```
import pandas as pd
import numpy as np
```

```
df = pd.read_csv("/content/Heart_Disease_Prediction.csv")
```

```
print("first 5 rows:\n", df.head(), "\n")
print("first 5 rows:\n", df.tail(), "\n")
```

```
first 5 rows:
    Age  Sex  Chest pain type   BP  Cholesterol  FBS over 120  EKG results  \
0   70    1                4  130          322             0            2
1   67    0                3  115          564             0            2
2   57    1                2  124          261             0            0
3   64    1                4  128          263             0            0
4   74    0                2  120          269             0            2

   Max HR  Exercise angina  ST depression  Slope of ST  \
0     109                0            2.4            2
1     160                0            1.6            2
2     141                0            0.3            1
3     105                1            0.2            2
4     121                1            0.2            1

   Number of vessels fluro  Thallium Heart Disease
0                        3         3      Presence
1                        0         7       Absence
2                        0         7      Presence
3                        1         7       Absence
4                        1         3       Absence

first 5 rows:
      Age  Sex  Chest pain type   BP  Cholesterol  FBS over 120  EKG results  \
265   52    1                3  172          199             1            0
266   44    1                2  120          263             0            0
267   56    0                2  140          294             0            2
268   57    1                4  140          192             0            0
269   67    1                4  160          286             0            2

     Max HR  Exercise angina  ST depression  Slope of ST  \
265     162                0            0.5            1
266     173                0            0.0            1
267     153                0            1.3            2
268     148                0            0.4            2
269     108                1            1.5            2

     Number of vessels fluro  Thallium Heart Disease
265                        0         7       Absence
266                        0         7       Absence
267                        0         3       Absence
268                        0         6       Absence
269                        3         3      Presence
```

```
print("Shape of dataset is: ", df.shape, "\n")
```

```
Shape of dataset is:  (270, 14)
```

```
print("column names:\n", df.columns.tolist())
```

```
column names:
 ['Age', 'Sex', 'Chest pain type', 'BP', 'Cholesterol', 'FBS over 120', 'EKG results', 'Max HR', 'Exercise angina', 'ST depressi
