Who Will Have a Heart Disease?

Team 8

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Spring 2023

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Data Information

Data Information

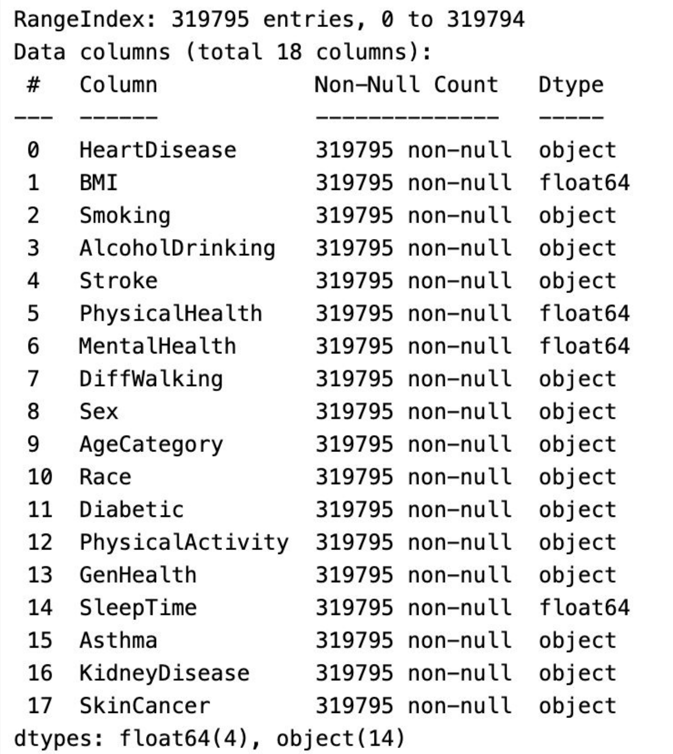
Data Size : *319,795*

Target: Yes - *27,373* No: *292,422*

Categorical Features: *13*

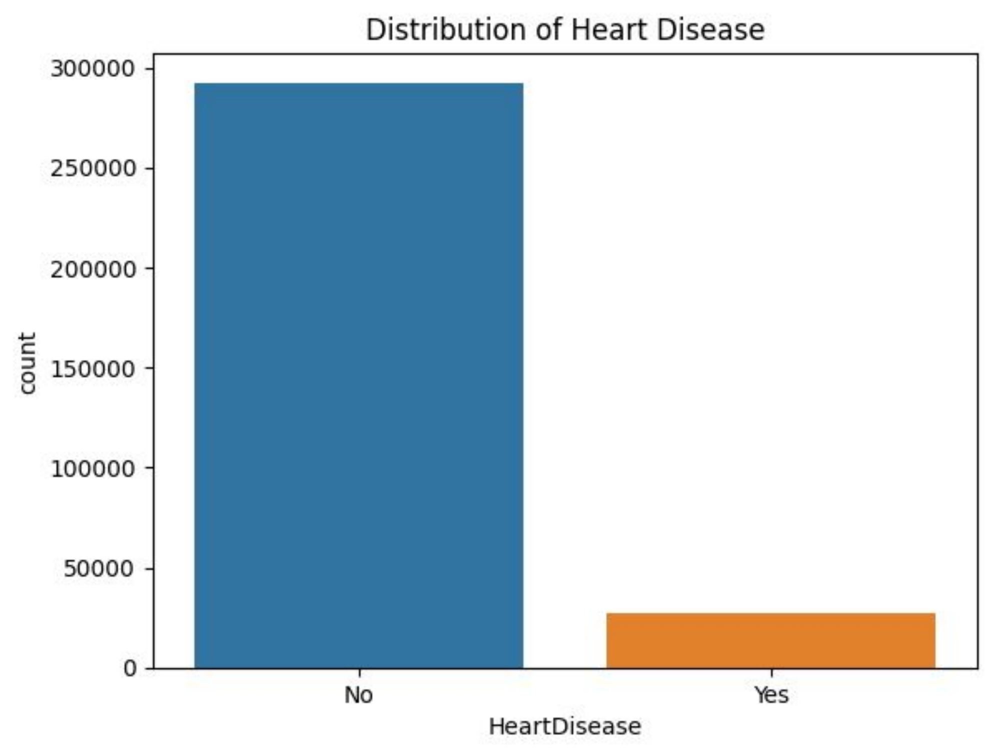
Numerical Features: *4*

- BMI, Physical Health,
  Mental Health, and Sleep Time



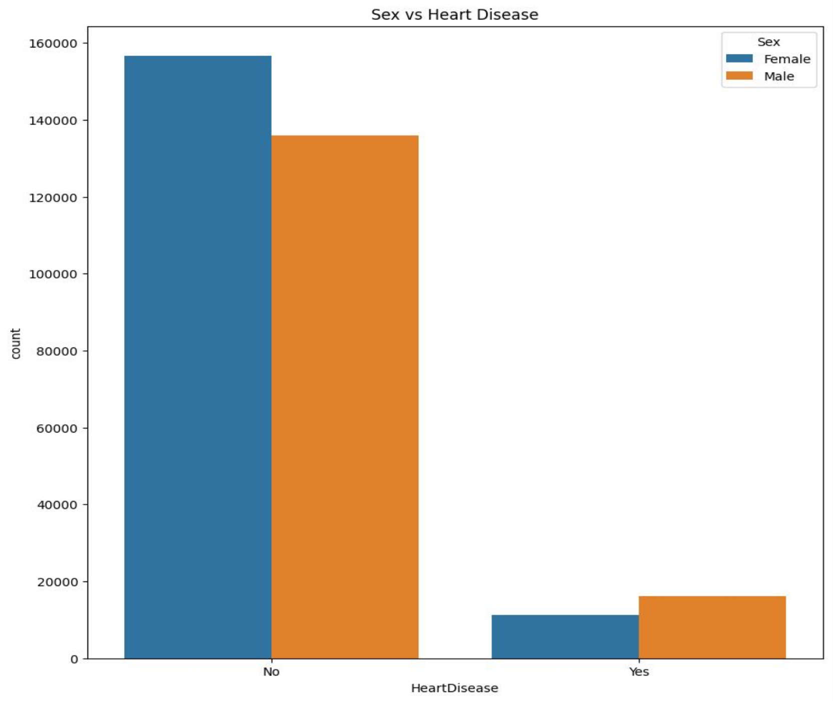
```
RangeIndex: 319795 entries, 0 to 319794
Data columns (total 18 columns):
 #   Column            Non-Null Count   Dtype  
---  ------            --------------   -----  
 0   HeartDisease      319795 non-null  object 
 1   BMI               319795 non-null  float64
 2   Smoking           319795 non-null  object 
 3   AlcoholDrinking   319795 non-null  object 
 4   Stroke            319795 non-null  object 
 5   PhysicalHealth    319795 non-null  float64
 6   MentalHealth      319795 non-null  float64
 7   DiffWalking       319795 non-null  object 
 8   Sex               319795 non-null  object 
 9   AgeCategory       319795 non-null  object 
 10  Race              319795 non-null  object 
 11  Diabetic          319795 non-null  object 
 12  PhysicalActivity  319795 non-null  object 
 13  GenHealth         319795 non-null  object 
 14  SleepTime         319795 non-null  float64
 15  Asthma            319795 non-null  object 
 16  KidneyDisease     319795 non-null  object 
 17  SkinCancer        319795 non-null  object 
dtypes: float64(4), object(14)
```

