HeartDiseaseDataset

June 16, 2025

[ ]:
```
# Hello, We're going to start working with Heart Disease Dataset, You
  ↪can find it here:
# https://www.kaggle.com/datasets/johnsmith88/heart-disease-dataset/
  ↪data


# Here are the arributes of the dataset:

# age
# sex
# chest pain type (4 values)
# resting blood pressure
# serum cholestoral in mg/dl
# fasting blood sugar > 120 mg/dl
# resting electrocardiographic results (values 0,1,2)
# maximum heart rate achieved
# exercise induced angina
# oldpeak = ST depression induced by exercise relative to rest
# the slope of the peak exercise ST segment
# number of major vessels (0-3) colored by flourosopy
# thal: 0 = normal; 1 = fixed defect; 2 = reversable defect
# target: Presence of heart disease (1 = yes, 0 = no).


# What you're to learn in this notebook:
# 1. How to load the dataset
# 2. How to explore the dataset
# 3. How to visualize the dataset

# Particularly, We will be seeing different techniques to analyze the
  ↪dataset, including:
# Univariate Analysis
# Bivariate Analysis
# Multivariate Analysis
```

[242]:
```
# importing libraries
import pandas as pd
```

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

[243]:
```
# Loading the dataset

df = pd.read_csv('C:
  ↪\\Users\\nikrc\\OneDrive\\Desktop\\Datasets\\heart.csv')
# TO show all columns in the dataset
pd.set_option('display.max_columns',None)

# Blocking the warnings
import warnings
warnings.filterwarnings('ignore')


df.head(10)
```

[243]:

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope
0	52	1	0	125	212	0	1	168	0	1.0	2
1	53	1	0	140	203	1	0	155	1	3.1	0
2	70	1	0	145	174	0	1	125	1	2.6	0
3	61	1	0	148	203	0	1	161	0	0.0	2
4	62	0	0	138	294	1	1	106	0	1.9	1
5	58	0	0	100	248	0	0	122	0	1.0	1
6	58	1	0	114	318	0	2	140	0	4.4	0
7	55	1	0	160	289	0	0	145	1	0.8	1
8	46	1	0	120	249	0	0	144	0	0.8	2
9	54	1	0	122	286	0	0	116	1	3.2	1

	ca	thal	target
0	2	3	0
1	0	3	0
2	0	3	0
3	1	3	0
4	3	2	0
5	0	2	1
6	3	1	0
7	1	3	0
8	0	3	0
9	2	2	0

[244]:
```
# Before we proceed with EDA , It's necessary to understand our
  ↪dataset better.
```

[245]:
```
# Let's understand the shape of the dataset
print(f"The number of rows and columns in the dataset is: {df.
  ↪shape[0], df.shape[1]}")
```

```
The number of rows and columns in the dataset is: (1025, 14)
```

[246]:
```
# Descriptive statistics of the dataset
print("Descriptive statistics of the dataset:")
df.describe().T
```

```
Descriptive statistics of the dataset:
```

[246]:

	count	mean	std	min	25%	50%	75%	max
age	1025.0	54.434146	9.072290	29.0	48.0	56.0	61.0	77.0
sex	1025.0	0.695610	0.460373	0.0	0.0	1.0	1.0	1.0
cp	1025.0	0.942439	1.029641	0.0	0.0	1.0	2.0	3.0
trestbps	1025.0	131.611707	17.516718	94.0	120.0	130.0	140.0	200.0
chol	1025.0	246.000000	51.592510	126.0	211.0	240.0	275.0	564.0
fbs	1025.0	0.149268	0.356527	0.0	0.0	0.0	0.0	1.0
restecg	1025.0	0.529756	0.527878	0.0	0.0	1.0	1.0	2.0
thalach	1025.0	149.114146	23.005724	71.0	132.0	152.0	166.0	202.0
exang	1025.0	0.336585	0.472772	0.0	0.0	0.0	1.0	1.0
oldpeak	1025.0	1.071512	1.175053	0.0	0.0	0.8	1.8	6.2
slope	1025.0	1.385366	0.617755	0.0	1.0	1.0	2.0	2.0
ca	1025.0	0.754146	1.030798	0.0	0.0	0.0	1.0	4.0
thal	1025.0	2.323902	0.620660	0.0	2.0	2.0	3.0	3.0
target	1025.0	0.513171	0.500070	0.0	0.0	1.0	1.0	1.0

[247]:
```
# What do we understand from the above statistics?

# The dataset contains 303 rows and 14 columns.
# The age of the patients ranges from 29 to 77 years.
# The maximum heart rate achieved is between 71 and 202.
# The target variable 'target' indicates whether a patient has heart
  ↪disease (1) or not (0).
```

[248]:
```
# What are the datatypes of the columns?

print("Datatypes of the columns:")
print(df.dtypes)
```

```
Datatypes of the columns:
age           int64
sex           int64
```

```
cp            int64
trestbps      int64
chol          int64
fbs           int64
restecg       int64
thalach       int64
exang         int64
oldpeak     float64
slope         int64
ca            int64
thal          int64
target        int64
dtype: object
```

[249]:
```
# Checking if there are any missing values in the dataset
df.isnull().sum()
```

[249]:
```
age         0
sex         0
cp          0
trestbps    0
chol        0
fbs         0
restecg     0
thalach     0
exang       0
oldpeak     0
slope       0
ca          0
thal        0
target      0
dtype: int64
```

[250]:
```
# There are no missing values in the dataset

# Now, We can also check for duplicates in the dataset
duplicates = df.duplicated().sum()
print(f"Number of duplicate rows in the dataset: {duplicates}")
```

```
Number of duplicate rows in the dataset: 723
```

[251]:
```
# Removing Duplicates
df.drop_duplicates(inplace=True)
```

[252]:
```
# Here we are going to learn about different types of analysis
  ↪techniques that can be used to analyze the dataset.

# 1. Univariate Analysis:
```

```
# Analysis of a single variable to understand its distribution and basic properties.
# 2. Bivariate Analysis:
# Bivariate analysis involves analyzing the relationship between two variables in the dataset.
# 3. Multivariate Analysis:
# Multivariate analysis involves analyzing the relationship between three or more variables in the dataset.
```

