

▼ 1. Importing Libraries

```
# 'os' module provides functions for interacting with the operating system
import os

# 'Numpy' is used for mathematical operations on large, multi-dimensional arrays and matrices
import numpy as np

# 'Pandas' is used for data manipulation and analysis
import pandas as pd

# 'Matplotlib' is a data visualization library for 2D and 3D plots, built on numpy
from matplotlib import pyplot as plt
%matplotlib inline

# 'Seaborn' is based on matplotlib; used for plotting statistical graphics
import seaborn as sns

# to suppress warnings
import warnings
warnings.filterwarnings("ignore")
```

▼ 2. Importing and Exploration of the dataset

```
# loading the data and setting the unique client_id as the index::

df = pd.read_csv('loans.csv', index_col = 'client_id')

# # showing the first 5 rows of the dataset:
df.head()
```

	loan_type	loan_amount	repaid	loan_id	loan_start	loan_end	rate
client_id							
46109	home	13672	0	10243	2002-04-16	2003-12-20	2.15
46109	credit	9794	0	10984	2003-10-21	2005-07-17	1.25
46109	home	12734	1	10990	2006-02-01	2007-07-05	0.68
46109	cash	12518	1	10596	2010-12-08	2013-05-05	1.24
46109	credit	14049	1	11415	2010-07-07	2012-05-21	3.13

```
# To check the Dimensions of the dataset:
df.shape
```

(443, 7)

```
# Checking the info of the data:
df.info()

<class 'pandas.core.frame.DataFrame'>
Int64Index: 443 entries, 46109 to 26945
Data columns (total 7 columns):
 #   Column      Non-Null Count  Dtype  
--- 
 0   loan_type    443 non-null    object 
 1   loan_amount  443 non-null    int64  
 2   repaid       443 non-null    int64  
 3   loan_id      443 non-null    int64  
 4   loan_start   443 non-null    object 
 5   loan_end     443 non-null    object 
 6   rate         443 non-null    float64
dtypes: float64(1), int64(3), object(3)
memory usage: 27.7+ KB
```

▼ 3. Checking the datatypes of the columns

```
df.dtypes
```

	Dtype
loan_type	object
loan_amount	int64
repaid	int64
loan_id	int64

```
loan_start      object
loan_end        object
rate           float64
dtype: object
```

▼ 4. Converting the data types of columns

```
- loan_id to object
- repaid to category dtype
- loan_start and loan_end to date type
```

```
# loan_id:
df['loan_id'] = df['loan_id'].astype('object')

# repaid:
df['repaid'] = df['repaid'].astype('category')
```

```
# loan_start:
df['loan_start'] = pd.to_datetime(df['loan_start'], format = '%Y-%m-%d')

# loan_end:
df['loan_end'] = pd.to_datetime(df['loan_end'], format = '%Y-%m-%d')
```

▼ Checking the datatypes again:

```
df.dtypes

loan_type          object
loan_amount       int64
repaid            category
loan_id           object
loan_start        datetime64[ns]
loan_end          datetime64[ns]
rate              float64
dtype: object
```

▼ 5. Summary Statistics of the data

```
# Summary Statistics for Numerical data:
df.describe()
```

	loan_amount	rate
count	443.000000	443.000000
mean	7982.311512	3.217156
std	4172.891992	2.397168
min	559.000000	0.010000
25%	4232.500000	1.220000
50%	8320.000000	2.780000
75%	11739.000000	4.750000
max	14971.000000	12.620000

```
# Summary Statistics for Categorical data:
df.describe(exclude=[np.number])
```

	<code>loan_type</code>	<code>repaid</code>	<code>loan_id</code>	<code>loan_start</code>	<code>loan_end</code>
<code>count</code>	443	443.0	443.0	443	443
<code>unique</code>	4	2.0	443.0	430	428
<code>top</code>	home	1.0	10239.0	2006-01-19 00:00:00	2004-05-16 00:00:00
<code>freq</code>	121	237.0	1.0	2	2
<code>first</code>	NaN	NaN	NaN	2000-01-26 00:00:00	2001-08-02 00:00:00
<code>last</code>	NaN	NaN	NaN	2014-11-11 00:00:00	2017-05-07 00:00:00

▼ 6. Missing Values

```
# use isnull().sum() to check for missing values
df.isnull().sum()
```

```
loan_type      0
loan_amount    0
repaid        0
loan_id       0
loan_start    0
loan_end      0
rate          0
dtype: int64
```

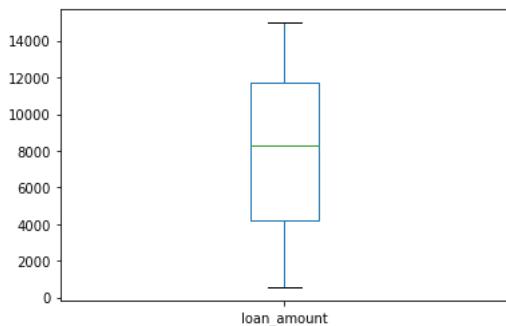
There are no missing values in the data.

Sk-learn library has an in-built function called Iterative Imputer to impute the missing values. Its sklearn documentation: <https://scikit-learn.org/stable/modules/generated/sklearn.impute.IterativeImputer.html>

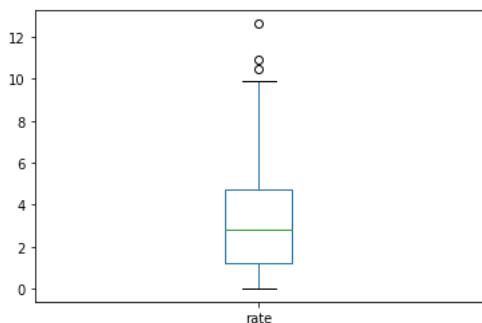
▼ 7. Outliers Treatment

To check for the presence of outliers, we plot Boxplot.

```
# For loan_amount
df['loan_amount'].plot(kind='box')
plt.show()
```



```
# For rate
df['rate'].plot(kind='box')
plt.show()
```



We can see that there are no outliers in the loan_amount column and some outliers are present in the rate column. To treat for outliers can either cap the values or transform the data. Shall demonstrate both the approaches here.

8. Transformation

8a. SQRT transformation

```
df['SQRT_RATE'] = df['rate']**0.5
```

```
df['sqrt_rate'] = np.sqrt(df['rate'])
```

```
df.head()
```

	loan_type	loan_amount	repaid	loan_id	loan_start	loan_end	rate	SQRT_TB	sqrt_tb	SQRT_RATE	sqrt_ra
client_id											
46109	home	13672	0	10243	2002-04-16	2003-12-20	2.15	1.466288	1.466288	1.466288	1.466288
46109	credit	9794	0	10984	2003-10-21	2005-07-17	1.25	1.118034	1.118034	1.118034	1.118034
46109	home	12734	1	10990	2006-02-01	2007-07-05	0.68	0.824621	0.824621	0.824621	0.824621

```
#checking the skewness, kurtosis between the original and transformed data:
print("The skewness of the original data is {}".format(df.rate.skew()))
print('The skewness of the SQRT transformed data is {}'.format(df.SQRT_RATE.skew()))

print('')

print("The kurtosis of the original data is {}".format(df.rate.kurt()))
print("The kurtosis of the SQRT transformed data is {}".format(df.SQRT_RATE.kurt()))
```

The skewness of the original data is 0.884204614329943

The skewness of the SQRT transformed data is 0.04964154055528862

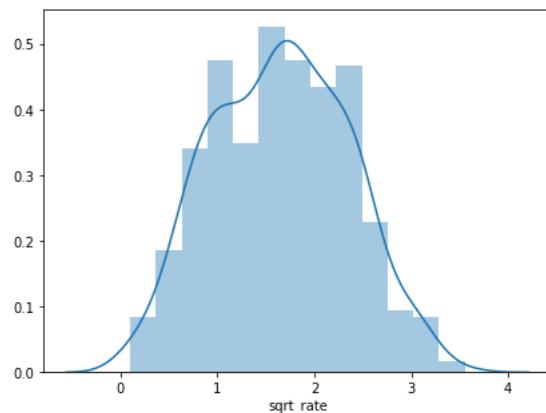
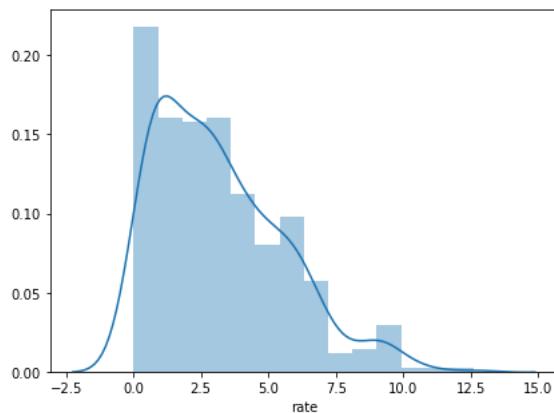
The kurtosis of the original data is 0.4243716514373652

The kurtosis of the SQRT transformed data is -0.6318437642052039

```
# plotting the distribution

fig, axes = plt.subplots(1,2, figsize=(15,5))
sns.distplot(df['rate'], ax=axes[0])
sns.distplot(df['sqrt_rate'], ax=axes[1])

plt.show()
```



Result:

The Rate column was right skewed earlier. The skewness and kurtosis has reduced significantly. The transformed SQRT rate, on the right graph resembles normal distribution now.

✓ 8b. Log Transformation

```
df['Log Rate'] = np.log(df['rate'])
```

```
df.head()
```

	loan_type	loan_amount	repaid	loan_id	loan_start	loan_end	rate	SQRT_RATE	sqrt_rate	Log Rate
client_id										
46109	home	13672	0	10243	2002-04-16	2003-12-20	2.15	1.466288	1.466288	0.765468
46109	credit	9794	0	10984	2003-10-21	2005-07-17	1.25	1.118034	1.118034	0.223144
46109	home	12734	1	10990	2006-02-01	2007-07-05	0.68	0.824621	0.824621	-0.385662
46109	cash	12518	1	10596	2010-12-08	2013-05-05	1.24	1.113553	1.113553	0.215111
46109	credit	14049	1	11415	2010-07-07	2012-05-21	3.13	1.769181	1.769181	1.141033

```
print("The skewness of the original data is {}".format(df.rate.skew()))
print('The skewness of the SQRT transformed data is {}'.format(df.SQRT_RATE.skew()))
print("The skewnss of the LOG transformed data is {}".format(df['Log Rate'].skew()))

print('')
```

```
print("The kurtosis of the original data is {}".format(df.rate.kurt()))
print("The kurtosis of the SQRT transformed data is {}".format(df.SQRT_RATE.kurt()))
print("The kurtosis of the LOG transformed data is {}".format(df['Log Rate'].kurt()))
```

```
The skewness of the original data is 0.884204614329943
The skewness of the SQRT transformed data is 0.04964154055528862
The skewnss of the LOG transformed data is -1.5943217626331552
```

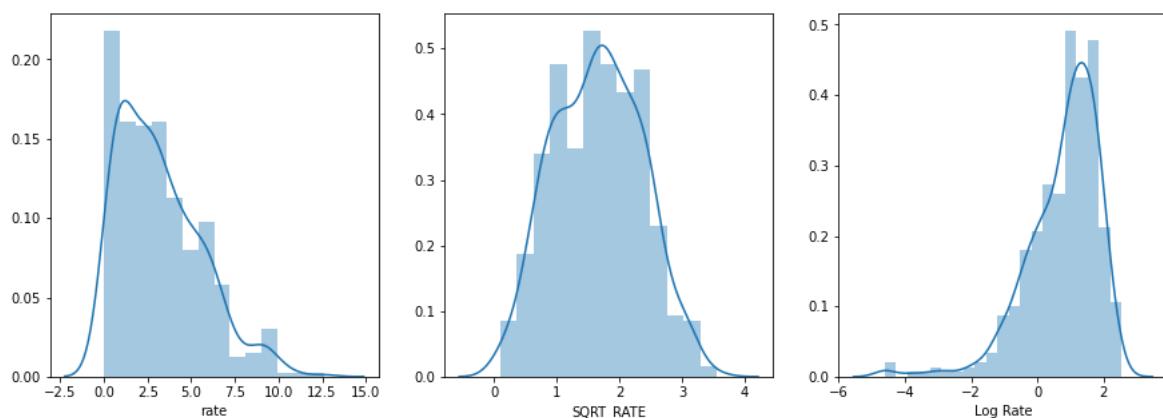
```
The kurtosis of the original data is 0.4243716514373652
The kurtosis of the SQRT transformed data is -0.6318437642052039
The kurtosis of the LOG transformed data is 4.157026150198228
```

```
# plot the graph:
```

```
fig, axes = plt.subplots(1,3,figsize=(15,5))

sns.distplot(df['rate'], ax=axes[0])
sns.distplot(df['SQRT RATE'], ax=axes[1])
sns.distplot(df['Log Rate'], ax=axes[2])

plt.show()
```



✓ Inference:

Log Transformation made the rate left skewed and more peaked.

However, Log transformation is more closer to 0 and hence is more normal. Though it heavily manipulates the data.

In our case, square root transformation is more suitable.

```
## Using Lambda function :

df['LOG_Rate'] = df['rate'].apply(lambda x:np.log(x))
```

```
df.head()
```

	loan_type	loan_amount	repaid	loan_id	loan_start	loan_end	rate	SQRT_RATE	sqrt_rate	Log Rate	LOG_
client_id											
46109	home	13672	0	10243	2002-04-16	2003-12-20	2.15	1.466288	1.466288	0.765468	0.76
46109	credit	9794	0	10984	2003-10-21	2005-07-17	1.25	1.118034	1.118034	0.223144	0.22
46109	home	12734	1	10990	2006-02-01	2007-07-05	0.68	0.824621	0.824621	-0.385662	-0.38

There are other transformations available also called BoxCox. There is an inbuilt function in Sci-kit Learn library called PowerTransformer for this which can also be called to transform the data. We'll see how it works below. Its sklearn documentation: https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.power_transform.html

▼ Outliers Treatment using Capping Approach

1) Z-Score approach to treat Outliers:

All the values above 3 standard deviation and below -3 standard deviation are outliers and can be removed

```
# loading the dataset and setting client id as index
df1 = pd.read_csv('loans.csv', index_col = 'client_id')
df1.head()
```

	loan_type	loan_amount	repaid	loan_id	loan_start	loan_end	rate
client_id							
46109	home	13672	0	10243	2002-04-16	2003-12-20	2.15
46109	credit	9794	0	10984	2003-10-21	2005-07-17	1.25
46109	home	12734	1	10990	2006-02-01	2007-07-05	0.68
46109	cash	12518	1	10596	2010-12-08	2013-05-05	1.24
46109	credit	14049	1	11415	2010-07-07	2012-05-21	3.13

```
# loan_id:
df1['loan_id'] = df1['loan_id'].astype('object')

# repaid:
df1['repaid'] = df1['repaid'].astype('category')
```

```
# loan_start:
df1['loan_start'] = pd.to_datetime(df1['loan_start'], format = '%Y-%m-%d')

# loan_end:
df1['loan_end'] = pd.to_datetime(df1['loan_end'], format = '%Y-%m-%d')
```

```
# 'SciPy' is used to perform scientific computations
import scipy.stats as stats
```

▼ Using SciPy Library to calculate the Z-Score:

```
# Creating new variable with Z-score of each record:
df1['ZR'] = stats.zscore(df1['rate'])
```

```
df1.head()
```

	loan_type	loan_amount	repaid	loan_id	loan_start	loan_end	rate	ZR
client_id								
46109	home	13672	0	10243	2002-04-16	2003-12-20	2.15	-0.445677
46109	credit	9794	0	10984	2003-10-21	2005-07-17	1.25	-0.821544
46109	home	12734	1	10990	2006-02-01	2007-07-05	0.68	-1.059594
46109	cash	12518	1	10596	2010-12-08	2013-05-05	1.24	-0.825721
46109	credit	14049	1	11415	2010-07-07	2012-05-21	3.13	-0.036399

```
# Combined Lower limit and Upper limit:
```

```
df1[(df1['ZR']<-3) | (df1['ZR']>3)]
```

	loan_type	loan_amount	repaid	loan_id	loan_start	loan_end	rate	ZR
client_id								
41480	credit	2947	1	10302	2005-11-10	2008-03-16	10.49	3.037362
48177	other	6318	0	10224	2003-02-02	2005-05-08	10.89	3.204415
49624	home	8133	1	10312	2009-03-14	2011-03-21	12.62	3.926916

```
# count of outliers:
```

```
df1[(df1['ZR']<-3) | (df1['ZR']>3)].shape[0]
```

```
3
```

```
### Cleaned Data: without outliers so z>-3 and z< +3
```

```
df2= df1[(df1['ZR']>-3) & (df1['ZR']<3)].reset_index()
df2.head()
```

	client_id	loan_type	loan_amount	repaid	loan_id	loan_start	loan_end	rate	ZR
0	46109	home	13672	0	10243	2002-04-16	2003-12-20	2.15	-0.445677
1	46109	credit	9794	0	10984	2003-10-21	2005-07-17	1.25	-0.821544
2	46109	home	12734	1	10990	2006-02-01	2007-07-05	0.68	-1.059594
3	46109	cash	12518	1	10596	2010-12-08	2013-05-05	1.24	-0.825721
4	46109	credit	14049	1	11415	2010-07-07	2012-05-21	3.13	-0.036399

```
df1.shape
```

```
(443, 8)
```

```
df2.shape
```

```
(440, 9)
```

▼ Interpretation:

A crude way to know whether the outliers have been removed or not is to check the dimensions of the data. From the above output, we can see that the dimensions are reduced that implies outliers are removed.

```
df3 = df2.copy()
```

```
df3.drop(columns = ['ZR'], inplace=True)
df3.head()
```

	client_id	loan_type	loan_amount	repaid	loan_id	loan_start	loan_end	rate
0	46109	home	13672	0	10243	2002-04-16	2003-12-20	2.15
1	46109	credit	9794	0	10984	2003-10-21	2005-07-17	1.25
2	46109	home	12734	1	10990	2006-02-01	2007-07-05	0.68
3	46109	cash	12518	1	10596	2010-12-08	2013-05-05	1.24
4	46109	credit	14049	1	11415	2010-07-07	2012-05-21	3.13

✓ 2) IQR Method to treat Outliers:

All the values below $Q1 - 1.5 \cdot IQR$ and values above $Q3 + 1.5 \cdot IQR$ are outliers and can be removed.

```
# finding the Quantiles:
Q1 = df3.rate.quantile(0.25)
Q2 = df3.rate.quantile(0.50)
Q3 = df3.rate.quantile(0.75)

# IQR : Inter-Quartile Range
IQR = Q3 - Q1

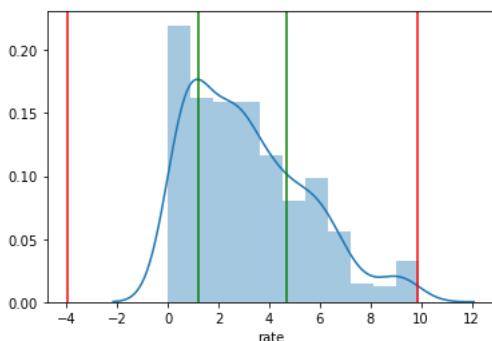
# Lower Limit:
LC = Q1 - (1.5*IQR)

# Upper Limit:
UC = Q3 + (1.5*IQR)

display(LC)
display(UC)
```

-3.976249999999999
9.87375

```
## Plot
sns.distplot(df3.rate)
plt.axvline(UC, color='r')
plt.axvline(LC, color='r')
plt.axvline(Q1, color='g')
plt.axvline(Q3, color='g')
plt.show()
```



```
# Find count of Outliers wrt IQR
df3[(df3.rate<LC) | (df3.rate>UC)].reset_index(drop=True)
```

	client_id	loan_type	loan_amount	repaid	loan_id	loan_start	loan_end	rate
0	39505	cash	11647	1	11928	2003-07-28	2005-12-24	9.91

```
df3[(df3.rate<LC) | (df3.rate>UC)].shape[0]
```

1

```
## Store the clean data wrt IQR:
```

```
df4 = df3[(df3.rate>LC) & (df3.rate<UC)]
df4.head()
```

	client_id	loan_type	loan_amount	repaid	loan_id	loan_start	loan_end	rate
0	46109	home	13672	0	10243	2002-04-16	2003-12-20	2.15
1	46109	credit	9794	0	10984	2003-10-21	2005-07-17	1.25
2	46109	home	12734	1	10990	2006-02-01	2007-07-05	0.68
3	46109	cash	12518	1	10596	2010-12-08	2013-05-05	1.24
4	46109	credit	14049	1	11415	2010-07-07	2012-05-21	3.13

df3.shape

(440, 8)

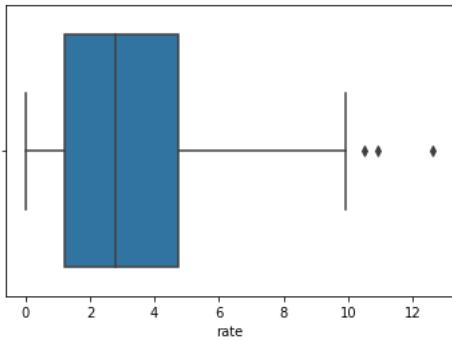
df4.shape

(439, 8)

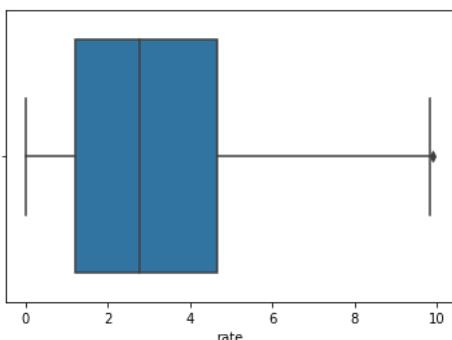
▼ Interpretation:

A crude way to know whether the outliers have been removed or not is to check the dimensions of the data. From the above output, we can see that the dimensions are reduced that implies outliers are removed.

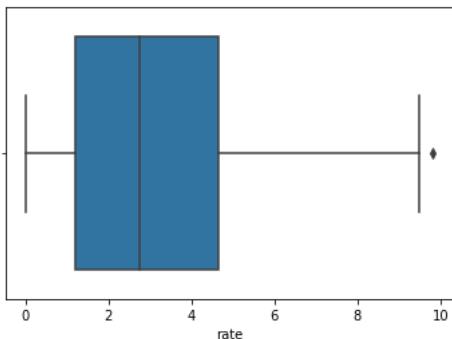
```
## Box Plot for rate--- based on IQR Method
sns.boxplot(df1.rate)
plt.show()
```



```
# Box Plot for rate --- based on Z-score cleaned data
sns.boxplot(df2.rate)
plt.show()
```



```
# Box Plot for rate --- based on IQR cleaned data
sns.boxplot(df4.rate)
plt.show()
```



9. Scaling the Numerical Features

There are two ways to scale the data:

1. Standardization (Z-Score)\
2. Normalization: Min Max Scalar

Both can be done manually as well as have in-built functions in sklearn. Will demonstrate both.

▼ 9a. Standardization (Z-Score)

Scales the data using the formula $(x - \text{mean})/\text{standard deviation}$

Manually:

```
# for Rate :
avg_rate = df3['rate'].mean()
avg_rate
```

```
3.161818181818183
```

```
std_rate = df3['rate'].std()
std_rate
```

```
2.307947418822915
```

```
# Step 1 : transform using Z-score
df3['Z_Score_Rate'] = (df3['rate'] - avg_rate)/std_rate
```

```
df3.head()
```

	client_id	loan_type	loan_amount	repaid	loan_id	loan_start	loan_end	rate	Z_Score_Rate
0	46109	home	13672	0	10243	2002-04-16	2003-12-20	2.15	-0.438406
1	46109	credit	9794	0	10984	2003-10-21	2005-07-17	1.25	-0.828363
2	46109	home	12734	1	10990	2006-02-01	2007-07-05	0.68	-1.075336
3	46109	cash	12518	1	10596	2010-12-08	2013-05-05	1.24	-0.832696
4	46109	credit	14049	1	11415	2010-07-07	2012-05-21	3.13	-0.013786

```
# checking if the skewness and kurtosis post scaling or not:
```

```
# For Rate:
```

```
print("The skewness for the original data is {}".format(df3.rate.skew()))
print("The kurtosis for the original data is {}".format(df3.rate.kurt()))
```

```
print('')
```

```
print("The skewness for the Zscore Scaled column is {}".format(df3.Z_Score_Rate.skew()))
print("The kurtosis for the Zscore Scaled columns is {}".format(df3.Z_Score_Rate.kurt()))
```

```
The skewness for the original data is 0.7594062707815686.
The kurtosis for the original data is -0.05964248048746912.
```

```
The skewness for the Zscore Scaled column is 0.7594062707815689.
The kurtosis for the Zscore Scaled columns is -0.05964248048746734.
```

```
# For Loan_amount:
avg_LA = df3['loan_amount'].mean()
avg_LA
```

```
7997.195454545455
```

```
std_LA = df3['loan_amount'].std()
std_LA
```

```
4179.435966237437
```

```
# Step 1 : transform using Z-score
df3['Z_Score_LA'] = (df3['loan_amount'] - avg_LA)/std_LA
```

```
df3.head()
```

	client_id	loan_type	loan_amount	repaid	loan_id	loan_start	loan_end	rate	Z_Score_Rate	Z_Score_LA
0	46109	home	13672	0	10243	2002-04-16	2003-12-20	2.15	-0.438406	1.357792
1	46109	credit	9794	0	10984	2003-10-21	2005-07-17	1.25	-0.828363	0.429916
2	46109	home	12734	1	10990	2006-02-01	2007-07-05	0.68	-1.075336	1.133360
3	46109	cash	12518	1	10596	2010-12-08	2013-05-05	1.24	-0.832696	1.081678
4	46109	credit	14049	1	11415	2010-07-07	2012-05-21	3.13	-0.013786	1.447996

```
# checking if the skewness and kurtosis post scaling or not:
```

```
# For Loan_amount:
```

```
print("The skewness for the original data is {}".format(df3.loan_amount.skew()))
print("The kurtosis for the original data is {}".format(df3.loan_amount.kurt()))
```

```
print('')
```

```
print("The skewness for the Zscore Scaled column is {}".format(df3.Z_Score_LA.skew()))
print("The kurtosis for the Zscore Scaled columns is {}".format(df3.Z_Score_LA.kurt()))
```

```
The skewness for the original data is -0.04678765472024289.
```

```
The kurtosis for the original data is -1.2354309429278456.
```

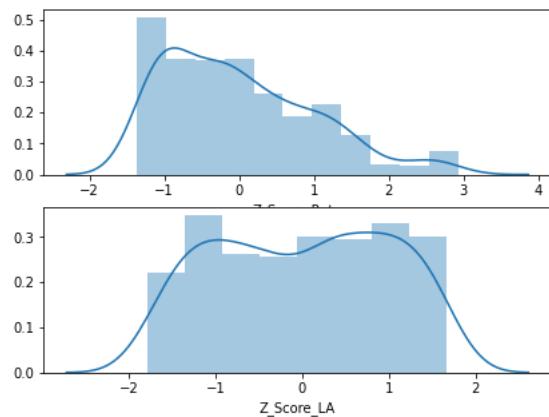
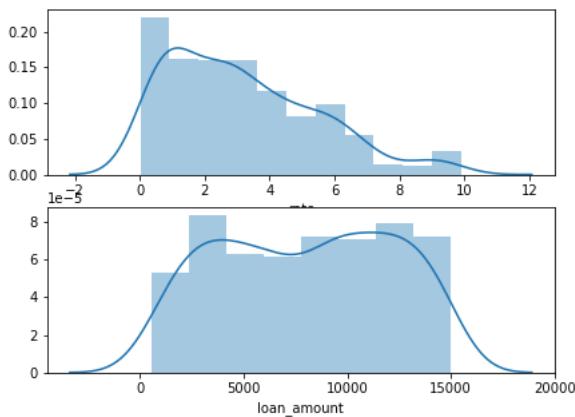
```
The skewness for the Zscore Scaled column is -0.04678765472024289.
The kurtosis for the Zscore Scaled columns is -1.2354309429278456.
```

```
# Distribution of the columns
```

```
fig, axes = plt.subplots(2,2, figsize=(15,5))

sns.distplot(df3['rate'], ax=axes[0,0])
sns.distplot(df3['Z_Score_Rate'], ax=axes[0,1])
sns.distplot(df3['loan_amount'], ax=axes[1,0])
sns.distplot(df3['Z_Score_LA'], ax=axes[1,1])
```

```
plt.show()
```



The only difference between the two curves is of the Range on the x-axis. The impact of scaling on data is: Skewness, Kurtosis and Distribution all remain same.

The need for Scaling is :

1. Comparison between variables is easier\
2. Computation power is more efficient and less time consuming.

✓ By SkLearn:

Documentation for Standard Scaler: <https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html>

```
# Loans data:
```

```
df4 = df3.copy()
df4.drop(columns = ['Z_Score_Rate'], inplace=True)
df4.head()
```

	client_id	loan_type	loan_amount	repaid	loan_id	loan_start	loan_end	rate
0	46109	home	13672	0	10243	2002-04-16	2003-12-20	2.15
1	46109	credit	9794	0	10984	2003-10-21	2005-07-17	1.25
2	46109	home	12734	1	10990	2006-02-01	2007-07-05	0.68
3	46109	cash	12518	1	10596	2010-12-08	2013-05-05	1.24
4	46109	credit	14049	1	11415	2010-07-07	2012-05-21	3.13

```
from sklearn.preprocessing import StandardScaler
```

```
df4_num = df[['loan_amount', 'rate']]
df4_num.head()
```

	loan_amount	rate
client_id		
46109	13672	2.15
46109	9794	1.25
46109	12734	0.68
46109	12518	1.24
46109	14049	3.13

```
SS = StandardScaler()
scaled_x = SS.fit_transform(df4_num)
```

Show hidden output

✓ 6b. Normalization: Min Max Scalar

Scales the data using the formula $(x - \min)/(max - \min)$

Manually:

```
# ForRate:
min_rate = df4.rate.min()
min_rate
```

```
max_rate = df4.rate.max()
max_rate
```

9.91

```
df4['Min_Max_R'] = (df4['rate'] - min_rate)/ (max_rate - min_rate)
```

```
# checking if the skewness and kurtosis post scaling or not:
```

```
# For Rate:
```

```
print("The skewness for the original data is {}.".format(df4.rate.skew()))
```

```
print("The skewness for the Zscore Scaled column is {}".format(df3.Z_Score_Rate.skew()))
print("The skewness for the Min Max Scaled Data is {}".format(df4.Min_Max_R.skew()))
```

```
print('')
```

```
print("The kurtosis for the original data is {}".format(df4.rate.kurt()))
print("The kurtosis for the Zscore Scaled columns is {}".format(df3.Z_Score_Rate.kurt()))
print("The kurtosis for the Min Max Scaled Data is {}".format(df4.Min_Max_R.kurt()))
```

```
The skewness for the original data is 0.7594062707815686.
The skewness for the Zscore Scaled column is 0.7594062707815689.
The skewness for the Min Max Scaled Data is 0.7594062707815686.
```

```
The kurtosis for the original data is -0.05964248048746912.
The kurtosis for the Zscore Scaled columns is -0.05964248048746734.
The kurtosis for the Min Max Scaled Data is -0.05964248048746823.
```

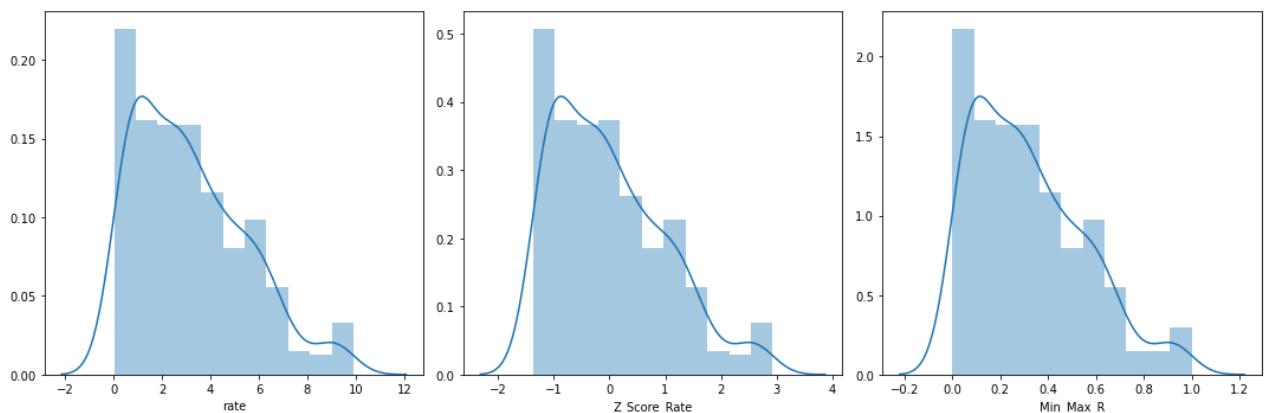
```
# Distribution of the columns
```

```
# For Rate
```

```
fig, axes = plt.subplots(1,3, figsize=(15,5))

sns.distplot(df3['rate'], ax=axes[0])
sns.distplot(df3['Z_Score_Rate'], ax=axes[1])
sns.distplot(df4['Min_Max_R'], ax=axes[2])

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



```
# For Loan_amount:
min_LA = df4.loan_amount.min()
min_LA
```

```
559
```

```
max_LA = df4.loan_amount.max()
max_LA
```

```
14971
```

```
df4['Min_Max_LA'] = (df4['loan_amount'] - min_LA)/ (max_LA - min_LA)
```

```
# checking if the skewness and kurtosis post scaling or not:
```

```
# For Rate:
```

```
print("The skewness for the original data is {}".format(df4.loan_amount.skew()))
print("The skewness for the Zscore Scaled column is {}".format(df3.Z_Score_LA.skew()))
print("The skewness for the Min Max Scaled Data is {}".format(df4.Min_Max_LA.skew()))
```

```
print('')
```

```
print("The kurtosis for the original data is {}".format(df4.loan_amount.kurt()))
print("The kurtosis for the Zscore Scaled columns is {}".format(df3.Z_Score_LA.kurt()))
print("The kurtosis for the Min Max Scaled Data is {}".format(df4.Min_Max_LA.kurt()))
```

```
The skewness for the original data is -0.04678765472024289.
```

```
The skewness for the Zscore Scaled column is -0.04678765472024289.
```

The skewness for the Min Max Scaled Data is -0.04678765472024256.

The kurtosis for the original data is -1.2354309429278456.
The kurtosis for the Zscore Scaled columns is -1.2354309429278456.
The kurtosis for the Min Max Scaled Data is -1.2354309429278452.

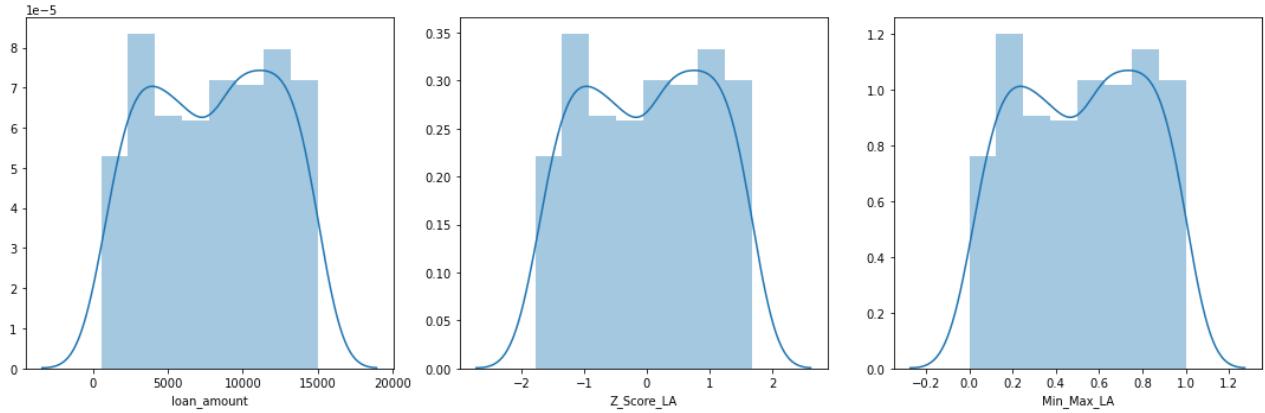
```
# Distribution of the columns

# For Loan_Amount

fig, axes = plt.subplots(1,3, figsize=(15,5))

sns.distplot(df3['loan_amount'], ax=axes[0])
sns.distplot(df3['Z_Score_LA'], ax=axes[1])
sns.distplot(df4['Min_Max_LA'], ax=axes[2])

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



▼ By Sklearn:

Documentation for Min Max Scaler: <https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.MinMaxScaler.html>

```
from sklearn.preprocessing import MinMaxScaler
```

```
MS = MinMaxScaler()

MinMaxScaled = MS.fit_transform(df4_num)
MinMaxScaled
```

Show hidden output

▼ Few things to keep in mind:

With Scaling all three - Skewness, Kurtosis and distribution remain same so there is no impact on outliers as well.

▼ 10. Encoding the Categorical Features

There are two ways to encode the categorical data into dummyvariables. Using:

1. pd.get_dummies\
2. sklearn's in-built function of OneHotEncoder and LabelEncoder

```
# Loans data:
```

```
df_loans = df3.copy()
```

```
df_loans.drop(columns = ['Z_Score_Rate'], inplace=True)
df_loans.drop(columns = ['Z_Score_LA'], inplace=True)
```

```
df_loans.head()
```

	client_id	loan_type	loan_amount	repaid	loan_id	loan_start	loan_end	rate
0	46109	home	13672	0	10243	2002-04-16	2003-12-20	2.15
1	46109	credit	9794	0	10984	2003-10-21	2005-07-17	1.25
2	46109	home	12734	1	10990	2006-02-01	2007-07-05	0.68
3	46109	cash	12518	1	10596	2010-12-08	2013-05-05	1.24
4	46109	credit	14049	1	11415	2010-07-07	2012-05-21	3.13

```
df_loans.dtypes
```

client_id		int64
loan_type		object
loan_amount		int64
repaid		category
loan_id		object
loan_start		datetime64[ns]
loan_end		datetime64[ns]
rate		float64
		dtype: object

```
# Repaid is also a categoriy columns and creating dummies for loan_type
df_loans.repaid.head()
```

0	0	
1	0	
2	1	
3	1	
4	1	
Name: repaid, dtype: category		
Categories (2, int64): [0, 1]		

▼ 1) pd.get_dummies approach:

```
dummy_cat = pd.get_dummies(df_loans['loan_type'], drop_first = True)
dummy_cat.head()

# drop_first = True drops the first column for each feature
```

	credit	home	other
0	0	1	0
1	1	0	0
2	0	1	0
3	0	0	0
4	1	0	0

▼ 2. OneHot Encoding

Documentation for this: <https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.OneHotEncoder.html>

```
from sklearn.preprocessing import OneHotEncoder

OE_tips = OneHotEncoder(drop ='first').fit(df_loans[['loan_type']])
OE_tips.categories_

[array(['cash', 'credit', 'home', 'other'], dtype=object)]
```

▼ 3. Label Encoding

Documentation for this: <https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.LabelEncoder.html>

```
from sklearn.preprocessing import LabelEncoder

LE = LabelEncoder()
LE_tips = LE.fit(df_loans[['loan_type']]

LE_tips.classes_
```

```
array(['cash', 'credit', 'home', 'other'], dtype=object)

# transform any new values to Dummy variables via Label Encoder
LE_tips.transform(['other', 'cash', 'home', 'credit'])

array([3, 0, 2, 1], dtype=int64)

# Inverse transform to get original values from the dummy variable
LE_tips.inverse_transform([1,2,3,0])

array(['credit', 'home', 'other', 'cash'], dtype=object)
```

▼ 11. Creating new Derived Features

We can use the loan_start and loan_end features to calculate the tenure of the loan.

```
import datetime as dt

df_loans['loan_tenure'] = df_loans['loan_end'] - df_loans['loan_start']

df_loans.head()
```

	client_id	loan_type	loan_amount	repaid	loan_id	loan_start	loan_end	rate	loan_tenure
0	46109	home	13672	0	10243	2002-04-16	2003-12-20	2.15	613 days
1	46109	credit	9794	0	10984	2003-10-21	2005-07-17	1.25	635 days
2	46109	home	12734	1	10990	2006-02-01	2007-07-05	0.68	519 days
3	46109	cash	12518	1	10596	2010-12-08	2013-05-05	1.24	879 days
4	46109	credit	14049	1	11415	2010-07-07	2012-05-21	3.13	684 days

```
df_loans.dtypes
```

```
client_id          int64
loan_type          object
loan_amount        int64
repaid             category
loan_id            object
loan_start         datetime64[ns]
loan_end           datetime64[ns]
rate               float64
loan_tenure        timedelta64[ns]
dtype: object
```

The number of days in the tenure are currently in TimeDelta, we want it integer hence will do the conversion as follows:

```
df_loans['loan_tenure'] = df_loans['loan_tenure'].dt.days  
df_loans['loan_tenure']  
  
0      613  
1      635  
2      519  
3      879  
4      684  
..  
435     928  
436     511  
437     948  
438     633  
439     638  
Name: loan_tenure, Length: 440, dtype: int64
```

Tenure in number of Years:

```
df_loans['loan_tenure'] = df_loans['loan_tenure']/365  
df_loans['loan tenure']
```

0	1.679452
1	1.739726
2	1.421918
3	2.408219
4	1.873973

```

435    2.542466
436    1.400000
437    2.597260
438    1.734247
439    1.747945
Name: loan_tenure, Length: 440, dtype: float64

```

▼ 12. Training and Testing data

Documentation for this: https://scikit-learn.org/stable/modules/generated/sklearn.model_selection.train_test_split.html

```
from sklearn.model_selection import train_test_split
```

```
## Splitting for X and Y variables:
```

```
Y = df_loans['loan_amount']
X = df_loans.drop('loan_amount', axis=1)
```

```
# Independent Variable
```

```
X.head()
```

	client_id	loan_type	repaid	loan_id	loan_start	loan_end	rate	loan_tenure
0	46109	home	0	10243	2002-04-16	2003-12-20	2.15	1.679452
1	46109	credit	0	10984	2003-10-21	2005-07-17	1.25	1.739726
2	46109	home	1	10990	2006-02-01	2007-07-05	0.68	1.421918
3	46109	cash	1	10596	2010-12-08	2013-05-05	1.24	2.408219
4	46109	credit	1	11415	2010-07-07	2012-05-21	3.13	1.873973

```
# Dependent or Target Variable
```

```
Y.head()
```

```

0    13672
1    9794
2    12734
3    12518
4    14049
Name: loan_amount, dtype: int64

```

```
## Splitting dataset into 80% Training and 20% Testing Data:
```

```
X_train, X_test, Y_train, Y_test = train_test_split(X,Y,train_size=0.8, random_state =0)

# random_state ---> is seed -- fixing the sample selection for Training & Testing dataset

# check the dimensions of the train & test subset for

print("The shape of X_train is:", X_train.shape)
print("The shape of X_test is:", X_test.shape)

print('')
print("The shape of Y_train is:", Y_train.shape)
print("The shape of Y_test is:", Y_test.shape)
```

```
The shape of X_train is: (352, 8)
The shape of X_test is: (88, 8)
```

```
The shape of Y_train is: (352,)
The shape of Y_test is: (88,)
```

To statistically test if the train and test representative of the overall data, would compute the Median for the independent variables for both the test and train sets.

```

# median for y_train
median_y_train = Y_train.median()

# median for y_test
median_y_test = Y_test.median()
```