

APPLICATION OF ARTIFICIAL INTELLIGENCE AND BIG DATA IN CHINA'S HEALTHCARE SERVICES

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In recent years, with a flourishing economy and the continuous progress of medical reform, China's healthcare system has experienced rapid expansion and significant service improvements. Today, there are over one million medical institutions in China.¹ Medical insurance covers more than 95% of the Chinese population.² Life expectancy has reached 76.4 years, an average higher than that of some high-income countries.³

However, population aging has put enormous pressure on China's healthcare system. To relieve this pressure, we consider how technology could help improve healthcare efficiency, and how solutions could be integrated into the healthcare system to help relieve the pain of patients and reduce the financial and psychological burden on their families.

The next generation of information technology (IT) represented by artificial intelligence (AI) and big data analytics could offer new tools to address China's healthcare challenges. Medical AI has the potential to complement doctor resources and enable broader access to high-quality medical services. This is of great significance for China where the current supply of healthcare services falls short of the growing demand from an aging population of 1.4 billion.

Impetus: potential of IT integration and innovation in China's healthcare services

The integration of IT into China's healthcare services is an inexorable trend and will unleash great potential. Growing demand for healthcare services, a favorable policy environment, surging capital investment, and emerging technology are four

driving factors. Combined, they bring new opportunities for IT integration and innovation to the healthcare system and facilitate innovative applications on a global scale.

1. Demand: growing healthcare demand creates opportunities for technological innovation

China's large healthcare sector is in the process of rapid expansion. Total national health expenditures exceeded 5 trillion yuan in 2017, accounting for 6.2% of the gross domestic product (GDP).⁴ This number will reach 16 trillion yuan by 2030, according to the *Healthy China 2030 Planning Outline*.⁵

This growth in national health expenditures is creating opportunities for medical AI in China. According to Tractica's forecast, China's AI medical market is developing rapidly, with the market size soaring from 9.661 billion yuan in 2016, and 13.65 billion yuan in 2017, to 20.4 billion yuan in 2018, maintaining a compound annual growth rate of more than 40%.⁶ At the same time, Chinese medical institutions and businesses are taking a proactive attitude towards AI. Nearly 80% of hospitals and medical companies are planning to, or already have, carried out medical AI applications and more than 75% of hospitals believe that such applications will become popular in the future.⁷

2. Technology: increasing standards and patents safeguard innovation

In recent years, AI technologies have flourished globally, and particularly in China. According to the Derwent World Patents Index (DWPI), global annual AI patent applications have surged since 2010. China contributed the highest number with a total

of 76,876 applications from 1985 to 2017 (Figure 5.1). According to the China Patent Abstract Database (CNABS), the top five patent applicants in China were Baidu, Chinese Academy of Sciences (CAS), Microsoft, Tencent, and Samsung.⁸

According to the Patentics database, in the field of healthcare, keyword analysis of global AI patents indicates two features.⁹ During the period 1985 to 2017, China ranked fourth in the total number of healthcare AI patent applications filed, contributing to 12% of the total. This implies that China's technological innovation has been comparatively less active in the field of healthcare AI compared to overall AI activity. In this same period, China rapidly increased patent applications from 2010 and surpassed Japan and the European Union to become the world's second largest healthcare AI applicant in 2016, which reflects the strong momentum of medical technology innovation in China (Figure 5.2).¹⁰

Also in the Patentics database, China's healthcare AI patents are classified into five categories: medical diagnostics, nursing/caring, medical devices, data and archiving, and pharmaceuticals. Among them, patents for AI in medical diagnostics and nursing/caring account for 29% and 28% respectively, far more than any other category, making these the two most active fields of healthcare AI innovation in China (Figure 5.3).