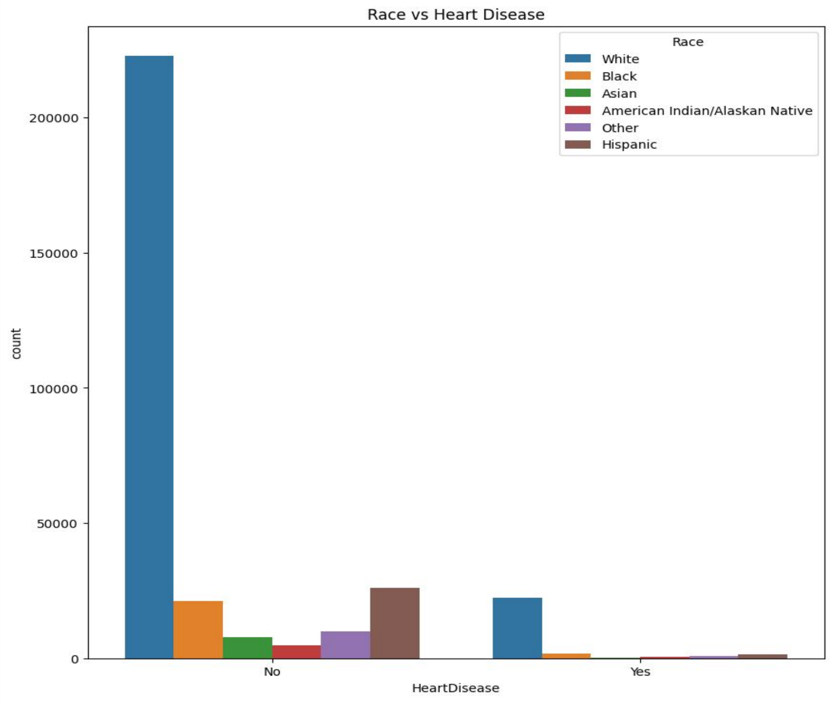
Target Variable - Heart Disease



- **Highly imbalanced dataset**

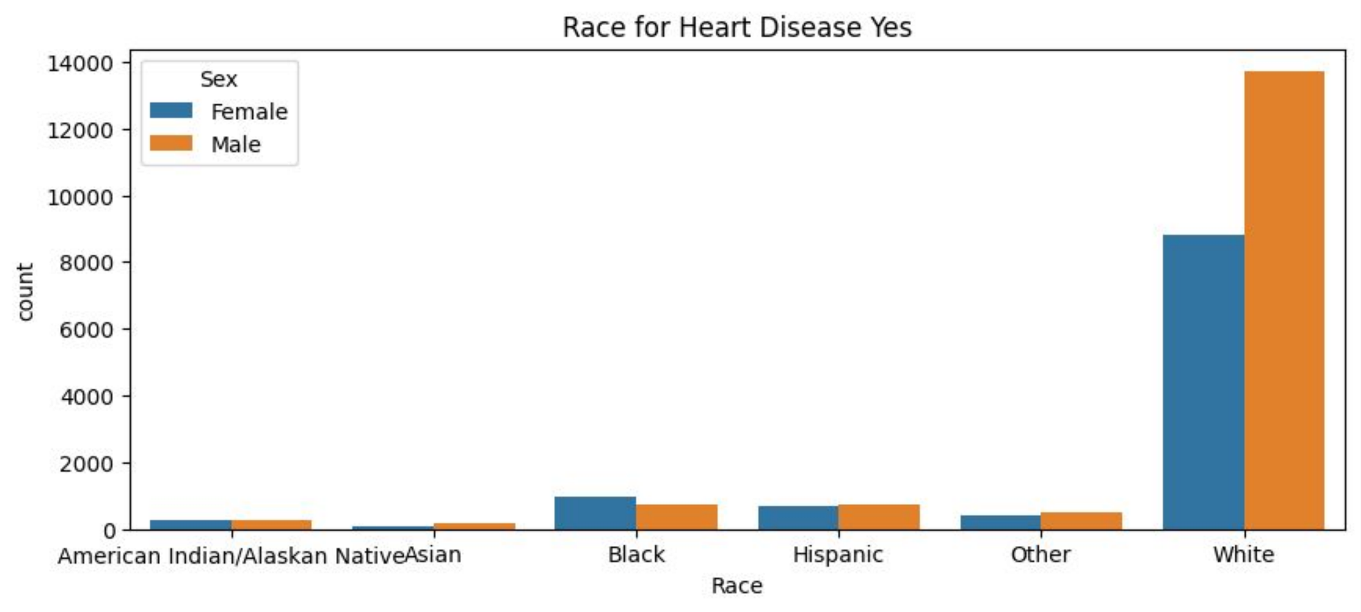
Sex/Race by Heart Disease





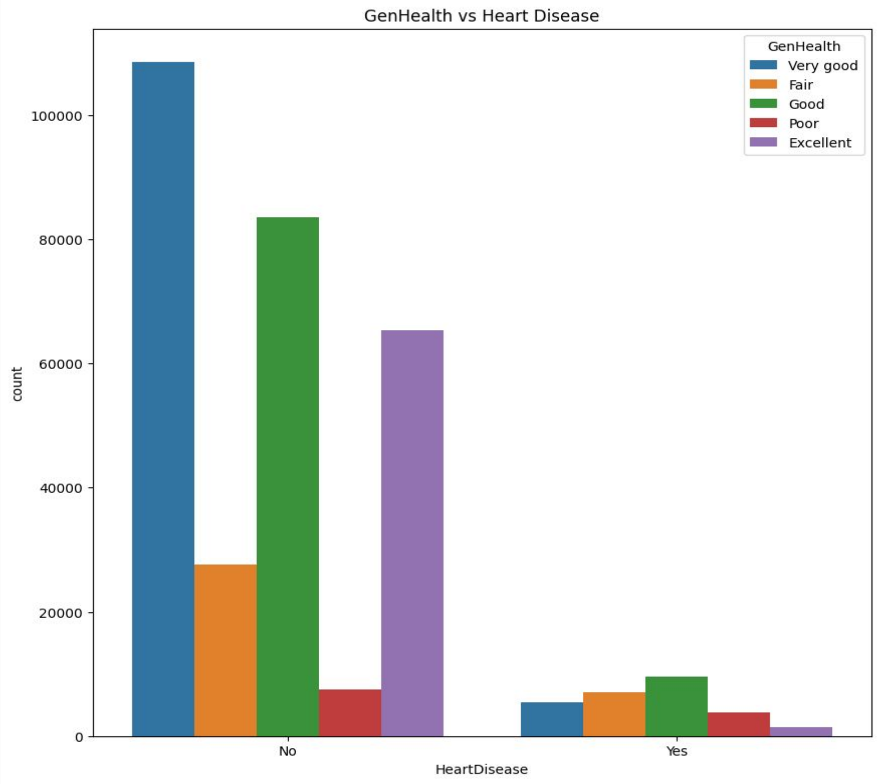
- For Sex, male has higher proportion for having heart disease in the dataset
- For Race, White has higher proportion for having heart disease in the dataset but the data is imbalanced

Race by Sex & Heart Disease

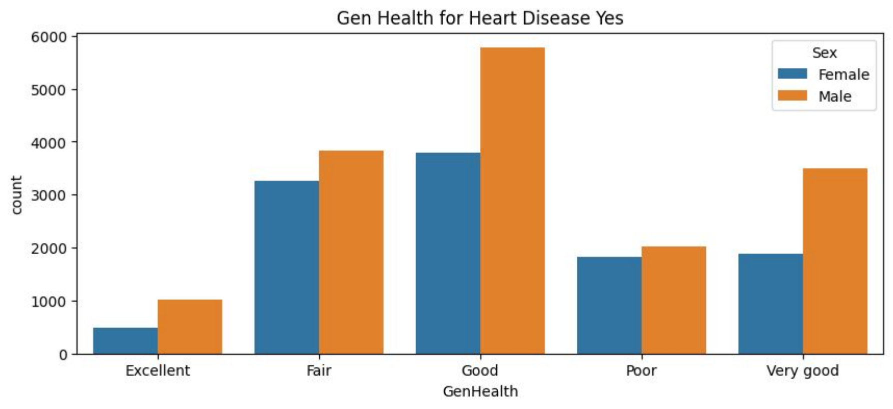


- By Race, Male still has higher portion for having heart disease for every race but Black

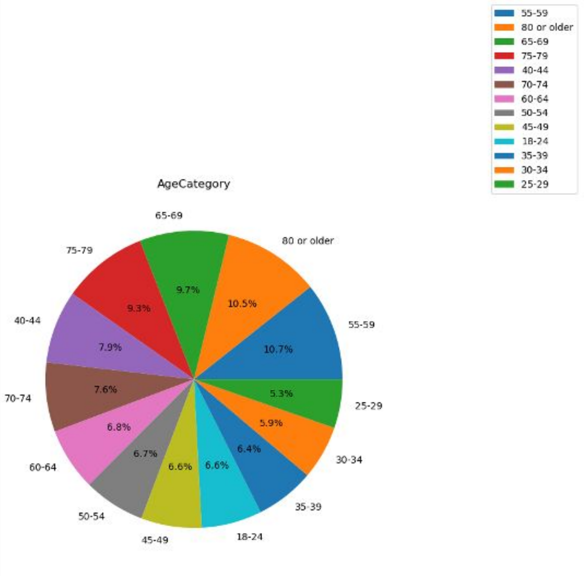
General Health by Heart Disease

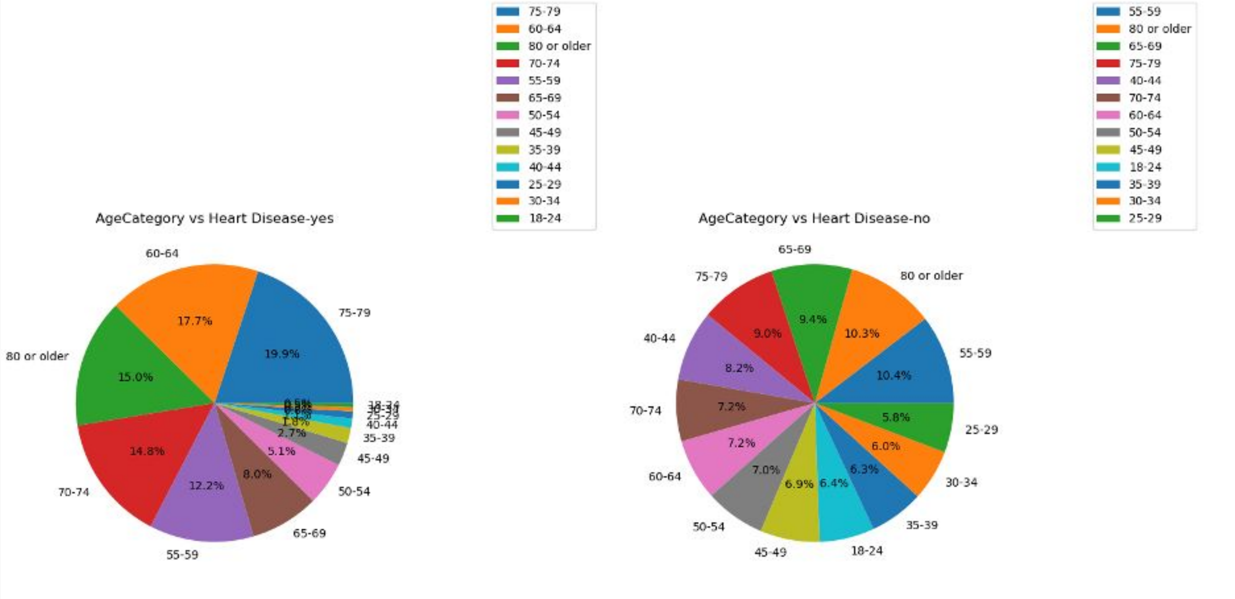


- For General Health, respondents who reported having Excellent, Very good or Good health have bigger proportion for not having heart disease
- For having heart disease, respondents who have Good health are take the biggest part followed by Fair



