Descriptive Statistics

Python Programming Lab

05506231 Statistics and Probability

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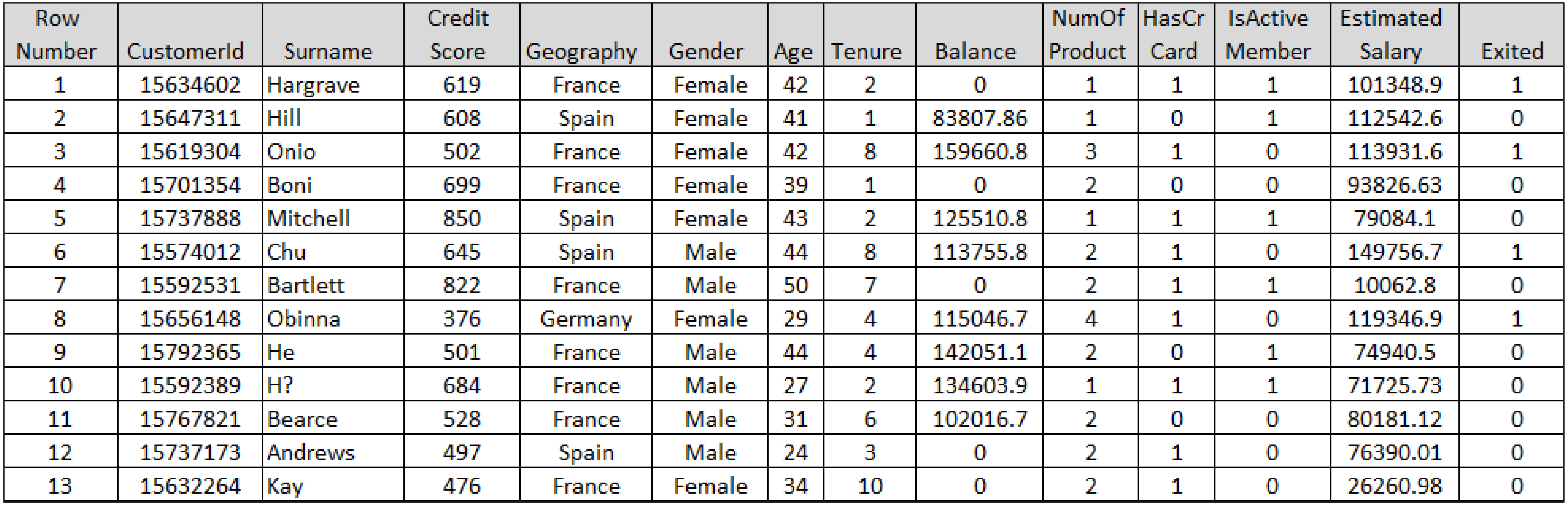
Outline

- Churn_Modelling Dataset
- Descriptive Statistics for Numeric Data
- Descriptive Statistics Categorical Data
- Data Visualization

Churn_Modelling Dataset



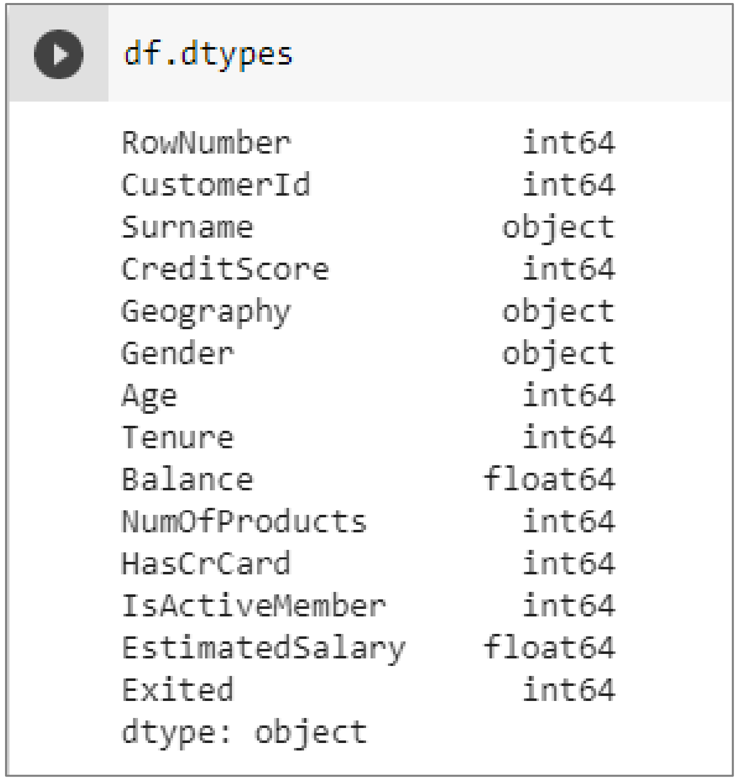
Row Number	CustomerId	Surname	Credit Score	Geography	Gender	Age	Tenure	Balance	NumOf Product	HasCr Card	IsActive Member	Estimated Salary	Exited
1	15634602	Hargrave	619	France	Female	42	2	0	1	1	1	101348.9	1
2	15647311	Hill	608	Spain	Female	41	1	83807.86	1	0	1	112542.6	0
3	15619304	Onio	502	France	Female	42	8	159660.8	3	1	0	113931.6	1
4	15701354	Boni	699	France	Female	39	1	0	2	0	0	93826.63	0
5	15737888	Mitchell	850	Spain	Female	43	2	125510.8	1	1	1	79084.1	0
6	15574012	Chu	645	Spain	Male	44	8	113755.8	2	1	0	149756.7	1
7	15592531	Bartlett	822	France	Male	50	7	0	2	1	1	10062.8	0
8	15656148	Obinna	376	Germany	Female	29	4	115046.7	4	1	0	119346.9	1
9	15792365	He	501	France	Male	44	4	142051.1	2	0	1	74940.5	0
10	15592389	H?	684	France	Male	27	2	134603.9	1	1	1	71725.73	0
11	15767821	Bearce	528	France	Male	31	6	102016.7	2	0	0	80181.12	0
12	15737173	Andrews	497	Spain	Male	24	3	0	2	1	0	76390.01	0
13	15632264	Kay	476	France	Female	34	10	0	2	1	0	26260.98	0

Churn_Modelling Dataset

```python
from google.colab import files
uploaded = files.upload()
```

```python
import pandas as pd
df = pd.read_csv( 'Churn_Modelling.csv' )
```

```python
df.dtypes
```



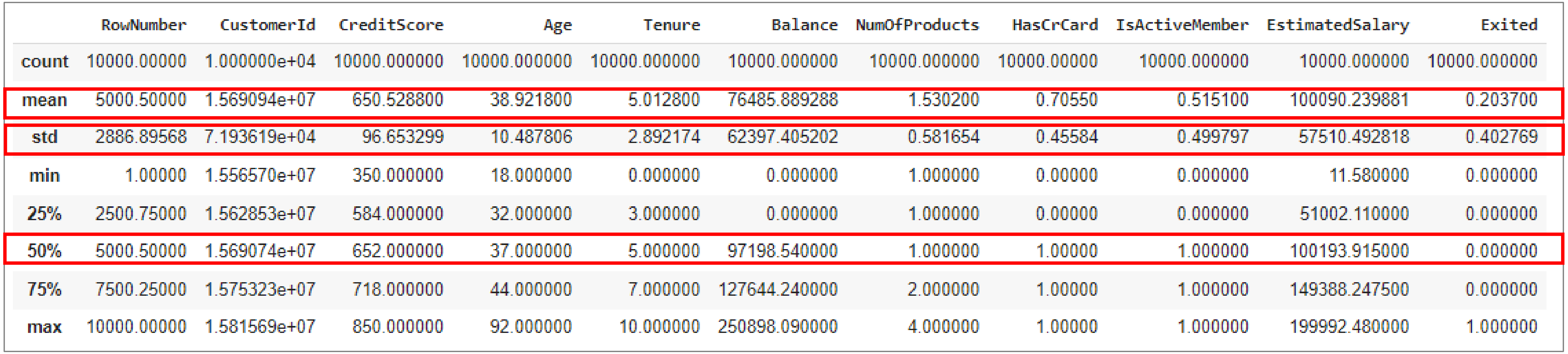
```
df.dtypes
```

```
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
```

Row Number	CustomerId	Surname	Credit Score	Geography	Gender	Age	Tenure	Balance	NumOf Product	HasCr Card	IsActive Member	Estimated Salary	Exited
1	15634602	Hargrave	619	France	Female	42	2	0	1	1	1	101348.9	1
2	15647311	Hill	608	Spain	Female	41	1	83807.86	1	0	1	112542.6	0

Descriptive Statistics for Numeric Data

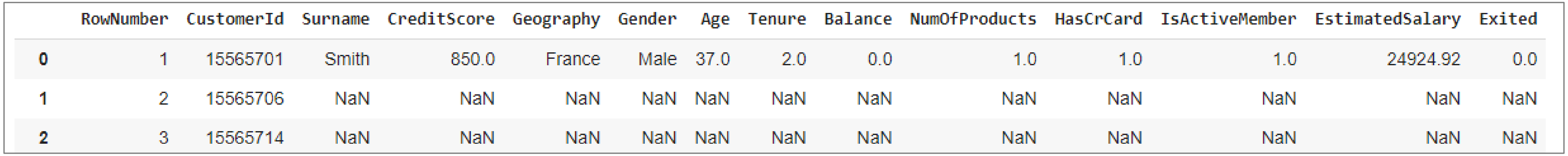
```
df.describe()
```



	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
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

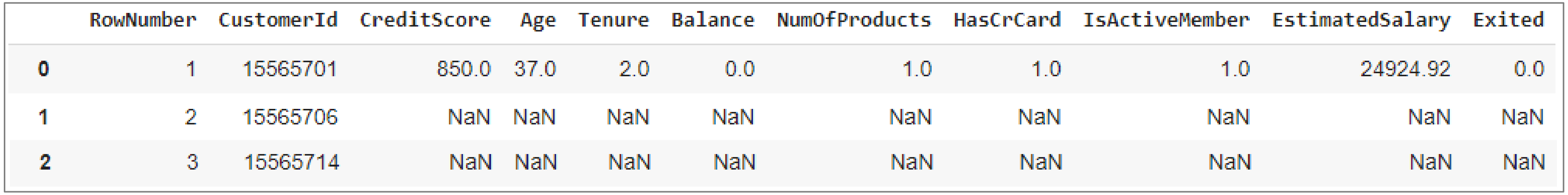
Mode

```
df.mode()
```

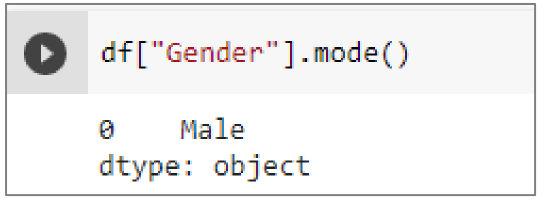


	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
0	1	15565701	Smith	850.0	France	Male	37.0	2.0	0.0	1.0	1.0	1.0	24924.92	0.0
1	2	15565706	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2	3	15565714	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

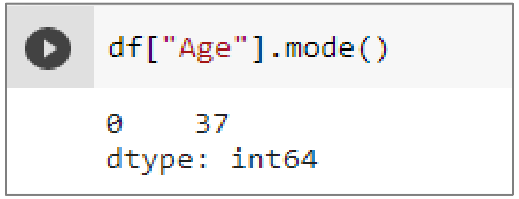
```
df.mode(numeric_only=True)
```



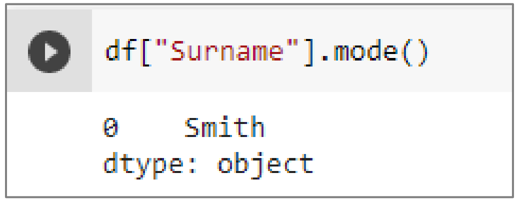
	RowNumber	CustomerId	CreditScore	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
0	1	15565701	850.0	37.0	2.0	0.0	1.0	1.0	1.0	24924.92	0.0
1	2	15565706	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2	3	15565714	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN



```
df["Gender"].mode()

0    Male
dtype: object
```



