



# Heart Disease Prediction Using Single And Multi Layered Perceptron Network Models

<sup>1</sup>Yazhini Karthik, <sup>2</sup>Deivarani S

<sup>1</sup>Student, <sup>2</sup>Assistant Professor

<sup>1</sup>Department of Computing-Data Science,

<sup>1</sup>Coimbatore Institute of Technology, Coimbatore, India

**ABSTRACT:** This study explores heart disease prediction using Single-Layer Perceptron (SLP) and Multi-Layer Perceptron (MLP) models. The research begins with Exploratory Data Analysis (EDA) to gain insights into the dataset, including attribute types, data distribution, and identification of missing or duplicate values. The SLP model, with a single hidden layer, classifies patients based on essential clinical attributes, while the MLP model leverages multiple hidden layers for deeper feature extraction. The performance of both models was evaluated and compared based on accuracy. Results indicate that the SLP model outperforms the MLP in this specific context due to the dataset's linear separability. The study emphasizes the importance of selecting appropriate machine learning models based on dataset characteristics. Additionally, it highlights the need for careful handling of challenges and limitations to ensure robust predictions, ultimately supporting better clinical decision-making.

**Index terms** – heart disease prediction, Single-Layer Perceptron (SLP), Multi-Layer Perceptron (MLP), Classification accuracy, Clinical decision-making

## I. INTRODUCTION

Despite substantial improvements in prevention, diagnosis, and treatment, heart disease is still a serious public health problem in the modern world. In reality, heart disease continues to be the leading cause of mortality globally, accounting for around one-third of all fatalities.

Today's globe has a high frequency of heart disease due to a number of variables. The growth of risk factors including obesity, diabetes, and high blood pressure is one of the most important. These ailments are frequently linked to harmful lifestyle choices, such as smoking, sedentary behavior, eating a diet rich in processed foods and low in fruits and vegetables, and engaging in sedentary activities.

The population's ageing is another factor influencing the prevalence of heart disease. Heart disease and other illnesses are more likely to strike as individuals live longer. Additionally, there are differences in the frequency of heart disease among various communities, with some having higher than average rates of the condition. A number of factors, including as genetics, socioeconomic position, and access to healthcare, may be to blame for these differences.

Despite these obstacles, there have recently been considerable improvements in the diagnosis, prevention, and treatment of heart disease. For instance, lifestyle changes like consistent exercise, a good diet, and stress management are becoming more and more important.

Additionally, there are a variety of treatments and drugs, such as statins, beta-blockers, angioplasty, and bypass surgery, that can be used to control heart disease and associated disorders. Our knowledge of heart disease is continually growing, and new treatment options are being discovered thanks to research.

Overall, despite the fact that heart disease is still a major public health problem in the modern world, there is cause for optimism because prevention, diagnosis, and treatment continue to advance.

## II. DATASET

The dataset falls under the domain Medical. This dataset contains patient's age, sex, CP, Trestbps, Chol, FBS, restECG, thalach, exang, old peak, slop, CA, thal and target. The dataset has 13 columns and 500 rows.

Age: specifies the age of the patient.

Sex: specifies whether the patient is male or female.

CP (Constrictive percarditis): specifies the chronic inflammatory process of the heart.

Trestbps: specifies the patient's resting blood sugar level.

Chol: specifies the patient's Cholesterol level.

FBS (Fasting Blood Sugar): specifies the patient's Fasting blood sugar level.

RestECG: specifies the patient's resting electrocardiographic result.

Thalach: specifies the patient's maximum heart rate achieved.

Exang: specifies the patient's exercise induced angina.

Old peak: specifies the patient's ST (Positions on ECG plot) depression induced by exercise relative to rest.

Slop: specifies the Slop of the peak exercise ST segment.

CA: specifies the number of major vessels.

Thal: specifies whether the patient has a disease called Thalassemia or not.

Target: specifies if the patient has heart disease or not

## III. CONCEPTS USED

### 3.1 Exploratory Data Analysis (EDA):

Exploratory Data Analysis (EDA) is an approach to analyzing and summarizing datasets in order to understand their main characteristics, identify patterns and trends, and identify potential outliers or anomalies. EDA typically involves visualizing data using graphs, charts, and other graphical representations, as well as conducting statistical analysis to summarize key features of the data.

