```
import pandas as pd
import numpy as np
df=pd.read_csv("/content/Heart_Disease_Prediction.csv")
```

```
print(df.head)
```

```
<bound method NDFrame.head of      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
..   ...  ...              ...  ...          ...           ...          ...
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  \
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
..      ...              ...            ...          ...
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
0                          3         3      Presence
1                          0         7       Absence
2                          0         7      Presence
3                          1         7       Absence
4                          1         3       Absence
..                       ...       ...           ...
265                        0         7       Absence
266                        0         7       Absence
267                        0         3       Absence
268                        0         6       Absence
269                        3         3      Presence

[270 rows x 14 columns]>
```

```
df.shape
```

```
(270, 14)
```

```
df.columns
```

```
Index(['Age', 'Sex', 'Chest pain type', 'BP', 'Cholesterol', 'FBS over 120',
       'EKG results', 'Max HR', 'Exercise angina', 'ST depression',
```

```
       'Slope of ST', 'Number of vessels fluro', 'Thallium', 'Heart Disease'],
      dtype='object')
```

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

```

Numerical Features:
['Age', 'Sex', 'Chest pain type', 'BP', 'Cholesterol', 'FBS over 120', 'EKG results', 'Max HR', 'Exercise angina', 'ST depression', 'Slope of ST', 'Number of vessels fl
```

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

```

Missing values in each 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
```

```
df.describe()
```

```
df.describe()
```

	Age	Sex	Chest pain type	BP	Cholesterol	FBS over 120	EKG results	Max HR	Exercise angina	ST depression	Slope of ST	Number of vessels fluro	Thallium
count	270.000000	270.000000	270.000000	270.000000	270.000000	270.000000	270.000000	270.000000	270.000000	270.00000	270.000000	270.000000	270.000000
mean	54.433333	0.677778	3.174074	131.344444	249.659259	0.148148	1.022222	149.677778	0.329630	1.05000	1.585185	0.670370	4.696296
std	9.109067	0.468195	0.950090	17.861608	51.686237	0.355906	0.997891	23.165717	0.470952	1.14521	0.614390	0.943896	1.940659
min	29.000000	0.000000	1.000000	94.000000	126.000000	0.000000	0.000000	71.000000	0.000000	0.00000	1.000000	0.000000	3.000000
25%	48.000000	0.000000	3.000000	120.000000	213.000000	0.000000	0.000000	133.000000	0.000000	0.00000	1.000000	0.000000	3.000000
50%	55.000000	1.000000	3.000000	130.000000	245.000000	0.000000	2.000000	153.500000	0.000000	0.80000	2.000000	0.000000	3.000000
75%	61.000000	1.000000	4.000000	140.000000	280.000000	0.000000	2.000000	166.000000	1.000000	1.60000	2.000000	1.000000	7.000000

```
age_mean=df['Age'].mean()
age_median=df['Age'].median()
age_std=df['Age'].std()
print(f"Mean Age: {age_mean:.2f}")
print(f"Median Age: {age_median:.2f}")
print(f"Standard Deviation of Age: {age_std:.2f}")
```

```
Mean Age: 54.43
Median Age: 55.00
Standard Deviation of Age: 9.11
```

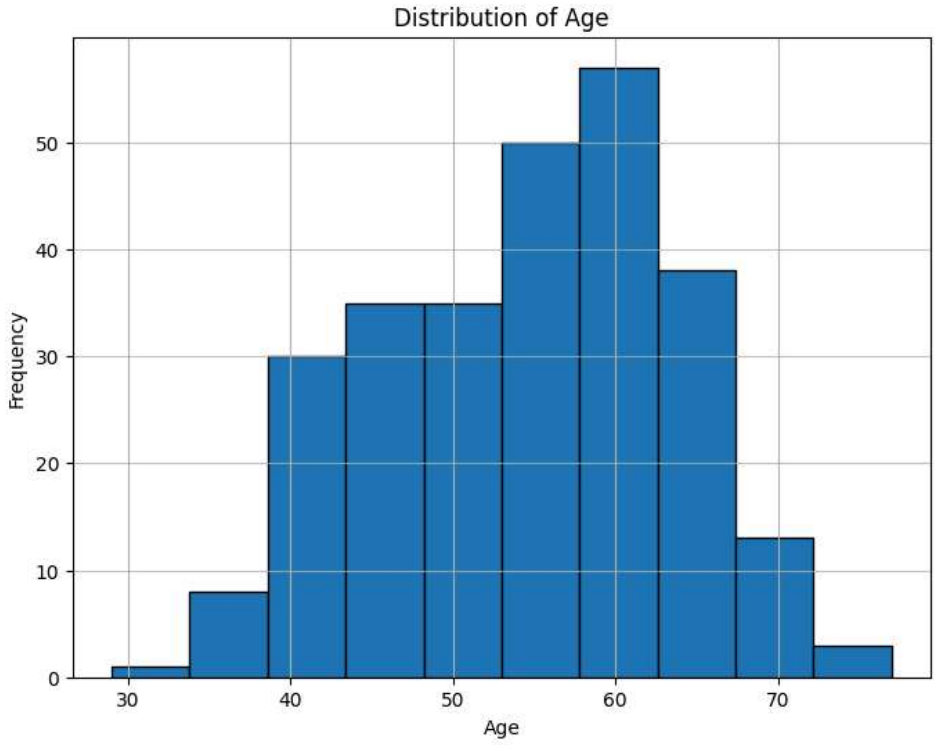
```
min_cholesterol=df['Cholesterol'].min()
max_cholesterol=df['Cholesterol'].max()
print(f"Minimum Cholesterol: {min_cholesterol}")
print(f"Maximum Cholesterol: {max_cholesterol}")
```

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

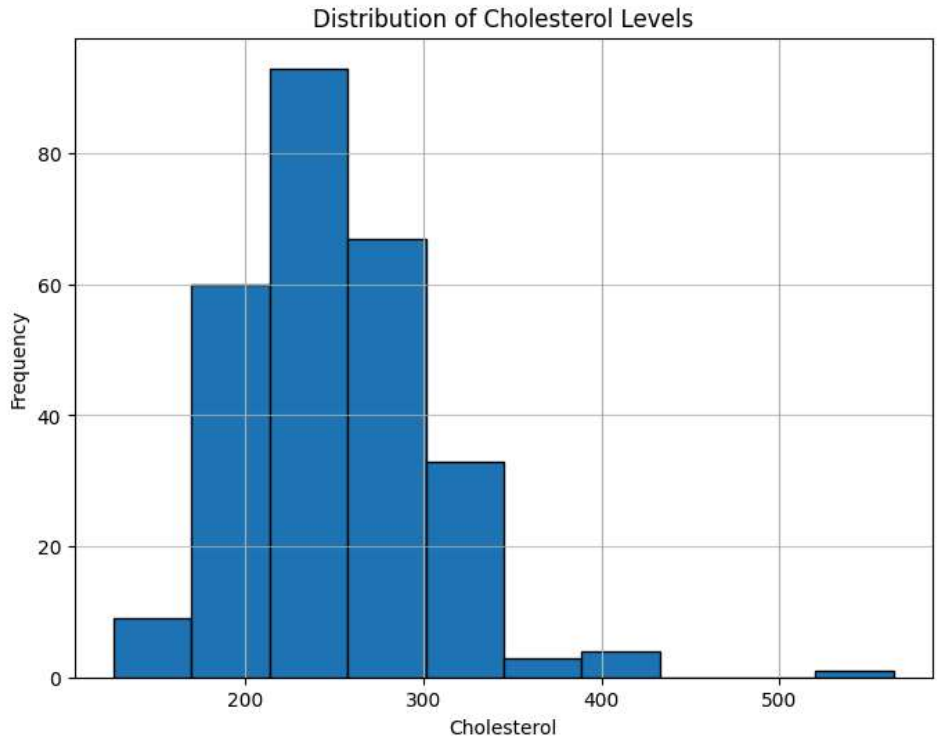
```
heart_disease_counts=df['Heart Disease'].value_counts()
print("Number of patients with and without heart disease:\n",
heart_disease_counts)
```

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

```
import matplotlib.pyplot as plt
plt.figure(figsize=(8, 6))
df['Age'].hist(bins=10, edgecolor='black')
plt.title('Distribution of Age')
plt.xlabel('Age')
plt.ylabel('Frequency')
plt.grid(axis='y', alpha=0.75)
plt.show()
```




```
import matplotlib.pyplot as plt
plt.figure(figsize=(8, 6))
df['Cholesterol'].hist(bins=10, edgecolor='black')
plt.title('Distribution of Cholesterol Levels')
plt.xlabel('Cholesterol')
plt.ylabel('Frequency')
plt.grid(axis='y', alpha=0.75)
plt.show()
```




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

```
Age                      1.000000 -0.094401         0.096920  0.273053
Sex                     -0.094401  1.000000         0.034636 -0.062693
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



Exercise angina             0.070343      0.004197     0.005008 -0.380710
```

```
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
```

```
correlation_threshold=0.7
highly_correlated_pairs=[]
# Iterate through the correlation matrix
# Using .abs() to consider both strong positive and strong negative correlations
# Using .unstack() to convert the matrix into a Series for easier filtering
# Filtering out self-correlations and duplicate pairs
for col1 in correlation_matrix.columns:
  for col2 in correlation_matrix.columns:
    if col1 != col2 and abs(correlation_matrix.loc[col1, col2]) > correlation_threshold:
    # Add only one instance of the pair (e.g., 'A'-'B' but not 'B'-'A')
      if (col2, col1, correlation_matrix.loc[col2, col1]) not in highly_correlated_pairs:
        highly_correlated_pairs.append((col1, col2, correlation_matrix.loc[col1, col2]))
if highly_correlated_pairs:
  print(f"Highly correlated variable pairs (absolute correlation > {correlation_threshold}):")
  for pair in highly_correlated_pairs:
    print(f"-{pair[0]} and {pair[1]}: {pair[2]:.4f}")
else:
  print(f"No highly correlated variable pairs found with an absolute correlation greater than {correlation_threshold}.")
```

```
No highly correlated variable pairs found with an absolute correlation greater than 0.7.
```

```
import matplotlib.pyplot as plt
plt.figure(figsize=(10, 6))
plt.scatter(df['Age'], df['Max HR'], alpha=0.7)
```

```
plt.scatter(df['Age'], df['Max HR'], alpha=0.7)
plt.title('Age vs. Maximum Heart Rate')
plt.xlabel('Age')
plt.ylabel('Maximum Heart Rate')
plt.grid(True)
plt.show()
```