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## 1. Downloading Dataset: Churn\_Modelling

### 2. Load The Dataset

```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
```

```
df = pd.read_csv('/content/drive/MyDrive/Churn_Modelling.csv')
df.head()
```

	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

```
df = df.drop(columns=['RowNumber', 'CustomerId', 'Surname'])
df.head()
```

	CreditScore	Geography	Gender	Age	Tenure	Balance
0	619	France	Female	42	2	0.00
1	608	Spain	Female	41	1	83807.86
1						

2	502	France	Female	42	8	159660.80
3	699	France	Female	39	1	0.00
2	850	Spain	Female	43	2	125510.82

	HasCrCard	IsActiveMember	EstimatedSalary	Exited
0	1	1	101348.88	1
1	0	1	112542.58	0
2	1	0	113931.57	1
3	0	0	93826.63	0
4	1	1	79084.10	0

```
df['IsActiveMember'] = df['IsActiveMember'].astype('category')
df['Exited'] = df['Exited'].astype('category')
df['HasCrCard'] = df['HasCrCard'].astype('category')
```

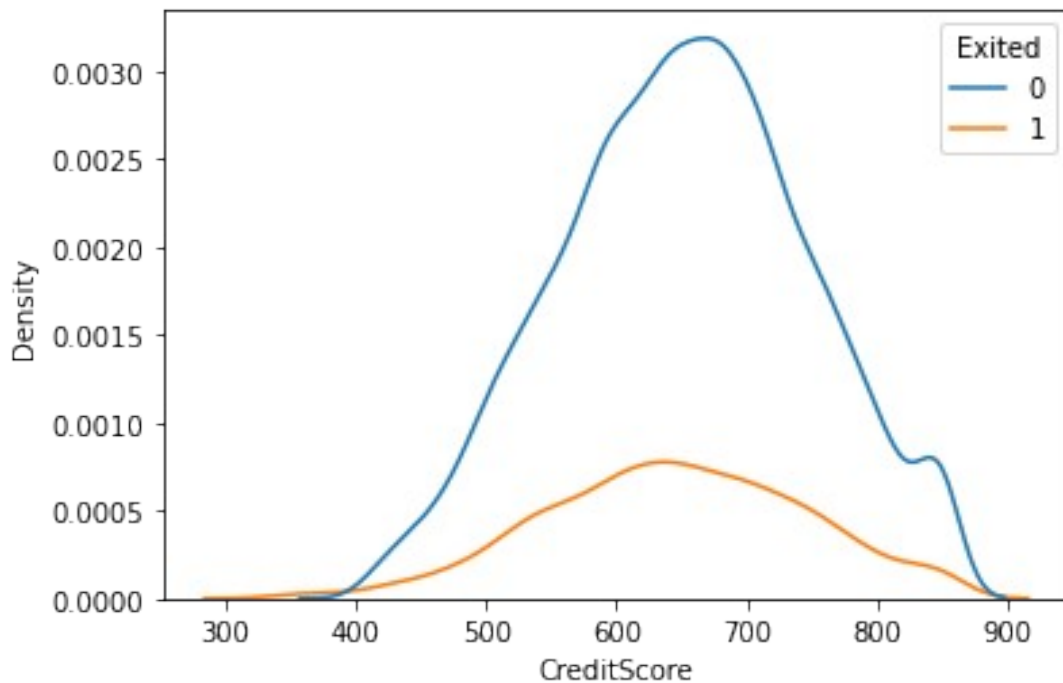
### 3. Perform

#### Univariate Analysis

#### Bi - Variate Analysis

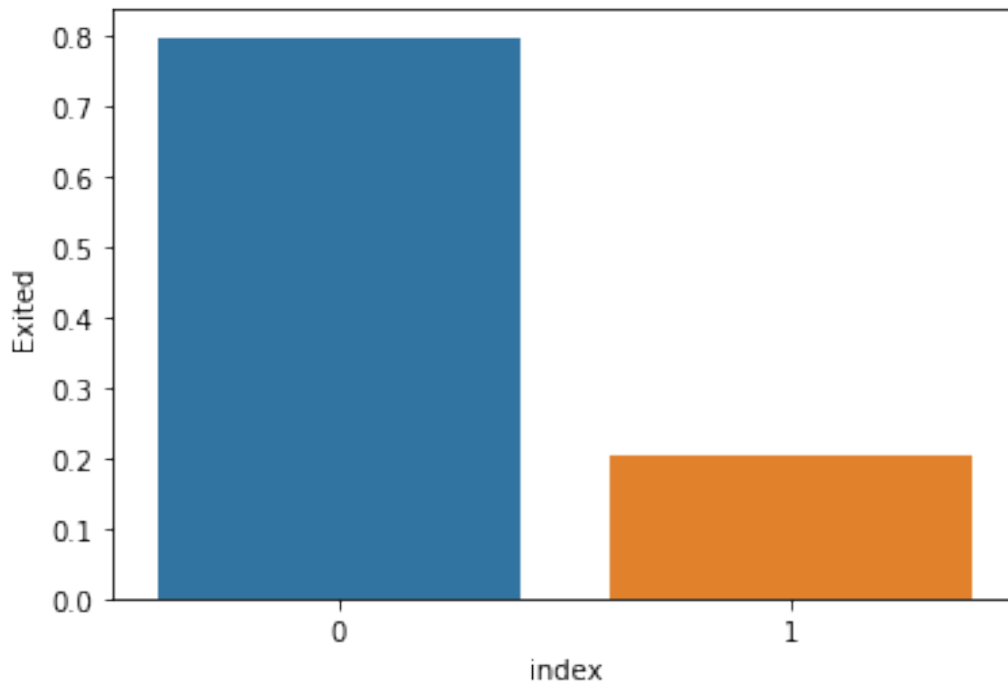
#### Multi - Variate Analysis

```
sns.kdeplot(x='CreditScore', data = df , hue = 'Exited')
plt.show()
```



```
density = df['Exited'].value_counts(normalize=True).reset_index()
sns.barplot(data=density, x='index', y='Exited', );
density
```

```
index  Exited
0      0  0.7963
1      1  0.2037
```

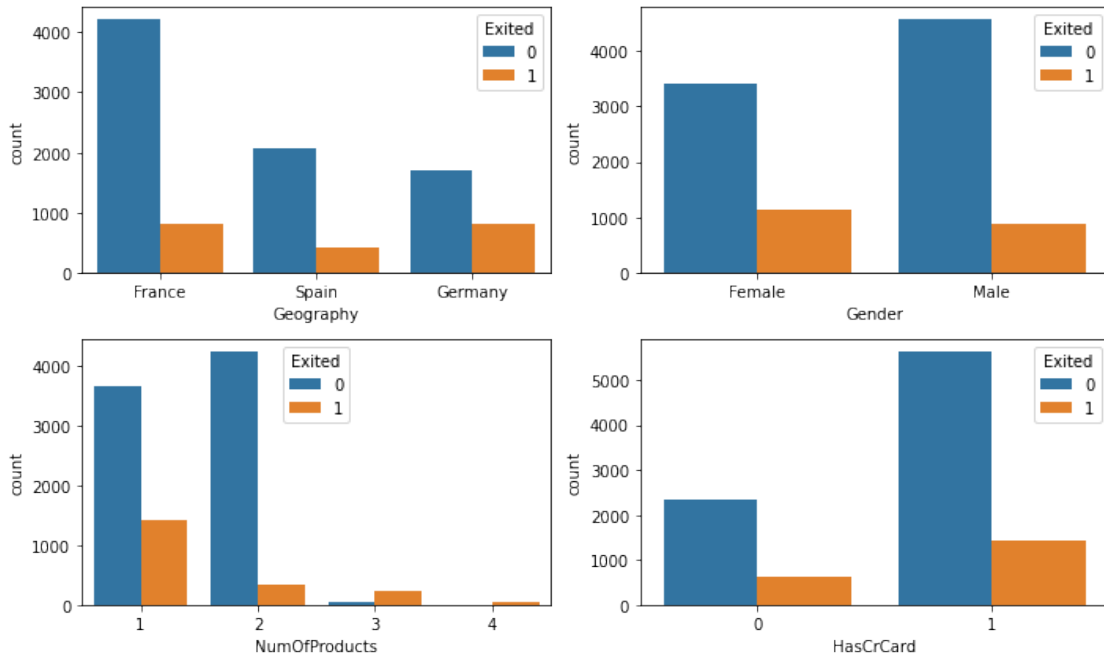


```
categorical = df.drop(columns=['CreditScore', 'Age', 'Tenure',
'Balance', 'EstimatedSalary'])
rows = int(np.ceil(categorical.shape[1] / 2)) - 1
fig, axes = plt.subplots(nrows=rows, ncols=2, figsize=(10,6))
axes = axes.flatten()

for row in range(rows):
    cols = min(2, categorical.shape[1] - row*2)
    for col in range(cols):
        col_name = categorical.columns[2 * row + col]
        ax = axes[row*2 + col]

        sns.countplot(data=categorical, x=col_name, hue="Exited",
ax=ax);

plt.tight_layout()
```



#### 4. Descriptive statistics bold text

df.info()

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 10000 entries, 0 to 9999
Data columns (total 11 columns):
#   Column                Non-Null Count  Dtype
---  -
0   CreditScore            10000 non-null  int64
1   Geography              10000 non-null  object
2   Gender                 10000 non-null  object
3   Age                    10000 non-null  int64
4   Tenure                 10000 non-null  int64
5   Balance                10000 non-null  float64
6   NumOfProducts          10000 non-null  int64
7   HasCrCard              10000 non-null  category
8   IsActiveMember         10000 non-null  category
9   EstimatedSalary        10000 non-null  float64
10  Exited                 10000 non-null  category
dtypes: category(3), float64(2), int64(4), object(2)
memory usage: 654.8+ KB
```

df.describe()

	CreditScore	Age	Tenure	Balance
NumOfProducts \				
count	10000.000000	10000.000000	10000.000000	10000.000000
mean	650.528800	38.921800	5.012800	76485.889288
	1.530200			

std	96.653299	10.487806	2.892174	62397.405202
0.581654				
min	350.000000	18.000000	0.000000	0.000000
1.000000				
25%	584.000000	32.000000	3.000000	0.000000
1.000000				
50%	652.000000	37.000000	5.000000	97198.540000
1.000000				
75%	718.000000	44.000000	7.000000	127644.240000
2.000000				
max	850.000000	92.000000	10.000000	250898.090000
4.000000				

	EstimatedSalary
count	10000.000000
mean	100090.239881
std	57510.492818
min	11.580000
25%	51002.110000
50%	100193.915000
75%	149388.247500
max	199992.480000

## 5. Handle Missing Values

```
df.isna().sum()
```

```
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 this dataset there is no missing values**

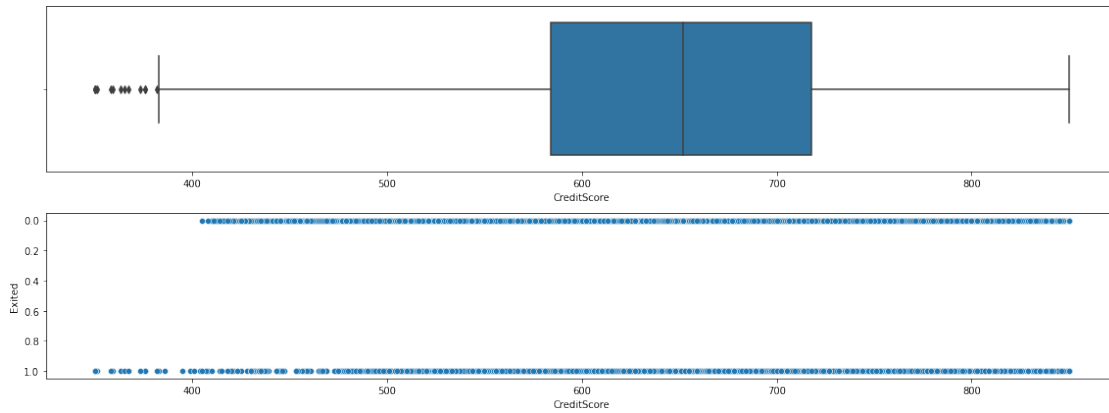
## 6. Find the outliers and replace the outliers

### Finding Outliers

```
def box_scatter(data, x, y):
    fig, (ax1, ax2) = plt.subplots(nrows=2, ncols=1, figsize=(16,6))
    sns.boxplot(data=data, x=x, ax=ax1)
    sns.scatterplot(data=data, x=x, y=y, ax=ax2)
```

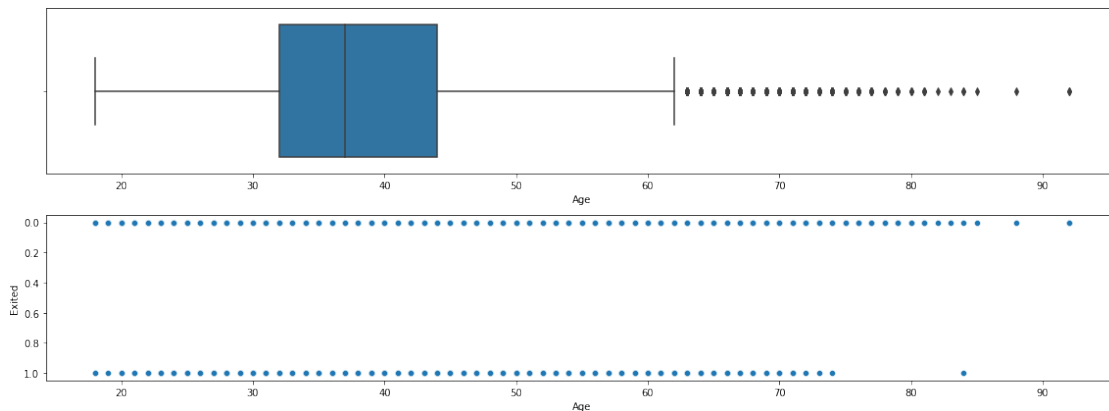
```
box_scatter(df, 'CreditScore', 'Exited');
plt.tight_layout()
print(f"# of Bivariate Outliers: {len(df.loc[df['CreditScore'] < 400])}")
```

# of Bivariate Outliers: 19



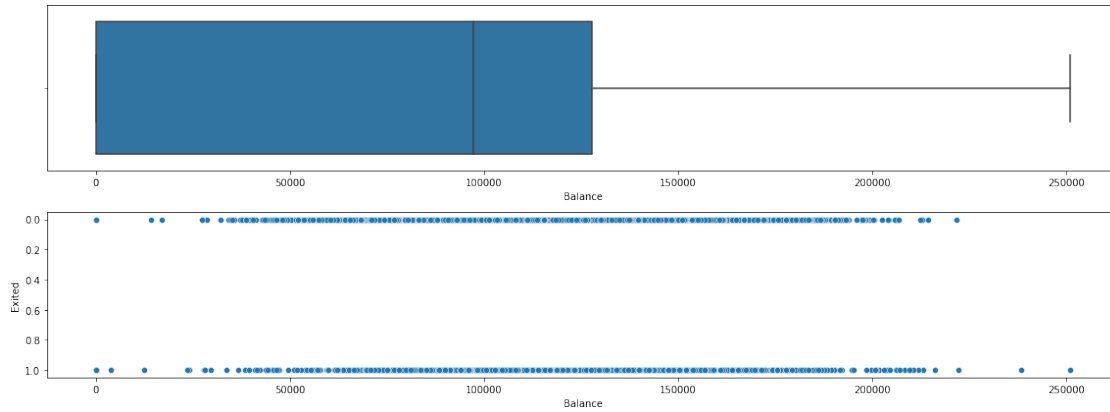
```
box_scatter(df, 'Age', 'Exited');
plt.tight_layout()
print(f"# of Bivariate Outliers: {len(df.loc[df['Age'] > 87])}")
```

# of Bivariate Outliers: 3

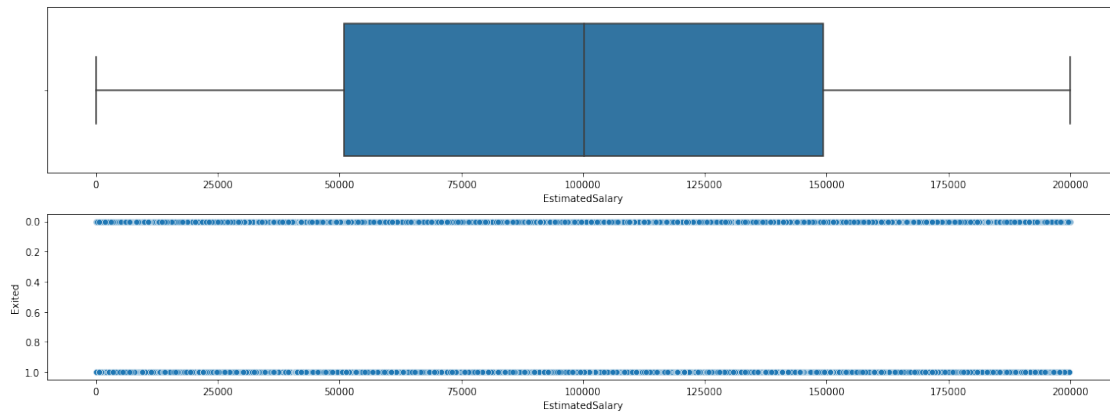


```
box_scatter(df, 'Balance', 'Exited');
plt.tight_layout()
print(f"# of Bivariate Outliers: {len(df.loc[df['Balance'] > 220000])}")
```

# of Bivariate Outliers: 4



```
box_scatter(df, 'EstimatedSalary', 'Exited');
plt.tight_layout()
```

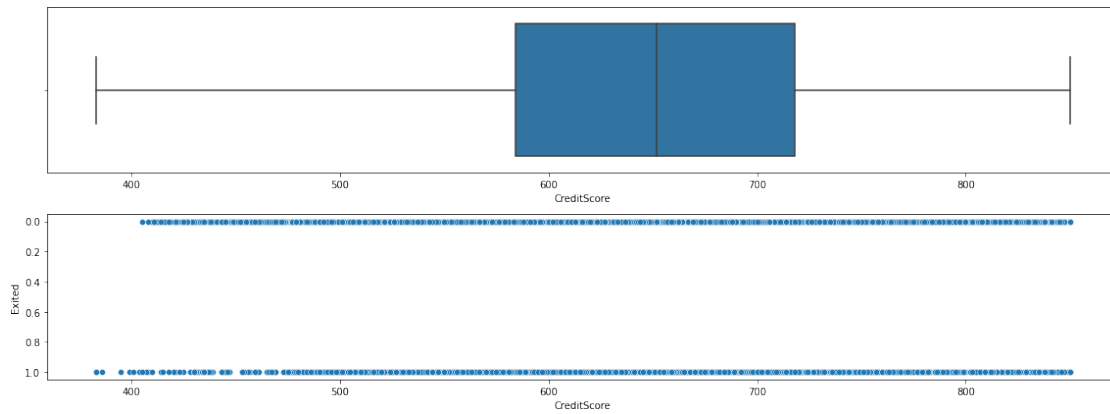


## Removing The Outliers

```
for i in df:
    if df[i].dtype=='int64' or df[i].dtypes=='float64':
        q1=df[i].quantile(0.25)
        q3=df[i].quantile(0.75)
        iqr=q3-q1
        upper=q3+1.5*iqr
        lower=q1-1.5*iqr
        df[i]=np.where(df[i] >upper, upper, df[i])
        df[i]=np.where(df[i] <lower, lower, df[i])

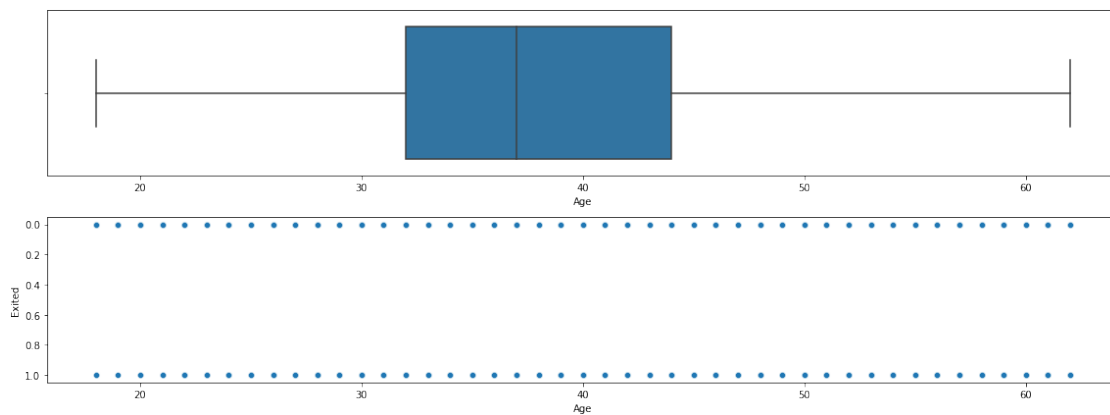
box_scatter(df, 'CreditScore', 'Exited');
plt.tight_layout()
print(f"# of Bivariate Outliers: {len(df.loc[df['CreditScore'] <
400])}")

# of Bivariate Outliers: 19
```



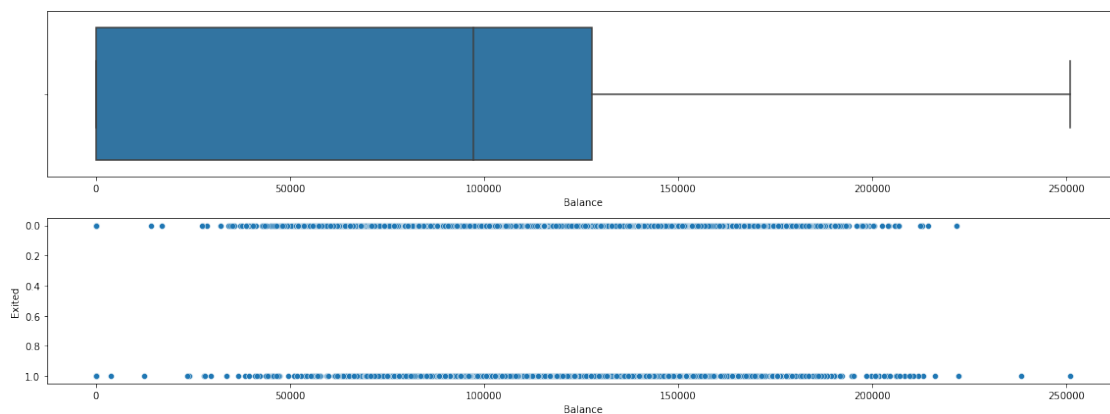
```
box_scatter(df, 'Age', 'Exited');
plt.tight_layout()
print(f"# of Bivariate Outliers: {len(df.loc[df['Age'] > 87])}")
```

# of Bivariate Outliers: 0



```
box_scatter(df, 'Balance', 'Exited');
plt.tight_layout()
print(f"# of Bivariate Outliers: {len(df.loc[df['Balance'] > 220000])}")
```

# of Bivariate Outliers: 4





## 7. Check for Categorical columns and perform encoding.

```
from sklearn.preprocessing import LabelEncoder
encoder=LabelEncoder()
for i in df:
    if df[i].dtype=='object' or df[i].dtype=='category':
        df[i]=encoder.fit_transform(df[i])
```

## 8. Split the data into dependent and independent variables.

```
x=df.iloc[:, :-1]
x.head()
```

	CreditScore	Geography	Gender	Age	Tenure	Balance
0	619.0	0	0	42.0	2.0	0.00
1	608.0	2	0	41.0	1.0	83807.86
2	502.0	0	0	42.0	8.0	159660.80
3	699.0	0	0	39.0	1.0	0.00
4	850.0	2	0	43.0	2.0	125510.82

	HasCrCard	IsActiveMember	EstimatedSalary
0	1	1	101348.88
1	0	1	112542.58
2	1	0	113931.57
3	0	0	93826.63
4	1	1	79084.10

```
y=df.iloc[:, -1]
y.head()
```

```
0    1
1    0
2    1
3    0
4    0
Name: Exited, dtype: int64
```

## 9. Scale the independent variables

```
from sklearn.preprocessing import StandardScaler
scaler=StandardScaler()
x=scaler.fit_transform(x)
print(x)
```

```
[[-0.32687761 -0.90188624 -1.09598752 ...  0.64609167  0.97024255
  0.02188649]
```

```

[-0.44080365  1.51506738 -1.09598752 ... -1.54776799  0.97024255
 0.21653375]
[-1.53863634 -0.90188624 -1.09598752 ...  0.64609167 -1.03067011
 0.2406869 ]
...
[ 0.60524449 -0.90188624 -1.09598752 ... -1.54776799  0.97024255
-1.00864308]
[ 1.25772996  0.30659057  0.91241915 ...  0.64609167 -1.03067011
-0.12523071]
[ 1.4648682  -0.90188624 -1.09598752 ...  0.64609167 -1.03067011
-1.07636976]]

```

## 10. Split the data into training and testing.

```

from sklearn.model_selection import train_test_split
x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.20)

print(x_train.shape)
print(x_test.shape)

(8000, 10)
(2000, 10)

print(y_train.shape)
print(y_test.shape)

(8000,)
(2000,)

```