Capstone Project

Supervised Machine Learning (Classification)

CARDIOVASCULAR RISK PREDICTION

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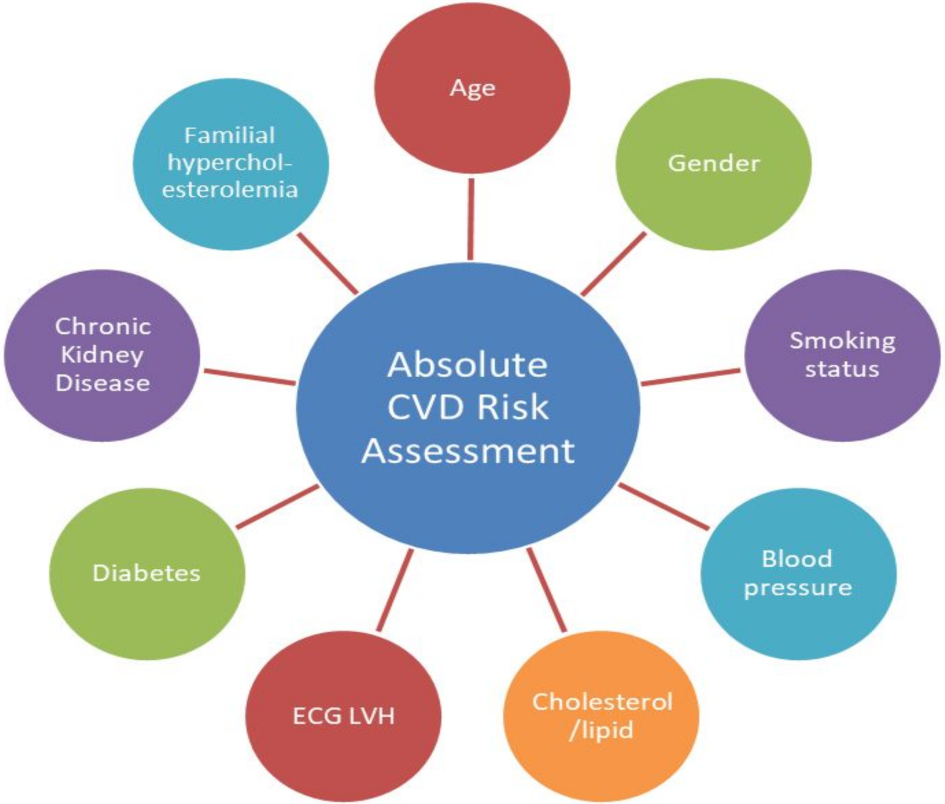
Flow of the Presentation



- → Introduction
- → Problem Statement
- → Exploratory Data Analysis
- → Feature Selection
- → Data Preparation
- → Model Implementation
- → Evaluation of model
- → Conclusion

Introduction

Cardiovascular sickness is a general class for a scope of infections that are influencing heart and veins.The most important behavioural risk factors of heart diseases & Stroke are physical inactivity , consumption of tobacco / alcohol.This increases the Blood pressure,blood glucose ,obesity,etc.

The dataset is from an ongoing cardiovascular study on residents of the town of Framingham, Massachusetts. The dataset provides the patients information. It includes over **3390 records and 17 attributes.**Database contains patients age group in between **32 to 70.**

In this project , we have used Machine Learning (Supervised)Classification algorithms.

Problem Statement

- To provide an overview of prediction models for risk of cardiovascular disease (CVD) in the general population.
- The classification goal is to predict whether the patient has a 10-year risk of future coronary heart disease (CHD).

Data Description

Demographic:
- Sex: male or female("M" or "F")
- Age: Age of the patient

Behavioral :
- is_smoking: whether or not the patient is a current smoker ("YES" or "NO")
- Cigs Per Day

Medical(history)
- BP Meds: whether or not the patient was on blood pressure medication (Nominal)
- Prevalent Stroke: whether or not the patient previously had a stroke (Nominal)
- Prevalent Hyp: whether or not the patient was hypertensive (Nominal)
- Diabetes: whether or not the patient had diabetes (Nominal)

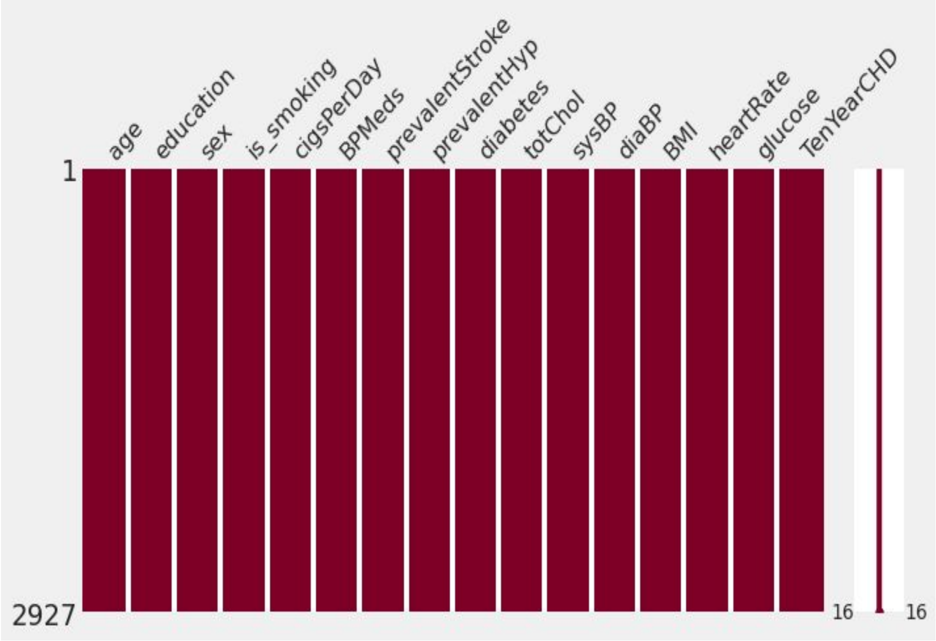
Medical(current)
- Tot Chol: total cholesterol level (Continuous)
- Sys BP: systolic blood pressure (Continuous)
- Dia BP: diastolic blood pressure (Continuous)
- BMI: Body Mass Index (Continuous)
- Heart Rate: heart rate (Continuous - In medical research, variables such as heart rate though in fact discrete, yet are considered continuous because of a large number of possible values.)
- Glucose: glucose level (Continuous)

