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# Parametric Analysis of Chronic Heart Disease (CHD) Using Machine Learning

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ABSTRACT

When it comes to mobility issues and heart disease, a machine learning computer can make critical predictions. The remainder of the body is the largest and most concentrated organ in the human body when compared to the heart. Predicting cardiac disease via data analysis is a critical medical endeavor. The medical business throughout the world recycles machine learning. When it comes to machine learning, whether a person has mobility abnormalities or heart ailments is a critical consideration. In medical facilities, data analysis aids in the prediction of more information and the prevention of certain diseases. The study paper's major objective is to forecast a patient's heart condition using a machine learning method such as a random forest, which is the most reliable. Every month, a huge amount of patient data is archived. The information that has been collected can be utilized to make predictions about what illnesses will arise in the future. Certain data mining and machine learning technologies are utilized to anticipate cardiac illness, such as artificial neural networks (ANN), decision trees, fuzzy logic, K-Nearest neighbors (KNN), naïve bays and vector support equipment, for example (SVM). The final goal of this research is to examine the best python learning-based logistic regression model. It is a machine learning model. The heart disease data sets were utilized by the UCI machine learning depot.

**Keywords:** UCI Machine Learning, Heart Disease, Artificial Neural Networks (ANN), Decision Trees, Fuzzy Logic, K-Nearest Neighbors (KNN), Naïve Bays and Vector Support Machine.

## I. INTRODUCTION

An AI field known as machine learning (ML) is being used in cardiovascular care. A computer's main function is to evaluate data and classify work done by humans or machines. An input model (such as an image or piece of text) is utilized in the conceptual framework of ML to foresee outputs using mathematical and statistical analysis optimization (e.g., favorable, unfavorable, or neutral). Every day, several ML algorithms were put to good use. Face-to-face, manual, or fraudulent credit card transaction

detection may find non-linear trends using SVM, a standard ML method. So-called boosting algorithms for prediction and classification were used to identify spam e-mails and manage them. The RF approach, which averages many nodes, may help you make decisions more quickly. It's possible to create a CNN by layering and combining several picture classification and segmentation techniques. Despite our prior technical investigation of each of these algorithms, no consensus could be reached to guide the selection of specific algorithms for clinical use in the cardiovascular sector. Cardiovascular disease prognostics will benefit from a novel technique based on machine learning. In the health club, patient data is analyzed to identify important information using a variety of machine learning approaches. Age, sex, Thalach, Exang, Ca, Thal, Nun, and genetically modified risk factors such as hypertension and diabetes may also contribute to heart disease [2-4]. In addition to the above traits, lifestyle behaviors such as eating habits, inactivity, and obesity are important risk factors as well. Heart disease, angina, coronary congestion, cardiomyopathy, congenital heart disease, arrhythmias, and myocarditis are only a few of the many kinds of heart disease [5-7]. To get the project going, we could make use of a wide range of approaches and methods.

### 1.1 The Machine Learning

Machine learning is used in a wide range of applications. News Feed Recommendation Engine on Facebook, for example, is a well-known application of machine learning. Each user's newsfeed on Facebook is customised by an algorithm. If a member consistently stops reading messages in a group, the recommendation engine will start providing more of the feed activity from that group sooner. The engine is always working in the background, attempting to better understand how people are using the internet. If a user's habits change and he or she stops reading messages from a certain group for a period, the news feed will update.

### 1.2 Prediction of Chronic Heart Disease

Adult mortality and morbidity are mostly caused by cardiovascular disease (CVD) [8]. High blood pressure, smoking, LDL cholesterol, HDL cholesterol, diabetes, and other medical disorders are all risk factors for heart disease and stroke [8-9]. A predictive function's ability to distinguish between high- and low-risk people is limited. What counts is the order in which the dangers occur, not their absolute number. The utility of the risk function in various trials was examined and appraised in several papers. It's more difficult to quantify relative risk than it is to place an order. Risk that's been diluted relative to the original. As a further criterion, all populations' sickness risk factors would need to be identical. Different conclusions were drawn from the results of literature comparisons based on these criteria [10-12].

## II. REVIEW OF LITERATURE

In paper [13], Using machine learning and image categorization, this article describes how clinicians can more quickly identify heart problems. There is an introduction to machine learning, followed by a summary of heart disease diagnostic categorization algorithms.

