Importing Libraries

In [ ]:

```
import math
import numpy as np
import pandas as pd
from pandas.plotting import autocorrelation_plot
import plotly



import plotly.express as px
import matplotlib.pyplot as plt
import matplotlib.colors as mcolors
import seaborn as sns
sns.set()
import calendar

from sklearn.preprocessing import StandardScaler
from sklearn.cluster import KMeans
from scipy import stats



from statsmodels.tsa.seasonal import seasonal_decompose
plotly.offline.init_notebook_mode (connected = True)
```

In [ ]:

```
data_sheet1 = pd.read_excel("RetailPulseAssignmentData.xlsx",sheet_name='Year 2009-2010')
data_sheet2 = pd.read_excel("RetailPulseAssignmentData.xlsx",sheet_name='Year 2010-2011')
```

In [ ]:

```
data_sheet1.head(10)
```

Out[ ]:

	Invoice	StockCode	Description	Quantity	InvoiceDate	Price	Customer ID	Country
0	489434	85048	15CM CHRISTMAS GLASS BALL 20 LIGHTS	12	2009-12-01 07:45:00	6.95	13085.0	United Kingdom
1	489434	79323P	PINK CHERRY LIGHTS	12	2009-12-01 07:45:00	6.75	13085.0	United Kingdom
2	489434	79323W	WHITE CHERRY LIGHTS	12	2009-12-01 07:45:00	6.75	13085.0	United Kingdom
3	489434	22041	RECORD FRAME 7" SINGLE SIZE	48	2009-12-01 07:45:00	2.10	13085.0	United Kingdom
4	489434	21232	STRAWBERRY CERAMIC TRINKET BOX	24	2009-12-01 07:45:00	1.25	13085.0	United Kingdom
5	489434	22064	PINK DOUGHNUT TRINKET POT	24	2009-12-01 07:45:00	1.65	13085.0	United Kingdom
6	489434	21871	SAVE THE PLANET MUG	24	2009-12-01 07:45:00	1.25	13085.0	United Kingdom
7	489434	21523	FANCY FONT HOME SWEET HOME DOORMAT	10	2009-12-01 07:45:00	5.95	13085.0	United Kingdom
8	489435	22350	CAT BOWL	12	2009-12-01 07:46:00	2.55	13085.0	United Kingdom
9	489435	22349	DOG BOWL , CHASING BALL DESIGN	12	2009-12-01 07:46:00	3.75	13085.0	United Kingdom

In [ ]:

```
data_sheet2.head(10)
```

Out[ ]:

	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	17850.0	United Kingdom
1	536365	71053	WHITE METAL LANTERN	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom
2	536365	84406B	CREAM CUPID HEARTS COAT HANGER	8	2010-12-01 08:26:00	2.75	17850.0	United Kingdom
3	536365	84029G	KNITTED UNION FLAG HOT WATER BOTTLE	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom
4	536365	84029E	RED WOOLLY HOTTIE WHITE HEART.	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom
5	536365	22752	SET 7 BABUSHKA NESTING BOXES	2	2010-12-01 08:26:00	7.65	17850.0	United Kingdom
6	536365	21730	GLASS STAR FROSTED T-LIGHT HOLDER	6	2010-12-01 08:26:00	4.25	17850.0	United Kingdom
7	536366	22633	HAND WARMER UNION JACK	6	2010-12-01 08:28:00	1.85	17850.0	United Kingdom
8	536366	22632	HAND WARMER RED POLKA DOT	6	2010-12-01 08:28:00	1.85	17850.0	United Kingdom
9	536368	22960	JAM MAKING SET WITH JARS	6	2010-12-01 08:34:00	4.25	13047.0	United Kingdom

In [ ]:

```
data_sheet1.dtypes
```

Out[ ]:

```
Invoice                object
StockCode              object
Description            object
Quantity                int64
InvoiceDate    datetime64[ns]
Price                 float64
Customer ID           float64
Country                object
dtype: object
```

In [ ]:

```
data_sheet2.dtypes
```

Out[ ]:

```
Invoice                object
StockCode              object
Description            object
Quantity                int64
InvoiceDate    datetime64[ns]
Price                 float64
Customer ID           float64
Country                object
dtype: object
```

In [ ]:

```
data_sheet1.info
```

Out[ ]:

```
<bound method DataFrame.info of        Invoice StockCode                          Description  Quantity  \
0       489434     85048  15CM CHRISTMAS GLASS BALL 20 LIGHTS        12
1       489434    79323P                   PINK CHERRY LIGHTS        12
2       489434    79323W                  WHITE CHERRY LIGHTS        12
3       489434     22041         RECORD FRAME 7" SINGLE SIZE         48
4       489434     21232       STRAWBERRY CERAMIC TRINKET BOX        24
...        ...       ...                                  ...       ...
525456  538171     22271                 FELTCRAFT DOLL ROSIE         2
525457  538171     22750         FELTCRAFT PRINCESS LOLA DOLL         1
525458  538171     22751       FELTCRAFT PRINCESS OLIVIA DOLL         1
525459  538171     20970   PINK FLORAL FELTCRAFT SHOULDER BAG         2
525460  538171     21931               JUMBO STORAGE BAG SUKI         2

               InvoiceDate  Price  Customer ID         Country
0      2009-12-01 07:45:00   6.95      13085.0  United Kingdom
1      2009-12-01 07:45:00   6.75      13085.0  United Kingdom
2      2009-12-01 07:45:00   6.75      13085.0  United Kingdom
3      2009-12-01 07:45:00   2.10      13085.0  United Kingdom
4      2009-12-01 07:45:00   1.25      13085.0  United Kingdom
...                    ...    ...          ...             ...
525456 2010-12-09 20:01:00   2.95      17530.0  United Kingdom
525457 2010-12-09 20:01:00   3.75      17530.0  United Kingdom
525458 2010-12-09 20:01:00   3.75      17530.0  United Kingdom
525459 2010-12-09 20:01:00   3.75      17530.0  United Kingdom
525460 2010-12-09 20:01:00   1.95      17530.0  United Kingdom

[525461 rows x 8 columns]>
```

In [ ]:

```
data_sheet2.info
```

Out[ ]:

```
<bound method DataFrame.info of        Invoice 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
...        ...       ...                                  ...       ...
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
541909  581587      POST                              POSTAGE         1

               InvoiceDate  Price  Customer ID         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
...                    ...    ...          ...             ...
541905 2011-12-09 12:50:00   2.10      12680.0          France
541906 2011-12-09 12:50:00   4.15      12680.0          France
541907 2011-12-09 12:50:00   4.15      12680.0          France
541908 2011-12-09 12:50:00   4.95      12680.0          France
541909 2011-12-09 12:50:00  18.00      12680.0          France

[541910 rows x 8 columns]>
```

In [ ]:

```
# Merging both sheets to get a single dataframe
dataframe = pd.concat([data_sheet1, data_sheet2], ignore_index=True, sort=False)
```

In [ ]:

```
dataframe.isnull().sum()
```

Out[ ]:

```
Invoice             0
StockCode           0
Description      4382
Quantity            0
InvoiceDate         0
Price               0
Customer ID    243007
Country             0
dtype: int64
```

In [ ]:

```
dataframe.describe()
```

Out[ ]:

	Quantity	Price	Customer ID
count	1.067371e+06	1.067371e+06	824364.000000
mean	9.938898e+00	4.649388e+00	15324.638504
std	1.727058e+02	1.235531e+02	1697.464450
min	-8.099500e+04	-5.359436e+04	12346.000000
25%	1.000000e+00	1.250000e+00	13975.000000
50%	3.000000e+00	2.100000e+00	15255.000000
75%	1.000000e+01	4.150000e+00	16797.000000
max	8.099500e+04	3.897000e+04	18287.000000

In [ ]:

```
dataframe
```

Out[ ]:

	Invoice	StockCode	Description	Quantity	InvoiceDate	Price	Customer ID	Country
0	489434	85048	15CM CHRISTMAS GLASS BALL 20 LIGHTS	12	2009-12-01 07:45:00	6.95	13085.0	United Kingdom
1	489434	79323P	PINK CHERRY LIGHTS	12	2009-12-01 07:45:00	6.75	13085.0	United Kingdom
2	489434	79323W	WHITE CHERRY LIGHTS	12	2009-12-01 07:45:00	6.75	13085.0	United Kingdom
3	489434	22041	RECORD FRAME 7" SINGLE SIZE	48	2009-12-01 07:45:00	2.10	13085.0	United Kingdom
4	489434	21232	STRAWBERRY CERAMIC TRINKET BOX	24	2009-12-01 07:45:00	1.25	13085.0	United Kingdom
...	...	...	...	...	...	...	...	...
1067366	581587	22899	CHILDREN'S APRON DOLLY GIRL	6	2011-12-09 12:50:00	2.10	12680.0	France
1067367	581587	23254	CHILDRENS CUTLERY DOLLY GIRL	4	2011-12-09 12:50:00	4.15	12680.0	France
1067368	581587	23255	CHILDRENS CUTLERY CIRCUS PARADE	4	2011-12-09 12:50:00	4.15	12680.0	France
1067369	581587	22138	BAKING SET 9 PIECE RETROSPOT	3	2011-12-09 12:50:00	4.95	12680.0	France
1067370	581587	POST	POSTAGE	1	2011-12-09 12:50:00	18.00	12680.0	France

1067371 rows × 8 columns

In [ ]:

```
dataframe.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1067371 entries, 0 to 1067370
Data columns (total 8 columns):
 #   Column       Non-Null Count    Dtype         
---  ------       --------------    -----         
 0   Invoice      1067371 non-null  object        
 1   StockCode    1067371 non-null  object        
 2   Description  1062989 non-null  object        
 3   Quantity     1067371 non-null  int64         
 4   InvoiceDate  1067371 non-null  datetime64[ns]
 5   Price        1067371 non-null  float64       
 6   Customer ID  824364 non-null   float64       
 7   Country      1067371 non-null  object        
dtypes: datetime64[ns](1), float64(2), int64(1), object(4)
memory usage: 65.1+ MB
```

Checking if the Sale is made on Weekend or Weekday

In [ ]:

```
dataframe["DayOfMonth"] = (dataframe["InvoiceDate"]).dt.day
dataframe["IsWeekend"] = (dataframe['InvoiceDate'].dt.dayofweek >= 5).astype(int)
dataframe.head()
```

Out[ ]:

	Invoice	StockCode	Description	Quantity	InvoiceDate	Price	Customer ID	Country	DayOfMonth	IsWeekend
0	489434	85048	15CM CHRISTMAS GLASS BALL 20 LIGHTS	12	2009-12-01 07:45:00	6.95	13085.0	United Kingdom	1	0
1	489434	79323P	PINK CHERRY LIGHTS	12	2009-12-01 07:45:00	6.75	13085.0	United Kingdom	1	0
2	489434	79323W	WHITE CHERRY LIGHTS	12	2009-12-01 07:45:00	6.75	13085.0	United Kingdom	1	0
3	489434	22041	RECORD FRAME 7" SINGLE SIZE	48	2009-12-01 07:45:00	2.10	13085.0	United Kingdom	1	0
4	489434	21232	STRAWBERRY CERAMIC TRINKET BOX	24	2009-12-01 07:45:00	1.25	13085.0	United Kingdom	1	0

In [ ]:

```
#Cehcking the distribution of 'IsWeekend' column
dataframe.IsWeekend.value_counts()
```

Out[ ]:

```
0    927713
1    139658
Name: IsWeekend, dtype: int64
```

In [ ]:

```
dataframe['BillValue'] = dataframe['Price'] * dataframe['Quantity']
dataframe
```

Out[ ]:

	Invoice	StockCode	Description	Quantity	InvoiceDate	Price	Customer ID	Country	DayOfMonth	IsWeekend	BillValue
0	489434	85048	15CM CHRISTMAS GLASS BALL 20 LIGHTS	12	2009-12-01 07:45:00	6.95	13085.0	United Kingdom	1	0	83.40
1	489434	79323P	PINK CHERRY LIGHTS	12	2009-12-01 07:45:00	6.75	13085.0	United Kingdom	1	0	81.00
2	489434	79323W	WHITE CHERRY LIGHTS	12	2009-12-01 07:45:00	6.75	13085.0	United Kingdom	1	0	81.00
3	489434	22041	RECORD FRAME 7" SINGLE SIZE	48	2009-12-01 07:45:00	2.10	13085.0	United Kingdom	1	0	100.80
4	489434	21232	STRAWBERRY CERAMIC TRINKET BOX	24	2009-12-01 07:45:00	1.25	13085.0	United Kingdom	1	0	30.00
...	...	...	...	...	...	...	...	...	...	...	...
1067366	581587	22899	CHILDREN'S APRON DOLLY GIRL	6	2011-12-09 12:50:00	2.10	12680.0	France	9	0	12.60
1067367	581587	23254	CHILDRENS CUTLERY DOLLY GIRL	4	2011-12-09 12:50:00	4.15	12680.0	France	9	0	16.60
1067368	581587	23255	CHILDRENS CUTLERY CIRCUS PARADE	4	2011-12-09 12:50:00	4.15	12680.0	France	9	0	16.60
1067369	581587	22138	BAKING SET 9 PIECE RETROSPOT	3	2011-12-09 12:50:00	4.95	12680.0	France	9	0	14.85
1067370	581587	POST	POSTAGE	1	2011-12-09 12:50:00	18.00	12680.0	France	9	0	18.00

1067371 rows × 11 columns

In [ ]:

```
#checking for negative values in 'Price'
(dataframe.Price <0).value_counts()
```

Out[ ]:

```
False    1067366
True           5
Name: Price, dtype: int64
```

In [ ]:

```
#removing the '-' sign from values
dataframe.Price = dataframe.Price.astype(str).str.replace('-', '').astype(float)
(dataframe.Price<0).value_counts()
```

Out[ ]:

```
False    1067371
Name: Price, dtype: int64
```

In [ ]:

```
#checking for negative value in 'Quantity
(dataframe.Quantity <0).value_counts()
```

Out[ ]:

```
False    1044421
True       22950
Name: Quantity, dtype: int64
```

In [ ]:

```
#changing the column values to absolute, removing any negative vlaues
dataframe.Quantity = dataframe.Quantity.abs()
(dataframe.Quantity <0).value_counts()
```

Out[ ]:

```
False    1067371
Name: Quantity, dtype: int64
```

In [ ]:

```
dataframe[dataframe.duplicated('StockCode', keep=False)].groupby('StockCode')['Description'].apply(list).reset_index()
```

Out[ ]:

	StockCode	Description
0	10002	[INFLATABLE POLITICAL GLOBE , INFLATABLE POLIT...
1	10080	[GROOVY CACTUS INFLATABLE, GROOVY CACTUS INFLA...
2	10109	[BENDY COLOUR PENCILS, nan]
3	10120	[DOGGY RUBBER, DOGGY RUBBER, DOGGY RUBBER, DOG...
4	10125	[MINI FUNKY DESIGN TAPES, MINI FUNKY DESIGN TA...
...	...	...
4867	gift_0001_60	[nan, nan]
4868	gift_0001_70	[nan, Dotcomgiftshop Gift Voucher £70.00, nan]
4869	gift_0001_80	[nan, Dotcomgiftshop Gift Voucher £80.00, Dotc...
4870	gift_0001_90	[nan, nan]
4871	m	[Manual, Manual, Manual, Manual, Manual]

4872 rows × 2 columns

EDA

Can customers be segmented into different categories? If yes then perform analysis on the same and also propose categories. If no, then explain why?

In [ ]:

```
dataframe = dataframe.dropna()
dataframe.isnull().sum()
```

Out[ ]:

```
Invoice        0
StockCode      0
Description    0
Quantity       0
InvoiceDate    0
Price          0
Customer ID    0
Country        0
DayOfMonth     0
IsWeekend      0
BillValue      0
dtype: int64
```

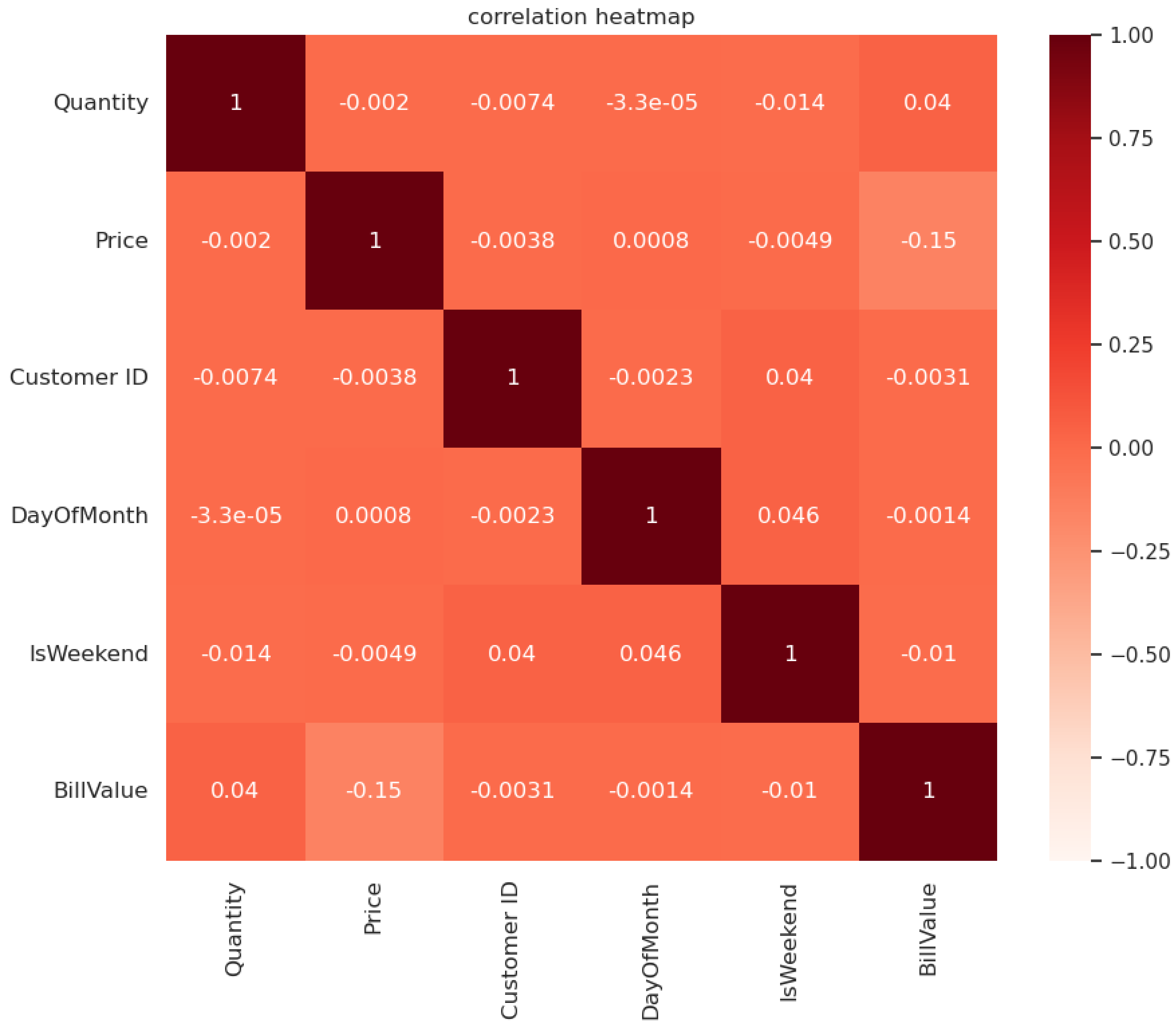
In [ ]:

```
dataframe.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 824364 entries, 0 to 1067370
Data columns (total 11 columns):
 #   Column       Non-Null Count   Dtype         
---  ------       --------------   -----         
 0   Invoice      824364 non-null  object        
 1   StockCode    824364 non-null  object        
 2   Description  824364 non-null  object        
 3   Quantity     824364 non-null  int64         
 4   InvoiceDate  824364 non-null  datetime64[ns]
 5   Price        824364 non-null  float64       
 6   Customer ID  824364 non-null  float64       
 7   Country      824364 non-null  object        
 8   DayOfMonth   824364 non-null  int64         
 9   IsWeekend    824364 non-null  int64         
 10  BillValue    824364 non-null  float64       
dtypes: datetime64[ns](1), float64(3), int64(3), object(4)
memory usage: 75.5+ MB
```

In [ ]:

```
plt.figure(figsize=(10,8))
s = sns.heatmap(dataframe.corr(),
               annot=True,
               cmap='Reds',
               vmin=-1,
               vmax=1)
s.set_yticklabels(s.get_yticklabels(),rotation=0,fontsize=12)
s.set_xticklabels(s.get_xticklabels(),rotation=90,fontsize=12)
plt.title('correlation heatmap')
plt.show()
```



In [ ]:

```
frequency_customer= dataframe.groupby(["Customer ID"]).agg({"Invoice" : "nunique"}).reset_index()
frequency_customer.columns = ['Customer ID', 'Frequency']
frequency_customer=frequency_customer.sort_values(["Frequency"], ascending=False).reset_index()
frequency_customer= frequency_customer.drop(columns=['index'])
frequency_customer['freq_score']=0
frequency_customer['freq_score'] = pd.qcut(frequency_customer['Frequency'], 4, ['1','2','3','4']).astype(int)

frequency_customer
```

Out[ ]:

	Customer ID	Frequency	freq_score
0	14911.0	510	4
1	12748.0	365	4
2	17841.0	289	4
3	15311.0	270	4
4	14606.0	259	4
...	...	...	...
5937	17079.0	1	1
5938	17077.0	1	1
5939	13328.0	1	1
5940	15352.0	1	1
5941	17318.0	1	1

