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Artificial Intelligence:
the Chinese approach in fighting
the COVID-19 pandemic

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前言

《我们必须始终保持高度警惕，既要高度警惕"黑天鹅"事件，也要防范"灰犀牛"事件》。这些就是中国共产党中央委员会和中华人民共和国主席习近平在 2019 年 1 月在中央党校举行的讲话中的一部分。习近平主席发表这个讲话的时候，他无法想象不到一年之后，一只大黑天鹅会攻击整个世界。

事实上，从 2019 年 12 月底开始，全世界不得不面对，并且很多地方要继续面对一个很大的敌人：2019 冠状病毒。新冠肺炎导致了习近平主席在 2019 年初提到的"黑天鹅事件"。如果管理不善，这个意料之外的事件，有可能会导致巨大的健康、经济和政治情况恶化的后果。

2020 年 3 月 11 日，世界卫生组织定义当前的健康危机一个全球范围的流行传染病。2019 冠状病毒除了迅速改变了人们的生活方式，它也改变了社会关系、经济活动，尤其是世界各地的健康状况。新冠肺炎被认为是本世纪人类面临的最大挑战。这是因为病毒的传播速度和方式，也是因为大量感染者导致医院、缺少必要的工具比如呼吸器和口罩、最初很多困难因为关于该病毒的已知知识几乎一无所获，更不用说该病毒对整个世界产生了巨大的经济影响。世界各地的卫生当局和政府已动员实施法规、法令和战略以遏制该流行病。但是，所有国家的行为方式各不相同。这是由于文化因素，也是由于国家拥有的不同资源所致。中国是第一个要应对冠状病毒的国家，因为据认为首例病毒病例是在 2019 年 12 月底发生在湖北省武汉市。习近平主席本人称 2019 冠状病毒为恶魔。中国采取了史无前例的措施，其速度是该国特有的，对民主制度而言是不可想象的。中国是人类历史上第一个进行最大检疫的国家。除了提高实验室能力，创纪录的时间内建立医院以面对过度拥挤的状况，关闭基本大学、学校和业务，中国还使用了一种伟大的工具来阻止这种流行病：技术。

本论文主要研究人工智能在中国抗 2019 冠状病毒大流行的应用。如今，人工智能、大数据、电子眼、人脸识别和机器人技术已成为中国人日常生活的一部分，并且在 2019 冠状病毒卫生危机的时候，这些技术得到了最大程度的利用。特别

是，本论文重点研究基于人工智能的工具，这些工具已用于接触者追踪、人脸识别、体温检测仪和诊断。

我决定深入研究这个主题，是为了对主题有一个更深入的了解，并且我想了解怎么一个拥有十多亿人口的这么大国家在短时间内成功地战胜了该病毒不同于其他国家，我还想了解为什么北京的方法不能在其他国家使用，因为它可能行不通。

这篇论文分为四个主要章节。

第一篇章节为读者提供了简要的历史介绍，为了了解人工智能从诞生到今天的发展。此外，在这篇章节中还提到了人工智能领域的四大浪潮，它们就是：第一个是互联网人工智能，第二个是商业人工智能，第三个是感知人工智能，第四个是自动化、自主化人工智能。然后，本章节重点讨论了大数据的重要性，大数据被认为是人工智能的燃料。

第二篇章完全专注于中国。它描述了中国人工智能的发展，并且这篇章涉及到与人工智能有关的最新项目和政策，比如《新一代人工智能发展规划》、《中国制造 2025》、《机器人产业发展计划》等等。本章也显示了习近平主席的野心是：将中国转变成科技超级大国。

第三篇章节是本研究的核心。首先，它将把 2019 冠状病毒时间线分为五个阶段，这是中国国务院新闻办公室在白皮书《抗击新冠肺炎疫情的中国行动》中划分的五个阶段：迅即应对突发疫情、初步遏制疫情蔓延势头、本土新增病例数逐步下降至个位数、取得武汉保卫战和湖北保卫战决定性成果、全国疫情防控进入常态化。然后，它将描述中国对战胜新病毒的反应，特别注意亮点大数据和人工智能时代的首次卫生紧急的特点。本章主要重点介绍人工智能和大数据在接触者追踪、体温检测仪和诊断的使用。关于接触者追踪，健康码系统是使用大数据和数字技术实施新冠肺炎流行病控制、限制人们的来往并改善公共卫生管理最好的例子。根据二维码的颜色，人们可以知道他们是否可以离开房子，是否可以进入任何公共场所、交通工具等等。得益于对人们的准确监测，在中国发现一个病灶以后，疫情迅速被得到控制。此外，商汤科技、旷视科技和百度等公司开发了许多不同的工具来在公共场所实施社会监控和提问检查。习近平主席振臂一呼以后，许多中国科技巨头率先对抗大流行，特别是在使用人工智能开发诊断工具方面。

第四篇章是最后的一章将重点讨论人工智能和大数据对安全性和个人隐私的影响。此外，特别是通过头条的一项调查，它将说明中国人对人工智能的看法，同时强调人们的忧虑，还强调人们积极的看法。

我经过分析了这些题材之后，从人工智能的历史以及中国政府目前对人工智能的重视开始，再分析它如何成为面对冠状病毒一种很有力的武器以后，我将会试着回应这个问题：自由还是安全？

INTRODUCTION

"We must keep our highest alert about 'black swans' [i.e., the unexpected] incidents and take steps to prevent 'gray rhinos' [i.e., known risks that are ignored] incidents", these were the words of the President and General Secretary of the Chinese Communist Party Xi Jinping in his major speech at the Central Party School in January 2019. When President Xi delivered this speech, he could not have imagined that a great black swan would precipitate on the whole world a little less than a year later.

Indeed, from the end of 2019, the entire world has had to face, and for the most part it is still dealing with, a powerful enemy: coronavirus disease 2019 (COVID-19). The coronavirus turned out to be the "black swan incident", that President Xi Jinping mentioned in early 2019. It is the unexpected event which, if badly managed, is capable of leading to terrific health, economic, and political consequences.

The current health crisis, defined by the World Health Organization as a global pandemic on March 11th, 2020, has rapidly changed people's lifestyles, social relationships, economic activities, and especially health conditions all around the world. COVID-19 is considered the greatest challenge that humankind has been called to face in this century. This is due to the speed and mode of transmission of the virus, the very high number of infected people that have led to the collapse of hospitals, the lack of necessary tools such as ventilators and masks, the initial difficulties related to the fact that what was known about the virus was practically nothing, not to mention the economic rebound that the health emergency has had all over the world. Health authorities and governments around the world have mobilized in the implementation of regulations, decrees and strategies in order to contain the epidemic. Not all countries have acted in the same way, this is due both to cultural factors and to the different resources that each state own. China was the first country that had to deal with the coronavirus, that President Xi Jinping himself called a "demon", as the first case is thought to have occurred in the city of Wuhan in Hubei Province at the end of December 2019. China took unprecedented measures, with a speed typical of that country and unthinkable for democratic systems, and it was the first country to carry out the largest quarantine in the history of humankind. In addition to improving laboratory capabilities, building hospitals in record time to cope with the overcrowding

of them, closing all businesses except for those of basic necessities, universities and schools, China has also used a great tool to stop the epidemic: technology.

The present work focuses on the application of artificial intelligence (AI) in the fight against COVID-19 pandemic in China. Nowadays, artificial intelligence, big data, video surveillance, facial recognitions, and robotics have been part of Chinese daily life for several years, and during the coronavirus disease 2019 health emergency these technologies were exploited to the fullest. In particular, the focus is on artificial intelligence-based tools used for contact tracing, facial recognition, body temperature scan, and diagnosis.

The reason why I decided to examine in depth this issue is to understand how a country with a billion and a half inhabitants and with a vast territory such as China has managed to defeat the virus in such a short period of time unlike other countries around the world, and moreover to understand why Beijing's approach can not be used in other countries as it probably would not work.

The present dissertation is divided into four main chapters, and the study was conducted according to literature review.

The first chapter provides the reader with a brief historical introduction to understand the evolution of artificial intelligence from its birth to the present days, moreover the four waves of artificial intelligence are mentioned, that are: the internet AI, business AI, perception AI and autonomous AI. Then, the chapter focuses on the importance of big data, that are considered the fuel of artificial intelligence.

The second chapter is entirely dedicated to China, moving to the development of artificial intelligence in the country, and providing a list of the most recent projects and policies concerning AI, such as the New Generation Artificial Intelligence Development Plan, Made in China 2025, Robotics Industry Development Plan, and so on. This chapter shows what President Xi Jinping's ambitions are: to transform China into a superpower in science and technology.

The third chapter gets to the heart of this research. Firstly, it provides a COVID-19 timeline, divided into five stages that the State Council Information Office of the People's Republic of China itself has divided in the white paper *Fighting COVID-19: China in Action*. Secondly, it describes the Chinese response to defeat the new virus, with particular attention to highlighting the characteristics of a health emergency in the era of

big data and artificial intelligence. The chapter focuses, above all, on the use of artificial intelligence and big data in contact tracing, body temperature screening and diagnosis. Regarding contact tracing, the Health Code system is the main example in the use of big data and digital technology to implement COVID-19 epidemic control, to limit people's movement and to improve public health management. Based on the color of a QR code, people are able to know if they can leave their house, if they can enter any public spaces, means of transport and so on. Thanks to this accurate monitoring of people, when an outbreak is spotted in China, it is quickly shut out. Furthermore, companies such as SenseTime, Megvii and Baidu have developed many different tools to implement social surveillance and body temperature screening in public places, and after President Xi's call to action, many Chinese tech giants have taken the lead in the war against the pandemic, especially in developing diagnosis tools using AI.

The fourth and last chapter will focus on the impact that artificial intelligence and big data have on privacy and security. In particular through a Toutiao's survey, the public perception of Chinese citizens regarding AI is illustrated highlighting both people's fears and positive perceptions of artificial intelligence.

Once inspected these issues, starting from the history and the importance that Chinese government is currently giving to the topic of artificial intelligence, and after analyzing how it has turned out to be a powerful weapon against the coronavirus, I will try to answer the following question: freedom or security?

Chapter 1

Artificial Intelligence: origin and definition

What is artificial intelligence (AI)? There are plenty of definitions of artificial intelligence. According to Kai Fu Lee AI is: "the elucidation of the human learning process, the quantification of the human thinking process, the explication of human behaviour, and the understanding of what makes intelligence possible"[1].

Artificial intelligence is a young discipline, it is a branch of computer science that allows the programming and design of both software and hardware systems, which enables machines to be equipped with some characteristics that are typical of human beings, such as decision-making, visual and space-time perceptions. In other words, it is a set of techniques, sciences and theories that has as purpose the imitation of the cognitive abilities of a human being. An intelligent system is realized by trying to recreate both different forms of intelligence that are defined as simply human, and particular behaviours reproducible by machines[2].

This new discipline is affecting almost all aspects of our life: our home, our work, the way we interact with other people, the way we travel, song or TV show recommendations from Spotify and Netflix, smart assistants, traffic control, medical diagnosis, space exploration, search engines, retailing, finance, translation, surveillance, industries and so on. There are two broad categories of artificial intelligence: narrow AI and Artificial General Intelligence (AGI). The first one is also known as Weak AI and it is a simulation of human intelligence, a few examples of narrow AI include image recognition software, Google search, personal assistants such as Alexa and Siri and self-driving cars. AGI, that it is also known as Strong AI, is a machine with general intelligence that can apply its intelligence to solve any problem[3].

With the impact of AI our life has dramatically changed, and this change has both positive and negative consequences; some negative aspects are that people are scared that

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[1] Kai Fu Lee, *AI Super-powers: China, Silicon Valley and the new world order*. Boston, Houghton Mifflin Harcourt, p. 7, 2018.

[2] *Intelligenza artificiale: cos'è, come funziona e a cosa serve?*, https://www.intelligenzaartificiale.it/

[3] Kerns J., What's the difference between Weak AI and Strong AI? MachineDesign, February 2017. https://www.machinedesign.com/markets/robotics/article/21835139/whats-the-difference-between-weak-and-strong-ai

machines will radically empower and displace human beings, including all the problem related to ethic and privacy, while the positive ones are that AI can enhance our quality of life by improving health care, making jobs safer, facilitating access to information, education and training, improving the sustainability of products, and so on.

1.1 History of Artificial Intelligence

The question "Can machines think?" is the incipit of Alan Turing's article *Computing machinery and intelligence*[4] and states the birth of artificial intelligence, but modern AI is the consequence of all humans attempts, throughout our history, to understand and recreate the human brain. Why in 1950 was Alan Turing interested in those themes? This is due to the fact that around 1940 several discoveries were made: from Alan Turing's computing theory to Claude Shannon's information theory, from the discovery that the internal structure of our brain is composed by a network of neurons, to Norbert Wiener's cybernetic theories. These scientists, firstly, began to wonder if it was possible to build an electronic brain, and then the idea of a thinking machine that can talk, learn and make human actions took origin[5]. Between 1940 and 1973 a period of unstoppable research took place. In 1943, Walter Pitts and McCulloch created the first brain-inspired neural network model, while in 1951 Marvin Minsky and Dean Edmonds developed the first neuro-computer, named SNARC. It was in 1956, when John McCarthy organized a conference at Dartmouth College in New Hampshire, that for the first time artificial intelligence was intended as a scientific discipline[6]. During the conference, Herbert Simon and Allen Newell presented Logic Theorist, that is considered the first artificial intelligence's program. In 1957, they created General Problem Solver (G.P.S.), a programme designed to imitate human problem-solving, capable of playing chess and solving theoretical and geometrical problems. In 1959, Arthur Samuel, a pioneer in the field of artificial intelligence and computer gaming, coined the term machine learning, defined it as the "field of study that gives computers the ability to learn without being

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[4] A. M. Turing; "Computing machinery and intelligence", *Mind*, Volume LIX, Issue 236, October 1950, Pages 433-460, https://doi.org/10.1093/mind/LIX.236.433.
[5] Stecher M.T., La storia dell'intelligenza artificiale, da Turing ad oggi, Cyberlaws, 21 Novembre 2018. https://www.cyberlaws.it/2018/la-storia-dellintelligenza-artificiale-da-turing-ad-oggi/
[6] J. Mccarthy; M.L. Minsky; N. Rochester; C.E: Shannon; "A proposal for the Dartmouth summer research project on artificial intelligence", 1955, *AI Magazine*, vol. XXVII, (4), 2006. aai.org

explicitly programmed"[7]. Between 1964 and 1966, Joseph Weizenbaum developed ELIZA, it was the first time that a human-machine interaction was developed, and it was an important step in the history of artificial intelligence. Between the 70s and 80s, the first moral problem arose, and Weizenbum himself, ELIZA's creator, began to wonder if AI was moral or not. In addition to moral problems, there were also complications related to limited computing power and the difficulty in managing large amounts of data, so successive failures and the inability to meet expected goals pushed the development of AI to a low point. After the success of Carnage Mellon's XCON, an expert system that permits to Digital Equipment Corporation to save forty million dollars a year, governments began to finance and invest again in the fields of artificial intelligence, pushing AI applications to a new peak of development. In 1987, the LISP machine market collapsed and artificial intelligence, once again, fell into disrepute and witnessed the beginning of a new AI winter. Following several failures in the middle of 90s, scholars changed their approach in studying AI, focusing on research on theoretical grounds, proven mathematical results and extensive experimentation.

In recent years, thanks to the development of Internet technology that accelerated innovative AI research, artificial intelligence technology became more practical. In 2000s, AI has been characterized by huge changes and results: in 1996, the world chess champion Gary Kasparov was beaten by the Blue Deep machine; in 2005 and also in 2007, a self-driving vehicle won the DARPA Grand Challenge; in 2008, Google made breakthroughs in speech recognition and introduced the feature in its iPhone app; in 2010, the era of Big Data began; in 2014, Google made first self-driving car to pass a state driving test; in 2016, Google DeepMind's AlphaGo defeated the world champion Go player Lee Sedol 4 to 1. This boom in the discipline of AI is due to the access to massive volumes of data and to the discovery of the very high efficiency of computer graphics card processors to accelerate the calculation of learning algorithms[8].

In the last twenty years, progress has advanced very fast and many unexpected goals have been reached. The reason why AI has been impressively developed in such a short time

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[7] Esposito M., Bheemaiah K., Tse T., What is machine learning?, The conversation.com, May 2017. https://theconversation.com/what-is-machine-learning-76759#:~:text=In%201959%2C%20Arthur%20Samuel%2C%20a,or%20to%20make%20accurate%20predictions.

[8] History of Artificial Intelligence, Council of Europe. https://www.coe.int/en/web/artificial-intelligence/history-of-ai

is due to the combination of scientific and social factors. In fact, algorithms are more complex and sophisticated and the power and computing capacity of computers have increased. The population has triggered a process of improvement of AI, allowing it, through the use of technology, to have access to millions of personal and non-personal data. These data come from the digitalization of documents, from any activity carried out on the internet, searches, purchases, saved pages, content published and likes on platform such as Facebook, Instagram and Twitter. In fact, in a short period of time, technological growth has transformed the user from being a consumer to being a supplier of raw material, in this case a supplier of data.

In conclusion, the history of artificial intelligence has been characterized by ups and downs. The idea that a computer can have human intelligence has been abandoned and now the approaches are more realistic.

Nowadays, the more relevant technologies related to AI are: text analytics, robotic process automation, deep learning platform, decision management, biometrics, AI-optimized hardware, machine learning platforms, natural language processing (NLP), speech recognition and virtual agent.

Figure 1: AI Development Timeline
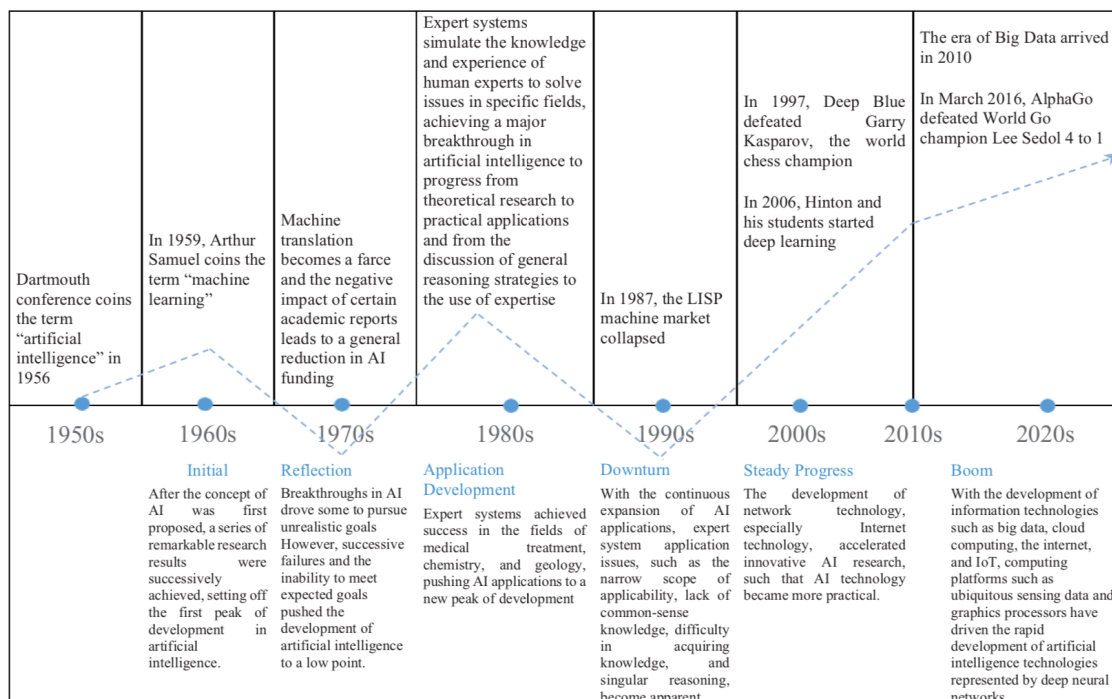
Source: AI Security Standardization White Paper (2019)

1.2 The four waves of artificial intelligence

In order to understand where AI is today and where it is going, Kai Fu Lee's framework on the four waves of artificial intelligence is extremely important[9]. According to Lee, the four waves of AI are: internet AI, business AI, perception AI and autonomous AI. Each of these waves exploit the power of artificial intelligence in a different way: internet AI and business AI are empowering internet companies, diagnosing illnesses, replacing paralegals with algorithms, and so on and today we are already used to them; perception AI is digitizing our world in a way that blends the boundaries between our physical and digital worlds, can recognize our faces, understand our requests and now can also "see" the world around us; autonomous AI is the most complex one, but it will have the deepest impact on our life, it will change our streets and skies with self-driving vehicles and drones and our industries with intelligent robots.

