

#libraries

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

#load dataset

```
df = pd.read_csv(r"/content/Churn_Modelling.csv")
```

```
df.head(10)
```

| | 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 |
| 5 | 6 | 15574012 | Chu | 645 | Spain | Male | 44 |
| 6 | 7 | 15592531 | Bartlett | 822 | France | Male | 50 |
| 7 | 8 | 15656148 | Obinna | 376 | Germany | Female | 29 |
| 8 | 9 | 15792365 | He | 501 | France | Male | 44 |
| 9 | 10 | 15592389 | H? | 684 | France | Male | 27 |

| | 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 | |
| 5 | 8 | 113755.78 | 2 | 1 | 0 | |
| 6 | 7 | 0.00 | 2 | 1 | 1 | |
| 7 | 4 | 115046.74 | 4 | 1 | 0 | |
| 8 | 4 | 142051.07 | 2 | 0 | 1 | |
| 9 | 2 | 134603.88 | 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 |
| 5 | 149756.71 | 1 |
| 6 | 10062.80 | 0 |
| 7 | 119346.88 | 1 |
| 8 | 74940.50 | 0 |
| 9 | 71725.73 | 0 |

```
df.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
```

```
#Visualizations
```

```
#Univariate Analysis
```

```
import seaborn as sns
```

```
sns.kdeplot(df['CreditScore'])
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc4a0cd2790>
```



#Bi - Variate Analysis

```
plt.bar(df.CustomerId, df.CreditScore)
plt.title('CreditScore')
plt.xlabel('CustomerId')
plt.ylabel('CreditScore')
Text(0, 0.5, 'CreditScore')
```



```
sns.lmplot(x='Tenure', y='Balance', data=df ,hue='Exited',size=8)
/usr/local/lib/python3.7/dist-packages/seaborn/regression.py:581:
UserWarning: The `size` parameter has been renamed to `height`; please
update your code.
  warnings.warn(msg, UserWarning)
<seaborn.axisgrid.FacetGrid at 0x7fc4a149e2d0>
```



#Multi - Variate Analysis

```
ax =  
df[["CreditScore","Age","Tenure","Balance"]].plot(figsize=(80,40))  
ax.legend(loc='center left', bbox_to_anchor=(1, 0.5));
```



```
df.isnull().sum()
```

```
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
```

```
plt.figure(figsize=(15,13))
sns.heatmap(df.corr(),annot=True,cmap='BuPu')
plt.show()
```



```
df.drop(['RowNumber', 'CustomerId', 'Surname'], axis=1, inplace=True)
```

```
df.head()
```

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

| | 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.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  int64
8   IsActiveMember        10000 non-null  int64
9   EstimatedSalary       10000 non-null  float64
10  Exited                 10000 non-null  int64
dtypes: float64(2), int64(7), object(2)
memory usage: 859.5+ KB
```

```
df["Geography"].unique()
```

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

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

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

```
geo=pd.get_dummies(df["Geography"],drop_first=False)
```

```
geo.head()
```

| | France | Germany | Spain |
|---|--------|---------|-------|
| 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 |
| 2 | 1 | 0 | 0 |
| 3 | 1 | 0 | 0 |
| 4 | 0 | 0 | 1 |

```
gen=pd.get_dummies(df["Gender"],drop_first=False)
```

```
df=pd.concat([df, geo,gen], axis=1)
```

```
df
```

| | CreditScore | Geography | Gender | Age | Tenure | Balance | NumOfProducts | \ |
|--|-------------|-----------|--------|-----|--------|---------|---------------|---|
|--|-------------|-----------|--------|-----|--------|---------|---------------|---|

| | | | | | | |
|------|-----|---------|--------|-----|-----|-----------|
| 0 | 619 | France | Female | 42 | 2 | 0.00 |
| 1 | | | | | | |
| 1 | 608 | Spain | Female | 41 | 1 | 83807.86 |
| 1 | | | | | | |
| 2 | 502 | France | Female | 42 | 8 | 159660.80 |
| 3 | | | | | | |
| 3 | 699 | France | Female | 39 | 1 | 0.00 |
| 2 | | | | | | |
| 4 | 850 | Spain | Female | 43 | 2 | 125510.82 |
| 1 | | | | | | |
| ... | ... | ... | ... | ... | ... | ... |
| ... | | | | | | |
| 9995 | 771 | France | Male | 39 | 5 | 0.00 |
| 2 | | | | | | |
| 9996 | 516 | France | Male | 35 | 10 | 57369.61 |
| 1 | | | | | | |
| 9997 | 709 | France | Female | 36 | 7 | 0.00 |
| 1 | | | | | | |
| 9998 | 772 | Germany | Male | 42 | 3 | 75075.31 |
| 2 | | | | | | |
| 9999 | 792 | France | Female | 28 | 4 | 130142.79 |
| 1 | | | | | | |

| | HasCrCard | IsActiveMember | EstimatedSalary | Exited | France |
|-----------|-----------|----------------|-----------------|--------|--------|
| Germany \ | | | | | |
| 0 | 1 | 1 | 101348.88 | 1 | 1 |
| 0 | | | | | |
| 1 | 0 | 1 | 112542.58 | 0 | 0 |
| 0 | | | | | |
| 2 | 1 | 0 | 113931.57 | 1 | 1 |
| 0 | | | | | |
| 3 | 0 | 0 | 93826.63 | 0 | 1 |
| 0 | | | | | |
| 4 | 1 | 1 | 79084.10 | 0 | 0 |
| 0 | | | | | |
| ... | ... | ... | ... | ... | ... |
| ... | | | | | |
| 9995 | 1 | 0 | 96270.64 | 0 | 1 |
| 0 | | | | | |
| 9996 | 1 | 1 | 101699.77 | 0 | 1 |
| 0 | | | | | |
| 9997 | 0 | 1 | 42085.58 | 1 | 1 |
| 0 | | | | | |
| 9998 | 1 | 0 | 92888.52 | 1 | 0 |
| 1 | | | | | |
| 9999 | 1 | 0 | 38190.78 | 0 | 1 |
| 0 | | | | | |

| | Spain | Female | Male |
|---|-------|--------|------|
| 0 | 0 | 1 | 0 |

```

1      1      1      0
2      0      1      0
3      0      1      0
4      1      1      0
...
9995   ...   ...   ...
9995      0      0      1
9996      0      0      1
9997      0      1      0
9998      0      0      1
9999      0      1      0

```

[10000 rows x 16 columns]

```
df.drop(["Geography","Gender"], axis=1, inplace=True)
```

```
df.head()
```

| | CreditScore | Age | Tenure | Balance | NumOfProducts | HasCrCard | \ |
|---|-------------|-----|--------|-----------|---------------|-----------|---|
| 0 | 619 | 42 | 2 | 0.00 | 1 | 1 | |
| 1 | 608 | 41 | 1 | 83807.86 | 1 | 0 | |
| 2 | 502 | 42 | 8 | 159660.80 | 3 | 1 | |
| 3 | 699 | 39 | 1 | 0.00 | 2 | 0 | |
| 4 | 850 | 43 | 2 | 125510.82 | 1 | 1 | |

| | IsActiveMember | EstimatedSalary | Exited | France | Germany | Spain | \ |
|--------|----------------|-----------------|--------|--------|---------|-------|---|
| Female | | | | | | | |
| 0 | 1 | 101348.88 | 1 | 1 | 0 | 0 | |
| 1 | | | | | | | |
| 1 | 1 | 112542.58 | 0 | 0 | 0 | 1 | |
| 1 | | | | | | | |
| 2 | 0 | 113931.57 | 1 | 1 | 0 | 0 | |
| 1 | | | | | | | |
| 3 | 0 | 93826.63 | 0 | 1 | 0 | 0 | |
| 1 | | | | | | | |
| 4 | 1 | 79084.10 | 0 | 0 | 0 | 1 | |
| 1 | | | | | | | |

| | Male |
|---|------|
| 0 | 0 |
| 1 | 0 |
| 2 | 0 |
| 3 | 0 |
| 4 | 0 |

```
x=df.drop('Exited',axis=1)
```

```
x
```

| | CreditScore | Age | Tenure | Balance | NumOfProducts | HasCrCard | \ |
|---|-------------|-----|--------|----------|---------------|-----------|---|
| 0 | 619 | 42 | 2 | 0.00 | 1 | 1 | |
| 1 | 608 | 41 | 1 | 83807.86 | 1 | 0 | |

| | | | | | | |
|------|-----|-----|-----|-----------|-----|-----|
| 2 | 502 | 42 | 8 | 159660.80 | 3 | 1 |
| 3 | 699 | 39 | 1 | 0.00 | 2 | 0 |
| 4 | 850 | 43 | 2 | 125510.82 | 1 | 1 |
| ... | ... | ... | ... | ... | ... | ... |
| 9995 | 771 | 39 | 5 | 0.00 | 2 | 1 |
| 9996 | 516 | 35 | 10 | 57369.61 | 1 | 1 |
| 9997 | 709 | 36 | 7 | 0.00 | 1 | 0 |
| 9998 | 772 | 42 | 3 | 75075.31 | 2 | 1 |
| 9999 | 792 | 28 | 4 | 130142.79 | 1 | 1 |

| | IsActiveMember | EstimatedSalary | France | Germany | Spain | Female |
|------|----------------|-----------------|--------|---------|-------|--------|
| Male | | | | | | |
| 0 | 1 | 101348.88 | 1 | 0 | 0 | 1 |
| 0 | | | | | | |
| 1 | 1 | 112542.58 | 0 | 0 | 1 | 1 |
| 0 | | | | | | |
| 2 | 0 | 113931.57 | 1 | 0 | 0 | 1 |
| 0 | | | | | | |
| 3 | 0 | 93826.63 | 1 | 0 | 0 | 1 |
| 0 | | | | | | |
| 4 | 1 | 79084.10 | 0 | 0 | 1 | 1 |
| 0 | | | | | | |
| ... | ... | ... | ... | ... | ... | ... |
| ... | | | | | | |
| 9995 | 0 | 96270.64 | 1 | 0 | 0 | 0 |
| 1 | | | | | | |
| 9996 | 1 | 101699.77 | 1 | 0 | 0 | 0 |
| 1 | | | | | | |
| 9997 | 1 | 42085.58 | 1 | 0 | 0 | 1 |
| 0 | | | | | | |
| 9998 | 0 | 92888.52 | 0 | 1 | 0 | 0 |
| 1 | | | | | | |
| 9999 | 0 | 38190.78 | 1 | 0 | 0 | 1 |
| 0 | | | | | | |

[10000 rows x 13 columns]

y=df['Exited']

y

| | |
|------|-----|
| 0 | 1 |
| 1 | 0 |
| 2 | 1 |
| 3 | 0 |
| 4 | 0 |
| ... | ... |
| 9995 | 0 |
| 9996 | 0 |
| 9997 | 1 |
| 9998 | 1 |

```

9999      0
Name: Exited, Length: 10000, dtype: int64

df.shape
(10000, 14)

x.shape
(10000, 13)

y.shape
(10000,)

from sklearn.model_selection import train_test_split
x_train,x_test, y_train,y_test = train_test_split(x,y,
test_size=0.2,random_state=0)

x_train.shape
(8000, 13)

x_test.shape
(2000, 13)

y_test.shape
(2000,)

from sklearn.preprocessing import StandardScaler
sc = StandardScaler()
x_train = sc.fit_transform(x_train)
x_train
array([[ 0.16958176, -0.46460796,  0.00666099, ...,  1.74309049,
         1.09168714, -1.09168714],
       [-2.30455945,  0.30102557, -1.37744033, ..., -0.57369368,
        -0.91601335,  0.91601335],
       [-1.19119591, -0.94312892, -1.031415  , ..., -0.57369368,
         1.09168714, -1.09168714],
       ...,
       [ 0.9015152 , -0.36890377,  0.00666099, ..., -0.57369368,
        -0.91601335,  0.91601335],
       [-0.62420521, -0.08179119,  1.39076231, ...,  1.74309049,
         1.09168714, -1.09168714],
       [-0.28401079,  0.87525072, -1.37744033, ..., -0.57369368,
         1.09168714, -1.09168714]])

x_test = sc.transform(x_test)

```

x_test

```
array([[ -0.55204276, -0.36890377,  1.04473698, ..., -0.57369368,
        1.09168714, -1.09168714],
       [ -1.31490297,  0.10961719, -1.031415   , ..., -0.57369368,
        1.09168714, -1.09168714],
       [  0.57162971,  0.30102557,  1.04473698, ...,  1.74309049,
        1.09168714, -1.09168714],
       ...,
       [ -0.74791227, -0.27319958, -1.37744033, ...,  1.74309049,
        -0.91601335,  0.91601335],
       [ -0.00566991, -0.46460796, -0.33936434, ..., -0.57369368,
        -0.91601335,  0.91601335],
       [ -0.79945688, -0.84742473,  1.04473698, ..., -0.57369368,
        -0.91601335,  0.91601335]])
```