5942 rows × 3 columns

In [ ]:

```
spending_customer = dataframe.groupby(["Customer ID"]).agg({"BillValue" : "sum"}).reset_index()
spending_customer.columns = ['Customer ID', 'monetary']
spending_customer = spending_customer.sort_values(["monetary"], ascending=False).reset_index()
spending_customer = spending_customer.drop(columns=['index'])
spending_customer['monetary_score']=0
spending_customer['monetary_score'] = pd.qcut(spending_customer['monetary'], 4, ['1','2','3','4']).astype(int)
spending_customer
```

Out[ ]:

	Customer ID	monetary	monetary_score
0	18102.0	598215.22	4
1	14646.0	523342.07	4
2	14156.0	296564.69	4
3	14911.0	270248.53	4
4	17450.0	233579.39	4
...	...	...	...
5937	16981.0	-4620.86	1
5938	15760.0	-5795.87	1
5939	15849.0	-5876.34	1
5940	12918.0	-10953.50	1
5941	17399.0	-25111.09	1

5942 rows × 3 columns

In [ ]:

```
customer_recency= dataframe.groupby(["Customer ID"]).agg({"InvoiceDate" : "max"}).reset_index()
customer_recency.columns = ['Customer ID', 'Recency']
customer_recency=customer_recency.sort_values(["Recency"], ascending=False).reset_index()
refrence_date = customer_recency.Recency.max() + dt.timedelta(days = 1)
customer_recency['Recency'] = (refrence_date - customer_recency.Recency).astype('timedelta64[D]')
```

```
customer_recency = customer_recency.drop(columns=['index'])
customer_recency['recency_score']=0
customer_recency['recency_score'] = pd.qcut(customer_recency['Recency'], 4, ['1','2','3','4']).astype(int)

customer_recency
```

Out[ ]:

	Customer ID	Recency	recency_score
0	12680.0	1.0	1
1	13113.0	1.0	1
2	15804.0	1.0	1
3	13777.0	1.0	1
4	17581.0	1.0	1
...	...	...	...
5937	14654.0	738.0	4
5938	17056.0	738.0	4
5939	17641.0	739.0	4
5940	17592.0	739.0	4
5941	12636.0	739.0	4

5942 rows × 3 columns

In [ ]:

```
customers = pd.merge(frequency_customer, spending_customer, on="Customer ID")
customers = pd.merge(customers, customer_recency, on="Customer ID")
customers
```

Out[ ]:

	Customer ID	Frequency	freq_score	monetary	monetary_score	Recency	recency_score
0	14911.0	510	4	270248.53	4	1.0	1
1	12748.0	365	4	49970.13	4	1.0	1
2	17841.0	289	4	69516.19	4	2.0	1
3	15311.0	270	4	113513.07	4	1.0	1
4	14606.0	259	4	30094.38	4	1.0	1
...	...	...	...	...	...	...	...
5937	17079.0	1	1	118.80	1	78.0	2
5938	17077.0	1	1	306.00	1	578.0	4
5939	13328.0	1	1	1308.48	3	316.0	3
5940	15352.0	1	1	114.95	1	549.0	4
5941	17318.0	1	1	164.28	1	725.0	4

5942 rows × 7 columns

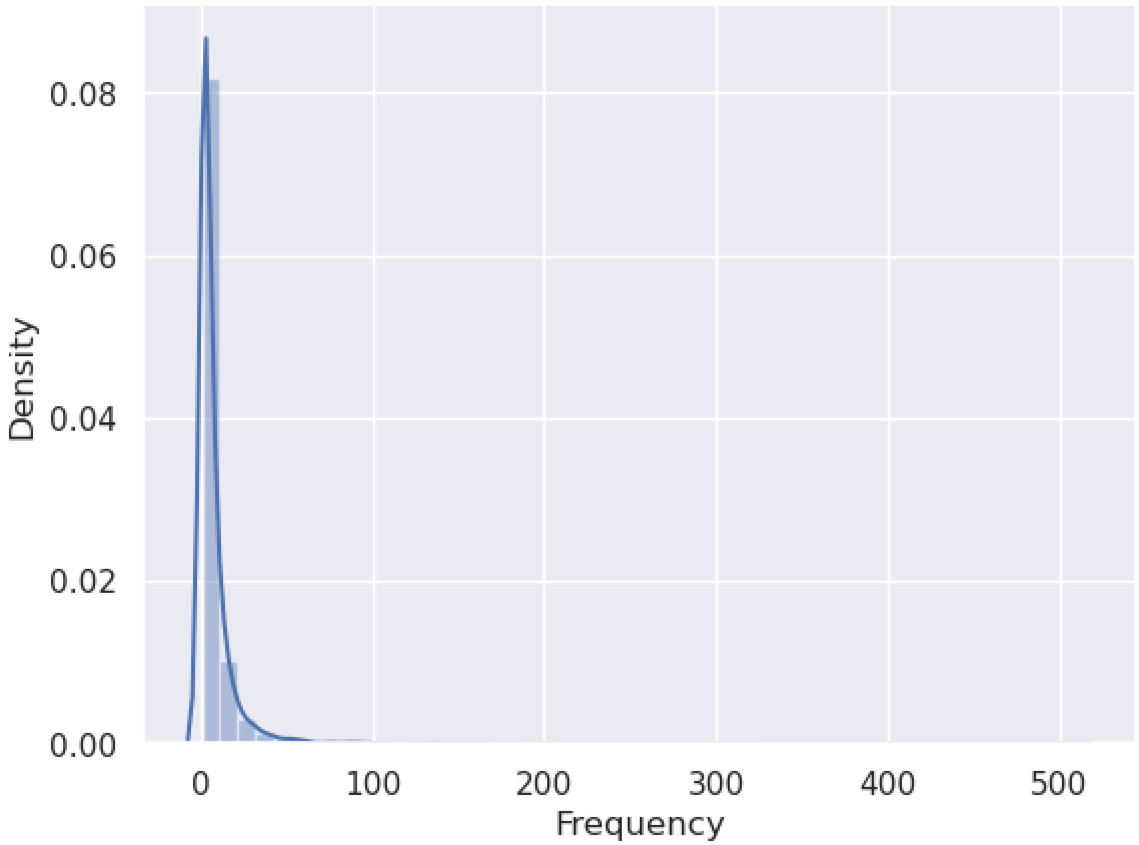
In [ ]:

```
sns.distplot(customers['Frequency'])
#sns.distplot((customers['monetary']))
#sns.distplot((customers['Recency']))
```

```
/tmp/ipykernel_67535/3086396657.py:1: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(customers['Frequency'])
```

Out[ ]:

```
<AxesSubplot: xlabel='Frequency', ylabel='Density'>
```



In [ ]:

```
customers.describe()
```

Out[ ]:

	Customer ID	Frequency	freq_score	monetary	monetary_score	Recency	recency_score
count	5942.000000	5942.000000	5942.000000	5942.000000	5942.000000	5942.000000	5942.000000
mean	15316.500000	7.552339	2.263548	2801.799459	2.500000	202.908617	2.492427
std	1715.451981	15.972262	1.204916	13973.922553	1.118279	211.857936	1.122909
min	12346.000000	1.000000	1.000000	-25111.090000	1.000000	1.000000	1.000000
25%	13831.250000	2.000000	1.000000	325.097500	1.250000	25.000000	1.000000
50%	15316.500000	4.000000	2.000000	843.970000	2.500000	96.000000	2.000000
75%	16801.750000	8.000000	3.000000	2182.005000	3.750000	381.000000	3.000000
max	18287.000000	510.000000	4.000000	598215.220000	4.000000	739.000000	4.000000

In [ ]:

```
customers['RFM'] = (customers.recency_score.astype(str)+ customers.freq_score.astype(str) + customers.monetary_score.astype(str)).astype(int)
customers = customers.sort_values(["RFM"], ascending=False).reset_index()
customers = customers.drop(columns=['index'])
customers
```

Out[ ]:

	Customer ID	Frequency	freq_score	monetary	monetary_score	Recency	recency_score	RFM
0	12835.0	49	4	6018.67	4	418.0	4	444
1	17465.0	9	4	2533.64	4	426.0	4	444
2	15633.0	18	4	4173.41	4	509.0	4	444
3	15538.0	11	4	3027.15	4	538.0	4	444
4	14685.0	13	4	4324.31	4	576.0	4	444
...	...	...	...	...	...	...	...	...
5937	14601.0	1	1	213.96	1	11.0	1	111
5938	12702.0	1	1	219.00	1	20.0	1	111
5939	13986.0	1	1	320.46	1	17.0	1	111
5940	15318.0	1	1	312.62	1	4.0	1	111
5941	14703.0	1	1	318.17	1	15.0	1	111

5942 rows × 8 columns

In [ ]:

```
customers['monetary'].replace(0,0.001,inplace=True)
```

In [ ]:

```
(customers.monetary <0).value_counts()
```

Out[ ]:

```
False    5857
True       85
Name: monetary, dtype: int64
```

In [ ]:

```
customers.monetary = customers.monetary.astype(str).str.replace('-', '').astype(float)
```

In [ ]:

```
# data is skewed so log transform and standard scaler helps to normalize it.
customers['recency_log'] = customers['Recency'].apply(math.log)
customers['frequency_log'] =customers['Frequency'].apply(math.log)
customers['monetary_log'] =customers['monetary'].apply(math.log)
scaler = StandardScaler()
scaled_features = scaler.fit_transform(customers[['monetary_log', 'recency_log','frequency_log']])
```