1.2.1 Internet AI

Internet AI began almost fifteen years ago, but it was in 2012 that reached more or less us all. Nowadays, the majority of people have a mobile phone or a personal computer and is used to surf on the internet. The first wave of AI uses AI algorithms as recommendation engines, that are systems that, knowing our preferences and tastes, serve up personalized content for each person. This domain is about companies like Alibaba, Baidu, Google and Facebook, in fact they have access to huge quantity of data and use recommendation algorithms to improve their user experience. These data become useful after being labelled, which means link a piece of data with a specific outcome, for example if you buy a product or not, if you watch a video until the end or not, and so on. How many times has it happened that we look for a product on Amazon, and then we see it advertised on Facebook or Instagram? Or simply watching a video on YouTube and then the platform suggest you a video you are more likely to watch? These labeled data build a perfect picture of our habits, demands, desires and personalities, that are extremely useful

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[9] Kai Fu Lee, *AI Super-powers: China, Silicon Valley and the new world order*. Boston, Houghton Mifflin Harcourt, 2018, pp. 105-139.

for internet companies because in this way they can recommend us content that we are likely to buy and to increase their profit.

One of China's leader in internet AI is Jinri Toutiao (ByteDance); Toutiao's editors are algorithms, they use natural language processing and computer vision to select videos and articles, and then use its users' views, likes, reads and comments to personalize news feed that are tailor-made for users' interests.

The first AI wave generates economic value, especially in the digital world and in the high-tech sector. It is the second wave of artificial intelligence that generates economic value in traditional companies.

1.2.2 Business AI

The second wave of artificial intelligence is business AI. For decades, traditional companies have labelled huge quantities of data, and business AI takes advantages from this. For example, insurance companies, banks and also medical institutions have stored and recorded credit histories, fraud, health status developments and archived diagnosis for years. It was very difficult for traditional companies to take advantage of these labelled data because they did not have all the instruments to exploit them for better results. Through the use of algorithms, business AI can now find all the hidden correlations that are difficult for humans to discover. Actually, while we base our predictions on obvious connections, or on the basis of strong features, AI algorithms base their predictions looking at thousands of other weak features that seem irrelevant to us. In such a way, by combining strong and weak features, algorithms will outperform at several analytical business tasks even the most expert humans.

Already in 2004, companies such as IBM Watson and Palantir offered their customers big-data business consulting, but it was only in 2013, with the use of deep learning, that new competitors arose. These startups helped companies to make smarter trade, uncover inefficiencies in supply chain and improve fraud detection.

The first examples of business AI are focused in the financial sector because it lends itself to data analysis. Smart finance is another Chinese artificial intelligence-powered tool that relies on algorithms; instead of looking at how much money is in the WeChat Wallet only, it also views how battery power is left in the phone, the speed at which we type in our

birthday date and other parameters. This is due to the fact that algorithms, combining strong and weak features, recognize all the hidden correlations inside massive streams of data.

Business AI is extremely important in medical diagnosis too. There are some algorithms that can diagnose specific illnesses based on image, for example pneumonia, in the same way a doctor can do. The use of artificial intelligence in the medical field was extremely important during the COVID-19 pandemic, and it was one of the reasons why China was able to jump out of the health emergency in such a short time. Nowadays, medical knowledge is guarded by a few talented individuals that have not a perfect memory and have not enough time to keep up with the innovations in the medical field. Diagnosis' task is to collect data, so to understand all symptoms and environmental factors, and then to predict the illness related to those data; it is in this field that deep learning stands out. This is what RXThinking, a Chinese startup, is trying to do by training medical AI algorithms. RXThinking's AI diagnosis app purpose is to empower doctors, not to replace them. In fact, doctors can always choose not to heed the app recommendations. This artificial intelligence tool will permit doctors and nurses to better concentrate on the human tasks, in fact a machine will never make patients feel cared, and will never be able to console them if the diagnosis is negative.

Similar principles are now being applied in China's legal system. iFlytek is applying artificial intelligence to Chinese courtrooms, using speech recognition and natural language processing to compare testimony, background material and documents presented, to find contradictory fact patterns. After performing all these actions, it informs the judge that will allow court officer to do further investigation and clarification. After having issued a sentence, the judge can also use another AI tool for suggestion on sentencing. How can the sentencing assistant doing it? It uses algorithms to scan other court records for similar cases. iFlytek's tools just help judges to make correct decision, is a way, as it happens with RXThinking, to empower individuals not to replace them.

All the applications of business AI have immediate impacts, but the algorithms will need more time to be independent from humans.

1.2.3 Perception AI

The third wave of artificial intelligence is perception AI and its purpose is to provide machines with ears and eyes and other senses, resulting in a fusion of the digital and physical world. Nowadays, algorithms can recognize objects and people in the same way as we do, and they can also choose words and analyze the meaning of a sentence. The digitalization of our environment, through the use of sensors and smart devices, is essential for the progress of perception AI.

The boundaries between our online and offline world are slowly disappearing, this is due to the fact that perception AI is getting better in understanding our voices, recognizing our faces and viewing the world around us. This fusion is also called online-merge-offline (OMO), and according to Kai Fu Lee "it brings the convenience of the online world offline and the rich sensory reality of the offline world online"[10]. In the near future, our homes, grocery stores, city streets, and shopping malls will turn into OMO environments thanks to perception AI. For example, it is possible that in a few years in grocery stores, through a scan of our faces, a device will provide us with a shopping list formulated on the basis of our personal data and our habits. Perception AI will provide supermarkets with the same kind of comprehensive understanding of consumer behaviour that was previously only directed at online retailers. Thanks to this, it will be possible to reduce food waste, increase profits and make improvements in the supply chain.

Speech recognition, visual identification and the creation of a profile based on one's personal habits and on one's past behaviour can be used also in education. In fact, it might be possible to personalize the learning process to each student through the use of artificial intelligence, according to the student's necessities, abilities, level of knowledge and way of learning.

In order to create all these OMO experiences, from grocery stores to education, an impressive number of data is required, and not all the people are willing to that. Chinese people are already used to having their faces, habits and voices digitized. Indeed, in almost all Chinese cities there is a huge network of cameras and sensors that are used to enforce traffic laws and to monitor offences committed by citizens. Nowadays, the

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[10] Kai Fu Lee, *AI Super-powers: China, Silicon Valley and the new world order*. Boston, Houghton Mifflin Harcourt,2018, p. 118.

problems related to the protection of privacy and public data are very common, and it is up to every single State to make its own decisions and regulations.

At the heart of the modern debate on artificial intelligence there is a question: freedom or security? It is very difficult to understand how much people are willing to sacrifice their privacy in favor of greater surveillance. What is clear, however, is that perception AI products are transforming our daily environment, making it difficult to identify the boundaries between the digital and the physical world, boundaries that are slowly disappearing. Thanks to its openness with the collection of data in public places, China has an advantage in the implementation of perception AI. Indeed, China is accelerating the digitization of urban environments and it is opening its arms to new OMO applications in the fields of security, transportation and retail. These innovations are creating and will create great economic opportunities and will be the basis for the last wave of artificial intelligence, that it is called autonomous AI.

1.2.4 Autonomous AI

The fourth wave of artificial intelligence is autonomous AI, it is the most complex one and represents the integration among internet, business and perception AI. The purpose of this wave is to create systems that can act one hundred percent autonomously. In order to understand the fourth wave of artificial intelligence, it is important to differentiate between automated and autonomous concepts. Our factories, industries and warehouses are already automated and machines have already replaced many blue-collar jobs. These automated machines can repeat an action several times but can not make decisions and improvise, and they must be controlled by humans. Autonomous means independent, without being controlled directly by humans, so it is completely different from the concept of automated. By providing machines with the power to hear, see, touch and optimize from data, the number of tasks they can handle will enormously increase.

Autonomous AI devices will dramatically change our daily lives, streets, malls, restaurants, farms, factories, and even fire departments. For example, the Californian startup Traptic has developed a farming robot that, by using visual algorithms, can select and pick strawberries checking the fruit ripeness. This machine can both reduce food

waste and increase the quality of the fruit produced[11]. Autonomous robots can create economic value for their owners, and can also do kind of jobs that are hard to find manpower. Another example of autonomous AI devices are drones, that can be used to extinguish fires in a more efficient way than traditional fire crews, to perform search-and-rescue operations after natural diseases, and so on. However, self-driving cars are the most famous autonomous AI devices and the closest to realization. It is said that, in a few years, drones will transform our skies, while self-driving vehicles will transform our roads. Self-driving cars will be safer and more efficient than human drivers, and besides revolutionizing our streets, they will also revolutionize the way we travel. Nowadays, Google and Tesla are competing for the leadership in developing these vehicles, other giants in this field are Baidu, Uber and Didi. Self-driving cars need to learn to identify objects, streets, pedestrians and obstacles, and in order to do such huge amounts of data are required. These data give power to artificial intelligence, without them any inventions and technology that have been mentioned earlier could hardly exist.

1.3 The importance of Big Data

There have been different approaches in describing big data peculiarities, one of them is the 3 Vs (Volume, Velocity, and Variety) concept developed in 2001 by the analyst Douglas Laney, from the information technology research and advisory company Gartner. The Gartner's definition is the following: "Big data is high-volume, high-velocity and high-variety information assets that demand cost effective, innovative forms of information processing that enable enhanced insight, decision making and process automation"[12]. Where Volume refers to the amount of data that are generated by different heterogeneous sources which can not be managed by traditional databases but need to be analyzed and organized; Variety refers to the number of types of data, and Velocity refers to the speed of data processing. More recently, also variability and value have been proposed in addition to the three former Vs.

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[11] Anderson L., Announcing Traptic - Strawberry Picking Robots, Traptic Blog, 2019. https://www.traptic.com/traptic-blog/2019/5/21/announcing-traptic-strawberry-picking-robots
[12] Gartner Information Technology Glossary, https://www.gartner.com/en/information-technology/glossary/big-data.

Big Data can be structured or unstructured. In the first case, data consists in information that are already managed by the organization, while in the second case the information are not organized and are not part of a predetermined format or model, an example is the data that come from social media sources.

How are big data collected? There are many ways of collecting data: from personal apps and electronics, through questionnaires, from comments and likes on social network platforms and websites, product purchases, and so on.

Nowadays, there is an impressive number of data available, and it presents both problems and opportunities. In order to increase customer's satisfaction, a large amount of in-depth analyzed data may help companies to better personalize products, purchases and marketing activities. However, since the number of data is high, it is difficult to determine which data are the most useful and which, instead, are rough. Furthermore, while structured data is easier to store and sort as it is made up of numeric values, unstructured data, such as videos and emails, require more sophisticated analytics before becoming useful data.

This is where artificial intelligence comes into play, it is possible to say that artificial intelligence and big data are complementary; it is thanks to AI that big data are managed, and the more data is given, the more AI becomes better. There is a kind of circle that describes the relationship between big data and artificial intelligence: firstly, the data is sent to the AI, consequently artificial intelligence becomes smarter thus limiting human interactions, and therefore fewer people are needed to make it work, and finally AI itself feeds new data[13].

Today, thanks to artificial intelligence that is able to analyze different types of data, tasks that were previously performed by humans, something that before taking weeks to be accomplished, now can be done in only one or two days. Human effort is a lot less time-consuming. In fact, artificial intelligence and machine learning help companies to analyze data in a faster and more efficient way than simple employees. An important factor that is to take into account, is that artificial intelligence systems, not only need to learn from data, but also need to learn from humans. Through the combination of technology and the power of the human brain, it is possible to save time and reduce the bias that can arise

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[13] Melnichuk A., How Big Data and AI Work Together, Ncube, 2020. https://ncube.com/blog/big-data-and-ai

from the interpretation of business user data. This will result in greater business productivity, more efficient business operations and quicker insights gleaned from data. Artificial intelligence and big data are only at the beginning of their capabilities, but in the future they will make human life even more comfortable. Data will always be collected, but the way we analyze it will improve.

Chapter 2

The history of artificial intelligence in China: projects and policies

In recent years, many countries have developed strategic programs to support artificial intelligence technologies, and China is one of these countries. Many Chinese internet and manufacturing companies and startups have adopted and developed AI, while different universities and institutions are carrying out academic research on artificial intelligence. The Chinese government is investing a huge amount of resources with the goal to make China emerge as a world leader in AI technology. Today, China is considered the second largest AI economy, just after the United States of America.

The promotion of artificial intelligence in China is part of a greater effort, which is to transform innovation as the axis of development and science and technology as one of its key factors[14]. The development of AI will help China to promote industrialization, improve intelligent manufacturing, integrate technology, develop high-end products, improve public support system, promote new generation AI industry, build a network powerhouse and to transform and upgrade the real economy. It means that China is looking at an integrated and collaborative innovation, that will not only transform business but also government policy, the industrial ecosystem and education[15].

As Professor Cai Zixing stated[16], Chinese policy began to address artificial intelligence relatively late compared to other countries. This was due to the country's political isolation imposed by the Maoist regime (1949-1976), which limited the exchange of scientific and technological knowledge only to the Soviet Union. It was not until 1975, with the publication of the third volume of Translating the Philosophy of Foreign Natural Sciences, that a change in trend was felt. In the second half of the '70s, also thanks to Deng Xiaoping's policy of reform and opening up, there were the first real opening up towards technology and science. During the '80s, the Chinese Society of AI (中国人工智能学会, Zhōngguó réngōng zhìnéng xuéhuì) was founded, The Journal of Artificial

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[14] Farah Calderón W., *Artificial Intelligence in China in its direct sources* (vol. I Specific Policies), 2017, p. 8.
[15] Battavia M., China's AI game plan, 2019. www.almostism.com
[16] 蔡自兴，中国人工智能 40 年，科技导报, 34, 2016, 12-32.

Intelligence (人工智能学报, Réngōng zhìnéng xuébào) was published, and many students who had studied abroad returned to China. In 1986, a series of projects involving intelligent computers, intelligent processors and intelligent robots were included in the "863 Program", a development plan founded by the Chinese government that aimed at stimulating high-tech growth in various fields so as to make China independent of foreign technologies, somewhat similar to the current Made in China 2025[17]. In the following years, Chinese interest in artificial intelligence grew more and more, in fact two more academic journals were published, the Journal of Intelligent Systems and the Journal of Pattern Recognition and Artificial Intelligence. In 2009, the PhD program in Intelligence Science and Technology, recognized by the Ministry of Education, was established. Today, the AI sector in China is currently experiencing a phase of intense vitality thanks to the definition of strategies, guidelines, regulations, to which significant investments at central and local level have been added. In 2011, since the development of Internet of Things, big data and other information technologies, artificial intelligence started to enter a fast growing stage. In 2015, the Chinese congress on AI, which took place in Beijing, gave the direction of artificial intelligence related industries in China. Since the State Council released the New generation artificial intelligence developing plan (新一代人工智能发展规划, xīnyīdài réngōngzhìnéng fāzhǎn guīhuà) in July 2017, there have been different signals that the implementation of AI is advancing throughout all levels of government.

The term artificial intelligence, it was mentioned for the first time in the 13th Five Year Plan (十三五年计划, shísān wǔnián jìhuà) where China's ambitions to transform itself into a superpower in science and technology were clear. In August 2016, Chinese government launched fifteen Science and Technology Innovation 2030 Mega-projects that included intelligent manufacturing and robotics and big data. Despite artificial intelligence was not included as a priority, it was mentioned in some prior plans, such as "Internet Plus" Artificial Intelligence Three-year Action Implementation Plan; the aim of this plan was to focus on funding and on the development of AI in order to improve China's economy.

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[17] Negro G., Intelligenza artificiale in Cina, oltre il presentismo, Sinosfere, Novembre 2019. http://sinosfere.com/2019/11/28/gianluigi-negro-intelligenza-artificiale-in-cina-oltre-il-presentismo/

It was only in May 2017, after the Ministry of Science and Technology added "AI 2.0" as the sixteenth mega project, that artificial intelligence became a full-fledged national priority[18]. Also in 2017, a crucial year for the development of artificial intelligence, the National Development and Reform Commission (NDRC) created the Alliance for the Development of AI Industry (人工智能产业发展联盟, réngōng zhìnéng chǎnyè fāzhǎn liánméng), which brings together research institutes and over two hundred companies and aims to optimize the sector and its related industries by sharing data, protocols and standards[19]. Another essential plan, in the field of artificial intelligence, was the Three-Year Action Plan for Promoting Development of a New Generation Artificial Intelligence Industry (2018-2020) (促进新一代人工智能产业发展三年行动计划, cùjìn xīn yīdài réngōng zhìnéng chǎnyè fāzhǎn sān nián xíngdòng jìhuà), that outlines the major areas to focus on, and clarifies the requirement and technical progress to be achieved in the three-year period. Some examples of the products, industries and technologies that China wants to concentrate on are: smart consolidation of software and hardware, such as neural network chips and sensors; integrated intelligent systems, such as drones, video image identification and voice interaction systems, translation systems and so on; and intelligent network infrastructure, intelligent manufacturing, network security, and industrial public support systems to improve the artificial intelligence development environment.

Figure 2: Recent AI Plans

Plan	Description	Key Elements	Importance
13th Five Year Plan for Developing National Strategic and Emerging Industries (2016-2020) ["十三五"国家战略性新兴产业发展规划]	A State Council policy document which specifies implementation measures for the 13th Five-Year Plan, focused on strategic industries	Highlighted development of AI as 6th among 69 major tasks[a] for the central government to pursue; Identified five agencies responsible for developing central	Links AI to the current Five Year Plan through this guiding plan

[18] Liu Yin, 科技创新 2030— 重大项目新添 " 人工智能 2.0" stdaily.com (2017). http://www.stdaily.com/zhuanti01/rgzn/2017-05-24/content_546702.shtml

[19] 中国人工智能产业发展联盟在京成立， 新华社，2017. http://www.xinhuanet.com/2017-10/13/c_1121801129.htm

		government policies in AI in the next five years	
"Internet Plus" and AI Three- Year Implementation Plan (2016-2018) ["互联网+"人工智能三年行动实施方案]	Jointly issued by the National Development and Reform Commission (NDRC)[b], the MoST, MIIT, and the Cyberspace Administration of China	Established a goal to grow the scale of the AI industry's market size to the "hundreds of billions" (RMB)	Connects AI development to highly touted "Internet Plus" policy which aims to catapult China to becoming a digital powerhouse
Robotics Industry Development Plan (2016- 2020) [机器人产业发展计划]	Plan to develop robotics industry released by the NDRC, the MIIT, and the Ministry of Finance (MOF)	Set specific targets for advancing the robotics industry; the second of two development plans containing a focus on AI released by central agencies with a policy planning mandate	Sets goal of manufacturing 100,000 industrial robots annually by 2020, making China the world's leading robot-maker
"Artificial Intelligence 2.0" [人工智能 2.0]	Proposal by Chinese Academy of Engineering added to a list of 15 "Sci- Tech Innovation 2030 – Megaprojects"[c]	Megaprojects were proposed and finalized in 2016 with the release of the "13th Five-Year Plan for National Science and Technology Innovation" but AI	Demonstrates how AI was elevated to the level of a megaproject only recently

		was added in Feb. 2017	
Three-Year Action Plan for Promoting Development of a New Generation Artificial Intelligence Industry (2018- 2020)	MIIT action plan for implementing tasks related to State Council's AI Plan and "Made in China 2025"	Sets out specific benchmarks for 2020 in a range of AI products and services, including smart, inter-connected cars, and intelligent service robots	Shows government's strong guiding role in developing the AI industry (convened top 30 companies to develop indicators)

Source: Jeffrey Ding "Deciphering China's AI Dream"

On August 2019, at the 2019 World Artificial Intelligence Conference, China's Ministry of Science and Technology (MOST) released the National New Generation Artificial Intelligence Open Innovation Platform, where they selected fifteen companies (Baidu, Alibaba Cloud, Tencent, iFlytek, SenseTime Group, Yitu Technology, Mininglamp Technology, Huawei, Ping An Technology, Hikvision Digital Technology, JD.com, Megvii Technology, Qihoo 360, Tal, Xiaomi) as National AI Team[20]. The National AI Team have has to guide the development of the sector using national and local funds, and at the same time committing to develop standards and platforms that can be used by smaller companies.

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[20] 人 工 智 能 " 国 家 队 " 扩 容 十 家 公 司 入 选 , 中 国 证 券 报 , 2019. http://www.xinhuanet.com/money/2019-08/30/c_1124939770.htm

Figure 3: China's National AI Team

Source: Larsen B., Drafting China's National AI Team for Governance, DigiChina Digest, June 2019.

