



Significance Of Machine Learning Algorithms In Medical Field

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Abstract: Machine Learning is a science that was developed in the area of artificial intelligence. Machine Learning and its algorithms are used for various purposes like pattern recognition, image processing, predictive analysis, deep learning, etc. Machine Learning works on the principle of determining the most appropriate model for the data. The research work highlights the work done by other authors in similar fields. A conclusive study of the work done has been discussed. The contribution of machine learning techniques in different sectors like computer vision, healthcare, construction, etc along with their purpose and applications is presented. The idea behind this study is to spread awareness about machine learning algorithms and their application areas. Healthcare sector is an important and crucial industry as it offers help to several people. It also contributes to the local economy. Various technologies like ML, and DL are contributing a lot to revolutionizing the healthcare sector. The benefits offered by these technologies are endless. Healthcare sector deserves special attention as it is related to the lives of humans. Any type of delay can be hazardous. It has been seen that machine learning and deep learning techniques prove to be very advantageous in predicting and diagnosing the disease at an early stage. The objective of this research paper is to analyze the growth and importance of data science in healthcare. This paper explores the work done in the healthcare sector with the help of machine learning and deep learning techniques like SVM, Naïve Bayes, ANN, KNN, Decision Tree, CNN, and many more.

Keywords: Machine Learning, Decision Tree, Regression, Naïve Bayes, Support Vector Machine.

1. Introduction

Machine Learning is a branch of artificial intelligence and the study of systems that can learn from data. According to Arthur Samuel (1959) "Machine Learning is a field of study that gives the computer the ability to learn without being explicitly programmed." Machine learning algorithm has mainly three components: representation, evaluation, and optimization.

Many organizations with enormous amounts of data are using machine learning algorithms to retrieve valuable information. The purpose of examining the data gathered in diverse areas changes with the different business domains such as stock market, military, image processing, speech recognition, handwriting recognition, education, and construction.

1.1 Different types of machine learning algorithms:

Machine learning algorithms are broadly categorized into four parts:

- 1) Supervised Learning - an algorithm where external assistance is required and the given input data is further categorized into train dataset and test dataset (labeled data). The outcome variable is predicted from the training dataset. Supervised learning is further classified into classification and regression learning. Some of the most popular classification and regression techniques are Decision Tree, Naive Bayes, and Support Vector Machine.
- 2) Unsupervised Learning: An output variable is not specified or stated in unsupervised learning. When novel data is given, it emphasizes the existing features to identify the data (unlabeled data). Unsupervised learning is further classified into clustering and association techniques. Some of the popular techniques are K-Means Clustering, Density-based clustering, Dimensionality reduction- Principal Component Analysis, and K-nearest neighbors.
- 3) Semi-supervised Learning: This learning method can be defined as a composition of supervised and unsupervised learning. The objective of this learning model is to produce better output for forecast than that provided already with labeled data. Semi-supervised learning can be implemented

both on labeled and unlabeled data. A few popular techniques are Self-training, Generative Models.

4) Reinforcement Learning: this learning model works on an environment-driven approach. The agent has no prior information or knowledge of which steps are to be taken in a particular scenario.

1.2 Applications of machine learning in different sectors

The earlier section defines the history of machine learning and its techniques. In the current segment, the glimpse regarding the applications, sectors, and which algorithms are used will be defined. Currently, the popularity of machine learning has increased tremendously in majorly all fields. Some of the observations are given below in Table 1: Overview of algorithms used in different application areas:

Computer Vision: is a broad segment of machine learning which learns the machines using machine learning algorithms. The few application areas are listed below:

- a) Face recognition
- b) Speech recognition
- c) Handwriting recognition

Financial Sector: One of the most popular and focused areas where the possibility of fraud detection and prevention is going viral. On the basis of pattern detection frauds can be detected and prevented at an early stage.