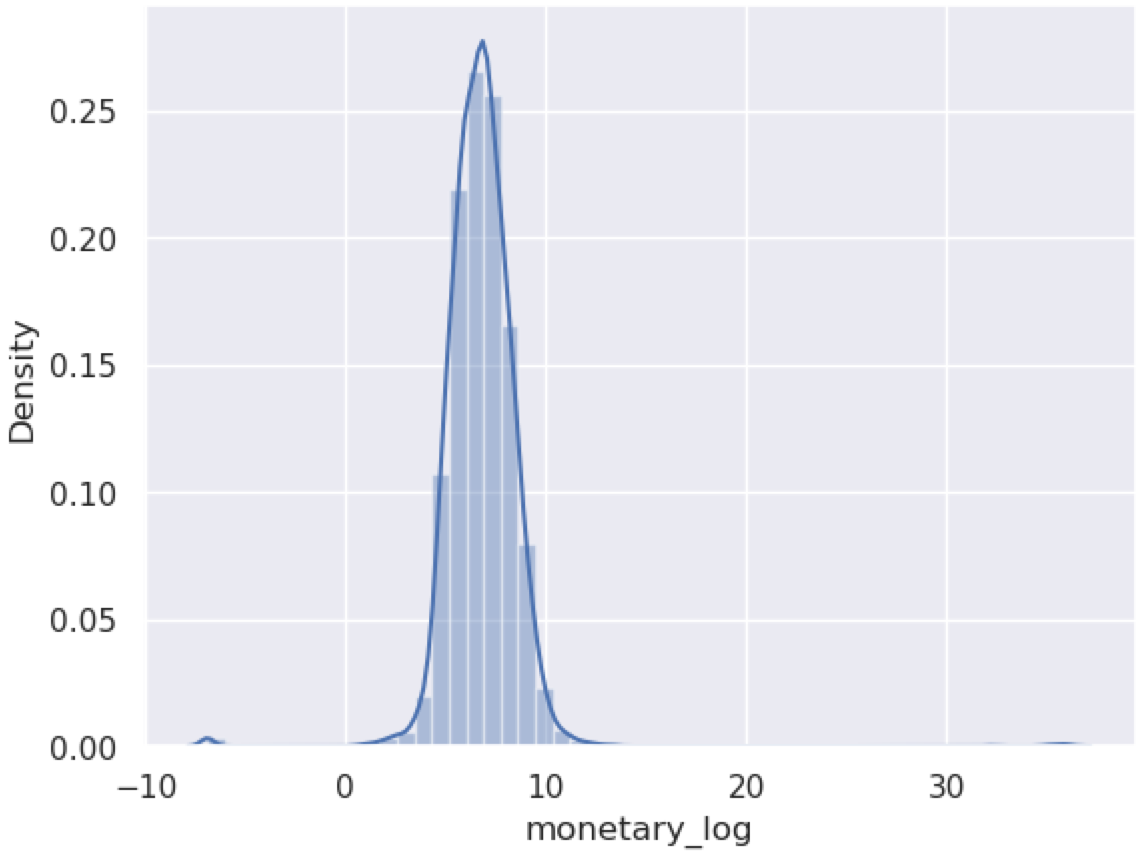
In [ ]:

```
sns.distplot((customers['monetary_log']))
#sns.distplot((customers['frequency_log']))
#sns.distplot((customers['recency_log']))
```

```
/tmp/ipykernel_67535/3241652451.py:1: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot((customers['monetary_log']))
```

Out[ ]:

```
<AxesSubplot: xlabel='monetary_log', ylabel='Density'>
```



In [ ]:

```
kmeans = KMeans(n_clusters=4, init="random", n_init=10, max_iter=500,random_state=75)
kmeans.fit(scaled_features)
customers['cluster'] = kmeans.labels_
cluster_centers=kmeans.cluster_centers_
```

In [ ]:

```
customers.head(10)
```

Out[ ]:

	Customer ID	Frequency	freq_score	monetary	monetary_score	Recency	recency_score	RFM	recency_log	frequency_log	monetary_log	cluster
0	12835.0	49	4	6018.670	4	418.0	4	444	6.035481	3.891820	8.702622	0
1	17465.0	9	4	2533.640	4	426.0	4	444	6.054439	2.197225	7.837412	0
2	15633.0	18	4	4173.410	4	509.0	4	444	6.232448	2.890372	8.336489	0
3	15538.0	11	4	3027.150	4	538.0	4	444	6.287859	2.397895	8.015377	0
4	14685.0	13	4	4324.310	4	576.0	4	444	6.356108	2.564949	8.372008	0
5	14590.0	28	4	2884.290	4	425.0	4	444	6.052089	3.332205	7.967034	0
6	15015.0	20	4	2275.820	4	501.0	4	444	6.216606	2.995732	7.730096	0
7	14025.0	10	4	3969.100	4	465.0	4	444	6.142037	2.302585	8.286295	0
8	14249.0	12	4	5625.461	4	411.0	4	444	6.018593	2.484907	8.635058	0
9	14134.0	15	4	11123.350	4	383.0	4	444	5.948035	2.708050	9.316802	0

In [ ]:

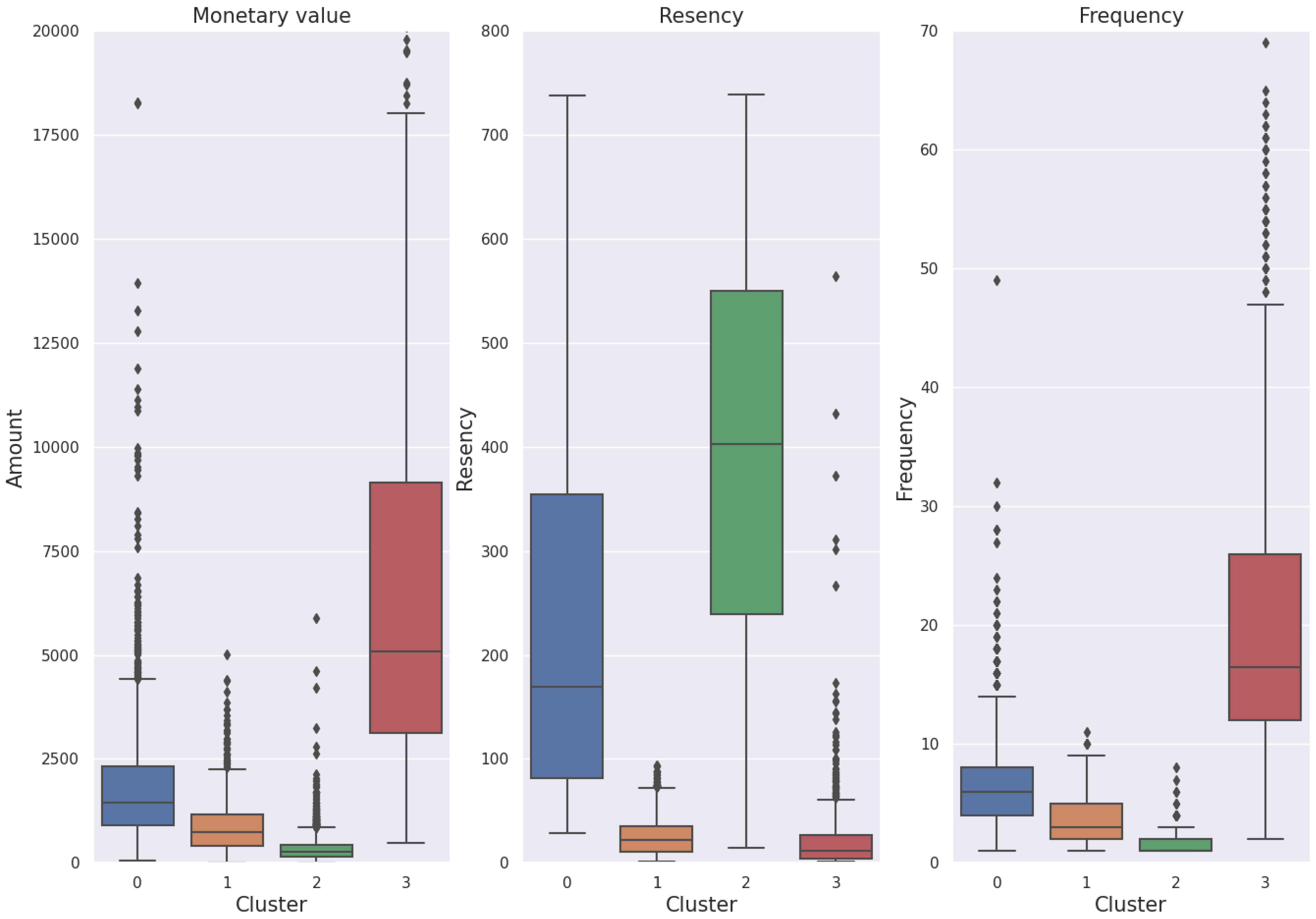
```
features = ['monetary',  'Recency',  'Frequency']
scaler.inverse_transform(kmeans.cluster_centers_)
data_inversed = scaler.inverse_transform(cluster_centers)
data_transformed=pd.DataFrame(np.exp(data_inversed),columns=features)
data_transformed.reset_index(inplace=True)
data_transformed.rename(columns={"index": "Cluster"},inplace=True)
```

In [ ]:

```
sns.set_style("darkgrid")
fig = plt.figure(figsize=(16,11))
f1 = fig.add_subplot(131)
sns.set(font_scale =1)
ax1=sns.boxplot(x=customers['cluster'],y=customers['monetary'])
ax1.set_title('Monetary value', fontsize = 15)
ax1.set_ylabel('Amount', fontsize =15)
ax1.set_xlabel ('Cluster', fontsize = 15)
ax1.set_ylim(top=20000,bottom=0)

f1 = fig.add_subplot(132)
sns.set(font_scale = 1)
ax2=sns.boxplot(x=customers['cluster'],y=customers[ 'Recency'])
ax2.set_title('Resency', fontsize =15)
ax2.set_ylabel('Resency', fontsize =15)
ax2.set_xlabel ('Cluster', fontsize = 15)
ax2.set_ylim(top=800,bottom=0)

f1 = fig.add_subplot(133)
sns.set(font_scale = 1)
ax3=sns.boxplot(x=customers['cluster'],y=customers[ 'Frequency'])
ax3.set_title('Frequency', fontsize = 15)
ax3.set_ylabel('Frequency', fontsize =15)
ax3.set_xlabel ('Cluster', fontsize = 15)
ax3.set_ylim(top=70,bottom=0)
```

Out[ ]:

```
(0.0, 70.0)
```


Monetary value
Amount
20000
17500
15000
12500
10000
7500
5000
2500
0
0
1
2
3
Cluster
Resency
Resency
800
700
600
500
400
300
200
100
0
0
1
2
3
Cluster
Frequency
Frequency
70
60
50
40
30
20
10
0
0
1
2
3
Cluster

Cluster 0: are low spenders, low number of orders, and recent purchase was long ago.

Cluster 1: are the frequent purchasers. This group buys often, bought recently and spends more.

Cluster 2: are probably new customers. Recent purchases but didn't spend much.

Cluster 3: are loyal customers who make big and frequent purchases, and the last purchase was also recently.

How would you define a loyal customer?

In [ ]:

```
len(customers.RFM.unique())
```

Out[ ]: 63

In [ ]:

```
rfm_customer = customers
rfm_customer['rfm_cluster']=0
rfm_customer['rfm_cluster'] = pd.qcut(customer_recency['Recency'], 4, ['0','1','2','3']).astype(int)
rfm_customer
```

Out[ ]:

	Customer ID	Frequency	freq_score	monetary	monetary_score	Recency	recency_score	RFM	recency_log	frequency_log	monetary_log	cluster	rfm_cluster
0	12835.0	49	4	6018.67	4	418.0	4	444	6.035481	3.891820	8.702622	0	0
1	17465.0	9	4	2533.64	4	426.0	4	444	6.054439	2.197225	7.837412	0	0
2	15633.0	18	4	4173.41	4	509.0	4	444	6.232448	2.890372	8.336489	0	0
3	15538.0	11	4	3027.15	4	538.0	4	444	6.287859	2.397895	8.015377	0	0
4	14685.0	13	4	4324.31	4	576.0	4	444	6.356108	2.564949	8.372008	0	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...
5937	14601.0	1	1	213.96	1	11.0	1	111	2.397895	0.000000	5.365789	1	3
5938	12702.0	1	1	219.00	1	20.0	1	111	2.995732	0.000000	5.389072	1	3
5939	13986.0	1	1	320.46	1	17.0	1	111	2.833213	0.000000	5.769757	1	3
5940	15318.0	1	1	312.62	1	4.0	1	111	1.386294	0.000000	5.744988	1	3
5941	14703.0	1	1	318.17	1	15.0	1	111	2.708050	0.000000	5.762586	1	3

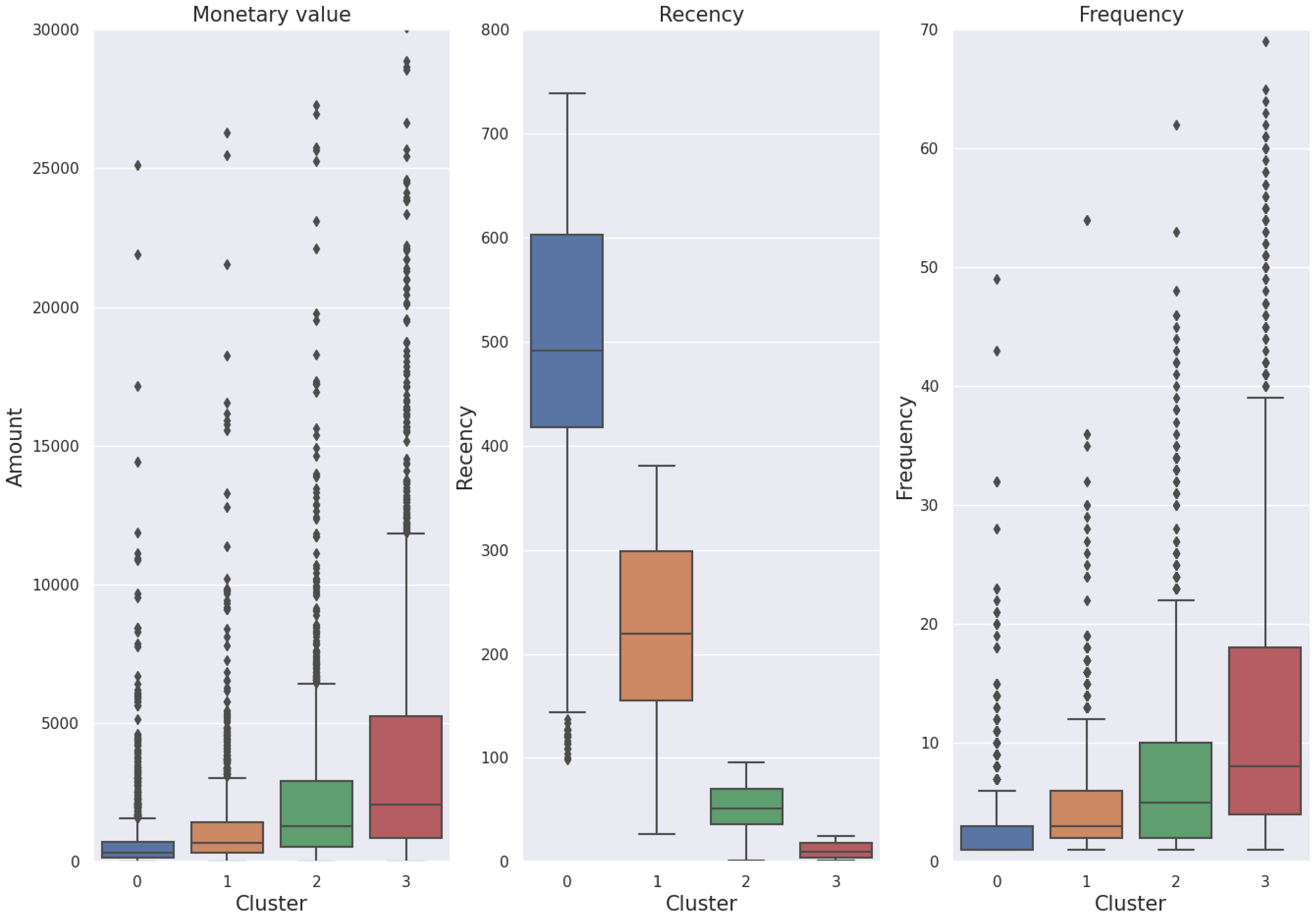
5942 rows × 13 columns

In [ ]:

```
sns.set_style("darkgrid")
fig = plt.figure(figsize=(16,11))
f1 = fig.add_subplot(131)
sns.set(font_scale =1)
ax1=sns.boxplot(x=rfm_customer['rfm_cluster'],y=rfm_customer['monetary'])
ax1.set_title('Monetary value', fontsize = 15)
ax1.set_ylabel('Amount', fontsize =15)
ax1.set_xlabel ('Cluster', fontsize = 15)
ax1.set_ylim(top=30000,bottom=0)

f1 = fig.add_subplot(132)
sns.set(font_scale = 1)
ax2=sns.boxplot(x=rfm_customer['rfm_cluster'],y=rfm_customer[ 'Recency'])
ax2.set_title('Recency', fontsize =15)
ax2.set_ylabel('Recency', fontsize =15)
ax2.set_xlabel ('Cluster', fontsize = 15)
```

```
ax2.set_ylim(top=800,bottom=0)

f1 = fig.add_subplot(133)
sns.set(font_scale = 1)
ax3=sns.boxplot(x=rfm_customer['rfm_cluster'],y=rfm_customer[ 'Frequency'])
ax3.set_title('Frequency', fontsize = 15)
ax3.set_ylabel('Frequency', fontsize =15)
ax3.set_xlabel ('Cluster', fontsize = 15)
ax3.set_ylim(top=70,bottom=0)
```

```
Out[ ]: (0.0, 70.0)
```


Monetary value
Amount
30000
25000
20000
15000
10000
5000
0
0
1
2
3
Cluster
Recency
Recency
800
700
600
500
400
300
200
100
0
0
1
2
3
Cluster
Frequency
Frequency
70
60
50
40
30
20
10
0
0
1
2
3
Cluster

Cluster 0: Lost Customers, rarely made a purchase that too of low amount.

Cluster 1: Wandering Customers, this groups shops around and spends less.

Cluster 2: Promising Customers, they also stick with their retailer but don’t spend big amounts.

Cluster 3: This cluster tends to visit frequently and spends more than any other cluster, their last purchase was also not long ago. We can say these are the loyal customers. This group tends to stick with their retailer.

What is the most popular time of year based on this sales data?

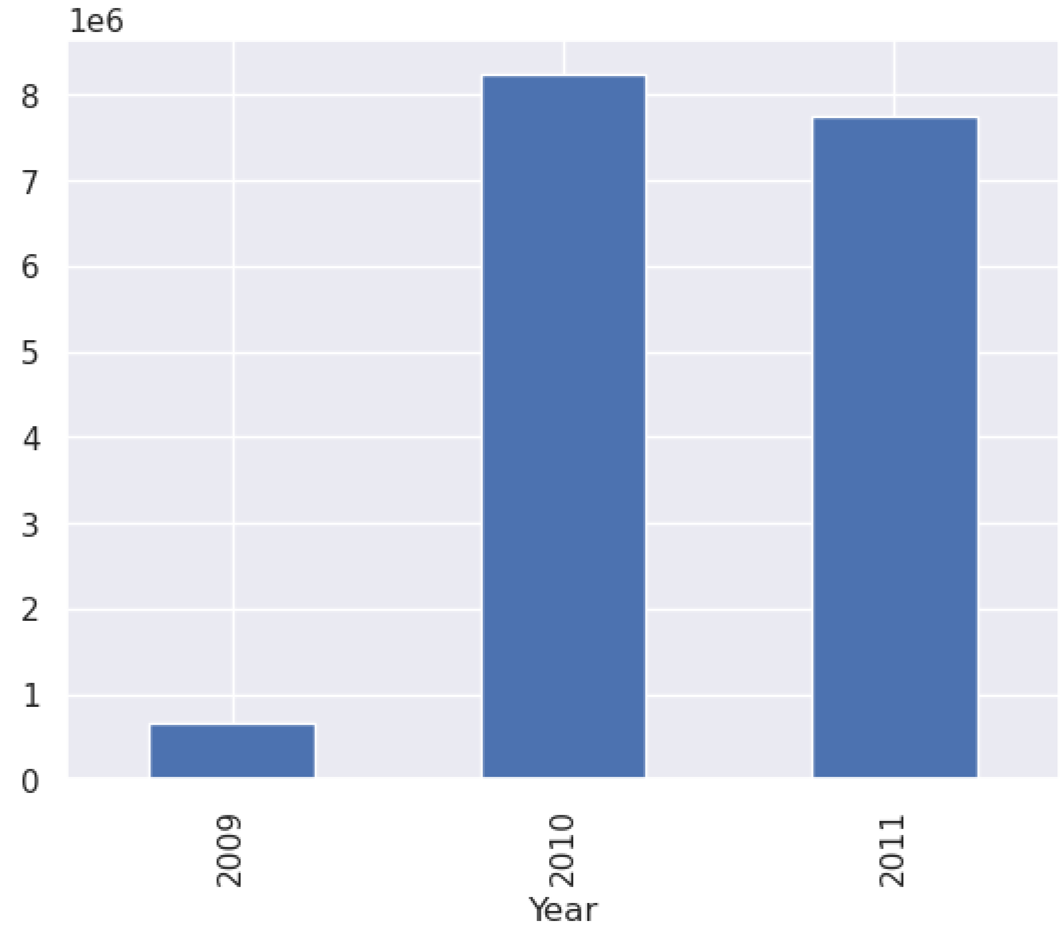
In [ ]:

```
df_year = dataframe
df_year["Year"] = (df_year.InvoiceDate).dt.year
df_year["Month"] = (df_year.InvoiceDate).dt.month

df_year.groupby('Year')['BillValue'].sum().plot(kind = 'bar')
```

```
/tmp/ipykernel_67535/3324638800.py:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_year["Year"] = (df_year.InvoiceDate).dt.year
/tmp/ipykernel_67535/3324638800.py:3: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_year["Month"] = (df_year.InvoiceDate).dt.month
```

Out[ ]:

```
<AxesSubplot: xlabel='Year'>
```

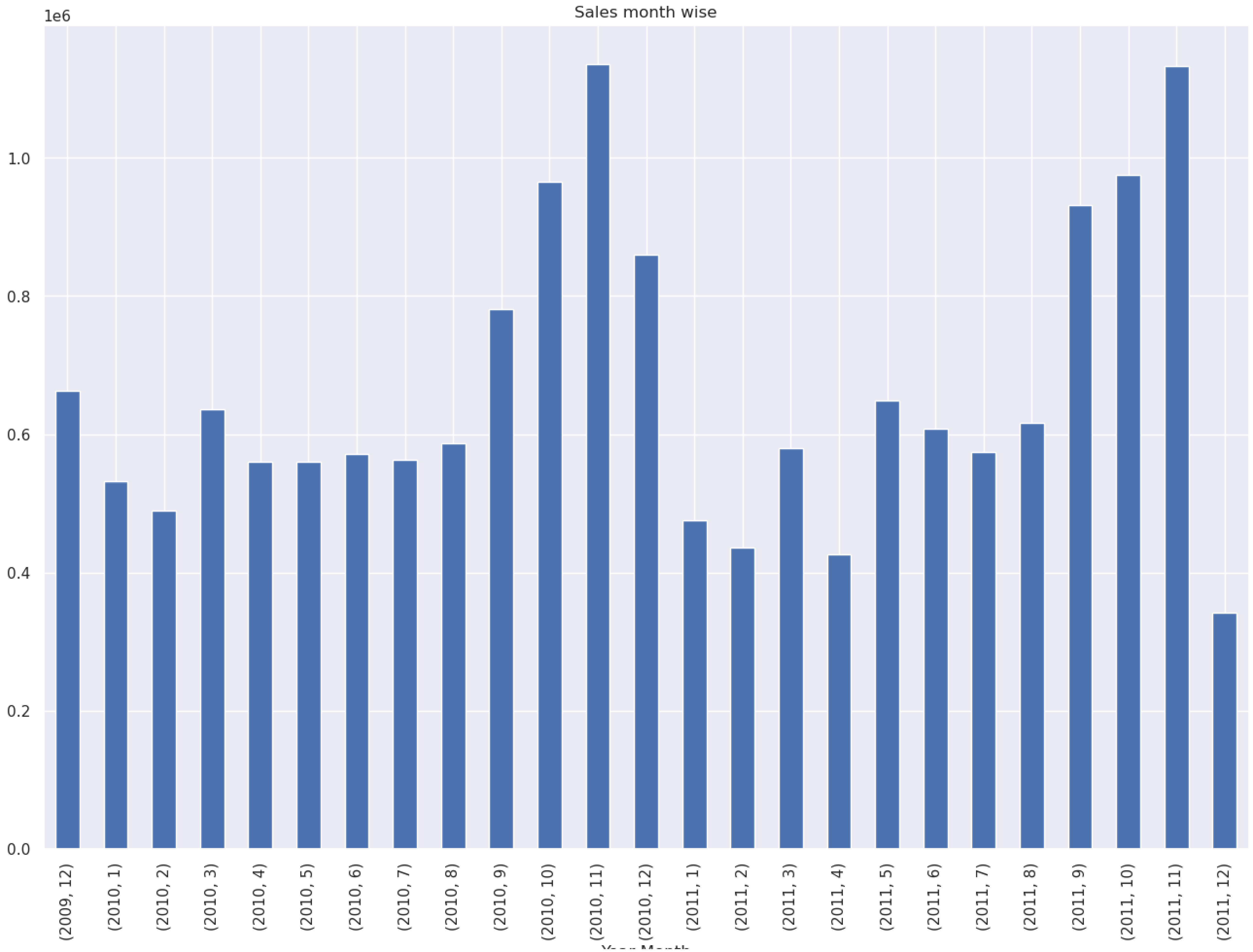


In [ ]:

```
df_year.groupby(['Year','Month'])['BillValue'].sum().plot(kind = 'bar', title = 'Sales month wise',figsize=(16,11))
```

Out[ ]:

```
<AxesSubplot: title={'center': 'Sales month wise'}, xlabel='Year,Month'>
```


Sales month wise
1e6
1.0
0.8
0.6
0.4
0.2
0.0
(2009, 12)
(2010, 1)
(2010, 2)
(2010, 3)
(2010, 4)
(2010, 5)
(2010, 6)
(2010, 7)
(2010, 8)
(2010, 9)
(2010, 10)
(2010, 11)
(2010, 12)
(2011, 1)
(2011, 2)
(2011, 3)
(2011, 4)
(2011, 5)
(2011, 6)
(2011, 7)
(2011, 8)
(2011, 9)
(2011, 10)
(2011, 11)
(2011, 12)
Year,Month

Year,Month

```
In [ ]: last_order_date = df_year['InvoiceDate'].max()
        last_order_date
```

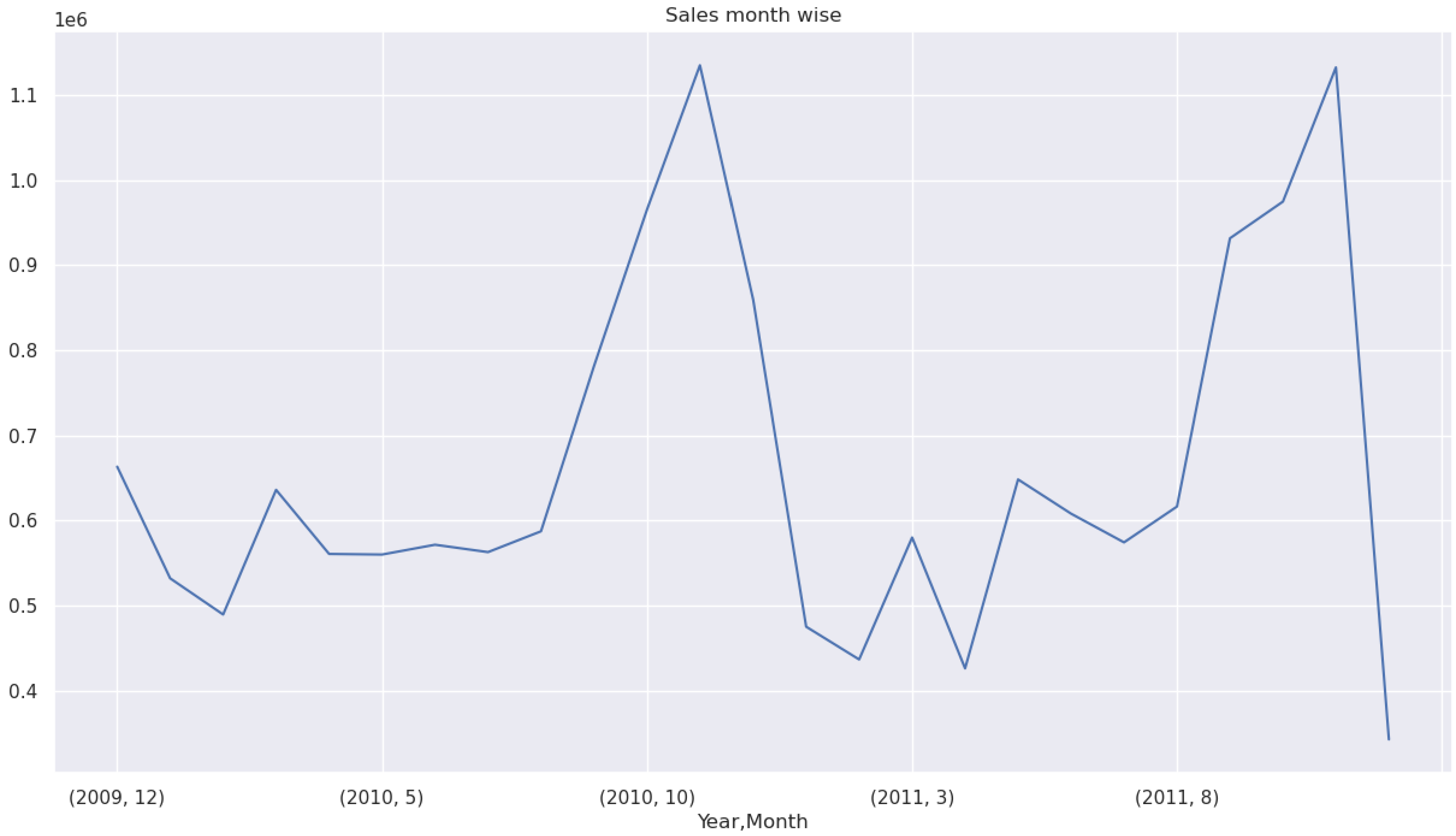
```
Out[ ]: Timestamp('2011-12-09 12:50:00')
```

According to the stastics in above bar plot we can se September, October and November is usually the most popular time. We have high sales in 2009 december and 2010 december as well but that trend did not continue to 2011. This is beacuse we only have data till 9 December 2011.

Is there any seasonality in data? Explain with supportive evidence.

```
In [ ]: df_year.groupby(['Year','Month'])['BillValue'].sum().plot(kind = 'line', title = 'Sales month wise',figsize=(15,8))
```

```
Out[ ]: <AxesSubplot: title={'center': 'Sales month wise'}, xlabel='Year,Month'>
```



Yes, there is a seasonality in data. As the data is not in 2 complete cycles. I cannot perform decomposition into seasonal, trend and residual component of time series analysis. But after looking at the above line graph of Sale value wrt time we can easily see a jump in sales around september in both year (2010 and 2011).

Discuss customer's lifetime with respect to the given dataset.

```
In [ ]: data_life = dataframe
```

```
In [ ]: data_life.InvoiceDate = pd.to_datetime(data_life.InvoiceDate).dt.date
        data_life = data_life[pd.notnull(data_life['Customer ID'])]
        data_life = data_life[(data_life.Quantity >0)]
        data_life['Total_Sales'] = data_life.Quantity * data_life.Price
        columns = ['Customer ID', 'InvoiceDate', 'Total_Sales']
```

```
data_life = data_life[columns]
data_life.head()
```

```
/tmp/ipykernel_67535/3131993596.py:1: SettingWithCopyWarning:


A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
```

Out[ ]:

	Customer ID	InvoiceDate	Total_Sales
0	13085.0	2009-12-01	83.4
1	13085.0	2009-12-01	81.0
2	13085.0	2009-12-01	81.0
3	13085.0	2009-12-01	100.8
4	13085.0	2009-12-01	30.0

In [ ]:

```
from lifetimes.plotting import *
from lifetimes.utils import *

data_life = summary_data_from_transaction_data(data_life,customer_id_col= 'Customer ID',datetime_col= 'InvoiceDate', monetary_value_col='Total_Sales', observation_period_end='2011-12-
data_life.reset_index()
```

Out[ ]:

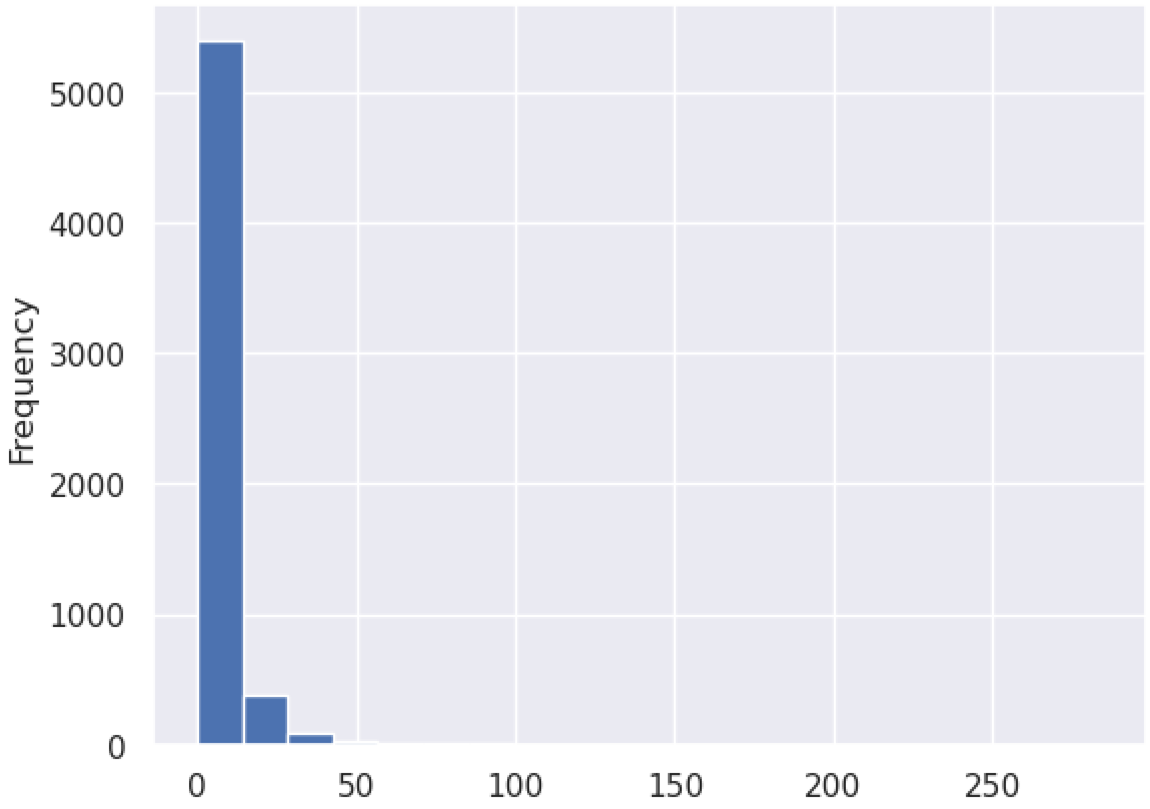
	Customer ID	frequency	recency	T	monetary_value
0	12346.0	10.0	400.0	725.0	15508.760000
1	12347.0	7.0	402.0	404.0	717.398571
2	12348.0	4.0	363.0	438.0	449.310000
3	12349.0	4.0	717.0	735.0	1107.172500
4	12350.0	0.0	0.0	310.0	0.000000
...	...	...	...	...	...
5937	18283.0	18.0	655.0	658.0	146.405556
5938	18284.0	1.0	2.0	431.0	25.000000
5939	18285.0	0.0	0.0	660.0	0.000000
5940	18286.0	2.0	247.0	723.0	470.740000
5941	18287.0	6.0	696.0	738.0	697.165000

5942 rows × 5 columns

In [ ]:

```
data_life.frequency.plot(kind='hist', bins=20)

one_time_buyers = sum(data_life.frequency == 0)/float(len(data_life))*100
print("Percentage of one time buyers:", one_time_buyers)
```

```
Percentage of one time buyers: 25.98451699764389
```



In [ ]:

```
from lifetimes import BetaGeoFitter
bgf = BetaGeoFitter(penalizer_coef=0.0)
bgf.fit(data_life.frequency, data_life.recency, data_life['T'])
print(bgf)
```

```
<lifetimes.BetaGeoFitter: fitted with 5942 subjects, a: 0.15, alpha: 49.94, b: 2.11, r: 0.67>
```

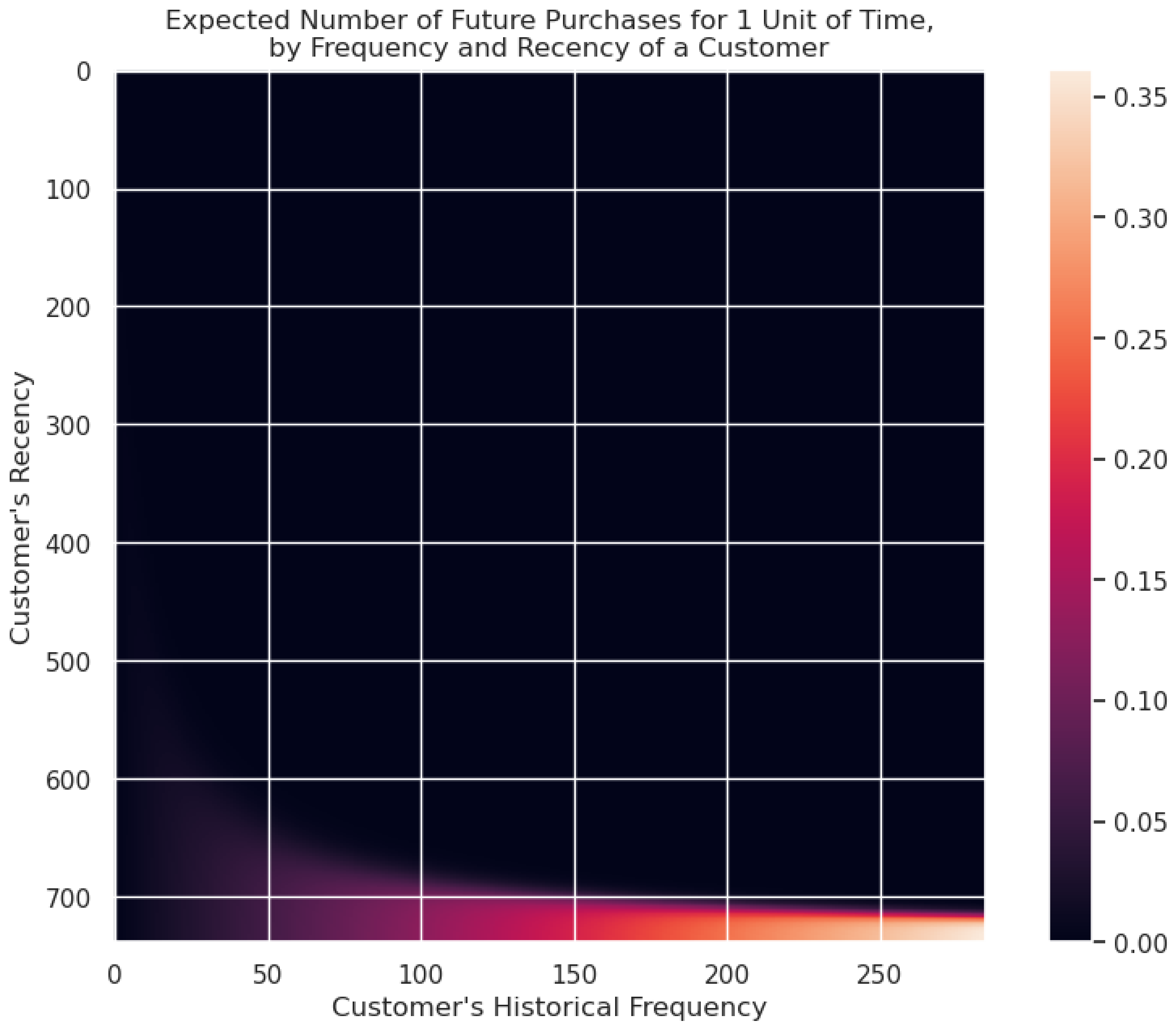
In [ ]:

```
fig = plt.figure(figsize=(10,7))
plot_frequency_recency_matrix(bgf)
```

```
/home/abhishek/anaconda3/envs/mtp/lib/python3.10/site-packages/lifetimes/fitters/beta_geo_fitter.py:256: RuntimeWarning:

overflow encountered in double_scalars
```

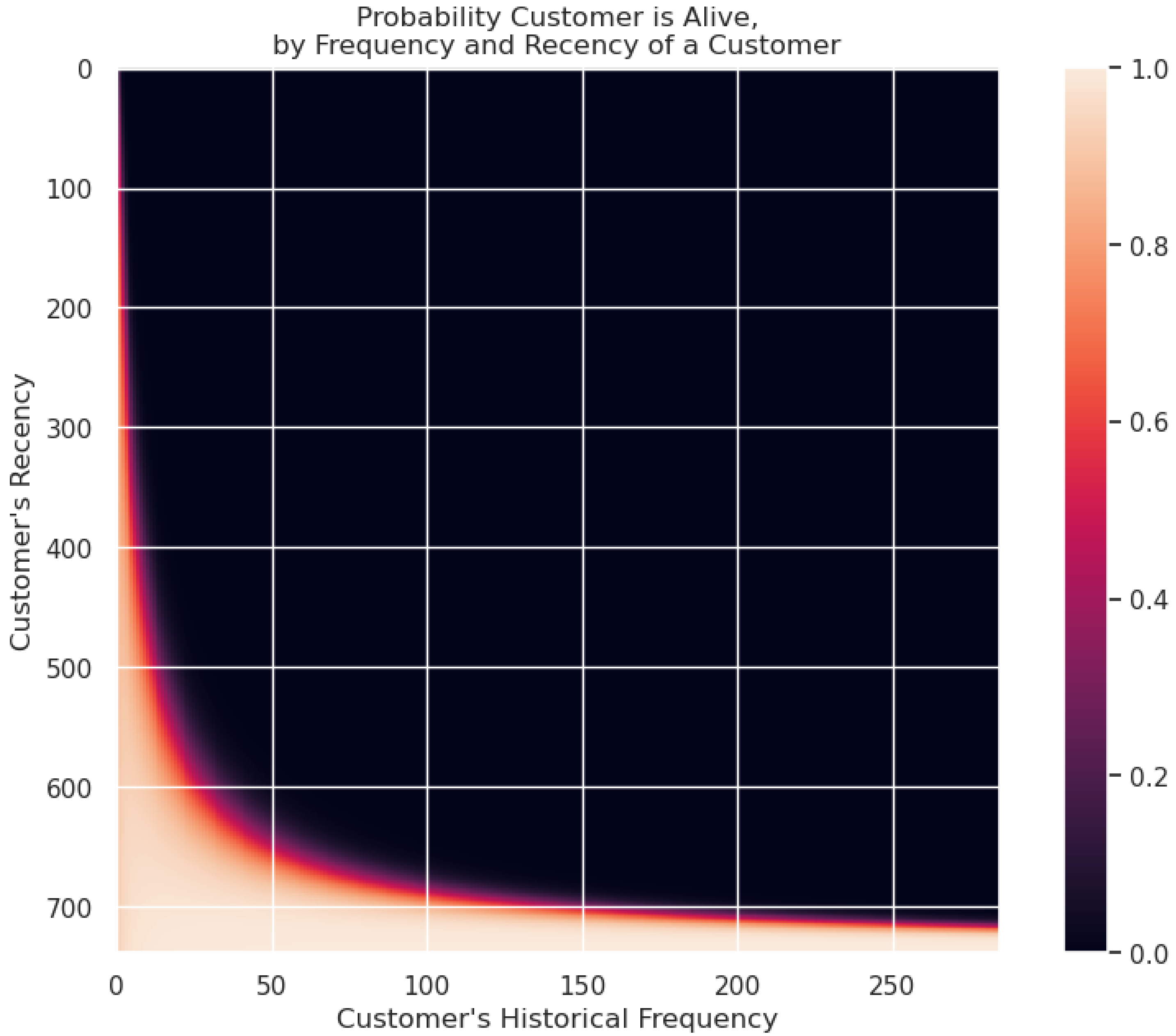
Out[ ]:

```
<AxesSubplot: title={'center': 'Expected Number of Future Purchases for 1 Unit of Time,\nby Frequency and Recency of a Customer'}, xlabel="Customer's Historical Frequency", ylabel="C
ustomer's Recency">
```



```
In [ ]: fig = plt.figure(figsize=(10,7))
        plot_probability_alive_matrix(bgf)
```

```
Out[ ]: <AxesSubplot: title={'center': 'Probability Customer is Alive,\nby Frequency and Recency of a Customer'}, xlabel="Customer's Historical Frequency", ylabel="Customer's Recency">
```



```
In [ ]: data_life['pred_num_txn'] = bgf.conditional_expected_number_of_purchases_up_to_time(15, data_life.frequency, data_life.recency, data_life['T'])
        data_life.sort_values(by='pred_num_txn', ascending=False).reset_index()
```

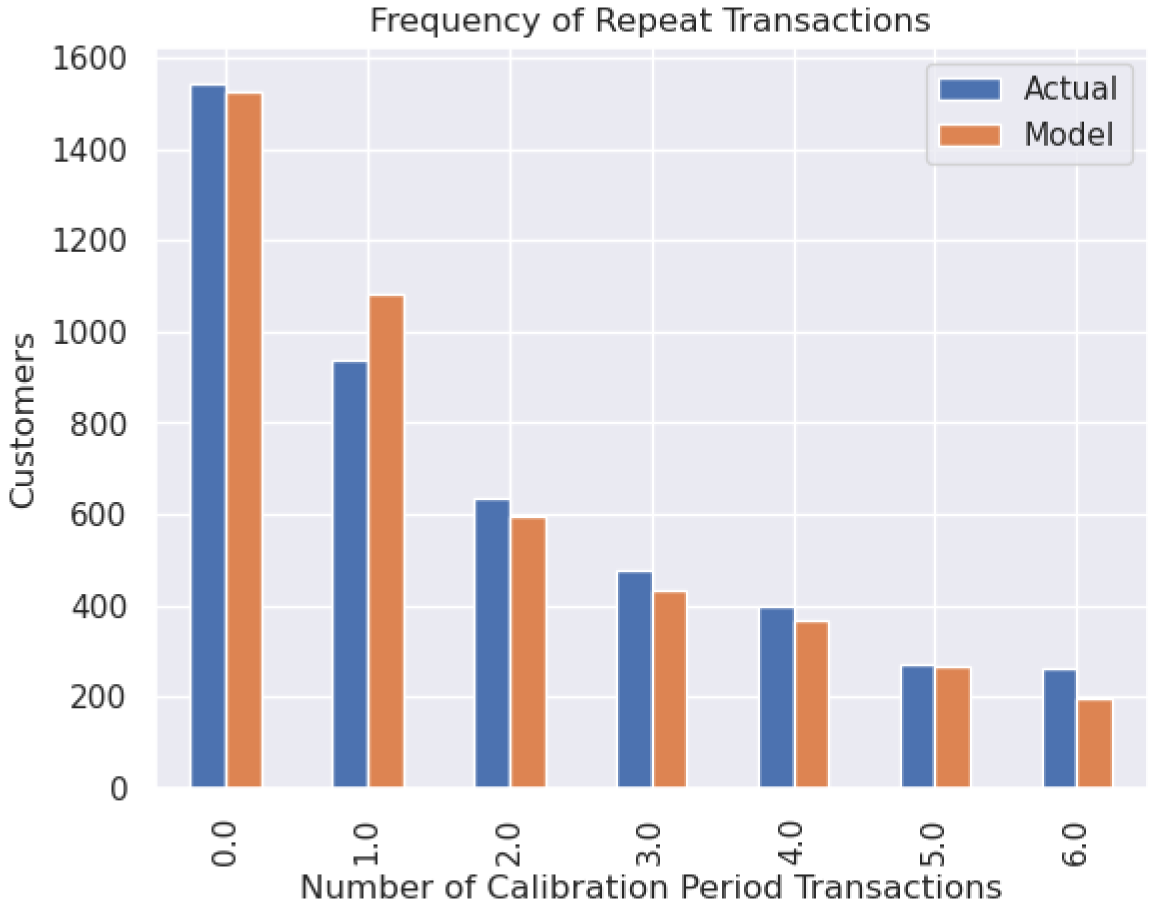
Out[ ]:

	Customer ID	frequency	recency	T	monetary_value	pred_num_txn
0	14911.0	284.0	737.0	738.0	1130.151761	5.407802e+00
1	12748.0	206.0	735.0	735.0	305.862864	3.941154e+00
2	15311.0	201.0	738.0	738.0	593.065821	3.831115e+00
3	17841.0	193.0	736.0	737.0	371.612383	3.682928e+00
4	14606.0	181.0	735.0	736.0	173.551050	3.458953e+00
...	...	...	...	...	...	...
5937	16754.0	20.0	269.0	641.0	3802.518000	7.482860e-06
5938	13446.0	17.0	243.0	663.0	212.572353	6.918304e-06
5939	15633.0	16.0	222.0	731.0	271.226250	8.686909e-07
5940	13093.0	70.0	468.0	735.0	783.144286	1.146590e-10
5941	12835.0	37.0	318.0	736.0	156.293514	7.219109e-11

5942 rows × 6 columns

In [ ]:
```
plot_period_transactions(bgf)
```

Out[ ]:
```
<AxesSubplot: title={'center': 'Frequency of Repeat Transactions'}, xlabel='Number of Calibration Period Transactions', ylabel='Customers'>
```



In [ ]:
```
data_life.corr()
```

Out[ ]:

	frequency	recency	T	monetary_value	pred_num_txn
frequency	1.000000	0.512776	0.306513	0.042126	0.896028
recency	0.512776	1.000000	0.625232	0.064859	0.384171
T	0.306513	0.625232	1.000000	0.029148	0.013955
monetary_value	0.042126	0.064859	0.029148	1.000000	0.037136
pred_num_txn	0.896028	0.384171	0.013955	0.037136	1.000000

In [ ]:

```
shortlisted_customers = data_life[data_life.frequency >0]
shortlisted_customers.reset_index()
```

Out[ ]:

	Customer ID	frequency	recency	T	monetary_value	pred_num_txn
0	12346.0	10.0	400.0	725.0	15508.760000	0.038732
1	12347.0	7.0	402.0	404.0	717.398571	0.248217
2	12348.0	4.0	363.0	438.0	449.310000	0.134854
3	12349.0	4.0	717.0	735.0	1107.172500	0.086357
4	12352.0	8.0	356.0	392.0	458.340000	0.284057
...	...	...	...	...	...	...
4393	18282.0	2.0	119.0	126.0	39.645000	0.215088
4394	18283.0	18.0	655.0	658.0	146.405556	0.391728
4395	18284.0	1.0	2.0	431.0	25.000000	0.013591
4396	18286.0	2.0	247.0	723.0	470.740000	0.032320
4397	18287.0	6.0	696.0	738.0	697.165000	0.123149

4398 rows × 6 columns

In [ ]:

```
from lifetimes import GammaGammaFitter
ggf = GammaGammaFitter(penalizer_coef = 0)
ggf.fit(shortlisted_customers.frequency, shortlisted_customers.monetary_value)
print(ggf)
```

```
<lifetimes.GammaGammaFitter: fitted with 4398 subjects, p: 1.17, q: 3.86, v: 865.47>
```

In [ ]:

```
ggf.conditional_expected_average_profit(data_life.frequency,data_life.monetary_value)
```

Out[ ]:

```
Customer ID
12346.0    12543.471490
12347.0      624.112486
12348.0      413.913342
12349.0      822.967778
12350.0      355.719248
                ...
18283.0      171.329036
18284.0      259.384093
18285.0      355.719248
18286.0      407.612130
18287.0      598.654483
Length: 5942, dtype: float64
```

In [ ]:

```
data_life['txn_value'] = ggf.conditional_expected_average_profit(data_life.frequency, data_life.monetary_value)
data_life.reset_index()
```

Out[ ]:

	Customer ID	frequency	recency	T	monetary_value	pred_num_txn	txn_value
0	12346.0	10.0	400.0	725.0	15508.760000	0.038732	12543.471490
1	12347.0	7.0	402.0	404.0	717.398571	0.248217	624.112486
2	12348.0	4.0	363.0	438.0	449.310000	0.134854	413.913342
3	12349.0	4.0	717.0	735.0	1107.172500	0.086357	822.967778
4	12350.0	0.0	0.0	310.0	0.000000	0.027783	355.719248
...	...	...	...	...	...	...	...
5937	18283.0	18.0	655.0	658.0	146.405556	0.391728	171.329036
5938	18284.0	1.0	2.0	431.0	25.000000	0.013591	259.384093
5939	18285.0	0.0	0.0	660.0	0.000000	0.014101	355.719248
5940	18286.0	2.0	247.0	723.0	470.740000	0.032320	407.612130
5941	18287.0	6.0	696.0	738.0	697.165000	0.123149	598.654483

5942 rows × 7 columns

In [ ]:

```
data_life['Cust_life_value'] = round(ggf.customer_lifetime_value(bgf, data_life.frequency, data_life.recency,
                                                  data_life['T'], data_life.monetary_value, time=12,
                                                 discount_rate=0.01), 2)

data_life.drop(data_life.iloc[:, 0:6], inplace=True, axis=1)

data_life.sort_values(by='Cust_life_value', ascending=False).head(10).reset_index()
```

Out[ ]:

	Customer ID	Cust_life_value
0	18102.0	250675.52
1	14646.0	216326.84
2	17450.0	139493.90
3	14156.0	135577.17
4	14096.0	133606.19
5	14911.0	133129.57
6	16446.0	131272.90
7	13694.0	82110.40
8	12415.0	74693.07
9	17511.0	71503.57

In the Given Dataset Customer 18102 is the most valuable customer followed by Customer 14646. These customers showed great brand loyalty and recurring revenue.