Capstone Retail Project

In [1]:

```
import pandas as pd
import numpy as np
import seaborn as sns
from operator import attrgetter
import matplotlib.colors as mcolors
import matplotlib.pyplot as plt
import datetime as dt
from scipy.stats import skewnorm
import scipy.stats as stats
from sklearn.preprocessing import LabelEncoder
from pandas_profiling import ProfileReport
import pylab as p
from sklearn.preprocessing import StandardScaler
%matplotlib inline
```

```
In C:\Users\frees\Anaconda3\lib\site-packages\matplotlib\mpl-data\stylelib
\_classic_test.mplstyle:
The text.latex.preview rcparam was deprecated in Matplotlib 3.3 and will b
e removed two minor releases later.
In C:\Users\frees\Anaconda3\lib\site-packages\matplotlib\mpl-data\stylelib
\_classic_test.mplstyle:
The mathtext.fallback_to_cm rcparam was deprecated in Matplotlib 3.3 and w
ill be removed two minor releases later.
In C:\Users\frees\Anaconda3\lib\site-packages\matplotlib\mpl-data\stylelib
\_classic_test.mplstyle: Support for setting the 'mathtext.fallback_to_cm'
rcParam is deprecated since 3.3 and will be removed two minor releases lat
er; use 'mathtext.fallback : 'cm' instead.
In C:\Users\frees\Anaconda3\lib\site-packages\matplotlib\mpl-data\stylelib
\_classic_test.mplstyle:
The validate_bool_maybe_none function was deprecated in Matplotlib 3.3 and
will be removed two minor releases later.
In C:\Users\frees\Anaconda3\lib\site-packages\matplotlib\mpl-data\stylelib
\_classic_test.mplstyle:
The savefig.jpeg_quality rcparam was deprecated in Matplotlib 3.3 and will
be removed two minor releases later.
In C:\Users\frees\Anaconda3\lib\site-packages\matplotlib\mpl-data\stylelib
\_classic_test.mplstyle:
The keymap.all_axes rcparam was deprecated in Matplotlib 3.3 and will be r
emoved two minor releases later.
In C:\Users\frees\Anaconda3\lib\site-packages\matplotlib\mpl-data\stylelib
\_classic_test.mplstyle:
The animation.avconv_path rcparam was deprecated in Matplotlib 3.3 and wil
l be removed two minor releases later.
In C:\Users\frees\Anaconda3\lib\site-packages\matplotlib\mpl-data\stylelib
\_classic_test.mplstyle:
The animation.avconv_args rcparam was deprecated in Matplotlib 3.3 and wil
l be removed two minor releases later.
```

In [2]:

```
df=pd.read_excel("Online Retail.xlsx",sheet_name='Online Retail')
```

In [3]:

```
df.head()
```

Out[3]:

	InvoiceNo	StockCode	Description	Quantity	InvoiceDate	UnitPrice	CustomerID	Country
0	536365	85123A	WHITE HANGING HEART T-LIGHT HOLDER	6	2010-12-01 08:26:00	2.55	17850.0	Unitec Kingdorr
1	536365	71053	WHITE METAL LANTERN	6	2010-12-01 08:26:00	3.39	17850.0	Unitec Kingdorr
2	536365	84406B	CREAM CUPID HEARTS COAT HANGER	8	2010-12-01 08:26:00	2.75	17850.0	Unitec Kingdorr
3	536365	84029G	KNITTED UNION FLAG HOT WATER BOTTLE	6	2010-12-01 08:26:00	3.39	17850.0	Unitec Kingdorr
4	536365	84029E	RED WOOLLY HOTTIE WHITE HEART.	6	2010-12-01 08:26:00	3.39	17850.0	Unitec Kingdorr

In [4]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 541909 entries, 0 to 541908
Data columns (total 8 columns):
 #   Column       Non-Null Count   Dtype         
---  ------       --------------   -----         
 0   InvoiceNo    541909 non-null  object        
 1   StockCode    541909 non-null  object        
 2   Description  540455 non-null  object        
 3   Quantity     541909 non-null  int64         
 4   InvoiceDate  541909 non-null  datetime64[ns]
 5   UnitPrice    541909 non-null  float64       
 6   CustomerID   406829 non-null  float64       
 7   Country      541909 non-null  object        
dtypes: datetime64[ns](1), float64(2), int64(1), object(4)
memory usage: 33.1+ MB
```

In [5]:

