Personal Key Indicaters of Heart Disease

My objective with this analysis is to acquire practical experience by applying a variety of techniques and approaches.My goal is to enhance my grasp of data analysis while simultaneously generating valuable insights through the utilization of machine learning methods. This project exemplifies my dedication to learning and my determination to excel in the field of data analysis.

Data Source:

I'm currently utilizing a dataset obtained from Kaggle, with a specific focus on the "Personal Key Indicators of Heart Disease" dataset. This dataset originates from the 2020 annual CDC survey, encompassing health-related information from a staggering 400,000 adults. It's worth noting that this dataset exhibits class imbalance, where one class significantly outweighs the other. To address this issue and enhance the performance of our machine learning model, I'm considering the implementation of oversampling techniques, such as SMOTE (Synthetic Minority Over-sampling Technique). SMOTE has the potential to rectify the class imbalance by generating synthetic data points for the minority class. This augmentation aids the model in better learning from the minority class, ultimately leading to more accurate predictions.

Loading libraries

In [ ]:
```
import numpy as np
import pandas as pd
import matplotlib
from matplotlib import pyplot as plt
import seaborn as sns
sns.set_theme()
sns.set(rc={'figure.figsize':(9, 5)})
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeClassifier
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from sklearn.preprocessing import LabelEncoder
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import accuracy_score, precision_score, recall_score, f1_score, cohen_kappa_score, roc_auc_score, confusion_matrix, classification_report
from imblearn.over_sampling import SMOTE
```

Loading the dataset:

In [ ]:
```
df = pd.read_csv("C:\\Users\\raffa\\OneDrive\\Documenti\\Heart_diseases\\heart_2020_cleaned.csv")
```

Exploring the dataset:

In [ ]:
```
df.shape
```

Out[ ]:
```
(319795, 18)
```

In [ ]:
```
df.head()
```

Out[ ]:

	HeartDisease	BMI	Smoking	AlcoholDrinking	Stroke	PhysicalHealth	MentalHealth	DiffWalking	Sex	AgeCategory	Race	Diabetic	PhysicalActivity	GenHealth	Sleep
0	No	16.60	Yes	No	No	3.0	30.0	No	Female	55-59	White	Yes	Yes	Very good	
1	No	20.34	No	No	Yes	0.0	0.0	No	Female	80 or older	White	No	Yes	Very good	
2	No	26.58	Yes	No	No	20.0	30.0	No	Male	65-69	White	Yes	Yes	Fair	
3	No	24.21	No	No	No	0.0	0.0	No	Female	75-79	White	No	No	Good	
4	No	23.71	No	No	No	28.0	0.0	Yes	Female	40-44	White	No	Yes	Very good	

In [ ]:
```
df.tail()
```

Out[ ]:

	HeartDisease	BMI	Smoking	AlcoholDrinking	Stroke	PhysicalHealth	MentalHealth	DiffWalking	Sex	AgeCategory	Race	Diabetic	PhysicalActivity	GenHealth
319790	Yes	27.41	Yes	No	No	7.0	0.0	Yes	Male	60-64	Hispanic	Yes	No	Fai
319791	No	29.84	Yes	No	No	0.0	0.0	No	Male	35-39	Hispanic	No	Yes	Very good
319792	No	24.24	No	No	No	0.0	0.0	No	Female	45-49	Hispanic	No	Yes	Good
319793	No	32.81	No	No	No	0.0	0.0	No	Female	25-29	Hispanic	No	No	Good
319794	No	46.56	No	No	No	0.0	0.0	No	Female	80 or older	Hispanic	No	Yes	Good

In [ ]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
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)
memory usage: 43.9+ MB
```

In [ ]:
```
df.isna().sum()
```

Out[ ]:
```
HeartDisease        0
BMI                 0
Smoking             0
AlcoholDrinking     0
Stroke              0
PhysicalHealth      0
MentalHealth        0
DiffWalking         0
Sex                 0
AgeCategory         0
Race                0
Diabetic            0
PhysicalActivity    0
GenHealth           0
SleepTime           0
Asthma              0
KidneyDisease       0
SkinCancer          0
dtype: int64
```

Observation of the variables:

In [ ]:
```
summary = df.describe().T
styled_summary = summary.style.background_gradient(cmap='coolwarm')
styled_summary
```

Out[ ]:

	count	mean	std	min	25%	50%	75%	max
BMI	319795.000000	28.325399	6.356100	12.020000	24.030000	27.340000	31.420000	94.850000
PhysicalHealth	319795.000000	3.371710	7.950850	0.000000	0.000000	0.000000	2.000000	30.000000
MentalHealth	319795.000000	3.898366	7.955235	0.000000	0.000000	0.000000	3.000000	30.000000
SleepTime	319795.000000	7.097075	1.436007	1.000000	6.000000	7.000000	8.000000	24.000000

Analysis by gender

In [ ]:
```
df.groupby(['Sex','HeartDisease'])['HeartDisease'].count()
```

Out[ ]:
```
Sex     HeartDisease
Female  No             156571
        Yes             11234
Male    No             135851
        Yes             16139
Name: HeartDisease, dtype: int64
```

In [ ]:
```
sns.countplot(x = df['Sex'], data=df, hue='HeartDisease', palette="winter")
plt.title('Heart Disease Frequency for Sex')
plt.xlabel('Sex')
plt.legend(["Haven't Disease", "Have Disease"])
plt.ylabel('Frequency')
plt.show()
```

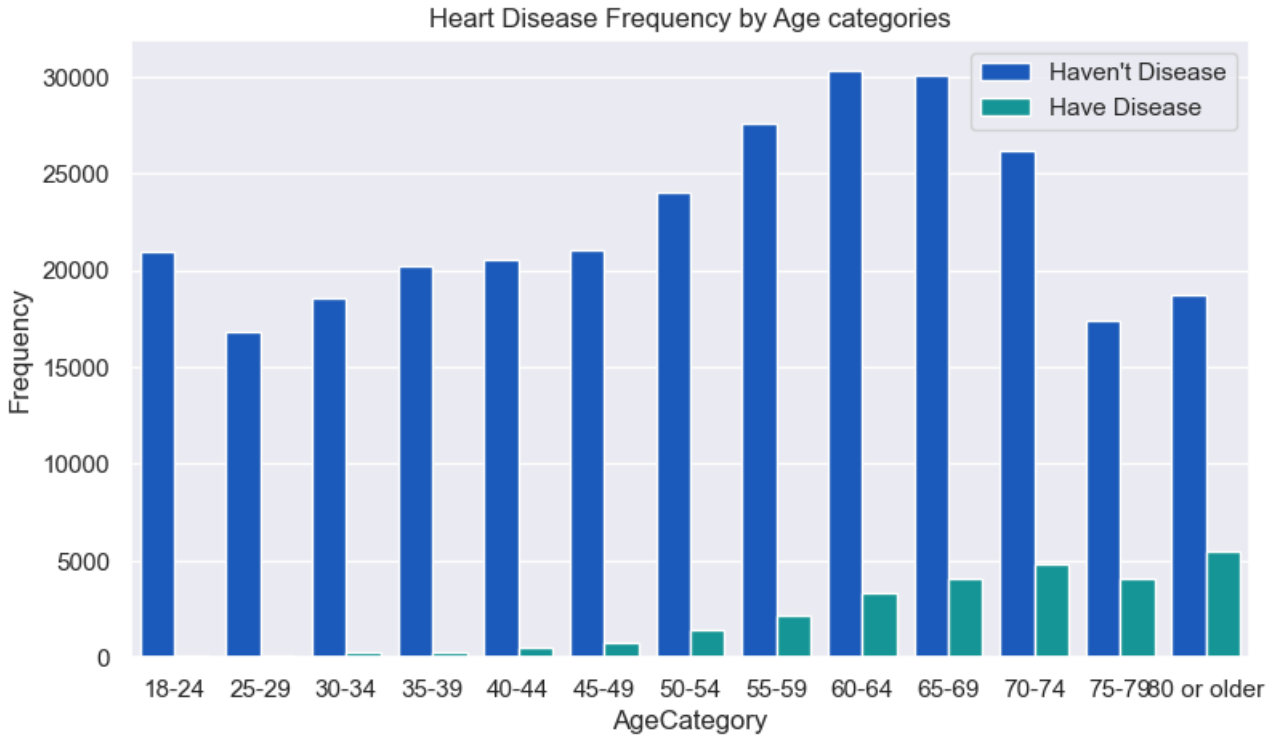
