

ARTIFICIAL INTELLIGENCE IN MODERN MEDICINE

Abstract

The foundation of evidence-based medicine is the derivation of associations and patterns from the pre-existing collection of data in order to produce clinical correlations and insights. In the past, we have relied on statistical techniques to identify these trends and connections. Using flowcharts and database approaches, computers can learn how to diagnose patients. Artificial intelligence (AI) is the phrase for the application of technology to replicate intelligent behavior and smart thought that is comparable to that of humans. The current focus of these applications involves software for analytical purposes, natural language processing, voice recognition and machine vision.

Artificial intelligence (AI) is extending its reach into the realm of public health and is poised to exert a substantial influence across all aspects of healthcare. With the support of AI-enabled computer programs, healthcare professionals, including physicians, are now better prepared to identify patients requiring heightened attention and provide personalized treatment plans for each unique case. Practicing physicians can leverage AI to assist in note-taking, analyze patient interactions, and input essential data into Electronic Medical Record (EMR) systems. These software solutions will collect and analyze patient data, offering healthcare providers valuable insights into their patients' medical needs.

In the forthcoming years, artificial intelligence (AI) is poised to become an essential element of the medical field. Consequently, it is imperative to instruct the upcoming generation of medical students in the concepts and practical applications of AI, enabling them to effectively collaborate

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with AI systems in a professional setting to enhance productivity. Simultaneously, it is equally important to nurture soft skills, such as empathy, among these students.

Keywords: Artificial Intelligence, Modern Medicine, Applications, AI in Health Care.

I. INTRODUCTION

John McCarthy, one of the co-founders of Artificial Intelligence (AI) and a co-author of the document that introduced the term AI, offered a definition of intelligence as "the computational aspect of the ability to achieve objectives in the real world." Among the trailblazers in the realms of contemporary computing and AI was Alan Turing in 1950. The "Turing test" was formulated on the premise that a computer could be regarded as intelligent if it could perform cognitive tasks at a level comparable to that of a human. A surge in interest related to AI emerged during the 1980s and 1990s. In 2016, concerning various industries, the healthcare sector received the largest portion of funding for AI research.

Artificial neural networks, a branch of machine learning that Drawing inspiration from biological nervous systems, neural networks have become indispensable in numerous AI applications. These networks rely on parameterized neuronal connections, where the weights evolve during the learning process to map various inputs to corresponding outputs, performing tasks such as pattern/image recognition and data classification. Neural networks operate by processing signals through layers of elementary computational units known as neurons. Deep learning networks, which have more layers than typical one- or two-layer neural networks, can recognize subtler and more complex patterns. Figure 1

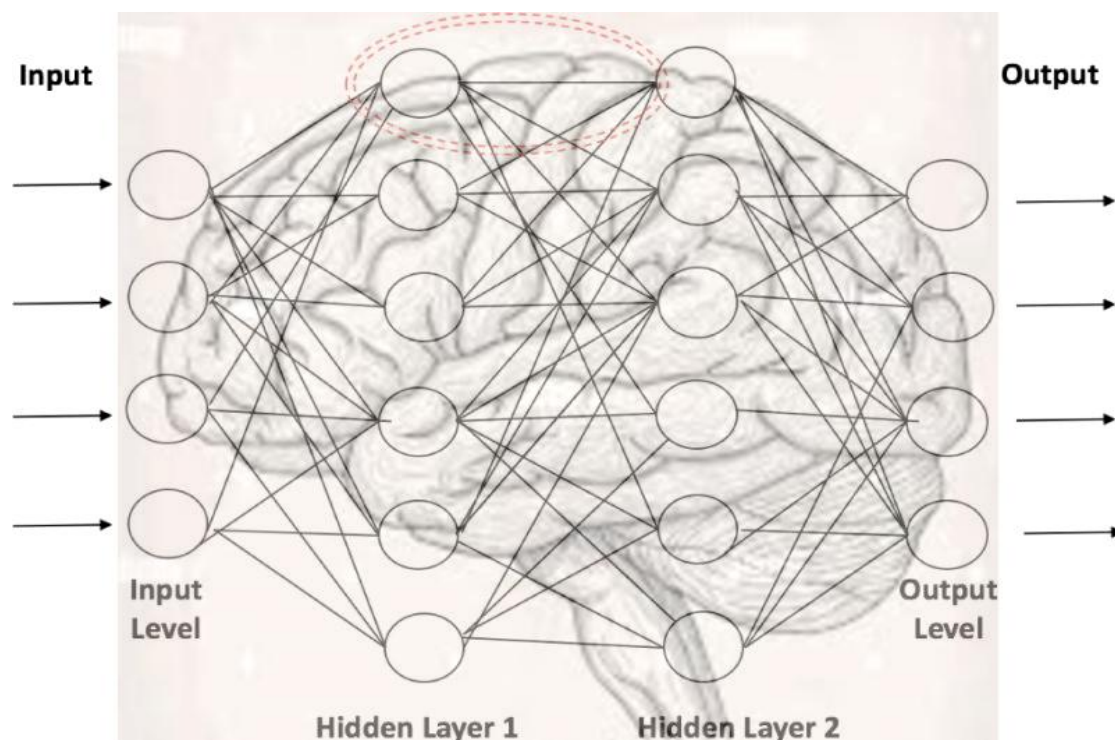


Figure 1: Neural Networks in Machine Learning

In 2016, a study discovered that doctors who availed themselves of electronic documentation services, such as dictation assistance or medical scribe support, allocated more of their time to direct patient interaction compared to their counterparts who did not utilize such services. Beyond alleviating manual work and granting clinicians more time, the increasing integration of AI in medicine enhances overall efficiency, precision, and productivity.

The primary objective should revolve around establishing a delicate and mutually beneficial equilibrium between a physician's inherent human strengths and judgment capabilities and the efficient utilization of automation and AI. This balance is pivotal because concerns arise when contemplating the possibility of AI completely supplanting humans in the medical field, as this could potentially curtail its manifold benefits.

Various clinical contexts within the medical field have adopted artificial intelligence methodologies, including fuzzy expert systems, Bayesian networks, artificial neural networks, and hybrid intelligent systems. AI endeavors to simulate human cognitive capabilities. The Netherlands, for instance, employs AI to scrutinize its healthcare system, aiming to pinpoint treatment errors and workflow inefficiencies to mitigate avoidable hospitalizations.

II. AI FOR THE MEDICAL INSTITUTION

The procedure of history-taking, in which a physician poses a series of inquiries and subsequently integrates the reported symptom pattern to arrive at a potential diagnosis, is transposed through the utilization of flowchart-based methodology. Due to the extensive array of symptoms and disease variations encountered in routine medical practice, this entails transmitting a substantial volume of data to machine-based cloud networks. However, since mechanical devices lack the capability to visually perceive and elicit signs that are only observable by a physician during direct patient interaction, the outcomes of this approach are inherently limited.

In contrast, the database approach employs principles such as deep learning and pattern recognition, involving the process of instructing a computer to identify specific sets of symptoms or distinct clinical and radiological images through repetitive computations. An illustrative example of this approach is Google's artificial brain project, which was introduced in 2012. This system, using a dataset of 10 million YouTube videos, autonomously learned to identify cats. With continued exposure to more images, its performance continually improved. After three days of learning, it could predict the presence of a cat in an image with an accuracy rate of 75%.

The University of Massachusetts designed a system to assist with decision-making called DXplain in 1986. It provided a list of potential diagnoses based on the constellation of symptoms and is also used as a teaching tool for medical students to fill in the void created by conventional textbooks. The University of Washington created the Germwatcher system to track down and look for illnesses acquired during hospital stay.¹

An AI start-up called Niramai offers quick and inexpensive breast cancer screenings at clinics in rural India, where there is a severe lack of radiologists and labs. On the subject of using thermal imaging to diagnose cancer, it holds 26 international patents, several of which are currently offered on the market internationally, notably in the UK, the US, and Japan.

1. Computer Vision: The phrase "computer vision" pertains to the ability of machines to comprehend images and videos. Due to substantial progress, robots now possess the capability to execute tasks such as object and scene recognition at a level comparable to that of humans. Within the domain of healthcare, computer vision research plays a vital role in image acquisition and interpretation, particularly in axial imaging. Its applications

span computer-aided diagnosis, image-guided surgery, and virtual lower gastrointestinal endoscopy. Notably, the field, which was initially rooted in statistical signal processing, has recently undergone a significant transformation, embracing data-intensive machine learning (ML) techniques, including neural networks, leading to their integration into novel applications.

Current research in computer vision is harnessing machine learning methodologies to focus on advanced concepts, including the analysis of patient cohorts based on images, conducting longitudinal studies, and making inferences in more intricate scenarios like surgical decision-making. It is worth noting that a mere sixty seconds of high-definition surgical video is believed to contain 25 times the amount of information found in a high-resolution computed tomography image, underscoring the potential wealth of valuable data within video content. Consequently, while predictive video analysis is still in its early stages, this research demonstrates that artificial intelligence can be employed to assess vast volumes of surgical data, enabling the detection or prediction of adverse outcomes in real-time to aid in intraoperative clinical decision-making.

- 2. AI in Radiology:** The field of radiology has been notably open to embracing new technologies. With the introduction of picture archiving and communication systems, computers, initially employed for administrative tasks like image acquisition and storage in clinical imaging, have now become integral to the radiology workflow. Computer-assisted diagnosis, known as CAD, finds frequent application in screening mammography. Recent studies, however, have indicated that CAD may not be particularly effective as a diagnostic tool when considering positive predictive values, sensitivity, and specificity. Moreover, false-positive findings from CAD can introduce bias and lead to unnecessary follow-up investigations. In light of these challenges, research suggests that AI could significantly aid the field of radiology. AI not only has the potential to swiftly identify negative exams but can also highlight abnormal findings in computed tomography, X-ray, and magnetic resonance images, especially in high-volume settings and in hospitals with limited human resources.
- 3. Use of AI in Surgery:** Early endeavors to employ AI for enhancing technical capabilities primarily focused on elementary tasks like suturing. These initial initiatives played a crucial role in establishing a foundation of knowledge for more intricate AI assignments. A notable example is the development of the Smart Tissue Autonomous Robot (STAR) at Johns Hopkins University. STAR was equipped with algorithms enabling it to autonomously perform ex-vivo and in-vivo bowel anastomosis in animal models, achieving results comparable to or surpassing those of human surgeons.

The introduction of the Da Vinci robotic surgical system has ushered in a revolution within surgical disciplines, particularly in urology and gynecological procedures. This system's robotic arms faithfully replicate a surgeon's manual dexterity, coupled with the advantages of 3D vision and magnification capabilities, enabling surgeons to perform procedures through exceptionally small incisions.²

In the pre-operative phase, individuals undergoing evaluation for bariatric surgery can utilize mobile apps and fitness trackers to monitor various parameters such as weight, blood sugar levels, meals, and physical activity. This data is seamlessly integrated into their Electronic Medical Record (EMR). An automated analysis of all preoperative

clinical and mobile data has the potential to yield a more precise patient-specific risk assessment for surgical planning and valuable predictors for postoperative care.

Real-time assessment of intraoperative progress, combining EMR data with surgical video, vital signs, instrument/hand tracking, and electrosurgical energy utilization, would empower surgeons to enhance their decision-making during surgery. This comprehensive monitoring of diverse data types during surgery could facilitate early detection and prevention of adverse outcomes.

Furthermore, the integration of preoperative, intraoperative, and postoperative data could simplify the monitoring of recovery and the anticipation of potential complications. Even after discharge, post-operative data from personal devices can continue to be integrated with hospitalization data, further contributing to weight loss and the management of obesity-related comorbidities.

Engineers have the capability to provide automated computational solutions for data analytics challenges that would otherwise be cost-prohibitive or time-intensive to address through manual methods. Concurrently, surgeons possess the clinical expertise that can guide data scientists and engineers in formulating the appropriate questions and selecting the relevant data. The widespread dissemination of surgical best practices facilitated by technology has the potential to elevate the global standard of surgical care, enabling each surgeon to contribute to this advancement.

- 4. AI for the Pregnant and Nursing Women:** From the fourth month of pregnancy until the kid reaches the age of one, Kilkari (Hindi for a baby's gurgle) sends weekly, time-sensitive audio updates regarding reproductive, maternal, newborn, and child health (RMNCH) straight to families' mobile phones. It attempts to increase families' awareness of and adoption of potentially life-saving preventative health measures. A weekly call with pre-recorded audio content pertinent to their stage of pregnancy, childbirth, or the growth and development of the child is made to families who have registered in the government's databases, either Mother and Child Tracking System (ACTS) or Reproductive and Child Health (RCH).

Kilkari is voiced by Dr. Anita, the fictional doctor from Mobile Kunji. Kilkari serves as a frequent and more constant source of current, pertinent information for families in addition to the counseling visits that Frontline health workers (FLWs) make, reaching out to families who might otherwise be excluded and addressing problems that FLWs are hesitant to address. Kilkari was developed and initially introduced in Bihar in 2013, adopted by the Ministry of Health and Family Welfare of the Indian Government, and scaled out nationally in 2014.

- 5. AI in the Pediatric Age Group:** Starting in 2018, Buoy Health and Boston Children's Hospital have engaged in a partnership to develop a web-based AI system. This system offers parents guidance for their ill child by responding to their inquiries concerning medications and determining if specific symptoms warrant a visit to the doctor.

Another noteworthy advancement in the field of healthcare involves the integration of AI into routine neonatal care, with a specific focus on the precise monitoring of jaundice in newborns. To facilitate the monitoring of neonatal jaundice, a

mobile phone-based information system was developed, employing a range of machine learning algorithms such as ridge regression, random forest support, least angle regression (LARS), fusion of least absolute shrinkage and selection operator (LARS-Lasso), Elastic Net, and vector regression.

In Aydin et al.'s neonatal jaundice detection system, when forecasting bilirubin levels, the feature-extracted datasets undergo regression using the k-nearest neighbor (KNN) and support vector regression algorithms. Four distinct machine learning models were employed to construct a diagnostic model aimed at identifying children with asthma. It was determined that three of these models exhibited effective performance when integrated with pre-existing decision trees. Furthermore, enhancements to the models' performance were observed by introducing additional factors such as weighting, socioeconomic status, and weather data.

In a related context, a model designed for pediatric community-acquired pneumonia has been effectively trained to retrospectively identify various atypical image patterns. With encouraging results, several researchers have used AI to analyze the genetics of congenital cleft lip and palate. However, only a small number of prospective controlled studies consider machine learning models to be an integral element of pediatricians' daily tasks. There are currently no fully developed AI systems available for diagnosing diseases. Text mining is an essential tool for creating contextualized theories of useful use in the area of electronic health records. The foundation of delivering medical care for children is the pediatrician-patient interaction, and the use of AI not only increases operational effectiveness but also enhances the nature of this relationship.

- 6. AI for the Clinician:** The AiCure App, developed by the National Institute of Health (NIH), utilizes smartphone webcams to monitor patient medication adherence, thereby reducing non-adherence rates. In addition to the current innovations in use, there are ongoing developments aimed at enhancing the effectiveness of medical practitioners. One notable example is IBM's Watson Health, which possesses the capability to swiftly diagnose indications of cardiovascular and oncological diseases.

Stanford University has introduced the AI-assisted care (PAC) program, which is also expanding its initiatives to encompass healthcare conversational agents and intelligent hand hygiene support. To promote optimal hand hygiene among doctors and nursing staff and reduce hospital-acquired infections, the hand hygiene support incorporates depth sensors to enhance computer vision technology.

The first medical speech recognition AI product in India, called Augnito, was bootstrapped by 22-year-old, well-established healthcare company Scribe tech. Digital scribing is made possible by Augnito, which offers a cutting-edge AI-based speech-to-text solution. 'Augmented cognition' is what Augnito stands for, and it offers a better tool for medical transcribing. With Augnito, medical professionals can continue speaking as software instantly turns their speech to text. This helps to remove the obstacles to the use of EMR in healthcare settings.

When specialists differ on a regular basis such as when interpreting chest radiographs for pulmonary tuberculosis, AI-based decision-making techniques are applied. Several studies have demonstrated that contemporary artificial intelligence-based

systems excel in the accurate classification of ambiguous skin lesions when compared to dermatologists. This superiority arises from the AI systems' ability to continuously learn from successive cases and their exposure to a multitude of cases within a brief timeframe, far surpassing what a human physician could review in a single lifetime.

A smartphone application called Nikshay is an integrated solution for managing tuberculosis in India. Nikshay was introduced in 2012 and has undergone significant development to help healthcare professionals and their support workers manage patients more easily and productively. Diagnostic tests, the start of the patient's therapy, co-morbidities, the last follow-up date, and the possibility to update treatment adherence are all included in Nikshay's comprehensive patient profile. Not only can you follow up with patients using Nikshay, but you can also check on their treatment compliance and schedule their appointments.

- 7. AI for the Healthcare Consumer:** Commercially available health trackers can monitor various parameters including heart rate, activity levels, and sleep patterns, and some now even incorporate ECG tracings as a new feature. These modern innovations are capable of alerting the user to any deviations and provide the physician with a more comprehensive understanding of the patient's health status. To promote early medical intervention, healthcare conversational initiatives are exploring how voice assistants like Siri, Google Now, S voice, and Cortana respond to queries from mobile phone users regarding mental health, interpersonal violence, and physical well-being. Additionally, a virtual nurse named Molly has been developed to follow up with patients after their discharge, allowing doctors to focus on more critical cases.

An Indian government web gateway for COVID-19 vaccine registration is called CoWIN, or Covid Vaccine Intelligence Network. It shows available booking times for the COVID-19 shot in the neighborhood. On the website, users can make vaccine appointments and request immunization records, which can then be saved in Digilocker and serve as Vaccine Passports during the COVID-19 pandemic.

Patients can now order test kits, check for symptoms, seek advice, track their health, and communicate with doctors online using the multitude of applications available on the internet. In addition, the range of applications for AI now includes therapeutic services. An online course called AI-therapy uses cognitive behavior therapy as a therapeutic strategy to help people improve their social anxiety. It was created using a CBTpsych.com program at the University of Sydney.³

III. LIMITATIONS OF ARTIFICIAL INTELLIGENCE

The "magic bullet" of artificial intelligence cannot provide all the answers. In some cases, machine learning is bettered by traditional analytical techniques,⁴ or the results of adding ML are not enhanced. The use of AI depends, as with any scientific endeavor, on whether the right scientific question is being posed and whether the necessary data is available to provide a response. When ML is used improperly, there are costs as well as risks involved. Table 1

The available data types and their accuracy significantly influence the outcomes of machine learning (ML) and other AI analyses. Systematic biases in clinical data collection, often stemming from historical underrepresentation in clinical trial and patient registry populations, can shape the patterns discerned by AI and the predictions it generates. This issue can particularly impact women and ethnic minorities. Supervised learning depends on the labeling of data, which can be expensive to collect and which will produce subpar results. Examples of this include identifying the variables currently utilized in patient registries relevant to surgery.

AI software that can diagnose chest x-rays has been created using a publicly accessible National Institutes of Health (NIH) collection of chest x-rays and reports. In order to create labels for chest x-rays, Natural language processing (NLP) was used to mine radiology records. These labels were subsequently employed to train a deep learning network for disease identification in images, with a particular emphasis on detecting pneumothorax. Nevertheless, a comprehensive analysis of the dataset conducted by Oakden-Rayner revealed that certain findings might be the result of inaccurately categorized data. Concerns arose over the network potentially misclassifying chest tubes as pneumothoraces, mainly due to the frequent co-occurrence of pneumothorax labels and chest tube presence in the X-ray images.

Although neural networks' automated nature enables the recognition of patterns that would otherwise go undetected by humans, it leaves human scientists with little ability to analyze how or why such patterns were identified by the computer. The use of AI in clinical practice can be impacted by factors such as algorithm accountability, the safety and authenticity of automated analyses, and the ramifications of these analyses on human-machine interactions. This is something that medicine has recognized very quickly. These worries have made it difficult to employ AI algorithms in a variety of practical domains, from autonomous vehicles to medicine, and they have driven data scientists to make AI findings easier to understand.

Table 1: Advantages vs disadvantages of Artificial intelligence in Medicine

Advantages	Disadvantages
Efficiency, accuracy, precision	Loss of jobs
Decreased work load	
Increased attention to the patient	Lack of human touch, empathy or emotional intelligence
Increased time on the critical cases	
Saves money	
Enhanced monitoring	

IV. CONCLUSIONS

The medical industry has already embraced a wide range of AI applications, including the scheduling of online appointments, electronic check-in at medical facilities, digitized storage of medical records, reminders in the form of text messages and calls for follow-up appointments, tracking immunization dates for children and expectant mothers, drug dosage algorithms, and alerts concerning potential adverse effects when recommending combinations of multiple drugs.

The advent of AI-enhanced healthcare practice has sparked both proponents and critics. Numerous aspiring doctors, practicing physicians, nursing staff, and paramedical professionals express concerns regarding the potential reduction in employment opportunities attributed to the increasing reliance on technology. While machines excel at analytically and logically interpreting human behavior, they fall short in cultivating human qualities such as critical thinking, interpersonal and communication skills, emotional intelligence, and creativity.

The complete extent of AI's capabilities remains uncertain and challenging to predict at present. While several potential applications of AI are still in their early stages and necessitate further investigation and advancement, they hold the capacity to profoundly transform the field of medicine in ways that were previously inconceivable. To enhance healthcare provision to the broader population, medical professionals must grasp and adapt to these advancements.

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