```
import numpy as np

import pandas as pd

df=pd.read_csv("Churn_Modelling.csv")

df
```

```
      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   
...         ...         ...        ...          ...       ...     ...  
...   
9995       9996    15606229   Obijiaku          771    France    Male   
39   
9996       9997    15569892  Johnstone          516    France    Male   
35   
9997       9998    15584532        Liu          709    France  Female   
36   
9998       9999    15682355  Sabbatini          772   Germany    Male   
42   
9999      10000    15628319     Walker          792    France  Female   
28   

      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   
...      ...        ...            ...        ...             ...   
9995       5       0.00              2          1               0   
9996      10   57369.61              1          1               1   
9997       7       0.00              1          0               1   
9998       3   75075.31              2          1               0   
9999       4  130142.79              1          1               0   

      EstimatedSalary  Exited  
0           101348.88       1  
1           112542.58       0  
2           113931.57       1  
3            93826.63       0  
```

```
4            79084.10       0
...               ...     ...
9995         96270.64       0
9996        101699.77       0
9997         42085.58       1
9998         92888.52       1
9999         38190.78       0

[10000 rows x 14 columns]
```

```
df.shape
```

```
(10000, 14)
```

```
df.columns
```

```
Index(['RowNumber', 'CustomerId', 'Surname', 'CreditScore',
'Geography',
       'Gender', 'Age', 'Tenure', 'Balance', 'NumOfProducts',
'HasCrCard',
       'IsActiveMember', 'EstimatedSalary', 'Exited'],
      dtype='object')
```

```
df["NumOfProducts"].unique()
```

```
array([1, 3, 2, 4])
```

```
df["NumOfProducts"].value_counts()
```

```
1    5084
2    4590
3     266
4      60
Name: NumOfProducts, dtype: int64
```

```
df.dtypes
```

```
RowNumber            int64
CustomerId           int64
Surname             object
CreditScore          int64
Geography           object
Gender              object
Age                  int64
Tenure               int64
Balance            float64
NumOfProducts        int64
HasCrCard            int64
IsActiveMember       int64
EstimatedSalary    float64
Exited               int64
dtype: object
```

```
df.head()

   RowNumber  CustomerId   Surname  CreditScore Geography  Gender  Age
\
0          1    15634602  Hargrave          619    France  Female   42

1          2    15647311      Hill          608     Spain  Female   41

2          3    15619304      Onio          502    France  Female   42

3          4    15701354      Boni          699    France  Female   39

4          5    15737888  Mitchell          850     Spain  Female   43


   Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0       2       0.00              1          1               1
1       1   83807.86              1          0               1
2       8  159660.80              3          1               0
3       1       0.00              2          0               0
4       2  125510.82              1          1               1

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

df.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
```

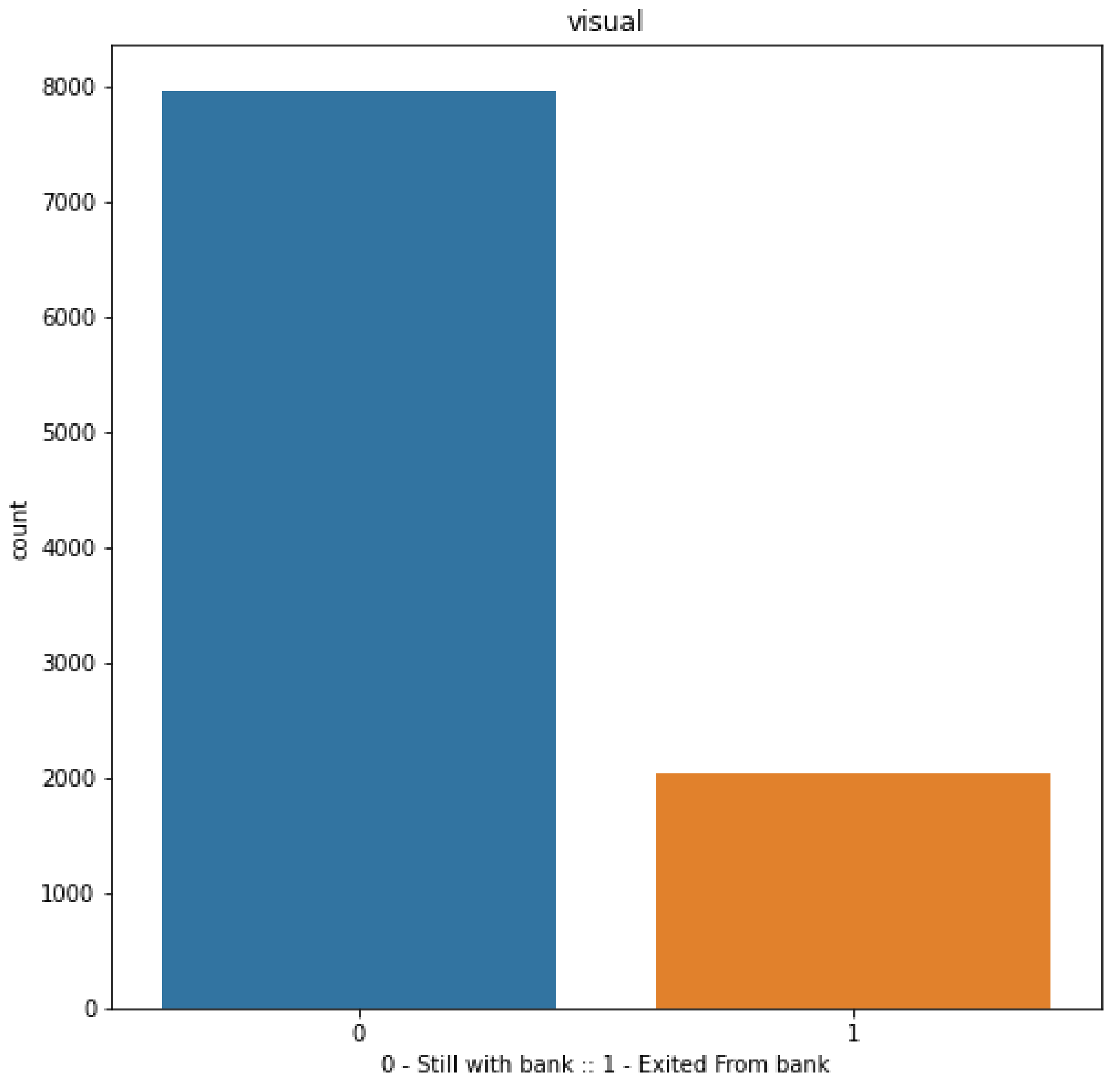
```
             Balance  NumOfProducts    HasCrCard  IsActiveMember  \
count   10000.000000   10000.000000  10000.00000    10000.000000   
mean    76485.889288       1.530200      0.70550        0.515100   
std     62397.405202       0.581654      0.45584        0.499797   
min         0.000000       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  
```

```
import matplotlib.pyplot as plt
```

```
import seaborn as sns
```

```
%matplotlib inline
```

```
plt.figure(figsize=(8,8))
sns.countplot(x='Exited',data=df)
plt.xlabel("0 - Still with bank :: 1 - Exited From bank")
plt.ylabel("count")
plt.title("visual")
plt.show()
```



```
df.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
```

```
df.isna().any()
```

```
RowNumber          False
CustomerId         False
Surname            False
CreditScore        False
Geography          False
Gender             False
Age                False
Tenure             False
Balance            False
NumOfProducts      False
HasCrCard          False
IsActiveMember     False
EstimatedSalary    False
Exited             False
dtype: bool
```

```
df.isnull().sum()
```

```
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
```

```
df1=df.copy()
```

```
df1.shape
```

```
(10000, 14)
```

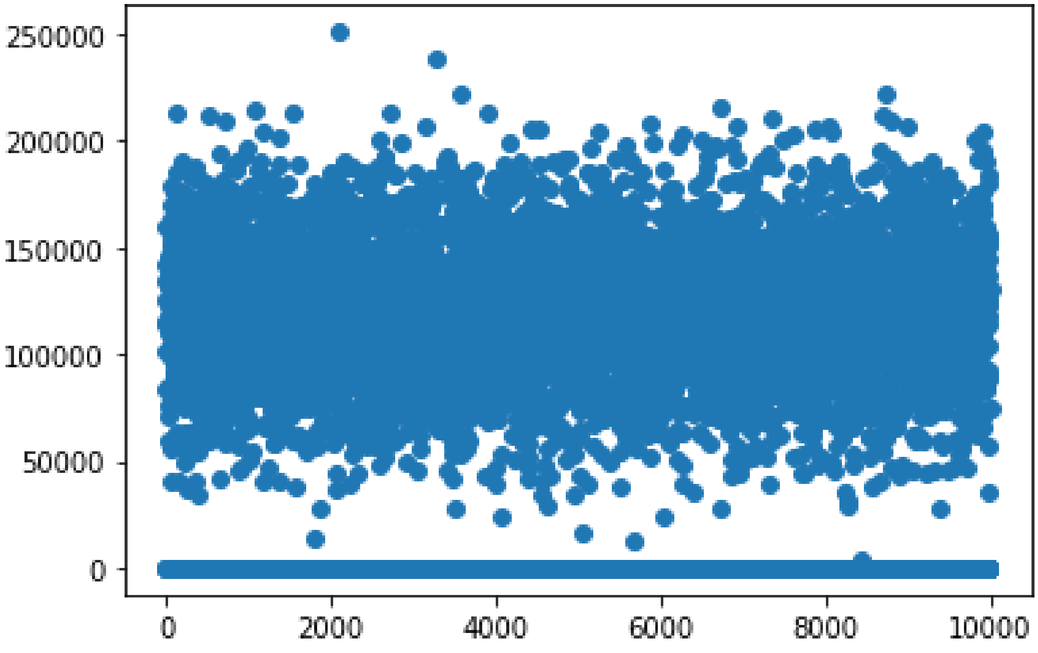
```
updated_df=df.dropna(axis=1)
updated_df.info()
```

```
<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
```

```
updated_df['Balance']=updated_df['Balance'].fillna(updated_df['Balance
'].mean())
updated_df.info()
```

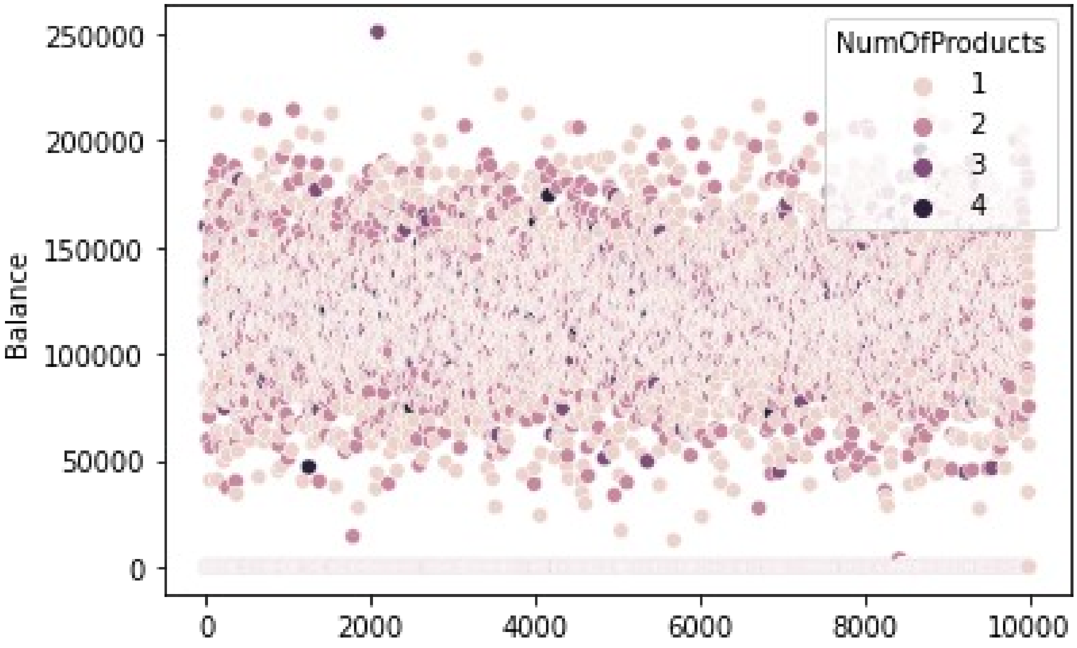
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 10000 entries, 0 to 9999
Data columns (total 14 columns):
 #   Column           Non-Null Count  Dtype  
---  ------           --------------  -----  
 0   RowNumber        10000 non-null  int64  
 1   CustomerId       10000 non-null  int64  
 2  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

```
plt.scatter(df.index,df['Balance'])
plt.show()
```



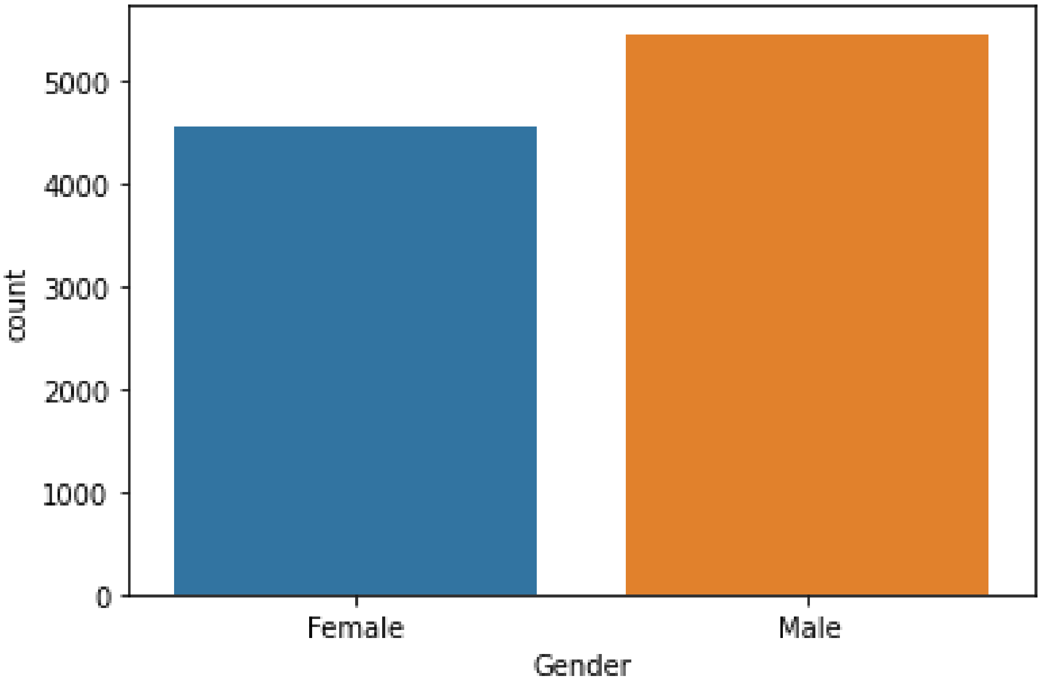
```
sns.scatterplot(x=df.index,y=df['Balance'],hue=df['NumOfProducts'])
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f2251ff7e50>
```



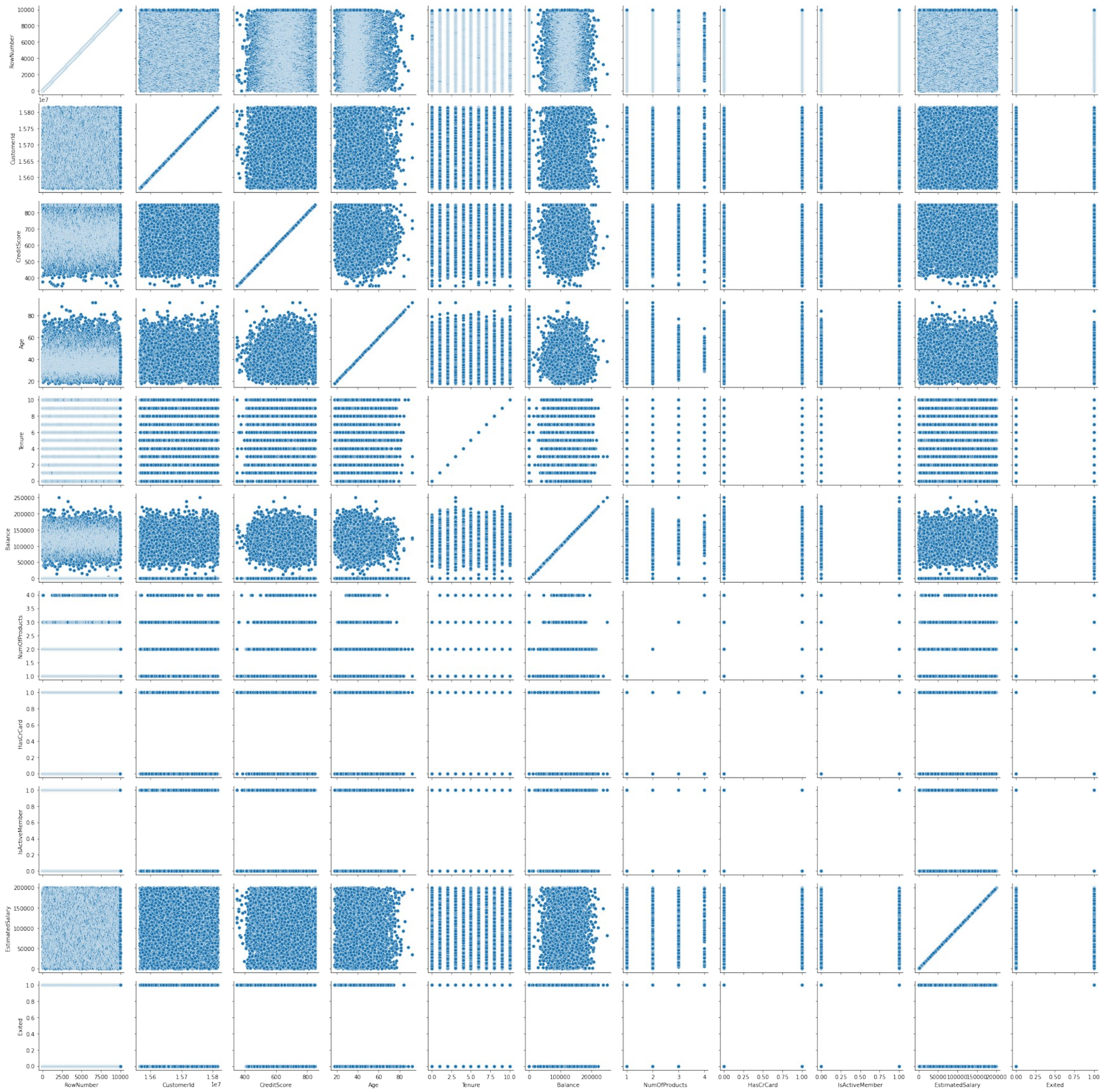
```
sns.barplot(x='Gender',y='Exited',data=df)
sns.countplot(x='Gender',data=df)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f2251d44210>
```



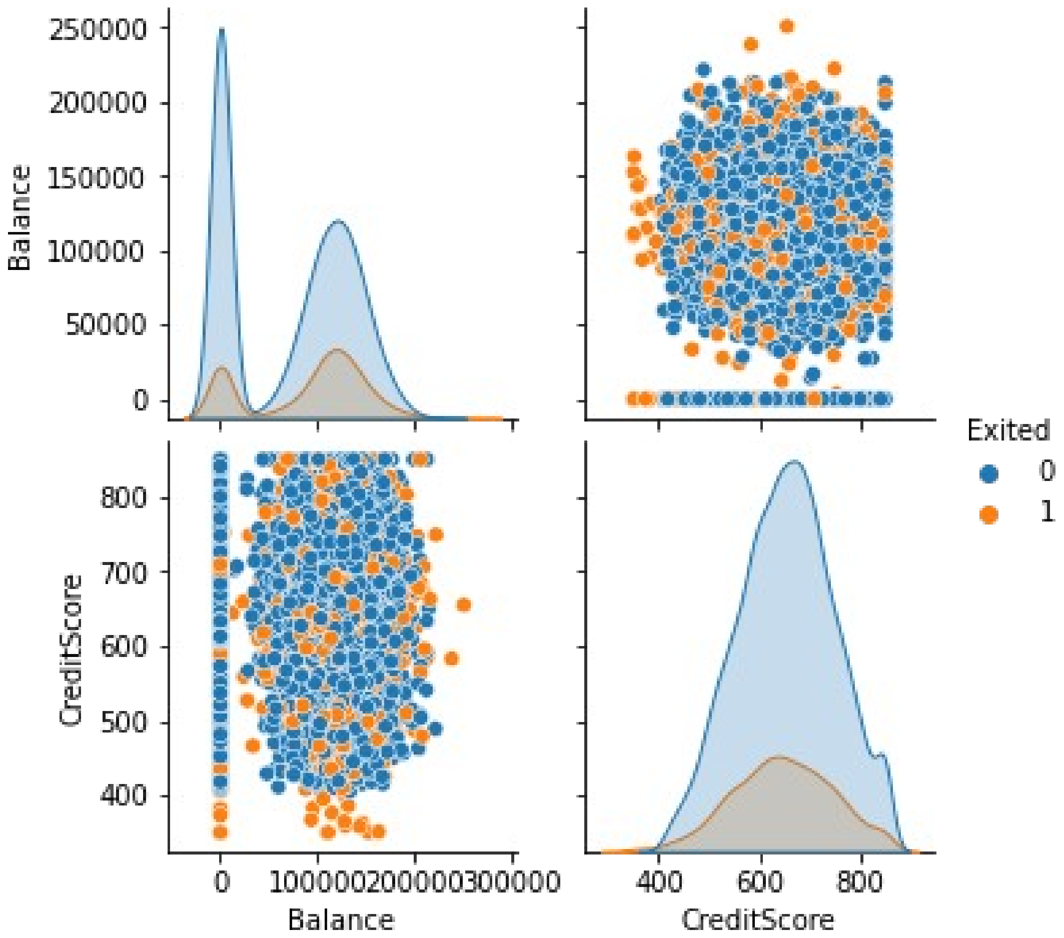
```
g=sns.PairGrid(df)
g.map(sns.scatterplot)
```

```
<seaborn.axisgrid.PairGrid at 0x7f2251f6a850>
```



```
sns.pairplot(data=df[['Balance','CreditScore','Exited']],hue='Exited')
```

```
<seaborn.axisgrid.PairGrid at 0x7f224bd66390>
```



```
df.describe(include='all')
```

```
          RowNumber    CustomerId Surname   CreditScore Geography
Gender  \
count   10000.00000  1.000000e+04   10000  10000.000000     10000
10000
unique          NaN           NaN    2932           NaN         3
2
top             NaN           NaN   Smith           NaN    France
Male
freq            NaN           NaN      32           NaN      5014
5457
mean     5000.50000  1.569094e+07     NaN    650.528800       NaN
NaN
std      2886.89568  7.193619e+04     NaN     96.653299       NaN
NaN
min         1.00000  1.556570e+07     NaN    350.000000       NaN
NaN
25%      2500.75000  1.562853e+07     NaN    584.000000       NaN
NaN
50%      5000.50000  1.569074e+07     NaN    652.000000       NaN
```

```
NaN
75%      7500.25000  1.575323e+07     NaN    718.000000       NaN
NaN
max     10000.00000  1.581569e+07     NaN    850.000000       NaN
NaN

                 Age        Tenure        Balance  NumOfProducts
HasCrCard  \
count   10000.000000  10000.000000   10000.000000   10000.000000
10000.00000
unique           NaN           NaN            NaN            NaN
NaN
top              NaN           NaN            NaN            NaN
NaN
freq             NaN           NaN            NaN            NaN
NaN
mean       38.921800      5.012800   76485.889288       1.530200
0.70550
std        10.487806      2.892174   62397.405202       0.581654
0.45584
min        18.000000      0.000000       0.000000       1.000000
0.00000
25%        32.000000      3.000000       0.000000       1.000000
0.00000
50%        37.000000      5.000000   97198.540000       1.000000
1.00000
75%        44.000000      7.000000  127644.240000       2.000000
1.00000
max        92.000000     10.000000  250898.090000       4.000000
1.00000

        IsActiveMember  EstimatedSalary        Exited
count     10000.000000     10000.000000  10000.000000
unique             NaN              NaN           NaN
top                NaN              NaN           NaN
freq               NaN              NaN           NaN
mean          0.515100    100090.239881      0.203700
std           0.499797     57510.492818      0.402769
min           0.000000        11.580000      0.000000
25%           0.000000     51002.110000      0.000000
50%           1.000000    100193.915000      0.000000
75%           1.000000    149388.247500      0.000000
max           1.000000    199992.480000      1.000000
```

```
df[(df['NumOfProducts']>2) | (df['NumOfProducts']<3)]
```

```
      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
...          ...         ...        ...          ...       ...     ...
...
9995        9996    15606229   Obijiaku          771    France    Male
39
9996        9997    15569892  Johnstone          516    France    Male
35
9997        9998    15584532        Liu          709    France  Female
36
9998        9999    15682355  Sabbatini          772   Germany    Male
42
9999       10000    15628319     Walker          792    France  Female
28

      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
...      ...        ...            ...        ...             ...
9995       5       0.00              2          1               0
9996      10   57369.61              1          1               1
9997       7       0.00              1          0               1
9998       3   75075.31              2          1               0
9999       4  130142.79              1          1               0

      EstimatedSalary  Exited
0           101348.88       1
1           112542.58       0
2           113931.57       1
3            93826.63       0
4            79084.10       0
...               ...     ...
9995         96270.64       0
9996        101699.77       0
9997         42085.58       1
9998         92888.52       1
9999         38190.78       0

[10000 rows x 14 columns]
```

```
df[(df['NumOfProducts']>2)]
```

```
      RowNumber  CustomerId       Surname  CreditScore Geography
Gender  \
2             3    15619304           Onio          502    France
Female
7             8    15656148         Obinna          376   Germany
Female
30           31    15589475        Azikiwe          591     Spain
Female
70           71    15703793     Konovalova          738   Germany
Male
88           89    15622897         Sharpe          646    France
Female
...         ...         ...            ...          ...       ...
...
9737       9738    15741197        Calzada          710     Spain
Male
9747       9748    15775761  Iweobiegbunam          610   Germany
Female
9800       9801    15640507             Li          762     Spain
Female
9877       9878    15572182     Onwuamaeze          505   Germany
Female
9895       9896    15796764          Bruno          684   Germany
Female

      Age  Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember
\
2      42       8  159660.80              3          1               0

7      29       4  115046.74              4          1               0

30     39       3       0.00              3          1               0

70     58       2  133745.44              4          1               0

88     46       4       0.00              3          1               0

...   ...     ...        ...            ...        ...             ...

9737   22       8       0.00              3          1               0

9747   69       5   86038.21              3          0               0

9800   35       3  119349.69              3          1               1

9877   33       3  106506.77              3          1               0

9895   56       3  127585.98              3          1               1
```

```
      EstimatedSalary  Exited
2           113931.57       1
7           119346.88       1
30          140469.38       1
70           28373.86       1
88           93251.42       1
...               ...     ...
9737        107292.91       0
9747        192743.06       1
9800         47114.18       1
9877         45445.78       1
9895         80593.49       1

[326 rows x 14 columns]
```

```
df['Age']=df['Age'].astype('float')
df.dtypes
```

```
RowNumber            int64
CustomerId           int64
Surname             object
CreditScore          int64
Geography           object
Gender              object
Age                float64
Tenure               int64
Balance            float64
NumOfProducts        int64
HasCrCard            int64
IsActiveMember       int64
EstimatedSalary    float64
Exited               int64
dtype: object
```

```
pd.get_dummies(df,columns=['Tenure']).head()
```

```
   RowNumber  CustomerId   Surname  CreditScore Geography  Gender
Age  \
0          1    15634602  Hargrave          619    France  Female
42.0
1          2    15647311      Hill          608     Spain  Female
41.0
2          3    15619304      Onio          502    France  Female
42.0
3          4    15701354      Boni          699    France  Female
39.0
4          5    15737888  Mitchell          850     Spain  Female
43.0

     Balance  NumOfProducts  HasCrCard  ...  Tenure_1  Tenure_2
```

```
Tenure_3  \
0       0.00              1          1  ...         0         1
0
1   83807.86              1          0  ...         1         0
0
2  159660.80              3          1  ...         0         0
0
3       0.00              2          0  ...         1         0
0
4  125510.82              1          1  ...         0         1
0

   Tenure_4  Tenure_5  Tenure_6  Tenure_7  Tenure_8  Tenure_9
Tenure_10
0         0         0         0         0         0         0
0
1         0         0         0         0         0         0
0
2         0         0         0         0         1         0
0
3         0         0         0         0         0         0
0
4         0         0         0         0         0         0
0

[5 rows x 24 columns]
```

```
x=df.iloc[:,:-1].values
y=df.iloc[:,4].values
print(x,y)
```

```
[[1 15634602 'Hargrave' ... 1 1 101348.88]
 [2 15647311 'Hill' ... 0 1 112542.58]
 [3 15619304 'Onio' ... 1 0 113931.57]
 ...
 [9998 15584532 'Liu' ... 0 1 42085.58]
 [9999 15682355 'Sabbatini' ... 1 0 92888.52]
 [10000 15628319 'Walker' ... 1 0 38190.78]] ['France' 'Spain'
'France' ... 'France' 'Germany' 'France']
```

```
x=df.iloc[1:3,:-1].values
x
```

```
array([[2, 15647311, 'Hill', 608, 'Spain', 'Female', 41.0, 1,
83807.86,
        1, 0, 1, 112542.58],
       [3, 15619304, 'Onio', 502, 'France', 'Female', 42.0, 8,
159660.8,
        3, 1, 0, 113931.57]], dtype=object)
```

```
x=df[['Gender','Age']]
print(x)
```

```
      Gender   Age
0     Female  42.0
1     Female  41.0
2     Female  42.0
3     Female  39.0
4     Female  43.0
...      ...   ...
9995    Male  39.0
9996    Male  35.0
9997  Female  36.0
9998    Male  42.0
9999  Female  28.0

[10000 rows x 2 columns]
```

```
from sklearn.model_selection import train_test_split
```

```
training_data,testing_data=train_test_split(df,test_size=1,random_stat
e=3)
print(training_data,testing_data)
```

```
      RowNumber  CustomerId          Surname  CreditScore Geography
Gender  \
6555       6556    15581505            Bales          641    France
Male
1448       1449    15585367           Diribe          555   Germany
Female
3351       3352    15792729          Holland          474   Germany
Female
231         232    15627000          Freeman          610    France
Male
1204       1205    15650098         Baranova          630    France
Female
...         ...         ...              ...          ...       ...
...
6400       6401    15585907          Collier          676     Spain
Female
9160       9161    15753679  Mullawirraburka          778    France
Male
9859       9860    15615430            Adams          678   Germany
Male
1688       1689    15804610           Valdez          601    France
Female
5994       5995    15746065          Lo Duca          580   Germany
Male

       Age  Tenure    Balance  NumOfProducts  HasCrCard
IsActiveMember  \
6555  35.0       5       0.00              2          1
0
1448  46.0       4  120392.99              1          1
0
3351  34.0       9  176311.36              1          1
0
231   40.0       0       0.00              2          1
0
1204  40.0       7       0.00              2          1
1
...    ...     ...        ...            ...        ...             ..
.
6400  30.0       5       0.00              2          0
0
9160  24.0       4       0.00              2          1
1
9859  55.0       4  129646.91              1          1
1
1688  41.0       1       0.00              2          0
1
5994  35.0      10  136281.41              2          1
1

      EstimatedSalary  Exited
6555         93148.93       0
1448        177719.88       1
3351        160213.27       0
231          62232.60       0
1204         34453.17       0
...               ...     ...
6400        179066.58       0
9160        162809.20       0
9859        184125.10       1
1688        160607.06       0
5994         24799.47       0

[9999 rows x 14 columns]       RowNumber  CustomerId    Surname
CreditScore Geography Gender   Age  \
5876       5877    15585379  Humphries          704    France   Male
39.0

      Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
5876       2  111525.02              1          1               0

      EstimatedSalary  Exited
5876        199484.96       0
```