Analysis by Age

In [ ]:
```
df.groupby(['AgeCategory','HeartDisease'])['HeartDisease'].count()
```

Out[ ]:
```
AgeCategory  HeartDisease
18-24        No             20934
             Yes              130
25-29        No             16822
             Yes              133
30-34        No             18527
             Yes              226
35-39        No             20254
             Yes              296
40-44        No             20520
             Yes              486
45-49        No             21047
             Yes              744
50-54        No             23999
             Yes             1383
55-59        No             27555
             Yes             2202
60-64        No             30359
             Yes             3327
65-69        No             30050
             Yes             4101
70-74        No             26218
             Yes             4847
75-79        No             17433
             Yes             4049
80 or older  No             18704
             Yes             5449
Name: HeartDisease, dtype: int64
```

In [ ]:
```
df['AgeCategory'] = pd.Categorical(df['AgeCategory'], ordered=True)
```

In [ ]:
```
sns.countplot(x = df['AgeCategory'], data=df, hue='HeartDisease', palette="winter")
plt.title('Heart Disease Frequency by Age categories')
plt.xlabel('AgeCategory')
plt.legend(["Haven't Disease", "Have Disease"])
plt.ylabel('Frequency')
plt.show()
```



Analysis by General Health and Gender

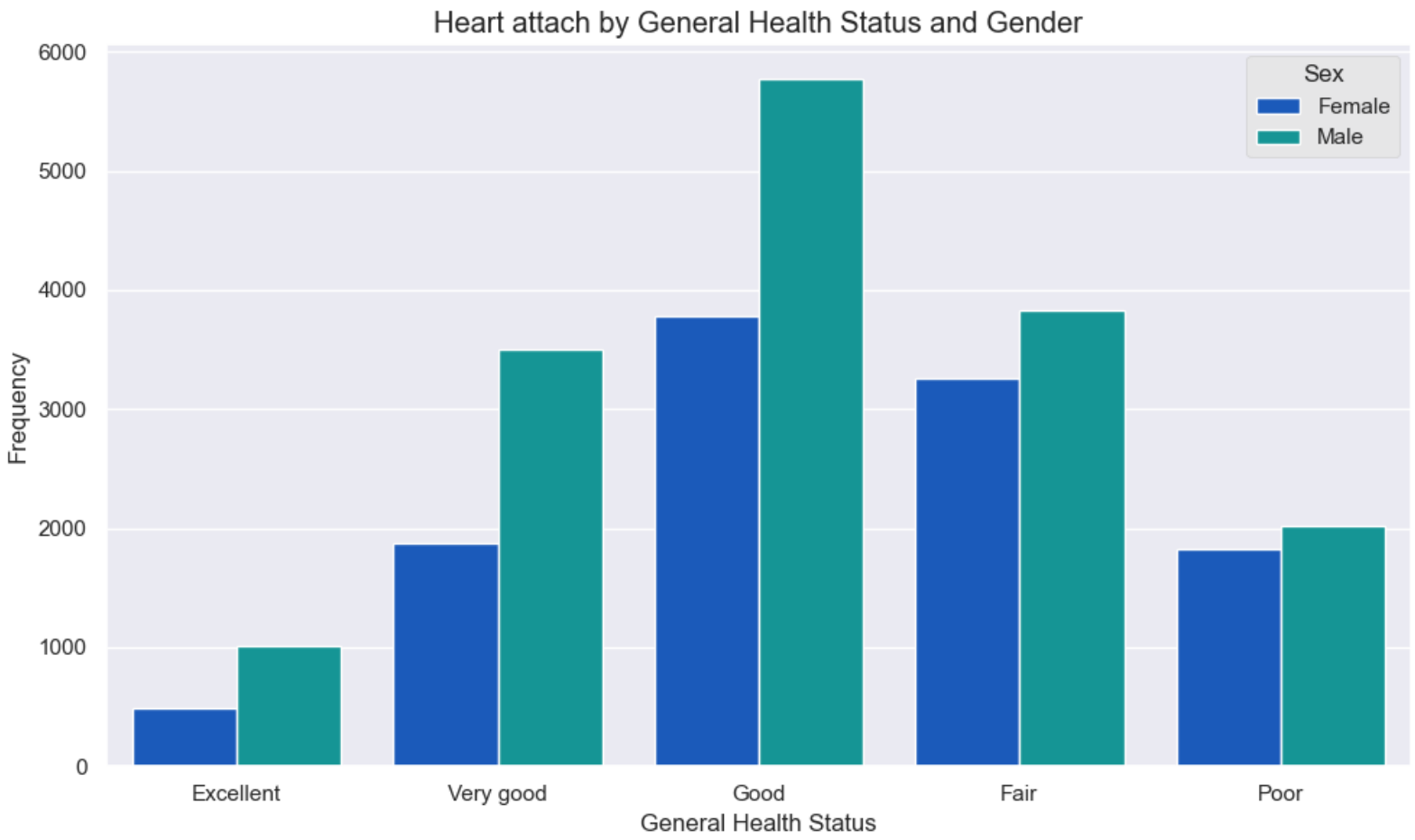
In [ ]:
```
have_heart_attack=df[df.HeartDisease =='Yes']
```

In [ ]:
```
General_health = pd.DataFrame(have_heart_attack.GenHealth.value_counts()/len(have_heart_attack.GenHealth)*100)
print(round(General_health,2))
```

```
           count
GenHealth
Good       34.92
Fair       25.88
Very good  19.66
Poor       14.06
Excellent   5.48
```

In [ ]:
```
GenHealth = ['Excellent', 'Very good', 'Good','Fair','Poor']
plt.figure(figsize=(10, 6))  # Set the figure size
sns.countplot(x=have_heart_attack['GenHealth'], hue=have_heart_attack['Sex'], palette='winter', order=GenHealth)
plt.style.use('ggplot')
plt.title('Heart attach by General Health Status and Gender')
plt.xlabel('General Health Status')
plt.ylabel('Frequency')
```

```
plt.legend(title='Sex')
plt.tight_layout()
plt.show()
```



Preparing the dataset for machine learning methods:

In [ ]:
```
df2 = df.copy()
```

In [ ]:
```
label=LabelEncoder() #Trasforming coloumn in numerical values
for col in df2:
    df2[col]=label.fit_transform(df2[col])
df2
```

Out[ ]:

	HeartDisease	BMI	Smoking	AlcoholDrinking	Stroke	PhysicalHealth	MentalHealth	DiffWalking	Sex	AgeCategory	Race	Diabetic	PhysicalActivity	GenHealth	Slee
0	0	223	1	0	0	3	30	0	0	7	5	2	1	4	
1	0	524	0	0	1	0	0	0	0	12	5	0	1	4	
2	0	1103	1	0	0	20	30	0	1	9	5	2	1	1	
3	0	883	0	0	0	0	0	0	0	11	5	0	0	2	
4	0	837	0	0	0	28	0	1	0	4	5	0	1	4	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
319790	1	1180	1	0	0	7	0	1	1	8	3	2	0	1	
319791	0	1397	1	0	0	0	0	0	1	3	3	0	1	4	
319792	0	886	0	0	0	0	0	0	0	5	3	0	1	2	
319793	0	1658	0	0	0	0	0	0	0	1	3	0	0	2	
319794	0	2700	0	0	0	0	0	0	0	12	3	0	1	2	

319795 rows × 18 columns

In [ ]:
```
df2.dtypes
```

Out[ ]:
```
HeartDisease        int32
BMI                 int64
Smoking             int32
AlcoholDrinking     int32
Stroke              int32
PhysicalHealth      int64
MentalHealth        int64
DiffWalking         int32
Sex                 int32
AgeCategory         int32
Race                int32
Diabetic            int32
PhysicalActivity    int32
GenHealth           int32
SleepTime           int64
Asthma              int32
KidneyDisease       int32
SkinCancer          int32
dtype: object
```

In [ ]:
```
X = df2.drop('HeartDisease',axis=1)
y = df2['HeartDisease']
```

```
smote = SMOTE()

X_resampled, y_resampled = smote.fit_resample(X, y)
```

In [ ]:
```
df2 = pd.concat([X_resampled, y_resampled], axis="columns")
df2.head()
```

Out[ ]:

	BMI	Smoking	AlcoholDrinking	Stroke	PhysicalHealth	MentalHealth	DiffWalking	Sex	AgeCategory	Race	Diabetic	PhysicalActivity	GenHealth	SleepTime	Asthma	Kid
0	223	1	0	0	3	30	0	0	7	5	2	1	4	4	1	
1	524	0	0	1	0	0	0	0	12	5	0	1	4	6	0	
2	1103	1	0	0	20	30	0	1	9	5	2	1	1	7	1	
3	883	0	0	0	0	0	0	0	11	5	0	0	2	5	0	
4	837	0	0	0	28	0	1	0	4	5	0	1	4	7	0	

Preparing the data into training and testing:

In [ ]:
```
X = df2.drop('HeartDisease',axis=1)
y = df2['HeartDisease']

X_train, X_test, y_train, y_test = train_test_split(X,y,test_size=0.33, random_state=42)
```

Decision Tree Classifies:

In [ ]:
```
DT = DecisionTreeClassifier()
DT = DecisionTreeClassifier(max_depth=4)
DT.fit(X_train, y_train)
```

Out[ ]:
```
DecisionTreeClassifier(max_depth=4)
```

In [ ]:
```
acc_lr=DT.score(X_test,y_test)
acc_DT=DT.score(X_test,y_test)
print("accuracy:", DT.score(X_test,y_test))
```

```
accuracy: 0.7539417302680325
```

Logistic Regression:

In [ ]:
```
mdl = LogisticRegression(solver='liblinear', max_iter=10000, C=10)  # Adjust max_iter as needed
mdl.fit(X_train, y_train)
```

Out[ ]:
```
LogisticRegression
LogisticRegression(C=10, max_iter=10000, solver='liblinear')
```

In [ ]:
```
mdl.feature_names_in_
```

Out[ ]:
```
array(['BMI', 'Smoking', 'AlcoholDrinking', 'Stroke', 'PhysicalHealth',
       'MentalHealth', 'DiffWalking', 'Sex', 'AgeCategory', 'Race',
       'Diabetic', 'PhysicalActivity', 'GenHealth', 'SleepTime', 'Asthma',
       'KidneyDisease', 'SkinCancer'], dtype=object)
```

In [ ]:
```
mdl.coef_
```

Out[ ]:
```
array([[ 3.12800916e-04, -1.72620198e-01, -2.07037820e+00,
         4.79195228e-02,  3.96445154e-02,  1.27323652e-02,
        -5.81606796e-01,  2.08905318e-01,  3.49718619e-01,
         3.87077639e-02,  1.78091100e-01, -1.00668102e+00,
        -1.58837474e-01, -2.01297353e-01, -9.45658645e-01,
        -5.75291957e-01, -9.33631478e-01]])
```

In [ ]:
```
mdl.intercept_
```

Out[ ]:
```
array([-1.16543333])
```

In [ ]:
```
y_pred_train = mdl.predict(X_train)
y_pred_test = mdl.predict(X_test)

train_accuracy = accuracy_score(y_train, y_pred_train)
test_accuracy = accuracy_score(y_test, y_pred_test)

print("Train Accuracy: ", train_accuracy)
print("Test Accuracy: ", test_accuracy)
```

```
Train Accuracy:  0.7481351044418073
Test Accuracy:  0.7483717532215193
```

Classification report:

In [ ]:
```
y_pred_test = mdl.predict(X_test)

report = classification_report(y_test, y_pred_test)
print("Classificaton Report:")
print(report)
```

```
Classificaton Report:
              precision    recall  f1-score   support

           0       0.76      0.72      0.74     96403
           1       0.74      0.77      0.76     96596

    accuracy                           0.75    192999
   macro avg       0.75      0.75      0.75    192999
weighted avg       0.75      0.75      0.75    192999
```