•Predict variable (desired target)
10-year risk of coronary heart disease CHD(binary: “1”, means “Yes”, “0” means “No”) -Dv

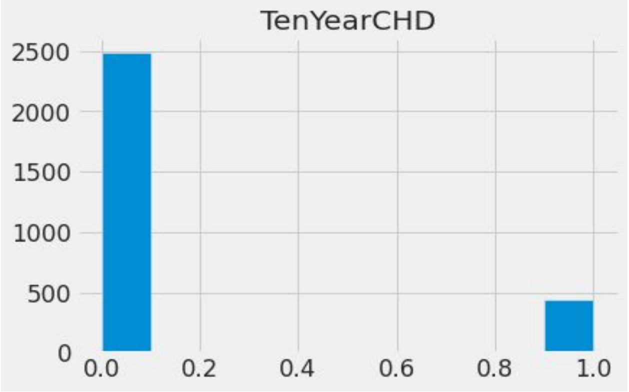
Data Cleaning

There were missing values present in the features such as education,cigs Per Day, BP Meds, totChol, BMI,heart Rate & glucose.

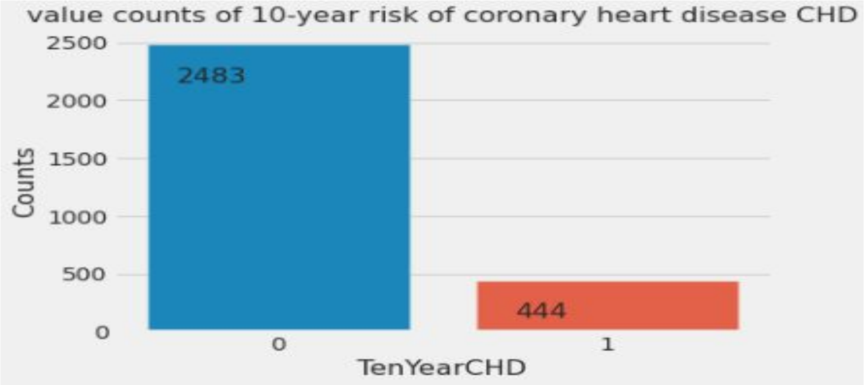
Visualization of replacing NAN values by unknown.

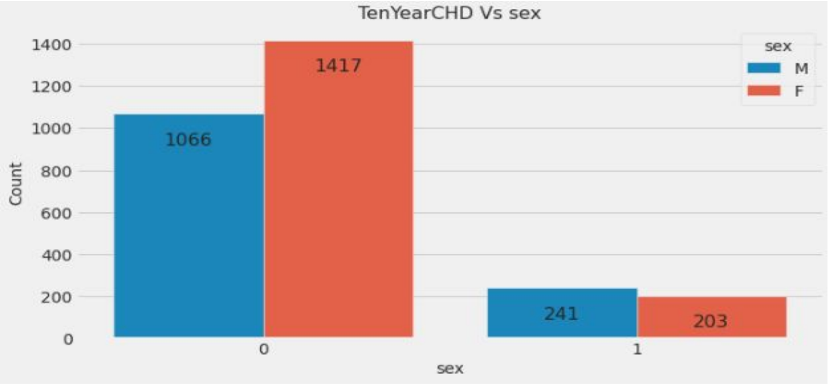


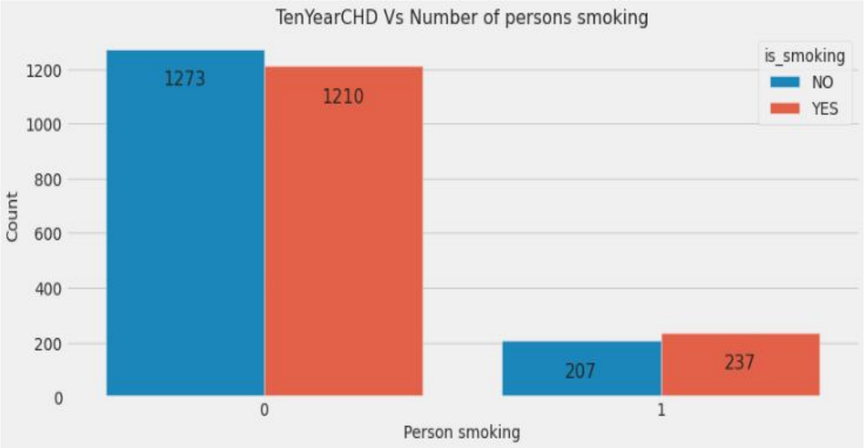
Exploratory Data Analysis

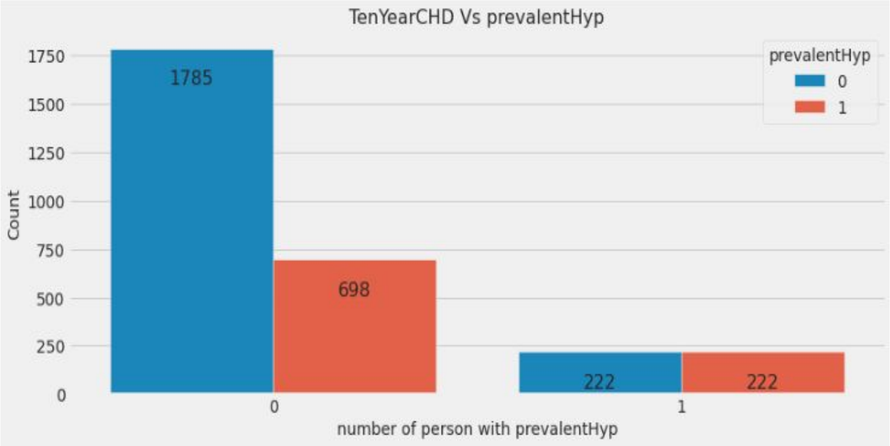


Visualization on Dependent and Independent Variables

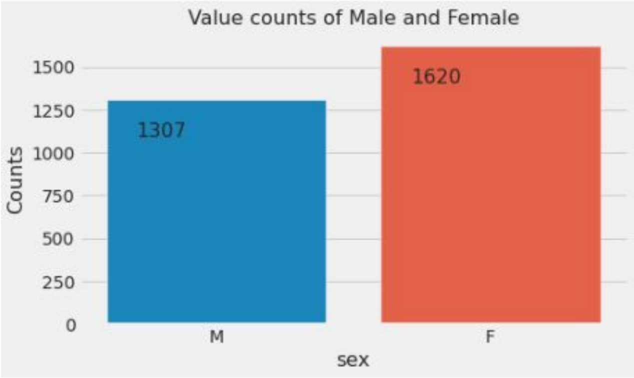


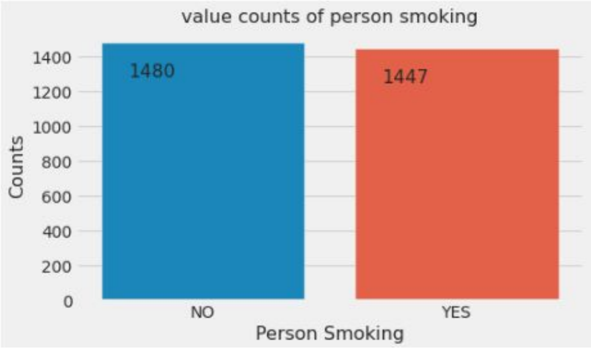


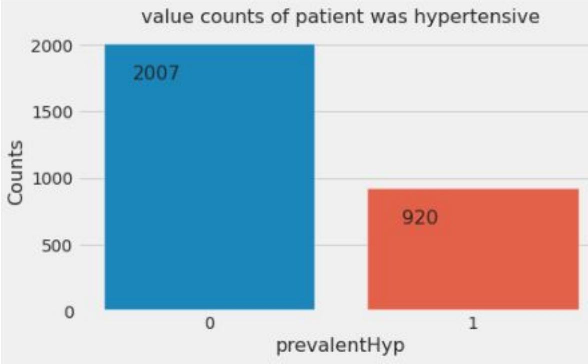


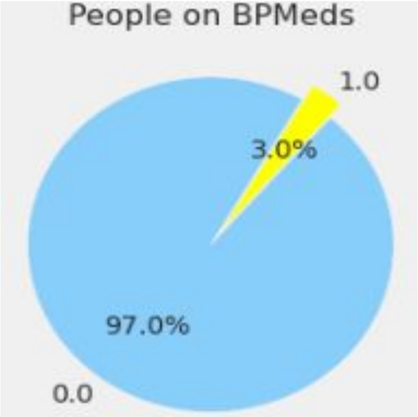


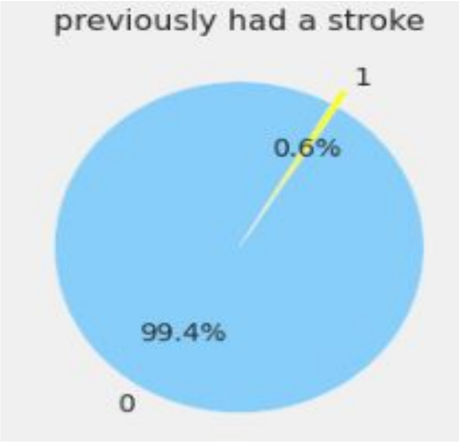
Analysis by Value Counts of some features

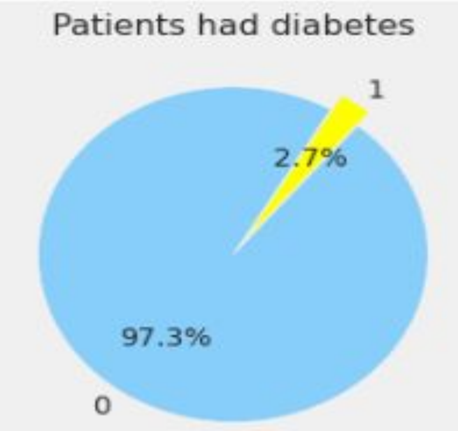




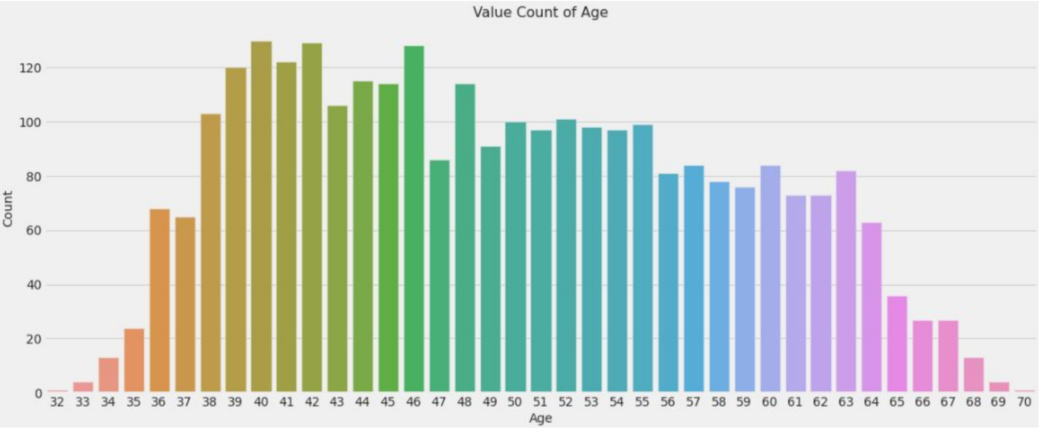


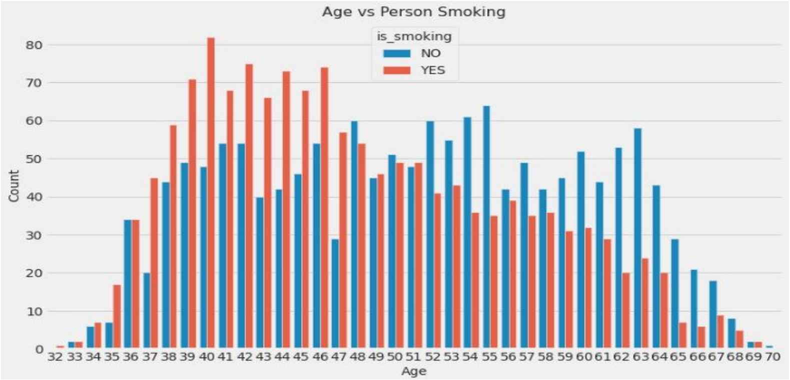


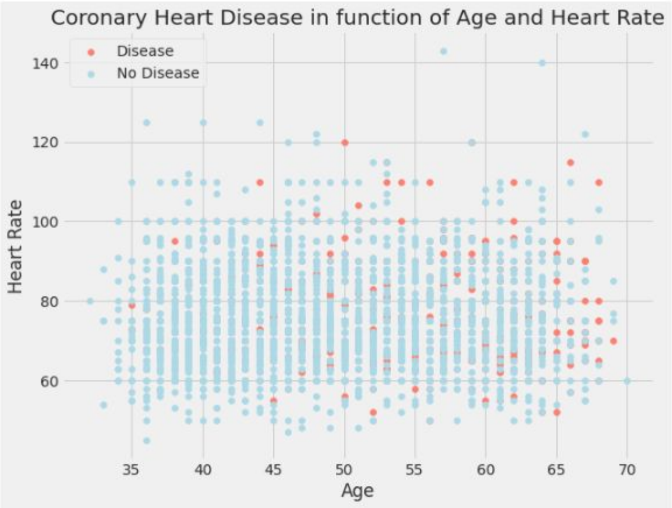




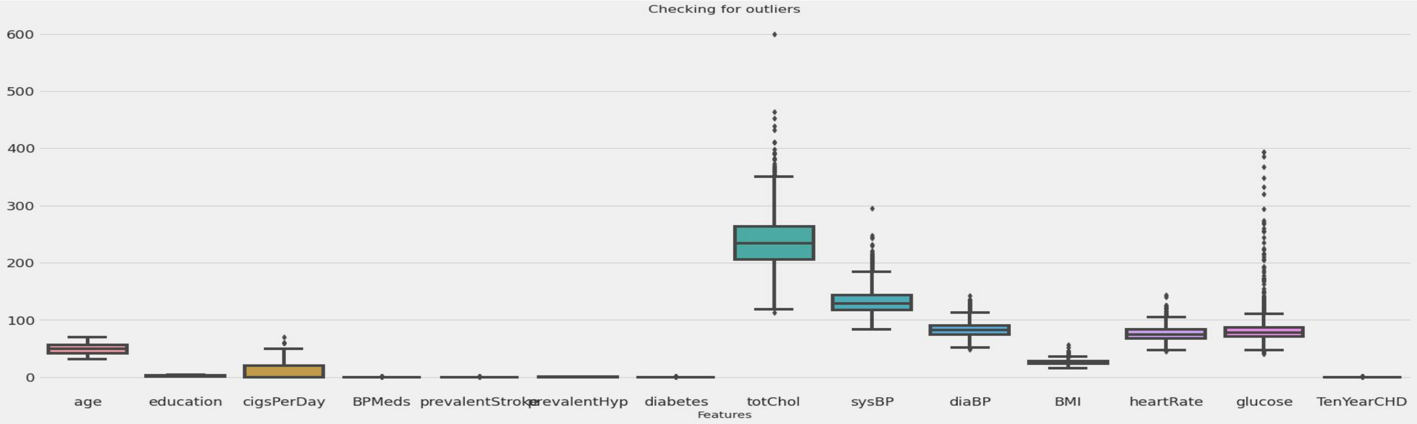
Bar plot and Scatter Plot for important variables



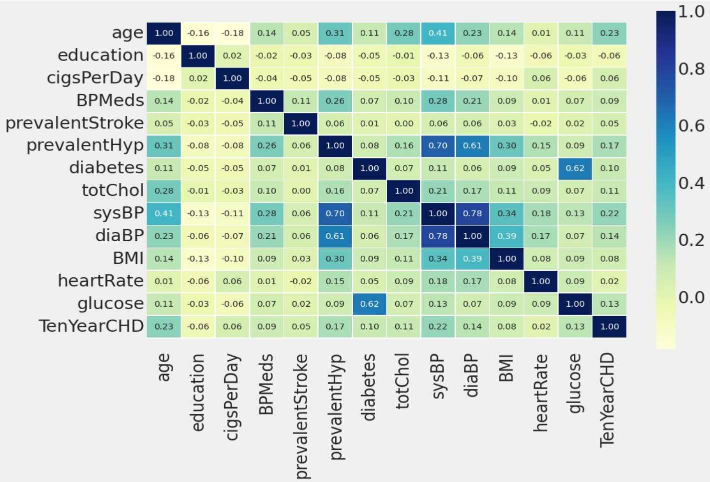




Feature Selection



Outliers



Correlation Matrix

- ➔ Some of the features have a negative correlation with the target value and some have positive.
- ➔ Heart Rate and Prevalent Stroke are the lowest correlated with the target variable.

Data Preparation

After exploring the dataset, We observed that there is need to convert some categorical variables into dummy variables and scale all the values before training the Machine Learning models. First, we use the get_dummies method to create dummy columns for categorical variables

```
# Adding pulse pressure as a column
df['pulsePressure'] = df['sysBP'] - df['diaBP']
# Dropping the systolic and diastolic BP columns
df.drop(['sysBP','diaBP'], axis = 1, inplace = True)
# Dropping the 'is_smoking' column
df.drop('is_smoking', axis = 1, inplace = True)
```

```
# To get the Categorical Variables
categorical_val = []
continous_val = []
for column in df.columns:
    if len(df[column].unique()) <= 10:
        categorical_val.append(column)
    else:
        continous_val.append(column)
categorical_val
```

One Hot Encoding

```
# Creating dummy variables-
categorical_val.remove('TenYearCHD')
df=pd.get_dummies(df, columns = categorical_val)
```

Synthetic Minority Oversampling Technique(SMOTE)

```
# Importing SMOTE
from imblearn.over_sampling  import SMOTE
...#Synthetic Minority Oversampling Technique
# transform the dataset
# Creating an instance for SMOTE
oversample = SMOTE()
X = df.drop('TenYearCHD', axis=1)
y = df.TenYearCHD
# The rows and columns of X and y
print(f'X has {X.shape[0]} rows and {X.shape[1]} columns')
print(f'y has {y.shape[0]} rows')
# Using SMOTE to oversample
X, y = oversample.fit_resample(X, y)
```

As there exits a clear imbalance in the classes. Hence, we used SMOTE to oversample the classes which are in less number.

Model Implementation

Standard Scaler Transformation

```
from sklearn.preprocessing import StandardScaler

s_sc = StandardScaler()
col_to_scale = ['age', 'cigsPerDay', 'totChol', 'BMI',
'heartRate', 'glucose', 'pulsePressure']
df[col_to_scale] = s_sc.fit_transform(df[col_to_scale])
df.head()
```

Evaluation of Models

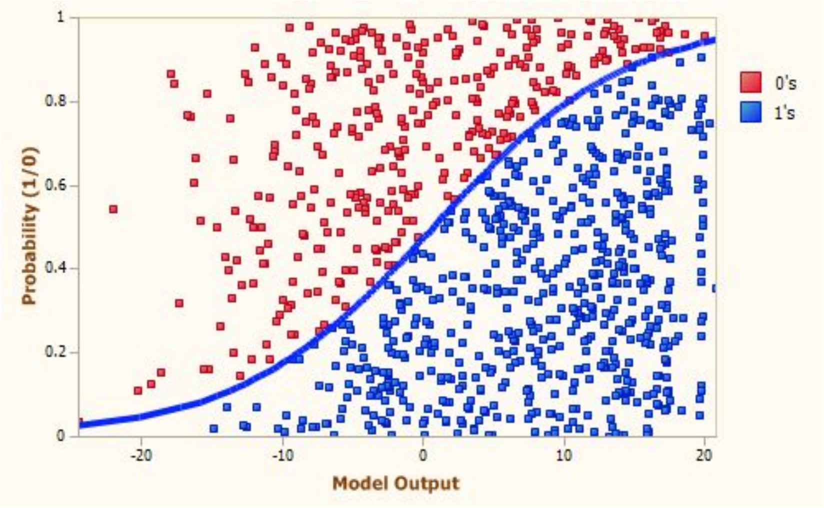
- Classification Report
- Confusion Matrix