```
df.describe().T
```

Out[5]:

	count	mean	std	min	25%	50%	75%
Quantity	541909.0	9.552250	218.081158	-80995.00	1.00	3.00	10.00
UnitPrice	541909.0	4.611114	96.759853	-11062.06	1.25	2.08	4.13
CustomerID	406829.0	15287.690570	1713.600303	12346.00	13953.00	15152.00	16791.00

In [6]:

```
#Perform descriptive analytics on the given data
profile = ProfileReport(df, title='Retail_Profiling_Report')
```

In [9]:

```
profile.to_file("Retail_Profiling_Report.html")
```

Data Cleaning

In [10]:

```
#missing Data and formulate an apt strategy to treat them
df.isnull().sum()
```

Out[10]:

```
InvoiceNo           0
StockCode           0
Description      1454
Quantity            0
InvoiceDate         0
UnitPrice           0
CustomerID     135080
Country             0
dtype: int64
```

In [11]:

```
df.dropna(subset=['CustomerID'], inplace=True)
```

In [12]:

```
df.isnull().sum()
```

Out[12]:

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

In [13]:

```
#Remove duplicate data records
df.drop_duplicates(inplace = True)
```

In [14]:

```
df.duplicated().sum()
```

Out[14]:

```
0
```

Data Transformation

In [15]:

```
#Cohort Analysis
df['order_month'] = df['InvoiceDate'].dt.to_period('M')
df['cohort'] = df.groupby('CustomerID')['InvoiceDate'] \
                 .transform('min') \
                 .dt.to_period('M')
df_cohort=pd.DataFrame(df.groupby(['cohort', 'order_month']) \
              .agg(n_customers=('CustomerID', 'nunique')) \
              .reset_index(drop=False))
```

In [16]:

```
df_cohort.head()
```

Out[16]:

	cohort	order_month	n_customers
0	2010-12	2010-12	948
1	2010-12	2011-01	362
2	2010-12	2011-02	317
3	2010-12	2011-03	367
4	2010-12	2011-04	341

In [17]:

```
#Active customer each Cohort
df_cohort['period_number'] = (df_cohort.order_month - df_cohort.cohort).apply(attrgette
r('n'))
df_cohort.head()
```

Out[17]:

	cohort	order_month	n_customers	period_number
0	2010-12	2010-12	948	0
1	2010-12	2011-01	362	1
2	2010-12	2011-02	317	2
3	2010-12	2011-03	367	3
4	2010-12	2011-04	341	4

In [18]:

```
cohort_pivot = df_cohort.pivot_table(index = 'cohort',
                                     columns = 'period_number',
                                     values = 'n_customers')
cohort_pivot
```

Out[18]:

period_number	0	1	2	3	4	5	6	7	8	9	10
cohort											
2010-12	948.0	362.0	317.0	367.0	341.0	376.0	360.0	336.0	336.0	374.0	354.0
2011-01	421.0	101.0	119.0	102.0	138.0	126.0	110.0	108.0	131.0	146.0	155.0
2011-02	380.0	94.0	73.0	106.0	102.0	94.0	97.0	107.0	98.0	119.0	35.0
2011-03	440.0	84.0	112.0	96.0	102.0	78.0	116.0	105.0	127.0	39.0	NaN
2011-04	299.0	68.0	66.0	63.0	62.0	71.0	69.0	78.0	25.0	NaN	NaN
2011-05	279.0	66.0	48.0	48.0	60.0	68.0	74.0	29.0	NaN	NaN	NaN
2011-06	235.0	49.0	44.0	64.0	58.0	79.0	24.0	NaN	NaN	NaN	NaN
2011-07	191.0	40.0	39.0	44.0	52.0	22.0	NaN	NaN	NaN	NaN	NaN
2011-08	167.0	42.0	42.0	42.0	23.0	NaN	NaN	NaN	NaN	NaN	NaN
2011-09	298.0	89.0	97.0	36.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2011-10	352.0	93.0	46.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2011-11	321.0	43.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2011-12	41.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

In [19]:

```
cohort_size = cohort_pivot.iloc[:,0]
retention_matrix = cohort_pivot.divide(cohort_size, axis = 0)
```

In [20]:

```
retention_matrix
```

Out[20]:

period_number	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
cohort								
2010-12	1.0	0.381857	0.334388	0.387131	0.359705	0.396624	0.379747	0.354430
2011-01	1.0	0.239905	0.282660	0.242280	0.327791	0.299287	0.261283	0.256532
2011-02	1.0	0.247368	0.192105	0.278947	0.268421	0.247368	0.255263	0.281579
2011-03	1.0	0.190909	0.254545	0.218182	0.231818	0.177273	0.263636	0.238636
2011-04	1.0	0.227425	0.220736	0.210702	0.207358	0.237458	0.230769	0.260870
2011-05	1.0	0.236559	0.172043	0.172043	0.215054	0.243728	0.265233	0.103943
2011-06	1.0	0.208511	0.187234	0.272340	0.246809	0.336170	0.102128	NaN
2011-07	1.0	0.209424	0.204188	0.230366	0.272251	0.115183	NaN	NaN
2011-08	1.0	0.251497	0.251497	0.251497	0.137725	NaN	NaN	NaN
2011-09	1.0	0.298658	0.325503	0.120805	NaN	NaN	NaN	NaN
2011-10	1.0	0.264205	0.130682	NaN	NaN	NaN	NaN	NaN
2011-11	1.0	0.133956	NaN	NaN	NaN	NaN	NaN	NaN
2011-12	1.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN

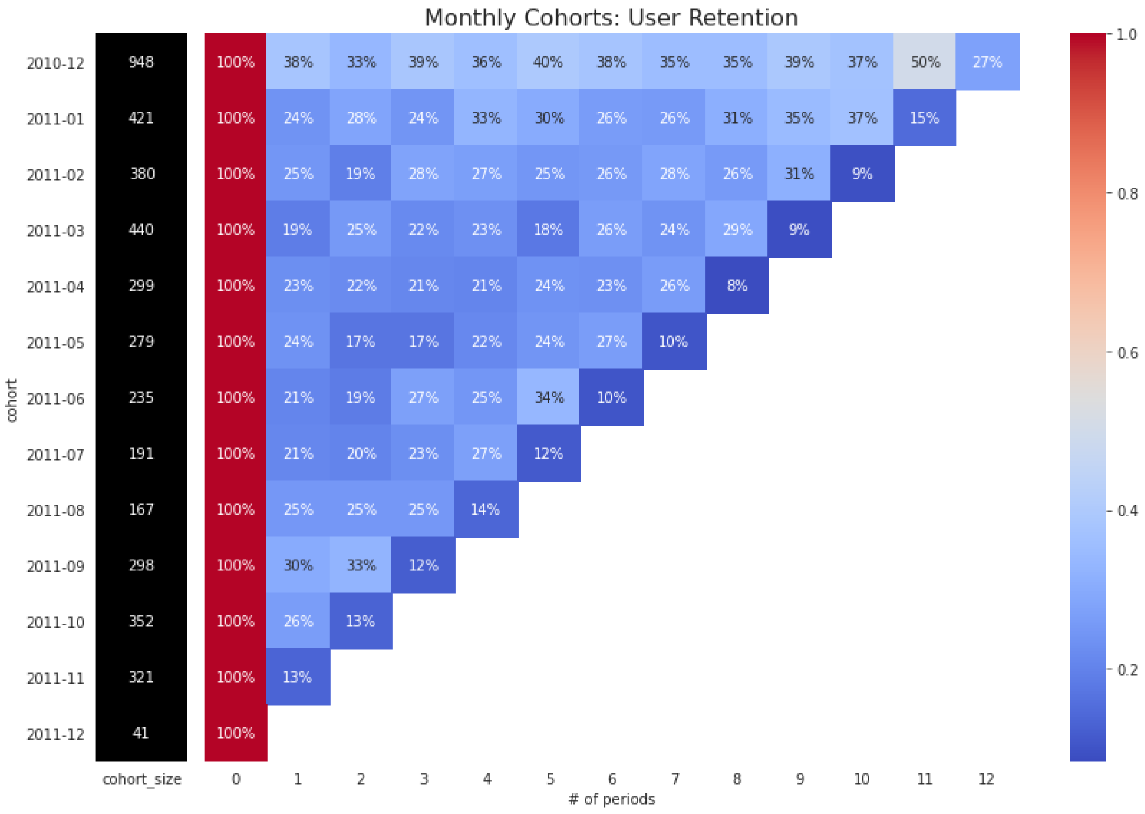
In [26]:

```
with sns.axes_style("white"):
    fig, ax = plt.subplots(1, 2, figsize=(12, 8), sharey=True, gridspec_kw={'width_rati
os': [1, 11]})

    # retention matrix
    sns.heatmap(retention_matrix,
                mask=retention_matrix.isnull(),
                annot=True,
                fmt='.0%',
                cmap='coolwarm',
                #cmap='RdYlGn',
                ax=ax[1])
    ax[1].set_title('Monthly Cohorts: User Retention', fontsize=16)
    ax[1].set(xlabel='# of periods',
              ylabel='')

    # cohort size
    cohort_size_df = pd.DataFrame(cohort_size).rename(columns={0: 'cohort_size'})
    white_cmap = mcolors.ListedColormap(['black'])
    sns.heatmap(cohort_size_df,
                annot=True,
                cbar=False,
                fmt='g',
                cmap=white_cmap,
                ax=ax[0])

    fig.tight_layout()
```



cohort	cohort_size	0	1	2	3	4	5	6	7	8	9	10	11	12
2010-12	948	100%	38%	33%	39%	36%	40%	38%	35%	35%	39%	37%	50%	27%
2011-01	421	100%	24%	28%	24%	33%	30%	26%	26%	31%	35%	37%	15%	
2011-02	380	100%	25%	19%	28%	27%	25%	26%	28%	26%	31%	9%		
2011-03	440	100%	19%	25%	22%	23%	18%	26%	24%	29%	9%			
2011-04	299	100%	23%	22%	21%	21%	24%	23%	26%	8%				
2011-05	279	100%	24%	17%	17%	22%	24%	27%	10%					
2011-06	235	100%	21%	19%	27%	25%	34%	10%						
2011-07	191	100%	21%	20%	23%	27%	12%							
2011-08	167	100%	25%	25%	25%	14%								
2011-09	298	100%	30%	33%	12%									
2011-10	352	100%	26%	13%										
2011-11	321	100%	13%											
2011-12	41	100%												

Week 2

In [27]:

```
#Build RFM model
df['InvoiceDate'].max()
```

Out[27]:

```
Timestamp('2011-12-09 12:50:00')
```

In [28]:

```
#RFM metrics
latestdate = dt.datetime(2011,12,10)
rfmtable=df.groupby('CustomerID').agg({'InvoiceDate': lambda x: (latestdate - x.max()).
days, 'InvoiceNo': lambda x: len(x),'UnitPrice': lambda x: x.sum()})
rfmtable=rfmtable.rename(columns={'InvoiceDate': 'recency',
                         'InvoiceNo': 'frequency',
                         'UnitPrice': 'monetary_value'})
rfmtable
```

Out[28]:

	recency	frequency	monetary_value
CustomerID			
12346.0	325	2	2.08
12347.0	2	182	481.21
12348.0	75	31	178.71
12349.0	18	73	605.10
12350.0	310	17	65.30
...	...	...	...
18280.0	277	10	47.65
18281.0	180	7	39.36
18282.0	7	13	62.68
18283.0	3	721	1174.33
18287.0	42	70	104.55

4372 rows × 3 columns

RFM segments Quantile

In [29]:

```
quantiles = rfmtable.quantile(q=[0.25,0.5,0.75])
quantiles.to_dict()
```

Out[29]:

```
{'recency': {0.25: 16.0, 0.5: 50.0, 0.75: 143.0},
 'frequency': {0.25: 17.0, 0.5: 41.0, 0.75: 99.25},
 'monetary_value': {0.25: 52.730000000000004, 0.5: 128.925, 0.75: 299.097
5}}
```

In [30]:

```
segmented_rfm = rfmtable
```

In [31]:

```
def recencyscore(x,p,d):
    if x <= d[p][0.25]:
        return 1
    elif x <= d[p][0.50]:
        return 2
    elif x <= d[p][0.75]:
        return 3
    else:
        return 4

def fmscore(x,p,d):
    if x <= d[p][0.25]:
        return 4
    elif x <= d[p][0.50]:
        return 3
    elif x <= d[p][0.75]:
        return 2
    else:
        return 1
```

Type Markdown and LaTeX: $\alpha2$

In [32]:

```
segmented_rfm['r_quartile'] = segmented_rfm['recency'].apply(recencyscore, args=('recency',quantiles,))
segmented_rfm['f_quartile'] = segmented_rfm['frequency'].apply(fmscore, args=('frequency',quantiles,))
segmented_rfm['m_quartile'] = segmented_rfm['monetary_value'].apply(fmscore, args=('monetary_value',quantiles,))


segmented_rfm.head()
```

Out[32]:

	recency	frequency	monetary_value	r_quartile	f_quartile	m_quartile
CustomerID						
12346.0	325	2	2.08	4	4	4
12347.0	2	182	481.21	1	1	1
12348.0	75	31	178.71	3	3	2
12349.0	18	73	605.10	2	2	1
12350.0	310	17	65.30	4	4	3

In [33]:

```
segmented_rfm.to_csv('SegmentedRFM.csv')
segmented_rfm['RFMScore'] = segmented_rfm.r_quartile.map(str)+segmented_rfm.f_quartile.map(str)+segmented_rfm.m_quartile.map(str)

segmented_rfm.head()
```

Out[33]:

	recency	frequency	monetary_value	r_quartile	f_quartile	m_quartile	RFMScor
CustomerID							
12346.0	325	2	2.08	4	4	4	44
12347.0	2	182	481.21	1	1	1	11
12348.0	75	31	178.71	3	3	2	33
12349.0	18	73	605.10	2	2	1	22
12350.0	310	17	65.30	4	4	3	44

In [34]:

```
#Customer Segementation according to RFM
pd.set_option("display.max_colwidth", 10000)
data = {'Customer Segement':['Best Customers', 'Loyal Customers', 'Big Spender', 'Almost Lost','Lost Customers','Lost Cheap Customers'], 'RFM':['111', 'X1X', 'XX1', '311','411','444'],'Desrciption':['Bought Most Recently and More Often', 'Buy Most Frequently', 'Spend The Most', 'Did not purchased for some time but purchased frequently and most', 'Did not purchased for some time but purchased frequently and most','Last purchased long ago,purchased few and spent little']}
pd.DataFrame(data)
```

Out[34]:

	Customer Segement	RFM	Desrciption
0	Best Customers	111	Bought Most Recently and More Often
1	Loyal Customers	X1X	Buy Most Frequently
2	Big Spender	XX1	Spend The Most
3	Almost Lost	311	Did not purchased for some time but purchased frequently and most
4	Lost Customers	411	Did not purchased for some time but purchased frequently and most
5	Lost Cheap Customers	444	Last purchased long ago,purchased few and spent little

Week 3

Clustering using K-mean

In [35]:

```
cluster = segmented_rfm
cluster = cluster.reset_index(level=0).iloc[:,[2,3]].values

pd.DataFrame(cluster)
```

Out[35]:

	0	1
0	2.0	2.08
1	182.0	481.21
2	31.0	178.71
3	73.0	605.10
4	17.0	65.30
...	...	...
4367	10.0	47.65
4368	7.0	39.36
4369	13.0	62.68
4370	721.0	1174.33
4371	70.0	104.55

4372 rows × 2 columns

In [36]:

