

Assignment – 2

Assignment Date	25 September 2022
Student Name	S.Santhosh
Student Roll Number	820319205031
Maximum Marks	2 Marks

1. Download the dataset: Dataset

2 . Load the dataset

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
df =pd.read_csv("gdrive/My Drive/Churn_Modelling.csv")
df.head()
```

OUTPUT:

	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

```
from google.colab import drive
drive.mount('/content/gdrive')
```

Mounted at /content/gdrive

```
#dropping row number columns as we already have index column by default
dataset.drop(['RowNumber'], axis=1,inplace=True)
```

3 . Visualizations

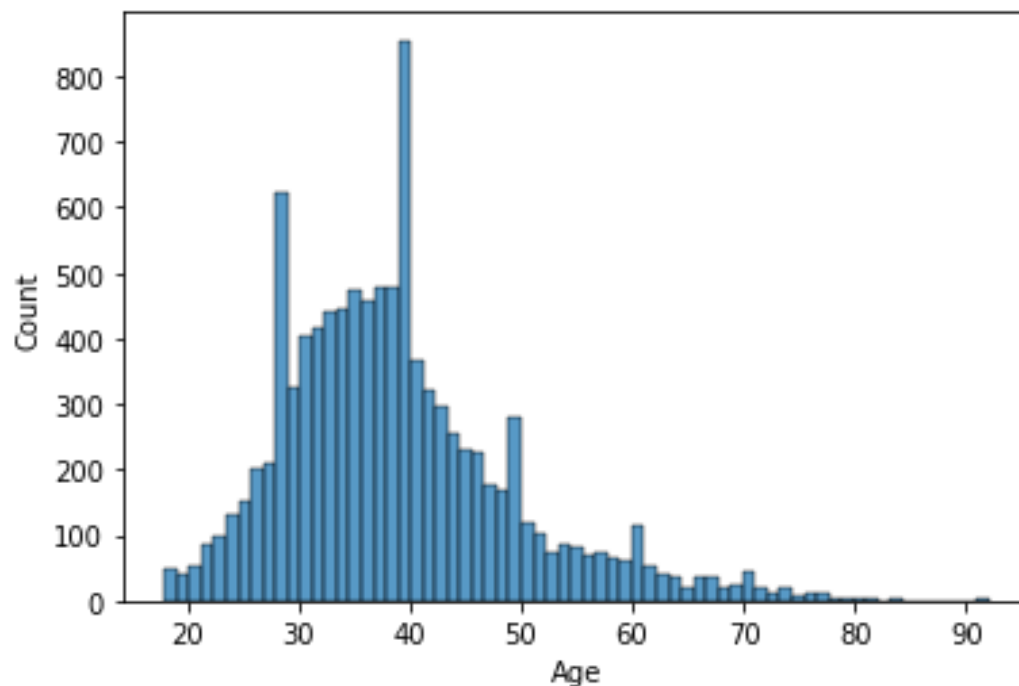
```
import matplotlib.pyplot as plt
import seaborn as sns
```

##Univariate Analysis

```
# plt.scatter(churn.index,churn["Age"])
# plt.show()
```

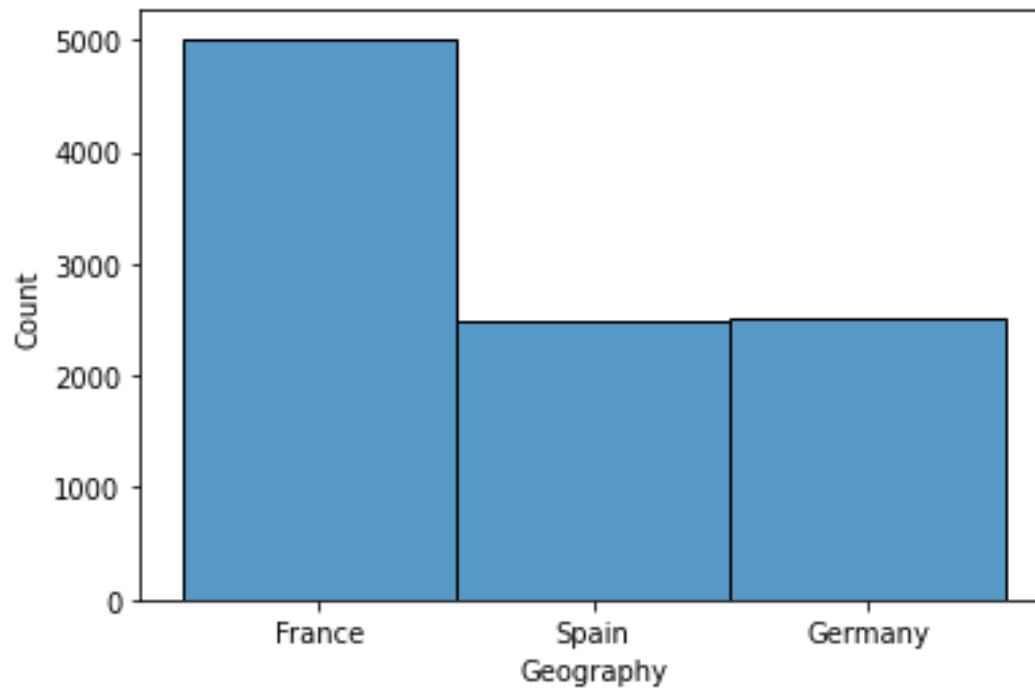
```
# Age Histogram
sns.histplot(x='Age', data=dataset)
```

<matplotlib.axes._subplots.AxesSubplot at 0x7f76872b9410>



```
# Geography Histogram
sns.histplot(x='Geography', data=dataset)
```

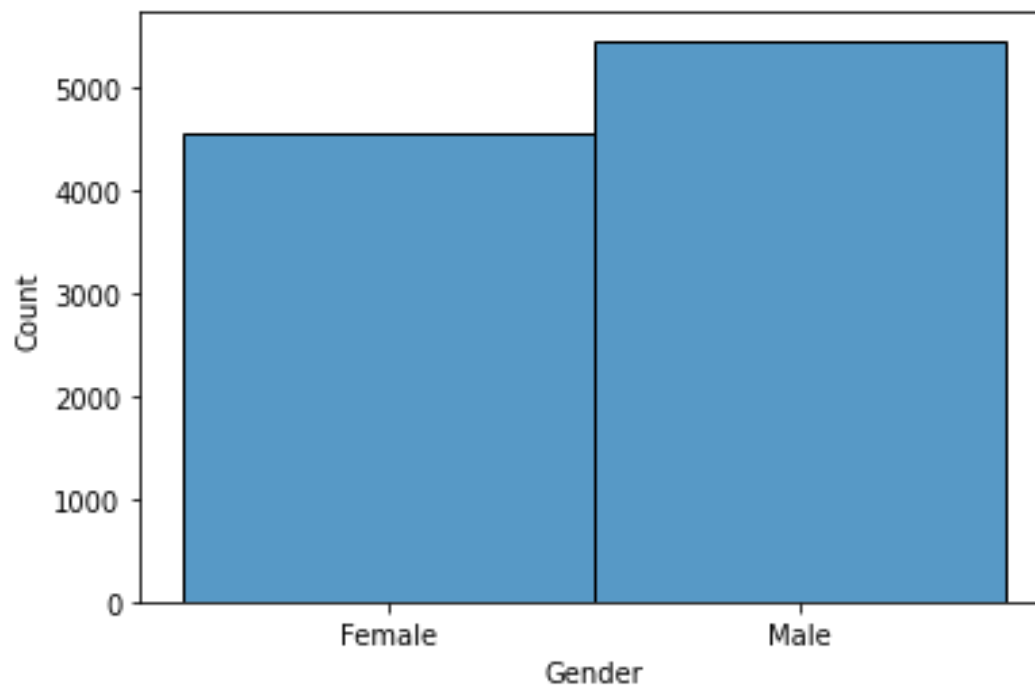
<matplotlib.axes._subplots.AxesSubplot at 0x7f76864b6390>



Geography Histogram

```
sns.histplot(x='Gender', data=dataset)
```

<matplotlib.axes._subplots.AxesSubplot at 0x7f7685fdee90>



```
cols = 3
```

```
rows = 3
```

```
num_cols = dataset.select_dtypes(exclude='object').columns #exclude string
```

based columns namely Surname, Geography, Gender

```
print(num_cols)
```

```
fig = plt.figure(figsize=(cols*5, rows*5))
```

```
for i, col in enumerate(num_cols[1:]): #exclude Customer ID
```

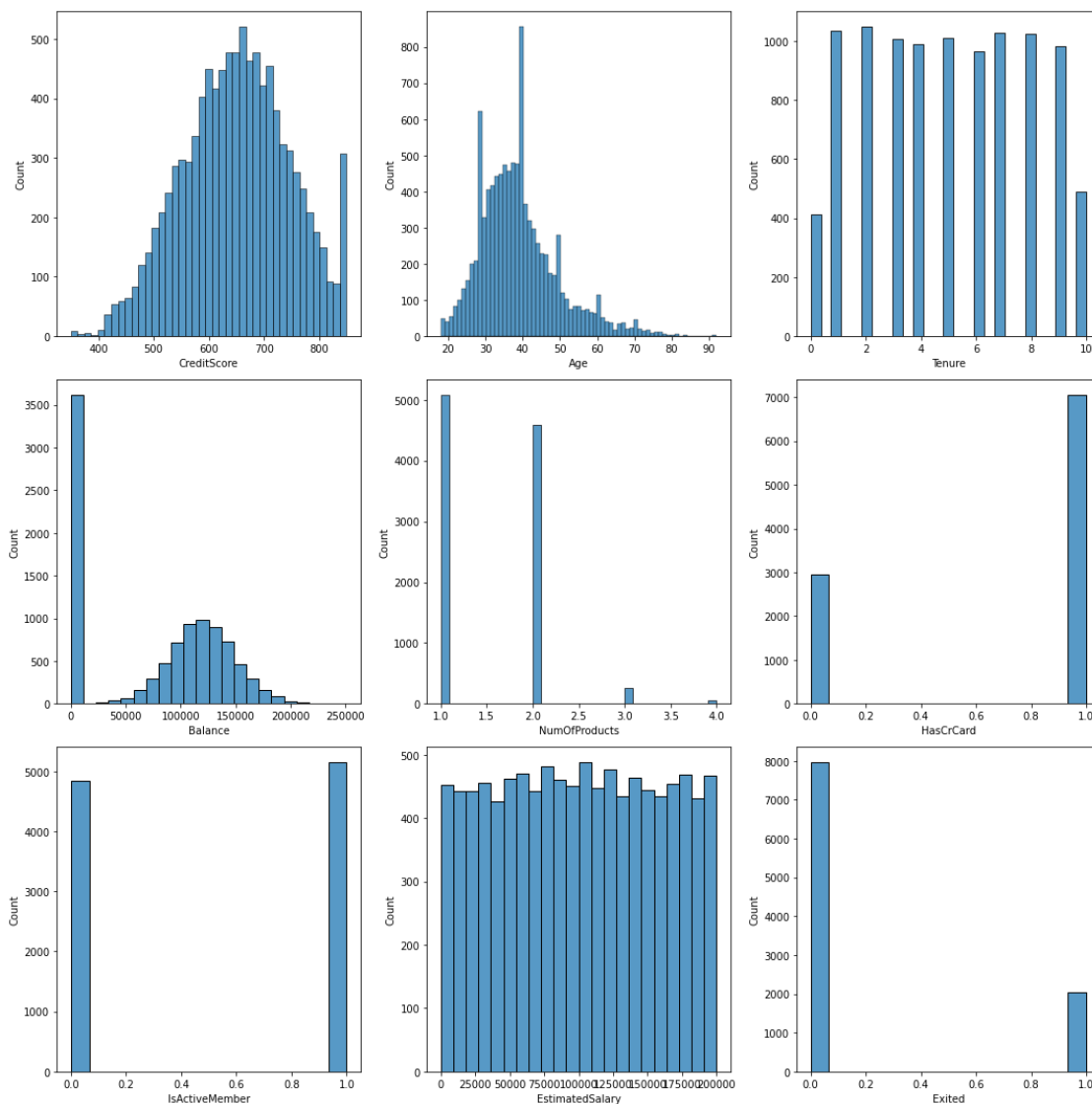
```
    ax=fig.add_subplot(rows,cols,i+1)
```

```
    sns.histplot(x = dataset[col], ax = ax)
```

```
fig.tight_layout()
```

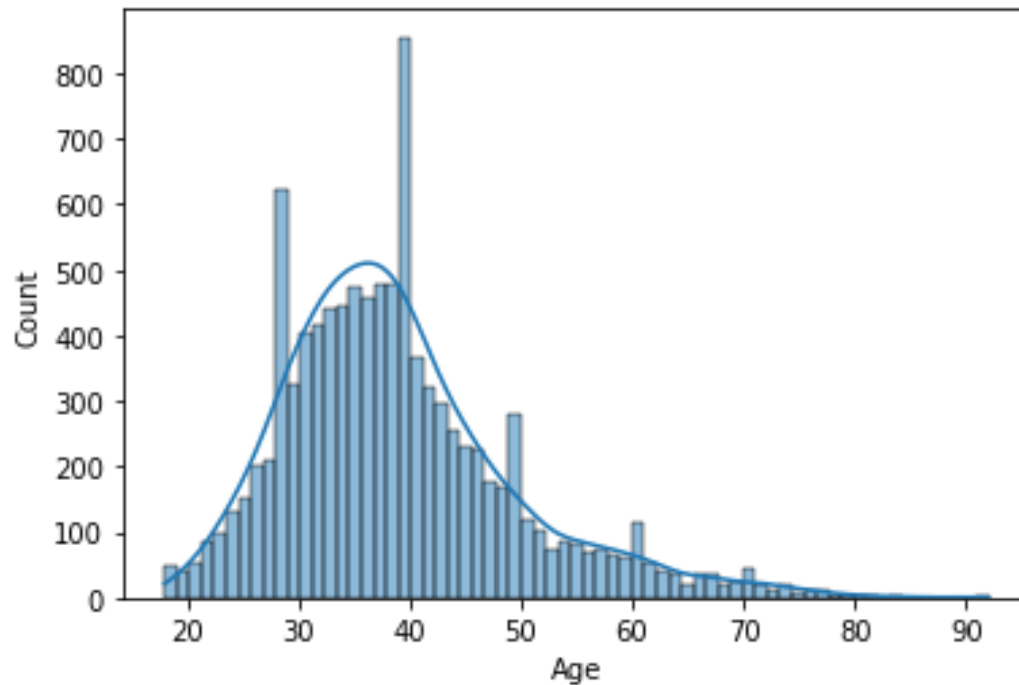
```
plt.show()
```

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



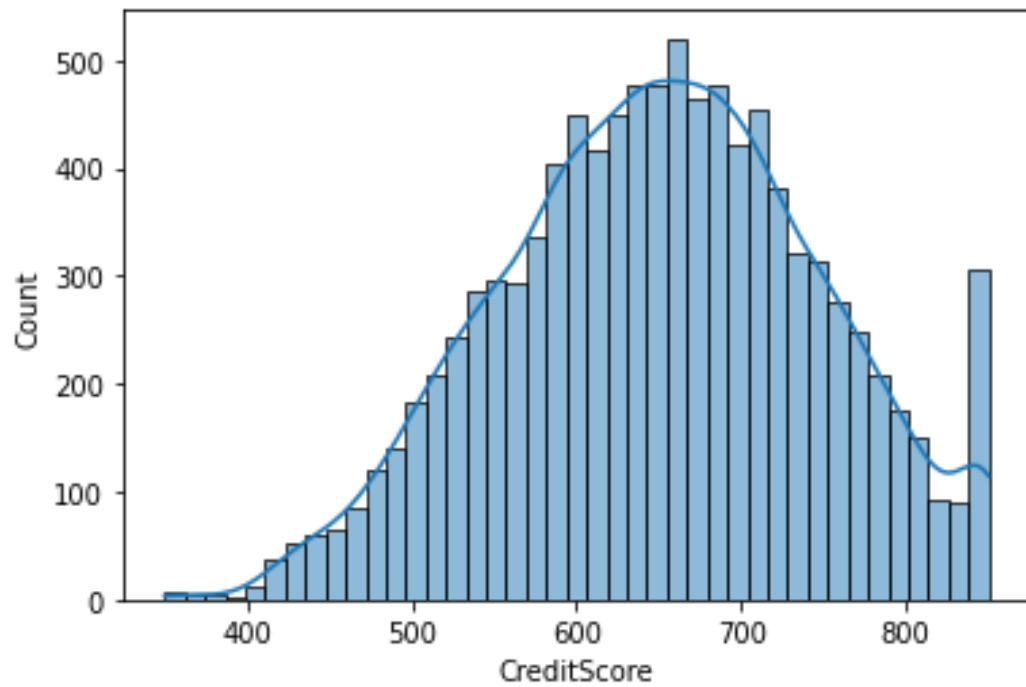
```
# sns.kdeplot(x='Age', data=churn, hue='Exited')
sns.histplot(x='Age', data=dataset, kde=True)

<matplotlib.axes._subplots.AxesSubplot at 0x7f7685ba8290>
```



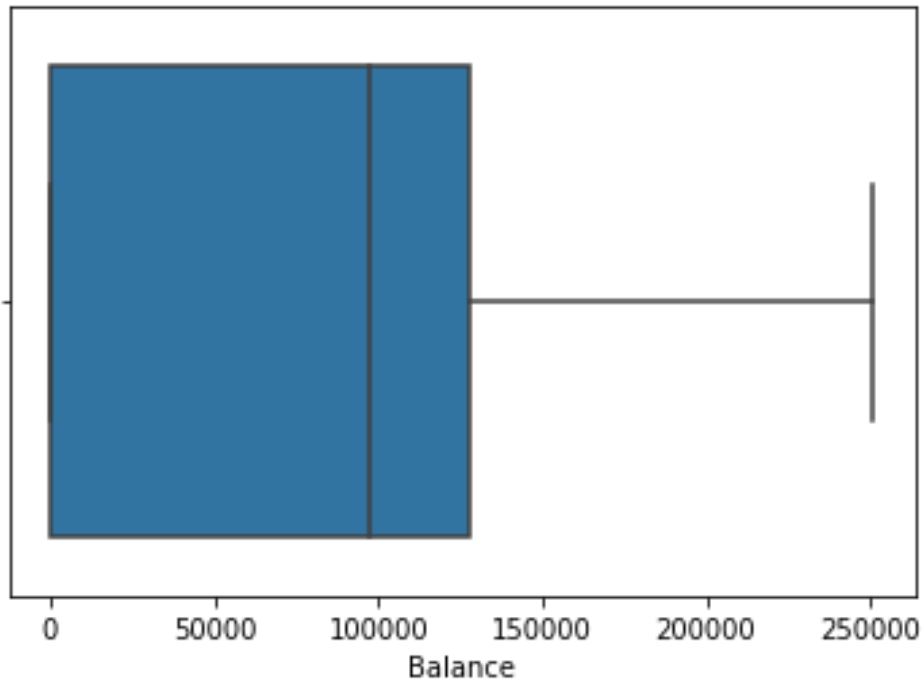
```
# sns.kdeplot(x='Age', data=churn, hue='IsActiveMember')
sns.histplot(x='CreditScore', data=dataset, kde=True)

<matplotlib.axes._subplots.AxesSubplot at 0x7f768597f2d0>
```



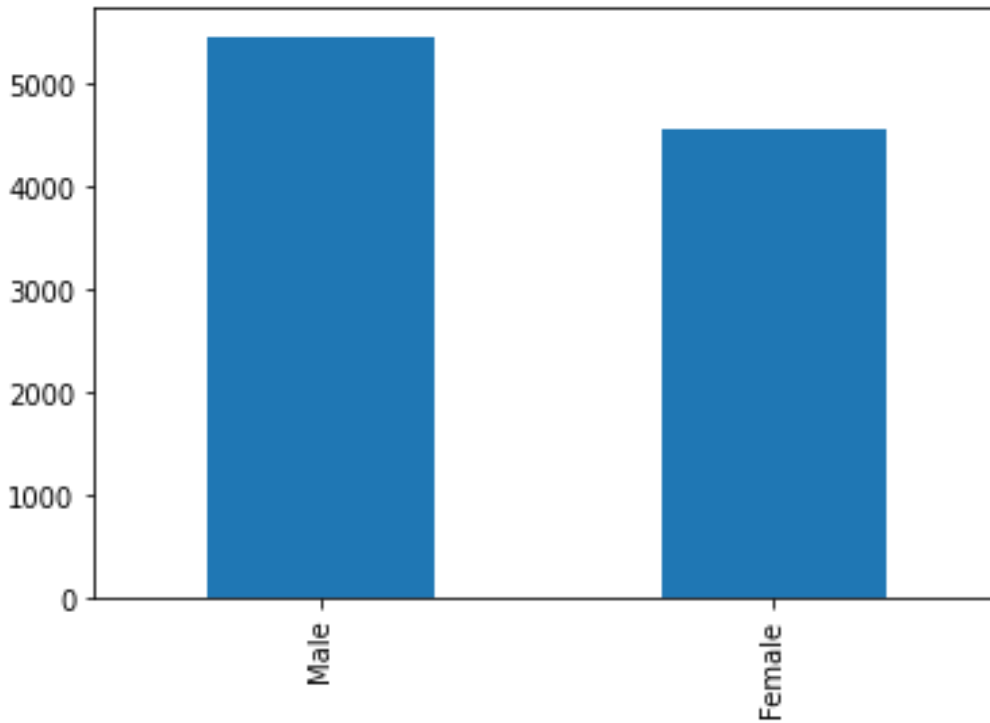
```
sns.boxplot(x=dataset['Balance'])
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f7686032110>
```



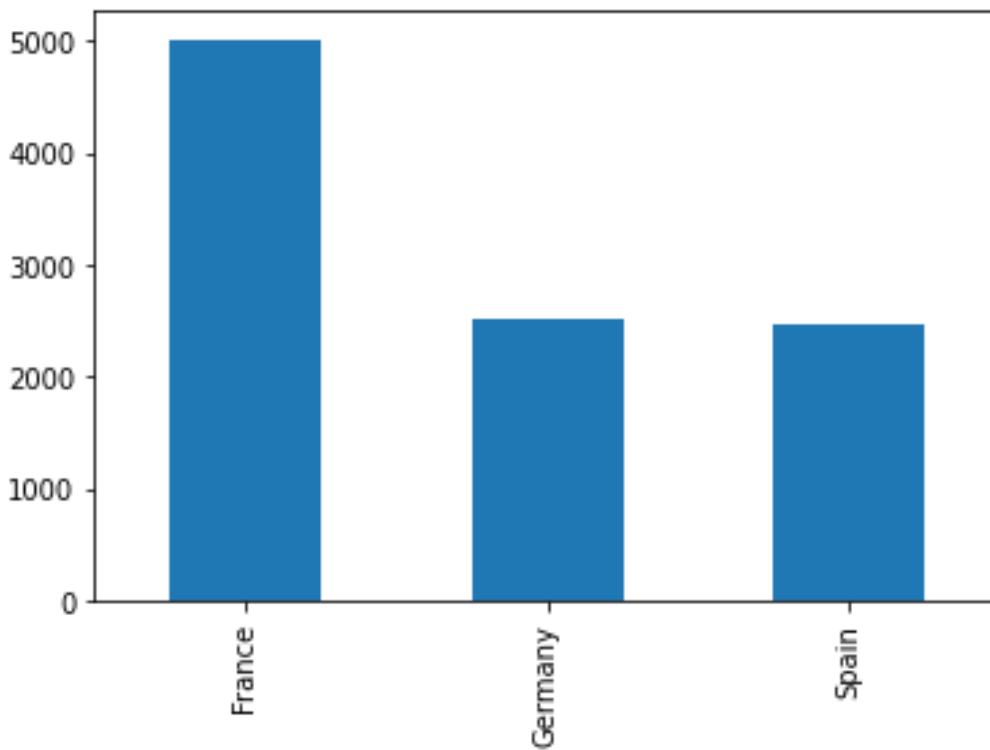
```
dataset['Gender'].value_counts().plot.bar()
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f7682e1ea50>
```



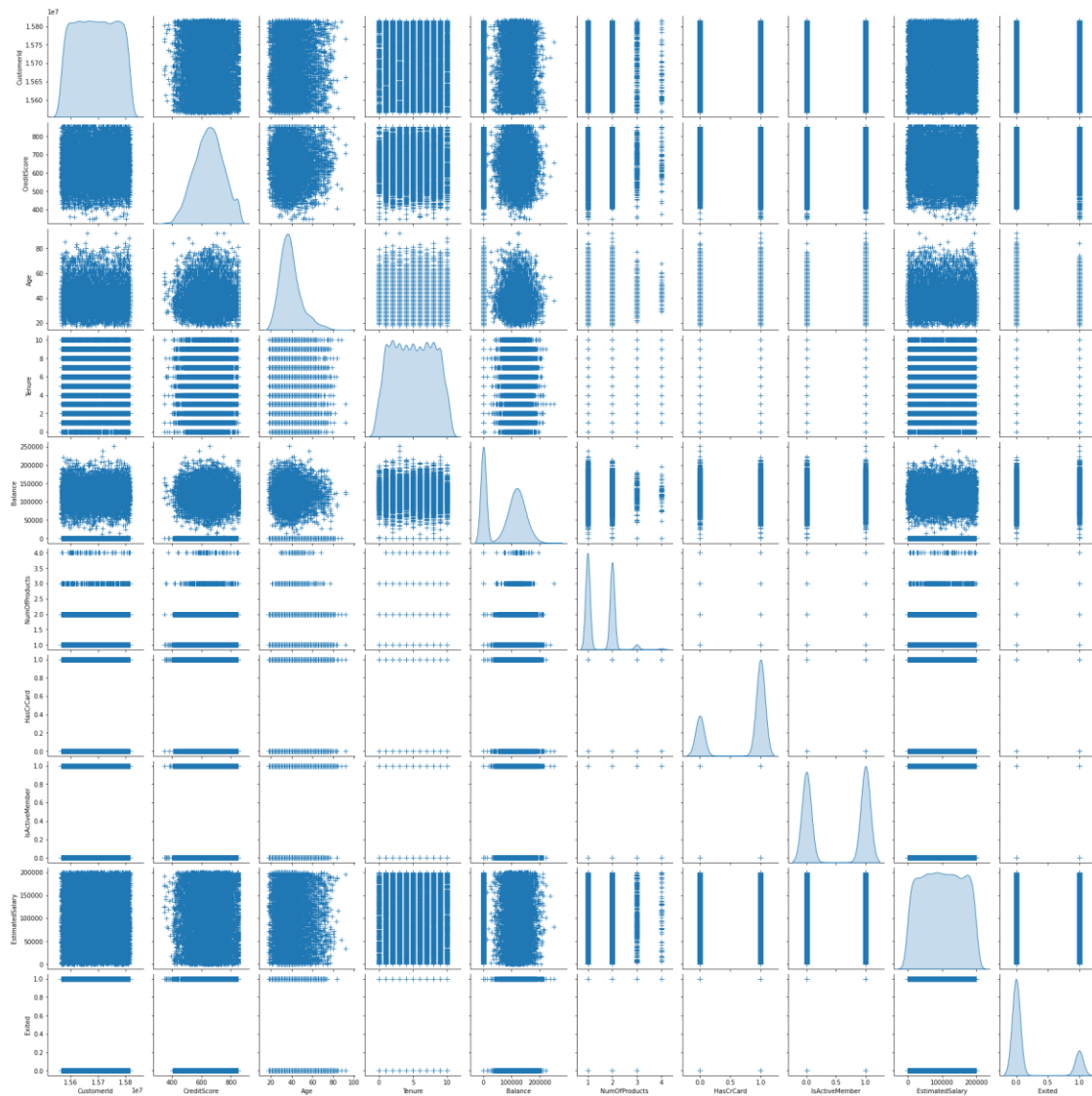
```
dataset['Geography'].value_counts().plot.bar()
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f7683120d90>
```



##Bi - Variate Analysis

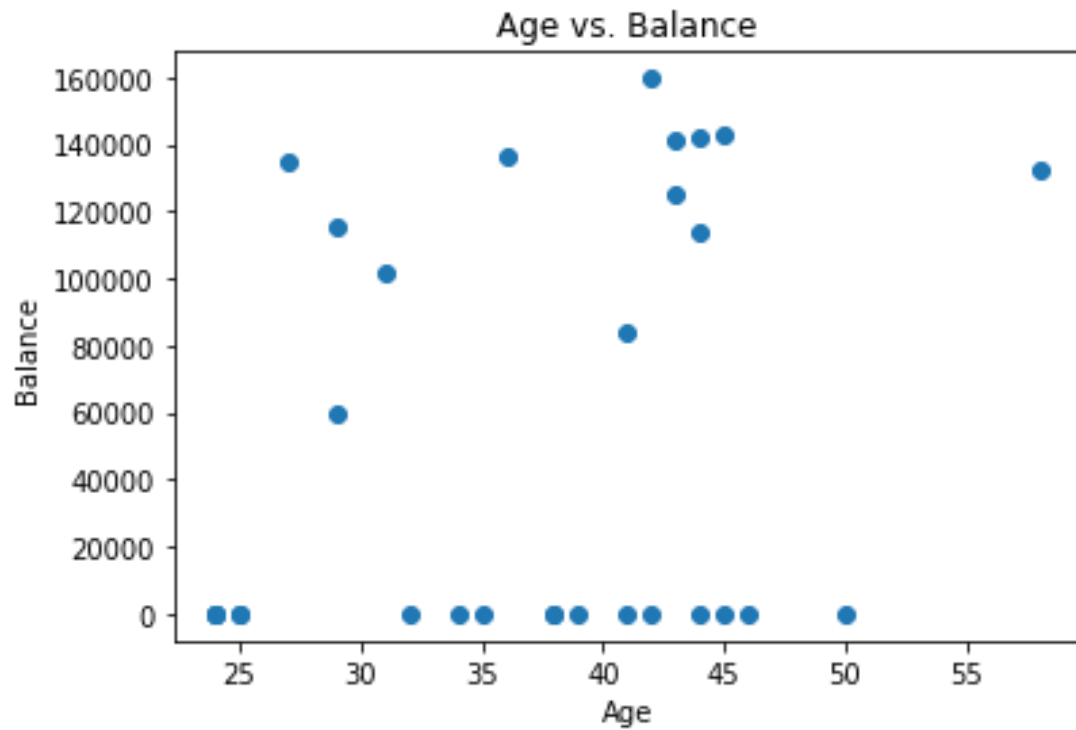
```
g = sns.pairplot(dataset, diag_kind="kde", markers="+",
                  plot_kws=dict(s=50, edgecolor="b", linewidth=1),
                  diag_kws=dict(shade=True))
```



```
import matplotlib.pyplot as plt
```

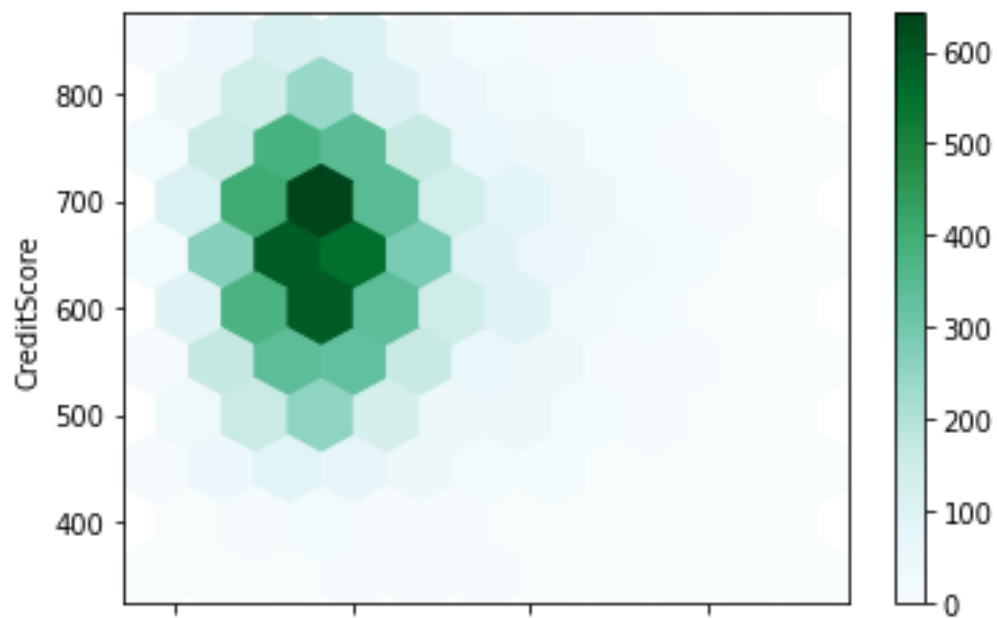
```
#create scatterplot of hours vs. score
plt.scatter(dataset.Age[:30], dataset.Balance[:30])
plt.title('Age vs. Balance')
plt.xlabel('Age')
plt.ylabel('Balance')

Text(0, 0.5, 'Balance')
```

```
dataset.plot.hexbin(x='Age', y='CreditScore', gridsize=10)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f7682d84690>
```



##Multi-variate Analysis

```
dataset.corr()
```

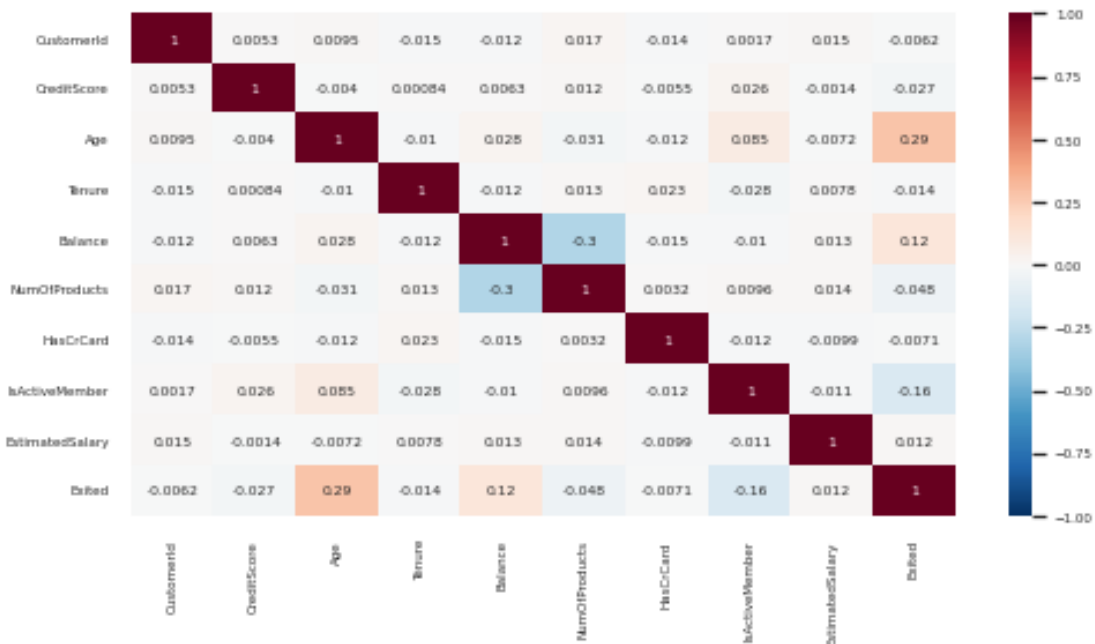
	CustomerId	CreditScore	Age	Tenure	Balance	\
CustomerId	1.000000	0.005308	0.009497	-0.014883	-0.012419	
CreditScore	0.005308	1.000000	-0.003965	0.000842	0.006268	
Age	0.009497	-0.003965	1.000000	-0.009997	0.028308	
Tenure	-0.014883	0.000842	-0.009997	1.000000	-0.012254	
Balance	-0.012419	0.006268	0.028308	-0.012254	1.000000	
NumOfProducts	0.016972	0.012238	-0.030680	0.013444	-0.304180	
HasCrCard	-0.014025	-0.005458	-0.011721	0.022583	-0.014858	
IsActiveMember	0.001665	0.025651	0.085472	-0.028362	-0.010084	
EstimatedSalary	0.015271	-0.001384	-0.007201	0.007784	0.012797	
Exited	-0.006248	-0.027094	0.285323	-0.014001	0.118533	

	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	\
CustomerId	0.016972	-0.014025	0.001665	0.015271	
CreditScore	0.012238	-0.005458	0.025651	-0.001384	
Age	-0.030680	-0.011721	0.085472	-0.007201	
Tenure	0.013444	0.022583	-0.028362	0.007784	
Balance	-0.304180	-0.014858	-0.010084	0.012797	
NumOfProducts	1.000000	0.003183	0.009612	0.014204	
HasCrCard	0.003183	1.000000	-0.011866	-0.009933	
IsActiveMember	0.009612	-0.011866	1.000000	-0.011421	
EstimatedSalary	0.014204	-0.009933	-0.011421	1.000000	
Exited	-0.047820	-0.007138	-0.156128	0.012097	

	Exited
CustomerId	-0.006248
CreditScore	-0.027094
Age	0.285323
Tenure	-0.014001
Balance	0.118533
NumOfProducts	-0.047820
HasCrCard	-0.007138
IsActiveMember	-0.156128
EstimatedSalary	0.012097
Exited	1.000000

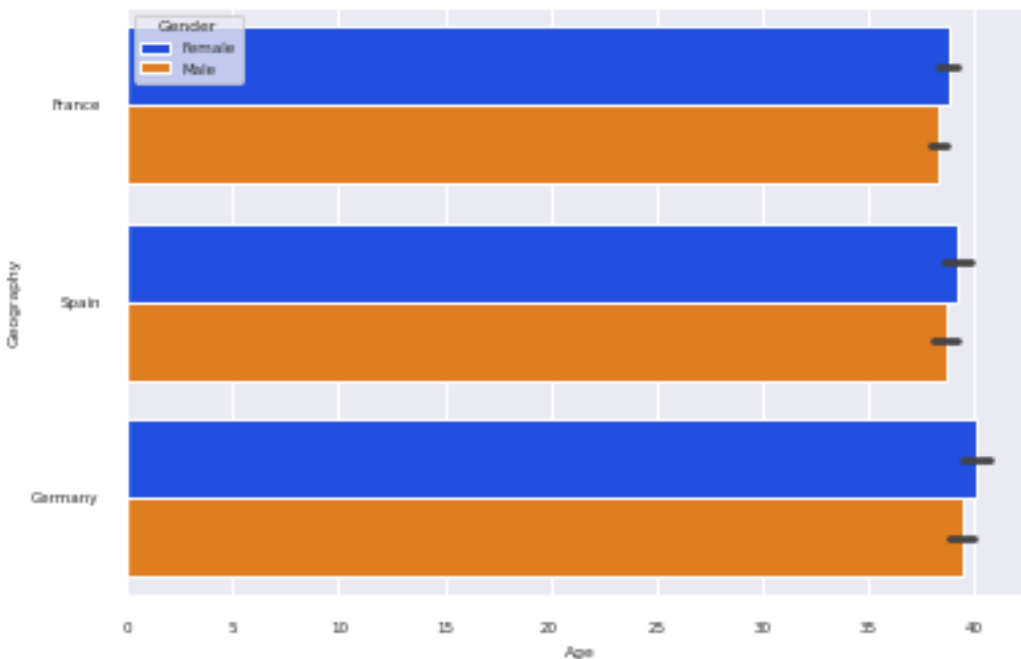
```
sns.set(font_scale=0.50)
plt.figure(figsize=(8,4))
sns.heatmap(dataset.corr(),cmap='RdBu_r', annot=True, vmin=-1, vmax=1)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f7680979950>
```



```
#Three variables - Multivariate
sns.barplot(x='Age', y='Geography', data=dataset,
palette='bright',hue='Gender')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f767ec905d0>
```



4 . Descriptive statistics

```
import statistics as st
```

```
dataset[['Age', 'Balance', 'EstimatedSalary']].mean()
```

```
Age                38.921800
Balance            76485.889288
EstimatedSalary    100090.239881
dtype: float64
```

```
dataset.info()
```

```
<class 'pandas.core.frame.DataFrame'>
```

```
RangeIndex: 10000 entries, 0 to 9999
```

```
Data columns (total 13 columns):
```

#	Column	Non-Null Count	Dtype
0	CustomerId	10000 non-null	int64
1	Surname	10000 non-null	object
2	CreditScore	10000 non-null	int64
3	Geography	10000 non-null	object
4	Gender	10000 non-null	object
5	Age	10000 non-null	int64
6	Tenure	10000 non-null	int64
7	Balance	10000 non-null	float64
8	NumOfProducts	10000 non-null	int64
9	HasCrCard	10000 non-null	int64
10	IsActiveMember	10000 non-null	int64
11	EstimatedSalary	10000 non-null	float64
12	Exited	10000 non-null	int64

```
dtypes: float64(2), int64(8), object(3)
```

```
memory usage: 1015.8+ KB
```

```
dataset.describe()
```

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

	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	
count	10000.000000	10000.000000	10000.000000	10000.000000	
mean	1.530200	0.70550	0.515100	100090.239881	
std	0.581654	0.45584	0.499797	57510.492818	
min	1.000000	0.00000	0.000000	11.580000	
25%	1.000000	0.00000	0.000000	51002.110000	
50%	1.000000	1.00000	1.000000	100193.915000	
75%	2.000000	1.00000	1.000000	149388.247500	

```
max          4.000000      1.00000      1.000000      199992.480000
```

```
      Exited
count  10000.000000
mean    0.203700
std     0.402769
min     0.000000
25%     0.000000
50%     0.000000
75%     0.000000
max     1.000000
```

```
dataset['Age'].median()
```

```
37.0
```

```
standard_deviation = dataset['CreditScore'].std()
print(standard_deviation)
```

```
96.65329873613035
```

```
st.mode(dataset['Geography'])
```

```
{"type": "string"}
```

```
st.median(dataset['Age'])
```

```
37.0
```

```
st.variance(dataset['CreditScore'])
```

```
9341.860156575658
```

5 . Handle Missing Values

```
dataset.isnull().sum() #no missing values
```

```
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
```

6 . Find and replace outliers

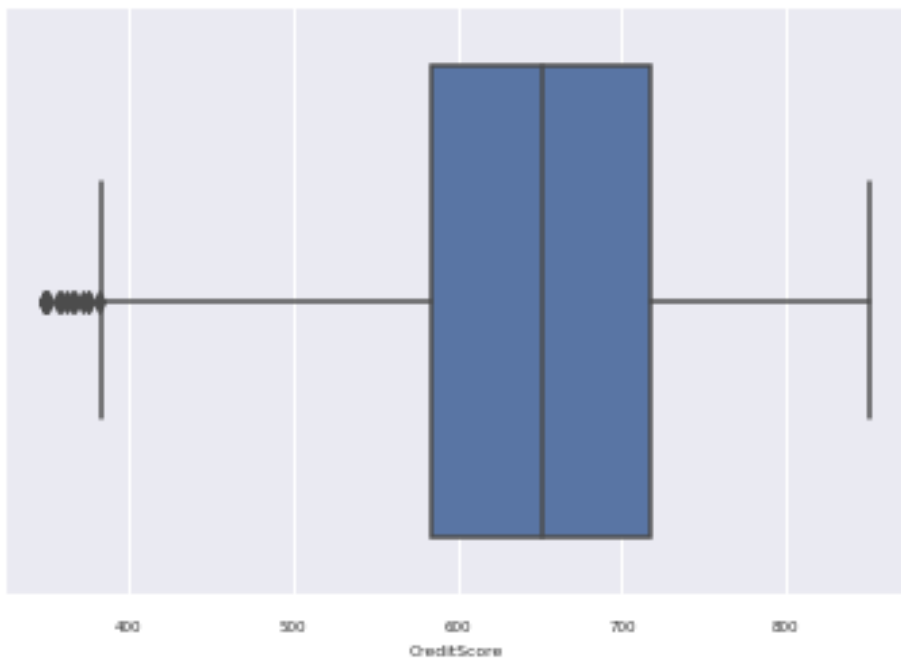
Visualize Outliers

```
sns.boxplot(dataset['CreditScore'],data=dataset)
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43:  
FutureWarning: Pass the following variable as a keyword arg: x. From version  
0.12, the only valid positional argument will be `data`, and passing other  
arguments without an explicit keyword will result in an error or  
misinterpretation.
```

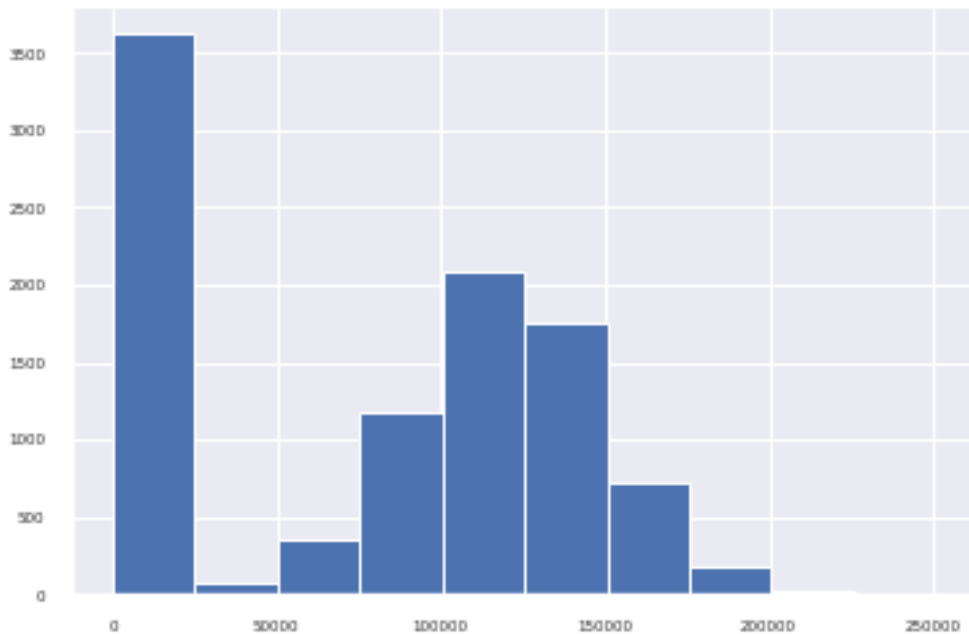
```
FutureWarning
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f767ebd9d90>
```



```
dataset['Balance'].hist()
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f767ebbefd0>
```



```
for col in num_cols[1:]:
    print('skewness value of ',col,dataset[col].skew())
```

#Skewness should be in the range of -1 to 1, any columns with skewness outside of that range would have outliers

```
skewness value of  CreditScore -0.07160660820092675
skewness value of  Age 1.0113202630234552
skewness value of  Tenure 0.01099145797717904
skewness value of  Balance -0.14110871094154384
skewness value of  NumOfProducts 0.7455678882823168
skewness value of  HasCrCard -0.9018115952400578
skewness value of  IsActiveMember -0.06043662833499078
skewness value of  EstimatedSalary 0.0020853576615585162
skewness value of  Exited 1.4716106649378211
```

```
Q1=dataset['Age'].quantile(0.25)
Q3=dataset['Age'].quantile(0.75)
IQR=Q3-Q1
```

IQR

12.0

Removing Outliers

#Values above than the upper bound and below than the lower bound are considered outliers

```
upper = dataset['Age'] >= (Q3+1.5*IQR)
```

```
# print("Upper bound:",upper)
print(np.where(upper))
```

```
lower = dataset['Age'] <= (Q1-1.5*IQR)
# print("Lower bound:", lower)
print(np.where(lower))
```

```
(array([ 58, 85, 104, 158, 181, 230, 234, 243, 252, 276, 310,
        364, 371, 385, 387, 399, 538, 559, 567, 602, 612, 617,
        658, 678, 696, 736, 766, 769, 807, 811, 823, 859, 884,
        888, 948, 952, 957, 963, 969, 997, 1009, 1039, 1040, 1055,
        1114, 1205, 1234, 1235, 1246, 1252, 1278, 1285, 1328, 1342, 1387,
        1407, 1410, 1433, 1439, 1457, 1519, 1543, 1607, 1614, 1642, 1790,
        1810, 1866, 1901, 1904, 1907, 1933, 1981, 1996, 2002, 2012, 2039,
        2053, 2078, 2094, 2108, 2154, 2159, 2164, 2244, 2274, 2433, 2458,
        2459, 2519, 2553, 2599, 2615, 2659, 2670, 2713, 2717, 2760, 2772,
        2778, 2791, 2855, 2877, 2901, 2908, 2925, 2926, 3008, 3033, 3054,
        3110, 3142, 3166, 3192, 3203, 3229, 3305, 3308, 3311, 3314, 3317,
        3346, 3366, 3368, 3378, 3382, 3384, 3387, 3396, 3403, 3434, 3462,
        3497, 3499, 3527, 3531, 3541, 3559, 3573, 3575, 3593, 3602, 3641,
        3646, 3647, 3651, 3690, 3691, 3702, 3719, 3728, 3733, 3761, 3813,
        3826, 3880, 3881, 3888, 3909, 3910, 3927, 3940, 3980, 3994, 4010,
        4025, 4048, 4051, 4095, 4142, 4147, 4157, 4162, 4170, 4241, 4244,
        4256, 4273, 4280, 4297, 4313, 4318, 4335, 4360, 4366, 4378, 4387,
        4396, 4435, 4438, 4463, 4490, 4501, 4506, 4559, 4563, 4590, 4595,
        4644, 4698, 4747, 4751, 4801, 4815, 4832, 4849, 4931, 4947, 4966,
        4992, 5000, 5020, 5038, 5068, 5132, 5136, 5148, 5159, 5197, 5223,
        5225, 5235, 5255, 5299, 5313, 5368, 5377, 5405, 5457, 5490, 5508,
        5514, 5576, 5577, 5581, 5655, 5660, 5664, 5671, 5698, 5777, 5783,
        5817, 5825, 5840, 5867, 5907, 5957, 5996, 6046, 6116, 6152, 6166,
        6167, 6173, 6212, 6230, 6278, 6289, 6315, 6357, 6366, 6373, 6375,
        6410, 6443, 6515, 6530, 6532, 6581, 6612, 6626, 6706, 6709, 6715,
        6721, 6759, 6763, 6812, 6899, 6970, 6997, 7008, 7057, 7058, 7063,
        7071, 7078, 7094, 7138, 7139, 7142, 7156, 7194, 7202, 7238, 7243,
        7272, 7302, 7362, 7375, 7392, 7499, 7514, 7523, 7526, 7548, 7552,
        7624, 7629, 7692, 7694, 7709, 7715, 7719, 7720, 7727, 7773, 7776,
        7784, 7788, 7802, 7813, 7851, 7894, 7898, 7933, 7956, 7995, 8019,
        8037, 8094, 8098, 8156, 8193, 8207, 8217, 8304, 8321, 8385, 8394,
        8444, 8458, 8467, 8469, 8478, 8488, 8562, 8568, 8577, 8602, 8674,
        8686, 8689, 8711, 8759, 8761, 8768, 8787, 8793, 8822, 8865, 8900,
        8917, 8930, 9018, 9062, 9080, 9112, 9116, 9162, 9223, 9279, 9292,
        9309, 9318, 9324, 9332, 9333, 9351, 9380, 9402, 9425, 9428, 9438,
        9472, 9490, 9506, 9555, 9557, 9582, 9587, 9589, 9593, 9646, 9671,
        9673, 9681, 9686, 9688, 9718, 9733, 9734, 9736, 9747, 9753, 9765,
        9832, 9879, 9894, 9936]),)
(array([], dtype=int64),)
```

```
#Removing outliers based off Age column
```

```
# IQR
```



```

Q1 = np.percentile(dataset['Age'], 25,
                    interpolation = 'midpoint')

Q3 = np.percentile(dataset['Age'], 75,
                    interpolation = 'midpoint')

IQR = Q3 - Q1

print("Old Shape: ", dataset.shape)

# Upper bound
upper = np.where(dataset['Age'] >= (Q3+1.5*IQR))
# Lower bound
lower = np.where(dataset['Age'] <= (Q1-1.5*IQR))

```

```

''' Removing the Outliers '''
dataset.drop(upper[0], inplace = True)
dataset.drop(lower[0], inplace = True)

```

```

print("New Shape: ", dataset.shape)

```

Old Shape: (10000, 13)

New Shape: (9589, 13)

dataset

	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	\
0	15634602	Hargrave	619	France	Female	42	2	
1	15647311	Hill	608	Spain	Female	41	1	
2	15619304	Onio	502	France	Female	42	8	
3	15701354	Boni	699	France	Female	39	1	
4	15737888	Mitchell	850	Spain	Female	43	2	
...	
9995	15606229	Obijiaku	771	France	Male	39	5	
9996	15569892	Johnstone	516	France	Male	35	10	
9997	15584532	Liu	709	France	Female	36	7	
9998	15682355	Sabbatini	772	Germany	Male	42	3	
9999	15628319	Walker	792	France	Female	28	4	

	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	\
0	0.00	1	1	1	101348.88	
1	83807.86	1	0	1	112542.58	
2	159660.80	3	1	0	113931.57	
3	0.00	2	0	0	93826.63	
4	125510.82	1	1	1	79084.10	
...	
9995	0.00	2	1	0	96270.64	
9996	57369.61	1	1	1	101699.77	
9997	0.00	1	0	1	42085.58	
9998	75075.31	2	1	0	92888.52	
9999	130142.79	1	1	0	38190.78	

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

[9589 rows x 13 columns]

```
for col in num_cols[1:]:
    print('skewness value of ',col,dataset[col].skew())
```

Now we have reduced the Age column's skewness values within -1 to 1 range
We left the Exited column's skewness value as it is the dependent variable

```
skewness value of  CreditScore -0.07274225895185718
skewness value of  Age 0.44721544739487257
skewness value of  Tenure 0.008085830714996462
skewness value of  Balance -0.1409005824644143
skewness value of  NumOfProducts 0.7470530176747141
skewness value of  HasCrCard -0.9034483996482451
skewness value of  IsActiveMember -0.008552881368996219
skewness value of  EstimatedSalary -0.0025661797132480266
skewness value of  Exited 1.4798502461410206
```

7 . Check for Categorical columns and perform encoding

##Label encoding and One Hot encoding

```
dataset.reset_index(inplace=True)
```

```
from sklearn.preprocessing import LabelEncoder
from sklearn.preprocessing import OneHotEncoder
from sklearn.compose import ColumnTransformer
```

```
categorical_feature_mask = dataset.dtypes==object
categorical_cols = dataset.columns[categorical_feature_mask].tolist()
```

```
categorical_cols=categorical_cols[1:]
categorical_cols
```

```
['Geography', 'Gender']
```

```

le = LabelEncoder()
dataset[categorical_cols] = dataset[categorical_cols].apply(lambda col:
le.fit_transform(col))
dataset[categorical_cols].head(10)

```

	Geography	Gender
0	0	0
1	2	0
2	0	0
3	0	0
4	2	0
5	2	1
6	0	1
7	1	0
8	0	1
9	0	1

```
categorical_feature_mask
```

index	False
CustomerId	False
Surname	True
CreditScore	False
Geography	True
Gender	True
Age	False
Tenure	False
Balance	False
NumOfProducts	False
HasCrCard	False
IsActiveMember	False
EstimatedSalary	False
Exited	False

dtype: bool

```

enc=OneHotEncoder()
enc_data=pd.DataFrame(enc.fit_transform(dataset[['Geography','Gender']]).toarray())
enc_data

```

	0	1	2	3	4
0	1.0	0.0	0.0	1.0	0.0
1	0.0	0.0	1.0	1.0	0.0
2	1.0	0.0	0.0	1.0	0.0
3	1.0	0.0	0.0	1.0	0.0
4	0.0	0.0	1.0	1.0	0.0
...
9584	1.0	0.0	0.0	0.0	1.0
9585	1.0	0.0	0.0	0.0	1.0
9586	1.0	0.0	0.0	1.0	0.0
9587	0.0	1.0	0.0	0.0	1.0

```
9588  1.0  0.0  0.0  1.0  0.0
```

```
[9589 rows x 5 columns]
```

#First three columns of enc_data is for Geography and the next two columns is for Gender, we can replace the already existing categorical columns with these encoded values

#Dropping already existing Geography and Gender columns

```
dataset.drop(['Geography'], axis=1,inplace=True)
```

```
dataset.drop(['Gender'], axis=1,inplace=True)
```

```
dataset.insert(2, "Geography_France", enc_data.iloc[:,0], True)
```

```
dataset.insert(3, "Geography_Germany", enc_data.iloc[:,1], True)
```

```
dataset.insert(4, "Geography_Spain", enc_data.iloc[:,2], True)
```

```
dataset.insert(5, "Gender_Female", enc_data.iloc[:,3], True)
```

```
dataset.insert(6, "Gender_Male", enc_data.iloc[:,4], True)
```

```
dataset
```

	index	CustomerId	Geography_France	Geography_Germany	Geography_Spain
\	0	15634602	1.0	0.0	0.0
1	1	15647311	0.0	0.0	1.0
2	2	15619304	1.0	0.0	0.0
3	3	15701354	1.0	0.0	0.0
4	4	15737888	0.0	0.0	1.0
...
9584	9995	15606229	1.0	0.0	0.0
9585	9996	15569892	1.0	0.0	0.0
9586	9997	15584532	1.0	0.0	0.0
9587	9998	15682355	0.0	1.0	0.0
9588	9999	15628319	1.0	0.0	0.0

	Gender_Female	Gender_Male	Surname	CreditScore	Age	Tenure	\
0	1.0	0.0	Hargrave	619	42	2	
1	1.0	0.0	Hill	608	41	1	
2	1.0	0.0	Onio	502	42	8	
3	1.0	0.0	Boni	699	39	1	
4	1.0	0.0	Mitchell	850	43	2	
...	
9584	0.0	1.0	Obijiaku	771	39	5	
9585	0.0	1.0	Johnstone	516	35	10	
9586	1.0	0.0	Liu	709	36	7	
9587	0.0	1.0	Sabbatini	772	42	3	
9588	1.0	0.0	Walker	792	28	4	

	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	\
0	0.00	1	1	1	101348.88	
1	83807.86	1	0	1	112542.58	

2	159660.80	3	1	0	113931.57
3	0.00	2	0	0	93826.63
4	125510.82	1	1	1	79084.10
...
9584	0.00	2	1	0	96270.64
9585	57369.61	1	1	1	101699.77
9586	0.00	1	0	1	42085.58
9587	75075.31	2	1	0	92888.52
9588	130142.79	1	1	0	38190.78

Exited	
0	1
1	0
2	1
3	0
4	0
...	...
9584	0
9585	0
9586	1
9587	1
9588	0

[9589 rows x 17 columns]

```
# We drop some irrelevant columns that does not contribute to prediction
dataset.drop(columns="CustomerId",axis=1,inplace=True)
dataset.drop(columns="Surname",axis=1,inplace=True)
dataset.drop(columns="index",axis=1,inplace=True)
```

dataset

	Geography_France	Geography_Germany	Geography_Spain	Gender_Female	\
0	1.0	0.0	0.0	1.0	
1	0.0	0.0	1.0	1.0	
2	1.0	0.0	0.0	1.0	
3	1.0	0.0	0.0	1.0	
4	0.0	0.0	1.0	1.0	
...	
9584	1.0	0.0	0.0	0.0	
9585	1.0	0.0	0.0	0.0	
9586	1.0	0.0	0.0	1.0	
9587	0.0	1.0	0.0	0.0	
9588	1.0	0.0	0.0	1.0	

	Gender_Male	CreditScore	Age	Tenure	Balance	NumOfProducts	\
0	0.0	619	42	2	0.00	1	
1	0.0	608	41	1	83807.86	1	
2	0.0	502	42	8	159660.80	3	
3	0.0	699	39	1	0.00	2	

4	0.0	850	43	2	125510.82	1
...
9584	1.0	771	39	5	0.00	2
9585	1.0	516	35	10	57369.61	1
9586	0.0	709	36	7	0.00	1
9587	1.0	772	42	3	75075.31	2
9588	0.0	792	28	4	130142.79	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
...
9584	1	0	96270.64	0
9585	1	1	101699.77	0
9586	0	1	42085.58	1
9587	1	0	92888.52	1
9588	1	0	38190.78	0

[9589 rows x 14 columns]

8 . Split the data into dependent and independent variables

X= dataset.iloc[:, :-1].values *#Independent variables*

y= dataset.iloc[:, -1].values *#Dependent variables*

X

```
array([[1.0000000e+00, 0.0000000e+00, 0.0000000e+00, ..., 1.0000000e+00,
        1.0000000e+00, 1.0134888e+05],
       [0.0000000e+00, 0.0000000e+00, 1.0000000e+00, ..., 0.0000000e+00,
        1.0000000e+00, 1.1254258e+05],
       [1.0000000e+00, 0.0000000e+00, 0.0000000e+00, ..., 1.0000000e+00,
        0.0000000e+00, 1.1393157e+05],
       ...,
       [1.0000000e+00, 0.0000000e+00, 0.0000000e+00, ..., 0.0000000e+00,
        1.0000000e+00, 4.2085580e+04],
       [0.0000000e+00, 1.0000000e+00, 0.0000000e+00, ..., 1.0000000e+00,
        0.0000000e+00, 9.2888520e+04],
       [1.0000000e+00, 0.0000000e+00, 0.0000000e+00, ..., 1.0000000e+00,
        0.0000000e+00, 3.8190780e+04]])
```

y

```
array([1, 0, 1, ..., 1, 1, 0])
```

9 . Scale the independent variable

```

from sklearn.preprocessing import StandardScaler
scale= StandardScaler()
X = scale.fit_transform(X)
X
array([[ 0.99718823, -0.57955796, -0.57297497, ...,  0.64561166,
         0.99573337,  0.01997639],
       [-1.0028197 , -0.57955796,  1.74527693, ..., -1.54891873,
         0.99573337,  0.21465635],
       [ 0.99718823, -0.57955796, -0.57297497, ...,  0.64561166,
        -1.00428491,  0.23881355],
       ...,
       [ 0.99718823, -0.57955796, -0.57297497, ..., -1.54891873,
         0.99573337, -1.01072631],
       [-1.0028197 ,  1.72545295, -0.57297497, ...,  0.64561166,
        -1.00428491, -0.12716553],
       [ 0.99718823, -0.57955796, -0.57297497, ...,  0.64561166,
        -1.00428491, -1.07846436]])

```

10 . Split the data into training and testing

```

from sklearn.model_selection import train_test_split

```

```

# We use train_test_split function to split the data such that 25% is used
for testing while the remaining 75% is used for training
X_train, X_test, y_train, y_test = train_test_split(X,y ,
random_state=104,test_size=0.25, shuffle=True)

```

X_train

```

array([[ 0.99718823, -0.57955796, -0.57297497, ...,  0.64561166,
         0.99573337, -1.74019169],
       [-1.0028197 , -0.57955796,  1.74527693, ..., -1.54891873,
        -1.00428491, -1.39787901],
       [-1.0028197 ,  1.72545295, -0.57297497, ..., -1.54891873,
         0.99573337, -1.48817335],
       ...,
       [ 0.99718823, -0.57955796, -0.57297497, ...,  0.64561166,
        -1.00428491,  0.71481237],
       [ 0.99718823, -0.57955796, -0.57297497, ..., -1.54891873,
        -1.00428491,  0.60834563],
       [-1.0028197 ,  1.72545295, -0.57297497, ...,  0.64561166,
         0.99573337,  0.0525285 ]])

```

X_test

```

array([[ -1.0028197 , -0.57955796,  1.74527693, ..., -1.54891873,
        -1.00428491, -0.90389608],
       [ 0.99718823, -0.57955796, -0.57297497, ...,  0.64561166,
         0.99573337, -0.54087223],
       [-1.0028197 , -0.57955796,  1.74527693, ...,  0.64561166,

```

```
0.99573337, -1.02004733],  
...,  
[ 0.99718823, -0.57955796, -0.57297497, ..., 0.64561166,  
0.99573337, -0.23978536],  
[ 0.99718823, -0.57955796, -0.57297497, ..., 0.64561166,  
0.99573337, -0.17457887],  
[ 0.99718823, -0.57955796, -0.57297497, ..., 0.64561166,  
-1.00428491, -0.0121091 ]])
```

y_train

```
array([0, 0, 0, ..., 0, 0, 0])
```

y_test

```
array([0, 1, 0, ..., 0, 0, 1])
```