ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 9| Issue: 3| March 2023|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2023: 8.224 || ISI Value: 1.188

EARLY PREDICTION OF HEART DISEASES USING LOGISTIC REGRESSION ALGORITHM

J. Sophia Jone, S. Kipsy
Assistant professor, Department of ECE, Bethlahem Institute of Engineering, Kanyakumari, Tamil Nadu, India
Student, ME - Communication Systems, Bethlahem Institute of Engineering, Kanyakumari, Tamil Nadu, India

ABSTRACT

World Health Organization has estimated that four out of five cardiovascular diseases (CVD) deaths are due to heart attacks. Heart disease is an uncommon condition of the heart and the blood circulation. Heart disease is also known as cardiovascular disease which is our country's main executioner. From past two decades Heart-disease remained as a leading cause of death at global level. Statistics illustrate the lethality of cardiovascular disease by showing the percentage of deaths caused by heart attacks worldwide. Therefore, it is crucial to predict the condition as earliest as possible time. Cardiologist have limitations, they cannot predict heart disease risk to a high degree of accuracy. So, a reliable, accurate and feasible system is required to predict such diseases in time for proper treatment. In order to automate analysis of large and complex medical datasets, Machine Learning algorithms and techniques have been applied. We have also seen machine learning (ML) techniques being used in recent developments in different areas of Internet of Things (IoT). Machine learning has been shown to be effective in assisting in making decisions and predictions from the large quantity of data produced by the healthcare industry. The main theme of the paper is the prediction of heart diseases using machine learning techniques by summarizing the few current researches. The main goal of our project is logistic regression algorithms used and the health care data which classifies the patients whether they are having heart diseases or not, according to the information of recorded data. Logistic Regression is a statistical and machine-learning technique classifying records of a dataset based on the values of the input fields. It predicts a dependent variable based on one or more set of independent variables to predict outcomes. It can be used both for binary classification and multi-class classification. Try to use this data a model which predicts the patient whether they are having heart disease or not.

KEYWORDS— ***Classification, Heart Disease, Decision Tree,Data Mining,***

I. INTRODUCTION

According to the World Health Organization, every year 12 million deaths occur worldwide due to heart disease. Heart disease is one of the biggest causes of morbidity and mortality among the population of the world. Prediction of cardiovascular disease is regarded as one of the most important subjects in the section of data analysis. The load of cardiovascular disease is rapidly increasing all over the world from the past few years. Many researches have been conducted in attempt to pinpoint the most influential factors of heart disease as well as accurately predict the overall risk. Heart Disease is even highlighted as a silent killer which leads to the death of the person without obvious symptoms. The early diagnosis of heart disease plays a vital role in making decisions on lifestyle changes in high-risk patients and in turn reduces the complications.

Machine learning proves to be effective in assisting in making decisions and predictions from the large quantity of data produced by the health care industry. This project aims to predict future heart disease by analyzing data of patients which classifies whether they have heart disease or not using machine-learning algorithm. Machine Learning techniques can be a boon in this regard. Even though heart disease can occur in different forms, there is a common set of core risk factors that influence whether someone will ultimately be at risk for heart disease or not. By collecting the data from various sources, classifying them under suitable headings & finally analyzing to extract the desired data we can say that this technique can be very well adapted to do the prediction of heart disease.

A. MOTIVATION FOR THE WORK

The main motivation of doing this research is to present a heart disease prediction model for the prediction of occurrence of heart disease. Further, this research work is aimed towards identifying the best classification algorithm for identifying the possibility of heart disease in a patient. This work is justified by performing a comparative study and analysis using three classification algorithms namely Naïve Bayes, Decision Tree, and Random Forest are used at different levels of evaluations. Although these are commonly used machine learning algorithms, the heart disease prediction is a vital task involving highest possible accuracy. Hence, the three algorithms are evaluated at numerous levels and types of evaluation strategies. This will provide researchers and medical practitioners to establish a better.

B. PROBLEM STATEMENT

The major challenge in heart disease is its detection. There are instruments available which can predict heart disease but either it is expensive or are not efficient to calculate chance of heart disease in human. Early detection of cardiac diseases can decrease the mortality rate and overall complications. However, it is not possible to monitor patients every day in all cases accurately and consultation of a patient for 24 hours by a doctor is not available since it requires more sapience, time and expertise. Since we have a good amount of data in today's world, we can use various machine learning algorithms to analyze the data for hidden patterns. The hidden patterns can be used for health diagnosis in medicinal data.

II. METHODOLOGIES

Heart disease is even being highlighted as a silent killer which leads to the death of a person without obvious symptoms. The nature of the disease is the cause of growing anxiety about the disease & its consequences. Machine Learning techniques can be a boon in this regard. By collecting the data from various sources, classifying them under suitable headings & finally analyzing to extract the desired data we can conclude. This technique can be very well adapted to the do the prediction of heart disease. As the well-known quote says "Prevention is better than cure", early prediction & its control can be helpful to prevent & decrease the death rates due to heart disease.

A. 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.

Collection of datasets: Initially, we collect a data set 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. 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.

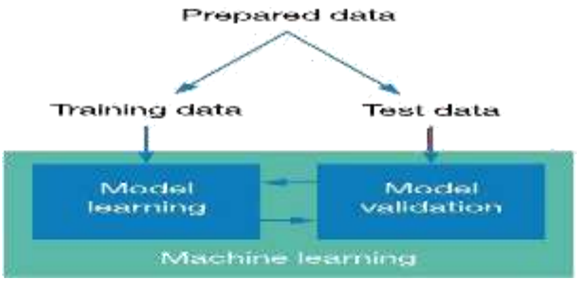


Figure:

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, etc., are selected for the prediction. The Correlation matrix is used for attribute selection for this model.

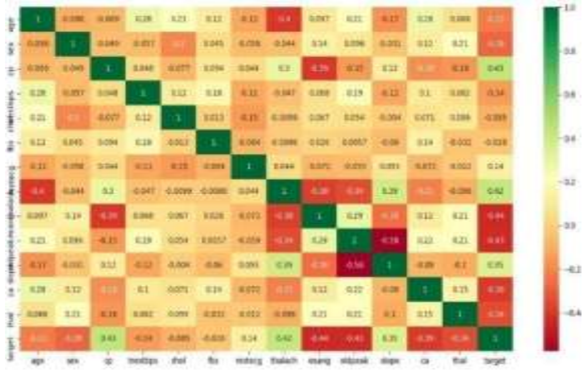


Figure: Correlation matrix

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.

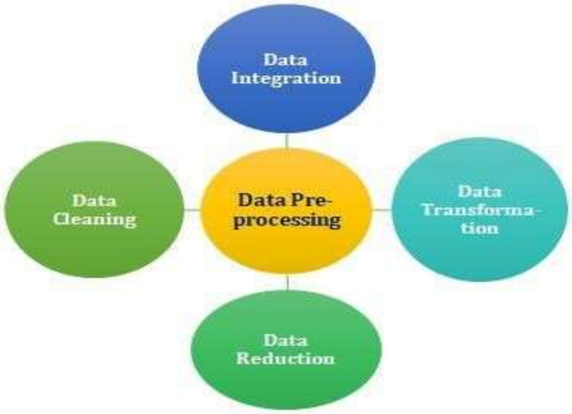


Figure: Data Pre-processing

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.

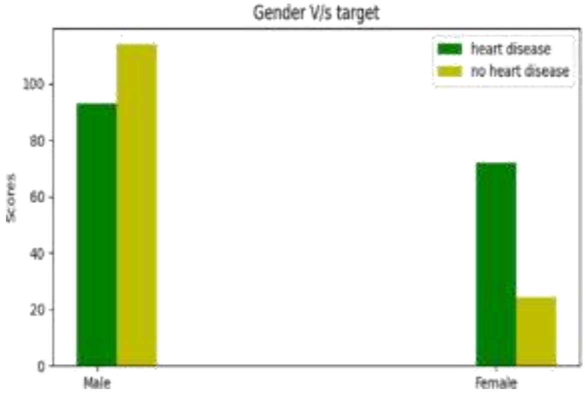
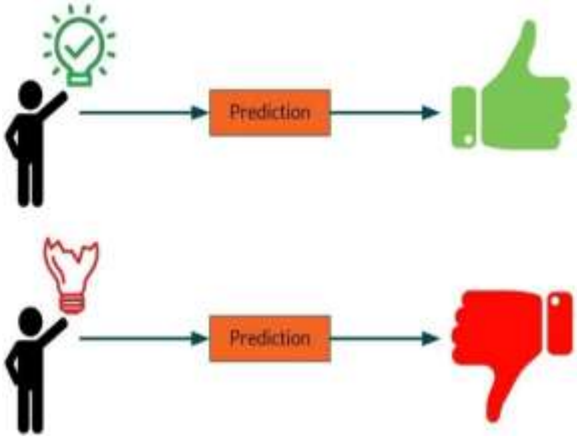


Figure: Data Balancing

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.

Figure:



Prediction of Disease

III. WORKING OF SYSTEM

A. SYSTEM ARCHITECTURE

The system architecture gives an overview of the working of the system. Dataset collection is collecting data which contains patient details. Attributes selection process selects the useful attributes for the prediction of heart disease. After identifying the available data resources, they are further selected, cleaned, made into the desired form. Different classification techniques as stated will be applied on preprocessed data to predict the accuracy of heart disease. Accuracy measure compares the accuracy of different classifiers.

