In [1]:

```
import pandas as pd
import numpy as np
```

In [2]:

```
df = pd.read_csv('sales_data_sample.csv', encoding='unicode_escape')
```

In [3]:

```
df.head
```

Out[3]:

```
<bound method NDFrame.head of       ORDERNUMBER  QUANTITYORDERED  PRICEEACH  ORDERLIN
ENUMBER    SALES  \
0           10107               30      95.70                2  2871.00
1           10121               34      81.35                5  2765.90
2           10134               41      94.74                2  3884.34
3           10145               45      83.26                6  3746.70
4           10159               49     100.00               14  5205.27
...           ...              ...        ...              ...      ...
2818        10350               20     100.00               15  2244.40
2819        10373               29     100.00                1  3978.51
2820        10386               43     100.00                4  5417.57
2821        10397               34      62.24                1  2116.16
2822        10414               47      65.52                9  3079.44

            ORDERDATE    STATUS  QTR_ID  MONTH_ID  YEAR_ID  ...  \
0      2/24/2003 0:00   Shipped       1         2     2003  ...
1       5/7/2003 0:00   Shipped       2         5     2003  ...
2       7/1/2003 0:00   Shipped       3         7     2003  ...
3      8/25/2003 0:00   Shipped       3         8     2003  ...
4     10/10/2003 0:00   Shipped       4        10     2003  ...
...               ...       ...     ...       ...      ...  ...
2818   12/2/2004 0:00   Shipped       4        12     2004  ...
2819   1/31/2005 0:00   Shipped       1         1     2005  ...
2820    3/1/2005 0:00  Resolved       1         3     2005  ...
2821   3/28/2005 0:00   Shipped       1         3     2005  ...
2822    5/6/2005 0:00   On Hold       2         5     2005  ...

                       ADDRESSLINE1  ADDRESSLINE2           CITY  STATE  \
0           897 Long Airport Avenue           NaN            NYC     NY
1                59 rue de l'Abbaye           NaN          Reims    NaN
2     27 rue du Colonel Pierre Avia           NaN          Paris    NaN
3                78934 Hillside Dr.           NaN       Pasadena     CA
4                   7734 Strong St.           NaN  San Francisco     CA
...                             ...           ...            ...    ...
2818             C/ Moralzarzal, 86           NaN         Madrid    NaN
2819                    Torikatu 38           NaN           Oulu    NaN
2820             C/ Moralzarzal, 86           NaN         Madrid    NaN
2821          1 rue Alsace-Lorraine           NaN       Toulouse    NaN
2822             8616 Spinnaker Dr.           NaN         Boston     MA

     POSTALCODE  COUNTRY TERRITORY CONTACTLASTNAME CONTACTFIRSTNAME DEALSIZE
0         10022      USA       NaN              Yu             Kwai    Small
1         51100   France      EMEA         Henriot             Paul    Small
2         75508   France      EMEA        Da Cunha           Daniel   Medium
3         90003      USA       NaN           Young            Julie   Medium
4           NaN      USA       NaN           Brown            Julie   Medium
...         ...      ...       ...             ...              ...      ...
2818      28034    Spain      EMEA          Freyre            Diego    Small
2819      90110  Finland      EMEA       Koskitalo           Pirkko   Medium
2820      28034    Spain      EMEA          Freyre            Diego   Medium
2821      31000   France      EMEA          Roulet          Annette    Small
2822      51003      USA       NaN         Yoshido             Juri   Medium

[2823 rows x 25 columns]>
```

In [4]:

```
df.info
```

Out[4]:

```
<bound method DataFrame.info of       ORDERNUMBER  QUANTITYORDERED  PRICEEACH  ORDERL
INENUMBER    SALES  \
0           10107               30      95.70                2  2871.00
1           10121               34      81.35                5  2765.90
2           10134               41      94.74                2  3884.34
3           10145               45      83.26                6  3746.70
4           10159               49     100.00               14  5205.27
...           ...              ...        ...              ...      ...
2818        10350               20     100.00               15  2244.40
2819        10373               29     100.00                1  3978.51
2820        10386               43     100.00                4  5417.57
2821        10397               34      62.24                1  2116.16
2822        10414               47      65.52                9  3079.44

            ORDERDATE    STATUS  QTR_ID  MONTH_ID  YEAR_ID  ...  \
0      2/24/2003 0:00   Shipped       1         2     2003  ...
1       5/7/2003 0:00   Shipped       2         5     2003  ...
2       7/1/2003 0:00   Shipped       3         7     2003  ...
3      8/25/2003 0:00   Shipped       3         8     2003  ...
4     10/10/2003 0:00   Shipped       4        10     2003  ...
...               ...       ...     ...       ...      ...  ...
2818   12/2/2004 0:00   Shipped       4        12     2004  ...
2819   1/31/2005 0:00   Shipped       1         1     2005  ...
2820    3/1/2005 0:00  Resolved       1         3     2005  ...
2821   3/28/2005 0:00   Shipped       1         3     2005  ...
2822    5/6/2005 0:00   On Hold       2         5     2005  ...

                       ADDRESSLINE1  ADDRESSLINE2           CITY STATE  \
0           897 Long Airport Avenue           NaN            NYC    NY
1                59 rue de l'Abbaye           NaN          Reims   NaN
2     27 rue du Colonel Pierre Avia           NaN          Paris   NaN
3                78934 Hillside Dr.           NaN       Pasadena    CA
4                   7734 Strong St.           NaN  San Francisco    CA
...                             ...           ...            ...   ...
2818             C/ Moralzarzal, 86           NaN         Madrid   NaN
2819                    Torikatu 38           NaN           Oulu   NaN
2820             C/ Moralzarzal, 86           NaN         Madrid   NaN
2821          1 rue Alsace-Lorraine           NaN       Toulouse   NaN
2822             8616 Spinnaker Dr.           NaN         Boston    MA

     POSTALCODE  COUNTRY TERRITORY CONTACTLASTNAME CONTACTFIRSTNAME DEALSIZE
0         10022      USA       NaN              Yu             Kwai    Small
1         51100   France      EMEA         Henriot             Paul    Small
2         75508   France      EMEA        Da Cunha           Daniel   Medium
3         90003      USA       NaN           Young            Julie   Medium
4           NaN      USA       NaN           Brown            Julie   Medium
...         ...      ...       ...             ...              ...      ...
2818      28034    Spain      EMEA          Freyre            Diego    Small
2819      90110  Finland      EMEA       Koskitalo           Pirkko   Medium
2820      28034    Spain      EMEA          Freyre            Diego   Medium
2821      31000   France      EMEA          Roulet          Annette    Small
2822      51003      USA       NaN         Yoshido             Juri   Medium

[2823 rows x 25 columns]>
```

In [5]:

```python
to_drop = ['ADDRESSLINE1', 'ADDRESSLINE2', 'STATE', 'POSTALCODE', 'PHONE']
df = df.drop(to_drop, axis=1)
```

In [6]:

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

Out[6]:

```
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 [7]:

```
df.dtypes
```

Out[7]:

```
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 [8]:

```
df['ORDERDATE'] = pd.to_datetime(df['ORDERDATE'])
```

In [13]:

```
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'
})


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

In [14]:

```
df_RFM.head()
```

Out[14]:

	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 [16]:

```
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[16]:

	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 [17]:

```
df_RFM['RFM_Score'] = df_RFM[['R', 'M', 'F']].sum(axis=1)
df_RFM.head()
```

Out[17]:

	Recency	Frequency	MonetaryValue	M	R	F	RFM_Score
CUSTOMERNAME							
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

In [20]:

```
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[20]:

	Recency	Frequency	MonetaryValue	M	R	F	RFM_Score	RFM_Level
CUSTOMERNAME								
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 [21]:

