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Prediction of Cardiovascular Diseases (CVDs) Using Machine Learning Techniques in Health Care Centers

Hafiz Gulfam Ahmad[1], Muhammad Jasim Shah[2]

[1] *Ghazi University, Dera Ghazi Khan, Pakistan, hahmad@gudgk.edu.pk*
[2] *Emerson University Multan, Pakistan, jasimshah@gamil.com*

*Correspondence: Hafiz Gulfam Ahmad, Ghazi University, Dera Ghazi Khan, Pakistan, hahmad@gudgk.edu.pk

Abstract

Cardiovascular Diseases (CVDs) are one of the most common health problems nowadays. Early diagnosis of heart disease is a significant concern for health professionals in medical centers. An incorrect forecast is more likely to have negative effects, such as disability or even death. Our research is motivated by the desire to predict cardiovascular diseases based on data mining that can be valuable to medical centers. Various data mining approaches are used for the early detection of cardiac diseases. This paper examines several research publications that work on various heart diseases. We compare and contrast several machine learning methods, such as KNN, ANN, Decision Tree, SVM, and Random Forest. We looked at 918 observations with several features related to heart disease. A comparative study with age and sex is established to predict cardiac disease using the decision tree approach. Our dataset contains 11 features that are used to forecast possible heart disease. One of the attributes indicates that the age factor has the most significant impact on heart disease. According to our findings, heart attacks cause four out of every five CVD deaths, with one-third of these deaths occurring suddenly in those under 70.

Keywords: NN, ANN, Decision tree, SVM, Random forest

1. Introduction

People with cardiovascular disease are at high risk (due to one or more risk factors such as hypertension, diabetes, hyperlipidemia, or already existing disease). Such people necessitate early detection and management. According to the WHO, cardiovascular diseases are the main cause of death globally, with 17.9 million people dying each year, accounting for 31% of deaths (kaggle.com). Machine learning models may be useful in resolving the problem of early diagnosis of cardiac disease. To avoid life-threatening dangers, an accurate cardiac disease prognosis is critical. Medical experts usually identify this ailment based on text, images, tests, or ECG data. Combining this data with some machine learning techniques may be more advantageous and

cost-effective. In our research, we employ data mining to forecast cardiac diseases. Machine learning, databases, and statistical analysis are already used in data mining. Medical specialists can be taught to use the heart disease prediction system trained by data mining data sets. Data prediction of cardiac problems will be accurate and straightforward if data mining techniques are used.

Furthermore, it can boost the efficiency of medical staff and health clinics in an emergency. According to the WHO, millions of people die from heart disease every year. Daily, medical care institutions acquire a large quantity of patient data, but this data is not analyzed, which is essential for uncovering hidden patterns to diagnose disease and make an effective choice. Data mining approaches classify, forecast, and cluster data to improve decision-making accuracy in medical settings where errors cannot be tolerated. Any person can live a healthy life with a properly functioning heart. The mechanical prediction of heart problems is time-consuming and challenging, but data mining makes it rapid and straightforward, while medical professionals should be provided with adequate help.

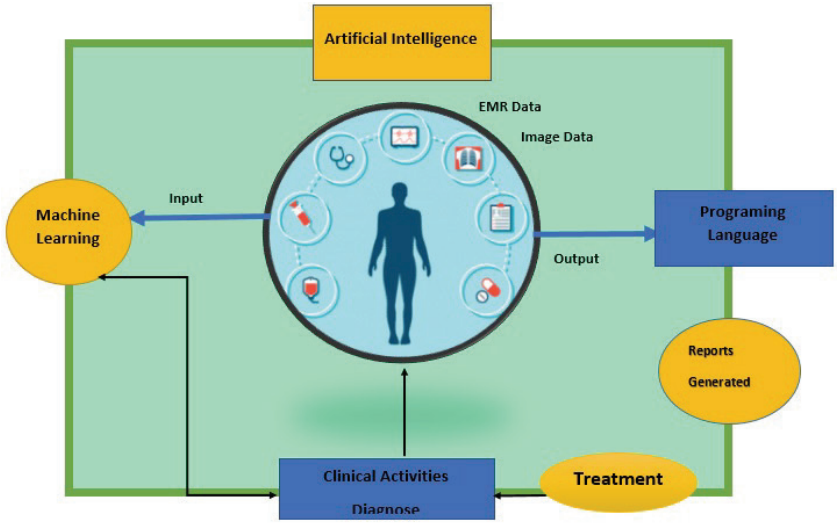


Fig. 1. Internal Structure of ML Analysis

In figure 1, we represent the internal structure of the machine learning general model. Purushottam, Saxena, and Sharma (2016) employ a decision tree to forecast cardiac disease efficiently. These decision trees aid classifiers in achieving accuracy in the testing phase (83.3%) and training phase (87.3%). Heart disease prediction utilizing DNFS approaches was carried out using various methodologies such as the Nave Bayess C4.5 Decision Tree, with CVD accuracy ranging from 85 to 99 percent and CHD accuracy ranging from 82 to 92 percent. 2016 (Reddy, Palagi, and Jaya). In ANN, you can forecast cardiac illnesses and receive high-accuracy results. (Marimuthu et al., 2018) employed data mining techniques and machine learning approaches to predict cardiovascular disorders. They used the Random Forest Algorithm, logistic model tree, and J48 and got a final result accuracy of 56.76 percent, better than the

industry standard.

The primary purpose of data mining and employing SVM (J48) algorithms to predict the development of cardiovascular illness is demonstrated. High-quality services with high-quality results (Shetty and Naik, 2016) are the crucial goal of a method for predicting heart disorders based on data mining. The neural network Weak Mat Lab had an accuracy of 84 percent. Palaniappan and Awang (2008) use big data to forecast cardiac disease using these strategies intelligently. The animation of this system is favorable, with mahout, hoop, and Naive Bayes. 2017 (Jayami and Cajal). We can anticipate cardiac disease using machine learning and data mining. UCI has higher accuracy than LMT. (Deepika and Seema, 2017), using data mining and chronic illness prediction approaches such as Naive Bayes, SVM, and decision trees (Deepika and Seema, 2017). SVM has a high accuracy of 95.56 percent in heart disease, and naive Bayes has a high accuracy of 73.588 percent in diabetes. (2016, Sharan M) Cardiovascular illnesses are studied using data mining and a simple CRT approach, with 92.2 percent accuracy. Heart disease prediction using the Weka (Sultana and Haier, 2017).

Mujawar and Devale (2015) (Mujawar and Devale, 2015).In the first step, K-Means is used to find a group of instances that behave identically and differently, such as malicious and non-malicious activity, while in the second stage, Nave Bayes categorizes all data into the right class category. (Mujawar and Devale, 2015) The k means algorithm and Nave Bayes algorithms are used to predict cardiac disease. 93 percent of cardiac diseases are detected using Naive Bayes and Modified K-means algorithms. Heart Infection Estimation Using C4.5 (Sharma, Saxena, and Sharma, 2016). The accuracy of C4.5 Rules is superior to those of the Naive Bayes algorithm (R. Sharmila, 2017). By applying Neural Network diagnosis of heart disease using ANN, fusion SVM in parallel has high efficiency compared to sequential SVM (Ajam, 2015; 88 percent accuracy; Gomathi and Priya, 2016). Data mining is being used to identify numerous disorders. (Bahrami and Shirvani, 2015) employ data mining, Nave Bayes, KNN, and other techniques to diagnose and forecast cardiac disease. The J48 technique is one of the most incredible supervised learning models for categorizing and continually examining data.J48 has higher accuracy than the other three approaches. By Kamat and Chala Beyene, data mining is a way of uncovering relevant patterns in large datasets to predict cardiac disorders (2018). SVM can distinguish between linear and non-linear patterns. SVM enhances classification accuracy and may be used to create a multidimensional hyperplane that divides classes and widens the gap between them. Taneja (Taneja, 2013). The J48 Decision Tree method uses NN and Nave Bayes classifiers to predict different cardiac conditions. A prediction algorithm for identifying cardiac illnesses was built in this study work employing several variables (Benjamin, David, and others, 2018). Three data mining classification methods are discussed in this study, which are utilized to construct a prediction system for assessing the risk of heart disease. (S. Dangare and S. Apte, 2012), which uses many factors to predict cardiac disease. Medical systems employ blood pressure, cholesterol levels, and other characteristics. Singh and Pandi-Jain (2018) created a technique for predicting high-level heart disease systems (EHDPS). The algorithm considers 15 medical factors such as age, cholesterol, and so on.

Table 1 Heart Disease Prediction by ANN

Sr. No.	References	Purpose	Accuracy	Techniques used
1	(Reddy, Palagi and Jaya, 2016)	Hearts diseases Prediction by ANN	High Performance	ANN
2	(Ajam, 2015)	Hearts diseases Prediction by ANN	88%	ANN
3	(Kamat and Chala Beyene, 2018)	Knowledge discovery method	81.82%	ANN

An artificial neural network (ANN) is a computer simulation model of many processing units that accept inputs and outputs based on their training algorithm. After establishing an ANN-based algorithm, which was subsequently deployed on Weka, the findings showed up to 100% accuracy. Yahaya, David Oye, and Joshua Garba; Yahaya, David Oye, and Joshua Garba, 2020); Yahaya, David Oye, and Joshua Garba, 2020); Yahaya, David Oye, and Joshua Garba, 2020); Yahaya, David The authors of this study look into clinical decision making in the prediction of cardiovascular disorders, which other authors have proposed before utilizing data mining and machine learning. 2020, Saleh et al. Weka 3.8.3 data mining software implements algorithms like j48, Nave Bayes, Random Forest, and Random Forest to predict cardiac illnesses. (Mayank and Chadha, 2016).

This study aims to examine and apply various data mining techniques to diagnose cardiac problems in patients by extracting exciting patterns from datasets utilizing various criteria. The data gathered by medical centers are heterogeneous. Therefore multiple types of data must be analyzed to predict cardiac disorders (Krishnaiah, Narsimha, and Subhash Chandra, 2015). Patients are categorized based on their characteristics. Fuzzy K-NN is utilized to categorize individuals with cardiac problems in this study.(2016, Zriqat, Mousa Altamimi, and Azzeh). Classification methods such as Decision Tree, Nave Bayes, and discriminant are utilized for predicting cardiac disorders. Different data mining approaches are employed to diagnose cardiac ailments in this study to aid in the remediation issue (Raju et al., 2018). Various data mining methods have been implemented. (2019, Latha and Jeeva). The main goal of this study is to improve performance by combining various classifiers. Selecting features improves performance even further. Prediction models are created in this study utilizing a mix of attributes and seven distinct classification algorithms, and data mining techniques are used to make early predictions.

2. Machine Learning Classification Techniques

(Thomas et al., 2016) Different classification strategies are employed in this study to forecast each patient's risk level utilizing data mining techniques such as KNN and others. (Taneja, 2013) used several data mining approaches to classify heart disease patients, including Decision Tree, Random Forest, and Logistic Regression.

The random forest has a higher accuracy rate than other data mining approaches. (Vijayashree, J., and et al., 2016) employed data mining techniques such as Multi-layer Perceptron, Decision Trees, Neural Networks, and Naive Bayes to reliably predict heart disease based on symptoms and gender or age. The accuracy was found to be 97.75 percent.

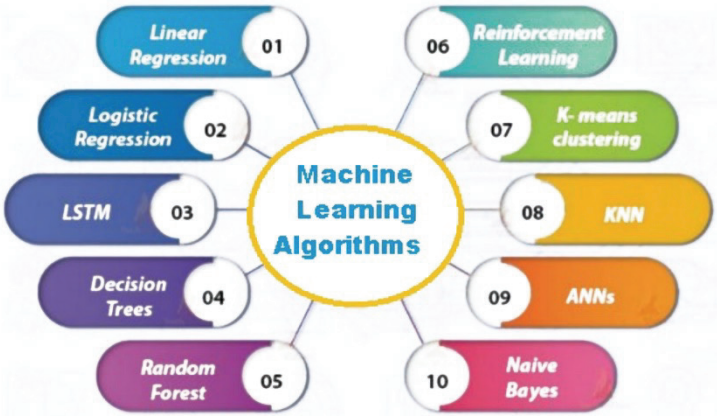


Fig 2. Machine Learning Techniques

(Purusothaman G. et al., 2015) compared the K.NN, Hybrid model, Neural network, and Navie Byes approaches for detecting heart disease. After comparing the results, it was discovered that the hybrid model method outperformed the other strategies. (Anbarasi M et al., 2010) used a variety of approaches to identify cardiac disease. Clustering, Navie Byes, and Decision Tree accuracy were all improved to 88 percent, 96.55 percent, and 99.2 percent, respectively. (Bhatla et al., 2012) discovered Surviving Techniques for Heart Disease Prediction using a hybrid intelligence methodology called fuzzy logic. This study effort has an accuracy rate of 86 percent.

(Thomas, J., and Princy, R.T., 2016) examined data mining techniques such as KNN and Navie Byes for heart disease diagnosis and detection. This comparison demonstrated that K.NN outperformed other strategies in terms of accuracy. (Jardan et al., 2012) used data mining approaches such as decision lists, Navie Byes, and K.NN to describe the complexity and prognosis of cardiac problems. The output rate of these procedures revealed that the Decision list and Navie Byes were both accurate. (Bhatla and Jyoti 2012) used a variety of data mining approaches to investigate the prognosis of cardiac problems, including Navie Byes, Decision trees, and Neural networks. Using the neural network data mining approach, 100 percent accuracy was achieved.

Table 1 Heart Disease Prediction by Decision trees

Sr. No.	References	Accuracy	Techniques used	Purpose
1	(Purushottam, Saxena and Sharma, 2016)	83.3 % in the testing phase and 87.3 % in the training phase	Decision tree	A Decision tree can accurately forecast heart disease.

2	(Deepika and Seema, 2017)	SVM has a high accuracy of 95.56 percent in heart disease, while Naive Bayes has a high accuracy of 73.588 percent in diabetes.	Naïve Bayes, SVM, Decision tree	Data mining for chronic Disease prediction
3	(Chadha and Mayank, 2016)	ANN is better than other techniques	Artificial Neural Networks, Decision Tree, and Naive Bayes	Compare various data mining algorithms for predicting heart disease in a patient utilizing vital parameters to find intriguing patterns in the data.
4	(Raju et al., 2018)	(SVM) have better performance	K-NN, association rule, decision trees, NN, SVM	To propose a viable solution for restorative situations.
5	Methaila et al. (2014)	Decision Trees: 99.62%	Decision Trees, Neural Network,	To detect early stages of heart problem
6	Vijayashree, J. and SrimanNarayanaIyengar, N.C., 2016.	Random Forest:84%	Decision Tree, Logistic Regression Multi-layer Perceptron Neural Networks, Decision Trees, Naive Bayes	Based on the gender or age, To predict the heart disease accurately
8		Decision Tree 97.75%		
9	Sultana et al. (2016)	Decision trees have better accuracy than others	Logistic regression Decision trees, Artificial neural networks	To predict the patient's attainment of heart disease with the use of data mining methods

10	Palaniappan et al., (2008)	NB 95% Decision Tree 95%,	Decision Trees, Neural Network and Naive Bayes	To predict prototype heart problems with three leading data mining techniques.

(Singh and Pandi-Jain, 2018) uses a neural network-based data mining approach to predict cardiac problems based on 13 variables. The outputs of the neural network were 100 percent correct. (Ansarullah et al., 2016) investigated the impact of several data mining strategies on heart disease diagnosis. The decision tree's influence became more precise. (Sharma, M., Singh, G., and Singh, R., 2017) used several data mining approaches such as KStar, J48, SMO, and MLP to improve heart disease utilizing two datasets: collected and UCI standard. Other data mining approaches fared worse than MLP. (Thomas, J., and Princy, R.T., 2016) examined data mining techniques such as KNN and Naive Bayes for heart disease diagnosis and detection. This comparison demonstrated that the precision of (Sultana et al., 2016) used data mining approaches such as logistic regression, decision trees, and artificial neural networks to forecast the patient's development of heart disease. Decision trees were shown to be more accurate than other methods. (Palaniappan et al., 2008) used three different data mining strategies to find prototype heart disease. This study showed that Naive Bayes had 95 percent accuracy with 432 supporting instances, Decision Tree had 94.93 percent accuracy with 106 supporting cases, and Neural Network had 93.54 percent accuracy with 298 supporting cases. (Rairikar et al., 2017) investigated the use of data mining techniques in healthcare and heart attack prevention. In this work, two major data mining approaches were used: Naive cradle and Naive Bayes. (Srinivas et al., 2010) developed a method for detecting cardiac problems that were 100 percent accurate utilizing the data mining method of neural networks. (Dangare et al., 2012) investigated the prediction and diagnosis of cardiac disease using data mining techniques such as fuzzy logic, decision trees, and neural networks. Fuzzy logic, Decision tree, and Neural network all scored 67, 73.8, and 94.5 percent, respectively. This is accomplished through the use of several medical profiles. Finally, it was discovered that Decision Trees outperform other data mining approaches by 99.62 percent. We studied several algorithms used in machine learning classification to predict heart disease.

3. Data Source

The dataset is obtained from ongoing cardiovascular research and is publicly available on the Kaggle platform. Some datasets that were earlier accessible but had not been integrated were used to create this dataset. We combine five datasets with 11 common characteristics to provide the largest heart disease dataset currently available for study. 2021. (Fedesoriano.)

4. Data Pre Processing

Individuals at high cardiovascular risk (due to risk factors such as hypertension, diabetes, or an existing condition, hyperlipidemia) require early identification and

care; a machine learning model may deliver good results to predict the correct disease.

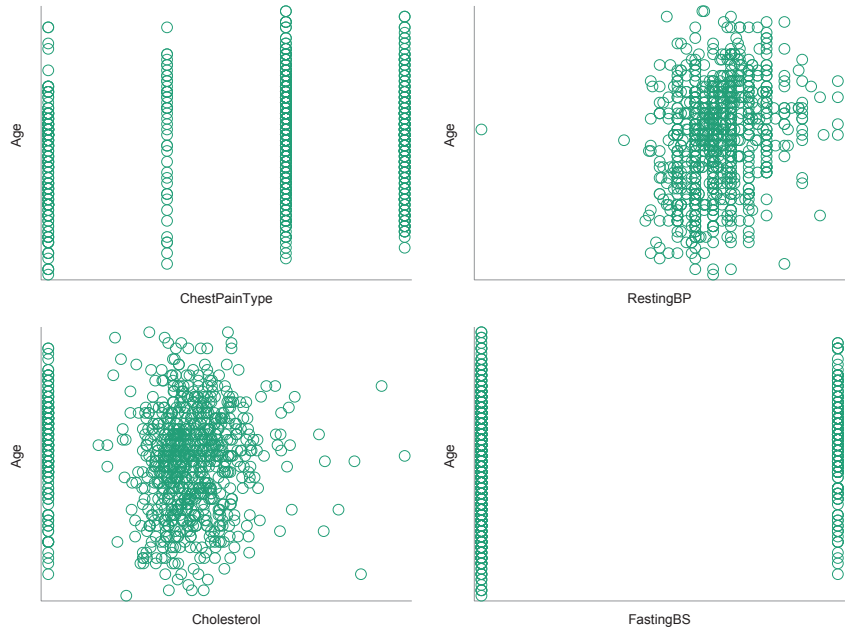
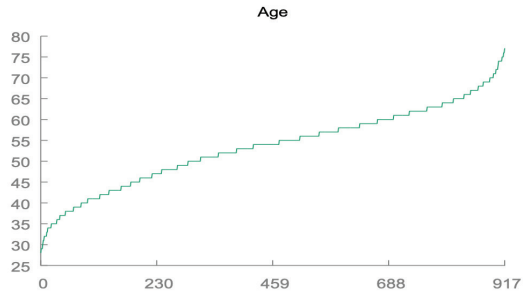


Fig. 3. relative comparison between ages 25-70

Above mention, the diagram shows machine learning (ML) impact and assessment to investigate in case of heart disease. Here, results predict that chest pain has impacted values to detect heart disease concerning age. On the other hand, cholesterol and resting BP also have alarming and highest values for this disease. However, fastings are not verified in the estimated assessment. When data inter, with the help of clinical activates, the output is generated based on artificial intelligence in Machine learning technique. As in diagram 2, performance through the ML technique elaborated that age is an essential factor that causes heart disease and from 917 observation results indicated that as age increases, heart disease will be shared an upward trend in humans. Again old peak also shows consistent results in this prospect.



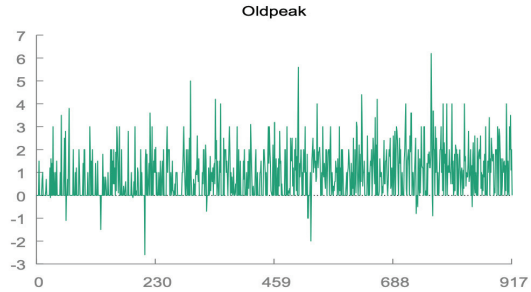


Fig. 4. Feature selection Performance

The comparison between two components of clinical investigation, weather, age, and sex, has more affected by heart disease. Again apply 917 observations, and the ML process generates the result. Outcomes are very astonishing, that sex in case of chest pain, resting ECG, and fasting BS (clinical activates) is not too much an appropriate indicator of heart disease, but Cholesterol, FastingBS, and MaxHR are most affected in case heart disease.

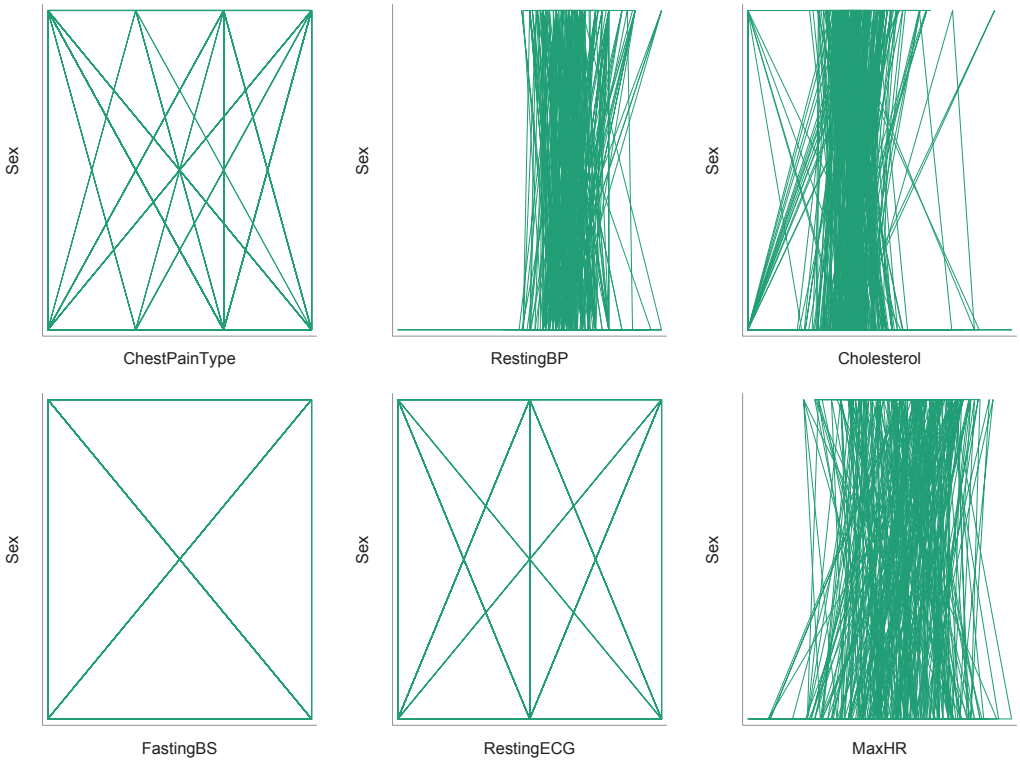


Fig. 5. Explanatory data analysis regarding gender

Furthermore, when trying to analyze the impact of age and take an age limit of 25-70, the outcomes of the ML technique interpreted that chest pain, restingBP, cholesterol, fastingBS, and resting ECG at their highest peak with upper age. These results are presented in given below diagram (figure 6).

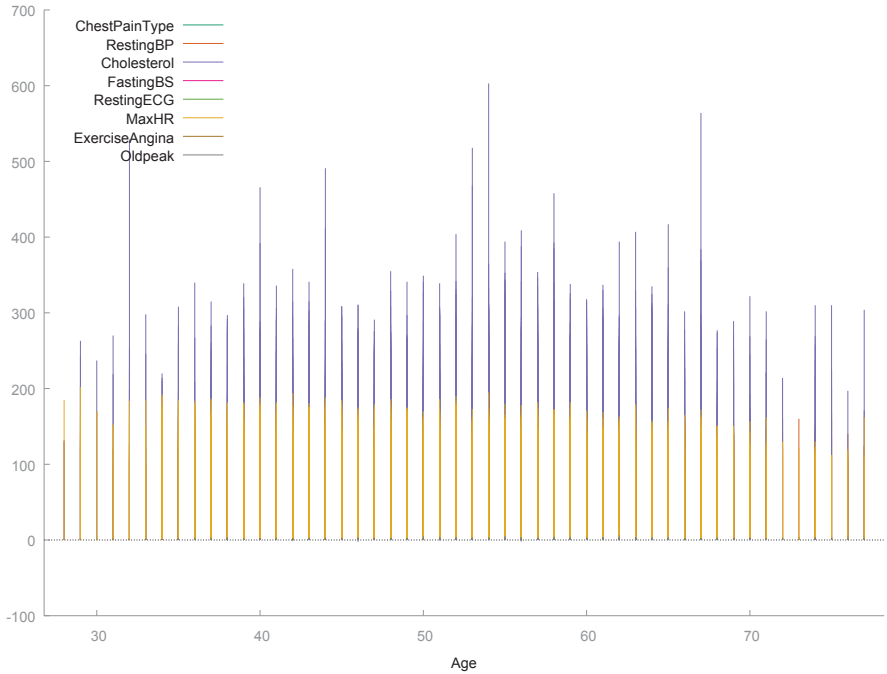


Fig. 6. Data Interpretation of heart disease regarding age

Four out of every five CVD deaths are caused by heart attacks and strokes, with one-third of these deaths happening before 70. Heart failure is frequently caused by cardiovascular disease (CVD), and this dataset comprises 11 characteristics that might be used to predict heart disease. For estimating the variable target age, traditional Machine Learning classification models such as Logistic Regression, KNeighbors Classifier, Decision Tree, Gradient Boosting Classifier, and Random Forest Classifier were suitable.

5. Conclusion

This paper provides a detailed analysis of diverse types of machine learning algorithms for the forecast of heart disease, including angina. Many data mining techniques take age, gender, blood pressure, cholesterol, etc., to predict the risk of different heart diseases. It is found that different algorithms of the HD dataset generate promising consequences in terms of classification accurateness. Decision Trees has 99.62% accuracy, which is the best result. In future work, we want to suggest a system that automatically gathers obligatory attributes and makes them available to

medical experts.

Furthermore, the performance can be enhanced by using Ensemble and Hybrid Machine Learning techniques. Medical professionals must be proficient in using this system to detect precise heart disease to save a patient's life. This proposed approach may help the medical profession respond proactively before heart-related disease happens.

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