Prediction and Analysis of Heart Failure

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Motivation and Goals

o Cardiovascular diseases are the **number one** cause of death globally

o Take an estimated 17.9 million lives each year (**31% of all deaths** worldwide)

o People with high cardiovascular risk need early detection.

o Goals: **Visualize** factors which lead to Heart Disease and try to **Predict** Heart Disease based on these factors.

Dataset

Data retrieved from four independently created datasets.

- o Key Column: HeartDisease (True/False)
- o Numerical Data: Age, RestingBP, Cholesterol, FastingBS, MaxHR, Oldpeak
- o Categorical Data: Sex, ChestPainType, RestingECG, ExerciseAngina, ST_Slope

|	HeartDisease	Age	RestingBP	Cholesterol	FastingBS	MaxHR	Oldpeak	Sex	ChestPainType	RestingECG	ExerciseAngina	ST_Slope
0	0	40	140	289	0	172	0.0	M	ATA	Normal	N	Up
1	1	49	160	180	0	156	1.0	F	NAP	Normal	N	Flat
2	0	37	130	283	0	98	0.0	M	ATA	ST	N	Up
3	1	48	138	214	0	108	1.5	F	ASY	Normal	Y	Flat
4	0	54	150	195	0	122	0.0	M	NAP	Normal	N	Up

How do numerical values contribute to Heart Disease?
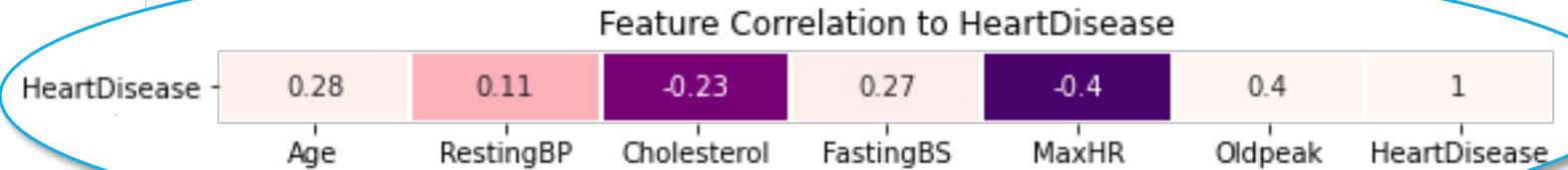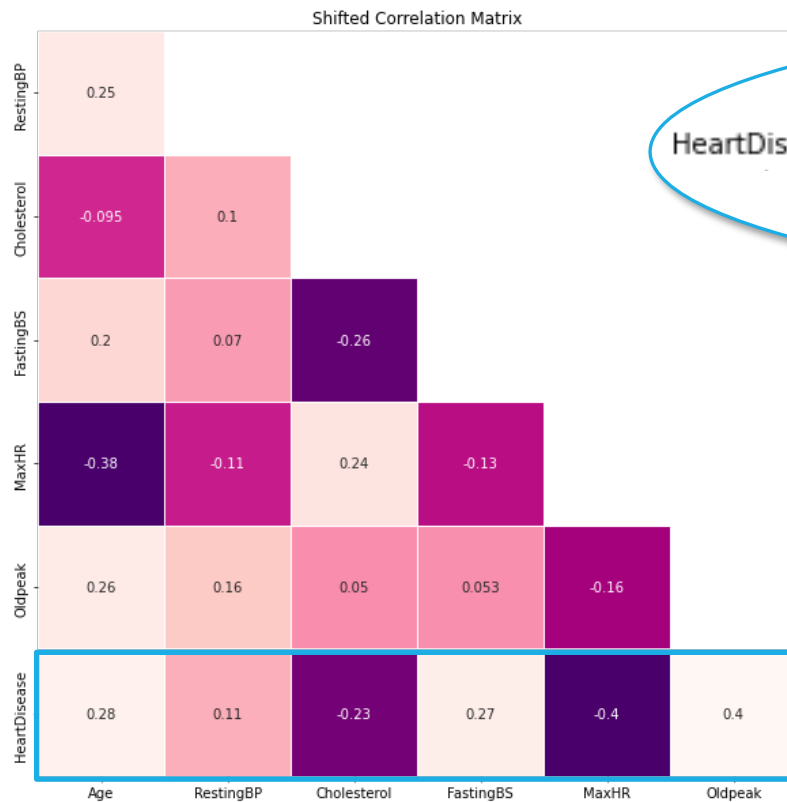
Cholesterol has negative correlation with Heart Disease

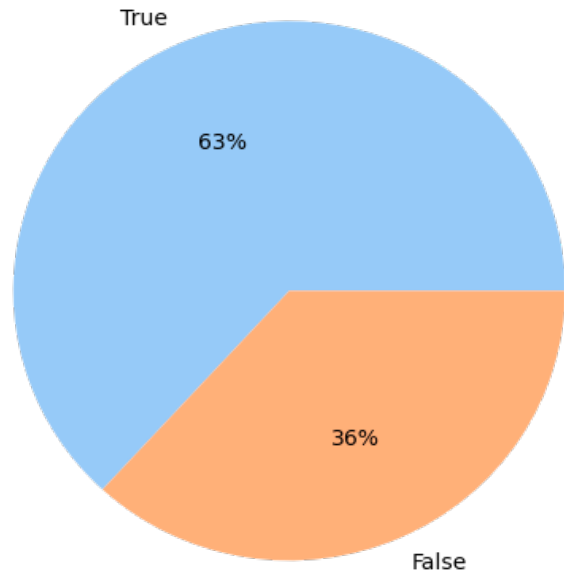Maximum Heart Rate also has negative correlation with Heart Disease

