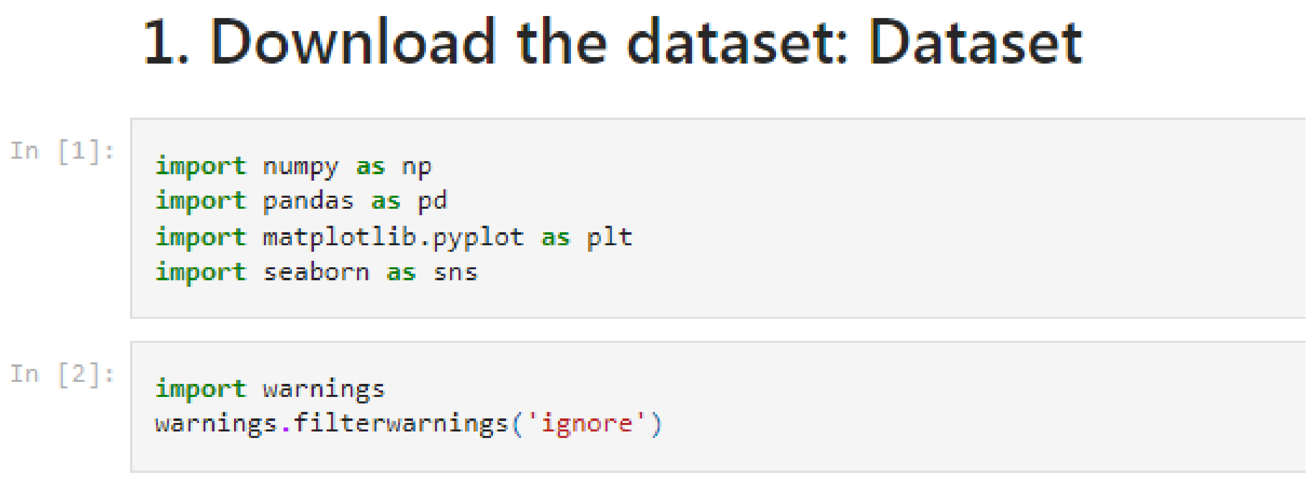
Assignment -2

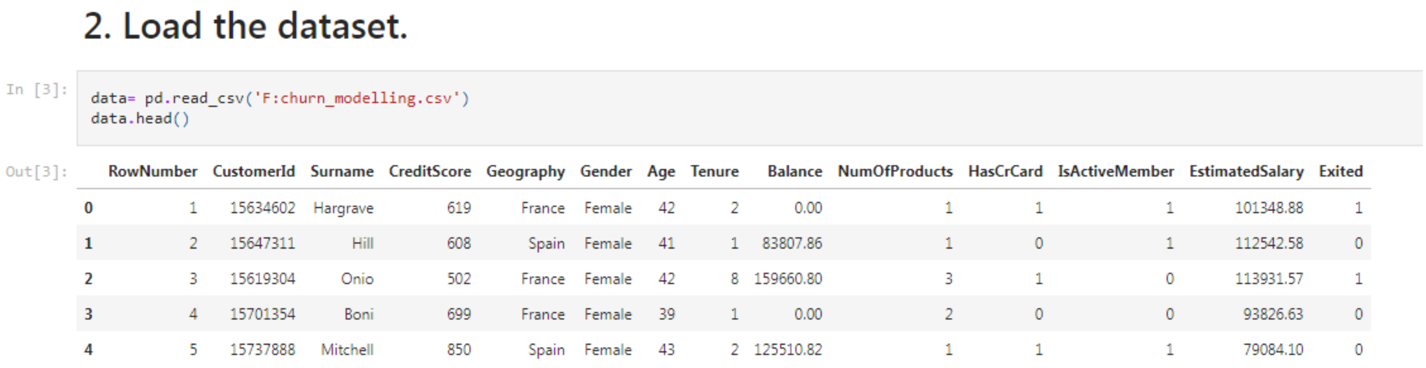
Assignment Date	17 September 2022
Student Name	Swati S
Student Roll Number	211419104283
Maximum Marks	2 Marks



1. Download the dataset: Dataset

In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

In [2]:
```
import warnings
warnings.filterwarnings('ignore')
```



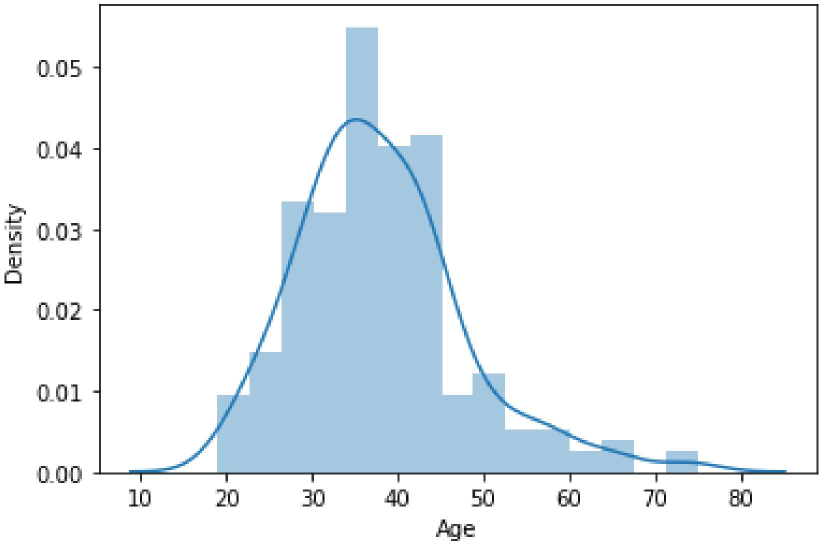
2. Load the dataset.

In [3]:
```
data= pd.read_csv('F:churn_modelling.csv')
data.head()
```

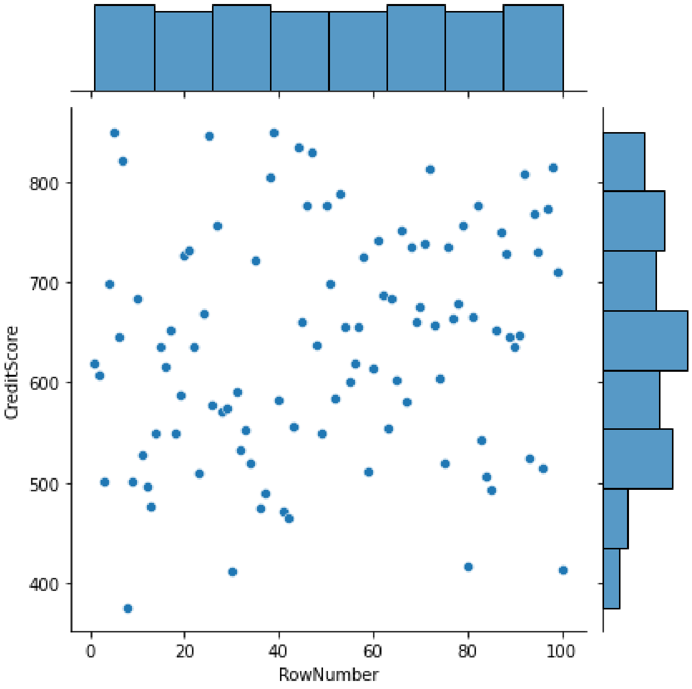
Out[3]:

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
0	1	15634602	Hargrave	619	France	Female	42	2	0.00	1	1	1	101348.88	1
1	2	15647311	Hill	608	Spain	Female	41	1	83807.86	1	0	1	112542.58	0
2	3	15619304	Onio	502	France	Female	42	8	159660.80	3	1	0	113931.57	1
3	4	15701354	Boni	699	France	Female	39	1	0.00	2	0	0	93826.63	0
4	5	15737888	Mitchell	850	Spain	Female	43	2	125510.82	1	1	1	79084.10	0

```
In [9]:  sns.distplot(data['Age'].head(200))

Out[9]:  <AxesSubplot:xlabel='Age', ylabel='Density'>
```



```
In [12]:  sns.jointplot(data['RowNumber'].head(100) ,data['CreditScore'].head(100),  )

Out[12]:  <seaborn.axisgrid.JointGrid at 0x1a2b931d400>
```



3. Perform Below Visualizations

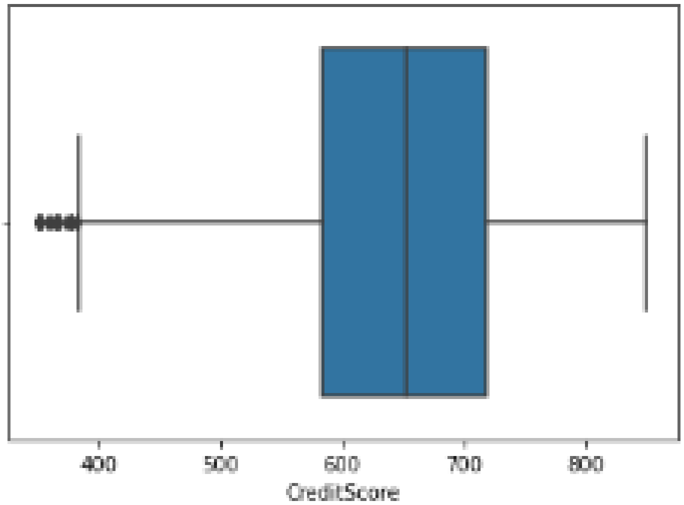
Univariate Analysis

In [4]:

```
# BoxpLot
sns.boxplot(data['CreditScore'])
```

Out[4]:

```
<AxesSubplot:xlabel='CreditScore'>
```

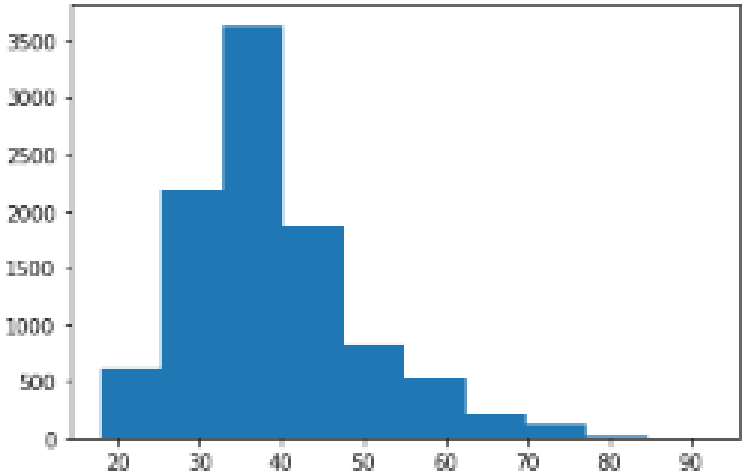


In [5]:

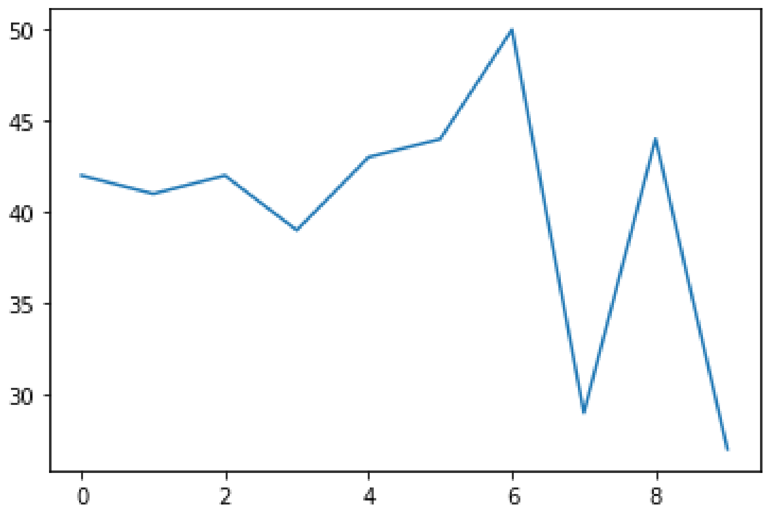
```
plt.hist(data['Age'])
```

Out[5]:

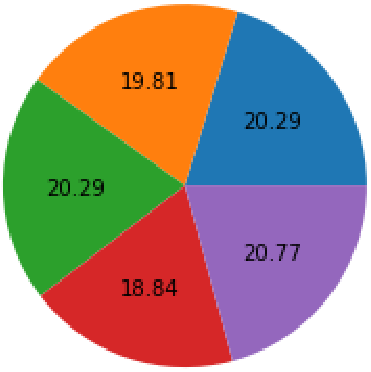
```
(array([ 611., 2179., 3629., 1871.,  828.,  523.,  208.,  127.,   20.,
           4.]),
 array([18. , 25.4, 32.8, 40.2, 47.6, 55. , 62.4, 69.8, 77.2, 84.6, 92. ]),
 <BarContainer object of 10 artists>)
```



```
In [7]: plt.plot(data['Age'].head(10))

Out[7]: [<matplotlib.lines.Line2D at 0x1a2b916c910>]
```



```
In [8]: plt.pie(data['Age'].head(), autopct="%.2f")

Out[8]: ([<matplotlib.patches.Wedge at 0x1a2b91d60a0>,
          <matplotlib.patches.Wedge at 0x1a2b91d6820>,
          <matplotlib.patches.Wedge at 0x1a2b91d6f40>,
          <matplotlib.patches.Wedge at 0x1a2b91e16a0>,
          <matplotlib.patches.Wedge at 0x1a2b91e1dc0>],
         [Text(0.8839942345509236, 0.654640506904917, ''),
          Text(-0.3525952068146547, 1.0419580702366729, ''),
          Text(-1.09987331875942, -0.01669379169450419, ''),
          Text(-0.35259525559223215, -1.0419580537304987, ''),
          Text(0.8739574598774371, -0.6679808068534441, '')],
         [Text(0.48217867339141285, 0.3570766401299547, '20.29'),
          Text(-0.19232465826253894, 0.5683407655836397, '19.81'),
          Text(-0.5999309011415017, -0.009105704560638648, '20.29'),
          Text(-0.19232468486849025, -0.5683407565802719, '18.84'),
          Text(0.47670406902405654, -0.3643531673746058, '20.77')])
```



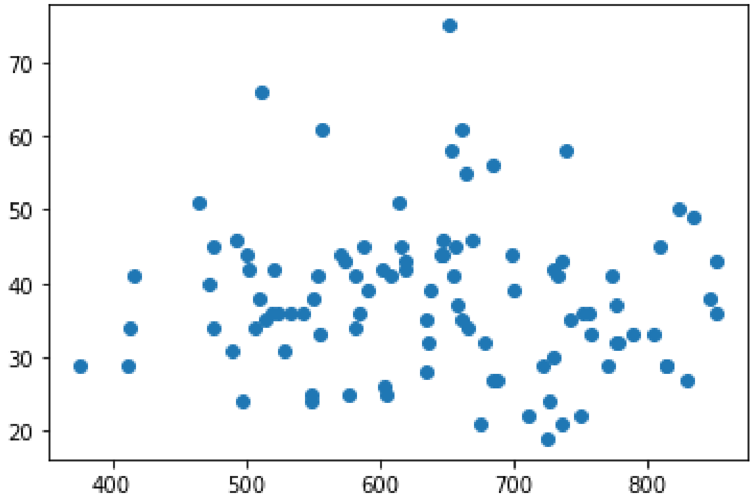
BI - Variate Analysis

In [10]:

```
plt.scatter(data['CreditScore'].head(100),data['Age'].head(100))
```

Out[10]:

```
<matplotlib.collections.PathCollection at 0x1a2b92deac0>
```

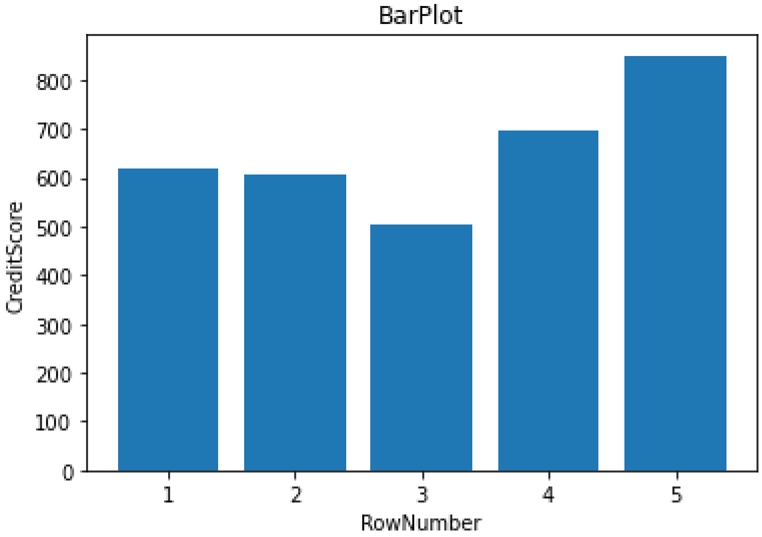


In [11]:

```
plt.bar(data['RowNumber'].head() ,data['CreditScore'].head(),  )

plt.title('BarPlot')
plt.xlabel('RowNumber')
plt.ylabel('CreditScore')
```

Out[11]:

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



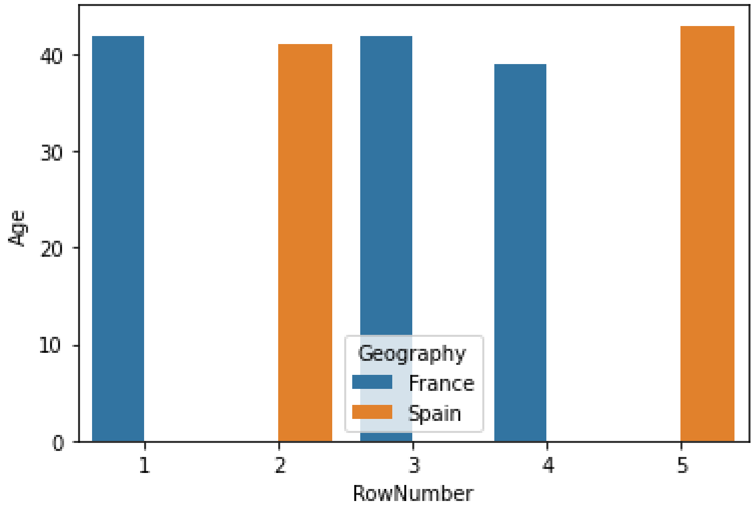
Multi - Variate Analysis

In [14]:

```
sns.barplot('RowNumber','Age',hue='Geography', data=data.head())
```

Out[14]:

```
<AxesSubplot:xlabel='RowNumber', ylabel='Age'>
```

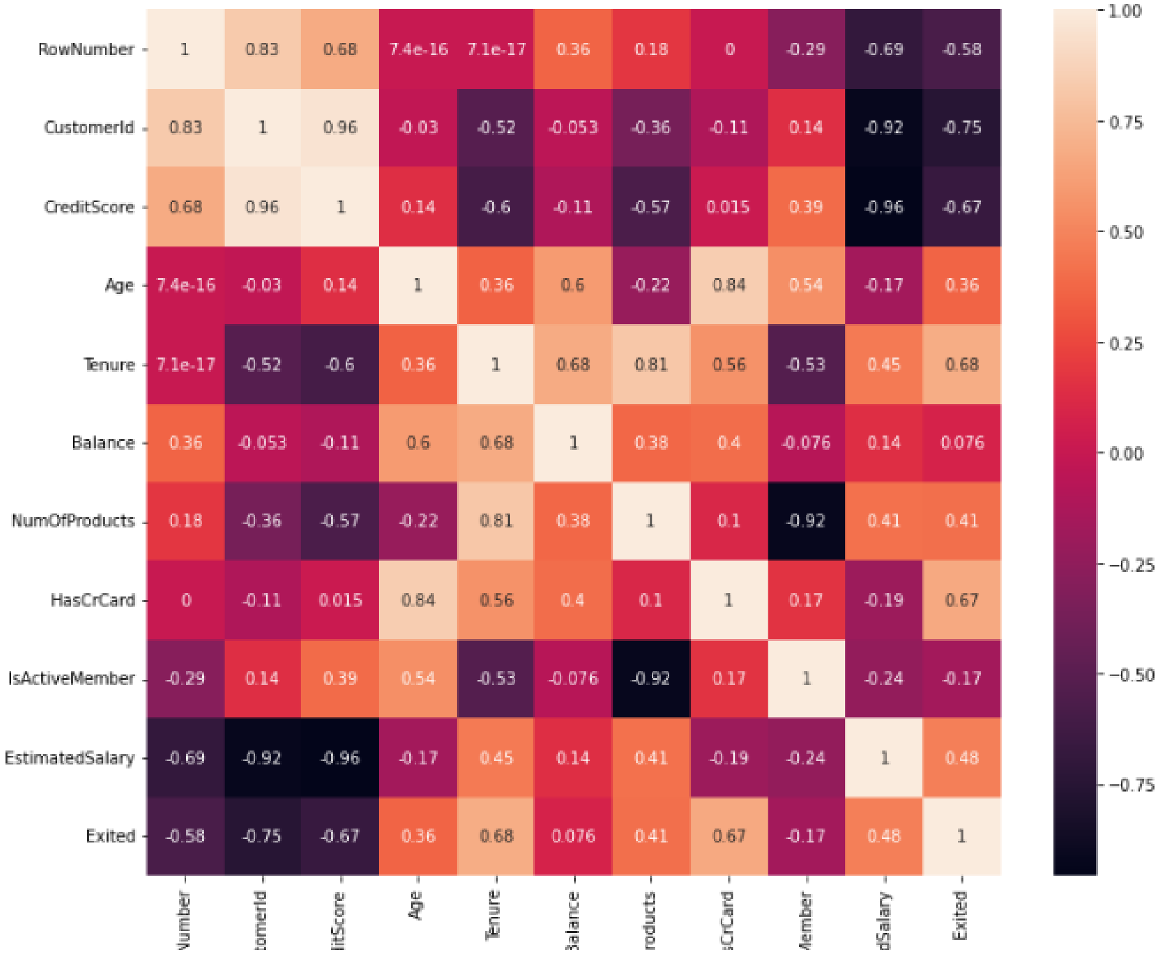


In [15]:

```
fig= plt.figure(figsize  =(12,10))
sns.heatmap(data.head().corr(), annot = True)
```

Out[15]:

```
<AxesSubplot:>
```



In [86]:

```
quantile= data['Age'].quantile(q=[0.75, 0.25])
quantile
```

Out[86]:

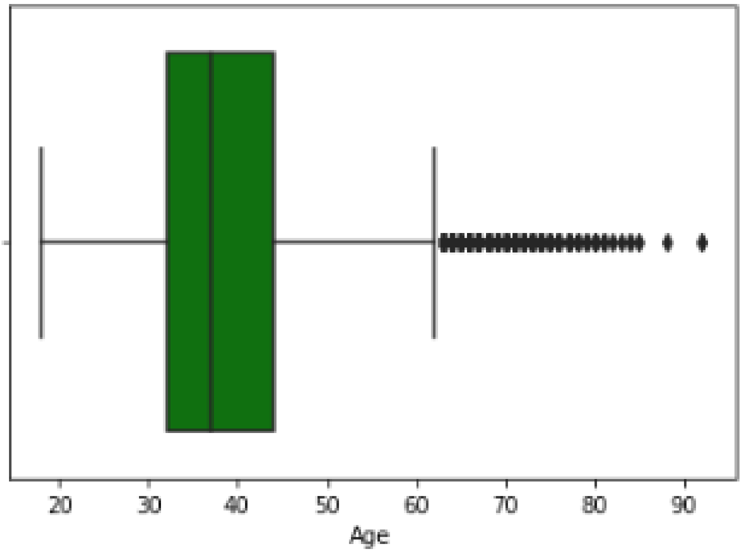
```
0.75    44.0
0.25    32.0
Name: Age, dtype: float64
```

In [23]:

```
sns.boxplot(data['Age'], color='green')
```

Out[23]:

```
<AxesSubplot:xlabel='Age'>
```



4. Perform descriptive statistics on the dataset.

In [21]:

```
data.head()
```

Out[21]:

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
0	1	15634602	Hargrave	619	France	Female	42	2	0.00	1	1	1	101348.88	1
1	2	15647311	Hill	608	Spain	Female	41	1	83807.86	1	0	1	112542.58	0
2	3	15619304	Onio	502	France	Female	42	8	159660.80	3	1	0	113931.57	1
3	4	15701354	Boni	699	France	Female	39	1	0.00	2	0	0	93826.63	0
4	5	15737888	Mitchell	850	Spain	Female	43	2	125510.82	1	1	1	79084.10	0

In [22]:

```
data.tail()
```

Out[22]:

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
9995	9996	15606229	Obijiaku	771	France	Male	39	5	0.00	2	1	0	96270.64	0
9996	9997	15569892	Johnstone	516	France	Male	35	10	57369.61	1	1	1	101699.77	0
9997	9998	15584532	Liu	709	France	Female	36	7	0.00	1	0	1	42085.58	1
9998	9999	15682355	Sabbatini	772	Germany	Male	42	3	75075.31	2	1	0	92888.52	1
9999	10000	15628319	Walker	792	France	Female	28	4	130142.79	1	1	0	38190.78	0

In [19]:

```
data.shape
```

Out[19]:

```
(10000, 14)
```

In [20]:

```
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 [ ]:

```
## 4 movement of business decisions
data.mean()
```

In [ ]:

```
data.median()
```

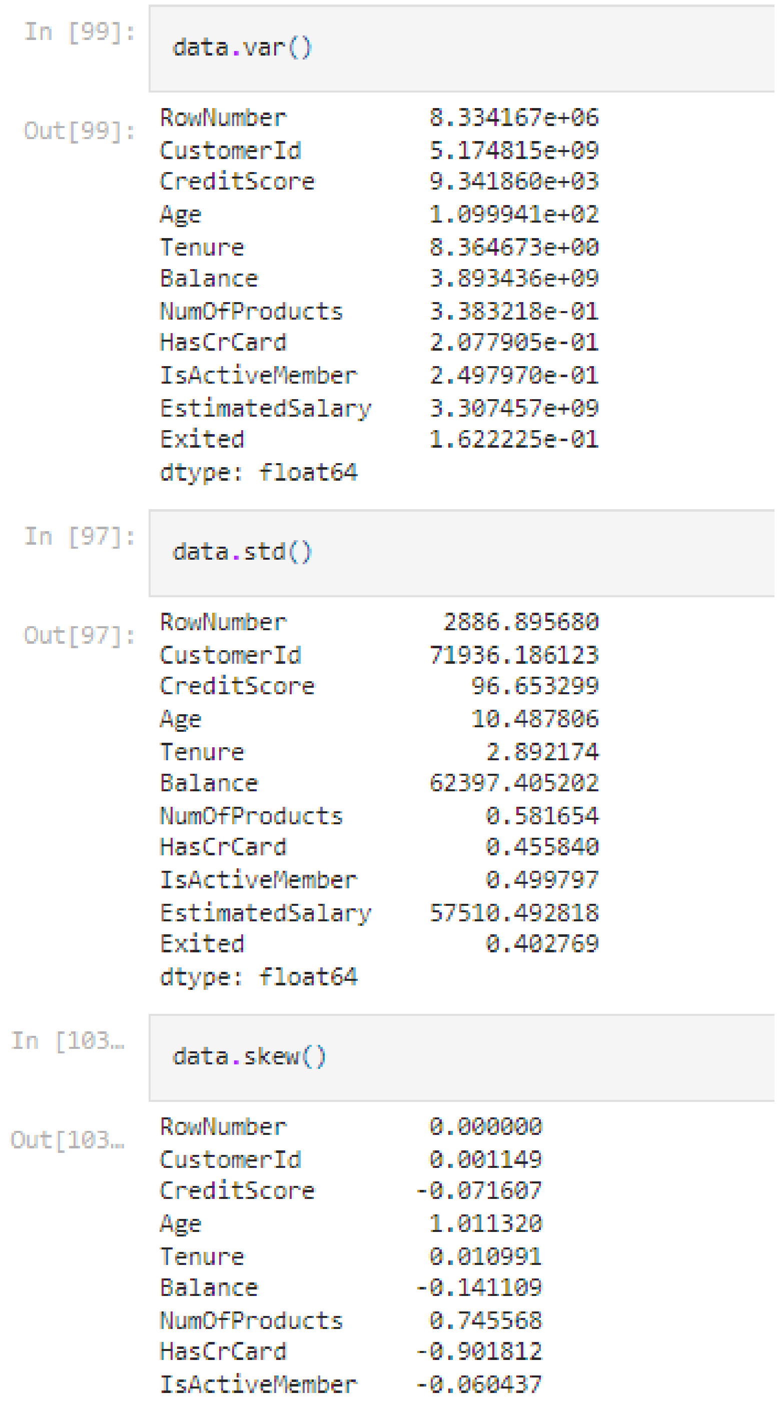
In [96]:

```
data.mode()
```

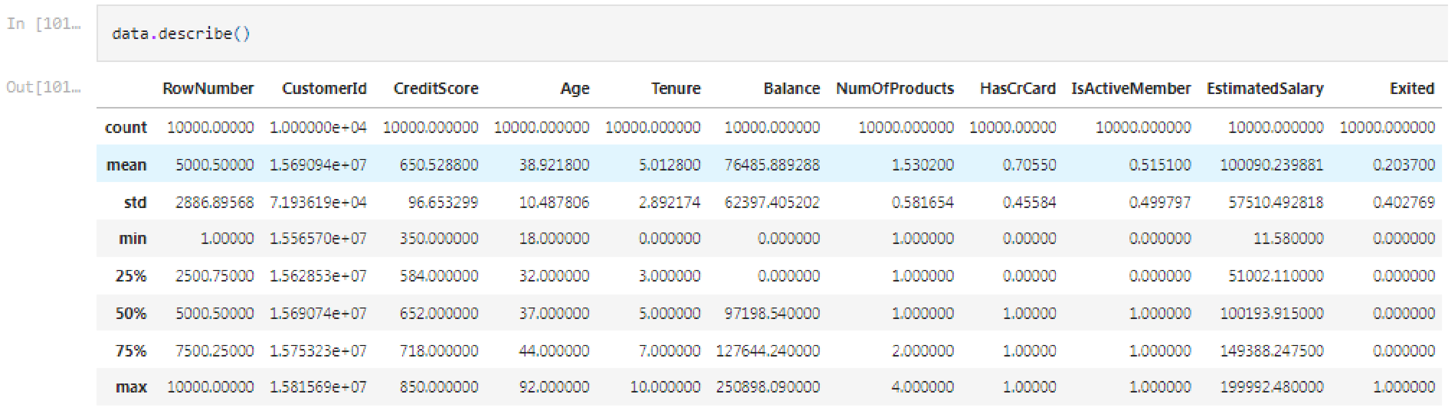
Out[96]:

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
0	1	15565701	Smith	850.0	France	Male	37.0	2.0	0.0	1.0	1.0	1.0	24924.92	0.0
1	2	15565706	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2	3	15565714	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
3	4	15565779	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
4	5	15565796	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
9995	9996	15815628	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
9996	9997	15815645	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
9997	9998	15815656	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
9998	9999	15815660	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
9999	10000	15815690	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

10000 rows × 14 columns



```
In [99]:  data.var()

Out[99]:  RowNumber          8.334167e+06
          CustomerId         5.174815e+09
          CreditScore        9.341860e+03
          Age                1.099941e+02
          Tenure             8.364673e+00
          Balance            3.893436e+09
          NumOfProducts      3.383218e-01
          HasCrCard          2.077905e-01
          IsActiveMember     2.497970e-01
          EstimatedSalary    3.307457e+09
          Exited             1.622225e-01
          dtype: float64

In [97]:  data.std()

Out[97]:  RowNumber           2886.895680
          CustomerId         71936.186123
          CreditScore           96.653299
          Age                   10.487806
          Tenure                 2.892174
          Balance            62397.405202
          NumOfProducts          0.581654
          HasCrCard              0.455840
          IsActiveMember         0.499797
          EstimatedSalary    57510.492818
          Exited                 0.402769
          dtype: float64

In [103…  data.skew()

Out[103…  RowNumber          0.000000
          CustomerId         0.001149
          CreditScore       -0.071607
          Age                1.011320
          Tenure             0.010991
          Balance           -0.141109
          NumOfProducts      0.745568
          HasCrCard         -0.901812
          IsActiveMember    -0.060437
```



```
In [101…  data.describe()
```

Out[101…

	RowNumber	CustomerId	CreditScore	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
count	10000.00000	1.000000e+04	10000.000000	10000.000000	10000.000000	10000.000000	10000.000000	10000.00000	10000.000000	10000.000000	10000.000000
mean	5000.50000	1.569094e+07	650.528800	38.921800	5.012800	76485.889288	1.530200	0.70550	0.515100	100090.239881	0.203700
std	2886.89568	7.193619e+04	96.653299	10.487806	2.892174	62397.405202	0.581654	0.45584	0.499797	57510.492818	0.402769
min	1.00000	1.556570e+07	350.000000	18.000000	0.000000	0.000000	1.000000	0.00000	0.000000	11.580000	0.000000
25%	2500.75000	1.562853e+07	584.000000	32.000000	3.000000	0.000000	1.000000	0.00000	0.000000	51002.110000	0.000000
50%	5000.50000	1.569074e+07	652.000000	37.000000	5.000000	97198.540000	1.000000	1.00000	1.000000	100193.915000	0.000000
75%	7500.25000	1.575323e+07	718.000000	44.000000	7.000000	127644.240000	2.000000	1.00000	1.000000	149388.247500	0.000000
max	10000.00000	1.581569e+07	850.000000	92.000000	10.000000	250898.090000	4.000000	1.00000	1.000000	199992.480000	1.000000

5. Handle the Missing values.

In [118…

```
data.isna().any()
```

Out[118…

```
RowNumber          False
CustomerId         False
Surname            False
CreditScore        False
Geography          False
Gender             False
Age                False
Tenure             False
Balance            False
NumOfProducts      False
HasCrCard          False
IsActiveMember     False
EstimatedSalary    False
Exited             False
dtype: bool
```

No missing values

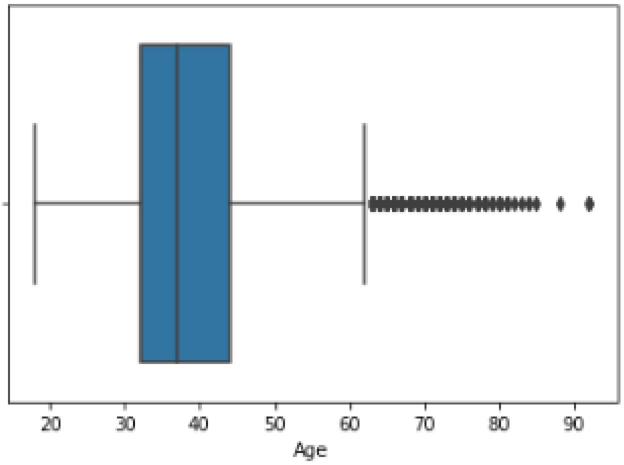
6. Find the outliers and replace the outliers

In [119…

```
sns.boxplot(data['Age'])
```

Out[119…

```
<AxesSubplot:xlabel='Age'>
```



In [120…

```
data.mean()
```

Out[120…

```
RowNumber          5.000500e+03
CustomerId         1.569094e+07
CreditScore        6.505288e+02
Age                3.892180e+01
Tenure             5.012800e+00
Balance            7.648589e+04
NumOfProducts      1.530200e+00
HasCrCard          7.055000e-01
IsActiveMember     5.151000e-01
EstimatedSalary    1.000902e+05
Exited             2.037000e-01
dtype: float64
```

```
qut= data.quantile(q=[0.25,0.75])
qut
```

	RowNumber	CustomerId	CreditScore	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
0.25	2500.75	15628528.25	584.0	32.0	3.0	0.00	1.0	0.0	0.0	51002.1100	0.0
0.75	7500.25	15753233.75	718.0	44.0	7.0	127644.24	2.0	1.0	1.0	149388.2475	0.0

```
irq=qut.loc[0.75]- qut.loc[0.25] # q3 and q1
irq
```

```
RowNumber            4999.5000
CustomerId         124705.5000
CreditScore           134.0000
Age                    12.0000
Tenure                  4.0000
Balance            127644.2400
NumOfProducts           1.0000
HasCrCard               1.0000
IsActiveMember          1.0000
EstimatedSalary     98386.1375
Exited                  0.0000
dtype: float64
```

```
# Lower
lower= qut.loc[0.25]+(1.5*irq)
lower
```

```
RowNumber          1.000000e+04
CustomerId         1.581559e+07
CreditScore        7.850000e+02
Age                5.000000e+01
Tenure             9.000000e+00
Balance            1.914664e+05
NumOfProducts      2.500000e+00
HasCrCard          1.500000e+00
IsActiveMember     1.500000e+00
EstimatedSalary    1.985813e+05
Exited             0.000000e+00
dtype: float64
```

In [146…

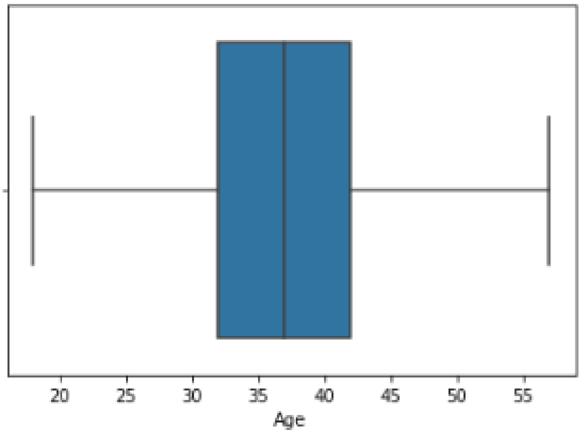
```
data['Age']=np.where(data['Age']>57,39, data['Age'])
```

In [147…

```
sns.boxplot(data['Age'])
```

Out[147…

```
<AxesSubplot:xlabel='Age'>
```



In [124…

```
#upper
upper= qut.loc[0.75]+(1.5*irq)
upper
```

Out[124…

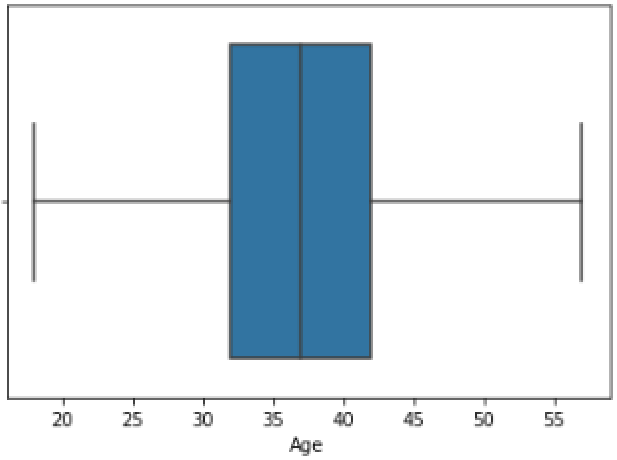
```
RowNumber          1.499950e+04
CustomerId         1.594029e+07
CreditScore        9.190000e+02
Age                6.200000e+01
Tenure             1.300000e+01
Balance            3.191106e+05
NumOfProducts      3.500000e+00
HasCrCard          2.500000e+00
IsActiveMember     2.500000e+00
EstimatedSalary    2.969675e+05
Exited             0.000000e+00
dtype: float64
```

In [144…

```
sns.boxplot(data['Age'])
```

Out[144…

```
<AxesSubplot:xlabel='Age'>
```



In [145…

```
data['Age'].mean()
```

Out[145…

```
37.2174
```

7. Check for Categorical columns and perform encoding.

[149…

```
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
```

[150…

```
data.head()
```

:[150…

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
0	1	15634602	Hargrave	619	France	Female	42	2	0.00	1	1	1	101348.88	1
1	2	15647311	Hill	608	Spain	Female	41	1	83807.86	1	0	1	112542.58	0
2	3	15619304	Onio	502	France	Female	42	8	159660.80	3	1	0	113931.57	1
3	4	15701354	Boni	699	France	Female	39	1	0.00	2	0	0	93826.63	0
4	5	15737888	Mitchell	850	Spain	Female	43	2	125510.82	1	1	1	79084.10	0

In [158…

```
data.Geography.unique()
```

Out[158…

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

In [162…

```
data['Gender'].replace({'Female':0, 'Male': 1 }, inplace=True)
data['Geography'].replace({'France':0,'Germany':1, 'Spain':2}, inplace=True)
data.head()
```

Out[162…

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
0	1	15634602	Hargrave	619	0	0	42	2	0.00	1	1	1	101348.88	1
1	2	15647311	Hill	608	2	0	41	1	83807.86	1	0	1	112542.58	0
2	3	15619304	Onio	502	0	0	42	8	159660.80	3	1	0	113931.57	1
3	4	15701354	Boni	699	0	0	39	1	0.00	2	0	0	93826.63	0
4	5	15737888	Mitchell	850	2	0	43	2	125510.82	1	1	1	79084.10	0

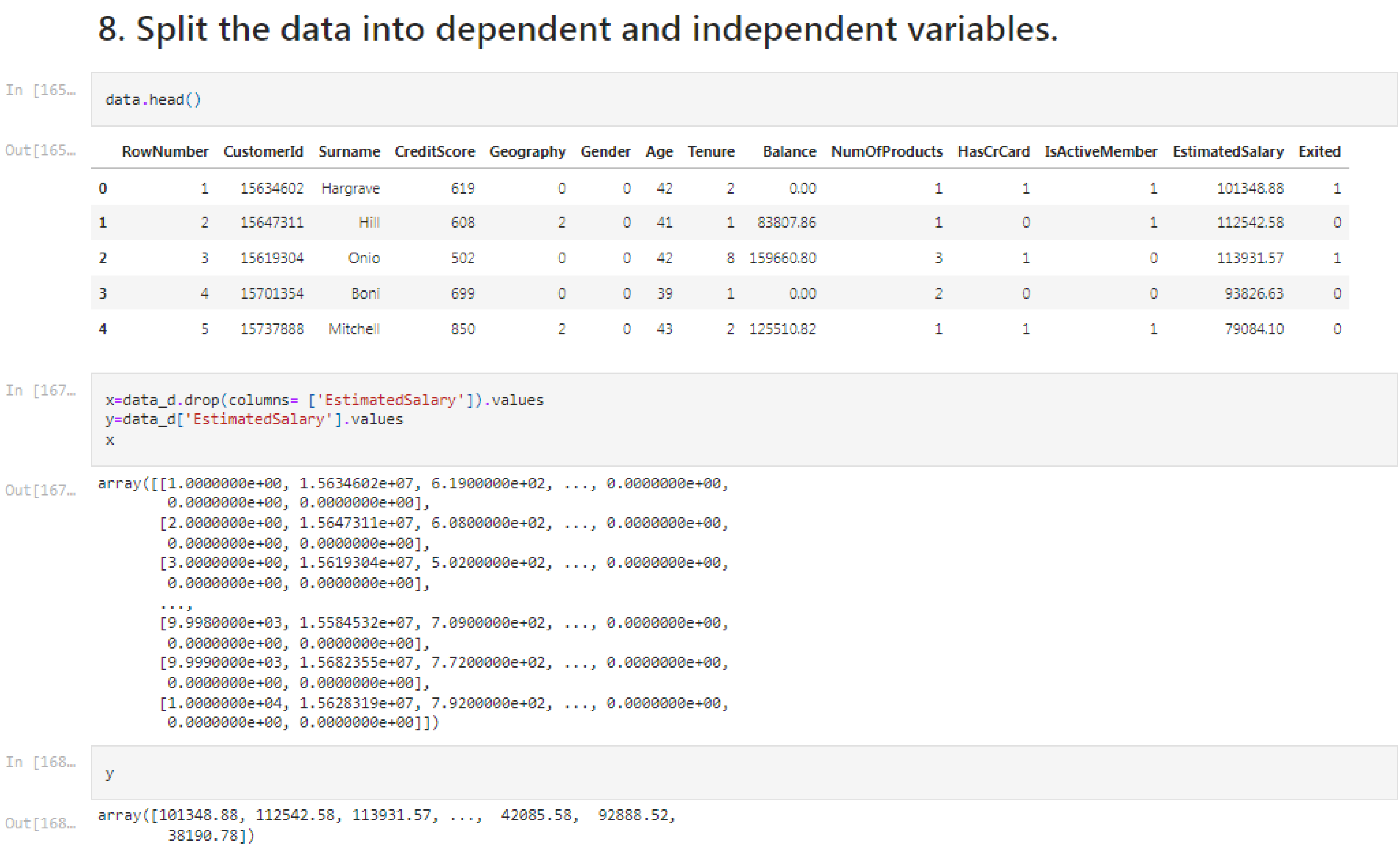
In [160…

```
# using dummy values
data_d= pd.get_dummies(data,columns = ['Surname'])
data_d.head()
```

Out[160…

	RowNumber	CustomerId	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	...	Surname_Zinachukwudi	Surname_Zito	Surname_Zotov
0	1	15634602	619	0	0	42	2	0.00	1	1	...	0	0	0
1	2	15647311	608	2	0	41	1	83807.86	1	0	...	0	0	0
2	3	15619304	502	0	0	42	8	159660.80	3	1	...	0	0	0
3	4	15701354	699	0	0	39	1	0.00	2	0	...	0	0	0
4	5	15737888	850	2	0	43	2	125510.82	1	1	...	0	0	0

5 rows × 2945 columns



8. Split the data into dependent and independent variables.

In [165…
```
data.head()
```

Out[165…

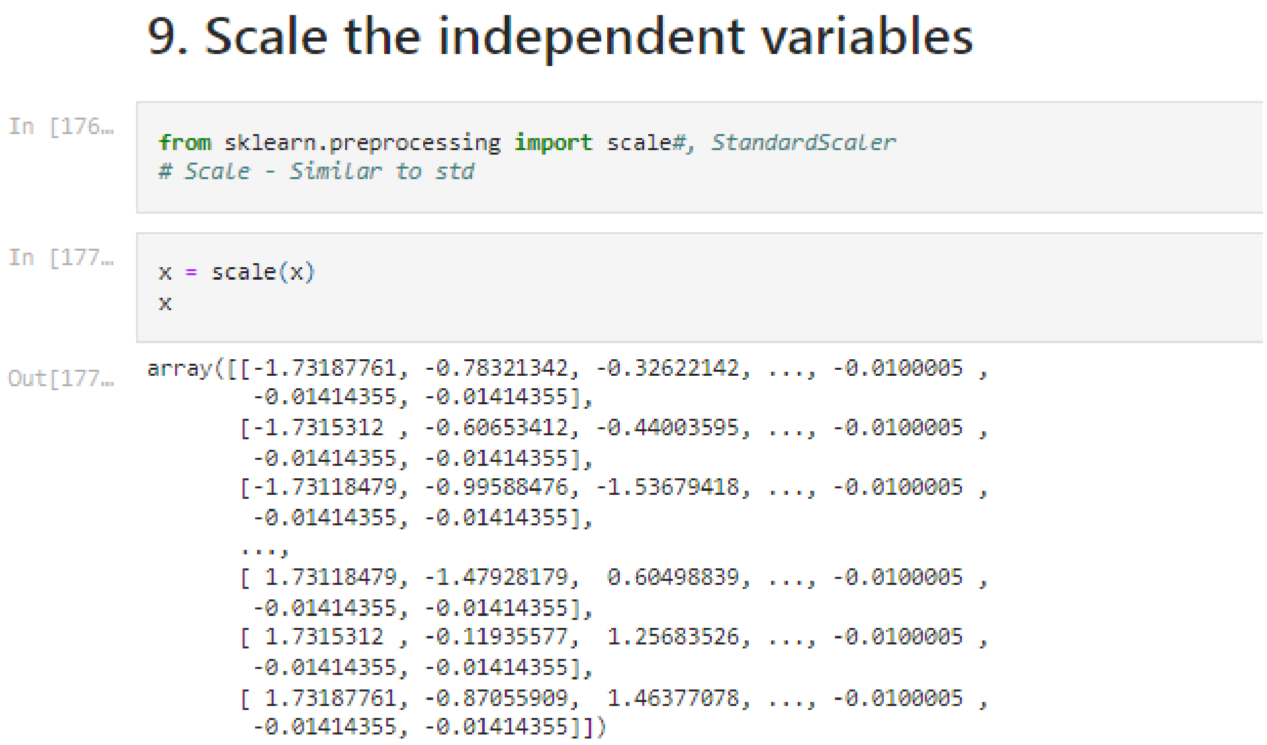
	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary	Exited
0	1	15634602	Hargrave	619	0	0	42	2	0.00	1	1	1	101348.88	1
1	2	15647311	Hill	608	2	0	41	1	83807.86	1	0	1	112542.58	0
2	3	15619304	Onio	502	0	0	42	8	159660.80	3	1	0	113931.57	1
3	4	15701354	Boni	699	0	0	39	1	0.00	2	0	0	93826.63	0
4	5	15737888	Mitchell	850	2	0	43	2	125510.82	1	1	1	79084.10	0

In [167…
```
x=data_d.drop(columns= ['EstimatedSalary']).values
y=data_d['EstimatedSalary'].values
x
```

Out[167…
```
array([[1.0000000e+00, 1.5634602e+07, 6.1900000e+02, ..., 0.0000000e+00,
        0.0000000e+00, 0.0000000e+00],
       [2.0000000e+00, 1.5647311e+07, 6.0800000e+02, ..., 0.0000000e+00,
        0.0000000e+00, 0.0000000e+00],
       [3.0000000e+00, 1.5619304e+07, 5.0200000e+02, ..., 0.0000000e+00,
        0.0000000e+00, 0.0000000e+00],
       ...,
       [9.9980000e+03, 1.5584532e+07, 7.0900000e+02, ..., 0.0000000e+00,
        0.0000000e+00, 0.0000000e+00],
       [9.9990000e+03, 1.5682355e+07, 7.7200000e+02, ..., 0.0000000e+00,
        0.0000000e+00, 0.0000000e+00],
       [1.0000000e+04, 1.5628319e+07, 7.9200000e+02, ..., 0.0000000e+00,
        0.0000000e+00, 0.0000000e+00]])
```

In [168…
```
y
```

Out[168…
```
array([101348.88, 112542.58, 113931.57, ...,  42085.58,  92888.52,
        38190.78])
```



9. Scale the independent variables

In [176…
```
from sklearn.preprocessing import scale#, StandardScaler
# Scale - Similar to std
```

In [177…
```
x = scale(x)
x
```

Out[177…
```
array([[-1.73187761, -0.78321342, -0.32622142, ..., -0.0100005 ,
        -0.01414355, -0.01414355],
       [-1.7315312 , -0.60653412, -0.44003595, ..., -0.0100005 ,
        -0.01414355, -0.01414355],
       [-1.73118479, -0.99588476, -1.53679418, ..., -0.0100005 ,
        -0.01414355, -0.01414355],
       ...,
       [ 1.73118479, -1.47928179,  0.60498839, ..., -0.0100005 ,
        -0.01414355, -0.01414355],
       [ 1.7315312 , -0.11935577,  1.25683526, ..., -0.0100005 ,
        -0.01414355, -0.01414355],
       [ 1.73187761, -0.87055909,  1.46377078, ..., -0.0100005 ,
        -0.01414355, -0.01414355]])
```

10. Split the data into training and testing

In [169…

```
from sklearn.model_selection import train_test_split
```

In [170…

```
x_train, x_test, y_train, y_test = train_test_split(x,y, test_size = 0.2)
```

In [171…

```
print(x_train.shape, x_test.shape)
```

```
(8000, 2944) (2000, 2944)
```