Examining Factors Responsible for Heart Attacks

Project 3

DESCRIPTION

Data Analysis is the process of creating a story using the data for easy and effective communication. It mostly utilizes visualization methods like plots, charts, and tables to convey what the data holds beyond the formal modeling or hypothesis testing task.

Domain: Healthcare

Read the information given below and also refer to the data dictionary provided separately in an excel file to build your understanding.

Cardiovascular diseases are the leading cause of death globally. To identify the causes and to develop a system to predict heart attack in an effective manner is necessary. The presented data has all the information about all the relevant factors that might have an impact on heart health. The data needs to be explained in detail for any further analysis.

1. Preliminary analysis:

Perform preliminary data inspection and report the findings as to the structure of the data, missing values, duplicates, etc.

Based on the findings from the previous question remove duplicates (if any) , treat missing values using an appropriate strategy.

1. Prepare an informative report about the data explaining the distribution of the disease and the related factors. You could use the below approach to achieve the objective

Get a preliminary statistical summary of the data. Explore the measures of central tendencies and the spread of the data overall.

Identify the data variables which might be categorical in nature. Describe and explore these variables using appropriate tools e.g. count plot

Study the occurrence of CVD across Age.

Study the composition of overall patients w.r.t. Gender.

Can we detect a heart attack based on anomalies in the Resting Blood Pressure of the patient?

Describe the relationship between Cholesterol levels and our target variable.

What can be concluded about the relationship between peak exercising and the occurrence of a heart attack.

Is thalassemia a major cause of CVD?

How are the other factors determining the occurrence of CVD?

Use a pair plot to understand the relationship between all the given variables.

1. Build a baseline model to predict using a Logistic Regression and explore the results.

Project Task: Week 1

Importing, Understanding, and Inspecting Data :

Perform preliminary data inspection and report the findings as the structure of the data, missing values, duplicates, etc.

Based on the findings from the previous question, remove duplicates (if any) and treat missing values using an appropriate strategy.

Get a preliminary statistical summary of the data. Explore the measures of central tendencies and the spread of the data overall.

Importing, Understanding, and Inspecting Data :

Perform preliminary data inspection and report the findings as the structure of the data, missing values, duplicates, etc.

In [1]:
```
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
import seaborn as sns
import warnings
warnings.filterwarnings("ignore")
```

In [2]:
```
Description = pd.read_excel('variable description.xlsx')
print(Description)
```

```
     variable                                              description
0         age                                                age in years
1         sex                                  (1 = male; 0 = female)
2          cp                                        chest pain type
3    trestbps    resting blood pressure (in mm Hg on admission...
4        chol                               serum cholestoral in mg/dl
5         fbs    (fasting blood sugar > 120 mg/dl) (1 = true; ...
6     restecg                 resting electrocardiographic results
7     thalach                              maximum heart rate achieved
8       exang           exercise induced angina (1 = yes; 0 = no)
9     oldpeak    ST depression induced by exercise relative to...
10      slope           the slope of the peak exercise ST segment
11         ca    number of major vessels (0-3) colored by flou...
12       thal    3 = normal; 6 = fixed defect; 7 = reversable ...
13     target                                               1 or 0
```

In [3]:
```
data = pd.read_excel('data.xlsx')
```

In [4]:
```
data.head()
```

Out[4]:

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

In [5]:
```
data.shape
```

Out[5]:
```
(303, 14)
```

In [6]:
```
data.columns
```

Out[6]:
```
Index(['age', 'sex', 'cp', 'trestbps', 'chol', 'fbs', 'restecg', 'thalach',
       'exang', 'oldpeak', 'slope', 'ca', 'thal', 'target'],
      dtype='object')
```

Based on the findings from the previous question, remove duplicates (if any) and treat missing values using an appropriate strategy.

In [7]:
```
data.isnull().sum().any()
```

Out[7]:
```
False
```

In [8]:
```
data.duplicated().any()
```

Out[8]:
```
True
```

In [9]:
```
data[data.duplicated()]
```

Out[9]:

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca	thal
164	38	1	2	138	175	0	1	173	0	0.0	2	4	2

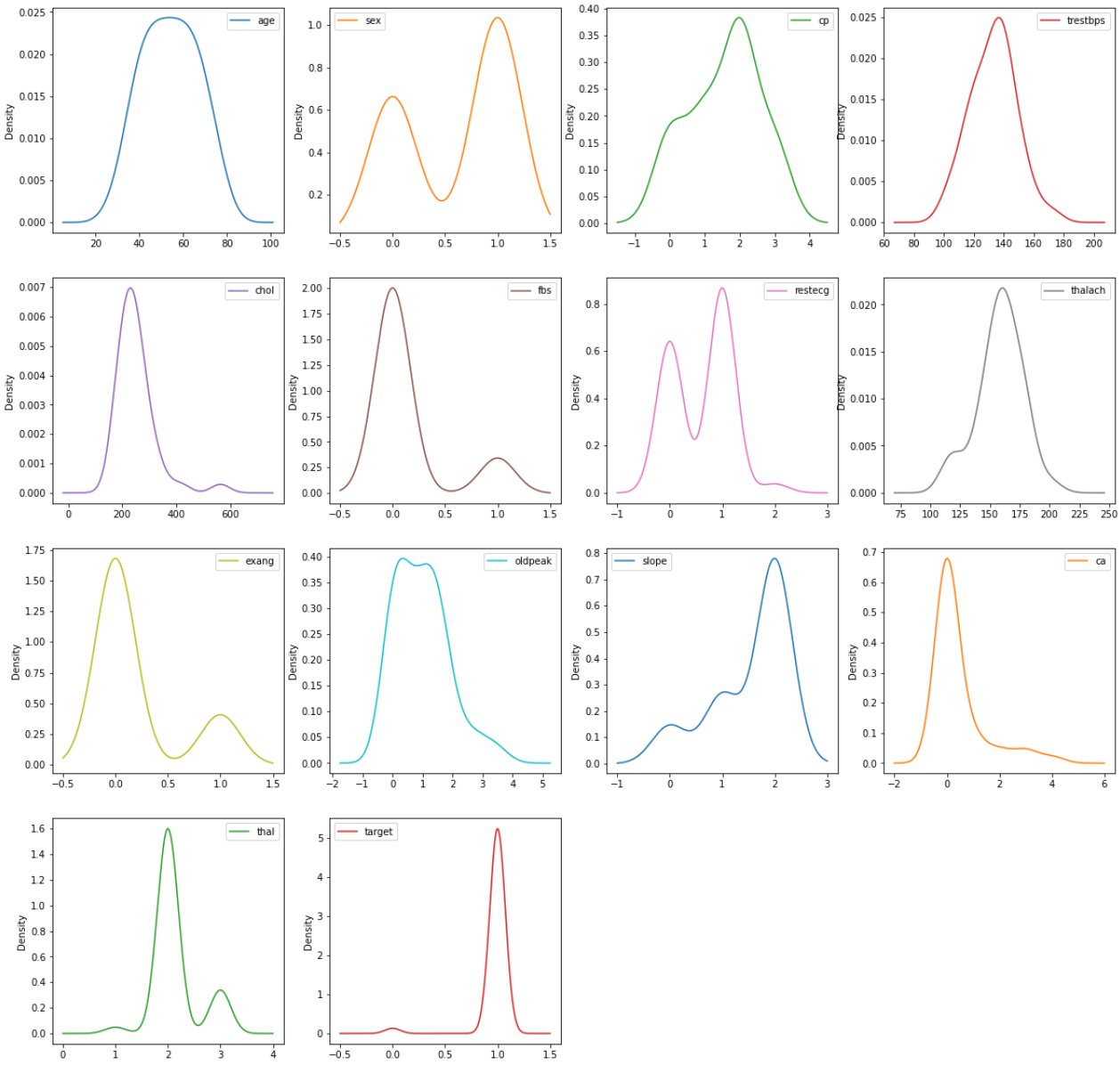
In [10]:
```
data.drop_duplicates(['age'], keep='first', inplace=True)
```

In [11]:
```
data.duplicated().any()
```

Out[11]:
```
False
```

Get a preliminary statistical summary of the data. Explore the measures of central tendencies and the spread of the data overall.

In [12]:
```
fig = plt.figure(figsize=(20, 20))
ax = fig.gca()
data.plot(kind='density', subplots=True, layout=(4, 4), sharex=False, ax=ax
plt.show()
```



In [13]:

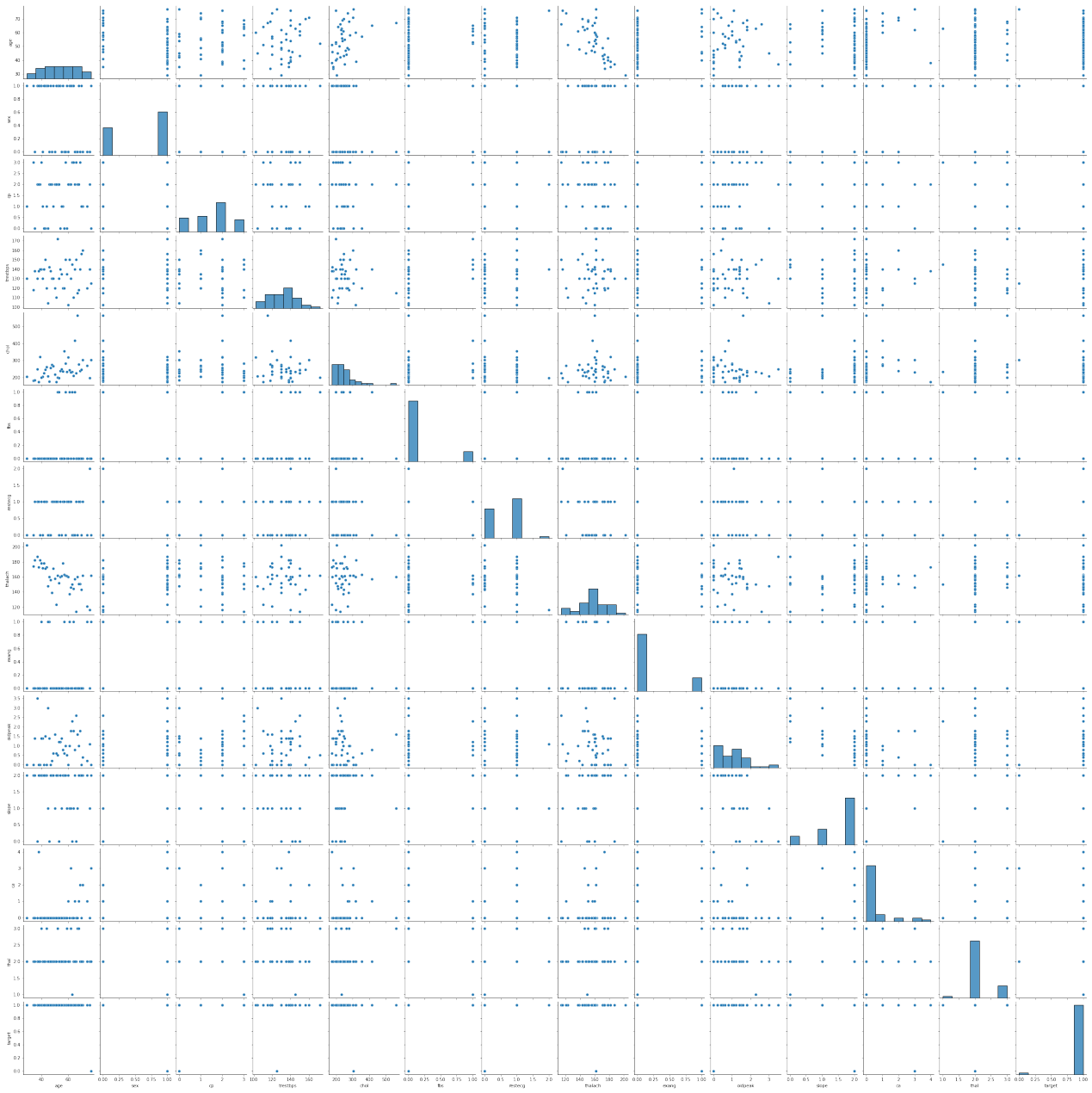
```
data.describe()
```

Out[13]:

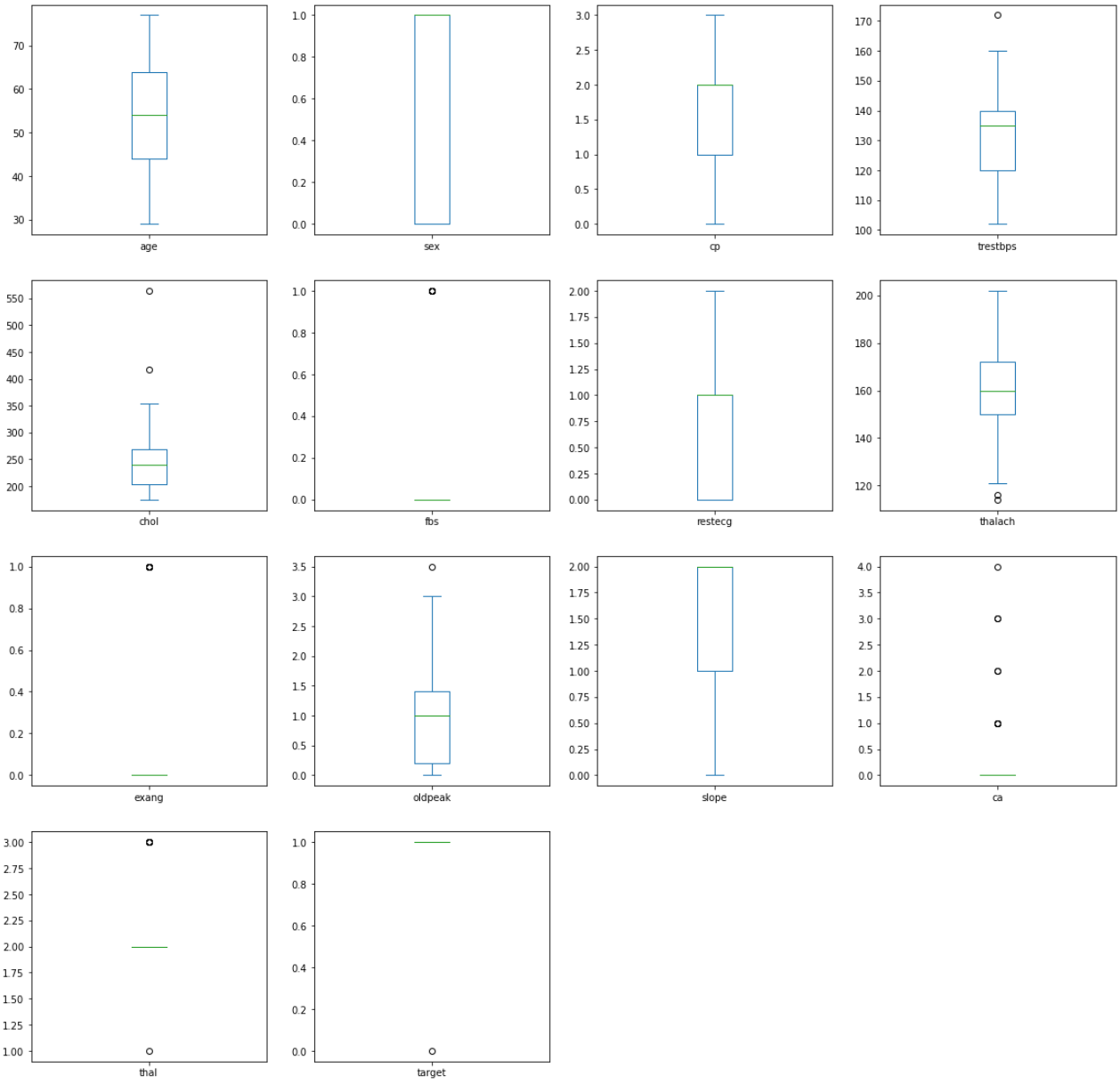
	age	sex	cp	trestbps	chol	fbs	restecg	
count	41.000000	41.000000	41.000000	41.000000	41.000000	41.000000	41.000000	
mean	54.024390	0.609756	1.560976	132.951220	251.195122	0.146341	0.609756	1
std	12.618415	0.493865	1.001219	15.159075	71.304705	0.357839	0.542128	
min	29.000000	0.000000	0.000000	102.000000	175.000000	0.000000	0.000000	1
25%	44.000000	0.000000	1.000000	120.000000	204.000000	0.000000	0.000000	1
50%	54.000000	1.000000	2.000000	135.000000	239.000000	0.000000	1.000000	1
75%	64.000000	1.000000	2.000000	140.000000	269.000000	0.000000	1.000000	1
max	77.000000	1.000000	3.000000	172.000000	564.000000	1.000000	2.000000	2

