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Hybrid Classification Technique for the Heart Disease Prediction

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Abstract : Data mining is a procedure that helps to extract important information from erratic data. The present data is used to forecast the future outcomes in the prediction analysis. This research aimed at forecasting heart disorders. This method is applied in stages to predict the occurrence of heart disease, during which data pre-processing, attribute extraction, and classification are carried out. The execution of both RF and LR algorithms is part of a hybrid method. To abstract the features, the RF algorithm is used. LR is used to categorize the photos. This study makes use of a number of indicators to evaluate the effectiveness of the suggested strategy. The newly developed method predicts heart disease with 95% accuracy.

IndexTerms **- Heart Disorder, Machine Learning, Feature Extraction, HybridClassification,Heart Disease Predication.**

I. INTRODUCTION

Data Mining is a procedure in which employed, anonymous and significant information is extracted from the collected data [1]. KDD extracts crucial, homogeneous, or high-quality information from collected datasets. You can find this information in a number of ways. Thus, a large database is a rich and consistent source for generating and validating information. Several researchers have identified the mining of from giant databanks as a main subject in database system and ML [2]. Many industries also see this as a large area of research with critical profit opportunities. The extracted information can be used to serve several different purposes. Research is being conducted in various fields such as AI, database systems, data collection and ML are heavily impacted by data mining.Additionally, many emerging applications in data delivery have demonstrated a lot of interest in data mining algorithms to produce a better understanding of consumer behavior, to enhance the service provided, and to increase the business's ability to seize opportunities. A type of ailment affecting the heart is heart disease. A problem involving the heart, blood vessels, or cardiovascular system is referred to as cardiovascular disease. The condition and abnormalities of the heart are known as a cardiac ailment. According to the CDC, heart disease is a significant factor in the deaths of people in the United Kingdom, Canada, the United States, and Australia. In the US, this disease has caused deaths [3].

There are numerous diseases associated with coronary disorders that have an impact on various organ components. Congenital heart disease, heart failure, and pulmonary stenosis are a few examples of coronary illnesses. Because of coronary artery disease, also known as ischemic heart disease, plaque builds up in the heart's arteries [4]. Depending on each person's health, different symptoms of this disease can be seen. Chest tightness, breathing problems, and other symptoms are some of the major heart condition symptoms. Angina, a widespread marker in a variety of heart disease categories, is what the chest pain is indicated by. The lack of oxygen in the heart is the cause of this illness. The chaotic circumstances that caused this problem lasted for ten minutes. Heart disease is brought on by damage to the coronary arteries in any area or across an organ, as well as by the heart not receiving enough oxygen and nutrients [5]. Another type of genetic cardiac disease is hypertrophic cardiomyopathy. These illnesses are caught before a child is born [6]. The severity of this condition is becoming more severe as a result of different styles of living. High blood pressure, smoking, sitting jobs, etc. are a few causes of heart attacks. It can be difficult in the clinical setting to protect the disease utilizing the DM method. This method can be modified to predict cardiac disease. Current scenario have seen the development of numerous DM algorithms that allow the key information to be recognized and extracted from the medical dataset with the least amount of human input and labor. With the aim of adopting DM in the clinical domain, researchers have investigated a variety of strategies over the past few decades [7][8]. As a result, many heart disease categories are accurately predicted. Depending on the various techniques used and the features that were chosen, the DM behaved differently. In general, the medical databanks that are available in this field are unreliable and unpredictable. Thus, in order to use DM approaches, prior and appropriate preparations are needed.

