In [1]:

```
import sklearn
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
```

In [2]:

```
bank = pd.read_csv('bank.csv')
```

In [3]:

```
# Data Exploration
```

In [4]:

```
bank.head()
```

Out[4]:

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Bal
0	1	15634602	Hargrave	619	France	Female	42	2	
1	2	15647311	Hill	608	Spain	Female	41	1	838
2	3	15619304	Onio	502	France	Female	42	8	1596
3	4	15701354	Boni	699	France	Female	39	1	
4	5	15737888	Mitchell	850	Spain	Female	43	2	1255

In [5]:

```
bank.shape
```

Out[5]:

```
(10000, 14)
```

In [6]:

```
# check data info
bank.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
```

In [7]:

```
# check the unique values for each column
bank.nunique()
```

Out[7]:

```
RowNumber          10000
CustomerId         10000
Surname             2932
CreditScore          460
Geography              3
Gender                 2
Age                   70
Tenure                11
Balance             6382
NumOfProducts          4
HasCrCard              2
IsActiveMember         2
EstimatedSalary     9999
Exited                 2
dtype: int64
```

In [8]:

```
# check missing values
bank.isnull().sum()
```

Out[8]:

```
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 [9]:

```
# understand Numerical feature
# discrete/continuous
# 'CreditScore', 'Age', 'Tenure', 'NumberOfProducts'
# 'Balance', 'EstimatedSalary'
bank[['CreditScore', 'Age', 'Tenure', 'NumOfProducts','Balance', 'EstimatedS
```

Out[9]:

	CreditScore	Age	Tenure	NumOfProducts	Balance	Estimat
count	10000.000000	10000.000000	10000.000000	10000.000000	10000.000000	1000
mean	650.528800	38.921800	5.012800	1.530200	76485.889288	10009
std	96.653299	10.487806	2.892174	0.581654	62397.405202	5751
min	350.000000	18.000000	0.000000	1.000000	0.000000	1
25%	584.000000	32.000000	3.000000	1.000000	0.000000	5100
50%	652.000000	37.000000	5.000000	1.000000	97198.540000	10019
75%	718.000000	44.000000	7.000000	2.000000	127644.240000	14938
max	850.000000	92.000000	10.000000	4.000000	250898.090000	19999

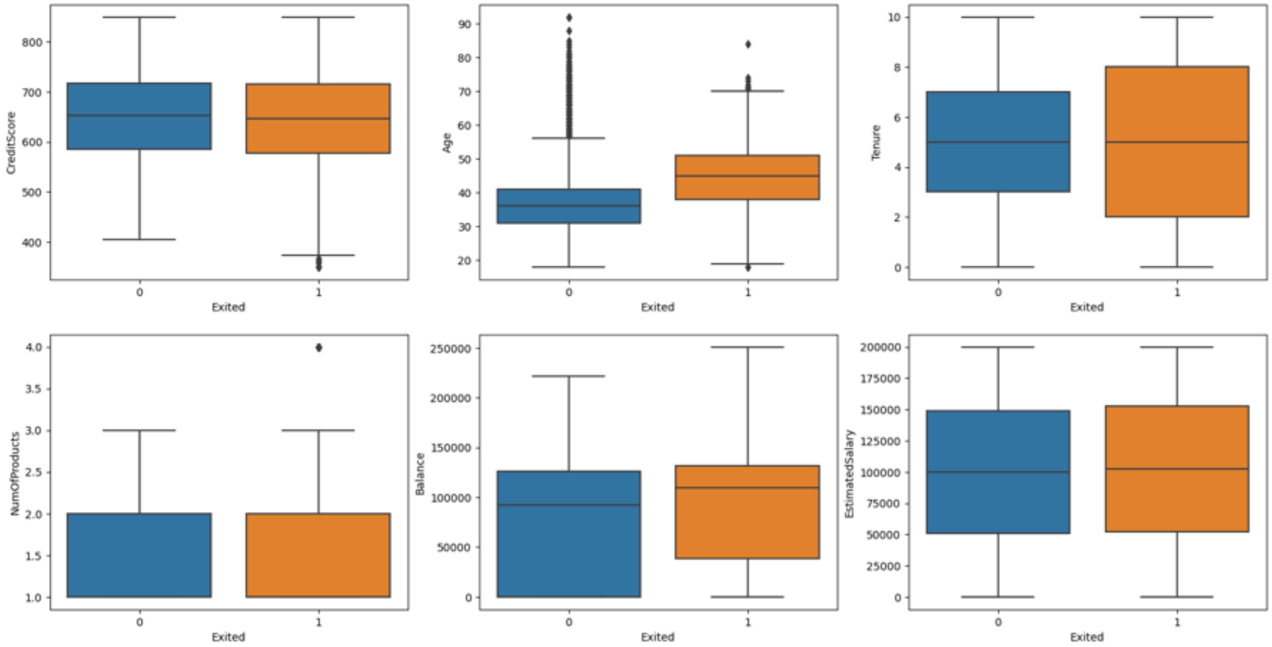
In [10]:

