Import Dataset

```
#import the necessary libraries
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import numpy as np
import datetime as dt
import time
%matplotlib inline


pd.set_option('display.float_format', lambda x: '%.2f' % x)
pd.set_option('display.max_columns', None)
data = pd.read_csv('OnlineRetail.csv')
data.head()
```

	InvoiceNo	StockCode	Description	Quantity	InvoiceDate	UnitPrice	CustomerID	Country
0	536365	85123A	WHITE HANGING HEART T-LIGHT HOLDER	6	12/1/2010 8:26	2.55	17850.00	United Kingdom
1	536365	71053	WHITE METAL LANTERN	6	12/1/2010 8:26	3.39	17850.00	United Kingdom
2	536365	84406B	CREAM CUPID HEARTS COAT HANGER	8	12/1/2010 8:26	2.75	17850.00	United Kingdom
3	536365	84029G	KNITTED UNION FLAG HOT WATER BOTTLE	6	12/1/2010 8:26	3.39	17850.00	United Kingdom
4	536365	84029E	RED WOOLLY HOTTIE WHITE HEART.	6	12/1/2010 8:26	3.39	17850.00	United Kingdom

TO-DO: Data Preprocessing

```
# **TO-DO** Print the number of duplicate items
```

```
Duplicate Items in Dataset:5268
```

TO-DO: Remove Duplicate items from dataset

```
# **TO-DO** Remove duplicate items from the dataset
```

TO-DO: Check for missing values

```
# **TO-DO** Display count of missing values
```

```
Count of Missing values:InvoiceNo          0
StockCode           0
Description      1454
Quantity            0
InvoiceDate         0
UnitPrice           0
CustomerID     135037
Country             0
dtype: int64
```

TO-DO: Create new Invoice List

```
# **TO-DO** Creates a list of unique invoice No. with Null Customer ID


print("InvoiceLise: ", invoice_list[:10])
print("Invoice Size:", len(invoice_list))
```

```
InvoiceLise:  ['536414', '536544', '536544', '536544', '536544', '536544', '536544', '536544', '536544', '536544']
Invoice Size: 135037
```

TO-DO: Removing Inconsistent Records

```
# **TO-DO** Checking the number of records with Quantity Negative and Prices 0 or Vice versa


# **TO-DO** Checking if Negative quantities are cancelled items

# **TO-DO** Checking for Records with Negative Unit Price

# **TO-DO** Checking for Records with Unit Price 0
```

```
The number of records with Quantity Negative and Prices 0 or Vice versa :  1336
Cancelled Items have Invoice Starting with :  ['C']
The number of transactions with Negative Unit Price :  2
The number of transactions with Unit Price 0 :  40
```

```
# **TO-DO** Removing records with Null Customer ID



# Copy the dataset and convert CustomerID to int
rfm_train = data.copy()
rfm_train.CustomerID = (rfm_train.CustomerID).astype(int)


# **TO-DO** Count the number of missing values
```

```
Count of Missing values:InvoiceNo      0
StockCode      0
Description    0
Quantity       0
InvoiceDate    0
UnitPrice      0
CustomerID     0
Country        0
dtype: int64
```

Cancelled Items

```
## remove transactions with Cancelled Items.
placed = rfm_train[~rfm_train.InvoiceNo.str.contains('C',na=False)]


placed['TotalCost'] = rfm_train.Quantity * rfm_train.UnitPrice
```

```
<ipython-input-24-ee3f9bd42329>: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
  placed['TotalCost'] = rfm_train.Quantity * rfm_train.UnitPrice
```

```
placed.head()
```

	InvoiceNo	StockCode	Description	Quantity	InvoiceDate	UnitPrice	CustomerID	Country	TotalCost
0	536365	85123A	WHITE HANGING HEART T-LIGHT HOLDER	6	12/1/2010 8:26	2.55	17850	United Kingdom	15.30
1	536365	71053	WHITE METAL LANTERN	6	12/1/2010 8:26	3.39	17850	United Kingdom	20.34
2	536365	84406B	CREAM CUPID HEARTS COAT HANGER	8	12/1/2010 8:26	2.75	17850	United Kingdom	22.00
3	536365	84029G	KNITTED UNION FLAG HOT WATER BOTTLE	6	12/1/2010 8:26	3.39	17850	United Kingdom	20.34
4	536365	84029E	RED WOOLLY HOTTIE WHITE HEART.	6	12/1/2010 8:26	3.39	17850	United Kingdom	20.34

TO-DO: Exploratory Data Analysis

```
# **TO-DO** Find The Time Period of Transactions
```

```
Oldest date is:1/10/2011 10:32

Latest date is:9/9/2011 9:52
```

TO-DO: Order Density in Different Countries

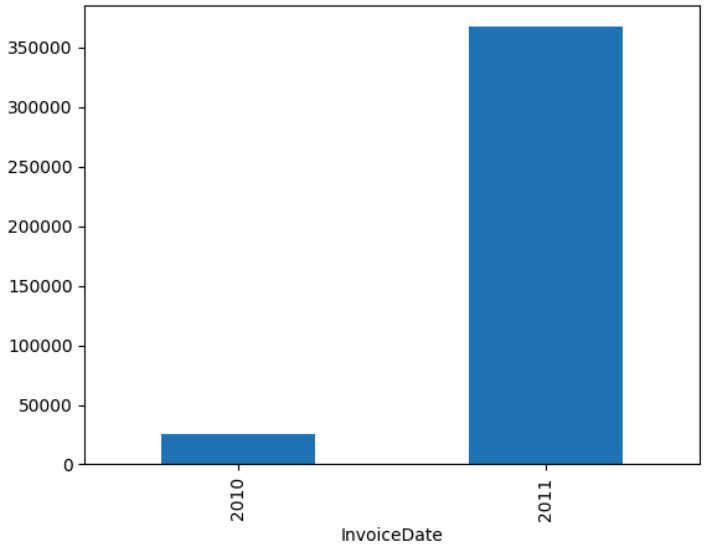
TO-DO Display the proportion of order based on country as below

Country	proportion
United Kingdom	88.9%
Germany	2.3%
France	2.1%
EIRE	1.8%
Spain	0.6%
Netherlands	0.6%
Belgium	0.5%
Switzerland	0.5%
Portugal	0.4%
Australia	0.3%
Norway	0.3%
Italy	0.2%

dtype: object

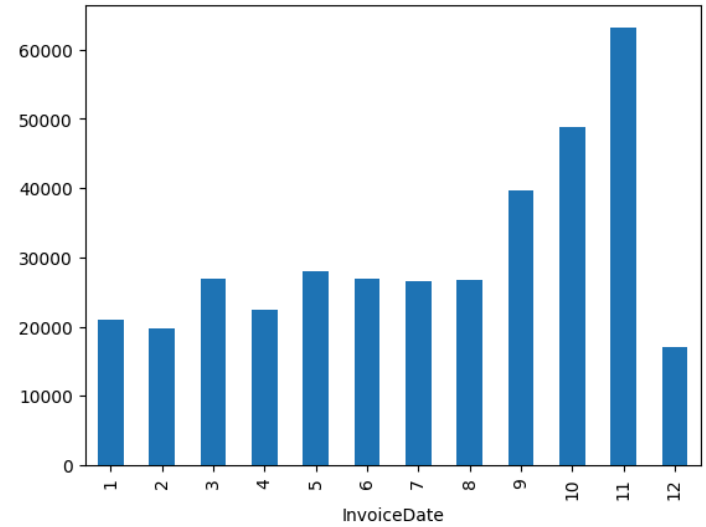
TO-DO Produce the following Bar Graph Below comparing the number invoices by year

```
<ipython-input-28-d377721275f0>: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
  placed['InvoiceDate'] = pd.to_datetime(placed['InvoiceDate'], errors='coerce')
<Axes: xlabel='InvoiceDate'>
```



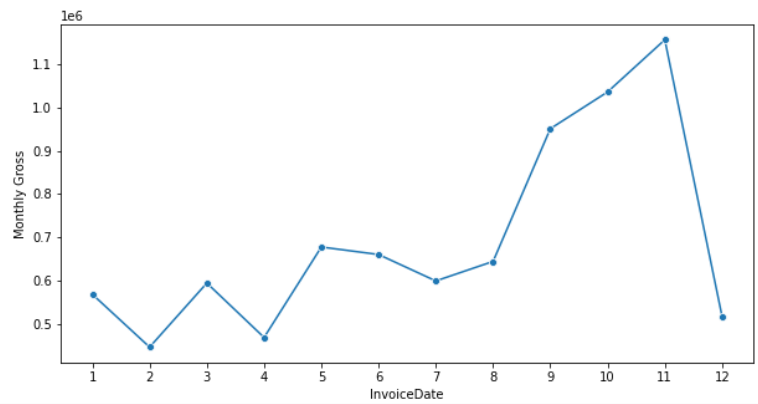
TO-DO Produce the following Bar Graph Below comparing the number invoices by month in 2011

```
<Axes: xlabel='InvoiceDate'>
```



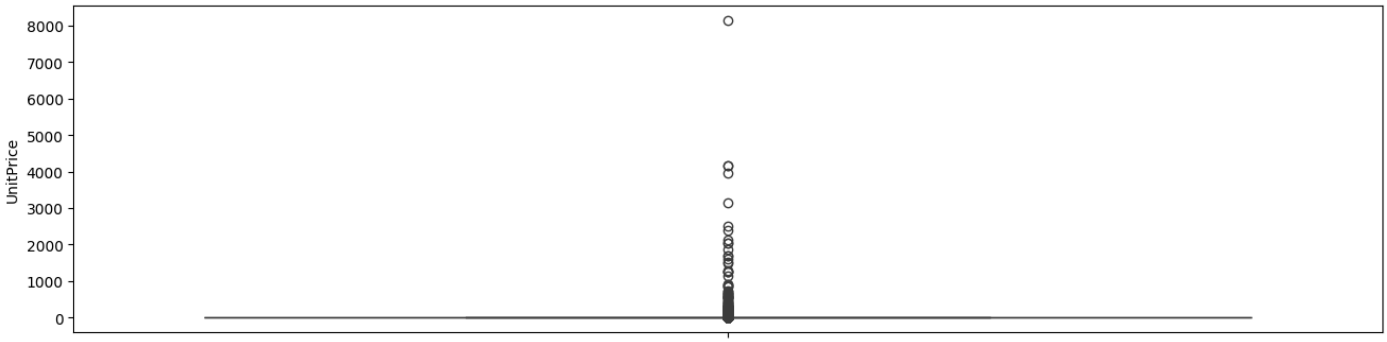
Monthly Gross

```
# **TO-DO** Produce the following Bar Graph Below comparing the monthly gross rate in 2011
```




```
plt.figure(figsize=(16,4))
sns.boxplot(y='UnitPrice',data = placed,orient=("Horizontal", "y"))
```

```
<Axes: ylabel='UnitPrice'>
```



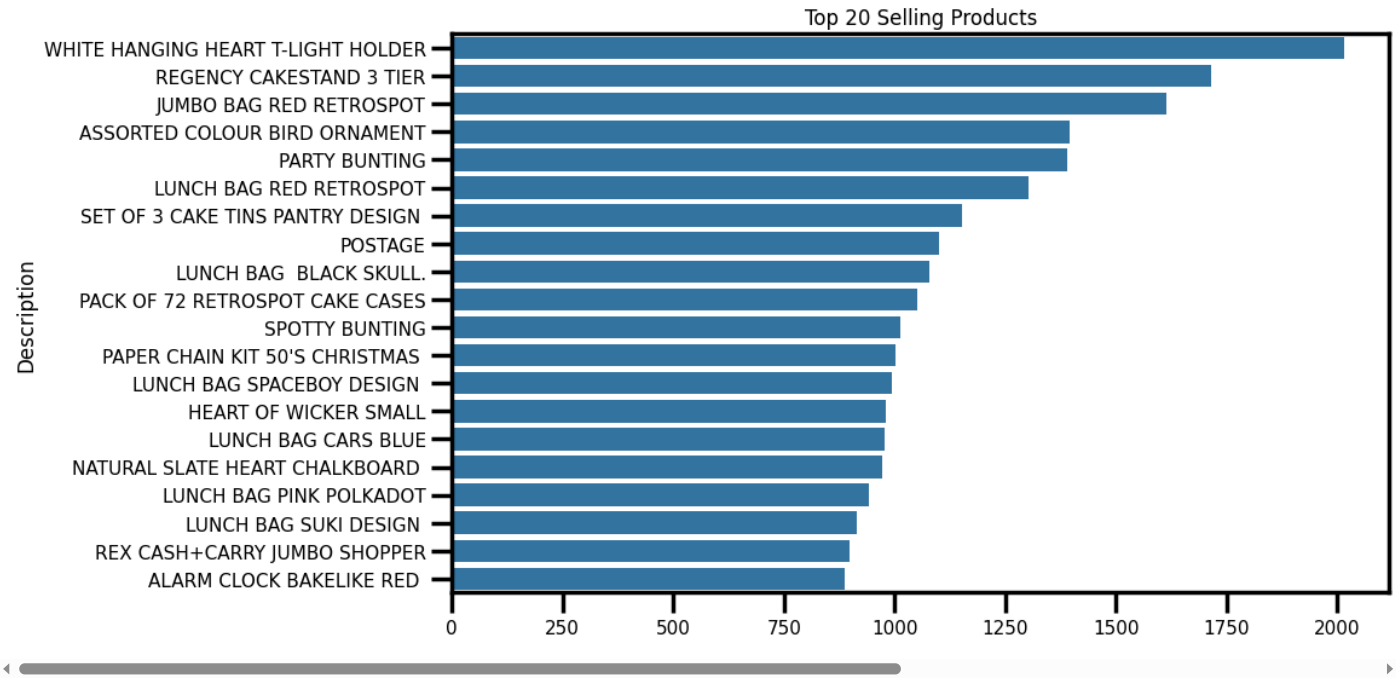
Unit Price is more concentrated in lower values of prices.

Top Selling Products

```
placed.head()
```

	InvoiceNo	StockCode	Description	Quantity	InvoiceDate	UnitPrice	CustomerID	Country	TotalCost
0	536365	85123A	WHITE HANGING HEART T-LIGHT HOLDER	6	2010-12-01 08:26:00	2.55	17850	United Kingdom	15.30
1	536365	71053	WHITE METAL LANTERN	6	2010-12-01 08:26:00	3.39	17850	United Kingdom	20.34
2	536365	84406B	CREAM CUPID HEARTS COAT HANGER	8	2010-12-01 08:26:00	2.75	17850	United Kingdom	22.00
3	536365	84029G	KNITTED UNION FLAG HOT WATER BOTTLE	6	2010-12-01 08:26:00	3.39	17850	United Kingdom	20.34
4	536365	84029E	RED WOOLLY HOTTIE WHITE HEART.	6	2010-12-01 08:26:00	3.39	17850	United Kingdom	20.34

```
# **TO-DO** Produce the following Graph displaying the top 20 selling products
```



TO-DO: Receny, Frequency, Montary (RFM) ANALYSIS

TO-DO: Recency

```
# **TO-DO** Print Lastest date in the Order History
```

```
9/9/2011 9:52
```

```
current_date = dt.date(2011,12,10)
```

```
rfm_train['InvoiceDate'] = pd.to_datetime(rfm_train['InvoiceDate'], errors='coerce')
rfm_train['Purchase_Date'] = rfm_train.InvoiceDate.dt.date
print(rfm_train['Purchase_Date'])
```

```
0         2010-12-01
1         2010-12-01
2         2010-12-01
3         2010-12-01
4         2010-12-01
             ...
541904    2011-12-09
541905    2011-12-09
541906    2011-12-09
541907    2011-12-09
541908    2011-12-09
Name: Purchase_Date, Length: 401604, dtype: object
```

TO-DO Create Seperate Column for Recency

```
recency = rfm_train.groupby('CustomerID')['Purchase_Date'].max().reset_index()
```

```
# **TO-DO** Calculate Recency based on purchase date and current date

# Display Recency
recency.head()
```

	CustomerID	Purchase_Date	Current_Date	Recency
0	12346	2011-01-18	2011-12-10	326
1	12347	2011-12-07	2011-12-10	3
2	12348	2011-09-25	2011-12-10	76
3	12349	2011-11-21	2011-12-10	19
4	12350	2011-02-02	2011-12-10	311

```
# **TO-DO** Drop Date Columns which are not useful anymore.

recency.head()
```

	CustomerID	Recency
0	12346	326
1	12347	3
2	12348	76
3	12349	19
4	12350	311

TO-DO Create Seperate Column for Frequency

```
# **TO-DO** Calculate Frequency based on Customer ID

frequency.head()
```

	CustomerID	Frequency
0	12346	2
1	12347	7
2	12348	4
3	12349	1
4	12350	1

TO-DO Create seperate Column for Monetary

```
# **TO-DO** Calculate Total Cost (Quantity * Price)

rfm_train.head()
```

	InvoiceNo	StockCode	Description	Quantity	InvoiceDate	UnitPrice	CustomerID	Country	Purchase_Date	TotalCost
0	536365	85123A	WHITE HANGING HEART T-LIGHT HOLDER	6	2010-12-01 08:26:00	2.55	17850	United Kingdom	2010-12-01	15.30
1	536365	71053	WHITE METAL LANTERN	6	2010-12-01 08:26:00	3.39	17850	United Kingdom	2010-12-01	20.34
2	536365	84406B	CREAM CUPID HEARTS COAT HANGER	8	2010-12-01 08:26:00	2.75	17850	United Kingdom	2010-12-01	22.00

```
# **TO-DO** Calculate Monetary based on total cost per Customer

monetary.head()
```

	CustomerID	Monetary
0	12346	0.00
1	12347	4310.00
2	12348	1797.24
3	12349	1757.55
4	12350	334.40

TO-DO: Combine Recency, Frequency and Monetary

```
# **TO-DO** Combine Recency, Frequency and Monetary into a single table

rfm_table.head()
```

CustomerID	Recency	Frequency	Monetary
12346	326	2	0.00
12347	3	7	4310.00
12348	76	4	1797.24
12349	19	1	1757.55
12350	311	1	334.40

TO-DO: QQ Plot

```
from scipy import stats
from scipy.stats import skew, norm, probplot, boxcox

def QQ_plot(data, measure):
    fig = plt.figure(figsize=(20,7))

    #Get the fitted parameters used by the function
    (mu, sigma) = norm.fit(data)

    #Kernel Density plot
    fig1 = fig.add_subplot(121)
    sns.distplot(data, fit=norm)
    fig1.set_title(measure + ' Distribution ( mu = {:.2f} and sigma = {:.2f} )'.format(mu, sigma), loc='center')
    fig1.set_xlabel(measure)
    fig1.set_ylabel('Frequency')

    #QQ plot
    fig2 = fig.add_subplot(122)
    res = probplot(data, plot=fig2)
    fig2.set_title(measure + ' Probability Plot (skewness: {:.6f} and kurtosis: {:.6f} )'.format(data.skew(), data.kurt()), loc='center')

    plt.tight_layout()
    plt.show()
```

A Quantile-Quantile (QQ) plot is a graphical tool to assess if a dataset follows a specified distribution, typically the normal distribution. It does this by plotting the quantiles of the dataset against the quantiles of the theoretical distribution. If the points roughly follow a straight line, the data is approximately normally distributed. Key Components of a QQ Plot

How to Interpret a QQ Plot

```
 Straight Line: If the points form a roughly straight line, the data follows the theoretical distribution.
 S-shaped Curve: If the points form an S-shape, the data may have heavier tails than the theoretical distribution.
 Convex/Concave Curve: Indicates a skewness in the data.


# **TO-DO** Generate the below Recency graphs using the QQ_plot function
```

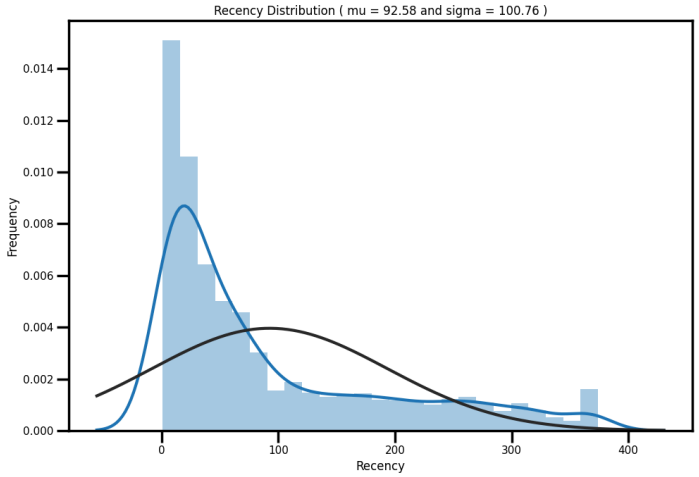
<ipython-input-52-1834c5c73f06>:12: UserWarning:

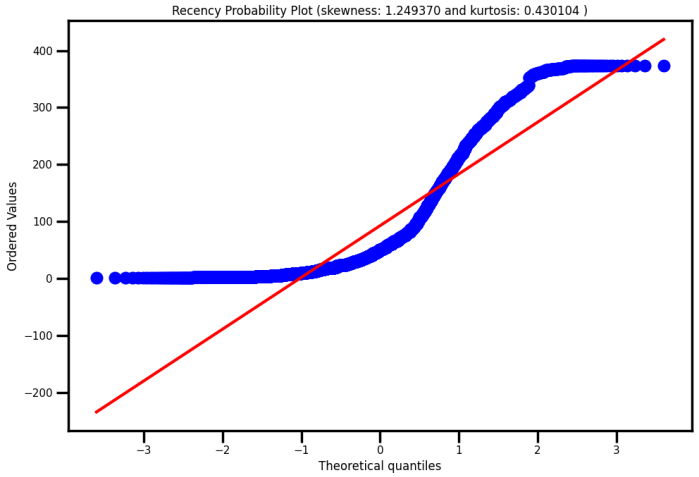
`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

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(data, fit=norm)
```





TO-DO Generate the below Frequency graphs using the QQ_plot function

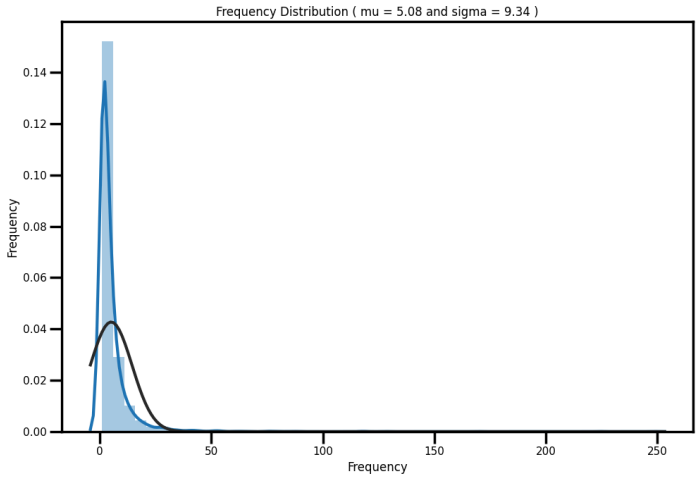
<ipython-input-52-1834c5c73f06>:12: UserWarning:

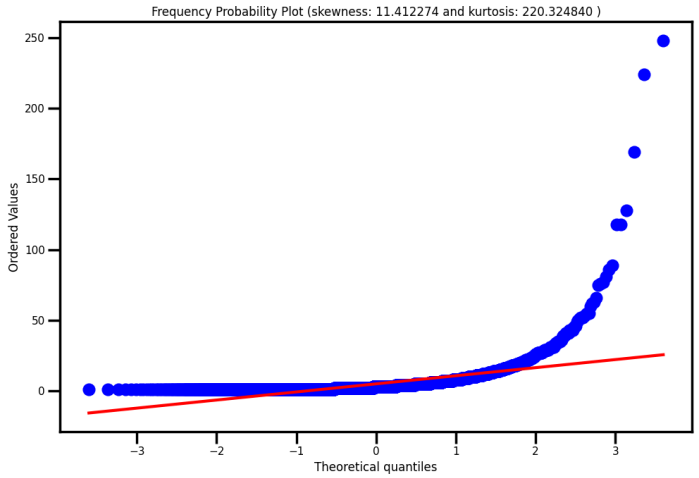
`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

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

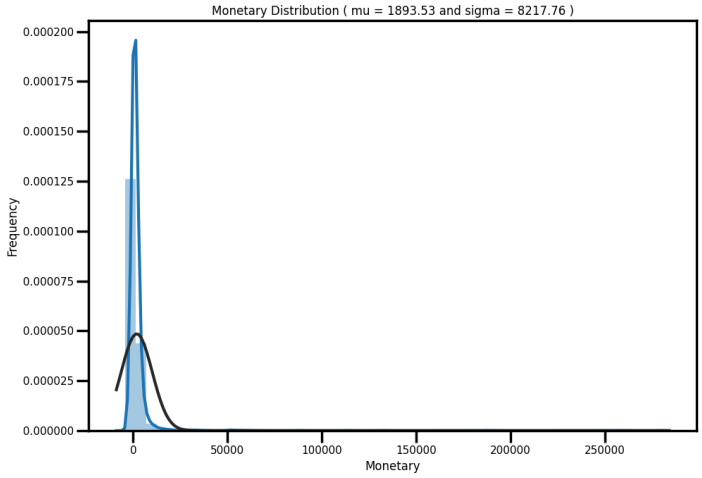
```
sns.distplot(data, fit=norm)
```

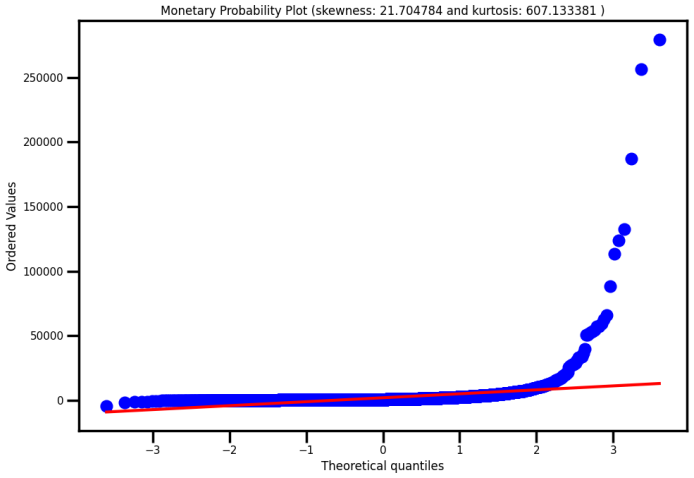




```
# **TO-DO** Generate the below Monetary graphs using the QQ_plot function
```

```
<ipython-input-52-1834c5c73f06>:12: 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(data, fit=norm)
```





Customer Segmentation Using Quantiles

```
# **TO-DO** Calcualte the quantils for recency, frenuency, and monetary

print(quantil)
```

```
       Recency  Frequency  Monetary
0.25    17.00       1.00    291.80
0.50    51.00       3.00    644.07
0.75   144.00       5.00   1608.34
```

Quantiles in General:

0.25 Quantile (25th Percentile): This is the value below which 25% of the data falls. It's also known as the first quartile.
0.50 Quantile (50th Percentile): This is the median, the middle value of the data. Half of the data lies below this value.
0.75 Quantile (75th Percentile): This is the value below which 75% of the data falls. It's also known as the third quartile.

```
# Convert quantil into dict to access each value
quantil = quantil.to_dict()
print(quantil)
```

```
{'Recency': {0.25: 17.0, 0.5: 51.0, 0.75: 144.0}, 'Frequency': {0.25: 1.0, 0.5: 3.0, 0.75: 5.0}, 'Monetary': {0.25: 291.795, 0.5: 644.0699999999999
```

RecencyPoints Function: Assigns points to customers based on how recently they made their last purchase, giving higher scores (4) to more recent purchases.
Freq_MonetaryPoints Function: Assigns points to customers based on their purchase frequency and monetary value, giving higher scores to more frequent and higher spending customers.

```
 Application: These functions are applied to the DataFrame to segment customers into quartiles for each RFM
 metric, facilitating further analysis and customer segmentation.
```

By applying these functions, businesses can better understand customer behavior and tailor marketing strategies accordingly, targeting different customer segments based on their RFM scores.

```
# **TO-DO** Define the recency points function
# 0-25% = 4 / 25%-50% = 3 / 50%-75% = 2 / 75%-100% = 1
def RecencyPoints(y,rfm,q):

  pass

# **TO-DO** Define the recency points function
# 0-25% = 4 / 25%-50% = 3 / 50%-75% = 2 / 75%-100% = 1
def Freq_MonetaryPoints(y,rfm,q):

    pass


# Copy RFM Table
rfm_segment = rfm_table.copy()

# **TO-DO** Apply RecencyPoint and MonetaryPoints function to Calculate Recency_Quartile, Frequency_Quartile, Monetary_Quartile

rfm_segment.head()
```

CustomerID	Recency	Frequency	Monetary	Recency_Quartile	Frequency_Quartile	Monetary_Quartile
12346	326	2	0.00	1	2	1
12347	3	7	4310.00	4	4	4
12348	76	4	1797.24	2	3	4
12349	19	1	1757.55	3	1	4
12350	311	1	334.40	1	1	2

RFM Classification

```
rfm_segment['RFMPoints'] = rfm_segment.Recency_Quartile.map(str)+rfm_segment.Frequency_Quartile.map(str)+rfm_segment.Monetary_Quartile.map(str)
print(rfm_segment['RFMPoints'])
```

```
CustomerID
12346    121
12347    444
12348    234
12349    314
12350    112
        ...
18280    111
18281    111
18282    421
18283    444
18287    324
Name: RFMPoints, Length: 4372, dtype: object
```

```
customer_dict = {'Best Customers':'444','Loyal Customers':'344','Big Spender':'334','Almost Lost':'244','Lost Customers':'144','Recent Customers':'443'
dict_segment = dict(zip( customer_dict.values(),customer_dict.keys()))


# Segment Customers based on RFM Points
rfm_segment['Segment'] = rfm_segment.RFMPoints.map(lambda x:dict_segment.get(x))
rfm_segment.Segment.fillna('others',inplace = True)

rfm_segment.sample(10)
```

```
<ipython-input-68-30a41837cc65>:3: FutureWarning: A value is trying to be set on a copy of a DataFrame or Series through chained assignment using a
The behavior will change in pandas 3.0. This inplace method will never work because the intermediate object on which we are setting values always b

For example, when doing 'df[col].method(value, inplace=True)', try using 'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value)
```

```
rfm_segment.Segment.fillna('others',inplace = True)
```

CustomerID	Recency	Frequency	Monetary	Recency_Quartile	Frequency_Quartile	Monetary_Quartile	RFMPoints	Segment
17817	5	3	387.68	4	2	2	422	others
17629	6	9	1784.12	4	4	4	444	Best Customers
15539	8	1	538.46	4	1	2	412	others
17839	43	1	318.15	3	1	2	312	others
16131	52	6	3506.54	2	4	4	244	Almost Lost
12815	148	2	1063.46	1	2	3	123	others
15998	37	6	3074.42	3	4	4	344	Loyal Customers
15224	359	3	310.48	1	2	2	122	Lost Cheap Customers
14178	9	7	1600.26	4	4	3	443	Recent Customers
12826	3	8	1468.12	4	4	3	443	Recent Customers

```
# **TO-DO** Display Best Customers whose recency, frequency as well as monetary attributes are the highest.
```

CustomerID	Recency	Frequency	Monetary	Recency_Quartile	Frequency_Quartile	Monetary_Quartile	RFMPoints	Segment
14646	2	77	279489.02	4	4	4	444	Best Customers
18102	1	62	256438.49	4	4	4	444	Best Customers
17450	9	55	187322.17	4	4	4	444	Best Customers
14911	2	248	132458.73	4	4	4	444	Best Customers
14156	10	66	113214.59	4	4	4	444	Best Customers

```
# **TO-DO** Display Big Spenders
```

CustomerID	Recency	Frequency	Monetary	Recency_Quartile	Frequency_Quartile	Monetary_Quartile	RFMPoints	Segment
16126	30	4	6287.77	3	3	4	334	Big Spender
13316	38	5	5570.69	3	3	4	334	Big Spender
16303	26	4	5305.83	3	3	4	334	Big Spender
16258	46	5	5203.51	3	3	4	334	Big Spender
12432	43	5	5059.32	3	3	4	334	Big Spender

```
# **TO-DO** Display Almost Lost who's recency is very low
```

CustomerID	Recency	Frequency	Monetary	Recency_Quartile	Frequency_Quartile	Monetary_Quartile	RFMPoints	Segment
12939	65	8	11581.80	2	4	4	244	Almost Lost
12409	79	7	11056.93	2	4	4	244	Almost Lost
16180	101	10	10217.48	2	4	4	244	Almost Lost
12744	52	10	9120.39	2	4	4	244	Almost Lost
16745	87	18	7157.10	2	4	4	244	Almost Lost

```
# **TO-DO** DisplayLost customers that don't need attention whose recency, frequency as well as monetary values are low
```

CustomerID	Recency	Frequency	Monetary	Recency_Quartile	Frequency_Quartile	Monetary_Quartile	RFMPoints	Segment
14481	165	2	636.51	1	2	2	122	Lost Cheap Customers
15384	170	3	635.76	1	2	2	122	Lost Cheap Customers
14000	207	2	633.71	1	2	2	122	Lost Cheap Customers
15045	152	3	633.66	1	2	2	122	Lost Cheap Customers
14220	248	2	632.40	1	2	2	122	Lost Cheap Customers

TO-DO Display loyal customers whose purchase frequency is high

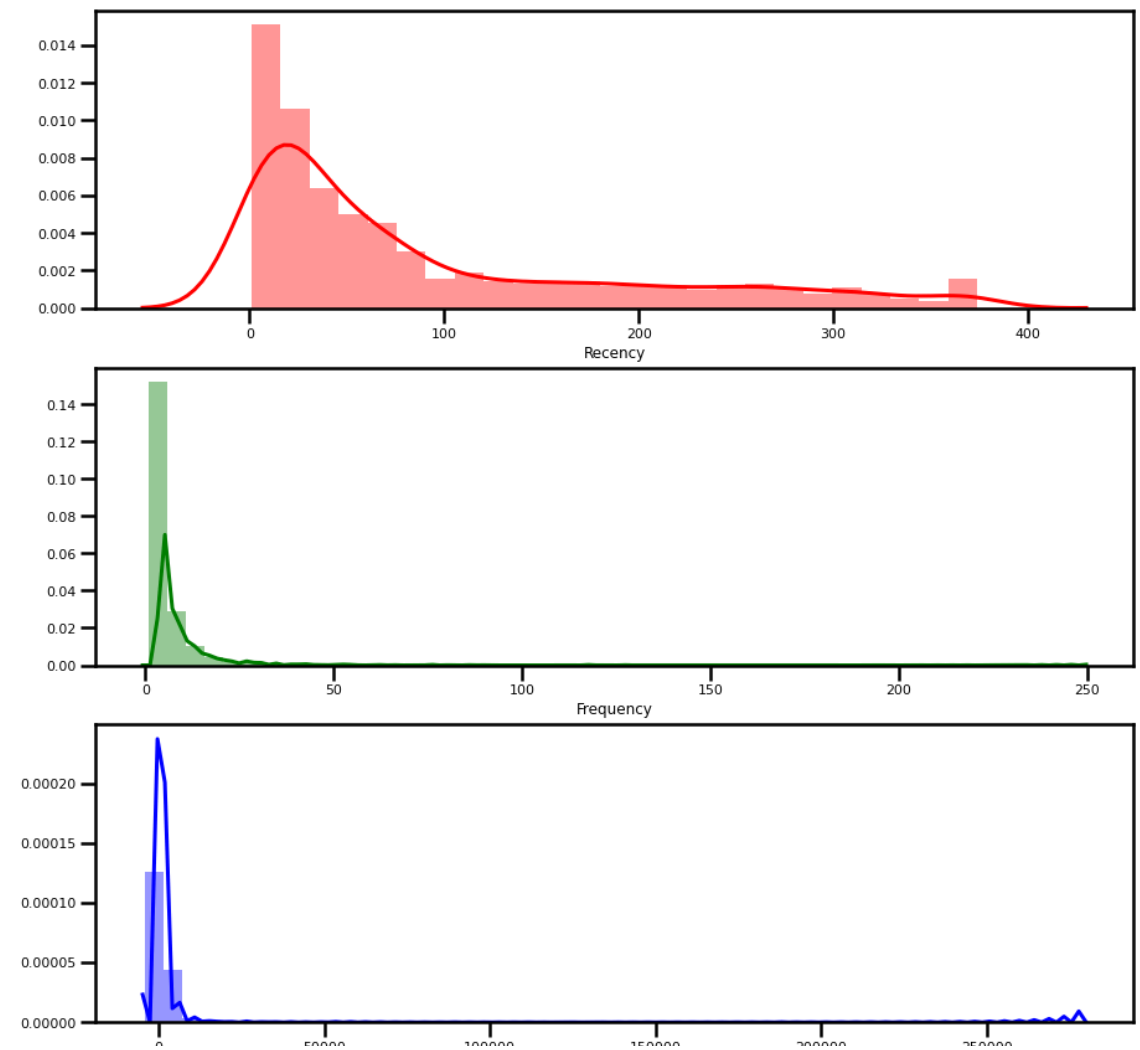
CustomerID	Recency	Frequency	Monetary	Recency_Quartile	Frequency_Quartile	Monetary_Quartile	RFMPoints	Segment
12415	25	26	123725.45	3	4	4	344	Loyal Customers
16029	39	76	53168.69	3	4	4	344	Loyal Customers
16422	18	75	33805.69	3	4	4	344	Loyal Customers
12931	22	20	33462.81	3	4	4	344	Loyal Customers
14680	26	23	26932.34	3	4	4	344	Loyal Customers

TO-DO Display customers that you must retain are those whose monetary and frequency was high but recency reduced quite a lot recently

CustomerID	Recency	Frequency	Monetary	Recency_Quartile	Frequency_Quartile	Monetary_Quartile	RFMPoints	Segment
12939	65	8	11581.80	2	4	4	244	Almost Lost
12409	79	7	11056.93	2	4	4	244	Almost Lost
16180	101	10	10217.48	2	4	4	244	Almost Lost
12744	52	10	9120.39	2	4	4	244	Almost Lost
16745	87	18	7157.10	2	4	4	244	Almost Lost

RFM Distribution Visualization

```
fig,axes = plt.subplots(3,1,figsize=(15,15))
sns.distplot(rfm_table.Recency,color='Red',axlabel='Recency',ax=axes[0])
sns.distplot(rfm_table.Frequency,color='Green',axlabel='Frequency',ax=axes[1])
sns.distplot(rfm_table.Monetary,color='Blue',axlabel='Monetary',ax=axes[2])
plt.show()
```




```
rfm_table.describe()
```

	Recency	Frequency	Monetary
count	4372.00	4372.00	4372.00
mean	92.58	5.08	1893.54
std	100.77	9.34	8218.70
min	1.00	1.00	-4287.63
25%	17.00	1.00	291.80
50%	51.00	3.00	644.07
75%	144.00	5.00	1608.34
max	374.00	248.00	279489.02

```
scaled_rfm = rfm_table.copy()
scaled_rfm.Monetary = rfm_table.Monetary + abs(rfm_table.Monetary.min())+1
scaled_rfm.Recency = rfm_table.Recency + abs(rfm_table.Recency.min())+1
scaled_rfm.describe()
```

```
        Recency  Frequency  Monetary
```

```
import numpy as np

from sklearn.preprocessing import StandardScaler

log_df = np.log(scaled_rfm)
scal = StandardScaler()
normal_ = scal.fit_transform(log_df)
normal_ = pd.DataFrame(data=normal_,index = rfm_table.index,columns=rfm_table.columns)

fig, axes = plt.subplots(3, 1, figsize=(15, 15))
sns.distplot(normal_.Recency , color="Red", ax=axes[0], axlabel='Recency')
sns.distplot(normal_.Frequency , color="Green", ax=axes[1], axlabel='Frequency')
sns.distplot(normal_.Monetary , color="Blue", ax=axes[2], axlabel='Monetary')
plt.show()
```