**PROJECT REPORT**

1. **Title of the Project: Heart failure prediction**

**Focus Area:** Heart failure clinical report and prediction

1. **Brief on the project**

**Heart failure causes:**

Heart failure can result from various underlying conditions or factors that impair the heart's ability to pump blood effectively. Some common reasons for heart failure include:

**1. Coronary Artery Disease (CAD) :**

- CAD is a condition where the coronary arteries, which supply blood to the heart muscle, become narrowed or blocked by plaque buildup. This reduces blood flow to the heart, leading to myocardial ischemia and eventually heart failure.

**2. Hypertension (High Blood Pressure):**

**-** Chronic high blood pressure puts extra strain on the heart, causing the heart muscle to thicken and stiffen over time. This can weaken the heart's pumping ability and contribute to heart failure.

**3. Cardiomyopathy:**

**-** Cardiomyopathy refers to diseases of the heart muscle, where the muscle becomes enlarged, thickened, or rigid. These changes can weaken the heart and impair its ability to pump blood effectively, leading to heart failure.

**4. Heart Valve Disorders:**

**-** Malfunctioning heart valves, such as mitral valve regurgitation or aortic stenosis, can cause the heart to work harder to pump blood. Over time, this increased workload can weaken the heart muscle and result in heart failure.

**5. Myocardial Infarction (Heart Attack):**

- A heart attack occurs when blood flow to a part of the heart is blocked, usually by a blood clot in a coronary artery. The lack of oxygen-rich blood can cause damage to the heart muscle, leading to impaired pump function and potentially heart failure.

**6. Arrhythmias:**

- Abnormal heart rhythms, such as atrial fibrillation or ventricular tachycardia, can disrupt the heart's normal pumping action and reduce its efficiency. Prolonged arrhythmias can contribute to heart failure over time**.**

**7. Congenital Heart Defects:**

**-** Some individuals are born with structural abnormalities in the heart that can affect its function. Depending on the nature and severity of the defect, these conditions may lead to heart failure later in life.

**8. Chronic Conditions:**

**-** Certain chronic conditions, such as diabetes, obesity, and kidney disease, can increase the risk of heart failure by contributing to cardiovascular damage or placing additional strain on the heart.

**9. Substance Abuse:**

- Excessive alcohol consumption, illicit drug use (particularly stimulants like cocaine or methamphetamine), and certain medications can have detrimental effects on the heart and contribute to heart failure.

**10. Other Factors:**

**-** Other factors such as age, genetics, smoking, sedentary lifestyle, and exposure to environmental toxins can also influence the development of heart failure**.**

It's important to note that heart failure is often a progressive condition that develops gradually over time, and individuals may have multiple contributing factors. Identifying and addressing these underlying causes are crucial for managing and preventing heart failure.

**3. Deliverables of the project:**

The deliverables of a heart failure prediction project typically include**:**

**1. Predictive Model:**

**-** The primary deliverable is a predictive model developed using statistical or machine learning techniques. This model should accurately estimate the risk of heart failure occurrence or progression based on input features such as demographic information, medical history, diagnostic test results, and clinical markers.

**2. Model Evaluation Metrics:**

**-** Documentation of the performance metrics used to evaluate the predictive model, such as accuracy, sensitivity, specificity, area under the receiver operating characteristic curve (AUC-ROC), or precision-recall curve.

**3. Feature Importance Analysis:**

- Analysis of the importance of input features in the predictive model. This helps identify which variables are most influential in predicting heart failure outcomes.

**4. Model Documentation:**

- Detailed documentation of the predictive model, including its algorithm, hyperparameters, training process, and validation methodology. This documentation facilitates the reproducibility and transparency of the model**.**

**5. Visualization of Results:**

- Visual representations of model performance and key insights, such as ROC curves, precision-recall curves, calibration plots, and feature importance plots. Visualization aids in interpreting and communicating the results effectively.

**6. Report or Presentation:**

**-** A comprehensive report or presentation summarizing the heart failure prediction project. This should include an overview of the problem statement, data used, methodology, results, discussion of findings, limitations, and recommendations for future research or clinical application.

**7. Code Repository:**

**-** Availability of code used for data preprocessing, model development, and evaluation in a version-controlled repository (e.g., GitHub). This allows others to review, replicate, and build upon the work.

**8. User Interface or Application (Optional):**

- Development of a user-friendly interface or application for healthcare professionals to input patient data and obtain predictions of heart failure risk. This facilitates the practical use of the predictive model in clinical settings.

**9. Documentation for End Users:**

- Instructions and documentation for end users (e.g., clinicians, researchers) on how to use the predictive model, interpret results, and understand its limitations.

**10. Ethical Considerations:**

**-** Discussion of ethical considerations related to data privacy, bias, fairness, and potential impact on patient care. Ensuring that the predictive model is ethically sound and does not perpetuate disparities in healthcare.

These deliverables collectively contribute to the successful implementation and utilization of the heart failure prediction model in clinical practice or research settings.

**\*Problem analysis:**

In the given study, we have a binary classification problem. We will predict the target variable heart failure cause.

Lastly, we will build a variety of Classification models and compare the models giving the best prediction on heart failure cause.

**\*Attribute Information**

i. Age: age of the patient [years]

ii. Sex: sex of the patient [M: Male, F: Female]

iii. ChestPainType: chest pain type [TA: Typical Angina, ATA: Atypical Angina, NAP: Non-Anginal Pain, ASY: Asymptomatic]

iv. RestingBP: resting blood pressure [mm Hg]

v. Cholesterol: serum cholesterol [mm/dl]

vi. FastingBS: fasting blood sugar [1: if FastingBS > 120 mg/dl, 0: otherwise]

vii. RestingECG: resting electrocardiogram results [Normal: Normal, ST: having ST-T wave abnormality (T wave inversions and/or ST elevation or depression of > 0.05 mV), LVH: showing probable or definite left ventricular hypertrophy by Estes' criteria]

viii. MaxHR: maximum heart rate achieved [Numeric value between 60 and 202]

ix. ExerciseAngina: exercise-induced angina [Y: Yes, N: No]

x. Oldpeak: oldpeak = ST [Numeric value measured in depression]

xi. ST\_Slope: the slope of the peak exercise ST segment [Up: upsloping, Flat: flat, Down: downsloping]

xii. HeartDisease: output class [1: heart disease, 0: Normal]

Preprocessing of the Dataset : EDA has been performed on the dataset and it does not have any null values and duplicated data. But outliers were present in the dataset and it has been treated properly and also for standardization standard scaler is used. Data Visualization is also done on the dataset.

1. **Resource:**

**Data set source: The data set source is from the below location**: https://www.kaggle.com/code /heart-failure-prediction-with-ensemble-models/notebook

· Software: The software used for analyzing the problem is Python with Scikit-Learn: Python is a popular programming language for machine learning.Scikit-Learn is used as machine machine-learning library that includes various classification algorithms. Matplotlib, seaborn, and sweetviz is used for data visualization.

1. **Individual Details:**

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1. **Conclusion:**

Looking ahead, ongoing research efforts aimed at elucidating the pathophysiology of heart failure, refining predictive models, and exploring novel therapeutic interventions hold promise for further improving patient outcomes.

Additionally, addressing disparities in access to care and ensuring equitable delivery of heart failure management services are critical considerations for healthcare systems worldwide.