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

Loading the dataset

In [6]:

```
df = pd.read_csv('Mall_Customers.csv')
df
```

Out[6]:

	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 [49]:

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

In [50]:

```
df
```

Out[50]:

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

200 rows × 6 columns

Visualizations

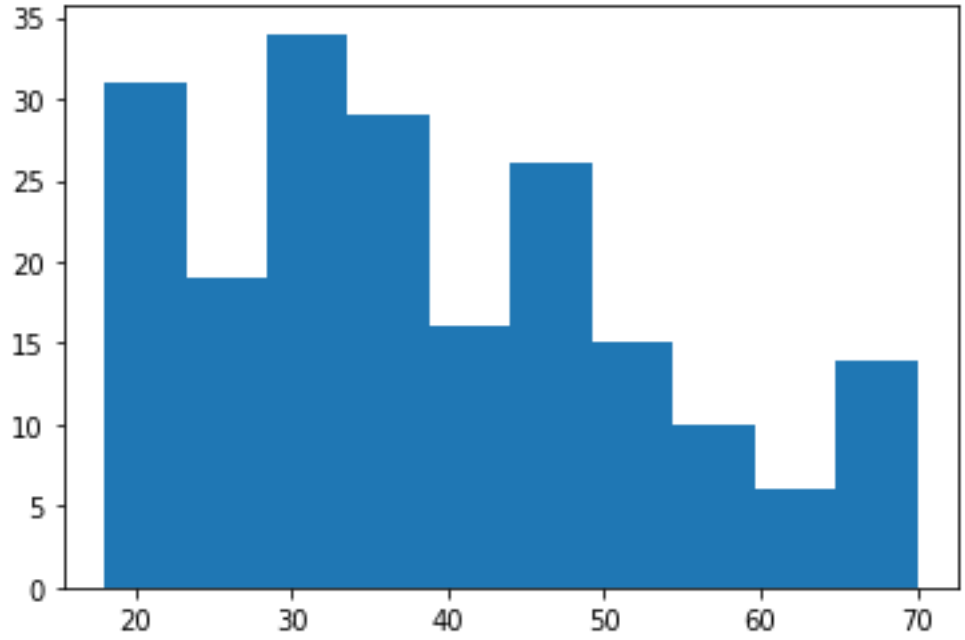
Univariate Analysis

In [9]:

```
plt.hist(df['Age'])
```

Out[9]:

```
(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. ]),
 )
```

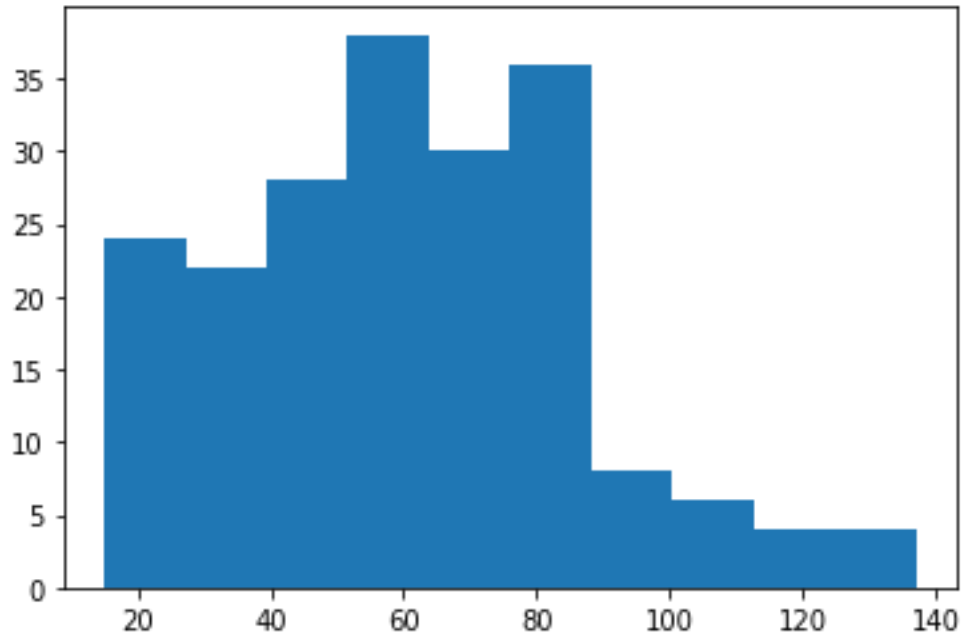


In [10]:

```
plt.hist(df['Annual Income (k$)'])
```

Out[10]:

```
(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. ]),
 )
```

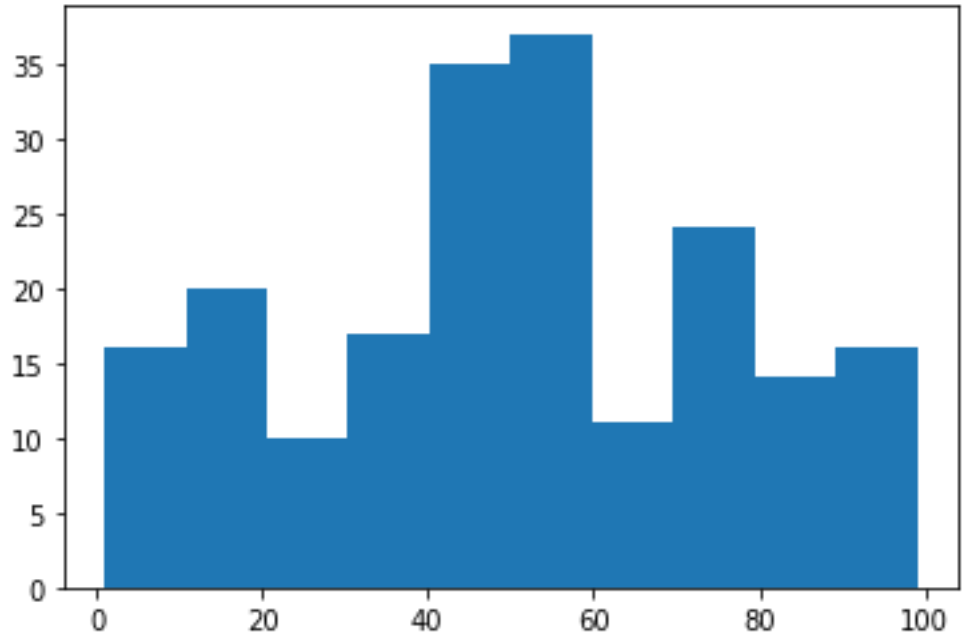


In [11]:

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

Out[11]:

```
(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. ]),
 )
```



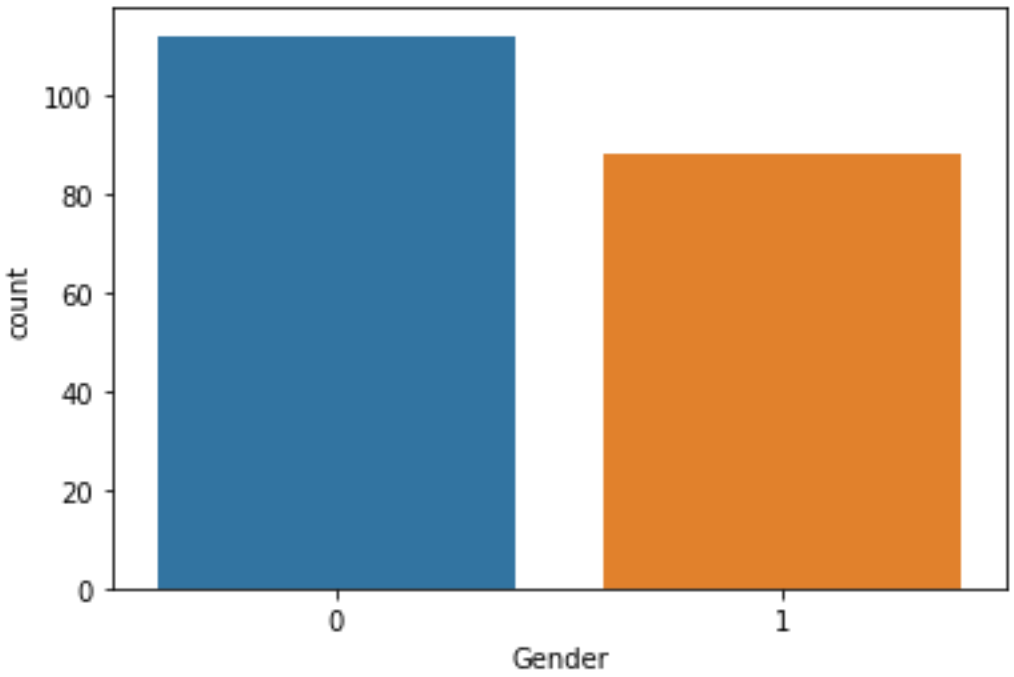
In [12]:

```
sns.countplot(df['Gender'])
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarni
ng: Pass the following variable as a keyword arg: x. From version 0.12, the o
```

```
nly valid positional argument will be `data`, and passing other arguments wit
hout an explicit keyword will result in an error or misinterpretation.
  FutureWarning
```

Out[12]:



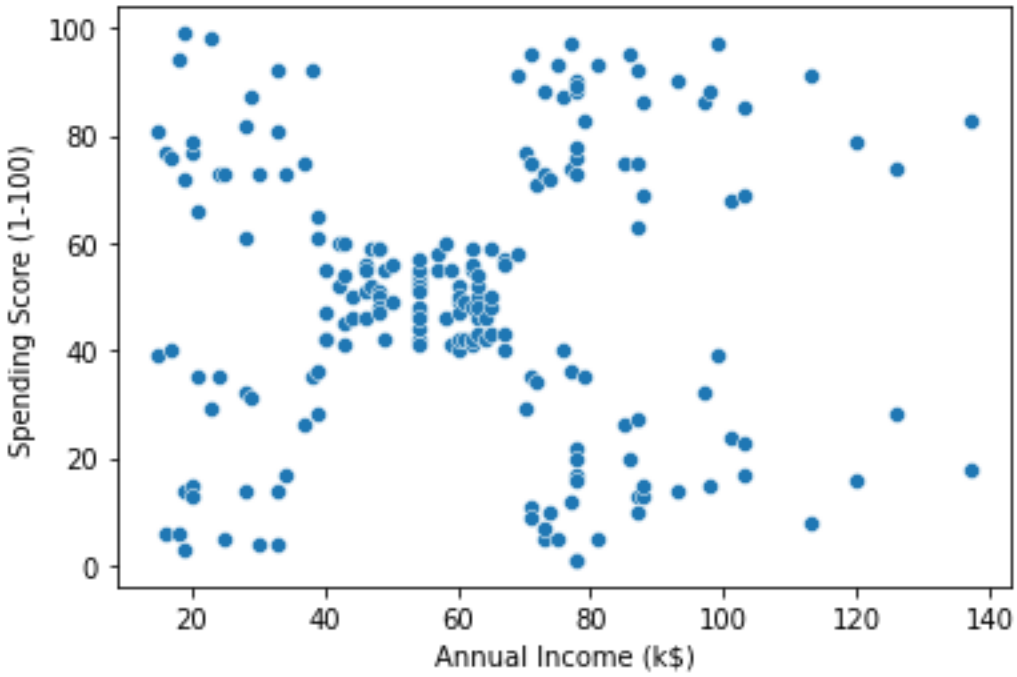
Bi-Variate Analysis

In [13]:

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

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarni
ng: Pass the following variables as keyword args: x, y. From version 0.12, th
e only valid positional argument will be `data`, and passing other arguments
without an explicit keyword will result in an error or misinterpretation.
  FutureWarning
```

Out[13]:

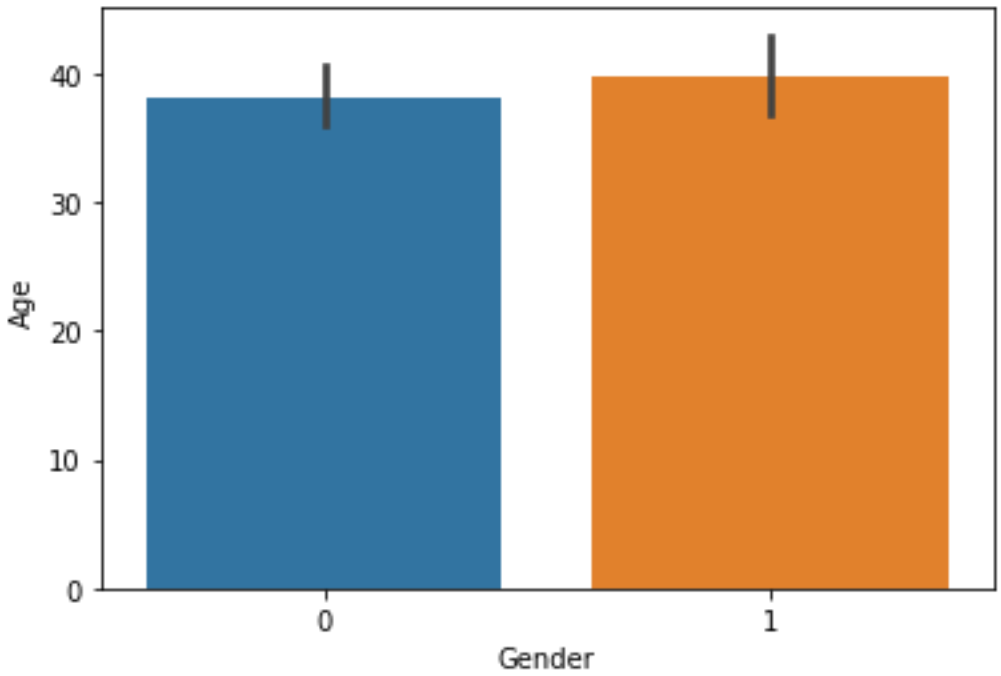


In [14]:

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

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarni
ng: Pass the following variables as keyword args: x, y. From version 0.12, th
e only valid positional argument will be `data`, and passing other arguments
without an explicit keyword will result in an error or misinterpretation.
  FutureWarning
```

Out[14]:



In [15]:

```
sns.heatmap(df.corr(), annot = True)
```

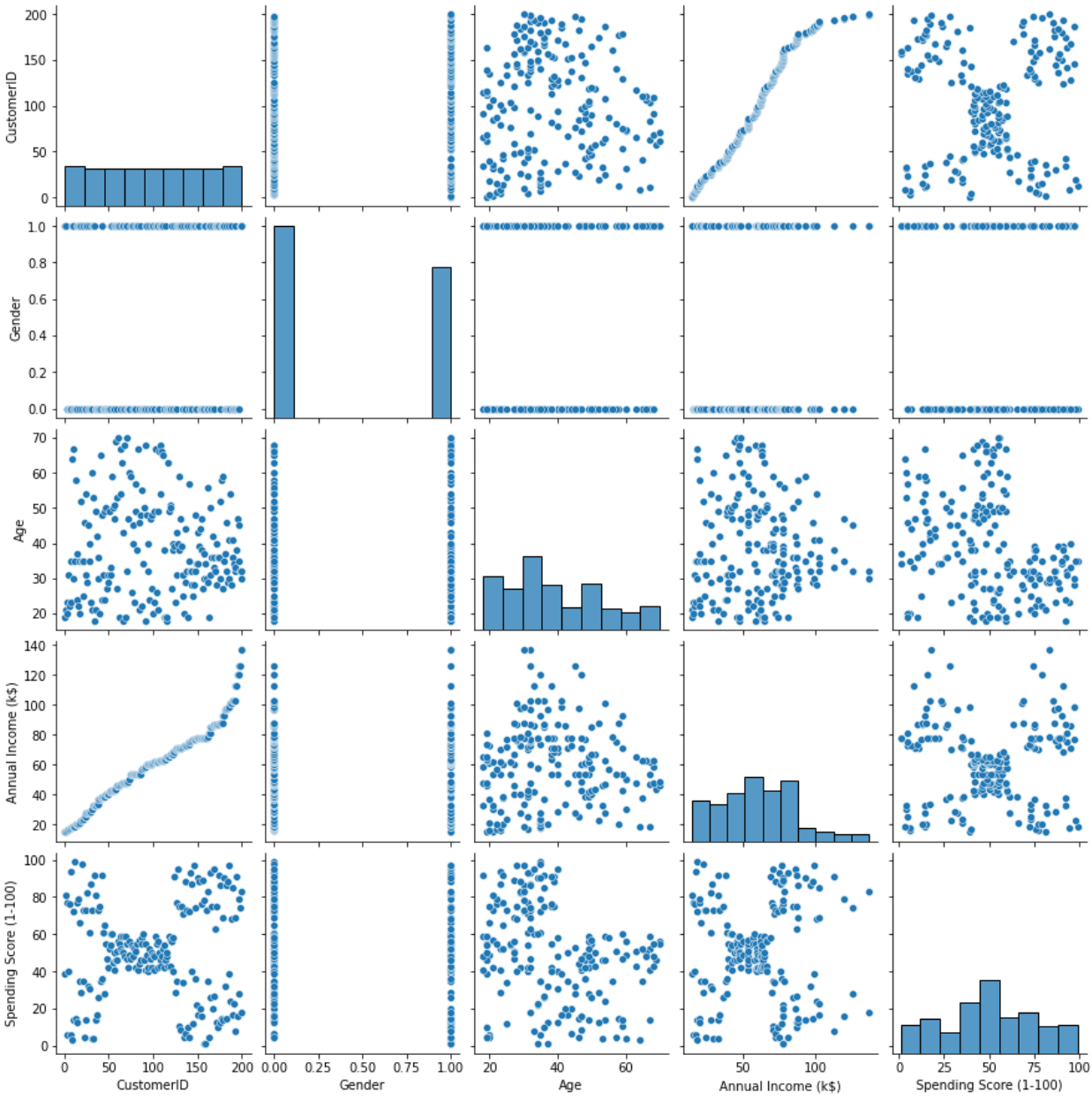
Out[15]:

Multi-variate Analysis

In [16]:

```
sns.pairplot(df)
```

Out[16]:



In [16]:

Descriptive Statistics

In [17]:

```
df.info()
```

```
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 [18]:

```
df.describe()
```

Out[18]:

	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 [19]:

```
df.skew()
```

Out[19]:

```
CustomerID               0.000000
Gender                   0.243578
Age                      0.485569
Annual Income (k$)       0.321843
Spending Score (1-100)  -0.047220
dtype: float64
```

In [20]:

```
df.kurt()
```

Out[20]:

```
CustomerID              -1.200000
Gender                  -1.960375
Age                     -0.671573
Annual Income (k$)      -0.098487
```

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

In [21]:

```
df.corr()
```

Out[21]:

	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 [22]:

```
df.var()
```

Out[22]:

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

In [23]:

```
df.std()
```

Out[23]:

```
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 [24]:

```
df.isna().sum()
```

Out[24]:

```
CustomerID               0
Gender                   0
```

```
Age                     0
Annual Income (k$)      0
Spending Score (1-100)  0
dtype: int64
```

In [25]:

```
df.isna().sum().sum()
```

Out[25]:

```
0
```

In [26]:

```
df.duplicated().sum()
```

Out[26]:

```
0
```

Finding & Handling Ouliers

In [27]:

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

Out[27]:

	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 [28]:

```
IQR = quantile.iloc[1] - quantile.iloc[0]
  IQR
```

Out[28]:

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

In [29]:

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

Out[29]:

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

In [30]:

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

Out[30]:

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

In [31]:

```
df.mean()
```

Out[31]:

```
CustomerID               100.50
Gender                     0.44
Age                       38.85
Annual Income (k$)        60.56
Spending Score (1-100)    50.20
dtype: float64
```

In [32]:

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

Out[32]:

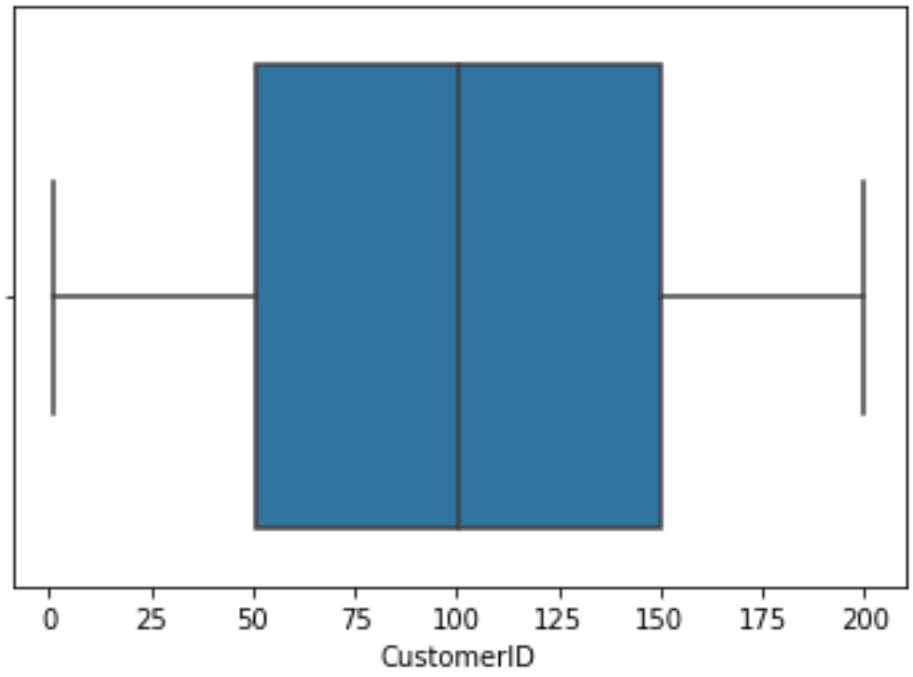
```
137
```

In [33]:

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

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarni
ng: Pass the following variable as a keyword arg: x. From version 0.12, the o
nly valid positional argument will be `data`, and passing other arguments wit
hout an explicit keyword will result in an error or misinterpretation.
  FutureWarning
```

Out[33]:

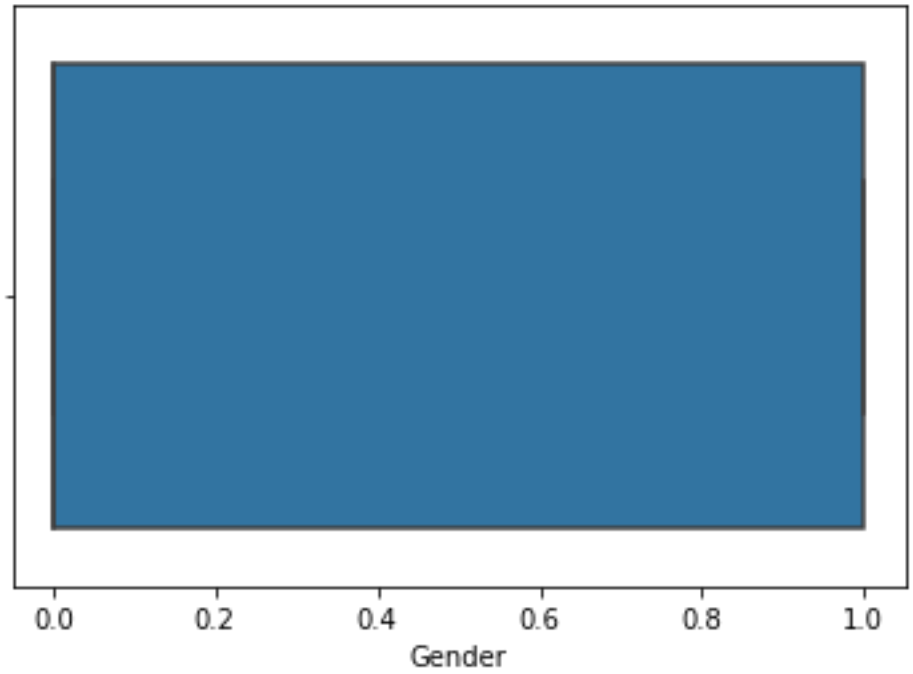


In [34]:

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

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarni
ng: Pass the following variable as a keyword arg: x. From version 0.12, the o
nly valid positional argument will be `data`, and passing other arguments wit
hout an explicit keyword will result in an error or misinterpretation.
  FutureWarning
```

Out[34]:

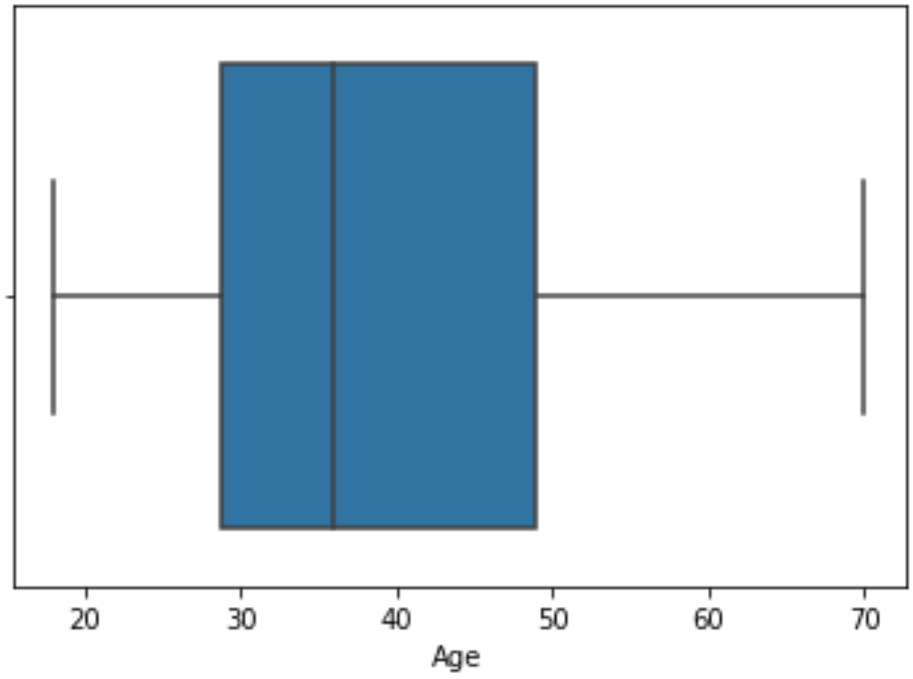


In [35]:

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

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarni
ng: Pass the following variable as a keyword arg: x. From version 0.12, the o
nly valid positional argument will be `data`, and passing other arguments wit
hout an explicit keyword will result in an error or misinterpretation.
  FutureWarning
```

Out[35]:

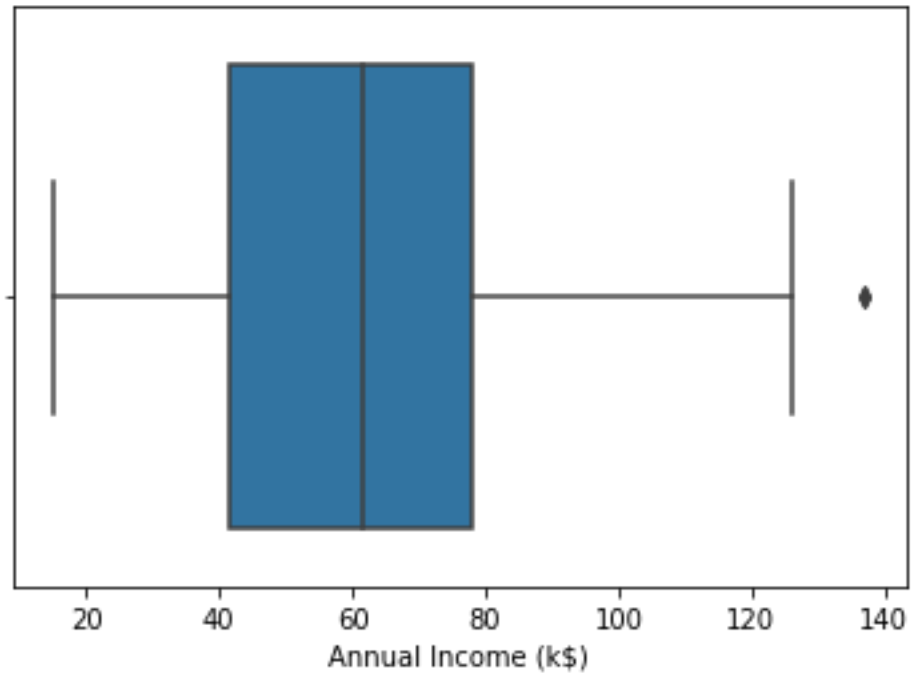


In [36]:

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

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarni
ng: Pass the following variable as a keyword arg: x. From version 0.12, the o
nly valid positional argument will be `data`, and passing other arguments wit
hout an explicit keyword will result in an error or misinterpretation.
  FutureWarning
```