- a) Bank sector
- b) Stock Market

Healthcare: In the healthcare industry the diagnosis of illness at an early stage is very important. Detecting the regularities and irregularities in patients' data is done with the help of machine learning algorithms. Some of the areas are listed below:

- a) Medicine

- b) Breast cancer
- c) Covid-19
- d) Dermatology
- e) Tumor
- f) Heart Disease

Construction: Machine learning is making an impact in the construction industry. Machine learning algorithms are being widely used in order to identify potential problems in the construction industry.

- a) Highways, roadways, flyovers
- b) Hydroelectric power plant
- c) Building

Cyber Security: Cybersecurity is very crucial in the current scenario of Industry 4.0. the data has increased tremendously. To detect dangerous network traffic or intrusions and prevent the same deadly attacks.

Agriculture: Machine learning algorithms are used in different phases of agriculture- predicting crops, soil properties, weather, and weed detection by assessing satellite images.

NLP and sentiment analysis: Natural language processing (NLP) includes the analysis of verbal or written language. In sentiment analysis, machine learning identifies and analyses the text for "optimistic", "non-optimistic" or "equitable" along with good, bad, very good, very bad, happy, sad, etc.

Earthquake: Earthquake early warning systems were developed with the help of machine learning to detect large earthquakes and to damage control the after-effects. But this method was insufficient to trace the medium earthquakes. In order to prevent and control the damages, a hybrid of GPS stations and seismometers was developed known as Distributed Multi-sensor Earthquake Early Warning (DMSEEW).

Table 1: Overview of algorithms used in different sectors

S.No	Sector	Algorithms Used	Used for	Purpose	Applications
1	Computer Vision	KNN, SVM, Naïve Bayes	Face Recognition,	helpful in contactless security	airports, security, aadhar cards
		ANN, Vector quantization, dynamic time wrapping	Speech Recognition,	processing, analyzing, recognizing	healthcare, military, car system
		KNN, SVM, Naïve Bayes	Handwriting Recognition	scanning and digitizing large documents	organizations with huge databases
2	Financial Sector	Classification, regression and Neural Network	Banking	identification of pattern	banks
		Artificial neural network, random forest	Stock Market	to control credits and assess the risks	market campaign
3	Healthcare	ANN, SVM, decision tree, random forest, deep learning	Dermatology	by analyzing data giving warnings and diagnosing the patient	Skin-related disease
		Extreme machine learning, random forest	Breast Cancer	to predict breast cancer at an early stage	problems related to breast cancer
		CNN, regression models	Covid-19	To detect and predict a number of cases around the world.	problems related to Covid-19
4	Construction	Neural network, multiple regression analysis	Hydroelectric Power plants	to predict cost estimation at an early stage	HEPP
		ANN, SVM, Random Forest, GA	construction sites: buildings, projects	to minimize the risk	Buildings, Projects
		Neural network	highways, roadways	to predict the cost, safety measures at an early stage	highways, roadways
5	Cybersecurity	classification, regression, neural network & Clustering techniques	cyber-anomalies, policy violations	to identify numerous cyber threats, attacks or intrusions	Preventing system, hardware, networks or digital data
6	Agriculture	NN, decision tree, regression techniques	crops, weather, soil	to increase overall productivity	weather prediction, soil properties & management, irrigation requirements
7	NLP and sentiment analysis	CNN, RNN& Reinforcement learning	syntax, semantics, expressions,	makes it easier to understand for human	Facebook, Twitter, Movie Reviews
8	Earthquake	DMSEEW(combination of GPS stations and seismometers)		to detect medium and large earthquakes	

2. Literature Review

A. Simon [1] demonstrated deep learning, their applications, and its relationship with machine learning, big data, and artificial intelligence. Many organizations are exploring and working on this area as it has evolved as one of the leading fields of technology in the modern era.

M. Gunduz et al [2] demonstrated on basis of accuracy, that the neural network is more appropriate than multiple regression analysis. for early cost estimation in HEPP (Hydroelectric power plant).

A. Dey [3] demonstrated different types of machine learning, their advantages, and application areas. The benefit of applying machine learning is that when an algorithm acquires knowledge of what to do with data, then it can operate individually.

Tanvi Sharma et al [4] briefed that heart diseases are very crucial and cost human lives if not diagnosed in the early stages. On the basis of human health conditions and required parameters, machine learning can help in predicting the diagnosis of heart disease from patient data.