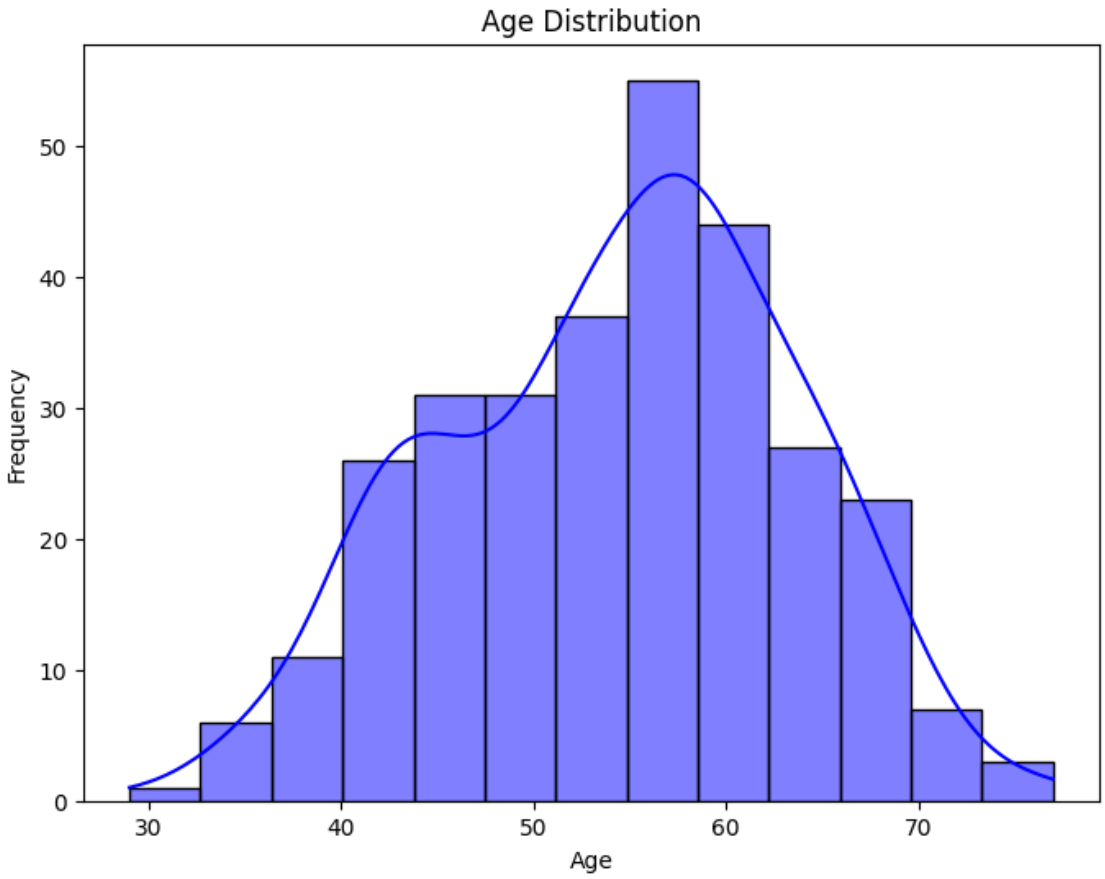
[253]:
```
# Before starting, Let's Divide the dataset into two parts:
# Numerical and Categorical features

# Numerical features
numerical_features = df.select_dtypes(include=['int64', 'float64']).columns.tolist()
# Categorical features
categorical_features = df.select_dtypes(include=['object', 'category']).columns.tolist()

# Why is it important to separate numerical and categorical features?
# Because different analysis techniques are applied to numerical and categorical data.

# Different data types require different visualization techniques.

# This table would help you:

# | Data Type   | Visualization Technique |
# |-------------|-------------------------|
# | Numerical   | Histogram, Boxplot      |
# | Categorical | Bar Chart, Pie Chart    |
# | Time Series | Line Chart              |
# | Text        | Word Cloud, Bar Chart   |


# Let's now print the numerical and categorical features
print("Numerical Features:")
print(numerical_features)
print("\nCategorical Features:")
print(categorical_features)
```

```
Numerical Features:
['age', 'sex', 'cp', 'trestbps', 'chol', 'fbs', 'restecg', 'thalach', 'exang',
'oldpeak', 'slope', 'ca', 'thal', 'target']

Categorical Features:
```

[]

[254]:
```
# As you can see, all the features in the dataset are numerical, but
  ↪age,sex and target are categorical features.
# So, we will treat them as categorical features for the purpose of
  ↪analysis.

# But it will be better to convert 'sex' column to categorical type
  ↪and add another target column with 'Yes' and 'No'
# We're naming that Heart Disease
df['Heart Disease'] = df['target'].apply(lambda x: "Yes" if x == 1
  ↪else "No")

df['sex'] = df['sex'].astype('category')
df['sex'] = df['sex'].apply(lambda x: "M" if x == 1 else "F")
```