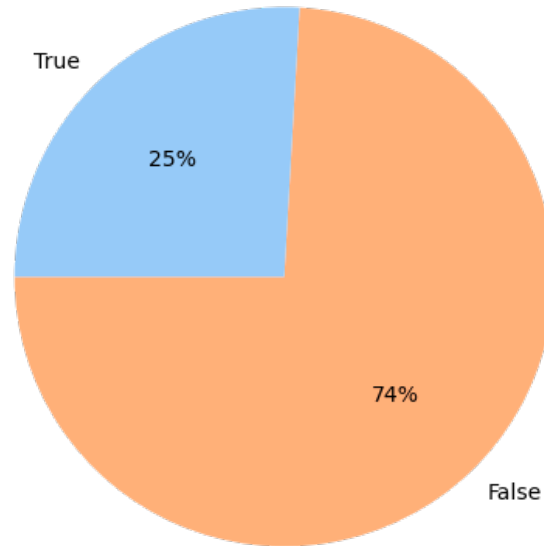# How does age play a role in Heart Disease?
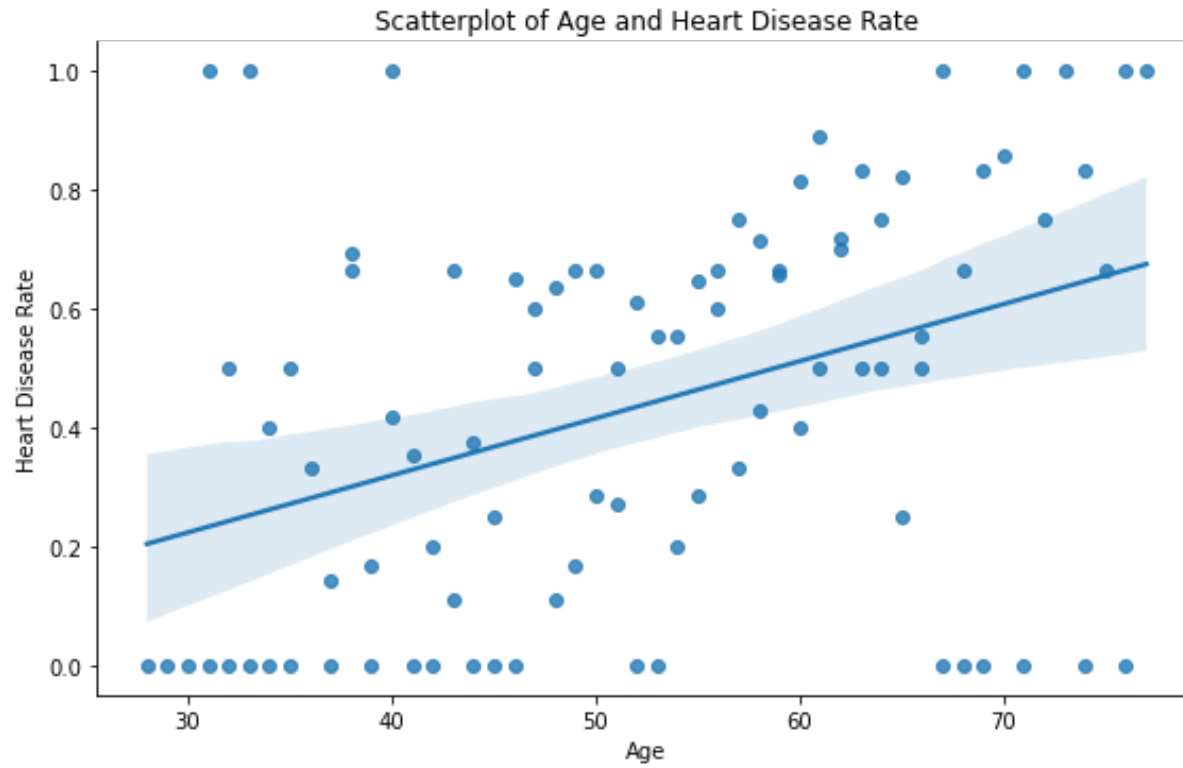
Risk of heart disease increases with age

Does gender play a role in Heart Disease?

