Assignment Date	22 October 2022
Student Name	Vishal.R
Student Roll Number	730419104089
Maximum Marks	2 Marks

In [1]:
```python
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

Loading the dataset

In [ ]:
```python
df = pd.read_csv('Mall_Customers.csv')
df
```

Out[ ]:

	CustomerID	Gender	Age	Annual Income (k$)	Spending Score (1-100)
0	1	Male	19	15	39
1	2	Male	21	15	81
2	3	Female	20	16	6
3	4	Female	23	16	77
4	5	Female	31	17	40
...	...	...	...	...	...
195	196	Female	35	120	79
196	197	Female	45	126	28
197	198	Male	32	126	74
198	199	Male	32	137	18
199	200	Male	30	137	83

200 rows × 5 columns

Encoding Categorical Columns

```
In [ ]:    from sklearn.preprocessing import LabelEncoder
           le = LabelEncoder()
           df['Gender'] = le.fit_transform(df['Gender'])
```

```
In [ ]:    df
```

Out[ ]:

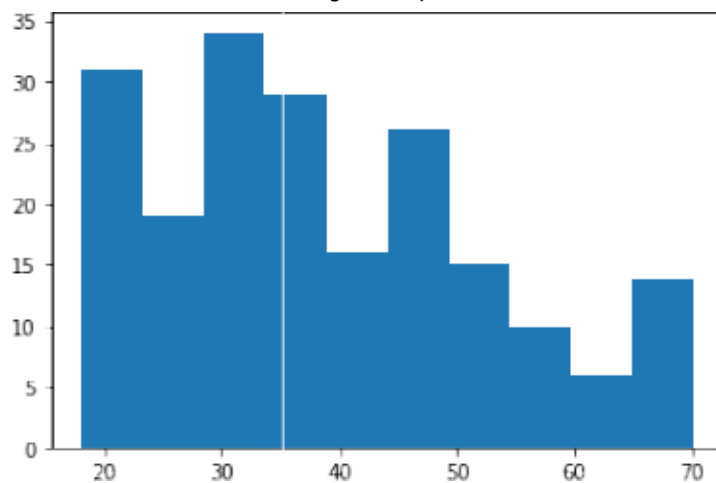|	CustomerID	Gender	Age	Annual Income (k$)	Spending Score (1-100)
0	1	1	19	15	39
1	2	1	21	15	81
2	3	0	20	16	6
3	4	0	23	16	77
4	5	0	31	17	40
...	...	...	...	...	...
195	196	0	35	120	79
196	197	0	45	126	28
197	198	1	32	126	74
198	199	1	32	137	18
199	200	1	30	137	83

200 rows × 5 columns
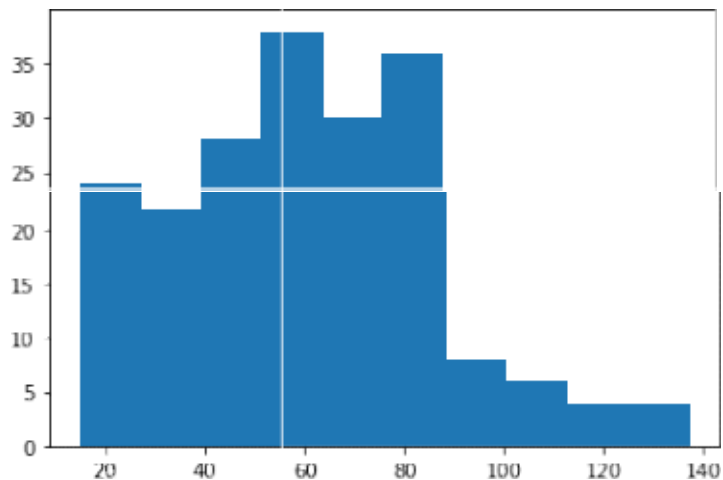
Visualizations

Univariate Analysis

In [ ]:
```python
plt.hist(df['Age'])
```

Out[ ]:
```
(array([31., 19., 34., 29., 16., 26., 15., 10.,  6., 14.]),
 array([18. , 23.2, 28.4, 33.6, 38.8, 44. , 49.2, 54.4, 59.6, 64.8, 70. ]),
 <a list of 10 Patch objects>)
```


In [ ]:
```python
plt.hist(df['Annual Income (k$)'])
```
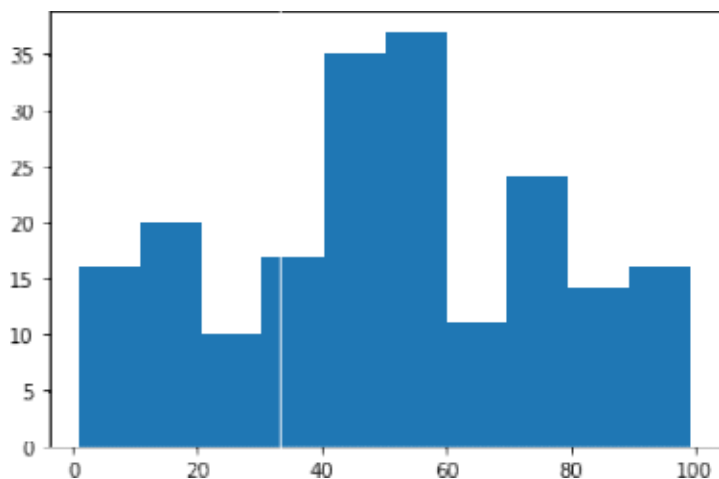
Out[ ]:
```
(array([24., 22., 28., 38., 30., 36.,  8.,  6.,  4.,  4.]),
 array([ 15. ,  27.2,  39.4,  51.6,  63.8,  76. ,  88.2, 100.4, 112.6,
        124.8, 137. ]),
```



```
<a list of 10 Patch objects>)
```

In [ ]:
```python
plt.hist(df['Spending Score (1-100)'])
```

Out[ ]:
```
(array([16., 20., 10., 17., 35., 37., 11., 24., 14., 16.]),
 array([ 1. , 10.8, 20.6, 30.4, 40.2, 50. , 59.8, 69.6, 79.4,  89.2, 99. ]),
 <a list of 10 Patch objects>)
```
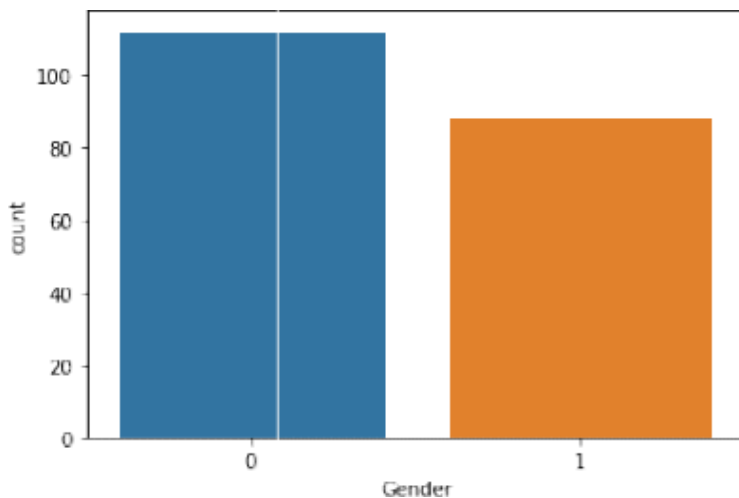

In [ ]:
```python
sns.countplot(df['Gender'])
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43:  FutureWarnin
g: 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 a
n explicit keyword  will result in an error or misinterpretation.
  FutureWarning
```

Out[ ]:
```
<matplotlib.axes._subplots.AxesSubplot  at  0x7fdb93a2d490>
```

Bi-Variate Analysis

In [ ]:
```python
sns.scatterplot(df['Annual Income (k$)'], df['Spending Score (1-100)'])
```

/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass the following variables as keyword args: x, y. 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.
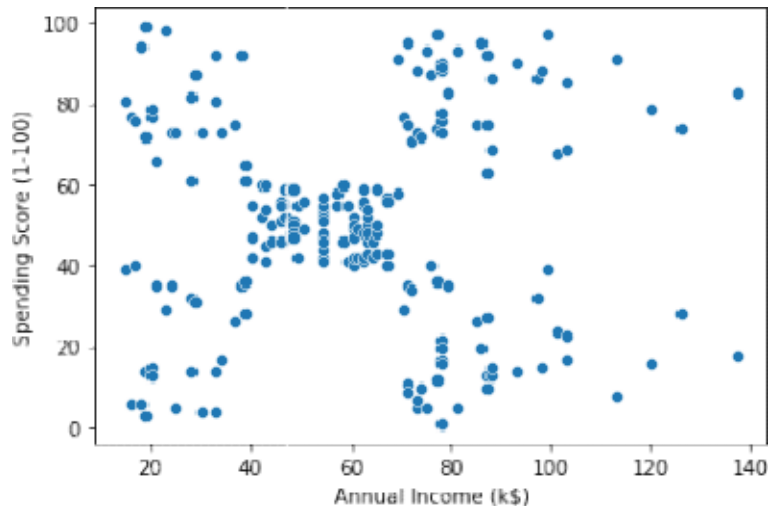FutureWarning

Out[ ]: <matplotlib.axes._subplots.AxesSubplot at 0x7fdb93a1f1d0>

In [ ]:
```python
sns.barplot(df['Gender'], df['Age'])
```

/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarning: Pass the following variables as keyword args: x, y. 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.
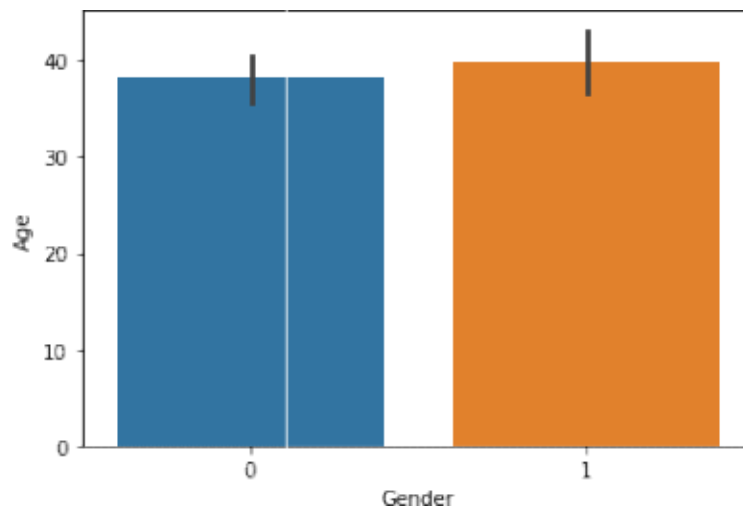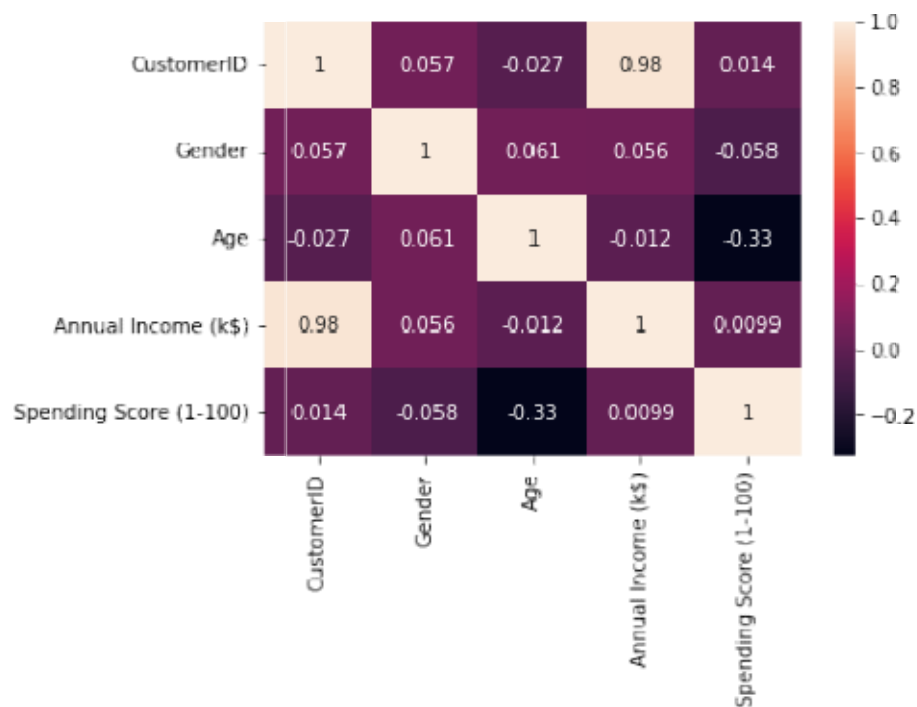FutureWarning

Out[ ]: <matplotlib.axes._subplots.AxesSubplot at 0x7fdb93931b90>

In [ ]:
```python
sns.heatmap(df.corr(), annot = True)
```
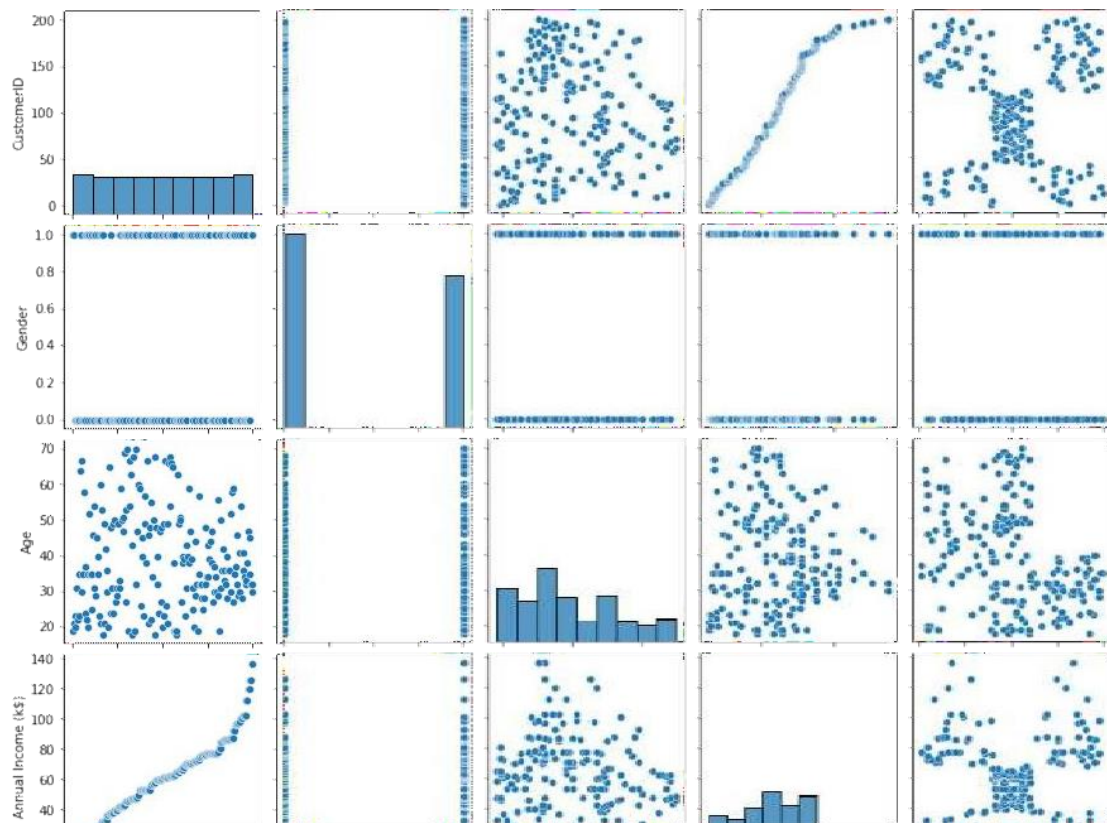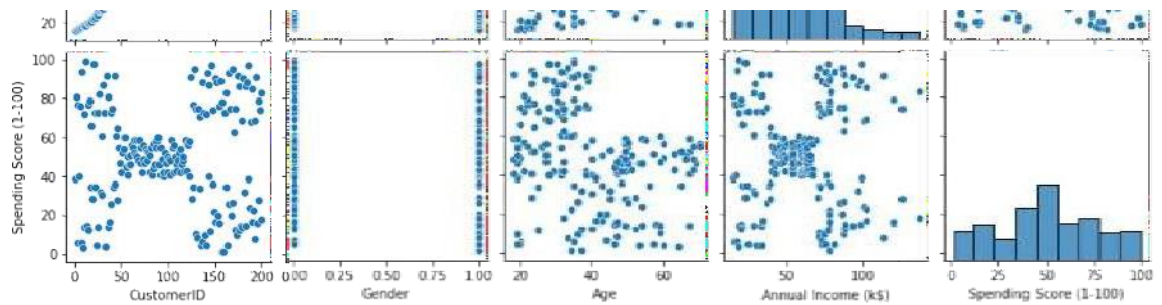
Multi-variate Analysis

In [ ]:
```
sns.pairplot(df)
```

In [ ]:

Descriptive Statistics

In [ ]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 200 entries, 0 to 199
Data columns (total 5 columns):
 #   Column                  Non-Null Count  Dtype

 0   CustomerID              200 non-null    int64
 1   Gender                  200 non-null    int64
 2   Age                     200 non-null    int64
 3   Annual Income (k$)      200 non-null    int64
 4   Spending Score (1-100)  200 non-null    int64
dtypes: int64(5)
memory usage: 7.9 KB
```

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

Out[ ]:

	CustomerID	Gender	Age	Annual Income (k$)	Spending Score (1-100)
count	200.000000	200.000000	200.000000	200.000000	200.000000
mean	100.500000	0.440000	38.850000	60.560000	50.200000
std	57.879185	0.497633	13.969007	26.264721	25.823522
min	1.000000	0.000000	18.000000	15.000000	1.000000
25%	50.750000	0.000000	28.750000	41.500000	34.750000
50%	100.500000	0.000000	36.000000	61.500000	50.000000
75%	150.250000	1.000000	49.000000	78.000000	73.000000
max	200.000000	1.000000	70.000000	137.000000	99.000000

In [ ]:
```
df.skew()
```

Out[ ]:
```
CustomerID            0.000000
Gender                0.243578
Age                   0.485569
Annual Income (k$)    0.321843
```

```
                  Spending Score (1-100)    -0.047220
                  dtype: float64
```

In [ ]:
```
df.kurt()
```

Out[ ]:
```
Spending Score (1-100)    -0.826629
dtype: float64
```

In [ ]:
```
df.corr()
```
```
CustomerID              -1.200000
Gender                  -1.960375
Age                     -0.671573
Annual Income (k$)      -0.098487
```

Out[ ]:

	CustomerID	Gender	Age	Annual Income (k$)	Spending Score (1-100)
CustomerID	1.000000	0.057400	-0.026763	0.977548	0.013835
Gender	0.057400	1.000000	0.060867	0.056410	-0.058109
Age	-0.026763	0.060867	1.000000	-0.012398	-0.327227
Annual Income (k$)	0.977548	0.056410	-0.012398	1.000000	0.009903
Spending Score (1-100)	0.013835	-0.058109	-0.327227	0.009903	1.000000

