ML Project 5 - Health Care

February 16, 2023

1 ML Project 5 - Health Care

1.1 Task to be performed:

1. Preliminary analysis:

- a. Perform preliminary data inspection and report the findings on the structure of the data, missing values, duplicates, etc.
- b. Based on these findings, remove duplicates (if any) and treat missing values using an appropriate strategy

2. Prepare a report about the data explaining the distribution of the disease and the related factors using the steps listed below:

- a. Get a preliminary statistical summary of the data and explore the measures of central tendencies and spread of the data
- b. Identify the data variables which are categorical and describe and explore these variables using the appropriate tools, such as count plot
- c. Study the occurrence of CVD across the Age category
- d. Study the composition of all patients with respect to the Sex category
- e. Study if one can detect heart attacks based on anomalies in the resting blood pressure (trestbps) of a patient
- f. Describe the relationship between cholesterol levels and a target variable
- g. State what relationship exists between peak exercising and the occurrence of a heart attack
- h. Check if thalassemia is a major cause of CVD
- i. List how the other factors determine the occurrence of CVD
- j. Use a pair plot to understand the relationship between all the given variables

3. Build a baseline model to predict the risk of a heart attack using a logistic regression and random forest and explore the results while using correlation analysis and logistic regression (leveraging standard error and p-values from statsmodels) for feature selection

[1]:

```python
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
```

2 1. Preliminary analysis:

- a. Perform preliminary data inspection and report the findings on the structure of the data, missing values, duplicates, etc.
- b. Based on these findings, remove duplicates (if any) and treat missing values using an appropriate strategy.

[2]:
```
df = pd.read_excel('1645792390_cep1_dataset.xlsx')
```

[3]:
```
df
```

[3]:
```
     age  sex  cp  trestbps  chol  fbs  restecg  thalach  exang  oldpeak  \
0     63    1   3       145   233    1        0      150      0      2.3
1     37    1   2       130   250    0        1      187      0      3.5
2     41    0   1       130   204    0        0      172      0      1.4
3     56    1   1       120   236    0        1      178      0      0.8
4     57    0   0       120   354    0        1      163      1      0.6
..  …  …  ..    …  …  …   …   …  …   …
298   57    0   0       140   241    0        1      123      1      0.2
299   45    1   3       110   264    0        1      132      0      1.2
300   68    1   0       144   193    1        1      141      0      3.4
301   57    1   0       130   131    0        1      115      1      1.2
302   57    0   1       130   236    0        0      174      0      0.0

     slope  ca  thal  target
0        0   0     1       1
1        0   0     2       1
2        2   0     2       1
3        2   0     2       1
4        2   0     2       1
..     …  ..   …    …
298      1   0     3       0
299      1   0     3       0
300      1   2     3       0
301      1   1     3       0
302      1   1     2       0

[303 rows x 14 columns]
```

[4]:
```
df.shape
```

[4]:
```
(303, 14)
```

[5]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 303 entries, 0 to 302
Data columns (total 14 columns):
 #   Column    Non-Null Count  Dtype
---  ------    --------------  -----
 0   age       303 non-null    int64
 1   sex       303 non-null    int64
 2   cp        303 non-null    int64
 3   trestbps  303 non-null    int64
 4   chol      303 non-null    int64
 5   fbs       303 non-null    int64
 6   restecg   303 non-null    int64
 7   thalach   303 non-null    int64
 8   exang     303 non-null    int64
 9   oldpeak   303 non-null    float64
 10  slope     303 non-null    int64
 11  ca        303 non-null    int64
 12  thal      303 non-null    int64
 13  target    303 non-null    int64
dtypes: float64(1), int64(13)
memory usage: 33.3 KB
```

[6]:

```
df.describe()
```

[6]:

```
              age         sex          cp    trestbps        chol         fbs  \
count  303.000000  303.000000  303.000000  303.000000  303.000000  303.000000
mean    54.366337    0.683168    0.966997  131.623762  246.264026    0.148515
std      9.082101    0.466011    1.032052   17.538143   51.830751    0.356198
min     29.000000    0.000000    0.000000   94.000000  126.000000    0.000000
25%     47.500000    0.000000    0.000000  120.000000  211.000000    0.000000
50%     55.000000    1.000000    1.000000  130.000000  240.000000    0.000000
75%     61.000000    1.000000    2.000000  140.000000  274.500000    0.000000
max     77.000000    1.000000    3.000000  200.000000  564.000000    1.000000

          restecg     thalach       exang     oldpeak       slope          ca  \
count  303.000000  303.000000  303.000000  303.000000  303.000000  303.000000
mean     0.528053  149.646865    0.326733    1.039604    1.399340    0.729373
std      0.525860   22.905161    0.469794    1.161075    0.616226    1.022606
min      0.000000   71.000000    0.000000    0.000000    0.000000    0.000000
25%      0.000000  133.500000    0.000000    0.000000    1.000000    0.000000
50%      1.000000  153.000000    0.000000    0.800000    1.000000    0.000000
75%      1.000000  166.000000    1.000000    1.600000    2.000000    1.000000
max      2.000000  202.000000    1.000000    6.200000    2.000000    4.000000

             thal      target
count  303.000000  303.000000
```

```
mean     2.313531    0.544554
std      0.612277    0.498835
min      0.000000    0.000000
25%      2.000000    0.000000
50%      2.000000    1.000000
75%      3.000000    1.000000
max      3.000000    1.000000
```

[7]:

```
df.isnull().sum()
```

[7]:

```
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
```

[8]:

```
df.dtypes
```

[8]:

```
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
```

[9]:

```
duplicate = df[df.duplicated()]
```

[10]:

```
duplicate
```

```
[10]:      age  sex  cp  trestbps  chol  fbs  restecg  thalach  exang  oldpeak  \
      164   38    1   2       138   175    0        1      173      0      0.0

           slope  ca  thal  target
      164      2   4     2       1
```

```
[11]: df = df.drop_duplicates()
```

```
[12]: df.duplicated().any()
```

```
[12]: False
```

3 2. Prepare a report about the data explaining the distribution of the disease and the related factors using the steps listed below:

- a. Get a preliminary statistical summary of the data and explore the measures of central tendencies and spread of the data
- b. Identify the data variables which are categorical and describe and explore these variables using the appropriate tools, such as count plot
- c. Study the occurrence of CVD across the Age category
- d. Study the composition of all patients with respect to the Sex category
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- f. Describe the relationship between cholesterol levels and a target variable
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- h. Check if thalassemia is a major cause of CVD
- i. List how the other factors determine the occurrence of CVD
- j. Use a pair plot to understand the relationship between all the given variables

```
[13]: df.describe()
```

```
[13]:              age         sex          cp    trestbps        chol         fbs  \
      count  302.00000  302.000000  302.000000  302.000000  302.000000  302.000000
      mean    54.42053    0.682119    0.963576  131.602649  246.500000    0.149007
      std      9.04797    0.466426    1.032044   17.563394   51.753489    0.356686
      min     29.00000    0.000000    0.000000   94.000000  126.000000    0.000000
      25%     48.00000    0.000000    0.000000  120.000000  211.000000    0.000000
      50%     55.50000    1.000000    1.000000  130.000000  240.500000    0.000000
      75%     61.00000    1.000000    2.000000  140.000000  274.750000    0.000000
      max     77.00000    1.000000    3.000000  200.000000  564.000000    1.000000
```

```
          restecg     thalach       exang     oldpeak       slope          ca  \
count  302.000000  302.000000  302.000000  302.000000  302.000000  302.000000
mean     0.526490  149.569536    0.327815    1.043046    1.397351    0.718543
std      0.526027   22.903527    0.470196    1.161452    0.616274    1.006748
min      0.000000   71.000000    0.000000    0.000000    0.000000    0.000000
25%      0.000000  133.250000    0.000000    0.000000    1.000000    0.000000
50%      1.000000  152.500000    0.000000    0.800000    1.000000    0.000000
75%      1.000000  166.000000    1.000000    1.600000    2.000000    1.000000
max      2.000000  202.000000    1.000000    6.200000    2.000000    4.000000

             thal      target
count  302.000000  302.000000
mean     2.314570    0.543046
std      0.613026    0.498970
min      0.000000    0.000000
25%      2.000000    0.000000
50%      2.000000    1.000000
75%      3.000000    1.000000
max      3.000000    1.000000
```

[14]:
```
df.mean(axis=0)
```

[14]:
```
age          54.420530
sex           0.682119
cp            0.963576
trestbps    131.602649
chol        246.500000
fbs           0.149007
restecg       0.526490
thalach     149.569536
exang         0.327815
oldpeak       1.043046
slope         1.397351
ca            0.718543
thal          2.314570
target        0.543046
dtype: float64
```

[15]:
```
df.median(axis=0)
```

[15]:
```
age          55.5
sex           1.0
cp            1.0
trestbps    130.0
chol        240.5
fbs           0.0
restecg       1.0
```

```
thalach     152.5
exang         0.0
oldpeak       0.8
slope         1.0
ca            0.0
thal          2.0
target        1.0
dtype: float64
```

[16]:
```
df.mode(axis=0).head(1)
```

[16]:
```
    age  sex   cp  trestbps  chol  fbs  restecg  thalach  exang  oldpeak  \
0  58.0  1.0  0.0     120.0   197  0.0      1.0    162.0    0.0      0.0

   slope   ca  thal  target
0    2.0  0.0   2.0     1.0
```

[17]:
```
cat_cols = ['sex','cp','fbs','restecg','exang','slope','ca','thal']
```

[18]:
```
con_cols = ['age','trestbps','chol','thalach','oldpeak']
```

[19]:
```
target_col = ['target']
```

[20]:
```
print('Categorical Columns are :',cat_cols)
print('Continuous Columns are :',con_cols)
print('Target variable are :',target_col)
```

```
Categorical Columns are : ['sex', 'cp', 'fbs', 'restecg', 'exang', 'slope',
'ca', 'thal']
Continuous Columns are : ['age', 'trestbps', 'chol', 'thalach', 'oldpeak']
Target variable are : ['target']
```

[21]:
```
df[con_cols].describe().transpose()
```

[21]:
```
          count        mean        std    min     25%    50%     75%    max
age       302.0   54.420530   9.047970   29.0   48.00   55.5   61.00   77.0
trestbps  302.0  131.602649  17.563394   94.0  120.00  130.0  140.00  200.0
chol      302.0  246.500000  51.753489  126.0  211.00  240.5  274.75  564.0
thalach   302.0  149.569536  22.903527   71.0  133.25  152.5  166.00  202.0
oldpeak   302.0    1.043046   1.161452    0.0    0.00    0.8    1.60    6.2
```

[22]:
```
df['age'].min()
```

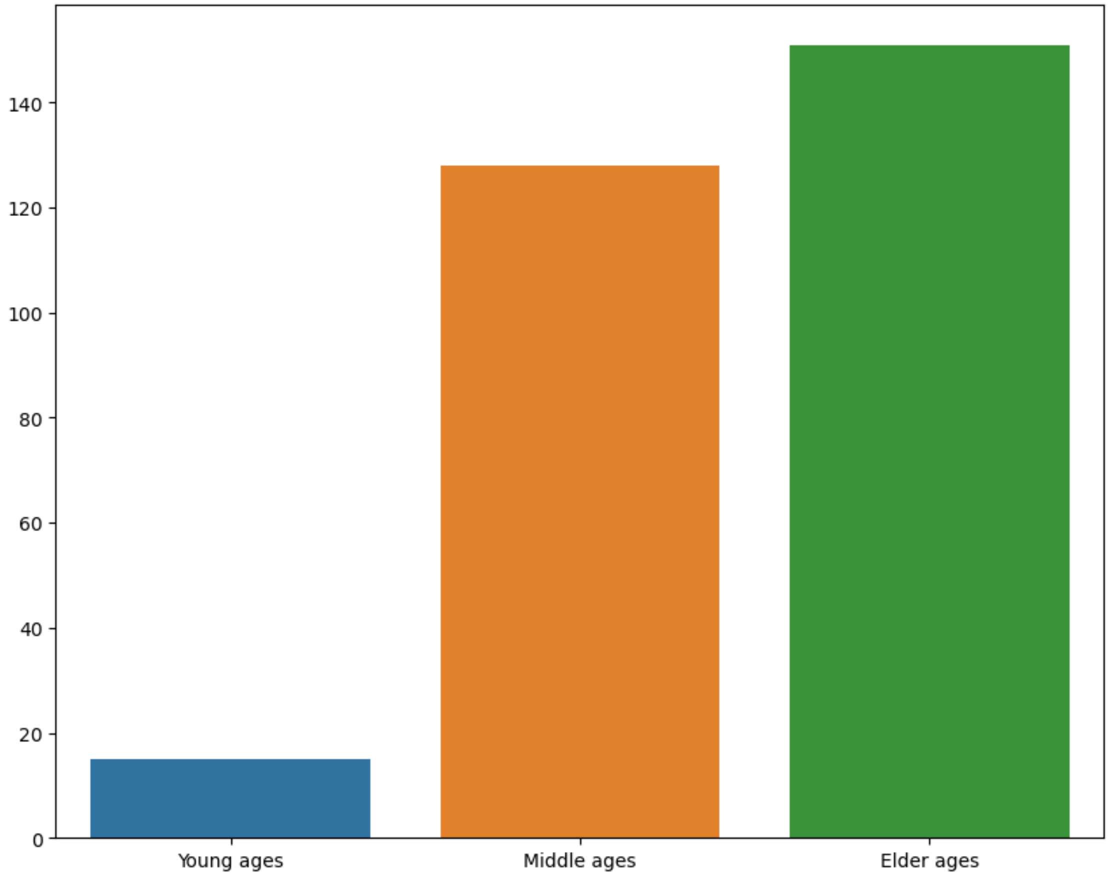
[22]:
```
29
```

[23]:
```
df['age'].max()
```

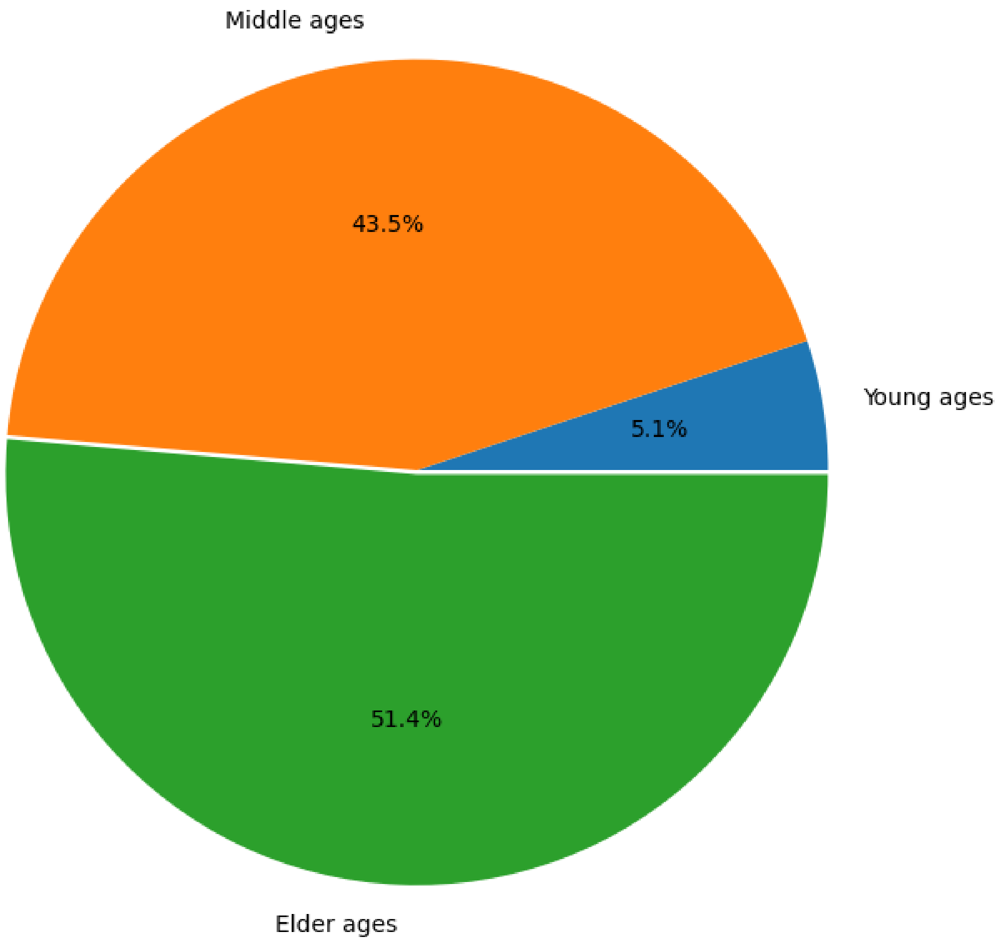
[23]:
```
77
```

