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Predicting Cardiac Arrest using a Multi-Layer Perceptron Classifier in Python

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Abstract*:* This study focusses on heart failure prediction using MLP classifier in python and the data is collected from Kaggle to train the model with the help of secondary sources. And the primary data "test data" is collected from the hospitals around the Vijayawada. A sample size of 120 respondents were taken to make prediction of heart failure. The sampling technique used in the study is Judgement or purposive Sampling technique. And the techniques used in this study are 1.MLP Classification;2. Supervised, 3. Pandas Profiling report. The main Objective of the study is "A Study on Heart Failure Prediction using MLP Classifier in python". The contribution of the Study is to help the doctors to predict the patient's death event by the heart failure condition or cardio vascular disease and also to prevent the people from to getting heart failure.

Keywords*: Heart, Failure Prediction; MLP Classifier; Python, Sampling technique*

1.Introduction

Heart disease is a major public health problem in today's society. It's difficult to manually calculate the probability of having heart disease given a set of risk factors. However, machine learning techniques are useful for making predictions based on the existing data. The Study is on predicting Heart Failure for the patients. For the patients who as age of 70 and above with diabetes and high blood pressure are likely to get heart failure. The patients who didn't have the normal range of creatinine and serum creatinine are to do exercise and eat more fiber to reduce the chances of heart failure. As high serum creatinine levels indicates that the kidneys aren't functioning properly.

Heart failure is a serious medical condition that can have a significant influence on a person's life. The majority of people consistently put their own health last on their list of priorities, despite the accelerated pace of life, increased portion sizes, and inactivity. In addition, because of the deterioration in the environment, those variables can contribute to the problem of heart failure, which has the potential to become increasingly prevalent in the years to come. If individuals did not pay attention to the problem of heart failure, it would eventually result in death.

Over the course of the past several years, numerous researchers have utilized a variety of approaches to data collection and analysis in an effort to better predict instances of heart failure. The Cleveland heart disease dataset, biomedical science datasets collected from the University of California, Irvine and other institutions, etc., are all examples of such data. These datasets were compiled from the electronic health records (EHR) of heart failure patients treated at hospitals in a wide range of countries. On the basis of these data, a variety of methods are being utilized.

The majority of the time, a blockage in the coronary artery is what leads to a heart attack. Despite a rise in heart attack survivors, cardiovascular disease remains the top cause of mortality in the United States. The early recognition of the disease's cardinal symptoms is vital for adequate care, which in turn is important for preventing unfavorable clinical consequences.

In order to reduce the amount of time that passes between the commencement of a heart attack and the

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patient's arrival at the hospital, it is essential to increase public awareness of the symptoms and signs of a stroke. Chest pain that radiates from the left arm to the neck is one of the symptoms of myocardial infarction (MI).

Poorer understanding of cardiovascular disease (CVD) was independently predicted by factors such as male gender, lower education level, older age, lack of regular exercise, unmarried status, unemployment, poor psychological status, poor economic status, poor health behaviors (high-salt diet, no health screening), and the presence of hypertension or dyslipidemia. These factors included self-perceived high stress and self-perceived poor health. It is possible to avoid having a heart attack by adopting preventative measures as early as possible. Quitting smoking is the most crucial step, but there are other vital strategies to reduce risks as well, such as eating properly, staying within safe limits of alcohol intake, engaging in regular exercise, and achieving and maintaining an appropriate weight. ACE inhibitors, antiplatelet treatment, beta-blockers, and statins are just some of the medications that a doctor might give to minimize a patient's risk.

The ability to rapidly, effectively, and precisely detect cardiac disease plays a crucial role in the adoption of preventative measures, which plays a critical part in the effort to avert death. Electrocardiograms, often known as ECGs, are used to diagnose myocardial infarction by analyzing electrical impulses in the heart as well as damage to the blood flow to the heart muscle. Troponin and creatine kinase (CK-MB) are the two blood tests that are most commonly performed. The shape of the tracing on an electrocardiogram can be used to identify between two different types of myocardial infarctions. This is done with the use of the ECG test. An ST-segment elevation myocardial infarction, also known as a STEMI, is a condition that requires emergency medical care and is identified by a ST segment of the tracing that is elevated above the baseline. The coronary angiography, often known as an X-ray of the heart and blood vessels, is a diagnostic procedure that is used to visualize coronary artery stenosis. In addition, a significant amount of research has been conducted, and numerous machine learning models have been utilized, in order to categorize and forecast cardiac disease.

