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Acute Heart Disease Case Study

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

```
from google.colab import drive
drive.mount('/content/drive');
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.
```

```
dataset = pd.read_csv('/content/Heart.csv')
```

```
dataset.head()
```

	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG	MaxHR	ExAng	Oldpeak	Slope
0	63	1	typical	145	233	1	2	150	0	2.3	3
1	67	1	asymptomatic	160	286	0	2	108	1	1.5	2
2	67	1	asymptomatic	120	229	0	2	129	1	2.6	2
3	37	1	nonanginal	130	250	0	0	187	0	3.5	3
4	41	0	nontypical	130	204	0	2	172	0	1.4	1

```
# display columns of dataset
df=dataset
```

```
df.columns
```

```
Index(['Age', 'Sex', 'ChestPain', 'RestBP', 'Chol', 'Fbs', 'RestECG', 'MaxHR',
       'ExAng', 'Oldpeak', 'Slope', 'Ca', 'Thal', 'AHD'],
      dtype='object')
```

```
dataset.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 303 entries, 0 to 302
Data columns (total 14 columns):
```

```
 #   Column     Non-Null Count  Dtype  
---  ------     --------------  -----  
 0   Age        303 non-null    int64  
 1   Sex        303 non-null    int64  
 2   ChestPain  303 non-null    object 
 3   RestBP     303 non-null    int64  
 4   Chol       303 non-null    int64  
 5   Fbs        303 non-null    int64  
 6   RestECG    303 non-null    int64  
 7   MaxHR      303 non-null    int64  
 8   ExAng      303 non-null    int64  
 9   Oldpeak    303 non-null    float64
 10  Slope      303 non-null    int64  
 11  Ca         299 non-null    float64
 12  Thal       301 non-null    object 
 13  AHD        303 non-null    object 
dtypes: float64(2), int64(9), object(3)
memory usage: 33.3+ KB
```

```
df.isnull().sum()
```

```
Age          0
Sex          0
ChestPain    0
RestBP       0
Chol         0
Fbs          0
RestECG      0
MaxHR        0
ExAng        0
Oldpeak      0
Slope        0
Ca           4
Thal         2
AHD          0
dtype: int64
```

```
#description  detalis of object type column
df.describe(include='O')
```

	ChestPain	Thal	AHD
count	303	301	303
unique	4	3	2
top	asymptomatic	normal	No
freq	144	166	164

```
#descriprtion details of numeric type column
df.describe(exclude='O')
```

	Age	Sex	RestBP	Chol	Fbs	RestECG	Max
count	303.000000	303.000000	303.000000	303.000000	303.000000	303.000000	303.0000
mean	54.438944	0.679868	131.689769	246.693069	0.148515	0.990099	149.6072
std	9.038662	0.467299	17.599748	51.776918	0.356198	0.994971	22.8750
min	29.000000	0.000000	94.000000	126.000000	0.000000	0.000000	71.0000
25%	48.000000	0.000000	120.000000	211.000000	0.000000	0.000000	133.5000
50%	56.000000	1.000000	130.000000	241.000000	0.000000	1.000000	153.0000
75%	61.000000	1.000000	140.000000	275.000000	0.000000	2.000000	166.0000
max	77.000000	1.000000	200.000000	564.000000	1.000000	2.000000	202.0000

```
#display row and column of dataset
df.shape
```

```
(303, 14)
```

```
print("number of rows in dataset:",df.shape[0])
```

```
number of rows in dataset: 303
```

Feature Engineering

```
df.Thal.unique()
```

```
array(['fixed', 'normal', 'reversable', nan], dtype=object)
```

```
df.Thal.value_counts()
```

```
normal        166
reversable    117
fixed          18
Name: Thal, dtype: int64
```

replacing null value with mode of column (higest ouccerence)

```
df.Thal.value_counts()[0]
```

```
166
```

```
df.Thal.value_counts().index[0]
```

```
'normal'
```

```
df.Thal=df.Thal.fillna(df.Thal.value_counts().index[0])
df.Thal.value_counts()
```

```
normal        168
reversable    117
fixed          18
Name: Thal, dtype: int64
```

```
df.Thal.isnull().sum()
```

```
0
```

```
df.Ca.unique()
```

```
array([ 0.,  3.,  2.,  1., nan])
```

```
df.Ca.value_counts()
```

```
0.0    176
1.0     65
2.0     38
3.0     20
Name: Ca, dtype: int64
```

