In [159…

```python
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.cluster import KMeans

import warnings
warnings.filterwarnings('ignore')
```

In [160…

```python
df = pd.read_csv('48_Pham Anh Vi_Ch3_K-means.csv')
df = df.drop(columns={'Unnamed: 0'})
df
```

Out[160]:

	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

Data Exploration

In [161…

```python
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 200 entries, 0 to 199
Data columns (total 5 columns):
 #   Column                  Non-Null Count  Dtype 
---  ------                  --------------  ----- 
 0   CustomerID              200 non-null    int64 
 1   Gender                  200 non-null    object
 2   Age                     200 non-null    int64 
 3   Annual Income (k$)      200 non-null    int64 
 4   Spending Score (1-100)  200 non-null    int64 
dtypes: int64(4), object(1)
memory usage: 7.9+ KB
```

In [162…

```python
df.describe()
```

Out[162]:

	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

In [163...

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

Out[163]:

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

In [164...

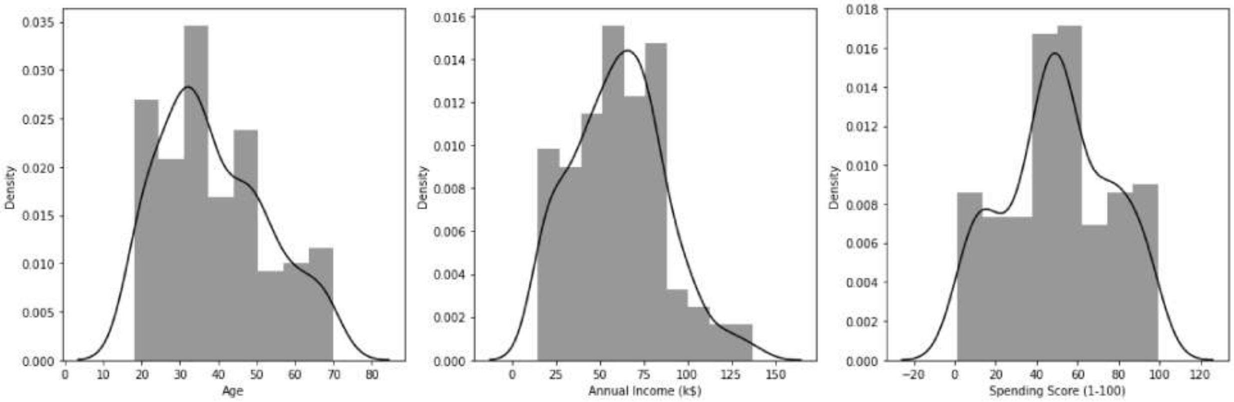
```
df.duplicated().sum()
```

Out[164]:

```
0
```

In [165...