```
[24]: Young = df[(df.age>=29) & (df.age<40)]
      Middle = df[(df.age>=40) & (df.age<55)]
      Elder = df[df.age>55]

      plt.figure(figsize=(10,8))
      sns.barplot(x=['Young ages','Middle ages','Elder␣
       ↪ages'],y=[len(Young),len(Middle),len(Elder)])
      plt.show()
```

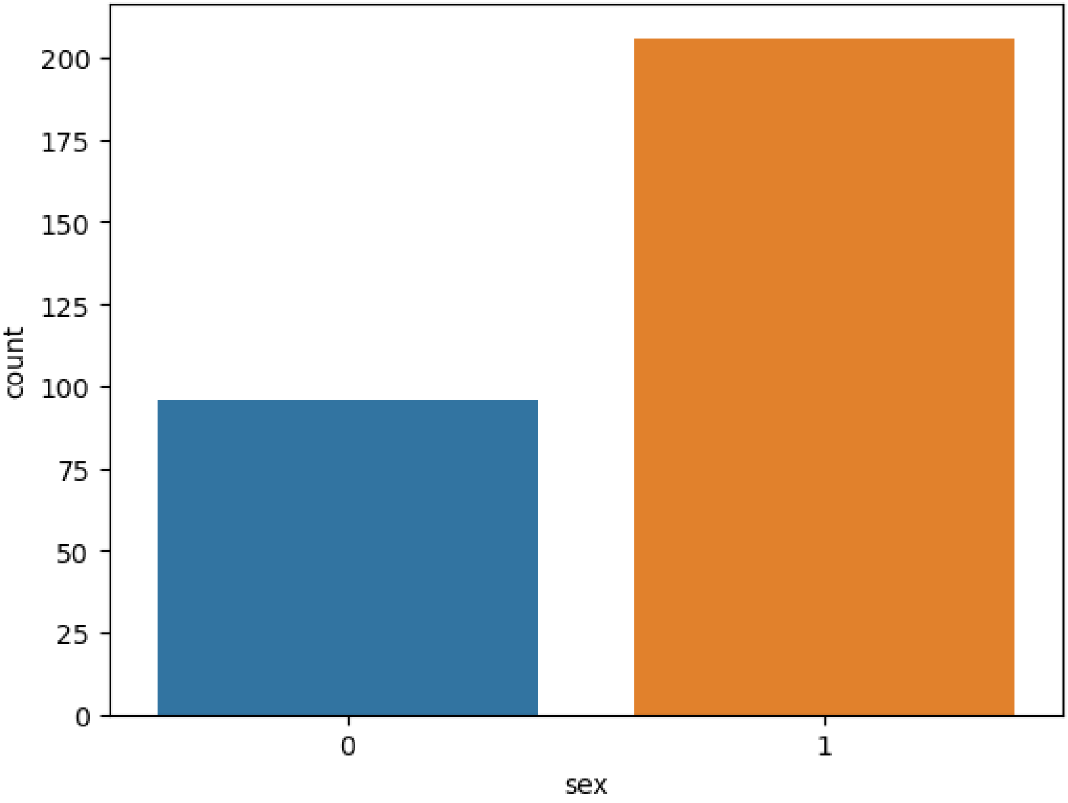


```
[25]: plt.figure(figsize=(10,8))
      plt.pie([len(Young),len(Middle),len(Elder)],labels=['Young ages','Middle␣
       ↪ages','Elder ages'],
              explode=[0,0,0.01],autopct='%1.1f%%')
      plt.show()
```



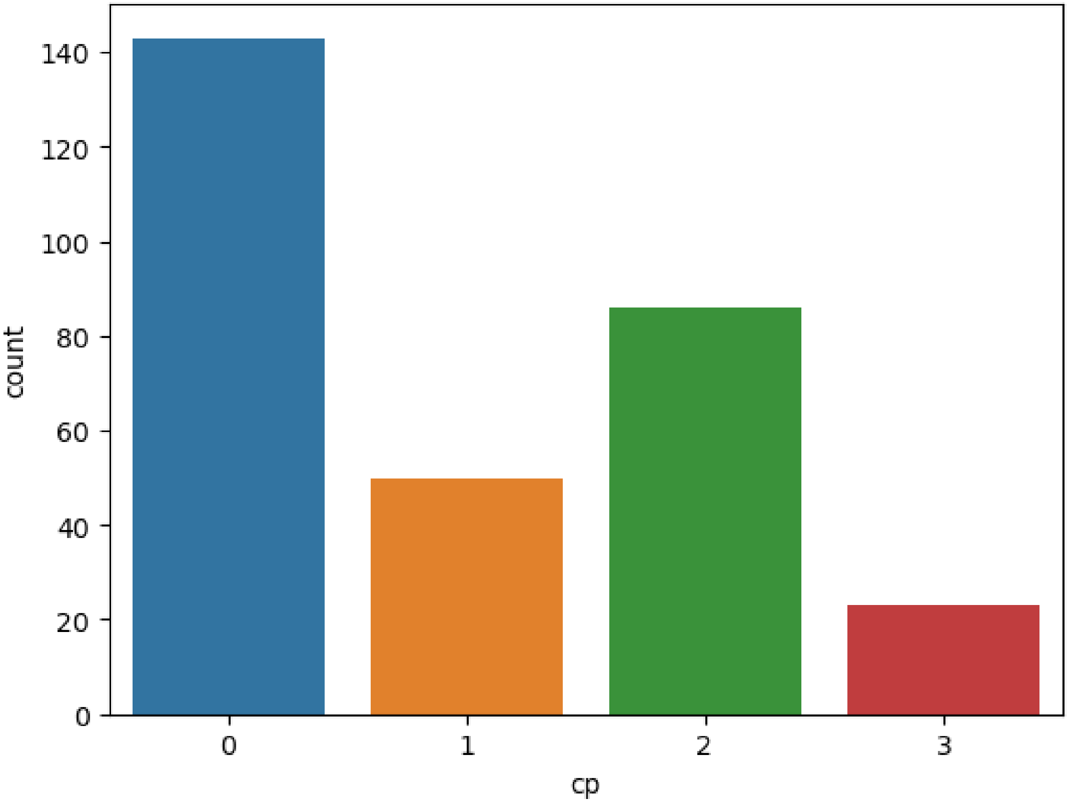
[26]:
```
sns.countplot(df['sex'])
plt.show()
```

```
C:\Users\Vinosh\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```



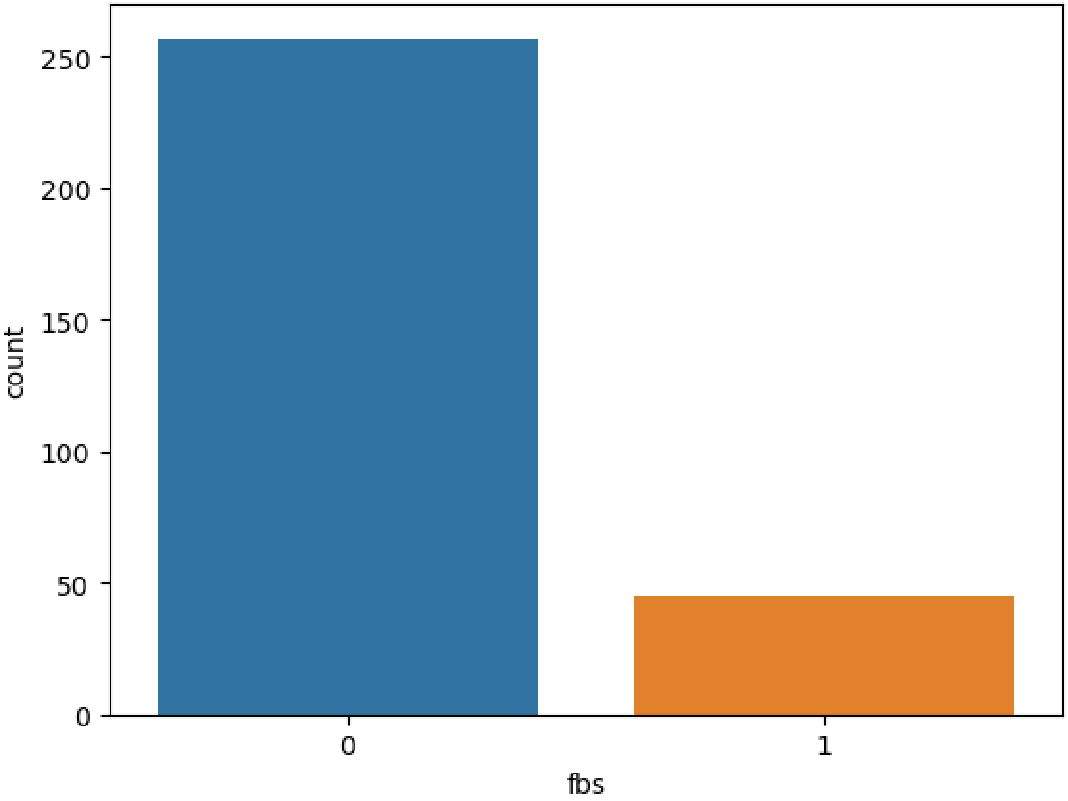
[27]:
```
sns.countplot(df['cp'])
plt.show()
```

```
C:\Users\Vinosh\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```



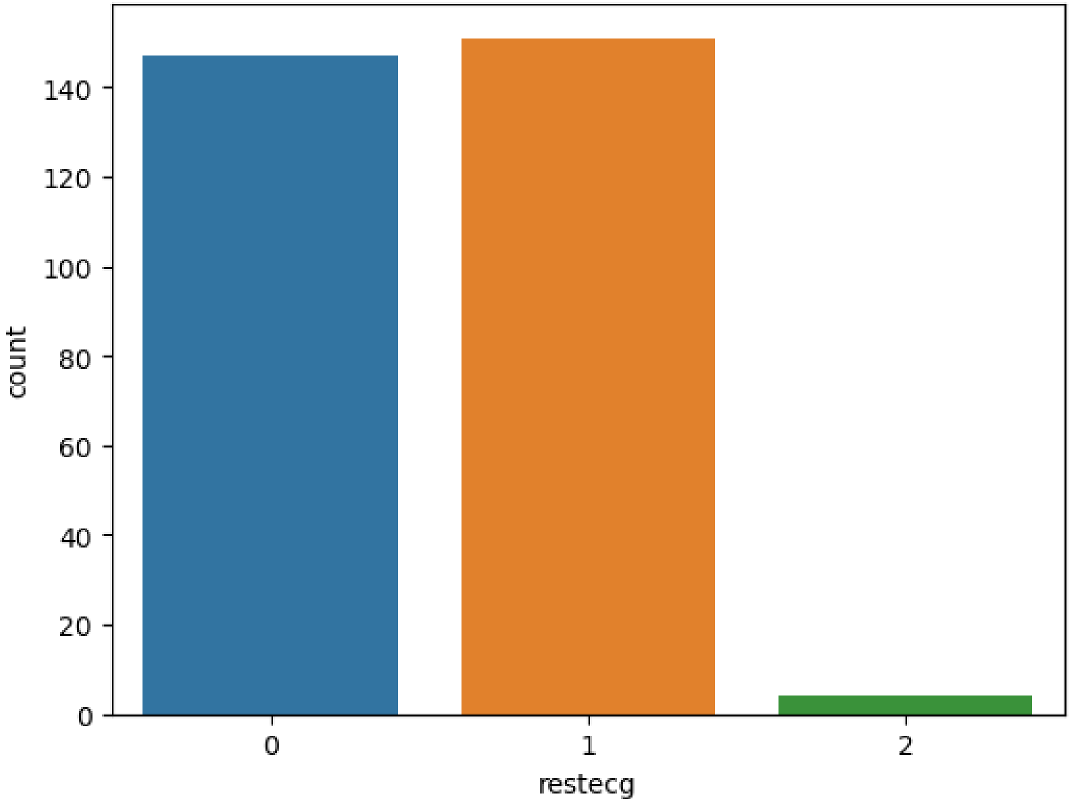
[28]:
```
sns.countplot(df['fbs'])
plt.show()
```

