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■ 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()
```

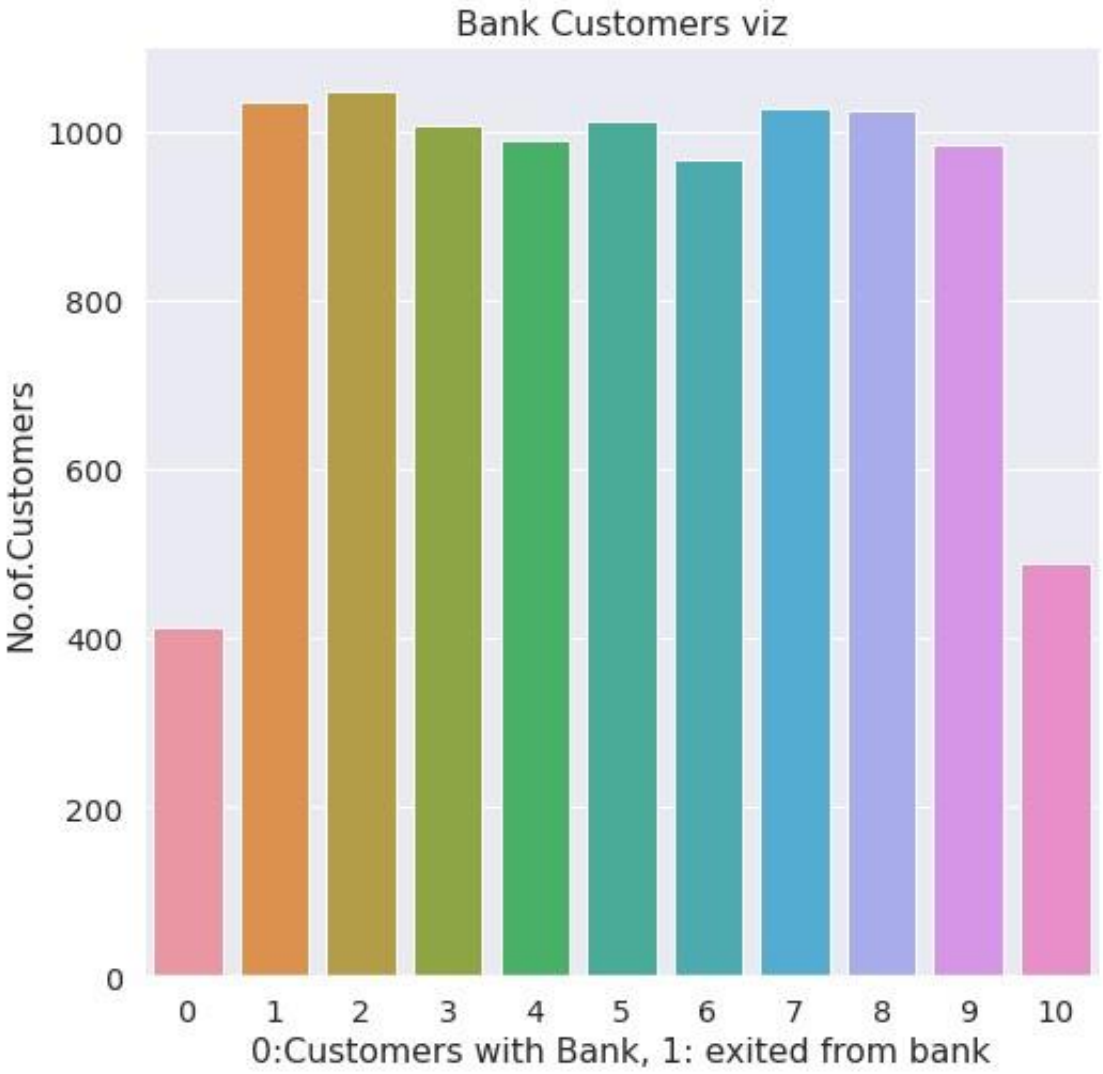
<class 'pandas.core.frame.DataFrame'> RangeIndex: 10000 entries, 0 to 9999

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

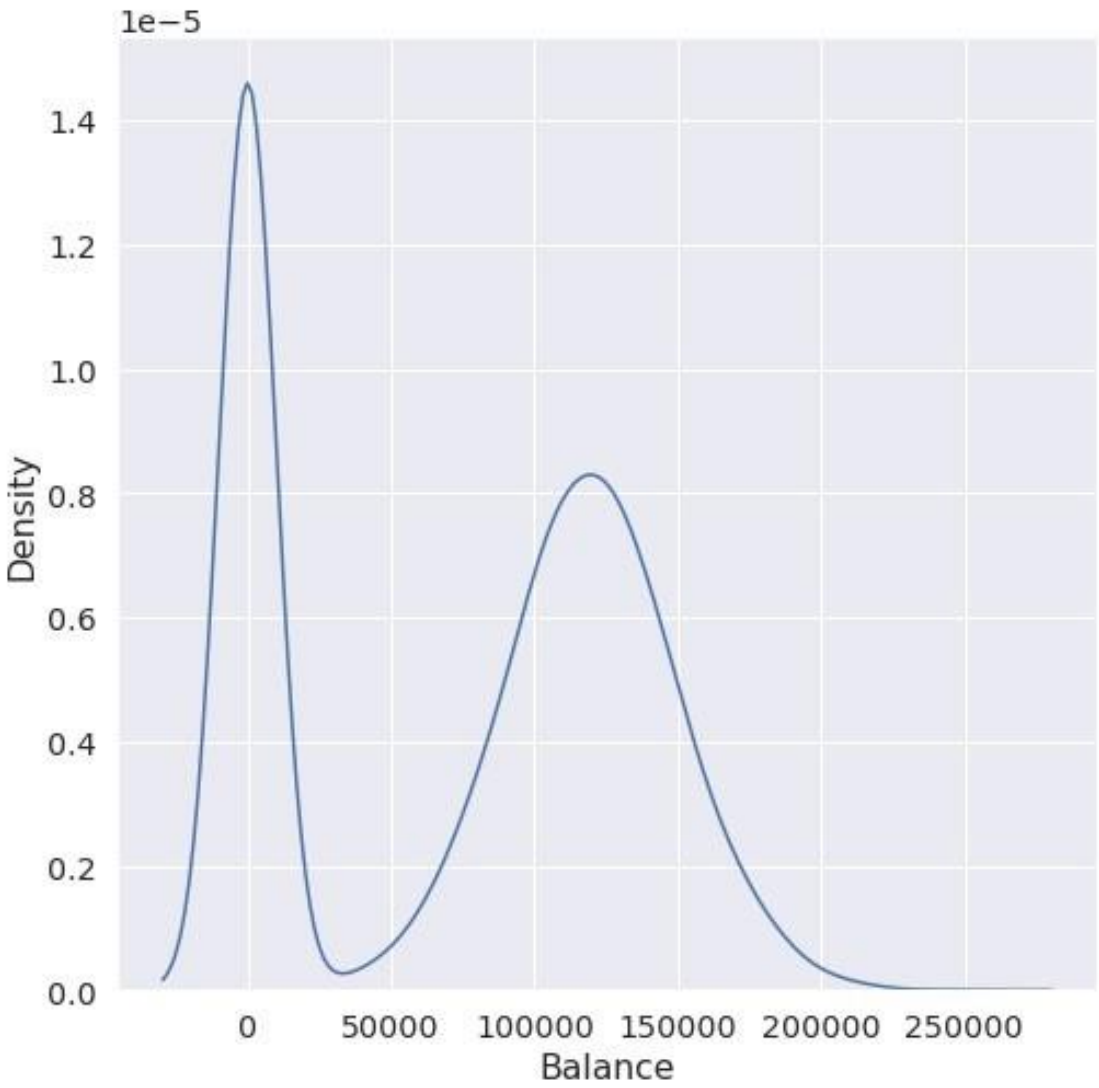
dtypes: float64(2), int64(7), object(2) memory usage: 859.5+ KB

```
#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()
```



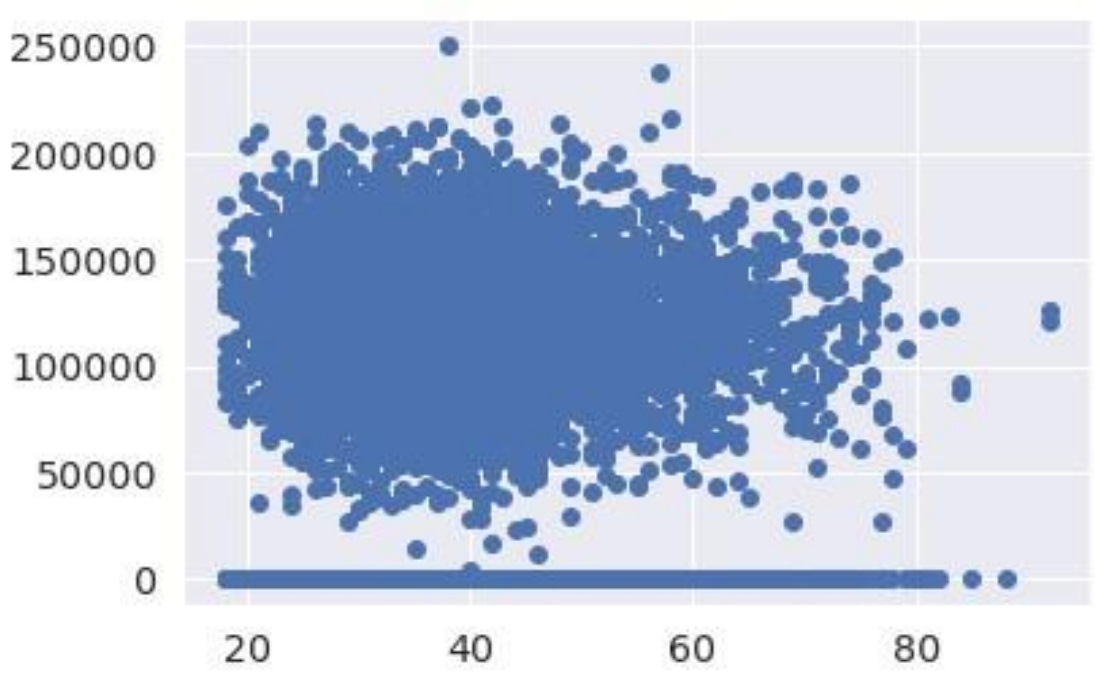

```
#Perform Univariate Analysis plt.figure(figsize=(8,8))
sns.kdeplot(x=df['Balance'])
```

<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:

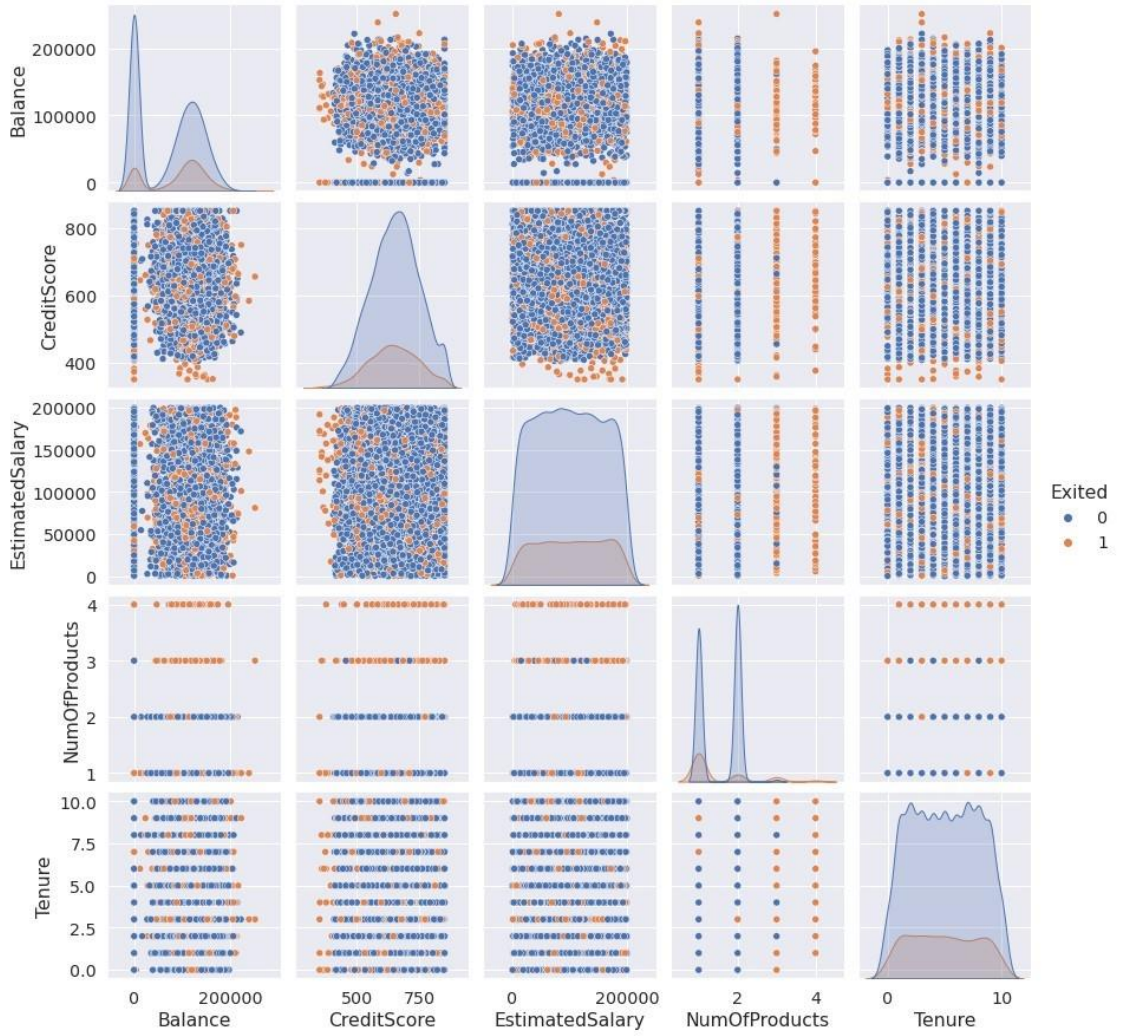
[1] Standard Errors assume that the covariance matrix of the errors iscorrectly specified.
[2] The condition number is large, 2.32e+05. This might indicate that there are strong multicollinearity or other numerical problems.

/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]
```

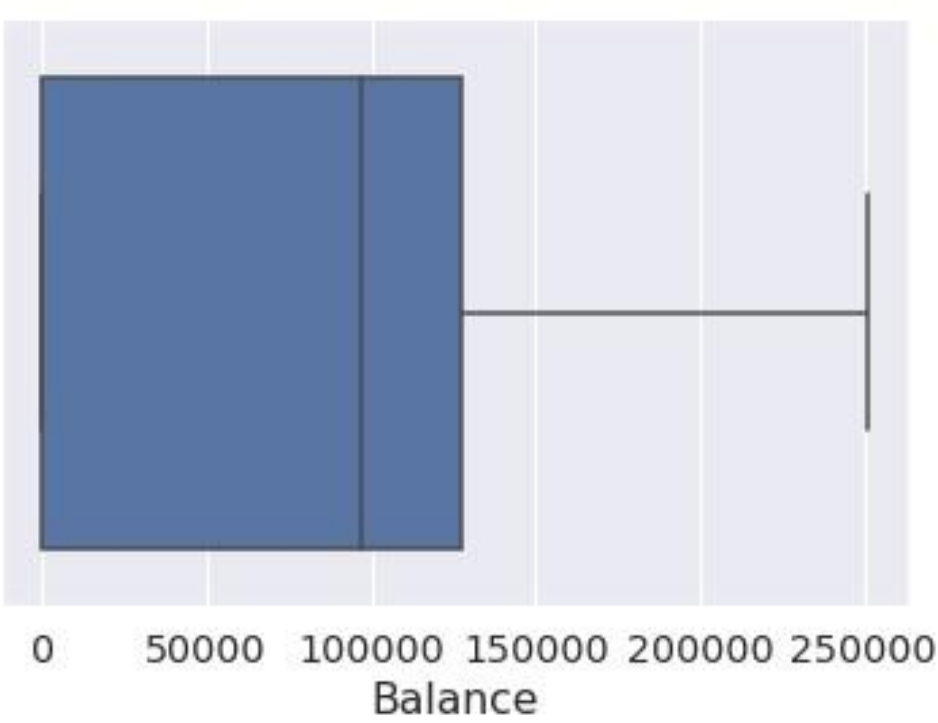
```
#Handling with missing Values
df.notnull()#Checking values are not null
```

```
   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