

```
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("C:\Users\varsh\OneDrive\Desktop/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

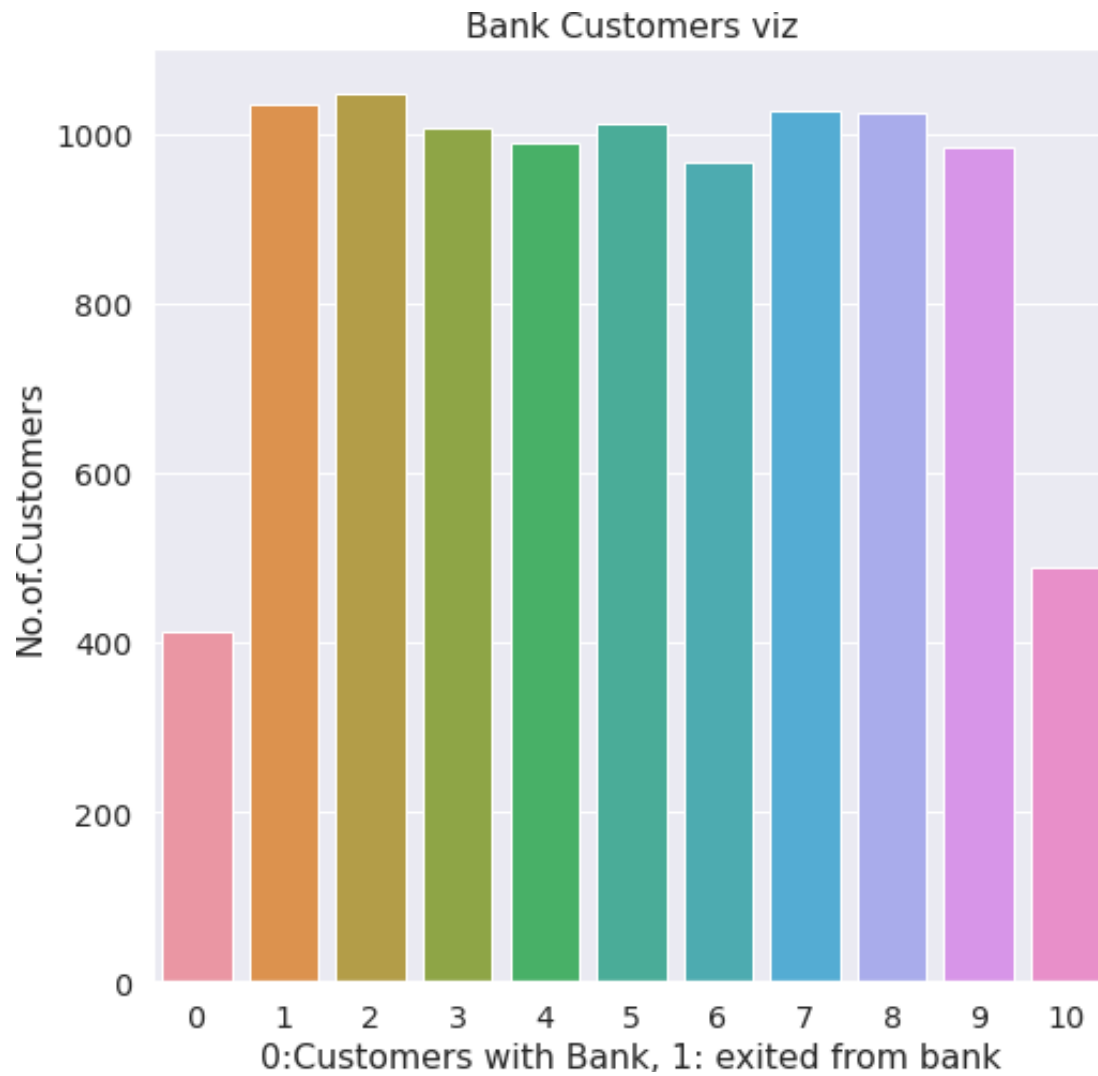
```
df.drop(["RowNumber", "CustomerId", "Surname"], axis=1, inplace=True)
```

```
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()
```

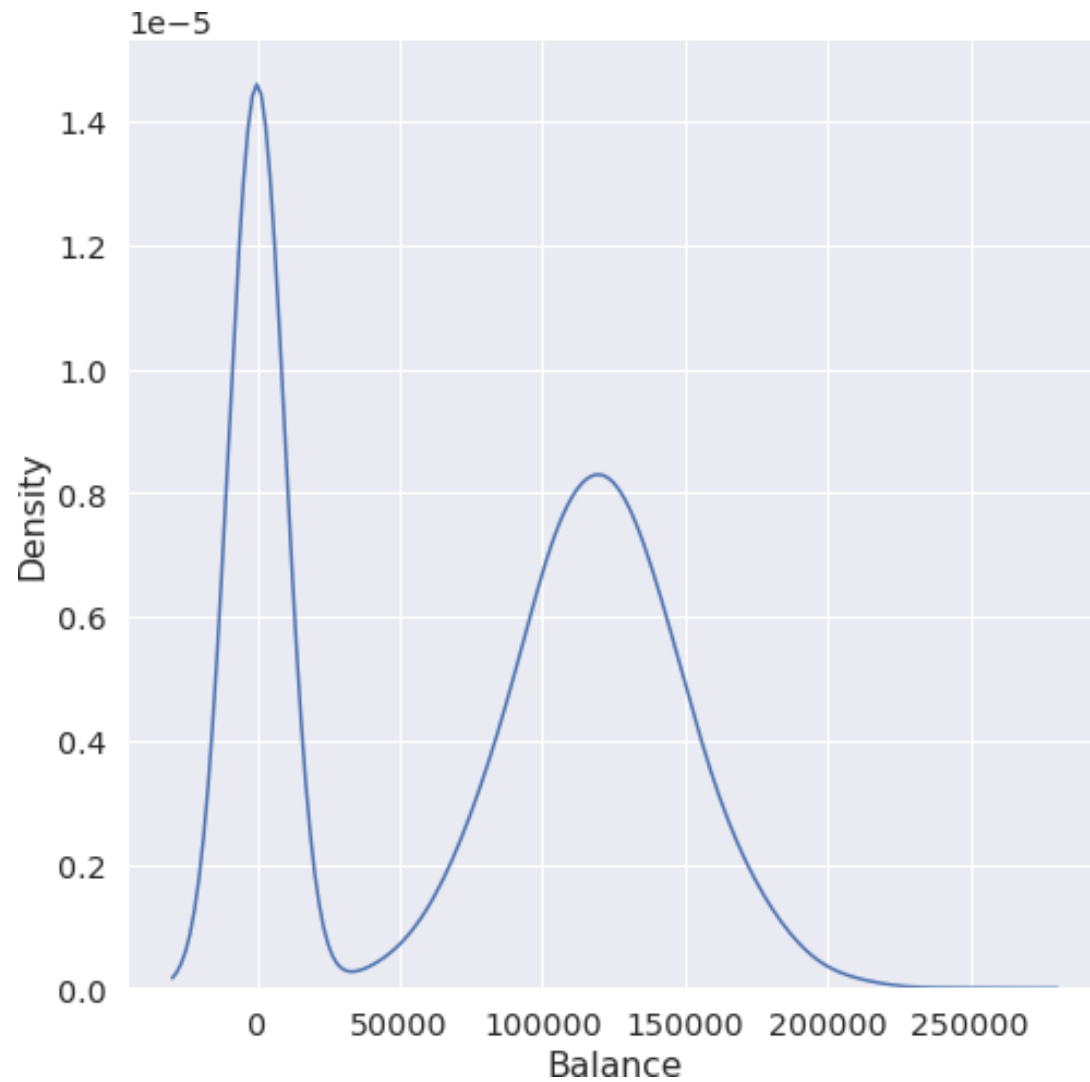


#Perform Univariate Analysis

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

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

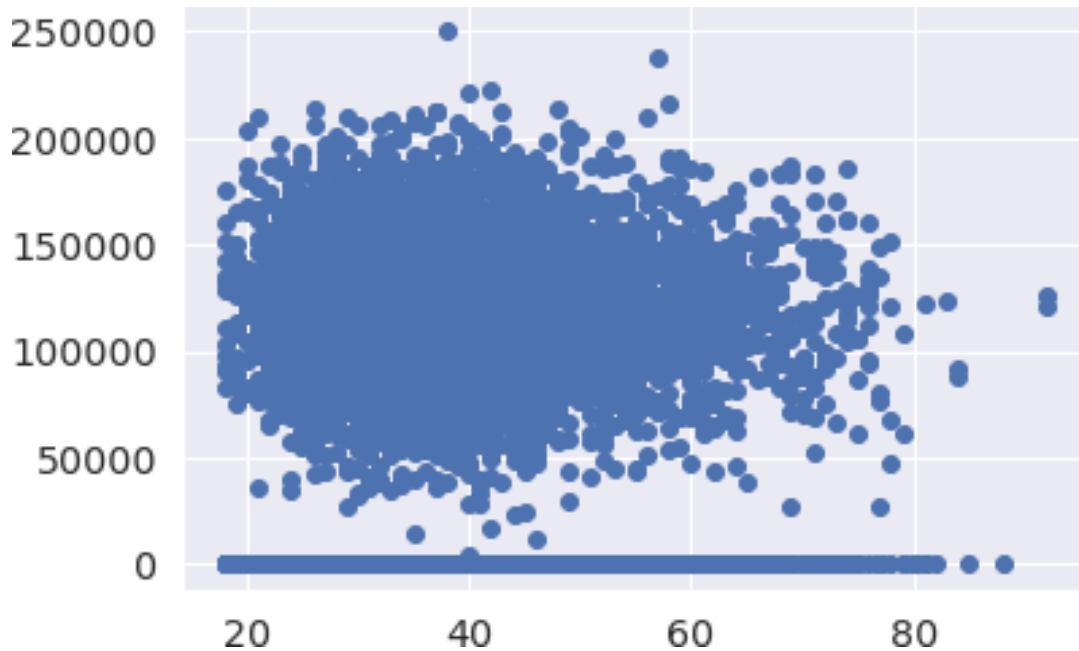
<matplotlib.axes._subplots.AxesSubplot at 0x7fa0c03906d0>



#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      -3.53e-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)
```

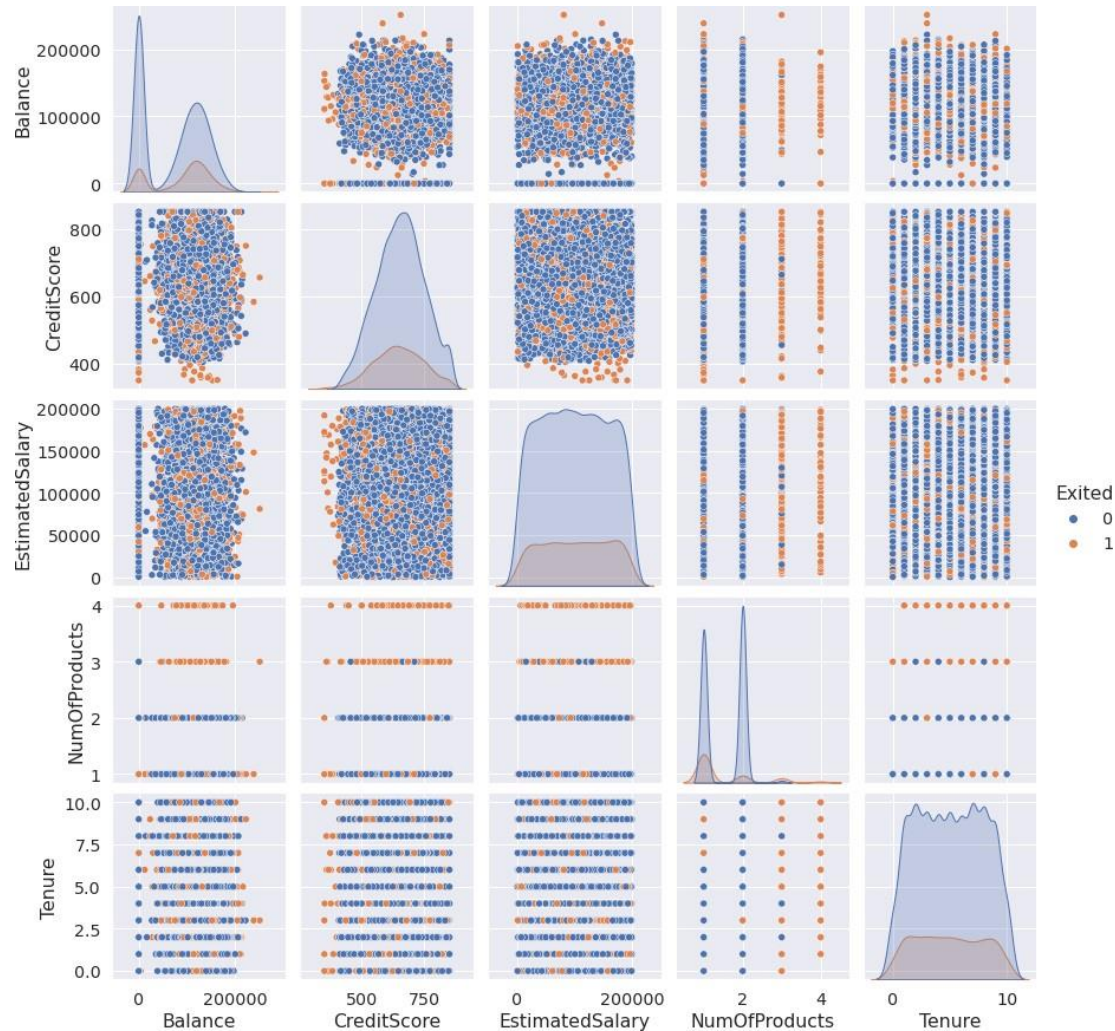
#Perform Multivariate Analysis

```
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>



#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      0
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
```

[illegible]

	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

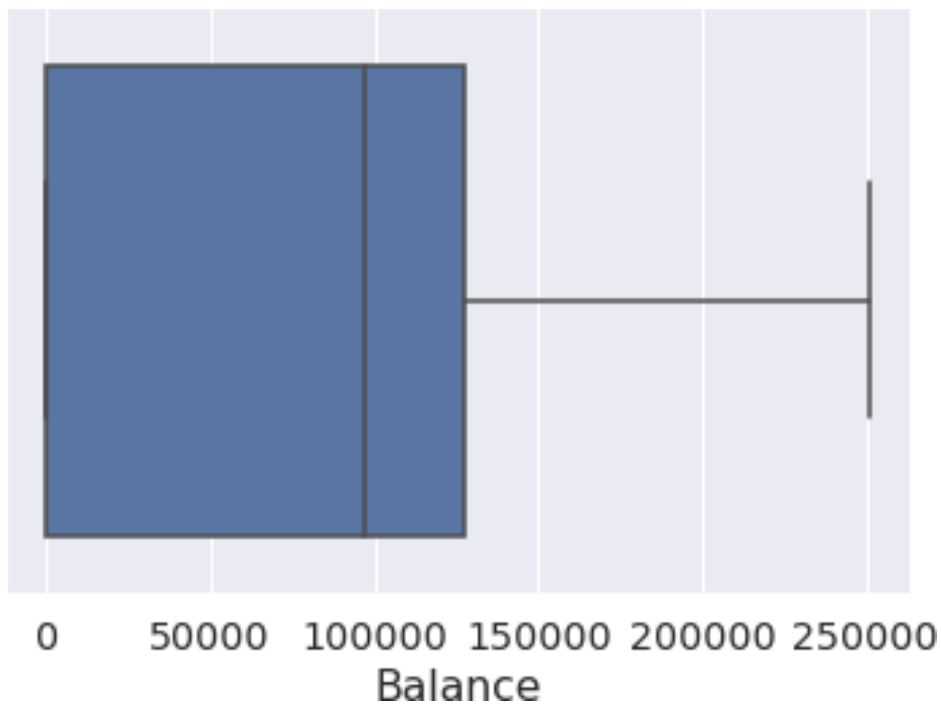
`sns.boxplot(df['Balance'])`

/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