The main goal of EDA is to get deeper understanding of the data and its features.<sup>[5]</sup>

### 3.2 Single layer perceptron model:

The single-layer is the first proposed neural model. The contents of the neuron's local memory consist of a vector of weights. The calculation of the single-layer, is done by multiplying the sum of the input vectors of each value by the corresponding elements of the weight vector. A Single Layer Perceptron (SLP) is a feed-forward network, based on a threshold transfer function. SLP is the simplest type of artificial neural networks and can only classify linearly separable cases with a binary target (1, 0). Activation functions are decision making units of neural networks. They calculate net output of a neural node.<sup>[1][2]</sup>

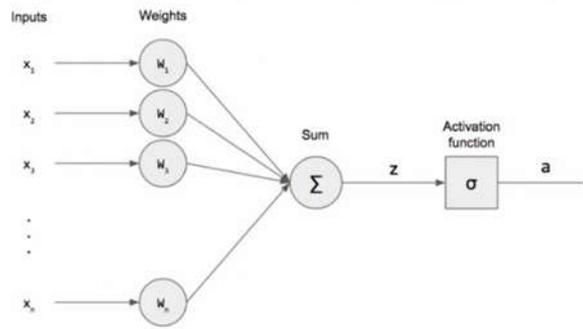


figure 1

### 3.3 Multi-layer perceptron mode:

The Multilayer Perceptron is a neural network where the mapping between inputs and output is non-linear. A Multilayer Perceptron has input and output layers, and one or more hidden layers with many neurons stacked together. While in the Perceptron the neuron must have an activation function that imposes a threshold.

Multilayer Perceptron falls under the category feedforward algorithms, because inputs are combined with the initial weights in a weighted sum and subjected to the activation function, just like in the Perceptron. But the difference is that each linear combination is propagated to the next layer.<sup>[3][4]</sup>

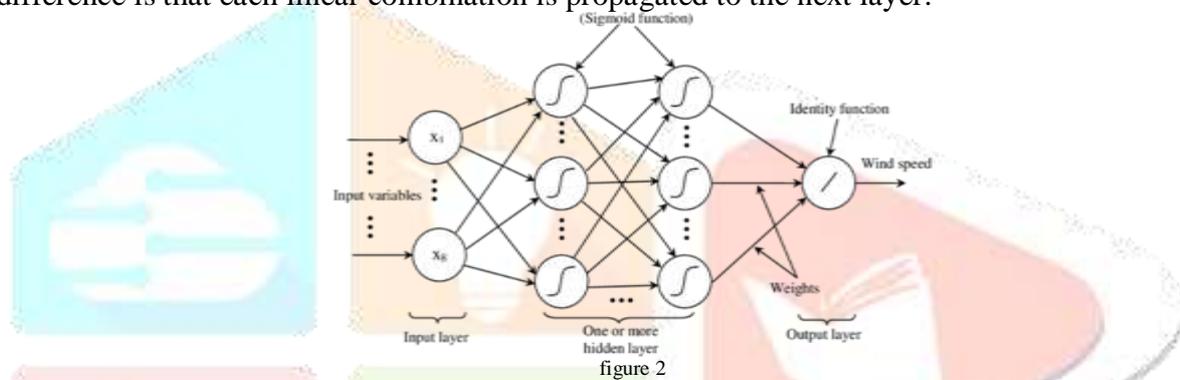


figure 2

## IV. RESULT

Exploratory analysis has been done to the dataset by checking the null and missing values, getting information about dataset types and also getting description about the dataset. This helps to enhance the dataset's utility for the prediction. The below figure depicts the analysis done.

