Churn Bank Customer Database

July 16, 2025

[70]:
```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

[71]:
```
df = pd.read_csv('../data/Churn_Modelling.csv')
print(df.head())
print(df.info())
```

```
   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
<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
None
```

[72]:
```
# Missing values are checked for each column
print("Missing values:\n", df.isna().sum())
```

```
Missing values:
 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
```

[73]:
```
#the average age of customers grouped by their geographical location.
avg_age_by_geo = df.groupby("Geography")["Age"].mean()
print(avg_age_by_geo)
```

```
Geography
France     38.511767
Germany    39.771622
Spain      38.890997
Name: Age, dtype: float64
```

[74]:
```
#how many customers are male or female.
gender_dist = df["Gender"].value_counts()
print(gender_dist)
```

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

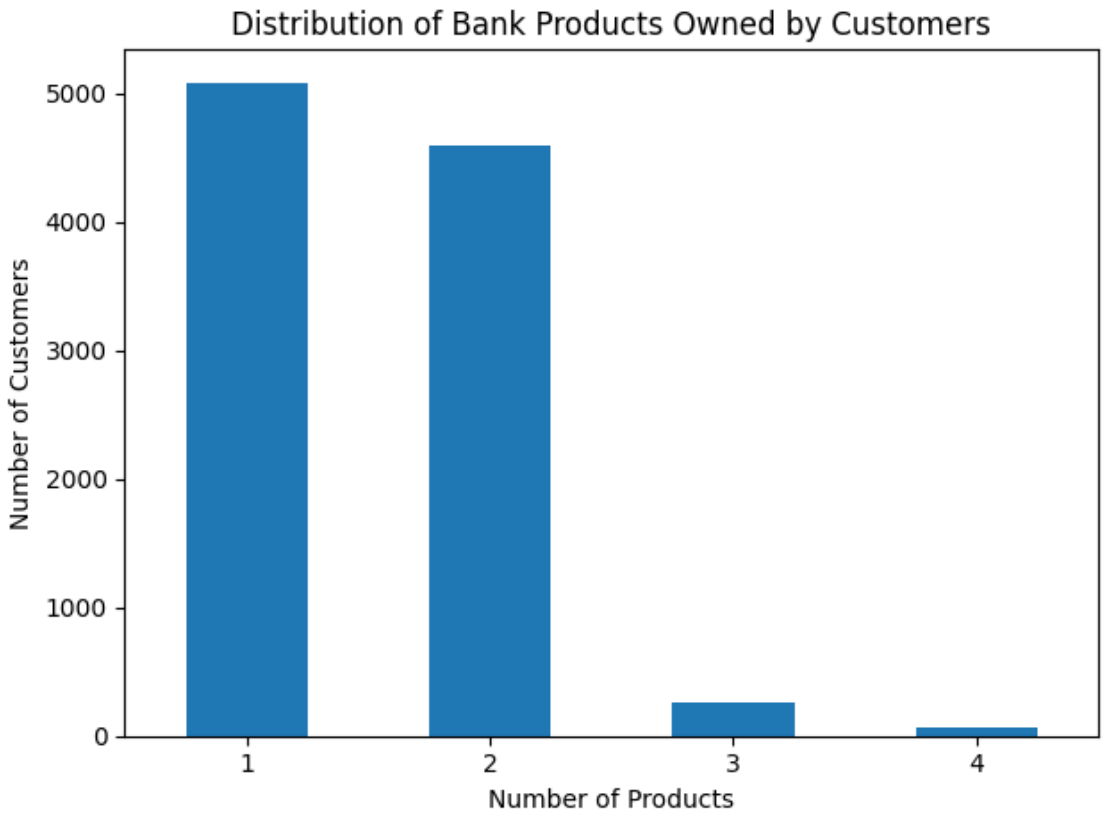
[75]:
```
#shows the average account balance of customers based on whether they exited the␣
↪bank or not.
balance_by_exited = df.groupby("Exited")["Balance"].mean()
print(balance_by_exited)
```

```
Exited
0    72745.296779
1    91108.539337
Name: Balance, dtype: float64
```

[76]:
```
#how many customers own 1, 2, or more bank products.
products_dist = df["NumOfProducts"].value_counts()
print(products_dist)
```

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

[77]:
```
products_dist.plot(kind="bar")
plt.title("Distribution of Bank Products Owned by Customers")
plt.xlabel("Number of Products")
plt.ylabel("Number of Customers")
plt.xticks(rotation=0)
plt.tight_layout()
plt.show()
```



[78]:
```
#the average income of active vs inactive customers.
salary_by_active = df.groupby("IsActiveMember")["EstimatedSalary"].mean()
print(salary_by_active)
```

```
IsActiveMember
0    100767.203854
1     99452.965894
Name: EstimatedSalary, dtype: float64
```

[79]:
```
#This aggregates total balance values per region, helping identify areas with␣
 ↪high financial value.
total_balance_by_geo = df.groupby("Geography")["Balance"].sum()
print(total_balance_by_geo)
```

```
Geography
France     3.113325e+08
Germany    3.004029e+08
Spain      1.531236e+08
Name: Balance, dtype: float64
```

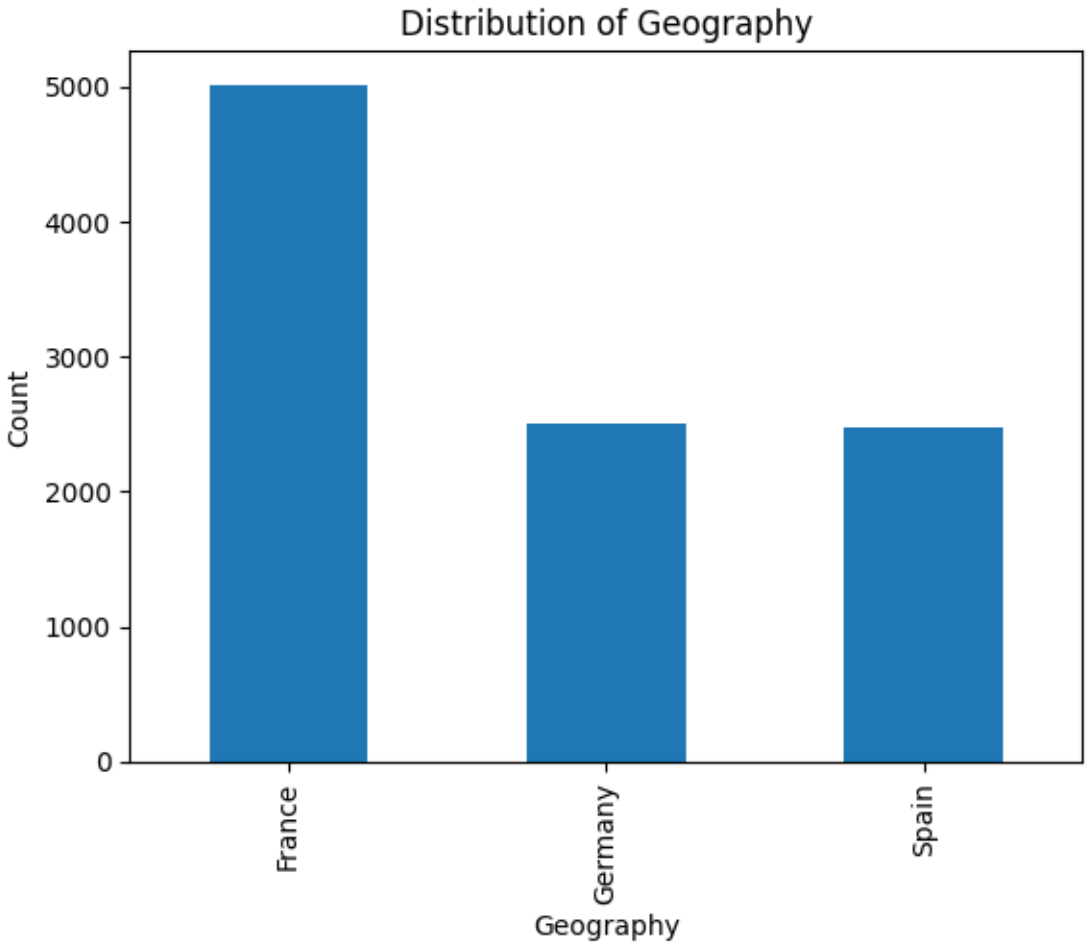
[80]:
```
#Top 5 Ages by Exit Count. Age groups with the highest number of customer exit
top_age_exited = df[df["Exited"] == 1].groupby("Age")["CustomerId"].count().
 ↪nlargest(5)
print(top_age_exited)
```

```
Age
46    91
40    89
43    88
45    87
48    80
Name: CustomerId, dtype: int64
```

[81]:
```
#It breaks down how many customers exited based on whether they had a credit␣
 ↪card.
exited_by_card = df.groupby("HasCrCard")["Exited"].value_counts()
print(exited_by_card)
```

```
HasCrCard  Exited
0          0         2332
           1          613
1          0         5631
           1         1424
Name: count, dtype: int64
```

[82]:
```
df["Geography"].value_counts().plot(kind="bar")
plt.title("Distribution of Geography")
plt.ylabel("Count")
plt.show()
```



[83]:
```
#how long customers stay with the bank, based on gender.
tenure_by_gender = df.groupby("Gender")["Tenure"].mean()
print(tenure_by_gender)
```

```
Gender
Female    4.966102
Male      5.051677
Name: Tenure, dtype: float64
```

[84]:
```
#Exit Rate by Region (as Percentage)
credit_by_exited = df.groupby("Exited")["CreditScore"].mean()
print(credit_by_exited)
```

```
Exited
0    651.853196
1    645.351497
Name: CreditScore, dtype: float64
```

[85]:
```
#shows the average credit score of customers who exited vs.
credit_by_exited = df.groupby("Exited")["CreditScore"].mean()
print(credit_by_exited)
```

```
Exited
0    651.853196
1    645.351497
Name: CreditScore, dtype: float64
```

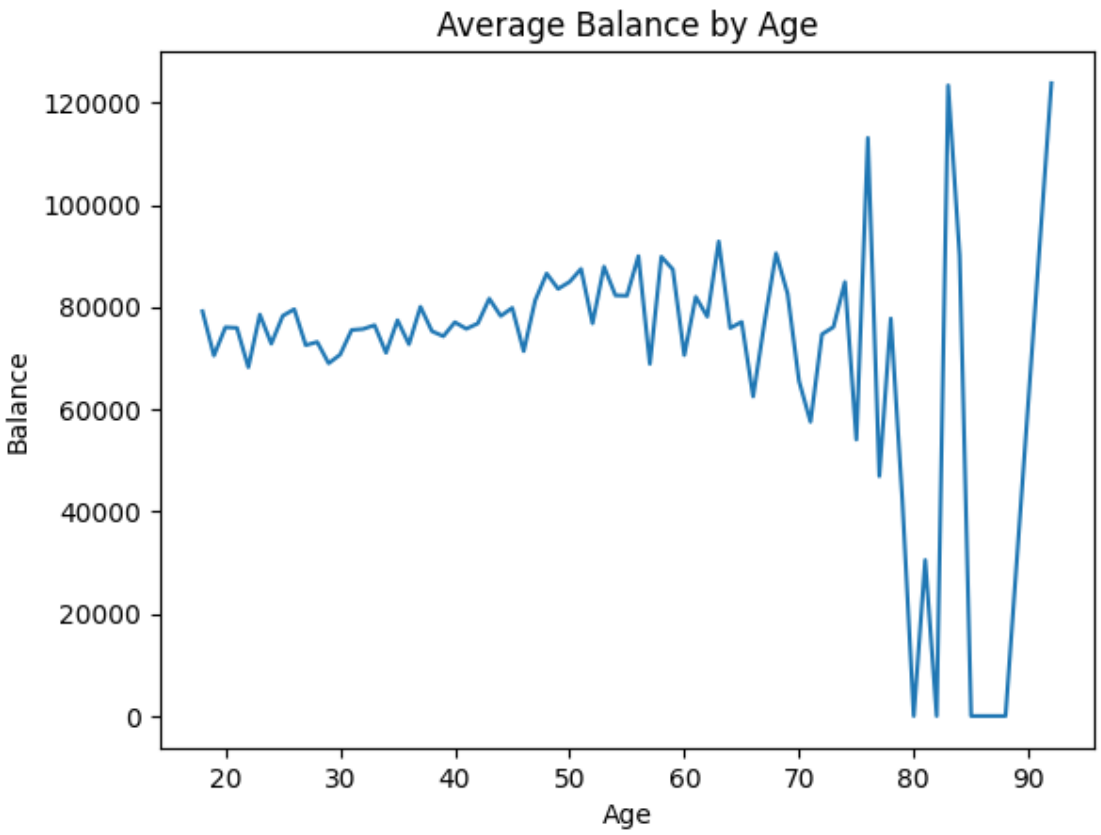
[86]:
```
# Average Number of Products by Activity
products_by_active = df.groupby("IsActiveMember")["NumOfProducts"].mean()
print(products_by_active)
```

```
IsActiveMember
0    1.524438
1    1.535624
Name: NumOfProducts, dtype: float64
```

[87]:
```
#Customer Count in Age Ranges.
age_bins = pd.cut(df["Age"], bins=[0, 30, 50, 70, 100])
age_dist = df.groupby(age_bins, observed=False)["CustomerId"].count()
print(age_dist)
```

```
Age
(0, 30]      1968
(30, 50]     6771
(50, 70]     1128
(70, 100]     133
Name: CustomerId, dtype: int64
```

[88]:
```
df.groupby("Age")["Balance"].mean().plot(kind="line")
plt.title("Average Balance by Age")
plt.ylabel("Balance")
plt.show()
```



[89]:
```
#compares the average income of customers who left vs.
salary_by_exited = df.groupby("Exited")["EstimatedSalary"].mean()
print(salary_by_exited)
```

```
Exited
0     99738.391772
1    101465.677531
Name: EstimatedSalary, dtype: float64
```

[90]:
```
#how many active customers exist in each region.
active_by_geo = df[df["IsActiveMember"] == 1].groupby("Geography")["CustomerId"].
 ↪count()
print(active_by_geo)
```

```
Geography
France     2591
```

```
Germany    1248
Spain      1312
Name: CustomerId, dtype: int64
```

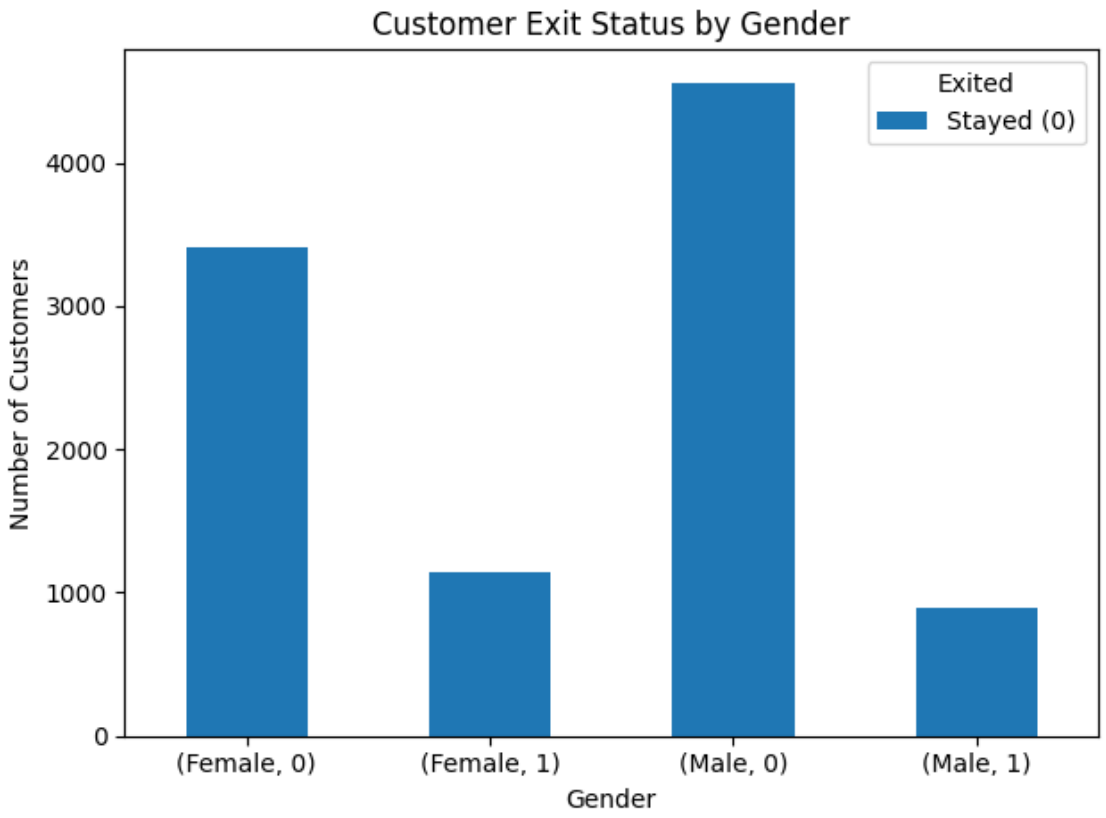
[91]:
```
#Top 10 Surnames Among Exited Customers
top_surnames_exited = df[df["Exited"] == 1].groupby("Surname")["CustomerId"].
 ↪count().nlargest(10)
print(top_surnames_exited)
```

```
Surname
Lin          9
Martin       9
McGregor     9
Smith        9
Cocci        7
Lo           7
Ma           7
Manna        7
Shih         7
Wang         7
Name: CustomerId, dtype: int64
```

[92]:
```
#how many males and females exited or stayed.
exited_by_gender = df.groupby("Gender")["Exited"].value_counts()
print(exited_by_gender)
```

```
Gender  Exited
Female  0         3404
        1         1139
Male    0         4559
        1          898
Name: count, dtype: int64
```

[93]:
```
exited_by_gender.plot(kind="bar")
plt.title("Customer Exit Status by Gender")
plt.xlabel("Gender")
plt.ylabel("Number of Customers")
plt.xticks(rotation=0)
plt.legend(title="Exited", labels=["Stayed (0)", "Exited (1)"])
plt.tight_layout()
plt.show()
```



[94]:
```
#Average Credit Score by Region
credit_by_geo = df.groupby("Geography")["CreditScore"].mean()
print(credit_by_geo)
```

```
Geography
France     649.668329
Germany    651.453567
Spain      651.333872
Name: CreditScore, dtype: float64
```

[95]:
```
#how often customers exit the bank based on how long they've been customers.
tenure_by_exited = df.groupby("Tenure")["Exited"].value_counts()
```

```
print(tenure_by_exited.head())
```

```
Tenure  Exited
0       0         318
        1          95
1       0         803
        1         232
2       0         847
Name: count, dtype: int64
```

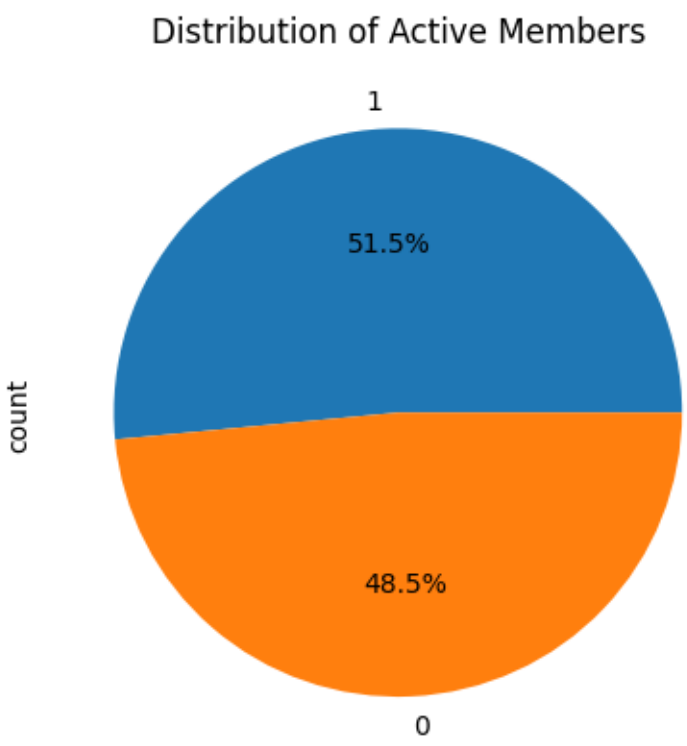
[96]:
```
#Number of Customers with Zero Balance
zero_balance = len(df[df["Balance"] == 0])
print(f"Customers with Zero Balance: {zero_balance}")
```

```
Customers with Zero Balance: 3617
```

[97]:
```
#xit Rate by Product Count
exit_rate_by_products = df[df["Exited"] == 1].
 ↪groupby("NumOfProducts")["CustomerId"].count() / df.
 ↪groupby("NumOfProducts")["CustomerId"].count() * 100
print(exit_rate_by_products)
```

```
NumOfProducts
1     27.714398
2      7.581699
3     82.706767
4    100.000000
Name: CustomerId, dtype: float64
```

[98]:
```
df["IsActiveMember"].value_counts().plot(kind="pie", autopct='%1.1f%%')
plt.title("Distribution of Active Members")
plt.show()
```



[99]:
```
#average customer income per region
salary_by_geo = df.groupby("Geography")["EstimatedSalary"].mean()
print(salary_by_geo)
```

```
Geography
France      99899.180814
Germany    101113.435102
Spain       99440.572281
Name: EstimatedSalary, dtype: float64
```

[100]:
```
#how credit card ownership correlates with customer activity levels.
active_by_card = df.groupby("HasCrCard")["IsActiveMember"].value_counts()
print(active_by_card)
```

```
HasCrCard  IsActiveMember
0          1                1544
           0                1401
1          1                3607
           0                3448
Name: count, dtype: int64
```

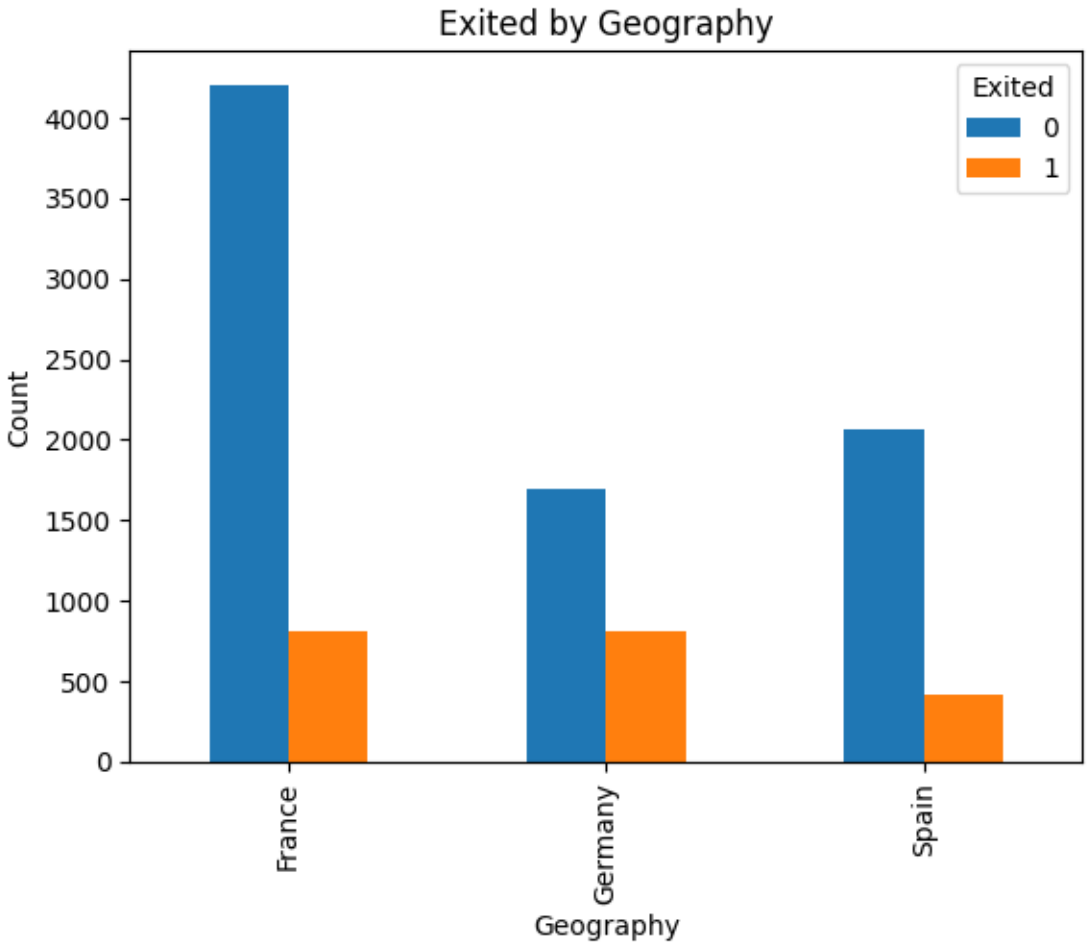
[101]:
```
#his totals the account balances held by males vs females.
total_balance_by_gender = df.groupby("Gender")["Balance"].sum()
print(total_balance_by_gender)
```

```
Gender
Female    3.437205e+08
Male      4.211384e+08
Name: Balance, dtype: float64
```

[102]:
```
#Top 5 Ages by Estimated Salary
top_age_salary = df.groupby("Age")["EstimatedSalary"].mean().nlargest(5)
print(top_age_salary)
```

```
Age
84    187360.250000
82    182055.360000
79    152474.975000
71    121040.188889
68    117195.776842
Name: EstimatedSalary, dtype: float64
```

[103]:
```
df.groupby("Geography")["Exited"].value_counts().unstack().plot(kind="bar")
plt.title("Exited by Geography")
plt.ylabel("Count")
plt.show()
```



[104]:
```
pivot = df.pivot_table(values="Balance", index="Age", aggfunc="mean")
sns.heatmap(pivot)
plt.title("Balance vs Age")
plt.show()
```