REVIEW ARTICLE

Role of Artificial Intelligence in Diagnosis and Treatment of Various Medical Diseases in Patients

Rahat Kumar[1], Avlokita Sharma[2], Pratyush Sharma[3], Richa Thaman[4]

Abstract

Artificial intelligence (AI) is defined as the capability of a machine to imitate intelligent human behavior in general. With a tremendous rise in computer capability the artificial intelligence by using various algorithms is helpful in helping medical experts for better diagnosis and treatment. Humans' mind first plans a goal and then requires AI to achieve this goal through supervised and unsupervised learning. The various algorithms used in AI are the artificial neural network, k-nearest neighbor, support vector machine, decision trees, regression analysis classifiers, Bayesian network, random forest, discriminant analysis. AI has various benefits as in breast cancer diagnosis and staging in whole-slide images histopathology study on lung adenocarcinoma and squamous cell carcinoma patients, faster interpretation, and diagnosis in the medical fields in quick diagnosis and treatment of cardiovascular disorders, psychiatric disorders, gastroenterology, surgery, ophthalmology, etc. The more useful is the interpretation and planning of the regimens for cancer diagnosis and treatment. However, AI lacks holistic approach of management and so can never replace treatment by humane methods but AI can be a useful supplement for doctors for planning therapeutics.

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

AMEI's Current Trends in Diagnosis & Treatment (2021): 10.5005/jp-journals-10055-0131

Introduction

The human mind limitation is in processing and retrieval of large data. The process of learning requires the integration of knowledge and experience which is acquired along the years. In the era of silicone chips vast amounts of patient data can be accessed, acquired, and stored for processing. Harnessing these enormous data banks and transforming them to gain experience is the mainstay of AI.[1] Computer software through the application of algorithms thus can gain far more experience in a significantly shorter amount of time than human subjects can acquire in their lifetime. Artificial intelligence (AI) is defined as the capability of a machine to imitate intelligent human behavior in general.[2] AI or also called as machine intelligence is defined as "a branch of computer science mimicking the human mind and its process." The term AI was first coined 60 years ago by Alan Mathison during a Turing test, which stated that if a human mind could not distinguish between machine's responses from being a machine or a human, then the machine could be considered intelligent. Although the idea of AI was proposed by Turing in 1950, but the definition of AI is still not clear till date. Although no one is clear about the concept of AI but we only know that AI is a type of computer science which is multidisciplinary in theory and practice. In the medical field, AI has therapeutic modality in the fields of medical diagnosis, treatment, risk prediction, clinical care, and drug discovery.[3] In the year 1980s and 1990s there was a surge in the field of AI, in particular related to healthcare and its techniques such as artificial neural networks, Bayesian networks, and hybrid intelligent systems. In the year 2016, there was a chunk of research in AI in healthcare applications compared with other sectors.[4] Over the next few decades, various algorithms were generated for mathematical problems and geometrical equations. With exponential rise in computer capability in terms of processing strength and storage capacity the software giants used artificial intelligence algorithms for understanding the consumer behavior, futuristic computer vision, natural language processing, and robotics for helping medical experts for better performance. The various applications of AI in medical therapeutics include natural language processing also including content extraction, machine learning especially deep learning, machine translation activity, question answering with text generation, visual applications including image recognition in the field of diagnostics, machine vision, Speech and Robotics and also monitoring of adverse drug events of the drugs, biological products, devices, and other therapeutics.

[1]Department of Pharmacology, SGRDIMSAR, Amritsar, Punjab, India

[2]Department of CSE, CSULB, California, United States of America

[3]Department of CSE, CSULA, California, United States of America

[4]Department of Physiology, Sri Guru Ram Das Institute of Medical Sciences and Research, Amritsar, Punjab, India

Corresponding Author: Rahat Kumar, Department of Pharmacology, SGRDIMSAR, Amritsar, Punjab, India, Phone: +91 9876125136, e-mail: rahat_sharma66@yahoo.com

How to cite this article: Kumar R, Sharma A, Sharma P, *et al*. Role of Artificial Intelligence in Diagnosis and Treatment of Various Medical Diseases in Patients. AMEI's Curr Trends Diagn Treat 2021;5(2):92–98.

Source of support: Nil

Conflict of interest: None

Artificial Intelligence, Machine Learning, and Deep Learning

According to Arthur Samuel the term "machine learning" is the "the ability to learn without being explicitly programmed." The algorithms in machine learning use self-training methods instead of coding language to complete its tasks and can study data directly.[5] Machine learning technology helps in many ways to modern society such as from search suggestions, email spam filters, online shopping suggestions, pattern recognition in smartphones, and speech recognition in smartphones, etc. Machine learning technology has the ability to perform comprehensive analysis even with a large amount of nonlinear data and is so a favorable option in medical decision-making.[6] Machine learning is classified into two main broad categories as supervised and unsupervised. This is based upon the type of task performed as

- Supervised learning means algorithm working with labelled training data. It involves the categorization of data and programming of the relationship between input and output data.
- Unsupervised learning means the algorithm identifies hidden patterns in a stack of data and its various outcomes.[7]

In the field of medicine both supervised and unsupervised learning are performed. The example includes as in case of medical imaging when we have labelled observations then the observations are paired to associated features with patients such as age, sex, or other clinical variables like associated chronic illnesses like diabetes, respiratory diseases, rheumatoid arthritis, hypertension, etc.

Various Algorithms in AI

By using machine learning several types of classification methods or algorithms can be applied for final image analysis. Among these the commonly used methods are the artificial neural network, k-nearest neighbor, support vector machine, decision trees, regression analysis classifiers, Bayesian network, random forest, discriminant analysis, etc.[8] The salient points of these networks are as follows:

- **Neural networks:** Artificial neural networks algorithms are a subset of machine learning designed to recognize neural patterns similar to human neural network and it is structured as one input layer of neurons with one or more "hidden layers" and one outmost layer. The input data are processed through a large number of highly interconnected elements called as neurons or nodes. Deep learning is a subtype of artificial neural network with stacked neural networks containing of one input and one output layer with >1 as hidden layer. Deep learning algorithms require advanced computation and very large data.[9] Deep neural networks can be divided further into normal (one-dimensional) or convoluted (two or three dimensions) networks. Convolutional neural network (CNN) is very useful for medical image analysis in extracting patterns or structures from images. Convolutions are nothing else but a type of mathematic operations required for pixel data in finding or filtering patterns.[10] CNN is further composed of three different types of layers or building blocks as convolution, pooling, and fully connected layers. The convolution and pooling layers are required for feature extraction and the fully connected layer maps the extracted features into final output. Through each input image a series of convolution layers pass with filters. As an example, once the first layer has recognized a feature like an edge, it is then shifted to the second layer which in itself trains to recognize more complex structural patterns like a corner in an image. The next layer called as the pooling or down sampling layer is then used to decrease the spatial dimensions for gaining computational performance. Since the model is repeatedly performed the individual convolutions begin to identify a specific portion of the image for further analysis. Finally, a hundred of these classifiers can be linked together to identify more complex structures within each image. Another, support vector machine (SVM) is a regression algorithm for data classification in two subclasses that are used for machine learning for maximizing the predictive accuracy but avoiding overfitting of generated data. However, SVM is a better indicative of accuracy as compared to sophisticated neural networks for image analysis.[11] The SVM classifier is constructed by projecting training data into a higher dimensional space known as a hyperplane, which maximizes the separation between the classes.
- **Natural language processing (NLP)**: NLP is a practical machine learning program used to understand and manipulate natural language text or speech. NLP is used for extracting information from unstructured data, for example, electronic health records like general physical examination, clinical laboratory data, operative notes, and discharge summaries or the information from various sources like medical journals, medical bulletins, etc. Easy data entry in electronic health records drastically decreases the time of patient record filling time, decreases the burnout, and focuses the medical personals to provide better patient care. The NLP processing aims for turning texts to machine-readable structured data for further analysis by other machine learning techniques.[12]
- **Computer vision:** It is the field in radiology that aims at designing systems mimicking the human intelligence. This field constitutes the various areas such as artificial intelligence, deep learning, pattern recognition, machine learning, digital image processing, and scientific computing. The applications of computer vision in medical field include diagnosis of lesion or cells classification and tumor identification and grading, 2D/3D radiological segmentation, 3D human organ reconstruction for CT, MRI, or ultrasound, vision-guided robotics surgery or robotics and human robot interactions.[13] The computer vision further comprises the followings topics as follows:
  - **Machine learning:** One of the most popular technologies of AI is called machine learning, which enables algorithms to understand and learn data. In fact, machine learning is usually synonymous with AI. Additionally, the key of machine learning is to find the regular pattern behind an observed data and build a model based on that data. Therefore, the machine can use this model to predict and determine future data.[14] Besides, machine learning can be categorized into supervised learning, unsupervised learning, and reinforcement learning, depending on the amount and type of supervision that the algorithms receive during training.
  - **Three classic genres of machine learning:** Supervised learning plays an important role not only in the operation of many biological networks but also plays an important role in the operation of artificial neural networks. Moreover, supervised learning has been widely applied and can solve any problem. In supervised learning, manually set labels help the machine achieve the desired results. Therefore, supervised learning is applicable to medical diagnosis and treatment, and has clear clinical guiding significance. In contrast, the unsupervised learning data set does not have a given label, which means that the machine must find the label itself. Furthermore, unsupervised learning algorithms have been successfully implemented in problems such as CVD (Cardiovascular disease) epidemiology, diagnosis and

treatment, and cardiovascular image analysis.[15] Humans propose a goal and then require AI to achieve this goal through supervised and unsupervised learning. After that, there is a feedback mechanism, often described as a "reward mechanism." The only aim of reinforcement learning is not to achieve the pre-set goal, but also to maximize the reward for the model during the learning process. This reinforcement learning is very useful in intensive care units (ICU) for better management of critical patients and to decide when to put of the patients from mechanical ventilation to machine-controlled ventilators.

– **The next step of machine learning-deep learning:** Deep learning is a subset of machine learning that can be described as the next generation of machine learning. It is a computational method that enables the algorithm to automatically program and learns from big data. The purpose of deep learning is to train the artificial neural network, which is composed of artificial neurons, or nodes. So far, it has made significant breakthroughs in the processing of image, video, voice, and audio data. In general, deep learning is very powerful and is especially suitable for medical imaging or radiology. When considering AI or machine learning, it is not known what practical medical value these systems have.
– **AI: Networks and tools:** AI utilizes several functioning methods domains, e.g., knowledge representation, reasoning, solution search, and machine learning (ML). ML by using algorithms can recognize various patterns within a set of data, and this data the subtype of ML called as deep learning (DL) engages further artificial neural networks (ANNs). ANN constitutes of a set of interconnected sophisticated computing elements which utilizes "perception analogous similar to human biological neurons and thus simulates the transmission of electrical impulses in the human brain."[16] ANNs by using a set of nodes receive a separate set of inputs and algorithms that then converts the nodes to output and hence solves the problems. ANNs are further classified into various types such as convolutional neural networks (CNNs), multilayer perceptron (MLP) networks, and recurrent neural networks (RNNs). These neural networks utilize supervised or unsupervised training procedures in healthcare data analysis.[17] MLP network is very useful in process identification, pattern recognition, optimization aids, and this network is used by supervised training methods that operate in a single direction only, and is used as universal pattern classifiers. RNNs networks are a type of closed-loop with a capability to memorize and store information similar to Boltzmann constants and Hopfield networks.[18] Several tools have been developed based on these networks which are crucial to the core architecture of AI systems. One such tool is the International business machine (IBM) Watson supercomputer (IBM, New York, USA). This tool was designed for assisting the physician for analysis of a patient's medical information and then correlating this output information with an abundant database and thus suggesting the treatment strategies for cancer therapy. CNNs have a series of dynamic systems with local connections having usage for image and video processing, complex brain functions, medical system modelling, pattern recognition, and sophisticated signal processing.[19] Thus the above-mentioned system is useful for the rapid detection and appropriate treatment of diseases including cancer treatment.[20] While this comprehensive term encompasses many forms of computer science, in medicine one can focus mainly on the following terms:[21]

- Image processing: A mathematical process that enhances an image for the purpose of clarity, retrieval of specific information, or pattern measurements. Basically, the input is a picture and the output is a better-defined picture for a specific applied purpose.
- Computer vision: The processing of an image to enable identification of the image input and to provide an appropriate output, i.e., interpretation of the image.
- Artificial neural network (ANN): A mathematical model based on nonlinear statistical data modelling tools where complex relationships occur between inputs and the output. This process imitates the human brain in processing several types of data and creating patterns for use in a decision-making process through neural networks. Basically, in ANN the input is entered into a set of algorithms and their output is re-entered to a different set of algorithms in order to reach the final output.
- Machine learning: It is the ability of a computer to learn from experiences and it is based on the modifying its processing on the basis of newly acquired information. This process can be based on a simple decision-making tree that leads to a conclusion using deep learning algorithms imitating the human brain processing. It involves the several types of data and creating patterns for use for decision making through neural networks. Thus, it can be interpreted that deep learning is a continuous process where an algorithm receives data (i.e., excel charts, images, etc.) and then further analyze it as per the predetermined pathway (artificial neural network) to solve the desired task.
- Convolutional neural network (CNN): A specific type of ANN typically based on deep learning algorithms with several hidden layers to analyze data. The relationships between layers are complex (hence the term convolutional) and multiple hidden layers exist in each CNN.
- Deep learning: Deep learning is a subset of machine learning which is structured similar to human brain processing, taking into account multiple datasets at the same time, which are evaluated and reprocessed for second and third different evaluations and so on, until reaching an output. Every evaluation is carried out in a different layer, meaning that it is based on the output of the previous layer. These layers of computation are called hidden layers because their inputs and outputs are not visible. For example, if the data entered is a colonoscopy image looking for polyps, the image will first be multiplied. Each image will then be scanned using different filters. Each filter will receive a score which will then be transferred to another layer of filters (e.g., color filters, edges markings filters, etc.). This workflow continues with multiple layers as needed (hence the term deep learning) while each filter creates an output score which is the input score of the next layer until a final result is achieved.

IBM Research

In 2011, IBMs computer system Watson beat the two highest ranked players on the classic television game show "Jeopardy!" in which answers are given first and the contestants must determine the questions. Following this success, IBM research took the challenge to modify the Deep QA technology toward medicine.[22] The driving force for this adaptation was the high medical and medication error rates, as well as the high cost, and low productivity in this area. The concept was to collect information, organize it, and provide insights to improve clinical decision-making. The first task of gathering evidence proved to be a huge challenge having different vocabularies and coding systems used by different sources which must be harmonized and transformed into usable evidence in the clinical setting. Once this was achieved, data of patients could be gathered and stored according to their symptoms, lab tests, findings, patient history, family history, demographics, current medications, and many others. One option then is to use this clinical content management database, together with specialized advanced analytics and compare it to the patient in question. When this patient is classified with similar databased patients, a diagnosis could be suggested as well as treatment protocols, outcomes and prognosis, all based on evidence-based medicine such as RCTs (randomized controlled studies), best practice guidelines, electronic medical records (EMRs), public health records, etc. In such a method Bakkar et al. were able to identify five additional RNA-binding proteins that are altered in ALS (Amyotrophic lateral sclerosis) and eventually improve diagnosis of this disease.[23] Similarly, other machine learning-based studies demonstrate the benefits of incorporating AI into EMRs, improving diagnosis rates of patients. As the case with hyperparathyroidism, a significantly underdiagnosed condition due to under recognition, with only 50% of patients referred for the necessary surgery. Despite showing great promise in the field of AI in medicine, IBMs Watson decision support system was recently called into question. As with any medical device, it is not uncommon during the clinical trial period to make changes and adjustments in order to further develop the product. Clinical decision-making support systems like Watson are still in a relatively early stage of clinical trials and with experience, alterations will need to be made. Such alterations should include transparency so that the user can understand the basis of the recommendation. Additionally, it is of importance to remember that these systems are support systems and not meant to replace physicians or their knowledge, but rather to augment it.

Role of AI in Medical Therapeutics in Human Diseases

- **AI in oncology:** Breast cancer diagnosis and staging are areas in which AI application may actually prove to provide better results than human readings. In a study by Bejnordi et al.,[24] using a training set of 129 slides (49 with metastases to lymph nodes and 80 without), when compared with 11 pathologies, the algorithm actually achieved better diagnostic performance. Additionally, the pathologists required 30 hours for assessment of all 129 slides, while the running time of the algorithm was presumed to be negligible. In the detection of lung cancer, AI algorithms have been shown to be more effective than a human. In a 2,186, whole-slide images histopathology study on lung adenocarcinoma and squamous cell carcinoma patients, Yu et al. demonstrated the higher accuracy of AI than manual diagnosis.[25] Their results suggest that AI can accurately predict the prognosis of lung cancer patients and thereby improve patient care via determination of oncological treatment. In dermatology the diagnosis and classification of skin lesions is primarily based on visual images; therefore AI has shown promise.
- **AI in cardiology:** The application of ML and AI results in faster interpretation and diagnosis in many areas of cardiology especially myocardial infarction, ventricular arrhythmia, myopathies, etc. Electrocardiogram readings are automatically interpreted, echocardiography with 3D mode cardiac imaging automatically provides measurements of cardiac function, SPECT imaging can automatically determine cardiac perfusion, and cardiac CT angiography can determine calcification of the coronary vessels. Cardiac MRI can perform automatic segmentation as well as measure perfusion and blood flow. The integration of AI into EMR has been shown to be effective in the reduction of mortality via early detection of heart failure. This is due to the ability of AI to perform a longitudinal evaluation of data to find patterns and thereby determine predictors for heart failure.[26] When including AI in the decision-making process as to which interventional procedure patients with angina should undergo either a coronary artery bypass grafting (CABG) or percutaneous cardiac intervention AI by using patients' EMRs can have a better predictive score for resulting in reduced mortality.[27]
- **Artificial intelligence in psychiatry:** Psychiatric disorders are one of the leading causes of disability worldwide, affecting individuals from an early age. They represent a major burden to the affected individuals in terms of years of life lost to disability or death. The "Diagnostic and Statistical Manual of Mental Disorders (DSM-5)" 2013 has helped the doctors to diagnose psychiatric disorders based on dimensions rather than categories and thus making it simple to understand.[28] However, despite introducing new and improved sets of diagnostic criteria, the DSM-5 not helpful in practical scenario because it lacks ability to identifying false positives and distinguishing risk from disorder.[29] AI in psychiatry is a broad term that involves the use of advanced computerized techniques such as automated language processing and machine learning algorithms for assessing a patient's mental state beyond what could be measured with self-reports and clinical observations. Although still in its infancy, AI has already revolutionized mental healthcare and has profoundly influenced the way clinicians detect, predict, and treat psychiatric disorders.[30] 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. LSA represents a semantic knowledge based on analysis of a wide array of words present in natural discourse that unravels the relationship between words and passage meanings. Thus, AI has a huge potential in healthcare system as it is useful in complementing human clinical ratings in neuropsychological disorders, reduces false-negative and false-positive diagnosis rates.
- **AI in radiology:** AI is gaining popularity in medicine, with the widest application being in the field of radiology. This is due in part to the remarkable progress in image-recognition tasks, which in recent years has seen growth in the amount of sufficient digital data accumulation and availability as well as significant computational power. Combined with the increase in access to radiological exams, the resultant increased workload for radiologists and a shortage of trained experienced radiologists, AI, and its capabilities has been driven to the frontlines in medicine. Multiple groups have developed image processing and computer vision algorithms to enable faster

diagnosis, enhance visualization of pathologies, alert emergency situations, and assist in the critical manpower deficiency problem. The development, however, should not be with the intent to replace the human radiologist, rather to augment and provide applications which highlight information that would otherwise not be obtained by human vision, or provide knowledge not widely available in a shorter amount of time. A platform that highlights intracranial bleeding for radiologists is already CE approved and was developed by MaxQ-AI Ltd. (Tel Aviv, Israel). This start-up company from Israel is focusing on real-time decision support tools to improve clinical outcomes in acute medical scenarios. They process three-dimensional CT data, detect intracranial bleeding, and highlight the bleeding area for the reader. Taking this concept one step further, Viz.ai Inc, a spinoff company from Stanford University, San Francisco, is aiming to decrease the time to treatment once a CT scan was performed. This FDA-approved platform can detect large vessel occlusion (LVO) in the brain causing stokes. The system can analyze the images, and when there is a suspected LVO, a text message alert is sent to the radiologist/neurologist bypassing the usual workflow of manual image postprocessing, manual read, and ED patient care. Current capabilities include automatic detection of liver, lung, cardiovascular, and bone disease. For example, automatic detection of vertebral fractures is performed using a set of algorithms which run on the chest and abdomen CT scans. The spinal column is segmented and sagittal patches are extracted using CNN, followed by a prediction of the presence of vertebral fracture. Similar algorithms exist for detection of calcium in the coronary arteries from noncontrast chest CT scans which predicts cardiovascular events and mortality,[32] as well as algorithms detecting osteoporosis which calculate bone mineral density similar to the DEXA score (Dual energy x-ray absorptiometry). Using deep learning for diagnosis has been proven to be as good as if not better than human performance in some areas such as lymph node metastasis detection and mammography malignancy detection. Detection of meningiomas in MRIs shows great potential and value for the application of AI.

- **AI in gastroenterology:** Diagnosis and treatment in gastroenterology are based on flexible endoscopic images of the stomach duodenum and colon. Early detection of cancers is a key factor for patient care and screening regimens are implemented worldwide. In order to improve detection in a clinical exam that lasts a few minutes only and is performed numerous times a day, an AI-based system was developed. The CADx system (Computer-aided diagnosis system) alerts the endoscopist to abnormal findings on the screen by highlighting the area of abnormality. After focusing on the abnormality and switching to NBI (narrow band imaging) view, the CADx system can define the endoscopic images further to a real-time suggested diagnosis. The CADx system was shown to detect early gastric and colonic cancers in endoscopy. It was demonstrated to have a 96.3% precision in the detection of early gastric cancers with a sensitivity of 96% and specificity of 95%.[33]
- **AI in ophthalmology:** Diabetic retinopathy (DR) affects 38% of the 400 million people worldwide who suffer from diabetes. This condition affects the tiny blood vessels which supply the retina and may cause hemorrhage or retinal detachment, leading to reduced vision and blindness. The American Academy of Ophthalmology recommends screening of this huge patient population to diagnose DR in its early stage. The application of AI and deep learning for the detection of diabetic retinopathy has been proven to be effective for earlier diagnosis. One may conclude from this study that deep learning has significant potential in the field of ophthalmology in the detection of diabetic retinopathy and macular edema from retinal images.
- **AI in surgery:** While computer science has already entered the operating room in the form of robotic assisted surgery, it is not associated with artificial intelligence. Indeed, the technology available today augments the surgeon's vision (3D cameras, near infra-red imaging) and mechanical capabilities (intuitive instrument articulation, tremor elimination and movement scaling), but it fails to translate into improved patient outcome. However, consensus documents from the "Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) and European Association for Endoscopic Surgery (EAES)" regarding robotic assisted surgery showed no improvement in patient outcome when comparing standard laparoscopic surgery to robotic assisted surgery.[34] So, it can be made out that the expectations are high from AI in patient care. Artificial intelligence can be applied in the operating rooms in many forms as anesthesia support, improving operating room workflow for more efficient time management and improved patient safety, as well as surgical instrumentation monitoring.

Cloud-based AI

The concept of cloud-based AI is an idea of providing artificial intelligence as a fee-for-service allowing the customer access to continuously updated algorithms. Another advantage is availability of service regardless of hardware used allowing for interoperability. Several companies have developed cloud-based AI platforms to assist in a variety of medical applications. Companies such as Zebra Medical Vision Ltd., Arterys Inc. (San Francisco, California, USA), and VIDA Diagnostics Inc. (Coralville, Iowa, USA) provide cloud-based AI services to assist in the analysis of lung diseases, cardiac imaging processing, liver imaging, and bone health.[35]

Future of AI in Clinical Research/ Healthcare

AI is still in stage of infancy and can never replace a doctor for patient diagnosis and treatment but the big question is how can machine learning be better than man intelligence for healthcare therapeutics? AI is based on various inputs that acknowledge the information retrieved to imitate human knowledge into AI and this can help both medical specialists and patients by various ways as under:

- Proving the research facility for examination, representation, and classifying of data procured.
- Proving various tools in diagnostic, therapeutical, medicinal programming.
- By idealizing various novel devices to bolster choice making and research.
- Offering a future logical restorative group and hence expanding a combination of insightful AI devices for medicinal applications that could enhance the effectiveness of medications and decreases the patient expenditure.
- Offering an advanced understanding and calculations in the field of radiology is considered as a key part of MRI diagnosis as latter is helpful in figuring out tomography frameworks.

- AI has changed the field of surgical mechanical technology where it has helped the robotic surgery to perform robotic surgical procedures with expanding effectiveness.

Artificial Intelligence Limitations

Artificial intelligence applications are useful but have limitations as well.

- Deep learning neural networks demand a large amount of information which is a drawback for diseases having low prevalence or where data are widespread across different populations.
- The heterogeneity and complexity of medical information data across various medical institutions can lead to over fitting models.
- The quality of data retrieved is dependent on the accuracy of the input data being entered and the infrastructure available for data sharing.
- Algorithms in AI can underperform in disease conditions when there is no information on new side effects of drugs or treatment resistance.
- Since detailed history, laboratory examination, and thorough clinical examination along with relevant investigations are the bases of diagnosis and treatment of diseases. So a holistic diagnosis with knowledge component of doctors cannot be replaced by AI.
- This is an important limitation of artificial intelligence in modern therapeutics.

Conclusion

Any new technology has its inherent advantages and disadvantages. The success of such technology depends on the various benefits it provides to the vast majority of the general population and also to the treating doctor. AI technology cannot replace medical professionals but their role is going to have a change in the era of artificial intelligence. In spite of the limitations of AI a gradual increase in efficiency of AI models for doctors and healthcare may become the essential feature of medical care in the future.

References

1. Turing AM. Computing machinery and intelligence. Mind 1950;59:433–460.
2. Definition "Artificial Intelligence." Available from: https://www.merriam-webster.com/dictionary/artificial%20intelligence [Last accessed on August 31, 2021].
3. Gulshan V, Peng L, Coram M, et al. Development and validation of a deep learning algorithm for detection of diabetic retinopathy in retinal fundus photographs. Journal of the American Medical Association 2016;316(22):2402–2410. DOI: 10.1001/jama.2016.17216.
4. CB Insights Research. Healthcare remains the hottest AI category for deals. 2017. Available from: https://www.cbinsights.com/research/artificial-intelligence-healthcare-startups-investors/ [Last accessed on August 31, 2021].
5. McClelland C. The difference between artificial intelligence, machine learning, and deep learning; 2017. Available from: https://medium.com/ iotforall/the-difference-between-artificial-intelligence-machine-learning-and-deep-learning-3aa67bff5991 [Last accessed on April 30, 2020].
6. Senders JT, Arnaout O, Karhade AV, et al. Natural and artificial intelligence in neurosurgery: a systematic review. Neurosurgery 2018;83(2):181–192. DOI: 10.1093/neuros/nyx384.
7. Choy G, Khalilzadeh O, Michalski M, et al. Current applications and future impact of machine learning in radiology. Radiology 2018;288(2):318–328. DOI: 10.1148/radiol.2018171820.
8. Okuboyejo DA, Olugbara OO. A review of prevalent methods for automatic skin lesion diagnosis. Open Dermatol J 2018;12(1):14–53. DOI: 10.2174/187437220181201014.
9. A beginner's guide to neural networks and deep learning. Available from: https://pathmind.com/wiki/neural-network [Last accessed on April 30, 2020].
10. Kohli M, Prevedello LM, Filice RW, et al. Implementing machine learning in radiology practice and research. AJR Am J Roentgenol 2017;208(4):754–760. DOI: 10.2214/AJR.16.17224.
11. Jakkula V. Tutorial on support vector machine (SVM). Available from: https://course.ccs.neu.edu/cs5100f11/resources/jakkula.pdf [Last accessed on August 31, 2021].
12. Craft JA 3rd. Artificial intelligence and the softer side of medicine. Mo Med 2018;115(5):406–409. PMID: 30385982.
13. Pun T, Gerig G, Ratib O. Image analysis and computer vision in medicine. Comput Med Imaging Graph1994;18(2):85–96. DOI: 10.1016/0895-6111(94)90017-5.
14. Ghahramani Z. Probabilistic machine learning and artificial intelligence. Nature 2015;521(7553):452–459. DOI: 10.1038/nature14541.
15. Krittanawong C, Zhang H, Wang Z, et al. Artificial intelligence in precision cardiovascular medicine. J Am Coll Cardiol 2017;69(21): 2657–2664. DOI: 10.1016/j.jacc.2017.03.571.
16. Beneke F, Mackenrodt MO. Artificial intelligence and collusion. IIC–Int Rev Intellect Prop Compet Law 2019;50:109–134. DOI: 10.1007/S40319-018-00773-X.
17. Kalyane D, Sanap G, Paul D, et al. Artificial intelligence in the pharmaceutical sector: current scene and future prospect. In: Tekade RK, editor. The future of pharmaceutical product development and research. Elsevier; 2020. p. 73–107.
18. Medsker L, Jain LC. Recurrent neural networks: design and applications. CRC Press; 1999.
19. Bielecki A, Bielecki A. Foundations of artificial neural networks. In: Kacprzyk J, editor. Models of neurons and perceptrons: selected problems and challenges. Springer International Publishing; 2019. p. 15–28.
20. Vyas M, Thakur S, Riyaz B, et al. Artificial intelligence: the beginning of a new era in pharmacy profession. Asian J Pharm 2018;12(2): 72–76.
21. LeCun Y, Bengio Y, Hinton G. Deep learning. Nature 2015;521(7553): 436–444. DOI: 10.1038/nature14539.
22. Ferrucci D, Levas A, Bagchi S, et al. Watson: beyond Jeopardy! Artif Intell 2012;199(200):93–105. DOI: 10.1016/j.artint.2012.06.009.
23. Bakkar N, Kovalik T, Lorenzini I, et al. Artificial intelligence in neurodegenerative disease research: use of IBM Watson to identify additional RNA_binding proteins altered in amyotrophic lateral sclerosis. Acta Neuropathol 2018;135(2):227–247. DOI: 10.1007/s00401-017-1785-8.
24. Bejnordi BE, Veta M, van Diest PJ, et al. Diagnostic assessment of deep learning algorithms for detection of lymph node metastasis in women with breast cancer. Journal of the American Medical Association 2017;318(22):2199–2210. DOI: 10.1001/jama.2017.14585.
25. Yu KH, Zhang C, Berry GI, et al. Predicting nonsmall cell lung cancer prognosis by fully automated microscopic pathology image features. Nat Commun 2016;7:12474. DOI: 10.1038/ncomms12474.
26. Choi E, Schuetz A, Stewart WF, et al. Using recurrent neural network models for early detection of heart failure. J Am MEd Inform Assoc 2017;24(2):361–370. DOI: 10.1093/jamia/ocw112.
27. Buzeav IV, Plechev V, Nikolaeva IE, et al. Artificial intelligence: neural network model as the multidisciplinary team member in clinical decision support to avoid medical mistakes. Chronic Dis Transl Med 2016;2(3):166–172. DOI: 10.1016/j.cdtm.2016.09.007.
28. Stein DJ, Lund C, Nesse RM. Classification systems in psychiatry: diagnosis and global mental health in the era of DSM-5 and ICD-11. Curr Opin Psychiatry 2013;26(5):493–497. DOI: 10.1097/YCO.0b013e3283642dfd.

29. Wakefield JC. Diagnostic issues and controversies in DSM-5: return of the false positives problem. Annu Rev Clin Psychol 2016;12:105–132. DOI: 10.1146/annurev-clinpsy-032814-112800.
30. Bedi G, Carrillo F, Cecchi GA, et al. Automated analysis of free speech predicts psychosis onset in high-risk youths. NPJ Schizophr 2015;1:15030. DOI: 10.1038/npjschz.2015.30.
31. Elvevag B, Foltz PW, Rosenstein M, et al. An automated method to analyze language use in patients with schizophrenia and their first-degree relatives. J Neurolinguistics 2010;23(3):270–284. DOI: 10.1016/j.jneuroling.2009.05.002.
32. Detrano R, Guerci A, Carr JJ, et al. Coronary calcium as a predictor of coronary events in four racial or ethnic groups. New Engl J Med 2008;358(13):1336–1345. DOI: 10.1056/NEJMoa072100.
33. Kanesaka T, Lee T, Uedo N, et al. Computer-aided diagnosis for identifying early gastric cancers in magnifying narrow band images. Gastrointest Endosc 2017;87(5):1339–1344. DOI: 10.1016/j.gie.2017.11.029.
34. Szold A, Bergamaschi R, Broeders I, et al. European Association of Endoscopic Surgeons European Association of Endoscopic Surgeons (EAES) Consensus statement on the use of robotics in general surgery. Surg Endosc 2015;29(2):253–288. DOI: 10.1007/s00464-014-3916-9.
35. Precision medicine that only human + AI can achieve. Reinventing imaging so you can practice better and faster. Arterys Website. Available from: https://www.arterys.com [Last accessed on August 31, 2021].