Train and Test data sets

```
# Importing packages to split data into train and test
from sklearn.model_selection import train_test_split

X = df.drop('TenYearCHD', axis=1)
y = df.TenYearCHD

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size= 0.3, random_state=42)
```

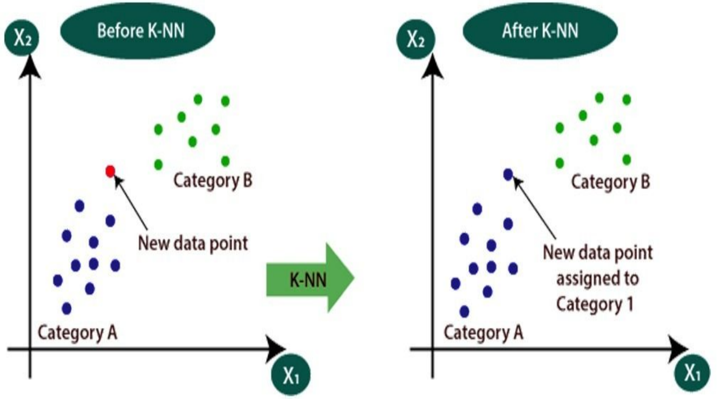
➔ Logistic Regression

```
Train Result:
================================================
Accuracy Score: 85.94%
_______________________________________________
CLASSIFICATION REPORT:
                     0           1  accuracy    macro avg  weighted avg
precision     0.860534    0.769231  0.859375     0.814882      0.847070
recall        0.996564    0.066225  0.859375     0.531394      0.859375
f1-score      0.923567    0.121951  0.859375     0.522759      0.805360
support    1746.000000  302.000000  0.859375  2048.000000   2048.000000
_______________________________________________
Confusion Matrix:
 [[1740    6]
 [ 282   20]]

Test Result:
================================================
Accuracy Score: 84.87%
_______________________________________________
CLASSIFICATION REPORT:
                    0           1  accuracy   macro avg  weighted avg
precision    0.848730    0.846154  0.848692    0.847442      0.848314
recall       0.997286    0.077465  0.848692    0.537376      0.848692
f1-score     0.917031    0.141935  0.848692    0.529483      0.791816
support    737.000000  142.000000  0.848692  879.000000    879.000000
_______________________________________________
Confusion Matrix:
 [[735   2]
 [131  11]]
```



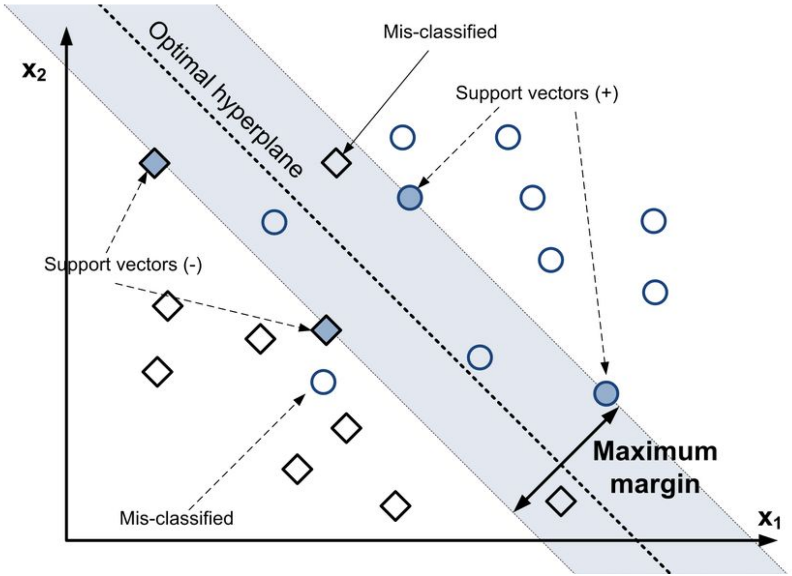
→ K-Nearest Neighbors

```
Train Result:
================================================
Accuracy Score: 86.67%
_______________________________________________
CLASSIFICATION REPORT:
                     0           1  accuracy    macro avg  weighted avg
precision     0.876341    0.659341  0.866699     0.767841      0.844342
recall        0.982245    0.198675  0.866699     0.590460      0.866699
f1-score      0.926276    0.305344  0.866699     0.615810      0.834713
support    1746.000000  302.000000  0.866699  2048.000000   2048.000000
_______________________________________________
Confusion Matrix:
 [[1715   31]
 [ 242   60]]

Test Result:
================================================
Accuracy Score: 82.82%
_______________________________________________
CLASSIFICATION REPORT:
                    0           1  accuracy   macro avg  weighted avg
precision    0.845519    0.354839  0.828214    0.600179      0.766251
recall       0.972863    0.077465  0.828214    0.525164      0.828214
f1-score     0.904732    0.127168  0.828214    0.515950      0.779119
support    737.000000  142.000000  0.828214  879.000000    879.000000
_______________________________________________
Confusion Matrix:
 [[717  20]
 [131  11]]
```



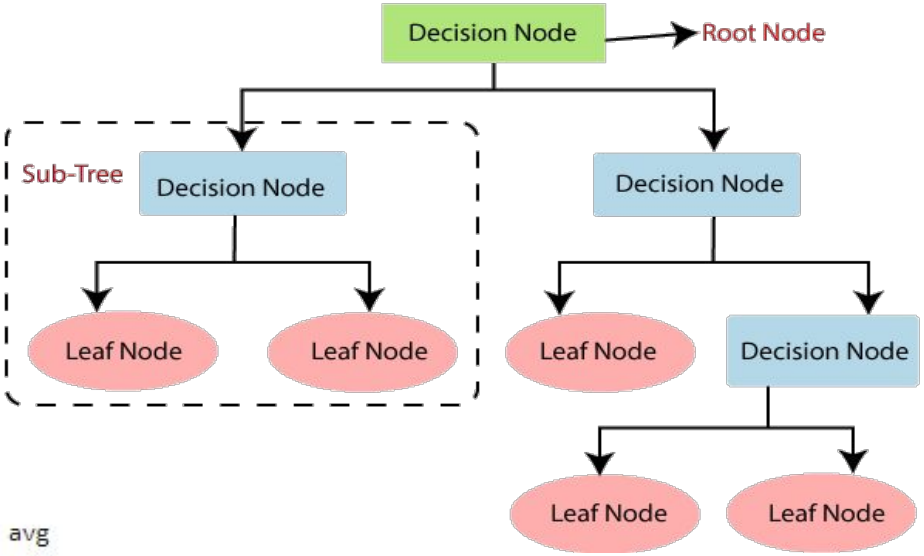
➔ Support Vector Machine

```
Train Result:
================================================
Accuracy Score: 85.99%
_______________________________________________
CLASSIFICATION REPORT:
                     0           1  accuracy    macro avg  weighted avg
precision     0.858829    1.000000  0.859863     0.929415      0.879646
recall        1.000000    0.049669  0.859863     0.524834      0.859863
f1-score      0.924054    0.094637  0.859863     0.509346      0.801747
support    1746.000000  302.000000  0.859863  2048.000000   2048.000000
_______________________________________________
Confusion Matrix:
 [[1746    0]
 [ 287   15]]

Test Result:
================================================
Accuracy Score: 83.85%
_______________________________________________
CLASSIFICATION REPORT:
                    0      1  accuracy   macro avg  weighted avg
precision    0.838453    0.0  0.838453    0.419226      0.703003
recall       1.000000    0.0  0.838453    0.500000      0.838453
f1-score     0.912129    0.0  0.838453    0.456064      0.764777
support    737.000000  142.0  0.838453  879.000000    879.000000
_______________________________________________
Confusion Matrix:
 [[737   0]
 [142   0]]
```

