Import libraries

In [3]:

```
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
import matplotlib.pyplot as plt # for data visualization
import seaborn as sns # for statistical data visualization
%matplotlib inline
```

In [6]:

```
df = pd.read_csv('Mall_Customers.csv')
```

Exploratory data analysis

In [7]:

```
df.shape
```

Out[7]:

```
(200, 5)
```

In [8]:

```
df.head()
```

Out[8]:

	CustomerID	Genre	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

In [9]:

```
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   Genre                   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 [10]:

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

Out[10]:

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

In [11]:

```
df.drop(['Genre'], axis=1, inplace=True)
```

In [12]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 200 entries, 0 to 199
Data columns (total 4 columns):
 #   Column                  Non-Null Count  Dtype
---  ------                  --------------  -----
 0   CustomerID              200 non-null    int64
 1   Age                     200 non-null    int64
 2   Annual Income (k$)      200 non-null    int64
 3   Spending Score (1-100)  200 non-null    int64
dtypes: int64(4)
memory usage: 6.4 KB
```

In [13]:

```
df.describe()
```

Out[13]:

	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 [14]:

```
df['CustomerID'].unique()
```

Out[14]:

```
array([  1,   2,   3,   4,   5,   6,   7,   8,   9,  10,  11,  12,  13,
        14,  15,  16,  17,  18,  19,  20,  21,  22,  23,  24,  25,  26,
        27,  28,  29,  30,  31,  32,  33,  34,  35,  36,  37,  38,  39,
        40,  41,  42,  43,  44,  45,  46,  47,  48,  49,  50,  51,  52,
        53,  54,  55,  56,  57,  58,  59,  60,  61,  62,  63,  64,  65,
        66,  67,  68,  69,  70,  71,  72,  73,  74,  75,  76,  77,  78,
        79,  80,  81,  82,  83,  84,  85,  86,  87,  88,  89,  90,  91,
        92,  93,  94,  95,  96,  97,  98,  99, 100, 101, 102, 103, 104,
       105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117,
       118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130,
       131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143,
       144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156,
       157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169,
       170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182,
       183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195,
       196, 197, 198, 199, 200], dtype=int64)
```

In [15]:

```
len(df['CustomerID'].unique())
```

Out[15]:

```
200
```

In [16]:

```
df['Age'].unique()
```

Out[16]:

```
array([19, 21, 20, 23, 31, 22, 35, 64, 30, 67, 58, 24, 37, 52, 25, 46, 5
4,
       29, 45, 40, 60, 53, 18, 49, 42, 36, 65, 48, 50, 27, 33, 59, 47, 5
1,
       69, 70, 63, 43, 68, 32, 26, 57, 38, 55, 34, 66, 39, 44, 28, 56, 4
1],
      dtype=int64)
```

In [17]:

```
len(df['Age'].unique())
```

Out[17]:

```
51
```

In [18]:

```
df['Annual Income (k$)'].unique()
```

Out[18]:

```
array([ 15,  16,  17,  18,  19,  20,  21,  23,  24,  25,  28,  29,  30,
        33,  34,  37,  38,  39,  40,  42,  43,  44,  46,  47,  48,  49,
        50,  54,  57,  58,  59,  60,  61,  62,  63,  64,  65,  67,  69,
        70,  71,  72,  73,  74,  75,  76,  77,  78,  79,  81,  85,  86,
        87,  88,  93,  97,  98,  99, 101, 103, 113, 120, 126, 137],
      dtype=int64)
```

In [19]:

```
len(df['Annual Income (k$)'].unique())
```

Out[19]:

```
64
```

In [20]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 200 entries, 0 to 199
Data columns (total 4 columns):
 #   Column                  Non-Null Count  Dtype
---  ------                  --------------  -----
 0   CustomerID              200 non-null    int64
 1   Age                     200 non-null    int64
 2   Annual Income (k$)      200 non-null    int64
 3   Spending Score (1-100)  200 non-null    int64
dtypes: int64(4)
memory usage: 6.4 KB
```

In [21]:

```
df.head()
```

Out[21]:

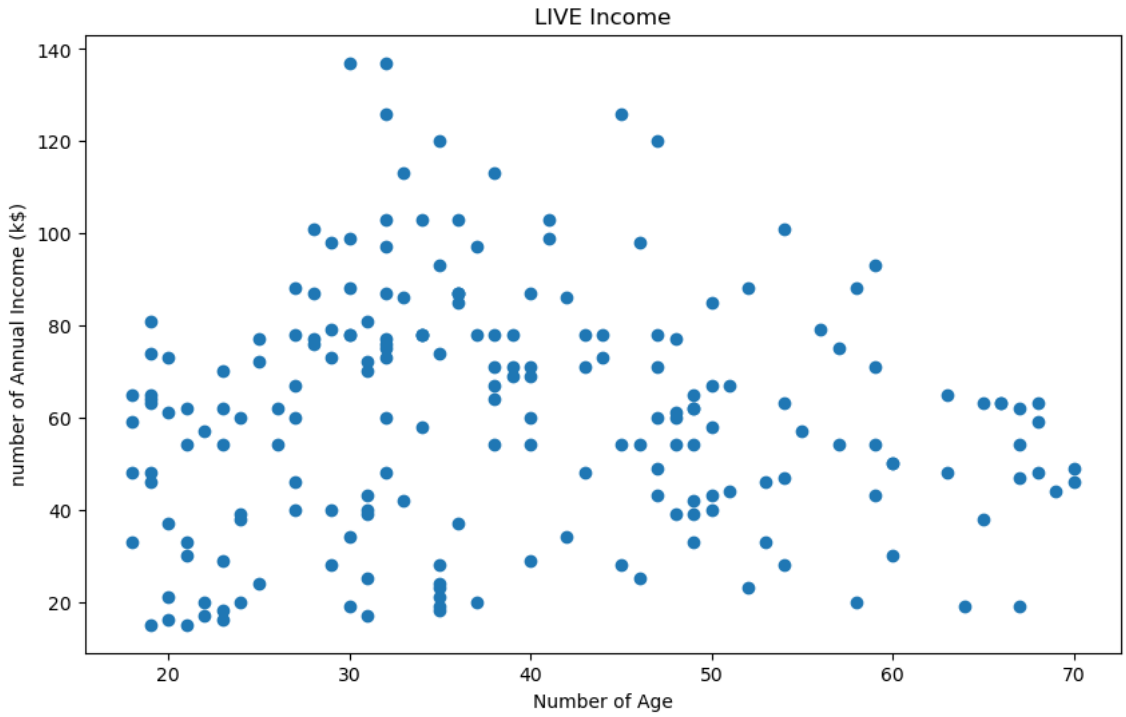
	CustomerID	Age	Annual Income (k$)	Spending Score (1-100)
0	1	19	15	39
1	2	21	15	81
2	3	20	16	6
3	4	23	16	77
4	5	31	17	40

In [25]:

```
plt.figure(figsize=(10,6))
plt.scatter(df['Age'],df['Annual Income (k$)'])
plt.xlabel('Number of Age')
plt.ylabel('number of Annual Income (k$)')
plt.title('LIVE Income')
```

Out[25]:

```
Text(0.5, 1.0, 'LIVE Income')
```



In [26]:

```
df.head(2)
```

Out[26]:

	CustomerID	Age	Annual Income (k$)	Spending Score (1-100)
0	1	19	15	39
1	2	21	15	81

In [29]:

```
from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()
df['CustomerID'] = le.fit_transform(df['CustomerID'])
```

In [30]:

```
y=df
cols = y.columns
from sklearn.preprocessing import MinMaxScaler
ms = MinMaxScaler()
y = ms.fit_transform(y)
y = pd.DataFrame(y, columns=[cols])
```

In [31]:

```
X = y.values
X[:5] # Show first 5 records only
```

Out[31]:

```
array([[0.        , 0.01923077, 0.        , 0.3877551 ],
       [0.00502513, 0.05769231, 0.        , 0.81632653],
       [0.01005025, 0.03846154, 0.00819672, 0.05102041],
       [0.01507538, 0.09615385, 0.00819672, 0.7755102 ],
       [0.0201005 , 0.25      , 0.01639344, 0.39795918]])
```

In [32]:

```
from sklearn.cluster import KMeans
clustering_score = []
for i in range(1, 11):
    kmeans = KMeans(n_clusters = i, init = 'random', random_state = 42)
    kmeans.fit(X)
    clustering_score.append(kmeans.inertia_)

plt.figure(figsize=(10,6))
plt.plot(range(1, 11), clustering_score)
plt.scatter(4,clustering_score[3], s = 200, c = 'red', marker='*')
plt.title('The Elbow Method')
plt.xlabel('No. of Clusters')
plt.ylabel('Clustering Score')
plt.show()
```

```
C:\Users\USER\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'aut
o' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
C:\Users\USER\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:138
2: UserWarning: KMeans is known to have a memory leak on Windows with MK
L, when there are less chunks than available threads. You can avoid it by
setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
C:\Users\USER\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'aut
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  warnings.warn(
C:\Users\USER\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:138
2: UserWarning: KMeans is known to have a memory leak on Windows with MK
L, when there are less chunks than available threads. You can avoid it by
setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
C:\Users\USER\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'aut
o' in 1.4. Set the value of `n_init` explicitly to suppress the warning
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C:\Users\USER\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:138
2: UserWarning: KMeans is known to have a memory leak on Windows with MK
L, when there are less chunks than available threads. You can avoid it by
setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
C:\Users\USER\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'aut
o' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
C:\Users\USER\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:138
2: UserWarning: KMeans is known to have a memory leak on Windows with MK
L, when there are less chunks than available threads. You can avoid it by
setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
C:\Users\USER\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'aut
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  warnings.warn(
C:\Users\USER\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:138
2: UserWarning: KMeans is known to have a memory leak on Windows with MK
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  warnings.warn(
C:\Users\USER\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'aut
o' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
C:\Users\USER\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:138
2: UserWarning: KMeans is known to have a memory leak on Windows with MK
L, when there are less chunks than available threads. You can avoid it by
setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
C:\Users\USER\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'aut
o' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
C:\Users\USER\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:138
2: UserWarning: KMeans is known to have a memory leak on Windows with MK
L, when there are less chunks than available threads. You can avoid it by
```
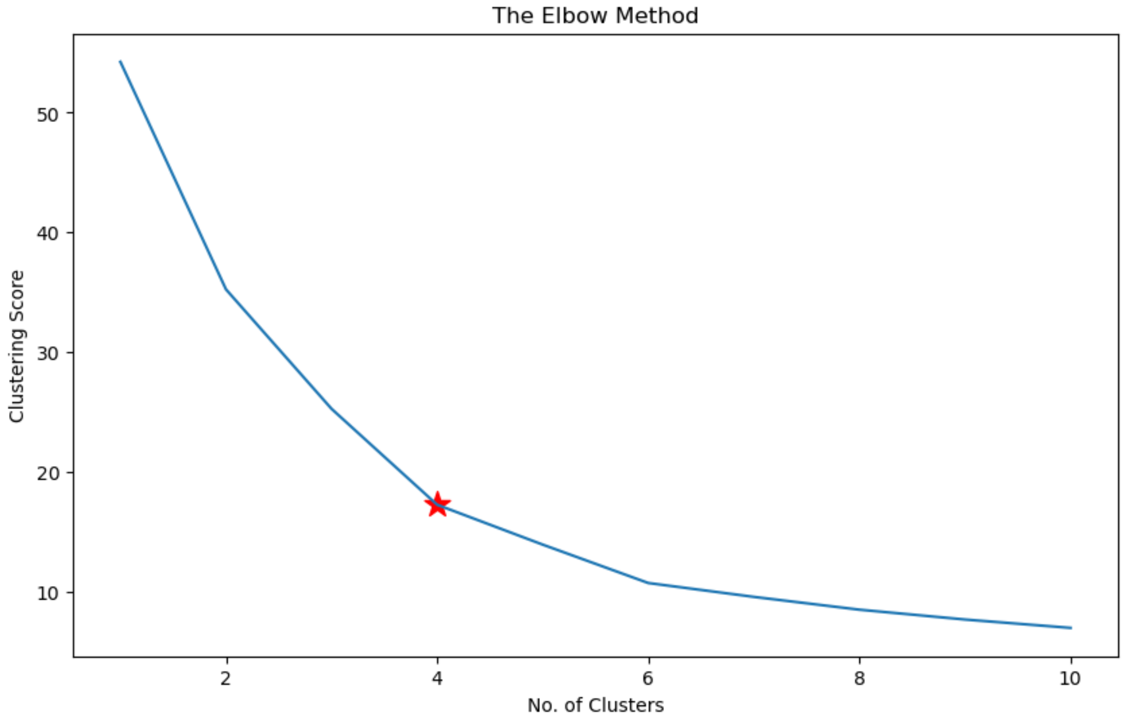

```
setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
C:\Users\USER\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'aut
o' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
C:\Users\USER\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:138
2: UserWarning: KMeans is known to have a memory leak on Windows with MK
L, when there are less chunks than available threads. You can avoid it by
setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
C:\Users\USER\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'aut
o' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
C:\Users\USER\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:138
2: UserWarning: KMeans is known to have a memory leak on Windows with MK
L, when there are less chunks than available threads. You can avoid it by
setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
C:\Users\USER\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'aut
o' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
C:\Users\USER\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:138
2: UserWarning: KMeans is known to have a memory leak on Windows with MK
L, when there are less chunks than available threads. You can avoid it by
setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
```



In [33]:

```
kmeans= KMeans(n_clusters = 5, random_state = 42)
# Compute k-means clustering
kmeans.fit(X)
# Compute cluster centers and predict cluster index for each sample.
pred = kmeans.predict(X)
pred
```

```
C:\Users\USER\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'aut
o' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
C:\Users\USER\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:138
2: UserWarning: KMeans is known to have a memory leak on Windows with MK
L, when there are less chunks than available threads. You can avoid it by
setting the environment variable OMP_NUM_THREADS=1.
  warnings.warn(
```

Out[33]:

```
array([2, 2, 3, 2, 3, 2, 3, 2, 3, 2, 3, 2, 3, 2, 3, 2, 3, 2, 3, 2,
       3, 2, 3, 2, 3, 2, 3, 2, 3, 2, 3, 2, 3, 2, 3, 2, 3, 2, 0, 2, 3, 2,
       3, 2, 0, 2, 2, 2, 0, 2, 2, 0, 0, 0, 0, 0, 2, 0, 0, 2, 0, 0, 0, 2,
       0, 0, 2, 2, 0, 0, 0, 0, 0, 2, 0, 0, 2, 0, 0, 2, 0, 0, 2, 0, 0, 2,
       2, 0, 0, 2, 0, 0, 2, 2, 0, 2, 0, 2, 2, 0, 0, 2, 0, 2, 0, 0, 0, 0,
       0, 2, 4, 2, 2, 2, 0, 0, 0, 0, 1, 4, 1, 1, 4, 1, 4, 1, 4, 1, 4, 1,
       4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1,
       4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1,
       4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1,
       4, 1])
```

In [34]:

```
df['Cluster'] = pd.DataFrame(pred, columns=['cluster'] )
print('Number of data points in each cluster= \n', df['Cluster'].value_counts())
df
```

```
Number of data points in each cluster=
 2    52
0    46
1    41
4    40
3    21
Name: Cluster, dtype: int64
```

Out[34]:

	CustomerID	Age	Annual Income (k$)	Spending Score (1-100)	Cluster
0	0	19	15	39	2
1	1	21	15	81	2
2	2	20	16	6	3
3	3	23	16	77	2
4	4	31	17	40	3
...	...	...	...	...	...
195	195	35	120	79	1
196	196	45	126	28	4
197	197	32	126	74	1
198	198	32	137	18	4
199	199	30	137	83	1

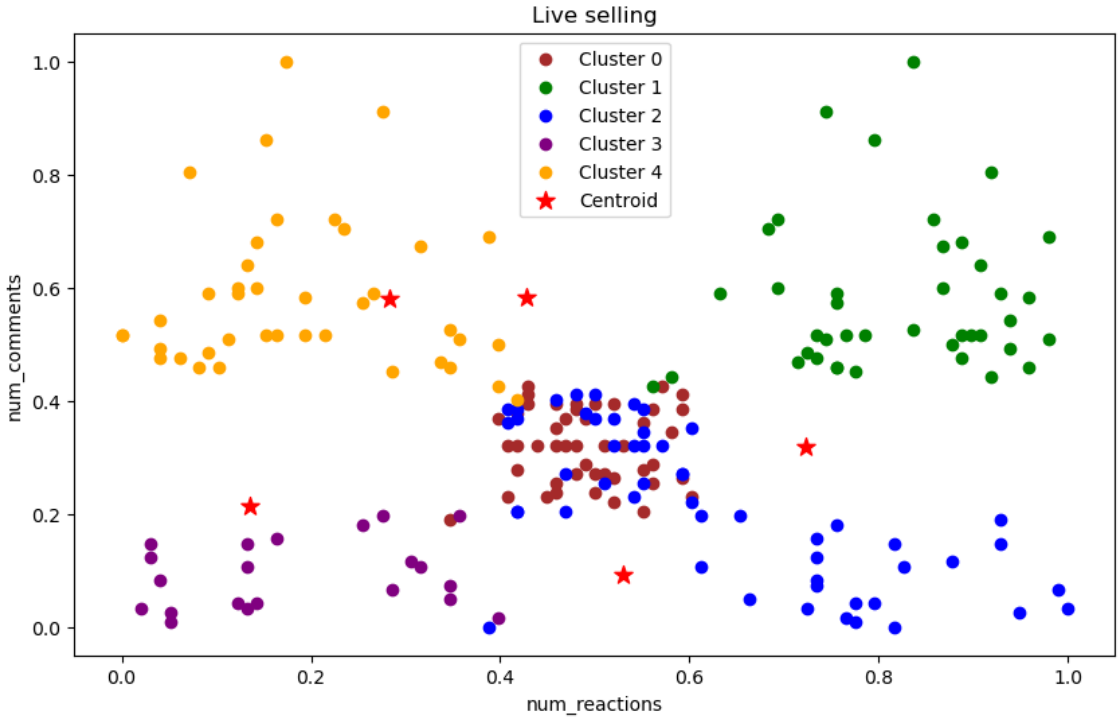
200 rows × 5 columns

In [35]:

```
plt.figure(figsize=(10,6))
plt.scatter(X[pred == 0, 3], X[pred == 0, 2], c = 'brown', label = 'Cluster 0')
plt.scatter(X[pred == 1, 3], X[pred == 1, 2], c = 'green', label = 'Cluster 1')
plt.scatter(X[pred == 2, 3], X[pred == 2, 2], c = 'blue', label = 'Cluster 2')
plt.scatter(X[pred == 3, 3], X[pred == 3, 2], c = 'purple', label = 'Cluster 3')
plt.scatter(X[pred == 4, 3], X[pred == 4, 2], c = 'orange', label = 'Cluster 4')
plt.scatter(kmeans.cluster_centers_[:,1], kmeans.cluster_centers_[:, 2],s =100, c = 'red
plt.xlabel('num_reactions')
plt.ylabel('num_comments')
plt.legend()
plt.title('Live selling')
```

Out[35]:

```
Text(0.5, 1.0, 'Live selling')
```



In [36]:

```
labels1 = kmeans.labels_
centroids1 = kmeans.cluster_centers_
labels1
```

Out[36]:

```
array([2, 2, 3, 2, 3, 2, 3, 2, 3, 2, 3, 2, 3, 2, 3, 2, 3, 2, 3, 2,
       3, 2, 3, 2, 3, 2, 3, 2, 3, 2, 3, 2, 3, 2, 3, 2, 3, 2, 0, 2, 3, 2,
       3, 2, 0, 2, 2, 2, 0, 2, 2, 0, 0, 0, 0, 0, 2, 0, 0, 2, 0, 0, 0, 2,
       0, 0, 2, 2, 0, 0, 0, 0, 0, 2, 0, 0, 2, 0, 0, 2, 0, 0, 2, 0, 0, 2,
       2, 0, 0, 2, 0, 0, 2, 2, 0, 2, 0, 2, 2, 0, 0, 2, 0, 2, 0, 0, 0, 0,
       0, 2, 4, 2, 2, 2, 0, 0, 0, 0, 1, 4, 1, 1, 4, 1, 4, 1, 4, 1, 4, 1,
       4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1,
       4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1,
       4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1,
       4, 1])
```

In [37]:

```
kmeans.inertia_
```

Out[37]:

```
13.967176243333345
```

In [ ]:

```

```