DATA PROCESSING

1.DOWNLOAD THE DATASET

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

```
    The given dataset has been downloaded successfully
```

2.LOAD THE DATASET

```
import pandas as pd
data=pd.read_csv("/content/drive/MyDrive/Colab
Notebooks/Churn_Modelling.csv")
data.head()
```

```
   RowNumber  CustomerId   Surname  CreditScore Geography  Gender  Age
\
0          1    15634602  Hargrave          619    France  Female   42

1          2    15647311      Hill          608     Spain  Female   41

2          3    15619304      Onio          502    France  Female   42

3          4    15701354      Boni          699    France  Female   39

4          5    15737888  Mitchell          850     Spain  Female   43


   Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0       2       0.00              1          1               1
1       1   83807.86              1          0               1
2       8  159660.80              3          1               0
3       1       0.00              2          0               0
4       2  125510.82              1          1               1

   EstimatedSalary  Exited
0        101348.88       1
1        112542.58       0
2        113931.57       1
3         93826.63       0
4         79084.10       0
```

New Section

3 A)UNI VARIATE ANALYSIS

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns


data=pd.read_csv("/content/drive/MyDrive/Colab
Notebooks/Churn_Modelling.csv")
data.head()
```

```
   RowNumber  CustomerId   Surname  CreditScore Geography  Gender  Age
\
0          1    15634602  Hargrave          619    France  Female   42

1          2    15647311      Hill          608     Spain  Female   41

2          3    15619304      Onio          502    France  Female   42

3          4    15701354      Boni          699    France  Female   39

4          5    15737888  Mitchell          850     Spain  Female   43

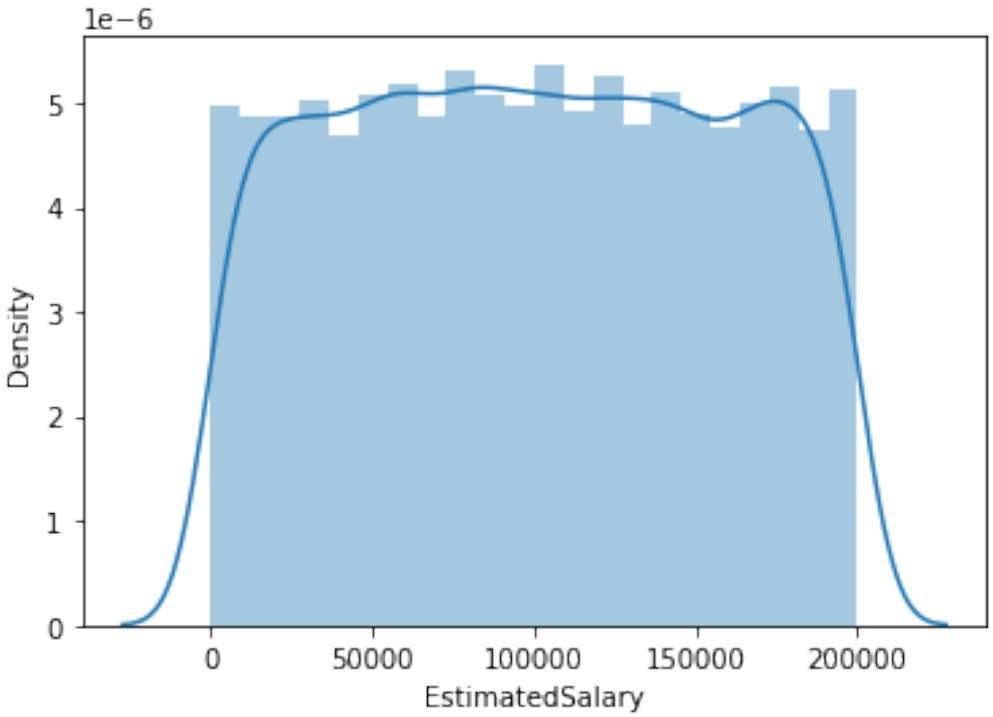

   Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0       2       0.00              1          1               1
1       1   83807.86              1          0               1
2       8  159660.80              3          1               0
3       1       0.00              2          0               0
4       2  125510.82              1          1               1

   EstimatedSalary  Exited
0        101348.88       1
1        112542.58       0
2        113931.57       1
3         93826.63       0
4         79084.10       0
```

```
sns.distplot(data['EstimatedSalary'])
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:2619:
FutureWarning: `distplot` is a deprecated function and will be removed
in a future version. Please adapt your code to use either `displot` (a
figure-level function with similar flexibility) or `histplot` (an
axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

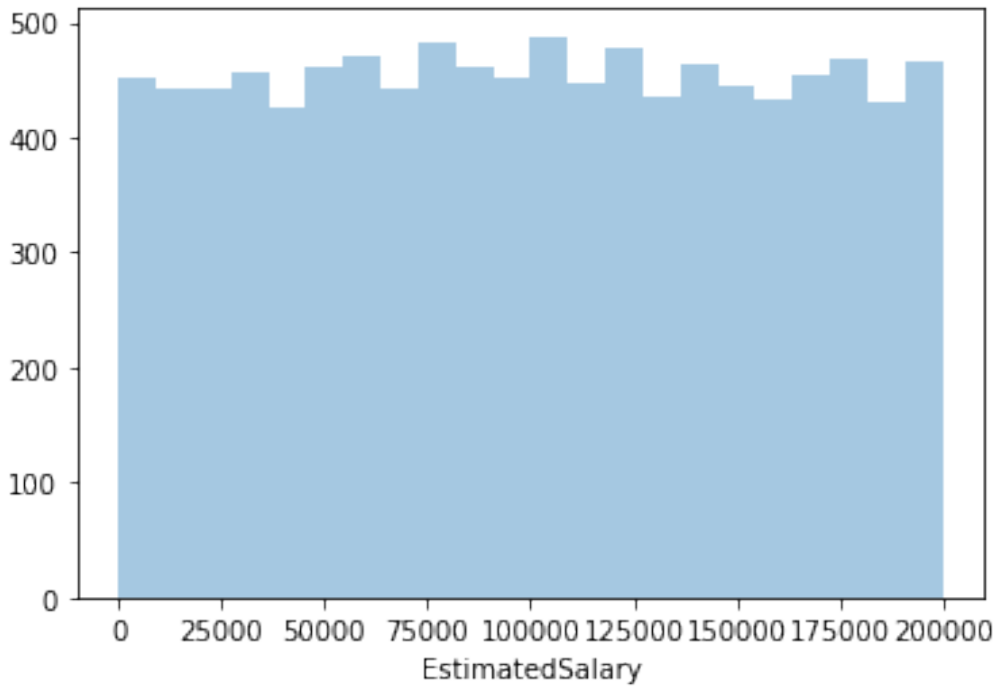
```
<matplotlib.axes._subplots.AxesSubplot at 0x7ff6bf6f60d0>
```




```
sns.distplot(data['EstimatedSalary'],kde=False)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/distributions.py:2619:
FutureWarning: `distplot` is a deprecated function and will be removed
in a future version. Please adapt your code to use either `displot` (a
figure-level function with similar flexibility) or `histplot` (an
axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

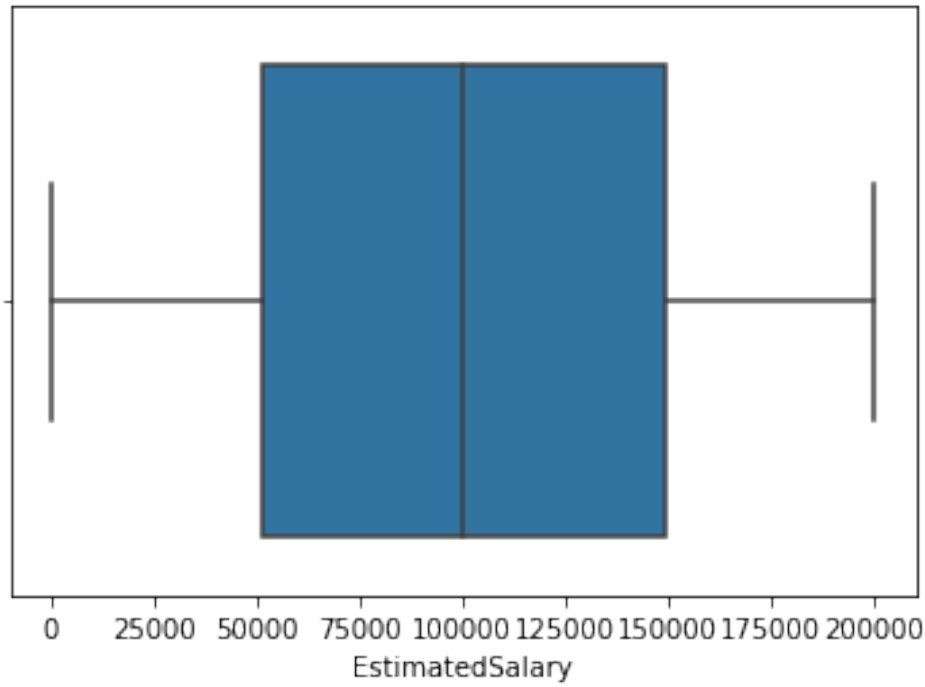
```
<matplotlib.axes._subplots.AxesSubplot at 0x7ff6bf5aac10>
```




```
sns.boxplot(data['EstimatedSalary']),
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43:
FutureWarning: Pass the following variable as a keyword arg: x. From
version 0.12, the only valid positional argument will be `data`, and
passing other arguments without an explicit keyword will result in an
error or misinterpretation.
  FutureWarning
```

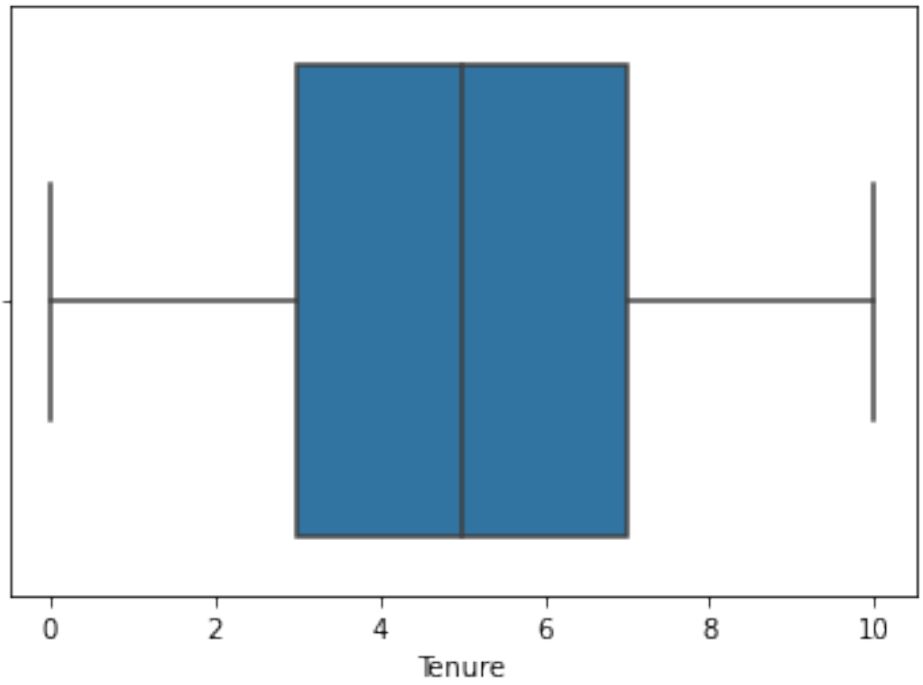
```
(<matplotlib.axes._subplots.AxesSubplot at 0x7ff6bf07ebd0>,)
```




```
sns.boxplot(data['Tenure']),
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43:
FutureWarning: Pass the following variable as a keyword arg: x. From
version 0.12, the only valid positional argument will be `data`, and
passing other arguments without an explicit keyword will result in an
error or misinterpretation.
  FutureWarning
```

```
(<matplotlib.axes._subplots.AxesSubplot at 0x7ff6bf00d690>,)
```



3 B)BI-VARIATE ANALYSIS

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import warnings
warnings.filterwarnings("ignore")

data=pd.read_csv("/content/drive/MyDrive/Colab
Notebooks/Churn_Modelling.csv")

data.head()
```

```
   RowNumber  CustomerId   Surname  CreditScore Geography  Gender  Age
\
0          1    15634602  Hargrave          619    France  Female   42

1          2    15647311      Hill          608     Spain  Female   41

2          3    15619304      Onio          502    France  Female   42

3          4    15701354      Boni          699    France  Female   39

4          5    15737888  Mitchell          850     Spain  Female   43

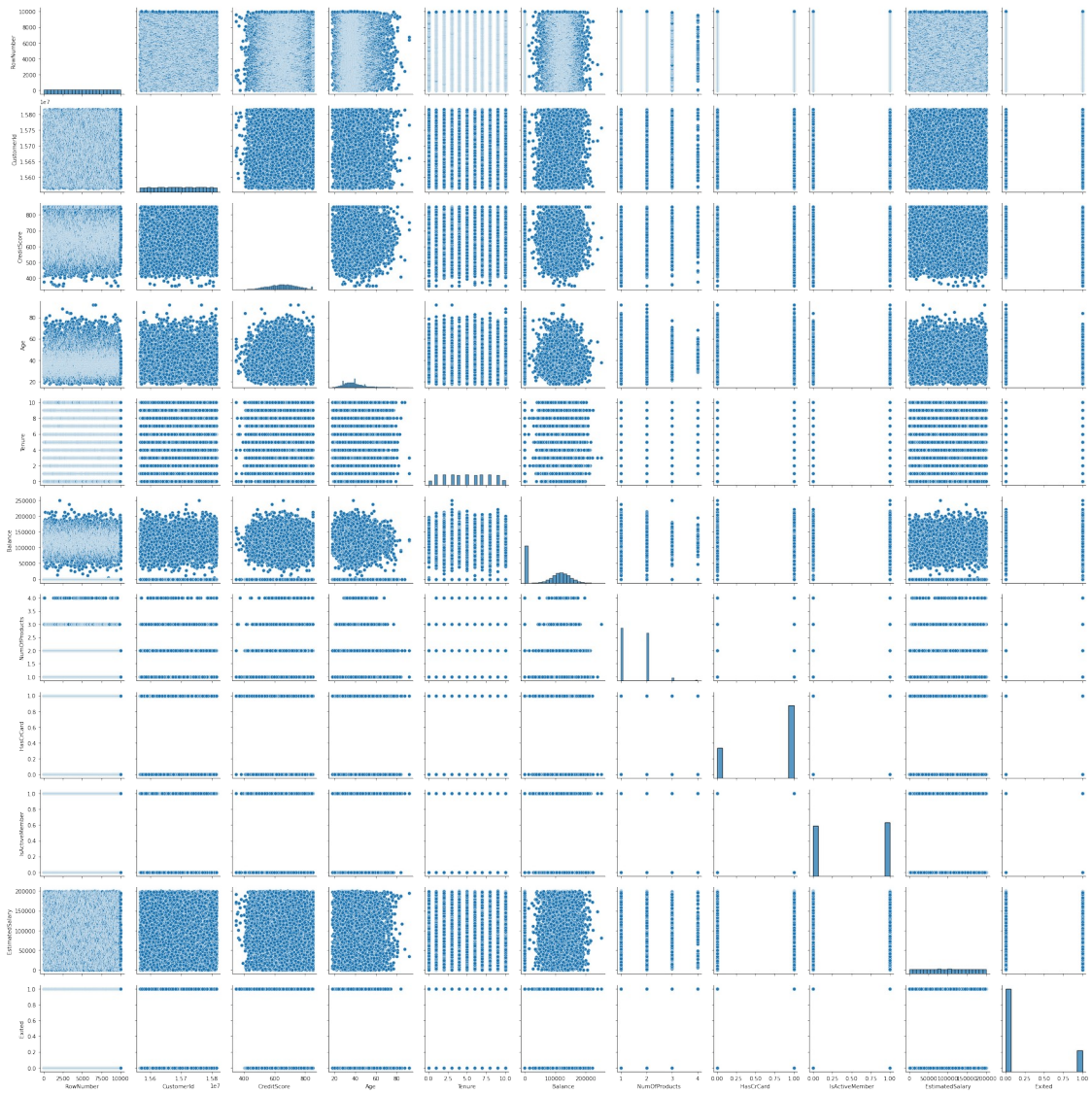

   Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0       2       0.00              1          1               1
```

```
1          1    83807.86              1           0                1
2          8   159660.80              3           1                0
3          1        0.00              2           0                0
4          2   125510.82              1           1                1

   EstimatedSalary  Exited
0        101348.88       1
1        112542.58       0
2        113931.57       1
3         93826.63       0
4         79084.10       0
```

```
sns.heatmap(data.corr(),annot=True)
plt.show()
```


```
sns.pairplot(data)
plt.show()
```



3 C)MULTI-VARIATE ANALYSIS

```
from pydoc import help
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import scale
from sklearn.decomposition import PCA
from sklearn.discriminant_analysis import LinearDiscriminantAnalysis
from scipy import stats
from IPython.display import display,HTML
%matplotlib inline
np.set_printoptions(suppress=True)
pd.set_option('display.max_rows',20)
import os
print(os.listdir("../NT project/"))
```

```
data=pd.read_csv("/content/drive/MyDrive/Colab
Notebooks/Churn_Modelling.csv")
data.head()
```

```
   RowNumber  CustomerId   Surname  CreditScore Geography  Gender  Age
\
0          1    15634602  Hargrave          619    France  Female   42

1          2    15647311      Hill          608     Spain  Female   41

2          3    15619304      Onio          502    France  Female   42

3          4    15701354      Boni          699    France  Female   39

4          5    15737888  Mitchell          850     Spain  Female   43


   Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0       2       0.00              1          1               1
1       1   83807.86              1          0               1
2       8  159660.80              3          1               0
3       1       0.00              2          0               0
4       2  125510.82              1          1               1

   EstimatedSalary  Exited
0        101348.88       1
1        112542.58       0
2        113931.57       1
3         93826.63       0
4         79084.10       0
```

```
data.columns
```

```
Index(['RowNumber', 'CustomerId', 'Surname', 'CreditScore',
'Geography',
       'Gender', 'Age', 'Tenure', 'Balance', 'NumOfProducts',
'HasCrCard',
       'IsActiveMember', 'EstimatedSalary', 'Exited'],
      dtype='object')
```

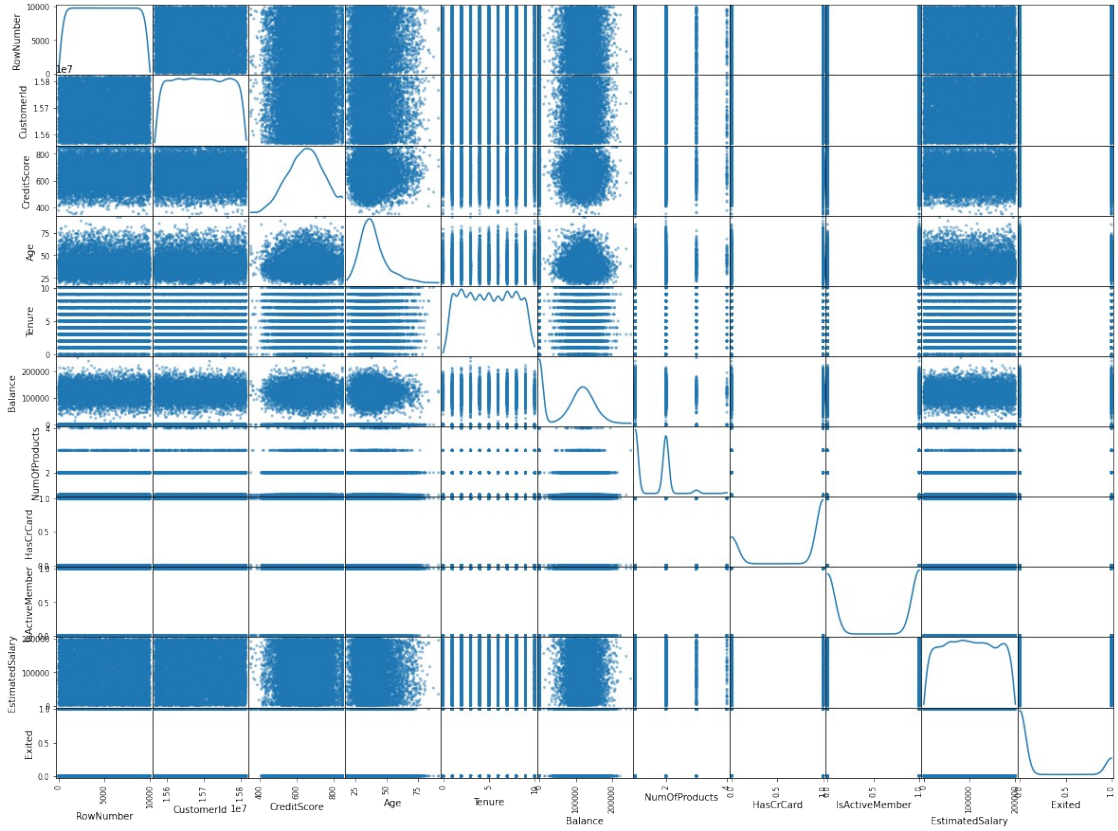
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 10000 entries, 0 to 9999
Data columns (total 14 columns):
 #   Column           Non-Null Count  Dtype
---  ------           --------------  -----
 0   RowNumber        10000 non-null  int64
 1   CustomerId       10000 non-null  int64
 2   Surname          10000 non-null  object
 3   CreditScore      10000 non-null  int64
```

```
 4   Geography         10000 non-null  object
 5   Gender            10000 non-null  object
 6   Age               10000 non-null  int64
 7   Tenure            10000 non-null  int64
 8   Balance           10000 non-null  float64
 9   NumOfProducts     10000 non-null  int64
 10  HasCrCard         10000 non-null  int64
 11  IsActiveMember    10000 non-null  int64
 12  EstimatedSalary   10000 non-null  float64
 13  Exited            10000 non-null  int64
dtypes: float64(2), int64(9), object(3)
memory usage: 1.1+ MB
```

MATRIX SCATTERPLOT

```
pd.plotting.scatter_matrix(data.loc[:,"RowNumber":"Exited"],diagonal="
kde",figsize=(20,15))
plt.show()
```



4.DESCRIPTIVE STATISTICS

```
import numpy as np
import pandas as pd
from pandas import Series,DataFrame
import scipy
from scipy import stats
```

```
data=pd.read_csv("/content/drive/MyDrive/Colab
Notebooks/Churn_Modelling.csv")
data.head()
```

```
   RowNumber  CustomerId   Surname  CreditScore Geography  Gender  Age
\
0          1    15634602  Hargrave          619    France  Female   42

1          2    15647311      Hill          608     Spain  Female   41

2          3    15619304      Onio          502    France  Female   42

3          4    15701354      Boni          699    France  Female   39

4          5    15737888  Mitchell          850     Spain  Female   43


   Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0       2       0.00              1          1               1
1       1   83807.86              1          0               1
2       8  159660.80              3          1               0
3       1       0.00              2          0               0
4       2  125510.82              1          1               1

   EstimatedSalary  Exited
0        101348.88       1
1        112542.58       0
2        113931.57       1
3         93826.63       0
4         79084.10       0
```

LOOKING AT SUMMARY STATISTICS THAT DESCRIBE A VARIABLE'S NUMERIC VALUES

```
data.sum()
```

```
RowNumber                                                   50005000
CustomerId                                                156909405694
Surname            HargraveHillOnioBoniMitchellChuBartlettObinnaH...
CreditScore                                                 6505288
Geography          FranceSpainFranceFranceSpainSpainFranceGermany...
Gender             FemaleFemaleFemaleFemaleFemaleMaleMaleFemaleMa...
Age                                                          389218
Tenure                                                        50128
Balance                                                764858892.88
NumOfProducts                                                 15302
HasCrCard                                                      7055
IsActiveMember                                                 5151
EstimatedSalary                                        1000902398.81
Exited                                                         2037
dtype: object
```

```
data.sum(axis=1)
```

```
0       15736618.88
1       15844315.44
2       15893456.37
3       15795925.63
4       15943385.92
           ...
9995    15713313.64
9996    15739522.38
9997    15637370.58
9998    15861138.83
9999    15807478.57
Length: 10000, dtype: float64
```

```
data.median()
```

```
RowNumber          5.000500e+03
CustomerId         1.569074e+07
CreditScore        6.520000e+02
Age                3.700000e+01
Tenure             5.000000e+00
Balance            9.719854e+04
NumOfProducts      1.000000e+00
HasCrCard          1.000000e+00
IsActiveMember     1.000000e+00
EstimatedSalary    1.001939e+05
Exited             0.000000e+00
dtype: float64
```

```
data.mean()
```

```
RowNumber          5.000500e+03
CustomerId         1.569094e+07
CreditScore        6.505288e+02
Age                3.892180e+01
Tenure             5.012800e+00
Balance            7.648589e+04
NumOfProducts      1.530200e+00
HasCrCard          7.055000e-01
IsActiveMember     5.151000e-01
EstimatedSalary    1.000902e+05
Exited             2.037000e-01
dtype: float64
```

```
data.max()
```

```
RowNumber              10000
CustomerId          15815690
Surname               Zuyeva
CreditScore              850
Geography              Spain
```

```
Gender                  Male
Age                       92
Tenure                    10
Balance            250898.09
NumOfProducts              4
HasCrCard                  1
IsActiveMember             1
EstimatedSalary    199992.48
Exited                     1
dtype: object
```

```
mpg=data.EstimatedSalary
mpg.idxmax()
```

```
6646
```

LOOKING AT SUMMARY STATISTICS THAT DESCRIBE VARIABLE DISTRIBUTION

```
data.std()
```

```
RowNumber           2886.895680
CustomerId         71936.186123
CreditScore           96.653299
Age                   10.487806
Tenure                 2.892174
Balance            62397.405202
NumOfProducts          0.581654
HasCrCard              0.455840
IsActiveMember         0.499797
EstimatedSalary    57510.492818
Exited                 0.402769
dtype: float64
```

```
data.var()
```

```
RowNumber          8.334167e+06
CustomerId         5.174815e+09
CreditScore        9.341860e+03
Age                1.099941e+02
Tenure             8.364673e+00
Balance            3.893436e+09
NumOfProducts      3.383218e-01
HasCrCard          2.077905e-01
IsActiveMember     2.497970e-01
EstimatedSalary    3.307457e+09
Exited             1.622225e-01
dtype: float64
```

```
num=data.NumOfProducts
num.value_counts()
```

```
1    5084
2    4590
3     266
4      60
Name: NumOfProducts, dtype: int64
```

```
data.describe()
```

```
         RowNumber    CustomerId   CreditScore           Age
Tenure  \
count  10000.00000  1.000000e+04  10000.000000  10000.000000
10000.000000
mean    5000.50000  1.569094e+07    650.528800     38.921800
5.012800
std     2886.89568  7.193619e+04     96.653299     10.487806
2.892174
min        1.00000  1.556570e+07    350.000000     18.000000
0.000000
25%     2500.75000  1.562853e+07    584.000000     32.000000
3.000000
50%     5000.50000  1.569074e+07    652.000000     37.000000
5.000000
75%     7500.25000  1.575323e+07    718.000000     44.000000
7.000000
max    10000.00000  1.581569e+07    850.000000     92.000000
10.000000

             Balance  NumOfProducts    HasCrCard  IsActiveMember  \
count   10000.000000   10000.000000  10000.00000    10000.000000
mean    76485.889288       1.530200      0.70550        0.515100
std     62397.405202       0.581654      0.45584        0.499797
min         0.000000       1.000000      0.00000        0.000000
25%         0.000000       1.000000      0.00000        0.000000
50%     97198.540000       1.000000      1.00000        1.000000
75%    127644.240000       2.000000      1.00000        1.000000
max    250898.090000       4.000000      1.00000        1.000000

       EstimatedSalary        Exited
count     10000.000000  10000.000000
mean     100090.239881      0.203700
std       57510.492818      0.402769
min          11.580000      0.000000
25%       51002.110000      0.000000
50%      100193.915000      0.000000
75%      149388.247500      0.000000
max      199992.480000      1.000000
```

5.HANDLE MISSING VALUE

```
import pandas as pd
```

```
data=pd.read_csv("/content/drive/MyDrive/Colab
Notebooks/Churn_Modelling.csv")
data.head()
```

```
   RowNumber  CustomerId   Surname  CreditScore Geography  Gender  Age
\
0          1    15634602  Hargrave          619    France  Female   42

1          2    15647311      Hill          608     Spain  Female   41

2          3    15619304      Onio          502    France  Female   42

3          4    15701354      Boni          699    France  Female   39

4          5    15737888  Mitchell          850     Spain  Female   43


   Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0       2       0.00              1          1               1
1       1   83807.86              1          0               1
2       8  159660.80              3          1               0
3       1       0.00              2          0               0
4       2  125510.82              1          1               1

   EstimatedSalary  Exited
0        101348.88       1
1        112542.58       0
2        113931.57       1
3         93826.63       0
4         79084.10       0
```

```
data.shape
```

```
(10000, 14)
```

```
data.isnull()
```

```
      RowNumber  CustomerId  Surname  CreditScore  Geography  Gender
Age  \
0         False       False    False        False      False   False
False
1         False       False    False        False      False   False
False
2         False       False    False        False      False   False
False
3         False       False    False        False      False   False
False
4         False       False    False        False      False   False
False
...         ...         ...      ...          ...        ...     ...
...
```

```
9995      False       False    False        False      False   False
False
9996      False       False    False        False      False   False
False
9997      False       False    False        False      False   False
False
9998      False       False    False        False      False   False
False
9999      False       False    False        False      False   False
False

      Tenure  Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0      False    False          False      False           False
1      False    False          False      False           False
2      False    False          False      False           False
3      False    False          False      False           False
4      False    False          False      False           False
...      ...      ...            ...        ...             ...
9995   False    False          False      False           False
9996   False    False          False      False           False
9997   False    False          False      False           False
9998   False    False          False      False           False
9999   False    False          False      False           False

      EstimatedSalary  Exited
0               False   False
1               False   False
2               False   False
3               False   False
4               False   False
...               ...     ...
9995            False   False
9996            False   False
9997            False   False
9998            False   False
9999            False   False

[10000 rows x 14 columns]

data.isnull().sum()

RowNumber          0
CustomerId         0
Surname            0
CreditScore        0
Geography          0
Gender             0
Age                0
Tenure             0
Balance            0
```

```
NumOfProducts      0
HasCrCard          0
IsActiveMember     0
EstimatedSalary    0
Exited             0
dtype: int64
```

```
data.isnull().sum().sum()
```

```
0
```

FILLING NULL VALUES

```
df=data.fillna(value=0)
df
```

```
      RowNumber  CustomerId    Surname  CreditScore Geography  Gender
Age  \
0             1    15634602   Hargrave          619    France  Female
42
1             2    15647311       Hill          608     Spain  Female
41
2             3    15619304       Onio          502    France  Female
42
3             4    15701354       Boni          699    France  Female
39
4             5    15737888   Mitchell          850     Spain  Female
43
...         ...         ...        ...          ...       ...     ...
...
9995       9996    15606229   Obijiaku          771    France    Male
39
9996       9997    15569892  Johnstone          516    France    Male
35
9997       9998    15584532        Liu          709    France  Female
36
9998       9999    15682355  Sabbatini          772   Germany    Male
42
9999      10000    15628319     Walker          792    France  Female
28

      Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0          2       0.00              1          1               1
1          1   83807.86              1          0               1
2          8  159660.80              3          1               0
3          1       0.00              2          0               0
4          2  125510.82              1          1               1
...      ...        ...            ...        ...             ...
9995       5       0.00              2          1               0
9996      10   57369.61              1          1               1
9997       7       0.00              1          0               1
```

```
9998       3   75075.31              2          1               0
9999       4  130142.79              1          1               0

      EstimatedSalary  Exited
0           101348.88       1
1           112542.58       0
2           113931.57       1
3            93826.63       0
4            79084.10       0
...               ...     ...
9995         96270.64       0
9996        101699.77       0
9997         42085.58       1
9998         92888.52       1
9999         38190.78       0

[10000 rows x 14 columns]
```

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

```
0
```

```
df1=data.fillna(value=5)
df1
```

```
      RowNumber  CustomerId    Surname  CreditScore Geography  Gender
Age  \
0             1    15634602   Hargrave          619    France  Female
42
1             2    15647311       Hill          608     Spain  Female
41
2             3    15619304       Onio          502    France  Female
42
3             4    15701354       Boni          699    France  Female
39
4             5    15737888   Mitchell          850     Spain  Female
43
...         ...         ...        ...          ...       ...     ...
...
9995       9996    15606229   Obijiaku          771    France    Male
39
9996       9997    15569892  Johnstone          516    France    Male
35
9997       9998    15584532        Liu          709    France  Female
36
9998       9999    15682355  Sabbatini          772   Germany    Male
42
9999      10000    15628319     Walker          792    France  Female
28

      Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
```

```
0          2       0.00              1          1               1
1          1   83807.86              1          0               1
2          8  159660.80              3          1               0
3          1       0.00              2          0               0
4          2  125510.82              1          1               1
...      ...        ...            ...        ...             ...
9995       5       0.00              2          1               0
9996      10   57369.61              1          1               1
9997       7       0.00              1          0               1
9998       3   75075.31              2          1               0
9999       4  130142.79              1          1               0

      EstimatedSalary  Exited
0           101348.88       1
1           112542.58       0
2           113931.57       1
3            93826.63       0
4            79084.10       0
...               ...     ...
9995         96270.64       0
9996        101699.77       0
9997         42085.58       1
9998         92888.52       1
9999         38190.78       0

[10000 rows x 14 columns]
```

FILLING NULL VALUES WITH A PREVIOUS VALUE

```
df2=data.fillna(method='pad')
df2
```

```
      RowNumber  CustomerId    Surname  CreditScore Geography  Gender
Age  \
0             1    15634602   Hargrave          619    France  Female
42
1             2    15647311       Hill          608     Spain  Female
41
2             3    15619304       Onio          502    France  Female
42
3             4    15701354       Boni          699    France  Female
39
4             5    15737888   Mitchell          850     Spain  Female
43
...         ...         ...        ...          ...       ...     ...
...
9995       9996    15606229   Obijiaku          771    France    Male
39
9996       9997    15569892  Johnstone          516    France    Male
35
9997       9998    15584532        Liu          709    France  Female
```

```
36
9998       9999    15682355  Sabbatini          772   Germany    Male
42
9999      10000    15628319     Walker          792    France  Female
28

      Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0          2       0.00              1          1               1
1          1   83807.86              1          0               1
2          8  159660.80              3          1               0
3          1       0.00              2          0               0
4          2  125510.82              1          1               1
...      ...        ...            ...        ...             ...
9995       5       0.00              2          1               0
9996      10   57369.61              1          1               1
9997       7       0.00              1          0               1
9998       3   75075.31              2          1               0
9999       4  130142.79              1          1               0

      EstimatedSalary  Exited
0           101348.88       1
1           112542.58       0
2           113931.57       1
3            93826.63       0
4            79084.10       0
...               ...     ...
9995         96270.64       0
9996        101699.77       0
9997         42085.58       1
9998         92888.52       1
9999         38190.78       0

[10000 rows x 14 columns]

df2.isnull().sum().sum()

0
```

####**Filling NULL values with the next value**

```
df3=data.fillna(method='bfill')
df3

      RowNumber  CustomerId    Surname  CreditScore Geography  Gender
Age  \
0             1    15634602   Hargrave          619    France  Female
42
1             2    15647311       Hill          608     Spain  Female
41
2             3    15619304       Onio          502    France  Female
42
```

```
3            4    15701354       Boni          699    France  Female
39
4            5    15737888   Mitchell          850     Spain  Female
43
...        ...         ...        ...          ...       ...     ...
...
9995      9996    15606229   Obijiaku          771    France    Male
39
9996      9997    15569892  Johnstone          516    France    Male
35
9997      9998    15584532        Liu          709    France  Female
36
9998      9999    15682355  Sabbatini          772   Germany    Male
42
9999     10000    15628319     Walker          792    France  Female
28

      Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0          2       0.00              1          1               1
1          1   83807.86              1          0               1
2          8  159660.80              3          1               0
3          1       0.00              2          0               0
4          2  125510.82              1          1               1
...      ...        ...            ...        ...             ...
9995       5       0.00              2          1               0
9996      10   57369.61              1          1               1
9997       7       0.00              1          0               1
9998       3   75075.31              2          1               0
9999       4  130142.79              1          1               0

      EstimatedSalary  Exited
0           101348.88       1
1           112542.58       0
2           113931.57       1
3            93826.63       0
4            79084.10       0
...               ...     ...
9995         96270.64       0
9996        101699.77       0
9997         42085.58       1
9998         92888.52       1
9999         38190.78       0

[10000 rows x 14 columns]
```

DROPPING NULL VALUES

```
df4=data.dropna()
df4
```

```
      RowNumber  CustomerId    Surname  CreditScore Geography  Gender
Age  \
0             1    15634602   Hargrave          619    France  Female
42
1             2    15647311       Hill          608     Spain  Female
41
2             3    15619304       Onio          502    France  Female
42
3             4    15701354       Boni          699    France  Female
39
4             5    15737888   Mitchell          850     Spain  Female
43
...         ...         ...        ...          ...       ...     ...
...
9995       9996    15606229   Obijiaku          771    France    Male
39
9996       9997    15569892  Johnstone          516    France    Male
35
9997       9998    15584532        Liu          709    France  Female
36
9998       9999    15682355  Sabbatini          772   Germany    Male
42
9999      10000    15628319     Walker          792    France  Female
28

      Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0          2       0.00              1          1               1
1          1   83807.86              1          0               1
2          8  159660.80              3          1               0
3          1       0.00              2          0               0
4          2  125510.82              1          1               1
...      ...        ...            ...        ...             ...
9995       5       0.00              2          1               0
9996      10   57369.61              1          1               1
9997       7       0.00              1          0               1
9998       3   75075.31              2          1               0
9999       4  130142.79              1          1               0

      EstimatedSalary  Exited
0           101348.88       1
1           112542.58       0
2           113931.57       1
3            93826.63       0
4            79084.10       0
...               ...     ...
9995         96270.64       0
9996        101699.77       0
9997         42085.58       1
9998         92888.52       1
9999         38190.78       0
```

```
[10000 rows x 14 columns]
```

```
df5=data.dropna(how='any')
df5
```

```
      RowNumber  CustomerId    Surname  CreditScore Geography  Gender
Age  \
0             1    15634602   Hargrave          619    France  Female
42
1             2    15647311       Hill          608     Spain  Female
41
2             3    15619304       Onio          502    France  Female
42
3             4    15701354       Boni          699    France  Female
39
4             5    15737888   Mitchell          850     Spain  Female
43
...         ...         ...        ...          ...       ...     ...
...
9995       9996    15606229   Obijiaku          771    France    Male
39
9996       9997    15569892  Johnstone          516    France    Male
35
9997       9998    15584532        Liu          709    France  Female
36
9998       9999    15682355  Sabbatini          772   Germany    Male
42
9999      10000    15628319     Walker          792    France  Female
28

      Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0          2       0.00              1          1               1
1          1   83807.86              1          0               1
2          8  159660.80              3          1               0
3          1       0.00              2          0               0
4          2  125510.82              1          1               1
...      ...        ...            ...        ...             ...
9995       5       0.00              2          1               0
9996      10   57369.61              1          1               1
9997       7       0.00              1          0               1
9998       3   75075.31              2          1               0
9999       4  130142.79              1          1               0

      EstimatedSalary  Exited
0           101348.88       1
1           112542.58       0
2           113931.57       1
3            93826.63       0
4            79084.10       0
```

```
...               ...     ...
9995         96270.64       0
9996        101699.77       0
9997         42085.58       1
9998         92888.52       1
9999         38190.78       0

[10000 rows x 14 columns]
```

replace()

```
import numpy as np
df6=df.replace(to_replace=np.nan,value=8763)
df6
```

```
      RowNumber  CustomerId    Surname  CreditScore Geography  Gender
Age  \
0             1    15634602   Hargrave          619    France  Female
42
1             2    15647311       Hill          608     Spain  Female
41
2             3    15619304       Onio          502    France  Female
42
3             4    15701354       Boni          699    France  Female
39
4             5    15737888   Mitchell          850     Spain  Female
43
...         ...         ...        ...          ...       ...     ...
...
9995       9996    15606229   Obijiaku          771    France    Male
39
9996       9997    15569892  Johnstone          516    France    Male
35
9997       9998    15584532        Liu          709    France  Female
36
9998       9999    15682355  Sabbatini          772   Germany    Male
42
9999      10000    15628319     Walker          792    France  Female
28

      Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0          2       0.00              1          1               1
1          1   83807.86              1          0               1
2          8  159660.80              3          1               0
3          1       0.00              2          0               0
4          2  125510.82              1          1               1
...      ...        ...            ...        ...             ...
9995       5       0.00              2          1               0
9996      10   57369.61              1          1               1
9997       7       0.00              1          0               1
9998       3   75075.31              2          1               0
```

```
9999       4  130142.79              1          1               0

      EstimatedSalary  Exited
0           101348.88       1
1           112542.58       0
2           113931.57       1
3            93826.63       0
4            79084.10       0
...               ...     ...
9995         96270.64       0
9996        101699.77       0
9997         42085.58       1
9998         92888.52       1
9999         38190.78       0

[10000 rows x 14 columns]
```

interpolate()

```
data['EstimatedSalary']=data['EstimatedSalary'].interpolate(method='li
near')
data
```

```
      RowNumber  CustomerId    Surname  CreditScore Geography  Gender
Age  \
0             1    15634602   Hargrave          619    France  Female
42
1             2    15647311       Hill          608     Spain  Female
41
2             3    15619304       Onio          502    France  Female
42
3             4    15701354       Boni          699    France  Female
39
4             5    15737888   Mitchell          850     Spain  Female
43
...         ...         ...        ...          ...       ...     ...
...
9995       9996    15606229   Obijiaku          771    France    Male
39
9996       9997    15569892  Johnstone          516    France    Male
35
9997       9998    15584532        Liu          709    France  Female
36
9998       9999    15682355  Sabbatini          772   Germany    Male
42
9999      10000    15628319     Walker          792    France  Female
28

      Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0          2       0.00              1          1               1
```

```
1          1   83807.86              1          0               1
2          8  159660.80              3          1               0
3          1       0.00              2          0               0
4          2  125510.82              1          1               1
...      ...        ...            ...        ...             ...
9995       5       0.00              2          1               0
9996      10   57369.61              1          1               1
9997       7       0.00              1          0               1
9998       3   75075.31              2          1               0
9999       4  130142.79              1          1               0

      EstimatedSalary  Exited
0           101348.88       1
1           112542.58       0
2           113931.57       1
3            93826.63       0
4            79084.10       0
...               ...     ...
9995         96270.64       0
9996        101699.77       0
9997         42085.58       1
9998         92888.52       1
9999         38190.78       0

[10000 rows x 14 columns]
```

6.FIND THE OUTLIERS AND REPLACE THE OUTLIERS

```
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline

data=pd.read_csv("/content/drive/MyDrive/Colab
Notebooks/Churn_Modelling.csv")
data1=data["CreditScore"]
outliers=[]
def detect_outliers(data):
    threshold=3
    mean=np.mean(data)
    std=np.std(data)
    for i in data:
        z_score=(i-mean)/std
        if np.abs(z_score)>threshold:
            outliers.append(z_score)
    return outliers

outlier_pt=detect_outliers(data1)

outlier_pt
```

```
[-3.0163831068948417,
 -3.1095040882937757,
 -3.1095040882937757,
 -3.026729882605834,
 -3.0991573125827827,
 -3.1095040882937757,
 -3.1095040882937757,
 -3.1095040882937757]
```

INTERQUANTILE RANGE

```
sorted(data1)
```

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 ...]
```

```
quantile1,quantile3=np.percentile(data1,[25,75])
```

```
print(quantile1,quantile3)
```

```
584.0 718.0
```

```
iqr_value=quantile3-quantile1
print(iqr_value)
```

```
134.0
```

```
lower_bound_val=quantile1-(1.5*iqr_value)
upper_bound_val=quantile3+(1.5*iqr_value)
```

```
print(lower_bound_val,upper_bound_val)
```

```
383.0 919.0
```

1. CHECK FOR CATEGORICAL COLUMNS AND PERFORM ENCODING

```
import pandas as pd
import numpy as np
import seaborn as sns
%matplotlib inline
```

METHOD I

```
data=pd.read_csv("/content/drive/MyDrive/Colab
Notebooks/Churn_Modelling.csv")
NEW_DataM1=data
data1=pd.get_dummies(NEW_DataM1["Gender"])
```

```
data1.head()
```

```
   Female  Male
0       1     0
1       1     0
2       1     0
3       1     0
4       1     0
```

```
NEW_DataM1.drop('Gender',axis='columns')
```

```
      RowNumber  CustomerId    Surname  CreditScore Geography  Age
Tenure  \
0             1    15634602   Hargrave          619    France   42
2
1             2    15647311       Hill          608     Spain   41
1
2             3    15619304       Onio          502    France   42
8
3             4    15701354       Boni          699    France   39
1
4             5    15737888   Mitchell          850     Spain   43
2
...         ...         ...        ...          ...       ...  ...
...
9995       9996    15606229   Obijiaku          771    France   39
5
9996       9997    15569892  Johnstone          516    France   35
10
9997       9998    15584532        Liu          709    France   36
7
9998       9999    15682355  Sabbatini          772   Germany   42
3
9999      10000    15628319     Walker          792    France   28
4

        Balance  NumOfProducts  HasCrCard  IsActiveMember
EstimatedSalary  \
0          0.00              1          1               1
101348.88
1      83807.86              1          0               1
112542.58
2     159660.80              3          1               0
113931.57
3          0.00              2          0               0
93826.63
4     125510.82              1          1               1
79084.10
...         ...            ...        ...             ...
...
9995       0.00              2          1               0
96270.64
9996   57369.61              1          1               1
101699.77
9997       0.00              1          0               1
42085.58
9998   75075.31              2          1               0
92888.52
9999  130142.79              1          1               0
```

```
38190.78

      Exited
0          1
1          0
2          1
3          0
4          0
...      ...
9995       0
9996       0
9997       1
9998       1
9999       0

[10000 rows x 13 columns]
```

```
NEW_DataM1["Male"]=data1["Male"].to_list()
NEW_DataM1["Female"]=data1["Female"].to_list()
```

```
NEW_DataM1
```

```
      RowNumber  CustomerId    Surname  CreditScore Geography  Gender
Age  \
0             1    15634602   Hargrave          619    France  Female
42
1             2    15647311       Hill          608     Spain  Female
41
2             3    15619304       Onio          502    France  Female
42
3             4    15701354       Boni          699    France  Female
39
4             5    15737888   Mitchell          850     Spain  Female
43
...         ...         ...        ...          ...       ...     ...
...
9995       9996    15606229   Obijiaku          771    France    Male
39
9996       9997    15569892  Johnstone          516    France    Male
35
9997       9998    15584532        Liu          709    France  Female
36
9998       9999    15682355  Sabbatini          772   Germany    Male
42
9999      10000    15628319     Walker          792    France  Female
28

      Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0          2       0.00              1          1               1
1          1   83807.86              1          0               1
```

```
2          8  159660.80              3          1               0
3          1       0.00              2          0               0
4          2  125510.82              1          1               1
...      ...        ...            ...        ...             ...
9995       5       0.00              2          1               0
9996      10   57369.61              1          1               1
9997       7       0.00              1          0               1
9998       3   75075.31              2          1               0
9999       4  130142.79              1          1               0

      EstimatedSalary  Exited  Male  Female
0           101348.88       1     0       1
1           112542.58       0     0       1
2           113931.57       1     0       1
3            93826.63       0     0       1
4            79084.10       0     0       1
...               ...     ...   ...     ...
9995         96270.64       0     1       0
9996        101699.77       0     1       0
9997         42085.58       1     0       1
9998         92888.52       1     1       0
9999         38190.78       0     0       1

[10000 rows x 16 columns]
```

```
NEW_DataM1.head(2)
```

```
   RowNumber  CustomerId   Surname  CreditScore Geography  Gender  Age
\
0          1    15634602  Hargrave          619    France  Female   42

1          2    15647311      Hill          608     Spain  Female   41


   Tenure   Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0       2      0.00              1          1               1
1       1  83807.86              1          0               1

   EstimatedSalary  Exited  Male  Female
0        101348.88       1     0       1
1        112542.58       0     0       1
```

METHOD II

```
from sklearn.preprocessing import LabelEncoder

data=pd.read_csv("/content/drive/MyDrive/Colab
Notebooks/Churn_Modelling.csv")
l3=LabelEncoder()
label=l3.fit_transform(data["Gender"])
```

```
l3.classes_
```

```
array(['Female', 'Male'], dtype=object)
```

```
Data=NEW_DataM1.drop("Gender",axis='columns')
Data
```

```
      RowNumber  CustomerId    Surname  CreditScore Geography  Age
Tenure  \
0             1    15634602   Hargrave          619    France   42
2
1             2    15647311       Hill          608     Spain   41
1
2             3    15619304       Onio          502    France   42
8
3             4    15701354       Boni          699    France   39
1
4             5    15737888   Mitchell          850     Spain   43
2
...         ...         ...        ...          ...       ...  ...
...
9995       9996    15606229   Obijiaku          771    France   39
5
9996       9997    15569892  Johnstone          516    France   35
10
9997       9998    15584532        Liu          709    France   36
7
9998       9999    15682355  Sabbatini          772   Germany   42
3
9999      10000    15628319     Walker          792    France   28
4

        Balance  NumOfProducts  HasCrCard  IsActiveMember
EstimatedSalary  \
0          0.00              1          1               1
101348.88
1      83807.86              1          0               1
112542.58
2     159660.80              3          1               0
113931.57
3          0.00              2          0               0
93826.63
4     125510.82              1          1               1
79084.10
...         ...            ...        ...             ...
...
9995       0.00              2          1               0
96270.64
9996   57369.61              1          1               1
101699.77
9997       0.00              1          0               1
```

```
42085.58
9998   75075.31              2          1               0
92888.52
9999  130142.79              1          1               0
38190.78

      Exited  Male  Female
0          1     0       1
1          0     0       1
2          1     0       1
3          0     0       1
4          0     0       1
...      ...   ...     ...
9995       0     1       0
9996       0     1       0
9997       1     0       1
9998       1     1       0
9999       0     0       1

[10000 rows x 15 columns]
```

```
Data["Gender"]=label
Data
```

```
      RowNumber  CustomerId    Surname  CreditScore Geography  Age
Tenure  \
0             1    15634602   Hargrave          619    France   42
2
1             2    15647311       Hill          608     Spain   41
1
2             3    15619304       Onio          502    France   42
8
3             4    15701354       Boni          699    France   39
1
4             5    15737888   Mitchell          850     Spain   43
2
...         ...         ...        ...          ...       ...  ...
...
9995       9996    15606229   Obijiaku          771    France   39
5
9996       9997    15569892  Johnstone          516    France   35
10
9997       9998    15584532        Liu          709    France   36
7
9998       9999    15682355  Sabbatini          772   Germany   42
3
9999      10000    15628319     Walker          792    France   28
4

        Balance  NumOfProducts  HasCrCard  IsActiveMember
```

```
EstimatedSalary  \
0          0.00              1          1               1
101348.88
1      83807.86              1          0               1
112542.58
2     159660.80              3          1               0
113931.57
3          0.00              2          0               0
93826.63
4     125510.82              1          1               1
79084.10
...         ...            ...        ...             ...
...
9995       0.00              2          1               0
96270.64
9996   57369.61              1          1               1
101699.77
9997       0.00              1          0               1
42085.58
9998   75075.31              2          1               0
92888.52
9999  130142.79              1          1               0
38190.78

      Exited  Male  Female  Gender
0          1     0       1       0
1          0     0       1       0
2          1     0       1       0
3          0     0       1       0
4          0     0       1       0
...      ...   ...     ...     ...
9995       0     1       0       1
9996       0     1       0       1
9997       1     0       1       0
9998       1     1       0       1
9999       0     0       1       0

[10000 rows x 16 columns]
```

8.SPLIT THE DATA INTO DEPENDENT AND INDEPENDENT VARIABLES

```
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd

data=pd.read_csv("/content/drive/MyDrive/Colab
Notebooks/Churn_Modelling.csv")

X=data.iloc[:,2:9]
X
```

```
        Surname  CreditScore Geography  Gender  Age  Tenure    Balance
0      Hargrave          619    France  Female   42       2       0.00
1          Hill          608     Spain  Female   41       1   83807.86
2          Onio          502    France  Female   42       8  159660.80
3          Boni          699    France  Female   39       1       0.00
4      Mitchell          850     Spain  Female   43       2  125510.82
...         ...          ...       ...     ...  ...     ...        ...
9995   Obijiaku          771    France    Male   39       5       0.00
9996  Johnstone          516    France    Male   35      10   57369.61
9997        Liu          709    France  Female   36       7       0.00
9998  Sabbatini          772   Germany    Male   42       3   75075.31
9999     Walker          792    France  Female   28       4  130142.79

[10000 rows x 7 columns]
```

```
Y=data.iloc[:,9]
Y
```

```
0       1
1       1
2       3
3       2
4       1
       ..
9995    2
9996    1
9997    1
9998    2
9999    1
Name: NumOfProducts, Length: 10000, dtype: int64
```

9.SCALE THE INDEPENDENT VARIABLES

```
import numpy as np
import pandas as pd
from pandas import Series,DataFrame
import matplotlib.pyplot as plt
from pylab import rcParams
import seaborn as sb
import scipy
import sklearn
from sklearn import preprocessing
from sklearn.preprocessing import scale

%matplotlib inline
rcParams['figure.figsize']=5,4
sb.set_style('whitegrid')
```

Normalizing and transfroming features with MinMaxScalar() and fit_transform()

```
data=pd.read_csv("/content/drive/MyDrive/Colab
Notebooks/Churn_Modelling.csv")
```

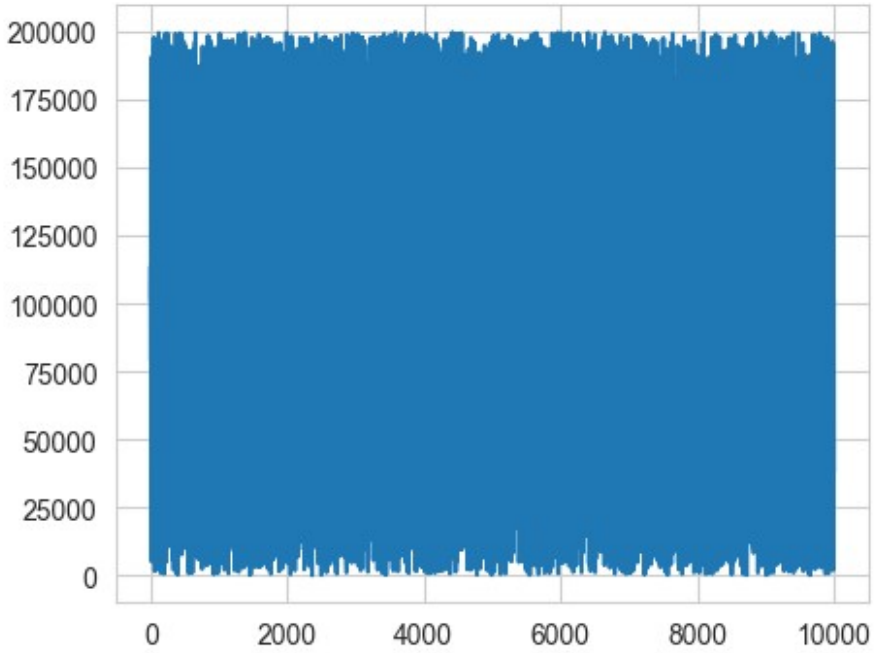
```
data.head()
```

```
   RowNumber  CustomerId   Surname  ...  IsActiveMember
EstimatedSalary Exited
0          1    15634602  Hargrave  ...               1
101348.88      1
1          2    15647311      Hill  ...               1
112542.58      0
2          3    15619304      Onio  ...               0
113931.57      1
3          4    15701354      Boni  ...               0
93826.63       0
4          5    15737888  Mitchell  ...               1
79084.10       0

[5 rows x 14 columns]
```

```
tenure=data.EstimatedSalary
plt.plot(tenure)
```

```
[<matplotlib.lines.Line2D at 0x14ec8f2b400>]
```



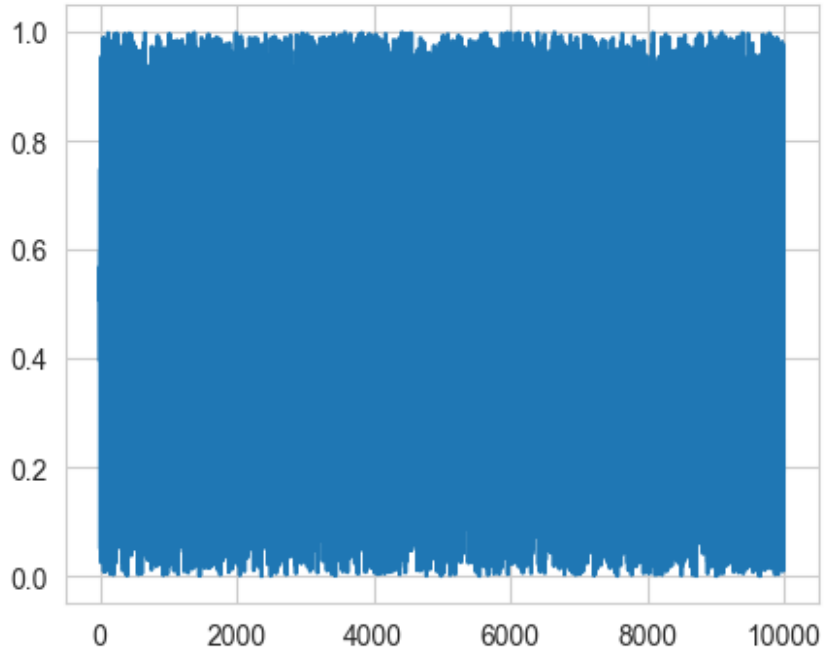

```
data[['Tenure']].describe()
```

```
             Tenure
count  10000.000000
mean       5.012800
std        2.892174
min        0.000000
25%        3.000000
```

```
50%         5.000000
75%         7.000000
max        10.000000
```

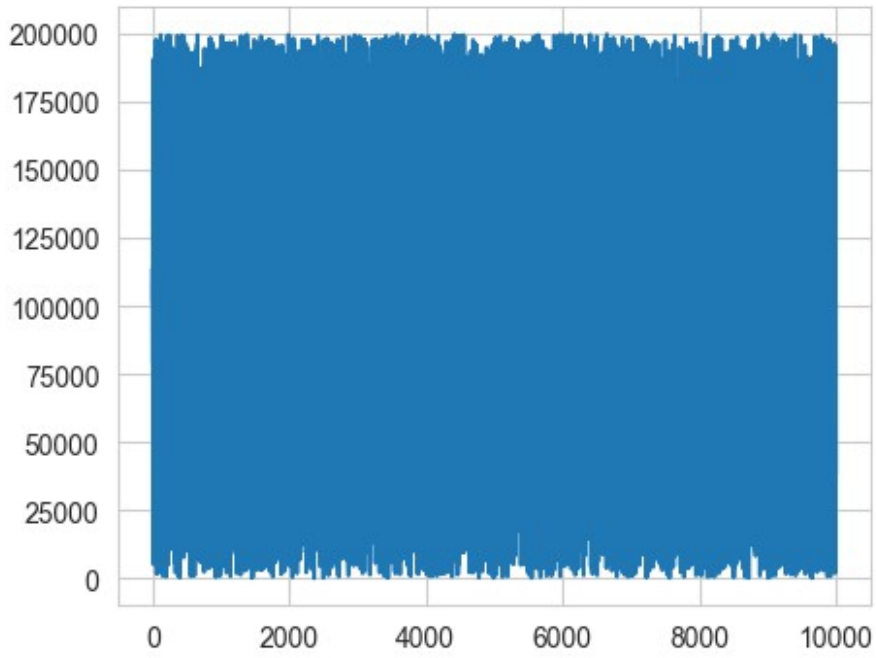
```
tenure_matrix=tenure.values.reshape(-1,1)
scaled=preprocessing.MinMaxScaler()
scaled_tenure=scaled.fit_transform(tenure_matrix)
plt.plot(scaled_tenure)
```

```
[<matplotlib.lines.Line2D at 0x14ec8dc02b0>]
```




```
std_tenure=scale(tenure,axis=0,with_mean=False,with_std=False)
plt.plot(std_tenure)
```

```
[<matplotlib.lines.Line2D at 0x14ec8ed07f0>]
```



10.SPLIT THE DATA INTO TRAINING AND TESTING

```
import pandas as pd
data=pd.read_csv("/content/drive/MyDrive/Colab
Notebooks/Churn_Modelling.csv")

data.describe()
```

```
         RowNumber    CustomerId  ...  EstimatedSalary        Exited
count  10000.00000  1.000000e+04  ...     10000.000000  10000.000000
mean    5000.50000  1.569094e+07  ...    100090.239881      0.203700
std     2886.89568  7.193619e+04  ...     57510.492818      0.402769
min        1.00000  1.556570e+07  ...        11.580000      0.000000
25%     2500.75000  1.562853e+07  ...     51002.110000      0.000000
50%     5000.50000  1.569074e+07  ...    100193.915000      0.000000
75%     7500.25000  1.575323e+07  ...    149388.247500      0.000000
max    10000.00000  1.581569e+07  ...    199992.480000      1.000000

[8 rows x 11 columns]
```

```
import numpy as np

x=np.array(data["CustomerId"]).reshape(-1,1)
x.shape
```

```
(10000, 1)
```

```
y=np.array(data["EstimatedSalary"])
y.shape
```

```
(10000,)
```

```
print(y)
```

```
[101348.88 112542.58 113931.57 ...  42085.58  92888.52  38190.78]
```

```
print(type(x))
```

```
<class 'numpy.ndarray'>
```

```
from sklearn.model_selection import train_test_split
x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.30)
```

```
x_train.shape
```

```
(7000, 1)
```

```
x_test.shape
```

```
(3000, 1)
```

```
y_train.shape
```

```
(7000,)
```

```
y.shape
```

```
(10000,)
```

```
print(y_train.shape)
```

```
(7000,)
```

```
print(y_test.shape)
```

```
(3000,)
```