In [1]:
```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
df=pd.read_csv("C:/Users/USER/Desktop/Datasets/Churn_Modelling.csv")
df.head(5)
```

Out[1]:

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

In [2]:
```
del(df["RowNumber"])
del(df["CustomerId"])
del(df["Surname"])
df
```

Out[2]:

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

10000 rows × 11 columns

In [3]:
```
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
```

In [4]:
```
x=pd.DataFrame(df.iloc[:,0:10])
x
```

Out[4]:

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

10000 rows × 10 columns

In [5]:
```
y=pd.DataFrame(df["Exited"])
y
```

Out[5]:

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

10000 rows × 1 columns

In [6]:
```
x.describe()
```

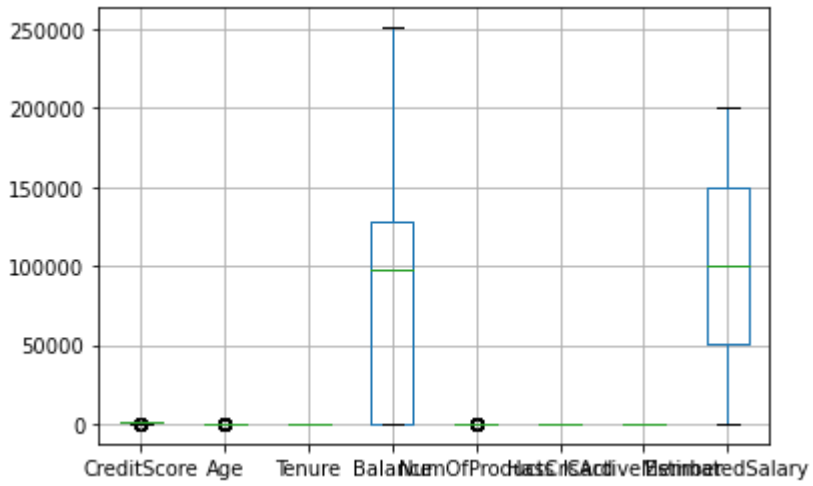
Out[6]:

	CreditScore	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsA
count	10000.000000	10000.000000	10000.000000	10000.000000	10000.000000	10000.00000	
mean	650.528800	38.921800	5.012800	76485.889288	1.530200	0.70550	
std	96.653299	10.487806	2.892174	62397.405202	0.581654	0.45584	
min	350.000000	18.000000	0.000000	0.000000	1.000000	0.00000	
25%	584.000000	32.000000	3.000000	0.000000	1.000000	0.00000	
50%	652.000000	37.000000	5.000000	97198.540000	1.000000	1.00000	
75%	718.000000	44.000000	7.000000	127644.240000	2.000000	1.00000	
max	850.000000	92.000000	10.000000	250898.090000	4.000000	1.00000	

In [7]:
```
x.isnull().sum()
```

Out[7]:
```
CreditScore        0
Geography          0
Gender             0
Age                0
Tenure             0
Balance            0
NumOfProducts      0
HasCrCard          0
IsActiveMember     0
EstimatedSalary    0
dtype: int64
```