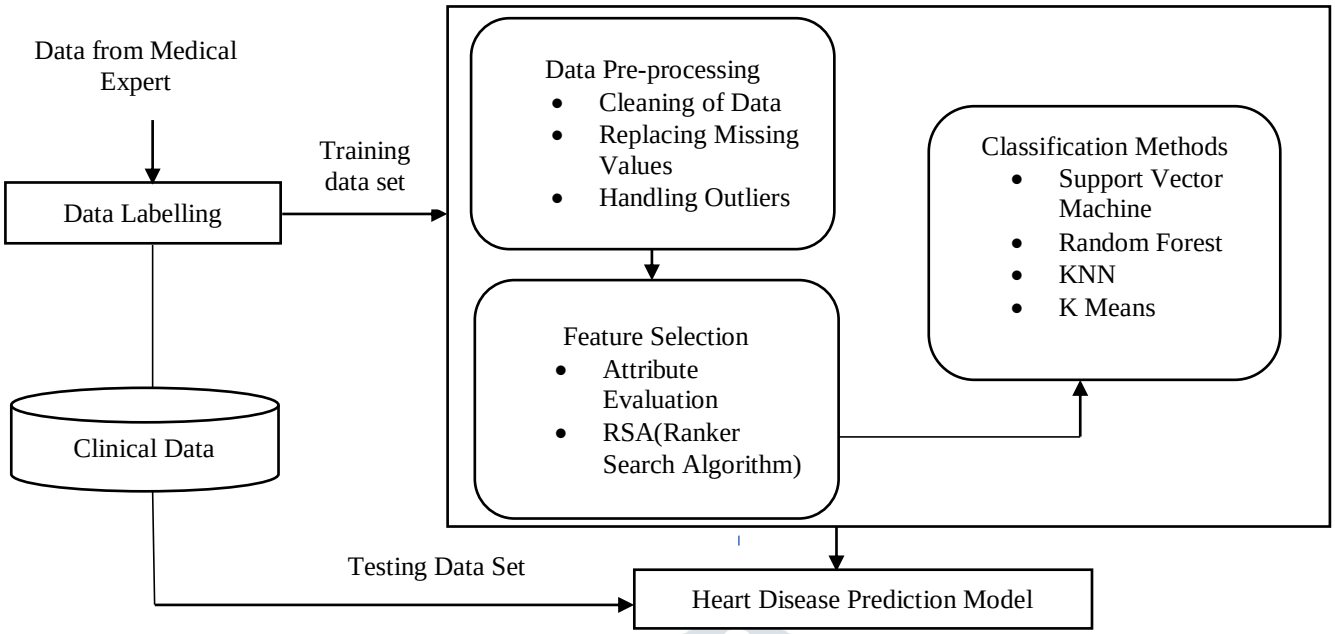

Figure 1: Heart Disease Prediction Model

There are various phases for forecasting heart disease, which are as follows:

a. Pre-processing of Data : Pre-processing the data is the initial step in the forecasting of the cardiac problem. It applies a variety of approaches to the supplied data to pre-process it and add wholeness. The best results are obtained in this method once the data is thoroughly analyzed. The data cleaning process is used to identify and get rid of reoccurring archives, misspellings, and dubious data. First, a mathematical filtering technique is used to identify the values absent in the data. This methodology enables the cleaning of numerical data, regardless of its size [9]. After creating and identifying the missing values, the average (mean) value in the allocated data is used to substitute these absent values by using filtering technique. Non-redundant and de-noised data are deployed during the attribute selection process as input. This process focuses on removing the dataset's insufficient properties. As a result, the training model is improved [10].

b. Feature selection: This step is primarily aimed at selecting the subset of exceptionally distinctive feature. This approach is used to choose properties that are connected to various existing classes. The dataset of heart disease includes a number of attributes. However, just a few of these characteristics are significant for deciding how to categorize disorders. In order to reduce the size of the feature vector to an appropriate sample size, the features are chosen based on the dataset values. Two tasks make up this process. A feature evaluator technique is used to compute the attributes of the dataset mostly based on the output class. Second, a search method is taken into account, using different combinations of features to choose the best set in order to answer the classification problem [11].

c. Prediction: This process maps the selected features upon the training model to categorize input features. The skilled cardiologist concentrates on labelling gathered dataset on heart disease in order to predict the outcome. The classification is regarded as a multi-class issue, and the medical information is divided into four different types of classes. As a result, each class is referred to as a certain heart disease group [12]. This stage helps determine the patient's likely disability based on several key characteristics.

1.1Machine learning Models for Heart Disease Prediction

An appropriate machine learning model is essential for high-quality outcomes. Clearly, an efficient machine learning model delivers good performance both on observed data during training (otherwise the machine learning model can only learn training data) as well as on hidden data. Following are the most frequently used ML algorithms for heart disease prediction.

a. Naïve Bayes: Naïve Bayes classification algorithms are a family of supervised learning algorithms planed according to Bayes' theorem with naïve independence assumption among the attributes. The NB algorithm provides greater accuracy in comparison with other classification algorithms [13]. The class variable y is related with attributes $x_1, \ldots\ldots, x_n$ in Bayes' theorem is expressed as:

$$P(y|x_1, \ldots., x_n) = \frac{P(y)P(x_1, \ldots., x_n|y)}{P(x_1 \ldots\ldots, x_n)} \quad (2)$$