In [14]:
```
sns.pairplot(data)
```

Out[14]:
```
<seaborn.axisgrid.PairGrid at 0x7fd58b25acd0>
```

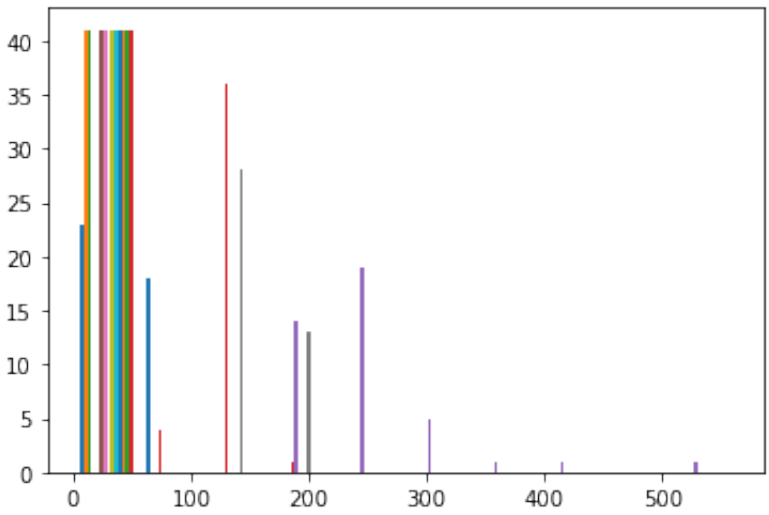


In [15]:
```
fig = plt.figure(figsize=(20, 20))
ax = fig.gca()
data.plot(kind='box', subplots=True, layout=(4, 4), sharex=False, ax=ax)
plt.show()
```



In [16]:

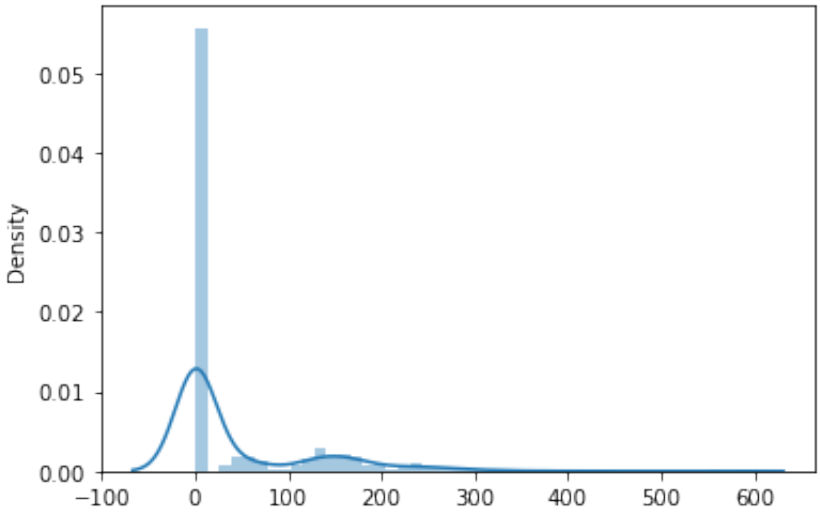
```
plt.hist(data);
```



In [17]:
```
import seaborn as sns
```

In [18]:
```
sns.distplot(data)
```

Out[18]:
```
<AxesSubplot:ylabel='Density'>
```



In [19]:
```
data.skew()
```

Out[19]:
```
age        -0.001766
sex        -0.467272
cp         -0.254509
trestbps    0.110403
chol        2.482868
fbs         2.078001
restecg     0.032971
thalach    -0.470243
exang       1.597700
oldpeak     0.866803
slope      -1.233994
ca          2.385096
thal        0.960198
target     -6.403124
dtype: float64
```

Performing EDA:

Identify the data variables which might be categorical in nature. Describe and explore these variables using appropriate tools. For example: count plot.

In [20]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 41 entries, 0 to 238
Data columns (total 14 columns):
 #   Column    Non-Null Count  Dtype  
---  ------    --------------  -----  
 0   age       41 non-null     int64  
 1   sex       41 non-null     int64  
 2   cp        41 non-null     int64  
 3   trestbps  41 non-null     int64  
 4   chol      41 non-null     int64  
 5   fbs       41 non-null     int64  
 6   restecg   41 non-null     int64  
 7   thalach   41 non-null     int64  
 8   exang     41 non-null     int64  
 9   oldpeak   41 non-null     float64
 10  slope     41 non-null     int64  
 11  ca        41 non-null     int64  
 12  thal      41 non-null     int64  
 13  target    41 non-null     int64  
dtypes: float64(1), int64(13)
memory usage: 5.9 KB
```

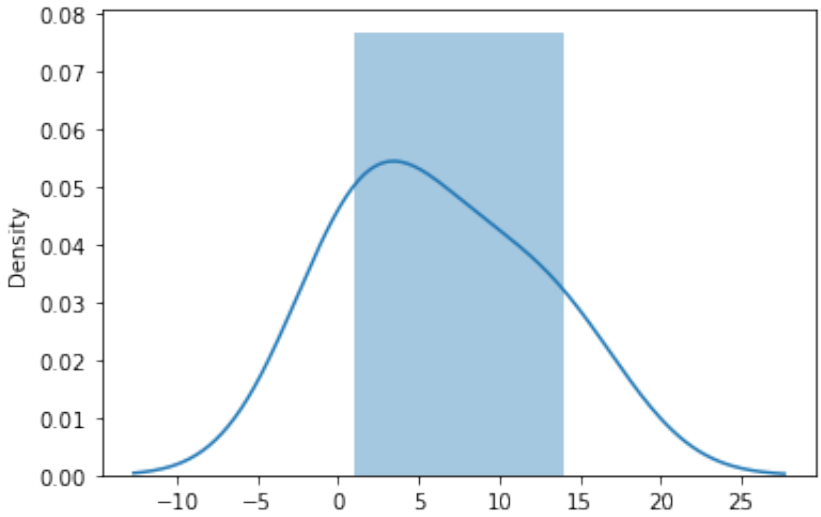
In [21]:
```
data.nunique() < 5
```

Out[21]:
```
age         False
sex          True
cp           True
trestbps    False
chol        False
fbs          True
restecg      True
thalach     False
exang        True
oldpeak     False
slope        True
ca          False
thal         True
target       True
dtype: bool
```

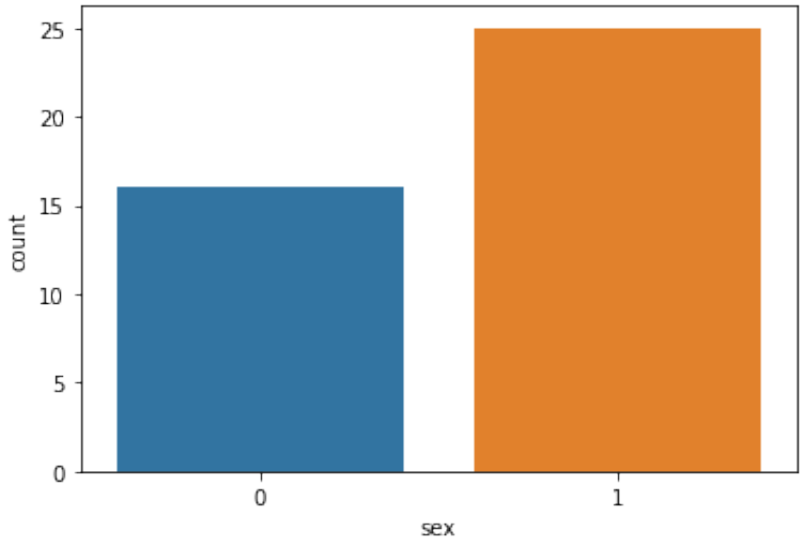
sex, cp, fbs, restecg, exang, slope, thal, target are categorical variables

In [22]:
```
sns.distplot((data.nunique() < 5).describe())
```

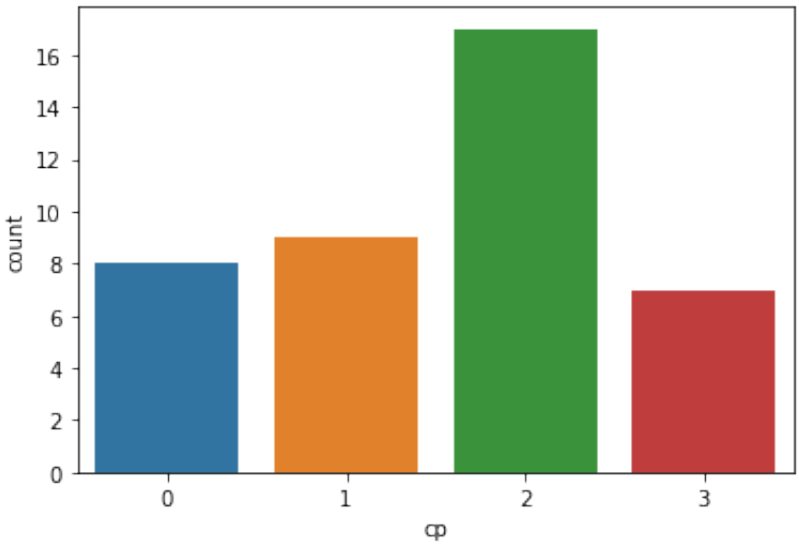
Out[22]: <AxesSubplot:ylabel='Density'>



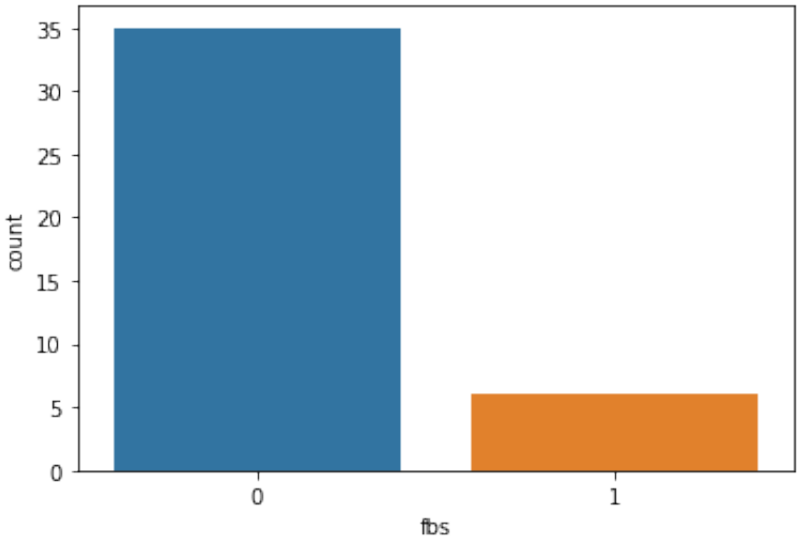
In [23]:
```
sns.countplot(x ='sex', data = data)
plt.show()
```



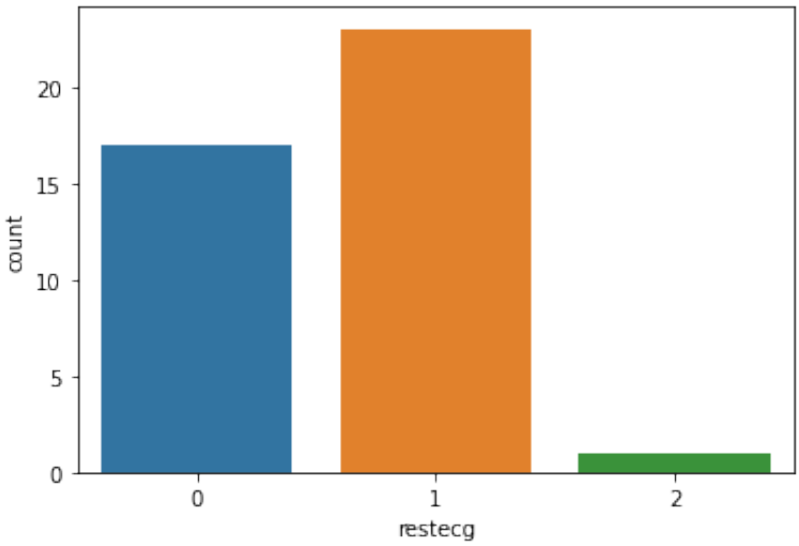
In [24]:
```
sns.countplot(x ='cp', data = data)
plt.show()
```



In [25]:
```
sns.countplot(x ='fbs',data = data)
plt.show()
```

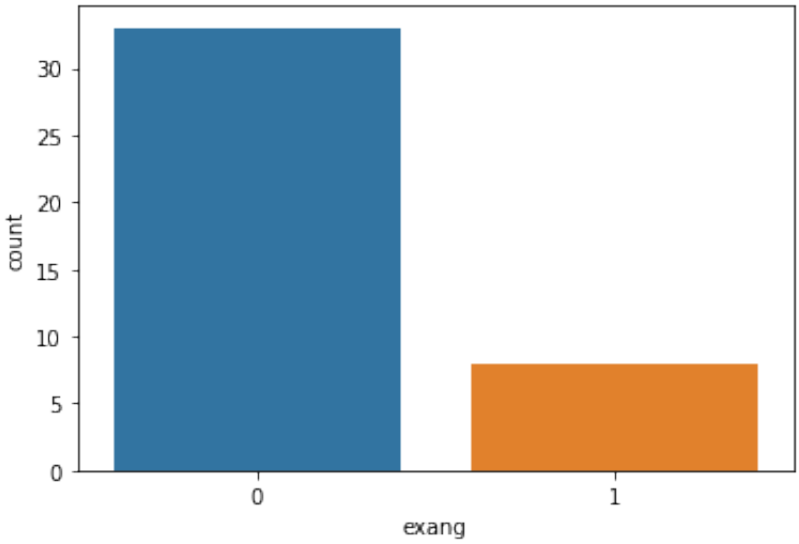


In [26]:
```
sns.countplot(x ='restecg', data = data)
plt.show()
```



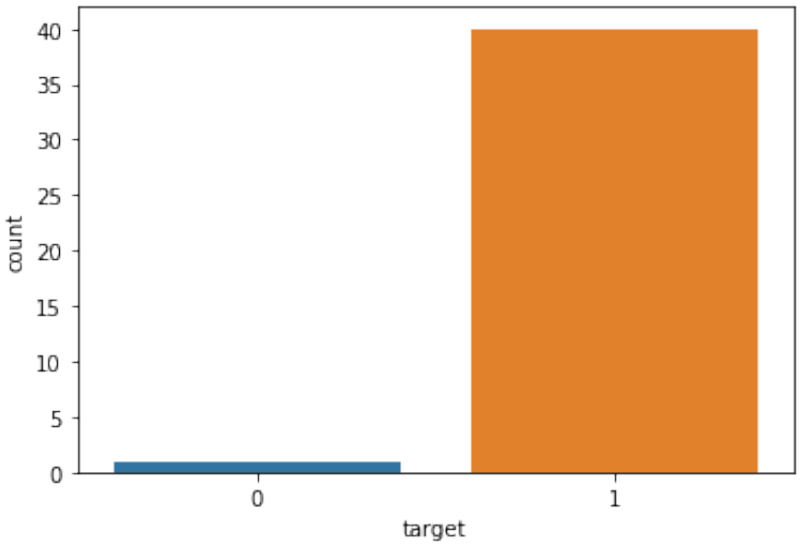
In [27]:

```
sns.countplot(x ='exang', data = data)
plt.show()
```



In [28]:

