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Recent advances of Machine Learning Techniques in Biomedicine

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ABSTRACT: Machine learning strategies, such as artificial neural networks (ANN), are being implemented by healthcare organisations in order to improve the quality of care provided while simultaneously reducing expenses. It is well-established that ANN can be utilised in a variety of real-world applications for the purposes of classification and prediction. One of these many components that goes into improving healthcare delivery is influencing the decisions that healthcare providers make. In recent years, there has been significant development in the field of machine learning in terms of software algorithms, the implementation of hardware, and applications in a wide variety of fields. This article provides a concise overview of the most recent developments in artificial intelligence (AI) applications in biomedicine, such as disease diagnosis, assistance with daily living, biomedical information processing, and biomedical research.

KEYWORDS: Artificial Neural Networks; Machine Learning; Artificial Intelligence; BioMedicine

I. INTRODUCTION

Machine Learning (ML)is now being used to assist hospitals optimise administrative operations, map and treat infectious diseases, and tailor medical treatments.[1] ML is referred as the Machine Learning.It has the potential to improve hospital and health-care system efficiency while lowering the value of care.[2-5]

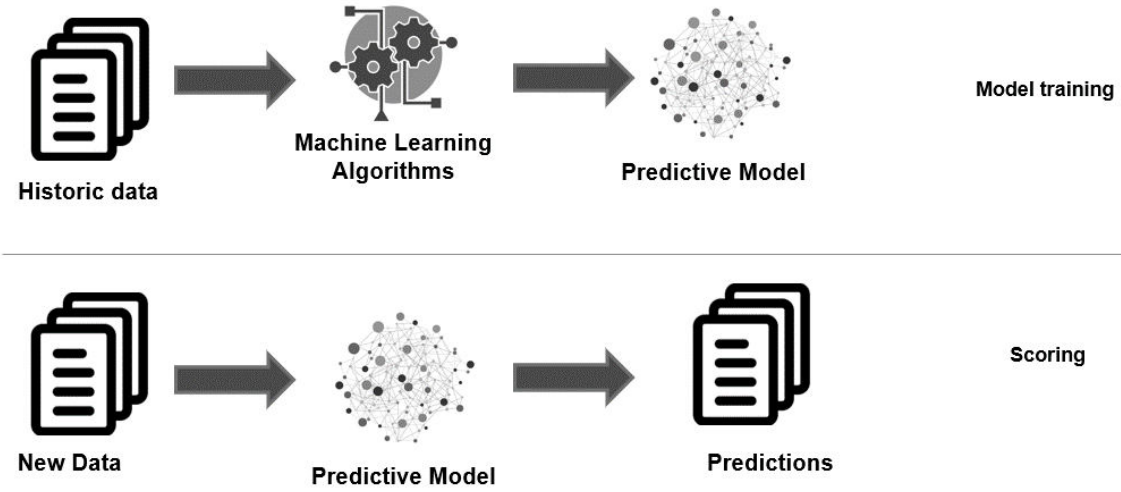

Fig.1. Machine learning based prediction model

A wide range of issues may be solved using machine learning methods. These are some of the tasks that machine learning might assist with in the healthcare industry:

1. **Classification**

   The kind of illness or medical condition you're dealing with can be determined and labelled using machine learning techniques.[6]

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2. **Recommendations**
   ML methods can provide essential medical information without the need to actively seek it out.[7][8]
3. **Clustering**
   ML can assist in grouping together comparable medical situations in order to analyse patterns and undertake future study.[3,4,5]
4. **Prediction**
   Based on historical data and current patterns, machine learning can forecast how future events will occur. [9]
5. **Anomaly detection**
   Using machine learning in healthcare, we may be able to identify objects that deviate from regular patterns and determine if they necessitate operation.
6. **Automation**
   Machine learning can handle data entry, appointment scheduling, inventory management, and other mundane repetitive activities that demand too much time and effort from physicians and patients.
7. **Ranking**
   ML can prioritise appropriate information, creating finding it easier.

The healthcare business now takes a more traditional approach to developing solutions. Typically, medical choices concerning diagnosis, prognosis, and therapy are based on generalisations about a hypothetical population generated from a small sample of people. This strategy, however, falls short for people with mental diseases since it ignores the numerous variables that each case presents.[10] These variables, which include interactions between and within the environmental, behavioural, cognitive, emotional, and biological systems, are unique to each person and are not taken into consideration in generalisations. As a result, although being produced from statistically significant research, data employed in traditional decision-making processes is not therapeutically useful.[11]

The healthcare manufacturing is divided into the five sectors listed below.

- Hospitals, surgery centres, nursing homes, and doctors and physicians are examples of healthcare providers and facilities.[12]
- Diagnostic equipment, orthopaedic devices, and medical instruments are examples of medical equipment and gadgets.
- Wholesalers and distributors of pharmaceuticals and equipment to healthcare professionals, such as pharmacies.[13]
- Pharmaceuticals, life sciences, and biotechnology
- Health insurance and managed care

AI's most prevalent form and application is machine learning (artificial intelligence). It is mostly concerned with the development of computer algorithms and the analysis of vast amounts of data in order to identify patterns that may be used to make better decisions.[14] Machine learning allows you to learn automatically through systems, without having to actively programme improvement from your previous experiences. Algorithms, or a collection of instructions for a system to do specified tasks, are used in their applications. Machine learning algorithms are primarily intended to allow computers to learn from data without the need for human intervention. Without programming, the algorithms' prediction accuracy improves over time.[15,16]
The machine learning process begins with observation, recorded data, or accepting instructions in order to extract patterns from data and then make future judgments based on those patterns. Machine learning algorithms are made up of three parts: representation (data should be in a format that computers can understand), evaluation (determining whether data categorization is valuable), and optimization (finding the optimum framework for accurate and effective results).[17]

II. LITERATURE SURVEY

It's possible that the organisational side of the industry could benefit from machine learning. A typical registered nurse in the United States devotes twenty-five percent of her working hours to managerial and administrative responsibilities[10]. The management of records, the processing of claims, the revenue cycle, and clinical documentation are all examples of tasks that could be easily replaced by technology.
Gaurav Parashar, Ajay Rana, and Alka Chaudhary A Comprehensive Analysis and Mapping Study of AI and Machine Learning in the Healthcare Industry, with an Eye Toward the Future (2021) The implementation of machine learning in the healthcare industry has produced a number of encouraging results, which has contributed to increased confidence in

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the sector. [11] Researchers used information and communications technology (ICT) as well as machine learning to devise methods that improved the efficiency of earlier approaches or procedures. [23] Big data, information and communications technology, and artificial intelligence and machine learning have all been extremely beneficial to the healthcare industry in terms of improving both accuracy and efficiency (ML). In their day-to-day work, research, and simulated testing of biomedicine's impact on humans, medical professionals and other healthcare workers have reaped significant benefits from the adoption of these technologies.

III. PROPOSED METHOD OF MACHINE LEARNING IN HEALTHCARE

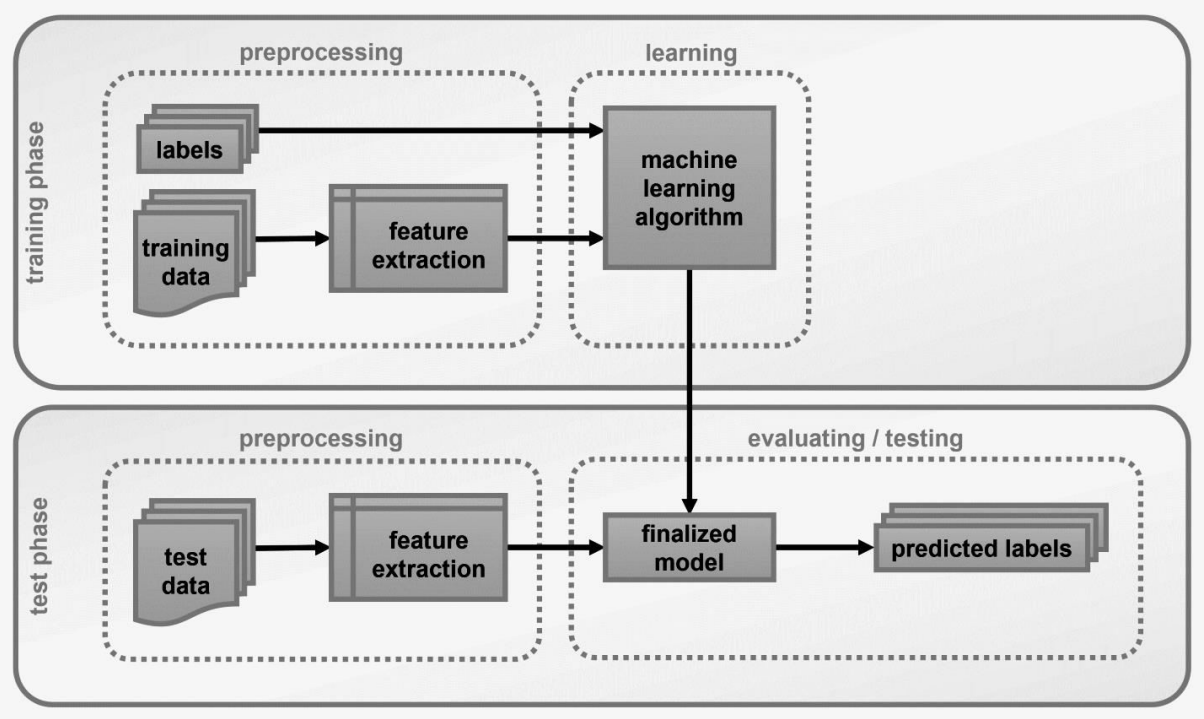

Fig.2. Architecture of Proposed model

1. Training phase:

In the healthcare industry, visual perception-based Machine Learning models are utilised to diagnose various diseases via medical imaging data analysis. If trained with the correct quality and quantity of healthcare training data, CT Scan , MRI, Ultrasoundand X-Rays reports can be evaluated using Machine Learning models.[18]

Healthcare Training Data for Following Machine Models:

- Skin Image Analysis & Personalized Treatment
- Early diagnosis of high-impact disorders like Glaucoma
- Data for Health Monitoring and Virtual Patient Care
- Data for Drug Creation and Healthcare System Analysis
- Data for Disease Management and Clinical Trials

Images acquired from a database may contain erroneous data and background noise. Preprocessing is used to remove noise from computed tomography (CT) pictures to create noise-free images that can be used in future computations. A mask was created by combining many morphological tasks.[19]

2. Test Phase :

Model testing is the process of evaluating the performance of a fully trained model on a testing set in machine learning.[20]

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ANN(Artificial Neural Network)

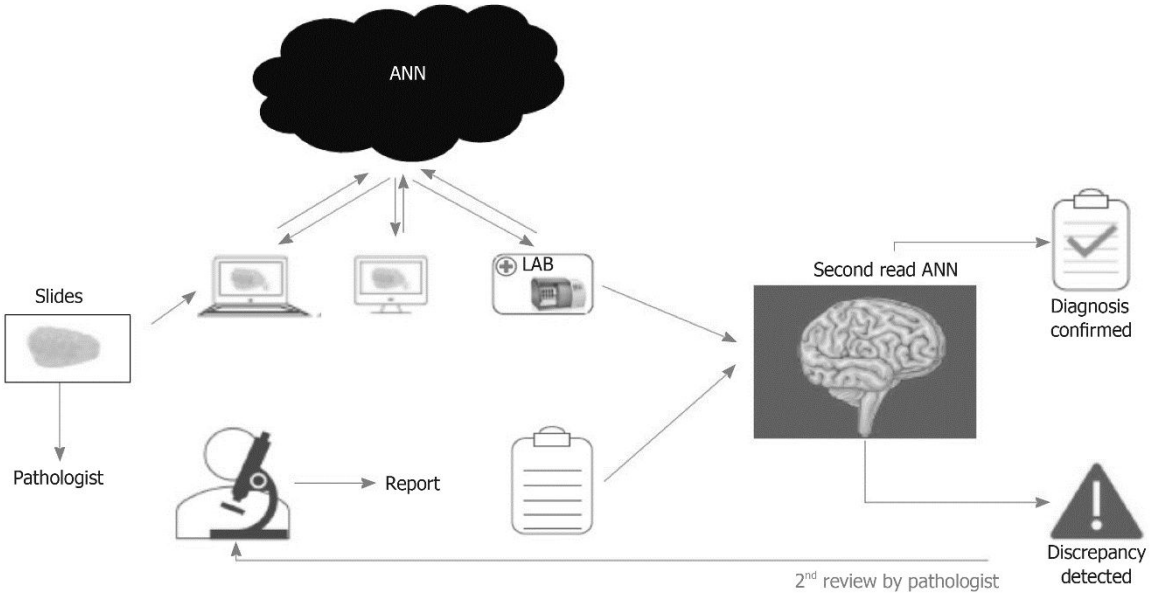

Fig. 2. Proposed ANN architecture

This method is a computational method that depends on a large collection of neural units to simulate, albeit in a very general way, how the brain works to find solutions to problems by utilising large clusters of biological neurons that are linked together by axons. Every single neuron is connected to a certain number of other neurons... These systems, rather than being explicitly coded, learn and train themselves..." [21]

Take into consideration the following possibility: A prognosis regarding a patient's health, such as whether or not she or he is at risk of acquiring a particular disease, is something that a physician wishes to determine. [22] How exactly would a medical professional go about obtaining this information? In most cases, it would involve conducting blood tests, tests of vital signs, and other tests in addition to other methods in order to identify characteristics that have been demonstrated to be effective predictors of patient health. What if, on the other hand, medical professionals are only aware of a small number of the risk factors associated with a particular disease, or even worse, they are unaware of any of them at all? It would not be possible to make any projections. [23]

ANNs contribute to the delivery of healthcare forecasts that individual physicians and surgeons would be unable to provide on their own. They are useful in circumstances in which we are able to collect data but are unsure as to which aspects of that data are most important. Because of this, these abstractions are able to capture intricate interactions that aren't immediately obvious, which leads to improved public health forecasting as a result. [24] The applications of neural networks in healthcare that are possible today include the following:

• Diagnostic systems – This technique, which makes use of big data as a source of information, can be utilised to diagnose a wide range of diseases, including cancer and heart disease, amongst others.

• Biochemical analysis – Artificial neural networks (ANNs) are used to evaluate urine and blood samples, as well as to track glucose levels in diabetics, determine ion levels in fluids, and diagnose a variety of medical disorders. ANNs are also used to track glucose levels in diabetics and determine ion levels in fluids.

• Image analysis – ANNs are routinely used to analyse medical images from a variety of fields within the healthcare industry. This includes the identification of tumours, x-ray classifications, and MRIs, among other applications.

• Drug development – As a final application, ANNs are used in the process of developing medications to treat a wide range of illnesses. These models rely on enormous amounts of data to arrive at decisions regarding patient care.

Neural networks are able to be found in the majority of places where artificial intelligence has made inroads into the healthcare industry. For instance, in the area of pharmaceutical research and development, the companies Data Collective and Khosla Ventures have recently made an investment in "Atomwise." This is a company that makes use of machine learning and neural networks to provide assistance to medical professionals in the rapid discovery of safer and more effective medications. [26] Atomwise's technologies are able to differentiate between potentially harmful drug

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options and alternatives that are less risky, and the company published its preliminary findings on Ebola treatment medications the year before. [25]

An artificial neural network, also known as an ANN, is a hierarchical network structure that is made up of a large number of neurons that are connected to one another through the application of a specific rule and that are organised into three layers: the input layer, the hidden layer, and the output layer [27,28]. An ANN's working performance is directly influenced by the training samples that it receives. If the training samples are inaccurate, too few, or too similar, the ANN's operating range and capabilities will be significantly reduced. To put it another way, the ANN's instructor will serve as the training sample. Because of this, the Artificial Neural Network (ANN) becomes more accurate and powerful as it accumulates more training samples. [29]Artificial neural networks (ANNs) are a type of AI. ANNs, unlike other AI systems, are capable of self-learning. To address problems, users don't need to write difficult programmes; all they need to do is submit data. The origin of most diseases is unknown at this time, and the symptoms of numerous diseases are constantly changing. The diagnosis of an illness and the treatment that goes with it is based on experience in medical practise. As a result, an ANN's learning, memory, and induction functions define its suitability for medical applications.[30]

IV. APPLICATION OF MACHINE LEARNING IN HEALTHCARE

a. Electronic Medical Records

Keeping accurate health records takes a lot of time, and even though technology has made it simpler to enter data, the fact of the matter is that a significant portion of the tasks still take a very long time to finish. [31] What is it that you ought to do? Machine learning is most commonly applied in the healthcare industry to automate processes for the purpose of reducing the amount of time, money, and effort spent. Document classification strategies that are based on vector Machine Learning-based OCR methods of recognition, such as MATLAB's ML and Google Cloud Vision API-based handwriting recognition technologies, are among the factors that are slowing down the process of collecting the stream of data. [32]

MIT is currently supplying and developing cutting-edge technology for the next generation of compact and intelligent health records. These records will use tools based on machine learning from the ground up to assist with clinical treatment diagnosis and recommendations. In the world as it exists today, MIT is the leading provider of such technology. [33] It is one of the machine learning applications that is used the most frequently in the medical industry.

b. Research and Testing in Human Subjects

Concerns have been raised by a number of individuals regarding the implementation and utilisation of machine learning in the medical industry. On the other hand, machine learning presents a diverse array of possible applications in clinical trials and research. [34] Everyone who works in the pharmaceutical industry is aware that clinical trials involving urgent care are extremely costly and frequently take a number of years to finish.

Researchers have the ability to build a candidate pool for clinical trials by employing machine learning-based predictive analysis on data obtained from a wide variety of sources, including social media, previous medical visits, and other similar activities. [35] In addition, ML has been shown to be beneficial in assuring real-time data access and monitoring of trial participants, financing the appropriate sample size to be tested, and leveraging the power of electronic records, all of which lead to a reduction in data-based errors [36].

c. Data Collection

Crowdsourcing, which is now a global phenomenon, is all the rage in the medical field. It enables researchers and practitioners to access a wide range of data from individuals who have given their consent for the data to be collected. These real-time health data will have a significant impact on how medicine will be practised in the years to come. Apple's ResearchKit gives users the ability to access interactive applications that treat Parkinson's disease and Asperger's disease by using machine learning-based face recognition [37]. IBM and Medtronic have announced that they will be working together to understand, collect, and make real-time data on insulin and diabetes available to the public. This partnership will be based on crowdsourcing data. Despite recent advancements in the Internet of Things, the healthcare industry is currently focusing on finding new ways to leverage data from the Internet of Things to solve difficult to unusual disease problems and assist in the general development of therapy and diagnostics. This is being done in an effort to aid in the general development of therapy and diagnostics. [38]

d. Improved Methods of Radiotherapy

Radiography is quickly becoming one of the most sought-after applications of machine learning in the field of healthcare. In the field of medical image analysis, there are a great deal of separate aspects that may or may not be

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important at any given moment. Many cancer foci, lesions, and other situations are difficult to model because they require the use of complex equations. As a result of the fact that algorithms for machine learning are taught from a diverse range of examples, it is sometimes much easier to establish diagnoses and determine the factors that are actually at play.

e. Forecasting the Next Epidemic [39]

At this time, AI and ML are being utilised all over the world in order to forecast and monitor the spread of epidemics. In today's world, scientists need to have access to a vast quantity of data that was gathered from various sources, such as satellites, website information, real-time updates from social media, and so on. [38] Artificial Intelligence The collection of data and prediction of everything from outbreaks of malaria to severe chronic infectious diseases can both be assisted by neural networks. In countries of the third world, where essential medical facilities and a functioning educational system are in short supply, epidemiological forecasting is an extremely important activity. For instance, ProMED–mail is an internet-based reporting management software that gives real-time epidemic data in addition to assisting in the monitoring of changing and emerging illnesses. This software also provides a means of managing reports.

V. CONCLUSION

In this piece of research, we evaluated the most recent advancements in the use of MI in biomedicine, including disease diagnoses and predictions, living aids, biomedical information processing, and biomedical research. Specifically, we focused on how MI has been used. MI has applications that could be of use in a wide variety of other biomedical fields. It is evident that MI is gaining more significance in the field of biomedicine, and this is not only due to the continuous development of MI itself; rather, it is also due to the inherent complexity of biomedical problems and the adaptability of AI to tackle such problems. The expansion of medical imaging capabilities enables the development of novel approaches to biomedical problems, and the development of biomedicine makes such expansion necessary.

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