Topic: Custumer Clustering with RFM & Clustering Algorithm

Demo: E-commerce Project

```
!pip install squarify
!pip install matplotlib==3.1.3
```

```
from google.colab import drive
drive.mount("/content/gdrive", force_remount=True)

%cd '/content/gdrive/My Drive/LDS0/Topic_5_2_1_3/demo/'
```

```
Mounted at /content/gdrive
/content/gdrive/My Drive/LDS0/Topic_5_2_1_3/demo
```

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import plotly.express as px
import squarify
from datetime import datetime
```

```
df = pd.read_csv('e-commerce.csv')
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 70052 entries, 0 to 70051
Data columns (total 17 columns):
 #   Column                  Non-Null Count  Dtype
---  ------                  --------------  -----
 0   product_title           70052 non-null  object
 1   product_type            70052 non-null  object
 2   variant_title           70052 non-null  object
 3   variant_sku             70052 non-null  object
 4   variant_id              70052 non-null  int64
 5   customer_id             70052 non-null  int64
 6   order_id                70052 non-null  int64
 7   day                     70052 non-null  object
 8   net_quantity            70052 non-null  int64
 9   gross_sales             70052 non-null  float64
 10  discounts               70052 non-null  float64
 11  returns                 70052 non-null  float64
 12  net_sales               70052 non-null  float64
 13  taxes                   70052 non-null  float64
 14  total_sales             70052 non-null  float64
 15  returned_item_quantity  70052 non-null  int64
 16  ordered_item_quantity   70052 non-null  int64
dtypes: float64(6), int64(6), object(5)
memory usage: 9.1+ MB
```

```
string_to_date = lambda x : datetime.strptime(x, "%d/%m/%Y").date()

# Convert InvoiceDate from object to datetime format
df['day'] = df['day'].apply(string_to_date)
df['day'] = df['day'].astype('datetime64[ns]')

# Drop NA values
df = df.dropna()
```

```
# Print DataFrame
df.head(3)
```

	product_title	product_type	variant_title	variant_sku	variant_id	customer_id	order_id	day	net_quantity	gross_sales	di
0	DPR	DPR	100	AD-982-708-895-F-6C894FB	52039657	1312378	83290718932496	2018-12-04	2	200.0	
1	RJF	Product P	28 / A / MTM	83-490-E49-8C8-8-3B100BC	56914686	3715657	36253792848113	2019-04-01	2	190.0	
2	CLH	Product B	32 / B / FtO	68-ECA-BC7-3B2-A-E73DE1B	24064862	9533448	73094559597229	2018-11-05	0	164.8	

```
df.tail(3)
```

	product_title	product_type	variant_title	variant_sku	variant_id	customer_id	order_id	day	net_quantity	gross_sales
70049	QID	Product H	33 / C / FtO	84-EB3-E68-8BF-1-F2EE65C	29857030	1201357	26287500138156	2018-11-19	-3	0.0
70050	KNB	Product P	40 / B / FtO	DB-5D5-1F5-964-6-F33469E	81507405	9368488	59112081344038	2019-04-08	-3	0.0
70051	WHX	Product P	38 / C / FtO	1C-F31-5C5-A71-9-E27F89C	23625707	7861225	34850379713899	2019-01-02	-3	0.0

```
# Let’s take a closer look at the data we will need to manipulate.
print('Transactions timeframe from {} to {}'.format(df['day'].min(), df['day'].max()))
print('{:,} transactions don\'t have a customer id'.format(df[df.customer_id.isnull()].shape[0]))
print('{:,} unique customer_id'.format(len(df.customer_id.unique())))
```

```
Transactions timeframe from 2018-11-01 00:00:00 to 2019-04-30 00:00:00
0 transactions don't have a customer id
25,543 unique customer_id
```

RFM

Create RFM analysis for each customers

```
# RFM
# Convert string to date, get max date of dataframe
max_date = df['day'].max().date()

Recency = lambda x : (max_date - x.max().date()).days
Frequency  = lambda x: len(x.unique())
Monetary = lambda x : round(sum(x), 2)

df_RFM = df.groupby('customer_id').agg({'day': Recency,
                                        'order_id': Frequency,
                                        'gross_sales': Monetary })
```

```
df_RFM.head()
```

customer_id	day	order_id	gross_sales
1000661	141	1	237.53
1001914	158	1	82.50
1002167	53	4	211.67
1002387	44	1	74.17
1002419	95	1	106.67

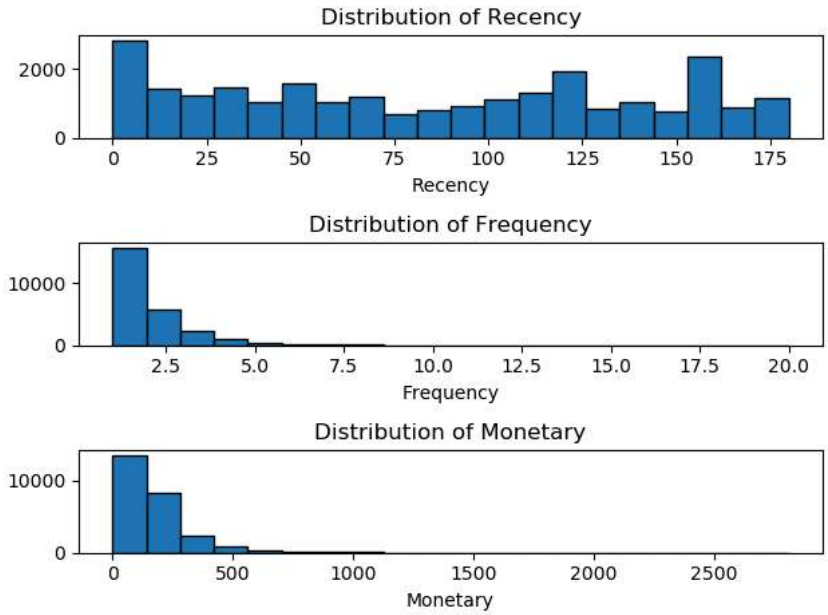
```
# Rename the columns of DataFrame
df_RFM.columns = ['Recency', 'Frequency', 'Monetary']
# Descending Sorting
df_RFM = df_RFM.sort_values('Monetary', ascending=False)


df_RFM.head()
```

customer_id	Recency	Frequency	Monetary
8325158	4	17	2812.58
2028611	98	17	2661.72
6578818	5	16	2486.73
7843272	0	20	2325.06
8032770	50	13	2065.88

```
df_RFM.shape
```

```
(25543, 3)
```

```
# Vẽ phân phối của 'Recency'
plt.subplot(3, 1, 1) # 3 hàng, 1 cột, vị trí thứ nhất
plt.hist(df_RFM['Recency'], bins=20, edgecolor='black') # Chọn số lượng bins phù hợp
plt.title('Distribution of Recency')
plt.xlabel('Recency')

# Vẽ phân phối của 'Frequency'
plt.subplot(3, 1, 2) # 3 hàng, 1 cột, vị trí thứ hai
plt.hist(df_RFM['Frequency'], bins=20, edgecolor='black') # Chọn số lượng bins phù hợp
plt.title('Distribution of Frequency')
plt.xlabel('Frequency')

# Vẽ phân phối của 'Monetary'
plt.subplot(3, 1, 3) # 3 hàng, 1 cột, vị trí thứ ba
plt.hist(df_RFM['Monetary'], bins=20, edgecolor='black') # Chọn số lượng bins phù hợp
plt.title('Distribution of Monetary')
plt.xlabel('Monetary')

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




```
# Frequency, Monetary: right skew
# Nhận xét các biểu đồ
```

Calculate RFM quartiles

```
# Create labels for Recency, Frequency, Monetary
r_labels = range(4, 0, -1) # số ngày tính từ lần cuối mua hàng lớn thì gán nhãn nhỏ, ngược lại thì nhãn lớn
f_labels = range(1, 5)
m_labels = range(1, 5)
```

```
[*r_labels]
```

```
[4, 3, 2, 1]
```

```
# Assign these labels to 4 equal percentile groups
r_groups = pd.qcut(df_RFM['Recency'].rank(method='first'), q=4, labels=r_labels)

f_groups = pd.qcut(df_RFM['Frequency'].rank(method='first'), q=4, labels=f_labels)

m_groups = pd.qcut(df_RFM['Monetary'].rank(method='first'), q=4, labels=m_labels)
```

```
# Create new columns R, F, M
df_RFM = df_RFM.assign(R = r_groups.values, F = f_groups.values,  M = m_groups.values)
df_RFM.head()
```

customer_id	Recency	Frequency	Monetary	R	F	M
8325158	4	17	2812.58	4	4	4
2028611	98	17	2661.72	2	4	4
6578818	5	16	2486.73	4	4	4
7843272	0	20	2325.06	4	4	4
8032770	50	13	2065.88	3	4	4

Concat RFM quartile values to create RFM Segments

```
def join_rfm(x): return str(int(x['R'])) + str(int(x['F'])) + str(int(x['M']))
df_RFM['RFM_Segment'] = df_RFM.apply(join_rfm, axis=1)
```

```
df_RFM.head()
```

customer_id	Recency	Frequency	Monetary	R	F	M	RFM_Segment
8325158	4	17	2812.58	4	4	4	444
2028611	98	17	2661.72	2	4	4	244
6578818	5	16	2486.73	4	4	4	444
7843272	0	20	2325.06	4	4	4	444
8032770	50	13	2065.88	3	4	4	344

Count num of unique segments

```
rfm_count_unique = df_RFM.groupby('RFM_Segment')['RFM_Segment'].nunique()
```

```
print(rfm_count_unique.sum())
```

```
48
```

- Having 48 different segments using the concatenate method quickly becomes unwieldy for any practical use. We will need a more concise way to define our segments.

Calculate RFM score and level

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

customer_id	Recency	Frequency	Monetary	R	F	M	RFM_Segment	RFM_Score
8325158	4	17	2812.58	4	4	4	444	12
2028611	98	17	2661.72	2	4	4	244	10
6578818	5	16	2486.73	4	4	4	444	12
7843272	0	20	2325.06	4	4	4	444	12
8032770	50	13	2065.88	3	4	4	344	11

Manual Segmentation

```
def rfm_level(df):
    # Check for special 'STARS' and 'NEW' conditions first
    if df['RFM_Score'] == 12:
        return 'STARS'
    elif df['R'] == 4 and df['F'] == 1 and df['M'] == 1:
        return 'NEW'
    # Then check for other conditions
    elif df['M'] == 4:
        return 'BIG SPENDER'
    elif df['F'] == 4:
        return 'LOYAL'
    elif df['R'] == 4:
        return 'ACTIVE'
    elif df['R'] == 1:
        return 'LOST'
    elif df['M'] == 1:
        return 'LIGHT'
    else:
        return 'REGULARS'


# Create a new column RFM_Level
df_RFM['RFM_Level'] = df_RFM.apply(rfm_level, axis=1)


df_RFM.head()
```

customer_id	Recency	Frequency	Monetary	R	F	M	RFM_Segment	RFM_Score	RFM_Level
8325158	4	17	2812.58	4	4	4	444	12	STARS
2028611	98	17	2661.72	2	4	4	244	10	BIG SPENDER
6578818	5	16	2486.73	4	4	4	444	12	STARS
7843272	0	20	2325.06	4	4	4	444	12	STARS
8032770	50	13	2065.88	3	4	4	344	11	BIG

```
# Print the header with top 5 rows
df_RFM[::2000]
```

customer_id	Recency	Frequency	Monetary	R	F	M	RFM_Segment	RFM_Score	RFM_Level
8325158	4	17	2812.58	4	4	4	444	12	STARS
4193770	0	5	380.85	4	4	4	444	12	STARS
4597386	2	2	270.82	4	3	4	434	11	BIG SPENDER
3382250	131	2	222.52	2	3	4	234	9	BIG SPENDER
6258536	107	3	172.50	2	4	3	243	9	LOYAL
7214317	125	1	156.67	2	1	3	213	6	REGULARS
6860385	4	2	148.32	4	4	3	443	11	LOYAL
7792319	124	1	106.67	2	1	2	212	5	REGULARS
1586258	147	1	82.50	1	1	2	112	4	LOST
6705571	138	1	79.17	1	2	2	122	5	LOST
9384463	60	1	74.17	3	2	1	321	6	LIGHT
1299152	93	1	74.17	2	2	1	221	5	LIGHT
3777544	125	1	51.67	2	3	1	231	6	LIGHT

Number of segments

```
df_RFM['RFM_Level'].value_counts()
```

```
LOST           5303
REGULARS       4855
BIG SPENDER    4691
LIGHT          3226
ACTIVE         3024
LOYAL          2749
STARS          1695
Name: RFM_Level, dtype: int64
```

Calculate mean values for each segment

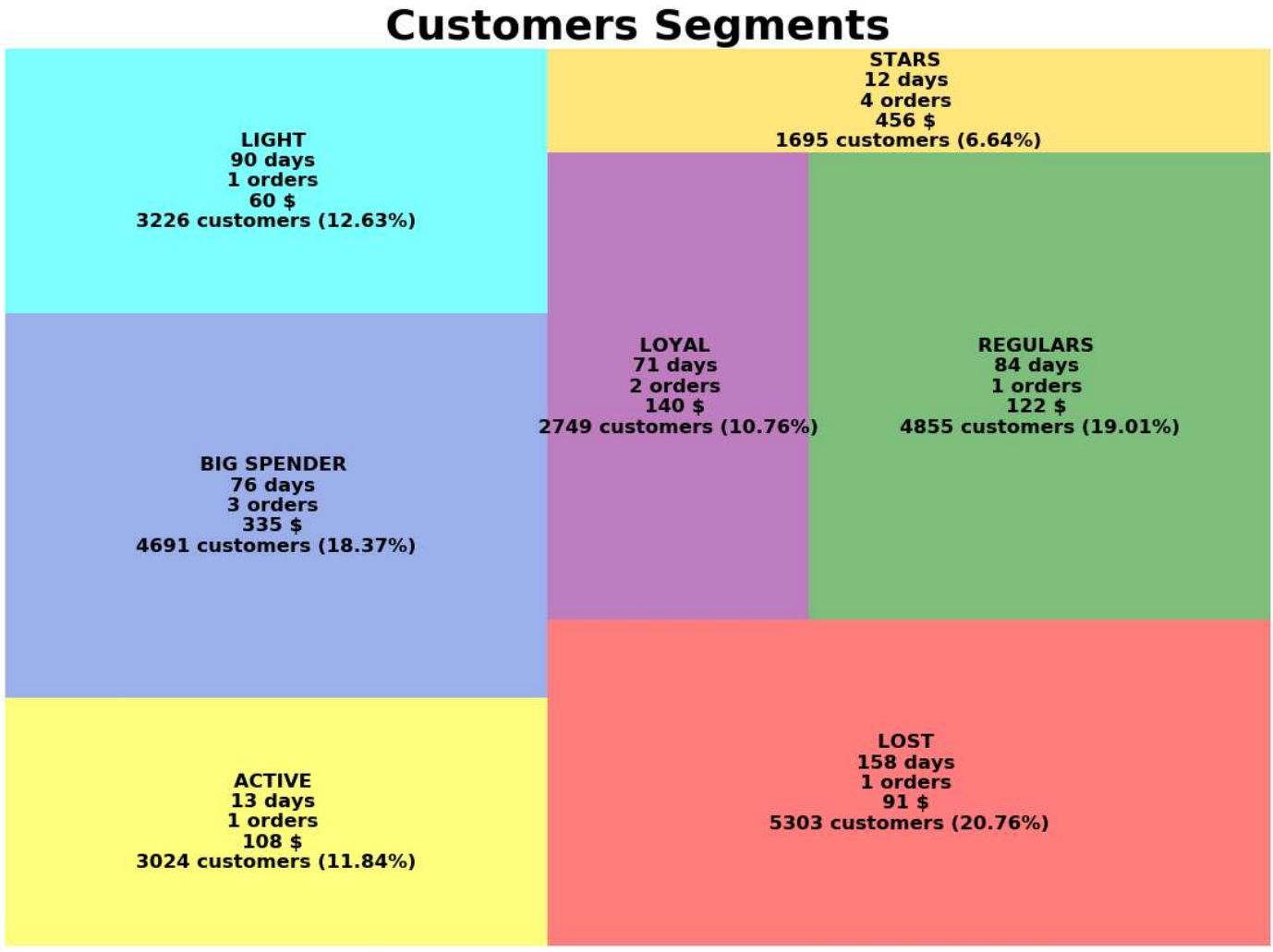
```
# Calculate average values for each RFM_Level, and return a size of each segment
rfm_agg = df_RFM.groupby('RFM_Level').agg({
    'Recency': 'mean',
    'Frequency': 'mean',
    'Monetary': ['mean', 'count']}).round(0)

rfm_agg.columns = rfm_agg.columns.droplevel()
rfm_agg.columns = ['RecencyMean','FrequencyMean','MonetaryMean', 'Count']
rfm_agg['Percent'] = round((rfm_agg['Count']/rfm_agg.Count.sum())*100, 2)

# Reset the index
rfm_agg = rfm_agg.reset_index()
```

```
rfm_agg
```

	RFM_Level	RecencyMean	FrequencyMean	MonetaryMean	Count	Percent
0	ACTIVE	13.0	1.0	108.0	3024	11.84
1	BIG SPENDER	76.0	3.0	335.0	4691	18.37
2	LIGHT	90.0	1.0	60.0	3226	12.63
3	LOST	158.0	1.0	91.0	5303	20.76
4	LOYAL	71.0	2.0	140.0	2749	10.76
5	REGULARS	84.0	1.0	122.0	4855	19.01
6	STARS	12.0	4.0	456.0	1695	6.64

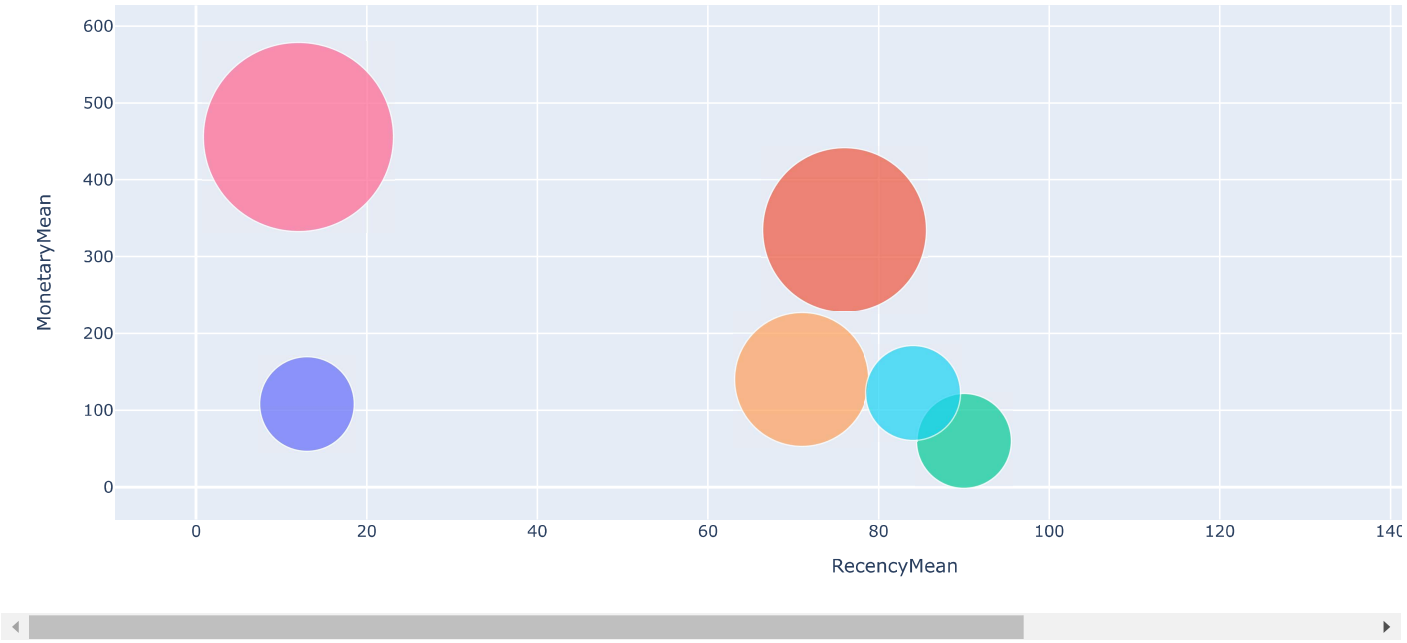
TreeMap

```
#Create our plot and resize it.
fig = plt.gcf()
ax = fig.add_subplot()
fig.set_size_inches(14, 10)

colors_dict = {'ACTIVE':'yellow','BIG SPENDER':'royalblue', 'LIGHT':'cyan',
               'LOST':'red', 'LOYAL':'purple', 'NEW':'green', 'STARS':'gold'}

squarify.plot(sizes=rfm_agg['Count'],
              text_kwargs={'fontsize':12,'weight':'bold', 'fontname':"sans serif"},
              color=colors_dict.values(),
              label=['{} \n{:.0f} days \n{:.0f} orders \n{:.0f} $ \n{:.0f} customers ({}%)'.format(*rfm_agg.iloc[i])
                      for i in range(0, len(rfm_agg))], alpha=0.5 )


plt.title("Customers Segments",fontsize=26,fontweight="bold")
plt.axis('off')

plt.savefig('RFM Segments.png')
plt.show()
```



Scatter Plot (RFM)

```
import plotly.express as px

fig = px.scatter(rfm_agg, x="RecencyMean", y="MonetaryMean", size="FrequencyMean", color="RFM_Level",
           hover_name="RFM_Level", size_max=100)
fig.show()
```



Summary:

- Hãy nhận xét chi tiết cho từng nhóm khách hàng!

RFM + KMeans

Kmeans clusters with the Elbow Method

```
df_now = df_RFM[['Recency','Frequency','Monetary']]
```

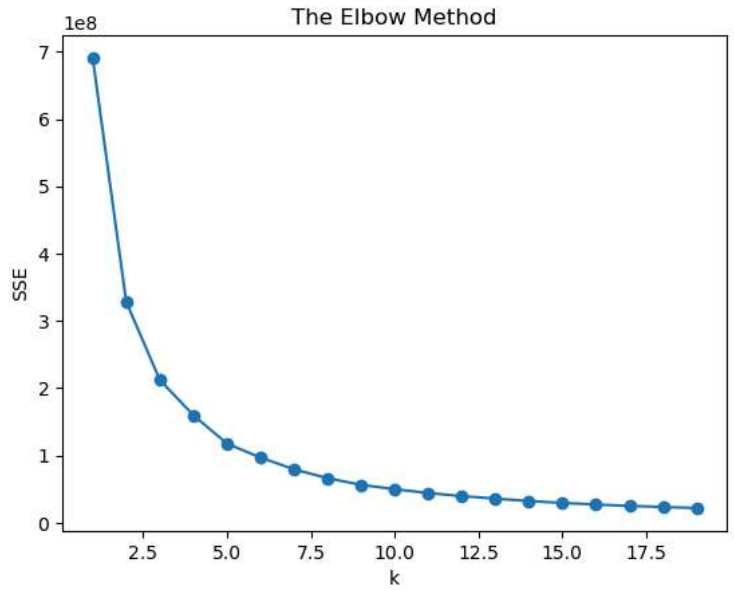
```
df_now.head()
```

customer_id	Recency	Frequency	Monetary
8325158	4	17	2812.58
2028611	98	17	2661.72
6578818	5	16	2486.73
7843272	0	20	2325.06
8032770	50	13	2065.88

```
df_now.tail()
```

customer_id	Recency	Frequency	Monetary
4745717	167	1	0.0
4766692	169	1	0.0
4767380	179	1	0.0
4772878	155	1	0.0
99774092719790	169	1	0.0

```
from sklearn.cluster import KMeans
sse = {}
for k in range(1, 20):
    kmeans = KMeans(n_clusters=k, random_state=42)
    kmeans.fit(df_now)
    sse[k] = kmeans.inertia_ # SSE to closest cluster centroid


plt.title('The Elbow Method')
plt.xlabel('k')
plt.ylabel('SSE')

plt.plot(list(sse.keys()), list(sse.values()), marker='o')
plt.show()
```




```
# Build model with k=5
model = KMeans(n_clusters=5, random_state=42)
model.fit(df_now)
model.labels_.shape
```

```
/usr/local/lib/python3.10/dist-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

(25543,)
```

```
df_now["Cluster"] = model.labels_
df_now.groupby('Cluster').agg({
    'Recency':'mean',
    'Frequency':'mean',
    'Monetary':['mean', 'count']}).round(2)
```

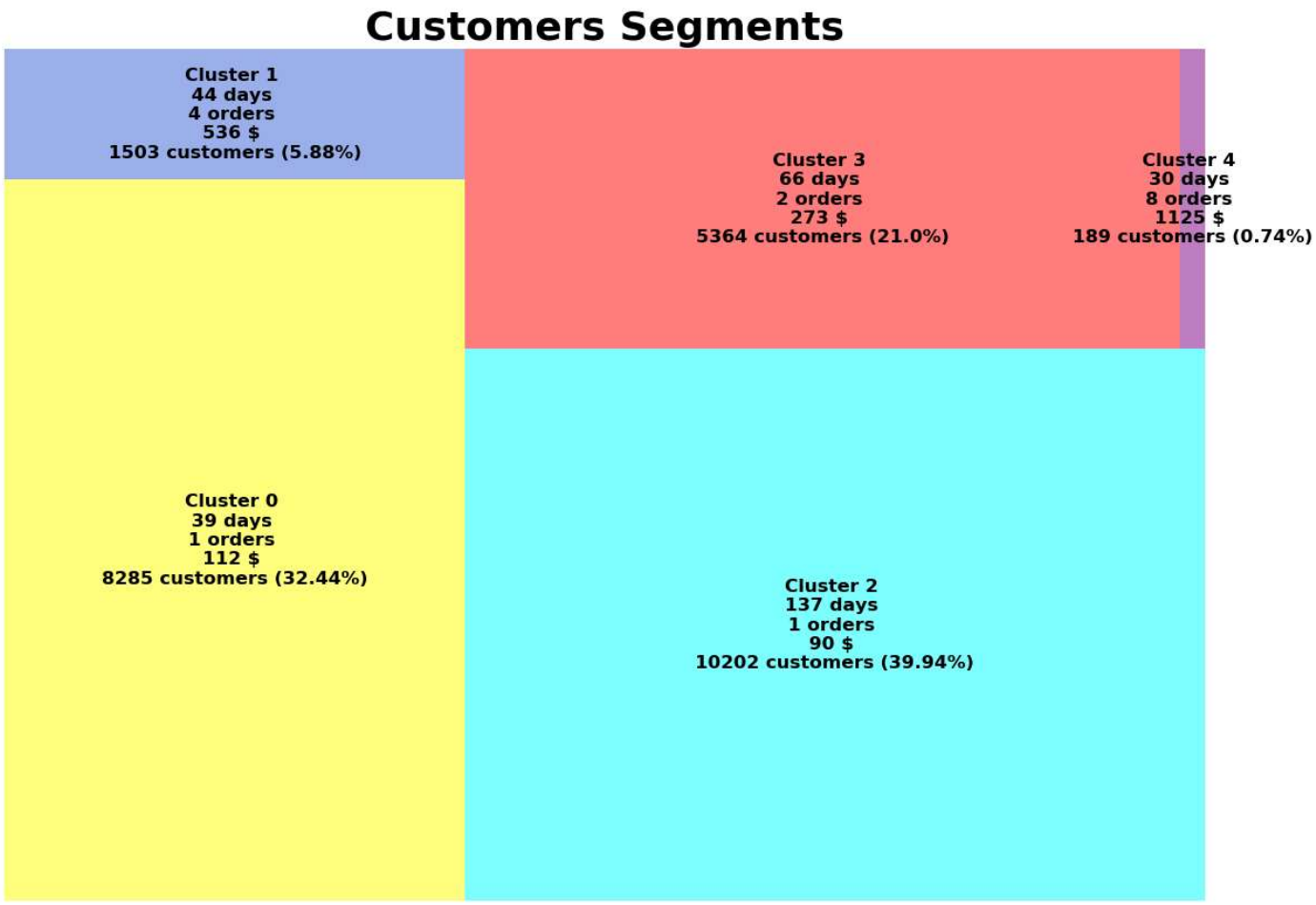
```
<ipython-input-86-4b7bf47954b9>:1: SettingWithCopyWarning:


A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_
```

	Recency	Frequency	Monetary	
	mean	mean	mean	count
Cluster				
0	39.00	1.32	111.69	8285
1	44.35	4.18	535.70	1503
2	136.81	1.14	90.29	10202
3	65.91	2.42	272.79	5364
4	29.53	7.69	1125.21	189

```
# Calculate average values for each RFM_Level, and return a size of each segment
rfm_agg2 = df_now.groupby('Cluster').agg({
    'Recency': 'mean',
    'Frequency': 'mean',
    'Monetary': ['mean', 'count']}).round(0)

rfm_agg2.columns = rfm_agg2.columns.droplevel()
rfm_agg2.columns = ['RecencyMean','FrequencyMean','MonetaryMean', 'Count']
rfm_agg2['Percent'] = round((rfm_agg2['Count']/rfm_agg2.Count.sum())*100, 2)

# Reset the index
rfm_agg2 = rfm_agg2.reset_index()

# Change thr Cluster Columns Datatype into discrete values
rfm_agg2['Cluster'] = 'Cluster '+ rfm_agg2['Cluster'].astype('str')

# Print the aggregated dataset
rfm_agg2
```

	Cluster	RecencyMean	FrequencyMean	MonetaryMean	Count	Percent
0	Cluster 0	39.0	1.0	112.0	8285	32.44
1	Cluster 1	44.0	4.0	536.0	1503	5.88
2	Cluster 2	137.0	1.0	90.0	10202	39.94
3	Cluster 3	66.0	2.0	273.0	5364	21.00
4	Cluster 4	30.0	8.0	1125.0	189	0.74

```
#Create our plot and resize it.
fig = plt.gcf()
ax = fig.add_subplot()
fig.set_size_inches(14, 10)

colors_dict2 = {'Cluster0':'yellow','Cluster1':'royalblue', 'Cluster2':'cyan',
                'Cluster3':'red', 'Cluster4':'purple', 'Cluster5':'green', 'Cluster6':'gold'}

squarify.plot(sizes=rfm_agg2['Count'],
              text_kwargs={'fontsize':12,'weight':'bold', 'fontname':"sans serif"},
              color=colors_dict2.values(),
              label=['{} \n{:.0f} days \n{:.0f} orders \n{:.0f} $ \n{:.0f} customers ({}%)'.format(*rfm_agg2.iloc[i])
                      for i in range(0, len(rfm_agg2))], alpha=0.5 )


plt.title("Customers Segments",fontsize=26,fontweight="bold")
plt.axis('off')

plt.savefig('Unsupervised Segments.png')
plt.show()
```




```
import plotly.express as px

fig = px.scatter(rfm_agg2, x="RecencyMean", y="MonetaryMean", size="FrequencyMean", color="Cluster",
           hover_name="Cluster", size_max=100)
fig.show()
```