ASSIGNMENT-2

Assignment Date	3rd October 2022
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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]:

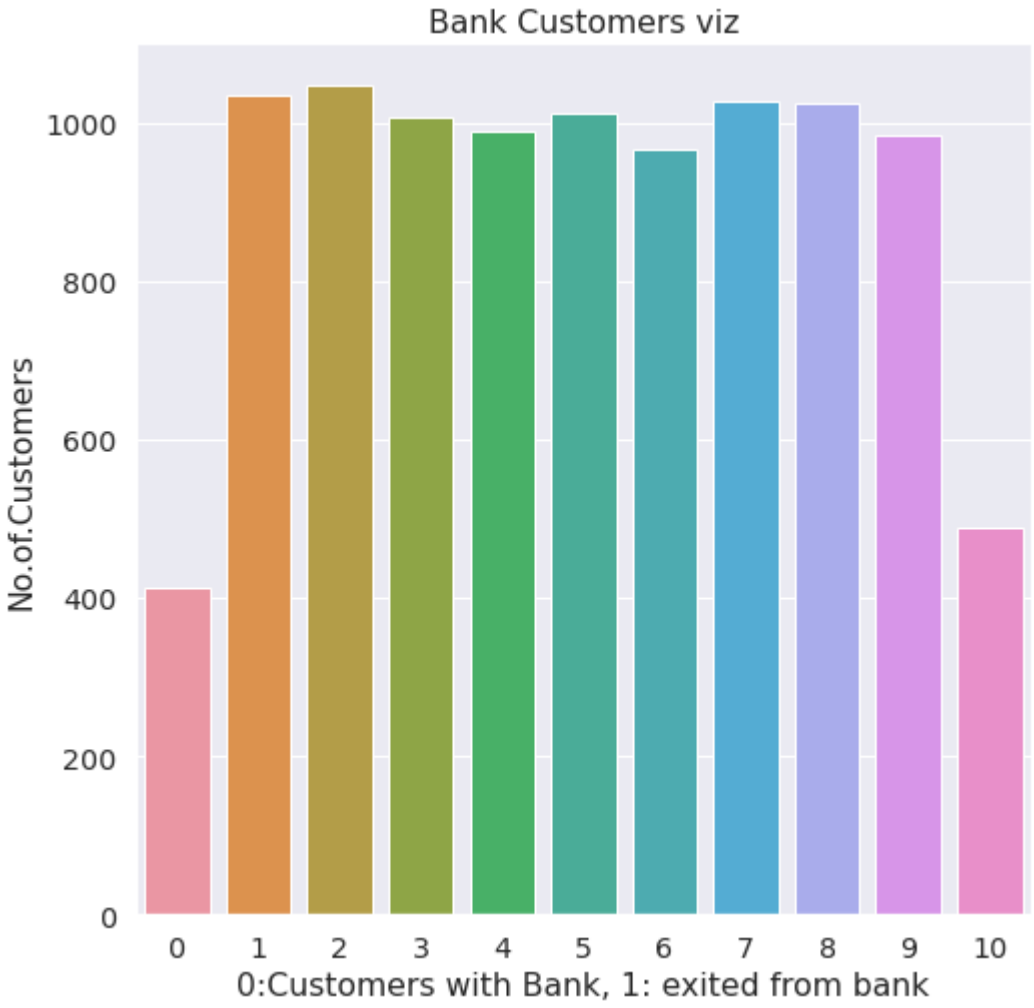
```
df.drop (["RowNumber","CustomerId","Surname"], axis=1, inplace=True)
```

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()
```



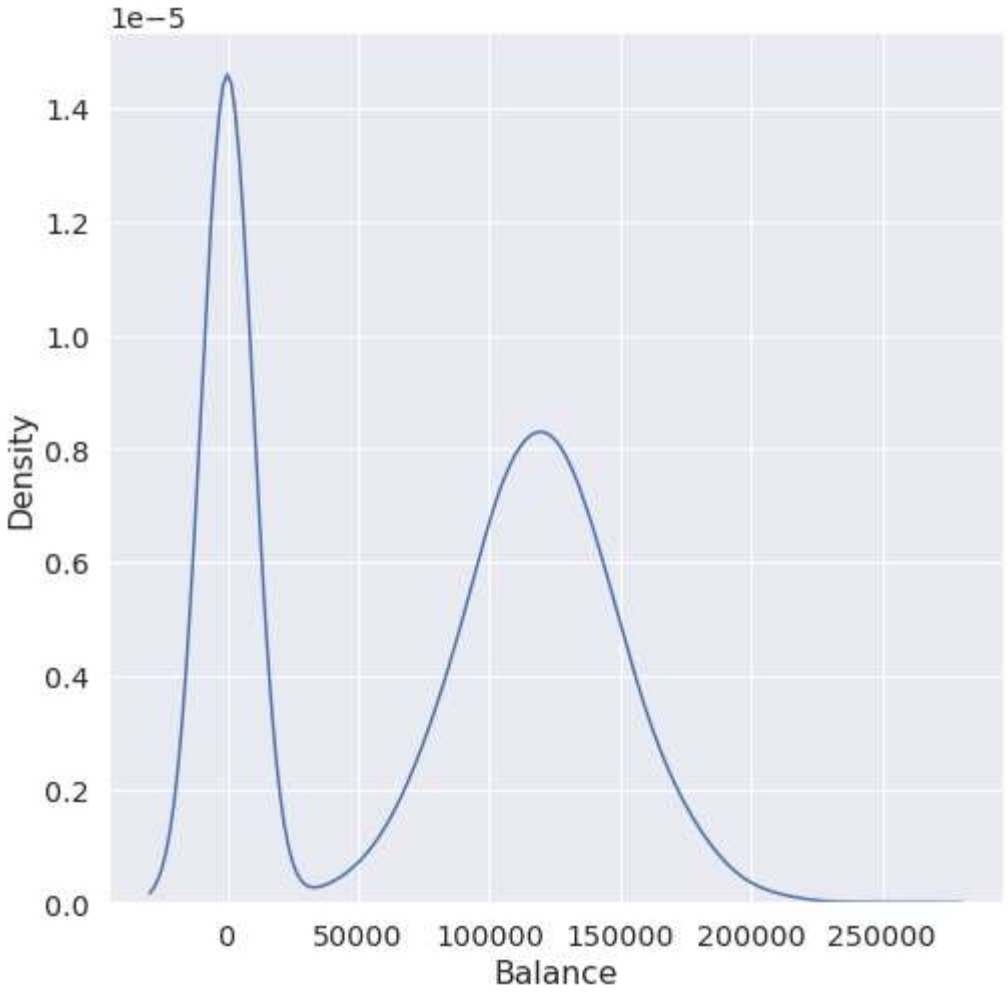
In[9]#Perform Univariate Analysis

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

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

Out[9]:

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

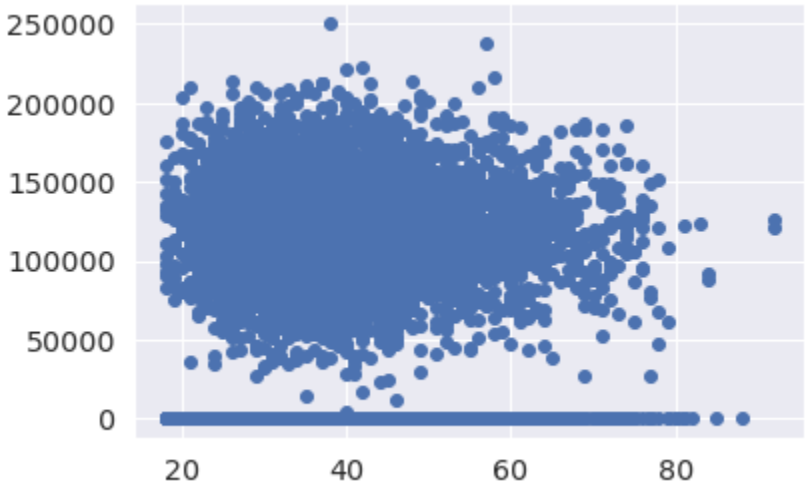


In[10]*#Perform Bivariate Analysis*

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)
```

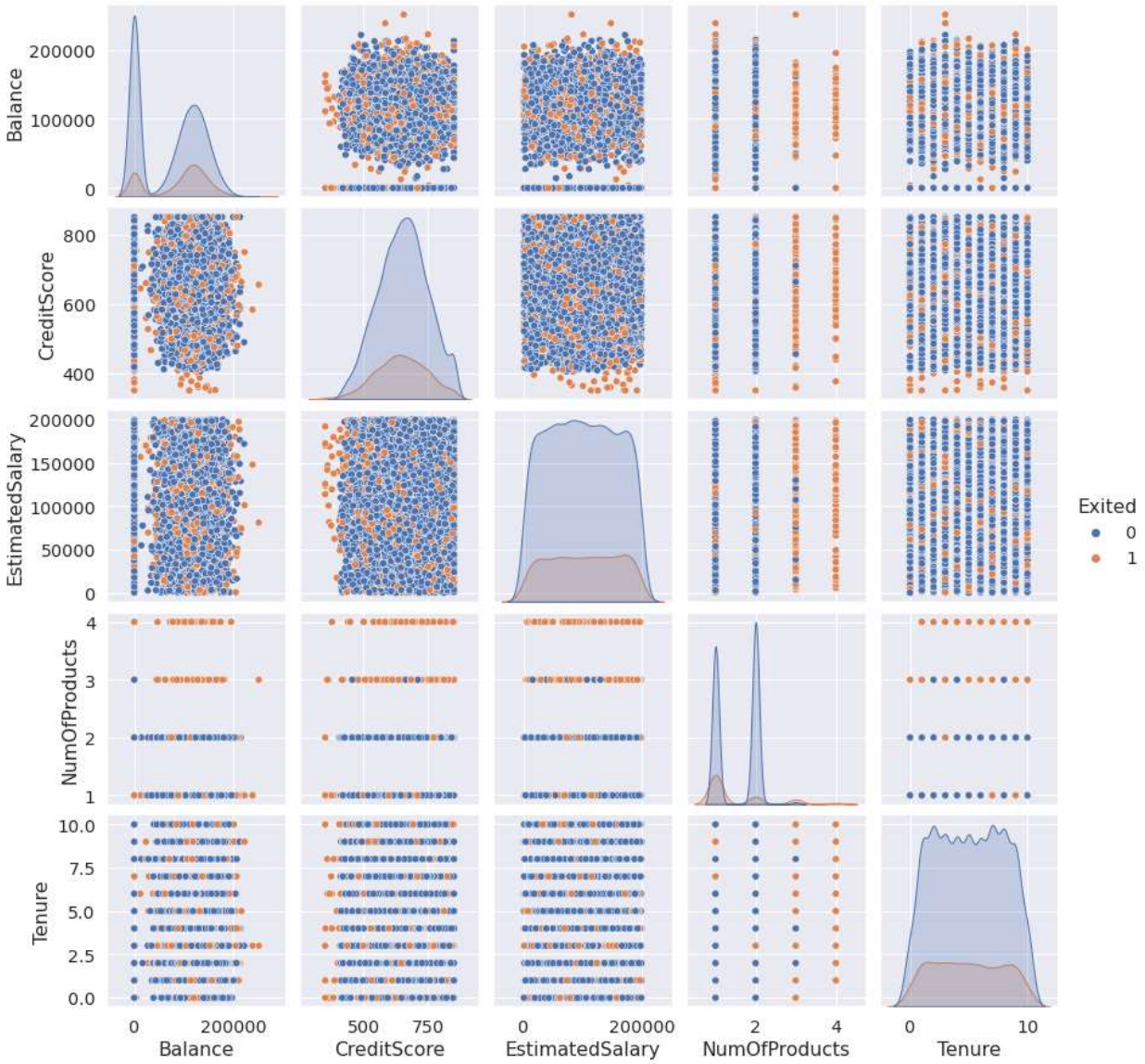
In [35]:

```
#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]:

	Credit Score	**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 [ ]:

#Split the data into training & testing

from sklearn.model_selection **import** train_test_split

In [ ]:

#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 [ ]:

#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