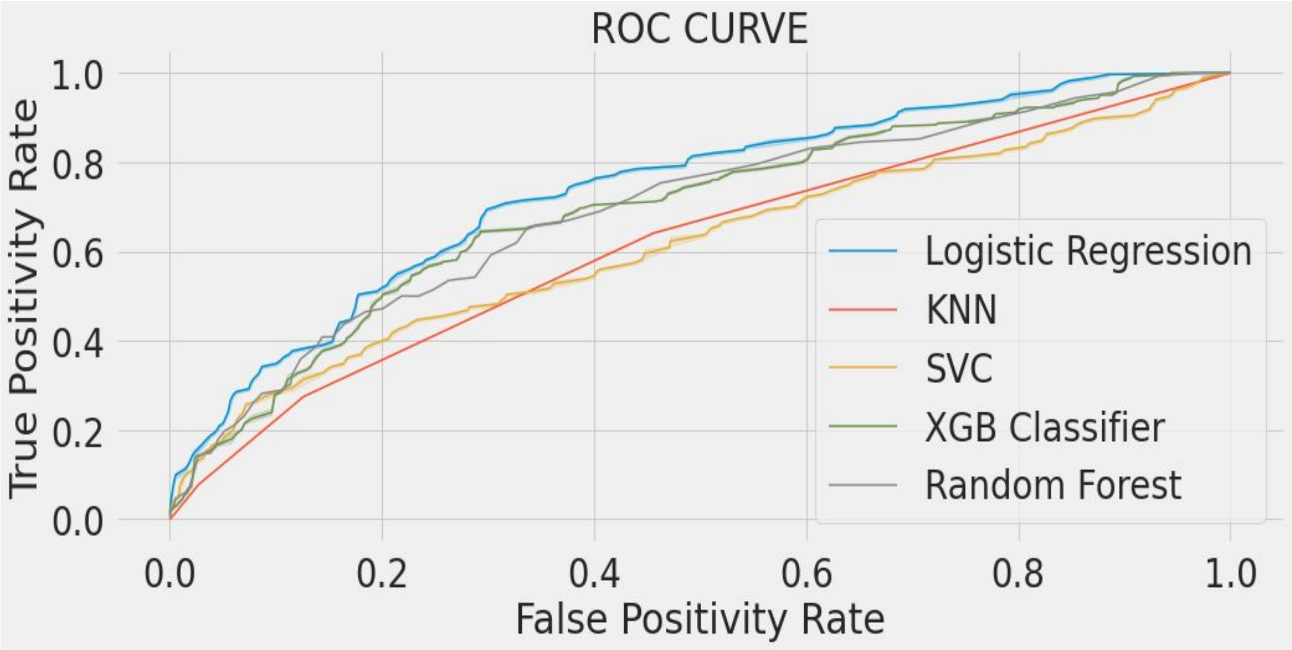


Decision Tree Classifier

```
Train Result:
================================================
Accuracy Score: 100.00%
_______________________________________________
CLASSIFICATION REPORT:
                0      1  accuracy  macro avg  weighted avg
precision     1.0    1.0       1.0        1.0           1.0
recall        1.0    1.0       1.0        1.0           1.0
f1-score      1.0    1.0       1.0        1.0           1.0
support    1746.0  302.0       1.0     2048.0        2048.0
_______________________________________________
Confusion Matrix:
 [[1746    0]
 [   0  302]]

Test Result:
================================================
Accuracy Score: 77.36%
_______________________________________________
CLASSIFICATION REPORT:
                    0           1  accuracy   macro avg  weighted avg
precision    0.862534    0.291971  0.773606    0.577252      0.770361
recall       0.868385    0.281690  0.773606    0.575038      0.773606
f1-score     0.865450    0.286738  0.773606    0.576094      0.771960
support    737.000000  142.000000  0.773606  879.000000    879.000000
_______________________________________________
Confusion Matrix:
 [[640  97]
 [102  40]]
```



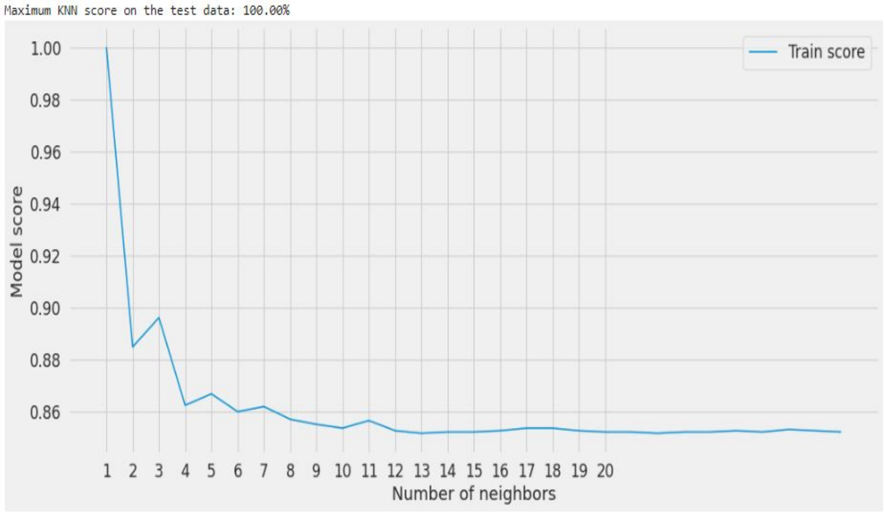
Diagramatic Representation of Models-ROC Curve



– Receiver Operating Classifier curve of a purely random classifier; a good classifier stays as far away from that line as possible (toward the top-left corner).
– The more that the curve hugs the top left corner of the plot, the better the model does at classifying the data into categories

Hyperparameter Tuning(K-Nearest Neighbors)

```
train_score = []
test_score = []
neighbors = range(1, 30)

for k in neighbors:
    model = KNeighborsClassifier(n_neighbors=k)
    model.fit(X_train, y_train)
    train_score.append(accuracy_score(y_train, model.predict(X_train)))
```



Test Accuracy using Hyperparameter Tuning = **84.07**

Conclusion

AI

- We have patients in the 32 to 70 age group. Number of patients from the 38 to 46 age group is high with smoking habits.
- Number of female patients is higher than male patients.
- There are 1307 male patients in the dataset out of which 809 mal patients smoke cigarettes.
- There are 1620 female patients in the dataset out of which 638 female patients smoke cigarettes.
- Number of patients with medical history like blood pressure medication, Diabetes, and patients who previously had a stroke is very low.
- Logistic Regression,K-Nearest Neighbors, Support Vector Machine & Decision Tree Classifier models were implemented.
- From above these models,we found that KNN is the best fitted model compared to other models
- In Hyperparameter tuning ,we observed that K-Nearest Neighbors accuracy has improved which shows that KNN (with Hyperparameter Tuning) is the best fitted model for Coronary Heart Disease dataset.
  Train Accuracy = **85.30** & Test Accuracy = **84.07**

	Model	Training Accuracy %	Testing Accuracy %
0	Logistic Regression	85.937500	84.869170
1	K-nearest neighbors	86.669922	82.821388
2	Support Vector Machine	85.986328	83.845279
3	Decision Tree Classifier	100.000000	77.360637

	Model	Training Accuracy %	Testing Accuracy %
0	Tuned K-nearest neighbors	85.302734	84.07281

Future Improvement

- For future improvement in the model fitting for Coronary Heart Disease , we can perform the Random Forest Classifier , XGBoost models also.
- Consulting medical people we can analyze the feature in proper and required manner to approach the disease cause and effects.

THANKYOU !!...