Proposed in [14], There has been a generic architecture presented in this study for health forecasts. The accuracy, sensitivity, and specificity of these machine learning algorithms, as well as their exactness, error rates, and correctness, were among the criteria used to evaluate them.

The hybridized feature selection strategy that combined the genetic algorithm (GA) with the recursive elimination function to pick out the most relevant characteristics from the input dataset. Python was used to analyses the hybrid system's performance in a simulation environment, and the results were quite accurate [15].

In [16], A better selection strategy is used in this work to improve the present categorization system. Because of this, the prediction model's error rate is lower, and

it is more accurate. The proposed method, which is based on parameter data, is an outstanding decision support tool for physicians in forecasting the stages of cardiac disease.

An overview of illness detection and prediction strategies is provided in this study, including Nave Bayes, logistic regression, vector supporting machinery, neighbor K-nearest, K-mean, and random forests. To find out what medical conditions may be detected using machine learning algorithms, researchers have been looking into this topic for the last three years. This study compares a wide range of algorithms, evaluation methods, and outcomes. Finally, there's a discussion of earlier initiatives [17].

In [18], The purpose of this research is to uncover significant variables and successful data mining methods that may be utilized to enhance survival rates for cardiovascular patients. Patients' survival can be predicted using nine different models, including decision trees, adaptive boost classification, logical recovery, stochastic gradient classification, and logistic regression (SVM). Using experimental data with SMOTE, researchers found that ETC outperformed other models and had an accuracy of 0.9262 percent when used with SMO.

Machine learning is used in this research by [19], to classify subtypes and forecast risk, particularly for cardiovascular illnesses (ML). Current ML models are not routinely used to treat cardiovascular problems because to a lack of established criteria, and their practical application phase remains unknown. They take special measures before engaging in safe machine training for cardiovascular and other clinical diseases.

Published a paper [20] on coronary heart disease (CHD), a hot scientific area that necessitates early therapy or intervention for patients before it becomes deadly. As a result, it was suggested that a Modified Artificial Plant Optimization (MAPO) algorithm be used to forecast heart rate using a fingertip video set, which further predisposes a person to have or not have coronary heart disease.

## III. GENERAL PROCEDURE & METHODOLOGY

There are several applications for machine learning all throughout the world. It's the same in the health care industry as anywhere else. Locomotive Disorders, Heart Diseases [21], and other ailments may be predicted using machine learning. This information, if expected well in advance, may provide important insights for doctors who may then change their diagnosis and treatment in accordance with their patient base. and treatment plan.

### 3.1 Standard Algorithms

#### Naïve-Bayes Classification

The Nave-Bayesian classification affects Bayes' hypothesis with autonomy assumptions among features [22, 24]. The Nave Bayes model treats each variable on its own, making it possible to make predictions even when there is no meaningful link between them.

- class (target) hindsight probability given predictor P(c|x) (attribute)
- Before class probability is known as P(c).
- Class predictor P(x|c) is a probability.
- In other words, P(x) represents the predictor's chance of being correct.

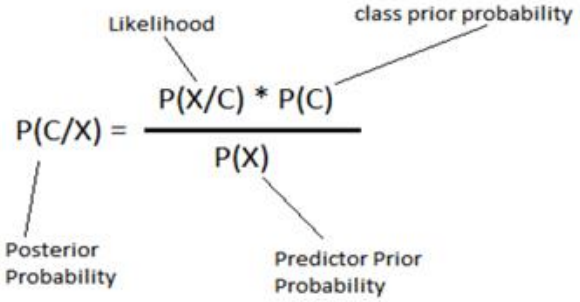


Fig. 1. Naïve Bayes process

#### K-means

In order to classify datasets, we employ a clustering technique called k-means to group data based on their similarity into k clusters. We next use k-means to fill in the missing data values. Clustering involves dividing the data into categories and then using those groupings to insert each dataset into a cluster if there

are missing values. Since we now know that the data can be used for prediction in Nave Bayes for prediction purposes, we can employ several prediction approaches to demonstrate this [23].

