Why RFM?

- RFM (Recency, Frequency, Monetary) analysis is a marketing model using customer segmentation based on their transaction history.
- This model could be very useful, especially for small and medium-sized enterprises (SMEs) with limited marketing resources, helping them focus on the potentially right customer segments to increase ROI, reduce churn, reduce cost, improve customer relationship, and a lot more.

How?

- In RFM analysis, customers are scored based on three factors (Recency - how recently, Frequency - how often, Monetary - how much), then labeled based on the combination of RFM scores.

Reference:

- https://www.putler.com/rfm-analysis (https://www.putler.com/rfm-analysis)

In [1]:

```
import pandas as pd
import numpy as np
import datetime
import matplotlib.pyplot as plt
import seaborn as sns
import squarify
```

Import data

In [2]:

```
# Orders table
order = pd.read_excel(r"Dataset.xlsx", sheet_name='Orders', dtype={'CustomerID': str,'InvoiceNo': str})
order
```

Out[2]:

	InvoiceNo	StockCode	Description	Quantity	InvoiceDate	UnitPrice	CustomerID
0	536365	85123A	WHITE HANGING HEART T-LIGHT HOLDER	6	2010-12-01 08:26:00	2.55	17850
1	536365	71053	WHITE METAL LANTERN	6	2010-12-01 08:26:00	3.39	17850
2	536365	84406B	CREAM CUPID HEARTS COAT HANGER	8	2010-12-01 08:26:00	2.75	17850
3	536365	84029G	KNITTED UNION FLAG HOT WATER BOTTLE	6	2010-12-01 08:26:00	3.39	17850
4	536365	84029E	RED WOOLLY HOTTIE WHITE HEART.	6	2010-12-01 08:26:00	3.39	17850
...	...	...	...	...	...	...	...
354340	581585	22466	FAIRY TALE COTTAGE NIGHT LIGHT	12	2011-12-09 12:31:00	1.95	15804
354341	581586	22061	LARGE CAKE STAND HANGING STRAWBERY	8	2011-12-09 12:49:00	2.95	13113
354342	581586	23275	SET OF 3 HANGING OWLS OLLIE BEAK	24	2011-12-09 12:49:00	1.25	13113
354343	581586	21217	RED RETROSPOT ROUND CAKE TINS	24	2011-12-09 12:49:00	8.95	13113
354344	581586	20685	DOORMAT RED RETROSPOT	10	2011-12-09 12:49:00	7.08	13113

354345 rows × 7 columns

In [3]:

```
order.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 354345 entries, 0 to 354344
Data columns (total 7 columns):
 #   Column       Non-Null Count   Dtype
---  ------       --------------   -----
 0   InvoiceNo    354345 non-null  object
 1   StockCode    354345 non-null  object
 2   Description  354345 non-null  object
 3   Quantity     354345 non-null  int64
 4   InvoiceDate  354345 non-null  datetime64[ns]
 5   UnitPrice    354345 non-null  float64
 6   CustomerID   354345 non-null  object
dtypes: datetime64[ns](1), float64(1), int64(1), object(4)
memory usage: 18.9+ MB
```

In [4]:
```
# Segmentations table
segment = pd.read_excel(r"Dataset.xlsx", sheet_name='Segmentation')
segment
```

Out[4]:

	Segment	RFM Score
0	Champions	555, 554, 544, 545, 454, 455, 445
1	Loyal	543, 444, 435, 355, 354, 345, 344, 335
2	Potential Loyalist	553, 551, 552, 541, 542, 533, 532, 531, 452, 4...
3	New Customers	512, 511, 422, 421, 412, 411, 311
4	Promising	525, 524, 523, 522, 521, 515, 514, 513, 425,42...
5	Need Attention	535, 534, 443, 434, 343, 334, 325, 324
6	About To Sleep	331, 321, 312, 221, 213, 231, 241, 251
7	At Risk	255, 254, 245, 244, 253, 252, 243, 242, 235, 2...
8	Cannot Lose Them	155, 154, 144, 214,215,115, 114, 113
9	Hibernating customers	332, 322, 233, 232, 223, 222, 132, 123, 122, 2...
10	Lost customers	111, 112, 121, 131,141,151

Calculate Recency, Frequency, Monetary

In [5]:
```
# calculate total sales of each order
order['Sales'] = order['UnitPrice'] * order['Quantity']
groupby_order = order.groupby(['InvoiceNo', 'InvoiceDate', 'CustomerID'], as_index=False)['Sales'].sum()
groupby_order
```

Out[5]:

	InvoiceNo	InvoiceDate	CustomerID	Sales
0	536365	2010-12-01 08:26:00	17850	139.12
1	536366	2010-12-01 08:28:00	17850	22.20
2	536367	2010-12-01 08:34:00	13047	278.73
3	536368	2010-12-01 08:34:00	13047	70.05
4	536369	2010-12-01 08:35:00	13047	17.85
...	...	...	...	...
16671	581582	2011-12-09 12:21:00	17581	29.88
16672	581583	2011-12-09 12:23:00	13777	124.60
16673	581584	2011-12-09 12:25:00	13777	140.64
16674	581585	2011-12-09 12:31:00	15804	329.05
16675	581586	2011-12-09 12:49:00	13113	339.20

16676 rows × 4 columns

In [6]:
```
# Assume "2011-12-31" is day used to calculate Recency
day_r = datetime.datetime.strptime('2011-12-31', '%Y-%m-%d')
```

In [7]:
```
# Calculate r value, f value, and m value

rfm = groupby_order.groupby('CustomerID').agg({'InvoiceDate': 'max', 'InvoiceNo': 'count', 'Sales': 'sum'}).reset_inde
rfm.columns = ['CustomerID', 'LastOrderDate', 'Frequency', 'Monetary']
rfm['Recency'] = (day_r - rfm['LastOrderDate']).dt.days
rfm = rfm[['CustomerID', 'Recency', 'Frequency', 'Monetary']]
rfm
```

Out[7]:

	CustomerID	Recency	Frequency	Monetary
0	12346	346	1	77183.60
1	12747	23	11	4196.01
2	12748	21	211	33719.73
3	12749	24	5	4090.88
4	12820	24	4	942.34
...	...	...	...	...
3916	18280	298	1	180.60
3917	18281	201	1	80.82
3918	18282	28	2	178.05
3919	18283	24	16	2094.88
3920	18287	63	3	1837.28

3921 rows × 4 columns

In [8]:

```python
# Calculate r score, f score, and m score
def R_score(x,d,s):
    if x <= d[s].quantile(0.2):
        return 5
    elif x <= d[s].quantile(0.4):
        return 4
    elif x <= d[s].quantile(0.6):
        return 3
    elif x <= d[s].quantile(0.8):
        return 2
    else:
        return 1

def FM_score(x,d,s):
    if x <= d[s].quantile(0.2):
        return 1
    elif x <= d[s].quantile(0.4):
        return 2
    elif x <= d[s].quantile(0.6):
        return 3
    elif x <= d[s].quantile(0.8):
        return 4
    else:
        return 5

rfm['R Score'] = rfm.apply(lambda row: R_score(row['Recency'], rfm, 'Recency'), axis=1)
rfm['F Score'] = rfm.apply(lambda row: FM_score(row['Frequency'], rfm, 'Frequency'), axis=1)
rfm['M Score'] = rfm.apply(lambda row: FM_score(row['Monetary'], rfm, 'Monetary'), axis=1)
```

In [9]:

```python
rfm['RFM Score'] = rfm['R Score'].astype(str) + rfm['F Score'].astype(str) + rfm['M Score'].astype(str)
rfm['RFM Score'] = rfm['RFM Score'].astype(int)
rfm
```

Out[9]:

	CustomerID	Recency	Frequency	Monetary	R Score	F Score	M Score	RFM Score
0	12346	346	1	77183.60	1	1	5	115
1	12747	23	11	4196.01	5	5	5	555
2	12748	21	211	33719.73	5	5	5	555
3	12749	24	5	4090.88	5	4	5	545
4	12820	24	4	942.34	5	4	4	544
...	...	...	...	...	...	...	...	...
3916	18280	298	1	180.60	1	1	1	111
3917	18281	201	1	80.82	1	1	1	111
3918	18282	28	2	178.05	5	2	1	521
3919	18283	24	16	2094.88	5	5	5	555
3920	18287	63	3	1837.28	3	3	4	334

3921 rows × 8 columns

In [ ]:

In [ ]:

In [10]:

```python
# convert comma-separated string to a list of RFM scores

segment['RFM Score'] = segment['RFM Score'].str.split(',')
segment = segment.explode('RFM Score').reset_index(drop=True)
segment['RFM Score'] = segment['RFM Score'].astype(int)
segment.sort_values(by='RFM Score')
segment.head(10)
```

Out[10]:

	Segment	RFM Score
0	Champions	555
1	Champions	554
2	Champions	544
3	Champions	545
4	Champions	454
5	Champions	455
6	Champions	445
7	Loyal	543
8	Loyal	444
9	Loyal	435

```
In [11]: joined = rfm.merge(segment, how='left', on='RFM Score')
         joined
```

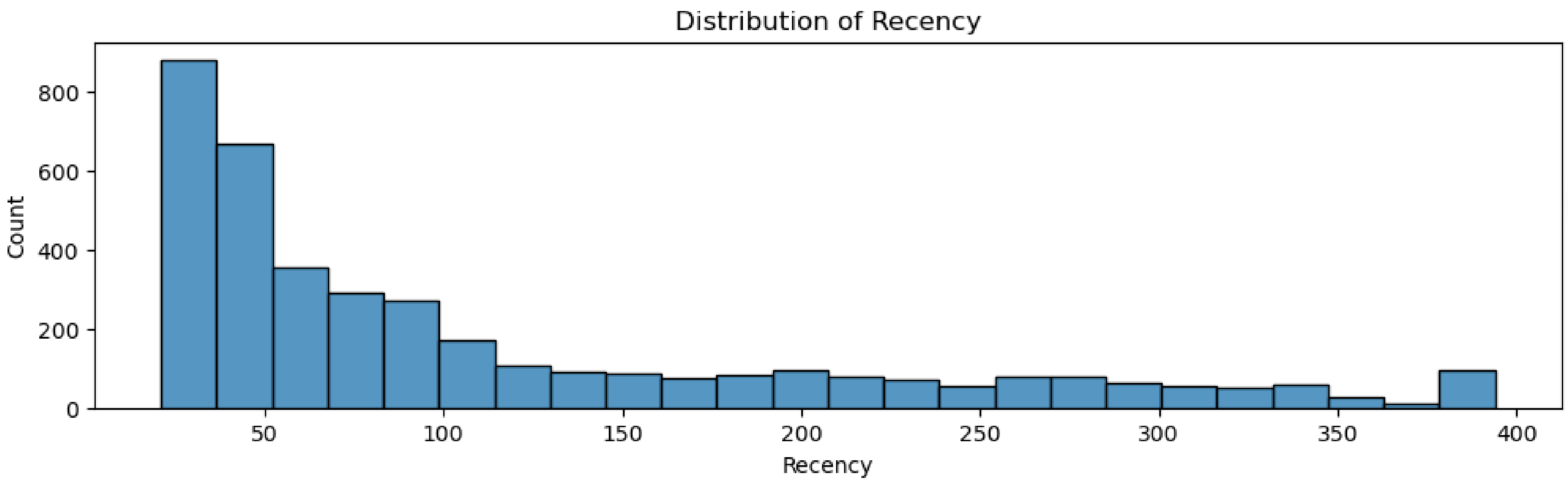
Out[11]:

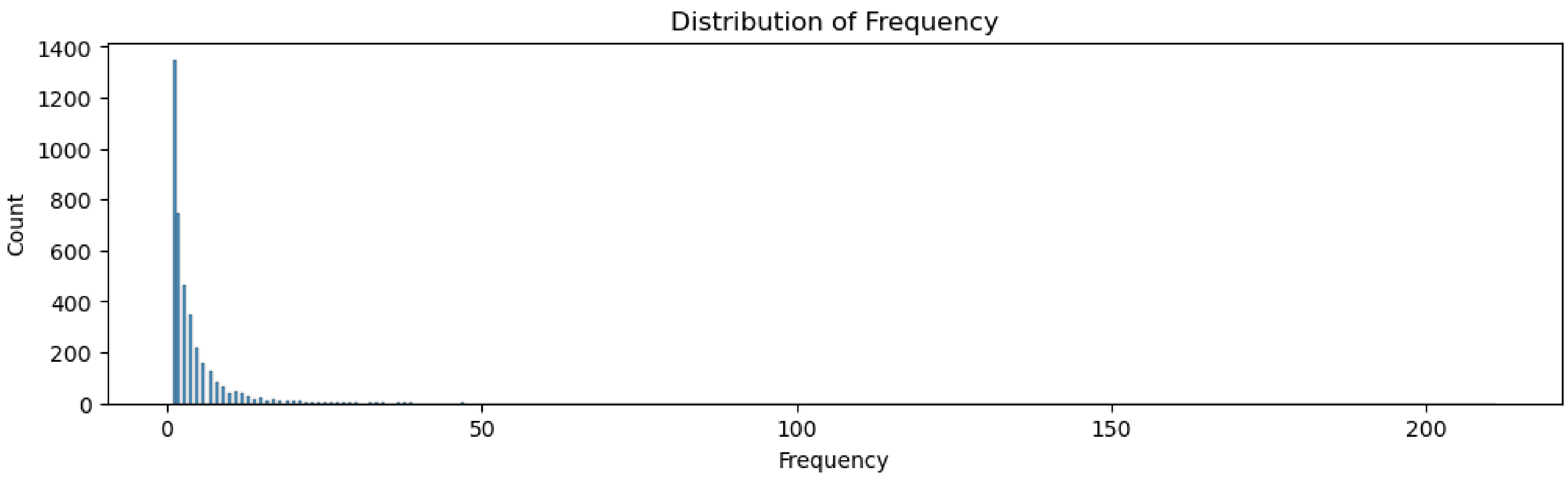
	CustomerID	Recency	Frequency	Monetary	R Score	F Score	M Score	RFM Score	Segment
0	12346	346	1	77183.60	1	1	5	115	Cannot Lose Them
1	12747	23	11	4196.01	5	5	5	555	Champions
2	12748	21	211	33719.73	5	5	5	555	Champions
3	12749	24	5	4090.88	5	4	5	545	Champions
4	12820	24	4	942.34	5	4	4	544	Champions
...	...	...	...	...	...	...	...	...	...
3916	18280	298	1	180.60	1	1	1	111	Lost customers
3917	18281	201	1	80.82	1	1	1	111	Lost customers
3918	18282	28	2	178.05	5	2	1	521	Promising
3919	18283	24	16	2094.88	5	5	5	555	Champions
3920	18287	63	3	1837.28	3	3	4	334	Need Attention

