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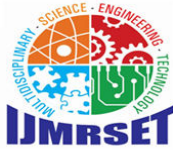
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Heart Disease Prediction using Machine Learning Algorithms

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ABSTRACT: Heart related diseases or Cardiovascular Diseases (CVDs) are the main reason for a huge number of death in the world over the last few decades and has emerged as the most life-threatening disease, not only in India but in the whole world. So, there is a need of reliable, accurate and feasible system to diagnose such diseases in time for proper treatment. Machine Learning algorithms and techniques have been applied to various medical datasets to automate the analysis of large and complex data. Many researchers, in recent times, have been using several machine learning techniques to help the health care industry and the professionals in the diagnosis of heart related diseases. This paper presents a survey of various models based on such algorithms and techniques and analyze their performance. Models based on supervised learning algorithms such as Support Vector Machines (SVM), K-Nearest Neighbour (KNN), Naïve Bayes, Decision Trees (DT), Random Forest (RF) are found very popular among the researchers.

Keywords: Cardiovascular Diseases, Support Vector Machines, Naïve Bayes, Decision Tree, Random Forest

I. INTRODUCTION

Heart is an important organ of the human body. It pumps blood to every part of our anatomy. If it fails to function correctly, then the brain and various other organs will stop working, and within few minutes, the person will die. Change in lifestyle, work related stress and bad food habits contribute to the increase in rate of several heart related diseases. Heart diseases have emerged as one of the most prominent cause of death all around the world. According to World Health Organisation, heart related diseases are responsible for the taking 17.7 million lives every year, 31% of all global deaths. In India too, heart related diseases have become the leading cause of mortality [1]. Heart diseases have killed 1.7 million Indians in 2016, according to the 2016 Global Burden of Disease Report, released on September 15, 2017. Heart related diseases increase the spending on health care and also reduce the productivity of an individual. Estimates made by the World Health Organization (WHO), suggest that India have lost up to \$237 billion, from 2005-2015, due to heart related or Cardiovascular diseases [2]. Thus, feasible and accurate prediction of heart related diseases is very important. Medical organizations, all around the world, collect data on various health related issues. These data can be exploited using various machine learning techniques to gain useful insights. But the data collected is very massive and, many a times, this data can be very noisy. These datasets, which are too overwhelming for human minds to comprehend, can be easily explored using various machine learning techniques. Thus, these algorithms have become very useful, in recent times, to predict the presence or absence of heart related diseases accurately.

II. LITERATURE SURVEY

With growing development in the field of medical science alongside machine learning various experiments and researches has been carried out in these recent years releasing the relevant significant papers.

Purushottam, et, al proposed a paper "Efficient Heart Disease Prediction System" using hill climbing and decision tree algorithms. They used Cleveland dataset and preprocessing of data is performed before using classification algorithms. The Knowledge Extraction is done based on Evolutionary Learning (KEEL), an open-source data mining tool that fills the missing values in the data set. A decision tree follows top-down order. For each actual node selected by hill-climbing algorithm a node is selected by a test at each level. The parameters and their values used are confidence. Its minimum confidence value is 0.25. The accuracy of the system is about 86.7%.



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Santhana Krishnan. J ,et ,al proposed a paper “Prediction of Heart Disease Using Machine Learning Algorithms” using decision tree and Naive Bayes algorithm for prediction of heart disease. In decision tree algorithm the tree is built using certain conditions which gives True or False decisions. The algorithms like SVM, KNN are results based on vertical or horizontal split conditions depends on dependent variables. But decision tree for a tree like structure having root node, leaves and branches base on the decision made in each of tree Decision tree also help in the understating the importance of the attributes in the dataset. They have also used Cleveland data set. Dataset splits in 70% training and 30% testing by using some methods. This algorithm gives 91% accuracy. The second algorithm is Naive Bayes, which is used for classification. It can handle complicated, nonlinear, dependent data so it is found suitable for heart disease dataset as this dataset is also complicated, dependent and nonlinear in nature. This algorithm gives an 87% accuracy.

Sonam Nikhar et al proposed paper “ Prediction of Heart Disease Using Machine Learning Algorithms” their research gives point to point explanation of Naïve Bayes and decision tree classifier that are used especially in the prediction of Heart Disease.

Some analysis has been led to think about the execution of prescient data mining strategy on the same dataset, and the result decided that Decision Tree has highest accuracy than Bayesian classifier.

