```python
import pandas as pd

heart = pd.read_csv('heartdisease.csv')

heart
```

```
       HeartDisease    BMI Smoking AlcoholDrinking Stroke
PhysicalHealth  \
0                No  16.60     Yes              No     No
3.0
1                No  20.34      No              No    Yes
0.0
2                No  26.58     Yes              No     No
20.0
3                No  24.21      No              No     No
0.0
4                No  23.71      No              No     No
28.0
...             ...    ...     ...             ...    ...
...
319790          Yes  27.41     Yes              No     No
7.0
319791           No  29.84     Yes              No     No
0.0
319792           No  24.24      No              No     No
0.0
319793           No  32.81      No              No     No
0.0
319794           No  46.56      No              No     No
0.0

        MentalHealth DiffWalking     Sex  AgeCategory      Race
Diabetic  \
0               30.0          No  Female        55-59     White
Yes
1                0.0          No  Female  80 or older     White
No
2               30.0          No    Male        65-69     White
Yes
3                0.0          No  Female        75-79     White
No
4                0.0         Yes  Female        40-44     White
No
...              ...         ...     ...          ...       ...       .
..
319790           0.0         Yes    Male        60-64  Hispanic
Yes
319791           0.0          No    Male        35-39  Hispanic
No
319792           0.0          No  Female        45-49  Hispanic
```

```
No
319793           0.0          No  Female        25-29  Hispanic
No
319794           0.0          No  Female  80 or older  Hispanic
No

       PhysicalActivity  GenHealth  SleepTime Asthma KidneyDisease
SkinCancer
0                   Yes  Very good        5.0    Yes            No
Yes
1                   Yes  Very good        7.0     No            No
No
2                   Yes       Fair        8.0    Yes            No
No
3                    No       Good        6.0     No            No
Yes
4                   Yes  Very good        8.0     No            No
No
...                 ...        ...        ...    ...           ...
...
319790               No       Fair        6.0    Yes            No
No
319791              Yes  Very good        5.0    Yes            No
No
319792              Yes       Good        6.0     No            No
No
319793               No       Good       12.0     No            No
No
319794              Yes       Good        8.0     No            No
No

[319795 rows x 18 columns]
```

```
#misisng values
heart.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
```

```
# Check for missing values
print(heart.isna().sum())
```

```
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
```

```
#Handling datatypes

from sklearn.preprocessing import LabelEncoder

# Initialize the LabelEncoder
label_encoder = LabelEncoder()

# Identify columns with dtype 'object' to apply label encoding
categorical_columns = heart.select_dtypes(include=['object']).columns

# Apply label encoding to each categorical column
for col in categorical_columns:
    heart[col] = label_encoder.fit_transform(heart[col])
```

```python
# Display the first few rows of the encoded dataset
print(heart.head())
```

```
   HeartDisease    BMI  Smoking  AlcoholDrinking  Stroke
PhysicalHealth  \
0             0  16.60        1                0       0
3.0
1             0  20.34        0                0       1
0.0
2             0  26.58        1                0       0
20.0
3             0  24.21        0                0       0
0.0
4             0  23.71        0                0       0
28.0

   MentalHealth  DiffWalking  Sex  AgeCategory  Race  Diabetic  \
0          30.0            0    0            7     5         2
1           0.0            0    0           12     5         0
2          30.0            0    1            9     5         2
3           0.0            0    0           11     5         0
4           0.0            1    0            4     5         0

   PhysicalActivity  GenHealth  SleepTime  Asthma  KidneyDisease
SkinCancer
0                 1          4        5.0       1              0
1
1                 1          4        7.0       0              0
0
2                 1          1        8.0       1              0
0
3                 0          2        6.0       0              0
1
4                 1          4        8.0       0              0
0
```

```python
print(heart.dtypes)
```

```
HeartDisease          int32
BMI                 float64
Smoking               int32
AlcoholDrinking       int32
Stroke                int32
PhysicalHealth      float64
MentalHealth        float64
DiffWalking           int32
Sex                   int32
AgeCategory           int32
Race                  int32
Diabetic              int32
```

```
PhysicalActivity      int32
GenHealth             int32
SleepTime           float64
Asthma                int32
KidneyDisease         int32
SkinCancer            int32
dtype: object
```

```python
#Identifying outliers
# Calculate Q1 (25th percentile) and Q3 (75th percentile)
Q1 = heart['BMI'].quantile(0.25)
Q3 = heart['BMI'].quantile(0.75)

# Calculate IQR
IQR = Q3 - Q1

# Define the lower and upper bounds for outliers
lower_bound = Q1 - 1.5 * IQR
upper_bound = Q3 + 1.5 * IQR

# Identify outliers
outliers = heart[(heart['BMI'] < lower_bound) | (heart['BMI'] >
upper_bound)]
print("Outliers based on IQR method:\n", outliers)
```

```
Outliers based on IQR method:
         HeartDisease    BMI  Smoking  AlcoholDrinking  Stroke
PhysicalHealth  \
32                 0  45.35        0                0       0
30.0
57                 0  46.52        1                0       0
30.0
90                 0  44.29        0                0       0
30.0
105                0  58.54        0                0       0
30.0
107                0  45.42        0                0       0
0.0
...              ...    ...      ...              ...     ...