```
sc= StandardScaler()
cluster = sc.fit_transform(cluster)
```

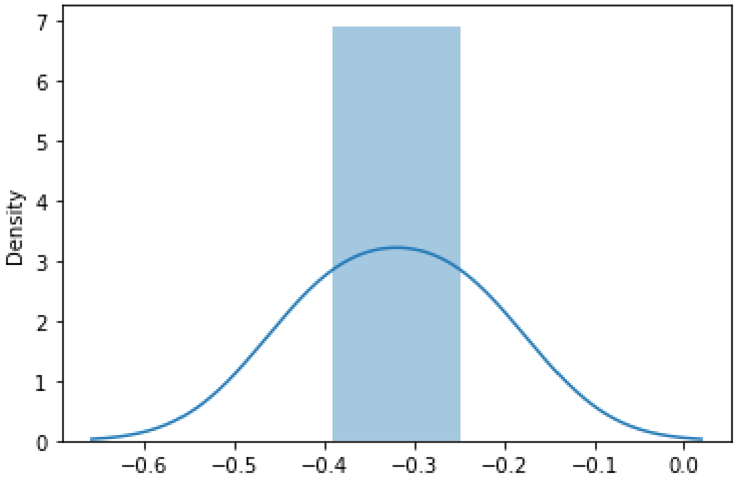
In [37]:

```
sns.distplot(cluster[0])
```

```
C:\Users\frees\Anaconda3\lib\site-packages\seaborn\distributions.py:2557:
FutureWarning: `distplot` is a deprecated function and will be removed in
a future version. Please adapt your code to use either `displot` (a figure
-level function with similar flexibility) or `histplot` (an axes-level fun
ction for histograms).
  warnings.warn(msg, FutureWarning)
```

Out[37]:

```
<AxesSubplot:ylabel='Density'>
```



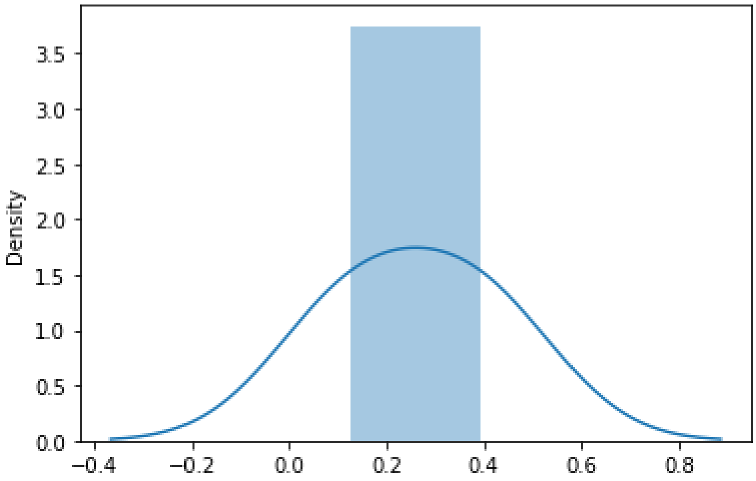
In [38]:

```
sns.distplot(cluster[1])
```

```
C:\Users\frees\Anaconda3\lib\site-packages\seaborn\distributions.py:2557:
FutureWarning: `distplot` is a deprecated function and will be removed in
a future version. Please adapt your code to use either `displot` (a figure
-level function with similar flexibility) or `histplot` (an axes-level fun
ction for histograms).
  warnings.warn(msg, FutureWarning)
```

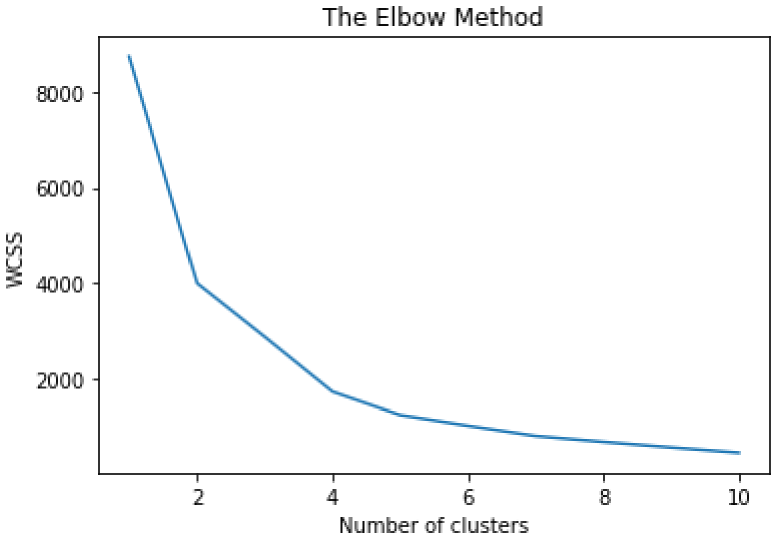
Out[38]:

```
<AxesSubplot:ylabel='Density'>
```



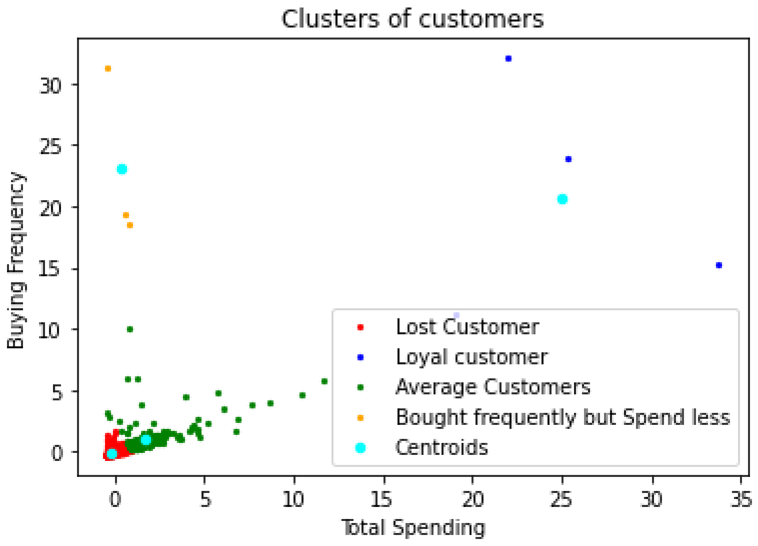
In [39]:

```
#WCSS
from sklearn.cluster import KMeans
wcss = []
for i in range(1, 11):
    kmeans = KMeans(n_clusters = i, init = 'k-means++')
    kmeans.fit(cluster)
    wcss.append(kmeans.inertia_)
plt.plot(range(1, 11), wcss)
plt.title('The Elbow Method')
plt.xlabel('Number of clusters')
plt.ylabel('WCSS')
plt.show()
```



In [45]:

```
#Optimum number of clusters to be formed is 4
kmeans = KMeans(n_clusters = 4, init = 'k-means++')
y_kmeans = kmeans.fit_predict(cluster)
plt.scatter(cluster[y_kmeans == 0, 0], cluster[y_kmeans == 0, 1], s = 5, c = 'red', label = 'Lost Customer')
plt.scatter(cluster[y_kmeans == 1, 0], cluster[y_kmeans == 1, 1], s = 5, c = 'blue', label = 'Loyal customer')
plt.scatter(cluster[y_kmeans == 2, 0], cluster[y_kmeans == 2, 1], s = 5, c = 'green', label = 'Average Customers')
plt.scatter(cluster[y_kmeans == 3, 0], cluster[y_kmeans == 3, 1], s = 5, c = 'orange', label = 'Bought frequently but Spend less')
plt.scatter(kmeans.cluster_centers_[:, 0], kmeans.cluster_centers_[:, 1], s = 20, c = 'cyan', label = 'Centroids')
plt.title('Clusters of customers')
plt.xlabel('Total Spending')
plt.ylabel('Buying Frequency')
plt.legend()
plt.show()
```



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