True

63%

False

36%

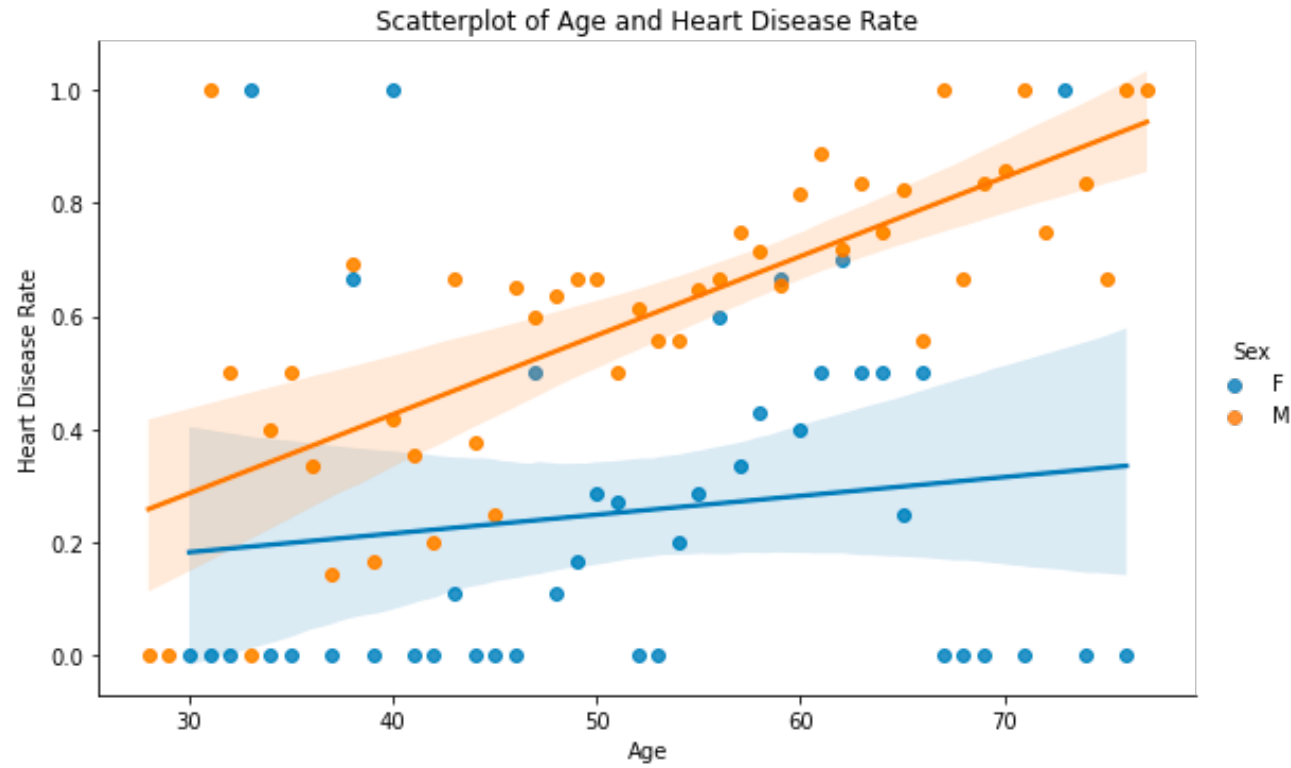Male Heart Disease

True

25%

74%

False

Female Heart Disease

Men are almost 2.5X more likely have heart disease than women!
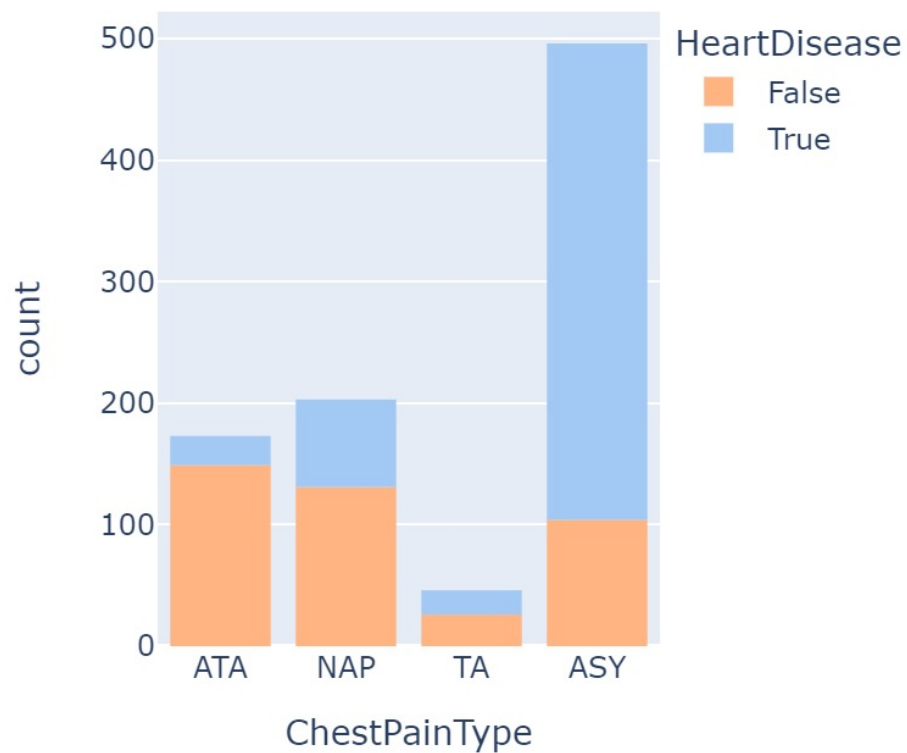
Does gender play a role in Heart Disease?