Aditi Gavhane et al proposed a paper “Prediction of Heart Disease Using Machine Learning”, in which training and testing of dataset is performed by using neural network algorithm multi-layer perceptron. In this algorithm there will be one input layer and one output layer and one or more layers are hidden layers between these two input and output layers. Through hidden layers each input node is connected to output layer. This connection is assigned with some random weights. The other input is called bias which is assigned with weight based on requirement the connection between the nodes can be feedforwarded or feedback.

Avinash Golande et al, proposed “Heart Disease Prediction Using Effective Machine Learning Techniques” in which few data mining techniques are used that support the doctors to differentiate the heart disease. Usually utilized methodologies are k-nearest neighbour, Decision tree and Naïve Bayes. Other unique characterization-based strategies utilized are packing calculation, Part thickness, consecutive negligible streamlining and neural systems, straight Kernel selfarranging guide and SVM (Bolster Vector Machine).

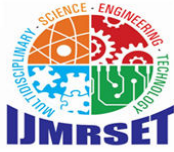
Lakshmana Rao et al,proposed “Machine Learning Techniques for Heart Disease Prediction” in which the contributing elements for heart disease are more. So, it is difficult to distinguish heart disease. To find the seriousness of the heart disease among people different neural systems and data mining techniques are used.

Abhay Kishore et alproposed “Heart Attack Prediction Using Deep Learning” in which heart attack prediction system by using Deep learning techniques and to predict the probable aspects of heart related infections of the patient Recurrent Neural System is used. This model uses deep learning and data mining to give the best precise model and least blunders. This paper acts as strong reference model for another type of heart attack prediction models

Senthil Kumar Mohan et al, proposed “Effective Heart Disease Prediction Using Hybrid Machine Learning Techniques” in which their main objective is to improve exactness in cardiovascular problems. The algorithms used are KNN, LR, SVM, NN to produce an improved exhibition level with a precision level of 88.7% through the prediction model for heart disease with hybrid random forest with linear model(HRFLM).

Anjan N. Repaka et al, proposed a model stated the performance of prediction for two classification models, which is analyzed and compared to previous work. The experimental results show that accuracy is improved in finding the percentage of risk prediction of our proposed method in comparison with other models.

Aakash Chauhan et al, proposed “Heart Disease Prediction using Evolutionary Rule Learning”. Data is directly retrieved from electronic records that reduce the manual tasks. The amount of services are decreased and shown major number of rules helps within the best prediction of heart disease. Frequent pattern growth association mining is performed on patient’s dataset to generate strong association.



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III. PROPOSED SYSTEM

The working of the system starts with the collection of data and selecting the important attributes. Then the required data is preprocessed into the required format. The data is then divided into two parts training and testing data. The algorithms are applied and the model is trained using the training data. The accuracy of the system is obtained by testing the system using the testing data. This system is implemented using the following modules.

1.) Collection of Dataset 2.) Selection of attributes 3.) Data Pre-Processing 4.) Balancing of Data 5.) Disease Prediction

Collection of dataset

Initially, we collect a dataset for our heart disease prediction system. After the collection of the dataset, we split the dataset into training data and testing data. The training dataset is used for prediction model learning and testing data is used for evaluating the prediction model. For this project, 70% of training data is used and 30% of data is used for testing as shown in figure 1. The dataset used for this project is Heart Disease UCI. The dataset consists of 76 attributes; out of which, 14 attributes are used for the system.

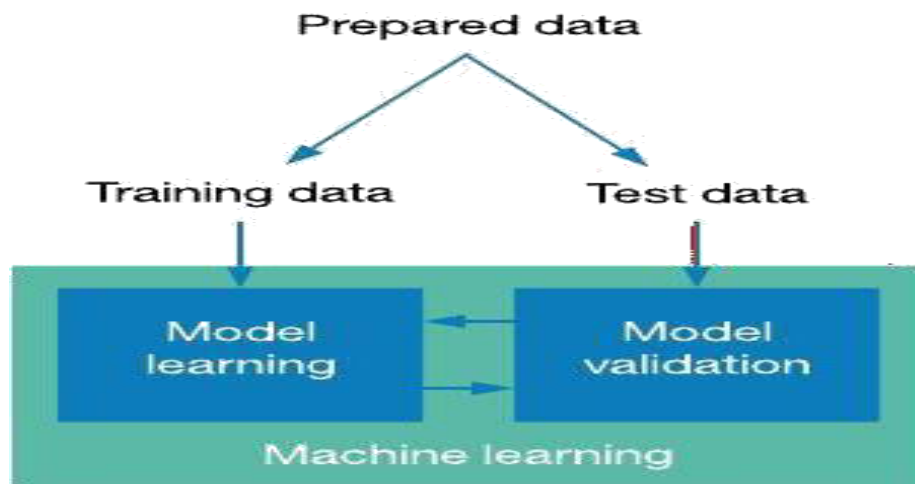
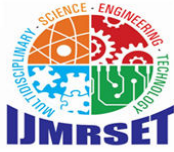


Figure 1: Collection of Data

Selection of attributes

Attribute or Feature selection includes the selection of appropriate attributes for the prediction system. This is used to increase the efficiency of the system. Various attributes of the patient like gender, chest pain type, fasting blood pressure, serum cholesterol, exang, etc are selected for the prediction. The Correlation matrix is used for attribute selection for this model is shown in figure 2.



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Figure 2: Correlation matrix

Pre-processing of Data

Data pre-processing is an important step for the creation of a machine learning model. Initially, data may not be clean or in the required format for the model which can cause misleading outcomes. In pre-processing of data, we transform data into our required format. It is used to deal with noises, duplicates, and missing values of the dataset. Data pre-processing has the activities like importing datasets, splitting datasets, attribute scaling, etc. Preprocessing of data is required for improving the accuracy of the model. The model diagram for Data Pre-processing is shown in figure3.

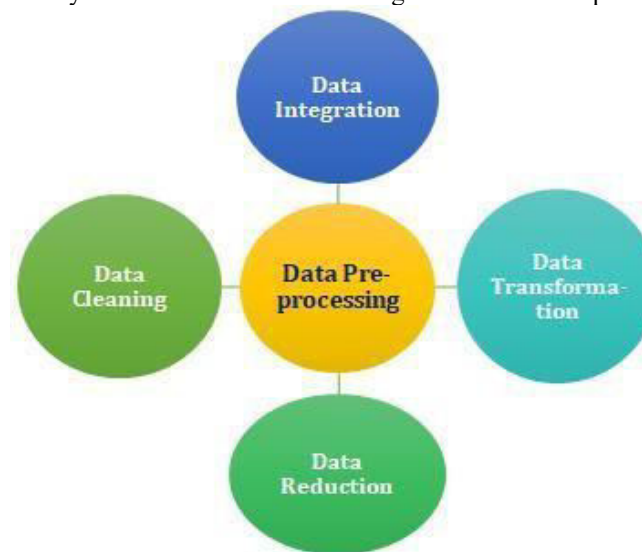


Figure 3: Data Pre-processing



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Balancing of Data

Imbalanced datasets can be balanced in two ways. They are Under Sampling and Over Sampling

(a) Under Sampling: In Under Sampling, dataset balance is done by the reduction of the size of the ample class. This process is considered when the amount of data is adequate.

(b) Over Sampling: In Over Sampling, dataset balance is done by increasing the size of the scarce samples. This process is considered when the amount of data is inadequate.

The same is depicted in figure 4.

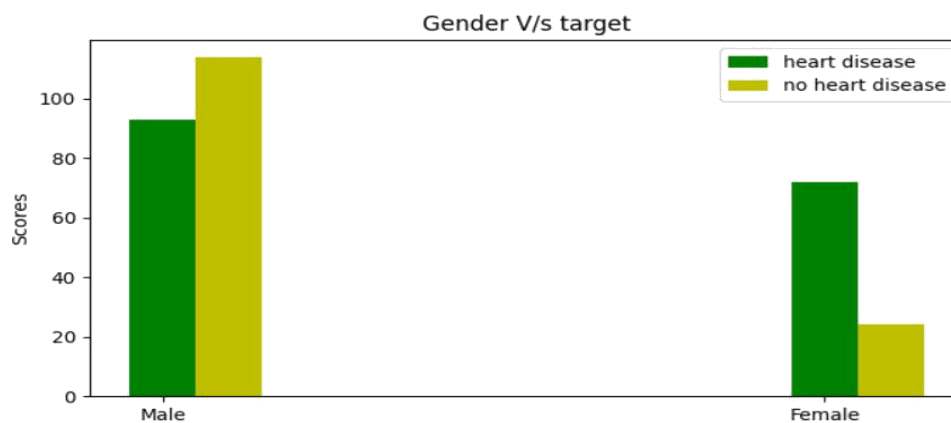


Figure 4: Data Balancing

Prediction of Disease

Various machine learning algorithms like SVM, Naive Bayes, Decision Tree, Random Tree, Logistic Regression, Ada-boost, Xg-boost are used for classification. Comparative analysis is performed among algorithms and the algorithm that gives the highest accuracy is used for heart disease prediction.

IV. RESULTS

DATASET DETAILS

Of the 76 attributes available in the dataset, 14 attributes are considered for the prediction of the output.

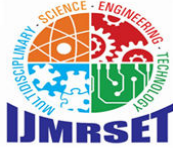
Heart Disease UCI : <https://archive.ics.uci.edu/ml/datasets/Heart+Disease>

Input dataset attributes

Gender (value 1: Male; value 0 : Female)

Chest Pain Type (value 1: typical type 1 angina, value 2: typical type angina, value 3: non-angina pain; value 4: asymptomatic)

- Fasting Blood Sugar (value 1: > 120 mg/dl; value 0:< 120 mg/dl)
- Exang – exercise induced angina (value 1: yes; value 0: no)
- CA – number of major vessels colored by fluoroscopy (value 0 – 3)
- Thal (value 3: normal; value 6: fixed defect; value 7:reversible defect)
- Trest Blood Pressure (mm Hg on admission to the hospital)
- Serum Cholesterol (mg/dl)
- Thalach – maximum heart rate achieved
- Age in Year
- Height in cms
- Weight in Kgs.
- Cholestrol
- Restecg



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PERFORMANCE ANALYSIS

In this project, various machine learning algorithms like SVM, Naive Bayes, Decision Tree, Random Forest, Logistic Regression, Adaboost, XG-boost are used to predict heart disease. Heart Disease UCI dataset, has a total of 76 attributes, out of those only 14 attributes are considered for the prediction of heart disease. Various attributes of the patient like gender, chest pain type, fasting blood pressure, serum cholesterol, exang, etc are considered for this project. The accuracy for individual algorithms has to measure and whichever algorithm is giving the best accuracy, that is considered for the heart disease prediction. For evaluating the experiment, various evaluation metrics like accuracy, confusion matrix, precision, recall, and f1-score are considered.

Accuracy- Accuracy is the ratio of the number of correct predictions to the total number of inputs in the dataset. It is expressed as: $\text{Accuracy} = \frac{TP + TN}{TP + FP + FN + TN}$.

Table 1 shows the comparison of various Machine learning models used and their accuracy.

Table 1: Comparison of Accuracy

ML Model	ACCURACY in %
Logistic Regression	86.9
Random Forest	85.6
Naive Bayes	87.3
KNN	70.7
Decision Tree	83.0
SVM	84.5
Gradient Boosting	88.5

V. CONCLUSION AND FUTURE WORK

Heart diseases are a major killer in India and throughout the world, application of promising technology like machine learning to the initial prediction of heart diseases will have a profound impact on society. The early prognosis of heart disease can aid in making decisions on lifestyle changes in high-risk patients and in turn reduce the complications, which can be a great milestone in the field of medicine. The number of people facing heart diseases is on a raise each year. This prompts for its early diagnosis and treatment. The utilization of suitable technology support in this regard can prove to be highly beneficial to the medical fraternity and patients. In this paper, the seven different machine learning algorithms used to measure the performance are SVM, Decision Tree, Random Forest, Naïve Bayes, Logistic Regression, KNN, and Extreme Gradient Boosting applied on the dataset.

The expected attributes leading to heart disease in patients are available in the dataset which contains 76 features and 14 important features that are useful to evaluate the system are selected among them. If all the features taken into the consideration then the efficiency of the system the author gets is less. To increase efficiency, attribute selection is done. In this n features have to be selected for evaluating the model which gives more accuracy. The correlation of some features in the dataset is almost equal and so they are removed. If all the attributes present in the dataset are taken into account then the efficiency decreases considerably.

All the seven machine learning methods accuracies are compared based on which one prediction model is generated. Hence, the aim is to use various evaluation metrics like confusion matrix, accuracy, precision, recall, and f1-score which predicts the disease efficiently. Comparing all seven the extreme gradient boosting classifier gives the highest accuracy of 88.5%.



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