

```
import pandas as pd
import numpy as np
```

#1. Download the dataset: Dataset

1. Load the dataset.

```
df=pd.read_csv('/content/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.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

```

## Handle the Missing values

```
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

```

#4. Perform descriptive statistics on the dataset.

```
df.describe()
```

```

      RowNumber  CustomerId  CreditScore  Age
Tenure \
count  10000.00000  1.000000e+04  10000.000000  10000.000000
10000.000000
mean    5000.50000  1.569094e+07    650.528800    38.921800
5.012800
std     2886.89568  7.193619e+04     96.653299    10.487806
2.892174
min       1.00000  1.556570e+07    350.000000    18.000000
0.000000
25%     2500.75000  1.562853e+07    584.000000    32.000000
3.000000
50%     5000.50000  1.569074e+07    652.000000    37.000000
5.000000
75%     7500.25000  1.575323e+07    718.000000    44.000000
7.000000

```

```
max    10000.00000  1.581569e+07  850.000000  92.000000
10.000000
```

```

      Balance  NumOfProducts  HasCrCard  IsActiveMember  \
count  10000.000000  10000.000000  10000.000000  10000.000000
mean    76485.889288    1.530200    0.70550    0.515100
std     62397.405202    0.581654    0.45584    0.499797
min       0.000000    1.000000    0.00000    0.000000
25%       0.000000    1.000000    0.00000    0.000000
50%     97198.540000    1.000000    1.00000    1.000000
75%    127644.240000    2.000000    1.00000    1.000000
max    250898.090000    4.000000    1.00000    1.000000

```

```

      EstimatedSalary  Exited
count  10000.000000  10000.000000
mean    100090.239881    0.203700
std     57510.492818    0.402769
min       11.580000    0.000000
25%     51002.110000    0.000000
50%    100193.915000    0.000000
75%    149388.247500    0.000000
max    199992.480000    1.000000

```

```
df['Geography'].value_counts()
```

```
France    5014
Germany   2509
Spain     2477
Name: Geography, dtype: int64
```

#7. Check for Categorical columns and perform encoding.

```
from sklearn.preprocessing import LabelEncoder
la=LabelEncoder()
```

```
df['Geography']=la.fit_transform(df['Geography'])
```

```
df['Surname'].value_counts()
```

```

Smith      32
Scott      29
Martin     29
Walker     28
Brown      26
..
Izmailov   1
Bold       1
Bonham     1
Poninski   1
Burbidge   1
Name: Surname, Length: 2932, dtype: int64

```

```
df['Surname']=la.fit_transform(df['Surname'])
```

```
df['Gender'].value_counts()
```

```
Male      5457
```

```
Female    4543
```

```
Name: Gender, dtype: int64
```

```
df['Gender']=la.fit_transform(df['Gender'])
```

```
df.head()
```

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age
0	1	15634602	1115	619	0	0	42
1	2	15647311	1177	608	2	0	41
2	3	15619304	2040	502	0	0	42
3	4	15701354	289	699	0	0	39
4	5	15737888	1822	850	2	0	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

#3. Perform Below Visualizations. ● Univariate Analysis ● Bi - Variate Analysis ● Multi - Variate Analysis

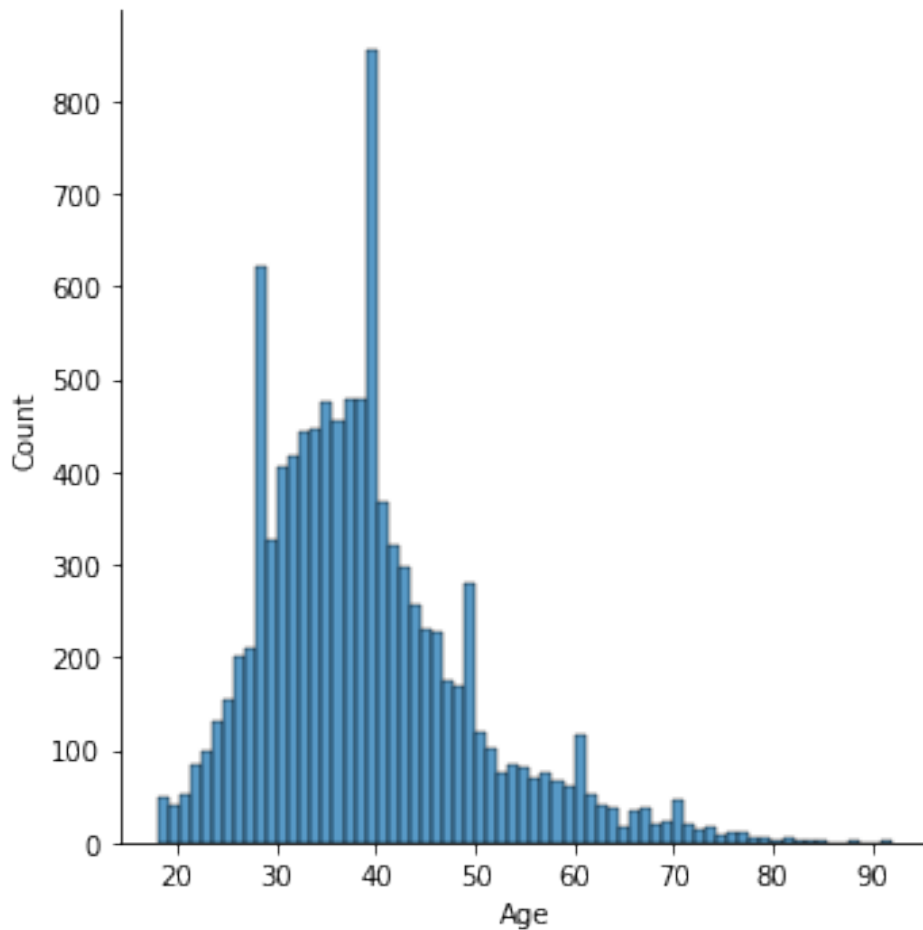
```
import matplotlib.pyplot as plt
```

```
import seaborn as sns
```

```
#univariate analysis
```

```
sns.displot(df['Age'])
```

```
<seaborn.axisgrid.FacetGrid at 0x7f4d13926250>
```



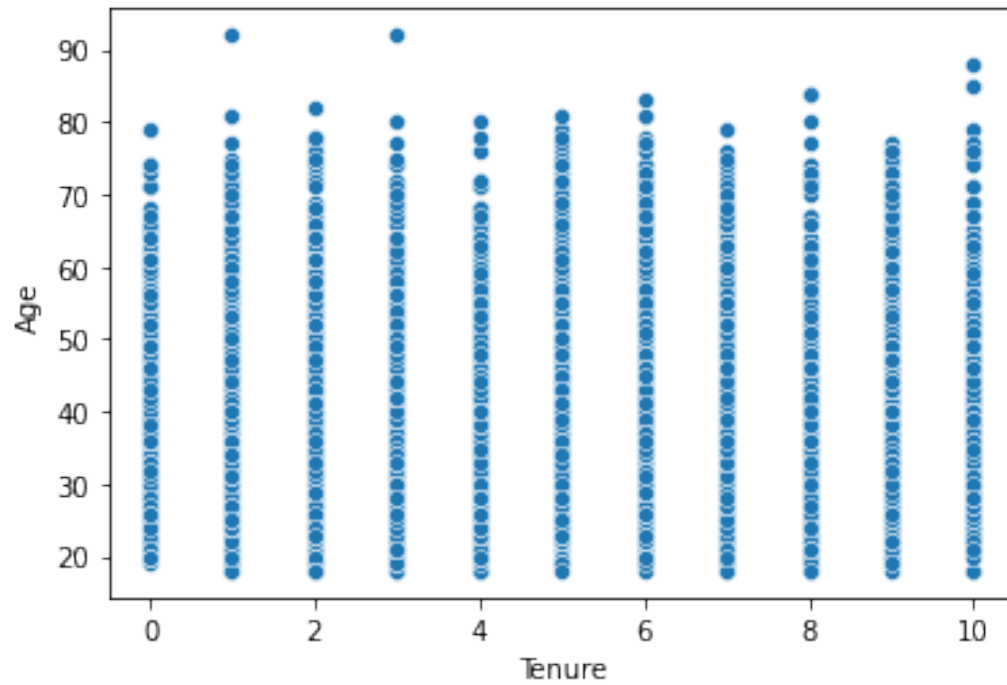
```
#bivariate analysis
```

```
sns.scatterplot(df['Tenure'],df['Age'])
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43:  
FutureWarning: Pass the following variables as keyword args: x, y.  
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
```

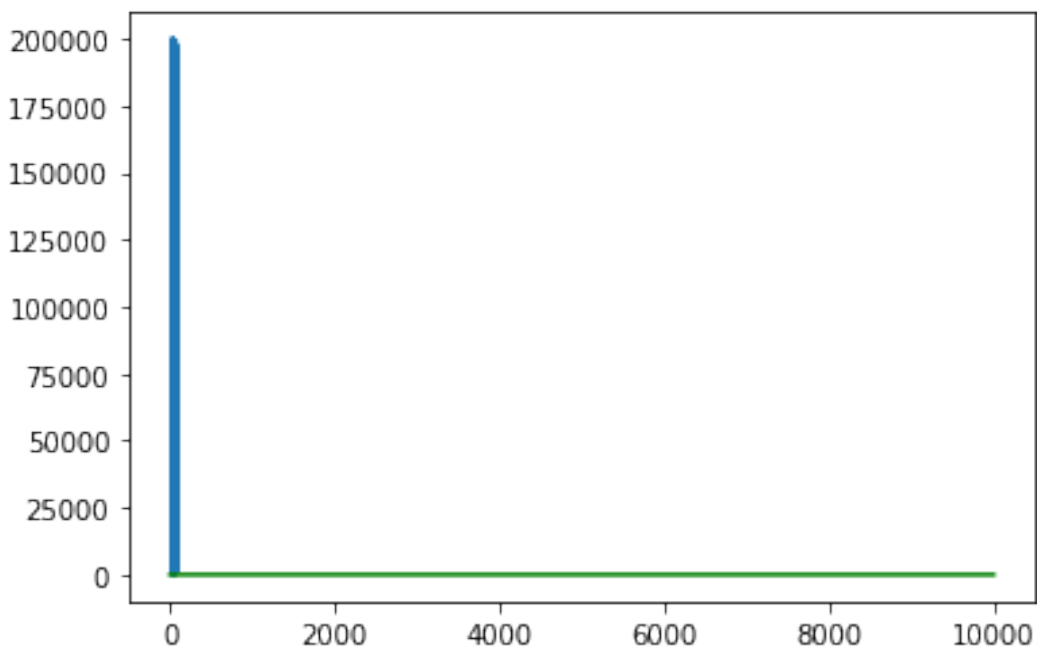
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f4d137c66d0>
```



#multivariate analysis

```
sns.jointplot(x='Age',y='Tenure',data=df)
```

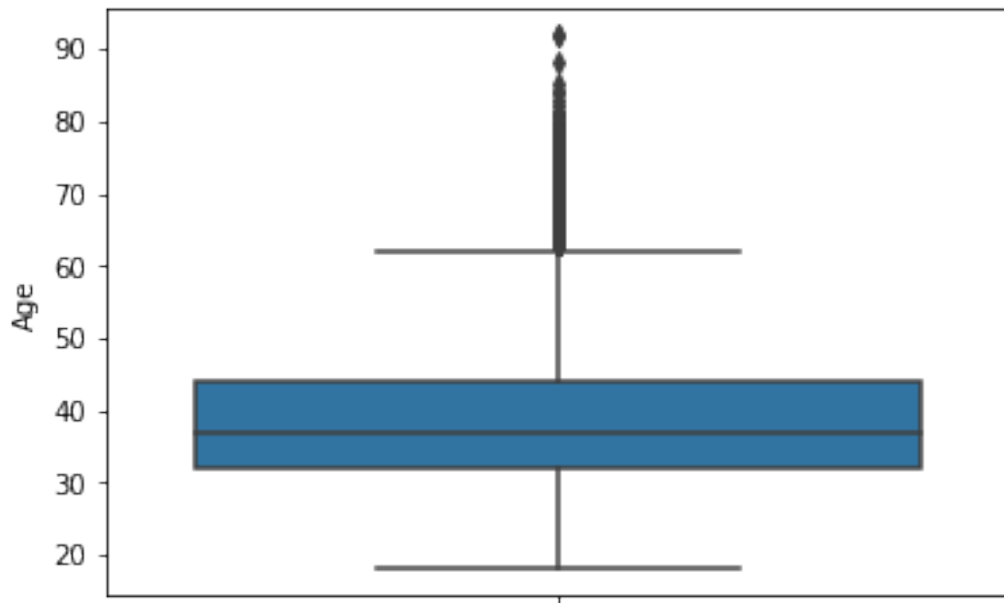
```
[<matplotlib.lines.Line2D at 0x7f4d10398450>,  
<matplotlib.lines.Line2D at 0x7f4d103985d0>]
```



#Finding outliers and replacing it

```
sns.boxplot(y='Age',data=df)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f9385510490>
```

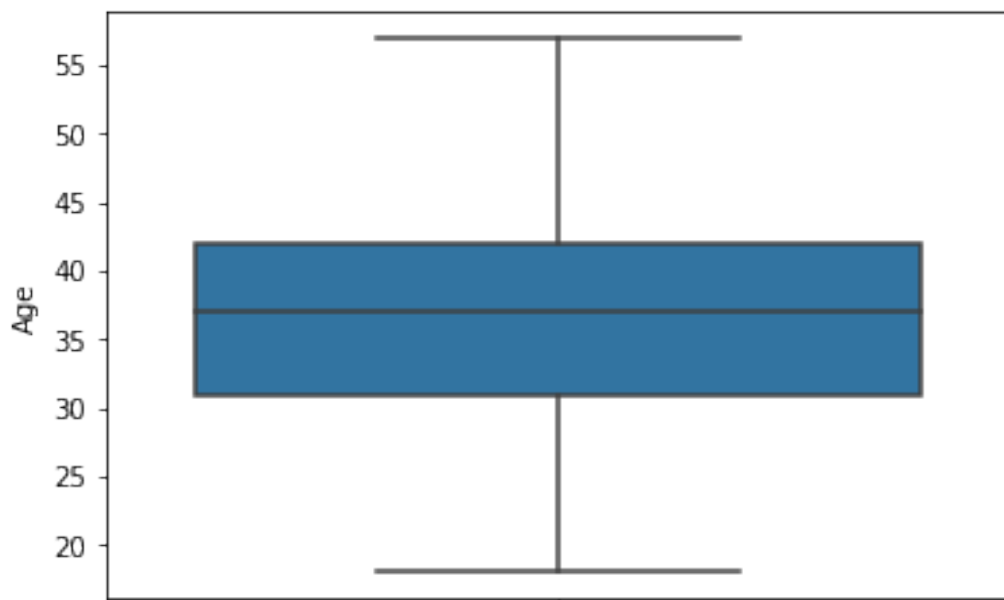


```
df['Age'].mean()
```

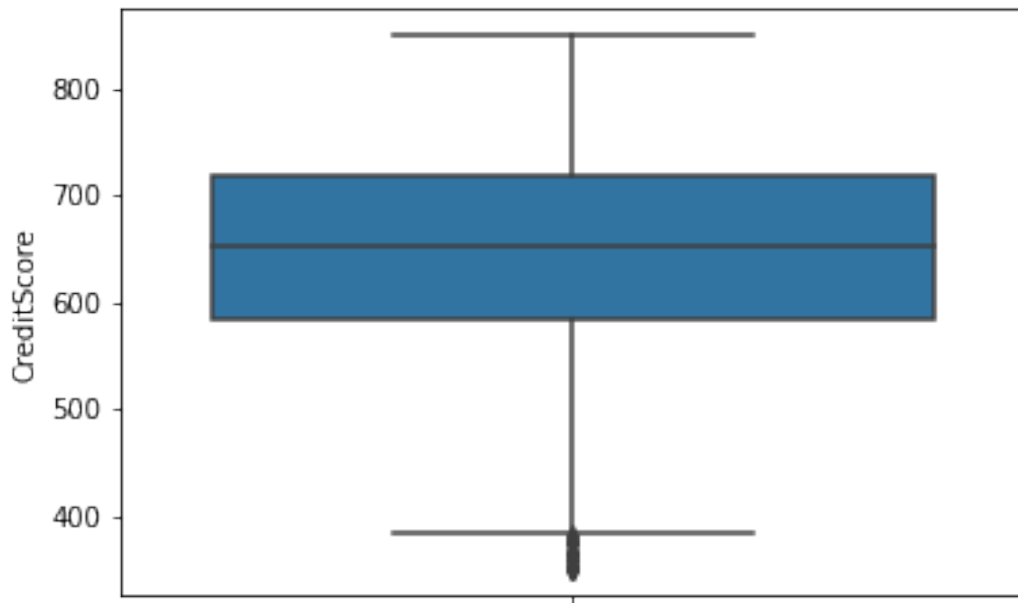
```
38.9218
```

```
df1=df[df['Age']<58]  
sns.boxplot(y='Age',data=df1)  
#df1['Age'].mean()
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f93842beed0>
```

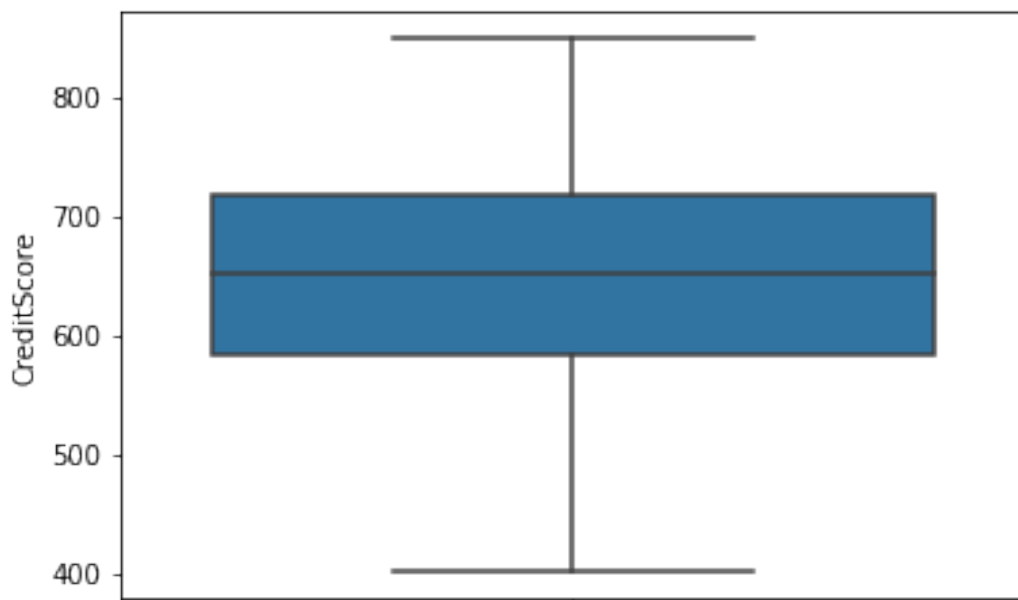


```
sns.boxplot(y='CreditScore',data=df)
<matplotlib.axes._subplots.AxesSubplot at 0x7f938567ded0>
```



```
df['CreditScore'].mean()
650.5288
df1=df[df['CreditScore']>400]
sns.boxplot(y='CreditScore',data=df1)
#df1['CreditScore'].mean()
```

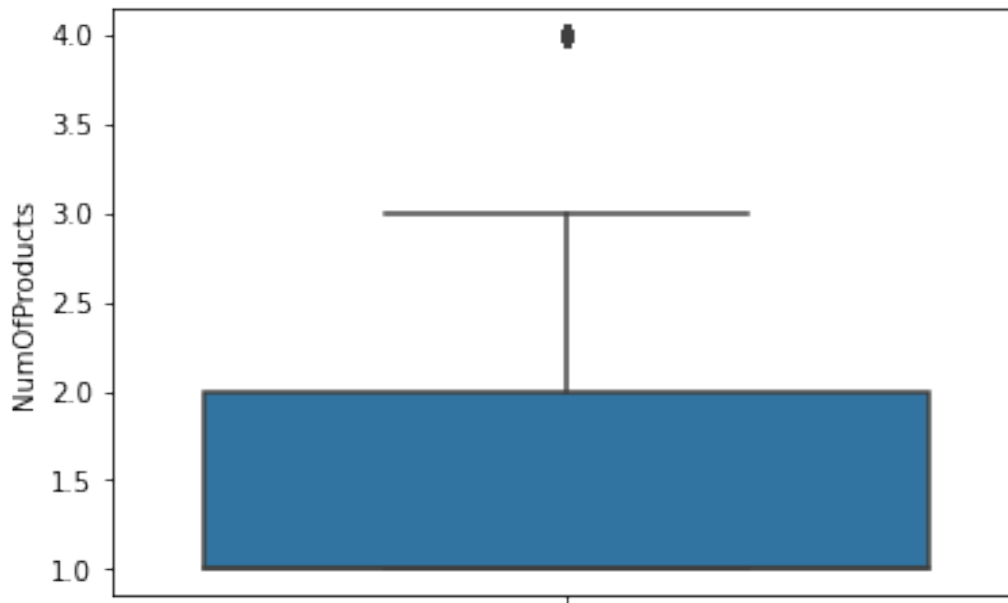
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f938427d2d0>
```





```
sns.boxplot(y='NumOfProducts',data=df)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f93855f7a10>
```

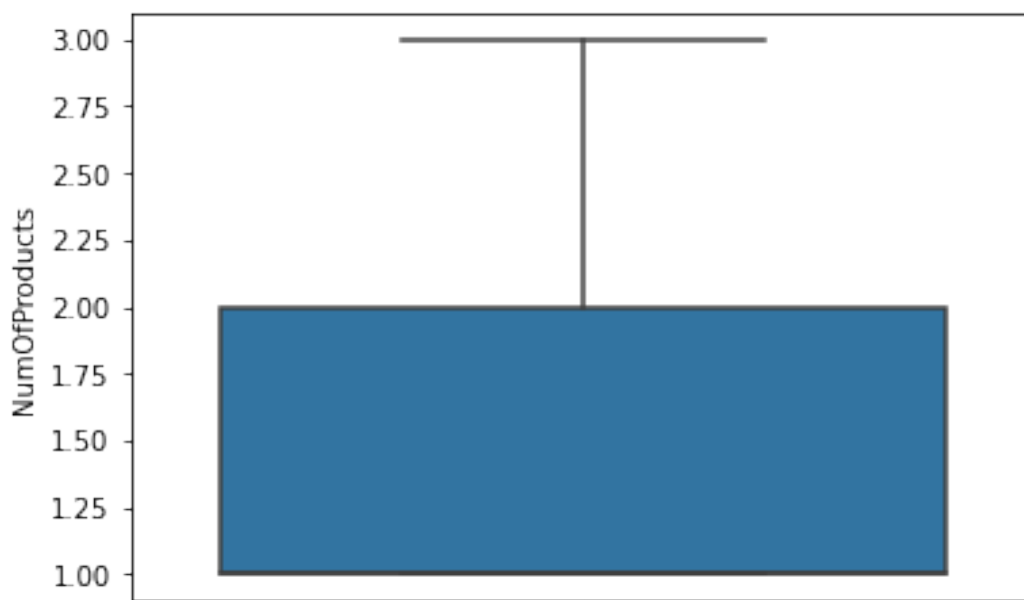


```
df['NumOfProducts'].mean()
```

```
1.5302
```

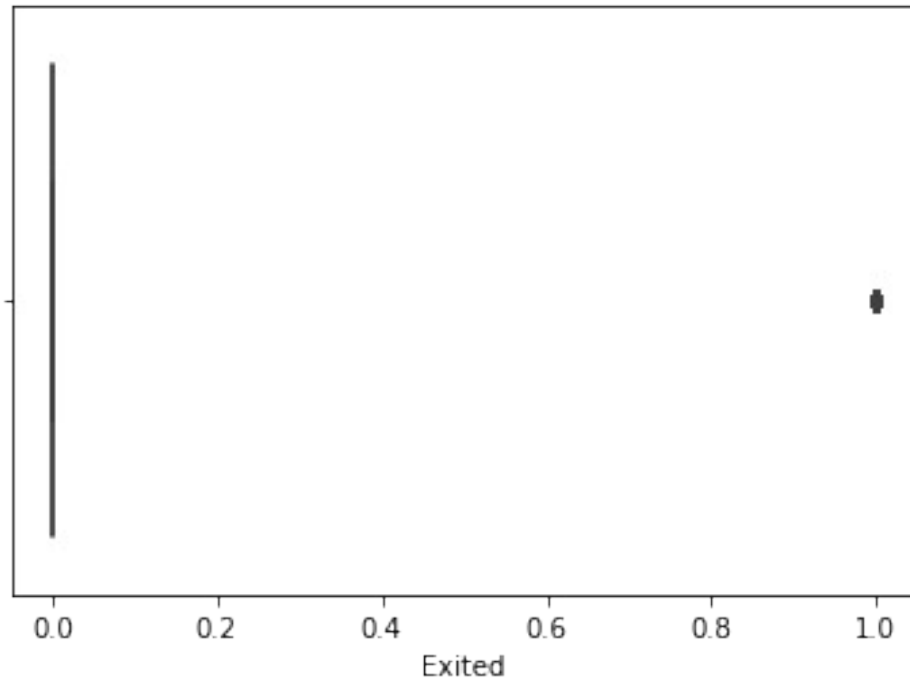
```
df1=df[df['NumOfProducts']<3.5]  
sns.boxplot(y='NumOfProducts',data=df1)  
#df1['NumOfProducts'].mean()
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f938426bc90>
```



```
sns.boxplot(x='Exited',data=df)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f9384464610>
```



```
df['Exited'].mean()
```

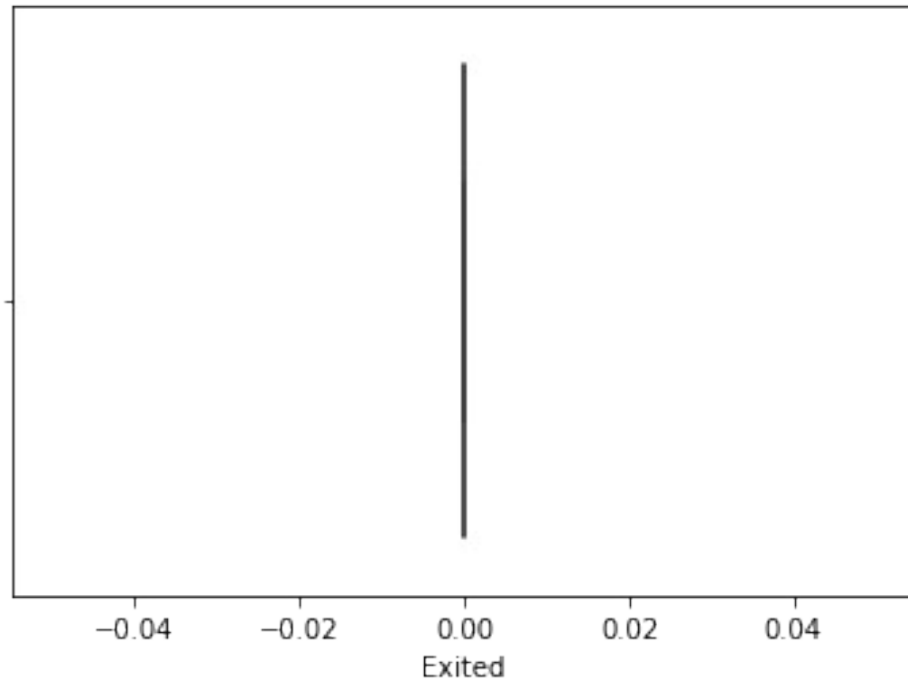
```
0.2037
```

```
df1=df[df['Exited']<0.8]
```

```
sns.boxplot(x='Exited',data=df1)
```

```
#df1['Exited'].mean()
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f9384263710>
```



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

`df.head()`

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age
0	1	15634602	1115	619	0	0	42
1	2	15647311	1177	608	2	0	41
2	3	15619304	2040	502	0	0	42
3	4	15701354	289	699	0	0	39
4	5	15737888	1822	850	2	0	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
```

```
x=df.iloc[:,0:13].values
x
```

```
array([[1.0000000e+00, 1.5634602e+07, 1.1150000e+03, ...,
1.0000000e+00,
        1.0000000e+00, 1.0134888e+05],
[2.0000000e+00, 1.5647311e+07, 1.1770000e+03, ...,
0.0000000e+00,
        1.0000000e+00, 1.1254258e+05],
[3.0000000e+00, 1.5619304e+07, 2.0400000e+03, ...,
1.0000000e+00,
        0.0000000e+00, 1.1393157e+05],
...,
[9.9980000e+03, 1.5584532e+07, 1.5700000e+03, ...,
0.0000000e+00,
        1.0000000e+00, 4.2085580e+04],
[9.9990000e+03, 1.5682355e+07, 2.3450000e+03, ...,
1.0000000e+00,
        0.0000000e+00, 9.2888520e+04],
[1.0000000e+04, 1.5628319e+07, 2.7510000e+03, ...,
1.0000000e+00,
        0.0000000e+00, 3.8190780e+04]])
```

```
y=df.iloc[0:,13].values
y
```

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

```
#9. Scale the independent variables
```

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

```
xtrain,xtest,ytrain,ytest=(train_test_split(x,y,test_size=0.3,random_s
tate=0))
```

```
xtrain
```

```
array([[7.6820000e+03, 1.5633608e+07, 2.5900000e+02, ...,
1.0000000e+00,
        1.0000000e+00, 5.5796830e+04],
[9.0320000e+03, 1.5742323e+07, 1.6400000e+02, ...,
1.0000000e+00,
        0.0000000e+00, 1.9823020e+04],
[3.6920000e+03, 1.5760244e+07, 1.3040000e+03, ...,
0.0000000e+00,
        1.0000000e+00, 1.3848580e+04],
...,
[3.2650000e+03, 1.5574372e+07, 1.2020000e+03, ...,
1.0000000e+00,
```

```

        0.0000000e+00, 1.8142987e+05],
        [9.8460000e+03, 1.5664035e+07, 2.1220000e+03, ...,
1.0000000e+00,
        1.0000000e+00, 1.4875016e+05],
        [2.7330000e+03, 1.5592816e+07, 2.6780000e+03, ...,
1.0000000e+00,
        0.0000000e+00, 1.1885526e+05]])

```

```

from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense

```

```

regressor=Sequential()
regressor.add(Dense(4,activation='relu'))
regressor.add(Dense(12,activation='relu'))
regressor.add(Dense(8,activation='relu'))
regressor.add(Dense(15,activation='relu'))
regressor.add(Dense(1,activation='linear'))

```

```

regressor.compile(optimizer='adam',loss='mse',metrics=['mse'])

```

```

regressor.fit(xtrain,ytrain,batch_size=100,epochs=300)

```

Epoch 1/300

```

70/70 [=====] - 1s 2ms/step - loss:
30584311808.0000 - mse: 30584311808.0000

```

Epoch 2/300

```

70/70 [=====] - 0s 2ms/step - loss:
6291467.0000 - mse: 6291467.0000

```

Epoch 3/300

```

70/70 [=====] - 0s 2ms/step - loss:
10654.1436 - mse: 10654.1436

```

Epoch 4/300

```

70/70 [=====] - 0s 2ms/step - loss: 2.7873 -
mse: 2.7873

```

Epoch 5/300

```

70/70 [=====] - 0s 2ms/step - loss: 0.1670 -
mse: 0.1670

```

Epoch 6/300

```

70/70 [=====] - 0s 2ms/step - loss: 0.1646 -
mse: 0.1646

```

Epoch 7/300

```

70/70 [=====] - 0s 2ms/step - loss: 0.1635 -
mse: 0.1635

```

Epoch 8/300

```

70/70 [=====] - 0s 2ms/step - loss: 0.1631 -
mse: 0.1631

```

Epoch 9/300

```

70/70 [=====] - 0s 2ms/step - loss: 0.1626 -
mse: 0.1626

```

Epoch 10/300

```

70/70 [=====] - 0s 2ms/step - loss: 0.1623 -

```

```
mse: 0.1623
Epoch 11/300
70/70 [=====] - 0s 2ms/step - loss: 0.1621 -
mse: 0.1621
Epoch 12/300
70/70 [=====] - 0s 2ms/step - loss: 0.1619 -
mse: 0.1619
Epoch 13/300
70/70 [=====] - 0s 2ms/step - loss: 0.1619 -
mse: 0.1619
Epoch 14/300
70/70 [=====] - 0s 2ms/step - loss: 0.1619 -
mse: 0.1619
Epoch 15/300
70/70 [=====] - 0s 2ms/step - loss: 0.1619 -
mse: 0.1619
Epoch 16/300
70/70 [=====] - 0s 2ms/step - loss: 0.1618 -
mse: 0.1618
Epoch 17/300
70/70 [=====] - 0s 2ms/step - loss: 0.1616 -
mse: 0.1616
Epoch 18/300
70/70 [=====] - 0s 2ms/step - loss: 0.1616 -
mse: 0.1616
Epoch 19/300
70/70 [=====] - 0s 2ms/step - loss: 0.1616 -
mse: 0.1616
Epoch 20/300
70/70 [=====] - 0s 2ms/step - loss: 0.1616 -
mse: 0.1616
Epoch 21/300
70/70 [=====] - 0s 2ms/step - loss: 0.1617 -
mse: 0.1617
Epoch 22/300
70/70 [=====] - 0s 2ms/step - loss: 0.1617 -
mse: 0.1617
Epoch 23/300
70/70 [=====] - 0s 2ms/step - loss: 0.1618 -
mse: 0.1618
Epoch 24/300
70/70 [=====] - 0s 2ms/step - loss: 0.1618 -
mse: 0.1618
Epoch 25/300
70/70 [=====] - 0s 2ms/step - loss: 0.1618 -
mse: 0.1618
Epoch 26/300
70/70 [=====] - 0s 3ms/step - loss: 0.1618 -
mse: 0.1618
Epoch 27/300
```

70/70 [=====] - 0s 2ms/step - loss: 0.1618 -  
mse: 0.1618  
Epoch 28/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1619 -  
mse: 0.1619  
Epoch 29/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1618 -  
mse: 0.1618  
Epoch 30/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1618 -  
mse: 0.1618  
Epoch 31/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1618 -  
mse: 0.1618  
Epoch 32/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1618 -  
mse: 0.1618  
Epoch 33/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1618 -  
mse: 0.1618  
Epoch 34/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1619 -  
mse: 0.1619  
Epoch 35/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1617 -  
mse: 0.1617  
Epoch 36/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1618 -  
mse: 0.1618  
Epoch 37/300  
70/70 [=====] - 0s 3ms/step - loss: 0.1617 -  
mse: 0.1617  
Epoch 38/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1618 -  
mse: 0.1618  
Epoch 39/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1619 -  
mse: 0.1619  
Epoch 40/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1618 -  
mse: 0.1618  
Epoch 41/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1620 -  
mse: 0.1620  
Epoch 42/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1618 -  
mse: 0.1618  
Epoch 43/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1618 -  
mse: 0.1618

Epoch 44/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1617 -  
mse: 0.1617  
Epoch 45/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1619 -  
mse: 0.1619  
Epoch 46/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1619 -  
mse: 0.1619  
Epoch 47/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1618 -  
mse: 0.1618  
Epoch 48/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1617 -  
mse: 0.1617  
Epoch 49/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1617 -  
mse: 0.1617  
Epoch 50/300  
70/70 [=====] - 0s 3ms/step - loss: 0.1618 -  
mse: 0.1618  
Epoch 51/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1618 -  
mse: 0.1618  
Epoch 52/300  
70/70 [=====] - 0s 3ms/step - loss: 0.1618 -  
mse: 0.1618  
Epoch 53/300  
70/70 [=====] - 0s 3ms/step - loss: 0.1618 -  
mse: 0.1618  
Epoch 54/300  
70/70 [=====] - 0s 3ms/step - loss: 0.1617 -  
mse: 0.1617  
Epoch 55/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1619 -  
mse: 0.1619  
Epoch 56/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1619 -  
mse: 0.1619  
Epoch 57/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1619 -  
mse: 0.1619  
Epoch 58/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1620 -  
mse: 0.1620  
Epoch 59/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1619 -  
mse: 0.1619  
Epoch 60/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1622 -



```
mse: 0.1622
Epoch 61/300
70/70 [=====] - 0s 2ms/step - loss: 0.1620 -
mse: 0.1620
Epoch 62/300
70/70 [=====] - 0s 2ms/step - loss: 0.1621 -
mse: 0.1621
Epoch 63/300
70/70 [=====] - 0s 2ms/step - loss: 0.1619 -
mse: 0.1619
Epoch 64/300
70/70 [=====] - 0s 2ms/step - loss: 0.1621 -
mse: 0.1621
Epoch 65/300
70/70 [=====] - 0s 3ms/step - loss: 0.1615 -
mse: 0.1615
Epoch 66/300
70/70 [=====] - 0s 2ms/step - loss: 0.1625 -
mse: 0.1625
Epoch 67/300
70/70 [=====] - 0s 2ms/step - loss: 0.1620 -
mse: 0.1620
Epoch 68/300
70/70 [=====] - 0s 2ms/step - loss: 0.1618 -
mse: 0.1618
Epoch 69/300
70/70 [=====] - 0s 2ms/step - loss: 0.1618 -
mse: 0.1618
Epoch 70/300
70/70 [=====] - 0s 2ms/step - loss: 0.1622 -
mse: 0.1622
Epoch 71/300
70/70 [=====] - 0s 2ms/step - loss: 0.1622 -
mse: 0.1622
Epoch 72/300
70/70 [=====] - 0s 2ms/step - loss: 0.1620 -
mse: 0.1620
Epoch 73/300
70/70 [=====] - 0s 2ms/step - loss: 0.1621 -
mse: 0.1621
Epoch 74/300
70/70 [=====] - 0s 2ms/step - loss: 0.1621 -
mse: 0.1621
Epoch 75/300
70/70 [=====] - 0s 2ms/step - loss: 0.1621 -
mse: 0.1621
Epoch 76/300
70/70 [=====] - 0s 2ms/step - loss: 0.1619 -
mse: 0.1619
Epoch 77/300
```

70/70 [=====] - 0s 3ms/step - loss: 0.1624 -  
mse: 0.1624  
Epoch 78/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1620 -  
mse: 0.1620  
Epoch 79/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1622 -  
mse: 0.1622  
Epoch 80/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1625 -  
mse: 0.1625  
Epoch 81/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1625 -  
mse: 0.1625  
Epoch 82/300  
70/70 [=====] - 0s 3ms/step - loss: 0.1621 -  
mse: 0.1621  
Epoch 83/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1631 -  
mse: 0.1631  
Epoch 84/300  
70/70 [=====] - 0s 3ms/step - loss: 0.1626 -  
mse: 0.1626  
Epoch 85/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1627 -  
mse: 0.1627  
Epoch 86/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1631 -  
mse: 0.1631  
Epoch 87/300  
70/70 [=====] - 0s 3ms/step - loss: 0.1642 -  
mse: 0.1642  
Epoch 88/300  
70/70 [=====] - 0s 3ms/step - loss: 0.1626 -  
mse: 0.1626  
Epoch 89/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1624 -  
mse: 0.1624  
Epoch 90/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1638 -  
mse: 0.1638  
Epoch 91/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1632 -  
mse: 0.1632  
Epoch 92/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1640 -  
mse: 0.1640  
Epoch 93/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1631 -  
mse: 0.1631

Epoch 94/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1650 -  
mse: 0.1650  
Epoch 95/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1632 -  
mse: 0.1632  
Epoch 96/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1637 -  
mse: 0.1637  
Epoch 97/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1635 -  
mse: 0.1635  
Epoch 98/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1635 -  
mse: 0.1635  
Epoch 99/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1640 -  
mse: 0.1640  
Epoch 100/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1672 -  
mse: 0.1672  
Epoch 101/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1639 -  
mse: 0.1639  
Epoch 102/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1659 -  
mse: 0.1659  
Epoch 103/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1681 -  
mse: 0.1681  
Epoch 104/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1636 -  
mse: 0.1636  
Epoch 105/300  
70/70 [=====] - 0s 3ms/step - loss: 0.1634 -  
mse: 0.1634  
Epoch 106/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1634 -  
mse: 0.1634  
Epoch 107/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1656 -  
mse: 0.1656  
Epoch 108/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1679 -  
mse: 0.1679  
Epoch 109/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1664 -  
mse: 0.1664  
Epoch 110/300  
70/70 [=====] - 0s 3ms/step - loss: 0.1726 -

```
mse: 0.1726
Epoch 111/300
70/70 [=====] - 0s 2ms/step - loss: 0.1643 -
mse: 0.1643
Epoch 112/300
70/70 [=====] - 0s 2ms/step - loss: 0.1652 -
mse: 0.1652
Epoch 113/300
70/70 [=====] - 0s 2ms/step - loss: 0.1690 -
mse: 0.1690
Epoch 114/300
70/70 [=====] - 0s 2ms/step - loss: 0.1829 -
mse: 0.1829
Epoch 115/300
70/70 [=====] - 0s 2ms/step - loss: 0.1651 -
mse: 0.1651
Epoch 116/300
70/70 [=====] - 0s 2ms/step - loss: 0.1760 -
mse: 0.1760
Epoch 117/300
70/70 [=====] - 0s 3ms/step - loss: 0.1739 -
mse: 0.1739
Epoch 118/300
70/70 [=====] - 0s 2ms/step - loss: 0.1690 -
mse: 0.1690
Epoch 119/300
70/70 [=====] - 0s 2ms/step - loss: 0.1707 -
mse: 0.1707
Epoch 120/300
70/70 [=====] - 0s 2ms/step - loss: 0.1744 -
mse: 0.1744
Epoch 121/300
70/70 [=====] - 0s 2ms/step - loss: 0.1971 -
mse: 0.1971
Epoch 122/300
70/70 [=====] - 0s 2ms/step - loss: 0.1724 -
mse: 0.1724
Epoch 123/300
70/70 [=====] - 0s 3ms/step - loss: 0.1876 -
mse: 0.1876
Epoch 124/300
70/70 [=====] - 0s 2ms/step - loss: 0.1821 -
mse: 0.1821
Epoch 125/300
70/70 [=====] - 0s 2ms/step - loss: 0.1690 -
mse: 0.1690
Epoch 126/300
70/70 [=====] - 0s 2ms/step - loss: 0.2038 -
mse: 0.2038
Epoch 127/300
```

70/70 [=====] - 0s 2ms/step - loss: 0.1704 -  
mse: 0.1704  
Epoch 128/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1714 -  
mse: 0.1714  
Epoch 129/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1851 -  
mse: 0.1851  
Epoch 130/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1733 -  
mse: 0.1733  
Epoch 131/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1902 -  
mse: 0.1902  
Epoch 132/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1918 -  
mse: 0.1918  
Epoch 133/300  
70/70 [=====] - 0s 2ms/step - loss: 0.2242 -  
mse: 0.2242  
Epoch 134/300  
70/70 [=====] - 0s 2ms/step - loss: 0.2030 -  
mse: 0.2030  
Epoch 135/300  
70/70 [=====] - 0s 3ms/step - loss: 0.2302 -  
mse: 0.2302  
Epoch 136/300  
70/70 [=====] - 0s 3ms/step - loss: 0.1823 -  
mse: 0.1823  
Epoch 137/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1733 -  
mse: 0.1733  
Epoch 138/300  
70/70 [=====] - 0s 2ms/step - loss: 0.2003 -  
mse: 0.2003  
Epoch 139/300  
70/70 [=====] - 0s 3ms/step - loss: 0.2109 -  
mse: 0.2109  
Epoch 140/300  
70/70 [=====] - 0s 2ms/step - loss: 0.1982 -  
mse: 0.1982  
Epoch 141/300  
70/70 [=====] - 0s 2ms/step - loss: 0.2050 -  
mse: 0.2050  
Epoch 142/300  
70/70 [=====] - 0s 2ms/step - loss: 0.2098 -  
mse: 0.2098  
Epoch 143/300  
70/70 [=====] - 0s 2ms/step - loss: 0.2404 -  
mse: 0.2404

```
Epoch 144/300
70/70 [=====] - 0s 2ms/step - loss: 0.1915 -
mse: 0.1915
Epoch 145/300
70/70 [=====] - 0s 2ms/step - loss: 0.1849 -
mse: 0.1849
Epoch 146/300
70/70 [=====] - 0s 3ms/step - loss: 0.2841 -
mse: 0.2841
Epoch 147/300
70/70 [=====] - 0s 2ms/step - loss: 0.2509 -
mse: 0.2509
Epoch 148/300
70/70 [=====] - 0s 2ms/step - loss: 0.2096 -
mse: 0.2096
Epoch 149/300
70/70 [=====] - 0s 2ms/step - loss: 0.3196 -
mse: 0.3196
Epoch 150/300
70/70 [=====] - 0s 3ms/step - loss: 0.3183 -
mse: 0.3183
Epoch 151/300
70/70 [=====] - 0s 3ms/step - loss: 0.2870 -
mse: 0.2870
Epoch 152/300
70/70 [=====] - 0s 2ms/step - loss: 0.4690 -
mse: 0.4690
Epoch 153/300
70/70 [=====] - 0s 2ms/step - loss: 0.6928 -
mse: 0.6928
Epoch 154/300
70/70 [=====] - 0s 2ms/step - loss: 1.4910 -
mse: 1.4910
Epoch 155/300
70/70 [=====] - 0s 2ms/step - loss:
57818.0195 - mse: 57818.0195
Epoch 156/300
70/70 [=====] - 0s 2ms/step - loss:
25041.3281 - mse: 25041.3281
Epoch 157/300
70/70 [=====] - 0s 2ms/step - loss: 8878.8057
- mse: 8878.8047
Epoch 158/300
70/70 [=====] - 0s 2ms/step - loss:
138062.7031 - mse: 138062.7031
Epoch 159/300
70/70 [=====] - 0s 2ms/step - loss: 108.1604
- mse: 108.1604
Epoch 160/300
70/70 [=====] - 0s 2ms/step - loss: 440.2988
```

- mse: 440.2988  
Epoch 161/300  
70/70 [=====] - 0s 2ms/step - loss:  
204107.6250 - mse: 204107.6250  
Epoch 162/300  
70/70 [=====] - 0s 2ms/step - loss: 209.5200  
- mse: 209.5200  
Epoch 163/300  
70/70 [=====] - 0s 2ms/step - loss: 1.3497 -  
mse: 1.3497  
Epoch 164/300  
70/70 [=====] - 0s 2ms/step - loss:  
137660.0938 - mse: 137660.0938  
Epoch 165/300  
70/70 [=====] - 0s 2ms/step - loss:  
28124.4785 - mse: 28124.4785  
Epoch 166/300  
70/70 [=====] - 0s 2ms/step - loss: 22.4480 -  
mse: 22.4480  
Epoch 167/300  
70/70 [=====] - 0s 2ms/step - loss:  
107435.9922 - mse: 107435.9922  
Epoch 168/300  
70/70 [=====] - 0s 3ms/step - loss:  
44864.9961 - mse: 44864.9961  
Epoch 169/300  
70/70 [=====] - 0s 2ms/step - loss: 59.0326 -  
mse: 59.0326  
Epoch 170/300  
70/70 [=====] - 0s 2ms/step - loss:  
108603.4766 - mse: 108603.4766  
Epoch 171/300  
70/70 [=====] - 0s 2ms/step - loss:  
11444.7637 - mse: 11444.7637  
Epoch 172/300  
70/70 [=====] - 0s 2ms/step - loss: 2521.9937  
- mse: 2521.9937  
Epoch 173/300  
70/70 [=====] - 0s 2ms/step - loss:  
131592.7969 - mse: 131592.7969  
Epoch 174/300  
70/70 [=====] - 0s 2ms/step - loss: 156.4212  
- mse: 156.4212  
Epoch 175/300  
70/70 [=====] - 0s 2ms/step - loss:  
128853.4922 - mse: 128853.4922  
Epoch 176/300  
70/70 [=====] - 0s 2ms/step - loss: 8577.1543  
- mse: 8577.1543  
Epoch 177/300

70/70 [=====] - 0s 2ms/step - loss: 12.4913 -  
mse: 12.4913  
Epoch 178/300  
70/70 [=====] - 0s 2ms/step - loss:  
186004.6406 - mse: 186004.6562  
Epoch 179/300  
70/70 [=====] - 0s 2ms/step - loss: 2721.3652  
- mse: 2721.3652  
Epoch 180/300  
70/70 [=====] - 0s 2ms/step - loss: 2.7106 -  
mse: 2.7106  
Epoch 181/300  
70/70 [=====] - 0s 2ms/step - loss:  
22739.0859 - mse: 22739.0859  
Epoch 182/300  
70/70 [=====] - 0s 2ms/step - loss:  
134225.4531 - mse: 134225.4531  
Epoch 183/300  
70/70 [=====] - 0s 2ms/step - loss: 72.1451 -  
mse: 72.1451  
Epoch 184/300  
70/70 [=====] - 0s 2ms/step - loss: 5132.5693  
- mse: 5132.5693  
Epoch 185/300  
70/70 [=====] - 0s 3ms/step - loss:  
130399.7109 - mse: 130399.7109  
Epoch 186/300  
70/70 [=====] - 0s 2ms/step - loss: 132.5570  
- mse: 132.5570  
Epoch 187/300  
70/70 [=====] - 0s 2ms/step - loss:  
111609.2188 - mse: 111609.2188  
Epoch 188/300  
70/70 [=====] - 0s 2ms/step - loss:  
15051.9482 - mse: 15051.9473  
Epoch 189/300  
70/70 [=====] - 0s 2ms/step - loss: 48.2443 -  
mse: 48.2443  
Epoch 190/300  
70/70 [=====] - 0s 2ms/step - loss:  
120236.1250 - mse: 120236.1172  
Epoch 191/300  
70/70 [=====] - 0s 2ms/step - loss: 696.5148  
- mse: 696.5148  
Epoch 192/300  
70/70 [=====] - 0s 2ms/step - loss:  
101383.5312 - mse: 101383.5312  
Epoch 193/300  
70/70 [=====] - 0s 2ms/step - loss:  
39916.8906 - mse: 39916.8906



Epoch 194/300  
70/70 [=====] - 0s 2ms/step - loss: 42.1277 -  
mse: 42.1277  
Epoch 195/300  
70/70 [=====] - 0s 2ms/step - loss:  
89276.3359 - mse: 89276.3359  
Epoch 196/300  
70/70 [=====] - 0s 3ms/step - loss:  
85382.7812 - mse: 85382.8047  
Epoch 197/300  
70/70 [=====] - 0s 2ms/step - loss: 50.1131 -  
mse: 50.1131  
Epoch 198/300  
70/70 [=====] - 0s 2ms/step - loss: 9.4429 -  
mse: 9.4429  
Epoch 199/300  
70/70 [=====] - 0s 2ms/step - loss:  
118366.1328 - mse: 118366.1328  
Epoch 200/300  
70/70 [=====] - 0s 2ms/step - loss: 1261.0273  
- mse: 1261.0273  
Epoch 201/300  
70/70 [=====] - 0s 3ms/step - loss: 4879.8662  
- mse: 4879.8662  
Epoch 202/300  
70/70 [=====] - 0s 3ms/step - loss:  
112256.9141 - mse: 112256.9141  
Epoch 203/300  
70/70 [=====] - 0s 2ms/step - loss: 84.1296 -  
mse: 84.1296  
Epoch 204/300  
70/70 [=====] - 0s 2ms/step - loss:  
134271.7031 - mse: 134271.7031  
Epoch 205/300  
70/70 [=====] - 0s 3ms/step - loss:  
24033.2246 - mse: 24033.2246  
Epoch 206/300  
70/70 [=====] - 0s 3ms/step - loss: 18.3730 -  
mse: 18.3730  
Epoch 207/300  
70/70 [=====] - 0s 3ms/step - loss: 2.3810 -  
mse: 2.3810  
Epoch 208/300  
70/70 [=====] - 0s 2ms/step - loss:  
173112.8438 - mse: 173112.8438  
Epoch 209/300  
70/70 [=====] - 0s 2ms/step - loss: 1049.9603  
- mse: 1049.9603  
Epoch 210/300  
70/70 [=====] - 0s 2ms/step - loss: 2.5872 -

```
mse: 2.5872
Epoch 211/300
70/70 [=====] - 0s 2ms/step - loss: 1361.4646
- mse: 1361.4646
Epoch 212/300
70/70 [=====] - 0s 2ms/step - loss:
99936.8906 - mse: 99936.8906
Epoch 213/300
70/70 [=====] - 0s 2ms/step - loss: 134.3728
- mse: 134.3728
Epoch 214/300
70/70 [=====] - 0s 2ms/step - loss:
136060.3906 - mse: 136060.3906
Epoch 215/300
70/70 [=====] - 0s 3ms/step - loss:
11396.9258 - mse: 11396.9258
Epoch 216/300
70/70 [=====] - 0s 2ms/step - loss: 10.6155 -
mse: 10.6155
Epoch 217/300
70/70 [=====] - 0s 3ms/step - loss: 71.1159 -
mse: 71.1159
Epoch 218/300
70/70 [=====] - 0s 2ms/step - loss:
128506.3672 - mse: 128506.3672
Epoch 219/300
70/70 [=====] - 0s 2ms/step - loss: 206.3261
- mse: 206.3261
Epoch 220/300
70/70 [=====] - 0s 3ms/step - loss: 1.5519 -
mse: 1.5519
Epoch 221/300
70/70 [=====] - 0s 2ms/step - loss:
178404.9375 - mse: 178404.9375
Epoch 222/300
70/70 [=====] - 0s 2ms/step - loss: 6442.3965
- mse: 6442.3965
Epoch 223/300
70/70 [=====] - 0s 2ms/step - loss: 5.3839 -
mse: 5.3839
Epoch 224/300
70/70 [=====] - 0s 2ms/step - loss: 0.9813 -
mse: 0.9813
Epoch 225/300
70/70 [=====] - 0s 2ms/step - loss:
55275.0977 - mse: 55275.0977
Epoch 226/300
70/70 [=====] - 0s 2ms/step - loss:
37341.9883 - mse: 37341.9883
Epoch 227/300
```

70/70 [=====] - 0s 2ms/step - loss: 27.7373 -  
mse: 27.7373  
Epoch 228/300  
70/70 [=====] - 0s 3ms/step - loss:  
105755.9844 - mse: 105755.9844  
Epoch 229/300  
70/70 [=====] - 0s 3ms/step - loss: 2007.6986  
- mse: 2007.6986  
Epoch 230/300  
70/70 [=====] - 0s 2ms/step - loss: 5.8304 -  
mse: 5.8304  
Epoch 231/300  
70/70 [=====] - 0s 2ms/step - loss:  
131172.7656 - mse: 131172.7656  
Epoch 232/300  
70/70 [=====] - 0s 3ms/step - loss: 3946.8232  
- mse: 3946.8232  
Epoch 233/300  
70/70 [=====] - 0s 2ms/step - loss: 3.5787 -  
mse: 3.5787  
Epoch 234/300  
70/70 [=====] - 0s 2ms/step - loss: 5.6051 -  
mse: 5.6051  
Epoch 235/300  
70/70 [=====] - 0s 2ms/step - loss:  
114169.5547 - mse: 114169.5547  
Epoch 236/300  
70/70 [=====] - 0s 2ms/step - loss: 710.6359  
- mse: 710.6359  
Epoch 237/300  
70/70 [=====] - 0s 2ms/step - loss: 2.5420 -  
mse: 2.5420  
Epoch 238/300  
70/70 [=====] - 0s 2ms/step - loss:  
93579.1328 - mse: 93579.1250  
Epoch 239/300  
70/70 [=====] - 0s 2ms/step - loss: 8975.5791  
- mse: 8975.5791  
Epoch 240/300  
70/70 [=====] - 0s 2ms/step - loss: 8.5117 -  
mse: 8.5117  
Epoch 241/300  
70/70 [=====] - 0s 3ms/step - loss:  
52114.9375 - mse: 52114.9375  
Epoch 242/300  
70/70 [=====] - 0s 2ms/step - loss:  
64428.4883 - mse: 64428.4922  
Epoch 243/300  
70/70 [=====] - 0s 2ms/step - loss: 32.0220 -  
mse: 32.0220

Epoch 244/300  
70/70 [=====] - 0s 2ms/step - loss: 3.7969 -  
mse: 3.7969  
Epoch 245/300  
70/70 [=====] - 0s 2ms/step - loss:  
97114.5156 - mse: 97114.5156  
Epoch 246/300  
70/70 [=====] - 0s 3ms/step - loss: 4249.4995  
- mse: 4249.5000  
Epoch 247/300  
70/70 [=====] - 0s 2ms/step - loss: 4.5857 -  
mse: 4.5857  
Epoch 248/300  
70/70 [=====] - 0s 2ms/step - loss: 4775.3823  
- mse: 4775.3823  
Epoch 249/300  
70/70 [=====] - 0s 2ms/step - loss:  
89631.6250 - mse: 89631.6250  
Epoch 250/300  
70/70 [=====] - 0s 3ms/step - loss: 54.8398 -  
mse: 54.8398  
Epoch 251/300  
70/70 [=====] - 0s 2ms/step - loss: 4.2461 -  
mse: 4.2461  
Epoch 252/300  
70/70 [=====] - 0s 3ms/step - loss:  
81272.3828 - mse: 81272.3828  
Epoch 253/300  
70/70 [=====] - 0s 3ms/step - loss: 403.5585  
- mse: 403.5585  
Epoch 254/300  
70/70 [=====] - 0s 2ms/step - loss: 11.3369 -  
mse: 11.3369  
Epoch 255/300  
70/70 [=====] - 0s 2ms/step - loss:  
68549.0938 - mse: 68549.0938  
Epoch 256/300  
70/70 [=====] - 0s 2ms/step - loss: 340.5391  
- mse: 340.5391  
Epoch 257/300  
70/70 [=====] - 0s 2ms/step - loss: 163.1477  
- mse: 163.1477  
Epoch 258/300  
70/70 [=====] - 0s 2ms/step - loss:  
94058.5781 - mse: 94058.5781  
Epoch 259/300  
70/70 [=====] - 0s 2ms/step - loss: 142.8987  
- mse: 142.8987  
Epoch 260/300  
70/70 [=====] - 0s 2ms/step - loss: 3.9678 -

mse: 3.9678  
Epoch 261/300  
70/70 [=====] - 0s 2ms/step - loss:  
55939.2930 - mse: 55939.2969  
Epoch 262/300  
70/70 [=====] - 0s 2ms/step - loss:  
24869.5586 - mse: 24869.5586  
Epoch 263/300  
70/70 [=====] - 0s 2ms/step - loss: 20.8369 -  
mse: 20.8369  
Epoch 264/300  
70/70 [=====] - 0s 3ms/step - loss: 3.5218 -  
mse: 3.5218  
Epoch 265/300  
70/70 [=====] - 0s 2ms/step - loss:  
89106.6953 - mse: 89106.6953  
Epoch 266/300  
70/70 [=====] - 0s 2ms/step - loss: 961.1131  
- mse: 961.1131  
Epoch 267/300  
70/70 [=====] - 0s 2ms/step - loss: 1.0757 -  
mse: 1.0757  
Epoch 268/300  
70/70 [=====] - 0s 2ms/step - loss: 2.1835 -  
mse: 2.1835  
Epoch 269/300  
70/70 [=====] - 0s 2ms/step - loss:  
78428.3984 - mse: 78428.3984  
Epoch 270/300  
70/70 [=====] - 0s 2ms/step - loss: 1819.1039  
- mse: 1819.1039  
Epoch 271/300  
70/70 [=====] - 0s 2ms/step - loss: 1.5418 -  
mse: 1.5418  
Epoch 272/300  
70/70 [=====] - 0s 2ms/step - loss: 2.7472 -  
mse: 2.7472  
Epoch 273/300  
70/70 [=====] - 0s 2ms/step - loss:  
83778.3828 - mse: 83778.3750  
Epoch 274/300  
70/70 [=====] - 0s 2ms/step - loss: 1355.8195  
- mse: 1355.8195  
Epoch 275/300  
70/70 [=====] - 0s 2ms/step - loss: 1.5471 -  
mse: 1.5471  
Epoch 276/300  
70/70 [=====] - 0s 2ms/step - loss: 1.3428 -  
mse: 1.3428  
Epoch 277/300

70/70 [=====] - 0s 2ms/step - loss:  
50758.2773 - mse: 50758.2773  
Epoch 278/300  
70/70 [=====] - 0s 2ms/step - loss: 9576.7676  
- mse: 9576.7676  
Epoch 279/300  
70/70 [=====] - 0s 2ms/step - loss: 6.5691 -  
mse: 6.5691  
Epoch 280/300  
70/70 [=====] - 0s 3ms/step - loss: 766.7400  
- mse: 766.7400  
Epoch 281/300  
70/70 [=====] - 0s 2ms/step - loss:  
59242.3398 - mse: 59242.3398  
Epoch 282/300  
70/70 [=====] - 0s 2ms/step - loss: 39.9056 -  
mse: 39.9056  
Epoch 283/300  
70/70 [=====] - 0s 3ms/step - loss: 3.8100 -  
mse: 3.8100  
Epoch 284/300  
70/70 [=====] - 0s 2ms/step - loss:  
44419.5547 - mse: 44419.5547  
Epoch 285/300  
70/70 [=====] - 0s 3ms/step - loss: 5129.8838  
- mse: 5129.8838  
Epoch 286/300  
70/70 [=====] - 0s 2ms/step - loss: 4.1865 -  
mse: 4.1865  
Epoch 287/300  
70/70 [=====] - 0s 2ms/step - loss: 525.1896  
- mse: 525.1896  
Epoch 288/300  
70/70 [=====] - 0s 2ms/step - loss:  
49930.1406 - mse: 49930.1406  
Epoch 289/300  
70/70 [=====] - 0s 2ms/step - loss: 35.0164 -  
mse: 35.0164  
Epoch 290/300  
70/70 [=====] - 0s 2ms/step - loss: 1.7944 -  
mse: 1.7944  
Epoch 291/300  
70/70 [=====] - 0s 3ms/step - loss:  
47959.7109 - mse: 47959.7109  
Epoch 292/300  
70/70 [=====] - 0s 2ms/step - loss: 7680.8154  
- mse: 7680.8154  
Epoch 293/300  
70/70 [=====] - 0s 3ms/step - loss: 6.4556 -  
mse: 6.4556

```
Epoch 294/300
70/70 [=====] - 0s 2ms/step - loss: 1.4416 -
mse: 1.4416
Epoch 295/300
70/70 [=====] - 0s 2ms/step - loss: 4882.7573
- mse: 4882.7573
Epoch 296/300
70/70 [=====] - 0s 3ms/step - loss:
29985.1270 - mse: 29985.1270
Epoch 297/300
70/70 [=====] - 0s 2ms/step - loss: 15.6138 -
mse: 15.6138
Epoch 298/300
70/70 [=====] - 0s 2ms/step - loss: 3.2061 -
mse: 3.2061
Epoch 299/300
70/70 [=====] - 0s 2ms/step - loss:
64720.9492 - mse: 64720.9492
Epoch 300/300
70/70 [=====] - 0s 2ms/step - loss: 972.4910
- mse: 972.4910
```

```
<keras.callbacks.History at 0x7ff5c5f6ced0>
```

```
ypred=regressor.predict(xtest)
```

```
ypred
```

```
array([[2.4521322],
       [2.4677572],
       [2.4911947],
       ...,
       [2.4911947],
       [2.4755697],
       [2.4521322]], dtype=float32)
```

```
ytest
```

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