CLASSIFICATION OF HEART DISEASE USING ARTIFICIAL NEURAL NETWORK

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This thesis report has been submitted in fulfilment of the requirements for the degree of Bachelor of Science in Software Engineering

Approval

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It is officially declared that **Farzana Shahrin**, 181-35-2340, completed this thesis under the supervision of **Ms. Nusrat Jahan**, Assistant Professor, Daffodil International University's Department of Software Engineering. It should also be stated that neither this thesis nor any part of it has been submitted to any other university for the purpose of receiving a degree.

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ABSTRACT

We are living in a postmodern time and there are colossal changes happening to our everyday schedules which make an effect on our wellbeing both emphatically and contrarily. As a result of these changes, different sorts of illnesses are exceedingly expanded. Heart disease has ended up more common these days. Variety in Blood weight, sugar, beat rate etc. can lead to heart maladies that incorporate limited or blocked blood vessels. It may cause Heart disappointment, Aneurysm, Fringe course infection, Heart assault, Stroke and indeed unexpected cardiac capture. Numerous shapes of heart disease can be recognized or analyzed with diverse restorative tests by considering family therapeutic history and other variables. In any case, the expectation of heart maladies without doing any restorative tests is very troublesome. The point of this venture is to analyses diverse heart disease and to create all conceivable safeguards to anticipate at an early stage at a reasonable rate. For heart disease classification, we use an Artificial Neural Network Algorithm.

Keywords: Heart Diseases, Artificial Neural Network.

CHAPTER 1

INTRODUCTION

1.1 Background

There are so numerous infections which influence us severely and one among them is Heart Disease. It may be a genuine malady since we frequently hear that most of the individuals die from Heart Disease and other sorts of comparable infections related to heart. It is watched by most of the therapeutic researchers that at numerous times most of the heart patients might not survive heart assaults and they die with it. Heart disease is the driving cause of passing for male, female and individuals of most racial and ethnic bunches within the Joined together States[1].One person passes on each 36 seconds inside the Joined together States from cardiovascular disease[2].According to World Wellbeing Association (WHO) information, heart malady is the driving cause of mortality[3].Heart disease is any unpredictable circumstance that is affecting a human's heart[4].Over 17.9 million people lost their lives due to cardiovascular disease , 80% from the total deaths are caused by coronary heart disease[5]. There are different types of heart disease, each of them affect the heart differently. Coronary heart disease, congenital heart problems, arrhythmia, myocardial infarction, and other types of heart disease are among the most frequent. When the blood arteries or the heart itself are injured, cardiac disease can develop [6].Heart disease can be diagnosed by doing physical exams and blood tests .Noninvasive tests include, for example, echocardiograms, stress tests, carotid ultrasounds, Holter monitors, CT scans, and others [7].Nowadays, with so much electronic health data, computer machines have entered the field to aid in diagnosis through Artificial Neural Network algorithm.

1.2 Motivation of the Research

Despite the fact that heart disease is one of the world's worst diseases, it's crucial to keep it under control. Its rate could be reduced by early detection. Angiography was the most prevalent approach for treating coronary artery disease. Angiography is the most expensive and has the most side effects. Because of the difficulties in detecting heart diseases due to risk factors, modern technologies for detecting the presence of cardiac disorders have evolved. Because it is difficult to manually identify cardiac abnormalities, traditional procedures are utilised, which are mostly based on the evaluation of patient data.

Therefore we want to develop a system to classify heart disease using ANN .

1.3 Problem Statement

Heart disease can be viably overseen with a combination of dietary changes, medicine, and, in a few circumstances, surgery. The side effects of heart disease can be decreased and the heart's work moved forward with the proper treatment. Anticipated results can be used to maintain a strategic distance from and subsequently lower the fetched of surgical treatment and other

costs. There are strategies that can estimate heart malady, but they are either as costly or incapable for calculating the hazard of heart malady in humans. The mortality rate and by and large results of heart disarranged can be decreased on the off chance that they are detected early. In any case, it isn't doable to precisely assess patients every day, and a doctor's 24-hour meeting isn't accessible since it requests more tirelessness, time, and involvement. We may utilise different profound learning calculations to examine the information for covered up designs since we have a part of information in today's world. In pharmaceutical information, the covered up designs can be utilised for wellbeing determ

1.4 Research Question

How does ANN help to analyse and predict Heart Disease?

1.5 Research Objectives

Heart disease is well known as life taking disease. Not only in the United States but also in many other countries it is one of the most common deadliest diseases. Diagnosing heart disease is quite difficult and time consuming and also costly. Many researchers worked on developing models to predict heart disease so it can be detected at an early stage .So that many patients could be rescued from death.

1.6 Research Scope

This research would be helpful for hospitals, clinics and cardiology research centers. This research could be helpful in reducing death caused by heart disease.

1.7 Thesis Organisation

The remaining part of the paper is laid out as follows. The second chapter gives a brief overview of some previous research that is relevant to this study. A basic summary of research methods is included in Chapter 3. The outcomes are described in Chapter 4. Finally, Chapter 5 discusses the research's future plans as well as some recommendations.

CHAPTER 2

LITERATURE REVIEW

Author	Year	Paper	Method	Findings
Farzana Taslim, Umme Habiba[8]	2021	A Comparative Study on Heart Disease Prediction Using Data Mining Techniques and Feature Selection	Naive Bayes,Support Vector Machine, k-nearest neighbour ,decision tree, Neural Networks,Logistic regression	Accuracy from NN was 86%

Farzana Tasnim and Umme Habiba (2021) proposed data mining techniques to predict the probability of coronary heart disease: Naive Bayes (NB), Support Vector Machine (SVM), k-nearest neighbours' (k-NN), Decision Tree (DT), Neural Network (NN), Logistic Regression (LR), Random Forest (RF), Gradient Boosting. They discovered that the Neural Network provides the highest level of accuracy.

