Assignment - 2

Assignment Date	25 September 2022
Student Name	Heena R
Student Roll Number	811519104042
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   Balance 10000 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()
```

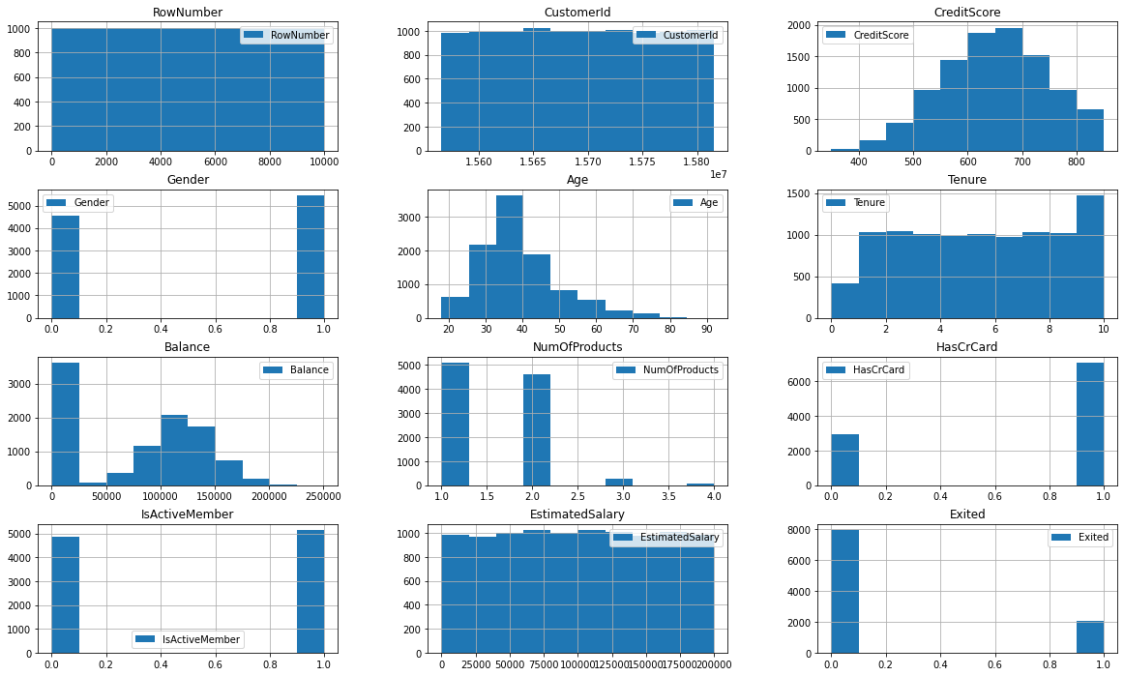
[7]:
```
France     5014
Germany    2509
Spain      2477
Name: Geography, dtype: int64
```

[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
```

..

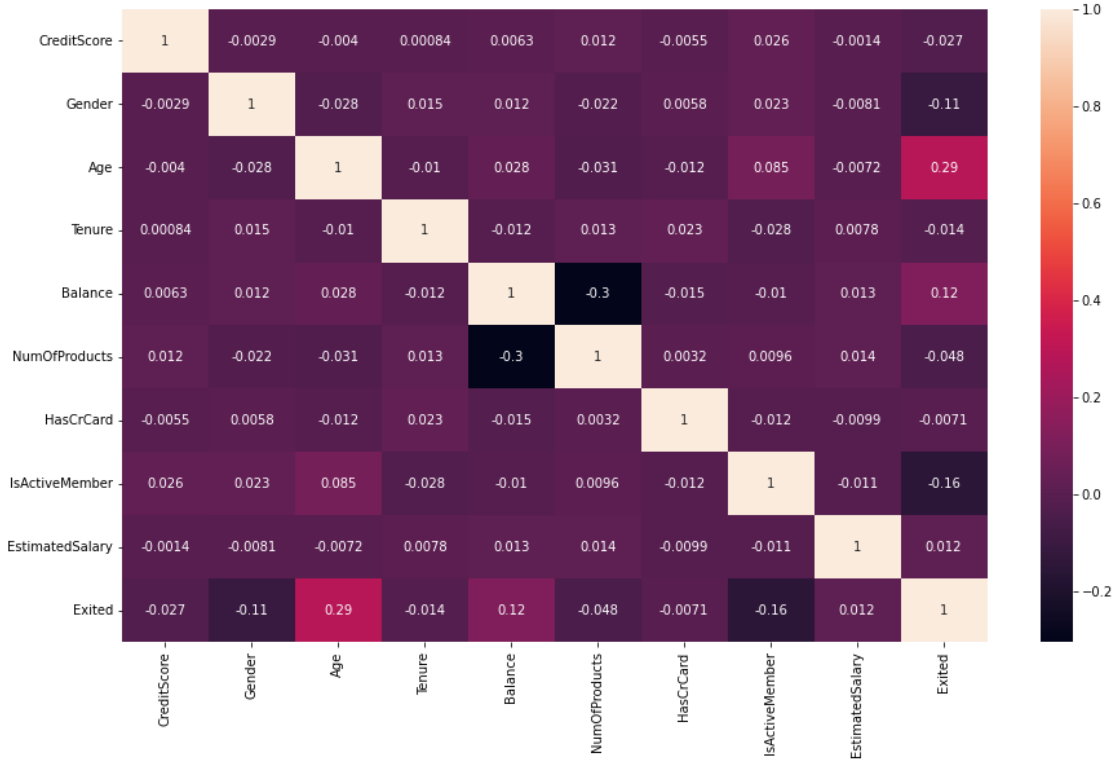
```
Izmailov    1
Bold        1
Bonham      1
Poninski    1
Burbidge    1
Name: Surname, Length: 2932, dtype: int64
```

[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     5.000000 97198.540000
75%    718.000000     1.000000    44.000000     7.000000 127644.240000
max    850.000000     1.000000    92.000000    10.000000 250898.090000

       NumOfProducts  HasCrCard  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
```

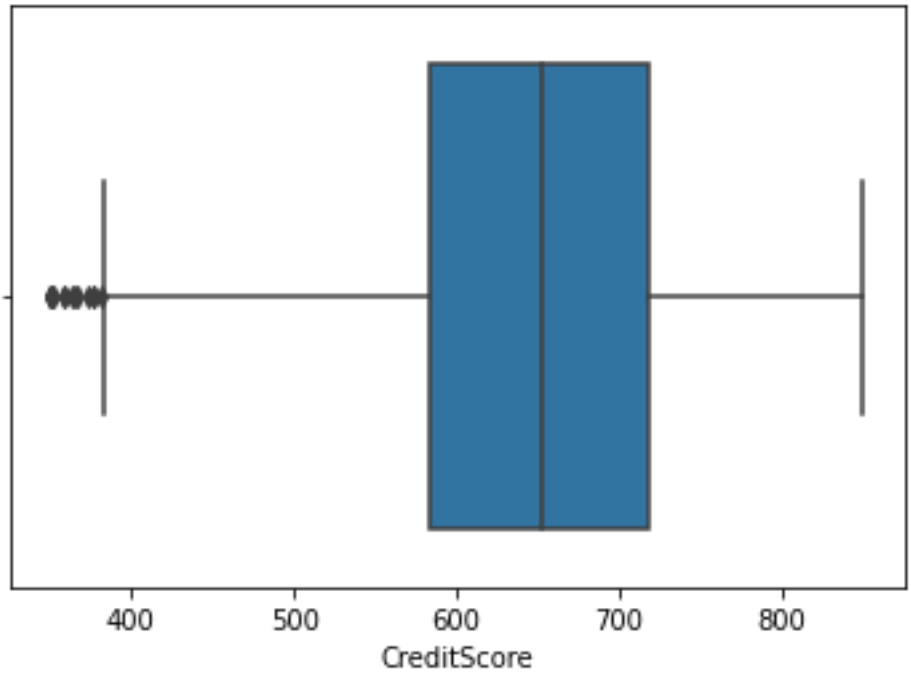
3 EDA analysis

Univariate Data Visualization

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

```
c:\users\arvin\appdata\local\programs\python\python39\lib\sitepackag
es\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(
```

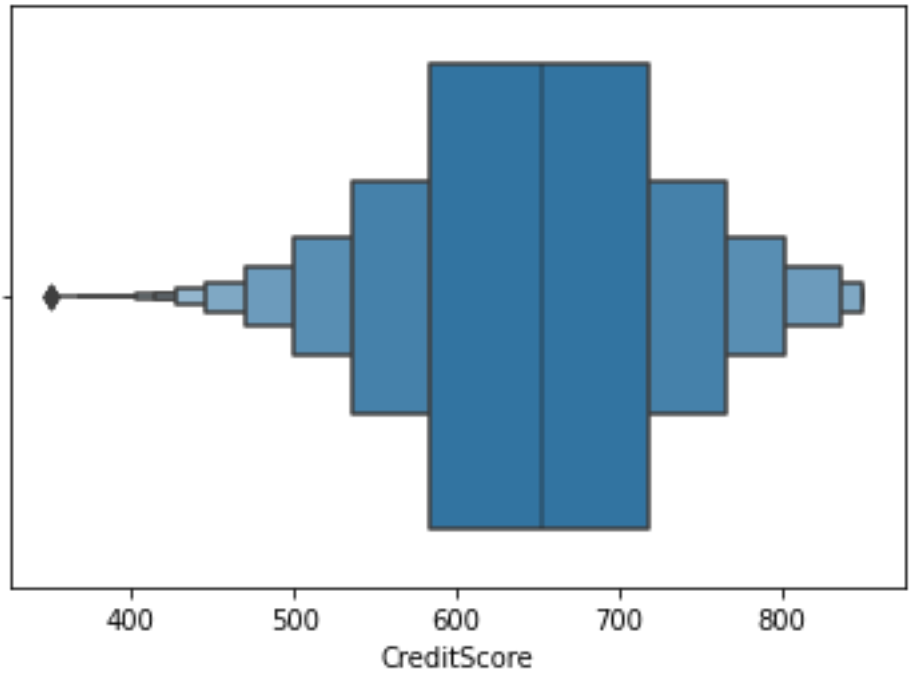
[15]:
```
<AxesSubplot:xlabel='CreditScore'>
```



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

```
c:\users\arvin\appdata\local\programs\python\python39\lib\sitepackag
es\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(
```

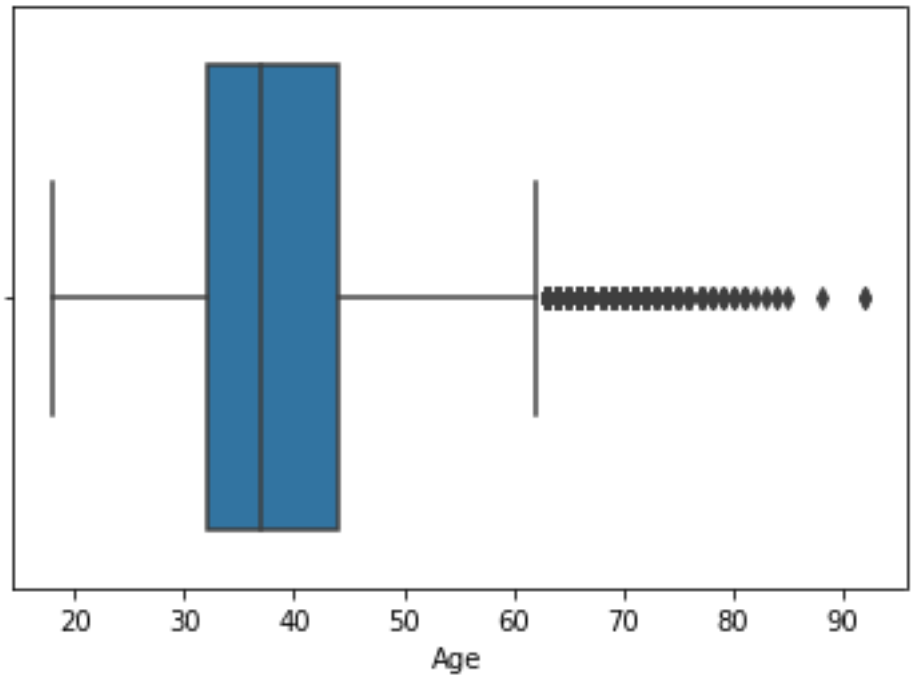
[16]: <AxesSubplot:xlabel='CreditScore'>



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

```
c:\users\arvin\appdata\local\programs\python\python39\lib\sitepackag
es\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(
```

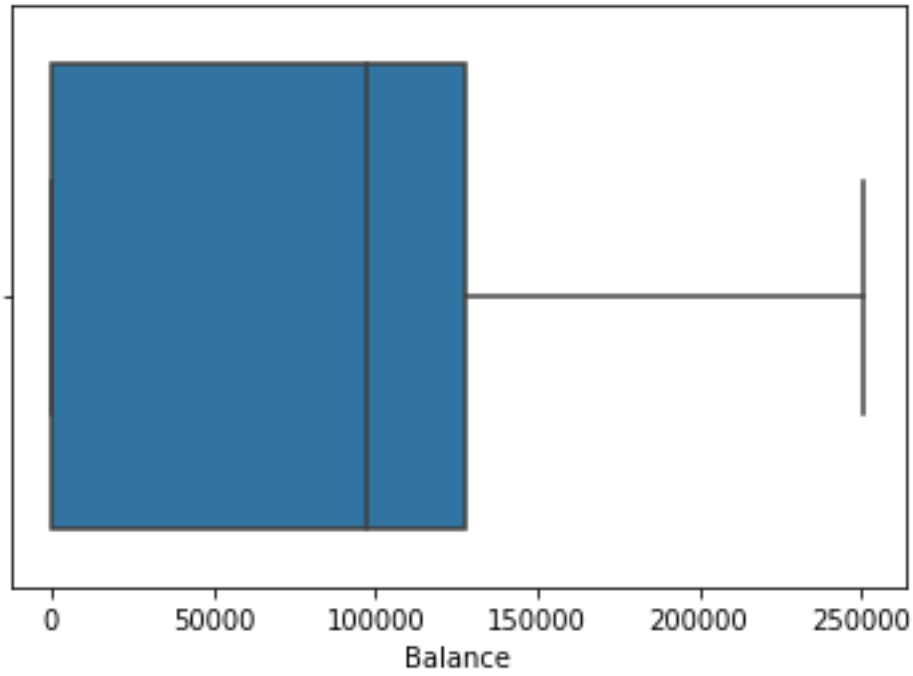
[17]: <AxesSubplot:xlabel='Age'>



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

```
c:\users\arvin\appdata\local\programs\python\python39\lib\sitepackag
es\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(
```

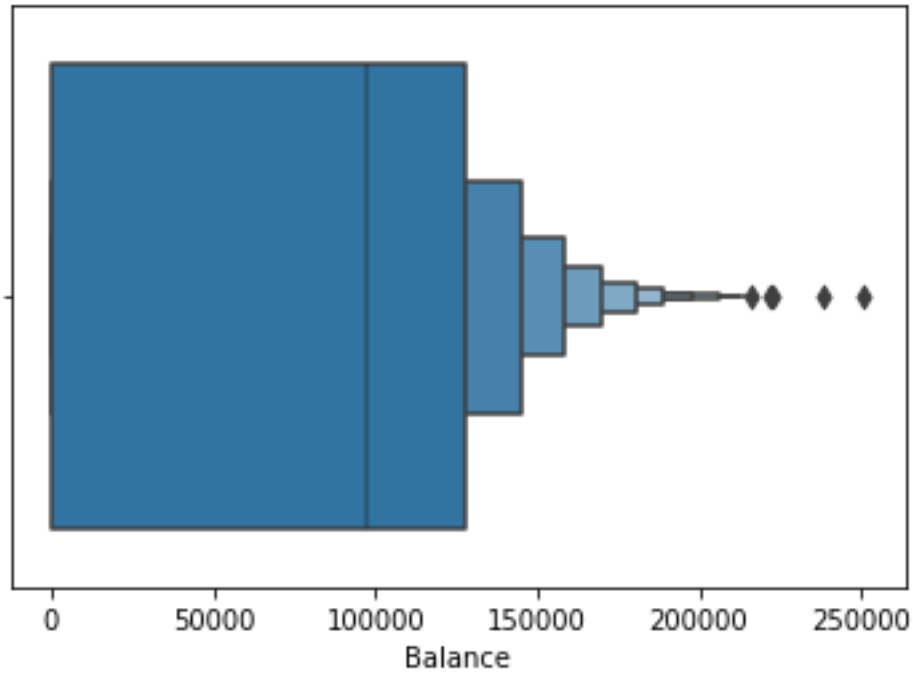
[18]: <AxesSubplot:xlabel='Balance'>



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

```
c:\users\arvin\appdata\local\programs\python\python39\lib\sitepackag
es\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(
```

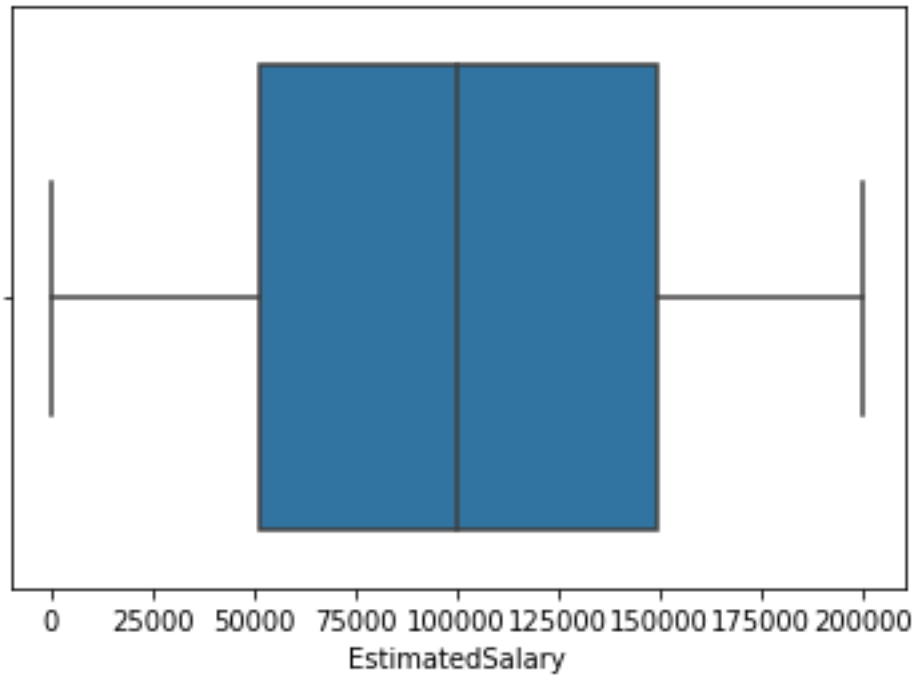
[19]: <AxesSubplot:xlabel='Balance'>



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

```
c:\users\arvin\appdata\local\programs\python\python39\lib\sitepackag
es\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'>

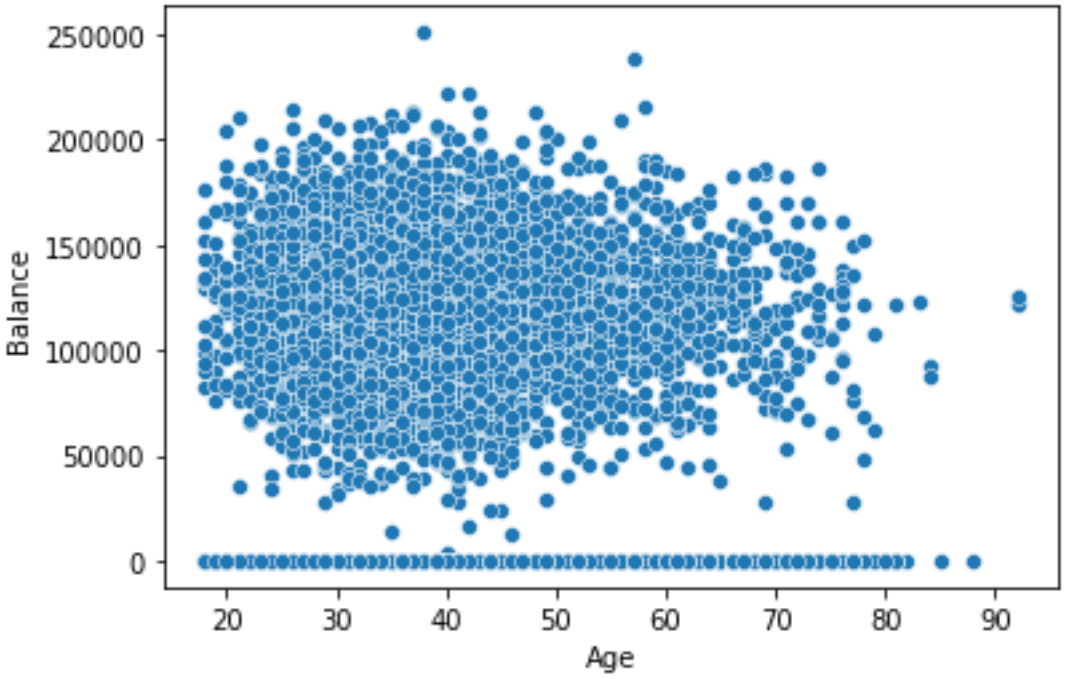


4 Bi-variate Data Visualization

[22]:
```
sns.scatterplot(data.Age,data.Balance)
```

```
c:\users\arvin\appdata\local\programs\python\python39\lib\sitepackag
es\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(
```

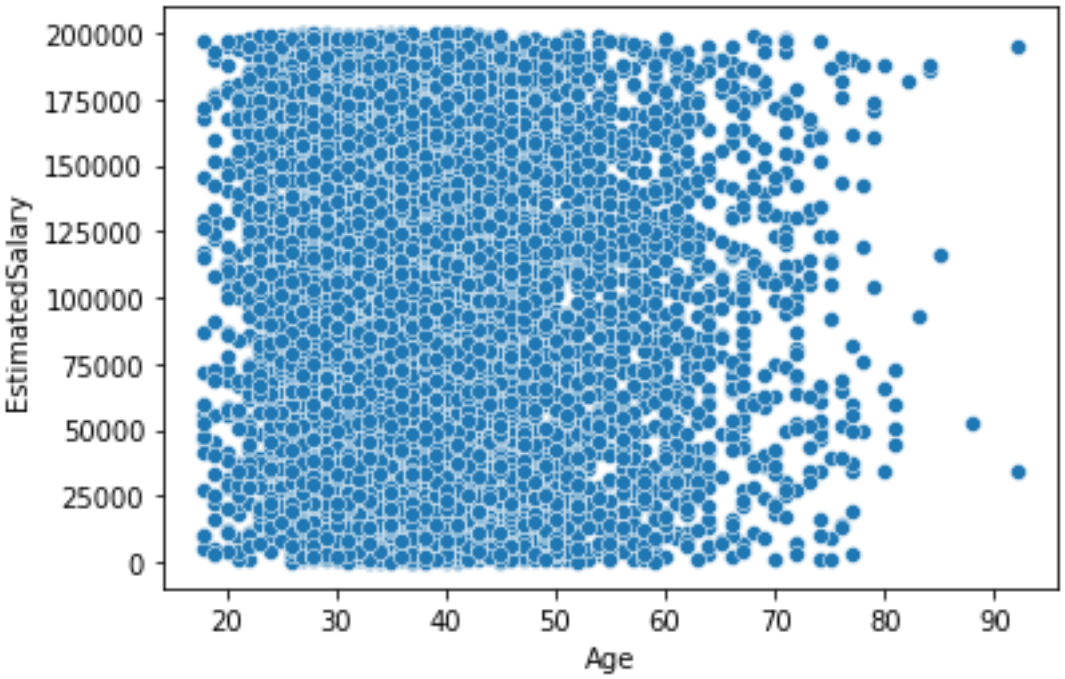
[22]: <AxesSubplot:xlabel='Age', ylabel='Balance'>



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

```
c:\users\arvin\appdata\local\programs\python\python39\lib\sitepackag
es\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(
```

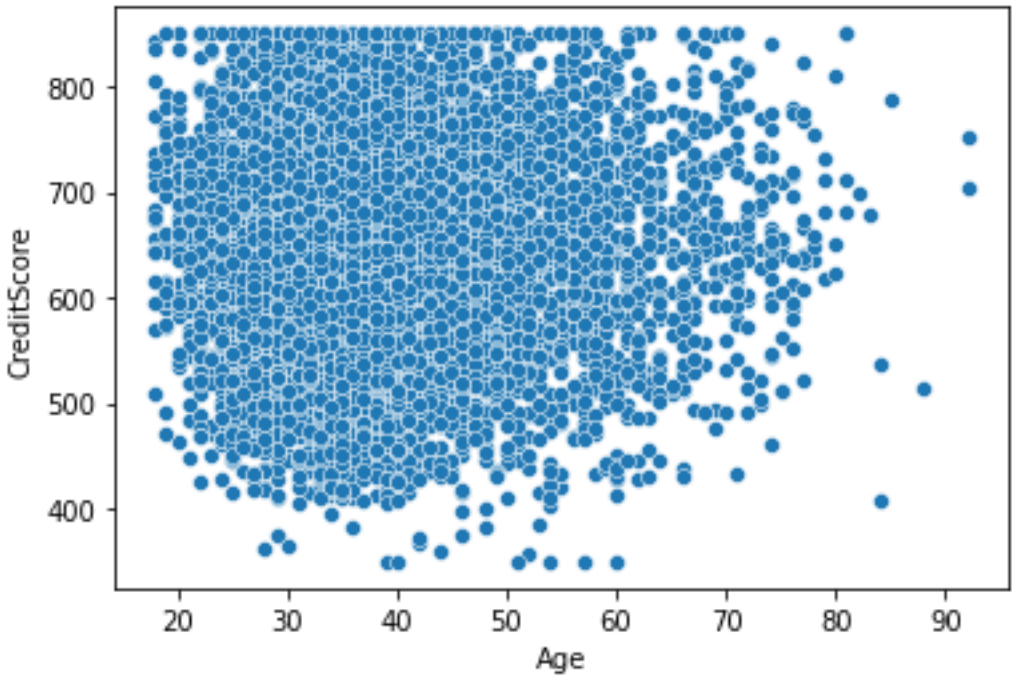
[23]: <AxesSubplot:xlabel='Age', ylabel='EstimatedSalary'>



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

```
c:\users\arvin\appdata\local\programs\python\python39\lib\sitepackag
es\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(
```

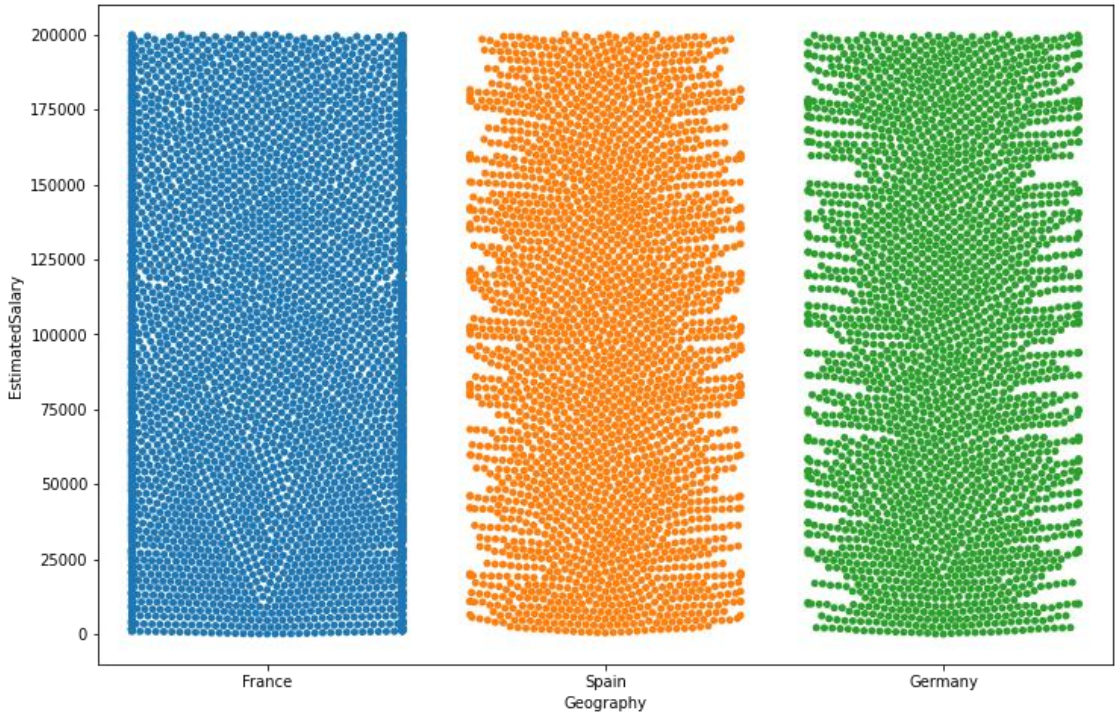
[24]: <AxesSubplot:xlabel='Age', ylabel='CreditScore'>



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

```
c:\users\arvin\appdata\local\programs\python\python39\lib\sitepackag
es\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\seab
orn\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\sitepackag
es\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)
```

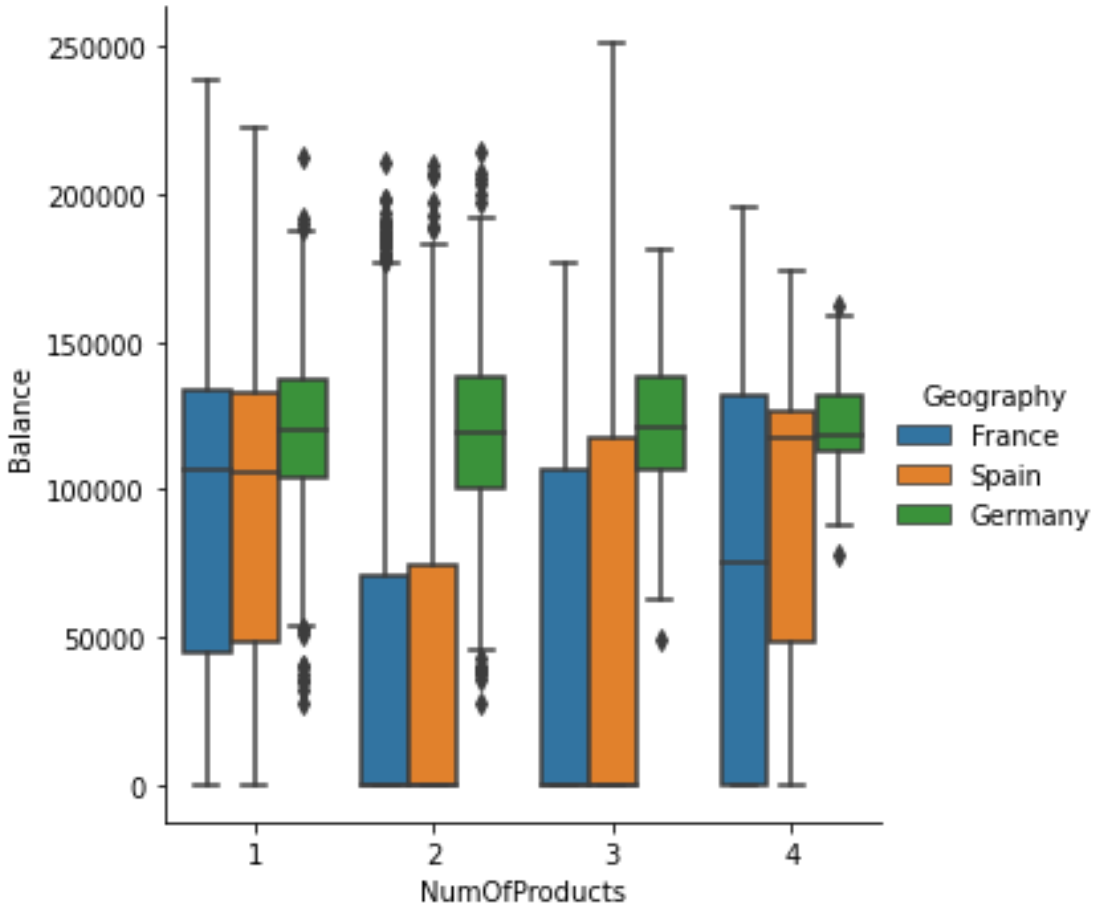
[25]: <AxesSubplot:xlabel='Geography', ylabel='EstimatedSalary'>



4.1 Multivariate Datavisualization

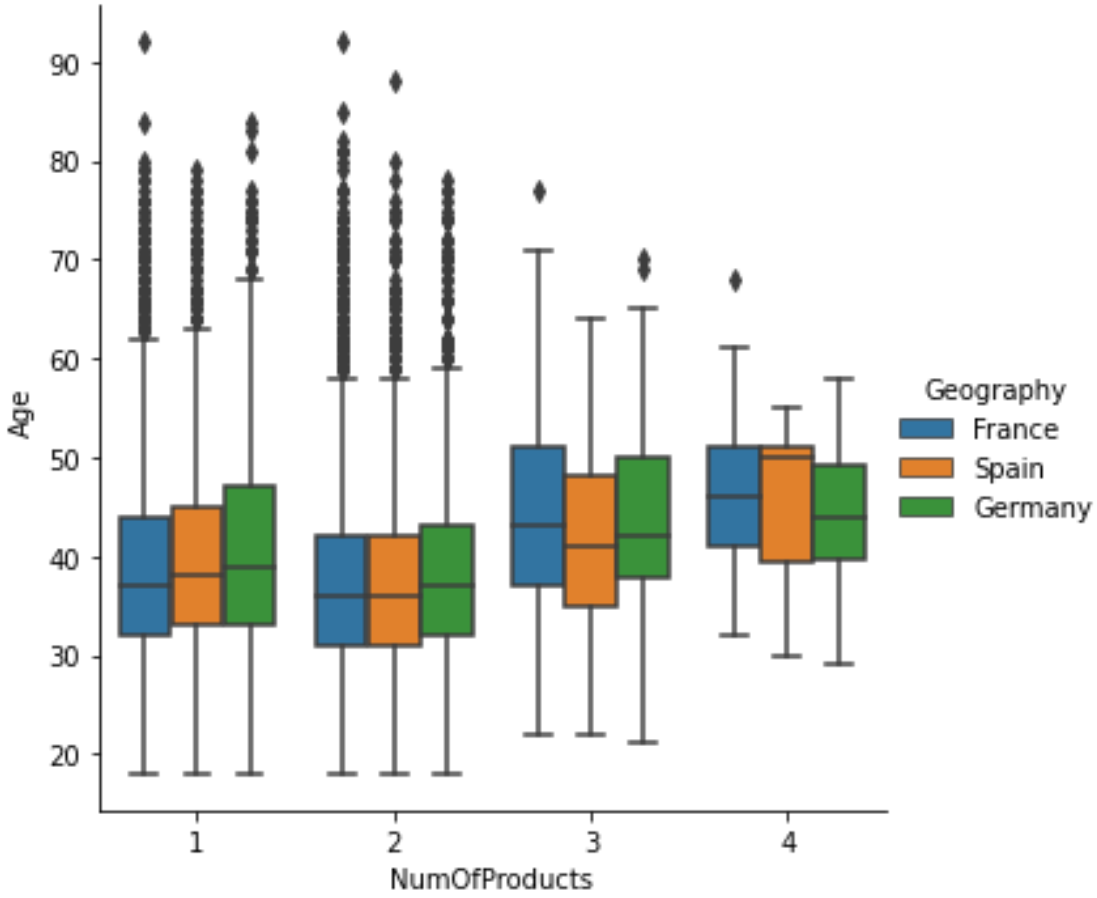
[26]:
```
sns.catplot(x="NumOfProducts",y="Balance",data=data,hue="Geography",kind='box')
```

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



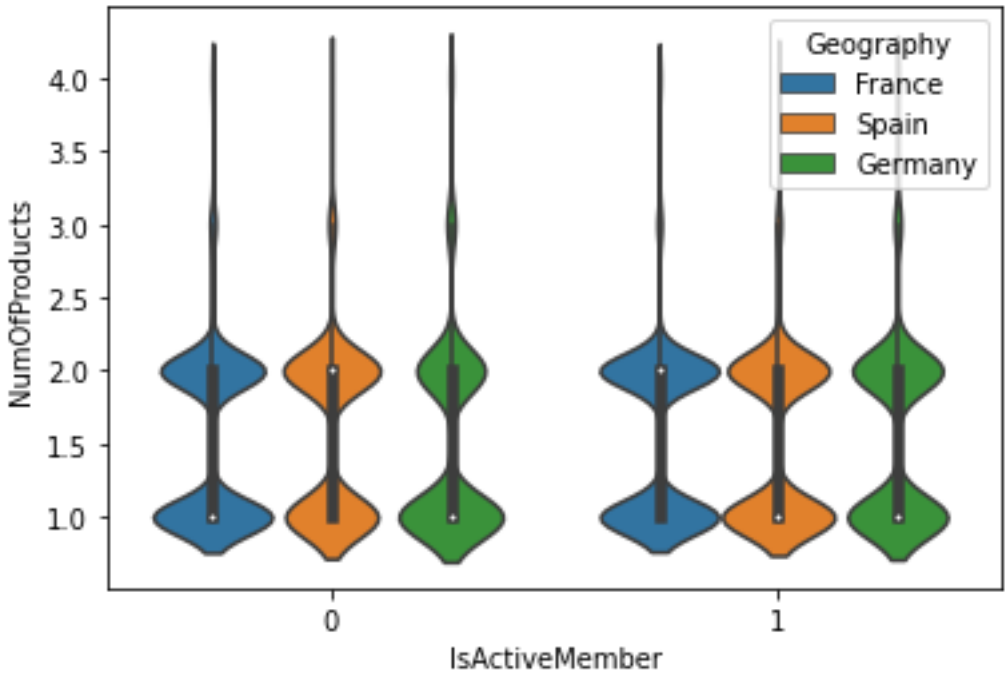
[27]:
```
sns.catplot(x="NumOfProducts",y="Age",data=data,hue="Geography",kind='box')
```

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



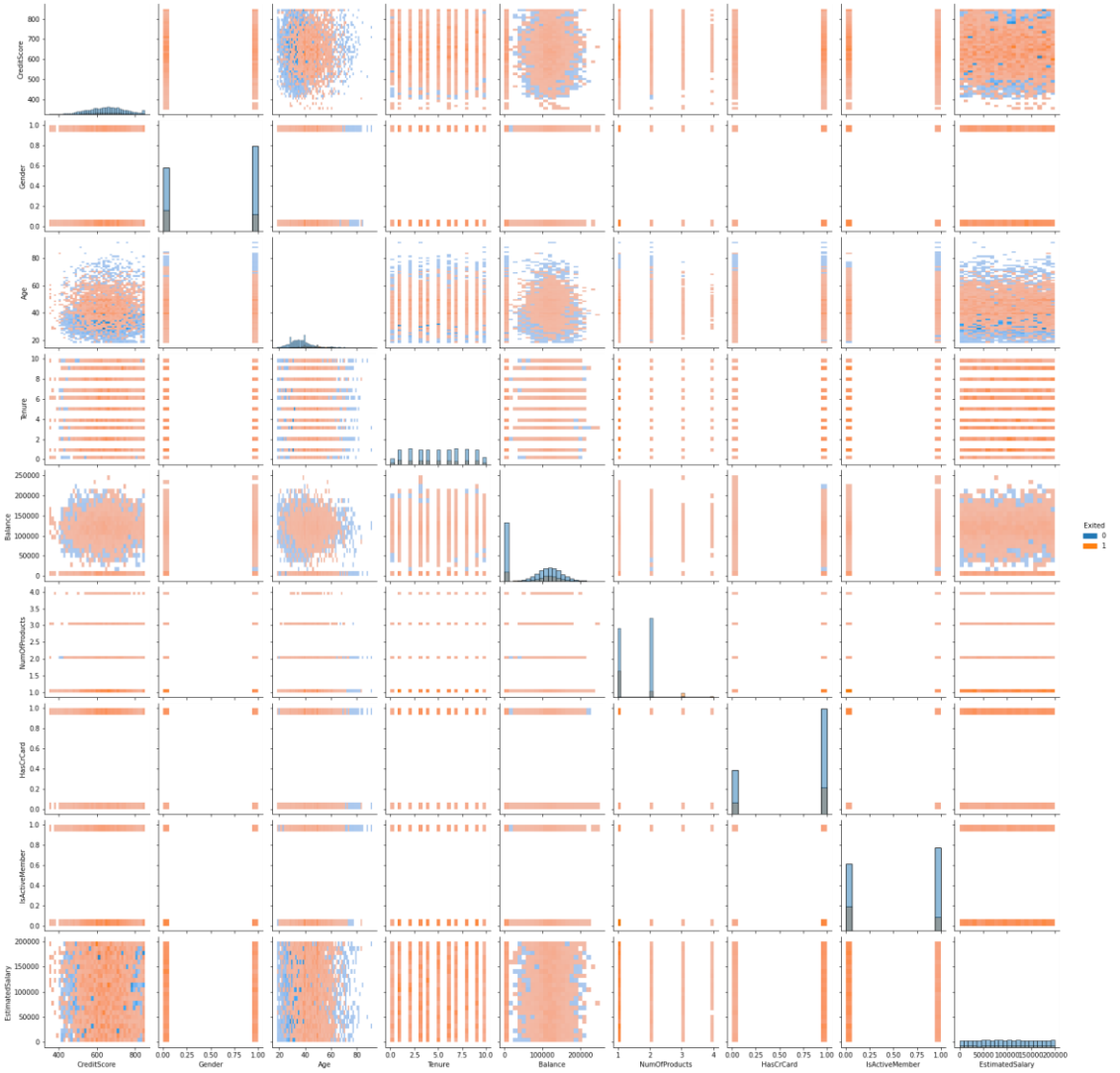
[28]:
```
sns.violinplot(x="IsActiveMember",y="NumOfProducts",data=data,hue="Geography")
```

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



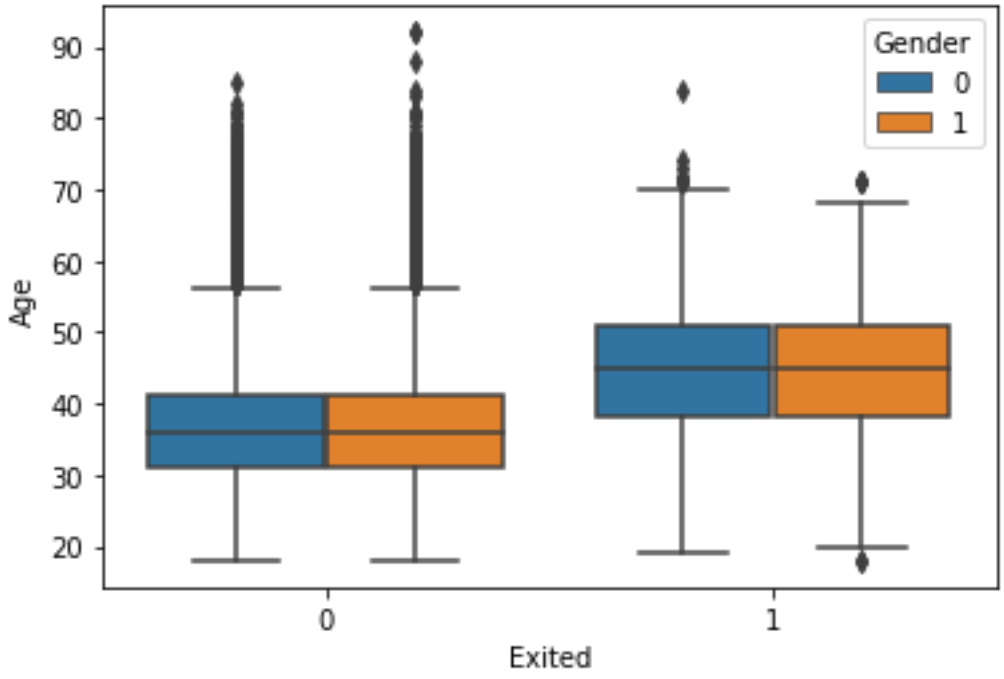
[29]:
```
sns.pairplot(data=data,hue="Exited",kind='hist')
```

[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*iq)))]
```

[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["CreditScore"]>(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	\
0	Hargrave	619	France	0	42	2	0.00	

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

      Germany Spain
0           0     0
1           0     1
2           0     0
3           0     0
4           0     1
…         …     …
9995        0     0
9996        0     0
9997        0     0
9998        1     0
9999        0     0

[9627 rows x 14 columns]
```

7 Split data into dependent and independent futures

[43]:
```
x=data1.drop(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 EstimatedSalary Germany    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))
```

[ ]:
```

```