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 270 entries, 0 to 269
Data columns (total 14 columns):
 #   Column                    Non-Null Count  Dtype
---  ------                    --------------  -----
 0   Age                       270 non-null    int64
 1   Sex                       270 non-null    int64
 2   Chest pain type           270 non-null    int64
 3   BP                        270 non-null    int64
 4   Cholesterol               270 non-null    int64
 5   FBS over 120              270 non-null    int64
 6   EKG results               270 non-null    int64
```

```
 7   Max HR                   270 non-null    int64
 8   Exercise angina          270 non-null    int64
 9   ST depression            270 non-null    float64
 10  Slope of ST              270 non-null    int64
 11  Number of vessels fluro  270 non-null    int64
 12  Thallium                 270 non-null    int64
 13  Heart Disease            270 non-null    object
dtypes: float64(1), int64(12), object(1)
memory usage: 29.7+ KB
```

```
numerical_features = df.select_dtypes(include=[np.number]).columns.tolist()
categorial_features = df.select_dtypes(exclude=[np.number]).columns.tolist()
print("\nNumerical Features:")
print(numerical_features)
print("\nCategorial Features:")
print(categorial_features)
```

```
Numerical Features:
['Age', 'Sex', 'Chest pain type', 'BP', 'Cholesterol', 'FBS over 120', 'EKG results', 'Max HR', 'Exercise angina', 'ST depressio

Categorial Features:
['Heart Disease']
```

```
print("Data types and non-null counts:")
df.info()
```

```
Data types and non-null counts:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 270 entries, 0 to 269
Data columns (total 14 columns):
 #   Column                   Non-Null Count  Dtype
---  ------                   --------------  -----
 0   Age                      270 non-null    int64
 1   Sex                      270 non-null    int64
 2   Chest pain type          270 non-null    int64
 3   BP                       270 non-null    int64
 4   Cholesterol              270 non-null    int64
 5   FBS over 120             270 non-null    int64
 6   EKG results              270 non-null    int64
 7   Max HR                   270 non-null    int64
 8   Exercise angina          270 non-null    int64
 9   ST depression            270 non-null    float64
 10  Slope of ST              270 non-null    int64
 11  Number of vessels fluro  270 non-null    int64
 12  Thallium                 270 non-null    int64
 13  Heart Disease            270 non-null    object
dtypes: float64(1), int64(12), object(1)
memory usage: 29.7+ KB
```

```
print("\nMissing values per column:")
print(df.isnull().sum())
```

```
Missing values per column:
Age                       0
Sex                       0
Chest pain type           0
BP                        0
Cholesterol               0
FBS over 120              0
EKG results               0
Max HR                    0
Exercise angina           0
ST depression             0
Slope of ST               0
Number of vessels fluro   0
Thallium                  0
Heart Disease             0
dtype: int64
```

```
print("Statistical summary of the dataset:")
print(df.describe())
```

```
Statistical summary of the dataset:
              Age         Sex  Chest pain type          BP  Cholesterol  \
count  270.000000  270.000000       270.000000  270.000000   270.000000
mean    54.433333    0.677778         3.174074  131.344444   249.659259
std      9.109067    0.468195         0.950090   17.861608    51.686237
min     29.000000    0.000000         1.000000   94.000000   126.000000
```

```
25%     48.000000    0.000000         3.000000  120.000000   213.000000
50%     55.000000    1.000000         3.000000  130.000000   245.000000
75%     61.000000    1.000000         4.000000  140.000000   280.000000
max     77.000000    1.000000         4.000000  200.000000   564.000000

       FBS over 120  EKG results      Max HR  Exercise angina  ST depression  \
count    270.000000   270.000000  270.000000       270.000000      270.00000
mean       0.148148     1.022222  149.677778         0.329630        1.05000
std        0.355906     0.997891   23.165717         0.470952        1.14521
min        0.000000     0.000000   71.000000         0.000000        0.00000
25%        0.000000     0.000000  133.000000         0.000000        0.00000
50%        0.000000     2.000000  153.500000         0.000000        0.80000
75%        0.000000     2.000000  166.000000         1.000000        1.60000
max        1.000000     2.000000  202.000000         1.000000        6.20000

       Slope of ST  Number of vessels fluro    Thallium
count   270.000000               270.000000  270.000000
mean      1.585185                 0.670370    4.696296
std       0.614390                 0.943896    1.940659
min       1.000000                 0.000000    3.000000
25%       1.000000                 0.000000    3.000000
50%       2.000000                 0.000000    3.000000
75%       2.000000                 1.000000    7.000000
max       3.000000                 3.000000    7.000000
```

```
print("Mean Age:", df['Age'].mean())
print("Median Age:", df['Age'].median())
print("Standard Deviation of Age:", df['Age'].std())
```

```
Mean Age: 54.43333333333333
Median Age: 55.0
Standard Deviation of Age: 9.109066523898203
```

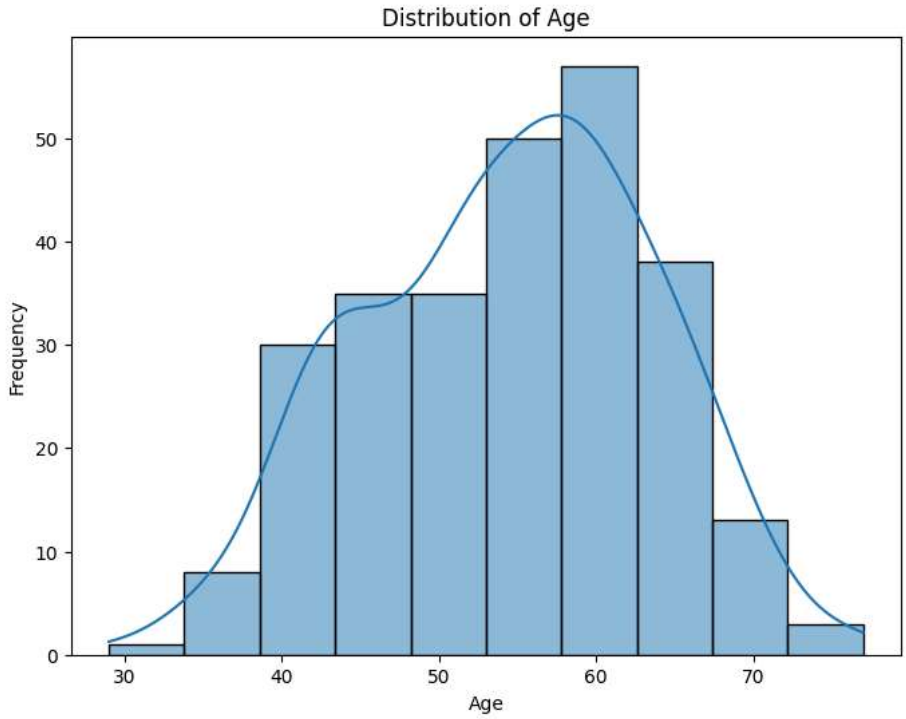
```
print("Minimum Cholesterol:", df['Cholesterol'].min())
print("Maximum Cholesterol:", df['Cholesterol'].max())
```

```
Minimum Cholesterol: 126
Maximum Cholesterol: 564
```

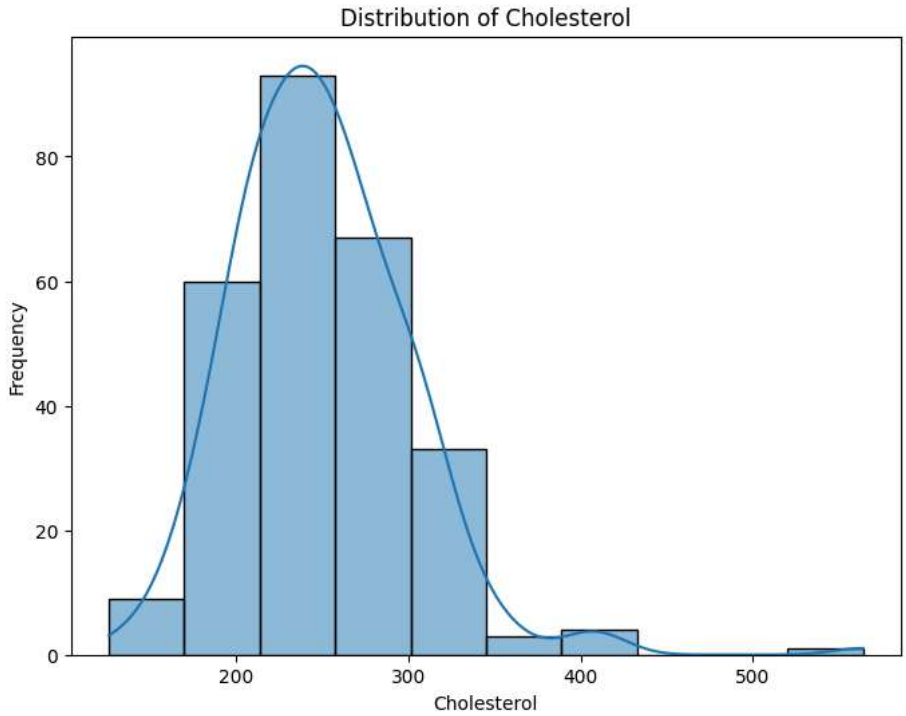
```
print("Count of patients with and without heart disease:")
print(df['Heart Disease'].value_counts())
```

```
Count of patients with and without heart disease:
Heart Disease
Absence     150
Presence    120
Name: count, dtype: int64
```

```
import matplotlib.pyplot as plt
import seaborn as sns

plt.figure(figsize=(8, 6))
sns.histplot(df['Age'], kde=True, bins=10)
plt.title('Distribution of Age')
plt.xlabel('Age')
plt.ylabel('Frequency')
plt.show()
```




```
import matplotlib.pyplot as plt
import seaborn as sns

plt.figure(figsize=(8, 6))
sns.histplot(df['Cholesterol'], kde=True, bins=10)
plt.title('Distribution of Cholesterol')
plt.xlabel('Cholesterol')
plt.ylabel('Frequency')
plt.show()
```




```
correlation_matrix = df[numerical_features].corr()
print("Correlation Matrix:")
print(correlation_matrix)
```

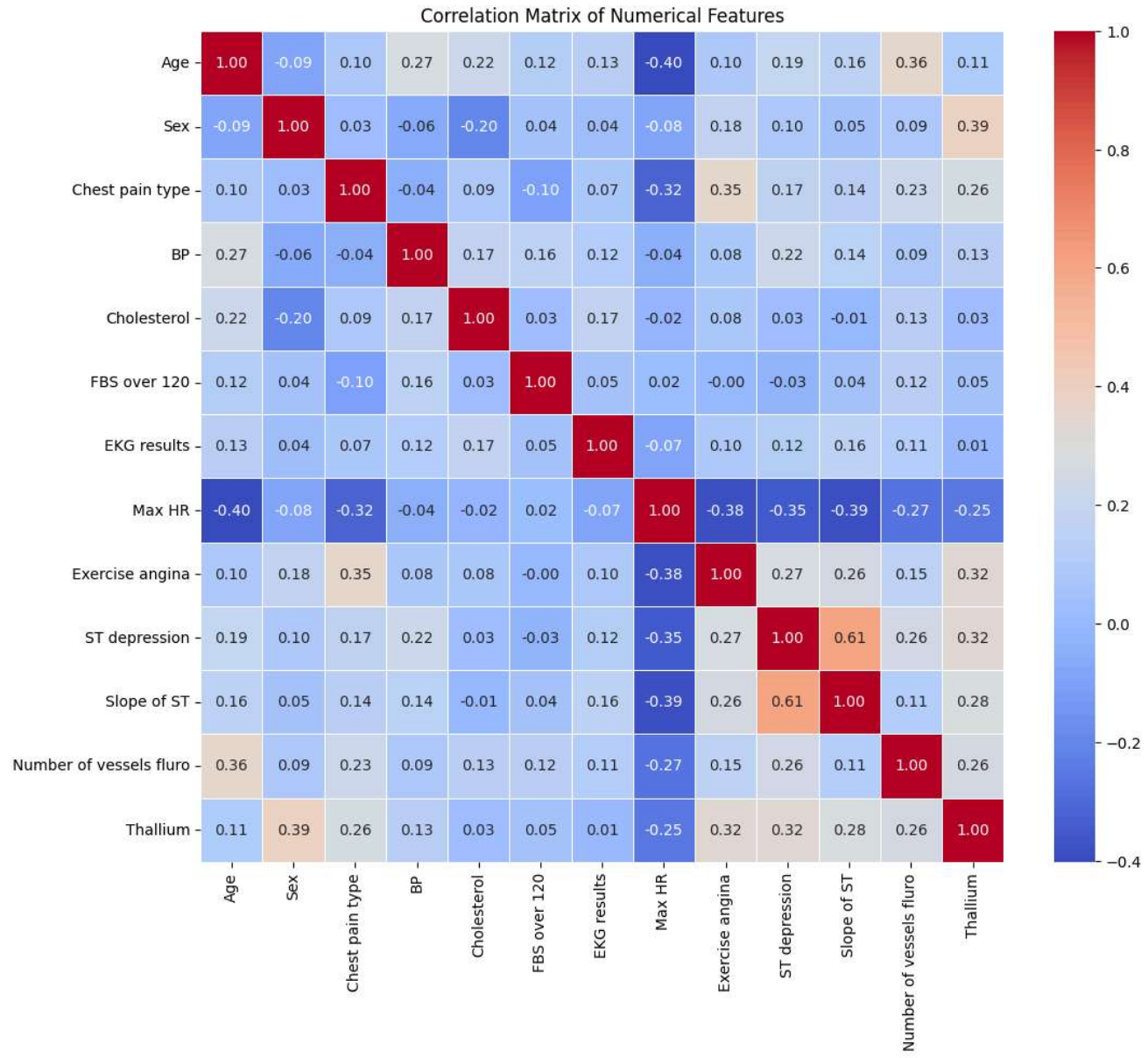
```
Chest pain type          0.096920  0.034636         1.000000 -0.043196
BP                       0.273053 -0.062693        -0.043196  1.000000
Cholesterol              0.220056 -0.201647         0.090465  0.173019
FBS over 120             0.123458  0.042140        -0.098537  0.155681
EKG results              0.128171  0.039253         0.074325  0.116157
Max HR                  -0.402215 -0.076101        -0.317682 -0.039136
Exercise angina          0.098297  0.180022         0.353160  0.082793
ST depression            0.194234  0.097412         0.167244  0.222800
Slope of ST              0.159774  0.050545         0.136900  0.142472
Number of vessels fluro  0.356081  0.086830         0.225890  0.085697
Thallium                 0.106100  0.391046         0.262659  0.132045

                         Cholesterol  FBS over 120  EKG results    Max HR  \
Age                         0.220056      0.123458     0.128171 -0.402215
Sex                        -0.201647      0.042140     0.039253 -0.076101
Chest pain type             0.090465     -0.098537     0.074325 -0.317682
BP                          0.173019      0.155681     0.116157 -0.039136
Cholesterol                 1.000000      0.025186     0.167652 -0.018739
FBS over 120                0.025186      1.000000     0.053499  0.022494
EKG results                 0.167652      0.053499     1.000000 -0.074628
Max HR                     -0.018739      0.022494    -0.074628  1.000000
Exercise angina             0.078243     -0.004107     0.095098 -0.380719
ST depression               0.027709     -0.025538     0.120034 -0.349045
Slope of ST                -0.005755      0.044076     0.160614 -0.386847
Number of vessels fluro     0.126541      0.123774     0.114368 -0.265333
Thallium                    0.028836      0.049237     0.007337 -0.253397

                         Exercise angina  ST depression  Slope of ST  \
Age                             0.098297       0.194234     0.159774
Sex                             0.180022       0.097412     0.050545
Chest pain type                 0.353160       0.167244     0.136900
BP                              0.082793       0.222800     0.142472
Cholesterol                     0.078243       0.027709    -0.005755
FBS over 120                   -0.004107      -0.025538     0.044076
EKG results                     0.095098       0.120034     0.160614
Max HR                         -0.380719      -0.349045    -0.386847
Exercise angina                 1.000000       0.274672     0.255908
ST depression                   0.274672       1.000000     0.609712
Slope of ST                     0.255908       0.609712     1.000000
Number of vessels fluro         0.153347       0.255005     0.109498
Thallium                        0.321449       0.324333     0.283678

                         Number of vessels fluro  Thallium
Age                                     0.356081  0.106100
Sex                                     0.086830  0.391046
Chest pain type                         0.225890  0.262659
BP                                      0.085697  0.132045
Cholesterol                             0.126541  0.028836
FBS over 120                            0.123774  0.049237
EKG results                             0.114368  0.007337
Max HR                                 -0.265333 -0.253397
Exercise angina                         0.153347  0.321449
ST depression                           0.255005  0.324333
Slope of ST                             0.109498  0.283678
Number of vessels fluro                 1.000000  0.255648
Thallium                                0.255648  1.000000
```

```
high_corr_pairs = []
for i in range(len(correlation_matrix.columns)):
    for j in range(i):
        if abs(correlation_matrix.iloc[i, j]) > 0.7:
            col1 = correlation_matrix.columns[i]
            col2 = correlation_matrix.columns[j]
            correlation = correlation_matrix.iloc[i, j]
            high_corr_pairs.append((col1, col2, correlation))

print("Pairs of variables with absolute correlation > 0.7:")
if high_corr_pairs:
    for pair in high_corr_pairs:
        print(f"{pair[0]} - {pair[1]}: {pair[2]:.4f}")
else:
    print("No pairs found with absolute correlation greater than 0.7.")
```

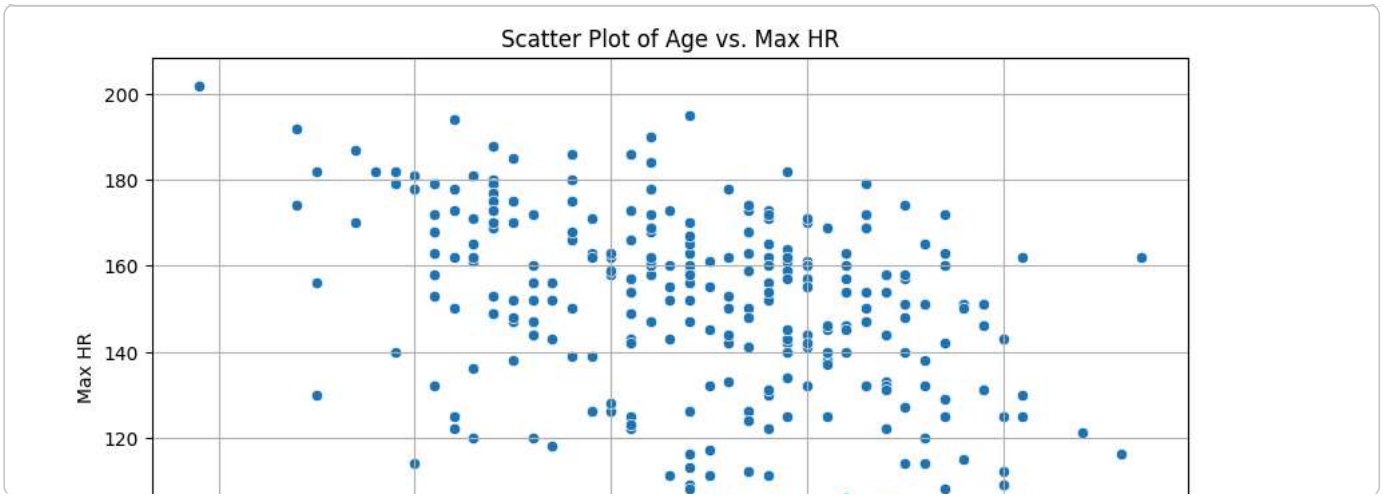
```
Pairs of variables with absolute correlation > 0.7:
No pairs found with absolute correlation greater than 0.7.
```

```
import matplotlib.pyplot as plt
import seaborn as sns

plt.figure(figsize=(12, 10))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', fmt=".2f", linewidths=.5)
```

```
plt.title('Correlation Matrix of Numerical Features')
plt.show()
```




```
import matplotlib.pyplot as plt
import seaborn as sns

plt.figure(figsize=(10, 6))
sns.scatterplot(data=df, x='Age', y='Max HR')
plt.title('Scatter Plot of Age vs. Max HR')
plt.xlabel('Age')
plt.ylabel('Max HR')
plt.grid(True)
plt.show()
```


Scatter Plot of Age vs. Max HR
Max HR
200
180
160
140
120