3. Capital: accelerating capital investment fuels innovation

Healthcare AI is drawing the attention of investors, which is bringing capital to the field and accelerating technological innovation. According to third-party statistics, global healthcare AI start-ups have raised US\$4.3 billion through 576 deals since 2013. China overtook the United Kingdom in the first half of 2018 to become the second most active country in terms of capital investment in healthcare AI.¹¹

Innovation: emergence of AI and big data applications in China's healthcare

Under favorable market and policy environments, healthcare AI and big data have developed more quickly in recent years. From 2007 to 2017, more than 100 companies dedicated to healthcare AI emerged in China. Since 2014, a surge in companies entering the space has caused innovation to accelerate.¹²

Many types of businesses and institutions have participated in the development of healthcare AI in China. Representative participants range from established Internet companies to technology start-ups, from healthcare software companies to medical device manufacturers, and from pharmaceutical companies to hospitals, universities, and research institutions.

Attempts to apply AI to over 20 types of diseases have been made. Lung cancer diagnosis and diabetic retinopathy are the most popular applications and are attracting the most start-ups. Many companies are also exploring AI applications in cardiovascular diseases.¹³

AI has already been extensively integrated into several sub-fields of the healthcare sector. In addition to medical services and hospital management and administration, applications are also deployed in fields such as pharmaceutical research and development, cost control for payers, and health management for individual consumers.

1. Smart doctors: leveraging medical imaging

Medical imaging has become the leading and most popular field for AI application in China's healthcare sector, having benefited from the mature technology found in machine learning-based image recognition and from the availability of massive medical imaging data. A wide range of products targeting cancers and chronic diseases have entered the clinical validation phase. These products focus on areas such as disease screening, target volume delineation for radiation therapy, and three-dimensional reconstruction.

In disease screening, AI-enabled software automatically marks lesions so that doctors can improve their focus and efficiency when reading medical images by referencing these marks. Clinical Target Volume (CTV) delineation, mainly used in radiotherapy, employs AI to automatically delineate target volumes based on medical images generated from computed tomography and/or magnetic resonance imaging machines.¹⁴ The results are then subject to use and correction by doctors. The application can significantly shorten the time required by traditional manual delineation and accelerate the implementation of radiotherapy. Three-dimensional reconstruction refers to the automatic creation of 3D models of human organs by machines, from which realistic physical models can be obtained to facilitate high-quality surgical procedures and other medical treatments.

For example, Tencent AI Medical Imaging, developed in 2017, is a system used for screening several diseases such as diabetic retinopathy, lung cancer, and esophageal cancer. The system is undergoing clinical validation in more than 100 major hospitals in China. It has assisted doctors in reading over 100 million medical images and served nearly one million patients cumulatively.

With the advancement of image recognition technologies, diagnostic precision has reached new levels. For example, data from Tencent shows that recognition accuracy reaches 90% for esophageal cancer, 97% for diabetic retinopathy, and 97.2% for colorectal cancer, making disease screening highly effective.

