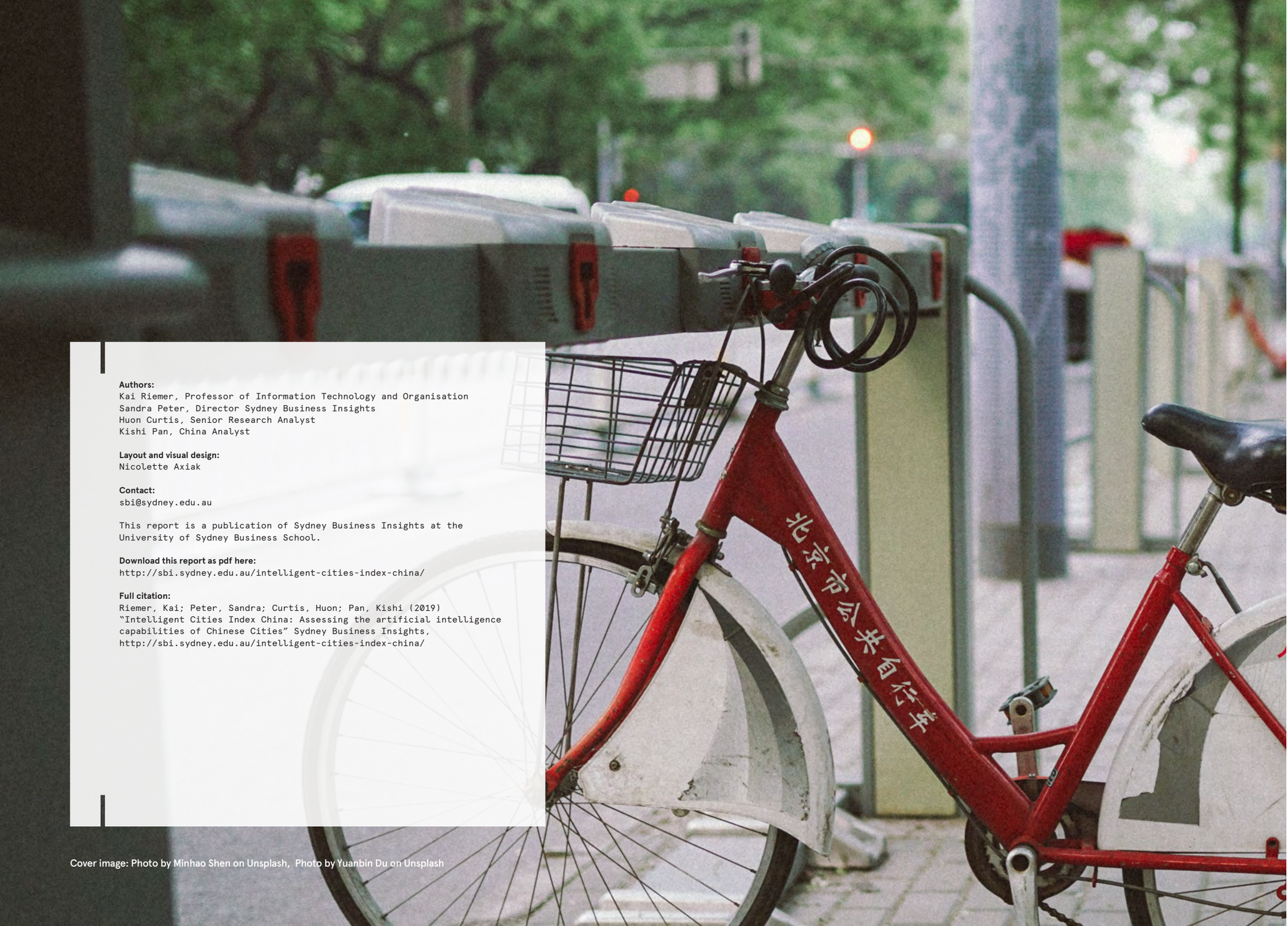
Sydney Business Insights

An initiative of THE UNIVERSITY OF SYDNEY Business School

Intelligent Cities Index China 2020

Assessing the artificial intelligence capabilities of Chinese cities

An introduction to the six city clusters leading the way on AI



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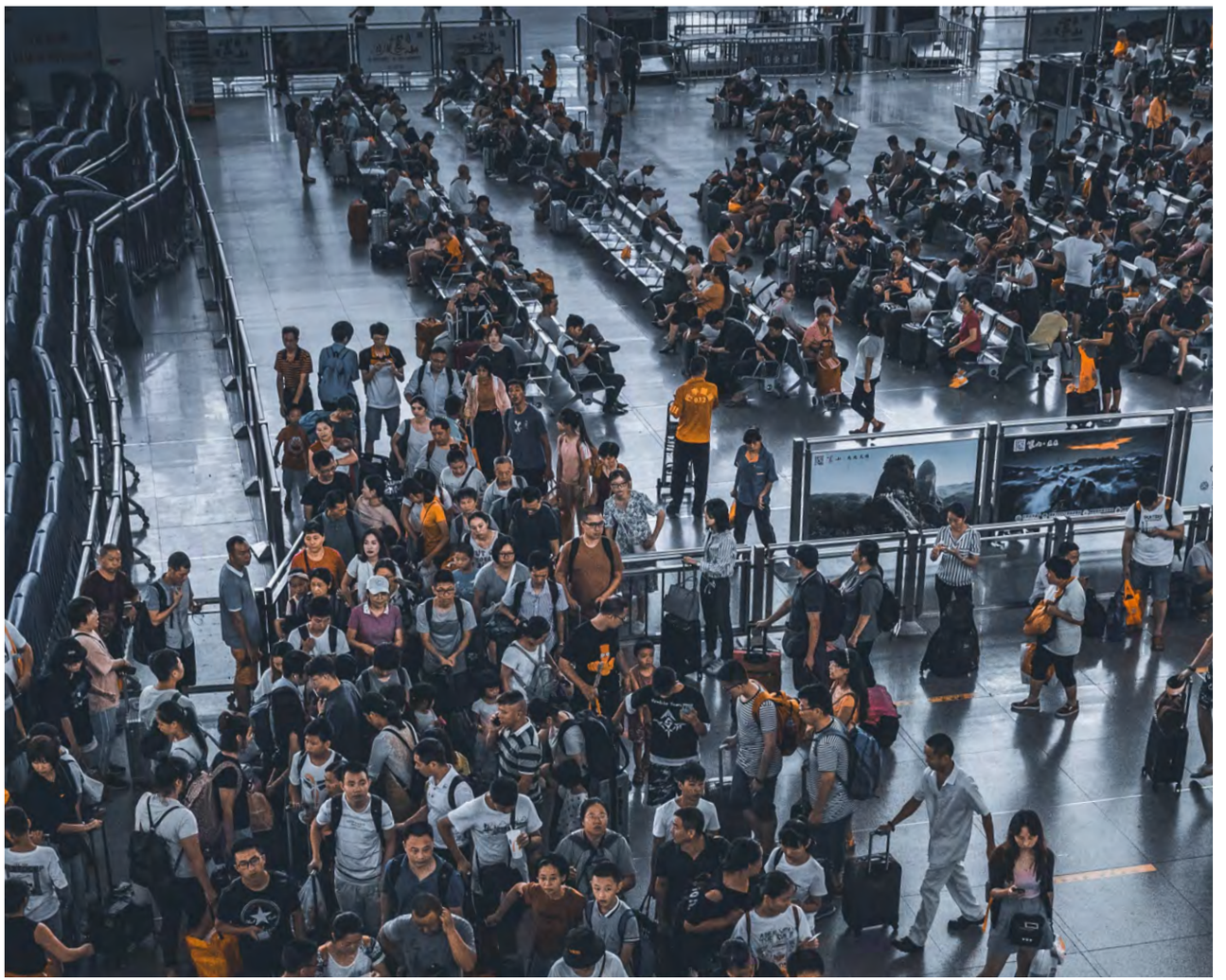

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Executive overview

What is the Intelligent Cities Index China (ICI-CN)?

The Intelligent Cities Index China provides a ranking of Chinese cities according to their activity in the emerging field of Artificial Intelligence.

It provides a resource for decision-makers and stakeholders who want to gain a regional and geographic overview of AI activity in China.

The top cities which make up the Index are portrayed in detail later in the report (see pages 30-41).

The Index is the result of meta-research. All scores and rankings have been developed from existing studies and publicly available data on AI in China with a focus on cities, provinces and regions (see page 21).

A number of reports and rankings on AI in Chinese cities have been published in recent years. This study collates their insights and consolidates them in one Index.

The Index is based on 10 indicators and presents the sum of four individual rankings, comprising 1) enterprise activity, 2) research proficiency, 3) infrastructure readiness, and 4) government engagement (see pages 22-25).

Key insights

- The Intelligent Cities Index China (ICI-CN) reveals six main clusters of leading cities in AI. These clusters correspond with the Economic Regions of China (see page 14).
- The Top 6 Intelligent cities are all located in the East Coast Region. Each of the other three economic regions comprises at least one Top 10 intelligent city.
- Beijing is the Intelligent Capital, a leader in research and enterprise activity.
- The East Coast Challengers Shanghai, Nanjing and Hangzhou are allrounders with strengths across all categories of the ICI.
- The Giants of the South Coast, Shenzhen and Guangzhou, are leading centres of government AI engagement and have strong enterprise sectors.
- The Rising Centre comprises Wuhan, an up and coming city with strengths in AI research and enabling infrastructure.
- The Industrial Northeast, Harbin and Shenyang are known for strong AI research.
- The Developing West comprises Xi'An and Chengdu, two cities with developing research strengths and favourable policy conditions for attracting AI talent.

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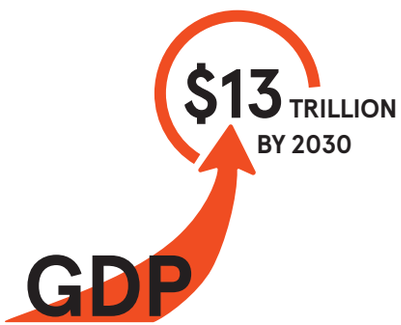
Background: artificial intelligence

Artificial Intelligence (AI) has generated immense hype with unrealistic promises and dystopian warnings

Artificial Intelligence (AI) invokes promises of thinking machines and higher intelligences capable of solving pernicious problems in never seen before ways. It promises unprecedent innovation and economic growth. For example, a recent McKinsey study suggests that global adoption of AI technologies could raise global GDP by as much as $13 trillion by 2030, about 1.2 percent additional GDP growth per year.[1]



At the same time AI stokes fears of automation, wide-spread job losses and 'the robots coming for us', with even younger, well-qualified employees at risk of job loss through automation from AI, according to a recent Axios study.[2]

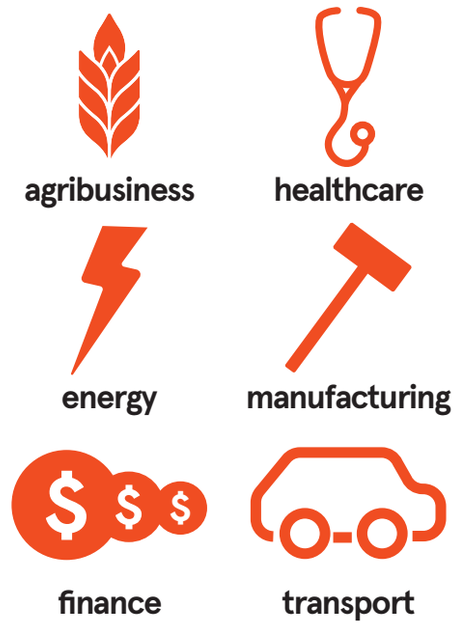
It is obvious that AI, heavily influenced by pop culture narratives rooted in science fiction, has generated much unhelpful hype and hyperbole. It is then no wonder that early dystopian predictions are still being heavily cited and publicly reinforced in media and political discourse,[3] even though they have since been discredited. One such study predicted that 47 percent of all workers in the US have jobs at high risk of potential automation over the next two decades.[4] In Australia, the CSIRO predicted a similar proportion of jobs at risk and the Bank of England warned that 80 million US and 15 million UK jobs might be lost to automation.[5]

More balanced analyses from labour economists have since shown how technological developments are both complementary and displacing in different ways.[6] Economic history has shown that job loss from automation is always counterbalanced with the creation of new tasks in which workers have a comparative advantage over the new technology.[7] Given that AI is not a single technology it is clear that its effect will be felt unevenly across work tasks and the economy in general.

Without question, AI is likely to change the nature and design of a great many jobs, the tasks that make up those jobs, and the types of skills needed to perform them. Adoption of AI has already been seen in sectors such as finance, manufacturing, energy, transport, health care and agribusiness. But the pace and extent of adoption of AI is likely to vary significantly across sectors and economies. In financial services, automated financial advice products and algorithmic trading systems are increasingly prevalent. In addition, AI-enabled systems have been developed for up to 25 years to assist in the detection of fraud by financial firms.[8] Major technology firms including Microsoft, IBM, Google and Intel have invested in healthcare startups, and partnered with research institutes and national health services in efforts to build systems that aid medical diagnosis and treatment.[9] Even in farming and agriculture, AI is being deployed to improve crop yield.

In order to unpack what makes AI a powerful new tool, and to distinguish realistic promises from unwarranted hype, it is important to understand what exactly we mean by AI, and how AI differs from traditional computing.