This relationship can be simplified with the help of naïve independence assumption as:

$$P(y|x_1, \ldots., x_n) = \frac{P(y)\prod_{i=1}^{n} P(x_i|y)}{P(x_1, \ldots\ldots, x_n)} \quad (3)$$

When $P(x_1, \dots \dots, x_n)$ is independent of y, the classification rule is expressed as:

$$\hat{y} = {}^{argmax}_{y} P(y) \prod_{i=1}^{n} P(x_i|y) \tag{4}$$

In which the training set is utilized to estimate$P(y)$ and$P(x_i|y)$. Multiple variants are available in NB classification algorithm. However, Gaussian Naïve Bayes algorithm is often implemented by assuming the likelihood of attributes is Gaussian [14].

b. Support Vector Machine: Cortes and Vapnik developed a supervised Machine Learning algorithm termed as Support Vector Machine (SVM) that assists in dealing with the classification issues. The output of this algorithm is obtained in the form of two classes in a binary classification. Thus, this algorithm becomes a non-probabilistic binary classification model. SVM focuses on discovering a linear maximum margin hyperplane which leads to separate the instances [15]. Let the hyperplane be$w^T x + b = 0$, in which $w$is utilized to denote a dimensional coefficient vector that is normal to the hyperplane of the surface, b defines the offset value from the origin, and dataset values are denoted with x. In general, the w and b are employed to verify the hyperplane. The data points present nearer to the hyperplane are known as support vectors. In the linear case, Lagrangian multiplier α_i was utilized to solve the w. The equation of $w$can be expressed as:

$$w = \sum_{i=1}^{m} \alpha_i \, y_i x_i \tag{5}$$

In which m denotes the number of support vectors and y_i defines the target labels to x. The linear discriminant function is expressed as [16]:

$$g(x) = sgn\left(\sum_{i=1}^{m} \alpha_i y_i \, x_i^T x + b\right) \tag{6}$$

In above equation, sgn denotes the sign function to compute the sign of a number, $sgn(x) = -1$ in case $x < 0$, $sgn(x) = 1$ in case $x > 0$. A kernel function is employed to separate the data set non-linearly. The discriminant function is mentioned as:

$$g(x) = sgn\left(\sum_{i=1}^{m} \alpha_i \, y_i K(x_i, x) + b\right) \tag{7}$$

In which $K(x_i, x)$ represents the kernel function.

c. K-Nearest Neighbours (KNN): KNN algorithm is a kind of supervised ML (machine learning) algorithm which assists in dealing with the issues such as regression and classification. This algorithm is planned on the basis of existence of similar observations nearer to proximity. Assume $D_t = \{(x_1, y_1), (x_2, y_2), \dots, (x_N, y_N)\}$ denotes observations set of q-dimensional patterns with $X = \{x\}_{i=1}^{N} \subset \mathbb{R}^q$, a corresponding labels set is represented with $Y = \{y\}_{i=1}^{N} \subset \mathbb{R}^q$ and N ilustrates the number of training entities. Minkowski metric is utilized to define a similarity measure as:

$$\left\|x' - x_j\right\|^P = \left(\sum_{i=1}^{q} \left|(x_i)' - (x_i)_j\right|^p\right)^{1/p} \tag{8}$$

The distance is called Euclidean distance. This metrics is applicable for discovering the distance among a data set and query points. In case of multi-class classification, for an unknown patternx_0, the KNN technique is implemented to predict the majority class label of the K-Nearest patterns in data space as [17]:

$$f_{K-NN}(x') = arg \max_{y=N_k(x')} \sum_{i \in N_k(x')} L(y_i = y) \tag{9}$$

With $L(\cdot)$is indicator function, in which

$$L(y_i = y) = \begin{cases} 1 & if\ argument\ is\ true \\ 0 & Otherwise \end{cases} \tag{10}$$

The choice of k value is often obtained as odd numbers.

II. LITERATURE REVIEW

Anjan Nikhil Repaka, et.al (2019) described that suggested technique focused on detecting the coronary ailment based on prior data and information [18]. Therefore, NB (Naïve Bayes) implemented to build this technique so that the risk factors of coronary disorders were predicted. This technique aimed to extract some attributes in order to predict the probability of heart disorders. Diverse phases executed such as to gather the dataset, register and login the user, employ NB to classify the diseases, predict the data and implement the AES (Advanced Encryption Standard) model for transmitting the data securely. DM techniques helped in explaining and presenting MKA (multiple knowledge abstraction) techniques. These techniques adopted to predict the coronary disorders. The findings indicated that the suggested technique was effective to predict the risk factors of cardiac diseases successfully.

Ankita Dewan, et.al (2015) introduced a hybrid method in which GA (Genetic Algorithm) and BP (Back Propagation) algorithm were integrated to predict the diseases of heart [19]. The major emphasize was on developing a prototype to determine and extract the unspecified knowledge regarding coronary diseases from a prior database. The proposed method had the potential to handle challenging predictions of illnesses connected to health. Therefore, the medicinal doctors for making smart health related decisions that were not made by the conventional systems. The applicability of the introduced method was proved in forecasting the heart disorders and mitigating the cost for its cure.

Monika Gandhi, et.al (2015) analyzed that the DM (data mining) methods presented diverse methods for investigating the hidden patterns so that decision was made in healthcare organizations [20]. The major intend was to implement DM classifiers in the process of discovering data. These techniques had pros and cons to classify the data and extract the knowledge. Moreover, Neural Network, Decision Tree or Naïve Bayes algorithms were described comprehensively for adopting an algorithm which was applicable in medical organizations.

Rashmi G Saboji, et.al (2017) projected a scalable technique in order to predict the coronary diseases in accordance with some attributes [21]. These attributes were taken from the medicinal data. This work concentrated on detecting and predicting the heart diseases with regard to some attributes. RF (random forest) algorithm was exploited on Apache Spark. The physicians got a wide opportunity for making the insightful decision using this solution on a database of enormous size. The outcomes demonstrated that the accuracy of the projected technique was counted 98%. The comparison of the projected technique was done with the existing technique. The findings exhibited that the projected technique was more robust concerning important margin as compared to other methods.

T. John Peter, et.al (2012) suggested a PR (pattern recognition) and DM (Data Mining) methods [22]. These methods were implemented using the system effective of predicting the risk of heart diseases. DM methods assisted in modelling and classifying the data. The standard linear mixtures of variables were comprised in the input set due to which it became impossible for modelling the nonlinear compound associations in the healthcare field. The earlier methods suffered from this limitation. Thus, the classifiers were adopted for tackling such an issue as these algorithms were effective to detect complex nonlinear connections among several variables. Additionally, the possible interactions were detected among predictor variables using these methods. The suggested methods effectively diagnosed the coronary disorders.

Cincy Raju, et.al (2018) analyzed that the heart disease became the major reason of increasing mortality rate [23]. This disorder led to cause serious disability of long period. The coronary diseases laid impact on people quickly. Thereafter, the major focus was on diagnosing the heart disorder in primary phase to get the proper treatment. The improper diagnosis degraded the reputation of some hospitals. Analyzing the coronary disease was a complex issue. DM (data mining) methods aided in curing the diseases efficiently. Additionally, the cardiac diseases were diagnosed on the basis of DT (decision tree), NN (neural network), NB (naïve bayes), SVM (support vector machine), AR (association rule) and KNN (k-nearest neighbor) algorithms. The results indicated the supremacy of the SVM algorithm over others.

Aakash Chauhan, et.al (2018) analyzed that various patients relied on healthcare system to diagnose the coronary disorders accurately and quickly [24]. The healthcare platforms generated and gathered a large volume of data daily. Diverse methods adopted for extracting the data to acquire the useful information. The task of extracting the data manually was removed. DM (data mining) technique known as WA (Weighted Association) rule was suggested and utilized to extract the data from ER (electronic records). The suggested technique was reliable for mitigating the expenses of treatment and saving the lives of patients. Moreover, this technique was successful to predict the patients of coronary disorder. The results revealed the superiority of the suggested technique to predict the coronary disease in accurate manner.

V. Chang, et.al (2022) suggested a python-based application for healthcare research which offered reliability and helped in tracking and establishing diverse kinds of applications to monitor the health [25]. The application was developed in 3 stages in which the database was gathered, LR (logistic regression) was carried out and the attributes of dataset were computed. The coronary diseases were predicted using RF (random forest) algorithm ta higher accuracy. The major task was to analyze the data for this application. The results indicated that the suggested application offered accuracy of 83%. Moreover, this application performed more effectively as compared to other methods.

Y. Pan, et.al (2020) projected an EDCNN (Enhanced Deep learning assisted Convolutional Neural Network) for predicting the coronary disorder in patients effectively [26]. A deeper architecture was considered for covering MLP (multi-layer perceptron) 'algorithm with RL (regularization learning) techniques. The performance of the classification techniques was affected when the

attributes were mitigated with regard to processing time, and accuracy. IoMT (Internet of Medical Things) platform was applied to compute the projected algorithm to assist the doctors in diagnosing the information related to the patient who suffered from the heart disorders. The outcomes revealed the effectiveness and flexibility of the projected algorithm for determining the risk of cardiac diseases and this algorithm attained an accuracy of 99.1%.

III. RESEARCH METHODOLOGY

The human body's most vital organ is the heart. Its primary taskis to pump blood through the circulatory system's blood vessels. Therefore, it is crucial that this organ function properly in order to lead a healthy lifestyle. Heart illness of any kind affects not only the heart but also other bodily components. Researchers use computer-aided data that is produced from enormously large datasets to forecast heart illness. The use of DM methods and techniques is done by numerous organizations. DM approaches are employed in the medical field to forecast a wide range of diseases. Numerous risk factors exist, contributing to the occurrence of heart-related disorders.

The following are various stages that helped anticipate the cardiac disorder:

A. Data Acquisition: The goal of this process is to collect data from various medical organizations in order to conduct experiments.

B. Data preprocessing: In this phase, ML techniques are used to demonstrate accuracy and perform comprehensive analysis of the data. In order to increase the effectiveness of the training model and send clean and denoised data in the attribute selection phase, we process the data to remove unnecessary attributes from the dataset.

C. Feature selection: To diagnose heart disorders, a subset is used that contains very distinctive characteristics. The current class of attributes is used to deal with these chosen attributes. The RF method is used in this study to choose the qualities. Using 100 as a guess is done by the RF algorithm which focuses on building a tree structure with the most important properties.In order to accurately forecast heart illness, the best and most appropriate features are chosen using the random forest method.

D. Classification: The selected attributes are mapped to the training model to classify the attributes provided in this step.As a result, predicting the disease is straightforward. A specific cardiac problem category is defined for each class. In order to categorize the disease, the logistic regression model is used. The collected attributes are used as input in the logistic regression. This study project gives two categories—having heart disease and normal—that represent the likelihood that a person will develop heart disease and the likelihood that they won't.

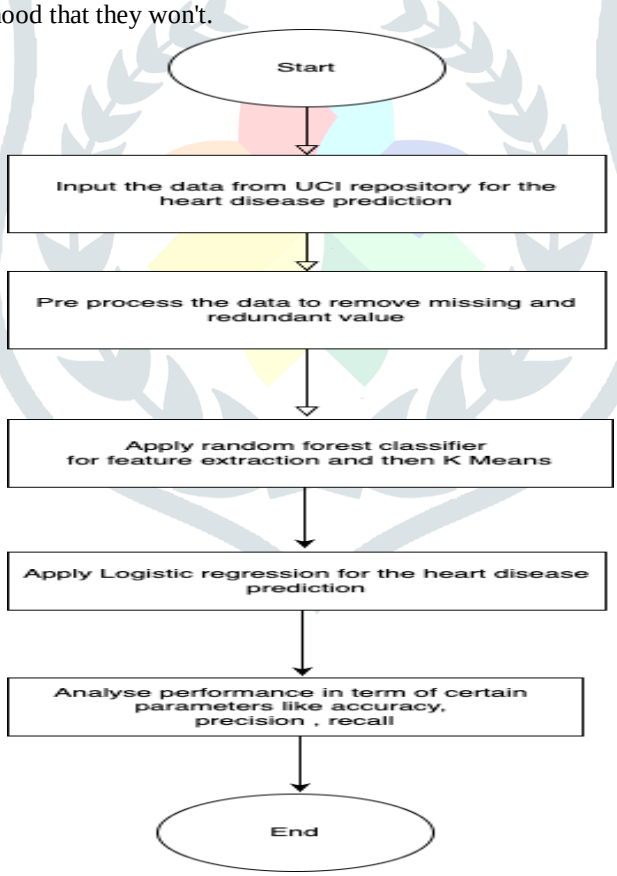

Figure 2: Presented Approach

IV. RESULT AND DISCUSSION

In order to forecast heart problems, this assessment applies the newly described approach to the Cleveland dataset. There are 14 parts to this dataset. This study focuses on utilising and contrasting several strategies to forecast heart illness . The suggested method is compared to ensemble classifiers based on DT (decision tree), NB (naive bayes), MLP (multilayer perc eptron), and RF (random forest) and NB methods with reference to various parameters.

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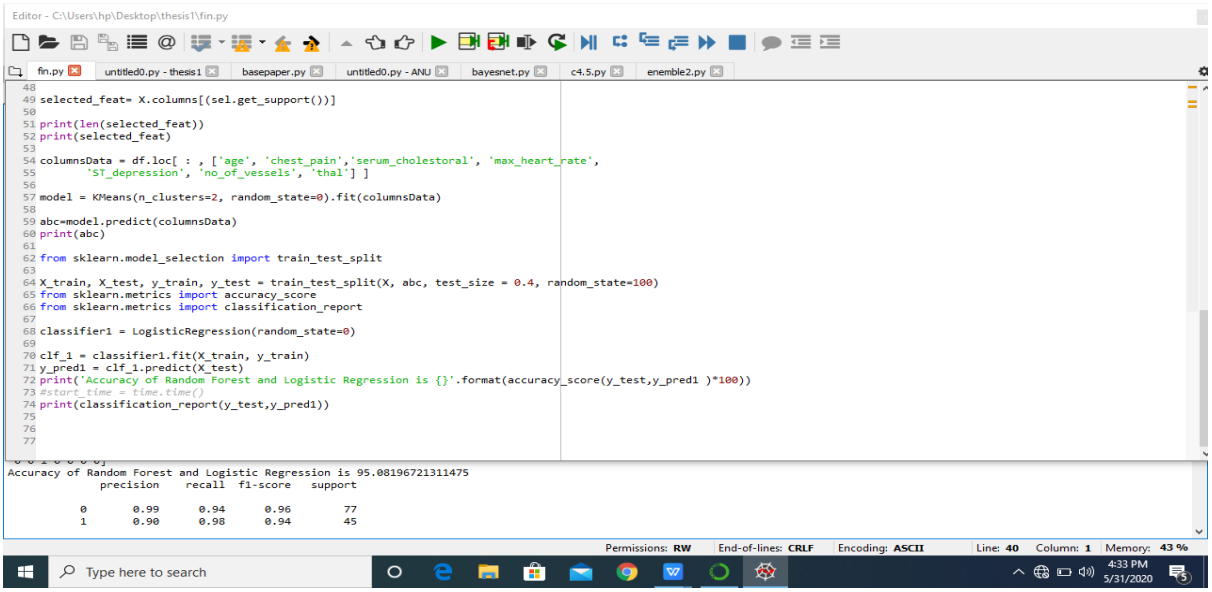
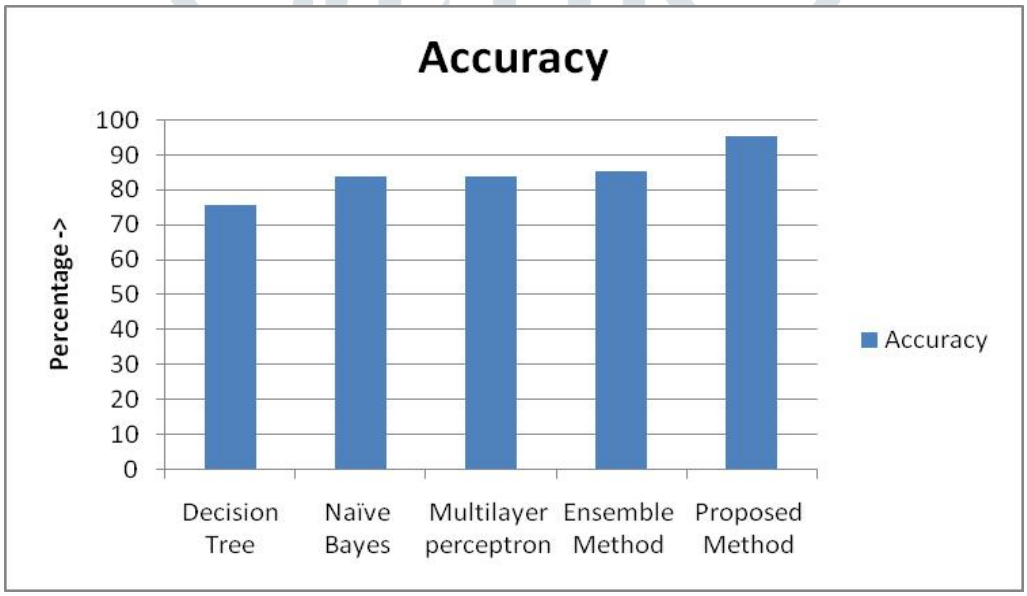


Figure 3: Demonstrated Classifier

Figure 3 illustrates the deployment of this dataset to predict coronary disorders. The introduced technique is proved capable of predicting the heart diseases.

Table 1: Accuracy Analysis



Models	Accuracy
Decision Tree	75.41 percent
Naïve Bayes	83.61 percent
Multilayer perceptron	83.61 percent
Ensemble Method	85.25 percent
Proposed Method	95.08 percent

Figure 4: Accuracy Analysis

The figure 4 demonstrates that various algorithms called DT (decision tree), NB (naïve bayes), MLP (Multilayer Perceptron) and ensemble classifier were compared with the introduced technique concerning accuracy. The outcomes revealed that the introduced technique offered 95% accuracy as comparison to various algorithms for predicting the heart disorders.

Table 2: Precision Analysis

Models	Precision
Decision Tree	75 percent
Naïve Bayes	84 percent
Multilayer perceptron	85 percent
Ensemble Method	86 percent
Proposed Method	95 percent

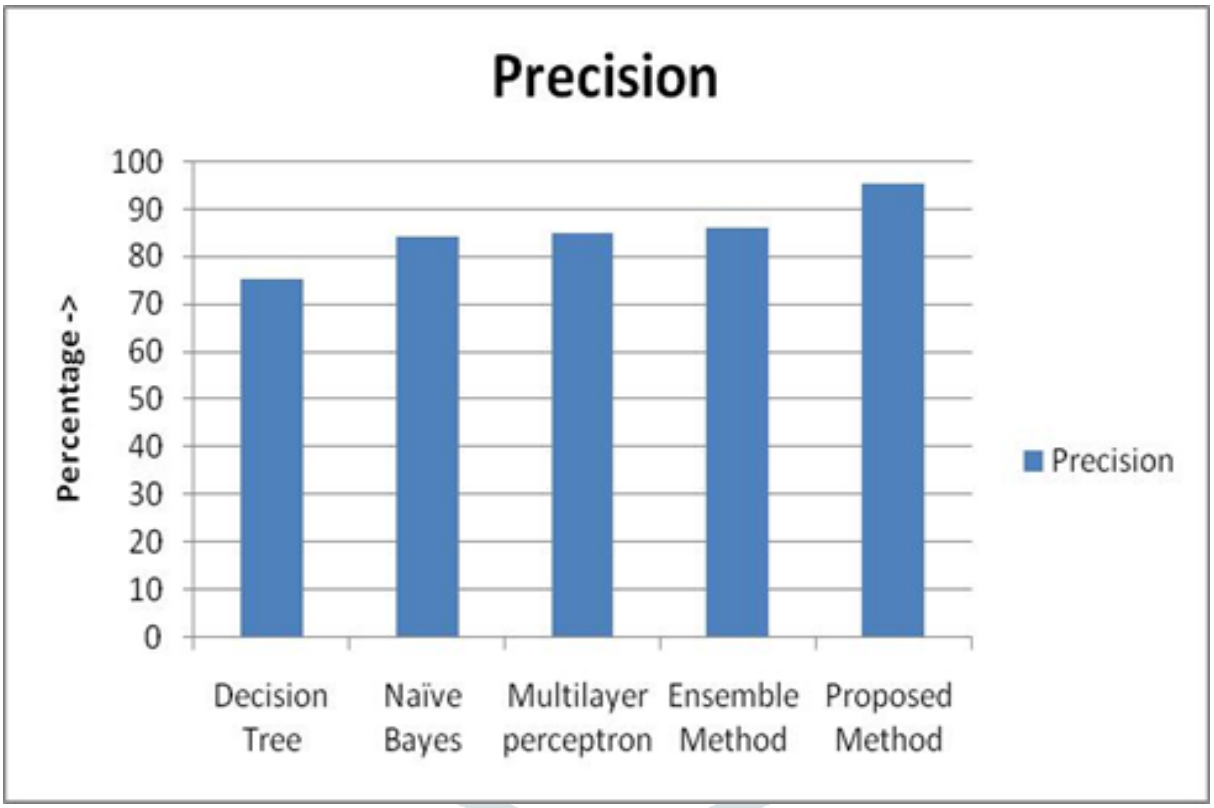


Figure 5: Precision analysis

The figure 4 demonstrates that various algorithms called Decision tree , Naïve bayes,Multilayer Perceptron and ensemble classifier were compared against the introduced technique concerning precision. The outcomes validated that the introduced technique offered 95% precision in contrast to the existing algorithms for predicting the heart disorders.

Table 3: Recall Analysis

Models	Precision
Decision Tree	75 percent
Naïve Bayes	84 percent
Multilayer perceptron	84 percent
Ensemble Method	85 percent
Proposed Method	95 percent

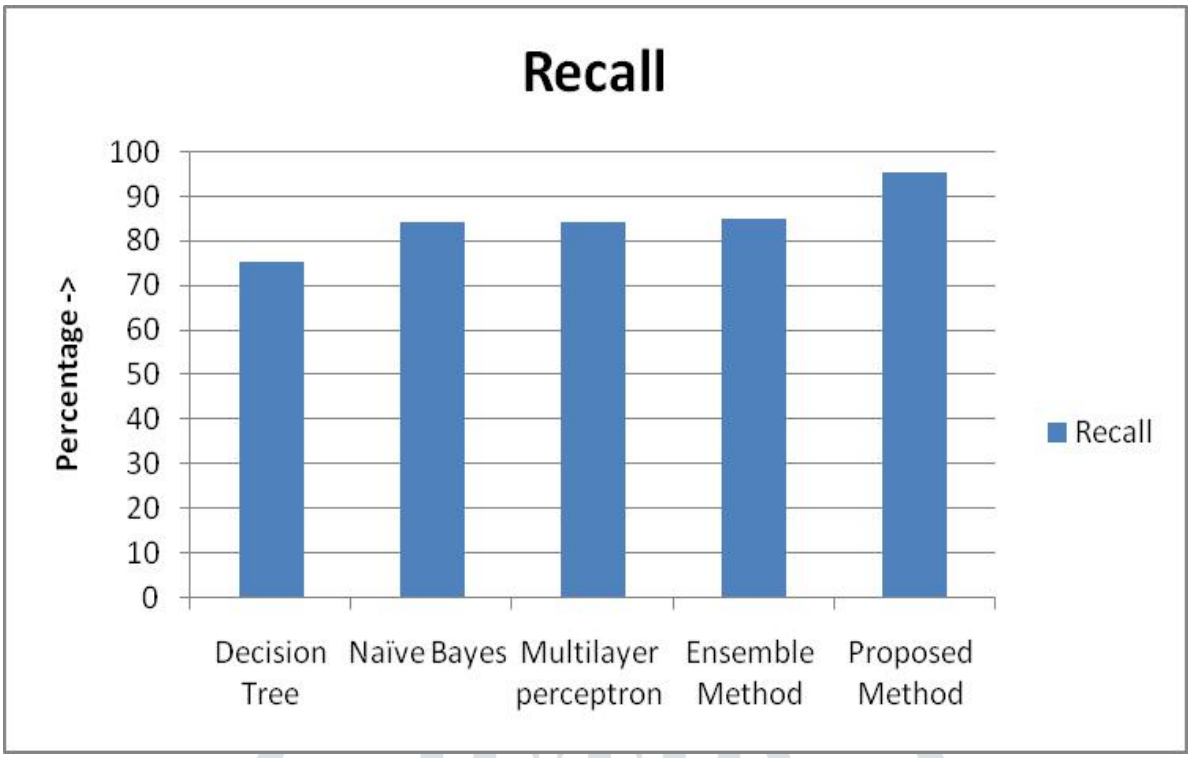


Figure 6: Recall Analysis

The figure 4 demonstrates that various algorithms called decision tree , NB naïve bayes, Multilayer Perceptron and ensemble classifier were compared with the introduced technique concerning recall. The outcomes exhibited that the introduced technique offered 95% recall over other algorithms for predicting the heart disorders.

V. CONCLUSION

The word "heart disease" refers to an illness that affects the heart. A problem that affects the heart, blood vessels, or circulatory system is known as coronary disease [9]. In addition, a heart disease is referred to as having troubles and problems in the heart. The CDC reports that heart disorders cause a number of deaths each year all across the globe, coronary disease is a cause of death. Different diseases are brought on by cardiac disorders that affect various organ segments. This experiment illustrates how difficult it is to anticipate cardiac disease because it has so many different characteristics. For the purpose of forecasting coronary illnesses, a novel technique incorporating RF and LR is presented. The properties taken from the Random Forest and LR are used in classification procedure. The introduced method offers 95% recall, accuracy, and precision.

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