

Assignment -4

Problem Statement :- SMS SPAM Classification

Assignment Date	19 October 2022
Student Name	Aswin A
Student Roll Number	CS19005
Maximum Marks	2 Marks

#import the necessary files

```
import numpy as np
```

```
import pandas as pd
```

```
import matplotlib.pyplot as plt
```

```
%matplotlib inline
```

```
import seaborn as sns
```

```
from sklearn.tree import DecisionTreeRegressor
```

```
from sklearn.ensemble import RandomForestRegressor
```

```
from sklearn.linear_model import LinearRegression
```

```
from sklearn.metrics import mean_squared_error, r2_score
```

```
from sklearn.svm import SVR
```

```
from sklearn.pipeline import Pipeline
```

```
from sklearn.impute import SimpleImputer
```

```
from sklearn.preprocessing import StandardScaler
```

```
data = pd.read_csv("Mall_Customers.csv")
```

```
data.head()
```

	CustomerID	Gender	Age	Annual Income (k\$)	Spending Score (1-100)	
		Male	19	15	39	1
1	2	Male	21	15	15	81
2	3	Female	20	16	16	6
3	4	Female	23	16	16	77
4	5	Female	31	17	17	40

```
print(data.shape)
```

```
data.info()
```

```
(200, 5)
```

```
<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

data.describe().T

	count	mean	std	min	25%	50%
CustomerID	200.0	100.50	57.879185	1.0	50.75	100.5
Age	200.0	38.85	13.969007	18.0	28.75	36.0
Annual Income (k\$)	200.0	60.56	26.264721	15.0	41.50	61.5

```
78.00
Spending Score (1-100)      200.0      50.20      25.823522      1.0      34.75      50.0
73.00
```

```
max
CustomerID      200.0
Age              70.0
Annual Income (k$) 137.0
Spending Score (1-100) 99.0
```

Visualizations

Univariate Analysis

```
data.head()
```

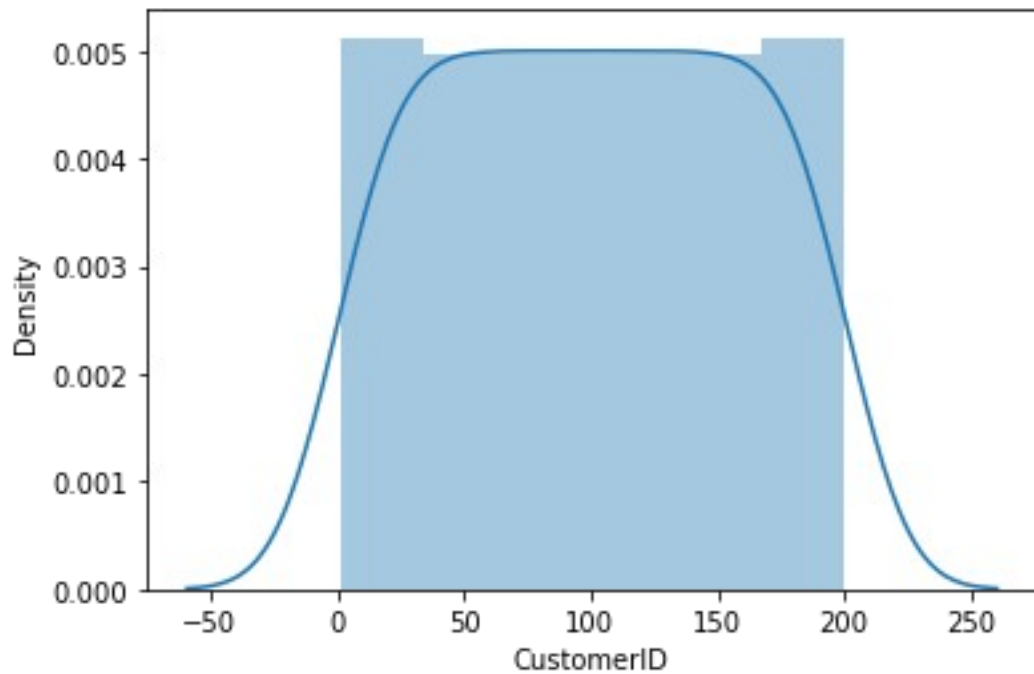
	CustomerID	Gender	Age	Annual Income (k\$)	Spending Score	(1-100)
0	1	Male	19	15		39
1	2	Male	21	15		81
2	3	Female	20	16		6
3	4	Female	23	16		77
4	5	Female	31	17		40

```
sns.distplot(data['CustomerID'])
```

C:\Users\balas\anaconda3\lib\site-packages\seaborn\distributions.py:2619: FutureWarning: ``distplot`` is a deprecated function and will be removed in a future version. Please adapt your code to use either ``displot`` (a figure-level function with similar flexibility) or ``histplot`` (an axes-level function for histograms).

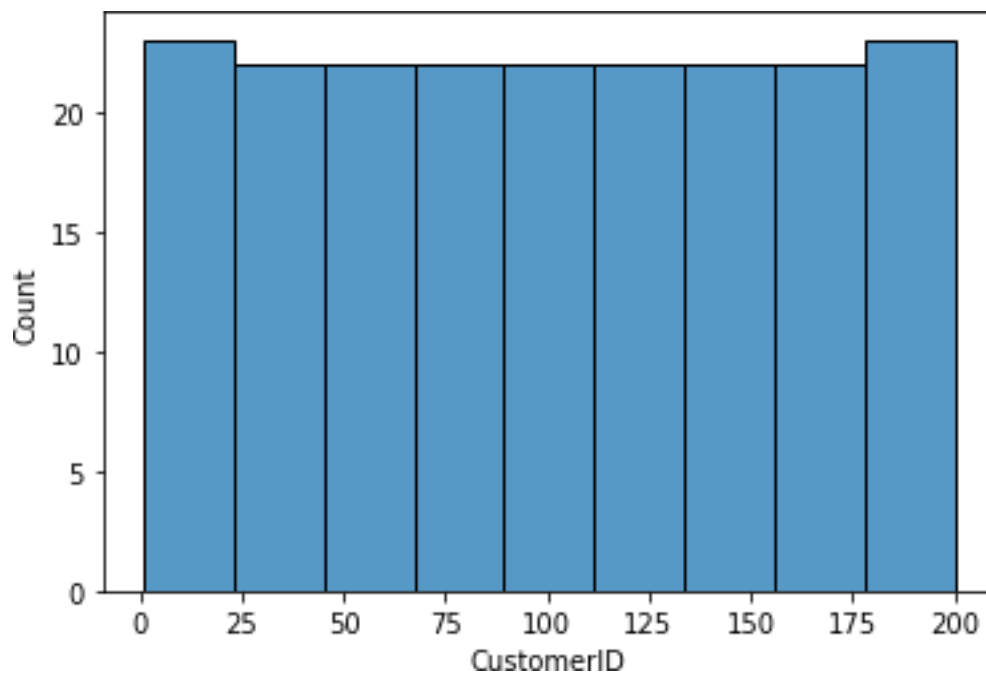
```
warnings.warn(msg, FutureWarning)
```

```
<AxesSubplot:xlabel='CustomerID', ylabel='Density'>
```



```
sns.histplot(data['CustomerID'])
```

```
<AxesSubplot:xlabel='CustomerID', ylabel='Count'>
```



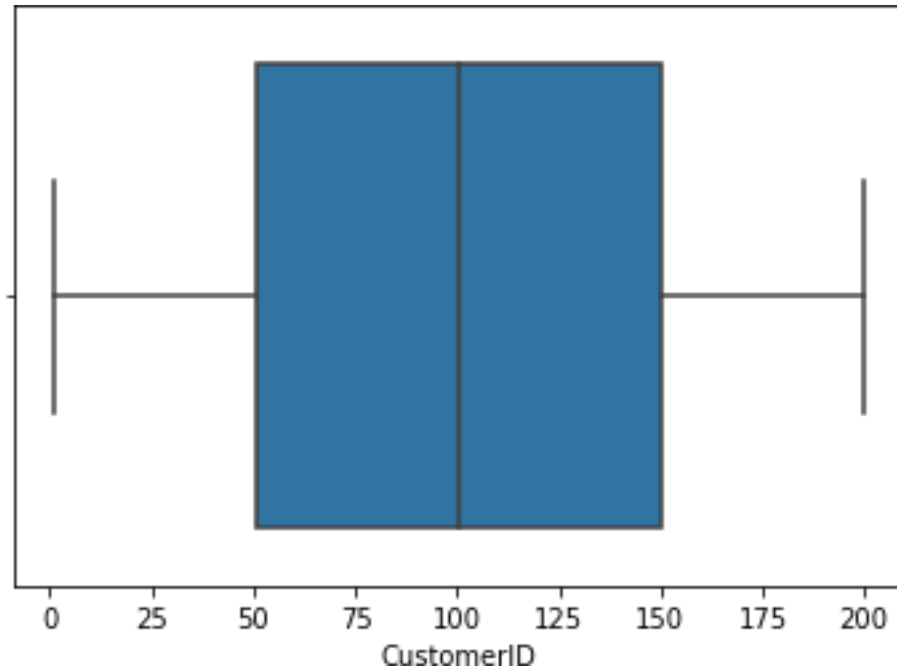
```
sns.boxplot(data['CustomerID'])
```

C:\Users\balas\anaconda3\lib\site-packages\seaborn_decorators.py:36:FutureWarning: 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 an explicit keyword will result in an error or misinterpretation.

```
warnings.warn(
```

```
<AxesSubplot:xlabel='CustomerID'>
```

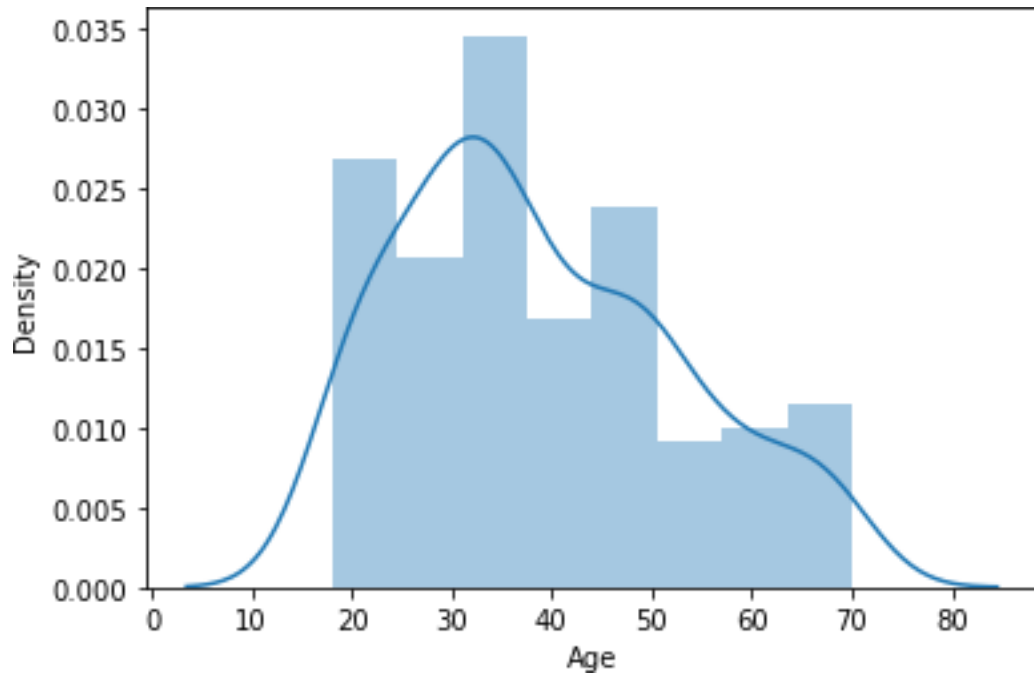


```
sns.distplot(data['Age'])
```

C:\Users\balas\anaconda3\lib\site-packages\seaborn\distributions.py:2619: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).

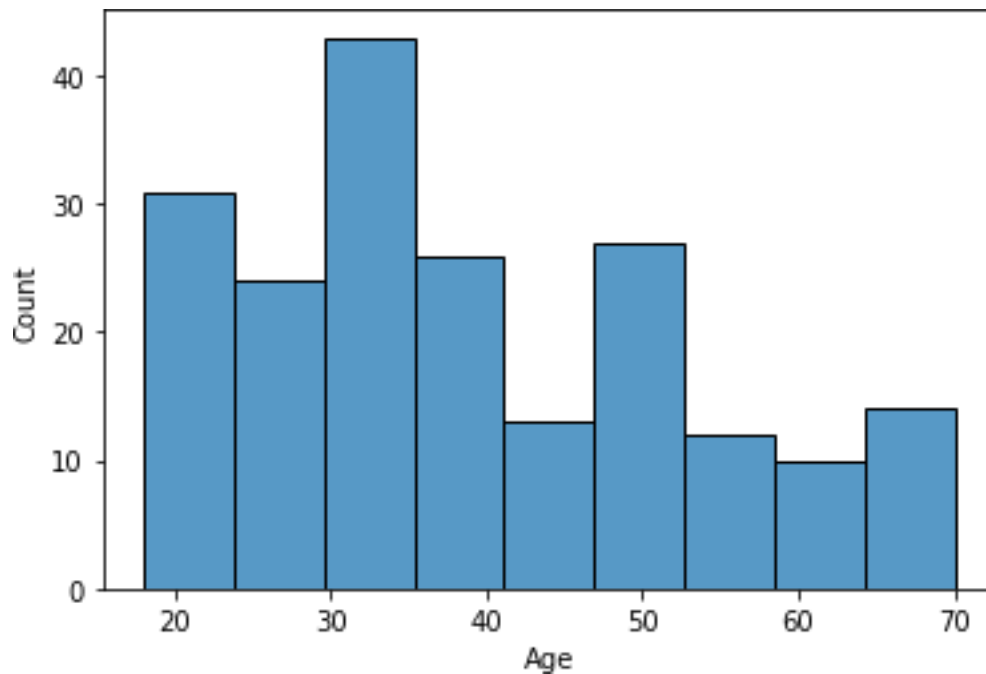
```
warnings.warn(msg, FutureWarning)
```

```
<AxesSubplot:xlabel='Age', ylabel='Density'>
```



```
sns.histplot(data['Age'])
```

```
<AxesSubplot:xlabel='Age', ylabel='Count'>
```



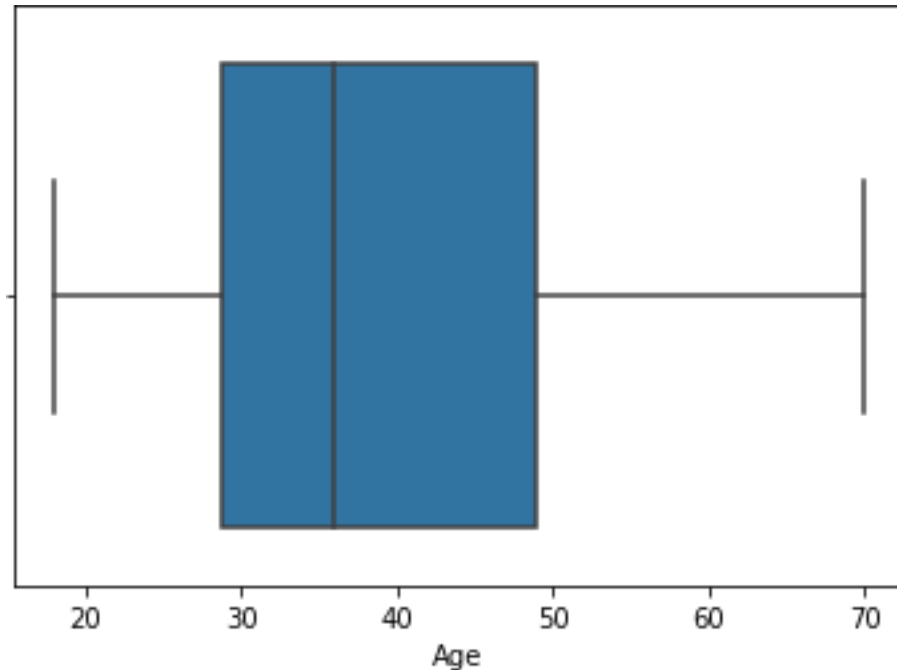
```
sns.boxplot(data['Age'])
```

C:\Users\balas\anaconda3\lib\site-packages\seaborn_decorators.py:36:FutureWarning: 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 an explicit keyword will result in an error or misinterpretation.

```
warnings.warn(
```

```
<AxesSubplot:xlabel='Age'>
```

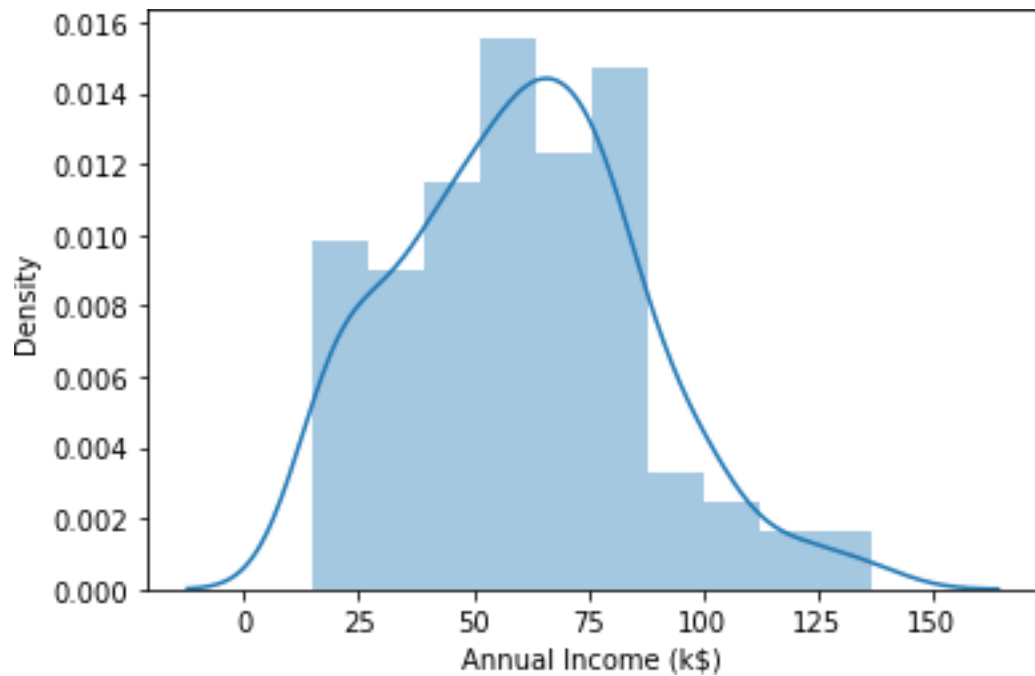


```
sns.distplot(data['Annual Income (k$)'])
```

C:\Users\balas\anaconda3\lib\site-packages\seaborn\distributions.py:2619: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).

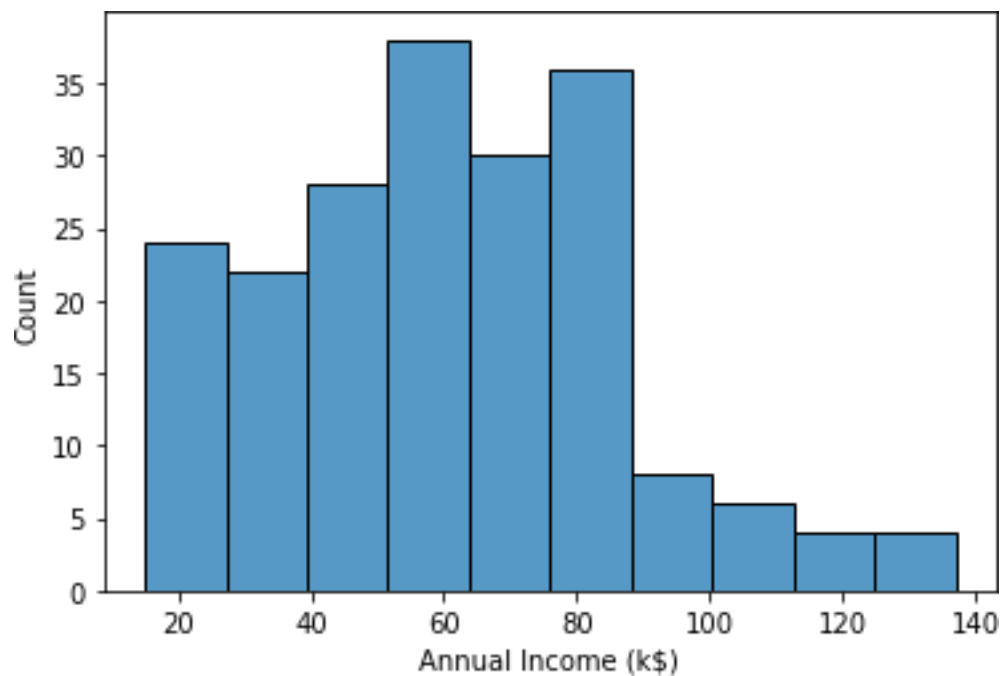
```
warnings.warn(msg, FutureWarning)
```

```
<AxesSubplot:xlabel='Annual Income (k$)', ylabel='Density'>
```



```
sns.histplot(data['Annual Income (k$)'])
```

```
<AxesSubplot:xlabel='Annual Income (k$)', ylabel='Count'>
```



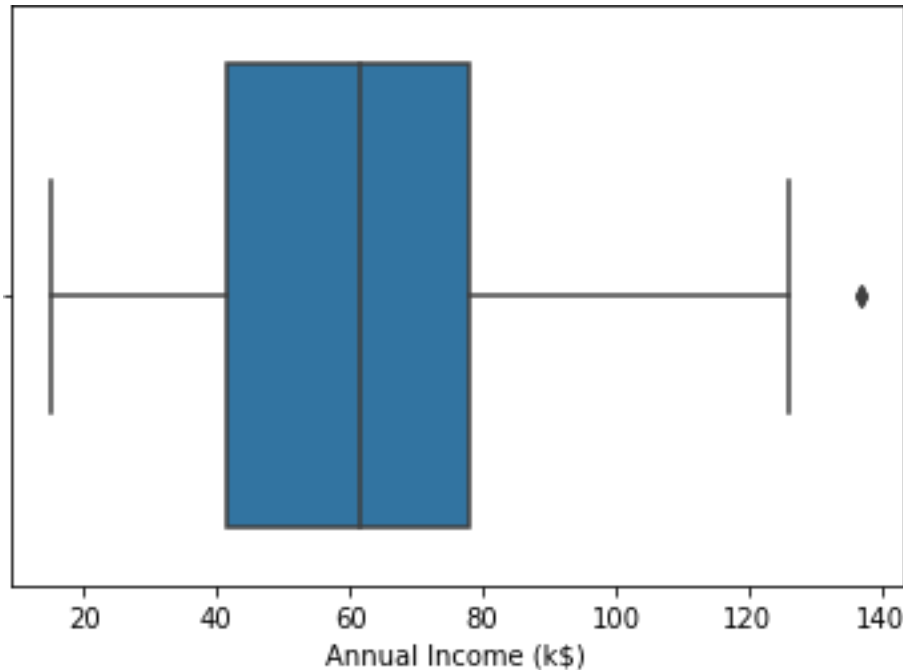
```
sns.boxplot(data['Annual Income (k$)'])
```

C:\Users\balas\anaconda3\lib\site-packages\seaborn_decorators.py:36:FutureWarning: 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 an explicit keyword will result in an error or misinterpretation.

```
warnings.warn(
```

```
<AxesSubplot:xlabel='Annual Income (k$)')>
```

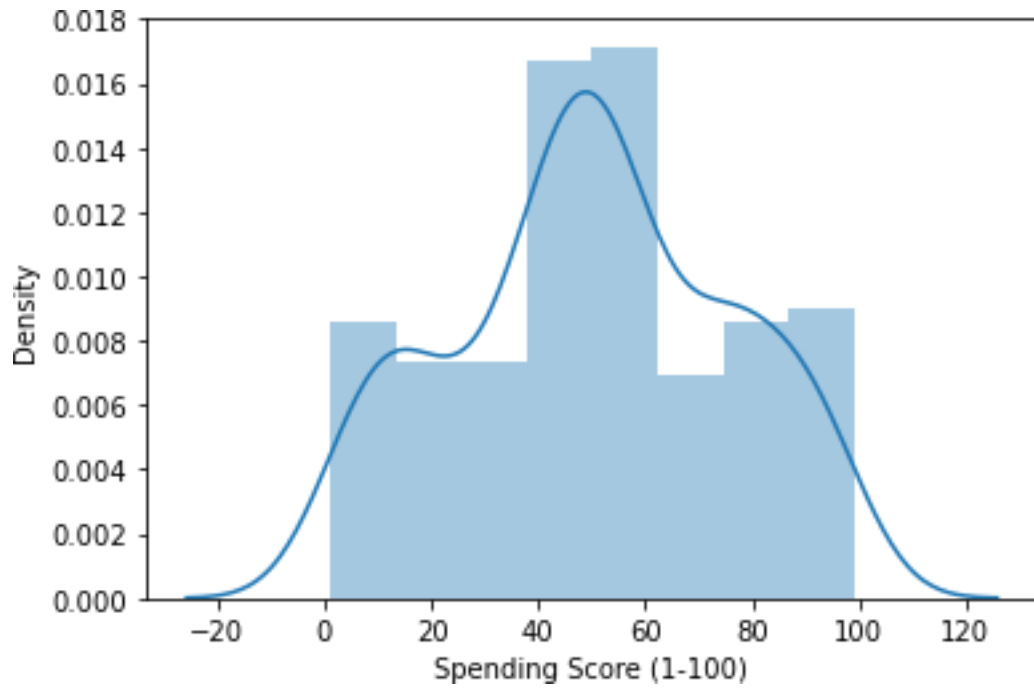


```
sns.distplot(data['Spending Score (1-100)'])
```

C:\Users\balas\anaconda3\lib\site-packages\seaborn\distributions.py:2619: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).

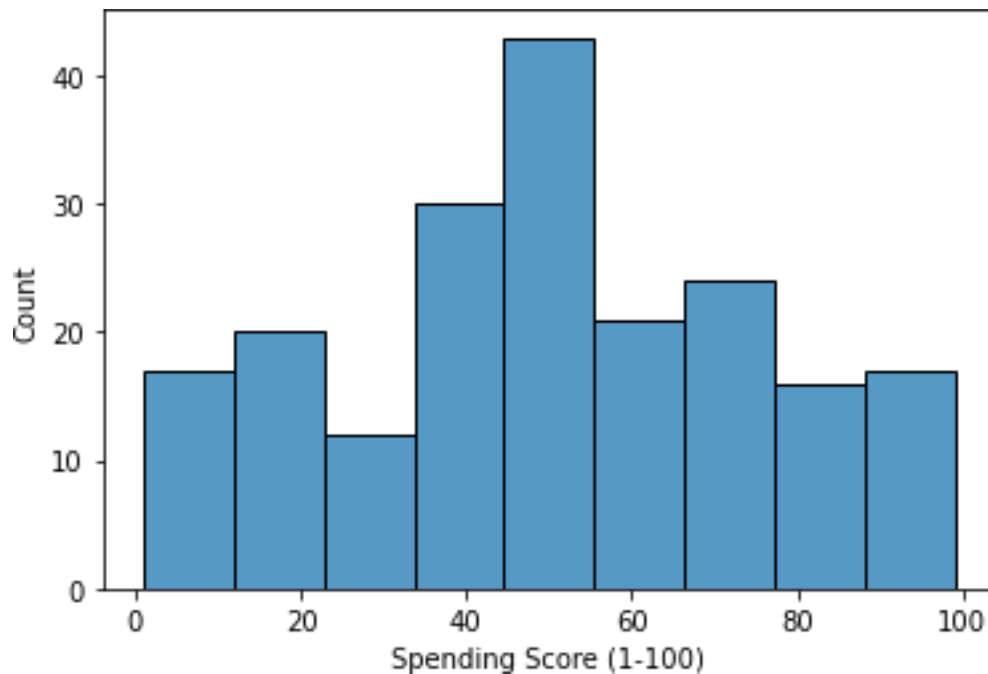
```
warnings.warn(msg, FutureWarning)
```

```
<AxesSubplot:xlabel='Spending Score (1-100)', ylabel='Density')>
```



```
sns.histplot(data['Spending Score (1-100)'])
```

```
<AxesSubplot:xlabel='Spending Score (1-100)', ylabel='Count'>
```



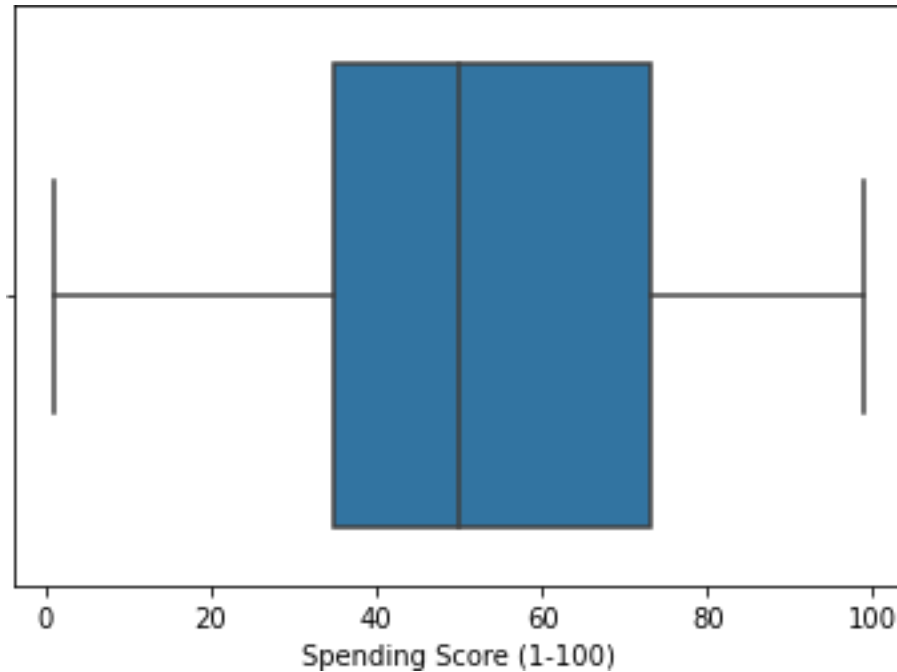
```
sns.boxplot(data['Spending Score (1-100)'])
```

C:\Users\balas\anaconda3\lib\site-packages\seaborn_decorators.py:36:FutureWarning: 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 an explicit keyword will result in an error or misinterpretation.

```
warnings.warn(
```

```
<AxesSubplot:xlabel='Spending Score (1-100)'\>
```



Bivariate Analysis

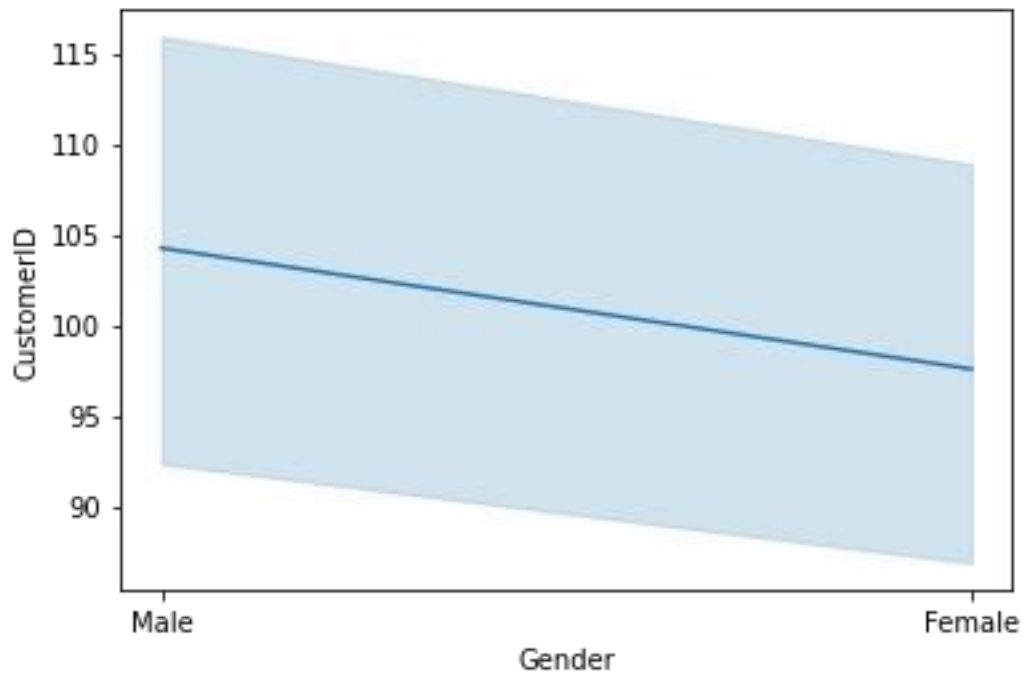
```
sns.lineplot(data['Gender'], data['CustomerID'])
```

C:\Users\balas\anaconda3\lib\site-packages\seaborn_decorators.py:36: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.

```
warnings.warn(
```

```
<AxesSubplot:xlabel='Gender', ylabel='CustomerID'\>
```



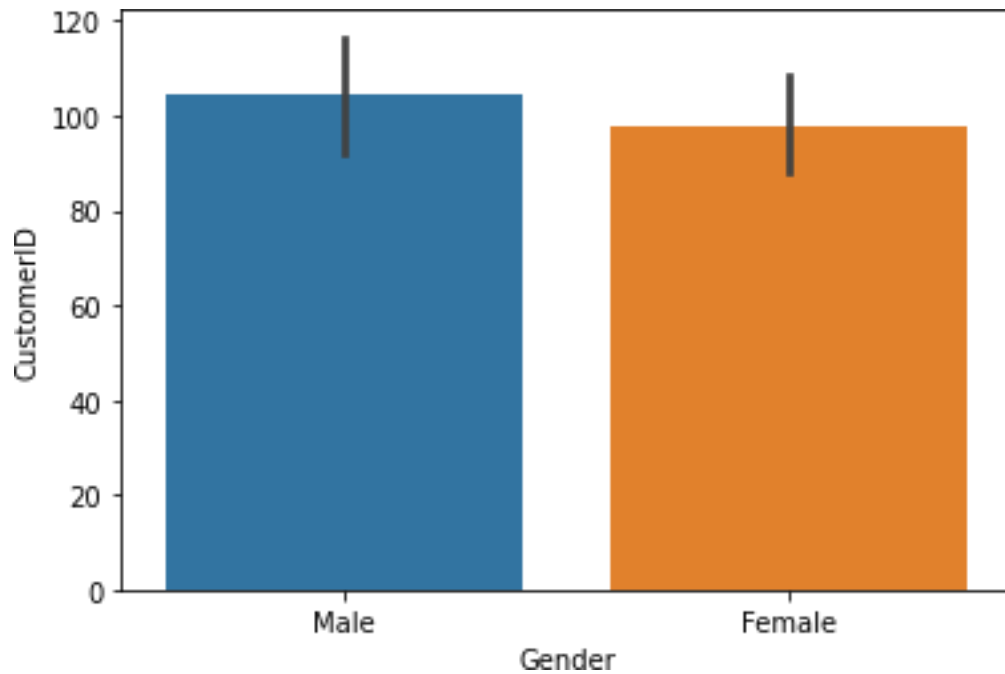
```
sns.barplot(data['Gender'], data['CustomerID'])
```

C:\Users\balas\anaconda3\lib\site-packages\seaborn_decorators.py:36: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.

```
warnings.warn(
```

```
<AxesSubplot:xlabel='Gender', ylabel='CustomerID'>
```



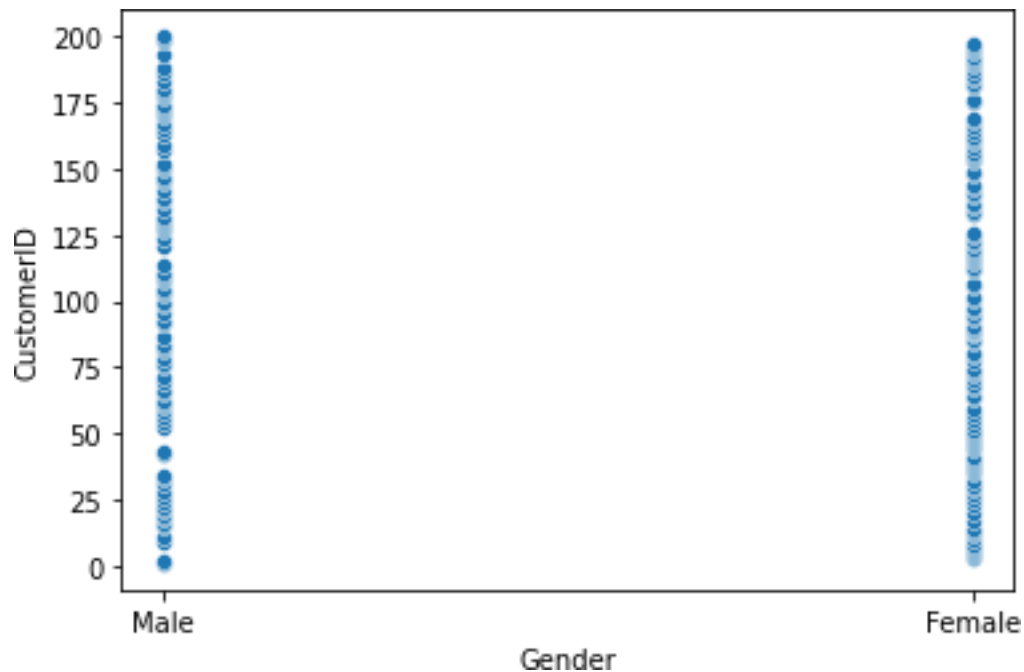
```
sns.scatterplot(data['Gender'], data['CustomerID'])
```

C:\Users\balas\anaconda3\lib\site-packages\seaborn_decorators.py:36: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.

```
warnings.warn(
```

```
<AxesSubplot:xlabel='Gender', ylabel='CustomerID'>
```



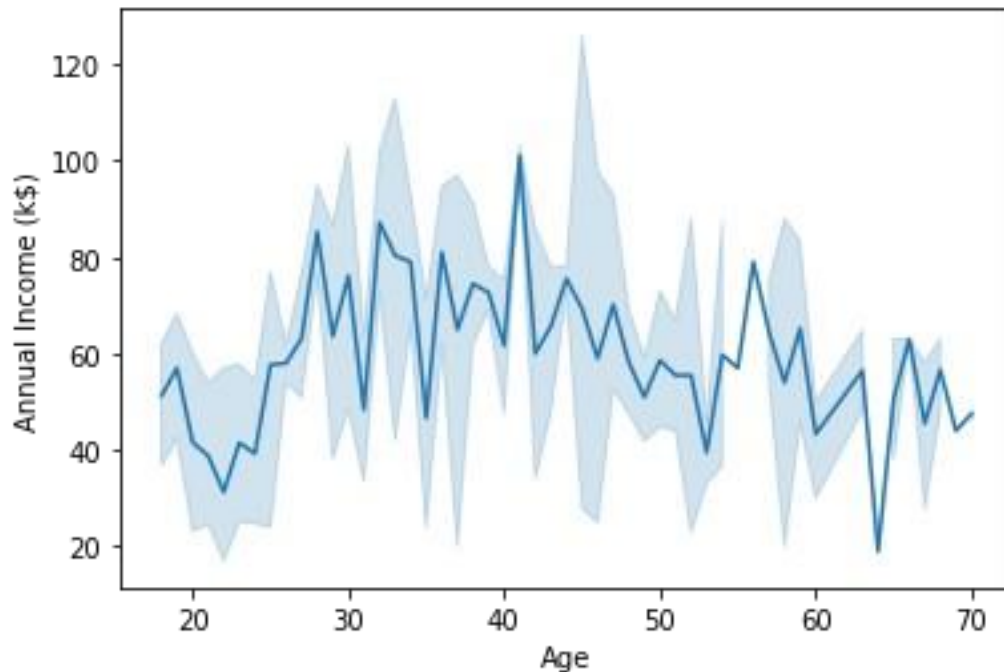
```
sns.lineplot(data['Age'], data['Annual Income (k$)'])
```

C:\Users\balas\anaconda3\lib\site-packages\seaborn_decorators.py:36: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.

```
warnings.warn(
```

```
<AxesSubplot:xlabel='Age', ylabel='Annual Income (k$)'\>
```



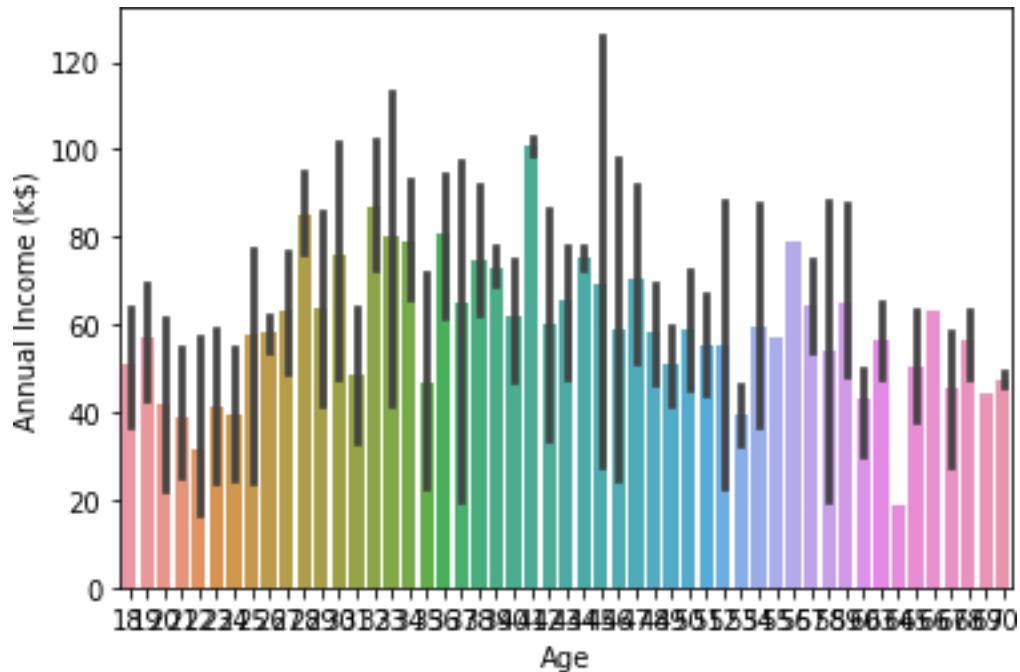
```
sns.barplot(data['Age'], data['Annual Income (k$)'])
```

C:\Users\balas\anaconda3\lib\site-packages\seaborn_decorators.py:36: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.

```
warnings.warn(
```

```
<AxesSubplot:xlabel='Age', ylabel='Annual Income (k$)')>
```



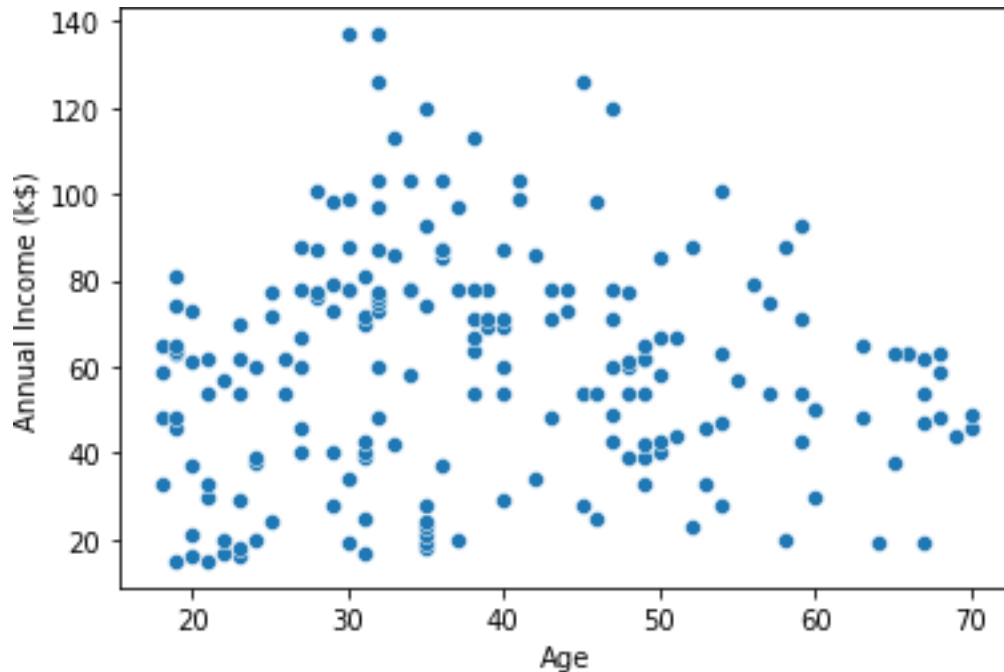
```
sns.scatterplot(data['Age'], data['Annual Income (k$)'])
```

C:\Users\balas\anaconda3\lib\site-packages\seaborn_decorators.py:36: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.

```
warnings.warn(
```

```
<AxesSubplot:xlabel='Age', ylabel='Annual Income (k$)'\>
```

Multivariate Analysis

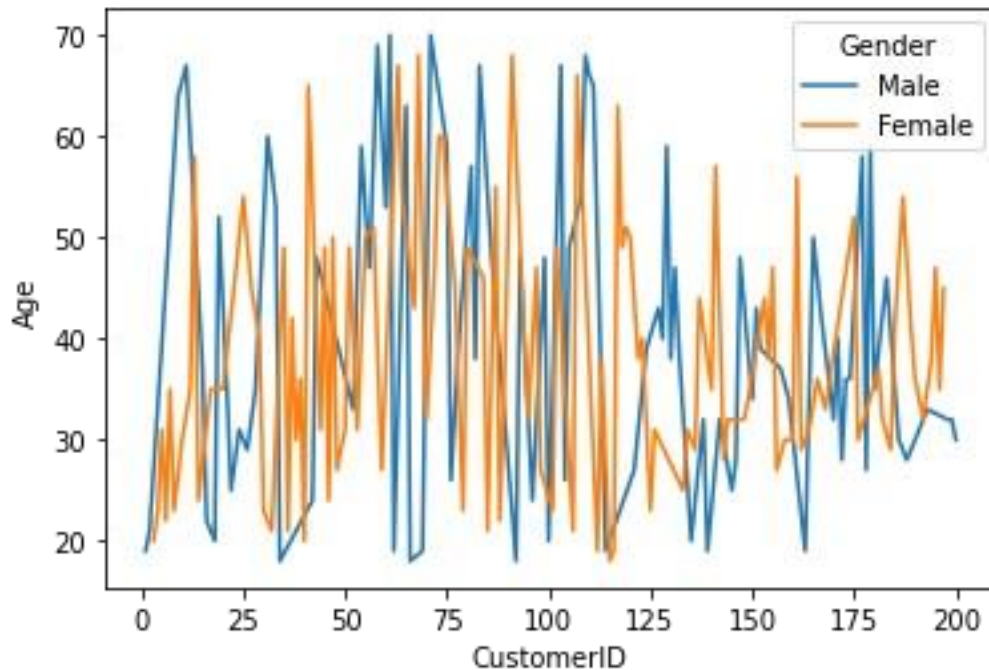
```
sns.lineplot(data['CustomerID'], data['Age'], hue = data['Gender'])
```

C:\Users\balas\anaconda3\lib\site-packages\seaborn_decorators.py:36: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.

```
warnings.warn(
```

```
<AxesSubplot:xlabel='CustomerID', ylabel='Age'>
```



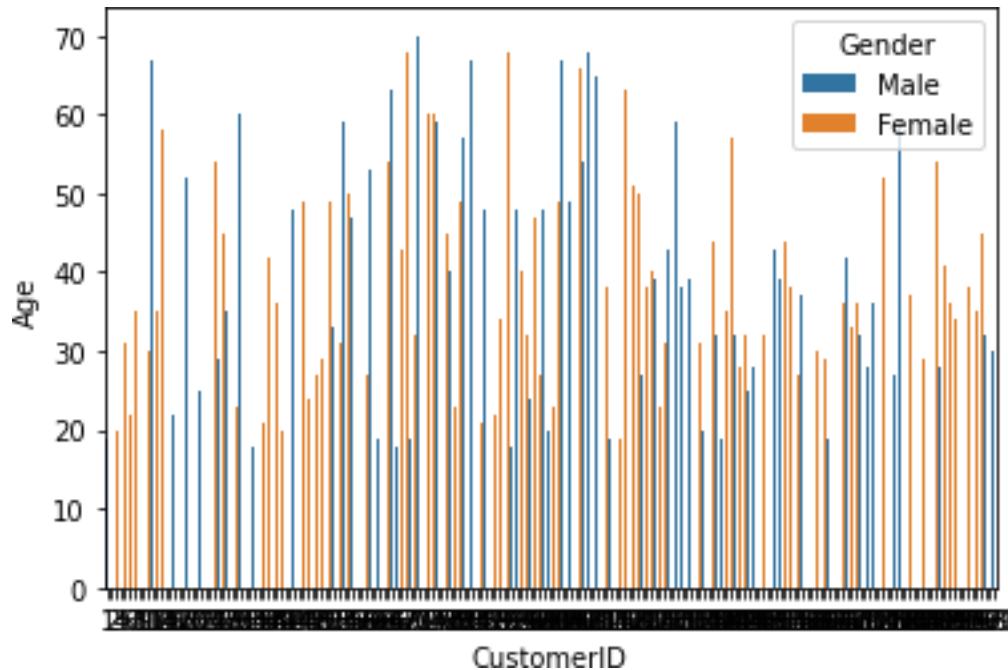
```
sns.barplot(data['CustomerID'], data['Age'], hue = data['Gender'])
```

C:\Users\balas\anaconda3\lib\site-packages\seaborn_decorators.py:36: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.

```
warnings.warn(
```

```
<AxesSubplot:xlabel='CustomerID', ylabel='Age'>
```



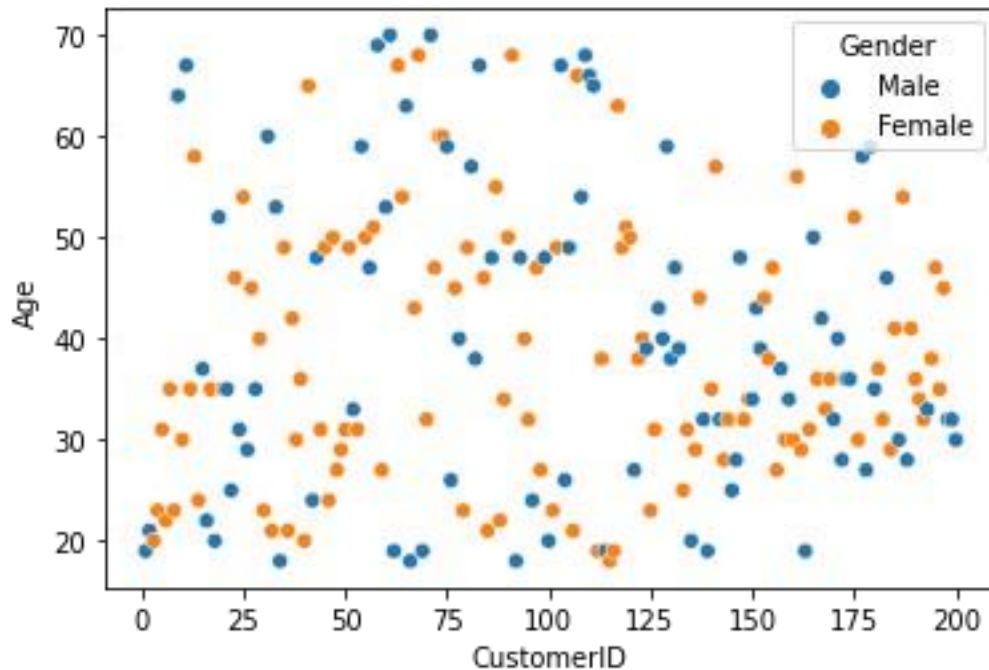
```
sns.scatterplot(data['CustomerID'], data['Age'], hue = data['Gender'])
```

C:\Users\balas\anaconda3\lib\site-packages\seaborn_decorators.py:36: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.

```
warnings.warn(
```

```
<AxesSubplot:xlabel='CustomerID', ylabel='Age'>
```



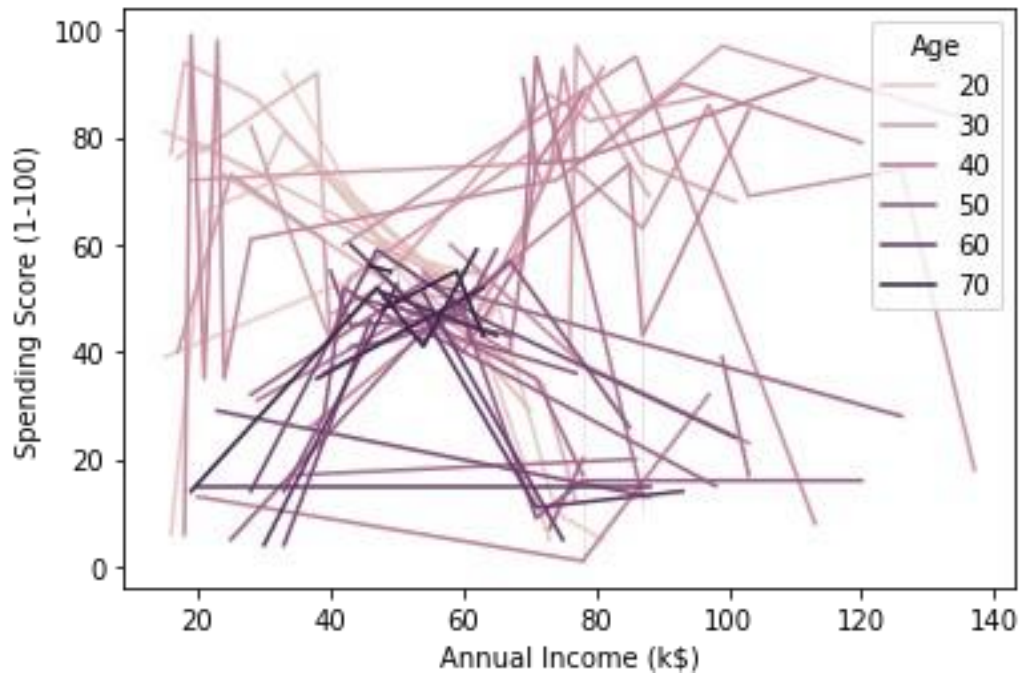
```
sns.lineplot(data['Annual Income (k$)'], data['Spending Score (1-100)'], hue = data['Age'])
```

C:\Users\balas\anaconda3\lib\site-packages\seaborn_decorators.py:36: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.

```
warnings.warn(
```

```
<AxesSubplot:xlabel='Annual Income (k$)', ylabel='Spending Score (1-100)')>
```



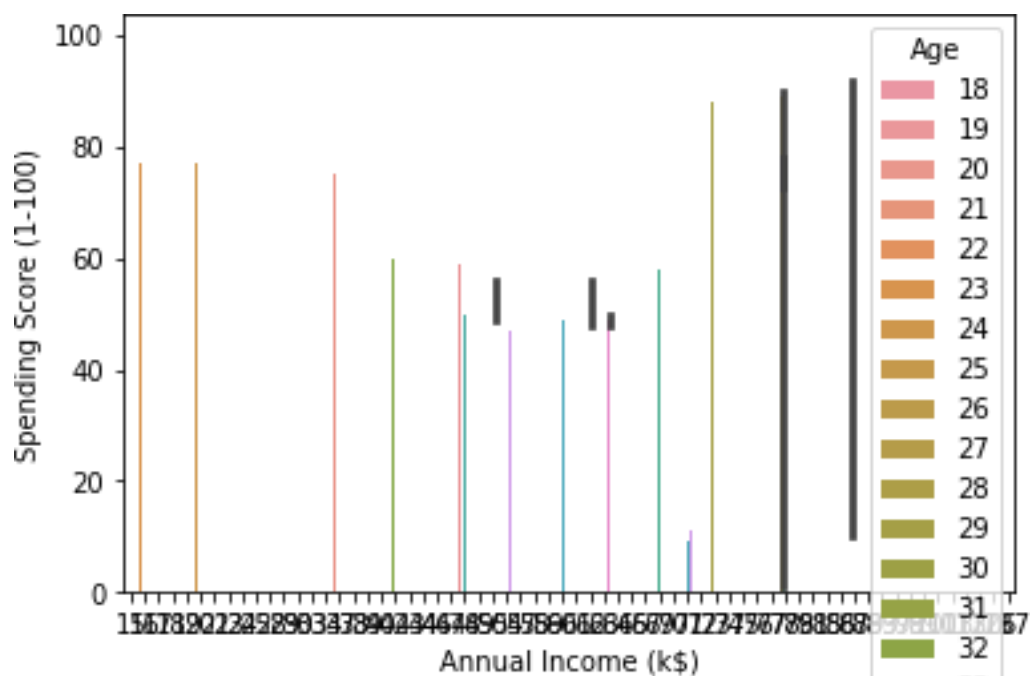
```
sns.barplot(data['Annual Income (k$)'], data['Spending Score (1-100)'], hue = data['Age'])
```

C:\Users\balas\anaconda3\lib\site-packages\seaborn_decorators.py:36: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.

```
warnings.warn(
```

```
<AxesSubplot:xlabel='Annual Income (k$)', ylabel='Spending Score (1-100)')>
```



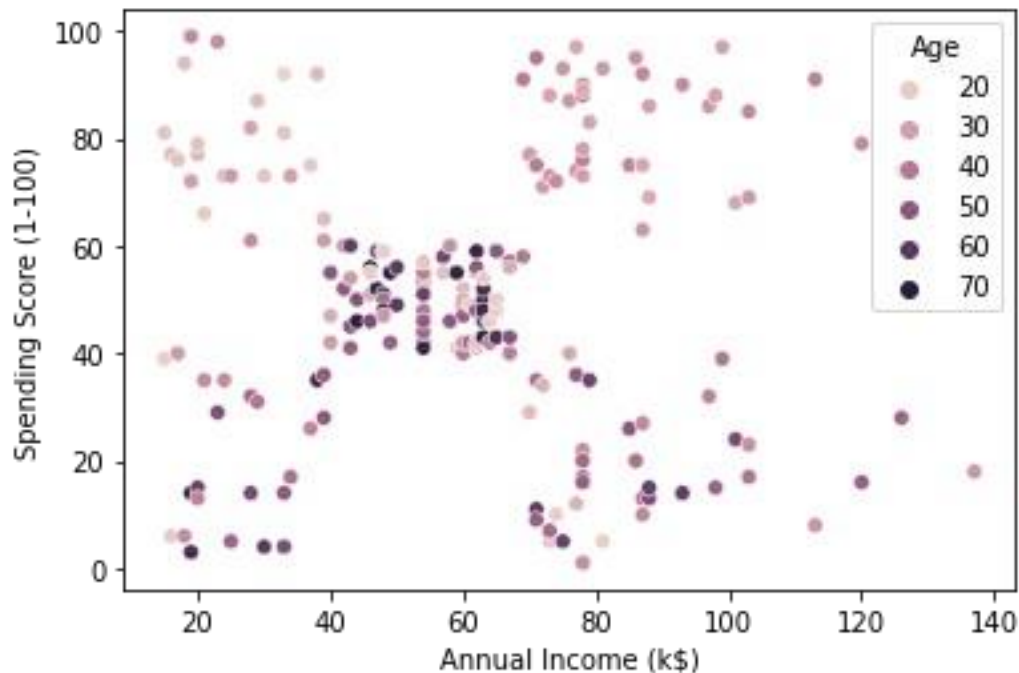
```
sns.scatterplot(data['Annual Income (k$)'], data['Spending Score (1-100)'], hue = data['Age'])
```

C:\Users\balas\anaconda3\lib\site-packages\seaborn_decorators.py:36: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.

```
warnings.warn(
```

```
<AxesSubplot:xlabel='Annual Income (k$)', ylabel='Spending Score (1-100)')>
```



Descriptive statistics

```
data.mean()
```

C:\Users\balas\AppData\Local\Temp\ipykernel_12512\531903386.py:1: FutureWarning: Dropping of nuisance columns in DataFrame reductions (with 'numeric_only=None') is deprecated; in a future version this will raise TypeError. Select only valid columns before calling the reduction.

```
data.mean()
```

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

	CustomerID	Gender	Age	Annual	Income	(k\$)	Spending	Score	(1-
100)									
0	1	Female	32.0			54.0			
42.0									
1	2	NaN	NaN			78.0			
NaN									
2	3	NaN	NaN			NaN			
NaN									
3	4	NaN	NaN			NaN			
NaN									
4	5	NaN	NaN			NaN			
NaN									
..			
...									
195	196	NaN	NaN			NaN			
NaN									
196	197	NaN	NaN			NaN			
NaN									
197	198	NaN	NaN			NaN			
NaN									
198	199	NaN	NaN			NaN			
NaN									
199	200	NaN	NaN			NaN			
NaN									

[200 rows x 5 columns]

data.median()

C:\Users\balas\AppData\Local\Temp\ipykernel_12512\4184645713.py:1: FutureWarning: Dropping of nuisance columns in DataFrame reductions (with 'numeric_only=None') is deprecated; in a future version this will raise TypeError. Select only valid columns before calling the reduction.

data.median()

CustomerID 100.5

Age 36.0

Annual Income (k\$) 61.5

Spending Score (1-100) 50.0

dtype: float64

data.var()

C:\Users\balas\AppData\Local\Temp\ipykernel_12512\445316826.py:1: FutureWarning: Dropping of nuisance columns in DataFrame reductions (with 'numeric_only=None') is deprecated; in a future version this will raise TypeError. Select only valid columns before calling the reduction.

data.var()


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

```
data.std()
```

C:\Users\balas\AppData\Local\Temp\ipykernel_12512\2723740006.py:1: FutureWarning: Dropping of nuisance columns in DataFrame reductions (with 'numeric_only=None') is deprecated; in a future version this will raise TypeError. Select only valid columns before calling the reduction.

```
data.std()
```

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

```
data.describe()
```

```
      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
```

```
data['Age'].unique ()array([19,
```

```
54,
```

```
29, 21, 20, 23, 31, 22, 35, 64, 30, 67, 58, 24, 37, 52, 25, 46,
```

```
51,
```

```
69, 45, 40, 60, 53, 18, 49, 42, 36, 65, 48, 50, 27, 33, 59, 47,
```

```
41],
```

```
70, 63, 43, 68, 32, 26, 57, 38, 55, 34, 66, 39, 44, 28, 56,
dtype=int64)
```

```
data['Gender'].unique ()
```

```
array(['Male', 'Female'], dtype=object)
```

```
data['CustomerID'].unique ()
```

```
array([ 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200], dtype=int64)
```

```
data['Annual Income (k$)'].unique ()
```

```
array([ 15, 16, 17, 18, 19, 20, 21, 23, 24, 25, 28, 29, 30, 33, 34, 37, 38, 39, 40, 42, 43, 44, 46, 47, 48, 49, 50, 54, 57, 58, 59, 60, 61, 62, 63, 64, 65, 67, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 81, 85, 86,
```

```
87, 88, 93, 97, 98, 99, 101, 103, 113, 120, 126, 137],  
dtype=int64)
```

```
data['Spending Score (1-100)'].unique ()
```

```
array([39, 81,  6, 77, 40, 76, 94,  3, 72, 14, 99, 15, 13, 79, 35, 66,
29,
      98, 73,  5, 82, 32, 61, 31, 87,  4, 92, 17, 26, 75, 36, 28, 65,
55,
      47, 42, 52, 60, 54, 45, 41, 50, 46, 51, 56, 59, 48, 49, 53, 44,
57,
      58, 43, 91, 95, 11,  9, 34, 71, 88,  7, 10, 93, 12, 97, 74, 22,
90,
      20, 16, 89,  1, 78, 83, 27, 63, 86, 69, 24, 68, 85, 23,  8,
18],
      dtype=int64)
```

Check for Missing values and deal with them.

```
data.isnull().any()
```

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

```
data.isnull().sum()
```

CustomerID	0
Gender	0
Age	0
Annual Income (k\$)	0
Spending Score (1-100)	0

```
data.mode()
```

	CustomerID	Gender	Age	Annual Income (k\$)	Spending Score (1-100)
0	1	Female	32.0	54.0	42.0
1	2	NaN	NaN	78.0	NaN
2	3	NaN	NaN	NaN	NaN
3	4	NaN	NaN	NaN	NaN
4	5	NaN	NaN	NaN	NaN

NaN	...			
..	196
...				
195		NaN	NaN	NaN
NaN				
196	197	NaN	NaN	NaN

NaN				
197	198	NaN	NaN	NaN
NaN				
198	199	NaN	NaN	NaN
NaN				
199	200	NaN	NaN	NaN
NaN				

[200 rows x 5 columns]

data['Age'].unique()

```
array([19,54,
       29, 21, 20, 23, 31, 22, 35, 64, 30, 67, 58, 24, 37, 52, 25, 46,
       51,
       69, 45, 40, 60, 53, 18, 49, 42, 36, 65, 48, 50, 27, 33, 59, 47,
       41],
      dtype=int64)
```

data['Age'].value_counts

```
<bound method IndexOpsMixin.value_counts of 0      19
1         21
2         20
3         23
4         31
..
195       35
196       45
197       32
198       32
199       30
```

Name: Age, Length: 200, dtype: int64>

replacing the null values

data['Age'] = data['Age'].fillna(data['Age'].median())data['Age']

```
0         19
1         21
2         20
3         23
4         31
..
195       35
196       45
197       32
198       32
199       30
```

Name: Age, Length: 200, dtype: int64

Find and Replace Outliers

```
data.describe()
```

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

```
data['Age'],data['Annual Income (k$)'].unique()
```

```
(0      19
 1      21
 2      20
 3      23
 4      31
 ..
195     35
196     45
197     32
198     32
199     30
Name: Age, Length: 200, dtype: int64,
array([ 15, 16, 17, 18, 19, 20, 21, 23, 24, 25, 28, 29,
30, 33, 34, 37, 38, 39, 40, 42, 43, 44, 46, 47, 48,
49, 50, 54, 57, 58, 59, 60, 61, 62, 63, 64, 65, 67,
69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 81, 85,
86, 87, 88, 93, 97, 98, 99, 101, 103, 113, 120, 126, 137],
```



```
dtype=int64))
```

```
q = data.quantile([0.75,0.50])q
```

	CustomerID	Age	Annual Income (k\$)	Spending	Score	(1-100)
0.75	150.25	49.0	78.0			73.0
0.50	100.50	36.0	61.5			50.0

```
iqr = q.iloc[0] - q.iloc[1]
```

```
iqr
```

```
CustomerID          49.75
Age                 13.00
Annual Income      (k$) 16.50
Spending Score (1-100)dtype: float64 23.00
```

```
u = q.iloc[0] + (1.5*iqr)      # q3 + 1.5*iqr
```

```
u
```

```
CustomerID          224.875
Age                 68.500
Annual Income (k$)  102.750
Spending Score (1-100)dtype: float64 107.500
```

```
l = q.iloc[1] - (1.5*iqr)
```

```
l
```

```
CustomerID          25.875
Age                 16.500
Annual Income (k$)  36.750
Spending Score (1-100)dtype: float64 15.500
```

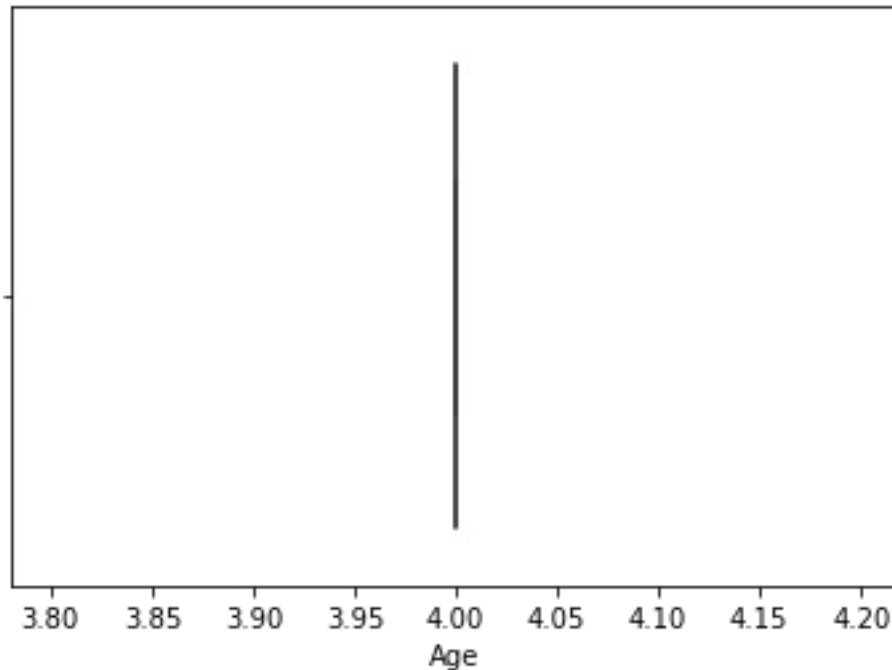
```
## handling outliers
```

```
data['Age'] = np.where(data['Age']>5,4,data['Age'])sns.boxplot(data['Age'])
```

C:\Users\balas\anaconda3\lib\site-packages\seaborn_decorators.py:36:FutureWarning: 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 an explicit keyword will result in an error or misinterpretation.

```
warnings.warn(
```

```
<AxesSubplot:xlabel='Age'>
```



Check for Categorical columns and perform encoding.

converting categorical values into numerical values - Encoding from sklearn.preprocessing

```
import LabelEncoder, OneHotEncoder
le = LabelEncoder()
```

```
oneh = OneHotEncoder()
```

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

	CustomerID	Gender	Age	Annual Income (k\$)	Spending Score (1-100)	
0		1	1	4	15	39
1		2	1	4	15	81
2		3	0	4	16	6
3		4	0	4	16	77
4		5	0	4	17	40

Scaling the data

```
from sklearn.preprocessing import MinMaxScaler
mm = MinMaxScaler()
```

```
mm.fit_transform(data)
```

```
x_scaled = mm.fit_transform(data)
```

```
array([[0.00502513, 1.0, 0.0, 0.3877551],
       [0.01005025, 1.0, 0.0, 0.81632653],
       [0.01507538, 0.0, 0.00819672, 0.05102041],
       [0.0201005, 0.0, 0.00819672, 0.7755102],
       [0.02512563, 0.0, 0.01639344, 0.39795918],
       [0.03015075, 0.0, 0.01639344, 0.76530612],
       [0.03517587, 0.0, 0.02459016, 0.05102041],
```

[0.03517588,	0.	, 0.	, 0.02459016,	0.94897959],
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[0.06030151,	0.	, 0.	, 0.04098361,	0.14285714],
[0.06532663,	0.	, 0.	, 0.04098361,	0.7755102],
[0.07035176,	1.	, 0.	, 0.04098361,	0.12244898],
[0.07537688,	1.	, 0.	, 0.04098361,	0.79591837],
[0.08040201,	0.	, 0.	, 0.04918033,	0.34693878],
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[0.11557789,	1.	, 0.	, 0.08196721,	0.73469388],
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[0.13065327,	0.	, 0.	, 0.10655738,	0.31632653],
[0.13567839,	1.	, 0.	, 0.10655738,	0.6122449],
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[0.93969849,	1.	, 0.	, 0.70491803,	0.68367347],
[0.94472362,	0.	, 0.	, 0.72131148,	0.16326531],
[0.94974874,	0.	, 0.	, 0.72131148,	0.85714286],
[0.95477387,	0.	, 0.	, 0.72131148,	0.2244898],
[0.95979899,	0.	, 0.	, 0.72131148,	0.69387755],
[0.96482412,	1.	, 0.	, 0.80327869,	0.07142857],
[0.96984925,	0.	, 0.	, 0.80327869,	0.91836735],
[0.97487437,	0.	, 0.	, 0.86065574,	0.15306122],
[0.9798995 ,	0.	, 0.	, 0.86065574,	0.79591837],
[0.98492462,	0.	, 0.	, 0.90983607,	0.2755102],
[0.98994975,	1.	, 0.	, 0.90983607,	0.74489796],
[0.99497487,	1.	, 0.	, 1. ,	0.17346939],

```
[1.          , 1.          , 0.          , 1.          , 0.83673469]])
```

Perform any of the clustering algorithms

```
from sklearn.cluster import KMeans
km = KMeans(n_clusters=2, random_state=0)
clus = km.fit_predict(x_scaled)
```

```
array([4, 4, 1, 1, 1, 1, 1, 1, 4, 1, 4, 1, 1, 1, 4, 4, 1, 4, 4, 1, 4,
4,
      1, 4, 1, 4, 1, 4, 1, 1, 4, 1, 4, 4, 1, 1, 1, 1, 1, 1, 1, 4, 4,
1,
      1, 1, 1, 1, 1, 1, 1, 4, 1, 4, 1, 4, 1, 3, 1, 3, 3, 3, 2, 2, 3,
3,
      2, 2, 3, 2, 3, 2, 2, 2, 3, 3, 2, 3, 2, 2, 3, 3, 3, 2, 2, 3, 2,
2,
      2, 2, 2, 3, 3, 2, 2, 3, 2, 2, 3, 3, 2, 2, 3, 3, 3, 2, 2, 3, 3,
3,
      3, 2, 2, 3, 2, 2, 2, 2, 2, 2, 3, 2, 2, 7, 2, 5, 3, 7, 0, 7, 0,
7,
      2, 5, 0, 5, 6, 7, 0, 5, 6, 7, 6, 5, 0, 7, 0, 5, 6, 7, 0, 7, 6,
5,
      6, 5, 0, 5, 0, 5, 6, 5, 0, 5, 0, 5, 0, 5, 6, 7, 0, 7, 0, 7, 6,
5,
      0, 7, 0, 7, 6, 5, 0, 5, 6, 7, 6, 7, 6, 5, 6, 5, 0, 5, 6, 5, 6,
7,
      0, 7])
```

```
names = data.columnsnames
Index(['CustomerID', 'Gender', 'Age', 'Annual Income (k$)', 'Spending Score (1-100)'],
      dtype='object')
```

```
data1 = pd.DataFrame(x_scaled, columns=names)data1.head()
```

	CustomerID	Gender	Age	Annual Income (k\$)	Spending Score (1-100)	
	1.0	0.0	0.000000		0.387755	0.000000
1	0.005025		1.0	0.0	0.000000	0.816327
2	0.010050		0.0	0.0	0.008197	0.051020
3	0.015075		0.0	0.0	0.008197	0.775510
4	0.020101		0.0	0.0	0.016393	0.397959

Add the cluster data with the primary dataset

```
data1['New clus'] = pd.Series(clus)data1.head()
```

\	CustomerID	Gender	Age	Annual Income (k\$)	Spending Score (1-100)
0	0.000000	1.0	0.0	0.000000	0.387755
1	0.005025	1.0	0.0	0.000000	0.816327
2	0.010050	0.0	0.0	0.008197	0.051020

3	0.015075	0.0	0.0	0.008197	0.775510
4	0.020101	0.0	0.0	0.016393	0.397959

	New clus
0	4
1	4
2	1
3	1
4	1

Split the data into dependent and independent variables

```
data.shape
```

```
(200, 5)
```

```
x = data.iloc[:, 0:5]
```

	CustomerID	Gender	Age	Annual Income (k\$)	Spending Score (1-100)
0	1	1	4	15	
39					
1	2	1	4	15	
81					
2	3	0	4	16	
6					
3	4	0	4	16	
77					
4	5	0	4	17	
40					
..
195	196	0	4	120	
79					
196	197	0	4	126	
28					
197	198	1	4	126	
74					
198	199	1	4	137	
18					
199	200	1	4	137	
83					

```
[200 rows x 5 columns]
```

```
y = data['Spending Score (1-100)']
```

```

0      39
1      81
2       6
3      77
4      40
..
195    79
196    28
197    74
198    18
199    83

```

Name: Spending Score (1-100), Length: 200, dtype: int64

Split the data into training and testing

```
from sklearn.model_selection import train_test_split
```

```
x_train, x_test, y_train, y_test = train_test_split(x_scaled, y, test_size = 0.5, random_state = 0)
```

x_train

```

array([[0.79396985, 1.          , 0.          , 0.51639344, 0.          ],
       [0.95979899, 0.          , 0.          , 0.72131148, 0.69387755],
       [0.25125628, 0.          , 0.          , 0.22131148, 0.52040816],
       [0.          , 1.          , 0.          , 0.          , 0.3877551 ],
       [0.47236181, 0.          , 0.          , 0.36885246, 0.41836735],
       [0.55276382, 1.          , 0.          , 0.39344262, 0.52040816],
       [0.47738693, 1.          , 0.          , 0.36885246, 0.52040816],
       [0.32160804, 1.          , 0.          , 0.2704918 , 0.51020408],
       [0.83919598, 0.          , 0.          , 0.58196721, 0.95918367],
       [0.20603015, 1.          , 0.          , 0.18852459, 0.92857143],
       [0.34673367, 0.          , 0.          , 0.2704918 , 0.46938776],
       [0.24623116, 0.          , 0.          , 0.20491803, 0.41836735],
       [0.24120603, 0.          , 0.          , 0.20491803, 0.41836735],
       [0.42713568, 1.          , 0.          , 0.31967213, 0.45918367],
       [0.06532663, 0.          , 0.          , 0.04098361, 0.7755102 ],
       [0.80904523, 0.          , 0.          , 0.52459016, 0.83673469],
       [0.11557789, 1.          , 0.          , 0.08196721, 0.73469388],
       [0.93467337, 0.          , 0.          , 0.70491803, 0.23469388],
       [0.67839196, 0.          , 0.          , 0.47540984, 0.8877551 ],
       [0.10050251, 1.          , 0.          , 0.07377049, 0.34693878],
       [0.07537688, 1.          , 0.          , 0.04098361, 0.79591837],
       [0.3919598 , 0.          , 0.          , 0.31967213, 0.52040816],
       [0.52261307, 1.          , 0.          , 0.3852459 , 0.56122449],
       [0.26130653, 0.          , 0.          , 0.2295082 , 0.54081633],
       [0.50251256, 0.          , 0.          , 0.3852459 , 0.40816327],
       [0.38190955, 0.          , 0.          , 0.31967213, 0.53061224],

```

[0.01507538,	0.	,	0.	,	0.00819672,	0.7755102],
[0.58291457,	0.	,	0.	,	0.40983607,	0.42857143],
[0.8241206 ,	1.	,	0.	,	0.57377049,	0.25510204],
[0.99497487,	1.	,	0.	,	1.	0.17346939],
[0.03015075,	0.	,	0.	,	0.02459016,	0.05102041],

[0.34170854,	1.	, 0.	, 0.2704918 ,	0.59183673],
[0.42211055,	0.	, 0.	, 0.31967213,	0.57142857],
[0.6080402 ,	0.	, 0.	, 0.42622951,	0.39795918],
[0.77889447,	0.	, 0.	, 0.51639344,	0.89795918],
[0.85929648,	1.	, 0.	, 0.59016393,	0.75510204],
[0.7839196 ,	1.	, 0.	, 0.51639344,	0.],
[0.45728643,	1.	, 0.	, 0.36065574,	0.40816327],
[1.	, 1.	, 0.	, 1.	, 0.83673469],
[0.05527638,	0.	, 0.	, 0.03278689,	1.],
[0.59798995,	0.	, 0.	, 0.42622951,	0.57142857],
[0.51256281,	1.	, 0.	, 0.3852459 ,	0.59183673],
[0.1758794 ,	0.	, 0.	, 0.14754098,	0.81632653],
[0.28643216,	1.	, 0.	, 0.23770492,	0.45918367],
[0.32663317,	1.	, 0.	, 0.2704918 ,	0.59183673],
[0.00502513,	1.	, 0.	, 0. ,	0.81632653],
[0.60301508,	1.	, 0.	, 0.42622951,	0.56122449],
[0.81407035,	1.	, 0.	, 0.54098361,	0.04081633],
[0.21105528,	1.	, 0.	, 0.19672131,	0.35714286],
[0.52763819,	0.	, 0.	, 0.3852459 ,	0.41836735],
[0.66331658,	0.	, 0.	, 0.46721311,	0.33673469],
[0.86934673,	1.	, 0.	, 0.59016393,	0.92857143],
[0.08542714,	1.	, 0.	, 0.04918033,	0.66326531],
[0.19095477,	0.	, 0.	, 0.18032787,	0.25510204],
[0.66834171,	0.	, 0.	, 0.46721311,	0.71428571],
[0.26633166,	1.	, 0.	, 0.2295082 ,	0.60204082],
[0.78894472,	0.	, 0.	, 0.51639344,	0.78571429],
[0.64321608,	1.	, 0.	, 0.45901639,	0.10204082],
[0.17085427,	0.	, 0.	, 0.14754098,	0.13265306],
[0.14070352,	0.	, 0.	, 0.1147541 ,	0.30612245],
[0.57286432,	0.	, 0.	, 0.40983607,	0.47959184],
[0.75879397,	1.	, 0.	, 0.51639344,	0.8877551],
[0.15577889,	0.	, 0.	, 0.12295082,	0.73469388],
[0.83417085,	1.	, 0.	, 0.58196721,	0.19387755],
[0.63819095,	1.	, 0.	, 0.45901639,	0.95918367],
[0.88442211,	1.	, 0.	, 0.59836066,	0.14285714],
[0.16080402,	1.	, 0.	, 0.14754098,	0.03061224],
[0.71356784,	0.	, 0.	, 0.5 ,	0.39795918],
[0.84924623,	1.	, 0.	, 0.59016393,	0.63265306],
[0.73869347,	0.	, 0.	, 0.50819672,	0.74489796],
[0.14572864,	0.	, 0.	, 0.1147541 ,	0.87755102],
[0.49748744,	1.	, 0.	, 0.37704918,	0.48979592],
[0.4120603 ,	1.	, 0.	, 0.31967213,	0.40816327],

[0.39698492,	0.	,	0.	,	0.31967213,	0.41836735],
[0.57788945,	0.	,	0.	,	0.40983607,	0.5],
[0.74371859,	0.	,	0.	,	0.51639344,	0.21428571],
[0.96984925,	0.	,	0.	,	0.80327869,	0.91836735],
[0.36180905,	0.	,	0.	,	0.28688525,	0.48979592],
[0.38693467,	1.	,	0.	,	0.31967213,	0.47959184],
[0.12562814,	1.	,	0.	,	0.10655738,	0.82653061],
[0.82914573,	0.	,	0.	,	0.57377049,	0.75510204],

[0.40703518, 1.	, 0.	, 0.31967213,	0.55102041],
[0.94472362, 0.	, 0.	, 0.72131148,	0.16326531],
[0.87437186, 0.	, 0.	, 0.59836066,	0.12244898],
[0.95477387, 0.	, 0.	, 0.72131148,	0.2244898],
[0.1959799 , 0.	, 0.	, 0.18032787,	0.75510204],
[0.29145729, 0.	, 0.	, 0.25409836,	0.51020408],
[0.70351759, 0.	, 0.	, 0.49180328,	0.04081633],
[0.44221106, 0.	, 0.	, 0.35245902,	0.60204082],
[0.35175879, 1.	, 0.	, 0.27868852,	0.55102041],
[0.43718593, 0.	, 0.	, 0.3442623 ,	0.55102041],
[0.18090452, 0.	, 0.	, 0.1557377 ,	0.16326531],
[0.10552764, 1.	, 0.	, 0.07377049,	0.73469388],
[0.04522613, 0.	, 0.	, 0.03278689,	0.7244898],
[0.51758794, 1.	, 0.	, 0.3852459 ,	0.55102041],
[0.33668342, 0.	, 0.	, 0.2704918 ,	0.47959184],
[0.96482412, 1.	, 0.	, 0.80327869,	0.07142857],
[0.5879397 , 0.	, 0.	, 0.40983607,	0.59183673],
[0.2361809 , 0.	, 0.	, 0.20491803,	0.46938776],
[0.86432161, 1.	, 0.	, 0.59016393,	0.09183673]])

x_train.shape

(100, 5)

x_test

array([[0.09045226,	1.	, 0.	, 0.06557377,	0.28571429],
[0.85427136, 1.	, 0.	, 0.59016393,	0.12244898],	
[0.53768844, 1.	, 0.	, 0.39344262,	0.45918367],	
[0.49246231, 1.	, 0.	, 0.37704918,	0.41836735],	
[0.88944724, 1.	, 0.	, 0.59836066,	0.69387755],	
[0.91457286, 1.	, 0.	, 0.68032787,	0.14285714],	
[0.02512563, 0.	, 0.	, 0.01639344,	0.76530612],	
[0.73366834, 1.	, 0.	, 0.50819672,	0.35714286],	
[0.06030151, 0.	, 0.	, 0.04098361,	0.14285714],	
[0.7638191 , 0.	, 0.	, 0.51639344,	0.19387755],	
[0.30653266, 1.	, 0.	, 0.25409836,	0.55102041],	
[0.6281407 , 0.	, 0.	, 0.45081967,	0.7755102],	
[0.90452261, 0.	, 0.	, 0.67213115,	0.31632653],	
[0.77386935, 0.	, 0.	, 0.51639344,	0.15306122],	
[0.40201005, 1.	, 0.	, 0.31967213,	0.51020408],	
[0.03517588, 0.	, 0.	, 0.02459016,	0.94897959],	
[0.16582915, 1.	, 0.	, 0.14754098,	0.92857143],	
[0.65326633, 1.	, 0.	, 0.45901639,	0.08163265],	
[0.18592965, 0.	, 0.	, 0.1557377 ,	0.73469388],	

[0.3718593 , 1.	, 0.	, 0.31967213,	0.46938776],
[0.91959799, 0.	, 0.	, 0.68032787,	0.8877551],
[0.72864322, 1.	, 0.	, 0.50819672,	0.97959184],
[0.22613065, 0.	, 0.	, 0.19672131,	0.65306122],
[0.79899497, 0.	, 0.	, 0.51639344,	0.73469388],
[0.30150754, 1.	, 0.	, 0.25409836,	0.56122449],

[0.61809045,	1.	, 0.	, 0.44262295,	0.91836735],
[0.89949749,	1.	, 0.	, 0.63934426,	0.90816327],
[0.92964824,	1.	, 0.	, 0.68852459,	0.97959184],
[0.61306533,	0.	, 0.	, 0.44262295,	0.58163265],
[0.22110553,	0.	, 0.	, 0.19672131,	0.2755102],
[0.08040201,	0.	, 0.	, 0.04918033,	0.34693878],
[0.27638191,	1.	, 0.	, 0.2295082 ,	0.40816327],
[0.75376884,	1.	, 0.	, 0.51639344,	0.16326531],
[0.55778894,	0.	, 0.	, 0.39344262,	0.54081633],
[0.11055276,	0.	, 0.	, 0.08196721,	0.04081633],
[0.94974874,	0.	, 0.	, 0.72131148,	0.85714286],
[0.64824121,	1.	, 0.	, 0.45901639,	0.75510204],
[0.0201005 ,	0.	, 0.	, 0.01639344,	0.39795918],
[0.41708543,	0.	, 0.	, 0.31967213,	0.43877551],
[0.53266332,	0.	, 0.	, 0.39344262,	0.5],
[0.67336683,	1.	, 0.	, 0.47540984,	0.04081633],
[0.33165829,	0.	, 0.	, 0.2704918 ,	0.5],
[0.13065327,	0.	, 0.	, 0.10655738,	0.31632653],
[0.5678392 ,	1.	, 0.	, 0.40163934,	0.45918367],
[0.84422111,	0.	, 0.	, 0.59016393,	0.26530612],
[0.31658291,	0.	, 0.	, 0.26229508,	0.59183673],
[0.04020101,	1.	, 0.	, 0.03278689,	0.02040816],
[0.37688442,	1.	, 0.	, 0.31967213,	0.54081633],
[0.59296482,	0.	, 0.	, 0.42622951,	0.42857143],
[0.71859296,	0.	, 0.	, 0.5 ,	0.87755102],
[0.35678392,	0.	, 0.	, 0.27868852,	0.41836735],
[0.62311558,	0.	, 0.	, 0.45081967,	0.28571429],
[0.92462312,	0.	, 0.	, 0.68852459,	0.3877551],
[0.48743719,	0.	, 0.	, 0.36885246,	0.5],
[0.74874372,	1.	, 0.	, 0.51639344,	0.90816327],
[0.12060302,	0.	, 0.	, 0.10655738,	0.13265306],
[0.15075377,	1.	, 0.	, 0.12295082,	0.03061224],
[0.8040201 ,	0.	, 0.	, 0.52459016,	0.34693878],
[0.20100503,	0.	, 0.	, 0.18852459,	0.34693878],
[0.28140704,	0.	, 0.	, 0.23770492,	0.5],
[0.65829146,	1.	, 0.	, 0.45901639,	0.75510204],
[0.48241206,	0.	, 0.	, 0.36885246,	0.46938776],
[0.90954774,	0.	, 0.	, 0.67213115,	0.86734694],
[0.09547739,	0.	, 0.	, 0.06557377,	0.98979592],
[0.76884422,	0.	, 0.	, 0.51639344,	0.76530612],
[0.46231156,	1.	, 0.	, 0.36885246,	0.48979592],
[0.27135678,	0.	, 0.	, 0.2295082 ,	0.44897959],

[0.81909548,	0.	,	0.	,	0.54098361,	0.93877551],
[0.25628141,	1.	,	0.	,	0.22131148,	0.60204082],
[0.4321608 ,	0.	,	0.	,	0.3442623 ,	0.58163265],
[0.69849246,	0.	,	0.	,	0.48360656,	0.7244898],
[0.45226131,	0.	,	0.	,	0.36065574,	0.55102041],
[0.68844221,	1.	,	0.	,	0.47540984,	0.73469388],
[0.50753769,	0.	,	0.	,	0.3852459 ,	0.47959184],
[0.72361809,	1.	,	0.	,	0.50819672,	0.1122449],

```
[0.44723618, 0.          , 0.          , 0.35245902, 0.45918367],
[0.54773869, 1.          , 0.          , 0.39344262, 0.47959184],
[0.07035176, 1.          , 0.          , 0.04098361, 0.12244898],
[0.13567839, 1.          , 0.          , 0.10655738, 0.6122449 ],
[0.70854271, 1.          , 0.          , 0.49180328, 0.93877551],
[0.93969849, 1.          , 0.          , 0.70491803, 0.68367347],
[0.23115578, 0.          , 0.          , 0.20491803, 0.55102041],
[0.69346734, 1.          , 0.          , 0.48360656, 0.09183673],
[0.9798995 , 0.          , 0.          , 0.86065574, 0.79591837],
[0.54271357, 1.          , 0.          , 0.39344262, 0.42857143],
[0.31155779, 0.          , 0.          , 0.26229508, 0.52040816],
[0.01005025, 0.          , 0.          , 0.00819672, 0.05102041],
[0.29648241, 1.          , 0.          , 0.25409836, 0.45918367],
[0.68341709, 0.          , 0.          , 0.47540984, 0.06122449],
[0.98994975, 1.          , 0.          , 0.90983607, 0.74489796],
[0.2160804 , 0.          , 0.          , 0.19672131, 0.6122449 ],
[0.05025126, 1.          , 0.          , 0.03278689, 0.13265306],
[0.97487437, 0.          , 0.          , 0.86065574, 0.15306122],
[0.36683417, 0.          , 0.          , 0.28688525, 0.56122449],
[0.98492462, 0.          , 0.          , 0.90983607, 0.2755102 ],
[0.89447236, 1.          , 0.          , 0.63934426, 0.13265306],
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[0.63316583, 1.          , 0.          , 0.45901639, 0.34693878],
[0.46733668, 0.          , 0.          , 0.36885246, 0.39795918],
[0.56281407, 0.          , 0.          , 0.40163934, 0.41836735]]]
```

```
x_test.shape(100,
5)
```

```
y_train
```

```
158      1
191      69
50       52
0        39
94       42
..
67       48
192       8
117      59
47       47
172      10
```

```
Name: Spending    Score (1-100),    Length:    100, dtype: int64
```

```
y_train.shape
```

(100,)
y_test

```

18      29
170     13
107     46
98      42
177     69
      ..
178     14
175     86
126     35
93      40
112     42

```

Name: Spending Score (1-100), Length: 100, dtype: int64y_test.shape
(100,)

Build the Model

```

from sklearn.ensemble import RandomForestRegressor
regr = RandomForestRegressor(max_depth=2, random_state=0,
                             n_estimators=100)

regr.fit(x_train, y_train)regr.fit(x_test,
y_test)
RandomForestRegressor(max_depth=2, random_state=0)y_train_pred =
regr.predict(x_train)
y_test_pred = regr.predict(x_test)

regr.score(x_train, y_train)
0.9752947343811537
regr.score(x_test, y_test)
0.9790787065797374

```

Train and Test

```

from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(x_scaled, y, test_size = 0.3, random_state = 0)

x_train

```

```

array([[0.65829146, 1.          , 0.          , 0.45901639, 0.75510204],
       [0.48241206, 0.          , 0.          , 0.36885246, 0.46938776],
       [0.90954774, 0.          , 0.          , 0.67213115, 0.86734694],
       [0.09547739, 0.          , 0.          , 0.06557377, 0.98979592],
       [0.76884422, 0.          , 0.          , 0.51639344, 0.76530612],
       [0.46231156, 1.          , 0.          , 0.36885246, 0.48979592],
       [0.27135678, 0.          , 0.          , 0.2295082 , 0.44897959],
       [0.81909548, 0.          , 0.          , 0.54098361, 0.93877551],

```


[0.25628141,	1.	, 0.	, 0.22131148,	0.60204082],
[0.4321608 ,	0.	, 0.	, 0.3442623 ,	0.58163265],
[0.69849246,	0.	, 0.	, 0.48360656,	0.7244898],
[0.45226131,	0.	, 0.	, 0.36065574,	0.55102041],
[0.68844221,	1.	, 0.	, 0.47540984,	0.73469388],
[0.50753769,	0.	, 0.	, 0.3852459 ,	0.47959184],
[0.72361809,	1.	, 0.	, 0.50819672,	0.1122449],
[0.44723618,	0.	, 0.	, 0.35245902,	0.45918367],
[0.54773869,	1.	, 0.	, 0.39344262,	0.47959184],
[0.07035176,	1.	, 0.	, 0.04098361,	0.12244898],
[0.13567839,	1.	, 0.	, 0.10655738,	0.6122449],
[0.70854271,	1.	, 0.	, 0.49180328,	0.93877551],
[0.93969849,	1.	, 0.	, 0.70491803,	0.68367347],
[0.23115578,	0.	, 0.	, 0.20491803,	0.55102041],
[0.69346734,	1.	, 0.	, 0.48360656,	0.09183673],
[0.9798995 ,	0.	, 0.	, 0.86065574,	0.79591837],
[0.54271357,	1.	, 0.	, 0.39344262,	0.42857143],
[0.31155779,	0.	, 0.	, 0.26229508,	0.52040816],
[0.01005025,	0.	, 0.	, 0.00819672,	0.05102041],
[0.29648241,	1.	, 0.	, 0.25409836,	0.45918367],
[0.68341709,	0.	, 0.	, 0.47540984,	0.06122449],
[0.98994975,	1.	, 0.	, 0.90983607,	0.74489796],
[0.2160804 ,	0.	, 0.	, 0.19672131,	0.6122449],
[0.05025126,	1.	, 0.	, 0.03278689,	0.13265306],
[0.97487437,	0.	, 0.	, 0.86065574,	0.15306122],
[0.36683417,	0.	, 0.	, 0.28688525,	0.56122449],
[0.98492462,	0.	, 0.	, 0.90983607,	0.2755102],
[0.89447236,	1.	, 0.	, 0.63934426,	0.13265306],
[0.87939698,	0.	, 0.	, 0.59836066,	0.86734694],
[0.63316583,	1.	, 0.	, 0.45901639,	0.34693878],
[0.46733668,	0.	, 0.	, 0.36885246,	0.39795918],
[0.56281407,	0.	, 0.	, 0.40163934,	0.41836735],
[0.79396985,	1.	, 0.	, 0.51639344,	0.],
[0.95979899,	0.	, 0.	, 0.72131148,	0.69387755],
[0.25125628,	0.	, 0.	, 0.22131148,	0.52040816],
[0. ,	1.	, 0.	, 0. ,	0.3877551],
[0.47236181,	0.	, 0.	, 0.36885246,	0.41836735],
[0.55276382,	1.	, 0.	, 0.39344262,	0.52040816],
[0.47738693,	1.	, 0.	, 0.36885246,	0.52040816],
[0.32160804,	1.	, 0.	, 0.2704918 ,	0.51020408],
[0.83919598,	0.	, 0.	, 0.58196721,	0.95918367],
[0.20603015,	1.	, 0.	, 0.18852459,	0.92857143],

[0.34673367,	0.	,	0.	,	0.2704918 ,	0.46938776],
[0.24623116,	0.	,	0.	,	0.20491803,	0.41836735],
[0.24120603,	0.	,	0.	,	0.20491803,	0.41836735],
[0.42713568,	1.	,	0.	,	0.31967213,	0.45918367],
[0.06532663,	0.	,	0.	,	0.04098361,	0.7755102],
[0.80904523,	0.	,	0.	,	0.52459016,	0.83673469],
[0.11557789,	1.	,	0.	,	0.08196721,	0.73469388],
[0.93467337,	0.	,	0.	,	0.70491803,	0.23469388],

[0.67839196,	0.	, 0.	, 0.47540984,	0.8877551],
[0.10050251,	1.	, 0.	, 0.07377049,	0.34693878],
[0.07537688,	1.	, 0.	, 0.04098361,	0.79591837],
[0.3919598 ,	0.	, 0.	, 0.31967213,	0.52040816],
[0.52261307,	1.	, 0.	, 0.3852459 ,	0.56122449],
[0.26130653,	0.	, 0.	, 0.2295082 ,	0.54081633],
[0.50251256,	0.	, 0.	, 0.3852459 ,	0.40816327],
[0.38190955,	0.	, 0.	, 0.31967213,	0.53061224],
[0.01507538,	0.	, 0.	, 0.00819672,	0.7755102],
[0.58291457,	0.	, 0.	, 0.40983607,	0.42857143],
[0.8241206 ,	1.	, 0.	, 0.57377049,	0.25510204],
[0.99497487,	1.	, 0.	, 1. ,	0.17346939],
[0.03015075,	0.	, 0.	, 0.02459016,	0.05102041],
[0.34170854,	1.	, 0.	, 0.2704918 ,	0.59183673],
[0.42211055,	0.	, 0.	, 0.31967213,	0.57142857],
[0.6080402 ,	0.	, 0.	, 0.42622951,	0.39795918],
[0.77889447,	0.	, 0.	, 0.51639344,	0.89795918],
[0.85929648,	1.	, 0.	, 0.59016393,	0.75510204],
[0.7839196 ,	1.	, 0.	, 0.51639344,	0.],
[0.45728643,	1.	, 0.	, 0.36065574,	0.40816327],
[1. ,	1.	, 0.	, 1. ,	0.83673469],
[0.05527638,	0.	, 0.	, 0.03278689,	1.],
[0.59798995,	0.	, 0.	, 0.42622951,	0.57142857],
[0.51256281,	1.	, 0.	, 0.3852459 ,	0.59183673],
[0.1758794 ,	0.	, 0.	, 0.14754098,	0.81632653],
[0.28643216,	1.	, 0.	, 0.23770492,	0.45918367],
[0.32663317,	1.	, 0.	, 0.2704918 ,	0.59183673],
[0.00502513,	1.	, 0.	, 0. ,	0.81632653],
[0.60301508,	1.	, 0.	, 0.42622951,	0.56122449],
[0.81407035,	1.	, 0.	, 0.54098361,	0.04081633],
[0.21105528,	1.	, 0.	, 0.19672131,	0.35714286],
[0.52763819,	0.	, 0.	, 0.3852459 ,	0.41836735],
[0.66331658,	0.	, 0.	, 0.46721311,	0.33673469],
[0.86934673,	1.	, 0.	, 0.59016393,	0.92857143],
[0.08542714,	1.	, 0.	, 0.04918033,	0.66326531],
[0.19095477,	0.	, 0.	, 0.18032787,	0.25510204],
[0.66834171,	0.	, 0.	, 0.46721311,	0.71428571],
[0.26633166,	1.	, 0.	, 0.2295082 ,	0.60204082],
[0.78894472,	0.	, 0.	, 0.51639344,	0.78571429],
[0.64321608,	1.	, 0.	, 0.45901639,	0.10204082],
[0.17085427,	0.	, 0.	, 0.14754098,	0.13265306],
[0.14070352,	0.	, 0.	, 0.1147541 ,	0.30612245],

[0.57286432,	0.	,	0.	,	0.40983607,	0.47959184],
[0.75879397,	1.	,	0.	,	0.51639344,	0.8877551],
[0.15577889,	0.	,	0.	,	0.12295082,	0.73469388],
[0.83417085,	1.	,	0.	,	0.58196721,	0.19387755],
[0.63819095,	1.	,	0.	,	0.45901639,	0.95918367],
[0.88442211,	1.	,	0.	,	0.59836066,	0.14285714],
[0.16080402,	1.	,	0.	,	0.14754098,	0.03061224],
[0.71356784,	0.	,	0.	,	0.5	, 0.39795918],

[0.84924623, 1.	, 0.	, 0.59016393,	0.63265306],
[0.73869347, 0.	, 0.	, 0.50819672,	0.74489796],
[0.14572864, 0.	, 0.	, 0.1147541 ,	0.87755102],
[0.49748744, 1.	, 0.	, 0.37704918,	0.48979592],
[0.4120603 , 1.	, 0.	, 0.31967213,	0.40816327],
[0.39698492, 0.	, 0.	, 0.31967213,	0.41836735],
[0.57788945, 0.	, 0.	, 0.40983607,	0.5],
[0.74371859, 0.	, 0.	, 0.51639344,	0.21428571],
[0.96984925, 0.	, 0.	, 0.80327869,	0.91836735],
[0.36180905, 0.	, 0.	, 0.28688525,	0.48979592],
[0.38693467, 1.	, 0.	, 0.31967213,	0.47959184],
[0.12562814, 1.	, 0.	, 0.10655738,	0.82653061],
[0.82914573, 0.	, 0.	, 0.57377049,	0.75510204],
[0.40703518, 1.	, 0.	, 0.31967213,	0.55102041],
[0.94472362, 0.	, 0.	, 0.72131148,	0.16326531],
[0.87437186, 0.	, 0.	, 0.59836066,	0.12244898],
[0.95477387, 0.	, 0.	, 0.72131148,	0.2244898],
[0.1959799 , 0.	, 0.	, 0.18032787,	0.75510204],
[0.29145729, 0.	, 0.	, 0.25409836,	0.51020408],
[0.70351759, 0.	, 0.	, 0.49180328,	0.04081633],
[0.44221106, 0.	, 0.	, 0.35245902,	0.60204082],
[0.35175879, 1.	, 0.	, 0.27868852,	0.55102041],
[0.43718593, 0.	, 0.	, 0.3442623 ,	0.55102041],
[0.18090452, 0.	, 0.	, 0.1557377 ,	0.16326531],
[0.10552764, 1.	, 0.	, 0.07377049,	0.73469388],
[0.04522613, 0.	, 0.	, 0.03278689,	0.7244898],
[0.51758794, 1.	, 0.	, 0.3852459 ,	0.55102041],
[0.33668342, 0.	, 0.	, 0.2704918 ,	0.47959184],
[0.96482412, 1.	, 0.	, 0.80327869,	0.07142857],
[0.5879397 , 0.	, 0.	, 0.40983607,	0.59183673],
[0.2361809 , 0.	, 0.	, 0.20491803,	0.46938776],
[0.86432161, 1.	, 0.	, 0.59016393,	0.09183673]])

x_test

array([[0.09045226,	1.	, 0.	, 0.06557377,	0.28571429],
[0.85427136, 1.	, 0.	, 0.59016393,	0.12244898],	
[0.53768844, 1.	, 0.	, 0.39344262,	0.45918367],	
[0.49246231, 1.	, 0.	, 0.37704918,	0.41836735],	
[0.88944724, 1.	, 0.	, 0.59836066,	0.69387755],	
[0.91457286, 1.	, 0.	, 0.68032787,	0.14285714],	
[0.02512563, 0.	, 0.	, 0.01639344,	0.76530612],	
[0.73366834, 1.	, 0.	, 0.50819672,	0.35714286],	
[0.06030151, 0.	, 0.	, 0.04098361,	0.14285714],	

[0.7638191 , 0.	, 0.	, 0.51639344,	0.19387755],
[0.30653266, 1.	, 0.	, 0.25409836,	0.55102041],
[0.6281407 , 0.	, 0.	, 0.45081967,	0.7755102],
[0.90452261, 0.	, 0.	, 0.67213115,	0.31632653],
[0.77386935, 0.	, 0.	, 0.51639344,	0.15306122],
[0.40201005, 1.	, 0.	, 0.31967213,	0.51020408],
[0.03517588, 0.	, 0.	, 0.02459016,	0.94897959],

[0.16582915,	1.	, 0.	, 0.14754098,	0.92857143],
[0.65326633,	1.	, 0.	, 0.45901639,	0.08163265],
[0.18592965,	0.	, 0.	, 0.1557377 ,	0.73469388],
[0.3718593 ,	1.	, 0.	, 0.31967213,	0.46938776],
[0.91959799,	0.	, 0.	, 0.68032787,	0.8877551],
[0.72864322,	1.	, 0.	, 0.50819672,	0.97959184],
[0.22613065,	0.	, 0.	, 0.19672131,	0.65306122],
[0.79899497,	0.	, 0.	, 0.51639344,	0.73469388],
[0.30150754,	1.	, 0.	, 0.25409836,	0.56122449],
[0.61809045,	1.	, 0.	, 0.44262295,	0.91836735],
[0.89949749,	1.	, 0.	, 0.63934426,	0.90816327],
[0.92964824,	1.	, 0.	, 0.68852459,	0.97959184],
[0.61306533,	0.	, 0.	, 0.44262295,	0.58163265],
[0.22110553,	0.	, 0.	, 0.19672131,	0.2755102],
[0.08040201,	0.	, 0.	, 0.04918033,	0.34693878],
[0.27638191,	1.	, 0.	, 0.2295082 ,	0.40816327],
[0.75376884,	1.	, 0.	, 0.51639344,	0.16326531],
[0.55778894,	0.	, 0.	, 0.39344262,	0.54081633],
[0.11055276,	0.	, 0.	, 0.08196721,	0.04081633],
[0.94974874,	0.	, 0.	, 0.72131148,	0.85714286],
[0.64824121,	1.	, 0.	, 0.45901639,	0.75510204],
[0.0201005 ,	0.	, 0.	, 0.01639344,	0.39795918],
[0.41708543,	0.	, 0.	, 0.31967213,	0.43877551],
[0.53266332,	0.	, 0.	, 0.39344262,	0.5],
[0.67336683,	1.	, 0.	, 0.47540984,	0.04081633],
[0.33165829,	0.	, 0.	, 0.2704918 ,	0.5],
[0.13065327,	0.	, 0.	, 0.10655738,	0.31632653],
[0.5678392 ,	1.	, 0.	, 0.40163934,	0.45918367],
[0.84422111,	0.	, 0.	, 0.59016393,	0.26530612],
[0.31658291,	0.	, 0.	, 0.26229508,	0.59183673],
[0.04020101,	1.	, 0.	, 0.03278689,	0.02040816],
[0.37688442,	1.	, 0.	, 0.31967213,	0.54081633],
[0.59296482,	0.	, 0.	, 0.42622951,	0.42857143],
[0.71859296,	0.	, 0.	, 0.5 ,	0.87755102],
[0.35678392,	0.	, 0.	, 0.27868852,	0.41836735],
[0.62311558,	0.	, 0.	, 0.45081967,	0.28571429],
[0.92462312,	0.	, 0.	, 0.68852459,	0.3877551],
[0.48743719,	0.	, 0.	, 0.36885246,	0.5],
[0.74874372,	1.	, 0.	, 0.51639344,	0.90816327],
[0.12060302,	0.	, 0.	, 0.10655738,	0.13265306],
[0.15075377,	1.	, 0.	, 0.12295082,	0.03061224],
[0.8040201 ,	0.	, 0.	, 0.52459016,	0.34693878],

```
[0.20100503, 0. , 0. , 0.18852459, 0.34693878],  
[0.28140704, 0. , 0. , 0.23770492, 0.5 ]])
```

y_train

131	75
96	47
181	86
19	98

153	76
-----	----

	..
--	----

67	48
----	----

192	8
-----	---

117	59
-----	----

47	47
----	----

172	10
-----	----

Name: Spending Score (1-100), Length: 140, dtype: int64y_test

18	29
----	----

170	13
-----	----

107	46
-----	----

98	42
----	----

177	69
-----	----

182	15
-----	----

5	76
---	----

146	36
-----	----

12	15
----	----

152	20
-----	----

61	55
----	----

125	77
-----	----

180	32
-----	----

154	16
-----	----

80	51
----	----

7	94
---	----

33	92
----	----

130	9
-----	---

37	73
----	----

74	47
----	----

183	88
-----	----

145	97
-----	----

45	65
----	----

159	73
-----	----

60	56
----	----

123	91
-----	----

179	90
-----	----

185	97
-----	----

122	58
-----	----

44	28
----	----

16	35
----	----

55	41
----	----

150	17
-----	----

111	54
-----	----

22	5
----	---

189	85
-----	----

129	75
4	40
83	44
106	50

134	5
66	50
26	32
113	46
168	27
63	59
8	3
75	54
118	43
143	87
71	42
124	29
184	39
97	50
149	90
24	14
30	4
160	35
40	35
56	50

Name: Spending Score (1-100), dtype: int64

Evaluation Metrics

```
from sklearn.metrics import r2_score
```

```
r2_score(y_pred, y_test)
```

0.9718954898467616

#MAE

```
from sklearn.metrics import mean_absolute_errorprint("MAE",mean_absolute_error(y_test,y_pred))
```

MAE 3.2810222489289385

#MSE

```
from sklearn.metrics import mean_squared_errorprint("MSE",mean_squared_error(y_test,y_pred))
```

MSE 17.504352105571893

#RMSE

```
print("RMSE",np.sqrt(mean_squared_error(y_test,y_pred)))
```

RMSE 4.183820276442559

#RMSLE

```
print("RMSE",np.log(np.sqrt(mean_squared_error(y_test,y_pred))))
```

RMSE 1.4312247708788837

RSquared

from sklearn.metrics import r2_score

```
r2 = r2_score(y_test,y_pred)print(r2)
```

```
0.9755948089587156
```

```
#Adjusted RSquared
```

```
n=40
```

```
k=2
```

```
adj_r2_score = 1 - ((1-r2)*(n-1)/(n-k-1))print(adj_r2_score)
```

```
0.9742756094429705
```