1	0.00	0	0	120	524	1	1	690	0	18	1	2	2	0
2	0.01	1	0	140	301	0	1	461	0	0.0	5	1	1	0
3	0.00	1	0	150	158	0	1	432	1	3.0	0	0	2	0
4	0.01	1	0	140	301	1	0	450	1	7.1	0	0	1	0
5	0.00	1	0	120	524	0	1	480	0	1.0	5	0	2	0

figure 3

## DATA TYPES:

```
age          int64
sex          int64
cp           int64
trestbps     int64
chol         int64
fbs          int64
restecg      int64
thalach      int64
exang        int64
oldpeak      float64
slope        int64
ca           int64
thal         int64
target       int64
dtype: object
```

figure 4

## NULL VALUES:

```
age          0
sex          0
cp           0
trestbps     0
chol         0
fbs          0
restecg      0
thalach      0
exang        0
oldpeak      0
slope        0
ca           0
thal         0
target       0
dtype: int64
```

figure 5

DESCRIPTION ABOUT DATASET:						
	age	sex	cp	trestbps	chol	fbs
count	499.000000	499.000000	499.000000	499.000000	499.000000	499.000000
mean	54.036072	0.711423	0.997996	132.438878	248.272545	0.164329
std	9.219256	0.453556	1.010982	18.070972	55.407960	0.370945
min	29.000000	0.000000	0.000000	94.000000	126.000000	0.000000
25%	47.000000	0.000000	0.000000	120.000000	211.000000	0.000000
50%	55.000000	1.000000	1.000000	130.000000	243.000000	0.000000
75%	60.500000	1.000000	2.000000	140.000000	282.000000	0.000000
max	77.000000	1.000000	3.000000	200.000000	564.000000	1.000000

figure 6

In single layer perceptron model, measured the accuracy and loss of the model. The below figure represents it.

```
17/17 [-----] - 0s 4ms/step - 
Accuracy: 0.8859315514564514
Error: 0.11406844854354858
```

figure 7

In multi-layer perceptron mode, measured the same accuracy as the evaluation metrics of the model. The below figure represents it.

```
accuracy is: 0.5333333333333333
```

figure 8

## V. CONCLUSION

Exploratory Data Analysis helps to know more about the data like attributes' datatypes, description etc. It also identifies null values and duplicate values. It gives deeper understanding of the data.<sup>[5]</sup>

Single Layer Perceptron uses one hidden layer and helps to classify whether the patient has heart disease or not with the necessary attributes considered as inputs. The accuracy has been calculated.<sup>[1][2]</sup>

Multi-Layer perceptron uses more than one hidden layer and also used to classify whether the patient has heart disease or not with the necessary attributes considered as inputs. The accuracy has been calculated.<sup>[3][4]</sup>

On comparing the accuracies of both SLP and MLP model, the accuracy of single layer perceptron is higher than multi-layer perceptron.

SLPs are better suited for linearly separable datasets, where a linear decision boundary can separate the classes than MLPs. That is the reason that SLP has more accuracy than MLP in this specific problem.<sup>[1][2]</sup>

Therefore, it is crucial for researchers to explore and assess the data using different machine learning algorithms in order to select the one with the best accuracy. Additionally, difficulties and restrictions encountered by the researchers must be properly controlled in order to provide data that will be satisfying and will advance clinical practice and decision-making.

## VI. FUTURE SCOPE

The ability of Artificial Neural Networks to forecast heart disease has been very promising. Future heart disease prediction with ANNs has a lot of potential thanks to the ongoing developments in machine learning.

Data from wearable devices, electronic health records, and genetics might all be used to improve heart disease prediction. These many data sets might be combined using ANNs to provide a more complete prediction model.

ANNs might be used to create personalized medication plans for people with heart disease. ANNs might offer specialized suggestions for treatment and lifestyle adjustments by analyzing the unique patient data.

Effective treatment of heart disease depends on early identification. A timely intervention might be made possible by the use of ANNs to analyze patient data and spot early heart disease symptoms.

Data from wearable gadgets like smartwatches and fitness trackers may be analyzed using ANNs. Patients may be able to remotely monitor their heart health and get tailored suggestions thanks to this.

ANNs can be challenging to understand, which is one of its drawbacks. ANNs' prediction processes may be better understood using comprehensible AI methodologies. As a result, there may be more confidence in the forecasts, which would improve clinical judgement.

In conclusion, ANNs show enormous promise for heart disease prediction and might be applied in a variety of ways to enhance patient outcomes. We may anticipate additional cutting-edge uses of ANNs for heart disease prediction as machine learning develops.

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