI principles in September 2019 (*U.S. Chamber Releases Artificial Intelligence Principles*, 2019). Tim Day, Senior Vice President, Chamber Technology Engagement Center said that "the advent of artificial intelligence will revolutionize businesses of all sizes and industries and has the potential to bring significant opportunities and challenges to the way Americans live and work" (*U.S. Chamber Releases Artificial Intelligence Principles*, 2019). The ten policies are: recognize trustworthy AI is a partnership; be mindful of existing rules and regulations; adopt risk-based approaches to AI governance; support private and public investment in AI research and development; build an AI-ready workforce; promote open and accessible government data; pursue robust and flexible privacy regimes; advance intellectual property frameworks that protect and promote innovation; commit to cross-border data flows; and abide by international standards (*U.S. Chamber Releases Artificial Intelligence Principles*, 2019). The U.S. Chamber of Commerce's policies tend to be more focused on international AI than other policies released by other parts of government.

The National Science Foundation fully supports research in AI through many programs and offices. In 2019, the National Science Foundation invested $30 million in each of their ten "Big Ideas" (*NSF's 10 Big Ideas—Special Report | NSF - National Science Foundation*, n.d.). The "Future of Work at the Human-Technology Frontier" focuses on the relationship between AI and humans to figure out the best way to bring them together and help the U.S. economy (*NSF's 10 Big Ideas—Special Report | NSF - National Science Foundation*, n.d.). The "Harnessing the Data Revolution" idea focuses on the development and research needed for a national data infrastructure and data-capable workers (*NSF's 10 Big Ideas—Special Report | NSF - National Science Foundation*, n.d.). This idea focuses on weather patterns and how AI and humans can work together on things like tornado detection and storm tracking. This idea's three main components are research, education, and cyberinfrastructure. Additionally, they support AI advancements in programs such as behavioral and cognitive sciences programs; civil, mechanical, and manufacturing innovation programs; cyber-physical systems; electrical, communications, and cyber systems programs; information and intelligent systems programs; mathematical sciences programs; National Robotics Initiative 2.0: Ubiquitous Collaborative Robots; smart and autonomous systems; smart and connected health; smart and connected communities; and social and economic sciences programs (*NSF's 10 Big Ideas—Special Report | NSF - National Science Foundation*, n.d.).

The bipartisan Congressional Artificial Intelligence Caucus is concerned about the "lack of coordination between individual federal departments' AI offices" (Eversden, 2019). For example, the Department of Defense has their Joint Artificial Intelligence Center and the Department of Energy has their AI office, but those offices work separately on AI. Co-chair Representative Jerry McDerney also believes that the U.S. government is "not spending enough resources right now to do the job. We need to increase federal participation in artificial intelligence both in terms of expenditure and in terms of creating job opportunities in the government for artificial intelligence" (Eversden, 2019). The main goals that the U.S. has with AI is to improve lives, grow industries, empower workers, and increase national security.

The Department of Defense is very interested in AI and its uses for national security in the future. In December 2017, President Trump signed a new National Security Strategy which wanted the U.S. to lead in research, technology, invention, and innovation in emerging technologies, including artificial intelligence (*Artificial Intelligence for the American People*,

n.d.). Additionally, the Trump Administration stated in the National Defense Strategy its intent to invest broadly in military application of AI and machine learning (*Artificial Intelligence for the American People*, n.d.). In June 2018, the DoD established the Joint Artificial Intelligence Center to be the main center in using AI in defense missions (*Artificial Intelligence for the American People*, n.d.). It would accelerate the delivery of AI-enabled capabilities and widen the impact of AI. AI in the Joint Artificial Intelligence Center would also be used for perception, predictive maintenance, humanitarian assistance and disaster relief, and cyber sensemaking (*Artificial Intelligence for the American People*, n.d.). The Joint Artificial Intelligence Center's mission is to deliver new AI-enabled capabilities to its people and develop a new, common foundation for shared data, reusable tools, frameworks, libraries, and standards (*Artificial Intelligence for the American People*, n.d.). In February 2019, the Department of Defense released its AI strategy, which focuses on using AI to advance the U.S.'s security and prosperity (*Artificial Intelligence for the American People*, n.d.). It defines the Joint Artificial Intelligence Center as the main effort of the Department of Defense and outlines on the following key strategic plans: deliver AI-enabled capabilities to key missions; partner with private sector technology companies, academia, and global allies; cultivate an AI workforce; and lead in military ethics and AI safety (*Artificial Intelligence for the American People*, n.d.).