Replace the null values with mode ofthe column

```
df.Ca=df.Ca.fillna(0.0)
df.Ca.value_counts()
```

```
0.0    180
1.0     65
2.0     38
3.0     20
Name: Ca, dtype: int64
```

```
df.Ca=df.Ca.fillna(df.Ca.value_counts().index[0])
df.Ca.value_counts()
```

```
0.0    180
1.0     65
2.0     38
3.0     20
Name: Ca, dtype: int64
```

```
print(df.ChestPain.unique())
print(df.Thal.unique())
print(df.AHD.unique())
```

```
['typical' 'asymptomatic' 'nonanginal' 'nontypical']
['fixed' 'normal' 'reversable']
['No' 'Yes']
```

```
df_encoding = pd.get_dummies(df[['ChestPain','Thal','AHD']])
df_final=pd.concat([df,df_encoding],1)
df_final = df_final.drop(['ChestPain','Thal','AHD'],axis = 1)
df_final
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:2: FutureWarning: In a
```

	Age	Sex	RestBP	Chol	Fbs	RestECG	MaxHR	ExAng	Oldpeak	Slope	Ca	ChestPa
0	63	1	145	233	1	2	150	0	2.3	3	0.0	
1	67	1	160	286	0	2	108	1	1.5	2	3.0	
2	67	1	120	229	0	2	129	1	2.6	2	2.0	
3	37	1	130	250	0	0	187	0	3.5	3	0.0	
4	41	0	130	204	0	2	172	0	1.4	1	0.0	
...	...	...	...	...	...	...	...	...	...	...	...	
298	45	1	110	264	0	0	132	0	1.2	2	0.0	
299	68	1	144	193	1	0	141	0	3.4	2	2.0	
300	57	1	130	131	0	0	115	1	1.2	2	1.0	
301	57	0	130	236	0	2	174	0	0.0	2	1.0	
302	38	1	138	175	0	0	173	0	0.0	1	0.0	

303 rows × 20 columns

```
df_final.isnull().sum()
```

```
Age                        0
Sex                        0
RestBP                     0
Chol                       0
Fbs                        0
RestECG                    0
MaxHR                      0
ExAng                      0
Oldpeak                    0
Slope                      0
Ca                         0
ChestPain_asymptomatic     0
ChestPain_nonanginal       0
ChestPain_nontypical       0
ChestPain_typical          0
Thal_fixed                 0
Thal_normal                0
Thal_reversable            0
AHD_No                     0
```

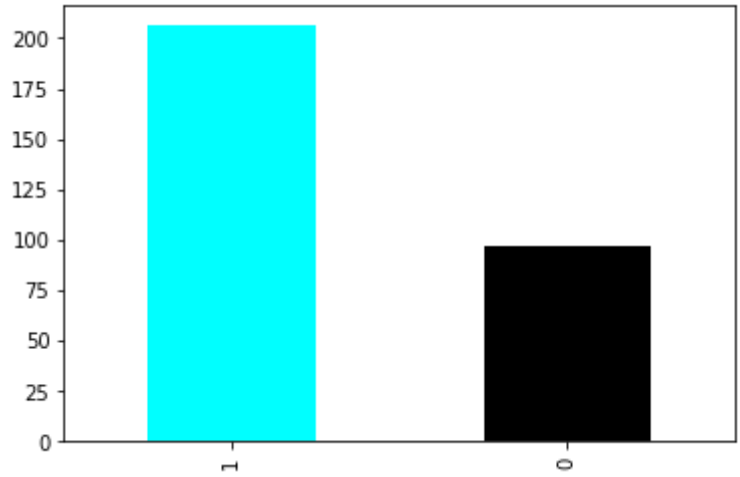
```
AHD_Yes                   0
dtype: int64
```

```
df_final.Sex.value_counts()
```

```
1    206
0     97
Name: Sex, dtype: int64
```

```
df_final.Sex.value_counts().plot(kind='bar',color=['cyan','black'])

plt.show()
```



