The Research on the Application of AI in Healthcare

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Abstract: *The advancement of AI has led to industrial development and in-depth applications in several vertical fields. This paper introduces several types of common scenarios and cases of AI application in healthcare and also presents the challenges of AI application in healthcare.*

Keywords: *AI; medical health; precise medical treatment; new drug R&D*

1. Introduction

In recent years, with AI-related technology becoming mature, AI technology is gradually stepping out of the laboratory and transforming from theoretical technology research to industrial applications. Among them, the application of AI in the field of healthcare in order to build the "AI + healthcare" is becoming a popular research area.

With the improved living standards of material and culture and increased health awareness, people are in a urgent need of enhancing the level of medical technology and the quality of health services. Thanks to the algorithm innovation of machine learning such as neural networks algorithm and the upgrading of computing chips powered by AI such as TPU and NPU, AI's development has made a breakthrough, meanwhile technologies such as computer vision and natural language processing are becoming increasingly mature, making it possible to improve medical technology through AI.

2. Application scenarios and cases

As AI technology has been put into use frequently in real life, there are many successful cases of applying AI to improve medical services. Artificial intelligence has stepped into all aspects of healthcare, including intelligent diagnosis and treatment, medical image analysis, medical data management, health management, precise medical treatment, new drug R&D and so on.

2.1. Intelligent diagnosis and treatment

In the past, doctors determined the disease and the course of the disease on the basis of their medical knowledge, clinical experience, patient's symptoms and examination results. Today, artificial intelligence is applied to medical diagnosis, which allows computers to "learn" specialized medical knowledge and "memorize" a large number of historical cases to build an intelligent diagnosis and treatment system, thus providing doctors with a "super assistant" to help them complete their diagnosis.

IBM Watson is a well-known case in the application of intelligent diagnosis and treatment [1]. Watson is an outstanding representative of cognitive computing system, which integrates cognitive technology, automatic reasoning, and machine learning. It is capable of collecting and analyzing large amount of information in a short time, reasoning and arguing for a specific problem by using available information, and obtaining feedback to optimize the model and to make progress through learning. In just 17 seconds, Watson can read 3469 medical monographs, 248,000 papers, 69 treatment protocols, 61,540 trial data, and 106,000 clinical reports. In 2012, Watson passed the U.S. Medical Licensing Examination (USMLE) and has been used in a number of hospitals in the U.S. to provide paramedical services. Currently, Watson provides diagnosis and treatment for a variety of cancers, including breast cancer, lung cancer, colon cancer, prostate cancer, bladder cancer, ovarian cancer, and uterine cancers.

2.2. Medical image analysis

In traditional medical image diagnosis, doctors often need to use their naked eyes to look at medical image data such as X-ray, CT, ultrasound and MR, and the machine only provides limited help for that. Today, AI-based medical image analysis systems can automatically identify patient image data and provide diagnostic references for doctors. As the computer vision technology is evolving, some AI-based machines for medical image analysis can even give diagnostic conclusions without relying on human doctors.

For example, a San Francisco-based company Enlitic applies deep learning technology to detect malignant tumor and builds an intelligent systems that is able to conduct machine learning from known medical image data, thus summarizing the features of malignant tumors in the image data, and find patterns to determine the presence or absence of malignant tumors.

In China, there are many cases where AI is applied in medical image analysis. According to statistics, more than 1/3 of the companies engaged in smart healthcare in China are doing medical image related products and applications. A well-known case would be Tencent Miying. This product applies AI in medical image analysis and gets trained in the study of various types of medical images so that it can effectively assist doctors in diagnosis and early screening of diseases such as esophageal cancer, lung nodules, diabetic retinopathy, cervical cancer and breast cancer. Nowadays, Tencent Miying has built joint laboratories with more than ten tertiary hospitals and hundreds of hospitals are ready to cooperate with it.

2.3. Medical data management

Medical data management usually refers to the process of thorough management and mining of disorganized medical and healthcare data (mainly medical records, medical examination results, health records, etc.) and finally unlocking the value of the data. Due to the imperfect medical information system in the past and the time constraint of doctors, there were often various problems such as irregular record formats, abbreviations and acronyms in the process of recording medical records, and hospitals had a large backlog of medical records that could not be entered and analyzed. But nowadays, through the introduction of artificial intelligence, computers can use natural language processing to automatically identify clinical variables and indicators in medical records and transform these unstructured records into standardized data for doctors to analyze.

There are extensive demand in healthcare data management in China and many "AI+Healthcare" startups regard it as an important development direction. For example, SYNYI AI, a Shanghai-based startup, is dedicated to medical data management. The company uses medical natural language processing technology to transform low-quality medical data into high-quality and analyzable data. By now, the company has launched a product that can automate the processing of medical records at a level equivalent to that of a post graduate medical student with eight years of clinical medical education. It has outperformed human doctors in a test that requires it to capture and understand all the clinical information in a 50-page medical record.

In addition, entering medical records by voice is another form of healthcare data management. A group of Chinese intelligent voice companies, represented by iflytek, have started to develop electronic medical record products based on voice recognition technology. By voice entry instead of typing, doctors can easily interact with computers, iPads, and mobile check-in devices through speaking. In addition, in the communication between doctors and patients, the AI system is expected to achieve real-time recording of the whole process and structure all the data such as patients' complaints and past history through voice recognition to help doctors in diagnosis and treatment.

2.4. Health management

With the gradual increase of people's health awareness, more people are seeking professional health management services. Based on individual health records, health management companies provide clients with personalized health management programs from various perspectives, such as physiology, psychology, nutrition and exercise, in order to help them maintain good habits and mental state. Health management is highly personalized and often requires differentiated one-to-one services for individual conditions. However, there are a limited number of health management practitioners with good professional competence, which confines the development of health management services to a certain extent.

Now, more companies are beginning to notice the great value of the health management and trying to use artificial intelligence technology to solve this industry's bottleneck so that everyone can enjoy their personalized health management services. Welltok, founded in 2009 in Denver, USA, is a good example of a company that has developed a health management platform able to provide customers with personalized health data analysis and health management advice based on AI technology. The company also cooperates with other service providers such as smart hardware, big data and insurance companies to further integrate user data and provide more accurate health management services. For example, by cooperating with wearable device manufacturers, the health management platform can obtain more exercise data, and the computer can determine whether the user adheres to the exercise program provided by the platform and give the users points or gift rewards to motivate them to stick to a good lifestyle and help them improve their health.

Sensely, another startup providing health management services, has developed a personal health assistant product. A virtual nurse called as Molly integrates artificial intelligence, medical sensing, telemedicine, augmented reality and other technologies. By monitoring the user's daily diet, exercise, medication and other lifestyle habits, Molly can analyze the health status of a specific user and assist the user in planning life. Users can access the service by communicating with Molly through questions on a PC, tablet or smartphone.

Mental health is also an indispensable part of health management. In the past, people could only turn to expensive psychologists, but now more people can have their own "AI psychotherapist" by using AI technology. For example, an artificial intelligence program developed at the University of Southern California can diagnose the presence of post-traumatic stress disorder by analyzing the facial expressions and changes in voice and tone of the soldiers interviewed, in conjunction with a questionnaire. A team of researchers from IBM who made use of machine learning is able to predict people's risk of suffering from mental illness by analyzing individual language patterns and language coherence. A medical chatbot named Woebot helps people relieve mental health problems such as depression and anxiety through cognitive behavioral therapy. In a study at Stanford University, patients experienced a reduction in anxiety and depression symptoms after two weeks of using Woebot. Although it cannot replace human therapists, Woebot does provide an outlet for people to relieve psychological stress [2].

2.5. Precise medical treatment

Precise medical treatment is a new medical concept and medical model based on individualized healthcare and develops in the context of the rapid progress of genome sequencing technology, the cross-application of bioinformatics and big data science. In recent years, with the wide application of big data and cloud computing, the development of precise medical treatment is in full swing and gains lots of attention nationwide. Its industry clusters represented by the United States, China and Europe are gradually taking shape.

In this field, AI is playing an increasingly significant role. By using this technology, researchers are able to mine through the ponderous data in order to find causal relationships of diseases at the molecular level and this has facilitated the generation of a large number of new molecular diagnostic indicators. This is not only beneficial for discovering new markers for diseases, but can also be used to detect many new targets for drug design.

In genetic testing, the ability of genome interpretation and analysis is the current bottleneck of clinical application of genetic testing industry. As artificial intelligence can model genomes and disease groups, it is expected to discover more patterns between genomes and disease groups and break through the bottleneck of genome interpretation and analysis capability. Deep Genomics, a Canadian startup, based on the combination of artificial intelligence and genetic testing, introduces AI technologies such as deep learning. The team built a mathematical model, then trained the model with whole genome sequences and RNA sequences of healthy people so that the model learns the RNA shearing patterns of healthy people, then confirmed and corrected the trained model by other molecular biology methods, and finally tested the accuracy of the model judgments by using known medical records. Based on this idea, Deep Genomics has launched a product called SPIDEX, which can analyze the effect of a variant on RNA shearing and work out the relationship between that variant and disease by simply importing the sequencing results and cell type.

Founded in 2011, Sophia Genetics is a Swiss company that mainly deals with data analysis of genetic information. The company received $30 million in Series D funding led by leading European venture capital firm Balderton in September 2017 to expand its DNA database and strengthen the

testing and diagnostic capabilities of its platform. The company's service is based on SaaS platform called Sophia DDM where healthcare professionals take DNA samples from patients through blood draws or tissue biopsies, then upload the collected clinical data to the platform through DNA sequencing, and use AI to identify mutations in the patient's genome to help doctors better develop the best treatment plan for their patients. Meanwhile, it has also developed 3 patented artificial intelligence-based genetic analysis technologies: PEPPER, MUSKAT and MOKA which are respectively designed to identify single nucleotide polymorphism variants and deletions, identify the number of copy variants and assess the severity of genetic variants, and these technologies are correct 99% of the time [3].

2.6 New drug R&D

AI can be applied in different stages of drug development, including drug efficacy and safety testing, building new drug molecules and biomarker screening, etc. Drug research and development, as it featurs with long R&D cycles, high capital investment and high risk of failure, requires constant search and even a stroke of luck. With the continuous development and application of AI technology, the number of companies that use AI in drug R&D are on the rise. Besides, with the increasing influx of capital, the scale of the intelligent pharmaceutical industry will further expand.

Atomwise located at Silicon Valley has developed AtomNet, a core platform based on deep convolutional neural networks. Through analysis of a large number of drug targets and structural features of small molecule drugs, AtomNet can learn the interaction patterns between small molecule drugs and their targets, and predict the biological activity of small molecules based on the learned patterns, thus accelerating the drug development process. IBM supercomputer can screen for the medical treatment in molecular structure databases and evaluate 8.2 million candidate compounds for drug development. In 2015, Atomwise applied AI algorithms and successfully identified two drug candidates that can control Ebola in less than a day on the basis of existing drug candidates. In addition, the company has collaborated with prestigious research institutions such as Stanford University, Scripps Research Institute and Merck in drug R&D [4].

Founded in London in 2013, BenevolenAI is dedicated to human health and the development and application of AI technologies. The company hopes to use artificial intelligence to radically improve the efficiency of drug R&D, select better targets, optimize compounds and derive novel insights from the complex associations between biologically meaningful entities and unstructured text. The company is currently developing an advanced AI platform that uses AI tools to generate useful knowledge from scientific papers, patents, clinical trial information and large amounts of unstructured information. And it understands information through deep learning language models and algorithms, and then generating unique hypotheses based on what has been learned. Since its inception, the company has developed multiple drug candidates and signed major licensing agreements with some of the world's largest pharmaceutical companies. In May 2017, a drug that was developed by this company to treat amyotrophic lateral sclerosis(ALS), has been proved by a research institute in Sheffield, UK that it does have an effect on curing motor nerve decline.

3. Conclusion

With the development and application of innovative technologies such as deep learning, voice entry, computer vision and natural language understanding, every aspect of health process management will be driven to become more intelligent. And the medical industry, characterized as data-intensive, knowledge-intensive and brainwork-intensive, will be deeply integrated with artificial intelligence, creating a trend of change and upgrading. It's reasonable to believe that AI will bring historic changes to healthcare. But we also have to face up to the current problems, and only when the problems are solved can we truly enjoy smart healthcare [5].

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