[255]:
```
# Univariate Analysis

# Distribution Analysis for age (KDE or Histograms)

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



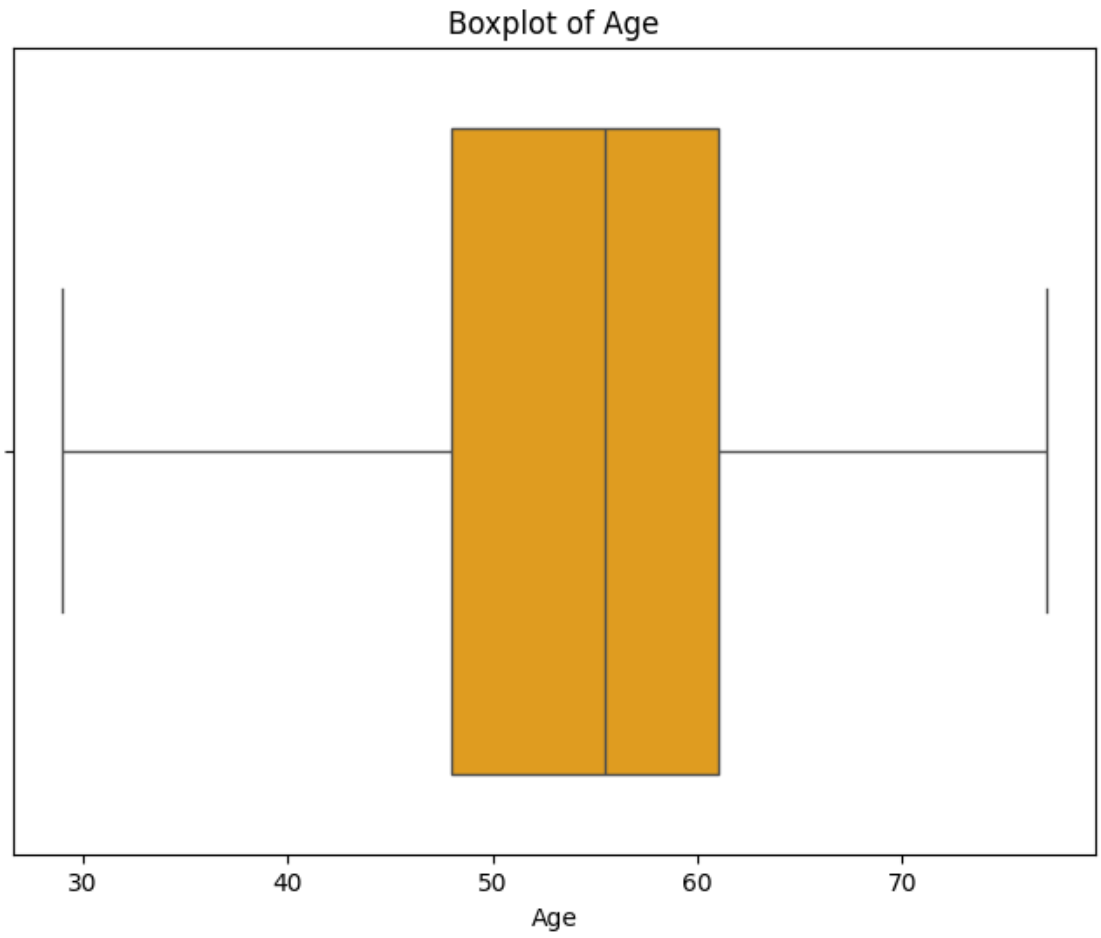
[256]:
```
# What can we observe from the above plot?
# The plot shows that the age distribution is slightly right-skewed,
  ↪with most patients being in their 50s and 60s.
# Mostly concentrated between 40 and 60 years of age.
```

[257]:
```
# Summary Statistics for age
age_summary = df['age'].describe()
print("Summary Statistics for Age: \n",age_summary)

mean_age = df['age'].mean()
median_age = df['age'].median()
std_deviation = df['age'].std()

print()

print(f"Mean Age: {mean_age}")
print(f"Median Age: {median_age}")
print(f"Standard Deviation of Age: {std_deviation}")
```

```
Summary Statistics for Age:
 count    302.00000
mean      54.42053
std        9.04797
min       29.00000
25%       48.00000
50%       55.50000
75%       61.00000
max       77.00000
Name: age, dtype: float64

Mean Age: 54.420529801324506
Median Age: 55.5
Standard Deviation of Age: 9.047969746247457
```

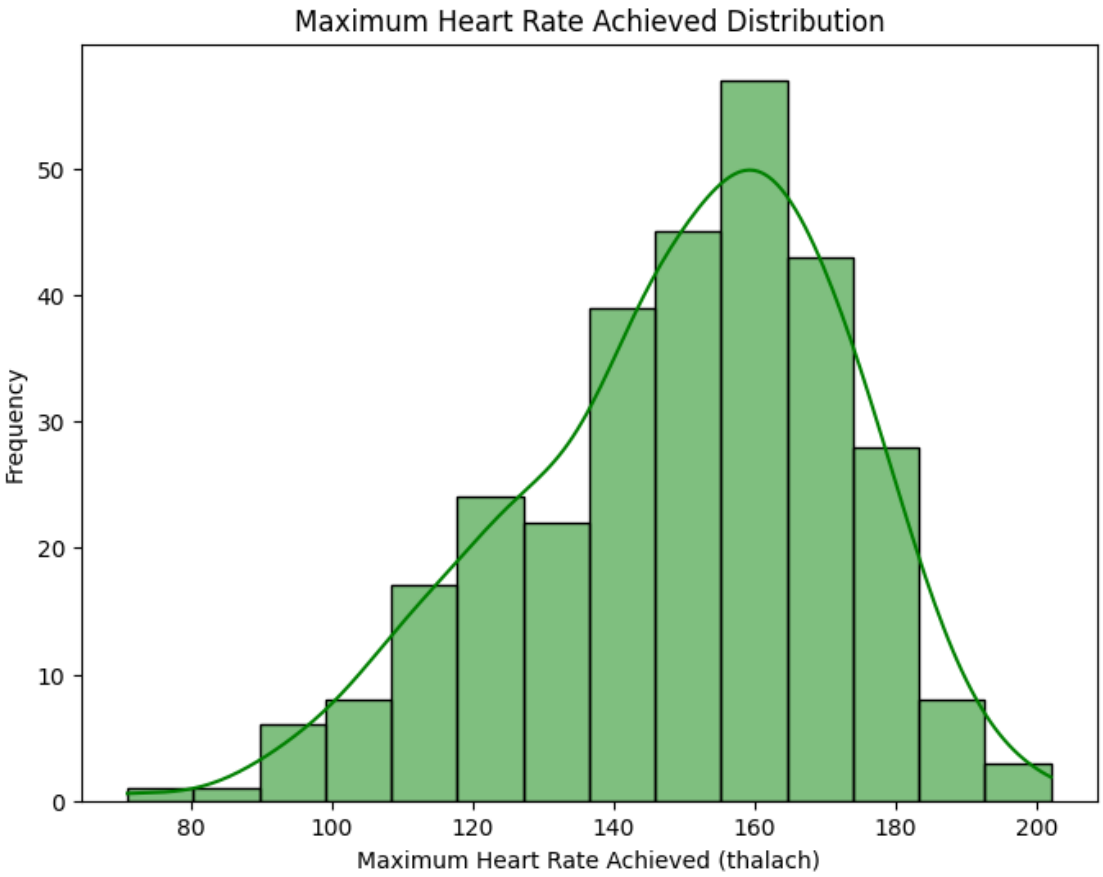
[258]:
```
# What can get from the above statistics?