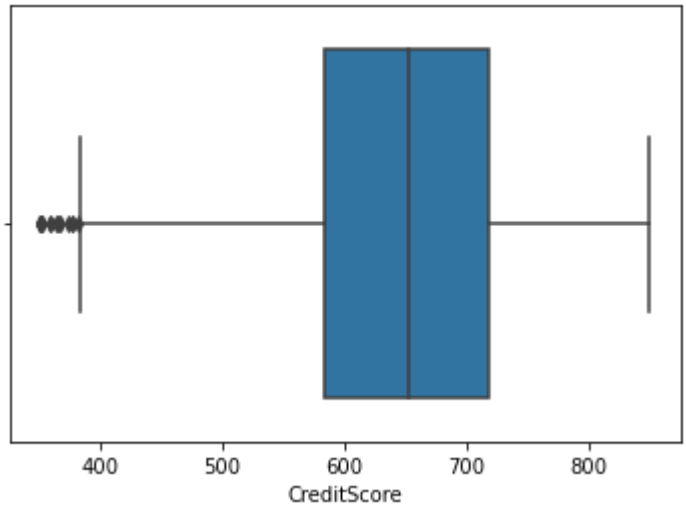
In [8]:
```
boxplot=x.boxplot()
```



In [9]:
```
sns.boxplot(x["CreditScore"])
```

```
C:\Users\USER\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarn
ing: Pass the following variable as a keyword arg: x. From version 0.12, the on
ly valid positional argument will be `data`, and passing other arguments withou
t an explicit keyword will result in an error or misinterpretation.
  warnings.warn(
```

Out[9]:
```
<AxesSubplot:xlabel='CreditScore'>
```



In [10]:
```
X=pd.get_dummies(x)
```

In [11]:
```
del X["Gender_Male"]
```

In [12]:
```
names=X.columns
```

In [13]:
```
X.shape
```

Out[13]:
```
(10000, 12)
```

In [14]:
```
from sklearn.preprocessing import scale
S_X=scale(X)
```

In [15]:
```
S_X=pd.DataFrame(S_X, columns=names)
S_X
```

Out[15]:

	CreditScore	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	E
0	-0.326221	0.293517	-1.041760	-1.225848	-0.911583	0.646092	0.970243	
1	-0.440036	0.198164	-1.387538	0.117350	-0.911583	-1.547768	0.970243	
2	-1.536794	0.293517	1.032908	1.333053	2.527057	0.646092	-1.030670	
3	0.501521	0.007457	-1.387538	-1.225848	0.807737	-1.547768	-1.030670	
4	2.063884	0.388871	-1.041760	0.785728	-0.911583	0.646092	0.970243	
...	...	...	...	...	...	...	...	
9995	1.246488	0.007457	-0.004426	-1.225848	0.807737	0.646092	-1.030670	
9996	-1.391939	-0.373958	1.724464	-0.306379	-0.911583	0.646092	0.970243	
9997	0.604988	-0.278604	0.687130	-1.225848	-0.911583	-1.547768	0.970243	
9998	1.256835	0.293517	-0.695982	-0.022608	0.807737	0.646092	-1.030670	
9999	1.463771	-1.041433	-0.350204	0.859965	-0.911583	0.646092	-1.030670	

10000 rows × 12 columns

In [16]:
```
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(S_X, y, test_size=0.2)
x_train
```

Out[16]:

	CreditScore	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	E
8368	-0.295181	-0.469311	0.687130	0.355639	-0.911583	0.646092	-1.030670	
1741	0.998166	-1.327494	-0.350204	-1.225848	0.807737	-1.547768	0.970243	
606	0.501521	1.342407	-0.350204	-1.225848	0.807737	-1.547768	0.970243	
8303	-1.340205	0.388871	1.032908	-1.225848	-0.911583	0.646092	0.970243	
4887	-0.315875	-0.183251	-1.733315	0.497851	-0.911583	0.646092	-1.030670	
...	...	...	...	...	...	...	...	
5105	0.211811	1.151700	-0.695982	0.327042	-0.911583	0.646092	-1.030670	
5071	0.263545	-0.373958	-0.004426	0.486435	0.807737	0.646092	-1.030670	
3345	0.077303	-0.755372	0.687130	0.761113	-0.911583	0.646092	-1.030670	
4373	-1.081536	0.579578	-1.041760	-1.225848	-0.911583	-1.547768	-1.030670	
1368	0.398053	-0.755372	-0.350204	-1.225848	0.807737	0.646092	0.970243	

