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Intensification of Artificial Intelligence in Medical Diagnosis: An Overview

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ABSTRACT

Artificial intelligence (AI) aims to mimic human cognitive functions. It is bringing a paradigm shift to healthcare, powered by increasing availability of healthcare data and rapid progress of analytics techniques. We survey the current status of AI applications in healthcare and discuss its future. AI can be applied to various types of healthcare data (structured and unstructured). Popular AI techniques include machine learning methods for structured data, such as the classical support vector machine and neural network, and the modern deep learning, as well as natural language processing for unstructured data. Major disease areas that use AI tools include cancer, neurology and cardiology. We then review in more details the AI applications in stroke, in the three major areas of early detection and diagnosis, treatment, as well as outcome prediction and prognosis evaluation. We conclude with discussion about pioneer AI systems, such as IBM Watson, and hurdles for real-life deployment of AI.

Diagnosis of diseases is the process of converting observed evidence into the names of diseases. Central to the effective delivery of health care by the physician is the complex skill of clinical problem solving. The accuracy of this skill is crucial to the life and well being of his/her patients. The efficiency with which it is applied is of great economic important. Applying Artificial Intelligence (AI) techniques in medical field may help not only in improving the accuracy performance of classification but also in saving diagnostics' time, cost, and the pain accompanying pathologies' tests. This paper introduces an evolution of AI techniques that have been used in medical diagnosis. Then, it introduces the author's experiments using Machine Learning (ML) algorithms on Thyroid Disease Datasets with and without Feature Subset Selection (FSS). The experiments' motivation is to determine the usefulness and the feasibility of FSS to decision making under risk (Medical field as an example).

KEYWORDS: AI, healthcare, diagnosis, artificial intelligence, diagnosis advancement

1. INTRODUCTION

Artificial Intelligence has taken over our daily lives. There are numerous projects being undertaken to study the "Future of Work" in the fourth Industrial Revolution. Technologies like artificial intelligence, big data, block-chain, internet of things all are now part of our daily lives. Be it our smartphones, T.V.s or watches. Any emerging technology is first utilized for security and medical research. In 1895, Wilhelm Rontgen received the Nobel Prize for taking a photograph of a human hand. Today X-ray examination is a sine-qua-non for every road injury affecting the bones and consequently has a significant role in Medical Diagnosis. But at that point in time it was an inventive step. A step which has led to every nook and corner of the world having an X-Ray machine of their own. Thus, even artificial intelligence is at the final stages of its research and very soon it will be hitting the road and those who are adept at handling technology will be preferred. Similarly, the term Artificial Intelligence, which was coined during a workshop held at Dartmouth College in 1956 [1] is just a subject of research but tomorrow it will be a tool because that is what humans have been doing, by developing cognitive offloading tools. Cognitive offloading is the tendency to rely on things like internet, calculators, appointment reminders, to do list etc. which only increases with time. Which is to say - the more we use the network to find information and encounter data, the fewer probabilities we will have to use our memory.

1.1 Artificial Intelligence (AI)

Artificial Intelligence (AI), which is now ubiquitous, will lead us in new directions. Its increasing use is a hot topic not only because of the opportunities it will bring but also the concerns it raises about the possible disruptive implications it will have on the way we live and work.

AI is now embedded into the lexicon of 21st century digital technology. Autonomous vehicles (driverless cars, trains and drones), intelligent manufacturing (smart factories), virtual home assistants (Alexa, Siri, etc.), auto diagnostics and robotic surgery are just some examples where AI is being applied. Advances in computer technology and machine-learning have brought us to a time when almost every human endeavour depends on their use. They are the key elements of automation.

If we trace back to the time when humans first made machines, then a primitive form of AI was used to instruct them to carry out physical tasks. A modern computer is just an extension of the human brain that can be programmed to provide instructions for machines. This was exemplified when the first computers were made in the 1940s. A machine language had to be created to enable a digital computer to understand instructions. This was a simple binary code organised in patterns of 0s and 1s.

The human brain is different to a digital computer since it operates in analogue mode. This gives our brain wider scope in analysing information owing to its cognitive abilities (pattern recognition, awareness and creative thinking). Although present supercomputers do not possess these attributes, they do have greater storage facilities and faster data retrieval ability. However, a greater understanding of the mechanism of neural processing in the brain will be necessary before AI can match human intelligence. The operational speed of the human brain is about 2.2 bn megaflops. The fastest supercomputer is about 9.3 bn megaflops[1]. For comparison, the iPad is 170 megaflops[2].

Numerous articles have been written about the applications and societal implications of AI, but in the context of this issue's industry focus, I will restrict my narrative to its use and impact on medical diagnostics and healthcare. It is a sector that has greatly benefited during the last decade from the developments in micro-nanotechnologies and one in which most governments are investing huge sums of money. Industry has responded by creating and manufacturing new types of precision diagnostic and analytical tools and surgical instruments that are now revolutionising medical practice. AI is also the foundation of the advancing use of robotic surgery.

1.2 Medical diagnostics

The rapid advance of technologies and operational methods used in medicine coupled with huge improvements in computing power, data collection and processing, has produced a paradigm shift in diagnostic methods and analytical techniques. A new range of precision instruments and tools endowed with AI are now available. Some are described in this and previous editions of the magazine. Many can be connected via Wi-Fi to medical centres to access records and information.

Computers endowed with AI enable huge amounts of data to be instantaneously accessed, processed and evaluated beyond the capability of the human brain. For example, in 2016, an innovative diagnosis was made at the University of Tokyo's Institute of Medical Science in Japan[3]. A computer was used to scan around 20 mn research papers, then using AI, a rare form of leukaemia that was in a patient in her 60s was identified in just 10 minutes. This could not have been diagnosed by specialists in such a short timescale. It helped doctors devise the optimal treatment and saved her life. This is one of many examples I found where AI had assisted a physician in making a more informed treatment decision.

The fast and intelligent evaluation of medical knowledge stored in vast databases worldwide can now be made available to practitioners to enable them to more accurately diagnose and treat disease. It removes ambiguity, saves lives and reduces the cost of treatment, particularly in the usage of drugs. The over-prescription and misuse of antibiotic drugs has produced bacteria resistance, making treatment less effective.

In the last year, researchers have revealed that AI computer systems can now diagnose diabetic eye disease, skin cancer and arrhythmias more effectively than human doctors. Clearly this is going to increase and advance the effectiveness of medical practice.

2. TECHNOLOGY BEHIND AI FOR DIAGNOSIS

These AI Systems for diagnosis uses deep learning techniques to arrive at a diagnosis. These systems source image data and symptoms data from healthcare facilities to train on. Then, the systems apply the techniques to arrive at the diagnosis. The problem with deep learning techniques is transparency. Although the inputs and the outputs to the AI systems are transparent, the way that the AI systems arrive at the diagnosis decision is unclear. The system is also dependent on the quality of the data to ensure accuracy.

Many of today's machine learning diagnostic applications appear to fall under the following categories:

- Chatbots: Companies are using AI-chatbots with speech recognition capability to identify patterns in patient symptoms to form a potential diagnosis, prevent disease and/or recommend an appropriate course of action.
- Oncology: Researchers are using deep learning to train algorithms to recognize cancerous tissue at a level comparable to trained physicians. Pathology: Pathology is the medical specialty that is concerned with the diagnosis of disease based on the laboratory analysis of bodily fluids such as blood and urine, as well as tissues. Machine vision and other machine learning technologies can enhance the efforts traditionally left only to pathologists with microscopes.
- Rare Diseases: Facial recognition software is being combined with machine learning to help clinicians diagnose rare diseases. Patient photos are analyzed using facial analysis and deep learning to detect phenotypes that correlate with rare genetic diseases.

It is important to note that this is not a complete list of all diagnostic applications of AI. We aimed to present a succinct representative group of current initiatives based on our research.

3. CHALLENGES OF SOURCING DATA

Artificial intelligence will likely help radiologists diagnose patients more rapidly, but there are still challenges to overcome, according to The Wall Street Journal.

A typical radiologist might review hundreds of X-ray images before detecting a medical concern. However, advanced AI algorithms could be used to identify and analyze images on their own, and flag issues for review by a human radiologist.

Still, AI algorithms are new systems in need of improvement. Here are four key challenges to developing AI for diagnosis, according to The Wall Street Journal.

- A developer trains an AI system on how to identify medical issues such as tumors or fractures using images of relevant examples. These example images must be labeled by a human being, so that the system identifies what to look for in the future.
- Healthcare companies often struggle to recruit top data scientists. GE Healthcare is working to address this issue by partnering with colleges to advance science, technology, engineering and math coursework.
- Some healthcare stakeholders also worry about patient privacy, since an AI system requires access to patient data to reach a diagnosis. In particular, hospital leaders might worry about whether companies accessing their medical records have proper information security protocols in place.
- Another challenge to deploying AI in healthcare involves perception, as physicians worry the technology might one day replace them. However, health IT companies has critiqued this view of AI.

"What we're developing is a suite of applications to make [people] more effective" at diagnosing and treating patients, Charles Koontz, chief digital officer of GE Healthcare, told The Wall Street Journal.

4. CONCLUSION

Artificial Intelligent systems can be developed to help physicians to make their decisions (diagnosis and therapy). The main AI applications related to the medical diagnosis are: Expert Systems, and Learning Systems. Expert systems are criticized for being limited in their abilities to surpass the level of existing experts, the great effort required to build and maintain a knowledge base, and shortage of trained knowledge engineers to interview experts and capture their knowledge in a set of decision rules or other representational elements, quite time consuming, leading to lengthy development, which must be continued if the system is to be maintained in routine use at a high level on performance

Medical diagnosis is a problem solving and decision making. Feature Subset Selection (FSS) selects a good subset of features for improving accuracy performance. Machine learning has nothing to do with differential medical diagnosis. Physicians must start their investigations to determine the directions of suspicions. In each direction physician needs some tests either to eliminate suspicions or to continue in one direction. Applying FSS in medical field may help not only in improving the accuracy performance of classification but also in saving time, cost, and the pain accompanying tests. Much effort has been done in applying neural networks and ML algorithms. Most of this work was concerned with improving the accuracy of the classification, but none of them studied the economic feasibility of applying FSS. Our experiments can be applied in any field that deals with a huge number of features especially in decision making under risk.

As AI innovations progress in healthcare, it's critical for medical technology companies, data providers (Google), hospitals, governments, and insurance companies to work together to foster an atmosphere of innovation. In this atmosphere of innovation, better opportunities for automation can be identified, proper data can be sourced, thus lead to better accuracy in both medical diagnosis and better efficiency in the healthcare workflow.

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