

11 - Neural Networks

Part 1 - XOR

1. Using the XOR dataset below, train (400 epochs) a neural network (NN) using 1, 2, 3, 4, and 5 hidden layers (where each layer has only 2 neurons). For each n layers, store the resulting loss score along with n. Plot the results to find what the optimal number of layers is.
2. Repeat the above with 3-neuron and 4-neuron Hidden layers. How do these results compare to the 2 neuron layers?
3. Using the most optimal configuration (n-layers, k-neurons per layer), compare how `tanh`, `sigmoid`, `softplus` and `relu` effect the loss after 400 epochs. Try other Activation functions as well (<https://keras.io/activations/>)
4. Instead of `SGD` try other optimizers and report on the loss score. (<https://keras.io/optimizers/>)

Part 2 - BYOD (Bring your own Dataset)

Using your own dataset, experiment and find the best Neural Network configuration. You may use any resource to improve results, just reference it.

While you may use any dataset, I'd prefer you didn't use the diabetes dataset used in the lesson.

<https://stackoverflow.com/questions/34673164/how-to-train-and-tune-an-artificial-multilayer-perceptron-neural-network-using-k>

<https://keras.io/>

In [1]:

```
from keras.models import Sequential
from keras.layers import Dense
from keras.optimizers import SGD #Stochastic Gradient Descent
from keras.optimizers import RMSprop
from keras.optimizers import Adagrad
from keras.optimizers import Adadelta
from keras.optimizers import Adam
from keras.optimizers import Adamax
from keras.optimizers import Nadam

import numpy as np
# fix random seed for reproducibility
np.random.seed(7)

import matplotlib.pyplot as plt
%matplotlib inline
```

Using TensorFlow backend.

Model Notation:

Example - "model_lay_one_two" translates to one layer, and two neurons per layer

Example - "model_lay_two_three" translates to two layers, and three neurons per layer

LABABIDI CAUTION: Please note that for questions 1-4 I ran into an issue with replicating my layer/neuron modifications in a linear, systematic, fashion after defining my dataset. Something with `.fit` or `.reshape` would alter my outputs, resulting in a systematic error that I could not put my finger on. As a result of my failure to find the reason for this I re-defined my random dataset for EACH modification. A means to the same end, as I was able to identify the optimal NN configuration regardless (I believe).

Part 1 Question 1: Two Neurons per Layer

One Layer

In [2]:

```
n = 40
xx = np.random.random((n,1))
yy = np.random.random((n,1))

X = np.array([np.array([xx - yy - yy * yy]) np.array([xx - yy * yy - yy * yy]) np.array([1])]).reshape(2,1*n).T
```

```
x = np.array([np.array([1,1,-1,-1]),np.array([1,1,-1,-1]),np.array([1,1,-1,-1])]).reshape(4,4)
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [3]:

```
#one layer, two neurons
model_lay_one_two = Sequential()

#hidden layers
model_lay_one_two.add(Dense(2, input_dim=2, activation='tanh'))

#output layer
model_lay_one_two.add(Dense(1, activation='sigmoid'))

sgd = SGD(lr=0.1)
model_lay_one_two.compile(loss='binary_crossentropy', optimizer='sgd')

model_lay_one_two.fit(X, y, batch_size=2, epochs=400)
print(model_lay_one_two.predict_proba(X).reshape(4*n))

#evaluate the model
scores_lay_one_two = model_lay_one_two.evaluate(X, y)
```

```
Epoch 1/400
160/160 [=====] - 0s 860us/step - loss: 0.7508
Epoch 2/400
160/160 [=====] - 0s 218us/step - loss: 0.7293
Epoch 3/400
160/160 [=====] - 0s 228us/step - loss: 0.7134
Epoch 4/400
160/160 [=====] - 0s 224us/step - loss: 0.7015
Epoch 5/400
160/160 [=====] - 0s 212us/step - loss: 0.6918
Epoch 6/400
160/160 [=====] - 0s 228us/step - loss: 0.6843
Epoch 7/400
160/160 [=====] - 0s 218us/step - loss: 0.6775
Epoch 8/400
160/160 [=====] - 0s 218us/step - loss: 0.6728
Epoch 9/400
160/160 [=====] - 0s 221us/step - loss: 0.6682
Epoch 10/400
160/160 [=====] - 0s 224us/step - loss: 0.6644
Epoch 11/400
160/160 [=====] - 0s 218us/step - loss: 0.6613
Epoch 12/400
160/160 [=====] - 0s 221us/step - loss: 0.6584
Epoch 13/400
160/160 [=====] - 0s 218us/step - loss: 0.6558
Epoch 14/400
160/160 [=====] - 0s 218us/step - loss: 0.6533
Epoch 15/400
160/160 [=====] - 0s 212us/step - loss: 0.6510
Epoch 16/400
160/160 [=====] - 0s 218us/step - loss: 0.6488
Epoch 17/400
160/160 [=====] - 0s 218us/step - loss: 0.6465
Epoch 18/400
160/160 [=====] - 0s 212us/step - loss: 0.6447
Epoch 19/400
160/160 [=====] - 0s 218us/step - loss: 0.6423
Epoch 20/400
160/160 [=====] - 0s 212us/step - loss: 0.6402
Epoch 21/400
160/160 [=====] - 0s 218us/step - loss: 0.6384
Epoch 22/400
160/160 [=====] - 0s 212us/step - loss: 0.6358
Epoch 23/400
160/160 [=====] - 0s 212us/step - loss: 0.6334
Epoch 24/400
160/160 [=====] - 0s 212us/step - loss: 0.6311
Epoch 25/400
160/160 [=====] - 0s 218us/step - loss: 0.6290
Epoch 26/400
160/160 [=====] - 0s 224us/step - loss: 0.6267
Epoch 27/400
160/160 [=====] - 0s 231us/step - loss: 0.6240
Epoch 28/400
```

Epoch 28/400
160/160 [=====] - 0s 218us/step - loss: 0.6215
Epoch 29/400
160/160 [=====] - 0s 218us/step - loss: 0.6188
Epoch 30/400
160/160 [=====] - 0s 218us/step - loss: 0.6161
Epoch 31/400
160/160 [=====] - 0s 224us/step - loss: 0.6134
Epoch 32/400
160/160 [=====] - 0s 237us/step - loss: 0.6105
Epoch 33/400
160/160 [=====] - 0s 231us/step - loss: 0.6074
Epoch 34/400
160/160 [=====] - 0s 224us/step - loss: 0.6042
Epoch 35/400
160/160 [=====] - 0s 231us/step - loss: 0.6010
Epoch 36/400
160/160 [=====] - 0s 224us/step - loss: 0.5977
Epoch 37/400
160/160 [=====] - 0s 218us/step - loss: 0.5940
Epoch 38/400
160/160 [=====] - 0s 218us/step - loss: 0.5906
Epoch 39/400
160/160 [=====] - 0s 218us/step - loss: 0.5869
Epoch 40/400
160/160 [=====] - 0s 218us/step - loss: 0.5828
Epoch 41/400
160/160 [=====] - 0s 218us/step - loss: 0.5790
Epoch 42/400
160/160 [=====] - 0s 224us/step - loss: 0.5750
Epoch 43/400
160/160 [=====] - 0s 218us/step - loss: 0.5704
Epoch 44/400
160/160 [=====] - 0s 218us/step - loss: 0.5661
Epoch 45/400
160/160 [=====] - 0s 218us/step - loss: 0.5615
Epoch 46/400
160/160 [=====] - 0s 218us/step - loss: 0.5569
Epoch 47/400
160/160 [=====] - 0s 218us/step - loss: 0.5526
Epoch 48/400
160/160 [=====] - 0s 221us/step - loss: 0.5473
Epoch 49/400
160/160 [=====] - 0s 218us/step - loss: 0.5424
Epoch 50/400
160/160 [=====] - 0s 218us/step - loss: 0.5375
Epoch 51/400
160/160 [=====] - 0s 221us/step - loss: 0.5327
Epoch 52/400
160/160 [=====] - 0s 212us/step - loss: 0.5275
Epoch 53/400
160/160 [=====] - 0s 218us/step - loss: 0.5222
Epoch 54/400
160/160 [=====] - 0s 228us/step - loss: 0.5173
Epoch 55/400
160/160 [=====] - 0s 218us/step - loss: 0.5122
Epoch 56/400
160/160 [=====] - 0s 218us/step - loss: 0.5069
Epoch 57/400
160/160 [=====] - 0s 228us/step - loss: 0.5019
Epoch 58/400
160/160 [=====] - 0s 218us/step - loss: 0.4969
Epoch 59/400
160/160 [=====] - 0s 218us/step - loss: 0.4920
Epoch 60/400
160/160 [=====] - 0s 212us/step - loss: 0.4870
Epoch 61/400
160/160 [=====] - 0s 206us/step - loss: 0.4822
Epoch 62/400
160/160 [=====] - 0s 206us/step - loss: 0.4771
Epoch 63/400
160/160 [=====] - 0s 199us/step - loss: 0.4721
Epoch 64/400
160/160 [=====] - 0s 199us/step - loss: 0.4681
Epoch 65/400
160/160 [=====] - 0s 206us/step - loss: 0.4634
Epoch 66/400
160/160 [=====] - 0s 212us/step - loss: 0.4587

100/100 Epoch 67/400
160/160 [=====] - 0s 199us/step - loss: 0.4544
Epoch 68/400
160/160 [=====] - 0s 199us/step - loss: 0.4503
Epoch 69/400
160/160 [=====] - 0s 199us/step - loss: 0.4459
Epoch 70/400
160/160 [=====] - 0s 206us/step - loss: 0.4421
Epoch 71/400
160/160 [=====] - 0s 206us/step - loss: 0.4382
Epoch 72/400
160/160 [=====] - 0s 199us/step - loss: 0.4342
Epoch 73/400
160/160 [=====] - 0s 199us/step - loss: 0.4305
Epoch 74/400
160/160 [=====] - 0s 199us/step - loss: 0.4270
Epoch 75/400
160/160 [=====] - 0s 199us/step - loss: 0.4235
Epoch 76/400
160/160 [=====] - 0s 199us/step - loss: 0.4204
Epoch 77/400
160/160 [=====] - 0s 206us/step - loss: 0.4169
Epoch 78/400
160/160 [=====] - 0s 199us/step - loss: 0.4140
Epoch 79/400
160/160 [=====] - 0s 199us/step - loss: 0.4108
Epoch 80/400
160/160 [=====] - 0s 199us/step - loss: 0.4079
Epoch 81/400
160/160 [=====] - 0s 206us/step - loss: 0.4051
Epoch 82/400
160/160 [=====] - 0s 199us/step - loss: 0.4022
Epoch 83/400
160/160 [=====] - 0s 199us/step - loss: 0.3998
Epoch 84/400
160/160 [=====] - 0s 209us/step - loss: 0.3970
Epoch 85/400
160/160 [=====] - 0s 199us/step - loss: 0.3946
Epoch 86/400
160/160 [=====] - 0s 206us/step - loss: 0.3921
Epoch 87/400
160/160 [=====] - 0s 206us/step - loss: 0.3900
Epoch 88/400
160/160 [=====] - 0s 206us/step - loss: 0.3877
Epoch 89/400
160/160 [=====] - 0s 193us/step - loss: 0.3856
Epoch 90/400
160/160 [=====] - 0s 212us/step - loss: 0.3831
Epoch 91/400
160/160 [=====] - 0s 212us/step - loss: 0.3816
Epoch 92/400
160/160 [=====] - 0s 206us/step - loss: 0.3793
Epoch 93/400
160/160 [=====] - 0s 206us/step - loss: 0.3774
Epoch 94/400
160/160 [=====] - 0s 199us/step - loss: 0.3756
Epoch 95/400
160/160 [=====] - 0s 199us/step - loss: 0.3739
Epoch 96/400
160/160 [=====] - 0s 193us/step - loss: 0.3722
Epoch 97/400
160/160 [=====] - 0s 206us/step - loss: 0.3709
Epoch 98/400
160/160 [=====] - 0s 206us/step - loss: 0.3691
Epoch 99/400
160/160 [=====] - 0s 212us/step - loss: 0.3675
Epoch 100/400
160/160 [=====] - 0s 199us/step - loss: 0.3662
Epoch 101/400
160/160 [=====] - 0s 199us/step - loss: 0.3647
Epoch 102/400
160/160 [=====] - 0s 206us/step - loss: 0.3632
Epoch 103/400
160/160 [=====] - 0s 209us/step - loss: 0.3622
Epoch 104/400
160/160 [=====] - 0s 206us/step - loss: 0.3606
Epoch 105/400

Epoch 105/400
160/160 [=====] - 0s 206us/step - loss: 0.3598
Epoch 106/400
160/160 [=====] - 0s 203us/step - loss: 0.3583
Epoch 107/400
160/160 [=====] - 0s 199us/step - loss: 0.3572
Epoch 108/400
160/160 [=====] - 0s 199us/step - loss: 0.3561
Epoch 109/400
160/160 [=====] - 0s 206us/step - loss: 0.3552
Epoch 110/400
160/160 [=====] - 0s 206us/step - loss: 0.3540
Epoch 111/400
160/160 [=====] - 0s 199us/step - loss: 0.3528
Epoch 112/400
160/160 [=====] - 0s 193us/step - loss: 0.3522
Epoch 113/400
160/160 [=====] - 0s 199us/step - loss: 0.3512
Epoch 114/400
160/160 [=====] - 0s 199us/step - loss: 0.3503
Epoch 115/400
160/160 [=====] - 0s 199us/step - loss: 0.3494
Epoch 116/400
160/160 [=====] - 0s 199us/step - loss: 0.3484
Epoch 117/400
160/160 [=====] - 0s 206us/step - loss: 0.3479
Epoch 118/400
160/160 [=====] - 0s 199us/step - loss: 0.3467
Epoch 119/400
160/160 [=====] - 0s 206us/step - loss: 0.3461
Epoch 120/400
160/160 [=====] - 0s 212us/step - loss: 0.3452
Epoch 121/400
160/160 [=====] - 0s 206us/step - loss: 0.3446
Epoch 122/400
160/160 [=====] - 0s 206us/step - loss: 0.3441
Epoch 123/400
160/160 [=====] - 0s 206us/step - loss: 0.3433
Epoch 124/400
160/160 [=====] - 0s 199us/step - loss: 0.3426
Epoch 125/400
160/160 [=====] - 0s 206us/step - loss: 0.3420
Epoch 126/400
160/160 [=====] - 0s 199us/step - loss: 0.3411
Epoch 127/400
160/160 [=====] - 0s 206us/step - loss: 0.3407
Epoch 128/400
160/160 [=====] - 0s 206us/step - loss: 0.3402
Epoch 129/400
160/160 [=====] - 0s 206us/step - loss: 0.3397
Epoch 130/400
160/160 [=====] - 0s 199us/step - loss: 0.3388
Epoch 131/400
160/160 [=====] - 0s 206us/step - loss: 0.3386
Epoch 132/400
160/160 [=====] - 0s 206us/step - loss: 0.3379
Epoch 133/400
160/160 [=====] - 0s 206us/step - loss: 0.3375
Epoch 134/400
160/160 [=====] - 0s 212us/step - loss: 0.3371
Epoch 135/400
160/160 [=====] - 0s 206us/step - loss: 0.3366
Epoch 136/400
160/160 [=====] - 0s 212us/step - loss: 0.3363
Epoch 137/400
160/160 [=====] - 0s 206us/step - loss: 0.3359
Epoch 138/400
160/160 [=====] - 0s 206us/step - loss: 0.3354
Epoch 139/400
160/160 [=====] - 0s 199us/step - loss: 0.3348
Epoch 140/400
160/160 [=====] - 0s 199us/step - loss: 0.3345
Epoch 141/400
160/160 [=====] - 0s 199us/step - loss: 0.3342
Epoch 142/400
160/160 [=====] - 0s 199us/step - loss: 0.3340
Epoch 143/400
160/160 [=====] - 0s 206us/step - loss: 0.3331

100/100 [=====] - 0s 200us/step - loss: 0.3254
Epoch 144/400
160/160 [=====] - 0s 199us/step - loss: 0.3333
Epoch 145/400
160/160 [=====] - 0s 206us/step - loss: 0.3330
Epoch 146/400
160/160 [=====] - 0s 199us/step - loss: 0.3327
Epoch 147/400
160/160 [=====] - 0s 193us/step - loss: 0.3324
Epoch 148/400
160/160 [=====] - 0s 212us/step - loss: 0.3322
Epoch 149/400
160/160 [=====] - 0s 203us/step - loss: 0.3315
Epoch 150/400
160/160 [=====] - 0s 199us/step - loss: 0.3315
Epoch 151/400
160/160 [=====] - 0s 212us/step - loss: 0.3312
Epoch 152/400
160/160 [=====] - 0s 209us/step - loss: 0.3307
Epoch 153/400
160/160 [=====] - 0s 199us/step - loss: 0.3308
Epoch 154/400
160/160 [=====] - 0s 199us/step - loss: 0.3301
Epoch 155/400
160/160 [=====] - 0s 203us/step - loss: 0.3299
Epoch 156/400
160/160 [=====] - 0s 199us/step - loss: 0.3296
Epoch 157/400
160/160 [=====] - 0s 206us/step - loss: 0.3298
Epoch 158/400
160/160 [=====] - 0s 203us/step - loss: 0.3292
Epoch 159/400
160/160 [=====] - 0s 199us/step - loss: 0.3292
Epoch 160/400
160/160 [=====] - 0s 199us/step - loss: 0.3289
Epoch 161/400
160/160 [=====] - 0s 199us/step - loss: 0.3286
Epoch 162/400
160/160 [=====] - 0s 199us/step - loss: 0.3283
Epoch 163/400
160/160 [=====] - 0s 206us/step - loss: 0.3280
Epoch 164/400
160/160 [=====] - 0s 212us/step - loss: 0.3278
Epoch 165/400
160/160 [=====] - 0s 199us/step - loss: 0.3279
Epoch 166/400
160/160 [=====] - 0s 199us/step - loss: 0.3279
Epoch 167/400
160/160 [=====] - 0s 199us/step - loss: 0.3274
Epoch 168/400
160/160 [=====] - 0s 199us/step - loss: 0.3272
Epoch 169/400
160/160 [=====] - 0s 199us/step - loss: 0.3271
Epoch 170/400
160/160 [=====] - 0s 199us/step - loss: 0.3269
Epoch 171/400
160/160 [=====] - 0s 199us/step - loss: 0.3270
Epoch 172/400
160/160 [=====] - 0s 199us/step - loss: 0.3263
Epoch 173/400
160/160 [=====] - 0s 199us/step - loss: 0.3264
Epoch 174/400
160/160 [=====] - 0s 199us/step - loss: 0.3264
Epoch 175/400
160/160 [=====] - 0s 199us/step - loss: 0.3265
Epoch 176/400
160/160 [=====] - 0s 199us/step - loss: 0.3259
Epoch 177/400
160/160 [=====] - 0s 193us/step - loss: 0.3263
Epoch 178/400
160/160 [=====] - 0s 212us/step - loss: 0.3260
Epoch 179/400
160/160 [=====] - 0s 206us/step - loss: 0.3256
Epoch 180/400
160/160 [=====] - 0s 199us/step - loss: 0.3257
Epoch 181/400
160/160 [=====] - 0s 212us/step - loss: 0.3252

Epoch 100/400

Epoch 102/400
160/160 [=====] - 0s 206us/step - loss: 0.3257
Epoch 183/400
160/160 [=====] - 0s 199us/step - loss: 0.3248
Epoch 184/400
160/160 [=====] - 0s 212us/step - loss: 0.3251
Epoch 185/400
160/160 [=====] - 0s 218us/step - loss: 0.3248
Epoch 186/400
160/160 [=====] - 0s 206us/step - loss: 0.3252
Epoch 187/400
160/160 [=====] - 0s 193us/step - loss: 0.3249
Epoch 188/400
160/160 [=====] - 0s 199us/step - loss: 0.3245
Epoch 189/400
160/160 [=====] - 0s 206us/step - loss: 0.3244
Epoch 190/400
160/160 [=====] - 0s 206us/step - loss: 0.3245
Epoch 191/400
160/160 [=====] - 0s 193us/step - loss: 0.3245
Epoch 192/400
160/160 [=====] - 0s 206us/step - loss: 0.3244
Epoch 193/400
160/160 [=====] - 0s 199us/step - loss: 0.3243
Epoch 194/400
160/160 [=====] - 0s 199us/step - loss: 0.3243
Epoch 195/400
160/160 [=====] - 0s 206us/step - loss: 0.3238
Epoch 196/400
160/160 [=====] - 0s 206us/step - loss: 0.3237
Epoch 197/400
160/160 [=====] - 0s 203us/step - loss: 0.3238
Epoch 198/400
160/160 [=====] - 0s 199us/step - loss: 0.3239
Epoch 199/400
160/160 [=====] - 0s 193us/step - loss: 0.3237
Epoch 200/400
160/160 [=====] - 0s 199us/step - loss: 0.3235
Epoch 201/400
160/160 [=====] - 0s 196us/step - loss: 0.3233
Epoch 202/400
160/160 [=====] - 0s 206us/step - loss: 0.3233
Epoch 203/400
160/160 [=====] - 0s 199us/step - loss: 0.3230
Epoch 204/400
160/160 [=====] - 0s 203us/step - loss: 0.3233
Epoch 205/400
160/160 [=====] - 0s 199us/step - loss: 0.3235
Epoch 206/400
160/160 [=====] - 0s 206us/step - loss: 0.3232
Epoch 207/400
160/160 [=====] - 0s 196us/step - loss: 0.3235
Epoch 208/400
160/160 [=====] - 0s 206us/step - loss: 0.3235
Epoch 209/400
160/160 [=====] - 0s 199us/step - loss: 0.3230
Epoch 210/400
160/160 [=====] - 0s 199us/step - loss: 0.3226
Epoch 211/400
160/160 [=====] - 0s 206us/step - loss: 0.3230
Epoch 212/400
160/160 [=====] - 0s 212us/step - loss: 0.3229
Epoch 213/400
160/160 [=====] - 0s 199us/step - loss: 0.3230
Epoch 214/400
160/160 [=====] - 0s 206us/step - loss: 0.3226
Epoch 215/400
160/160 [=====] - 0s 199us/step - loss: 0.3228
Epoch 216/400
160/160 [=====] - 0s 206us/step - loss: 0.3230
Epoch 217/400
160/160 [=====] - 0s 199us/step - loss: 0.3224
Epoch 218/400
160/160 [=====] - 0s 199us/step - loss: 0.3227
Epoch 219/400
160/160 [=====] - 0s 199us/step - loss: 0.3226
Epoch 220/400

160/160 [=====] - 0s 199us/step - loss: 0.3222
Epoch 221/400
160/160 [=====] - 0s 212us/step - loss: 0.3220
Epoch 222/400
160/160 [=====] - 0s 212us/step - loss: 0.3223
Epoch 223/400
160/160 [=====] - 0s 206us/step - loss: 0.3227
Epoch 224/400
160/160 [=====] - 0s 206us/step - loss: 0.3220
Epoch 225/400
160/160 [=====] - 0s 206us/step - loss: 0.3224
Epoch 226/400
160/160 [=====] - 0s 212us/step - loss: 0.3224
Epoch 227/400
160/160 [=====] - 0s 212us/step - loss: 0.3221
Epoch 228/400
160/160 [=====] - 0s 199us/step - loss: 0.3220
Epoch 229/400
160/160 [=====] - 0s 206us/step - loss: 0.3223
Epoch 230/400
160/160 [=====] - 0s 206us/step - loss: 0.3222
Epoch 231/400
160/160 [=====] - 0s 206us/step - loss: 0.3219
Epoch 232/400
160/160 [=====] - 0s 206us/step - loss: 0.3221
Epoch 233/400
160/160 [=====] - 0s 199us/step - loss: 0.3220
Epoch 234/400
160/160 [=====] - 0s 203us/step - loss: 0.3223
Epoch 235/400
160/160 [=====] - 0s 206us/step - loss: 0.3217
Epoch 236/400
160/160 [=====] - 0s 206us/step - loss: 0.3218
Epoch 237/400
160/160 [=====] - 0s 215us/step - loss: 0.3219
Epoch 238/400
160/160 [=====] - 0s 206us/step - loss: 0.3215
Epoch 239/400
160/160 [=====] - 0s 218us/step - loss: 0.3219
Epoch 240/400
160/160 [=====] - 0s 206us/step - loss: 0.3217
Epoch 241/400
160/160 [=====] - 0s 212us/step - loss: 0.3217
Epoch 242/400
160/160 [=====] - 0s 218us/step - loss: 0.3215
Epoch 243/400
160/160 [=====] - 0s 212us/step - loss: 0.3218
Epoch 244/400
160/160 [=====] - 0s 212us/step - loss: 0.3213
Epoch 245/400
160/160 [=====] - 0s 199us/step - loss: 0.3217
Epoch 246/400
160/160 [=====] - 0s 206us/step - loss: 0.3217
Epoch 247/400
160/160 [=====] - 0s 199us/step - loss: 0.3221
Epoch 248/400
160/160 [=====] - 0s 212us/step - loss: 0.3220
Epoch 249/400
160/160 [=====] - 0s 206us/step - loss: 0.3219
Epoch 250/400
160/160 [=====] - 0s 199us/step - loss: 0.3219
Epoch 251/400
160/160 [=====] - 0s 199us/step - loss: 0.3214
Epoch 252/400
160/160 [=====] - 0s 212us/step - loss: 0.3213
Epoch 253/400
160/160 [=====] - 0s 206us/step - loss: 0.3214
Epoch 254/400
160/160 [=====] - 0s 218us/step - loss: 0.3215
Epoch 255/400
160/160 [=====] - 0s 196us/step - loss: 0.3217
Epoch 256/400
160/160 [=====] - 0s 206us/step - loss: 0.3213
Epoch 257/400
160/160 [=====] - 0s 206us/step - loss: 0.3215
Epoch 258/400
160/160 [=====] - 0s 196us/step - loss: 0.3216

Epoch 259/400
160/160 [=====] - 0s 199us/step - loss: 0.3213
Epoch 260/400
160/160 [=====] - 0s 212us/step - loss: 0.3211
Epoch 261/400
160/160 [=====] - 0s 199us/step - loss: 0.3215
Epoch 262/400
160/160 [=====] - 0s 199us/step - loss: 0.3213
Epoch 263/400
160/160 [=====] - 0s 199us/step - loss: 0.3213
Epoch 264/400
160/160 [=====] - 0s 193us/step - loss: 0.3212
Epoch 265/400
160/160 [=====] - 0s 199us/step - loss: 0.3214
Epoch 266/400
160/160 [=====] - 0s 206us/step - loss: 0.3209
Epoch 267/400
160/160 [=====] - 0s 199us/step - loss: 0.3214
Epoch 268/400
160/160 [=====] - 0s 199us/step - loss: 0.3214
Epoch 269/400
160/160 [=====] - 0s 212us/step - loss: 0.3215
Epoch 270/400
160/160 [=====] - 0s 206us/step - loss: 0.3213
Epoch 271/400
160/160 [=====] - 0s 199us/step - loss: 0.3212
Epoch 272/400
160/160 [=====] - 0s 218us/step - loss: 0.3214
Epoch 273/400
160/160 [=====] - 0s 212us/step - loss: 0.3212
Epoch 274/400
160/160 [=====] - 0s 206us/step - loss: 0.3211
Epoch 275/400
160/160 [=====] - 0s 212us/step - loss: 0.3213
Epoch 276/400
160/160 [=====] - 0s 206us/step - loss: 0.3212
Epoch 277/400
160/160 [=====] - 0s 206us/step - loss: 0.3212
Epoch 278/400
160/160 [=====] - 0s 206us/step - loss: 0.3209
Epoch 279/400
160/160 [=====] - 0s 206us/step - loss: 0.3215
Epoch 280/400
160/160 [=====] - 0s 199us/step - loss: 0.3212
Epoch 281/400
160/160 [=====] - 0s 199us/step - loss: 0.3211
Epoch 282/400
160/160 [=====] - 0s 199us/step - loss: 0.3214
Epoch 283/400
160/160 [=====] - 0s 206us/step - loss: 0.3210
Epoch 284/400
160/160 [=====] - 0s 206us/step - loss: 0.3207
Epoch 285/400
160/160 [=====] - 0s 206us/step - loss: 0.3211
Epoch 286/400
160/160 [=====] - 0s 196us/step - loss: 0.3211
Epoch 287/400
160/160 [=====] - 0s 206us/step - loss: 0.3213
Epoch 288/400
160/160 [=====] - 0s 199us/step - loss: 0.3206
Epoch 289/400
160/160 [=====] - 0s 199us/step - loss: 0.3212
Epoch 290/400
160/160 [=====] - 0s 206us/step - loss: 0.3209
Epoch 291/400
160/160 [=====] - 0s 206us/step - loss: 0.3212
Epoch 292/400
160/160 [=====] - 0s 199us/step - loss: 0.3208
Epoch 293/400
160/160 [=====] - 0s 199us/step - loss: 0.3211
Epoch 294/400
160/160 [=====] - 0s 199us/step - loss: 0.3214
Epoch 295/400
160/160 [=====] - 0s 206us/step - loss: 0.3207
Epoch 296/400
160/160 [=====] - 0s 199us/step - loss: 0.3210
Epoch 297/400

160/160 [=====] - 0s 199us/step - loss: 0.3207
Epoch 298/400
160/160 [=====] - 0s 199us/step - loss: 0.3212
Epoch 299/400
160/160 [=====] - 0s 199us/step - loss: 0.3209
Epoch 300/400
160/160 [=====] - 0s 199us/step - loss: 0.3206
Epoch 301/400
160/160 [=====] - 0s 196us/step - loss: 0.3208
Epoch 302/400
160/160 [=====] - 0s 199us/step - loss: 0.3203
Epoch 303/400
160/160 [=====] - 0s 206us/step - loss: 0.3211
Epoch 304/400
160/160 [=====] - 0s 203us/step - loss: 0.3210
Epoch 305/400
160/160 [=====] - 0s 206us/step - loss: 0.3208
Epoch 306/400
160/160 [=====] - 0s 199us/step - loss: 0.3208
Epoch 307/400
160/160 [=====] - 0s 209us/step - loss: 0.3208
Epoch 308/400
160/160 [=====] - 0s 199us/step - loss: 0.3207
Epoch 309/400
160/160 [=====] - 0s 199us/step - loss: 0.3210
Epoch 310/400
160/160 [=====] - 0s 203us/step - loss: 0.3206
Epoch 311/400
160/160 [=====] - 0s 206us/step - loss: 0.3207
Epoch 312/400
160/160 [=====] - 0s 206us/step - loss: 0.3204
Epoch 313/400
160/160 [=====] - 0s 206us/step - loss: 0.3203
Epoch 314/400
160/160 [=====] - 0s 199us/step - loss: 0.3209
Epoch 315/400
160/160 [=====] - 0s 206us/step - loss: 0.3204
Epoch 316/400
160/160 [=====] - 0s 199us/step - loss: 0.3204
Epoch 317/400
160/160 [=====] - 0s 199us/step - loss: 0.3208
Epoch 318/400
160/160 [=====] - 0s 206us/step - loss: 0.3209
Epoch 319/400
160/160 [=====] - 0s 206us/step - loss: 0.3207
Epoch 320/400
160/160 [=====] - 0s 212us/step - loss: 0.3208
Epoch 321/400
160/160 [=====] - 0s 206us/step - loss: 0.3207
Epoch 322/400
160/160 [=====] - 0s 199us/step - loss: 0.3207
Epoch 323/400
160/160 [=====] - 0s 206us/step - loss: 0.3208
Epoch 324/400
160/160 [=====] - 0s 199us/step - loss: 0.3208
Epoch 325/400
160/160 [=====] - 0s 199us/step - loss: 0.3205
Epoch 326/400
160/160 [=====] - 0s 199us/step - loss: 0.3205
Epoch 327/400
160/160 [=====] - 0s 206us/step - loss: 0.3211
Epoch 328/400
160/160 [=====] - 0s 199us/step - loss: 0.3204
Epoch 329/400
160/160 [=====] - 0s 206us/step - loss: 0.3206
Epoch 330/400
160/160 [=====] - 0s 218us/step - loss: 0.3203
Epoch 331/400
160/160 [=====] - 0s 212us/step - loss: 0.3207
Epoch 332/400
160/160 [=====] - 0s 206us/step - loss: 0.3207
Epoch 333/400
160/160 [=====] - 0s 218us/step - loss: 0.3208
Epoch 334/400
160/160 [=====] - 0s 212us/step - loss: 0.3207
Epoch 335/400
160/160 [=====] - 0s 212us/step - loss: 0.3202

Epoch 336/400
160/160 [=====] - 0s 212us/step - loss: 0.3209
Epoch 337/400
160/160 [=====] - 0s 212us/step - loss: 0.3208
Epoch 338/400
160/160 [=====] - 0s 206us/step - loss: 0.3202
Epoch 339/400
160/160 [=====] - 0s 206us/step - loss: 0.3204
Epoch 340/400
160/160 [=====] - 0s 218us/step - loss: 0.3208
Epoch 341/400
160/160 [=====] - 0s 231us/step - loss: 0.3209
Epoch 342/400
160/160 [=====] - 0s 218us/step - loss: 0.3210
Epoch 343/400
160/160 [=====] - 0s 206us/step - loss: 0.3206
Epoch 344/400
160/160 [=====] - 0s 193us/step - loss: 0.3206
Epoch 345/400
160/160 [=====] - 0s 218us/step - loss: 0.3204
Epoch 346/400
160/160 [=====] - 0s 212us/step - loss: 0.3204
Epoch 347/400
160/160 [=====] - 0s 206us/step - loss: 0.3205
Epoch 348/400
160/160 [=====] - 0s 206us/step - loss: 0.3208
Epoch 349/400
160/160 [=====] - 0s 209us/step - loss: 0.3209
Epoch 350/400
160/160 [=====] - 0s 209us/step - loss: 0.3205
Epoch 351/400
160/160 [=====] - 0s 209us/step - loss: 0.3204
Epoch 352/400
160/160 [=====] - 0s 203us/step - loss: 0.3202
Epoch 353/400
160/160 [=====] - 0s 206us/step - loss: 0.3205
Epoch 354/400
160/160 [=====] - 0s 206us/step - loss: 0.3205
Epoch 355/400
160/160 [=====] - 0s 203us/step - loss: 0.3206
Epoch 356/400
160/160 [=====] - 0s 218us/step - loss: 0.3208
Epoch 357/400
160/160 [=====] - 0s 209us/step - loss: 0.3204
Epoch 358/400
160/160 [=====] - 0s 206us/step - loss: 0.3205
Epoch 359/400
160/160 [=====] - 0s 218us/step - loss: 0.3209
Epoch 360/400
160/160 [=====] - 0s 206us/step - loss: 0.3206
Epoch 361/400
160/160 [=====] - 0s 215us/step - loss: 0.3206
Epoch 362/400
160/160 [=====] - 0s 221us/step - loss: 0.3200
Epoch 363/400
160/160 [=====] - 0s 212us/step - loss: 0.3200
Epoch 364/400
160/160 [=====] - 0s 206us/step - loss: 0.3204
Epoch 365/400
160/160 [=====] - 0s 218us/step - loss: 0.3207
Epoch 366/400
160/160 [=====] - 0s 218us/step - loss: 0.3205
Epoch 367/400
160/160 [=====] - 0s 206us/step - loss: 0.3201
Epoch 368/400
160/160 [=====] - 0s 212us/step - loss: 0.3202
Epoch 369/400
160/160 [=====] - 0s 206us/step - loss: 0.3203
Epoch 370/400
160/160 [=====] - 0s 206us/step - loss: 0.3203
Epoch 371/400
160/160 [=====] - 0s 206us/step - loss: 0.3204
Epoch 372/400
160/160 [=====] - 0s 237us/step - loss: 0.3208
Epoch 373/400
160/160 [=====] - 0s 199us/step - loss: 0.3207
Epoch 374/400

160/160 [=====] - 0s 206us/step - loss: 0.3203
Epoch 375/400
160/160 [=====] - 0s 249us/step - loss: 0.3202
Epoch 376/400
160/160 [=====] - 0s 287us/step - loss: 0.3206
Epoch 377/400
160/160 [=====] - 0s 280us/step - loss: 0.3204
Epoch 378/400
160/160 [=====] - 0s 274us/step - loss: 0.3200
Epoch 379/400
160/160 [=====] - 0s 268us/step - loss: 0.3204
Epoch 380/400
160/160 [=====] - 0s 262us/step - loss: 0.3207
Epoch 381/400
160/160 [=====] - 0s 234us/step - loss: 0.3201
Epoch 382/400
160/160 [=====] - 0s 231us/step - loss: 0.3200
Epoch 383/400
160/160 [=====] - 0s 218us/step - loss: 0.3198
Epoch 384/400
160/160 [=====] - 0s 243us/step - loss: 0.3204
Epoch 385/400
160/160 [=====] - 0s 237us/step - loss: 0.3204
Epoch 386/400
160/160 [=====] - ETA: 0s - loss: 0.052 - 0s 237us/step - loss: 0.3204
Epoch 387/400
160/160 [=====] - 0s 234us/step - loss: 0.3204
Epoch 388/400
160/160 [=====] - 0s 237us/step - loss: 0.3203
Epoch 389/400
160/160 [=====] - 0s 240us/step - loss: 0.3203
Epoch 390/400
160/160 [=====] - 0s 218us/step - loss: 0.3204
Epoch 391/400
160/160 [=====] - 0s 224us/step - loss: 0.3200
Epoch 392/400
160/160 [=====] - 0s 218us/step - loss: 0.3200
Epoch 393/400
160/160 [=====] - 0s 218us/step - loss: 0.3202
Epoch 394/400
160/160 [=====] - 0s 206us/step - loss: 0.3203
Epoch 395/400
160/160 [=====] - 0s 203us/step - loss: 0.3204
Epoch 396/400
160/160 [=====] - 0s 274us/step - loss: 0.3201
Epoch 397/400
160/160 [=====] - 0s 256us/step - loss: 0.3208
Epoch 398/400
160/160 [=====] - 0s 218us/step - loss: 0.3207
Epoch 399/400
160/160 [=====] - 0s 231us/step - loss: 0.3200
Epoch 400/400
160/160 [=====] - 0s 218us/step - loss: 0.3199
[0.83822453 0.78272396 0.93020695 0.86127865 0.63056546 0.9394084
0.95151377 0.11702998 0.95120496 0.9226682 0.9169666 0.84070563
0.9187 0.72580993 0.9487154 0.09114994 0.94757855 0.9167474
0.8110696 0.2821478 0.85231173 0.9144979 0.93826574 0.9225343
0.88935286 0.95146096 0.7411176 0.9355796 0.93932533 0.95526683
0.33895305 0.8526295 0.9531391 0.9551087 0.8344372 0.8635443
0.38361698 0.9550441 0.9196206 0.9551347 0.8277143 0.7920059
0.9243494 0.87031657 0.6336961 0.9347264 0.9531072 0.11862142
0.9529216 0.915955 0.9230581 0.8500917 0.9116598 0.7167985
0.94574696 0.09138426 0.95009756 0.9094884 0.8204382 0.28943333
0.8414874 0.92066765 0.9422515 0.9281816 0.8971555 0.9491978
0.7308659 0.9302747 0.9345845 0.9549422 0.34534255 0.86210585
0.9542708 0.9551673 0.8235449 0.87241685 0.3761448 0.95428056
0.925527 0.95449764 0.58293164 0.05231986 0.05499693 0.05556508
0.0417016 0.04559086 0.08751787 0.07010003 0.7477578 0.04619034
0.05478317 0.04680202 0.06453464 0.44676366 0.2408545 0.09041824
0.8977239 0.05005436 0.0414575 0.21246117 0.04048555 0.04007425
0.909462 0.10992726 0.04095989 0.8495421 0.04103509 0.03981557
0.0407887 0.07995409 0.05991587 0.38838765 0.27541396 0.07990669
0.05385406 0.04376264 0.09159849 0.31400216 0.09358566 0.481475
0.58036536 0.04744928 0.0504663 0.05114121 0.03500303 0.03965655
0.08674505 0.06735629 0.738664 0.04035717 0.05024816 0.04108572
0.06120427 0.45044369 0.24831167 0.09008545 0.88946474 0.04482789
0.03469903 0.21896105 0.0334641 0.03292774 0.90199584 0.11127441