## Decision Tree

A DT may be used to classify both categorical and numerical data. It's employed in the construction of a tree-like edifice. The Decision Tree comes in helpful when dealing with the management of medical data. A tree-shaped graph's implementation and analysis are both straightforward. The decision-making model examines three nodes [24]. This strategy divides the data into two or more analogue sets, which are then subdivided again based on the main indications. Forecasters with the biggest data gain or the lowest entropy receive the most credit for the prediction. The entropy of each characteristic is calculated, and the data is then divided down.

$$\text{Entropy}(S) = \sum_{i=1}^{c} -Pi \log_2 Pi,$$

$$\text{Gain}\ (S, A) = \text{Entropy}(S) - \sum_{v \in \text{Values}(A)} \frac{|Sv|}{|S|} \text{Entropy}\ (Sv).$$

Findings are easier to comprehend and interpret now [3]. Using the dataset in the tree-like graph, this technique outperforms others in terms of accuracy. It's possible that the data has been over-categorized, and just one attribute is being examined for decision-making now.

## K Nearest Neighbor (KNN)

A supervised learning technique, the KNN algorithm is based on a genetic algorithm. It organizes items based on what's closest in proximity. It's a case-based approach to learning. The simplest technique, K-NN, creates noise and is hence ineffective [25].

## Random Forest Algorithm

The random forest technique employs many trees in a controlled algorithmic categorization strategy. The trees of this algorithm come together to form a forest. The trees in the random forest have class expectations, and the class with the greatest votes is utilized to make the model prediction [26]. The categorization will be more random as there are more trees in the forest. In general, people use one of three approaches:

- RI forest (inputs chosen at random);
- random-combination forest (RC forest)
- RI and RC Forest Combinations.

This method can deal with classification and regression issues alike, even if some data is missing. Furthermore, because generating predictions necessitates a big amount of data as well as a higher number of trees, the outcomes are rash.

## Linear Regression

Making reasonable judgments about real-world values is possible with its help (cost of homes, number of calls, total sales, etc.). (s). We've established a connection between the independent and dependent variables using a best-line model. Data may be described in terms of a linear equation: Y = a*X + b is an expression for the regression line, which fits the data the best [27].

## Logistic Regression-LR

Regression is a category, not a process. To estimate discrete values based on the collection of independent factors (s). By adding data to a login function, it calculates the probability that a certain event will occur. Logit regression, on the other hand, is well-known. 0 to 1 are possible outcomes since it forecasts probability (as expected).

## SVM

It's a system for classifying objects according to their similarities and differences. At first, the variables would be drawn in two-dimensional areas with two cords at each point [28], each with a single attribute, such as height and hair length (these co-ordinates are known as Support Vectors).

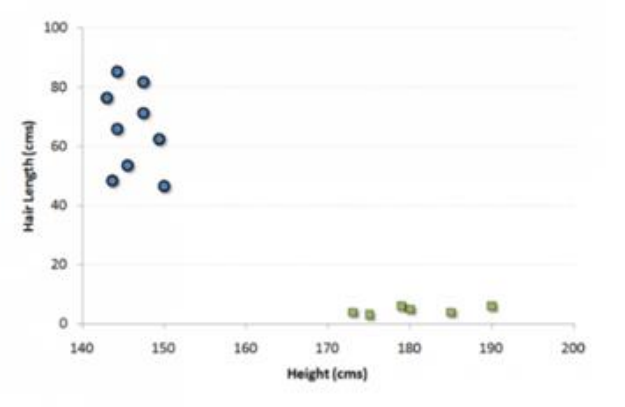


Fig. 2. SVM

Next, we look for a line that divides our classified data into two halves. Closest places of the two groupings are separated by a huge distance. This is when things start to get dicey.

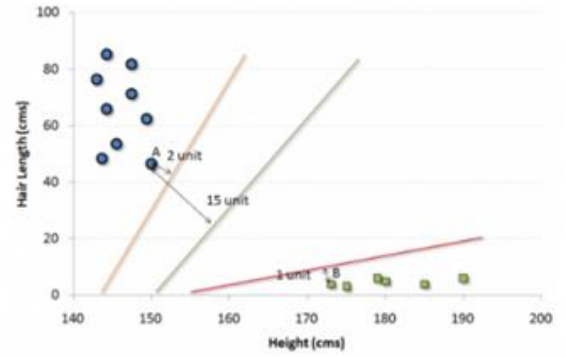


Fig. 3. SVM -data into two separate categories

See how the data is divided into two distinct groups when a black line cross it. Any item that fits into a specific category goes here. In this class, new data is assigned based on where the test data is situated on either side of the line.

### Random Forest

The word Random Forest serves as a metaphor for a group of people who are in the decision-making phase of the decision-making process. Each tree is planted and cared for in the following ways: When there are N examples in the training set, a random but replaceable sample is chosen [29].

### Neural Network

Neural networks, a group of machine learning algorithms used to represent complex patterns in huge data sets, include several hidden layers and non-linear activation functions. Using an input, a neural network processes information via numerous layers of hidden neurons (mini functions with unique coefficients that must be learnt) to produce a forecast that reflects all the neurons' inputs together [30].

### Neural Network Classifier

When utilizing the NN, you may think of it as a typical regression classifier that first changes the input using non-linear regression learning before doing the final classification. This alteration divides the supplied data in half using a straight line. Hidden layers are those which aren't apparent to the human eye, such as those found in software. It just takes one hidden layer to turn NNs become a universal standard [31]. With only one hidden layer, a NN (Artificial Neural Network — ANN) may be stated like this: in bold

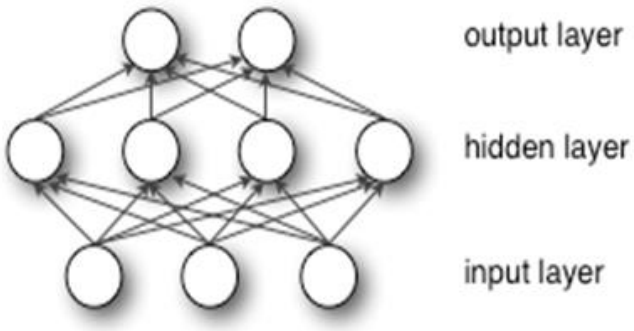


Fig. 4. Neural network

## IV. RESULT AND SIMULATION

It's necessary to use the preprocessed data from the UCI library, and then perform machine learning on it in the MATLAB environment. The following are the most important steps in using the collected data to make a prognosis about cardiac heart disease.

### Procedures

STEP 1:Identify critical heart data features. For statistical analysis, the characteristic with the smallest and largest available data sets is chosen.

STEP 2:Using a mathematical investigation, determine the normative facts.

STEP 3:It's time to figure out how to keep lost qualities from reappearing.

STEP 4:Use the medium and median data set to fill in the missing numbers.

STEP 5:Use a 70:30 split of the test and training data for this step.

STEP 6:Run the ML-learning algorithm for train data collection in STEP 6.

STEP 7:Analyze the results.

STEP 8:Improve the current work by integrating scaled fuzzy systems.

STEP 9:Create a visual representation of the data you've gathered in the previous steps.

## Prediction of Heart Disease

The dimension reduction approach is generally used by ML algorithms to lower the size of the data collection [32]. Filtering crucial data sets that have the biggest influence on illness begins with this first step and the most fundamental method. This forecast contains the following stage, for which the data has already been prepared.

- To condense the most critical information.
- The treatment for a missing value (Replace the shapes or median values of the blank spaces).
- Split the dataset in half and create two new ones.
- We'll start with a dataset for testing, and then move on to one for training.
- Organize your data sets properly.
- Increase your level of accuracy.
- Find the algorithm with the highest degree of accuracy.

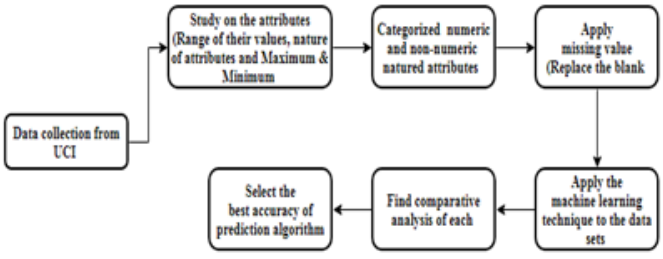


Fig. 5. Process of Prediction and Analysis

## Flow Chart of Execution

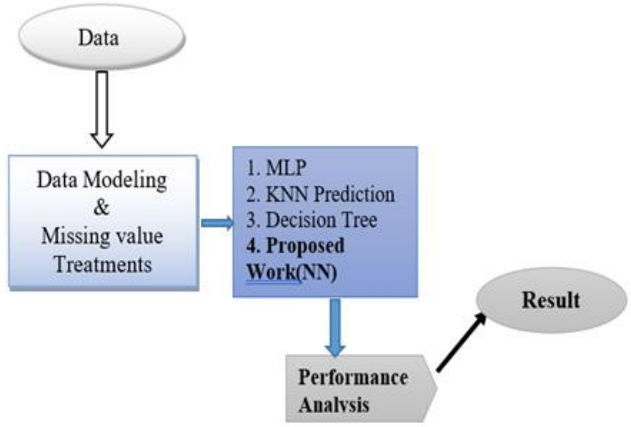


Fig. 6. Flow Chart of Execution

## Result and Discussion

This was added to the MATLAB source code. The following table illustrates how well cardiac data may be predicted from the data supplied above with respect to accuracy. So, we can see that f-accuracy, call's precision, and reliability are on par with what we've seen from previous techniques.

## Frequency Distribution of Data

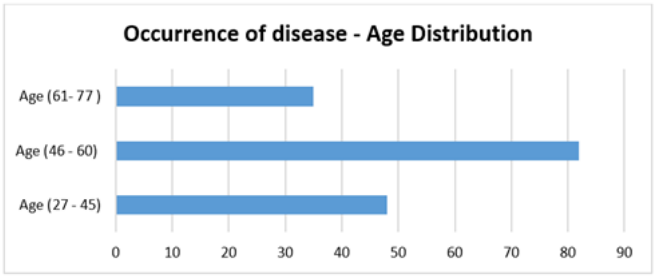


**Fig. 7. Age wise Frequency of heart disease**

The graphic above shows the age-sensitive incidence of cardiac disease. This analysis is easy to distribute.

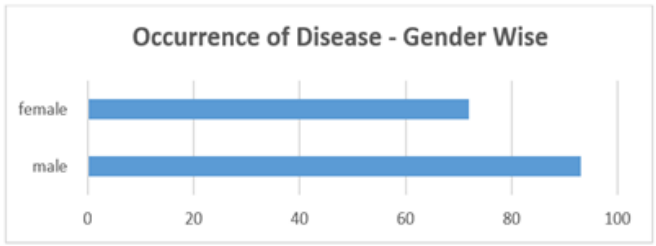


**Fig. 8. Frequency of disease - Gender Wise**

The graph above illustrates the frequency with which disease occurs according on gender. This research is simple to disseminate.

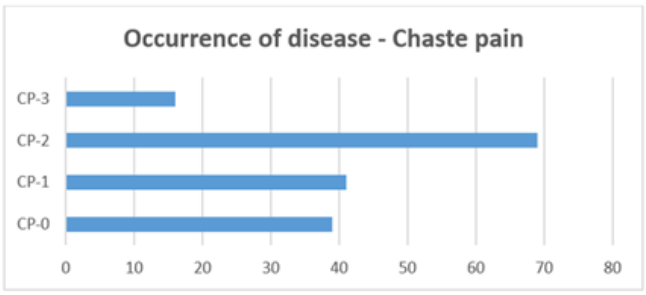


**Fig. 9. Frequency of disease - Chaste pain**

An example of how often chaste pain occurs is seen in the figure on the right. This research is simple to disseminate.

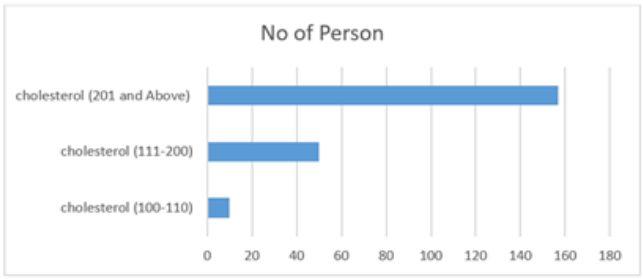


**Fig. 10. Frequency of disease - Cholesterol**

The graph above depicts the patients' cholesterol levels based on measurements made throughout the course of treatment.

### Prediction Analysis

The effectiveness, accuracy, and significance of each data collection are evaluated using a variety of methodologies in this study. The study put a lot of attention on looking at the 11 most effective categorization algorithms. Logistical regression (LR), KNN, and Decision Tree (DT) are a few examples. The accuracy, recall, and measurement findings have been reported in numerical and graphical form.

### Data Set

The data used in the experiment was obtained from the Kaggle Library of Experiments. The following is a link to the repository that was discovered. Kaggle's repository of data was used to gather this data set. There are 13 qualities in all, and 10 of them have a major influence on an active illness. In addition, these variables include things like age, gender, height, and weight as well as ap lo (Diastolic blood pressure) and ap hi (Systolic blood pressure). https://www.kaggle.com/sulianova/cardiovascular-disease-dataset

### Result After MATLAB

Table 1. Comparisons of Results

| | knn_results | dt_results | mlp_results | Proposed |
|---|---|---|---|---|
| Accuracy | 57.3333 | 67.8667 | 70.8000 | 95.6429 |
| Precision | 58.7067 | 70.9749 | 74.0019 | 95.1905 |
| F-Score | 59.2611 | 66.2573 | 69.2217 | 96.3262 |
| Time | 1.0830 | 0.6147 | 7.6302 | 49.4291 |

Table 2. Comparative Analysis

| Model | Techniques | Productivity Tool | Accuracy |
|---|---|---|---|
| **Otoom et.al.** | Naves Bayes<br>SVM<br>Functional (Decision) Root Function | Weka-Pro | 84.45 % (All) |
| **Shubhankar Rawat** | SVM Logistic Regression | Python | 80.32 % |
| **Proposed** | KNN<br>Decision Tree-DT<br>Multi-Layer Perceptron-MLP<br>Proposed NN | MATLAB | 57.33<br>67.86<br>70.80<br>95.64 29 |

Methods for Disease Modeling Otoom and colleagues examine the precision of tools. Using weka techniques, Vembandasamy et al. investigated on cardiac data sets and discovered a level of precision of 86.4 percent. As opposed to that, our suggested study has a detection

accuracy of above 97.24 percent. The proposed (Scaled Fuzzy Logic Sampling) method has been successful in predicting cardiac data.

Classifiers have been used to classify the data for accuracy, precision, and F1-Score in the prediction of heart disease.

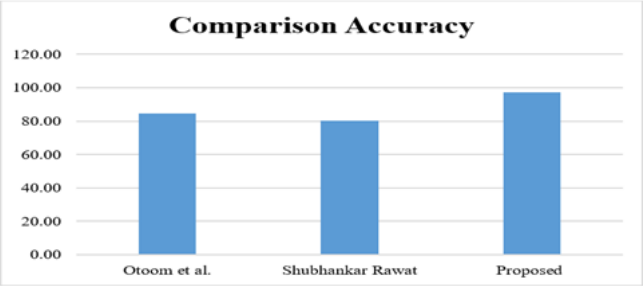


**Fig. 11**. Comparison Accuracy

Using machine learning methods, all eleven classifiers in the table above have been tested and shown to be accurate. The results shown in the table above may easily be compared to the precision value's degree of accuracy. Results showed that KNN had the best accuracy, followed by DT and MLP, with 95% accuracy, with Proposed NN-based Scaled Fuzzy Logic Sampling coming in fourth. Picking the optimal classifier for prediction and designing the framework should take accuracy into account while selecting a classifier.

## V. CONCLUSION AND FUTURE WORK

Cardiac prediction algorithms are discussed, and an algorithm is used to assess how accurate the categorization strategy is. These approaches are described in detail in this paper. This study evaluates the consistency, accuracy, and significance of F1 for different learning algorithms in each data collection. It would be nearly impossible for future civilizations with vast populations to have enough doctors to treat everyone. We can now make more precise predictions for all three data sets investigated in this dissertation because to this study. For this report, the best computer algorithms for each data set produce a different conclusion. Variety in machine learning techniques shows variable forecasting accuracy. A wide range of accuracy, precision, and F-scores are available from this unique data set.

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