In [ ]:
```
df.var()
```

Out[ ]:
```
CustomerID               3350.000000
Gender                      0.247638
Age                       195.133166
Annual Income (k$)        689.835578
Spending Score (1-100)    666.854271
dtype: float64
```

In [ ]:
```
df.std()
```

Out[ ]:
```
CustomerID                57.879185
Gender                     0.497633
Age                       13.969007
Annual Income (k$)        26.264721
Spending Score (1-100)    25.823522
dtype: float64
```

Checking for missing values

In [ ]:
```
df.isna().sum()
```

Out[ ]:
```
CustomerID               0
Gender                   0
Age                      0
```

Spending Score (1-100)   0

```
dtype: int64
```

In [ ]:
```python
df.isna().sum().sum()
```

Out[ ]: 0

In [ ]:
```python
df.duplicated().sum()
```

Out[ ]: 0

Finding & Handling Ouliers

In [ ]:
```python
quantile = df.quantile(q = [0.25, 0.75])
quantile
```

Out[ ]:

	CustomerID	Gender	Age	Annual Income (k$)	Spending Score (1-100)
0.25	50.75	0.0	28.75	41.5	34.75
0.75	150.25	1.0	49.00	78.0	73.00

In [ ]:
```python
IQR = quantile.iloc[1] - quantile.iloc[0]
IQR
```

Out[ ]:
```
CustomerID              99.50
Gender                   1.00
Age                     20.25
Annual Income (k$)      36.50
Spending Score (1-100)  38.25
dtype: float64
```

In [ ]:
```python
upper = quantile.iloc[1] + (1.5 *IQR)
upper
```

Out[ ]:
```
CustomerID              299.500
Gender                    2.500
Age                      79.375
Annual Income (k$)      132.750
Spending Score (1-100)  130.375
dtype: float64
```

In [ ]:
```python
lower = quantile.iloc[0] - (1.5* IQR)
lower
```

Out[ ]:
```
CustomerID               -98.500
Gender                    -1.500
Age                       -1.625
Annual    Income    (k$)  -13.250
Spending Score  (1-100)   -22.625
dtype: float64
```

```
In [ ]:    df.mean()
```

```
Out[ ]:    CustomerID                100.50
           Gender                      0.44
           Age                        38.85
           Annual Income (k$)         60.56
           Spending Score (1-100)     50.20
           dtype: float64
```
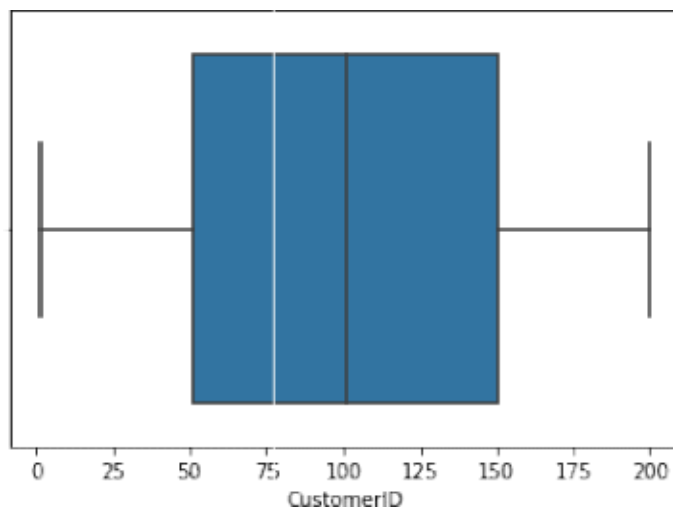
```
In [ ]:    df['Annual Income (k$)'].max()
```

```
Out[ ]:    137
```

```
In [ ]:    sns.boxplot(df['CustomerID'])
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43:   FutureWarnin
g: 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 a
n explicit keyword  will result in an error or misinterpretation.
  FutureWarning
```

```
Out[ ]:    <matplotlib.axes._subplots.AxesSubplot at 0x7fdb904c1290>
```



```
In [ ]:    sns.boxplot(df['Gender'])
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43:   FutureWarnin
g: 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 a
n explicit keyword  will result in an error or misinterpretation.
  FutureWarning
```

```
Out[ ]:    <matplotlib.axes._subplots.AxesSubplot at 0x7fdb8ebea250>
```

In [ ]:
```
sns.boxplot(df['Age'])
```

/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarnin
g: 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 a
n explicit keyword will result in an error or misinterpretation.
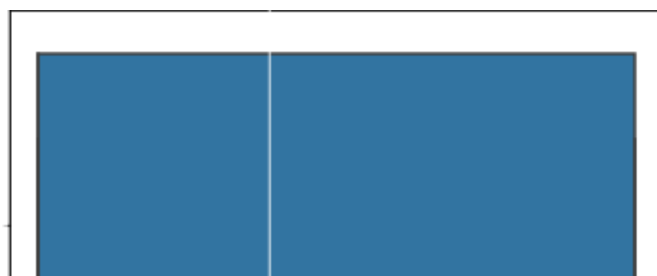 FutureWarning