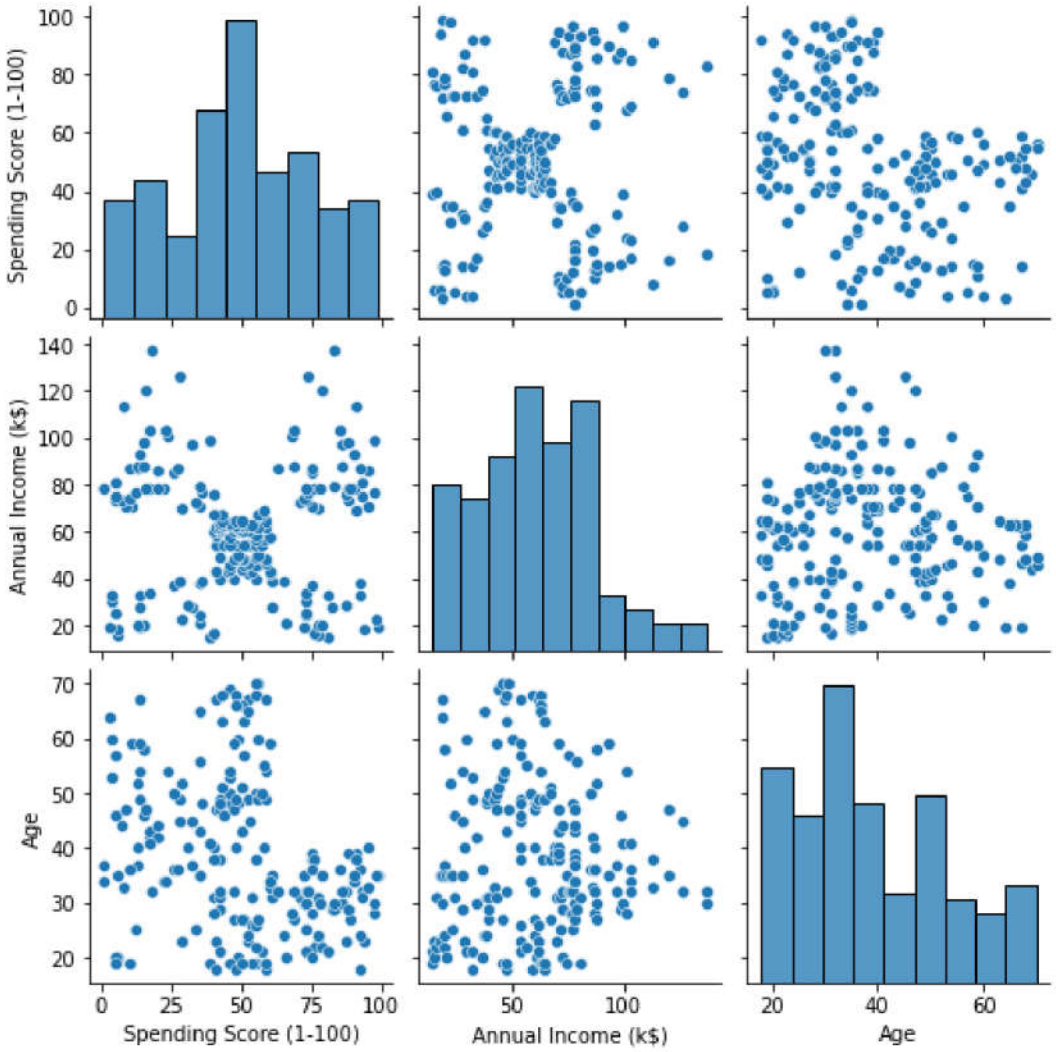
```
#Data distribution
plt.figure(figsize=(15,5))
for ind, col in enumerate(df.columns[2:]):
    plt.subplot(1,3, ind+1)
    sns.distplot(df[col], color='black')
plt.tight_layout()
plt.show()
```



In [166...

```
plt.figure(figsize=(12,10))
sns.pairplot(df,vars = ['Spending Score (1-100)', 'Annual Income (k$)', 'Age'])
plt.show()
```

```
<Figure size 864x720 with 0 Axes>
```

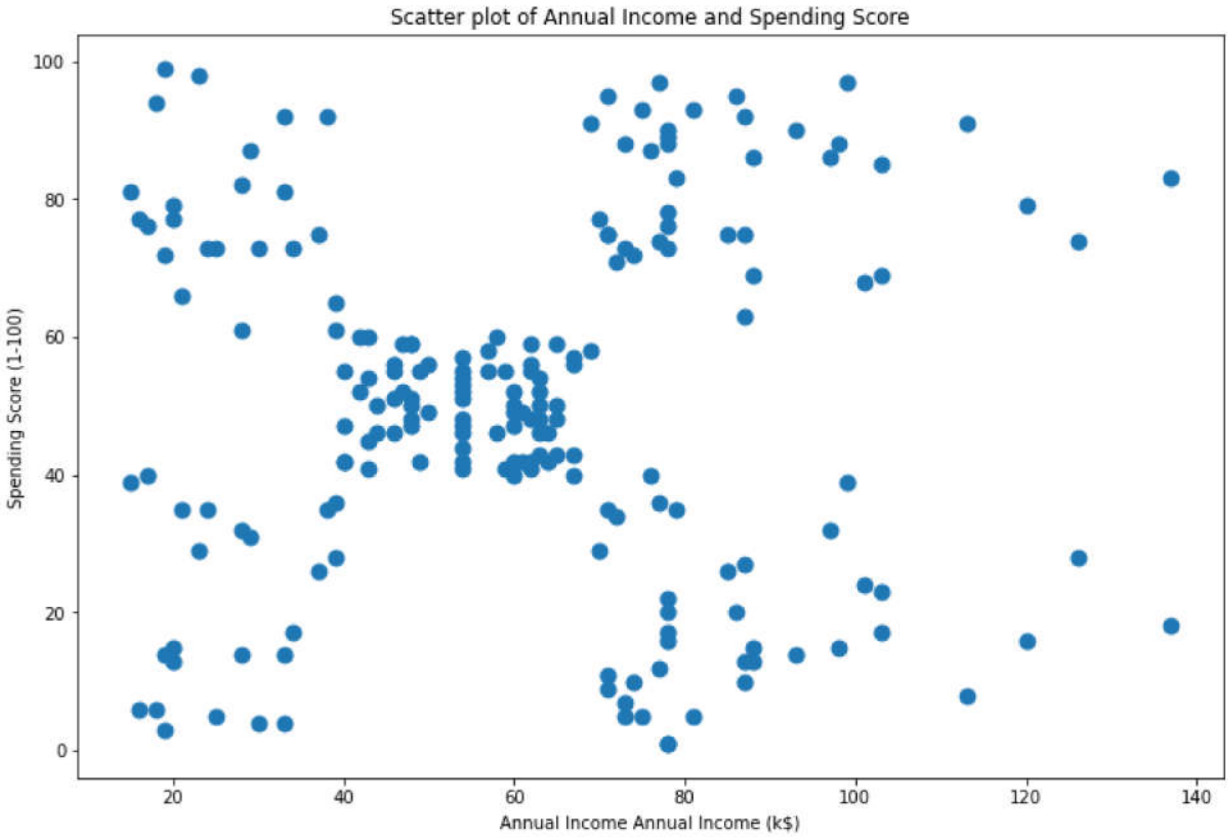


K-means Model: Annual Income and Spending Score

Plotting data

In [176…

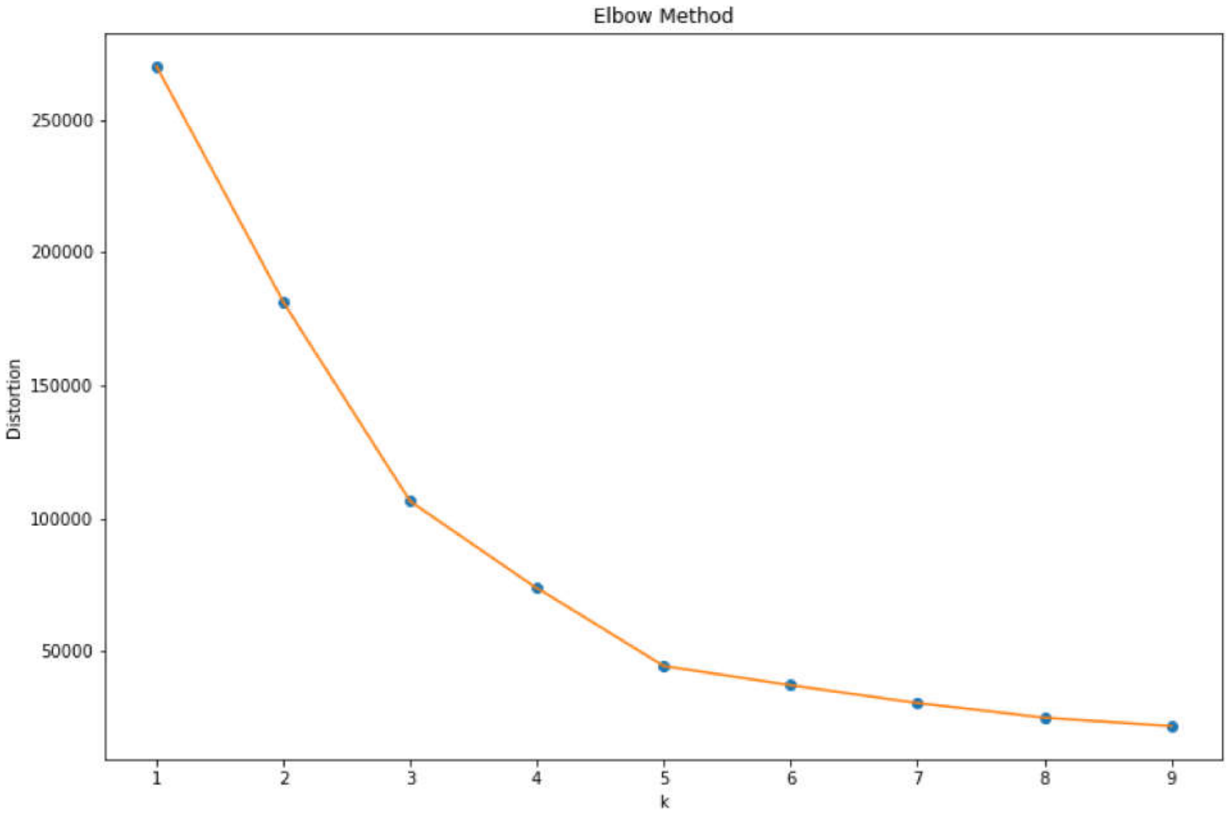
```
plt.figure(figsize =(12,8))
plt.title('Scatter plot of Annual Income and Spending Score')
plt.xlabel('Annual Income Annual Income (k$)')
plt.ylabel('Spending Score (1-100)')
plt.scatter(x = 'Annual Income (k$)', y = 'Spending Score (1-100)', data = df, s=80)
plt.show()
```



Choosing K

In [174…

```
# Get inertia with 10 K
X = df.loc[:,['Annual Income (k$)' , 'Spending Score (1-100)']].values
K = range(1,10)
distortions = []
for k in K:
    model = KMeans(n_clusters=k, init='k-means++', n_init=15, max_iter=350)
    model.fit(X)
    distortions.append(model.inertia_)

# Visualize result
plt.figure(figsize=(12,8))
plt.plot(K, distortions, 'o')
plt.plot(K, distortions, '-')
plt.xlabel('k')
plt.ylabel('Distortion')
plt.title('Elbow Method')
plt.show()
```



Building model with K = 5

In [169…

```
X = df.loc[:,['Annual Income (k$)' , 'Spending Score (1-100)']].values
# Init model with k=5
#                  k-means++: init centroids on data to boost speed
#                  n-init=15: 15 times of seeding centroids
#                  max_iter=350: looping 350 times for each seed
model = KMeans(n_clusters = 5, init='k-means++', n_init = 15, max_iter=350)
model.fit(X)

# clustering data
labels = model.labels_

# getting centroids coordinates (matrix 5,2)
centroids = model.cluster_centers_
```

