DNN- Experiment 3

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- PRN: 20190802107

Dataset - Churn Dataset.

In [11]:
```
import pandas as pd
from sklearn.model_selection import train_test_split
```

In [12]:
```
churn_df=pd.read_csv(r'D:/Churn Dataset.csv')
```

In [13]:
```
X = pd.get_dummies(churn_df.drop(['Churn','customerID'],axis=1))
y = churn_df['Churn'].apply(lambda x: 1 if x =='Yes' else 0)
```

In [14]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=.2)
```

In [15]:
```
X_train.head()
```

Out[15]:

	SeniorCitizen	tenure	MonthlyCharges	gender_Female	gender_Male	Partner_No	Partner_Yes	Dependents_No	Dependents_Yes	PhoneService_No	...	TotalCharges_
4602	0	67	26.10	1	0	1	0	1	0	0	...	
5398	0	2	19.75	0	1	1	0	1	0	0	...	
539	0	60	80.60	1	0	0	1	0	1	0	...	
4456	0	68	24.95	1	0	0	1	1	0	0	...	
3813	0	69	105.00	0	1	0	1	0	1	0	...	

5 rows × 6575 columns

Dependencies

In [16]:
```
from tensorflow.keras.models import Sequential, load_model
from tensorflow.keras.layers import Dense
from sklearn.metrics import accuracy_score
```

Build & Compile model

In [17]:
```
model = Sequential()
model.add(Dense(units=32, activation ='relu', input_dim =len(X_train.columns)))
model.add(Dense(units=64, activation ='relu'))
model.add(Dense(units=1, activation ='sigmoid'))
```

In [18]:
```
model.compile(loss = 'binary_crossentropy', optimizer = 'sgd', metrics ='accuracy')
```

Fit, Predict and Evaluate

In [19]:
```
model.fit(X_train, y_train, epochs =200, batch_size = 32)
```

```
Epoch 1/200
177/177 [==============================] - 2s 4ms/step - loss: 0.5049 - accuracy: 0.7528
Epoch 2/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4928 - accuracy: 0.7689
Epoch 3/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4831 - accuracy: 0.7732
Epoch 4/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4775 - accuracy: 0.7780
Epoch 5/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4772 - accuracy: 0.7771
Epoch 6/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4736 - accuracy: 0.7806
Epoch 7/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4734 - accuracy: 0.7767
Epoch 8/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4683 - accuracy: 0.7785
Epoch 9/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4690 - accuracy: 0.7815
Epoch 10/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4658 - accuracy: 0.7804
Epoch 11/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4627 - accuracy: 0.7817
Epoch 12/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4623 - accuracy: 0.7803
Epoch 13/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4615 - accuracy: 0.7859
Epoch 14/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4580 - accuracy: 0.7847
Epoch 15/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4598 - accuracy: 0.7804
Epoch 16/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4642 - accuracy: 0.7799
Epoch 17/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4587 - accuracy: 0.7836
Epoch 18/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4579 - accuracy: 0.7771
Epoch 19/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4587 - accuracy: 0.7792
Epoch 20/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4593 - accuracy: 0.7787
Epoch 21/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4577 - accuracy: 0.7820
Epoch 22/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4567 - accuracy: 0.7817
Epoch 23/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4555 - accuracy: 0.7797
Epoch 24/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4575 - accuracy: 0.7794
Epoch 25/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4547 - accuracy: 0.7822
Epoch 26/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4527 - accuracy: 0.7813
Epoch 27/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4545 - accuracy: 0.7796
Epoch 28/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4558 - accuracy: 0.7806
Epoch 29/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4534 - accuracy: 0.7863
Epoch 30/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4532 - accuracy: 0.7861
Epoch 31/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4512 - accuracy: 0.7813
Epoch 32/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4515 - accuracy: 0.7796
Epoch 33/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4517 - accuracy: 0.7842
Epoch 34/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4518 - accuracy: 0.7833
Epoch 35/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4497 - accuracy: 0.7856
Epoch 36/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4526 - accuracy: 0.7801
Epoch 37/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4482 - accuracy: 0.7849
Epoch 38/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4494 - accuracy: 0.7854
Epoch 39/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4498 - accuracy: 0.7847
Epoch 40/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4517 - accuracy: 0.7829
Epoch 41/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4483 - accuracy: 0.7852
Epoch 42/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4516 - accuracy: 0.7865
Epoch 43/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4480 - accuracy: 0.7827
Epoch 44/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4468 - accuracy: 0.7842
Epoch 45/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4489 - accuracy: 0.7840
Epoch 46/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4456 - accuracy: 0.7884
Epoch 47/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4481 - accuracy: 0.7787
Epoch 48/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4468 - accuracy: 0.7847
Epoch 49/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4490 - accuracy: 0.7843
Epoch 50/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4449 - accuracy: 0.7824
Epoch 51/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4447 - accuracy: 0.7872
Epoch 52/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4475 - accuracy: 0.7874
Epoch 53/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4460 - accuracy: 0.7886
Epoch 54/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4417 - accuracy: 0.7918
Epoch 55/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4441 - accuracy: 0.7867
Epoch 56/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4433 - accuracy: 0.7868
```