As age increases men have a higher risk of heart disease than women

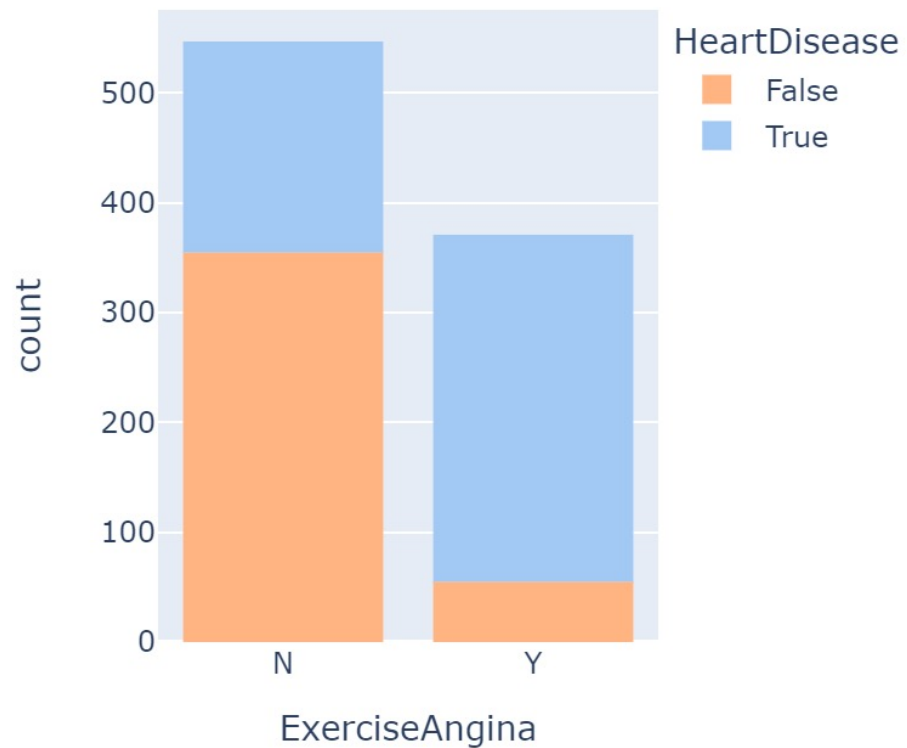# Does certain chest pain type strongly indicate Heart Disease?

Most cases of heart disease have no chest pain!

