- You have the flexibility to choose any clustering algorithm and any number of clusters in between(2 and 10)

In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import StandardScaler
from sklearn.cluster import KMeans
from sklearn.metrics import silhouette_score
```

In [2]:
```
df = pd.read_csv("C:\\Users\\ppp\\Downloads\\Customers.csv")
df1=pd.read_csv("C:\\Users\\ppp\\Downloads\\Transactions.csv")
```

In [3]:
```
df
```

Out[3]:

	CustomerID	CustomerName	Region	SignupDate
0	C0001	Lawrence Carroll	South America	2022-07-10
1	C0002	Elizabeth Lutz	Asia	2022-02-13
2	C0003	Michael Rivera	South America	2024-03-07
3	C0004	Kathleen Rodriguez	South America	2022-10-09
4	C0005	Laura Weber	Asia	2022-08-15
...	...	...	...	...
195	C0196	Laura Watts	Europe	2022-06-07
196	C0197	Christina Harvey	Europe	2023-03-21
197	C0198	Rebecca Ray	Europe	2022-02-27
198	C0199	Andrea Jenkins	Europe	2022-12-03
199	C0200	Kelly Cross	Asia	2023-06-11

200 rows × 4 columns

In [4]:
```
df1
```

Out[4]:

	TransactionID	CustomerID	ProductID	TransactionDate	Quantity	TotalValue	Price
0	T00001	C0199	P067	2024-08-25 12:38:23	1	300.68	300.68
1	T00112	C0146	P067	2024-05-27 22:23:54	1	300.68	300.68
2	T00166	C0127	P067	2024-04-25 07:38:55	1	300.68	300.68
3	T00272	C0087	P067	2024-03-26 22:55:37	2	601.36	300.68
4	T00363	C0070	P067	2024-03-21 15:10:10	3	902.04	300.68
...	...	...	...	...	...	...	...
995	T00496	C0118	P037	2024-10-24 08:30:27	1	459.86	459.86
996	T00759	C0059	P037	2024-06-04 02:15:24	3	1379.58	459.86
997	T00922	C0018	P037	2024-04-05 13:05:32	4	1839.44	459.86
998	T00959	C0115	P037	2024-09-29 10:16:02	2	919.72	459.86
999	T00992	C0024	P037	2024-04-21 10:52:24	1	459.86	459.86

1000 rows × 7 columns

In [6]:
```
merged_data = df1.merge(df, on='CustomerID')
```

In [7]:
```
merged_data
```

Out[7]:

	TransactionID	CustomerID	ProductID	TransactionDate	Quantity	TotalValue	Price	CustomerName	Region	SignupDate
0	T00001	C0199	P067	2024-08-25 12:38:23	1	300.68	300.68	Andrea Jenkins	Europe	2022-12-03
1	T00761	C0199	P022	2024-10-01 05:57:09	4	550.16	137.54	Andrea Jenkins	Europe	2022-12-03
2	T00626	C0199	P079	2024-08-17 12:06:08	2	834.74	417.37	Andrea Jenkins	Europe	2022-12-03
3	T00963	C0199	P008	2024-10-26 00:01:58	2	293.70	146.85	Andrea Jenkins	Europe	2022-12-03
4	T00112	C0146	P067	2024-05-27 22:23:54	1	300.68	300.68	Brittany Harvey	Asia	2024-09-04
...	...	...	...	...	...	...	...	...	...	...
995	T00774	C0095	P056	2024-01-07 14:19:49	2	32.16	16.08	William Walker	South America	2023-03-04
996	T00823	C0095	P079	2024-09-30 10:45:06	3	1252.11	417.37	William Walker	South America	2023-03-04
997	T00369	C0151	P082	2024-12-24 11:40:24	4	223.96	55.99	Amber Gonzalez	South America	2024-11-22
998	T00809	C0078	P075	2024-12-09 11:44:44	2	995.52	497.76	Julia Palmer	Asia	2024-11-13
999	T00527	C0110	P028	2024-01-02 19:11:34	4	942.32	235.58	Elizabeth Wells	Asia	2024-09-21

1000 rows × 10 columns

In [8]:
```
customer_profiles = merged_data.groupby('CustomerID').agg({
    'TotalValue': 'sum',
    'TransactionID': 'count',
    'Quantity': 'sum'
}).reset_index()
```

In [9]:
```
customer_profiles
```

Out[9]:

	CustomerID	TotalValue	TransactionID	Quantity
0	C0001	3354.52	5	12
1	C0002	1862.74	4	10
2	C0003	2725.38	4	14
3	C0004	5354.88	8	23
4	C0005	2034.24	3	7
...	...	...	...	...
194	C0196	4982.88	4	12
195	C0197	1928.65	3	9
196	C0198	931.83	2	3
197	C0199	1979.28	4	9
198	C0200	4758.60	5	16

199 rows × 4 columns

Merge with customer profile data

In [11]:
```
customer_profiles = customer_profiles.merge(df[['CustomerID', 'Region']], on='CustomerID')
```

In [12]:
```
customer_profiles
```

Out[12]:

	CustomerID	TotalValue	TransactionID	Quantity	Region
0	C0001	3354.52	5	12	South America
1	C0002	1862.74	4	10	Asia
2	C0003	2725.38	4	14	South America
3	C0004	5354.88	8	23	South America
4	C0005	2034.24	3	7	Asia
...	...	...	...	...	...
194	C0196	4982.88	4	12	Europe
195	C0197	1928.65	3	9	Europe
196	C0198	931.83	2	3	Europe
197	C0199	1979.28	4	9	Europe
198	C0200	4758.60	5	16	Asia

199 rows × 5 columns

Normalize features

In [17]:
```
scaler = StandardScaler()
normalized_features = scaler.fit_transform(customer_profiles[['TotalValue', 'TransactionID', 'Quantity']])
```

In [18]:
```
normalized_features
```

Out[18]:
```
array([[-0.06170143, -0.01145819, -0.12203296],
       [-0.87774353, -0.46749414, -0.44800021],
       [-0.40585722, -0.46749414,  0.20393428],
       [ 1.03254704,  1.35664965,  1.67078689],
       [-0.78392861, -0.92353008, -0.93695108],
       [ 0.41587942, -0.46749414, -0.12203296],
       [-0.48548229, -0.92353008, -0.77396745],
       [ 0.43997044,  2.26872154,  1.18183602],
       [-1.40630171, -0.92353008, -1.58888557],
       [-0.9571662 , -0.46749414, -0.12203296],
       [ 0.14369581, -0.01145819,  0.04095066],
       [ 0.96492372,  0.9006137 ,  1.0188524 ],
       [ 1.38575064,  0.9006137 ,  0.85586877],
       [-1.72239508, -1.83560198, -1.75186919],
       [-1.26353893, -1.37956603, -1.42590195],
       [ 0.22269727, -0.01145819, -0.44800021],
       [ 0.70375173,  1.35664965,  1.34481964],
       [ 0.71908486, -0.01145819,  0.85586877],
       [-0.70101045,  0.44457776, -0.28501659],
       [-1.39212827, -1.83560198, -1.58888557],
       [ 1.0681256 ,  1.35664965,  0.69288515],
       [ 0.64973294,  0.44457776,  0.3669179 ],
       [ 0.92520418,  0.44457776,  0.20393428],
       [ 0.08736309,  0.9006137 ,  0.20393428],
       [-1.02704328, -0.46749414, -0.77396745],
       [ 0.04471149, -0.46749414, -0.12203296],
       [-0.49471609, -0.46749414, -0.12203296],
       [ 1.83377022,  1.35664965,  1.83377051],
       [-0.9197934 , -0.46749414, -0.44800021],
       [-0.50196965, -0.01145819,  0.04095066],
       [-0.79971578, -0.46749414, -0.44800021],
       [-1.52856197, -0.92353008, -1.26291832],
       [-1.82415282, -1.83560198, -1.75186919],
       [-0.21559072,  0.44457776,  0.69288515],
       [-0.48122096, -0.46749414, -0.44800021],
       [-0.8694178 , -0.92353008, -0.77396745],
       [ 0.42966447, -0.01145819,  0.20393428],
       [-0.42146387, -0.01145819,  0.04095066],
       [ 0.42246014,  0.44457776,  0.85586877],
       [ 0.27465378, -0.92353008, -0.44800021],
       [ 1.46737783,  0.9006137 ,  1.67078689],
       [-0.58248637, -0.92353008, -1.0999347 ],
       [-1.27784912, -0.92353008, -1.0999347 ],
       [-0.1297569 , -0.92353008, -0.93695108],
       [ 1.39736947,  0.9006137 ,  1.67078689],
       [ 1.18185773,  0.9006137 ,  1.0188524 ],
       [-0.32645096,  0.9006137 ,  0.04095066],
       [ 0.2098531 , -0.01145819, -0.12203296],
       [-0.63008308,  1.35664965,  0.69288515],
       [-0.21798122, -0.92353008, -0.77396745],
       [ 1.22110135,  0.9006137 ,  0.52990153],
       [-0.53570473, -0.46749414, -0.44800021],
       [ 1.01153031,  0.44457776,  0.85586877],
       [ 2.50159022,  1.35664965,  1.83377051],
       [-0.33348571, -0.01145819, -0.12203296],
       [-0.15556011, -0.01145819, -0.12203296],
       [ 0.58481739,  0.44457776,  0.52990153],
       [-1.67990212, -1.83560198, -1.91485281],
       [ 1.97255613,  1.35664965,  1.34481964],
       [-1.85165727, -1.83560198, -1.75186919],
       [-0.72702699, -0.92353008, -1.0999347 ],
       [-0.99983968, -0.92353008, -0.77396745],
       [-1.14281581, -1.37956603, -1.26291832],
       [ 0.31314798, -0.01145819,  0.04095066],
       [ 2.29553108,  2.26872154,  2.32272138],
       [ 0.18159375, -0.92353008, -0.61098383],
       [ 0.34108459,  0.44457776,  0.20393428],
       [ 1.35832277,  1.35664965,  1.50780326],
       [-0.3219927 , -0.01145819, -0.44800021],
       [-0.18698674, -0.46749414, -0.12203296],
       [-1.13042021, -0.92353008, -0.93695108],
       [-0.25585728, -0.01145819,  0.04095066],
       [-0.76954183, -0.92353008, -0.44800021],
       [-0.22542624, -0.92353008, -0.77396745],
       [ 1.302827  ,  1.8126856 ,  2.485705  ],
       [-0.62046637, -0.01145819, -0.28501659],
       [-1.43868564, -0.92353008, -0.93695108],
       [-1.35213522, -1.83560198, -1.75186919],
       [ 0.42900257, -0.46749414, -0.12203296],
       [-1.34557091, -1.83560198, -1.58888557],
       [ 0.04111754,  0.44457776,  0.20393428],
       [ 2.24586661,  0.9006137 ,  1.67078689],
       [-1.54508215, -0.92353008, -1.42590195],
       [ 0.53268583,  1.8126856 ,  1.18183602],
       [-0.47535685, -0.92353008, -0.93695108],
       [-0.38982937, -0.01145819,  0.04095066],
       [ 1.71597369,  0.9006137 ,  1.50780326],
       [-0.72860243, -0.01145819, -0.44800021],
       [-0.4983921 , -1.37956603, -0.93695108],
       [ 0.36696985,  0.9006137 ,  0.52990153],
       [-0.18032944,  0.44457776,  1.18183602],
       [-0.24690794, -0.46749414, -0.44800021],
       [ 0.99978567,  1.8126856 ,  1.0188524 ],
       [-1.25834765, -0.46749414, -0.61098383],
       [-1.19418153, -1.37956603, -1.26291832],
       [ 1.42533343, -0.01145819,  0.52990153],
       [-1.82147239, -1.83560198, -1.91485281],
       [-0.16919199,  1.35664965,  0.20393428],
       [ 1.77696159,  1.35664965,  1.34481964],
       [ 0.84030578,  0.44457776,  0.20393428],
       [ 1.13982427,  1.35664965,  1.18183602],
       [ 1.45784864,  1.35664965,  1.34481964],
       [-0.549632  , -0.01145819, -0.93695108],
       [ 1.70222693,  1.35664965,  1.34481964],
       [ 0.73308872,  0.44457776,  0.52990153],
       [-0.28883747, -0.01145819,  0.04095066],
       [ 0.08566731, -0.01145819, -0.12203296],
       [ 0.75556601,  0.9006137 ,  0.52990153],
       [ 1.10495684,  2.72475749,  3.13763949],
       [-1.38123699, -1.83560198, -1.42590195],
       [-0.81741753, -0.01145819,  0.52990153],
       [-0.82480785, -0.92353008, -0.77396745],
       [ 0.73563239,  1.35664965,  1.50780326],
       [ 1.26533386, -0.01145819,  0.85586877],
       [-0.18059201, -0.92353008, -0.77396745],
       [-0.38764126,  0.44457776, -0.28501659],
       [ 0.30685718, -0.46749414, -0.12203296],
       [-0.01780261,  0.44457776, -0.44800021],
       [-1.24486894, -0.01145819, -1.0999347 ],
       [-0.54554572, -0.92353008, -0.61098383],
       [-1.36362276, -0.46749414, -0.77396745],
       [ 0.87810526,  0.9006137 ,  0.69288515],
       [-1.13084142, -1.37956603, -1.42590195],
       [ 0.43598809,  0.9006137 ,  1.0188524 ],
       [-0.26987756, -0.46749414, -0.44800021],
       [ 0.60077413,  0.44457776,  0.04095066],
       [-0.12824164,  0.44457776, -0.28501659],
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       [-0.61688335, -0.92353008, -0.61098383],
       [-1.5677509 , -1.83560198, -1.75186919],
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       [-0.31890748, -0.46749414, -0.28501659],
       [-0.43107511, -0.01145819,  0.52990153],
       [-0.18146725, -0.46749414, -0.44800021],
       [ 0.454948  ,  0.44457776,  1.34481964],
       [-0.07371958, -0.01145819, -0.28501659],
       [ 1.17224101, -0.01145819,  0.69288515],
       [ 0.12927621,  1.35664965,  0.04095066],
       [-0.86384908, -1.37956603, -1.26291832],
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       [-0.67189773, -0.46749414, -0.28501659],
       [ 1.40985807,  0.9006137 ,  1.34481964],
       [-1.18301673, -1.37956603, -0.77396745],
       [ 1.2603231 ,  1.35664965,  1.18183602],
       [-0.49041646, -0.46749414, -0.77396745],
       [-0.28383765,  1.8126856 ,  0.20393428],
       [ 1.08884146, -0.01145819,  0.85586877],
       [ 0.51281786, -0.01145819,  0.3669179 ],
       [-1.57924938, -1.83560198, -1.75186919],
       [-1.77419842, -1.83560198, -1.42590195],
       [-0.04455764, -0.01145819, -0.44800021],
       [ 0.69881209,  0.44457776,  0.69288515],
       [ 0.1292598 ,  0.44457776, -0.28501659],
       [ 1.04510128,  0.9006137 ,  0.69288515],
       [ 2.27953058,  2.72475749,  2.485705  ],
       [-0.87043527, -0.01145819, -0.44800021],
       [ 0.1363219 , -0.46749414, -0.61098383],
       [-0.76304864, -0.92353008, -0.77396745],
       [-0.29560418, -0.01145819,  0.20393428],
       [-0.17804834,  1.35664965,  0.20393428],
       [ 0.73023872,  1.35664965,  1.18183602],
       [ 1.26251668,  0.44457776,  1.0188524 ],
       [-0.20766431, -0.01145819, -0.44800021],
       [ 1.77279325,  1.8126856 ,  2.81167225],
       [-0.58092188, -0.46749414, -0.28501659],
       [-0.63832129, -0.92353008, -0.77396745],
       [ 0.86786493, -0.46749414, -0.12203296],
       [ 0.58313255,  0.44457776,  1.18183602],
       [ 0.80107856, -0.01145819,  0.3669179 ],
       [ 0.91792873, -0.01145819,  0.3669179 ],
       [-0.69232368,  0.44457776, -0.44800021],
       [ 1.28043724,  1.35664965,  1.18183602],
       [-0.31473914, -0.01145819, -0.12203296],
       [ 1.50060964,  2.26872154,  2.15973776],
       [-0.6214182 , -0.92353008, -0.12203296],
       [-0.52377957, -0.46749414, -0.61098383],
       [-0.4149105 , -0.46749414, -0.61098383],
       [ 0.10148183,  0.44457776,  0.20393428],
       [-0.06548685,  0.44457776,  0.3669179 ],
       [ 0.82789923, -0.01145819,  0.69288515],
       [ 0.20945925, -0.01145819, -0.12203296],
       [-0.04055341,  0.9006137 , -0.28501659],
       [-0.02351903, -0.92353008, -0.61098383],
       [-0.93304784, -0.92353008, -0.93695108],
       [ 0.62641323, -0.01145819, -0.28501659],
       [ 1.99336499,  1.35664965,  1.34481964],
       [-0.45080633, -0.01145819, -0.28501659],
       [-0.2649215 , -0.01145819,  0.20393428],
       [-0.25674347, -0.01145819, -0.28501659],
       [-0.76287906, -0.46749414, -0.77396745],
       [-0.25055113, -0.46749414, -0.28501659],
       [ 0.21982538,  0.9006137 ,  0.20393428],
       [ 0.31123339,  0.44457776,  0.69288515],
       [ 0.82905346, -0.46749414, -0.12203296],
       [-0.84168906, -0.92353008, -0.61098383],
       [-1.38697529, -1.37956603, -1.58888557],
       [-0.81399315, -0.46749414, -0.61098383],
       [ 0.70636652, -0.01145819,  0.52990153]])
```

Determine the optimal number of clusters using the Elbow Method

In [19]:
```
inertia = []
silhouette_scores = []
K = range(2, 11)
for k in K:
    kmeans = KMeans(n_clusters=k, random_state=42)
    kmeans.fit(normalized_features)
    inertia.append(kmeans.inertia_)
    silhouette_scores.append(silhouette_score(normalized_features, kmeans.labels_))
```

```
C:\Users\ppp\AppData\Roaming\Python\Python311\site-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(
C:\Users\ppp\AppData\Roaming\Python\Python311\site-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(
C:\Users\ppp\AppData\Roaming\Python\Python311\site-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(
C:\Users\ppp\AppData\Roaming\Python\Python311\site-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(
C:\Users\ppp\AppData\Roaming\Python\Python311\site-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(
C:\Users\ppp\AppData\Roaming\Python\Python311\site-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(
C:\Users\ppp\AppData\Roaming\Python\Python311\site-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(
C:\Users\ppp\AppData\Roaming\Python\Python311\site-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(
C:\Users\ppp\AppData\Roaming\Python\Python311\site-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(
```

In [20]:
```
plt.figure(figsize=(12, 5))
```

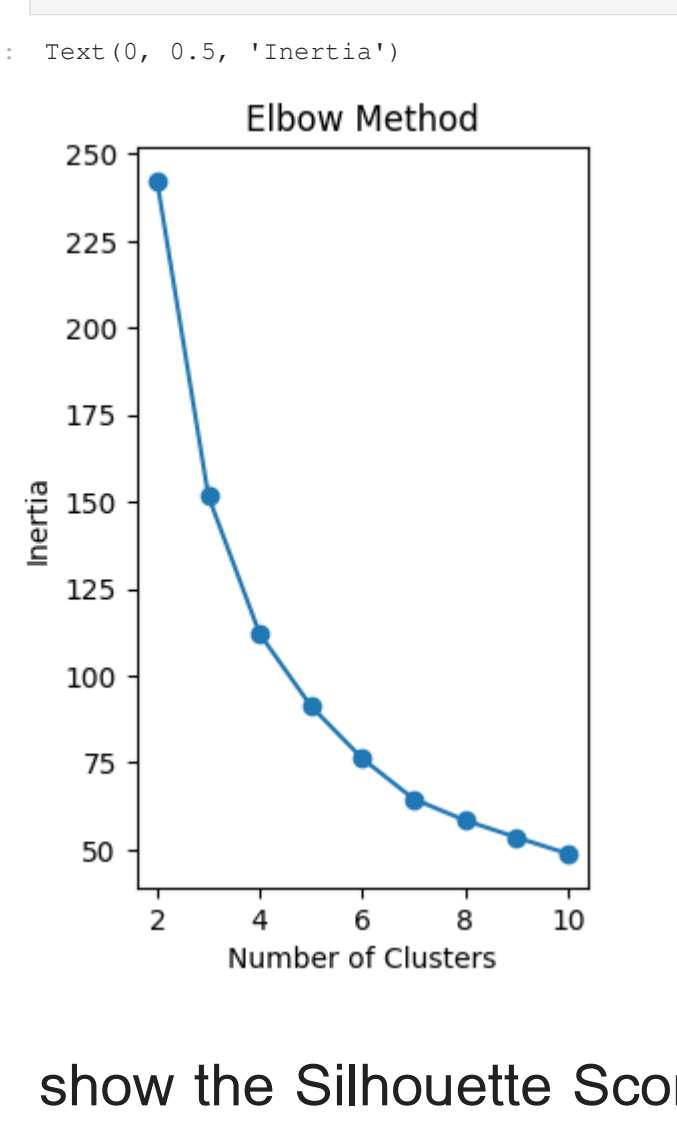
Out[20]: <Figure size 1200x500 with 0 Axes>

<Figure size 1200x500 with 0 Axes>

Elbow Method

In [21]:
```
plt.subplot(1, 2, 1)
plt.plot(K, inertia, marker='o')
plt.title('Elbow Method')
plt.xlabel('Number of Clusters')
plt.ylabel('Inertia')
```

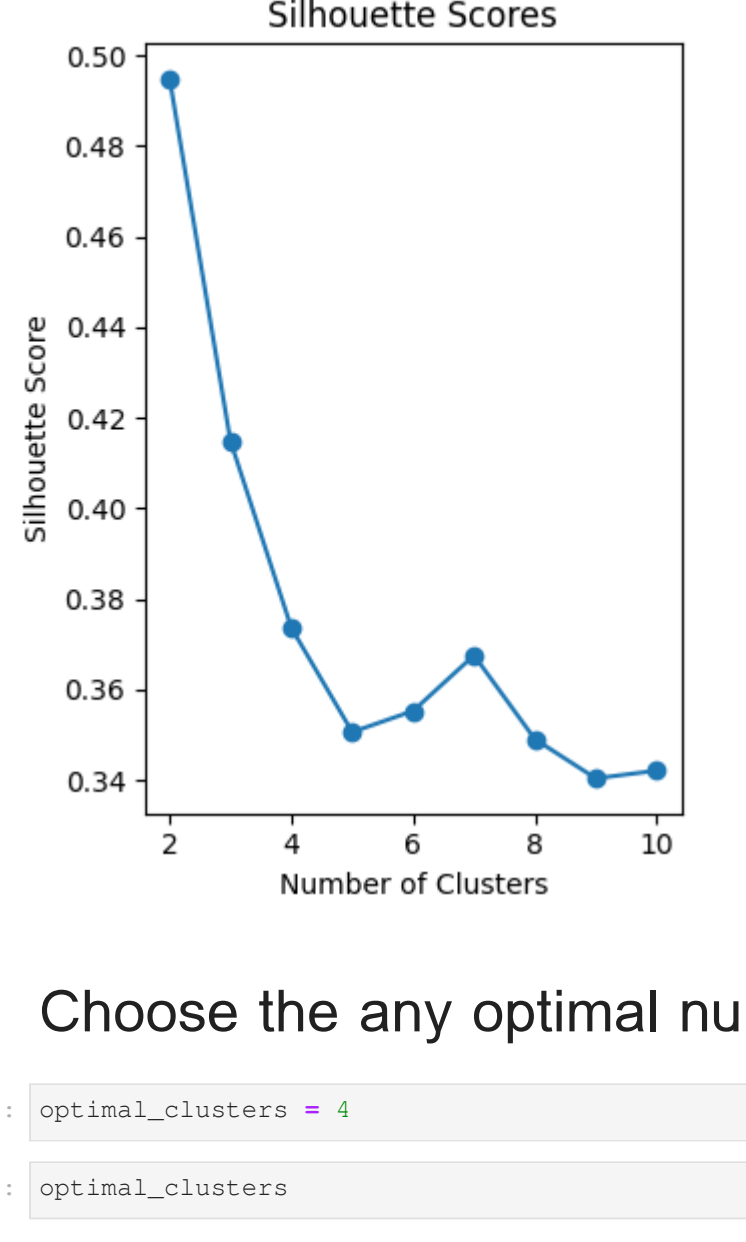
Out[21]: Text(0, 0.5, 'Inertia')



show the Silhouette Scores

In [23]:
```
plt.subplot(1, 2, 2)
plt.plot(K, silhouette_scores, marker='o')
plt.title('Silhouette Scores')
plt.xlabel('Number of Clusters')
plt.ylabel('Silhouette Score')

plt.tight_layout()
plt.show()
```



Choose the any optimal number of clusters

In [24]:
```
optimal_clusters = 4
```

In [25]:
```
optimal_clusters
```

Out[25]: 4

Fit KMeans with the optimal number of clusters

In [26]:
```
kmeans = KMeans(n_clusters=optimal_clusters, random_state=42)
customer_profiles['Cluster'] = kmeans.fit_predict(normalized_features)
```

```
C:\Users\ppp\AppData\Roaming\Python\Python311\site-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(
```

Analyze the clusters

In [27]:
```
cluster_summary = customer_profiles.groupby('Cluster').agg({
    'TotalValue': 'mean',
    'TransactionID': 'mean',
    'Quantity': 'mean',
    'CustomerID': 'count'
}).reset_index()

cluster_summary.columns = ['Cluster', 'AverageTotalValue', 'AverageTransactions', 'AverageQuantity', 'CustomerCount']
print(cluster_summary)
```

```
   Cluster  AverageTotalValue  AverageTransactions  AverageQuantity  \
0        0        4477.572041             6.306122        16.102041
1        1        2982.406711             4.394737        10.868421
2        2        1273.368182             2.363636         5.272727
3        3        6263.447333             8.433333        23.000000

   CustomerCount
0             49
1             76
2             44
3             30
```

Visualize the clusters

In [28]:
```
plt.figure(figsize=(10, 6))
sns.scatterplot(data=customer_profiles, x='TotalValue', y='TransactionID', hue='Cluster', palette='viridis', s=100)
plt.title('Customer Segmentation Clusters')
plt.xlabel('Total Value Spent')
plt.ylabel('Total Transactions')
plt.legend(title='Cluster')
plt.show()
```