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# HEALTHCARE DIAGNOSIS USING ARTIFICIAL INTELLIGENCE

Nazima Begum[1], Dr. Mohammed Jameel Hashmi[2]
[1]PG Scholar, Department of CSE, ISL Engineering College
[2]Associate Professor, Department of CSE, ISL Engineering College

**ABSTRACT:** The term "artificial intelligence" (AI) refers to a machine's capacity to mimic human intellect. Artificial intelligence, by using a variety of algorithms made possible by the exponential growth in computer power, aids medical professionals in providing more accurate diagnoses and more effective treatments. Humans use AI for supervised and unsupervised learning to help them reach their goals, which they first map out in their minds. Artificial neural networks, k-nearest neighbors, support vector machines, decision trees, regression analysis classifiers, Bayesian networks, random forests, and discriminant analyses are only few of the many methods utilized in AI. Faster interpretation and diagnosis in the medical fields, including the quick diagnosis and treatment of cardiovascular disorders, psychiatric disorders, gastroenterology, surgery, ophthalmology, etc., are just a few examples of how artificial intelligence (AI) can help patients. The better the understanding and design of treatment regimens for cancer, the better. AI may be a helpful addition for physicians in designing treatments, but it will never be able to replace human care because of its lack of a comprehensive approach to management.

**Keywords:** Algorithms, Artificial intelligence, Machine intelligence, Therapeutics.

## I. Introduction

When it comes to dealing with massive amounts of information, the human brain just can't keep up. Integration of learned information and life experience is essential to the learning process. Silicone chips have made it possible to access, gather, and store huge volumes of medical data for later analysis. The foundation of AI is the use of these massive data stores for training purposes.[1] Algorithms used in software allow computers to learn far faster than humans do, allowing them to amass much more experience in a shorter length of time. The term "artificial intelligence" (AI) refers to a machine's capacity to mimic human intellect.[2] Artificial intelligence, sometimes known as'machine intelligence,' is described as "a branch of computer science mimicking the human mind and its process." Sixty years ago, during a Turing test, Alan Mathison invented the term artificial intelligence (AI). The test's premise was that a computer may be deemed intelligent if a human mind could not discern whether the machine or person was responding. Although AI was first postulated by Turing in 1950, its precise description has remained elusive ever since. No one can agree on a single definition of artificial intelligence, but we do know that it is a branch of computer science that draws from a wide range of academic disciplines. Therapeutic applications of AI in medicine include diagnosis, therapy, risk assessment, clinical care, and the development of new drugs.[3] The 1980s and 1990s saw a boom in the study of artificial intelligence (AI), especially as it pertained to healthcare and the use of AI tools such artificial neural networks, Bayesian networks, and hybrid intelligent systems. In 2016, healthcare applications received a disproportionate share of AI research funding.[4] Over the subsequent decades, several techniques for solving mathematical problems and geometric equations were developed. The software industry has taken advantage of the exponential growth in computing power in terms of processing strength and storage capacity by employing artificial intelligence algorithms for analyzing consumer behavior, developing cutting-edge computer vision and natural language processing systems, and providing robotic assistance to medical professionals. Natural language processing, content extraction, machine learning (particularly deep learning), machine translation, question answering with text generation, visual applications like image recognition in diagnostics, machine vision, speech recognition, and robotics are just some of the ways AI is being used in medical therapeutics.

## Artificial Intelligence, Machine Learning and Deep Learning

When it comes to computing, "machine learning" refers to what Arthur Samuel calls "the ability to learn without being explicitly programmed." Machine learning algorithms are capable of in-depth data analysis and may self-train to perform their functions.[5] Search suggestions, email spam filters, online shopping recommendations, pattern recognition in smartphones, voice recognition in smartphones, etc. are just a few of the numerous ways in which contemporary civilization benefits from machine learning technology. Machine learning technology is a promising choice in medical decision-making since it can conduct thorough analysis despite a massive volume of nonlinear data.[6] There are two basic categories when discussing machine learning: supervised and unsupervised. This is because the sort of work being done has a role in

- In supervised learning, the algorithm is fed labeled training data in order to learn. Data is organized into categories, and the connection between input and output is predetermined by programming.
- In unsupervised learning, the algorithm looks for hidden patterns in a pile of data and the diverse results it produces. Both supervised and unsupervised learning are used in the medical industry. Observations are paired with features of patients, such as age, sex, or other clinical variables like associated chronic illnesses like diabetes, respiratory diseases, rheumatoid arthritis, hypertension, etc., as in the case of medical imaging.

### VARIOUS ALGORITHMS In AI

Machine learning allows for the application of many categorization strategies and algorithms to the final stage of picture analysis. Artificial neural networks, k-nearest neighbors, support vector machines, decision trees, regression analysis classifiers, Bayesian networks, random forests, discriminant analyses, and so on are all examples of these types of methods.[8] Some key features of these networks include the following.

- Neural networks: Artificial neural networks algorithms are a subclass of machine learning meant to identify neural patterns similar to those of the human neural network, and it is constructed as one input layer of neurons followed by one or more "hidden layers" and one outer layer. Many neurons or nodes, which are themselves extensively linked, process the incoming data. Deep learning is a specialization of ANNs (artificial neural networks) that uses several hidden layers and just one input layer and one output layer. The techniques used in deep learning demand complex computers and massive amounts of data.[9] Deep neural networks may be further categorized as either simple (one-dimensional) or complex (two- or three-dimensional). Medical image analysis benefits greatly from the use of convolutional neural networks (CNNs) for extracting underlying structures and patterns in pictures. Mathematical procedures called convolutions are necessary for processing pixel data while searching for or filtering patterns.[10] A convolutional neural network (CNN) consists of three distinct layers: a convolutional layer, a pooling layer, and a fully connected layer. The fully connected layer translates the collected features into the final output, which necessitates the use of the convolution and pooling layers for feature extraction. Multiple convolutional filter layers are passed across each input picture. When the first layer successfully identifies a feature, such as an edge, the data is sent to the second layer, which is trained to identify more complicated structural patterns, such as a corner. To improve computing speed, we then utilize a layer known as the pooling or down sampling layer to reduce the number of spatial dimensions. As the model is run several times, the convolutions inside it start to zero in on a certain region of the picture.

analysis. Last but not least, one hundred of these classifiers may be interconnected to spot even more subtle nuances in each picture. In addition, support vector machine (SVM) is a regression approach used in machine learning to maximize predicted accuracy while minimizing overfitting of produced data for categorization of data into two categories. When comparing SVM to more complex neural networks for image analysis, the former provides a more reliable indicator of accuracy.[11] The SVM classifier is built by projecting the training data onto a hyperplane, which optimizes the separation between the classes.

NLP, or natural language processing, is a useful machine learning software for processing text and voice in its natural forms. Information from electronic health records (EHRs) such as the results of a general physical examination, clinical laboratory data, surgical notes, and discharge summaries, as well as information from other sources (medical journals, medical bulletins, etc.), may be extracted with the use of natural language processing (NLP). Data input in electronic health records may be done quickly and easily, leading to significant time savings, less medical staff burnout, and more concentration on patient care. The goal of natural language processing (NLP) is to convert human-written texts into structured data that can be read and analyzed by computers.[12]

- Computer vision is the subfield of radiology concerned with developing artificial intelligence. Artificial intelligence encompasses a wide range of subfields, including machine learning, digital image processing, scientific computing, and pattern recognition. Vision-guided robotic surgery, 3D human organ reconstruction for CT, MRI, or ultrasound, and human-robot interactions are just some of the medical applications of computer vision.[13] Other areas of computer vision include the following: lesion/cell classification/tumor identification/grading; 2D/3D radiological segmentation;

One of the most talked about AI technologies is machine learning, which gives computers the ability to learn from data. In reality, nowadays AI and machine learning are often used interchangeably. Machine learning relies on identifying and exploiting regular patterns in observed data in order to construct a model. The computer may then use this model to make predictions and determinations about future data.[14] Additionally, machine learning can be broken down into subfields such as supervised learning, unsupervised learning, and reinforcement learning based on the degree of human intervention during the training process.

In addition to its central role in the functioning of many biological networks, supervised learning also plays a significant role in the functioning of artificial neural networks. Supervised learning has been used extensively because it can address any issue. In supervised learning, the machine learns to do a task with the aid of labels that humans have already established. Thus, supervised learning may be used in medical diagnosis and therapy, and it has obvious practical importance as a therapeutic guide. In contrast, the unsupervised learning data set doesn't come with a predetermined label, thus the computer is left to figure it out on its own. In addition, CVD (Cardiovascular disease) epidemiology, diagnosis, and treatment are only a few examples of areas where unsupervised learning algorithms have been effectively used.

therapy, and cardiovascular imaging analysis.[15] Humans set a goal and then demand AI to accomplish this objective through supervised and unsupervised learning. Then, the model receives input from a system that aims to maximize its reward as it learns, thus the term "reward mechanism." In the intensive care unit (ICU), reinforcement learning helps doctors determine when to switch patients from manual ventilation to fully automated ventilation.

Deep learning, a subfield of machine learning, is sometimes referred to as "machine learning 2.0." This computational approach allows the algorithm to self-program and acquires knowledge from massive amounts of data. The goal of deep learning is to optimize the performance of a network of virtual neurons. Significant progress has been achieved in the areas of image, video, speech, and audio processing thus far. Deep learning is quite effective generally and works particularly well with radiology and other forms of medical imaging. It is unclear what, if any, medical benefit may be derived from using AI or machine learning.

Knowledge representation, reasoning, solution search, and machine learning (ML) are only few of the many functional techniques fields used by AI. Artificial neural networks (ANNs) are used in conjunction with a subset of ML called deep learning (DL) to detect patterns in large datasets. Synthetic Neural Networks (ANNs) are complex computing systems made up of interconnected nodes that use "perception analogous similar to human biological neurons and thus simulates the transmission of electrical impulses in the human brain."16 These nodes, called "nodes," each receive their own unique set of inputs and algorithms, which in turn convert the nodes from input to output and solve the problems at hand. Different forms of ANNs exist, such as recurrent neural networks (RNNs), multilayer perceptron networks (MLPs), and convolutional neural networks (CNNs). In healthcare data analysis, these neural networks use either supervised or unsupervised training procedures.[17] Multilayer Perceptron (MLP) networks are particularly useful for process identification, pattern recognition, and optimization aids; they are also employed by unidirectional supervised training methods and serve as universal pattern classifiers. Like Boltzmann constants and Hopfield networks,[18] RNNs networks are a sort of closed-loop with the capacity to remember and retain information. These networks have inspired the creation of a number of technologies that are fundamental to the design of modern AI. The IBM Watson supercomputer (IBM, New York, USA) is one example of such a device. This resource was developed to aid in the study of a patient's medical records, with the ultimate goal of recommending a course of action for cancer treatment based on the results of a comparison with a large database. Although this broad term encompasses many branches of computer science, in medicine one can focus on the following applications of CNNs: image and video processing, modeling of complex brain functions and medical systems, pattern recognition, and sophisticated signal processing.[19] This system is useful for the early detection and proper treatment of diseases, including cancer.[20]

"Image processing" refers to the mathematical operations performed on a picture to improve its quality for viewing, searching for, and quantifying patterns. The output is a refined version of the input image that may be used for some practical purpose.

The term "computer vision" refers to the practice of analyzing visual data to draw meaningful conclusions about the world around us.

One definition of an ANN is a mathematical model that uses nonlinear statistical data modeling methods to account for the complicated interactions that exist between an ANN's inputs and its outputs. This method uses artificial neural networks to mimic the way the human brain processes various sorts of input and generates patterns for use in making decisions. Simply defined, ANN works by feeding data into one set of algorithms, and then using that data as input into a second set of algorithms.