ATA: Atypical Angina, TA: Typical Angina, NAP: Non-Anginal Pain, ASY: Asymptomatic
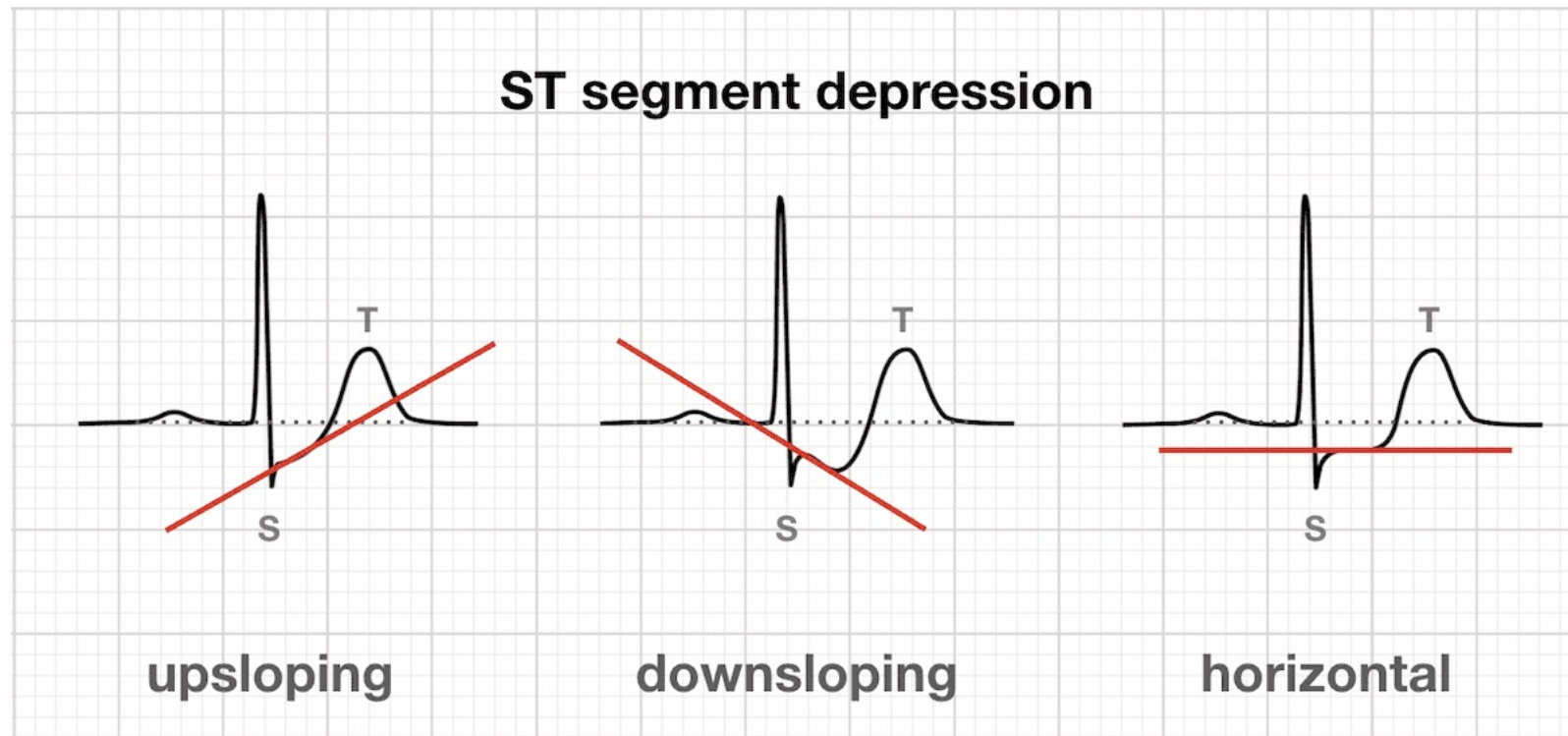
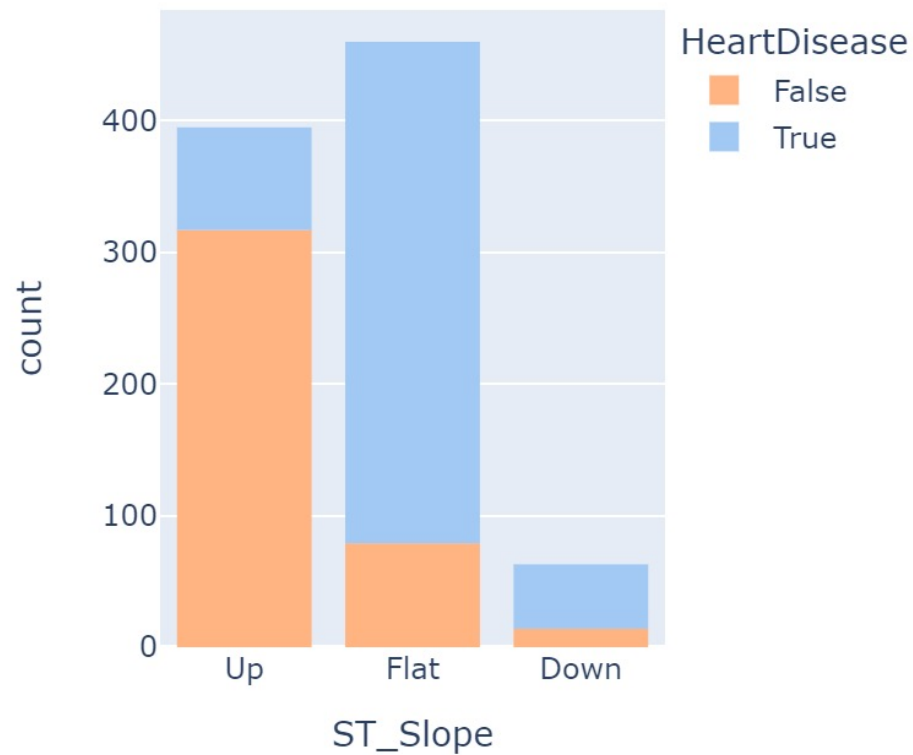# Does chest pain when exercising strongly indicate Heart Disease?

