mall-customer

November 4, 2023

1 Project Name : Mall Customers Analysis

AUTHOR : **Jamshed Butt** from **Data Science**

Introduction :

This notebook explores customer segmentation and analysis based on a dataset from a shopping mall. The dataset includes customer information, such as age, annual income, and spending score, along with unique identifiers and gender.

Dataset Overview

CustomerID: A unique identifier for each customer.

Gender: Customer gender (Male or Female).

Age: Customer age.

Annual Income (k$): Customer annual income in thousands of dollars.

Spending Score (1-100): A score reflecting customer spending behavior and habits.

Purpose

The goal of this analysis is to cluster customers based on their attributes and behavior. By segmenting customers, we aim to gain insights into their preferences and tailor marketing strategies to improve customer satisfaction and optimize business operations.

2 Import Libraries

[98]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import scipy.stats as stats
import pylab

from sklearn.preprocessing import LabelEncoder, StandardScaler

#Model
from sklearn.cluster import KMeans,AgglomerativeClustering,DBSCAN
```

3 Load Dataset

[2]:
```
df = pd.read_csv("/content/drive/MyDrive/Datasets/Mall_Customers/Mall_Customers.csv")
df.head()
```

[2]:

	CustomerID	Genre	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

[3]:
```
df.shape
```

[3]:
```
(200, 5)
```

[4]:
```
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   Genre                   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
```

[5]:
```
df.describe()
```

[5]:

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

[6]:
```
df.drop(["CustomerID"],axis=1,inplace=True)
```

[7]:
```
df.rename(columns = {'Genre':'Gender'}, inplace = True)
```

[8]:
```
df.head()
```

[8]:

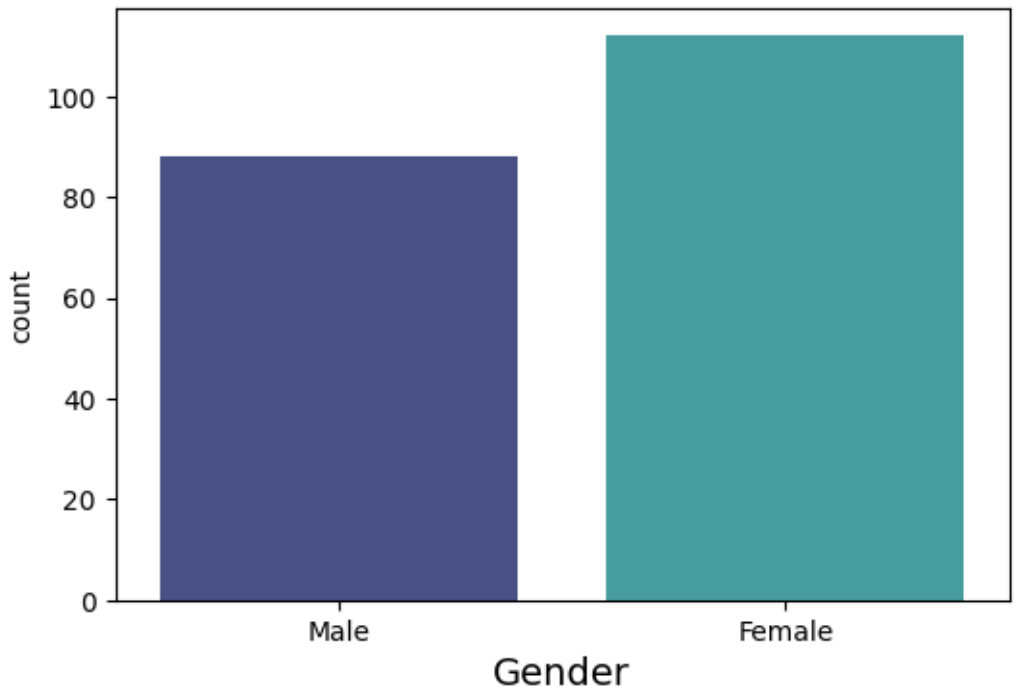
	Gender	Age	Annual Income (k$)	Spending Score (1-100)
0	Male	19	15	39
1	Male	21	15	81
2	Female	20	16	6
3	Female	23	16	77
4	Female	31	17	40

4 Univariate Analysis

[9]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 200 entries, 0 to 199
Data columns (total 4 columns):
 #   Column                  Non-Null Count  Dtype
---  ------                  --------------  -----
 0   Gender                  200 non-null    object
 1   Age                     200 non-null    int64
 2   Annual Income (k$)      200 non-null    int64
 3   Spending Score (1-100)  200 non-null    int64
dtypes: int64(3), object(1)
memory usage: 6.4+ KB
```

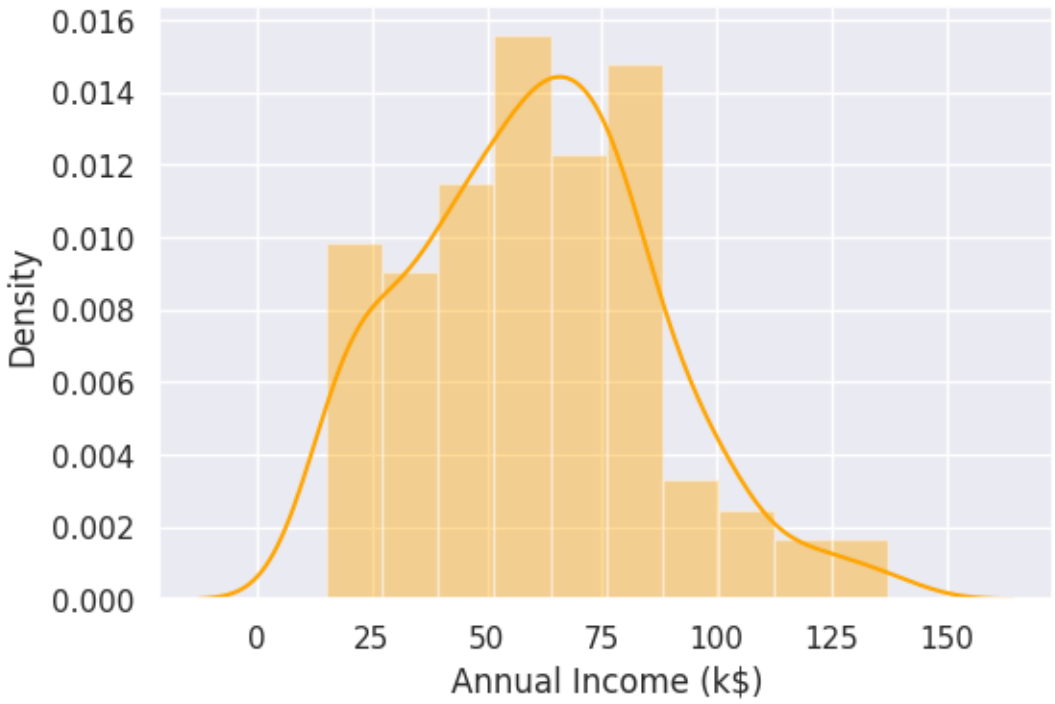
[10]:
```
plt.figure(figsize=(6,4))
sns.countplot(x="Gender", data=df, palette="mako")
plt.xlabel("Gender", fontsize=14)
plt.show()
```



[11]:
```
sns.set(rc={"figure.figsize":(6,4)})
sns.distplot(df["Annual Income (k$)"], kde=True, color="orange", bins=10)
```

```
<ipython-input-11-f2968f390614>:2: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(df["Annual Income (k$)"], kde=True, color="orange", bins=10)
```

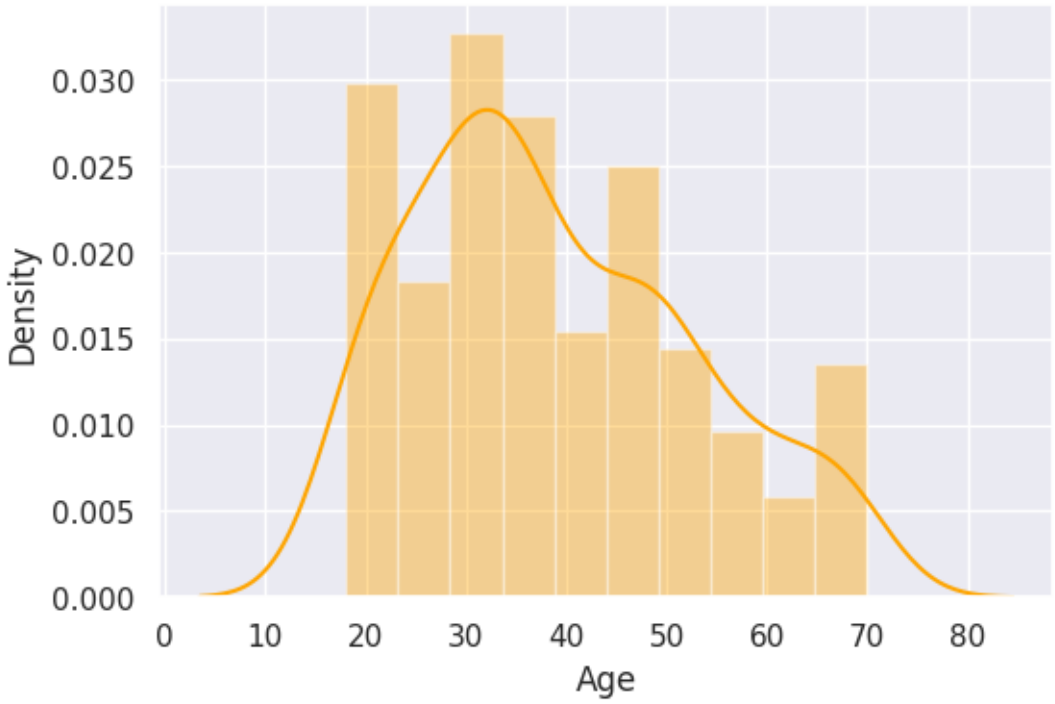
[11]: `<Axes: xlabel='Annual Income (k$)', ylabel='Density'>`



[12]:
```
sns.set(rc={"figure.figsize":(6,4)})
sns.distplot(df["Age"], kde=True, color="orange", bins=10)
```

```
<ipython-input-12-511f0157ff88>:2: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(df["Age"], kde=True, color="orange", bins=10)
```

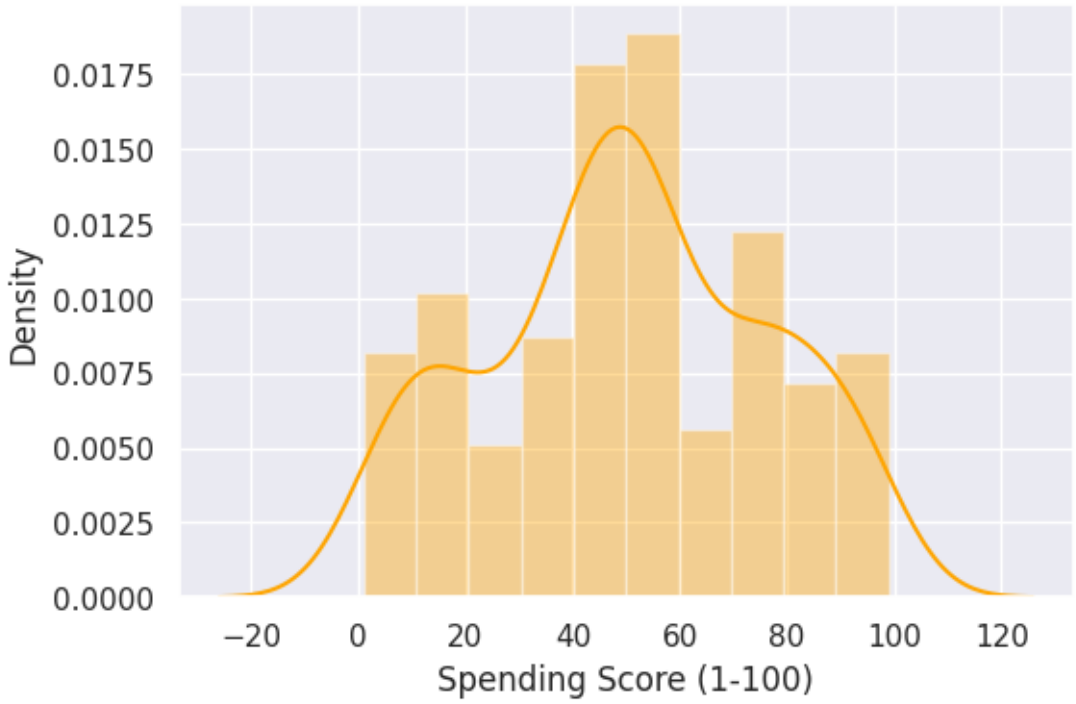
[12]: <Axes: xlabel='Age', ylabel='Density'>



[13]:
```
sns.set(rc={"figure.figsize":(6,4)})
sns.distplot(df["Spending Score (1-100)"], kde=True, color="orange", bins=10)
```

```
<ipython-input-13-3765b8f0404d>:2: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(df["Spending Score (1-100)"], kde=True, color="orange", bins=10)
```

[13]:
```
<Axes: xlabel='Spending Score (1-100)', ylabel='Density'>
```



5 EDA (Exploratory Data Analysis)

Remove Duplicate

[14]:
```
duplicated = df.duplicated()
print(duplicated.sum())
```

```
0
```

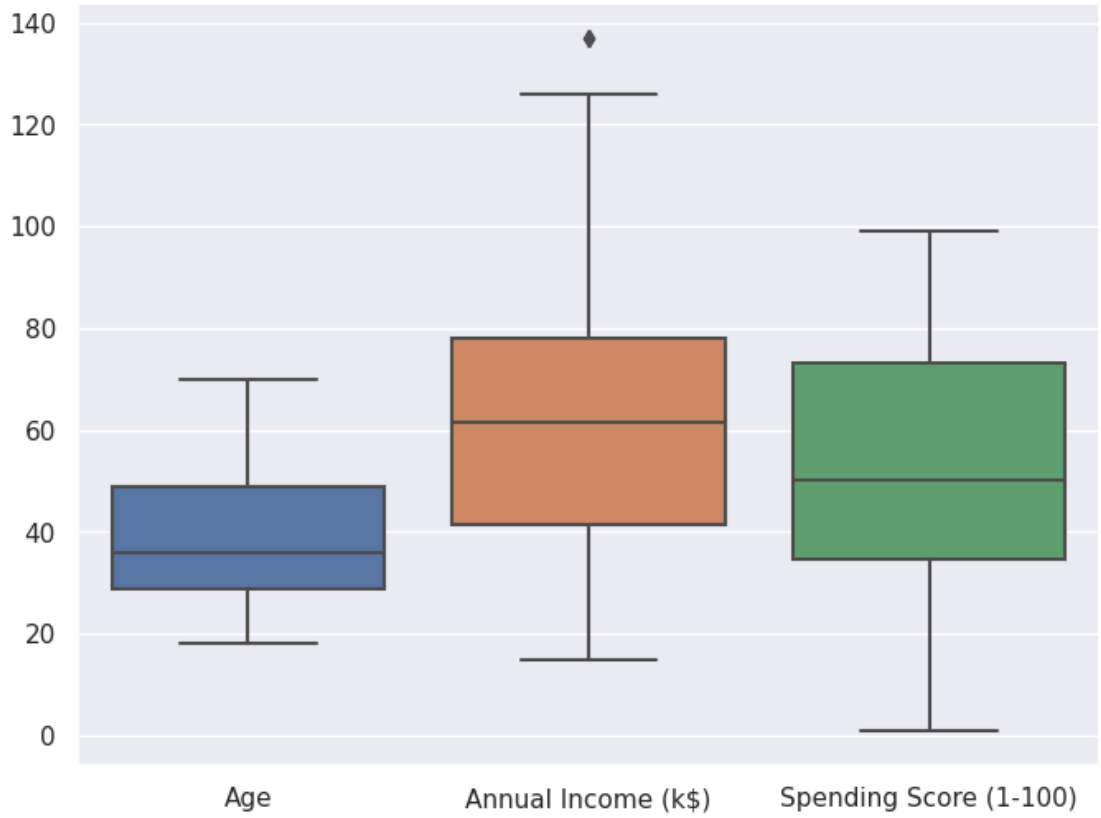
Check And Remove NaN Values

[15]:
```
df.isnull().sum()
```

[15]:
```
Gender                    0
Age                       0
Annual Income (k$)        0
Spending Score (1-100)    0
dtype: int64
```

Remove Outlier

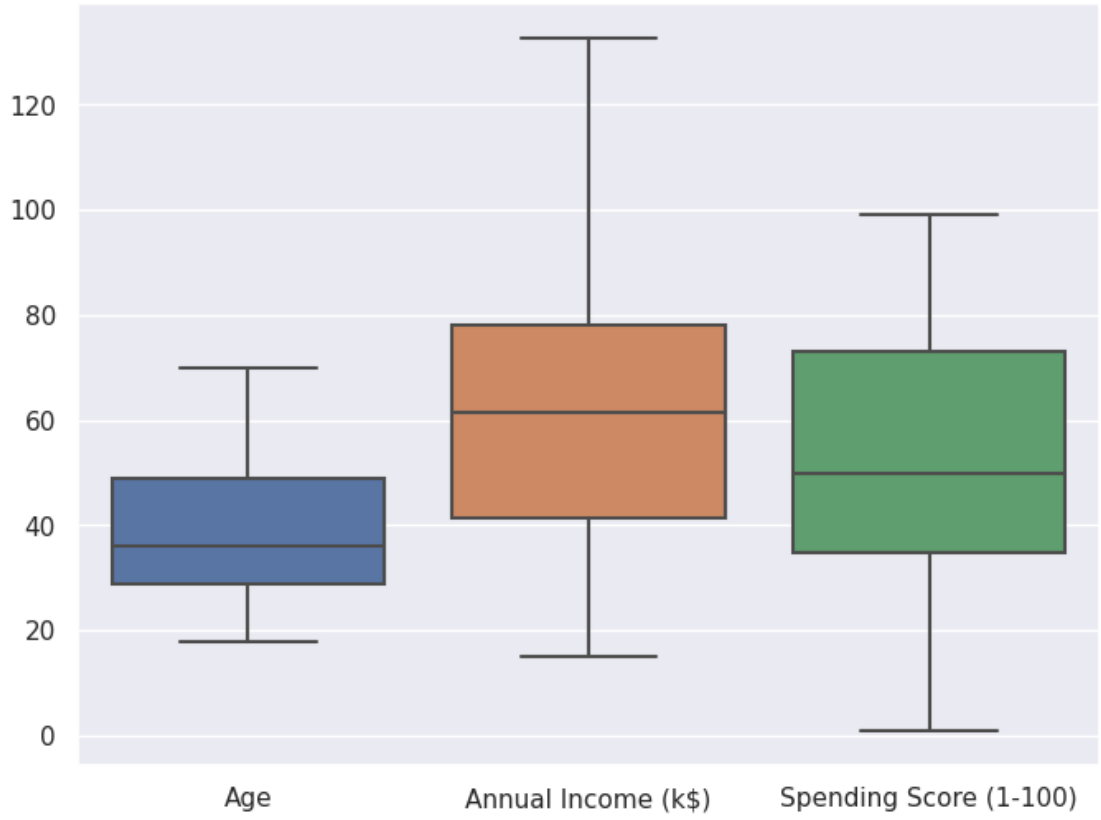
[16]:
```
plt.figure(figsize=(8,6))
sns.boxplot(data=df)
plt.show()
```



[17]:
```
def remove_outlier(col):
  sorted(col)
  Q1,Q3 = col.quantile([0.25,0.75])
  IQR = Q3 - Q1
  lower_range = Q1 - (1.5 * IQR)
  upper_range = Q3 + (1.5 * IQR)
  return lower_range,upper_range
```

[18]:
```
lower_range,upper_range = remove_outlier(df["Annual Income (k$)"])
df["Annual Income (k$)"] = np.where(df["Annual Income (k$)"] > upper_range,␣
 ↪upper_range, df["Annual Income (k$)"])
df["Annual Income (k$)"] = np.where(df["Annual Income (k$)"] < lower_range,␣
 ↪lower_range, df["Annual Income (k$)"])
```

[19]:
```
plt.figure(figsize=(8,6))
sns.boxplot(data=df)
plt.show()
```



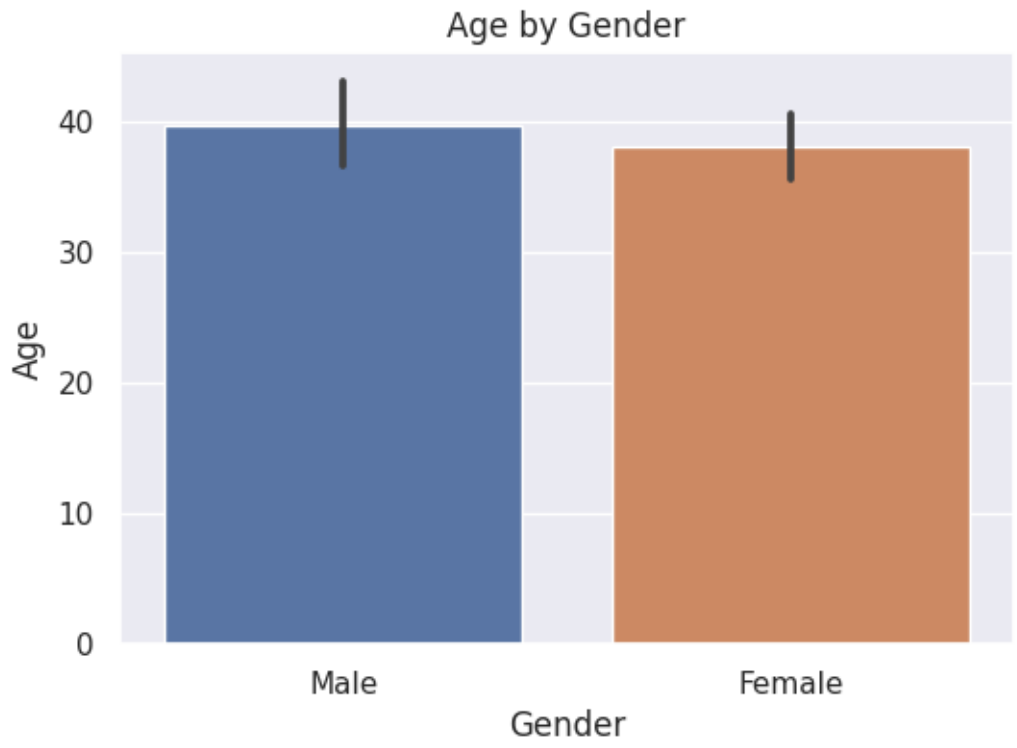
Bivariate Analysis

[20]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 200 entries, 0 to 199
Data columns (total 4 columns):
 #   Column                  Non-Null Count  Dtype
---  ------                  --------------  -----
 0   Gender                  200 non-null    object
 1   Age                     200 non-null    int64
 2   Annual Income (k$)      200 non-null    float64
 3   Spending Score (1-100)  200 non-null    int64
dtypes: float64(1), int64(2), object(1)
memory usage: 6.4+ KB
```

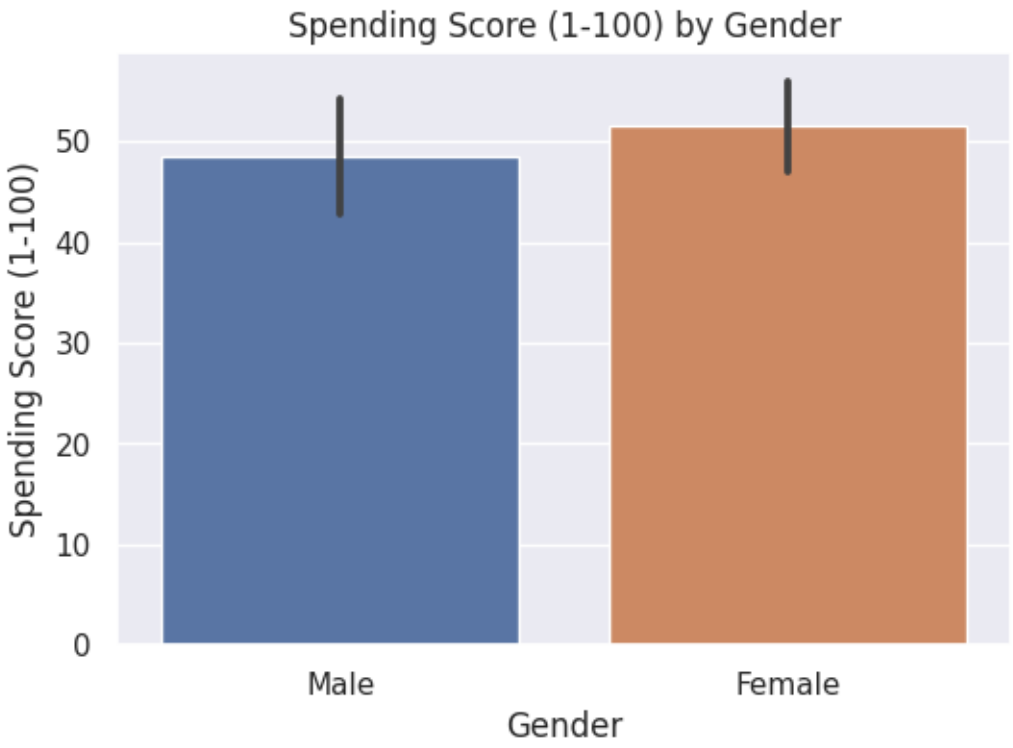
[21]:
```
plt.figure(figsize=(6, 4))
sns.barplot(x='Gender', y='Age', data=df)
plt.title('Age by Gender')
plt.xlabel('Gender')
plt.ylabel('Age')
```

```
plt.show()
```



[22]:
```
plt.figure(figsize=(6, 4))
sns.barplot(x='Gender', y='Annual Income (k$)', data=df)
plt.title('Annual Income (k$) by Gender')
plt.xlabel('Gender')
plt.ylabel('Annual Income (k$)')
plt.show()
```

[23]:
```
plt.figure(figsize=(6, 4))
sns.barplot(x='Gender', y='Spending Score (1-100)', data=df)
plt.title('Spending Score (1-100) by Gender')
plt.xlabel('Gender')
plt.ylabel('Spending Score (1-100)')
plt.show()
```

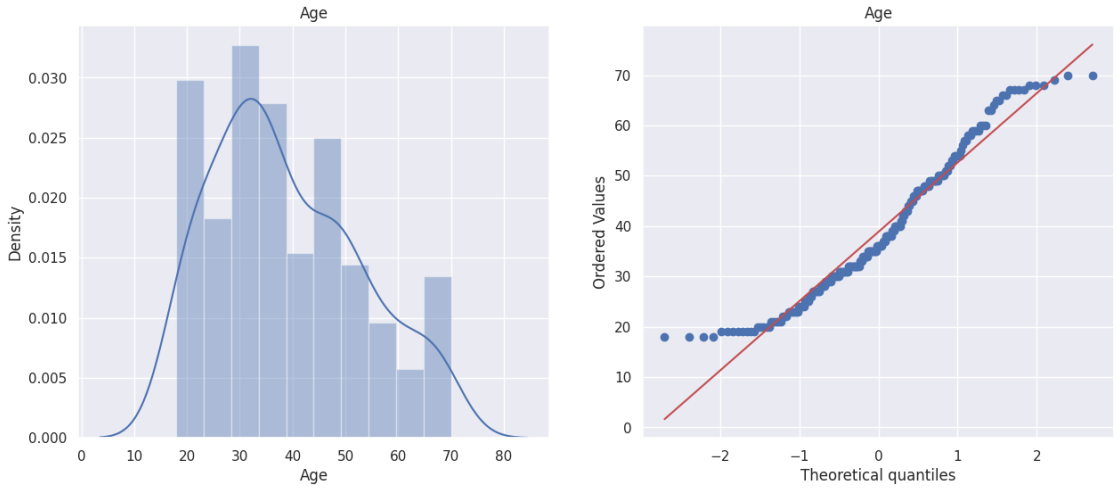


[117]:
```
sns.regplot(x='Age', y='Spending Score (1-100)', data=df, color='b')
plt.xlabel('Age')
plt.ylabel('Spending Score (1-100)')
plt.title('Age vs. Spending Score')
plt.show()
```

[24]:
```
num_cols = df.select_dtypes(include=["int64","float64"])
def plots(num_cols, variable):
    plt.figure(figsize=(15,6))
    plt.subplot(1, 2, 1)
    #num_cols[variable].hist()
    sns.distplot(num_cols[variable], kde=True, bins=10)
    plt.title(variable)
    plt.subplot(1, 2, 2)
    stats.probplot(num_cols[variable], dist="norm", plot=pylab)
    plt.title(variable)
    plt.show()
for i in num_cols.columns:
  plots(num_cols, i)
```

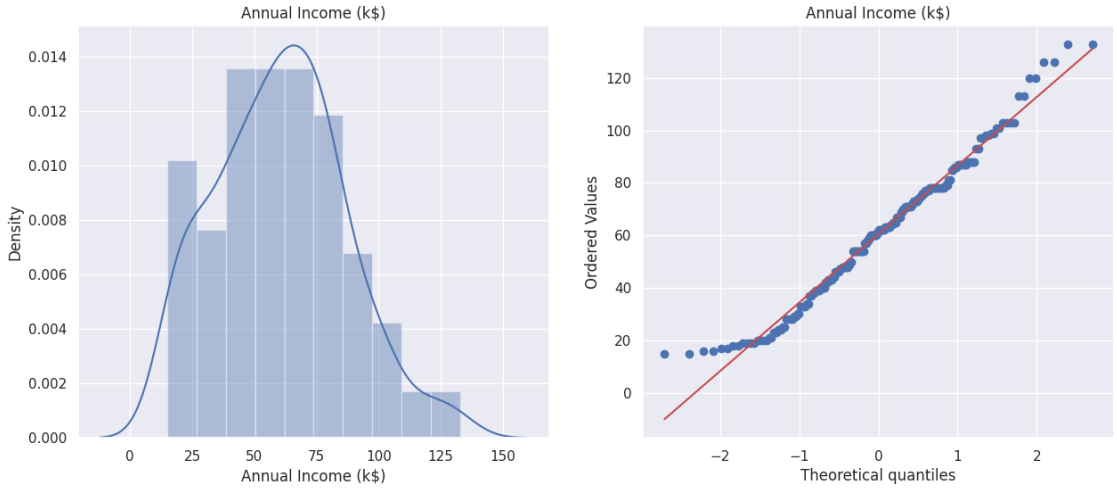
```
<ipython-input-24-7af58d2ef5aa>:6: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751
```

```
  sns.distplot(num_cols[variable], kde=True, bins=10)
```

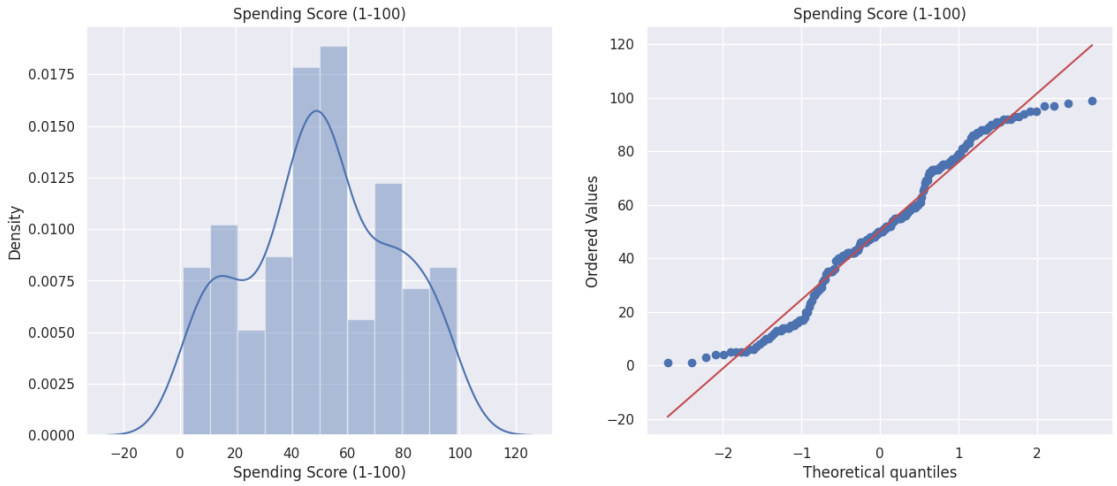



```
<ipython-input-24-7af58d2ef5aa>:6: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751
```

```
  sns.distplot(num_cols[variable], kde=True, bins=10)
```



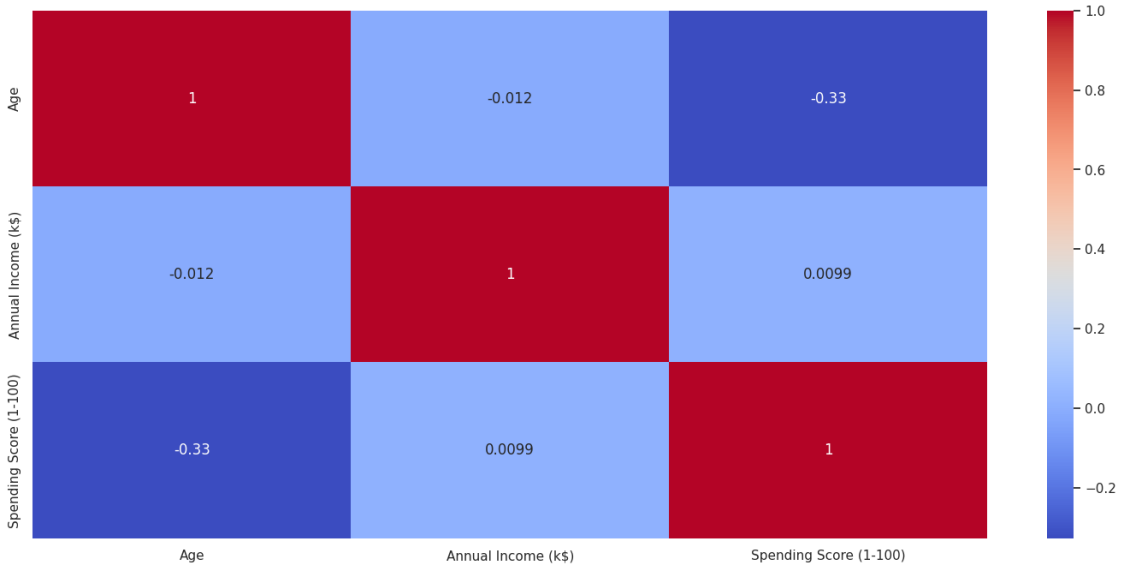
```
<ipython-input-24-7af58d2ef5aa>:6: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(num_cols[variable], kde=True, bins=10)
```



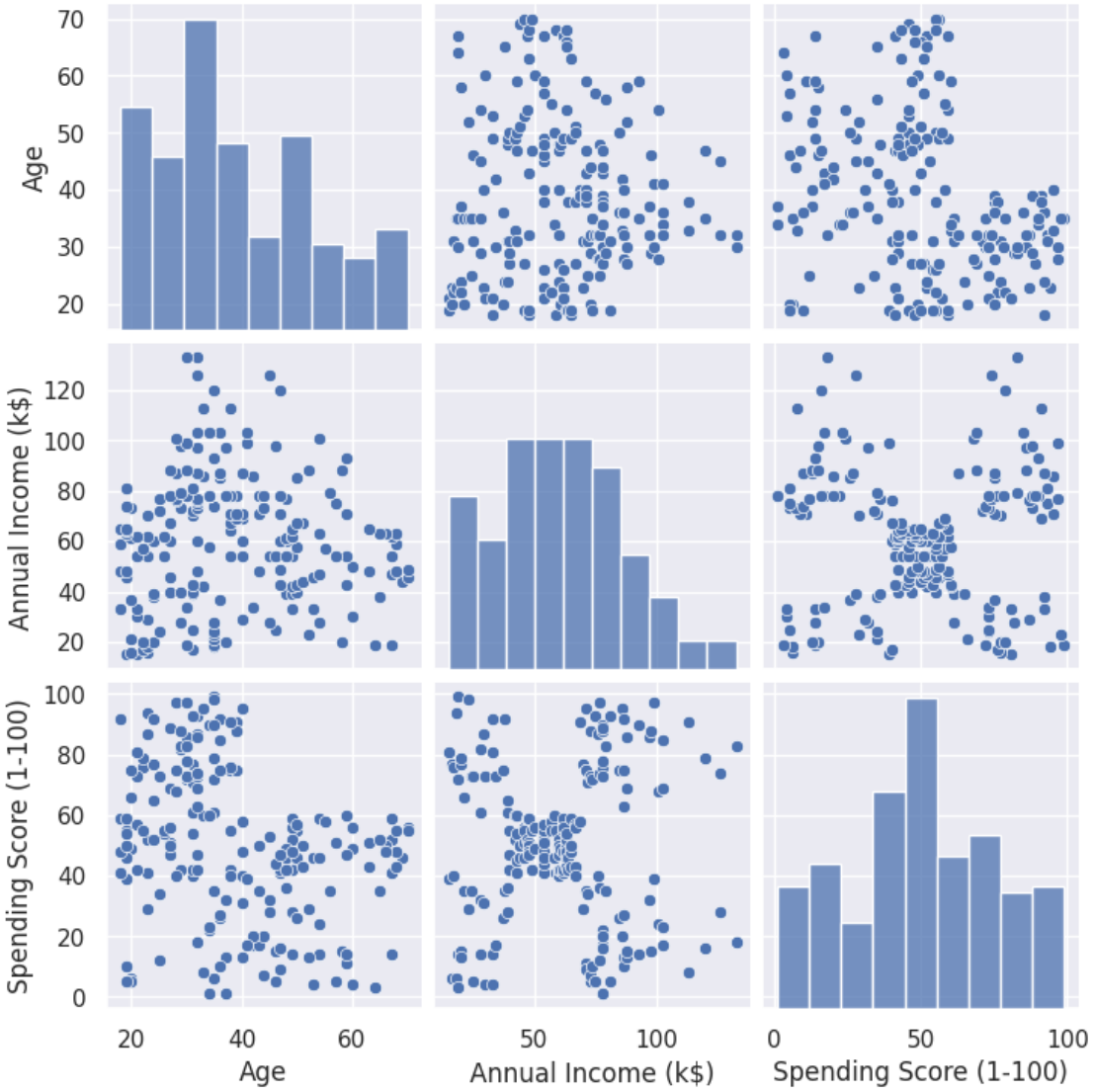
[25]:
```
fig, ax = plt.subplots(figsize=(18, 8))
sns.heatmap(df.corr(), annot=True, cmap='coolwarm', ax=ax)
```

```
<ipython-input-25-50c0f90b2df7>:2: 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, cmap='coolwarm', ax=ax)
```

[25]: <Axes: >



[26]:
```
sns.pairplot(df)
plt.show()
```



Drop Columns that are not used further

[40]:
```
X = df.iloc[:,[2,3]]
```

[41]:
```
X.head()
```

[41]:

	Annual Income (k$)	Spending Score (1-100)
0	15.0	39
1	15.0	81
2	16.0	6
3	16.0	77
4	17.0	40

6 Feature Engineering

Normalizing Data

[76]:
```
sc = StandardScaler()
X = sc.fit_transform(X)
```

[77]:
```
X
```

[77]:
```
array([[-1.74542941, -0.43480148],
       [-1.74542941,  1.19570407],
       [-1.70708307, -1.71591298],
       [-1.70708307,  1.04041783],
       [-1.66873673, -0.39597992],
       [-1.66873673,  1.00159627],
       [-1.6303904 , -1.71591298],
       [-1.6303904 ,  1.70038436],
       [-1.59204406, -1.83237767],
       [-1.59204406,  0.84631002],
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       [-1.59204406,  1.89449216],
       [-1.55369772, -1.36651894],
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       [-1.55369772,  1.11806095],
       [-1.51535138, -0.59008772],
       [-1.51535138,  0.61338066],
       [-1.43865871, -0.82301709],
       [-1.43865871,  1.8556706 ],
       [-1.40031237, -0.59008772],
       [-1.40031237,  0.88513158],
       [-1.36196603, -1.75473454],
       [-1.36196603,  0.88513158],
       [-1.24692702, -1.4053405 ],
       [-1.24692702,  1.23452563],
       [-1.24692702, -0.7065524 ],
       [-1.24692702,  0.41927286],
       [-1.20858069, -0.74537397],
       [-1.20858069,  1.42863343],
       [-1.17023435, -1.7935561 ],
       [-1.17023435,  0.88513158],
       [-1.05519534, -1.7935561 ],
       [-1.05519534,  1.62274124],
       [-1.05519534, -1.4053405 ],
       [-1.05519534,  1.19570407],
       [-1.016849  , -1.28887582],
       [-1.016849  ,  0.88513158],
       [-0.90180999, -0.93948177],
```

```
[-0.90180999,  0.96277471],
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[-0.7100783 ,  0.38045129],
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[-0.24992225,  0.26398661],
[-0.24992225, -0.16305055],
```

```
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[ 0.40196548,  0.96277471],
[ 0.40196548, -1.5994483 ],
[ 0.40196548,  0.96277471],
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```

```
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[ 0.47865816, -1.75473454],
[ 0.47865816,  1.46745499],
[ 0.47865816, -1.67709142],
[ 0.47865816,  0.88513158],
[ 0.51700449, -1.56062674],
[ 0.51700449,  0.84631002],
[ 0.55535083, -1.75473454],
[ 0.55535083,  1.6615628 ],
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[ 0.59369717,  1.42863343],
[ 0.6320435 , -1.48298362],
[ 0.6320435 ,  1.81684904],
[ 0.6320435 , -0.55126616],
[ 0.6320435 ,  0.92395314],
[ 0.67038984, -1.09476801],
[ 0.67038984,  1.54509812],
[ 0.67038984, -1.28887582],
[ 0.67038984,  1.46745499],
[ 0.67038984, -1.17241113],
[ 0.67038984,  1.00159627],
[ 0.67038984, -1.32769738],
[ 0.67038984,  1.50627656],
[ 0.67038984, -1.91002079],
[ 0.67038984,  1.07923939],
[ 0.67038984, -1.91002079],
[ 0.67038984,  0.88513158],
[ 0.70873618, -0.59008772],
[ 0.70873618,  1.27334719],
[ 0.78542885, -1.75473454],
[ 0.78542885,  1.6615628 ],
[ 0.9388142 , -0.93948177],
[ 0.9388142 ,  0.96277471],
[ 0.97716054, -1.17241113],
[ 0.97716054,  1.73920592],
[ 1.01550688, -0.90066021],
[ 1.01550688,  0.49691598],
[ 1.01550688, -1.44416206],
[ 1.01550688,  0.96277471],
[ 1.01550688, -1.56062674],
[ 1.01550688,  1.62274124],
[ 1.05385321, -1.44416206],
[ 1.05385321,  1.38981187],
[ 1.05385321, -1.36651894],
[ 1.05385321,  0.72984534],
[ 1.2455849 , -1.4053405 ],
[ 1.2455849 ,  1.54509812],
```

```
       [ 1.39897025, -0.7065524 ],
       [ 1.39897025,  1.38981187],
       [ 1.43731659, -1.36651894],
       [ 1.43731659,  1.46745499],
       [ 1.47566292, -0.43480148],
       [ 1.47566292,  1.81684904],
       [ 1.5523556 , -1.01712489],
       [ 1.5523556 ,  0.69102378],
       [ 1.62904827, -1.28887582],
       [ 1.62904827,  1.35099031],
       [ 1.62904827, -1.05594645],
       [ 1.62904827,  0.72984534],
       [ 2.01251165, -1.63826986],
       [ 2.01251165,  1.58391968],
       [ 2.28093601, -1.32769738],
       [ 2.28093601,  1.11806095],
       [ 2.51101403, -0.86183865],
       [ 2.51101403,  0.92395314],
       [ 2.76985181, -1.25005425],
       [ 2.76985181,  1.27334719]])
```

7 Model

KMean Model

[79]:
```
wscc = []
```

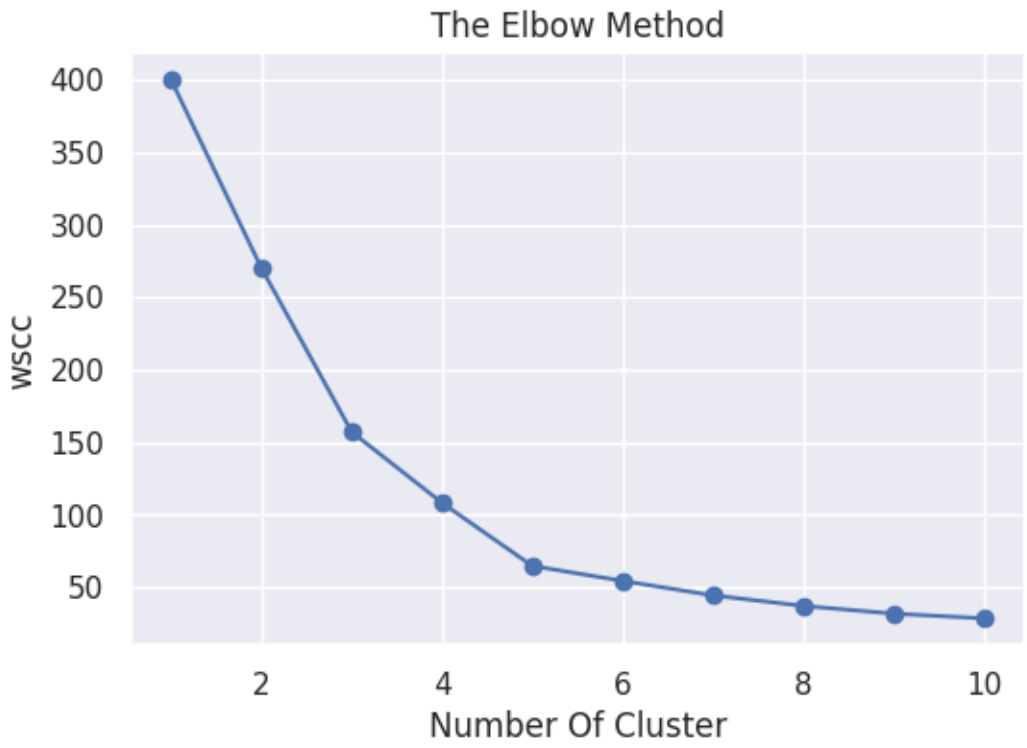
[80]:
```
for i in range(1,11):
  model_kmean = KMeans(n_clusters=i,init="k-means++",random_state=0)
  model_kmean.fit(X)
  wscc.append(model_kmean.inertia_)
```

```
/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(
```

[81]:

```
plt.plot(range(1,11),wscc, marker = 'o')
plt.title("The Elbow Method")
plt.xlabel("Number Of Cluster")
plt.ylabel("wscc")
plt.show()
```



[82]:
```
model_kmean = KMeans(n_clusters=5,random_state=0).fit(X)
```

```
/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(
```

[83]:
```
y_cluster = model_kmean.predict(X)
```

[84]:
```
y_cluster
```

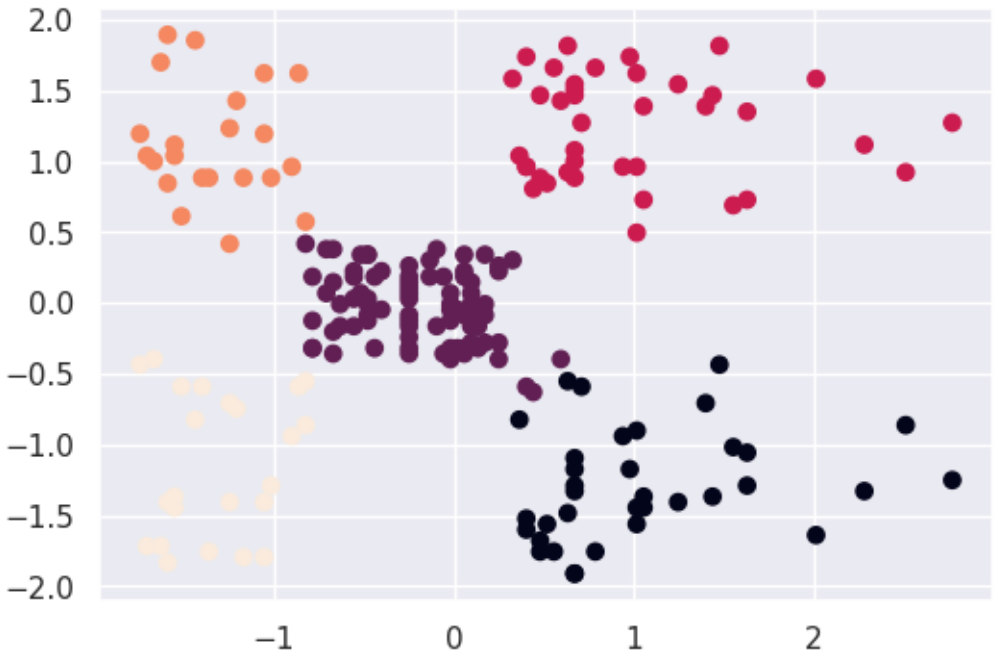
[84]:
```
array([4, 3, 4, 3, 4, 3, 4, 3, 4, 3, 4, 3, 4, 3, 4, 3, 4, 3, 4, 3,
       4, 3, 4, 3, 4, 3, 4, 3, 4, 3, 4, 3, 4, 3, 4, 3, 4, 3, 4, 1,
       4, 3, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 2, 0, 2, 1, 2, 0, 2, 0, 2,
       1, 2, 0, 2, 0, 2, 0, 2, 0, 2, 1, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2,
       0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2,
       0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2,
       0, 2], dtype=int32)
```

[86]:
```
from sklearn.metrics import silhouette_score
silhouette_score(X, y_cluster)
```

[86]:
```
0.5555014501078793
```

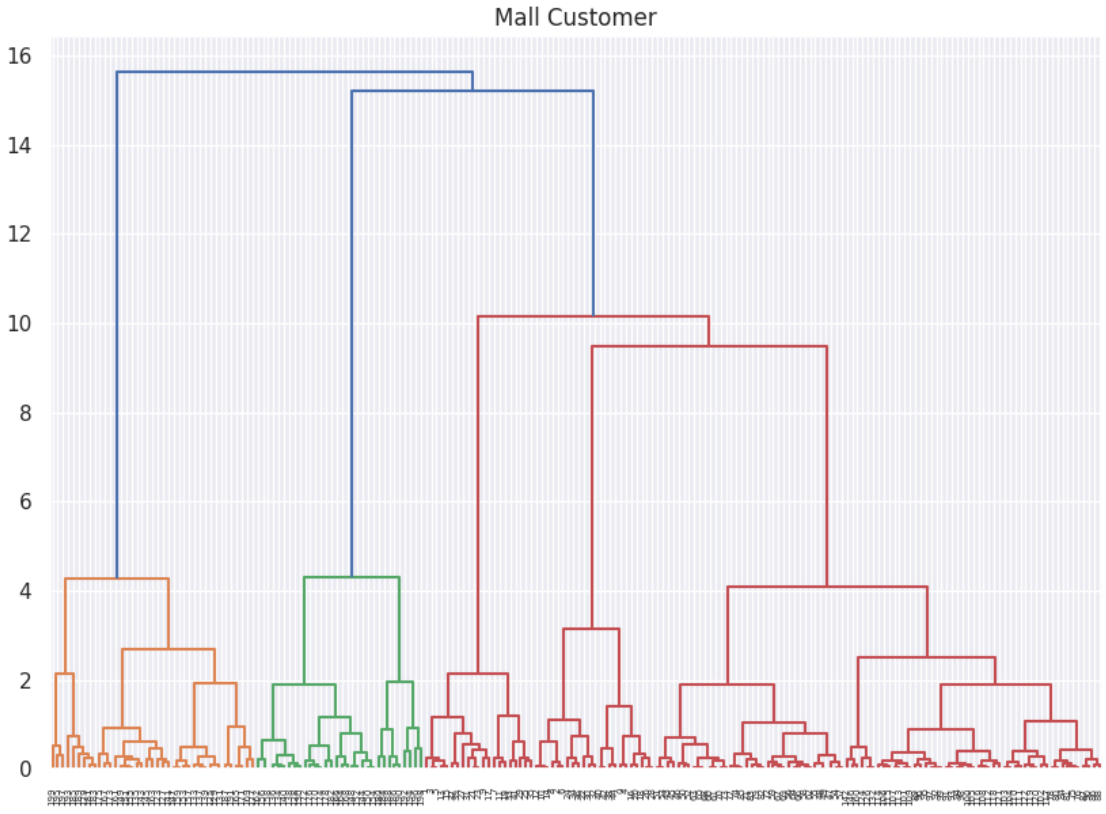
[85]:
```
plt.scatter(X[:,0], X[:,1], c=y_cluster)
```

[85]:
```
<matplotlib.collections.PathCollection at 0x7a561dfea890>
```



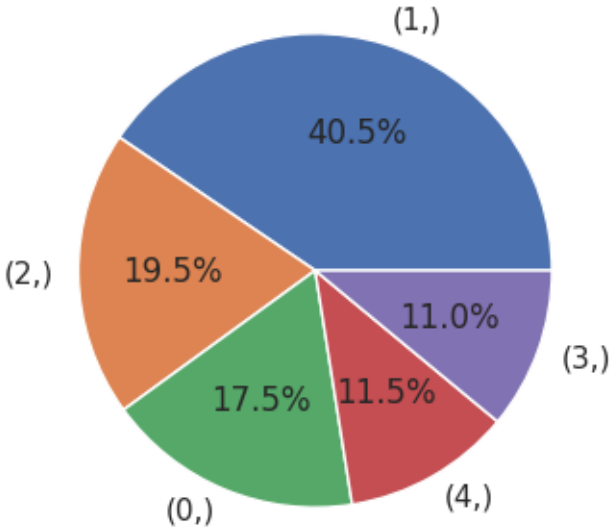
[87]:
```
# Another Way To Used Linkage Metrics
from scipy.cluster.hierarchy import dendrogram,linkage
import matplotlib.pyplot as plt

plt.figure(figsize=(10,7))
plt.title("Mall Customer")
dend = dendrogram(linkage(X,method="ward"))
```



[114]:
```
y_cluster = pd.DataFrame(y_cluster)
y_cluster.value_counts().plot.pie(autopct= '%.1f%%')
```

[114]: <Axes: >



Agglomerative Clustering

[99]:
```
model_agg = AgglomerativeClustering(n_clusters=5)
```

[100]:
```
y_pred = model_kmean.predict(X)
```

[101]:
```
y_pred
```

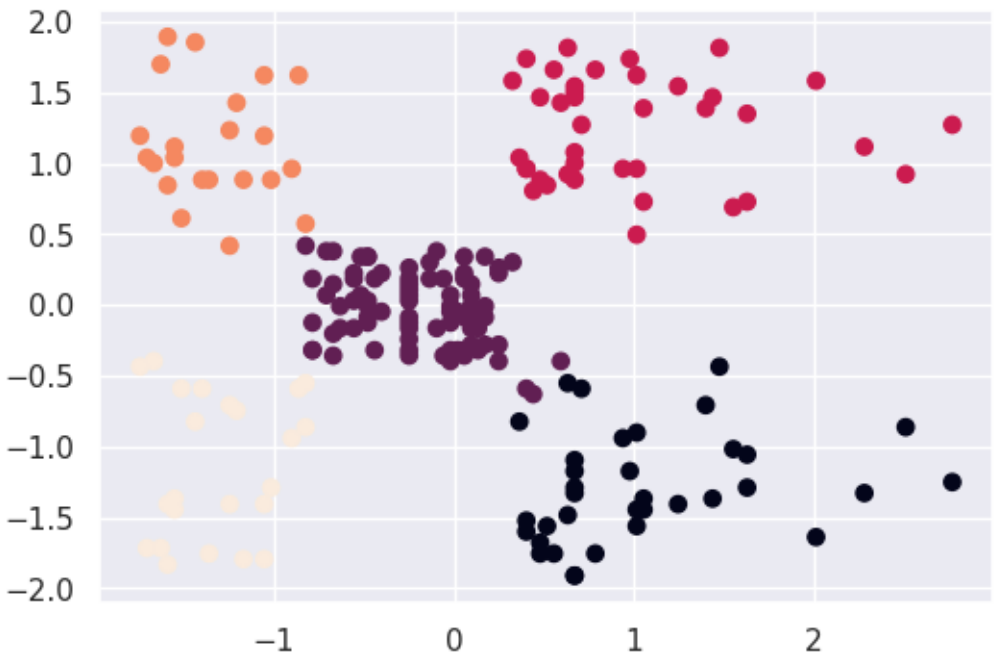
[101]:
```
array([4, 3, 4, 3, 4, 3, 4, 3, 4, 3, 4, 3, 4, 3, 4, 3, 4, 3, 4, 3,
       4, 3, 4, 3, 4, 3, 4, 3, 4, 3, 4, 3, 4, 3, 4, 3, 4, 3, 4, 1,
       4, 3, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 2, 0, 2, 1, 2, 0, 2, 0, 2,
       1, 2, 0, 2, 0, 2, 0, 2, 0, 2, 1, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2,
       0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2,
       0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2, 0, 2,
       0, 2], dtype=int32)
```

[102]:
```
silhouette_score(X, y_pred)
```

[102]:
```
0.5555014501078793
```

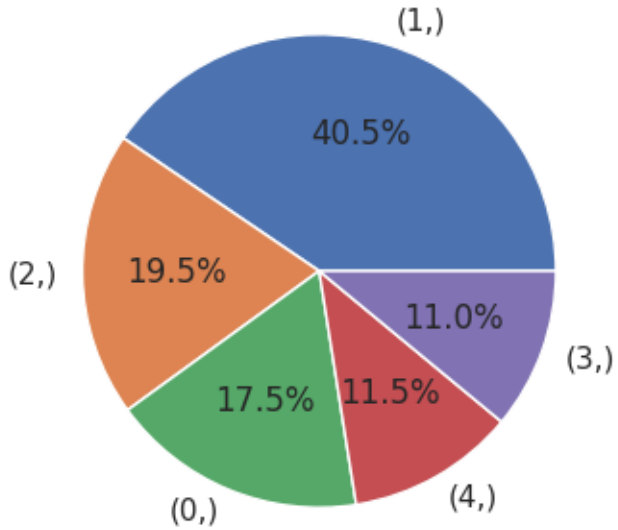
[103]:
```
plt.scatter(X[:,0], X[:,1], c=y_pred)
```

[103]:
```
<matplotlib.collections.PathCollection at 0x7a56219e25f0>
```



[113]:
```
y_pred = pd.DataFrame(y_pred)
y_pred.value_counts().plot.pie(autopct= '%.1f%%')
```

[113]: <Axes: >



[ ]: