Assignment Date	3october 2022
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Rollnumber	820319205003
Maximum Marks	2Marks

```
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)
```

In [25]:

```
df=pd.read_csv("/content/drive/MyDrive/IBM/Assignment - 2 /Churn_Modelling.csv")
```

In [26]:

```
df.head ()
```

Out [26]:

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
0	1	15634602	Hargrave	619	France	Female	42	2	0.00	1	1	1	101348.88	1
1	2	15647311	Hill	608	Spain	Female	41	1	83807.86	1	0	1	112542.58	0

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
2	3	15619304	Onio	502	France	Female	42	8	159660.80	3	1	0	113931.57	1
3	4	15701354	Boni	699	France	Female	39	1	0.00	2	0	0	93826.63	0
4	5	15737888	Mitchell	850	Spain	Female	43	2	125510.82	1	1	1	79084.10	0

In [29]:

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

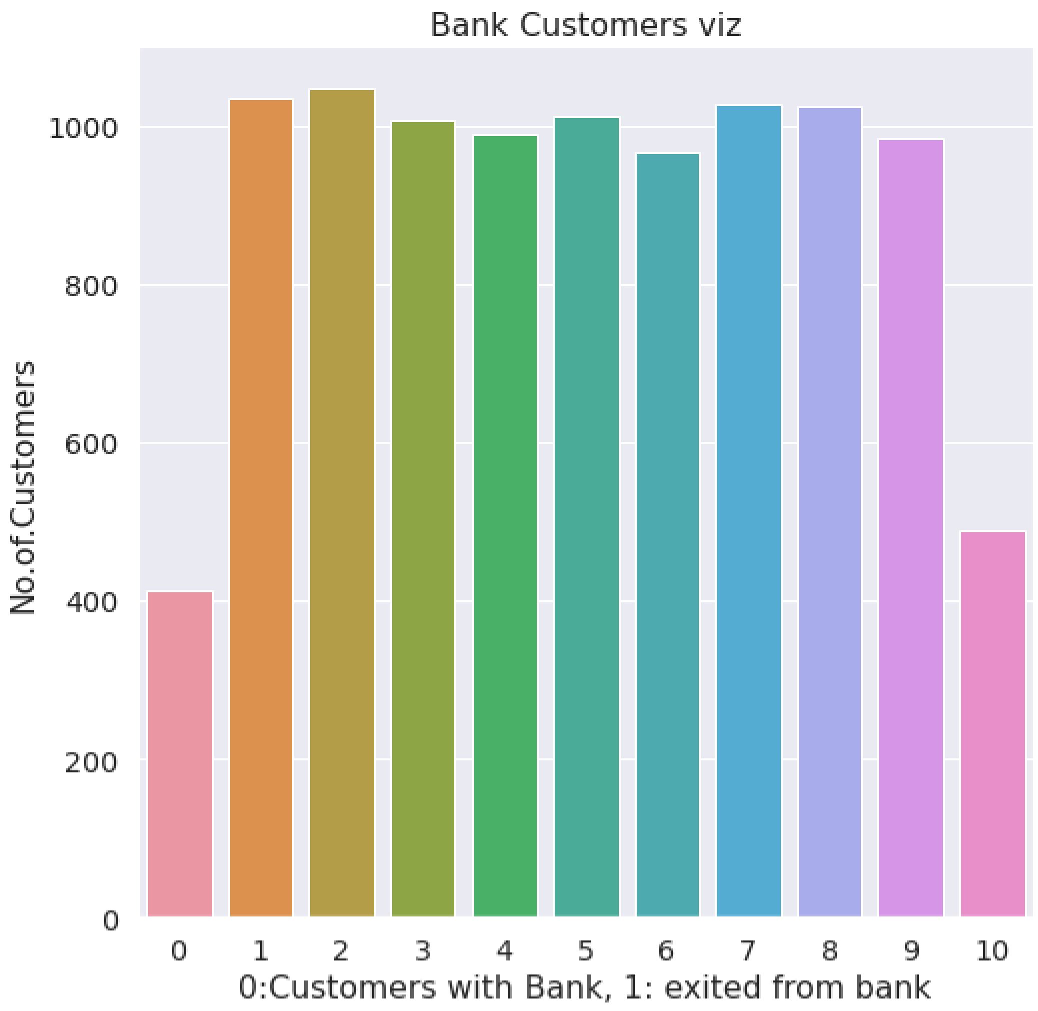
In [30]:

```
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
```

In [28]:

```
#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()
```

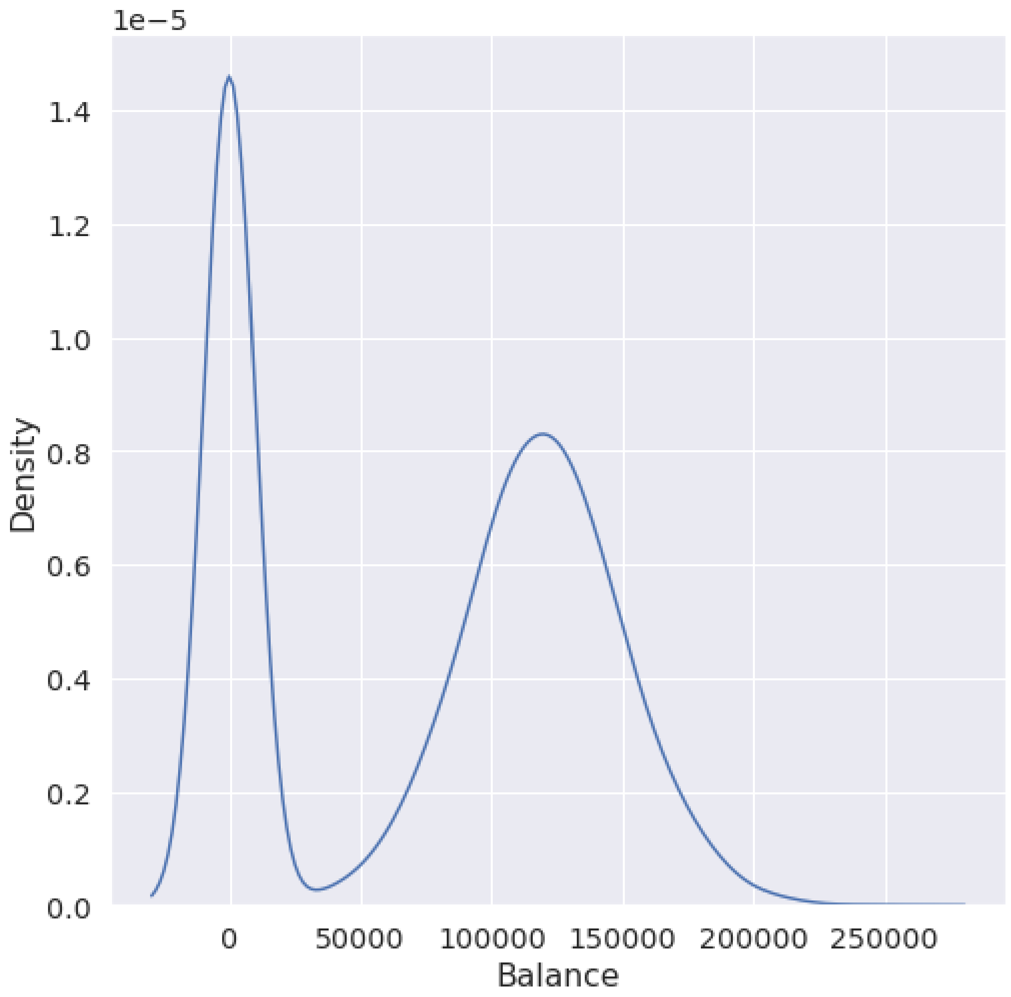


In[9]#Perform Univariate Analysis

```
plt.figure(figsize=(8,8))

sns.kdeplot(x=df['Balance'])
```

Out[9]:

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

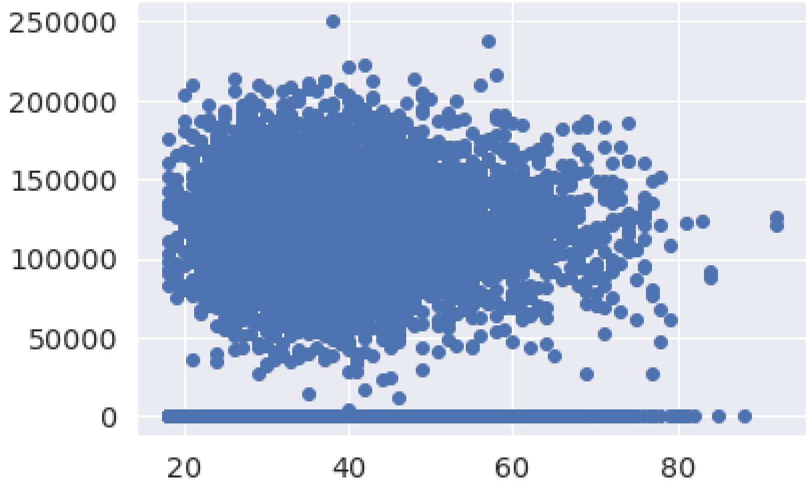


In[10]*#Perform Bivariate Analysis*

```
plt.scatter(df.Age,df.Balance)
```

Out[10]:

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



#Perform Bivariate Analysis

df.corr()

Out[54]:

	CreditScore	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
CreditScore	1.000000	0.007888	-0.003965	0.000842	0.006268	0.012238	-0.005458	0.025651	-0.001384	-0.027094
Gender	0.007888	1.000000	0.022812	0.003739	0.069408	0.003972	-0.008523	0.006724	-0.001369	0.035943
Age	-0.003965	0.022812	1.000000	-0.009997	0.028308	-0.030680	-0.011721	0.085472	-0.007201	0.285323
Tenure	0.000842	0.003739	-0.009997	1.000000	-0.012254	0.013444	0.022583	-0.028362	0.007784	-0.014001
Balance	0.006268	0.069408	0.028308	-0.012254	1.000000	-0.304180	-0.014858	-0.010084	0.012797	0.118533

	CreditScore	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
NumOfProducts	0.012238	0.003972	-0.030680	0.013444	-0.304180	1.000000	0.003183	0.009612	0.014204	-0.047820
HasCrCard	-0.005458	-0.008523	-0.011721	0.022583	-0.014858	0.003183	1.000000	-0.011866	-0.009933	-0.007138
IsActiveMember	0.025651	0.006724	0.085472	-0.028362	-0.010084	0.009612	-0.011866	1.000000	-0.011421	-0.156128
EstimatedSalary	-0.001384	-0.001369	-0.007201	0.007784	0.012797	0.014204	-0.009933	-0.011421	1.000000	0.012097
Exited	-0.027094	0.035943	0.285323	-0.014001	0.118533	-0.047820	-0.007138	-0.156128	0.012097	1.000000

In [36]:

```
#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())
```

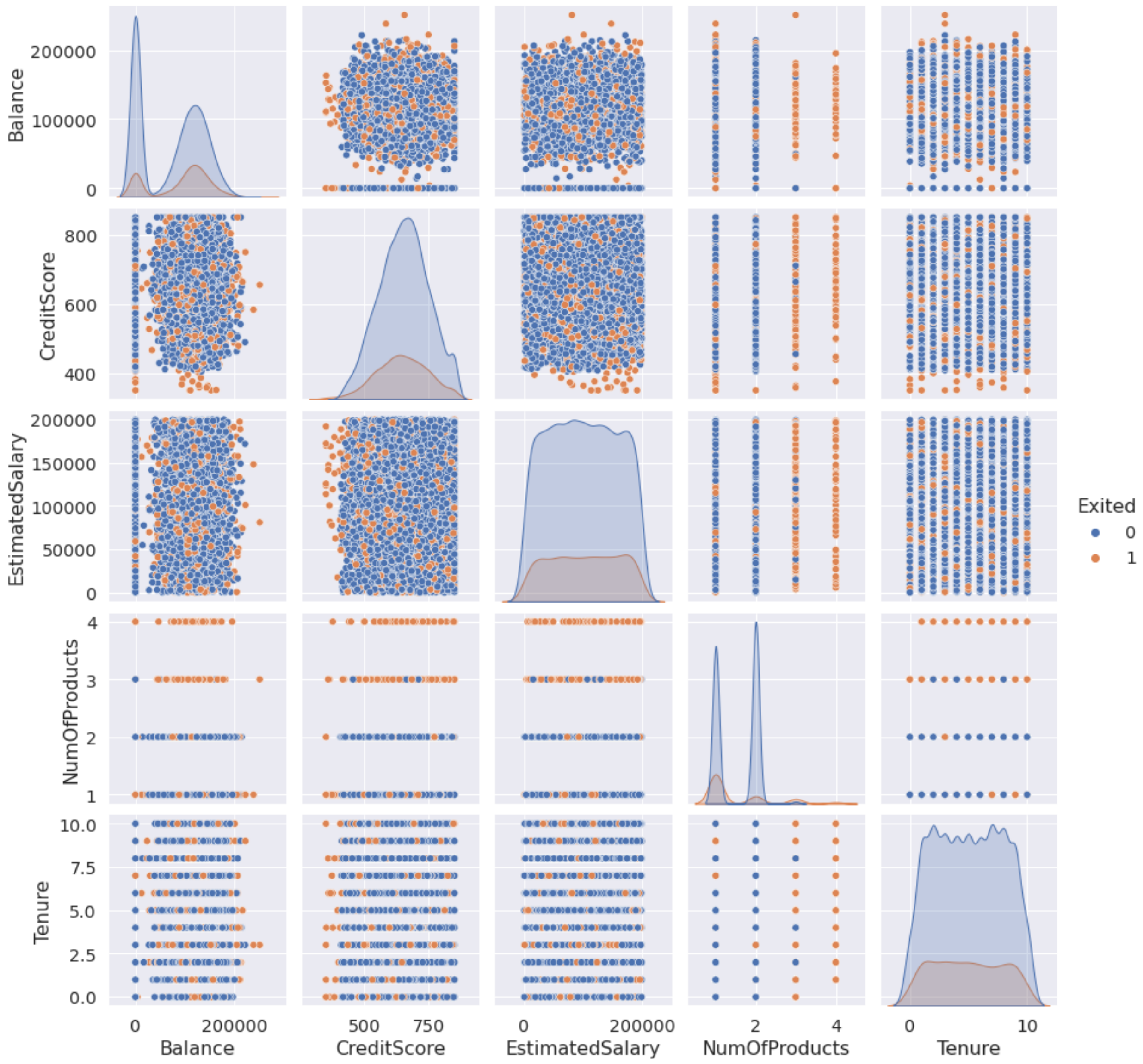
```
                     OLS Regression Results
==============================================================================
Dep. Variable:          CreditScore   R-squared:                   0.000
Model:                        OLS   Adj. R-squared:              -0.000
Method:              Least Squares   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   -3.53e-05    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 is correctly 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 keyword-only

  x = pd.concat(x[::order], 1)
```

In [35]:

```
#Perform Multivariate Analysis

plt.figure(figsize=(4,4))

sns.pairplot(data=df[["Balance","CreditScore","EstimatedSalary","NumOfProducts","Tenure","Exited"]], hue="Exited")
```

Out[35]:

```
<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
```

In [39]:

```
#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.
```

In [38]:

```
#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.
```

In [41]:

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

Out[41]:

	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
0	False	False	False	False	False	False	False	False	False	False	False
1	False	False	False	False	False	False	False	False	False	False	False
2	False	False	False	False	False	False	False	False	False	False	False
3	False	False	False	False	False	False	False	False	False	False	False
4	False	False	False	False	False	False	False	False	False	False	False

	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
...	...	...	...	...	...	...	...	...	...	...	...
9995	False	False	False	False	False	False	False	False	False	False	False
9996	False	False	False	False	False	False	False	False	False	False	False
9997	False	False	False	False	False	False	False	False	False	False	False
9998	False	False	False	False	False	False	False	False	False	False	False
9999	False	False	False	False	False	False	False	False	False	False	False

10000 rows × 11 columns

In [42]:

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

Out[42]:

	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
0	True	True	True	True	True	True	True	True	True	True	True
1	True	True	True	True	True	True	True	True	True	True	True
2	True	True	True	True	True	True	True	True	True	True	True

	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
3	True	True	True	True	True	True	True	True	True	True	True
4	True	True	True	True	True	True	True	True	True	True	True
...	...	...	...	...	...	...	...	...	...	...	...
9995	True	True	True	True	True	True	True	True	True	True	True
9996	True	True	True	True	True	True	True	True	True	True	True
9997	True	True	True	True	True	True	True	True	True	True	True
9998	True	True	True	True	True	True	True	True	True	True	True
9999	True	True	True	True	True	True	True	True	True	True	True

10000 rows × 11 columns

In [43]:

```
#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
```

Out[43]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fa0af6dcf90>
```

```
#Find outliers & replace the outliers

print(np.where(df['Balance']>100000))

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

 9995   771   France    0   39   5    0.00        2   1   0   96270.64    0

 9996   516   France    0   35   10   57369.61    1   1   1   101699.77   0

 9997   709   France    0   36   7    0.00        1   0   1   42085.58    1

 9998   772   Germany   1   42   3    75075.31    2   1   0   92888.52    1

 9999   792   France    0   28   4    130142.79   1   1   0   38190.78    0

10000 rows × 11 columns

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
---------------------------------------
```

In [ ]:

```
#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]]
```

In [ ]:

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

In [ ]:

```python
#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
```

Out[ ]:

```
        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 × 2 columns
```

In [ ]:

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

```
x_test
```

Out[ ]:

	const	EstimatedSalary
1603	1.0	23305.85
8713	1.0	41248.80
4561	1.0	143317.42
6600	1.0	174123.16

In [ ]:

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

Out[ ]:

```
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
```

In [ ]:

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

```
Out[ ]:

1603    576

8713    786

4561    562

6600    505

Name: CreditScore, dtype: int64
```