Data mining is the process of extracting useful information from enormous databases for use in a range of fields, such as education, commerce, and medicine, among others. Machine learning is one of the subfields of artificial intelligence that is experiencing the most rapid expansion. These algorithms are able to do in-depth analysis on massive volumes of data drawn from a wide variety of fields, including the medical industry. It is a computer-assisted alternative to the classic prediction modeling that is used for the purpose of gaining knowledge of complex and nonlinear interactions among multiple components. This is accomplished by decreasing mistakes in both the results that were projected and those that were actually achieved. Data mining is the process of studying enormous datasets in an effort to unearth previously concealed information that can be used in future analysis for essential decision-making.

The medical field is replete with data pertaining to patients. Several different machine learning techniques will need to be used in order to assess these data.

These data are evaluated by medical specialists so that they can make accurate diagnostic judgments. Clinical aid can be obtained through the use of medical data mining and classification algorithms through analysis. This puts classification algorithms to the test to determine whether or not patients have cardiac disease.

2. Review of Literature

Heart disease, stroke, high blood pressure, high cholesterol, and other pathologies are all considered cardiovascular diseases (CVDs) by Anna Karen Garate-Escamila, Amir Hajjam El Hassani, and Emmanuel Andres (2017). Nearly seventeen million people every year lose their lives to cardiovascular disease; in the United Kingdom, mortality rates have recently risen for the first time in half a century. When the heart is unable to pump enough blood to the body, a condition known as heart failure occurs. Heart failure is commonly brought on by diabetes, high blood pressure, or another heart condition.

Kavitha et al. (2010) claim that there has been a continual rise in the requirement for efficient identification of information, contextual data, non-obvious information, and important information for decision making from a big collection of data. Knowledge Discovery from Data is the name of the interactive, iterative process that entails a number of decisions and subtasks. Data mining, which converts data into information for decision-making, is the main method of knowledge discovery.

The purpose of this research that was conducted by Rustem Ylmaz (2021) was to create a predictive classification model that is capable of determining the elements that put a person at risk for heart attack disease. This study aimed to examine the differences between those who were at low and high risk for having a heart attack [8]. In order to determine risk factors, the authors assessed the relevance of the variables. Radial basis function and multilayer perceptual neural networks were used to compare and contrast the results of the

categorization prediction analyses. MLP model criteria also included Specificity 0.92. The top three most important risk factors for having a heart attack were found to be trestbps, oldpeak, and chol . These factors may be connected with having a heart attack. The model that was developed using the MLP neural network was able to provide more accurate predictions of the heart attack than the model that was developed using the RBF neural network. This is something that can be deduced from the outcomes of the prediction results. In addition, the estimation of the importance values of the elements that are most commonly connected with a heart attack is a promising outcome for the diagnosis, treatment, and prognosis of the condition.

Diseases of the cardiovascular system are consistently ranked among the top causes of mortality for the general population. Patients with cardiac illnesses have a far lower likelihood of surviving if their conditions are not detected early on. It is well recognized that a number of parameters are known to have an influence on life-threatening heart problems; nevertheless, due to the high number of variables, it is frequently difficult for an expert to evaluate each patient while taking this information into account. For the purpose of determining whether or not a patient is at risk of developing cardiovascular disease, Garcá-Ordás(2023) suggests employing methods of deep learning in conjunction with approaches for feature augmentation. This proposal can be found in the aforementioned publication [9]. The findings of the proposed methods outperform those of existing methods that are considered to be state of the art by 4.4%, which results in a precision of 90%. This represents a significant increase, especially when it comes to a condition that affects a wide population.

The diagnosis of heart illness can be challenging; hence, researchers have developed a number of different intelligent diagnostic systems in an effort to increase the accuracy of heart disease diagnosis. However, these methods still have an issue with their low accuracy in predicting cardiovascular illness. We present a method for feature selection that makes use of a floating window with adaptive size for feature elimination (also known as FWAFE) in order to improve the accuracy of heart risk prediction. Following the removal of unnecessary features, artificial neural networks (ANN) and deep neural networks (DNN) are utilized as classification frameworks. In light of this, the author of this research, Ashir Javeed(2020), proposes two distinct varieties of hybrid diagnostic systems, namely, FWAFE-ANN and FWAFE-DNN. Experiments are conducted to evaluate the efficacy of the provided methodologies [10] on a dataset acquired from the Cleveland online cardiac disease database. Accuracy, sensitivity, specificity, Matthews's correlation coefficient (MCC), and the receiver operating characteristics (ROC) curve are just few of the metrics used to evaluate the efficacy of the offered methods. The results of the experiments demonstrate that the proposed models performed better than eighteen other techniques that had been proposed in the past, which had achieved accuracies ranging from 50.00–91.83%. Furthermore, when compared to other state-of-the-art machine learning techniques for the diagnosis of cardiovascular sickness, the performance of the recommended models is highly excellent. In addition, the technologies that have been presented can provide assistance to medical professionals in the process of accurately identifying cardiac disease.

The diagnosis and prognosis of cardiovascular illness are essential medical duties that must be performed to ensure accurate categorization of the patient. Accurate classification enables cardiologists to offer the patient with the appropriate treatment. As a result of their ability to spot patterns in data, machine learning systems have become increasingly popular in the medical sector. The use of machine learning to classify the occurrence of cardiovascular illness can help diagnosticians reduce the number of incorrect diagnoses they make [11]. This research aims to construct a model that is capable of accurately predicting cardiovascular diseases in order to cut down on the number of deaths caused by cardiovascular diseases. The method of k-modes clustering with Huang beginning that is proposed in this research by Bhatt, C.M (2023) is one that has the potential to improve classification accuracy. XGBoost (XGB), random forest (RF), decision tree classifier (DT), multilayer perceptron (MP), and other models are employed in this process. In order to achieve the best possible outcome, GridSearchCV was utilized in order to fine-tune the relevant parameters of the model that was deployed. A real-world dataset of 70,000 occurrences was obtained from Kaggle and used to test the suggested model. Models were trained using data that was split 80:20, and the following levels of accuracy were reached as a result: XGBoost scored 86.87% and 87.02%, random forest scored 87.05% and 86.92% and multilayer perceptron scored 87.28% (with cross-validation) and 86.94% (without cross-validation). The following AUC (area under the curve) values may be found in the proposed models: 0.94 for the decision tree, 0.95 for the XGBoost, 0.95 for the random forest, and 0.95 for the multilayer perceptron. In terms of accuracy, the multilayer perceptron method with cross-validation has been shown to perform superiorly to every other algorithm that has been investigated. This is the conclusion that has been derived from the research that has been conducted. It had the maximum accuracy possible, coming in at 87.28%.

Around the world, cardiovascular disease is still responsible for an alarmingly high number of deaths each year. The most serious problem facing industrialized countries today is cardiovascular disease (CVD). Not only does cardiovascular disease suddenly take the lives of a sizeable portion of the population, but it also leaves an even greater number of people in chronic pain and unable to work. Even though a considerable fraction of cardiovascular diseases can be avoided through better lifestyle choices, the incidence of these conditions is nonetheless steadily increasing. In this work by Kirmani (2017), the data mining technique known as Multilayer Perceptron is presented as a method for diagnosing CVD [12]. The newly acquired information can be put to use by healthcare administrators in order to enhance the level of service provided, and it can also be utilized by medical professionals in order to lessen the amount of adverse drug effects.

It is both disturbing and necessary to be able to predict cardiac problems early on since the rate at which they are rising daily at a rapid pace is. The diagnosis of cardiac disease is a difficult task, as it requires precision and expertise in order to be completed successfully. This investigation by Ali M. A. Barhoom (2022) seeks to identify, on the basis of a variety of clinical characteristics, the individual patient who is at a higher risk of suffering from coronary artery disease. For the purpose of predicting whether or not a person will be diagnosed with a cardiac ailment, the authors constructed a model that takes into account the individual's medical history. In this study, researchers used many different machine learning algorithms to categorize people with heart disease. The model's potential application was effectively regulated to improve the precision with which heart problems might be predicted for each one individual. The suggested model outperformed the previous classifiers used, which was very encouraging, and it successfully predicted the presence of heart disease in a given individual. This was accomplished by utilizing Deep Learning and the Random Forest Classifier, both of which demonstrated a good level of accuracy. The methodology that is being developed for predicting cardiac disease will both improve medical care and bring down associated costs. The results of this study provide us with important information that can improve our ability to diagnose individuals with heart disease. The dataset was obtained from the Kaggle depository, and python was utilized throughout the development of the model.

3. Research Methodology with Result analysis with Coding

The data is collected from Kaggle to train the model with the help of secondary sources. And the primary data "test data" is collected from the hospitals around the Vijayawada. The secondary sourcesconsist of readymade data available and already combined statistical data and reports whose information is used by researchers as well for their studies. Secondary sources do not include publishes sources but also unpublished records such as accounting and financial records, inventory records etc.

3.1 Sample Size:

A sample size of 120 respondents were taken to make prediction of heart failure.

3.2 Sample Technique:

The sampling technique used in the study is Judgement or purposive Sampling technique.

3.3 Data Analysis Techniques

1. MLP Classification
2. Supervised
3. Pandas Profiling report

3.4 Objective of the study

The main Objective of the study is "A Study on Heart Failure Prediction using MLP Classifier inpython"

3.5 Contribution of the Study

The contribution of the Study is to help the doctors to predict the patient's death event by the heartfailure condition or cardio vascular disease and also to prevent the people from to getting heart failure.

3.6 Data Analysis

Analysis of Python:

For the above dataset we apply the MLP Classifier algorithm in python to predict the death event ofthe patient's it is as follows:

Code 1: Importing Packages

```
from sklearn.neural_network import MLPClassifier from sklearn.preprocessing import MinMaxScaler from sklearn.model_selection import train_test_split

from sklearn.metrics import confusion_matrix, accuracy_scoreimport pandas_profiling as pf

import pandas as pd

from pandas_profiling import ProfileReportimport matplotlib.pyplot as plt

import seaborn as sns

%matplotlib inline
```

Code 2: To import the train data

data=pd.read_csv("A:/data/heart_failure_clinical_records_dataset.csv") data.columns

Output Index(['age', 'anaemia', 'creatinine_phosphokinase', 'diabetes', 'ejection_fraction', 'high_blood_pressure', 'platelets', 'serum_creatinine', 'serum_sodium', 'sex', 'smoking', 'DEATH_EVENT'], dtype='object')

Code 3: Exploratory Data Analysis for train data

profile=pf.ProfileReport(data)profile

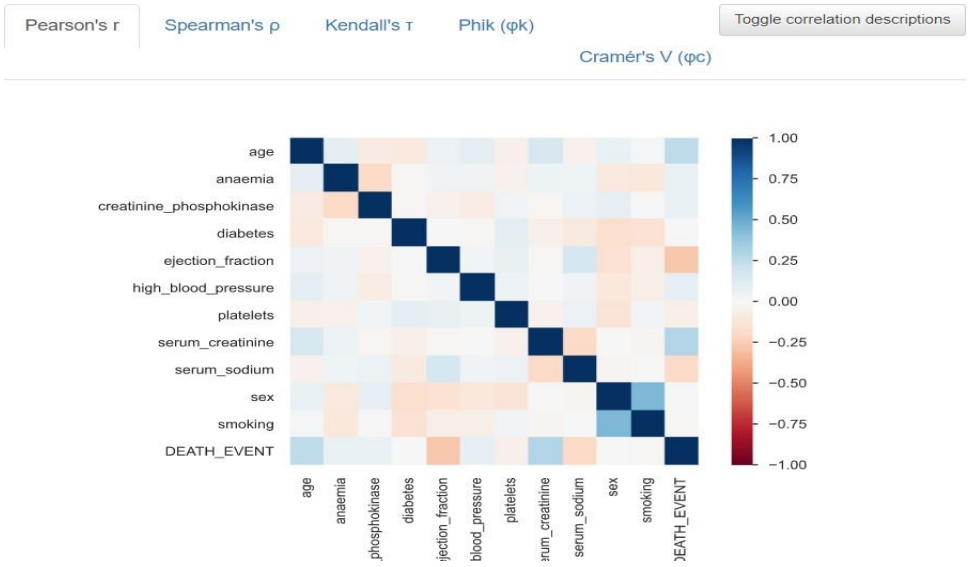

Fig 1: The Figure Shows the Pearson's correlation for train data

Interpretation:

The following analysis of the study identifies Pearson's correlation between the columns. From the plot it is observed that there is high correlation between sex and smoking of respondents ofrespondents.

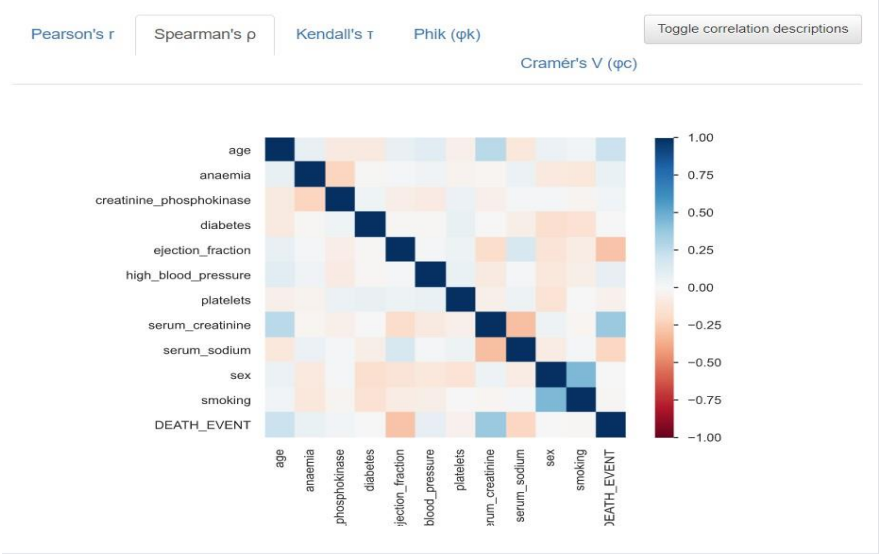

Fig 2: The Figure Shows the Spearman's correlation for train data

Interpretation:

The following analysis of the study identifies Spearman's correlation between the columns. From the plot it is observed that there is high correlation between sex and smoking of respondents ofrespondents.

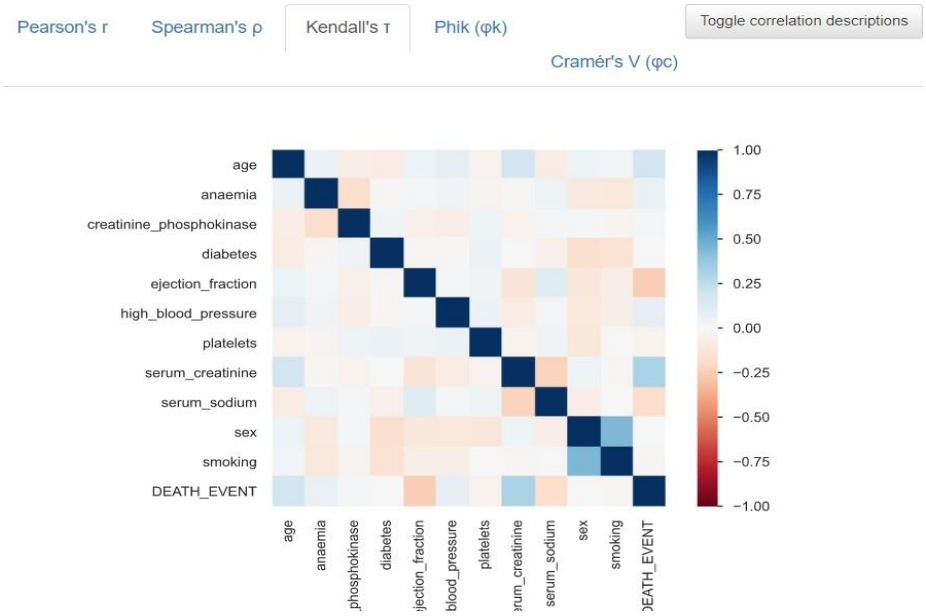

Fig 3: The Figure shows the Kendall's correlation for the train data

Interpretation:

The following plot shows the correlation between the columns. From the plot it is observed thatthere is high correlation between sex and smoking of respondents.

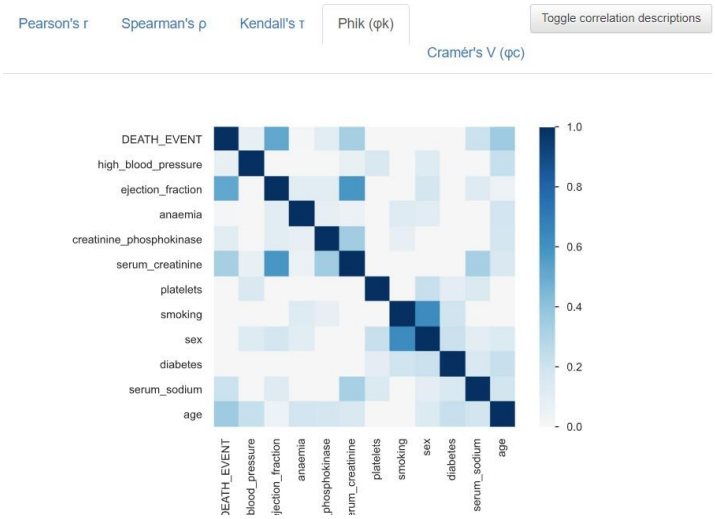

Fig 4: The Figure shows the Phik correlation for train data

Interpretation:

The following plot shows the correlation between the columns. From the plot it is observed thatthere is high correlation between sex and smoking of respondents.

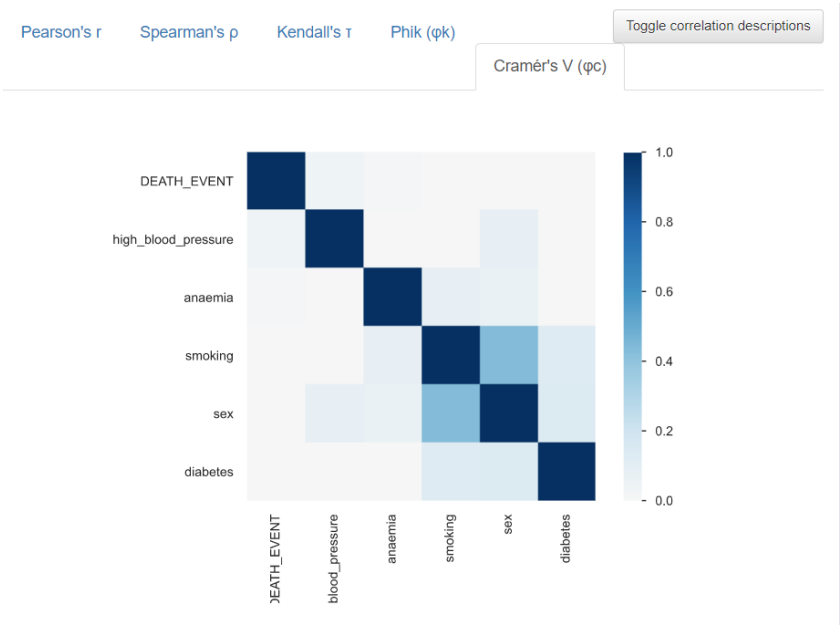

Fig 5: The Figure shows the Cramer's correlation of train data

Interpretation:

The following plot shows the correlation between the columns. From the plot it is observed thatthere is high correlation between sex and smoking of respondents.

Code 4: To plot the correlation of the test data.

plt.subplots(figsize=(11,11))sns.heatmap(data.corr())

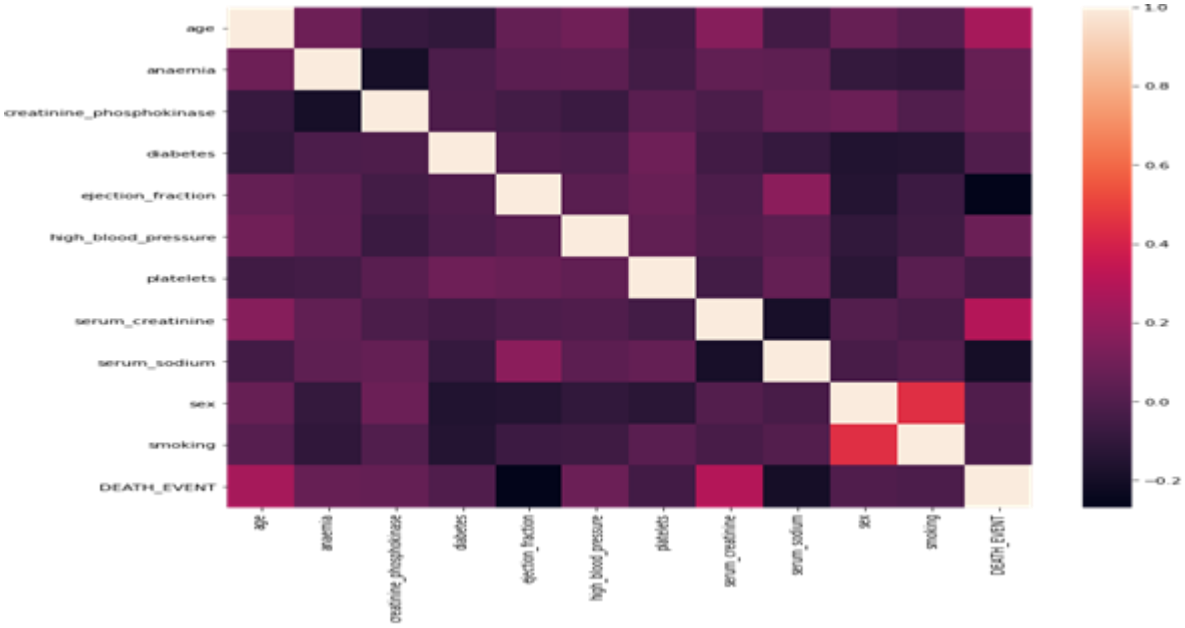

Fig 4.6: The Figure shows the heatmap of train data

Interpretation:

The heatmap above displays the correlation between the columns. It is observed that the there iscorrelation between sex, smoking ejection fraction, serum creatinine & serum sodium of respondents.

Code 5: Data Pre-processing scaler = MinMaxScaler() scaler.fit(data)

scaled_features = scaler.transform(data) data_MinMax=pd.DataFrame(data=scaled_features, columns=['age','serum_creatinine','anaemia','creatinine_phosphokinase','diabetes','ejection_fraction', 'high_blood_pressure','platelets','serum_sodium','sex','smoking','DEATH_EVENT'])

Code 6: Splitting the data train_set,test_set=train_test_split(data_MinMax,train_size=0.8,test_size=0.2,random_state=40) print(len(train_set),'Training Set +', len(test_set), ' Testing Set')

Out: 239 Training Set + 60 Testing Set X_train =

train_set.drop('DEATH_EVENT',axis=1) Y_train = train_set['DEATH_EVENT'].copy() X_test = test_set.drop('DEATH_EVENT',axis=1) Y_test = test_set['DEATH_EVENT'].copy()

Code 7: Building & Fitting MLP Classifier Model

cls=MLPClassifier(hidden_layer_sizes=(13,20,30),activation='relu',solver='lbfgs',learning_rate='constant',learning_rate_init=0.001,tol=0.00001,max_iter=150,verbose=True,max_fun=20000)

trained = cls.fit(X_train,Y_train)

Out: The accuracy of the model is 75.0

Now since the building of the model is completed so let's predict the death event of the patients

Code 8: Load the Test data

test_data=pd.read_csv('A:/data/Heart Condition of the Patient.csv')

Code 9: EDA for the data

test_profile=pf.ProfileReport(test_data)

test_profile

Code 10: Plotting correlation of test data

plt.subplots(figsize=(11,11)) sns.heatmap(test_data.corr())