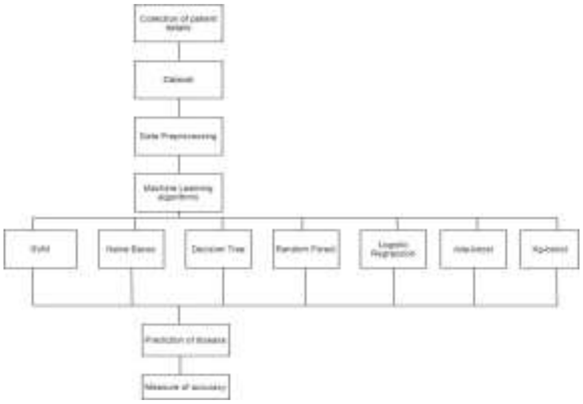


Figure: SYSTEM ARCHITECTURE

B. MACHINE LEARNING

In machine learning, classification refers to a predictive modeling problem where a class label is predicted for a given example of input data.

Supervised Learning: Supervised learning is the type of machine learning in which machines are trained using well "labelled" training data, and on the basis of that data, machines predict the output. The labelled data means some input data is already tagged with the correct output. In supervised learning, the training data provided to the machines work as the supervisor that teaches the machines to predict the output correctly. It applies the same concept as a student learns in the supervision of the teacher.

Supervised learning is a process of providing input data as well as correct output data to the machine learning model. The aim of a supervised learning algorithm is to find a mapping function to map the input variable(x) with the output variable(y).

Unsupervised learning: Unsupervised learning cannot be directly applied to a regression or classification problem because unlike supervised learning, we have the input data but no corresponding output data. The goal of unsupervised learning is to find the underlying structure of dataset, group that data according to similarities, and represent that dataset in a compressed format.

1) Unsupervised learning is helpful for finding useful insights from the data.
2) Unsupervised learning is much similar to how a human learns to think by their own experiences, which makes it closer to the real AI.
3) Unsupervised learning works on unlabeled and uncategorized data which make unsupervised learning more important.
4) In real-world, we do not always have input data with the corresponding output so to solve such cases, we need unsupervised learning.

Reinforcement learning: Reinforcement learning is an area of Machine Learning. It is about taking suitable action to maximize reward in a particular situation. It is employed by various software and machines to find the best possible behavior or path it should take in a specific situation. Reinforcement learning differs from supervised learning in a way that in supervised learning the training data has the answer key with it so the model is trained with the correct answer itself whereas in reinforcement learning, there is no answer but the reinforcement agent decides what to do to perform the given task. In the absence of a training dataset, it is bound to learn from its experience.

IV. ALGORITHMS

A. SUPPORT VECTOR MACHINE (SVM)

Support Vector Machine or SVM is one of the most popular Supervised Learning algorithms, which is used for Classification as well as Regression problems. However, primarily, it is used for Classification problems in Machine Learning.

The goal of the SVM algorithm is to create the best line or decision boundary that can segregate n-dimensional space into classes so that we can easily put the new data point in the correct category in the future. This best decision boundary is called a hyperplane chooses the extreme points/vectors that help in creating the hyperplane. These extreme cases are called support vectors, and hence the algorithm is termed as Support Vector Machine.

Support vector machines (SVMs) are powerful yet flexible supervised machine learning algorithms which are used both for classification and regression. But generally, they are used in classification problems. In the 1960s, SVMs were first introduced but later they got refined in 1990.

SVMs have their unique way of implementation as compared to other machine learning algorithms. Lately, they are extremely popular because of their ability to handle multiple continuous and categorical variables.

The followings are important concepts in SVM -

- Support Vectors - Data Points that are closest to the hyperplane are called support vectors. Separating line will be defined with the help of these data points.
- Hyperplane - As we can see in the above diagram, it is a decision plane or space which is divided between a set of objects having different classes.
- Margin - It may be defined as the gap between two lines on the closest data points of different classes.
- Large margin is considered as a good margin and small margin is considered as a bad margin.

Types of SVM

● Linear SVM: Linear SVM is used for linearly separable data, which means if a dataset can be classified into two classes by using a single straight line, then such data is termed as linearly separable data, and classifier is used called as Linear SVM classifier.

● Non-linear SVM: Non-Linear SVM is used for non-linearly separated data, which means if a dataset cannot be classified by using a straight line, then such data is termed as non-linear data and classifier used is called as Non-linear SVM classifier.

● The objective of the support vector machine algorithm is to find a hyperplane in an N- dimensional space (N - the number of features) that distinctly classifies the data points.

The advantages of support vector machines are

- Effective in high dimensional spaces.
- Still effective in cases where the number of dimensions is greater than the number of samples.
- Uses a subset of training points in the decision function (called support vectors), so it is also memory efficient.
- Versatile: different kernel functions can be specified for the decision function. Common kernels are provided, but it is also possible to specify custom kernels.

The disadvantages of support vector machines include:

- If the number of features is much greater than the number of samples, avoid over-fitting in choosing Kernel functions and regularization term is crucial.
- SVMs do not directly provide probability estimates, these are calculated using an expensive five-fold cross-validation.

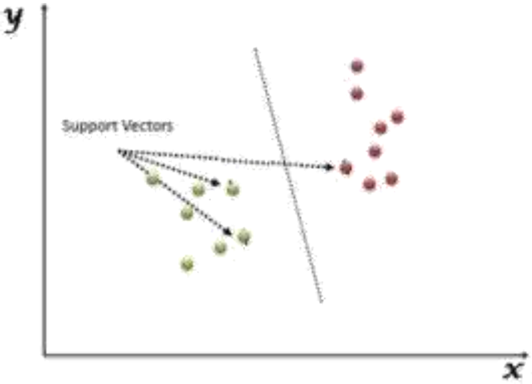


Figure: Support Vector Machine

B. NAIVE BAYES ALGORITHM

Naive Bayes algorithm is a supervised learning algorithm, which is based on Bayes theorem and used for solving classification problems. It is mainly used in text classification that includes a high-dimensional training dataset.

Naive Bayes Classifier is one of the simple and most effective Classification algorithms which helps in building the fast machine learning models that can make quick predictions.

It is a probabilistic classifier, which means it predicts on the basis of the probability of an object. Some popular examples of Naïve Bayes Algorithm are spam filtration, Sentimental analysis, and classifying articles.

It is a classification technique based on Bayes' Theorem with an assumption of independence among predictors. In simple terms, a Naive Bayes classifier assumes that the presence of a particular feature in a class is unrelated to the presence of any other feature.

The Naive Bayes model is easy to build and particularly useful for very large data sets. Along with simplicity, Naive Bayes is known to outperform even highly sophisticated classification methods.

The Naive Bayes algorithm is comprised of two words Naive and Bayes, which can be described as:

- Naive: It is called Naive because it assumes that the occurrence of a certain feature is independent of the occurrence of other features. Such as if the fruit is identified on the basis of color, shape, and taste, then red, spherical, and sweet fruit is recognized as an apple. Hence each feature individually contributes to identify that it is an apple without depending on each other.
- Bayes: It is called Bayes because it depends on the principle of Bayes' Theorem.

Bayles's theorem: Bayes' theorem is also known as Bayes' Rule or Bayes' law, which is used to determine the probability of a hypothesis with prior knowledge. It depends on the conditional probability.

The formula for Bayes' theorem is given as:

$$\mathbf{P}(\boldsymbol{A}/\boldsymbol{B}) = \frac{\mathbf{P}(\boldsymbol{B}/\boldsymbol{A})\mathbf{P}(\mathbf{A})}{\mathbf{P}(\mathbf{B})}$$

Were,

P(A|B) is Posterior probability: Probability of hypothesis A on the observed event B.

P(B|A) is Likelihood probability: Probability of the evidence given that the probability of a hypothesis is true.

P(A) is Prior Probability: Probability of hypothesis before observing the evidence. P(B) is Marginal Probability: Probability of Evidence.

Types of Naive Bayes model:

Gaussian: The Gaussian model assumes that features follow a normal distribution. This means if predictors take continuous values instead of discrete, then the model assumes that these values are sampled from the Gaussian distribution.

Multinomial: The Multinomial Naïve Bayes classifier is used when the data is multinomial distributed. It is primarily used for document classification problems; it means a particular document belongs to which category such as Sports, Politics, education, etc. The classifier uses the frequency of words for the predictors.

Bernoulli: The Bernoulli classifier works similar to the Multinomial classifier, but the predictor variables are the independent Booleans variables. Such as if a particular word is present or not in a document. This model is also famous for document classification tasks.

C. DECISION TREE ALGORITHM

Decision Tree is a Supervised learning technique that can be used for both classification and regression problems, but mostly it is preferred for solving classification problems. It is a tree-structured classifier, where internal nodes represent the features of a dataset, branches represent the decision rules and each leaf node represents the outcome. In a Decision Tree, there are two nodes, which are the Decision Node and Leaf Node.

Decision nodes are used to make any decision and have multiple branches, whereas Leaf nodes are the output of those decisions and do not contain any further branches. The decisions or the test are performed on the basis of features of the given dataset. It is a graphical representation for getting all the possible solutions to a problem/decision based on given conditions. It is called a Decision Tree because, similar to a tree, it starts with the root node, which expands on further branches and constructs a tree-like structure. In order to build a tree, we use the CART algorithm, which stands for Classification and Regression Tree algorithm. A Decision Tree simply asks a question, and based on the answer (Yes/No), it further split the tree into subtrees.

In Decision Tree the major challenge is to identify the attribute for the root node in each level. This process is known as attribute selection. We have two popular attribute selection measures:

1) Information Gain: when we use a node in a Decision Tree to partition the training instances into smaller subsets, the entropy changes. Information gain is a measure of this change in entropy. Entropy is the measure of uncertainty of a random variable, it characterizes the impurity of an arbitrary collection of examples. The higher the entropy the more the information content.

2) Gini Index: Gini Index is a metric to measure how often a randomly chosen element would be incorrectly identified. It means an attribute with lower Gini index should be preferred. Sklearn supports "Gini" criteria for Gini Index and by default, it takes "gini" value.

The most notable types of Decision Tree algorithms are: -

1.IDichotomiser 3 (ID3):

This algorithm uses Information Gain to decide which attribute is to be used to classify the current subset of the data. For each level of the tree, information gain is calculated for the remaining data recursively.

2.C4.5: This algorithm is the successor of the ID3 algorithm. This algorithm uses either Information gain or Gain ratio to decide upon the classifying attribute. It is a direct improvement from the ID3 algorithm as it can handle both continuous and missing attribute values.

3.Classification and Regression Tree (CART): It is a dynamic learning algorithm which can produce a regression tree as well as a classification tree depending upon the dependent variable.

Working: In a Decision Tree, for predicting the class of the given dataset, the algorithm starts from the root node of the tree. This algorithm compares the values of the root attribute with the record (real dataset) attribute and, based on the comparison, follows the branch and jumps to the next node.

For the next node, the algorithm again compares the attribute value with the other sub-nodes and moves further. It continues the process until it reaches the leaf node of the tree. The complete process can be better understood using the below algorithm:

Step-1: Begin the tree with the root node, says S, which contains the complete dataset.

Step-2: Find the best attribute in the dataset using Attribute Selection Measure (ASM).

Step-3: Divide the S into subsets that contains possible values for the best attributes.

Step-4: Generate the Decision Tree node, which contains the best attribute.

Step-5: Recursively make new decision trees using the subsets of the dataset created in step -3. Continue this process until a stage is reached where you cannot further classify the nodes and call the final node as a leaf node.

D. RANDOM FOREST ALGORITHM

Random Forest is a supervised learning algorithm. It is an extension of machine learning classifiers which include the bagging to improve the performance of Decision Tree. It combines tree predictors, and trees are dependent on a random vector which is independently sampled. The distribution of all trees is the same. Random Forests splits nodes using the best among of a predictor subset that are randomly chosen from the node itself, instead of splitting nodes based on the variables. The time complexity of the worst case of learning with Random Forests is O(M(doing)), where M is the number of growing trees, n is the number of instances, and d is the data dimension.

It can be used both for classification and regression. It is also the most flexible and easy to use algorithm. A forest consists of trees. It is said that the more trees it has, the more robust a forest is. Random Forests have a variety of applications, such as recommendation engines, image classification and feature selection. It can be used to classify loyal loan applicants, identify fraudulent activity and predict diseases. It lies at the base of the Boruta algorithm, which selects important features in a dataset. Random Forest is a popular machine learning algorithm that belongs to the supervised learning technique. It can be used for both Classification and Regression problems in ML. It is based on the concept of ensemble learning, which is a process of combining multiple classifiers to solve a complex problem and to improve the performance of the model.

It works in four steps

- Select random samples from a given dataset.
- Construct a Decision Tree for each sample and get a prediction result from each Decision Tree.
- Perform a vote for each predicted result.
- Select the prediction result with the most votes as the final prediction.

Advantages:

- Random Forest is capable of performing both Classification and Regression tasks.
- It is capable of handling large datasets with high dimensionality.
- It enhances the accuracy of the model and prevents the overfitting issue.

Disadvantages:

- Although Random Forest can be used for both classification and regression tasks, it is not more suitable for Regression tasks.

E. LOGISTIC REGRESSION ALGORITHM

Logistic regression is one of the most popular Machine Learning algorithms, which comes under the Supervised Learning technique. It is used for predicting the categorical dependent variable using a given set of independent variables.

Logistic regression predicts the output of a categorical dependent variable. Therefore, the outcome must be a categorical or discrete value. It can be either Yes or No, 0 or 1, true or False, etc. but instead of giving the exact value as 0 and 1, it gives the probabilistic values which lie between 0 and 1. Logistic Regression is much similar to the Linear Regression except that how they are used. Linear Regression is used for solving Regression problems, whereas logistic regression is used for solving the classification problems. In Logistic regression, instead of fitting a regression line, we fit a "Shaped logistic function, which predicts two maximum values (0 or 1).

The curve from the logistic function indicates the likelihood of something such as whether the cells are cancerous or not, a mouse is obese or not based on its weight, etc. Logistic Regression is a significant machine learning algorithm because it has the ability to provide probabilities and classify new data using continuous and discrete datasets. Advantages: Logistic Regression is one of the simplest machine learning algorithms and is easy to implement yet provides great training efficiency in some cases. Also due to these reasons, training a model with this algorithm doesn't require high computation power.

The predicted parameters (trained weights) give inference about the importance of each feature. The direction of association i.e., positive or negative is also given. So, we can use Logistic Regression to find out the relationship between the features. Logistic Regression outputs well-calibrated probabilities along with classification results. This is an advantage over models that only give the final classification as results. If a training example has a 95% probability for a class, and another has a 55% probability for the same class, we get an inference about which training examples are more accurate for the formulated problem.

Disadvantages:
Logistic Regression is a statistical analysis model that attempts to predict precise probabilistic outcomes based on independent features. On high dimensional datasets, this may lead to the model being over-fit on the training set, which means overstating the accuracy of predictions on the training set and thus the model may not be able to predict accurate results on the test set. This usually happens in the case when the model is trained on little training data with lots of features. So, on high dimensional datasets, Regularization techniques should be considered to avoid over- fitting (but this makes the model complex). Very high regularization factors may even lead to the model being under-fit on the training data.

Nonlinear problems can't be solved with logistic regression since it has a linear decision surface. Linearly separable data is rarely found in real world scenarios. So, the transformation of nonlinear features is required which can be done by increasing the number of features such that the data becomes linearly separable in higher dimensions.

Non-Linearly Separable Data:
It is difficult to capture complex relationships using logistic regression. More powerful and complex algorithms such as Neural Networks can easily outperform this algorithm

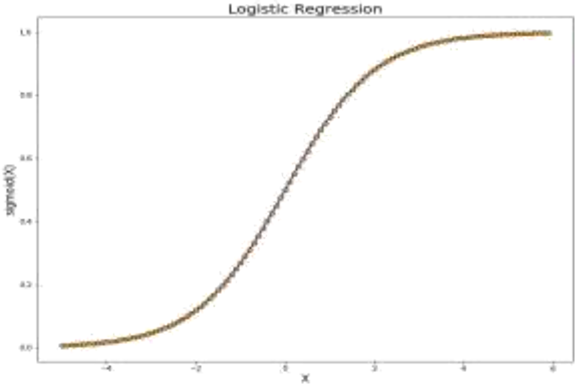


Figure: Logistic Regression

F. ADABOOST ALGORITHM

Adaboost was the first really successful boosting algorithm developed for the purpose of binary classification. Adaboost is short for Adaptive Boosting and is a very popular boosting technique which combines multiple “weak classifiers” into a single “strong classifier”

Algorithm:

1. Initially, Adaboost selects a training subset randomly.
2. It iteratively trains the Adaboost machine learning model by selecting the training set based on the accurate prediction of the last training.
3. It assigns the higher weight to wrong classified observations so that in the next iteration these observations will get the high probability for classification.
4. Also, it assigns the weight to the trained classifier in each iteration according to the accuracy of the classifier. The more accurate classifier will get high weight.
5. This process iterates until the complete training data fits without any error or until reached to the specified maximum number of estimators.
6. To classify, perform a "vote" across all of the learning algorithms you built

Advantages
Adaboost has many advantages due to its ease of use and less parameter tweaking when compared with the SVM algorithms. Plus, Adaboost can be used with SVM though theoretically, overfitting is not a feature of Adaboost applications, perhaps because the parameters are not optimized jointly and the learning process is slowed due to estimation stage-wise. This link is useful to understand mathematics. The flexible Adaboost can also be used for accuracy improvement of weak classifiers and cases in image/text classification.

Disadvantages:
Adaboost uses a progressively learning boosting technique. Hence high-quality data is needed in examples of Adaboost vs Random Forest. It is also very sensitive to outliers and noise in data requiring the elimination of these factors before using the data. It is also much slower than the XG-boost algorithm.

G. XGBOOST ALGORITHM

XG-boost is an implementation of Gradient Boosted decision trees. It is a type of Software library that was designed basically to improve speed and model performance. In this algorithm, decision trees are created in sequential form. Weights play an important role in XG-boost. Weights are assigned to all the independent variables which are then fed into the decision tree which predicts results. Weight of variables predicted wrong by the tree is increased and these the variables are then fed to the second decision tree. These individual classifiers/predictors then assemble to give a strong and more precise model. It can work on regression, classification, ranking, and user-defined predict.

Regularization: XG-boost has in-built L1 (Lasso Regression) and L2 (Ridge Regression) regularization which prevents the model from overfitting. That is why, XG-boost is also called regularized form of GBM (Gradient Boosting Machine).

While using Scikit Learn library, we pass two hyper-parameters (alpha and lambda) to XG-boost related to regularization. alpha is used for L1 regularization and lambda is used for L2 regularization.

2. Parallel Processing: XG-boost utilizes the power of parallel processing and that is why it is much faster than GBM. It uses multiple CPU cores to execute the model. While using Scikit Learn library, thread hyper-parameter is used for parallel processing. nthread represents number of CPU cores to be used.

If you want to use all the available cores, don't mention any value for nthread and the algorithm will detect automatically.

3. *Handling Missing Values:* XG-boost has an in-built capability to handle missing values. When XG-boost encounters a missing value at a node, it tries both the left- and right-hand split and learns the way leading to higher loss for each node. It then does the same when working on the testing data.

4. *Cross Validation:* XG-boost allows user to run a cross-validation at each iteration of the boosting process and thus it is easy to get the exact optimum number of boosting iterations in a single run. This is unlike GBM where we have to run a grid-search and only a limited values can be tested.

5. *Effective Tree Pruning*: A GBM would stop splitting a node when it encounters a negative loss in the split. Thus, it is more of a greedy algorithm. XG-boost on the other hand make splits up to the max_depth specified and then start pruning the tree backwards and remove splits beyond which there is no positive gain. 5.2

V. DATASET DETAILS

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

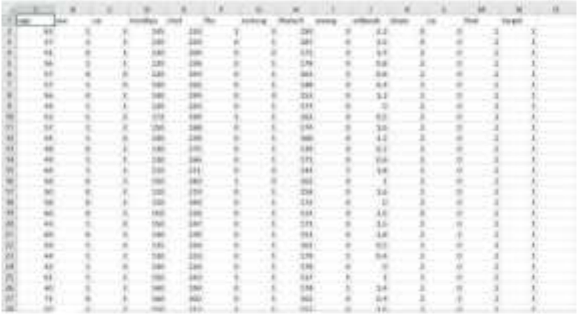


Figure: Dataset Attributes

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.
- Cholesterol
- Restecg

S.No	Attribute	Description	Type
1	Age	Patient's age (29 to 77)	Numerical
2	Sex	Gender of patient (male-0 female-1)	Nominal
3	Cp	Chest pain type	Nominal
4	Trestbps	Resting blood pressure (in mm Hg on admission to hospital, values from 94	Numerical
5	Chol	Serum cholesterol in mg/dl, values from 126 to 564)	Numerical
6	Fbs	Fasting blood sugar>120 mg/dl, true-	Nominal
7	Resting	Resting electrocardiographics result	Nominal
8	Thali	Maximum heart rate achieved (71 to 202)	Numerical
9	Exang	Exercise included agina(1-yes 0- no)	Nominal
10	Oldpeak	ST depression introduced by exercise relative to rest (0 to .2)	Numerical
11	Slope	The slop of the peak exercise ST segment (0 to 1)	Nominal
12	Ca	Number of major vessels (0-3)	Numerical
13	Thal	3-normal	Nominal
14	Targets	1 or 0	Nominal

TABLE: Attributes of the dataset

A. 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:

Accuracy = (TP + TN) /(TP+FP+FN+TN)

Confusion Matrix- It gives us a matrix as output and gives the total performance of the system.

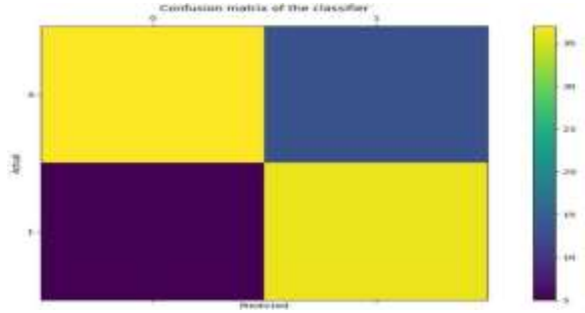


Figure: Confusion Matrix

Were

TP: True positive

FP: False Positive

FN: False Negative

TN: True Negative

Correlation Matrix: The correlation matrix in machine learning is used for feature selection. It represents dependency between various attributes.

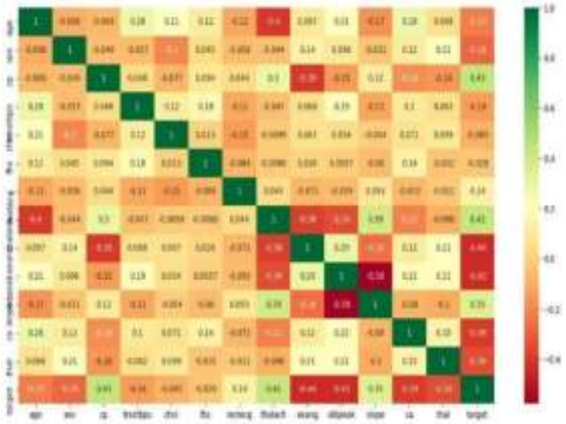


Fig: Correlation matrix

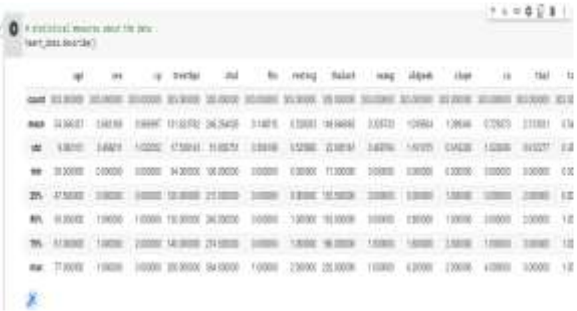
Precision- It is the ratio of correct positive results to the total number of positive results predicted by the system.

It is expressed as: Recall-It is the ratio of correct positive results to the total number of positive results predicted by the system.

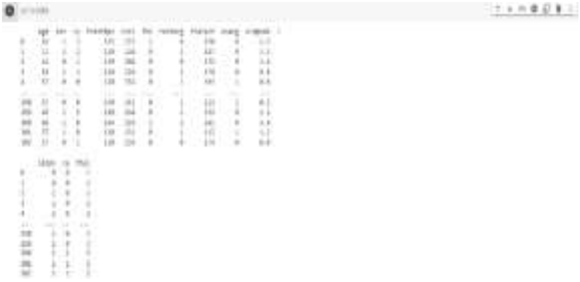
It is expressed as: F1 Score-It is the harmonic mean of Precision and Recall. It measures the test accuracy. The range of this metric is 0 to 1.

A. OUTPUT DATA COLLECTION AND PROCESSING

STASTISTICAL MEASURES OF DATA



SPLITTING FEATURES AND TARGET



B. LOGISTIC REGRESSION

TRAINING LOGISTIC MODEL

```
Logistic Regression

[11] model = LogisticRegression()

[12] # training the LogisticRegression model with Training data
     model.fit(X_train, Y_train)

     [illegible]
     [illegible]

     [illegible]
       [illegible]
     [illegible]
       [illegible]
       [illegible]
     LogisticRegression()
```

ACCURACY

```
Accuracy Score

[14] # accuracy on training data
     X_train_prediction = model.predict(X_train)
     training_data_accuracy = accuracy_score(X_train_prediction, Y_train)

[15] print('Accuracy on Training data : ', training_data_accuracy)

     Accuracy on Training data : [illegible]

     # accuracy on test data
     X_test_prediction = model.predict(X_test)
     test_data_accuracy = accuracy_score(X_test_prediction, Y_test)

     print('Accuracy on Test data : ', test_data_accuracy)

     Accuracy on Test data : [illegible]
```

C. RESULT

After performing the machine learning approach for training and testing we find that accuracy of the logistic regression is better compared to other algorithms. Accuracy is calculated with the support of the confusion matrix of each algorithm, here the number count of TP, TN, FP, FN is given and using the equation of accuracy, value has been calculated and it is concluded that extreme logistic regression is best with 85% accuracy and the comparison is shown below.

Algorithm	Accuracy
Logistic Regression	85%
Random Forest	79.1%
Naive Bayes	76.9%
Decision Tree	75.8%
Adaboost	73.6%

TABLE: Accuracy comparison of algorithms Algorithm Accuracy by referring papers

VI. 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, Adaptive Boosting, 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 81%

REFERENCE

1. *Soni J, Ansari U, Sharma D & Soni S (2011). Predictive data mining for medical diagnosis: an overview of heart disease prediction. International Journal of Computer Applications, 17(8), 43-8*
2. *Dangare C S & Apte S S (2012). Improved study of heart disease prediction system using data mining classification techniques. International Journal of Computer Applications, 47(10), 44-8*
3. *Ordonez C (2006). Association rule discovery with the train and test approach for heart disease prediction. IEEE Transactions on Information Technology in Biomedicine, 10(2), 334-43.*
4. *Shinde R, Arjun S, Patil P & Waghmare J (2015). An intelligent heart disease prediction system using k-means clustering and Naïve Bayes algorithm. International Journal of Computer Science and Information Technologies, 6(1), 637-9*
5. *Bashir S, Qamar U & Javed M Y (2014, November). An ensemble-based decision support framework for intelligent heart disease diagnosis. In International Conference on Information Society (i-Society 2014) (pp. 259-64). IEEE. ICCRDA 2020 IOP Conf. Series: Materials Science and Engineering 1022 (2021) 012072 IOP Publishing doi:10.1088/1757-899X/1022/1/012072*
6. *Jee S H, Jang Y, Oh D J, Oh B H, Lee S H, Park S W & Yun Y D (2014). A coronary heart disease prediction model: the Korean Heart Study. BMJ open, 4(5),e005025*
7. *Jabbar M A, Deekshatulu B L & Chandra P (2013, March). Heart disease prediction using lazy associative classification. In 2013 International Mutli- Conference on Automation, Computing, Communication, Control and Compressed Sensing (iMac4s) (pp. 40- 6). IEEE*
8. *Brown N, Young T, Gray D, Skene A M & Hampton J R (1997). Inpatient deaths from acute myocardial infarction,*

1982-92: analysis of data in the Nottingham heart attack register. BMJ, 315(7101), 159-64.

9. *Folsom A R, Prineas R J, Kaye S A & Soler J T (1989). Body fat distribution and self-reported prevalence of hypertension, heart attack, and other heart disease in older women. International journal of epidemiologyy, 18(2), 361-7*
10. *Chen A H, Huang S Y, Hong P S, Cheng C H & Lin E J (2011, September). HDPS: Heart disease prediction system. In 2011 Computing in Cardiology (pp. 557- 60). IEEE*