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

Understanding the Data

```
df=pd.read_csv('/content/Mall_Customers.csv')
df.head()
```

```
   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
```

```
df.shape
```

```
(200, 5)
```

```
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    object
 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(4), object(1)
memory usage: 7.9+ KB
```

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

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

Data Preprocessing

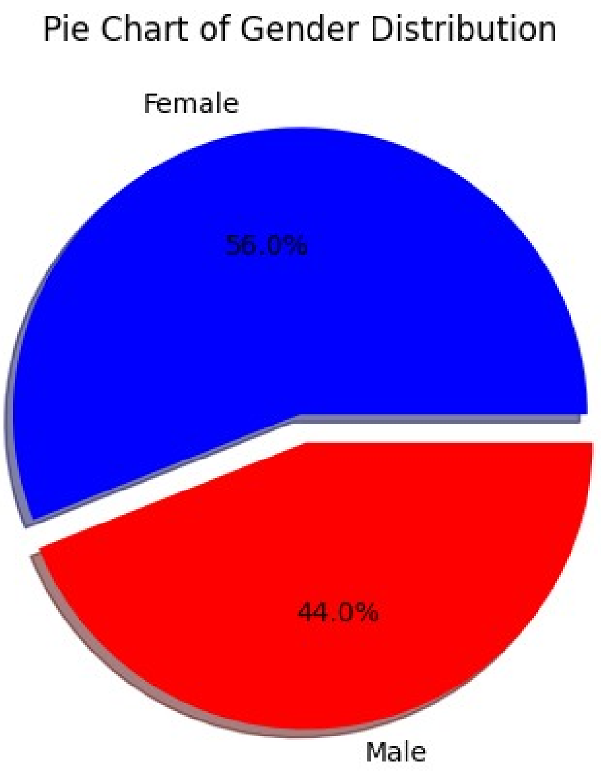
Visualizations

Univariate Analysis-1 (Pie Chart)

```
df['Gender'].value_counts()
```

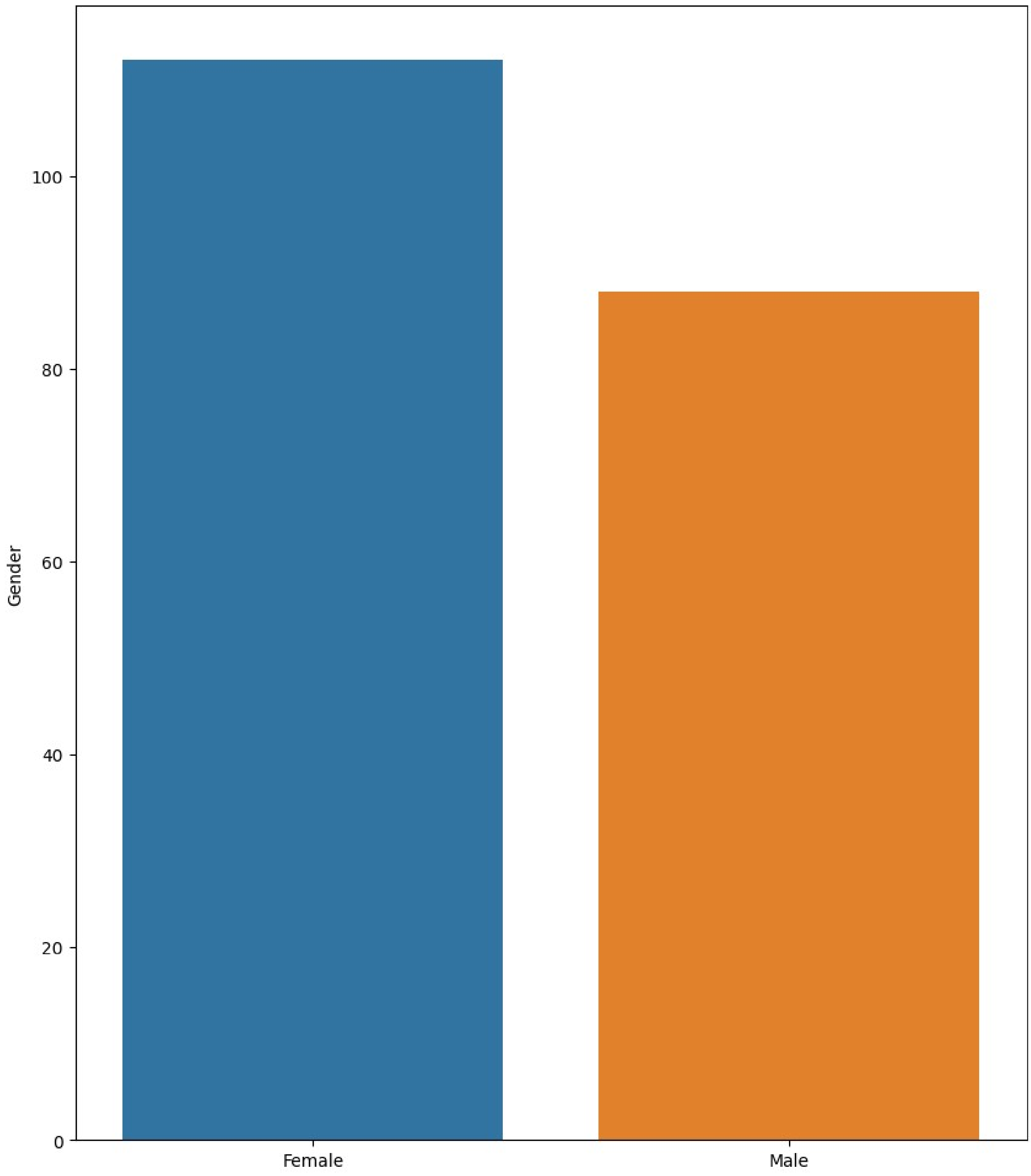
```
Female    112
Male       88
Name: Gender, dtype: int64
```

```
plt.pie(df['Gender'].value_counts(),
[0,0.1],labels=['Female','Male'],autopct='%1.1f%
%',shadow=True,colors=['blue','red'])
plt.title('Pie Chart of Gender Distribution')
plt.show()
```



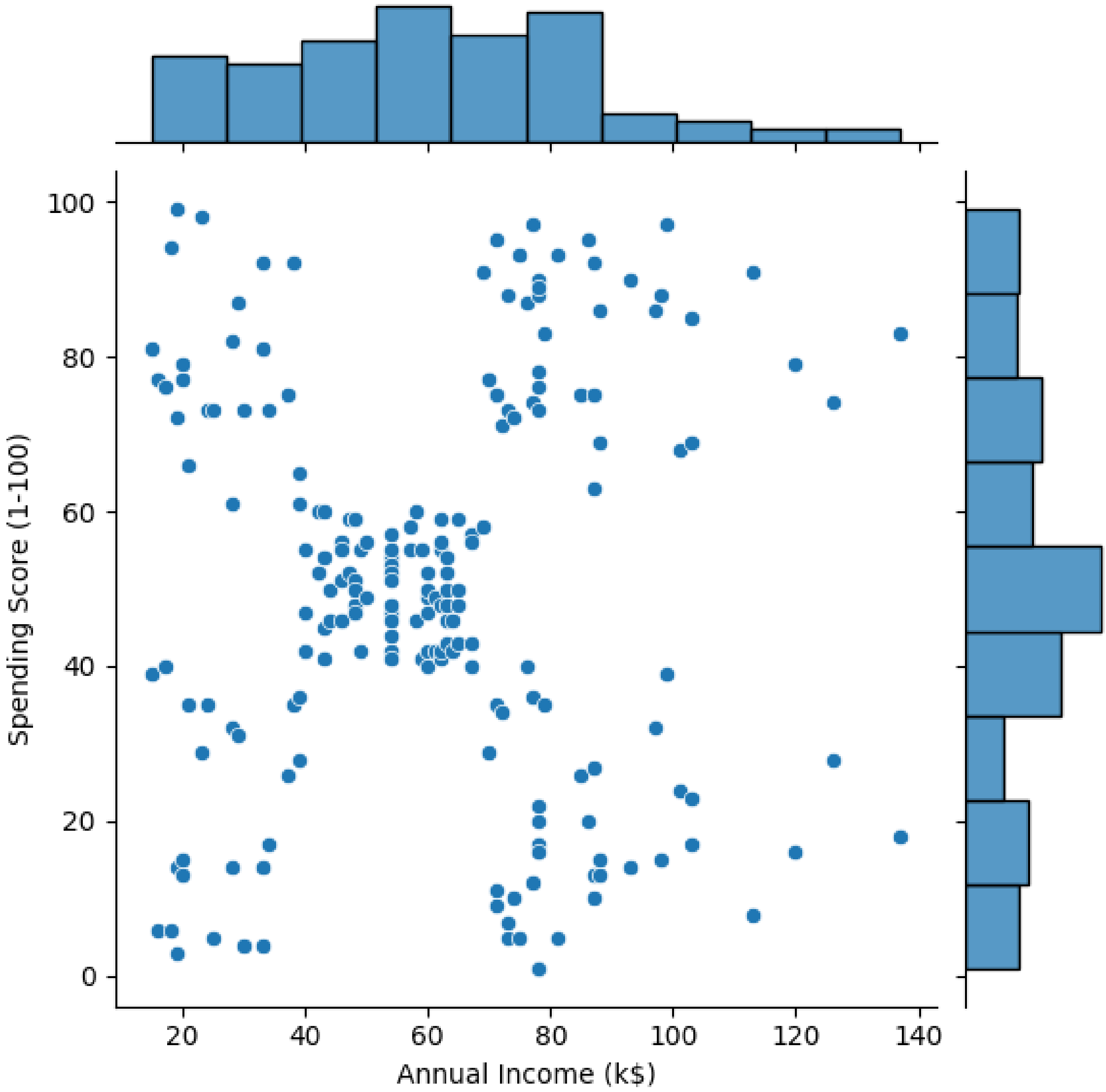
Univariate Analysis-2 (Bar Plot)

```
plt.figure(figsize=(10,12))
sns.barplot(x=df['Gender'].value_counts().index,y=df['Gender'].value_c
ounts())
plt.show()
```



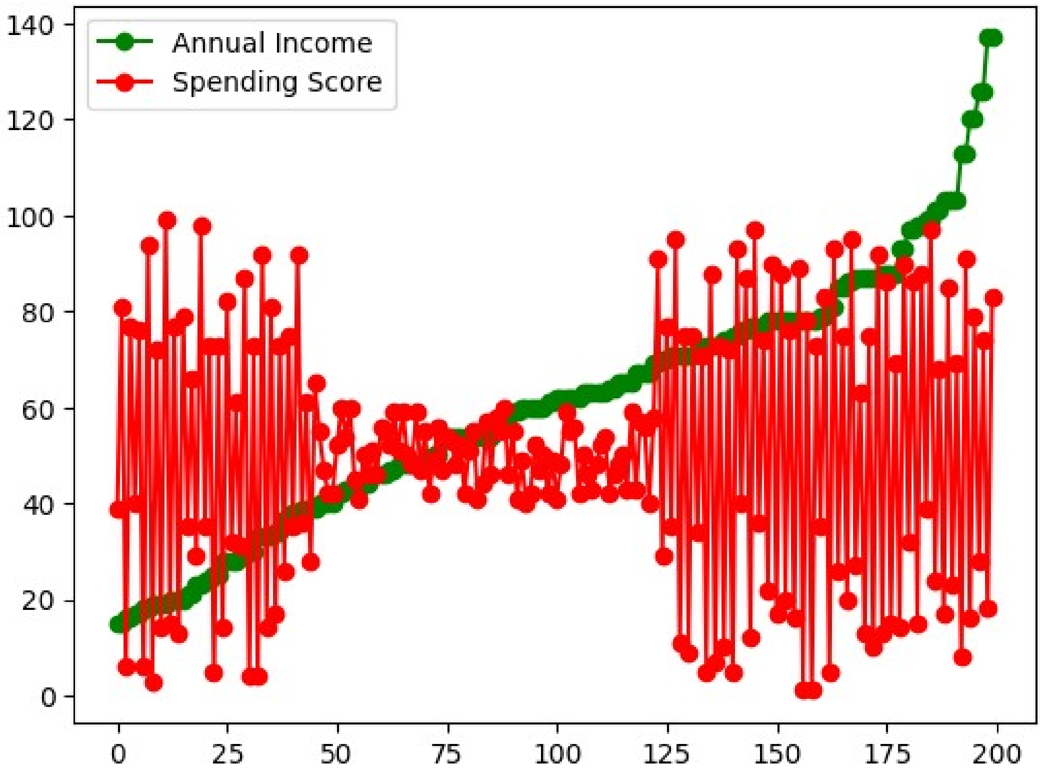
Bivariate Analysis-1 (Joint Plot)

```
sns.jointplot(x="Annual Income (k$)",y="Spending Score (1-
100)",data=df)
plt.show()
```

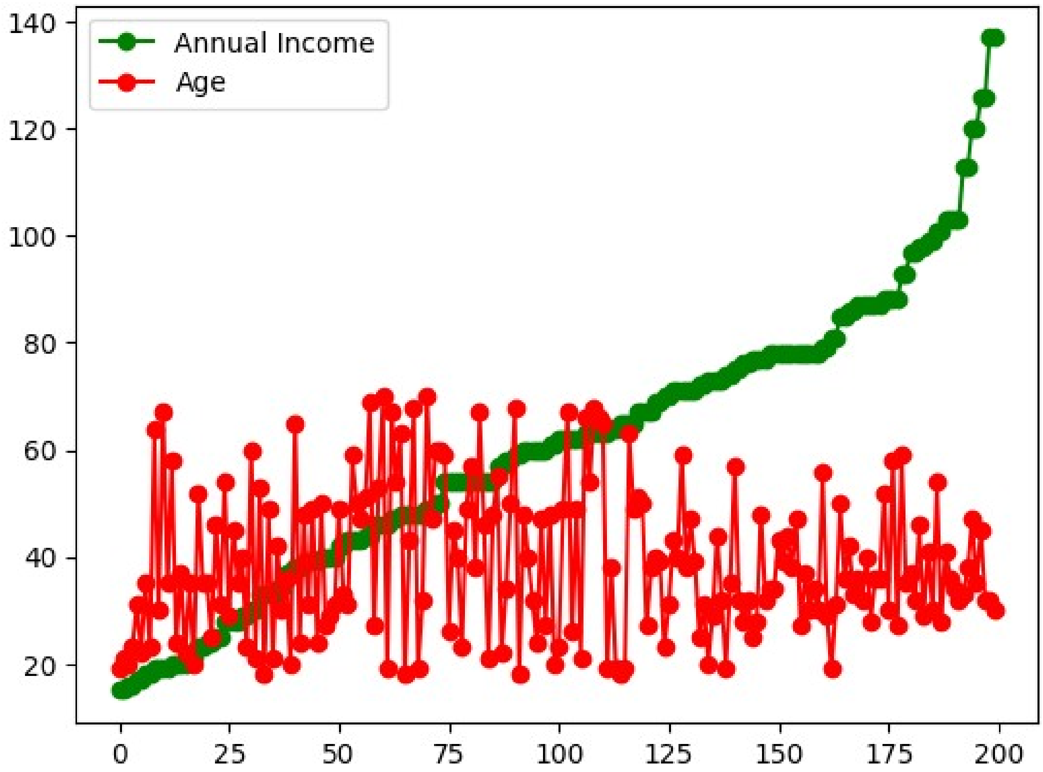


Bivariate Analysis-2 (Line Plot)

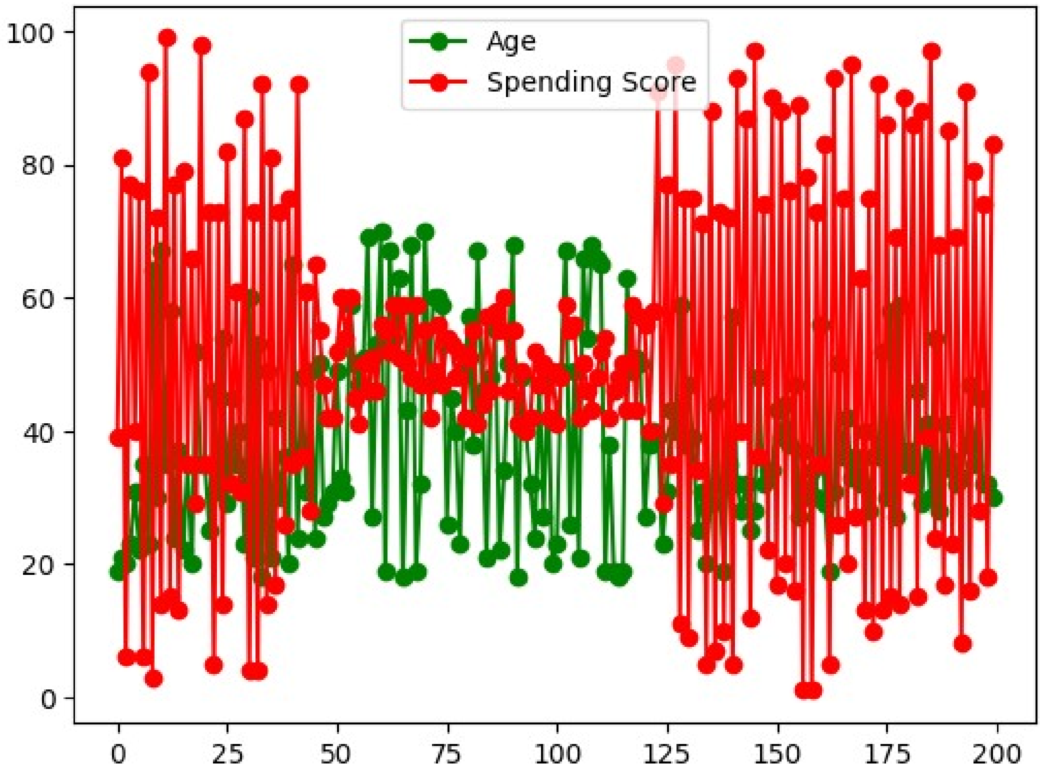
```
line1=df['Annual Income (k$)']
line2=df['Spending Score (1-100)']
plt.plot(line1,'o-g')
plt.plot(line2,'o-r')
plt.legend(['Annual Income','Spending Score'])
plt.show()
```



```
line1=df['Annual Income (k$)']
line2=df['Age']
plt.plot(line1,'o-g')
plt.plot(line2,'o-r')
plt.legend(['Annual Income','Age'])
plt.show()
```

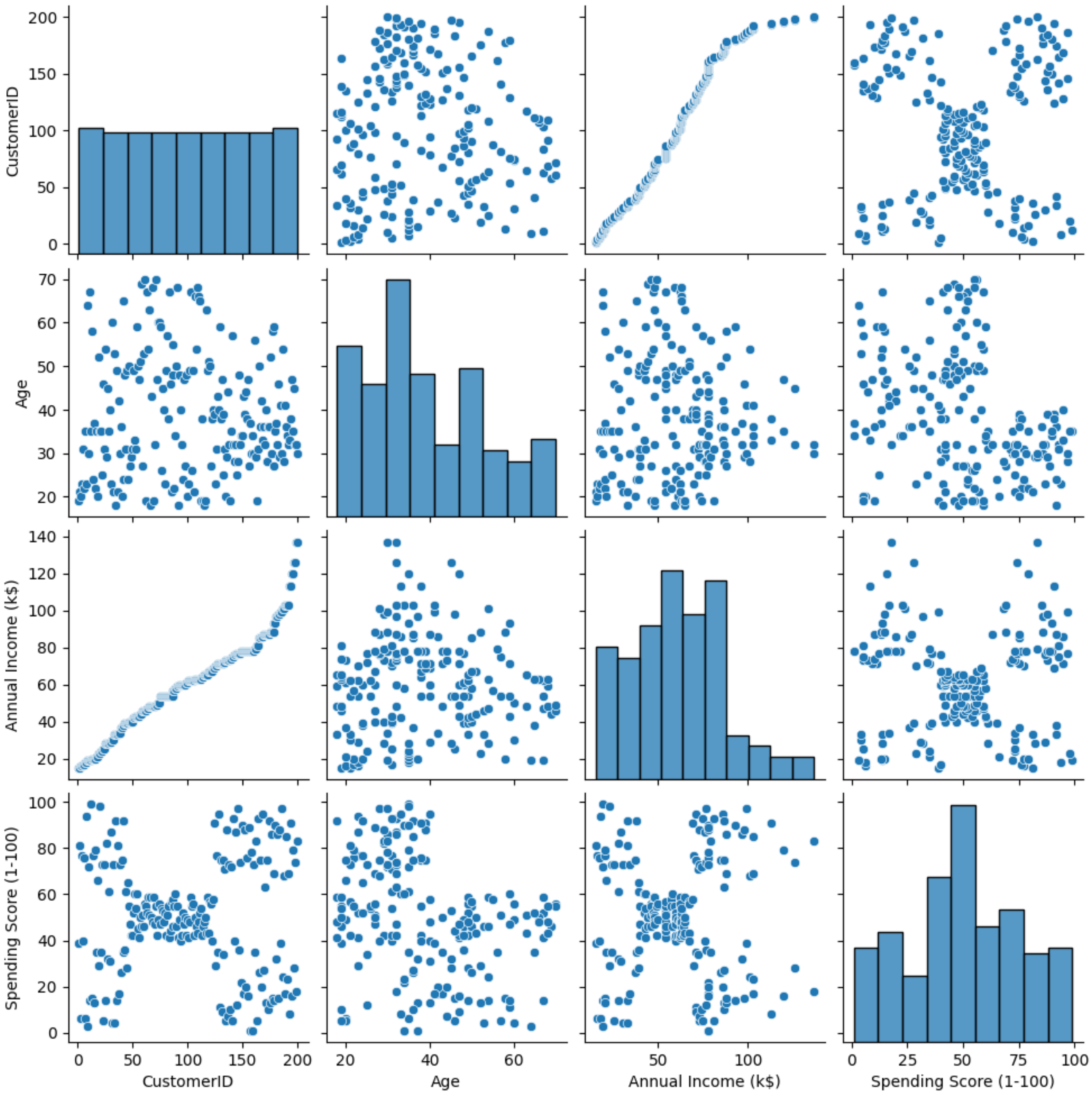


```
line1=df['Age']
line2=df['Spending Score (1-100)']
plt.plot(line1,'o-g')
plt.plot(line2,'o-r')
plt.legend(['Age','Spending Score'])
plt.show()
```



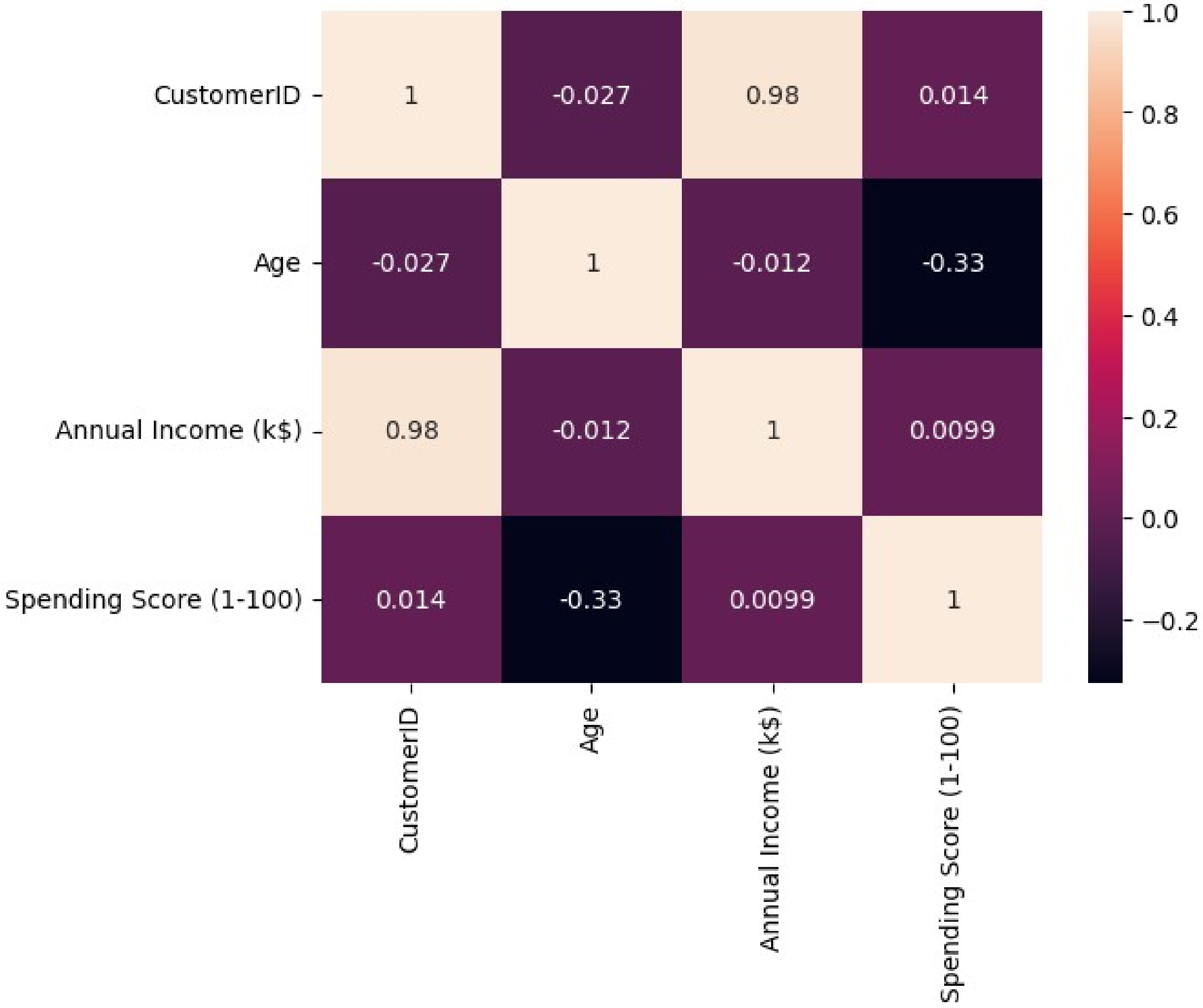
Multivariate Analysis-1 (Pair Plot)

```
sns.pairplot(df)
plt.show()
```



Multivariate Analysis-2 (Heat map)

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

<ipython-input-619-f6412ee67fb3>:1: FutureWarning: The default value
of numeric_only in DataFrame.corr is deprecated. In a future version,
it will default to False. Select only valid columns or specify the
value of numeric_only to silence this warning.
  sns.heatmap(df.corr(),annot=True)
```



Label Encoding

```
from sklearn.preprocessing import LabelEncoder
le=LabelEncoder()

df['Gender']=le.fit_transform(df['Gender'])
df.head()
```

```
   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
```

Dropping unwanted column

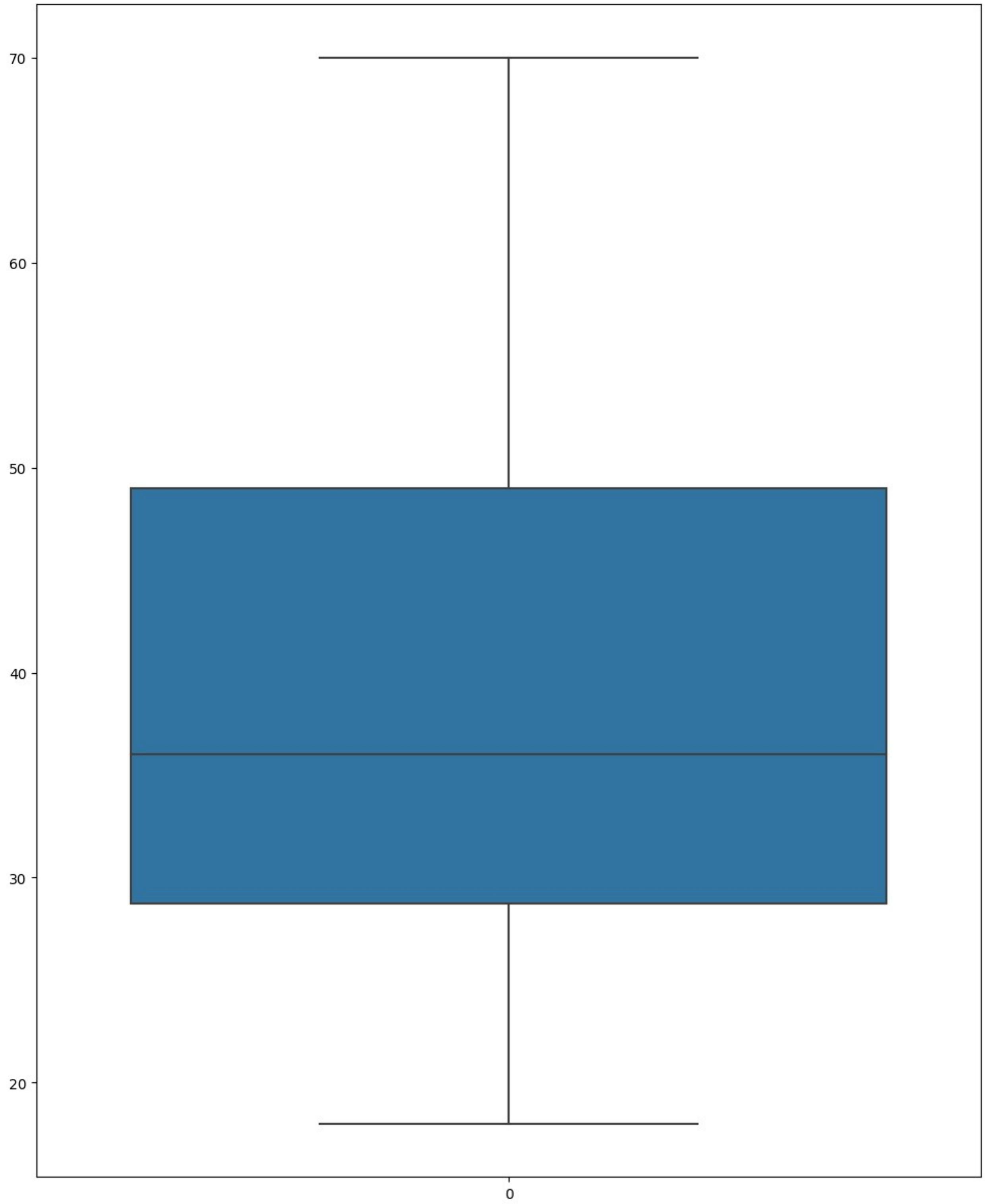
```
df.drop(columns=['CustomerID'],inplace=True)
df.head()
```

```
   Gender  Age  Annual Income (k$)  Spending Score (1-100)
0       1   19                  15                      39
1       1   21                  15                      81
2       0   20                  16                       6
3       0   23                  16                      77
4       0   31                  17                      40
```

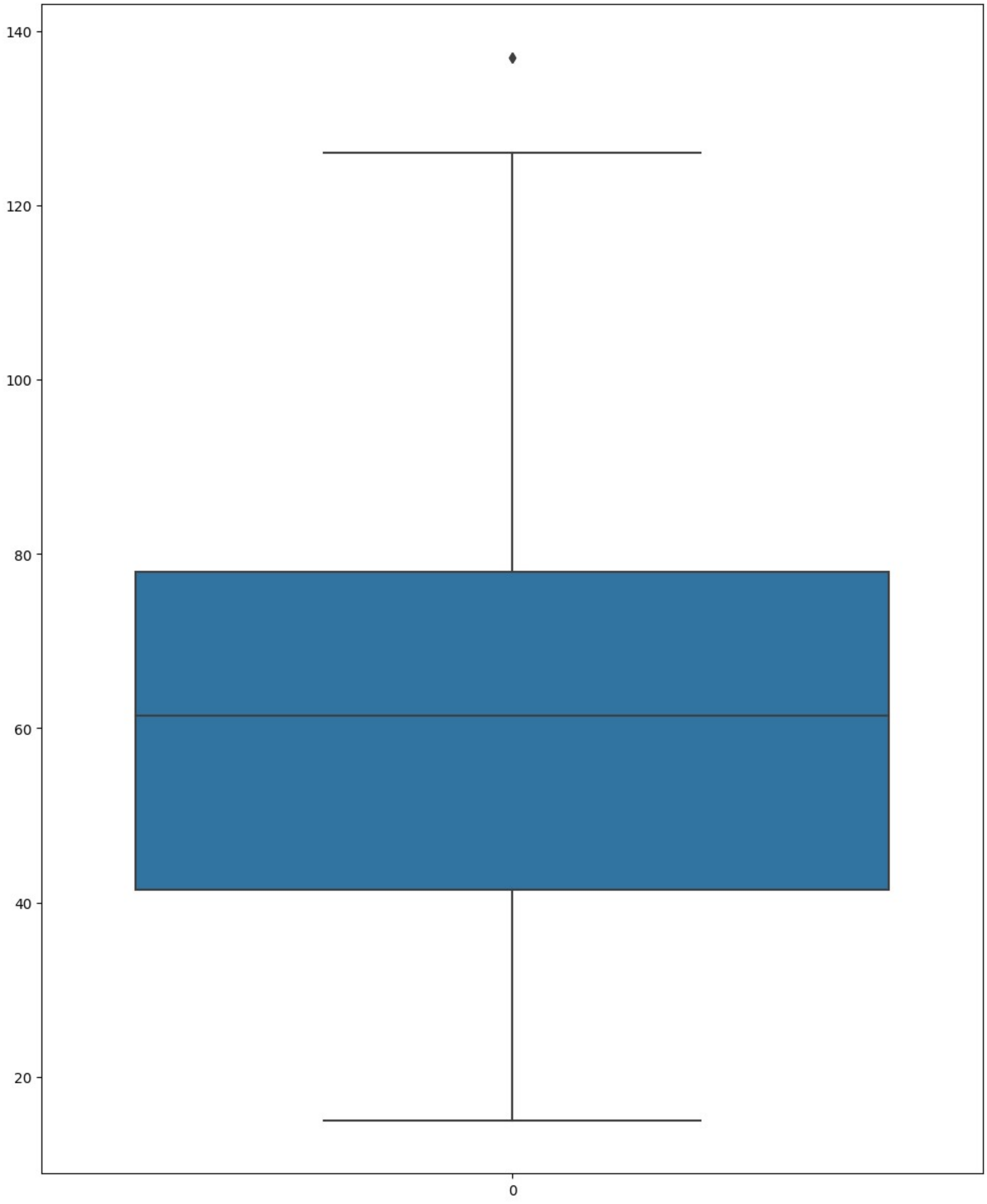
Checking for outliers and handling them

```
plt.figure(figsize=(12,15))
sns.boxplot(df['Age'])
```

```
<Axes: >
```



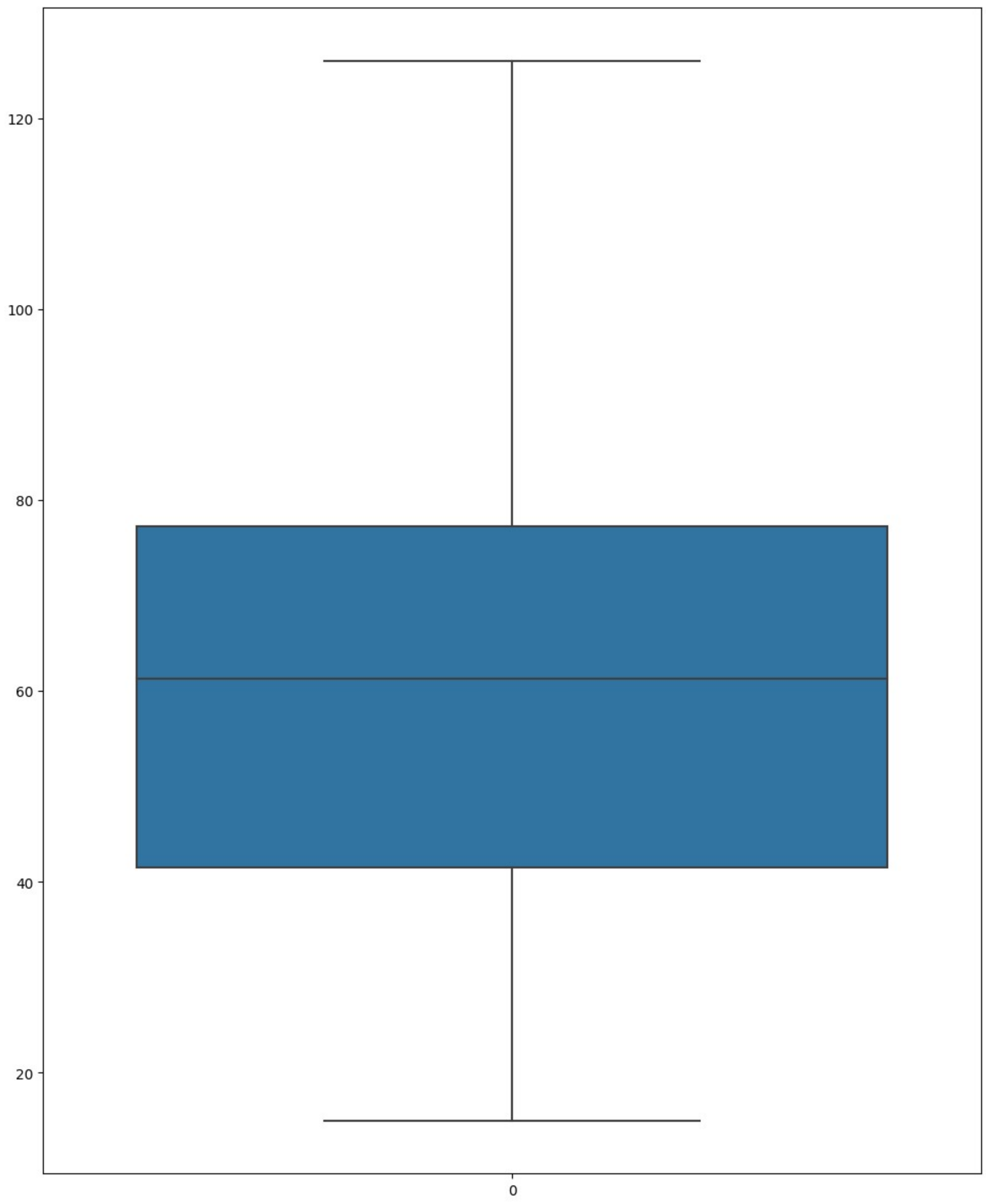
```
plt.figure(figsize=(12,15))
sns.boxplot(df['Annual Income (k$)'])

<Axes: >
```



```
q1=df['Annual Income (k$)'].quantile(0.25)
q3=df['Annual Income (k$)'].quantile(0.75)
IQR = q3-q1
upper_limit = q3 + 1.5*IQR
```

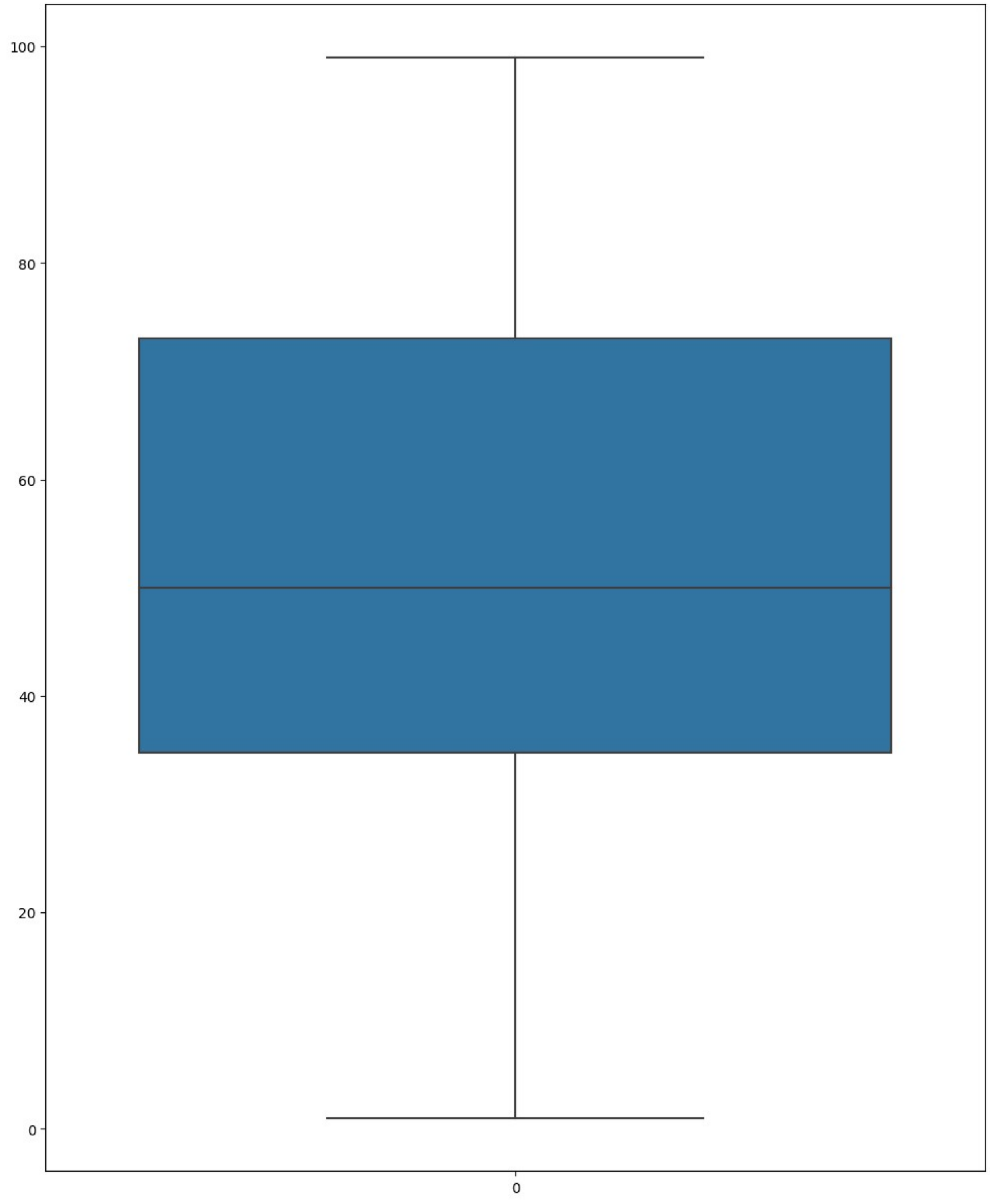
```
lower_limit = q1 - 1.5*IQR
df['Annual Income (k$)'] = np.where((df['Annual Income
(k$)']>upper_limit) | (df['Annual Income
(k$)']<lower_limit),df['Annual Income (k$)'].median(),df['Annual
Income (k$)'])

plt.figure(figsize=(12,15))
sns.boxplot(df['Annual Income (k$)'])
```

```
<Axes: >
```



```
plt.figure(figsize=(12,15))
sns.boxplot(df['Spending Score (1-100)'])
```

```
<Axes: >
```



Model Building (K-Means ++ Clustering)

```
df.head()
```

```
   Gender  Age  Annual Income (k$)  Spending Score (1-100)
0       1   19                15.0                      39
1       1   21                15.0                      81
2       0   20                16.0                       6
3       0   23                16.0                      77
4       0   31                17.0                      40
```

```
from sklearn import cluster

error=[]
for i in range(1,11):
  kmeans=cluster.KMeans(n_clusters=i,init='k-means++',random_state=0)
  kmeans.fit(df)
  error.append(kmeans.inertia_)
```

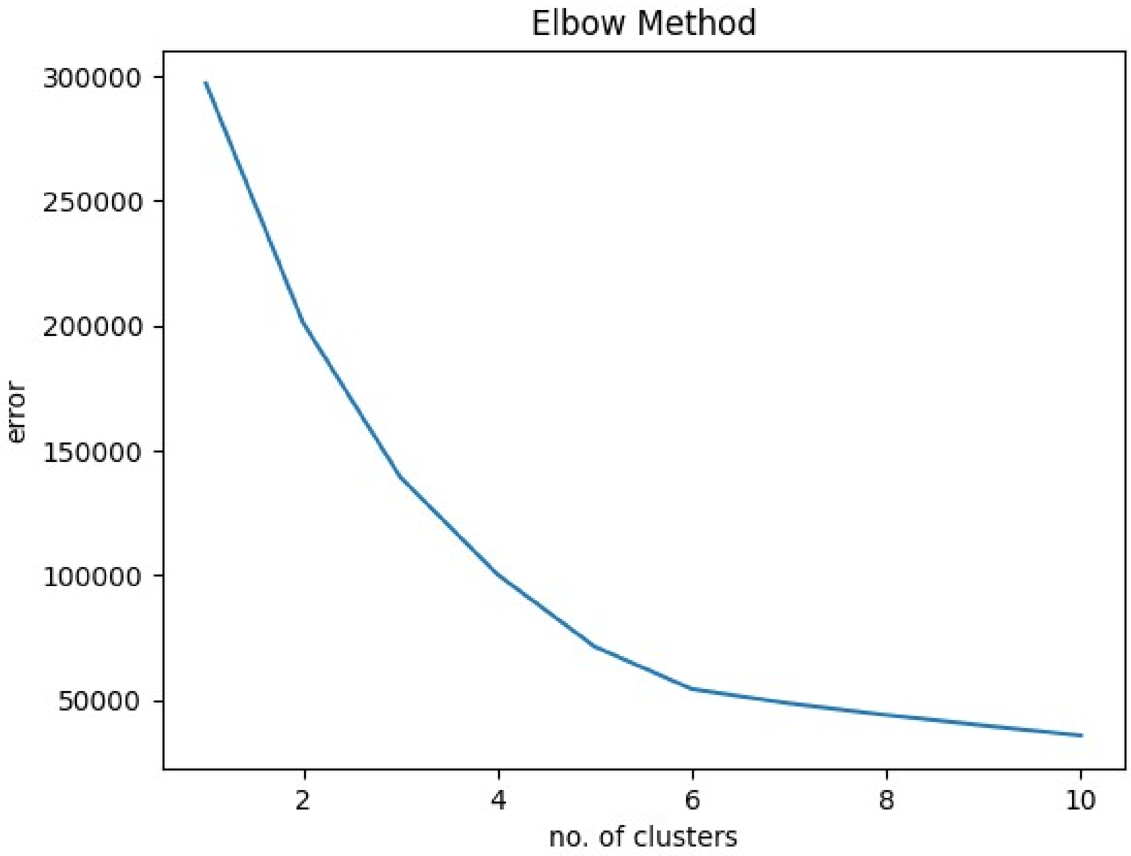
```
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870
: FutureWarning: The default value of `n_init` will change from 10 to
'auto' in 1.4. Set the value of `n_init` explicitly to suppress the
warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870
: FutureWarning: The default value of `n_init` will change from 10 to
'auto' in 1.4. Set the value of `n_init` explicitly to suppress the
warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870
: FutureWarning: The default value of `n_init` will change from 10 to
'auto' in 1.4. Set the value of `n_init` explicitly to suppress the
warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870
: FutureWarning: The default value of `n_init` will change from 10 to
'auto' in 1.4. Set the value of `n_init` explicitly to suppress the
warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870
: FutureWarning: The default value of `n_init` will change from 10 to
'auto' in 1.4. Set the value of `n_init` explicitly to suppress the
warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870
: FutureWarning: The default value of `n_init` will change from 10 to
'auto' in 1.4. Set the value of `n_init` explicitly to suppress the
warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870
: FutureWarning: The default value of `n_init` will change from 10 to
'auto' in 1.4. Set the value of `n_init` explicitly to suppress the
warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870
: FutureWarning: The default value of `n_init` will change from 10 to
'auto' in 1.4. Set the value of `n_init` explicitly to suppress the
warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870
: FutureWarning: The default value of `n_init` will change from 10 to
'auto' in 1.4. Set the value of `n_init` explicitly to suppress the
warning
  warnings.warn(
```

```
error
```

```
[297063.67500000005,
 201152.1081841432,
 139326.23321730684,
 100349.31619915173,
 71452.15398255127,
 54455.93879921248,
 48690.46594333272,
 44049.34418034487,
 39872.05312036622,
 35841.183878126976]
```

```
plt.plot(range(1,11),error)
plt.title('Elbow Method')
plt.xlabel('no. of clusters')
plt.ylabel('error')
```

```
Text(0, 0.5, 'error')
```



```
km_model = cluster.KMeans(n_clusters=5, init = 'k-means++',
random_state=0)

km_model.fit(df)

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(

KMeans(n_clusters=5, random_state=0)

pred=km_model.predict(df)
pred

array([4, 0, 4, 0, 4, 0, 4, 0, 4, 0, 4, 0, 4, 0, 4, 0, 4, 0, 4, 0, 4,
0,
       4, 0, 4, 0, 4, 0, 4, 0, 4, 0, 4, 0, 4, 0, 4, 0, 4, 0, 4, 0, 4,
2,
       4, 0, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
2,
       2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
2,
       2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
2,
       2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 1, 3, 1, 2, 1, 3, 1, 3,
1,
       3, 1, 3, 1, 3, 1, 3, 1, 3, 1, 2, 1, 3, 1, 3, 1, 3, 1, 3, 1, 3,
1,
       3, 1, 3, 1, 3, 1, 3, 1, 3, 1, 3, 1, 3, 1, 3, 1, 3, 1, 3, 1, 3,
1,
       3, 1, 3, 1, 3, 1, 3, 1, 3, 1, 3, 1, 3, 1, 3, 1, 3, 1, 3, 1, 3,
1,
       3, 1], dtype=int32)
```

Testing with random observations

```
km_model.predict([[1,25,54,46]])
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:439:
UserWarning: X does not have valid feature names, but KMeans was
fitted with feature names
  warnings.warn(
```

```
array([2], dtype=int32)
```

```
km_model.predict([[0,18,81,92]])
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:439:
UserWarning: X does not have valid feature names, but KMeans was
fitted with feature names
  warnings.warn(
```

```
array([1], dtype=int32)
```

```
km_model.predict([[0,17,12,10]])
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:439:
UserWarning: X does not have valid feature names, but KMeans was
fitted with feature names
  warnings.warn(
```

```
array([4], dtype=int32)
```

```
km_model.predict([[1,55,48,31]])
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:439:
UserWarning: X does not have valid feature names, but KMeans was
fitted with feature names
  warnings.warn(
```

```
array([2], dtype=int32)
```

```
km_model.predict([[1,35,127,28]])
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:439:
UserWarning: X does not have valid feature names, but KMeans was
fitted with feature names
  warnings.warn(
```

```
array([3], dtype=int32)
```

```
km_model.predict([[0,47,49,115]])
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:439:
UserWarning: X does not have valid feature names, but KMeans was
fitted with feature names
  warnings.warn(
```

```
array([0], dtype=int32)
```

Evaluation

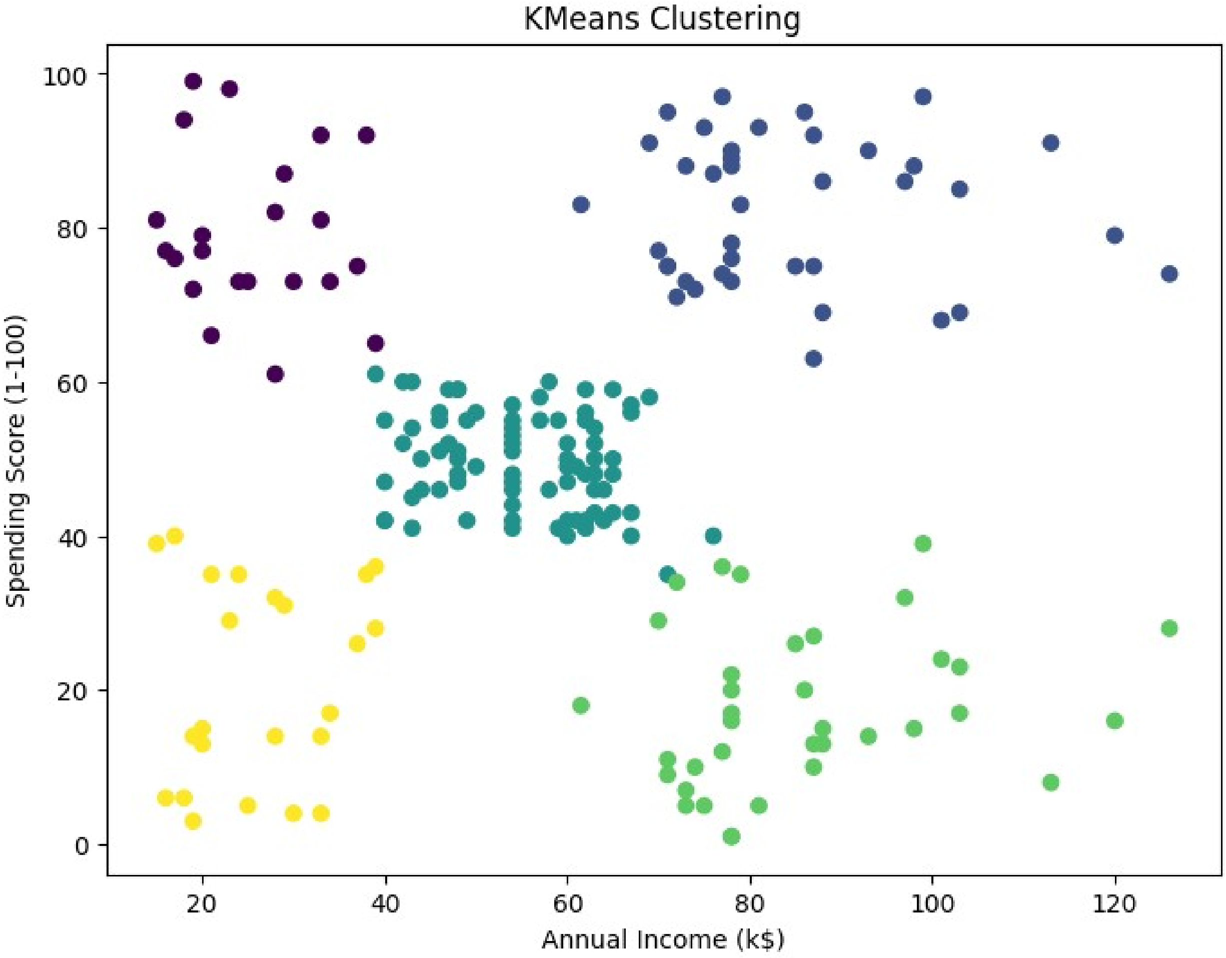
```
from sklearn.metrics import silhouette_score
```

```
silhouette_score(df, km_model.labels_, metric='euclidean')
```

```
0.4458441722923995
```

Cluster diagram

```
plt.figure(figsize=(8, 6))
plt.scatter(df['Annual Income (k$)'], df['Spending Score (1-100)'],
c=km_model.labels_)
plt.xlabel('Annual Income (k$)')
plt.ylabel('Spending Score (1-100)')
plt.title('KMeans Clustering')
plt.show()
```


KMeans Clustering
Spending Score (1-100)
100
80
60
40
20
0
20
40
60
80
100
120
Annual Income (k$)