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Team Size	4
Team ID	PNT2022TMID43507

■ ASSIGNMENT-II

```
import pandas as pd import seaborn as sns import matplotlib.pyplot as plt import numpy as
np sns.set_style('darkgrid') sns.set(font_scale=1.3)

df=pd.read_csv("/content/drive/MyDrive/IBM/Assignment - 2

/Churn_Modelling.csv") df.head()
```

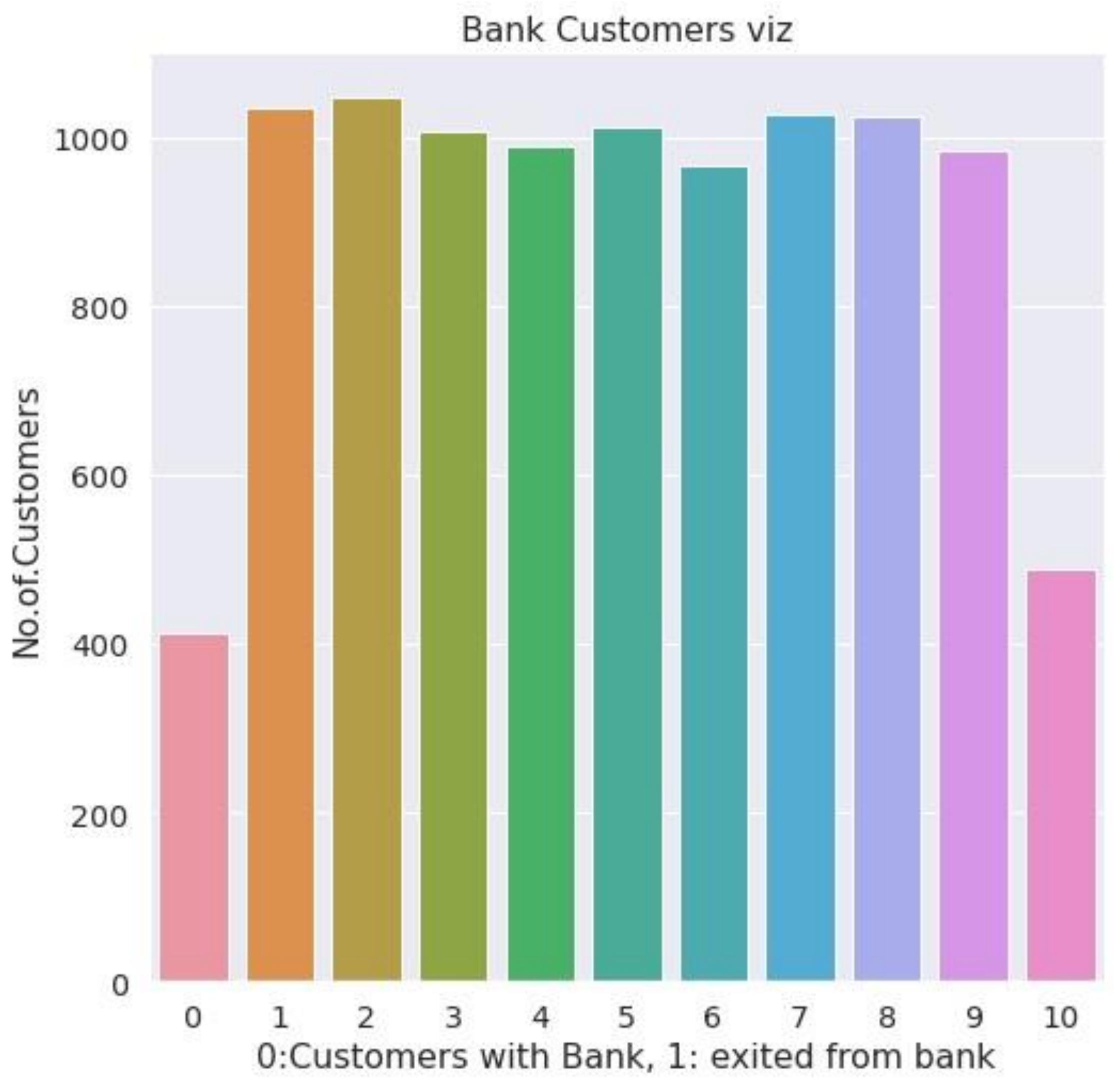
```
   RowNumber  CustomerId   Surname  CreditScore Geography  Gender  Age  
\
0          1    15634602  Hargrave          619    France  Female   42
1          2    15647311      Hill          608     Spain  Female   41
2          3    15619304      Onio          502    France  Female   42
3       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

```
df.drop(["RowNumber","CustomerId","Surname"],axis=1,inplace=True) df.info()
```

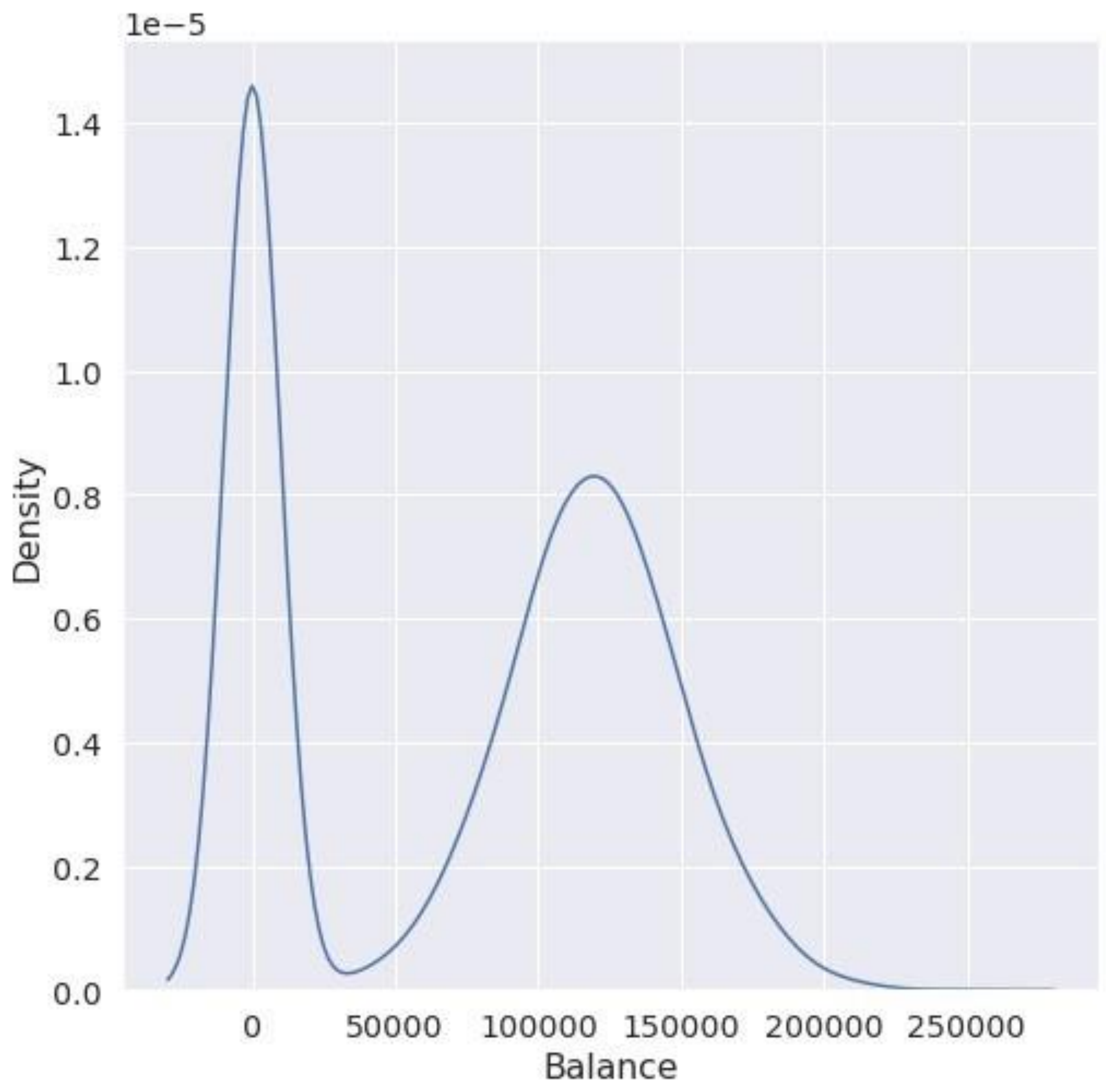
```
<class 'pandas.core.frame.DataFrame'> RangeIndex: 10000
entries, 0 to 9999

Data columns (total 11 columns):

 #   Column          Non-Null Count  Dtype

---  ------          --------------  -----

 0   CreditScore     10000 non-null  int64   1   Geography
10000 non-null  object  2   Gender          10000 non-null
object  3   Age             10000 non-null  int64

 4   Tenure          10000 non-null  int64   5   Balance
10000 non-null  float64  6   NumOfProducts    10000 non-
null  int64

 7   HasCrCard       10000 non-null  int64   8
IsActiveMember   10000 non-null  int64   9
EstimatedSalary  10000 non-null  float64  10  Exited
10000 non-null  int64  dtypes: float64(2), int64(7),
object(2) memory usage: 859.5+ KB
```

```
#Perform Univariate Analysis  plt.figure(figsize=(8,8))
sns.countplot(x='Tenure',data=df)

plt.xlabel('0:Customers with Bank, 1: exited from bank')
plt.ylabel('No.of.Customers') plt.title("Bank Customers viz") plt.show()
```



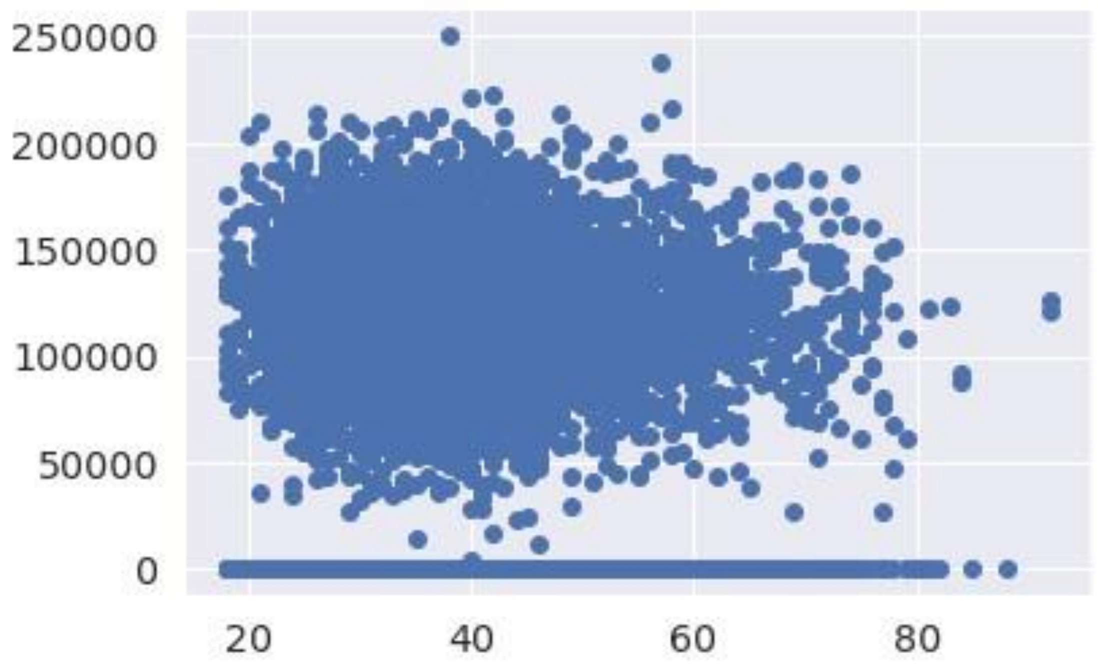
```
#Perform Univariate Analysis plt.figure(figsize=(8,8))
sns.kdeplot(x=df['Balance'])
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fa0c03906d0>
```



```
#Perform Bivariate Analysis plt.scatter(df.Age,df.Balance)
```

```
<matplotlib.collections.PathCollection at 0x7fa0d35a7dd0>
```



```
#Perform Bivariate Analysis
df.corr()
```

```
           CreditScore   Gender     Age   Tenure

Balance  \

CreditScore       1.000000  0.007888 -0.003965  0.000842  0.006268  Gender

0.007888  1.000000  0.022812  0.003739  0.069408


Age            -0.003965  0.022812  1.000000 -0.009997  0.028308  Tenure           0.000842

0.003739 -0.009997  1.000000 -0.012254


Balance          0.006268  0.069408  0.028308 -0.012254  1.000000  NumOfProducts

0.012238  0.003972 -0.030680  0.013444 -0.304180


HasCrCard        -0.005458 -0.008523 -0.011721  0.022583 -0.014858

IsActiveMember     0.025651  0.006724  0.085472 -0.028362 -0.010084

EstimatedSalary    -0.001384 -0.001369 -0.007201  0.007784  0.012797

Exited           -0.027094  0.035943  0.285323 -0.014001  0.118533
```

```
            NumOfProducts  HasCrCard  IsActiveMember  EstimatedSalary  \
CreditScore         0.012238  -0.005458       0.025651        -
0.001384
Gender              0.003972  -0.008523       0.006724        -
0.001369
Age                -0.030680  -0.011721       0.085472        -
0.007201
Tenure              0.013444   0.022583      -0.028362
0.007784
Balance            -0.304180  -0.014858      -0.010084
0.012797
NumOfProducts       1.000000   0.003183       0.009612
0.014204
HasCrCard           0.003183   1.000000      -0.011866        -
0.009933
IsActiveMember      0.009612  -0.011866       1.000000        -
0.011421
EstimatedSalary     0.014204  -0.009933      -0.011421
1.000000
Exited             -0.047820  -0.007138      -0.156128
0.012097

              Exited
CreditScore    -0.027094  Gender
0.035943  Age           0.285323
Tenure        -0.014001  Balance
0.118533  NumOfProducts   -
0.047820
HasCrCard      -0.007138
IsActiveMember  -0.156128
EstimatedSalary  0.012097  Exited
1.000000
```

```
#Perform Bivariate Analysis
import statsmodels.api as sm

#define response
variable  y =
df['CreditScore']

#define explanatory
variable  x =
df[['EstimatedSalary']]

#add constant to predictor
variables  x = sm.add_constant(x)

#fit linear regression model
model = sm.OLS(y, x).fit()

#view model summary
print(model.summary())                          OLS
Regression Results

==============================================================================

========

Dep. Variable:          CreditScore   R-squared:                 0.000

Model:                        OLS   Adj. R-squared:

-0.000

Method:               Least Squares   F-statistic:

0.01916

Date:              Sat, 24 Sep 2022   Prob (F-statistic):         0.890

Time:                      05:06:19   Log-Likelihood:

-59900.

No. Observations:             10000   AIC:

1.198e+05

Df Residuals:                  9998   BIC:

1.198e+05

Df Model:                         1

Covariance Type:          nonrobust
```

```
==============================================================================
=============
                  coef    std err          t      P>|t|
[0.025      0.975]
------------------------------------------------------------------------------
-------------
const           650.7617      1.940    335.407      0.000
646.958     654.565
EstimatedSalary -2.326e-06   1.68e-05     -0.138      0.890   -3.53e05    3.06e-05
==============================================================================
========
Omnibus:                    132.939   Durbin-Watson:
2.014
Prob(Omnibus):                0.000   Jarque-Bera (JB):
84.242
Skew:                        -0.072   Prob(JB):
5.10e-19
Kurtosis:                     2.574   Cond. No.
2.32e+05
==============================================================================
========
```

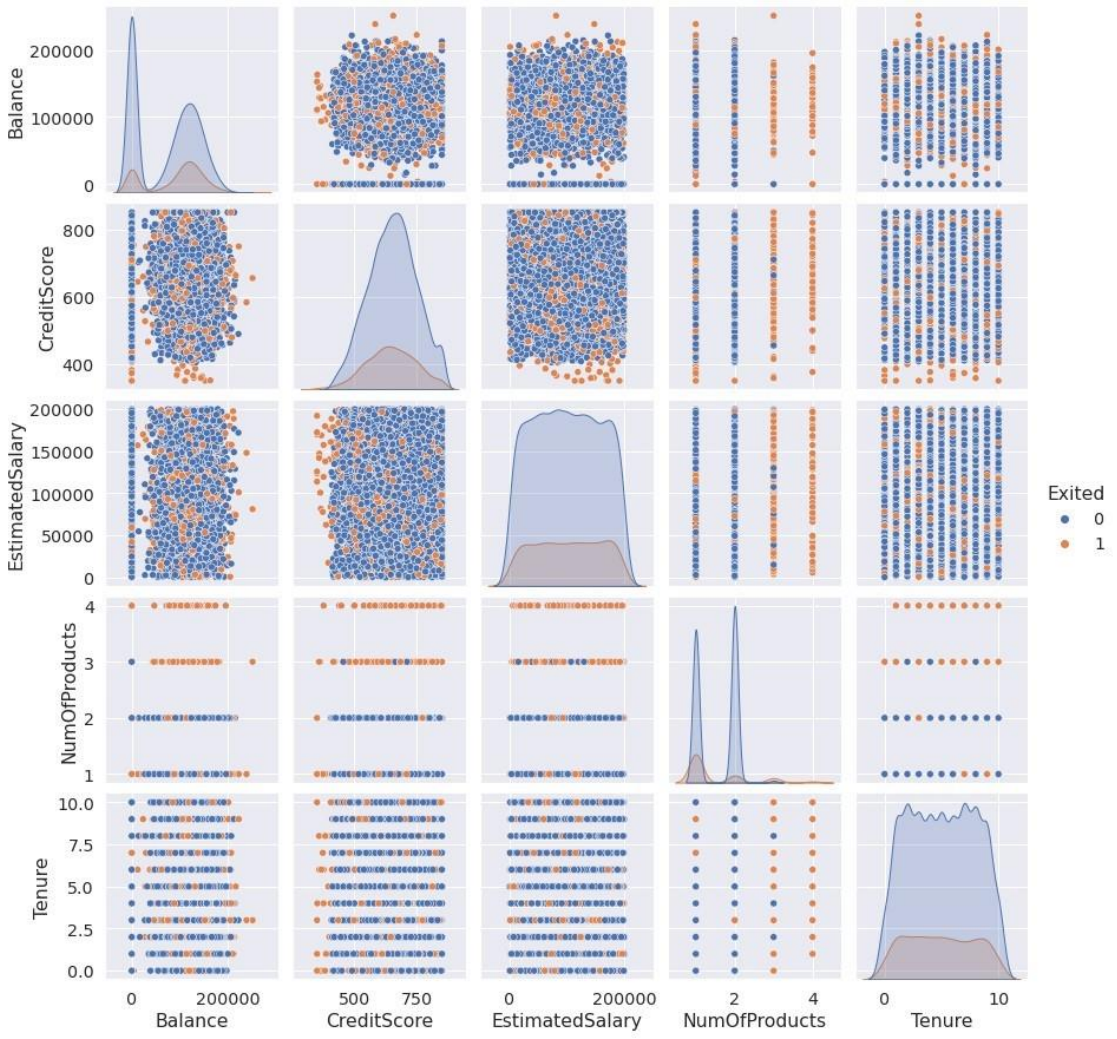
Notes:

[1] Standard Errors assume that the covariance matrix of the errors iscorrectly specified.
[2] The condition number is large, 2.32e+05. This might indicate that there are strong multicollinearity or other numerical problems.

/usr/local/lib/python3.7/dist-packages/statsmodels/tsa/ tsatools.py:142: FutureWarning: In a future version of pandas all arguments of concat except for the argument 'objs' will be keywordonly   x = pd.concat(x[::order], 1)

```
#Perform Multivariate Analysis
plt.figure(figsize=(4,4))
sns.pairplot(data=df[["Balance","CreditScore","EstimatedSalary","NumOf
Products","Tenure","Exited"]],hue="Exited")
```

```
<seaborn.axisgrid.PairGrid at 0x7fa0b00a1b10>

<Figure size 288x288 with 0 Axes>
```



```
#Perform Descriptive
Statistics df=pd.DataFrame(df)
print(df.sum())
```

```
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
```

```
#Perform Descriptive Statistics print("--
--Sum Value-----") print(df.sum(1))
```

```
print("---------------------------------") print("-----Product Value-----
") print(df.prod())

print("---------------------------------")

----Sum Value-----

0         102015.88
1         197002.44
2         274149.37
3         94567.63
4         205492.92       ...  9995   97088.64
9996      159633.38
9997      42840.58
9998      168784.83
9999      169159.57
Length: 10000, dtype: float64

---------------------------------

-----Product Value-----

CreditScore     0.0

Age             0.0 Tenure          0.0
Balance          0.0 NumOfProducts
0.0

HasCrCard       0.0

IsActiveMember    0.0
EstimatedSalary   inf Exited
0.0 dtype: float64

--------------------------------/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:3:

FutureWarning: Dropping of nuisance columns in DataFrame reductions (with
'numeric_only=None') is deprecated; in a future version this will raise TypeError.  Select only
valid columns before calling the reduction.

  This is separate from the ipykernel package so we can avoid doing imports until

/usr/local/lib/python3.7/dist-packages/numpy/core/_methods.py:52: RuntimeWarning:
overflow encountered in reduce

  return umr_prod(a, axis, dtype, out, keepdims, initial, where) /usr/local/lib/python3.7/dist-
packages/ipykernel_launcher.py:6:

FutureWarning: Dropping of nuisance columns in DataFrame reductions (with
'numeric_only=None') is deprecated; in a future version this will raise TypeError.  Select
only valid columns before calling the reduction.
```

```
#Perform Descriptive Statistics print("----------Mean
Value-----------") print(df.mean())

print("------------------------------") print("----------Median Value---------")
print(df.median())

print("------------------------------") print("----------Mode Value------------")
print(df.mode())

print("------------------------------")
```

```
----------Mean Value-----------

CreditScore         650.528800

Age                38.921800 Tenure
5.012800 Balance          76485.889288
NumOfProducts         1.530200

HasCrCard            0.705500

IsActiveMember        0.515100 EstimatedSalary
100090.239881 Exited               0.203700 dtype:
float64

------------------------------

----------Median Value---------

CreditScore         652.000

Age                37.000 Tenure
5.000 Balance          97198.540
NumOfProducts         1.000

HasCrCard            1.000

IsActiveMember        1.000 EstimatedSalary
100193.915 Exited               0.000 dtype:
float64

------------------------------

----------Mode Value------------

  CreditScore Geography Gender  Age  Tenure  Balance

NumOfProducts  \

0       850    France   Male   37     2     0.0           1
```

```
  HasCrCard  IsActiveMember  EstimatedSalary  Exited 0        1           1
24924.92      0

-------------------------------

/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:3:

FutureWarning: Dropping of nuisance columns in DataFrame reductions (with
'numeric_only=None') is deprecated; in a future version this will raise TypeError.  Select only
valid columns before calling the reduction.

  This is separate from the ipykernel package so we can avoid doing imports until

/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:6:

FutureWarning: Dropping of nuisance columns in DataFrame reductions (with
'numeric_only=None') is deprecated; in a future version this will raise TypeError.  Select
only valid columns before calling the reduction.
```

```
#Handling with missing Values
df.isnull()#Checking values are null
```

```
     CreditScore  Geography  Gender   Age  Tenure  Balance

NumOfProducts  \

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

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

[10000 rows x 11 columns]
```

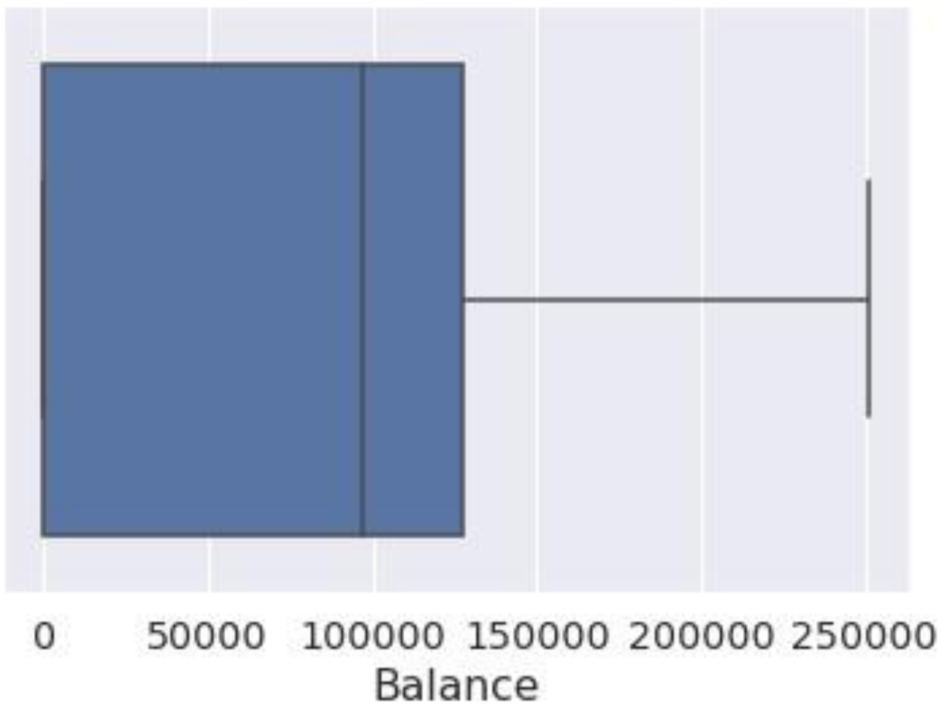
```
#Handling with missing Values
df.notnull()#Checking values are not null
```

```
   CreditScore  Geography  Gender  Age  Tenure  Balance
NumOfProducts  \
0              True     True   True True   True    True
True
1              True     True   True True   True    True
True
2              True     True   True True   True    True
True
3              True     True   True True   True    True
True
4              True     True   True True   True    True
True
...        ...       ...    ...  ...    ...     ...         ...
9995           True     True   True True   True    True
True
9996           True     True   True True   True    True
True
9997           True     True   True True   True    True
True
```

```
9998             True     True   True  True   True    True
True

9999             True     True   True  True   True    True        True

   HasCrCard  IsActiveMember  EstimatedSalary  Exited
0            True        True         True   True
1            True        True         True   True
2            True        True         True   True
3            True        True         True   True
4            True        True         True   True ...       ...          ...            ...    ...
9995         True        True         True   True
9996         True        True         True   True
9997         True        True         True   True
9998         True        True         True   True
9999         True        True         True   True

[10000 rows x 11 columns]
```

```
#Find outliers & replace the outliers
sns.boxplot(df['Balance'])
```

```
/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 0x7fa0af6dcf90>
```



```
#Find outliers & replace the outliers
print(np.where(df['Balance']>100000))
```

```
(array([   2,    4,    5, ..., 9987, 9993, 9999]),)
```

```
#Find outliers & replace the
outliers from scipy import stats import
numpy as np


z = np.abs(stats.zscore(df["EstimatedSalary"])) print(z)
```

```
0         0.021886
1         0.216534
2         0.240687
3         0.108918
4         0.365276        ...   9995    0.066419
9996      0.027988
9997      1.008643
9998      0.125231
9999      1.076370
Name: EstimatedSalary, Length: 10000, dtype: float64
```

```
#Check for categorical columns & performs
encoding from sklearn.preprocessing import LabelEncoder
df['Gender'].unique()
```

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

```
#Check for categorical columns & performs encoding
df['Gender'].value_counts()
```

```
Male      5457 Female
4543

Name: Gender, dtype: int64
```

```
#Check for categorical columns & performs encoding
encoding=LabelEncoder()
df["Gender"]=encoding.fit_transform(df.iloc[:,1].values) df
```

```
   CreditScore Geography  Gender  Age  Tenure    Balance

NumOfProducts  \

0              619   France     0  42      2       0.00
1

1              608    Spain     2  41      1   83807.86
1

2              502   France     0  42      8  159660.80
3

3              699   France     0  39      1       0.00
2

4              850    Spain     2  43      2  125510.82
1

...        ...     ...     ... ...    ...       ...        ...

9995           771   France     0  39      5       0.00
2

9996           516   France     0  35     10   57369.61
1

9997           709   France     0  36      7       0.00
1

9998           772  Germany     1  42      3   75075.31
2

9999           792   France     0  28      4  130142.79          1

   HasCrCard  IsActiveMember  EstimatedSalary  Exited

0              1           1       101348.88      1
1              0           1       112542.58      0
2              1           0       113931.57      1
```

```
3                     0          0      93826.63     0
4                     1          1      79084.10     0 ...       ...         ...          ...    ...
9995                  1          0      96270.64     0
9996                  1          1     101699.77      0
9997                  0          1      42085.58     1
9998                  1          0      92888.52     1
9999                  1          0      38190.78     0
```

[10000 rows x 11 columns]

```
#Check for categorical columns & performs encoding

#Split the data into Dependent & Independent Variables print("------
----Dependent Variables----------")
X=df.iloc[:,1:4] print(X)

print("--------------------------------------") print("---------Independent
Variables---------")

Y=df.iloc[:,4] print(Y)

print("--------------------------------------")
```

```
----------Dependent Variables-----------

    Age  Tenure   Balance 0     42
2      0.00

1          41      1   83807.86
2          42      8  159660.80
3          39      1       0.00
4          43      2  125510.82 ...    ...      ...        ... 9995   39      5      0.00
9996       35     10   57369.61
9997       36      7       0.00
9998       42      3   75075.31
9999       28      4  130142.79
[10000 rows x 3 columns]

--------------------------------------

---------Independent Variables---------

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
```

```
#Scale the independent Variables
from sklearn.preprocessing import StandardScaler object=
StandardScaler() # standardization scale =
object.fit_transform(df) print(scale)

[[-0.32622142  0.29351742 -1.04175968 ...  0.97024255  0.02188649

  1.97716468]

 [-0.44003595  0.19816383 -1.38753759 ...  0.97024255  0.21653375

 -0.50577476]

 [-1.53679418  0.29351742  1.03290776 ... -1.03067011  0.2406869    1.97716468]  ...
 [ 0.60498839 -0.27860412  0.68712986 ...  0.97024255 -1.00864308

  1.97716468]

 [ 1.25683526  0.29351742 -0.69598177 ... -1.03067011 -0.12523071

  1.97716468]

 [ 1.46377078 -1.04143285 -0.35020386 ... -1.03067011 -1.07636976   -0.50577476]]

#Split the data into training & testing from
sklearn.model_selection import train_test_split

#Split the data into training &
testing
x_train, x_test, y_train, y_test = train_test_split(x, y,
test_size=4,random_state=4) x_train

    const  EstimatedSalary 2558    1.0
137903.54

7642    1.0       121765.00

8912    1.0       109470.34

3319    1.0         2923.61

6852    1.0         7312.25 ...     ...
... 456     1.0         7666.73

6017    1.0         9085.00
```

```
709     1.0       147794.63

8366    1.0       102515.42

1146    1.0        54776.64

[9996 rows x 2 columns]
```

```
#Split the data into training &
testing x_test
```

```
     const  EstimatedSalary 1603    1.0
23305.85

8713    1.0        41248.80

4561    1.0       143317.42

6600    1.0       174123.16
```

```
#Split the data into training &
testing y_train
```

```
2558    727

7642    811

8912    623

3319    430

6852      600
... 456    733
6017    487

709     686

8366    637

1146    614

Name: CreditScore, Length: 9996, dtype: int64
```

```
#Split the data into training &
testing y_test
```

```
1603    576

8713    786

4561    562

6600    505

Name: CreditScore, dtype: int64
```