```
sns.countplot(x='target', data=data)
plt.show()
```



Study the occurrence of CVD across different ages.

In [29]:
```
data.head()
```

Out[29]:

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

In [30]:
```
data['age'].values
```

Out[30]:
```
array([63, 37, 41, 56, 57, 44, 52, 54, 48, 49, 64, 58, 50, 66, 43, 69, 59,
       42, 61, 40, 71, 51, 65, 53, 46, 45, 39, 47, 62, 34, 35, 29, 55, 60,
       67, 68, 74, 76, 70, 38, 77])
```

In [31]:
```
data['age'].value_counts()
```

Out[31]:
```
63    1
51    1
53    1
46    1
45    1
39    1
47    1
62    1
34    1
35    1
29    1
55    1
60    1
67    1
68    1
74    1
76    1
70    1
38    1
65    1
71    1
37    1
40    1
41    1
56    1
57    1
44    1
52    1
54    1
48    1
49    1
64    1
58    1
50    1
66    1
43    1
69    1
59    1
42    1
61    1
77    1
Name: age, dtype: int64
```

In [32]:
```
data['age'].sort_values(ascending=False)
```

Out[32]:
```
238    77
144    76
129    74
25     71
145    70
19     69
86     68
85     67
17     66
28     65
13     64
0      63
52     62
23     61
82     60
20     59
14     58
4      57
3      56
75     55
10     54
29     53
8      52
27     51
15     50
12     49
11     48
47     47
35     46
42     45
7      44
18     43
22     42
2      41
24     40
44     39
163    38
1      37
65     35
58     34
72     29
Name: age, dtype: int64
```

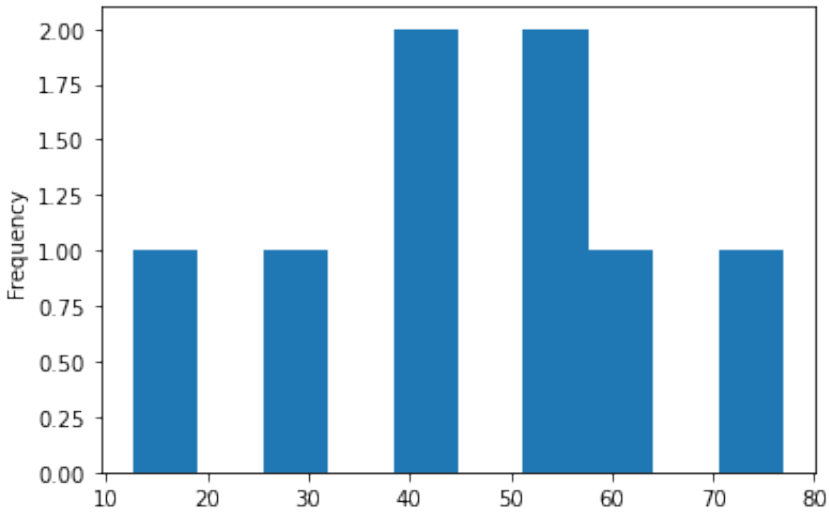
In [33]:
```
data['age'].nunique()
```

Out[33]:
```
41
```

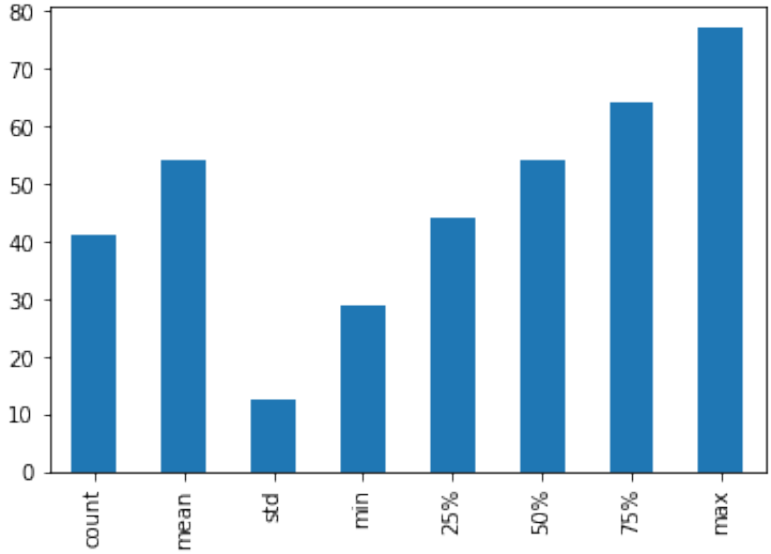
In [34]:
```
data['age'].describe().plot
```

Out[34]:
```
<pandas.plotting._core.PlotAccessor object at 0x7fd579a4bb20>
```

In [35]:
```
data['age'].describe().plot(kind='hist');
```

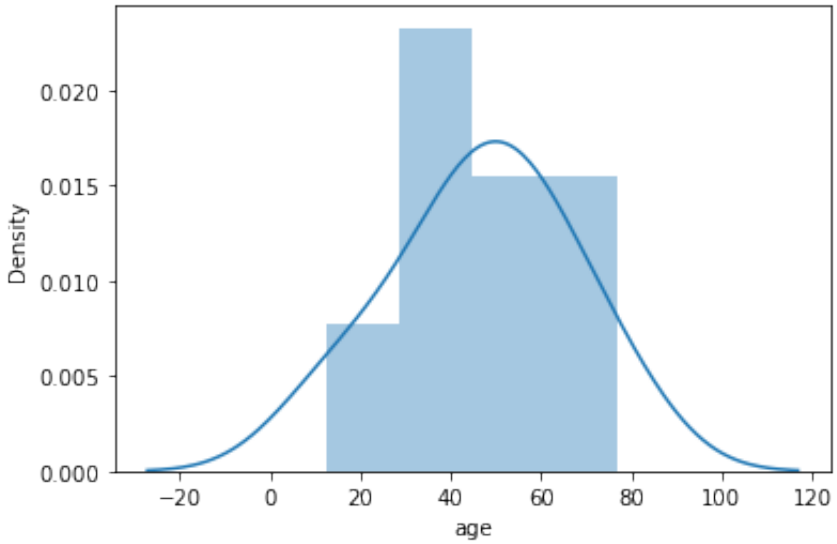


In [36]:
```
data['age'].describe().plot(kind='bar');
```



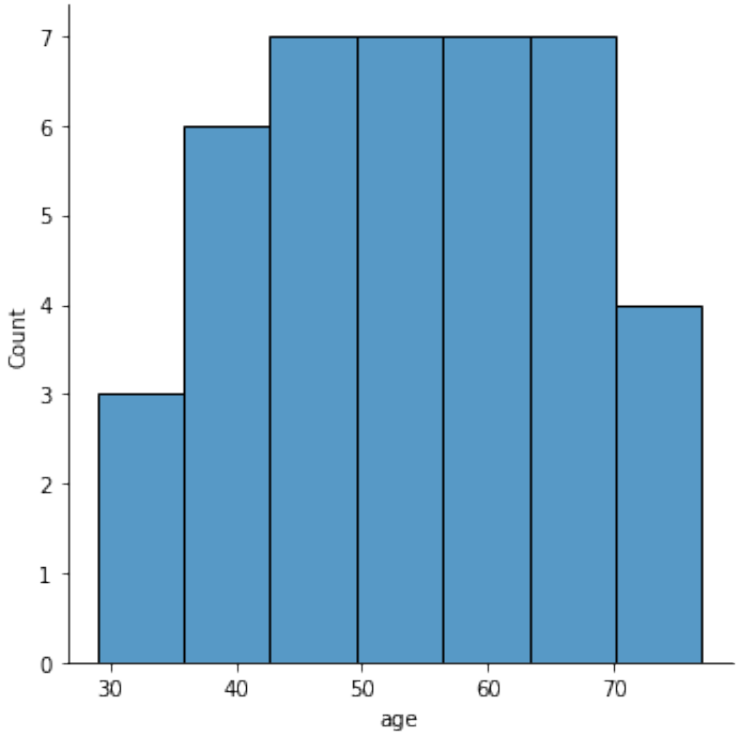
In [37]:
```
sns.distplot(data['age'].describe())
```

Out[37]:
```
<AxesSubplot:xlabel='age', ylabel='Density'>
```



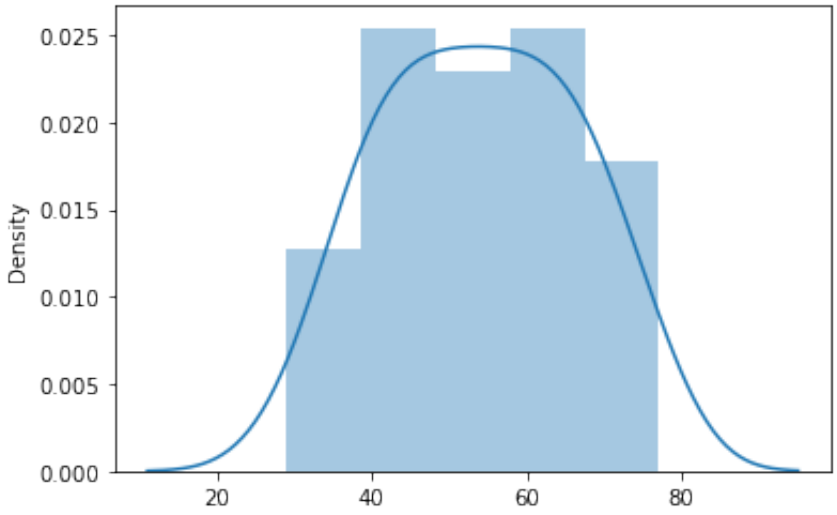
In [38]:
```
sns.displot(data['age'])
```

Out[38]:
```
<seaborn.axisgrid.FacetGrid at 0x7fd579a367f0>
```



In [39]:
```
sns.distplot(data['age'].values)
```

Out[39]:
```
<AxesSubplot:ylabel='Density'>
```



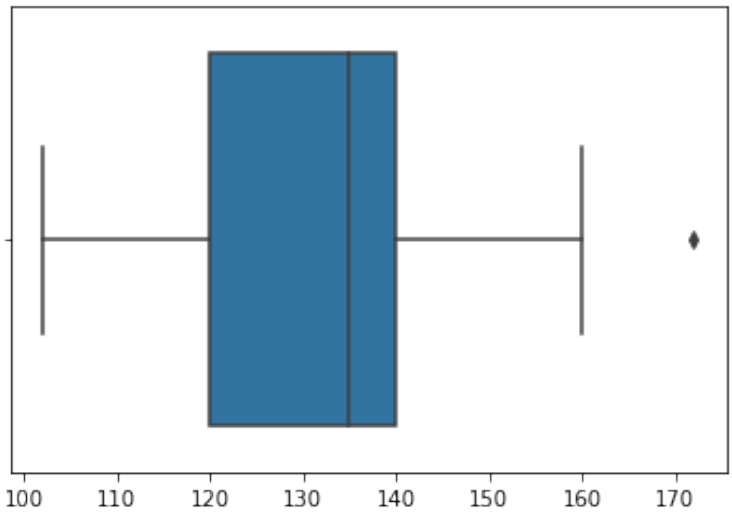
In [40]:
```
data['target'].value_counts()
```

Out[40]:
```
1    40
0     1
Name: target, dtype: int64
```

Can we detect heart attack based on anomalies in resting blood pressure of the patient?

In [41]:
```
sns.boxplot(data['trestbps'].values)
```

Out[41]:
```
<AxesSubplot:>
```



In [42]:
```
data[data['trestbps']>160]
```

Out[42]:

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca	thal	ta
8	52	1	2	172	199	1	1	162	0	0.5	2	0	3	

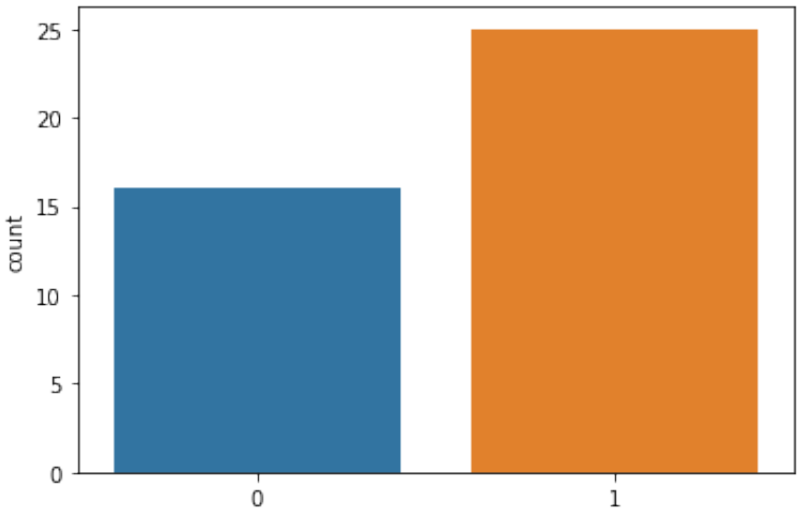
Yes,we can detect heart attack based on anomalies in resting blood pressure of the patient

Study the composition of overall patients w.r.t . gender.

1 = male; 0 = female

In [43]:
```
sns.countplot(data['sex'].values)
```

Out[43]:
```
<AxesSubplot:ylabel='count'>
```



In [44]:
```
data['sex'].value_counts()
```

Out[44]:
```
1    25
0    16
Name: sex, dtype: int64
```

males are larger in number as compared to females

Project Task: Week 2

Performing EDA and Modeling:

Describe the relationship between cholesterol levels and our target variable.

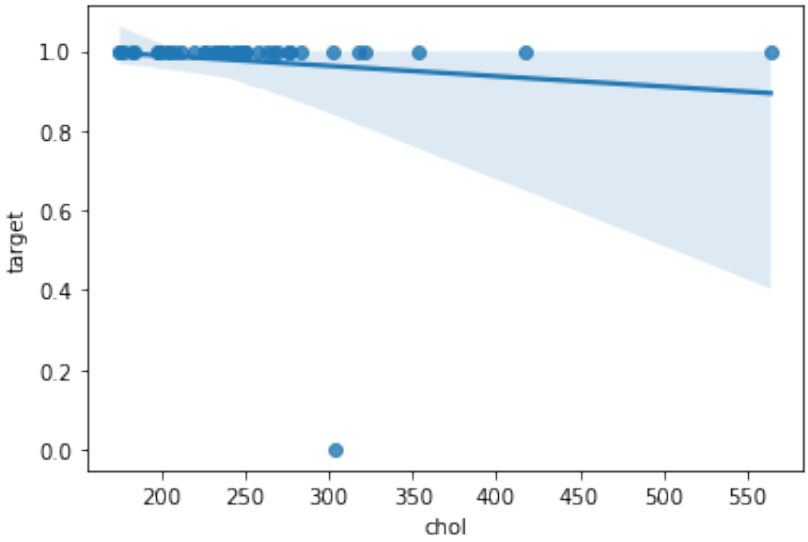
In [45]:
```
data[['chol','target']].corr()
```

Out[45]:

	chol	target
chol	1.000000	-0.118546
target	-0.118546	1.000000

In [46]:
```
sns.regplot(x=data.chol,y=data.target)
```

Out[46]:
```
<AxesSubplot:xlabel='chol', ylabel='target'>
```



Negatively correlated

What can be concluded about the relationship between peak exercising and occurrence of heart attack?

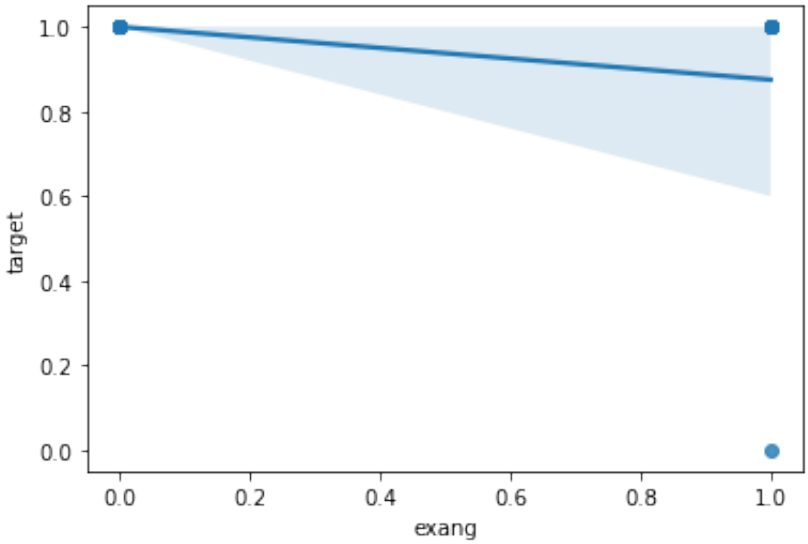
In [47]:
```
data[['exang','target']].corr()
```

Out[47]:

	exang	target
exang	1.000000	-0.321131
target	-0.321131	1.000000

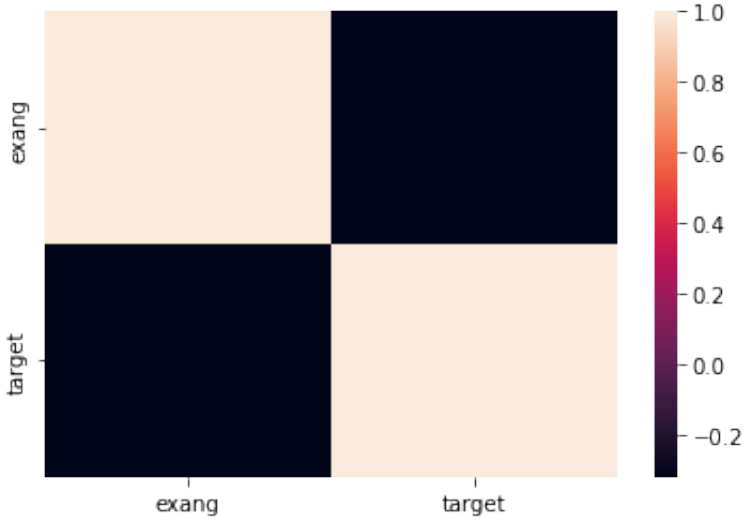
In [48]:
```
sns.regplot(x=data.exang,y=data.target)
```

Out[48]: <AxesSubplot:xlabel='exang', ylabel='target'>



In [49]:
```
sns.heatmap(data[['exang','target']].corr())
```

Out[49]: <AxesSubplot:>



negatively correlated

Is thalassemia a major cause of CVD?

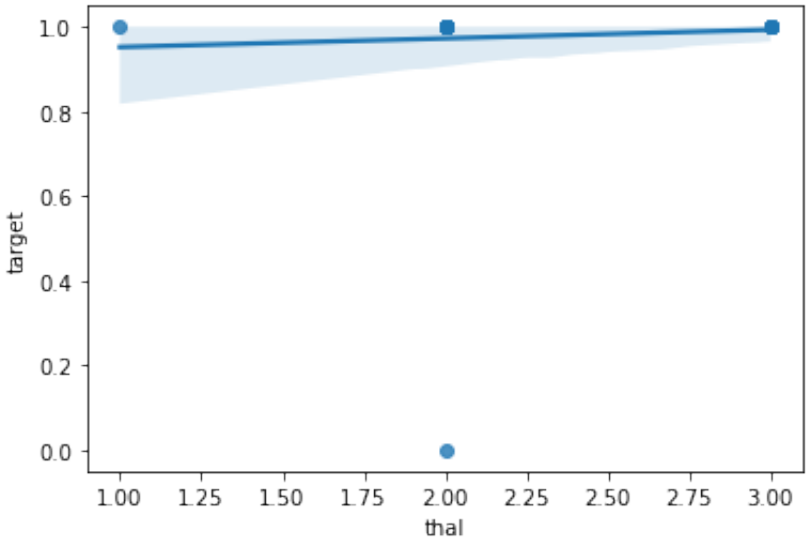
In [50]:
```
data[['thal','target']].corr()
```

Out[50]:

	thal	target
thal	1.000000	0.055517
target	0.055517	1.000000

In [51]:
```
sns.regplot(x=data.thal,y=data.target)
```

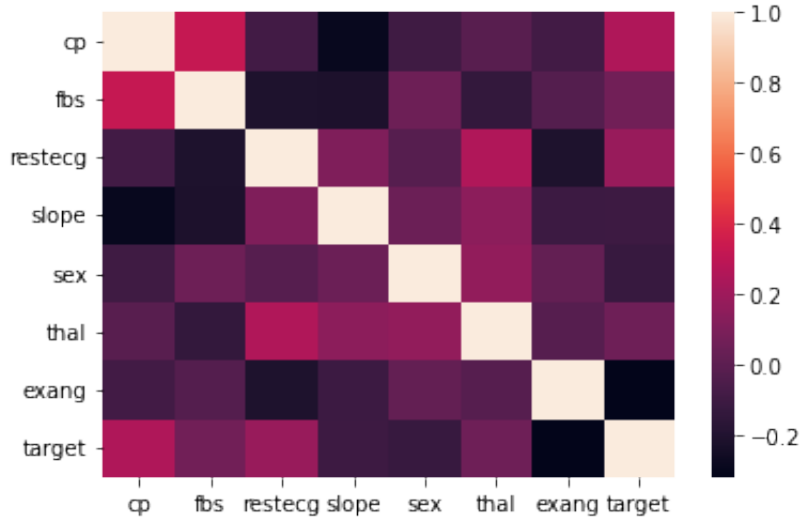
Out[51]: <AxesSubplot:xlabel='thal', ylabel='target'>



How are the other factors determining the occurrence of CVD?

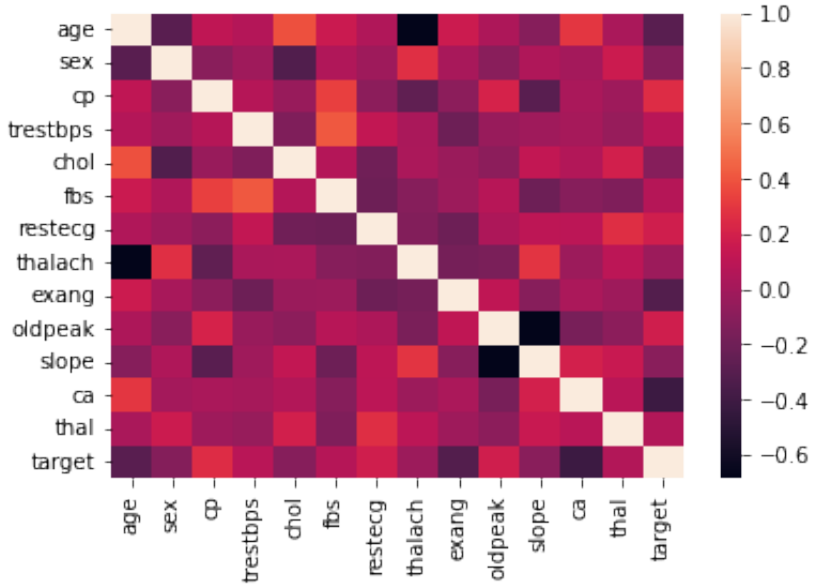
In [52]:
```
sns.heatmap(data[['cp','fbs','restecg','slope','sex','thal','exang','target
```

Out[52]: <AxesSubplot:>



In [53]:
```
sns.heatmap(data.corr())
```

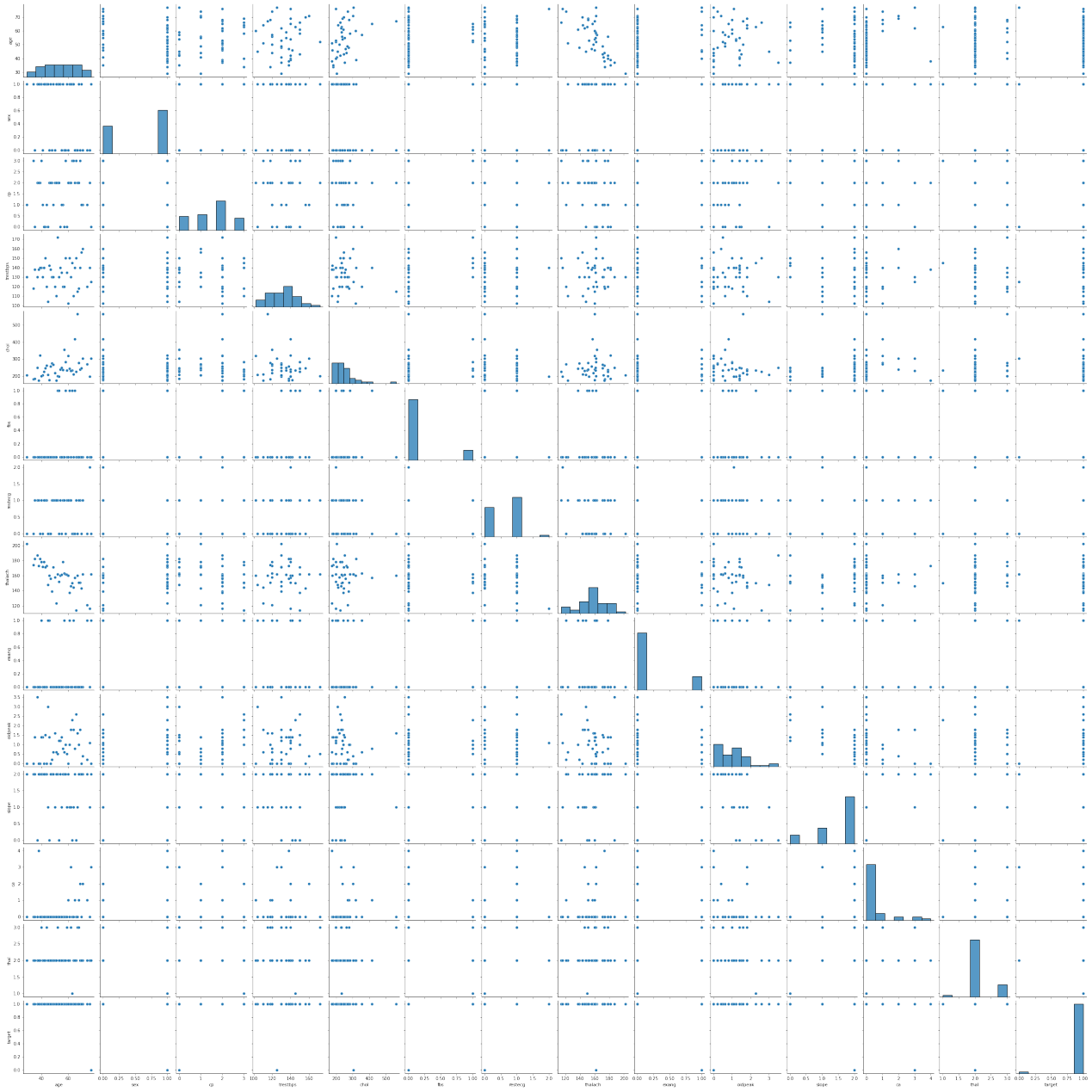
Out[53]: <AxesSubplot:>



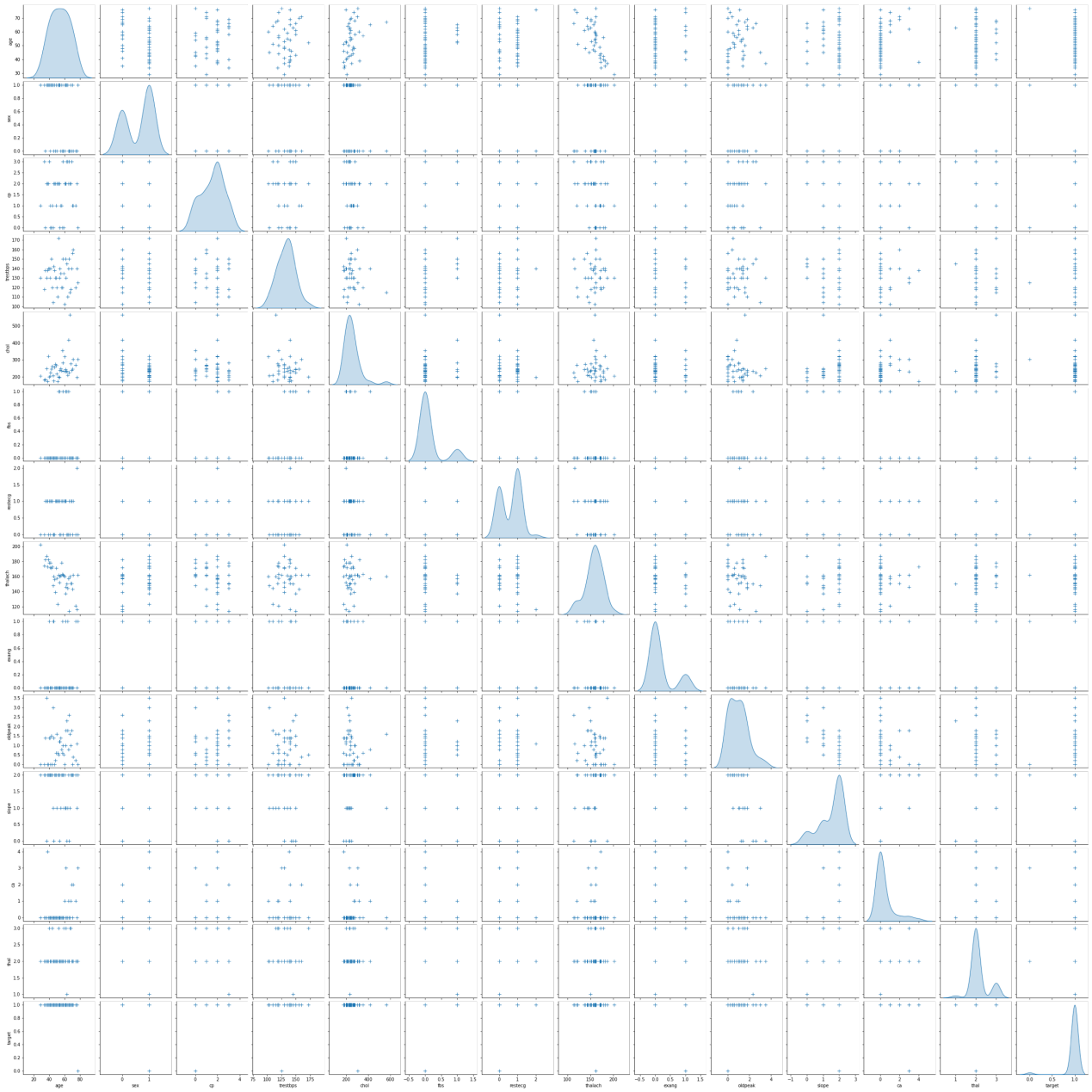
Use a pair plot to understand the relationship between all the given variables.

In [54]:
```
sns.pairplot(data)
```

Out[54]: <seaborn.axisgrid.PairGrid at 0x7fd579b810a0>



In [55]:
```
g = sns.pairplot(data, diag_kind="kde", markers="+",
                 plot_kws=dict(s=50, edgecolor="b", linewidth=1),
                 diag_kws=dict(shade=True))
```



Perform logistic regression, predict the outcome for test data, and validate the results by using the confusion matrix.

In [56]:
```
data.head()
```

Out[56]:

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

Spliting data into x and y

In [57]:
```
X = data.loc[:, data.columns != 'target' ] # independent variable

y = data.loc[:, data.columns == 'target'] #target variable
```

In [58]:
```
X = pd.get_dummies(X, drop_first=True)
```

In [59]:
```
X.head()
```

Out[59]:

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

In [60]:
```
y.head()
```

Out[60]:

	target
0	1
1	1
2	1
3	1
4	1

Train-Test split

In [61]:
```
from sklearn.model_selection import train_test_split
from sklearn.metrics import confusion_matrix
from sklearn.linear_model import LogisticRegression
```

In [62]:
```
X_train,X_test,y_train,y_test = train_test_split(X,y,test_size=0.3,random_s
```

In [63]:
```
X_train.head()
```

Out[63]:

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca	thal
65	35	0	0	138	183	0	1	182	0	1.4	2	0	2
10	54	1	0	140	239	0	1	160	0	1.2	2	0	2
18	43	1	0	150	247	0	1	171	0	1.5	2	0	2
1	37	1	2	130	250	0	1	187	0	3.5	0	0	2
24	40	1	3	140	199	0	1	178	1	1.4	2	0	3

In [64]:
```
X_test.head()
```

Out[64]:

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca	thal
19	69	0	3	140	239	0	1	151	0	1.8	2	2	2
12	49	1	1	130	266	0	1	171	0	0.6	2	0	2
44	39	1	2	140	321	0	0	182	0	0.0	2	0	2
29	53	1	2	130	197	1	0	152	0	1.2	0	0	2
20	59	1	0	135	234	0	1	161	0	0.5	1	0	3

In [65]:
```
X_train.shape,X_test.shape
```

Out[65]:
```
((28, 13), (13, 13))
```

In [66]:
```
logreg = LogisticRegression()
logreg.fit(X_train, y_train)
```

Out[66]:
```
LogisticRegression()
```

In [67]:
```
y_pred = logreg.predict(X_test)
print('Accuracy of logistic regression classifier on test set: {:.2f}'.forr
```

```
Accuracy of logistic regression classifier on test set: 0.92
```

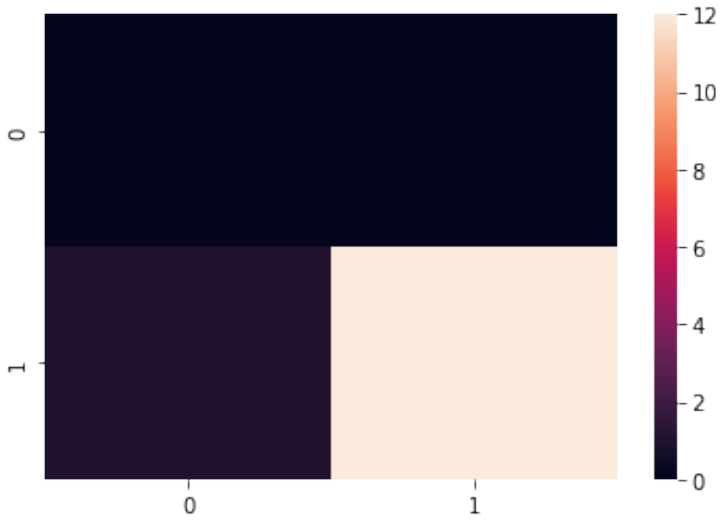
In [68]:
```
from sklearn.metrics import confusion_matrix
confusion_matrix = confusion_matrix(y_test, y_pred)
```

In [69]:
```
confusion_matrix
```

Out[69]:
```
array([[ 0,  0],
       [ 1, 12]])
```

In [70]:
```
sns.heatmap(confusion_matrix)
```

Out[70]: <AxesSubplot:>



In [71]:
```
from sklearn.metrics import classification_report
print(classification_report(y_test, y_pred))
```

```
              precision    recall  f1-score   support

           0       0.00      0.00      0.00         0
           1       1.00      0.92      0.96        13

    accuracy                           0.92        13
   macro avg       0.50      0.46      0.48        13
weighted avg       1.00      0.92      0.96        13
```

Dashboarding:

Visualize the variables using Tableau to create an understanding for attributes of a Diseased vs. a Healthy person.

Demonstrate the variables associated with each other and factors to build a dashboard

In [72]:
```
data.to_excel('exdata.xlsx')
```

https://public.tableau.com/app/profile/rushikesh.khankar/viz/ExaminingFactor
publish=yes

https://public.tableau.com/app/profile/rushikesh.khankar/viz/ExaminingFactor
publish=yes