Out[ ]: <matplotlib.axes._subplots.AxesSubplot at 0x7fdb93b3ee50>

In [ ]:
```
sns.boxplot(df['Annual Income (k$)'])
```

/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarnin
g: 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 a
n explicit keyword will result in an error or misinterpretation.
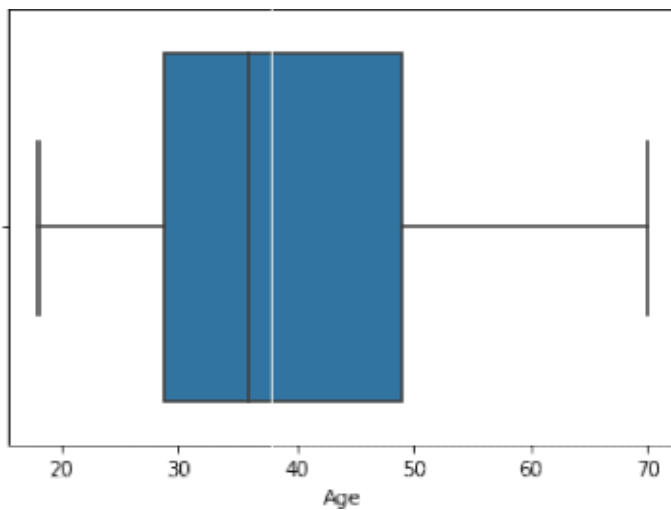 FutureWarning

Out[ ]: <matplotlib.axes._subplots.AxesSubplot at 0x7fdb8eb28450>

In [ ]:
```python
df['Annual Income (k$)'] = np.where(df['Annual Income (k$)'] > 132.750, 60.55,
```

In [ ]:
```python
sns.boxplot(df['Annual Income (k$)'])
```

/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarnin
g: 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 a
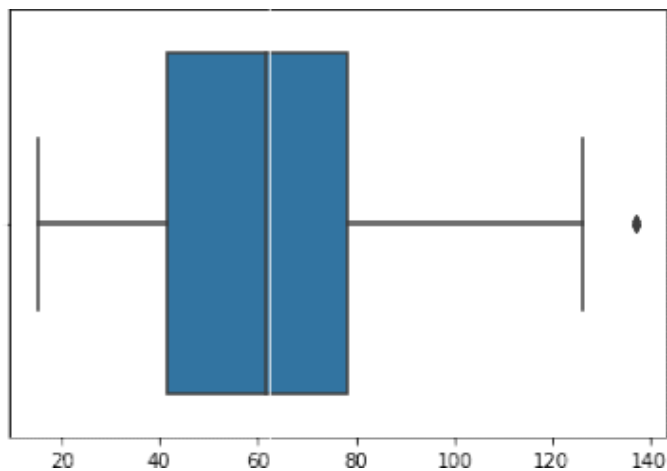n explicit keyword will result in an error or misinterpretation.
  FutureWarning

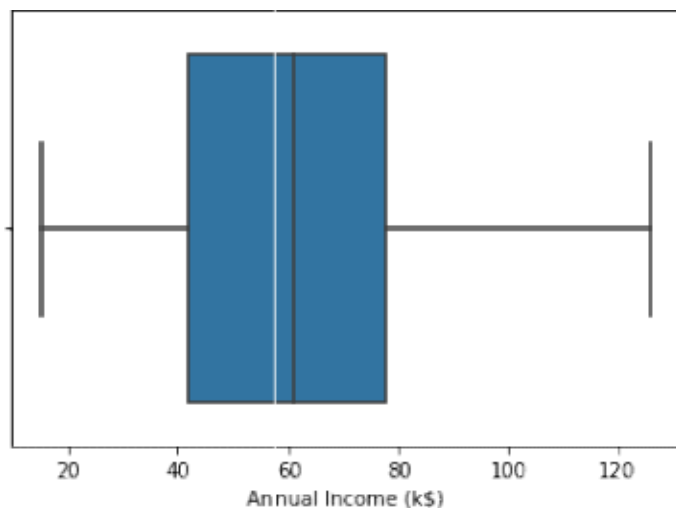Out[ ]: <matplotlib.axes._subplots.AxesSubplot at 0x7fdb8eb18e90>

In [ ]:
```python
df['Annual Income (k$)'].max()
```

Out[ ]: 126.0

In [ ]:
```python
sns.boxplot(df['Spending Score (1-100)'])
```

/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarnin
g: 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 a
n explicit keyword will result in an error or misinterpretation.
  FutureWarning

Out[ ]: <matplotlib.axes._subplots.AxesSubplot at 0x7fdb8ea8fc10>

Spending Score (1-100)
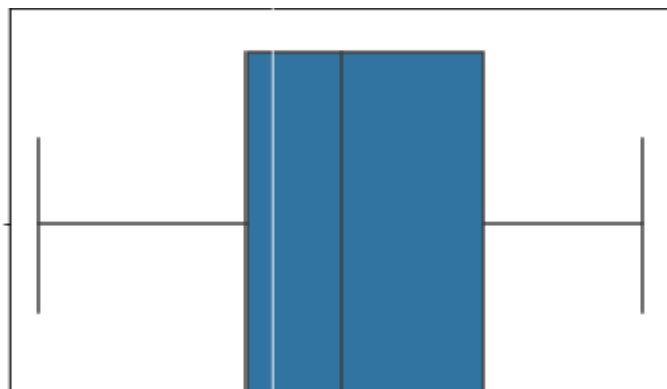
Scaling the data

In [ ]:
```python
from sklearn.preprocessing import StandardScaler
ss = StandardScaler().fit_transform(df)
ss
```

Out[ ]:
```
array([[-1.7234121 ,  1.12815215, -1.42456879, -1.78843062, -0.43480148],
       [-1.70609137,  1.12815215, -1.28103541, -1.78843062,  1.19570407],
       [-1.68877065, -0.88640526, -1.3528021 , -1.74850629, -1.71591298],
       [-1.67144992, -0.88640526, -1.13750203, -1.74850629,  1.04041783],
       [-1.6541292 , -0.88640526, -0.56336851, -1.70858195, -0.39597992],
       [-1.63680847, -0.88640526, -1.20926872, -1.70858195,  1.00159627],
       [-1.61948775, -0.88640526, -0.27630176, -1.66865761, -1.71591298],
       [-1.60216702, -0.88640526, -1.13750203, -1.66865761,  1.70038436],
       [-1.5848463 ,  1.12815215,  1.80493225, -1.62873328, -1.83237767],
       [-1.56752558, -0.88640526, -0.6351352 , -1.62873328,  0.84631002],
       [-1.55020485,  1.12815215,  2.02023231, -1.62873328, -1.4053405 ],
       [-1.53288413, -0.88640526, -0.27630176, -1.62873328,  1.89449216],
       [-1.5155634 , -0.88640526,  1.37433211, -1.58880894, -1.36651894],
       [-1.49824268, -0.88640526, -1.06573534, -1.58880894,  1.04041783],
       [-1.48092195,  1.12815215, -0.13276838, -1.58880894, -1.44416206],
       [-1.46360123,  1.12815215, -1.20926872, -1.58880894,  1.11806095],
       [-1.4462805 , -0.88640526, -0.27630176, -1.5488846 , -0.59008772],
       [-1.42895978,  1.12815215, -1.3528021 , -1.5488846 ,  0.61338066],
       [-1.41163905,  1.12815215,  0.94373197, -1.46903593, -0.82301709],
       [-1.39431833, -0.88640526, -0.27630176, -1.46903593,  1.8556706 ],
       [-1.3769976 ,  1.12815215, -0.27630176, -1.42911159, -0.59008772],
       [-1.35967688,  1.12815215, -0.99396865, -1.42911159,  0.88513158],
       [-1.34235616, -0.88640526,  0.51313183, -1.38918726, -1.75473454],
       [-1.32503543,  1.12815215, -0.56336851, -1.38918726,  0.88513158],
       [-1.30771471, -0.88640526,  1.08726535, -1.26941425, -1.4053405 ],
       [-1.29039398,  1.12815215, -0.70690189, -1.26941425,  1.23452563],
       [-1.27307326, -0.88640526,  0.44136514, -1.26941425, -0.7065524 ],
       [-1.25575253,  1.12815215, -0.27630176, -1.26941425,  0.41927286],
       [-1.23843181, -0.88640526,  0.08253169, -1.22948991, -0.74537397],
       [-1.22111108, -0.88640526, -1.13750203, -1.22948991,  1.42863343],
       [-1.20379036,  1.12815215,  1.51786549, -1.18956557, -1.7935561 ],
       [-1.18646963, -0.88640526, -1.28103541, -1.18956557,  0.88513158],
       [-1.16914891,  1.12815215,  1.01549866, -1.06979256, -1.7935561 ],
       [-1.15182818,  1.12815215, -1.49633548, -1.06979256,  1.62274124],
       [-1.13450746, -0.88640526,  0.7284319 , -1.06979256, -1.4053405 ],
       [-1.11718674, -0.88640526, -1.28103541, -1.06979256,  1.19570407],
       [-1.09986601, -0.88640526,  0.22606507, -1.02986823, -1.28887582],
       [-1.08254529, -0.88640526, -0.6351352 , -1.02986823,  0.88513158],
       [-1.06522456, -0.88640526, -0.20453507, -0.91009522, -0.93948177],
       [-1.04790384, -0.88640526, -1.3528021 , -0.91009522,  0.96277471],
       [-1.03058311, -0.88640526,  1.87669894, -0.87017088, -0.59008772],
       [-1.01326239,  1.12815215, -1.06573534, -0.87017088,  1.62274124],
       [-0.99594166,  1.12815215,  0.65666521, -0.83024654, -0.55126616],
       [-0.97862094, -0.88640526, -0.56336851, -0.83024654,  0.41927286],
       [-0.96130021, -0.88640526,  0.7284319 , -0.83024654, -0.86183865],
       [-0.94397949, -0.88640526, -1.06573534, -0.83024654,  0.5745591 ],
```

```
[-0.92665877, -0.88640526,  0.80019859, -0.79032221,  0.18634349],
[-0.90933804, -0.88640526, -0.85043527, -0.79032221, -0.12422899],
[-0.89201732, -0.88640526, -0.70690189, -0.79032221, -0.3183368 ],
[-0.87469659, -0.88640526, -0.56336851, -0.79032221, -0.3183368 ],
[-0.85737587, -0.88640526,  0.7284319 , -0.71047353,  0.06987881],
[-0.84005514,  1.12815215, -0.41983513, -0.71047353,  0.38045129],
[-0.82273442, -0.88640526, -0.56336851, -0.6705492 ,  0.14752193],
[-0.80541369,  1.12815215,  1.4460988 , -0.6705492 ,  0.38045129],
[-0.78809297, -0.88640526,  0.80019859, -0.6705492 , -0.20187212],
[-0.77077224,  1.12815215,  0.58489852, -0.6705492 , -0.35715836],
[-0.75345152, -0.88640526,  0.87196528, -0.63062486, -0.00776431],
[-0.73613079,  1.12815215,  2.16376569, -0.63062486, -0.16305055],
[-0.71881007, -0.88640526, -0.85043527, -0.55077619,  0.03105725],
[-0.70148935,  1.12815215,  1.01549866, -0.55077619, -0.16305055],
[-0.68416862,  1.12815215,  2.23553238, -0.55077619,  0.22516505],
[-0.6668479 ,  1.12815215, -1.42456879, -0.55077619,  0.18634349],
[-0.64952717, -0.88640526,  2.02023231, -0.51085185,  0.06987881],
[-0.63220645, -0.88640526,  1.08726535, -0.51085185,  0.34162973],
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```

Clustering Algorithm

In [ ]:
```python
from sklearn.cluster import KMeans
TWSS = []
k = list(range(2,9))

for i in k:
    kmeans = KMeans(n_clusters = i , init = 'k-means++')
    kmeans.fit(df)
    TWSS.append(kmeans.inertia_)
```
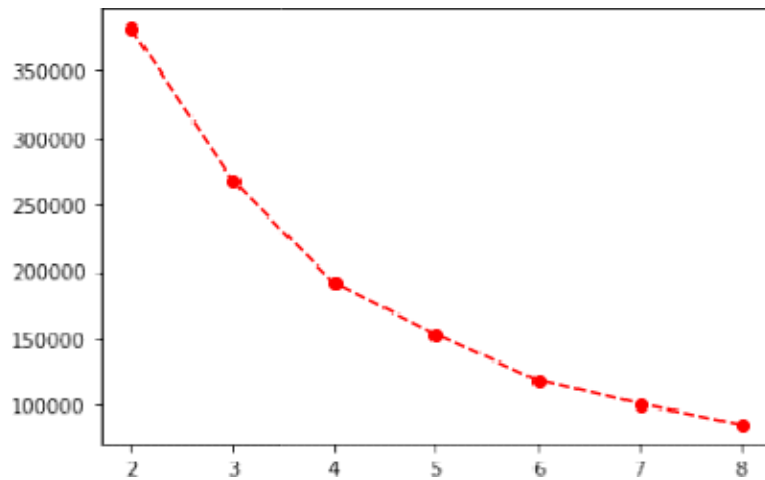
In [ ]:
```python
TWSS
```

Out[ ]:
```
[381507.64738523855,
 268062.55433747417,
 191550.08627670942,
 153530.68956249507,
 119166.15727643928,
 101321.0166427429,
 85744.90139221892]
```

In [ ]:
```python
plt.plot(k,TWSS, 'ro--')
```

[<matplotlib.lines.Line2D at 0x7fdb8d642b90>]

In [ ]:
```python
model = KMeans(n_clusters = 4)
model.fit(df)
```

Out[ ]: KMeans(n_clusters=4)

In [ ]:
```python
mb = pd.Series(model.labels_)
```

In [ ]:
```python
df['Cluster'] = mb
```

In [ ]:
```python
df
```

Out[ ]:

	CustomerID	Gender	Age	Annual Income (k$)	Spending Score (1-100)	Cluster
0	1	1	19	15.00	39	0
1	2	1	21	15.00	81	0
2	3	0	20	16.00	6	0
3	4	0	23	16.00	77	0
4	5	0	31	17.00	40	0
...	...	...	...	...	...	...
195	196	0	35	120.00	79	1
196	197	0	45	126.00	28	3
197	198	1	32	126.00	74	1
198	199	1	32	60.55	18	3
199	200	1	30	60.55	83	1

200 rows × 6 columns