```
data = df_RFM[['Recency', 'Frequency', 'MonetaryValue']]
data.head()
```

Out[21]:

	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 [22]:

```
data_log = np.log(data)
data_log.head()
```

Out[22]:

	Recency	Frequency	MonetaryValue
CUSTOMERNAME			
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 [25]:

```
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_l
data_normalized.describe().round(2)
```

Out[25]:

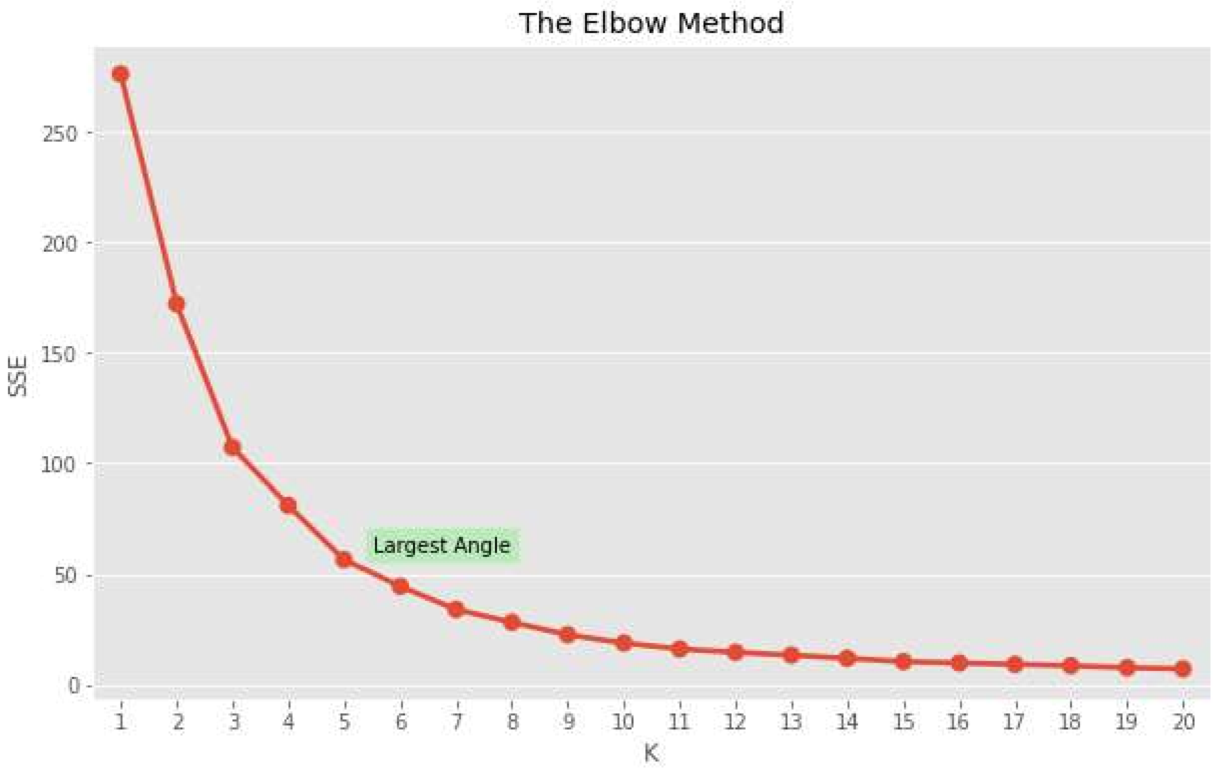
	Recency	Frequency	MonetaryValue
count	92.00	92.00	92.00
mean	0.00	-0.00	0.00
std	1.01	1.01	1.01
min	-3.51	-3.67	-3.82
25%	-0.24	-0.41	-0.39
50%	0.37	0.06	-0.04
75%	0.53	0.45	0.52
max	1.12	4.03	3.92

In [28]:

```
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_
```

In [31]:

```
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 [32]:

```
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()
```

Out[32]:

	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