```
C:\Users\Vinosh\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```



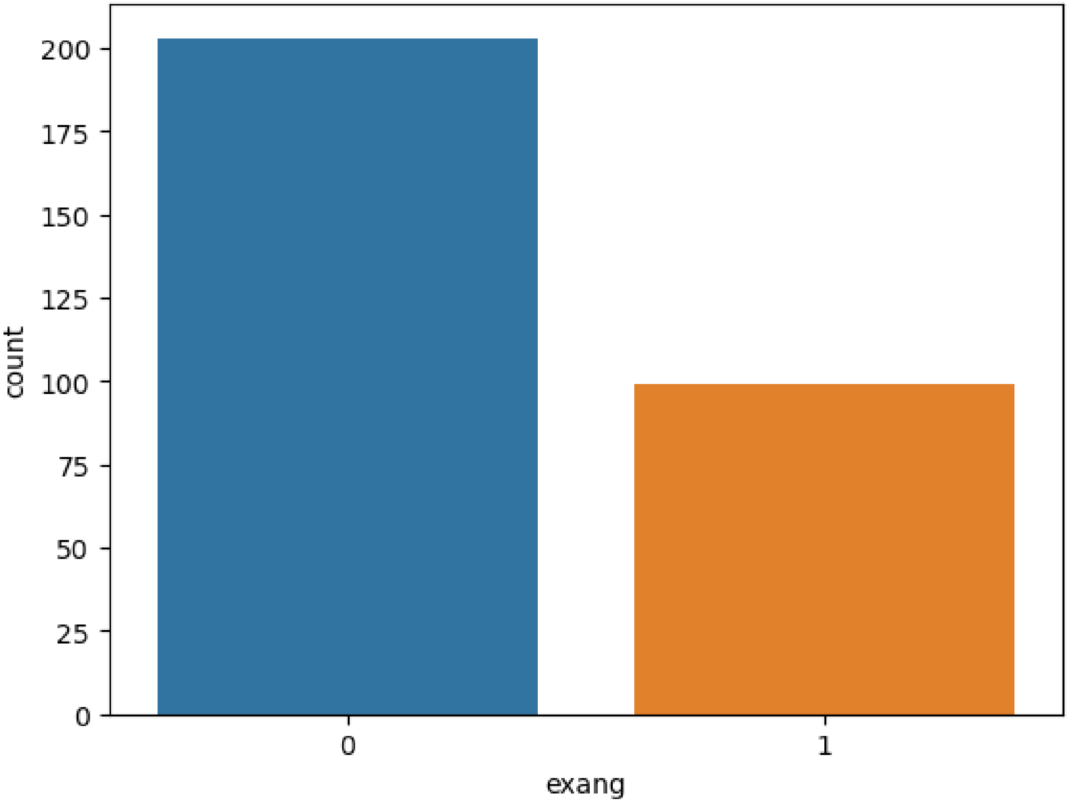
[29]:
```
sns.countplot(df['restecg'])
plt.show()
```

```
C:\Users\Vinosh\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```



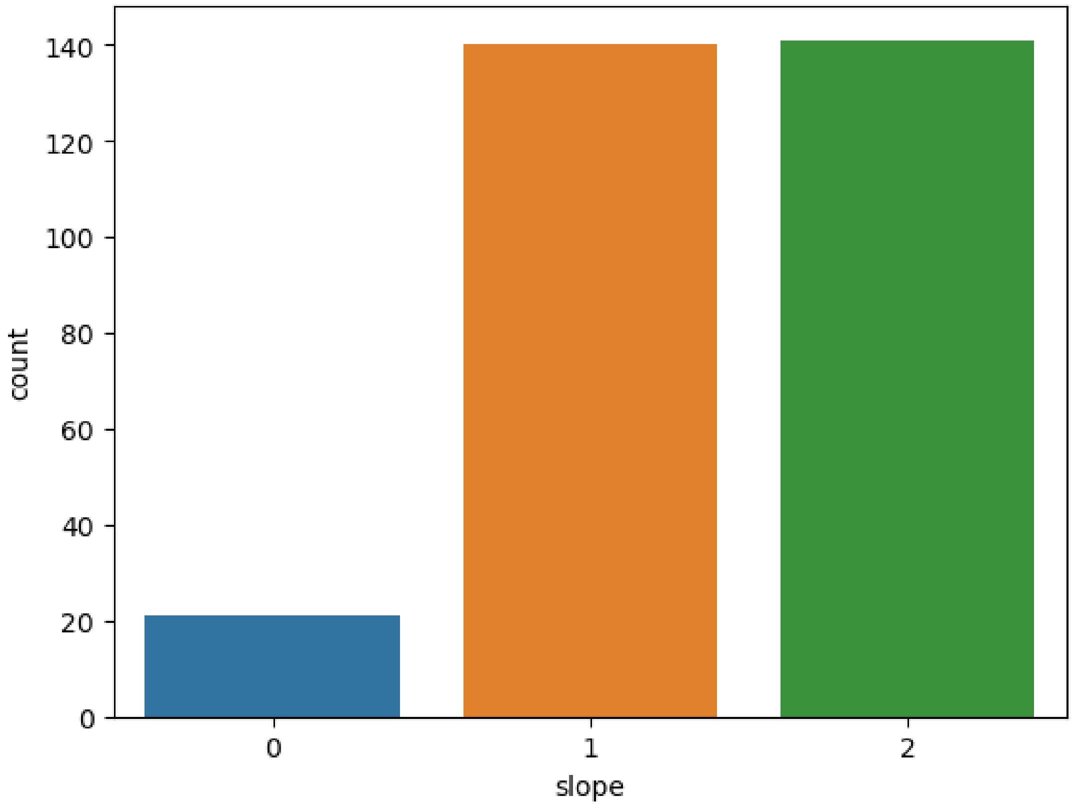
[30]:
```
sns.countplot(df['exang'])
plt.show()
```

```
C:\Users\Vinosh\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```



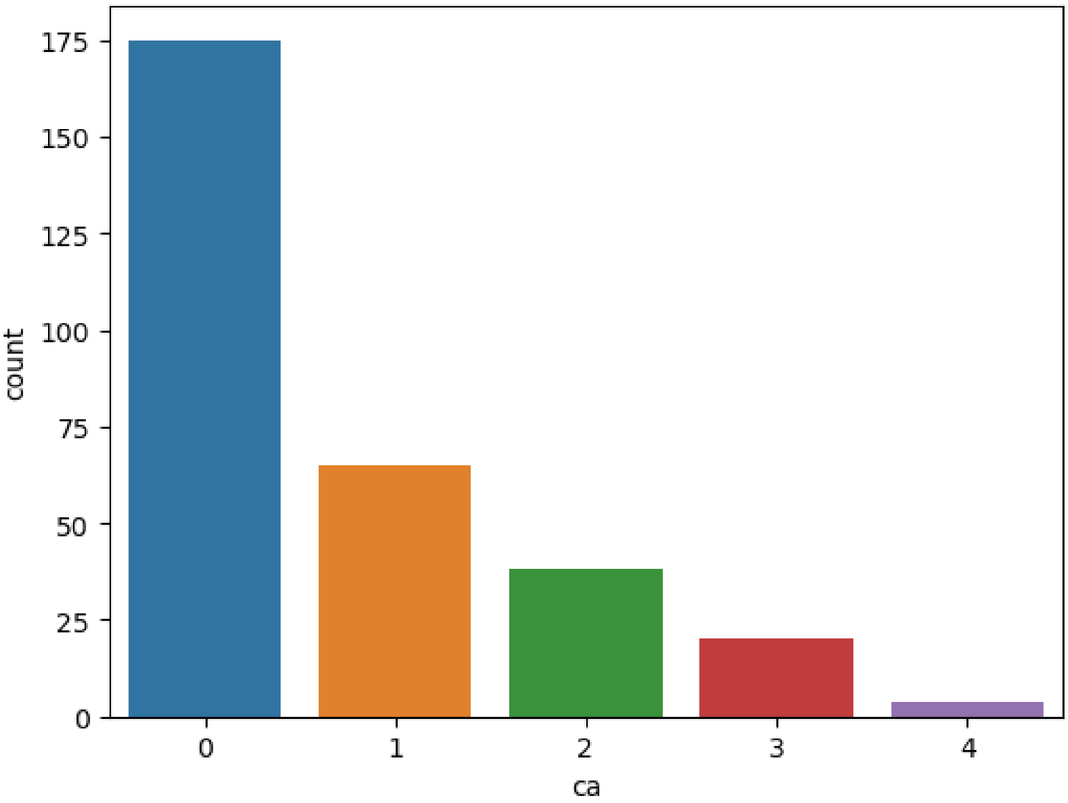
[31]:
```
sns.countplot(df['slope'])
plt.show()
```

```
C:\Users\Vinosh\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```



[32]:
```
sns.countplot(df['ca'])
plt.show()
```

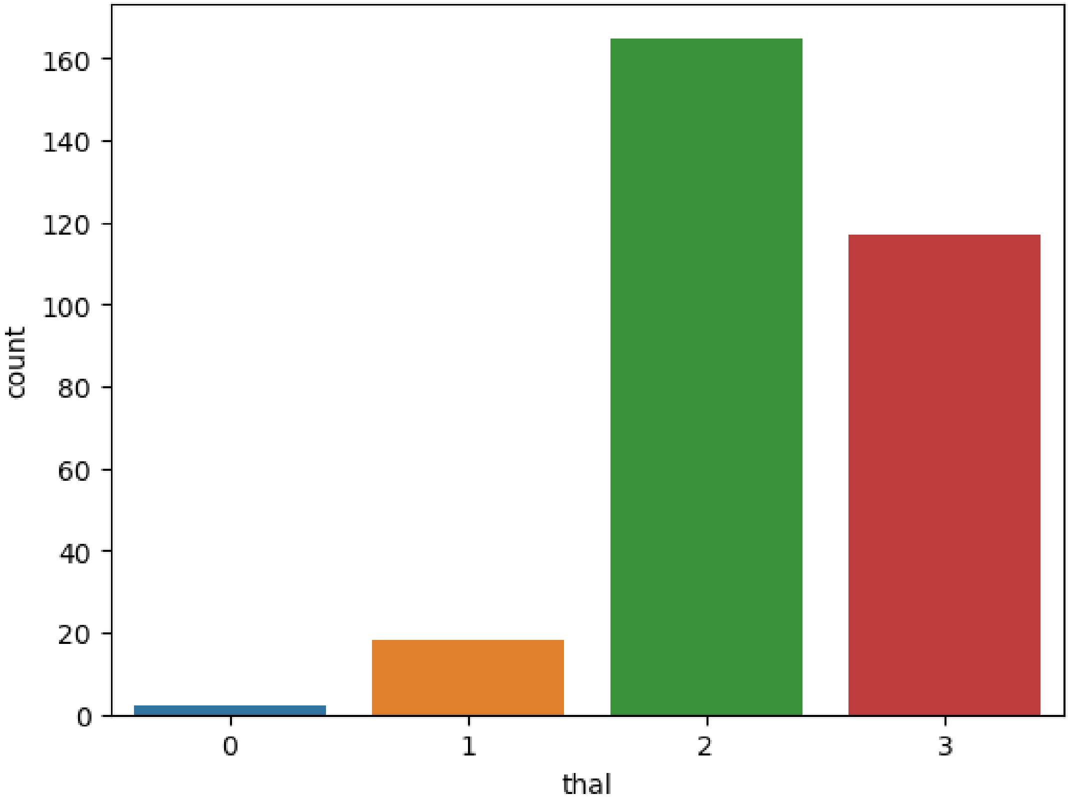
```
C:\Users\Vinosh\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```



[33]:

```
sns.countplot(df['thal'])
plt.show()
```

```
C:\Users\Vinosh\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```

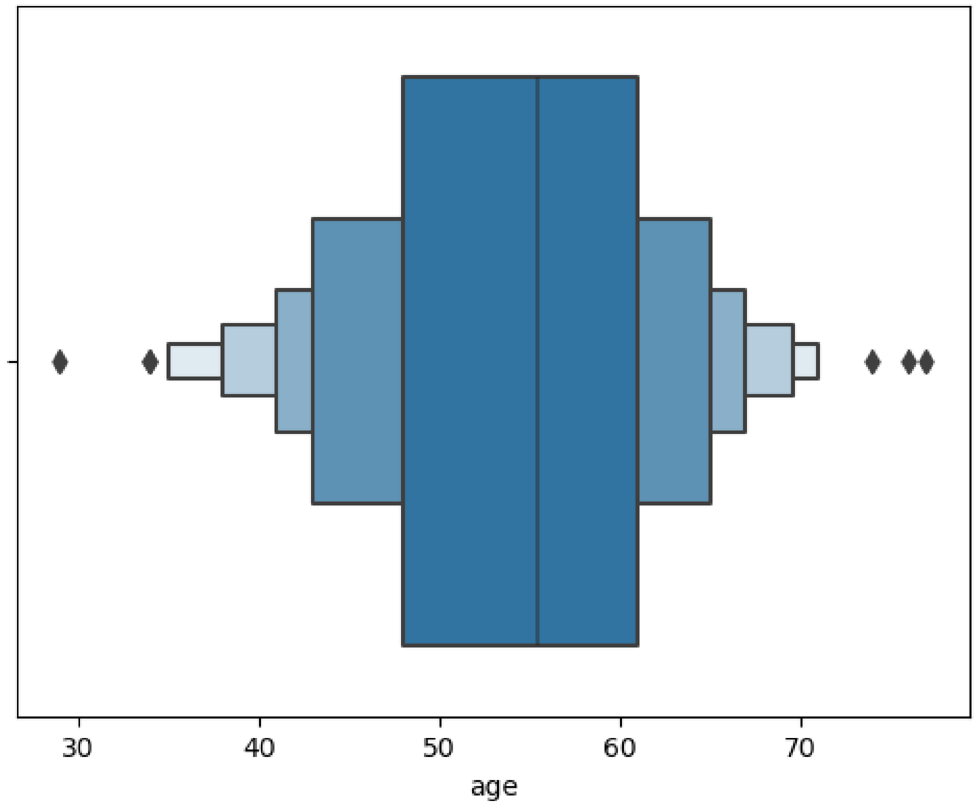


[34]:

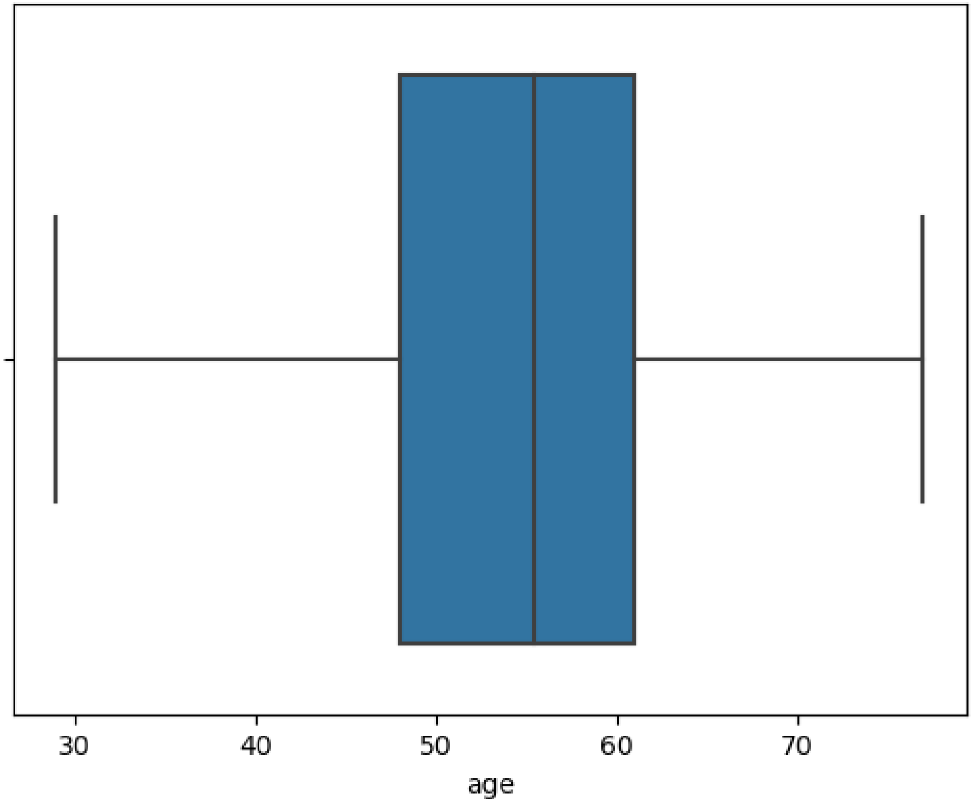
```
sns.boxenplot(df['age'])
plt.show()

