```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.colors as mcolors
from scipy import stats
import seaborn as sns
from textwrap import wrap
from sklearn.cluster import KMeans
from sklearn.manifold import TSNE
from sklearn.preprocessing import StandardScaler

import warnings
warnings.filterwarnings('ignore')

#Reading train and test dataset in pandas dataframe
train_df = pd.read_excel('train.xlsx')
test_df = pd.read_excel('test.xlsx')

# Concatinate train & test dataset
df = pd.concat([train_df,test_df], axis=0)

print("Dimension of the Data set is", df.shape)
print()
df.head()
```

```
Dimension of the Data set is (541909, 8)
```

	InvoiceNo	StockCode	Description	Quantity	InvoiceDate	UnitPrice	CustomerID	Country
0	558904	22292	HANGING CHICK YELLOW DECORATION	1	2011-07-04 16:18:00	1.25	NaN	United Kingdom
1	556072	20970	PINK FLORAL FELTCRAFT SHOULDER BAG	8	2011-06-08 14:57:00	3.75	16126.0	United Kingdom
2	551739	21559	STRAWBERRY LUNCH BOX WITH CUTLERY	2	2011-05-04 10:58:00	2.55	18118.0	United Kingdom
3	541658	21988	PACK OF 6 SKULL PAPER PLATES	1	2011-01-20 12:16:00	0.85	15529.0	United Kingdom
4	538364	85099C	JUMBO BAG BAROQUE BLACK WHITE	10	2010-12-10 17:26:00	1.95	14448.0	United Kingdom

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 541909 entries, 0 to 162572
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: 37.2+ MB
```

```
df.describe().transpose()
```

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

                75%      max
Quantity       10.00  80995.0
UnitPrice       4.13  38970.0
CustomerID  16791.00  18287.0
```

```
# Checking all the records which were returned
df[df["InvoiceNo"].str.startswith('C',na=False)]
```

```
       InvoiceNo StockCode                          Description
Quantity  \
415      C549269    75049L        LARGE CIRCULAR MIRROR MOBILE
-9
487      C572109     23064              CINDERELLA CHANDELIER
-1
613      C537860     22180                     RETROSPOT LAMP
-1
834      C560540     23240   SET OF 4 KNICK KNACK TINS DOILEY
-1
874      C542910     20726                  LUNCH BAG WOODLAND
-1
...          ...       ...                                 ...       .
..
162302   C558712     21735              TWO DOOR CURIO CABINET
-1
162334   C550780    84507C     BLUE CIRCLES DESIGN MONKEY DOLL
-1
162344   C553031     21533            RETROSPOT LARGE MILK JUG
-3
162421   C542910    85123A  WHITE HANGING HEART T-LIGHT HOLDER
-1
162458   C543368     22941        CHRISTMAS LIGHTS 10 REINDEER
```

```
-4
```

```
               InvoiceDate  UnitPrice  CustomerID         Country
415    2011-04-07 12:47:00       0.85     16701.0  United Kingdom
487    2011-10-20 18:24:00      49.95     13350.0  United Kingdom
613    2010-12-08 16:15:00       9.95     16252.0  United Kingdom
834    2011-07-19 12:26:00       4.15     12415.0       Australia
874    2011-02-01 15:38:00       1.45     17511.0  United Kingdom
...                    ...        ...         ...             ...
162302 2011-07-01 13:06:00      12.75     17338.0  United Kingdom
162334 2011-04-20 13:39:00       2.55     17211.0  United Kingdom
162344 2011-05-12 19:43:00       4.95     13908.0  United Kingdom
162421 2011-02-01 15:38:00       2.55     17511.0  United Kingdom
162458 2011-02-07 14:46:00       8.50     18245.0  United Kingdom

[9288 rows x 8 columns]
```

```
# Deleting all the records which were returned
df=df[~df['InvoiceNo'].str.startswith('C',na=False)]

df.shape
```

```
(532621, 8)
```

```
# Checking for missing values
df.isnull().sum()
```

```
InvoiceNo          0
StockCode          0
Description      1454
Quantity           0
InvoiceDate        0
UnitPrice          0
CustomerID     134697
Country            0
dtype: int64
```

```
# Deleting all the missing values
df = df[pd.notnull(df['CustomerID'])]

# Creating a new column Total Sales
df['Total_sales'] = df['Quantity'] * df['UnitPrice']

df.describe().transpose()
```

```
                count          mean           std      min       25%
50%  \
Quantity     397924.0     13.021823   180.420210      1.0      2.00
6.00
UnitPrice    397924.0      3.116174    22.096788      0.0      1.25
1.95
CustomerID   397924.0  15294.315171  1713.169877  12346.0  13969.00
```

```
15159.00
Total_sales  397924.0     22.394749   309.055588      0.0      4.68
11.80

                  75%        max
Quantity        12.00   80995.00
UnitPrice        3.75    8142.75
CustomerID   16795.00   18287.00
Total_sales     19.80  168469.60
```

```
df[(df['Quantity'] > 500) & (df['Total_sales'] > 1000)].head(14)
```

```
      InvoiceNo StockCode                          Description
Quantity  \
440      548011     22630                DOLLY GIRL LUNCH BOX
640
4766     570094     22273                FELTCRAFT DOLL MOLLY
720
6586     540815     21108  FAIRY CAKE FLANNEL ASSORTED COLOUR
3114
9074     536809     84950      ASSORTED COLOUR T-LIGHT HOLDER
1824
14761    567423     23285            PINK VINTAGE SPOT BEAKER
1944
15029    554845    85123A  WHITE HANGING HEART T-LIGHT HOLDER
608
15177    573008     84077   WORLD WAR 2 GLIDERS ASSTD DESIGNS
4800
17773    574294     22086     PAPER CHAIN KIT 50'S CHRISTMAS
1020
30612    558526     23170            REGENCY TEA PLATE ROSES
720
36091    558554     23245          SET OF 3 REGENCY CAKE TINS
576
37150    574294     21915              RED  HARMONICA IN BOX
2100
37246    543379     21623        VINTAGE UNION JACK MEMOBOARD
504
38594    546789    85099B             JUMBO BAG RED RETROSPOT
1200
43525    581483     23843         PAPER CRAFT , LITTLE BIRDIE
80995

              InvoiceDate  UnitPrice  CustomerID         Country
Total_sales
440   2011-03-29 11:14:00       1.65     14646.0     Netherlands
1056.00
4766  2011-10-07 11:56:00       2.55     16029.0  United Kingdom
1836.00
6586  2011-01-11 12:55:00       2.10     15749.0  United Kingdom
```

```
6539.40
9074  2010-12-02 16:48:00       0.55     15299.0  United Kingdom
1003.20
14761 2011-09-20 11:05:00       1.08     17450.0  United Kingdom
2099.52
15029 2011-05-26 19:49:00       3.24     17450.0  United Kingdom
1969.92
15177 2011-10-27 12:26:00       0.21     12901.0  United Kingdom
1008.00
17773 2011-11-03 15:47:00       2.55     16333.0  United Kingdom
2601.00
30612 2011-06-30 11:01:00       1.45     17949.0  United Kingdom
1044.00
36091 2011-06-30 12:50:00       4.15     17949.0  United Kingdom
2390.40
37150 2011-11-03 15:47:00       1.06     16333.0  United Kingdom
2226.00
37246 2011-02-07 15:37:00       6.38     18102.0  United Kingdom
3215.52
38594 2011-03-17 10:17:00       1.65     15769.0  United Kingdom
1980.00
43525 2011-12-09 09:15:00       2.08     16446.0  United Kingdom
168469.60
```

```
# Deleting record for Inovice no. 581483
df.drop(43525, axis =0, inplace = True)
```

```
df.describe().transpose()
```

```
                count          mean           std      min       25%
50%  \
Quantity     397922.0     12.818334   126.770315      1.0      2.00
6.00
UnitPrice    397922.0      3.116180    22.096843      0.0      1.25
1.95
CustomerID   397922.0  15294.310475  1713.172833  12346.0  13969.00
15159.00
Total_sales  397922.0     21.971467   155.592056      0.0      4.68
11.80

                 75%       max
Quantity       12.00  74215.00
UnitPrice       3.75   8142.75
CustomerID   16795.00  18287.00
Total_sales     19.80  77183.60
```

```
df[df['Quantity'] == 74215]
```

```
       InvoiceNo StockCode                         Description
Quantity  \
322892    541431     23166  MEDIUM CERAMIC TOP STORAGE JAR     74215
```

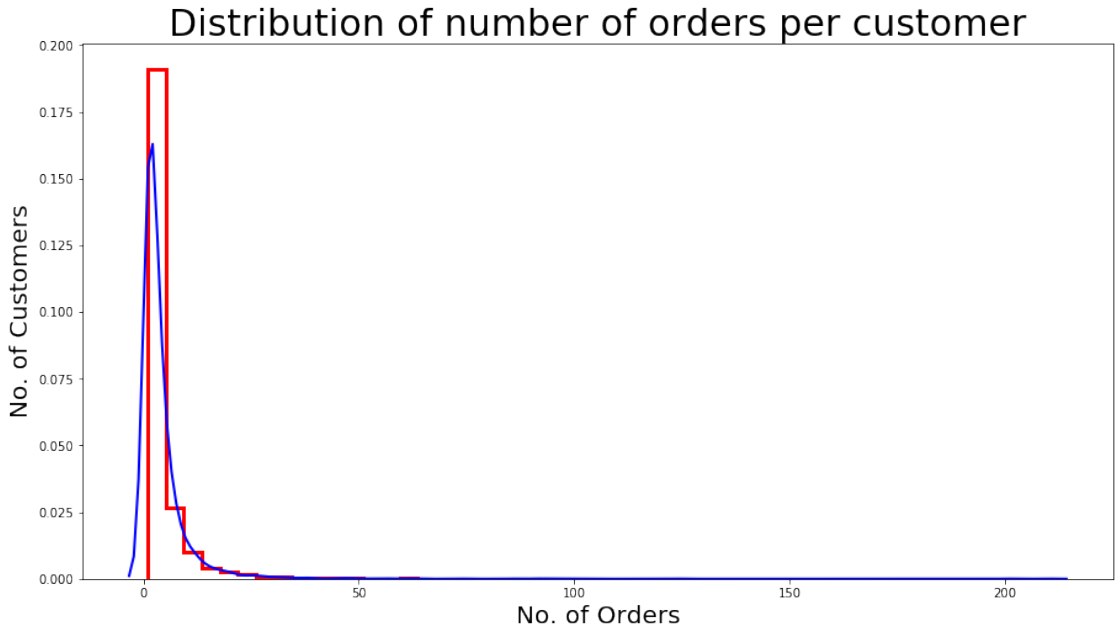
```
               InvoiceDate  UnitPrice  CustomerID         Country
Total_sales
322892 2011-01-18 10:01:00       1.04     12346.0  United Kingdom
77183.6
```

```
# Removing the record for invoice number 541431
df.drop(322892, axis =0, inplace = True)
```

```
orders_n = df.groupby(['CustomerID']) ['InvoiceNo'].nunique()
more_than_one = np.sum(orders_n > 1) / df['CustomerID'].nunique()
print(f'{100 * more_than_one:.2f}% of customers ordered more than
once')
```

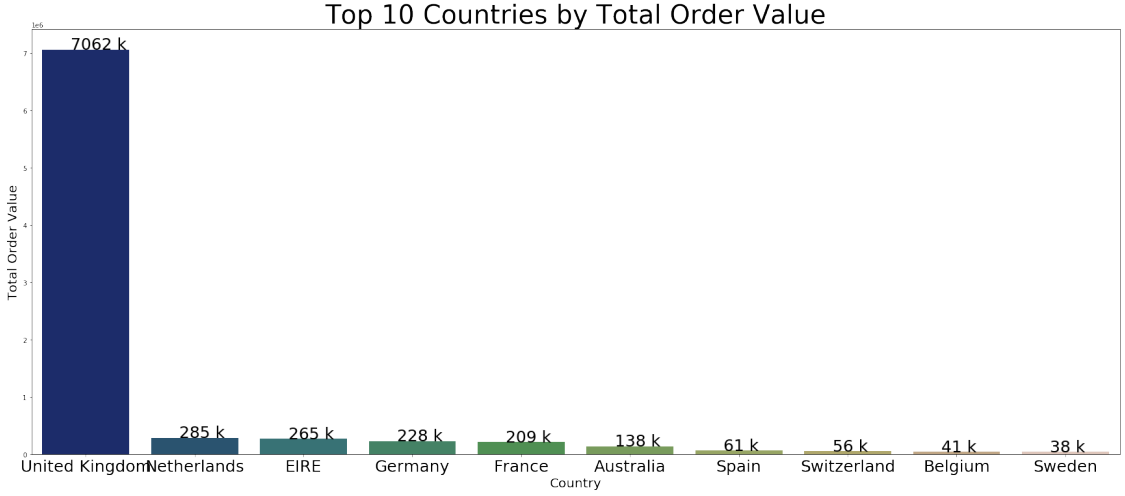
```
65.56% of customers ordered more than once
```

```
plt.figure(figsize=(15,8))
plt.style.use('_classic_test_patch')
px = sns.distplot(orders_n, hist = True, rug_kws={"color": "r"},
                  kde_kws={"color": "b", "lw": 2, "label": "KDE"},
                  hist_kws={"histtype": "step", "linewidth": 3,
                            "alpha": 1, "color": "r"})

px.set_title('Distribution of number of orders per customer', fontsize
= 30)
px.set_xlabel('No. of Orders', fontsize = 20)
px.set_ylabel('No. of Customers', fontsize = 20);
```



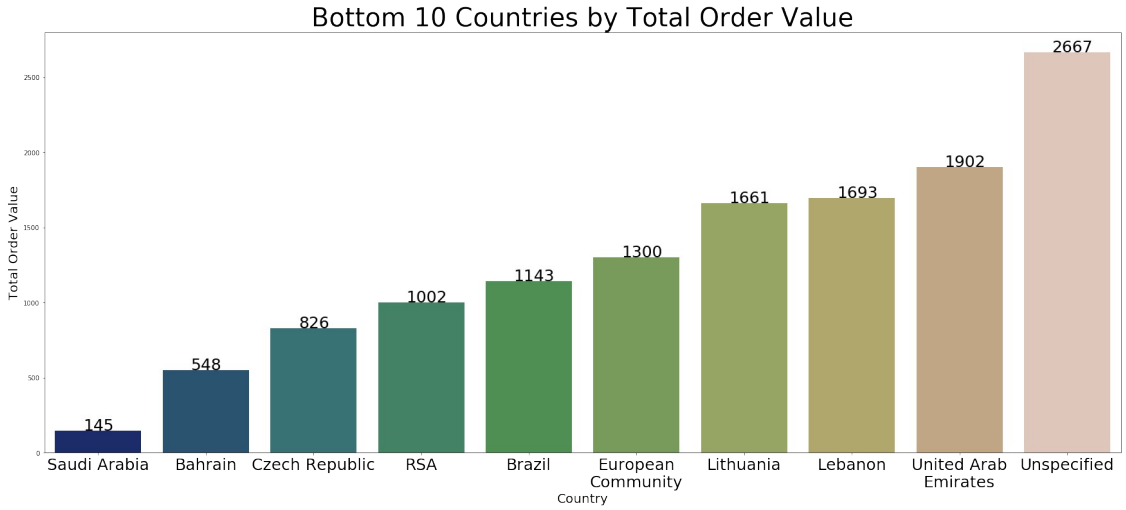

```
order_country = df.groupby('Country').sum()
['Total_sales'].nlargest(10)
plt.figure(figsize=(30,12))
```

```
plt.style.use('_classic_test_patch')
px = sns.barplot(x = order_country.index, y = order_country.values,
palette = 'gist_earth')
px.set_xlabel('Country', fontsize = 20)
px.set_ylabel('Total Order Value', fontsize = 20)
px.set_title('Top 10 Countries by Total Order Value', fontsize = 40)

labels = [ '\n'.join(wrap(l, 15)) for l in order_country.index ]
px.set_xticklabels(labels, fontsize = 25)

value_ticks = []
for x in order_country.values:
    value_ticks.append(str(int(x/1000))+' k')
value_ticks[0]

for a, label in zip(px.patches, value_ticks):
    px.annotate(label, (a.get_x() + 0.26, a.get_height() + 2),
fontsize = 25)
```

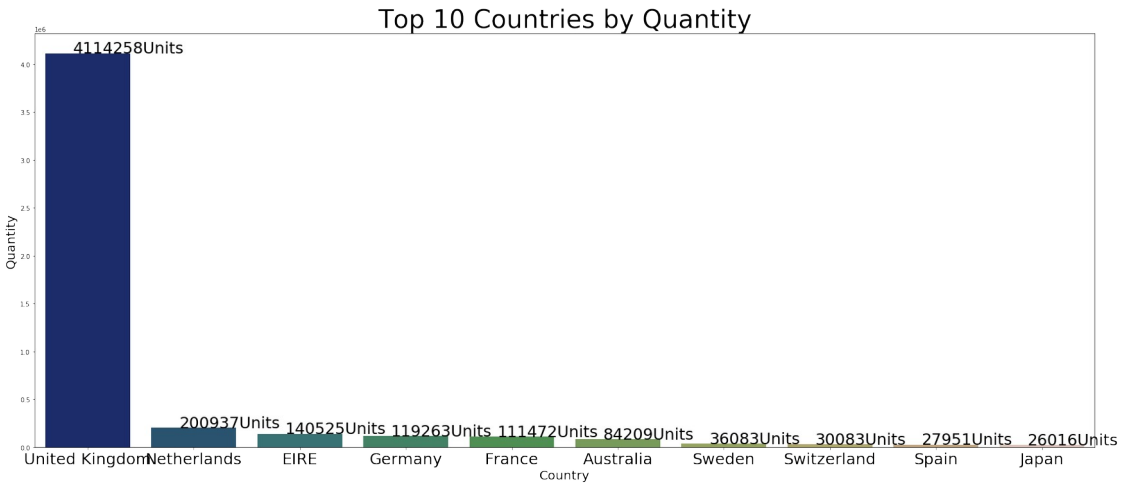



```
order_country = df.groupby('Country').sum()
['Total_sales'].nsmallest(10)
plt.figure(figsize=(30,12))
plt.style.use('_classic_test_patch')
px = sns.barplot(x = order_country.index, y = order_country.values,
palette = 'gist_earth')
px.set_xlabel('Country', fontsize = 20)
px.set_ylabel('Total Order Value', fontsize = 20)
px.set_title('Bottom 10 Countries by Total Order Value', fontsize =
40)

labels = [ '\n'.join(wrap(l, 15)) for l in order_country.index ]
px.set_xticklabels(labels, fontsize = 25)

value_ticks = []
for x in order_country.values:
```

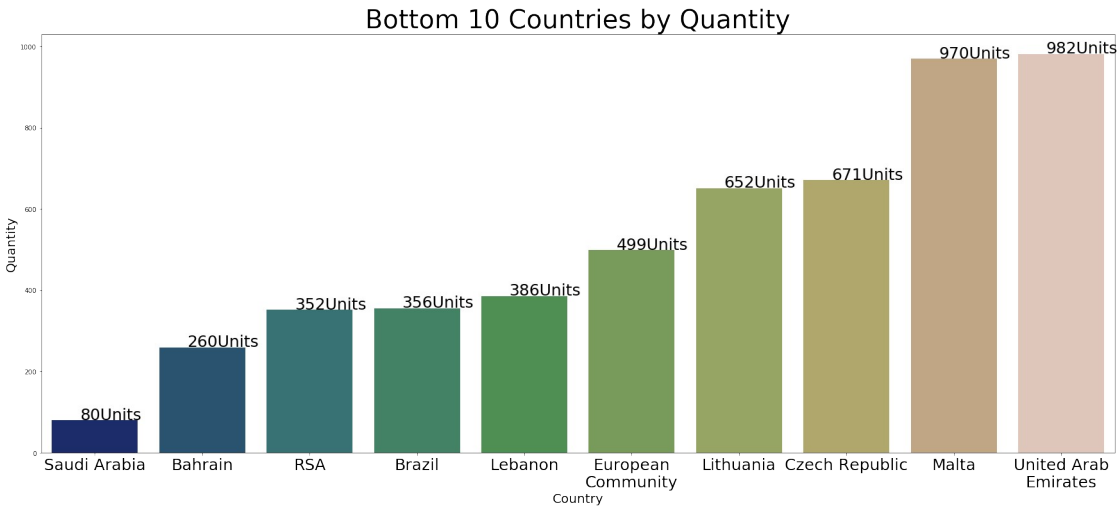
```
    value_ticks.append(str(int(x)))
value_ticks[0]

for a, label in zip(px.patches, value_ticks):
    px.annotate(label, (a.get_x() + 0.26, a.get_height() + 2),
fontsize = 25)
```



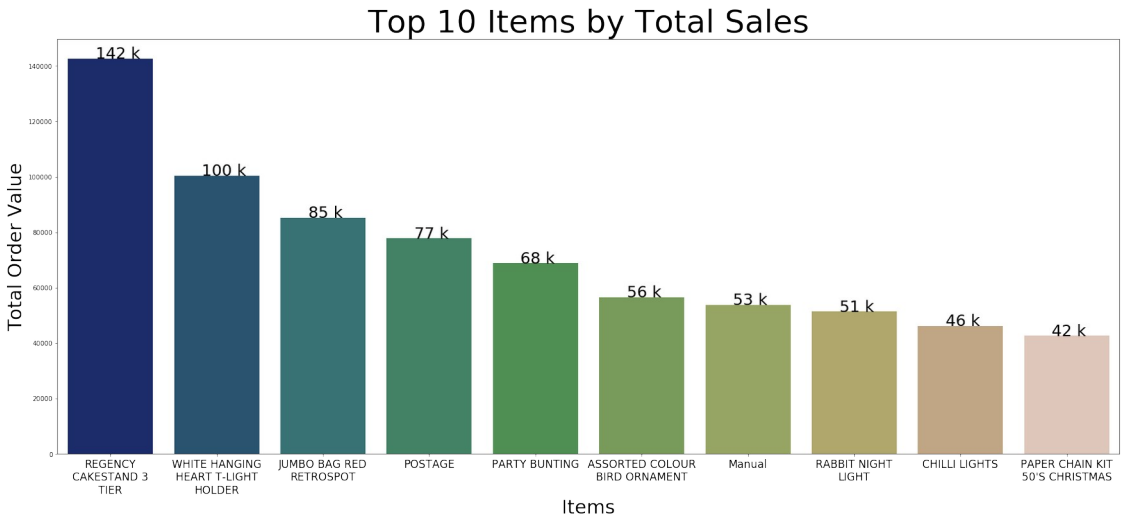

```
order_country =
df['Quantity'].groupby(df['Country']).agg('sum').sort_values(ascending
=False).head(10)
plt.figure(figsize=(30,12))
plt.style.use('_classic_test_patch')
px = sns.barplot(x = order_country.index, y = order_country.values,
palette = 'gist_earth')
px.set_xlabel('Country', fontsize = 20)
px.set_ylabel('Quantity', fontsize = 20)
px.set_title('Top 10 Countries by Quantity', fontsize = 40)

labels = [ '\n'.join(wrap(l, 15)) for l in order_country.index ]
px.set_xticklabels(labels, fontsize = 25)

value_ticks = []
for x in order_country.values:
    value_ticks.append(str(int(x))+'Units')
value_ticks[0]

for a, label in zip(px.patches, value_ticks):
    px.annotate(label, (a.get_x() + 0.26, a.get_height() + 2),
fontsize = 25)
```




```
order_country =
df['Quantity'].groupby(df['Country']).agg('sum').sort_values(ascending
=True).head(10)
plt.figure(figsize=(30,12))
plt.style.use('_classic_test_patch')
px = sns.barplot(x = order_country.index, y = order_country.values,
palette = 'gist_earth')
px.set_xlabel('Country', fontsize = 20)
px.set_ylabel('Quantity', fontsize = 20)
px.set_title('Bottom 10 Countries by Quantity', fontsize = 40)

labels = [ '\n'.join(wrap(l, 15)) for l in order_country.index ]
px.set_xticklabels(labels, fontsize = 25)

value_ticks = []
for x in order_country.values:
    value_ticks.append(str(int(x))+'Units')
value_ticks[0]

for a, label in zip(px.patches, value_ticks):
    px.annotate(label, (a.get_x() + 0.26, a.get_height() + 2),
fontsize = 25)
```




```
#Total order value by country's

sales_items = df.groupby('Description').sum()
['Total_sales'].nlargest(10)
plt.figure(figsize=(30,12))
plt.style.use('_classic_test_patch')
px = sns.barplot(x = sales_items.index, y = sales_items.values,
palette = 'gist_earth')
px.set_xlabel('Items', fontsize = 30)
px.set_ylabel('Total Order Value', fontsize = 30)
px.set_title('Top 10 Items by Total Sales', fontsize = 50)

labels_x = [ '\n'.join(wrap(l, 15)) for l in sales_items.index ]
px.set_xticklabels(labels_x, fontsize = 17)

value_ticks = []
for x in sales_items.values:
    value_ticks.append(str(int(x/1000))+' k')

for a, label in zip(px.patches, value_ticks):
    px.annotate(label, (a.get_x() + 0.26, a.get_height() + 2),
fontsize = 25)
```




```
#Cohort Analysis

# Creating a copy of the cleaned data
df_cohort = df.copy()

# As we have only 9 days information of December 2011, so we would not
use that for cohort analysis.
df_cohort = df_cohort[~(df_cohort['InvoiceDate'] > '2011-12-01')]

# Extracting month and year column from the Invoice date column
df_cohort['invoice_month'] = df_cohort['InvoiceDate'].apply(lambda x:
x.strftime('%Y-%m'))

month_grp = df_cohort.groupby('invoice_month')

month_grp_agg = month_grp.agg({'CustomerID': pd.Series.nunique,
'Description': pd.Series.nunique,
                               'Quantity': np.sum, 'Total_sales':
np.sum})

month_grp_agg.rename(columns ={'CustomerID':'# customers',
'Description':'tot_item_types',}, inplace = True)

month_grp_agg
```

invoice_month	# customers	tot_item_types	Quantity	Total_sales
2010-12	885	2418	312276	572705.490
2011-01	740	2117	274932	492261.440
2011-02	758	2122	265638	447137.350
2011-03	974	2240	348544	595500.760
2011-04	856	2225	292225	469200.361
2011-05	1056	2255	373685	678594.560
2011-06	991	2361	363699	661213.690
2011-07	949	2373	369432	600091.011

```
2011-08                935            2386    398938   645343.900
2011-09               1266            2581    544899   952838.382
2011-10               1364            2681    593908  1039318.790
2011-11               1665            2719    681888  1161817.380
```

```
#Creating Label for customer cohort
df_cohort.set_index('CustomerID', inplace = True)
df_cohort.head()
```

```
           InvoiceNo StockCode                          Description
Quantity  \
CustomerID

16126.0       556072     20970  PINK FLORAL FELTCRAFT SHOULDER BAG
8
18118.0       551739     21559   STRAWBERRY LUNCH BOX WITH CUTLERY
2
15529.0       541658     21988        PACK OF 6 SKULL PAPER PLATES
1
14448.0       538364    85099C      JUMBO  BAG BAROQUE BLACK WHITE
10
13911.0       552306     84789           ENCHANTED BIRD PLANT CAGE
4

                   InvoiceDate  UnitPrice         Country  Total_sales
\
CustomerID

16126.0    2011-06-08 14:57:00       3.75  United Kingdom        30.00

18118.0    2011-05-04 10:58:00       2.55  United Kingdom         5.10

15529.0    2011-01-20 12:16:00       0.85  United Kingdom         0.85

14448.0    2010-12-10 17:26:00       1.95  United Kingdom        19.50

13911.0    2011-05-08 15:20:00       3.75  United Kingdom        15.00


           invoice_month
CustomerID
16126.0          2011-06
18118.0          2011-05
15529.0          2011-01
14448.0          2010-12
13911.0          2011-05
```

```
df_cohort['cust_cohort'] = df_cohort.groupby(level=0)
['InvoiceDate'].min().apply(lambda x: x.strftime('%Y-%m'))
df_cohort.head()
```

```
           InvoiceNo StockCode                          Description
Quantity  \
CustomerID

16126.0       556072     20970  PINK FLORAL FELTCRAFT SHOULDER BAG
8
18118.0       551739     21559   STRAWBERRY LUNCH BOX WITH CUTLERY
2
15529.0       541658     21988        PACK OF 6 SKULL PAPER PLATES
1
14448.0       538364    85099C      JUMBO  BAG BAROQUE BLACK WHITE
10
13911.0       552306     84789           ENCHANTED BIRD PLANT CAGE
4

                   InvoiceDate  UnitPrice         Country  Total_sales
\
CustomerID

16126.0    2011-06-08 14:57:00       3.75  United Kingdom        30.00

18118.0    2011-05-04 10:58:00       2.55  United Kingdom         5.10

15529.0    2011-01-20 12:16:00       0.85  United Kingdom         0.85

14448.0    2010-12-10 17:26:00       1.95  United Kingdom        19.50

13911.0    2011-05-08 15:20:00       3.75  United Kingdom        15.00


           invoice_month cust_cohort
CustomerID
16126.0          2011-06     2011-02
18118.0          2011-05     2010-12
15529.0          2011-01     2010-12
14448.0          2010-12     2010-12
13911.0          2011-05     2011-02

df_cohort.reset_index(inplace = True)
df_cohort.head()

   CustomerID InvoiceNo StockCode                          Description
\
0     16126.0    556072     20970  PINK FLORAL FELTCRAFT SHOULDER BAG

1     18118.0    551739     21559   STRAWBERRY LUNCH BOX WITH CUTLERY

2     15529.0    541658     21988        PACK OF 6 SKULL PAPER PLATES
```

```
3     14448.0    538364    85099C      JUMBO  BAG BAROQUE BLACK WHITE

4     13911.0    552306     84789           ENCHANTED BIRD PLANT CAGE


   Quantity         InvoiceDate  UnitPrice         Country
Total_sales  \
0         8 2011-06-08 14:57:00       3.75  United Kingdom
30.00
1         2 2011-05-04 10:58:00       2.55  United Kingdom
5.10
2         1 2011-01-20 12:16:00       0.85  United Kingdom
0.85
3        10 2010-12-10 17:26:00       1.95  United Kingdom
19.50
4         4 2011-05-08 15:20:00       3.75  United Kingdom
15.00

  invoice_month cust_cohort
0       2011-06     2011-02
1       2011-05     2010-12
2       2011-01     2010-12
3       2010-12     2010-12
4       2011-05     2011-02
```

```
cust_grp = df_cohort.groupby(['cust_cohort','invoice_month'])

cust_grp_agg = cust_grp.agg({'CustomerID': pd.Series.nunique,
'Description': pd.Series.nunique,
                     'Quantity': np.sum, 'Total_sales': np.sum})

cust_grp_agg.rename(columns ={'CustomerID':'# customers',
'Description':'tot_item_types',}, inplace = True)

cust_grp_agg.head()
```

```
                          # customers  tot_item_types  Quantity
Total_sales
cust_cohort invoice_month

2010-12     2010-12               885            2418    312276
572705.49
            2011-01               324            1787    158708
276237.69
            2011-02               286            1697    136860
233845.37
            2011-03               340            1834    177580
303119.39
            2011-04               321            1781    131378
204407.66
```

```
def cohort_num(df_cohort):
    df_cohort['cohort_num'] = np.arange(len(df_cohort)) + 1
    return df_cohort

cust_grp_agg = cust_grp_agg.groupby(level=0).apply(cohort_num)
cust_grp_agg.head(10)
```

```
                           # customers  tot_item_types  Quantity
Total_sales  \
cust_cohort invoice_month

2010-12     2010-12                885            2418    312276
572705.49
            2011-01                324            1787    158708
276237.69
            2011-02                286            1697    136860
233845.37
            2011-03                340            1834    177580
303119.39
            2011-04                321            1781    131378
204407.66
            2011-05                352            1851    178599
336627.50
            2011-06                321            1871    178645
314162.61
            2011-07                309            1954    177188
310783.92
            2011-08                313            1952    207217
331749.22
            2011-09                350            2138    250114
472813.64

                           cohort_num
cust_cohort invoice_month
2010-12     2010-12                 1
            2011-01                 2
            2011-02                 3
            2011-03                 4
            2011-04                 5
            2011-05                 6
            2011-06                 7
            2011-07                 8
            2011-08                 9
            2011-09                10
```

```
#Project Task 2
#Data Modelling
```

```
# Creating a copy of the original dataframe which will have records of
December 2011 as well
rfm_df = df.copy(deep=True)

# Checking for duplicates
rfm_df.duplicated().sum()
```

```
5192
```

```
# Dropping all the duplicated records
rfm_df.drop_duplicates(inplace = True)

rfm_df.duplicated().sum()
```

```
0
```

```
rfm_df.shape
```

```
(392729, 9)
```

```
# The last transaction date we have is 12-09-2011, so we would take
that as current date to calculate the recency
import datetime as dt
last_date = df['InvoiceDate'].max()

RFM_table = rfm_df.groupby('CustomerID').agg({'InvoiceDate': lambda x:
(last_date - x.max()).days, # Recency
                                              'InvoiceNo': 'count',
# Frequency
                                              'Total_sales': 'sum'})
# Monetary Value

RFM_table.rename(columns={'InvoiceDate': 'Recency',
                          'InvoiceNo': 'Frequency',
                          'Total_sales': 'Monetary'}, inplace=True)

RFM_table.head(10)
```

CustomerID	Recency	Frequency	Monetary
12347.0	1	182	4310.00
12348.0	74	31	1797.24
12349.0	18	73	1757.55
12350.0	309	17	334.40
12352.0	35	85	2506.04
12353.0	203	4	89.00
12354.0	231	58	1079.40
12355.0	213	13	459.40
12356.0	22	59	2811.43
12357.0	32	131	6207.67

```
RFM_table.reset_index(inplace = True)
```

```
quartiles = RFM_table.quantile(q=[0.25,0.50,0.75])
quartiles = quartiles.to_dict()

RFM_table_copy = RFM_table.copy()

def RScore(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

def FMScore(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

RFM_table_copy['R'] = RFM_table_copy['Recency'].apply(RScore,
args=('Recency',quartiles))
RFM_table_copy['F'] = RFM_table_copy['Frequency'].apply(FMScore,
args=('Frequency',quartiles))
RFM_table_copy['M'] = RFM_table_copy['Monetary'].apply(FMScore,
args=('Monetary',quartiles))

RFM_table_copy['RFM'] = RFM_table_copy.R.map(str)
+RFM_table_copy.F.map(str)+RFM_table_copy.M.map(str)

RFM_table_copy['RFM_Score'] =
RFM_table_copy[['R','F','M']].sum(axis=1)
RFM_table_copy.head()
```

	CustomerID	Recency	Frequency	Monetary	R	F	M	RFM	RFM_Score
0	12347.0	1	182	4310.00	4	4	4	444	12
1	12348.0	74	31	1797.24	2	2	4	224	8
2	12349.0	18	73	1757.55	3	3	4	334	10
3	12350.0	309	17	334.40	1	1	2	112	4
4	12352.0	35	85	2506.04	3	3	4	334	10

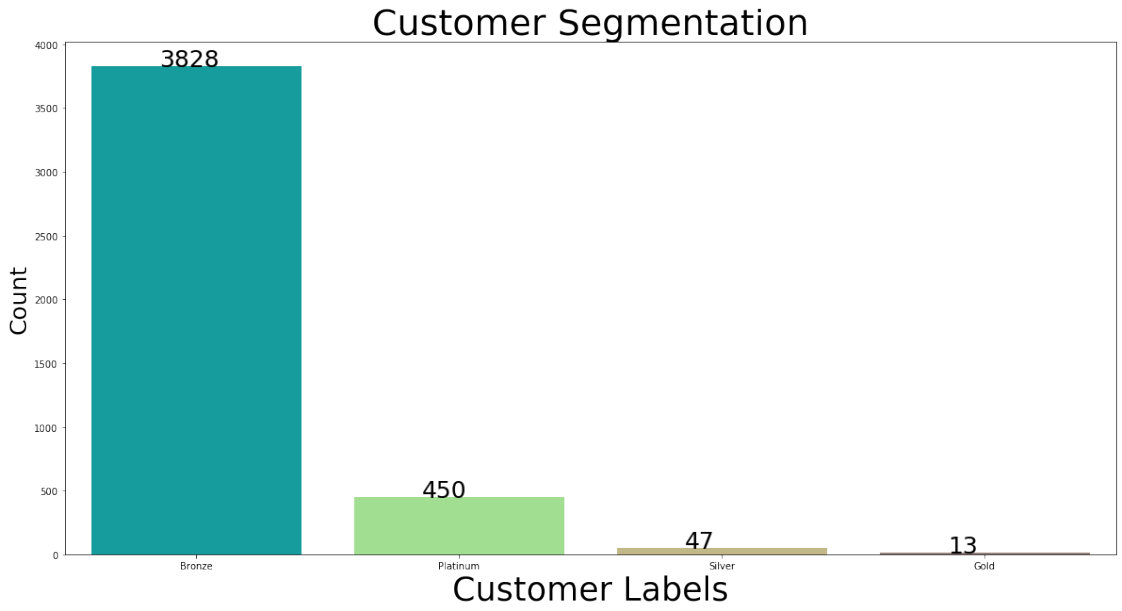
```
RFM_table_copy.groupby('RFM_Score').agg({'Recency':
'mean','Frequency': 'mean', 'Monetary': ['mean', 'count'] }).round(1)
```

	Recency	Frequency	Monetary
	mean	mean	mean count
RFM_Score			

```
3           259.6       8.2    157.0   382
4           176.2      13.6    240.0   388
5           152.1      21.2    366.7   517
6            94.3      27.9    649.7   455
7            78.6      37.9    759.1   465
8            63.0      55.9    986.6   455
9            45.1      78.9   1391.5   413
10           31.5     110.6   2057.4   425
11           20.3     186.7   4055.8   388
12            6.2     367.9   9285.9   450
```

```
# Setting up the label for each client and adding the column "Label"
to the dataframe

Segment = [0] * len(RFM_table_copy)

for i in range(0,len(RFM_table_copy)):

    if RFM_table_copy['RFM'][i] == '444':
        Segment[i] = "Platinum"

    elif RFM_table_copy['RFM'][i] == '413':
        Segment[i] = "Gold"

    elif RFM_table_copy['RFM'][i] == '323':
        Segment[i] = "Silver"

    else:
        Segment[i] = "Bronze"

RFM_table_copy['Segment'] = Segment

plt.figure(figsize=(20,10))
plt.style.use('_classic_test_patch')
ax = sns.countplot(x='Segment', data=RFM_table_copy,
palette="terrain",
order=RFM_table_copy['Segment'].value_counts().index[:5])
ax.set_ylabel('Count', fontsize = 25)
ax.set_xlabel('Customer Labels', fontsize = 35)
#ax.set_xticklabels(rfm_table['Label'].index, fontsize = 25)
ax.set_title('Customer Segmentation', fontsize = 38);

#labels_x = [ '\n'.join(wrap(l, 15)) for l in rfm_table['Label'].index
]
#ax.set_xticklabels(labels_x, fontsize = 19)

value_ticks = []
for x in RFM_table_copy['Segment'].value_counts():
    value_ticks.append(str(int(x)))
```

```
for a, label in zip(ax.patches, value_ticks):
    ax.annotate(label, (a.get_x() + 0.26, a.get_height() + 2),
fontsize = 25)
```



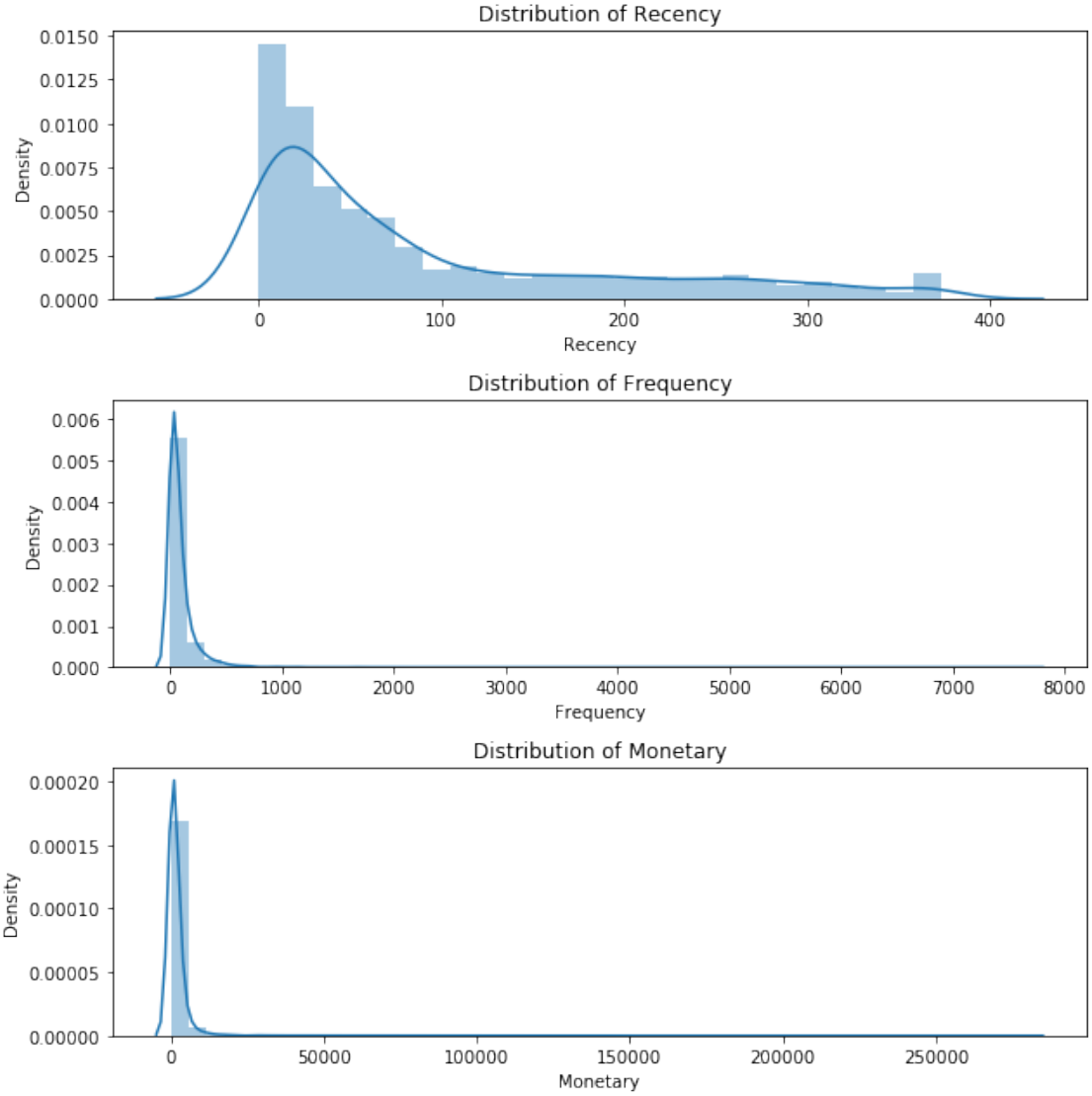

```
RFM_table_copy.groupby('Segment').agg({'Recency':'mean',
'Frequency':'mean', 'Monetary':['mean','count']}).round(1)
```

	Recency	Frequency	Monetary	
	mean	mean	mean	count
Segment				
Bronze	102.5	58.9	1150.8	3828
Gold	9.4	11.9	1081.5	13
Platinum	6.2	367.9	9285.9	450
Silver	33.3	31.8	923.4	47

```
def skewness(df_skew, column):
    skew = stats.skew(df_skew[column])
    skewtest = stats.skewtest(df_skew[column])
    plt.title('Distribution of ' + column)
    sns.distplot(df_skew[column])
    print("{}'s: Skew: {}, : {}".format(column, skew, skewtest))
    return

# Plot all 3 graphs together for summary findings
plt.figure(figsize=(9, 9))

plt.subplot(3, 1, 1)
skewness(RFM_table_copy,'Recency')

plt.subplot(3, 1, 2)
skewness(RFM_table_copy,'Frequency')
```

```
plt.subplot(3, 1, 3)
skewness(RFM_table_copy,'Monetary')

plt.tight_layout()
```

```
Recency's: Skew: 1.2457125234954753, :
SkewtestResult(statistic=26.608212114006275,
pvalue=5.454166575151001e-156)
Frequency's: Skew: 18.036037104330713, :
SkewtestResult(statistic=83.48256629177025, pvalue=0.0)
Monetary's: Skew: 20.624815446376232, :
SkewtestResult(statistic=86.43722008800931, pvalue=0.0)
```



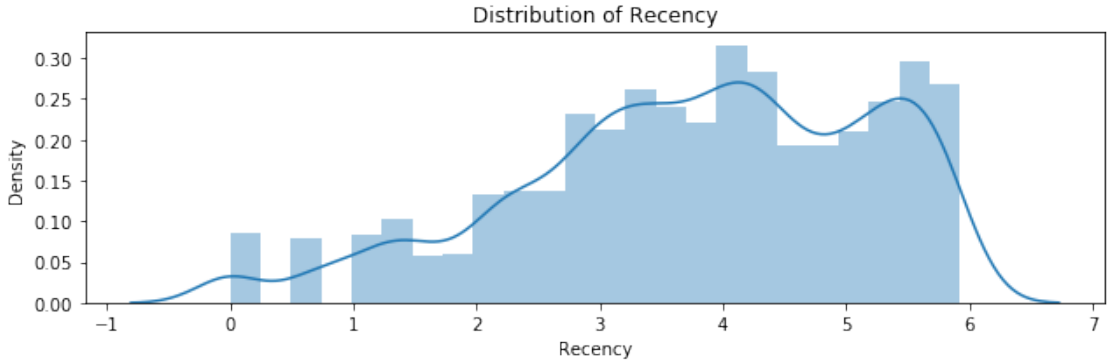

```
#Project Task 3
#Data Modelling
#K-means Clustering
```

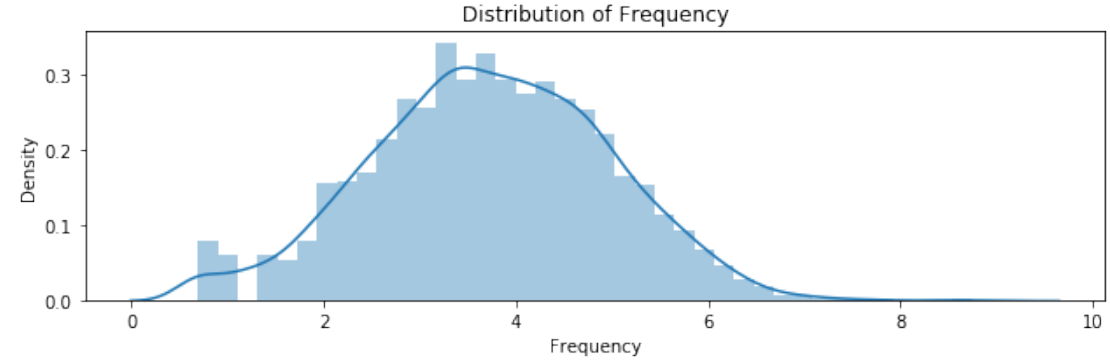
```
df_rfm_log = RFM_table.copy()
print(df_rfm_log.describe())
```

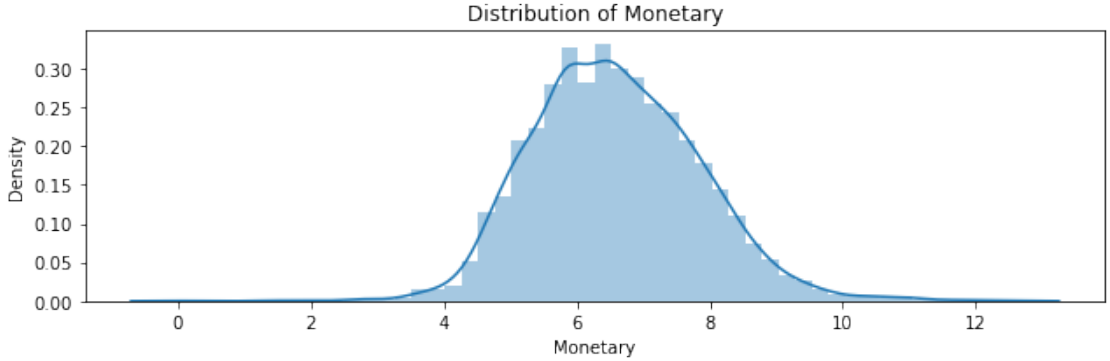
```
         CustomerID      Recency    Frequency       Monetary
count   4338.000000  4338.000000  4338.000000    4338.000000
mean   15300.617796    91.511757    90.532273    1992.057929
std     1721.503870    99.963616   225.537197    8546.651225
min    12347.000000     0.000000     1.000000       0.000000
25%    13813.250000    17.000000    17.000000     306.210000
50%    15299.500000    50.000000    41.000000     668.040000
75%    16778.750000   141.000000    98.000000    1656.537500
max    18287.000000   373.000000  7676.000000  280206.020000
```

```
# A constant of 1 is added to the log to ensure we have all positive
values
df_rfm_log = np.log(df_rfm_log+1)
plt.figure(figsize=(9, 9))

plt.subplot(3, 1, 1)
skewness(df_rfm_log,'Recency')

plt.subplot(3, 1, 2)
skewness(df_rfm_log,'Frequency')

plt.subplot(3, 1, 3)
skewness(df_rfm_log,'Monetary')

plt.tight_layout()
```

```
Recency's: Skew: -0.553047774132005, : SkewtestResult(statistic=-
13.947408787843337, pvalue=3.262444980776586e-44)
Frequency's: Skew: -0.012391467138597751, : SkewtestResult(statistic=-
0.3337508666486869, pvalue=0.7385675621614818)
Monetary's: Skew: 0.3271118898101863, :
SkewtestResult(statistic=8.59167125141112, pvalue=8.571333684337599e-
18)
```





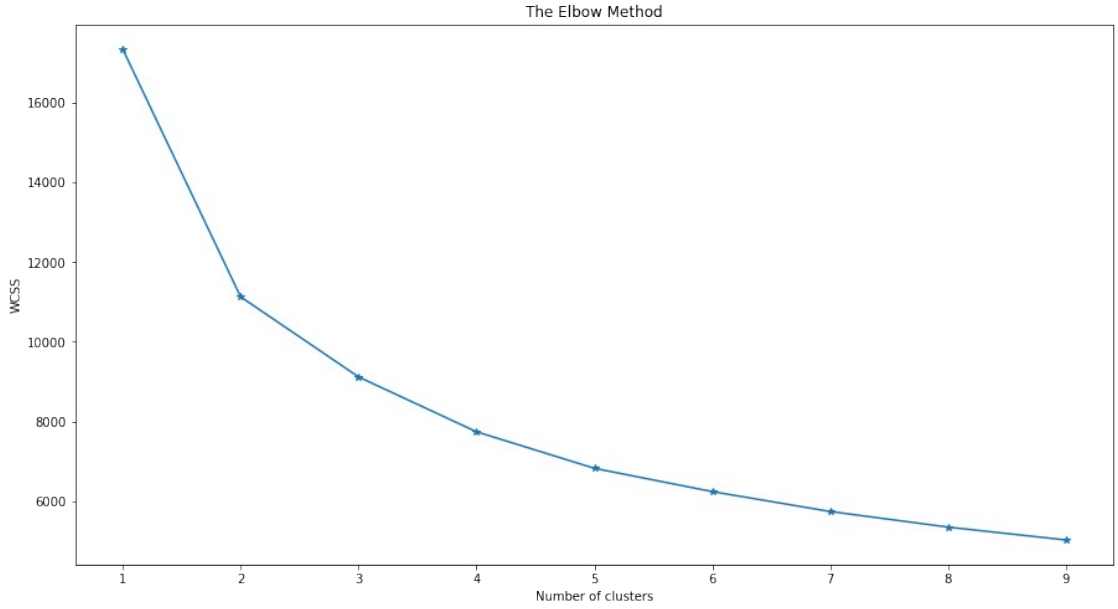



```
print(df_rfm_log.describe())
```

```
        CustomerID      Recency    Frequency     Monetary
count  4338.000000  4338.000000  4338.000000  4338.000000
mean      9.629314     3.768036     3.729132     6.583507
std       0.113513     1.431272     1.245280     1.260195
min       9.421249     0.000000     0.693147     0.000000
25%       9.533456     2.890372     2.890372     5.727531
50%       9.635641     3.931826     3.737670     6.505844
75%       9.727928     4.955827     4.595120     7.413088
max       9.814000     5.924256     8.945984    12.543284
```

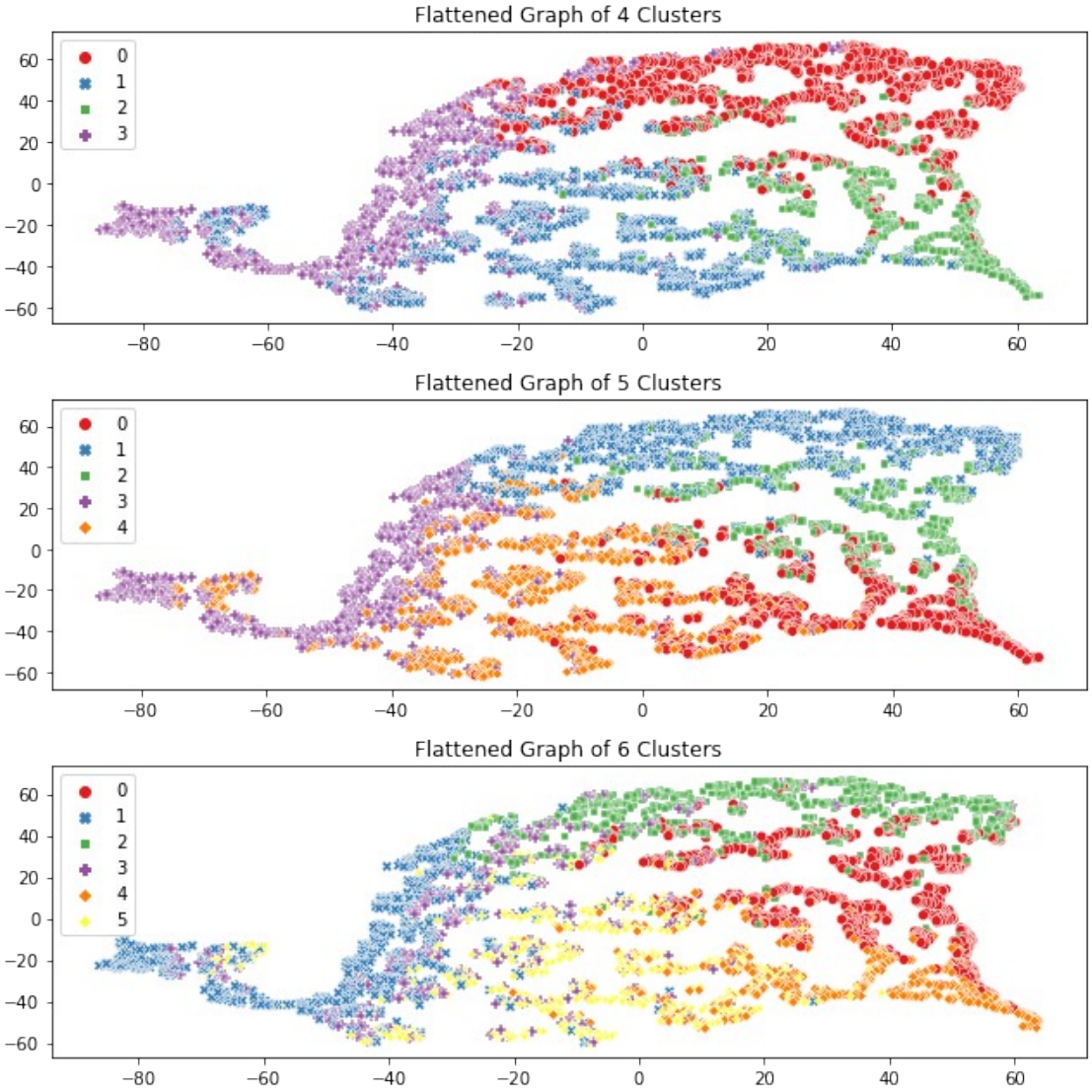
```
# Standardrizing the data
scaler = StandardScaler()
scaler.fit(df_rfm_log)
```

```
# Store it separately for clustering
rfm_scaled= scaler.transform(df_rfm_log)

wcss = []
for i in range(1, 10):
    kmeans = KMeans(n_clusters = i, init = 'k-means++', random_state =
42)
    kmeans.fit(rfm_scaled)
    wcss.append(kmeans.inertia_)

f, ax = plt.subplots(figsize=(15, 8))
plt.style.use('_classic_test_patch')
plt.plot(range(1, 10), wcss, '-*')
plt.title('The Elbow Method')
plt.xlabel('Number of clusters')
plt.ylabel('WCSS');
```



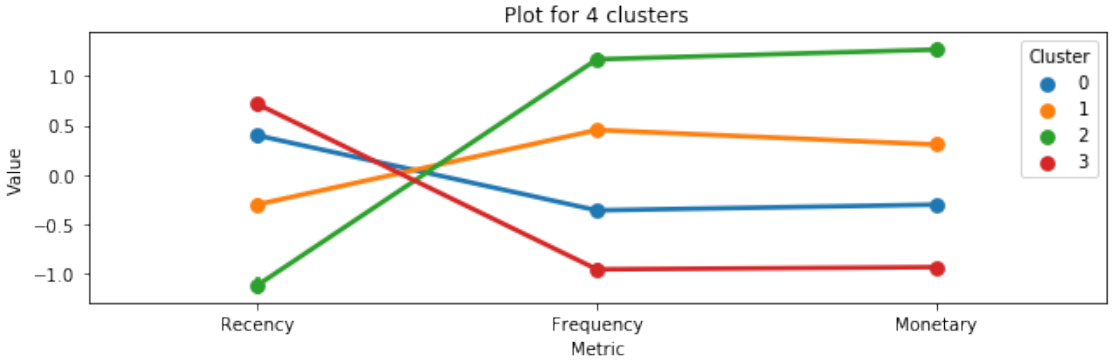

```
def kmeans(rfm_scaled, clusters_number, original_df_rfm):

    kmeans = KMeans(n_clusters = clusters_number, random_state = 1)
    kmeans.fit(rfm_scaled)

    # Extract cluster labels
    cluster_labels = kmeans.labels_

    # Create a cluster label column in original dataset
    df_new = original_df_rfm.assign(Cluster = cluster_labels)

    # Initialise TSNE
    model = TSNE(random_state=1)
    transformed = model.fit_transform(df_new)
```

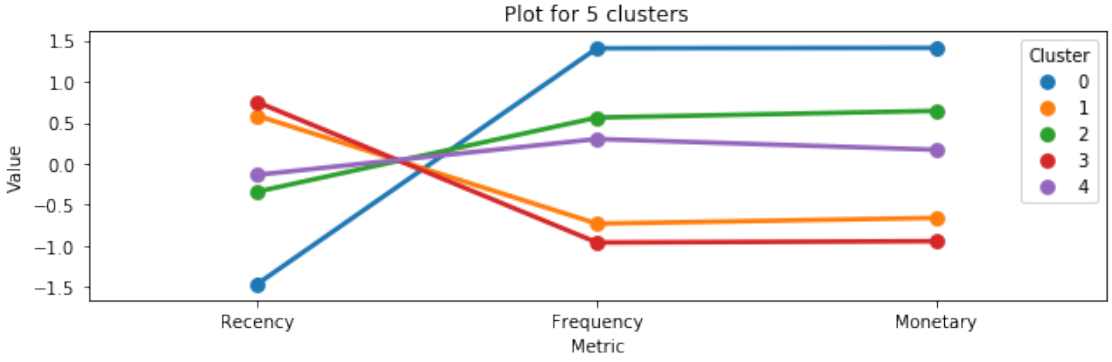
```
    # Plot t-SNE
    plt.title('Flattened Graph of {}
Clusters'.format(clusters_number))
    sns.scatterplot(x=transformed[:,0], y=transformed[:,1],
hue=cluster_labels, style=cluster_labels, palette="Set1")

    return df_new

plt.figure(figsize=(9, 9))

plt.subplot(3, 1, 1)
df_rfm_k4 = kmeans(rfm_scaled, 4, RFM_table)

plt.subplot(3, 1, 2)
df_rfm_k5 = kmeans(rfm_scaled, 5, RFM_table)

plt.subplot(3, 1, 3)
df_rfm_k6 = kmeans(rfm_scaled, 6, RFM_table)

plt.tight_layout()
```

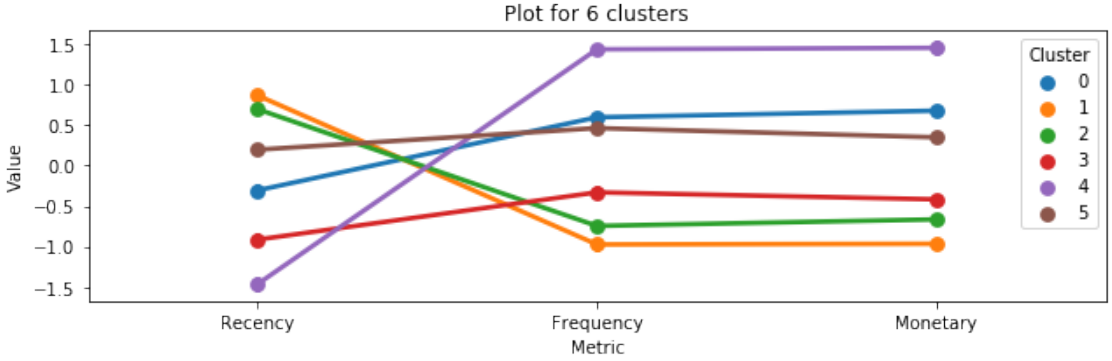



```
def wire_plot(rfm_scaled, df_rfm_kmeans, df_rfm_original):

    rfm_scaled = pd.DataFrame(rfm_scaled,
                                        index=RFM_table.index,
                                        columns=RFM_table.columns)
    rfm_scaled['Cluster'] = df_rfm_kmeans['Cluster']

    # Melt data into long format
    df_melt = pd.melt(rfm_scaled.reset_index(),
                        id_vars=['CustomerID', 'Cluster'],
                        value_vars=['Recency', 'Frequency',
'Monetary'],
                        var_name='Metric',
                        value_name='Value')

    plt.xlabel('Metric')
```

```
    plt.ylabel('Value')
    sns.pointplot(data=df_melt, x='Metric', y='Value', hue='Cluster')

    return

plt.figure(figsize=(9, 9))

plt.subplot(3, 1, 1)
plt.title('Plot for 4 clusters')
wire_plot(rfm_scaled, df_rfm_k4, RFM_table)

plt.subplot(3, 1, 2)
plt.title('Plot for 5 clusters')
wire_plot(rfm_scaled, df_rfm_k5, RFM_table)

plt.subplot(3, 1, 3)
plt.title('Plot for 6 clusters')
wire_plot(rfm_scaled, df_rfm_k6, RFM_table)

plt.tight_layout()
```








```
# clustering
kc = KMeans(n_clusters= 4, random_state=42)
kc.fit(rfm_scaled)

#Create a cluster label column in the original DataFrame
cluster_labels = kc.labels_

#Calculate average RFM values and size for each cluster:
df_rfm_k4 = df_rfm_log.assign(K_Cluster = cluster_labels)

#Calculate average RFM values and sizes for each cluster:
df_rfm_k4.groupby('K_Cluster').agg({'Recency': 'mean','Frequency':
'mean',
                                   'Monetary': ['mean',
'count'],}).round(0)
```

```
           Recency Frequency Monetary
              mean      mean     mean count
K_Cluster
0              4.0       3.0      6.0  1190
1              3.0       4.0      7.0  1195
2              5.0       3.0      5.0  1120
3              2.0       5.0      8.0   833
```

```
rfm_scaled =
pd.DataFrame(rfm_scaled,index=RFM_table.index,columns=RFM_table.column
s)
rfm_scaled['K_Cluster'] = kc.labels_
rfm_scaled['Segment'] = RFM_table_copy['Segment']
rfm_scaled['CustomerID'] = RFM_table_copy['CustomerID']
rfm_scaled.reset_index(inplace = True)

#Melt the data into a long format so RFM values and metric names are
stored in 1 column each
rfm_melt =
pd.melt(rfm_scaled,id_vars=['CustomerID','Segment','K_Cluster'],value_
vars=['Recency', 'Frequency', 'Monetary'],
var_name='Metric',value_name='Value')
rfm_melt.head()
```

```
   CustomerID   Segment  K_Cluster   Metric     Value
0     12347.0  Platinum          3  Recency -2.148608
1     12348.0    Bronze          0  Recency  0.383935
2     12349.0    Bronze          3  Recency -0.575496
3     12350.0    Bronze          0  Recency  1.375533
4     12352.0    Bronze          3  Recency -0.128933
```

```
f, (ax1, ax2) = plt.subplots(1,2, figsize=(15, 8))
sns.lineplot(x = 'Metric', y = 'Value', hue = 'Segment', data =
rfm_melt,ax=ax1)

# a snake plot with K-Means
sns.lineplot(x = 'Metric', y = 'Value', hue = 'K_Cluster', data =
rfm_melt,ax=ax2)

plt.suptitle("Plot of RFM Segments & Clusters",fontsize=24)
plt.show()
```

Plot of RFM Segments & Clusters