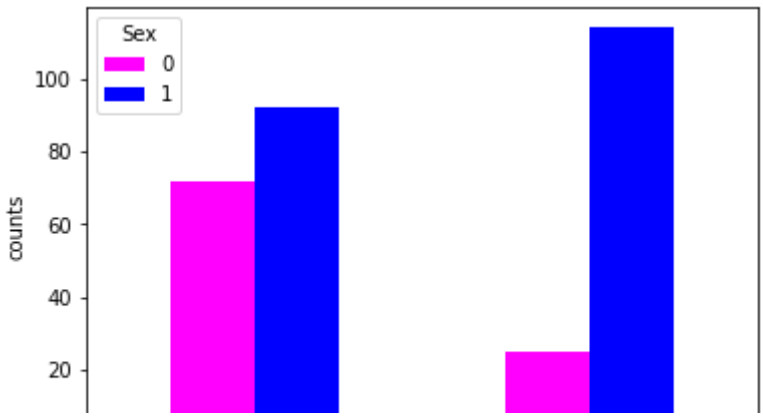

```
df_final.columns
```

```
Index(['Age', 'Sex', 'RestBP', 'Chol', 'Fbs', 'RestECG', 'MaxHR', 'ExAng',
       'Oldpeak', 'Slope', 'Ca', 'ChestPain_asymptomatic',
       'ChestPain_nonanginal', 'ChestPain_nontypical', 'ChestPain_typical',
       'Thal_fixed', 'Thal_normal', 'Thal_reversable', 'AHD_No', 'AHD_Yes'],
      dtype='object')
```

```
ct=pd.crosstab(df_final.AHD_Yes,df_final.Sex)
ct
```

Sex	0	1
AHD_Yes		
0	72	92
1	25	114

```
ct.plot(kind='bar',color=['magenta','blue'])
plt.xlabel("AHD Yes(0 : Female)(1 : Male)")
plt.ylabel("counts")
plt.show()
```



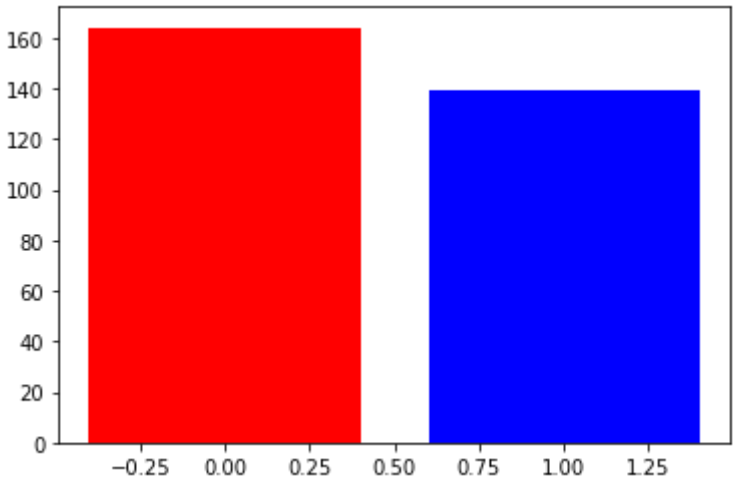

```
df_final.AHD_Yes.value_counts()
```

```
0    164
1    139
Name: AHD_Yes, dtype: int64
```

```
#df_final.AHD_Yes.value_counts().plot(kind='bar',color=['magenta','blue'])

plt.bar(df_final.AHD_Yes.unique(),df_final.AHD_Yes.value_counts(),color=['r','b'])

plt.show()
```




```
df_final.Sex[df_final.AHD_Yes==1].value_counts().plot(kind='bar',color=['b','r'])
plt.xlabel("Sex (0:Female)(1:Male)")
plt.ylabel("Counts")
plt.show()
```