Select sectors adopting AI applications



Deep Learning (DL) – a new computing paradigm

The field of AI is almost as old as computing itself, with roots in the 1950s. Yet, early AI solutions were very different to the current suite of technologies. In the early days, computer scientists had set their minds on teaching the computer all the facts and rules available about the world, in order to replicate in the machine the same reasoning abilities that make human cognition so powerful. However, this initiative failed spectacularly when the field encountered what is today known as 'the common-sense problem', the ways in which human knowing is embodied in tacit forms of knowledge that cannot be expressed in explicit facts and logical statements.[10]

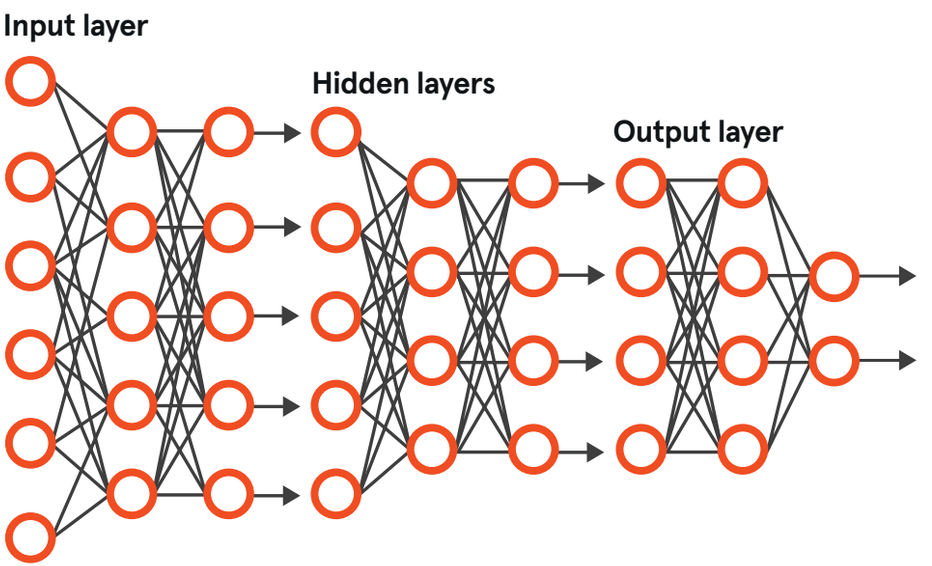
The failure in the 1980s of what is now commonly known as "Good old-fashioned AI (GOFAI)" led to the long AI winter, during which research persisted in Universities yet without wide-spread visibility or applications in industry. It was in 2012 with the success of a revolutionary, so-called "deep learning algorithm" in the now famous image recognition competition ImageNet that AI was catapulted back into the spotlight. This breakthrough in machine learning combined with advances in computing power and new forms of data collection through social media to create the current hype.

How Deep Learning works

Deep Learning (DL) is very different from conventional computing. In conventional computing, an algorithm is a set of pre-determined steps to achieve a goal. In other words, we program software with a set of instructions, or rules to achieve a specific task. Deep learning however is radically different. Rather than encoding explicit rules for solving a problem, the idea is to derive patterns from existing data sets that are then used for classification. As such, DL systems can be immensely useful in fields such as document classification, image and speech recognition, or decision support in areas that rely on large amounts of data.

DL algorithms are created by 'training' layers of complex networks of numerical values (so-called neural networks) with a training data set prepared by humans such that for each training input (e.g. a particular picture) a pathway through the network is generated that arrives at the right output category (e.g. a label describing what is in the picture). The network thus 'learns' to recognise patterns in the input data and associate it with labels we provide it with. The usefulness of deep learning is that the network will classify any input of the same kind and give us an output, even if that input was not contained in the training data. It does so by interpolating, by filling in the blanks so to speak.

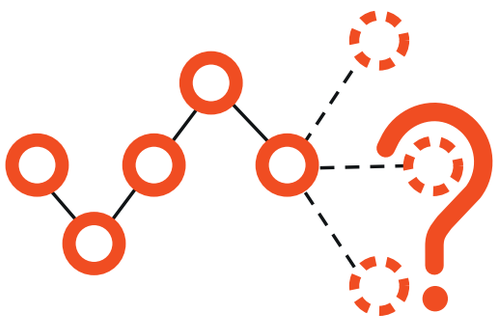
Figure 1: Deep learning neural network



Promises and challenges of Deep Learning

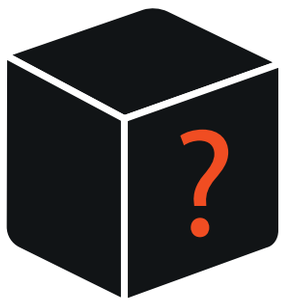
What is exciting about deep learning is the ability to classify and find complex patterns. Traditional algorithms are limited to what the programmer encodes in its instructions, whereas deep learning 'learns' patterns too complex for humans to understand. It can recognise patterns in images in ways that go beyond human abilities (e.g. detecting cancerous cells in MRI images). And while curating and labelling the data to train these algorithms can be time-consuming, the classification of patterns can be done at lightning speed. But this ability comes at a price.

1. DL algorithms are fundamentally unreliable – they make mistakes when they are given inputs that fall outside of their training data, but they have no way of telling us when that happens, so mistakes typically go unnoticed.[11] In many areas of application, this is not a problem, but it limits where we might want to use such systems.



2. DL is reliant on the quality of training data. For example, if data is laden with stereotypes of gender, race, disability sexuality, or other facts, the resulting application of the technology will perpetuate bias and inequity.[12] Training algorithms on historical data may further reinforce existing exclusions and discriminatory practices.

3. DL systems are largely black boxes, in that it is not possible to fully understand how a particular output was arrived at (e.g. how particular characteristics in the input data contribute to the output).



Deep learning algorithms are used to detect cancerous cells in MRI images

Thus, AI raises complex ethical, legal, and security questions. For example, the use of AI to make consequential decisions about people in legal contexts has led to concerns about how to ensure justice, fairness, accountability and transparency.[13]

Much research will need to go into improving deep learning and building on its capabilities, while limiting the problems associated with its inherent limitations. There is no doubt that AI will enable wide-spread changes to business and society. Yet, it is impossible to predict what these changes will look like in detail. Therefore, it is important to follow these developments closely and gain a better understanding for what the main drivers are and who the main players are.

Where is AI going? Investments are not yet mirrored in applications

Global private investments in AI technology and associated business ventures are soaring. In 2018, AI start-ups emerged at record rates,[14] as they attracted around 12% of all worldwide private equity investments, a sharp increase from just 3% of deals in 2011.[15] Companies based in the USA and China have dominated - in 2017 US-based companies accounted for 50% and China-based companies attracted approximately 36% of private equity investment.[16]

The most valuable deals in 2018 were the US$500M funding round for US self-driving startup Zoox and a US$600M investments for China's SenseTime. According to Venture Scanner, investment in AI startups in China grew from $1 billion in 2016 to over $8 billion in 2018, while the US attracted $3 billion in 2016 and $8 billion in 2018.[17]

While innovation expenses are increasing sharply, diffusion and application are still somewhat lacking. The most impressive capabilities of AI have not yet been adopted widely.[18] Companies are still exploring how to apply technologies to specific business problems. IBM has struggled to transform IBM Watson into commercial products.[19] Business development is also constrained by definitional issues. AI is a term that is widely invoked. And while academia and experts refer to deep learning when they use the AI label, up to 40% of 'AI startups' have been found to not actually use AI in ways that are material to their businesses.[20] Riding the hype, a number of companies have been accused of deploying 'pseudo-AI', (e.g. humans pretending to be chat-bots) while telling investors they have developed scalable AI technology.[21]

Developing AI is resource intensive, in business and in research. For example, the resources required to produce publication-worthy results has made it increasingly challenging for researchers working in universities to contribute to advances in the field. Deep learning algorithms are costly to train and develop, both financially, due to the time required to label data for training the algorithm, the cost of hardware and cloud computing time, and environmentally, due to the carbon footprint required to run modern computers.[22] Yet much research will need to be done in order to not only advance deep learning technologies, but also to explore the best ways to employ such new computing technologies in ways that benefit both the business and public sectors.

At the same time, global government policy responses are characterised by a lack of consensus over what the developments of AI means for social, economic and workplace policy. Various governments

Figure 2: AI start-ups as % of private equity investments

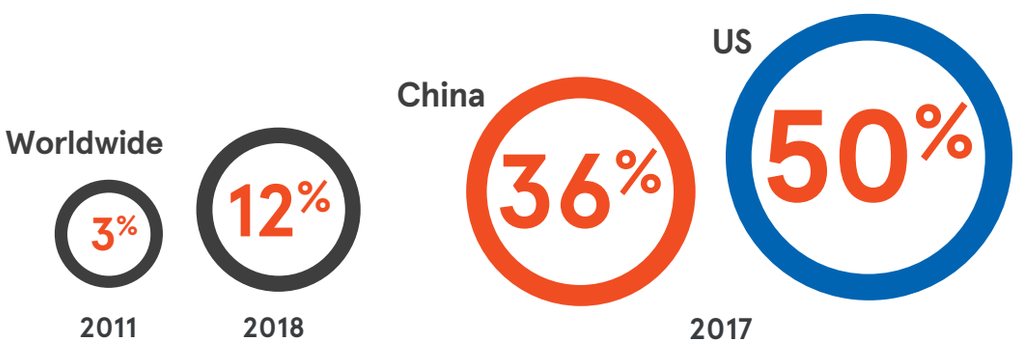


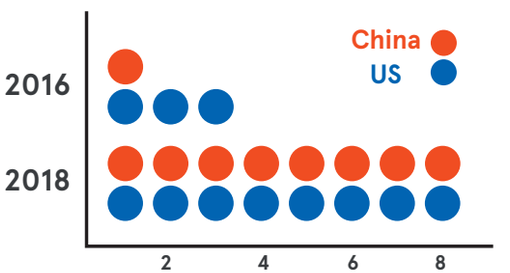
Figure 3: Most valuable deals of 2018

ZOOX

US$500m
For US self-driving start-up Zoox

US$600m
For China's SenseTime

Figure 4: Investment in AI start-ups (US$Billion)



have put forward position statements and strategies on the development of AI for social good, AI for humanity, or labour market reform. And while the US government, with US White House Executive Order on AI 2019, has outlined ambitions for a comprehensive AI strategy which includes priorities for 5G mobile technology, Internet of things (IoT), and advances in manufacturing, it has pledged very little funding compared to other jurisdictions. In contrast, the European Commission's AI strategy called for the EU's public and private sectors to increase AI investment by at least €20 billion, and pledged to boost its own contribution to €1.5 billlion. Germany has announced €3 billion AI specific funding, and the UK £1 billion.

Most notable is the rise of China in the AI space. Publicly available figures show that China's national and city governments are committing many billions to AI. The city of Beijing alone announced a US$2.1 billion AI-centric technology park, and Tianjin plans to set up a US$16 billion AI fund. Consequently, it is to China that the world is turning its attention.

China is a major AI player with a dedicated government plan

China is approaching AI like its own lunar mission. It has viewed AI as a national priority since 2015 and its current engagement builds on previous science and technology plans. China's State Council recently announced the "New Generation of Artificial Intelligence Development Plan" which aims to prepare China to become the world leader in AI. China's AI Plan aims to build a domestic AI industry worth at least AU$225 billion by 2030.

The AI Plan has led to considerable government and private-sector innovation, investment and development. Overseen by the Ministry of Industry and Information Technology (MIIT) the latest AI Plan outlines four major tasks, including targets for the development of (1) smart products, (2) intelligent manufacturing; (3) achieving breakthroughs in the core foundations of AI including faster neural network computer chips; and (4) building a public support system by accelerating the development of 5G.

China's embrace of the so-called second machine age and fourth industrial revolution have made for some remarkable stories of progress. In China the growth of the technology sector is largely unprecedented. Baidu, Alibaba and Tencent, each founded just 20 years ago, are now among the largest firms globally.

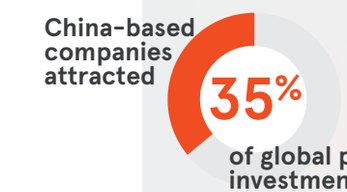
China-based companies attracted approximately 35% of global private equity investment in 2018. China's SenseTime, founded in 2014, is the world's most valuable AI company.

China is assumed to have a distinct comparative advantage when it comes to developing AI applications, due partly to its population size, which allows for the accumulation of vast amounts of data. China is also assumed to have a more open data environment, which fuels the growth of its tech sector which sees many businesses now among the world's biggest tech companies.[23] However, focusing on these factors only would over-simplify the complex drivers of Chinese development in the area.

China's latest AI plan is increasingly looking outward. It prioritises cultivating AI researchers both internally and externally for collaborations, visiting fellowships and academic exchanges

"New Generation of Artificial Intelligence Plan"

China to build a AU$225 billion AI industry by 2030



(e.g. the Thousand Talents Program). Moreover, the government announced the Double First

Class University Plan to create 42 world class universities by 2050. Already, China's researchers are increasingly prominent at international AI conferences and in published journals.[24] In order to develop strategic partnerships Chinese firms have been encouraged to pursue investments and to establish research and development centres overseas.

At the same time, the implementation of its AI plan is done in a considered and increasingly regionalised approach. The AI Plan incentivises city and provincial governments to pursue AI-friendly policies and work with the private sector in accelerating these technologies. There are a growing number of local and provincial government AI policy initiatives. Shanghai, Wuhan, Beijing and other cities have issued AI implementation plans. Examples of AI-focused industrial parks, research institutes, financing initiatives, and local-government subsidies for AI-enterprises are emerging across the country.

The focus of AI development at the city level is emblematic of two broad trends converging in China to create a very regionalised approach to AI at the cities level. China's national government has incentivised its city and provincial governments to pursue AI-friendly policies and to work with the private sector to develop AI technologies to enhance the digitalisation of city management and public services.

Thousand Talents Program

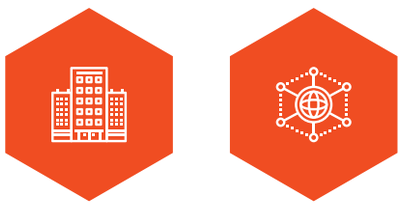
Double First Class University Plan

42 world class universities by 2050

Photo by Hanny Naibaho on Unsplash

Background: intelligent cities

Megatrends, impactful technology and rapid urbanisation, are combining in China to create *intelligent* cities



Impactful technology is the megatrend comprising the emergence of artificial intelligence reshaping our modern world.[25]

The second megatrend heavily implicated in the development of modern Chinese society is rapid urbanisation.

Both megatrends work in unison to bring about a variety of regional and local developments in AI at the city level.

Rapid urbanisation is a global megatrend. More than half the world's population lives in cities and they generate 85% of the global GDP. China now has more than 800 million urban residents. China's urbanisation rate has increased from 13% in 1950 to 59% in 2018.[26] Twenty-five of the world's largest 100 cities are in China, and the country already has at least 15 megacities (cities with more than 10 million residents) and expects several more urban centres to reach megacity status by the end of the decade. In 1978, the urban GDP accounted for only 36 percent of China's overall GDP. Today, urban areas account for about 80 per cent of China's GDP.

China's New Urbanisation Plan drives city-level AI developments

China's National Plan on New Urbanisation for 2014-2020 outlined 11 "urban clusters" and reforms of the hukou household-registration system to create a more mobile workforce. It also sets out targets for broadband information networks, e-government platforms and intelligent infrastructure. The largest urban cluster will be Jing-Jin-Ji (Beijing-Tianjin-Hebei – population 112 million); the region around Chengdu and Chongqing (population 60 million); the Yangtze Delta cluster around Shanghai (population 90 million); and the Yangtze River Middle Reaches cluster around Wuhan (population 29 million). These developments will build on existing major city clusters such as the Yangtze River Delta and Pearl River Delta regions.

In accordance with this strategy the central government has developed a number of initiatives to regionalise its AI strategy. On the one hand, it develops distinct urban

Figure 5: Urbanisation in China

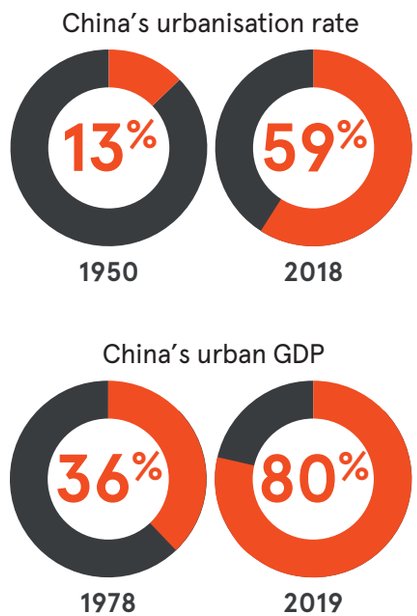
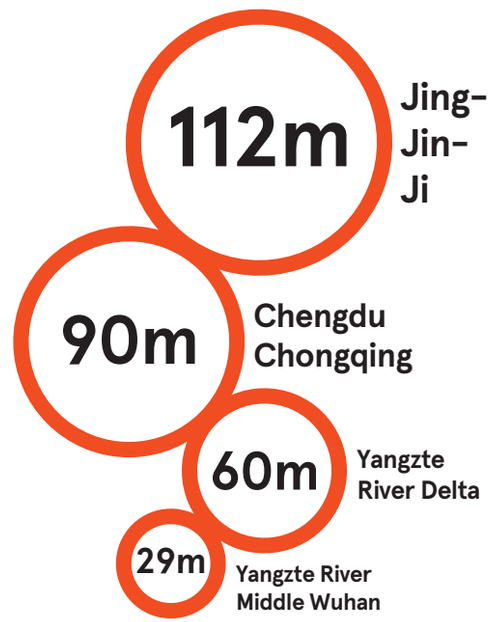


Figure 6: Urban clusters by population



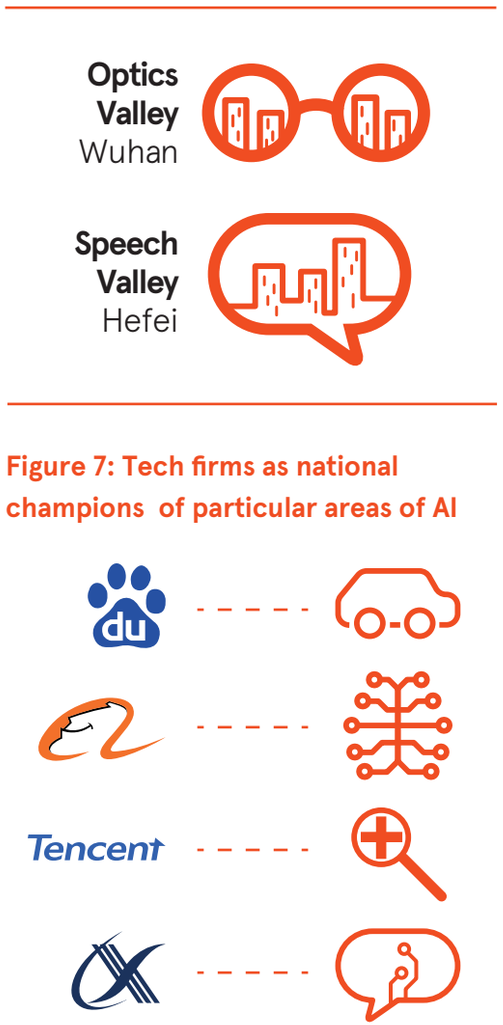


Figure 7: Tech firms as national champions of particular areas of AI

clusters with technological focuses. For example, it is pushing for regions to specialise in particular technologies, such as the Optics Valley in Wuhan and Speech Valley in Hefei. On the other hand, it has identified large-tech firms as national champions of particular applications of AI. For example, Baidu's focus is on autonomous driving; Alibaba is tasked with prioritising "city brains" – platforms that focuses particularly on traffic flow and emergency response time; Tencent's focus is on computer vision for medical diagnosis; while Shenzhen-listed iFlytek will specialise in voice technologies. China's systematic approach distinguishes it from other countries because it ties AI development to city growth. This is unique globally because it creates powerful synergies between local governments, tech firms and city innovation clusters. In turn, Chinese cities are transitioning from simply building infrastructure, to trying to improve quality of life. For example, technology is playing a major role in easing traffic congestion, as well as the creation of entirely new service industries and high value-added exports like technology and finance.

China's city-level AI initiatives

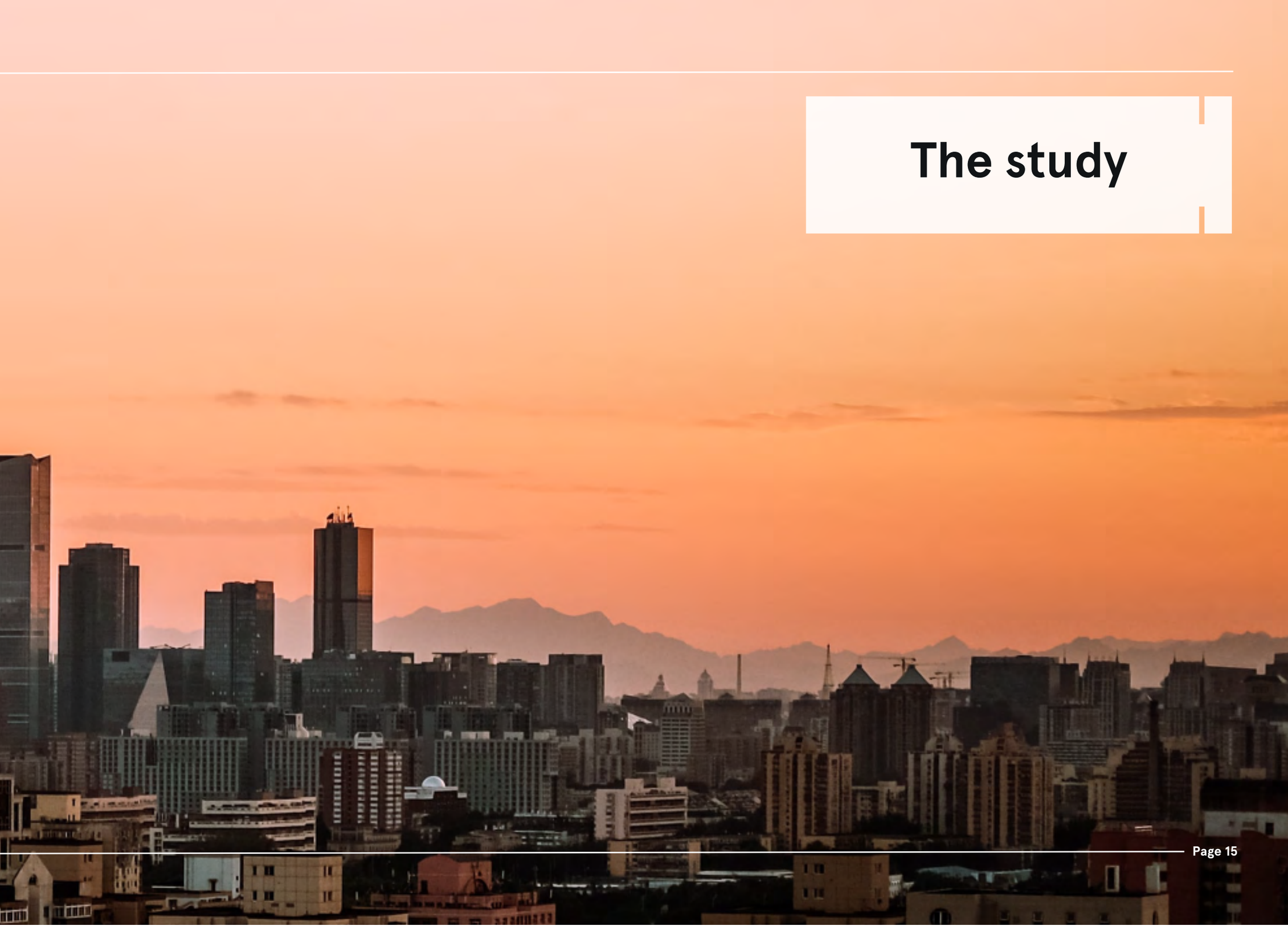
The national objectives of the AI and Urbanisation Plans are translating into city-level initiatives with the aim to boost demand for AI-driven services and spur a positive cycle of further innovation, research, investment and productivity growth. Competition amongst firms at the city level, and between cities themselves is designed to create an environment where the exchange of resources in the form of subsidies, industrial parks and investment by city governments, returns increased jobs opportunities, tax revenue and economic growth. As a result, city governments are effectively serving as incubators and funders of AI projects. To this end, city governments implement national frameworks by setting up industrial parks, providing funding and resources for select companies. Shanghai, Wuhan, Beijing and other cities have issued AI implementation plans. Shanghai will subsidize key AI projects with 30 percent of their investment. Wuhan has developed a strategic partnership with Xiaomi to build an R&D centre for AI, cloud computing and big data. The Tianjin Eco-city has become a test-site for the expansion of China's 5G network and sustainable technologies.

Intelligent Cities

Following these insights, and in line with the Chinese government focus on both AI and Urbanisation, in this report we focus specifically on the development of AI capacity in China at the city-level. We coin the term "Intelligent Cities" to refer to the capacity of a particular city for engaging with Artificial Intelligence as a national priority. Under this definition a city is an "Intelligent City" if it has built significant capacity in one or all areas of 1) enterprise and business, 2) research and innovation, 3) government policy and/or 4) enabling infrastructure. We investigate the level of capacity and engagement of Chinese cities in these four broad categories and develop a scoring model and ranking system, which we have termed the Intelligent Cities Index China.

Photo by Wong Zihoo on Unsplash

The study



Study overview

The Intelligent Cities Index China measures the capacity and engagement of Chinese cities with Artificial Intelligence (AI) in four broad categories: enterprise, research, infrastructure and government. Consequently, the index is made up of four sections. Each section comprises a separate scoring model and results in a ranking. Together these are aggregated to form the Intelligent Cities Index China (ICI-CN). The report is the result of meta-research.

The Index was built from a combination and consolidation of a range of secondary data from existing reports, and other publicly available data. The detailed scoring model and sources are listed on page 21.

Enterprise ranking

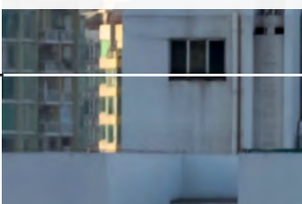
The enterprise ranking captures the engagement with AI of the local industry in each city. The ranking is built from a combination of three separate activity measures. Breadth of activity is a quantity measure comprising both how many companies in a city are known to actively engage with AI in their products, services and/or development, as well as a city's share of the national AI employment. Depth of activity is a quality measure that captures the proportion of the Top 100 AI companies located in each city. It is noteworthy that those companies are distributed across just 10 cities. Finally, agility of activity is a measure for how vibrant the AI start-up sector is in each city. This is measured through both the number of AI start-ups headquartered in each city and the size of investments into start-ups in each city. This measure clearly separates those cities with strong AI innovation in their enterprise sectors from those in which enterprises are merely applying AI – or in other words AI leaders from AI followers.

Research ranking

The research ranking is based on the AI research proficiency, capacity, quality, and applicability of the University sector in each city. Included in the data are all Universities with notable AI research outputs and all data are aggregated at the city, rather than the University level. Research proficiency and research capacity are purely quantitative measures that capture the size of AI-related research activity measured in terms of the number of AI-related papers produced by the top Universities within a city and the number of AI researchers active in that city respectively. Research quality and research applicability on the other hand capture how well-received and how useful such research is. They are measured by the number of top AI papers (in terms of citations) and the number of patents obtained by AI researchers in those cities. Patents are of a solid proxy for usefulness because only original and innovative research is suitable for patent application.

Infrastructure ranking

The infrastructure ranking captures the extent to which cities engage with basic technology relevant to AI innovation. This includes the roll-out of 5G mobile networks and smart city technology, such as Internet of Things, sensors, smart electricity grids, real-time data in the transport system. We utilise two reputable rankings provided by Deloitte to approximate smart city proficiency, the smart cities ranking that scores and ranks cities according to their breadth of smart technology application, and an innovation score which distinguishes cities according to how much they engage in leadership in applying novel technologies and concepts. In addition, we include data on the planned roll-out of 5G mobile technology in each city, measured by the number of 5G base stations per 100K people. 5G will become an important enabler for the everyday use of advanced AI technologies, such as AI-driven personal avatars used for mobile communication or the next generation AI personal assistants.



Government ranking

We measure government engagement through the number of AI-related policies provincial and city government have executed. Multiple cities located in the same province receive the same score. Unsurprisingly there is strong correlation between the infrastructure score and the government score even though each is measured by different means, which indicates that those cities active in engaging with AI policy are also those rolling out smart cities initiatives that provide the backbone for AI research and application.

Photo by Scarbor Siu on Unsplash

Scoring model

The Intelligent Cities Capability Pyramid visualises how these four scores built on each other, with 1) government setting the framework in which AI can proliferate, 2) smart cities infrastructure providing essential ingredients, 3) research driving foundational development, and 4) the enterprise sector leading the charge in innovation and application of AI. In total, the ICI-CN is based on 12 separate indicators that aggregate into the four complementing scoring models.

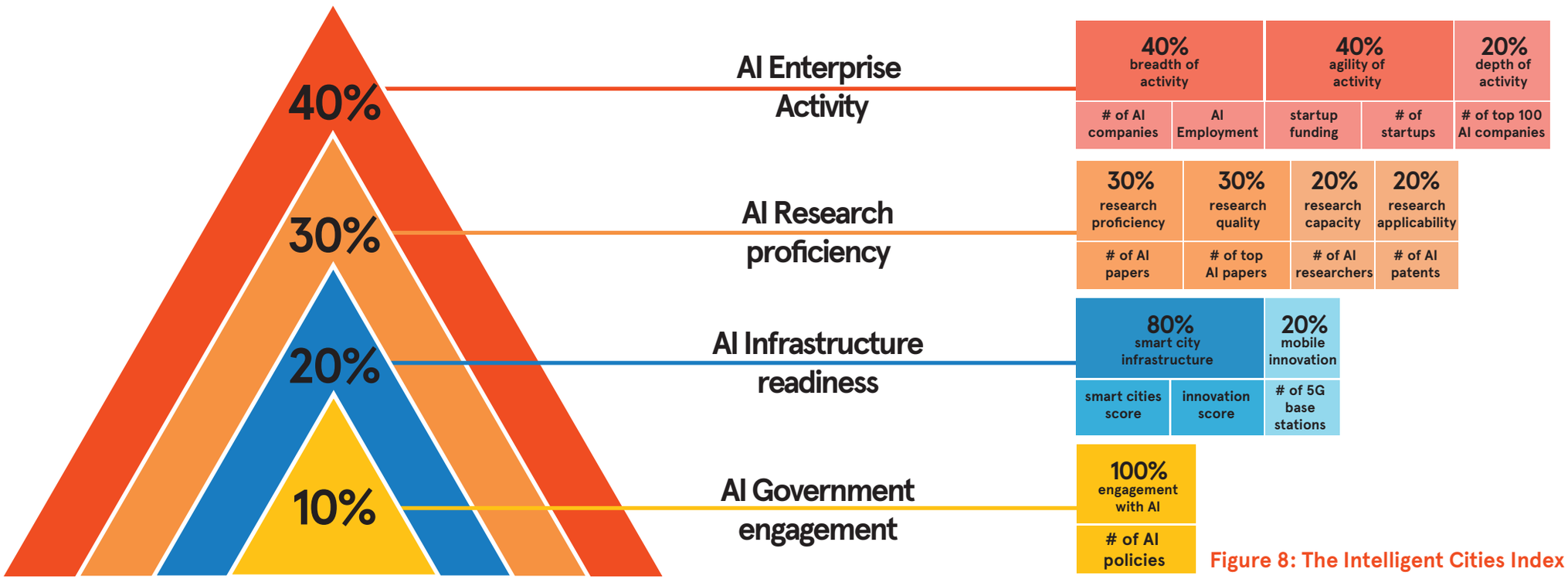


Figure 8: The Intelligent Cities Index

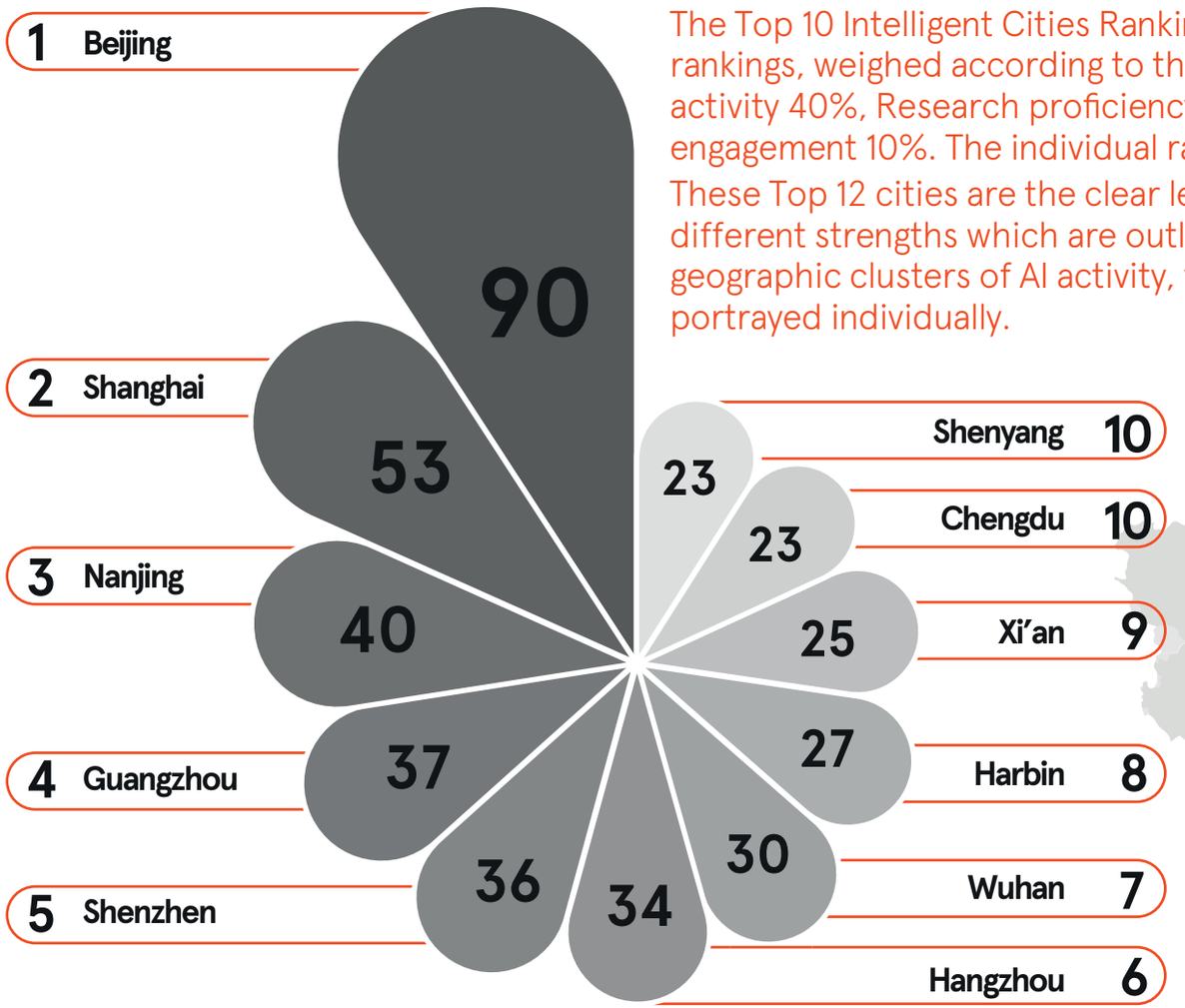
Data Sources:
Enterprise indicators: EO Intelligence 2018 AI business landing | Tsinghua 2018 - China AI development report | Deloitte 2019 Scenarios and potentials of AI commercial application in china | IDC (2018), China AI City Development White Paper.
Research indicators: Tsinghua 2018 - China AI development report
Infrastructure indicators: Deloitte Digital, 2018, Super Smart City Report | 5G data collected from: Xinhuanet, Technode, Lifewire, China Daily
Government indicator: Tsinghua 2018 - China AI development report

The index

Photo by Maud Bocquillod on Unsplash

Photo by Zhang Kaiyv on Unsplash

The Intelligent Cities Index China (ICI-CN)



The Top 10 Intelligent Cities Ranking presents the aggregate result of the four individual rankings, weighed according to the Intelligent Cities Capabilities Pyramid: Enterprise activity 40%, Research proficiency 30%, Infrastructure readiness 20% and Government engagement 10%. The individual rankings are presented on the subsequent pages.

These Top 12 cities are the clear leaders in terms AI activity within China. The cities have different strengths which are outlined in the individual rankings and they fall into different, geographic clusters of AI activity, which are introduced on page 28, before each city is portrayed individually.

Enterprise ranking

Enterprises are both users and innovators in the AI space and those that bring AI to the people. Cities that attract key innovators will drive the adoption of AI but also provide a test-bed and data source for more research into AI to take place.

1 Beijing

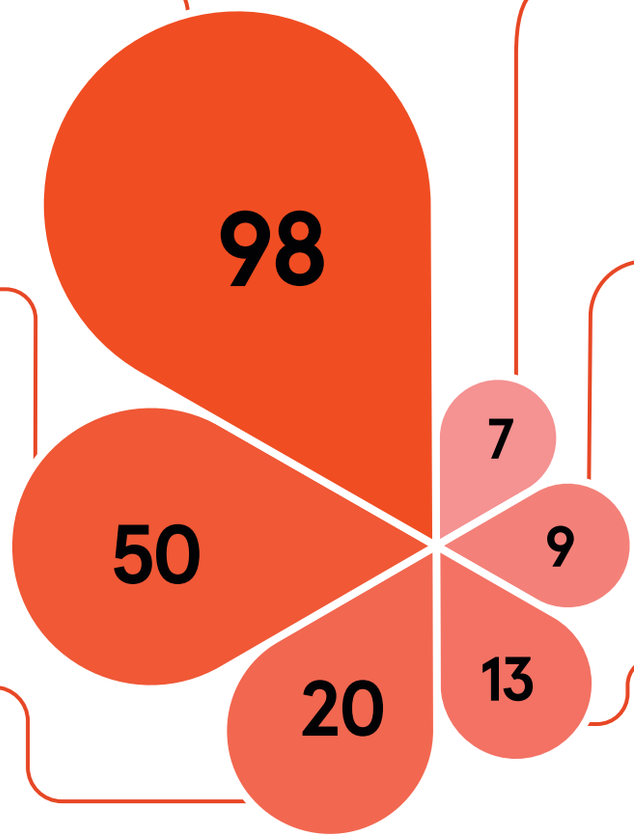
The Zhongguancun area of Beijing is a leading global innovator of start-ups and tech firms. Zhongguancun has attracted nearly 20,000 high and new-tech enterprises over the last 2 decades. Beijing is leading as the home to the headquarters of companies leading in the AI space.

2 Shanghai

Shanghai ranks second because of its key relationships with 15 leading Chinese AI firms including Baidu Innovation Centre, iFlyTek, Horizon Robotics, and Cambricon. The city will be granted greater administrative autonomy to spearhead the opening-up of the Yangtze River Delta. Shanghai's Lingang Area Development Administration plays a key role in enterprise support.

3 Shenzhen

Shenzhen's ranking is due to the solid private funding opportunities for local start-ups. Shenzhen is home of one of the only two stock exchanges in the Chinese mainland. Shenzhen has more than 30 listed companies engaging in cloud computing and big data.



Nanjing 6

The city of Nanjing is doing well due to the profile of its 216 square kilometre research zone designed to support entrepreneurs. The zone will house dozens of high-profile companies as well as a range of start-ups.

Guangzhou 5

The Guangzhou International Institute of AI was launched in the Nansha Free Trade Zone in 2017 to serve as a lynchpin to support enterprise development. Led by Jerry Yang (co-founder and former CEO of Yahoo) and Tian Suning (China Broadband Capital Partners), the Institute aims to recruit to 30 high-end talent teams by 2020.

Hangzhou 4

Hangzhou challenges Beijing for the status as China's Silicon Valley. Hangzhou is home to the world's largest retailer and e-commerce company, Alibaba, one of the largest Internet and AI companies in the world, and clusters of other fin-tech firms.

Research ranking

Scientific research and development plays a key role in driving commercial innovation. China's universities, research institutes and high-tech enterprises are developing relationships that are designed to have national and global influence. Boosting standards of basic research is occurring alongside emerging frontier research.

1 Beijing

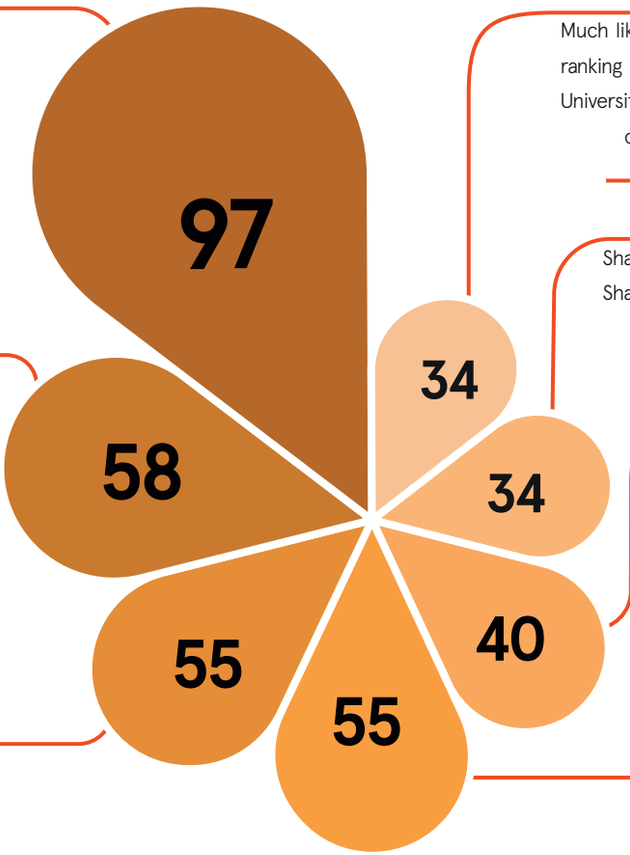
Beijing is by far the leading city for AI research in the country, because it is home to 5 research Universities with notable AI research outputs, most importantly Tsinghua University which is ranked 2nd overall.

2 Xi'an

Xi'an's performance in the research ranking is due to the cumulative result of three Universities with notable AI research. For example, Xidian University is responsible for the highest number of all AI-related patents in our sample of Universities.

3 Harbin

According to our data, Harbin is home to the leading AI research institution in China, the Harbin Institute of Technology. Harbin's research ranking is solely based on the performance of this top institution.



Hangzhou 6

Much like its direct neighbour Shanghai, Hangzhou's equal 5th ranking is also the result of a single top University, Zhejiang University which is ranked 4th overall and 1st for AI research capacity, the number of academics active in the AI space.

Shanghai 6

Shanghai's performance in this ranking is the sole result of Shanghai Jiao Tong Universities' 3rd rank of all Universities with notable AI research.

Wuhan 5

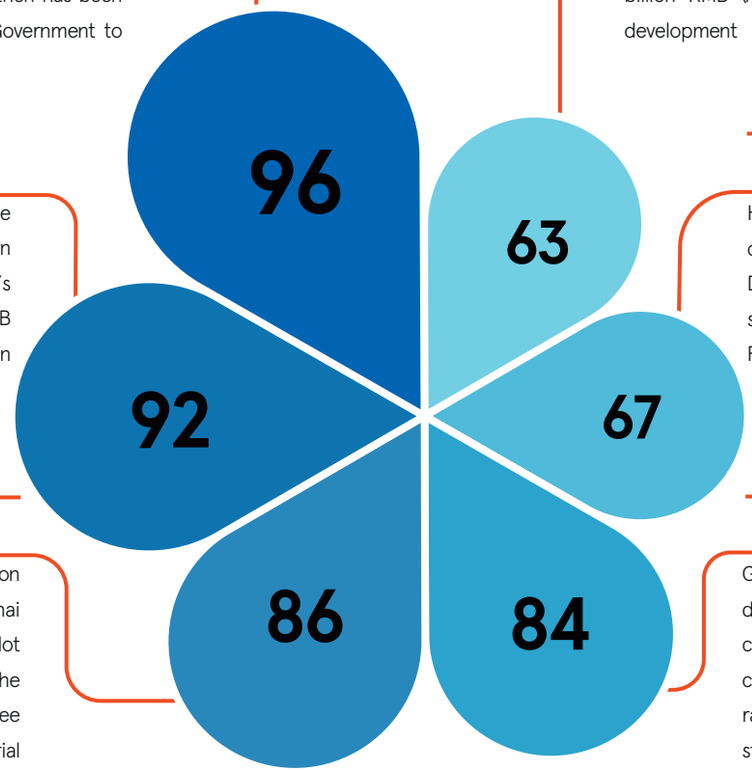
Wuhan has two strong Universities, Wuhan University and Huazhong University of Science and Technology, with the latter ranked 6th of all Universities with notable AI research. The Wuhan East Lake High-tech Development Zone is home to 42 universities, 22 state key laboratories, 24 national engineering technology centres, and 56 national scientific research institutes.

Nanjing 3

Nanjing comes equal third in our research ranking, in particular due to the ranking of Southeast University which is ranked 5th overall and 2nd for the number of most-cited AI papers.

Infrastructure ranking

Key cities in China are boosting AI infrastructure to create an enabling context for further industry innovation. Cities are designating areas as `smart towns' to conduct experiments in connected technologies. Infrastructure is designed to enhance coordination between cities and provinces and to strengthen technology ecosystems.



1 Shenzhen

Shenzhen is leading on infrastructure due to the focus on building the city as the centre of economic and business in the Greater Bay Area. Shenzhen has been granted special status by the Central Government to carry out bold reforms.

2 Beijing

Beijing is ranked second due to the key role played by tech-hub Zhongguancun, known as China's Silicon Valley. Beijing's government announced a 14 billion RMB (AU$3 billion) AI industrial park in Mentougou district in January 2018.

3 Shanghai

Shanghai ranks highly due to its focus on industrial clusters. The Shanghai government is building China's first pilot zone for testing the applications of AI. The pilot zone in the Pudong New Area has three main tasks, to establish an AI core industrial cluster, to promote AI applications and to build a supporting system for AI innovation.

Guangzhou 4

Guangzhou's infrastructure development is designed to capitalise on its status as a gateway city. It is a key node in efforts to build up the capacities of the Greater Bay Area. Guangzhou ranks 1st for the per-capita number of 5G base stations to be rolled out by the year 2020, and is well-known for its smart transportation infrastructure which monitors passenger flows in the city using a large network of sensor points.

Hangzhou 5

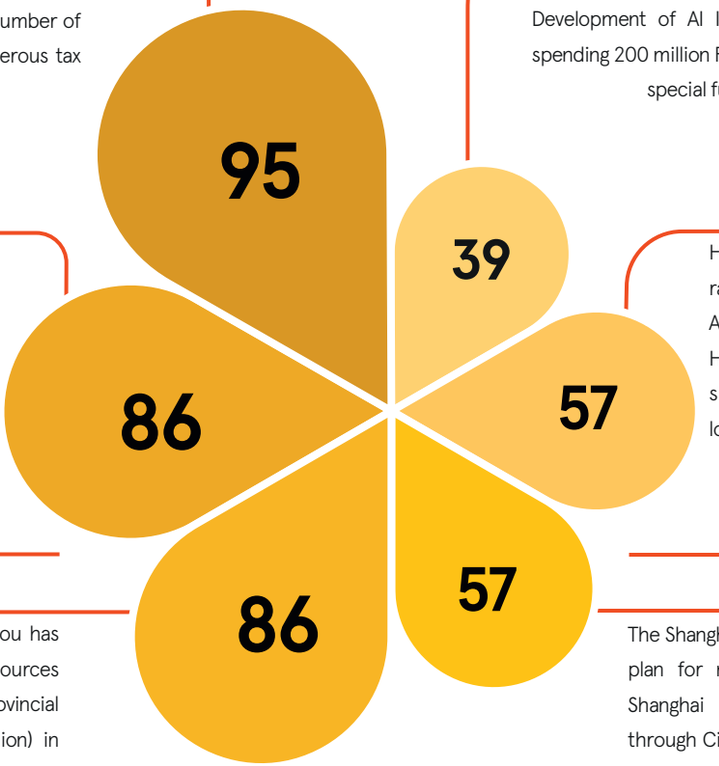
Hangzhou is advancing by focusing on industrial clusters. The Hangzhou High-Tech Industrial Development Zone (HHTZ) hosts more than 1,100 software developers. Hangzhou is home to the Future Sci-Tech City initiative, supported by Zhejiang University and Alibaba Group.

Wuhan 6

Wuhan is building its infrastructure capabilities by aiming to install 3000 5G base stations by 2020. Wuhan, will invest 40 billion RMB (AU$8 billion) to provide key support to the development of high-tech infrastructure by 2022, local authorities said.

Government ranking

City governments aim to foster environments where policy creates ambitious targets for AI to become central to economic and technological development. China's city governments are harnessing the capacities of tech firms to create platforms for the provision of government services. Various AI initiatives aim to increase cooperation between high-tech firms and government.



1 Nanjing

Nanjing ranks first due to its endeavours to become a hub of innovation, opening up the Yangtze River economic belt. Nanjing has developed high-tech parks and built a number of public service platforms for AI. Nanjing offers numerous tax breaks and incentives for R&D and start-ups.

2 Shenzhen

Shenzhen is ranked equal second due to the advance of its government information and resources sharing platform, which involves 49 municipal institutions. Government programs include the 500 million RMB (AU$100 million) annual budget to develop robotics, wearable devices and smart manufacturing services.

2 Guangzhou

Much like its neighbouring city Shenzhen, Guangzhou has launched an e-government cloud incorporating resources across 22 public agencies. The Guangdong provincial government offered 943 billion RMB (AU$194 billion) in subsidies between 2015-2018 to help local manufacturers automate. Guangzhou citizens have the first electronic social security card, delivered by app, with facial recognition capabilities.

Wuhan 6

Wuhan's is creating a supportive AI policy environment. The government released its policy plan for "Promoting Development of AI Industry" in November 2017. Wuhan is spending 200 million RMB (AU$41 million) per year to establish a special fund for talent recruitment and innovation.

Hangzhou 4

Hangzhou is ranked equal third due to a range of initiatives including Alibaba/Foxconn "City Brain" project. The Hangzhou AI Town was inaugurated to showcase tech innovations. Hangzhou has loosened regulations on its hukou system to encourage AI talents to remain in the city.

Shanghai 4

The Shanghai government issued its implementation plan for new generation AI in November 2017. Shanghai has streamlined government services through Citizen Cloud, a cloud-based platform that doubles as a mobile app. The Citizen Cloud provides access to over 100 government services and includes drivers' license information, healthcare records and a wide range of community services.

花旗集团
未来资产

The cities

Photo by Federico Rizzarelli on Unsplash

Intelligent City clusters

The cities in our Intelligent Cities Index China, can be distinguished into six clusters. These clusters have distinct profiles and correspond to the major economic regions of China and reflect the historical development of the country (see opposite page). Reflecting the economic profile of the country, three of the six clusters and the Top 6 cities are located in the East Coast region.

The Intelligent Capital: Beijing is clearly the leading intelligent city in China. It dominates in both the enterprise and research rankings. With the most vibrant AI start-up scene and five Universities with strong AI research groups, Beijing is the worthy intelligent capital.

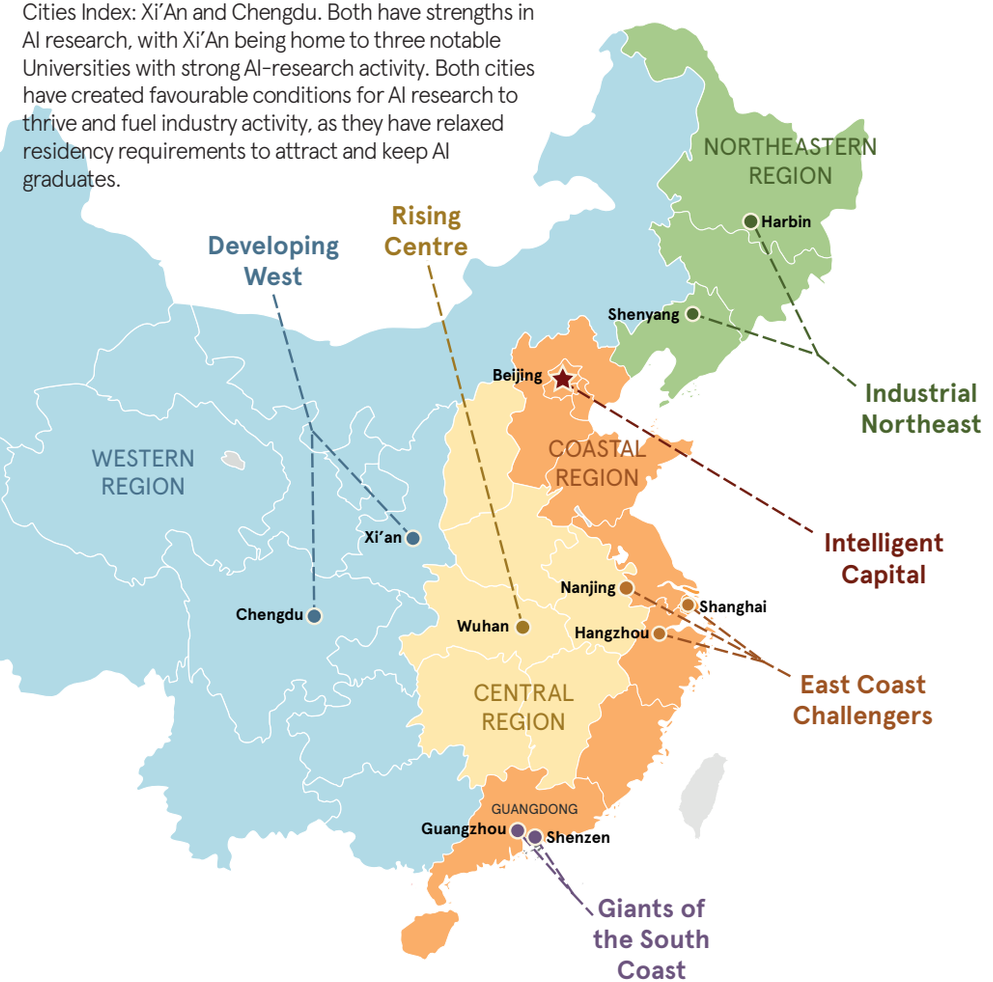
The East Coast Challengers: The three coastal cities of Shanghai, Nanjing and Hangzhou build a strong intelligent cities cluster with strengths in all aspects of the Index. Shanghai and Hangzhou feature in the Top 6 of all four individual rankings. While Nanjing has particular strengths in the research sector, Shanghai is strong in the AI enterprise space with a growing AI start-up sector.

The Giants of the South Coast: The two Guangdong province cities, Shenzhen, Guangzhou, are located in the 'Greater Bay Area' of the Chinese South-East. They are known as hotbeds of innovation and growth. Not surprisingly they have strong AI enterprise sectors, as well as government engagement and enabling infrastructure. They are lacking significant research capacity however.

The Rising Centre: The city of Wuhan is emblematic of the aspirations of China's central regions. It made the Top 6 in three of the four rankings, with particular strengths in AI research and infrastructure. While Wuhan is working to attract more AI startups it has been successful in convincing leading AI enterprises to locate their second headquarters in the city.

The Industrial Northeast: The two Northeastern Chinese cities of Harbin and Shenyang are known as centres of traditional industrial activity. Both cities have built considerable strengths in AI research. While Harbin is home to the leading University-based AI research department, Shenyang has invested heavily into its innovation sector.

The Developing West: Two cities from the Western regions of China have made the Top 10 of the Intelligent Cities Index: Xi'An and Chengdu. Both have strengths in AI research, with Xi'An being home to three notable Universities with strong AI-research activity. Both cities have created favourable conditions for AI research to thrive and fuel industry activity, as they have relaxed residency requirements to attract and keep AI graduates.



China's economic regions

In the wake of the "Culture Revolution", [27] China embraced a new economic reform doctrine of "socialist modernization and development", which has its starting point in 1978. Then leader Deng Xiaoping proposed to allow certain regions, enterprises and workers to make more advanced economic achievements and become "well off" ahead of others. [28] This led to the development of the "Eastern China Economic Zone", with the transformation of four east coastal cities into "special economic zones" (SEZs), to become as export centres specialised in different economic sectors.[29] Having accomplished remarkable progress, economic differences between the East and the rest of China became apparent, leading to further division of economic zones throughout the rest of China.[30] Today, there are four major economic regions.

Coastal Region: Today, China's coastal region along the East and part of the South Coast is home to its high-tech, innovation and major export sectors. This region includes the capital Beijing, as well as the East-Coast hub of cities around Shanghai and the 'Greater Bay Area' of the South with the port city of Shenzhen. China's Top 4 provinces by Growth Domestic Product (GDP), Guangdong, Jiangsu, Shandong, and Zhejiang, are all located in this economic region.

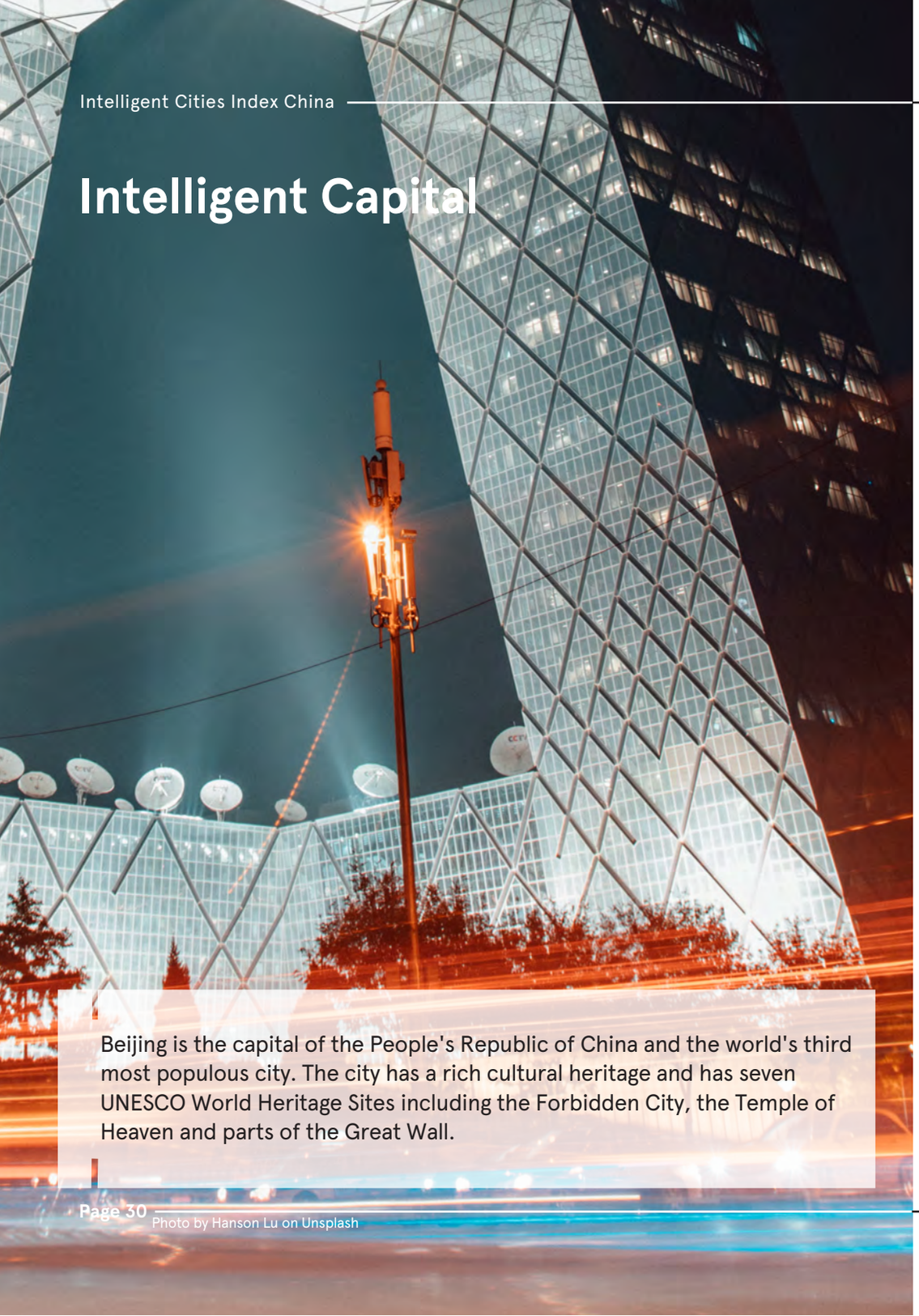
Western Region: Between 1999 and 2001, China's government launched the "China Western Development", which included six provinces that together make up to 71.4% of the Chinese territory, yet with only 28.8% of the nation's population. The aim was to shrink the disparity in development between east and west. To implement the plan, the government loosened certain migration policies and encouraged labour with required skills to migrate west. It also built the famous Qinghai-Tibet Railway to connect the West to the rest of the country. [31]

Northeastern Region: In 2003, the government adopted the "Northeast Revitalization Plan", covering three major provinces in northeast China and the east of Inner Mongolia. This region has historically been China's heavy industry centre, and the aim was to reboot the productivity established equipment manufacturing sectors and to develop new high-tech industries.[32]

Central Region: Finally, in 2004, Prime Minister Wen Jiabao introduced the "Rise of Central China Plan", which included six provinces in central China, to achieve substantially enhanced economic productivity and sustainability by the year 2015. The plan focused on four areas, agricultural industrialization, coal industry and electricity production, research and development, and the communication and transportation system.[33]

Photo by James Wheeler on Unsplash

Intelligent Capital



Beijing is the capital of the People's Republic of China and the world's third most populous city. The city has a rich cultural heritage and has seven UNESCO World Heritage Sites including the Forbidden City, the Temple of Heaven and parts of the Great Wall.

Photo by Hanson Lu on Unsplash

Beijing

AI profile

Beijing's Zhongguancun area (also known as China's Silicon Valley) is close to two of China's most prestigious Universities, Peking and Tsinghua, as well as the Chinese Academy of Sciences. The city has 91 Universities in total and is expanding opportunities in cooperation with international universities and high-tech firms. Beijing has a favourable climate for early stage funding. In 2018 the government announced a AU$2.1 billion development site dedicated to AI on its western outskirts.

Major industries

Services, high-tech, manufacturing, construction, agriculture, mining

Startups and tech firms

Baidu specialises in internet-related services and AI. Baidu has the second largest search engine in the world. In 2017 it acquired three AI startups: RavenTech, which focuses on the operating systems; Xperception, a vision perception company and KITT.AI, a natural language processing and conversational interface company.

ByteDance operates several machine learning-enabled content platforms including Toutiao and TikTok. It is one of the world's most valuable unicorns with over 800 million daily active users.

Cambricon builds processor computer chips for cloud servers. It introduced the first commercial deep learning processor for smart phones and wearable devices in 2016.

Didi provides app-based transportation services, including taxi hailing, private car hailing, ride-sharing and on-demand delivery services. Didi has three AI research centres.

Mobvoi sells and develops consumer electronics and voice recognition technologies. Products include TicMirror, an AI enabled mirror for automobiles and TicWatch, a smartwatch. Founder, Zhifei Li, founder and Mike Lei, CTO were formerly in charge of the Google Translate and Google Voice Search teams.

MEGVII (Face ++) is the highest ranked Chinese AI company by Crunchbase. Face++ can c onfirm a person's identity with a high degree of accuracy. It's the most extensive facial recognition platform in the world, used by over 300,000 developers in 150 countries.

Photo by Zhang Kaiyv on Unsplash

East Coast Challenger

Shanghai is by most counts the largest city in the world with the world's busiest container port. Shanghai is the commercial and financial centre of China. Since the economic reforms introduced by Deng Xiaoping there has been intense re-development of the city.

Photo by Denys Nevozhai on Unsplash

Shanghai

AI profile

Global tech giants have opened R&D branches in Shanghai's Zhangjiang Hi-Tech Park. Shanghai plans to set up investment funds worth more than 100 billion RMB (AU$20 billion) over the 2018-19 period to encourage the development of businesses related to AI technologies. Shanghai lacks big companies like Baidu-Alibaba-Tencent (BAT). The Shanghai government issued an AI implementation plan in November 2017.

Startups and tech firms

DianneiDNA is a medicine company that has developed an AI-powered diagnostic software platform to intelligently screen for lung cancer.

Lufax is an online Internet finance marketplace. The company started with peer-to-peer lending and is now the second largest P2P lender in China. It has AI-driven wealth management products.

Yitu is a computer vision company that develops cloud-based technology to detect faces and cars. The company's tech is now used in over 300 cities in China. It has also developed AI-based cancer screening products.

Major industries

Manufacturing industries, commerce, agriculture, tourism, storage and transportation, shipbuilding

Nanjing

AI profile

Nanjing has a number of high-quality universities and research institutes including Nanjing University and Southeast University. Nanjing University announced the establishment of an AI School in 2018. Many leading firms such as Huawei, ZTE and Lenovo have key R&D institutes in the city. The city is developing a 216 square kilometre research zone housing dozens of high-profile companies as well as a multitude of startups.

Startups and tech firms

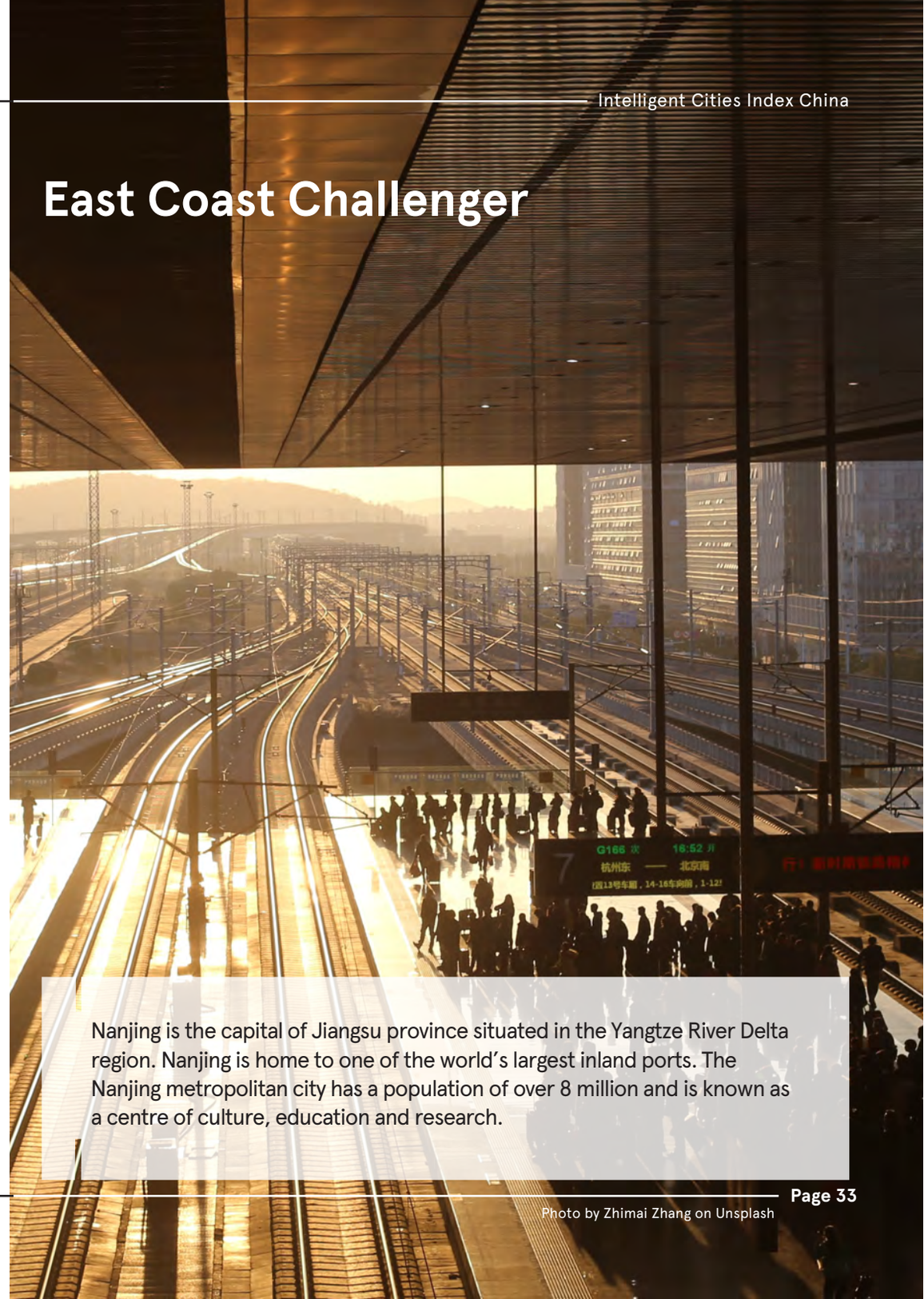
BYTON operates as an electric vehicle company that designs cars as a fully connected smart device on wheels. Its model M-Byte automobile is powered by Byton's own AI system.

QingSo develops AI, computer vision and big data analysis. IT focuses on crime detection, public security and anti-terrorism by using facial recognition.

Major industries

Information technology, energy saving and environmental protection, new energy, smart power grids, intelligent equipment manufacturing

East Coast Challenger



Nanjing is the capital of Jiangsu province situated in the Yangtze River Delta region. Nanjing is home to one of the world's largest inland ports. The Nanjing metropolitan city has a population of over 8 million and is known as a centre of culture, education and research.

Photo by Zhimai Zhang on Unsplash

East Coast Challenger

Hangzhou is the capital and most populous city of Zhejiang Province and an important part of China's Yangtze River Delta, China's largest economic zone. Hangzhou is an industrial city with developed light industry, agriculture, and textiles. It is an important manufacturing base and logistics hub for coastal China. Hangzhou has seen substantial development in its financial sector in recent years.

Photo by Jade Masri on Unsplash

Hangzhou

AI profile

Hangzhou is home to some of China's largest tech companies and challenges Beijing for the label of China's Silicon Valley. Hangzhou is a major fintech hub. The China Banknote Printing and Minting Corporation, which is China's official mint, has chosen Hangzhou as the location for its research academy to track the latest developments in blockchain and digital currency technologies and applications. The city has become a leader in mobile payments and is largely cashless.

Startups and tech firms

Alibaba holds the title of world's largest retailer and e-commerce company. It conducts extensive research on AI in its Damo academy and deploys AI across its product lines including Alibaba Cloud.

Ant Financial Services Group formerly known as Alipay, is the highest valued fintech company in the world. AI powers its personal finance applications and asset management products.

Rokid is a technology company specialising in robotics research and AI development. Rokid's AI robots have won innovation prizes at the CES Tech Show in 2016 and 2017.

Major industries

Manufacturing industries, commerce, agriculture, tourism, storage and transportation, shipbuilding

Wuhan

AI profile

In 2011 the Donghu New Technology Development Zone in Wuhan was designated as a specialist district for optical technology. The zone is known informally as the "Optics Valley" of China. In July 2018 Megvii Technology (Face ++) officially put its AI engineering institute into operation in the district. The city is aiming to create an AI industrial cluster of global influence. The city is the location of the second HQ of internet companies including Xiaomi, Qihoo 360 and Xiaohongshu (Little Red Book). Wuhan's latest five-year plan sets the target of keeping 1 million college graduates by relaxing its *hukou* system.

Startups and tech firms

JIMU Intelligent, founded in 2011, is a AI company dedicated to vision-based driving technology. It provides lane departure warning systems, forward collision warning systems and pedestrian collision warning systems. Its investors include Hyundai Motor Company and TransLink Capital.

Douyu is a live streaming video website. They partner with an AI startup Video ++ to optimise video ad content.

Turing Technology Co., Ltd provides Internet of Things services to cities. Its products include video systems that run on deep learning neural network technology and monitoring sensors. Their partners include Huawei, Aliyun, Ping An, and China Mobile.

Major industries

Optical-electronics, telecommunications, and equipment manufacturing (automotive, steel and iron) and high-tech industries

Rising Centre

Wuhan is the capital and largest city of the Chinese province of Hubei. It is the most populous city in Central China. Wuhan is an important centre for economy, trade, finance, transportation, information technology, and education in China. It is the only megacity within Central China. It also serves as a major transportation hub within China with the first bridge to cross the Yangtze River.

Photo by Tauno Tõhk on Flickr

Giant of the South Coast

Shenzhen is a major city in Guangdong Province, China; it forms part of the Pearl River Delta megalopolis. The city has grown from a village of 30,000 people in the early 1970s to a city of over 10 million. Shenzhen was the first of the Special Economic Zones to be established by Deng Xiaoping. Shenzhen's most important economic sector lies in its role as the headquarters for many of China's high-tech companies. Shenzhen epitomizes the country's emergence from being economically underdeveloped four decades ago into the world's second-largest economy.

Photo by Kin Li on Unsplash

Shenzhen

AI profile

As a high-tech centre Shenzhen is home to some of the most influential tech companies, most notably the online conglomerate Tencent, as well as globally renown drone manufacturer DJI, both of which are leaders in the AI space. For many years the region was associated with imitation - shanzhai – products but is referred to increasingly as China's Silicon Valley.

Startups and tech firms

Huawei, the world's largest telecom equipment maker, is headquartered in Shenzhen. The company launched a powerful AI processor in 2019 and invests heavily in AI research.

Tencent Holdings Limited is a Chinese multinational investment holding conglomerate. The company's dedication has as one of its slogans, "Make AI everywhere," and focuses on research and applications of AI, particularly in cloud services.

DJI is the world's leader in commercial and civilian drone industry, accounting for over 70 percent of the drone market. DJI has partnered with Microsoft to increase the AI capabilities of its drones.

Ping An Insurance is the world's largest and most valuable insurer, worth AU$320 billion. Ping An claims its A.I. can read 54 distinct "micro-expressions" to determine whether loan applicants are lying

Major industries

Hi-tech, finance, logistics and cultural industry

Guangzhou

AI profile

Guangzhou is well-known for its smart transportation infrastructure. The city piloted issuing business licenses using blockchain and AI in the Huangpu district in 2019. It has prioritised building 5G base stations. The bureau of education has begun to pilot AI courses in primary and middle schools.

Startups and tech firms

F5 Future Store runs 24-hour smart unmanned convenience stores that uses a combination of machine automation and AI instead of labour. All cooking, brewing drinks, picking, clearing, inventory, cleaning work are done by robots.

WeRide.ai is a automated vehicle company powered by AI and robotics. Renault, Nissan, and Mitsubishi are all investors.

Major industries

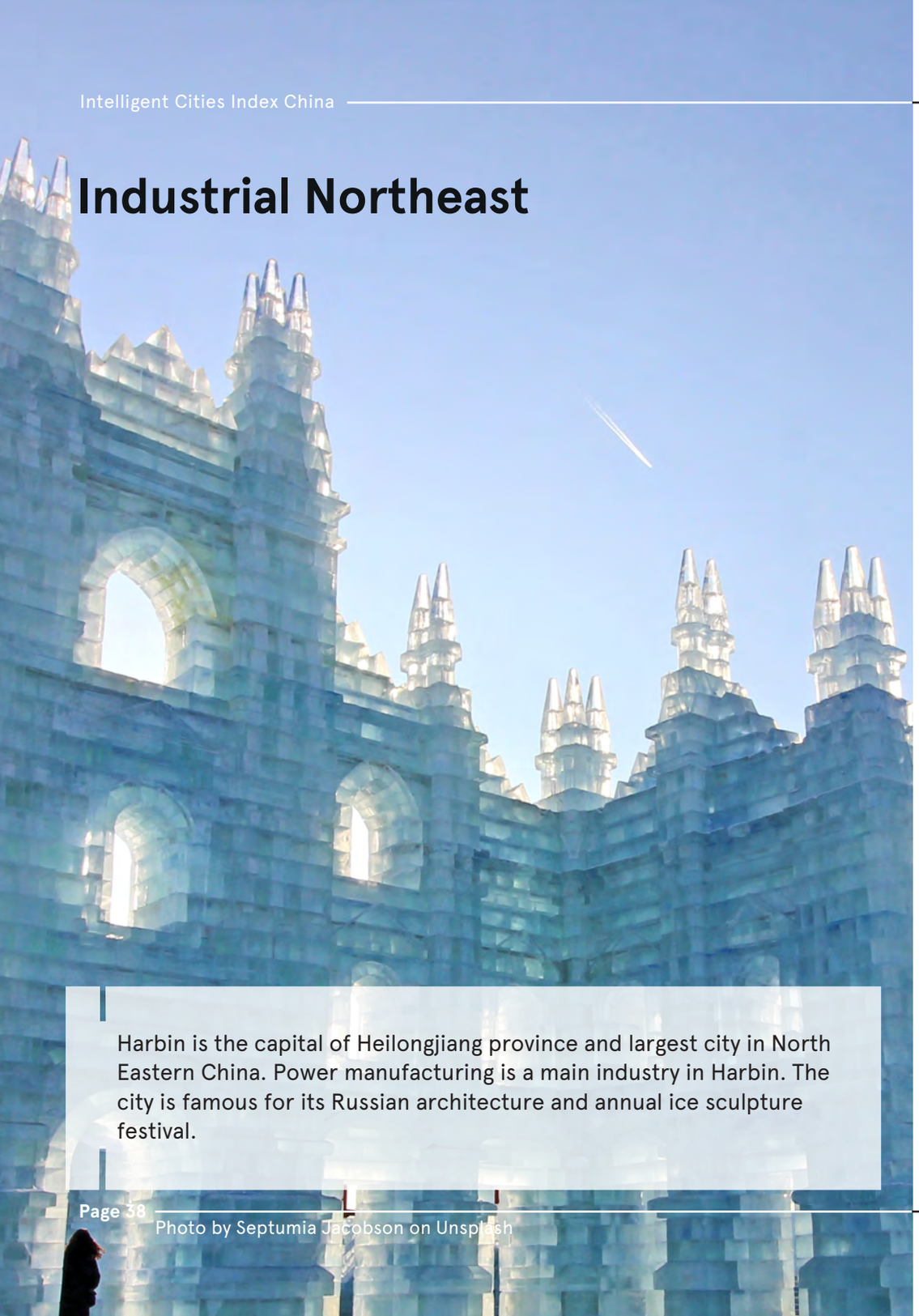
Automobiles, petrochemicals, electronics

Giant of the South Coast

Guangzhou is the capital and most populous city of the province of Guangdong. Guangzhou is the main manufacturing hub of the Pearl River Delta, one of mainland China's leading commercial and manufacturing regions. Guangdong province is China’s largest regional economy.

Photo by Twk Tt on Unsplash

Industrial Northeast



Harbin is the capital of Heilongjiang province and largest city in North Eastern China. Power manufacturing is a main industry in Harbin. The city is famous for its Russian architecture and annual ice sculpture festival.

Photo by Septumia Jacobson on Unsplash

Harbin

AI profile

Harbin is a research specialist in AI. Researchers at Harbin Institute of Technology (HIT) began studying Russia-Chinese machine translation in the 1960s, and shifted to Chinese-English in the 1980s. HIT has the second largest number of AI talents after Zhejiang University. HIT is one of the top nine key universities in China. Harbin is also home to the Key Laboratory of Natural Language Processing and Speech. The Lab has registered multiple patents and authorised Microsoft to use its technology to drive its Pinyin capabilities.

Startups and tech firms

Harbin Xinguang Optic-Electronics Technology Co., Ltd. develops and sells computer vision simulation software, particularly for missile systems.

Major industries

Automobiles, petrochemicals, electronics, engineering

Shenyang

AI profile

The Shenyang Shenfu Science and Technology Innovation Park signed strategic cooperation agreements with 14 companies in 2019 including AliBaba Cloud service. The innovation park will focus on technology and talent in an effort to build a vibrant tech cluster. Huawei established it first AI innovation centre in the Shenfu New Area in 2019. Shenyang is home to Neusoft Group, the biggest software company in China.

Startups and tech firms

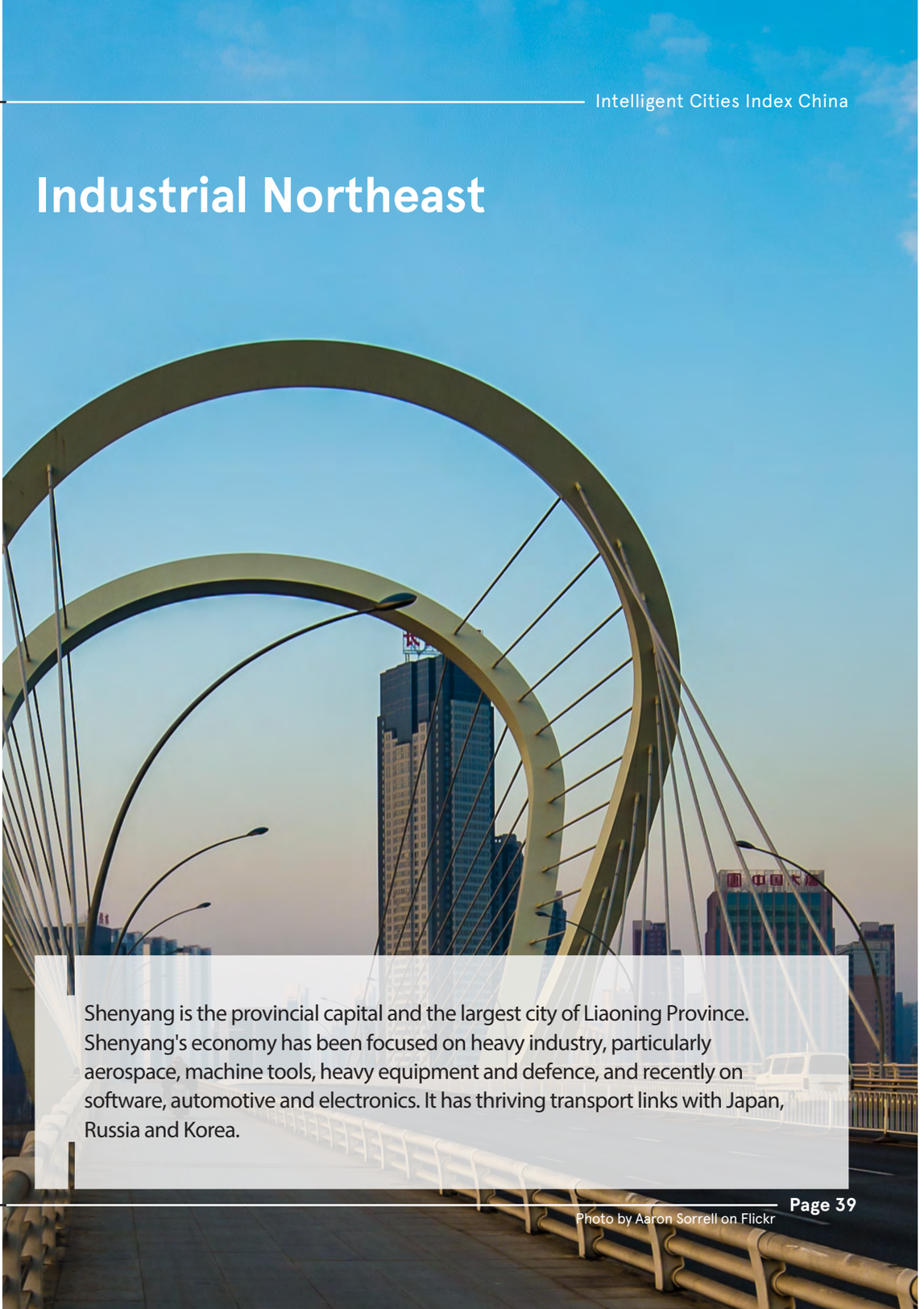
Neusoft is the largest China-based company providing IT services. It develops AI products for enterprise asset management and medical diagnosis.

Siasun is China's largest domestic robot maker by market value. It develops AI applications in industrial robot systems.

Major industries

Auto and auto parts, modern construction, agricultural product processing, chemicals, steel and nonferrous metals

Industrial Northeast



Shenyang is the provincial capital and the largest city of Liaoning Province. Shenyang's economy has been focused on heavy industry, particularly aerospace, machine tools, heavy equipment and defence, and recently on software, automotive and electronics. It has thriving transport links with Japan, Russia and Korea.

Photo by Aaron Sorrell on Flickr

Developing West

Xi’an, the ancient city known for its terracotta warriors, is also one of the first outsourcing cities in China. Xi’an is the capital city of Shaanxi province and an important historical centre of China. Xi’an is on the Eurasia rail link, which runs to Rotterdam in the Netherlands.

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Xi’an

AI profile

Xi'an Hi-Tech Industries Development Zone has more than 16,000 enterprises. Xi’an’s main FDI competitor is Chengdu, capital of Sichuan. In recent years, Xi’an has attracted large investments from ABB Inc (a Swiss-Swedish industrial robot company), Applied Materials, Inc., (a US manufacture of semi-conductor chips) and Micron Technology, Inc (a US producer of computer memory and data storage). Xi’an allows anyone with a university degree to settle there, regardless of age.

Startups and tech firms

Chishine 3D has partnerships with Tsinghua and Fudan, Zhejiang Universities, and Baidu, Lenovo, Microsoft Research and Alibaba. It has a number of AI enabled products, particularly in the facial recognition space.

Wingspan uses AI to power its medical imaging and diagnostics platform.

Major industries

Equipment manufacturing, tourism, and service outsourcing, aerospace, solar photovoltaics

Chengdu

AI profile

Chengdu has loosened policy around residency requirements, hoping to increase the number of university graduates staying in the city. In 2018 SenseTime, a Shenzhen-headquartered unicorn company specializing in the R&D of AI technologies, opened a Chengdu office on the unicorn island, Tianfu New Area. The city is offering AI startups subsidies of up to 3 million RMB (AU$600,000).

Startups and tech firms

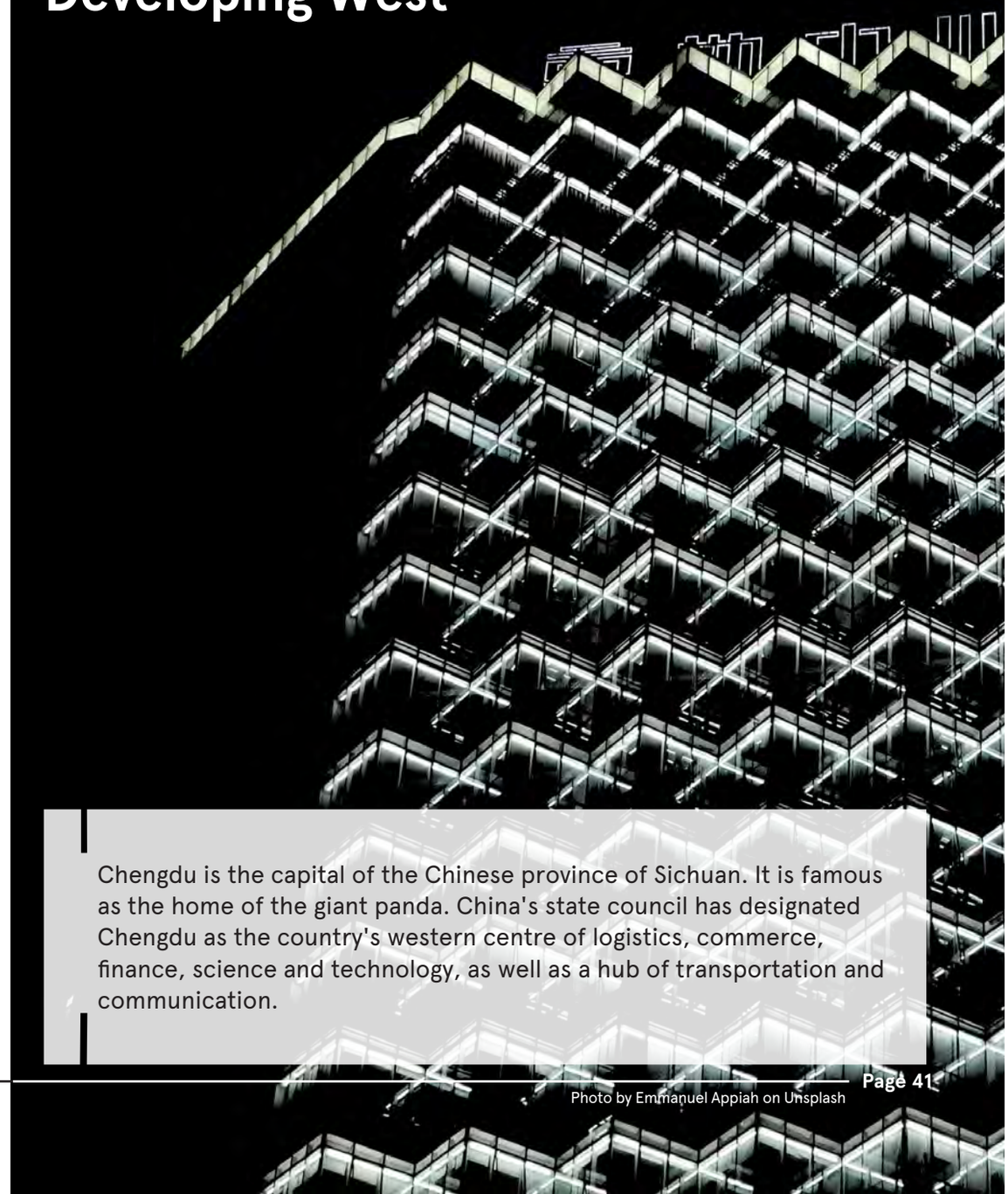
Big Quant is an AI-Driven Investment platform that applies AI to quantitative investment.

Chipintelli Technology Co., Ltd. is a company which focus on the AI computer chip and provides related integrated circuit design.

Major industries

Electronic information, food processing (including tobacco), machinery, petrochemicals, metallurgy, automobiles, building materials and light industry

Developing West



Chengdu is the capital of the Chinese province of Sichuan. It is famous as the home of the giant panda. China's state council has designated Chengdu as the country's western centre of logistics, commerce, finance, science and technology, as well as a hub of transportation and communication.

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Glossary

5G Fifth-generation mobile cellular networks which power the data capability of mobile devices. 5G capability is associated with vastly improved mobile Internet speeds, potentially enabling game-changing new applications.

Algorithm Refers to the series of unambiguous instructions that enables a computer to perform a specified task or class of problems. The term is today also applied to machine learning techniques, where its meaning is altered (see below).

Artificial Intelligence A capability described to machines, in particular computer systems, that perform tasks commonly associated with human intelligence, also: the sub field of computer science concerned with developing the kinds of algorithm that let computers perform such tasks.

Deep Learning A form of machine learning that has become the dominant technology to underpin Artificial Intelligence; commonly used for pattern matching tasks such as in speech, image or face recognition.

Intelligent City For the purpose of this report we define an intelligent city as one with significant activity in the field of Artificial Intelligence, in particular research, innovation and business activity.

Machine Learning The capability of a computer system to perform a specific task without pre-programmed instructions, by way of inference of patterns from large data sets (so-called training data). Machine learning does not provide the same deterministic reliable as traditional algorithms.

Megatrends Large-scale transformative processes with global reach, broad scope and fundamental impact on many aspects of society.

Smart city A city with significant IT infrastructure deployed in public spaces with the deliberate aim to collect data (e.g. via sensors) and deliver digital services (e.g. in transportation services).

Start-up company A newly founded business entity, typically engaged in innovative entrepreneurship, often underpinned by modern technology.

Urbanisation Megatrend which refers to the migration of populations from rural areas to cities. With this shift in residential patterns comes a shift in focus of government attention and business activity.

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