project_UKonline_retail

May 19, 2025

[105]:

```python
import pandas as pd
df=pd.read_csv('/Users/soniazhai/Desktop/online_retail_II.csv')
print(df.shape)
df.info()
df.head()
```

```
(1067371, 8)
<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  object 
 5   Price        1067371 non-null  float64
 6   Customer ID  824364 non-null   float64
 7   Country      1067371 non-null  object 
dtypes: float64(2), int64(1), object(5)
memory usage: 65.1+ MB
```

[105]:

```
  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   

           InvoiceDate  Price  Customer ID         Country  
0  2009-12-01 07:45:00   6.95     13085.00  United Kingdom  
1  2009-12-01 07:45:00   6.75     13085.00  United Kingdom  
2  2009-12-01 07:45:00   6.75     13085.00  United Kingdom  
3  2009-12-01 07:45:00   2.10     13085.00  United Kingdom  
4  2009-12-01 07:45:00   1.25     13085.00  United Kingdom  
```

[106]:

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

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

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

```
[107]:         Quantity      Price  Customer ID
       count 1067371.00 1067371.00    824364.00
       mean         9.94       4.65     15324.64
       std        172.71     123.55      1697.46
       min     -80995.00  -53594.36     12346.00
       25%          1.00       1.25     13975.00
       50%          3.00       2.10     15255.00
       75%         10.00       4.15     16797.00
       max      80995.00   38970.00     18287.00
```

```
[108]: df['InvoiceDate']=pd.to_datetime(df['InvoiceDate'],errors='coerce')
       df=df.dropna(subset=['Customer ID'])
       df['Customer ID']=df['Customer ID'].astype('float').fillna(0).astype('int').
        ↪astype('str')
       df_clean=df

       print(df_clean.shape)
       print(df_clean.info)
```

```
(824364, 8)
<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
…          …        …                                  …       …
1067366  581587     22899         CHILDREN'S APRON DOLLY GIRL          6
1067367  581587     23254        CHILDRENS CUTLERY DOLLY GIRL          4
1067368  581587     23255      CHILDRENS CUTLERY CIRCUS PARADE         4
1067369  581587     22138        BAKING SET 9 PIECE RETROSPOT          3
1067370  581587      POST                              POSTAGE         1

                InvoiceDate  Price Customer ID         Country
0       2009-12-01 07:45:00   6.95       13085  United Kingdom
```

```
1       2009-12-01 07:45:00   6.75      13085  United Kingdom
2       2009-12-01 07:45:00   6.75      13085  United Kingdom
3       2009-12-01 07:45:00   2.10      13085  United Kingdom
4       2009-12-01 07:45:00   1.25      13085  United Kingdom
…                      …    …         …              …
1067366 2011-12-09 12:50:00   2.10      12680          France
1067367 2011-12-09 12:50:00   4.15      12680          France
1067368 2011-12-09 12:50:00   4.15      12680          France
1067369 2011-12-09 12:50:00   4.95      12680          France
1067370 2011-12-09 12:50:00  18.00      12680          France

[824364 rows x 8 columns]>
```

```
[109]: df_clean.isnull().sum()
```

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

```
[110]: df_clean['InvoiceMonth']=df_clean['InvoiceDate'].dt.to_period('M')
       df_clean['Sales']=df_clean['Quantity']*df_clean['Price']
       df_clean.head()
```

```
[110]:   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

                 InvoiceDate  Price Customer ID         Country InvoiceMonth  Sales
       0 2009-12-01 07:45:00   6.95       13085  United Kingdom      2009-12  83.40
       1 2009-12-01 07:45:00   6.75       13085  United Kingdom      2009-12  81.00
       2 2009-12-01 07:45:00   6.75       13085  United Kingdom      2009-12  81.00
       3 2009-12-01 07:45:00   2.10       13085  United Kingdom      2009-12 100.80
       4 2009-12-01 07:45:00   1.25       13085  United Kingdom      2009-12  30.00
```

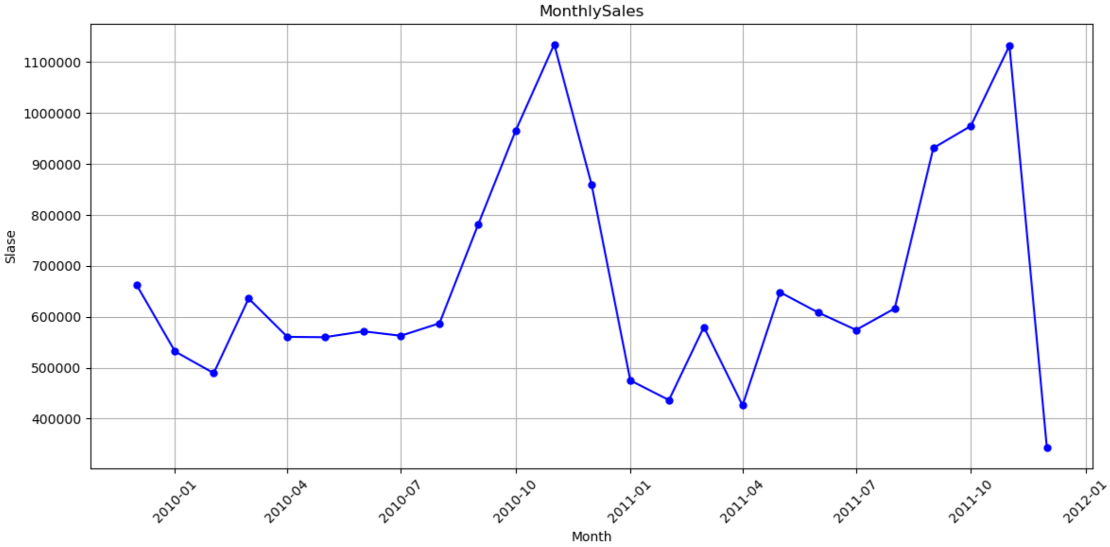
```
[123]: Monthly_Sale=df_clean.groupby('InvoiceMonth').
         ↪agg(Sales=('Sales','sum'),Quantity=('Quantity','sum'),num_unique_cus=('Customer␣
         ↪ID','nunique'),num_order=('Invoice','nunique')).reset_index()
```

```
Monthly_Sale['sales_per_order']=(Monthly_Sale['Sales']/
 ↪Monthly_Sale['num_order']).round(2)
Monthly_Sale['InvoiceMonth']=Monthly_Sale['InvoiceMonth'].dt.to_timestamp()
Monthly_Sale.head()
```

```
[123]:   InvoiceMonth      Sales  Quantity  num_unique_cus  num_order  sales_per_order
       0   2009-12-01  663272.05    390286            1045       1900           349.09
       1   2010-01-01  531952.90    367141             786       1296           410.46
       2   2010-02-01  489399.59    366317             807       1335           366.59
       3   2010-03-01  635996.48    499030            1111       1907           333.51
       4   2010-04-01  560635.02    345590             998       1615           347.14
```

Monthly Sales Trends

```
[124]: import matplotlib.pyplot as plt
       plt.figure(figsize=(12,6))
       plt.
        ↪plot(Monthly_Sale['InvoiceMonth'],Monthly_Sale['Sales'],color='blue',marker='o',linestyle='
       plt.ticklabel_format(style='plain', axis='y')
       plt.title('MonthlySales')
       plt.xlabel('Month')
       plt.ylabel('Slase')
       plt.grid(True)
       plt.xticks(rotation=45)
       plt.tight_layout()
       plt.show()
```



Sales Top 5 Per Month

[113]:
```
produc_monthly_sales=df_clean.groupby(['InvoiceMonth','Description']).
  ↪agg(total_quantity=('Quantity','sum')).reset_index()
produc_monthly_sales['Rank']=produc_monthly_sales.
  ↪groupby('InvoiceMonth')['total_quantity'].
  ↪rank(method='first',ascending=False).astype(int)
produc_monthly_sales=produc_monthly_sales[produc_monthly_sales['Rank']<=5]
produc_monthly_sales=produc_monthly_sales.
  ↪sort_values(['InvoiceMonth','Rank'],ascending=[True,True])
produc_monthly_sales.head(10)
```

[113]:
```
     InvoiceMonth                         Description  total_quantity  Rank
2625      2009-12  WHITE HANGING HEART T-LIGHT HOLDER            6204     1
1565      2009-12      PACK OF 12 RED SPOTTY TISSUES             5311     2
1566      2009-12            PACK OF 12 SKULL TISSUES            5232     3
1567      2009-12        PACK OF 12 WOODLAND TISSUES             4839     4
1575      2009-12    PACK OF 72 RETRO SPOT CAKE CASES            4708     5
3806      2010-01                 JAZZ HEARTS MEMO PAD           9489     1
3805      2010-01        JAZZ HEARTS MAGNETIC MEMO PAD           7022     2
4314      2010-01            POP-ART FLUORESCENT PENS            6144     3
2959      2010-01  BLACK AND WHITE PAISLEY FLOWER MUG            6029     4
5043      2010-01  WHITE HANGING HEART T-LIGHT HOLDER            5380     5
```

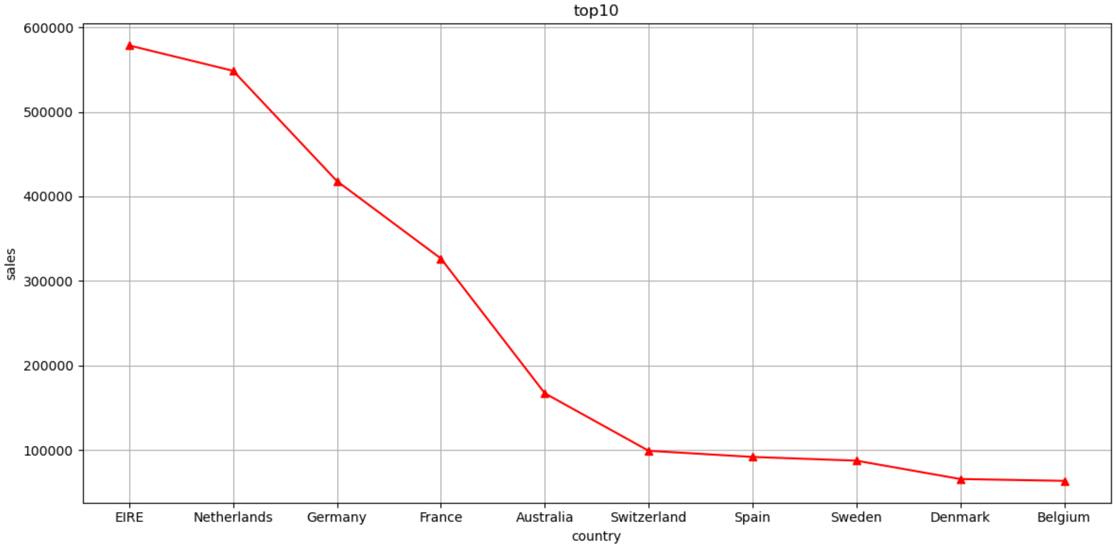
Sales Top 10 Per Country Except The UK

[114]:
```
pd.set_option('display.float_format', '{:.2f}'.format)
sales_of_country=df_clean.groupby('Country')['Sales'].sum().reset_index()
sales_of_country=sales_of_country.sort_values('Sales',ascending=False)
sales_of_country=sales_of_country[sales_of_country['Country']!='United Kingdom']
sales_of_country.head()
```

[114]:
```
        Country     Sales
10         EIRE 578501.63
24  Netherlands 548524.95
14      Germany 417988.56
13       France 326504.67
0     Australia 167129.07
```

[115]:
```
top10=sales_of_country.head(10)
plt.figure(figsize=(12,6))
plt.title('top10')
plt.
  ↪plot(top10['Country'],top10['Sales'],color='red',marker='^',linestyle='-',markersize=6)
plt.xlabel('country')
plt.ylabel('sales')
plt.grid(True)
plt.tight_layout()
print(top10)
```

```
        Country      Sales
10         EIRE 578501.63
24  Netherlands 548524.95
14      Germany 417988.56
13       France 326504.67
0     Australia 167129.07
34  Switzerland  99082.81
32        Spain  91859.48
33       Sweden  87455.42
9       Denmark  65741.09
3       Belgium  63574.49
```



Rate of Return

[116]:
```
df_clean['Return']=df_clean['Invoice'].str.startswith('C')
total_invoice=df_clean['Invoice'].nunique()

num_return=df_clean[df_clean['Return']]['Invoice'].nunique()

rate_return=round(100*(num_return/total_invoice),2)
print(f"{rate_return}%")

df_clean.head()
```

```
17.61%
```

[116]:
```
  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

           InvoiceDate  Price  Customer ID         Country InvoiceMonth  Sales  \
0 2009-12-01 07:45:00   6.95        13085  United Kingdom      2009-12  83.40
1 2009-12-01 07:45:00   6.75        13085  United Kingdom      2009-12  81.00
2 2009-12-01 07:45:00   6.75        13085  United Kingdom      2009-12  81.00
3 2009-12-01 07:45:00   2.10        13085  United Kingdom      2009-12 100.80
4 2009-12-01 07:45:00   1.25        13085  United Kingdom      2009-12  30.00

   Return
0   False
1   False
2   False
3   False
4   False
```

Top 10 of Return Item

[117]:

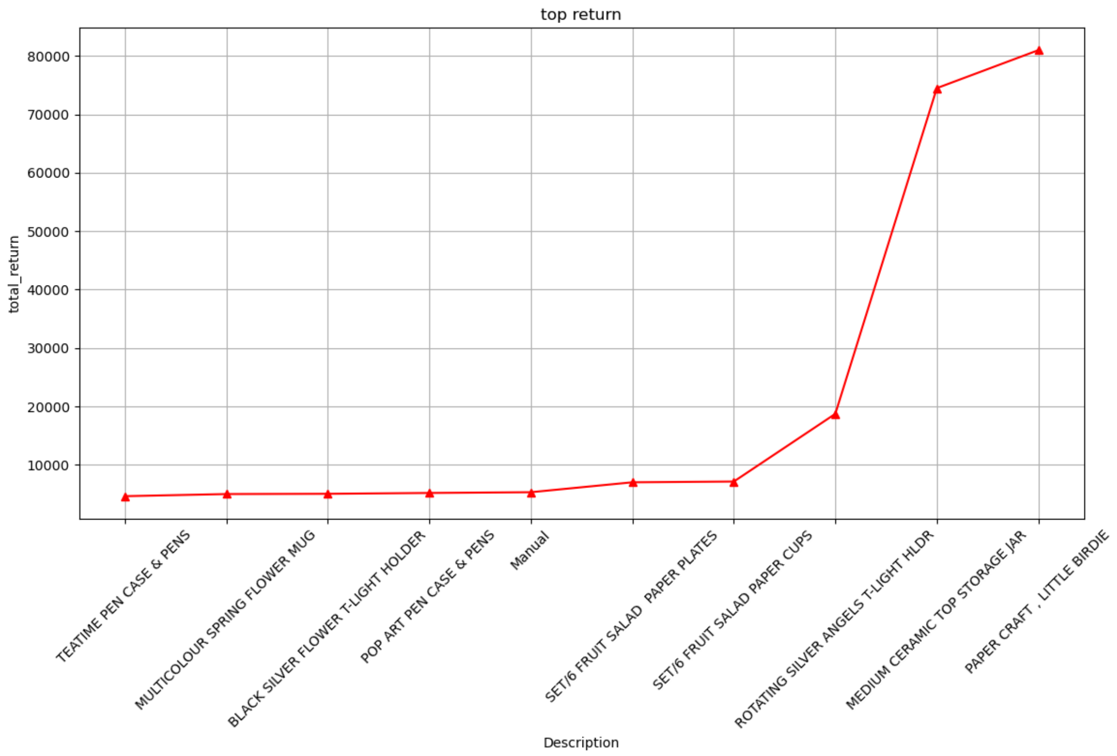
```
return_item=df_clean[df_clean['Return']]
top_return=return_item.groupby('Description').
 ↪agg(total_return=('Quantity','sum')).reset_index().
 ↪sort_values('total_return',ascending=False).tail(10)
top_return['total_return']=top_return['total_return'].abs()



top_return.head()
```

[117]:

```
                                Description  total_return
2717             TEATIME PEN CASE & PENS          4632
1643       MULTICOLOUR SPRING FLOWER MUG          4996
269    BLACK SILVER FLOWER T-LIGHT HOLDER          5040
1972             POP ART PEN CASE & PENS          5184
1650                                 Manual          5311
```

[118]:

```
plt.figure(figsize=(12,6))
plt.
 ↪plot(top_return['Description'],top_return['total_return'],color='red',marker='^',linestyle=
plt.title('top return')
plt.xlabel('Description')
plt.ylabel('total_return')
plt.grid(True)
plt.tight_layout()
plt.xticks(rotation=45)
plt.show()
```



Top 10 Purchased Customer

```
[ ]: import seaborn as sns
     customer_summary=df_clean.groupby('Customer ID').
       ↪agg(total_sale=('Sales','sum'),sale_count=('Invoice','nunique')).
       ↪reset_index()
     customer_summary=customer_summary.sort_values('total_sale',ascending=False).
       ↪head(10)
     customer_summary.head(10)
     plt.figure(figsize=(12,6))
     sns.barplot(x='total_sale',y='Customer␣
       ↪ID',data=customer_summary,palette='Greens_r')
     plt.title('Top 10 Purchased Customer')
```

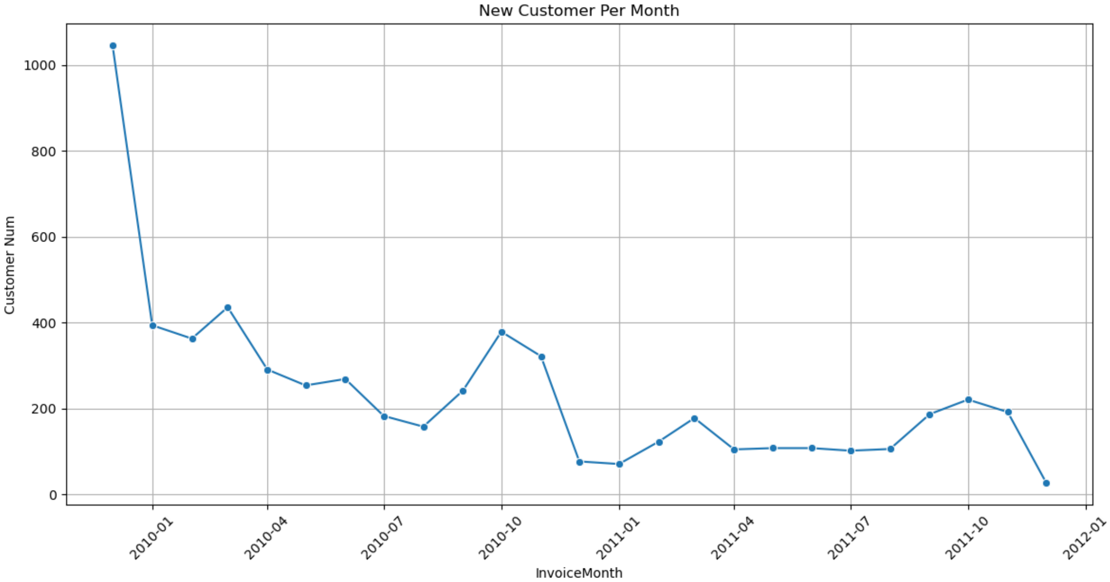
Rate of Repeat

```
[133]: repeat_customer=customer_summary[customer_summary['sale_count']>1]
       onetime_customer=customer_summary[customer_summary['sale_count']==1]

       rate_repeat=100*len(repeat_customer)/customer_summary.shape[0]
       print(f"{rate_repeat}%")
```

```
100.0%
```

New Customer Per Month

```
[ ]: df_clean['InvoiceMonth']=df_clean['InvoiceDate'].dt.to_period('M').dt.
      ↪to_timestamp()
     First_month=df_clean.groupby('Customer ID')['InvoiceMonth'].min().reset_index()
     customer_num_permonth=First_month.groupby('InvoiceMonth')['Customer ID'].
      ↪nunique().reset_index(name='Customer Num')

     plt.figure(figsize=(12,6))
     sns.lineplot(x='InvoiceMonth',y='Customer␣
      ↪Num',data=customer_num_permonth,marker='o')
     plt.title('New Customer Per Month')
     plt.tight_layout()
     plt.grid(True)
     plt.xticks(rotation=45)
     plt.show()
     customer_num_permonth.head()
```



```
[ ]:   InvoiceMonth  Customer Num
     0   2009-12-01          1045
     1   2010-01-01           394
     2   2010-02-01           363
     3   2010-03-01           436
     4   2010-04-01           291
```

```
[ ]:
```