These intensive programming activities are accompanied by contextual factors that place China in a particularly favorable position for the development of AI and other data-intensive technologies: closure to foreign digital platforms, agility in the collection and management of personal data and extraordinary volume of data available.[21]

Jeffrey Ding provides a version of the Chinese AI strategy in his Deciphering China's AI Dream paper[22]: by 2020, catching up to the most advanced AI powers; by 2025, becoming one of the world leaders in AI; by 2030, achieving primacy in AI innovation.

An important factor in AI development in China, is the cooperation between the Chinese government, the private sectors, investors and academia, that, as said Irakli Beridze, "are working hand-in-hand to achieve this (national AI) goal"[23], in fact, the private sector moves within the national development goals. It is also important to take into account that China has the advantages of a high level of AI adoption and that the citizens' perception towards artificial intelligence is quite positive. Furthermore, China has enormous amounts of data at its disposal, thanks to its population size and the increasing number of digitally connected users, and data is the fuel that artificial intelligence technology

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[21] Agamennone E., Andornino G., Brigadoi Cologna D., Brombal D., et al., La Cina: sviluppi interni, proiezione esterna, parte III - la Cina e l'innovazione, Osservatorio di Politica Internazionale, ottobre 2020.
[22] Jeffrey Ding, Deciphering China's AI Dream, Governance of AI Program, Future of Humanity Institute, University of Oxford, March 2018.
[23] Daniel Faggella, The strengths of the AI ecosystem in China - Perspectives from a UN leader, The AI Research and Advisory Company, https://emerj.com/ai-podcast-interviews/the-strengths-of-the-ai-ecosystem-in-china-perspectives-from-a-un-leader/, 2019.

consumes to develop. Thus, China can analyze and acquire this large volume of big data to reach its AI goals.

Nowadays, Chinese artificial intelligence industry is becoming one of the most important markets in the nation, and there is a large space for development AI market in the country.

Figure 4: China's artificial intelligence market size (billion RMB, 2015-2020)
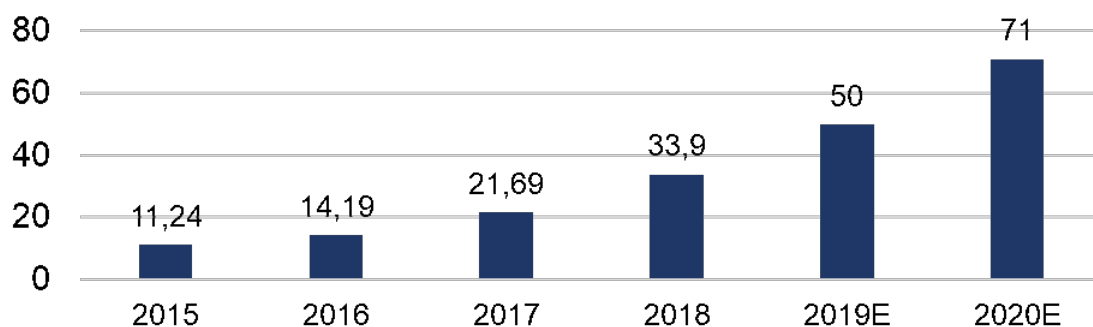
Source: China's AI market growth from Daxue Consulting

In 2018, the size of AI market reached 33,9 billion RMB, while in 2019 it was expected to reach 50 billion RMB, and in 2020 71 billion RMB.

The artificial intelligence ecosystem in China is not without any weaknesses: there is shortage of AI talent that could represent a big problem for a country which aims to lead the world on AI field, there is a high competition between local and international markets, there are irregular distribution of funds across different sectors, and finally there is a debate over data privacy regulations and protections. Chinese government is working hard to overcome these weak links, and is trying to remedy them with fast execution of national policies.

2.1 Made in China 2025

Made in China 2025 (中国制造 2025, *zhōngguó zhìzào èrlíng'èrwǔ*) is an industrial plan launched by the premier Li Keqiang in 2015, with which Beijing aims to become self-sufficient in high technology. In ten years, the programme aims to transform China from the factory of the world to an industry 4.0.

Figure 5: The ten core industries in Made in China 2025
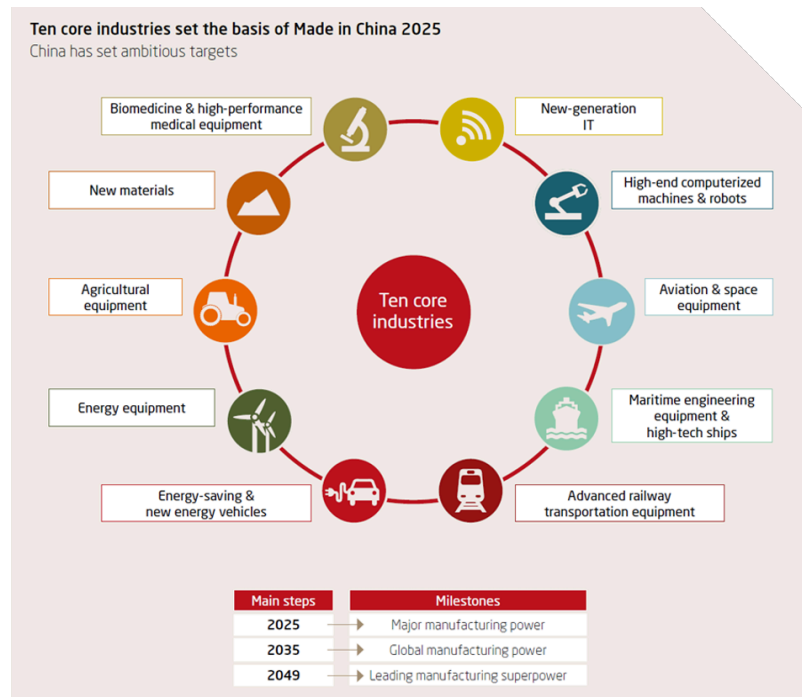
Source: State Council of China, MERICS

Made in China 2025 includes investments in ten core sectors as high-end computerized machines and robots, aviation and space equipment, advanced railway transportation equipment, new-generation IT, new materials, biomedicine and high-performance medical equipment, agricultural equipment, energy equipment and maritime engineering equipment and high-tech ships.

By focusing on these industrial sectors, China is launching again some of the objectives that were already included in the 13th Five-year Plan (2016-2020), which had defined the need for technological advancement and the reconsideration of the Chinese development model, announcing the country's entry into a new phase of economic developed so called "New Normal"[24]. One objective of this projects is to change the production from a quantitative to a more qualitative regime, pushing the Chinese manufacturing in a higher

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[24] Michel Aglietta & Guo Bai, "China's 13th Five-Year Plan. In Pursuit of a 'Moderately Prosperous Society'", CEPII, 2016.

place of the global value chain, and thus approaching the standards of biggest industrialized countries[25].

The ten sectors mentioned earlier represent 40% of Chinese value-added manufacturing production, so investing in their expansion would give a huge boost to the Chinese high value industry.

The development targets are dictated by the "Made in China Major Technical Roadmap", which establishes the growth objectives and the market share that must be achieved in the strategic sectors indicated. China has provided a system of incentives to promote a greater localization of production, that will benefit more Chinese companies than the foreigner ones. In fact, the ultimate goal of the Chinese government is to achieve a full autonomy.

Another important point of this strategy, is to invest in research and development, since China has not yet the manufacturing capabilities and the adequate know-how to develop cutting-edge technologies that can compete with foreign markets.

It is also very important to take human capital into account to carry out MIC 2025 (Made in China 2025). In recent years, the percentage of the population that concludes their studies has increased, and the number of people who go to study abroad, and then use their know-how in China has also increased.

So, manufacturing capacity, research and development, and human capital together can allow China to take off in technology.

2.2 "Internet Plus" and AI Three-year Implementation Plan

The Internet Plus and artificial intelligence three-year implementation plan ("互联网+" 人工智能三年行动实施方案, "hùliánwǎng+" réngōng zhìnéng sān nián xíngdòng shíshī fāng'àn) was jointly issued, in May 2016, by the National Development and Reform Commission (NDRC), the Ministry of Science and Technology (MOST), Ministry of Industry and Information Technology (MIIT) and by the Cyberspace Administration of China, and it was the first time that China proposed a specific strategy for the

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[25] 李永胜, 中国制造 2025，核心内容分析, (2015).

development of artificial intelligence. This plan connects AI development to highly touted "Internet Plus" policy which aims to catapult China to becoming a digital powerhouse.

The plan foresaw that basic artificial intelligence resources and innovation platforms must had to be built, that the industrial system of AI, the system of innovation services, and the standardization system had to be established, and that the overall technology and industrial development had to be synchronized with the international level by 2018. The main task of the plan was further advance the R&D and industrialization of key technologies such as computer vision, intelligent speech processing, biometric recognition, natural language processing, and so on.

The action plan proposed three major directions and a total of nine major projects:

1. To cultivate and develop emerging industries of artificial intelligence, the key projects were core technology R&D and industrialization projects, and basic resources public service platform projects.

2. To promote smart product innovation in key areas, key projects were smart home demonstration projects, smart car R&D and industrialization projects, smart unmanned system application projects, and smart security promotion projects.

3. To enhance the intelligent terminal products, key projects were smart terminal application capability improvement projects, smart wearable device development project, and smart robot R&D and application project.

The purpose was to give full play to the leading role of AI technological innovation, to support entrepreneurship and the "Internet" innovation, and to promote a new impetus for economic development.

It focused on enhancing artificial intelligence hardware capacity, strong platform ecosystems, the innovation of artificial intelligence applications, the promotion of AI in important socio-economic areas, and AI's impact on society.

One objective of "Internet Plus" and AI Three-year Implementation Plan was to create a USD 15 billion market by 2018 by investing in research and supporting the development of the Chinese artificial intelligence industry.

The plan also put forward specific requirements in terms of financial support, standard system construction, intellectual property protection, talent training and international cooperation.

Analysts believe that artificial intelligence is the fundamental force of future industrial transformation, and that the intelligent transformation of different industries and scenarios is the future trend. Medical care, security, finance, smart home, agriculture, automotive, manufacturing, advertising, education, media, law and so on, are all directions for artificial intelligence.

"Internet Plus" and AI Three-year Implementation Plan have given birth to a new industrial revolution, and artificial intelligence is the foundation of the new industrial revolution.

2.3 13th Five-year Plan for Developing National Strategic and Emerging Industries

The 13th Five-year Plan for Developing National Strategic and Emerging Industries ("十三五"国家战略性新兴产业发展规划, "shísānwǔ" guójiā zhànlüè xìng xīnxīng chǎnyè fāzhǎn guīhuà)[26] was issued by the State Council of China on December 2016, to support and direct the development of the seven strategic emerging industries: new energy industry, new energy automobile industry, new material industry, energy-saving and environmental protection industry, new-generation information technology industry, high-end equipment manufacturing industry, and biology industry. During the 12th Five-Year Plan period, these strategic industries have developed rapidly. In 2015, the added value of strategic emerging industries accounted for about 8% of Gross Domestic Product (GDP) and China aimed to increase that to 15% by 2020, furthermore the ability of industrial innovation and profitability was significantly improved.

Since technologies such as the Internet of Things (IoT), big data, cloud computing, and artificial intelligence have widely penetrated into all fields of the economy and society, the 13th Five-Year Plan period is crucial for a new round of global technological revolution and industrial transformation, and it is also a period of strategic opportunities for strategic emerging industries, so investing in these fields is essential. This Plan represents the direction of a new round of technological revolution and industrial transformation. During the 13th Five-Year Plan period, strategic emerging industries must be placed in a more prominent position for economic and social development, vigorously

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[26] 中华人民共和国中央人民政府， 国务院关于印发"十三五"国家战略性新兴产业发展规划的通知, www.gov.cn, 2016.

build a new modern industrial system, and promote sustained and healthy economic and social development. According to the relevant deployment of the 13thFive-Year Plan outline, the planning period is from 2016 to 2020.

When the 13th Five-year Plan for Developing National Strategic and Emerging Industries was issued, the overall innovation level of China's strategic emerging industries was not high, and the core technology in some fields was still under the control of others. So, in order to become a powerful driving force for economic and social development, it was urgent to strengthen overall planning and policy support, creating an ecological environment leading to the development of emerging industries, ideas and quality.

The Plan aims to have the total output value of the new-generation information technology industry exceed RMB 12 trillion, the output value of high-end equipment manufacturing industry and the new materials industry exceed RMB 12 trillion, the output value of the biology industry reached RMB 8 trillion, total output value of the new-energy automobile industry, the new energy industry, and the energy-saving and environmental protection industry exceed RMB 10 trillion, and the output value of the digital creativity industry reached RMB 8 trillion by 2020[27].

The main principles of this Plan are to insist on supply innovation, to persist in demand leadership, to push on industrial clustering, to insist on talents and business, and on openness and integration.

By 2020, the development of strategic emerging industries must achieve the following goals:

1. The scales of the industry should continue to grow, becoming a new driving force for economic and social development.

2. The innovation abilities and competitiveness needed to be significantly improved, forming a new highland for global industrial development.

3. The industrial structure must have been further optimized, and a new industrial system must have been formed.

To achieve these goals, the focus would be on developing information technology, accelerating the development of information infrastructure construction by progressing the broadband rural demonstration project, accelerating the popularization of e-

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[27] Lingna Yan, China Issues 13th Five Year Plan for Strategic Emerging Industries, King & Spalding, 2016.
https://www.kslaw.com/blog-posts/china-issues-13th-five-year-plan-strategic-emerging-industries

commerce, smart agriculture, e-government, distance education, and so on. In addition, the "Internet Plus" project would be supported to promote business model innovation based on cloud computing, to strengthen the research on Internet of Thing and organize its major application demonstrations. It was important to integrate information technology in all social and economic sectors and to implement a national big data strategy, promoting the collection, application and integration of data. The State Council of China also stressed the need to develop artificial intelligence by building an AI public service platform and realizing the industrialization of intelligent robots and intelligent application systems. It was also necessary to maintain the leading position in railway transportation equipment and increase the competitiveness of marine engineering equipment, develop high-end equipment and new materials, forge a smart manufacturing brand and develop the aeronautical industry. There are also other projects that the State Council of China intends to realize, for example green and low-carbon technology and equipment development projects, new drug creation, biological industry innovation and others.

In this way, by 2030, the development of strategic emerging industries will become the leading force to promote the sustained and healthy development of China's economy, and China will become an important manufacturing centre and innovation centre for strategic emerging industries in the world, forming a group of innovative leading companies with global influence and leading positions.

2.4 Robotics Industry Development Plan

The Robotics Industry Development Plan (机器人产业发展计划, jīqìrén chǎnyè fāzhǎn jìhuà) was jointly issued on April 2016 by the Ministry of Industry and Information Technology, the National Development and Reform Commission, and the Ministry of Finance to guide the development of Chinese robot industry, to promote robot applications to a wider range of fields, to attract foreign investment, and to increase domestic production of robots. The Plan stated that by 2020, industrial robots produced

by domestic technology annually would reach 100,000 units[28], and the annual sales revenue of service robots will exceed RMB 30 billion.

The robotics R&D in China started in the 1970s, but in recent years, under the support of a series of policies and driven by market demand, China's robotics industry has developed rapidly. Although China's robotics industry had made considerable progress, compared with industrialized countries there was still a big gap. So, the 13th Five-Year Plan period was extremely important for the development of Chinese robotics industry.

The Robotics Industry Development Plan's specific development goals for 2020 are as follows: the scale of the industry must continue to grow; the technical level must have been significantly improved; major breakthroughs must have been made in key components; significant results must have been achieved in integrated applications.

This plan has the five-year objective of establishing a complete robotic industrial system, and it proposes five main tasks:

1. Promote the first breakthrough in major landmark products, focusing on smart production, smart logistics, and conquering key technologies of industrial robots. Promote the development of service robots to a wider field, focusing on family services, energy security, medical rehabilitation, and also on the development of fire rescue robots, surgical robots, etc.

2. Develop key parts of robots, with five key components: high-precision reducer, high-speed and high-performance controller, sensors, special servo motors and drivers for high-performance robots, and end effectors.

3. Strengthen industrial innovation capabilities and research on common key technologies, establish a sound robot innovation platform, strengthen the construction of robot standard system and establish a robot inspection and certification centers.

4. Focus on promoting application demonstration, implementing industry application demonstration projects in the key areas of manufacturing, medical rehabilitation, disaster relief, and other service areas.

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[28] I-Ting S. L., The Robotics Industry in China, China Briefing, 2018. https://www.china-briefing.com/news/chinas-robot-industry/

5. Actively cultivate leading enterprises, by guiding enterprises to develop in the direction of differentiation around market segments, and support the integration of Internet and traditional robot enterprises.

The Plan proposes also six safeguard measures, that are to strengthen overall planning and resource integration, to increase fiscal and taxation support, broaden investment and financing channels, create a good market environment, strengthen the construction of talent teams, and expand international exchanges and cooperation.

2.5 New Generation Artificial Intelligence Development Plan

The New Generation Artificial Intelligence Development Plan (新一代人工智能发展规划, xīnyīdài réngōngzhìnéng fāzhǎn guīhuà)[29] was released by the State Council of China in July 2017. The aim of this plan is to let China become the leading AI power by 2030. AI has become the new opportunity for social development, the new focus of international competition and has become a new engine of economic growth. This plan marks the evolution of artificial intelligence sector as a national priority, and it is seen as the extension of Made in China 2025 (中国制造 2025, zhōngguó zhìzào 2025) and of the Chinese government's 13th Five-Year Plan (十三五年计划, shísān wǔnián jìhuà).

There are three strategic steps:

1. By 2020 it is important that technology and application of AI reach a global advance level; in order to do so, it is necessary the optimization of artificial intelligence development environment, making progress in AI theory and technology, and the development into the first international phalanx of AI industry competitiveness, with a core AI industry gross output exceeding RMB 150 billion and AI-related industry gross output exceeding RMB 1 trillion.

2. By 2025 China should achieve a major breakthrough in AI basic theory, artificial intelligence should become a driving force in China's economic transformation, and make some progress in the construction of an AI society; for that purpose, it is important first to make AI industry develop into the global high-end value chain, then

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[29] 中华人民共和国中央人民政府，国务院关于印发新一代人工智能发展规划的通知, www.gov.cn, 2017. http://www.gov.cn/zhengce/content/2017-07/20/content_5211996.htm

to establish laws, regulations, policy systems and ethical norms, with a core AI industry gross output exceeding RMB 400 billion and AI-related industry gross output exceeding RMB 5 trillion.

3. By 2030 China has to become the world major artificial intelligence innovation centre; so that, a more mature and new generation of AI theory and technology system are required, and it is essential to expand artificial intelligence in social governance, national defense, production and life and so on, it is also necessary to build more comprehensive regulations and laws and ethics and policy system of artificial intelligence, with a core AI industry gross output exceeding RMB 1 trillion and AI-related gross output exceeding RMB 10 trillion.

Figure 6: China next generation AI development goals

Year	Focus	Core industry revenue (billion RMB)	AI related industry revenue (billion RMB)
2020	Big data intelligence, autonomous intelligence systems, cross-medium intelligence, swarm intelligence, hybrid enhanced intelligence, AI foundational theories	150	1,000
2025	Intelligent manufacturing, intelligent medicine, intelligent city, intelligent agriculture, national defense construction, AI laws and regulations, AI security assessment and control capabilities	400	5,000
2030	Social governance, national defense construction, industrial value chain	1,000	10,000

Source: State Council, Eurasia Group

This Plan will be guided by a new AI Strategy Advisory Committee, established in November 2017, and will be coordinated by the Ministry of Science and Technology (MIST) and the AI Plan Promotion Office[30]. The major tasks of New Generation Artificial Intelligence Development Plan are: set up an open and cooperative AI technology system; seize the peculiarities of a highly integrate technical and social attributes; stick to "Three in One" promotion of R&D, product application and industrial cultivation; and enhance Four Supports (science and technology, economic, social development and national security). According to the New Generation Artificial Intelligence Development Plan, the three areas where artificial intelligence can make difference within China are: social governance, economic development and international competition.

Chinese government's key tasks are:

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[30] Roberts H. et al., "The Chinese approach to artificial intelligence: an analysis of policy, ethics, and regulation", *AI & Society*, 36:59-77, June 2020.

1. Build open and cooperative AI science and technology innovation system, by establishing a new generation of basic theory of AI system, setting a new generation of AI key common technology system, coordinating the set-up of AI innovation platform, and accelerating the cultivation of high-level AI talents.

