Assignment 2

In [ ]:

```
#import libraries
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
#to view graph in colab itself
```

In [ ]:

```
#load dataset
df=pd.read_csv("/content/Churn_Modelling (1).csv")
```

In [ ]:

```
df
```

Out[ ]:

	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
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
9995	9996	15606229	Obijiaku	771	France	Male	39	5	0.00	2	1	0	96270.64	0

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
9996	9997	15569892	Johnstone	516	France	Male	35	10	57369.61	1	1	1	101699.77	0
9997	9998	15584532	Liu	709	France	Female	36	7	0.00	1	0	1	42085.58	1
9998	9999	15682355	Sabbatini	772	Germany	Male	42	3	75075.31	2	1	0	92888.52	1
9999	10000	15628319	Walker	792	France	Female	28	4	130142.79	1	1	0	38190.78	0

10000 rows × 14 columns

Perform Below Visualizations. ● Univariate Analysis ● Bi - Variate Analysis ● Multi - Variate Analysis

In [ ]:

```
df.columns
```

Out[ ]:

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

In [ ]:

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

Out[ ]:

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

In [ ]:

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

Out[ ]:

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

In [ ]:

```
df.dtypes
```

Out[ ]:

```
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
```

In [ ]:

```
df.head()
```

Out[ ]:

	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

In [ ]:

```
df.tail()
```

Out[ ]:

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
99	9996	15606229	Obijiaku	771	France	Male	39	5	0.00	2	1	0	96270.64	0

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
95														
9996	9997	15569892	Johnstone	516	France	Male	35	10	57369.61	1	1	1	101699.77	0
9997	9998	15584532	Liu	709	France	Female	36	7	0.00	1	0	1	42085.58	1
9998	9999	15682355	Sabbatini	772	Germany	Male	42	3	75075.31	2	1	0	92888.52	1
9999	10000	15628319	Walker	792	France	Female	28	4	130142.79	1	1	0	38190.78	0

In [ ]:

```
df.describe()
```

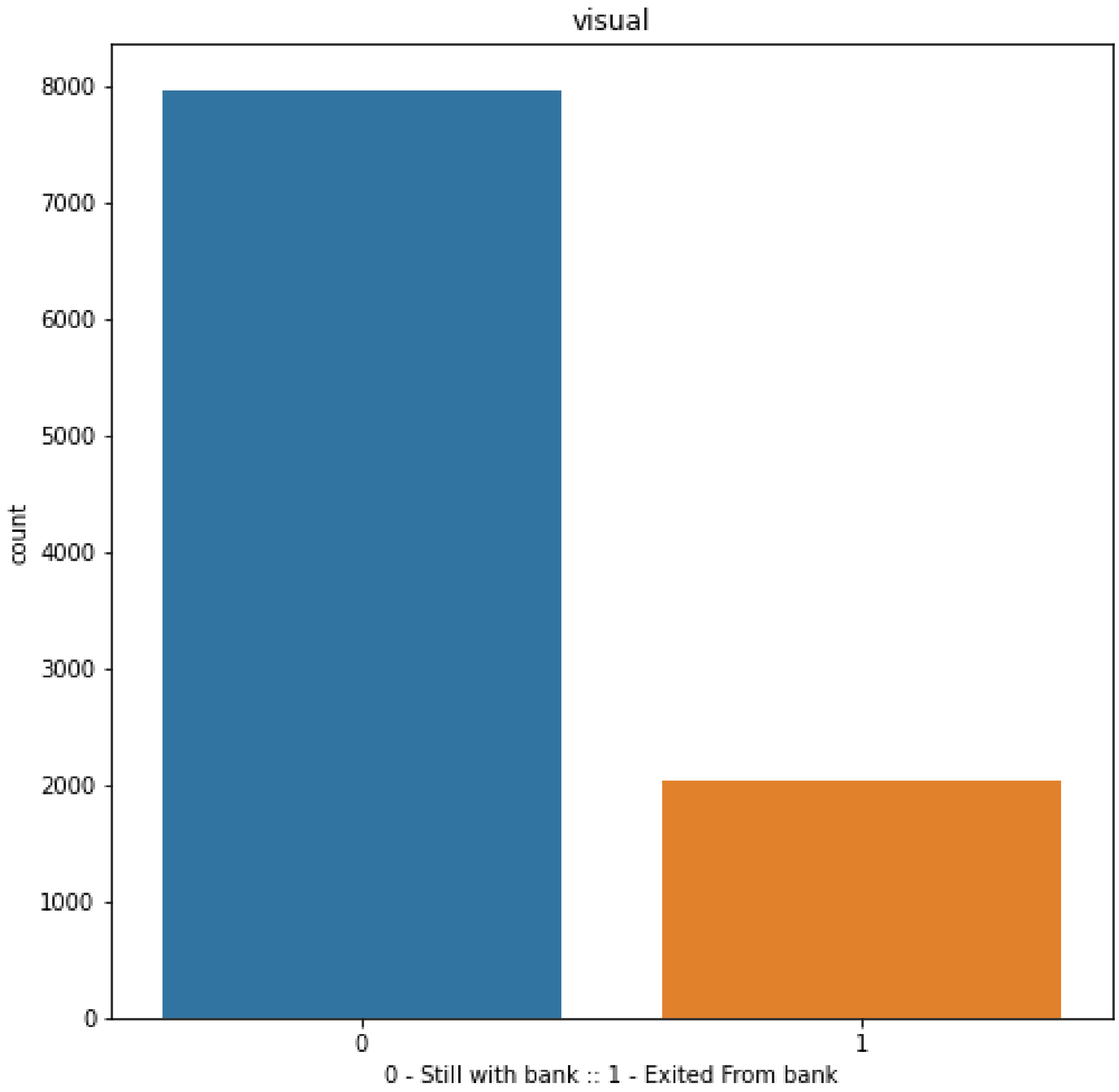
Out[ ]:

	RowNumber	CustomerId	CreditScore	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
count	10000.00000	1.000000e+04	10000.000000	10000.000000	10000.000000	10000.000000	10000.000000	10000.00000	10000.000000	10000.000000	10000.000000
mean	5000.50000	1.569094e+07	650.528800	38.921800	5.012800	76485.889288	1.530200	0.70550	0.515100	100090.239881	0.203700
std	2886.89568	7.193619e+04	96.653299	10.487806	2.892174	62397.405202	0.581654	0.45584	0.499797	57510.492818	0.402769
min	1.00000	1.556570e+07	350.000000	18.000000	0.000000	0.000000	1.000000	0.00000	0.000000	11.580000	0.000000

	RowNumber	**CustomerId**	**CreditScore**	**Age**	**Tenure**	**Balance**	**NumOfProducts**	**HasCrCard**	**IsActiveMember**	**EstimatedSalary**	**Exited**
25%	2500.75000	1.562853e+07	584.000000	32.000000	3.000000	0.000000	1.000000	0.00000	0.000000	51002.110000	0.000000
50%	5000.50000	1.569074e+07	652.000000	37.000000	5.000000	97198.540000	1.000000	1.00000	1.000000	100193.915000	0.000000
75%	7500.25000	1.575323e+07	718.000000	44.000000	7.000000	127644.240000	2.000000	1.00000	1.000000	149388.247500	0.000000
max	10000.00000	1.581569e+07	850.000000	92.000000	10.000000	250898.090000	4.000000	1.00000	1.000000	199992.480000	1.000000

In [ ]:

```
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()
```



In [ ]:

```
df.info()
```

```
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
```

In [ ]:

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

Out[ ]:

```
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
```

In [ ]:

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

Out[ ]:

```
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
```

In [ ]:

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

In [ ]:

```
df1.shape
```

Out[ ]:

```
(10000, 14)
```

In [ ]:

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

```
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
```

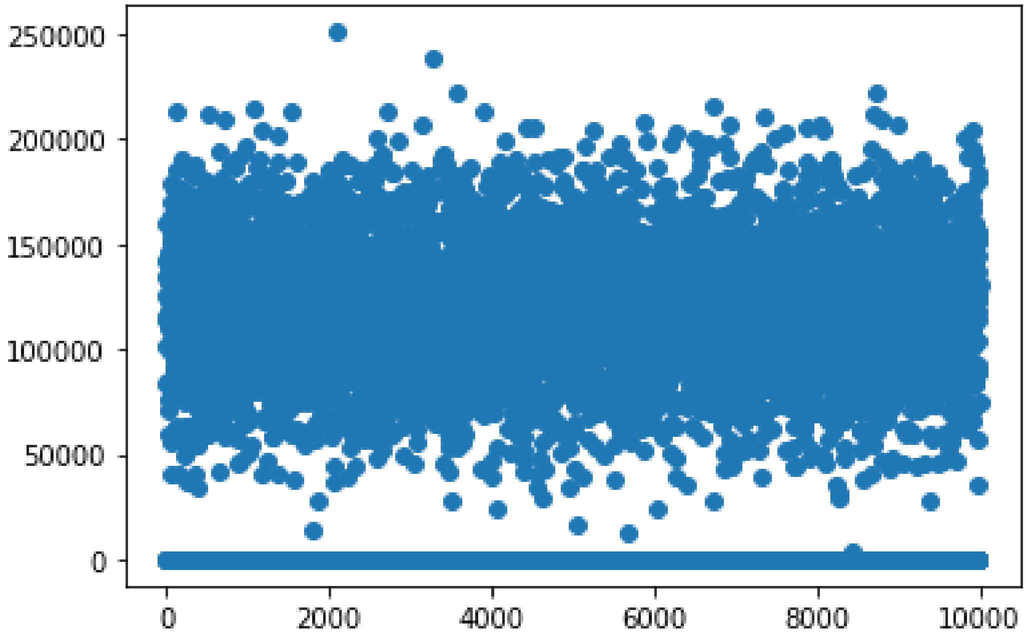
In [ ]:

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

```
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
```

In [ ]:

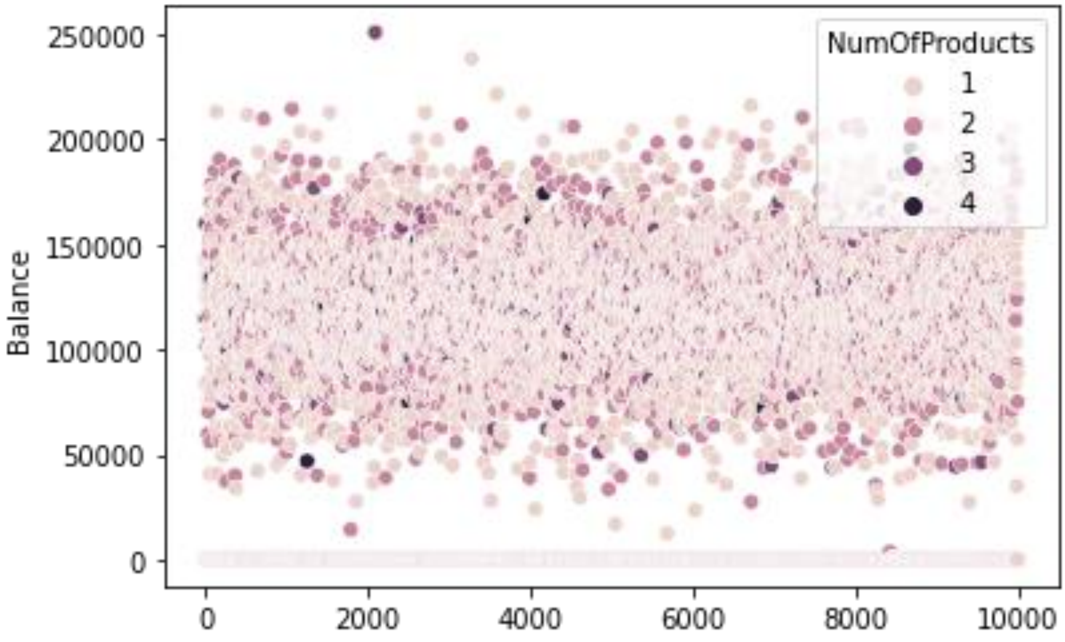
```
plt.scatter(df.index,df['Balance'])
plt.show()
```



In [ ]:

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

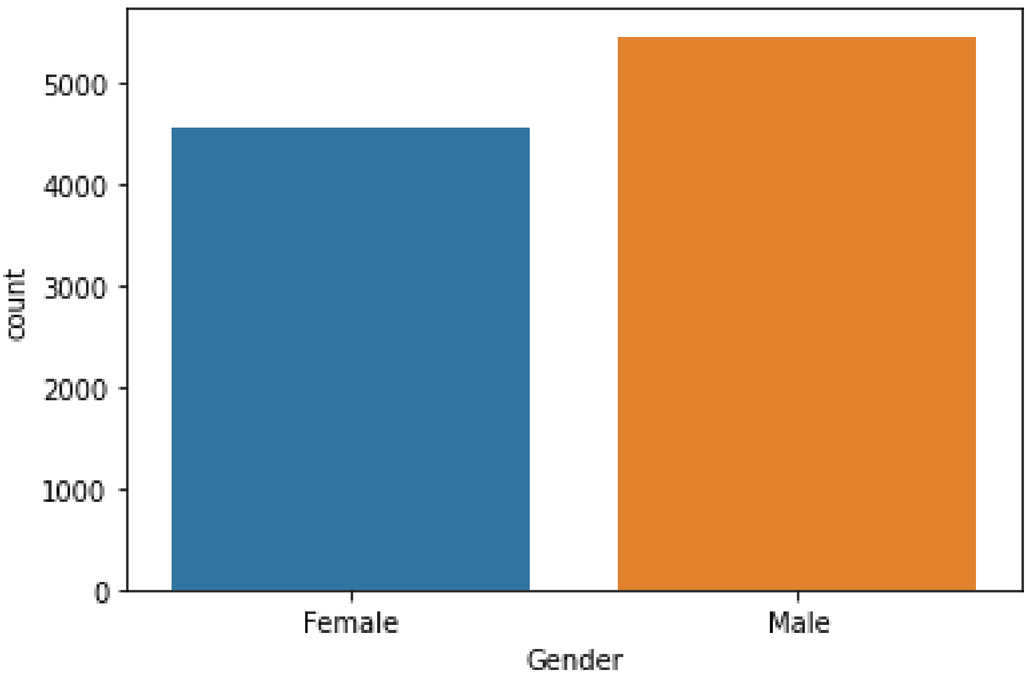
Out[ ]:



In [ ]:

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

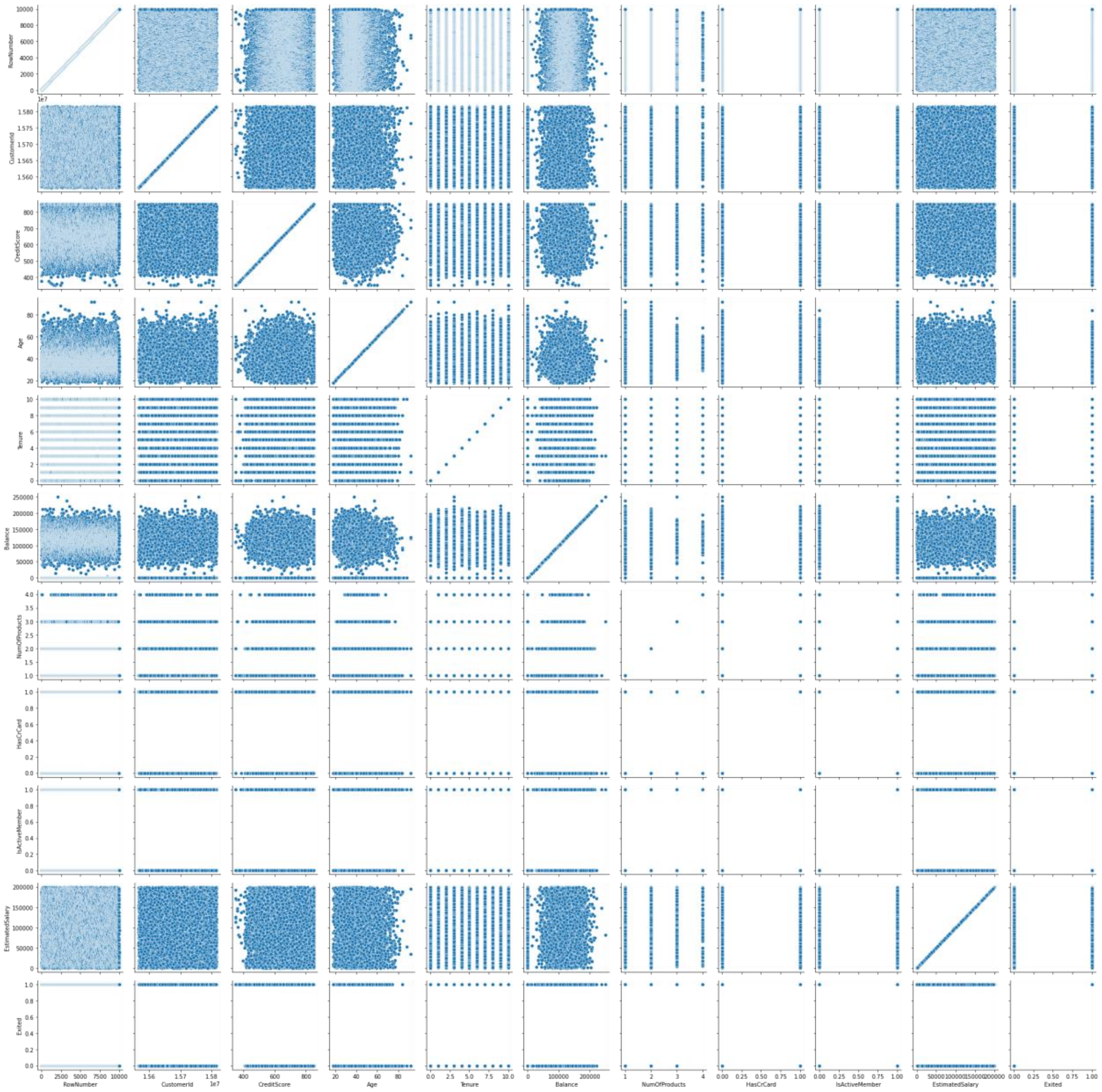
Out[ ]:



In [ ]:

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

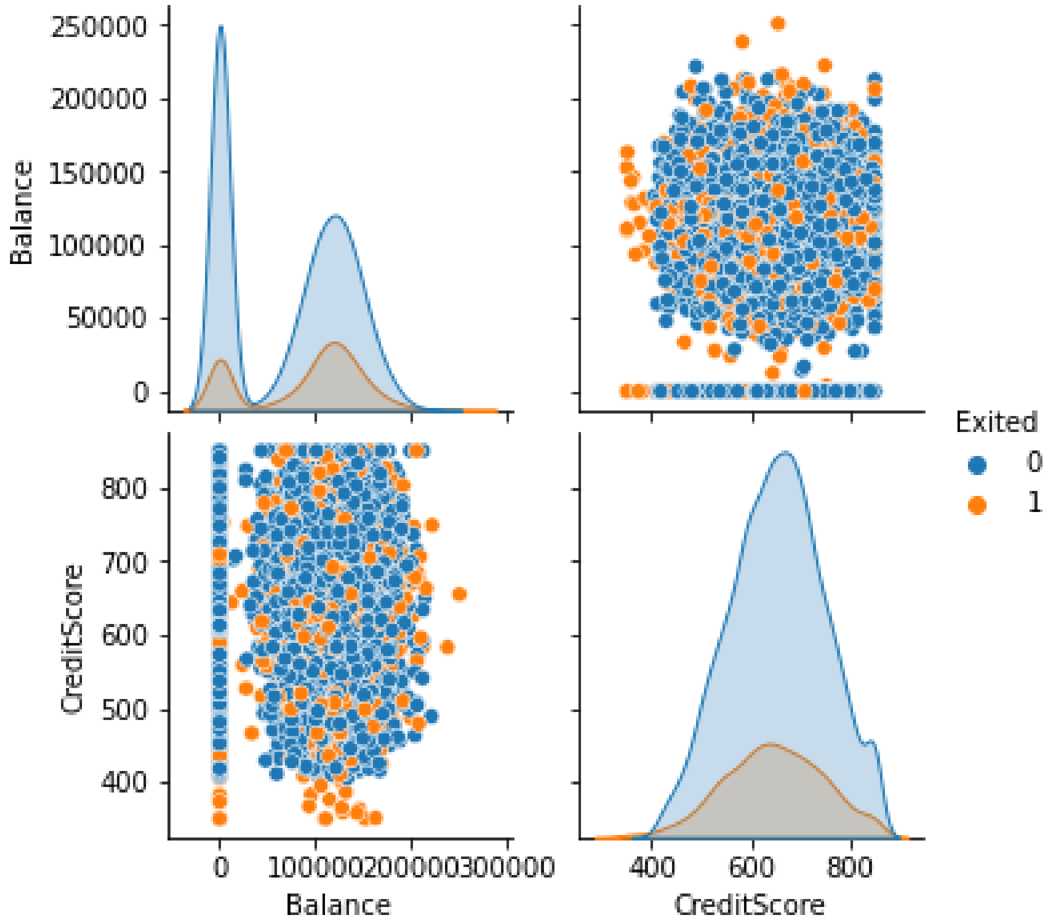
Out[ ]:



In [ ]:

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

Out[ ]:



In [ ]:

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

Out[ ]:

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
count	10000.00000	1.000000e+04	10000	10000.000000	10000	10000	10000.000000	10000.000000	10000.000000	10000.000000	10000.00000	10000.000000	10000.000000	10000.000000
unique	NaN	NaN	2932	NaN	3	2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
top	NaN	NaN	Smith	NaN	France	Male	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
freq	NaN	NaN	32	NaN	5014	5457	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
mean	5000.50000	1.569094e+07	NaN	650.528800	NaN	NaN	38.921800	5.012800	76485.889288	1.530200	0.70550	0.515100	100090.239881	0.203700
std	2886.89568	7.193619e+04	NaN	96.653299	NaN	NaN	10.487806	2.892174	62397.405202	0.581654	0.45584	0.499797	57510.492818	0.402769
min	1.00000	1.556570e+07	NaN	350.000000	NaN	NaN	18.000000	0.000000	0.000000	1.000000	0.00000	0.000000	11.580000	0.000000
25%	2500.75000	1.562853e+07	NaN	584.000000	NaN	NaN	32.000000	3.000000	0.000000	1.000000	0.00000	0.000000	51002.110000	0.000000
50%	5000.50000	1.569074e+07	NaN	652.000000	NaN	NaN	37.000000	5.000000	97198.540000	1.000000	1.00000	1.000000	100193.915000	0.000000
75%	7500.25000	1.575323e+07	NaN	718.000000	NaN	NaN	44.000000	7.000000	127644.240000	2.000000	1.00000	1.000000	149388.247500	0.000000
max	10000.00000	1.581569e+07	NaN	850.000000	NaN	NaN	92.000000	10.000000	250898.090000	4.000000	1.00000	1.000000	199992.480000	1.000000

Find the outliers and replace the outliers

In [ ]:

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

Out[ ]:

	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

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
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
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
9995	9996	15606229	Obijiaku	771	France	Male	39	5	0.00	2	1	0	96270.64	0
9996	9997	15569892	Johnstone	516	France	Male	35	10	57369.61	1	1	1	101699.77	0
9997	9998	15584532	Liu	709	France	Female	36	7	0.00	1	0	1	42085.58	1
9998	9999	15682355	Sabbatini	772	Germany	Male	42	3	75075.31	2	1	0	92888.52	1
9999	10000	15628319	Walker	792	France	Female	28	4	130142.79	1	1	0	38190.78	0

10000 rows × 14 columns

In [ ]:

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

Out[ ]:

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
2	3	15619304	Onio	502	France	Female	42	8	159660.80	3	1	0	113931.57	1
7	8	15656148	Obinna	376	Germany	Female	29	4	115046.74	4	1	0	119346.88	1
30	31	15589475	Azikiwe	591	Spain	Female	39	3	0.00	3	1	0	140469.38	1
70	71	15703793	Konovalova	738	Germany	Male	58	2	133745.44	4	1	0	28373.86	1
88	89	15622897	Sharpe	646	France	Female	46	4	0.00	3	1	0	93251.42	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
9737	9738	15741197	Calzada	710	Spain	Male	22	8	0.00	3	1	0	107292.91	0
9747	9748	15775761	Iweobiegbunam	610	Germany	Female	69	5	86038.21	3	0	0	192743.06	1
9800	9801	15640507	Li	762	Spain	Female	35	3	119349.69	3	1	1	47114.18	1
9877	9878	15572182	Onwuamaeze	505	Germany	Female	33	3	106506.77	3	1	0	45445.78	1
98	9896	15796764	Bruno	684	Germany	Female	56	3	127585.98	3	1	1	80593.49	1

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
95														

326 rows × 14 columns

Check for Categorical columns and perform encoding

In [ ]:

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

Out[ ]:

```
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
```

In [ ]:

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

Out[ ]:

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Balance	NumOfProducts	HasCrCard	...	Tenure_1	Tenure_2	Tenure_3	Tenure_4	Tenure_5	Tenure_6	Tenure_7	Tenure_8	Tenure_9	Tenure_10
0	1	15634602	Hargrave	619	France	Female	42.0	0.00	1	1	...	0	1	0	0	0	0	0	0	0	0
1	2	15647311	Hill	608	Spain	Female	41.0	83807.	1	0	...	1	0	0	0	0	0	0	0	0	0

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Balance	NumOfProducts	HasCrCard	...	Tenure_1	Tenure_2	Tenure_3	Tenure_4	Tenure_5	Tenure_6	Tenure_7	Tenure_8	Tenure_9	Tenure_10
								86													
2	3	15619304	Onio	502	France	Female	42.0	159660.80	3	1	...	0	0	0	0	0	0	0	1	0	0
3	4	15701354	Boni	699	France	Female	39.0	0.00	2	0	...	1	0	0	0	0	0	0	0	0	0
4	5	15737888	Mitchell	850	Spain	Female	43.0	125510.82	1	1	...	0	1	0	0	0	0	0	0	0	0

5 rows × 24 columns

Split the data into dependent and independent variables

In [ ]:

```
x=df.iloc[:,:-1].values #independent variables
y=df.iloc[:,-1].values #dependent variables
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]] [1 0 1 ... 1 1 0]
```

Scale the independent variables

In [ ]:

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

Out[ ]:

```
array([[2, 15647311, 'Hill', 608, 'Spain', 'Female', 41, 1, 83807.86, 1,
        0, 1, 112542.58],
       [3, 15619304, 'Onio', 502, 'France', 'Female', 42, 8, 159660.8, 3,
        1, 0, 113931.57]], dtype=object)
```

In [ ]:

```
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]
```

Split the data into training and testing

In [ ]:

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

In [ ]:

```
training_data,testing_data=train_test_split(df,test_size=1,random_state=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  CreditScor
e 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
```