Out[36]:



In [37]:

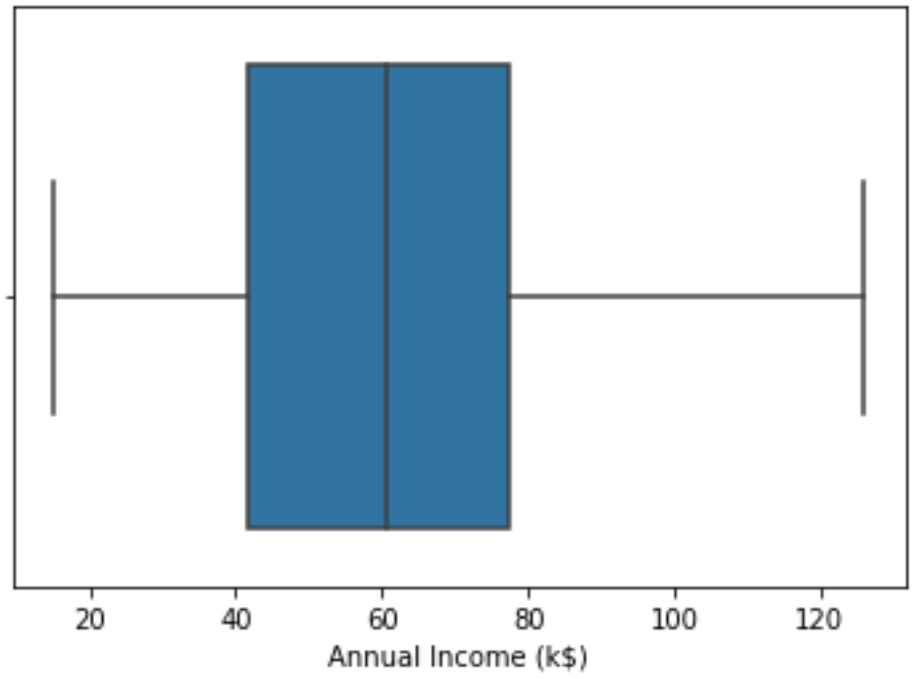
```
df['Annual Income (k$)'] = np.where(df['Annual Income (k$)'] > 132.750,
60.55, df['Annual Income (k$)'])
```

In [38]:

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

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarni
ng: Pass the following variable as a keyword arg: x. From version 0.12, the o
nly valid positional argument will be `data`, and passing other arguments wit
hout an explicit keyword will result in an error or misinterpretation.
  FutureWarning
```

Out[38]:



In [39]:

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

Out[39]:

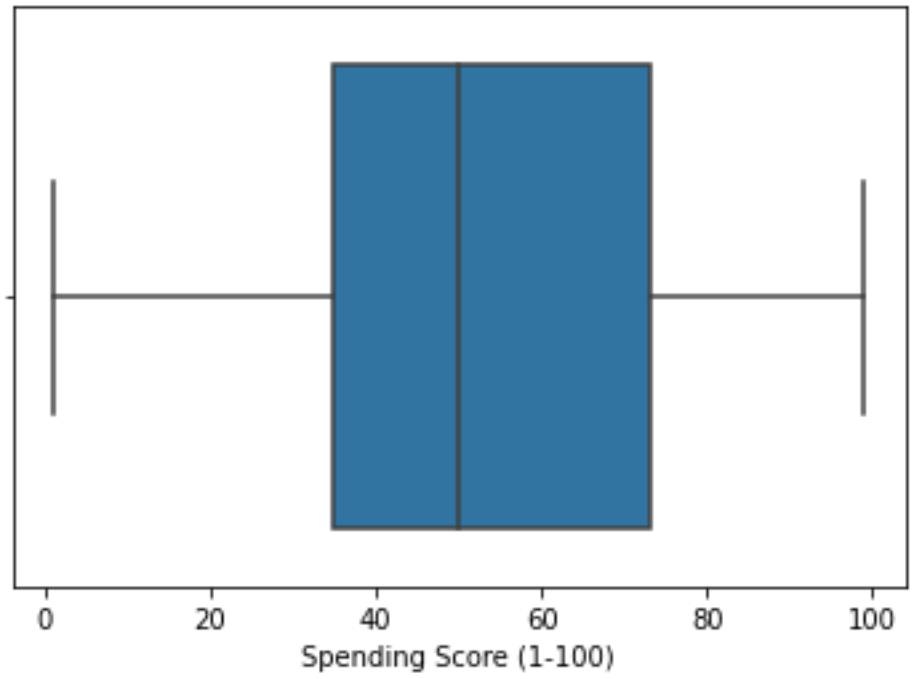
```
126.0
```

In [40]:

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

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: FutureWarni
ng: Pass the following variable as a keyword arg: x. From version 0.12, the o
nly valid positional argument will be `data`, and passing other arguments wit
hout an explicit keyword will result in an error or misinterpretation.
  FutureWarning
```

Out[40]:



Scaling the data

In [41]:

```
from sklearn.preprocessing import  StandardScaler
ss = StandardScaler().fit_transform(df)
ss
```

Out[41]:

```
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],
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```

Clustering Algorithm

In [42]:

```
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 [43]:

```
TWSS
```

Out[43]:

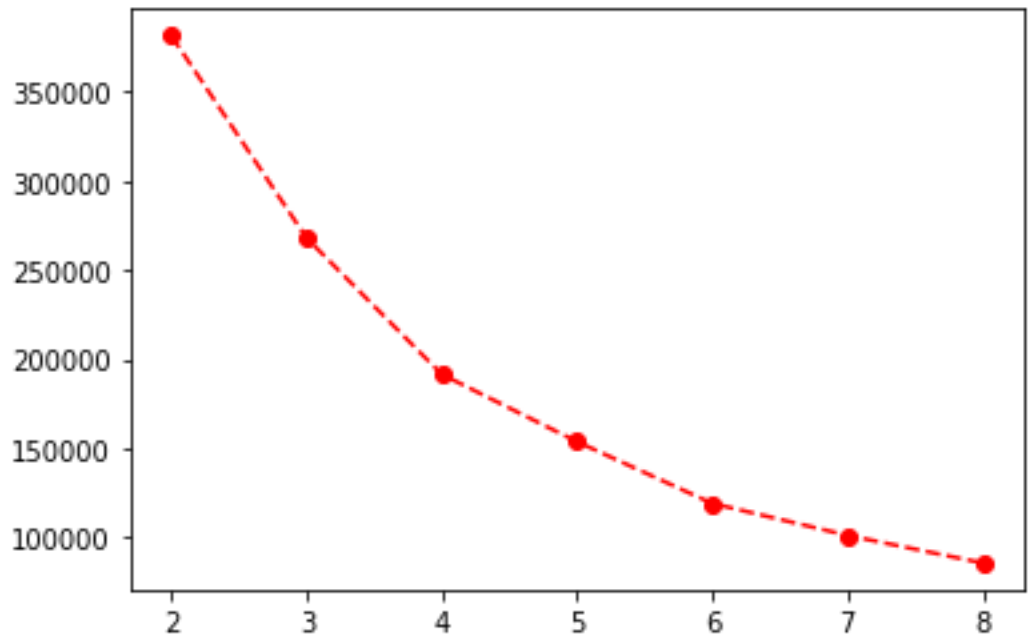
```
[381507.64738523855,
 268062.55433747417,
 191550.08627670942,
 153777.55391034693,
 119166.15727643928,
 101239.32626154403,
 85744.90139221892]
```

In [44]:

```
plt.plot(k,TWSS, 'ro--')
```

Out[44]:

```
[]
```



In [45]:

```
model = KMeans(n_clusters = 4)
model.fit(df)
```

Out[45]:

```
KMeans(n_clusters=4)
```

In [46]:

```
mb = pd.Series(model.labels_)
```

In [47]:

```
df['Cluster'] = mb
```

In [48]:

```
df
```

Out[48]:

	CustomerID	Gender	Age	Annual Income (k$)	Spending Score (1-100)	Cluster
0	1	1	19	15.00	39	2
1	2	1	21	15.00	81	2
2	3	0	20	16.00	6	2
3	4	0	23	16.00	77	2
4	5	0	31	17.00	40	2

	CustomerID	Gender	Age	Annual Income (k$)	Spending Score (1-100)	Cluster
...	...	...	...	...	...	...
195	196	0	35	120.00	79	3
196	197	0	45	126.00	28	1
197	198	1	32	126.00	74	3
198	199	1	32	60.55	18	1
199	200	1	30	60.55	83	3

200 rows × 6 columns

In [48]:

In [48]: