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Review Article

Review on Artificial Intelligence in Medicine

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ABSTRACT

Complex medical data can be extracted using artificial intelligence, a branch of computer science. Their capacity to identify meaningful relationships within a data set can be applied in a variety of therapeutic settings for outcome prediction, diagnosis, and treatment. Artificial intelligence in medicine is developing swiftly. Artificial intelligence-powered medical technology is fast becoming practical clinical practice-related solutions. The increasing amounts of data generated by mobile monitoring sensors found in wearables, smartphones, and other medical equipment can be handled by machine learning algorithms. The use of Artificial Intelligence (AI) in many medical professions is discussed in this illustrative article from the perspectives of seven distinct fields: machine learning, intelligent robotics, image recognition technology, expert systems, artificial neural networks, and evolutionary computation. Additionally, it covers AI's prospective and current applications in medicine.

Keywords: Artificial intelligence, AI, Medicine, Technology.

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INTRODUCTION

The digital revolution has had an impact on every facet of society. Healthcare computer systems are expected to support medical professionals in challenging clinical situations in addition to supporting administrative and paperwork activities.

The technical term for these kinds of systems is Clinical Decision Support System (CDSS). They are also known as computerized systems, and their main objective is to support clinical decision-making by utilizing distinct patient characteristics to produce recommendations for treatment.[1]

The phrase "Medical Technology" is widely used to describe a range of tools that can assist clinicians in making earlier diagnosis, preventing issues, optimizing therapy, providing less intrusive options, and reducing the length of hospital stays for both patients and society at large. Prior to the mobile era, medical technologies were mainly known as conventional medical devices (such as implants, prosthetics, and stents), but the development of smart phones, wearable sensors, and communication systems has revolutionized medicine by allowing the storage of Artificial Intelligence (AI)-powered tools in incredibly small sizes.[2]

Artificial intelligence (AI), which is typically described as the area of computer science that can handle challenging difficulties with a wide range of applications in domains with large amounts of data but little theory, has revolutionized medical technology.[3]

In order to tackle tough clinical problems, modern medicine must find a way to collect, evaluate, and use the large amount of knowledge needed. The development of medical AI has been associated with the design of AI programmes meant to aid physicians in the formulation of diagnoses, the making of therapeutic decisions, and the prediction of results. They are designed to aid in the processing of information and knowledge necessary for tasks that healthcare professionals must perform on a regular basis. Examples of such systems include hybrid intelligent systems, fuzzy expert systems, evolutionary computation, and artificial neural networks (ANN).

As a branch of computer science, Artificial Intelligence (AI) research primarily examines the following subjects: machine learning, intelligent robotics, neural networks, language recognition, image recognition, and expert systems.[4]

COMPONENTS OF ARTIFICIAL INTELLIGENCE

Machine learning

Arthur Samuel used the phrase "machine learning" in 1959 to refer to a set of algorithms and the development of classifiers. The algorithm automatically learns from the input data and builds a model based on it in order to accurately anticipate fresh data.[5,6]

Computers can carry out this task attributed to artificial intelligence (AI) and machine learning by algorithmically creating efficient representations of data. In this context, "machine learning" and "artificial intelligence" both approximately refer to

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the same concept, while machine learning is better understood as a set of techniques that enable AI. Classical statistics and machine learning differ from one another more in terms of culture and objective than in terms of approach.

Image recognition technology

Image recognition is the use of computers to process and analyze images. It is an essential piece of artificial intelligence technology that uses deep learning. The three stages of the evolution of image recognition technology are text recognition, digital image recognition, and object recognition.[7]

The input processing, image preprocessing, image extraction, classifier development, and output generation are the five steps of the recognition process.[8]

Expert system

A computer programme known as an expert system facilitates decision-making by human specialists. One of the first effective AI programmes, it harnesses the body of existing knowledge to reason and address a range of complex problems.[9,10]

The expert system exhibits advantages in terms of disease detection and diagnosis as well as a strong capacity for clinical judgement. The system must be considered, along with the patient's medical background and the doctor's professional experience, in sync. Medical discoveries and information also need to be updated often to provide professionals with the most recent diagnoses and treatment alternatives.[11]

Intelligent robots

Robots with intelligence were employed in surgery in the 1980s. For instance, PUMA 560 was employed in prostate surgery in 1988 and neurosurgical biopsies in 1985. The first intelligent robot recognized by the US Food and Drug Administration was called ROBODOC, which was developed in 1992. (FDA). It was largely utilized for hip replacement surgeries in orthopedic surgery.[12] Three different robotic surgical systems, including the ZUES and Da Vinci, are currently approved by the FDA. An automated endoscopic method for putting robots in the best positions. Due to their precise, advanced, and safe properties, intelligent robots are frequently utilised in orthopedics, urology, orthopedics, stomatology, and other specialties.[13,14]

Fuzzy expert system

Fuzzy logic is the science of reasoning, thinking, and acting that acknowledges and makes use of the fact that everything in the real world is a question of degree. Fuzzy logic accepts that most circumstances would actually fall into one of numerous shades of grey, in contrast to conventional logic, which maintains that everything is either black or white. It was made popular in 1965 by engineer Lofti Zadeh of the University of California.[15] It employs continuous set membership from 0 to 1, as opposed to Boolean or conventional logic, which uses sharp differences, such as 0 for false and 1 for true. Despite the fact that medicine is basically a continuous area, medical data is often imperfect by nature. Fuzzy logic is a technique for handling data that takes uncertainties into account, making it particularly suitable for use in medical applications. From a computational perspective, it successfully applies and incorporates the concept of fuzziness. According to Zadeh in 1969, the most likely area of application for this theory "lies in medical diagnostics and, to a lesser extent, in the description of biological systems," he stated.[16]

Artificial neural networks

ANNs are computerized analytical tools that mimic the biological nervous system. They consist of "neurons," or networks of connected computer processors, which may perform parallel calculations for knowledge representation and data processing. They are an especially enticing analytical tool in the field of medicine because of their ability to generalize, simplifying application of the model to independent data, manage incomplete information, analyze non-linear data, and learn from prior examples. McCulloch and Pitts developed the first artificial neuron in 1943 using simple binary threshold functions.[17]

Evolutionary computation

A number of computational techniques that mimic natural selection and the survival of the fittest while addressing real-world problems are referred to as "evolutionary computation." The most popular kind of evolutionary computation for medical applications is "Genetic Algorithms." The idea was put forth by John Holland in 1975.[18]

These strategies for random search and optimization are based on biological evolution that occurs naturally. They function by offering a variety of irrational solutions to the problem at hand. After that, as other choices become more prevalent from one generation to the next, the problem will eventually be successfully resolved. The most successful solutions are used, and the ineffective ones are abandoned. If this process is repeated among the better elements, the population will continue to evolve, survive, and generate fresh ideas.

ARTIFICIAL INTELLIGENCE APPLICATION IN MEDICINE

AI in Cardiology

A novel blood pressure measurement based on CNN-convolutional recurrent neural network - blood pressure (CRNN-BP) was developed in 2002 in order to address the issue of the extraction of pulse waveform feature points and low robustness in conventional medicine, as well as to increase the precision of the model. This procedure complies with the British and Irish Hypertension Society's and the Association for the Advancement of Medical Instrumentation's criteria.[19]

The early detection of atrial fibrillation was one of the first medical applications of AI. After receiving FDA certification in 2014, the mobile application Kardia created by AliveCor now allows smartphone-based ECG monitoring and atrial fibrillation identification. According to the most recent REHEARSE-AF research, remote ECG monitoring with Kardia is more likely to detect atrial fibrillation in mobile patients than standard care (19). Additionally, Apple's Apple Watch 4 was given FDA certification; it allows for easy ECG acquisition and atrial fibrillation diagnosis. Through a smartphone, you can transmit these data to the doctor of your choosing.[20]

When applied to electronic medical data, AI has been shown to predict the risk of cardiovascular disease, such as acute coronary syndrome,[21] and heart failure,[22] better than traditional scales.

AI in neurology

Intelligent seizure detection technology is poised to significantly improve seizure management through ongoing ambulatory monitoring. The wearable Embrace by Empatica received FDA certification in 2018. It can detect generalized epilepsy seizures when used in conjunction with electrodermal captors, and it can record such seizures to a mobile application, which can subsequently alert close family members and a reliable doctor and provide additional information about the patient's whereabouts.[23]

In a different study, the expert system was used to identify a variety of headache types, such as tension headaches, migraine headaches, and headaches brought on by drugs. The computerized headache evaluation instrument properly detected 94.4% of migraine headaches and 93% of common symptoms (CHAT). 98% of diagnoses were accurate on average. As a result, the introduction of the CHAT expert system can assist medical professionals in identifying the type of headache that has been identified, which is crucial for medical therapy.[24]

Wearable sensors have proved successful in objectively measuring gait, posture, and tremor in people with multiple sclerosis, Parkinson disease, Parkinsonism, and Huntington disease.[25]

AI in pulmonary medicine

A recent study found that AI-based software can interpret the results of lung function tests more accurately and serve as a decision support tool, making this a promising field for the development of AI applications in pulmonary medicine. One of the objections levelled at the study was that the pulmonologists who participated in it had much lower rates of accurate diagnosis than the national average.[26,27]

Radiation therapy is frequently administered to patients with lung cancer, especially small cell lung cancer. However, prolonged radiation exposure can have disastrous side effects, such as radiation pneumonitis, which can lead to respiratory failure and even death. Artificial neural networks were used in the prediction of radiation pneumonitis by researchers. Additionally, they created a network with extensive memory and data training that could foresee challenges more precisely.[28,29]

AI in orthopedics

A study found that map projection technology could more accurately and efficiently identify the bones that were most prone to fractures between the femoral and trochanter than conventional heat map technology. They demonstrated a connection between the patients' gender and age and the area where the fracture line was distributed. Technologies for image recognition have tremendously aided in the diagnosis and treatment of intertrochanteric fractures.[30]

Elderly individuals with hip pain, dysfunction, and deformity are at risk for femoral neck fractures. Surgery is the best option for treating these fractures because non-union of the fracture and avascular necrosis of the femoral head are potential outcomes. In 2018, a study on methods to reduce bleeding after femoral neck fracture operations was carried out. The use of surgical robots allowed physicians to target the surgical site and induce fewer punctures, which lowered the amount of bleeding during the process, according to a comparison of the two surgical approaches—robotic orthopedic surgery and manual nailing more precisely.[31]

Depending on the type of orthopedic surgery they are employed for, robots can be categorized into three groups: joint surgery robots, spinal orthopedic robots, and traumatic orthopedic robots. Despite being used extensively in orthopedics, intelligent robots still have limits because of their high costs, large sizes, and limited range of applications.[32]

AI in cancer

Cervical cancer, which is brought on by papilloma virus infection, is one of the top four killers of women. Patients initially don't exhibit any overt symptoms. A later onset of symptoms could include anaemia and cachexia. Despite having access to a variety of therapies, including surgery, radiation, and chemotherapy, women with cervical cancer have a much better chance of surviving if the disease is caught early. With an accuracy rate of roughly 90%, deep learning-based intelligent photo recognition of the cervix could aid medical professionals in the early diagnosis of cervical cancer.[33,34] Using fuzzy logic, diagnosis for acute leukemia,[35] breast cancer,[36] and pancreatic cancer,[37] have all been examined.

They have also been used to characterize MRI scans of brain tumors,[38] ultrasound scans of liver lesions,[39] and CT scans of breasts,[40,41] Fuzzy logic has also been used to predict the survival rates of breast cancer patients.[42]

Using the principles of genetic algorithms, the outcomes of lung cancer,[43] melanoma,[44] and the reaction to warfarin[45] have all been predicted. The computerized diagnosis of malignant melanomas,[46,47] the segmentation of brain tumors on MRI to evaluate the efficacy of treatment,[48] and the analysis of mammographic microcalcification have all benefited from their use.[46]

AI in gynecology

Intelligent robots are also often used in gynecological surgery. For instance, a patient with early ovarian cancer may have an abdominal lump, ovarian tumor pedicle twisting, and tumor rupture. In order to effectively treat this cancer, surgical procedures must be done when it is still in its early stages. Using the Da Vinci Systems during surgery provided significant advantages, according to a meta-analysis, as it allowed for the removal of numerous lymph nodes and resulted in a low rate of blood transfusion in patients. This surgical procedure was therefore even more secure than laparoscopic surgery.[49]

FUTURE ASPECTS OF ARTIFICIAL INTELLIGENCE IN MEDICINE

Acknowledgement of AI-Based Technologies: A Reproducibility Crisis on the Horizon?

One of the biggest problems of using AI in medicine in the coming years will be the clinical validation of freshly developed fundamental principles and techniques. Following, we'll talk about three of these limitations and offer potential fixes.

To start, it has been found that the majority of studies contrasting the efficacy of AI and doctors lack primary replication, or the validation of the algorithms developed in samples derived from sources other than those used to train the algorithms.[50] As open data and open procedures become more widely accepted as best practises in research, this problem may be solved in the era of open science.

Second, it is well known that studies describing the use of AI in clinical practice have limitations related to retrospective designs and sample sizes. These designs may include selection and spectrum bias, which refers to the development of models that are overfitted to a specific data set and do not replicate the same results in other datasets.[51] After the adoption of algorithms that are deemed to be overfitting to account for changes in patient demographics, software should require constant re-evaluation and calibration. Additionally, there is growing consensus that algorithms must be developed that are specifically designed to take into account subgroups while also accommodating bigger communities.[52]

Third, there are not many research comparing AI to clinicians using the same data sets; even in those, detractors have pointed out that the diagnosis accuracy rates of specialised doctors aren't as high as they ought to be.[27] Despite the fact that the scientific literature is heavily biased against AI and doctors, many studies are currently concentrating on the interaction between clinicians and algorithms since the merger of human and artificial intelligence outperforms either one alone.[52]

THE PRINCIPLES OF CONTINUOUS MONITORING

Continuous monitoring and privacy violations, for instance, may increase stigmatization of the chronically ill or more disadvantaged population,[53] and may punish those who are unable to adopt new healthy lifestyle standards by, among other things, restricting their access to health insurance and care. However, these significant and potentially catastrophic errors in the creation of health policy have received little to no debate.

Despite being a topic for more than 20 years, data ownership and protection are becoming more crucial in today's techno-political climate.[54] Many different perspectives on data ownership are described in the literature. The consensus is shifting toward patient ownership because it has a positive effect on patient engagement and may enhance information exchange if a data use agreement is developed between the patient and healthcare professionals,[55,56] even though some works argue for shared ownership of patient data to benefit personalized medicine approaches.[57]

THE NEED FOR AUGMENTED DOCTORS TO RECEIVE EDUCATION

A number of colleges have started to create cutting-edge medical curriculum, including a doctor-engineering, in response to the need to prepare future medical leaders for the issues that artificial intelligence in medicine would present.[58,59] In such a curriculum, computer sciences, coding, algorithmics, and mechatronic engineering are added, and the hard sciences (such as physics and mathematics) are tackled more rigorously. In order to solve the issues of modern medicine, help build the digital strategies for healthcare organizations, manage the digital transition, and train patients and colleagues, these "augmented doctors" would draw on both their clinical knowledge and their digital skills.

PREVENTING TECHNOLOGICAL DEHUMANIZATION WITH THE PLEDGE OF UBIQUITOUS CLINICAL INSIGHT

One of the main barriers to doctors embracing advanced medical technologies is the concern that medicine may become less compassionate. The increased administrative burden,[60] that is put on doctors is mostly to blame for this. However, modern techniques, such as ACI and natural language processing, will surely alleviate the issue of administrative load and let practitioners to focus more on the patient.

Ambient clinical intelligence is a sensitive, adaptive, and responsive digital environment that surrounds the clinician and the patient (ACI).[61] For instance, ACI has the capacity to analyze the Q&A session and automatically fill the patient's electronic health records. Several projects are currently in development to develop an ACI, which would be a crucial use of artificial intelligence in medicine and essential for addressing existing challenges with the medical workforce.

ARTIFICIAL INTELLIGENCE: WOULD IT END UP REPLACING DOCTORS?

As has recently been shown in the literature, artificial intelligence won't likely replace clinicians; rather, smart medical technology exists to help doctors manage patients more effectively.[62,63] Nevertheless, as recent study has revealed,[50] doctors and artificial intelligence solutions are frequently contrasted, as if the two professions were rivals. Future studies should compare physicians who employ AI applications to those who don't, and they should take translational clinical trials into account. Artificial intelligence won't be accepted as a medical supplement until then.

CONCLUSION

In the future, it is anticipated that AI will face more difficult development issues. There are numerous AI techniques that can be used to address a wide range of therapeutic issues. AI has fundamentally altered the way traditional medicine is practiced, considerably raised the bar for medical services, and provided numerous assurances for human health. Future development of medical AI is projected to be more widespread. Primary care physicians need to become knowledgeable about upcoming AI developments and the new, uncharted region that the field of medicine is moving toward. The objective should be to create a gentle, mutually advantageous balance between primary care physicians' human strengths and judgment and the optimal use of automation and AI. There is strong evidence that medical AI can help clinicians provide healthcare effectively in the twenty-first century.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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