sns.boxplot(df['age'])
plt.show()
```

```
C:\Users\Vinosh\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```



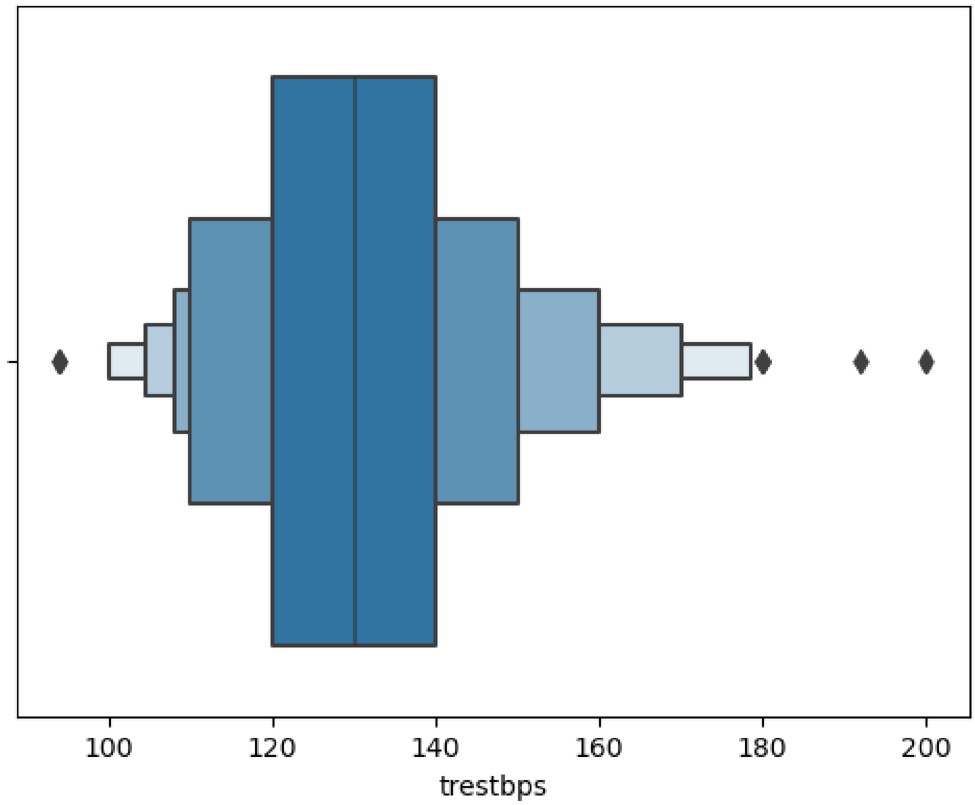
```
C:\Users\Vinosh\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```



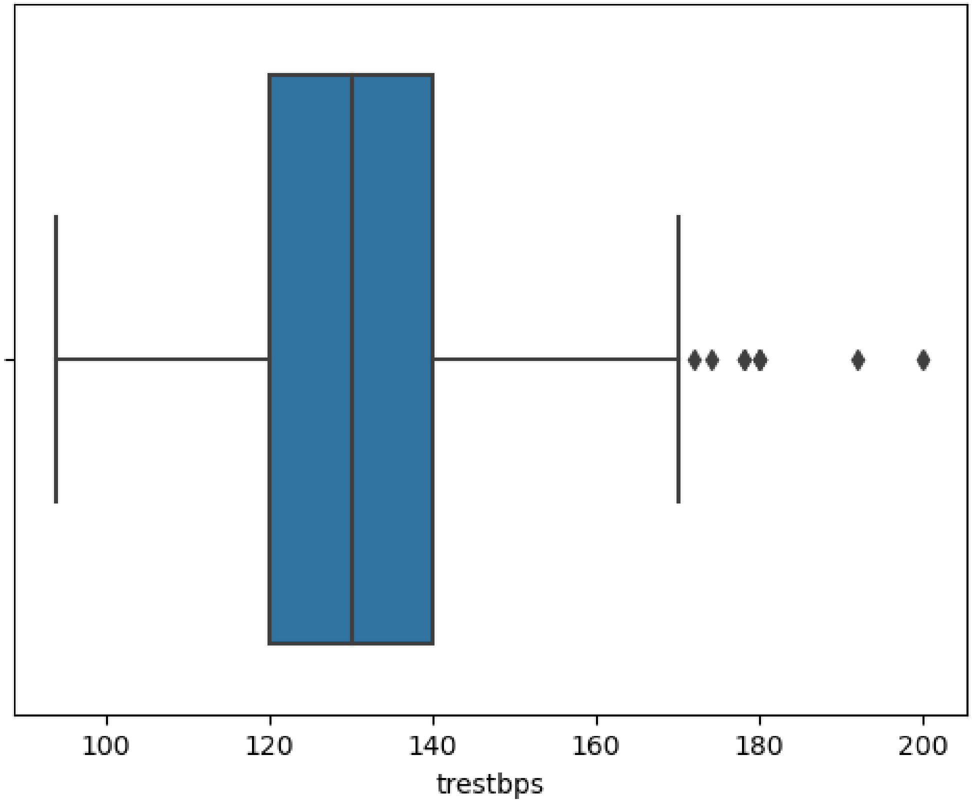
[35]:
```
sns.boxenplot(df['trestbps'])
plt.show()

sns.boxplot(df['trestbps'])
plt.show()
```

```
C:\Users\Vinosh\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```



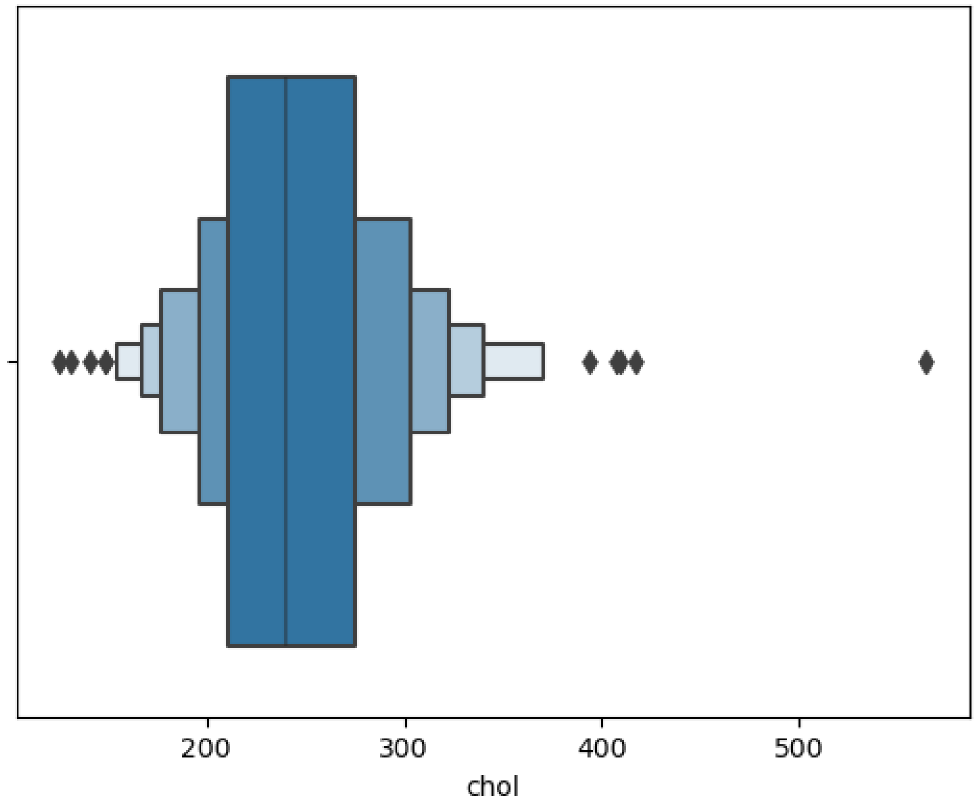
```
C:\Users\Vinosh\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```



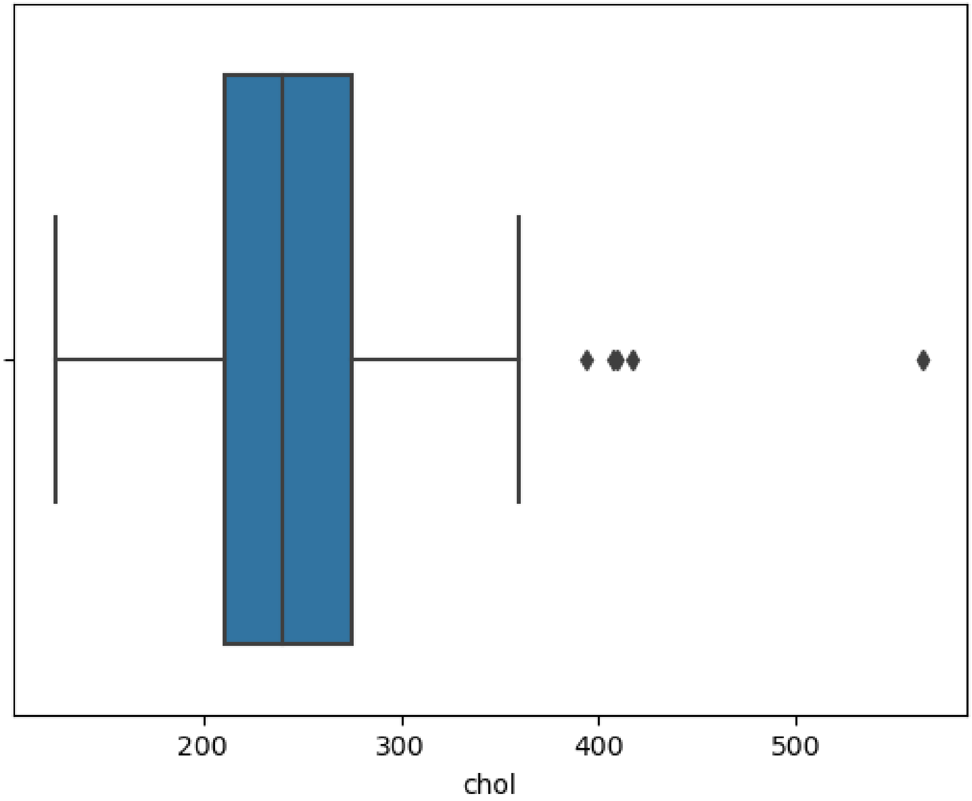
[36]:
```
sns.boxenplot(df['chol'])
plt.show()

sns.boxplot(df['chol'])
plt.show()
```

```
C:\Users\Vinosh\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```



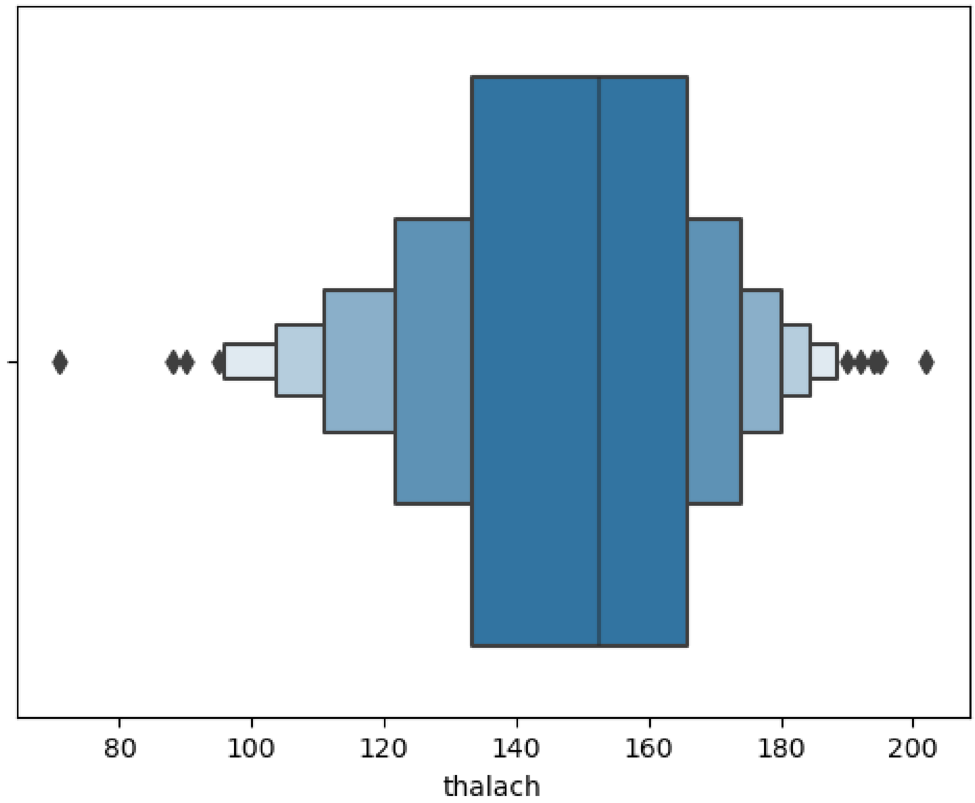
```
C:\Users\Vinosh\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```



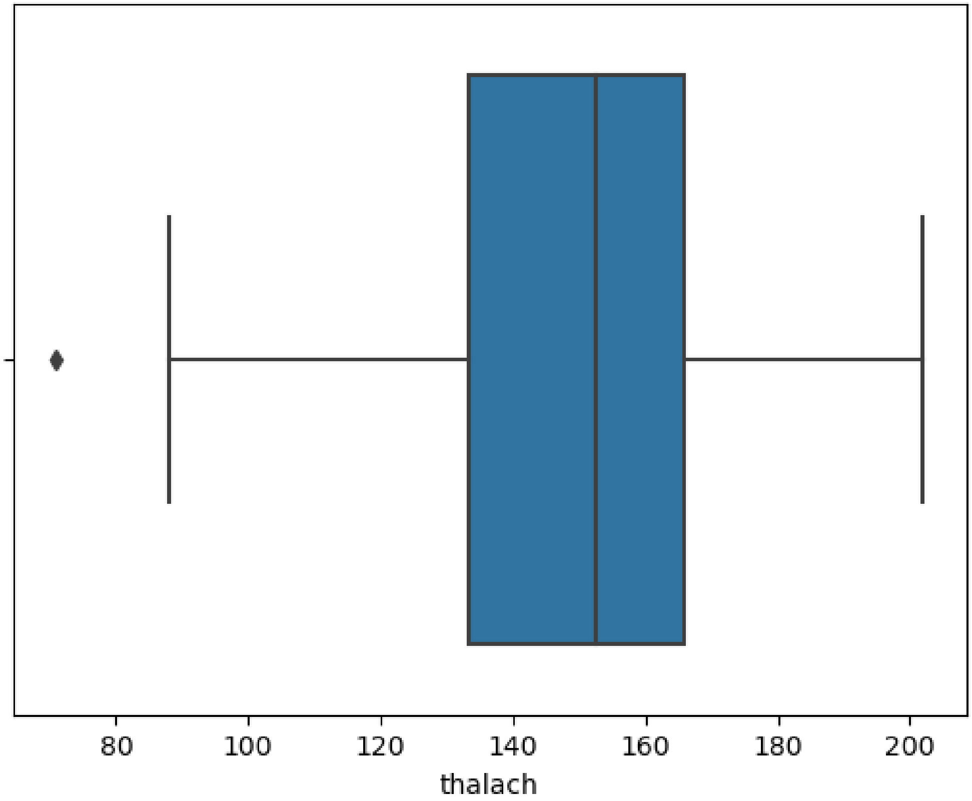
[37]:
```
sns.boxenplot(df['thalach'])
plt.show()

sns.boxplot(df['thalach'])
plt.show()
```

```
C:\Users\Vinosh\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```



```
C:\Users\Vinosh\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```

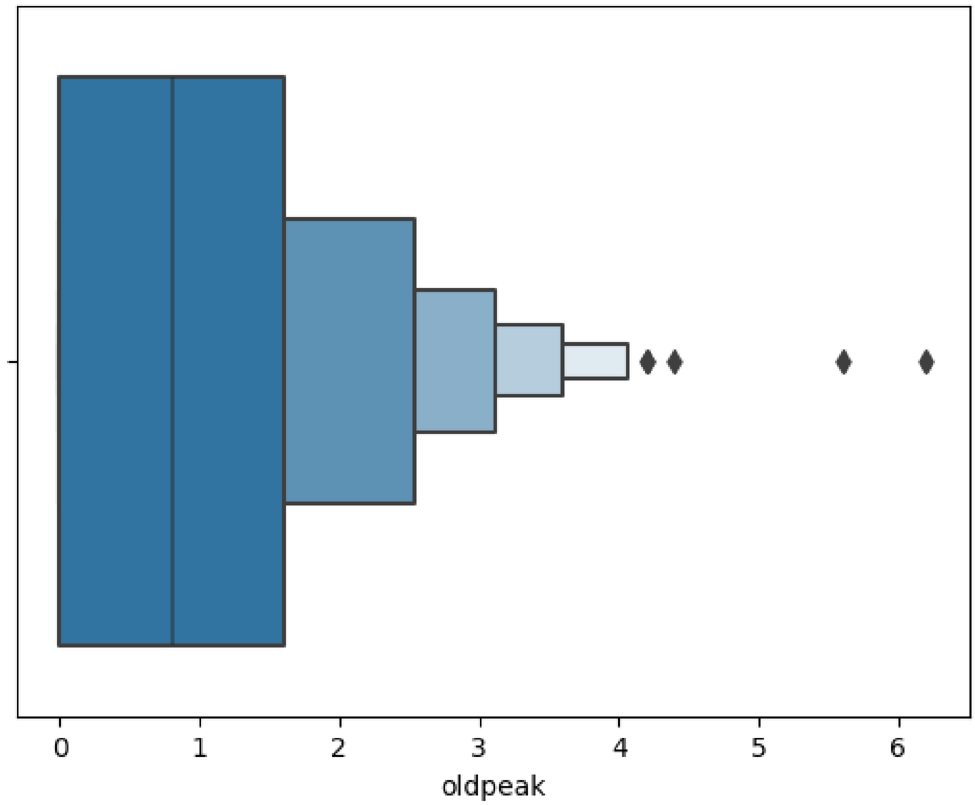


[38]:

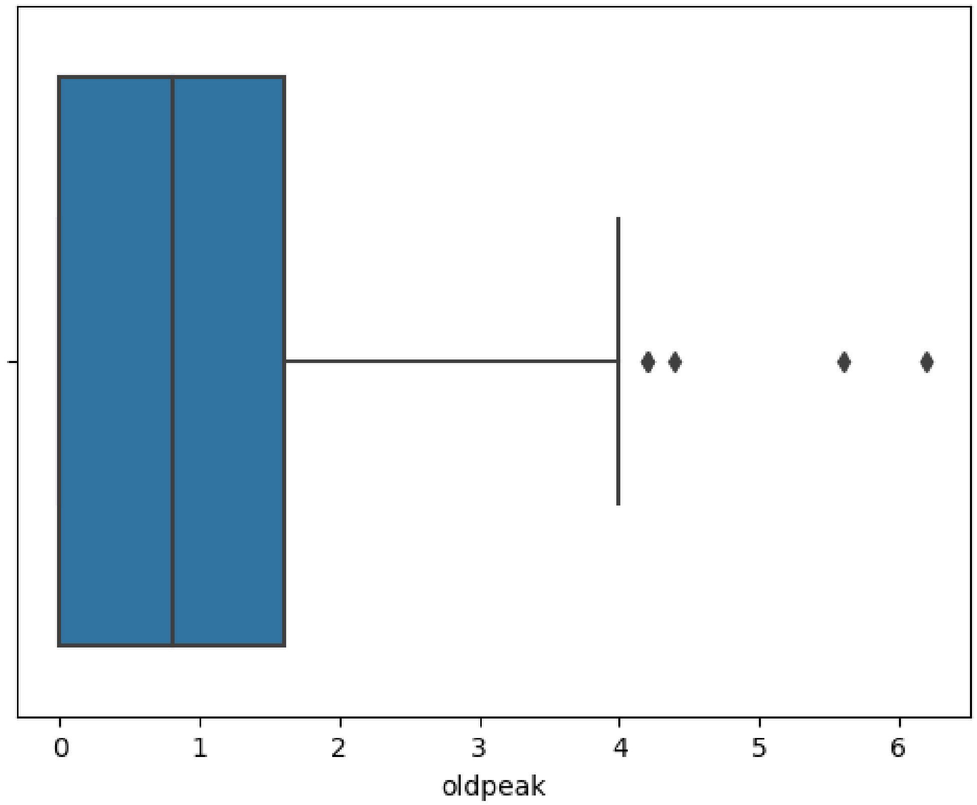
```
sns.boxenplot(df['oldpeak'])
plt.show()

sns.boxplot(df['oldpeak'])
plt.show()
```

```
C:\Users\Vinosh\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```

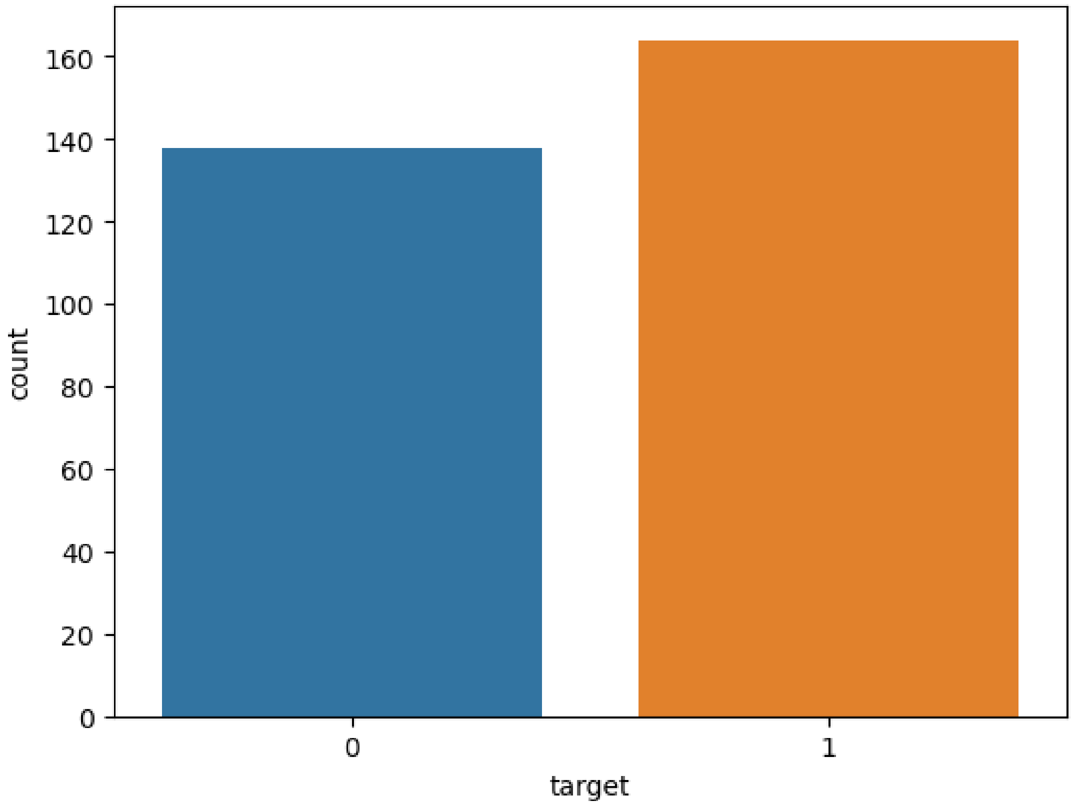


```
C:\Users\Vinosh\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```



```
[39]: sns.countplot(df['target'])
plt.show()
```

```
C:\Users\Vinosh\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```



[40]:

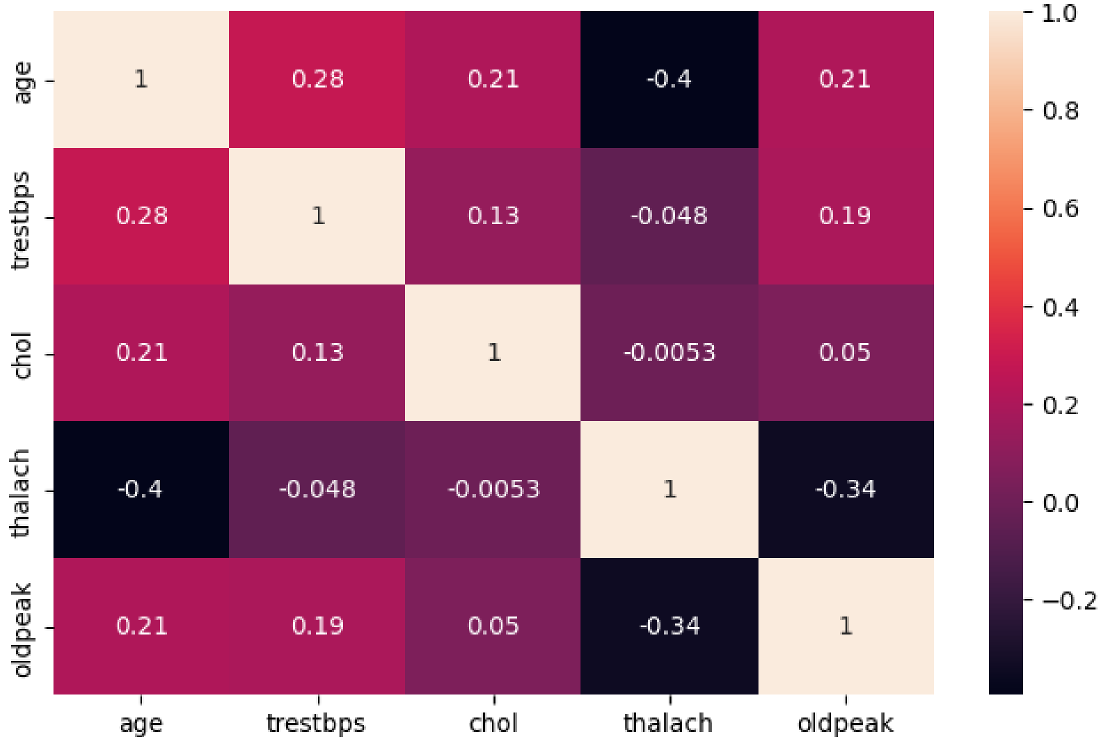
```
df[con_cols].corr()
```

[40]:

```
               age  trestbps      chol   thalach   oldpeak
age       1.000000  0.283121  0.207216 -0.395235  0.206040
trestbps  0.283121  1.000000  0.125256 -0.048023  0.194600
chol      0.207216  0.125256  1.000000 -0.005308  0.050086
thalach  -0.395235 -0.048023 -0.005308  1.000000 -0.342201
oldpeak   0.206040  0.194600  0.050086 -0.342201  1.000000
```

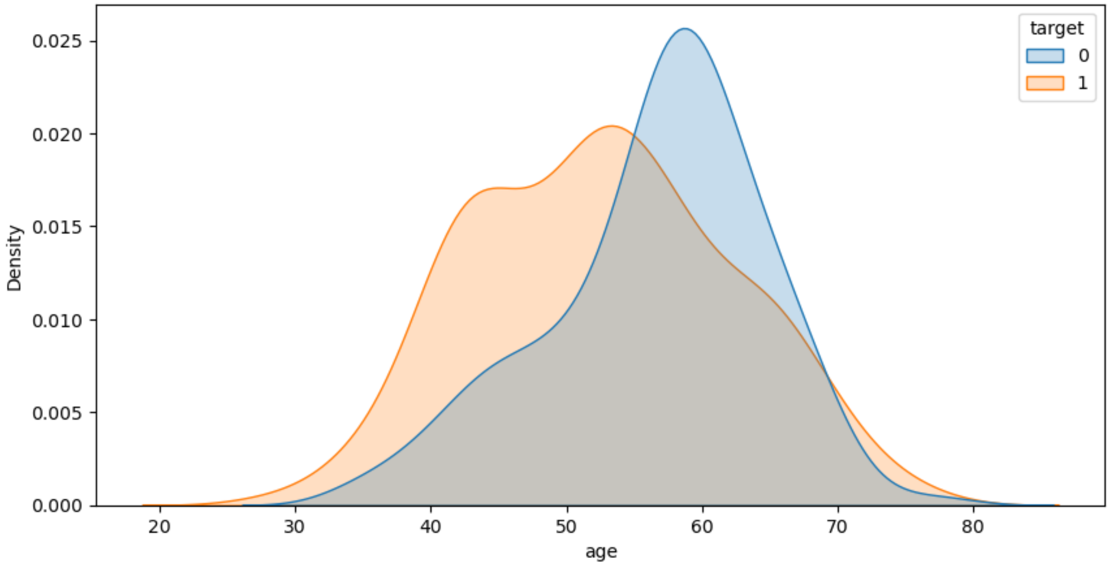
[41]:

```
plt.figure(figsize=(8,5))
sns.heatmap(df[con_cols].corr(),annot=True)
plt.show()
```

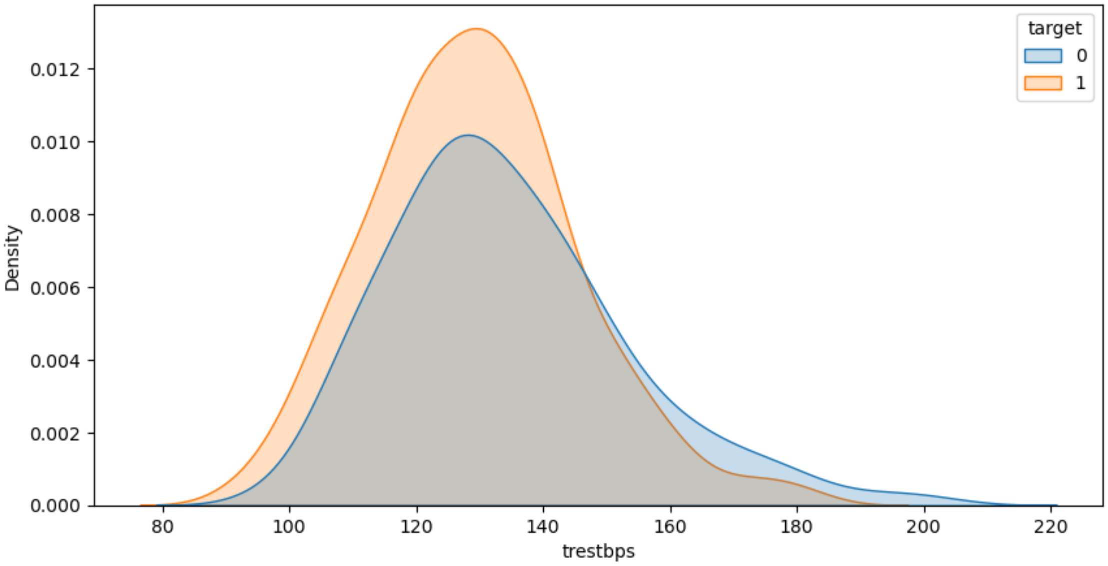


[42]:

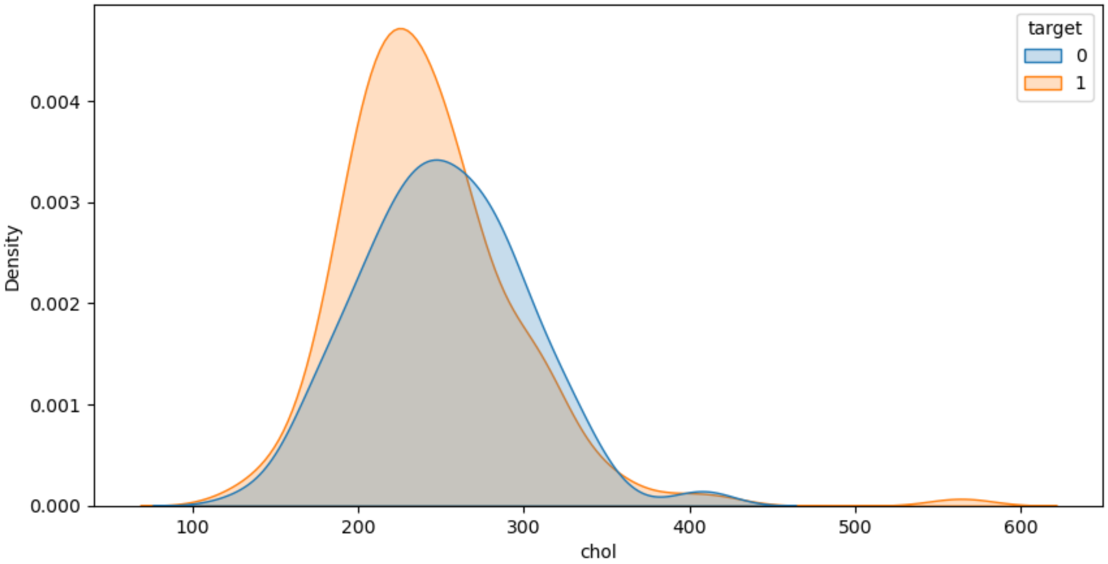
```
plt.figure(figsize=(10,5))
sns.kdeplot(df['age'],hue=df['target'],fill=True)
plt.show()
```



[43]:
```
plt.figure(figsize=(10,5))
sns.kdeplot(df['trestbps'],hue=df['target'],fill=True)
plt.show()
```

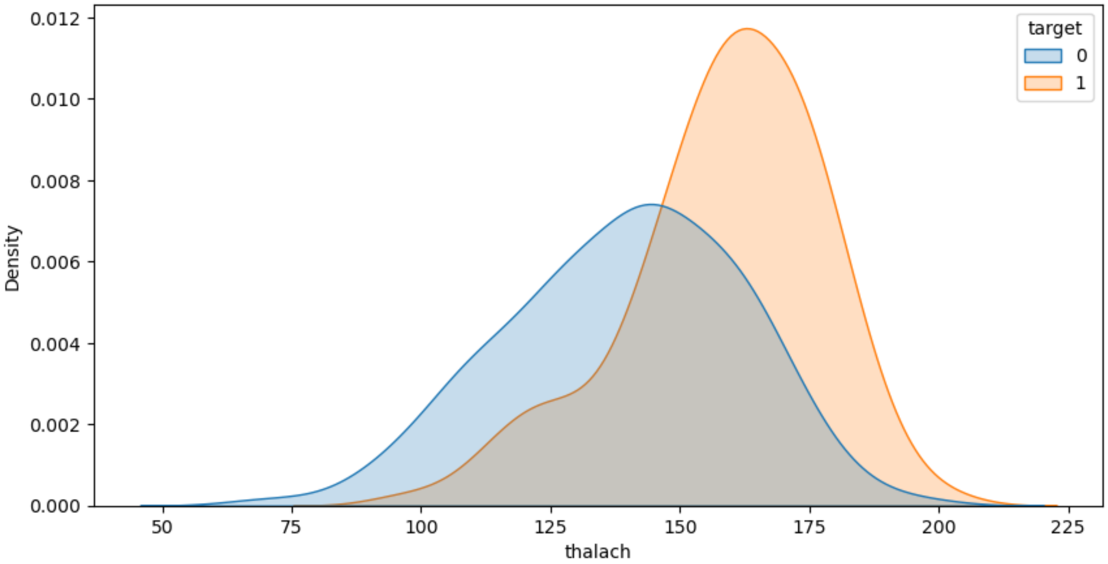


[44]:
```
plt.figure(figsize=(10,5))
sns.kdeplot(df['chol'],hue=df['target'],fill=True)
plt.show()
```



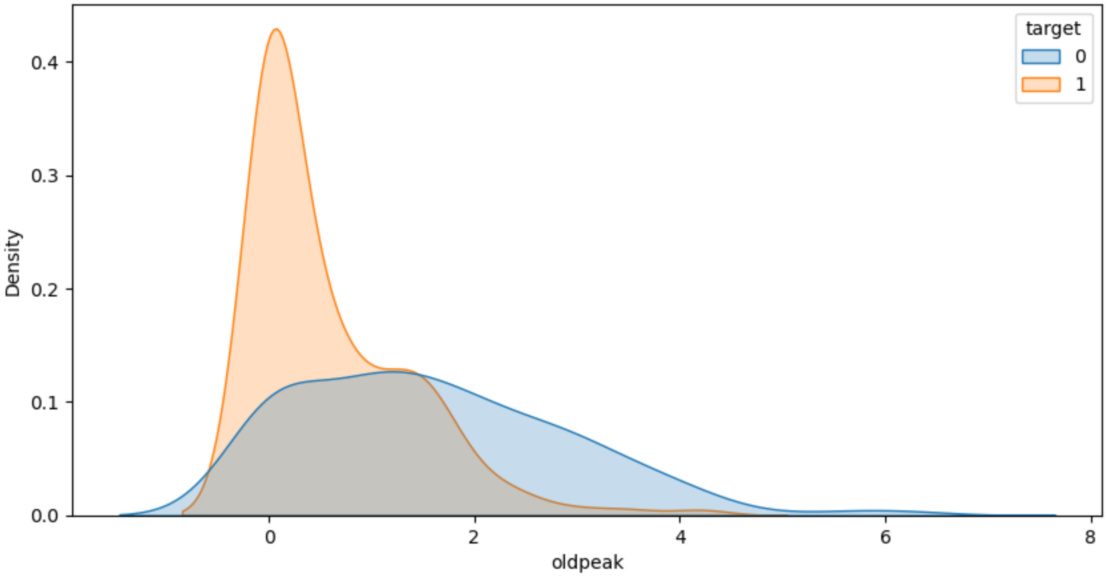
[45]:

```
plt.figure(figsize=(10,5))
sns.kdeplot(df['thalach'],hue=df['target'],fill=True)
plt.show()
```



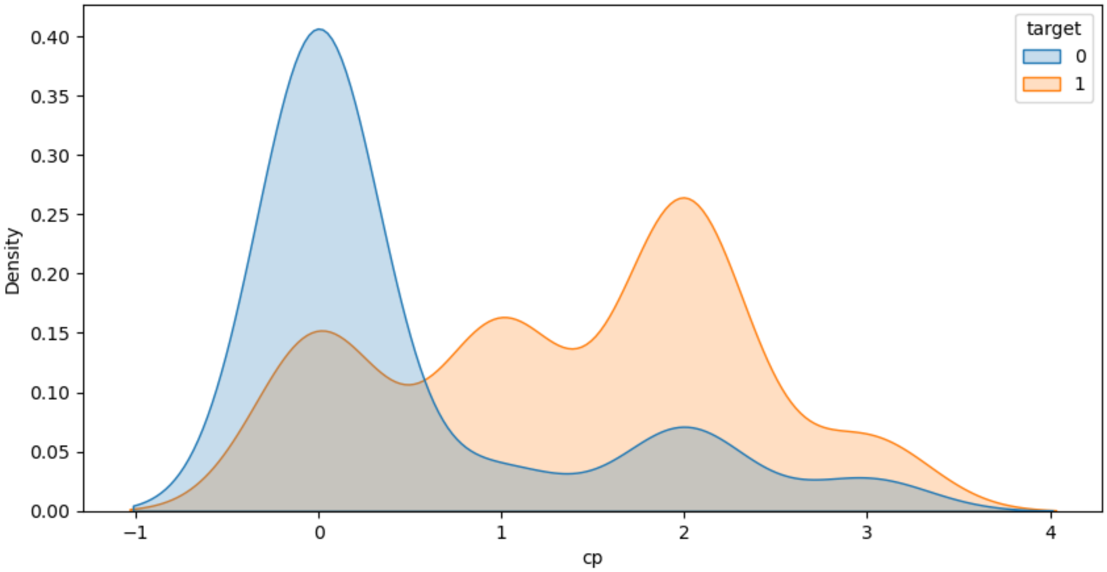
[46]:

```
plt.figure(figsize=(10,5))
sns.kdeplot(df['oldpeak'],hue=df['target'],fill=True)
plt.show()
```



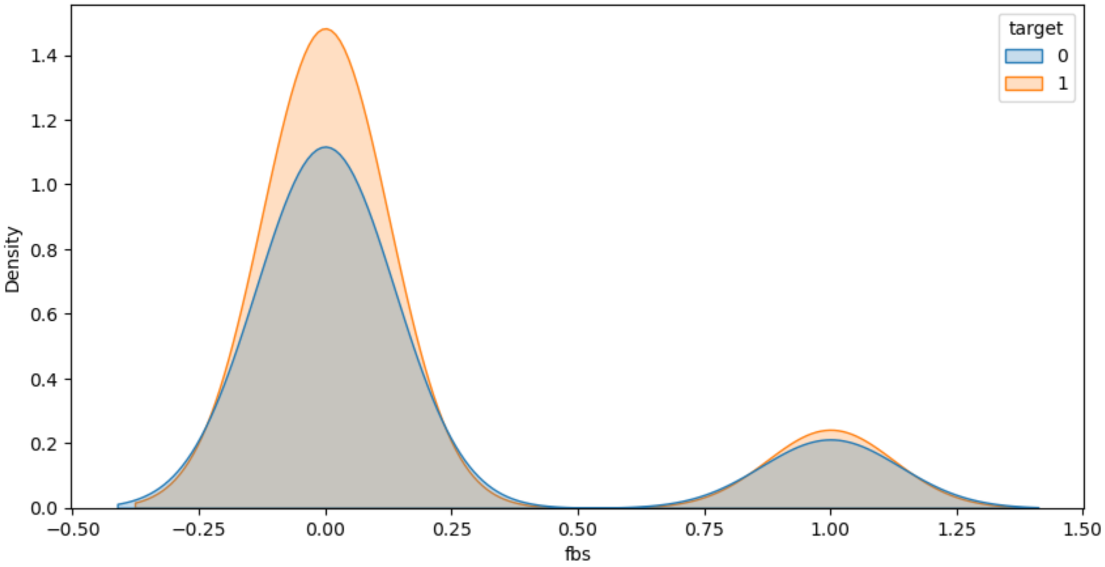
[47]:

```
plt.figure(figsize=(10,5))
sns.kdeplot(df['cp'],hue=df['target'],fill=True)
plt.show()
```



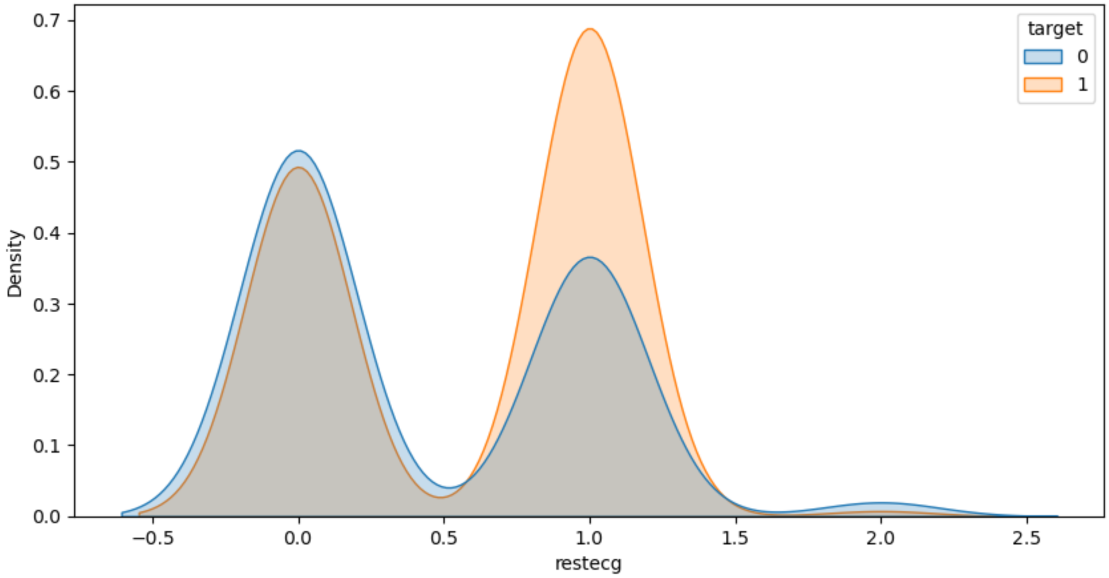
[48]:

```
plt.figure(figsize=(10,5))
sns.kdeplot(df['fbs'],hue=df['target'],fill=True)
plt.show()
```



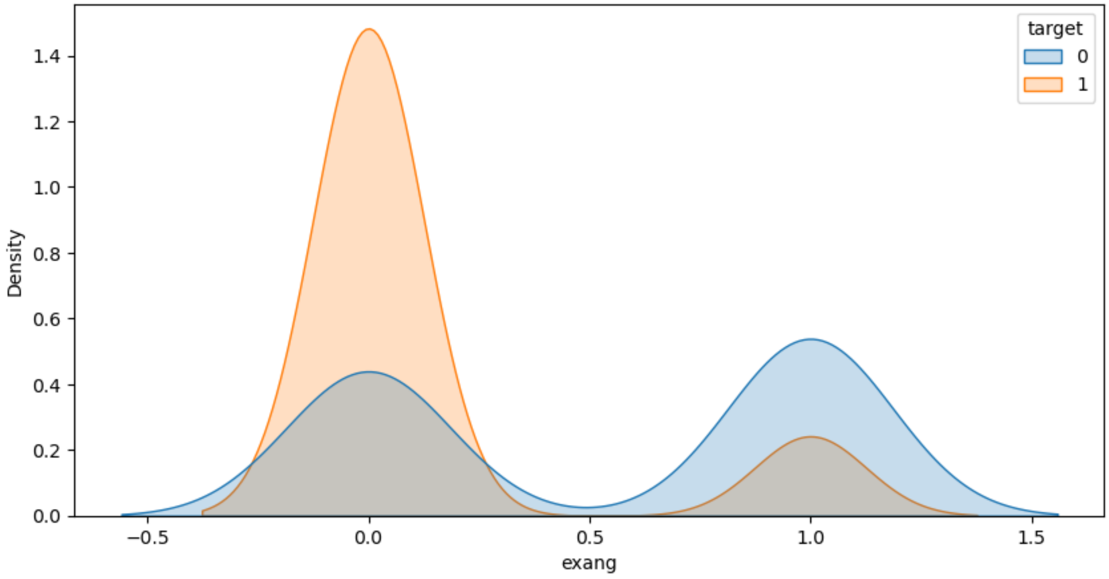
[49]:

```
plt.figure(figsize=(10,5))
sns.kdeplot(df['restecg'],hue=df['target'],fill=True)
plt.show()
```



