Heart Disease Predictions Using Machine Learning

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***Abstract***— **Machine learning is a branch of artificial intelligence (AI) and computer science which focuses on the use of data and algorithms to imitate the way that humans learn, gradually improving its accuracy.** **Classification algorithms based on supervised learning, a type of machine learning, can make diagnoses of cardiovascular diseases easy. Three supervised machine learning algorithms are used in this paper which are Logistical Regression, Naive Bayes, Decision Trees. These algorithms can be used to classify people who have a heart disease from people who do not although Some risk factors for heart disease cannot be controlled, such as your age or family history.**

Keywords— Machine learning, Heart Disease, Heart Disease Dataset, Classification, Logistical Regression, Naive Bayes, Decision Trees

# Introduction

Our goal for the project is to approach heart disease and compare different classification algorithms on a Heart Failure Prediction Dataset to predict and compare which one does well. We will also compare our algorithms with a neural network to see if does any better. Our predictions will have a substantial impact on detecting early identification of heart disease. This important because it can provide treatment, increase life expectancy, prevent disability and costly hospitalizations while improving the quality of life. Loss of heart function is irreversible. Once the damage has been done, a person cannot return to having a fully functional heart. Early detection for a heart condition is key to finding a possible remedy.

# Background

Cardiovascular disease (CVD) is a term used to describe a class of diseases that affect the heart and blood vessels. It is a broad term that encompasses various conditions, including coronary artery disease, heart failure, stroke, and peripheral artery disease, among others. CVD is a leading cause of death globally, accounting for a significant proportion of mortality in many countries, taking an estimated 17.9 million lives each year, which accounts for 31% of all deaths worldwide. Four out of 5 CVD deaths are due to heart attacks or strokes, and one-third of these deaths occur prematurely in people under 70 years of age. Heart failure is a common event caused by CVDs and this dataset contains 11 features that can be used to predict heart disease.

People with cardiovascular disease or who are at high cardiovascular risk (due to the presence of one or more risk factors such as hypertension, diabetes, hyperlipidemia or already established disease) need early detection and management wherein a machine learning model can be of great help.

# Methodology

The manufacturing process models are done with the following steps: data collecting, pre-processing, model building, comparison of models, and evaluation. The algorithms we will be evaluating to train a model are Logistic Regression, Naive Bayes, and Decision Trees. Additional analysis will involve utilizing a Neural Network comparison.

## Logistic Regression

One of the simplest and best ML classification algorithm is Logistic Regression. It is a supervised ML binary classification algorithm widely used in most applications. It works on categorical dependent variables and the result can be discrete or binary categorical variable 0 or 1.

The logistic regression model is based on the logistic function, also known as the sigmoid function. The sigmoid function maps any real-valued number to a value between 0 and 1. In logistic regression, this function is used to transform a linear combination of predictor variables into a probability value. The goal of logistic regression is to estimate the probability of the "success" outcome given the values of the independent variables.

## Naive Bayes

Naive Bayes classifier is a statistical based classifier which is based on Bayes Theory. The "naïve" assumption in Naïve Bayes refers to the assumption of independence among the features. This classifier is based on probabilities. Given two events A and B, P (A) is prior probability and P (A|B) is posterior probability, then according to Bayes theorem.

**P (A|B) = P (B/A) P (A)/P (B)** and

**P (B|A)** is computed as **P (A ∩ B) = P (A)**

These Bayesian probabilities are used to determine the most likely next event for the given instance given all the training data. Conditional probabilities are determined from the training data. The Naive Bayes model is based on the conditional independence model of each predictor give the target class. This classifier yields optimal prediction (given the assumptions). It can also handle discrete or numeric attribute values.

## Decision Trees

The decision tree algorithm is a supervised learning algorithm that can be used in both classification and regression analysis. Unlike linear algorithms, decision trees algorithms are capable of handling nonlinear relationships between variables in the data. The information gained in the decision tree can be defined as the amount of information improved in the nodes before splitting them for making further decisions.

To measure the information gain we use the entropy. Which is a quantified measurement of the amount of uncertainty because of any process or any given random variable. Mathematically the formula for entropy is:

A picture containing black, darkness

Description automatically generated

Decision trees other advantages include their interpretability and the ability to handle both numerical and categorical features. They can handle large datasets and are relatively insensitive to outliers.

## Outline of the Proposed Work

A diagram of data processing

Description automatically generated with low confidence

**Fig -1**: Outline of the Proposed Work.

# Dataset

Our source is the Heart Failure Prediction Dataset that includes 11 clinical features for predicting heart disease events. This dataset was taken from Kaggle.com created by combining different datasets already available independently but not combined before. In this dataset, 5 heart datasets are combined over 11 common features which makes it the largest heart disease dataset available so far for research purposes. The five datasets used for its curation are:

* Cleveland: 303 observations
* Hungarian: 294 observations
* Switzerland: 123 observations
* Long Beach VA: 200 observations
* Stalog (Heart) Data Set: 270 observations

*Total: 1190 observations  
Duplicated: 272 observations*

*Final dataset: 918 observations*

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# Experimental Result

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# Conclusion

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