Position on International AI

According to the Campaign to Stop Killer Robots, the United States did not negotiate a new treaty on fully autonomous weapons in November 2018. The U.S. was one of the countries that gave their views at the Human Rights Council in Geneva in May 2013. The United States did not join 28 other countries calling for a prohibition on fully autonomous weapons. More recently, in 2019, the Department of Defense's Advanced Targeting and Lethality System called on potential vendors to submit ideas for their program (Rohrlich, n.d.). The Department of Defense says that this program will use AI and machine learning to give ground-combat vehicles autonomous targeting capabilities (Rohrlich, n.d.). Although the U.S. declined to give their view on "killer robots" at the Human Rights Council in 2013, it seems as though the U.S. supports this idea in their own programs.

Research and Development

The United States government has invested money recently in new initiatives and programs to help national security and defense in the United States. The private sector has taken advantage of the resources and tools available to them in the United States to research AI into the future.

Collaborations

The U.S. government's AI research and development landscape is characterized through several initiatives to further develop AI capabilities, such as through building supercomputers. The Defense Advanced Research Projects Agency announced a $2 billion initiative in 2018 called AI Next (Gruss, 2018). This program aims to improve AI research to change computers from specialized tools to problem-solving partners with humans. It is the second biggest AI-related initiative after the DoD's Joint AI Center, which provides around 600 AI-related programs (*AI*, n.d.). The funding for AI Next is similar to the Joint AI Center, which is expected to cost about $1.7 billion. The Joint AI Center is expected to focus on applications for AI while

the Defense Advanced Research Projects Agency program will focus on new AI capabilities, the failure modes of AI, protecting machine learning software, sustainable high-performance AI, and the next generation of AI (*AI Next Campaign*, n.d.). The Defense Advanced Research Projects Agency wants to realize what AI can do in the "third wave" of AI technology. This initiative is focused on using AI as a colleague rather than a tool. It will allow better decisions to be made in military systems. This project is focused on military defense.

The National Science Foundation also invests significantly in the exploration, development, and deployment of a wide range of cyberinfrastructure technologies that can be useful for AI R&D, including next-generation supercomputers (*ORNL Launches Summit Supercomputer | ORNL*, n.d.). The Centers for Medicare & Medicaid Services' Center for Medicare and Medicaid Innovation has launched the Artificial Intelligence Health Outcomes Challenge, in collaboration with the American Academy of Family Physicians and the Laura and John Arnold Foundation (*ORNL Launches Summit Supercomputer | ORNL*, n.d.). The CMS AI Health Outcomes Challenge will distribute up to $1.65 million to encourage further progress in AI for health and healthcare and to accelerate development of real-world applications for this technology (*NSF Award Search: Advanced Search Results.*, n.d.). On the economic side, the U.S. Securities and Exchange Commission is actively implementing machine learning algorithms to monitor and detect potential investment market. Additionally, in September 2019, the Consumer Financial Protection Bureau issued new policies that allow for an increased use of data and machine learning algorithms in financial products and services (Ficklin & Watkins –, n.d.).

In June 2018, at Oak Ridge National Laboratory, the U.S. Department of Energy introduced the Summit scientific supercomputer (*ORNL Launches Summit Supercomputer | ORNL*, n.d.). It offers unmatched capabilities for AI research and integration. In May 2019, the U.S. Department of Energy and Intel announced that they had teamed up to build "Aurora," another supercomputer that will supersede the first, for scientific research (*U.S. Department of Energy and Intel to Build First Exascale Supercomputer*, n.d.). Furthermore, the National Science Foundation invests a significant amount in the study and execution of cyberinfrastructure technologies that could be useful for AI research and development, including these supercomputers (*ORNL Launches Summit Supercomputer | ORNL*, n.d.).

The National Science Foundation and the Defense Advanced Research Projects Agency have partnered to explore real-time machine learning. This partnership was created to figure out the next-generation co-design of RTML algorithms and hardware, with the main focus on developing novel hardware architectures and learning algorithms in which all stages of training can be used in real time (*Real-Time Machine Learning*, n.d.). The partnership accepts proposals from external researchers, and because it is connected with the Defense Advanced Research Projects Agency, it primarily focuses on topics of national security, although it mentions wanting this program to address autonomous vehicles, healthcare, and business as well (*Real-Time Machine Learning*, n.d.).

The National Science Foundation has also partnered with Amazon to focus on conditional research of fairness in AI, with a goal of transforming trustworthy AI already deployed to help address greater challenges in society (*NSF Program on Fairness in Artificial Intelligence*, n.d.). Topics included in this partnership include "transparency, explainability, accountability, potential adverse biases and effects, mitigation strategies, validation of fairness, and considerations of inclusivity" (*NSF Program on Fairness in Artificial Intelligence (AI)*, n.d.). For example, one award selection chose the topic of looking at fairness in AI in deep neural networks

with learning interpretation. The primary goal of this project is to find the root cause of discrimination in natural language processing (*NSF Award Search*, n.d.).

Collaborations surrounding AI research and development are not all connected to governmental organizations, as collaborations between non-profits also push the conversation around AI forward. Partnership on AI is a nonprofit coalition focused on conducting research, discussions, and consultations with the public and media. They have four goals based on their mission: develop and share best practices; advance public understanding; provide an open and inclusive platform for discussion and engagement; and identify and foster aspirational efforts in AI for socially beneficial purposes (*About*, n.d.). With over 100 partners in 13 countries, the coalition is one of the best sources of information concerning AI in the world. One of their programs is the Early-Concept Grants for Exploratory Research to understand social issues regarding AI and brainstorm solutions to combat these challenges (*About*, n.d.). Topics include the following: safety, robustness, and accountability of AI systems; bias and fairness of AI systems; intelligibility, explanation, and transparency of AI inferences; privacy challenges with AI development and use; sociotechnical challenges involving ethical considerations; economic impacts of AI on society; and social consequences of AI system deployments. This program is mainly concerned with the connection between humans and AI (*About*, n.d.).

Industry

There is a lot of research and development in U.S. companies such as Google, Amazon, Intel, Tesla, and IBM. The AI companies that lead the U.S. in terms of software and revenue include Apple, Amazon, Microsoft, Google, and Facebook (D'Onfro, n.d.). Apple has acquired the work of many AI start-ups to include in their products, such as their new facial recognition security system (D'Onfro, n.d.). Amazon offers AI software and hardware service to people and businesses (D'Onfro, n.d.). Google is researching how to leverage AI in all sectors, from education to health to security (D'Onfro, n.d.). Facebook is pursuing research and development in machine learning, cloud computing, and other forms of AI software (D'Onfro, n.d.). Google is known for their search engine platform, but they have vast amounts of money dedicated towards cloud computing and machine learning research (D'Onfro, n.d.). For example, Google has a research area called "AI Fundamentals and Applications" where they are trying to find solutions to fundamental computational problems (*ORNL Launches Summit Supercomputer | ORNL*, n.d.). One of these papers titled "Now playing: Continuous low-power music recognition" is trying to find a way to run a low power music recognizer on a phone to recognize music without any user activation (Gfeller et al., 2017). This is one of the simpler research initiatives by Google, but it is one that shows the problems that Google is trying to solve for consumers and that can make more sense for the everyday American to understand.

Academia

There is a variety of AI research at universities across the United States. An example that highlights the types of research being done is The Allen Institute for AI, which is heavily involved in AI research and development at the University of Washington. It was founded in 2014 and focuses on contributions to humanity through AI research (*About—Allen Institute for AI*, n.d.) They use their research in open-source natural language processing software, information extraction, knowledge representation, machine reasoning, and commonsense knowledge to use AI to their advantage (*About—Allen Institute for AI*, n.d.). They have a number

of projects that they are currently working on. For example, AllenNLP is focused on new learning programs and infrastructure that people can use. 15 companies currently use this program, including AirBnB and Amazon Alexa (*AllenNLP*, n.d.).

Country-to-country

The G20 Leaders' Summit in June 2019 drew from the Organization for Economic Cooperation and Development Principles on AI, which the United States was present for (*#EUTrade news*, n.d.). The G20 AI Principles included the following principles: "inclusive growth, sustainable development and well-being;" "human-centered values and fairness;" "transparency and explainability;" "robustness, security and safety;" and "accountability" (*#EUTrade news*, n.d.). In addition to those principles, the G20 AI Principles focuses on how trustworthy AI can be achieved through national policies and international cooperation (*#EUTrade news*, n.d.).

The new United States-Mexico-Canada Agreement regards artificial intelligence and its use between these three countries for the future. This agreement allows for algorithmic transparency and the regulation of artificial intelligence (*How Will the Digital Economy Fare under the USMCA?*, n.d.). Article 19.16 of the agreement focuses on source code and acknowledges that a type of regulatory body or authority will need to determine what an algorithm is doing, how it is doing it, and why it is doing it, to ensure transparency throughout the entire process (*How Will the Digital Economy Fare under the USMCA?*, n.d.).

Products and Applications

The United States government uses AI to protect its borders and its interests abroad. Industries are creating products for consumers to make their lives easier and better tailored to their needs.

Collaborations

Due to the vast number of AI products and applications in the U.S., only a sample of currently relevant ones is examined here. In 2017, the U.S. Department of Defense (DoD) and Google teamed up for Project Maven under the Algorithmic Warfare Cross-Functional Team established by then Deputy Defense Secretary Bob Work (*Project Maven to Deploy Computer Algorithms to War Zone by Year's End*, n.d.). This project focused on machine learning to autonomously collect and detect objects in video data to help combat counterinsurgency and counterterrorism (*Project Maven to Deploy Computer Algorithms to War Zone by Year's End*, n.d.). In 2018, 3,000 Google employees signed a petition protesting the company's involvement with the DoD (*Project Maven to Deploy Computer Algorithms to War Zone by Year's End*, n.d.). Employees were concerned about the weaponization of AI and how Project Maven could be used for drone strikes and other attacks. Google pushed back on these statements saying that this project flags images for human review, and is for non-offensive uses only and that it was simply to "provide open source TensorFlow APIs that can assist in object recognition on unclassified data" (*What is Project Maven?*, n.d.). This project cost $70 million in its first year and Phase 2 was supposed to turn the data into "actionable intelligence and decision-quality insights at speed" (*What is Project Maven?*, n.d.). Although Google is no longer part of that contract, an unnamed technology company has taken over Google's part in the project, continuing the project's work despite ethics concerns (Fang, 2019).

The U.S. Department of Energy has been very involved in AI and will continue to be for the near future. The U.S. Department of Energy has many AI applications, mostly machine learning, for energy, national security, science, medicine, and transportation. For example, Argonne has utilized machine learning to cut down the time it takes to create better engines for cars (*Argonne's next top model | Argonne National Laboratory*, n.d.). This application augments "high-fidelity modeling with machine learning to dramatically accelerate the process, while maintaining the reliability of the data" (*Argonne's next top model | Argonne National Laboratory*, n.d.). In 2018, Argonne worked with a major petroleum and natural gas company to optimize an engine with fuel that the company was developing (*Argonne's next top model | Argonne National Laboratory*, n.d.). They have also worked towards active learning, which would take real-time data and help manufacturers optimize other parts of their business (*Transforming transportation with machine learning | Argonne National Laboratory*, n.d.).

Industry

AI products from U.S. industries cover a vast range of sectors, so here are some of the most pertinent examples of AI in the United States. Aurora Innovation is a self-driving car company that sells its systems to car companies like Hyundai, which will use those systems as future software in its Kia cars (D'Onfro, n.d.). The company is a combination of experts from Tesla, Google, and Uber (D'Onfro, n.d.). Companies like Tempus focus on using AI to analyze medical data to assist in treatments tailored for specific needs (*Best healthcare startups to watch in 2020*, n.d.). Google has a vast number of AI products and applications. For example, Google's AI building blocks help businesses add sight, language, conversation, data, and cloud automation to their applications. Google's Deep Learning VM Image helps existing virtual machines, such as Spotify (*Google AI*, n.d.). IBM's biggest AI achievement to date is Watson. Watson helps to predict and shape future outcomes, automate complex processes, and optimize the times of employees (*Operationalize AI throughout your business*, 2020). Watson is designed to help businesses by computing things like prediction analysis, fraud detection, and financial planning (*Operationalize AI throughout your business*, 2020).

Everyday applications of AI are used by U.S. citizens to improve their lives. Google Maps uses AI to analyze the speed of movement of traffic and give people the fastest routes, avoiding accidents and construction (Narula, n.d.). Ridesharing apps like Uber and Lyft use machine learning to determine ride prices, minimize wait times, and detect fraud (Narula, n.d.). Commercial flights, as reported in 2015 by the New York Times, use AI systems that only need humans to steer the flight for seven minutes in Boeing planes. Google's Gmail uses machine learning algorithms to filter spam on an ongoing basis as well as prioritize emails (Narula, n.d.).

Banking uses AI to consumers' advantage as well. Mobile check deposits use Mitek's AI and machine learning to convert handwriting into text through optical character recognition (Narula, n.d.). FICO scores use neural networks to predict fraud in banking transactions and look into factors like frequency, size, and where transactions occurred to determine fraud (Narula, n.d.). Similarly, FICO uses machine learning to develop credit scores and figure out the risk involved with the loan or credit card (Narula, n.d.). MIT found that machine learning could reduce a bank's losses by 25% (Narula, n.d.). Social media, like Facebook and Snapchat, use neural networks for facial recognition software (Narula, n.d.). They also use AI to personalize users' feeds and more accurately target ads and posts to attract people on their network for longer. Online shopping uses AI to help people find products as quickly as possible and to suggest similar products. Smart personal assistants, like Alexa, Google Home, and Siri, all use

neural networks to power voice search and recognition (Narula, n.d.). All Americans are using AI in their lives every day due to the vast number of AI products and various uses of them.

Ethics

The U.S government had the most ethical guidelines released in 2019, reflecting its commitment to maintaining robust ethics standards around the world (Jobin et al., 2019). In addition, President Trump signed Executive Order on Maintaining American Leadership in Artificial Intelligence which emphasizes protecting civil liberties, privacy, and American values (*White House announces creation of Select Committee on Artificial Intelligence—FedScoop*, n.d.).

In June 2019, the Select Committee on Artificial Intelligence of the National Science & Technology Council released its National Artificial Intelligence Research and Development Strategic Plan for the year (*White House announces creation of Select Committee on Artificial Intelligence—FedScoop*, n.d.). The report was an updated rendition of its 2016 version, reflecting the growing complexity of the AI landscape. The report suggested 8 different strategies with each strategy focusing on a different aspect of AI. Strategy three focuses on the ethical, legal and societal side of AI and its implications. The strategy concluded that more R&D is needed in order to properly develop AI architectures that account for ethical, legal and societal concerns with "technical mechanisms" such as transparency and explainability (*White House announces creation of Select Committee on Artificial Intelligence—FedScoop*, n.d.). It also mentioned that R&D by itself will not be effective unless there is collaboration with technical experts in social and behavioral sciences, law, ethics, and philosophy and stakeholders in those fields. It asserts that this process needs to be incorporated in all the steps, including training, design, testing, evaluation and implementation of AI (*White House announces creation of Select Committee on Artificial Intelligence—FedScoop*, n.d.). Several approaches were suggested which included a two-tier architecture that separates the operational AI from a monitor agent that oversees it or carries out ethical or legal assessment. A precise conceptual framework for the AI agent architecture is used to ensure that AI behavior is safe and not harmful to humans and to formulate an ethical architecture using set theoretic principles combined with logical constraints on AI system behavior that restrict action to conform to ethical doctrine (*White House announces creation of Select Committee on Artificial Intelligence—FedScoop*, n.d.).

In May 2019, the United States joined twenty governments in the OECD Principles on AI. This recommendation includes five principles for "responsible stewardship of trustworthy AI" (*OECD Principles on Artificial Intelligence—Organisation for Economic Co-operation and Development*, n.d.). The principles assert that AI should be driven by inclusive growth and sustainable development; AI system design should respect laws, human rights, and democratic values and include the proper safeguards for society; transparent and responsible disclosures on AI systems should be put into place in order to make sure that AI-based outcomes can be analyzed and challenged by people; AI systems must be safe and secure and potential risks must be assessed and managed; and AI systems developing and developed should act properly in accordance with the principles mentioned above (*OECD Principles on Artificial Intelligence—Organisation for Economic Co-operation and Development*, n.d.). It is important to note that this is a non-binding agreement but has metrics in place to measure its implementation.

However, despite being a progressive country regarding the field of AI ethics, the U.S. cannot cover all areas of AI or develop a fully comprehensive regulating policy. For example, there are no federal laws regarding the regulation of biometric data (*Just How Important Is It to*

Protect the Privacy of Biometric Data?, n.d.). Only Illinois, Texas, and Washington have their own laws that protect the use of their citizens' biometric data and require consent to obtain those types of data (*Just How Important Is It to Protect the Privacy of Biometric Data?*, n.d.). However, since these regulations are state-specific and do not apply to the entire country, it is easier to find loopholes and work around these existing laws.

Recommendations for the U.S.

The United States mentioned in Executive Order 13859, the American AI Initiative, that it wants to remove barriers for AI innovation. This includes removing "regulatory barriers" (*Artificial Intelligence for the American People*, n.d.). This seems to clash with their other goals of fostering public trust and promoting trustworthy technology. During Trump's presidency, the government has focused on rules and regulations that inhibit companies and others from advancing AI innovation. Despite this, the United States should continue to enforce these rules and regulations to help AI move forward in a safe way. There needs to be more safeguards based on the testing and deployment of AI, such as self-driving cars. There was a report in 2018 where Arizona was more lenient on regulations to lure self-driving car companies to test their products in Arizona (*Self-Driving Uber Car Kills Pedestrian in Arizona, Where Robots Roam—The New York Times*, n.d.). This led to one fatality caused by a self-driving car. Accidents like these could be avoided if regulation is in place and enforced.

Additionally, the United States should increase the yearly research and development funding for AI. Currently, there is about $5 billion of annual federal funding in AI development (*Administration Projects Agencies Will Spend $1 Billion on Artificial Intelligence Next Year*, n.d.). About $1 billion will be used on nondefense AI research and development in 2020, which is an increase from $1 billion spent in total on AI, including defense, in 2016 (*Administration Projects Agencies Will Spend $1 Billion on Artificial Intelligence Next Year*, n.d.). This budget should be increased in order to keep the U.S. at the forefront of AI technology. Next, the United States should develop human capital. Updating curriculum in the STEM area for students in grades K-12 would be beneficial for the United States to remain competitive in AI research and development in the future by cultivating AI talent at a young age. The National Science Foundation already has a program in place to support this idea. Their K-12 program is designed to give the opportunity to students to learn about computer science and computational thinking in their schools. It is meant to provide teachers and schools with the support and resources needed to fill this void in education (*Artificial Intelligence (AI) at NSF | NSF - National Science Foundation*, n.d.). More money and resources need to be provided in these types of programs so that they can have a greater impact and effect on the students and people working to help these programs. This would be similar to the case of the 1958 National Defense Education Act when legislation pumped large amounts of money into schools during the "space race." Finally, the United States must protect its AI-related hardware so that other countries, like China, cannot take its place among the best AI countries (Rasser, n.d.).

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