K. Shailaja et al [5] demonstrated that various machine learning algorithms are playing an important role in the healthcare industry. It helps in the decision-making process in healthcare. Early diagnosis of illness can help in giving medical aid to the patient at an early stage.

C. Ming et al [6] demonstrated that women all over the world are fighting one of the deadliest diseases in the world. Breast cancer can cost someone's life. In this paper, the machine learning techniques are compared with already existing BCRAT and BOADICEA models to identify the women at high risk.

Ozer Celik et al [7] explained machine learning and its application areas. Machine Learning works on the phenomenon of identifying the suitable model for the latest data along with the existing available set of data.

Heejae Ahn et al [8] explained the scope and importance of machine learning in different application areas to enhance the safety measures and minimize the waste of labor at construction sites.

G. Mahalakshmi et al [9] demonstrated that machine learning technologies can be helpful in minimizing the cost and effort by early estimating the costs of highway projects in India. There are many parameters that play a vital role in predicting cost at an early stage. Raw material, time duration, soil, and topographical conditions, assembly, and analysis of data are done.

Ahmed Gondia et al [10] briefed that machine learning and its algorithms play an important role and are very efficient in minimizing delay in risk prediction. Decision Tree and Naïve Bayes classification algorithms were selected for decision making in forecasting delay risk prediction.

H. Dhahri et al [11] explained that breast cancer is widespread among women globally. In this research paper, the main focus is to identify harmless and harmful tumors with the help of machine learning algorithms using AU-ROC, accuracy, precision, and specificity as research parameters.

Amy X. Du et al [12] demonstrated the relevance of machine learning technologies in forecasting clinical end-result in dermatology with a variety of skin conditions. The author also states when and where machine learning should be applied to produce more accurate results.

Kevin Fauvel et al [13] briefed that individual GPS stations and seismometers are not sufficient for predicting both medium and large earthquakes. Earthquakes are very disastrous. If we predict earthquakes at an early stage, we can save the lives of many people.

Chhaya Gupta et al [14] demonstrated that breast cancer is one of the most common and dangerous diseases these days which costs many lives. Machine learning and its techniques are very helpful in forecasting breast cancer at an early stage. So far, extreme machine learning gives better results with accuracy and time.

Sana Tayefeh Hashemi et al [15] explained that price estimation and forecasting are necessary for construction projects. Construction price forecasting minimizes the risk, human effort, and extra costs involved in construction projects like highways, roadways, hydroelectric and power

plants, and many more. Machine learning techniques play a vital in cost estimation and prediction and suggest which machine learning technique is suitable in a particular scenario.

Neha Sharma et al [16] demonstrated the importance of machine learning in different application areas is in trend these days. Further in detail discussed how deep learning came into existence and its application areas like computer vision, financial sector, agriculture, cybersecurity, healthcare, and many more. Also, deep learning and machine learning played a crucial role during Covid-19.

Iqbal H. Sarker [17] demonstrated the importance of machine learning and techniques in real-world applications and research. The author helps in finding a suitable model for the particular situation.

Md. Milan Islam et al [18] demonstrated that due to tremendous growth in the population and a large amount of available data. Diagnosing the disease at an early stage has become a cumbersome task. The author applied five machine learning algorithms Support Vector Machine (SVM), k-nearest neighbor (K-NN), artificial neural network (ANN), and Random Forest to the dataset.

S. Kazeminia et al [19] demonstrated GANs in various medical areas. Generative Adversarial Networks are used in image processing, X-ray, ultrasound, MRI, and many others in the medical field.

S. Bhise et al [20] that the detection of cancer at a prior stage is very crucial due to its small size. Breast cancer is very common these days in women's bodies due to which the death percentage has also increased. Machine learning techniques assist in detecting the tumor at an early stage with high precision.

D.Chicco & G.Jurman [21] demonstrated that electronic medical records can be assumed as relevant sources of information. Applying machine learning models to health records facilitates our doctors in predicting the survival chances of heart failure patients.

D.E Salhi et al [22] demonstrated that heart diseases are one of the deadliest diseases that can cost one's life. It is very important to predict heart diseases as early as possible, so

that necessary preventive measures can be taken. Leading a healthy lifestyle can help in the prevention of heart disease. Machine Learning technologies play an important role in predicting heart diseases to avoid a troublesome situation in the future.

B.V. Rindhe et al [23] briefed about heart-related diseases are very fatal and dangerous for human lives. Forecasting and detection of heart diseases have become challenging these days all over the world. In order to minimize a large number of casualties from cardiovascular or heart-related diseases, an efficient model is needed to be developed. Forecasting heart diseases can be done with the help of machine learning algorithms such as Neural Network, SVM, and Random Forests.

S.Tuli [24] et al briefed that an ensemble model of machine learning techniques with cloud computing gives considerably good results in forecasting the increment of the Covid-19 pandemic using the dataset Our World in data by Hannah Ritchie.

V.K Kamal and D. Kumari [25] states that artificial intelligence or machine learning depicts better efficiency in cancer treatment during coronavirus pandemic. The objective is to visualize up to what degree the impact appears on chest scan are because of Covid-19.

A. Jaglan et al [26] demonstrated that novel coronavirus has been spread in the world at much faster rate. Linear Polynomial Regression techniques gives good results on the non-linear dataset along with TF-IDF vectorization.

3. Machine learning in the medical field

As we all know that machine learning algorithms have been applied in almost every area. However, it is being observed that machine learning is playing an active role in the area of healthcare. The application areas range from the case management of chronic diseases to leveraging the health data of patients. Machine learning technology can help doctors in generating precise medicine solutions customized as per the characteristics of an individual's medical history data available. ML helps in predicting a patient's health condition and assists the patient in knowing what medicine needs to be consumed and when. On the other hand, it helps

the administration in keeping track of their patients and following up with them.

Machine learning techniques in healthcare help in the decision-making process. Decision-making could be either financial, for example, Medicaid or insurance-related, diagnosis of disease, etc. Machine learning is also helpful in keeping track of a patient’s medical history and to identify the disease at an early stage so that appropriate medical aid can be given at the right time. ML techniques make it possible to give the best possible treatment on time and minimize the treatment costs.

This research paper gives an insight into various ML techniques being used in the area of the health sector. The enhancement of ML models in healthcare over years has also been discussed. For detection of disease at an early stage, a few parameters have been taken into consideration, like accuracy, precision, ROC-curve, and F1-score. A comparison study has been done along with the dataset being used for research. The comparison parameters help in analyzing the performance with accurate positive and negative, and inaccurate positive and negative values.

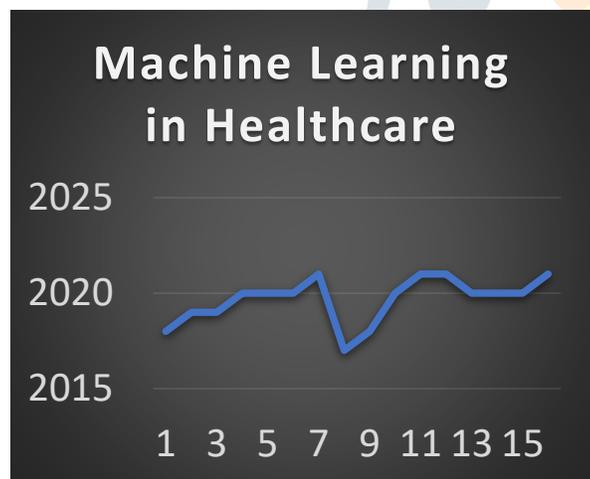


Fig. 1-Growth of machine learning in healthcare over the years

3.1 Parameters used for performance analysis

To understand the concept in detail, let us discuss a case: the dataset consists of 60 data points. We considered a few real and assumed values.

The real values: The individual who doesn’t have a disease. The individual who has a disease.

The assumed values: The individual who is assumed to have an occurrence of disease.

The individual is assumed to have a non-occurrence of the disease.

- The individual who did not suffer from the disease, but our model assumed non-occurrence of it: Accurate negatives.
- The individual who suffered from the disease and our model assumed the same: Accurate positives.
- The individual who didn’t suffer from the disease but our model assumed occurrence of it: Inaccurate positives.
- The individual who suffered from the disease, but our model assumed non-occurrence of it: Inaccurate negatives.

There are a number of parameters that are used to enhance the performance for prediction using machine learning techniques. For instance, accuracy, precision, recall, etc.

Accuracy: Accuracy is the proportion of the sum of accurate forecasts and the sum of forecasts.

$$\text{Accuracy} = \frac{\text{Accurate positive} + \text{accurate negative}}{\text{Accurate positive} + \text{Accurate negative} + \text{Inaccurate positive} + \text{Inaccurate negative}} \quad \text{---(i)}$$

Precision: Precision is the proportion between accurate positives and the sum of all positives.

$$\text{Precision} = \frac{\text{Accurate positive}}{\text{Accurate positive} + \text{Inaccurate positive}} \quad \text{---(ii)}$$

Recall: In recall, our technique correctly illuminated accurate positives. The individuals who suffered from the illness, recall state that how many of them were true.

$$\text{Recall} = \frac{\text{Accurate positive}}{\text{Accurate positive} + \text{Inaccurate negative}} \quad \text{---(iii)}$$

F1 Score: The F1 score can be calculated as the Pythagorean mean of recall and precision.

$$\text{F1 Score} = \frac{2(\text{Precision} * \text{Recall})}{\text{Precision} + \text{Recall}} \quad \text{--- (iv)}$$

After examining the work, a table has been proposed (Table 2). the table enlists the following:

1. Area – It talks about the specific healthcare sector in which ML algorithms are being applied.
2. Author Name and Year – It tells which author proposed the given work and in which year.

3. Technology used – The specific ML techniques being used in that area of the health sector.
4. Parameters – a few parameters have been used by different authors like accuracy, precision, and sensitivity on the basis of which the performance of the ML algorithm has been evaluated in various domains of health.
5. Dataset- highlights the commonly used dataset for evaluation purposes. It has been seen those datasets like WISCONSIN, and UCI have been used by the majority of authors.
6. Observation – this parameter helps in understanding which ML technique is providing more accurate results in a specific sub-area of the health sector.
7. Challenges – this parameter helps us in understanding what types of challenges one may face while carrying out the implementation.

Table 2 (a) - Machine learning in breast cancer

S.No	Area	Author Name	Year	Technology Used	Parameter	Dataset	Observation
1	Breast Cancer	K.Shailaja et al	2018	Decision Tree, SVM, Naïve Bayes, k-nearest neighbor	Accuracy	WISCONSIN	SVM provides better accuracy than Decision Tree, Naïve Bayes, k-NN
2		Chang Ming et al	2019	BCRAT,BOADICEA, Random Forest, logistic regression, k-nearest neighbor, MCMC GLMM, Linear model	AU-ROC, accuracy	US population-based and Swiss clinic-based data	By using Machine learning models accuracy increases upto 30% to 35% than already existing BCRAT and BOADICEA models
3		Habib Dhahri et al	2019	GNB, DT, RF, SVM, K-NN,PCA, GP	Sensitivity, accuracy, specificity, precision, accuracy, ROC curves	WISCONSIN	Genetic programming gives better result
4		Md. Milon Islam et al	2020	SVM, KNN, ANN, RF, LR	Sensitivity, accuracy, specificity, F1 score	UCI dataset	ANN achieve maximum accuracy, sensitivity and precision
5		Chhaya Gupta and Nasib Singh Gill	2020	SVM, DT, RF, Extreme learning machine, KNN	Accuracy and time	WISCONSIN	Extreme Learning Machine with respect to other ML algorithms
6		Priyanka & Kumar Sanjeev	2020	KNN, SVM, DT, RF, Deep learning CNN	Accuracy, precision, ROC curve, sensitivity	WISCONSIN, UCI dataset and many other	CNN
7		Sweta Bhise and Simran Bepari	2021	KNN, SVM, DT, RF, Deep learning CNN, Naïve Bayes	accuracy, precision	BreaKHis 400X dataset	CNN

Table 2 (b) - Machine learning in heart disease

S.No	Area	Author Name	Year	Technology Used	Parameter	Dataset	Observation
8	Heart Disease	Tanvi Sharma, Sahil Verma and Kavita	2017	DT, MARS, RF, TGMA	Accuracy and time	UCI repository or Cleveland dataset	Decision tree gives better result with respect to accuracy and time
9		K.Shailaja et al	2018	Decision Tree, SVM, Naïve Bayes, K-nearest neighbor	Accuracy	WISCONSIN	Naïve Bayes provides better accuracy than Decision Tree, SVM, k-NN
10		Davide Chicco & Giuseppe Jurman	2020	Logistic regression, Linear Regression, DT, ANN, Random Forests, KNN, Naïve Bayes	Accuracy, MCC, F1 score, ROC AUC	Dataset from Faisalabad Institute of Cardiology and Allied Hospital in Faisalabad	Machine Learning algorithms gives better results for binary classification of electronic health records
11		Dhai Eddine Salhi et al	2021	NN, SVM, KNN	Accuracy	EHS Hospital data	NN gives accuracy(93%) better than SVM and KNN
12		Baban U. Rindhe et al	2021	ANN, SVM, RANDOM FOREST	Accuracy	UCI Machine learning Repository	Support Vector Machine gives maximum accuracy(84%) for prediction of cardiovascular heart diseases

Table 2 (c) - Machine learning in Covid-19

S.No	Area	Author Name	Year	Technology Used	Parameter	Dataset	Observation
13	Covid-19	Shreshth Tuli et al	2020	Cloud Computing & Machine Learning Model	Mean square error (MSE) and Mean absolute percentage error (MAPE)	Our World in Data by Hannah Ritchie	Cloud Computing & Machine Learning Model gives good result in predicting the growth of the pandemic
14		Vineet Kumar Kamal and Dolly Kumari	2020	AI and ML	efficiency	real time data	AI and ML algos increases the efficiency upto 90% for cancer patients
15		Abhishek Jaglan et al	2020	Linear Polynomial Regression and TF-IDF Vectorization	Accuracy	2019 Novel Coronavirus Visual Dashboard	Linear Polynomial Regression achieves good accuracy (71%)
16		Mustafa Ghaderzadeh and Farkhondeh Asadi	2021	Deep Learning	Accuracy, sensitivity and specificity	Pubmed, scopus, web of science from November 1, 2019 to July 20, 2020	Deep Learning minimizes false negative and positive errors in the identification and analysis of the disease

4. Conclusion

Data is growing at a tremendous rate. This paves the way for different algorithms to handle this voluminous data. Machine learning is one such technique that is capable of handling this voluminous data. Machine learning is growing rapidly and so is its application area. This paper gives an insight into various machine learning algorithms which are available along with the areas where it is being applied. It will help in understanding the basics of different Machine learning algorithms, and which algorithm will be suitable in a particular application area. A comprehensive literature review has been carried out which helps in knowing the work done to date by various authors in this area. A tabular representation is presented at the end which gives an overview of algorithms used in different sectors on the basis of different parameters like sector, algorithms used for, purpose and applications. This will help in understanding in detail machine learning techniques. Machine learning algorithms have proven their worth in a variety of business fields and so in healthcare. The healthcare sector is facing a lot of challenges and the cost of healthcare is rising day by day. Various machine learning models are applied to resolve them. In this paper, we tried to study numerous ML algorithms being used in healthcare for early forecasting of different diseases like breast cancer, heart diseases, and Covid-19. It has been seen that the research is data-dependent and requires a big dataset to train the machines. A table has been proposed which gives an insight into the various techniques used in the specific area of healthcare. It has been concluded that in the case of breast cancer, SVM gives the best performance in terms of accuracy, recall, and f1-score. In the forthcoming era, the work can be towards the diagnosis of other diseases which may help the doctors in the prognosis of disease at an early stage.

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