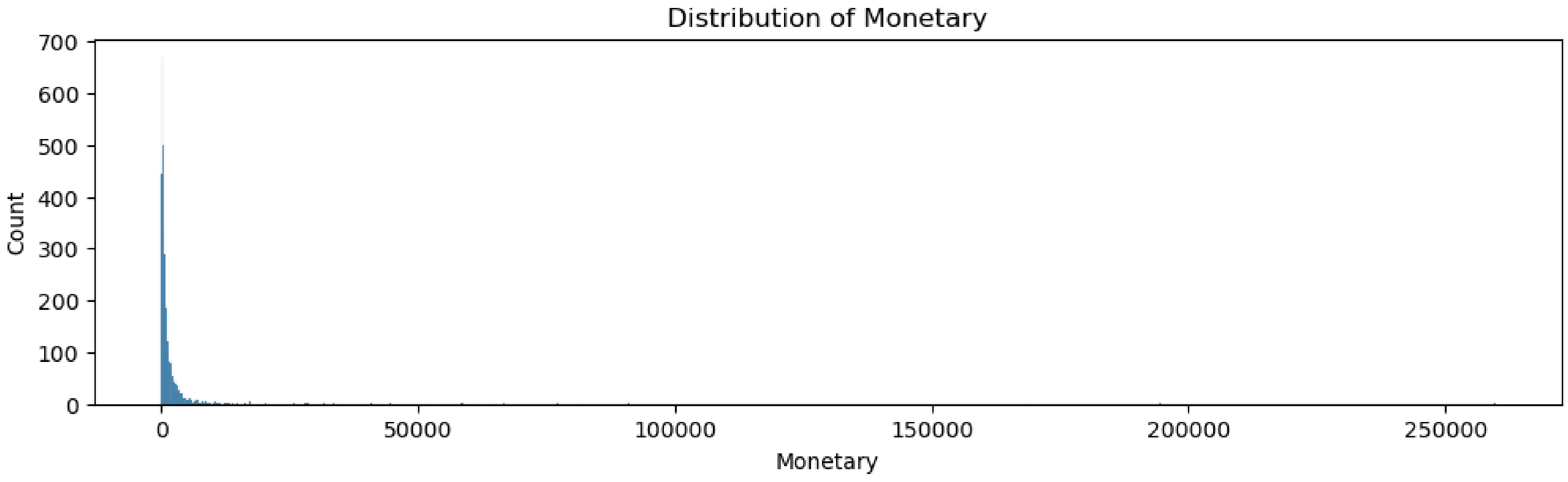
3921 rows × 9 columns

Visualization

```
In [12]: # show distribution of each variable of the model

         colnames = ['Recency', 'Frequency', 'Monetary']

         for col in colnames:
             fig, ax = plt.subplots(figsize=(12,3))
             sns.histplot(rfm[col])
             ax.set_title('Distribution of %s' % col)
             plt.show()
```







In [13]:

```
grp = joined.groupby('Segment').agg({'CustomerID': 'count',
                                     'Monetary': 'sum',
                                     'Recency': 'mean',
                                     'Frequency': 'mean'}).reset_index()
grp.columns = ['Segment', 'CustomerCount', 'TotalMonetary', 'AvgRecency', 'AvgFrequency']
grp.sort_values(by='CustomerCount', ascending=False, inplace=True)
grp
```

Out[13]:

	Segment	CustomerCount	TotalMonetary	AvgRecency	AvgFrequency
3	Champions	724	4389847.630	31.273481	12.270718
4	Hibernating customers	589	225520.612	156.925297	1.747029
5	Lost customers	514	109648.670	296.359922	1.060311
6	Loyal	363	847617.220	57.606061	5.707989
8	New Customers	360	76038.990	50.822222	1.169444
1	At Risk	315	596119.641	156.361905	4.161905
9	Potential Loyalist	293	178514.510	52.276451	2.730375
7	Need Attention	231	275286.701	53.809524	3.320346
10	Promising	214	329753.980	42.271028	1.607477
0	About To Sleep	209	78533.700	100.100478	1.363636
2	Cannot Lose Them	109	201509.900	260.633028	2.000000

In [14]:

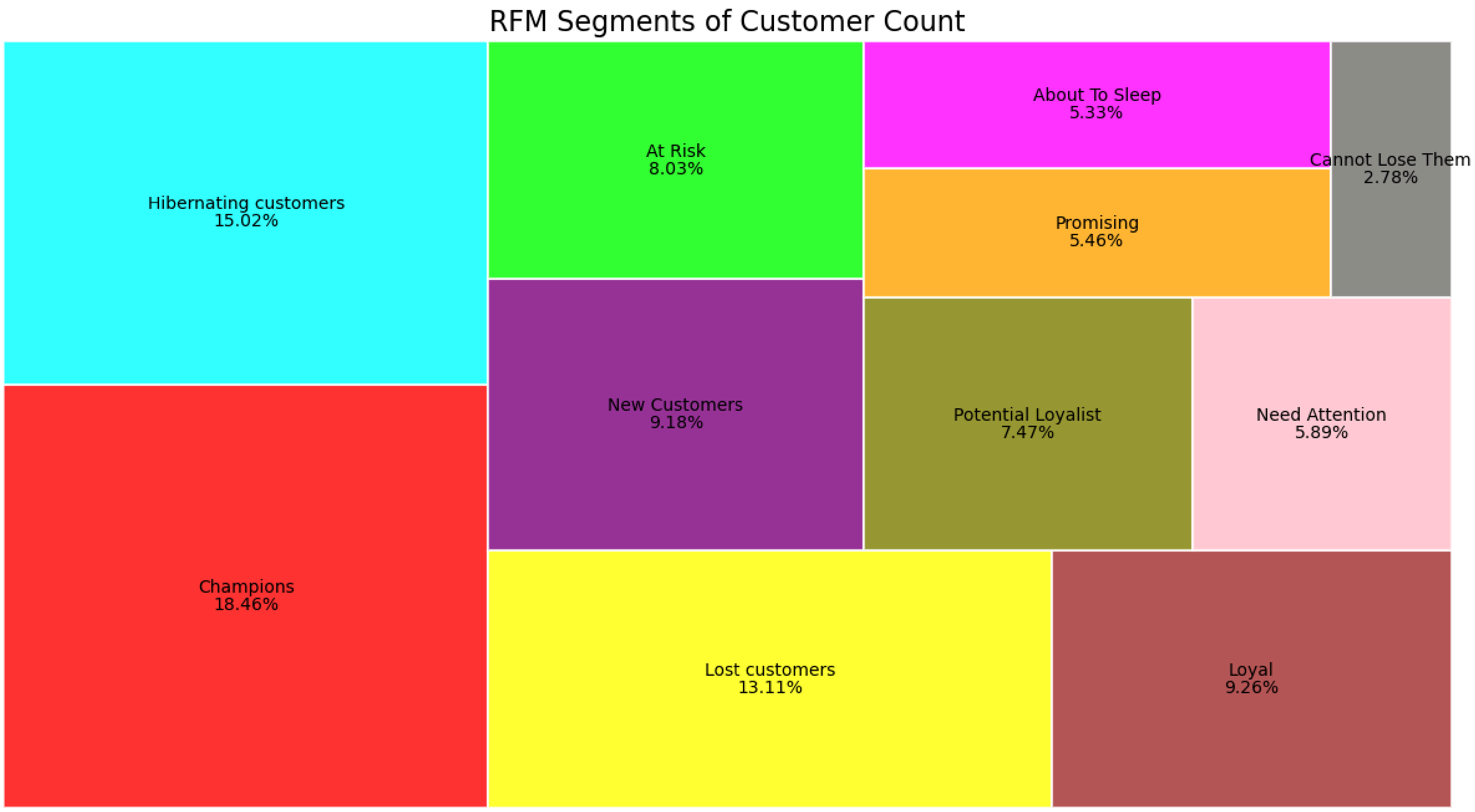
```
grp['CountShare'] = grp['CustomerCount'] / grp['CustomerCount'].sum()
grp['MonetaryShare'] = grp['TotalMonetary'] / grp['TotalMonetary'].sum()
grp
```

Out[14]:

	Segment	CustomerCount	TotalMonetary	AvgRecency	AvgFrequency	CountShare	MonetaryShare
3	Champions	724	4389847.630	31.273481	12.270718	0.184647	0.600659
4	Hibernating customers	589	225520.612	156.925297	1.747029	0.150217	0.030858
5	Lost customers	514	109648.670	296.359922	1.060311	0.131089	0.015003
6	Loyal	363	847617.220	57.606061	5.707989	0.092578	0.115979
8	New Customers	360	76038.990	50.822222	1.169444	0.091813	0.010404
1	At Risk	315	596119.641	156.361905	4.161905	0.080337	0.081566
9	Potential Loyalist	293	178514.510	52.276451	2.730375	0.074726	0.024426
7	Need Attention	231	275286.701	53.809524	3.320346	0.058914	0.037667
10	Promising	214	329753.980	42.271028	1.607477	0.054578	0.045120
0	About To Sleep	209	78533.700	100.100478	1.363636	0.053303	0.010746
2	Cannot Lose Them	109	201509.900	260.633028	2.000000	0.027799	0.027572

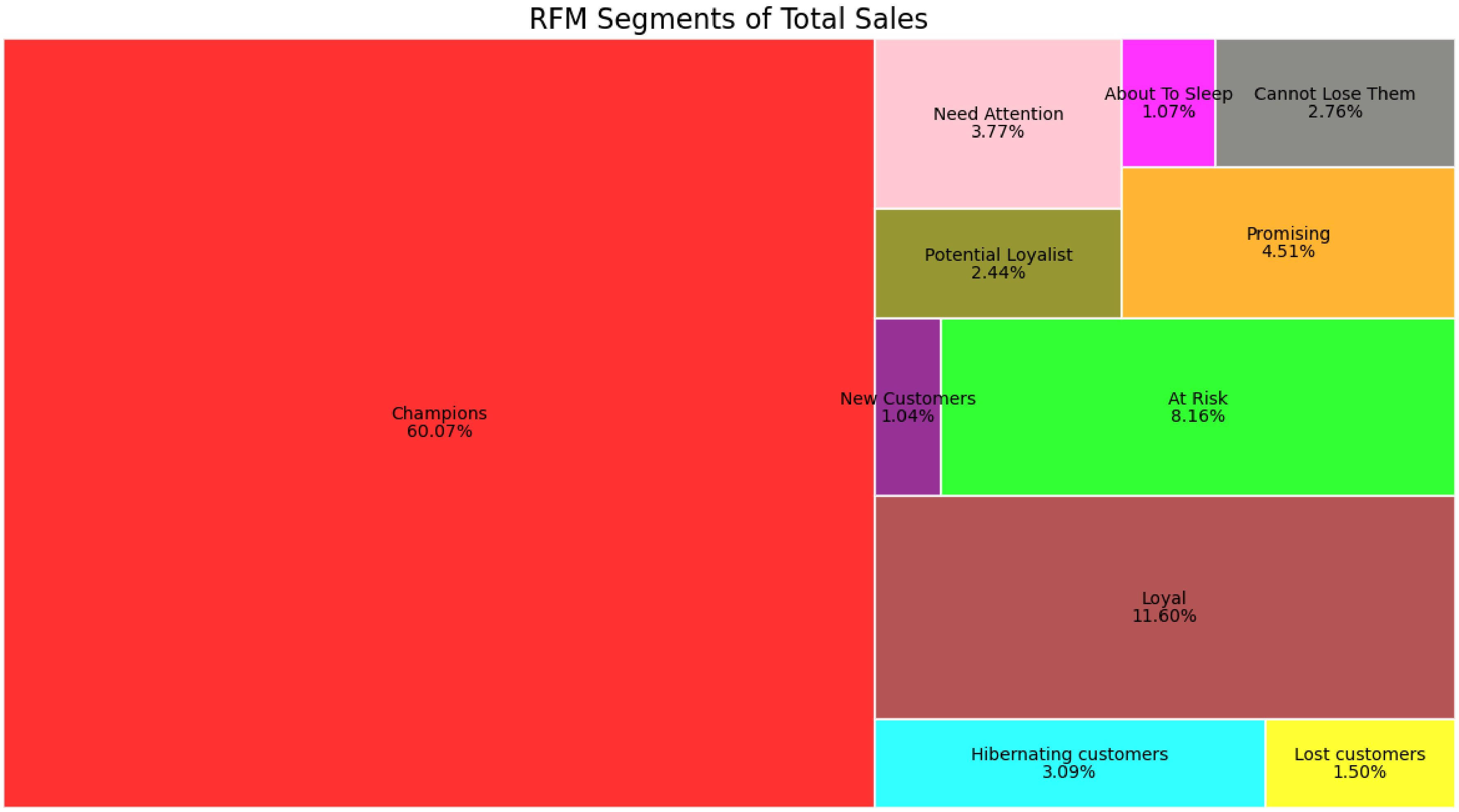
In [15]:

```python
colors = ['#FF0000','#00FFFF','#FFFF00','#A52A2A','#800080','#00FF00','#808000','#FFC0CB','#FFA500','#FF00FF','#736F6

fig, ax = plt.subplots(1, figsize = (15,8))

squarify.plot(sizes=grp['CustomerCount'],
              label=grp['Segment'],
              value=[f'{x*100:.2f}%' for x in grp['CountShare']],
              alpha=.8,
              color=colors,
              bar_kwargs=dict(linewidth=1.5, edgecolor="white")
             )
plt.title('RFM Segments of Customer Count', fontsize=16)
plt.axis('off')
plt.show()
```



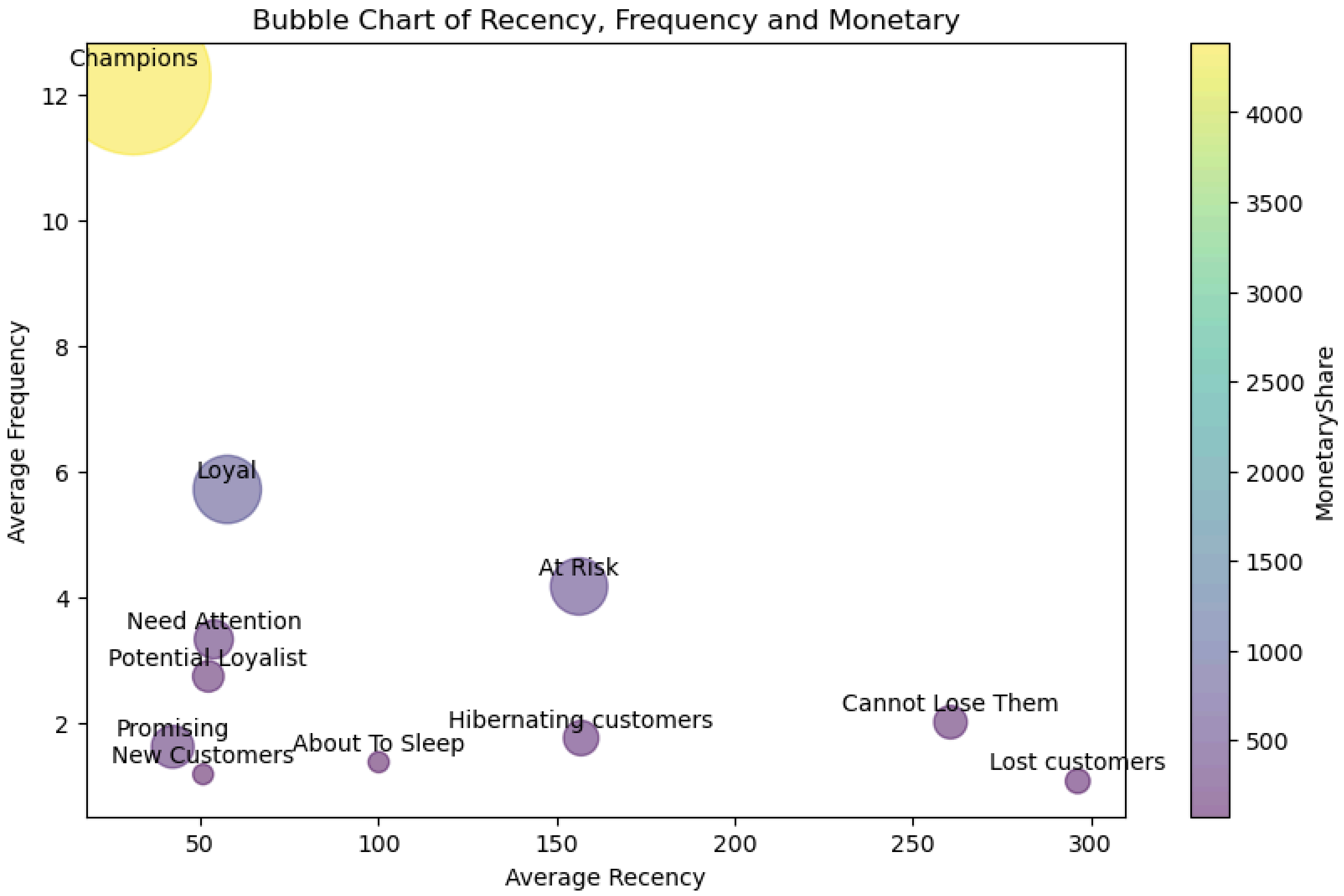
In [16]:

```python
colors = ['#FF0000','#00FFFF','#FFFF00','#A52A2A','#800080','#00FF00','#808000','#FFC0CB','#FFA500','#FF00FF','#736F6

fig, ax = plt.subplots(1, figsize = (15,8))

squarify.plot(sizes=grp['MonetaryShare'],
              label=grp['Segment'],
              value=[f'{x*100:.2f}%' for x in grp['MonetaryShare']],
              alpha=.8,
              color=colors,
              bar_kwargs=dict(linewidth=1.5, edgecolor="white")
             )
plt.title('RFM Segments of Total Sales', fontsize=16)
plt.axis('off')
plt.show()
```



In [17]:

```
plt.figure(figsize=(10, 6))

plt.scatter(grp['AvgRecency'], grp['AvgFrequency'], s=grp['TotalMonetary']/1000, alpha=0.5, c=grp['TotalMonetary']/10

plt.xlabel('Average Recency')
plt.ylabel('Average Frequency')
plt.title('Bubble Chart of Recency, Frequency and Monetary')

plt.colorbar(label='MonetaryShare')

for i in range(grp.shape[0]):
    plt.annotate(
        grp['Segment'].iloc[i],
        (grp['AvgRecency'].iloc[i], grp['AvgFrequency'].iloc[i]),
        textcoords="offset points",
        xytext=(0,5),
        ha='center'
    )

plt.show()
```



In [ ]: