In [1]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from IPython import get_ipython
import warnings
warnings.filterwarnings("ignore")
```

In [3]:

```
data = pd.read_csv("churn.csv")
```

In [4]:

```
data.head()
```

Out[4]:

| | RowNumber | CustomerId | Surname | CreditScore | Geography | Gender | Age | Tenure | Balance |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 1 | 15634602 | Hargrave | 619 | France | Female | 42 | 2 | 0.00 |
| **1** | 2 | 15647311 | Hill | 608 | Spain | Female | 41 | 1 | 83807.86 |
| **2** | 3 | 15619304 | Onio | 502 | France | Female | 42 | 8 | 159660.80 |
| **3** | 4 | 15701354 | Boni | 699 | France | Female | 39 | 1 | 0.00 |
| **4** | 5 | 15737888 | Mitchell | 850 | Spain | Female | 43 | 2 | 125510.82 |

In [5]:

```
data.tail()
```

Out[5]:

| | RowNumber | CustomerId | Surname | CreditScore | Geography | Gender | Age | Tenure | Bal |
|---|---|---|---|---|---|---|---|---|---|
| **9995** | 9996 | 15606229 | Obijiaku | 771 | France | Male | 39 | 5 | |
| **9996** | 9997 | 15569892 | Johnstone | 516 | France | Male | 35 | 10 | 5736 |
| **9997** | 9998 | 15584532 | Liu | 709 | France | Female | 36 | 7 | |
| **9998** | 9999 | 15682355 | Sabbatini | 772 | Germany | Male | 42 | 3 | 7507 |
| **9999** | 10000 | 15628319 | Walker | 792 | France | Female | 28 | 4 | 13014 |

In [6]:

```
data.shape
```

Out[6]:

```
(10000, 14)
```

In [7]:

```
data.columns
```

Out[7]:

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

In [8]:

```
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
```

In [9]:

```
data.describe()
```

Out[9]:

| | RowNumber | CustomerId | CreditScore | Age | Tenure | Balance |
|---|---|---|---|---|---|---|
| **count** | 10000.00000 | 1.000000e+04 | 10000.000000 | 10000.000000 | 10000.000000 | 10000.000000 |
| **mean** | 5000.50000 | 1.569094e+07 | 650.528800 | 38.921800 | 5.012800 | 76485.889288 |
| **std** | 2886.89568 | 7.193619e+04 | 96.653299 | 10.487806 | 2.892174 | 62397.405202 |
| **min** | 1.00000 | 1.556570e+07 | 350.000000 | 18.000000 | 0.000000 | 0.000000 |
| **25%** | 2500.75000 | 1.562853e+07 | 584.000000 | 32.000000 | 3.000000 | 0.000000 |
| **50%** | 5000.50000 | 1.569074e+07 | 652.000000 | 37.000000 | 5.000000 | 97198.540000 |
| **75%** | 7500.25000 | 1.575323e+07 | 718.000000 | 44.000000 | 7.000000 | 127644.240000 |
| **max** | 10000.00000 | 1.581569e+07 | 850.000000 | 92.000000 | 10.000000 | 250898.090000 |

In [10]:

```
data.isnull().sum()
```

Out[10]:

```
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 [11]:

```
data.nunique()
```

Out[11]:

```
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 [12]:

```
data_new = data.drop(['RowNumber', 'CustomerId', 'Surname'], axis = 1)
```

In [13]:

```
data_new.head()
```

Out[13]:

| | CreditScore | Geography | Gender | Age | Tenure | Balance | NumOfProducts | HasCrCard | IsActiv |
|---|---|---|---|---|---|---|---|---|---|
| **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 [14]:

```
data_new['Geography'].unique()
```

Out[14]:

```
array(['France', 'Spain', 'Germany'], dtype=object)
```

In [15]:

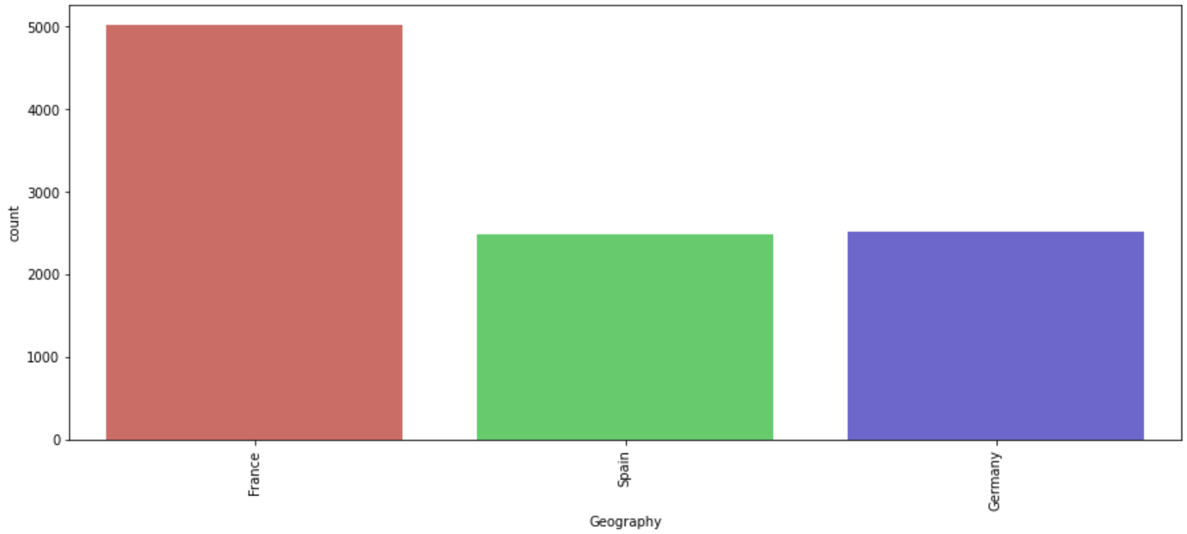
```
data_new['Geography'].value_counts()
```

Out[15]:

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

In [16]:

```
plt.figure(figsize=(15,6))
sns.countplot('Geography', data = data_new,
                  palette='hls')
plt.xticks(rotation = 90)
plt.show()
```

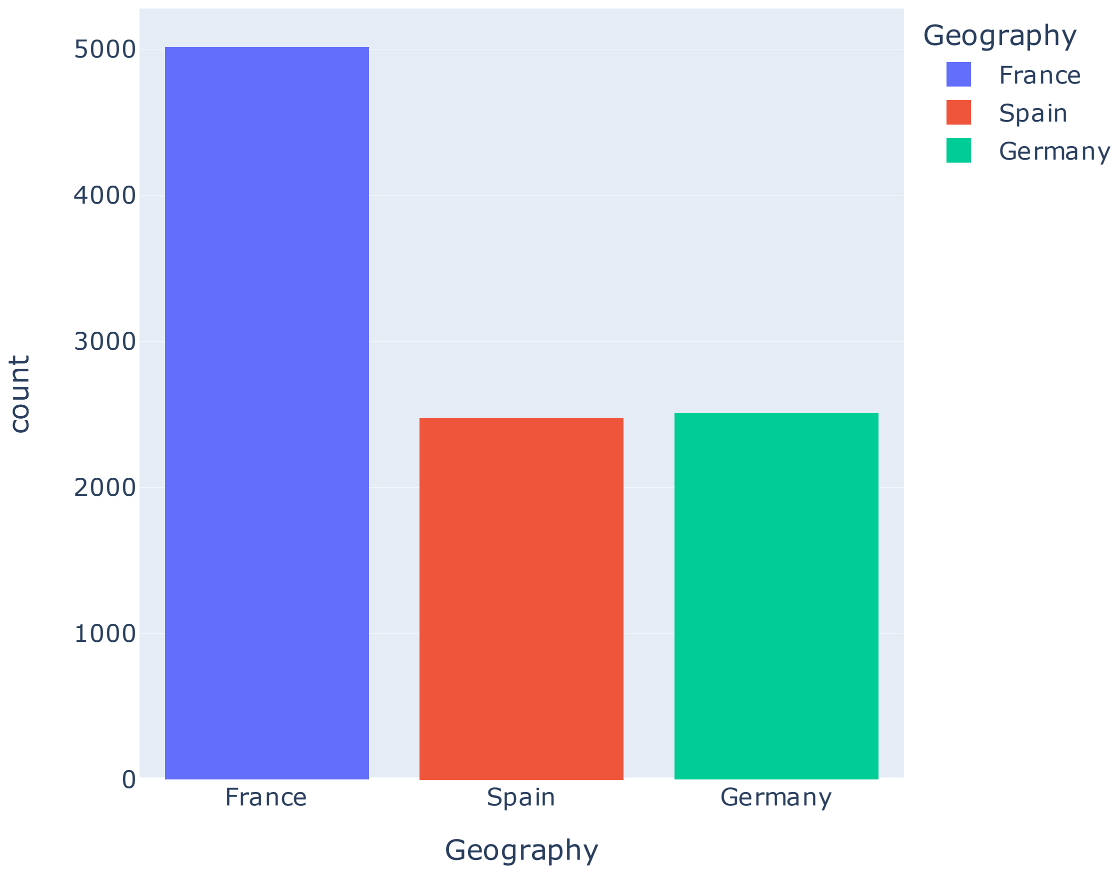


In [17]:

```
import plotly.express as px
```

In [18]:

```
fig1 = px.histogram(data_new, x = 'Geography', color = 'Geography')
fig1.show()
```



In [19]:

```
data_new['Gender'].unique()
```

Out[19]:

```
array(['Female', 'Male'], dtype=object)
```

In [20]:

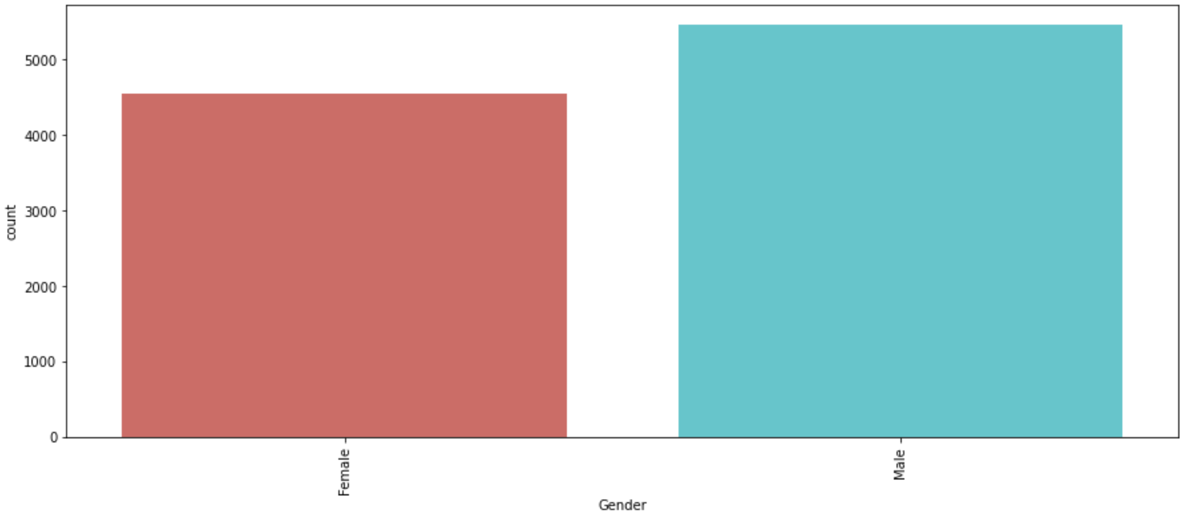
```
data_new['Gender'].value_counts()
```

Out[20]:

```
Male      5457
Female    4543
Name: Gender, dtype: int64
```

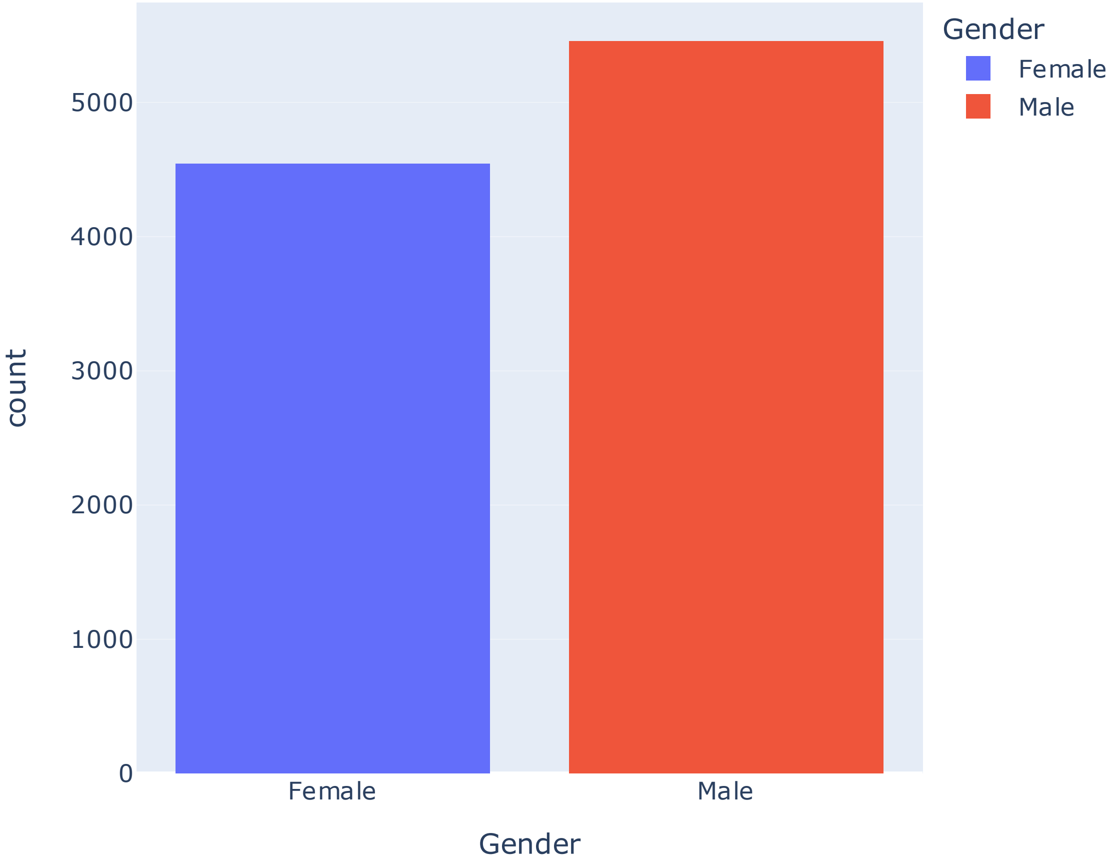
In [21]:

```
plt.figure(figsize=(15,6))
sns.countplot('Gender', data = data_new,
                  palette='hls')
plt.xticks(rotation = 90)
plt.show()
```



In [22]:

```
fig2 = px.histogram(data_new, x = 'Gender', color = 'Gender')
fig2.show()
```



In [23]:

```
data_new['NumOfProducts'].unique()
```

Out[23]:

```
array([1, 3, 2, 4], dtype=int64)
```

In [25]:

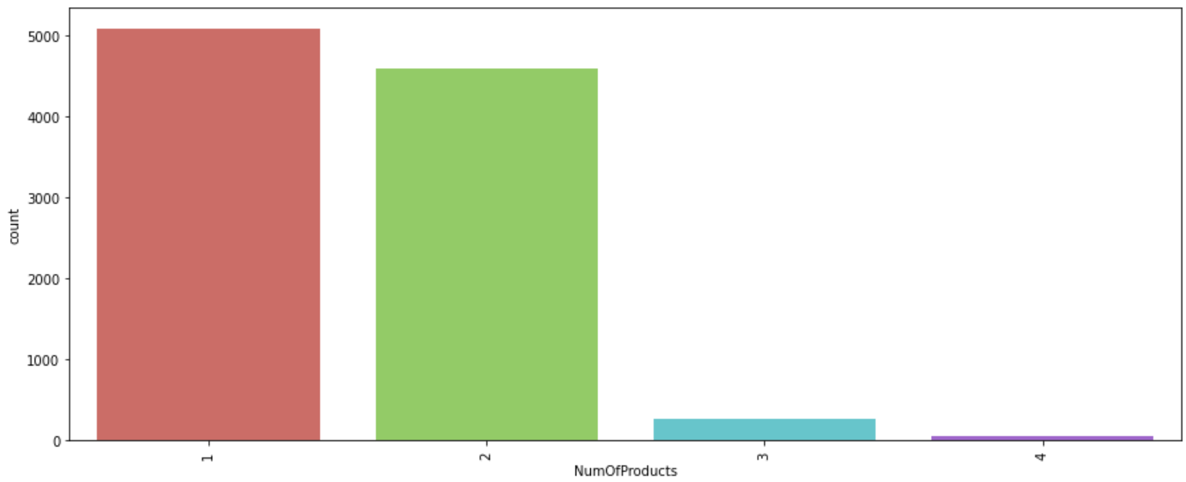
```
data_new['NumOfProducts'].value_counts()
```

Out[25]:

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

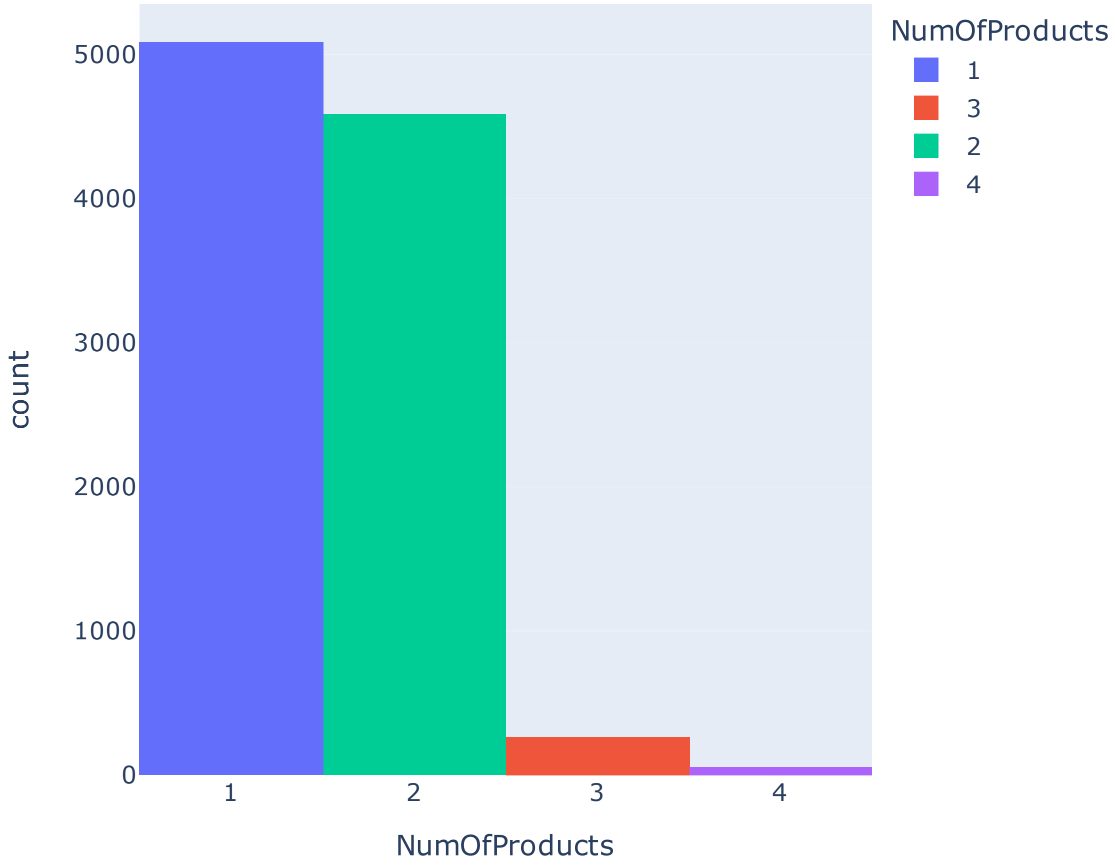
In [26]:

```
plt.figure(figsize=(15,6))
sns.countplot('NumOfProducts', data = data_new,
                  palette='hls')
plt.xticks(rotation = 90)
plt.show()
```



In [27]:

```
fig3 = px.histogram(data_new, x = 'NumOfProducts', color = 'NumOfProducts')
fig3.show()
```



In [29]:

```
data_new['HasCrCard'].unique()
```

Out[29]:

```
array([1, 0], dtype=int64)
```

In [30]:

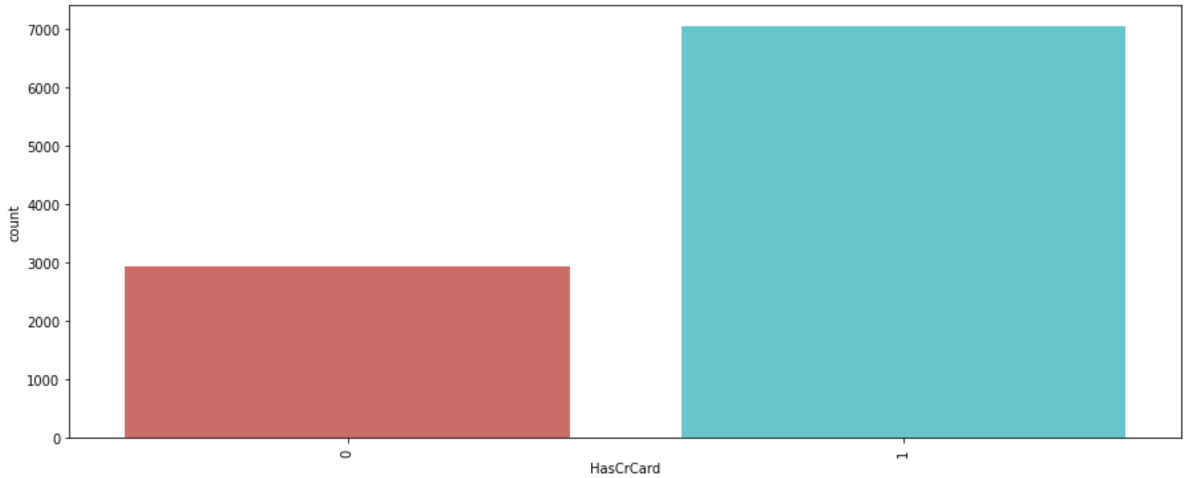
```
data_new['HasCrCard'].value_counts()
```

Out[30]:

```
1    7055
0    2945
Name: HasCrCard, dtype: int64
```

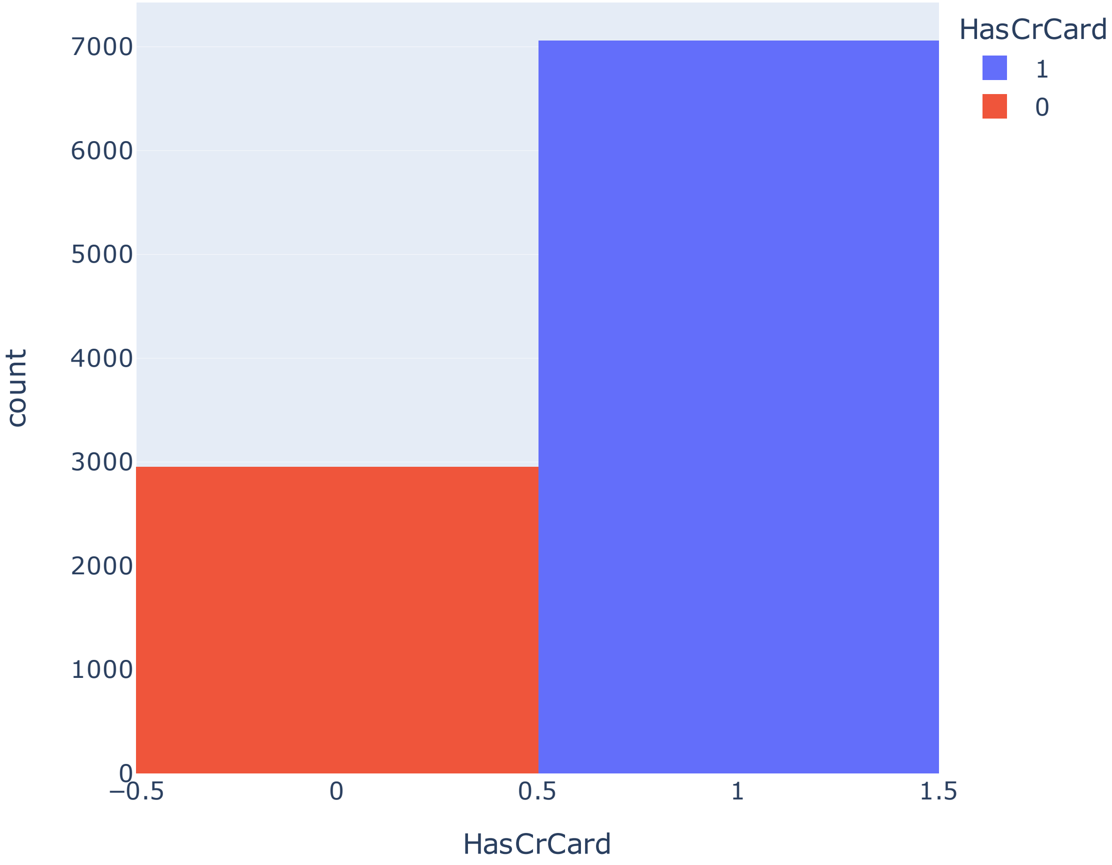
In [31]:

```
plt.figure(figsize=(15,6))
sns.countplot('HasCrCard', data = data_new,
                  palette='hls')
plt.xticks(rotation = 90)
plt.show()
```



In [32]:

```
fig4 = px.histogram(data_new, x = 'HasCrCard', color = 'HasCrCard')
fig4.show()
```



In [33]:

```
data_new['IsActiveMember'].unique()
```

Out[33]:

```
array([1, 0], dtype=int64)
```

In [34]:

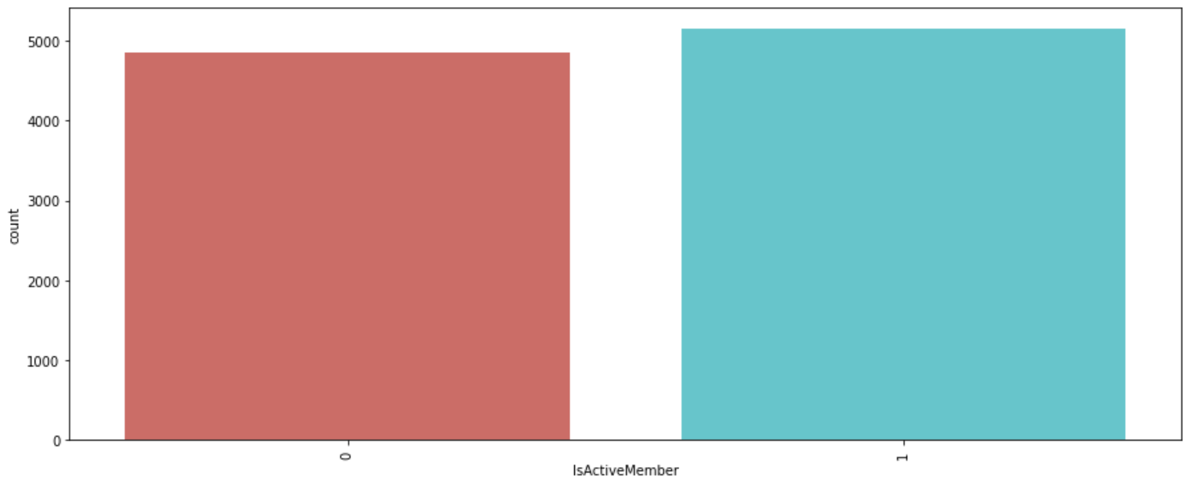
```
data_new['IsActiveMember'].value_counts()
```

Out[34]:

```
1    5151
0    4849
Name: IsActiveMember, dtype: int64
```

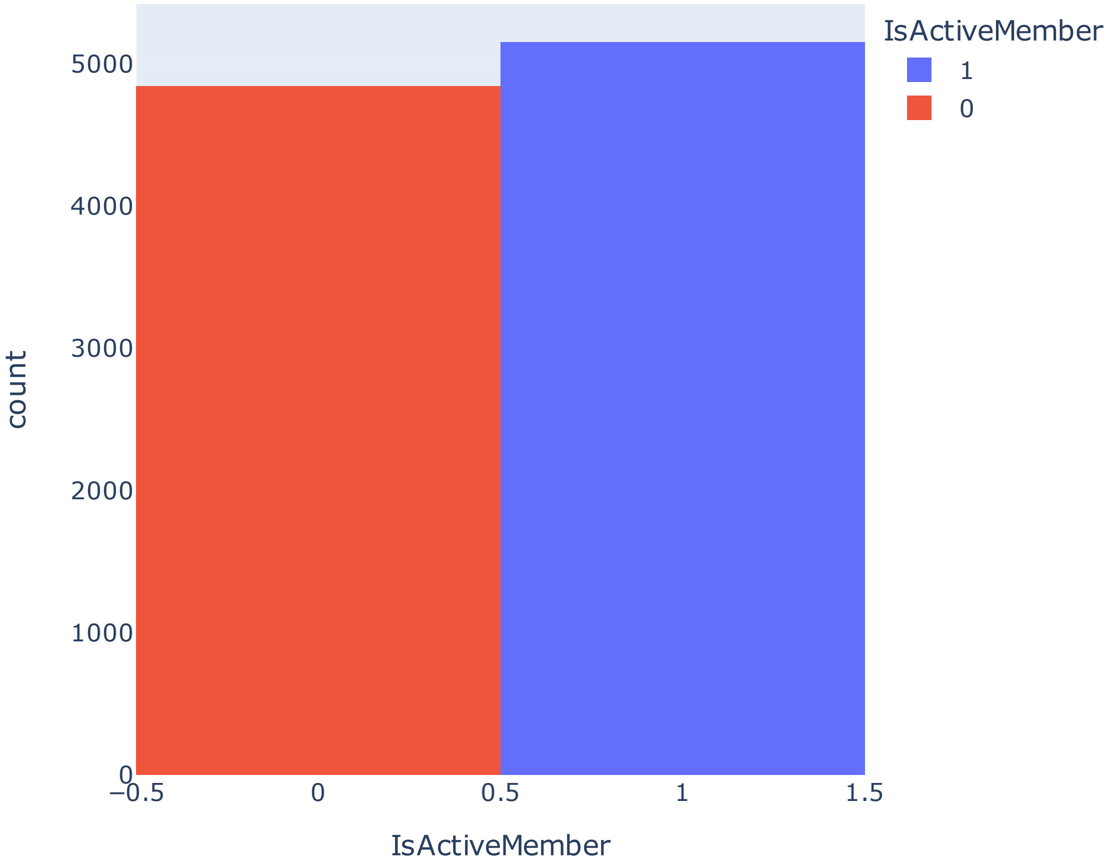
In [35]:

```
plt.figure(figsize=(15,6))
sns.countplot('IsActiveMember', data = data_new,
                  palette='hls')
plt.xticks(rotation = 90)
plt.show()
```



In [36]:

```
fig5 = px.histogram(data_new, x = 'IsActiveMember', color = 'IsActiveMember')
fig5.show()
```



In [37]:

```
data_new['Exited'].unique()
```

Out[37]:

```
array([1, 0], dtype=int64)
```

In [38]:

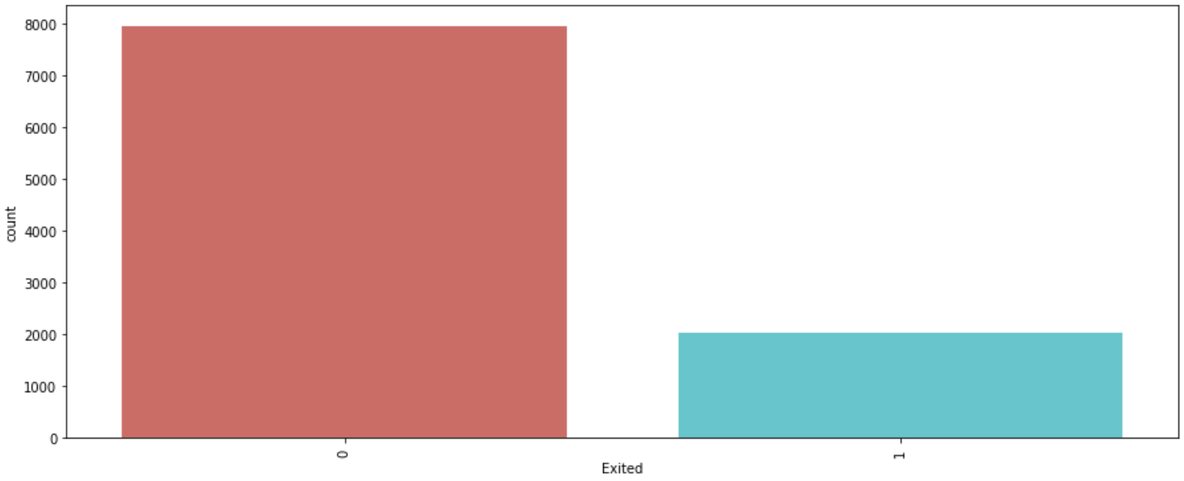
```
data_new['Exited'].value_counts()
```

Out[38]:

```
0    7963
1    2037
Name: Exited, dtype: int64
```

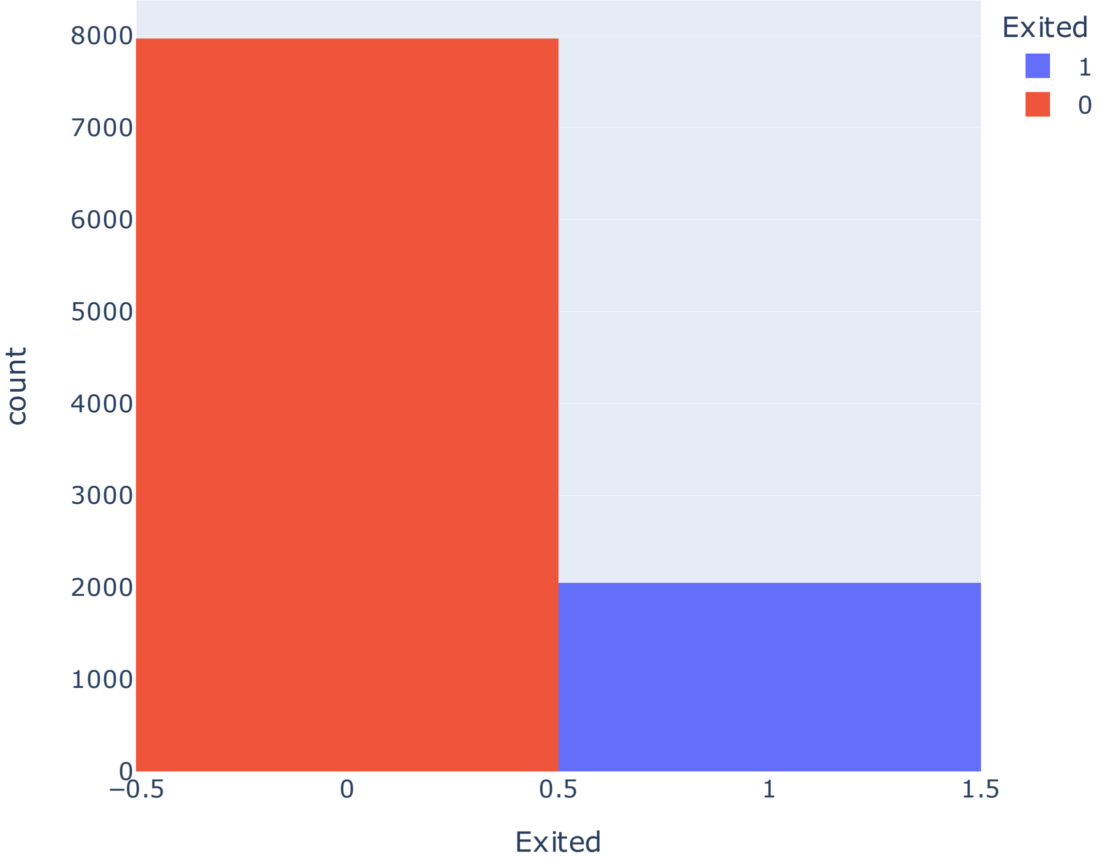
In [39]:

```
plt.figure(figsize=(15,6))
sns.countplot('Exited', data = data_new,
                  palette='hls')
plt.xticks(rotation = 90)
plt.show()
```



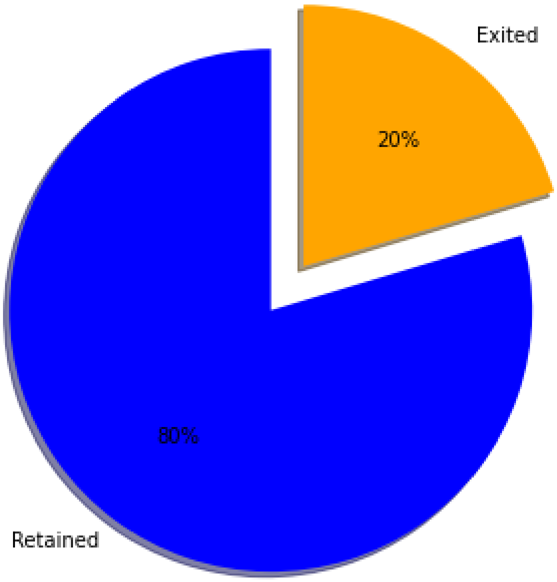
In [40]:

```
fig6 = px.histogram(data_new, x = 'Exited', color = 'Exited')
fig6.show()
```



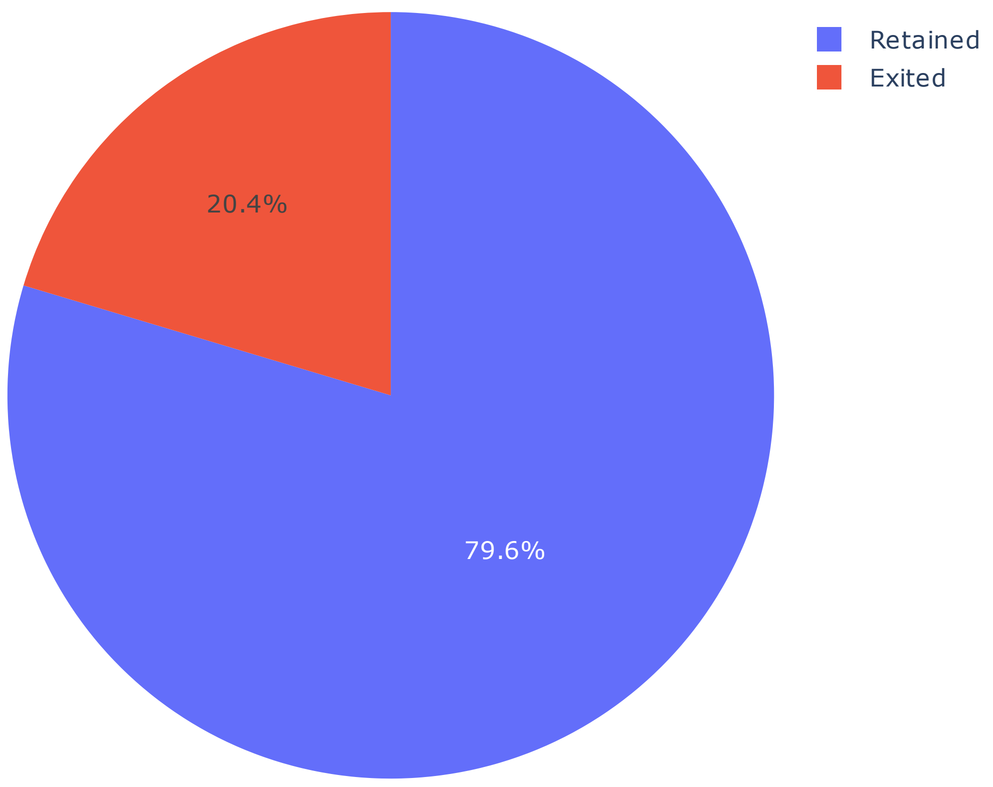
In [42]:

```
plt.figure(figsize=(15,6))
colors = sns.color_palette('bright')
explode = [0.3, 0.02]
plt.pie(data_new['Exited'].value_counts(), colors = ['blue', 'orange'],
        labels = ['Retained', 'Exited'],
        explode = [0.2,0.01], autopct = '%0.0f%%', shadow = 'True',
        startangle = 90)
plt.show()
```



In [47]:

```
values = data_new['Exited'].value_counts()
names = ['Retained', 'Exited']
fig7 = px.pie(values = values, names = names)
fig7.show()
```



In [48]:

```
data_new.columns
```

Out[48]:

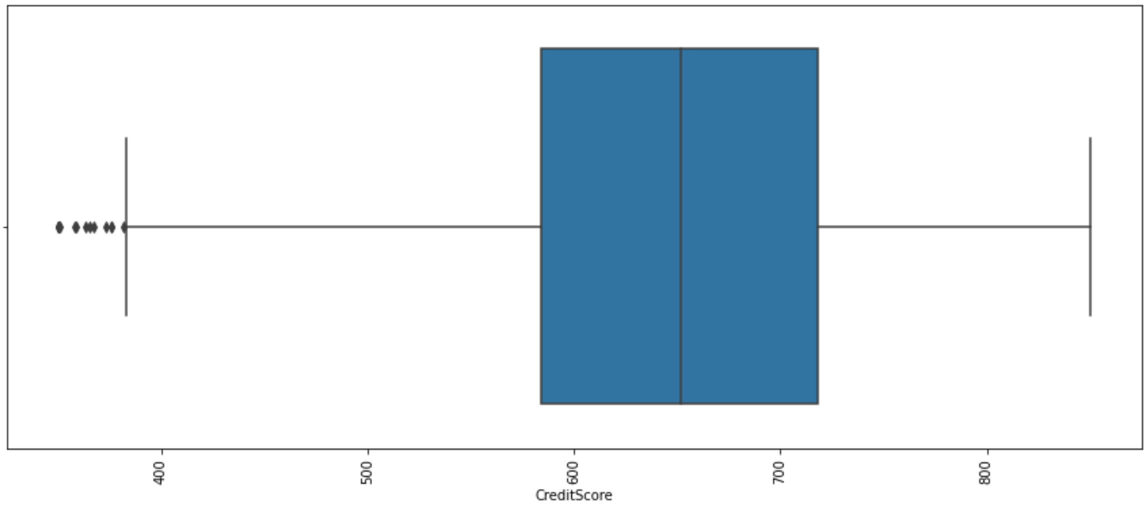
```
Index(['CreditScore', 'Geography', 'Gender', 'Age', 'Tenure', 'Balance',
       'NumOfProducts', 'HasCrCard', 'IsActiveMember', 'EstimatedSalary',
       'Exited'],
      dtype='object')
```

In [49]:

```
data_new_numeric = data_new[['CreditScore', 'Age', 'Tenure', 'Balance',
       'NumOfProducts', 'HasCrCard', 'IsActiveMember', 'EstimatedSalary',
       'Exited']]
```

In [51]:

```
for i in data_new_numeric.columns:
    plt.figure(figsize=(15,6))
    sns.boxplot(data_new_numeric[i], data = data_new_numeric)
    plt.xticks(rotation = 90)
    plt.show()
```



In [54]:

```
for i in data_new_numeric.columns:
    plt.figure(figsize=(15,6))
    sns.distplot(data_new_numeric[i], color='green')
    plt.tight_layout()
```

In [55]:

```
data_exited = data_new.drop(columns = 'Exited')
```

In [58]:

```
data_exited.columns
```

Out[58]:

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

In [59]:

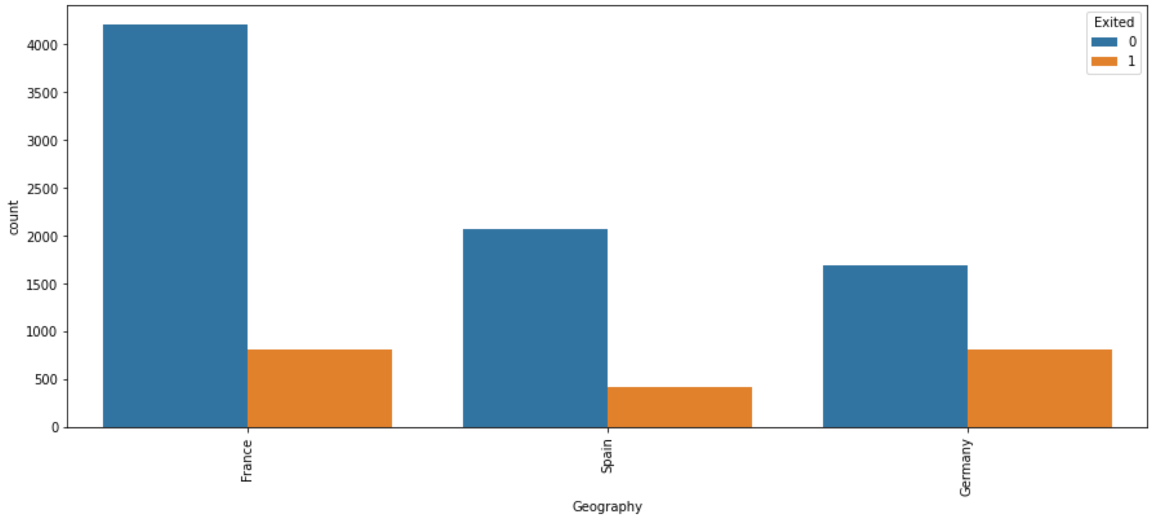
```
data_exited.head()
```

Out[59]:

| | CreditScore | Geography | Gender | Age | Tenure | Balance | NumOfProducts | HasCrCard | IsActiv |
|---|---|---|---|---|---|---|---|---|---|
| **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 | |

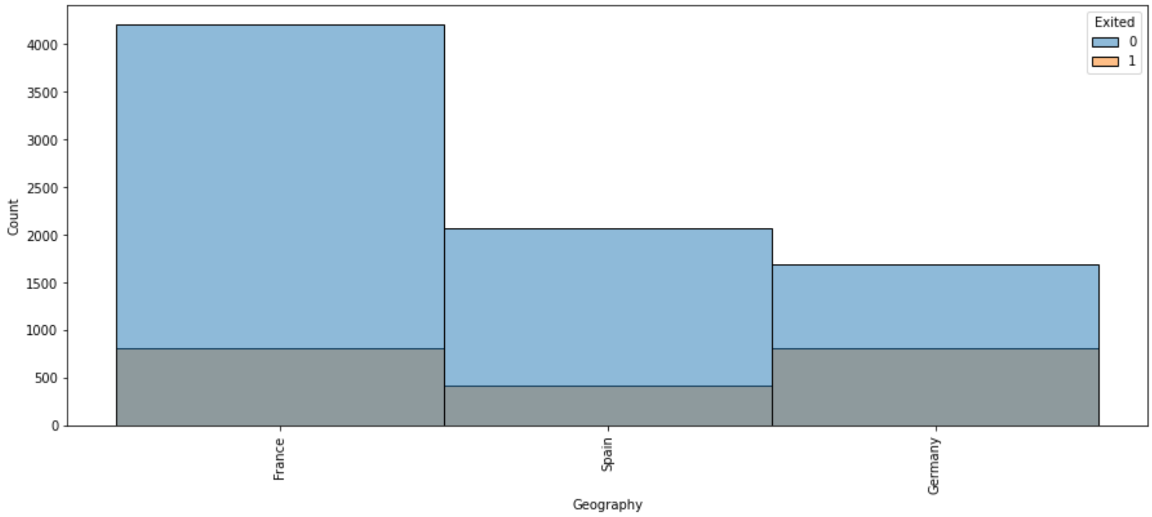
In [61]:

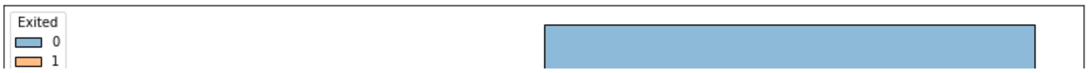
```
for i in data_exited[['Geography', 'Gender', 'Age', 'Tenure',
       'NumOfProducts', 'HasCrCard', 'IsActiveMember']]:
    plt.figure(figsize=(15,6))
    sns.countplot(data_exited[i], hue = 'Exited' ,
                  data = data_new_numeric)
    plt.xticks(rotation = 90)
    plt.show()
```



In [64]:

```
for i in data_exited[['Geography', 'Gender', 'Age', 'Tenure',
       'NumOfProducts', 'HasCrCard', 'IsActiveMember']]:
    plt.figure(figsize=(15,6))
    sns.histplot(data_new_numeric, x = data_exited[i], hue = 'Exited')
    plt.xticks(rotation = 90)
    plt.show()
```





In [65]:

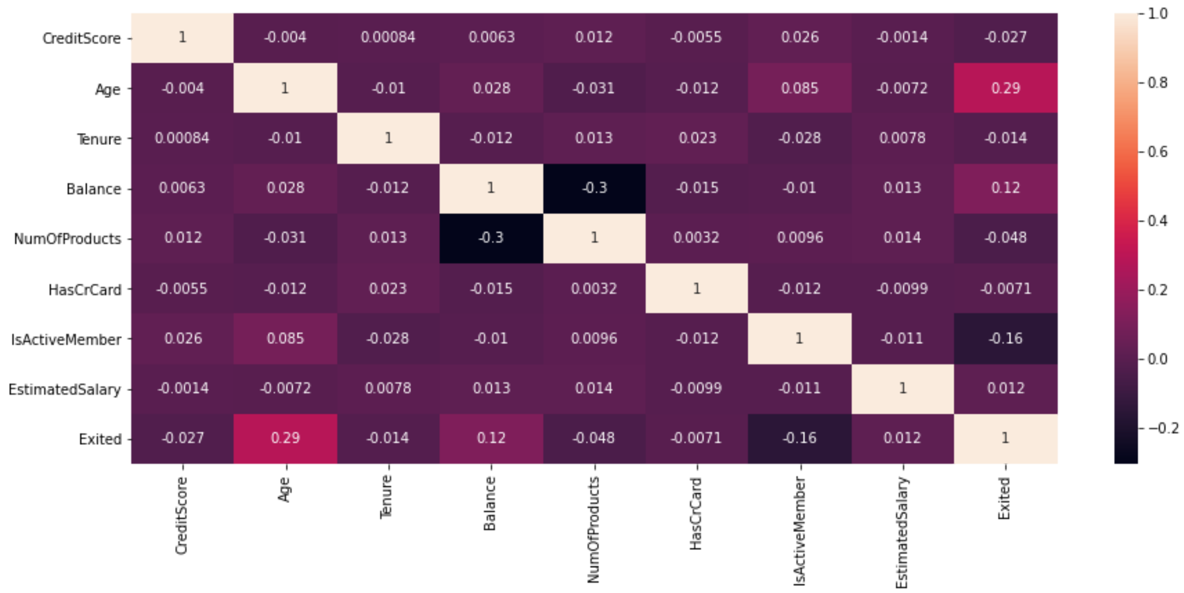
```
data_new_numeric.corr()
```

Out[65]:

| | CreditScore | Age | Tenure | Balance | NumOfProducts | HasCrCard | IsAct |
|---|---|---|---|---|---|---|---|
| **CreditScore** | 1.000000 | -0.003965 | 0.000842 | 0.006268 | 0.012238 | -0.005458 | |
| **Age** | -0.003965 | 1.000000 | -0.009997 | 0.028308 | -0.030680 | -0.011721 | |
| **Tenure** | 0.000842 | -0.009997 | 1.000000 | -0.012254 | 0.013444 | 0.022583 | |
| **Balance** | 0.006268 | 0.028308 | -0.012254 | 1.000000 | -0.304180 | -0.014858 | |
| **NumOfProducts** | 0.012238 | -0.030680 | 0.013444 | -0.304180 | 1.000000 | 0.003183 | |
| **HasCrCard** | -0.005458 | -0.011721 | 0.022583 | -0.014858 | 0.003183 | 1.000000 | |
| **IsActiveMember** | 0.025651 | 0.085472 | -0.028362 | -0.010084 | 0.009612 | -0.011866 | |
| **EstimatedSalary** | -0.001384 | -0.007201 | 0.007784 | 0.012797 | 0.014204 | -0.009933 | |
| **Exited** | -0.027094 | 0.285323 | -0.014001 | 0.118533 | -0.047820 | -0.007138 | |

In [66]:

```
plt.figure(figsize=(15,6))
sns.heatmap(data_new_numeric.corr(), annot = True)
plt.show()
```



In [79]:

```
data_new['age_groups'] = pd.cut(data_new['Age'], bins=6)
```

In [80]:

```
data_new_age = data_new.copy()
```

In [81]:

```
data_new_age = data_new_age.groupby(['age_groups','Exited']).agg({'Gender' : 'count'}).r
data_new_age.columns = ['age_groups','Exited','user_count']
data_new_age['Exited'] = data_new_age['Exited'].apply(lambda x : 'Exited' if x == 1 else
```

In [82]:

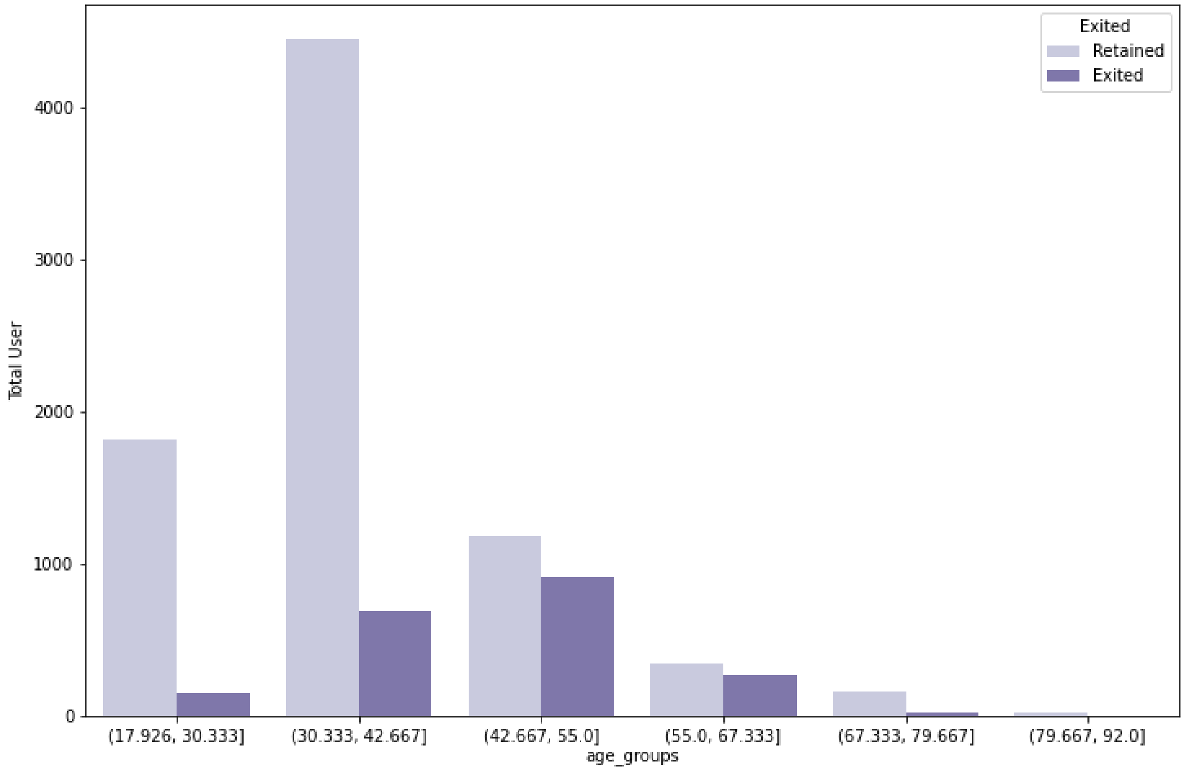
```
data_new_age
```

Out[82]:

| | age_groups | Exited | user_count |
|---|---|---|---|
| **0** | (17.926, 30.333] | Retained | 1820 |
| **1** | (17.926, 30.333] | Exited | 148 |
| **2** | (30.333, 42.667] | Retained | 4454 |
| **3** | (30.333, 42.667] | Exited | 684 |
| **4** | (42.667, 55.0] | Retained | 1183 |
| **5** | (42.667, 55.0] | Exited | 911 |
| **6** | (55.0, 67.333] | Retained | 337 |
| **7** | (55.0, 67.333] | Exited | 271 |
| **8** | (67.333, 79.667] | Retained | 155 |
| **9** | (67.333, 79.667] | Exited | 22 |
| **10** | (79.667, 92.0] | Retained | 14 |
| **11** | (79.667, 92.0] | Exited | 1 |

In [87]:

```
plt.figure(figsize=(12,8))
sns.barplot(data = data_new_age, x = 'age_groups', y = 'user_count',
            hue = 'Exited', palette = 'Purples')
plt.ylabel('Total User')
plt.show()
```



In [84]:

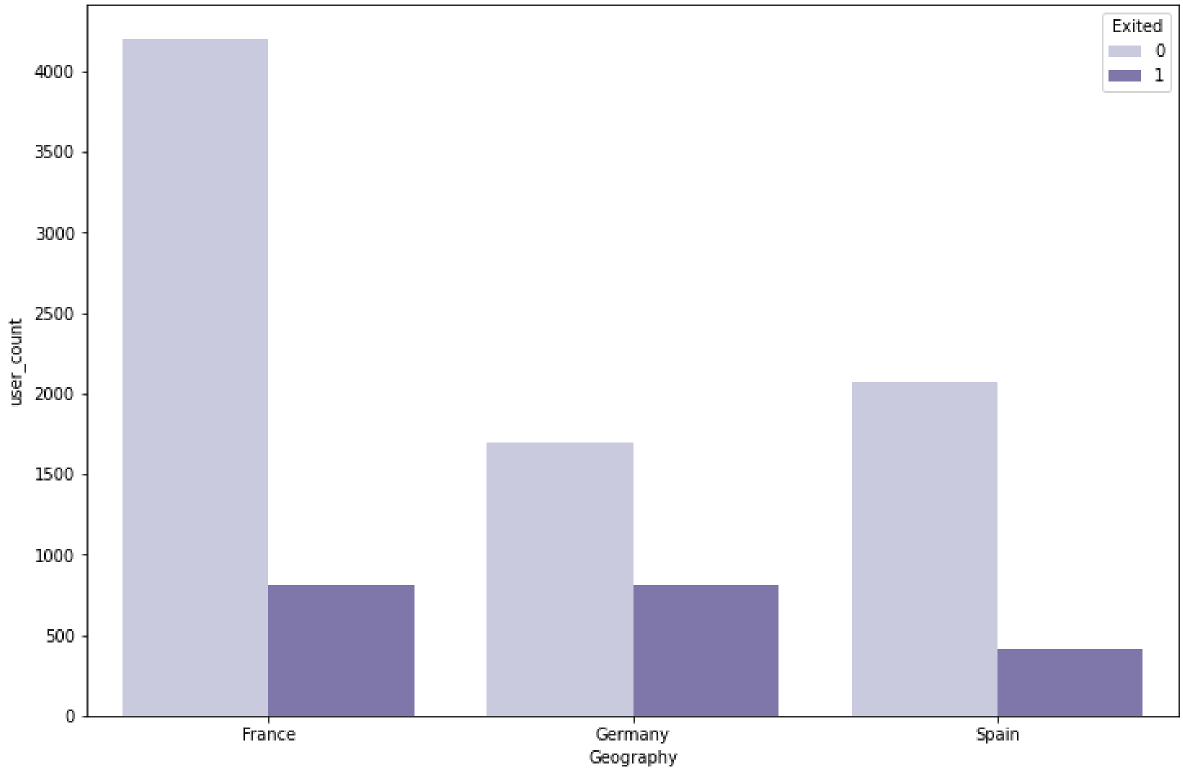
```
data_new_geo = data_new.groupby(['Geography','Exited']).agg({'Gender':'count'}).reset_i
data_new_geo.columns = ['Geography','Exited','user_count']
data_new_geo
```

Out[84]:

| | Geography | Exited | user_count |
|---|---|---|---|
| **0** | France | 0 | 4204 |
| **1** | France | 1 | 810 |
| **2** | Germany | 0 | 1695 |
| **3** | Germany | 1 | 814 |
| **4** | Spain | 0 | 2064 |
| **5** | Spain | 1 | 413 |

In [86]:

```
plt.figure(figsize=(12,8))
sns.barplot(data = data_new_geo, x = 'Geography',y='user_count',
            hue='Exited',palette = 'Purples')
plt.show()
```



In [88]:

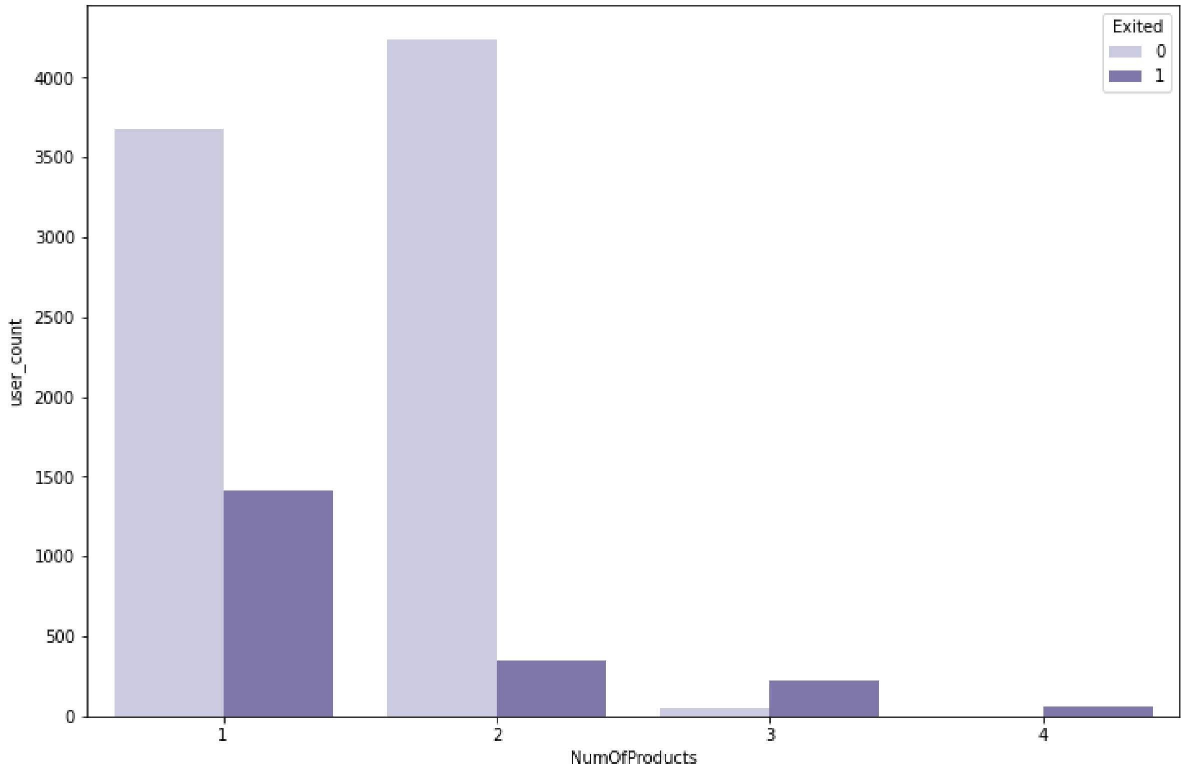
```
data_new_product = data_new.groupby(['NumOfProducts','Exited']).agg({'Gender' : 'count'
data_new_product.columns = ['NumOfProducts','Exited','user_count']
data_new_product
```

Out[88]:

| | NumOfProducts | Exited | user_count |
|---|---|---|---|
| **0** | 1 | 0 | 3675 |
| **1** | 1 | 1 | 1409 |
| **2** | 2 | 0 | 4242 |
| **3** | 2 | 1 | 348 |
| **4** | 3 | 0 | 46 |
| **5** | 3 | 1 | 220 |
| **6** | 4 | 1 | 60 |

In [90]:

```
plt.figure(figsize=(12,8))
sns.barplot(data = data_new_product, x = 'NumOfProducts',y='user_count',
            hue='Exited',palette = 'Purples')
plt.show()
```



In [93]:

```
data_new['CreditScoreNew'] = pd.cut(data_new['CreditScore'], bins=6)
```

In [94]:

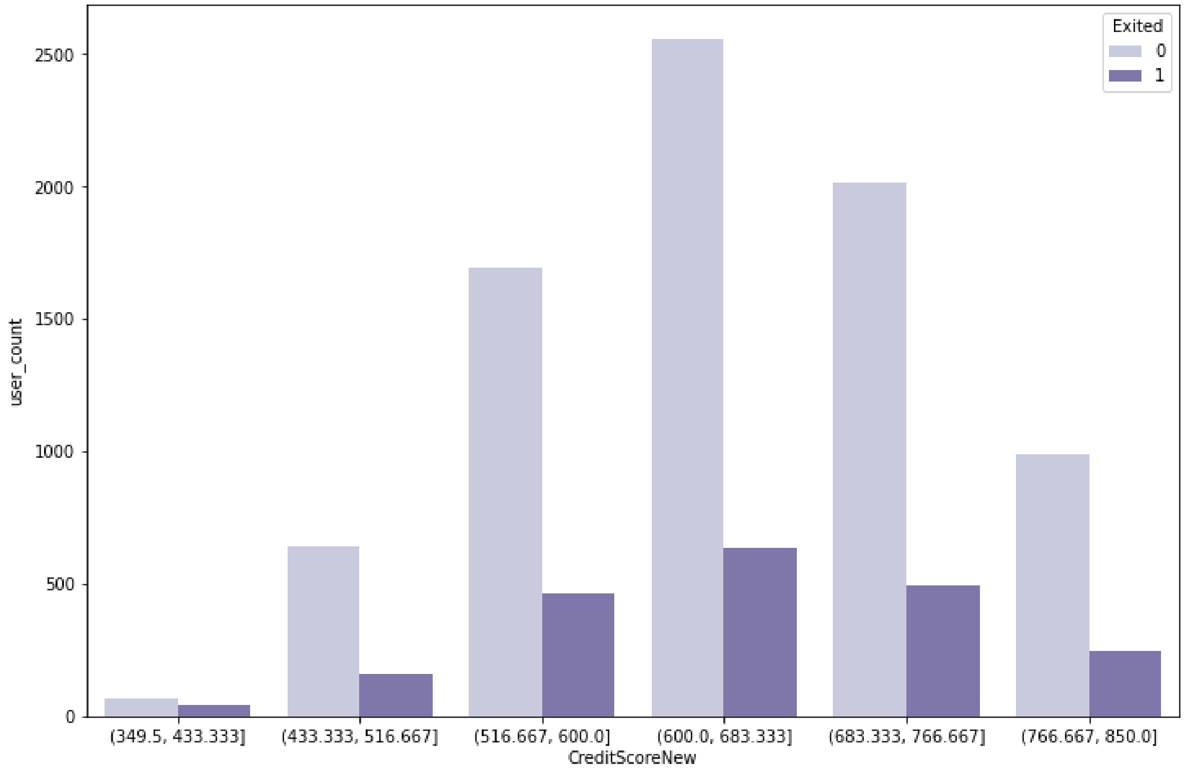
```
data_new_creditscore = data_new.groupby(['CreditScoreNew','Exited']).agg({'Gender' : 'co
data_new_creditscore.columns = ['CreditScoreNew','Exited','user_count']
data_new_creditscore
```

Out[94]:

| | CreditScoreNew | Exited | user_count |
|---|---|---|---|
| **0** | (349.5, 433.333] | 0 | 67 |
| **1** | (349.5, 433.333] | 1 | 40 |
| **2** | (433.333, 516.667] | 0 | 640 |
| **3** | (433.333, 516.667] | 1 | 162 |
| **4** | (516.667, 600.0] | 0 | 1694 |
| **5** | (516.667, 600.0] | 1 | 463 |
| **6** | (600.0, 683.333] | 0 | 2560 |
| **7** | (600.0, 683.333] | 1 | 633 |
| **8** | (683.333, 766.667] | 0 | 2013 |
| **9** | (683.333, 766.667] | 1 | 496 |
| **10** | (766.667, 850.0] | 0 | 989 |
| **11** | (766.667, 850.0] | 1 | 243 |

In [95]:

```
plt.figure(figsize=(12,8))
sns.barplot(data = data_new_creditscore, x = 'CreditScoreNew',y='user_count',
            hue='Exited',palette = 'Purples')
plt.show()
```



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