# This indicates that the ages of the patients are generally around 54
  ↪years, with some variation.
# And the mean and median are close to each other, indicating a
  ↪relatively symmetric distribution.
```

[259]:
```
# Outliers in age
plt.figure(figsize=(8, 6))
sns.boxplot(x = df['age'],color = 'orange')
plt.title('Boxplot of Age')
plt.xlabel('Age')
plt.show()
```



[260]:
```
# There are no outliers in the age column, as the boxplot shows no
  ↪points outside the whiskers.
# You can also use the IQR method to detect outliers in the age
  ↪column, but in this case, there's no need as the boxplot already
  ↪shows no outliers.
```

[261]:
```
# Univariate Analysis for thalach
plt.figure(figsize=(8, 6))
sns.histplot(df['thalach'], kde=True, color='green')
plt.title('Maximum Heart Rate Achieved Distribution')
plt.xlabel('Maximum Heart Rate Achieved (thalach)')
plt.ylabel('Frequency')
plt.show()
```



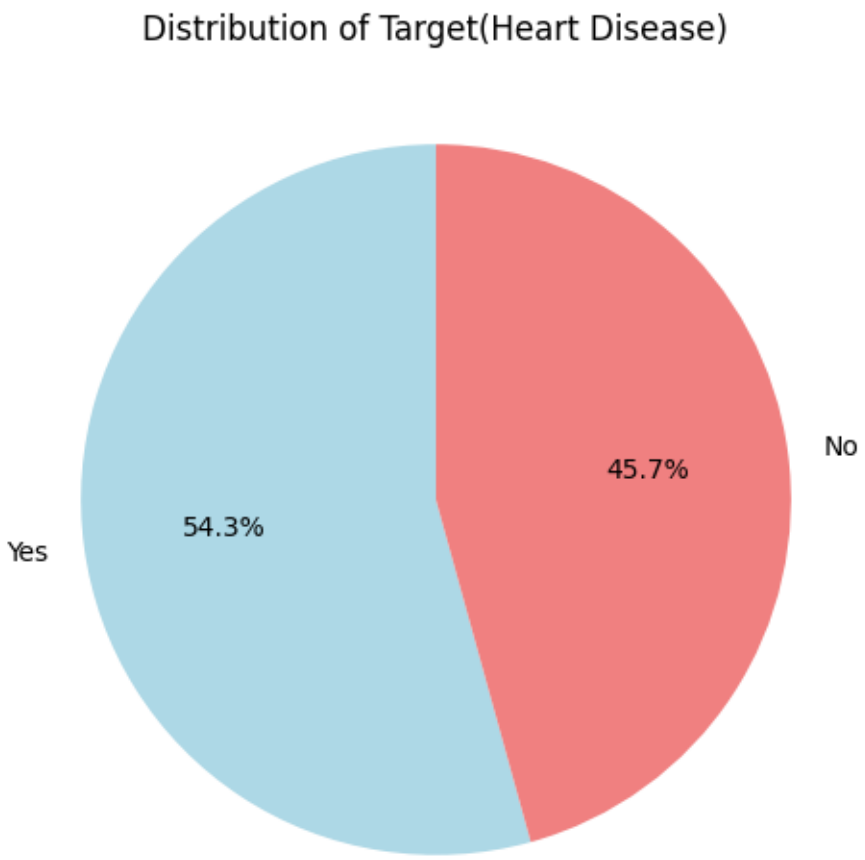
[262]:
```
# What can we observe from the above plot?
# The plot shows that the maximum heart rate achieved is generally
  ↪between 120 and 180, with a peak around 150.
```

[263]:
```
# Outliears in thalach

# Earlier we used boxplot , Let's use IQR method for this one
Q1 = df['thalach'].quantile(0.25)
Q2 = df['thalach'].quantile(0.75)
IQR = Q2 - Q1

lower_bound = Q1 - 1.5 * IQR
upper_bound = Q2 + 1.5 * IQR

outliers = df[(df['thalach'] < lower_bound) | (df['thalach'] >
  ↪upper_bound)]
print(f"Number of outliers in thalach: {len(outliers)}")
```

```
Number of outliers in thalach: 1
```

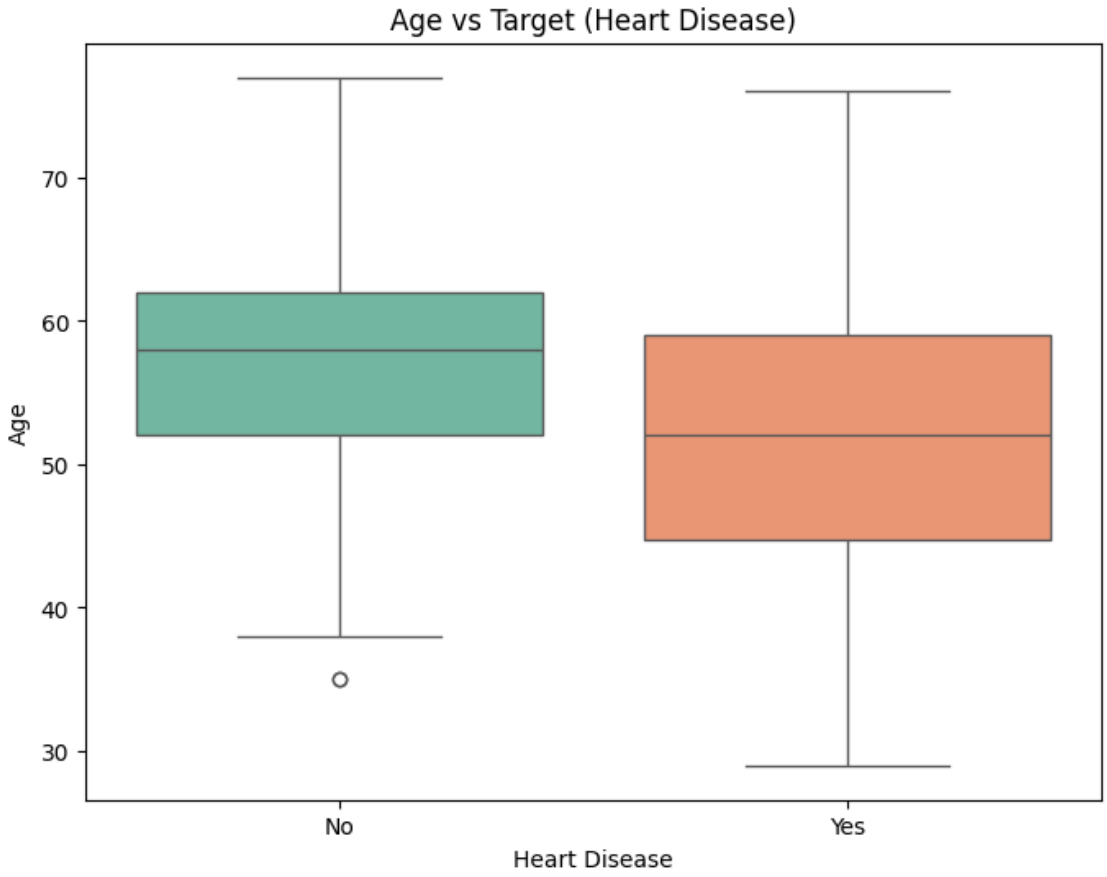
[264]:
```
# Here, We don't need to remove the outliers as they are not
  ↪significant enough to affect the analysis.
```

[265]:
```
# Univariate Analysis for target
plt.figure(figsize=(8, 6))
df['Heart Disease'].value_counts().plot.pie(autopct='%1.1f%%',
  ↪colors=['lightblue', 'lightcoral'], startangle=90)
plt.title('Distribution of Target(Heart Disease)')
plt.ylabel('')
plt.show()
```



[266]:
```
# What to observe from the above plot?
# We can see that there are more patients without heart disease (No)
  ↪than with heart disease (Yes).
# We can say that the dataset is imbalanced
```

[267]:
```
# Let's Now Begin with Bivariate Analysis


# Bivariate Analysis
# Bivariate analysis involves analyzing the relationship between two
  ↪variables in the dataset.

# Let's start with the relationship between age and target (heart
  ↪disease)
plt.figure(figsize=(8, 6))
sns.boxplot(x='Heart Disease', y='age', data=df, palette='Set2')
plt.title('Age vs Target (Heart Disease)')
plt.xlabel('Heart Disease')
plt.ylabel('Age')
plt.show()
```

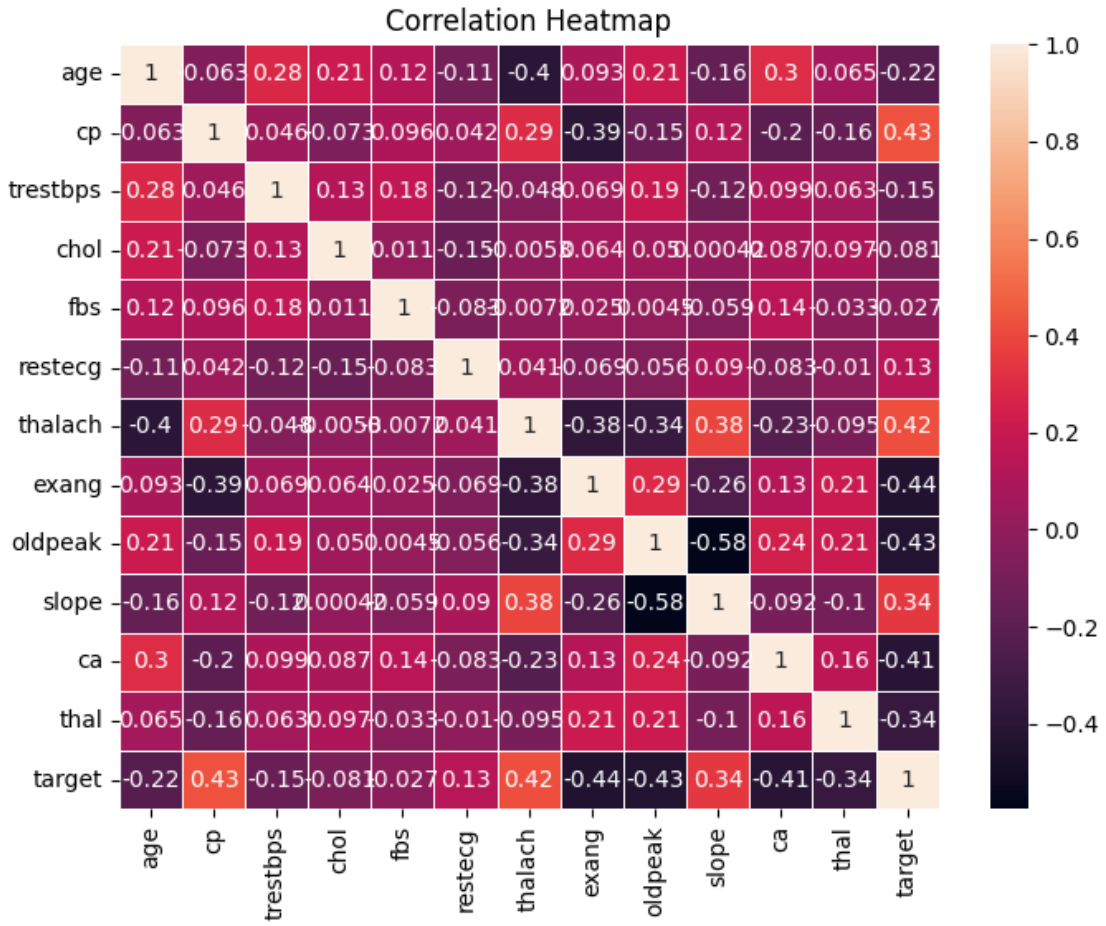


[268]:
```
# We can se that the Individuals without heart disease tend to have a
  ↪slightly higher median age compared to those with heart disease.
```

```
# also, the age distribution for individuals with heart disease is more spread out, indicating a wider range of ages.
```

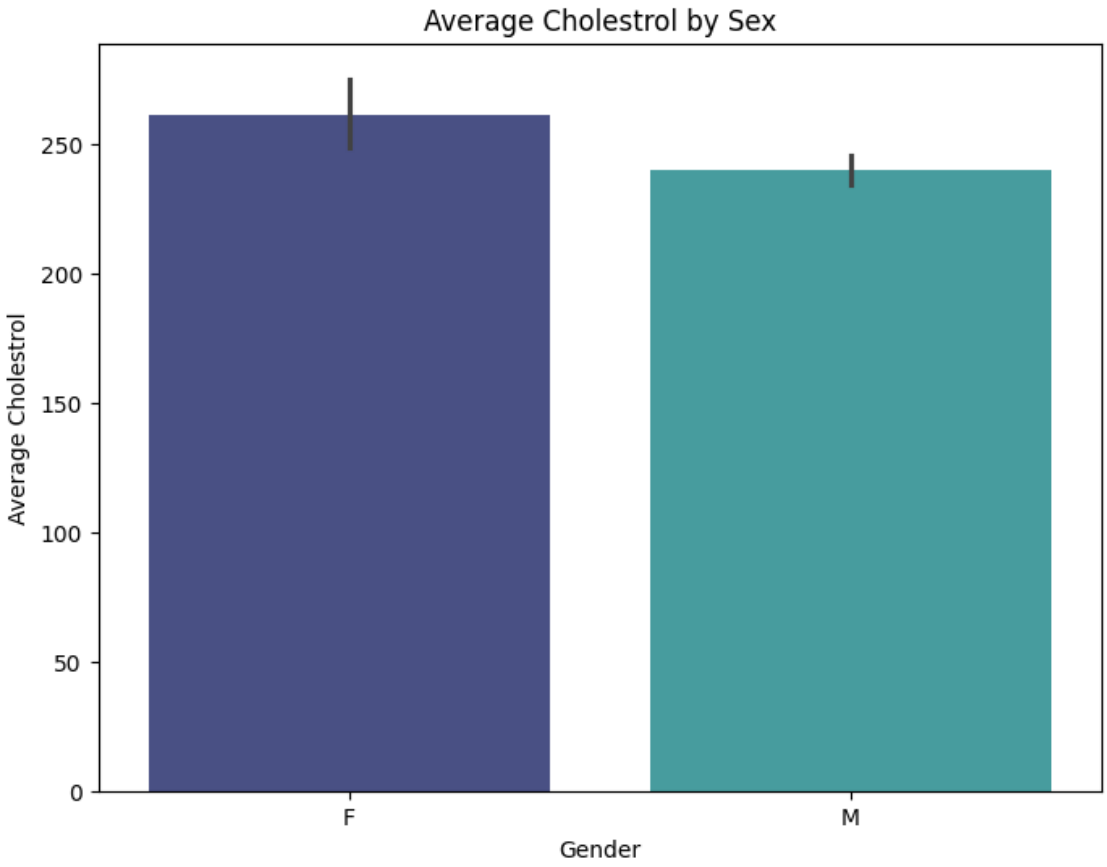
[271]:
```
# Correlation Analysis

correlation = df['age'].corr(df['thalach'])
print(f"Correlation between Age and Maximum Heart Rate Achieved (thalach): {correlation:.2f}")


# First we need to extract numerical values for correlation analysis
numerical_features = df.select_dtypes(include=['int64', 'float64'])

# Correlation HeatMap
plt.figure(figsize=(8, 6))
sns.heatmap(numerical_features.corr(), annot=True, cmap='rocket', linewidths=0.5)
plt.title('Correlation Heatmap')
plt.show()
```

```
Correlation between Age and Maximum Heart Rate Achieved (thalach): -0.40
```



[272]:
```
# We can see that the highest correlation is between 'cp' (chest pain
  ↪type) and 'target' (heart disease),
# followed by 'thalach' (maximum heart rate achieved) and 'target'.
```

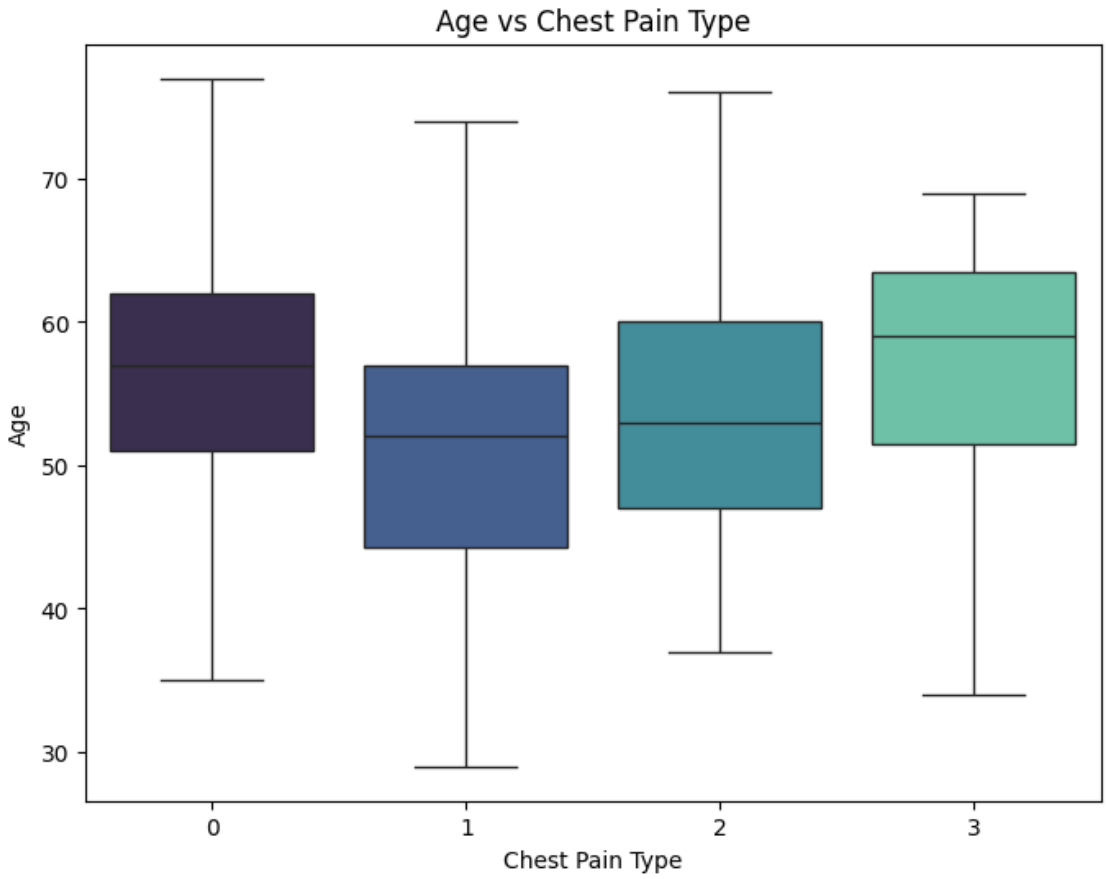
[278]:
```
# Average Cholestrol by Sex

plt.figure(figsize=(8, 6))
sns.barplot(x = 'sex', y = 'chol',data=df, palette='mako')
plt.title('Average Cholestrol by Sex')
plt.xlabel("Gender")
plt.ylabel('Average Cholestrol')
plt.show()
```



[284]:
```
# Here we can see that the average cholesterol level is slightly
  ↪higher for Females compared Males.

# Further we can create a cross-tabulation
pd.crosstab(df['sex'], df['target'], margins=True)
```

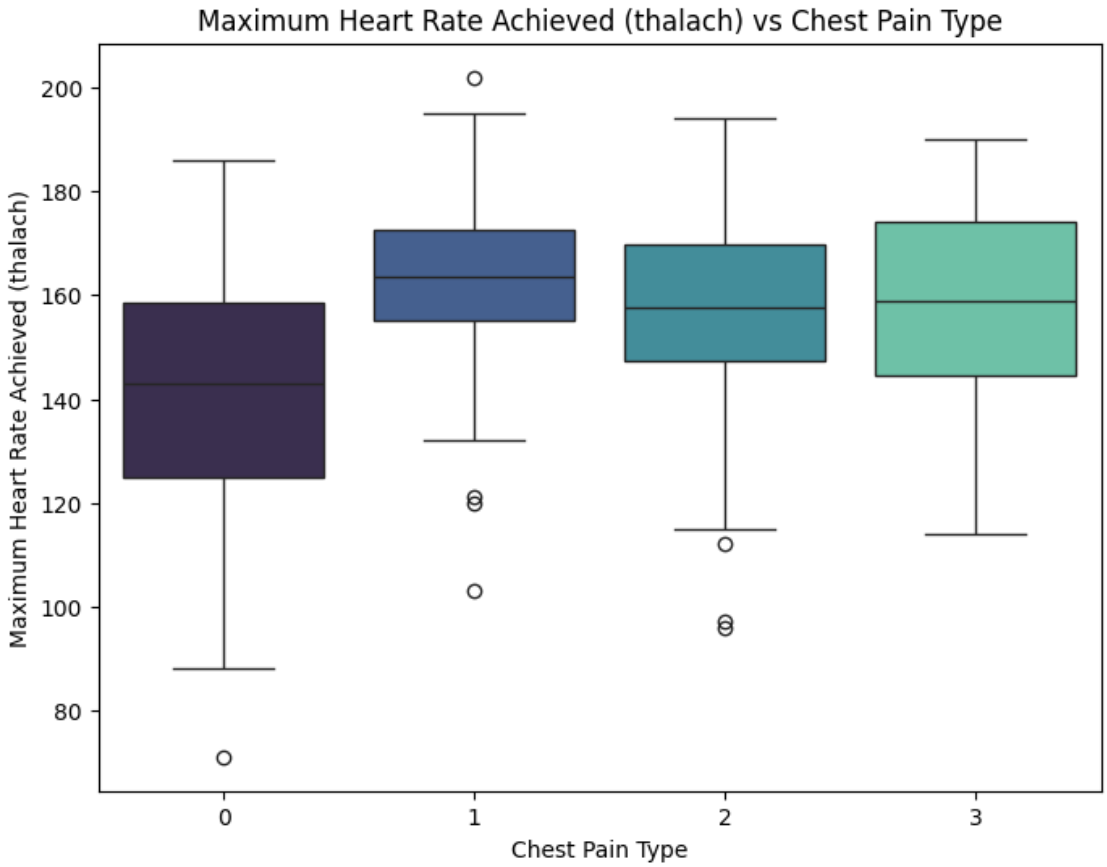
[284]:
```
target    0    1  All
sex
F        24   72   96
M       114   92  206
All     138  164  302
```

[292]:
```
# Distribution for age and cp
plt.figure(figsize=(8, 6))
sns.boxplot(x='cp', y='age', data=df, palette='mako')
plt.title('Age vs Chest Pain Type')
plt.xlabel('Chest Pain Type')
plt.ylabel('Age')
plt.show()
```



[ ]:
```
# We can see that chest pain type 3 has the highest median age, while
  ↪chest pain type 1 has the lowest median age.
# This indicates that individuals with chest pain type 3 tend to be
  ↪older compared to those with other chest pain types.
```

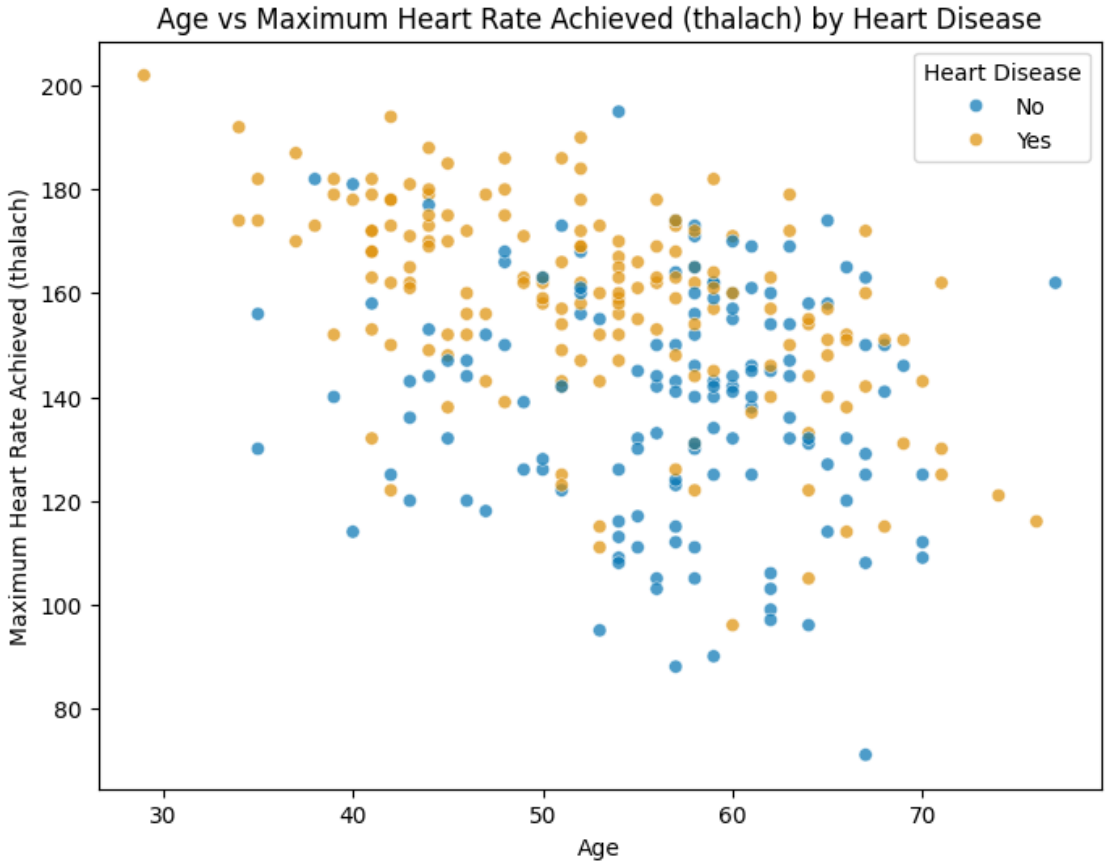
[293]:
```
# Relationship between thalach and cp (chest pain type)
plt.figure(figsize=(8, 6))
sns.boxplot(x='cp', y='thalach', data=df, palette='mako')
plt.title('Maximum Heart Rate Achieved (thalach) vs Chest Pain Type')
plt.xlabel('Chest Pain Type')
plt.ylabel('Maximum Heart Rate Achieved (thalach)')
plt.show()
```



[ ]:
```
# We can clearly see that chest pain type 0 has the lowest median maximum heart rate achieved (thalach), while chest pain type 1 has the highest median maximum heart rate achieved (thalach).
# This indicates that individuals with chest pain type 0 tend to have lower maximum heart rates compared to those with other chest pain types.
```

[286]:
```
# Moving onto the Multivariate Analysis

# Multivariate Analysis

# Multivariate analysis involves analyzing the relationship between three or more variables in the dataset.

# Let's start with the relationship between age, thalach (maximum heart rate achieved), and target (heart disease)
plt.figure(figsize=(8, 6))
sns.scatterplot(x='age', y='thalach', hue='Heart Disease', data = df, palette='colorblind', alpha=0.7)
```

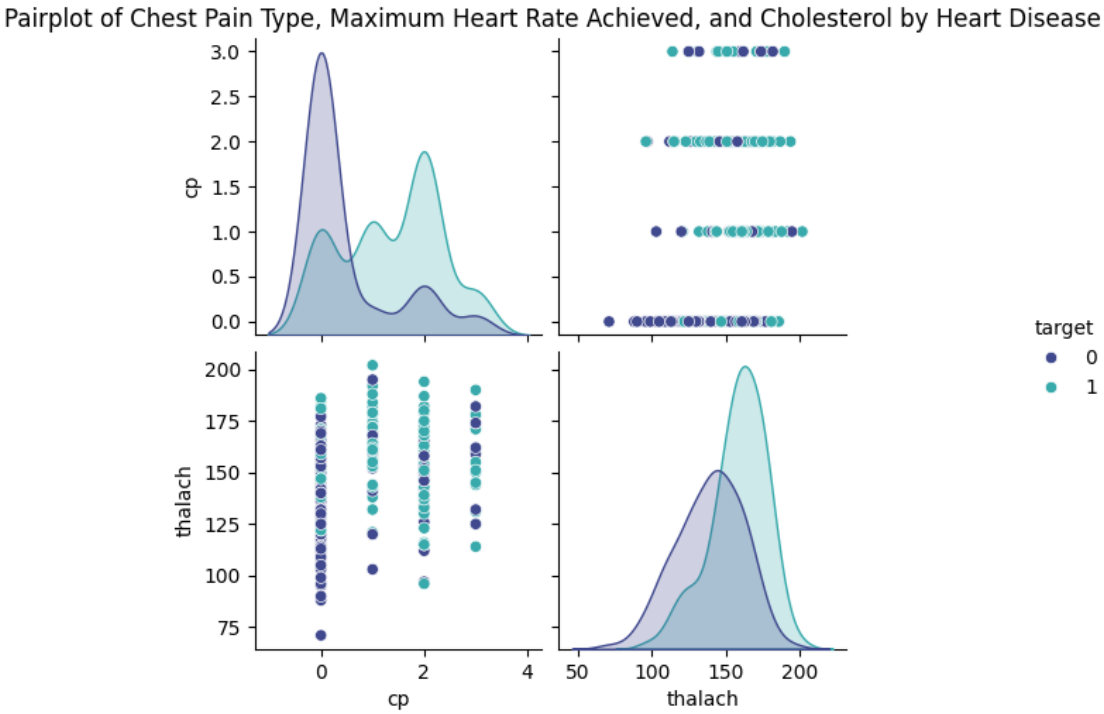
```
plt.title('Age vs Maximum Heart Rate Achieved (thalach) by Heart Disease')
plt.xlabel('Age')
plt.ylabel('Maximum Heart Rate Achieved (thalach)')
plt.legend(title='Heart Disease')
plt.show()
```



[ ]:
```
# What can we observe from the above pie chart?
# The scatter plot shows that as age increases, the maximum heart rate achieved (thalach) tends to decrease.
```

[294]:
```
#  Now,let's analyze the relationship between chest pain type (cp), maximum heart rate achieved (thalach), and target (heart disease)
plt.figure(figsize=(8, 6))
sns.pairplot(df, vars=['cp', 'thalach'], hue='target', palette='mako')
plt.suptitle('Pairplot of Chest Pain Type, Maximum Heart Rate Achieved, and Cholesterol by Heart Disease', y=1.02)
plt.show()
```

```
<Figure size 800x600 with 0 Axes>
```



[ ]:
```
# We can see that individuals with chest pain type 0 tend to have lower maximum heart rates achieved (thalach) compared to those with other chest pain types.
# This indicates that chest pain type 0 is associated with lower maximum heart rates, while chest pain types 1, 2, and 3 are associated with higher maximum heart rates.
```

[ ]:
```
# This marks the end of our analysis on the Heart Disease Dataset.
# We have performed univariate, bivariate, and multivariate analysis to understand the relationships between different variables in the dataset.
# We have also visualized the data using various plots to gain insights into the dataset.
# The analysis shows that age, chest pain type, and maximum heart rate achieved are important factors in determining the presence of heart disease.
# Thank you for reading this notebook, I hope you found it helpful.

# If you have any questions or suggestions, feel free to reach out.
# Happy Learning!
```