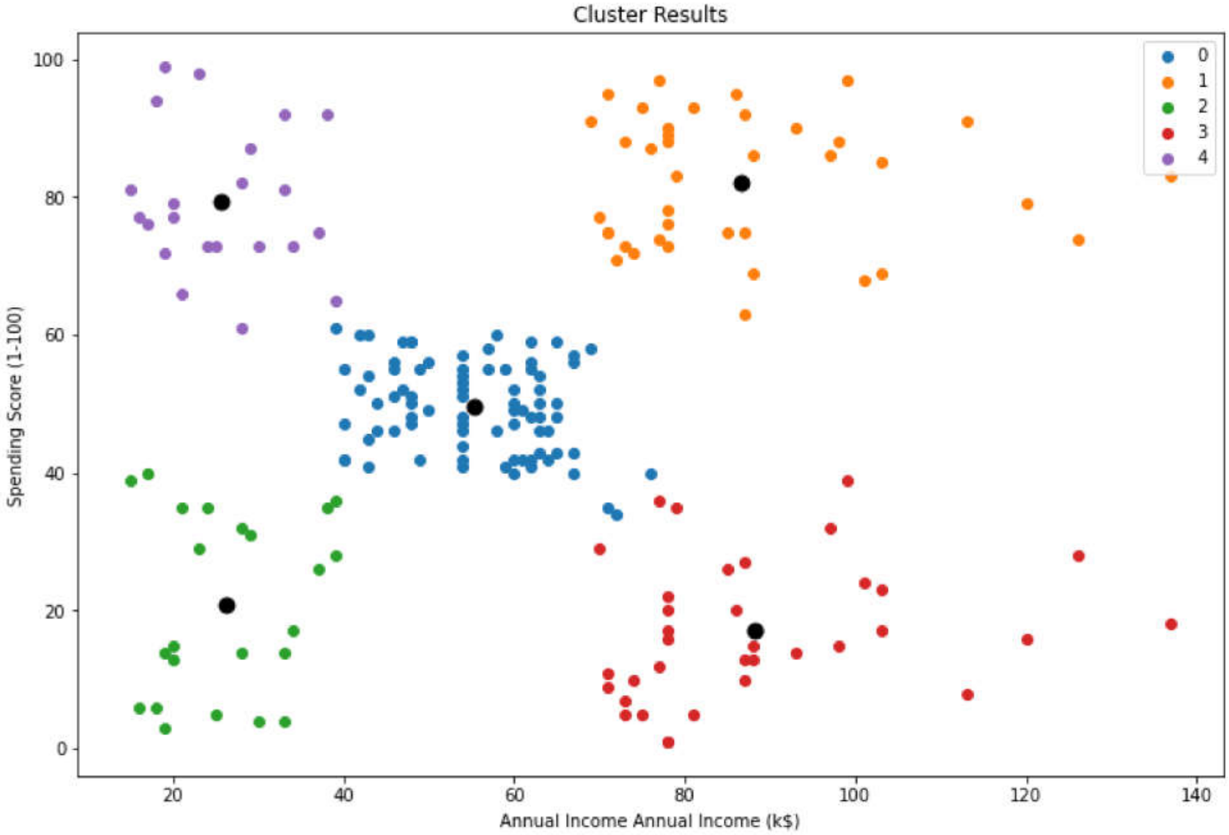
In [170…

```
# add labels for records
df['labels'] = labels
```

In [171…

```
# print SSE
print(f'Sum of Squared Error: {model.inertia_}')

# VISUALIZATION
plt.figure(figsize=(12,8))
#unique labels
u_labels = np.unique(labels)

#visualizing labeled data
for i in u_labels:
    df_filtered = df[df['labels'] == i]
    col_annual = df_filtered['Annual Income (k$)']
    col_spending = df_filtered['Spending Score (1-100)']
    plt.scatter(col_annual, col_spending , label = i)

# visualizing cluster
plt.scatter(centroids[:,0] , centroids[:,1] , s = 80, color = 'k')

# title
plt.title('Cluster Results')
plt.xlabel('Annual Income Annual Income (k$)')
plt.ylabel('Spending Score (1-100)')
plt.legend()
plt.show()
```

```
Sum of Squared Error: 44448.45544793371
```


Cluster Results
Spending Score (1-100)
Annual Income Annual Income (k$)
● 0
● 1
● 2
● 3
● 4