Research Office
Legislative Council Secretariat

Information Note

Study of development blueprints and growth drivers of artificial intelligence in selected places

IN01/19-20

1. Introduction

1.1 The artificial intelligence ("AI") technical landscape has evolved progressively from 1950 when British mathematician Alan Turing first posed the question of whether machines could think. Coined as a term at the Dartmouth Conference in 1956[1], AI has evolved from symbolic AI which tried to teach computers how to reason abstractly to the point today where some people have speculated an era that robots will soon be replacing human jobs[2].

1.2 While AI is rapidly developing as an inevitable component of emerging technologies, there is no widely accepted definition of it. AI generally refers to a machine-based system (especially a computer system) that can accomplish tasks requiring skills and abilities associated with human intelligence, such as visual and speech recognition, reasoning, learning and problem solving.

1.3 In recent years, AI has developed not only as a field of research, but also as a technology that expands across a wide range of applications. It is estimated that AI has the potential to reshape the competitive landscape of companies and jobs, as well as delivering additional US$15.7 trillion (HK$123.1 trillion) to the global gross domestic product ("GDP") in 2030[3]. Amid the potential economic benefits of AI, many governments have developed formal AI frameworks[4] to capitalize on the opportunities brought about by AI. At present, the US and China are the global leaders in AI. The US enjoys a "first-mover advantage" with leadership in AI experts and

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1 The Dartmouth Conference in the United States ("US") gathered the first batch of researchers to determine the name and mission of AI, which has been considered as the birth of AI.

2 In December 2017, McKinsey Global Institute released a report predicting that by 2030, as many as 800 million workers worldwide could be replaced at work by robots.

3 See PricewaterhouseCoopers (2017).

4 These range from US President Donald Trump's Executive Order on AI and China's "Next Generation Artificial Intelligence Development Plan" to "AI Made in Germany" and the "Pan-Canadian Artificial Intelligence Strategy".

excellence in AI research and innovation. China is catching up rapidly, attributable to the sheer size of its Internet population – 800 million-plus users – and their willingness to try new AI products and services.

1.4 In the wave of AI, Hong Kong has an edge in developing this emerging technology in view of its high level of academic research on innovation and technology ("I&T") and top positions occupied by local universities in international university rankings. However, Hong Kong's progress in applying AI has been slow, and mainstream society is not prepared to embrace AI. According to the Asian Index of Artificial Intelligence compiled by the Asia Business Council in 2017[5], Hong Kong was in second last place of the eight regions of Asia studied, just ahead of Indonesia. China topped the list by a big lead, followed by Singapore, India and Japan.

1.5 At the request of Hon Martin LIAO Cheung-kong, the Research Office has prepared this information note on the development of AI in the US and China. The information note will first briefly discuss the applications of AI and the associated benefits and risks, as well as the growth drivers of AI development. It will then review the AI development in Hong Kong, followed by a study of the relevant experience of the US and China with special reference to their development blueprints and strengths in AI growth drivers.

2. Applications of artificial intelligence

2.1 In recent years, the availability of big data, cloud computing and the associated computational and storage capacity have resulted in a breakthrough in AI technology called machine learning ("ML"). ML involves the creation of algorithms that can find patterns and make predictions from complex data without being explicitly programmed or "taught" by humans. A powerful sub-branch of ML is deep learning ("DL"), whereby the computer mimics human neural networks, running data input through multiple layers of processing and "learning" from successive data layers[6].

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5 See Asia Business Council (2017).

6 ML learns patterns from structured data composed of clearly defined data types whose pattern makes them easily searchable. In contrast, DL recognizes patterns from unstructured data, which is comprised of data that is usually not easily searchable, including formats like audio, video, and social media postings.

2.2 With ML and DL technologies, computers can be taught to analyse data, identify patterns and make decisions with minimal human intervention. This has precipitated significant progress in many core AI research areas such as natural language processing[7], autonomous vehicles and robotics, computer vision[8] and language learning.

2.3 Some of the most interesting AI developments are outside of computer science in sectors such as transport, healthcare, financial services, and marketing. An exemplary list of applications based on AI systems across different sectors is presented in **Table 1** below:

Table 1 — Examples of AI use cases across different industries

Industry	Use cases	Benefits
Transport	Autonomous vehicles with virtual driver systems	Reduce car crashes caused by drunk, distracted or tired human drivers
Healthcare	Medical imaging diagnosis to interpret big patient data from doctors' reports, test results and medical images	Aid radiologists in clinical diagnosis, facilitating the delivery of better healthcare faster and at a lower cost
Financial services	AI algorithms to (a) help determine creditworthiness of borrowers based on their personal spending history; (b) automate investment management advice/strategies through robot-advisory services; and (c) enable mobile payment	Make the delivery of financial services cheaper and more targeted and convenient to customers
Security	Predictive policing to train machines to examine massive video data to spot suspicious criminal activities	Improve the allocation of law enforcement resources
Education	AI-driven software to help teachers automate the process of grading homework and tests	Save teachers' time for student interaction, class preparation and/or career development

[7] Natural language processing is a field of AI study that helps computers understand, interpret and manipulate human language like speech and text.

[8] Computer vision is a field of AI that seeks to develop techniques to help computers "see" and understand the content of digital image, e.g. facial recognition technology.

Table 1 — Examples of AI use cases across different industries (cont'd)

Industry	Use cases	Benefits
Marketing	Data mining techniques to analyse customer preference and predict customer consumption habits	Help marketers to automate the process of customer pattern searching and enable the delivery of more personalized products to existing and new customers
Agriculture	AI solutions to provide site-specific and timely data about crops to enable application of appropriate inputs such as fertilizers and chemicals	Enhance farmers' income and increase farm productivity
Scientific research	AI to assist scientists and engineers in reading publications and patents, generating hypotheses and testing them through the usage of robotic system	Help reproduce experiments and lower their cost as well as accelerate scientific discovery
Manufacturing	Industrial robots to automate high-risk jobs and repetitive tasks	Increase productivity and enhance worker safety while reducing operating costs

Source: Organisation for Economic Co-operation and Development (2019).

2.4 While AI applications are experiencing rapid uptakes in a number of sectors, AI also brings about challenges such as:

(a) **bias** – biases might find their way into the AI systems as a result of skewed data or an algorithm that does not account for skewed data[9];

(b) **privacy and security** – the onset of big data era inevitably increases the exposure of personal and proprietary data to the risks of data leakages, security breaches and malicious accesses;

(c) **safety concerns** – unintended and harmful behaviour may emerge from poor design of AI systems;

[9] For example, there were cases of job-screening systems suppressing female candidates for certain jobs simply based on historical hiring data and credit-scoring systems using ethnicity as a scoring variable for rejecting or approving loan applications.

(d) **liability issues** – AI-enabled devices could take over many decisions from humans, generating difficulty in establishing a clear liability framework around AI[10]; and

(e) **black box algorithms** – AI that relies on ML algorithms, such as deep neural networks, can be difficult to understand and therefore may be subject to malicious manipulation.

2.5 There are no standard indicators available for comparing AI development among different countries and places. Nevertheless, there are a number of common metrics that can reflect the current state of AI development in a country/place[11]. The sections below examine the following six categories of metrics, where applicable, to measure AI progress in Hong Kong, the US and China:

(a) **talent** – countries/places with the requisite talent can better develop and implement AI systems, attract business and ensure their universities have enough talented AI professors to teach the next generation of AI researchers;

(b) **research** – research is a critical factor for pursuing new knowledge and guiding technological breakthroughs, which in turn sustain and expand AI innovation;

(c) **industry development** – a healthy AI ecosystem facilitates the development of innovative AI technologies/firms and helps attract the best research talent in AI;

(d) **adoption** – firms increasingly need to adopt AI in order to remain competitive in the global economy. Successful implementation of AI techniques allows firms to automate and optimize many facets of their business and deliver new products and services;

[10] For example, as autonomous vehicles shift the responsibility of driving from humans to automated technology, it is disputable as to which party is liable for a car accident: the car driver, manufacturer or software developer.

[11] See Castro (2019).

(e) **data** – AI systems often rely on vast quantities of data for training. In many areas of AI (particularly ML and DL technologies), the more data that is fed into the computers, the better will be the results; and

(f) **hardware** – semiconductor devices can expand the capabilities of AI systems through enhancing their computation power. High-performance computing generates more data for computers to perceive, reason and learn.

3. Hong Kong

3.1 According to the Government[12], I&T are drivers for economic growth and the key to enhance competitiveness of local industries. In particular, the central government unveiled in February 2019 the "Outline Development Plan of the Guangdong-Hong Kong-Macao Greater Bay Area" which links Hong Kong with nine Mainland cities and Macao to form an integrated economic hub. It is believed that the Greater Bay Area has good potential to develop itself into a global AI centre, and provides opportunity for Hong Kong to deepen its role as a connector for Chinese I&T start-ups and help them expand overseas[13].

3.2 The Innovation and Technology Bureau ("ITB"), established in November 2015, dedicates to driving I&T development in Hong Kong. It is responsible for formulating holistic policies covering areas such as AI, big data, data analytics and cybersecurity. The Office of the Government Chief Information Officer under ITB provides leadership for delivering information and communications technology function within the Government. Meanwhile, the Hong Kong Science and Technology Parks Corporation ("HKSTPC") provides one-stop infrastructural and other support services to technology-based companies and activities, and Hong Kong Cyberport Management Company Limited manages Cyberport as a creative digital community for technology and digital content start-ups to grow and thrive.[14]

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[12] See GovHK (2019).

[13] The Government is working to develop the Lok Ma Chau Loop into the Hong Kong-Shenzhen Innovation and Technology Park which helps make Hong Kong an important I&T hub in the Greater Bay Area.

[14] HKSTPC manages three industrial estates located at Tai Po, Yuen Long and Tseung Kwan O, whereas Cyberport is a business park with four office buildings, a hotel and a retail entertainment complex.

Development of AI in Hong Kong

3.3 Hong Kong has an edge in developing AI. According to the Government [15], universities in Hong Kong perform outstandingly in AI technology and related fields with world-leading research and development ("R&D") capabilities. As early as in 2014, a research team of the Chinese University of Hong Kong developed a novel facial recognition system with the world's highest accuracy of 99.15%. In 2017, another local research team using AI technologies to process medical image for lung cancer and breast cancer achieved diagnostic accuracies of 91% and 99% respectively.

3.4 Furthermore, according to Scopus[16], universities in Hong Kong as a whole ranked 3rd globally in 2017 in terms of producing the most highly cited and impactful research on AI[17]. As another indicator of Hong Kong's R&D capability, local universities occupy high positions in the QS World University Ranking[18], particularly in science and engineering subjects (**Figure 1**).

Figure 1 — Hong Kong universities with top-100 ranking by subject*

Subject	University (Rank)
Electrical & Electronic Engineering	HKUST (22), HKU (30), CUHK (51-100), CityU (51-100), PolyU (51-100)
Computer Science & Information Systems	HKUST (26), HKU (33), CUHK (36), CityU (50), PolyU (51-100)
Mathematics	CUHK (28), HKUST (36), HKU (45), CityU (51-100), PolyU (51-100)
Chemical Engineering	HKUST (34), HKU (51-100)
Chemistry	HKUST (22), HKU (34), CUHK (51-100)
Medicine	HKU (29), CUHK (45)
Physics & Astronomy	HKUST (51-100), HKU (51-100)

Note: (*) HKUST = The Hong Kong University of Science and Technology, HKU = The University of Hong Kong, CUHK = The Chinese University of Hong Kong, CityU = City University of Hong Kong, and PolyU = The Hong Kong Polytechnic University.

Source: QS World University Rankings by Subject 2019.

15 See GovHK (2018b).

16 Scopus is a large, multi-disciplinary abstract and citation database of peer-reviewed literature, including scientific journals, books and conference proceedings.

17 See GovHK (2018b).

18 The QS World University Rankings, complied annually by a British education company, ranks the world's top universities in 48 subject areas.

3.5 Hong Kong also has a thriving AI startup ecosystem with local industry engaged in developing products and services based on AI, such as computer vision and cloud computing platforms in the areas of facial recognition, large-scale semantic image segmentation and classification. In particular, SenseTime is a home-grown technology company headquartered at Hong Kong Science Park[19]. It is now China's largest AI unicorn and a world-leading DL and computer vision platform developer. A unicorn broadly refers to an unlisted start-up with a market valuation of over US$1 billion (HK$7.84 billion) and a history of less than 10 years.

3.6 Recognizing Hong Kong's strength in AI, the Government has set out AI as one of its key focused technology areas. In this connection, ITB released the Smart City Blueprint for Hong Kong[20] in December 2017 which proposes, among other things, using AI and other emerging technologies to build Hong Kong into a smart city. In the 2018-2019 Budget, the Government identified AI, together with financial technologies, smart city and biotechnology, as the four areas of strength for development in Hong Kong.

3.7 Against the above, the Government has devoted more resources and initiatives in recent years to enhance Hong Kong's R&D capacities in the AI field[21], train and attract technology talent, support technology start-ups to boost the development of AI technology in Hong Kong (see **Appendix I** for the government's funding for training of technology talent and supporting technology start-ups), and open up government data[22] for technology research and smart city development.

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[19] SenseTime was co-founded in October 2014 by Tang Xiao'ou, a Chinese University of Hong Kong professor, and computer scientist Xu Li, among others.

[20] Smart City Blueprint for Hong Kong maps out development plans up to 2022 and beyond under six major areas, namely Smart Mobility, Smart Living, Smart Environment, Smart People, Smart Government and Smart Economy.

[21] The Government has earmarked HK$10 billion in the 2018-2019 Budget to fund the establishment of two research clusters – the "Health@InnoHK" on healthcare technologies and the "AIR@InnoHK" on AI and robotics technologies – at the Hong Kong Science Park. It also funds AI-related R&D projects through different schemes under the Innovation and Technology Fund ("ITF"). To encourage enterprises to invest more in local R&D, the Government also provides enterprises with enhanced tax deduction for their expenditure incurred in qualifying R&D activities. There is no cap on the amount of enhanced tax deduction.

[22] By end-2019, the total number of datasets available in the Public Sector Information Portal would be increased from about 3 300 to nearly 4 000. The Government would also establish a one-stop data supermarket – Common Spatial Data Infrastructure ("CSDI") – by end-2022. CSDI enables sharing of geospatial data, which is important since 80% of information is currently related to location. Geospatial data facilitates urban planning, infrastructural development, architectural design, transportation systems, car navigation and more. See Chow (2019).

Hong Kong's competitiveness in AI development

3.8 While Hong Kong has an edge in developing AI in view of its potential in I&T academic research and top-ranking positions occupied by local universities in international surveys, it was in second-last position in the 2017 Asian Index of Artificial Intelligence, and ranked 18th in the 2018/19 Top 50 Smart City Government Rankings[23]. The paragraphs below assess Hong Kong's competitiveness in AI against the following relevant growth drivers: talent, application, data, research and industry development.

Talent

3.9 The success of a country/place's ability in AI development will depend on its ability to develop and attract human capital. Hong Kong relies heavily on its financial and real estate sectors, with a relatively narrow industrial structure for nurturing technology talents[24]. In 2017, university students attending AI-related fields of study[25] as a whole only accounted for 16.7% of the overall student enrolment of the University Grants Committee funded-programmes, which was less than the corresponding proportion of 18.1% for students attending business and management studies[26]. Furthermore, only 95 800 persons or 2.4% of the total labour force were engaged in information technology-related work in 2018.[27]

3.10 In view of the talent gap, the Government has introduced various talent admission schemes to attract more overseas professionals to work and settle in Hong Kong. Yet, competition for talent is intensifying around the world. High cost of living has eroded Hong Kong's competitiveness in terms of the salary levels offered to attract foreign talent[28]. The quality of living, as

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[23] The 2018/19 rankings studied 140 smart cities and ranked them across 10 areas including "Development of an innovation ecosystem", "Implementation of "smart" policies" and "Support programmes". See Eden Strategy Institute & OXD (2018).

[24] According to an estimate by a local academic, there were less than 1 000 AI talent in the local tertiary institutions as at August 2018. See Tang (2018b).

[25] AI-related fields of study herein refer to computer science and information technology, mathematical science, physical science and biological science.

[26] See Census and Statistics Department (2019a).

[27] See Census and Statistics Department (2019b).

[28] According to Economist Intelligence Unit, Hong Kong joined Singapore and Paris as the world's most expensive cities to live in 2018.

reflected by Hong Kong's low rankings in various global liveability surveys[29], adds to the concern over the attractiveness of Hong Kong to foreign talent.

3.11 The response to the Technology Talent Admission Scheme, which was recently implemented in June 2018, has yet to be ascertained. Yet, the Admission Scheme for Mainland Talents and Professionals ("ASMTP"[30]) has met with limited success. Between 1 October 2018 and 31 March 2019, 7 093 applications were approved and 2 603 of them were long-term applications with employment period of not less than 12 months[31]. Among the long-term applications, only 237 were jobs offered in the areas of information technology, telecommunications and biotechnology. For the quota-based Quality Migrant Admission Scheme[32], there are only a few hundred applications approved each year, far below the annual quota of 1 000.

3.12 Nurturing local talents is also important for AI development. In Hong Kong, science, technology, engineering, and mathematics ("STEM") education has been identified as a weak link in the development of I&T[33]. The promotion of STEM education was first proposed in the 2015 Policy Address and further supported in the 2016 Policy Address. In the curriculum context of Hong Kong, STEM education is promoted through Science, Technology and Mathematics education. Although Mathematics is compulsory, Science and Technology subjects are optional for senior secondary students sitting the Hong Kong Diploma of Secondary Education Examination.

3.13 Furthermore, the Government has invested a lot of resources in STEM education, which tends to be planned by the schools themselves (i.e. school-based). There is no coherent strategy for STEM learning. In 2018, local media reviewed the 507 primary schools covered in the "Primary School 2018 Profiles" and found that about 62% of them mentioned of promoting STEM education in the school.[34] However, they differed somewhat in organizing AI-related learning activities, ranging from teaching of

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[29] Hong Kong ranked 71st in the Mercer's 2019 Quality of Living Survey, despite performing better in the Economic Intelligence Unit's 2019 Global Liveability Index (38th) and ECA International's 2018 Most Liveable City Survey (41st).

[30] ASMTP is a quota-free scheme introduced in 2003 to attract qualified talent and professionals from the Mainland to work in Hong Kong.

[31] See Legislative Council Secretariat (2019a).

[32] The scheme was introduced in July 2006 to attract 1 000 high skilled or talented people to settle in Hong Kong each year.

[33] See Academy of Sciences of Hong Kong (2016).

[34] See《明報》(2018) and Tang (2019b).

coding and three-dimensional printing technology to exchange programmes in STEM study with overseas countries.

Application

3.14 Hong Kong's Internet access and smart devices are both affordable and ubiquitous. However, local people have yet to integrate digital technologies into their daily lives. In Hong Kong, there are several factors hindering the adoption of AI, including presence of a large number of easily accessible outlets for in-store shopping, continued reliance on traditional payment methods (e.g. using Octopus cards for public transport fares and small-value purchases and credit cards for large-value payments), and data privacy and security concerns over the use of online banking.

3.15 In October 2018, Google Hong Kong released a survey report, *Smarter Digital City 2.0*, which reveals Hong Kong's slow acceptance to AI applications. In Hong Kong, digital engagement as measured by Consumer Digital Index scored 2.44 out of 5 in 2018, representing a slight increase of 0.09 percentage points from 2.35 in 2017. In addition, only 30% of local people considered Hong Kong as a smart city despite high Internet penetration, ranking it behind Tokyo (53%) and Singapore (39%).

3.16 *Smarter Digital City 2.0* also examines consumer adoption of digital channels relating to Travel, Finance, Retail and Living (**Table 2**). Among the four sectors examined, only Smart Travel enjoyed a significant year-on-year increase in digital adoption. The other sectors remained relatively flat in comparison, suggesting that progress has been slow to materialize Smart Finance, Smart Retail and Smart Living.

Table 2 — Level of digital activities adoption*

	2017	2018	Change vs 2017
Travel	42%	53%	+11%
Finance	37%	38%	+1%
Retail	48%	44%	-4%
Living	38%	38%	0%
TOTAL	41%	42%	+1%

Note: (*) Level of digital adoption is defined as the average usage percentage of digital activities under each category.

Source: Google Hong Kong (2018).

Data

3.17 Key to much of AI development is data. According to Google Hong Kong's *Smarter Digital City 2.0*, only 21% of the Hong Kong public think "open data" is currently a strength for the territory. Furthermore, at the meeting of the Panel on Information Technology and Broadcasting held on 10 June 2019, there were Members expressing concerns over the quality and usefulness of government data that had been opened up[35]. These concerns included that the relevant government department was slow in updating the data in Public Sector Information Portal, and that the Administration might need to enhance the coordination among various bureaux/departments to promote the opening up of government data.

3.18 There are also calls for opening up all public data not detrimental to privacy to enrich the current pool of data for AI development[36]. Some of the data collected and possessed by public bodies or commercial organizations are not yet opened but of public interest. For example, the licence conditions of telecom operators in Hong Kong prohibit them from disclosing customer information even if it is aggregate and anonymous. Anonymous mobile phone data – Call Detail Records[37] and related location data – has the potential to become an important data source for urban and business planning.

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35 See Legislative Council Secretariat (2019c).

36 See, for example, Tang (2019a).

37 Call Detail Record is the detailed record of all the telephonic calls that pass through a telephone exchange or any other telecommunications equipment.

3.19 In Asia, Singapore has made use of mobile data in an anonymous manner by allowing mobile phone operators to provide data analytics to business as well as government agencies.[38] For instance, retailers can use big data on people's travel patterns to determine where future stores should be located. Likewise, public authorities can track how crowds build up and disperse to better allocate resources for public safety.

Research

3.20 AI innovation requires a wide array of private and public investment in R&D activities, which can be represented by the gross expenditure on R&D ("GERD") as a percentage of GDP. In Hong Kong, GERD as a ratio to GDP has been standing at a low of less than 1% since 2000. In 2017, GERD accounted for 0.8% of Hong Kong's GDP, lagging behind many developed economies such as South Korea (4.55%) and Japan (3.20%) as well as the neighbouring Shenzhen (4.13%) and Guangzhou (2.48%)[39]. Even with the Government's huge funding commitment to R&D in the latest Policy Addresses and Budgets, Hong Kong might need to do more to catch up.[40]

Industry development

3.21 In Hong Kong, the Government has been providing funding through ITF to assist local companies in upgrading their technological level and introducing innovative ideas to their business. The amount of ITF funding increased from HK$0.6 billion in 2008 to HK$1.3 billion in 2017[41]. Yet, such amount paled in comparison with the total expenditure on technological innovation of the business sector that doubled from HK$14.7 billion to HK$29.5 billion during 2008-2017. Furthermore, there have been concerns from the academia over the vetting and approval procedure for various funding schemes under ITF. For example, government officials might not

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38 See Tan (2017).

39 See Legislative Council Secretariat (2019d).

40 For example, the local market is too small for AI applications and many research results could not be commercialized due to the lack of manufacturing industry in Hong Kong. With a sizeable market, the Greater Bay Area offers more cooperation opportunities for local I&T enterprises as well as capabilities in commercialising R&D results and advanced manufacturing. See Budget Speech (2019).

41 Ibid.

have sufficient experience in R&D in conducting preliminary screening of funding applications[42].

4. The United States

4.1 The US is the global leader in developing and using AI, with clear lead in cutting-edge research, semiconductor technology and manufacturing and AI talent pool. It is also home to some of the world's biggest digital players such as Apple, Microsoft, Amazon, Facebook and IBM[43]. These companies have been driving AI development in the US, through access to large volumes of proprietary data, technology and capital, as well as the ability to attract highly skilled labour.

4.2 In the US, Silicon Valley has been at the forefront of I&T which brings together talent and research capabilities from leading universities, start-ups, technology companies and venture capitalists. With some two million technology workers employed at the headquarters of some of the world's biggest digital players as well as in some 15 000-16 000 start-ups, Silicon Valley dominates the world's start-up ecosystem.

Development of AI in the United States

4.3 In the US, the Office of Science and Technology Policy ("OSTP") is responsible for advising the President on the federal R&D budget and shaping R&D priorities across those federal agencies that have significant portfolios in science and technology. OSPT also has responsibility – with the help of the National Science and Technology Council ("NSTC"[44]) – for co-ordinating interagency research initiatives.

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42 See Legislative Council Secretariat (2019b).

43 According to the 2019 Forbes Global 2000, eight of the top 10 technology companies in the world were US companies. They were Apple (1st), Microsoft (3rd), Alphabet (4th), Intel (5th), IBM (6th), Facebook (7th), Cisco Systems (8th) and Oracle (10th). See Ponciano (2019).

44 NSTC, which is overseen by OSTP, is a Cabinet-level council made up of virtually every cabinet officials and Executive Agency heads.

4.4 NSTC has established two subcommittees – *the Subcommittee on Networking and Information Technology Research and Development* and *the Subcommittee on Machine Learning and Artificial Intelligence* – to co-ordinate the application of AI technologies across federal agencies. Recently, NSTC established the Select Committee on Artificial Intelligence in May 2018 to advise the White House on interagency AI R&D priorities.

Policy approach to AI

4.5 Notwithstanding the dedicated administrative structure established to co-ordinate AI development in the US, the US government has generally followed a market-oriented approach for developing and using AI. This approach is based on the belief that the private sector can, with little government support, drive AI development and adoption[45]. In particular, the government can rely on the local technology giants which have already been transformed into the leading AI companies in the world.

4.6 Amid the market-oriented approach, the US currently has no central investment plan. Neither does the US have a co-ordinated national strategy to respond to the challenges of AI. During the final months of Barack Obama's presidency, the White House initiated some steps to support AI through the issue of three separate reports. The succeeding Trump administration initially reached slowly to the rise of AI, but this situation has undergone challenges amid the gradual ascendency of China to become a serious challenger for global AI dominance in recent years. The recent policy developments of AI in the US are shown in **Table 3** below:

[45] See Castro (2019) and European Parliament (2018).

Table 3 — Developments of AI policy in the US

May 2016	• The White House announced the ***White House Future of Artificial Intelligence Initiative*** – featuring a series of public engagement activities, policy analyses and workshops led by OSTP to explore the impacts of AI.
October 2016	• The Obama administration released two AI reports: (a) ***Preparing for the Future of Artificial Intelligence*** which surveys the current state of AI and makes recommendations for further AI-related actions by federal agencies; and (b) ***National Artificial Intelligence Research and Development Strategic Plan*** which details seven strategies to guide AI R&D activities in the US.
December 2016	• The Obama administration released another AI report – ***Artificial Intelligence, Automation, and the Economy*** – to examine the impact of automation and what policies are needed to increase the benefits of AI and mitigate its costs.
December 2017	• The Trump administration unveiled its ***National Security Strategy Report*** in which the US would prioritize those emerging technologies (including AI) critical to economic growth and security.
May 2018	• The White House hosted the **Artificial Intelligence for American Industry Summit** convening leading technology companies to discuss methods for fostering the advancement of AI. At the summit, the US announced the establishment of the Select Committee on Artificial Intelligence under NTSC to examine US priorities and investment on AI development.
February 2019	• President Trump signed the **Executive Order on Maintaining American Leadership in Artificial Intelligence** to launch the American AI Initiative with a multipronged approach to advance AI.
March 2019	• The US federal government launched the website – **AI.gov** – to make it easier to access all of the government AI initiatives currently underway.
June 2019	• The Select Committee on Artificial Intelligence released an updated version of the ***National Artificial Intelligence Research and Development Strategic Plan*** which includes eight strategies to guide the federal AI R&D investments.
September 2019	• The White House held a summit to address the use of AI in government.

4.7 Among the development blueprints released above, President Trump's Executive Order on launching the American AI Initiative represents a high-level strategy setting out a concerted government action to promote AI technologies within the US. Under the Executive Order, all federal departments and agencies are required to adhere to the following six strategic objectives: (a) promoting sustained investment in AI R&D; (b) enhancing access to federal data, models, and computing resources; (c) reducing barriers to the use of AI technologies; (d) ensuring that technical standards minimize vulnerability to attacks from malicious actors; (e) training the next generation of AI researchers and users; and (f) implementing an action plan to protect US economic and national security interests. The Executive Order also addresses some of the ethical issues posed by AI, as it stipulates the principle of fostering public trust and confidence in AI technologies and protecting privacy, civil liberties and American value in their applications[46].

US competitiveness in AI development

4.8 The US currently leads in four of the six AI growth drivers, namely talent, research, industry development and hardware. However, its smaller population is a modest disadvantage in generating the data necessary to develop AI systems[47]. Large swaths of the US economy are still not fully digitalized, adding to the difficulty in the collection, sharing and analysis of data for AI development[48]. Furthermore, the US may be lagging in AI adoptions in part due to the negative perceptions of AI in the country. For example, more US adults (35%) disagree with the belief that innovations such as AI will make workers better off in the future than who agree (30%)[49].

[46] After the release of the Executive Order, House Resolution 153 was introduced in February 2019 to support the development of guidelines for ethical development of AI. The resolution recommends a total of 10 issues to be addressed, including the need for transparent and explainable AI systems, information privacy and personal data protection, access and fairness in technological services and benefits, as well as accountability and oversight for automated decision-making.

[47] The US population totalled 327 million in 2018, lagging behind China's 1.39 billion and India's 1.35 billion.

[48] See Castro (2019).

[49] Ibid.

Talent

4.9 The US benefits from its ability to attract, educate and retain local and foreign talent. It is home to many world-leading universities[50] that attract large numbers of students interested in pursuing undergraduate and graduate degrees related to AI around the world. In addition, the US has been one of the most popular immigration destination countries in the world, particularly for people with advanced education and skills[51].

4.10 As a result of the above, the US takes the lead in the number of AI researchers[52] with as many as 28 536 AI talent in 2017, representing 13.9% of the global total[53]. It is not just the number of AI researcher that matters but also their quality. According to the China AI Development Report 2018[54], the US led with 5 158 **top** AI talents, representing 25.2% of the global total or 4.4 times of the number of the United Kingdom in second place.

4.11 Developing local AI talents is also important for AI development. The US has been putting much effort into AI education, with the implementation of a number of initiatives as early as in 2011 to expand STEM awareness and STEM education among K-12 students[55]. For example, President Obama announced the goal to prepare 100 000 new STEM teachers over the next decade in his 2011 State of the Union Address. Most recently, the US has moved from STEM education to AI education. In May 2018, the Association for the Advancement of Artificial Intelligence ("AAAI") and the Computer Science Teachers Association ("CSTA") announced a joint initiative to (a) develop national guidelines for teaching K-12 students about AI; and (b) define what students in each grade should know about AI, ML and robotics[56].

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[50] According to the World Reputation Rankings 2019, 27 of the top 50 universities in the world were in the US. See Times Higher Education (2019).

[51] According to the United Nations (2017), the largest number of international migrants resided in the US in 2017. The US hosted 50 million or 19% of the total number of international migrants in 2017.

[52] An AI researcher is defined as someone who has published a journal article or had a patent on AI-related topic.

[53] See Tsinghua University (2018).

[54] Ibid.

[55] K-12 is a school term which stands for kindergarten to 12th grade, i.e. school grades prior to college.

[56] Founded in 1999, AAAI is a non-profit scientific society devoted to, among other things, improving the teaching and training of AI practitioners. Meanwhile, CSTA is a professional association whose mission is to "empower, engage and advocate for K-12 computer science teachers worldwide".

Research

4.12 Countries/places need organizations to perform research in order to sustain and expand AI innovation. The US leads in AI research with the presence of many top-level research organizations in the country. For example, the top-five software and computer services firms for R&D are US firms[57]. Another way to assess the research capacity of a country/place is to examine the impact of its organizations publishing the most AI papers. The US leads in this measure as well. The top-five US-based organizations that published the most AI research papers between 2013 and 2017 had a field-weighted citation impact ("FWCI"[58]) of 4.0. The figure was significantly higher than FWCIs of the top-five European Union ("EU") and Chinese organizations, which stood at 1.9 and 1.4 respectively[59].

Industry development

4.13 To experience the full benefits of AI, countries/places must have sufficient venture capital and private equity funding to connect inventors with the money and expertise necessary to develop and sell their products or services. The US led in venture capital and private equity funding for AI firms between 2017 and 2018. The amount totalled an estimated US$16.9 billion (HK$132.5 billion), which was higher than China's US$13.5 billion (HK$105.8 billion) and the EU's US$2.8 billion (HK$22.0 billion)[60].

4.14 In addition to tracking private funding, the number of AI enterprises and patents also help measure the strength of a country/place's AI ecosystem. There were 4 925 AI enterprises worldwide as at June 2018, with the US having the greatest number at 2 028 and China coming into second at 1 011. Meanwhile, the US has applied for the most number of AI-related patents, at 152 981 applications in its history, followed by China (137 010) and Japan (83 197).[61]

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[57] See Castro (2019).

[58] A FWCI of greater than 1.00 indicates that the publications have been cited more than would be expected based on the world average for similar publications, e.g. a score of 1.44 means that the publications have been cited 44% more than the world average.

[59] See Castro (2019).

[60] Ibid.

[61] See World Intellectual Property Organization (2019).

Hardware

4.15 AI systems rely on semiconductor devices that can perform large number of operations per second. In recent years, graphics processing units ("GPUs" [62]) have catalysed AI developments. Technologies such as supercomputers, which combine processing units such as central processing units and GPUs, can expand the capabilities of AI systems through massive computation power.

4.16 The US has a significant lead in semiconductors, as reflected by its position in the development of the world's fastest supercomputers. Currently, six of the world's 10 fastest supercomputers reside in the US.[63] Furthermore, the R&D spending by semiconductor firms is typically a major factor affecting the breakthroughs in innovation and hence which firms can develop the best chips. In 2017, five US firms were ranked among the world's top 10 semiconductor firms in R&D spending[64]. Added to this, the GPU industry, which is characterized by very high entry barriers, has been dominated by three US firms globally (namely Intel, Advanced Micro Devices and Nvidia).

5. China

5.1 In China, ageing population and slowing economic growth have precipitated the need to find innovative ways to accelerate the productivity growth. Different AI technologies are experiencing rapid growth in China with the help of a favourable regulatory environment [65] and strong government support. The central government has been extremely proactive in designing and pushing forward a succession of national initiatives to guide

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[62] GPU was originally intended for display devices. In recent years GPU-accelerated computing has become mainstream, where the combination of central processing unit and GPU delivers computing power that is able to support the resource-intensive training of AI algorithms.

[63] See Castro (2019).

[64] These top 10 were Intel (US), Qualcomm (US), Broadcom (US), Samsung (South Korea), Toshiba (Japan), TSMC (Taiwan), MediaTek (Taiwan), Micron (US), Nvidia (US) and SK Hynix (South Korea). See IC Insights (2019).

[65] For new technologies, China initially encourages them to grow with a "light touch" regulatory approach and only in a later phase introduces more stringent regulations for healthy market development and better risk management. For example, regulators set a cap on the value of online money transfers 11 years after Alipay introduced them in 2005. See McKinsey Global Institute (2017b).

AI development. Of particular importance was the release of a national AI strategy – the Next Generation Artificial Intelligence Development Plan – in July 2017 to guide China to become the world AI leader by 2030.

5.2 Also lending support to China's AI development is the vast population and diverse industry mix that provide a massive volume of data and an enormous market for AI applications. Indeed, China is currently well ahead in many AI applications with leading enterprises such as Baidu, Alibaba and Tencent (technology conglomerates collectively known as BAT); iFlytek (a leading voice intelligence specialist), DJI (the world's largest drone producer); and SenseTime (the world's largest AI start-up focusing on computer vision and DL).

5.3 China is now widely considered the second largest in AI economy after the US, being home to the most number of AI unicorns based on an annual report released by CB Insights[66] in February 2019. According to the report, five of the 11 so-called unicorns in CB Insight's annual compilation of the world's top 100 AI start-ups were from China, with SenseTime taking top spot with a valuation of US$4.5 billion (HK$35.3 billion)[67].

Development of AI in China

5.4 In recent years, the development of AI in China has been in line with the Next Generation Artificial Intelligence Development Plan ("the Plan") released in July 2017. In order to effectively implement the Plan, the State Council has entrusted its Central Leading Group for National Science and Technology System Reform and Innovation System Construction (國家科技體制改革和創新體系建設領導小組) and the Ministry of Science and Technology ("MOST") to lead the formulation and implementation of the relevant AI plans and projects.

[66] CB Insights is a research firm that tracks venture capital activity.

[67] See CB Insights (2019).

5.5 In 2017, a new office called the Next Generation Artificial Intelligence Promotion Office was set up under MOST to assist in pushing the Plan into action. In the same year, the Next Generation Artificial Intelligence Strategic Advisory Committee, formed by 27 renowned industry and academic experts from leading AI enterprises, was also established to provide technical advice and support to relevant authorities during the implementation of the Plan.

Policy approach to AI

5.6 China follows a top-down government-driven approach with the release of a succession of policy documents and plans to guide and promote the development of AI technology and related industries. The government's AI policies can be divided into the following four stages according to the timing and content of key AI policy documents and plans released (See **Appendix II** for details of these policy documents and plans):

(a) **Stage 1 (before 2013) of potential development** where AI R&D and application did not attract much attention and were mainly discussed in the academic fields;

(b) **Stage 2 (2013-2015) of preliminary development** where the importance of AI began gaining recognition across various sectors of society;

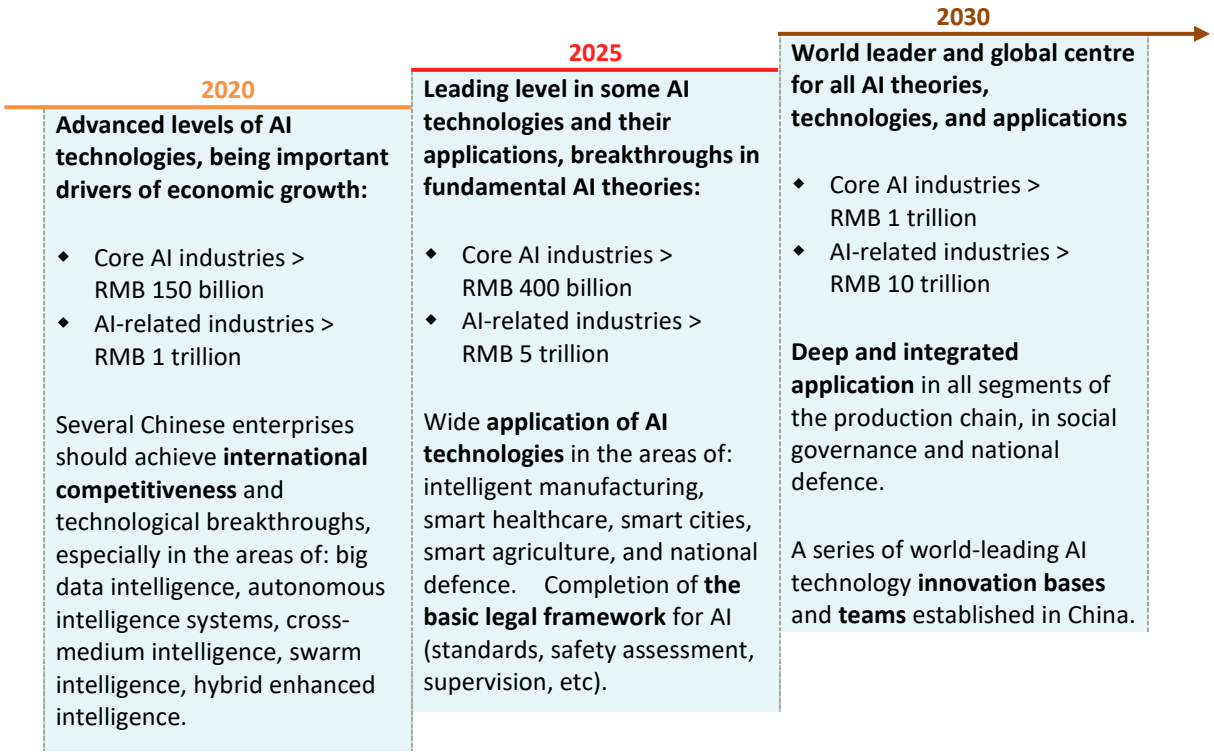
(c) **Stage 3 (2015-2016) of rapid development** where a number of AI-related policy documents and plans were released and AI was elevated as a national strategy; and

(d) **Stage 4 (2016-present) of stable development** where all sectors gain a more pragmatic understanding of AI and AI-related policies are more specifically targeted.

5.7 Among the government's development blueprints released over the years, the Plan is the most comprehensive in terms of AI-related initiatives and goals. These include a three-step plan to transform China into the world's major AI innovation centre by 2030 (**Figure 2**). The Plan also lays out the government's intention to recruit the world's best AI talent, strengthen the

training of local AI labour force, and lead the world in laws, regulations, and ethical norms that promote the development of AI.

Figure 2 — Next Generation Artificial Intelligence Development Plan (2020-2030)



Source: Development Solutions (2018).

5.8 The Plan also lays out several "guarantee measures" intended to support and guide the development and application of AI. These include setting out laws and regulations and ethical frameworks to ensure healthy development of AI; strengthening research on legal, ethical, and social issues related to AI; developing a code of ethics for R&D designers of AI products; and stepping up disciplinary measures against the abuse of data, violations of personal privacy, and anything morally unethical[68].

[68] In May 2018, China promulgated the Personal Information Security Specification which governs the way in which companies collect, process, transfer and share personal information. In particular, the Specification requires the collecting entity to explicitly notify relevant individuals of the rules regarding collecting personal information and to obtain consent from the relevant individuals. It also establishes the procedures for addressing security incidents.

5.9 While the central government has been proactive in designing and advancing various national AI strategies, China has been developing leadership in AI with private company dynamism. It has named 17 key areas as priorities for AI development and called on Chinese technology companies and research institutions to participate in the so-called national team to achieve technological breakthroughs. In November 2017, MOST designated Baidu, Alibaba, Tencent and iFlytek as the first batch of "national champions" in AI. They are each assigned to lead one AI-related industry: self-driving cars, smart cities, medical imaging and voice intelligence respectively.

5.10 In addition to becoming beneficiaries of government funding programmes, "national champions" can receive support from the central government in the regulatory sphere. They are not only given the freedom to experiment their new AI products and services, but are also allowed to access critical infrastructure and data. For example, Baidu is enabled to test autonomous cars on the streets of Beijing, and Tencent is permitted to experiment with AI technologies in medical clinics and laboratories. Likewise, Alibaba partners Hangzhou to improve the city's traffic efficiency, empowered to take automated decisions on road planning, bus routes and traffic lights.

China's competitiveness in AI development

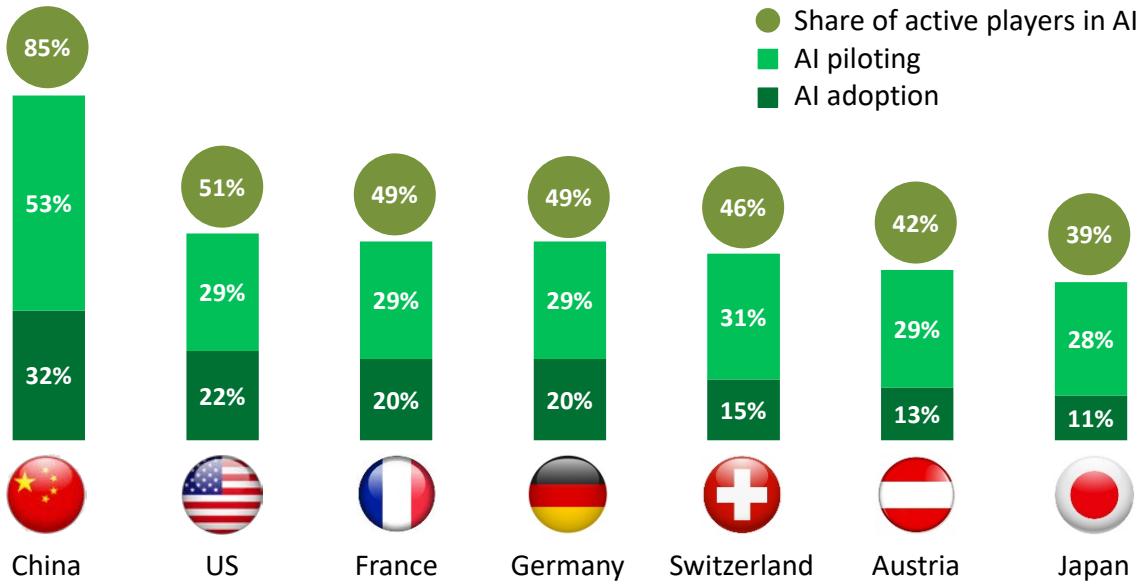
5.11 As a relative latecomer to the global AI race, China needs to catch up in three core areas of AI growth: hardware, research and industry development. Nevertheless, China has several advantages, such as a high AI adoption rate, availability and easy access to a huge amount of personal data, and improving talent pool, which set the stage for the take-off of its AI economy.

AI adoption

5.12 According to a study conducted by a management consulting firm, China was ahead of the rest of industrialized world in AI adoption in 2018. A remarkable 85% of Chinese companies were identified as "active AI players" in 2018[69] (**Figure 3**).

[69] According to BCG Gamma (2018b), active players are defined as those companies which are already moving to adopt AI into some existing processes or currently running pilot initiatives.

Figure 3 — Share of active players in AI by country (2018)



Source: BCG Gamma (2018b).

5.13 China's dominance in AI applications reached across multiple industries compared with the majority of countries only concentrating on a few (**Figure 4**).

Figure 4 — Share of active players in AI by country/industry cluster (2018)

	China	US	France	Germany	Switzerland	Austria	Japan	Total
Consumer	84%	41%	57%	39%	65%	32%	35%	50%
Energy	86%	73%	48%	50%	n.a.	67%	38%	67%
Financial services	86%	61%	45%	34%	67%	22%	42%	52%
Health care	83%	49%	51%	43%	38%	33%	23%	49%
Industrial	83%	49%	43%	60%	35%	44%	32%	55%
Technology, media, telecom	89%	65%	63%	64%	43%	67%	60%	71%
Total	85%	51%	49%	49%	46%	42%	39%	55%

Notes: (1) Values denote the percentage share of active players in each country and/or industry. Colours highlight their relative positioning.
(2) "n.a." denotes clusters with insufficient survey statistics.

Source: BCG Gamma (2018b).

5.14 China's lead in AI applications is in part because the importance of AI has permeated Chinese culture and Mainland people and business recognize the value of AI in higher rates. According to a 2018 survey[70], a higher share of Chinese individuals (76%) believe AI will have a positive impact on the entire economy than individuals in the US (58%), Germany (57%), Spain (55%), France (52%) and the United Kingdom (51%). Also contributing to China's high AI adoption rate is the top-down government-driven approach featuring ambitious national AI strategies and government-led collaboration with private technology companies and research institutions in AI applications (see paragraphs 5.8-5.9 above).

Data

5.15 China's large population gives it a significant data advantage in AI development. Specifically, China had more than 800 million Internet users in 2018, more than the EU and the US combined[71]. Internet users generate a large amount of data each time when they engage in online activities such as using search engines, posting on social media and making online purchases. This is more apparent in China where some 95% of users access the Internet via mobile devices[72] and customers are accustomed to paying for goods and services online without being overly concerned about privacy or data sharing[73].

5.16 Furthermore, large Chinese Internet firms have grown the breadth of their offerings and created all-in-one super apps to cater for different needs of their customers. This affords them the opportunity to collect a greater variety and depth of data than their counterparts in the West.[74] For example, BAT currently has distinct datasets underpinned by their unique core offerings: search, e-commerce, and social media/gaming.

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[70] See BCG Gamma (2018a).

[71] See McKinsey Global Institute (2019).

[72] According to International Telecommunication Union (2018), China had a high smartphone adoption rate, at 76% of mobile subscriptions, in 2017. Accessing the Internet via smartphones can generate more valuable data than via desktop computers because smartphones contain sensors (embedded Global Positioning System receivers) and are carried around.

[73] According to McKinsey Global Institute (2019), China accounts for more than 40% of the global retail e-commerce transactions.

[74] For example, WeChat, an app owned by Tencent, allows users to hail a taxi, order a meal, book a hotel, manage a phone bill, and buy a flight to the US, all without ever leaving the app. In the US, these services and thus the data are divided between such firms as Uber, Postmates, Expedia, Verizon and Venmo. See Castro (2019).

Talent

5.17 China lags behind the US in the talent needed to power AI R&D. In 2017, there were more than 1.9 million AI engineers worldwide, among whom about 850 000 were working in the US and some 50 000 in China[75]. Added to this, there were 367 universities worldwide that had listed AI as a major in 2017, of which 168 were in the US and 20 in China[76]. Nevertheless, there are a couple of reasons that may enable China to close its talent gap with the US. Firstly, China has been investing in AI education; and secondly it has been implementing a variety of preferential policies and incentive schemes to attract local and foreign talent.

Investing in education

5.18 In April 2018, the Ministry of Education laid out the "Action Plan for Artificial Intelligence Innovation in Colleges and Universities" with multiple initiatives to boost AI education in China. These include plans to (a) establish a hundred "Artificial Intelligence + X" (with X standing for a non-AI major) compound specialities by 2020; (b) compile 50 world-class AI textbooks, develop 50 national-level high quality AI courses, and set up 50 research centres by 2020; and (c) transform Chinese colleges and universities into the world leading innovation centres in AI and hotbeds for AI talents by 2030.

5.19 China also looks to the younger generation than its huge pool of college and university graduates to close the gap in AI talents. In January 2018, the Ministry of Education promulgated the "Curriculum Standards for General Senior High Schools and Chinese and Other Disciplines", which (a) incorporate AI, Internet of Things and Big Data Processing into the new "Curriculum Standards for Information Technology Courses in General Senior High Schools", and (b) establish two modules of "Data and Computing" and "Information System and Society" as compulsory courses in high schools.

5.20 China has also published its first AI textbook, named "Fundamentals of Artificial Intelligence", for high school students. The nine-chapter textbook, compiled by SenseTime and released in April 2018, is currently taught as a pilot programme in more than 100 schools throughout China. In addition, Shanghai's East China Normal University Press recently introduced

[75] See LinkedIn (領英) (2017).

[76] See 騰訊研究院 (2017).

six AI textbooks for primary and high school students, and it has put another four AI textbooks on its publishing schedule for 2019.

Talent attraction programmes

5.21 China is also actively retaining local talent and attracting talented individuals from abroad, particularly overseas-studied Chinese returnees. Many Mainland cities have implemented a variety of preferential talent attraction policies, offering hukou[77], housing benefits and/or cash incentive. Reflecting the effectiveness of these policies, about eight out of every 10 Chinese students studying overseas returned home in 2018, compared with one out of every 10 in the early 2000s.

6. Concluding remarks

6.1 Hong Kong has an edge in developing AI. It has world-class academics and researchers, but the relatively narrow industrial structure and limited success of talent admission schemes have aroused the concern over its ability to educate and attract enough talent for AI development. In the US, the presence of many world-leading universities and research organizations has helped the country gather some of the best AI talent in the world. Meanwhile, China has been actively implementing a variety of preferential policies and incentive schemes to attract local and foreign talent, which have started to bear fruit in recent years.

6.2 In Hong Kong, STEM education has been identified as another weak link in the development of AI talent. The Government has been investing in STEM education which has been promoted through Mathematics, Science and Technology education in schools. While Mathematics is a compulsory subject throughout the six-year secondary education, Science and Technology subjects are optional at senior secondary level. In addition, there is also no coherent strategy for implementing STEM education which tends to be school-based. In contrast, the US has moved beyond STEM education to plan for developing **national guidelines** to teach K-12 students about AI. China has looked to the

[77] A hukou is a domestic household registration permit for Chinese citizens, allowing holders to access permanent residence right and the associated social benefits such as education, healthcare, public medical insurance and government welfare payment.

younger generation than college and university graduates to close the gap in AI talents. The Ministry of Education has recently made AI-related courses **compulsory** to all high schools, and the first AI textbook for high school students was released in April 2018.

6.3 In addition to talent development, public and private R&D investment is a key growth driver of AI development. Yet, Hong Kong's GERD as a ratio to GDP has been standing at a low of less than 1% since 2000. As to public R&D investment, Hong Kong has been providing funding through ITF totalling HK$1.3 billion in 2017. However, the amount pales in comparison with the total expenditure on technological innovation of the business sector, at HK$29.5 billion, in 2017. Furthermore, there have been concerns over the vetting and approval procedure for various funding schemes under ITF.

6.4 Regarding AI applications, Hong Kong fails to stimulate the integration of digital technologies into everyday life. There are several factors hindering the adoption of AI, such as presence of a large number of easily accessible outlets for in-store shopping and continued reliance on traditional payment methods. Furthermore, the Hong Kong market is too small for AI applications and many research results could not be commercialized due to a lack of manufacturing base in the territory.

6.5 In February 2019, the central government unveiled the "Outline Development Plan of the Guangdong-Hong Kong-Macao Greater Bay Area". The Greater Bay Area initiative links Hong Kong with nine Mainland cities and Macao to form an integrated economic hub, offering catalyst for Hong Kong's AI innovation. It is believed that the Greater Bay Area has good potential to develop itself into a global AI centre, and provides opportunity for Hong Kong to deepen its role as a connector for Chinese I&T start-ups and help them expand overseas. Local AI companies also benefits from the much bigger market in the Greater Bay Area, which should be conducive to achieving the scale efficiency required for commercializing their AI technologies and inventions.

Funding for training of technology talent and supporting technology start-ups

Training Technology Talent	
Researcher Programme	• supports the recruitment of up to two local graduate researchers for up to 36 months in - organizations undertaking R&D projects - incubatees and I&T tenants of HKSTPC and Cyberport - investee start-ups of the Innovation and Technology Venture Fund • monthly allowance - Bachelor's: **HK$18,000** - Master's: **HK$21,000**
Postdoctoral Hub	• supports the recruitment of up to two postdoctoral talent for up to 36 months in - organizations undertaking R&D projects - incubatees and I&T tenants of HKSTPC and Cyberport - investee start-ups of the Innovation and Technology Venture Fund • monthly allowance of **HK$32,000**
Reindustrialisation and Technology Training Programme	• supports staff training in advanced technologies, especially those related to "Industry 4.0" • up to **HK$500,000** per enterprise per year • on a 2 (Government) : 1 (enterprise) matching basis
Supporting Technology Start-up	
Innovation and Technology Venture Fund	• co-invests with venture capital funds in local start-ups • fund size: **HK$2 billion** • on an approximately 1 (Government) : 2 (Venture Capital Fund) matching ratio for investment (up to **40%** of total investment amount sought by the investee company or **HK$30** million per deal, whichever is lower)
HKSTPC Corporate Venture Fund	• co-invests on a matching basis with angel investors or venture capital funds in start-ups of HKSTPC • provides funding from seed stage (seed funding) up to Series A stage (funding to accelerate growth) • up to **HK$8 million** per company
Cyberport Creative Micro Fund	• provides seed funding to high potential and innovative start-ups in information and communications technology • up to **HK$100,000** per project
Cyberport Macro Fund	• provides pre-Series A funding to co-invest with investors in Cyberport start-ups • **HK$1 million - HK$20 million** accumulative investment per investee
Technology Start-up Support Scheme for Universities	• supports teams of local universities to start technology businesses • up to **HK$1.5 million** per start-up per year for no more than three years

Source: Innovation and Technology Commission (2019).

Appendix II

China's key AI policy documents/plans

Issue date	Document/plan	Description
February 2006	National Medium- and Long-Term Plan for the Development of Science and Technology (2006-2020)	Establishing smart sensors and robots among the frontier technologies to be prioritized for development
February 2013	Guidelines on Promoting the Healthy and Orderly Development of the Internet of Things	Outlining key principles for Internet of Things development and calling for near-term breakthroughs by 2015
May 2015	Made in China 2015	Being the first 10-year plan calling for green, innovative and intelligent manufacturing in China
July 2015	The "Internet+" Action Plan	Listing AI as one of the 11 prioritized areas of development
March 2016	13th Five-year Plan for Developing National Strategic and Emerging Industries (2016-2020)	Identifying AI as 6th among 69 major tasks for the central government to pursue
April 2016	Robotics Industry Development Plan (2016-2020)	Setting concrete technology targets and government strategies for developing robotics industry in China in the next five years
May 2016	Three-year Implementation Plan for "Internet+" Artificial Intelligence	Establishing a goal to create an AI market that is hundreds of billions of Renminbi in size.
August 2016	13th Five-year National Science and Technology Innovation Plan	Launching a series of 15 "Science and Technology Innovation 2030 Megaprojects"
February 2017	"Artificial Intelligence 2.0"	Adding AI to the list of "Science and Technology Innovation 2030 Megaprojects"
July 2017	Next Generation Artificial Intelligence Development Plan	Setting a road map to make China the world's primary AI innovation centre by 2030
December 2017	Three-year Action Plan for Promoting the Development of Next Generation Artificial Intelligence Industry (2018-2020)	Setting out specific benchmark for 2020 in a range of AI products, including intelligence service robots and video image identification system
April 2018	Action Plan for Artificial Intelligence Innovation in Colleges and Universities	Calling for developing 50 world-class AI textbooks, 50 national-level AI courses, 50 research centre, and 100 "AI+X" compound specialities by 2020

Source: Various sources.

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