Author	Year	Paper	Method	Findings
Monika Gandhi, Dr.Shailendra Narayan Singh [9]	2015	Predictions in Heart Disease Using Techniques of Data Mining	Decision tree,neural networks, naive bayes	Authors found that despite some disadvantages neural networks work well in classification problems.

Monika Gandhi, Dr.Shailendra Narayan Singh (2015) adopted some data mining techniques like decision tree,neural networks, naive bayes to predict heart disease.These algorithm are analysed on medical data sets.Authors found that despite some disadvantages neural networks work well in classification problems.

Author	Year	Paper	Method	Findings
EO Olaniyi, OK Oyedotun,K Adnan [10]	2015	Heart Disease Diagnosis Using Neural Network Arbitration	Neural Networks,SVM	This research says that classification accuracy is 85%

EO Olaniyi, OK Oyedotun, and K Adnan presented a strategy to prevent misdiagnosis, which is the most common error made by clinicians. The feed forward multilayer perceptron and support vector machine were used to model the intelligent system. For feedforward multilayer

perceptron and support vector machine, the results were 85 percent and 87.5 percent, respectively.

Author	Year	Paper	Method	Findings
Anchana Khemphila, Veera Boonjing [11]	2020	Heart disease Classification using Neural Network and Feature Selection	Neural Network	Findings 82%.

Information Gain was utilised by Anchana Khemphila and Veera Boonjing (2020) to determine the qualities, reducing the number of attributes that needed to be collected from patients. Patients' diagnoses are classified using an artificial neural network. The number of qualities is reduced from thirteen to eight. In the training data set, the accuracy difference between 13 and 8 features is 1.1 percent, while in the validation data set, it is 0.82 percent.

Author	Year	Paper	Method	Findings
Voon Khai, Ng Yung Meeng, Nur Farahiyh Mohammad, Nor Hazlyna Harun,Hiam Alquran and Mohamad Farah Mohamad [12]	2021	Classification of Heart Disease Using ANN	Artificial Neural networks	Authors come to the conclusion that ANN is suitable and powerful technique for classification any kind of foetal or chronic disease The accuracy is 80.66%

Voon Khai, Ng Yung Meeng,Nur Farahiyh Mohammad, Nor Hazlyna Harun,Hiam Alquran and Mohamad Farah Mohamad (2021) proposed ANN to classify heart disease. They used sigmoid activation function to yield the result .They found 80.66% accuracy. Authors found that ANN is good to classify heart disease.

Author	Year	Paper	Method	Findings
Tülay KarayÕlan,Özkan KÕlÕç [13]	2017	Prediction of Heart Disease Using Neural Network	Neural networks	Authors classified heart disease in multiplelayers.They found 82% accuracy ,86% recall and 72% precision.

Tülay Karaylan,zkan Klç (2017) developed and suggested an artificial neural network backpropagation algorithm for prediction of heart disease. The neural network was fed 13 clinical features as input and then trained with a backpropagation technique to predict the presence or absence of heart disease.

Author	Year	Paper	Method	Findings
Amin Ul Haq, Jian Ping Li,Muhammad Hammad Memon, Shah Nazir, and Ruinan Sun[14]	2018	A Hybrid Intelligent System Framework for the Prediction of Heart Disease Using Machine Learning Algorithms	Artificial Neural Networks	Researchers found classification accuracy is 80.41%.

Amin Ul Haq, Jian Ping Li, Muhammad Hammad Memon, Shah Nazir, and Ruinan Sun (2018) suggested a technique that can quickly distinguish healthy persons from people with cardiac disease. They used ANN to create the model. The accuracy of classification was determined to be 80.41 percent.

SUMMARY

From the above literature review we can see that Artificial Neural Network is good for c;assifying or predicting heart disease . Many researchers prefer this technique . The accuracy could be increased by adding a few other techniques. The accuracy differs according to feature selection and pre-processing. Reviewing these research papers we could say that ANN can be good for classification of heartheasease and other chronic and foetal diseases . However it has some disadvantages too. Such as

- Hardware is required for ANNs to work.
- We may not be able to define what is the right network topology of an Artificial Neural network because its functionality is similar to that of the human brain.

- When an artificial neural network delivers a solution to a problem, we have no idea on what basis it will supply the solution, and ANN is not reliable this time.

CHAPTER 3

RESEARCH METHODOLOGY

For this research we used a deep learning algorithm - Artificial Neural Network. Firstly, we collected data from UCI Machine Learning Repository.Then we load raw dataset and pre-process them. After processing data, we split data into test and training data. Later, The training set contained a known output, and the model learned about that data in order to generalise it to other data later. There was also a test set, which was used to test the model's prediction on that sub-set. The training set was then fitted by an algorithm, which produced a model. The intended prediction is obtained after evaluating the test dataset.

3.1 The Methodology Diagram

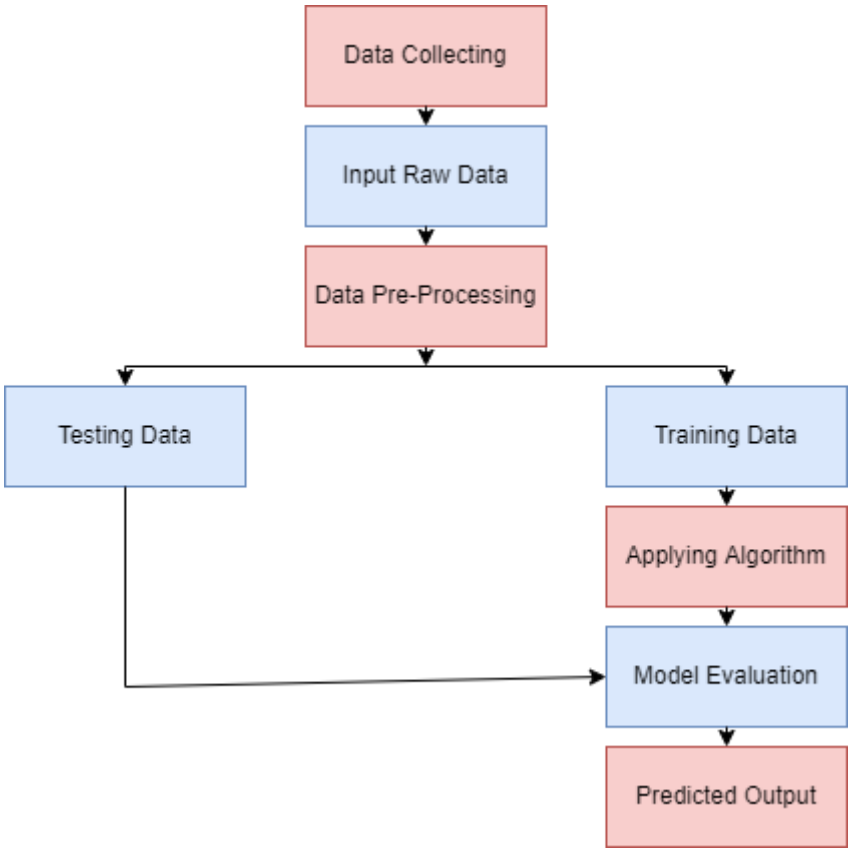

Fig3.1: Methodology Diagram

3.2 Procedure of Data Collection and Dataset

The dataset is collected from UCI machine learning repository.In spite of the fact that there are 76 qualities in this database, all distributed considers as it were to utilise a subset of 14 of them. The Cleveland database, in specific, is the as it were one that has been utilised by machine learning analysts to date. Link to the dataset:
https://archive.ics.uci.edu/ml/machine-learning-databases/heart-disease/processed.cleveland.data [15]
Feature Selectoin :Two qualities related to age and sex are utilized to identify the patient's personal information from the data set's 13 attributes. The next 11 attributes are significant because they provide critical clinical data. Clinical data are essential for determining the degree of cardiac disease and diagnosing it.

Table 1: Description of attributes

Attribute	Description
Age	Patient's age in years completed
Sex	Gender of the Patient (male represented as1 and female as 0)
Cp	There are four types of chest pain: 1. typical angina, 2. atypical angina, 3. nonanginal pain, and 4. asymptomatic angina.
Trestbps	Blood pressure in the resting state (in mm/Hg at the time of hospital admission)
Chol	cholesterol levels in the blood in mg/dl
Fbs	Fasting blood sugar levels > 120 mg/dl; expressed as 1 in real cases and 0 in false cases.
Restecg	The results of an ECG taken while at rest are divided into three categories: Value 0 represents normal condition, Value 1 represents abnormality in ST-T wave (which may include inversions of T-wave and/or depression or elevation of ST of > 0.05 mV), and Value 2 represents any possibility or certainty of LV hypertrophy based on Estes' criteria.
Thalach	The achievement of the maximum heart rate
Exang	Exercise-induced angina. 'No' is represented by 0 and 'yes' is represented by 1.
Oldpeak	In comparison to while you're at rest, exercise causes ST depression.
Slope	ST segment measured in terms of the slope during peak exercise depicted in three values: 1. unsloping, 2. flat and 3. downsloping

Ca	Fluoroscopy coloured major vessels numbered from 0 to 3
Thal	The state of the heart is represented by three unique numerical values. Normal defects are numbered 3, fixed defects are numbered 6, and reversible defects are numbered 7.
Target	Heart disease status . 0=Normal , 1=Heart disease

3.3 Data Pre-processing

In this step the data cleaning, data reduction, feature selection and data transformation has been made to prepare the best quality datasets for further analysis. This database contains 76 attributes, but all published experiments refer to using a subset of 14 of them that are directly involved in heart disease and help to classify the disease. This pre-processing includes-

- Convert categorical column names to indicator variables using pandas.get_dummies(dataset).
- Scale some columns with scalable columns, such as 'age', 'chol', 'oldpeak', 'thalach', 'trestbps', 'chol'.
- Split the dataset into 80% training and 20% testing.

3.4 The Data Analysis Technique

Artificial neural Network:
Frank Rosenblatt proposed the ANN approach in 1958 [16]. Artificial neural systems, regularly known as neural systems (NN), are computing frameworks that are demonstrated after the natural neural systems that make up human brains.
Artificial neurons are a set of associated units or hubs in an ANN that freely reproduce the neurons in an organic brain. Each connection can send a flag to other neurons, a bit like neural connections in a human brain. An artificial neuron receives a flag, investigates it, and after that sends signals to neurons it is associated with. Each neuron's yield is created by a few non-linear work of the sum of its inputs, and the "flag" at an association could be a genuine number. Edges are the terms for the associations. The weight of neurons and edges is regularly balanced as learning advances. The flag quality at an association is expanded or diminished by the weight. Neurons may have an edge that permits them to send a flag as it were in the event that the total flag surpasses it. Neurons are ordinarily gathered into layers. On their inputs, partitioned layers may apply distinctive changes. Signals move from the primary (input) layer to the final (yield) layer, maybe after navigating the layers a few times.
Neural systems learn (or are prepared) by dissecting cases with a known "input" and "yield," building up probability-weighted affiliations between the two that are put away inside the net's information structure. The contrast between the network's handled yield (ordinarily a forecast) and a target yield is as often as possible decided when preparing a neural organiser from a given

test. This disparity is the imperfection. The arrange at that point adjusts its weighted affiliations utilising this mistake esteem and a learning methodology. With each alter, the neural arrangement will make yield that's increasingly comparable to the objective yield. The preparation can be finished based on indicated criteria after an adequate number of these adjustments have been made. Administered learning is the term for this [16]
Three layers make up ANN. Input layer, hidden layer, and output layer are the three layers. Hidden level nodes must be linked to input level nodes. With the nodes of the output layer from each hidden layer node the data is taken from the network by the input layer. The input layer accepts data, next the hidden layer processes it, and finally the output layer generates output. [17] Preceding information for neural networks is stored in the input layer. Hidden Layer: a layer that sits between the input and yield layers and is where all of the computing takes place. Output Layer: Produces output for the specified input layer.

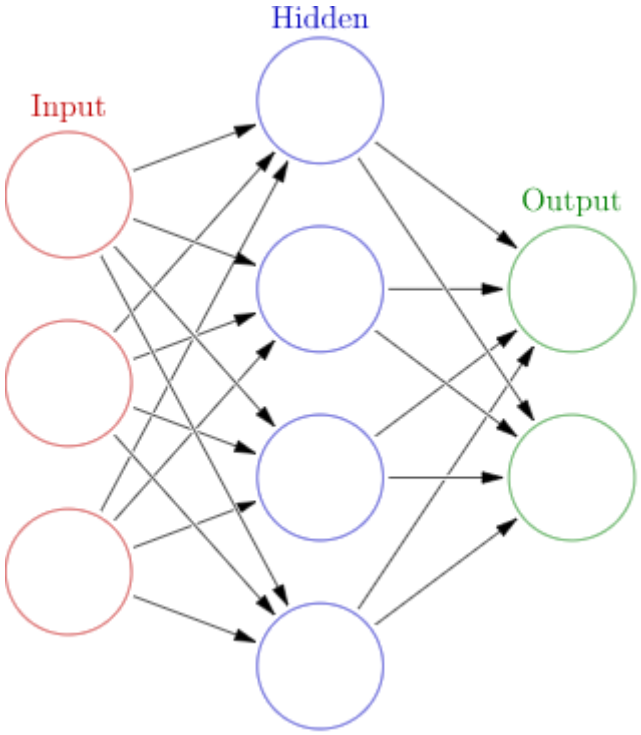

Fig 3.2: Architecture of Artificial Neural Network

Neurons are ordinarily gathered into layers. On their inputs, partitioned layers may apply distinctive changes. Flag voyages from the primary (input layer) to the ultimate (yield layer), perhaps numerous times. A heart illness expectation system was developed utilising the Backpropagation Calculation, which could be a common Artificial Neural Network learning technique. The Backpropagation Algorithm is the best classification algorithm for heart disease prediction since it is the only technology that can handle nonlinear relationships. [18]

The neural network equation is a linear combination of the independent variables, their weights, and the bias (or the intercept) term for each neuron.This is how the neural network equation looks:

$$Z = Bias + W1X1 + W2X2 + \ldots + WnXn$$

Where,

* The over graphical representation of ANN is signified by the letter Z.

*Wis indicates the weights or beta coefficients, whereas

*Xis signifies the autonomous factors or inputs.

*Intercept or predisposition = W0 In any neural arrange, there are three steps to follow: 1.First, compute the yield or expected Y values, called the Ypred, utilising the input factors and the previously mentioned direct combination condition of Z = W0 + W1X1 + W2X2 +...+ WnXn. 2.Work out the misfortune or mistake term. The mistake term is the distinction between the genuine and anticipated values.

*Make the blunder word as brief as conceivable.[19]

Here we use two activation functions. Sigmoid and relu.

Sigmoid activation function:

This work acknowledges any genuine esteem as input and returns a esteem between and 1. As seen underneath, the bigger the input (more positive), the closer the yield esteem is to 1.0, and the littler the input (more negative), the closer the yield is to 0 [20].

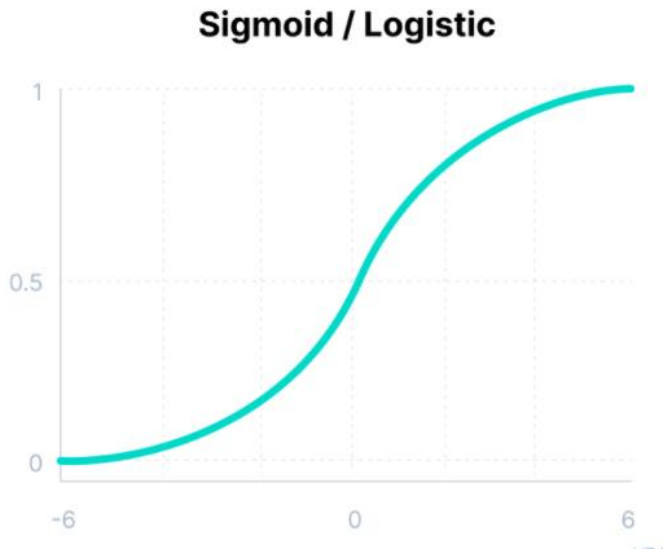

Fig 3.3: Sigmoid Function

It can be expressed mathematically as:

Sigmoid / Logistic

$$f(x) = \frac{1}{1 + e^{-x}}$$

ReLU Function:
Rectified Linear Unit (ReLU) is a truncation for Amended Direct Unit. ReLU includes a subsidiary work and empowers for backpropagation whereas remaining computationally proficient, in spite of the truth that it appears to be a straight function. The key caveat is that the ReLU work does not at the same time invigorate all of the neurons. Only in case the direct change yield is less than will the neurons be deactivated [20].

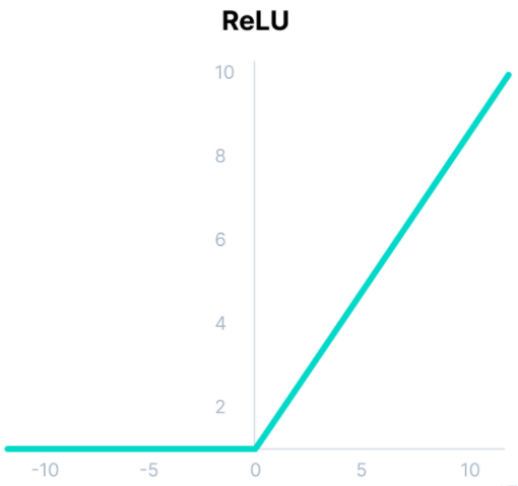

Fig 3.4:Relu Function

It can be expressed mathematically as:

$$ReLU$$

$$f(x) = max\,(0, x)$$

3.5 Summary

For solving classification problems using ANN is quite popular in this new era.It is revealed by researchers that neural network based classification produces promising results , in which the neural network represents the problem layer by layer using N-dimensional tensor.

CHAPTER 4

4.1 RESULTS AND DISCUSSION

We have divided our dataset into two classes in this research paper: 0 and 1.By applying ANN on the dataset we found 86% accuracy.
Using the Extra tree classifier, we discovered the greatest contributing factors to heart disease. Extremely Randomised Trees Classifier (Additional Trees Classifier) may be a sort of gathering learning method that yields a classification result by clustering the results of a few de-correlated choice trees collected in a "forest." The Extra Trees Forest's Decision Trees are all made from the initial preparing sample. Then, at each test hub, each tree is given an arbitrary sample of k highlights from the feature-set, from which it must select the most excellent include to part the information utilising a few numerical criteria. Numerous de-correlated decision trees are made from this random test of features.During the improvement of the timberland, the standardised add up to lessening within the numerical criteria used within the include part choice is computed for each include. The Gini Significance of the include is the title given to this esteem. Each feature is put in descending order according to its Gini Important to conduct feature importance. [21]
The plot below shows that Chest pain is the most important feature in this dataset and the lowest impact on the dataset is 'Rest ECG'.
.

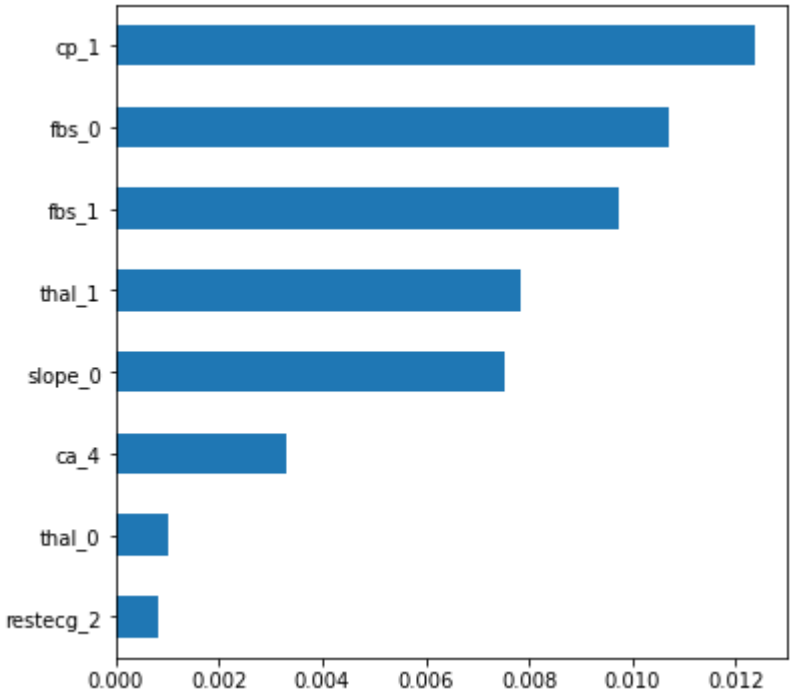

Fig4.1: Features Importance

We also distributed heart disease patients and normal patients by different attributes. That are described below:

4.1.1 Distribution of

Heart disease

These figures show the distribution of heart disease among normal and affected people. The left most figure shows 54% people are having heart disease and 46% are normal. The right most shows 165 heart disease patients and 138 normal people. 0 represents the number of normal people and 1 represents the heart disease patients.

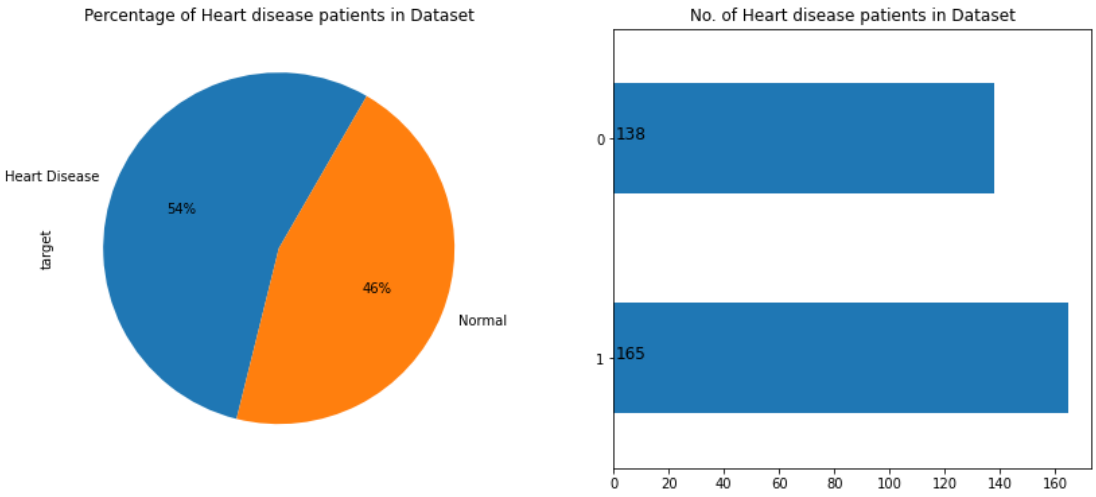

Fig4.2: Distribution of Heart disease

4.1.2 Checking Gender & Age Wise Distribution

The leftmost figure in the plot below demonstrates that males have a much higher percentage than females in this dataset. Males comprise 68 percent of the population, while females comprise 32 percent.
Where the rightmost figure represents age wise distribution. X axis represents ‘age’ and Y axis repents ‘density '.The average age of patients is around 57.

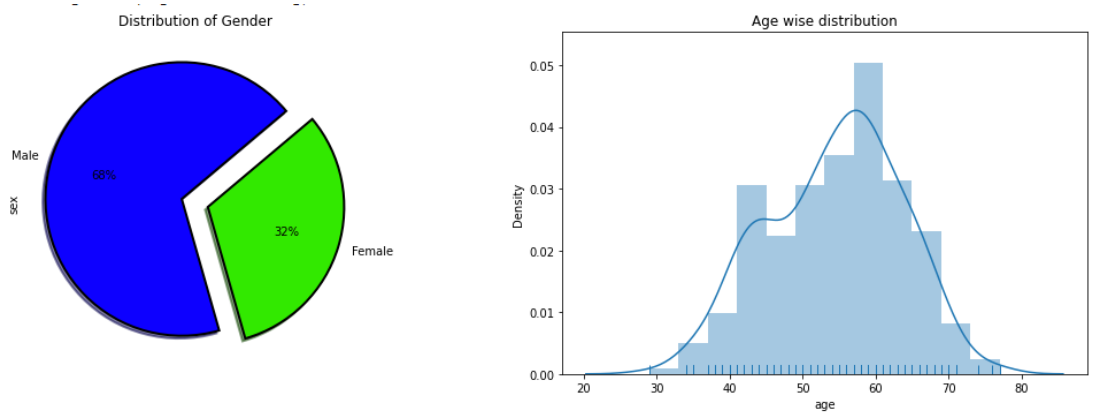

Fig4.3: Checking Gender & Age Wise Distribution

4.1.3 Gender and Age Wise Distribution of Normal Patients & Heart Disease Patients

As seen in the graph below, male patients have more heart disease than female patients, despite the fact that the average age of heart disease patients is about 57 to 60 years.
The upper row depicts the age and gender distribution of healthy persons, whereas the lower row depicts the age and gender distribution of heart disease patients.

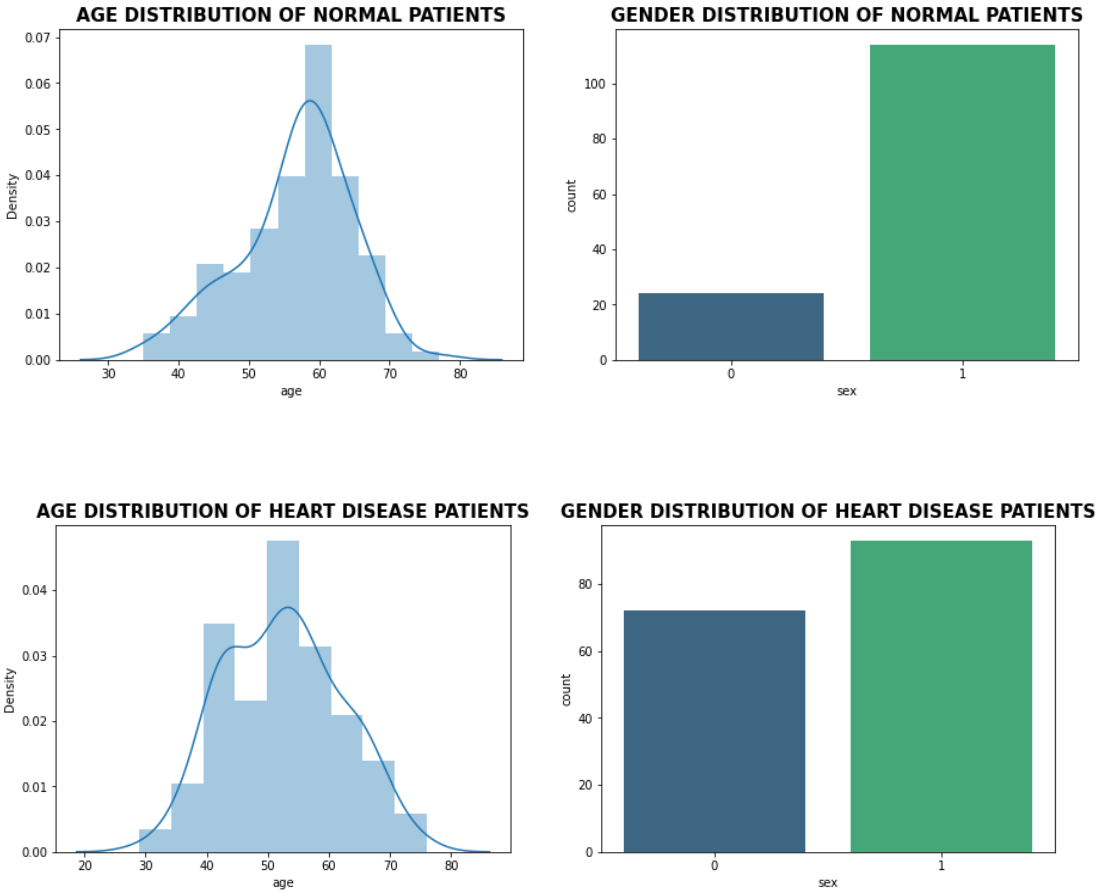

Fig4.4: Checking Gender & Age Wise Distribution of Normal & Disease Patient

4.1.4 Distribution of Chest Pain Type

We categorise chest pain into four categories.
Atypical angina, typical angina, and non-anginal pain are the three types of angina. 4. The asymptomatic X axis depicts different types of chest discomfort, while the Y axis represents the number of angina patients.

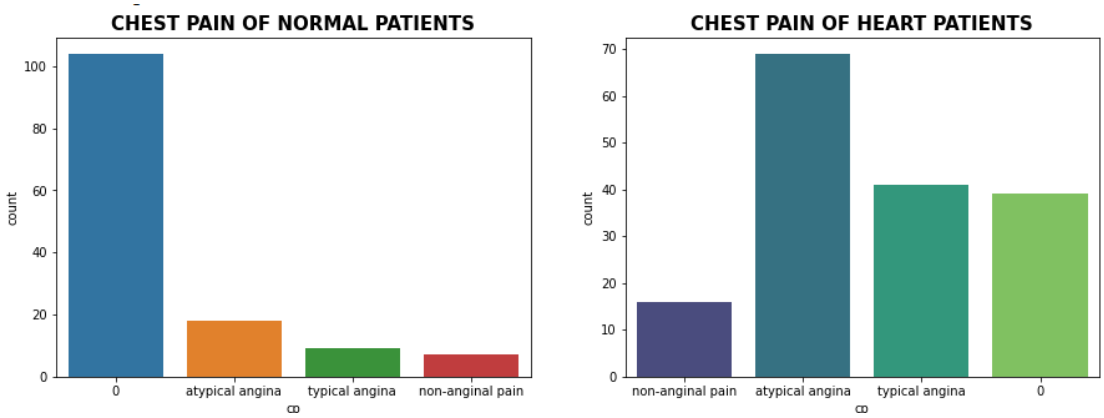

Fig4.5: Distribution of Chest Pain Type

From the above plot, we can see typical angina 143, non-anginal pain 87, atypical angina 50,asymptomatic 23.

4.1.5 Distribution of Rest ECG

There are three forms of resting ECG. They are: 1.ST-T wave abnormality; 2.ST-T wave abnormality; 3.ST-T wave abnormality; 4.ST
2.Normal
3. Hypertrophy of the left ventricle
The X axis depicts Rest ECG types, while the Y axis depicts the number of persons.

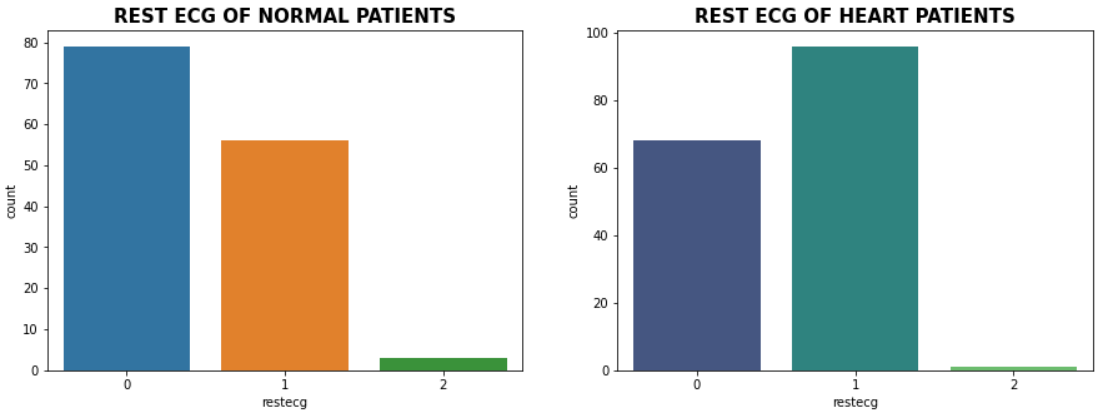

Fig4.6: Distribution of Rest ECG

From the above plot, we can see, ST-T wave abnormality is 152, normal is 147,left ventricular hypertrophy is 4.

4.1.6 Distribution of ST-Slope

There are three types of ST-Slope .
Flat
Down sloping
Up sloping
The X axis represents ST-Slope types and Y axis represents counts of people.

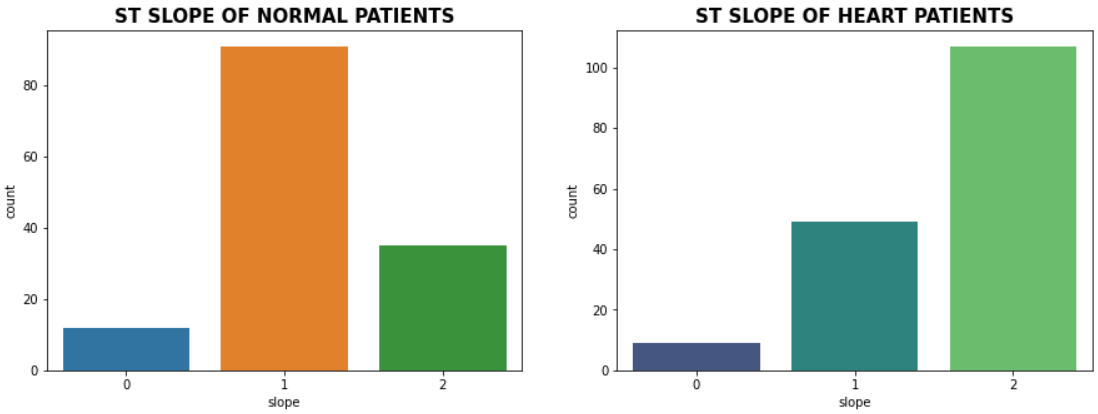

Fig4.7: Distribution of ST-Slope

From the above plot, we can see down sloping 142,flat 140 ,up sloping 21.

4.1.7 Histogram

A histogram may be a graphical representation of information that employs bars of changing statues. Each bar in a histogram isolates numbers into ranges. More information falls inside the run as the bars get taller. The frame and scattering of nonstop test information are spoken to by a histogram.

This image depicts the form and distribution of continuous sample data from the dataset utilised in this study.

This histogram depicts age, gender, cp, trestbps, chol, fbs, restecg, thalac, exang, oldpeak, slope, ca, thal, target.

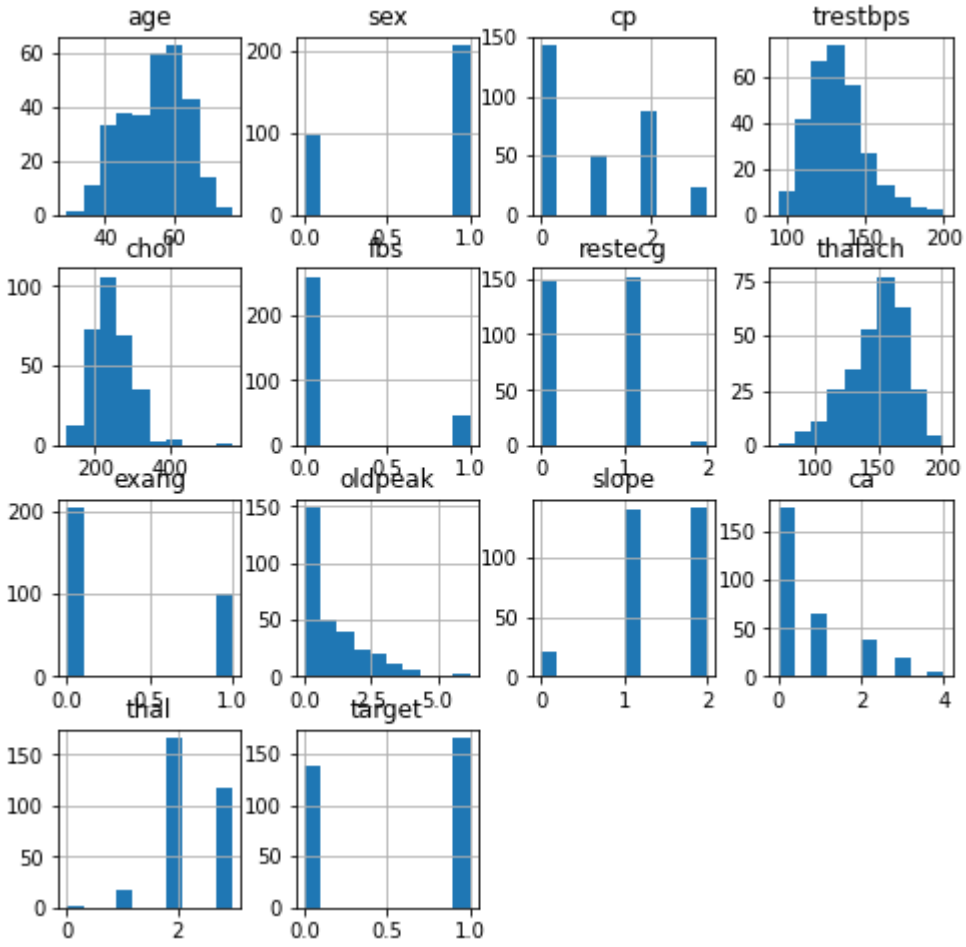

Fig4.8: Histogram

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Findings and Contributions

Some other researchers worked on it. We tried our best to improve the accuracy rate from this research. We found 86% accuracy. We think this accuracy rate is quite good for classifying heart disease cases. According to the findings, an artificial neural network method is the best at classifying knowledge from medical data. When neural networks are fed normalised input, they produce good results with increased efficiency. It's a system that backs up the doctor's choice. One of the most effective methods for predicting heart disease is the artificial neural network.
We hope that this research will prove to be extremely useful in medical science when it comes to classifying cardiac disease.

5.2 Recommendations for Future Works

In the future, we want to work on increasing accuracy and also try different techniques to increase accuracy and compare which algorithms work better for classifying heart disease. .Therefore, it will be helpful for hospitals, patients and medical practitioners.

Chapter 6

REFERENCE

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