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]:
```
# 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]:
```
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 [10]:
```
# 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

Customer Characteristics and Recommended Actions

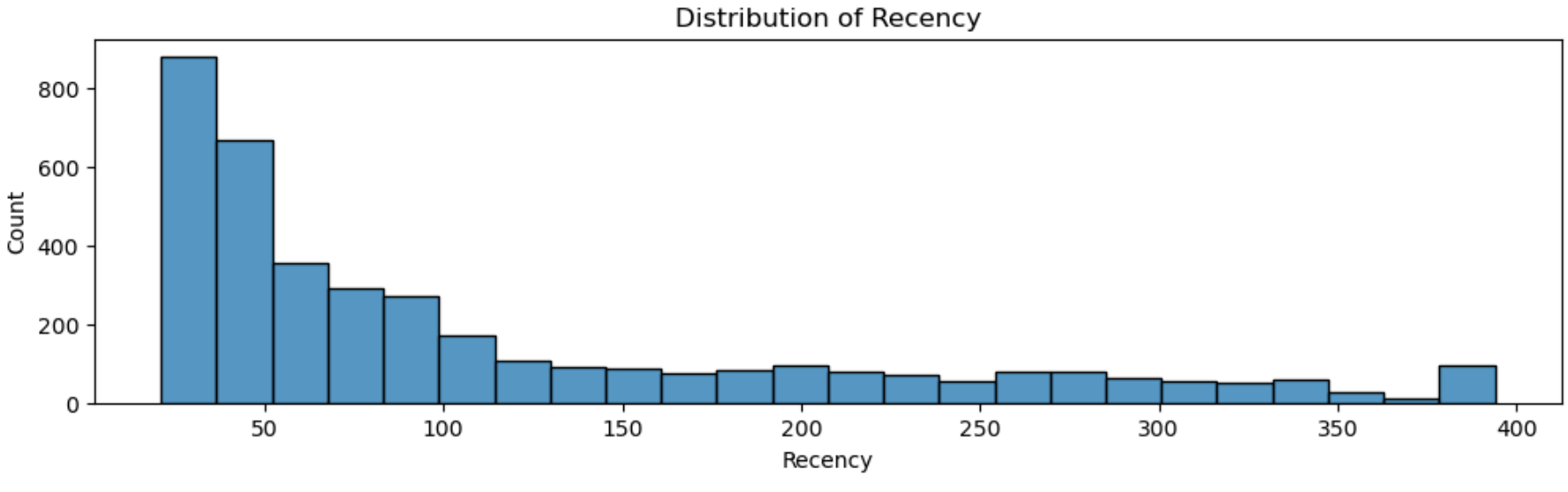
Segment	Characteristics	Actionable Tip
Champions	Bought recently, buy often and spend the most.	Reward them. Can be early adopters to new products. Will promote your brand.
Loyal	Spend good money with us often. Responsive to promotions.	Upsell higher value products. Ask for reviews. Engage them.
Potential Loyalist	Recent customers but spent a good amount and bought more than once.	Offer membership / loyalty program, recommend other products.
New Customers	Bought most recently, but not often.	Provide on-boarding support, give them early success, start building relationship.
Promising	Recent shoppers but haven’t spent much.	Create brand awareness, offer free trials
Needing Attention	Above average recency, frequency and monetary values. May not have bought very recently though.	Make limited time offers, recommend based on past purchases. Reactivate them.
About To Sleep	Below average recency, frequency and monetary values. Will lose them if not reactivated.	Share valuable resources, recommend popular products, renewals at discount, reconnect with them.
At Risk	Spent big money and purchased often but a long time ago.	Need to bring them back! Send personalized emails to reconnect, offer renewals, provide helpful resources.
Cannot Lose Them	Made the biggest purchases, and often. But haven’t returned for a long time.	Win them back via renewals or newer products, don’t lose them to competition, talk to them.
Hibernating customers	Last purchase was long back, low spenders and low number of orders.	Offer other relevant products and special discounts. Recreate brand value.
Lost customers	Lowest recency, frequency and monetary scores.	Revive interest with reach out campaign, ignore otherwise.