You are at high risk of heart disease if you experience chest pain **when exercising**

Does looking at the patients ECG give us an indication of Heart Disease?

ST segment depression

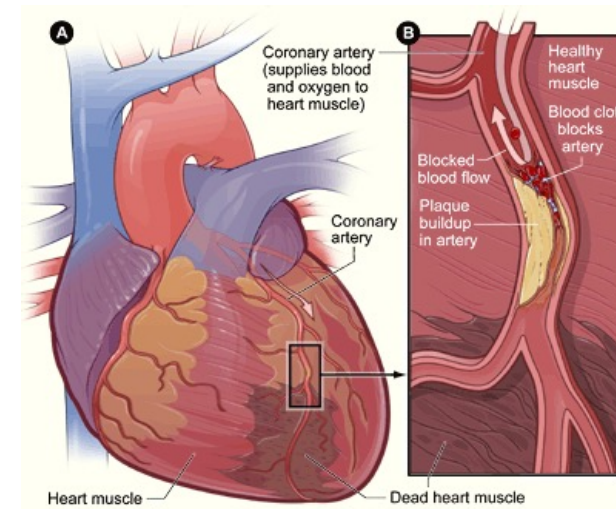upsloping   downsloping   horizontal

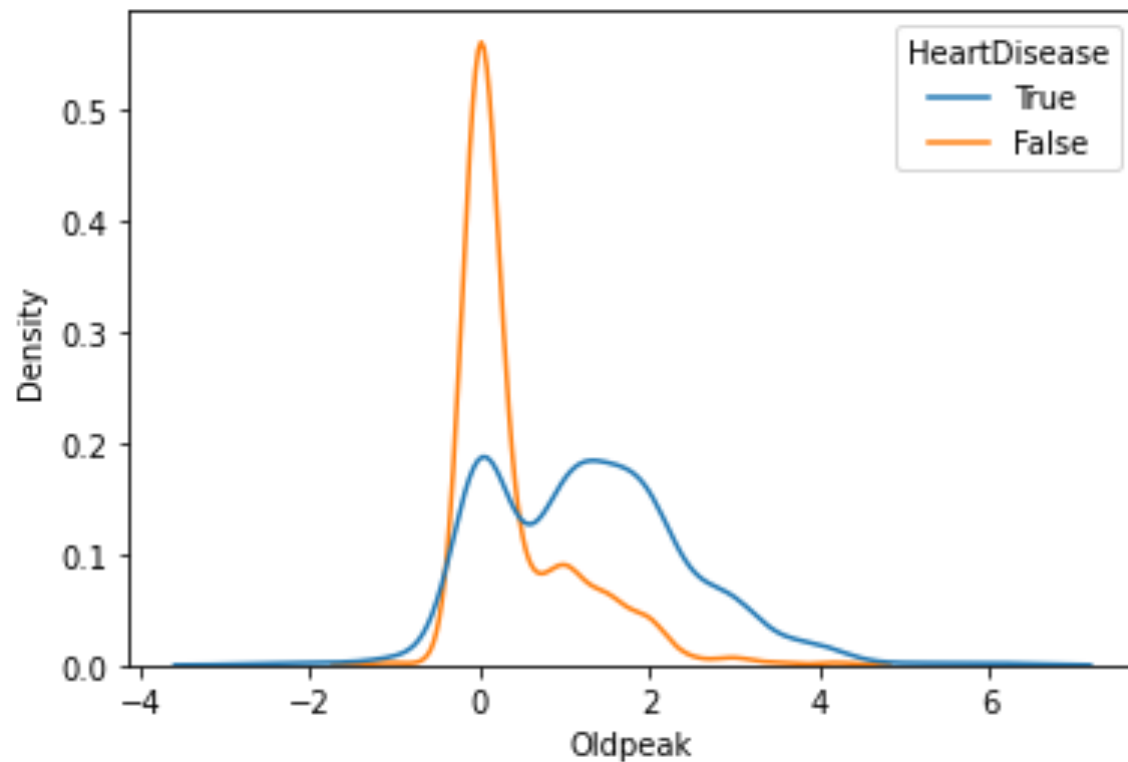# Does looking at the patients ECG give us an indication of Heart Disease?

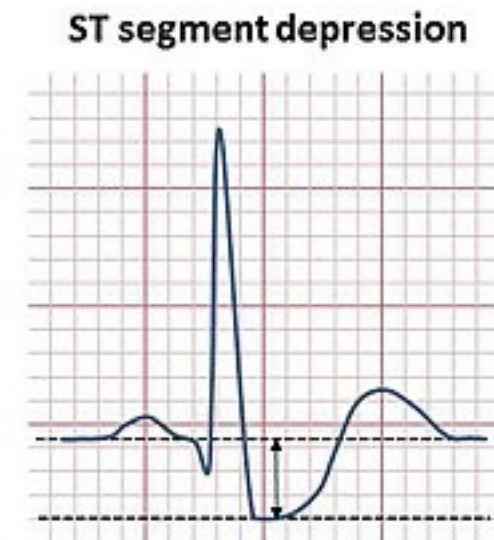The normal ST slope should be slightly upsloping.

Flat and down-sloping ST slopes are likely to indicate heart disease.

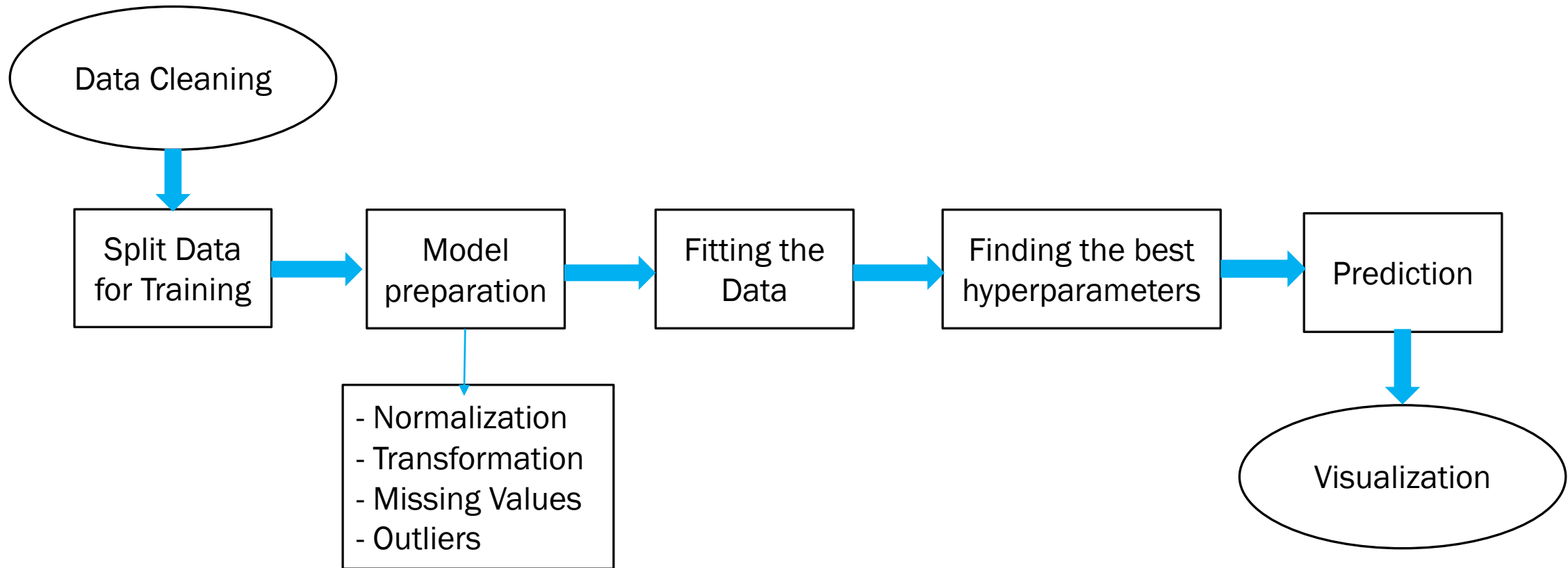# Does looking at the patients ECG give us an indication of Heart Disease?

