retail_costumer_analysis

November 10, 2024

0.0.1 Retail costumer analysis

- consuming behavior
- costumer segmentation
- identifying patterns

[62]:
```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

from sklearn.cluster import KMeans
from sklearn.metrics import silhouette_score
from sklearn.preprocessing import StandardScaler

pd.options.display.float_format = '{:20.3f}'.format

pd.set_option('display.max_columns',999)
```

[8]:
```
df = pd.read_excel('online_retail_II.xlsx',sheet_name=0)
df.head(10)
```

[8]:

	Invoice	StockCode	Description	Quantity	InvoiceDate	Price	Customer ID
0	489434	85048	15CM CHRISTMAS GLASS BALL 20 LIGHTS	12	2009-12-01 07:45:00	6.95	13085.00
1	489434	79323P	PINK CHERRY LIGHTS	12	2009-12-01 07:45:00	6.75	13085.00
2	489434	79323W	WHITE CHERRY LIGHTS	12	2009-12-01 07:45:00	6.75	13085.00
3	489434	22041	RECORD FRAME 7" SINGLE SIZE	48	2009-12-01 07:45:00	2.10	13085.00
4	489434	21232	STRAWBERRY CERAMIC TRINKET BOX	24			
5	489434	22064	PINK DOUGHNUT TRINKET POT	24			
6	489434	21871	SAVE THE PLANET MUG	24			
7	489434	21523	FANCY FONT HOME SWEET HOME DOORMAT	10			
8	489435	22350	CAT BOWL	12			
9	489435	22349	DOG BOWL , CHASING BALL DESIGN	12			

```
4 2009-12-01 07:45:00                1.25             13085.00
5 2009-12-01 07:45:00                1.65             13085.00
6 2009-12-01 07:45:00                1.25             13085.00
7 2009-12-01 07:45:00                5.95             13085.00
8 2009-12-01 07:46:00                2.55             13085.00
9 2009-12-01 07:46:00                3.75             13085.00

          Country
0  United Kingdom
1  United Kingdom
2  United Kingdom
3  United Kingdom
4  United Kingdom
5  United Kingdom
6  United Kingdom
7  United Kingdom
8  United Kingdom
9  United Kingdom
```

[9]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 525461 entries, 0 to 525460
Data columns (total 8 columns):
 #   Column       Non-Null Count   Dtype
---  ------       --------------   -----
 0   Invoice      525461 non-null  object
 1   StockCode    525461 non-null  object
 2   Description  522533 non-null  object
 3   Quantity     525461 non-null  int64
 4   InvoiceDate  525461 non-null  datetime64[ns]
 5   Price        525461 non-null  float64
 6   Customer ID  417534 non-null  float64
 7   Country      525461 non-null  object
dtypes: datetime64[ns](1), float64(2), int64(1), object(4)
memory usage: 32.1+ MB
```

[19]:
```
df.describe()
```

[19]:
```
                Quantity                    InvoiceDate  \
count           525461.00                         525461
mean                10.34  2010-06-28 11:37:36.845017856
min              -9600.00            2009-12-01 07:45:00
25%                  1.00            2010-03-21 12:20:00
50%                  3.00            2010-07-06 09:51:00
75%                 10.00            2010-10-15 12:45:00
max              19152.00            2010-12-09 20:01:00
std                107.42                            NaN
```

```
                Price          Customer ID
count       525461.00            417534.00
mean             4.69             15360.65
min         -53594.36             12346.00
25%              1.25             13983.00
50%              2.10             15311.00
75%              4.21             16799.00
max          25111.09             18287.00
std            146.13              1680.81
```

[15]:
```
df.describe(include='O')
```

[15]:
```
        Invoice StockCode                          Description         Country
count    525461    525461                               522533          525461
unique    28816      4632                                 4681              40
top      537434    85123A  WHITE HANGING HEART T-LIGHT HOLDER  United Kingdom
freq        675      3516                                 3549          485852
```

[20]:
```
df.isna().sum()
```

[20]:
```
Invoice            0
StockCode          0
Description     2928
Quantity           0
InvoiceDate        0
Price              0
Customer ID    107927
Country            0
dtype: int64
```

[24]:
```
df.loc[df['Quantity'] < 0].head(10)
```

[24]:
```
     Invoice StockCode                         Description  Quantity  \
178  C489449     22087           PAPER BUNTING WHITE LACE       -12
179  C489449    85206A       CREAM FELT EASTER EGG BASKET        -6
180  C489449     21895      POTTING SHED SOW 'N' GROW SET        -4
181  C489449     21896                POTTING SHED TWINE        -6
182  C489449     22083         PAPER CHAIN KIT RETRO SPOT       -12
183  C489449     21871               SAVE THE PLANET MUG       -12
184  C489449     84946    ANTIQUE SILVER TEA GLASS ETCHED       -12
185  C489449    84970S  HANGING HEART ZINC T-LIGHT HOLDER       -24
186  C489449     22090          PAPER BUNTING RETRO SPOTS       -12
196  C489459    90200A         PURPLE SWEETHEART BRACELET        -3

             InvoiceDate                Price          Customer ID  \
178 2009-12-01 10:33:00                 2.95             16321.00
```

```
179 2009-12-01 10:33:00                1.65            16321.00
180 2009-12-01 10:33:00                4.25            16321.00
181 2009-12-01 10:33:00                2.10            16321.00
182 2009-12-01 10:33:00                2.95            16321.00
183 2009-12-01 10:33:00                1.25            16321.00
184 2009-12-01 10:33:00                1.25            16321.00
185 2009-12-01 10:33:00                0.85            16321.00
186 2009-12-01 10:33:00                2.95            16321.00
196 2009-12-01 10:44:00                4.25            17592.00

            Country
178       Australia
179       Australia
180       Australia
181       Australia
182       Australia
183       Australia
184       Australia
185       Australia
186       Australia
196  United Kingdom
```

[27]:
```
df['Invoice'] = df['Invoice'].astype('str')
df[df['Invoice'].str.match('^\\d{6}$') ==  False]
```

[27]:
```
        Invoice StockCode                          Description  Quantity  \
178     C489449     22087          PAPER BUNTING WHITE LACE       -12
179     C489449    85206A       CREAM FELT EASTER EGG BASKET        -6
180     C489449     21895     POTTING SHED SOW 'N' GROW SET        -4
181     C489449     21896                POTTING SHED TWINE        -6
182     C489449     22083         PAPER CHAIN KIT RETRO SPOT       -12
…         …       …                                    …       …
524695  C538123     22956          36 FOIL HEART CAKE CASES        -2
524696  C538124         M                            Manual        -4
524697  C538124     22699  ROSES REGENCY TEACUP AND SAUCER         -1
524698  C538124     22423          REGENCY CAKESTAND 3 TIER        -1
525282  C538164    35004B       SET OF 3 BLACK FLYING DUCKS        -1

                InvoiceDate                Price          Customer ID  \
178    2009-12-01 10:33:00                 2.95             16321.00
179    2009-12-01 10:33:00                 1.65             16321.00
180    2009-12-01 10:33:00                 4.25             16321.00
181    2009-12-01 10:33:00                 2.10             16321.00
182    2009-12-01 10:33:00                 2.95             16321.00
…                      …                    …                    …
524695 2010-12-09 15:41:00                 2.10             12605.00
524696 2010-12-09 15:43:00                 0.50             15329.00
```

```
524697 2010-12-09 15:43:00                 2.95             15329.00
524698 2010-12-09 15:43:00                12.75             15329.00
525282 2010-12-09 17:32:00                 1.95             14031.00

                Country
178           Australia
179           Australia
180           Australia
181           Australia
182           Australia
…                   …
524695          Germany
524696   United Kingdom
524697   United Kingdom
524698   United Kingdom
525282   United Kingdom

[10209 rows x 8 columns]
```

[29]:
```
df['Invoice'].str.replace("[0-9]","",regex=True).unique()
```

[29]:
```
array(['', 'C', 'A'], dtype=object)
```

[33]:
```
df[df['Invoice'].str.startswith('A')].head()
```

[33]:
```
        Invoice StockCode      Description  Quantity         InvoiceDate  \
179403  A506401         B  Adjust bad debt         1 2010-04-29 13:36:00
276274  A516228         B  Adjust bad debt         1 2010-07-19 11:24:00
403472  A528059         B  Adjust bad debt         1 2010-10-20 12:04:00

                     Price  Customer ID         Country
179403           -53594.36          NaN  United Kingdom
276274           -44031.79          NaN  United Kingdom
403472           -38925.87          NaN  United Kingdom
```

[32]:
```
df[df['Invoice'].str.startswith('A')].shape
```

[32]:
```
(3, 8)
```

[43]:
```
df['StockCode']= df['StockCode'].astype('str')
df[(df['StockCode'].str.match('^d\\{5}$') == False) & (df['StockCode'].str.
  ↪match('^d\\{5}[a-zA-z]+') == False)]["StockCode"].unique()
```

[43]:
```
array(['85048', '79323P', '79323W', …, '22935', '22933', '21120'],
      dtype=object)
```

[42]:
```
df['Country'].unique()
```

[42]:
```
array(['United Kingdom', 'France', 'USA', 'Belgium', 'Australia', 'EIRE',
       'Germany', 'Portugal', 'Japan', 'Denmark', 'Nigeria',
       'Netherlands', 'Poland', 'Spain', 'Channel Islands', 'Italy',
       'Cyprus', 'Greece', 'Norway', 'Austria', 'Sweden',
       'United Arab Emirates', 'Finland', 'Switzerland', 'Unspecified',
       'Malta', 'Bahrain', 'RSA', 'Bermuda', 'Hong Kong', 'Singapore',
       'Thailand', 'Israel', 'Lithuania', 'West Indies', 'Lebanon',
       'Korea', 'Brazil', 'Canada', 'Iceland'], dtype=object)
```

[44]:
```
cleaned_df = df.copy()
```

[45]:
```
cleaned_df['Invoice'] = cleaned_df['Invoice'].astype('str')
```

[46]:
```
mask = (
    cleaned_df['Invoice'].str.match('^\\d{6}$') == True
)
cleaned_df = cleaned_df[mask]
```

[47]:
```
cleaned_df
```

[47]:

	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	\
0	2009-12-01 07:45:00	6.95	13085.00	
1	2009-12-01 07:45:00	6.75	13085.00	
2	2009-12-01 07:45:00	6.75	13085.00	
3	2009-12-01 07:45:00	2.10	13085.00	
4	2009-12-01 07:45:00	1.25	13085.00	
…	…	…	…	
525456	2010-12-09 20:01:00	2.95	17530.00	
525457	2010-12-09 20:01:00	3.75	17530.00	
525458	2010-12-09 20:01:00	3.75	17530.00	
525459	2010-12-09 20:01:00	3.75	17530.00	
525460	2010-12-09 20:01:00	1.95	17530.00	

	Country

```
0         United Kingdom
1         United Kingdom
2         United Kingdom
3         United Kingdom
4         United Kingdom
…                    …
525456    United Kingdom
525457    United Kingdom
525458    United Kingdom
525459    United Kingdom
525460    United Kingdom

[515252 rows x 8 columns]
```

[48]:
```
cleaned_df.drop('StockCode',axis=1,inplace=True)
```

[49]:
```
cleaned_df.dropna(subset='Customer ID',inplace=True)
```

[52]:
```
cleaned_df.describe()
```

[52]:
```
                 Quantity                    InvoiceDate  \
count            407695.00                         407695
mean                 13.59  2010-07-01 10:10:10.782177792
min                   1.00            2009-12-01 07:45:00
25%                   2.00            2010-03-26 14:01:00
50%                   5.00            2010-07-09 15:46:00
75%                  12.00            2010-10-14 17:09:00
max                19152.00            2010-12-09 20:01:00
std                   96.84                            NaN

                      Price          Customer ID
count            407695.00            407695.00
mean                  3.29             15368.50
min                   0.00             12346.00
25%                   1.25             13997.00
50%                   1.95             15321.00
75%                   3.75             16812.00
max                10953.50             18287.00
std                   34.76              1679.80
```

[65]:
```
len(cleaned_df[cleaned_df['Price'] == 0])
cleaned_df = cleaned_df[cleaned_df['Price'] > 0.001]
```

[67]:
```
cleaned_df.describe()
```

[67]:
```
                 Quantity                    InvoiceDate  \
count          407650.000                         407650
```

```
mean                 13.586  2010-07-01 10:18:51.269422336
min                   1.000            2009-12-01 07:45:00
25%                   2.000            2010-03-26 14:01:00
50%                   5.000            2010-07-09 15:48:00
75%                  12.000            2010-10-14 17:09:00
max                19152.000            2010-12-09 20:01:00
std                   96.842                            NaN

                       Price          Customer ID
count             407650.000            407650.000
mean                   3.295             15368.620
min                    0.030             12346.000
25%                    1.250             13997.000
50%                    1.950             15321.000
75%                    3.750             16812.000
max                10953.500             18287.000
std                   34.759              1679.767
```

[70]:
```
len(cleaned_df) / len(df) *100
```

[70]:
```
77.5794968608517
```

during the cleaning process with lost 23% of our data

0.0.2 Feature Engineering

[73]:
```
cleaned_df['Sales'] = cleaned_df['Quantity'] * cleaned_df['Price']
```

[75]:
```
cleaned_df.columns
```

[75]:
```
Index(['Invoice', 'Description', 'Quantity', 'InvoiceDate', 'Price',
       'Customer ID', 'Country', 'Sales'],
      dtype='object')
```

[76]:
```
agg_df = cleaned_df.groupby('Customer ID',as_index=False).agg(
Monetary = ("Sales","sum"),
Frequency = ("Invoice",'nunique'),
lst_invoice_date = ("InvoiceDate","max")
)

agg_df.head()
```

[76]:

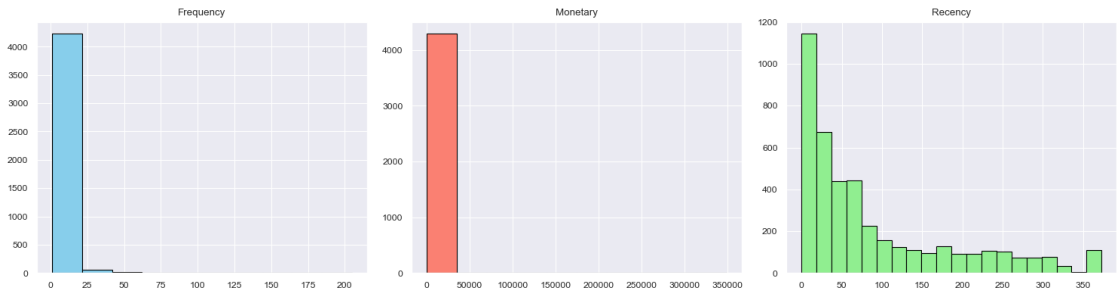
	Customer ID	Monetary	Frequency	lst_invoice_date
0	12346.000	372.860	11	2010-06-28 13:53:00
1	12347.000	1323.320	2	2010-12-07 14:57:00
2	12348.000	222.160	1	2010-09-27 14:59:00
3	12349.000	2671.140	3	2010-10-28 08:23:00
4	12351.000	300.930	1	2010-11-29 15:23:00

[85]:
```
max_date = cleaned_df['InvoiceDate'].max()

agg_df['Recency'] = ( max_date - agg_df['lst_invoice_date'] ).dt.days
```

[86]:
```
agg_df.head()
```

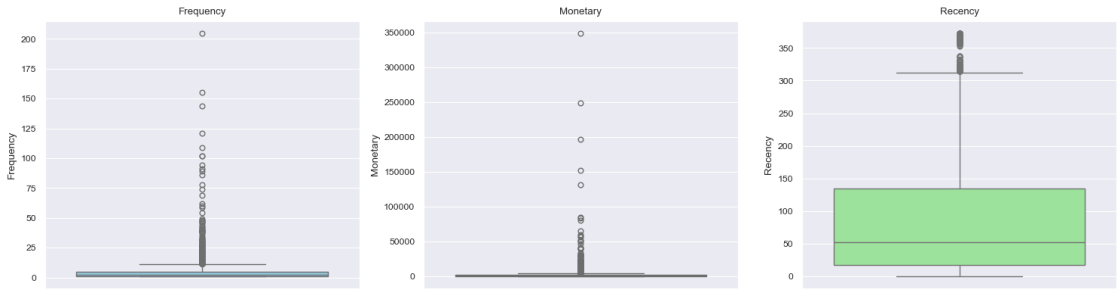
[86]:
```
            Customer ID            Monetary  Frequency    lst_invoice_date  \
0             12346.000             372.860         11 2010-06-28 13:53:00
1             12347.000            1323.320          2 2010-12-07 14:57:00
2             12348.000             222.160          1 2010-09-27 14:59:00
3             12349.000            2671.140          3 2010-10-28 08:23:00
4             12351.000             300.930          1 2010-11-29 15:23:00

   Recency
0      164
1        2
2       73
3       42
4       10
```

[104]:
```
sns.set_theme('paper')
fig,axs = plt.subplots(1,3,figsize=(15,4))
axs[0].hist(agg_df['Frequency'],bins=10,color='skyblue',edgecolor='black')
axs[0].set_title('Frequency')

axs[1].hist(agg_df['Monetary'],bins=10,color='salmon',edgecolor='black')
axs[1].set_title('Monetary')

axs[2].hist(agg_df['Recency'],bins=20,color='lightgreen',edgecolor='black')
axs[2].set_title('Recency')
plt.tight_layout()
```



[108]:
```
sns.set_theme('paper')
fig,axs = plt.subplots(1,3,figsize=(15,4))
sns.boxplot(y=agg_df['Frequency'],color='skyblue',ax=axs[0])
axs[0].set_title('Frequency')
```

```
sns.boxplot(agg_df['Monetary'],color='salmon',ax=axs[1])
axs[1].set_title('Monetary')

sns.boxplot(agg_df['Recency'],color='lightgreen',ax=axs[2])
axs[2].set_title('Recency')
plt.tight_layout()
```



[129]:
```
M_Q1 = agg_df['Monetary'].quantile(0.25)
M_Q3 = agg_df['Monetary'].quantile(0.75)
M_IQR = M_Q3 - M_Q1

montery_outlaiers_df = agg_df[(agg_df['Monetary'] > (M_Q3 + 1.5 * M_IQR)) |␣
↪(agg_df['Monetary'] < (M_Q1 - 1.5 * M_IQR))].copy()
```

[124]:
```
montery_outlaiers_df.describe()
```

[124]:

	Customer ID	Monetary	Frequency	\
count	4312.000	4312.000	4312.000	
mean	15349.290	2048.238	4.456	
min	12346.000	2.950	1.000	
25%	13882.500	307.988	1.000	
50%	15350.500	706.020	2.000	
75%	16834.250	1723.142	5.000	
max	18287.000	349164.350	205.000	
std	1701.200	8914.481	8.170	

	lst_invoice_date	Recency
count	4312	4312.000
mean	2010-09-10 09:08:37.138219008	90.172
min	2009-12-01 09:55:00	0.000
25%	2010-07-27 09:53:00	17.000
50%	2010-10-18 16:34:30	52.000
75%	2010-11-22 11:01:30	135.000
max	2010-12-09 20:01:00	373.000
std	NaN	96.861

[130]:
```
M_Q1 = agg_df['Frequency'].quantile(0.25)
M_Q3 = agg_df['Frequency'].quantile(0.75)
M_IQR = M_Q3 - M_Q1

Frequency_outliers_df = agg_df[(agg_df['Frequency'] > (M_Q3 + 1.5 * M_IQR)) |␣
↪(agg_df['Frequency'] < (M_Q1 - 1.5 * M_IQR))].copy()
```

[131]:
```
non_outliers = agg_df[(~agg_df.index.isin(montery_outlaiers_df.index)) &␣
↪(~agg_df.index.isin(Frequency_outliers_df.index))]
non_outliers
```

[131]:

	Customer ID	Monetary	Frequency	lst_invoice_date	Recency
0	12346.000	372.860	11	2010-06-28 13:53:00	164
1	12347.000	1323.320	2	2010-12-07 14:57:00	2
2	12348.000	222.160	1	2010-09-27 14:59:00	73
3	12349.000	2671.140	3	2010-10-28 08:23:00	42
4	12351.000	300.930	1	2010-11-29 15:23:00	10
…	…	…	…	…	…
4307	18283.000	641.770	6	2010-11-22 15:30:00	17
4308	18284.000	461.680	1	2010-10-04 11:33:00	66
4309	18285.000	427.000	1	2010-02-17 10:24:00	295
4310	18286.000	1296.430	2	2010-08-20 11:57:00	111
4311	18287.000	2345.710	4	2010-11-22 11:51:00	17

[3828 rows x 5 columns]

[133]:
```
non_outliers.describe()
```

[133]:

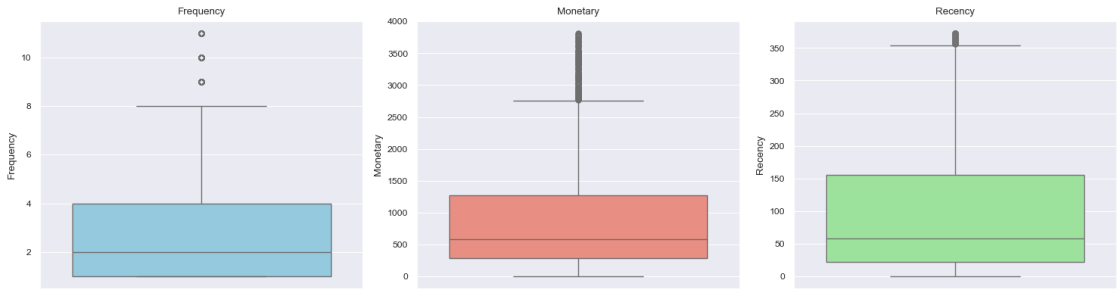
	Customer ID	Monetary	Frequency
count	3828.000	3828.000	3828.000
mean	15372.738	889.864	2.864
min	12346.000	2.950	1.000
25%	13910.500	281.207	1.000
50%	15380.500	589.135	2.000

```
75%          16846.250          1273.608             4.000
max          18287.000          3817.180            11.000
std           1693.298           824.808             2.242
```

```
                    lst_invoice_date             Recency
count                           3828            3828.000
mean   2010-09-02 15:28:27.931034368              97.908
min              2009-12-01 09:55:00               0.000
25%              2010-07-07 12:00:45              22.000
50%              2010-10-12 12:44:30              58.000
75%              2010-11-17 13:09:30             155.000
max              2010-12-09 20:01:00             373.000
std                              NaN              98.742
```

0.0.3 validating the outliers

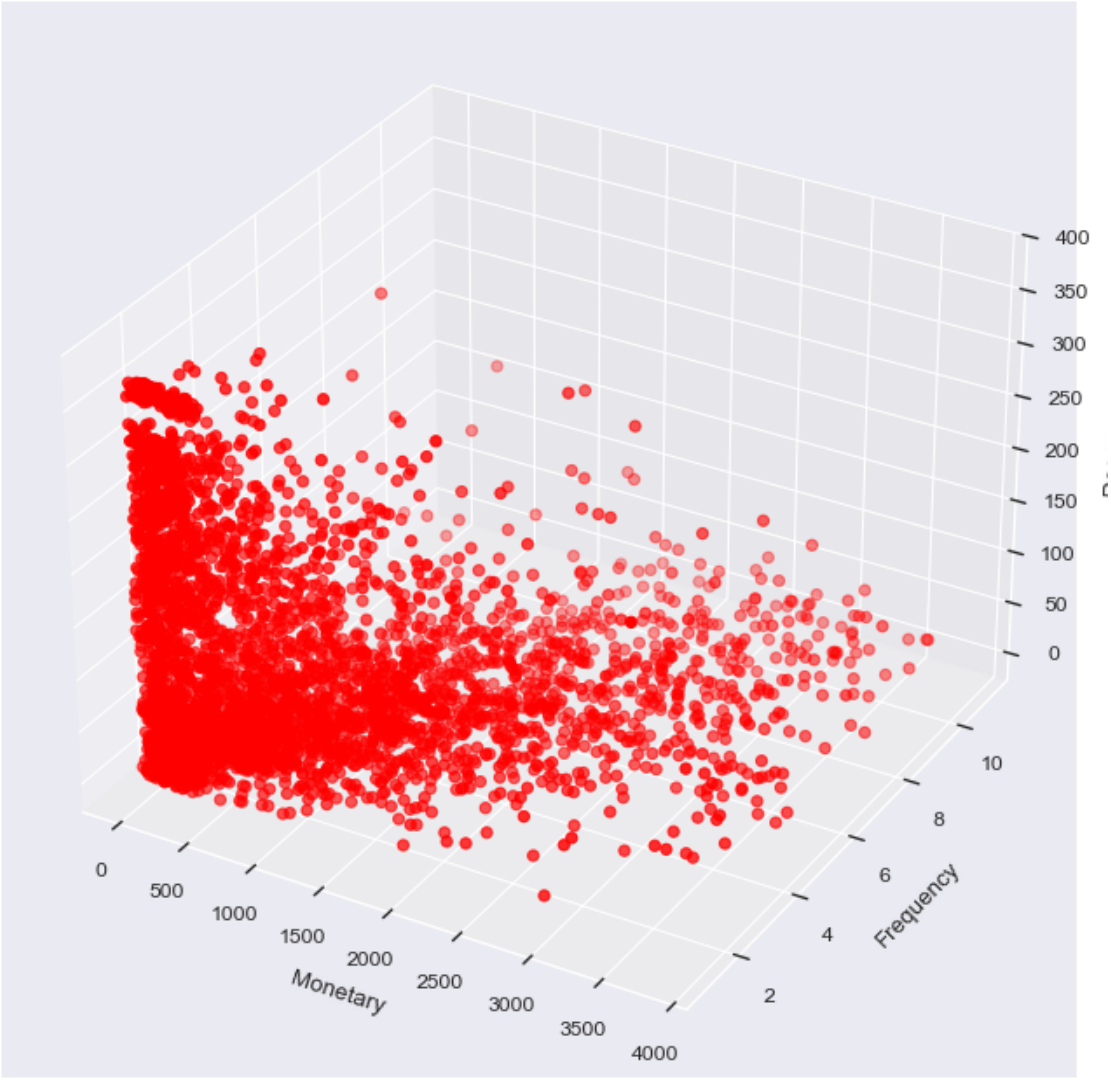
[134]:
```
sns.set_theme('paper')
fig,axs = plt.subplots(1,3,figsize=(15,4))
sns.boxplot(y=non_outliers['Frequency'],color='skyblue',ax=axs[0])
axs[0].set_title('Frequency')

sns.boxplot(non_outliers['Monetary'],color='salmon',ax=axs[1])
axs[1].set_title('Monetary')

sns.boxplot(non_outliers['Recency'],color='lightgreen',ax=axs[2])
axs[2].set_title('Recency')
plt.tight_layout()
```



[ ]:
```
fig = plt.figure(figsize=(8,8))

ax =fig.add_subplot(projection="3d")

scatter = ax.
 ↪scatter(non_outliers['Monetary'],non_outliers['Frequency'],non_outliers['Recency'],color='r
```

```
ax.set_xlabel('Monetary')
ax.set_ylabel('Frequency')
ax.set_zlabel('Recency')
```

[ ]:
```
Text(0.5, 0, 'Recency')
```



[151]:
```
import plotly.express as px

# Create a 3D scatter plot with Plotly Express
fig = px.scatter_3d(
    non_outliers,
    x='Monetary',
    y='Frequency',
```

```
    z='Recency',
    color_discrete_sequence=['blue']  # Set color to red
)

# Update axis labels
fig.update_layout(
    scene=dict(
        xaxis_title='Monetary',
        yaxis_title='Frequency',
        zaxis_title='Recency'
    ),
    width=800,  # Equivalent to figsize=(8,8)
    height=800
)

# Show the figure
fig.show()
```

[157]:
```
scaler = StandardScaler()
scaled_data = scaler.fit_transform(non_outliers[['Monetary', 'Frequency',␣
 ↪'Recency']])
scaled_data
```

[157]:
```
array([[-0.62689958,  3.62975807,  0.66943051],
       [ 0.52559219, -0.38566835, -0.9714245 ],
       [-0.80963268, -0.83182684, -0.25228434],
       …,
       [-0.56125146, -0.83182684,  1.99629474],
       [ 0.4929864 , -0.38566835,  0.13260757],
       [ 1.76530355,  0.50664863, -0.81949348]])
```

[164]:
```
scaled_data = pd.DataFrame(scaled_data,index=non_outliers.
 ↪index,columns=('Monetary', 'Frequency', 'Recency'))
```

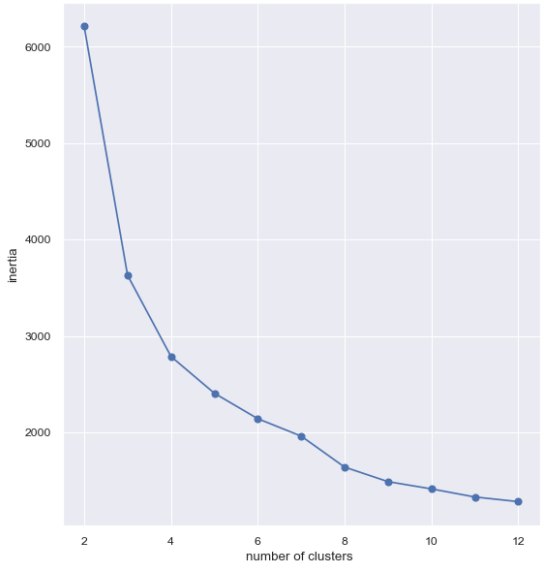
[165]:
```
fig = px.scatter_3d(
    scaled_data,
    x='Monetary',
    y='Frequency',
    z='Recency',
    color_discrete_sequence=['green']  # Set color to red
)

# Update axis labels
fig.update_layout(
    scene=dict(
        xaxis_title='Monetary',
        yaxis_title='Frequency',
```

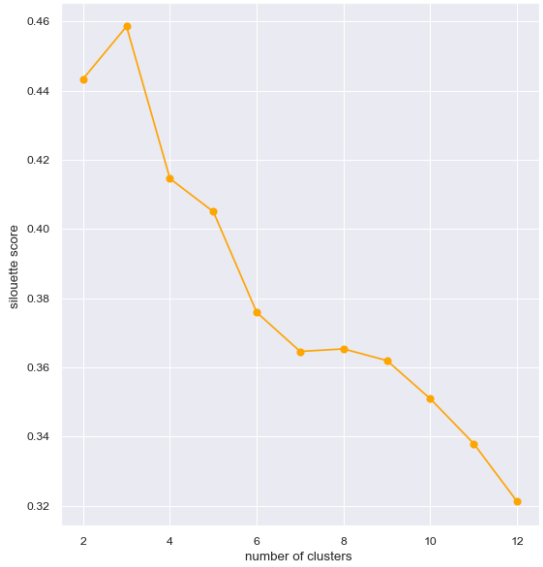
```
        zaxis_title='Recency'
    ),
    width=800,  # Equivalent to figsize=(8,8)
    height=800
)

# Show the figure
fig.show()
```

0.1 K_means Clustring

[226]:
```
max_k=12
inertia = []
silhouette_scores = []
k_value = range(2, max_k+1)
for k in range(2,max_k+1):
    km = KMeans(n_clusters=k,random_state=42,max_iter=1000)
    Cluster_labels = km.fit_predict(scaled_data)
    score = silhouette_score(scaled_data, Cluster_labels)
    silhouette_scores.append(score)
    inertia.append(km.inertia_)
```

[232]:
```
plt.figure(figsize=(14,7))

plt.subplot(1, 2, 1)
plt.plot(k_value,inertia,marker='o')
plt.ylabel("inertia")
plt.xlabel('number of clusters ')
plt.grid(True)

plt.subplot(1, 2, 2)
plt.plot(k_value,silhouette_scores,marker='o',color='orange')
plt.ylabel("silouette score ")
plt.xlabel('number of clusters ')
plt.grid(True)
```





[234]:
```
kmeans = KMeans(n_clusters=4,max_iter=1000,random_state=42)
Cluster_labels = kmeans.fit_predict(scaled_data)

Cluster_labels
```

[234]:
```
array([3, 2, 1, …, 0, 2, 2])
```

[235]:
```
non_outliers['Cluster'] = Cluster_labels
non_outliers
```

```
C:\Users\ayman\AppData\Local\Temp\ipykernel_17400\3884812653.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
```

[235]:

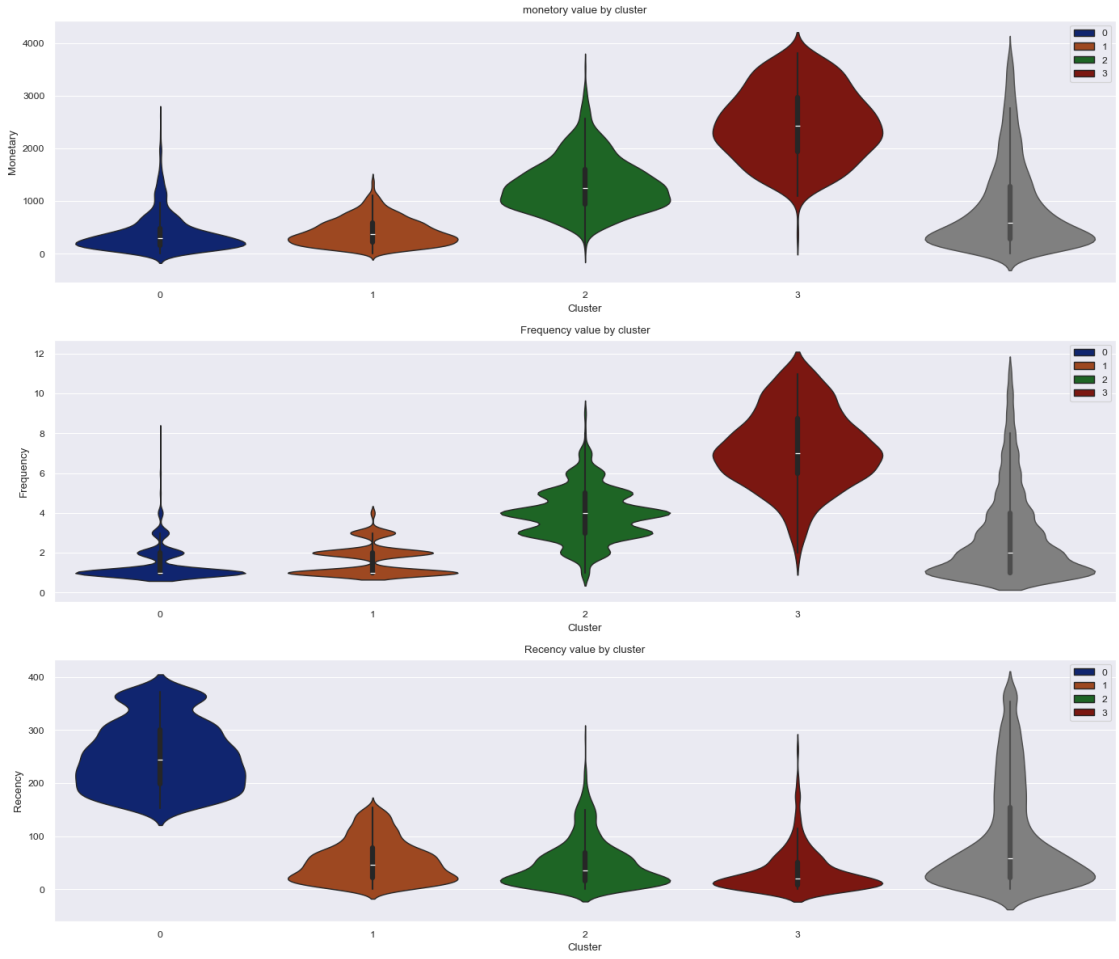
	Customer ID	Monetary	Frequency	lst_invoice_date	\
0	12346.000	372.860	11	2010-06-28 13:53:00	
1	12347.000	1323.320	2	2010-12-07 14:57:00	
2	12348.000	222.160	1	2010-09-27 14:59:00	
3	12349.000	2671.140	3	2010-10-28 08:23:00	
4	12351.000	300.930	1	2010-11-29 15:23:00	
…	…	…	…	…	

```
4307            18283.000             641.770          6 2010-11-22 15:30:00
4308            18284.000             461.680          1 2010-10-04 11:33:00
4309            18285.000             427.000          1 2010-02-17 10:24:00
4310            18286.000            1296.430          2 2010-08-20 11:57:00
4311            18287.000            2345.710          4 2010-11-22 11:51:00

      Recency  Cluster
0         164        3
1           2        2
2          73        1
3          42        2
4          10        1
…         …        …
4307       17        2
4308       66        1
4309      295        0
4310      111        2
4311       17        2

[3828 rows x 6 columns]
```

[244]:
```
sns.set_palette('pastel')
fig = px.scatter_3d(non_outliers,
                    x='Monetary',
                    y='Frequency',
                    z='Recency',
                    color='Cluster',
                    color_discrete_sequence=px.colors.qualitative.Pastel)

fig.update_layout(
    scene=dict(
        xaxis_title='Monetary',
        yaxis_title='Frequency',
        zaxis_title='Recency'
    ),
    width=800,  # Equivalent to figsize=(8,8)
    height=800)
fig.show()
```

[248]:
```
plt.figure(figsize=(14,12))

plt.subplot(3, 1, 1)
sns.
 ↪violinplot(data=non_outliers,x='Cluster',y='Monetary',palette='dark',hue='Cluster')
sns.violinplot(data=non_outliers,y='Monetary',color='gray',linewidth=1.0)
plt.title('monetory value by cluster')
```

```
plt.subplot(3, 1, 2)
sns.
  ↪violinplot(data=non_outliers,x='Cluster',y='Frequency',palette='dark',hue='Cluster')
sns.violinplot(data=non_outliers,y='Frequency',color='gray',linewidth=1.0)
plt.title('Frequency value by cluster')

plt.subplot(3, 1, 3)
sns.
  ↪violinplot(data=non_outliers,x='Cluster',y='Recency',palette='dark',hue='Cluster')
sns.violinplot(data=non_outliers,y='Recency',color='gray',linewidth=1.0)
plt.title('Recency value by cluster')

plt.tight_layout()
```



[251]:
```
plt.figure(figsize=(14,12))

plt.subplot(3, 1, 1)
```

```
sns.
  ↪boxplot(data=non_outliers,x='Cluster',y='Monetary',palette='dark',hue='Cluster')
sns.boxplot(data=non_outliers,y='Monetary',color='gray',linewidth=1.0)
plt.title('monetory value by cluster')

plt.subplot(3, 1, 2)
sns.
  ↪boxplot(data=non_outliers,x='Cluster',y='Frequency',palette='dark',hue='Cluster')
sns.boxplot(data=non_outliers,y='Frequency',color='gray',linewidth=1.0)
plt.title('Frequency value by cluster')

plt.subplot(3, 1, 3)
sns.
  ↪boxplot(data=non_outliers,x='Cluster',y='Recency',palette='dark',hue='Cluster')
sns.boxplot(data=non_outliers,y='Recency',color='gray',linewidth=1.0)
plt.title('Recency value by cluster')

plt.tight_layout()
```