

## ASSIGNMENT-2

Assignment Date	29 September 2022
Name	Aarthi.R
Rollnumber	820319205001
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]:
```

	Row Number	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

	Row Number	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))
```

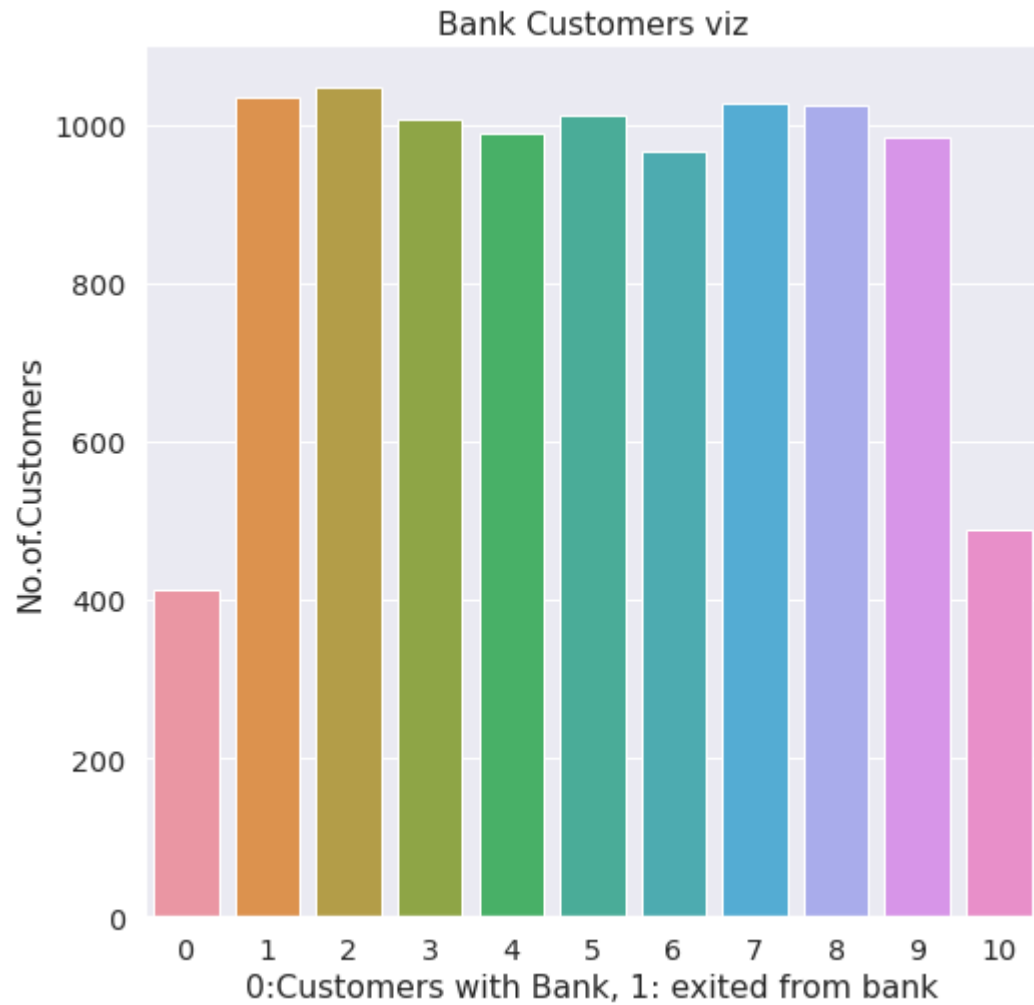
```
sns.countplot(x='Tenure',data=df)
```

```
plt.xlabel('0:Customers with Bank, 1: exited from bank')
```

```
plt.ylabel('No.of.Customers')
```

```
plt.title("Bank Customers viz")
```

```
plt.show()
```



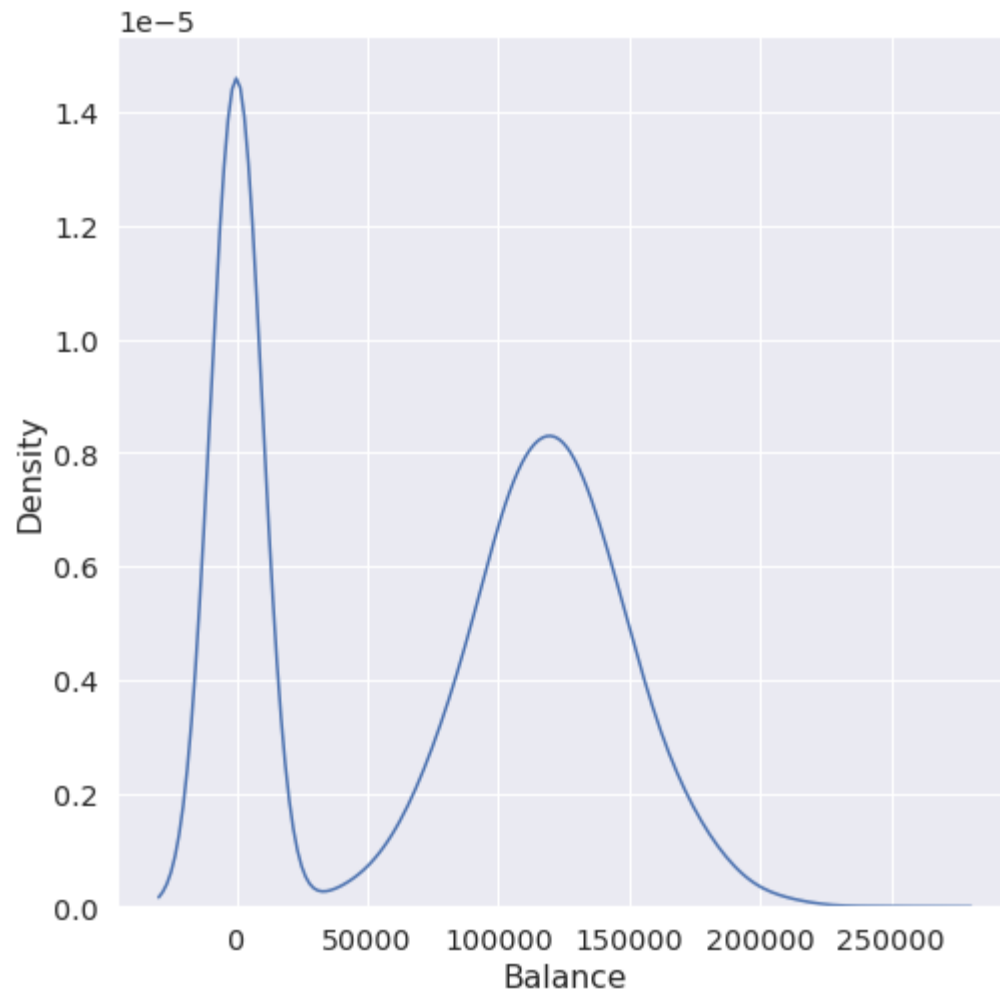
*In[9]#Perform Univariate Analysis*

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

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

Out[9]:

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

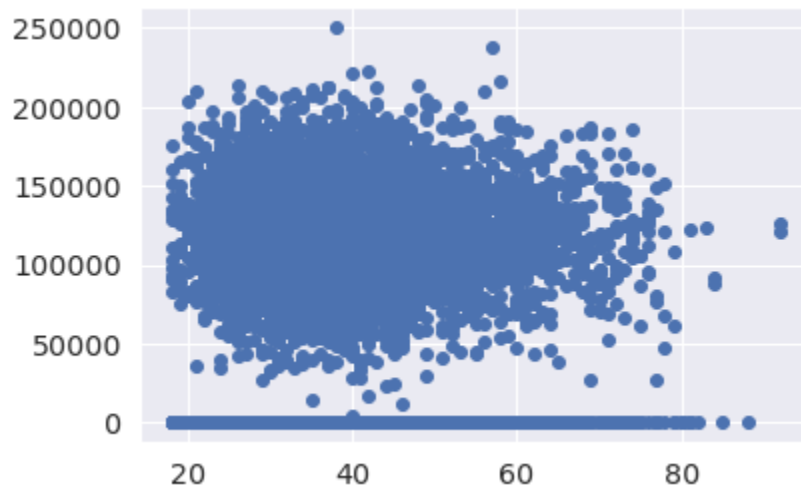


```
In[10]#Perform Bivariate Analysis
```

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

```
Out[10]:
```

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



*#Perform Bivariate Analysis*

df.corr()

Out[54]:

	Credit Score	Gen der	Age	Tenu re	Bala nce	NumOfP roducts	HasCr Card	IsActive Member	Estimate dSalary	Exite d
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

	Credit Score	Gen der	Age	Tenu re	Bala nce	NumOfP roducts	HasCr Card	IsActive Member	Estimate dSalary	Exite d
<b>NumOfPr oducts</b>	0.012 238	0.00 3972	- 0.03 0680	0.01 3444	- 0.30 4180	1.000000	0.003 183	0.009612	0.014204	- 0.04 7820
<b>HasCrCar d</b>	- 0.005 458	- 0.00 8523	- 0.01 1721	0.02 2583	- 0.01 4858	0.003183	1.000 000	- 0.011866	- 0.009933	- 0.00 7138
<b>IsActive Member</b>	0.025 651	0.00 6724	0.08 5472	- 0.02 8362	- 0.01 0084	0.009612	- 0.011 866	1.000000	- 0.011421	- 0.15 6128
<b>Estimate dSalary</b>	- 0.001 384	- 0.00 1369	- 0.00 7201	0.00 7784	0.01 2797	0.014204	- 0.009 933	- 0.011421	1.000000	0.01 2097
<b>Exited</b>	- 0.027 094	0.03 5943	0.28 5323	- 0.01 4001	0.11 8533	- 0.047820	- 0.007 138	- 0.156128	0.012097	1.00 0000

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
```

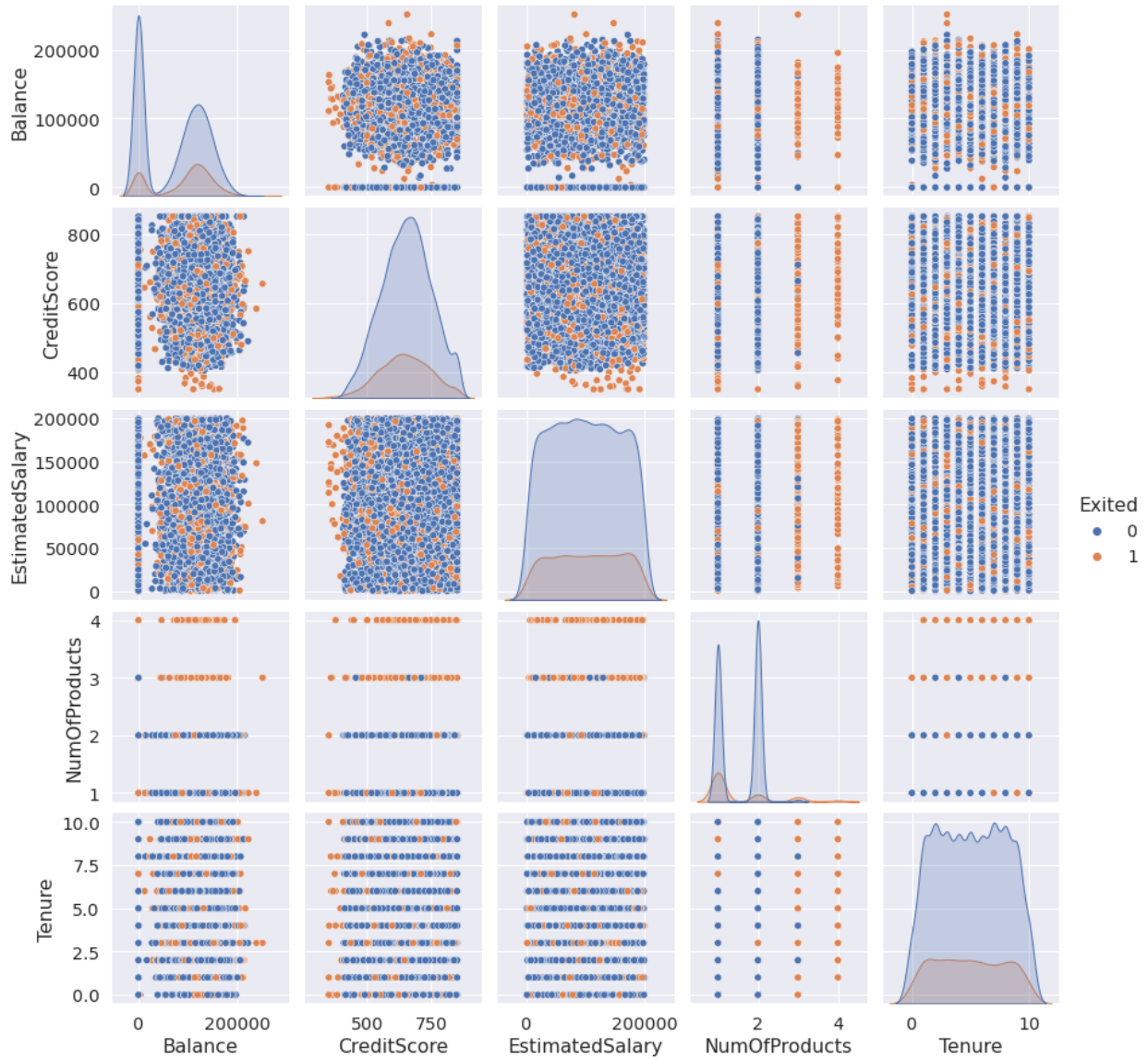
```
plt.figure(figsize=(4,4))
```

```
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]:

[illegible]

[illegible]

10000 rows x 11 columns

In [42]:

## #Handling with missing Values

```
df.notnull()#Checking values are not null
```

Out[42]:

[illegible]

	Credit Score	Geogr aphy	Gen der	Ag e	Ten ure	Bala nce	NumOfPr oducts	HasCr Card	IsActiveM ember	Estimate dSalary	Exit ed
3	True	True	True	True	True	True	True	True	True	True	True
4	True	True	True	True	True	True	True	True	True	True	True
...	...	...	...	...	...	...	...	...	...	...	...
99 95	True	True	True	True	True	True	True	True	True	True	True
99 96	True	True	True	True	True	True	True	True	True	True	True
99 97	True	True	True	True	True	True	True	True	True	True	True
99 98	True	True	True	True	True	True	True	True	True	True	True
99 99	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]),)
```

<b>9995</b>	771	France	0	39	5	0.00	2	1	0	96270.64	0
<b>9996</b>	516	France	0	35	10	57369.61	1	1	1	101699.77	0
<b>9997</b>	709	France	0	36	7	0.00	1	0	1	42085.58	1
<b>9998</b>	772	Germany	1	42	3	75075.31	2	1	0	92888.52	1
<b>9999</b>	792	France	0	28	4	130142.79	1	1	0	38190.78	0

10000 rows x 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