...
319693             0  44.29        0                0       0
0.0
319709             0  51.46        1                0       0
30.0
319725             0  53.16        0                0       0
29.0
319777             0  42.57        0                0       0
0.0
319794             0  46.56        0                0       0
0.0
```

```
        MentalHealth  DiffWalking  Sex  AgeCategory  Race  Diabetic  \
32               0.0            1    1           10     5         2
57               0.0            0    1            9     5         2
90              10.0            1    0           10     5         0
105              0.0            1    1            9     4         1
107              0.0            0    0            5     5         0
...              ...          ...  ...          ...   ...       ...
319693           0.0            0    0            1     3         0
319709           0.0            0    1            7     3         0
319725           0.0            1    1            1     3         1
319777           0.0            1    0            8     3         0
319794           0.0            0    0           12     3         0

        PhysicalActivity  GenHealth  SleepTime  Asthma  KidneyDisease
\
32                     0          2        8.0       0              0

57                     0          3        8.0       1              0

90                     0          1        7.0       0              0

105                    1          3        3.0       1              0

107                    1          4        7.0       1              0

...                  ...        ...        ...     ...            ...

319693                 1          4        7.0       0              0

319709                 1          2        7.0       1              0

319725                 0          1        5.0       1              0

319777                 0          2        7.0       0              0

319794                 1          2        8.0       0              0


        SkinCancer
32               0
57               0
90               1
105              0
107              0
...            ...
319693           0
319709           0
319725           0
319777           0
319794           0
```

```
[10396 rows x 18 columns]

#removing
# Remove outliers by filtering the data within the bounds
heart_cleaned = heart[(heart['BMI'] >= lower_bound) & (heart['BMI'] <=
upper_bound)]

# Display the cleaned dataset
print("Data after removing outliers:\n", heart_cleaned.head())

Data after removing outliers:
    HeartDisease    BMI  Smoking  AlcoholDrinking  Stroke
PhysicalHealth  \
0              0  16.60        1                0       0
3.0
1              0  20.34        0                0       1
0.0
2              0  26.58        1                0       0
20.0
3              0  24.21        0                0       0
0.0
4              0  23.71        0                0       0
28.0

   MentalHealth  DiffWalking  Sex  AgeCategory  Race  Diabetic  \
0          30.0            0    0            7     5         2
1           0.0            0    0           12     5         0
2          30.0            0    1            9     5         2
3           0.0            0    0           11     5         0
4           0.0            1    0            4     5         0

   PhysicalActivity  GenHealth  SleepTime  Asthma  KidneyDisease
SkinCancer
0                 1          4        5.0       1              0
1
1                 1          4        7.0       0              0
0
2                 1          1        8.0       1              0
0
3                 0          2        6.0       0              0
1
4                 1          4        8.0       0              0
0

#Normalization

# Select all numerical columns including 'float64'
numerical_columns = heart.select_dtypes(include=['float64']).columns

# Apply Min-Max scaling or Standardization to all numerical columns
```

```
from sklearn.preprocessing import MinMaxScaler

scaler = MinMaxScaler()
heart[numerical_columns] =
scaler.fit_transform(heart[numerical_columns])

print(heart.dtypes)
```

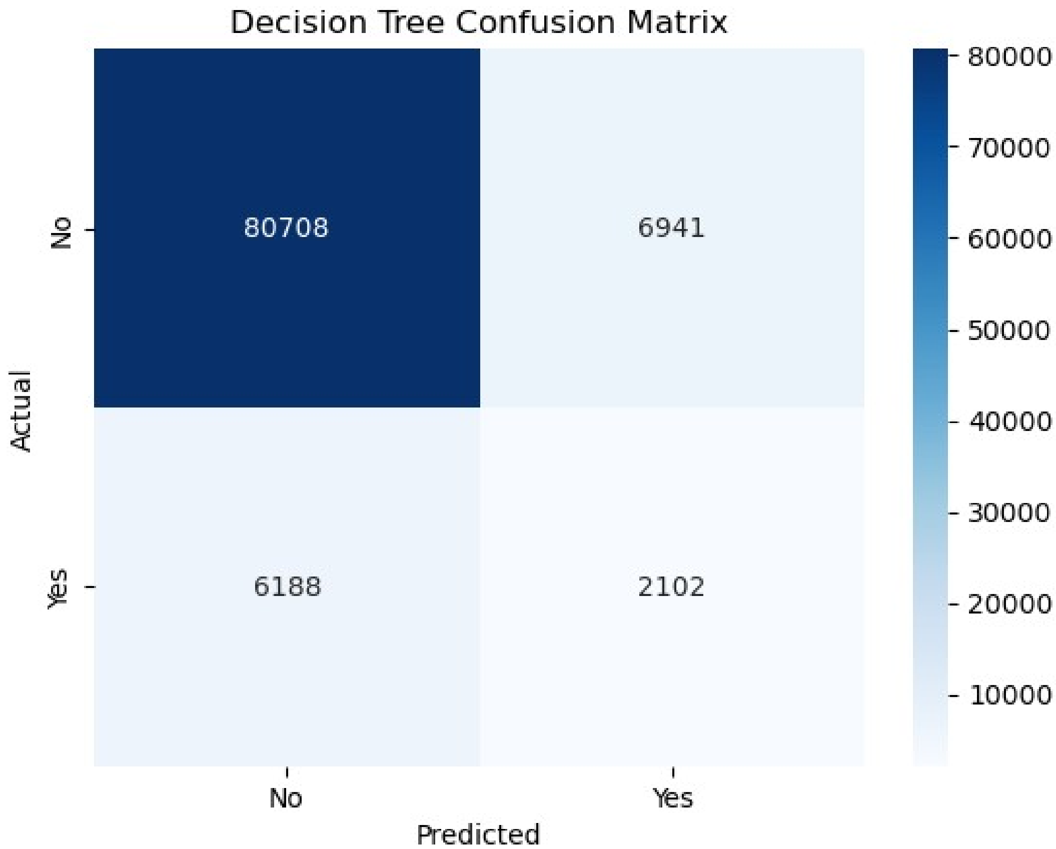
```
HeartDisease          int32
BMI                 float64
Smoking               int32
AlcoholDrinking       int32
Stroke                int32
PhysicalHealth      float64
MentalHealth        float64
DiffWalking           int32
Sex                   int32
AgeCategory           int32
Race                  int32
Diabetic              int32
PhysicalActivity      int32
GenHealth             int32
SleepTime           float64
Asthma                int32
KidneyDisease         int32
SkinCancer            int32
dtype: object
```

Apply decision tree

```
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import confusion_matrix, accuracy_score,
classification_report
import seaborn as sns
import matplotlib.pyplot as plt

# Split the dataset into features (X) and target (y)
X = heart.drop('HeartDisease', axis=1)  # Features
y = heart['HeartDisease']  # Target variable

# Split the dataset into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.3, random_state=42)

# Initialize the Decision Tree Classifier
dt_classifier = DecisionTreeClassifier(random_state=42)
```

```python
# Fit the model on the training data
dt_classifier.fit(X_train, y_train)

# Make predictions
y_pred_dt = dt_classifier.predict(X_test)

# Evaluate the model
dt_accuracy = accuracy_score(y_test, y_pred_dt)
dt_conf_matrix = confusion_matrix(y_test, y_pred_dt)

# Display results
print("Decision Tree Accuracy: ", dt_accuracy)
print("Classification Report:\n", classification_report(y_test,
y_pred_dt))

