# Implement K-Means clustering/ hierarchical clustering on sales_data_sample.csv dataset. Determine thenumber of clusters using the elbow method.

In [27]:
```
import pandas as pd
import numpy as np
```

In [28]:
```
df = pd.read_csv('./sales_data_sample.csv', encoding='unicode_escape')
```

In [29]:
```
df.head()
```

Out[29]:

| | ORDERNUMBER | QUANTITYORDERED | PRICEEACH | ORDERLINENUMBER | SALES | ORDERDATE | STATUS |
|---|---|---|---|---|---|---|---|
| **0** | 10107 | 30 | 95.70 | 2 | 2871.00 | 2/24/2003 0:00 | Shipped |
| **1** | 10121 | 34 | 81.35 | 5 | 2765.90 | 5/7/2003 0:00 | Shipped |
| **2** | 10134 | 41 | 94.74 | 2 | 3884.34 | 7/1/2003 0:00 | Shipped |
| **3** | 10145 | 45 | 83.26 | 6 | 3746.70 | 8/25/2003 0:00 | Shipped |
| **4** | 10159 | 49 | 100.00 | 14 | 5205.27 | 10/10/2003 0:00 | Shipped |

5 rows × 25 columns

In [30]:
```
#Columns to Remove
to_drop = ['ADDRESSLINE1', 'ADDRESSLINE2', 'STATE', 'POSTALCODE', 'PHONE']
df = df.drop(to_drop, axis=1)
```

In [31]:
```
#Check for null values
df.isnull().sum()
```

Out[31]:
```
ORDERNUMBER            0
QUANTITYORDERED        0
PRICEEACH              0
ORDERLINENUMBER        0
SALES                  0
ORDERDATE              0
STATUS                 0
QTR_ID                 0
MONTH_ID               0
YEAR_ID                0
PRODUCTLINE            0
MSRP                   0
PRODUCTCODE            0
CUSTOMERNAME           0
CITY                   0
COUNTRY                0
TERRITORY           1074
CONTACTLASTNAME        0
CONTACTFIRSTNAME       0
DEALSIZE               0
dtype: int64
```

In [32]:
```
#But territory does not have significant impact on analysis, let it be
```

In [33]:
```
df.dtypes
```

Out[33]:
```
ORDERNUMBER            int64
QUANTITYORDERED        int64
PRICEEACH            float64
ORDERLINENUMBER        int64
SALES                float64
ORDERDATE             object
STATUS                object
QTR_ID                 int64
MONTH_ID               int64
YEAR_ID                int64
PRODUCTLINE           object
MSRP                   int64
PRODUCTCODE           object
CUSTOMERNAME          object
CITY                  object
COUNTRY               object
TERRITORY             object
CONTACTLASTNAME       object
CONTACTFIRSTNAME      object
DEALSIZE              object
dtype: object
```

In [34]:
```
#ORDERDATE Should be in date time
df['ORDERDATE'] = pd.to_datetime(df['ORDERDATE'])
```

In [35]:
```
#We need to create some features in order to create cluseters
#Recency: Number of days between customer's latest order and today's date
#Frequency : Number of purchases by the customers
#MonetaryValue : Revenue generated by the customers
import datetime as dt
snapshot_date = df['ORDERDATE'].max() + dt.timedelta(days = 1)
df_RFM = df.groupby(['CUSTOMERNAME']).agg({
    'ORDERDATE' : lambda x : (snapshot_date - x.max()).days,
    'ORDERNUMBER' : 'count',
    'SALES' : 'sum'
})

#Rename the columns
df_RFM.rename(columns = {
    'ORDERDATE' : 'Recency',
    'ORDERNUMBER' : 'Frequency',
    'SALES' : 'MonetaryValue'
}, inplace=True)
```

In [36]:
```
df_RFM.head()
```

Out[36]:

| | Recency | Frequency | MonetaryValue |
|---|---|---|---|
| **CUSTOMERNAME** | | | |
| **AV Stores, Co.** | 196 | 51 | 157807.81 |
| **Alpha Cognac** | 65 | 20 | 70488.44 |
| **Amica Models & Co.** | 265 | 26 | 94117.26 |
| **Anna's Decorations, Ltd** | 84 | 46 | 153996.13 |
| **Atelier graphique** | 188 | 7 | 24179.96 |

In [37]:
```
# Divide into segments
# We create 4 quartile ranges
df_RFM['M'] = pd.qcut(df_RFM['MonetaryValue'], q = 4, labels = range(1,5))
df_RFM['R'] = pd.qcut(df_RFM['Recency'], q = 4, labels = list(range(4,0,-1)))
df_RFM['F'] = pd.qcut(df_RFM['Frequency'], q = 4, labels = range(1,5))

df_RFM.head()
```

Out[37]:

| | Recency | Frequency | MonetaryValue | M | R | F |
|---|---|---|---|---|---|---|
| **CUSTOMERNAME** | | | | | | |
| **AV Stores, Co.** | 196 | 51 | 157807.81 | 4 | 2 | 4 |
| **Alpha Cognac** | 65 | 20 | 70488.44 | 2 | 4 | 2 |
| **Amica Models & Co.** | 265 | 26 | 94117.26 | 3 | 1 | 2 |
| **Anna's Decorations, Ltd** | 84 | 46 | 153996.13 | 4 | 3 | 4 |
| **Atelier graphique** | 188 | 7 | 24179.96 | 1 | 2 | 1 |

In [38]:
```python
#Create another column for RFM score
df_RFM['RFM_Score'] = df_RFM[['R', 'M', 'F']].sum(axis=1)
df_RFM.head()
```

Out[38]:

| CUSTOMERNAME | Recency | Frequency | MonetaryValue | M | R | F | RFM_Score |
|---|---|---|---|---|---|---|---|
| AV Stores, Co. | 196 | 51 | 157807.81 | 4 | 2 | 4 | 10 |
| Alpha Cognac | 65 | 20 | 70488.44 | 2 | 4 | 2 | 8 |
| Amica Models & Co. | 265 | 26 | 94117.26 | 3 | 1 | 2 | 6 |
| Anna's Decorations, Ltd | 84 | 46 | 153996.13 | 4 | 3 | 4 | 11 |
| Atelier graphique | 188 | 7 | 24179.96 | 1 | 2 | 1 | 4 |

# We create levels for our Customers

### RFM Score > 10 : High Value Customers

### RFM Score < 10 and RFM Score >= 6 : Mid Value Customers

### RFM Score < 6 : Low Value Customers

In [39]:
```python
def rfm_level(df):
    if bool(df['RFM_Score'] >= 10):
        return 'High Value Customer'

    elif bool(df['RFM_Score'] < 10) and bool(df['RFM_Score'] >= 6):
        return 'Mid Value Customer'
    else:
        return 'Low Value Customer'
df_RFM['RFM_Level'] = df_RFM.apply(rfm_level, axis = 1)
df_RFM.head()
```

Out[39]:

| CUSTOMERNAME | Recency | Frequency | MonetaryValue | M | R | F | RFM_Score | RFM_Level |
|---|---|---|---|---|---|---|---|---|
| AV Stores, Co. | 196 | 51 | 157807.81 | 4 | 2 | 4 | 10 | High Value Customer |
| Alpha Cognac | 65 | 20 | 70488.44 | 2 | 4 | 2 | 8 | Mid Value Customer |
| Amica Models & Co. | 265 | 26 | 94117.26 | 3 | 1 | 2 | 6 | Mid Value Customer |
| Anna's Decorations, Ltd | 84 | 46 | 153996.13 | 4 | 3 | 4 | 11 | High Value Customer |
| Atelier graphique | 188 | 7 | 24179.96 | 1 | 2 | 1 | 4 | Low Value Customer |

In [40]:
```python
# Time to perform KMeans
data = df_RFM[['Recency', 'Frequency', 'MonetaryValue']]
data.head()
```

Out[40]:

| CUSTOMERNAME | Recency | Frequency | MonetaryValue |
|---|---|---|---|
| AV Stores, Co. | 196 | 51 | 157807.81 |
| Alpha Cognac | 65 | 20 | 70488.44 |
| Amica Models & Co. | 265 | 26 | 94117.26 |
| Anna's Decorations, Ltd | 84 | 46 | 153996.13 |
| Atelier graphique | 188 | 7 | 24179.96 |

In [41]:
```python
# Our data is skewed we must remove it by performing log transformation
data_log = np.log(data)
data_log.head()
```

Out[41]:

| CUSTOMERNAME | Recency | Frequency | MonetaryValue |
|---|---|---|---|
| AV Stores, Co. | 5.278115 | 3.931826 | 11.969133 |
| Alpha Cognac | 4.174387 | 2.995732 | 11.163204 |
| Amica Models & Co. | 5.579730 | 3.258097 | 11.452297 |
| Anna's Decorations, Ltd | 4.430817 | 3.828641 | 11.944683 |
| Atelier graphique | 5.236442 | 1.945910 | 10.093279 |

In [42]:
```python
#Standardization
from sklearn.preprocessing import StandardScaler
scaler = StandardScaler()
scaler.fit(data_log)
data_normalized = scaler.transform(data_log)
data_normalized = pd.DataFrame(data_normalized, index = data_log.index, columns=data_log.
data_normalized.describe().round(2)
```

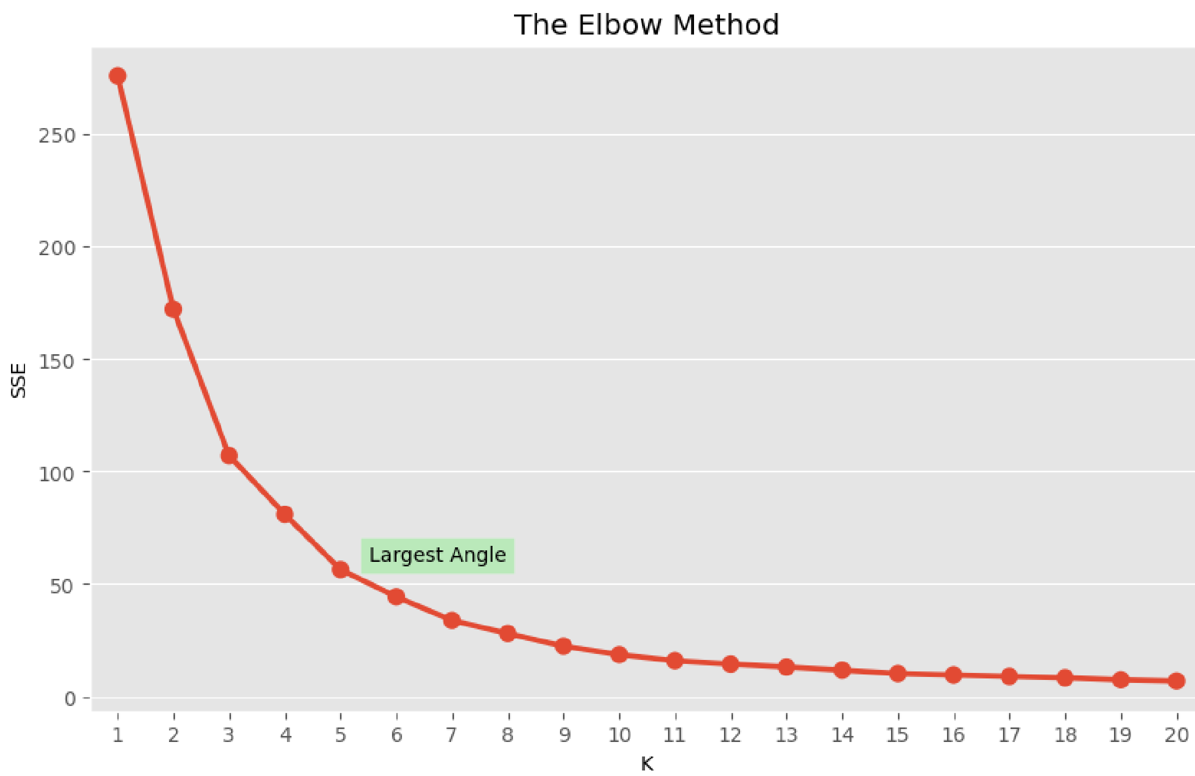
Out[42]:

| | Recency | Frequency | MonetaryValue |
|---|---|---|---|
| count | 92.00 | 92.00 | 92.00 |
| mean | 0.00 | -0.00 | 0.00 |
| std | 1.01 | 1.01 | 1.01 |
| min | -3.51 | -3.67 | -3.82 |
| 25% | -0.24 | -0.41 | -0.39 |
| 50% | 0.37 | 0.06 | -0.04 |
| 75% | 0.53 | 0.45 | 0.52 |
| max | 1.12 | 4.03 | 3.92 |

In [43]:
```python
#Fit KMeans and use elbow method to choose the number of clusters
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.cluster import KMeans

sse = {}

for k in range(1, 21):
    kmeans = KMeans(n_clusters = k, random_state = 1)
    kmeans.fit(data_normalized)
    sse[k] = kmeans.inertia_
```

```
of `n_init` explicitly to suppress the warning
  warnings.warn(
C:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarnin
g: KMeans is known to have a memory leak on Windows with MKL, when there are less chun
ks than available threads. You can avoid it by setting the environment variable OMP_NU
M_THREADS=1.
  warnings.warn(
C:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870: FutureWarni
ng: 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:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarnin
g: KMeans is known to have a memory leak on Windows with MKL, when there are less chun
ks than available threads. You can avoid it by setting the environment variable OMP_NU
M_THREADS=1.
  warnings.warn(
C:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870: FutureWarni
ng: 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
```

In [44]:
```
plt.figure(figsize=(10,6))
plt.title('The Elbow Method')

plt.xlabel('K')
plt.ylabel('SSE')
plt.style.use('ggplot')

sns.pointplot(x=list(sse.keys()), y = list(sse.values()))
plt.text(4.5, 60, "Largest Angle", bbox = dict(facecolor = 'lightgreen', alpha = 0.5))
plt.show()
```




In [45]:
```
# 5 number of clusters seems good
kmeans = KMeans(n_clusters=5, random_state=1)
kmeans.fit(data_normalized)
cluster_labels = kmeans.labels_

data_rfm = data.assign(Cluster = cluster_labels)
data_rfm.head()
```

```
C:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870: FutureWarnin
g: 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:\ProgramData\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1382: UserWarning:
KMeans is known to have a memory leak on Windows with MKL, when there are less chunks th
an available threads. You can avoid it by setting the environment variable OMP_NUM_THREA
DS=1.
  warnings.warn(
```

Out[45]:

| | Recency | Frequency | MonetaryValue | Cluster |
|---|---|---|---|---|
| **CUSTOMERNAME** | | | | |
| **AV Stores, Co.** | 196 | 51 | 157807.81 | 3 |
| **Alpha Cognac** | 65 | 20 | 70488.44 | 0 |
| **Amica Models & Co.** | 265 | 26 | 94117.26 | 0 |
| **Anna's Decorations, Ltd** | 84 | 46 | 153996.13 | 3 |
| **Atelier graphique** | 188 | 7 | 24179.96 | 2 |