r-analysis-2

September 2, 2023

[10]:

```
import pandas as pd
import numpy as np
import datetime as dt
import matplotlib.pyplot as plt
import seaborn as sns
import sklearn
from sklearn.preprocessing import StandardScaler
from sklearn.cluster import KMeans
```

[11]:

```
data = pd.read_excel('Online Retail.xlsx')
```

[12]:

```
data.head()
```

[12]:

```
  InvoiceNo StockCode                          Description  Quantity  \
0    536365    85123A   WHITE HANGING HEART T-LIGHT HOLDER         6
1    536365     71053                  WHITE METAL LANTERN         6
2    536365    84406B       CREAM CUPID HEARTS COAT HANGER         8
3    536365    84029G  KNITTED UNION FLAG HOT WATER BOTTLE         6
4    536365    84029E       RED WOOLLY HOTTIE WHITE HEART.         6

          InvoiceDate  UnitPrice  CustomerID         Country
0 2010-12-01 08:26:00       2.55     17850.0  United Kingdom
1 2010-12-01 08:26:00       3.39     17850.0  United Kingdom
2 2010-12-01 08:26:00       2.75     17850.0  United Kingdom
3 2010-12-01 08:26:00       3.39     17850.0  United Kingdom
4 2010-12-01 08:26:00       3.39     17850.0  United Kingdom
```

[13]:

```
data.isna().sum()
```

[13]:

```
InvoiceNo           0
StockCode           0
Description      1454
Quantity            0
InvoiceDate         0
UnitPrice           0
CustomerID     135080
Country             0
```

```
dtype: int64
```

[14]:
```
data['Description']=data['Description'].fillna('Missing')
```

[15]:
```
data.dropna(axis=0,how = 'any',inplace = True)
```

[16]:
```
data.isna().sum()
```

[16]:
```
InvoiceNo      0
StockCode      0
Description    0
Quantity       0
InvoiceDate    0
UnitPrice      0
CustomerID     0
Country        0
dtype: int64
```

[17]:
```
data.drop_duplicates(inplace=True)
```

[18]:
```
data.describe()
```

[18]:
```
            Quantity      UnitPrice     CustomerID
count  401604.000000  401604.000000  401604.000000
mean       12.183273       3.474064   15281.160818
std       250.283037      69.764035    1714.006089
min    -80995.000000       0.000000   12346.000000
25%         2.000000       1.250000   13939.000000
50%         5.000000       1.950000   15145.000000
75%        12.000000       3.750000   16784.000000
max     80995.000000   38970.000000   18287.000000
```

[19]:
```
data.head()
```

[19]:
```
  InvoiceNo StockCode                          Description  Quantity  \
0    536365    85123A   WHITE HANGING HEART T-LIGHT HOLDER         6
1    536365     71053                  WHITE METAL LANTERN         6
2    536365    84406B       CREAM CUPID HEARTS COAT HANGER         8
3    536365    84029G  KNITTED UNION FLAG HOT WATER BOTTLE         6
4    536365    84029E       RED WOOLLY HOTTIE WHITE HEART.         6

          InvoiceDate  UnitPrice  CustomerID         Country
0 2010-12-01 08:26:00       2.55     17850.0  United Kingdom
1 2010-12-01 08:26:00       3.39     17850.0  United Kingdom
2 2010-12-01 08:26:00       2.75     17850.0  United Kingdom
3 2010-12-01 08:26:00       3.39     17850.0  United Kingdom
4 2010-12-01 08:26:00       3.39     17850.0  United Kingdom
```

[20]:
```
data['InvoiceDate'] = pd.to_datetime(data['InvoiceDate'])
```

[21]:
```
# Convert the datetime values to "Month Year" format
data['month_year']=data['InvoiceDate']
data['month_year'] = data['InvoiceDate'].dt.to_period('M')
```

[22]:
```
data['diff'] = max(data['InvoiceDate']) - data['InvoiceDate']
recency = data.groupby('CustomerID')['diff'].min()
recency = recency.reset_index()
recency.head()
```

[22]:
```
   CustomerID              diff
0     12346.0 325 days 02:33:00
1     12347.0   1 days 20:58:00
2     12348.0  74 days 23:37:00
3     12349.0  18 days 02:59:00
4     12350.0 309 days 20:49:00
```

[23]:
```
recency['diff'] = recency['diff'].dt.days
```

[24]:
```
recency.head()
```

[24]:
```
   CustomerID  diff
0     12346.0   325
1     12347.0     1
2     12348.0    74
3     12349.0    18
4     12350.0   309
```

[25]:
```
recency.tail()
```

[25]:
```
      CustomerID  diff
4367     18280.0   277
4368     18281.0   180
4369     18282.0     7
4370     18283.0     3
4371     18287.0    42
```

[26]:
```
frequency = data.groupby('CustomerID')['InvoiceDate'].count()
frequency = frequency.reset_index()
frequency.head()
```

[26]:
```
   CustomerID  InvoiceDate
0     12346.0            2
1     12347.0          182
2     12348.0           31
3     12349.0           73
```

```
4     12350.0           17
```

[27]:
```
data['Amount'] = data['Quantity']*data['UnitPrice']
monetary = data.groupby('CustomerID')['Amount'].sum()
monetary = monetary.reset_index()
monetary.tail()
```

[27]:
```
      CustomerID   Amount
4367     18280.0   180.60
4368     18281.0    80.82
4369     18282.0   176.60
4370     18283.0  2045.53
4371     18287.0  1837.28
```

[28]:
```
data.head()
```

[28]:
```
  InvoiceNo StockCode                          Description  Quantity  \
0    536365    85123A   WHITE HANGING HEART T-LIGHT HOLDER         6
1    536365     71053                  WHITE METAL LANTERN         6
2    536365    84406B       CREAM CUPID HEARTS COAT HANGER         8
3    536365    84029G  KNITTED UNION FLAG HOT WATER BOTTLE         6
4    536365    84029E       RED WOOLLY HOTTIE WHITE HEART.         6

          InvoiceDate  UnitPrice  CustomerID         Country month_year  \
0 2010-12-01 08:26:00       2.55     17850.0  United Kingdom    2010-12
1 2010-12-01 08:26:00       3.39     17850.0  United Kingdom    2010-12
2 2010-12-01 08:26:00       2.75     17850.0  United Kingdom    2010-12
3 2010-12-01 08:26:00       3.39     17850.0  United Kingdom    2010-12
4 2010-12-01 08:26:00       3.39     17850.0  United Kingdom    2010-12

               diff  Amount
0 373 days 04:24:00   15.30
1 373 days 04:24:00   20.34
2 373 days 04:24:00   22.00
3 373 days 04:24:00   20.34
4 373 days 04:24:00   20.34
```

[29]:
```
data.tail()
```

[29]:
```
       InvoiceNo StockCode                      Description  Quantity  \
541904    581587     22613      PACK OF 20 SPACEBOY NAPKINS        12
541905    581587     22899     CHILDREN'S APRON DOLLY GIRL          6
541906    581587     23254    CHILDRENS CUTLERY DOLLY GIRL          4
541907    581587     23255  CHILDRENS CUTLERY CIRCUS PARADE         4
541908    581587     22138    BAKING SET 9 PIECE RETROSPOT          3

               InvoiceDate  UnitPrice  CustomerID Country month_year   diff  \
541904 2011-12-09 12:50:00       0.85     12680.0  France    2011-12 0 days
541905 2011-12-09 12:50:00       2.10     12680.0  France    2011-12 0 days
541906 2011-12-09 12:50:00       4.15     12680.0  France    2011-12 0 days
541907 2011-12-09 12:50:00       4.15     12680.0  France    2011-12 0 days
541908 2011-12-09 12:50:00       4.95     12680.0  France    2011-12 0 days

        Amount
541904   10.20
541905   12.60
541906   16.60
541907   16.60
541908   14.85
```

```
[30]: rfm = pd.merge(recency, frequency, on='CustomerID', how='inner')
```

```
[31]: rfm = pd.merge(rfm, monetary, on='CustomerID', how='inner')
```

```
[32]: rfm.columns = ['CustomerID','Recency','Frequency','Monetary']
```

```
[33]: rfm.head()
```

```
[33]:    CustomerID  Recency  Frequency  Monetary
      0     12346.0      325          2      0.00
      1     12347.0        1        182   4310.00
      2     12348.0       74         31   1797.24
      3     12349.0       18         73   1757.55
      4     12350.0      309         17    334.40
```

```
[54]: rfm['Recency_labels']=pd.cut(rfm['Recency'],␣
        ↪bins=5,labels=['newest','newer','medium','older','oldest'])
```

```
[55]: rfm['Frequency_labels']=pd.cut(rfm['Frequency'],␣
        ↪bins=5,labels=['less','lesser','medium','high','more'])
```

```
[56]: rfm['Monetary_labels']=pd.cut(rfm['Monetary'],␣
        ↪bins=4,labels=['lowest','lower','average','high'])
```

```
[57]: rfm['RFM_segment']=rfm['Recency_labels'].astype(str)+rfm['Frequency_labels'].
        ↪astype(str)+rfm['Monetary_labels'].astype(str)
```

```
[58]: recency_dict = {'newest':5,'newer':4,'medium':3,'older':2,'oldest':1}
```

```
[59]: frequency_dict = {'more':5,'high':4,'medium':3,'lesser':2,'less':1}
```

```
[60]: monetary_dict = {'high':4,'average':3,'lower':2,'lowest':1}
```

[64]:
```
rfm['RFM_score'] = rfm['Recency_labels'].map(recency_dict).
 ↪astype(int)+rfm['Frequency_labels'].map(frequency_dict).
 ↪astype(int)+rfm['Frequency_labels'].map(frequency_dict).astype(int)
```

[65]:
```
rfm.head()
```

[65]:
```
   CustomerID  Recency  Frequency  Monetary Recency_labels Frequency_labels  \
0     12346.0      325          2      0.00         oldest             less
1     12347.0        1        182   4310.00         newest             less
2     12348.0       74         31   1797.24         newest             less
3     12349.0       18         73   1757.55         newest             less
4     12350.0      309         17    334.40         oldest             less

  Monetary_labels       RFM_segment  RFM_score
0          lowest  oldestlesslowest          3
1          lowest  newestlesslowest          7
2          lowest  newestlesslowest          7
3          lowest  newestlesslowest          7
4          lowest  oldestlesslowest          3
```

[66]:
```
rfm['RFM_score'].unique()
```

[66]:
```
array([ 3,  7,  5,  4,  6, 11,  9, 13, 15])
```

[71]:
```
import numpy as np

# Assuming you have an existing DataFrame named 'rfm' with an 'RFM_score' column
rfm["customer_segment"] = np.select(
    [rfm['RFM_score'] > 10, (10 >= rfm['RFM_score']) & (rfm['RFM_score'] >= 5),␣
 ↪rfm['RFM_score'] < 5],
    ["Top Customers", "Medium Value Customer", "Low Value Customer"],
    default="Unknown"
)
```

[72]:
```
rfm
```

[72]:
```
      CustomerID  Recency  Frequency  Monetary Recency_labels  \
0        12346.0      325          2      0.00         oldest
1        12347.0        1        182   4310.00         newest
2        12348.0       74         31   1797.24         newest
3        12349.0       18         73   1757.55         newest
4        12350.0      309         17    334.40         oldest
…            …        …          …         …              …
4367     18280.0      277         10    180.60          older
4368     18281.0      180          7     80.82         medium
4369     18282.0        7         13    176.60         newest
4370     18283.0        3        721   2045.53         newest
```

```
4371     18287.0       42         70   1837.28         newest

     Frequency_labels Monetary_labels        RFM_segment  RFM_score  \
0                less          lowest  oldestlesslowest          3
1                less          lowest  newestlesslowest          7
2                less          lowest  newestlesslowest          7
3                less          lowest  newestlesslowest          7
4                less          lowest  oldestlesslowest          3
…               …             …               …        …
4367             less          lowest   olderlesslowest          4
4368             less          lowest  mediumlesslowest          5
4369             less          lowest  newestlesslowest          7
4370             less          lowest  newestlesslowest          7
4371             less          lowest  newestlesslowest          7

           customer_segment
0         Low Value Customer
1      Medium Value Customer
2      Medium Value Customer
3      Medium Value Customer
4         Low Value Customer
…                    …
4367      Low Value Customer
4368   Medium Value Customer
4369   Medium Value Customer
4370   Medium Value Customer
4371   Medium Value Customer

[4372 rows x 10 columns]
```

