SEQUENTIAL AND SPATIAL DATAMMING

DIGITAL ASSIGNMENT-3

R F M ANALYSIS(Recency,Frequency,Monetory Analysis)

In [1]:
```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import datetime as d
import squarify
import warnings
warnings.filterwarnings("ignore")
warnings.simplefilter(action='ignore', category=FutureWarning)

pd.set_option('display.max_columns', None)
pd.options.display.float_format = '{:.2f}'.format
```

In [2]:
```
pip install squarify
```

```
Requirement already satisfied: squarify in c:\users\asus\miniconda3\lib\site-packages (0.4.3)Note: you may need to re
start the kernel to use updated packages.
```

In [4]:
```
raw9 = pd.read_excel("/Users/Asus/Desktop/online_retail_II.xlsx", sheet_name = "Year 2009-2010")
raw10 = pd.read_excel("/Users/Asus/Desktop/online_retail_II.xlsx", sheet_name = "Year 2010-2011")
df1 = raw9.copy()
df2 = raw10.copy()
```

In [5]:
```
(df1.shape, df2.shape)
```

Out[5]:
```
((525461, 8), (541910, 8))
```

In [6]:
```
df2
```

Out[6]:

	Invoice	StockCode	Description	Quantity	InvoiceDate	Price	Customer ID	Country
0	536365	85123A	WHITE HANGING HEART T-LIGHT HOLDER	6	2010-12-01 08:26:00	2.55	17850.00	United Kingdom
1	536365	71053	WHITE METAL LANTERN	6	2010-12-01 08:26:00	3.39	17850.00	United Kingdom
2	536365	84406B	CREAM CUPID HEARTS COAT HANGER	8	2010-12-01 08:26:00	2.75	17850.00	United Kingdom
3	536365	84029G	KNITTED UNION FLAG HOT WATER BOTTLE	6	2010-12-01 08:26:00	3.39	17850.00	United Kingdom
4	536365	84029E	RED WOOLLY HOTTIE WHITE HEART.	6	2010-12-01 08:26:00	3.39	17850.00	United Kingdom
...	...	...	...	...	...	...	...	...
541905	581587	22899	CHILDREN'S APRON DOLLY GIRL	6	2011-12-09 12:50:00	2.10	12680.00	France
541906	581587	23254	CHILDRENS CUTLERY DOLLY GIRL	4	2011-12-09 12:50:00	4.15	12680.00	France
541907	581587	23255	CHILDRENS CUTLERY CIRCUS PARADE	4	2011-12-09 12:50:00	4.15	12680.00	France
541908	581587	22138	BAKING SET 9 PIECE RETROSPOT	3	2011-12-09 12:50:00	4.95	12680.00	France
541909	581587	POST	POSTAGE	1	2011-12-09 12:50:00	18.00	12680.00	France

541910 rows × 8 columns

3. Missing Values

In [7]:
```
print("2009-2010")
print("Missing Frequency: \n")
print(df1.isnull().sum().sort_values(ascending = False), "\n")
print("Missing Proportion: \n")
print((df1.isnull().sum() / df1.shape[0]).sort_values(ascending = False))
print("")
print("2010-2011")
print("Missing Frequency: \n")
print(df2.isnull().sum().sort_values(ascending = False), "\n")
print("Missing Proportion: \n")
print((df2.isnull().sum() / df2.shape[0]).sort_values(ascending = False))
```

```
2009-2010
Missing Frequency:

Customer ID    107927
Description      2928
Country             0
Price               0
InvoiceDate         0
Quantity            0
StockCode           0
Invoice             0
dtype: int64

Missing Proportion:

Customer ID   0.21
Description   0.01
Country       0.00
Price         0.00
InvoiceDate   0.00
Quantity      0.00
StockCode     0.00
Invoice       0.00
dtype: float64

2010-2011
Missing Frequency:

Customer ID    135080
Description      1454
Country             0
Price               0
InvoiceDate         0
Quantity            0
StockCode           0
Invoice             0
dtype: int64

Missing Proportion:

Customer ID   0.25
Description   0.00
Country       0.00
Price         0.00
InvoiceDate   0.00
Quantity      0.00
StockCode     0.00
Invoice       0.00
dtype: float64
```

In [8]:
```
df1.dropna(inplace = True)
df2.dropna(inplace = True)
```

4. Summary Stats & Outlier Values

In [9]:
```
df1.describe([0.01, 0.05, 0.10, 0.20, 0.90, 0.95, 0.99]).T
```

Out[9]:

	count	mean	std	min	1%	5%	10%	20%	50%	90%	95%	99%	max
Quantity	417534.00	12.76	101.22	-9360.00	-2.00	1.00	1.00	1.00	4.00	24.00	36.00	144.00	19152.00
Price	417534.00	3.89	71.13	0.00	0.29	0.42	0.65	0.85	1.95	6.75	8.50	14.95	25111.09
Customer ID	417534.00	15360.65	1680.81	12346.00	12435.00	12725.00	13042.00	13624.00	15311.00	17706.00	17913.00	18196.00	18287.00

In [10]:
```
df2.describe([0.01, 0.05, 0.10, 0.20, 0.90, 0.95, 0.99]).T
```

Out[10]:

	count	mean	std	min	1%	5%	10%	20%	50%	90%	95%	99%	max
Quantity	406830.00	12.06	248.69	-80995.00	-2.00	1.00	1.00	1.00	5.00	24.00	36.00	120.00	80995.00
Price	406830.00	3.46	69.32	0.00	0.21	0.42	0.55	0.85	1.95	6.75	8.50	15.00	38970.00
Customer ID	406830.00	15287.68	1713.60	12346.00	12415.00	12626.00	12876.00	13536.00	15152.00	17719.00	17905.00	18212.00	18287.00

Remove negative values!

Negative values are returned items.

In [11]:
```
df1 = df1[~df1["Invoice"].str.contains("C", na = False)]
df2 = df2[~df2["Invoice"].str.contains("C", na = False)]
```

In [12]:
```
df1.describe([0.01, 0.05, 0.10, 0.20, 0.90, 0.95, 0.99]).T
```

Out[12]:

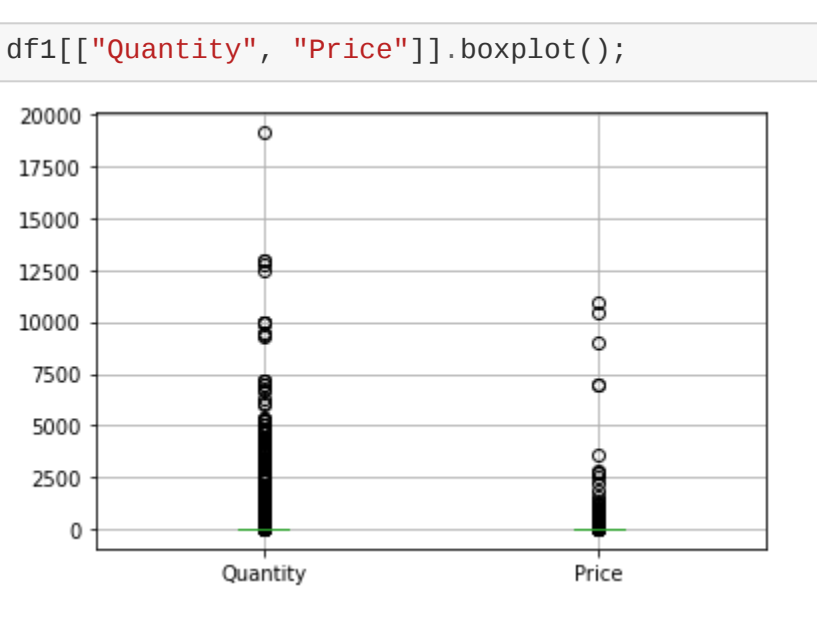
	count	mean	std	min	1%	5%	10%	20%	50%	90%	95%	99%	max
Quantity	407695.00	13.59	96.84	1.00	1.00	1.00	1.00	2.00	5.00	24.00	36.00	144.00	19152.00
Price	407695.00	3.29	34.76	0.00	0.29	0.42	0.65	0.85	1.95	6.75	8.50	14.95	10953.50
Customer ID	407695.00	15368.50	1679.80	12346.00	12435.00	12731.00	13044.00	13635.00	15321.00	17706.00	17913.00	18196.00	18287.00

In [13]:
```
df2.describe([0.01, 0.05, 0.10, 0.20, 0.90, 0.95, 0.99]).T
```

Out[13]:

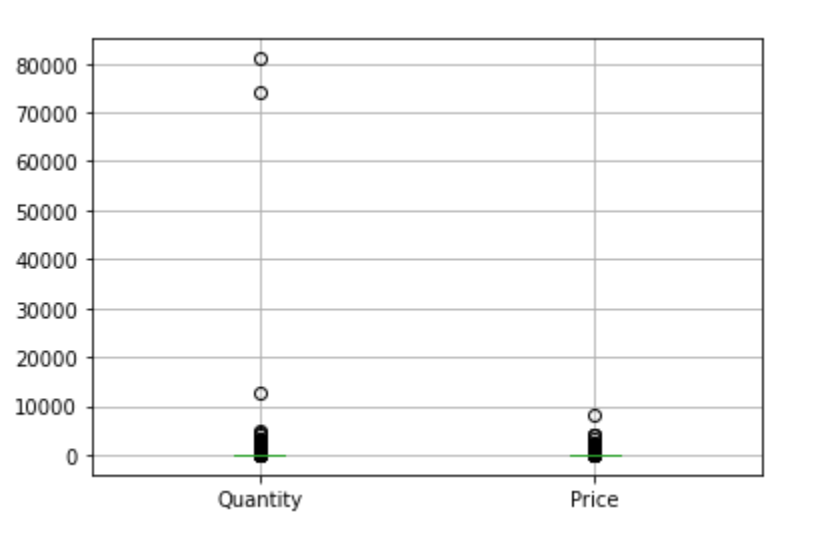
	count	mean	std	min	1%	5%	10%	20%	50%	90%	95%	99%	max
Quantity	397925.00	13.02	180.42	1.00	1.00	1.00	1.00	2.00	6.00	24.00	36.00	120.00	80995.00
Price	397925.00	3.12	22.10	0.00	0.21	0.42	0.55	0.85	1.95	6.35	8.50	14.95	8142.75
Customer ID	397925.00	15294.31	1713.17	12346.00	12415.00	12627.00	12883.00	13552.00	15159.00	17725.00	17912.00	18211.00	18287.00

In [14]:
```
df1[["Quantity", "Price"]].boxplot();
```



In [15]:
```
df2[["Quantity", "Price"]].boxplot()
```

Out[15]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x13f21270>
```



5. RFM Analysis

Recency

In [16]:
```
print("2009-2010: Min Date", df1["InvoiceDate"].min(), "Max Date", df1["InvoiceDate"].max())
print("2010-2011: Min Date", df2["InvoiceDate"].min(), "Max Date", df2["InvoiceDate"].max())
```

```
2009-2010: Min Date 2009-12-01 07:45:00 Max Date 2010-12-09 20:01:00
2010-2011: Min Date 2010-12-01 08:26:00 Max Date 2011-12-09 12:50:00
```

In [17]:
```
recency1 = (dt.datetime(2010, 12, 9) - df1.groupby("Customer ID").agg({"InvoiceDate":"max"})).rename(columns = {"Inv
oiceDate":"Recency"})
recency2 = (dt.datetime(2011, 12, 9) - df2.groupby("Customer ID").agg({"InvoiceDate":"max"})).rename(columns = {"Inv
oiceDate":"Recency"})

recency1["Recency"] = recency1["Recency"].apply(lambda x: x.days)
recency2["Recency"] = recency2["Recency"].apply(lambda x: x.days)

recency2.head()
```

Out[17]:

Customer ID	Recency
12346.00	324
12347.00	1
12348.00	74
12349.00	17
12350.00	309

Frequency

In [18]:
```
freq1 = df1.groupby("Customer ID").agg({"InvoiceDate":"nunique"}).rename(columns={"InvoiceDate": "Frequency"})
freq2 = df2.groupby("Customer ID").agg({"InvoiceDate":"nunique"}).rename(columns={"InvoiceDate": "Frequency"})

freq2
```

Out[18]:

Customer ID	Frequency
12346.00	1
12347.00	7
12348.00	4
12349.00	1
12350.00	1
...	...
18280.00	1
18281.00	1
18282.00	2
18283.00	16
18287.00	3

4339 rows × 1 columns

Monetary

In [19]:
```
df1["TotalPrice"] = df1["Quantity"] * df1["Price"]
df2["TotalPrice"] = df2["Quantity"] * df2["Price"]

monetary1 = df1.groupby("Customer ID").agg({"TotalPrice":"sum"}).rename(columns={"TotalPrice":"Monetary"})
monetary2 = df2.groupby("Customer ID").agg({"TotalPrice":"sum"}).rename(columns={"TotalPrice":"Monetary"})

monetary2.head()
```

Out[19]:

Customer ID	Monetary
12346.00	77183.60
12347.00	4310.00
12348.00	1797.24
12349.00	1757.55
12350.00	334.40

In [20]:
```
rfm1 = pd.concat([recency1, freq1, monetary1],  axis=1)
rfm2 = pd.concat([recency2, freq2, monetary2],  axis=1)

rfm2.head()
```

Out[20]:

Customer ID	Recency	Frequency	Monetary
12346.00	324	1	77183.60
12347.00	1	7	4310.00
12348.00	74	4	1797.24
12349.00	17	1	1757.55
12350.00	309	1	334.40

Create RFM Score

In [21]:
```
rfm1["RecencyScore"] = pd.qcut(rfm1["Recency"], 5, labels = [5, 4 , 3, 2, 1])
rfm2["RecencyScore"] = pd.qcut(rfm2["Recency"], 5, labels = [5, 4 , 3, 2, 1])

rfm1["FrequencyScore"]= pd.qcut(rfm1["Frequency"].rank(method="first"),5, labels=[1,2,3,4,5])
rfm2["FrequencyScore"]= pd.qcut(rfm2["Frequency"].rank(method="first"),5, labels=[1,2,3,4,5])

rfm1["MonetaryScore"] = pd.qcut(rfm1['Monetary'], 5, labels = [1, 2, 3, 4, 5])
rfm2["MonetaryScore"] = pd.qcut(rfm2['Monetary'], 5, labels = [1, 2, 3, 4, 5])

rfm2.head()
```

Out[21]:

Customer ID	Recency	Frequency	Monetary	RecencyScore	FrequencyScore	MonetaryScore
12346.00	324	1	77183.60	1	1	5
12347.00	1	7	4310.00	5	5	5
12348.00	74	4	1797.24	2	4	4
12349.00	17	1	1757.55	4	1	4
12350.00	309	1	334.40	1	1	2

In [22]:
```
rfm1["RFM_SCORE"] = (rfm1['RecencyScore'].astype(str) +
                    rfm1['FrequencyScore'].astype(str) +
                    rfm1['MonetaryScore'].astype(str))

rfm2["RFM_SCORE"] = (rfm2['RecencyScore'].astype(str) +
                    rfm2['FrequencyScore'].astype(str) +
                    rfm2['MonetaryScore'].astype(str))

rfm2.head()
```

Out[22]:

Customer ID	Recency	Frequency	Monetary	RecencyScore	FrequencyScore	MonetaryScore	RFM_SCORE
12346.00	324	1	77183.60	1	1	5	115
12347.00	1	7	4310.00	5	5	5	555
12348.00	74	4	1797.24	2	4	4	244
12349.00	17	1	1757.55	4	1	4	414
12350.00	309	1	334.40	1	1	2	112

In [23]:
```
seg_map = {
    r'[1-2][1-2]': 'Hibernating',
    r'[1-2][3-4]': 'At Risk',
    r'[1-2]5': 'Can\'t Loose',
    r'3[1-2]': 'About to Sleep',
    r'33': 'Need Attention',
    r'[3-4][4-5]': 'Loyal Customers',
    r'41': 'Promising',
    r'51': 'New Customers',
    r'[4-5][2-3]': 'Potential Loyalists',
    r'5[4-5]': 'Champions'
}

rfm1['Segment'] = rfm1['RecencyScore'].astype(str) + rfm1['FrequencyScore'].astype(str)
rfm1['Segment'] = rfm1['Segment'].replace(seg_map, regex=True)

rfm2['Segment'] = rfm2['RecencyScore'].astype(str) + rfm2['FrequencyScore'].astype(str)
rfm2['Segment'] = rfm2['Segment'].replace(seg_map, regex=True)

rfm2.head()
```

Out[23]:

Customer ID	Recency	Frequency	Monetary	RecencyScore	FrequencyScore	MonetaryScore	RFM_SCORE	Segment
12346.00	324	1	77183.60	1	1	5	115	Hibernating
12347.00	1	7	4310.00	5	5	5	555	Champions
12348.00	74	4	1797.24	2	4	4	244	At Risk
12349.00	17	1	1757.55	4	1	4	414	Promising
12350.00	309	1	334.40	1	1	2	112	Hibernating

Summary Statistics

In [24]:
```
rfmStats1 = rfm1[["Segment","Recency","Frequency", "Monetary"]].groupby("Segment").agg(["mean","median","count", "st
d"])
rfmStats1.columns = rfmStats1.columns.map('_'.join).str.strip('|')
rfmStats1
```

Out[24]:

Segment	Recency_mean	Recency_median	Recency_count	Recency_std	Frequency_mean	Frequency_median	Frequency_count	Frequency_std	Monetary_m
About to Sleep	51.85	51.00	343	10.26	1.20	1.00	343	0.40	44
At Risk	149.94	128.00	611	69.98	3.07	3.00	611	1.09	118
Can't Loose	121.72	106.50	78	49.72	9.04	7.50	78	5.78	407
Champions	5.12	5.00	663	4.62	12.50	8.00	663	17.19	685
Hibernating	212.31	211.00	1016	89.78	1.13	1.00	1016	0.33	40
Loyal Customers	34.28	29.00	743	16.06	6.82	5.00	743	4.38	274
Need Attention	51.21	51.00	207	9.84	2.45	2.00	207	0.50	105
New Customers	6.58	6.50	50	4.31	1.00	1.00	50	0.00	38
Potential Loyalists	16.77	17.00	516	9.73	2.02	2.00	516	0.70	72
Promising	23.76	23.00	87	6.03	1.00	1.00	87	0.00	36

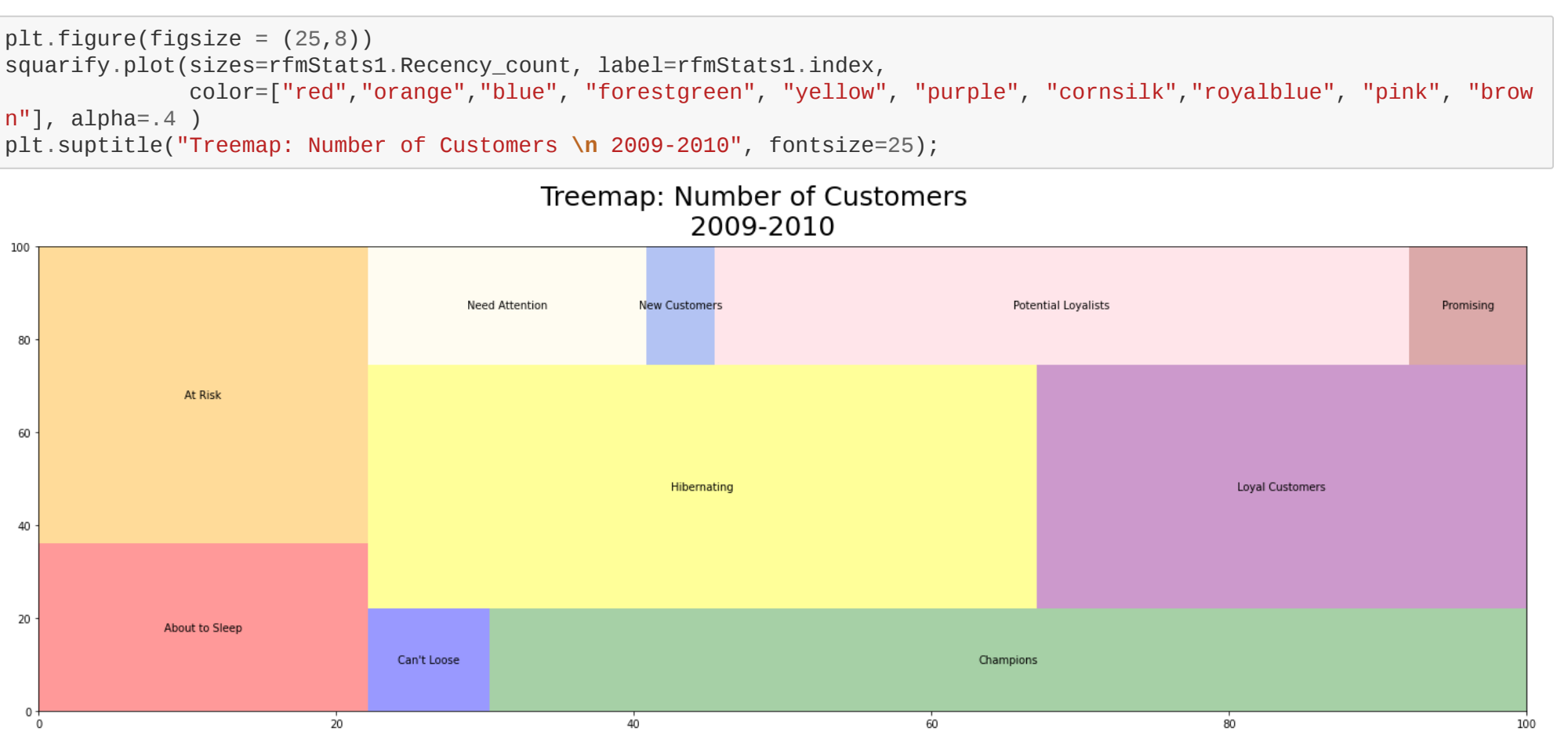
In [25]:
```
rfmStats2 = rfm2[["Segment","Recency","Frequency", "Monetary"]].groupby("Segment").agg(["mean","median","count", "st
d"])
rfmStats2.columns = rfmStats2.columns.map('_'.join).str.strip('|')
rfmStats2
```

Out[25]:

Segment	Recency_mean	Recency_median	Recency_count	Recency_std	Frequency_mean	Frequency_median	Frequency_count	Frequency_std	Monetary_m
About to Sleep	51.37	51	353	10.97	1.16	1	353	0.37	47
At Risk	152.04	137	594	68.64	2.87	3	594	0.94	107
Can't Loose	130.05	105	64	65.15	8.31	7	64	4.14	279
Champions	4.37	3	632	3.68	12.34	8	632	16.37	686
Hibernating	215.66	217	1069	92.04	1.10	1	1069	0.30	48
Loyal Customers	31.69	28	820	15.60	6.44	5	820	4.45	286
Need Attention	50.27	50	184	11.53	2.32	2	184	0.47	89
New Customers	5.43	6	42	3.90	1.00	1	42	0.00	38
Potential Loyalists	15.37	16	486	9.34	2.01	2	486	0.65	104
Promising	21.42	21	95	5.24	1.00	1	95	0.00	29

6. Visualize

In [26]:
```
plt.figure(figsize = (25,8))
squarify.plot(sizes=rfmStats1.Recency_count, label=rfmStats1.index,
              color=["red","orange","blue", "forestgreen", "yellow", "purple", "cornsilk","royalblue", "pink", "brow
n"], alpha=.4 )
plt.suptitle("Treemap: Number of Customers \n 2009-2010", fontsize=25);
```



In [27]:
```
plt.figure(figsize = (25,8))
squarify.plot(sizes=rfmStats2.Recency_count, label=rfmStats2.index,
              color=["red","orange","blue", "forestgreen", "yellow", "purple", "cornsilk","royalblue", "pink", "brow
n"], alpha=.4 )
plt.suptitle("Treemap: Number of Customers \n 2010-2011", fontsize=25);
```