**Assignment -1**

| | |
|---|---|
| Assignment Date | 15 october 2022 |
| Student Name | S. SREEJA |
| Student Roll Number | 811519104103 |
| Maximum Marks | 2 Marks |

[1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

# 1 Load the dataset

[3]:
```
data = pd.read_csv("Churn_Modelling.csv")
data.head()
```

[3]:

| | 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 |

[4]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 10000 entries, 0 to 9999
Data columns (total 14 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   RowNumber       10000 non-null  int64
 1   CustomerId      10000 non-null  int64
 2   Surname         10000 non-null  object
 3   CreditScore     10000 non-null  int64
 4   Geography       10000 non-null  object
 5   Gender          10000 non-null  object
```

```
6   Age    10000 non-null int64
7   Tenure 10000 non-null int64
8   Balance10000 non-null float64
9   NumOfProducts     10000 non-null int64
10  HasCrCard    10000 non-null int64
11  IsActiveMember    10000 non-null int64
12  EstimatedSalary 10000 non-null float64
13  Exited 10000 non-null int64
    dtypes: float64(2), int64(9),
    object(3) memory usage: 1.1+ MB
```

## 2 Data Cleaning/Preprocessing

Handle Missing values

[5]:
```
data.isnull().sum()
```

[5]:
```
RowNumber        0
CustomerId       0
Surname          0
CreditScore      0
Geography        0
Gender           0
Age              0
Tenure           0
Balance          0
NumOfProducts    0
HasCrCard        0
IsActiveMember   0
EstimatedSalary  0
Exited           0
```

```
dtype: int64
```

[6]:
```
data['Gender'].value_counts()
data['Gender'].replace({'Male':1,'Female':0},inplace=True)
data['Surname']=data['Surname'].astype(str)
```

[7]:
```
data['Geography'].value_counts()
```

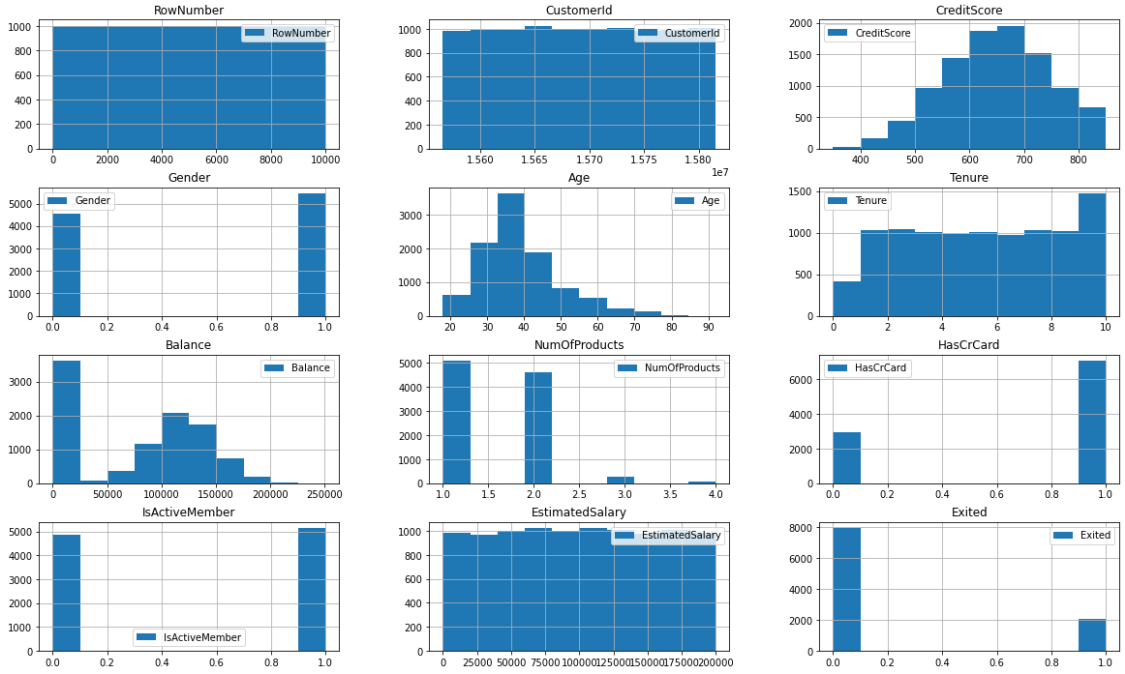
[7]:
```
France    5014
Germany   2509
Spain     2477
     Name: Geography, dtype: int64
```

[8]:
```
data['Geography'].str.strip()
data['Surname'].str.strip()
```

[8]:
```
0       Hargrave
1           Hill
2           Onio
3           Boni
4       Mitchell
…
9995     Obijiaku
9996     Johnstone
9997     Liu
9998     Sabbatini
9999     Walker
          Name: Surname, Length: 10000, dtype: object
```

[9]:
```
data.hist(figsize=(20,12),legend=True)
```

[9]:
```
array([[<AxesSubplot:title={'center':'RowNumber'}>,
        <AxesSubplot:title={'center':'CustomerId'}>,
        <AxesSubplot:title={'center':'CreditScore'}>],
       [<AxesSubplot:title={'center':'Gender'}>,
        <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)
```




[10]:
```
data.drop(columns=["RowNumber","CustomerId"],inplace=True)
data.head()
```

[10]:

| | Surname | CreditScore | Geography | Gender | Age | Tenure | Balance | NumOfProducts | HasCrCard | IsActiveMember | EstimatedSalary | Exited |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Hargrave | 619 | France | 0 | 42 | 2 | 0.00 | 1 | 1 | 1 | 101348.88 | 1 |
| 1 | Hill | 608 | Spain | 0 | 41 | 1 | 83807.86 | 1 | 0 | 1 | 112542.58 | 0 |
| 2 | Onio | 502 | France | 0 | 42 | 8 | 159660.80 | 3 | 1 | 0 | 113931.57 | 1 |
| 3 | Boni | 699 | France | 0 | 39 | 1 | 0.00 | 2 | 0 | 0 | 93826.63 | 0 |
| 4 | Mitchell | 850 | Spain | 0 | 43 | 2 | 125510.82 | 1 | 1 | 1 | 79084.10 | 0 |

[11]:
```
data["Surname"].value_counts()
```

[11]:
```
Smith     32
Scott     29
Martin    29
Walker    28
```

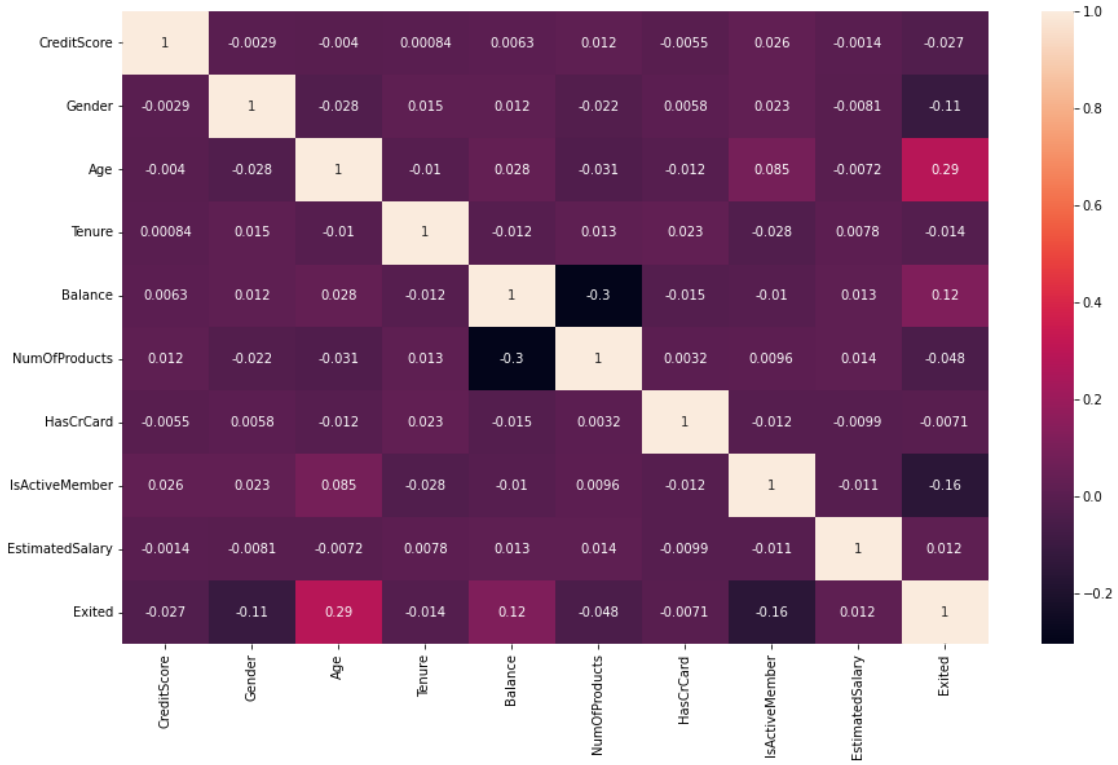
```
Brown      26
..
Izmailov    1
Bold        1
Bonham      1
Poninski    1
Burbidge    1
      Name: Surname, Length: 2932, dtype: int64
```

[12]:
```
data.duplicated().value_counts()
```

[12]:
```
False  10000
      dtype: int64
```

[13]:
```
plt.figure(figsize=(15,9))
sns.heatmap(data.corr(),annot=True)
```

[13]: <AxesSubplot:>




[14]:
```
data.describe()
```

[14]:
```
       CreditScore        Gender           Age        Tenure         Balance \
count   10000.000000   10000.000000   10000.000000   10000.000000
10000.000000   mean    650.528800     0.545700    38.921800     5.012800
```

```
76485.889288    std    96.653299    0.497932    10.487806    2.892174
62397.405202
min    350.000000     0.000000   18.000000    0.000000     0.000000
25%    584.000000     0.000000   32.000000    3.000000     0.000000
50%    652.000000     1.000000   37.000000    5.00000097198.540000
75%    718.000000     1.000000   44.000000  7.000000 127644.240000
max    850.000000     1.000000   92.000000 10.000000 250898.090000

       NumOfProductsHasCrCard IsActiveMember EstimatedSalary \
count  10000.000000 10000.00000 10000.000000   10000.000000
mean       1.530200     0.70550     0.515100   100090.239881
std        0.581654     0.45584     0.499797    57510.492818
min        1.000000     0.00000     0.000000       11.580000
25%        1.000000     0.00000     0.000000    51002.110000
50%        1.000000     1.00000     1.000000   100193.915000
75%        2.000000     1.00000     1.000000   149388.247500
max        4.000000     1.00000     1.000000   199992.480000

           Exited
count 10000.000000
mean  0.203700 std
      0.402769 min
      0.000000 25%
      0.000000
50%   0.000000 75%
      0.000000 max
      1.000000
```

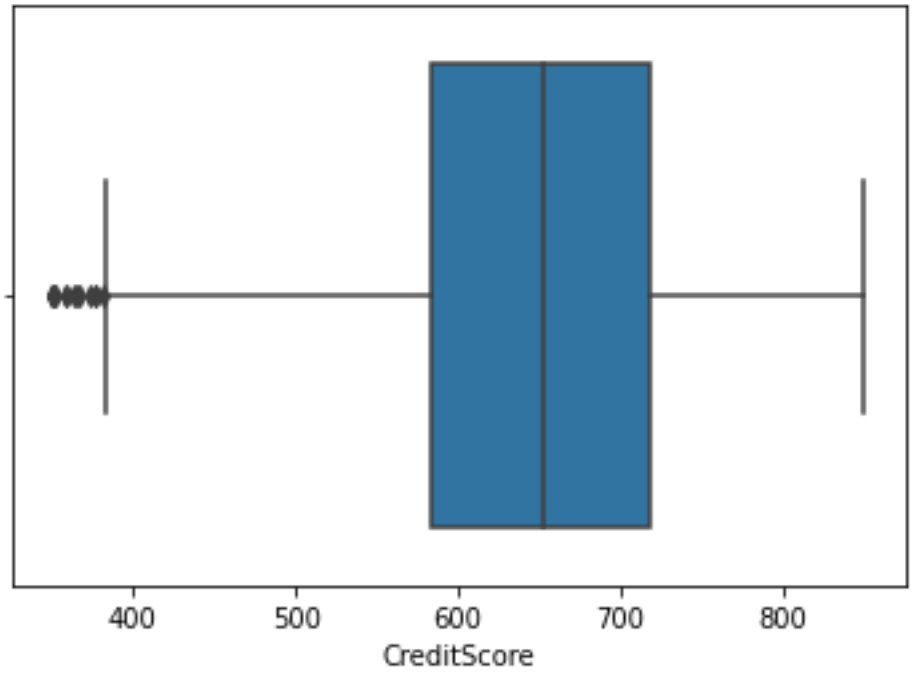
# 3 EDA analysis

Univariate Data Visualization

[15]:
```
sns.boxplot(data["CreditScore"])
```

```
c:\users\arvin\appdata\local\programs\python\python39\lib\sitepacka
ges\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(
```

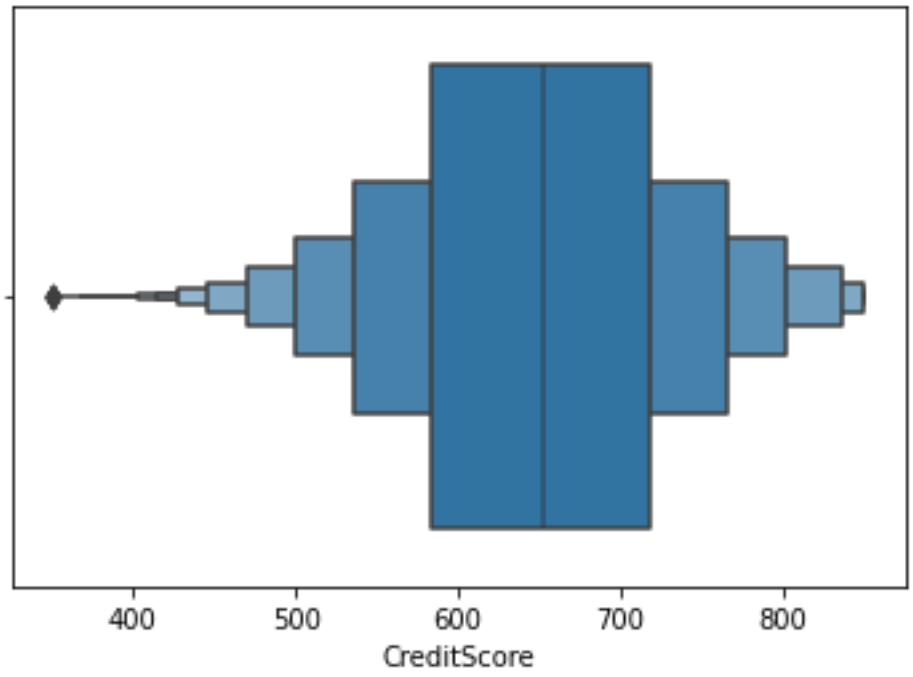
[15]: <AxesSubplot:xlabel='CreditScore'>




[16]:
```
sns.boxenplot(data=CreditScore)
```

```
c:\users\arvin\appdata\local\programs\python\python39\lib\sitepacka
ges\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(
```

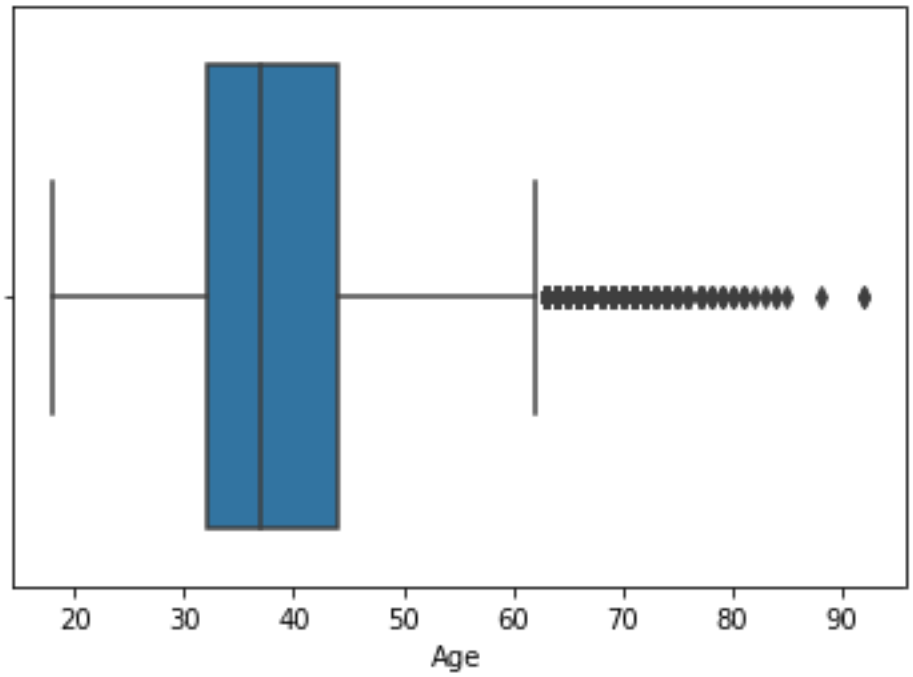
[16]: <AxesSubplot:xlabel='CreditScore'>




[17]:
```
sns.boxplot(data["Age"])
```

```
c:\users\arvin\appdata\local\programs\python\python39\lib\sitepacka
ges\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(
```

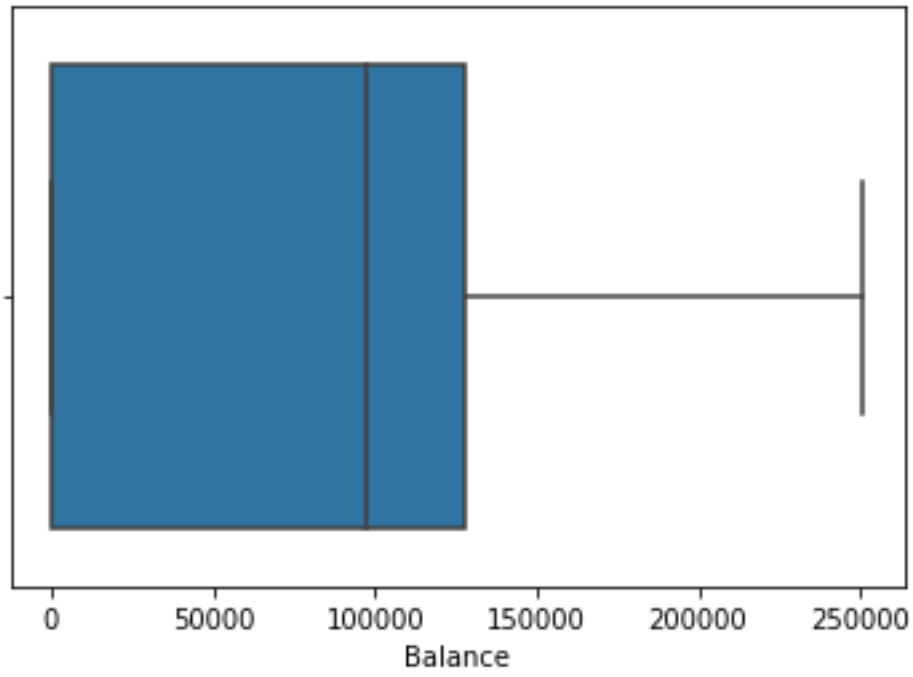
[17]: <AxesSubplot:xlabel='Age'>




[18]:
```
sns.boxplot(data["Balance"])
```

```
c:\users\arvin\appdata\local\programs\python\python39\lib\sitepacka
ges\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(
```

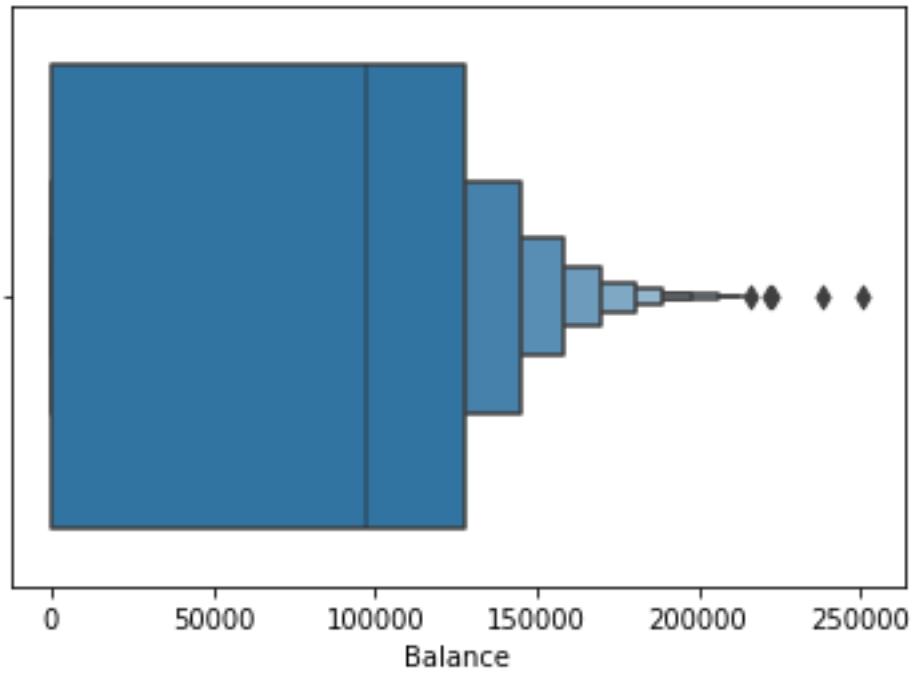
[18]: <AxesSubplot:xlabel='Balance'>




[19]:
```
sns.boxenplot(data.Balance)
```

```
c:\users\arvin\appdata\local\programs\python\python39\lib\sitepacka
ges\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(
```

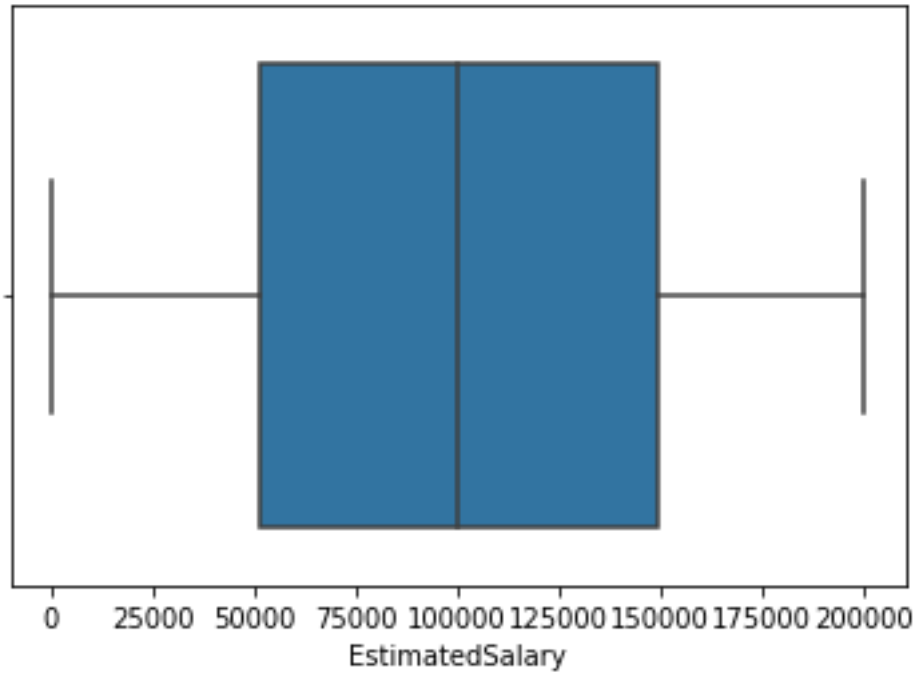
[19]: <AxesSubplot:xlabel='Balance'>




[21]:
```
sns.boxplot(data.EstimatedSalary)
```

```
c:\users\arvin\appdata\local\programs\python\python39\lib\sitepacka
ges\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(
```

[21]: <AxesSubplot:xlabel='EstimatedSalary'>

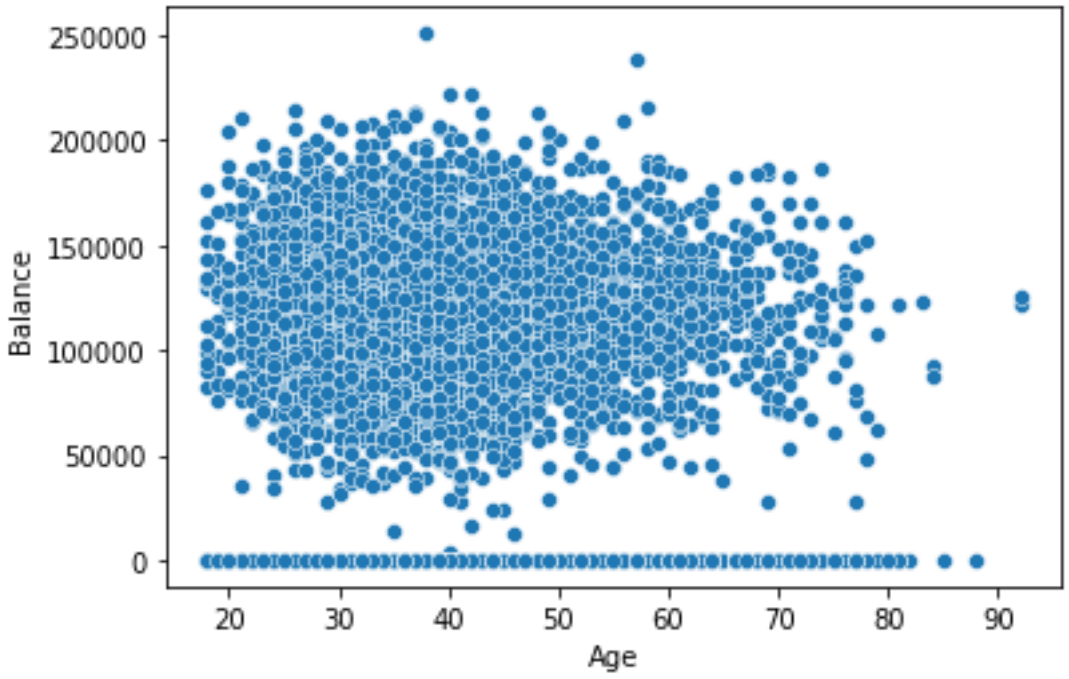



## 4 Bi-variate Data Visualization

[22]:
```
sns.scatterplot(dataAge,dataBalance)
```

```
c:\users\arvin\appdata\local\programs\python\python39\lib\sitepacka
ges\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(
```

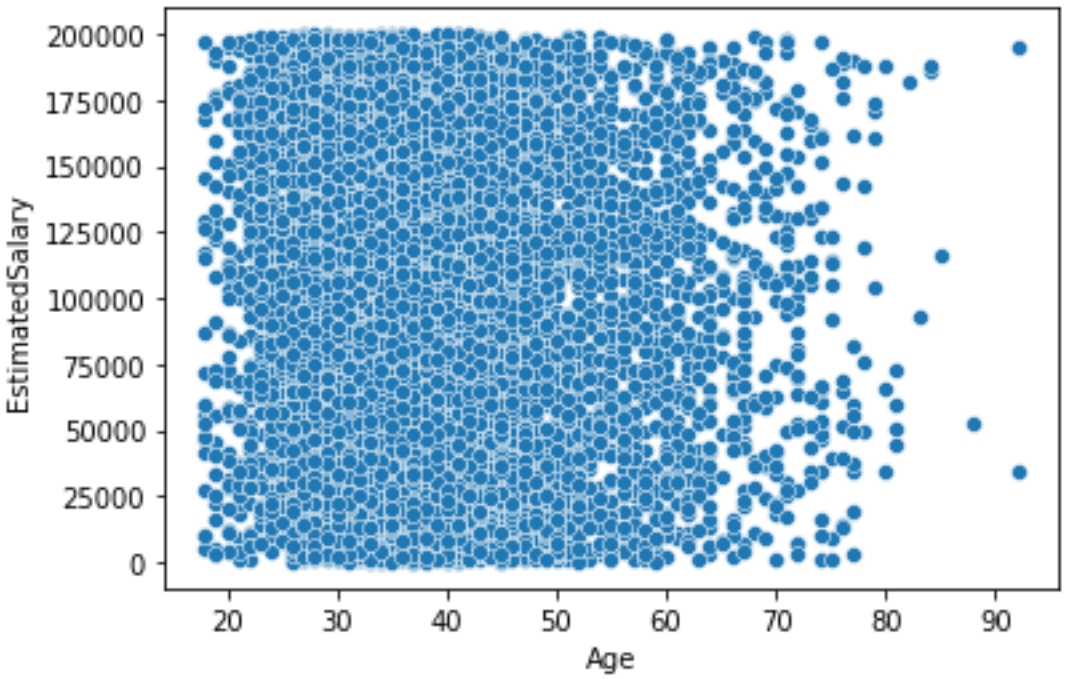
[22]: <AxesSubplot:xlabel='Age', ylabel='Balance'>




```
[23]: sns.scatterplot(data.Age,data.EstimatedSalary)
```

```
c:\users\arvin\appdata\local\programs\python\python39\lib\sitepacka
ges\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(
```

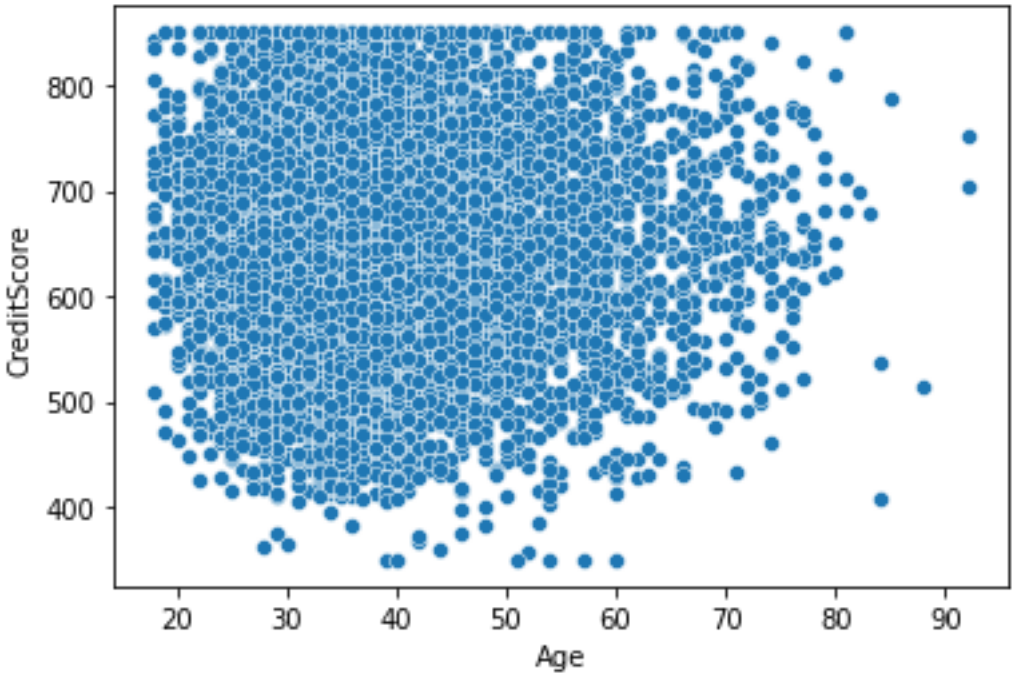
```
[23]: <AxesSubplot:xlabel='Age', ylabel='EstimatedSalary'>
```



[24]:
```
sns.scatterplot(data.Age,data.CreditScore)
```

```
c:\users\arvin\appdata\local\programs\python\python39\lib\sitepacka
ges\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(
```

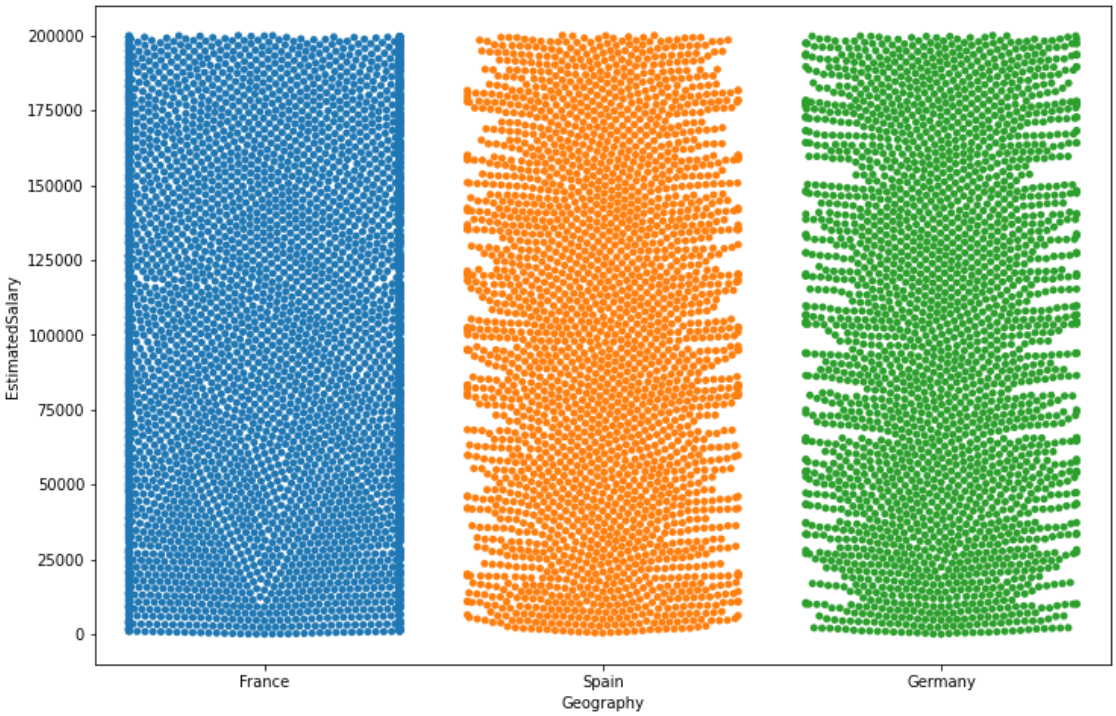
[24]: <AxesSubplot:xlabel='Age', ylabel='CreditScore'>




[25]:
```
plt.figure(figsize=(12,8))
sns.swarmplot(data.Geography,data.EstimatedSalary,data=data)
```

```
c:\users\arvin\appdata\local\programs\python\python39\lib\sitepacka
ges\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(
c:\users\arvin\appdata\local\programs\python\python39\lib\sitepackages\se
aborn\categorical.py:1296: UserWarning: 43.3% of the points cannot be
placed; you may want to decrease the size of the markers or use
stripplot.
      warnings.warn(msg, UserWarning)
c:\users\arvin\appdata\local\programs\python\python39\lib\sitepacka
ges\seaborn\categorical.py:1296: UserWarning: 5.5% of the points
cannot be placed; you may want to decrease the size of the markers
or use stripplot. warnings.warn(msg, UserWarning)
```

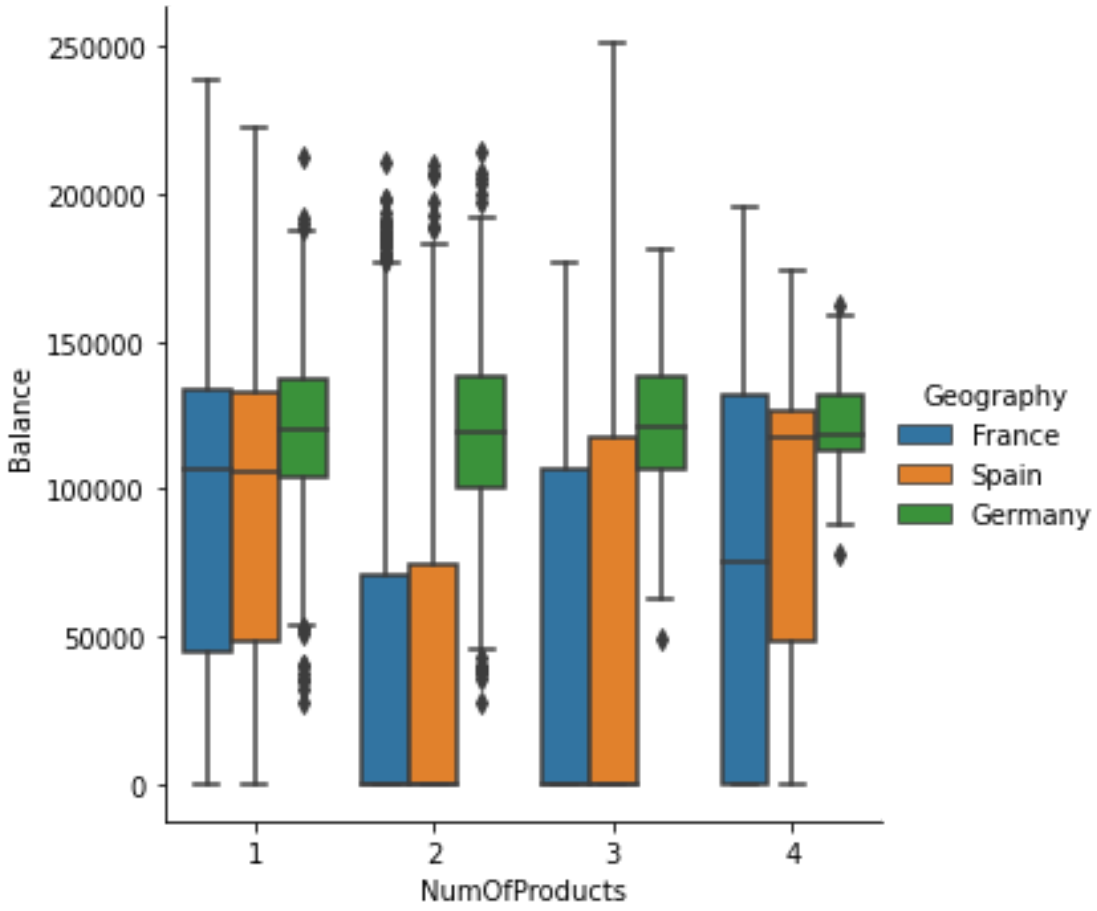
[25]: <AxesSubplot:xlabel='Geography', ylabel='EstimatedSalary'>




### 4.1 Multivariate Datavisualization

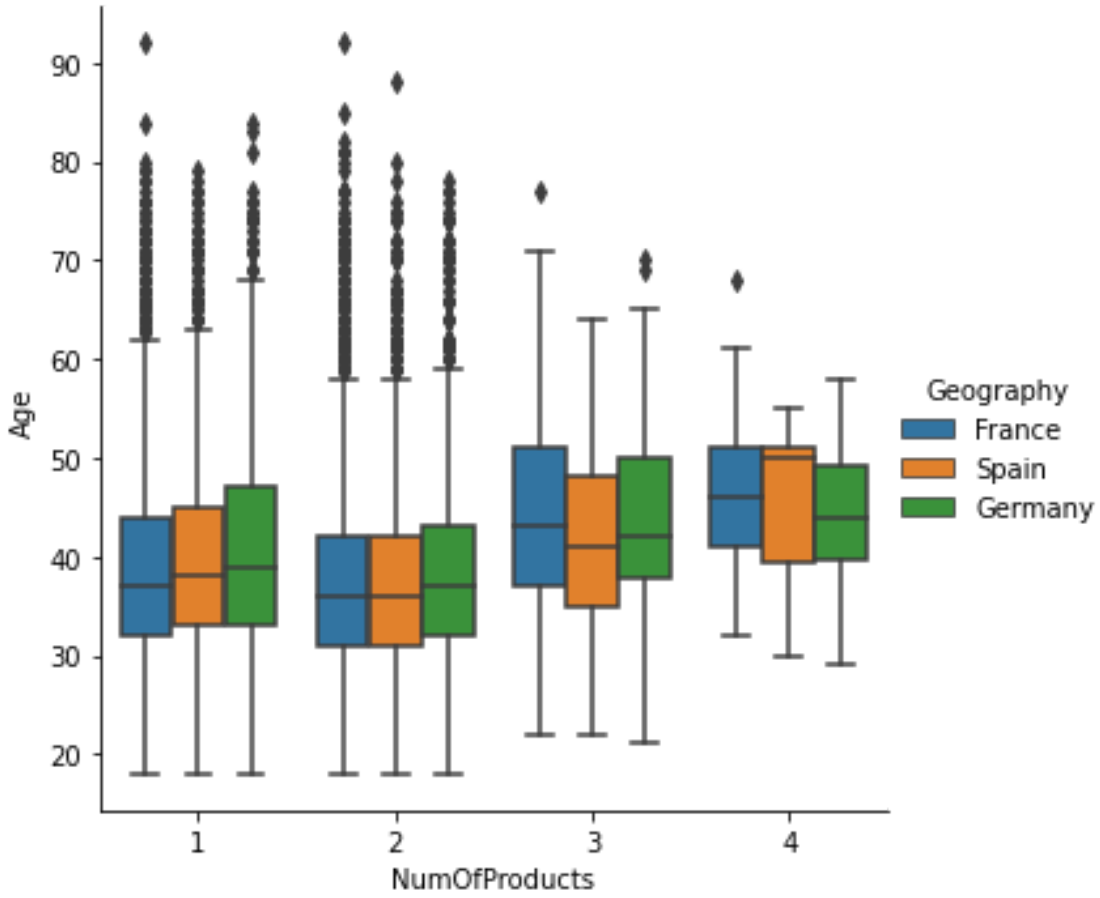
[26]:
```
sns.catplot(x="NumOfProducts",y="Balance",data=data,hue="Geography",kind='box')
```

[26]: <seaborn.axisgrid.FacetGrid at 0x188ce353790>



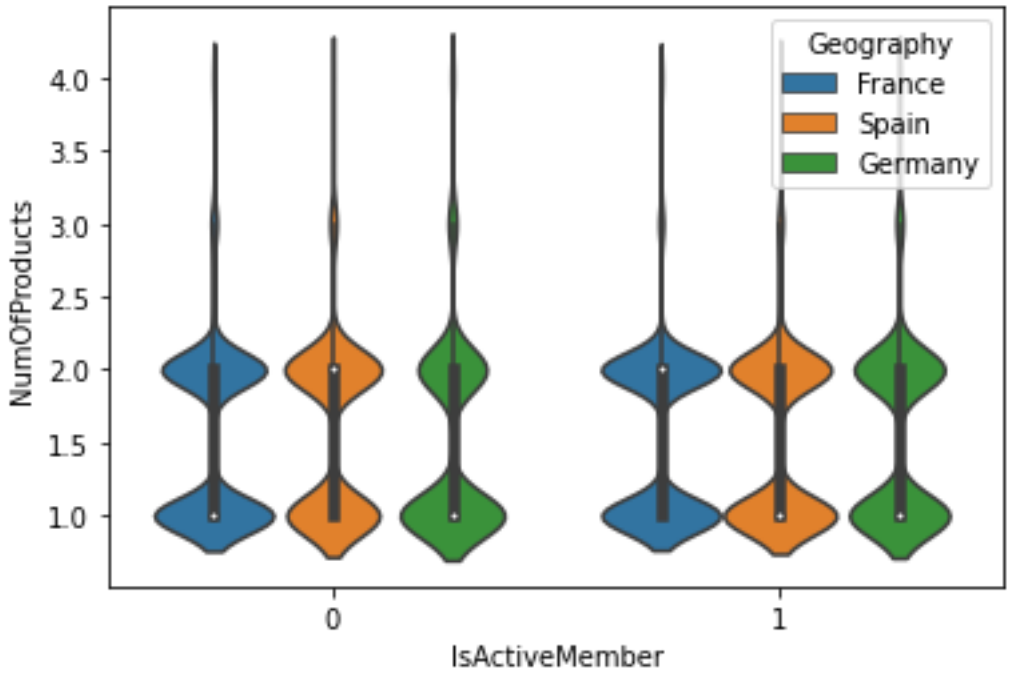

[27]:
```
sns.catplot(x="NumOfProducts",y="Age",data=data,hue="Geography",kind='box')
```

[27]: <seaborn.axisgrid.FacetGrid at 0x188cf3fed90>



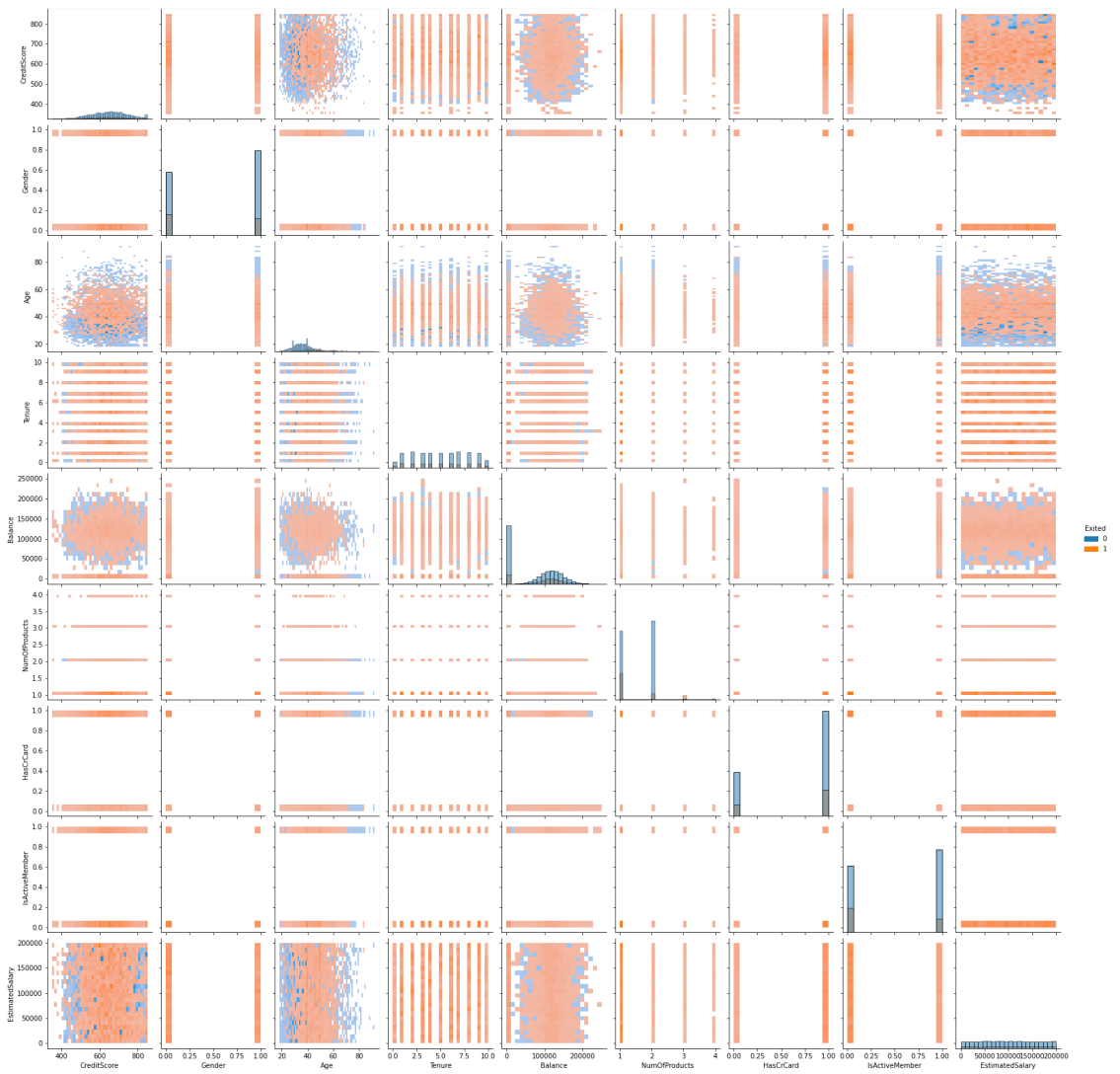

[28]:
```
sns.violinplot(x="IsActiveMember",y="NumOfProducts",data=data,hue="Geography")
```

[28]: <AxesSubplot:xlabel='IsActiveMember', ylabel='NumOfProducts'>



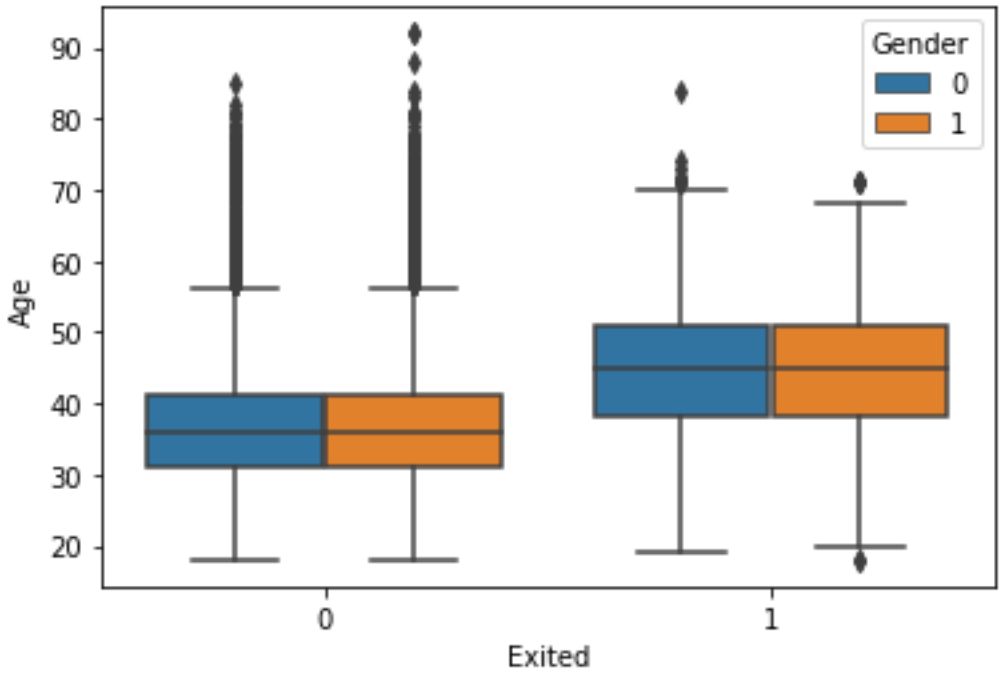

[29]:
```
sns.pairplot(data=data,hue="Exited",kind='hist')
```

[29]:
```
<seaborn.axisgrid.PairGrid at 0x188ce3a7ca0>
```




```
[30]: sns.boxplot(x="Exited",y="Age",data=data,hue="Gender")
```

```
[30]: <AxesSubplot:xlabel='Exited', ylabel='Age'>
```




## 5 Identify remove outliners

[31]:
```
q1=data["Age"].quantile(0.25)
q3=data["Age"].quantile(0.75)
iq=q3-q1
data=data[~((data["Age"]<(q1-1.5*iq))|(data["Age"]>(q3+1.5*i
                            q)))]
```

[32]:
```
q1=data["CreditScore"].quantile(0.25)
q3=data["CreditScore"].quantile(0.75) iq=q3-q1
data=data[~((data["CreditScore"]<(q1-1.5*iq))|(data["CreditSco
re"]>(q3+1. ↪5*iq)))]
```

[33]:
```
data[(data["Age"]<(data["Age"].mean()-3*data["Age"].
↪std()))|(data["Age"]>(data["Age"].mean()+3*data["Age"].std())
                                )]
```

[33]:
```
Empty DataFrame
      Columns: [Surname, CreditScore, Geography, Gender, Age,
                                                  Tenure, Balance,
 NumOfProducts, HasCrCard, IsActiveMember, EstimatedSalary,
                           Exited]
    Index: []
```

## 6 encoding Geography column by dummy variable technique

[34]:
```
geo=pd.get_dummies(data["Geography"],drop_first=True)
data1=pd.concat([data,geo],axis=1)
data1
```

[34]:

| | Surname | CreditScore | Geography | Gender | Age | Tenure | Balance | NumOfProducts | HasCrCard | IsActiveMember | EstimatedSalary | Exited | Germany | Spain |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Hargrave | 619 | France | 0 | 42 | 2 | 0.00 | 1 | 1 | 1 | 101348.88 | 1 | 0 | 0 |
| 1 | Hill | 608 | Spain | 0 | 41 | 1 | 83807.86 | 1 | 0 | 1 | 112542.58 | 0 | 0 | 1 |
| 2 | Onio | 502 | France | 0 | 42 | 8 | 159660.80 | 3 | 1 | 0 | 113931.57 | 1 | 0 | 0 |
| 3 | Boni | 699 | France | 0 | 39 | 1 | 0.00 | 2 | 0 | 0 | 93826.63 | 0 | 0 | 0 |
| 4 | Mitchell | 850 | Spain | 0 | 43 | 2 | 125510.82 | 1 | 1 | 1 | 79084.10 | 0 | 0 | 1 |
| … | … | … | … | … | … | … | … | … | … | … | … | … | … | … |
| 9995 | Obijiaku | 771 | France | 1 | 39 | 5 | 0.00 | 2 | 1 | 0 | 96270.64 | 0 | 0 | 0 |
| 9996 | Johnstone | 516 | France | 1 | 35 | 10 | 57369.61 | 1 | 1 | 1 | 101699.77 | 0 | 0 | 0 |
| 9997 | Liu | 709 | France | 0 | 36 | 7 | 0.00 | 1 | 0 | 1 | 42085.58 | 1 | 0 | 0 |
| 9998 | Sabbatini | 772 | Germany | 1 | 42 | 3 | 75075.31 | 2 | 1 | 0 | 92888.52 | 1 | 1 | 0 |
| 9999 | Walker | 792 | France | 0 | 28 | 4 | 130142.79 | 1 | 1 | 0 | 38190.78 | 0 | 0 | 0 |

[9627 rows x 14 columns]

## 7 Split data into dependent and independent futures

```
[43]: x=dataldrop(columns$"Surname","Geography","Exited"])
      y=data['Exited']
      x.head()
```

```
[43]:  CreditScore Gender Age Tenure  Balance NumOfProducts HasCrCard \
0         619    0 42  2     0.00  1     1
1         608    0 41  1     83807.86   1     0
2         502    0 42  8 159660.80      3     1
3         699    0 39  1     0.00  2     0
4         850    0 43  2 125510.82      1     1

         IsActiveMember EstimatedSalary Germany Spain
0              1  101348.88  0     0
1              1  112542.58  0     1
2              0  113931.57  0     0
3              0  93826.63   0     0
4              1  79084.10   0     1
```

## 8 Scaling independent futures

```
[44]: from sklearn.preprocessing import
      StandardScaler from sklearn.model_selection
      import train_test_split sc=StandardScaler()
           scaled_data=sc.fit_transform(x)
      scaled_data=pd.
       ↪DataFrame(scaled_data,columns=["CreditScore","Gender","Age","Tenure","Balance"
      ,"NumOfProduct scaled_data.head()
```

```
[44]:  CreditScore  Gender     Age   Tenure Balance NumOfProducts \
0    -0.329901 -1.097262 0.479327 -1.044311 -1.226614-0.914075

1    -0.444342 -1.097262 0.365664 -1.390532 0.116511  -0.914075

2    -1.547136 -1.097262 0.479327 1.033018 1.332148   2.529401

3    0.502395 -1.097262 0.138339 -1.390532 -1.226614  0.807663

4    2.073356 -1.097262 0.592990 -1.044311 0.784853   -0.914075

     HasCrCard IsActiveMember EstimatedSalaryGermany    Spain

          0 0.646875 0.992858 0.021336 -0.579629 -0.573072 1
     -1.545894 0.992858 0.215937 -0.579629 1.744981
          2 0.646875 -1.007193 0.240084 -0.579629 -0.573072 3
     -1.545894 -1.007193 -0.109438 -0.579629 -0.573072
     4  0.646875      0.992858     -0.365734 -0.579629 1.744981
```

## 9 Splitting data into train and test datasets

```
[45]:
x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.2,random_state=1)
```

[46]:
```
x_train.shape,x_test.shape
```

[46]:
```
((7701, 11), (1926, 11))
```

[ ]:
```

```