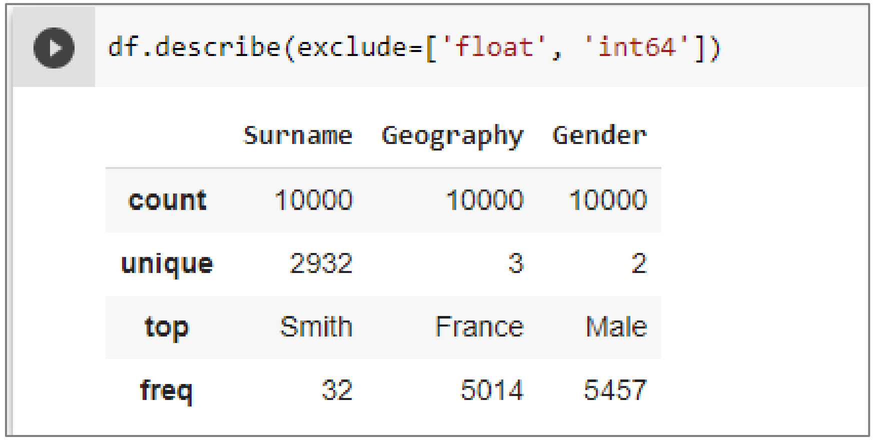
```
df["Age"].mode()

0    37
dtype: int64
```



```
df["Surname"].mode()

0    Smith
dtype: object
```

Descriptive Statistics for Categorical Data

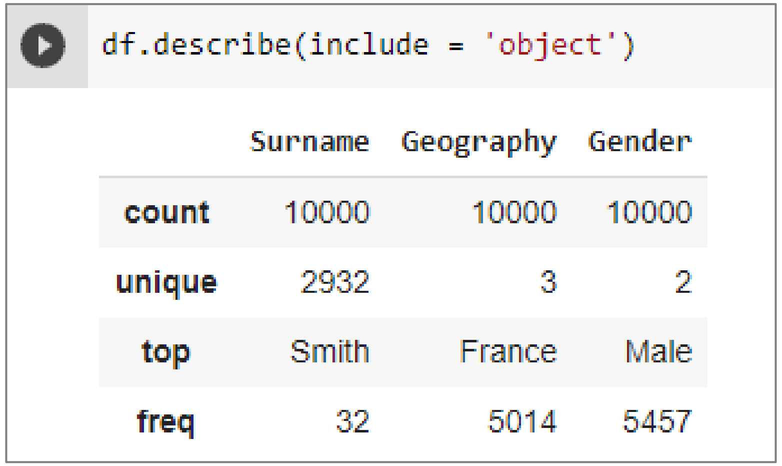
```
df.describe(exclude=['float', 'int64'])
```



```
df.describe(exclude=['float', 'int64'])
```

	Surname	Geography	Gender
count	10000	10000	10000
unique	2932	3	2
top	Smith	France	Male
freq	32	5014	5457

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



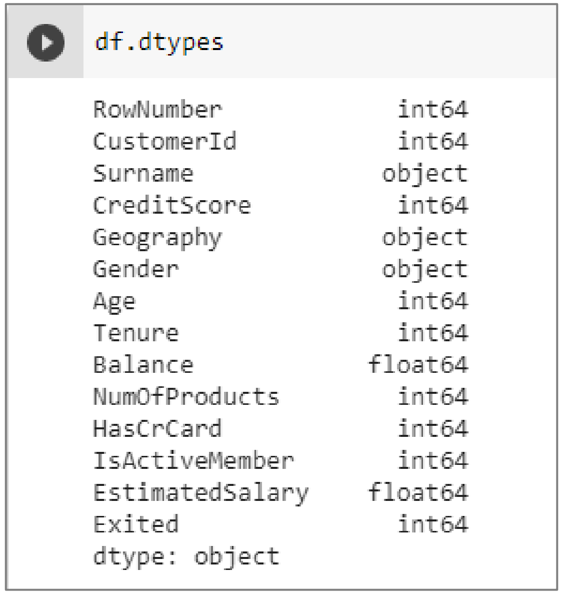
```
df.describe(include = 'object')
```

	Surname	Geography	Gender
count	10000	10000	10000
unique	2932	3	2
top	Smith	France	Male
freq	32	5014	5457

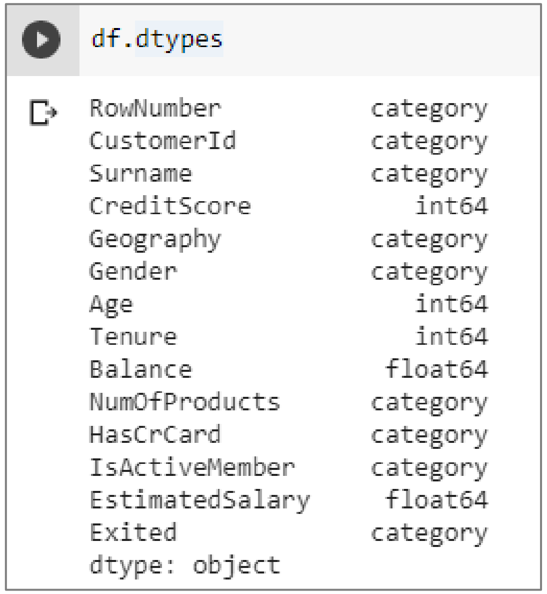
Convert Data Type

```
df.RowNumber=df.RowNumber.astype('category')
df.CustomerId=df.CustomerId.astype('category')
df.HasCrCard=df.HasCrCard.astype('category')
df.IsActiveMember=df.IsActiveMember.astype('category')
df.Exited=df.Exited.astype('category')
df.NumOfProducts=df.NumOfProducts.astype('category')
```

```
df.Geography = df.Geography.astype('category')
df.Surname = df.Surname.astype('category')
df.Gender = df.Gender.astype('category')
```



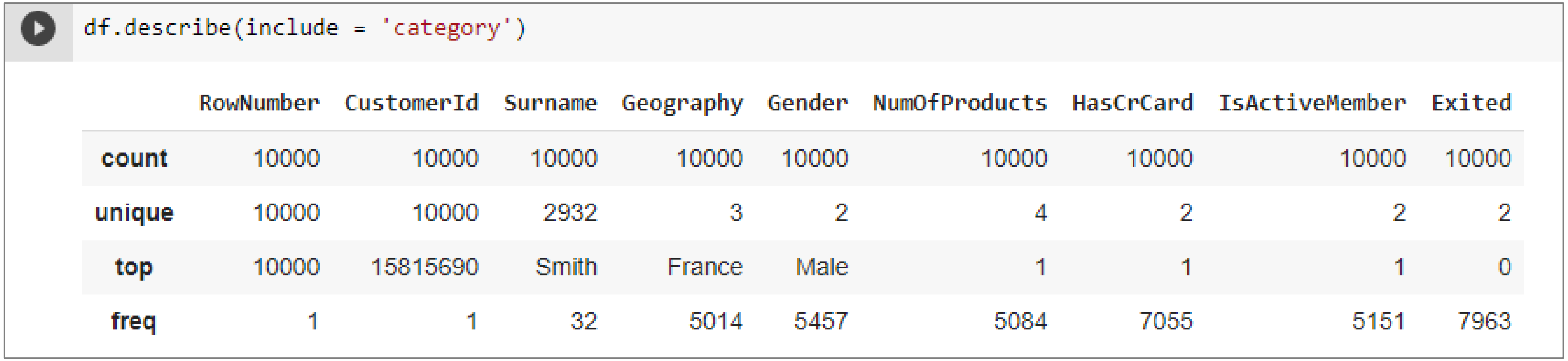
```
df.dtypes

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.dtypes

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

Descriptive Statistics for Categorical Data

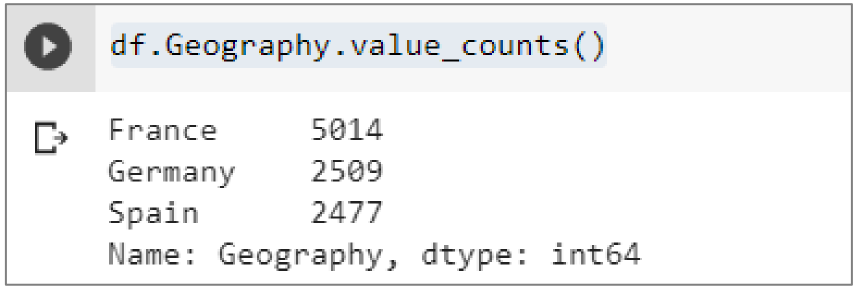
```
df.describe(include = 'category')
```



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

	RowNumber	CustomerId	Surname	Geography	Gender	NumOfProducts	HasCrCard	IsActiveMember	Exited
count	10000	10000	10000	10000	10000	10000	10000	10000	10000
unique	10000	10000	2932	3	2	4	2	2	2
top	10000	15815690	Smith	France	Male	1	1	1	0
freq	1	1	32	5014	5457	5084	7055	5151	7963

```
df.Geography.value_counts()
```



```
df.Geography.value_counts()
```

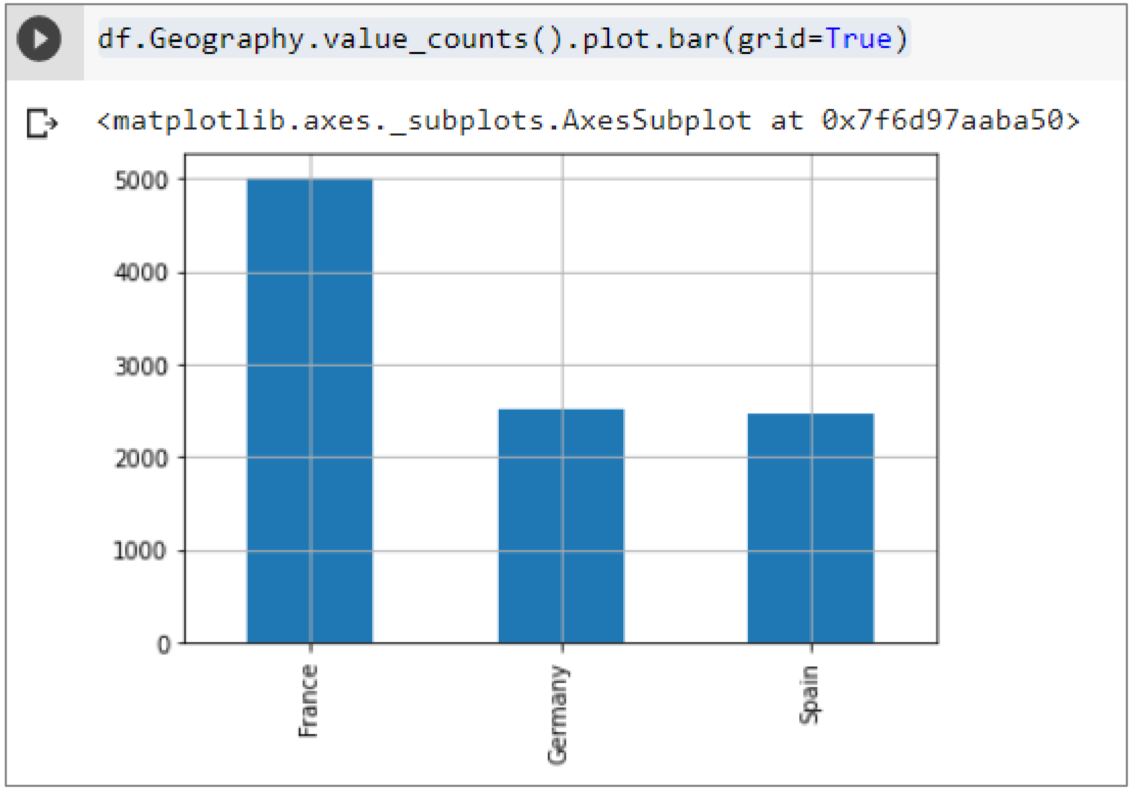
```
France     5014
Germany    2509
Spain      2477
Name: Geography, dtype: int64
```

Data Visualization

- Bar charts
- Box plot
- Histogram

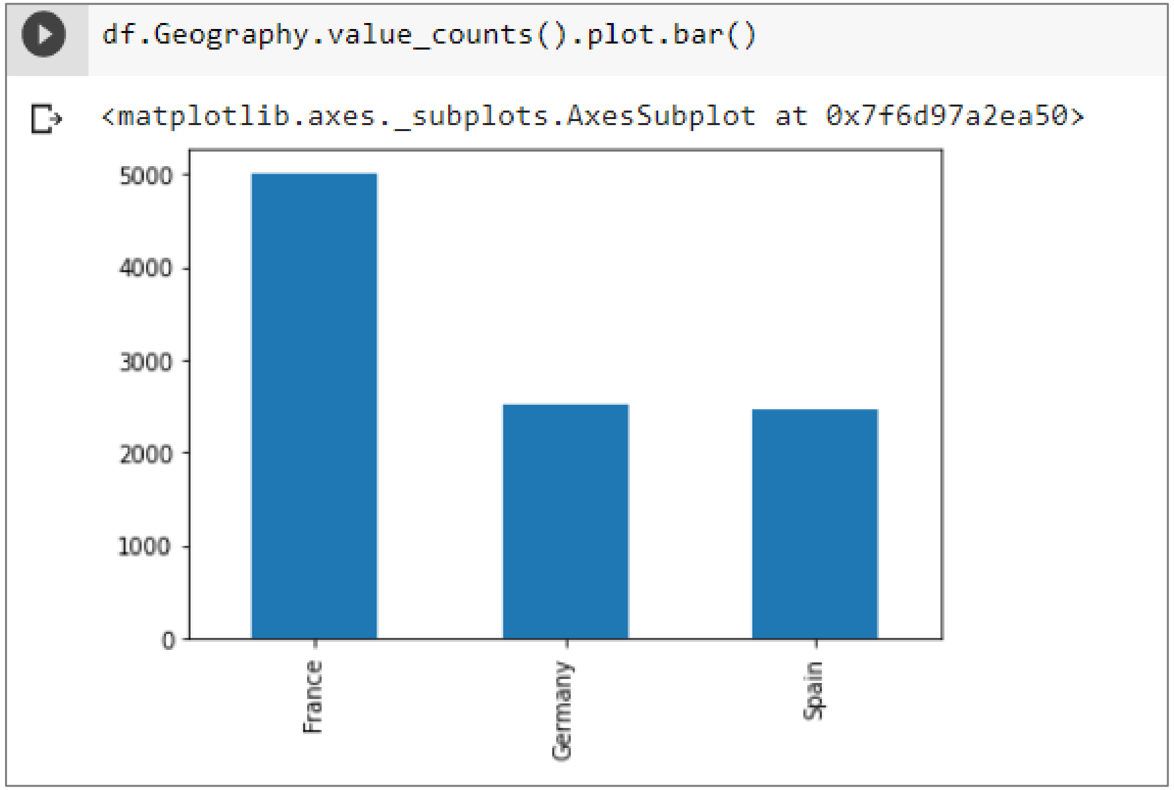
Bar Charts

```
df.Geography.value_counts().plot.bar(grid=True)
```



```
df.Geography.value_counts().plot.bar(grid=True)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f6d97aaba50>
```



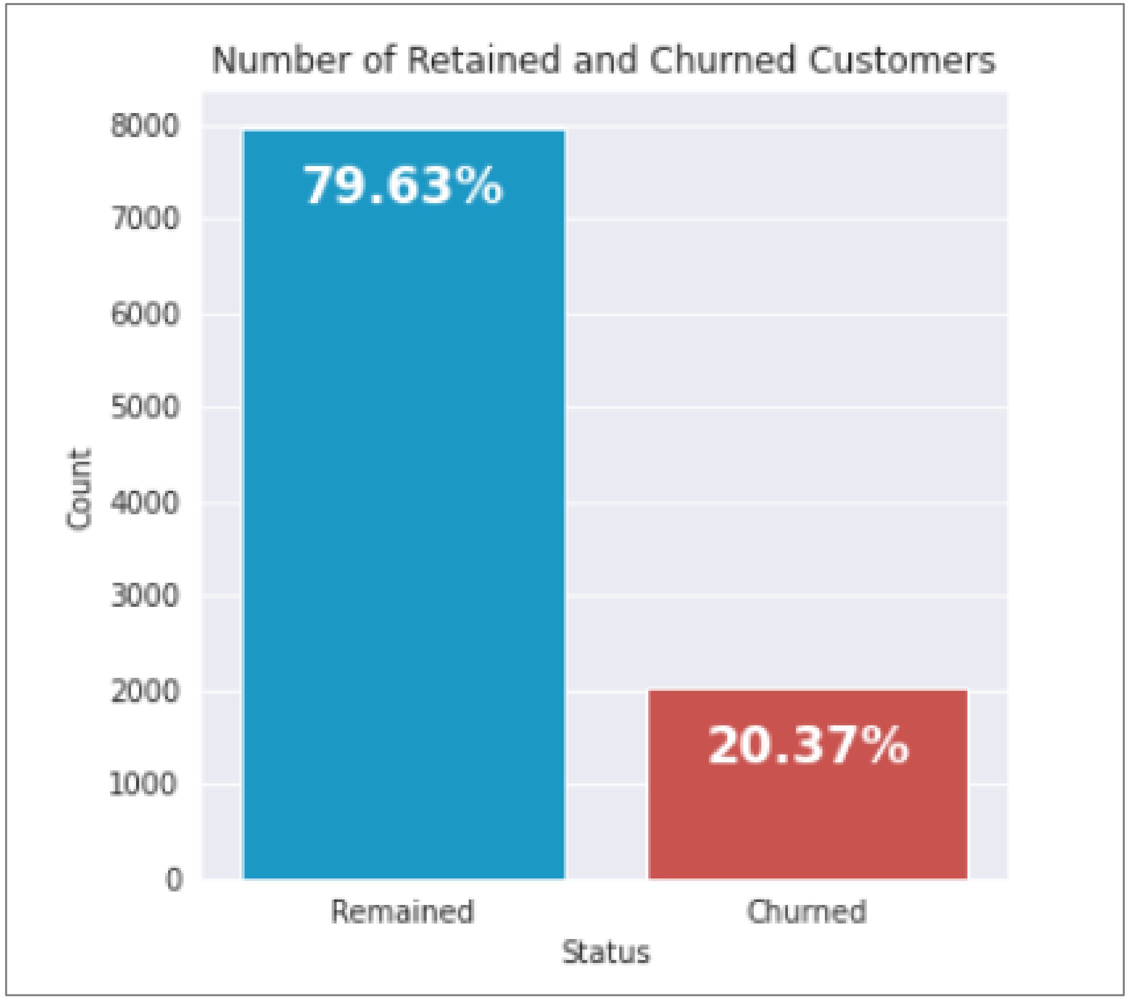
```
df.Geography.value_counts().plot.bar()
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f6d97a2ea50>
```

Bar Chart

```python
import matplotlib.pyplot as plt
import seaborn as sns
sns.set_style('darkgrid')
colors = ['#00A5E0', '#DD403A']

fig = plt.figure(figsize = (5, 5))
sns.countplot(x = 'Exited', data = df, palette = colors)

for index, value in enumerate(df['Exited'].value_counts()):
    label =  '{}%'.format(round( (value/df['Exited'].shape[0])*100, 2))
    plt.annotate(label, xy = (index -0.25, value -800), color = 'w',fontweight='bold',size=17)
plt.title('Number of Retained and Churned Customers')
plt.xticks([0, 1], ['Remained', 'Churned'])
plt.xlabel('Status')
plt.ylabel('Count');
```

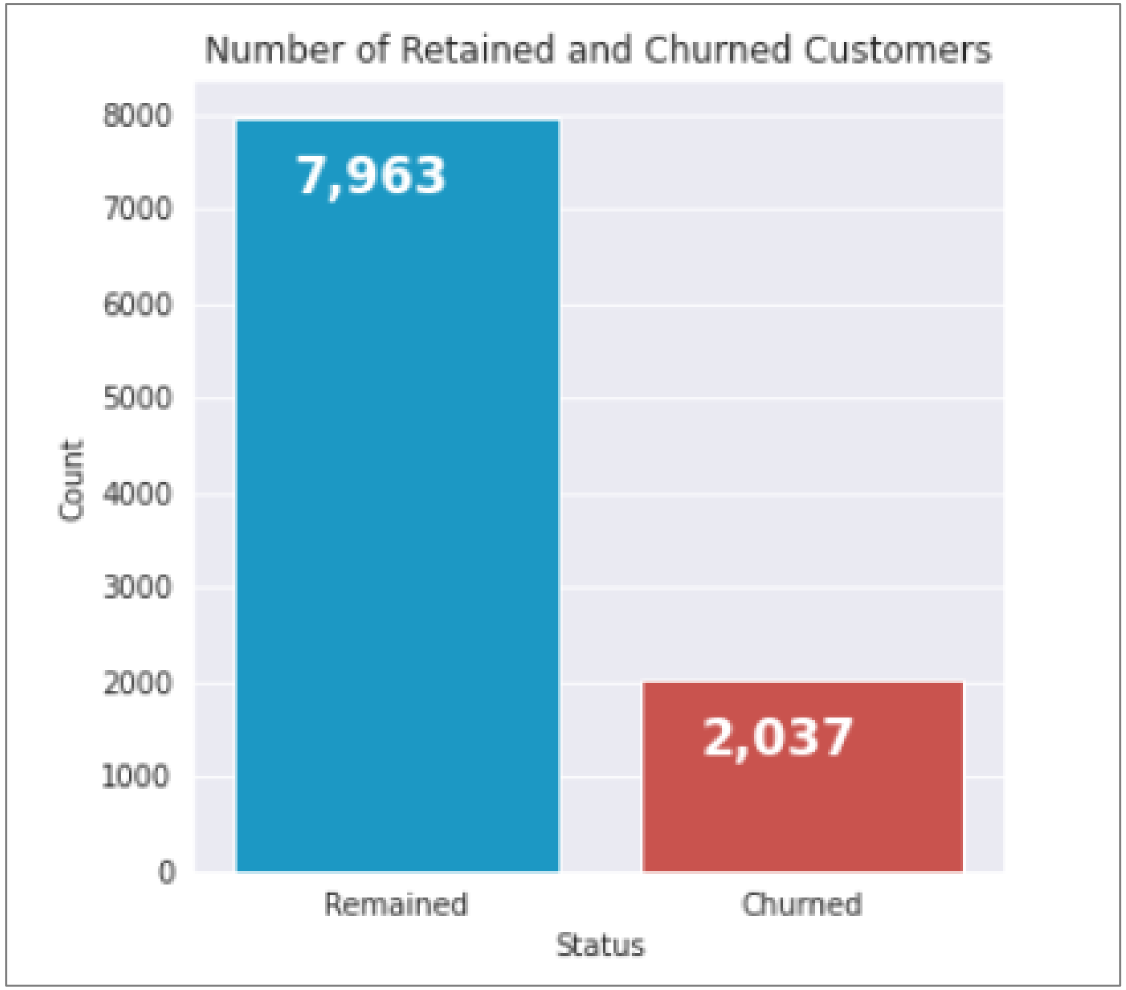
Bar Chart


Number of Retained and Churned Customers
8000
7000
6000
5000
4000
3000
2000
1000
0
Count
79.63%
20.37%
Remained
Churned
Status

Bar Chart

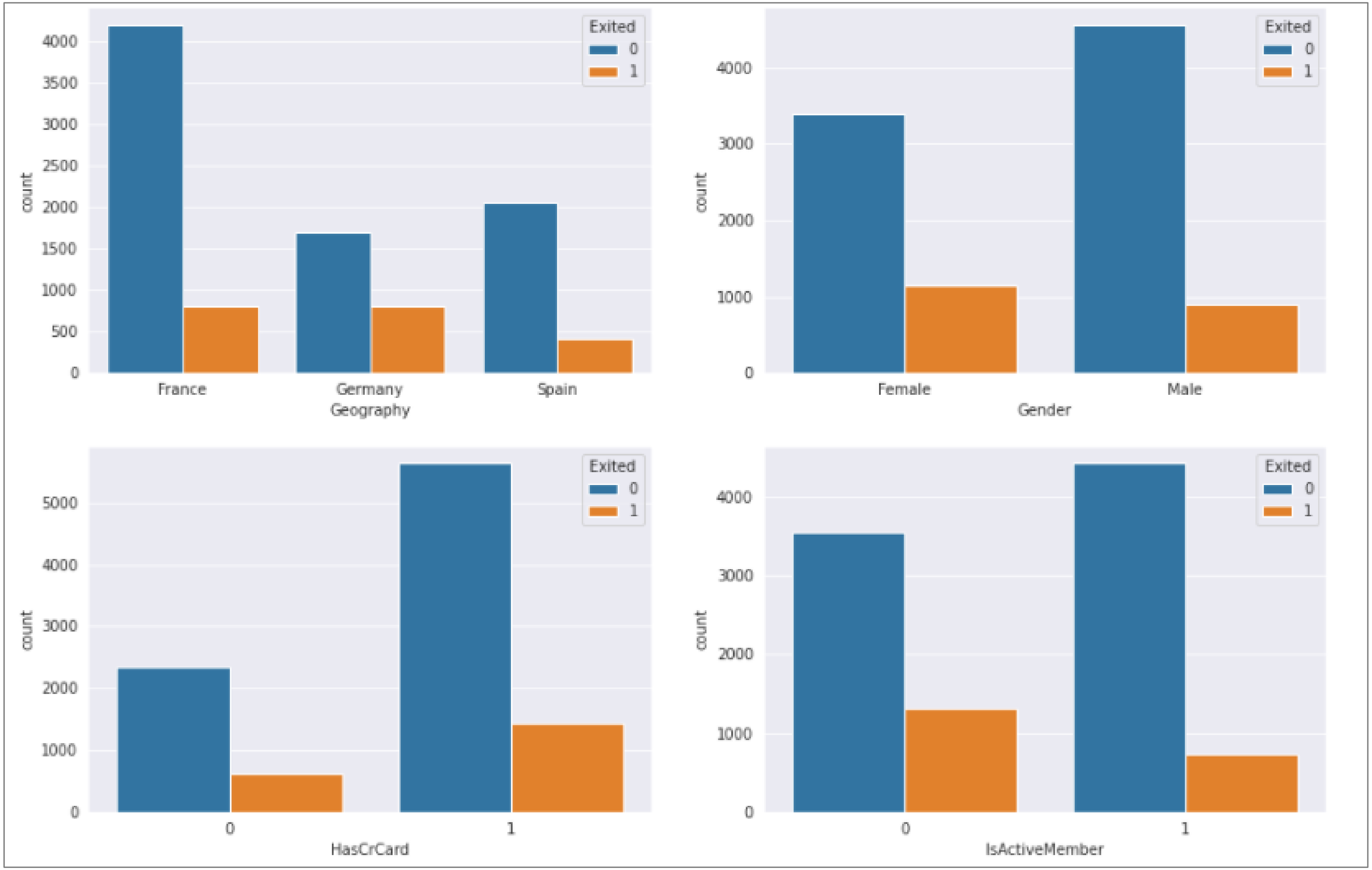
```python
sns.set_style('darkgrid')
colors = ['#00A5E0', '#DD403A']

fig = plt.figure(figsize = (5, 5))
sns.countplot(x = 'Exited', data = df, palette = colors)

for index, value in enumerate(df['Exited'].value_counts()):
    label = '{:,}'.format(value)
    plt.annotate(label, xy = (index -0.25, value -800), color = 'w',fontweight='bold',size=17)
plt.title('Number of Retained and Churned Customers')
plt.xticks([0, 1], ['Remained', 'Churned'])
plt.xlabel('Status')
plt.ylabel('Count');
```

Bar Chart

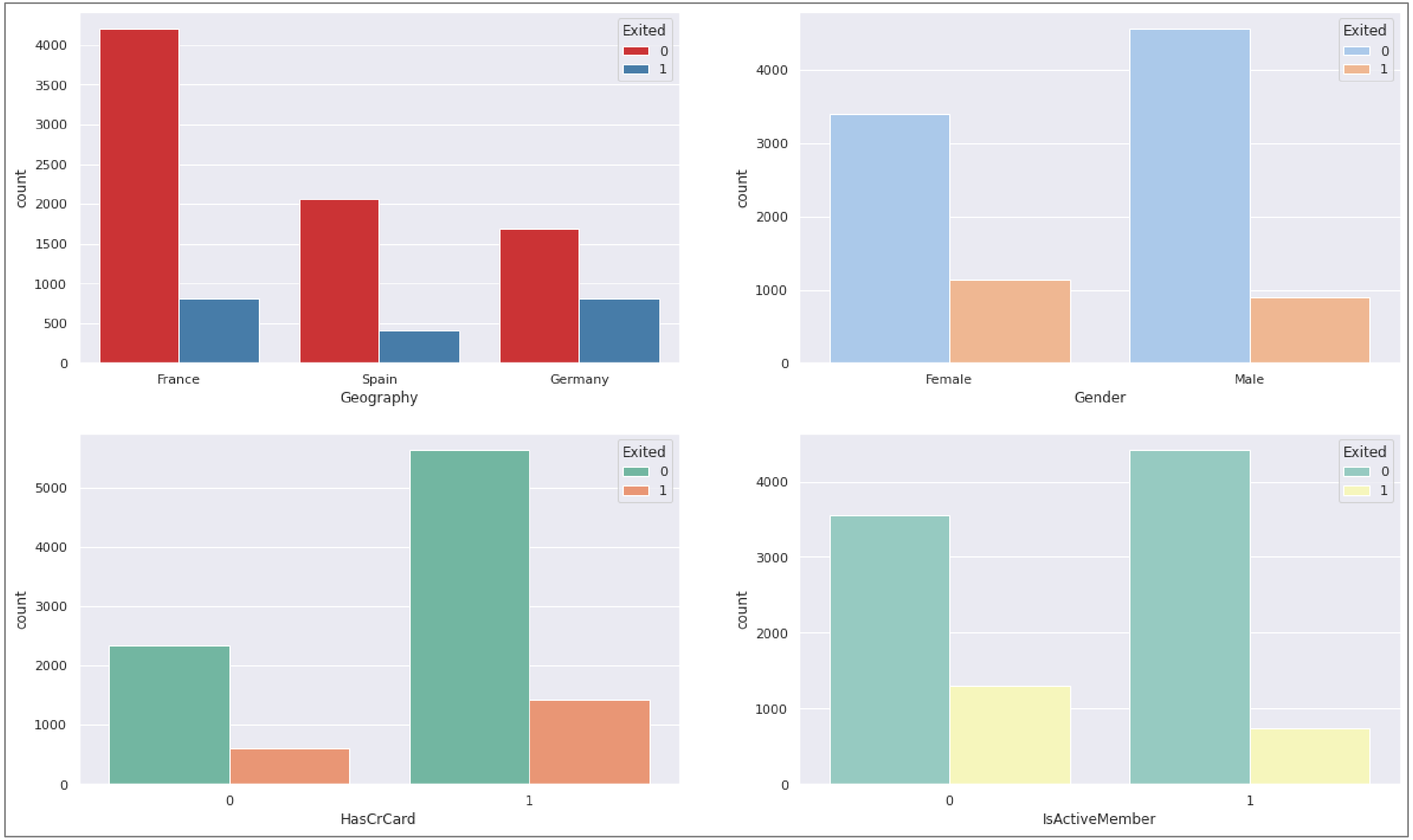

Number of Retained and Churned Customers
8000
7000
6000
5000
4000
3000
2000
1000
0
Count
7,963
2,037
Remained
Churned
Status

Bar Chart

```
fig, axarr = plt.subplots(2, 2, figsize=(20, 12))
sns.countplot(x='Geography', hue = 'Exited',data = df, ax=axarr[0][0])
sns.countplot(x='Gender', hue = 'Exited',data = df, ax=axarr[0][1])
sns.countplot(x='HasCrCard', hue = 'Exited',data = df, ax=axarr[1][0])
sns.countplot(x='IsActiveMember', hue = 'Exited',data = df, ax=axarr[1][1])
```

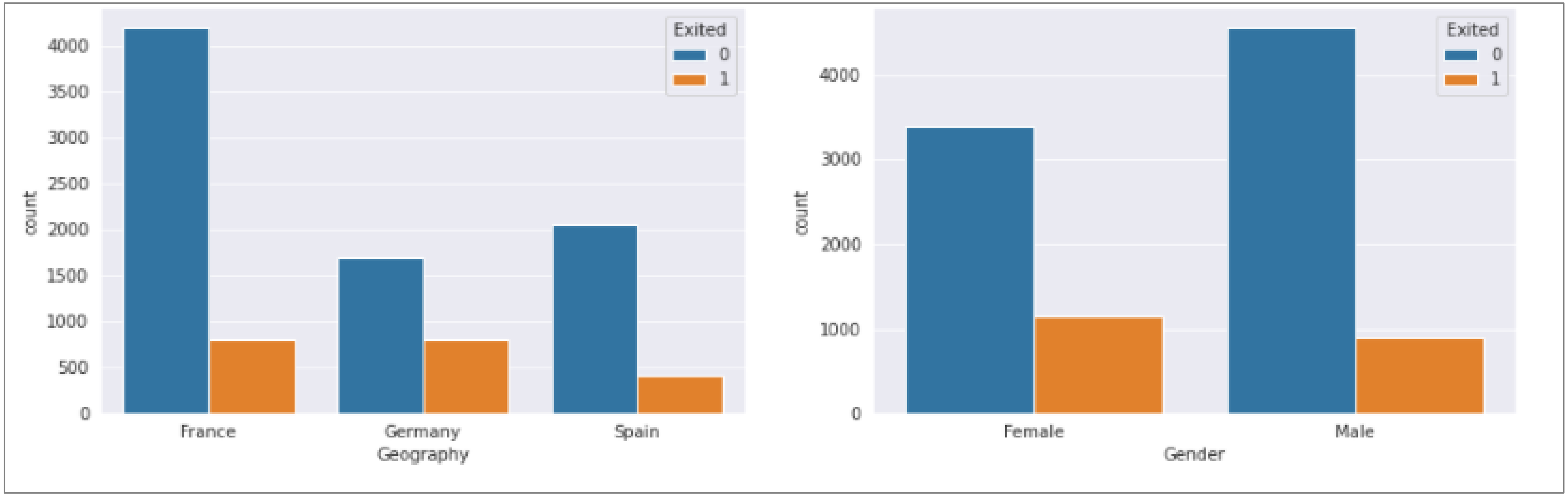

count
4000
3500
3000
2500
2000
1500
1000
500
0
France
Germany
Spain
Geography
Exited
0
1
count
4000
3000
2000
1000
0
Female
Male
Gender
Exited
0
1
count
5000
4000
3000
2000
1000
0
0
1
HasCrCard
Exited
0
1
count
4000
3000
2000
1000
0
0
1
IsActiveMember
Exited
0
1

```
fig, axarr = plt.subplots(2, 2, figsize=(20, 12))
sns.countplot(x='Geography', hue='Exited',data = df, palette="Set1", ax=axarr[0][0])
sns.countplot(x='Gender', hue ='Exited',data = df, palette="pastel", ax=axarr[0][1])
sns.countplot(x='HasCrCard', hue='Exited',data = df, palette="Set2", ax=axarr[1][0])
sns.countplot(x='IsActiveMember', hue='Exited',data = df, palette="Set3", ax=axarr[1][1])
```



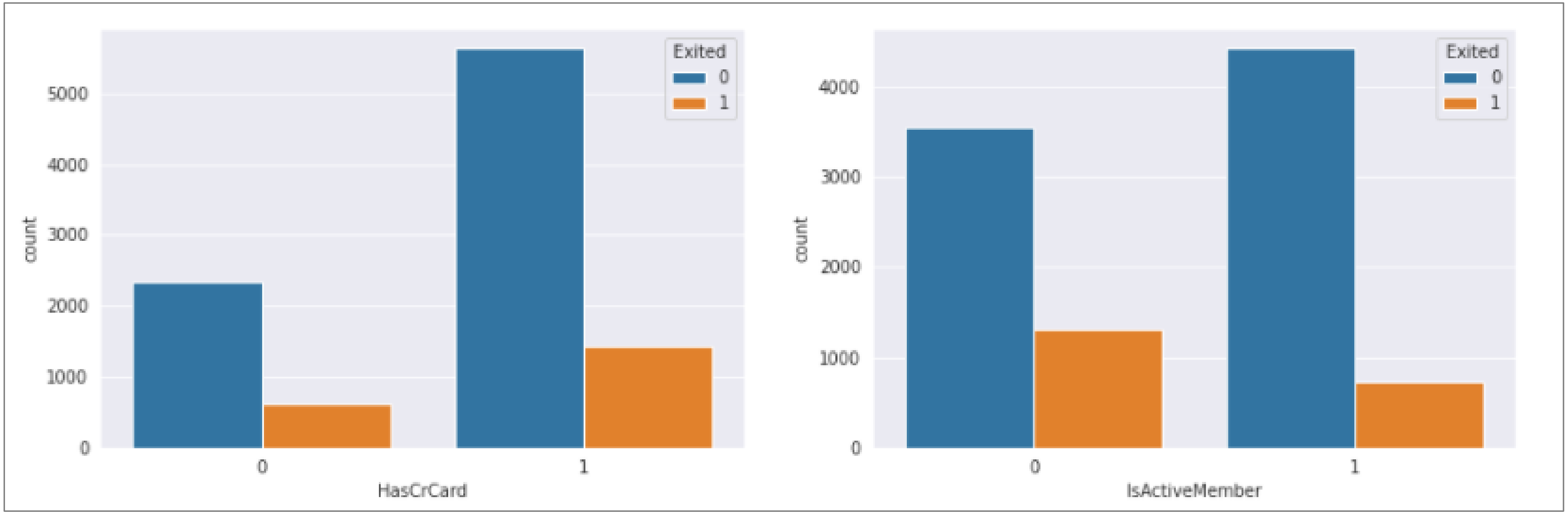
Bar Chart

- Majority of the data is from persons from France. Germany has the highest proportion of churned customers.
- The proportion of female customers churning is also greater than that of male customers



Bar Chart

- No different proportion of customer churning between HasCrCard and not have.
- The inactive members have a greater churn.



Box Plot

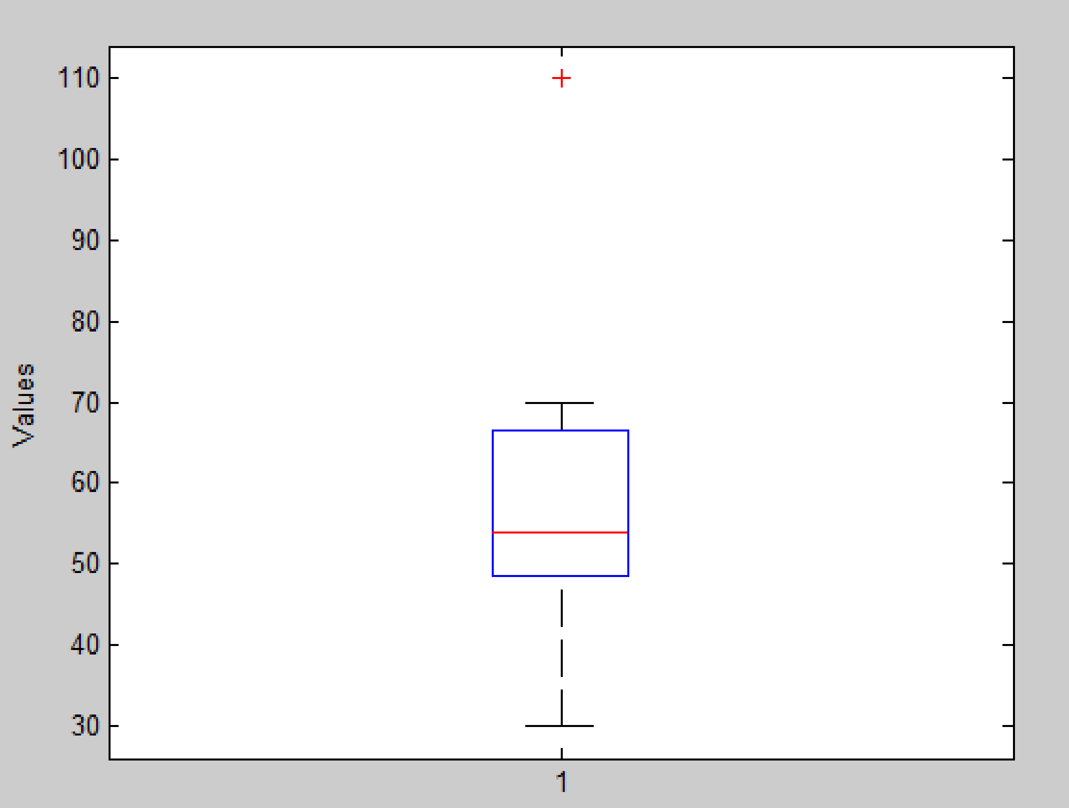
- Data is represented with a box
- The ends of the box are at the first and third quartiles, i.e., the height of the box is IQR

$$IQR = Q_3 - Q_1$$

- The median is marked by a line within the box
- Whiskers: two lines outside the box extended to Minimum and Maximum
- Outliers: points beyond a specified outlier threshold, plotted individually

Box Plot

Example: 30, 36, 47, 50, 52, 52, 56, 60, 63, 70, 70, 110



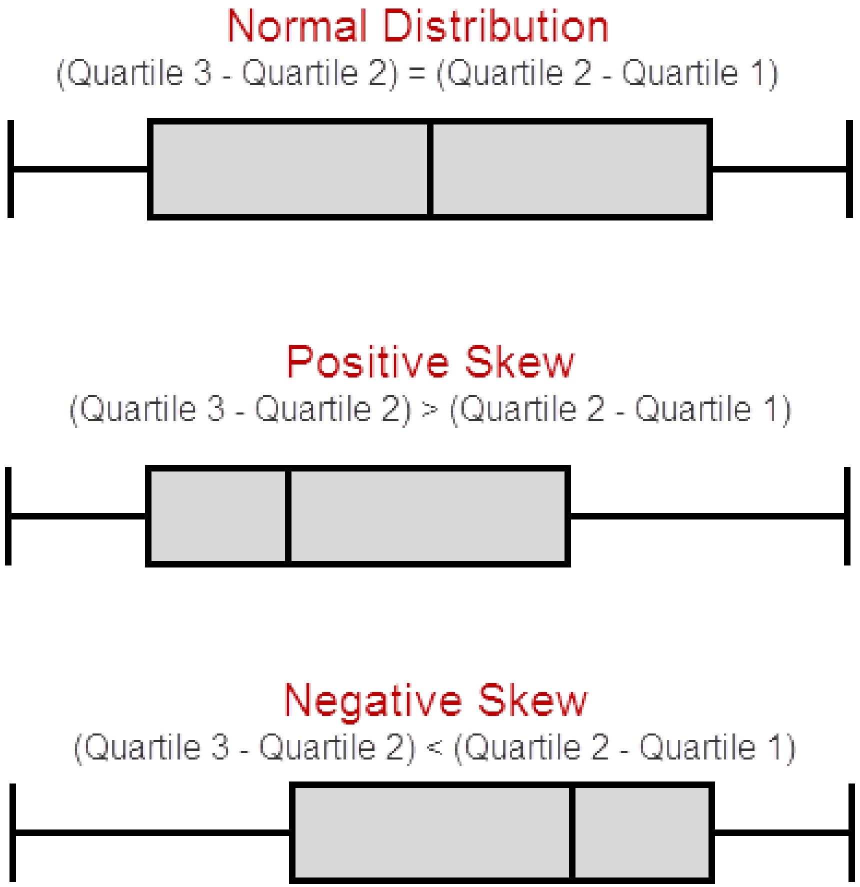
$Q_1 = 48.5$

$Q_2 = 54$

$Q_3 = 66.5$

$IQR = 18$

Box Plot



Normal Distribution

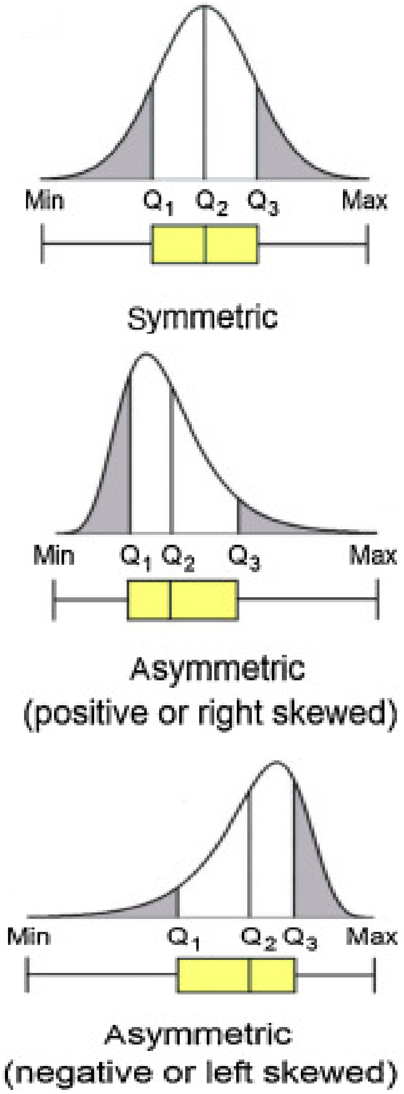
(Quartile 3 - Quartile 2) = (Quartile 2 - Quartile 1)

Positive Skew

(Quartile 3 - Quartile 2) > (Quartile 2 - Quartile 1)

Negative Skew

(Quartile 3 - Quartile 2) < (Quartile 2 - Quartile 1)



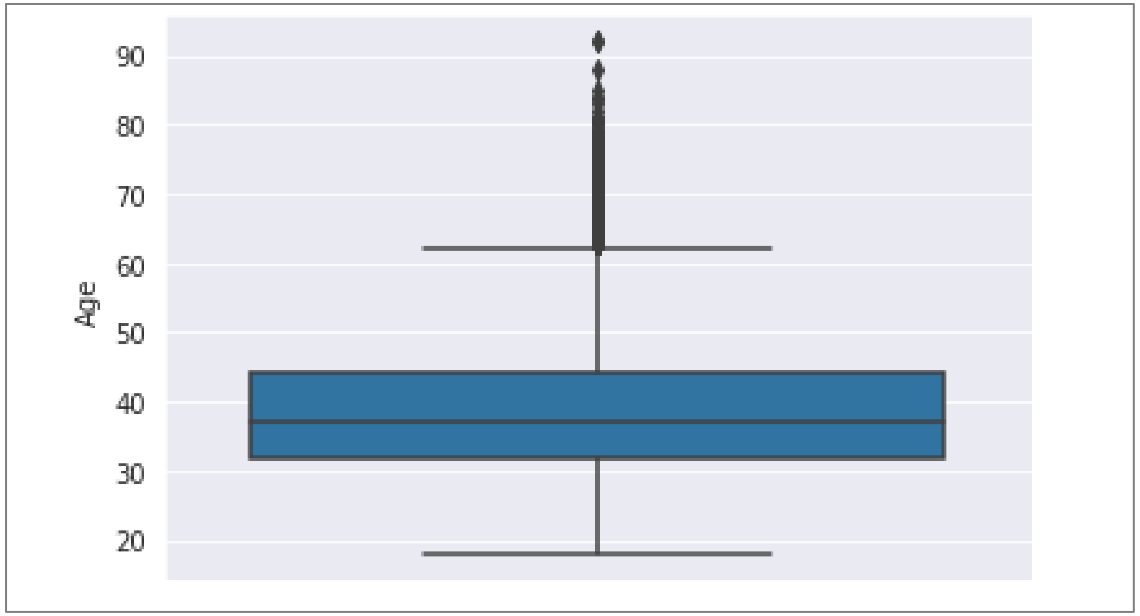
Symmetric

Asymmetric
(positive or right skewed)

Asymmetric
(negative or left skewed)

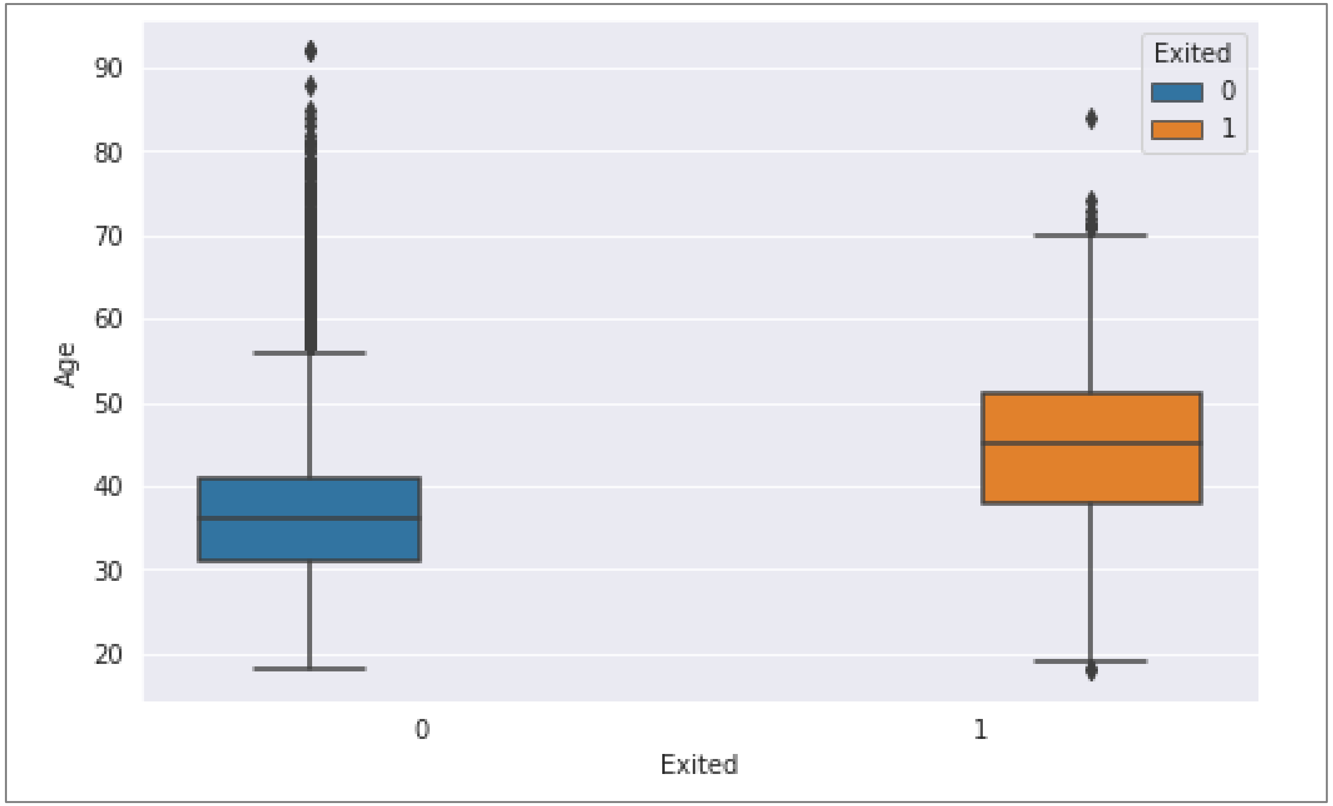
Box Plot

```
sns.boxplot(y='Age',data = df)
```



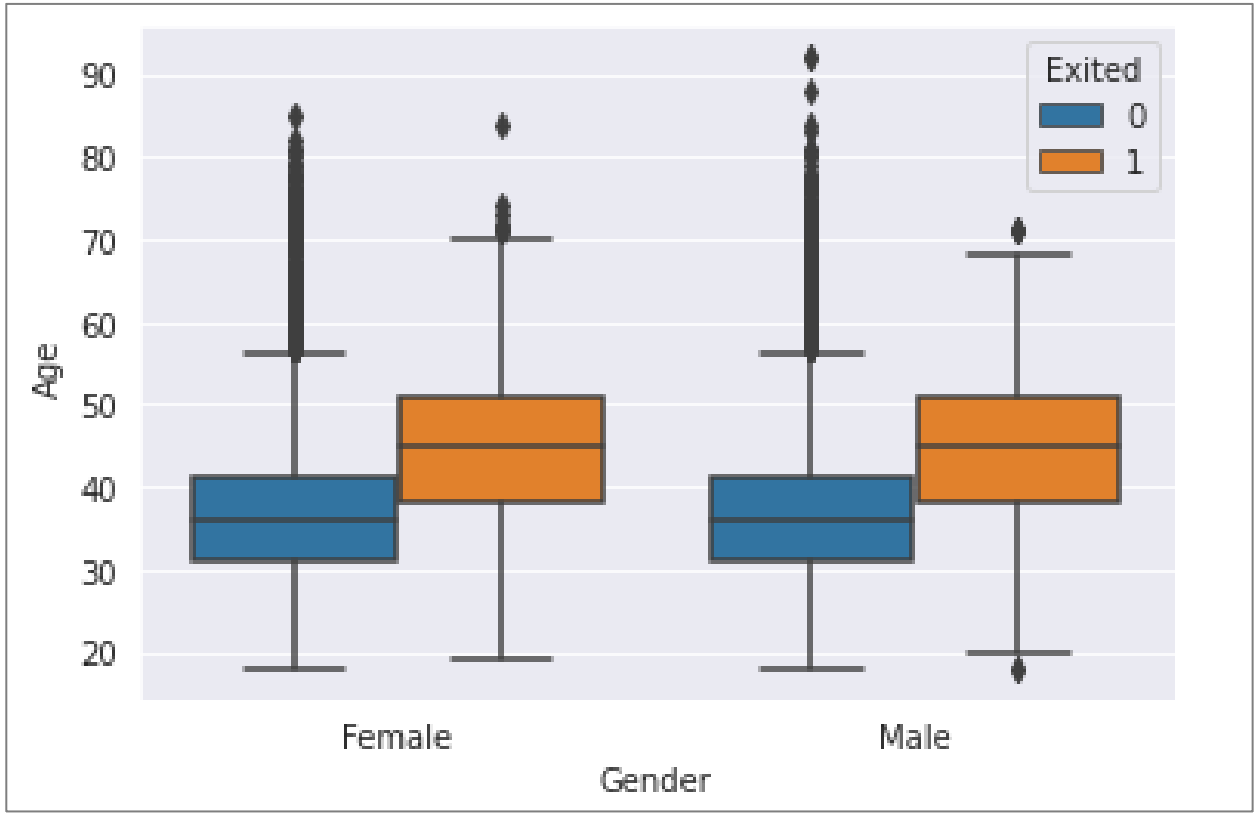
Box Plot

```
fig = plt.figure(figsize = (8, 5))
sns.boxplot(y='Age',x = 'Exited', hue = 'Exited',data = df)
```



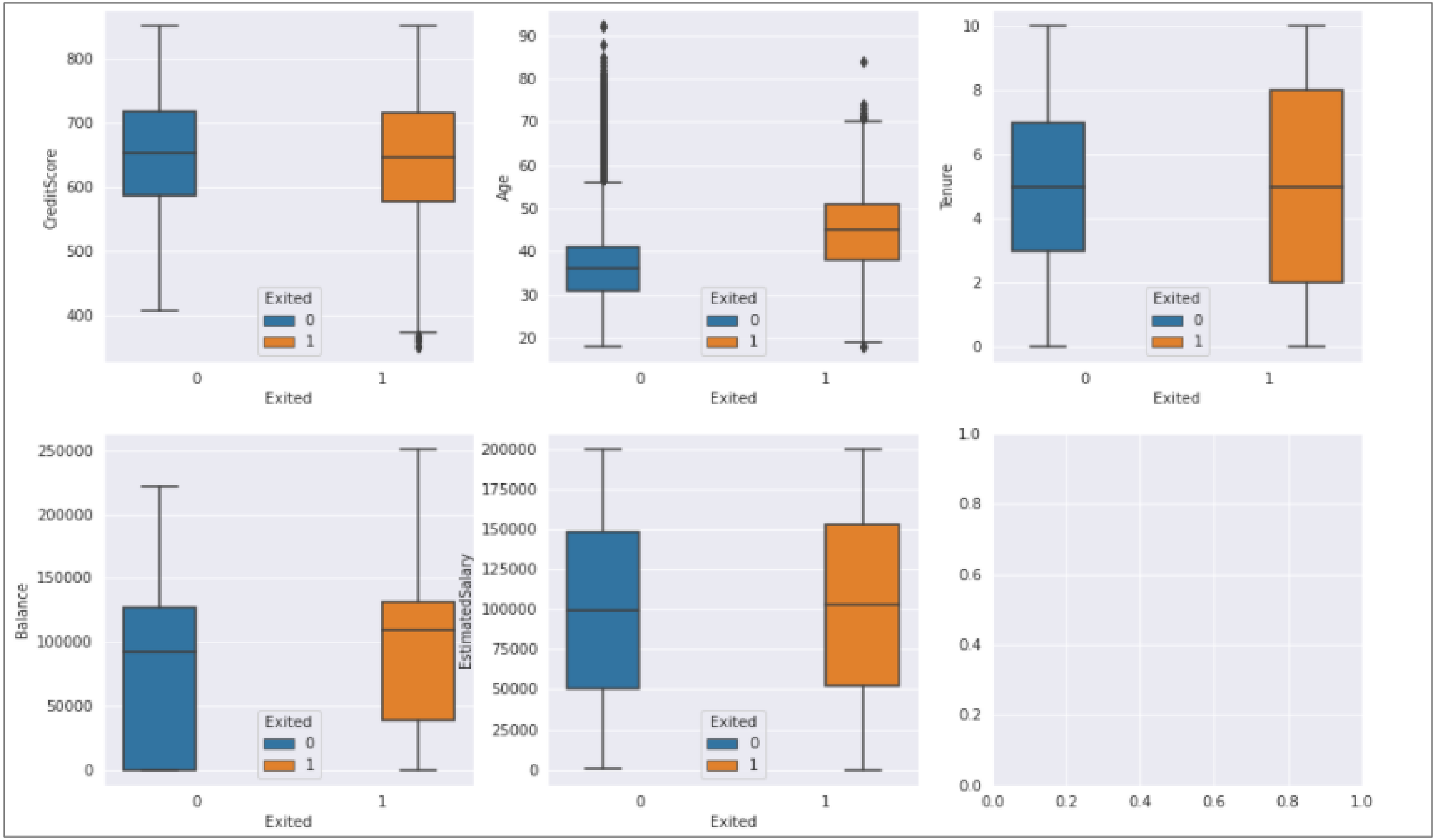
Box Plot

```
sns.boxplot(y='Age',x = 'Gender', hue = 'Exited', data = df)
```



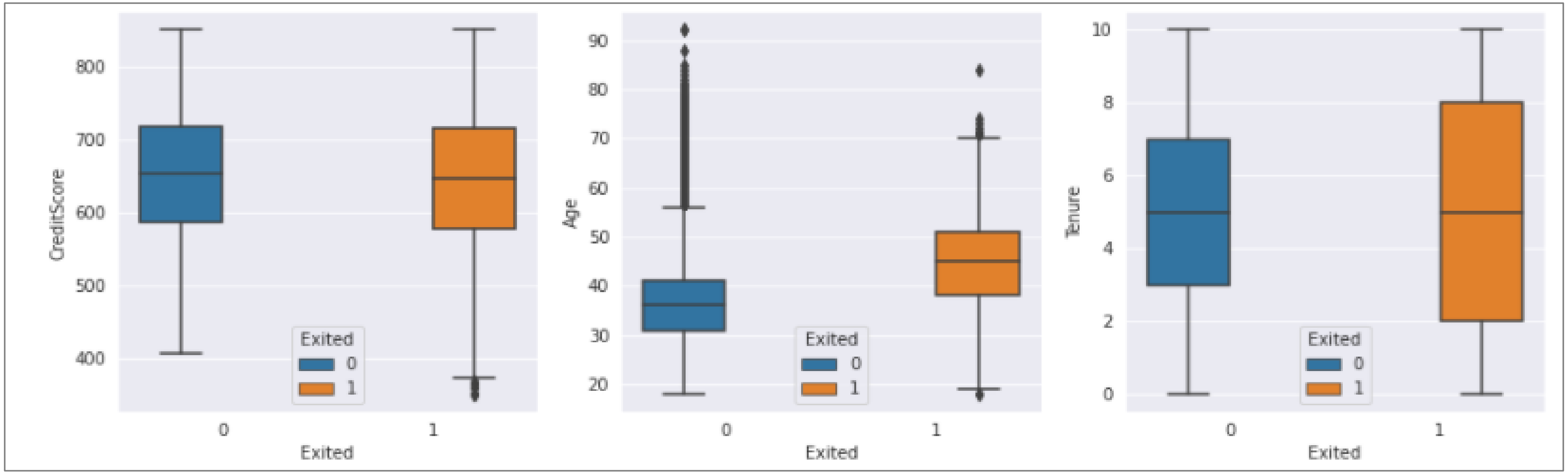
Box Plot

```
fig, axarr = plt.subplots( 2, 3, figsize=(15, 10))
sns.boxplot(y='CreditScore',x = 'Exited', hue = 'Exited',data = df, ax=axarr[0][0])
sns.boxplot(y='Age',x = 'Exited', hue = 'Exited',data = df , ax=axarr[0][1])
sns.boxplot(y='Tenure',x = 'Exited', hue = 'Exited',data = df, ax=axarr[0][2])
sns.boxplot(y='Balance',x = 'Exited', hue = 'Exited',data = df, ax=axarr[1][0])
sns.boxplot(y='EstimatedSalary',x = 'Exited', hue = 'Exited',data = df, ax=axarr[1][1])
```


CreditScore
800
700
600
500
400
Age
90
80
70
60
50
40
30
20
Tenure
10
8
6
4
2
0
Balance
250000
200000
150000
100000
50000
0
EstimatedSalary
200000
175000
150000
125000
100000
75000
50000
25000
0
Exited
0
1
0
1
Exited
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0

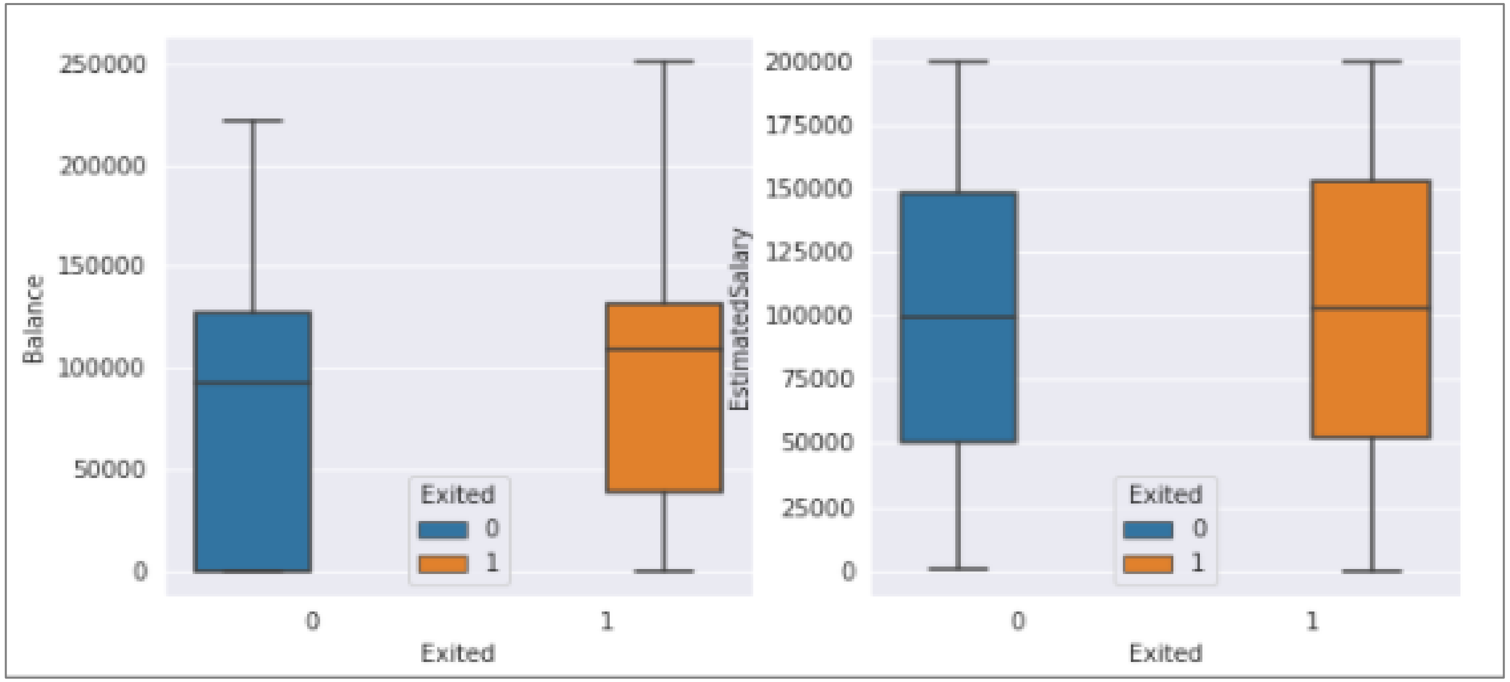
Box Plot

- There is no significant difference in the credit score distribution between retained and churned customers.
- The older customers are churning at more than the younger ones.
- The customers on either extreme end (spent little time with the bank or a lot of time with the bank) are more likely to churn compared to those that are of average tenure.



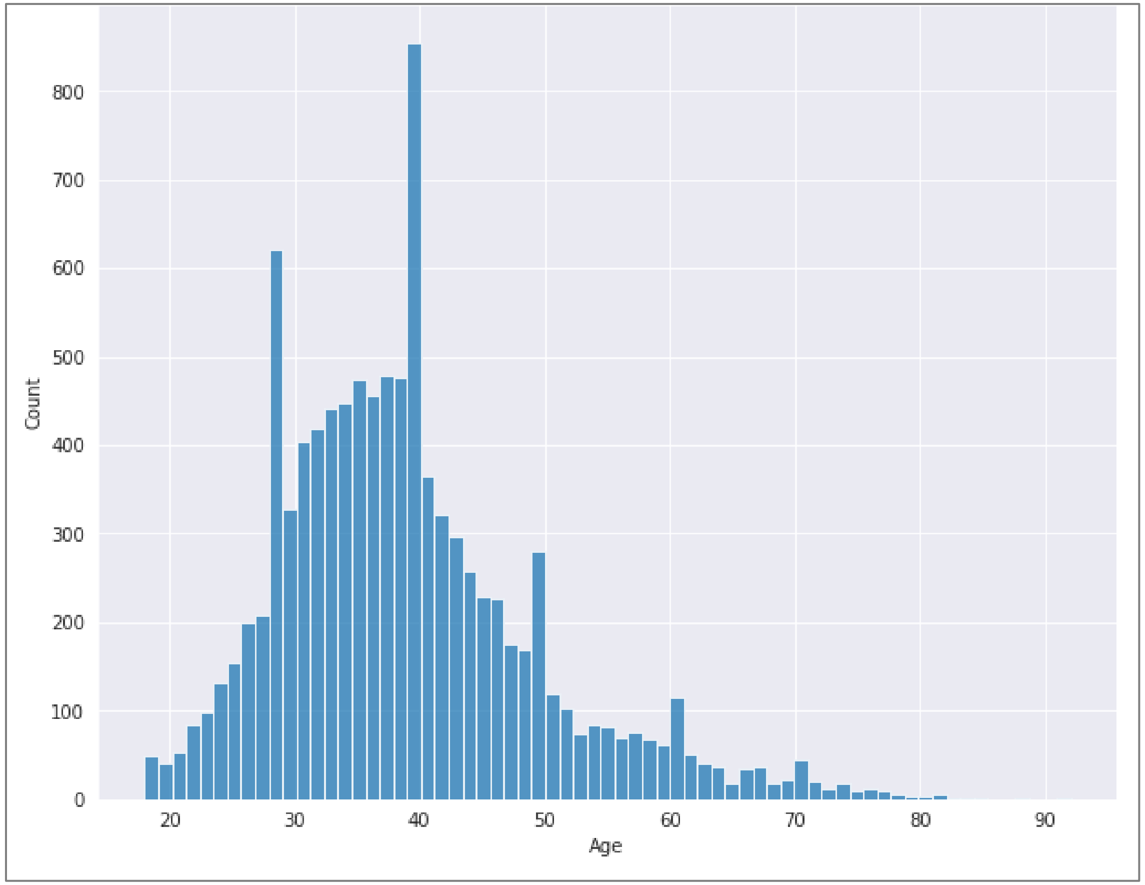
Box Plot

- The bank is losing customers with significant bank balances.
- The salary has no significant effect on the likelihood to churn.



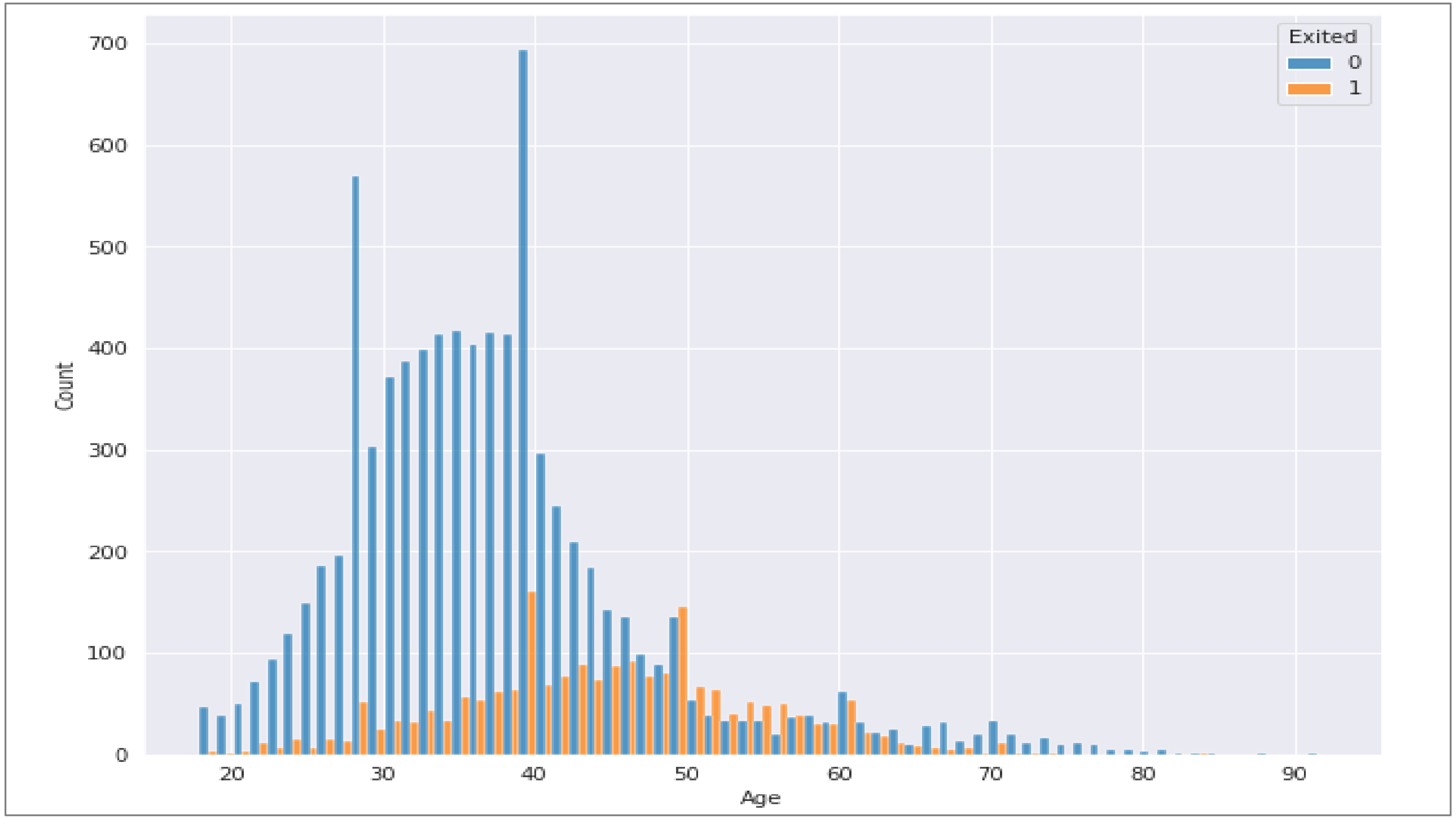
Histogram

```
fig = plt.figure(figsize = (10,8))
sns.histplot(df, x="Age")
```



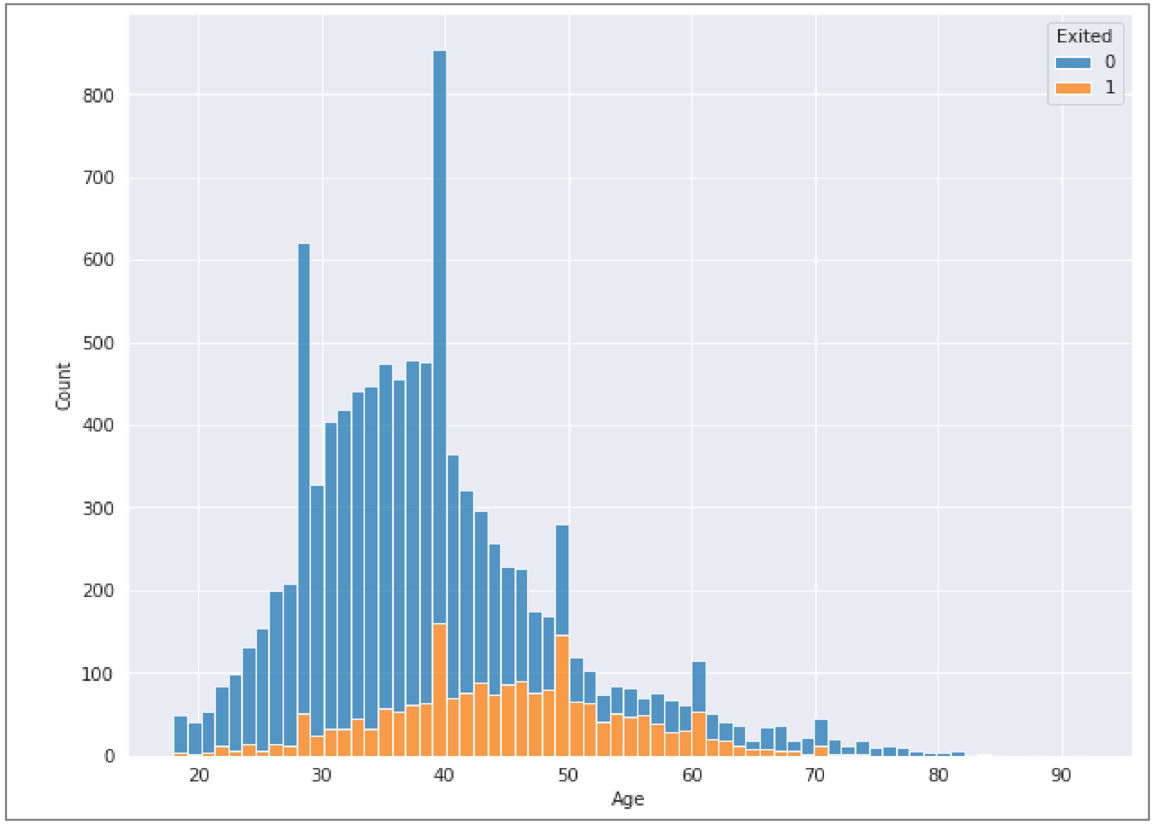
Histogram

```
fig = plt.figure(figsize = (10, 8))
sns.histplot(df, x="Age", hue = 'Exited',multiple="dodge")
```

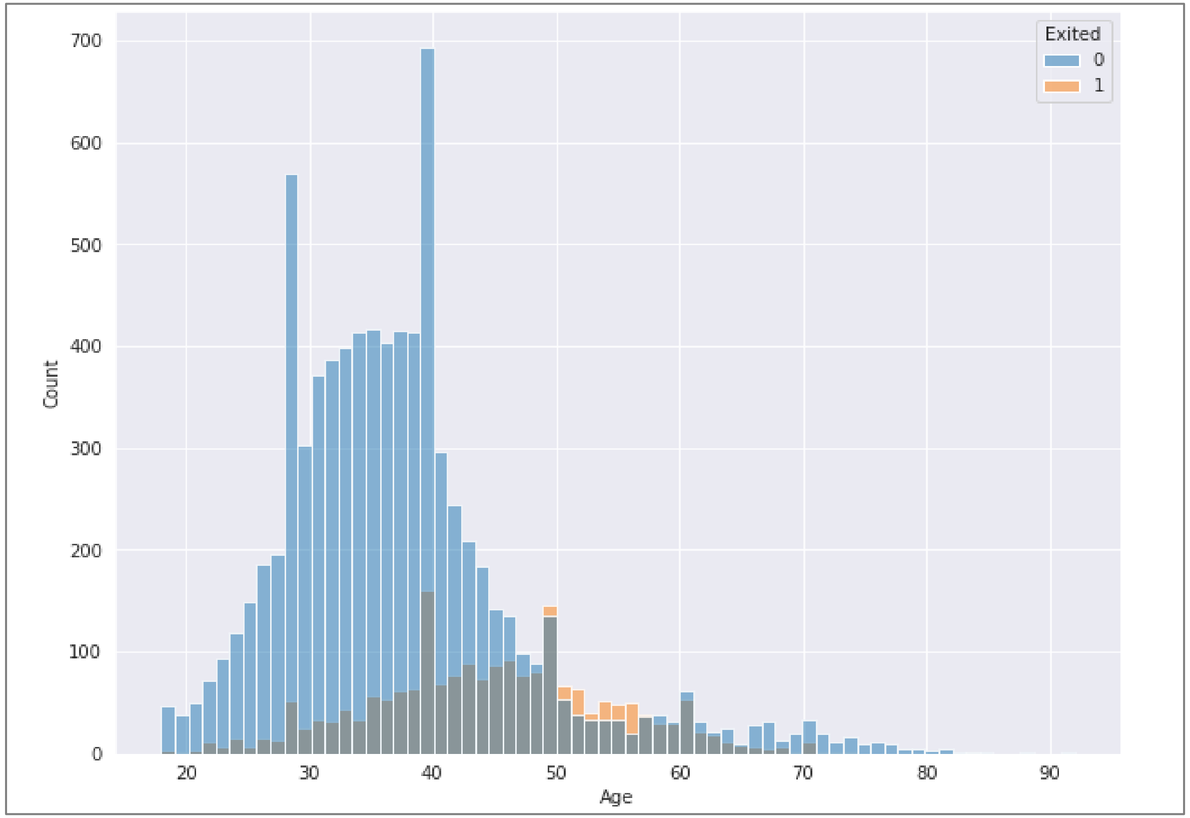


Histogram

`multiple="stack"`

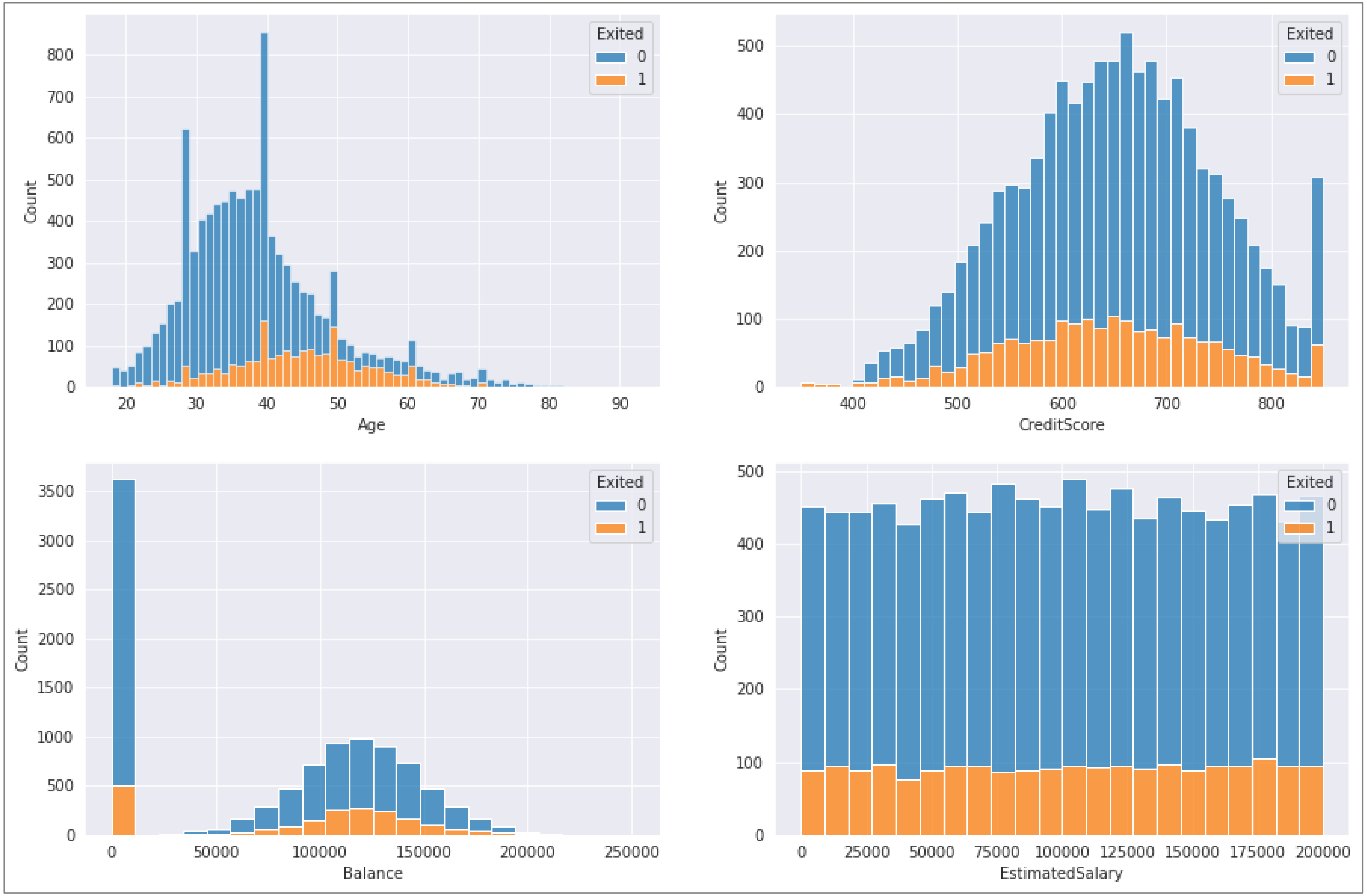


`multiple="layer"`



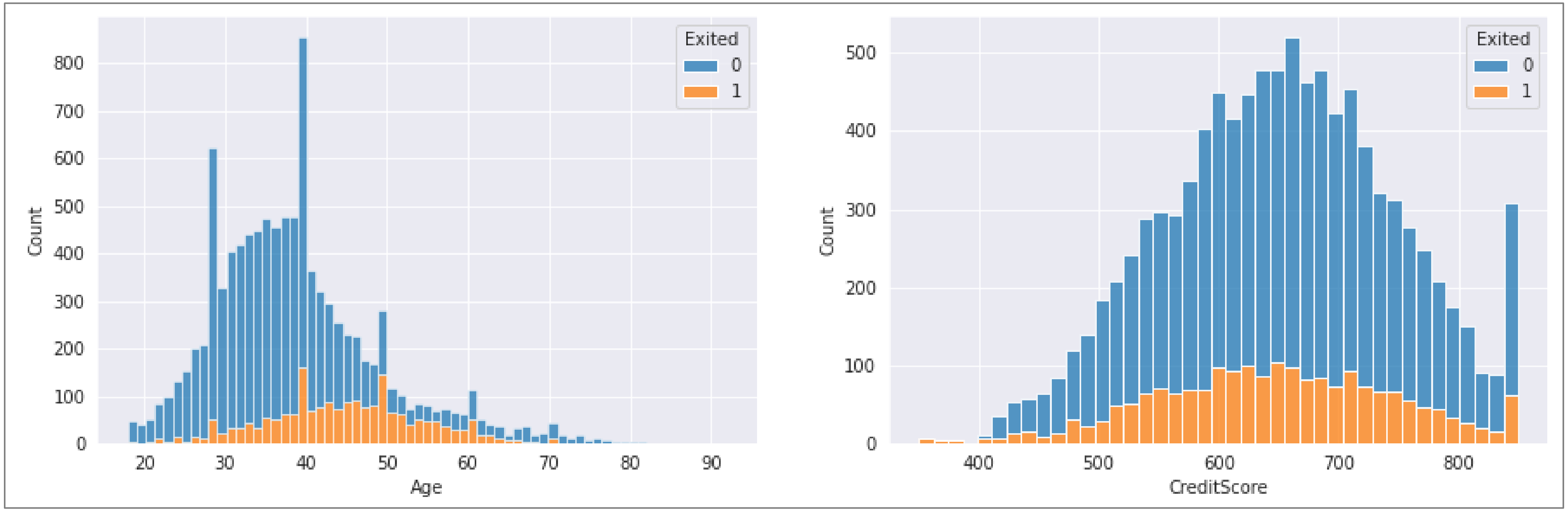
Histogram

```
fig, axarr = plt.subplots( 2, 2, figsize=(15, 10))
sns.histplot(df, x="Age", hue = 'Exited',multiple="stack", ax=axarr[0][0])
sns.histplot(df, x="CreditScore", hue = 'Exited',multiple="stack", ax=axarr[0][1])
sns.histplot(df, x="Balance", hue = 'Exited',multiple="stack", ax=axarr[1][0])
sns.histplot(df, x="EstimatedSalary", hue = 'Exited',multiple="stack", ax=axarr[1][1])
```


Count
Age
CreditScore
Balance
EstimatedSalary
Exited
0
1
0
100
200
300
400
500
600
700
800
20
30
40
50
60
70
80
90
400
500
600
700
800
500
1000
1500
2000
2500
3000
3500
50000
100000
150000
200000
250000
25000
75000
125000
175000

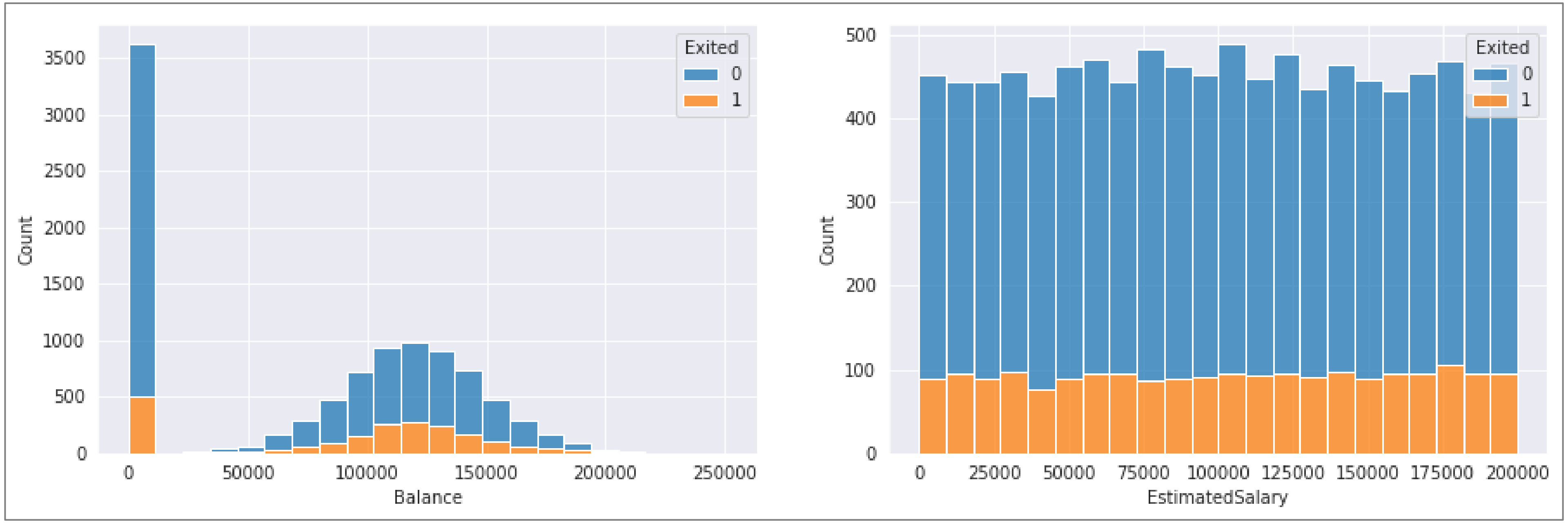
Histogram

- Most of our customers are between the age of 28 to 40.
- Credit Score seems like left skewed.



Histogram

- Balances of the customers are seemed to be symmetrically distributed.
- There is not much variation in Estimated salary.


Exited
Count
Balance
Exited
Count
EstimatedSalary