o Oldpeak is how low ST segment is below the baseline

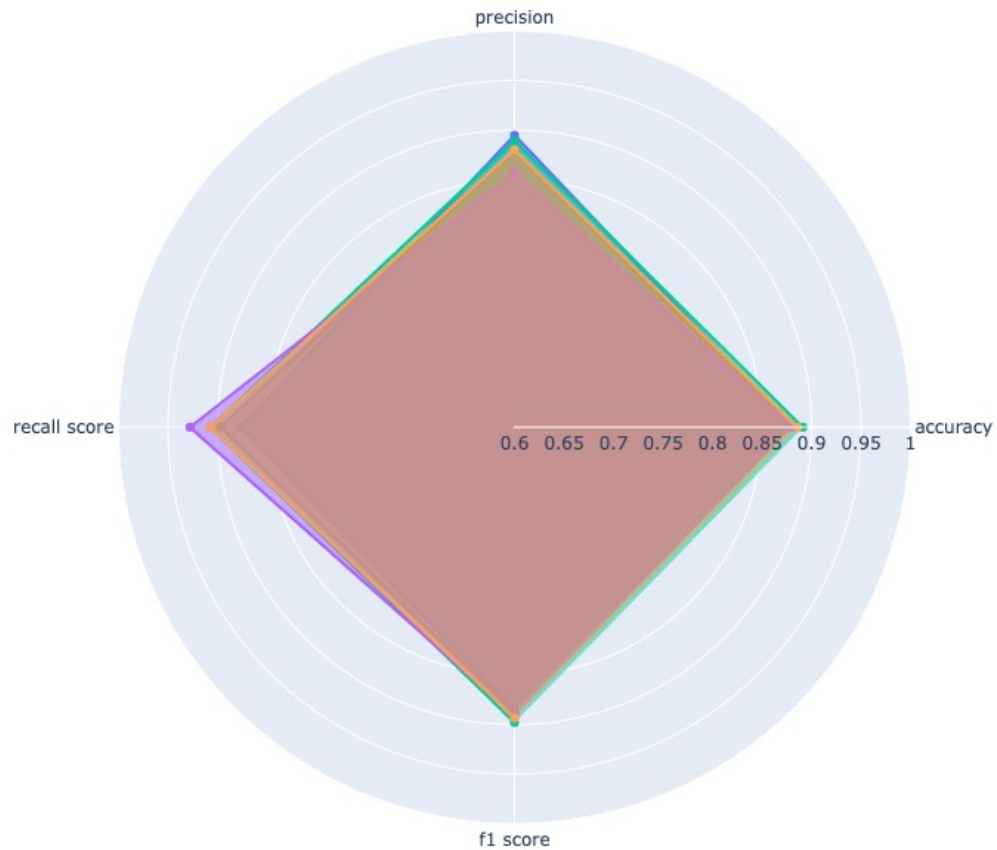o Higher Oldpeak is an indication of Heart Disease

Prediction of Heart Disease

Machine Learning Model Pipeline

Evaluation and Model Selection


- Training on 5 Machine Learning models

- Choose the important features

- All models perform nearly the same

- Considering all the metrics of the ML model, **Random Fores**t performs the best.

- The accuracy achieved was approximately 89%.

Prediction of Heart Failure – Random Forest Results

o St_Slope is found to be the most important feature.

o While RestingECG and Sex are not the most important features, they contribute to the prediction.

o Consistent with the data analyzed.

Important Features for Random Forest

Prediction of Heart Failure – Random Forest Results

confusion matrix for random forest
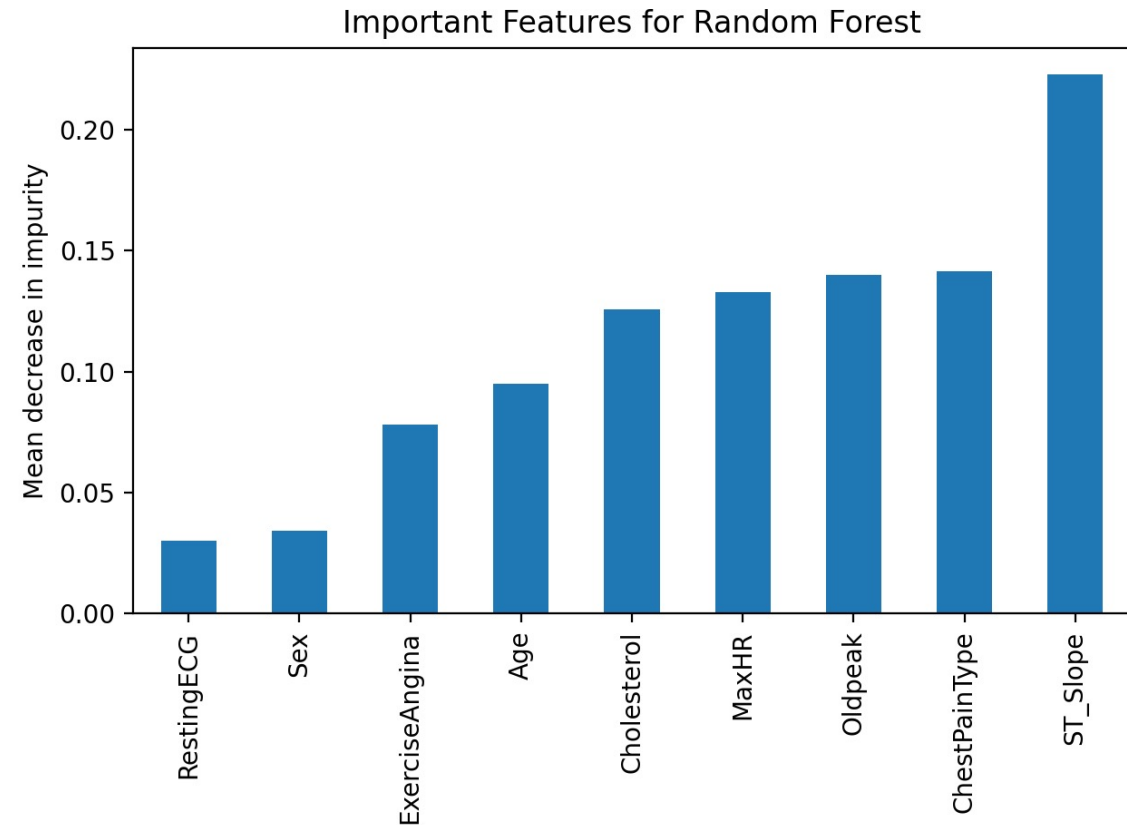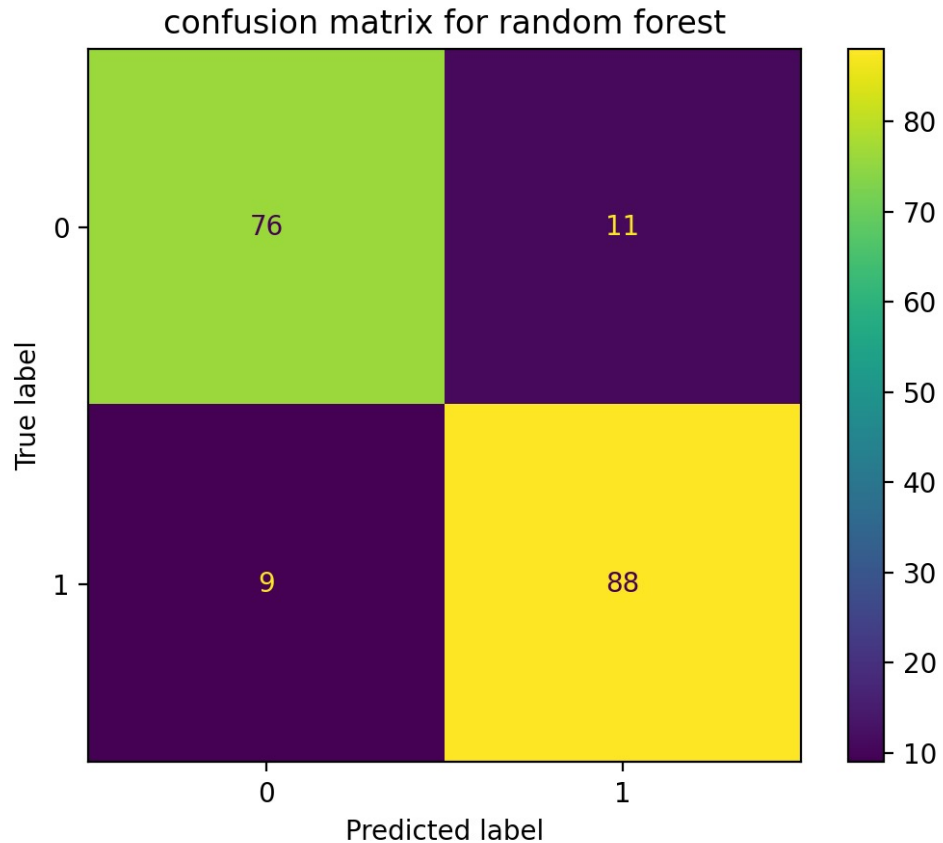
- Most samples are predicted correctly

- Same performance for false negative & false positive

- Model Accuracy: 89.13%

Conclusions

- Heart Disease risk increases with age.

- Men are more likely to have heart failure than women.

- By the analysis of the ECG data, one can predict heart disease.

- Predicting heart failure is a typical 0-1 classification task, our models can classify the labels correctly with accuracy of about 89%

- In our model, ST_Slope has the highest feature importance for predicting heart failure.

References

o https://www.kaggle.com/fedesoriano/heart-failure-prediction

o https://litfl.com/st-segment-ecg-library/ -

o Mattu A, Tabas JA, Brady WJ. Electrocardiography in Emergency, Acute, and Critical Care. 2e, 2019

o Lanza, G A et al. "Diagnostic and prognostic value of ST segment depression limited to the recovery phase of exercise stress test." Heart (British Cardiac Society) vol. 90,12 (2004)

o https://ecgwaves.com/topic/ecg-st-segment-depression-ischemia-infarction-differential-diagnoses/