

# **Machine learning in healthcare: applications. challenges and benefits**

## **1.Introduction:**

Machine learning is a branch of Artificial Intelligence(AI) that enable machine learns from data to execute some tasks and make predictions or decisions without doing any programming. In day to day life machine learning is making our life easier. Nowadays, machine learning plays an important role in healthcare by achieving improvement in diagnostic accuracy, treatment ability, operational efficiency and medical research. This following report is intended to talk about the applications, challenges of machine learning in healthcare and to discuss about the potential benefits of machine learning in this field.

## **2. Machine learning algorithms used in healthcare:**

Machine learning algorithms used in various context in the field of healthcare. Here are some example:

### **2.1 Linear Regression:**

Linear regression is a method that used to predict the value of variable dependent on the other variable where the variable necessary to predict known as dependent variable and the value try to predict other variables value is called independent variable[1].In healthcare industry, linear regression helps in predicting patient cost, hospital readmission risk and many more. Mainly it try to predict continuous outcomes.

### **2.2 Logistic Regression:**

Logistic regression predict binary outcomes based on the predictor variables which can be one or more[1]. Logistic regression usually used in binary classification to predict diseases. Logistic regression evaluating genetics, environment and lifestyle for predicting cancer risk, aiding in early risk and personalized interventions[2].

### **2.3 Support Vector Machines(SVMs):**

SVM are used in healthcare sector for various tasks such as diagnosis, prognosis and prediction of diseases outcomes[3].

## **2.4 Decision Trees:**

Decision trees are a class of supervised machine learning algorithms which is used in classification and regression tasks. Decision trees are easy to interpret. With the help of this, machine learning algorithms can make interpretable models. For clinical decision making such as mental health decision trees introduce a significant approach due to their interpretability, capacity to identify risk patient and provide support in treatment planning[4].

## **2.5 Principle Component Analysis:**

Principle component analysis helps researchers to examine cancer related data which has multidimensional nature with the help of reducing the dimensionality of the dataset while most of its preserving variability[2].

## **3.Applications in healthcare:**

In healthcare, machine learning has various kind of applications across different categories :

### **3.1 Pathology:**

Pathology is the study of medical science which talks about understanding causes and consequences of diseases[5].By examining the organs, tissues, bodily fluids and whole body , pathologist can find the diseases. Machine learning algorithm can explore digital images of tissue sample to identify cancer sells, tumor margin and other pathological feature which is difficult for human pathologist to detect traditionally.

### **3.2 Medical Image Analysis and Diagnostic:**

Through the use of ML algorithms, analyze the images related to medical such as X-rays ,CT scans and MRIs as well as assist in the diagnosis, segmentation and detection of abnormalities. For identifying tumors, fractures, lesions and other anomalies these algorithms are helpful. By using these tools radiologist can make more accurate diagnosis. In radiology, ML model can identify breast cancer by examining mammograms, improve early detection rates and patient outcomes[6].

### **3.3 Predictive Analysis and Disease Prediction:**

In healthcare sector, predictive analysis plays a significant role for disease prediction . ML models can predict the chances of disease development by analyzing historical patient data, explore the huge amounts of medical image and patient data accurately, healthcare professionals take proper actions to improve patient outcome [6].

### **3.4 Drug Discovery and Development:**

ML has a significant role for discovering drug. For drug discovery machine learning model can examine the biological and chemical data to find drug candidates, predict their efficiency also managing how to improve the existing drug .Machine learning model reduces cost and time for drug development. ML algorithms is not only improve the development of drug discovery process but also make a new way in personalized medicine and patient care[6].

### **3.5 Drug Response Prediction:**

Machine learning can determine how patient will response with certain drug by mining biological data so that healthcare providers can provide proper treatment based on their unique genetic and molecular profiles[6]. Therefore, by predicting drug response , clinician can make more informed decision and achieve better patient outcomes[6].

### **3.6 Personalized Treatment:**

Machine learning algorithm enhance the process of personalized treatment by examining patient data including medical records, genetic information, lifestyle , environment, different outcome to therapies for individual patient. People related to healthcare can open new opportunities to improve patient outcomes, optimize treatment efficacy by using the algorithms of machine learning[7]. Using machine learning in precision medicine opens new way for medical treatment[7].

### **3.6 Electronic health record and Clinical decision support:**

Based on EHR data, it's easy to find public health trends, planning, resources allocation, risk factor in certain population. Electronic health record helps the healthcare provider to take the proper clinical decision.

### **3.7 Remote Health Monitoring and Telehealth:**

For monitoring clinical data remotely , Support Vector Machine(SVM) and Artificial Neural Network(ANN) , techniques of machine learning are used [8]. Machine learning algorithms enable remote monitoring and telemedicine that can make it more easier for people to get treatment from home which is safe and comfortable.

### **3.8 Public Health Management:**

Using Machine learning algorithm researcher can identify population health trends, predict diseases outbreak or health related events and many more. Predictive model, Electronic Health Record(EHR) plays a significant role in public health management. Researchers can know about disease surveillance, high risk disease so they can optimize treatment plan, improve patient outcomes and manage a better healthcare system.

Machine learning is improving healthcare sector. These are some few example of machine learning applications. As technology is improving day by day, applications of machine learning algorithms and techniques making healthcare system more efficient.

## **4. Challenges of machine learning in healthcare:**

Machine learning has the potentiality to bring up revolutionize change in healthcare. Though machine learning has so many advantages , it faces significant challenges.

### **4.1 Data Privacy and security concerns:**

In healthcare system, patient data privacy is the most important thing. Healthcare data such as patient records, medical images and sensitive issues need to be kept confidential. In clinical research, researchers need to collect clinical dataset which is related to patient privacy, so there are some risk that their privacy would be violated[9].For implementing machine learning

algorithm in healthcare industry also need patient data. So it is quite challenging to secure these data.

## **4.2 Regulatory compliance:**

Machine learning algorithms should follow some regulations such as the Health Insurance Portability and Accountability Act(HIPAA) and the General Data Protection Regulation(GDPR) these are operated by healthcare industry for ensuring patient data [6].

## **4.3 Algorithm Transparency and Explainability:**

ML models have some incomprehensibility which creates ethical issues such as, lack of transparency, can not explain their decision – increases concerns related to trust and accountability[6].

## **4.4 Ethical consideration and Bias:**

Machine learning algorithm bias shows some ethical issues, making biased decision with the basis of historical data can immortalize the existing inequality in the field of healthcare[6].

## **4.5 Responsible Use of Machine learning:**

Using machine learning properly in healthcare system is quite hard, should focus on transparency, accountability and ethical decision making to protect the patient safety and to maintain the integrity of healthcare system[6]. Whenever using machine learning algorithm should take fair and unbiased decision.

# **5. Potential Benefits in healthcare:**

Machine learning has huge potentiality for transforming healthcare, offering a wide range of benefits such as improve patient outcome, clinical decision making, reduce cost and enhance the efficiency of healthcare delivery. Here are some potential benefits of machine learning:

## **5.1 Predictive analytics for Preventive care:**

By utilizing machine learning algorithms and analyzing patient data healthcare providers can identify risk for individuals, with the help of these healthcare provider can improve their treatment, it also allows for early interventions and personalized preventive measures[6].

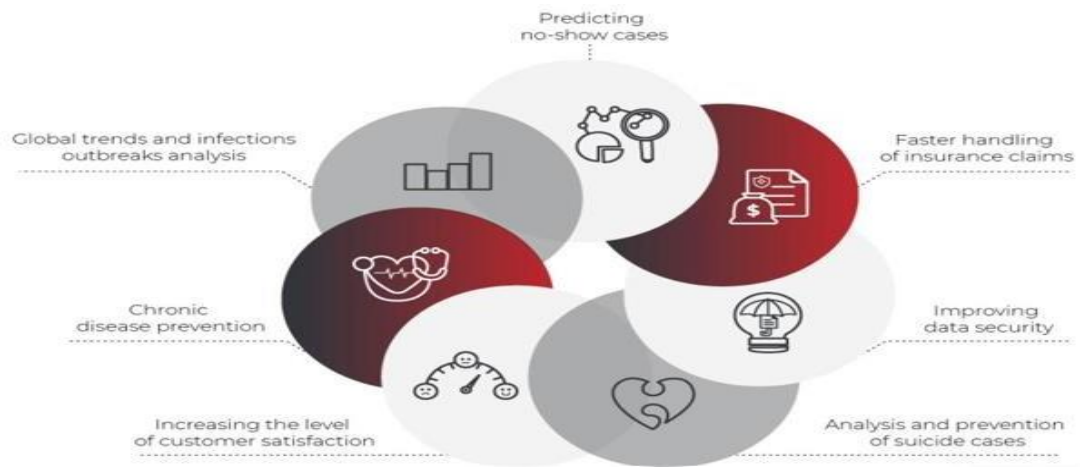


Figure1: Predictive analytics in Healthcare [6]

## **5.2 Drug Discovery and Development:**

Machine learning algorithms enhance data discovery process. Machine learning algorithms have brought about revolutionary changes in drug discovery process.

## **5.3 Clinical decision support systems:**

Healthcare professionals can make more accurate diagnosis and treatment decision by examining patient data , also give proper advice to the patient[10]. Machine learning based clinical system plays a significant role in healthcare industry. It is now easy for healthcare professionals to make better decision for their patient.

## **5.4 Precision Medicine and Personalized healthcare:**

With the help of machine learning healthcare provider can give personalized medicine, preventive care and tailoring treatment plans, for these healthcare providers can examine the unique genetic makeup, lifestyle and environment factor[6].

## **5.5 Remote Monitoring and Telemedicine:**

Machine learning based wearable devices and telemedicine platforms are improving their efficiency day by day[10].In the near future, patients will get their treatment from home without visiting the doctor in person with the help of remote monitoring[10]. Telemedicine and remote monitoring is a blessing for modern healthcare system. Machine learning model made it more easier for people.

## **5.6 Operational Efficiency:**

Machine learning can improve hospital operations by optimizing resource allocation, scheduling and patient flow management[10].Based on predictive analytics machine learning can predict patient readmission rate which will also play important role in hospital operations.

## **5.7 Genomics:**

Genomics is the field of genetics, focuses on the study of complete sets of genes in organism which is known as genome[11].Machine learning and data mining technologies plays a vital role for analyzing genomic and critical data, with the help of these technologies, large-scale dataset can be uncovered which is impossible to do naturally[11].By analyzing large genomic dataset machine learning are used to detect diseases and predict individual response to treatment, this will help to doctor create personalized treatments based on patient's unique genetic profile[10].

Machine learning has numerous benefits in healthcare. Healthcare system is improving day by day with the help of machine learning algorithms.

## **6.Discussion:**

Machine learning has brought about a great change in healthcare industry by predicting diseases, accurate diagnosis, better treatment plan, discovering new drugs and more importantly provide remote monitoring system in healthcare system. But in machine learning technology there are some challenges too. Machine learning algorithms explore large patient dataset so healthcare provider need to careful about data privacy and security. On the other hand, machine learning has various type of benefits. In conclusion, machine learning is improving healthcare system gradually.



## 7 References:

- [1] D. Kumar Ghosh, “Perspective Chapter: Linear Regression and Logistic Regression Models,” in *Recent Advances in Biostatistics*, B. Santhosh Kumar, Ed., IntechOpen, 2024. doi: 10.5772/intechopen.1003183.
- [2] M. A. Abubakar, M. U. Adehi, and M. A. Abubakar, “Using Principal Component Analysis and Logistics Regression to Model Major Types of Cancer among Youth: A Review,” *African Journal of Advances in Science and Technology Research*, vol. 14, no. 1, pp. 61–72, Apr. 2024, doi: 10.62154/ee3ykg53.
- [3] R. Guido, S. Ferrisi, D. Lofaro, and D. Conforti, “An Overview on the Advancements of Support Vector Machine Models in Healthcare Applications: A Review,” *Information*, vol. 15, no. 4, p. 235, Apr. 2024, doi: 10.3390/info15040235.
- [4] A. B. N, T. Patel, S. Patil, R. L. S, and V. Singh, “Enhancing the Quality and Efficiency of Mental Health Care using Decision Trees,” in *2023 14th International Conference on Computing Communication and Networking Technologies (ICCCNT)*, Jul. 2023, pp. 1–5. doi: 10.1109/ICCCNT56998.2023.10306470.
- [5] S. K. B. Sangeetha, R. Dhaya, D. T. Shah, R. Dharanidharan, and K. P. S. Reddy, “An empirical analysis of machine learning frameworks for digital pathology in medical science,” *J. Phys.: Conf. Ser.*, vol. 1767, no. 1, p. 012031, Feb. 2021, doi: 10.1088/1742-6596/1767/1/012031.
- [6] N. Narayan Koranchirath, “Impact of Machine Learning on Healthcare Analytics,” *IJSR*, vol. 13, no. 2, pp. 942–947, Feb. 2024, doi: 10.21275/SR24210203022.
- [7] B. Srinivasaiah, “The Power of Personalized Healthcare: Harnessing the Potential of Machine Learning in Precision Medicine,” *IJSR*, vol. 13, no. 5, pp. 426–429, May 2024, doi: 10.21275/SR24506012313.
- [8] T. N. Abiodun, D. Okunbor, and V. C. Osamor, “Remote Health Monitoring in Clinical Trial using Machine Learning Techniques: A Conceptual Framework,” *Health Technol.*, vol. 12, no. 2, pp. 359–364, Mar. 2022, doi: 10.1007/s12553-022-00652-z.
- [9] K. Tucker *et al.*, “Protecting patient privacy when sharing patient-level data from clinical trials,” *BMC Medical Research Methodology*, vol. 16, no. 1, p. 77, Jul. 2016, doi: 10.1186/s12874-016-0169-4.

- [10] K. K. Yadav and A. Gaurav, "Application and Challenges of Machine Learning in Healthcare," *IJRASET*, vol. 11, no. 9, pp. 458–466, Sep. 2023, doi: 10.22214/ijraset.2023.55678.
- [11] F. C. Udegbe, O. R. Ebulue, C. C. Ebulue, and C. S. Ekesiobi, "PRECISION MEDICINE AND GENOMICS: A COMPREHENSIVE REVIEW OF IT-ENABLED APPROACHES," *International Medical Science Research Journal*, vol. 4, no. 4, pp. 509–520, Apr. 2024, doi: 10.51594/imsrj.v4i4.1053.





## 8 References:

- [1] D. Kumar Ghosh, “Perspective Chapter: Linear Regression and Logistic Regression Models,” in *Recent Advances in Biostatistics*, B. Santhosh Kumar, Ed., IntechOpen, 2024. doi: 10.5772/intechopen.1003183.
- [2] M. A. Abubakar, M. U. Adehi, and M. A. Abubakar, “Using Principal Component Analysis and Logistics Regression to Model Major Types of Cancer among Youth: A Review,” *African Journal of Advances in Science and Technology Research*, vol. 14, no. 1, pp. 61–72, Apr. 2024, doi: 10.62154/ee3ykg53.
- [3] R. Guido, S. Ferrisi, D. Lofaro, and D. Conforti, “An Overview on the Advancements of Support Vector Machine Models in Healthcare Applications: A Review,” *Information*, vol. 15, no. 4, p. 235, Apr. 2024, doi: 10.3390/info15040235.
- [4] A. B. N, T. Patel, S. Patil, R. L. S, and V. Singh, “Enhancing the Quality and Efficiency of Mental Health Care using Decision Trees,” in *2023 14th International Conference on Computing Communication and Networking Technologies (ICCCNT)*, Jul. 2023, pp. 1–5. doi: 10.1109/ICCCNT56998.2023.10306470.