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

```
import pandas as pd
import numpy as np

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

df.head

<bound method NDFrame.head of       ORDERNUMBER  QUANTITYORDERED
PRICEEACH  ORDERLINENUMBER    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]>

df.info

<bound method DataFrame.info of       ORDERNUMBER  QUANTITYORDERED
PRICEEACH  ORDERLINENUMBER    SALES  \
0           10107               30      95.70                2
2871.00
1           10121               34      81.35                5
2765.90
2           10134               41      94.74                2
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4           10159               49     100.00               14
5205.27
...           ...              ...        ...              ...      ..
.
2818        10350               20     100.00               15
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            ORDERDATE    STATUS  QTR_ID  MONTH_ID  YEAR_ID  ...  \
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4     10/10/2003 0:00   Shipped       4        10     2003  ...
...               ...       ...     ...       ...      ...  ...
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...                             ...           ...            ...   ...
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2819                   Torikatu 38            NaN           Oulu   NaN
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2822             8616 Spinnaker Dr.           NaN         Boston    MA


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1         51100   France      EMEA         Henriot              Paul
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Medium
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2821      31000   France      EMEA          Roulet           Annette
Small
2822      51003      USA       NaN         Yoshido              Juri
Medium

[2823 rows x 25 columns]>
```

```
#Columns to Remove
to_drop = ['ADDRESSLINE1', 'ADDRESSLINE2', 'STATE', 'POSTALCODE',
```

```
'PHONE']
df = df.drop(to_drop, axis=1)

#Check for null values
df.isnull().sum()
```

```
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
```

```
#Bhai bhai look at territory
#But territory does not have significant impact on analysis, let it be

df.dtypes
```

```
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
```

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

#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)

df_RFM.head()
```

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

```
# 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()
```

CUSTOMERNAME	Recency	Frequency	MonetaryValue	M	R	F
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
```

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

```
                          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
```

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

```
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()
```

```
                          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
```

```
                          RFM_Score            RFM_Level
CUSTOMERNAME
AV Stores, Co.                   10  High Value Customer
Alpha Cognac                      8   Mid Value Customer
Amica Models & Co.                6   Mid Value Customer
Anna's Decorations, Ltd          11  High Value Customer
Atelier graphique                 4   Low Value Customer
```

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

```
                          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
```

```
# Our data is skewed we must remove it by performing log
transformation
data_log = np.log(data)
data_log.head()
```

```
                           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
```

```
#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.columns)
data_normalized.describe().round(2)
```

```
       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
```

```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_
```

```
c:\Anaconda\anaconda2\lib\site-packages\sklearn\cluster\
_kmeans.py:1412: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
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OMP_NUM_THREADS=1.
  warnings.warn(
c:\Anaconda\anaconda2\lib\site-packages\sklearn\cluster\
_kmeans.py:1412: 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
  super()._check_params_vs_input(X, default_n_init=10)
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_kmeans.py:1436: UserWarning: KMeans is known to have a memory leak on
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```
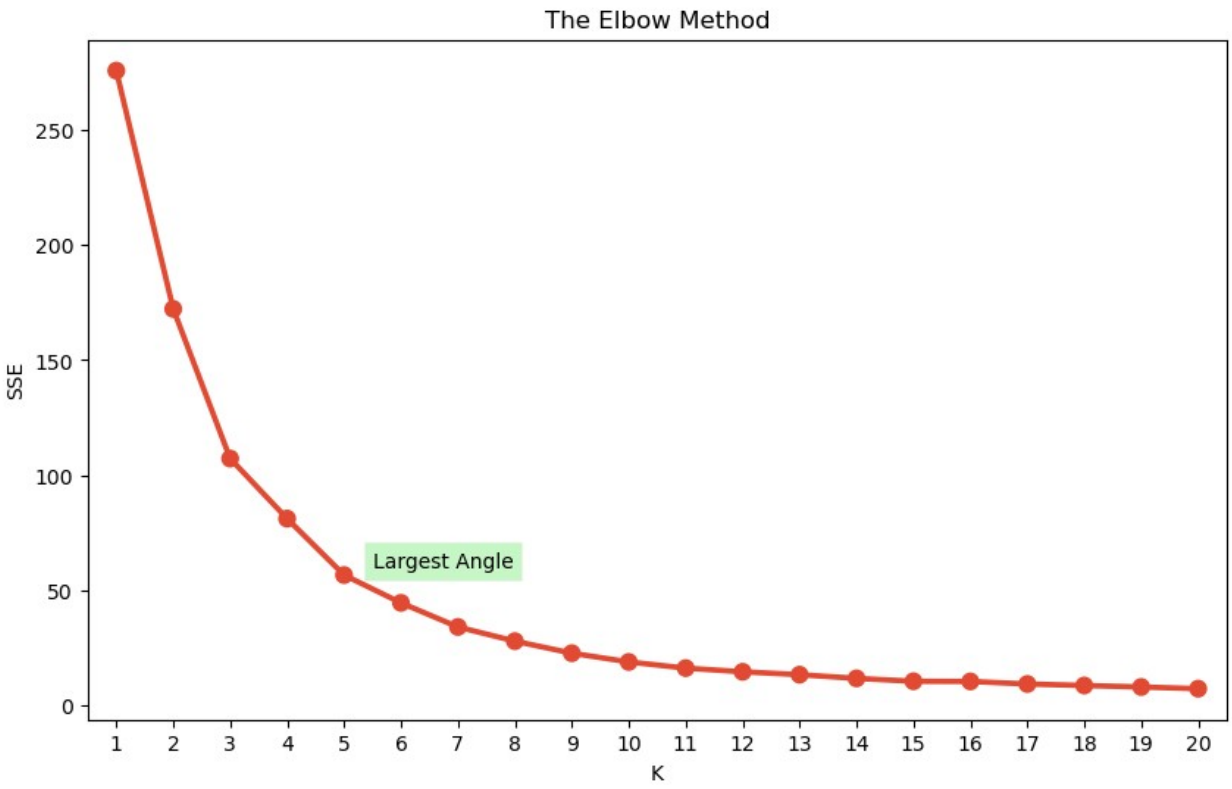

```
plt.figure(figsize=(10,6))
plt.title('The Elbow Method')

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()
```




```
# 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:\Anaconda\anaconda2\lib\site-packages\sklearn\cluster\
_kmeans.py:1412: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
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```

CUSTOMERNAME	Recency	Frequency	MonetaryValue	Cluster

AV Stores, Co.	196	51	157807.81	1
Alpha Cognac	65	20	70488.44	2
Amica Models & Co.	265	26	94117.26	2
Anna's Decorations, Ltd	84	46	153996.13	1
Atelier graphique	188	7	24179.96	0