```
import matplotlib.pyplot as plt
import seaborn as sns
```

In [11]:

```
# boxplot for numerical feature
_,axss = plt.subplots(2,3, figsize=[20,10])
sns.boxplot(x='Exited', y ='CreditScore', data=bank, ax=axss[0][0])
sns.boxplot(x='Exited', y ='Age', data=bank, ax=axss[0][1])
sns.boxplot(x='Exited', y ='Tenure', data=bank, ax=axss[0][2])
sns.boxplot(x='Exited', y ='NumOfProducts', data=bank, ax=axss[1][0])
sns.boxplot(x='Exited', y ='Balance', data=bank, ax=axss[1][1])
sns.boxplot(x='Exited', y ='EstimatedSalary', data=bank, ax=axss[1][2])
```

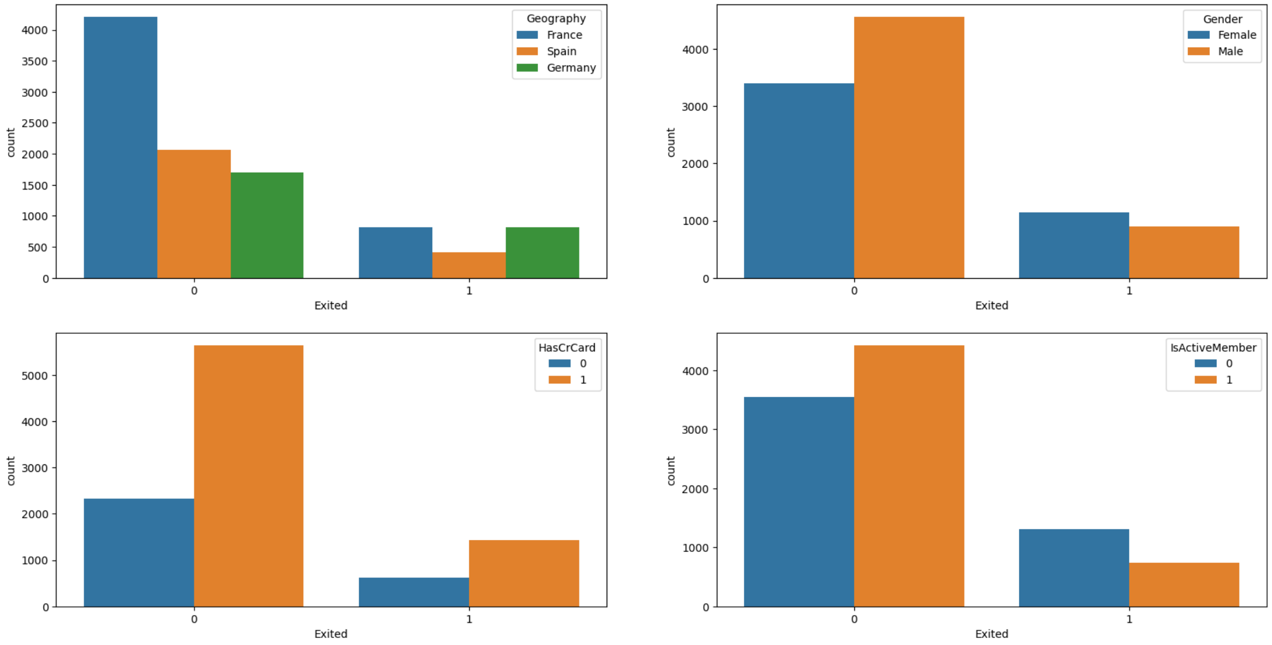
Out[11]: `<AxesSubplot: xlabel='Exited', ylabel='EstimatedSalary'>`



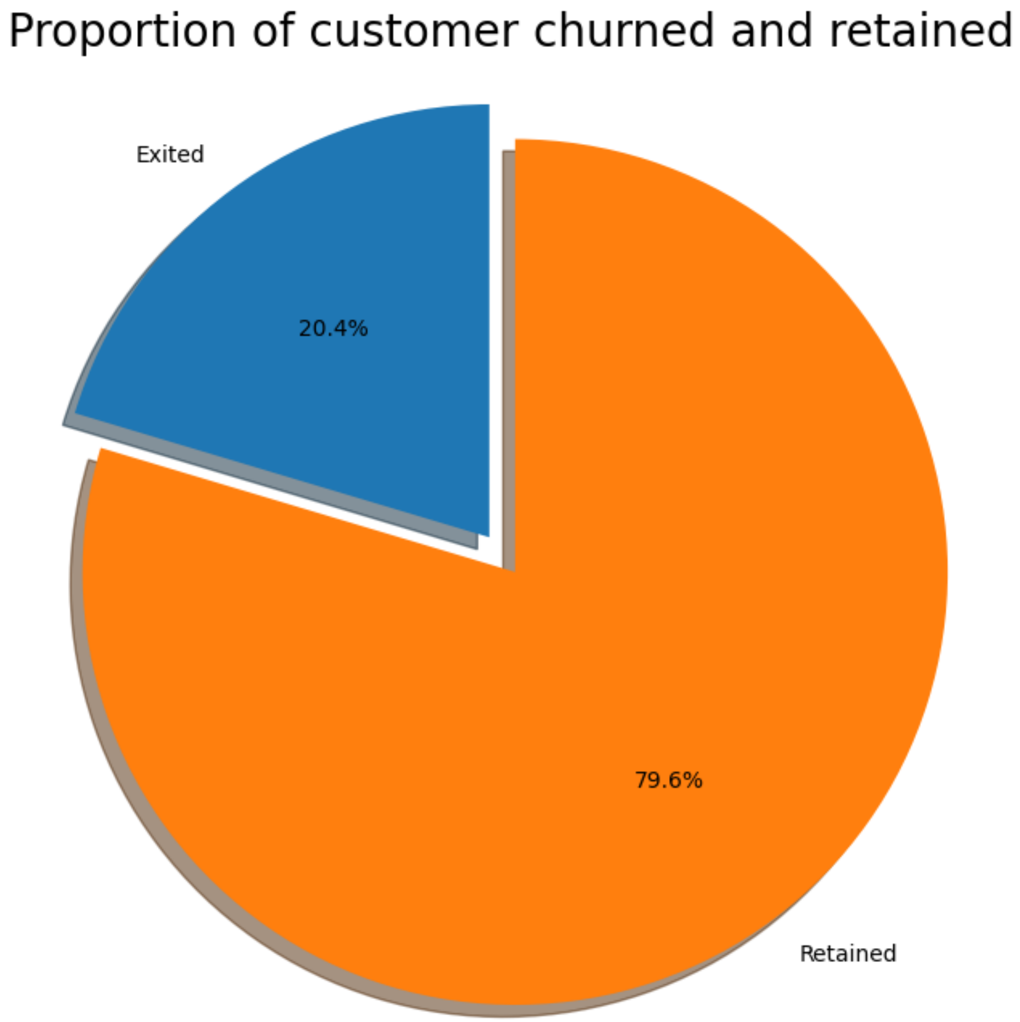
In [12]:

```
# understand categorical feature
# 'Geography', 'Gender'
# 'HasCrCard', 'IsActiveMember'
_,axss = plt.subplots(2,2, figsize=[20,10])
sns.countplot(x='Exited', hue='Geography', data=bank, ax=axss[0][0])
sns.countplot(x='Exited', hue='Gender', data=bank, ax=axss[0][1])
sns.countplot(x='Exited', hue='HasCrCard', data=bank, ax=axss[1][0])
sns.countplot(x='Exited', hue='IsActiveMember', data=bank, ax=axss[1][1])
```

Out[12]: `<AxesSubplot: xlabel='Exited', ylabel='count'>`



In [13]:
```
labels = 'Exited', 'Retained'
sizes = [bank.Exited[bank['Exited']==1].count(), bank.Exited[bank['Exited']=
explode = (0, 0.1)
fig1, ax1 = plt.subplots(figsize=(10, 8))
ax1.pie(sizes, explode=explode, labels=labels, autopct='%1.1f%%',
        shadow=True, startangle=90)
ax1.axis('equal')
plt.title("Proportion of customer churned and retained", size = 20)
plt.show()
```



In [14]:
```
# Feature Preprocessing
# Drop useless feature
bank1 = bank.drop(['RowNumber','CustomerId','Surname','Exited'], axis=1)
```

In [15]:
```
bank1.head()
```

Out[15]:

	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	I
0	619	France	Female	42	2	0.00	1	1	
1	608	Spain	Female	41	1	83807.86	1	0	
2	502	France	Female	42	8	159660.80	3	1	
3	699	France	Female	39	1	0.00	2	0	
4	850	Spain	Female	43	2	125510.82	1	1	

In [16]:

```
bank1.dtypes
```

Out[16]:

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

In [17]:

```
X = bank1
```

In [18]:

```
# Get target variable
y = bank['Exited']
```

In [19]:

```
# convert categorical varaiables to numerical variables
from sklearn.preprocessing import LabelEncoder
lb = LabelEncoder()
bank1['Gender']= lb.fit_transform(bank1['Gender'])
```

In [20]:

```
bank1 = pd.get_dummies(bank1, columns = ['Geography'])
```

In [21]:

```
# Splite data into training and testing
from sklearn import model_selection

# #stratified sampling
X_train, X_test, y_train, y_test = model_selection.train_test_split(X, y, te
```