8000 rows × 12 columns

In [17]:
```
!pip install keras
!pip install tensorflow
import keras
import tensorflow
from keras.models import Sequential
from keras.layers import Dense
```

```
Requirement already satisfied: keras in c:\users\user\anaconda3\lib\site-pack
ages (2.8.0)
Requirement already satisfied: tensorflow in c:\users\user\anaconda3\lib\site
-packages (2.8.0)
Requirement already satisfied: libclang>=9.0.1 in c:\users\user\anaconda3\lib
\site-packages (from tensorflow) (13.0.0)
Requirement already satisfied: tensorboard<2.9,>=2.8 in c:\users\user\anacond
a3\lib\site-packages (from tensorflow) (2.8.0)
Requirement already satisfied: termcolor>=1.1.0 in c:\users\user\anaconda3\li
b\site-packages (from tensorflow) (1.1.0)
Requirement already satisfied: absl-py>=0.4.0 in c:\users\user\anaconda3\lib
\site-packages (from tensorflow) (1.0.0)
Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.23.1 in c:\use
rs\user\anaconda3\lib\site-packages (from tensorflow) (0.24.0)
Requirement already satisfied: astunparse>=1.6.0 in c:\users\user\anaconda3\l
ib\site-packages (from tensorflow) (1.6.3)
Requirement already satisfied: gast>=0.2.1 in c:\users\user\anaconda3\lib\sit
e-packages (from tensorflow) (0.5.3)
Requirement already satisfied: flatbuffers>=1.12 in c:\users\user\anaconda3\l
ib\site-packages (from tensorflow) (2.0)
Requirement already satisfied: keras-preprocessing>=1.1.1 in c:\users\user\an
aconda3\lib\site-packages (from tensorflow) (1.1.2)
Requirement already satisfied: setuptools in c:\users\user\anaconda3\lib\site
-packages (from tensorflow) (58.0.4)
Requirement already satisfied: keras<2.9,>=2.8.0rc0 in c:\users\user\anaconda
3\lib\site-packages (from tensorflow) (2.8.0)
Requirement already satisfied: typing-extensions>=3.6.6 in c:\users\user\anac
onda3\lib\site-packages (from tensorflow) (3.10.0.2)
Requirement already satisfied: six>=1.12.0 in c:\users\user\anaconda3\lib\sit
e-packages (from tensorflow) (1.16.0)
Requirement already satisfied: opt-einsum>=2.3.2 in c:\users\user\anaconda3\l
ib\site-packages (from tensorflow) (3.3.0)
Requirement already satisfied: tf-estimator-nightly==2.8.0.dev2021122109 in
c:\users\user\anaconda3\lib\site-packages (from tensorflow) (2.8.0.dev2021122
109)
Requirement already satisfied: h5py>=2.9.0 in c:\users\user\anaconda3\lib\sit
e-packages (from tensorflow) (3.2.1)
Requirement already satisfied: google-pasta>=0.1.1 in c:\users\user\anaconda3
\lib\site-packages (from tensorflow) (0.2.0)
Requirement already satisfied: numpy>=1.20 in c:\users\user\anaconda3\lib\sit
e-packages (from tensorflow) (1.20.3)
Requirement already satisfied: grpcio<2.0,>=1.24.3 in c:\users\user\anaconda3
\lib\site-packages (from tensorflow) (1.44.0)
Requirement already satisfied: protobuf>=3.9.2 in c:\users\user\anaconda3\lib
\site-packages (from tensorflow) (3.19.4)
Requirement already satisfied: wrapt>=1.11.0 in c:\users\user\anaconda3\lib\s
ite-packages (from tensorflow) (1.12.1)
Requirement already satisfied: wheel<1.0,>=0.23.0 in c:\users\user\anaconda3
\lib\site-packages (from astunparse>=1.6.0->tensorflow) (0.37.0)
```

```
Requirement already satisfied: markdown>=2.6.8 in c:\users\user\anaconda3\lib
\site-packages (from tensorboard<2.9,>=2.8->tensorflow) (3.3.6)
Requirement already satisfied: werkzeug>=0.11.15 in c:\users\user\anaconda3\l
ib\site-packages (from tensorboard<2.9,>=2.8->tensorflow) (2.0.2)
Requirement already satisfied: requests<3,>=2.21.0 in c:\users\user\anaconda3
\lib\site-packages (from tensorboard<2.9,>=2.8->tensorflow) (2.26.0)
Requirement already satisfied: google-auth-oauthlib<0.5,>=0.4.1 in c:\users\u
ser\anaconda3\lib\site-packages (from tensorboard<2.9,>=2.8->tensorflow) (0.
4.6)
Requirement already satisfied: google-auth<3,>=1.6.3 in c:\users\user\anacond
a3\lib\site-packages (from tensorboard<2.9,>=2.8->tensorflow) (2.6.0)
Requirement already satisfied: tensorboard-data-server<0.7.0,>=0.6.0 in c:\us
ers\user\anaconda3\lib\site-packages (from tensorboard<2.9,>=2.8->tensorflow)
(0.6.1)
Requirement already satisfied: tensorboard-plugin-wit>=1.6.0 in c:\users\user
\anaconda3\lib\site-packages (from tensorboard<2.9,>=2.8->tensorflow) (1.8.1)
Requirement already satisfied: cachetools<6.0,>=2.0.0 in c:\users\user\anacon
da3\lib\site-packages (from google-auth<3,>=1.6.3->tensorboard<2.9,>=2.8->ten
sorflow) (5.0.0)
Requirement already satisfied: pyasn1-modules>=0.2.1 in c:\users\user\anacond
a3\lib\site-packages (from google-auth<3,>=1.6.3->tensorboard<2.9,>=2.8->tens
orflow) (0.2.8)
Requirement already satisfied: rsa<5,>=3.1.4 in c:\users\user\anaconda3\lib\s
ite-packages (from google-auth<3,>=1.6.3->tensorboard<2.9,>=2.8->tensorflow)
(4.8)
Requirement already satisfied: requests-oauthlib>=0.7.0 in c:\users\user\anac
onda3\lib\site-packages (from google-auth-oauthlib<0.5,>=0.4.1->tensorboard<
2.9,>=2.8->tensorflow) (1.3.1)
Requirement already satisfied: importlib-metadata>=4.4 in c:\users\user\anaco
nda3\lib\site-packages (from markdown>=2.6.8->tensorboard<2.9,>=2.8->tensorfl
ow) (4.8.1)
Requirement already satisfied: zipp>=0.5 in c:\users\user\anaconda3\lib\site-
packages (from importlib-metadata>=4.4->markdown>=2.6.8->tensorboard<2.9,>=2.
8->tensorflow) (3.6.0)
Requirement already satisfied: pyasn1<0.5.0,>=0.4.6 in c:\users\user\anaconda
3\lib\site-packages (from pyasn1-modules>=0.2.1->google-auth<3,>=1.6.3->tenso
rboard<2.9,>=2.8->tensorflow) (0.4.8)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in c:\users\user\anacond
a3\lib\site-packages (from requests<3,>=2.21.0->tensorboard<2.9,>=2.8->tensor
flow) (1.26.7)
Requirement already satisfied: charset-normalizer~=2.0.0 in c:\users\user\ana
conda3\lib\site-packages (from requests<3,>=2.21.0->tensorboard<2.9,>=2.8->te
nsorflow) (2.0.4)
Requirement already satisfied: idna<4,>=2.5 in c:\users\user\anaconda3\lib\si
te-packages (from requests<3,>=2.21.0->tensorboard<2.9,>=2.8->tensorflow) (3.
2)
Requirement already satisfied: certifi>=2017.4.17 in c:\users\user\anaconda3
\lib\site-packages (from requests<3,>=2.21.0->tensorboard<2.9,>=2.8->tensorfl
ow) (2021.10.8)
Requirement already satisfied: oauthlib>=3.0.0 in c:\users\user\anaconda3\lib
\site-packages (from requests-oauthlib>=0.7.0->google-auth-oauthlib<0.5,>=0.
4.1->tensorboard<2.9,>=2.8->tensorflow) (3.2.0)
```

In [18]:
```
model=Sequential()
```

In [19]:
```
x_train.shape[1]
```

Out[19]:
```
12
```

In [20]:
```
model.add(Dense(input_dim=12, kernel_initializer="random_uniform", activation="re
```

In [21]:
```
model.add(Dense(kernel_initializer="random_uniform",activation="relu",units=20))
model.add(Dense(kernel_initializer="random_uniform",activation="relu",units=20))
```

In [22]:
```
model.add(Dense(kernel_initializer="random_uniform",activation="sigmoid",units=1)
```

In [23]:
```
model.compile(loss="binary_crossentropy",optimizer="adam",metrics=["accuracy"])
```

In [24]:
```
model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense (Dense)               (None, 6)                 78

 dense_1 (Dense)             (None, 20)                140

 dense_2 (Dense)             (None, 20)                420

 dense_3 (Dense)             (None, 1)                 21

=================================================================
Total params: 659
Trainable params: 659
Non-trainable params: 0
_________________________________________________________________
```

In [25]:
```
train_history = model.fit(x_train,y_train,epochs=100,batch_size=16)
```

```
500/500 [==============================] - 1s 2ms/step - loss: 0.3328 - accur
acy: 0.8615
Epoch 64/100
500/500 [==============================] - 1s 1ms/step - loss: 0.3313 - accur
acy: 0.8643
Epoch 65/100
500/500 [==============================] - 1s 1ms/step - loss: 0.3308 - accur
acy: 0.8639
Epoch 66/100
500/500 [==============================] - 1s 1ms/step - loss: 0.3314 - accur
acy: 0.8627
Epoch 67/100
500/500 [==============================] - 1s 1ms/step - loss: 0.3313 - accur
acy: 0.8644
Epoch 68/100
500/500 [==============================] - 1s 1ms/step - loss: 0.3315 - accur
acy: 0.8614
Epoch 69/100
500/500 [==============================] - 1s 1ms/step - loss: 0.3293 - accur
acy: 0.8650
```

In [26]:
```
train_history
```

Out[26]:
```
<keras.callbacks.History at 0x1f3c24886a0>
```

In [27]:
```
model
```

Out[27]:
```
<keras.engine.sequential.Sequential at 0x1f3b9cb3f10>
```

In [28]:
```
y_pred=model.predict(x_test)
y_pred
```

Out[28]:
```
array([[0.9910361 ],
       [0.01627061],
       [0.05940503],
       ...,
       [0.18023175],
       [0.4500526 ],
       [0.12948889]], dtype=float32)
```

In [29]:
```
y_pred=y_pred>0.5
```

In [30]:
```
from sklearn.metrics import accuracy_score
accuracy_score(y_test, y_pred)
```

Out[30]:
```
0.8335
```

In [31]:
```
print("Test Accuracy Score:", accuracy_score(y_test,y_pred)*100,"%")
```

```
Test Accuracy Score: 83.35000000000001 %
```

In [32]:
```
train_history.history
```

```
0.3493916392326355,
0.344724178314209,
0.3409246504306793,
0.33590462803840637,
0.3364691734313965,
0.3342670798301697,
0.33390599489212036,
0.33306685090065,
0.33276066184043884,
0.331277996301651,
0.3307946026325226,
0.3314361870288849,
0.3312731087207794,
0.33154451847076416,
0.3292553722858429,
0.3305748403072357,
0.3302324712276459,
0.3297758102416992,
0.32846036553382874,
0.3298720717430115
```

In [34]:
```
model.save("Ann CHM.h5")
```

In [ ]:
```

```