# Plot Confusion Matrix (Heatmap)
sns.heatmap(dt_conf_matrix, annot=True, fmt='d', cmap='Blues',
            xticklabels=['No', 'Yes'], yticklabels=['No', 'Yes'])
plt.title('Decision Tree Confusion Matrix')
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.show()
```

```
Decision Tree Accuracy:  0.8631526282325227
Classification Report:
               precision    recall  f1-score   support

           0       0.93      0.92      0.92     87649
           1       0.23      0.25      0.24      8290

    accuracy                           0.86     95939
   macro avg       0.58      0.59      0.58     95939
weighted avg       0.87      0.86      0.87     95939
```

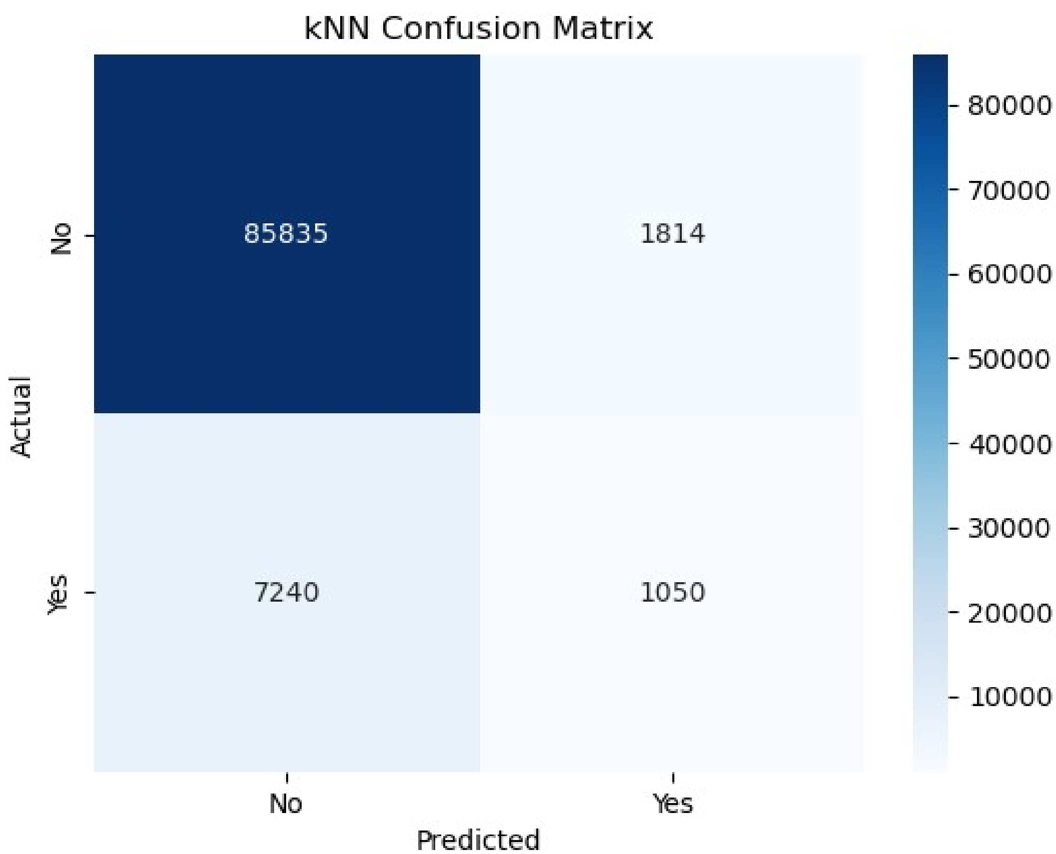


KNN

```
from sklearn.neighbors import KNeighborsClassifier

# Initialize the kNN classifier
knn_classifier = KNeighborsClassifier(n_neighbors=5)

# Fit the model on the training data
knn_classifier.fit(X_train, y_train)

# Make predictions
y_pred_knn = knn_classifier.predict(X_test)

# Evaluate the model
knn_accuracy = accuracy_score(y_test, y_pred_knn)
knn_conf_matrix = confusion_matrix(y_test, y_pred_knn)

# Display results
print("kNN Accuracy: ", knn_accuracy)
print("Classification Report:\n", classification_report(y_test,
y_pred_knn))
```

```python
# Plot Confusion Matrix (Heatmap)
sns.heatmap(knn_conf_matrix, annot=True, fmt='d', cmap='Blues',
xticklabels=['No', 'Yes'], yticklabels=['No', 'Yes'])
plt.title('kNN Confusion Matrix')
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.show()
```

```
kNN Accuracy:  0.9056275341623323
Classification Report:
               precision    recall  f1-score   support

           0       0.92      0.98      0.95     87649
           1       0.37      0.13      0.19      8290

    accuracy                           0.91     95939
   macro avg       0.64      0.55      0.57     95939
weighted avg       0.87      0.91      0.88     95939
```




```python
#Conaprison ROC
from sklearn.metrics import roc_curve, auc
import matplotlib.pyplot as plt
```

```
# Compute ROC curve for Decision Tree
fpr_dt, tpr_dt, _ = roc_curve(y_test,
dt_classifier.predict_proba(X_test)[:, 1])
roc_auc_dt = auc(fpr_dt, tpr_dt)

# Compute ROC curve for kNN
fpr_knn, tpr_knn, _ = roc_curve(y_test,
knn_classifier.predict_proba(X_test)[:, 1])
roc_auc_knn = auc(fpr_knn, tpr_knn)

# Plot ROC curves for both models
plt.figure(figsize=(10, 6))
plt.plot(fpr_dt, tpr_dt, color='blue', lw=2, label=f'Decision Tree
(AUC = {roc_auc_dt:.2f})')
plt.plot(fpr_knn, tpr_knn, color='green', lw=2, label=f'kNN (AUC =
{roc_auc_knn:.2f})')
plt.plot([0, 1], [0, 1], color='gray', linestyle='--')  # Random
classifier line
plt.title('Receiver Operating Characteristic (ROC) Curve')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.legend(loc='lower right')
plt.grid(True)
plt.show()
```