```python
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)
```

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

```python
df.head()
```

	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
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

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

```python
df.info()
```

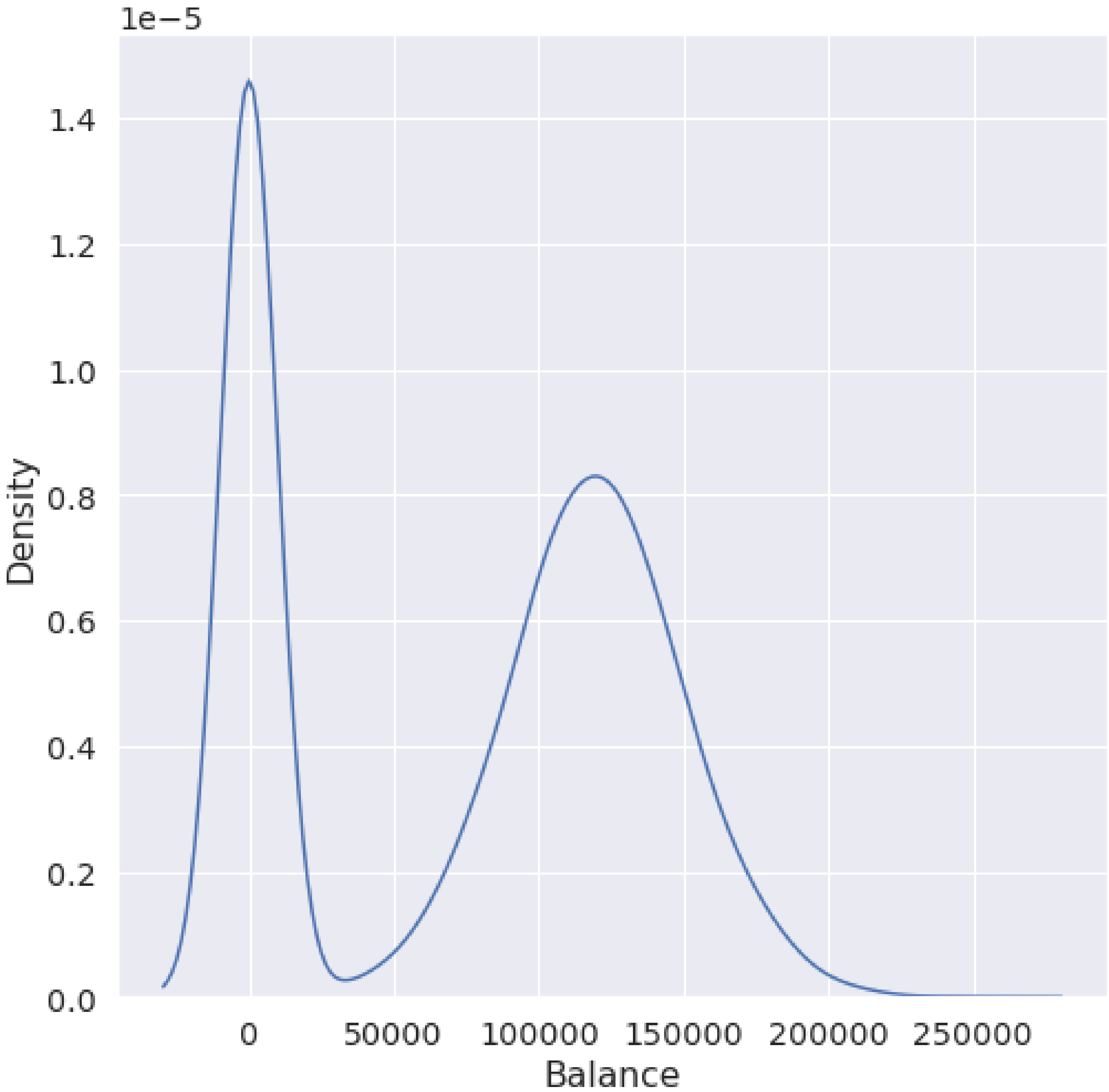
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 10000 entries, 0 to 9999
Data columns (total 11 columns):
 #   Column           Non-Null Count  Dtype  
---  ------           --------------  -----  
 0   CreditScore      10000 non-null  int64  
 1   Geography        10000 non-null  object 
 2   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()
```

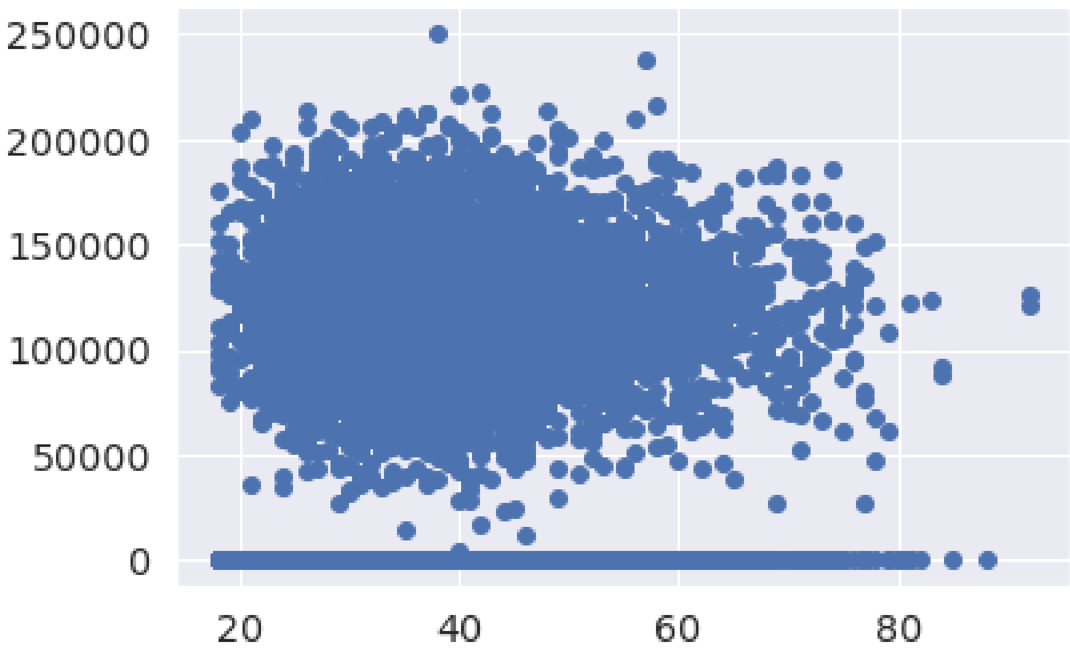
```
#Perform Univariate Analysis
plt.figure(figsize=(8,8))
sns.kdeplot(x=df['Balance'])
```

```
<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**	**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

```
#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())
```

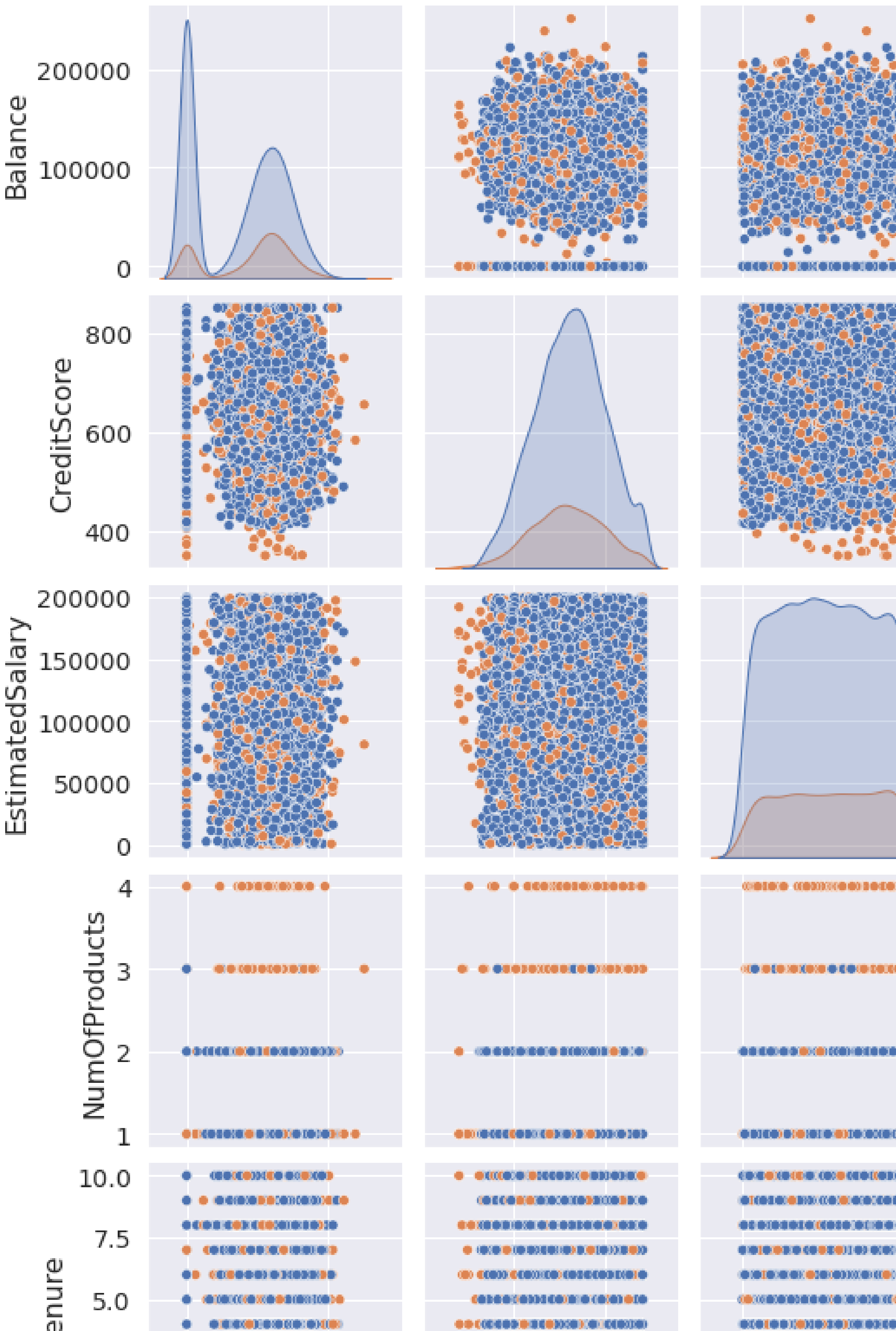
```
                     OLS Regression Results
==============================================================================
Dep. Variable:          CreditScore   R-squared:                       0.000
Model:                          OLS   Adj. R-squared:                 -0.000
Method:               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.
```

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

```
<seaborn.axisgrid.PairGrid at 0x7fa0b00a1b10>
<Figure size 288x288 with 0 Axes>
```



Balance
200000
100000
0
CreditScore
800
600
400
EstimatedSalary
200000
150000
100000
50000
0
NumOfProducts
4
3
2
1
enure
10.0
7.5
5.0

```
#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
----------------------------------
```

```
#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
-------------------------------
```

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

	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

	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
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
...	...	...	...	...	...	...	...	...	...	...	...
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

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

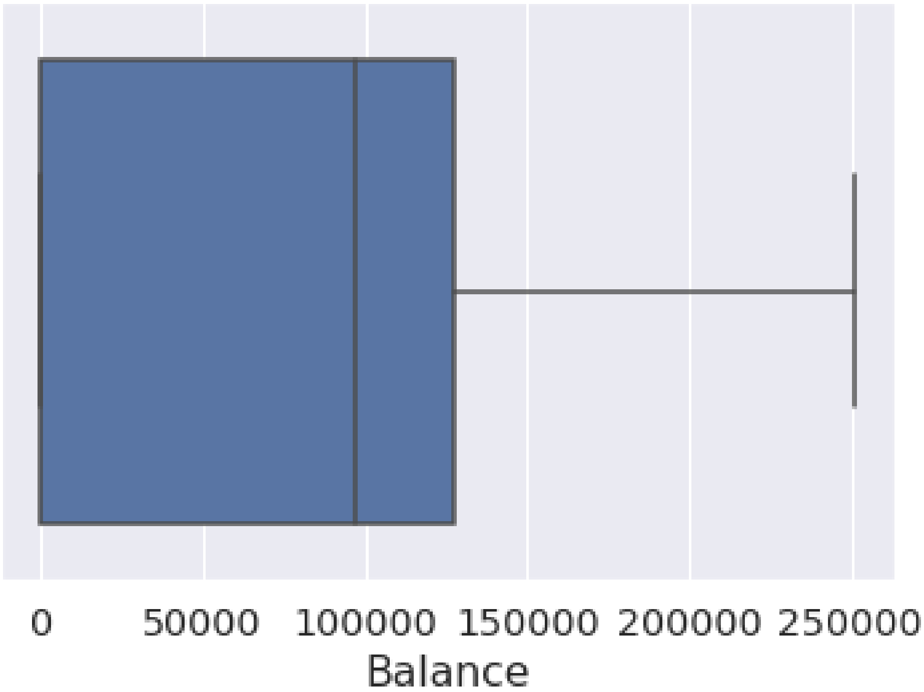
	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
0	True	True	True	True	True	True	True	True	True	True	True
1	True	True	True	True	True	True	True	True	True	True	True
2	True	True	True	True	True	True	True	True	True	True	True

	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

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

<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	HasCrCard	IsActiveMember	EstimatedSalary	Exited
0	619	France	0	42	2	0.00	1	1	1	101348.88	1
1	608	Spain	2	41	1	83807.86	1	0	1	112542.58	0
2	502	France	0	42	8	159660.80	3	1	0	113931.57	1
3	699	France	0	39	1	0.00	2	0	0	93826.63	0
4	850	Spain	2	43	2	125510.82	1	1	1	79084.10	0
...	...	...	...	...	...	...	...	...	...	...	...
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

```
#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]]
```

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

```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
```

	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

```python
#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
```