



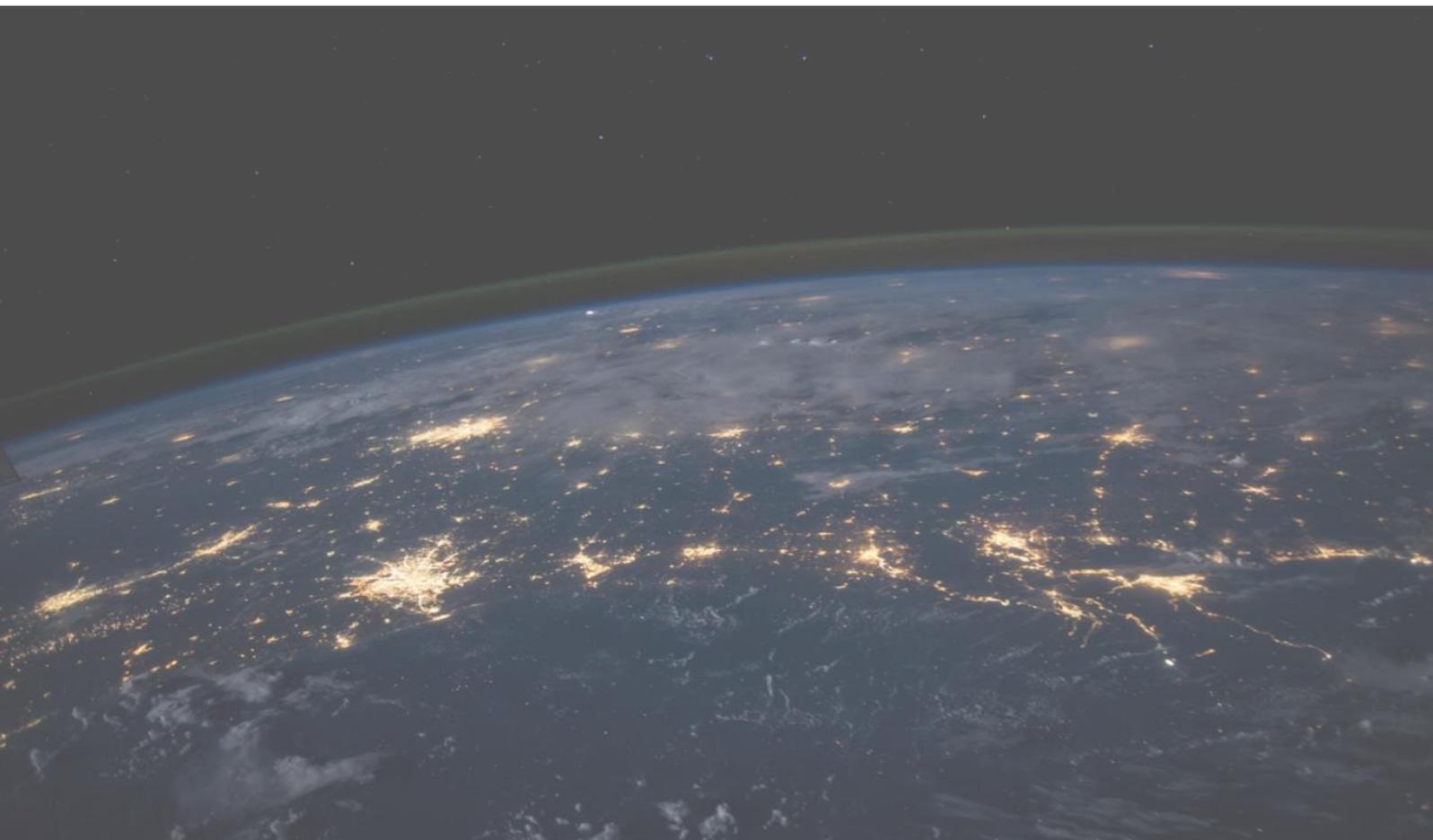
# ARTIFICIAL INTELLIGENCE: AN OVERVIEW OF STATE INITIATIVES

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## FOREWORD

Artificial intelligence (AI) has the attention of States for its potential to contribute positively (and negatively) to their economic, defensive, societal and political postures. As a platform technology—one that yields numerous applications in diverse areas such as robotics, defence, social media, financial services and healthcare—AI has seen increasing engagement by States, especially in the last few years. Numerous States have proposed and implemented national plans or strategies to guide their interests in AI leadership.

Significant implications exist from the adoption (or non-adoption) of AI by States. Specific impacts from AI are feasible in the areas of crime and justice, since power, conflict and stability are all manifest in the application of AI. By identifying which States have national plans or actions taken toward drafting them, as well as the preponderance of government-sponsored AI investments, this report provides both a foundation and insights upon which one can appreciate potential global impacts of AI geopolitically and economically, as well as what this means for specific communities or sectors.

The focus of FutureGrasp is to capture and to comprehend emerging and disruptive technologies. "Grasp" means both "to seize upon" and "to comprehend"; FutureGrasp thus enables clients to lead in rapid technology changes. It is hoped that this report contributes to the on-going dialogue surrounding the transformative technology of AI.

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## EXECUTIVE SUMMARY

This report offers an overview of State actions in artificial intelligence (AI), focusing specifically on national strategies and plans and related government investments, major venture capital funds and industry venture capital funding.

Many governments and companies are active in AI. However, for the purposes of this report, only those States currently with or having demonstrated some form of interest in developing an AI national strategy or plan at the time of writing are considered here. Additional criteria for inclusion are that there must be open source, unclassified information and data, and that this information and data must be available in English.

The author has found that, of the United Nation's 193 States, only 41 States meet the stated criteria. Notably, it has been observed that there are few States with AI national strategies or plans or significant investments in several geographic regions across the globe, including: South America, Central America, Eastern Europe, Central Asia, Southeast Asia, and Africa. Moreover, of the 41 States described, only 19 of these have actually released an AI national strategy or plan.

AI State funding globally also has strong parallels to AI national plans. Salient findings are that:

- There is an estimated total of US \$152 billion committed toward AI by States.
- 20 States have government investments in AI.
- The rankings among States of annual and gross national investments in AI are mostly comparable; those countries investing the most overall also lead annual funding.

As AI continues to accelerate in its global development and deployment, it incumbent upon States to engage in the drafting and the execution of AI national plans and related investments. Maintaining a strategic focus on a disruptive technology such as AI is critical for States to guide posture with respect to their economic, cultural and national interests – all of which will be impacted by AI.

Crime, justice and social stability are also among the many issues to be affected by advancements in AI. In addition to several positive applications for law enforcement (for example, predictive policing), AI can be used globally maliciously (for example, enhanced cyber-hacking and fake news). Inequality and labour disruption due to AI are two further issues that have potential to cause economic disturbances. Such disruptions could also give rise to increased crime as inequality increases and fewer opportunities are available for making a living wage. Seven States have noted that law enforcement and/or crime prevention are important topics within their AI national plans, although no specific funding or dedicated AI sector is explicitly described or mentioned for law enforcement and/or crime prevention in any AI national plans.

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## 1. INTRODUCTION AND SCOPE

Artificial intelligence (AI) is a platform technology that can be applied across the full strata of the global economy, including healthcare, finances, transportation, etc. Developments in AI can, for instance, be utilized to contribute to the achievement of the 17 goals of the 2030 Agenda for Sustainable Development adopted by world leaders in 2015, to *inter alia* tackle the challenges of poverty, inequality and climate change. During the opening of the 73rd General Assembly in 2018, the United Nations (UN) Secretary-General António Guterres acknowledged this, emphasising the potential of technologies such as AI to “turbocharge” progress towards these goals.<sup>1</sup> Accordingly, States have strong interest in AI — societally, economically, politically and even strategically. With respect to Sustainable Development Goal 16 on Peace, Justice and Strong institutions, the promise of AI is significant, in particular in terms of contributing to enhancing the capacities of law enforcement and creating a world free of violence and crime.

At the same time, however, AI is inherently dual-use in nature. Algorithms can be used for societal good or for malicious purposes. As the Secretary-General further noted, AI can equally intensify cyber-attacks, monitoring of citizens, and weapons developments. Although significant efforts are being made to raise awareness of these issues and to direct attention for stakeholder collaboration to address them, these developments are undergoing rapid change, obscuring the possibility for global consensus on important topics such as governance.

As leaders realize the potential of AI for their specific use cases, interest in AI by States and industry continues to rapidly increase. With the AI ecosystem booming, the likelihood of not only the positive, but also the possible negative aspects of AI materialising significantly grows. In this regard, an assessment of the current *status quo* of AI national strategies and related investments is warranted to provide a snapshot of the current state of the AI ecosystem and to ensure that the appropriate yardsticks are used when measuring the likelihood of the promises of AI materialising, as well as the level of risk for any possible harmful effects of AI on society – intentional or otherwise.

This report is structured as follows: First, an outline is provided of some of the implications, promises and perils of AI from a crime, justice and social stability perspective. Second, a brief overview of technologies that affect AI, beyond mere algorithms, is provided. It is important to recognize that AI does not live in a vacuum; technologies such as sensors, semiconductors and robotics play direct roles in data collection, processing and applications of AI. Finally, the report concludes with its central component – a State-by-State analysis of national AI strategies or plans and related public and private investments in AI. Key concepts and terms are described in an Appendix. While strict definitions cannot be offered in this fluid field, descriptions provided in this report are given in the interests of clarity.

It is essential to note upfront that a major challenge for any analysis in the realm of AI is to remain contemporary. Like other emerging technologies, the pace of AI development is measured in mere months, if not weeks. Thus, the data presented in this report is kept to within a roughly six to twelve month timeframe from this writing, valid up to early June 2019. Funding considerations go back to January 2017, as several States made multi-year AI investments in early 2017.

## 2. CRIME, JUSTICE AND SOCIAL STABILITY PERSPECTIVES

AI is a technology that is particularly well-suited for crime prevention and control<sup>2</sup>. By its nature, law enforcement is an information – or data – based operation. For law enforcement to be effective in the fight against crime, large quantities of data on human behaviour from a variety of sources must be gathered, analysed and acted upon. As a technology with data at its very core, that utilises computational power to bring this data together and to solve problems that humans could not possibly otherwise solve, AI presents enormous promise for law enforcement. AI could significantly enhance how officers can efficiently and accurately leverage information collected on a daily basis. In fact, in many criminal cases, there is already an overwhelming amount of data being generated and collected for officers to assess. With the increased proliferation of sensors and growth of big data, it is therefore even conceivable that, not only will AI become increasingly relevant for law enforcement, but it will even become heavily dependent on AI in the near future.

Broadly speaking, there are four main categories for how AI can interface with cyber-physical space in the context of law enforcement operations: 1) Prediction and Analysis, 2) Recognition, 3) Exploration, and 4) Communication. The use of AI to increase accountability and transparency within law enforcement could also be considered as a possible fifth area of AI, although it is not strictly operations-related. There are no strict boundaries between these categories, yet they can be distinguished from one another based on varying degrees of complexity and interaction with the environment. The greater the degree of complexity of a specific case (i.e., the number of actors involved, types of databases, etc.) the more chaotic the environment in which an AI system must operate. In turn, the more chaotic the environment, the more challenging the system will be to develop, prototype and, ultimately, integrate into law enforcement.

There is accordingly a broad spectrum of potential law enforcement use cases. Examples include computer vision software to identify stolen cars, sentiment analysis to monitor for the drivers for radicalization, and even forecasting where and what type of crimes are likely to occur in order to support law enforcement to optimize resources.

A common theme traversing virtually all use cases is enhanced surveillance capabilities. With any type of surveillance, the potential impact on the fundamental human right to privacy, as recognized by the Universal Declaration of Human Rights (UDHR) and the International Covenant on Civil and Political Rights (ICCPR) as well as numerous other international and regional legal instruments, is an essential consideration. As the use of AI by law enforcement becomes more pervasive throughout society, touching ever more upon the lives of citizens, it also becomes increasingly important for law enforcement to ensure that the use of these technologies is compliant with these fundamental rights and can be considered 'ethical'.

At the same time, while AI promises to transform crime prevention and control, it is very much a dual-use technology in nature. It can profoundly change how law enforcement operates, yet it can just as easily enhance the *modus operandi* of a criminal or terrorist group or even create entire new classes of crime altogether. A recent report by 26 authors from 14 academic, civil society, and industry representatives investigated this issue and suggested that many of the same features that might make AI appealing for law enforcement (such as scale, speed, performance, distance) might make AI equally attractive to criminals and terrorist groups.<sup>3</sup> The report identifies three main domains of attack:

- **Digital attacks**, such as automated spear phishing, automated discovery and exploitation of cyber-vulnerabilities
- **Political attacks**, such as the proliferation of fake news or media to generate confusion or conflict, and face-swapping and spoofing tools to manipulate video and endanger trust in political figures or even result in the validity of evidence being questioned in court

- **Physical attacks**, such as face-recognizing armed drones or drones smuggling contraband. In the context of digital attacks, the report further notes that AI could be used either to directly carry out a harmful act or to subvert another AI system by poisoning data sets.

Although the technologies or the means to develop such technologies exist and are, to a certain degree, open source or commercially available, AI has apparently not played as significant a role in crime or terrorism as might be expected. While there have been alarming instances involving such technologies, in particular involving the use of drones, the integration of broader AI-based technology into crime and terrorism has not yet been substantially identified. Examples of the misuse of drones include the landing of a radioactive substance on the roof of the Japanese Prime Minister's office in Tokyo<sup>4</sup>; entering unauthorized airspace in United States Air Force and Navy nuclear facilities<sup>5</sup>; and controlling unmanned aerial improvised explosive devices by the Islamic State of Iraq and the Levant (ISIL).<sup>6</sup> While these instances may not have leveraged AI fully because of manual remote drone operation, the advancing capabilities of AI may lead soon to greater autonomy in such attacks. The limited number of such instances to date should not, however, be interpreted as indicating that such technologies will not be utilised for malicious purposes in the future. There is, at present, simply a lack of empirical evidence on the development and use of such technologies for malicious purposes.

The use of AI for criminal or terrorist purposes should however be expected to increase over time, in particular as AI becomes more integrated into the functioning of society and, as costs and technical knowledge required decrease.

Beyond these perhaps more traditional perspectives, there are other areas of concern with AI that have the potential to foment unrest throughout society and generate conditions that may arguably be conducive to criminality. Two frequently cited areas are described below.

First, as detailed in the sections that follow, while several States are actively pursuing national initiatives on AI, several other States and regions lack any substantial AI activities. There are also many States included in this report that, although they have expressed interest in a national plan, have provided no AI investments from their respective governments to be able to leverage the promise of AI.

A leading concern for those States not presently engaged in AI and related technologies is that they will fall behind those that are already heavily innovating and investing. As noted in the following section, in addition to expert programmers, AI requires an entire infrastructure of capabilities like next-generation semiconductors, advanced materials, cloud computing, robotics and especially science, technology, engineering and mathematics (STEM) education. Without these aspects in place, States may not be able to engage or compete in AI in the future. Governments that can successfully cultivate the necessary culture will be strategically positioned, whereas those without the means or resources to do so may face additional barriers to their competitiveness. Such disparities, and a world of AI 'haves' and 'have nots', threaten to feed a growing inequality and socioeconomic divisions.<sup>7</sup>

Second, there is intense debate around the possible impact of AI on labour and the future of work.<sup>8 9</sup> AI by its very definition is designed to mimic human cognitive functions, enabling it automate many tasks performed by humans. If and when AI reaches a certain point of maturity, AI systems and robots may become more efficient and cost-effective in the work place than humans. This change may ripple throughout the global economy, sparking a global mass unemployment. While there is, at this stage, no certainty of this, a future transition to an automated and robotized work force would most certainly be challenging for society and rising unemployment may generate negative consequences, such as higher crime rates and unmanageable economic migration.

A common response to the fear of AI-induced unemployment is that history books already contain several examples of analogous developments that did in fact not result in bleak

outcomes. The Agricultural Revolution, the Industrial Revolution, the Computer Age – all precipitated widespread belief in the last few centuries that jobs would disappear and countless numbers would be left unemployed. Yet new jobs were created to leverage the new technologies, population numbers grew, and the economy at times even boomed during those technology disruptions. It has also been suggested that, although AI may automate many routine tasks, there will be plenty of scope for people to be re-educated to ensure their competitiveness on the job market, and that humans will remain fully employable in ‘high-touch’ and caring jobs, such as nurses and therapists, or creative jobs, such as artists, musicians or business entrepreneurs<sup>10</sup>. Once again, however, there is at this stage no certainty of this either.

One thing certain is that, as States continue to invest into AI and the ecosystem around it grows, the prospect of AI impacting society, for better or for worse, vastly increases. While innovation cannot and should not be stopped, it is important that those working to prevent crime, service justice and, in general, foster a fair, just and equal society, remain cognisant of how AI may be used or misused and what the unintended consequences may be in order to prepare for any inevitable outcomes.

### 3. TECHNOLOGIES AFFECTING ARTIFICIAL INTELLIGENCE

Before delving into State actions in AI, it is important to note that like all other technologies, AI is part of an ecosystem of the digital world. Accordingly, it is important to also look at AI in the context of other key technologies that support or enable its calculations.

What follows is a brief introduction to and overview of three major sectors that have direct effects upon AI: the Internet of Things, advanced computation (semiconductors and quantum computing), and robotics. This broad focus on AI should be borne in mind throughout the reading of this report.

#### 3.1. Internet of Things

The Internet of Things characterizes the universe of internet-connected devices and sensors. Since its inception in 1969 with the Advanced Research Projects Agency Network (ARPANET), the internet has grown from a handful of interconnected desktop computers to billions of connected devices and sensors. Current estimates place the number of internet-connected devices at roughly 17 billion, with an anticipated 34 billion devices to be connected by 2025.<sup>11</sup> The Internet of Things both practically enables internet use, as well as provides the data that programmers need for AI.

Estimates of the data produced by the Internet of Things are astounding. In 2012, the amount of data generated over the internet doubled roughly every 1.25 years;<sup>12</sup> it is assuredly even faster now. Every day now approximately 2.5 quintillion bytes of new data is created.<sup>13</sup> This digital tsunami tasks States in their abilities to gather data, to comprehend it, and to craft sound policies from it. AI plays a critical role in making meaning from the Internet of Things.<sup>14</sup>

#### 3.2. Advanced Computation

In 1965, Dr. Gordon E. Moore wrote an article based on a trend he noticed: the number of transistors in an integrated circuit doubles approximately every two years.<sup>15</sup> Fuelled by unrelenting demands from more complex software, faster games and broadband video, Moore's Law has held true for over 50 years.<sup>16</sup> It became the *de-facto* roadmap against which the semiconductor industry drove its research and development and chip production. Recently, that roadmap has faltered due to limitations set by the laws of physics and the high cost-benefit economics incurred by the incredibly small scales that chip manufacturing has reached. Electron leakages and difficulties shaping matter at the single-digit nanometer scales of the transistors fundamentally limit further miniaturization. A new fabrication plant can cost several billions of dollars, severely limiting the number of companies able to produce denser integrated circuits.

Despite the end of Moore's Law, computationally-intensive AI has exploded in capabilities in the last few years. The solution to exceeding compute limitations of traditional central processing units (CPUs) has been to invent and leverage wholly new architectures not dependent on traditional designs. A wide range of new computing architectures – including graphics processing units (GPUs), application specific integrated circuits (ASICs), field programmable gate arrays (FPGAs), quantum computers, neuromorphic chips, nanomaterial-based chips, optical-based integrated circuits, and even biochemical designs - are being researched and implemented to better enable deep learning and other instantiations of AI.

Quantum computing is especially interesting for AI. Traditional computers operate with *bits* that are either *on* or *off* depending on their electrical state. Quantum computers on the other hand use *qubits*, in which an individual bit can be in one of three states: on, off, and, uniquely, both on and off simultaneously. As with other advanced computational architectures, quantum computing is still in early stages of development. Quantum computing has unique hardware issues – for example, the need to cool the processing chip to near absolute zero temperatures to avoid disturbing processing in the qubits.

Speed is the leverage that quantum computing offers AI, especially in machine learning. Quantum computing has the potential to spot patterns extremely quickly within large data sets, possibly even to access all items in a database at the same time to identify similarities in a matter of seconds.<sup>17</sup> For an AI that must analyse billions of images or data points, to execute this analysis in seconds using the power of the simultaneous on-off qubit is considerable compared to a sequential CPU that might take weeks or months for the same action.

National and regional investments in quantum computing are correspondingly significant. China, for example, is investing tens of billions of US dollars into its portfolio of quantum computing initiatives.<sup>18</sup> The European Union too is pushing forward on a €1 billion [US \$1.1 billion] quantum flagship programme.<sup>19</sup> Canada invested CAN \$101.8 million (US \$76.0 million) in several projects that integrate quantum, artificial intelligence and machine learning technologies.<sup>20</sup> The United States also recently signed a US \$1.2 billion quantum initiative.<sup>21</sup>

### 3.3. Robotics

Robots have a long history. Stemming from the Czech word *robota* for ‘forced labor,’ the word was coined in K. Čapek’s play *R.U.R. Rossum’s Universal Robots* in 1920. Since these early days, mankind has sought to create utility robots, some of which look nothing like humans, while others are directly modeled after humans.

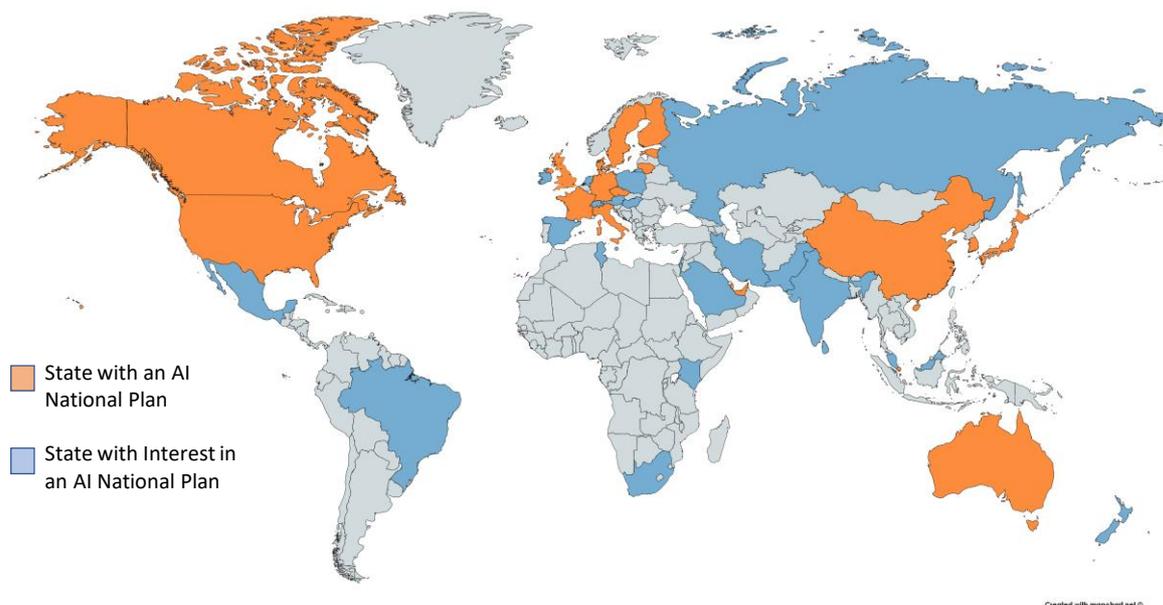
Of course, robots require more than just mechanical limbs and wheels; they also need programming. Code is essential to a robot’s engagement with the world. Controls of an advanced robot stem from much of a human’s senses – vision, hearing, touch. To dynamically process this data and take actions without remote controls – i.e., autonomously – is a goal of robot designers. AI is a diverse tool for making sense of data collected by a robot.

With industry keen on leveraging the 24/7 capabilities of robots, the future of the robotics market looks promising. According to the new World Robotics Report, a record high of 381,000 units were shipped globally in 2017 – a 30 percent increase on the previous year. The report notes that “...this means that the annual sales volume of industrial robots increased by 114 percent over the last five years (2013-2017). The sales value increased by 21 percent compared to 2016 to a new peak of US \$16.2 billion in 2017.”<sup>22</sup> The demand for industrial robotics is anticipated to grow exponentially during the forecasting period, as driven by advantages such as cost reduction, improved quality, increased production, and improved workplace health and safety.<sup>23</sup> Personal and professional service robots have seen increased use in several markets, including medical, agriculture and security.

## 4. STATE INITIATIVES ON ARTIFICIAL INTELLIGENCE

In an effort to tap into the potential of AI, several States have sought to develop national strategies or plans to serve as frameworks for action. For the purposes of this report, a national strategy or plan is considered as an overarching document adopted by a Government with a specific political and legal character that is intended to guide all national efforts in a respective field and to coordinate and to align the activities of stakeholders. This definition strictly excludes national narratives on a specific topic, strategic or otherwise, that may consist of a range of actions, such as the establishment of agency or authority or the allocation of funding. These criteria also exclude States that have significant AI industry activity, yet no current government initiatives.

At the time of the preparation of this report, 19 States had released such framework documents, each coming at issues such as research, development, investments and regulation from the perspective of their respective national interests. A further 22 States were identified as having demonstrated interest in an AI national strategy or plan. For the purposes of this report 'interest' is defined as taking steps toward the development of such a document, for instance through the publication of a precursor report and/or the formation of working group. Figure 1 provides an overview of AI national frameworks.



*Figure 1. States with or having demonstrated interest in an AI national strategy or plan.*

An overview of some of the most relevant AI-related actions in each of these 41 States, starting from early 2017 until early June 2019, is provided in the sections that follow. Those States that specifically acknowledge the relevance of AI for law enforcement and crime prevention are identified. This is by no means a comprehensive summary of global AI initiatives, or an assessment of or commentary upon the quality or merit of these frameworks. Rather, it is intended to provide the reader with a brief introduction to the breadth of some of the more structured national AI activities worldwide and, additionally, to understand to what degree law enforcement and crime prevention feature in this regard.

It should also be noted that the overview includes only:

- open source, unclassified information and data, and
- information and data available in English.

Financial investments into AI from national governments, as well as – where possible – major venture capital funds and industry (large corporate and start-ups) are taken as further measures of the degree of national engagement. It should be noted that it is possible that financial results only reflect a partial slice of information from each government, since available open source information (press releases, published budgets) may only provide partial data from the full scope of government investments. Moreover, some governments include AI projects with other technology funding; wherever possible, AI-specific funding is noted. In order to facilitate comparative analysis, figures are provided in United States dollars (USD).

For additional information on national strategies, plans or related initiatives, several notable overviews have been released that provide varying levels of detail and information.<sup>24 25 26 27 28 29</sup>

Lastly, it is noted that, in addition to national actions with respect to AI described below, there has also been considerable work carried out regionally. This includes, perhaps most notably, the European Union (EU), which published a coordinated plan on the development of AI in the EU in December 2018.<sup>30</sup> This plan envisages that, by mid-2019, all EU Member States will have their own AI strategies in place. The Nordic-Baltic Region, under the leadership of Sweden, has also issued a regional declaration on AI with a view towards maintaining their position as Europe's leading region in the area of digital development<sup>31</sup>.

#### 4.1. Australia

The Australian government is executing a national plan for AI with its publication of the report *Australia 2030: Prosperity through Innovation*, in which AI is prominently featured as part of its recommendations on its Digital Economy Strategy.<sup>32</sup> In May 2018, Australia's federal government set aside AUS \$29.9 million [US \$21.2 million] over four years to strengthen its standing in AI and machine learning. The 2018-2019 Australian budget overview states that "A Technology Roadmap, a Standards Framework and a national AI Ethics Framework will help identify opportunities in AI and machine learning for Australia and support the responsible development of these technologies. This measure will also support Cooperative Research Centre projects, PhD scholarships and school-related learning to increase knowledge and develop the skills needed for AI and machine learning."<sup>33</sup>

Australian venture capital investments broke AUS \$130.5 million [US \$94.9 million] in the first three months of 2018; some of that funding went to support AI companies.<sup>34</sup>

#### 4.2. Austria

Although it has not adopted a national framework for AI, the Austrian Government confirmed a Council on Robotics and Artificial Intelligence in July 2017 to assess opportunities in robotics and AI, as well as their risks. The Council identified smart governance, smart regulation, and smart innovation as its focus areas in a November 2018 white paper.<sup>35</sup> The Council was reportedly provided a €1 million [US \$1.1 million] budget from the Ministry of Infrastructure and a two-year timeframe to develop an AI national plan, including recommendations for politics, business and the population, which take into account the development of the business location, legal requirements and social and ethical values.<sup>36</sup>

#### 4.3. Brazil

Although Brazil does not have yet an AI national plan, on March 21, 2018, President Michel Temer signed a decree during creating the *Brazilian Digital Transformation Strategy (E-Digital)*<sup>37</sup> and the *Inter-ministerial Committee for Digital Transformation*. Addressing AI in its Digital Strategy, the Brazilian Government defines 100 actions to increase the productive processes online, to boost internet access for society as a whole, to protect citizens' rights and to maintain privacy, and to work with other countries to develop new technologies. The

deadline for completion of the project is four years, and the main objectives are to increase the country's competitiveness and productivity.<sup>38</sup> No specific funding is allocated for AI.

#### 4.4. Canada

The Canadian Government released with its 2017 federal budget a CAN \$125 million *Pan-Canadian Artificial Intelligence Strategy*.<sup>39</sup> The strategy, led by the Canadian Institute for Advanced Research (CIFAR), outlines four major national goals:

1. Increase the number of outstanding AI researchers and skilled graduates in Canada
2. Establish interconnected nodes of scientific excellence in Canada's three major centers for AI in Edmonton, Montreal and Toronto
3. Develop global thought leadership on the economic, ethical, policy and legal implications of advances in AI
4. Support a national research community on AI

This plan focuses upon the establishment and continued support of AI institutes, university faculty chairs, and societal outreach. Canada is reported to have built on its AI research advantage in 2017 with more than CAN \$300 million [US \$229 million] in new research funding and CAN \$260 million [US \$199 million] raised by startups.<sup>40</sup>

With government investments and favorable immigration policies providing foreign researchers a path toward working visas and citizenship, industry has taken notice of Canada. A wide range of leading AI firms have established research centers in Canada, including Microsoft, Google, Facebook, Adobe Systems Inc., NVIDIA Corp., Uber Technologies, Thales SA, Samsung Electronics Co. Ltd., Fujitsu, Ltd., and LG Electronics Inc.<sup>41</sup>

Venture capital investments in Canadian AI startups have increased steadily in the past few years. According to a white paper by PwC, "Investment in Canadian AI companies jumped to CAN \$169M [US \$129 million] in Q2'18, an increase of 104% over Q1. The sector recorded 13 deals in Q2'18."<sup>42</sup>

#### 4.5. China

China announced its *New Generation Artificial Intelligence Development Plan* in July 2017 with its goal of becoming world leader in AI by 2030. The plan has three main agenda points: tackling key problems in research and development, pursuing a range of products and applications, and cultivating an AI industry.<sup>43</sup>

The AI plan additionally specifically cites the need to "Develop laws and regulations and ethical norms that promote the development of AI" as one of its Assurance Measures. Within that context is noted the goal to "Carry out research on legal issues such as civil and criminal responsibility confirmation, privacy and property protection, information security utilization related to the application of AI."<sup>43</sup>

In July 2017, the Chinese Government published its *Three-Year Action Plan for Promoting Development of a New Generation Artificial Intelligence Industry (2018–2020)*.<sup>44</sup> An English translation by New America notes that it "focuses on the in-depth integration of information technology and manufacturing technology, with the industrialization and integration of the new generation of AI technology application as the focal point, to promote the in-depth integration of AI and the manufacturing industry and speed up the building of China into a manufacturing superpower and a cyber superpower."<sup>45</sup>

In January 2018, the official Xinhua news agency reported Beijing's intention for a 13.8 billion Yuan [US \$2.12 billion] AI development park. The AI park will house up to 400 enterprises and have an estimated annual output of 50 billion Yuan [US \$7.4 billion], with its focus upon developing areas such as super high-speed big data, cloud computing, biometric identification and deep learning.<sup>46</sup>

During a March 2018 press conference, the Chinese Minister of Science and Technology, Mr. Wan Gang, indicated that China would soon release guidelines and detailed regulations on AI development, although since then there have been no official documents released.<sup>47</sup>

At the World Artificial Intelligence Conference in Shanghai in September 2018, Chinese leaders, including Vice Premier Liu He, called for foreign investment in China, pledging to foster “an environment of free thinking” to support development.<sup>48</sup>

Chinese national investments go beyond merely algorithms, with its combined investment in AI, chips and electric cars estimated at US \$300 billion.<sup>49</sup> China’s total spending on AI is unclear, although it has been estimated at around US \$12 billion in 2017 and that it will grow to at least US \$70 billion by 2020.<sup>50</sup>

Taiwan, Province of China, has also uniquely been active with respect to AI, releasing its *Taiwan AI Action Plan* in January 2018 and allocating an annual budget of between NT \$9 billion and NT \$10 billion [US \$304.4 million and US \$338.3 million] to develop its national AI industry.<sup>51</sup> According to Premier William Lai, “The plan outlines five initiatives: cultivating talent, developing Taiwan’s niche AI, incubating local AI start-ups, reconciling laws for AI development, and introducing AI technologies to industries.”<sup>52</sup> In the same week, Microsoft announced a new research and development center in Taiwan.<sup>53</sup>

In the private sector, China possesses some of the world’s largest AI companies. It is estimated that there are 14 unicorns (companies with valuations exceeding US \$1 billion) in China.<sup>54</sup> Baidu, Alibaba and Tencent (collectively referred to as the BAT) are the most widely known firms leveraging AI, but there are many other companies either invested in by the BAT or independent. Chinese venture capital funding is also increasing, fueling the growth of startups. It is believed that nearly US \$5 billion in venture capital funding was raised in 2017 and that overall investments in AI startups increased 150% globally year-over-year in 2017.<sup>55</sup>

#### 4.6. Czech Republic

The Czech Republic adopted its *National Artificial Intelligence Strategy of the Czech Republic* in May 2019.<sup>56</sup> The priority topics of the adopted strategy include security and defense, industrial production and human-machine communication. It will also focus on computer security, robotics, self-driving cars and applications for language recognition.<sup>57</sup> Although the strategy has several notices of planned funding, none are noted yet in this initiative.

#### 4.7. Denmark

In January 2018, the Danish Government released the *Strategy for Denmark’s Digital Growth*. The report details 38 major initiatives, one of which is the formation of a National Centre for Research in Digital Technologies, to include research in AI, the Internet of Things, and Big Data. The Danish Government has allocated almost DKK 1 billion [US \$153 million] until 2025 for the implementation of the initiatives in the strategy.<sup>58</sup>

Several companies and AI-related organizations have established innovation hubs in Denmark, including Singularity University,<sup>59</sup> IBM<sup>60</sup> and SAP<sup>61</sup>.

#### 4.8. Estonia

Estonia has developed extensive expertise in AI, becoming a leader in particular with respect to addressing the plethora of legal aspects related to the subject. In line with this approach, Estonia developed a legal framework for AI, which was debated by parliament as a bill and was approved by the Estonian Government as the Estonian AI national plan on June 6, 2019<sup>62 63 64 65</sup>.

The birthplace of Skype, Estonia has had a vibrant startup community since 2003. With half a billion dollars US invested in the past roughly two years, Estonia has numerous startups

leveraging AI, including Milrem Robotics, based in Tallinn, which builds the world's first fully modular hybrid unmanned ground vehicle (UGV), the Tracked Hybrid Modular Infantry System (THeMIS).<sup>66</sup>

## 4.9. Finland

In May 2017, the Ministry of Economic Affairs and Employment of Finland launched its *Artificial Intelligence Programme* and appointed a steering group<sup>67</sup>, which subsequently released a report, *Finland's Age of Artificial Intelligence: Turning Finland into a leading country in the application of artificial intelligence*, in December 2017<sup>68</sup>. The report details eight key action items for taking Finland toward the age of AI:

- 1) Enhancement of business competitiveness through the use of AI
- 2) Effective utilization of data in all sectors
- 3) Ensure AI can be adopted more quickly and easily
- 4) Ensure top-level expertise and attract top experts
- 5) Make bold decisions and investments
- 6) Build the world's best public services
- 7) Establish new models for collaboration
- 8) Make Finland a frontrunner in the age of AI

The Finnish Government in April 2018 endorsed the strategy and put in place plans for its execution through 2022.<sup>69</sup> In June 2018, the Finnish Government published the report *Artificial Intelligence: four perspectives on the economy, employment, knowledge and ethics*, which detailed:

- 1) Effects of artificial intelligence on general economic and employment development
- 2) Labour change and the labour market
- 3) Education and skills management
- 4) Ethics<sup>70</sup>

The Finnish AI Business Programme is investing to make these plans proceed, providing approximately half of the €200 million [US \$227 million] budget for 2018 to 2022, as well as €60 million [US \$68 million] for building and development, including for example digital platforms.<sup>71</sup> Startups in Finland have competed in business pitches and received funds up to €50,000 [US \$56,000] from larger firms.<sup>72</sup> Top-named Finnish AI startups cover markets as diverse as education, health insurance and e-commerce, among others.<sup>73</sup>

## 4.10. France

On 29 March 2018, France unveiled its vision for amplifying engagement in AI at the *AI for Humanity Summit* in Paris, accompanied by a €1.5 billion [US \$1.7 billion] investment from the French Government over a five-year term.<sup>74</sup> The plan is largely inspired the report by France's 2010 Field's Medal winner Cedric Villani, *For a Meaningful Artificial Intelligence: Towards a French and European Strategy*, which proposes four aspects:

- 1) Reinforcing the AI ecosystem in order to attract the very best talents
- 2) Developing an open data policy, above all in sectors where France already has the potential for excellence, such as healthcare
- 3) Creating a regulatory and financial framework favouring emergence of "AI champions", through provision of special support to AI research projects and startups
- 4) Giving thought to AI regulation and ethics, to ensure its development in line with the very best standards of acceptability for citizens<sup>75</sup>

During the unveiling of the plan, President Emmanuel Macron especially emphasized the potential for AI's application in healthcare and transportation.

Moreover, within "Part 5 – What are the Ethics of AI?" of the French AI national plan is a description of the promises and perils of predictive policing, in which predictive algorithms are used to aid law enforcement. The plan notes that while AI algorithms can offer potential substantial benefit to streamlining analysis of geographic data, social data and individual behaviour to more effectively target criminals, "...sophisticated as they are, these systems remain fallible; they are capable of making errors, with potentially disastrous consequences for the lives of the individuals they wrongly assess."<sup>75</sup>

Industry is a strong part of France's AI vision and, alongside the conference, IBM, Samsung, Fujitsu, and Google DeepMind announced the establishment of new AI research centers in France. These companies join Facebook and Google, which previously announced investment plans in France during the *Choose France!* Summit in February 2018.<sup>76</sup>

Leading French AI startups range across the economic spectrum including social media, marketing, data analytics, virtual assistants and more.<sup>77</sup>

#### 4.11. Germany

On 15 November 2018, the German Government published the *Strategie Künstliche Intelligenz der Bundesregierung [Artificial Intelligence Strategy of the Federal Government]*.<sup>78</sup>

<sup>79</sup> The German strategy pursues three objectives:

- 1) Making Germany and Europe global leaders on the development and use of AI technologies and securing Germany's competitiveness in the future
- 2) Safeguarding the responsible development and use of AI to serve the good of society
- 3) Integrating AI in society in ethical, legal, cultural and institutional terms in the context of a broad societal dialogue and active political measures

The German AI plan furthermore recognizes that AI can be leveraged in law enforcement, specifically in predictive policing; for example, in the protection of children and adolescents from sexual violence on the internet and in the fight against privacy violations in social media.<sup>79</sup>

Concomitantly, the German Government set aside €3 billion [US \$3.4 billion], to be spent by 2025, for research and development of AI in November 2018. It is further assumed that an additional €3 billion [US \$3.4 billion] will follow in corporate investments in AI to complement this initiative, bringing the full Germany AI initiative to €6 billion [US \$6.8 billion].<sup>80 81</sup>

Top German AI startups cover such market sectors as healthcare, personal finance, document management and others.<sup>82</sup>

#### 4.12. Hungary

In the leadup to developing its AI national plan, Hungary formed an AI Coalition in October 2018.<sup>83</sup> Six working groups were established to identify specific needs and potential directions for development from cloud platforms to smart hospitals to chatbots in government services.<sup>84</sup>

Led by the coalition, Hungary is in the process of drafting a comprehensive AI strategy, but no further reporting has been identified on its recent progress.

#### 4.13. India

In June 2018 the report *National Strategy for Artificial Intelligence #AIforAll* was published by the Indian Government think-tank, Niti Aayog.<sup>85</sup> This paper is positioned as a precursor to a future National Strategy for AI in India. Economic focus areas for "AI Intervention" include healthcare, agriculture, education, smart cities and infrastructure, and smart mobility and transportation. The section "Ethics, Security, Privacy and Artificial Intelligence" highlights the

need to be conscious of the probable factors of the AI ecosystem that may undermine ethical conduct, impinge on one's privacy, and undermine the security protocol.

Budget allocation for Digital India, the government's umbrella initiative to promote AI, machine learning, 3D printing, and other technologies, was almost doubled to Rs 3,073 crore [US \$477 million] in 2018.<sup>86</sup>

Between 2014 and 2017, AI startups in India are believed to have raised circa US \$100 million from venture capital.<sup>86</sup>

#### 4.14. Ireland

Ireland has not adopted an AI national plan or specific government-sourced investments, although it has been reported that public consultations for the development of a new National Digital Strategy closed in November 2018<sup>87</sup>.

The Irish Government has also worked with industry representatives of the Irish Economic Development Agency<sup>88</sup> and Enterprise Ireland<sup>89</sup> to create an infographic showcasing leading AI companies in Ireland – both domestic to Ireland and international with branch offices in Ireland.<sup>90</sup>

#### 4.15. The Islamic Republic of Iran

Although not yet possessing an AI strategic plan or any published government-sourced investments, the Iranian Government reported to local media that it had launched a pilot project in October 2018 for using AI in legislation, ostensibly to supplement policymaker decision-making.<sup>91</sup> There is discussion within the Iranian Government of establishing a Ministry of Artificial Intelligence.<sup>92</sup> A particular strength for Iranian AI efforts is its application in the field of robotics.<sup>93</sup>

#### 4.16. Israel

Although not having an AI national plan yet, the Israeli Government has nevertheless recognized the need for such a framework. In its *Israel Innovation Authority 2018-2019 Report*<sup>94</sup> the Israel Innovation Authority wrote that the State of Israel must close the gap with other countries that already have made substantial investments in AI infrastructures. The need to implement policies to strengthen academic research, to develop infrastructure, and to regulate the industry have been stressed.

Israel's startup ecosystem is particularly robust, especially for a country of only 8.7 million people.<sup>95 96</sup> A few statistics shed light on AI entrepreneurialism in Israel<sup>97</sup>:

- The Israeli startup ecosystem has raised over US \$7.5 billion.
- There are over 950 active startups utilizing or developing AI technologies, of which 445 startups have raised one or more funding rounds. Over the last five years, an average of 140 startups are established annually.

#### 4.17. Italy

Led by an AI task force, the Italian Government released a white paper, *Artificial Intelligence: At the Service of Citizens*, in March 2018<sup>98</sup>. The release of this document makes Italy unique with respect to other States with the initial focus of its AI national plan being how the government might leverage AI in its public administration. The stated objective of the plan is to "facilitate the adoption of these technologies in the Italian Public Administration, to improve services to citizens and businesses, thus giving a decisive impulse to innovation, the proper functioning of the economy and, more generally, to progress in daily life."<sup>99</sup>

Moreover, within the Italian AI plan's "Main application areas" it is noted that law enforcement agencies can leverage AI "...to patrol cities, based on continuously updated data, linked to the crimes committed in the various areas and to other significant variables." One project example for automatic data mining and analysis solutions is cited to leverage AI in its ability to identify, retrieve, collect and analyse large quantities of heterogeneous content, including multiple languages both in the normally accessible internet and in the dark web, to trace the operations of terrorist networks.<sup>98</sup>

No Italian government-sourced investments were noted for AI.

The Agency for Digital Italy is also undertaking a comprehensive mapping of public and private sector activities by Italian AI organizations in its Artificial Intelligence Ecosystem.<sup>100</sup>

## 4.18. Japan

In March 2017, the Japanese Government released its *Artificial Intelligence Technology Strategy*.<sup>101</sup> The strategy contains a roadmap toward AI industrialization and focuses on key areas such as productivity improvement, healthcare, medical care and welfare, mobility and information security.

Following the release of the Strategy, *Draft AI Guidelines for International Discussions* were also released in July 2017 to serve as a basis for international discussions with the Group of Seven (G7) countries and the Organisation for Economic Co-operation and Development (OECD) on cooperation on AI research and development.<sup>102</sup> The Guidelines includes five major goals:

1. Achieve a human-centered society
2. Share the Guidelines, as non-binding soft law, and their best practices internationally among stakeholders
3. Ensure an appropriate balance between the benefits and risks of AI networks
4. Make sure that AI research and development activities based on specific technologies or techniques are not hindered in light of ensuring technological neutrality, and to be mindful that developers are not imposed of excessive burden
5. Constantly review the Guidelines and flexibly revise them as necessary

AI is also an integral part of Japan's Society 5.0 initiative<sup>103</sup>, in which the Japanese Government proposes the transition from Society 1.0 (Hunting Society) through Society 5.0 (Super Smart Society). Drones, AI home appliances, smart work, smart management, and autonomous vehicles, among others, comprise the Society 5.0 foci.

Japanese Government investment in AI in 2018 is reported to be US \$720 million, whereas private sector investment annually is on the order of US \$5.3 billion.<sup>104</sup>

Large industry is embracing AI within Japan with the AI market estimated to grow from JPY 3.7 trillion [US \$33 billion] in 2015 to JPY 87 trillion [US \$770 billion] by 2030.<sup>105</sup> Japan is also the home of Softbank, which continues to invest heavily in AI around the world with its more than US \$100 billion in venture capital funding.<sup>106</sup>

## 4.19. Kenya

As a precursor to a possible future AI national plan, the Kenyan Government created a task force for Blockchain and AI in February 2018, with the reported goal of generating a report "...to make recommendations on how the government can leverage on the emerging technologies in the next five years, with other key milestones in 2027 and 2032."<sup>107</sup> The report is presently under review by the Kenyan Government prior to release to the public.<sup>108</sup>

## 4.20. Lithuania

In April 2019, Lithuania published its *Lithuanian Artificial Intelligence Strategy*<sup>109</sup>. Key sections include:

1. Ethical and legal core principles for the development and use of artificial intelligence
2. A breakdown of Lithuania's position in the AI ecosystem
3. Integration of artificial intelligence systems across all economic sectors
4. National development of skills and competencies needed for a future with artificial intelligence
5. Growth of Artificial Intelligence Research and Development
6. A responsible and efficient approach to data

Moreover, a specific citation is given of the potential for crime prediction using AI models to discover high risk areas for crime in cities.<sup>109</sup>

From 2015 to 2018, Lithuanian public sector investment in AI was more significant than from the private sector, with a total of €26.5 million (US \$30 million) and €3.2 million (US \$3.6 million), respectively. In total, 39 different AI projects received funding from the Ministry of Economy and Innovation initiatives, totaling €12.5 million (US \$14.1 million) since 2016. When combined with private capital brought in, the total value of projects for the last three years was over €20 million (US \$22.6 million). Almost all of the submitted projects approved received funding greater than or equal to 50 percent of the total value of the project. AI academic research projects also received €6.5 million (US \$7.4 million) under the Ministry of Education and Science. Private investment came primarily from venture capital firms with varying origins including Lithuania, United States, France and Russia.<sup>109</sup>

## 4.21. Malaysia

In October 2017, the Malaysian Government announced its intention to develop a National Artificial Intelligence Framework, as based on a 'cloud-first' policy.<sup>110</sup> A Malaysian AI national plan is expected by the end of 2019.<sup>111</sup> AI startups in Malaysia focus on diverse topics, including emotion, disease and credit card fraud detections.<sup>112</sup>

## 4.22. Malta

In November 2018, the Maltese Government published the white paper *Malta.AI—Towards a National AI Strategy*<sup>113</sup>. In March 2019, the Maltese Government published their guiding document, *Malta-Towards an AI Strategy; High-Level Policy Document for Public Consultation*<sup>114</sup>. The Strategy is built on three Strategic Pillars: Investment, Start-ups and Innovation; Public Sector Adoption; and Private Sector Adoption. These pillars, in turn, are supported by three Strategic Enablers: Education and Workforce; Legal and Ethical Framework; and Ecosystem Infrastructure. Although not yet an AI national plan, the report sets the stage for its drafting within Fall 2019.

## 4.23. Mexico

Although commissioned by the British Embassy in Mexico City and written by Oxford Insights and C-Minds, the Mexican Government collaborated with the drafters and supported the process in the production of the June 2018 report, *Towards an AI Strategy in Mexico: Harnessing the AI Revolution*.<sup>115</sup> This report defines arguments for the creation of a national AI strategy for Mexico and makes recommendations in five areas: government and public services; data and digital infrastructure; research and development; capacity, skills and education; and ethics.

Mexican banks are reportedly beginning to leverage AI for a variety of its financial activities, for instance to power chatbots, but not fraud or anti-money laundering detection.<sup>116</sup>

#### 4.24. The Netherlands

A first draft for a Dutch AI national strategy was published in April 2019.<sup>117</sup> Written by the AINED - a public-private partnership with TopTeam ICT, Dutch employer federation VNO-NCW, business group MKB Nederland, Innovation Center for Artificial Intelligence, Netherlands Organisation for Scientific Research (NWO), and Netherlands Organisation for Applied Scientific Research (TNO) - the document spells out the need for a more formal AI national plan that emphasizes a human-centric approach in which man and machine work side-by-side. No funding commitments have been made yet by the Dutch Government at this writing.

#### 4.25. New Zealand

In May 2018, the AI Forum of New Zealand released the report *Artificial Intelligence: Shaping a Future New Zealand*.<sup>118</sup> The report, which is not a national plan, is structured in four parts: The AI Landscape (including a global survey of national AI strategies); The AI Economy (as relative to New Zealand); AI and Society; and Where to From Here? (including policy recommendations for New Zealand officials). Although no specific government funding is noted, the report does comment that AI has the potential to increase New Zealand's GDP by NZ \$54 billion [US \$37.1 billion].

New Zealand has an active AI ecosystem, as captured in an AI ecosystem map produced by AI Forum of New Zealand, which details initiatives in the public sector; professional services; startups, enterprises, and commercial AI; research and education; and platform enablers<sup>119</sup>.

#### 4.26. Pakistan

Although no mention is made of an AI national strategy, the Pakistani Government announced an AI initiative in April 2018 to be funded at US \$3.3 million over three years. The project will be supervised by the Higher Education Commission (HEC), with six public sector universities selected to develop nine AI research labs.<sup>120</sup>

#### 4.27. Poland

With the long-term vision of drafting an AI national strategy, the Polish Government held its first roundtable to discuss the potential impact and importance of AI at the Warsaw Stock Exchange in May 2018.<sup>121</sup> A map of the Polish AI landscape was published in January 2019<sup>122</sup> and work on an AI national strategy is expected to begin in late 2019.<sup>123</sup>

#### 4.28. Qatar

Qatar released its *National Artificial Intelligence Strategy For Qatar*<sup>124</sup> in January 2019. With its foundational pillars of Race for Talent, AI Augmented Jobs, and Knowledge Economy (grounded in Data and Computer Infrastructure and Ethics and Governance of AI), Qatar seeks to serve as a role model for an AI+X Nation, in which AI is likely to be embedded in all aspects of human activity.

#### 4.29. The Republic of Korea

In December 2016, the Government of the Republic of Korea published its *Mid- to Long-Term Master Plan in Preparation for the Intelligent Information Society Managing the Fourth Industrial Revolution*.<sup>125</sup> The strategy has four components:

1. Foster an intelligent information society on the basis of public-private partnership, with businesses and citizens playing leading roles and the government and research community providing support
2. Devise and implement a balanced policy regime that encompasses technologies, industries, and society and shapes the development of a more humane society
3. Provide strategic support for the prompt securement of the rights and access to Intelligent IT and other related resources to ensure and foster industrial competitiveness in advance
4. Reform policies and expand the social security net on the basis of social consensus

The Korean plan is designed to encourage public-private-partnerships among Korean Government and industry. It furthermore considers legal and ethical implications of AI.

Within the context of a “Proactive application of Intelligent IT to national services,” the Korean AI plan cites the goal to develop an intelligent crime response system. The noted goal is to “increase the arrest rate by at least 10 percentage points by developing AI systems for the analysis of crime information and carrying out prompt responses to crime (from 78 percent in 2014 to 88 percent in 2030).”<sup>125</sup>

The Korean Government is investing 2.2 trillion won [US \$2 billion] in AI projects from 2018-2022 and will initiate large-scale AI projects in national defence, life sciences and public safety, as well as undertake projects in next-generation AI chips and new drugs and future materials via AI research and development.<sup>126 127</sup>

### 4.30. The Russian Federation

The Government of the Russian Federation is in the process of drafting an AI national roadmap, with plans for releasing it in mid-2019, as noted by Russian state media.<sup>128</sup> The new document is expected to form a cornerstone of a larger Digital Technologies national programme.<sup>129</sup> During a recent meeting, Russian President Vladimir Putin emphasized that the Russian Government needs to enshrine and protect citizens’ rights and new intellectual property in connection with the development of technologies in the field of AI.<sup>130 131</sup>

Prior to the announcement of the development of an AI national roadmap, the Ministry of Defence of the Russian Federation, together with the Ministry of Education and Science of the Russian Federation and the Russian Academy of Sciences, organized and held a conference in March 2018 on “Artificial Intelligence: Problems and ways to solve them – 2018”. This meeting yielded a 10-point plan for new AI programmes, training, military games, and an annual programme for a Conference on Artificial Intelligence.<sup>132 133</sup>

Russia’s annual domestic AI investment is estimated at around 700 million rubles [US \$12.5 million], as reported in April 2018.<sup>134 135</sup> A more recent report calls for much higher spending: “[US] \$287 million for leading research centers and start-ups, [US] \$145 million to develop products, services and platforms, and [US] \$287 million for technology.”<sup>136</sup> This would amount to a total of US \$719 million for Russian Government AI investments.

The top 10 Russian AI startups have collectively raised US \$30 million as of June 2018.<sup>137</sup>

### 4.31. Saudi Arabia

Although Saudi Arabia does not yet have a published official AI strategy, the Saudi Government has significant goals with AI as evidenced within its Vision 2030 plan<sup>138 139</sup>, which has been accompanied by several other government actions and announcements. The vision for a new US \$500 billion planned city, NEOM, especially leverages AI and the Internet of

Things, but the portion of this large infrastructure investment that is actually going to AI is difficult to discern<sup>a, 140</sup>

Saudi Arabia is particularly keen on investments in technologies that leverage AI. Notably, the Saudi Government has made multi-billion investments in Tesla [US \$2 billion], Uber [US \$3.5 billion], Softbank Group Corp. [US \$47 billion], and Virgin Group [US \$1 billion].<sup>140</sup>

### 4.32. Singapore

In May 2017, Singapore launched a national programme, *AI Singapore*,<sup>141</sup> to catalyze research and development, as well as corporate investment into the country, providing an investment of S \$150 million [US \$109 million].<sup>142</sup> This national programme was followed by an announcement in June 2018 of three initiatives on AI governance and ethics: an Advisory Council, a discussion paper by the Personal Data Protection Commission, and a 5-year research programme.<sup>143</sup> Singapore also announced an “AI for Everyone” programme in August 2018, in which 10,000 students will be taught the basics of AI for free.<sup>144</sup>

### 4.33. South Africa

Although South Africa lacks a specific AI strategy, it launched its “Intsimbi Future Production Technologies Initiative” in 2018 to enable government and industry to cooperate on large-scale interventions required to rehabilitate the South African Tool, Die and Mouldmaking (TDM) sector for the benefit of the South African manufacturing sector, within which AI is considered a core component.<sup>145</sup>

### 4.34. Spain

In March 2019, the Spanish Government prepared an internal document that is a precursor toward a National Strategy on AI, which 11 ministerial departments will work on and which is to be ready later this year.<sup>146</sup> During the research, development and innovation (R&D+i) in Artificial Intelligence workshop, held in Granada, Spain’s Prime Minister Pedro Sánchez highlighted that technologies related to AI are already one of the main factors of growth, and hence Spain and Europe have to make a joint effort to move forward on this important line for social and economic progress. No funding announcements were made at the workshop.

### 4.35. Sri Lanka

Sri Lanka, through its National Export Strategy Advisory Committee, announced an *AI Nation* to promote education of 5,000 data scientists from 2018 to 2025.<sup>147</sup> This will serve as a step to drafting an AI national plan.

### 4.36. Sweden

In May 2018, Sweden released the report, *National Approach to Artificial Intelligence*<sup>148</sup>. Education and training, research, innovation and use, and framework and infrastructure are described as key conditions for use of AI in Sweden.

The Swedish Government followed the national framework with investments of SEK 40 million [US \$4.5 million] for 2018-2019 to advance education in AI.<sup>149</sup> Vinnova, Sweden’s innovation agency, also announced investment of SEK 100 million [US \$11.1 million] per year over the next ten years in collaboration with business, public sector, universities and research institutes.<sup>150</sup>

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<sup>a</sup> Precisely due to the difficulty of discerning this, NEOM is not included in the later funding assessments.

#### 4.37. Switzerland

In September 2018, Switzerland adopted its *Digital Switzerland Strategy* for the next two years.<sup>151 152</sup> While not yet an AI national plan, this initial AI strategy establishes a working group on AI and supports initiatives on Smart Cities, with the overall goal of intensifying dialogue among key stakeholders, especially those within the Swiss cantons. The strategy has the goal to submit to the Federal Council by autumn 2019 an overview of existing measures, an assessment of new fields of action, and considerations for the transparent and responsible application of AI.

SwissCognitive was created in September 2016 to support industry and research.<sup>153</sup> One of its goals is to be a Global AI Ecosystem, where the potentials of AI are openly discussed so that effective change can be initiated and further built upon for the greater good.

#### 4.38. Tunisia

Tunisia initiated its consideration of an AI national strategy in April 2018 by kicking-off its AI Task Force and Steering Committee.<sup>154</sup> During the initial workshop three possible pillars for action were presented: seedbed (research and development, data and infrastructure), enablers (multi-stakeholder partnerships and policy), and talents (capacity motivation and enhancement).<sup>155</sup>

#### 4.39. The United Arab Emirates

The United Arab Emirates (UAE) launched its national AI strategy in 2017.<sup>156</sup> Nine sectors are considered in the strategy: transport, health, space, renewable energy, water, technology, education, environment and traffic. The AI strategy is comprised also of five themes: the formation of the UAE AI Council; workshops, programmes, initiatives and field visits to government bodies; development of capabilities and skills of all staff operating in the field of technology and organisation of training courses for government officials; provision of all services via AI and the full integration of AI into medical and security services; and launching of a leadership strategy and issuance of a government law on the safe use of AI.<sup>157</sup> Uniquely, the UAE was the first State to appoint a State Minister for Artificial Intelligence.<sup>158</sup>

Notably, in the specific field of law enforcement, the Dubai Government also adopted the Dubai Police Strategic Plan (2018-2021), in line with which a new General Department of Artificial Intelligence was created in the Dubai Police and a summit on AI-led policing “Future Societies 5.0” was announced.<sup>159</sup> Similarly, in Abu Dhabi, the Centennial Vision 2057 of Abu Dhabi Police adopted in 2017 equally envisages a strong role for AI in Abu Dhabi and details more than 50 strategic initiatives harnessed by AI for the force.<sup>160 161</sup>

The UAE is reported to have made investments of Dh33 billion [US \$9.0 billion] in AI in 2017.<sup>162</sup>

#### 4.40. The United Kingdom of Great Britain and Northern Ireland

The Government of the United Kingdom of Great Britain and Northern Ireland (UK) released its *Artificial Intelligence Sector Deal* in April 2018<sup>163</sup>, which identifies AI and Big Data as among its four ‘Grand Challenges’. This industry strategy is based on five foundations: ideas, people, infrastructure, business environment and places.

The AI Sector Deal commits £0.95 billion [US \$1.2 billion], including government, industry and academic contributions £603 million [US \$760 million] in newly allocated funding and £342 million [US \$431 million] from within existing budgets, as well as £250 million [US \$316 million] for Connected and Autonomous Vehicles. This support complements and leverages some of the £1.7 billion [US \$2.2 billion] that has been announced under the cross-sectoral Industrial Strategy Challenge Fund so far, with five challenges having AI components that business will be able to bid toward in future competitions.<sup>163</sup>

The UK's Centre for Data Ethics and Innovation (CDEI), which will pursue extensive engagement with the public, industry and regulators, will align governance measures with the concerns of the public and businesses.<sup>164</sup>

Just prior to the publication of the AI Sector Deal plan, the House of Lords published a 163-page report, *AI in the UK: Ready, Willing and Able?*,<sup>165</sup> in which recommendations are given to the UK Government on issues as diverse as the development of industry and AI ethics considerations. The government followed-up in June 2018 with its *Government response to House of Lords Artificial Intelligence Select Committee's Report on AI in the UK: Ready, Willing and Able?*<sup>166</sup>, in which it gave detailed responses to 74 recommendations made in the earlier report.

Companies as diverse as Google DeepMind, NVIDIA, and others are investing heavily in the UK AI sector.

#### 4.41. United States of America

On February 11, 2019 US President Donald Trump signed an Executive Order for an *American Artificial Intelligence Initiative*.<sup>167</sup> Five key areas of emphasis are noted:

- 1) Investing in AI research and development
- 2) Unleashing AI resources
- 3) Setting AI governance standards
- 4) Building the AI workforce
- 5) International engagement and protecting our AI advantage

To fulfill the first pillar of the American AI Initiative, the Government of the United States published *The National Artificial Intelligence Research and Development Strategic Plan: 2019 Update* on June 21, 2019. In this strategic plan, eight strategic priorities are identified. The first seven priorities continue from an earlier 2016 AI Research and Development Plan<sup>168</sup>; the eighth priority is new and focuses on the recognized importance of public-private partnerships. The eight priorities are:

- 1) Make long-term investments in AI research
- 2) Develop effective methods for human-AI collaboration
- 3) Understand and address the ethical, legal, and societal implications of AI
- 4) Ensure the safety and security of AI systems
- 5) Develop shared public datasets and environments for AI training and testing
- 6) Measure and evaluate AI technologies through standards and benchmarks
- 7) Better understand the national AI research and development workforce needs
- 8) Expand public-private partnerships to accelerate advances in AI

As noted in the plan's introduction letter: "While this Plan does not define specific research agendas for Federal agency investments, it does provide an expectation for the overall portfolio for Federal AI R&D investments. This coordinated Federal strategy for AI R&D will help the United States continue to lead the world in cutting-edge advances in AI that will grow our economy, increase our national security, and improve quality of life."<sup>169</sup>

The work preceding the American AI Initiative and publication of the updated R&D strategic plan is substantial and covers several years of interagency collaborations. In October 2016, several comprehensive reports were published: *Preparing for the Future of Artificial Intelligence*<sup>170</sup>, *The National Artificial Intelligence Research and Development Strategic Plan*<sup>168</sup>, and *Artificial Intelligence, Automation and the Economy*<sup>171</sup>. Written by experts in the field of AI under the direction of the Office of Science and Technology Policy (OSTP), the reports detailed the need for a structured, national approach to AI, as well as AI's potential

implications to society, ethics, regulations, research and development, cybersecurity, and the national economy.

In May 2018, the White House hosted the *AI for American Industry* summit to discuss the promise of AI and the policies needed to realize this promise and maintain US leadership in this field. During this summit it was noted that AI was highlighted in the 2017 National Security Strategy, 2018 Summary of the National Defense Strategy, the Office of Management and Budget (OMB) and OSTP Administration Research and Development Budget Priorities for fiscal year 2019, and the Budget Request for fiscal year 2019. OSTP also held a summit on the topic in May 2018 and established the National Science and Technology Council Select Committee on AI.<sup>172</sup>

Also in February 2019, the US Department of Defense released its *Summary of the 2018 Department of Defense Artificial Intelligence Strategy* to create a focal point within the whole department for AI.<sup>173 174</sup> The *Joint Artificial Intelligence Center (JAIC)* was formed by the US Department of Defense in June 2018 with a view toward establishing a common set of AI standards, tools, shared data, reusable technology, processes and expertise for the Department of Defense.<sup>175</sup>

On March 19, 2019, the US Government launched [AI.gov](http://AI.gov)<sup>176</sup> to act as a clearinghouse for all US Government AI initiatives.

In May 2019, the US Government joined the OECD (Organisation for Economic Co-operation and Development) in its unveiling of principles for the innovation and trustworthy development and application of AI.<sup>177</sup> Also that month, the bipartisan Artificial Intelligence Initiative Act (AI-IA) was introduced at the US Senate, which would organize a coordinated national strategy for developing AI and provide a US \$2.2 billion federal investment over five years to build an AI-ready workforce, accelerating the responsible delivery of AI applications from government agencies, academia, and the private sector over the next 10 years.<sup>178</sup>

Aside from such national strategy specific funding, AI investments within the United States have been agency-specific and growing. The Defense Advanced Research Projects Agency (DARPA) announced a US \$2.0 billion initiative over the next five years in AI research and development.<sup>179</sup> According to an October 2017 report from the Networking and Information Technology Research and Development (NITRD) Program and the White House report, *Artificial Intelligence for the American People*, it is estimated that: “The Federal Government’s investment in unclassified research and development for AI and related technologies has grown by over 40% since 2015, in addition to substantial classified investments across the defense and intelligence communities.”<sup>180 181</sup> Moreover, the NITRD report provides that the President’s 2018 Budget Request for AI and AI-related technologies was US \$4.46 billion.

The largess of AI funding in the US resides nevertheless in the private sector. Corporate giants such as Google, Facebook, Twitter, Amazon, Netflix, Microsoft, IBM, Uber, Salesforce, Spotify and Apple have invested hundreds of billions of US dollars into AI to secure their specific market sectors.<sup>182</sup> The AI startup ecosystem is also robust; as of May 2018, it is estimated there are approximately 1,400 startups leveraging AI in the US, compared to 3,465 globally.<sup>183</sup> To sustain these startups, venture capital funding in the US has been significant and, in 2017, venture capital investments in AI were estimated at roughly US \$12 billion.<sup>184</sup>

#### 4.42. Core Observations from State Initiatives

Several core observations can be made from the above overview—see Figure 2:

- 41 States have taken AI-related actions, of which 19 States have released framework documents and a further 22 States have demonstrated interest in an AI national strategy or plan.
- Of those 41 States, 20 have matched their AI actions with government investments in AI, and 21 have allocated no specific funding toward AI.

- Seven States have adopted a national strategy on AI that acknowledges the relevance of AI for law enforcement and/or crime prevention or related topics, although no specific funding or dedicated AI sector is allocated to law enforcement and/or crime prevention in any AI national plans.
- Globally, it is estimated there is a total of US \$152 billion committed by States toward AI research and development.
- The rankings among States of annual and gross national investments in AI are largely comparable; those countries investing the most overall also lead annual funding.
- China and Saudi Arabia have both invested over \$10 billion US in AI.
- The United Arab Emirates, the United States of America, Germany, The Republic of Korea, France and The United Kingdom of Great Britain and Northern Ireland have similar orders of magnitude in government investments, in the range of single billion US dollars.
- Japan, The Russian Federation, India, Finland, Denmark, Singapore, Canada, Lithuania and Australia are making investments between US \$10 million and US \$1 billion.
- Sweden, Pakistan and Austria are all devoting funding in the range of US \$1.0 to 10 million.

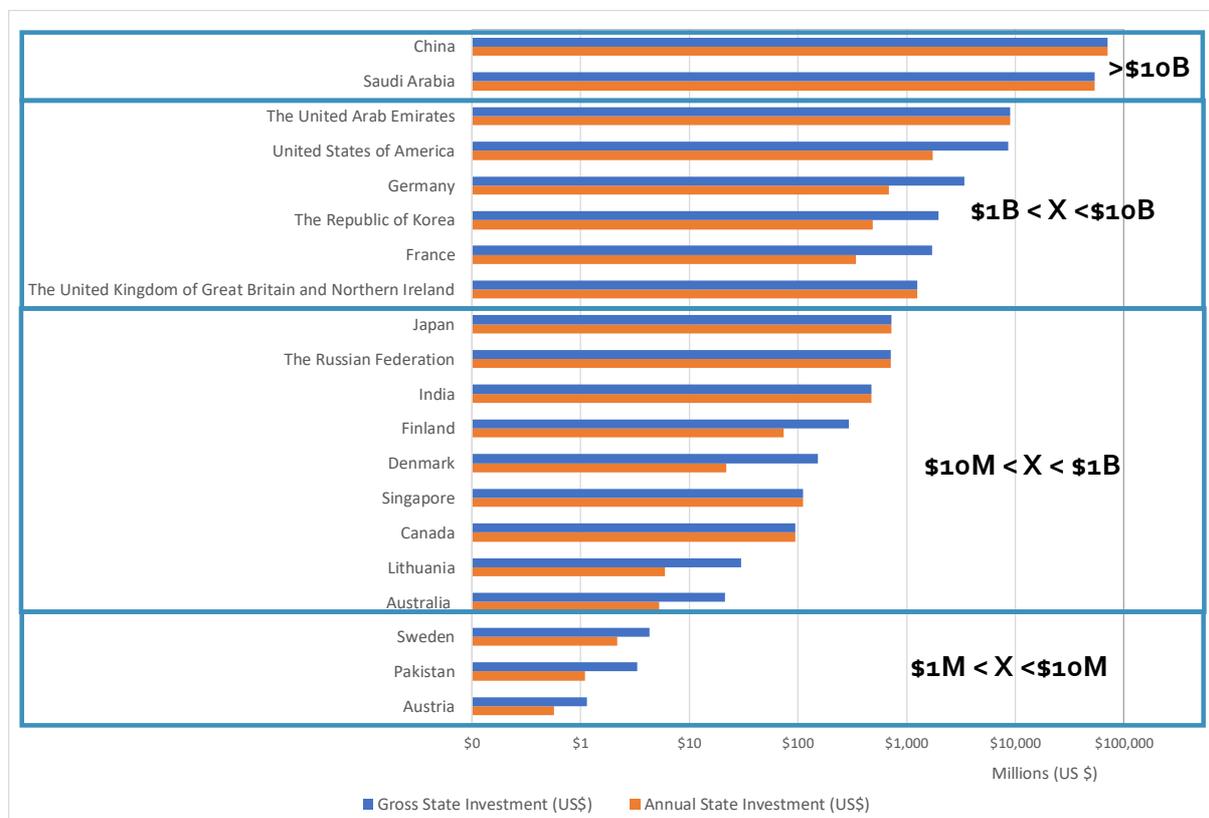


Figure 2. AI investments by States for which government-sourced AI investments were identified.

While information on State’s overall AI investment values is informative, insight into how those funds are being spent is even more valuable. State AI national plans and budgets can offer such insights. Leveraging similar AI sectors highlighted by an earlier report<sup>28</sup> – Research, Infrastructure, Talent/Education, Industrial Strategy, Ethics/Legal Implications, Data, and AI in Government – it is possible to assess from AI national plans and/or respective State budgets how much emphasis each State places on each of these AI sectors.

It should be noted that only 9 of 20 AI national plans or budgets accessible at the time of writing explicitly define how national funds are being spent, per the sectors defined above. For

those States without explicit budgets, the total State AI budget is divided by how many AI sectors each State expresses in their AI national plan in order to give a rough estimate of spending allocations. For example, Australia has an overall budget for AI of approximately US \$21 million, with three AI sectors listed in its national plan: research, talent/education, and ethics/legal implications. For the purposes of this exercise, it is assumed that each sector is given approximately US \$7 million.

Figure 3 presents a logarithmic radar mapping of State investments by AI sector. Salient points that can be extracted from this graphic include:

- Research dominates the AI plans for States – 16 out of 19 States devote some portion of their AI funding toward basic research.
- The next most dominant interest by States in AI sectors are: Talent/Education (11 States), Industrial Strategy (9 States), and Ethics/Legal (8 States).
- Seemingly of lesser interest to States for AI funding are Infrastructure and AI in Government (6 States each), and Data (4 States).
- Only China and the United States address all seven AI sectors. All other States address six or fewer AI sectors in their AI national plans or budgets.

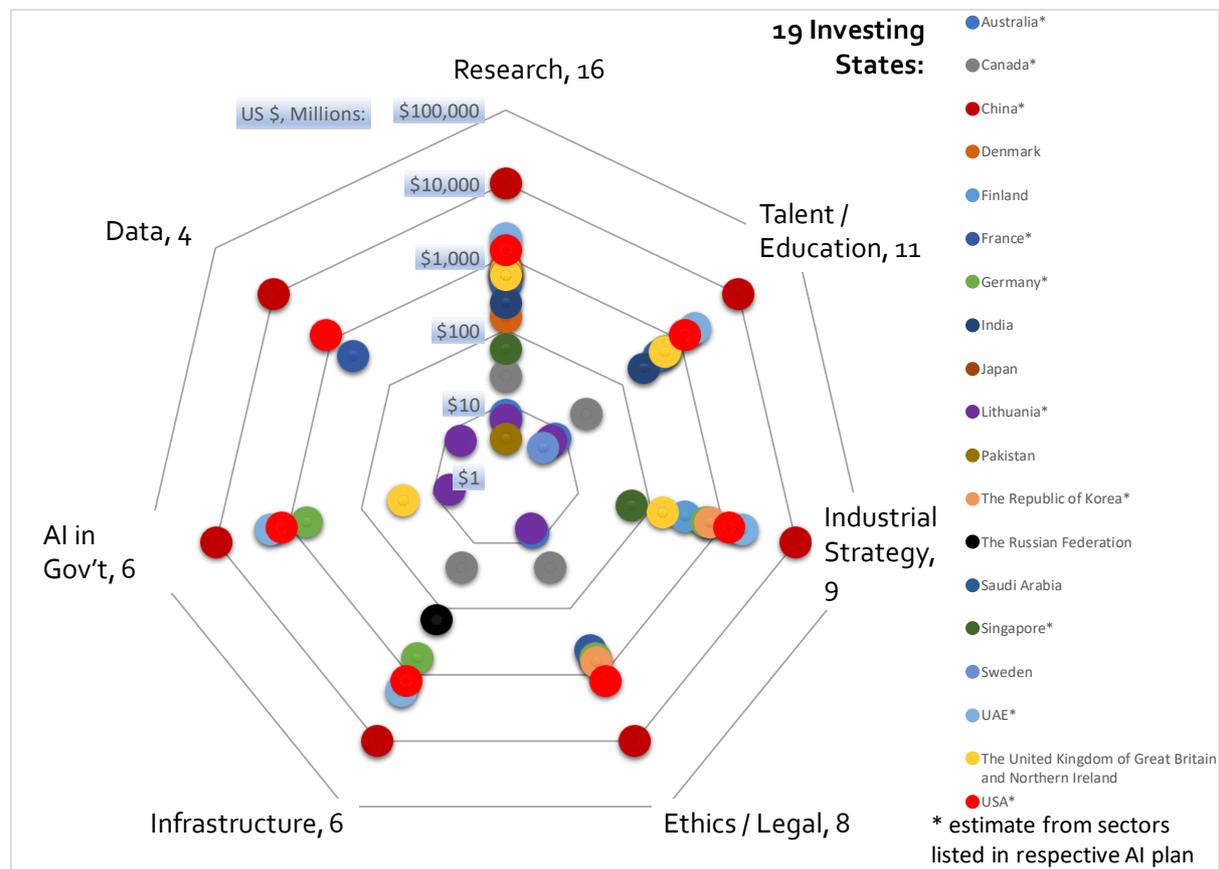


Figure 3. State Investments by AI Sector.<sup>b</sup> Numbers next to each spoke label denote how many States are investing in each Sector.

<sup>b</sup> Although Austria has invested roughly US \$1.1 million for the development of an AI National Plan, it is not included on this graphic as its funds cannot be assigned one of the AI Sectors shown.

To get a sense of how much investment is allocated globally by AI sector, Figure 4 sums all State AI sector funds. The most notable take-aways from this graphic are:

- Industrial Strategy dominates with approximately US \$66 billion being allocated globally toward engaging with the private sector.
- The remaining AI sectors – Research, Talent/Education, Infrastructure, AI in Government, Ethics/Legal Implications, and Data – all have just over US \$10 billion allocated toward them.

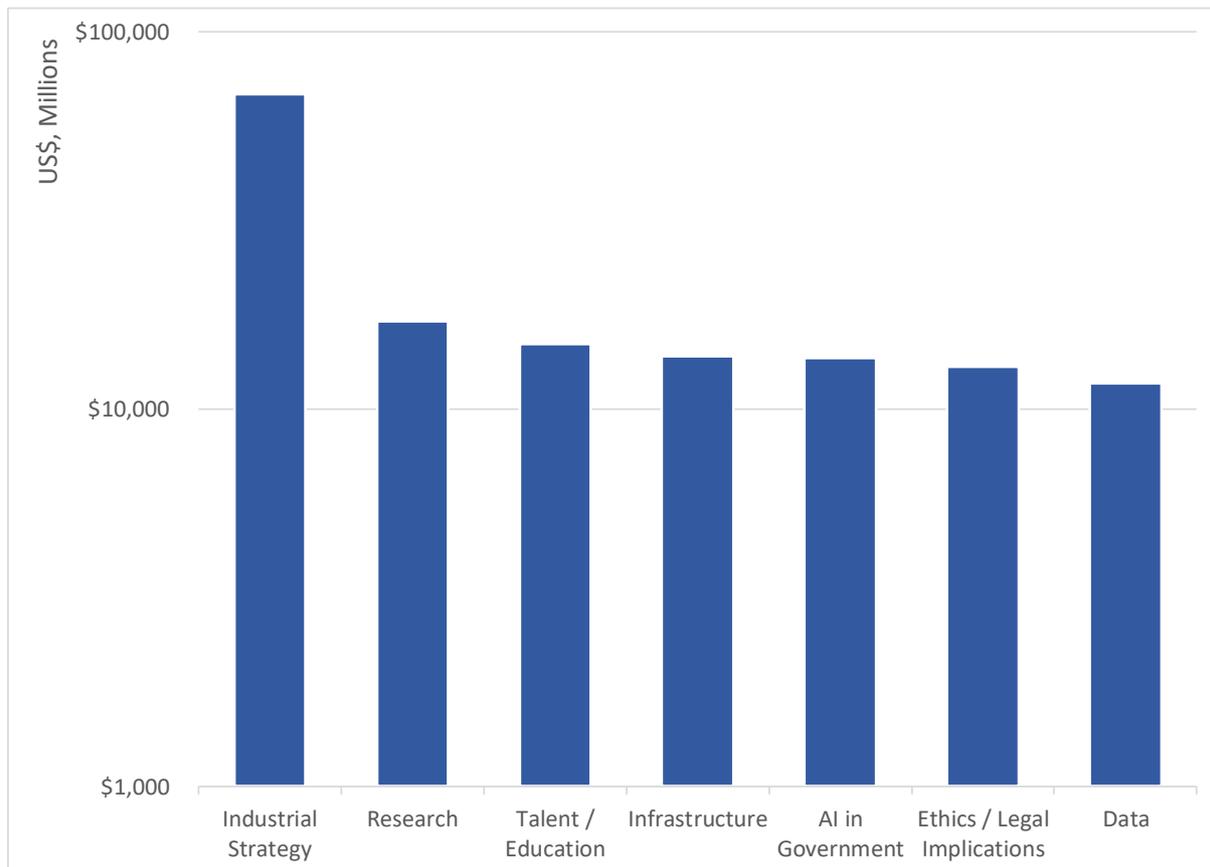


Figure 4. Summed AI State Investments by AI Sector

## APPENDIX - TERMINOLOGY

To assist the reader in grasping the nuances of AI, descriptions of the main concepts and terms used in this report are provided below. These descriptions should not be taken as *de-facto* definitions in this fluid field; it is beyond the scope of this report to provide strict definitions of each of these terms.

**Autonomy:** the freedom a system has to accomplish the goals with which it has been programmed. Autonomous systems can be either semi-autonomous, which have a human in the loop, or fully autonomous, which can perform programmed tasks without the need of any human intervention.

**Artificial Intelligence (AI):** An intelligence demonstrated by machines, in contrast to the natural intelligence displayed by humans and other animals. The term is applied particularly when a machine mimics cognitive functions that are associated with human minds, such as “learning” and “problem solving”.

**AI National Plan or Strategy:** An overarching document adopted by a Government with a specific political and legal character that is intended to guide all national efforts in a respective field, and to coordinate and to align the activities of stakeholders.

**Big Data:** The massive volumes of data produced by way of people’s digital actions, which, if harnessed and processed, can be used to improve decision-making. It is difficult to process this data using traditional database and software techniques due to its large volume.

**Chatbot:** An AI-enabled communication programme that interacts with people over the internet, to provide or collect information following a pre-defined script.

**Deep Learning:** A method of machine learning that uses a cascade of multiple layers of (deep) matrix calculation units for feature extraction and transformation. Deep learning stands apart from other machine learning methods in that it does not require that the features of the target data be defined; instead, it merely requires a large amount of data and resources to process the data.

**Internet of Things:** The universe of devices connected to the internet, including not just computational devices such as desktops, laptops, tablets, smartphones, but also sensors of all kinds.

**Machine Learning:** A computer programming technique that uses statistical techniques to give computer systems the ability to “learn” (e.g., progressively improve performance on a specific task) from data, without being explicitly programmed.

**Neural Network:** A computational network loosely inspired by biological neurons. Neural networks consist of numerous interconnected processing units, each with their own respective spheres of knowledge. In response to a given input, a neural network can adapt as needed to provide the correct output.

**Robotics:** A branch of engineering that focuses on the development of programmable machines, or robots, that can be remotely operated or autonomous. Robots often rely on legs, wheels, tracks or propellers for movement.

**Semiconductor:** A computational element that is programmed for a specific task.

**Sensor:** A device that detects a stimulus, such as sound, temperature, geophysical location, motion, acceleration, proximity, pressure, etc., and converts it into actionable input for an AI or robotic system.

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## ABOUT FUTUREGRASP

*FutureGrasp (<https://www.futuregrasp.com/>) is an advisory group established in 2017 to assist organizations around the world in capturing and comprehending emerging and disruptive technologies. It is critical to not only identify new technologies, but also to assess their implications in the larger context of geopolitics, economics and security. Toward this end, FutureGrasp's scope includes individual technologies, as well as their intersections and the potential for new technology developments. Topics addressed include big data analytics and artificial intelligence, biotechnology, Internet of Things, nanotechnology and semiconductors, and 3D- and 4D-Printing.*