[74]:

```
# rfm["customer_segment"] = ((np.where(rfm['RFM_score']>10,"Top␣
↪Customers")),(np.where(10>rfm['RFM_score']>=5,"Medium Value Customer")),(np.
↪where(rfm['RFM_score']<5, "Low value customer")))
```

[33]:

```
#rfm['Frequency'].idxmax()
```

[34]:

```
#rfm['CustomerID'][4042]
```

[35]:

```
#rfm['Frequency'][4042]
```

[ ]:

```

```

[85]:

```
t_s = "C:/Users/Naina Dutraj/Downloads/cu_seg.csv"
rfm.to_csv(t_s)

# ec = "C:/Users/Naina Dutraj/Downloads/EC_DATA.csv"
# EC_DATA.to_csv(ec)
```

[86]:

```
scaler = StandardScaler()
rfm_normalized = rfm[['Monetary','Frequency','Recency']]
rfm_normalized.head()
```

[86]:

```
   Monetary  Frequency  Recency
0      0.00          2      325
1   4310.00        182        1
2   1797.24         31       74
3   1757.55         73       18
4    334.40         17      309
```

[87]:

```
rfm_normalized = scaler.fit_transform(rfm_normalized)
rfm_normalized = pd.DataFrame(rfm_normalized)
rfm_normalized.head()
```

[87]:

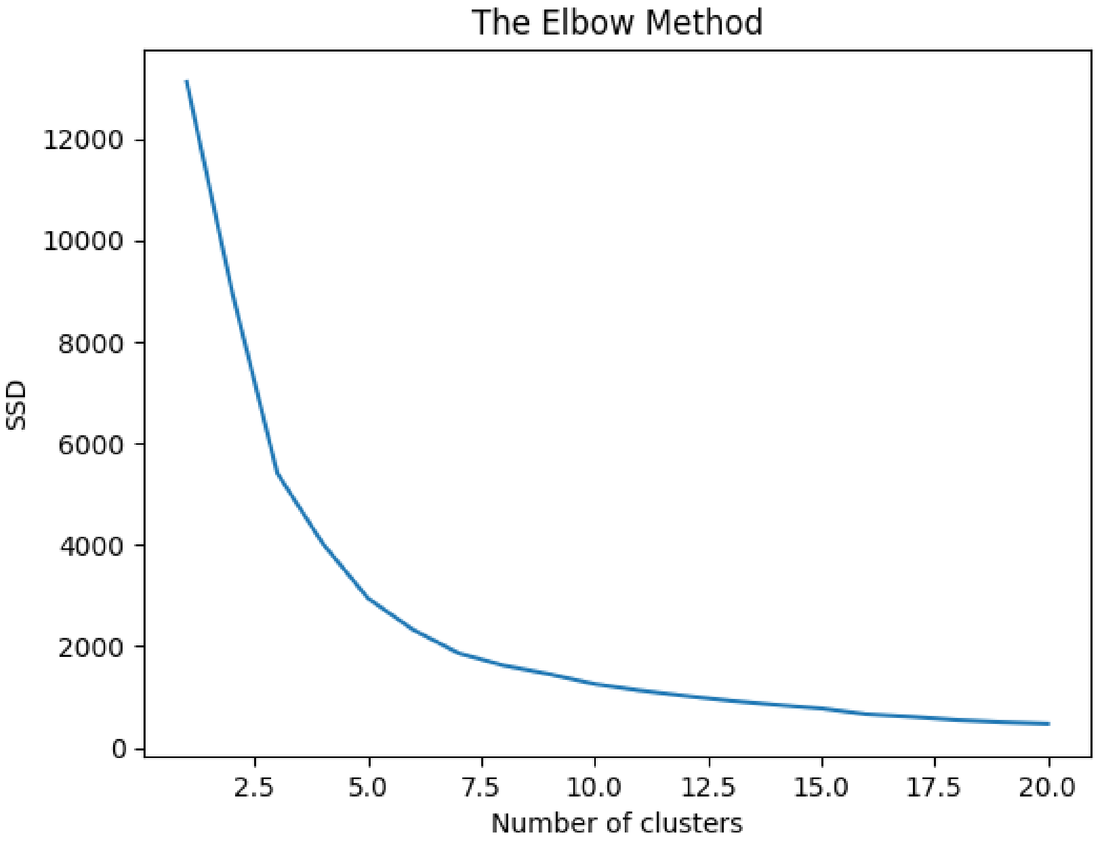
```
          0         1         2
0 -0.230420 -0.392056  2.322023
1  0.294055  0.393293 -0.893733
2 -0.011717 -0.265527 -0.169196
3 -0.016547 -0.082279 -0.725005
4 -0.189727 -0.326610  2.163220
```