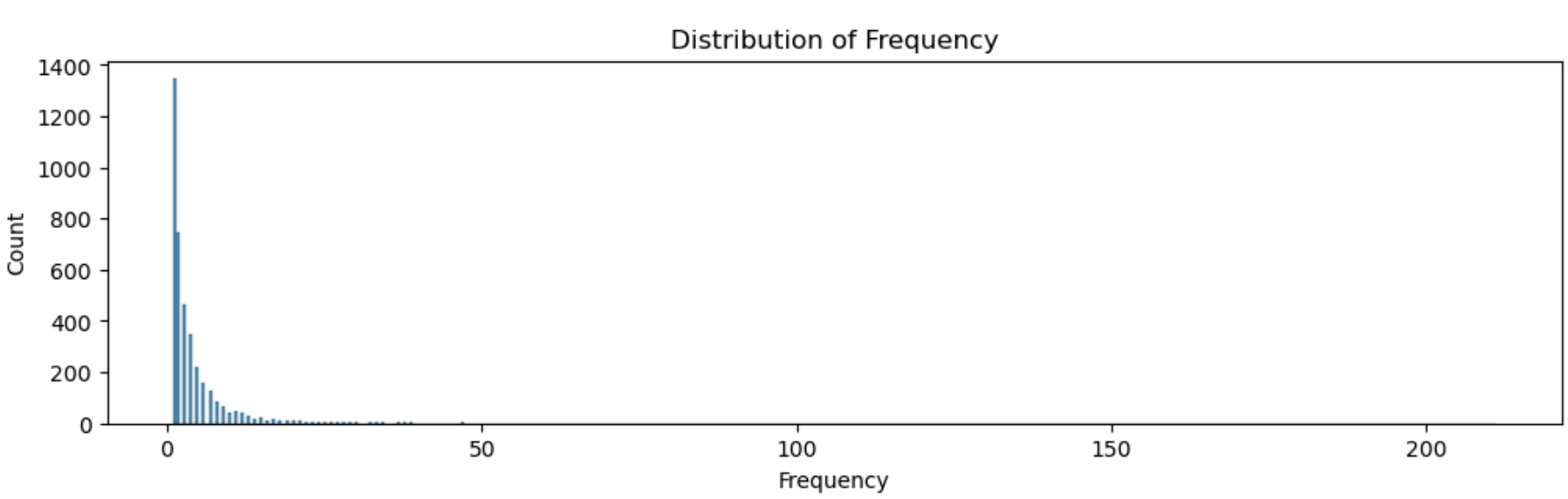
Visualization

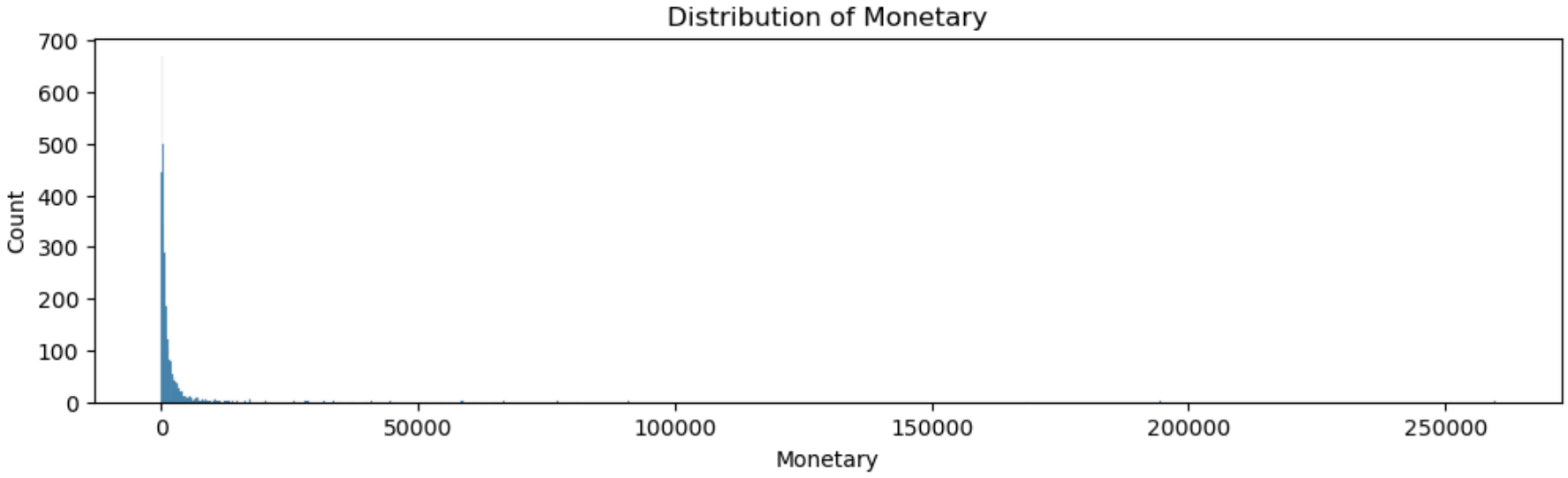
In [12]:
```
# show distribution of each variable of the model

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

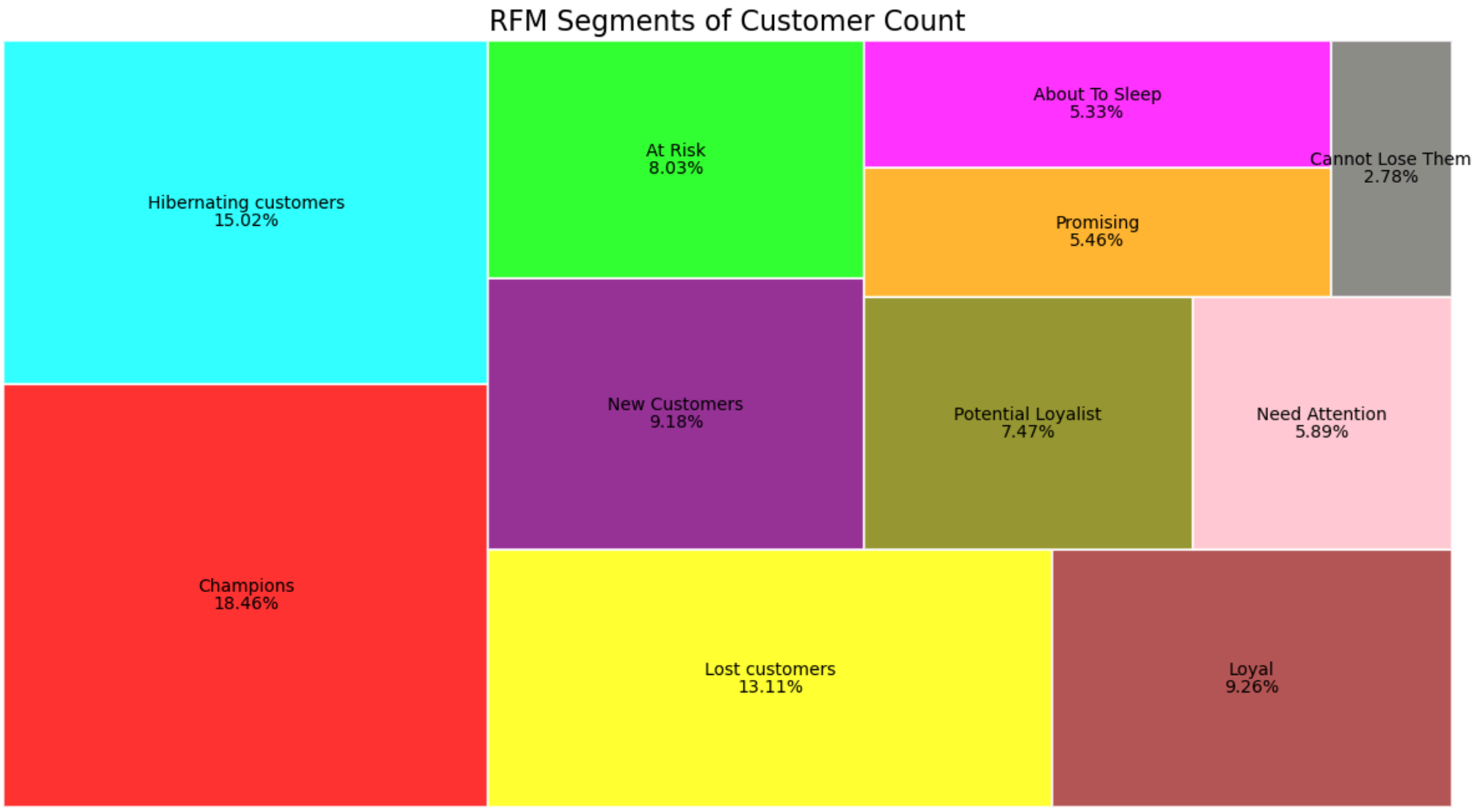
In [14]:
```
grp['CountShare'] = grp['CustomerCount'] / grp['CustomerCount'].sum()
grp['MonetaryShare'] = grp['TotalMonetary'] / grp['TotalMonetary'].sum()
grp
```

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

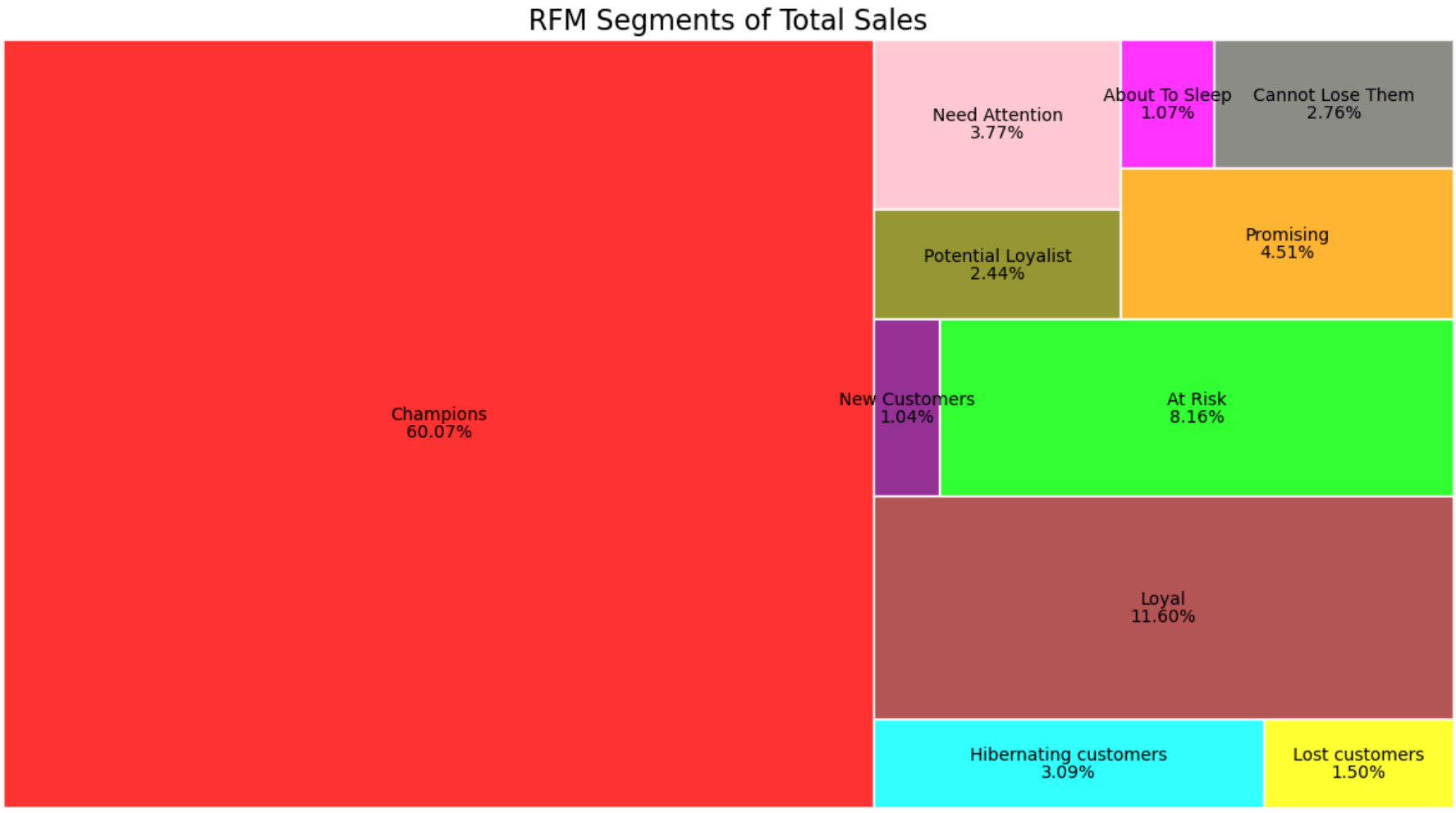
In [15]:
```
colors = ['#FF0000','#00FFFF','#FFFF00','#A52A2A','#800080','#00FF00','#808000','#FFC0CB','#FFA500','#FF00FF','#736F6E
fig, ax = plt.subplots(1, figsize = (15,8))

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]:
```
colors = ['#FF0000','#00FFFF','#FFFF00','#A52A2A','#800080','#00FF00','#808000','#FFC0CB','#FFA500','#FF00FF','#736F6E
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]:

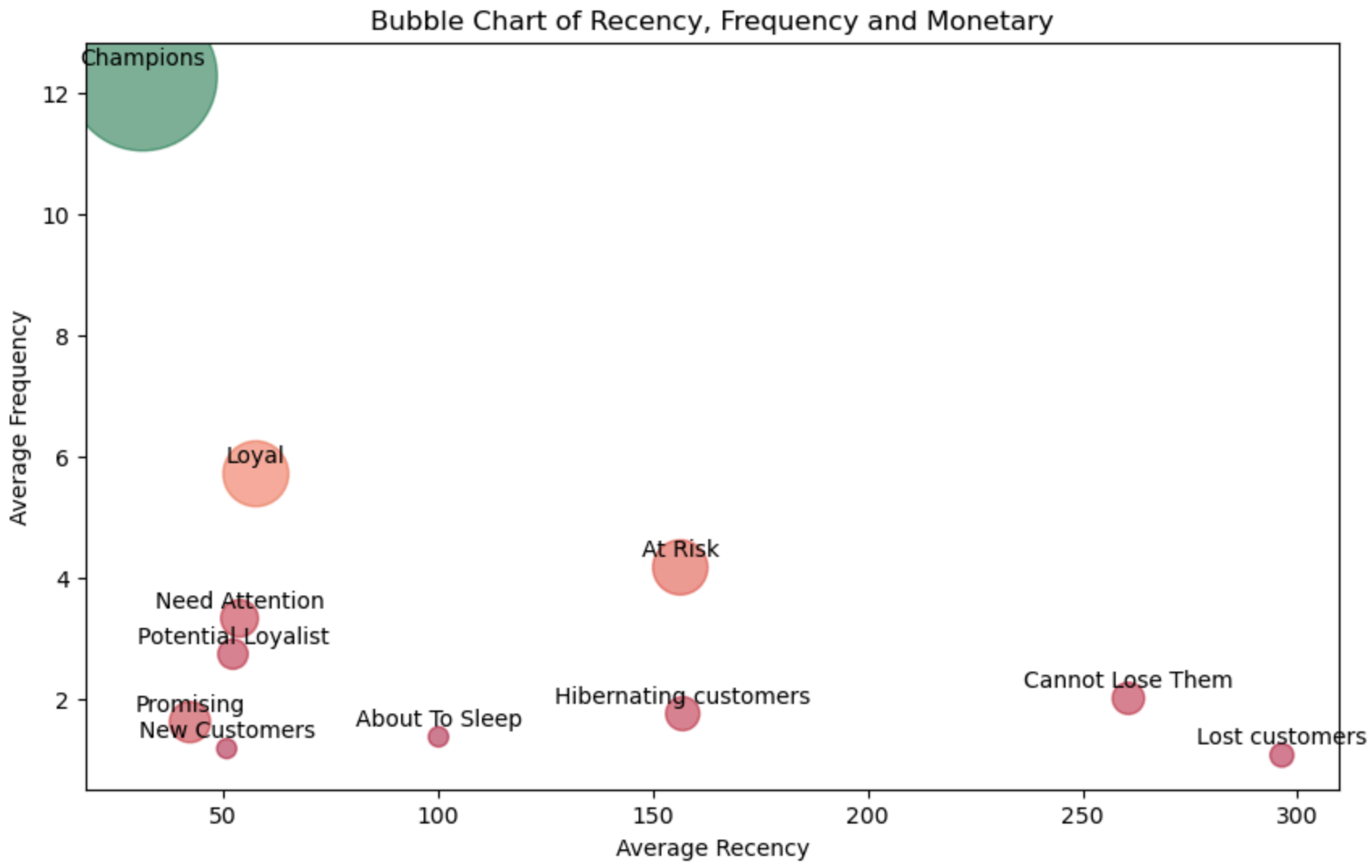
```
plt.figure(figsize=(10, 6))

plt.scatter(grp['AvgRecency'], grp['AvgFrequency'], s=grp['TotalMonetary']/1000, alpha=0.5, c=grp['TotalMonetary']/100

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


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()
```



Insights

- Chamption customers have the largest number (**18.46%**) and bring the highest value (**4,389,847**).
- Hibernating and Lost customers account for a high proportion (**15.08%** and **13.11%**), need campaigns to motivate them to return to purchase.
- Potential Loyalist and New Customers have a relative proportion (**7.47%** and **9.18%**),need to build relationship with them, directing them to higher value segment groups.

In [ ]: