Assignment -2

Python Programming

Assignment Date	29 September 2022
Student Name	Ms.Aishwarya.G
Student Roll Number	113219071001
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
```

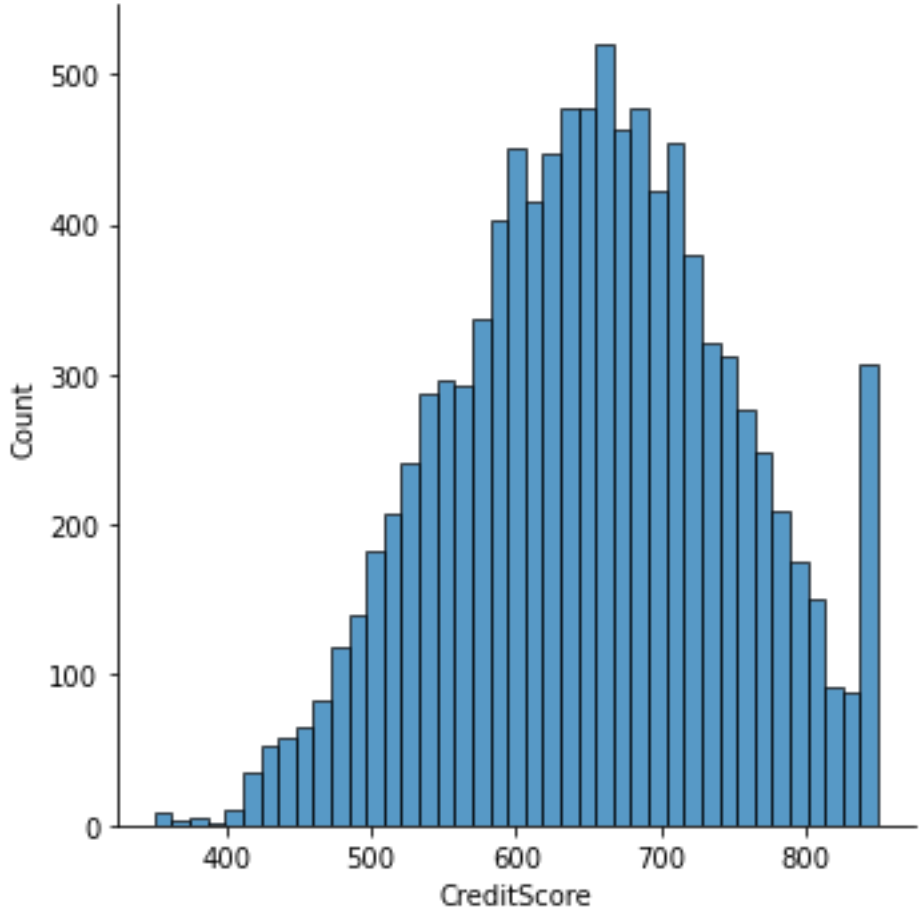
Visualizations

Univariate Analysis

Solution :

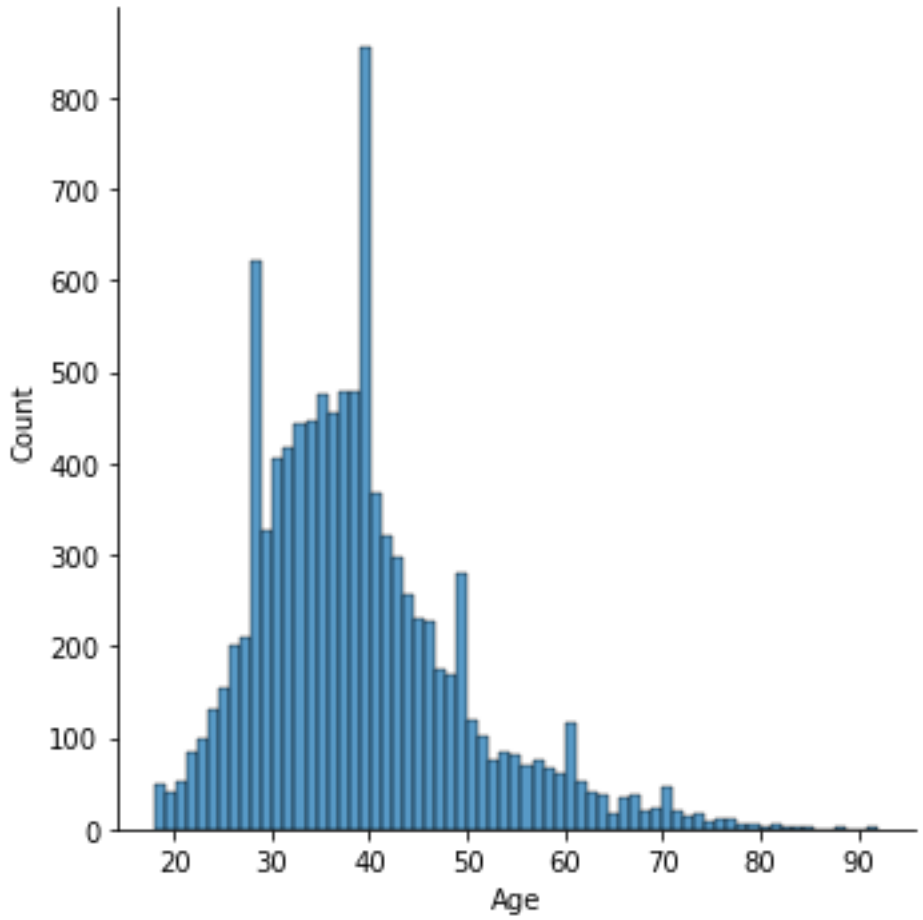
```
sns.displot(data.CreditScore)
```

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



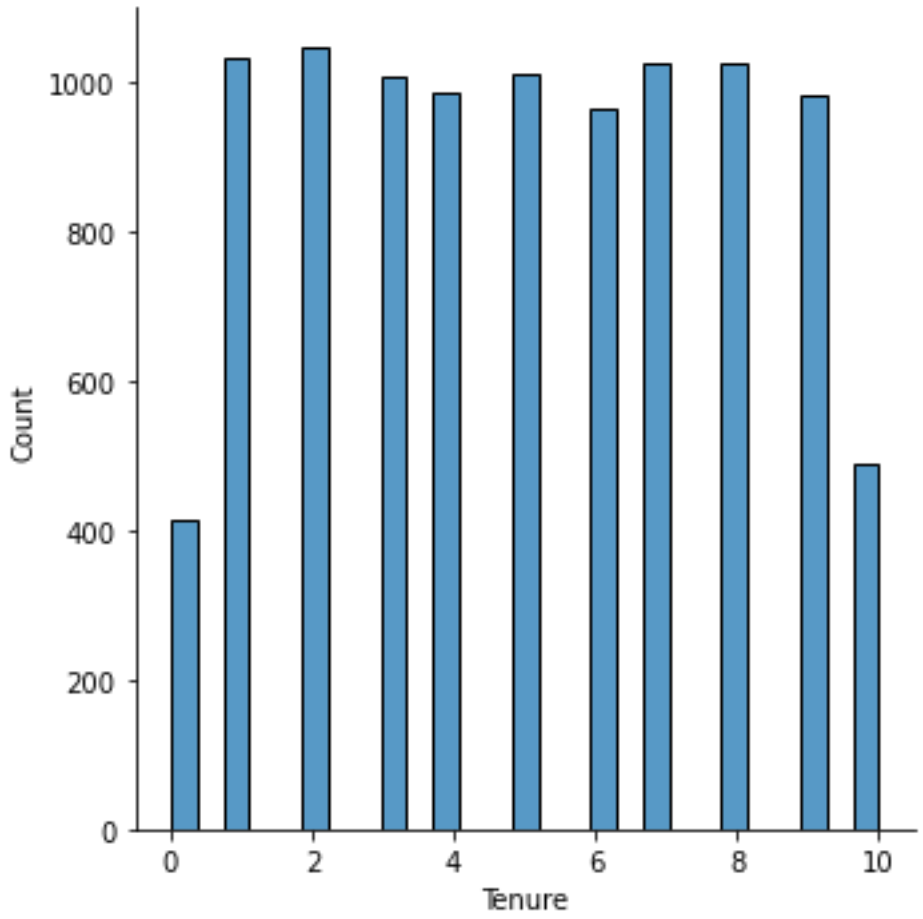

```
sns.displot(data.Age)
```

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




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

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

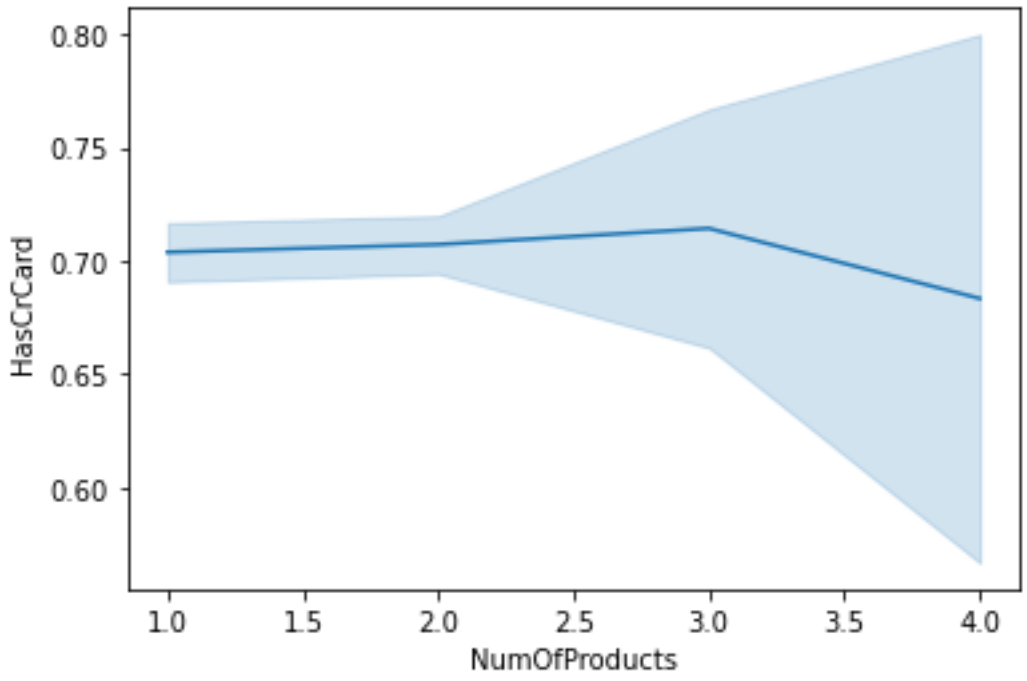


Bi-Variate Analysis

Solution :

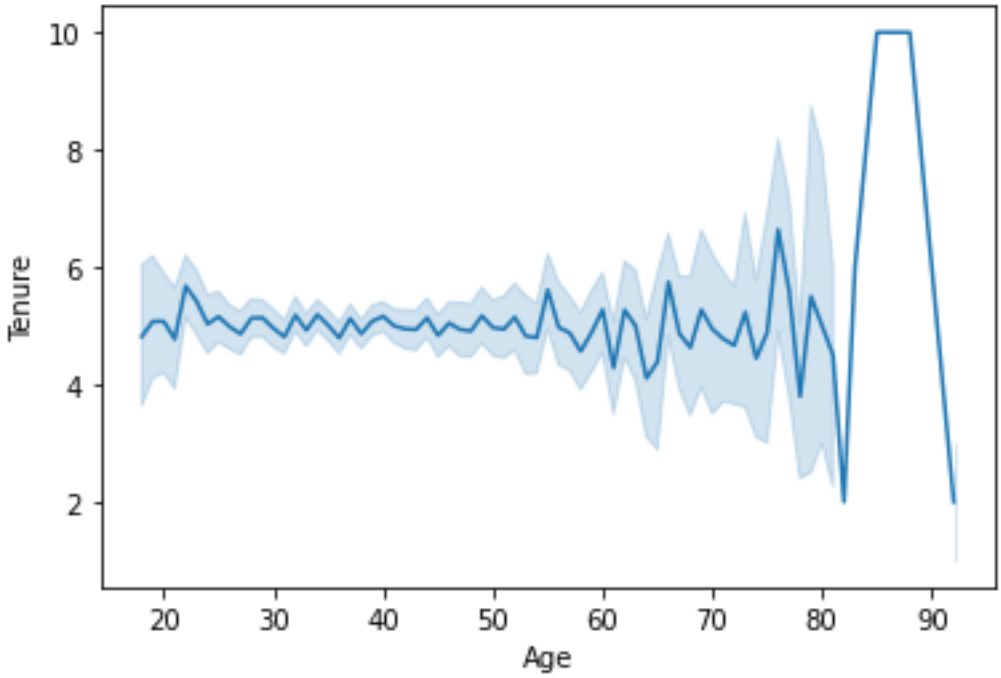
```
sns.lineplot(x=data.NumOfProducts, y=data.HasCrCard)
```

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




```
sns.lineplot(x=data.Age, y=data.Tenure)
```

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

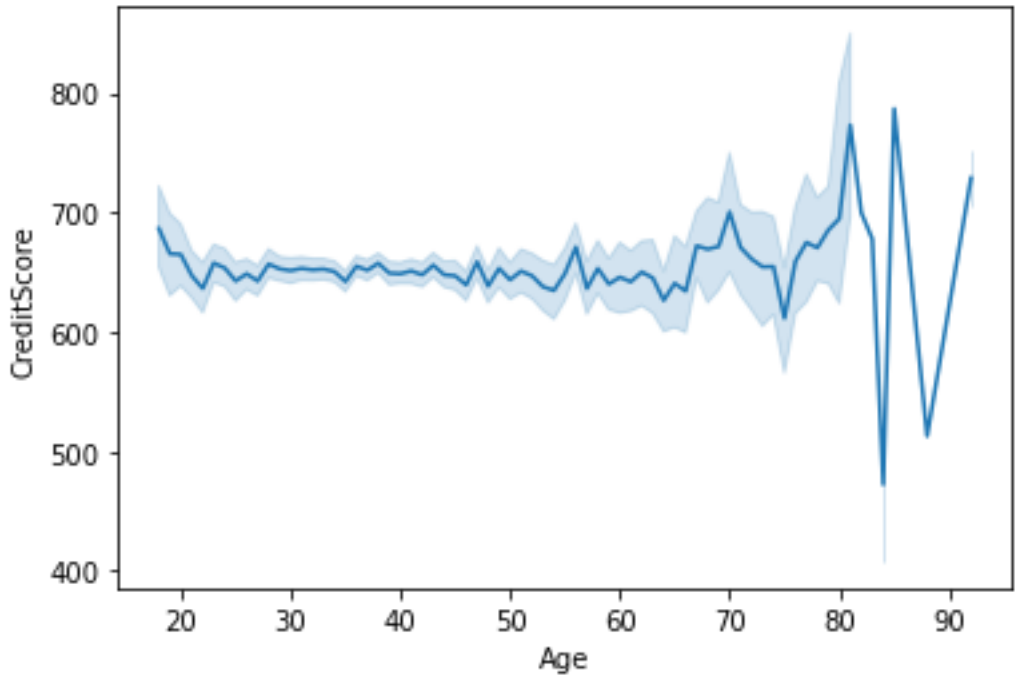



```
sns.lineplot(data.Age,data.CreditScore)
```

```
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(
```

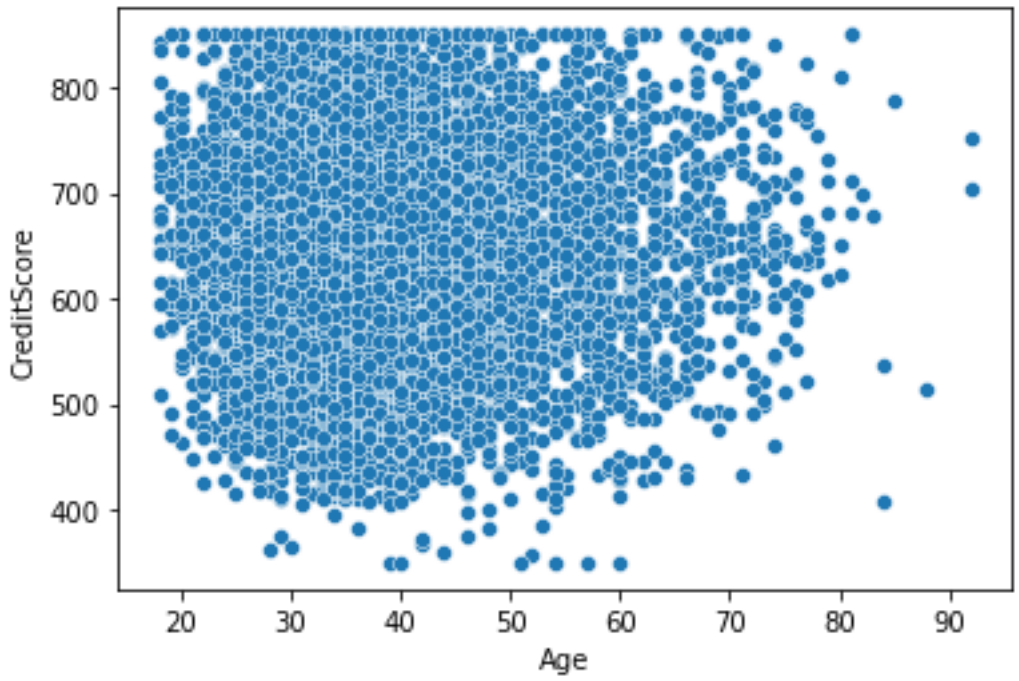
```
<AxesSubplot:xlabel='Age', ylabel='CreditScore'>
```




```
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(
```

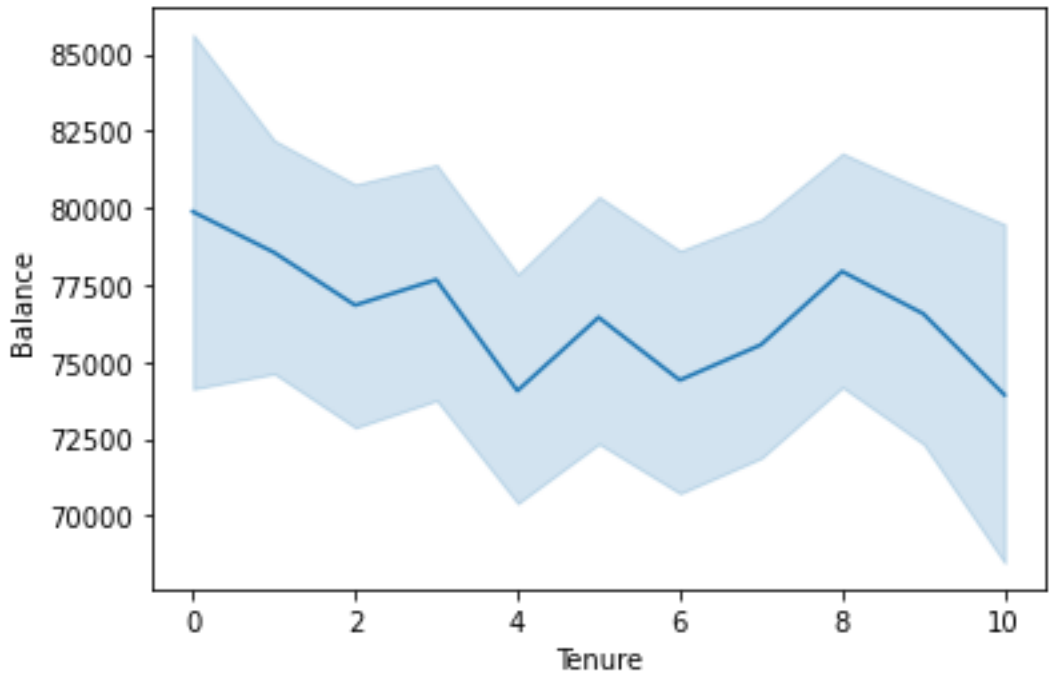
```
<AxesSubplot:xlabel='Age', ylabel='CreditScore'>
```




```
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(
```

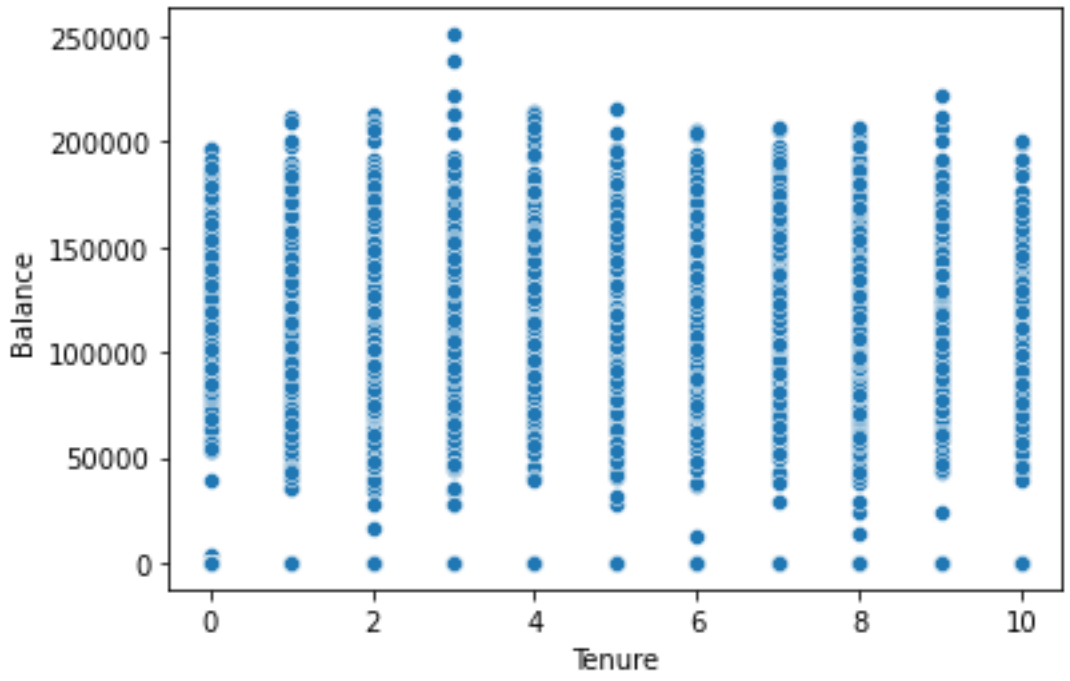
```
<AxesSubplot:xlabel='Tenure', ylabel='Balance'>
```




```
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(
```

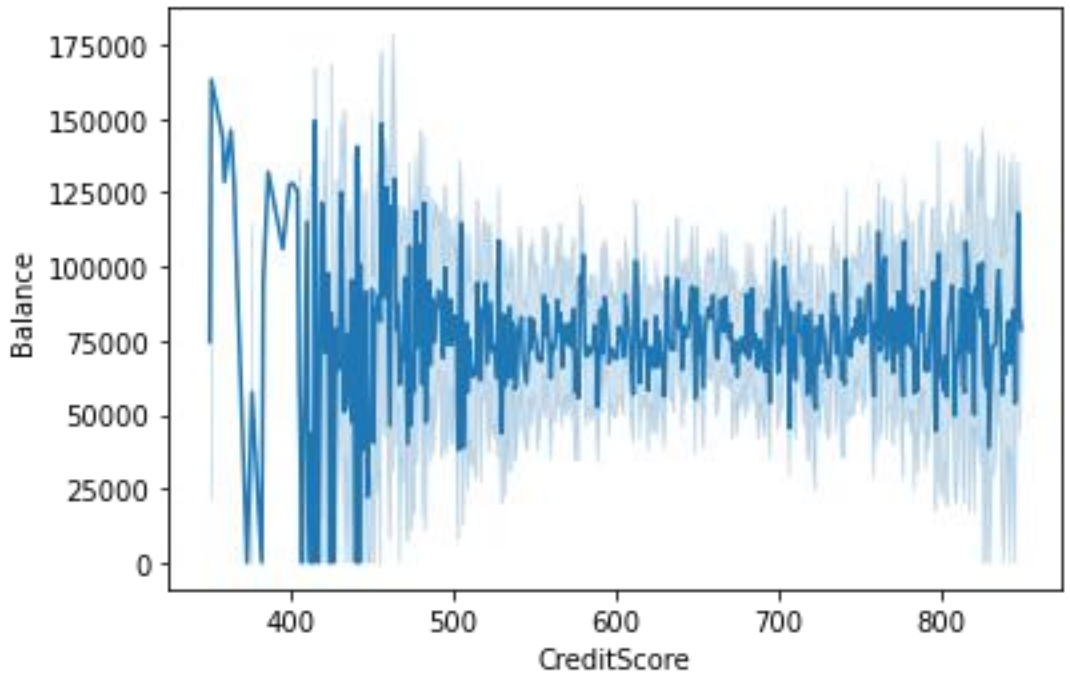
```
<AxesSubplot:xlabel='Tenure', ylabel='Balance'>
```




```
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(
```

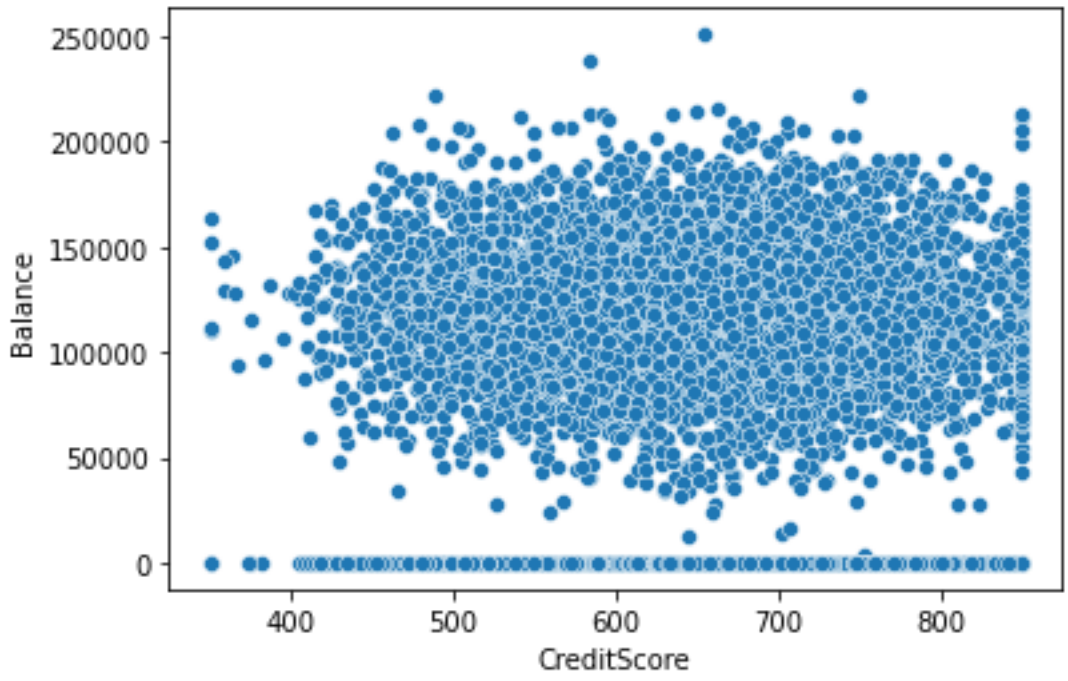
```
<AxesSubplot:xlabel='CreditScore', ylabel='Balance'>
```




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

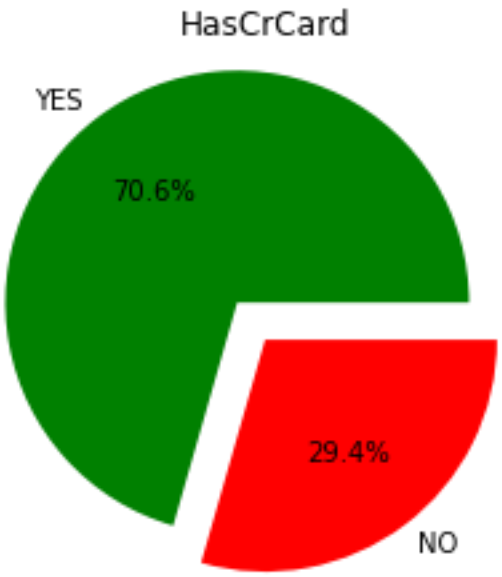
```
C:\Users\vijay\anaconda3\lib\site-packages\seaborn\_decorators.py:36:
FutureWarning: Pass the following variables as keyword args: x, y. From
version 0.12, the only valid positional argument will be `data`, and passing
other arguments without an explicit keyword will result in an error or
misinterpretation.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



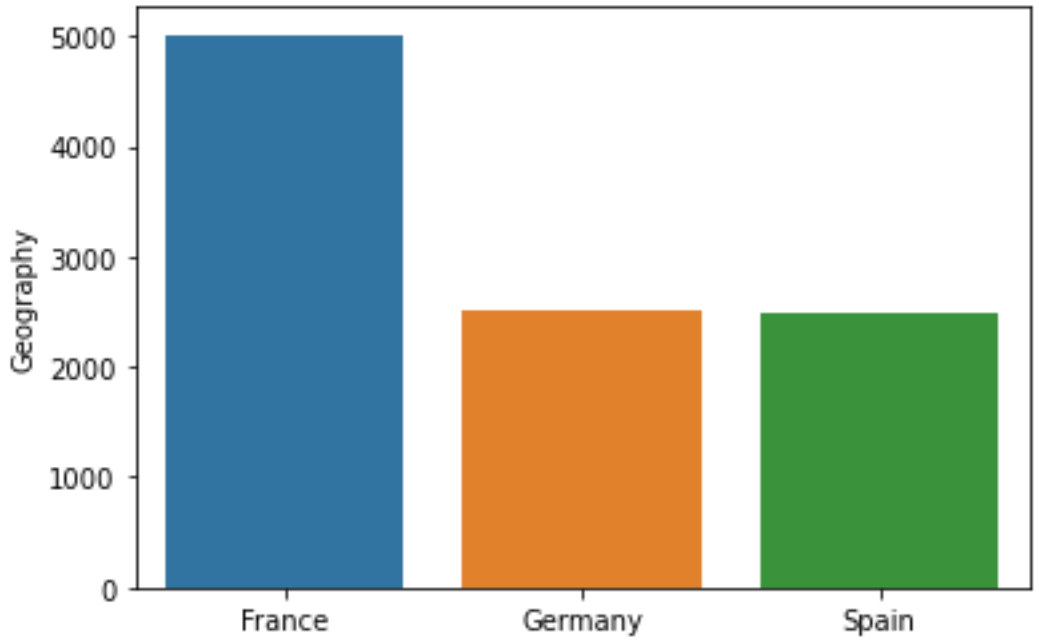

```
data.HasCrCard.value_counts()
```

```
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(
```

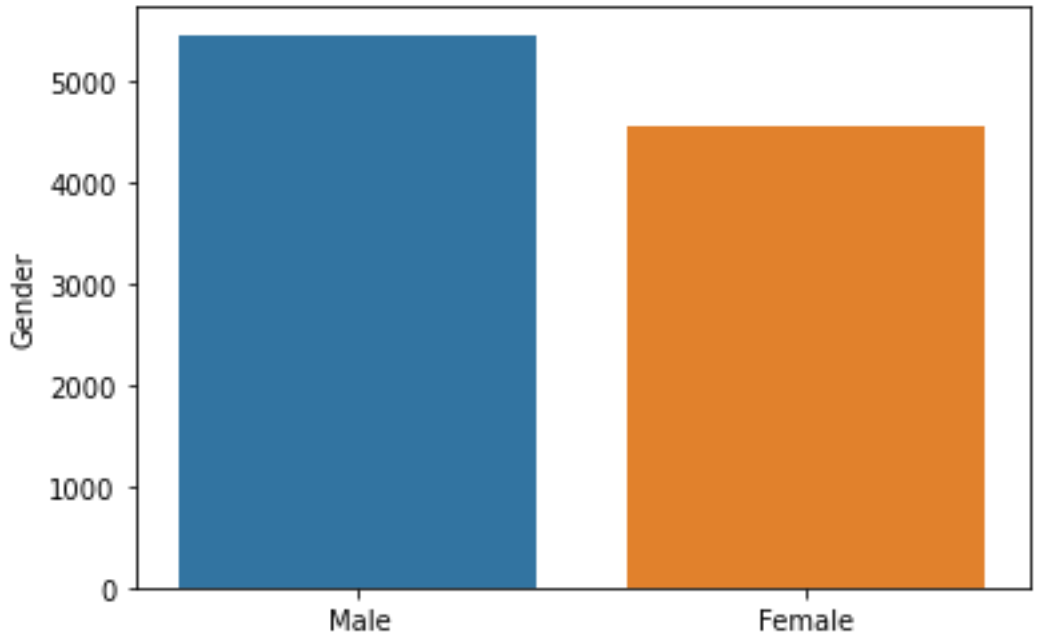
```
<AxesSubplot:ylabel='Geography'>
```




```
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(
```

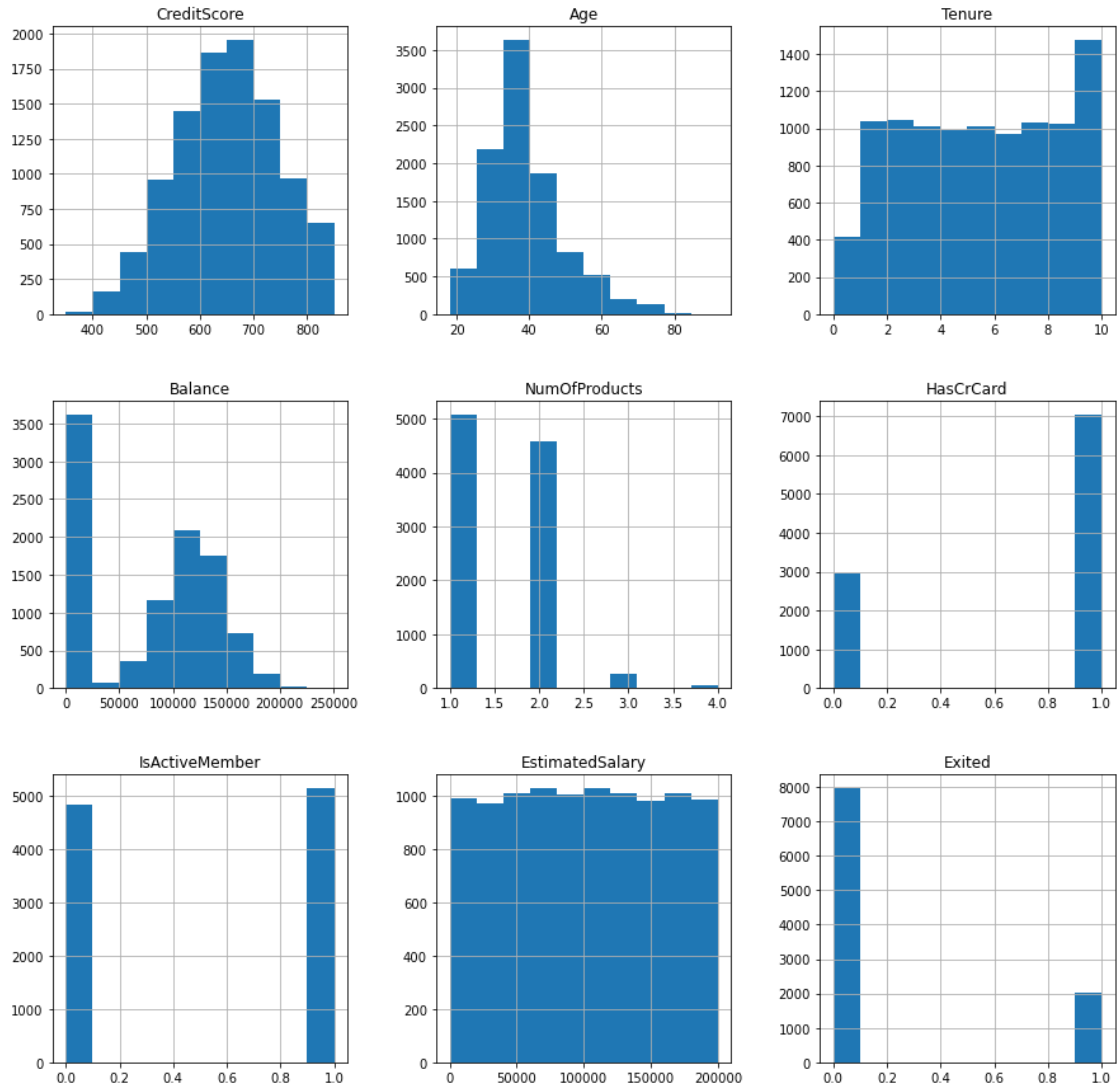
```
<AxesSubplot:ylabel='Gender'>
```



Multi-Variate Analysis

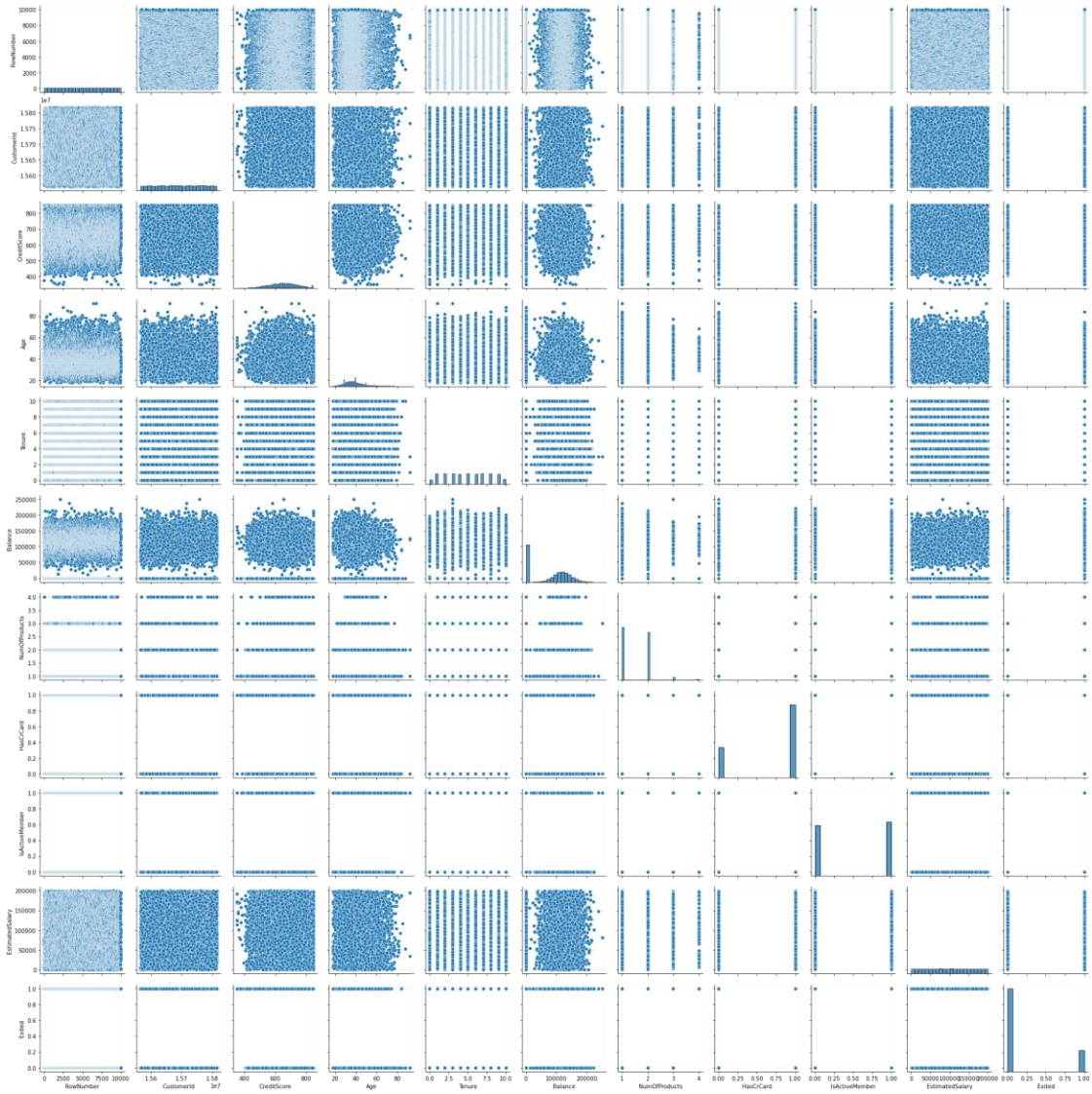
```
data.hist(figsize=(15,15))
```

```
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)
```



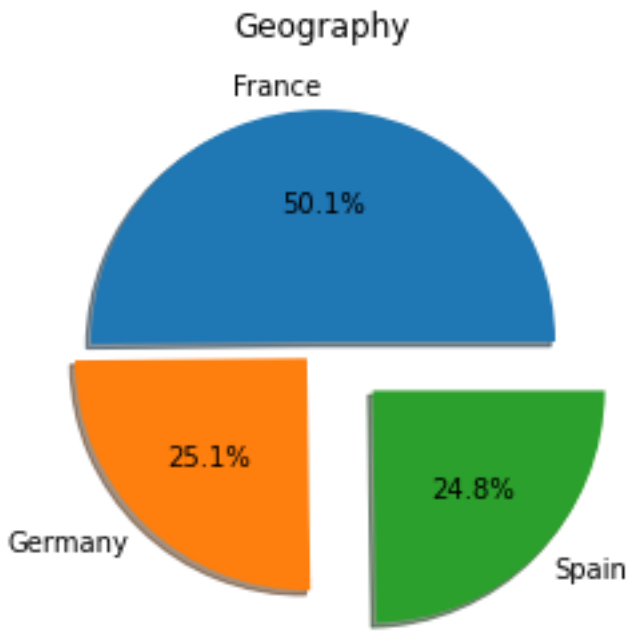

```
sns.pairplot(data)
```

```
<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()
```

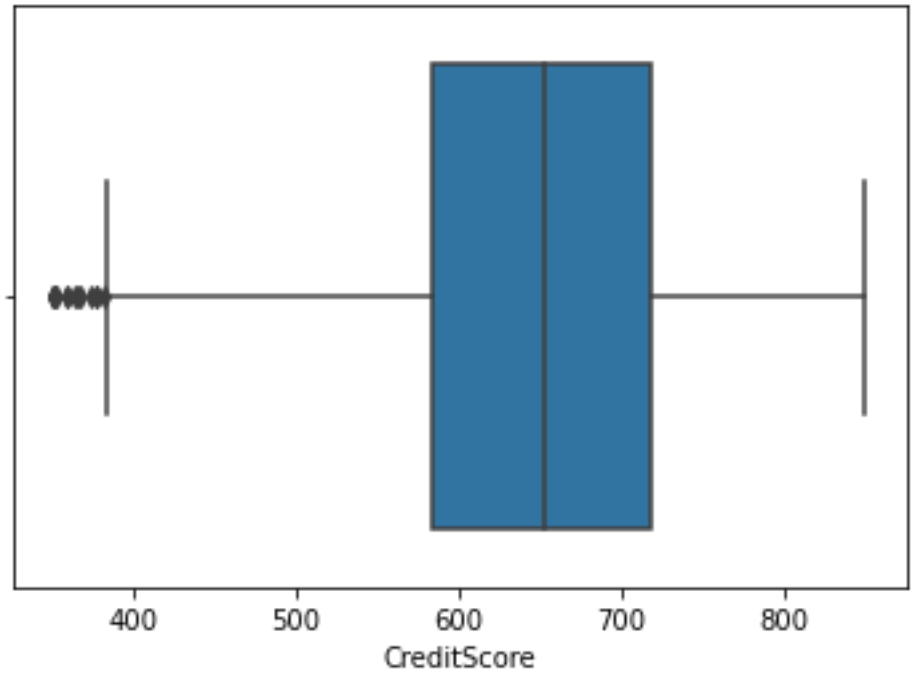
```
France     5014
Germany    2509
Spain      2477
Name: Geography, dtype: int64
```

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
```

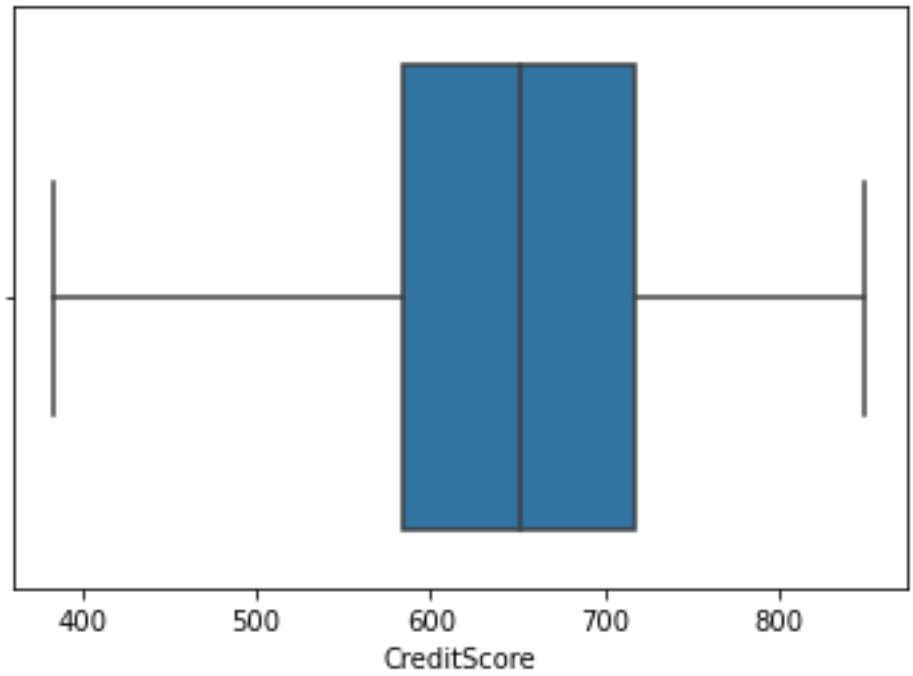
```
Exited                  0.000
dtype: float64
```

```
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
```

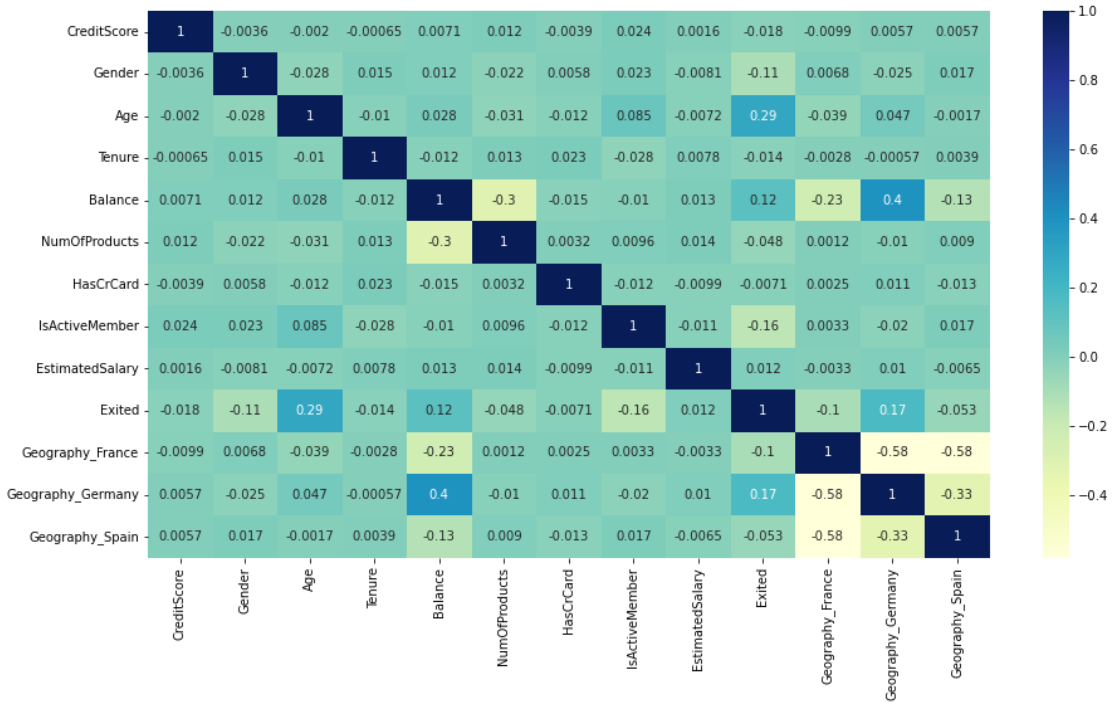
```
Tenure                0.013444   0.022583       -0.028362         0.007784
Balance              -0.304180  -0.014858       -0.010084         0.012797
NumOfProducts         1.000000   0.003183        0.009612         0.014204
HasCrCard             0.003183   1.000000       -0.011866        -0.009933
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.shape

(7000, 12)

y_train.shape

(7000,)

X_test.shape

(3000, 12)

y_test.shape

(3000,)
```