```
Epoch 57/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4426 - accuracy: 0.7900
Epoch 58/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4420 - accuracy: 0.7882
Epoch 59/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4509 - accuracy: 0.7827
Epoch 60/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4424 - accuracy: 0.7882
Epoch 61/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4470 - accuracy: 0.7920
Epoch 62/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4448 - accuracy: 0.7833
Epoch 63/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4432 - accuracy: 0.7900
Epoch 64/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4427 - accuracy: 0.7914
Epoch 65/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4442 - accuracy: 0.7922
Epoch 66/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4408 - accuracy: 0.7865
Epoch 67/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4416 - accuracy: 0.7865
Epoch 68/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4419 - accuracy: 0.7929
Epoch 69/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4449 - accuracy: 0.7911
Epoch 70/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4396 - accuracy: 0.7900
Epoch 71/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4395 - accuracy: 0.7907
Epoch 72/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4406 - accuracy: 0.7911
Epoch 73/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4403 - accuracy: 0.7884
Epoch 74/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4412 - accuracy: 0.7888
Epoch 75/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4406 - accuracy: 0.7923
Epoch 76/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4524 - accuracy: 0.7829
Epoch 77/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4440 - accuracy: 0.7888
Epoch 78/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4426 - accuracy: 0.7875
Epoch 79/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4386 - accuracy: 0.7893
Epoch 80/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4378 - accuracy: 0.7870
Epoch 81/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4376 - accuracy: 0.7938
Epoch 82/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4389 - accuracy: 0.7911
Epoch 83/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4368 - accuracy: 0.7906
Epoch 84/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4374 - accuracy: 0.7911
Epoch 85/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4369 - accuracy: 0.7845
Epoch 86/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4358 - accuracy: 0.7914
Epoch 87/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4437 - accuracy: 0.7886
Epoch 88/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4379 - accuracy: 0.7916
Epoch 89/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4405 - accuracy: 0.7943
Epoch 90/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4377 - accuracy: 0.7877
Epoch 91/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4365 - accuracy: 0.7879
Epoch 92/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4371 - accuracy: 0.7929
Epoch 93/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4359 - accuracy: 0.7925
Epoch 94/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4393 - accuracy: 0.7902
Epoch 95/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4356 - accuracy: 0.7932
Epoch 96/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4362 - accuracy: 0.7900
Epoch 97/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4384 - accuracy: 0.7934
Epoch 98/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4369 - accuracy: 0.7898
Epoch 99/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4353 - accuracy: 0.7948
Epoch 100/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4387 - accuracy: 0.7900
Epoch 101/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4329 - accuracy: 0.7900
Epoch 102/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4340 - accuracy: 0.7916
Epoch 103/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4327 - accuracy: 0.7943
Epoch 104/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4363 - accuracy: 0.7900
Epoch 105/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4327 - accuracy: 0.7929
Epoch 106/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4356 - accuracy: 0.7879
Epoch 107/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4353 - accuracy: 0.7913
Epoch 108/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4350 - accuracy: 0.7918
Epoch 109/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4347 - accuracy: 0.7929
Epoch 110/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4345 - accuracy: 0.7925
Epoch 111/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4332 - accuracy: 0.7904
Epoch 112/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4336 - accuracy: 0.7966
```

```
Epoch 113/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4527 - accuracy: 0.7875
Epoch 114/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4362 - accuracy: 0.7938
Epoch 115/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4363 - accuracy: 0.7914
Epoch 116/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4358 - accuracy: 0.7914
Epoch 117/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4349 - accuracy: 0.7934
Epoch 118/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4482 - accuracy: 0.7893
Epoch 119/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4343 - accuracy: 0.7932
Epoch 120/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4377 - accuracy: 0.7957
Epoch 121/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4331 - accuracy: 0.8003
Epoch 122/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4375 - accuracy: 0.7923
Epoch 123/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4373 - accuracy: 0.7904
Epoch 124/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4332 - accuracy: 0.7922
Epoch 125/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4341 - accuracy: 0.7962
Epoch 126/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4328 - accuracy: 0.7936
Epoch 127/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4306 - accuracy: 0.7966
Epoch 128/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4344 - accuracy: 0.7918
Epoch 129/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4324 - accuracy: 0.7938
Epoch 130/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4352 - accuracy: 0.7936
Epoch 131/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4333 - accuracy: 0.7943
Epoch 132/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4301 - accuracy: 0.7966
Epoch 133/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4348 - accuracy: 0.7948
Epoch 134/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4365 - accuracy: 0.7943
Epoch 135/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4334 - accuracy: 0.7939
Epoch 136/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4362 - accuracy: 0.7946
Epoch 137/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4330 - accuracy: 0.7969
Epoch 138/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4322 - accuracy: 0.7959
Epoch 139/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4294 - accuracy: 0.7953
Epoch 140/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4304 - accuracy: 0.7922
Epoch 141/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4356 - accuracy: 0.7936
Epoch 142/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4316 - accuracy: 0.7952
Epoch 143/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4305 - accuracy: 0.7929
Epoch 144/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4310 - accuracy: 0.7987
Epoch 145/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4344 - accuracy: 0.7982
Epoch 146/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4296 - accuracy: 0.7936
Epoch 147/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4288 - accuracy: 0.7936
Epoch 148/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4290 - accuracy: 0.7977
Epoch 149/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4375 - accuracy: 0.7916
Epoch 150/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4301 - accuracy: 0.7950
Epoch 151/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4287 - accuracy: 0.7969
Epoch 152/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4283 - accuracy: 0.7964
Epoch 153/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4325 - accuracy: 0.7923
Epoch 154/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4285 - accuracy: 0.7922
Epoch 155/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4280 - accuracy: 0.7945
Epoch 156/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4312 - accuracy: 0.7955
Epoch 157/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4295 - accuracy: 0.7987
Epoch 158/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4299 - accuracy: 0.7984
Epoch 159/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4274 - accuracy: 0.7961
Epoch 160/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4295 - accuracy: 0.7929
Epoch 161/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4274 - accuracy: 0.7985
Epoch 162/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4280 - accuracy: 0.7991
Epoch 163/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4303 - accuracy: 0.7938
Epoch 164/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4271 - accuracy: 0.7980
Epoch 165/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4269 - accuracy: 0.7969
Epoch 166/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4255 - accuracy: 0.7962
Epoch 167/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4297 - accuracy: 0.7985
Epoch 168/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4276 - accuracy: 0.7948
```

```
Epoch 169/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4302 - accuracy: 0.7996
Epoch 170/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4257 - accuracy: 0.7966
Epoch 171/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4303 - accuracy: 0.7936
Epoch 172/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4310 - accuracy: 0.7934
Epoch 173/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4272 - accuracy: 0.7971
Epoch 174/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4295 - accuracy: 0.7955
Epoch 175/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4278 - accuracy: 0.7978
Epoch 176/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4264 - accuracy: 0.8001
Epoch 177/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4280 - accuracy: 0.7977
Epoch 178/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4280 - accuracy: 0.7962
Epoch 179/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4294 - accuracy: 0.7941
Epoch 180/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4264 - accuracy: 0.7962
Epoch 181/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4313 - accuracy: 0.7948
Epoch 182/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4264 - accuracy: 0.7996
Epoch 183/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4299 - accuracy: 0.7968
Epoch 184/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4264 - accuracy: 0.7938
Epoch 185/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4284 - accuracy: 0.7962
Epoch 186/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4242 - accuracy: 0.7978
Epoch 187/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4334 - accuracy: 0.7904
Epoch 188/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4263 - accuracy: 0.7975
Epoch 189/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4253 - accuracy: 0.7998
Epoch 190/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4282 - accuracy: 0.7975
Epoch 191/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4277 - accuracy: 0.7961
Epoch 192/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4262 - accuracy: 0.8007
Epoch 193/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4256 - accuracy: 0.7996
Epoch 194/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4263 - accuracy: 0.7957
Epoch 195/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4291 - accuracy: 0.7966
Epoch 196/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4256 - accuracy: 0.8010
Epoch 197/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4274 - accuracy: 0.7991
Epoch 198/200
177/177 [==============================] - 0s 3ms/step - loss: 0.4269 - accuracy: 0.7959
Epoch 199/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4238 - accuracy: 0.7964
Epoch 200/200
177/177 [==============================] - 1s 3ms/step - loss: 0.4289 - accuracy: 0.7985
```

Out[19]:

```
<keras.callbacks.History at 0x23a800969d0>
```

In [20]:

```python
y_hat = model.predict(X_test)
y_hat = [0 if val <0.5 else 1 for val in y_hat]
```

```
45/45 [==============================] - 0s 3ms/step
```

In [21]:

```python
print(y_hat)
```

```
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
1, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0,
0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0,
0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 1, 0,
0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
```

In [22]:

```python
accuracy_score(y_test,y_hat)
```

Out[22]:

```
0.8076650106458482
```