Age Category by Sex & Heart Disease





- For Age category, the biggest one is age from 55-59, followed by 80 or older
- For Age category with having heart disease, age group 75-79 has the highest portion, followed by 60-64

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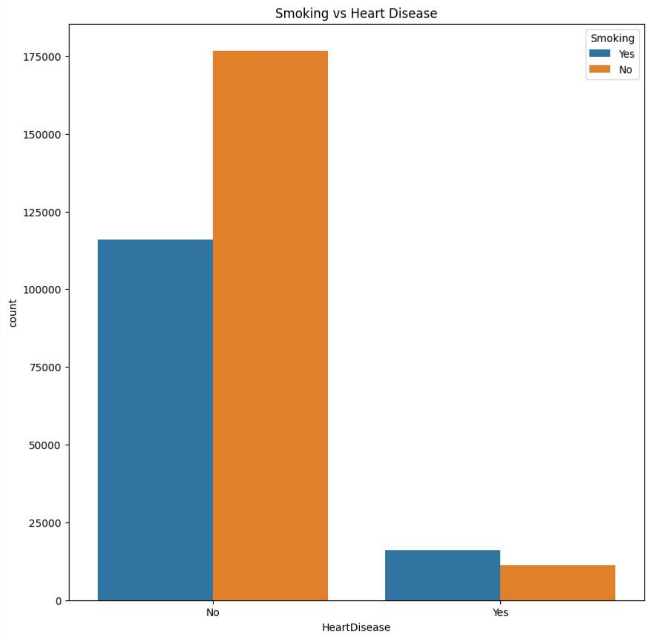
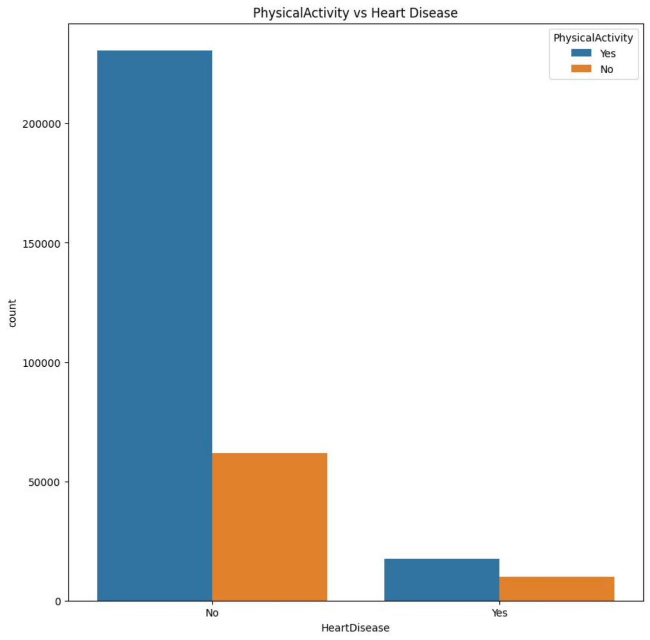
Exploratory Data Analysis - Categorical Features

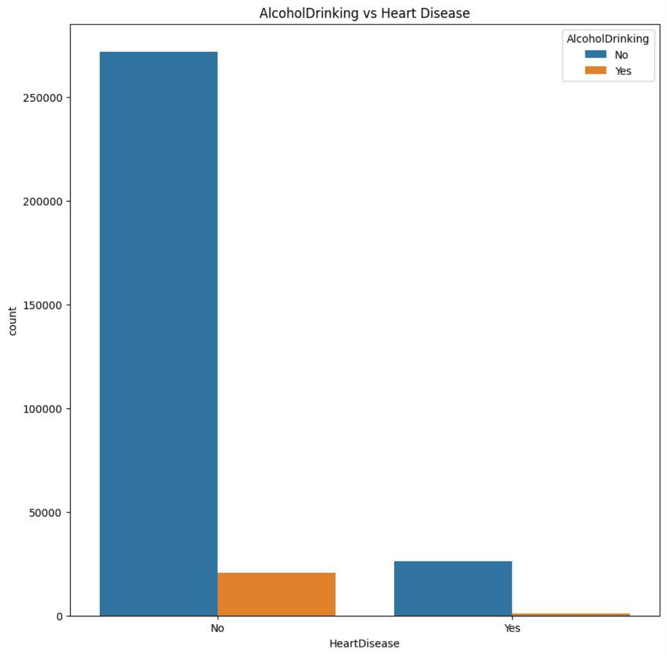
Behavior Category by Heart Disease

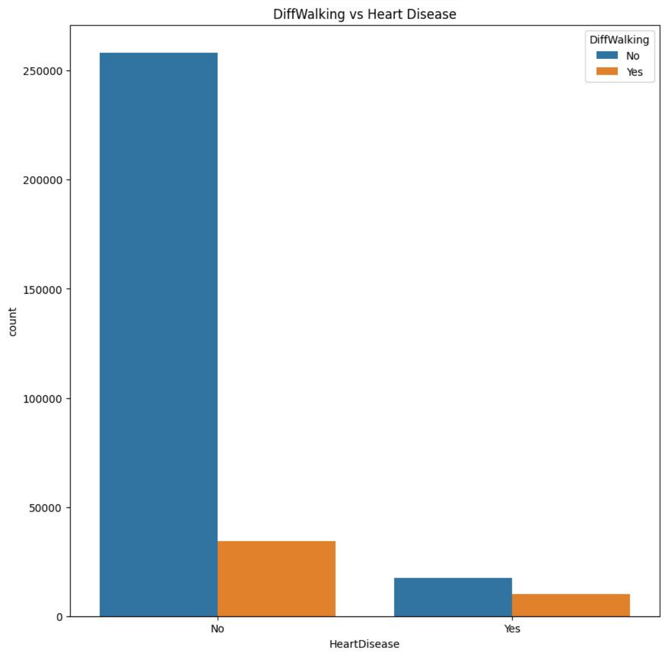




- Individuals who smoke have higher risk of getting a heart disease.
- Individuals who are doing physical activity or exercise other than their regular job have higher risk of getting a heart disease compared to those who doesn't.

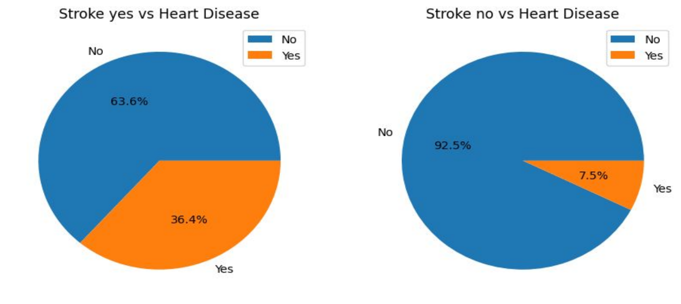
Behavior Category by Heart Disease



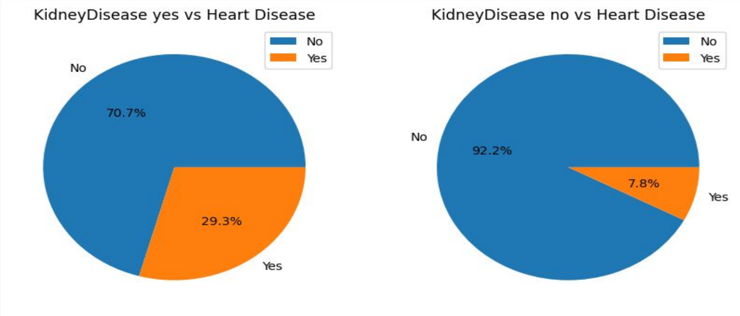


- Alcohol drinking does not have huge impact on having a heart disease as individuals who drink alcohol do not tend to have heart disease.
- Difficult walking seem to not have much impact on heart disease in general, because individuals who have difficult walking do not tend to have heart disease.