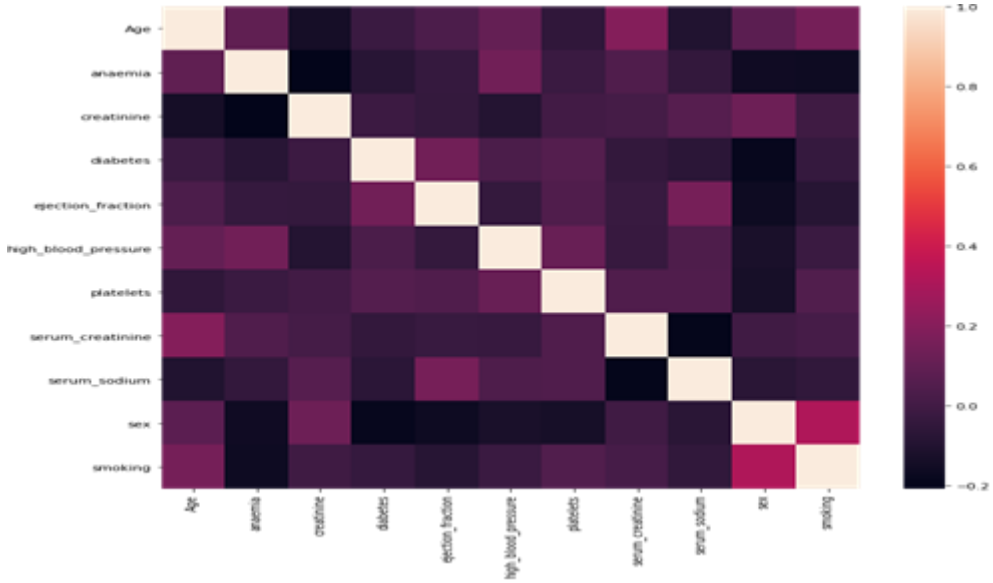

Fig 4.7: The Figure shows the Heatmap for test data

Interpretation: The heatmap above displays the correlation between the columns. It is observed thatthere is correlation between sex, smoking ejection_fraction, serum_creatinine & serum_sodium of respondents

Code 11: Data Pre-pressing of Test data

scaler = MinMaxScaler()scaler.fit(test_data)

scaled_features = scaler.transform(test_data)

Code 12: Making Predictions

test_data_MinMax=pd.DataFrame(data=scaled_features, columns=['age','serum_creatinine','anaemia','creatinine_phosphokinase','diabetes','ejection_fraction','high_blood_pressure','platelets','serum_sodium','sex','smoking'])

predictions=trained.predict(test_data) predictions

array([0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	1.,	1.,	1.,	1.,	0.,	0.,	0.,	0.,	0.,
0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,
0.,	0.,	0.,	1.,	0.,	1.,	0.,	0.,	0.,	0.,	1.,	0.,	0.,	0.,	0.,	0.,	0.,
0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	1.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,
0.,	0.,	0.,	1.,	1.,	0.,	1.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,
0.,	0.,	0.,	0.,	0.,	1.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,

0.,	1.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	0.,

0.])

test_data['Predictins’] =predictions

	Age	anaemia	creatinine	diabetes	ejection_fraction	high_blood_pressure	platelets	serum_creatinine	serum_sodium	sex	smoking	Predictions
0	75	0	580	0	20	1	265000	1.90	130	1	0	0.0
1	55	0	7861	0	38	0	263358	1.10	136	1	0	0.0
2	60	0	146	0	20	0	162000	1.30	129	1	0	0.0
3	50	1	111	0	20	0	210000	1.90	137	1	0	0.0
4	65	1	160	1	20	0	327000	2.70	116	0	0	0.0
...	...	...	...	...	...	...	...	...	...	...	...	...
115	60	0	96	1	38	0	228000	0.75	140	0	0	0.0
116	63	1	1767	0	45	0	73000	0.70	137	1	0	0.0
117	45	0	582	0	20	1	126000	1.60	135	1	0	0.0
118	55	1	2794	0	35	1	141000	1.00	140	0	0	0.0
119	50	1	54	0	40	0	279000	0.80	141	1	0	0.0

120 rows × 12 columns

4. Conclusion

Heart disease is a major public health problem in today's society. It's difficult to manually calculate the probability of having heart disease given a set of risk factors. However, machine learning techniques are useful for making predictions based on the existing data. The study aims to foretell patients' heart failure. Heart failure is a possibility for patients with diabetes and high blood pressure who are 70 years of age or older. Exercise and consuming more fiber are advised for patients whose serum and creatinine levels were outside of the normal range in order to lower their risk of developing heart failure. Because elevated serum creatinine levels are a sign of dysfunctional kidneys.

Patients who have high blood pressure run the risk of developing heart failure. They are therefore urged to have a heart-healthy diet because it is essential for lowering high blood pressure. Additionally, it's crucial for controlling already-controlled hypertension and lowering the likelihood of problems. Heart problems, strokes, and heart attacks are some of these issues. A diet that is heart-healthy places an emphasis on fruits, vegetables, whole grains, and lean meats like fish. Smokers are advised to give up because nicotine makes blood vessels constrict, which reduces the amount of blood that can reach your organs. Constant narrowing causes blood vessels to become less flexible and more rigid. Reduced blood flow reduces the quantity of oxygen and nutrients reaching your cells.

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