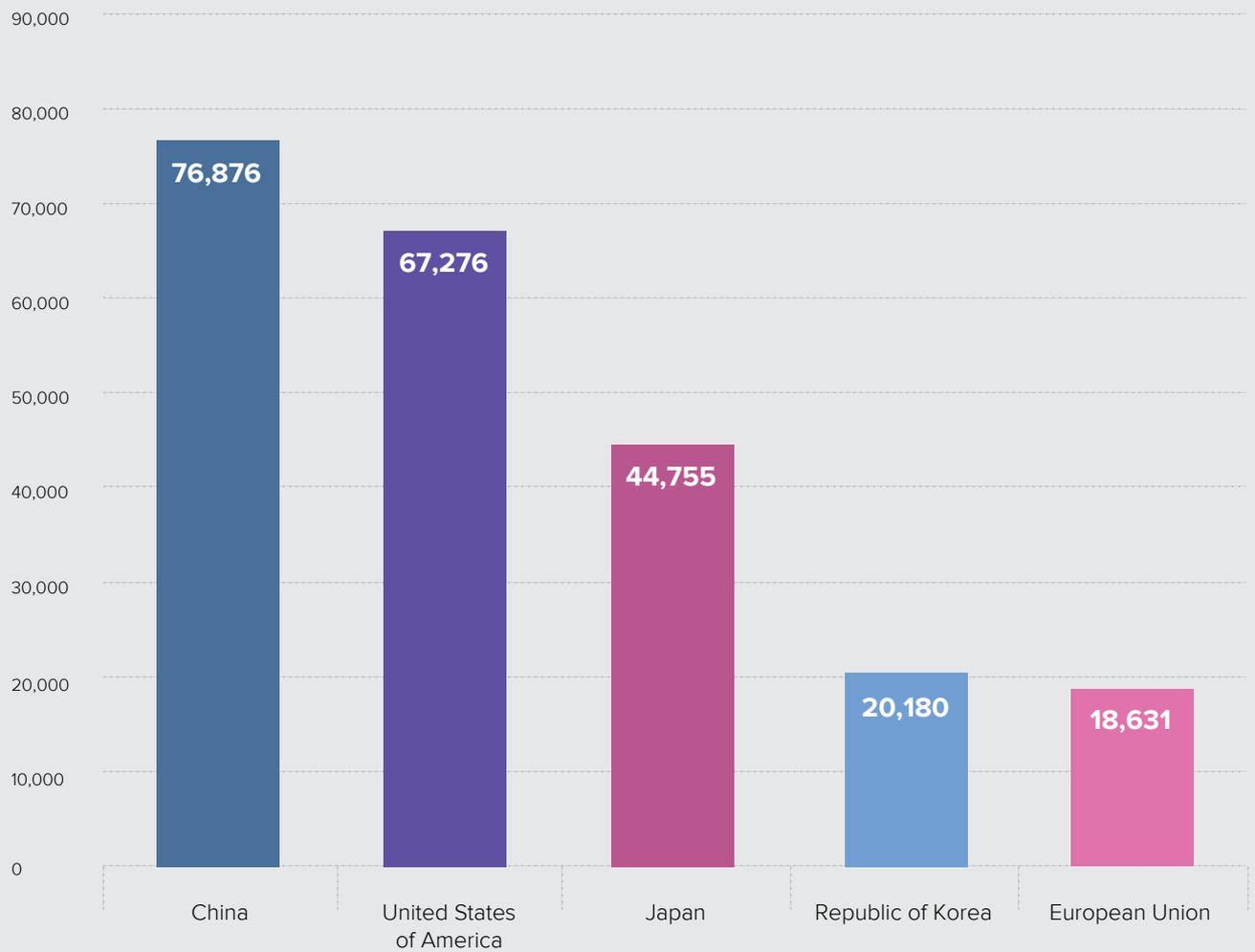
2. Smart doctors: leveraging diagnosis support

Healthcare services involve extensive and varied text data such as consultation records, medical records, and research studies. Using AI to comprehensively mine and analyze text data will help doctors improve diagnostic efficiency and create significant opportunities for AI and big data applications throughout healthcare. Specific applications include:

- **Intelligent triage:** Patients can quickly and accurately obtain triaging information by entering symptoms and other required information in mobile apps and robotic devices that guide patients in hospitals.

FIGURE 5.1

Top five countries/regions for AI patent applications, 1985 to 2017

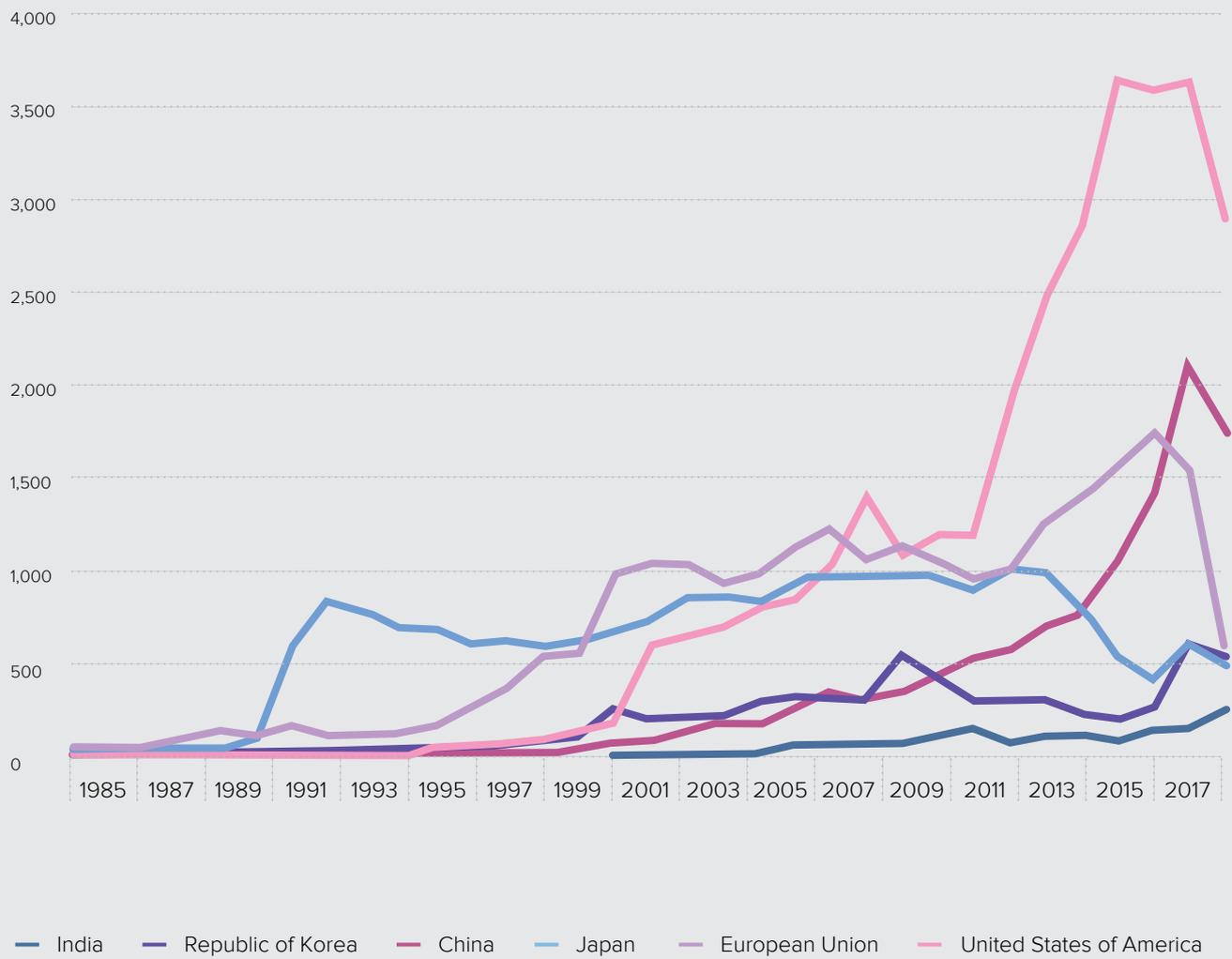


Source: Patent Protection Association of China, 2018.

Note: Analysis report based on data sourced from China Patent Abstract Database (CNABS).

FIGURE 5.2

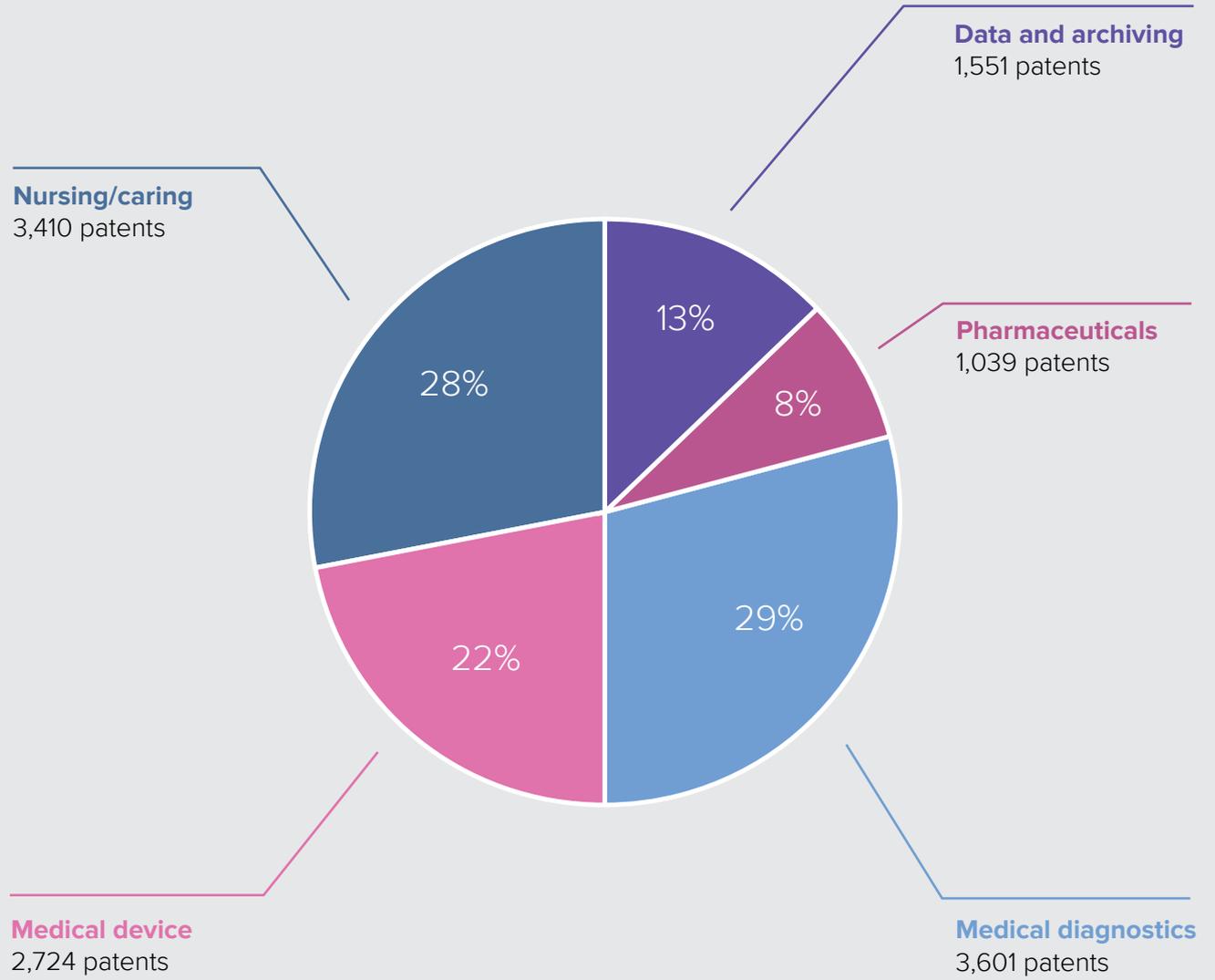
Healthcare AI patent applications in major countries and regions, 1985 to 2017



Source: Patentics Database.
Note: Data analyzed by Tencent.

FIGURE 5.3

Healthcare AI patent categories in China



Source: Patentics Database.
Note: Data analyzed by Tencent.

- **Intelligent medical record management:** Medical records retain essential information for medical services, but it is challenging to manage and utilize medical records because the data are primarily recorded as unstructured, free-form text. Text recognition and natural language processing not only improves the efficiency of medical record processing but also supports the extraction and analysis of disease characteristics, improving follow-up diagnosis and scientific research.
- **Intelligent risk monitoring:** AI helps doctors monitor and adjust their diagnosis and treatment plans and further reduces the risk of missed diagnosis and misdiagnosis.

At the level of implementation, the concept of enabling clinical decision support systems (CDSS) with AI is drawing more attention. AI-enabled CDSS is expected to provide doctors with efficient decision support throughout a patient's continuum of care. Several national projects are underway including projects jointly conducted by Tencent, CAS Institute of Automation, and multiple medical institutions such as the People's Hospital of Peking University. These projects have already shown promising outcomes. For cardiovascular and cerebrovascular diseases, an intelligent analysis system for electrocardiogram has been introduced. For Parkinson's disease, intelligent assessment of motor function has been enabled by applying AI-based video analysis technologies. For head and neck radiotherapy, an innovative rapid organ guidance technique has been developed.

3. Intelligent hospitals: boosting management and operational efficiency through mobile Internet

One primary reason that Chinese hospitals adopted IT applications was to improve the efficiency of management and operations. At present, most hospitals are in the process of migrating to mobile Internet services, that is, digitalizing hospital services, management, and operation procedures through mobile applications. The use of mobile apps is greatly improving the efficiency of hospitals and is emerging as a distinct feature of some forward-thinking hospitals in China. Exploration is extending to the automation of administrative tasks with the help from AI technologies and intelligent decision support based on big data analytics.

4. Intelligent pharmaceuticals: exploring digital and intelligent pharmaceutical research & development

The environment for innovation in pharmaceutical research and development (R&D) improved significantly in China over the past few years. The *Opinions on Deepening the Reform of Review and Approval System to Encourage the Innovation of Drugs and Medical Devices*, issued by the State Council in 2017, noted that China's pharmaceutical and medical device industries have developed rapidly amid ascending innovation and entrepreneurship, medical review reform, and approval system advances. China has independently researched and developed new drugs in recent years that have contributed about 4% to the global novel drug market, approximately one-twelfth of the contribution from that of the United States of America.¹⁵ Digital modeling and simulation will facilitate independent drug R&D in China by effectively reducing cost and accelerating development. A group of Chinese emerging

start-ups, including Deep Intelligent Pharma (compound synthesis), XtaiPi (crystal structure prediction), and LinkDoc (recruitment of clinical trial participants), are at the forefront of exploration.

5. Smart users: expanding from medical knowledge to health management

For individuals, medical care is only a means, while health is the end goal. As the standard of living improves, people become more proactive about preventing and treating health issues. In this context, health management has become an emerging field for IT application. AI and big data technologies can be applied in two ways:

- **Making specialized healthcare knowledge accessible to the public:** Knowledge and information can be more accurately disseminated to users from content databases that integrate AI and big data technologies. For example, Tencent Medipedia provides users with information based on content from internationally acclaimed medical information providers—such as WebMD or Healthline—and leading hospitals in China.
- **Managing and monitoring personal health data:** AI and big data technologies are also used to monitor users' health conditions with the help of intelligent wearables that provide personalized health advice.

Future: fostering synergies to make healthcare more intelligent in China

New technologies, such as artificial intelligence and big data analytics, have been innovatively applied in China's medical service sector and exhibit great potential for further development. Looking ahead, joint efforts are needed to advance these applications toward *Tech for Social Good*.¹⁶

First, data governance should be strengthened. Using digital technologies such as cloud computing and big data, appropriate rules and processes should be established for data collection, utilization, and protection among healthcare institutions. Data sharing and circulation mechanisms should be secured to achieve standardized collection, integration, sharing, and compliant application of healthcare big data.

Second, collaboration should be encouraged. Open platforms of innovation in the field of healthcare should be built through joint efforts, which could strengthen the sharing of mature technologies and expertise to solve common problems and lower the technical threshold for large-scale application of digital technology.

Finally, coordinated security assurance should be established. A sound and coordinated system that covers network security, system security, and data security for healthcare institutions should be established. The principles and requirements of security assurance should be clearly defined for involved parties to ensure privacy and prevent unintended disclosure.

Notes:

- 1 National Health Commission of People's Republic of China, 2018a.
- 2 Xinhuanet, 2018.
- 3 World Health Organization, 2018.
- 4 National Health Commission of People's Republic of China, 2018b.
- 5 Xinhua News Agency, 2017.
- 6 iResearch, 2019.
- 7 HC3i, 2017.
- 8 Patent Protection Association of China, 2018.
- 9 Patentics database, n.d.
- 10 Tencent, 2019. New patent applications are usually not published in 18 months, therefore part of the applications in the late 2017 are not included.
- 11 CB Insights, 2018.
- 12 EO Intelligence, 2017.
- 13 VCbeat, 2018.
- 14 In radiotherapy, Clinical Target Volume (CTV) refers to a tissue volume that contains the Gross Tumor Volume and/or subclinical malignant disease at a certain probability level. It is a proxy of the extent of tumor spread, plus a margin of safety.
- 15 Wu et al., 2017.
- 16 Tencent upgraded its mission and vision to Tech for Social Good recently, aiming to harness technology for the benefit of mankind.

References:

- CB Insights. (2018, September 13). The AI Industry Series: Top Healthcare AI Trends To Watch. Retrieved from <https://www.cbinsights.com/research/report/ai-trends-healthcare/>
- EO Intelligence. (2017, August 25). Research Report on AI Enabling the Healthcare Industry. Retrieved from <https://www.iyiou.com/intelligence/reportPreview?id=85323&&did=530>
- HC3i. (2017, June 27). AI in Healthcare Market Analysis and Trend Report (2016–2017). Retrieved from <http://news.hc3i.cn/art/201706/39588.htm>.
- iResearch. (2019, January 25). Global Artificial Intelligence Empowerment China Summit 2019 will be held in Shanghai on March 28th. Retrieved from <http://news.iresearch.cn/content/2019/01/282947.shtml>
- National Health Commission of People's Republic of China. (2018a, January 23). Number of National Healthcare Institutions by the End of November 2018. Retrieved from <http://www.nhc.gov.cn/mohwsbwstjxxzx/s7967/201901/94fcf9be64b84ccca2f94e3efead7965.shtml>
- . (2018b, June 12). Statistical Communiqué on China's Healthcare Development in 2017. Retrieved from <http://www.nhc.gov.cn/guihuaxxs/s10743/201806/44e3cdfef1fa4c7f928c879d435b6a18.shtml>
- Patent Protection Association of China. (2018, November 12). In-depth Analysis Report of AI Patents 2018. Retrieved from img.ppac.org.cn/attachments/2018/11/1542002367d9905c035a6e00a5.doc
- Patentics database. (n.d.). Retrieved from <http://patentics.com/web/en/database/>
- The State Council of the People's Republic of China. (2016, June 24). The Guiding Opinions of the State Council on Promoting and Regulating the Application of Big Data in Healthcare. Retrieved

from http://www.xinhuanet.com/2017-08/14/c_1121481192.htm

- . (2017, July 20). The New Generation Artificial Intelligence Development Plan. Retrieved from http://www.gov.cn/zhengce/content/2017-07/20/content_5211996.htm
- . (2018, April 28). The Opinions of the State Council on Promoting the Development of Internet Plus Healthcare. Retrieved from http://www.gov.cn/zhengce/content/2018-04/28/content_5286645.htm
- Tencent. (2019). Global Statistical Analysis of Healthcare AI Patents.
- VCbeat. (2018, September 27). Healthcare AI Report 2018. Retrieved from <https://vcbeat.net/MjiiNzEwOGY0M2M4YTlhM2lyOTdhZjA2MTBhNDA1Yjg=>
- World Health Organization. (2018). *World Health Statistics 2018: Monitoring health for the SDGs*, 60. Retrieved from <https://apps.who.int/iris/bitstream/handle/10665/272596/9789241565585-eng.pdf?ua=1>
- Wu, L., & Chen, Y. (2017). Novel Drug Research and Development Ability in China: An International Comparison and Analysis. *Chinese Journal of Health Policy*, 2017, 10(8): 23-28. Retrieved from <http://journal.healthpolicy.cn/html/20170805.htm>
- Xinhuanet. (2018, February 12). National Health Commission: China's Basic Medical Insurance Covered 1.35 Billion People. Retrieved from http://www.xinhuanet.com/2018-02/12/c_1122407264.htm.
- Xinhua News Agency. (2017, August 14). National Health Commission: China's Healthcare Industry to Reach 16 Trillion Yuan in 2030. Retrieved from http://www.xinhuanet.com/2017-08/14/c_1121481192.htm.