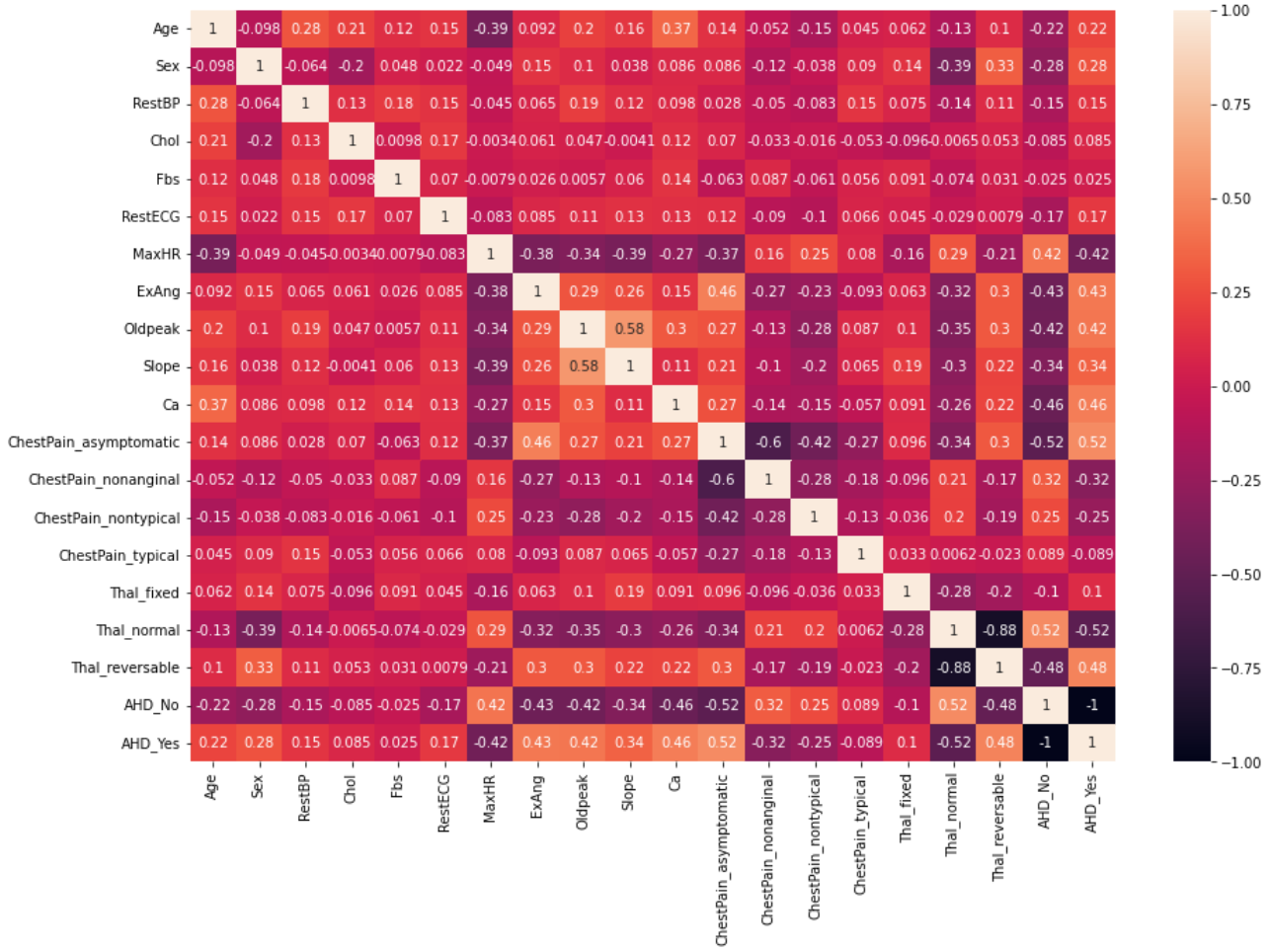

```
df_final.corr()
```

	Age	Sex	RestBP	Chol	Fbs	RestECG
Age	1.000000	-0.097542	0.284946	0.208950	0.118530	0.148868
Sex	-0.097542	1.000000	-0.064456	-0.199915	0.047862	0.021647
RestBP	0.284946	-0.064456	1.000000	0.130120	0.175340	0.146560
Chol	0.208950	-0.199915	0.130120	1.000000	0.009841	0.171043
Fbs	0.118530	0.047862	0.175340	0.009841	1.000000	0.069564
RestECG	0.148868	0.021647	0.146560	0.171043	0.069564	1.000000
MaxHR	-0.393806	-0.048663	-0.045351	-0.003432	-0.007854	-0.083389
ExAng	0.091661	0.146201	0.064762	0.061310	0.025665	0.084867
Oldpeak	0.203805	0.102173	0.189171	0.046564	0.005747	0.114133
Slope	0.161770	0.037533	0.117382	-0.004062	0.059894	0.133946
Ca	0.365323	0.086048	0.097528	0.123726	0.140764	0.131749
ChestPain_asymptomatic	0.135337	0.086398	0.027710	0.070343	-0.062929	0.122589
ChestPain_nonanginal	-0.051714	-0.117189	-0.050127	-0.033223	0.087027	-0.089526
ChestPain_nontypical	-0.151684	-0.037990	-0.083234	-0.016453	-0.060649	-0.102979
ChestPain_typical	0.045438	0.089828	0.149737	-0.053021	0.055511	0.065581
Thal_fixed	0.062042	0.142524	0.075157	-0.095743	0.091351	0.044672
Thal_normal	-0.132264	-0.387396	-0.139782	-0.006479	-0.073766	-0.028989
Thal_reversable	0.104902	0.326284	0.106210	0.053100	0.030953	0.007905
AHD_No	-0.223120	-0.276816	-0.150825	-0.085164	-0.025264	-0.169202
AHD_Yes	0.223120	0.276816	0.150825	0.085164	0.025264	0.169202

```
import seaborn as sns

fig,ax=plt.subplots(figsize=(15,10))
sns.heatmap(df_final.corr(), annot=True)

plt.show()
```




```
df_final = df_final.drop('AHD_No',axis=1)
df_final.head()
```

	Age	Sex	RestBP	Chol	Fbs	RestECG	MaxHR	ExAng	Oldpeak	Slope	Ca	ChestPain
0	63	1	145	233	1	2	150	0	2.3	3	0.0	
1	67	1	160	286	0	2	108	1	1.5	2	3.0	
2	67	1	120	229	0	2	129	1	2.6	2	2.0	
3	37	1	130	250	0	0	187	0	3.5	3	0.0	
4	41	0	130	204	0	2	172	0	1.4	1	0.0	

```
df_final.columns
```

```
Index(['Age', 'Sex', 'RestBP', 'Chol', 'Fbs', 'RestECG', 'MaxHR', 'ExAng',
       'Oldpeak', 'Slope', 'Ca', 'ChestPain_asymptomatic',
       'ChestPain_nonanginal', 'ChestPain_nontypical', 'ChestPain_typical',
       'Thal_fixed', 'Thal_normal', 'Thal_reversable', 'AHD_Yes'],
      dtype='object')
```

Applying preprocessing-MinMaxScalar

```
from sklearn.preprocessing import MinMaxScaler
MMsc=MinMaxScaler()
features=['Age', 'Sex', 'RestBP', 'Chol', 'Fbs', 'RestECG', 'MaxHR', 'ExAng',
       'Oldpeak', 'Slope', 'Ca', 'ChestPain_asymptomatic',
       'ChestPain_nonanginal', 'ChestPain_nontypical', 'ChestPain_typical',
       'Thal_fixed', 'Thal_normal', 'Thal_reversable']
df_final[features]=MMsc.fit_transform(df_final[features])
df_final.head()
```

	Age	Sex	RestBP	Chol	Fbs	RestECG	MaxHR	ExAng	Oldpeak	Slope
0	0.708333	1.0	0.481132	0.244292	1.0	1.0	0.603053	0.0	0.370968	1.0
1	0.791667	1.0	0.622642	0.365297	0.0	1.0	0.282443	1.0	0.241935	0.5
2	0.791667	1.0	0.245283	0.235160	0.0	1.0	0.442748	1.0	0.419355	0.5
3	0.166667	1.0	0.339623	0.283105	0.0	0.0	0.885496	0.0	0.564516	1.0
4	0.250000	0.0	0.339623	0.178082	0.0	1.0	0.770992	0.0	0.225806	0.0

```
X=df_final.drop('AHD_Yes',axis=1)
y=df_final.AHD_Yes
```

```
from sklearn.model_selection import train_test_split
X_train,X_test,y_train,y_test=train_test_split(X,y,test_size=0.2,random_state=1)
```

Model

RandomForestClassifier

```
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import r2_score,accuracy_score
```

```
rft=RandomForestClassifier()
rft.fit(X_train,y_train)
y_pred_rft=rft.predict(X_test)

print("R2 Score for predicted value: ", r2_score(y_test,y_pred_rft))
print("Accuracy Score of RFT: ", accuracy_score(y_test,y_pred_rft))
```

```
R2 Score for predicted value:  0.13616557734204793
Accuracy Score of RFT:  0.7868852459016393
```

```
from sklearn.metrics import confusion_matrix,accuracy_score,classification_report
cm=confusion_matrix(y_test,y_pred_rft)
print('Confusion Matrix')
print(cm)
print("Accuracy Score:",accuracy_score(y_test,y_pred_rft))
print('_'*20,'Classification Report','-'*20)
print(classification_report(y_test,y_pred_rft))
```

```
Confusion Matrix
[[27  7]
 [ 6 21]]
Accuracy Score:  0.7868852459016393
____________________ Classification Report --------------------
              precision    recall  f1-score   support

           0       0.82      0.79      0.81        34
           1       0.75      0.78      0.76        27

    accuracy                           0.79        61
   macro avg       0.78      0.79      0.78        61
weighted avg       0.79      0.79      0.79        61
```

AdaBoosting

```
from sklearn.ensemble import AdaBoostClassifier
adb=AdaBoostClassifier()
adb.fit(X_train,y_train)
y_pred_adb=adb.predict(X_test)

print("R2 Score for predicted value: ", r2_score(y_test,y_pred_adb))
print("Accuracy Score of KNN: ", accuracy_score(y_test,y_pred_adb))
```

```
R2 Score for predicted value:  0.20261437908496727
Accuracy Score of KNN:  0.8032786885245902
```

Gradient Boosting

```
from sklearn.ensemble import GradientBoostingClassifier
```

```
gdb= GradientBoostingClassifier()
gdb.fit(X_train,y_train)
y_pred_gdb=gdb.predict(X_test)

print("R2 Score for predicted value: ", r2_score(y_test,y_pred_gdb))
print("Accuracy Score of KNN: ", accuracy_score(y_test,y_pred_gdb))
```

```
R2 Score for predicted value:  0.0032679738562091387
Accuracy Score of KNN:  0.7540983606557377
```

XGBClassifier

```
from xgboost import XGBClassifier
from sklearn.metrics import r2_score,accuracy_score

xgb= XGBClassifier()
xgb.fit(X_train,y_train)
y_pred_xgb=xgb.predict(X_test)

print("R2 Score for predicted value: ", r2_score(y_test,y_pred_xgb))
print("Accuracy Score of XGB: ", accuracy_score(y_test,y_pred_xgb))
```

```
R2 Score for predicted value:  0.13616557734204793
Accuracy Score of XGB:  0.7868852459016393
```

```
from sklearn.metrics import confusion_matrix,accuracy_score,classification_report
cm=confusion_matrix(y_test,y_pred_xgb)
print('Confusion Matrix' )
print(cm)
print("Accuracy Score: ", accuracy_score(y_test,y_pred_xgb))
print('_'*20,'Classification Report','-'*20)
print(classification_report(y_test,y_pred_xgb))
```

```
Confusion Matrix
[[27  7]
 [ 6 21]]
Accuracy Score:  0.7868852459016393
____________________ Classification Report --------------------
              precision    recall  f1-score   support

           0       0.82      0.79      0.81        34
           1       0.75      0.78      0.76        27

    accuracy                           0.79        61
   macro avg       0.78      0.79      0.78        61
weighted avg       0.79      0.79      0.79        61
```

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