Assignment-4 Python Programming

In [1]:

**import** pandas **as** pd

**import** numpy **as** np

**import** matplotlib.pyplot **as** plt

**import** seaborn **as** sns

# Loading the dataset

In [ ]:

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

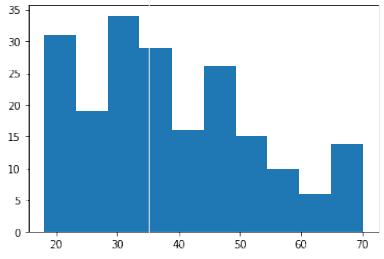
plt**.**hist(df['Age'])

In [ ]:

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>)



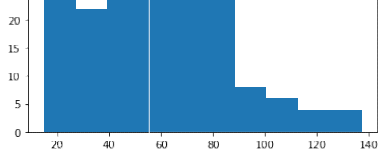
In [ ]:

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 [ ]:

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

Out[ ]:

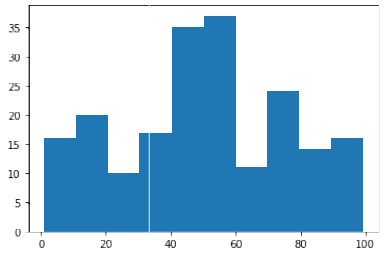
In [ ]:

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

(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,

<a list of 10 Patch objects>)

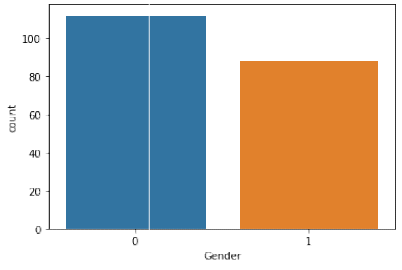


89.2, 99. ]),

/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 FutureWarning

will result in an error or misinterpretation.

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

# Bi-Variate Analysis

In [ ]:

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

Out[ ]:

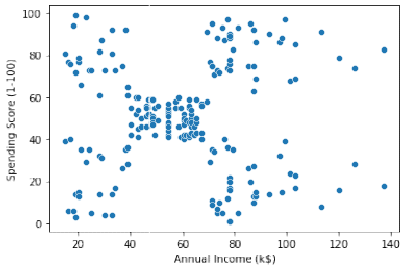
In [ ]:

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

/usr/local/lib/python3.7/dist-packages/seaborn/\_decorators.py:43: FutureWarnin g: Pass the following variables as keyword args: x, y. From version 0.12, the o nly valid positional argument will be `data`, and passing other arguments witho ut an explicit keyword will result in an error or misinterpretation.

FutureWarning

<matplotlib.axes.\_subplots.AxesSubplot at 0x7fdb93a1f1d0>



Out[ ]:

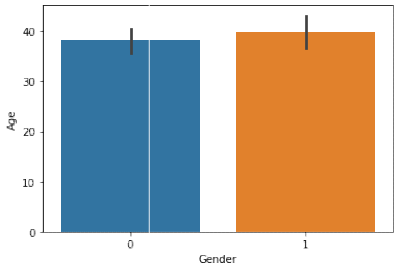
In [ ]:

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

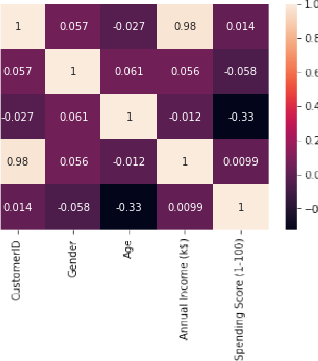
/usr/local/lib/python3.7/dist-packages/seaborn/\_decorators.py:43: FutureWarnin g: Pass the following variables as keyword args: x, y. From version 0.12, the o nly valid positional argument will be `data`, and passing other arguments witho ut an explicit keyword will result in an error or misinterpretation.

FutureWarning

<matplotlib.axes.\_subplots.AxesSubplot at 0x7fdb93931b90>



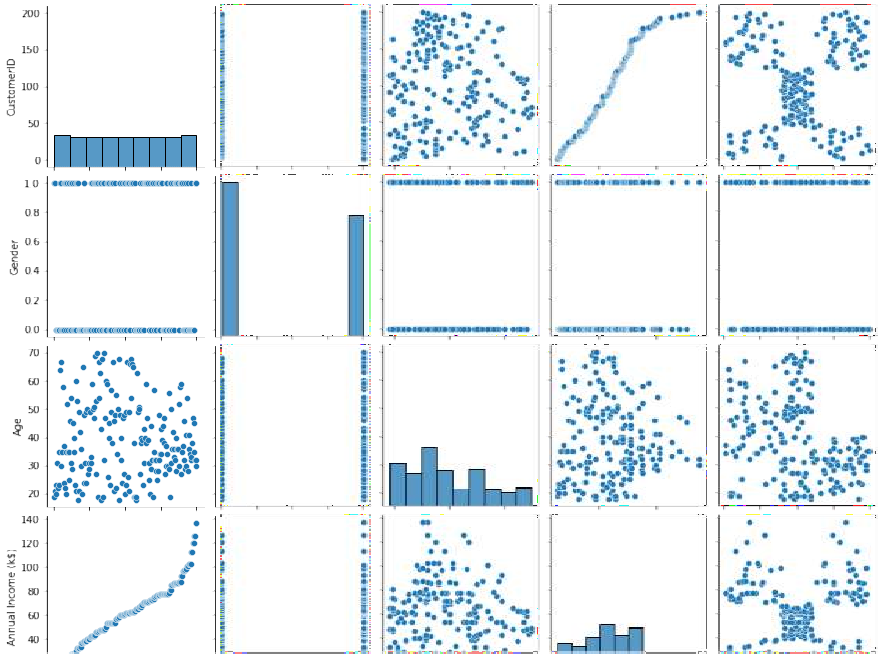
Out[ ]: <matplotlib.axes.\_subplots.AxesSubplot at 0x7fdb9390e4d0>

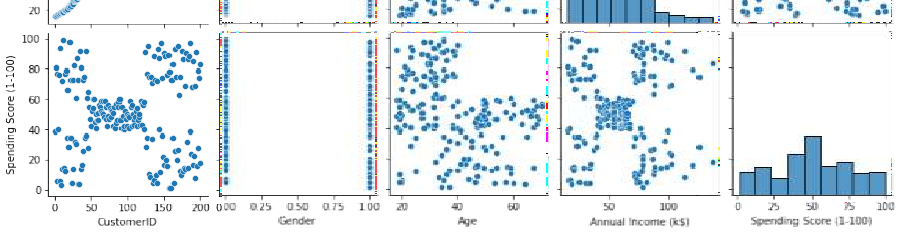


# Multi-variate Analysis

In [ ]:

sns**.**pairplot(df)

Out[ ]: <seaborn.axisgrid.PairGrid at 0x7fdb91011e50>



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[ ]:

In [ ]:

df**.**corr()

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

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

Out[ ]: **CustomerID Gender Age Annual Income Spending Score**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | | | **(k$)** | **(1-100)** |
| **CustomerID** | 1.000000 | 0.057400 | -0.026763 | 0.977548 | 0.013835 |
| **Gender** | 0.057400 | 1.000000 | 0.060867 | 0.056410 | -0.058109 |
| **Age** | -0.026763 | 0.060867 | 1.000000 | -0.012398 | -0.327227 |
| **Annual Income (k$)** | 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 dtype: float64

df**.**std()

(1-100) 666.854271

In [ ]:

Out[ ]:

In [ ]:

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

# Checking for missing values

Out[ ]: CustomerID 0

df**.**isna()**.**sum()

Gender 0

Age 0

Spending Score (1-100) 0

dtype: int64

In [ ]:

df**.**isna()**.**sum()**.**sum()

Out[ ]: 0

In [ ]:

df**.**duplicated()**.**sum()

Out[ ]:

In [ ]:

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

0

# Finding & Handling Ouliers

Out[ ]:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **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 [ ]:

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

**CustomerID Gender Age Annual Income (k$) Spending Score (1-100)**

Out[ ]:

In [ ]:

CustomerID 99.50

Gender 1.00

Age 20.25

Annual Income (k$) 36.50

Spending Score (1-100) 38.25

dtype: float64

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

Out[ ]:

In [ ]:

CustomerID 299.500

Gender 2.500

Age 79.375

Annual Income (k$) 132.750

Spending Score (1-100) 130.375

dtype: float64

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  dtype: float64 | (1-100) -22.625 |

In [ ]:

Out[ ]:

In [ ]:

df**.**mean()

|  |  |  |
| --- | --- | --- |
| CustomerID |  | 100.50 |
| Gender |  | 0.44 |
| Age |  | 38.85 |
| Annual Income | (k$) | 60.56 |

Spending Score (1-100) 50.20

dtype: float64

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

Out[ ]:

In [ ]:

137

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

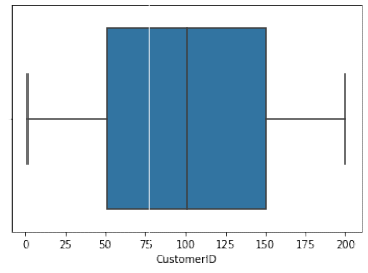
n explicit keyword FutureWarning

will result in an error or misinterpretation.

Out[ ]:

In [ ]:

<matplotlib.axes.\_subplots.AxesSubplot at 0x7fdb904c1290>

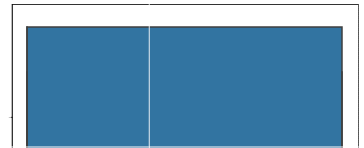


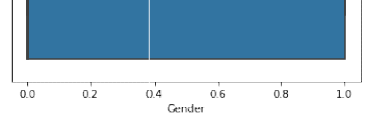
sns**.**boxplot(df['Gender'])

/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 FutureWarning

will result in an error or misinterpretation.

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

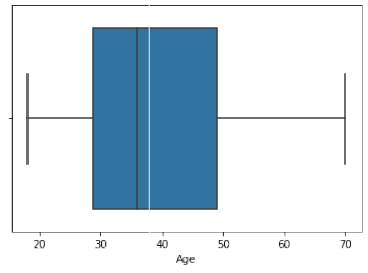
n explicit keyword FutureWarning

will result in an error or misinterpretation.

Out[ ]:

In [ ]:

<matplotlib.axes.\_subplots.AxesSubplot at 0x7fdb93b3ee50>

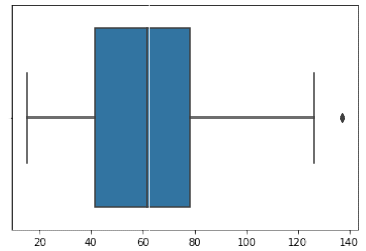


sns**.**boxplot(df['Annual Income (k$)'])

/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 FutureWarning

will result in an error or misinterpretation.

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



In [ ]:

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

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 FutureWarning

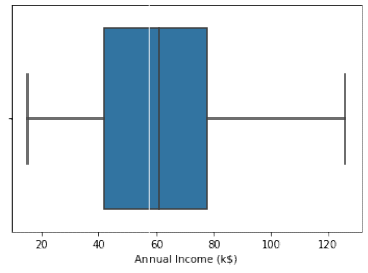
will result in an error or misinterpretation.

Out[ ]:

In [ ]:

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

<matplotlib.axes.\_subplots.AxesSubplot at 0x7fdb8eb18e90>



Out[ ]:

In [ ]:

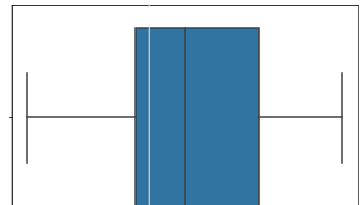
126.0

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 FutureWarning

will result in an error or misinterpretation.

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



# Scaling the data

In [ ]:

**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], |
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| [ | 0.02598109, | -0.88640526, | 0.7284319 , | 0.0880132 | , | -0.08540743], |
| [ | 0.04330181, | 1.12815215, | 2.02023231, | 0.0880132 | , | 0.34162973], |
| [ | 0.06062254, | 1.12815215, | -0.92220196, | 0.0880132 | , | 0.18634349], |
| [ | 0.07794326, | 1.12815215, | 0.7284319 , | 0.0880132 | , | 0.22516505], |
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| --- | --- | --- | --- | --- | --- | --- |
| [ | 0.12990543, | 1.12815215, | 1.08726535, | 0.12793754, | | -0.16305055], |
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| [ | 0.30311268, | -0.88640526, | 0.7284319 , | 0.20778621, | | 0.34162973], |
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| [ | 1.67144992, | -0.88640526, | 0.44136514, | 2.64317075, | | -0.86183865], |
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| [ | 1.7234121 , | 1.12815215, | -0.6351352 , | 0.03012291, | | 1.27334719]]) |

# Clustering Algorithm

In [ ]:

**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 [ ]:

TWSS

Out[ ]:

In [ ]:

[381507.64738523855,

268062.55433747417,

191550.08627670942,

153530.68956249507,

119166.15727643928,

101321.0166427429,

85744.90139221892]

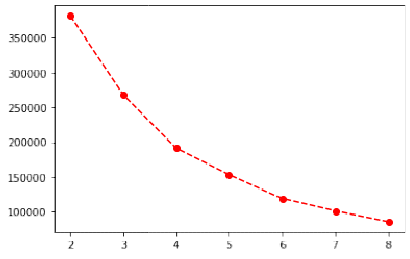
plt**.**plot(k,TWSS, 'ro--')

Out[ ]:

In [ ]:

model **=** KMeans(n\_clusters **=** 4) model**.**fit(df)

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



Out[ ]:

In [ ]:

mb **=** pd**.**Series(model**.**labels\_)

KMeans(n\_clusters=4)

In [ ]:

df['Cluster'] **=** mb

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| In [ ]: | 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