

## Assignment -2

### Python Programming

Assignment Date	29 September 2022
Student Name	Mr. T.L.Sureeth
Student Roll Number	113219071044
Maximum Marks	2 Marks

## Download the Dataset

[Churn\\_Modelling.csv](#) | Kaggle

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

## Dataset loading

Solution :

```
data = pd.read_csv(r'C:\Users\Sureeth\Desktop\Churn_Modelling.csv')
data.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

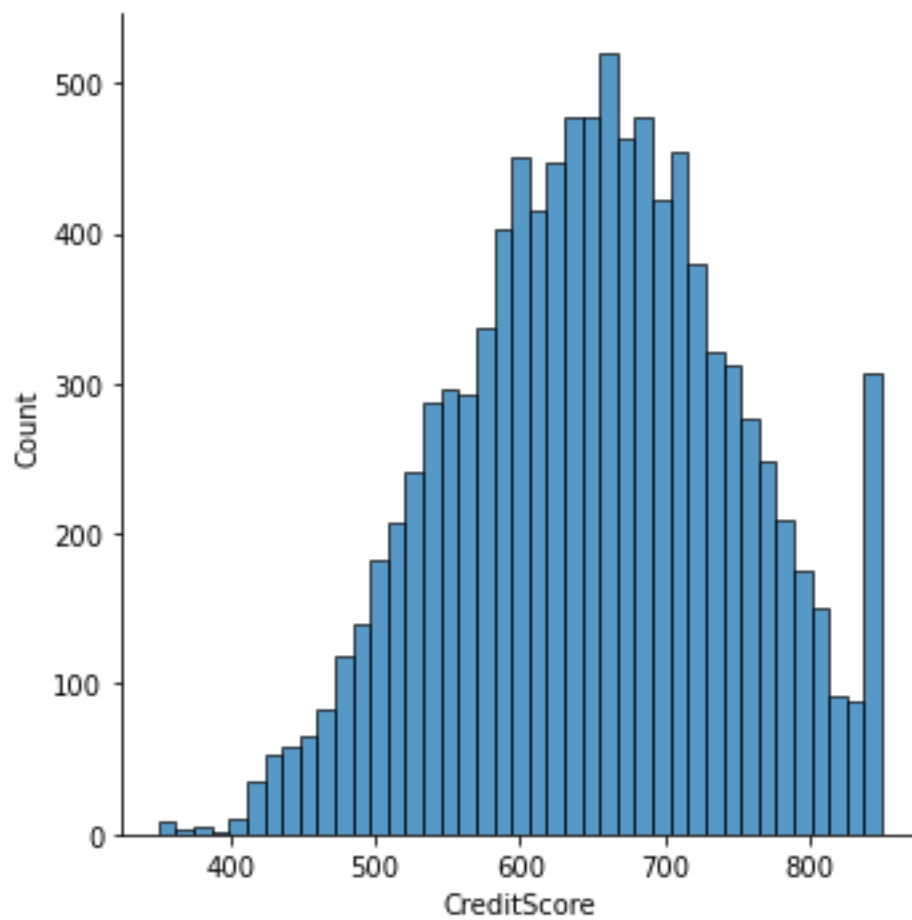
## Visualizations

### Univariate Analysis

Solution :

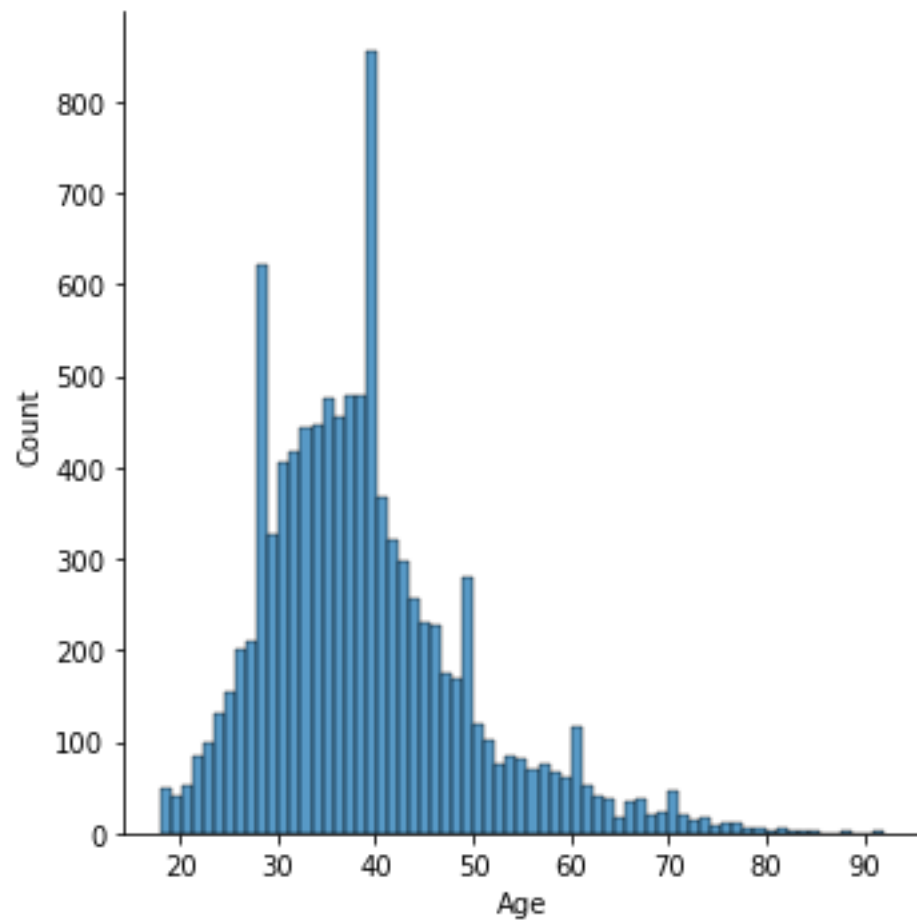
```
sns.displot(data.CreditScore)
```

```
<seaborn.axisgrid.FacetGrid at 0x26bd9c96610>
```



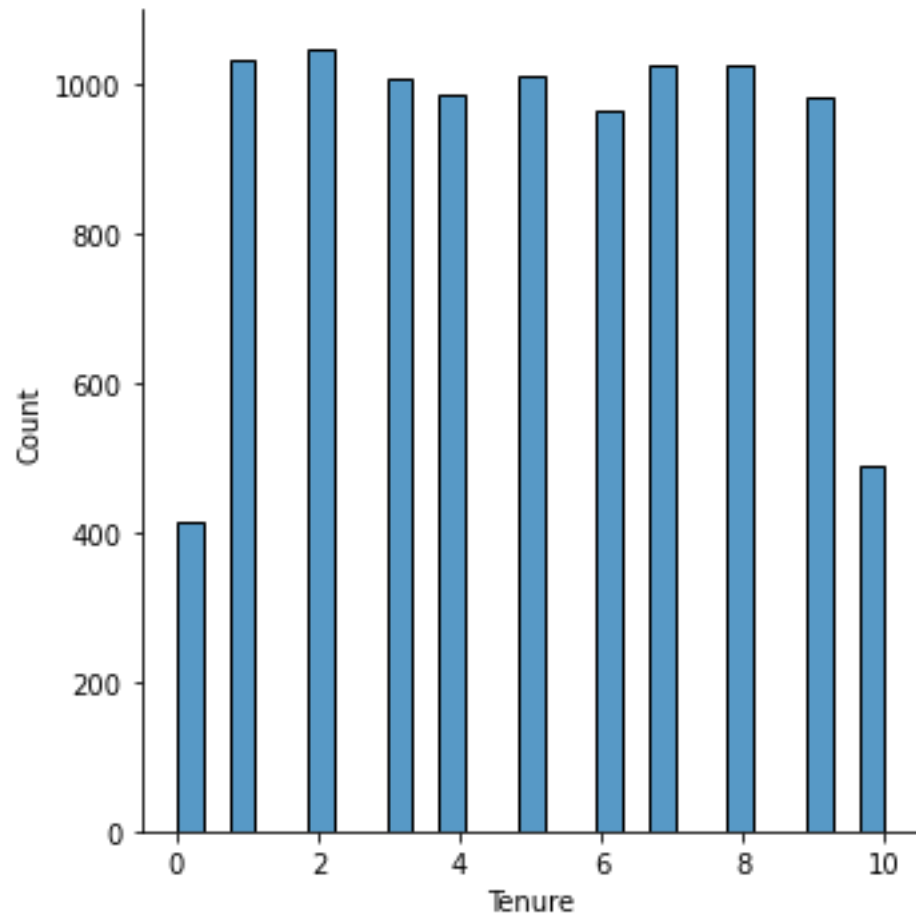
```
sns.displot(data.Age)
```

```
<seaborn.axisgrid.FacetGrid at 0x26bf8f28490>
```



```
sns.displot(data.Tenure)
```

```
<seaborn.axisgrid.FacetGrid at 0x26bf6cd5f70>
```

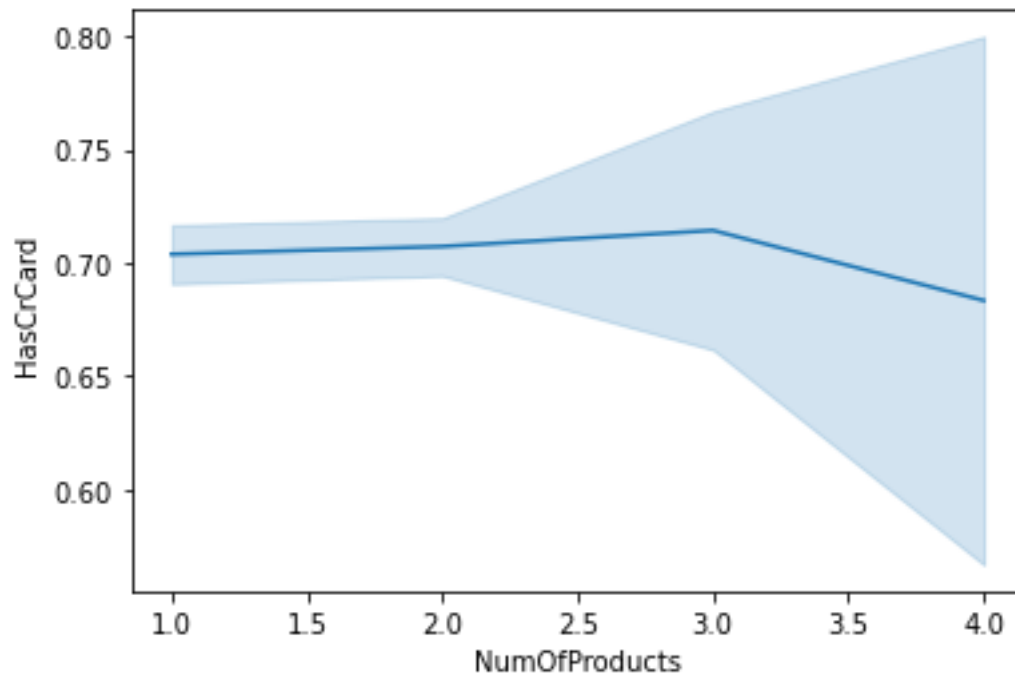


## Bi-Variate Analysis

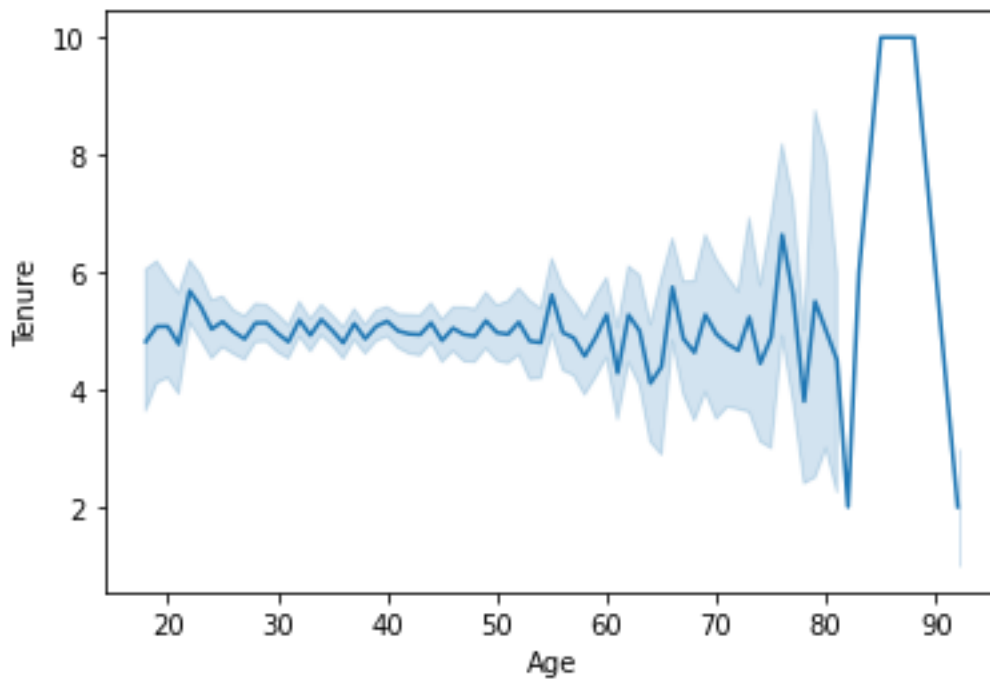
Solution :

```
sns.lineplot(x=data.NumOfProducts, y=data.HasCrCard)
```

```
<AxesSubplot:xlabel='NumOfProducts', ylabel='HasCrCard'>
```



```
sns.lineplot(x=data.Age, y=data.Tenure)
<AxesSubplot:xlabel='Age', ylabel='Tenure'>
```



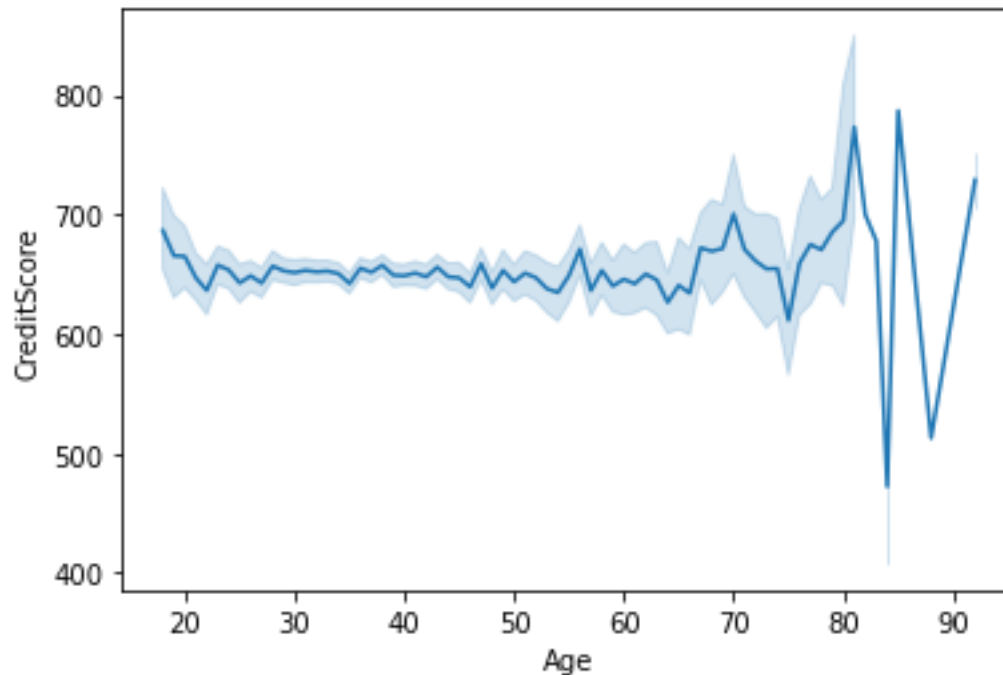
```
sns.lineplot(data.Age,data.CreditScore)
```

C:\Users\vijay\anaconda3\lib\site-packages\seaborn\\_decorators.py:36:  
FutureWarning: Pass the following variables as keyword args: x, y. 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.

```
warnings.warn(
```

```
<AxesSubplot:xlabel='Age', ylabel='CreditScore'>
```

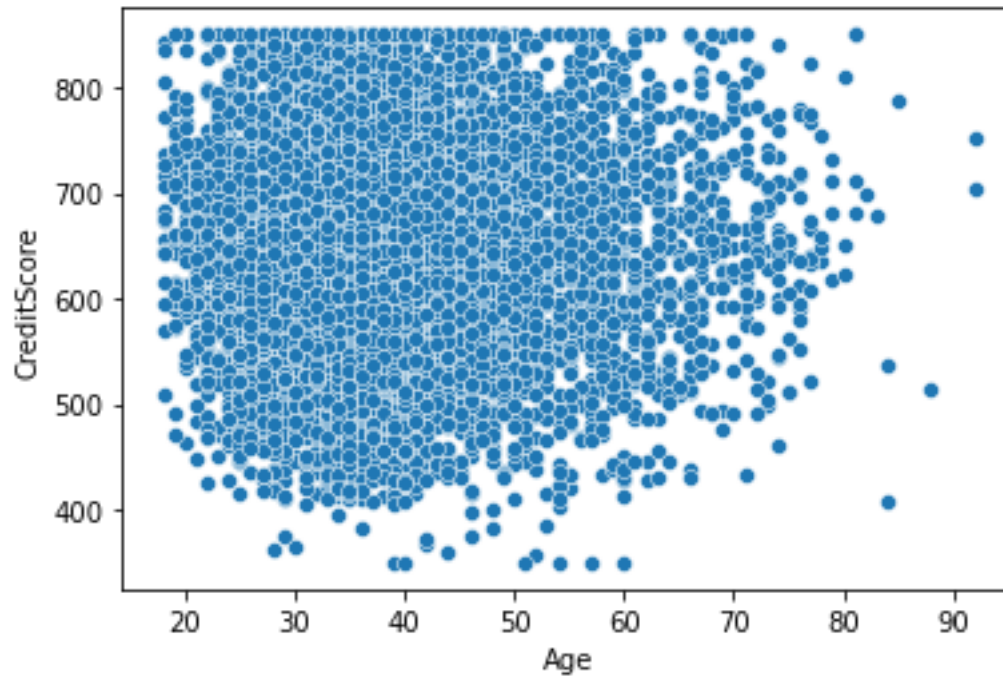


```
sns.scatterplot(data.Age,data.CreditScore)
```

C:\Users\vijay\anaconda3\lib\site-packages\seaborn\\_decorators.py:36:  
FutureWarning: Pass the following variables as keyword args: x, y. 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.

```
warnings.warn(
```

```
<AxesSubplot:xlabel='Age', ylabel='CreditScore'>
```



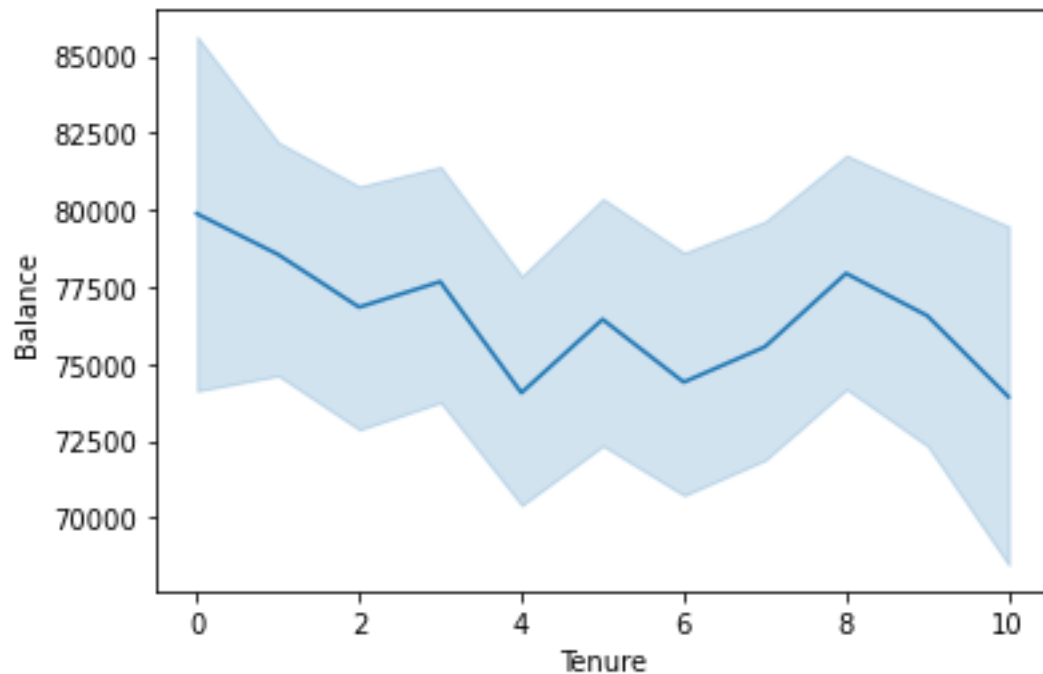
```
sns.lineplot(data.Tenure,data.Balance)
```

```
C:\Users\vijay\anaconda3\lib\site-packages\seaborn\_decorators.py:36:  
FutureWarning: Pass the following variables as keyword args: x, y. 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.
```

```
warnings.warn(  

```

```
<AxesSubplot:xlabel='Tenure', ylabel='Balance'>
```



```
sns.scatterplot(data.Tenure,data.Balance)
```

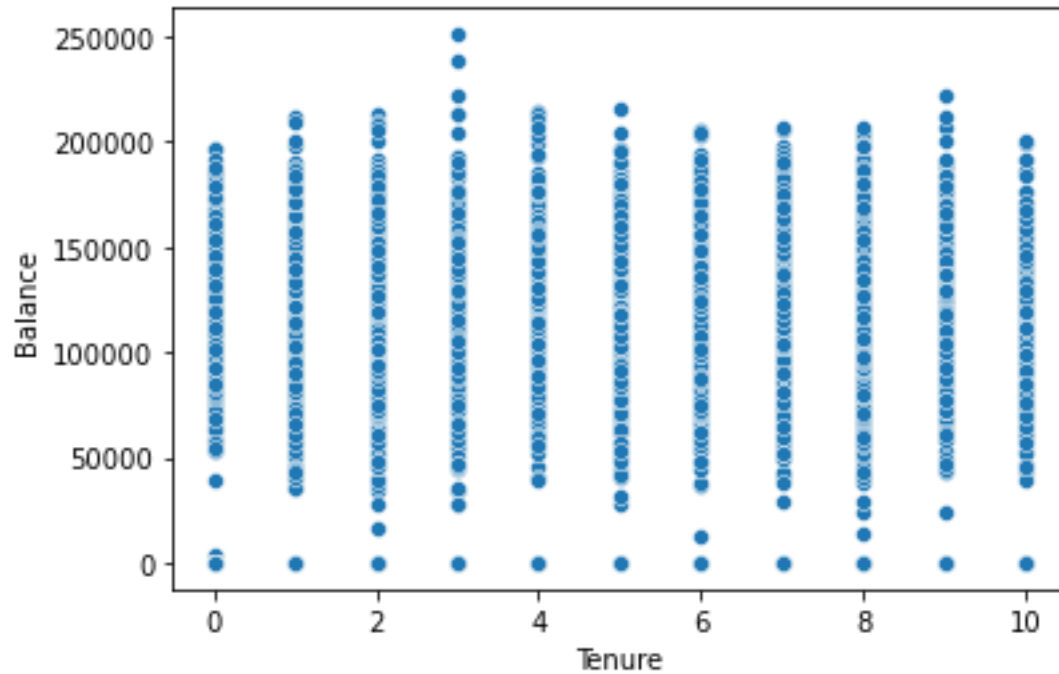
```
C:\Users\vijay\anaconda3\lib\site-packages\seaborn\_decorators.py:36:  
FutureWarning: Pass the following variables as keyword args: x, y. From  
version 0.12, the only valid positional argument will be `data`, and passing  
other arguments without an explicit keyword will result in an error or  
misinterpretation.
```

```
warnings.warn(  

```

```
<AxesSubplot:xlabel='Tenure', ylabel='Balance'>
```





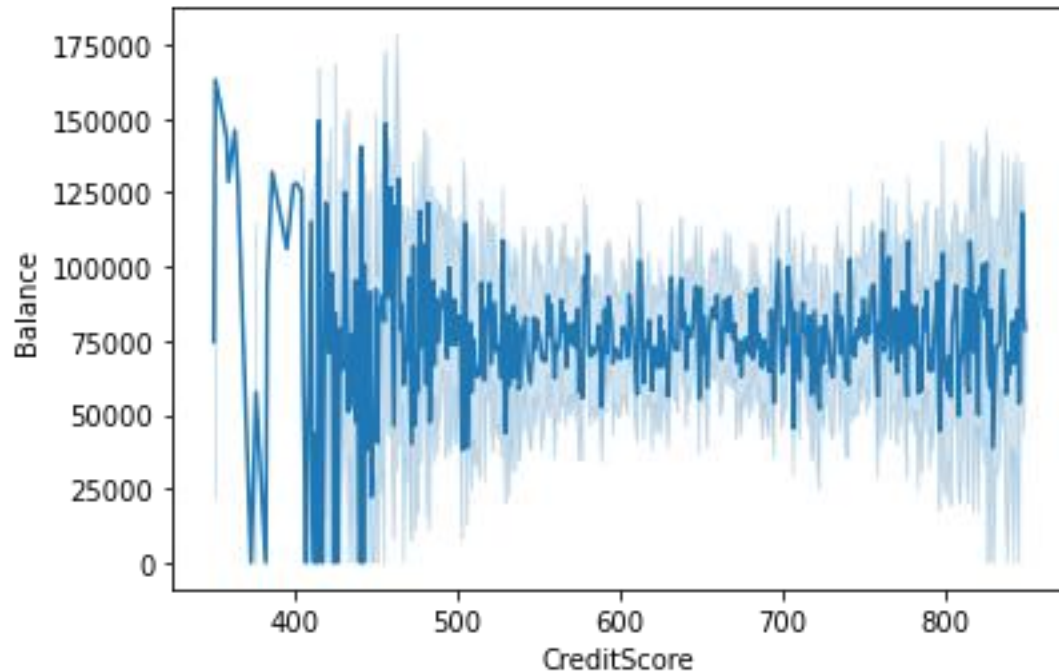
```
sns.lineplot(data.CreditScore,data.Balance)
```

```
C:\Users\vijay\anaconda3\lib\site-packages\seaborn\_decorators.py:36:  
FutureWarning: Pass the following variables as keyword args: x, y. 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.
```

```
warnings.warn(  

```

```
<AxesSubplot:xlabel='CreditScore', ylabel='Balance'>
```



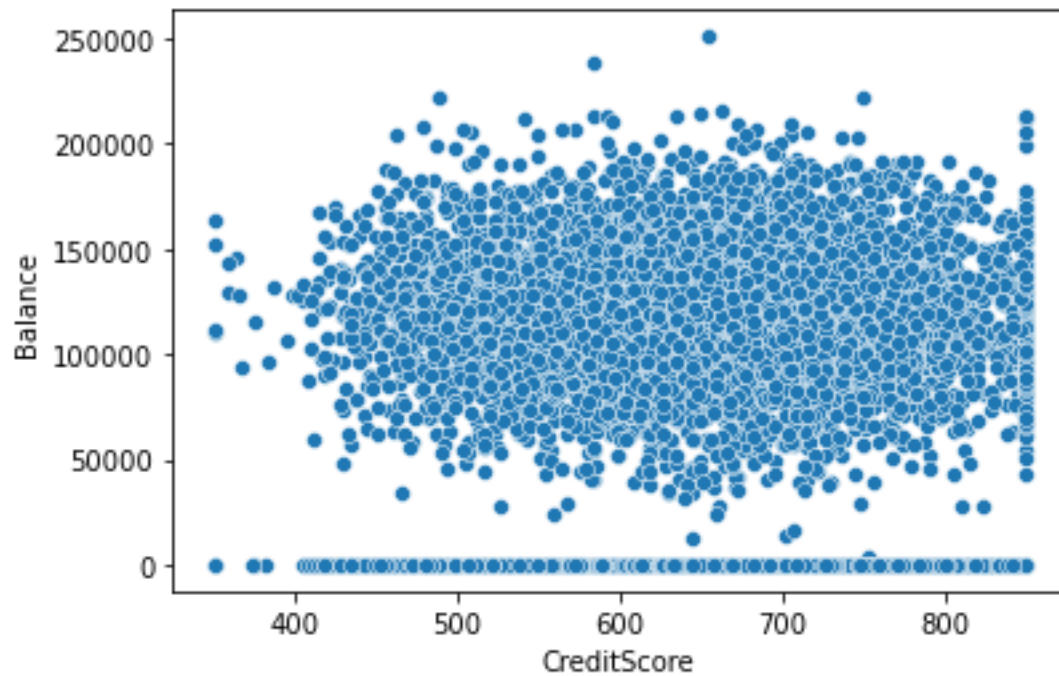
```
sns.scatterplot(data.CreditScore,data.Balance)
```

```
C:\Users\vijay\anaconda3\lib\site-packages\seaborn\_decorators.py:36:  
FutureWarning: Pass the following variables as keyword args: x, y. 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.
```

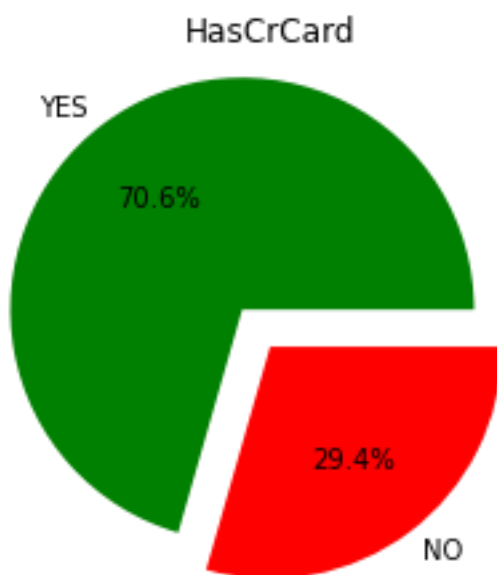
```
warnings.warn(  

```

```
<AxesSubplot:xlabel='CreditScore', ylabel='Balance'>
```



```
plt.pie(data.HasCrCard.value_counts(), [0.2, 0], labels=['YES', 'NO'], autopct="%1
.1f%", colors=['green', 'red'])
plt.title('HasCrCard')
Text(0.5, 1.0, 'HasCrCard')
```



```
data.HasCrCard.value_counts()
```

```
1    7055
```

```
0    2945
```

```
Name: HasCrCard, dtype: int64
```

```
sns.barplot(data.Geography.value_counts().index,data.Geography.value_counts()  
)
```

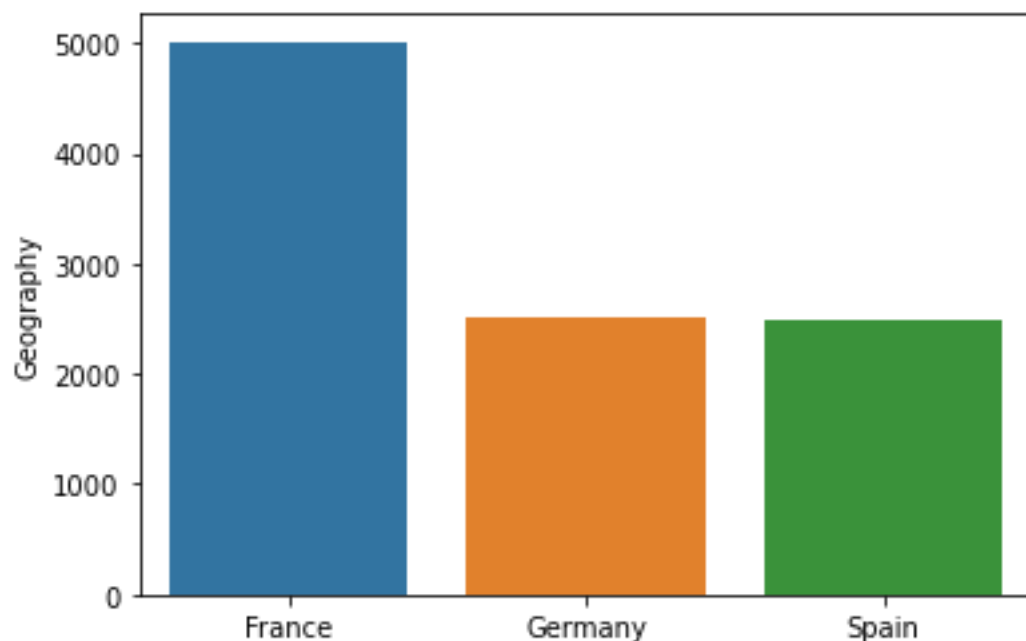
```
C:\Users\vijay\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
```

```
FutureWarning: Pass the following variables as keyword args: x, y. 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.
```

```
warnings.warn(  

```

```
<AxesSubplot:ylabel='Geography'>
```



```
sns.barplot(data.Gender.value_counts().index,data.Gender.value_counts())
```

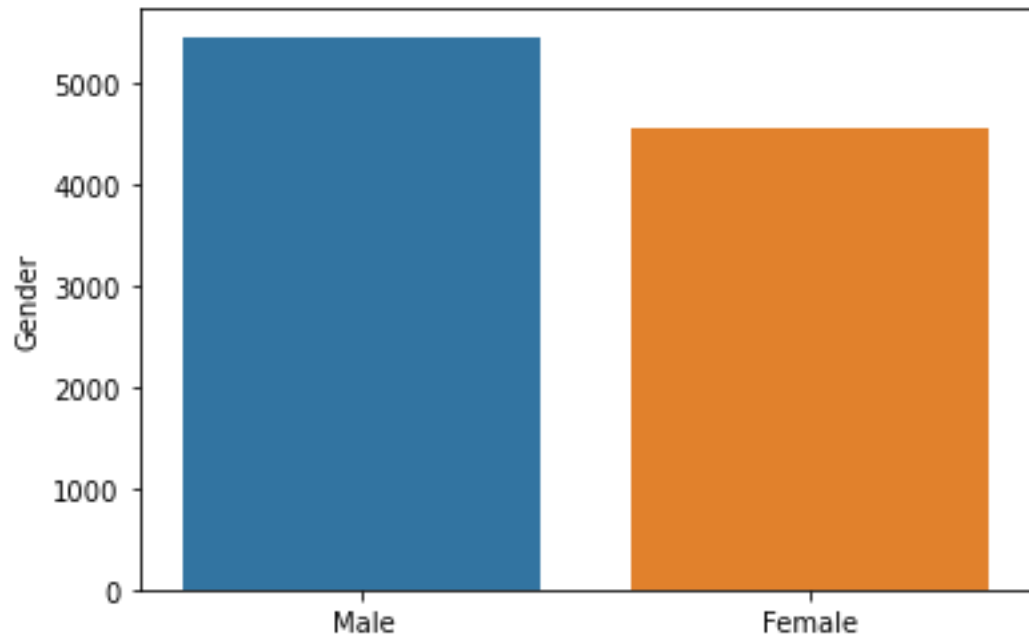
```
C:\Users\vijay\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
```

```
FutureWarning: Pass the following variables as keyword args: x, y. 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.
```

```
warnings.warn(  

```

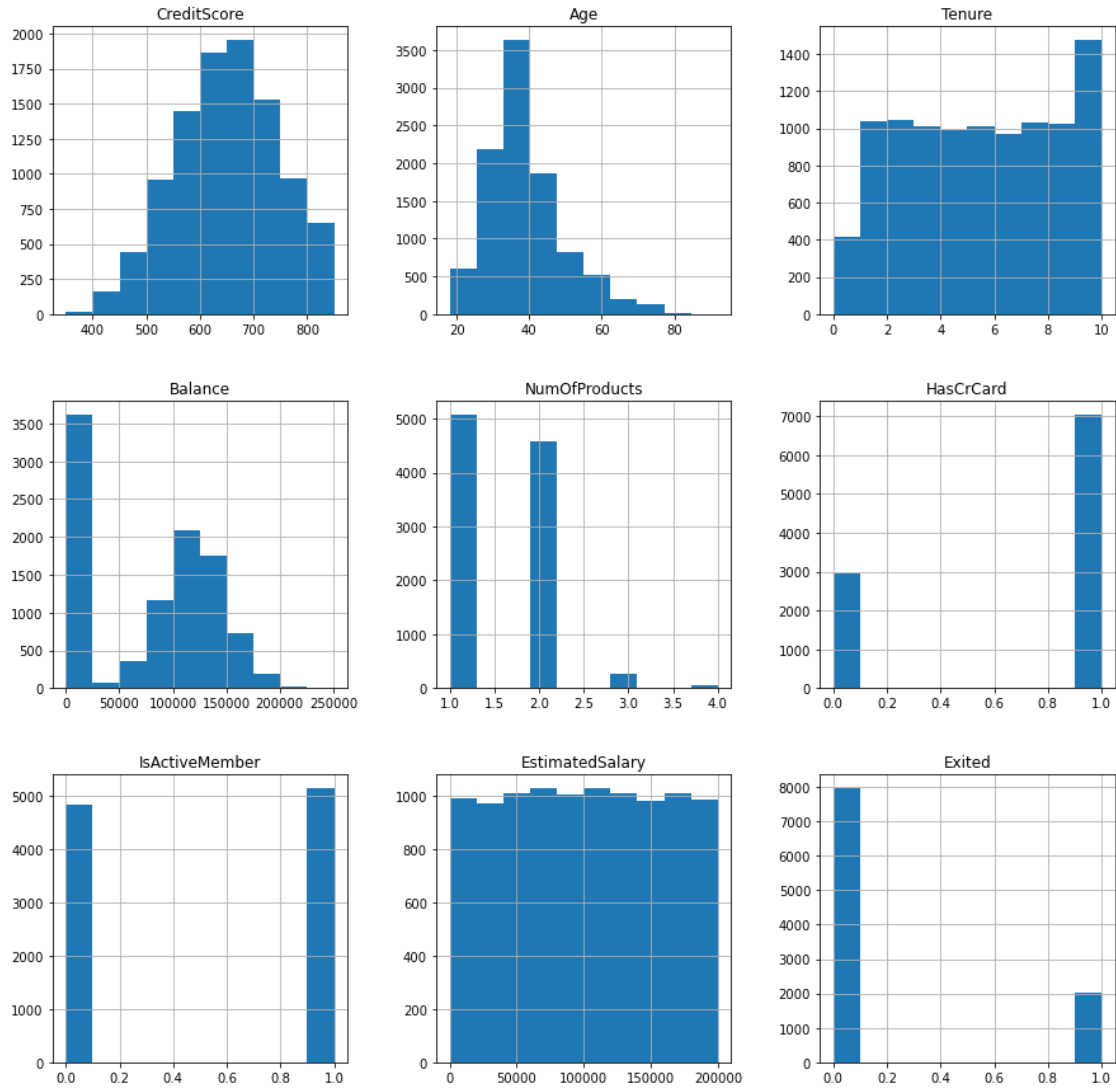
```
<AxesSubplot:ylabel='Gender'>
```



## Multi-Variate Analysis

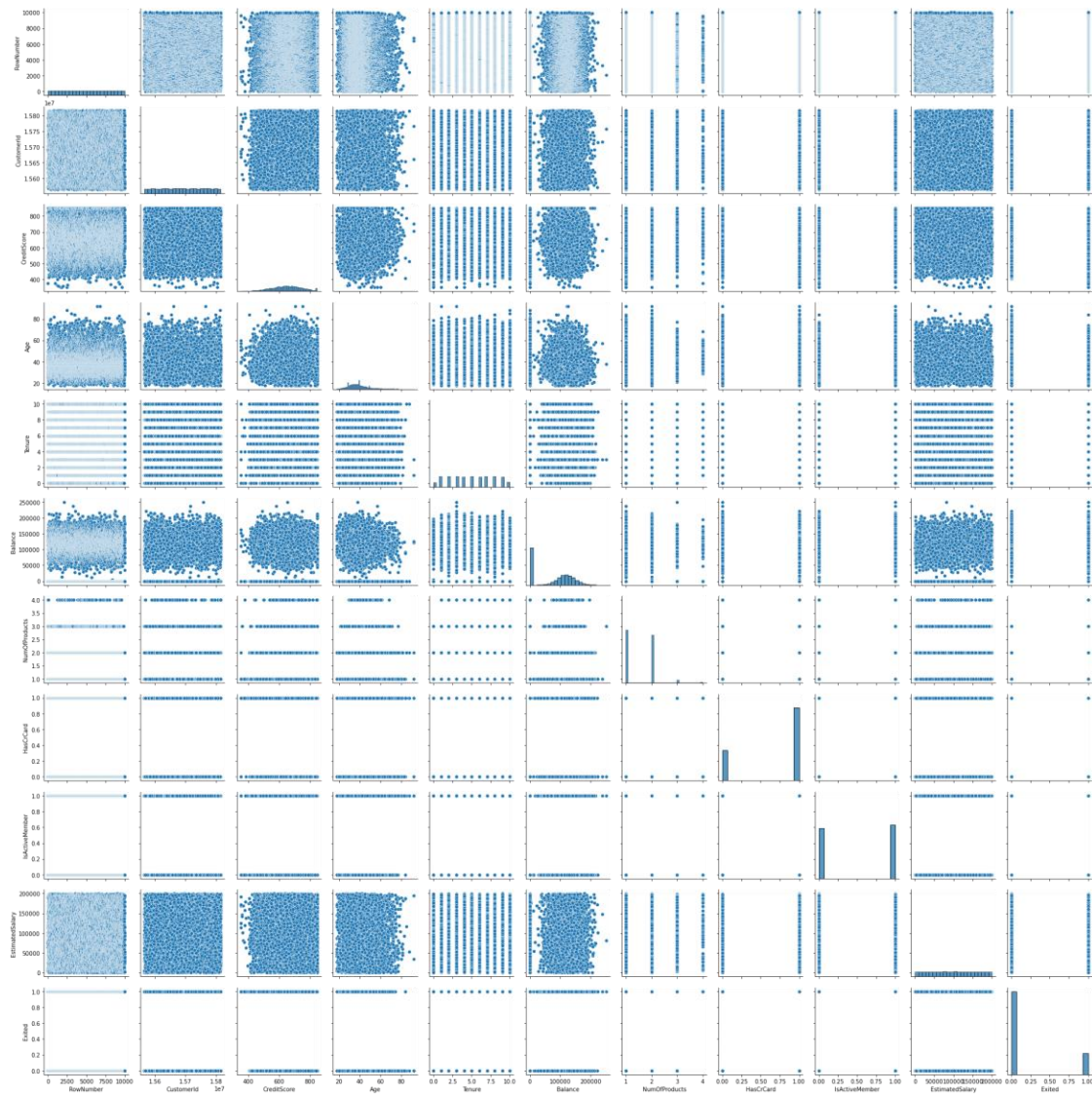
```
data.hist(figsize=(15,15))
```

```
array([[<AxesSubplot:title={'center':'CreditScore'}>,  
       <AxesSubplot:title={'center':'Age'}>,  
       <AxesSubplot:title={'center':'Tenure'}>],  
      [<AxesSubplot:title={'center':'Balance'}>,  
       <AxesSubplot:title={'center':'NumOfProducts'}>,  
       <AxesSubplot:title={'center':'HasCrCard'}>],  
      [<AxesSubplot:title={'center':'IsActiveMember'}>,  
       <AxesSubplot:title={'center':'EstimatedSalary'}>,  
       <AxesSubplot:title={'center':'Exited'}>]], dtype=object)
```



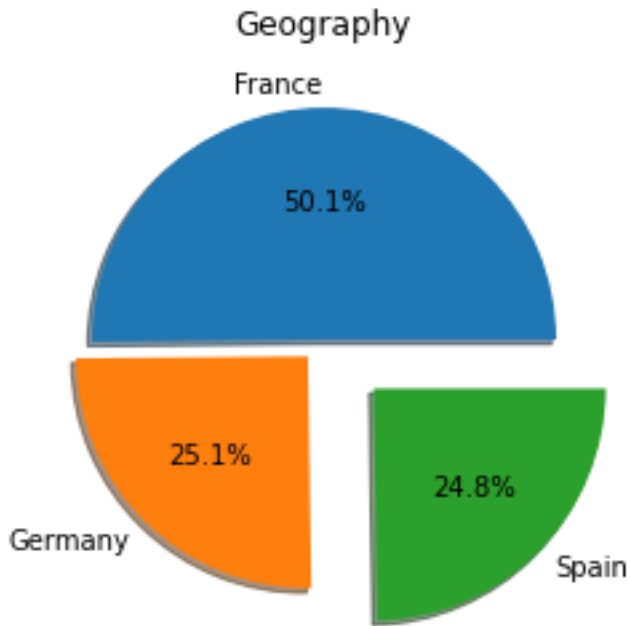
```
sns.pairplot(data)
```

```
<seaborn.axisgrid.PairGrid at 0x26bf6d1e070>
```



```
plt.pie(data.Geography.value_counts(), [0, 0.1, 0.3], shadow=True, labels=['France', 'Germany', 'Spain'], autopct="%1.1f%%")
plt.title('Geography')
```

```
Text(0.5, 1.0, 'Geography')
```



## Descriptive statistics on the dataset

data.describe()

	RowNumber	CustomerId	CreditScore	Age	Tenure	\
count	10000.00000	1.000000e+04	10000.000000	10000.000000	10000.000000	
mean	5000.50000	1.569094e+07	650.528800	38.921800	5.012800	
std	2886.89568	7.193619e+04	96.653299	10.487806	2.892174	
min	1.00000	1.556570e+07	350.000000	18.000000	0.000000	
25%	2500.75000	1.562853e+07	584.000000	32.000000	3.000000	
50%	5000.50000	1.569074e+07	652.000000	37.000000	5.000000	
75%	7500.25000	1.575323e+07	718.000000	44.000000	7.000000	
max	10000.00000	1.581569e+07	850.000000	92.000000	10.000000	

	Balance	NumOfProducts	HasCrCard	IsActiveMember	\
count	10000.000000	10000.000000	10000.00000	10000.000000	
mean	76485.889288	1.530200	0.70550	0.515100	
std	62397.405202	0.581654	0.45584	0.499797	
min	0.000000	1.000000	0.00000	0.000000	
25%	0.000000	1.000000	0.00000	0.000000	
50%	97198.540000	1.000000	1.00000	1.000000	
75%	127644.240000	2.000000	1.00000	1.000000	
max	250898.090000	4.000000	1.00000	1.000000	

	EstimatedSalary	Exited
count	10000.000000	10000.000000
mean	100090.239881	0.203700
std	57510.492818	0.402769
min	11.580000	0.000000



```
25%      51002.110000      0.000000
50%     100193.915000      0.000000
75%     149388.247500      0.000000
max      199992.480000      1.000000
```

```
data.Geography.unique()
```

```
array(['France', 'Spain', 'Germany'], dtype=object)
```

```
data.Gender.value_counts()
```

```
Male      5457
```

```
Female    4543
```

```
Name: Gender, dtype: int64
```

```
data.Geography.value_counts()
```

```
France     5014
```

```
Germany    2509
```

```
Spain      2477
```

```
Name: Geography, dtype: int64
```

## Handling the missing data and outliers

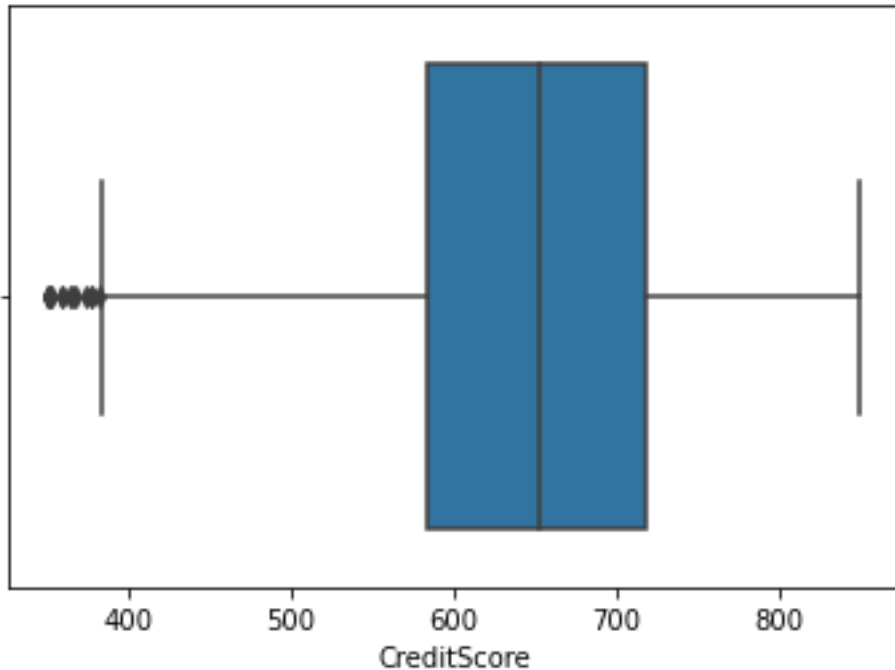
```
sns.boxplot(data.CreditScore)
```

```
C:\Users\vijay\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
```

```
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.
```

```
warnings.warn(
```

```
<AxesSubplot:xlabel='CreditScore'>
```



```
q1=data.CreditScore.quantile(0.25)
q3=data.CreditScore.quantile(0.75)
```

```
IQR=q3-q1
```

```
upper_limit= q3 + 1.5*IQR
lower_limit= q1 - 1.5*IQR
```

```
print("Upper limit :",upper_limit)
print("Lower limit :",lower_limit)
```

```
Upper limit : 919.0
Lower limit : 383.0
```

```
data.median()
```

```
C:\Users\vijay\AppData\Local\Temp\ipykernel_2108\4184645713.py:1:
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.
  data.median()
```

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
```

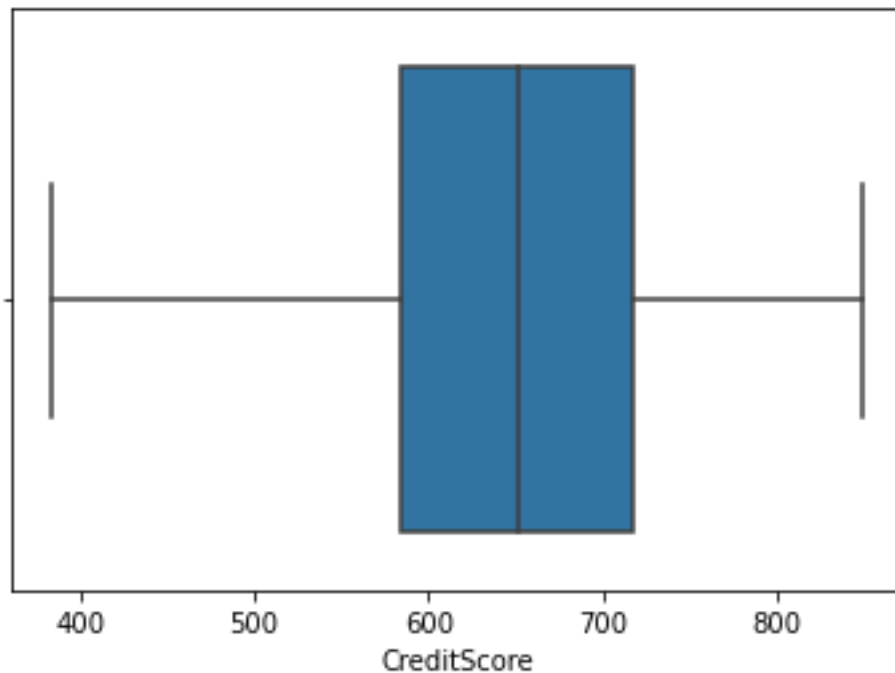
```
data['CreditScore']=
np.where(data['CreditScore']<lower_limit,6.520000e+02,data['CreditScore'])

sns.boxplot(data.CreditScore)
```

```
C:\Users\vijay\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
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.
```

```
warnings.warn(
```

```
<AxesSubplot:xlabel='CreditScore'>
```



## Label Encoding

```
from sklearn.preprocessing import LabelEncoder
```

```
le=LabelEncoder()
```

```
data.Gender=le.fit_transform(data.Gender)
```

```
data.head(10)
```

	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	\
0	619.0	France	0	42	2	0.00	1	
1	608.0	Spain	0	41	1	83807.86	1	

2	502.0	France	0	42	8	159660.80	3
3	699.0	France	0	39	1	0.00	2
4	850.0	Spain	0	43	2	125510.82	1
5	645.0	Spain	1	44	8	113755.78	2
6	822.0	France	1	50	7	0.00	2
7	652.0	Germany	0	29	4	115046.74	4
8	501.0	France	1	44	4	142051.07	2
9	684.0	France	1	27	2	134603.88	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
5	1	0	149756.71	1
6	1	1	10062.80	0
7	1	0	119346.88	1
8	0	1	74940.50	0
9	1	1	71725.73	0

## One hot encoding

```
data_main=pd.get_dummies(data,columns=['Geography'])
data_main.head(15)
```

	CreditScore	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	\
0	619.0	0	42	2	0.00	1	1	
1	608.0	0	41	1	83807.86	1	0	
2	502.0	0	42	8	159660.80	3	1	
3	699.0	0	39	1	0.00	2	0	
4	850.0	0	43	2	125510.82	1	1	
5	645.0	1	44	8	113755.78	2	1	
6	822.0	1	50	7	0.00	2	1	
7	652.0	0	29	4	115046.74	4	1	
8	501.0	1	44	4	142051.07	2	0	
9	684.0	1	27	2	134603.88	1	1	
10	528.0	1	31	6	102016.72	2	0	
11	497.0	1	24	3	0.00	2	1	
12	476.0	0	34	10	0.00	2	1	
13	549.0	0	25	5	0.00	2	0	
14	635.0	0	35	7	0.00	2	1	

	IsActiveMember	EstimatedSalary	Exited	Geography_France	\
0	1	101348.88	1	1	
1	1	112542.58	0	0	
2	0	113931.57	1	1	
3	0	93826.63	0	1	
4	1	79084.10	0	0	

5	0	149756.71	1	0
6	1	10062.80	0	1
7	0	119346.88	1	0
8	1	74940.50	0	1
9	1	71725.73	0	1
10	0	80181.12	0	1
11	0	76390.01	0	0
12	0	26260.98	0	1
13	0	190857.79	0	1
14	1	65951.65	0	0

	Geography_Germany	Geography_Spain
0	0	0
1	0	1
2	0	0
3	0	0
4	0	1
5	0	1
6	0	0
7	1	0
8	0	0
9	0	0
10	0	0
11	0	1
12	0	0
13	0	0
14	0	1

data\_main.corr()

	CreditScore	Gender	Age	Tenure	Balance	\
CreditScore	1.000000	-0.003613	-0.001992	-0.000650	0.007074	
Gender	-0.003613	1.000000	-0.027544	0.014733	0.012087	
Age	-0.001992	-0.027544	1.000000	-0.009997	0.028308	
Tenure	-0.000650	0.014733	-0.009997	1.000000	-0.012254	
Balance	0.007074	0.012087	0.028308	-0.012254	1.000000	
NumOfProducts	0.012293	-0.021859	-0.030680	0.013444	-0.304180	
HasCrCard	-0.003942	0.005766	-0.011721	0.022583	-0.014858	
IsActiveMember	0.023596	0.022544	0.085472	-0.028362	-0.010084	
EstimatedSalary	0.001619	-0.008112	-0.007201	0.007784	0.012797	
Exited	-0.018298	-0.106512	0.285323	-0.014001	0.118533	
Geography_France	-0.009889	0.006772	-0.039208	-0.002848	-0.231329	
Geography_Germany	0.005748	-0.024628	0.046897	-0.000567	0.401110	
Geography_Spain	0.005681	0.016889	-0.001685	0.003868	-0.134892	

	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary
\				
CreditScore	0.012293	-0.003942	0.023596	0.001619
Gender	-0.021859	0.005766	0.022544	-0.008112
Age	-0.030680	-0.011721	0.085472	-0.007201

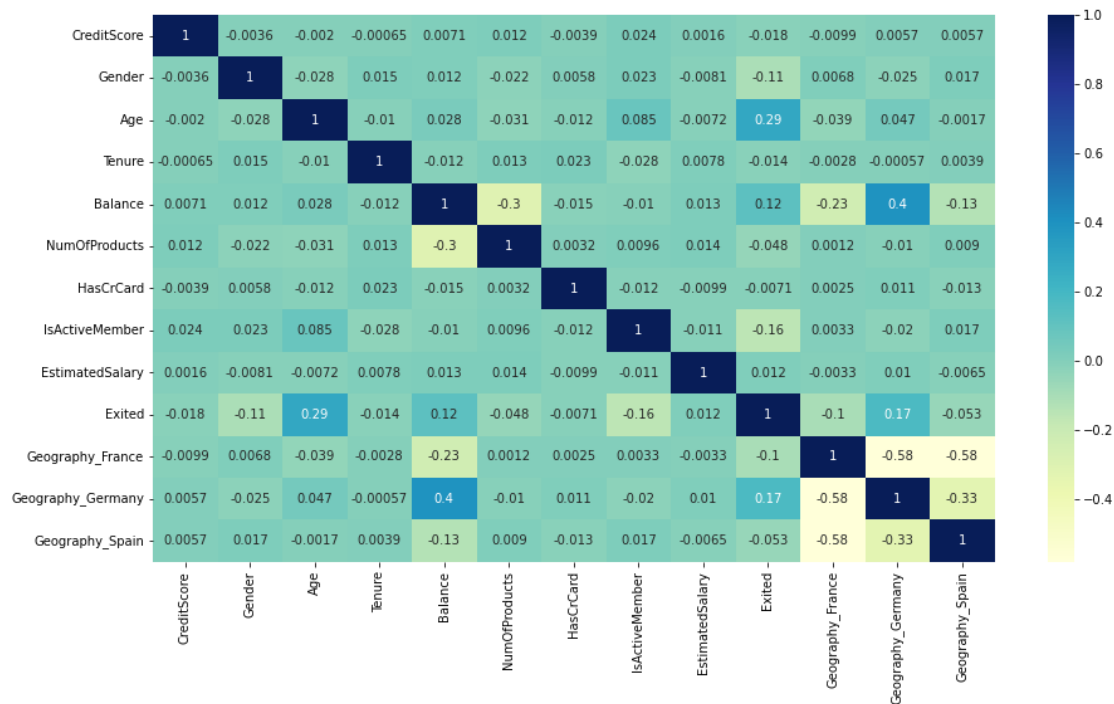
Tenure	0.013444	0.022583	-0.028362	0.007784
Balance	-0.304180	-0.014858	-0.010084	0.012797
NumOfProducts	1.000000	0.003183	0.009612	0.014204
HasCrCard	0.003183	1.000000	-0.011866	-0.009933
IsActiveMember	0.009612	-0.011866	1.000000	-0.011421
EstimatedSalary	0.014204	-0.009933	-0.011421	1.000000
Exited	-0.047820	-0.007138	-0.156128	0.012097
Geography_France	0.001230	0.002467	0.003317	-0.003332
Geography_Germany	-0.010419	0.010577	-0.020486	0.010297
Geography_Spain	0.009039	-0.013480	0.016732	-0.006482

	Exited	Geography_France	Geography_Germany	\
CreditScore	-0.018298	-0.009889	0.005748	
Gender	-0.106512	0.006772	-0.024628	
Age	0.285323	-0.039208	0.046897	
Tenure	-0.014001	-0.002848	-0.000567	
Balance	0.118533	-0.231329	0.401110	
NumOfProducts	-0.047820	0.001230	-0.010419	
HasCrCard	-0.007138	0.002467	0.010577	
IsActiveMember	-0.156128	0.003317	-0.020486	
EstimatedSalary	0.012097	-0.003332	0.010297	
Exited	1.000000	-0.104955	0.173488	
Geography_France	-0.104955	1.000000	-0.580359	
Geography_Germany	0.173488	-0.580359	1.000000	
Geography_Spain	-0.052667	-0.575418	-0.332084	

	Geography_Spain
CreditScore	0.005681
Gender	0.016889
Age	-0.001685
Tenure	0.003868
Balance	-0.134892
NumOfProducts	0.009039
HasCrCard	-0.013480
IsActiveMember	0.016732
EstimatedSalary	-0.006482
Exited	-0.052667
Geography_France	-0.575418
Geography_Germany	-0.332084
Geography_Spain	1.000000

```
plt.figure(figsize=(15,8))
sns.heatmap(data_main.corr(),annot=True,cmap="YlGnBu")
```

<AxesSubplot:>



```
data_main.corr().Exited.sort_values(ascending=False)
```

```
Exited          1.000000
Age             0.285323
Geography_Germany 0.173488
Balance         0.118533
EstimatedSalary 0.012097
HasCrCard      -0.007138
Tenure         -0.014001
CreditScore    -0.018298
NumOfProducts  -0.047820
Geography_Spain -0.052667
Geography_France -0.104955
Gender         -0.106512
IsActiveMember -0.156128
Name: Exited, dtype: float64
```

```
data_main.head()
```

```
   CreditScore  Gender  Age  Tenure  Balance  NumOfProducts  HasCrCard  \
0         619.0      0   42      2      0.00              1           1
1         608.0      0   41      1  83807.86              1           0
2         502.0      0   42      8 159660.80              3           1
3         699.0      0   39      1      0.00              2           0
4         850.0      0   43      2 125510.82              1           1

   IsActiveMember  EstimatedSalary  Exited  Geography_France  \
0                1      101348.88      1              1
1                1      112542.58      0              0
```

2	0	113931.57	1	1
3	0	93826.63	0	1
4	1	79084.10	0	0

	Geography_Germany	Geography_Spain
0	0	0
1	0	1
2	0	0
3	0	0
4	0	1

## Spilting of data for Training and Testing

### Dependent variable

```
y=data_main['Exited']
print(y)
```

```
0      1
1      0
2      1
3      0
4      0
..
9995   0
9996   0
9997   1
9998   1
9999   0
Name: Exited, Length: 10000, dtype: int64
```

### independent variable

```
X=data_main.drop(columns=['Exited'],axis=1)
X.head(10)
```

	CreditScore	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	\
0	619.0	0	42	2	0.00	1	1	
1	608.0	0	41	1	83807.86	1	0	
2	502.0	0	42	8	159660.80	3	1	
3	699.0	0	39	1	0.00	2	0	
4	850.0	0	43	2	125510.82	1	1	
5	645.0	1	44	8	113755.78	2	1	
6	822.0	1	50	7	0.00	2	1	
7	652.0	0	29	4	115046.74	4	1	
8	501.0	1	44	4	142051.07	2	0	
9	684.0	1	27	2	134603.88	1	1	



	IsActiveMember	EstimatedSalary	Geography_France	Geography_Germany	\
0	1	101348.88	1	0	
1	1	112542.58	0	0	
2	0	113931.57	1	0	
3	0	93826.63	1	0	
4	1	79084.10	0	0	
5	0	149756.71	0	0	
6	1	10062.80	1	0	
7	0	119346.88	0	1	
8	1	74940.50	1	0	
9	1	71725.73	1	0	

	Geography_Spain
0	0
1	1
2	0
3	0
4	1
5	1
6	0
7	0
8	0
9	0

## Scaling

```
from sklearn.preprocessing import scale
```

```
x_scaled=pd.DataFrame(scale(X),columns=X.columns)
x_scaled.head()
```

	CreditScore	Gender	Age	Tenure	Balance	NumOfProducts	\
0	-0.332983	-1.095988	0.293517	-1.041760	-1.225848	-0.911583	
1	-0.447572	-1.095988	0.198164	-1.387538	0.117350	-0.911583	
2	-1.551792	-1.095988	0.293517	1.032908	1.333053	2.527057	
3	0.500391	-1.095988	0.007457	-1.387538	-1.225848	0.807737	
4	2.073384	-1.095988	0.388871	-1.041760	0.785728	-0.911583	

	HasCrCard	IsActiveMember	EstimatedSalary	Geography_France	\
0	0.646092	0.970243	0.021886	0.997204	
1	-1.547768	0.970243	0.216534	-1.002804	
2	0.646092	-1.030670	0.240687	0.997204	
3	-1.547768	-1.030670	-0.108918	0.997204	
4	0.646092	0.970243	-0.365276	-1.002804	

	Geography_Germany	Geography_Spain
0	-0.578736	-0.573809
1	-0.578736	1.742740
2	-0.578736	-0.573809

3	-0.578736	-0.573809
4	-0.578736	1.742740

## Train Test Split

```
from sklearn.model_selection import train_test_split
X_train,X_test,y_train,y_test =
train_test_split(x_scaled,y,test_size=0.3,random_state=0)
```

```
x_train.head()
```

```
X_train.shape
```

```
(7000, 12)
```

```
y_train.shape
```

```
(7000,)
```

```
X_test.shape
```

```
(3000, 12)
```

```
y_test.shape
```

```
(3000,)
```