[88]:

```
ssd =[]

for num_clusters in range(1,21):
    kmeans = KMeans(n_clusters = num_clusters, max_iter=100)
    kmeans.fit(rfm_normalized)

    ssd.append(kmeans.inertia_)
plt.plot(range(1,21), ssd)
plt.title('The Elbow Method')
plt.xlabel('Number of clusters')
plt.ylabel('SSD')
plt.show()
```



[89]:
```
rfm_normalized.head()
```

[89]:
```
          0         1         2
0 -0.230420 -0.392056  2.322023
1  0.294055  0.393293 -0.893733
2 -0.011717 -0.265527 -0.169196
3 -0.016547 -0.082279 -0.725005
4 -0.189727 -0.326610  2.163220
```

[90]:
```
#ssd
```

[91]:
```
#EC_DATA = pd.DataFrame({"n_cluster":range(1,21),"k_means":ssd})
```

[92]:
```
#EC_DATA.head()
```

[93]:
```
# ec = "C:/Users/Naina Dutraj/Downloads/EC_DATA.csv"
# EC_DATA.to_csv(ec)
```

[94]:
```
kmeans = KMeans(n_clusters = 3, max_iter=100)
kmeans.fit(rfm_normalized)
```

```
[94]: KMeans(max_iter=100, n_clusters=3)
```

```
[95]: rfm_normalized.loc[:,'CustomerID'] = rfm['CustomerID']
      rfm_normalized
```

```
[95]:              0         1         2  CustomerID
      0    -0.230420 -0.392056  2.322023     12346.0
      1     0.294055  0.393293 -0.893733     12347.0
      2    -0.011717 -0.265527 -0.169196     12348.0
      3    -0.016547 -0.082279 -0.725005     12349.0
      4    -0.189727 -0.326610  2.163220     12350.0
      …          …         …         …           …
      4367 -0.208443 -0.357152  1.845615     18280.0
      4368 -0.220585 -0.370241  0.882873     18281.0
      4369 -0.208929 -0.344062 -0.834182     18282.0
      4370  0.018496  2.744979 -0.873883     18283.0
      4371 -0.006845 -0.095368 -0.486801     18287.0

      [4372 rows x 4 columns]
```

```
[96]: rfm_normalized.columns = ['Monetary','Frequency','Recency','CustomerID']
      rfm_normalized.head()
```

```
[96]:    Monetary  Frequency   Recency  CustomerID
      0 -0.230420  -0.392056  2.322023     12346.0
      1  0.294055   0.393293 -0.893733     12347.0
      2 -0.011717  -0.265527 -0.169196     12348.0
      3 -0.016547  -0.082279 -0.725005     12349.0
      4 -0.189727  -0.326610  2.163220     12350.0
```

```
[97]: rfm_normalized['cluster'] = kmeans.labels_
      rfm_normalized
```

