# AI in Healthcare and Medicine

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**Abstract**

Artificial intelligence is perhaps the most researched science and technology topic of the last century. It is no longer a fantasy and we are already using AI systems in our routine life. Its applications in the practice of medicine has shown promising results and it may be not long before we see its use in our day to day clinical practice. This article focuses on a brief introduction to AI and its applications in health and medicine, how its being used in various specialities medicine. The possible ethical issues and ways to address it have also been discussed at the end.

**Keywords:** Artifical Intellingence, Machine Learning, Neural Networks, Healthcare, Digital Radiology, Digital Pathology

## 1. Introduction

For centuries, human brain has been entitled to be the pinnacle of Mother Nature's marvellous creations, with the brain of no other living organism capable of coming near to its raw power. But over the last century, which has seen mankind's best and worse time periods, thanks to the industrial revolution, advancements in science and technology, humans have this elusive dream of creating a 'super intelligent machine'. A machine that can outsmart, outmatch the thinking, reasoning and grasping power of a human brain. Though this idea was thought to be an impossible fantasy which existed only in books and movies, things soon started take shape in the real world starting with early algorithms like The Turing Test, developed by Dr Alan Turing during the world war in 1942[1] Decades later after much research and "AI winters", the word AI (common abbreviation for Artificial Intelligence) as of today, sparks both excitement and fear in the hearts of many. As computational and manufacturing power grew exponentially complex "virtual brains" which can mimic certain human tasks without supervision became a reality. From IBM's WATSON, which can read analyse and interpret and give suggestions about various input images to AlphaGo, which can outsmart human players at the most complex board game Go[2]and many more of such examples, it is evident that AI is here to stay will soon become a norm in our lives forward. In fact, with the current smartphone revolution, AI has already become a part of our routine life, from AI based personal assistants (Google, Siri, Cortana), intelligent apps like Facebook, Instagram curating our social life to the most used online taxi service app in the world, Uber, which uses AI to assign drivers near your location.[3]

Not surprisingly, AI soon found its way to the medical science. Healthcare professionals and researchers were mesmerized by the thought using AI to help monitor, classify, predict and even give treatment suggestions for all kinds of disease conditions. The goal of this paper is to brush upon the basics of AI, its current developments in health and medicine and to discuss the possible ethical issues of AI systems replacing human doctors.

## 2. AI and How it Works

The English Oxford Living Dictionary defines Artificial Intelligence or AI as "The theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages." Simply put it's the ability of computer or a set of computers to mimic human intelligent behaviour. It does this by using a set of mathematical algorithms to identify a common pattern from the given input data and form a set of rules which can thereby used to "teach" the machine to identify, classify and extract information. This forms the basic purpose of every AI system created and based on the complexity of algorithms and volume of data it uses for the task assigned they can be subclassified into:

### 1) Machine Learning

Machine learning (ML) is a subfield of AI that provides machines the ability to learn from data without being explicitly programmed.[4] ML systems use algorithms that can be used extract features from a given set of data.

The advantage of ML is that it evolves over time as its exposed to more and more input data.[5] The most common ML algorithms used in medicine are Support Vector Machine (SVM), Neural Networks and Discrimination analysis.[6] A simple ML system can be trained to classify in patient traits like age, sex and other demographic data to detecting abnormal lung nodules from a set of normal and abnormal chest radiographs.

### 2) Neural Networks

Neural network is an advanced machine learning algorithm inspired the functional organisation of human brain. Similar to the brain the neural network system contains individual functional units like neurons called nodes. Several nodes are arranged layer by layer called 'hidden layers', which collects the input data and filters it through different layers of nodes to give the final output data[7].

### 3) Deep Learning

Deep learning systems are aimed at becoming the true AI brain which are capable of handling high volume and high dimensional data through feature extraction, classification, text to speech conversion.

Based on the method of AI learning its classified into supervised learning and unsupervised learning. Supervised deep learning techniques are further classified into Convoluted neural network (CNN) and Recurrent neural network (RNN). CNN have brought about breakthroughs in processing images, video, speech and audio, whereas RNN have shone light on sequential data such as text and speech.[8]

## 3. AI in Health And Healthcare Management

### I. Wearable Devices

Wearable devices have already become popular in our modern-day lifestyle. They have been developed with various functions in mind, from simple fitness trackers, pedometers to advanced functions like monitoring heart rate, ECG, SpO2, stress levels and so on. These data are collected by the user's smartphone and analysed to provide suggestions for change of lifestyle, diet etc. G. Tartarisco et al. developed a pervasive mobile system consisting of a wearable sensor, a mobile platform and remote decision support system for continuous monitoring stress levels in an individual. They used autoregressive modelling, artificial neural networks and fuzzy-logic rule-based algorithms to monitor stress levels as low, medium and high and alerted the user to take a more proactive action in case of rising stress levels.[9] In this way, the seamless integration of AI and portable or wearable devices will help in monitoring and warning patients in real time for potential health risks that they could encounter.

### II. Healthcare Management

Healthcare management often faces many challenges like high cost of equipment, rise of hospital acquired infections, inappropriate triage of various patients in the emergency department, data loss of patient records etc which can cause serious mismanagement issues for hospital/clinic. With the help of AI, rapid decisions like recruiting more doctors to critically ill patients, hospital inventory management, proper storage and retrieval of patient records from a cloud server, risk of readmission of patients and many such tasks and automated without human supervision.[10,11] Recent advances in machine learning and AI has helped in building predictive models for making real-time inferences from a large patient population for purposes like alerts, stratifying risk, and predicting the length of stay.[12-15]

## 4. AI in Medicine

The use of AI in medicine has been on the rise over the past few years. With the help of Machine Learning and Deep Learning algorithms, AI can be used identify, classify give treatment suggestion from millions of radiographic, clinical and pathological images. Traditionally physicians rely on their experience, judgement and problem-solving skills to diagnose each individual case but this a time and energy consuming process.[16] At the end of day when physical and mental fatigue sets in, the efficiency of the physicians obviously tends to reduce. The major advantage of Deep learning AI is that, the algorithm evolves itself and improves its accuracy as more and more images are analysed.[17] Below are few examples which has shown the potential of AI in different medical specialities.

### 1) Radiology

Perhaps no other speciality has received such great attention in integrating AI systems in to their daily practice as Radiology does. With the advent of digital radiology and computed tomography from the last few decades, the amount of diagnostic data which can be obtained from a single digital image has increased tremendously, opening the eyes of many radiologists worldwide. But when it comes to imaging a region with lot complex morphological/anatomical variations, like the head and neck region, diagnostic features can at times be missed or misinterpreted due to the sheer volume of data. AI can help in managing these large volumes data analyse and augment the findings of radiologist to achieve better precision.

Deep learning methods have been used successfully for image segmentation of anatomical and pathological structures for example, segmentation of the lungs[18], tumours and other structures in the brain[19,20], tibial cartilage[21], bone tissue[22]. The progress of AI applications in radiology has been rapid and has shows significant accuracy when compared to real life radiologists. Wang, X. et al. conducted to study to test the accuracy of a Convoluted Neural Network algorithm in detecting different lung diseases in over 108,948 frontal view X-ray images of 32,717 unique patients with the text mined eight disease image labels (where each image can have multi-labels), from the associated radiological reports using natural language processing and found promising results pledging more extensive research to improve it further.[23] In another validation study deep learning based automatic detection algorithm was found to be more accurate than 17-18 physicians included in the study.[24] In fact, currently there are more than 10 AI systems that US FDA approved for analysing CT and MRI images, with "Arterys" being the first AI system to achieve FDA approval in 2017 for use in radiology.[25] Current generation DICOM viewers software's used for CT, CBCT and MRI are already equipped with AI based automatic segmentation and registration features. Thus, it is evident that AI and radiology will coexist become a norm in the very near future.

### 2) Pathology

Just as in the case of digital radiology, digital pathology created a revolution among pathologists improving their diagnostic efficiency. This also allowed storage of large amounts pathological images on a local hard drive or cloud server. But soon pathology labs became loaded with a high volume of data which needed to be stored and analysed within a short period of time. This is where AI and Deep Learning algorithms stepped in and many researchers have successfully developed algorithms that can analyse millions of histological images, classify different lesions and even stage malignant changes all within one third of the time it usually takes real life pathologist to achieve. In a study conducted to assess the performance of several automated deep learning algorithms at detecting metastases in hematoxylin and eosin–stained tissue sections of lymph nodes of women with breast cancer and comparing it with pathologists', it was found that out of the 32 algorithms, 7 out performed a panel of 11 well experienced pathologist with a accuracy over 90%.[26] Litjens G et al assessed the use of 'deep learning' as a technique to improve the objectivity and efficiency of histopathologic slide analysis found more than 90% accuracy in a convolutional neural network algorithm for the detection of prostate cancer and sentinel lymph node of breast cancer in H&E-stained whole slide biopsy specimens.[28] Many publications such as above exist which shows significant accuracy of Deep learning algorithms in detecting lung cancer[29], brain tumours[30], breast cancer metastases.[31,32] Recently FDA granted Breakthrough Device designation to AI system known as Paige.AI developed by a start-up company in New York for its outstanding performance in diagnosis of life threatening and debilitating diseases.[33]

### 3) Other Specialities

Although most of the studies based on AI and medicine done with help of analysing radiological and pathological images other specialities like ophthalmology, cardiology etc have used images from specific diagnostic equipment's to train AI systems. For example, using retinal fundoscopy images many neural network and deep learning algorithms have been developed to detect diabetic retinopathy,[34-36] congenital cataracts[37], macular degeneration[38, 39] and most studies have found high accuracy of these algorithms ranging from 88% to 92%. In cardiology, ECG and echocardiography images have been used to train deep learning algorithms to detect heart attacks[40], arrhythmias[41], hypertrophic cardiomyopathy, cardiac amyloid and pulmonary hypertension.[42] Similarly, in gastroenterology, colonoscopy images were analysed to detect small and sessile polyps which are usually difficult to identify by a real-life gastroenterologist and was detected by the algorithm with an accuracy of 94%.[43, 44] And off late in dentistry too a few studies have been reported where Machine learning and Deep learning neural networks have been used to classify dental diseases[45], for assessing risk factors for periodontitis[46] and assess risk factors for oral cancer in a population-based study[47]. As with general radiology and general pathology, it is evident that AI algorithms can be used in the fields of maxillofacial radiology and pathology also.

## 5. Ethical Issues: AI Vs Human Touch[16, 48]

So, with all the talk about the exciting potential of AI and its use in health and medicine a few rather pressing questions comes to the mind of any reader like perhaps the most important question of all – does this mean doctors, specialists and super specialists are going out of jobs? Is AI going to change the entire medical landscape as we know it? To answer these questions, one must understand the very core idea that goes into developing an AI system – to augment and increase the efficiency of existing systems. As of today, AI has its limitation in a clinical setting. Even the most efficient unsupervised algorithms cannot make decisions of an unprecedented event as good and quick as well experienced clinician. We should always remember that, no matter how technologically advanced medical science gets, it is us doctors who are treating the patients and it is our human touch that gives them comfort in their ailments and not a AI bot. Doctors must certainly embrace and integrate AI into their daily practice to improve their diagnostic and therapeutic workflow but should never become dependent on it and leave his or her clinical experience at the doorstep. Effective guidelines must be put into place before AI has approved for regular clinical use. Doctors and patients must be made aware of the advantages and limitations of AI and its abilities. And furthermore, even after successful deputation of AI systems they must be continuously monitored and evaluated for their effectiveness in a particular clinical setting. With such measures, we can ensure going forward our patients are well cared for with all the best possible tools at our disposal.

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