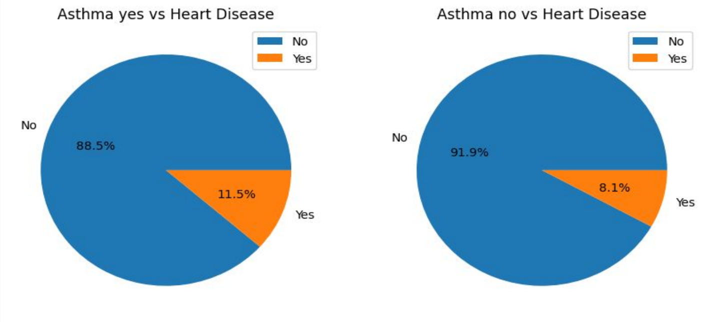
Diseases Categories by Heart Disease



- Individuals who have suffered from a stroke are at an elevated risk of developing heart disease

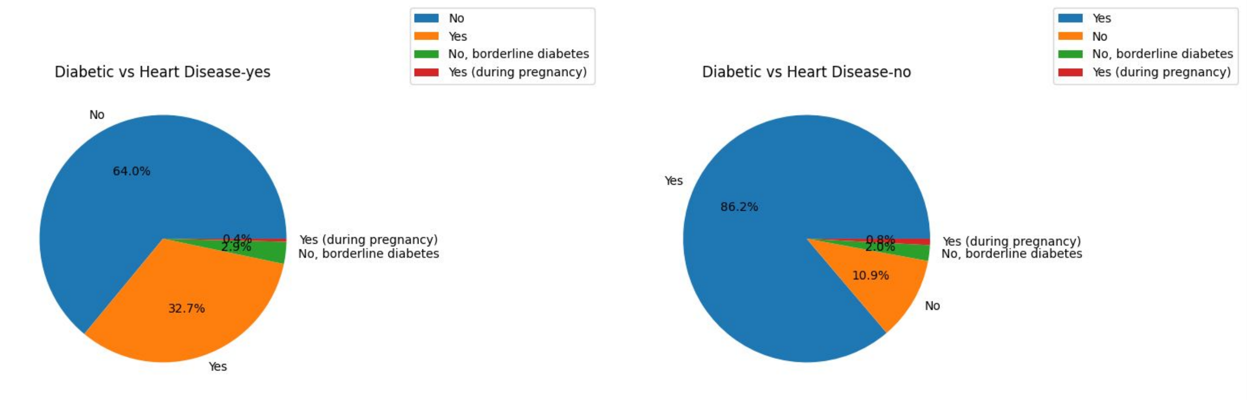


- Individuals with kidney disease have a higher risk of developing heart disease

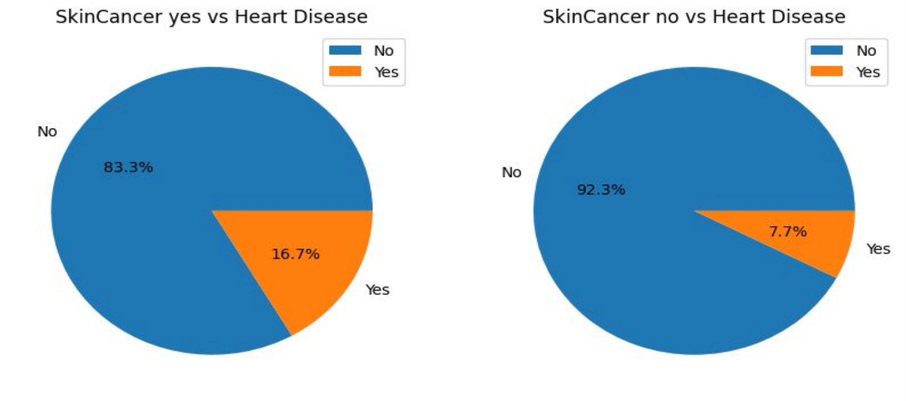


- Individuals who have suffered from a Asthma does not have great impact on heart disease

Diseases Categories by Heart Disease

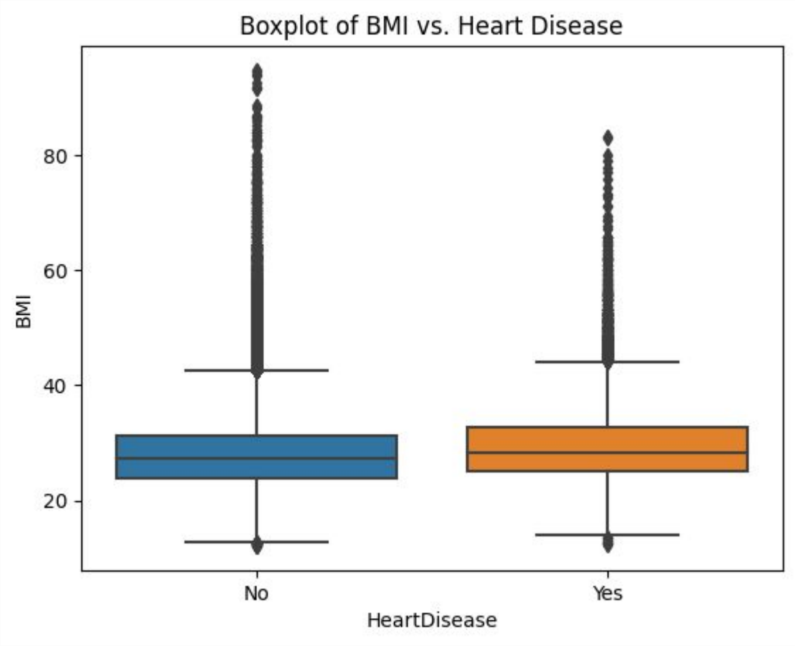


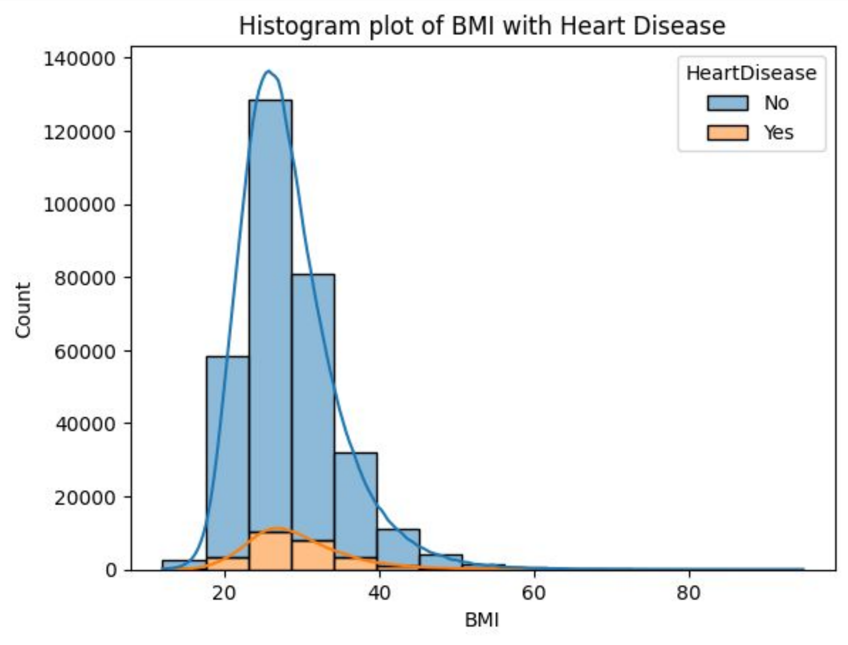
- Individuals with no diabetic have a higher risk of developing heart disease



- Individuals with Skin Cancer have a higher risk of developing heart disease

BMI by Heart Disease





- For both groups, who are having heart disease yes and no, the distributions of BMI are similar.

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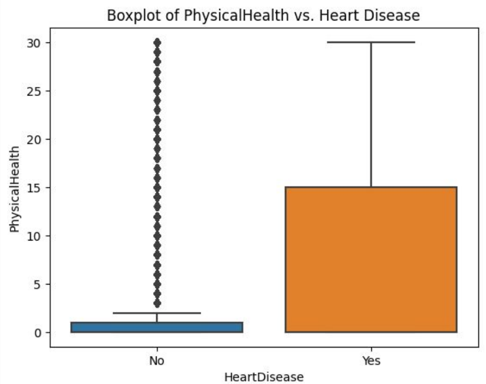
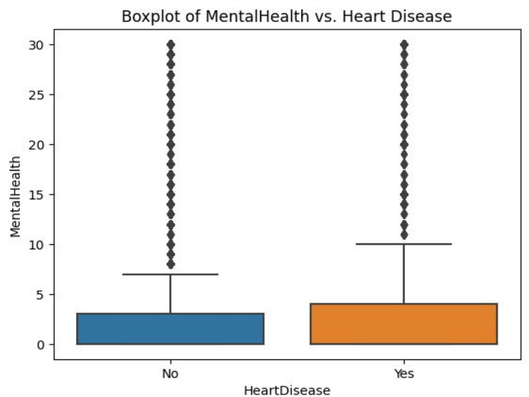
Exploratory Data Analysis - Numerical Features

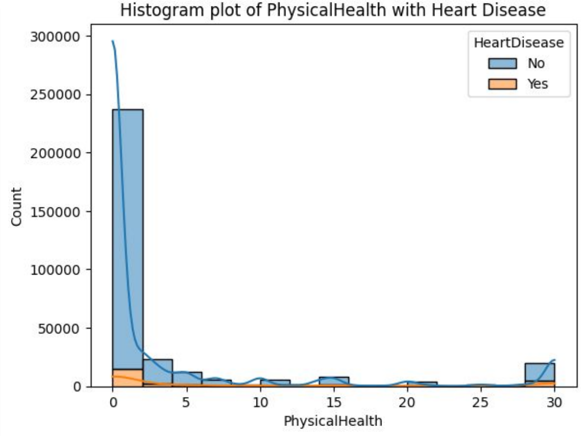
Health Condition by Heart Disease

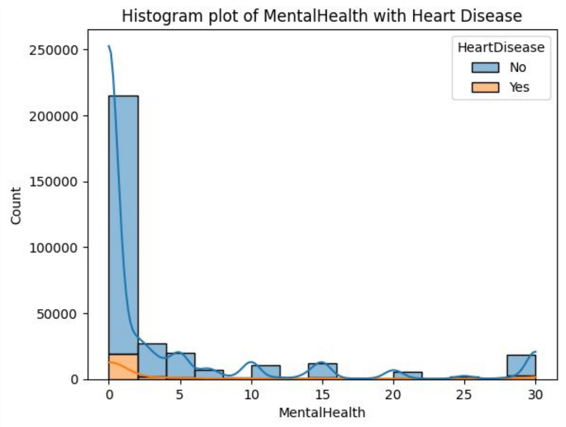

Boxplot of PhysicalHealth vs. Heart Disease

- For both groups, who are having heart disease yes and no, have similar Physical Health condition during the past 30 days.

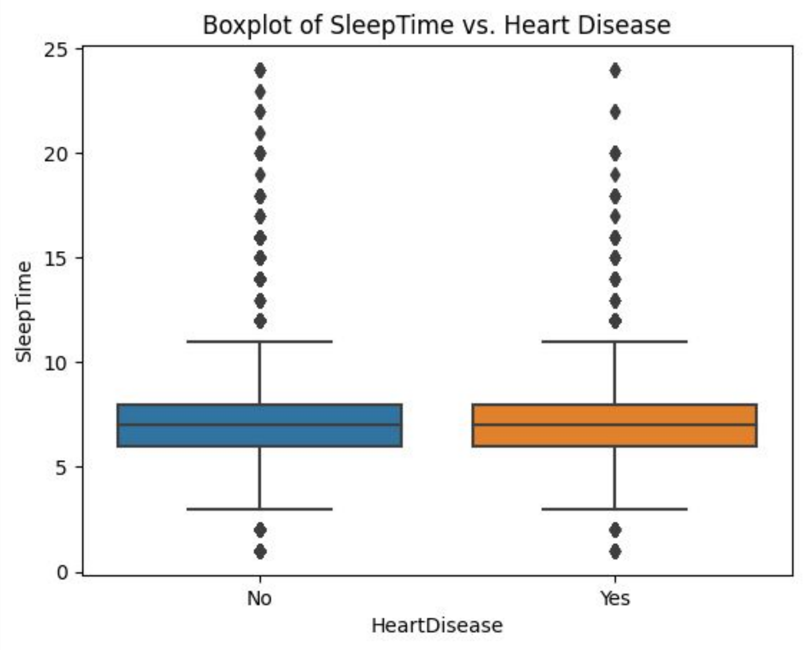

Boxplot of MentalHealth vs. Heart Disease

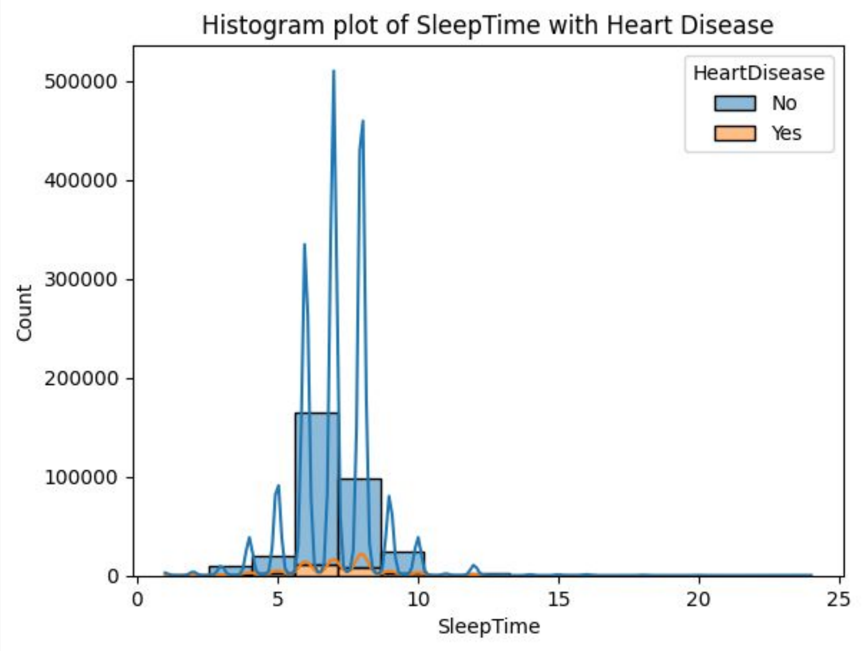
- For both groups, who are having heart disease yes and no, have similar Mental Health condition during the past 30 days.


Histogram plot of PhysicalHealth with Heart Disease


Histogram plot of MentalHealth with Heart Disease

Sleep Time by Heart Disease





- For both groups, who have heart disease yes and no, have similar hours of sleep time in 24 hours.

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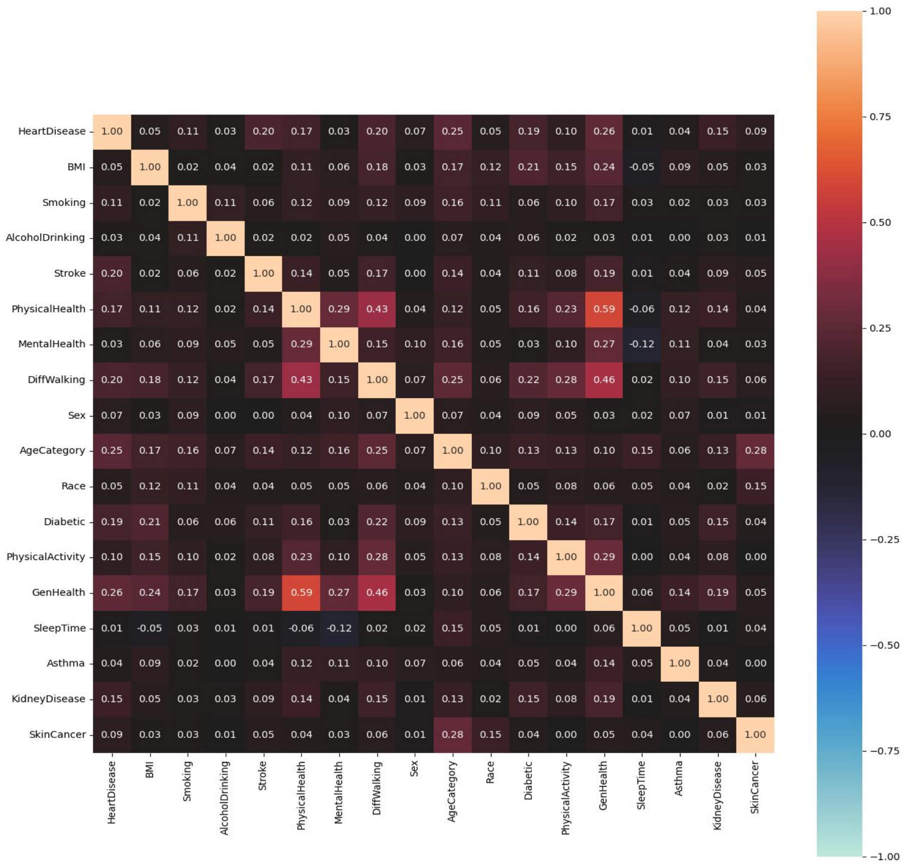
Exploratory Data Analysis - Correlation