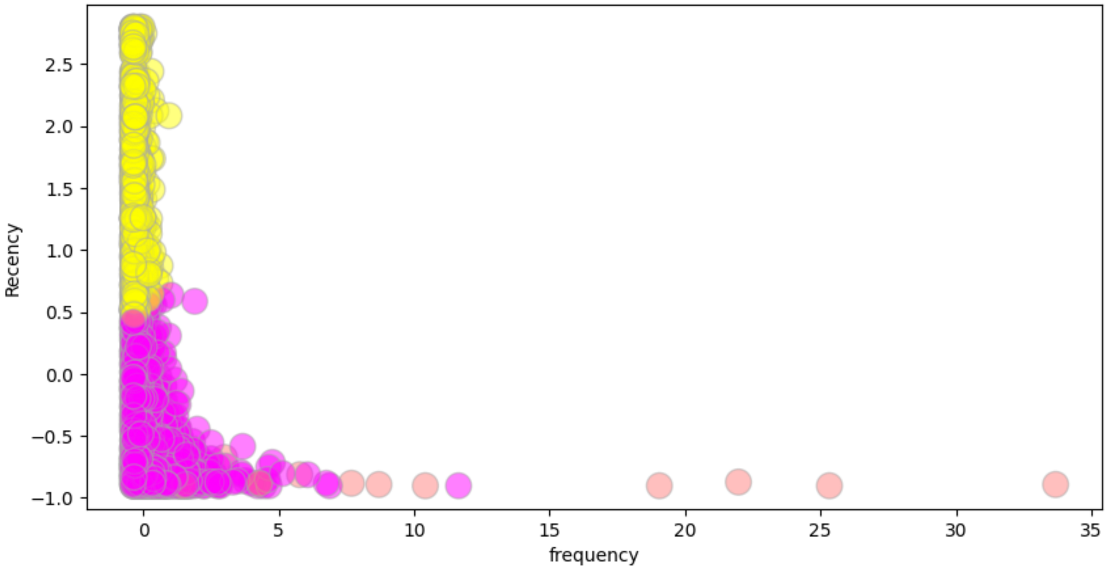
```
[97]:       Monetary  Frequency   Recency  CustomerID  cluster
      0    -0.230420  -0.392056  2.322023     12346.0        2
      1     0.294055   0.393293 -0.893733     12347.0        0
      2    -0.011717  -0.265527 -0.169196     12348.0        0
      3    -0.016547  -0.082279 -0.725005     12349.0        0
      4    -0.189727  -0.326610  2.163220     12350.0        2
      …          …          …         …           …        …
      4367 -0.208443  -0.357152  1.845615     18280.0        2
      4368 -0.220585  -0.370241  0.882873     18281.0        2
      4369 -0.208929  -0.344062 -0.834182     18282.0        0
      4370  0.018496   2.744979 -0.873883     18283.0        0
      4371 -0.006845  -0.095368 -0.486801     18287.0        0

      [4372 rows x 5 columns]
```

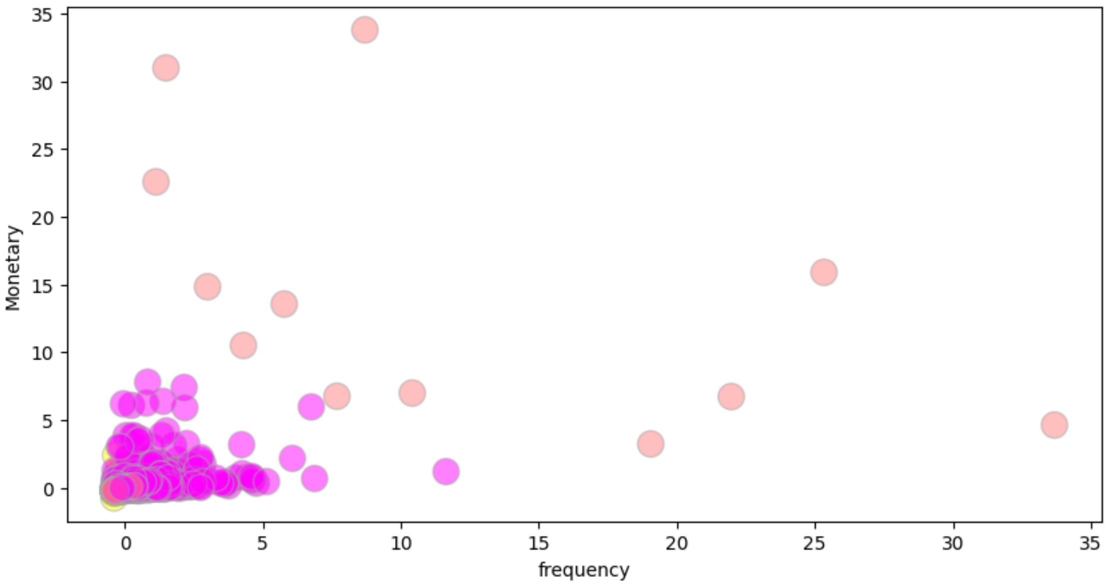
[98]:
```
# rfm['cluster']=kmeans.labels_
# rfm
```

[99]:
```
# rfm2 ="C:/Users/Naina Dutraj/Downloads/rf.csv"
# rfm.to_csv(rfm2)
```

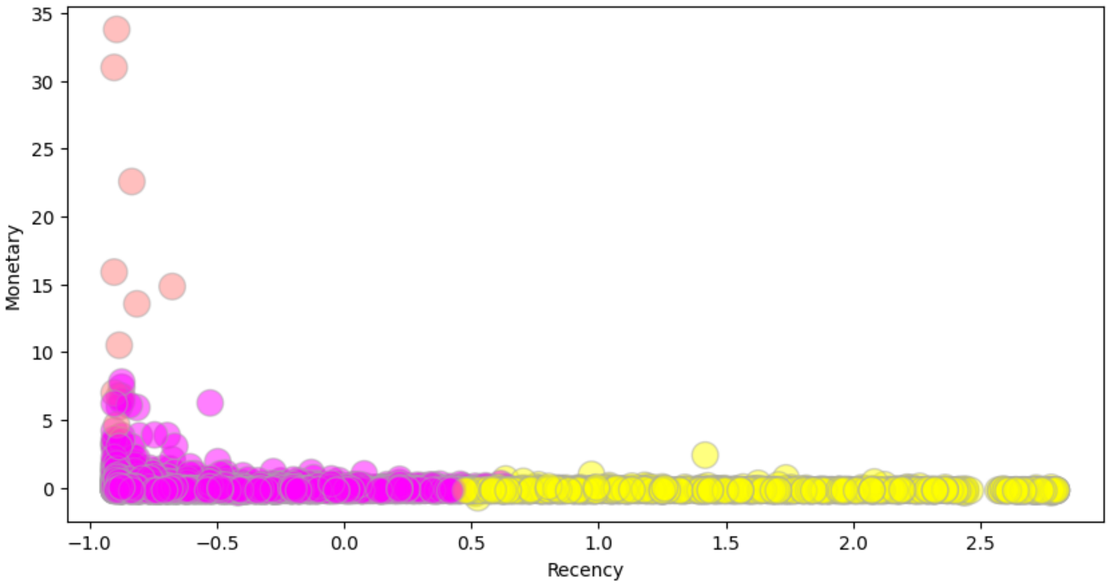
[100]:
```
plt.rcParams["figure.figsize"] = (10,5)
plt.scatter(rfm_normalized['Frequency'],rfm_normalized['Recency'],
            c=rfm_normalized['cluster'],
            s=200,
            cmap='spring',
            alpha=0.5,
            edgecolor='darkgrey')
plt.xlabel("frequency")
plt.ylabel("Recency")
plt.show()
```



[101]:
```
plt.scatter(rfm_normalized['Frequency'],rfm_normalized['Monetary'],
            c=rfm_normalized['cluster'],
            s=200,
            cmap='spring',
            alpha=0.5,
            edgecolor='darkgrey')
plt.xlabel("frequency")
plt.ylabel("Monetary")
plt.show()
```



[102]:
```
plt.scatter(rfm_normalized['Recency'],rfm_normalized['Monetary'],
            c=rfm_normalized['cluster'],
            s=200,
            cmap='spring',
            alpha=0.5,
            edgecolor='darkgrey')
plt.xlabel("Recency")
plt.ylabel("Monetary")
plt.show()
```



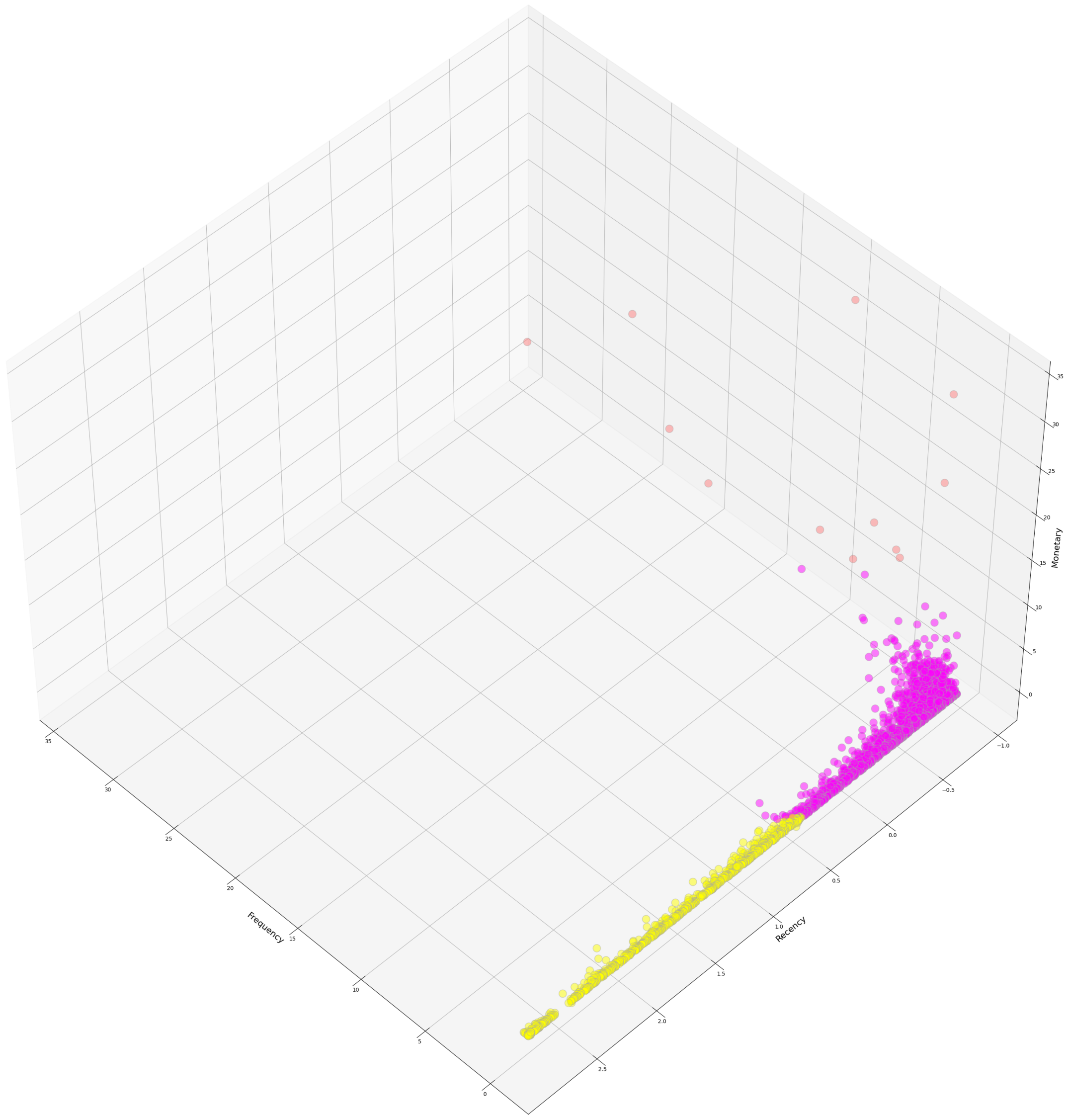
[103]:

```
from mpl_toolkits.mplot3d import Axes3D
plt.rcParams["figure.figsize"] = (30,30)
fig = plt.figure(1)

plt.clf()
ax=Axes3D(fig,
          rect=[0,0,.95,1],
          elev=48,
          azim=135)
plt.cla()
ax.
 ↪scatter(rfm_normalized['Frequency'],rfm_normalized['Recency'],rfm_normalized['Monetary'],
           c=rfm_normalized['cluster'],
           s=200,
           cmap='spring',
           alpha=0.5,
           edgecolor='darkgrey')
ax.set_xlabel('Frequency',
             fontsize = 16)
ax.set_ylabel('Recency',
             fontsize = 16)
ax.set_zlabel('Monetary',
             fontsize = 16)

plt.show()
```

```
C:\Users\Naina Dutraj\AppData\Local\Temp\ipykernel_19264\1678968775.py:6:
MatplotlibDeprecationWarning: Axes3D(fig) adding itself to the figure is
deprecated since 3.4. Pass the keyword argument auto_add_to_figure=False and use
fig.add_axes(ax) to suppress this warning. The default value of
auto_add_to_figure will change to False in mpl3.5 and True values will no longer
work in 3.6.  This is consistent with other Axes classes.
  ax=Axes3D(fig,
```


Monetary
35
30
25
20
15
10
5
0
Frequency
35
30
25
20
15
10
5
0
Recency
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
2.5

[ ]:

[ ]:

[ ]: