AI IN HEALTH CARE

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INTRODUCTION

Development in the field of Artificial intelligence (AI) and associated technologies have created a big impact in business and society including healthcare. AI can be integrated into clinical diagnosis, administrative process relating to patient data, insurance verification and handling, and pharmaceutical organizations. The availability of data points across various medical conditions can be utilised efficiently by the AI to diagnose or predict diseases and suggest personalised health care. Various AI tools and diagnostic devices have entered medical field and are performing better than radiologists in detecting malignant tumours and managing researchers to design efficient clinical trials. However, these achievements have certain downfall due to the limitations of such algorithms for a variety of reasons. AI may take many decades to replace human's role in medical process domains. Here we describe the aspects and possibilities of rapid implementation of AI in healthcare.

Types of AI in healthcare

AI is a collection of multiple technologies with specific use cases in automation of knowledge-based tasks. Many of these technologies are relevant to the healthcare field except for few modifications required in them to support its various process domains. Following are the list of AI technologies of high value to healthcare:

1. Machine learning – neural networks and deep learning

Machine learning (ML) enables creating statistical models from a huge reservoir of data using periodic learning and training. These statistical outputs could determine possible accurate outcomes for a theoretical problem. ML is the most popular form of AI used across industries to determine market outcomes, customer outcomes, genome outcome prediction, health prediction and others.

In healthcare, ML is extensively used for precision medicine. It refers to AI based prediction to determine what treatment protocols bring the best outcome in a patient with respect to patient's characteristics. The health record repository of millions of patients can be trained using "supervised learning" as part of ML and can be employed into precision medicine applications.

Another intricate form of ML is the artificial neural network (ANN) – a technology that can extract features based on training outputs from thousands of previously collected diagnostic data points and inferences. Thanks to the previously available diagnostic data and inferences from clinicians and doctors, ANN models create cluster of neural points with relevant information. These neural cluster networks are utilised for predicting and identifying similarities and differences in each task or problem. The ANN predictions thus made are more accurate than the predictions made by clinicians or doctors due to the ability of detecting and differentiating even a minute variation present in patients diagnostic report.

Every ML platform involve deep learning, or neural network models with several layers of elements or variables that predict outcomes. These features/elements could only be uncovered via faster processing capabilities and related cloud architectures. These advances will help apply the technologies like radiomics for oncology-oriented image analysis and prognosis. The AI-radiomics combination offers greater accuracy in diagnosis than the existing automated tools for image analysis known as computer-aided detection or CAD.

The development of machine learning along with the ever-increasing healthcare data will assist healthcare workers to take better predictive approach to create unified systems towards patient care and processes.

One example of deep learning could be cited at MD Anderson centre where data scientists have developed a healthcare algorithm to predict acute radiation therapy toxicities in patients with head and neck cancers. The data produced via healthcare deep learning can recognize complex patterns and apply it in clinical workflows to offer primary care and decision support at the point of care in hospitals.

There exist large volumes of unstructured healthcare data for ML in the form of information held or "locked" in electronic health record systems. These data cannot be analysed as it requires extensive reading through the medical records making it a hectic task. Human language, or "natural language," is very complex, lacking uniformity and incorporates an enormous amount of ambiguity, jargon, and vagueness. To convert such large documents into analysable data, ML in healthcare often relies on AI like natural language processing (NLP) programs.

2. Deep learning - Natural language processing

Natural language processing (NLP) is a deep learning method used for speech recognition, text analysis, translation sentiment analysis, predict text or audio-based reactions, and other goals related to language. Like other AI models NLP also use probability and statistics based on various text datasets to predict the word sequence in a sentence. NLP applications in healthcare will involve the audio to text or vice versa for medical report generation, understanding and classification of unstructured clinical data on patients, medical transcription, and conversational AI.

3. Deep learning - Rule-based expert systems

When working with huge knowledge domain, experts and data engineers construct a set of 'if-then' rules to help 'clinical decision support'. When the amount of such rules exceeds to number of thousands or more, then rules begin to conflict. An update or upgrade in the knowledge domain will change the related rules, changing such rules may become difficult and time-consuming. Deep learning platforms can assist in generation and updating of knowledge domain rules and manage them efficiently for 'clinical decision support' system. Manual rules and decision of healthcare systems are replaced in healthcare by advances based on data and ML algorithms.

4. Physical robots

Physical robots or machine have been used in industries under a category known as industrial robots. They can perform pre-defined tasks like lifting, welding, painting, repositioning, or object assembling in factories, warehouses, and hospitals. More recently, efforts have been made to collaborate robots with humans to carry them through a desired task. Inclusion of faster algorithm, sensor, and processing technology, along with other AI capabilities will produce intelligent physical robots in healthcare that could even do unassisted pinpoint accurate surgeries reducing tissue damage and time for patient recovery.

Currently, surgical robots approved in USA provide surgeons with the ability to detect, and perform precise and least invasive incisions, stitching and others. These robots are being used in gynaecologic, prostate, gastrointestinal, cardiothoracic, urologic, spinal, hepatobiliary, colorectal and head and neck surgery. Still, important decisions in all these are made by human surgeons to monitor and minimise complexities arising in such procedures as part of patient safety.

5. Robotic process automation

Robotic Process Automation (RPA) is a type of software technology that automates repetitive and routine tasks by using scripts to imitate human actions. It does this by utilizing APIs and user interface interactions to execute tasks across different software systems, making it possible to complete tasks such as data extraction, form filling, and file moving in an autonomous manner.

In healthcare organizations all processes are run real-time. A cumbersome and error prone task can slow down entire process concerning from cost structures to compliance to the patient experience. RPAs provide structured and logic format considering the existing knowledge domain rules to automate decisions with a business rule engine. RPAs when integrated stably with NLPs and intelligent automation (IA) could mimic human actions using specific or related bots. RPAs can mitigate healthcare challenges in administrative data entry, document digitization, appointment scheduling, billing and processing, records management and customer support. In the future RPAs will benefit healthcare organizations by reducing running cost via improving speed of operations and increasing efficiency of business process and patient care.

Applications of AI in Healthcare

1. Disease Diagnosis

Dataset of multiple diagnostic images, related results, and decisions can be fed into deep learning algorithms to generate statistical patterns for diagnostic prediction. These statistical outputs can be applied in any field of diagnosis including, radiology, microscopy, and fluorimetry. These Ais can accurately diagnose disease and assist in designing treatment protocols for the patient. At present, the AI for diagnosis is still in developmental phase and some of the deep learning algorithms in combination with APIs can diagnose results in the field of radiology.

The MYCIN AI system, developed by Stanford for diagnosing blood-borne bacterial infections, was not adopted for clinical use due to safety concerns for patients. Despite its development, subsequent diagnostic tools using AI have not shown substantial improvement over human diagnosticians, largely due to difficulties in integrating the technology with clinical workflows and medical record systems.

2. Developing Clinical Study Design

The integration of AI, ML and NLP technologies enables the analysis of primary and secondary endpoint data in study design, leading to the creation of more efficient clinical study designs (CSD). These AI-powered CSDs take into account country and site specific requirements, enrollment strategies, patient recruitment, and test launch plans, resulting in more accurate outcomes, faster protocol development, fewer revisions, and improved efficacy across the field.

3. Pharmacovigilance

Pharmacovigilance creates a huge amount of both structured and unstructured data that must be analyzed and monitored for quality control. AI and ML can tackle these challenges through data training and prediction to provide statistical insights that improve quality and oversight. These technologies can streamline manual processes, provide medical translation, and digitize safety and adverse drug reaction reports, allowing for the identification of the best patterns. Integration of optical character recognition (OCR) and NPL APIs further enhances these tools by allowing for faster and more efficient review of both structured and unstructured data.

4. Clinical Monitoring

Manual analysis and documentation of site risks and the creation of "action items" to mitigate those risks is a time-consuming task. AI and ML can significantly reduce the time needed for risk assessment and provide statistical support for an effective clinical monitoring system. Advanced statistical techniques, such as deep learning, can be utilized to create composite site rankings for comprehensive risk evaluation, pinpointing significant risk sites and reducing false positives. These approaches can also aid in identifying high-risk sites, key risk indicators (KRIs), and site risk ranking, enabling quicker actions to be taken and potential limitations to be avoided.

5. Patient engagement and adherence applications

Patient engagement and adherence stand as the final barrier between ineffective and effective treatment methodologies. The proactive participation of patients in medical treatment procedures can generate better outcomes by reducing their cost, optimal facility utilisation, and member experience. These concerns can be addressed using big data analysis, AI and

Healthcare providers and hospitals rely on their clinical knowledge to create treatment plans aimed at improving the health of patients with chronic or acute conditions. However, if the patient fails to make the necessary behavioural changes, such as adhering to a diet, following a treatment plan, scheduling follow-up appointments, or taking prescribed medications, the efficacy of the treatment plan can be impacted. Noncompliance, where a patient does not comply with a treatment regimen or take medication as prescribed, is a major issue.

AI based capabilities can address non-cooperation from patients by constantly reminding them about state of health and live health monitoring with treatment regimes. These systems can be referred to as the ‘choice architecture’ to alter patient behaviour based on anticipatory responses form the real world. AI software can be connected to various healthcare tools, including provider EHR systems, biosensors, smartwatches, smartphones, conversational interfaces, and other instruments, to provide recommendations by comparing patient data with a proven effective treatment plan. The recommendations can be synced or shared among healthcare providers (hospital), patients, nurses, or care delivery coordinators.

6. Administrative applications

The use of AI for administrative purposes may seem less potential but can provide substantial efficiencies. AIs can be integrated into healthcare, for claims processing, clinical documentation, revenue cycle management and medical records management. ML based AI technologies can be used for matching of data across different databases to verify medical insurance claims and provide health insurers, governments safety with time and finance. The NLP-integrated applications can be used in the form of chatbots for patient interaction, mental health and wellness, telehealth, refilling prescriptions or making appointments.

Implications of AI in Healthcare

1. Implications on healthcare workforce

Study reports on healthcare workforce with adaptation of AI have given mixed outputs. Report by Deloitte and Oxford Martin Institute suggested that AIs will replace some of the job aspects in UK. Other reports suggested that the total cost and dependency on healthcare workers will not eradicate healthcare jobs but will assist workers to increase efficiency. It is evident as of now that automations will be included in certain fields of healthcare system such as the ones dealing with digital information, radiology and pathology for example, rather than those with direct patient contact. The penetration of AI into the jobs of radiologist and pathologist is likely to be slow. This is because the radiologists and pathologists do more than diagnosis the test images or reports. They consult with other physicians for patient disease diagnosis and treatment and help design workplan for patient care. They also discuss medical records and procedures with patients for better care and recovery.

Also the lack of definitive labelled image data in case of broken bones or pathology tests are unavailable for the deep learning AI to learn and predict outcomes. There exists a limitation of introducing regulations for medical practice and health insurance based on the AI diagnosis and care predictions.

2. Ethical implications

The current issue with an AI based diagnosis is the non-belief in the patient's mind accepting the diagnosis results. This arises as an inability to interpret how an AI concluded the result. Also, the use of AI based prediction and data usage raises issues of accountability, transparency, permission, and privacy. The interpretations of an AI prediction cannot be interpreted by a physician in many cases, and there arises an issue with privacy of an AI. A misdiagnosed test result or an ineffective treatment plant dictated by the AI arises the issue of accountability. These AIs may also run the process with algorithm bias predicting likelihood of disease based on age, gender, or race other than the causal factors.

AI integration into healthcare is one of the powerful and consequential technologies so far. This system requires constant monitoring and regulations by the governmental and regulatory authorities to limit negative outcomes.

3. The future of AI in healthcare

It is a fact that the future will be AI enabled. AI will have its intervention into the field of healthcare and much more. As the AI improves itself by means of algorithm and learning it will play significant role in precision medicine and treatment work plans and even surgical assistance. Given the rapid advances in AI based diagnosis, it is likely that most radiology and pathology reports will be examined and diagnosed by an AI enabled machine. The use of NPL based AIs will increase the use in patient communication, clinical notes, and documentation capture, and making administrative decision.

It is also evident that AI systems will not replace human clinicians, but rather will augment their ability to diagnose, and treat patients with the optimal care they need. Over time, human clinicians may be assigned with tasks that require drawing unique human skills like empathy, persuasion, and big-picture integration. Thus, it can be said that the only healthcare providers losing jobs over time may be those who refuse to work alongside AI.

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