	HeartDisease	BMI	Smoking	AlcoholDrinking	Stroke	PhysicalHealth	MentalHealth	DiffWalking	Sex	AgeCategory	Race	Diabetic	PhysicalActivity	GenHealth	SleepTime	Asthma	KidneyDisease	SkinCancer
HeartDisease	1.00	0.05	0.11	0.03	0.20	0.17	0.03	0.20	0.07	0.25	0.05	0.19	0.10	0.26	0.01	0.04	0.15	0.09
BMI	0.05	1.00	0.02	0.04	0.02	0.11	0.06	0.18	0.03	0.17	0.12	0.21	0.15	0.24	-0.05	0.09	0.05	0.03
Smoking	0.11	0.02	1.00	0.11	0.06	0.12	0.09	0.12	0.09	0.16	0.11	0.06	0.10	0.17	0.03	0.02	0.03	0.03
AlcoholDrinking	0.03	0.04	0.11	1.00	0.02	0.02	0.05	0.04	0.00	0.07	0.04	0.06	0.02	0.03	0.01	0.00	0.03	0.01
Stroke	0.20	0.02	0.06	0.02	1.00	0.14	0.05	0.17	0.00	0.14	0.04	0.11	0.08	0.19	0.01	0.04	0.09	0.05
PhysicalHealth	0.17	0.11	0.12	0.02	0.14	1.00	0.29	0.43	0.04	0.12	0.05	0.16	0.23	0.59	-0.06	0.12	0.14	0.04
MentalHealth	0.03	0.06	0.09	0.05	0.05	0.29	1.00	0.15	0.10	0.16	0.05	0.03	0.10	0.27	-0.12	0.11	0.04	0.03
DiffWalking	0.20	0.18	0.12	0.04	0.17	0.43	0.15	1.00	0.07	0.25	0.06	0.22	0.28	0.46	0.02	0.10	0.15	0.06
Sex	0.07	0.03	0.09	0.00	0.00	0.04	0.10	0.07	1.00	0.07	0.04	0.09	0.05	0.03	0.02	0.07	0.01	0.01
AgeCategory	0.25	0.17	0.16	0.07	0.14	0.12	0.16	0.25	0.07	1.00	0.10	0.13	0.13	0.10	0.15	0.06	0.13	0.28
Race	0.05	0.12	0.11	0.04	0.04	0.05	0.05	0.06	0.04	0.10	1.00	0.05	0.08	0.06	0.05	0.04	0.02	0.15
Diabetic	0.19	0.21	0.06	0.06	0.11	0.16	0.03	0.22	0.09	0.13	0.05	1.00	0.14	0.17	0.01	0.05	0.15	0.04
PhysicalActivity	0.10	0.15	0.10	0.02	0.08	0.23	0.10	0.28	0.05	0.13	0.08	0.14	1.00	0.29	0.00	0.04	0.08	0.00
GenHealth	0.26	0.24	0.17	0.03	0.19	0.59	0.27	0.46	0.03	0.10	0.06	0.17	0.29	1.00	0.06	0.14	0.19	0.05
SleepTime	0.01	-0.05	0.03	0.01	0.01	-0.06	-0.12	0.02	0.02	0.15	0.05	0.01	0.00	0.06	1.00	0.05	0.01	0.04
Asthma	0.04	0.09	0.02	0.00	0.04	0.12	0.11	0.10	0.07	0.06	0.04	0.05	0.04	0.14	0.05	1.00	0.04	0.00
KidneyDisease	0.15	0.05	0.03	0.03	0.09	0.14	0.04	0.15	0.01	0.13	0.02	0.15	0.08	0.19	0.01	0.04	1.00	0.06
SkinCancer	0.09	0.03	0.03	0.01	0.05	0.04	0.03	0.06	0.01	0.28	0.15	0.04	0.00	0.05	0.04	0.00	0.06	1.00

```
HeartDisease        1.000000
GenHealth           0.259519
AgeCategory         0.245588
DiffWalking         0.201234
Stroke              0.196798
Diabetic            0.185101
PhysicalHealth      0.170721
KidneyDisease       0.145157
Smoking             0.107738
PhysicalActivity    0.100001
SkinCancer          0.093281
Sex                 0.070007
BMI                 0.051803
Race                0.051230
Asthma              0.041390
AlcoholDrinking     0.032009
MentalHealth        0.028591
SleepTime           0.008327
```

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Data Preprocessing

Data Preprocessing

Outliers

Outliers = ***1,5 **** IQR

Total outliers: *994,324*

Data Size: *319,795 - 225,471*

Data Encoding

Target: yes: ***1*** No: ***0***

Cat Features : One hot Encoding

Standardization

Normalization

Split the Data

Test Size = 0.2

Modelling - Pipeline

Step 01

Balance the Data

RandomUnderSampler

Step 02

Feature Reduction

RFECV

Step 03

Train the models

- Logistic Regression
- Decision Tree
- Random Forest

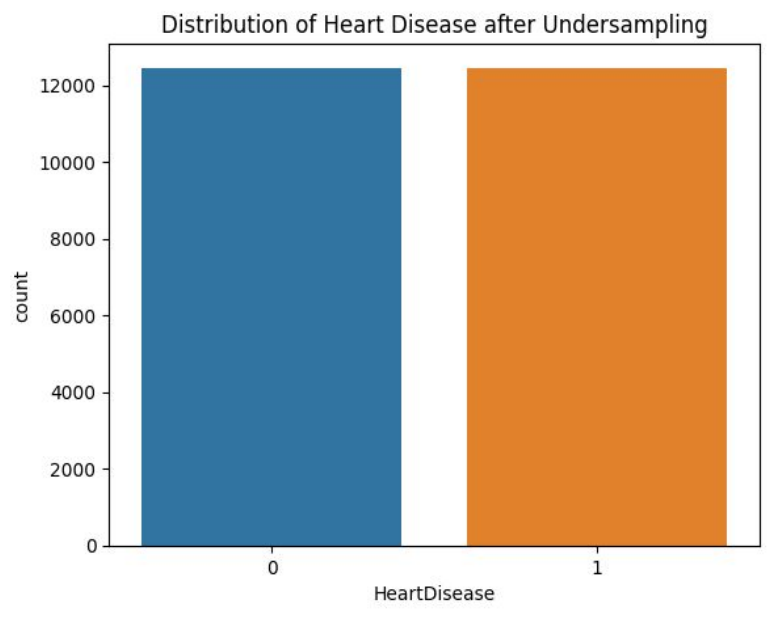
Step 04

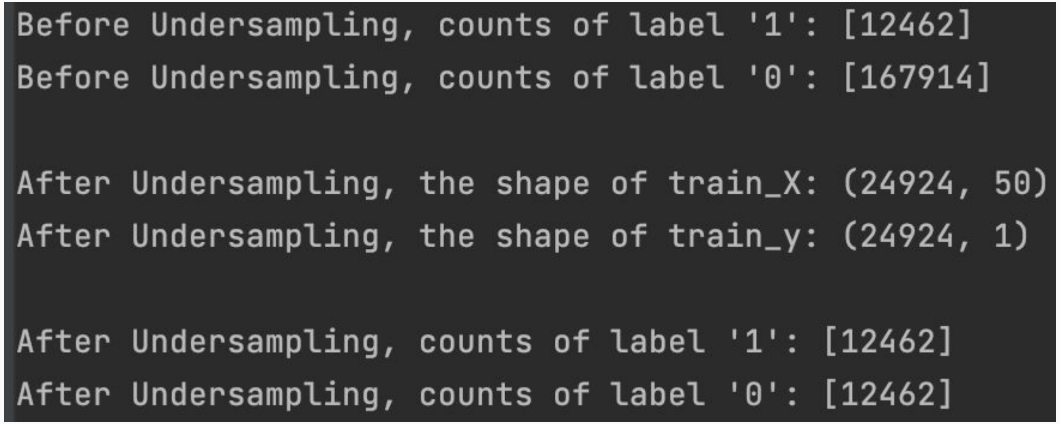
Fit in the test data

- Logistic Regression
- Decision Tree
- Random Forest

Balance the Data

Undersampling





```
Before Undersampling, counts of label '1': [12462]
Before Undersampling, counts of label '0': [167914]

After Undersampling, the shape of train_X: (24924, 50)
After Undersampling, the shape of train_y: (24924, 1)

After Undersampling, counts of label '1': [12462]
After Undersampling, counts of label '0': [12462]
```

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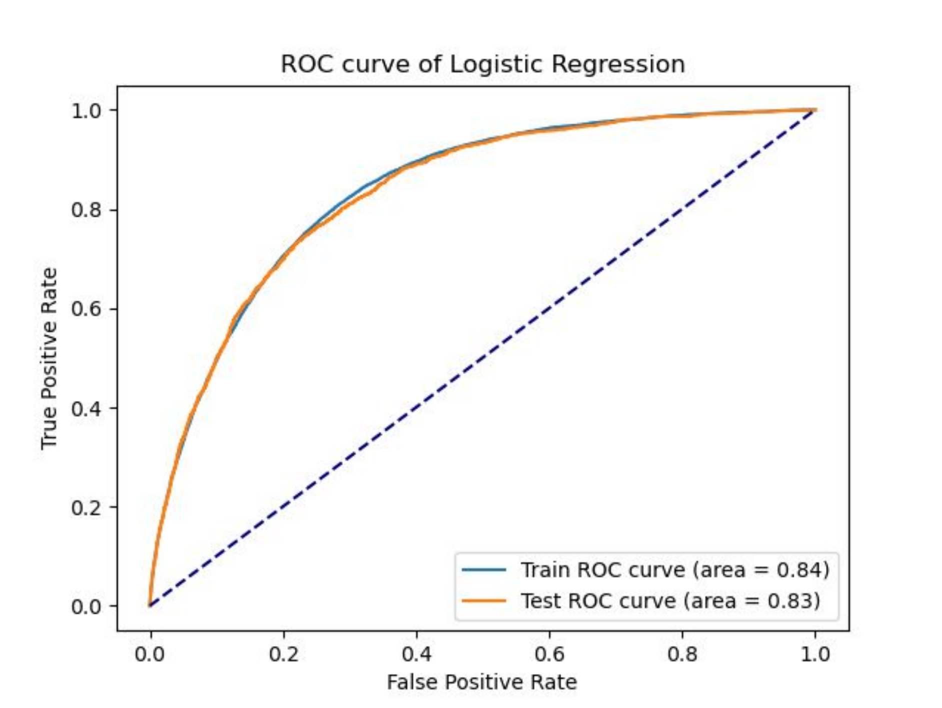
Train the Data

Logistic Regression



Number of features selected: 43

Target	Precision	Recall	f1-score
0	0.98	0.74	0.84
1	0.18	0.78	0.3
accuracy		0.74	
macro avg	0.58	0.76	0.57
weighed avg	0.92	0.74	0.8
balanced Accuracy	0.7563		

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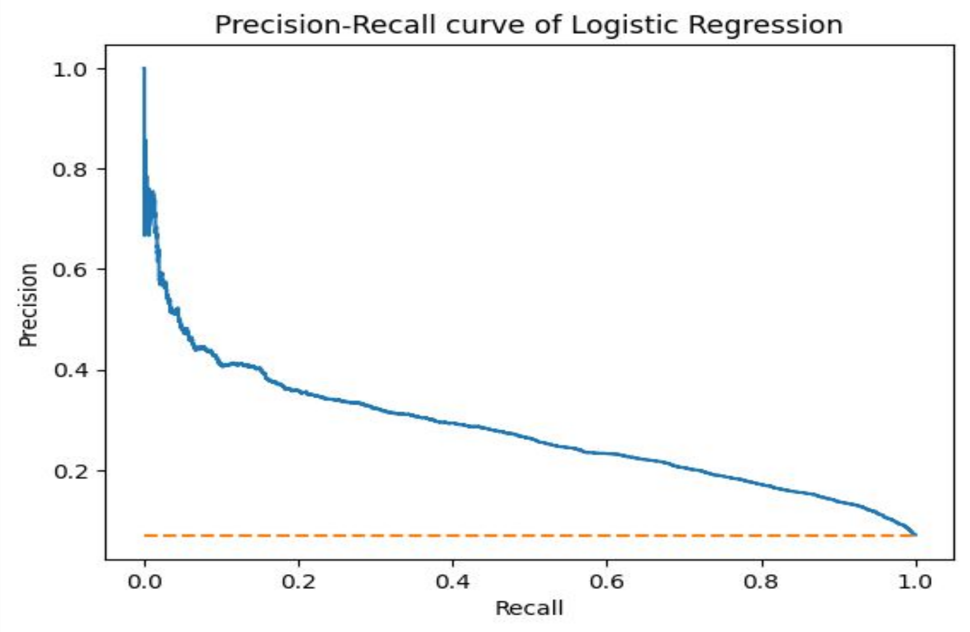
Train the Data

Logistic Regression



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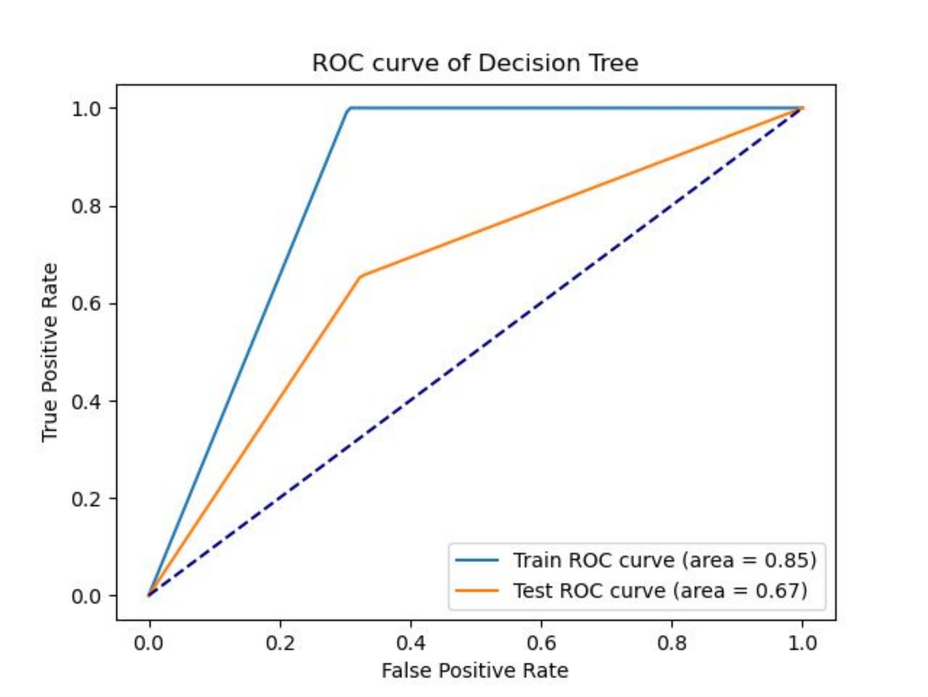
Train the Data

Decision Tree



Number of features selected: 49

Target	Precision	Recall	f1-score
0	0.96	0.68	0.80
1	0.13	0.65	0.22
accuracy		0.68	
macro avg	0.55	0.767	0.51
weighed avg	0.91	0.68	0.76
balanced Accuracy	0.6645		

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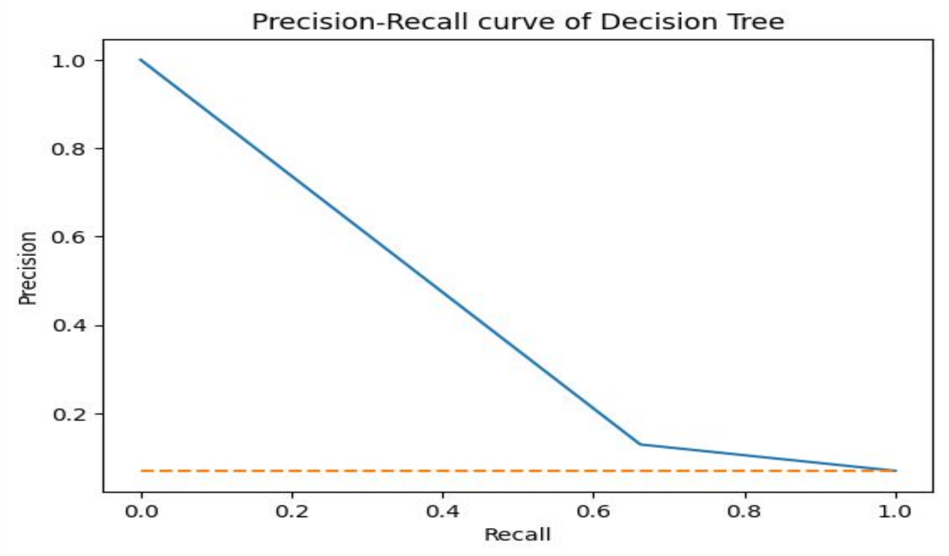
Train the Data

Decision Tree



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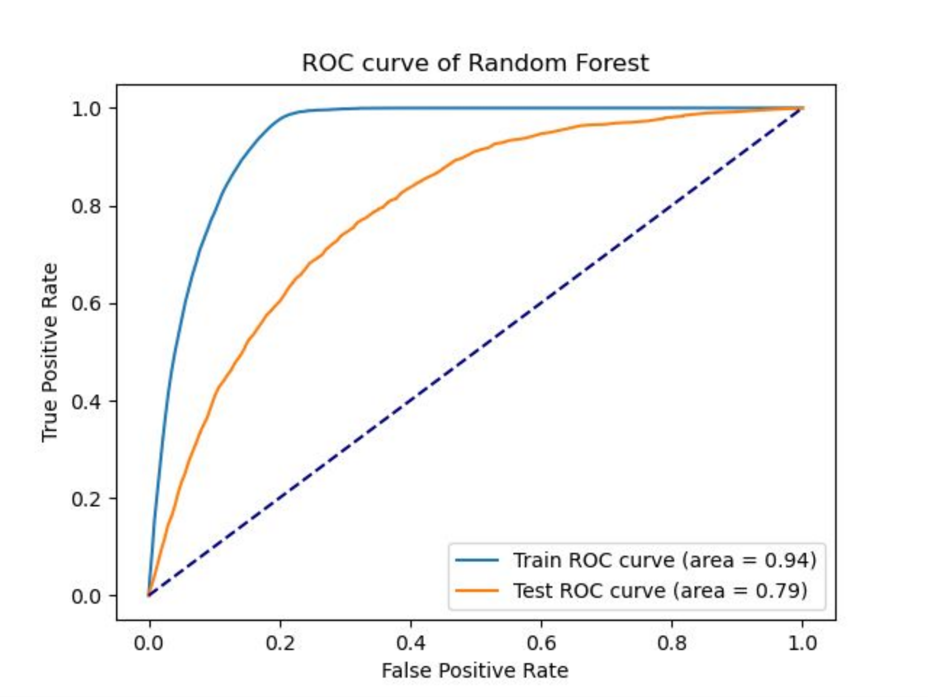
Train the Data

Random Forest



Number of features selected: 42

Target	Precision	Recall	f1-score
0	0.97	0.71	0.82
1	0.16	0.74	0.26
accuracy		0.71	
macro avg	0.57	0.72	0.54
weighed avg	0.92	0.71	0.78
balanced Accuracy	0.7218		

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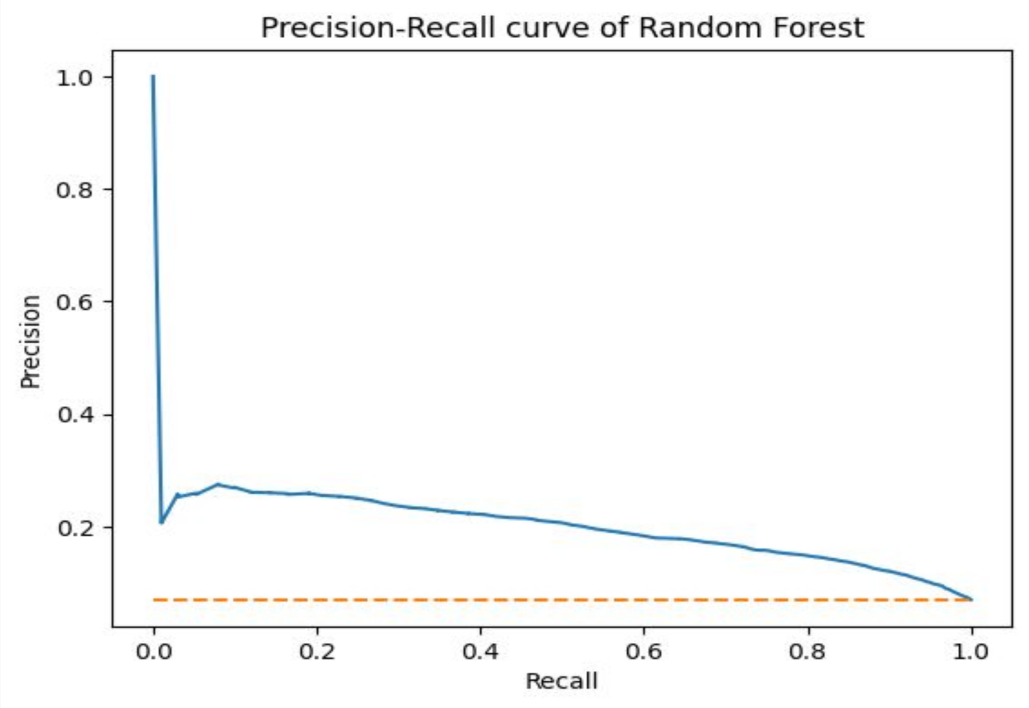
Train the Data

Random Forest



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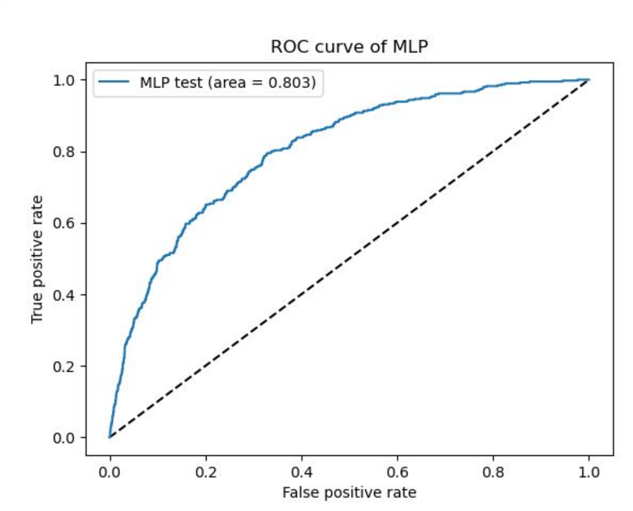
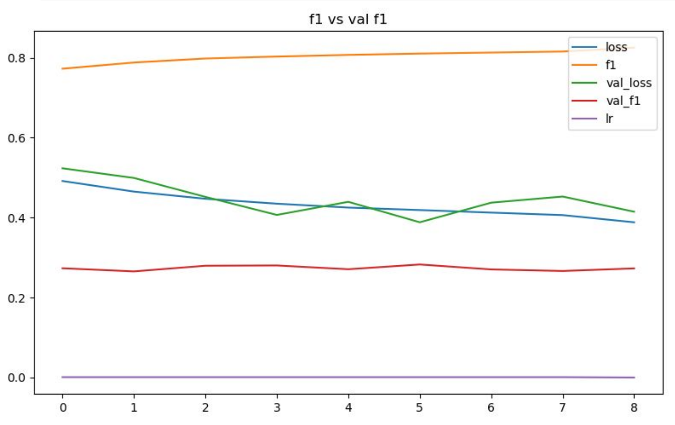
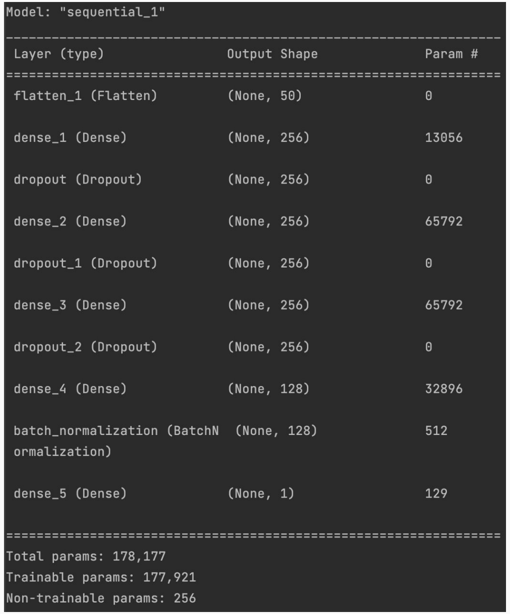
Train the Data

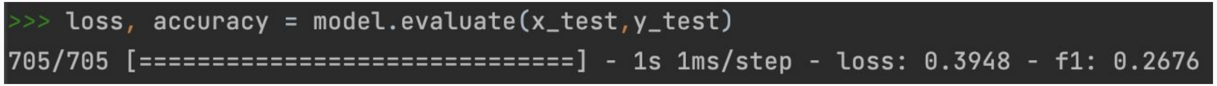
Multi Layer Perceptron


ROC curve of MLP


f1 vs val f1



```
Model: "sequential_1"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 flatten_1 (Flatten)         (None, 50)                0

 dense_1 (Dense)             (None, 256)               13056

 dropout (Dropout)           (None, 256)               0

 dense_2 (Dense)             (None, 256)               65792

 dropout_1 (Dropout)         (None, 256)               0

 dense_3 (Dense)             (None, 256)               65792

 dropout_2 (Dropout)         (None, 256)               0

 dense_4 (Dense)             (None, 128)               32896

 batch_normalization (BatchN  (None, 128)              512
 ormalization)

 dense_5 (Dense)             (None, 1)                 129

=================================================================
Total params: 178,177
Trainable params: 177,921
Non-trainable params: 256
```



```
>>> loss, accuracy = model.evaluate(x_test,y_test)
705/705 [==============================] - 1s 1ms/step - loss: 0.3948 - f1: 0.2676
```

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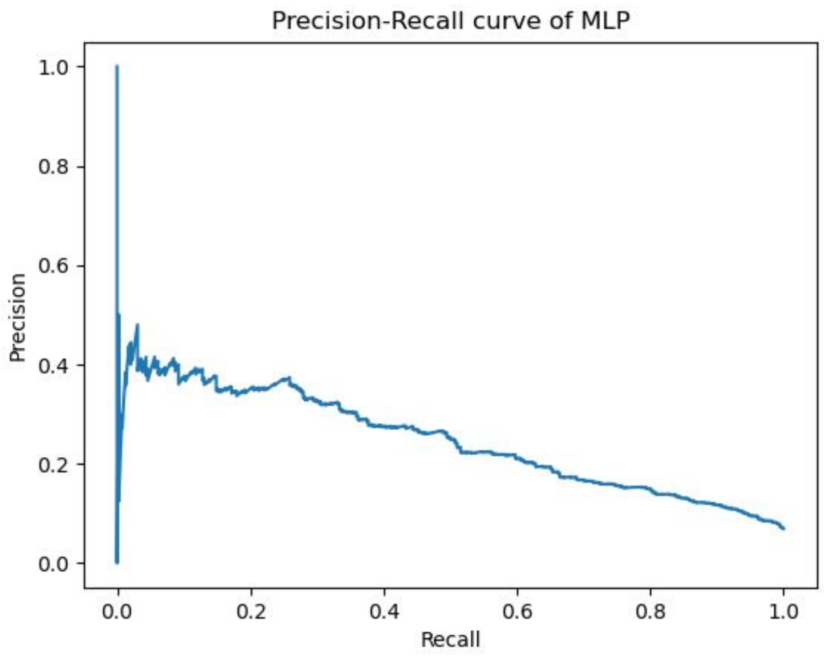
Train the Data

Multi Layer Perceptron



Conclusion

Best Model - Logistic Regression

- Based on the F1 Score,
  Logistic Regression model has the highest score for both

Model	F1 Score
Logistic Regression	0.57
Decision Tree	0.51
Random Forest	0.54
Neural Networks	0.26

Thanks !