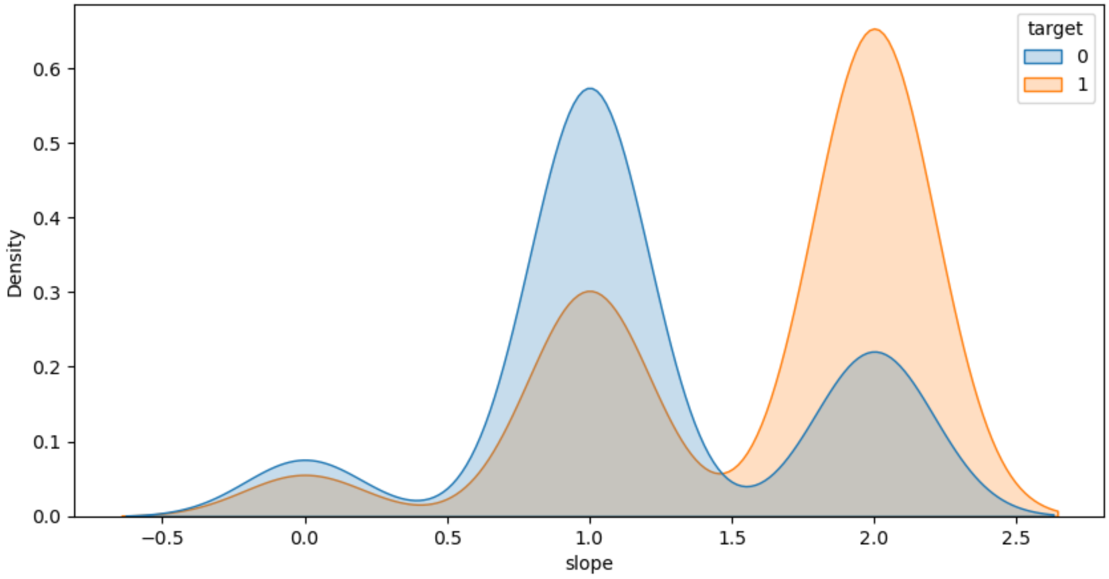
[50]:

```
plt.figure(figsize=(10,5))
sns.kdeplot(df['exang'],hue=df['target'],fill=True)
plt.show()
```



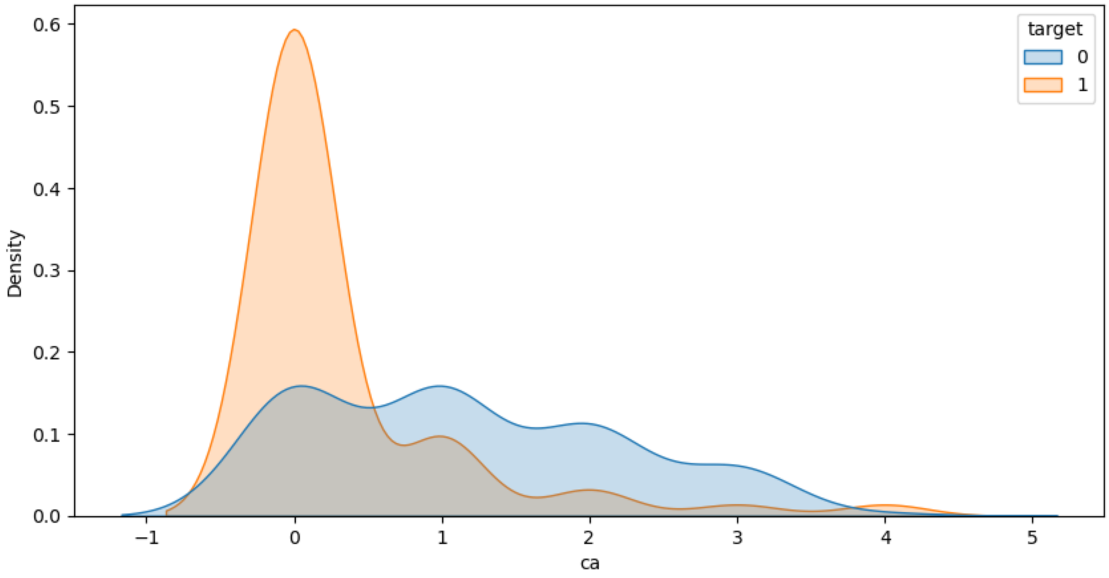
[51]:

```
plt.figure(figsize=(10,5))
sns.kdeplot(df['slope'],hue=df['target'],fill=True)
plt.show()
```



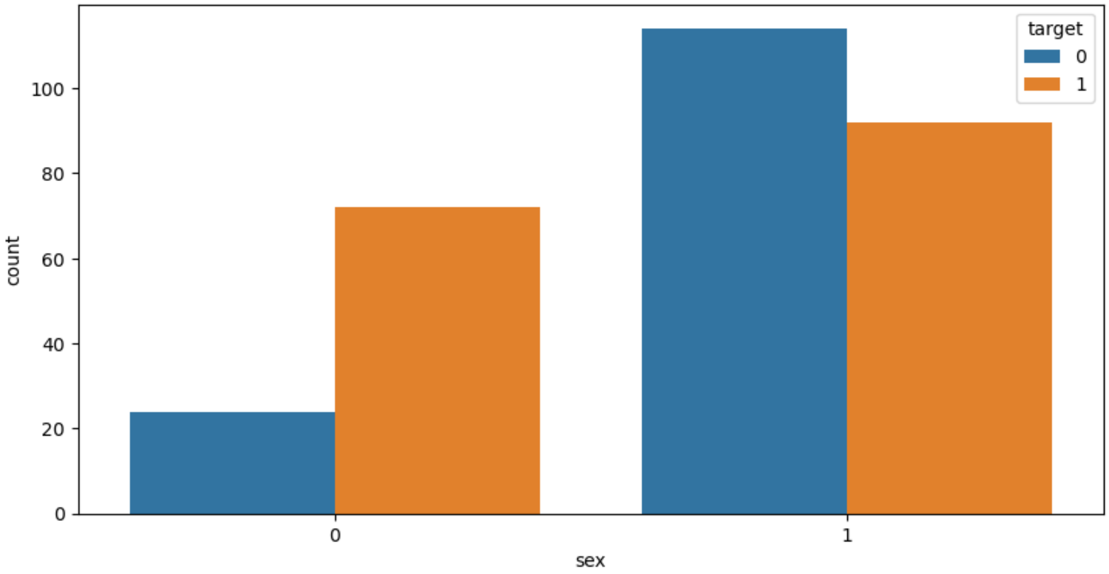
[52]:

```
plt.figure(figsize=(10,5))
sns.kdeplot(df['ca'],hue=df['target'],fill=True)
plt.show()
```

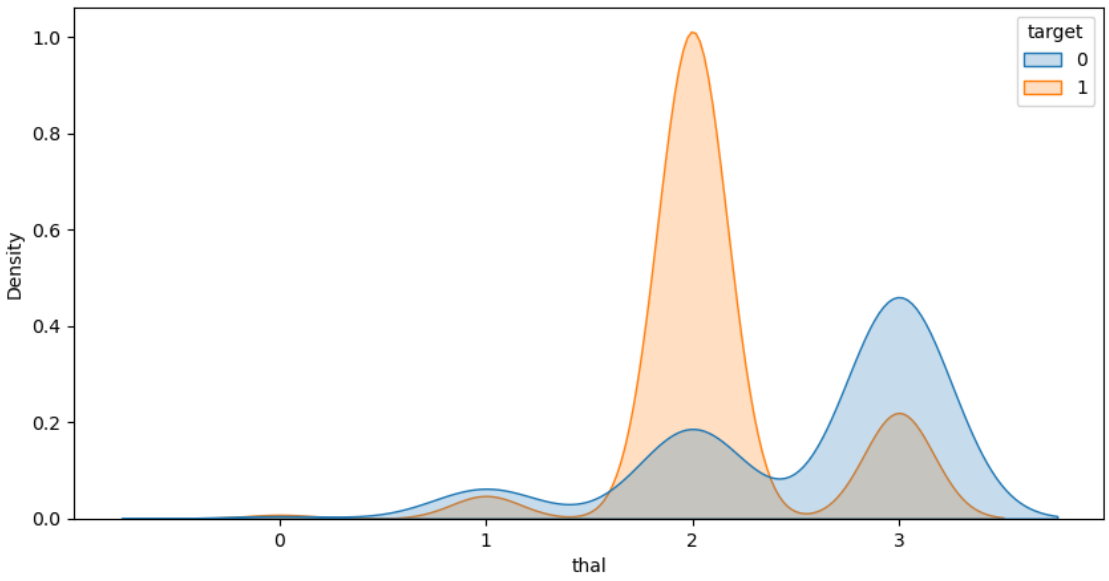


[53]:
```
plt.figure(figsize=(10,5))
sns.countplot(df['sex'],hue=df['target'])
plt.show()
```

```
C:\Users\Vinosh\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variable as a keyword arg: x. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```



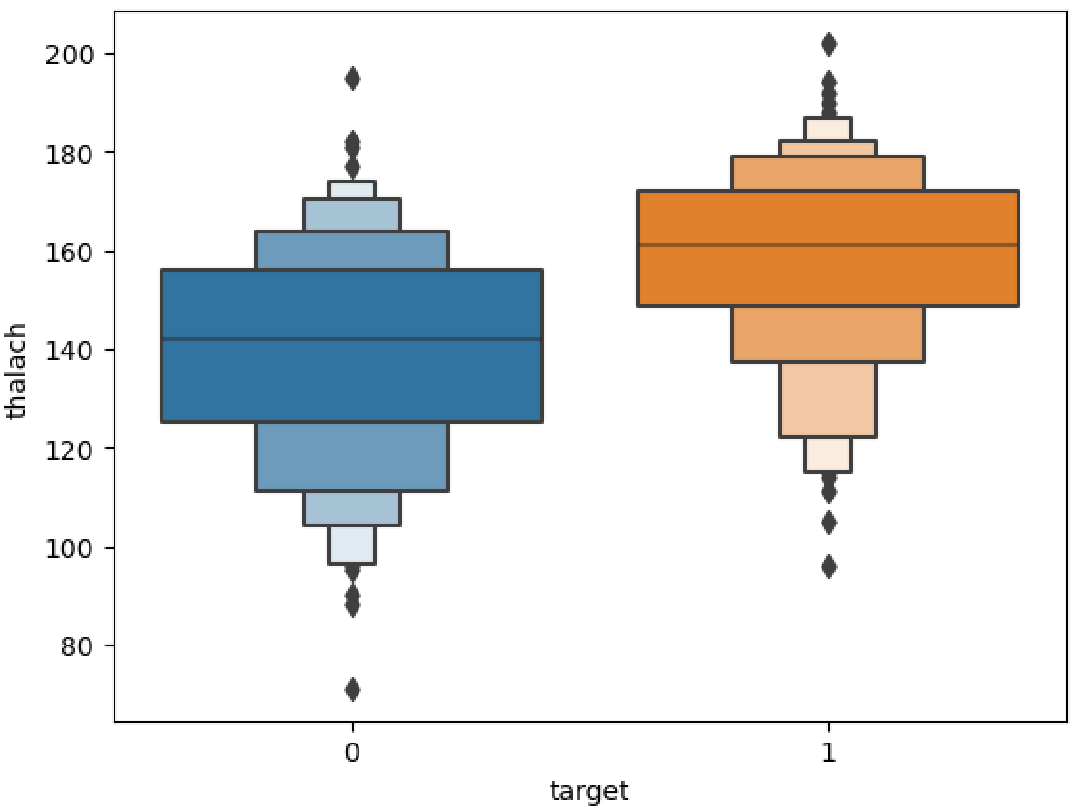
[54]:
```
plt.figure(figsize=(10,5))
sns.kdeplot(df['thal'],hue=df['target'],fill=True)
plt.show()
```

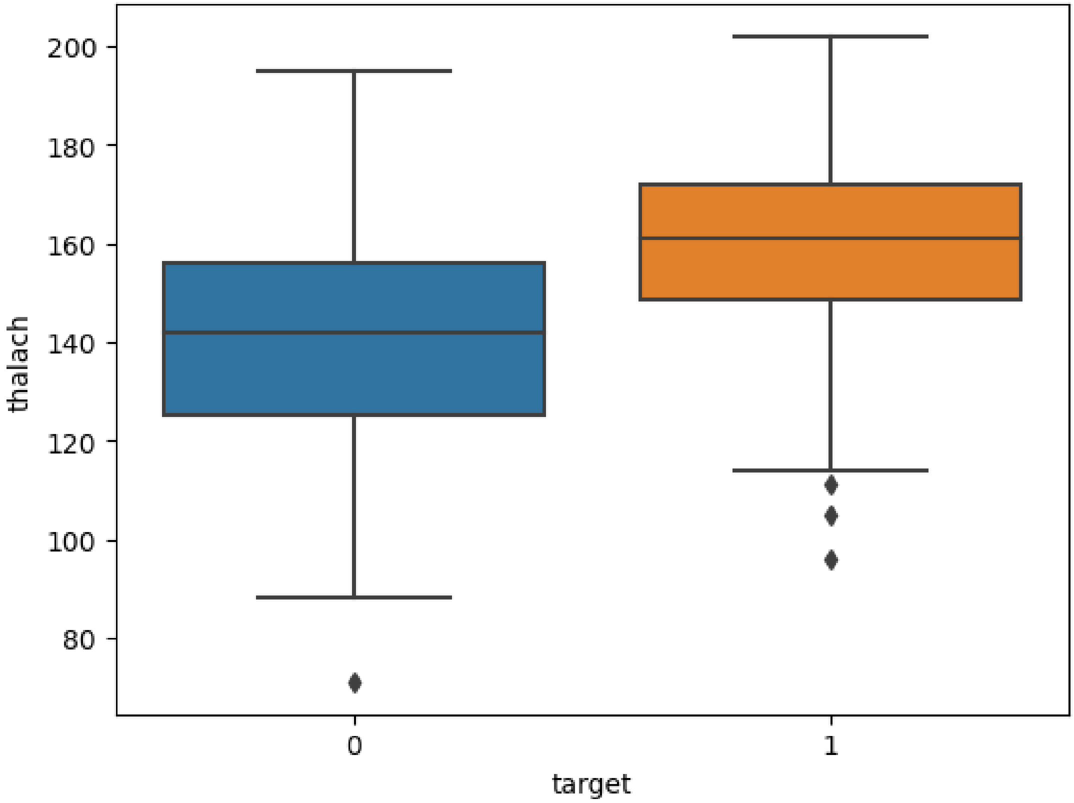


[55]:

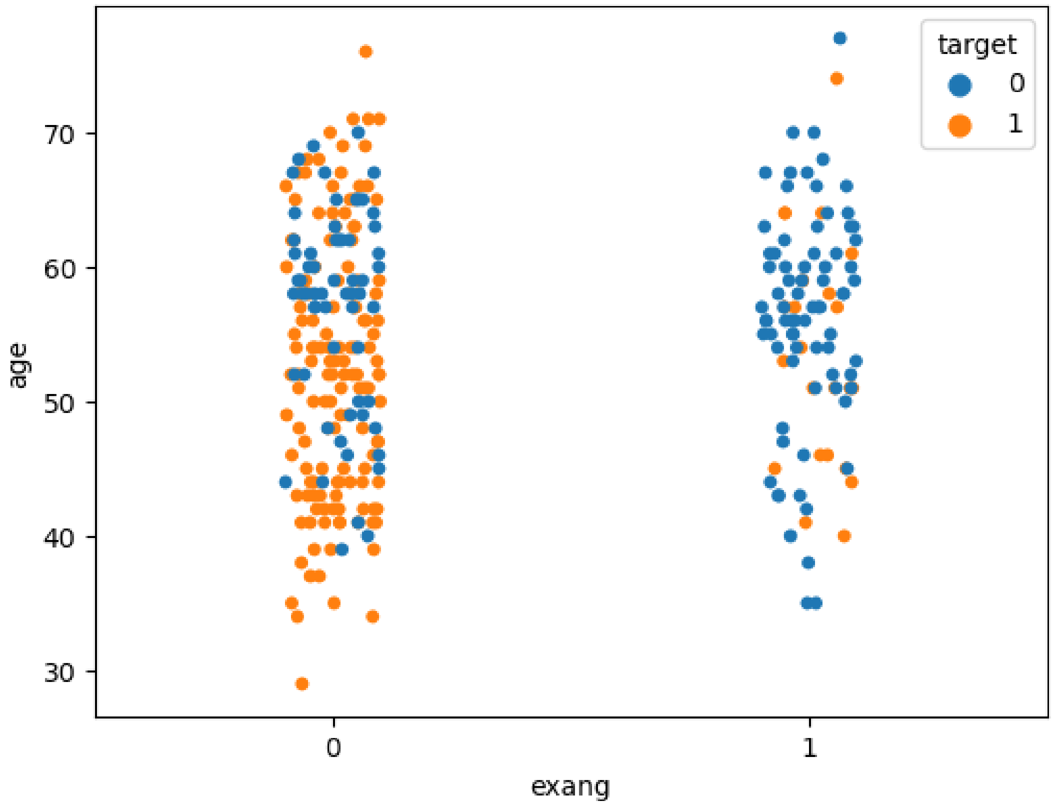
```
sns.boxenplot(y=df['thalach'],x=df['target'])
plt.show()

sns.boxplot(y=df['thalach'],x=df['target'])
plt.show()
```

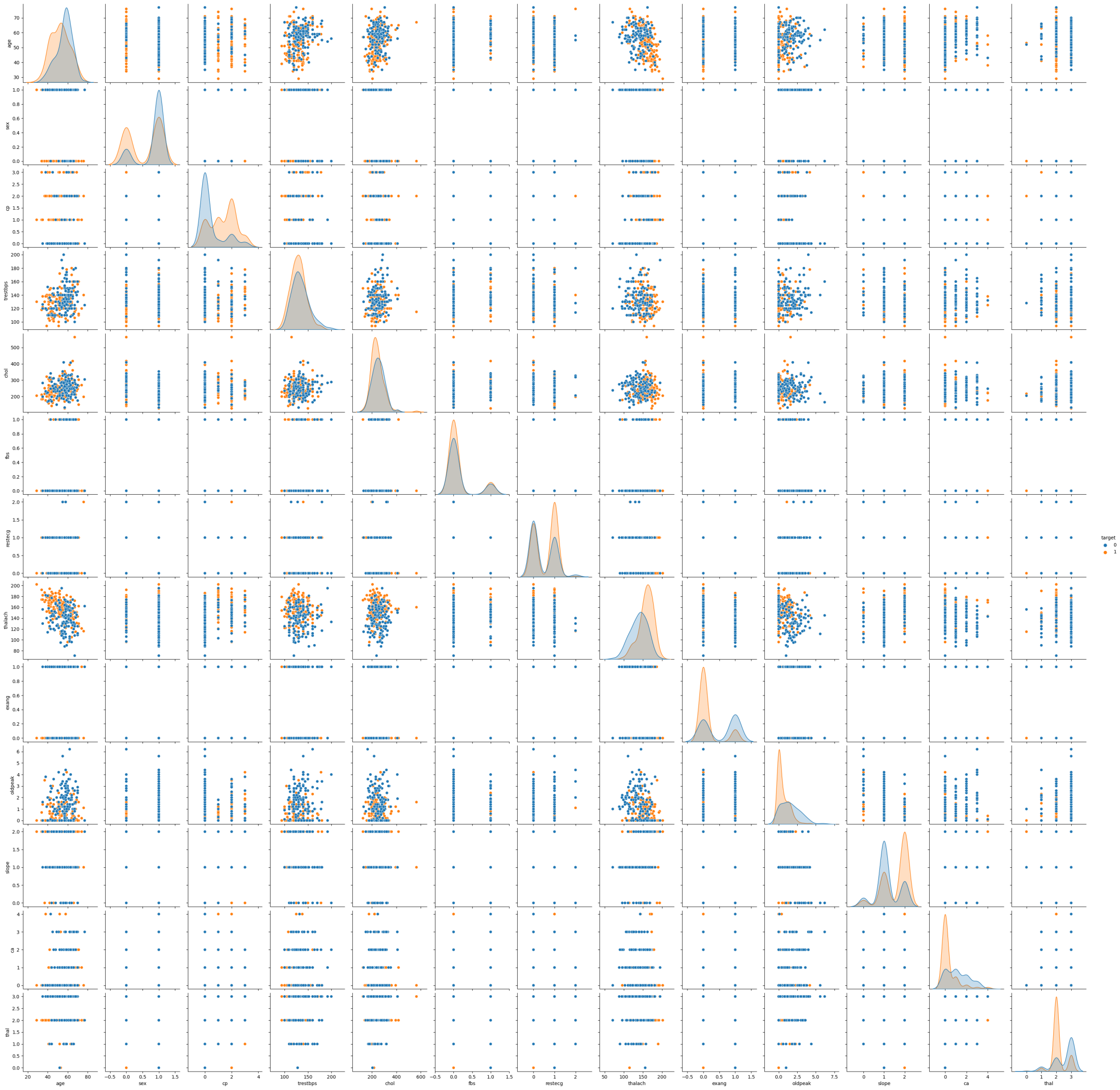

200
180
160
140
120
100
80
thalach
0
1
target



[56]:
```
sns.stripplot(x=df['exang'],y=df['age'],hue=df['target'])
plt.show()
```



[57]:
```
sns.pairplot(df,hue='target')
plt.show()
```



4 3. Build a baseline model to predict the risk of a heart attack using a logistic regression and random forest and explore the results while using correlation analysis and logistic regression (leveraging standard error and p-values from statsmodels) for feature selection

[58]:
```
df1 = df
```

[59]:
```
df1.head()
```

[59]:

```
   age  sex  cp  trestbps  chol  fbs  restecg  thalach  exang  oldpeak  slope  \
0   63    1   3       145   233    1        0      150      0      2.3      0
1   37    1   2       130   250    0        1      187      0      3.5      0
2   41    0   1       130   204    0        0      172      0      1.4      2
3   56    1   1       120   236    0        1      178      0      0.8      2
4   57    0   0       120   354    0        1      163      1      0.6      2

   ca  thal  target
0   0     1       1
1   0     2       1
2   0     2       1
3   0     2       1
4   0     2       1
```

[60]:

```
cat_cols = ['sex','cp','fbs','restecg','exang','slope','ca','thal']
con_cols = ['age','trestbps','chol','thalach','oldpeak']
```

[61]:

```
df1 = pd.get_dummies(df1, columns=cat_cols)
```

[62]:

```
df1.head()
```

[62]:

```
   age  trestbps  chol  thalach  oldpeak  target  sex_0  sex_1  cp_0  cp_1  \
0   63       145   233      150      2.3       1      0      1     0     0
1   37       130   250      187      3.5       1      0      1     0     0
2   41       130   204      172      1.4       1      1      0     0     1
3   56       120   236      178      0.8       1      0      1     0     1
4   57       120   354      163      0.6       1      1      0     1     0

   …  slope_2  ca_0  ca_1  ca_2  ca_3  ca_4  thal_0  thal_1  thal_2  thal_3
0  …        0     1     0     0     0     0       0       1       0       0
1  …        0     1     0     0     0     0       0       0       1       0
2  …        1     1     0     0     0     0       0       0       1       0
3  …        1     1     0     0     0     0       0       0       1       0
4  …        1     1     0     0     0     0       0       0       1       0

[5 rows x 31 columns]
```

[63]:

```
X = df1.drop(['target'],axis=1)
```

[64]:

```
X
```

[64]:

```
     age  trestbps  chol  thalach  oldpeak  sex_0  sex_1  cp_0  cp_1  cp_2  \
0     63       145   233      150      2.3      0      1     0     0     0
1     37       130   250      187      3.5      0      1     0     0     1
2     41       130   204      172      1.4      1      0     0     1     0
3     56       120   236      178      0.8      0      1     0     1     0
4     57       120   354      163      0.6      1      0     1     0     0
..   …        …     …        …        …      …      …     …     …     …
```

```
298   57       140   241      123      0.2      1      0     1     0     0
299   45       110   264      132      1.2      0      1     0     0     0
300   68       144   193      141      3.4      0      1     1     0     0
301   57       130   131      115      1.2      0      1     1     0     0
302   57       130   236      174      0.0      1      0     0     1     0

     …  slope_2  ca_0  ca_1  ca_2  ca_3  ca_4  thal_0  thal_1  thal_2  \
0    …        0     1     0     0     0     0       0       1       0
1    …        0     1     0     0     0     0       0       0       1
2    …        1     1     0     0     0     0       0       0       1
3    …        1     1     0     0     0     0       0       0       1
4    …        1     1     0     0     0     0       0       0       1
..   …      …   …   …   …   …   …     …     …     …
298  …        0     1     0     0     0     0       0       0       0
299  …        0     1     0     0     0     0       0       0       0
300  …        0     0     0     1     0     0       0       0       0
301  …        0     0     1     0     0     0       0       0       0
302  …        0     0     1     0     0     0       0       0       1

     thal_3
0         0
1         0
2         0
3         0
4         0
..      …
298       1
299       1
300       1
301       1
302       0

[302 rows x 30 columns]
```

[65]:
```
y = df1['target']
```

[66]:
```
y
```

[66]:
```
0      1
1      1
2      1
3      1
4      1
      ..
298    0
299    0
300    0
```

```
301    0
302    0
Name: target, Length: 302, dtype: int64
```

[67]:
```
from sklearn.preprocessing import StandardScaler
```

[68]:
```
std = StandardScaler()
```

[69]:
```
X[con_cols] = std.fit_transform(X[con_cols])
```

[70]:
```
X.head()
```

[70]:
```
        age  trestbps      chol   thalach   oldpeak  sex_0  sex_1  cp_0  cp_1  \
0  0.949794  0.764066 -0.261285  0.018826  1.084022      0      1     0     0
1 -1.928548 -0.091401  0.067741  1.636979  2.118926      0      1     0     0
2 -1.485726 -0.091401 -0.822564  0.980971  0.307844      1      0     0     1
3  0.174856 -0.661712 -0.203222  1.243374 -0.209608      0      1     0     1
4  0.285561 -0.661712  2.080602  0.587366 -0.382092      1      0     1     0

   cp_2  …  slope_2  ca_0  ca_1  ca_2  ca_3  ca_4  thal_0  thal_1  thal_2  \
0     0  …        0     1     0     0     0     0       0       1       0
1     1  …        0     1     0     0     0     0       0       0       1
2     0  …        1     1     0     0     0     0       0       0       1
3     0  …        1     1     0     0     0     0       0       0       1
4     0  …        1     1     0     0     0     0       0       0       1

   thal_3
0       0
1       0
2       0
3       0
4       0

[5 rows x 30 columns]
```

[71]:
```
from sklearn.model_selection import train_test_split
```

[72]:
```
X_train,X_test,y_train,y_test = train_test_split(X,y,test_size=0.
 ↪20,random_state=42)
```

[73]:
```
from sklearn.linear_model import LogisticRegression
```

[74]:
```
lr = LogisticRegression()
```

[75]:
```
lr.fit(X_train,y_train)
```

[75]:
```
LogisticRegression()
```

[76]:

```
from sklearn.feature_selection import f_regression
```

[77]:

```
reg_score = pd.DataFrame(f_regression(X_train,y_train))
reg_score
```

[77]:

```
           0         1         2             3             4          5  \
0  10.979172  5.790709  0.315221  4.680671e+01  5.107591e+01  23.169146
1   0.001064  0.016871  0.575020  6.520819e-11  1.070977e-11   0.000003

           6             7          8          9  …            20  \
0  23.169146  6.881119e+01  12.878390  23.933569  …  4.136295e+01
1   0.000003  7.945327e-15   0.000403   0.000002  …  6.822119e-10

              21         22         23        24        25        26        27  \
0  6.764737e+01  17.902679  17.146113  8.001474  0.172190  0.825156  3.211829
1  1.257446e-14   0.000033   0.000048  0.005071  0.678545  0.364592  0.074373

              28            29
0  9.351766e+01  7.780579e+01
1  6.997584e-19  2.429851e-16

[2 rows x 30 columns]
```

[78]:

```
print('F-score :',reg_score[0:])
```

```
F-score :            0         1         2             3             4          5
\
0  10.979172  5.790709  0.315221  4.680671e+01  5.107591e+01  23.169146
1   0.001064  0.016871  0.575020  6.520819e-11  1.070977e-11   0.000003

           6             7          8          9  …            20  \
0  23.169146  6.881119e+01  12.878390  23.933569  …  4.136295e+01
1   0.000003  7.945327e-15   0.000403   0.000002  …  6.822119e-10

              21         22         23        24        25        26        27  \
0  6.764737e+01  17.902679  17.146113  8.001474  0.172190  0.825156  3.211829
1  1.257446e-14   0.000033   0.000048  0.005071  0.678545  0.364592  0.074373

              28            29
0  9.351766e+01  7.780579e+01
1  6.997584e-19  2.429851e-16

[2 rows x 30 columns]
```

[79]:

```
print('P-score :',reg_score[1:])
```

```
P-score :           0         1        2             3             4         5
\
1  0.001064  0.016871  0.57502  6.520819e-11  1.070977e-11  0.000003

          6             7         8         9  …            20  \
1  0.000003  7.945327e-15  0.000403  0.000002  …  6.822119e-10

             21        22        23        24        25        26        27  \
1  1.257446e-14  0.000033  0.000048  0.005071  0.678545  0.364592  0.074373

             28            29
1  6.997584e-19  2.429851e-16

[1 rows x 30 columns]
```

[80]:

```python
y_pred = lr.predict(X_test)
```

[81]:

```python
from sklearn.metrics import accuracy_score, confusion_matrix,␣
 ↪classification_report
```

[82]:

```python
print('Accuracy Score :',accuracy_score(y_test,y_pred)*100)
```

```
Accuracy Score : 88.52459016393442
```

[83]:

```python
print(confusion_matrix(y_test,y_pred))
```

```
[[27  2]
 [ 5 27]]
```

[84]:

```python
print(classification_report(y_test,y_pred))
```

```
              precision    recall  f1-score   support

           0       0.84      0.93      0.89        29
           1       0.93      0.84      0.89        32

    accuracy                           0.89        61
   macro avg       0.89      0.89      0.89        61
weighted avg       0.89      0.89      0.89        61
```

Accuracy score from Logistic Regression is 88.52%

[85]:

```python
X_train,X_test,y_train,y_test = train_test_split(X,y,test_size=0.
 ↪20,random_state=42)
```

[86]:

```python
from sklearn.ensemble import RandomForestClassifier
```

[87]:

```python
rdc = RandomForestClassifier()
```

[88]:

```python
rdc.fit(X_train,y_train)
```

[88]:
```
RandomForestClassifier()
```

[89]:
```
y_pred1 = rdc.predict(X_test)
```

[90]:
```
print('Accuracy Score :',accuracy_score(y_test,y_pred1)*100)
```

```
Accuracy Score : 85.24590163934425
```

[91]:
```
print(confusion_matrix(y_test,y_pred1))
```

```
[[26  3]
 [ 6 26]]
```

[92]:
```
print(classification_report(y_test,y_pred1))
```

```
              precision    recall  f1-score   support

           0       0.81      0.90      0.85        29
           1       0.90      0.81      0.85        32

    accuracy                           0.85        61
   macro avg       0.85      0.85      0.85        61
weighted avg       0.86      0.85      0.85        61
```

Accuracy score from Random Forest is 85.23%

[ ]:
```

```