Improving Diagnosis and Treatment of Lung Cancer with Artificial Intelligence

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Abstract

AI is such an emerging discipline resulting from the interdisciplinary development of the disciplines of ensemble computer science, informatics, neuroscience, psychology, cybernetics, linguistics, and many others. Artificial intelligence expands human brain function and enables automation of human intellectual activity. The combination of AI and medicine can expand the medical field professional skills and brain labor, improve the medical work efficiency, while effectively protecting the safety and reliability of medical activities. Lung cancer, as the leading cause of cancer death in men and women, accounts for one-fifth of all cancer deaths, and lung cancer is broadly classified into non-small cell lung cancer (NSCLC) versus small cell lung cancer, with 80-85% of lung cancer patients being non-small cell lung cancer patients. Most NSCLC patients are diagnosed at an advanced stage of the disease, whereas approximately 25-30% of patients can have their tumors surgically removed at the time of diagnosis. A substantial proportion of NSCLC patients who can undergo tumor resection surgery eventually experience tumor recurrence. Lung cancer is a major factor threatening human life safety, and this article summarizes the research findings in recent years of artificial intelligence technologies for lung cancer-related fields by reading through it.

Keywords

Artificial Intelligence; Lung Cancer; Diagnosis and Treatment.

1. Artificial intelligence concepts

Artificial intelligence (AI), the study of the ability of computers to model human thought processes and only behavior (e.g., learning, reasoning, thinking, planning, etc.), is a science about knowledge.AI involves disciplines such as computer science, neuroscience, psychology, philosophy, and Linguistics and mainly consists of the principle that computers achieve intelligence, manufacture intelligent computers similar to the human brain, and allow computers to achieve high-level applications. Overall AI is a science of knowledge, defined by the science of studying knowledge, discovering knowledge, and applying knowledge. As of today, AI development has come over the course of almost half a century, and although academia has a variety of different interpretations of AI, in essence, AI is the science of studying how to make intelligent machines or be intelligent systems that mimic human intelligent activities and extend the application of human intelligence.

2. History of AI development

The history of AI development can be divided into three phases: budding, formative, and developmental. AI was proposed at Dartmouth in 1956, with development experiencing two troughs and currently in the developmental period. The first three decades were based on expression and inference from mathematical logic, while the second three decades were based on statistical learning, computation and modeling from stochastic mathematics.

Just before 1956, based on the level of recognition and the technical conditions at that time, humans attempted to replace human brain activity by machines and improve productive efficiency. Until 1956, a historic meeting at Dartmouth College in the United States was considered the hallmark of the birth of artificial intelligence. The concept of artificial intelligence was proposed at the meeting, so McCarthy was called the father of artificial intelligence. This important historical meeting, marked the formal birth of artificial intelligence as an emerging discipline. [1] A program of mathematical

theorem proof of logic theory machines, compiled by Newell and Simon et al[2]., in 1957, proved the 38 theorem from Chapter 2 in the book of mathematical principles of Russell and White. This thought activity addresses not only mathematical problems but also broadly. At the same time, they also created table processing techniques as well as chess machines. These work-related Newville's paper on adaptive chess and Simon's paper on problem solving and behavioral theories of rational choice and environmental influences in decision-making were important achievements in information processing. Their duo students did much, such as the EPAM model[3] of human verbal learning and memory (1959), the early natural language comprehension program SAD-SAM, and others. In addition, they explore heuristic solution.

1956 IBM's Samuel study[4] of a program of American checkers with self-learning as well as self-organization was impactful work, which allowed one to look a few steps forward to play chess like an excellent checker. It is also possible to learn the checkerboard spectrum, and after analyzing 175000 different checkers, it is possible to speculate on the recommended way of playing chess in the book with an accuracy rate of up to 48%, an important exploration of human learning processes.

The table (symbol) processing language LISP invented by McCarthy [5] in 1959 became the primary language for AI program design and is still widely used today. The action plan advisory system, established by McCarthy in 1958, and the 1960 McCarthy paper, the step to AI, both contributed positively to AI.

After 1970, artificial intelligence research has gained increasing and widespread attention since the 1970s.In the future to reveal the principles of AI, researchers successively solve the problem, game, theorem proof, program design, machine vision, natural language understanding, and other fields of research in depth. A. comerauer of Marseille University, France, in 1972 proposed the logic program design language Prolog; E.H. Shortliffe at Stanford University in the United States equals the start of research in 1972 on mycin, an expert system for the diagnosis and treatment of infectious diseases. E.A. Feigenbaum from Stanford University in 1977 suggested research directions in knowledge engineering that triggered deeper research and development efforts with expert systems and knowledgebase systems. In addition, some topics such as intelligent robot, natural language and automatic program design, which are more concentrated research subjects in this period, have also achieved a lot of results.

Beginning in the mid-1980s and following more than 10 years of low tide, there have been groundbreaking advances in research regarding artificial intelligence neuronal networks. In 1982, biophysist Hupfeld (Hopfield) proposed a new fully interconnected neural network model, which is called Hopfield model[6]. With the monotonic descent characteristic of the energy of the model, it can be used to solve the optimization problem for approximate computation. Hopfield used this model in 1985 to successfully solve the problem of "" traveller (TSP) "".In 1986, F. Rosenblatt[7], an American psychologist, proposed back propagation (BP) learning algorithm, which solved the learning problem of multi-layer artificial intelligence network and became a widely used neuronal network learning algorithm. Since then, many new neuronal networks have been proposed and widely used in many fields, such as pattern recognition, fault judgment, prediction and intelligent control.

In May 1997, the IBM Corporation's development of the "" deep blue "" computer, which for the first time outcompeted the human chess world champion Kasparov in a formal competition at 3.5:2.5, caused a stir worldwide. This marks in some areas where, after efforts, AI systems can reach the highest levels of humanity[8].

In 2011, IBM developed the artificial intelligence program "" Watson "" to participate in a course of intellectual Q & A and beat two human champions. Watson stores 200 million pages of data and is able to draw keywords related to questions from seemingly relevant answers[9].

In 2016-2017, alphago, an artificial intelligence Go program with self-learning capabilities developed by Google DeepMind, outcompeted the champions for go. It enables the collection of a large collection of celebrity checkers data on go, learning and mimicking human play of chess. DeepMind has advanced into areas such as healthcare[10].

In 2017, AlphaGo Zero (fourth generation AlphaGo) crossed over the previous version of AlphaGo at 100:0 simply 3 days after starting self-study chess without any data input, and 40 days after learning outcompeted the third generation AlphaGo that was out of reach at the human high[11].

The United States is the birthplace of AI, and with the development of AI, relevant scholars in the world have joined this ranks successively. China was the only research on AI topics from 1978, mainly on theorem proof, natural language understanding in Chinese, robots and expert systems, and some preliminary results have been obtained.

3. The role played by artificial intelligence in lung cancer research

Lung cancer as the cancer with the highest incidence worldwide[12], lung cancer therapeutics are the R & D priority of various large pharmaceutical companies. While the classification of lung cancer is a very complex problem, to specifically define what type a certain type of lung cancer is actually, 3 aspects information including typing, staging and molecules need to be combined to understand. The classification mainly describes lung cancer cell lines. According to the morphological characteristics of lung cancer cells under microscope, it can be preliminarily divided into two types: small cell lung cancer (SCLC) and non-small cell lung cancer (NSCLC).The two types of lung cancer differ in growth characteristics, risk of spread, and treatment options, so they should be distinguished first.

The vast majority of lung cancers are NSCLC, which accounts for approximately 85%, and NSCLC can be further classified into three types[13], namely: adenocarcinoma, squamous cell carcinoma, and large cell carcinoma. Of these, adenocarcinoma is the most predominant type, accounting for approximately 50% of NSCLC. Staging primarily describes the extent of lung cancer cell spread. After the diagnosis of lung cancer, doctors use a series of examinations to judge whether cancer cells are only local, or have spread to the lymph nodes or other organs of the body, in order to decide the stage of lung cancer. NSCLC and SCLC differ slightly in the specialized staging systems, but both can eventually be summarized as stage 0, I, II, III, or IV for communication convenience.1. Stages II and III are sometimes divided into a and B, such as stage IIA, IIIB, etc. Stages 0 and I have the best prognosis and the highest cure rate, while stage IV is commonly known as an advanced cancer, which indicates that cancer cells have metastasized to other tissues or organs. Molecularly is genotyping, lung cancer is mainly divided into EGFR mutation, ALK mutation and ROS1 mutation according to the type of gene mutation, and so on, the targeted drugs applicable to different gene mutation types are also different.

4. Applications of artificial intelligence in cancer

Medicine deals with diseases or lesions by means of science or technology so that patients regain the science of health. Medicine, a systematic discipline from prevention to treatment of diseases, is an advanced science dealing with human diseases with the purpose of treating prevention of physiological diseases and improving the health of the human physiological organism. Artificial intelligence is the study of the science of making computers that model human thought processes and intelligent behavior, to knowledge. Now, with the development of science and technology, medicine is more and more connected with artificial intelligence, medicine is an important foundation of artificial intelligence, and many artificial intelligence methods are inspired by medical research, such as artificial neural networks are receiving the human nervous system neurons and the launching of their connections; Convolutional neural networks have only evolved based on a mechanistic understanding of vision; Natural language processing and image processing performance in the area of artificial intelligence are enhanced based on the understanding of the mechanisms of human brain's higher cognitive functions attention; The GA and immunoalgorithm for the intelligent optimization approach are based on the principles of medical genetics and immunology. Therefore, the research and development of basic medicine such as brain science and nervous system is an important foundation and safeguard for the development of artificial intelligence. Second, AI promotes the development of Medicine: AI is widely used in various branches of medicine, including basic medicine, clinical medicine, preventive medicine, and so on. Using clinical medicine as an example,

clinical decision support systems greatly assist clinicians in their diagnostic activities, improve diagnostic accuracy, and reduce clinician labor burden. Medicine and artificial intelligence complement each other and promote each other.

AI research for lung cancer is now largely in diagnostics and therapeutics. For lung cancer diagnosis, a collaboration between software engineers and clinical researchers to create an artificial intelligence program published in nature medicine journals, where the R & D team collaborates with radiologists to screen for cancer based on multiple computed tomography (CT) scans of the same individual with an accuracy of 94%, with a single scan alone outperforming physician judgment for lung cancer."" this technology developed by these individuals will greatly improve the accuracy of screening, "" said Johns Hopkins oncologists[14] and epidemiologists (who were not involved in the new study)

A previous National Institutes of Health (NIH) study of lung cancer screening for smokers has found that detection of early symptoms of the disease by CT scan reduces mortality by approximately 20%, but procedures such as biopsies have led to death in some individuals with false positives on CT scan (NEJM, 2011,doi:10.1056/NEJMoa1102873). To understand whether artificial intelligence (AI) could enhance the accuracy of radiologists when analyzing CT scans, the research team entered thousands of CT scans from early NIH studies into Google's computers, with input also of patients' later diagnostic results. After training, the research team tested the accuracy of this algorithm for detecting cancer based on a new CT scan and compared it with six radiologists. Over time, this algorithm performed as well as radiologists when multiple scans were performed on one individual, but when only one scanned image was available, it produced 5% fewer false negatives and 11% fewer false positives compared to clinicians. And scientists from institutions such as Stanford University have analyzed and examined this machine learning system, and its ability to look for circulating tumor DNA (ctDNA) in blood samples, by studying or hopefully using machine learning means to detect early lung cancer in human patient organisms. Researchers have long wanted to develop, through research, blood tests that would enable the diagnosis of lung cancer at an early stage. Novel means of blood testing will involve screening ctDNA from blood samples, and investigators have subsequently turned to developing machine learning systems, following findings that have shown the promise of utilizing machine learning techniques to identify early breast and other types of cancer. In this study, researchers trained a machine learning model to identify data parameters associated with NSCLC, which enabled effective assessment of lung cancer risk in established patients once the machine model was trained. During testing, this machine learning system found that 63% of patients with stage 1 lung cancer, although not as good as a CT scan result, was sufficient for early screening of patients with high-risk lung cancer, and the investigators stated that many of the current high-risk patients are not screened in a timely manner, and once a patient has a positive result, they seek help and further undergo more accurate and complex testing; Finally, investigators state that such screens, such as machine learning techniques, promise to extend the lifespan of 600-1200 individuals each year, and they can also be used to screen for other types of cancer.

And a deep learning based intelligent diagnostic model of lung pathological images was developed jointly by Prof. Wei Zhong Li's team from Zhongshan Medical College and Prof. Xuefu Ke's team from the Affiliated First Hospital[15], which could accurately distinguish the pathological images of lung cancer and its easily confused diseases. Researchers construct deep learning classifiers of histological types of lung diseases by supervised learning, visualize the results in a Heatmap manner, and validate the comprehensive performance of the model with independent datasets from multiple medical centers to further evaluate the clinical significance of the model in a human-computer comparative manner. This model is the first six classifiers that can distinguish lung adenocarcinoma, lung squamous cell carcinoma, small cell lung cancer, tuberculosis, organizing pneumonia, and normal lung tissues, and extends the AI assisted diagnostic scope of lung tissue typing to a complex multi disease diagnostic requirement with great clinical interpretability. The researchers tested on more than 1000 pathological slides from four different medical centers, and the highest AUC reached 0.978, which was in good agreement with the clinical true diagnosis. Four pathologists of different years from the Department of pathology of the First Affiliated Hospital of our university were also

invited to perform double-blind reading controls, which showed that the model reached a similar level of diagnosis as experienced pathologists. The proposed artificial intelligence model was used to identify the pathological image of lung cancer and its easily confused disease, which exhibited excellent accuracy, stability and practicality in the face of complex clinicopathological scenarios, and its clinical translational application will improve the efficiency and accuracy of pathological diagnosis and reach the purpose of intelligent assisted diagnosis.

In terms of lung cancer treatment, common treatment modalities including surgery, radiotherapy, chemotherapy, targeted therapy, immunotherapy, etc., the advent of targeted therapy and immunotherapy has ushered in a new era in the treatment of lung cancer. More and more lung cancer patients have achieved long-term survival and higher quality of life by virtue of innovative drugs, breaking the traditional perception of lung cancer treatment. But in terms of lung cancer treatment, there may be a better drug cooperation. The day before, in a report on research published in the international journal Nature communications[16], scientists from institutions such as the University of Alto went through studies that indicated that utilizing artificial intelligence technologies or were expected to predict which combinations of drugs would effectively kill cancer cells. When clinicians treat patients with advanced cancer, they often require the use of combination anticancer therapies, whereas in addition to cancer surgery, patients are often treated with radiotherapy, medical therapy, or both.

Drugs can be combined with drugs targeting specific cancer cells, and combinatorial drug therapies often improve the therapeutic efficiency of therapies and reduce harmful side effects of drugs if single drug doses can be reduced, however, experimental screening of drug combinations is often very slow and expensive, Therefore researchers often fail to detect the full benefit of combination therapy; In this study, with the help of a novel machine learning approach, researchers may be able to identify optimal drug combinations to selectively kill cancer cells carrying special genetic or functional compositions. We developed a machine learning model that accurately predicts how combinations of multiple cancer drugs kill multiple types of cancer cells, says investigator juho Rousu; We were able to train this new type of AI model using the large amount of data obtained from this previous study, which had primarily investigated the association between drugs and cancer cells, a model utilizing machine learning that was actually a polynomial function similar to school mathematics, but was nevertheless very complex. This model enables the discovery of associations between drugs and cancer cells that have not been observed by previous investigators; At the same time, the model was also able to give very precise results, for example, where the value of the so-called correlation coefficient exceeded 0.9 in an experiment, which indicates very high reliability, whereas in an experimental assay, a correlation coefficient of 0.8-0.9 was considered to give very reliable results.

5. Conclusions and perspectives

Lung cancer is the cancer with the highest morbidity and mortality worldwide. The current common treatment modalities for lung cancer include surgery, radiotherapy, chemotherapy, targeted therapy, immunotherapy, etc., and the advent of targeted therapy and immunotherapy has ushered in a new era in the treatment of lung cancer. More and more lung cancer patients have achieved long-term survival and higher quality of life by virtue of innovative drugs, breaking the traditional perception of lung cancer treatment.AI technology has greatly developed and can help scientific researchers to understand the mechanism of lung cancer disease through AI technology based on patient data, help prevent lung carcinogenesis, and carry out highly effective early screening of lung cancer in people; At the same time, according to the treatment plan of patients, lung cancer treatment options with the best treatment effect can be screened out, improving the chances of patient survival. With the development of artificial intelligence in medicine, it is believed that in the near future, humans can attack lung cancer.

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