2. Cultivate a high-end and efficient intelligent economy, by developing AI emerging industry, speeding up industrial intelligent upgrading, developing AI enterprise, and by setting up AI innovation highland.

3. Construct safe and convenient intelligent society, by developing convenient and efficient intelligent service, promoting intelligent social governance, through the use of artificial intelligence to improve capacity to protect public security and promoting mutual trust and sharing in society.

4. Strengthen AI in the field of military-civilian integration, for example by setting up regular communication and coordination mechanisms like higher education and research institutions, military institutes and companies.

5. Build a safe and efficient intelligent infrastructure system, such as network infrastructure, big data infrastructure, and high performance computing infrastructure.

6. Lay out a new generation of AI major science and technology projects, by focusing on China's artificial intelligence weak links and needs, strengthening the overall coordination, clarifying task boundaries and R&D focus.

In this Chinese plan, a few supporting measures arise such as the formulation of laws and regulations and ethical related norms that promote development of artificial intelligence, the improvement of the key policies to support AI development, the establishment of standards and intellectual property systems for AI technology an of safety supervision and evaluation systems for AI. Furthermore, in the New Generation of Artificial Intelligence Development Plan, the Chinese government marks the need to strengthen the organization and the leadership, to clarify division labor in planning tasks, develop specific programs to carry out pilot demonstrations; and the full use of both new and traditional media is also needed in order to obtain a public support.

2.6 Artificial Intelligence 2.0

Artificial Intelligence 2.0 was added, in 2017, by the Chinese Academy of Engineering to the list of Sci-Tech Innovation 2030 - Megaprojects (科技创新 2030—重大项目, *kējì chuàngxīn 2030—zhòngdà xiàngmù*)[31]. The mega-projects were proposed and finalized in 2016 with the release of the 13th Five-Year Plan for National Science and Technology Innovation.

Sci-Tech Innovation 2030 - Megaprojects are major scientific and technological projects that reflect the national strategic intentions that China wants to reach by 2030. They focus on cutting-edge technology and national security needs. The high-tech fields involved are the following: aircraft and gas turbines, national cyberspace security, in-orbit service and maintenance systems of deep-space exploration and spacecraft, clean and efficient utilization of coal, smart power grids, space-ground integrated information networks, deep-sea space station, quantum communication and computing, health, brain science and brain-like research, environmental management of the Jing-Jin-Ji region, independent innovation in seed industry, big data, intelligent manufacturing and robotics, research and development and application of new key materials, and artificial intelligence 2.0[32].

The addition of Artificial Intelligence 2.0 as one of the Sci-tech innovation 2030- megaprojects is relevant because it demonstrates, once again, the recent importance of AI and its rapid development.

Pan Yunhe, with the purpose to better communicate AI 2.0's methods, theory and technology, published a paper, in the Journal of the Chinese Academy of Engineering in December 2016, entitled *Heading toward artificial intelligence 2.0*[33]. He said that artificial intelligence 2.0 is a new generation of artificial intelligence based on a new information environment with major changes and new development goals. In fact, following the popularization of the internet, big data, e-commerce, cyberspace and so on,

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[31] 中华人民共和国科学技术部，中国"科技创新 2030—重大项目"将新增"人工智能 2.0"，2017. http://www.most.gov.cn/xinwzx/mtjj/ztjj/201702/t20170216_130982.htm

[32] 中 华 人 民 共 和 国 中 央 人 民 政 府 ， 科 技 创 新 2030— 重 大 项 目 启 动 ， 2017. http://www.gov.cn/xinwen/2017-02/20/content_5169236.htm

[33] Yunhe P., Heading toward Artificial Intelligence 2.0, Engineering, Vol.2, Issue 4, pages 409-413, Dicember 2016. https://doi.org/10.1016/J.ENG.2016.04.018

the information environment that surrounds the development of artificial intelligence has dramatically changed that has led to artificial intelligence 2.0.

Artificial Intelligence 2.0 will help humans to solve some specific problems as energy conservation, product design, safe driving and medical treatment. It will also be useful to obtain better insight and effective management to interact with complex macroscopic systems that involve ecological protection, financial risks, urban development and economic management.

AI 2.0 is based on a new information environment that includes the Internet, networking communities, mobile devices, big data and so on. It is also based on new development goals, which include the development of smart cities, smart vehicles, digital economies and smart manufacturing.

Artificial intelligence 2.0 will have distinctive features: it will be characterized by a shift towards new forms of hybrid-augmented intelligence, research will involve on more autonomous and intelligent systems focused on the development of intelligent machinery and products, technologies and platforms will be built to promote crowd-based intelligence to develop a higher level of internet based community intelligence.

With the aim of improving human intellectual activity, artificial intelligence 2.0 will combine natural intelligence and artificial intelligence, and will be inserted into human life becoming part of the human body, being able to read, provide suggestions for social problems, and even going so far as to exceed man in the areas of translation, recognition and control.

2.7 Three Year Action Plan for Promoting development of a New Generation Artificial Intelligence Industry

The Three Year Action Plan for Promoting development of a New Generation Artificial Intelligence Industry (2018-2020) (促进新一代人工智能产业发展三年行动计划, cùjìn xīn yīdài réngōng zhìnéng chǎnyè fāzhǎn sān nián xíngdòng jìhuà)[34] was issued by the Ministry of Industry and Information Technology (MIIT) with the aim to implement the plans of Made in China 2025 and New Generation of Artificial Intelligence Development

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[34] Ministry of Industry and Information Technology, 促进新一代人工智能产业发展三年行动计划, 2017. http://www.miit.gov.cn/n1146295/n1652858/n1652930/n3757016/c5960820/content.html.

Plan, and to accelerate the development of advanced manufacturing. This Action Plan aims to promote the in-depth integration of artificial intelligence and the manufacturing industry, and to accelerate China's transformation into a cyber and manufacturing superpower.

The basic principles of this Plan are systemic layout, key breakthroughs, collaborative innovation, and open and orderly. China plans to accelerate the industrialization and implementation of applications, and above all to support research and development of artificial intelligence products.

According to the Plan, in order to achieve the goals they have set, it is also necessary to support both small and medium-sized enterprises and leading enterprises in the sector, and to strengthen international cooperation.

By 2020, through the implementation of four key tasks, the Chinese government intends to further deepen the integration of AI and the real economy and further optimize the industrial development environment.

The four main tasks are the following[35]:

1. The training and development of intelligent and networked vehicles must be greatly improved, the large-scale application of drones, intelligent service robots, medical image assisted diagnostic systems, and other products must have strong global competitiveness. In addition, video image identification systems, intelligent voice interactive systems, intelligent translation systems must reach an international advanced level.

2. The core capabilities of artificial intelligence need to be significantly improved, while the development of intelligent sensors must achieve groundbreaking breakthroughs. Neural network semiconductors and open source platforms must achieve mass production.

3. The development of smart manufacturing must be intensified, as well as the recognition of the complex environment and the new human-computer interaction. Furthermore, it is important to support the exploration and application of the new generation of artificial intelligence technology in all aspects of the industrial sector, and to promote new models of intelligent production.

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[35] Triolo P., Kania E., Webster G., Translation: Chinese government outlines AI ambitions through 2020, New America, 2018. https://www.newamerica.org/cybersecurity-initiative/digichina/blog/translation-chinese-government-outlines-ai-ambitions-through-2020/

4. It is necessary to build a comprehensive AI support system, an intellectual property service platform, and standard testing in order to improve the environment for the development of artificial intelligence. In addition, the plan contains goals for the development of industrial internet, 5G and internet of vehicles.

This plan promotes the creation of manufacturing innovation centers in relevant sectors, the establishment of laboratories, and aims, by 2020, to significantly improve the fundamental capabilities of AI, to develop in depth intelligent manufacturing, and create a support system for the artificial intelligence industry.

The Plan forecasts the development of intelligent products in different fields, such as agriculture, finance, education, healthcare, logistics and so on. Intelligent networked vehicles, intelligent service robots, intelligent unmanned aerial vehicles, medical imaging diagnosis systems, video image identification systems, intelligent voice interactive systems, intelligent translation systems, and smart home products are some of the areas to focus on in order to achieve initial breakthroughs. Also, support the R&D of smart sensors, develop high-performance and low-power cloud neural network chips, support open-source platforms is essential.

2.8 National New Generation Artificial Intelligence Open Innovation Platforms

The Chinese government is devising new means to drive the development more in tune with leading private sector firms promoting leading AI technologies. So, in 2017, the Chinese Ministry of Science and Technology (MOST) developed the National New Generation of Artificial Intelligence Open Innovation Platforms (国家新一代人工智能开放创新平台, guójiā xīn yīdài réngōng zhìnéng kāifàng chuàngxīn píngtái) and chose four private sector companies as a National AI Team (国家队, guójiā duì), Baidu, Alibaba, Tencent and iFlyTek, to lead in the building of open innovation platforms for specific purpose and to promote a deep integration between artificial intelligence and the real economy. One year later, in 2018, the MOST added SenseTime as the fifth artificial intelligence open innovation platform (AIOIP). In 2019, at the World Artificial

Intelligence Conference based in Shanghai, the initiative was officially expanded to other ten companies[36], and it remained open for further entities to apply.

This project focuses on the key segments of artificial intelligence and gives full play to the leading role of industry leaders and research institutes, integrating in an efficient way financial, technological and industrial resources. Through the construction of open innovation platforms, it will be possible to improve technological innovation and research and development capabilities, and it will be possible to encourage open source and the opening of various general software and technologies, and to support the entire society's innovative entrepreneurs, small, medium and micro-sized enterprises to devote themselves to artificial intelligence technology research and development. AIOIPs will promote the diffusion, transformation and application of AI achievements, and will make AI a new engine driving the construction of the real economy and the development of social enterprises.

The goal of AIOIPs must be driven by technology leaders in the artificial intelligence sector, and the subdivisions of the innovation platform should be distinct and focused. AIOIPs should meet the following basic conditions:

1. To have an exceptional technical strength and an influence on industrial innovation, and being able to play a leading and demonstrative role in the artificial intelligence sector.

2. To have the technical bases and service capabilities to provide open and shared services to society, be able to effectively integrate technical, industrial and financial resources, have the technical capabilities to rapidly train external services in order to reduce research and development of technologies industries, stimulating the collaborative development of small, medium and micro enterprises.

3. To invest in funds, talents and infrastructures for the construction of the open innovation platform, and provide guarantee conditions for the development of the platform itself.

4. To have a clear open service operating mechanism, establish a relatively complete organizational structure and operating model that supports the sustainable development of the open innovation platform.

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[36] 王蓓蓓，人工智能"国家队"扩容 十家公司入选，中国证券报，2019. http://www.xinhuanet.com/money/2019-08/30/c_1124939770.htm

According to the guidelines for the construction of National new generation artificial intelligence open innovation platforms[37], entities that meet the application requirements and are willing to provide public innovation services, combine with their own technical foundation and development positioning, have to select specific sub-field and subscribe the application for the construction of the national new generation AIOIPs and apply to the MOST through the self-recommendation of the supporting unit or of the provincial science and technology department. The MOST selects a team of experts that have to judge if the applicants' technological capabilities are in accordance with the selection criteria. The selected companies are representative and leading large-scale artificial intelligence in various fields. Baidu provides space for testing autonomous vehicles, Alibaba provides access to city infrastructure for monitoring and upgrade, Tencent provides access to surveillance systems, iFlyTek provides access to the judicial system, SenseTime provides access to surveillance systems, it will rely on Yitu Technology to build a visual computing AIOIP, Mininglamp Technology provides access to smart marketing, Huawei provides software and hardware, Ping An Technology provides access to inclusive finance, Hikvision Digital Technology to video perception, JD.com provides access to smart supply chain, Megvii Technology to image perception, Qihoo 360 to cybersecurity, Tal to smart education, and Xiaomi provides access to smart home.

This National AI Team is expected to perform four main tasks: R&D, sharing data and open source software, ecosystem participation, and support for entrepreneurship of small and medium-sized enterprises[38]. Furthermore, each AIOIP entity is required to provide annual reports summarizing the ongoing progress of their open innovation platforms and submit it to the MOST after being reviewed by the provincial science and technology department.

Provincial-level science and technology authorities should actively promote the construction of AIOIPs in accordance with the characteristics of regional development, they should assist in the promotion and application of technology, and should provide relevant policy support. If an open innovation platform can not continue to perform the

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[37] 中华人民共和国中央人民政府，科技部关于印发《国家新一代人工智能开放创新平台建设工作指引》的通知, 2019. http://www.gov.cn/xinwen/2019-08/04/content_5418542.htm

[38] Larsen B., "China's National AI Team - The role of National AI Open Innovation Platforms, AI Policy and China - Realities of State-Led Development", *Stanford - New America DigiChina Project*, Special Report No. 1, pag. 16-20, 2019.

responsibilities of the supporting unit or have some social adverse effects, the MOST has the duty to revoke it.

Chapter 3

Application of Artificial Intelligence and Big Data in fighting the COVID-19 pandemic in China

Coronavirus disease 2019 (COVID-19) has dramatically changed our daily life, it affected not only the healthcare system, but also education, transportation, economy, politics, international trade and all aspects of our life.

The main problem related to COVID-19 was and continues to be the high rate of human-to-human transmission, which leads to a very high number of patients hospitalized and consequently to the collapse of the hospitals. Suffice to say that in just over a year, the number of infections, at March 8th, 2021, from the beginning of the pandemic is 116,521,281 and the number of deaths is 2,589,548[39].

The main challenges that countries had to face and are still facing during the current health crisis are: how to screen people with symptoms effectively; how to cope with the lack of necessary tools such as ventilators and masks; how to address labor shortages in the areas most affected by the virus; how to ensure that society continues to operate in relative safety; how to protect medical staff and those most at risk of infection, and so on.

At a time when hospitals were collapsing, medical personnel were exhausted and at a very high risk of infection, and the situation seemed out of control, using technology to prevent, track and identify the virus could give a breath of relief to people who were constantly struggling with the virus. In fact, artificial intelligence and big data offered powerful tools to fight against the COVID-19 pandemic. It was the novel virus that led the integration of artificial intelligence and emerging technologies such as 5G, big data and Internet of Things. Combined with AI analytics, big data can help to understand the COVID-19 in terms of outbreak tracking, virus structure, virus origin, virus rate of spread, vaccine manufacturing and disease treatment. New AI applications in body temperature sensing, voice assistant, service robots, tracking apps, autonomous vehicles, drones, e-learning platforms are just a few of the technologies that have been widely implemented and have supported the battle against the virus. The health emergency has meant that

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[39] WHO, WHO Coronavirus (COVID-19) Dashboard, 8 March 2021. https://covid19.who.int/

technological progress continued, despite the economic and social uncertainties that emerged during 2020.

The best example of a country in which technology has moved from being nice to have to essential to address the disease is China[40]. In fact, according to a World Health Organization report, in China, "the implementation of containment measures has been supported and enabled by the innovative and aggressive use of cutting edge technologies"[41].

The word crisis in Chinese is 危机 (wéijī), 危 (wéi) means danger, while 机(jī) means opportunity. What at first seemed a danger for China and Xi Jinping, now seems an opportunity both to accelerate the process already underway of rebalancing global geopolitical leadership with the United States of America, and to carry out all the objectives concerning the new technologies that the country had previously set itself.

3.1 Coronavirus Disease 2019 timeline

The State Council Information Office of the People's Republic of China, in the white paper *Fighting COVID-19 China in Action*[42], divides China's fight against the epidemic into five stages: from December 27th, 2019 to January 19th, 2020; from January 20th, 2020 to February 20th, 2020; from February 21st to March 17th, 2020; from March 18th to April 28th, 2020; since April 29th, 2020.

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[40] Bennehard M., AI and the coronavirus in China: China's cutting edge technologies to defeat the coronavirus, Daxue Consulting, March 2020. https://daxueconsulting.com/ai-and-the-coronavirus-in-china/

[41] WHO, Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (VOVID-19), 16-24 February 2020.

[42] State Council Information Office of the People's Republic of China, Fighting Covid-19: China in Action, June 2020.

Figure 7: Five stages of China's fight against COVID-19

Dicember 27th - January 19th, 2020
Swift response to the publiv health emergency

January 20th - February 20th, 2020
Initial progress in containing the virus

February 21st - March 17th, 2020
Newly confirmed domestic cases on the Chinese mainland drop to single digits

March 18th - April 28th, 2020
Initial victory in a critical battle

Since April 29th, 2020
Ongoing prevention and control

3.1.1 Stage I: swift response to the public health emergency

At the beginning of December 2019, there were abnormal cases of pneumonia in China. Some doctors believed that it was again SARS (Severe Acute Respiratory Syndrome), another form of coronavirus registered in China since the end of 2002. It lasted until 2003, it resulted in 8,098 infections and it killed 774 people in 17 countries around the world. The Chinese authorities were held responsible for the spread of the virus, because they minimized the epidemic for a long time without raising the alarm, thus contributing to fatally delaying the adoption of countermeasures.

The coronavirus outbreak is thought to have originated in Huanan Seafood Wholesale Market, in the centre of Wuhan city, where wild animals are sold. Wuhan is a city located in the centre of China, in the Hubei Province, and which has 11 million inhabitants. It is a developed and in many ways a high-tech city, and it is also an important connecting hub between major Chinese cities. The delay of the Chinese authorities in communicating the emergency was minimal, in fact on December 31st, 2019, Beijing reported the existence of the virus first to the World Health Organization (WHO), and only later to its own population. After the outbreak has been traced at the Huanan Seafood Wholesale Market, the Chinese authorities immediately closed the market on January 1st, 2020. On January

3rd, 2020 the national authorities reported a total of 44 cases of pneumonia, however the causative agent was still unknown. On January 7th, 2020, Chinese authorities identified the new virus, that initially was termed as 2019 Novel Coronavirus (2019-nCoV), which is part of the coronavirus family, such as SARS and the common cold, and that can cause a range of mild to severe respiratory illnesses. Subsequently, the novel virus was identified as Severe Acute Respiratory Syndrome Coronavirus type 2 (SARS-CoV-2), that is a betacoronavirus (β-CoV)[43]. The disease is highly contagious, and the patients infected by the virus can be both symptomatic or asymptomatic, the most common symptoms are muscle pain, fever, cough and sore throat that can degenerate in pneumonia, respiratory failure, and even death.

3.1.2 Stage II: initial progress in containing the virus

On January 20th, some Chinese experts revealed that the virus is also transmitted from human to human, in fact until that moment there was the belief that the only infected had gone or worked at the Wuhan fish market. However, after the wife of the first COVID-19 victim, a few days after her husband's death, felt the first symptoms, this belief was demystified. One of the causes of the rapid spread of the virus was that, for the celebrations due to the Chinese New Year, at least 5 million inhabitants of the city of Wuhan on January 20th had already left the city to reach either other Chinese cities or cities outside China. As a result, China has acted as it usually does, that is to proceed at full speed to remedy the problem. In fact, on January 22nd, Wuhan was quarantined together with 17 other cities, thus triggering the obligation not to leave the house, to wear masks at public locations, and to maintain the social distancing policy. In addition, all the celebrations related to the Chinese New Year were canceled, the entire national production and also the transport network were blocked. Between January 23rd and 25th, thirty out of thirty-one local administrations, except Tibet, declared the highest level of health alert. On January 26th, the General Office of the State Council issued the decision

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[43] Sohrabi C., Alsafi Z., O'Neill N., Khan M., Kerwan A., Al-Jabir A., Iosifidis C., and Agha R., "World Health Organization declares global emergency: A review of the 2019 novel coronavirus (COVID-19)," *International Journal of Surgery*, vol. 76, pp. 71 – 76, 2020.

to extend the Chinese New Year holiday and to postpone the opening of schools of every grade and of all universities. On January 31st, the WHO declared the novel coronavirus outbreak a public health emergency of international concern. The outbreak of COVID-19 in China has presented the greatest degree of difficulty and the fastest spread in controlling infections of any health emergency since the founding of the People's Republic of China in 1949, and has proven to be the most difficult virus to contain. On February 2nd, 2020, in time record, the Huoshenshan Hospital was inaugurated in Wuhan city, that housed one thousand beds and had an area of 25 thousand square meters to address the scarcity of intensive care required by the spread of the virus. The building was completed in only ten days and started to receive patients on February 3rd, 2020. On February 15th, the State Council Information Office organized its first press conference on COVID-19 prevention and control in Wuhan, and later they made progress in drug screening, development of vaccines and therapeutic regimens. On February 19th, for the first time in Wuhan, newly cured and discharged cases exceeded newly confirmed ones.

3.1.3 Stage III: newly confirmed domestic cases on the Chinese mainland drop to single digits

On February 21st, several provinces started to downgrade their public health emergency response level, and gradually lifted traffic restrictions. On February 25th, in order to minimize the cross-border spread of the epidemic, Chinese government started to tighten up border quarantine, to conduct a strict control of health and body temperature, and to carry out medical inspection, epidemiological investigation, and medical screening. On March 10, Xi Jinping, for the first time after the outbreak, went to Wuhan to inspect work on epidemic control. On March 11th, the World Health Organization, after more than 118,000 cases were counted in 114 different countries and after 4,291 people lost their lives, officially declared COVID-19 global pandemic[44]. While many countries had begun to come to terms with the coronavirus, China was slowly beginning to relieve from the emergency. Around the middle of March, Xi Jinping announced that the country was ready to restart. The recovery has been very slow and cautious, because of fears of new

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[44] World Health Organization, WHO director- General's opening remarks at the media briefing on Covid-19, 11 March 2020. https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020

cases and because many Western countries are in a period of deep crisis. At this stage, China had made significant progress. Indeed, the rapid spread of the novel virus had been contained in Wuhan and the rest of Hubei Province, so the situation in other parts of China had stabilized.

3.1.4 Stage IV: an initial victory in a critical battle

On March 19th, for the first time since the outbreak began, China recorded zero contagions in Wuhan and in Hubei province, and on March 25th Chinese authorities lifted travel restrictions in Hubei province. To prevent the new return infections, China imposed increasingly restrictive measures for those arriving from abroad, it set up body temperature screening everywhere, and it converted some old hotels into mandatory quarantine sites at travelers' expense. It then decided on March 28th to close its borders to foreigners. On April 8th, Wuhan lifted its 76-day outbound traffic restrictions, and local work and daily life began to return to normal. On April 26th, the last hospitalized COVID-19 patient in Wuhan was discharged. At this stage of the fight against COVID-19 pandemic sporadic cases were reported, and more infections were caused by inbound arrivals carrying the virus, which continued to spread overseas.

3.1.5 Stage V: Ongoing Prevention and Control

On April 29th, 2020 Xi Jinping headed a meeting of the Standing Committee of the Political Bureau of the Communist Party of China (CPC) Central Committee. In his speech, he underline that thanks to significant efforts, China had won the battle against the COVID-19 pandemic, and he emphasize that the control on the virus must continue in key regions, with a focus on inbound cases. Although the situation in China seem calm, on May 1st, 2020 the WHO announced that the novel coronavirus "still constitutes a public health emergency of international concern"[45]. On May 7th, 2020, the State Council released the Guidelines on conducting COVID-19 prevention and control on an ongoing

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[45] World Health Organization, Statement on the third meeting of the International Health Regulations (2005) Emergency Committee regarding the outbreak of coronavirus disease (COVID-19, 1 May 2020. https://www.who.int/news/item/01-05-2020-statement-on-the-third-meeting-of-the-international-health-regulations-(2005)-emergency-committee-regarding-the-outbreak-of-coronavirus-disease-(covid-19)

basis. On May 18, Xi Jinping, at the virtual event for the opening of the 73rd World Health Assembly, made a statement in which he noted that in facing COVID-19 "people have looked out for each other and pulled together as one[46]". Xi Jinping has also proposed a series of behaviours that are important to maintain: providing greater support to Africa, strengthening global governance in the public health sector, restoring economic and social development, strengthening international cooperation, and continuing to do everything possible to control and treat the novel virus. During the same event, Xi Jinping also announced that China would provide two billion dollars over two years to help with COVID-19 response in affected countries, would collaborate with the United Nations to create a global humanitarian response depot and hub in China, would establish a cooperation mechanism for its hospitals to associate with 30 African hospitals, and so on. From April 29th, inbound cases were under control. China made great efforts to resume work and to reopen schools, and life slowly began to return to normal.

3.2 The Chinese response to defeat the COVID-19 pandemic

The quarantine, and several other elements, put into practice with great determination, has allowed China to limit the infection so as to be able to face the new return infections later, those caused by the Chinese who have returned from abroad. However, from December 31st, 2019, when the WHO China Country Office was informed about a cluster of 27 pneumonia cases of unknown reason in Wuhan, to January 20th, 2020, when it was revealed that the virus was also transmitted from human to human, twenty-one days passed, that revealed an unforgivable delay in blocking the infection.

Why did the Chinese authorities not act earlier and did not immediately decide to take restrictive measures?

There are various theories that explain the delay in the reaction in the dissemination of information to citizens, probably the authorities took some time to understand what was happening. In fact, China immediately warned the WHO of the existence of an anomalous strain of pneumonia, it is no longer the China at the time of SARS in 2003. In fact, China

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[46] Ministry of Foreign Affairs of the People's Republic of China, President Xi Jinping makes statement at the virtual event of the opening of the 73rd world health assembly, 18 May 2020. https://www.fmprc.gov.cn/mfa_eng/zxxx_662805/t1780682.shtml

today is the second world power, no longer the factory of the world, and it is able to stand up to the United States and to present itself as a credible global guide alternative to what was that of Donald Trump. During the first days of the spread of the virus, what was known was practically nothing, consequently creating panic among one and a half billion people could have become a huge problem of public order. Furthermore, communications between the centre and periphery in China have always been complex. This has two consequences: in places far from Beijing we have often seen the emergence of power groups that do not follow the directives issued by the centre to the letter; local officials find it difficult to report issues that could put the stability of the country in danger. Additionally, the news of the virus began to circulate among the Wuhan authorities on the eve of the New Year, a very important holiday in Chinese culture and also the period when Beijing begins to organize the National People's Congress of the People's Republic of China (NPC) in March. According to local politicians, therefore, it was not the right time to give bad news. The mayor of Wuhan claimed that the lack of coronavirus alarm would have depended on the law that establishes that issues related to epidemics and serious health emergencies are made official by the State Council, so by the Beijing government. The official Communist Party's magazine 求是 *Qiúshì* implicitly responded to this statement in an article published a few days after the mayor's interview[47]: it claims that Xi Jinping had already ordered to contain the epidemic on January 7th, an unusual precision of a party organ that, however, indicates the central government's willingness to emphasize the responsibility of local officials in Hubei, the region to which Wuhan is part, for the initial lack of alarm, and also serves to justify their removal and their replacement with new officials. In fact, shortly thereafter, Xi Jinping replaced the leaders of Hubei and the municipality of Wuhan with a host of his loyalists. The truth about delays will be probably never be known. The fact remains that the temporal discrepancy between the communication to the world health authorities and the beginning of procedures to contain the virus has aggravated the spread of the infection. However, the measures that have been taken subsequently, that is to close the entire nation and carry

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[47] 习近平，在中央政治局常委会会议研究应对新型冠状病毒肺炎疫情工作时的讲话，求是，四月 2020. http://www.qstheory.cn/dukan/qs/2020-02/15/c_1125572832.htm

out the largest quarantine in the history of humankind, seem to have worked. In fact, after two months and with great caution, the infection seemed to have stopped. But it was not just a simple quarantine and social distancing, but a series of different factors that helped to manage the emergency. First of all, great efforts were made to improve laboratory capabilities; in fact, it took only a week to identify the virus, whereas SARS had taken two months. In addition, national authorities placed public health strategies, and assigned more than 1,800 teams of epidemiologists to track down tens of thousands of people a day in the city of Wuhan, and sent military and doctors to the field to deal with the emergency. Temperature screening were implemented through the installation of infrared thermometers in the most crowded places, such as train, subway and bus stations, ferry terminals and airport. Hospitals, medical centers and quarantine facilities were built in record time to cope with overcrowded hospitals and the lack of intensive care required, in order to try to slow down the infection. All the commercial establishments closed, except for basic necessities, so those that provide food and medicine; also schools and colleges postponed the reopening. A further measure that was taken by the Chinese government was to make daily reports on new suspected, diagnosed and asymptomatic cases and on the number of deaths. Doctors were tasked with reporting all cases electronically, and reports were generated through a system developed in 2004 after the SARS outbreak, China's National Infectious Disease Information System (IDIS). The reports are based on the National Disease Reporting System (NDRS) between the National and Provincial Health Commissions, which covers the entire population of China[48]. Furthermore, in order to avoid fake news that could create panic and to prevent the criticism of emergency management, the government has implemented a strict control of information online. Beijing has also granted incentives to the scientific community to proceed swiftly towards the discovery of a vaccine. Last but not least, the Chinese population diligently complied with all the measures imposed by the government.

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[48] Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19), 2020. https://www.who.int/docs/default-source/coronaviruse/who-china-joint-mission-on-covid-19-final-report.pdf

All these factors deal with both the structural characteristics of the country and the cultural aspects. As Simone Pieranni and Giada Messetti tell in the podcast *Risciò[49]*, the basic element of the Chinese response to the coronavirus can be summed up with the word 动员 (dòngyuán), which means mobilization. It is a concept that has to do with both communism and Confucius. According to Li Zhiyu, the term mobilization "denotes the use of an ideological system by a political party to encourage, or coerce, the members of a society to participate in certain political, economic, or social objectives, in order to achieve large-scale centralization and deployment of resources and manpower"[50]. This is what happened and is happening in facing the coronavirus. The population, in fact, despite all the criticisms, has shown itself to be inclined to respect the directives of the government. This is also due to Confucianism and the philosophy that underlies Chinese culture. In Chinese society, the individual feels part of a complex collective body in which he or she must take part by respecting social obligations. In China, the individual is subordinate to the context, and the sense of the collective good is greater than the individual good. In fact, the individual is part of a mechanism, and his role is to keep it from jamming. Chinese people have made themselves available to solve the problem. Thousands of people have risked their lives to deliver food, to check that people complied with security measures, and so on. Thanks to this collective attitude, China was able to overcome the first phase and manage the second one.

During the outbreak of the coronavirus epidemic, China witnessed a rare phenomenon: critical journalism. For example, on January 23rd, the 三联生活周刊 (Sānlián shēnghuó zhōukān) magazine published a report denouncing the shortage of beds and doctors in Wuhan hospital in the face of a very high number of people with fever[51]. There has also been a widespread use of 自媒体 (zì méitǐ), which are videos and reports shot circulated by individuals on social media. Some of these reports have been removed from the web, but many are still available. These videos made it possible to block official communications and offer a visual of what was really happening in the areas most

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[49] Messetti, G. and Pieranni, S., 2020. *La Cina e il coronavirus. Parte 1*. [podcast] Risciò. Available at: https://open.spotify.com/episode/7AOAu2lnR9fidSpqa0z3xG?si=EB68t19TQfml_1zRHpNyCA [Accessed 9 February 2021].
[50] Sorace C., Franceschini I., Loubere N., eds. *Afterlives of Chinese Communism: political concepts from Mao to Xi*, ANU Press, p. 135, 2019. http://www.jstor.org/stable/j.ctvk3gng9
[51] 张从志，武汉肺炎重症患者：一床难求，三联生活周刊，2020.01.23. https://news.ifeng.com/c/7tTLiu7tp8C

affected by the virus. Probably, the Chinese Communist Party (CCP) used journalists to understand what was happening in the country, and in this way they understood that the population was terrified by the spread of the virus, and therefore it needed to know what was really going on.

3.3 The first health emergency in artificial intelligence and big data era

Another essential element in the fight against the outbreak of COVID-19 is technology, such as the use of artificial intelligence, 5G, big data, cloud computing, that have improved in an incisive way the efficiency of China's efforts in epidemic monitoring, prevention, control, treatment, virus tracking, and resource allocation. At the beginning of February, a man, after spending the New Year's holidays with his family in Wenzhou, returned home to Hangzhou. Shortly thereafter, he received a call from the local police, as a coronavirus outbreak occurred in Wenzhou and the license plate of his car was spotted first in Wenzhou and then in Hangzhou. The police informed him that he must quarantine at home for two weeks, measure his body temperature and notify the health authorities in case of fever. After a few days, despite the obligation of quarantine, the man left the house to go out for a walk. After a few minutes, he was contacted by his employer. In fact, facial recognition cameras had seen the man far from his home and the local police contacted the company where he worked. This event shows how the means installed to ensure the safety of citizens, are also a threat to their own privacy. Indeed, all their movements are tracked by both cameras and their smartphone data. COVID-19, in fact, is the first health emergency in the era of artificial intelligence. By now, big data, artificial intelligence, video surveillance and facial recognition have been part of our life for several years. All these technologies have been used to cope with the health emergency, this has both made technological surveillance of the population even more invasive, and has allowed for further evolution of the high-tech sector. There have been several applications of artificial intelligence to defeat the coronavirus: from facial recognition and infrared scanners, to the use of AI to diagnose and detect coronavirus, the deployment of disinfection robots, big data powered maps, and so on. If the masks were missing, for example, they were produced by 3D printers. One solution adopted by China to prevent contagions has been the use of drones. In areas that were difficult to reach by the police

and the soldiers, drones were used to communicate to people the obligation to wear masks, and to communicate messages with both loudspeakers and clearly visible signs. A video in which an elderly woman in Inner Mongolia is visited by a drone to remind her the obligation to wear a mask became viral on the web, but this was not the only employment of drones[52]. In fact, multi-rotor drones, equipped with tanks and nozzles for spray delivery, have also been adopted to disinfect towns and villages[53]. Several companies active in the field of robotics have taken steps to install machines in hospitals that assist the medical staff on several sectors in a way that does not endanger their health, such as sanitizing spaces, distributing food to patients, and cleaning in areas of hospitals designated for coronavirus infected and ill patients. Another example is that telephone companies and some applications have developed a system capable of checking whether people have been close or in contact with someone who tested positive for coronavirus during their travels. Furthermore, instead of doctors, voice assistants, based on artificial intelligence, have been used to give information to people in quarantine, capable of making two-hundred calls within five minutes and suggesting treatment or immediate hospitalizations, and store data. This robotic call service can help frontline doctors to control the situation. With technologies such as speech recognition, semantic understanding, and human-machine dialogue, robots are able to understand human languages precisely, obtain basic information and provide answer[54]. Also, since the key to prevent the spread of the virus is to reduce contact between people, self-driving vehicles were used to distribute food and medical supplies, and in order to reduce the risk of contagion, leading e-commerce platforms have launched the contactless delivery. Apollo, Baidu's autonomous vehicle platform, partnered with a local self-driving startup called Neolix provided supplies and food to Beijing Haidian Hospital. This initiative helped feed over a hundred frontline staff members as they were working to treat a large number of patients. Apollo and Neolix also used their autonomous vehicles to disinfect streets in Shanghai and to control and create alerts, at night-time, to people that were not

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[52] Wang W., Man uses drone to persuade villagers to wear masks in China, South China Morning Post, February 2020. https://www.scmp.com/video/china/3048929/man-uses-drone-persuade-villagers-wear-masks-china

[53] Coronavirus: la Cina ricorre ai droni per prevenire il contagio. Il commento di ProjectEMS, Elettronicaplus.it, March 2020. http://elettronica-plus.it/coronavirus-la-cina-ricorre-ai-droni-per-prevenire-il-contagio-il-commento-di-projectems_104648/

[54] Pieranni S., Red Mirror: il nostro futuro si scrive in Cina, pag. 146-147, Editori Laterza, 2020.

respecting coronavirus prevention guidelines, such as not wearing masks and gathering in large crowds[55]. WeChat has created maps that updated the location of the infected in the different neighborhoods in real time, while China Mobile has communicated that Beijing residents would be able to monitor their movements over the past 30 days through a dedicated system. 5G networks were used in both hospitals and ambulances to allow doctors to transfer patient data as quickly as possible, in fact by the time the patient arrived at the hospital, a number of procedures, that previously took up a lot of time, had already been carried out. On the medical research side, the website of the Cyberspace Administration of China, in the article *Artificial intelligence and big data help research and development of new coronavirus drugs* (人工智能、大数据助力新型冠状病毒药物开发, Réngōng zhìnéng, dà shùjù zhùlì xīnxíng guānzhuàng bìngdú yàowù kāifā)[56], announced the launch of a plan to research and develop drugs using artificial intelligence and big data sharing platforms, as well as all sorts of research and bibliographic material. In addition, several Chinese tech companies, through their technologies, tried to understand how their contribution could help in the fight against the virus. There are many examples, from Alibaba Damo Academy to Baidu, SenseTime and others, that will be discuss later in this chapter. This healthcare emergency has shown that the Chinese are also willing to sacrifice their privacy and private sphere in the name of security, stability and improvement of their living conditions. It was President Xi Jinping himself, back in February, who issued a call to Chinese tech companies to face the epidemic. SenseTime, a leader in facial-recognition cameras, has developed a platform that can scan citizens also if they are wearing masks. The "contactless" body temperature scanning software has been deployed in subway stations, public centers in Beijing, Shanghai and Shenzhen, and also in schools. Megvii, another facial recognition company, has also developed a new system that can identify people with fever using facial and body data. This new temperature detection system has been supported by the Chinese Ministry of Science and Technology, and it is able to simultaneously check the body temperatures of fifteen people every second, even if people are wearing masks that cover their faces[57]. These

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[55] How coronavirus is accelerating a future with autonomous vehicles, MIT Technology Review, May 2020. https://www.technologyreview.com/2020/05/18/1001760/how-coronavirus-is-accelerating-autonomous-vehicles/

[56] 中共中央网络安全和信息化委员会办公室，人工智能、大数据助力新型冠状病毒药物开发，2020.02.06. http://www.cac.gov.cn/2020-02/06/c_1582531845922369.htm

[57] The AI ecosystem in China 2020, Daxue Consulting, March 2020.

companies operate within a system that relies on the state supporting private companies in implementing technologies that leverage access to personal data, for purposes that are questionable from a privacy perspective, but definitely useful in times of coronavirus. Alibaba and Tencent have activated within their platforms a system to assess the probability of contagion quantified through movements and contacts. Alibaba launched the Alipay Health Code application, which assigns each citizen a different colour: red signals citizens in supervised quarantine; yellow identifies people in self-quarantine; green indicates those with freedom of movement. In addition, the application alerts the user in case he or she has come into contact with an infected person, it selects who should stay home and who is allowed to attend public places. This application worked effectively also thanks to facial recognition cameras, voiceprints, and biometric data that together proved useful in constantly tracking the infection. In such a way, when an outbreak is spotted, it is quickly shut out. The Ministry of Industry and Information Technology, China Academy of Information and Communications Technology, and the three major national telecommunications operators China Telecom, China Mobile, and China Unicom launched the Information Big Data Itinerary Pass platform to collect data on the movements of all active telephone users[58]. The General Office of the State Council, the state-owned enterprise China Electronics Technology Group Corporations (CETC), MIIT and National Health Commission (NHC) created the Close Contact Detector service that unified all the data on contagion into a unified platform[59]. Users can scan a QR code via mobile apps like Alipay, WeChat or QQ to make an enquiry. This application pays attention, in particular, to public transport records, that include both trains and flights. In addition, the mandatory linking of one's ID card, phone account and social accounts allowed for unequivocal tracking of individuals. Baidu, has also leveraged AI-powered mapping systems to identify the flow of travels across high-risk areas using its Baidu

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[58] "Gongxin bu "tongxin das huju xingcheng ka" fuwu shangxian quanguo yiti hua zhengwu fuwu pingtai" "工信部"通信大数据行程卡"服务 上线全国一体化政务服务平台", *Xinhua*, April 2020. http://m.xinhuanet.com/2020-04-09/c_1125832845.htm

[59] China introduces novel coronavirus close contact detection app, Xinhua, February 2020. http://www.xinhuanet.com/english/2020-02/10/c_138770415.htm

Maps "migration big data platform"[60]. Thanks to this system, it is possible to build an approximate picture of the migration of people, and it is also possible to obtain real-time information on the spread of the virus. Dynamic experimentation with online education platforms was then initiated, which saw exponential growth in supply and demand. China has been investing in virtual conferencing and e-learning for a while, and following the closure of schools and offices there has been a sharp increase in the use of these platforms. Schools have used ready-made software that allows several students to be connected at the same time, providing the teacher with all the necessary data, including that recorded by cameras on the attention shown by students during the lesson. SenseTime has also used cutting-edge technology to allow students to take free online course on artificial intelligence. SenseTime also unveiled an online AI learning platform that can help students study at home. In fact, the company planned to provide both teachers and students with high-quality educational resources during the pandemic.

The power of Chinese apps has been presented by the Chinese government and operators as a great service in an emergency situation. Artificial intelligence solutions to COVID-19 in China were born from the need to cope with an unprecedented situation, which was defined by the WHO as the greatest global crisis after the Second World War. In our eyes it may seem like an invasion of privacy, but in China it has turned out to be a positive move to reassure people. It is impossible to know when the pandemic will end, however it is certain that the technologies used to defeat the virus will last.

3.5 Case studies

The main challenges countries have faced and are facing during the current health crisis are: how to track contacts in a way that limits the spread of the virus; how to effectively screen people with symptoms and correctly diagnose the virus; how to ensure that patients receive prompt and appropriate care amidst the rapid spread of the virus and in the face of limited resources; how to address labor shortages in the areas most affected by the virus; and how to ensure that society continues to operate in relative safety. Lots of attempt have been paid for solutions to fight against the COVID-19 outbreak, and

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[60] 2020 Retrospective: Baidu's AI innovations, Baidu Research, January 2021. http://research.baidu.com/Blog/index-view?id=149

technology plays an important role in containing the pandemic. The involvement of giant tech companies is needed because they can support in an efficient way researchers, doctors and scientists to expedite the research and development of COVID-19.

In order to deeply understand the importance that technology had in the fight against coronavirus disease 2019, I will analyze a three way in which the use of artificial intelligence and big data has been essential: contact tracing, surveillance and body temperature screening and diagnosis.

3.5.1 Contact tracing

As the information is significant for public health authorities to contain the pandemic, contact tracing is extremely important in an outbreak for public health to help getting care to infected persons[61]. In early stages of an outbreak, so when specific treatments are limited, contact tracing can be the main public health response strategy to identify potentially infected individuals before severe symptoms emerge[62]. It consists of three steps: contact identification, contact listing and contact follow-up. Contact tracing is one of the measures that Chinese government has adopted to reduce the spread of the epidemic, and as a report of the European Centre for Disease Prevention and Control illustrates, its aim is to "rapidly identify potentially newly infected persons who may have come into contact with existing cases, in order to reduce further onward transmission"[63]. The main example of using big data and digital technology to implement COVID-19 epidemic control, to limit people's movement and to improve public health management is contact tracing through Health Code (健康码, Jiànkāng mǎ). The Health Code system was developed by both Chinese institutions and private companies such as Ant Financial, a subsidiary of Alibaba and focuses on finance and e-commerce, and Tencent, which is well known for WeChat and QQ. The original intention of developing this system was to

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[61] Agbehadji I.E., Awuzie B.O., Ngowi A.B., Millham R.C., "Review of big data analytics, artificial intelligence and nature-inspired computing models towards accurate detection of COVID-19 pandemic cases and contact tracing", *International Journal of Environmental Research and Public Health*, 2020; 17(15):5330. https://doi.org/10.3390/ijerph17155330

[62] Keeling M.J., Hollingsworth T.D., Read M.J., "The efficacy of contact tracing for the containment of the 2019 Novel Coronavirus (COVID-19)", *Journal of Epidemiology and Community Health*, February 2020. doi: https://doi.org/10.1101/2020.02.14.20023036

[63] *Contact tracing for COVID-19: current evidence, options for scale-up and an assessment of resources needed*, European Centre for Disease Prevention and Control, April 2020.

replace paper certificates, and on February 9th, 2020 both Alibaba and Tencent launched their Health Code applications.

Figure 8: Alipay Health Code

Alipay Health Code it was initially adopted in the city of Hangzhou in Zhejiang Province, before being used in many other provinces and municipalities across the nation, such as Shanghai, Chongqing, Sichuan and Zhejiang. Citizens sign up through Alipay, an online payment app, and after entering their personal information into the app, including medical information, travel history and COVID-19 contact history, they receive a QR (Quick Response) code that can be of three different colors corresponding to the individual's health status: green, yellow or red. If the QR code is green, the citizen can move freely by scanning the code at the entrance of places such as apartment buildings, offices, shopping malls and supermarkets. If the code is yellow, it means that a contact with a person affected by COVID-19 has been detected, so the citizen must remain in preventive quarantine at home. If the QR code is red, there is a high risk of infection and medical personnel should be contacted. After authorizing access to their data, including information about recent travel and health conditions, users allow a part of the app's program, "*Report Info And Location To Police*", to transmit the name of the city, their location and the ID code number to a law enforcement server. As a result, the Chinese

government is constantly updated on the movements of all individuals[64]. Moreover, since every user has to scan his or her QR code before entering any public place, the government is able to reconstruct the contact network of citizens and people infected by COVID-19 quickly, so that, it can intervene immediately in case of a travel violation.

Figure 9: Alipay Health Code's functions
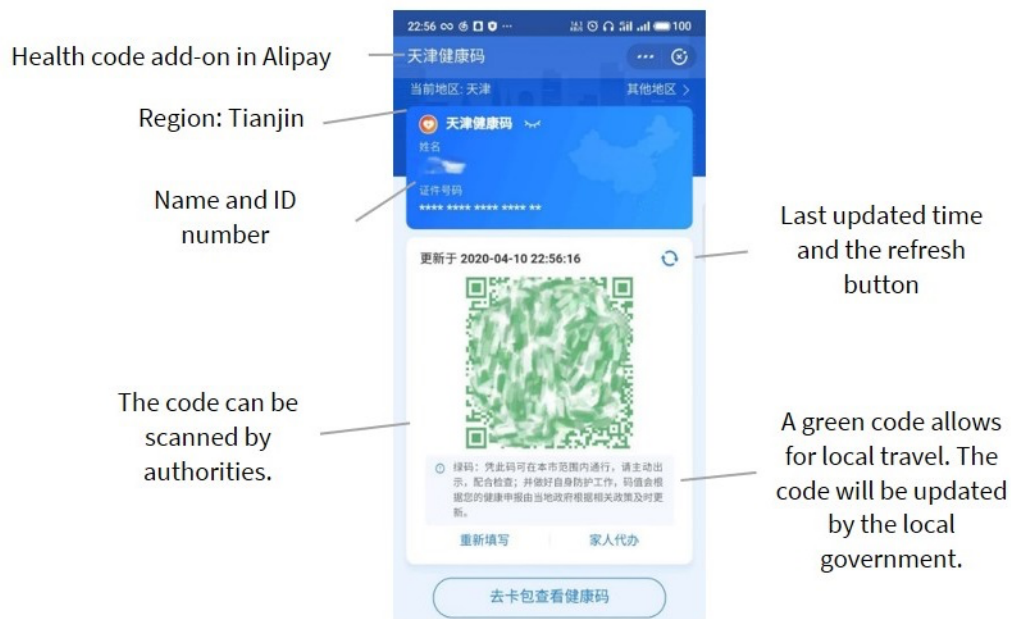
Source: Shining Tan, *China's novel health tracker: green on public health, red on data*, Center for Strategic and International Studies.

The development and launch of the health code system has been fueled by the strong competition between the two Chinese leading tech companies, Alibaba and Tencent. Tencent has launched its Health Code first in Shenzhen, where the company have its headquarter, then other provinces and municipalities, with the help of WeChat, have created other versions of Health Code, different from Alipay's. Strong competition from these two tech giants and broad support from local governments across the country have, however, allowed a rapid expansion of the Health Code system. Individuals can apply for the Tencent-developed Health Code through the "epidemic prevention information code" and entry in WeChat's "national government services health code platform" mini-

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[64] Mazzarella M., *La Cina e le applicazioni per ridurre il contagio: quali tutele per la privacy durante la pandemia?*, Istituto di Ricerche sulla Pubblica Amministrazione, 2020. https://www.irpa.eu/la-cina-e-le-applicazioni-per-ridurre-il-contagio-quali-tutele-per-la-privacy-durante-la-pandemia/

program. After authenticating with their real name and simply reporting their personal health status, users can apply for epidemic prevention information code.

Figure 10: Health Code on WeChat

The 47th China Statistical Report on Internet Development[65], published by China Internet Network Information Center, shows that during the prevention and control of the coronavirus disease 2019 outbreak, the Health Code was requested by almost 900 million people and was used more than 40 billion times.

Health Codes played a very important role in the gradual lifting of travel restrictions in Hubei Province, where movement had been restricted to almost 60 million people following the impediments imposed at the end of January. On March 10th, 2020 the province issued its own Health Code for residents who wanted to travel within the province. However, one of the biggest problems that they met in using this technology is

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[65] 中华人民共和国国家互联网信息办公室，第 47 次中国互联网络发展状况统计报告，2021 年 2 月. http://www.cac.gov.cn/2021-02/03/c_1613923423079314.htm

moving between regions; in fact, not all cities and provinces recognize each other's Health Codes. This is due to the fact that Health Codes are based on different COVID-19 databases created by local authorities, even though the codes are developed by the same companies. To cope with this problem, basic data sharing and mutual recognition have been realized by making use of the support of data sharing on the National Integrated Government Service platform. The realization of a set of national standards provides technical support to accelerate cross-regional mutual recognition of Health Codes in various regions. On March 21st, 2020, during a State Council Joint Prevention and Control Mechanism Press Conference, Mao Qun'an said that China offers three paths for cross-province mutual recognition and sharing across localities[66]: to add cross-regional mutual recognition to local health pass codes through data sharing of cross-regional epidemic prevention and health information without changing the existing local health pass codes; to realize cross-regional mutual recognition of health pass codes by docking local health pass codes with the epidemic prevention information codes on the national integration platform and using them as intermediaries for conversion; to adopt the epidemic prevention information codes on the national integration platform in regions that have not established local health codes.

On April 29th, 2020 the three national standards of "health information code reference model", "personal health information code data format" and "personal health information code application interface" were released, in the attempt to unify the code and display system[67]. However, there are some provinces and cities that still have an "access code". This is due to the fact that epidemic prevention and control policies differ from region to region. As a consequence, it is very complex to combine the epidemic prevention and health information catalogues of the various regions into one integrated national platform. Health Code also raises concerns about accuracy, privacy and security; it poses a threat to data security and reflects tensions between public values and privacy. The New York Times claims that this is a "bold mass experiment in using data to regulate citizens' lives" and also that this is an operation that risks "setting new forms of automated social control

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[66] 健康码：让复工复产按下快捷键，光明日报，2020 年 3 月 22 日. http://www.gov.cn/xinwen/2020-03/22/content_5494086.htm

[67] 彭训文，健康码累计申领近 9 亿人使用超 400 亿人次，人民日报海外版，2021 年 3 月 1 日. http://www.ce.cn/cysc/tech/gd2012/202103/01/t20210301_36345645.shtml

that could persist even long after the epidemic subsides"[68], in fact there are many questions about the protection of privacy, and people are concerned that this mass data collection could be accepted, even after the COVID-19 has become less of a threat to the public, as a norm[69]. There have been complaints from Chinese social media users about the lack of transparency on how the app works and how it collects user data. In fact, it is not clear who is in control of data flows, who owns user health data, and how Health Code is regulated by governments. Furthermore, there is the fear that once a technology is built and data gathered, it might be used for many purposes beyond that for which it was originally intended[70].

3.5.2 Surveillance and body temperature screening

Surveillance cameras and body temperature screening tools were another way of using AI in the fight against COVID-19 in China. Body temperature screening was essential to detect symptoms and to isolate individuals who were suspected to be infected. Since elevated body temperatures is one of the key symptoms of the coronavirus disease 2019, the implementation of thermal cameras helped to identify people with fever accurately and quickly. Chinese state and non-state entities both have stepped up efforts to provide hospitals, public places and local authorities with AI surveillance technology, aiming to improve monitoring and tracking of sick persons in medical and non-medical environments[71]. Some of the companies that have developed surveillance and body temperature screening tools are SenseTime, Baidu and Megvii.

SenseTime is a world-leading artificial intelligence company that is specialized in computer vision, face recognition and deep learning. Nowadays, SenseTime is one of the largest algorithm provider in China and the fifth largest AI platform. It was established in Hong Kong in October 2014, and in only four years it passed from an academic project

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[68] Krolik A., Mozur P., Zhong R., *In coronavirus fight, China gives citizens a color code, with red flags*, The New York Times, March 2020. https://www.nytimes.com/2020/03/01/business/china-coronavirus-surveillance.html#:~:text=People%20in%20China%20sign%20up,rolled%20out%20nationwide%2C%20Ant%20says.

[69] Yu A., "Digital surveillance in post-coronavirus China: a feminist view on the price we pay", *Gend Work Organ.*, June 2020; 10.1111/gwao.12471. doi:10.1111/gwao12471

[70] Dubal V., The expansion of mass surveillance to stop coronavirus should worry us all, The Guardian, April 2020. https://www.theguardian.com/commentisfree/2020/apr/18/mass-surveillance-coronavirus-technology-expansion

[71] Weinstein E., *China's use of AI in its COVID-19 response*, CSET Data Brief, August 2020.

to the world's most valuable artificial intelligence company[72]: nowadays, it is valued over 7.7 billion dollars. SenseTime has been able to grow so quickly partly thanks to the support of the government itself, and direct access to China's databases regarding its residents. During the outbreak of COVID-19 pandemic, SenseTime developed the Smart AI Epidemic Prevention Solution with the purpose to help control the spread of the virus across China[73]. SenseTime's solution consist in a system of screening and detection of suspected carriers of COVID-19 in public spaces. This system is able to scan ten people per second without direct contact and to identify individuals that display symptoms of a fever. It is applied in crowded places, such as subway station, community center and school, and it improves the efficiency of fever screening and minimizes the risk of cross-infection among citizens. The Smart AI Epidemic Prevention Solution integrates sophisticated AI algorithms with infrared thermal technology, so it can detect the forehead temperature within an accuracy of 0.3°C. It can also identifies all individuals that are not wearing a mask with a success rate over 99% and sends notification, and it allows administrators to retrieve and search for previous records of the temperature screening and mask identification. Thanks to this system, people, being aware that Smart AI Epidemic Prevention Solution will identify symptoms and people who do not wear masks, are more comfortable to continue their daily lives. Furthermore, its software can identify people, with high accuracy, even if they are wearing masks[74]. This system is useful, for example, for building access control, since people started to return to offices, because it allows employees, that have the obligation to wear masks, to be identified. This system is able to read the facial characteristics that are not covered by the mask, such as eyes and eyebrows. The general manager of SenseTime's education department, Dai Juan, said that artificial intelligence has played a key and an active role in fighting the epidemic, including the use of big data to control the epidemic and facilitate disease screening and

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[72] Marr B., Meet the world's most valuable AI startup: China's SenseTime, Forbes, June 2019. https://www.forbes.com/sites/bernardmarr/2019/06/17/meet-the-worlds-most-valuable-ai-startup-chinas-sensetime/
[73] SenseTime 'Smart AI epidemic prevention solution' helps control coronavirus cross-infections, SenseTime, February 2020. https://www.sensetime.com/en/news-detail/3783?categoryId=1072
[74] Li J., *China's facial-recognition giant says it can crack masked faces during the coronavirus*, Quartz, February 2020. https://qz.com/1803737/chinas-facial-recognition-tech-can-crack-masked-faces-amid-coronavirus/

diagnosis[75]. This has shown how artificial intelligence has become a new type of productivity for social development.

To safely re-open businesses, accurate and efficient screening is critical. Baidu has also developed an AI-based body temperature measurement system that quickly and easily monitors people's temperatures. This system, as well as SenseTime's, has also been adopted in train and subway stations, and has become an effective anti-epidemic technology. Baidu, is constantly evolving in this area. With Baidu's AI infrared vision technology, crowds can be quickly screened to improve detection efficiency and accuracy, thereby reducing the risk of cross-infection[76], as Haifeng Wang, CTO at Baidu, said: "traditional approaches, such as station personnel using frontal medical thermometer devices, can easily cause crowds and increase the risk of cross-infection. Baidu's AI temperature sensor system can quickly screen crowds to improve detection efficiency and accuracy without creating unnecessary risks"[77].

Another Chinese artificial intelligence company specialized in facial recognition is Megvii Technology Limited, that was founded in 2011 in Beijing. On February 7th, Megvii announced that it built a solution that it is able to integrate body detection, face detection and dual-sensing through infrared cameras and visible light. The system can monitor the body temperature of fifteen people per second simultaneously, even when they are wearing masks or hats[78]. This new temperature control system was used for the first time on February 4th at the subway station in Haidian District, Beijing. With fever being one of the main symptoms of COVID-19, contactless body temperature screening has been a very effective tool in containing the spread of the virus, making it safer and more efficient than manual thermometers since it eliminates the need for close physical contact between individuals[79].

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[75] Si M., SenseTime uses AI to fight novel coronavirus outbreak, chinadaily.com, February 2020. https://global.chinadaily.com.cn/a/202002/20/WS5e4e2b1aa31012821727902c.html

[76] Liang V., Baidu's AI-related patented technologies: doing battle with Covid-19, Wipo Magazine, June 2020. https://www.wipo.int/wipo_magazine/en/2020/02/article_0003.html

[77] How Baidu is bringing AI to the fight against coronavirus, MIT Technology Review, March 2020. https://www.technologyreview.com/2020/03/11/905366/how-baidu-is-bringing-ai-to-the-fight-against-coronavirus/

[78] Shen X., Megvii denies its facial recognition can identify you with a mask on, South China Morning Post, 2020-02-12. https://www.scmp.com/abacus/news-bites/article/3050314/megvii-denies-its-facial-recognition-can-identify-you-mask

[79] Megvii deploys AI-enabled temperature screening solution to protect essential personnel and communities during Covid-19, Cision PR Newswire, April 2020. https://www.prnewswire.com/ae/news-

3.5.3 Diagnosis

During the outbreak of COVID-19, there were several private companies that contributed in the fight against the novel virus. This was also due to President Xi Jinping's call to action, in particular Chinese tech giants take the lead in the war against the pandemic, especially in developing diagnosis tools using artificial intelligence. Actually, in the fight against COVID-19 pandemic, it is vital to mitigate the impact of the virus developing efficient diagnostic tools and treatment methods[80].

Alibaba DAMO Academy, which is Alibaba Group's research and innovation institute, together with Alibaba Cloud, have developed a technology that can analyze CT images within 20 seconds for diagnosing suspected novel coronavirus cases with an accuracy rate of 96%, a procedure that usually takes around five to ten minutes.

The AI system identifies the novel virus through computed tomography scans of the chest. The algorithm has been trained on data and CT scans from more than 5,000 confirmed coronavirus cases so far, and taps into deep learning to study patterns of infection. In an interview with Alizila[81], Xu Mingfeng, that is a DAMO's AI-algorithm expert, said that Damo team started to train its algorithms two weeks right after the lockdown was imposed in Wuhan city. In the past the team had already been doing AI-enabled medical-imaging work, especially in the field of common respiratory diseases, so it took only five days to develop an AI system able to track treatment responses in confirmed cases and to provide diagnoses for suspected cases. Artificial intelligence is essential in terms of time and precision, normally a CT machine produces from 300 to 400 chest scans to start the diagnosis of novel coronavirus disease 2019, and then a doctor takes from ten to fifteen minutes to go through such massive amounts of information. During a pandemic, time is even more precious than usual, so any technology that can help better manage the epidemic, especially in the medical field, is essential. One of the first hospital that has introduced this AI algorithm to aid clinical diagnosis is Qiboshan Hospital in Zhengzhou,

releases/megvii-deploys-ai-enabled-temperature-screening-solution-to-protect-essential-personnel-and-communities-during-covid-19-879970836.html

[80] Pham Q., Nguyen D.C., Huynh-The T., Hwang W., Pathinara P.N., "Artificial intelligence (AI) and big data for Coronavirus (COVID-19) pandemic: a survey on the state of the arts", *IEEE Access*, vol. 8, pp. 130820-130839, 2020, doi: 10.1109/ACCESS.20203009328.

[81] Li C., How Damo academy's AI system detects coronavirus cases, Alizila, March 2020. https://www.alizila.com/how-damo-academys-ai-system-detects-coronavirus-cases/

and according to Alibaba the system will be adopted in more than 100 hospitals in the regions of Anhui, Hubei and Guangdong.

As soon as the COVID-19 outbreak broke out, Alibaba Group immediately set out to help with the spread of the virus. In addition to the development of this system, Jack Ma, the founder of Alibaba Group, donated 24 million dollars to address the outbreak. The company also donated 144 million dollars to provide medical supplies to Hubei Province[82]. This new diagnostic system is not Alibaba's only attempt to face the virus; in fact, researchers at Damo Academy have also developed a public health service tool, also based on AI, that provides information related to COVID-19. Although Alibaba is known for its e-commerce and online payment platforms, the company's cloud division has continued to make strides in genomic research since 2015.

In addition to Alibaba, Ping An Smart Healthcare, a team under Ping An Insurance (Group) Company of China Ltd., which is a world-leading technology-powered retail financial services group with over 210 million retail customers and 560 million Internet users[83], has also developed a system similar to the one of Damo Academy. Ping An's system relies on artificial intelligence to detect the virus from computed tomography images. Ping An's healthcare team said that AI analysis engine can conduct a comparative analysis of multiple CT scan images of the same patient while measuring the changes in lesions. Their system can also help doctors in tracking the development of the disease, evaluating treatment and making prognoses for patients.

Research giant Baidu has made its RNA prediction algorithm, LinearFold, open source to help researchers and medical and scientific teams predict the secondary structure of virus RNA in significantly faster time than traditional algorithms. In fact, the overall analysis time has been reduced from 55 minutes to 27 seconds[84]. In addition, Baidu has partnered with LinkingMed, a Beijing-based oncology data platform, to develop an open source AI model for analyzing CT images of pneumonia. This model is powered by PaddlePaddle, a Baidu's open source deep learning platform. Leveraging PaddlePaddle,

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[82] Das S., How Alibaba is leading the war against coronavirus outbreak, Analytics India Magazine, March 2020. https://analyticsindiamag.com/how-alibaba-is-leading-the-war-against-coronavirus-outbreak/
[83] Ping An accelerates digital innovations in response to Covid-19, Cision PR Newswire, September 2020. https://www.prnewswire.com/news-releases/ping-an-accelerates-digital-innovations-in-response-to-covid-19-301133820.html
[84] How Baidu is bringing AI to the fight against coronavirus, MIT Technology Review, March 2020. https://www.technologyreview.com/2020/03/11/905366/how-baidu-is-bringing-ai-to-the-fight-against-coronavirus/

LinkingMed developed a pneumonia screening and lesion detection system that relies on artificial intelligence. It has been used in a hospital affiliated with Xiangnan University in Hunan Province, and has a detection accuracy of 92% and a recall rate of 97% on test datasets. The platform is also used to support clinical research related to COVID-19. Baidu's ability to respond quickly to the health crisis has been made possible by its long-distance investment in cutting-edge research and development.

SenseTime has also been working with hospitals and medical institutions in Hubei Province and other cities across China with the purpose to understand how AI could be leveraged to help diagnose COVID-19. Within a short period of time, the company developed SenseCare, an AI-assisted intelligent diagnosis application for both common lung diseases and COVID-19, through which the burden on medical staff during the outbreak could be alleviated and diagnostic procedures accelerated. SenseCare was provided, free of charge, by the company and has been used in hospitals in Hubei Province and other hospitals and medical institutions in several Chinese cities, such as Shanghai, Beijing and Tianjin by collaborating with the medical imaging cloud service platform. With the help of AI algorithms, the system provides doctors with auxiliary diagnostic results that can quickly identify suspicious lesions from CT images. Furthermore, SenseCare can also measure the quantity and severity of pulmonary involvement in the disease to provide physicians with a comprehensive analysis of the results. Dr. Zhang Shaoting, vice president and deputy head of research at SenseTime, said "our goal is to develop AI for good and it is encouraging that AI technologies are helping to support doctors during the crisis"[85].

Another Chinese artificial intelligence startup is Beijing Infervision Technology, that was founded in 2015. It is specialized in deep learning technology and computer vision to help diagnose cancer and other diseases, and to help in the fight against COVID-19 it has developed Inferread CT Pneumonia reading software to detect lesions from possible pneumonia caused by COVID-19, and the all whole process takes only 10 seconds. On March 5, 2020 the Infervision's system was deployed in 34 hospitals across China[86].

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[85] Doctors leverage SenseTime AI to improve and accelerate covid-19 testing, SenseTime, February 2020. https://www.sensetime.com/me-en/news-detail/23875?categoryId=21072

[86] Mak E., China uses AI in medical imaging to speed up covid-19 diagnosis, BioWorld, March 2020. https://www.bioworld.com/articles/433530-china-uses-ai-in-medical-imaging-to-speed-up-covid-19-diagnosis

These are only a few Chinese companies that developed new technologies to face the virus, but there are many other more, for example AI startup Deepwise Technology developed the Dr. Wise cloud+whole lung AI-aided medical diagnosis system, Iflytek Science and Technology developed an AI-based COVID-19 diagnosis platform with the Chinese Academy of Sciences, and Shanghai Yitu Information Technology has also introduced a scan-reading system.

Chapter 4

General impact of artificial intelligence and public perception

One purpose of the New Generation Artificial Intelligence Development Plan, released in July 2017, was to emerge China as a driving force in setting ethical norms and standards for artificial intelligence.

In March 2019, in order to better coordinate the relationship between AI development and governance, and to ensure that artificial intelligence is safe, reliable and controllable, China's Ministry of Science and Technology established the National New Generation Artificial Intelligence Governance Expert Committee that, on June 17th, 2019, released the Governance Principles for a New Generation of Artificial Intelligence: Develop Responsible Artificial Intelligence (新一代人工智能治理原则——发展负责任的人工智能, Xīn yīdài réngōng zhìnéng zhìlǐ yuánzé——fāzhǎn fù zérèn de réngōng zhìnéng)[87]. The eight principles, listed in this document, that all parties involved in the development of artificial intelligence should follow are the following ones: harmony and friendship, fairness and justice, tolerance and sharing, respect for privacy, security and control, shared responsibility, open collaboration, and agile governance.

Furthermore, the Big Data Security Standards Special Working Group of the National Information Security Standardization Technical Committee of the People's Republic of China released a white paper on AI standards[88]. According to the White Paper on Artificial Intelligence Security Standardization, the three key principles for setting the ethical requirements of AI technologies are:

1. The principle of human interest, which states that the ultimate goal of AI is to benefit human welfare; according to this principle, laws and policies should promote the education on awareness on artificial intelligence's ethics and safety

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[87] 中华人民共和国科学技术部，发展负责任的人工智能：新一代人工智能治理原则发布，2019 年 06 月 17 日. http://www.most.gov.cn/kjbgz/201906/t20190617_147107.htm

[88] 全国信息安全标准化技术委员会，大数据安全标准特别工作组，*Rengong zhineng anquan biazhunhua baipishu* 人工智能安全标准化白皮书 (Artificial Intelligence Security Standardization White Paper), 2019.

for individuals in society, should dedicate to the construction of the external social environment for the development of AI, and should control that society guard itself against the risk of abuse of AI technologies.

2. The principle of liability emphasizes the need to establish accountability as a requirement for both the development and deployment of AI systems and solutions; under this principle, technology development and applications should also follow both the principle of transparency and the principle of equal rights and responsibility.

3. The principle of consistency of rights and responsibilities emphasizes that necessary business data should be properly recorder and that commercial entities should be able to protect their intellectual property rights. This principle has not yet been completely implemented by the business community and the government in the practice of ethics[89].

It is very important to release ethical standards on the development of artificial intelligence because the impact that it has on society is enormous. In fact, it is transforming several sectors such as agriculture, retail, finance, education, logistics and so on. According to some data reported by the International Data Corporation (IDC) in 2017[90], the next five years would see the improvement of the efficiency of AI applied to related industries, 82% for education, 71% for retail, 64% for manufacturing, 58% for finance, 52% for healthcare, and 45% for government.

The purpose of AI is not to replace human beings, but to free them from the most dangerous, mechanical and repetitive jobs and support them in their work to improve their efficiency. For example, in education, it is about tailoring teaching in such a way that students can maintain a high level of interest in learning, while also increasing efficiency. AI can help reduce teacher workload through optimize courses, answer question, analyze student behaviour, but it can not replace them. In fact, any technology can not provide the emotional support that teachers humans can give. However, since artificial intelligence is a relatively modern field and not yet known in all its aspects, and having science fiction

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[89] Ding J., Triolo P., Translation: Excerpts from China's "White Paper on Artificial Intelligence Standardization", New America, June 2018. https://www.newamerica.org/cybersecurity-initiative/digichina/blog/translation-excerpts-chinas-white-paper-artificial-intelligence-standardization/

[90] IDC releases white paper on artificial intelligence: information flow leads to a new era, Programmer Sought, 2017. https://www.programmersought.com/article/56014556867/

helped to bring out doubts and fears about it, the perceptions of AI are very discordant. Among the greatest doubts of ordinary people on the use of artificial intelligence are, above all, the impact it will have on privacy and security.

4.1 Artificial intelligence's impact on privacy

One of the most popular question and doubt about artificial intelligence and big data that affects the majority of people is: how to protect our privacy when using AI products?

In the 2018 China Economic Life Survey, 76.3% of respondents said they thought some applications of artificial intelligence would compromise their privacy, and more than 30% also worried that AI would threaten their livelihoods[91].

The issue of privacy protection in China is a rather sensitive one, in fact there is a debate on what types of data should be protected. Chinese legislative process on personal information's protection began in November 2016, when the Standing Committee of the 12th National People's Congress adopted the Cybersecurity Law, which entered into force on June 1st, 2017. For the first time in China's law history, in chapter VII Article 76.5 of the Cybersecurity Law, were provided a definition of "personal information" (个人信息,

Gèrén xìnxī): "all kinds of information, recorded electronically or through other means, that taken alone or together with other information, is sufficient to identify a natural person's identity, including, inter alia, name and surname, date of birth, identification number, biometric data, address and phone number"[92]. In addition to prohibiting online service providers from collecting and selling users' personal information without their consent, this Law also establishes basic privacy requirements, such as prohibiting network operators from collecting data that is not relevant to their services, prohibiting the sharing of identifiable data without consent and the requirement to companies to safeguard personal data[93].

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[91] Hersey F., Almost 80% of Chinese concerned about AI threat to privacy, 32% already feel a threat to their work, Technode, March 2018. https://technode.com/2018/03/02/almost-80-chinese-concerned-ai-threat-privacy-32-already-feel-threat-work/

[92] Creemers R., Triolo P., Webster G., Translation: Cybersecurity Law of the People's Republic of China (effective June 1, 2017), New America, June 2018. https://www.newamerica.org/cybersecurity-initiative/digichina/blog/translation-cybersecurity-law-peoples-republic-china/

[93] Sheng W., One year after GDPR, China strengthens personal data regulations, welcoming dedicated law, TechNode, June 2019. https://technode.com/2019/06/19/china-data-protections-law/

During the COVID-19 pandemic, the Chinese government used big data analysis and artificial intelligence tools to monitor Chinese citizens through facial recognition technology or private smartphone tracking. On the one hand, the use of these technologies has led to enormous benefits, such as identifying citizens who have contracted the coronavirus disease 2019 in order to contain the disease; on the other hand, the use of these advanced technologies can harm the people being monitored, or violate privacy and confidentiality rights and individual freedoms in morally problematic ways.

According to the South China Morning Post, three out four people in China are worried about the threat that artificial intelligence poses to their privacy[94].

In 2018, Robin Li, Baidu's founder, declared: "Over the past few years, China has also become increasingly aware of this problem [data protection], and has been enforcing relevant laws and regulations, during the process of which, I think that the Chinese people are more open, or not so sensitive, about the privacy issue. If they are able to exchange privacy for convenience or efficiency, they are willing to do so in many cases"[95]. After Li's statement, many netizens felt outraged, and following some high-profile data breaches and scams, they started demanding more and more stringent privacy laws[96]. The Internet Society of China, after made a questionnaire, said that 54% of respondents believe issues concerning personal data breaches are "severe"[97]. So, China has begun to implement privacy protection measures. In May 2018, the Personal Information Security Specification (信息安全技术　个人信息安全的规范, Xìnxī ānquán jìshù gèrén xìnxī ānquán de guīfàn) was released, and it was meant to elaborate on the broader privacy rules, which were established in the 2017 Cyber Security Law[98]. The Personal Information Security Specification is considered one of the most similar to the European

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[94] Soo Z., The increasing use of artificial intelligence is stocking privacy concerns in China, South China Morning Post, March 2018. https://www.scmp.com/business/companies/article/2135713/increasing-use-artificial-intelligence-stoking-privacy-concerns

[95] Baidu chief under fire for privacy comments, CRI Online, 28 March 2018. http://en.people.cn/n3/2018/0328/c90000-9442509.html

[96] Golley J., Javin L., Hillman B., Strange S., eds. *China Dreams*, Anu Press, p. 148-149, 2020.

[97] Sun Y., "China's citizens do care about their data privacy, actually", MIT Technology Review, 28 March 2018. https://www.technologyreview.com/2018/03/28/67113/chinas-citizens-do-care-about-their-data-privacy-actually/

[98] Huw R., Cowls J. Et al., "The Chinese approach to artificial intelligence: an analysis of policy, ethics, and regulation", *AI & Society* 36:59-77, 2020. https://doi.org/10.1007/s00146-020-00992-2

General Data Protection Regulation. The Specification that covers the collection, use, storage, sharing, transfer and disclosure of personal information was readapted in 2020. The 2020 version of the Specification pays more attention to protecting people's rights and interests, reflecting the latest regulatory trends[99]. The main changes that have been implemented from the previous version include: addition of "voluntary selection of multiple business functions"; "exceptions to consent"; "restrictions on use of User Profiling"; "use of Personalized Display"; "convergence and consolidation of Personal Information (PI) collected for different business purposes"; "third-party connection management"; "clarification on departments and personnel"; "PI security engineering"; "recording of PI processing activities"; revisions to "exceptions to soliciting Consent"; refinements with respect to personal biometric information[100].

During the first press conference of the second session of the 13th National People's Congress in March 2019, Zhang Yesui, the spokesperson of the conference, said that the formulation of the personal data protection law was included in the legislative plan, in fact, a secure and standardized network was an inevitable requirement for healthy and orderly development and to avoid violations of citizens' privacy and rights[101].

In May 2019, the Beijing Academy of Artificial Intelligence and the Chinese Ministry of Science and Technology published the Beijing AI Principles, that marked the importance of AI to be open, responsible, diverse and beneficial for humanity. On September 4th, 2020, President Xi announced the creation of a Special Economic Zone entirely dedicated to big data technologies and digital trade[102], while foreign minister Wang Yi announced a global data security initiative whose details have not yet been disclosed[103].

A draft of a data security law, the Personal Information Protection Law (PIPL), was submitted to the National People's Congress on October 13th, 2020, and it was published

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[99] 陈际红，吴佳蔚，杨润，全景解读 2020 版《个人信息保护规范》重要变化，中伦资讯，2020 年 3 月 11 日．http://www.zhonglun.com/Content/2020/03-11/1841330819.html

[100] Ross L., Zhou K., Liu T., China Issues New Personal Information Security Specification, WilmerHale, March 2020. https://www.wilmerhale.com/en/insights/client-alerts/20200324-china-issues-new-personal-information-security-specification

[101] 张艳玲，张业遂：制定个人信息保护法已列入本届立发规划，中国网，2019 年 3 月 4 日. http://www.china.com.cn/lianghui/news/2019-03/04/content_74529251.shtml

[102] Beijing plans to build a pilot digital trade zone, China Global Television Network, September 2020. https://news.cgtn.com/news/2020-09-07/Beijing-to-build-pilot-digital-trade-zone-big-data-exchange-TAnxSsh96M/index.html

[103] Agamennone E., et al., *La Cina: sviluppi interni, proiezione esterna, Parte III: La Cina e l'innovazione*, Osservatorio di Politica internazionale, Ottobre 2020, p. 13.

for public consultation. The style of the draft of the PIPL is reminiscent of the European General Data Protection Regulation (GDPR) in many aspects, but the substance is not identical. However, what is certain is that the GDPR has strongly influenced the Chinese government in drafting the Personal Information Protection Law. This Law will further promote the commercial use of data while outlining privacy protection mechanisms. For some time now, digital privacy in China has been the subject of numerous debates, especially as buyers are often scammed due to the sale of user data. The PIPL will be the first organic and systematic law on data protection[104], and it will be applicable to every organization and individual that processes personal data in China. With this law, China has taken a first important step towards recognizing a right to the protection of personal data. The draft law provides considerable penalties for serious violations, thus demonstrating the country's intention to play an active role on a rather complicated issue. As we have seen previously, personal information in China has so far been governed by various regulations, some scholars even claim that there are over two hundred different rules relating to the protection of personal information[105], and the PIPL, when it will be promulgated, it will establish the first dedicated system to protect privacy and personal data in China.

4.2 Artificial Intelligence's impact on security

As Kai Fu Lee said, there is no right answer to questions about what level of social surveillance is a worthwhile price for greater convenience and safety, but in terms of immediate impact, China's relative openness with data collection in public places is giving it a massive head start on implementation of perception AI[106]. Thanks to the development of face recognition, speech recognition and other capabilities derived from machine learning algorithms, businesses can better understand costumers and provide them more satisfying and tailor-made experiences through precisely targeted and

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[104] Paneta R., Data protection, la Cina pronta per la sua prima legge: ecco cosa dice, agendadigitale.eu, Novembre 2020. https://www.agendadigitale.eu/sicurezza/privacy/data-protection-la-cina-pronta-per-la-sua-prima-legge-ecco-cosa-dice/
[105] Geraci M., Privacy e protezione dati in Cina, c'è una prima legge: luci e ombre, Agenda Digitale, Novembre 2020. https://www.agendadigitale.eu/sicurezza/privacy/la-proposta-della-cina-su-privacy-e-protezione-dati-perche-alloccidente-non-va-giu-a-prescindere/
[106] Lee K.F., *AI superpowers: China, Silicon Valley and the New World Order*, Houghton Mifflin Harcourt, Boston, 2018, p.125.

differentiated services. On the one hand, this ability can promise an enormous business value, on the other hand can negatively affect and pose some challenges to public security[107]. China uses facial recognition cameras, as well as for commercial purposes, to speed up access to public places, control traffic offenses, track down criminal, and so on, to make Chinese people's life safer. China has been at the forefront of the development of smart cities, with approximately half of the world's smart cities located within China, and the majority of resources used for the development of these cities have focused on surveillance technologies, such as facial recognition and cloud computing for ordinary policing.

Figure 11: Cities with the most surveillance cameras per 1,000 inhabitants in 2020
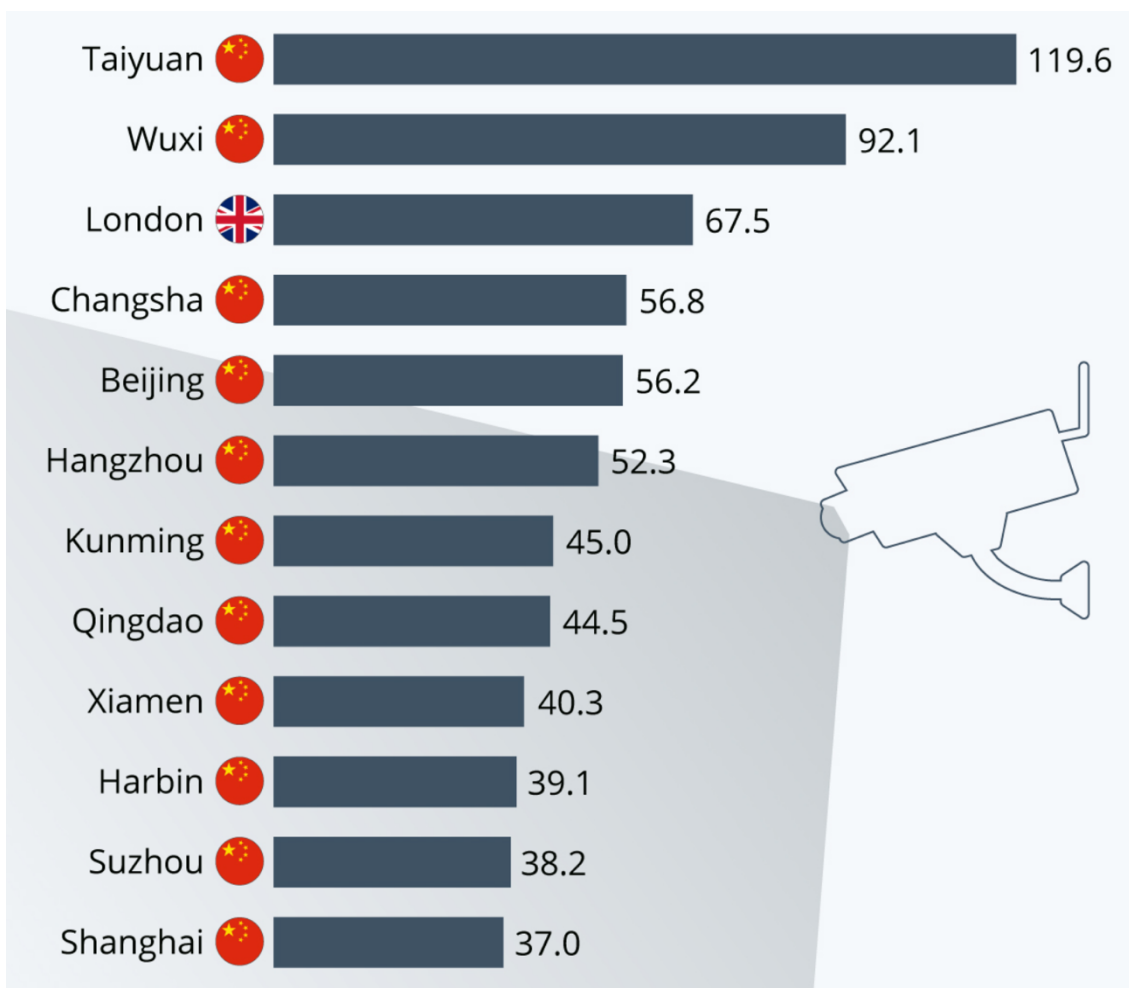
Source: Comparitech, based on an analysis of the 150 most populated cities in the world

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China is a world leader in facial recognition technology, just think that eleven out twelve of the most surveilled cities in the world in 2020 are Chinese cities, and according to CNBC, one billion surveillance cameras are expected to be installed globally by the end of 2021, 54% of which installed in China[108].

In the draft of the Personal Information Protection Law (PIPL) there is an article regarding the collection of images and equipment for the recognition of personal identity, as facial recognition cameras, that allows the apparently unlimited collection of information "vital to take care of public security"[109]. This shows that legislators are more concerned with how companies use data in China, rather than how authorities use it to observe citizens. People are afraid that once biometric data is linked to other personal information, the State will be able to fully monitor its citizens. In fact, in the PIPL there are only few limitations to the government's ability to collect or store biometric data obtained through facial recognition. Some experts argue that there is no indication about the responsibilities of government entities that collect people's data and who should be held accountable when it leaks. For example, during the COVID-19 pandemic, some local officials leaked the personal information of residents in Wuhan and Hubei Province and about COVID-19 patients in other parts of the country. However, the Chinese Communist Party (CCP) demonstrated that mass surveillance during a global pandemic is effective and feasible. An analysis of Lowy Institute shows that China has used the COVID-19 pandemic to extend its model of digital authoritarianism at home, in fact the country has exploited the health emergency to promote its norms and approaches to personal information collection, privacy, development and implementation of artificial intelligence, and digital rights. Digital authoritarianism is "the use of technology by authoritarian governments not only to control, but to shape, the behaviour of its citizens via surveillance, repression, manipulation, censorship, and the provision of services in order to retain and expand political control"[110] and China is an example of it, as a matter of fact digital authoritarianism involves the use of surveillance cameras, facial recognition camera, GPS

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[108] Cosgrove E., One billion surveillance cameras will be watching around the world in 2021, a new study says, CNBC, December 2019. https://www.cnbc.com/2019/12/06/one-billion-surveillance-cameras-will-be-watching-globally-in-2021.html

[109] Au L., Wilhelm B., China's New Data Protection Law Won't Rein in State Surveillance, World Politics Review, October 2020. https://www.worldpoliticsreview.com/trend-lines/29174/china-s-new-data-protection-law-won-t-rein-in-state-surveillance

[110] Khalil L., "Digital Authoritarianism, China and COVID", Lowy Institute Analysis, November 2020, p.6.

tracking, drones and other digital technologies that are strongly implement in China. As Edmund Santurri said during a conference at St. Olaf College in March 2020, "John M. Barry suggested that the Chinese seem to have been able to make some progress in containing the coronavirus partly because China is a politically authoritarian society in which government is willing to use surveillance technologies in relatively invasive ways"[111], and this perfectly explain the other side of the coin.

Public opinion is already very concerned about the spread of facial recognition, in fact, cameras are now everywhere, in supermarkets, mall, streets, office buildings, stations, airports, and so on. In October 2019, Guo Bing, a law professor at Zhejiang Sci-Tech University, sued Hangzhou Safari Park for inserting facial recognition cameras at the park entrance, thus requiring all visitors to undergo a facial recognition scan. He said that the wildlife park was "violating consumer protection law by compulsory collecting visitors' individual characteristics"[112]. The lawsuit was accepted by the Hangzhou Fuyang District People's Court, and it was the first court case involving the use of facial recognition in China[113]. One year later, on November 2020, the Court ordered the wildlife park to erase Guo Bing's facial recognition data and awarded him with compensation of RMB 1,038 (equivalent to USD 158)[114]. On April 9th, 2020, the Hangzhou Fuyang District People's Court made its final judgment announcing that it will uphold the original judgments. According to the *People's Daily*, the court's final judgment means that people can now "bravely say no to facial recognition"[115]. Chinese government promotes artificial intelligence as an accurate scientific tool for monitoring and preventing security threats, however there are risks and disadvantages. There are many questions that can not be answered, as reported by China Daily newspaper, such as where is all the facial information stored? Is it secure? Is the organization collecting the information trustworthy or is there the possibility it may sell facial information to an illegal profit chain? The

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[111] Ding J., Ma D., Qiang X., Part of the 2020 Spring series: U.S.-China Relations, *China: Big Data, AI, and Privacy*, St. Olaf, March 2020.
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[113] Zhouxiang Z., *Who has the power to collect my face information?,* China Daily, November 2019. https://www.chinadaily.com.cn/a/201911/05/WS5dc0af2da310cf3e355755fc.html
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lawsuit filed by Guo Bing was the first attempt to finally be able to answer the previously questions and doubt that are gripping Chinese people, and it was a sort of request to the government to provide proper rules to whom can collect facial information or not.

4.3 Public Perception of Artificial Intelligence in China

Artificial intelligence is changing people's lives, and it is becoming a powerful engine that drives direct change. Although it is the subject of numerous strategies and policies that most states and especially China, as we have seen, are pursuing, and although it has now penetrated into our lives, not all people are aware of what it is and what could be its effects on our daily life.

Toutiao conducted a survey among its users to understand the perception that individuals have on artificial intelligence[116]. The total answers that have been collected are 2,088, of which: 5.32% were given by professionals in the field, 6.23% of respondents did not know what AI was, 12.72% had become aware of the existence of AI through friends, 34.46% through books, 37.5% through movies, and most, that is 80.27%, through news.
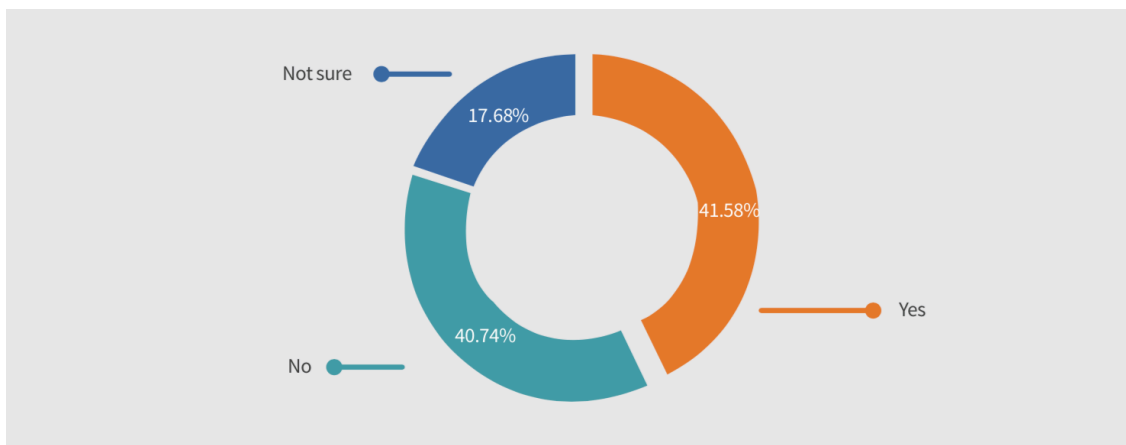
Figure 12: AI awareness by channel
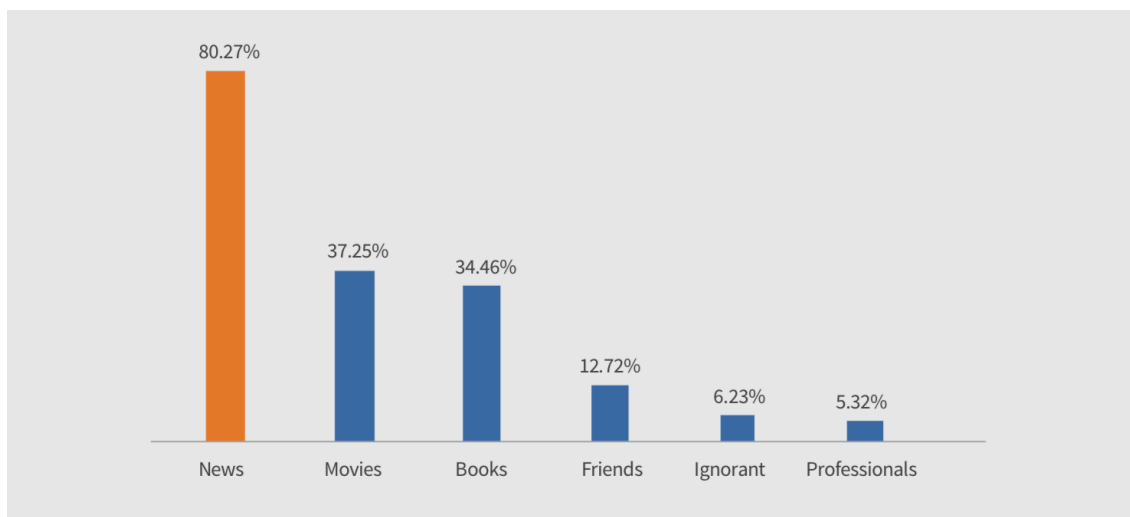
Source: China AI development report 2018

Furthermore, despite the level of awareness of AI being quite high, 40.74% of respondents stated that they had never used AI products, 17.68% did not know what makes a product an AI product, and the remainder, that is 41.58%, declared they had used artificial intelligence products.
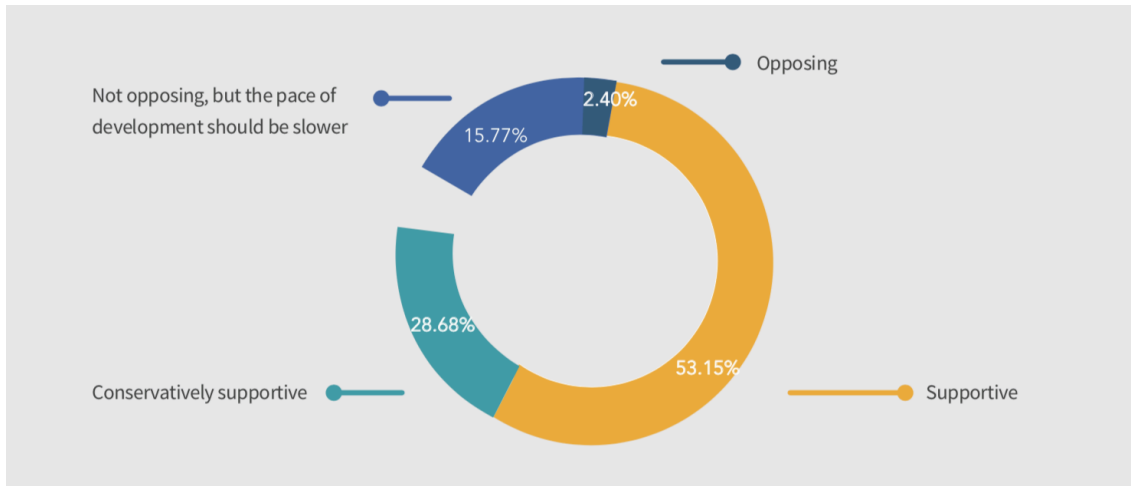
Figure 13: Awareness of AI product use

The most common questions concerning artificial intelligence that affects the majority of individuals are the following: what jobs will be replaced by AI? What harms will AI cause? And will AI become a subject capable of legal and moral awareness and civil conduct? People experience a feeling of uncertainty because they are scared that AI will have negative implications in their life, especially in their work. In fact, people are willing to know more about the risks that artificial intelligence might bring. In Toutiao's survey, individuals' three main concerns are related to the possibilities that AI could lose control and cause social crises, could make wrong decisions or judgements, and could lose control and cause personal injuries. However, people that are supportive about in-depth and comprehensive development of artificial intelligence are 53.15%, 28.68% of respondents are "conservatively supportive", so they believe artificial intelligence development should only be targeted at relatively low-risk projects, 15.77% do not oppose to AI but they think the pace of development should slow down, while the percentage of respondents who oppose to AI development is just 2.40%.

Figure 14: Expectation of AI development

Toutiao also conducted a survey to understand the age range and gender of people who are most interested in artificial intelligence. According to the data collected, the users who are most interested in AI are those in the age group of 31 to 40 years old, followed by the age group of 41 to 50 years old. It was also inferred that male users show more interest in AI than female users, 0.66% vs. 0.27%.

Figure 15: Interest in AI by age group and gender
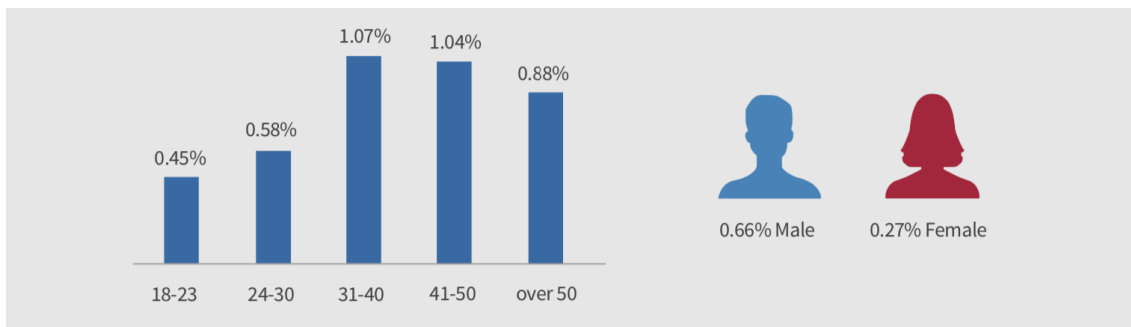
Also Daxue Consulting has conducted a survey about AI's public perceptions on the platform Zhihu[117]. Zhihu is a question and answer (Q&A) website that was launched in 2011, and it is the largest knowledge sharing platform in China. The platform is quite trustworthy as it leverages artificial intelligence programs to detect spam and delete

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[117] *The AI ecosystem in China 2020*, Daxue Consulting, pp. 12-13, March 2020.

offensive and irrelevant posts, in this way relevant results tailored to users' personal interests are maintained[118]. According to Daxue Consulting, the most common posts and questions on Zhihu about artificial intelligence are: how will AI change people's lives in the future? Which industries will be replaced by AI in the future? How to protect personal privacy when using AI products? With the rapid development of AI, what should we do about our personal privacy?

In fact, many smart devices record personal information, and according to system experts, the manufacturers of the devices collect and store a lot of data in order to improve their products, but also to sell them to advertiser for money.

There are both positive and negative perceptions of artificial intelligence. AI could facilitate the daily life of citizens, by promoting the innovation of teaching methods, improving the diagnosis and treatment efficiency in the healthcare industry as we have seen during the COVID-19 pandemic, and by also improving traffic conditions and reducing the occurrence of road crimes. Although these positive opinions on artificial intelligence, there are some common concerns about it too. People, in fact, are scared that AI could cause some social problems such as mass unemployment in some industries, it can challenge personal information protection, and lastly autonomous driving technology can not face emergency with humans' same urgency.

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CONCLUSIONS

As I said earlier, one of the reasons that led me to deal deeper with this topic, was to understand how a country with a vast territory and a population of approximately one and a half billion inhabitants has succeeded, in a relatively short period of time, to defeat an enemy as strong as unknown. Why other countries continue to have many difficulties in containing the virus? And why the Chinese approach can hardly be applied in Western countries?

What distinguishes the Chinese response from the Western ones is, above all, the cultural factors. While in the West the individual prevails over the group, in the East it is the group that prevails. There is a sense of collectivity that unites the whole population, in fact the individual is part of a large collective mechanism and his task is not to let it jam, as a consequence putting himself at the service of the community turns out to be automatic and natural. A common example may be the use of masks, since the government declared the obligation to wear them, every single citizen has done it without complaining or rebelling as has happened in some Western countries. Aware of the strong cultural base that characterizes the country, in this emergency situation the Chinese Communist Party has managed in a certain way to exploit its ideology to fight the virus. Indeed, there has been a very strong collaboration, in which each citizen has done his own by resorting to personal responsibility for a greater good, the security and the safety of the country.

In addition to the strong sense of collectivity, there is another very important cultural factor that has played a fundamental role: mass mobilization. From 1949 to today, the Chinese government has repeatedly mobilized the country, especially in cases of emergency and sudden crises such as the SARS epidemic in 2003, the Sichuan earthquake in 2008, and more recently the COVID-19 pandemic. But what does the term mobilization means? The definition is given by Li Zhiyu in Afterlives of Communism, who explains that the concept of mobilization "denotes the use of an ideological system by a political party to encourage, or coerce, the members of a society to participate in certain political, economic, or social objectives, in order to achieve large-scale centralization and deployment of resources and manpower". And this is exactly what happened again in China. Indeed, once again, the Beijing authorities have been able to involve and mobilize

the entire population, with the aim of finding common solutions to overcome the critical phase.

A further fundamental factor that has contributed to the fight against COVID-19 is the speed of the Chinese response. This is due both to the fact that China has always been used to acting quickly, and to the fact that the memories of the SARS epidemic in 2003 were still vivid in the minds of many Chinese, and the state was already ready to face new epidemics, avoiding past mistakes. In addition, the effective national contact tracing system, the ability to increase the production of masks and white coats, the control of local spread of the virus, and so on were of fundamental help.

Another essential factor is the use of technology on all sides, and this is the point at the heart of this thesis. In fact, another question I asked myself before writing this paper was how the use of artificial intelligence and big data have been of great help to China in dealing with COVID-19, and how Chinese citizens reacted to further tightening of government surveillance and control at the expense of what could be called freedom. We have seen how, in recent times, there has been an awareness on part of citizens on the strict control by the government. In fact, they have begun to ask for more and more rights and transparency on the use of the infinite data that the government obtains via smartphones, facial recognition cameras and other technological tools. With regard to contact tracing through Health Code applications, if on the one hand Chinese public opinion did not seem particularly upset during the fight against COVID-19, on the other hand facial recognition was immediately given a colder welcome. Being aware of the growing popular discontent, after years of discussion, last October the government published a draft law to find a balance between the wild use and collection of big data and the protection of privacy. However, the biometric data obtained from the facial recognition cameras and location data could hide real problems and differential outcomes that arise when the public health infrastructure is linked to the collection of profit-based data.

Surely, the use of artificial intelligence and big data during the coronavirus pandemic have greatly helped the Chinese government to rapidly contain the spread of the virus. In fact, artificial intelligence can ensure early warning and alert, tracking and prediction, diagnosis and prognosis, treatments and cures and social control. So, the effort of man, implemented by the use of artificial intelligence, meant that infections were blocked.

However, digital surveillance despite being perceived as a successful development in China's response to COVID-19, having been a particularly effective form of social control during a global pandemic, raises further fears in Chinese citizens. It is important to take into account that the measures that are adopted in exceptional situations must remain temporary, and not cause a normalizing effect. Indeed, the main fear is that all data collected in contact tracing and trough facial recognition cameras will be used even when the virus will be completely eradicated, thus allowing the central government to exercise complete control over its population.

The large-scale use of artificial intelligence and mass surveillance tools have proven to be powerful means in emergency situations, it is also thanks to them that China is currently in a state of almost normality while in other countries the emergency situation caused by COVID-19 is still critical. Although very often they seem to violate the rights of individuals, Chinese citizens have been shown that perhaps it is worth sacrificing some freedoms in the name of public health in this case, or security in another case. In fact, the Chinese government has always asked its citizens for some renounces in terms of freedom in exchange for well-being and stability. The relationship between freedom and security is a dialectic constantly present in China, it may appear oxymoronic but the longevity of the Chinese Communist Party also depends on it. However, security and freedom should both be guaranteed to citizens, both being fundamental and complementary rights that can not be contrasted.

These tools can make a difference, and it is undoubtedly important to continue improving them, however the government should protect its population from the repercussions they could have from the development of such technologies, ensuring transparency and protection of rights. The aspiration should be the following: to ensure that technologies can become a tool for improving people's lives, rather than a weapon of social control in the hands of states and technological platforms.

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