Heart Failure Prediction using Different MachineLearning Techniques

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Abstract - *A heart disease is a type of condition that affects the heart and blood vessels. It can also be referred to as cardiovascular disease. Getting the right diagnosis and treatment of heart disease is very important in order to improve the quality of healthcare. Clinical data analysis faces a significant problem when predicting cardiovascular disease. The current situation of applying conventional approaches in practically the whole medical field is being revolutionized and changed by Machine Learning, the Internet of Things (IoT), Artificial Intelligence, and Big Data. With the use of machine learning (ML), it has been possible to make predictions and judgments from the vast amount of data generated by the healthcare sector. In this paper, we present several Machine Learning models and attain the best model to improve the precision of cardiovascular disease prediction. Different feature selection techniques and many well-known strategies are used to improve the accuracy.*

Key Words: **Machine Learning, Artificial Intelligence, Cardiovascular Disease, Feature Selection, Heart Disease Prediction**

1. INTRODUCTION

A number of contributing risk factors, namely diabetes, high blood pressure, excessive cholesterol, an irregular pulse rate, and many other factors make it challenging to diagnose heart disease(HD). The severity of cardiac disease in humans has been determined using various data mining and neural network techniques. Several Classifiers namely Random Forest, K-Nearest Neighbour(KNN), Logistic Regression and Naïve Bayes Since cardiac illness has a complex character, it requires cautious management. Failure to do so could harm the heart or result in premature death. To identify different types of metabolic syndromes, data mining and the perspective of medical research are employed. Heart disease prediction and data analysis both greatly benefit from data mining with classification. HD is often diagnosed by a doctor after reviewing the patient's medical history, the results of their physical exam, and any concerning symptoms. However, the results of this method of diagnosis do not reliably identify heart disease patients. Additionally, analysis is costly and computationally challenging. To tackle these problems, a non-invasive diagnosis system based on classifiers of machine learning (ML) must be created. To identify the best-suited machine learning model we compare the accuracies of different classification models and find out the best fit model with the best accuracy. Due to the dimensionality constraint, it is required to reduce the dimensionality of data for a variety of learning tasks. The choice of features has a significant impact on a variety of applications, including making buildings simpler, improving learning outcomes, and producing clear and comprehensible data. Due to the large amount of dimensions in big data, selecting features from it is a difficult task that leads to significant issues. Additionally, there are difficulties choosing features for structured, heterogeneous, and streaming data, as well as problems with scalability and stability. The feature selection issues must be overcome for large data analytics.

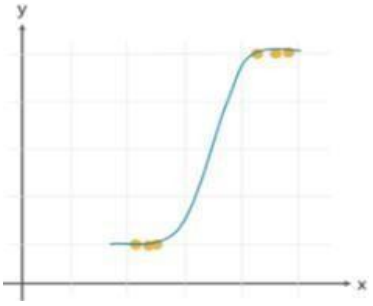
On the other hand, effective machine learning requires an appropriate model. Naturally, a strong machine learning model is one that excels both on data that isn't seen during training (otherwise, the model would only learn the training data) and on data that hasn't been seen before. To test every classifier using data, and discover that they correctly classify 50% of the cases on average. Additionally, when a model is trained and tested on a dataset, adequate cross-validation methodologies and performance evaluation criteria are essential.

In the paper, the sections are structured as follows.

The literature related to the problem has been discussed in Section 2. In Section 3 the System Architecture is discussed. In Section 4 the Research Methodologies which consist of Data Set, Data Collection, and Preprocessing along with classification Techniques are discussed. The Theoretical and mathematical knowledge of feature selection and classification algorithms are discussed in detail. Further, the Conclusion and the Future Scope of the study have been discussed in detail in Sections 5 and 6 respectively. The last section consists of acknowledgment and references which made this study possible.

- **Logistic Regression**

It is a machine learning classification algorithm that selects a result by considering one or more independent variables. Since the variable being used to quantify, it is a dichotomous variable, the output will only have two possible possibilities.The goal of logistic regression is to identify the relationship that best fits the dependent variable and a set of independent factors. In comparison to other binary classification techniques like the closest neighbour, it performs better because it unbiasedly describes the contributing factors classification.



Graph-1: Logistic Regression Graph

This method involves analyzing a collection of data that includes a dependent variable and one or more independent variables in order to forecast the result of a binary variable, which has only two possible possibilities. The dependent variable's nature is categorical. The independent variables are known as predictors, while the dependent variable is also known as the target variable. In a specific version of linear regression called logistic regression, we can only predict the result of a categorical variable. By means of the log function, it forecasts the likelihood of the event. In order to forecast the category value, we employ the Sigmoid function or curve. The result (win or lose) is determined by the threshold value.

Sigmoid function: $p = 1 / 1 + e^{-y}$

Logistic Regression equation:

$$p = 1 / 1 + e^{-(\beta 0 + \beta 1X1 + \beta 2X2 \ldots + \beta nXn)}$$

A strong statistical analysis method is regression analysis. In a data collection, a dependent variable that interests us is utilized to forecast the values of other independent variables. Regression is something that we frequently encounter in an intuitive way.

- **Random Forest Classifier**

Both classification and regression techniques employ Random Forest algorithms. In order to generate predictions, it builds a tree for the data. Using Random Forest on huge

datasets generate the same outcome from the missing values. Samples produced by the Classifier can store a decision tree so you may utilize it later. Additional information can be obtained by making a forecast after creating a random forest by using a classifier developed in thefirst random forest stage.

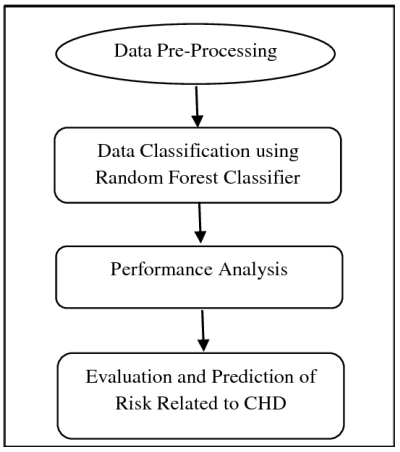


Fig-2: Random Forest Classifier

Using random forest algorithm, we can obtain accuracy High Accuracy for prediction of heart disease.

- **Naïve Bayes**

The family of straightforward "probabilistic classifiers" known as "Naive Bayes Classifiers" in statistics is based on the application of Bayes' theorem with strong (naive) independent assumptions between the features. Although they are some of the simplest Bayesian network models, they may achieve high levels of accuracy when combined with kernel density estimation. Naive Bayes classifiers are very scalable since the number of parameters needed is linear in the number of variables (features/predictors) in a learning job. When compared to many other types of classifiers, maximum-likelihood training can be performed in linear time by evaluating a closed-form expression as opposed to being costly approximated iteratively. In the statistics literature, naïve Bayes classification models go by the titles simple Bayes and independent Bayes.

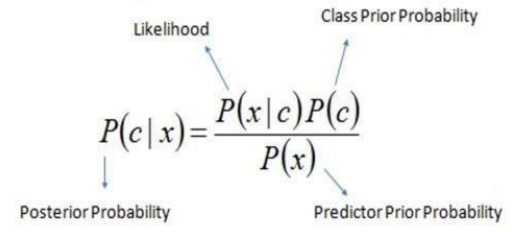


Fig-3: Naïve Bayes Formula

$$P(c|X) = P(x_1|c)\times P(x_2|c)\times\cdots\times P(x_n|c)\times P(c)$$

- **K-Nearest Neighbors**

KNN is a lazily supervised machine learning technique that uses distance measurements to predict and categorize unknown data from known data. The distance metric is used to determine the distance between each point in the training data and each point in the testing data. Fundamentally, the k-nearest neighbour classifier depends on a distance metric. The more accurately that metric captures label similarity, the more accurate the classification. The Minkowski distance is the most popular option which is :

dist(x,z)=(d∑r=1|xr−zr|p)1/p.

With k-NN, all computation is postponed until after the function has been evaluated and the function is only locally approximated. Since this technique depends on distance for classification, normalizing the training data can significantly increase accuracy if the features reflect several physical units or have distinct sizes. Assigning weights to neighbor contributions may be a helpful strategy for both classification and regression, making the closer neighbours contribute more to the average than thefarther neighbours. As an illustration, a typical weighting method assigns each neighbour a weight of 1/d, where d isthe distance between the neighbours.

5. CONCLUSION

The long-term saving of human lives and the early detection of irregularities in heart problems will be made possible by identifying the processing of raw healthcare data of heart information. To process the raw data and deliver a fresh and original insight into heart disease, machine learning techniques were applied in this study. Prediction of heart disease is difficult and crucial in the medical industry. However, if the disease is discovered in its early stages and preventative measures are implemented as soon as feasible, the fatality rate can be significantly reduced. In this Study, Various Machine Learning Algorithms have been studied and analyzed. This Study will help us obtain the best Machine Learning Model for Efficient Heart Disease Prediction with the most accuracy. Our study's use of feature selection algorithms to identify the right features that improve classification accuracy and reduce the diagnosis system's processing time is another novel component. We'll put additional feature selection algorithms as well as optimization algorithms in the future to increase a prediction system's ability to diagnose Heart Disease.

6. FUTURE WORK

In the future work, More machine learning classification algorithms and data pretreatment approaches may be usedin subsequent works to provide outcomes.

In light of the fact that more data equals more accurate results, it follows that a large amount of data will result in better prediction. Since the patient may not always have time to visit the doctor, this issue can be resolved by creating a website or smartphone application with a graphical user interface. This website streamlines the prediction process and allows patients to access the results at home by simply entering their risk factors.

ACKNOWLEDGMENT

First and Foremost, We are thankful to our college AISSMS Institute of Information Technology and the Engineering Department and our Guide Mr. Pritesh Patil, Associate Professor, AISSMS Institute of Information Technology. A special word of gratitude to Dr. Meenakshi Thalor, Head of Department, Information Technology and Engineering Department, AISSMS IOIT college of Engineering, for her continuous guidance and support for our project work.

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