The capacity of a computer to learn from its past mistakes and successes by adapting its strategy in light of new information is known as machine learning. Using deep learning algorithms that mimic the way the human brain works, this procedure may be based on a straightforward decision tree that results in a verdict. Neural networks are used to make




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decisions based on patterns discovered in a variety of data. One way to put it is that deep learning is a never-ending process in which an algorithm takes in data (Excel charts, photos, etc.) and processes it according to a set of rules it has previously learned (an artificial neural network) in order to complete a certain goal.

- CNNs are a subset of ANNs that use deep learning techniques with several hidden layers to evaluate data. Each CNN consists of several secret layers with intricate dependencies between them (hence the name convolutional).
- Deep learning is a kind of machine learning that mimics the way the human brain works by simultaneously considering many datasets, each of which is reviewed and then reprocessed for further assessments. The results of one layer's assessment are used as input for the next layer's evaluation. Because their inputs and outputs are not readily apparent, these computational levels are known as hidden layers. If a colonoscopy picture is submitted to detect polyps, for instance, the image will first be multiplied. After then, various filters will be applied to each scan. Each filter will be given a score, and that score will be passed on to the filters in the next layer. at get at a final conclusion, this process goes through as many layers as necessary (thus the name "deep learning"), with each filter producing an output score that is the input score of the following layer.

**Therapeutic Applications of Artificial Intelligence in Human Illness**

- Artificial intelligence in oncology: AI application may show to deliver better outcomes than human readings in areas such as breast cancer diagnosis and staging. When compared to 11 other diseases, the algorithm performed better in a research conducted by Bejnordi et al.24 using a training set of 129 slides (49 with metastases to lymph nodes and 80 without). In addition, evaluating all 129 slides took the pathologists 30 hours, whereas the time it took the algorithm to execute was assumed to be minimal. Artificial intelligence systems have been demonstrated to be more accurate than humans in spotting lung cancer. An AI's ability to accurately predict the prognosis of lung cancer patients and, by extension, improve patient care via determination of oncological treatment, was demonstrated by Yu et al.25 in a study of 2,186 cases of lung adenocarcinoma and squamous cell carcinoma using whole-slide images histopathology. Artificial intelligence (AI) has showed potential in dermatology, where visual pictures are used extensively in the detection and categorization of skin lesions.
- Artificial intelligence (AI) in cardiology: Using ML and AI to understand and diagnose cardiac conditions, such as myocardial infarction, ventricular arrhythmia, myopathies, etc., may significantly reduce diagnostic time. Automatic electrocardiogram interpretation, automated cardiac CT angiography for coronary artery calcification detection, automated cardiac SPECT imaging for cardiac perfusion assessment, and automated cardiac echocardiography for cardiac function assessment are all possible today. In addition to measuring perfusion and blood flow, cardiac MRI is capable of doing automated segmentation. Death rates can be lowered by identifying heart failure cases at an earlier stage thanks to AI's incorporation into EMR. A better predictive score can be obtained using AI by analyzing patients' EMRs, and this is because AI can perform a longitudinal evaluation of data to find patterns and, thus, determine predictors for heart failure.[26] This is especially true when deciding whether a patient with angina should undergo a coronary artery bypass grafting (CABG) or percutaneous cardiac intervention (PCI).
- The application of AI in psychiatry: Mental health issues are a major contributor to early life handicap globally. In terms of years of life lost due to incapacity or death, they are very costly. The "Diagnostic and Statistical Manual of Mental Disorders (DSM-5)" 2013 has helped doctors diagnose psychiatric disorders based on dimensions rather than categories, making it simple to understand.[28] However, despite introducing new and improved sets of diagnostic criteria, the DSM-5 is not helpful in practical scenario because it lacks ability to identifying false positives and distinguishing risk from




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disorder.[29] Artificial intelligence (AI) in psychiatry is a broad term that involves a variety of technologies. Latent semantic analysis (LSA) is very useful for psychiatrist due to its automated high-dimensional tool useful in the analysis of speech transcripts.[31] LSA is a computational technique in natural language processing for concept-based text analysis, and its use in psychiatry is still in its infancy despite its revolutionary impact on mental healthcare. LSA is a kind of semantic knowledge that delves into the connection between words and the meanings they convey in context by analyzing a large corpus of words from everyday conversation. With its ability to complement human clinical judgments in neuropsychological diseases and lower both false-negative and false-positive diagnosis rates, AI has great promise in the healthcare system.

Artificial intelligence in radiology: Among the many medical specialties, radiology has found the most use for AI. This is in part because of the tremendous strides that have been made in image-recognition tasks in recent years, thanks to the collection and availability of large amounts of digital data and the availability of powerful computing resources. As more people have access to imaging services, radiologists take on more work, and there is a skills gap in the field, artificial intelligence (AI) and its capabilities have moved to the forefront of medical practice. Image processing and computer vision algorithms have been created by a number of organizations in order to speed up diagnosis, improve the visualization of diseases, detect emergency situations, and help with the severe shortage of available medical professionals. However, the development shouldn't aim to replace human radiologists; rather, it should give supplementary tools that emphasize data that cannot be seen by the naked eye or reveal previously unavailable information in a more efficient manner. MaxQ-AI Ltd. (Tel Aviv, Israel) has created a CE-approved platform that draws radiologists' attention to cerebral hemorrhage. This Israeli startup is developing real-time decision assistance systems to enhance clinical outcomes in emergency medical settings. They analyze 3D CT images, identify cerebral hemorrhage, and highlight the affected region for the clinician. Viz.ai Inc, a spinoff business from Stanford University in San Francisco, takes this idea further by working to shorten the time between a CT scan and therapy. Large vascular occlusion (LVO), the most common cause of strokes in the brain, may be detected with this FDA-approved platform. Instead of the standard sequence of manual image postprocessing, manual read, and emergency department (ED) patient care, the system may analyze the pictures and send a text message alert to the radiologist/neurologist if an LVO is detected. Liver, lung, heart, and bone diseases can all be detected automatically with our current capabilities. When used to CT images of the chest and abdomen, for instance, a set of algorithms can automatically identify vertebral fractures. Vertebral fracture prediction is preceded by segmentation of the spinal column and extraction of sagittal patches using convolutional neural networks. Algorithms that detect osteoporosis and calculate bone mineral density are similar to the DEXA score (Dual energy x-ray absorptiometry) and can predict cardiovascular events and mortality32 from noncontrast chest CT scans. Lymph node metastasis identification and mammography malignancy detection are two domains where deep learning for diagnosis has been shown to be on par with or even superior than human performance. Meningioma detection in MRIs is a promising area for the use of artificial intelligence.

Artificial intelligence is being used in the field of gastroenterology, which relies on flexible endoscopic pictures of the gastrointestinal tract to make diagnoses and plan courses of therapy. Screening regimens are performed on a global scale as a means of early cancer identification, which plays a crucial role in patient treatment. An artificial intelligence (AI) based system was created to aid in the detection process during a brief clinical test that is repeated many times daily. The CADx system (Computer-aided diagnostic system) highlights the aberrant region on the screen to inform the endoscopist to any abnormal results. The CADx system may define the endoscopic pictures further to a real-time proposed diagnosis after the user has zeroed in on the anomaly and flipped to NBI (narrow band imaging) view. The CADx system has been validated for use in endoscopic screening for stomach and colon cancer. It was shown to have a sensitivity of 96% and a specificity of 95% in the diagnosis of early gastric cancers.[33]

Why Artificial intelligence in ophthalmology: 38% of the 400 million persons with diabetes globally have diabetic retinopathy (DR). Blindness or severely impaired vision may result from this disorder, which damages the small blood arteries that nourish the retina. Screening for this is recommended by the American Academy of Ophthalmology.

• a large number of potential patients for early DR diagnosis. Artificial intelligence and deep learning have been shown to be useful in the early identification of diabetic retinopathy. This research suggests that deep learning may be useful in the diagnosis of diabetic retinopathy and macular edema from retinal pictures, expanding the scope of ophthalmology.

Although computer science has already made its way into the operating theatre through robotic aided surgery, this advancement in technology is not often connected with artificial intelligence. While current technology does increase the surgeon's visual acuity (3D cameras, near infrared imaging) and mechanical proficiency (intuitive tool articulation, tremor eradication, and movement scaling), this has not translated into a better patient outcome. Patient outcomes did not improve from standard laparoscopic surgery to robotic assisted surgery, according to consensus documents from the "Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) and European Association for Endoscopic Surgery (EAES)"[34]. Nonetheless, high hopes are placed on AI's ability to improve healthcare for the future. Anesthesia assistance, operating room workflow improvement, better time management, and increased patient safety are just a few of the numerous ways in which artificial intelligence may be used in the operating room.

Artificial Intelligence on the Cloud

The goal of cloud-based AI is to make AI available to customers for a cost, with the added benefit of giving them access to improved algorithms on a regular basis. Service availability independent of hardware type is an additional perk that promotes interoperability. For use in a wide range of healthcare settings, many businesses have created cloud-based AI systems. The cloud-based AI services of companies like Zebra Medical Vision Ltd., Arterys Inc. (San Francisco, California, USA), and VIDA Diagnostics Inc. (Coralville, Iowa, USA) aid in the analysis of lung disorders, cardiac imaging processing, liver imaging, and bone health.[35]

## Future of AI in Clinical Research/Healthcare

The challenge is how machine learning can be superior than human intelligence for healthcare therapies, given that AI is still in its infancy and can never replace a doctor for patient diagnosis and treatment. Artificial intelligence (AI) relies on a number of inputs that accept the information gathered in order to simulate human understanding, and this may aid both medical professionals and patients in a number of ways.

• Demonstrating the research infrastructure for analyzing, visualizing, and categorizing collected data.

Validating a wide range of diagnostic, therapeutic, and medicinal software applications.

• By holding in high esteem some cutting-edge tools meant to improve deliberation and study.

• Providing a future logical restorative group and, by extension, a collection of insightful AI devices for medicinal applications that may increase the efficacy of pharmaceuticals and lower patient expenditure.

• Providing sophisticated knowledge and computations in radiology is essential to MRI diagnosis, as this paves the way for determining tomography frameworks.

• Artificial intelligence has altered the surgical mechanical technology area by assisting the robotic surgery in carrying out robotic surgical operations with increasing efficacy.

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### Artificial Intelligence Limitations

Applications using artificial intelligence may be helpful, but they are not without their drawbacks.

- The high data requirements of deep learning neural networks are a disadvantage for illnesses with low prevalence or for situations in which data are dispersed across diverse populations.

Overfitting occurs when a model fails to account for the variation and complexity present in the medical information data collected by different hospitals.

- Input data accuracy and data sharing infrastructure are two factors that affect the quality of recovered data.
- Artificial intelligence algorithms may fail to adequately address illness states in the absence of data on emerging therapeutic adverse effects or treatment resistance.

The foundations of illness diagnosis and therapy include a comprehensive patient history, complete laboratory and clinical examination, and appropriate investigations. An fundamental constraint of AI in contemporary medicine is that it cannot replace clinicians in making comprehensive diagnoses that include human expertise.

## Conclusion

There are pros and cons to using any cutting-edge technology. The widespread use of such technology hinges on its many advantages for both patients and their doctors. Human doctors will still be necessary in the age of AI, but their work will shift in new ways. Despite AI's drawbacks, advances in the effectiveness of AI models for physicians and healthcare suggest they may one day become the backbone of the industry.

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