```
0.0340738 0.83943516 0.03416417 0.03257831 0.03385361 0.07838465  
0.0559939 0.39497235 0.28333312 0.07833486 0.04916107 0.03750238  
0.09133312 0.32169676 0.09344205 0.48415935]  
160/160 [=====] - 0s 115us/step
```

In [4]:

```
#one layer, two neurons: loss  
scores_lay_one_two, model_lay_one_two.metrics_names
```

Out[4]:

```
(0.3170800030231476, ['loss'])
```

Two Layers

In [5]:

```
n = 40  
xx = np.random.random((n,1))  
yy = np.random.random((n,1))  
  
X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T  
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [6]:

```
#two layers, two neurons per layer  
model_lay_two_two = Sequential()  
  
#hidden layers  
model_lay_two_two.add(Dense(2, input_dim=2, activation='tanh'))  
model_lay_two_two.add(Dense(2, activation='tanh'))  
  
#output layer  
model_lay_two_two.add(Dense(1, activation='sigmoid'))  
  
sgd = SGD(lr=0.1)  
model_lay_two_two.compile(loss='binary_crossentropy', optimizer='sgd')  
  
model_lay_two_two.fit(X, y, batch_size=2, epochs=400)  
print(model_lay_two_two.predict_proba(X).reshape(4*n))  
  
#evaluate the model  
scores_lay_two_two = model_lay_two_two.evaluate(X, y)
```

```
Epoch 1/400  
160/160 [=====] - 0s 947us/step - loss: 0.7124  
Epoch 2/400  
160/160 [=====] - 0s 224us/step - loss: 0.6973  
Epoch 3/400  
160/160 [=====] - 0s 218us/step - loss: 0.6868  
Epoch 4/400  
160/160 [=====] - 0s 224us/step - loss: 0.6789  
Epoch 5/400  
160/160 [=====] - 0s 218us/step - loss: 0.6723  
Epoch 6/400  
160/160 [=====] - 0s 231us/step - loss: 0.6664  
Epoch 7/400  
160/160 [=====] - 0s 224us/step - loss: 0.6603  
Epoch 8/400  
160/160 [=====] - 0s 224us/step - loss: 0.6549  
Epoch 9/400  
160/160 [=====] - 0s 224us/step - loss: 0.6491  
Epoch 10/400  
160/160 [=====] - 0s 221us/step - loss: 0.6437  
Epoch 11/400  
160/160 [=====] - 0s 218us/step - loss: 0.6373  
Epoch 12/400  
160/160 [=====] - 0s 218us/step - loss: 0.6319  
Epoch 13/400  
160/160 [=====] - 0s 215us/step - loss: 0.6253  
Epoch 14/400  
160/160 [=====] - 0s 212us/step - loss: 0.6185  
Epoch 15/400  
160/160 [=====] - 0s 224us/step - loss: 0.6113  
Epoch 16/400
```

160/160 [=====] - 0s 224us/step - loss: 0.6034
Epoch 17/400
160/160 [=====] - 0s 218us/step - loss: 0.5956
Epoch 18/400
160/160 [=====] - 0s 224us/step - loss: 0.5861
Epoch 19/400
160/160 [=====] - 0s 237us/step - loss: 0.5766
Epoch 20/400
160/160 [=====] - 0s 228us/step - loss: 0.5661
Epoch 21/400
160/160 [=====] - 0s 231us/step - loss: 0.5558
Epoch 22/400
160/160 [=====] - 0s 224us/step - loss: 0.5433
Epoch 23/400
160/160 [=====] - 0s 224us/step - loss: 0.5307
Epoch 24/400
160/160 [=====] - 0s 224us/step - loss: 0.5175
Epoch 25/400
160/160 [=====] - 0s 237us/step - loss: 0.5037
Epoch 26/400
160/160 [=====] - 0s 224us/step - loss: 0.4904
Epoch 27/400
160/160 [=====] - 0s 234us/step - loss: 0.4748
Epoch 28/400
160/160 [=====] - 0s 231us/step - loss: 0.4620
Epoch 29/400
160/160 [=====] - 0s 228us/step - loss: 0.4473
Epoch 30/400
160/160 [=====] - 0s 224us/step - loss: 0.4326
Epoch 31/400
160/160 [=====] - 0s 237us/step - loss: 0.4192
Epoch 32/400
160/160 [=====] - 0s 237us/step - loss: 0.4056
Epoch 33/400
160/160 [=====] - 0s 237us/step - loss: 0.3934
Epoch 34/400
160/160 [=====] - 0s 231us/step - loss: 0.3810
Epoch 35/400
160/160 [=====] - 0s 224us/step - loss: 0.3693
Epoch 36/400
160/160 [=====] - 0s 231us/step - loss: 0.3598
Epoch 37/400
160/160 [=====] - 0s 312us/step - loss: 0.3499
Epoch 38/400
160/160 [=====] - 0s 224us/step - loss: 0.3401
Epoch 39/400
160/160 [=====] - 0s 224us/step - loss: 0.3327
Epoch 40/400
160/160 [=====] - 0s 224us/step - loss: 0.3238
Epoch 41/400
160/160 [=====] - 0s 262us/step - loss: 0.3147
Epoch 42/400
160/160 [=====] - 0s 249us/step - loss: 0.3119
Epoch 43/400
160/160 [=====] - 0s 237us/step - loss: 0.3027
Epoch 44/400
160/160 [=====] - 0s 237us/step - loss: 0.2999
Epoch 45/400
160/160 [=====] - 0s 243us/step - loss: 0.2944
Epoch 46/400
160/160 [=====] - 0s 237us/step - loss: 0.2886
Epoch 47/400
160/160 [=====] - 0s 237us/step - loss: 0.2845
Epoch 48/400
160/160 [=====] - 0s 237us/step - loss: 0.2819
Epoch 49/400
160/160 [=====] - 0s 243us/step - loss: 0.2770
Epoch 50/400
160/160 [=====] - 0s 231us/step - loss: 0.2745
Epoch 51/400
160/160 [=====] - 0s 237us/step - loss: 0.2699
Epoch 52/400
160/160 [=====] - 0s 231us/step - loss: 0.2680
Epoch 53/400
160/160 [=====] - 0s 237us/step - loss: 0.2654
Epoch 54/400
160/160 [=====] - 0s 237us/step - loss: 0.2623

Epoch 55/400
160/160 [=====] - 0s 224us/step - loss: 0.2591
Epoch 56/400
160/160 [=====] - 0s 221us/step - loss: 0.2569
Epoch 57/400
160/160 [=====] - 0s 228us/step - loss: 0.2574
Epoch 58/400
160/160 [=====] - 0s 218us/step - loss: 0.2539
Epoch 59/400
160/160 [=====] - 0s 231us/step - loss: 0.2528
Epoch 60/400
160/160 [=====] - 0s 237us/step - loss: 0.2518
Epoch 61/400
160/160 [=====] - 0s 224us/step - loss: 0.2498
Epoch 62/400
160/160 [=====] - 0s 224us/step - loss: 0.2482
Epoch 63/400
160/160 [=====] - 0s 224us/step - loss: 0.2469
Epoch 64/400
160/160 [=====] - 0s 209us/step - loss: 0.2465
Epoch 65/400
160/160 [=====] - 0s 212us/step - loss: 0.2452
Epoch 66/400
160/160 [=====] - 0s 224us/step - loss: 0.2426
Epoch 67/400
160/160 [=====] - 0s 221us/step - loss: 0.2433
Epoch 68/400
160/160 [=====] - 0s 224us/step - loss: 0.2430
Epoch 69/400
160/160 [=====] - 0s 218us/step - loss: 0.2411
Epoch 70/400
160/160 [=====] - 0s 224us/step - loss: 0.2379
Epoch 71/400
160/160 [=====] - 0s 231us/step - loss: 0.2385
Epoch 72/400
160/160 [=====] - 0s 231us/step - loss: 0.2393
Epoch 73/400
160/160 [=====] - 0s 212us/step - loss: 0.2362
Epoch 74/400
160/160 [=====] - 0s 218us/step - loss: 0.2353
Epoch 75/400
160/160 [=====] - 0s 246us/step - loss: 0.2374
Epoch 76/400
160/160 [=====] - 0s 218us/step - loss: 0.2326
Epoch 77/400
160/160 [=====] - 0s 212us/step - loss: 0.2379
Epoch 78/400
160/160 [=====] - 0s 215us/step - loss: 0.2354
Epoch 79/400
160/160 [=====] - 0s 218us/step - loss: 0.2328
Epoch 80/400
160/160 [=====] - 0s 212us/step - loss: 0.2351
Epoch 81/400
160/160 [=====] - 0s 218us/step - loss: 0.2343
Epoch 82/400
160/160 [=====] - 0s 218us/step - loss: 0.2348
Epoch 83/400
160/160 [=====] - 0s 212us/step - loss: 0.2333
Epoch 84/400
160/160 [=====] - 0s 218us/step - loss: 0.2325
Epoch 85/400
160/160 [=====] - 0s 231us/step - loss: 0.2336
Epoch 86/400
160/160 [=====] - 0s 224us/step - loss: 0.2344
Epoch 87/400
160/160 [=====] - 0s 224us/step - loss: 0.2330
Epoch 88/400
160/160 [=====] - 0s 224us/step - loss: 0.2306
Epoch 89/400
160/160 [=====] - 0s 206us/step - loss: 0.2330
Epoch 90/400
160/160 [=====] - 0s 212us/step - loss: 0.2330
Epoch 91/400
160/160 [=====] - 0s 224us/step - loss: 0.2303
Epoch 92/400
160/160 [=====] - 0s 212us/step - loss: 0.2319
Epoch 93/400

160/160 [=====] - 0s 218us/step - loss: 0.2290
Epoch 94/400
160/160 [=====] - 0s 218us/step - loss: 0.2269
Epoch 95/400
160/160 [=====] - 0s 215us/step - loss: 0.2316
Epoch 96/400
160/160 [=====] - 0s 224us/step - loss: 0.2307
Epoch 97/400
160/160 [=====] - 0s 212us/step - loss: 0.2309
Epoch 98/400
160/160 [=====] - 0s 218us/step - loss: 0.2304
Epoch 99/400
160/160 [=====] - 0s 224us/step - loss: 0.2307
Epoch 100/400
160/160 [=====] - 0s 224us/step - loss: 0.2281
Epoch 101/400
160/160 [=====] - 0s 231us/step - loss: 0.2281
Epoch 102/400
160/160 [=====] - 0s 212us/step - loss: 0.2308
Epoch 103/400
160/160 [=====] - 0s 218us/step - loss: 0.2277
Epoch 104/400
160/160 [=====] - 0s 209us/step - loss: 0.2286
Epoch 105/400
160/160 [=====] - 0s 212us/step - loss: 0.2301
Epoch 106/400
160/160 [=====] - 0s 212us/step - loss: 0.2294
Epoch 107/400
160/160 [=====] - 0s 218us/step - loss: 0.2300
Epoch 108/400
160/160 [=====] - 0s 231us/step - loss: 0.2276
Epoch 109/400
160/160 [=====] - 0s 218us/step - loss: 0.2289
Epoch 110/400
160/160 [=====] - 0s 212us/step - loss: 0.2280
Epoch 111/400
160/160 [=====] - 0s 212us/step - loss: 0.2279
Epoch 112/400
160/160 [=====] - 0s 218us/step - loss: 0.2277
Epoch 113/400
160/160 [=====] - 0s 218us/step - loss: 0.2283
Epoch 114/400
160/160 [=====] - 0s 268us/step - loss: 0.2265
Epoch 115/400
160/160 [=====] - 0s 268us/step - loss: 0.2288
Epoch 116/400
160/160 [=====] - 0s 231us/step - loss: 0.2280
Epoch 117/400
160/160 [=====] - 0s 231us/step - loss: 0.2270
Epoch 118/400
160/160 [=====] - 0s 218us/step - loss: 0.2269
Epoch 119/400
160/160 [=====] - 0s 231us/step - loss: 0.2296
Epoch 120/400
160/160 [=====] - 0s 221us/step - loss: 0.2261
Epoch 121/400
160/160 [=====] - 0s 224us/step - loss: 0.2245
Epoch 122/400
160/160 [=====] - 0s 218us/step - loss: 0.2294
Epoch 123/400
160/160 [=====] - 0s 218us/step - loss: 0.2269
Epoch 124/400
160/160 [=====] - 0s 237us/step - loss: 0.2232
Epoch 125/400
160/160 [=====] - 0s 268us/step - loss: 0.2290
Epoch 126/400
160/160 [=====] - 0s 237us/step - loss: 0.2252
Epoch 127/400
160/160 [=====] - 0s 218us/step - loss: 0.2301
Epoch 128/400
160/160 [=====] - 0s 221us/step - loss: 0.2264
Epoch 129/400
160/160 [=====] - 0s 215us/step - loss: 0.2283
Epoch 130/400
160/160 [=====] - 0s 224us/step - loss: 0.2291
Epoch 131/400
160/160 [=====] - 0s 224us/step - loss: 0.2277

Epoch 132/400
160/160 [=====] - 0s 218us/step - loss: 0.2264
Epoch 133/400
160/160 [=====] - 0s 224us/step - loss: 0.2274
Epoch 134/400
160/160 [=====] - 0s 228us/step - loss: 0.2274
Epoch 135/400
160/160 [=====] - 0s 218us/step - loss: 0.2292
Epoch 136/400
160/160 [=====] - 0s 215us/step - loss: 0.2248
Epoch 137/400
160/160 [=====] - 0s 224us/step - loss: 0.2271
Epoch 138/400
160/160 [=====] - 0s 223us/step - loss: 0.2248
Epoch 139/400
160/160 [=====] - 0s 218us/step - loss: 0.2268
Epoch 140/400
160/160 [=====] - 0s 218us/step - loss: 0.2301
Epoch 141/400
160/160 [=====] - 0s 224us/step - loss: 0.2241
Epoch 142/400
160/160 [=====] - 0s 231us/step - loss: 0.2291
Epoch 143/400
160/160 [=====] - 0s 237us/step - loss: 0.2210
Epoch 144/400
160/160 [=====] - 0s 218us/step - loss: 0.2292
Epoch 145/400
160/160 [=====] - 0s 231us/step - loss: 0.2268
Epoch 146/400
160/160 [=====] - 0s 231us/step - loss: 0.2228
Epoch 147/400
160/160 [=====] - 0s 224us/step - loss: 0.2319
Epoch 148/400
160/160 [=====] - 0s 218us/step - loss: 0.2243
Epoch 149/400
160/160 [=====] - 0s 218us/step - loss: 0.2306
Epoch 150/400
160/160 [=====] - 0s 228us/step - loss: 0.2261
Epoch 151/400
160/160 [=====] - 0s 224us/step - loss: 0.2277
Epoch 152/400
160/160 [=====] - 0s 218us/step - loss: 0.2270
Epoch 153/400
160/160 [=====] - 0s 224us/step - loss: 0.2295
Epoch 154/400
160/160 [=====] - 0s 218us/step - loss: 0.2277
Epoch 155/400
160/160 [=====] - 0s 218us/step - loss: 0.2285
Epoch 156/400
160/160 [=====] - 0s 218us/step - loss: 0.2211
Epoch 157/400
160/160 [=====] - 0s 218us/step - loss: 0.2263
Epoch 158/400
160/160 [=====] - 0s 218us/step - loss: 0.2284
Epoch 159/400
160/160 [=====] - 0s 218us/step - loss: 0.2279
Epoch 160/400
160/160 [=====] - 0s 231us/step - loss: 0.2261
Epoch 161/400
160/160 [=====] - 0s 224us/step - loss: 0.2268
Epoch 162/400
160/160 [=====] - 0s 218us/step - loss: 0.2262
Epoch 163/400
160/160 [=====] - 0s 212us/step - loss: 0.2286
Epoch 164/400
160/160 [=====] - 0s 206us/step - loss: 0.2248
Epoch 165/400
160/160 [=====] - 0s 209us/step - loss: 0.2235
Epoch 166/400
160/160 [=====] - 0s 212us/step - loss: 0.2270
Epoch 167/400
160/160 [=====] - 0s 221us/step - loss: 0.2251
Epoch 168/400
160/160 [=====] - 0s 231us/step - loss: 0.2273
Epoch 169/400
160/160 [=====] - 0s 212us/step - loss: 0.2274
Epoch 170/400

160/160 [=====] - 0s 228us/step - loss: 0.2231
Epoch 171/400
160/160 [=====] - 0s 237us/step - loss: 0.2270
Epoch 172/400
160/160 [=====] - 0s 218us/step - loss: 0.2249
Epoch 173/400
160/160 [=====] - 0s 215us/step - loss: 0.2270
Epoch 174/400
160/160 [=====] - 0s 218us/step - loss: 0.2285
Epoch 175/400
160/160 [=====] - 0s 212us/step - loss: 0.2284
Epoch 176/400
160/160 [=====] - 0s 218us/step - loss: 0.2244
Epoch 177/400
160/160 [=====] - 0s 212us/step - loss: 0.2263
Epoch 178/400
160/160 [=====] - 0s 212us/step - loss: 0.2262
Epoch 179/400
160/160 [=====] - 0s 212us/step - loss: 0.2262
Epoch 180/400
160/160 [=====] - 0s 224us/step - loss: 0.2281
Epoch 181/400
160/160 [=====] - 0s 218us/step - loss: 0.2267
Epoch 182/400
160/160 [=====] - 0s 218us/step - loss: 0.2250
Epoch 183/400
160/160 [=====] - 0s 218us/step - loss: 0.2190
Epoch 184/400
160/160 [=====] - 0s 218us/step - loss: 0.2280
Epoch 185/400
160/160 [=====] - 0s 212us/step - loss: 0.2268
Epoch 186/400
160/160 [=====] - 0s 224us/step - loss: 0.2273
Epoch 187/400
160/160 [=====] - 0s 221us/step - loss: 0.2275
Epoch 188/400
160/160 [=====] - 0s 231us/step - loss: 0.2257
Epoch 189/400
160/160 [=====] - 0s 218us/step - loss: 0.2238
Epoch 190/400
160/160 [=====] - 0s 218us/step - loss: 0.2259
Epoch 191/400
160/160 [=====] - 0s 218us/step - loss: 0.2271
Epoch 192/400
160/160 [=====] - 0s 224us/step - loss: 0.2231
Epoch 193/400
160/160 [=====] - 0s 224us/step - loss: 0.2281
Epoch 194/400
160/160 [=====] - 0s 224us/step - loss: 0.2288
Epoch 195/400
160/160 [=====] - 0s 224us/step - loss: 0.2253
Epoch 196/400
160/160 [=====] - 0s 224us/step - loss: 0.2248
Epoch 197/400
160/160 [=====] - 0s 212us/step - loss: 0.2263
Epoch 198/400
160/160 [=====] - 0s 218us/step - loss: 0.2307
Epoch 199/400
160/160 [=====] - 0s 246us/step - loss: 0.2251
Epoch 200/400
160/160 [=====] - 0s 265us/step - loss: 0.2265
Epoch 201/400
160/160 [=====] - 0s 237us/step - loss: 0.2259
Epoch 202/400
160/160 [=====] - 0s 243us/step - loss: 0.2248
Epoch 203/400
160/160 [=====] - 0s 237us/step - loss: 0.2280
Epoch 204/400
160/160 [=====] - 0s 249us/step - loss: 0.2244
Epoch 205/400
160/160 [=====] - 0s 218us/step - loss: 0.2254
Epoch 206/400
160/160 [=====] - 0s 231us/step - loss: 0.2271
Epoch 207/400
160/160 [=====] - 0s 268us/step - loss: 0.2251
Epoch 208/400
160/160 [=====] - 0s 249us/step - loss: 0.2248

Epoch 209/400
160/160 [=====] - 0s 249us/step - loss: 0.2282
Epoch 210/400
160/160 [=====] - 0s 252us/step - loss: 0.2266
Epoch 211/400
160/160 [=====] - 0s 243us/step - loss: 0.2251
Epoch 212/400
160/160 [=====] - 0s 240us/step - loss: 0.2246
Epoch 213/400
160/160 [=====] - 0s 231us/step - loss: 0.2255
Epoch 214/400
160/160 [=====] - 0s 218us/step - loss: 0.2253
Epoch 215/400
160/160 [=====] - 0s 212us/step - loss: 0.2224
Epoch 216/400
160/160 [=====] - 0s 218us/step - loss: 0.2289
Epoch 217/400
160/160 [=====] - 0s 215us/step - loss: 0.2267
Epoch 218/400
160/160 [=====] - 0s 218us/step - loss: 0.2286
Epoch 219/400
160/160 [=====] - 0s 218us/step - loss: 0.2295
Epoch 220/400
160/160 [=====] - 0s 224us/step - loss: 0.2269
Epoch 221/400
160/160 [=====] - 0s 218us/step - loss: 0.2253
Epoch 222/400
160/160 [=====] - 0s 218us/step - loss: 0.2226
Epoch 223/400
160/160 [=====] - 0s 243us/step - loss: 0.2214
Epoch 224/400
160/160 [=====] - 0s 224us/step - loss: 0.2294
Epoch 225/400
160/160 [=====] - 0s 243us/step - loss: 0.2242
Epoch 226/400
160/160 [=====] - 0s 231us/step - loss: 0.2237
Epoch 227/400
160/160 [=====] - 0s 212us/step - loss: 0.2245
Epoch 228/400
160/160 [=====] - 0s 218us/step - loss: 0.2263
Epoch 229/400
160/160 [=====] - 0s 218us/step - loss: 0.2224
Epoch 230/400
160/160 [=====] - 0s 218us/step - loss: 0.2216
Epoch 231/400
160/160 [=====] - 0s 224us/step - loss: 0.2234
Epoch 232/400
160/160 [=====] - 0s 218us/step - loss: 0.2251
Epoch 233/400
160/160 [=====] - 0s 218us/step - loss: 0.2252
Epoch 234/400
160/160 [=====] - 0s 218us/step - loss: 0.2270
Epoch 235/400
160/160 [=====] - 0s 218us/step - loss: 0.2206
Epoch 236/400
160/160 [=====] - 0s 231us/step - loss: 0.2220
Epoch 237/400
160/160 [=====] - 0s 218us/step - loss: 0.2271
Epoch 238/400
160/160 [=====] - 0s 218us/step - loss: 0.2231
Epoch 239/400
160/160 [=====] - 0s 231us/step - loss: 0.2262
Epoch 240/400
160/160 [=====] - 0s 237us/step - loss: 0.2250
Epoch 241/400
160/160 [=====] - 0s 231us/step - loss: 0.2247
Epoch 242/400
160/160 [=====] - 0s 221us/step - loss: 0.2224
Epoch 243/400
160/160 [=====] - 0s 231us/step - loss: 0.2279
Epoch 244/400
160/160 [=====] - 0s 231us/step - loss: 0.2271
Epoch 245/400
160/160 [=====] - 0s 231us/step - loss: 0.2234
Epoch 246/400
160/160 [=====] - 0s 249us/step - loss: 0.2255
Epoch 247/400

160/160 [=====] - 0s 274us/step - loss: 0.2265
Epoch 248/400
160/160 [=====] - 0s 262us/step - loss: 0.2247
Epoch 249/400
160/160 [=====] - 0s 237us/step - loss: 0.2262
Epoch 250/400
160/160 [=====] - 0s 237us/step - loss: 0.2245
Epoch 251/400
160/160 [=====] - 0s 231us/step - loss: 0.2256
Epoch 252/400
160/160 [=====] - 0s 249us/step - loss: 0.2256
Epoch 253/400
160/160 [=====] - 0s 218us/step - loss: 0.2307
Epoch 254/400
160/160 [=====] - 0s 212us/step - loss: 0.2245
Epoch 255/400
160/160 [=====] - 0s 215us/step - loss: 0.2234
Epoch 256/400
160/160 [=====] - 0s 206us/step - loss: 0.2249
Epoch 257/400
160/160 [=====] - 0s 218us/step - loss: 0.2250
Epoch 258/400
160/160 [=====] - 0s 215us/step - loss: 0.2235
Epoch 259/400
160/160 [=====] - 0s 218us/step - loss: 0.2217
Epoch 260/400
160/160 [=====] - 0s 221us/step - loss: 0.2202
Epoch 261/400
160/160 [=====] - 0s 212us/step - loss: 0.2277
Epoch 262/400
160/160 [=====] - 0s 224us/step - loss: 0.2262
Epoch 263/400
160/160 [=====] - 0s 221us/step - loss: 0.2252
Epoch 264/400
160/160 [=====] - 0s 212us/step - loss: 0.2261
Epoch 265/400
160/160 [=====] - 0s 218us/step - loss: 0.2220
Epoch 266/400
160/160 [=====] - 0s 215us/step - loss: 0.2261
Epoch 267/400
160/160 [=====] - 0s 218us/step - loss: 0.2224
Epoch 268/400
160/160 [=====] - 0s 218us/step - loss: 0.2271
Epoch 269/400
160/160 [=====] - 0s 218us/step - loss: 0.2248
Epoch 270/400
160/160 [=====] - 0s 212us/step - loss: 0.2260
Epoch 271/400
160/160 [=====] - 0s 218us/step - loss: 0.2218
Epoch 272/400
160/160 [=====] - 0s 218us/step - loss: 0.2244
Epoch 273/400
160/160 [=====] - 0s 212us/step - loss: 0.2287
Epoch 274/400
160/160 [=====] - 0s 212us/step - loss: 0.2254
Epoch 275/400
160/160 [=====] - 0s 218us/step - loss: 0.2257
Epoch 276/400
160/160 [=====] - 0s 206us/step - loss: 0.2263
Epoch 277/400
160/160 [=====] - 0s 212us/step - loss: 0.2262
Epoch 278/400
160/160 [=====] - 0s 224us/step - loss: 0.2256
Epoch 279/400
160/160 [=====] - 0s 212us/step - loss: 0.2249
Epoch 280/400
160/160 [=====] - 0s 231us/step - loss: 0.2232
Epoch 281/400
160/160 [=====] - 0s 218us/step - loss: 0.2247
Epoch 282/400
160/160 [=====] - 0s 218us/step - loss: 0.2257
Epoch 283/400
160/160 [=====] - 0s 212us/step - loss: 0.2261
Epoch 284/400
160/160 [=====] - 0s 212us/step - loss: 0.2224
Epoch 285/400
160/160 [=====] - 0s 237us/step - loss: 0.2263

Epoch 286/400
160/160 [=====] - 0s 218us/step - loss: 0.2267
Epoch 287/400
160/160 [=====] - 0s 212us/step - loss: 0.2260
Epoch 288/400
160/160 [=====] - 0s 218us/step - loss: 0.2256
Epoch 289/400
160/160 [=====] - 0s 224us/step - loss: 0.2259
Epoch 290/400
160/160 [=====] - 0s 218us/step - loss: 0.2256
Epoch 291/400
160/160 [=====] - 0s 212us/step - loss: 0.2259
Epoch 292/400
160/160 [=====] - 0s 218us/step - loss: 0.2241
Epoch 293/400
160/160 [=====] - 0s 218us/step - loss: 0.2265
Epoch 294/400
160/160 [=====] - 0s 212us/step - loss: 0.2234
Epoch 295/400
160/160 [=====] - 0s 218us/step - loss: 0.2230
Epoch 296/400
160/160 [=====] - 0s 212us/step - loss: 0.2265
Epoch 297/400
160/160 [=====] - 0s 218us/step - loss: 0.2255
Epoch 298/400
160/160 [=====] - 0s 206us/step - loss: 0.2197
Epoch 299/400
160/160 [=====] - 0s 218us/step - loss: 0.2257
Epoch 300/400
160/160 [=====] - 0s 218us/step - loss: 0.2266
Epoch 301/400
160/160 [=====] - 0s 218us/step - loss: 0.2238
Epoch 302/400
160/160 [=====] - 0s 212us/step - loss: 0.2229
Epoch 303/400
160/160 [=====] - 0s 218us/step - loss: 0.2264
Epoch 304/400
160/160 [=====] - 0s 212us/step - loss: 0.2222
Epoch 305/400
160/160 [=====] - 0s 212us/step - loss: 0.2274
Epoch 306/400
160/160 [=====] - 0s 221us/step - loss: 0.2268
Epoch 307/400
160/160 [=====] - 0s 212us/step - loss: 0.2250
Epoch 308/400
160/160 [=====] - 0s 224us/step - loss: 0.2224
Epoch 309/400
160/160 [=====] - 0s 228us/step - loss: 0.2270
Epoch 310/400
160/160 [=====] - 0s 218us/step - loss: 0.2264
Epoch 311/400
160/160 [=====] - 0s 218us/step - loss: 0.2238
Epoch 312/400
160/160 [=====] - 0s 218us/step - loss: 0.2248
Epoch 313/400
160/160 [=====] - 0s 212us/step - loss: 0.2230
Epoch 314/400
160/160 [=====] - 0s 218us/step - loss: 0.2250
Epoch 315/400
160/160 [=====] - 0s 212us/step - loss: 0.2236
Epoch 316/400
160/160 [=====] - 0s 212us/step - loss: 0.2251
Epoch 317/400
160/160 [=====] - 0s 224us/step - loss: 0.2245
Epoch 318/400
160/160 [=====] - 0s 218us/step - loss: 0.2260
Epoch 319/400
160/160 [=====] - 0s 224us/step - loss: 0.2239
Epoch 320/400
160/160 [=====] - 0s 218us/step - loss: 0.2273
Epoch 321/400
160/160 [=====] - 0s 218us/step - loss: 0.2212
Epoch 322/400
160/160 [=====] - 0s 218us/step - loss: 0.2239
Epoch 323/400
160/160 [=====] - 0s 218us/step - loss: 0.2270
Epoch 324/400

Epoch 321/400
160/160 [=====] - 0s 212us/step - loss: 0.2258
Epoch 325/400
160/160 [=====] - 0s 218us/step - loss: 0.2262
Epoch 326/400
160/160 [=====] - 0s 249us/step - loss: 0.2262
Epoch 327/400
160/160 [=====] - 0s 224us/step - loss: 0.2251
Epoch 328/400
160/160 [=====] - 0s 231us/step - loss: 0.2250
Epoch 329/400
160/160 [=====] - 0s 224us/step - loss: 0.2244
Epoch 330/400
160/160 [=====] - 0s 218us/step - loss: 0.2253
Epoch 331/400
160/160 [=====] - 0s 218us/step - loss: 0.2220
Epoch 332/400
160/160 [=====] - 0s 212us/step - loss: 0.2248
Epoch 333/400
160/160 [=====] - 0s 206us/step - loss: 0.2226
Epoch 334/400
160/160 [=====] - 0s 224us/step - loss: 0.2276
Epoch 335/400
160/160 [=====] - 0s 221us/step - loss: 0.2219
Epoch 336/400
160/160 [=====] - 0s 218us/step - loss: 0.2208
Epoch 337/400
160/160 [=====] - 0s 228us/step - loss: 0.2282
Epoch 338/400
160/160 [=====] - 0s 224us/step - loss: 0.2240
Epoch 339/400
160/160 [=====] - 0s 218us/step - loss: 0.2242
Epoch 340/400
160/160 [=====] - 0s 212us/step - loss: 0.2258
Epoch 341/400
160/160 [=====] - 0s 231us/step - loss: 0.2237
Epoch 342/400
160/160 [=====] - 0s 218us/step - loss: 0.2250
Epoch 343/400
160/160 [=====] - 0s 218us/step - loss: 0.2252
Epoch 344/400
160/160 [=====] - 0s 218us/step - loss: 0.2271
Epoch 345/400
160/160 [=====] - 0s 212us/step - loss: 0.2265
Epoch 346/400
160/160 [=====] - 0s 218us/step - loss: 0.2204
Epoch 347/400
160/160 [=====] - 0s 212us/step - loss: 0.2280
Epoch 348/400
160/160 [=====] - 0s 218us/step - loss: 0.2196
Epoch 349/400
160/160 [=====] - 0s 218us/step - loss: 0.2255
Epoch 350/400
160/160 [=====] - 0s 224us/step - loss: 0.2246
Epoch 351/400
160/160 [=====] - 0s 206us/step - loss: 0.2242
Epoch 352/400
160/160 [=====] - 0s 212us/step - loss: 0.2272
Epoch 353/400
160/160 [=====] - 0s 212us/step - loss: 0.2246
Epoch 354/400
160/160 [=====] - 0s 212us/step - loss: 0.2261
Epoch 355/400
160/160 [=====] - 0s 221us/step - loss: 0.2244
Epoch 356/400
160/160 [=====] - 0s 212us/step - loss: 0.2255
Epoch 357/400
160/160 [=====] - 0s 209us/step - loss: 0.2267
Epoch 358/400
160/160 [=====] - 0s 212us/step - loss: 0.2251
Epoch 359/400
160/160 [=====] - 0s 212us/step - loss: 0.2221
Epoch 360/400
160/160 [=====] - 0s 212us/step - loss: 0.2231
Epoch 361/400
160/160 [=====] - 0s 212us/step - loss: 0.2269
Epoch 362/400
160/160 [=====] - 0s 218us/step - loss: 0.2232

100/100 Epoch 363/400
160/160 [=====] - 0s 218us/step - loss: 0.2247
Epoch 364/400
160/160 [=====] - 0s 218us/step - loss: 0.2241
Epoch 365/400
160/160 [=====] - 0s 231us/step - loss: 0.2247
Epoch 366/400
160/160 [=====] - 0s 237us/step - loss: 0.2225
Epoch 367/400
160/160 [=====] - 0s 218us/step - loss: 0.2250
Epoch 368/400
160/160 [=====] - 0s 224us/step - loss: 0.2223
Epoch 369/400
160/160 [=====] - 0s 218us/step - loss: 0.2250
Epoch 370/400
160/160 [=====] - 0s 212us/step - loss: 0.2258
Epoch 371/400
160/160 [=====] - 0s 231us/step - loss: 0.2226
Epoch 372/400
160/160 [=====] - 0s 212us/step - loss: 0.2188
Epoch 373/400
160/160 [=====] - 0s 218us/step - loss: 0.2242
Epoch 374/400
160/160 [=====] - 0s 212us/step - loss: 0.2240
Epoch 375/400
160/160 [=====] - 0s 212us/step - loss: 0.2241
Epoch 376/400
160/160 [=====] - 0s 218us/step - loss: 0.2196
Epoch 377/400
160/160 [=====] - 0s 212us/step - loss: 0.2226
Epoch 378/400
160/160 [=====] - 0s 212us/step - loss: 0.2244
Epoch 379/400
160/160 [=====] - 0s 218us/step - loss: 0.2250
Epoch 380/400
160/160 [=====] - 0s 218us/step - loss: 0.2253
Epoch 381/400
160/160 [=====] - 0s 218us/step - loss: 0.2245
Epoch 382/400
160/160 [=====] - 0s 218us/step - loss: 0.2242
Epoch 383/400
160/160 [=====] - 0s 218us/step - loss: 0.2251
Epoch 384/400
160/160 [=====] - 0s 212us/step - loss: 0.2221
Epoch 385/400
160/160 [=====] - 0s 212us/step - loss: 0.2245
Epoch 386/400
160/160 [=====] - 0s 212us/step - loss: 0.2211
Epoch 387/400
160/160 [=====] - 0s 218us/step - loss: 0.2237
Epoch 388/400
160/160 [=====] - 0s 224us/step - loss: 0.2218
Epoch 389/400
160/160 [=====] - 0s 218us/step - loss: 0.2260
Epoch 390/400
160/160 [=====] - 0s 218us/step - loss: 0.2231
Epoch 391/400
160/160 [=====] - 0s 224us/step - loss: 0.2236
Epoch 392/400
160/160 [=====] - 0s 206us/step - loss: 0.2250
Epoch 393/400
160/160 [=====] - 0s 224us/step - loss: 0.2212
Epoch 394/400
160/160 [=====] - 0s 224us/step - loss: 0.2262
Epoch 395/400
160/160 [=====] - 0s 215us/step - loss: 0.2213
Epoch 396/400
160/160 [=====] - 0s 218us/step - loss: 0.2256
Epoch 397/400
160/160 [=====] - 0s 215us/step - loss: 0.2240
Epoch 398/400
160/160 [=====] - 0s 212us/step - loss: 0.2230
Epoch 399/400
160/160 [=====] - 0s 224us/step - loss: 0.2237
Epoch 400/400
160/160 [=====] - 0s 215us/step - loss: 0.2222
In 6841797 n 97492695 n 97486377 n 91661143 n 97328115 n 97388715

```

0.9743289 0.94626904 0.9621056 0.912134 0.97392094 0.9737384
0.97286814 0.9742164 0.3350311 0.5238447 0.9746464 0.931367
0.9552302 0.9748971 0.97446716 0.9745866 0.96922505 0.9279953
0.97305083 0.95943624 0.8468003 0.972762 0.8858153 0.9748548
0.9604087 0.9712747 0.9700198 0.94742596 0.9693691 0.974922
0.91433156 0.41781744 0.0792328 0.9676173 0.6321033 0.97490907
0.97487384 0.9136885 0.97341937 0.97371906 0.9743969 0.9463698
0.9612583 0.90784377 0.97400576 0.9738374 0.973011 0.97428066
0.40057242 0.58097744 0.97467583 0.9302677 0.9543848 0.97486067
0.9743833 0.9746056 0.968745457 0.9281917 0.9727916 0.95977473
0.83046323 0.9729217 0.8773168 0.97480834 0.96089596 0.97091585
0.9695267 0.9474397 0.96889526 0.97489184 0.9155741 0.3430162
0.06568123 0.9680347 0.03373486 0.01243328 0.26432204 0.19206168
0.03877234 0.01376334 0.18456487 0.745457 0.01287897 0.01154511
0.01276147 0.01380916 0.01146929 0.01287459 0.02586616 0.01349726
0.01388816 0.5868666 0.03194031 0.13132899 0.97368443 0.01065085
0.5101328 0.0161722 0.01101939 0.01117671 0.02349699 0.01455633
0.01565911 0.12173698 0.05704657 0.14638826 0.01145142 0.02258541
0.38311976 0.03489814 0.01401371 0.02231658 0.06423891 0.45750308
0.03497459 0.00949347 0.32866853 0.24571471 0.04157884 0.01074657
0.23524524 0.7761645 0.00989889 0.00872121 0.0097956 0.01079716
0.00865711 0.0099006 0.02452985 0.01048056 0.01087343 0.6440066
0.03232655 0.1671972 0.9735328 0.00803757 0.57284635 0.01320683
0.00829847 0.00842139 0.02177213 0.01154443 0.0126973 0.15453802
0.0667999 0.18615322 0.00864062 0.02064178 0.45253247 0.03632473
0.01098622 0.02034165 0.07720967 0.5273478 ]
160/160 [=====] - 0s 143us/step

```

In [7]:

```
#two layers, two neurons per layer: loss  
scores_lay_two_two, model_lay_two_two.metrics_names
```

Out[7]:

(0.21448635309934616, ['loss'])

Three Layers

In [8]:

```
n = 40
xx = np.random.random((n,1))
yy = np.random.random((n,1))

X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [9]:

```
#three layers, two neurons per layer
model_lay_three_two = Sequential()

#hidden layers
model_lay_three_two.add(Dense(2, input_dim=2, activation='tanh'))
model_lay_three_two.add(Dense(2, activation='tanh'))
model_lay_three_two.add(Dense(2, activation='tanh'))

#output layer
model_lay_three_two.add(Dense(1, activation='sigmoid'))

sgd = SGD(lr=0.1)
model_lay_three_two.compile(loss='binary_crossentropy', optimizer='sgd')

model_lay_three_two.fit(X, y, batch_size=2, epochs=400)
print(model_lay_three_two.predict_proba(X).reshape(4*n))

#evaluate the model
scores = model_lay_three_two.evaluate(X, y)
```

```
Epoch 1/400  
160/160 [=====] - 0s 1ms/step - loss: 0.6951  
Epoch 2/400  
160/160 [=====] - 0s 237us/step - loss: 0.6887  
Epoch 3/400  
160/160 [=====] - 0s 231us/step - loss: 0.6830  
Epoch 4/400
```

Epoch 1/400
160/160 [=====] - 0s 231us/step - loss: 0.6768
Epoch 5/400
160/160 [=====] - 0s 231us/step - loss: 0.6697
Epoch 6/400
160/160 [=====] - 0s 237us/step - loss: 0.6617
Epoch 7/400
160/160 [=====] - 0s 231us/step - loss: 0.6520
Epoch 8/400
160/160 [=====] - 0s 231us/step - loss: 0.6402
Epoch 9/400
160/160 [=====] - 0s 243us/step - loss: 0.6274
Epoch 10/400
160/160 [=====] - 0s 237us/step - loss: 0.6123
Epoch 11/400
160/160 [=====] - 0s 243us/step - loss: 0.5951
Epoch 12/400
160/160 [=====] - 0s 243us/step - loss: 0.5770
Epoch 13/400
160/160 [=====] - 0s 237us/step - loss: 0.5562
Epoch 14/400
160/160 [=====] - 0s 231us/step - loss: 0.5346
Epoch 15/400
160/160 [=====] - 0s 224us/step - loss: 0.5121
Epoch 16/400
160/160 [=====] - 0s 231us/step - loss: 0.4888
Epoch 17/400
160/160 [=====] - 0s 234us/step - loss: 0.4668
Epoch 18/400
160/160 [=====] - 0s 231us/step - loss: 0.4441
Epoch 19/400
160/160 [=====] - 0s 231us/step - loss: 0.4225
Epoch 20/400
160/160 [=====] - 0s 231us/step - loss: 0.4023
Epoch 21/400
160/160 [=====] - 0s 237us/step - loss: 0.3851
Epoch 22/400
160/160 [=====] - 0s 237us/step - loss: 0.3704
Epoch 23/400
160/160 [=====] - 0s 231us/step - loss: 0.3561
Epoch 24/400
160/160 [=====] - 0s 237us/step - loss: 0.3431
Epoch 25/400
160/160 [=====] - 0s 243us/step - loss: 0.3341
Epoch 26/400
160/160 [=====] - 0s 231us/step - loss: 0.3217
Epoch 27/400
160/160 [=====] - 0s 237us/step - loss: 0.3128
Epoch 28/400
160/160 [=====] - 0s 231us/step - loss: 0.3095
Epoch 29/400
160/160 [=====] - 0s 231us/step - loss: 0.3012
Epoch 30/400
160/160 [=====] - 0s 234us/step - loss: 0.2954
Epoch 31/400
160/160 [=====] - 0s 231us/step - loss: 0.2890
Epoch 32/400
160/160 [=====] - 0s 224us/step - loss: 0.2888
Epoch 33/400
160/160 [=====] - 0s 234us/step - loss: 0.2779
Epoch 34/400
160/160 [=====] - 0s 231us/step - loss: 0.2786
Epoch 35/400
160/160 [=====] - 0s 243us/step - loss: 0.2758
Epoch 36/400
160/160 [=====] - 0s 228us/step - loss: 0.2781
Epoch 37/400
160/160 [=====] - 0s 237us/step - loss: 0.2710
Epoch 38/400
160/160 [=====] - 0s 237us/step - loss: 0.2694
Epoch 39/400
160/160 [=====] - 0s 237us/step - loss: 0.2709
Epoch 40/400
160/160 [=====] - 0s 237us/step - loss: 0.2668
Epoch 41/400
160/160 [=====] - 0s 231us/step - loss: 0.2672
Epoch 42/400
160/160 [=====] - 0s 231us/step - loss: 0.2649

100/100 [=====] - 0s 231us/step - loss: 0.2492
Epoch 43/400
160/160 [=====] - 0s 237us/step - loss: 0.2685
Epoch 44/400
160/160 [=====] - 0s 224us/step - loss: 0.2574
Epoch 45/400
160/160 [=====] - 0s 231us/step - loss: 0.2628
Epoch 46/400
160/160 [=====] - 0s 231us/step - loss: 0.2524
Epoch 47/400
160/160 [=====] - 0s 224us/step - loss: 0.2492
Epoch 48/400
160/160 [=====] - 0s 256us/step - loss: 0.2591
Epoch 49/400
160/160 [=====] - 0s 231us/step - loss: 0.2580
Epoch 50/400
160/160 [=====] - 0s 224us/step - loss: 0.2514
Epoch 51/400
160/160 [=====] - 0s 231us/step - loss: 0.2594
Epoch 52/400
160/160 [=====] - 0s 237us/step - loss: 0.2535
Epoch 53/400
160/160 [=====] - 0s 231us/step - loss: 0.2562
Epoch 54/400
160/160 [=====] - 0s 231us/step - loss: 0.2575
Epoch 55/400
160/160 [=====] - 0s 237us/step - loss: 0.2487
Epoch 56/400
160/160 [=====] - 0s 231us/step - loss: 0.2540
Epoch 57/400
160/160 [=====] - 0s 231us/step - loss: 0.2496
Epoch 58/400
160/160 [=====] - 0s 224us/step - loss: 0.2535
Epoch 59/400
160/160 [=====] - 0s 218us/step - loss: 0.2578
Epoch 60/400
160/160 [=====] - 0s 224us/step - loss: 0.2589
Epoch 61/400
160/160 [=====] - 0s 224us/step - loss: 0.2583
Epoch 62/400
160/160 [=====] - 0s 237us/step - loss: 0.2585
Epoch 63/400
160/160 [=====] - 0s 231us/step - loss: 0.2521
Epoch 64/400
160/160 [=====] - 0s 243us/step - loss: 0.2532
Epoch 65/400
160/160 [=====] - 0s 231us/step - loss: 0.2572
Epoch 66/400
160/160 [=====] - 0s 224us/step - loss: 0.2462
Epoch 67/400
160/160 [=====] - 0s 243us/step - loss: 0.2488
Epoch 68/400
160/160 [=====] - 0s 231us/step - loss: 0.2470
Epoch 69/400
160/160 [=====] - 0s 224us/step - loss: 0.2531
Epoch 70/400
160/160 [=====] - 0s 231us/step - loss: 0.2476
Epoch 71/400
160/160 [=====] - 0s 234us/step - loss: 0.2555
Epoch 72/400
160/160 [=====] - 0s 224us/step - loss: 0.2513
Epoch 73/400
160/160 [=====] - 0s 240us/step - loss: 0.2534
Epoch 74/400
160/160 [=====] - 0s 224us/step - loss: 0.2447
Epoch 75/400
160/160 [=====] - 0s 224us/step - loss: 0.2568
Epoch 76/400
160/160 [=====] - 0s 221us/step - loss: 0.2484
Epoch 77/400
160/160 [=====] - 0s 237us/step - loss: 0.2542
Epoch 78/400
160/160 [=====] - 0s 224us/step - loss: 0.2533
Epoch 79/400
160/160 [=====] - 0s 221us/step - loss: 0.2446
Epoch 80/400
160/160 [=====] - 0s 231us/step - loss: 0.2490
Epoch 81/400

Epoch 01/400
160/160 [=====] - 0s 228us/step - loss: 0.2499
Epoch 82/400
160/160 [=====] - 0s 224us/step - loss: 0.2466
Epoch 83/400
160/160 [=====] - 0s 224us/step - loss: 0.2552
Epoch 84/400
160/160 [=====] - 0s 237us/step - loss: 0.2534
Epoch 85/400
160/160 [=====] - 0s 231us/step - loss: 0.2505
Epoch 86/400
160/160 [=====] - 0s 224us/step - loss: 0.2501
Epoch 87/400
160/160 [=====] - 0s 224us/step - loss: 0.2422
Epoch 88/400
160/160 [=====] - 0s 231us/step - loss: 0.2572
Epoch 89/400
160/160 [=====] - 0s 237us/step - loss: 0.2487
Epoch 90/400
160/160 [=====] - 0s 243us/step - loss: 0.2437
Epoch 91/400
160/160 [=====] - 0s 249us/step - loss: 0.2509
Epoch 92/400
160/160 [=====] - 0s 224us/step - loss: 0.2462
Epoch 93/400
160/160 [=====] - 0s 224us/step - loss: 0.2542
Epoch 94/400
160/160 [=====] - 0s 224us/step - loss: 0.2492
Epoch 95/400
160/160 [=====] - 0s 224us/step - loss: 0.2440
Epoch 96/400
160/160 [=====] - 0s 231us/step - loss: 0.2486
Epoch 97/400
160/160 [=====] - 0s 231us/step - loss: 0.2419
Epoch 98/400
160/160 [=====] - 0s 231us/step - loss: 0.2478
Epoch 99/400
160/160 [=====] - 0s 231us/step - loss: 0.2493
Epoch 100/400
160/160 [=====] - 0s 224us/step - loss: 0.2434
Epoch 101/400
160/160 [=====] - 0s 224us/step - loss: 0.2501
Epoch 102/400
160/160 [=====] - 0s 231us/step - loss: 0.2502
Epoch 103/400
160/160 [=====] - 0s 224us/step - loss: 0.2507
Epoch 104/400
160/160 [=====] - 0s 231us/step - loss: 0.2462
Epoch 105/400
160/160 [=====] - 0s 231us/step - loss: 0.2472
Epoch 106/400
160/160 [=====] - 0s 228us/step - loss: 0.2439
Epoch 107/400
160/160 [=====] - 0s 224us/step - loss: 0.2480
Epoch 108/400
160/160 [=====] - 0s 231us/step - loss: 0.2591
Epoch 109/400
160/160 [=====] - 0s 231us/step - loss: 0.2465
Epoch 110/400
160/160 [=====] - 0s 224us/step - loss: 0.2467
Epoch 111/400
160/160 [=====] - 0s 231us/step - loss: 0.2472
Epoch 112/400
160/160 [=====] - 0s 231us/step - loss: 0.2491
Epoch 113/400
160/160 [=====] - 0s 224us/step - loss: 0.2476
Epoch 114/400
160/160 [=====] - 0s 224us/step - loss: 0.2465
Epoch 115/400
160/160 [=====] - 0s 224us/step - loss: 0.2469
Epoch 116/400
160/160 [=====] - 0s 249us/step - loss: 0.2473
Epoch 117/400
160/160 [=====] - 0s 237us/step - loss: 0.2489
Epoch 118/400
160/160 [=====] - 0s 237us/step - loss: 0.2432
Epoch 119/400
160/160 [=====] - 0s 219us/step - loss: 0.2400

100/100 [=====] - 0s 231us/step - loss: 0.2400
Epoch 120/400
160/160 [=====] - 0s 231us/step - loss: 0.2358
Epoch 121/400
160/160 [=====] - 0s 231us/step - loss: 0.2504
Epoch 122/400
160/160 [=====] - 0s 234us/step - loss: 0.2434
Epoch 123/400
160/160 [=====] - 0s 231us/step - loss: 0.2451
Epoch 124/400
160/160 [=====] - 0s 231us/step - loss: 0.2496
Epoch 125/400
160/160 [=====] - 0s 228us/step - loss: 0.2485
Epoch 126/400
160/160 [=====] - 0s 224us/step - loss: 0.2450
Epoch 127/400
160/160 [=====] - 0s 231us/step - loss: 0.2431
Epoch 128/400
160/160 [=====] - 0s 231us/step - loss: 0.2446
Epoch 129/400
160/160 [=====] - 0s 231us/step - loss: 0.2407
Epoch 130/400
160/160 [=====] - 0s 231us/step - loss: 0.2468
Epoch 131/400
160/160 [=====] - 0s 231us/step - loss: 0.2396
Epoch 132/400
160/160 [=====] - 0s 224us/step - loss: 0.2480
Epoch 133/400
160/160 [=====] - 0s 231us/step - loss: 0.2423
Epoch 134/400
160/160 [=====] - 0s 224us/step - loss: 0.2506
Epoch 135/400
160/160 [=====] - 0s 224us/step - loss: 0.2461
Epoch 136/400
160/160 [=====] - 0s 224us/step - loss: 0.2426
Epoch 137/400
160/160 [=====] - 0s 243us/step - loss: 0.2409
Epoch 138/400
160/160 [=====] - 0s 237us/step - loss: 0.2425
Epoch 139/400
160/160 [=====] - 0s 224us/step - loss: 0.2394
Epoch 140/400
160/160 [=====] - 0s 231us/step - loss: 0.2446
Epoch 141/400
160/160 [=====] - 0s 231us/step - loss: 0.2470
Epoch 142/400
160/160 [=====] - 0s 237us/step - loss: 0.2413
Epoch 143/400
160/160 [=====] - 0s 224us/step - loss: 0.2401
Epoch 144/400
160/160 [=====] - 0s 231us/step - loss: 0.2398
Epoch 145/400
160/160 [=====] - 0s 237us/step - loss: 0.2420
Epoch 146/400
160/160 [=====] - 0s 231us/step - loss: 0.2414
Epoch 147/400
160/160 [=====] - 0s 231us/step - loss: 0.2448
Epoch 148/400
160/160 [=====] - 0s 231us/step - loss: 0.2499
Epoch 149/400
160/160 [=====] - 0s 231us/step - loss: 0.2467
Epoch 150/400
160/160 [=====] - 0s 224us/step - loss: 0.2471
Epoch 151/400
160/160 [=====] - 0s 224us/step - loss: 0.2435
Epoch 152/400
160/160 [=====] - 0s 224us/step - loss: 0.2469
Epoch 153/400
160/160 [=====] - 0s 231us/step - loss: 0.2397
Epoch 154/400
160/160 [=====] - 0s 224us/step - loss: 0.2386
Epoch 155/400
160/160 [=====] - 0s 231us/step - loss: 0.2428
Epoch 156/400
160/160 [=====] - 0s 218us/step - loss: 0.2442
Epoch 157/400
160/160 [=====] - 0s 224us/step - loss: 0.2411
Epoch 158/400

Epoch 158/400
160/160 [=====] - 0s 224us/step - loss: 0.2343
Epoch 159/400
160/160 [=====] - 0s 224us/step - loss: 0.2468
Epoch 160/400
160/160 [=====] - 0s 228us/step - loss: 0.2474
Epoch 161/400
160/160 [=====] - 0s 231us/step - loss: 0.2404
Epoch 162/400
160/160 [=====] - 0s 237us/step - loss: 0.2317
Epoch 163/400
160/160 [=====] - 0s 234us/step - loss: 0.2497
Epoch 164/400
160/160 [=====] - 0s 224us/step - loss: 0.2436
Epoch 165/400
160/160 [=====] - 0s 221us/step - loss: 0.2427
Epoch 166/400
160/160 [=====] - 0s 224us/step - loss: 0.2371
Epoch 167/400
160/160 [=====] - 0s 231us/step - loss: 0.2489
Epoch 168/400
160/160 [=====] - 0s 228us/step - loss: 0.2428
Epoch 169/400
160/160 [=====] - 0s 237us/step - loss: 0.2450
Epoch 170/400
160/160 [=====] - 0s 224us/step - loss: 0.2427
Epoch 171/400
160/160 [=====] - 0s 231us/step - loss: 0.2423
Epoch 172/400
160/160 [=====] - 0s 237us/step - loss: 0.2344
Epoch 173/400
160/160 [=====] - 0s 224us/step - loss: 0.2450
Epoch 174/400
160/160 [=====] - 0s 231us/step - loss: 0.2457
Epoch 175/400
160/160 [=====] - 0s 218us/step - loss: 0.2419
Epoch 176/400
160/160 [=====] - 0s 218us/step - loss: 0.2429
Epoch 177/400
160/160 [=====] - 0s 224us/step - loss: 0.2332
Epoch 178/400
160/160 [=====] - 0s 218us/step - loss: 0.2451
Epoch 179/400
160/160 [=====] - 0s 231us/step - loss: 0.2456
Epoch 180/400
160/160 [=====] - 0s 224us/step - loss: 0.2443
Epoch 181/400
160/160 [=====] - 0s 224us/step - loss: 0.2414
Epoch 182/400
160/160 [=====] - 0s 224us/step - loss: 0.2432
Epoch 183/400
160/160 [=====] - 0s 224us/step - loss: 0.2395
Epoch 184/400
160/160 [=====] - 0s 231us/step - loss: 0.2452
Epoch 185/400
160/160 [=====] - 0s 231us/step - loss: 0.2479
Epoch 186/400
160/160 [=====] - 0s 224us/step - loss: 0.2391
Epoch 187/400
160/160 [=====] - 0s 237us/step - loss: 0.2439
Epoch 188/400
160/160 [=====] - 0s 224us/step - loss: 0.2421
Epoch 189/400
160/160 [=====] - 0s 224us/step - loss: 0.2382
Epoch 190/400
160/160 [=====] - 0s 231us/step - loss: 0.2396
Epoch 191/400
160/160 [=====] - 0s 224us/step - loss: 0.2427
Epoch 192/400
160/160 [=====] - 0s 224us/step - loss: 0.2427
Epoch 193/400
160/160 [=====] - 0s 228us/step - loss: 0.2431
Epoch 194/400
160/160 [=====] - 0s 231us/step - loss: 0.2450
Epoch 195/400
160/160 [=====] - 0s 231us/step - loss: 0.2446
Epoch 196/400

160/160 [=====] - 0s 221us/step - loss: 0.2443
Epoch 197/400
160/160 [=====] - 0s 231us/step - loss: 0.2377
Epoch 198/400
160/160 [=====] - 0s 231us/step - loss: 0.2441
Epoch 199/400
160/160 [=====] - 0s 237us/step - loss: 0.2386
Epoch 200/400
160/160 [=====] - 0s 231us/step - loss: 0.2363
Epoch 201/400
160/160 [=====] - 0s 224us/step - loss: 0.2431
Epoch 202/400
160/160 [=====] - 0s 231us/step - loss: 0.2405
Epoch 203/400
160/160 [=====] - 0s 231us/step - loss: 0.2399
Epoch 204/400
160/160 [=====] - 0s 237us/step - loss: 0.2362
Epoch 205/400
160/160 [=====] - 0s 237us/step - loss: 0.2467
Epoch 206/400
160/160 [=====] - 0s 231us/step - loss: 0.2380
Epoch 207/400
160/160 [=====] - 0s 224us/step - loss: 0.2451
Epoch 208/400
160/160 [=====] - 0s 231us/step - loss: 0.2331
Epoch 209/400
160/160 [=====] - 0s 234us/step - loss: 0.2457
Epoch 210/400
160/160 [=====] - 0s 231us/step - loss: 0.2356
Epoch 211/400
160/160 [=====] - 0s 224us/step - loss: 0.2439
Epoch 212/400
160/160 [=====] - 0s 228us/step - loss: 0.2450
Epoch 213/400
160/160 [=====] - 0s 224us/step - loss: 0.2448
Epoch 214/400
160/160 [=====] - 0s 240us/step - loss: 0.2368
Epoch 215/400
160/160 [=====] - 0s 224us/step - loss: 0.2394
Epoch 216/400
160/160 [=====] - 0s 237us/step - loss: 0.2412
Epoch 217/400
160/160 [=====] - 0s 228us/step - loss: 0.2434
Epoch 218/400
160/160 [=====] - 0s 231us/step - loss: 0.2454
Epoch 219/400
160/160 [=====] - 0s 224us/step - loss: 0.2406
Epoch 220/400
160/160 [=====] - 0s 228us/step - loss: 0.2393
Epoch 221/400
160/160 [=====] - 0s 237us/step - loss: 0.2406
Epoch 222/400
160/160 [=====] - 0s 231us/step - loss: 0.2444
Epoch 223/400
160/160 [=====] - 0s 231us/step - loss: 0.2419
Epoch 224/400
160/160 [=====] - 0s 231us/step - loss: 0.2421
Epoch 225/400
160/160 [=====] - 0s 231us/step - loss: 0.2400
Epoch 226/400
160/160 [=====] - 0s 231us/step - loss: 0.2425
Epoch 227/400
160/160 [=====] - 0s 224us/step - loss: 0.2368
Epoch 228/400
160/160 [=====] - 0s 224us/step - loss: 0.2408
Epoch 229/400
160/160 [=====] - 0s 237us/step - loss: 0.2464
Epoch 230/400
160/160 [=====] - 0s 237us/step - loss: 0.2296
Epoch 231/400
160/160 [=====] - 0s 231us/step - loss: 0.2417
Epoch 232/400
160/160 [=====] - 0s 224us/step - loss: 0.2377
Epoch 233/400
160/160 [=====] - 0s 237us/step - loss: 0.2422
Epoch 234/400
160/160 [=====] - 0s 237us/step - loss: 0.2453
- 0s 237us/step - loss: 0.2453

Epoch 235/400
160/160 [=====] - 0s 231us/step - loss: 0.2415
Epoch 236/400
160/160 [=====] - 0s 231us/step - loss: 0.2404
Epoch 237/400
160/160 [=====] - 0s 231us/step - loss: 0.2423
Epoch 238/400
160/160 [=====] - 0s 224us/step - loss: 0.2282
Epoch 239/400
160/160 [=====] - 0s 231us/step - loss: 0.2367
Epoch 240/400
160/160 [=====] - 0s 224us/step - loss: 0.2390
Epoch 241/400
160/160 [=====] - 0s 231us/step - loss: 0.2429
Epoch 242/400
160/160 [=====] - 0s 224us/step - loss: 0.2373
Epoch 243/400
160/160 [=====] - 0s 224us/step - loss: 0.2462
Epoch 244/400
160/160 [=====] - 0s 224us/step - loss: 0.2407
Epoch 245/400
160/160 [=====] - 0s 231us/step - loss: 0.2401
Epoch 246/400
160/160 [=====] - 0s 231us/step - loss: 0.2320
Epoch 247/400
160/160 [=====] - 0s 224us/step - loss: 0.2414
Epoch 248/400
160/160 [=====] - 0s 224us/step - loss: 0.2409
Epoch 249/400
160/160 [=====] - 0s 224us/step - loss: 0.2335
Epoch 250/400
160/160 [=====] - 0s 231us/step - loss: 0.2455
Epoch 251/400
160/160 [=====] - 0s 256us/step - loss: 0.2363
Epoch 252/400
160/160 [=====] - 0s 231us/step - loss: 0.2459
Epoch 253/400
160/160 [=====] - 0s 237us/step - loss: 0.2407
Epoch 254/400
160/160 [=====] - 0s 231us/step - loss: 0.2361
Epoch 255/400
160/160 [=====] - 0s 224us/step - loss: 0.2420
Epoch 256/400
160/160 [=====] - 0s 224us/step - loss: 0.2359
Epoch 257/400
160/160 [=====] - 0s 224us/step - loss: 0.2457
Epoch 258/400
160/160 [=====] - 0s 228us/step - loss: 0.2326
Epoch 259/400
160/160 [=====] - 0s 231us/step - loss: 0.2366
Epoch 260/400
160/160 [=====] - 0s 224us/step - loss: 0.2416
Epoch 261/400
160/160 [=====] - 0s 228us/step - loss: 0.2432
Epoch 262/400
160/160 [=====] - 0s 231us/step - loss: 0.2390
Epoch 263/400
160/160 [=====] - 0s 224us/step - loss: 0.2444
Epoch 264/400
160/160 [=====] - 0s 231us/step - loss: 0.2441
Epoch 265/400
160/160 [=====] - 0s 231us/step - loss: 0.2380
Epoch 266/400
160/160 [=====] - 0s 231us/step - loss: 0.2394
Epoch 267/400
160/160 [=====] - 0s 246us/step - loss: 0.2374
Epoch 268/400
160/160 [=====] - 0s 231us/step - loss: 0.2437
Epoch 269/400
160/160 [=====] - 0s 237us/step - loss: 0.2336
Epoch 270/400
160/160 [=====] - 0s 237us/step - loss: 0.2306
Epoch 271/400
160/160 [=====] - 0s 231us/step - loss: 0.2414
Epoch 272/400
160/160 [=====] - 0s 231us/step - loss: 0.2364
Epoch 273/400

160/160 [=====] - 0s 237us/step - loss: 0.2381
Epoch 274/400
160/160 [=====] - 0s 237us/step - loss: 0.2389
Epoch 275/400
160/160 [=====] - 0s 231us/step - loss: 0.2348
Epoch 276/400
160/160 [=====] - 0s 231us/step - loss: 0.2399
Epoch 277/400
160/160 [=====] - 0s 246us/step - loss: 0.2439
Epoch 278/400
160/160 [=====] - 0s 237us/step - loss: 0.2355
Epoch 279/400
160/160 [=====] - 0s 237us/step - loss: 0.2426
Epoch 280/400
160/160 [=====] - 0s 237us/step - loss: 0.2398
Epoch 281/400
160/160 [=====] - 0s 231us/step - loss: 0.2443
Epoch 282/400
160/160 [=====] - 0s 231us/step - loss: 0.2384
Epoch 283/400
160/160 [=====] - 0s 237us/step - loss: 0.2413
Epoch 284/400
160/160 [=====] - 0s 237us/step - loss: 0.2409
Epoch 285/400
160/160 [=====] - 0s 234us/step - loss: 0.2247
Epoch 286/400
160/160 [=====] - 0s 243us/step - loss: 0.2413
Epoch 287/400
160/160 [=====] - 0s 231us/step - loss: 0.2266
Epoch 288/400
160/160 [=====] - 0s 224us/step - loss: 0.2414
Epoch 289/400
160/160 [=====] - 0s 231us/step - loss: 0.2418
Epoch 290/400
160/160 [=====] - 0s 228us/step - loss: 0.2406
Epoch 291/400
160/160 [=====] - 0s 224us/step - loss: 0.2286
Epoch 292/400
160/160 [=====] - 0s 224us/step - loss: 0.2298
Epoch 293/400
160/160 [=====] - 0s 299us/step - loss: 0.2397
Epoch 294/400
160/160 [=====] - 0s 274us/step - loss: 0.2388
Epoch 295/400
160/160 [=====] - 0s 249us/step - loss: 0.2457
Epoch 296/400
160/160 [=====] - 0s 268us/step - loss: 0.2424
Epoch 297/400
160/160 [=====] - 0s 274us/step - loss: 0.2404
Epoch 298/400
160/160 [=====] - 0s 284us/step - loss: 0.2424
Epoch 299/400
160/160 [=====] - 0s 247us/step - loss: 0.2442
Epoch 300/400
160/160 [=====] - 0s 249us/step - loss: 0.2390
Epoch 301/400
160/160 [=====] - 0s 249us/step - loss: 0.2406
Epoch 302/400
160/160 [=====] - 0s 256us/step - loss: 0.2431
Epoch 303/400
160/160 [=====] - 0s 234us/step - loss: 0.2326
Epoch 304/400
160/160 [=====] - 0s 249us/step - loss: 0.2366
Epoch 305/400
160/160 [=====] - 0s 243us/step - loss: 0.2351
Epoch 306/400
160/160 [=====] - 0s 224us/step - loss: 0.2401
Epoch 307/400
160/160 [=====] - 0s 240us/step - loss: 0.2408
Epoch 308/400
160/160 [=====] - 0s 256us/step - loss: 0.2348
Epoch 309/400
160/160 [=====] - 0s 234us/step - loss: 0.2366
Epoch 310/400
160/160 [=====] - 0s 231us/step - loss: 0.2412
Epoch 311/400
160/160 [=====] - 0s 231us/step - loss: 0.2359

Epoch 312/400
160/160 [=====] - 0s 234us/step - loss: 0.2427
Epoch 313/400
160/160 [=====] - 0s 231us/step - loss: 0.2364
Epoch 314/400
160/160 [=====] - 0s 234us/step - loss: 0.2355
Epoch 315/400
160/160 [=====] - 0s 228us/step - loss: 0.2409
Epoch 316/400
160/160 [=====] - 0s 243us/step - loss: 0.2426
Epoch 317/400
160/160 [=====] - 0s 249us/step - loss: 0.2335
Epoch 318/400
160/160 [=====] - 0s 249us/step - loss: 0.2374
Epoch 319/400
160/160 [=====] - 0s 237us/step - loss: 0.2341
Epoch 320/400
160/160 [=====] - 0s 231us/step - loss: 0.2418
Epoch 321/400
160/160 [=====] - 0s 231us/step - loss: 0.2356
Epoch 322/400
160/160 [=====] - 0s 243us/step - loss: 0.2353
Epoch 323/400
160/160 [=====] - 0s 231us/step - loss: 0.2397
Epoch 324/400
160/160 [=====] - 0s 240us/step - loss: 0.2414
Epoch 325/400
160/160 [=====] - 0s 240us/step - loss: 0.2435
Epoch 326/400
160/160 [=====] - 0s 231us/step - loss: 0.2388
Epoch 327/400
160/160 [=====] - 0s 231us/step - loss: 0.2305
Epoch 328/400
160/160 [=====] - 0s 224us/step - loss: 0.2403
Epoch 329/400
160/160 [=====] - 0s 237us/step - loss: 0.2432
Epoch 330/400
160/160 [=====] - 0s 231us/step - loss: 0.2383
Epoch 331/400
160/160 [=====] - 0s 237us/step - loss: 0.2361
Epoch 332/400
160/160 [=====] - 0s 237us/step - loss: 0.2206
Epoch 333/400
160/160 [=====] - 0s 237us/step - loss: 0.2404
Epoch 334/400
160/160 [=====] - 0s 237us/step - loss: 0.2369
Epoch 335/400
160/160 [=====] - 0s 243us/step - loss: 0.2351
Epoch 336/400
160/160 [=====] - 0s 237us/step - loss: 0.2374
Epoch 337/400
160/160 [=====] - 0s 243us/step - loss: 0.2388
Epoch 338/400
160/160 [=====] - 0s 231us/step - loss: 0.2331
Epoch 339/400
160/160 [=====] - 0s 234us/step - loss: 0.2268
Epoch 340/400
160/160 [=====] - 0s 231us/step - loss: 0.2291
Epoch 341/400
160/160 [=====] - 0s 231us/step - loss: 0.2265
Epoch 342/400
160/160 [=====] - 0s 231us/step - loss: 0.2242
Epoch 343/400
160/160 [=====] - 0s 224us/step - loss: 0.2140
Epoch 344/400
160/160 [=====] - 0s 231us/step - loss: 0.2151
Epoch 345/400
160/160 [=====] - 0s 237us/step - loss: 0.2069
Epoch 346/400
160/160 [=====] - 0s 237us/step - loss: 0.2025
Epoch 347/400
160/160 [=====] - 0s 243us/step - loss: 0.1855
Epoch 348/400
160/160 [=====] - 0s 231us/step - loss: 0.1920
Epoch 349/400
160/160 [=====] - 0s 231us/step - loss: 0.1745
Epoch 350/400

160/160 [=====] - 0s 231us/step - loss: 0.1614
Epoch 351/400
160/160 [=====] - 0s 224us/step - loss: 0.1563
Epoch 352/400
160/160 [=====] - 0s 221us/step - loss: 0.1477
Epoch 353/400
160/160 [=====] - 0s 224us/step - loss: 0.1340
Epoch 354/400
160/160 [=====] - 0s 224us/step - loss: 0.1319
Epoch 355/400
160/160 [=====] - 0s 234us/step - loss: 0.1230
Epoch 356/400
160/160 [=====] - 0s 218us/step - loss: 0.1190
Epoch 357/400
160/160 [=====] - 0s 231us/step - loss: 0.1153
Epoch 358/400
160/160 [=====] - 0s 234us/step - loss: 0.1092
Epoch 359/400
160/160 [=====] - 0s 231us/step - loss: 0.1040
Epoch 360/400
160/160 [=====] - 0s 231us/step - loss: 0.1004
Epoch 361/400
160/160 [=====] - 0s 231us/step - loss: 0.0966
Epoch 362/400
160/160 [=====] - 0s 268us/step - loss: 0.0925
Epoch 363/400
160/160 [=====] - 0s 249us/step - loss: 0.0886
Epoch 364/400
160/160 [=====] - 0s 281us/step - loss: 0.0867
Epoch 365/400
160/160 [=====] - 0s 256us/step - loss: 0.0806
Epoch 366/400
160/160 [=====] - 0s 268us/step - loss: 0.0819
Epoch 367/400
160/160 [=====] - 0s 268us/step - loss: 0.0781
Epoch 368/400
160/160 [=====] - 0s 280us/step - loss: 0.0704
Epoch 369/400
160/160 [=====] - 0s 252us/step - loss: 0.0747
Epoch 370/400
160/160 [=====] - 0s 256us/step - loss: 0.0680
Epoch 371/400
160/160 [=====] - 0s 256us/step - loss: 0.0654
Epoch 372/400
160/160 [=====] - 0s 256us/step - loss: 0.0614
Epoch 373/400
160/160 [=====] - 0s 262us/step - loss: 0.0649
Epoch 374/400
160/160 [=====] - 0s 256us/step - loss: 0.0653
Epoch 375/400
160/160 [=====] - 0s 249us/step - loss: 0.0587
Epoch 376/400
160/160 [=====] - 0s 224us/step - loss: 0.0553
Epoch 377/400
160/160 [=====] - 0s 224us/step - loss: 0.0568
Epoch 378/400
160/160 [=====] - 0s 243us/step - loss: 0.0573
Epoch 379/400
160/160 [=====] - 0s 237us/step - loss: 0.0553
Epoch 380/400
160/160 [=====] - 0s 237us/step - loss: 0.0479
Epoch 381/400
160/160 [=====] - 0s 231us/step - loss: 0.0529
Epoch 382/400
160/160 [=====] - 0s 237us/step - loss: 0.0470
Epoch 383/400
160/160 [=====] - 0s 231us/step - loss: 0.0472
Epoch 384/400
160/160 [=====] - 0s 224us/step - loss: 0.0487
Epoch 385/400
160/160 [=====] - 0s 231us/step - loss: 0.0482
Epoch 386/400
160/160 [=====] - 0s 224us/step - loss: 0.0367
Epoch 387/400
160/160 [=====] - 0s 237us/step - loss: 0.0472
Epoch 388/400
160/160 [=====] - 0s 231us/step - loss: 0.0458

```

Epoch 389/400
160/160 [=====] - 0s 237us/step - loss: 0.0413
Epoch 390/400
160/160 [=====] - 0s 231us/step - loss: 0.0387
Epoch 391/400
160/160 [=====] - 0s 237us/step - loss: 0.0365
Epoch 392/400
160/160 [=====] - 0s 249us/step - loss: 0.0442
Epoch 393/400
160/160 [=====] - 0s 231us/step - loss: 0.0419
Epoch 394/400
160/160 [=====] - 0s 237us/step - loss: 0.0381
Epoch 395/400
160/160 [=====] - 0s 231us/step - loss: 0.0385
Epoch 396/400
160/160 [=====] - 0s 228us/step - loss: 0.0352
Epoch 397/400
160/160 [=====] - 0s 231us/step - loss: 0.0352
Epoch 398/400
160/160 [=====] - 0s 231us/step - loss: 0.0393
Epoch 399/400
160/160 [=====] - 0s 240us/step - loss: 0.0345
Epoch 400/400
160/160 [=====] - 0s 237us/step - loss: 0.0374
[0.98710316 0.9949346 0.9933209 0.99015474 0.9952165 0.9939009
 0.99273163 0.99495935 0.97806007 0.99514717 0.9929635 0.96260196
 0.99515766 0.9141731 0.9932981 0.99501896 0.9703525 0.9392485
 0.99516344 0.99441034 0.9951127 0.99494237 0.99474996 0.99517643
 0.9904536 0.99504256 0.99474674 0.9951929 0.9951041 0.99471927
 0.9951067 0.99431545 0.99098563 0.8044618 0.99506086 0.9947178
 0.9942504 0.97156066 0.9936254 0.9947408 0.98495865 0.99550664
 0.9941847 0.9900995 0.99575293 0.99423486 0.9935709 0.99549735
 0.9584838 0.99567246 0.9923907 0.95496976 0.9956832 0.89555573
 0.9929813 0.9955467 0.95930475 0.8416532 0.99570423 0.99479985
 0.99564856 0.99549145 0.99524456 0.9957098 0.99166507 0.9955918
 0.99522275 0.9957321 0.99564457 0.9952644 0.9956541 0.9945344
 0.9921638 0.5439114 0.9955907 0.99510384 0.99467105 0.9386584
 0.9943064 0.9952251 0.00385694 0.00410654 0.0071479 0.00426354
 0.00420495 0.00406709 0.00632381 0.00409759 0.01445939 0.00422643
 0.00750824 0.01522079 0.00423199 0.20785609 0.006597 0.00414442
 0.00482209 0.27482557 0.00416054 0.00427053 0.00415694 0.00408302
 0.00412265 0.00419867 0.01488094 0.00410469 0.00418807 0.00417923
 0.0041389 0.00404938 0.00412374 0.00529535 0.01411872 0.27747858
 0.00415624 0.00473924 0.00406507 0.04011149 0.00470646 0.00415149
 0.00305545 0.00296571 0.00451031 0.00318549 0.00294976 0.00306671
 0.00411521 0.00295673 0.01555032 0.00297464 0.00555137 0.00809368
 0.00297425 0.10969862 0.00481424 0.00296751 0.0035089 0.5249114
 0.00294544 0.00313371 0.0029544 0.00295269 0.00300275 0.00295686
 0.00819336 0.00294655 0.00303744 0.00294595 0.00294896 0.00296476
 0.00294299 0.00372138 0.00784569 0.55323696 0.00296455 0.00331886
 0.00303229 0.06201221 0.00332616 0.00301934]
160/160 [=====] - 0s 193us/step

```

In [10]:

```
#three layers, two neurons per layer: loss
scores_lay_three_two, model_lay_three_two.metrics_names
```

Out[10]:

```
(0.031000974774360656, ['loss'])
```

Four Layers

In [11]:

```
n = 40
xx = np.random.random((n,1))
yy = np.random.random((n,1))

X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [12]:

```
#four layers, two neurons per layer
model_lay_four_two = Sequential()
```

```

#hidden layers
model_lay_four_two.add(Dense(2, input_dim=2, activation='tanh'))
model_lay_four_two.add(Dense(2, activation='tanh'))
model_lay_four_two.add(Dense(2, activation='tanh'))
model_lay_four_two.add(Dense(2, activation='tanh'))

#output layer
model_lay_four_two.add(Dense(1, activation='sigmoid'))

sgd = SGD(lr=0.1)
model_lay_four_two.compile(loss='binary_crossentropy', optimizer='sgd')

model_lay_four_two.fit(X, y, batch_size=2, epochs=400)
print(model_lay_four_two.predict_proba(X).reshape(4*n))

#evaluate the model
scores_lay_four_two = model_lay_four_two.evaluate(X, y)

```

```

Epoch 1/400
160/160 [=====] - 0s 1ms/step - loss: 0.6928
Epoch 2/400
160/160 [=====] - 0s 256us/step - loss: 0.6789
Epoch 3/400
160/160 [=====] - 0s 249us/step - loss: 0.6684
Epoch 4/400
160/160 [=====] - 0s 243us/step - loss: 0.6600
Epoch 5/400
160/160 [=====] - 0s 243us/step - loss: 0.6531
Epoch 6/400
160/160 [=====] - 0s 249us/step - loss: 0.6471
Epoch 7/400
160/160 [=====] - 0s 243us/step - loss: 0.6411
Epoch 8/400
160/160 [=====] - 0s 243us/step - loss: 0.6353
Epoch 9/400
160/160 [=====] - 0s 249us/step - loss: 0.6299
Epoch 10/400
160/160 [=====] - 0s 237us/step - loss: 0.6247
Epoch 11/400
160/160 [=====] - 0s 243us/step - loss: 0.6197
Epoch 12/400
160/160 [=====] - 0s 249us/step - loss: 0.6152
Epoch 13/400
160/160 [=====] - 0s 237us/step - loss: 0.6109
Epoch 14/400
160/160 [=====] - 0s 243us/step - loss: 0.6067
Epoch 15/400
160/160 [=====] - 0s 237us/step - loss: 0.6031
Epoch 16/400
160/160 [=====] - 0s 237us/step - loss: 0.5998
Epoch 17/400
160/160 [=====] - 0s 249us/step - loss: 0.5969
Epoch 18/400
160/160 [=====] - 0s 243us/step - loss: 0.5940
Epoch 19/400
160/160 [=====] - 0s 237us/step - loss: 0.5916
Epoch 20/400
160/160 [=====] - 0s 243us/step - loss: 0.5890
Epoch 21/400
160/160 [=====] - 0s 246us/step - loss: 0.5869
Epoch 22/400
160/160 [=====] - 0s 237us/step - loss: 0.5854
Epoch 23/400
160/160 [=====] - 0s 259us/step - loss: 0.5836
Epoch 24/400
160/160 [=====] - 0s 237us/step - loss: 0.5816
Epoch 25/400
160/160 [=====] - 0s 249us/step - loss: 0.5803
Epoch 26/400
160/160 [=====] - 0s 240us/step - loss: 0.5788
Epoch 27/400
160/160 [=====] - 0s 243us/step - loss: 0.5775
Epoch 28/400
160/160 [=====] - 0s 240us/step - loss: 0.5764
Epoch 29/400
160/160 [=====] - 0s 243us/step - loss: 0.5756

```

Epoch 30/400
160/160 [=====] - 0s 256us/step - loss: 0.5747
Epoch 31/400
160/160 [=====] - 0s 256us/step - loss: 0.5735
Epoch 32/400
160/160 [=====] - 0s 256us/step - loss: 0.5730
Epoch 33/400
160/160 [=====] - 0s 256us/step - loss: 0.5717
Epoch 34/400
160/160 [=====] - 0s 249us/step - loss: 0.5708
Epoch 35/400
160/160 [=====] - 0s 243us/step - loss: 0.5700
Epoch 36/400
160/160 [=====] - 0s 237us/step - loss: 0.5697
Epoch 37/400
160/160 [=====] - 0s 237us/step - loss: 0.5696
Epoch 38/400
160/160 [=====] - 0s 249us/step - loss: 0.5682
Epoch 39/400
160/160 [=====] - 0s 256us/step - loss: 0.5678
Epoch 40/400
160/160 [=====] - 0s 249us/step - loss: 0.5674
Epoch 41/400
160/160 [=====] - 0s 256us/step - loss: 0.5673
Epoch 42/400
160/160 [=====] - 0s 249us/step - loss: 0.5661
Epoch 43/400
160/160 [=====] - 0s 249us/step - loss: 0.5655
Epoch 44/400
160/160 [=====] - 0s 243us/step - loss: 0.5653
Epoch 45/400
160/160 [=====] - 0s 243us/step - loss: 0.5640
Epoch 46/400
160/160 [=====] - 0s 249us/step - loss: 0.5638
Epoch 47/400
160/160 [=====] - 0s 262us/step - loss: 0.5640
Epoch 48/400
160/160 [=====] - 0s 256us/step - loss: 0.5632
Epoch 49/400
160/160 [=====] - 0s 249us/step - loss: 0.5623
Epoch 50/400
160/160 [=====] - 0s 249us/step - loss: 0.5620
Epoch 51/400
160/160 [=====] - 0s 246us/step - loss: 0.5606
Epoch 52/400
160/160 [=====] - 0s 249us/step - loss: 0.5602
Epoch 53/400
160/160 [=====] - 0s 237us/step - loss: 0.5602
Epoch 54/400
160/160 [=====] - 0s 243us/step - loss: 0.5589
Epoch 55/400
160/160 [=====] - 0s 249us/step - loss: 0.5594
Epoch 56/400
160/160 [=====] - 0s 249us/step - loss: 0.5580
Epoch 57/400
160/160 [=====] - 0s 249us/step - loss: 0.5568
Epoch 58/400
160/160 [=====] - 0s 243us/step - loss: 0.5560
Epoch 59/400
160/160 [=====] - 0s 237us/step - loss: 0.5552
Epoch 60/400
160/160 [=====] - 0s 243us/step - loss: 0.5537
Epoch 61/400
160/160 [=====] - 0s 243us/step - loss: 0.5537
Epoch 62/400
160/160 [=====] - 0s 243us/step - loss: 0.5515
Epoch 63/400
160/160 [=====] - 0s 243us/step - loss: 0.5506
Epoch 64/400
160/160 [=====] - 0s 246us/step - loss: 0.5483
Epoch 65/400
160/160 [=====] - 0s 243us/step - loss: 0.5470
Epoch 66/400
160/160 [=====] - 0s 240us/step - loss: 0.5453
Epoch 67/400
160/160 [=====] - 0s 243us/step - loss: 0.5420
Epoch 68/400

160/160 [=====] - 0s 243us/step - loss: 0.5406
Epoch 69/400
160/160 [=====] - 0s 240us/step - loss: 0.5371
Epoch 70/400
160/160 [=====] - 0s 243us/step - loss: 0.5335
Epoch 71/400
160/160 [=====] - 0s 259us/step - loss: 0.5308
Epoch 72/400
160/160 [=====] - 0s 243us/step - loss: 0.5262
Epoch 73/400
160/160 [=====] - 0s 249us/step - loss: 0.5209
Epoch 74/400
160/160 [=====] - 0s 237us/step - loss: 0.5133
Epoch 75/400
160/160 [=====] - 0s 237us/step - loss: 0.5096
Epoch 76/400
160/160 [=====] - 0s 243us/step - loss: 0.4984
Epoch 77/400
160/160 [=====] - 0s 243us/step - loss: 0.4929
Epoch 78/400
160/160 [=====] - 0s 243us/step - loss: 0.4816
Epoch 79/400
160/160 [=====] - 0s 243us/step - loss: 0.4705
Epoch 80/400
160/160 [=====] - 0s 237us/step - loss: 0.4560
Epoch 81/400
160/160 [=====] - 0s 237us/step - loss: 0.4424
Epoch 82/400
160/160 [=====] - 0s 237us/step - loss: 0.4253
Epoch 83/400
160/160 [=====] - 0s 237us/step - loss: 0.4088
Epoch 84/400
160/160 [=====] - 0s 231us/step - loss: 0.3904
Epoch 85/400
160/160 [=====] - 0s 237us/step - loss: 0.3736
Epoch 86/400
160/160 [=====] - 0s 237us/step - loss: 0.3564
Epoch 87/400
160/160 [=====] - 0s 249us/step - loss: 0.3386
Epoch 88/400
160/160 [=====] - 0s 243us/step - loss: 0.3256
Epoch 89/400
160/160 [=====] - 0s 249us/step - loss: 0.3096
Epoch 90/400
160/160 [=====] - 0s 243us/step - loss: 0.2960
Epoch 91/400
160/160 [=====] - 0s 237us/step - loss: 0.2816
Epoch 92/400
160/160 [=====] - 0s 243us/step - loss: 0.2677
Epoch 93/400
160/160 [=====] - 0s 243us/step - loss: 0.2544
Epoch 94/400
160/160 [=====] - 0s 246us/step - loss: 0.2414
Epoch 95/400
160/160 [=====] - 0s 243us/step - loss: 0.2276
Epoch 96/400
160/160 [=====] - 0s 243us/step - loss: 0.2142
Epoch 97/400
160/160 [=====] - 0s 246us/step - loss: 0.2024
Epoch 98/400
160/160 [=====] - 0s 268us/step - loss: 0.1885
Epoch 99/400
160/160 [=====] - 0s 268us/step - loss: 0.1794
Epoch 100/400
160/160 [=====] - 0s 274us/step - loss: 0.1671
Epoch 101/400
160/160 [=====] - 0s 256us/step - loss: 0.1567
Epoch 102/400
160/160 [=====] - 0s 249us/step - loss: 0.1481
Epoch 103/400
160/160 [=====] - 0s 237us/step - loss: 0.1393
Epoch 104/400
160/160 [=====] - 0s 237us/step - loss: 0.1317
Epoch 105/400
160/160 [=====] - 0s 249us/step - loss: 0.1206
Epoch 106/400
160/160 [=====] - 0s 243us/step - loss: 0.1192

Epoch 107/400
160/160 [=====] - 0s 249us/step - loss: 0.1107
Epoch 108/400
160/160 [=====] - 0s 231us/step - loss: 0.1081
Epoch 109/400
160/160 [=====] - 0s 234us/step - loss: 0.1029
Epoch 110/400
160/160 [=====] - 0s 237us/step - loss: 0.0958
Epoch 111/400
160/160 [=====] - 0s 237us/step - loss: 0.0963
Epoch 112/400
160/160 [=====] - 0s 246us/step - loss: 0.0903
Epoch 113/400
160/160 [=====] - 0s 237us/step - loss: 0.0855
Epoch 114/400
160/160 [=====] - 0s 240us/step - loss: 0.0827
Epoch 115/400
160/160 [=====] - 0s 237us/step - loss: 0.0785
Epoch 116/400
160/160 [=====] - 0s 231us/step - loss: 0.0748
Epoch 117/400
160/160 [=====] - 0s 234us/step - loss: 0.0808
Epoch 118/400
160/160 [=====] - 0s 243us/step - loss: 0.0714
Epoch 119/400
160/160 [=====] - 0s 237us/step - loss: 0.0688
Epoch 120/400
160/160 [=====] - 0s 231us/step - loss: 0.0673
Epoch 121/400
160/160 [=====] - 0s 237us/step - loss: 0.0632
Epoch 122/400
160/160 [=====] - 0s 237us/step - loss: 0.0631
Epoch 123/400
160/160 [=====] - 0s 243us/step - loss: 0.0641
Epoch 124/400
160/160 [=====] - 0s 249us/step - loss: 0.0637
Epoch 125/400
160/160 [=====] - 0s 231us/step - loss: 0.0577
Epoch 126/400
160/160 [=====] - 0s 243us/step - loss: 0.0644
Epoch 127/400
160/160 [=====] - 0s 237us/step - loss: 0.0572
Epoch 128/400
160/160 [=====] - 0s 237us/step - loss: 0.0656
Epoch 129/400
160/160 [=====] - 0s 237us/step - loss: 0.0562
Epoch 130/400
160/160 [=====] - 0s 231us/step - loss: 0.0555
Epoch 131/400
160/160 [=====] - 0s 231us/step - loss: 0.0526
Epoch 132/400
160/160 [=====] - 0s 231us/step - loss: 0.0522
Epoch 133/400
160/160 [=====] - 0s 231us/step - loss: 0.0577
Epoch 134/400
160/160 [=====] - 0s 237us/step - loss: 0.0547
Epoch 135/400
160/160 [=====] - 0s 243us/step - loss: 0.0508
Epoch 136/400
160/160 [=====] - 0s 237us/step - loss: 0.0515
Epoch 137/400
160/160 [=====] - 0s 237us/step - loss: 0.0521
Epoch 138/400
160/160 [=====] - 0s 237us/step - loss: 0.0554
Epoch 139/400
160/160 [=====] - 0s 237us/step - loss: 0.0457
Epoch 140/400
160/160 [=====] - 0s 237us/step - loss: 0.0440
Epoch 141/400
160/160 [=====] - 0s 246us/step - loss: 0.0482
Epoch 142/400
160/160 [=====] - 0s 243us/step - loss: 0.0549
Epoch 143/400
160/160 [=====] - 0s 237us/step - loss: 0.0449
Epoch 144/400
160/160 [=====] - 0s 237us/step - loss: 0.0522
Epoch 145/400

160/160 [=====] - 0s 237us/step - loss: 0.0499
Epoch 146/400
160/160 [=====] - 0s 237us/step - loss: 0.0489
Epoch 147/400
160/160 [=====] - 0s 237us/step - loss: 0.0425
Epoch 148/400
160/160 [=====] - 0s 256us/step - loss: 0.0395
Epoch 149/400
160/160 [=====] - 0s 249us/step - loss: 0.0430
Epoch 150/400
160/160 [=====] - 0s 262us/step - loss: 0.0412
Epoch 151/400
160/160 [=====] - 0s 237us/step - loss: 0.0396
Epoch 152/400
160/160 [=====] - 0s 249us/step - loss: 0.0419
Epoch 153/400
160/160 [=====] - 0s 237us/step - loss: 0.0368
Epoch 154/400
160/160 [=====] - 0s 228us/step - loss: 0.0417
Epoch 155/400
160/160 [=====] - 0s 237us/step - loss: 0.0328
Epoch 156/400
160/160 [=====] - 0s 240us/step - loss: 0.0424
Epoch 157/400
160/160 [=====] - 0s 237us/step - loss: 0.0396
Epoch 158/400
160/160 [=====] - 0s 237us/step - loss: 0.0491
Epoch 159/400
160/160 [=====] - 0s 240us/step - loss: 0.0377
Epoch 160/400
160/160 [=====] - 0s 237us/step - loss: 0.0344
Epoch 161/400
160/160 [=====] - 0s 231us/step - loss: 0.0312
Epoch 162/400
160/160 [=====] - 0s 231us/step - loss: 0.0397
Epoch 163/400
160/160 [=====] - 0s 237us/step - loss: 0.0356
Epoch 164/400
160/160 [=====] - 0s 237us/step - loss: 0.0292
Epoch 165/400
160/160 [=====] - 0s 237us/step - loss: 0.0389
Epoch 166/400
160/160 [=====] - 0s 243us/step - loss: 0.0301
Epoch 167/400
160/160 [=====] - 0s 237us/step - loss: 0.0258
Epoch 168/400
160/160 [=====] - 0s 243us/step - loss: 0.0329
Epoch 169/400
160/160 [=====] - 0s 231us/step - loss: 0.0276
Epoch 170/400
160/160 [=====] - 0s 237us/step - loss: 0.0331
Epoch 171/400
160/160 [=====] - 0s 249us/step - loss: 0.0468
Epoch 172/400
160/160 [=====] - 0s 243us/step - loss: 0.0324
Epoch 173/400
160/160 [=====] - 0s 243us/step - loss: 0.0414
Epoch 174/400
160/160 [=====] - 0s 274us/step - loss: 0.0282
Epoch 175/400
160/160 [=====] - 0s 262us/step - loss: 0.0229
Epoch 176/400
160/160 [=====] - 0s 256us/step - loss: 0.0269
Epoch 177/400
160/160 [=====] - 0s 243us/step - loss: 0.0239
Epoch 178/400
160/160 [=====] - 0s 237us/step - loss: 0.0223
Epoch 179/400
160/160 [=====] - 0s 243us/step - loss: 0.0233
Epoch 180/400
160/160 [=====] - 0s 237us/step - loss: 0.0247
Epoch 181/400
160/160 [=====] - 0s 249us/step - loss: 0.0432
Epoch 182/400
160/160 [=====] - 0s 243us/step - loss: 0.0374
Epoch 183/400
160/160 [=====] - 0s 262us/step - loss: 0.0423

Epoch 184/400
160/160 [=====] - 0s 249us/step - loss: 0.0200
Epoch 185/400
160/160 [=====] - 0s 243us/step - loss: 0.0217
Epoch 186/400
160/160 [=====] - 0s 256us/step - loss: 0.0203
Epoch 187/400
160/160 [=====] - 0s 237us/step - loss: 0.0197
Epoch 188/400
160/160 [=====] - 0s 237us/step - loss: 0.0295
Epoch 189/400
160/160 [=====] - 0s 256us/step - loss: 0.0311
Epoch 190/400
160/160 [=====] - 0s 249us/step - loss: 0.0191
Epoch 191/400
160/160 [=====] - 0s 237us/step - loss: 0.0193
Epoch 192/400
160/160 [=====] - 0s 237us/step - loss: 0.0186
Epoch 193/400
160/160 [=====] - 0s 231us/step - loss: 0.0176
Epoch 194/400
160/160 [=====] - 0s 231us/step - loss: 0.0197
Epoch 195/400
160/160 [=====] - 0s 237us/step - loss: 0.0175
Epoch 196/400
160/160 [=====] - 0s 243us/step - loss: 0.0176
Epoch 197/400
160/160 [=====] - 0s 240us/step - loss: 0.0175
Epoch 198/400
160/160 [=====] - 0s 237us/step - loss: 0.0177
Epoch 199/400
160/160 [=====] - 0s 243us/step - loss: 0.0165
Epoch 200/400
160/160 [=====] - 0s 256us/step - loss: 0.0165
Epoch 201/400
160/160 [=====] - 0s 249us/step - loss: 0.0169
Epoch 202/400
160/160 [=====] - 0s 237us/step - loss: 0.0170
Epoch 203/400
160/160 [=====] - 0s 243us/step - loss: 0.0164
Epoch 204/400
160/160 [=====] - 0s 243us/step - loss: 0.0182
Epoch 205/400
160/160 [=====] - 0s 243us/step - loss: 0.0192
Epoch 206/400
160/160 [=====] - 0s 243us/step - loss: 0.0195
Epoch 207/400
160/160 [=====] - 0s 243us/step - loss: 0.0177
Epoch 208/400
160/160 [=====] - 0s 237us/step - loss: 0.0171
Epoch 209/400
160/160 [=====] - 0s 243us/step - loss: 0.0258
Epoch 210/400
160/160 [=====] - 0s 237us/step - loss: 0.0368
Epoch 211/400
160/160 [=====] - 0s 237us/step - loss: 0.0342
Epoch 212/400
160/160 [=====] - 0s 237us/step - loss: 0.0171
Epoch 213/400
160/160 [=====] - 0s 243us/step - loss: 0.0143
Epoch 214/400
160/160 [=====] - 0s 237us/step - loss: 0.0140
Epoch 215/400
160/160 [=====] - 0s 243us/step - loss: 0.0137
Epoch 216/400
160/160 [=====] - 0s 231us/step - loss: 0.0142
Epoch 217/400
160/160 [=====] - 0s 243us/step - loss: 0.0135
Epoch 218/400
160/160 [=====] - 0s 237us/step - loss: 0.0133
Epoch 219/400
160/160 [=====] - 0s 243us/step - loss: 0.0133
Epoch 220/400
160/160 [=====] - 0s 237us/step - loss: 0.0131
Epoch 221/400
160/160 [=====] - 0s 246us/step - loss: 0.0132
Epoch 222/400

160/160 [=====] - 0s 231us/step - loss: 0.0125
Epoch 223/400
160/160 [=====] - 0s 240us/step - loss: 0.0127
Epoch 224/400
160/160 [=====] - 0s 243us/step - loss: 0.0122
Epoch 225/400
160/160 [=====] - 0s 249us/step - loss: 0.0125
Epoch 226/400
160/160 [=====] - 0s 246us/step - loss: 0.0121
Epoch 227/400
160/160 [=====] - 0s 237us/step - loss: 0.0116
Epoch 228/400
160/160 [=====] - 0s 246us/step - loss: 0.0120
Epoch 229/400
160/160 [=====] - 0s 237us/step - loss: 0.0114
Epoch 230/400
160/160 [=====] - 0s 237us/step - loss: 0.0120
Epoch 231/400
160/160 [=====] - 0s 240us/step - loss: 0.0117
Epoch 232/400
160/160 [=====] - 0s 237us/step - loss: 0.0114
Epoch 233/400
160/160 [=====] - 0s 237us/step - loss: 0.0115
Epoch 234/400
160/160 [=====] - 0s 234us/step - loss: 0.0113
Epoch 235/400
160/160 [=====] - 0s 231us/step - loss: 0.0111
Epoch 236/400
160/160 [=====] - 0s 249us/step - loss: 0.0112
Epoch 237/400
160/160 [=====] - 0s 231us/step - loss: 0.0108
Epoch 238/400
160/160 [=====] - 0s 237us/step - loss: 0.0110
Epoch 239/400
160/160 [=====] - 0s 231us/step - loss: 0.0109
Epoch 240/400
160/160 [=====] - 0s 237us/step - loss: 0.0108
Epoch 241/400
160/160 [=====] - 0s 231us/step - loss: 0.0105
Epoch 242/400
160/160 [=====] - 0s 240us/step - loss: 0.0104
Epoch 243/400
160/160 [=====] - 0s 237us/step - loss: 0.0105
Epoch 244/400
160/160 [=====] - 0s 234us/step - loss: 0.0103
Epoch 245/400
160/160 [=====] - 0s 231us/step - loss: 0.0103
Epoch 246/400
160/160 [=====] - 0s 231us/step - loss: 0.0100
Epoch 247/400
160/160 [=====] - 0s 240us/step - loss: 0.0100
Epoch 248/400
160/160 [=====] - 0s 231us/step - loss: 0.0100
Epoch 249/400
160/160 [=====] - 0s 231us/step - loss: 0.0098
Epoch 250/400
160/160 [=====] - 0s 237us/step - loss: 0.0098
Epoch 251/400
160/160 [=====] - 0s 243us/step - loss: 0.0097
Epoch 252/400
160/160 [=====] - 0s 249us/step - loss: 0.0097
Epoch 253/400
160/160 [=====] - 0s 243us/step - loss: 0.0095
Epoch 254/400
160/160 [=====] - 0s 237us/step - loss: 0.0095
Epoch 255/400
160/160 [=====] - 0s 237us/step - loss: 0.0093
Epoch 256/400
160/160 [=====] - 0s 237us/step - loss: 0.0092
Epoch 257/400
160/160 [=====] - 0s 237us/step - loss: 0.0093
Epoch 258/400
160/160 [=====] - 0s 237us/step - loss: 0.0091
Epoch 259/400
160/160 [=====] - 0s 249us/step - loss: 0.0090
Epoch 260/400
160/160 [=====] - 0s 249us/step - loss: 0.0090

..., ...
Epoch 261/400
160/160 [=====] - 0s 243us/step - loss: 0.0090
Epoch 262/400
160/160 [=====] - 0s 237us/step - loss: 0.0090
Epoch 263/400
160/160 [=====] - 0s 231us/step - loss: 0.0089
Epoch 264/400
160/160 [=====] - 0s 231us/step - loss: 0.0088
Epoch 265/400
160/160 [=====] - 0s 237us/step - loss: 0.0087
Epoch 266/400
160/160 [=====] - 0s 231us/step - loss: 0.0086
Epoch 267/400
160/160 [=====] - 0s 243us/step - loss: 0.0087
Epoch 268/400
160/160 [=====] - 0s 243us/step - loss: 0.0085
Epoch 269/400
160/160 [=====] - 0s 249us/step - loss: 0.0084
Epoch 270/400
160/160 [=====] - 0s 240us/step - loss: 0.0085
Epoch 271/400
160/160 [=====] - 0s 249us/step - loss: 0.0083
Epoch 272/400
160/160 [=====] - 0s 243us/step - loss: 0.0083
Epoch 273/400
160/160 [=====] - 0s 249us/step - loss: 0.0082
Epoch 274/400
160/160 [=====] - 0s 237us/step - loss: 0.0083
Epoch 275/400
160/160 [=====] - 0s 237us/step - loss: 0.0082
Epoch 276/400
160/160 [=====] - 0s 249us/step - loss: 0.0081
Epoch 277/400
160/160 [=====] - 0s 274us/step - loss: 0.0080
Epoch 278/400
160/160 [=====] - 0s 262us/step - loss: 0.0080
Epoch 279/400
160/160 [=====] - 0s 237us/step - loss: 0.0079
Epoch 280/400
160/160 [=====] - 0s 237us/step - loss: 0.0078
Epoch 281/400
160/160 [=====] - 0s 237us/step - loss: 0.0079
Epoch 282/400
160/160 [=====] - 0s 243us/step - loss: 0.0078
Epoch 283/400
160/160 [=====] - 0s 234us/step - loss: 0.0077
Epoch 284/400
160/160 [=====] - 0s 237us/step - loss: 0.0076
Epoch 285/400
160/160 [=====] - 0s 240us/step - loss: 0.0076
Epoch 286/400
160/160 [=====] - 0s 237us/step - loss: 0.0076
Epoch 287/400
160/160 [=====] - 0s 256us/step - loss: 0.0075
Epoch 288/400
160/160 [=====] - 0s 246us/step - loss: 0.0075
Epoch 289/400
160/160 [=====] - 0s 243us/step - loss: 0.0074
Epoch 290/400
160/160 [=====] - 0s 246us/step - loss: 0.0074
Epoch 291/400
160/160 [=====] - 0s 256us/step - loss: 0.0073
Epoch 292/400
160/160 [=====] - 0s 237us/step - loss: 0.0073
Epoch 293/400
160/160 [=====] - 0s 240us/step - loss: 0.0073
Epoch 294/400
160/160 [=====] - 0s 243us/step - loss: 0.0072
Epoch 295/400
160/160 [=====] - 0s 231us/step - loss: 0.0071
Epoch 296/400
160/160 [=====] - 0s 243us/step - loss: 0.0071
Epoch 297/400
160/160 [=====] - 0s 243us/step - loss: 0.0070
Epoch 298/400
160/160 [=====] - 0s 237us/step - loss: 0.0071
Epoch 299/400

Epoch 299/400
160/160 [=====] - 0s 237us/step - loss: 0.0070
Epoch 300/400
160/160 [=====] - 0s 237us/step - loss: 0.0069
Epoch 301/400
160/160 [=====] - 0s 249us/step - loss: 0.0069
Epoch 302/400
160/160 [=====] - 0s 243us/step - loss: 0.0069
Epoch 303/400
160/160 [=====] - 0s 252us/step - loss: 0.0069
Epoch 304/400
160/160 [=====] - 0s 243us/step - loss: 0.0068
Epoch 305/400
160/160 [=====] - 0s 243us/step - loss: 0.0068
Epoch 306/400
160/160 [=====] - 0s 237us/step - loss: 0.0067
Epoch 307/400
160/160 [=====] - 0s 243us/step - loss: 0.0067
Epoch 308/400
160/160 [=====] - 0s 243us/step - loss: 0.0067
Epoch 309/400
160/160 [=====] - 0s 237us/step - loss: 0.0066
Epoch 310/400
160/160 [=====] - 0s 237us/step - loss: 0.0066
Epoch 311/400
160/160 [=====] - 0s 243us/step - loss: 0.0065
Epoch 312/400
160/160 [=====] - 0s 243us/step - loss: 0.0065
Epoch 313/400
160/160 [=====] - 0s 237us/step - loss: 0.0064
Epoch 314/400
160/160 [=====] - 0s 237us/step - loss: 0.0065
Epoch 315/400
160/160 [=====] - 0s 237us/step - loss: 0.0064
Epoch 316/400
160/160 [=====] - 0s 231us/step - loss: 0.0064
Epoch 317/400
160/160 [=====] - 0s 237us/step - loss: 0.0063
Epoch 318/400
160/160 [=====] - 0s 243us/step - loss: 0.0063
Epoch 319/400
160/160 [=====] - 0s 234us/step - loss: 0.0063
Epoch 320/400
160/160 [=====] - 0s 231us/step - loss: 0.0062
Epoch 321/400
160/160 [=====] - 0s 231us/step - loss: 0.0062
Epoch 322/400
160/160 [=====] - 0s 243us/step - loss: 0.0062
Epoch 323/400
160/160 [=====] - 0s 243us/step - loss: 0.0061
Epoch 324/400
160/160 [=====] - 0s 249us/step - loss: 0.0061
Epoch 325/400
160/160 [=====] - 0s 237us/step - loss: 0.0061
Epoch 326/400
160/160 [=====] - 0s 231us/step - loss: 0.0060
Epoch 327/400
160/160 [=====] - 0s 243us/step - loss: 0.0060
Epoch 328/400
160/160 [=====] - 0s 249us/step - loss: 0.0060
Epoch 329/400
160/160 [=====] - 0s 249us/step - loss: 0.0060
Epoch 330/400
160/160 [=====] - 0s 243us/step - loss: 0.0059
Epoch 331/400
160/160 [=====] - 0s 256us/step - loss: 0.0059
Epoch 332/400
160/160 [=====] - 0s 231us/step - loss: 0.0059
Epoch 333/400
160/160 [=====] - 0s 268us/step - loss: 0.0058
Epoch 334/400
160/160 [=====] - 0s 259us/step - loss: 0.0058
Epoch 335/400
160/160 [=====] - 0s 231us/step - loss: 0.0058
Epoch 336/400
160/160 [=====] - 0s 231us/step - loss: 0.0058
Epoch 337/400
160/160 [=====] - 0s 246us/step - loss: 0.0057

100/100 [=====] - 0s 240us/step - loss: 0.0051
Epoch 338/400
160/160 [=====] - 0s 231us/step - loss: 0.0057
Epoch 339/400
160/160 [=====] - 0s 237us/step - loss: 0.0057
Epoch 340/400
160/160 [=====] - 0s 237us/step - loss: 0.0056
Epoch 341/400
160/160 [=====] - 0s 237us/step - loss: 0.0056
Epoch 342/400
160/160 [=====] - 0s 237us/step - loss: 0.0056
Epoch 343/400
160/160 [=====] - 0s 231us/step - loss: 0.0056
Epoch 344/400
160/160 [=====] - 0s 231us/step - loss: 0.0055
Epoch 345/400
160/160 [=====] - 0s 231us/step - loss: 0.0055
Epoch 346/400
160/160 [=====] - 0s 237us/step - loss: 0.0055
Epoch 347/400
160/160 [=====] - 0s 243us/step - loss: 0.0055
Epoch 348/400
160/160 [=====] - 0s 237us/step - loss: 0.0054
Epoch 349/400
160/160 [=====] - 0s 231us/step - loss: 0.0054
Epoch 350/400
160/160 [=====] - 0s 231us/step - loss: 0.0054
Epoch 351/400
160/160 [=====] - 0s 237us/step - loss: 0.0054
Epoch 352/400
160/160 [=====] - 0s 231us/step - loss: 0.0053
Epoch 353/400
160/160 [=====] - 0s 237us/step - loss: 0.0053
Epoch 354/400
160/160 [=====] - 0s 243us/step - loss: 0.0053
Epoch 355/400
160/160 [=====] - 0s 243us/step - loss: 0.0053
Epoch 356/400
160/160 [=====] - 0s 249us/step - loss: 0.0053
Epoch 357/400
160/160 [=====] - 0s 237us/step - loss: 0.0052
Epoch 358/400
160/160 [=====] - 0s 237us/step - loss: 0.0052
Epoch 359/400
160/160 [=====] - 0s 231us/step - loss: 0.0052
Epoch 360/400
160/160 [=====] - 0s 237us/step - loss: 0.0052
Epoch 361/400
160/160 [=====] - 0s 231us/step - loss: 0.0051
Epoch 362/400
160/160 [=====] - 0s 237us/step - loss: 0.0051
Epoch 363/400
160/160 [=====] - 0s 237us/step - loss: 0.0051
Epoch 364/400
160/160 [=====] - 0s 231us/step - loss: 0.0051
Epoch 365/400
160/160 [=====] - 0s 231us/step - loss: 0.0051
Epoch 366/400
160/160 [=====] - 0s 237us/step - loss: 0.0050
Epoch 367/400
160/160 [=====] - 0s 237us/step - loss: 0.0050
Epoch 368/400
160/160 [=====] - 0s 237us/step - loss: 0.0050
Epoch 369/400
160/160 [=====] - 0s 237us/step - loss: 0.0050
Epoch 370/400
160/160 [=====] - 0s 237us/step - loss: 0.0049
Epoch 371/400
160/160 [=====] - 0s 240us/step - loss: 0.0049
Epoch 372/400
160/160 [=====] - 0s 237us/step - loss: 0.0049
Epoch 373/400
160/160 [=====] - 0s 240us/step - loss: 0.0049
Epoch 374/400
160/160 [=====] - 0s 237us/step - loss: 0.0049
Epoch 375/400
160/160 [=====] - 0s 237us/step - loss: 0.0049
Epoch 376/400

Epoch 376/400
160/160 [=====] - 0s 234us/step - loss: 0.0048
Epoch 377/400
160/160 [=====] - 0s 243us/step - loss: 0.0048
Epoch 378/400
160/160 [=====] - 0s 237us/step - loss: 0.0048
Epoch 379/400
160/160 [=====] - 0s 231us/step - loss: 0.0048
Epoch 380/400
160/160 [=====] - 0s 256us/step - loss: 0.0048
Epoch 381/400
160/160 [=====] - 0s 243us/step - loss: 0.0047
Epoch 382/400
160/160 [=====] - 0s 243us/step - loss: 0.0047
Epoch 383/400
160/160 [=====] - 0s 231us/step - loss: 0.0047
Epoch 384/400
160/160 [=====] - 0s 237us/step - loss: 0.0047
Epoch 385/400
160/160 [=====] - 0s 237us/step - loss: 0.0047
Epoch 386/400
160/160 [=====] - 0s 237us/step - loss: 0.0046
Epoch 387/400
160/160 [=====] - 0s 237us/step - loss: 0.0046
Epoch 388/400
160/160 [=====] - 0s 237us/step - loss: 0.0046
Epoch 389/400
160/160 [=====] - 0s 237us/step - loss: 0.0046
Epoch 390/400
160/160 [=====] - 0s 237us/step - loss: 0.0046
Epoch 391/400
160/160 [=====] - 0s 237us/step - loss: 0.0046
Epoch 392/400
160/160 [=====] - 0s 237us/step - loss: 0.0045
Epoch 393/400
160/160 [=====] - 0s 237us/step - loss: 0.0045
Epoch 394/400
160/160 [=====] - 0s 237us/step - loss: 0.0045
Epoch 395/400
160/160 [=====] - 0s 243us/step - loss: 0.0045
Epoch 396/400
160/160 [=====] - 0s 237us/step - loss: 0.0045
Epoch 397/400
160/160 [=====] - 0s 243us/step - loss: 0.0045
Epoch 398/400
160/160 [=====] - 0s 237us/step - loss: 0.0044
Epoch 399/400
160/160 [=====] - 0s 237us/step - loss: 0.0044
Epoch 400/400
160/160 [=====] - 0s 240us/step - loss: 0.0044
[9.9686819e-01 9.9687839e-01 9.9688762e-01 9.7823358e-01 9.9687445e-01
9.9689060e-01 9.9613935e-01 9.9657023e-01 9.8968267e-01 9.9537718e-01
9.9686819e-01 9.9026221e-01 9.9390173e-01 9.9685597e-01 9.9686772e-01
9.9637419e-01 9.9642134e-01 9.9682343e-01 9.9684441e-01 9.9683565e-01
9.9687153e-01 9.9687505e-01 9.9687362e-01 9.9674988e-01 9.9685979e-01
9.9688405e-01 9.9684095e-01 9.9685585e-01 9.9686372e-01 9.9688476e-01
9.9685681e-01 9.9687022e-01 9.9688834e-01 9.9653637e-01 9.9688607e-01
9.9685752e-01 9.9687362e-01 9.9686891e-01 9.9687201e-01 9.9686474e-01
9.9689829e-01 9.9690312e-01 9.9689436e-01 9.7540092e-01 9.9690163e-01
9.9690384e-01 9.9631977e-01 9.9662328e-01 9.9158984e-01 9.9566132e-01
9.9689877e-01 9.8929787e-01 9.9460924e-01 9.9689096e-01 9.9689829e-01
9.9651033e-01 9.9651080e-01 9.9686736e-01 9.9688321e-01 9.9687624e-01
9.9690032e-01 9.9690187e-01 9.9690115e-01 9.9680591e-01 9.9689353e-01
9.9688941e-01 9.9688065e-01 9.9689108e-01 9.9689108e-01 9.9690527e-01
9.9689180e-01 9.9689937e-01 9.9690503e-01 9.9662519e-01 9.9690539e-01
9.9689215e-01 9.9690080e-01 9.9689889e-01 9.9690056e-01 9.9689674e-01
6.7938757e-03 6.8034767e-03 6.8920231e-03 2.6335366e-02 6.7915982e-03
6.8464908e-03 7.1796072e-03 7.4297269e-03 1.5423900e-02 7.4504986e-03
6.7827706e-03 1.8955193e-02 9.5793707e-03 6.7979502e-03 6.7871413e-03
7.1290792e-03 7.2597596e-03 6.8257870e-03 6.8071382e-03 6.8184696e-03
6.7885751e-03 6.7916233e-03 6.7930580e-03 6.9084098e-03 6.7918710e-03
6.9297659e-03 6.8096342e-03 6.7962958e-03 6.8994067e-03 6.8083862e-03
6.7955488e-03 6.7940047e-03 6.8943766e-03 7.0504700e-03 6.8185404e-03
6.7940559e-03 6.8019694e-03 6.7878487e-03 6.7868391e-03 6.7865048e-03
4.1761942e-04 4.2079639e-04 4.4972191e-04 1.3859632e-02 4.1690381e-04
4.3486131e-04 5.4396380e-04 6.2785106e-04 5.2296626e-03 6.3636468e-04
4.1397996e-04 7.7345828e-03 1.5348918e-03 4.1889332e-04 4.1541498e-04
5.2702612e-01 5.7032626e-01 4.2702622e-01 4.2101010e-01 4.2510020e-01

```
5.2702015e-04 5.1020098e-04 4.270502e-04 4.2101049e-04 4.2049920e-04  
4.1590072e-04 4.1691575e-04 4.1737783e-04 4.5450605e-04 4.1691773e-04  
4.6203309e-04 4.2263756e-04 4.1833342e-04 4.5183432e-04 4.2243136e-04  
4.1809221e-04 4.1766721e-04 4.5034522e-04 5.0074712e-04 4.2573825e-04  
4.1762018e-04 4.2028207e-04 4.1565063e-04 4.1533579e-04 4.1518456e-04]  
160/160 [=====] - 0s 231us/step
```

In [13]:

```
#four layers, two neurons per layer: loss  
scores_lay_four_two, model_lay_four_two.metrics_names
```

Out[13]:

```
(0.004339942126534879, ['loss'])
```

Five Layers

In [14]:

```
n = 40  
xx = np.random.random((n,1))  
yy = np.random.random((n,1))  
  
X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T  
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [15]:

```
#five layers, two neurons per layer  
model_lay_five_two = Sequential()  
  
#hidden layers  
model_lay_five_two.add(Dense(2, input_dim=2, activation='tanh'))  
model_lay_five_two.add(Dense(2, activation='tanh'))  
model_lay_five_two.add(Dense(2, activation='tanh'))  
model_lay_five_two.add(Dense(2, activation='tanh'))  
model_lay_five_two.add(Dense(2, activation='tanh'))  
  
#output layer  
model_lay_five_two.add(Dense(1, activation='sigmoid'))  
  
sgd = SGD(lr=0.1)  
model_lay_five_two.compile(loss='binary_crossentropy', optimizer='sgd')  
  
model_lay_five_two.fit(X, y, batch_size=2, epochs=400)  
print(model_lay_five_two.predict_proba(X).reshape(4*n))  
  
#evaluate the model  
scores_lay_five_two = model_lay_five_two.evaluate(X, y)
```

```
Epoch 1/400  
160/160 [=====] - 0s 1ms/step - loss: 0.7071  
Epoch 2/400  
160/160 [=====] - 0s 252us/step - loss: 0.7039  
Epoch 3/400  
160/160 [=====] - 0s 249us/step - loss: 0.7008  
Epoch 4/400  
160/160 [=====] - 0s 246us/step - loss: 0.7005  
Epoch 5/400  
160/160 [=====] - 0s 249us/step - loss: 0.6998  
Epoch 6/400  
160/160 [=====] - 0s 249us/step - loss: 0.6977  
Epoch 7/400  
160/160 [=====] - 0s 256us/step - loss: 0.6993  
Epoch 8/400  
160/160 [=====] - 0s 256us/step - loss: 0.6981  
Epoch 9/400  
160/160 [=====] - 0s 262us/step - loss: 0.6994  
Epoch 10/400  
160/160 [=====] - 0s 274us/step - loss: 0.6986  
Epoch 11/400  
160/160 [=====] - 0s 290us/step - loss: 0.6959  
Epoch 12/400  
160/160 [=====] - 0s 293us/step - loss: 0.6984  
Epoch 13/400  
160/160 [=====] - 0s 268us/step - loss: 0.6990  
Epoch 14/400
```

Epoch 14/400
160/160 [=====] - 0s 252us/step - loss: 0.6962
Epoch 15/400
160/160 [=====] - 0s 262us/step - loss: 0.6960
Epoch 16/400
160/160 [=====] - 0s 262us/step - loss: 0.6963
Epoch 17/400
160/160 [=====] - 0s 287us/step - loss: 0.6971
Epoch 18/400
160/160 [=====] - 0s 287us/step - loss: 0.6981
Epoch 19/400
160/160 [=====] - 0s 268us/step - loss: 0.6969
Epoch 20/400
160/160 [=====] - 0s 274us/step - loss: 0.6991
Epoch 21/400
160/160 [=====] - 0s 281us/step - loss: 0.6986
Epoch 22/400
160/160 [=====] - 0s 293us/step - loss: 0.6969
Epoch 23/400
160/160 [=====] - 0s 274us/step - loss: 0.6981
Epoch 24/400
160/160 [=====] - 0s 256us/step - loss: 0.6975
Epoch 25/400
160/160 [=====] - 0s 249us/step - loss: 0.6977
Epoch 26/400
160/160 [=====] - 0s 249us/step - loss: 0.6962
Epoch 27/400
160/160 [=====] - 0s 256us/step - loss: 0.6974
Epoch 28/400
160/160 [=====] - 0s 252us/step - loss: 0.6946
Epoch 29/400
160/160 [=====] - 0s 256us/step - loss: 0.6973
Epoch 30/400
160/160 [=====] - 0s 256us/step - loss: 0.6953
Epoch 31/400
160/160 [=====] - 0s 256us/step - loss: 0.6959
Epoch 32/400
160/160 [=====] - 0s 280us/step - loss: 0.6945
Epoch 33/400
160/160 [=====] - 0s 249us/step - loss: 0.6927
Epoch 34/400
160/160 [=====] - 0s 268us/step - loss: 0.6943
Epoch 35/400
160/160 [=====] - 0s 274us/step - loss: 0.6893
Epoch 36/400
160/160 [=====] - 0s 268us/step - loss: 0.6916
Epoch 37/400
160/160 [=====] - 0s 268us/step - loss: 0.6903
Epoch 38/400
160/160 [=====] - 0s 293us/step - loss: 0.6881
Epoch 39/400
160/160 [=====] - 0s 284us/step - loss: 0.6861
Epoch 40/400
160/160 [=====] - 0s 268us/step - loss: 0.6857
Epoch 41/400
160/160 [=====] - 0s 296us/step - loss: 0.6820
Epoch 42/400
160/160 [=====] - 0s 262us/step - loss: 0.6783
Epoch 43/400
160/160 [=====] - 0s 256us/step - loss: 0.6761
Epoch 44/400
160/160 [=====] - 0s 252us/step - loss: 0.6712
Epoch 45/400
160/160 [=====] - 0s 262us/step - loss: 0.6666
Epoch 46/400
160/160 [=====] - 0s 271us/step - loss: 0.6621
Epoch 47/400
160/160 [=====] - 0s 256us/step - loss: 0.6579
Epoch 48/400
160/160 [=====] - 0s 268us/step - loss: 0.6509
Epoch 49/400
160/160 [=====] - 0s 246us/step - loss: 0.6459
Epoch 50/400
160/160 [=====] - 0s 243us/step - loss: 0.6384
Epoch 51/400
160/160 [=====] - 0s 243us/step - loss: 0.6315
Epoch 52/400

160/160 [=====] - 0s 240us/step - loss: 0.6245

160/160 [=====] - 0s 249us/step - loss: 0.6240
Epoch 53/400
160/160 [=====] - 0s 249us/step - loss: 0.6184
Epoch 54/400
160/160 [=====] - 0s 249us/step - loss: 0.6134
Epoch 55/400
160/160 [=====] - 0s 256us/step - loss: 0.6075
Epoch 56/400
160/160 [=====] - 0s 268us/step - loss: 0.6022
Epoch 57/400
160/160 [=====] - 0s 256us/step - loss: 0.5980
Epoch 58/400
160/160 [=====] - 0s 259us/step - loss: 0.5925
Epoch 59/400
160/160 [=====] - 0s 256us/step - loss: 0.5880
Epoch 60/400
160/160 [=====] - 0s 249us/step - loss: 0.5858
Epoch 61/400
160/160 [=====] - 0s 262us/step - loss: 0.5825
Epoch 62/400
160/160 [=====] - 0s 249us/step - loss: 0.5795
Epoch 63/400
160/160 [=====] - 0s 243us/step - loss: 0.5769
Epoch 64/400
160/160 [=====] - 0s 256us/step - loss: 0.5740
Epoch 65/400
160/160 [=====] - 0s 262us/step - loss: 0.5702
Epoch 66/400
160/160 [=====] - 0s 249us/step - loss: 0.5675
Epoch 67/400
160/160 [=====] - 0s 243us/step - loss: 0.5687
Epoch 68/400
160/160 [=====] - 0s 249us/step - loss: 0.5649
Epoch 69/400
160/160 [=====] - 0s 256us/step - loss: 0.5625
Epoch 70/400
160/160 [=====] - 0s 243us/step - loss: 0.5593
Epoch 71/400
160/160 [=====] - 0s 243us/step - loss: 0.5582
Epoch 72/400
160/160 [=====] - 0s 249us/step - loss: 0.5558
Epoch 73/400
160/160 [=====] - 0s 252us/step - loss: 0.5547
Epoch 74/400
160/160 [=====] - 0s 268us/step - loss: 0.5520
Epoch 75/400
160/160 [=====] - 0s 249us/step - loss: 0.5488
Epoch 76/400
160/160 [=====] - 0s 256us/step - loss: 0.5470
Epoch 77/400
160/160 [=====] - 0s 249us/step - loss: 0.5448
Epoch 78/400
160/160 [=====] - 0s 268us/step - loss: 0.5394
Epoch 79/400
160/160 [=====] - 0s 274us/step - loss: 0.5413
Epoch 80/400
160/160 [=====] - 0s 262us/step - loss: 0.5349
Epoch 81/400
160/160 [=====] - 0s 268us/step - loss: 0.5307
Epoch 82/400
160/160 [=====] - 0s 256us/step - loss: 0.5317
Epoch 83/400
160/160 [=====] - 0s 249us/step - loss: 0.5261
Epoch 84/400
160/160 [=====] - 0s 249us/step - loss: 0.5171
Epoch 85/400
160/160 [=====] - 0s 246us/step - loss: 0.5178
Epoch 86/400
160/160 [=====] - 0s 249us/step - loss: 0.5173
Epoch 87/400
160/160 [=====] - 0s 256us/step - loss: 0.5123
Epoch 88/400
160/160 [=====] - 0s 259us/step - loss: 0.5071
Epoch 89/400
160/160 [=====] - 0s 262us/step - loss: 0.5009
Epoch 90/400
160/160 [=====] - 0s 287us/step - loss: 0.4926

Epoch 91/400
160/160 [=====] - 0s 280us/step - loss: 0.4829
Epoch 92/400
160/160 [=====] - 0s 274us/step - loss: 0.4707
Epoch 93/400
160/160 [=====] - 0s 249us/step - loss: 0.4683
Epoch 94/400
160/160 [=====] - 0s 243us/step - loss: 0.4581
Epoch 95/400
160/160 [=====] - 0s 249us/step - loss: 0.4405
Epoch 96/400
160/160 [=====] - 0s 243us/step - loss: 0.4299
Epoch 97/400
160/160 [=====] - 0s 249us/step - loss: 0.4179
Epoch 98/400
160/160 [=====] - 0s 243us/step - loss: 0.4019
Epoch 99/400
160/160 [=====] - 0s 249us/step - loss: 0.3886
Epoch 100/400
160/160 [=====] - 0s 256us/step - loss: 0.3635
Epoch 101/400
160/160 [=====] - 0s 249us/step - loss: 0.3536
Epoch 102/400
160/160 [=====] - 0s 249us/step - loss: 0.3362
Epoch 103/400
160/160 [=====] - 0s 249us/step - loss: 0.3238
Epoch 104/400
160/160 [=====] - 0s 243us/step - loss: 0.3109
Epoch 105/400
160/160 [=====] - 0s 249us/step - loss: 0.2991
Epoch 106/400
160/160 [=====] - 0s 249us/step - loss: 0.2844
Epoch 107/400
160/160 [=====] - 0s 243us/step - loss: 0.2636
Epoch 108/400
160/160 [=====] - 0s 249us/step - loss: 0.2699
Epoch 109/400
160/160 [=====] - 0s 249us/step - loss: 0.2626
Epoch 110/400
160/160 [=====] - 0s 246us/step - loss: 0.2441
Epoch 111/400
160/160 [=====] - 0s 249us/step - loss: 0.2314
Epoch 112/400
160/160 [=====] - 0s 243us/step - loss: 0.2169
Epoch 113/400
160/160 [=====] - 0s 256us/step - loss: 0.2326
Epoch 114/400
160/160 [=====] - 0s 259us/step - loss: 0.2055
Epoch 115/400
160/160 [=====] - 0s 249us/step - loss: 0.2143
Epoch 116/400
160/160 [=====] - 0s 249us/step - loss: 0.2038
Epoch 117/400
160/160 [=====] - 0s 256us/step - loss: 0.1948
Epoch 118/400
160/160 [=====] - 0s 243us/step - loss: 0.2174
Epoch 119/400
160/160 [=====] - 0s 243us/step - loss: 0.2013
Epoch 120/400
160/160 [=====] - 0s 243us/step - loss: 0.2063
Epoch 121/400
160/160 [=====] - 0s 249us/step - loss: 0.1845
Epoch 122/400
160/160 [=====] - 0s 256us/step - loss: 0.1811
Epoch 123/400
160/160 [=====] - 0s 256us/step - loss: 0.1904
Epoch 124/400
160/160 [=====] - 0s 249us/step - loss: 0.1888
Epoch 125/400
160/160 [=====] - 0s 240us/step - loss: 0.1782
Epoch 126/400
160/160 [=====] - 0s 249us/step - loss: 0.2063
Epoch 127/400
160/160 [=====] - 0s 249us/step - loss: 0.1860
Epoch 128/400
160/160 [=====] - 0s 246us/step - loss: 0.1962
Epoch 129/400

160/160 [=====] - 0s 249us/step - loss: 0.1442
Epoch 130/400
160/160 [=====] - 0s 252us/step - loss: 0.1840
Epoch 131/400
160/160 [=====] - 0s 249us/step - loss: 0.1720
Epoch 132/400
160/160 [=====] - 0s 246us/step - loss: 0.1855
Epoch 133/400
160/160 [=====] - 0s 249us/step - loss: 0.1933
Epoch 134/400
160/160 [=====] - 0s 249us/step - loss: 0.1533
Epoch 135/400
160/160 [=====] - 0s 256us/step - loss: 0.2015
Epoch 136/400
160/160 [=====] - 0s 249us/step - loss: 0.1644
Epoch 137/400
160/160 [=====] - 0s 249us/step - loss: 0.1703
Epoch 138/400
160/160 [=====] - 0s 280us/step - loss: 0.1706
Epoch 139/400
160/160 [=====] - 0s 268us/step - loss: 0.1919
Epoch 140/400
160/160 [=====] - 0s 243us/step - loss: 0.1663
Epoch 141/400
160/160 [=====] - 0s 243us/step - loss: 0.1729
Epoch 142/400
160/160 [=====] - 0s 243us/step - loss: 0.1633
Epoch 143/400
160/160 [=====] - 0s 256us/step - loss: 0.1656
Epoch 144/400
160/160 [=====] - 0s 256us/step - loss: 0.1924
Epoch 145/400
160/160 [=====] - 0s 243us/step - loss: 0.1543
Epoch 146/400
160/160 [=====] - 0s 249us/step - loss: 0.1490
Epoch 147/400
160/160 [=====] - 0s 249us/step - loss: 0.1677
Epoch 148/400
160/160 [=====] - 0s 249us/step - loss: 0.1850
Epoch 149/400
160/160 [=====] - 0s 243us/step - loss: 0.1603
Epoch 150/400
160/160 [=====] - 0s 243us/step - loss: 0.1371
Epoch 151/400
160/160 [=====] - 0s 256us/step - loss: 0.1291
Epoch 152/400
160/160 [=====] - 0s 249us/step - loss: 0.1502
Epoch 153/400
160/160 [=====] - 0s 256us/step - loss: 0.1862
Epoch 154/400
160/160 [=====] - 0s 256us/step - loss: 0.1623
Epoch 155/400
160/160 [=====] - 0s 256us/step - loss: 0.1670
Epoch 156/400
160/160 [=====] - 0s 256us/step - loss: 0.1534
Epoch 157/400
160/160 [=====] - 0s 249us/step - loss: 0.1426
Epoch 158/400
160/160 [=====] - 0s 249us/step - loss: 0.1597
Epoch 159/400
160/160 [=====] - 0s 249us/step - loss: 0.1513
Epoch 160/400
160/160 [=====] - 0s 256us/step - loss: 0.1612
Epoch 161/400
160/160 [=====] - 0s 249us/step - loss: 0.1492
Epoch 162/400
160/160 [=====] - 0s 256us/step - loss: 0.1680
Epoch 163/400
160/160 [=====] - 0s 256us/step - loss: 0.1362
Epoch 164/400
160/160 [=====] - 0s 268us/step - loss: 0.1765
Epoch 165/400
160/160 [=====] - 0s 274us/step - loss: 0.1849
Epoch 166/400
160/160 [=====] - 0s 277us/step - loss: 0.1482
Epoch 167/400
160/160 [=====] - 0s 243us/step - loss: 0.1252

Epoch 168/400
160/160 [=====] - 0s 249us/step - loss: 0.1149
Epoch 169/400
160/160 [=====] - 0s 252us/step - loss: 0.1443
Epoch 170/400
160/160 [=====] - 0s 249us/step - loss: 0.1558
Epoch 171/400
160/160 [=====] - 0s 249us/step - loss: 0.1556
Epoch 172/400
160/160 [=====] - 0s 256us/step - loss: 0.1440
Epoch 173/400
160/160 [=====] - 0s 237us/step - loss: 0.1559
Epoch 174/400
160/160 [=====] - 0s 256us/step - loss: 0.1463
Epoch 175/400
160/160 [=====] - 0s 249us/step - loss: 0.1670
Epoch 176/400
160/160 [=====] - 0s 249us/step - loss: 0.1228
Epoch 177/400
160/160 [=====] - 0s 249us/step - loss: 0.1383
Epoch 178/400
160/160 [=====] - 0s 243us/step - loss: 0.1384
Epoch 179/400
160/160 [=====] - 0s 243us/step - loss: 0.1371
Epoch 180/400
160/160 [=====] - 0s 262us/step - loss: 0.1541
Epoch 181/400
160/160 [=====] - 0s 256us/step - loss: 0.1426
Epoch 182/400
160/160 [=====] - 0s 274us/step - loss: 0.1931
Epoch 183/400
160/160 [=====] - 0s 280us/step - loss: 0.1271
Epoch 184/400
160/160 [=====] - 0s 274us/step - loss: 0.1410
Epoch 185/400
160/160 [=====] - 0s 305us/step - loss: 0.1228
Epoch 186/400
160/160 [=====] - 0s 293us/step - loss: 0.1477
Epoch 187/400
160/160 [=====] - 0s 299us/step - loss: 0.1514
Epoch 188/400
160/160 [=====] - 0s 287us/step - loss: 0.1234
Epoch 189/400
160/160 [=====] - 0s 277us/step - loss: 0.1284
Epoch 190/400
160/160 [=====] - 0s 274us/step - loss: 0.1286
Epoch 191/400
160/160 [=====] - 0s 256us/step - loss: 0.1212
Epoch 192/400
160/160 [=====] - 0s 268us/step - loss: 0.1240
Epoch 193/400
160/160 [=====] - 0s 271us/step - loss: 0.1494
Epoch 194/400
160/160 [=====] - 0s 256us/step - loss: 0.1519
Epoch 195/400
160/160 [=====] - 0s 280us/step - loss: 0.1215
Epoch 196/400
160/160 [=====] - 0s 274us/step - loss: 0.1393
Epoch 197/400
160/160 [=====] - 0s 280us/step - loss: 0.1197
Epoch 198/400
160/160 [=====] - 0s 330us/step - loss: 0.1262
Epoch 199/400
160/160 [=====] - 0s 262us/step - loss: 0.1331
Epoch 200/400
160/160 [=====] - 0s 268us/step - loss: 0.1441
Epoch 201/400
160/160 [=====] - 0s 268us/step - loss: 0.1477
Epoch 202/400
160/160 [=====] - 0s 265us/step - loss: 0.1531
Epoch 203/400
160/160 [=====] - 0s 256us/step - loss: 0.1111
Epoch 204/400
160/160 [=====] - 0s 268us/step - loss: 0.1374
Epoch 205/400
160/160 [=====] - 0s 252us/step - loss: 0.1325
Epoch 206/400

160/160 [=====] - 0s 256us/step - loss: 0.1457
Epoch 207/400
160/160 [=====] - 0s 252us/step - loss: 0.1240
Epoch 208/400
160/160 [=====] - 0s 243us/step - loss: 0.1407
Epoch 209/400
160/160 [=====] - 0s 262us/step - loss: 0.1490
Epoch 210/400
160/160 [=====] - 0s 271us/step - loss: 0.1490
Epoch 211/400
160/160 [=====] - 0s 262us/step - loss: 0.1310
Epoch 212/400
160/160 [=====] - 0s 249us/step - loss: 0.1436
Epoch 213/400
160/160 [=====] - 0s 256us/step - loss: 0.1261
Epoch 214/400
160/160 [=====] - 0s 249us/step - loss: 0.1229
Epoch 215/400
160/160 [=====] - 0s 249us/step - loss: 0.1331
Epoch 216/400
160/160 [=====] - 0s 256us/step - loss: 0.1403
Epoch 217/400
160/160 [=====] - 0s 256us/step - loss: 0.1216
Epoch 218/400
160/160 [=====] - 0s 262us/step - loss: 0.1311
Epoch 219/400
160/160 [=====] - 0s 268us/step - loss: 0.1445
Epoch 220/400
160/160 [=====] - 0s 256us/step - loss: 0.1266
Epoch 221/400
160/160 [=====] - 0s 256us/step - loss: 0.1272
Epoch 222/400
160/160 [=====] - 0s 256us/step - loss: 0.1271
Epoch 223/400
160/160 [=====] - 0s 262us/step - loss: 0.1089
Epoch 224/400
160/160 [=====] - 0s 262us/step - loss: 0.1374
Epoch 225/400
160/160 [=====] - 0s 256us/step - loss: 0.1141
Epoch 226/400
160/160 [=====] - 0s 256us/step - loss: 0.1409
Epoch 227/400
160/160 [=====] - 0s 256us/step - loss: 0.1364
Epoch 228/400
160/160 [=====] - 0s 262us/step - loss: 0.1411
Epoch 229/400
160/160 [=====] - 0s 268us/step - loss: 0.1379
Epoch 230/400
160/160 [=====] - 0s 256us/step - loss: 0.1324
Epoch 231/400
160/160 [=====] - 0s 252us/step - loss: 0.1236
Epoch 232/400
160/160 [=====] - 0s 256us/step - loss: 0.1262
Epoch 233/400
160/160 [=====] - 0s 262us/step - loss: 0.1285
Epoch 234/400
160/160 [=====] - 0s 277us/step - loss: 0.1205
Epoch 235/400
160/160 [=====] - 0s 249us/step - loss: 0.1273
Epoch 236/400
160/160 [=====] - 0s 256us/step - loss: 0.1432
Epoch 237/400
160/160 [=====] - 0s 256us/step - loss: 0.1400
Epoch 238/400
160/160 [=====] - 0s 249us/step - loss: 0.1138
Epoch 239/400
160/160 [=====] - 0s 249us/step - loss: 0.1303
Epoch 240/400
160/160 [=====] - 0s 249us/step - loss: 0.1145
Epoch 241/400
160/160 [=====] - 0s 256us/step - loss: 0.1115
Epoch 242/400
160/160 [=====] - 0s 256us/step - loss: 0.1291
Epoch 243/400
160/160 [=====] - 0s 249us/step - loss: 0.1126
Epoch 244/400
160/160 [=====] - 0s 256us/step - loss: 0.1241

Epoch 245/400
160/160 [=====] - 0s 249us/step - loss: 0.1363
Epoch 246/400
160/160 [=====] - 0s 252us/step - loss: 0.1117
Epoch 247/400
160/160 [=====] - 0s 256us/step - loss: 0.1190
Epoch 248/400
160/160 [=====] - 0s 259us/step - loss: 0.1093
Epoch 249/400
160/160 [=====] - 0s 262us/step - loss: 0.1374
Epoch 250/400
160/160 [=====] - 0s 249us/step - loss: 0.1266
Epoch 251/400
160/160 [=====] - 0s 252us/step - loss: 0.1243
Epoch 252/400
160/160 [=====] - 0s 249us/step - loss: 0.0900
Epoch 253/400
160/160 [=====] - 0s 256us/step - loss: 0.1437
Epoch 254/400
160/160 [=====] - 0s 249us/step - loss: 0.1292
Epoch 255/400
160/160 [=====] - 0s 249us/step - loss: 0.1231
Epoch 256/400
160/160 [=====] - 0s 256us/step - loss: 0.1240
Epoch 257/400
160/160 [=====] - 0s 274us/step - loss: 0.1243
Epoch 258/400
160/160 [=====] - 0s 274us/step - loss: 0.0999
Epoch 259/400
160/160 [=====] - 0s 262us/step - loss: 0.1518
Epoch 260/400
160/160 [=====] - 0s 249us/step - loss: 0.1115
Epoch 261/400
160/160 [=====] - 0s 256us/step - loss: 0.1132
Epoch 262/400
160/160 [=====] - 0s 249us/step - loss: 0.1296
Epoch 263/400
160/160 [=====] - 0s 262us/step - loss: 0.1233
Epoch 264/400
160/160 [=====] - 0s 243us/step - loss: 0.1346
Epoch 265/400
160/160 [=====] - 0s 262us/step - loss: 0.1357
Epoch 266/400
160/160 [=====] - 0s 249us/step - loss: 0.1180
Epoch 267/400
160/160 [=====] - 0s 243us/step - loss: 0.1073
Epoch 268/400
160/160 [=====] - 0s 249us/step - loss: 0.1094
Epoch 269/400
160/160 [=====] - 0s 249us/step - loss: 0.1247
Epoch 270/400
160/160 [=====] - 0s 249us/step - loss: 0.1084
Epoch 271/400
160/160 [=====] - 0s 256us/step - loss: 0.1200
Epoch 272/400
160/160 [=====] - 0s 256us/step - loss: 0.0964
Epoch 273/400
160/160 [=====] - 0s 252us/step - loss: 0.1189
Epoch 274/400
160/160 [=====] - 0s 249us/step - loss: 0.1315
Epoch 275/400
160/160 [=====] - 0s 252us/step - loss: 0.1251
Epoch 276/400
160/160 [=====] - 0s 256us/step - loss: 0.0939
Epoch 277/400
160/160 [=====] - 0s 243us/step - loss: 0.1279
Epoch 278/400
160/160 [=====] - 0s 249us/step - loss: 0.1025
Epoch 279/400
160/160 [=====] - 0s 243us/step - loss: 0.1085
Epoch 280/400
160/160 [=====] - 0s 249us/step - loss: 0.1339
Epoch 281/400
160/160 [=====] - 0s 249us/step - loss: 0.1164
Epoch 282/400
160/160 [=====] - 0s 243us/step - loss: 0.0825
Epoch 283/400

160/160 [=====] - 0s 256us/step - loss: 0.1171
Epoch 284/400
160/160 [=====] - 0s 249us/step - loss: 0.1125
Epoch 285/400
160/160 [=====] - 0s 243us/step - loss: 0.1169
Epoch 286/400
160/160 [=====] - 0s 249us/step - loss: 0.1030
Epoch 287/400
160/160 [=====] - 0s 249us/step - loss: 0.0994
Epoch 288/400
160/160 [=====] - 0s 249us/step - loss: 0.1193
Epoch 289/400
160/160 [=====] - 0s 243us/step - loss: 0.1052
Epoch 290/400
160/160 [=====] - 0s 259us/step - loss: 0.1026
Epoch 291/400
160/160 [=====] - 0s 249us/step - loss: 0.1098
Epoch 292/400
160/160 [=====] - 0s 262us/step - loss: 0.1059
Epoch 293/400
160/160 [=====] - 0s 271us/step - loss: 0.1088
Epoch 294/400
160/160 [=====] - 0s 268us/step - loss: 0.1268
Epoch 295/400
160/160 [=====] - 0s 281us/step - loss: 0.0793
Epoch 296/400
160/160 [=====] - 0s 280us/step - loss: 0.1302
Epoch 297/400
160/160 [=====] - 0s 268us/step - loss: 0.1255
Epoch 298/400
160/160 [=====] - 0s 262us/step - loss: 0.1025
Epoch 299/400
160/160 [=====] - 0s 249us/step - loss: 0.1384
Epoch 300/400
160/160 [=====] - 0s 249us/step - loss: 0.1143
Epoch 301/400
160/160 [=====] - 0s 249us/step - loss: 0.0919
Epoch 302/400
160/160 [=====] - 0s 256us/step - loss: 0.1051
Epoch 303/400
160/160 [=====] - 0s 249us/step - loss: 0.1016
Epoch 304/400
160/160 [=====] - 0s 256us/step - loss: 0.1159
Epoch 305/400
160/160 [=====] - 0s 256us/step - loss: 0.0913
Epoch 306/400
160/160 [=====] - 0s 262us/step - loss: 0.1072
Epoch 307/400
160/160 [=====] - 0s 274us/step - loss: 0.0723
Epoch 308/400
160/160 [=====] - 0s 262us/step - loss: 0.1101
Epoch 309/400
160/160 [=====] - 0s 256us/step - loss: 0.1031
Epoch 310/400
160/160 [=====] - 0s 249us/step - loss: 0.0767
Epoch 311/400
160/160 [=====] - 0s 249us/step - loss: 0.1069
Epoch 312/400
160/160 [=====] - 0s 256us/step - loss: 0.1096
Epoch 313/400
160/160 [=====] - 0s 256us/step - loss: 0.0906
Epoch 314/400
160/160 [=====] - 0s 252us/step - loss: 0.1205
Epoch 315/400
160/160 [=====] - 0s 249us/step - loss: 0.0874
Epoch 316/400
160/160 [=====] - 0s 256us/step - loss: 0.1160
Epoch 317/400
160/160 [=====] - 0s 256us/step - loss: 0.1023
Epoch 318/400
160/160 [=====] - 0s 249us/step - loss: 0.0919
Epoch 319/400
160/160 [=====] - 0s 256us/step - loss: 0.0873
Epoch 320/400
160/160 [=====] - 0s 249us/step - loss: 0.1234
Epoch 321/400
160/160 [=====] - 0s 256us/step - loss: 0.0993

Epoch 322/400
160/160 [=====] - 0s 262us/step - loss: 0.1120
Epoch 323/400
160/160 [=====] - 0s 249us/step - loss: 0.1046
Epoch 324/400
160/160 [=====] - 0s 256us/step - loss: 0.0722
Epoch 325/400
160/160 [=====] - 0s 256us/step - loss: 0.1061
Epoch 326/400
160/160 [=====] - 0s 252us/step - loss: 0.0886
Epoch 327/400
160/160 [=====] - 0s 249us/step - loss: 0.1269
Epoch 328/400
160/160 [=====] - 0s 249us/step - loss: 0.1160
Epoch 329/400
160/160 [=====] - 0s 252us/step - loss: 0.1019
Epoch 330/400
160/160 [=====] - 0s 274us/step - loss: 0.0819
Epoch 331/400
160/160 [=====] - 0s 271us/step - loss: 0.1257
Epoch 332/400
160/160 [=====] - 0s 256us/step - loss: 0.0938
Epoch 333/400
160/160 [=====] - 0s 256us/step - loss: 0.1010
Epoch 334/400
160/160 [=====] - 0s 249us/step - loss: 0.1214
Epoch 335/400
160/160 [=====] - 0s 256us/step - loss: 0.0823
Epoch 336/400
160/160 [=====] - 0s 256us/step - loss: 0.1088
Epoch 337/400
160/160 [=====] - 0s 262us/step - loss: 0.1022
Epoch 338/400
160/160 [=====] - 0s 256us/step - loss: 0.1085
Epoch 339/400
160/160 [=====] - 0s 249us/step - loss: 0.1039
Epoch 340/400
160/160 [=====] - 0s 256us/step - loss: 0.0966
Epoch 341/400
160/160 [=====] - 0s 256us/step - loss: 0.1159
Epoch 342/400
160/160 [=====] - 0s 249us/step - loss: 0.1070
Epoch 343/400
160/160 [=====] - 0s 256us/step - loss: 0.0816
Epoch 344/400
160/160 [=====] - 0s 249us/step - loss: 0.1003
Epoch 345/400
160/160 [=====] - 0s 256us/step - loss: 0.1176
Epoch 346/400
160/160 [=====] - 0s 249us/step - loss: 0.0847
Epoch 347/400
160/160 [=====] - 0s 256us/step - loss: 0.0904
Epoch 348/400
160/160 [=====] - 0s 256us/step - loss: 0.0638
Epoch 349/400
160/160 [=====] - 0s 255us/step - loss: 0.1134
Epoch 350/400
160/160 [=====] - 0s 256us/step - loss: 0.1314
Epoch 351/400
160/160 [=====] - 0s 249us/step - loss: 0.0985
Epoch 352/400
160/160 [=====] - 0s 249us/step - loss: 0.0985
Epoch 353/400
160/160 [=====] - 0s 249us/step - loss: 0.1075
Epoch 354/400
160/160 [=====] - 0s 256us/step - loss: 0.0925
Epoch 355/400
160/160 [=====] - 0s 256us/step - loss: 0.0852
Epoch 356/400
160/160 [=====] - 0s 262us/step - loss: 0.1184
Epoch 357/400
160/160 [=====] - 0s 249us/step - loss: 0.1031
Epoch 358/400
160/160 [=====] - 0s 256us/step - loss: 0.1039
Epoch 359/400
160/160 [=====] - 0s 249us/step - loss: 0.0884
Epoch 360/400

160/160 [=====] - 0s 256us/step - loss: 0.0839
Epoch 361/400
160/160 [=====] - 0s 243us/step - loss: 0.0988
Epoch 362/400
160/160 [=====] - 0s 256us/step - loss: 0.1192
Epoch 363/400
160/160 [=====] - 0s 252us/step - loss: 0.0956
Epoch 364/400
160/160 [=====] - 0s 256us/step - loss: 0.0872
Epoch 365/400
160/160 [=====] - 0s 265us/step - loss: 0.1002
Epoch 366/400
160/160 [=====] - 0s 249us/step - loss: 0.0799
Epoch 367/400
160/160 [=====] - 0s 256us/step - loss: 0.0963
Epoch 368/400
160/160 [=====] - 0s 252us/step - loss: 0.0630
Epoch 369/400
160/160 [=====] - 0s 249us/step - loss: 0.1263
Epoch 370/400
160/160 [=====] - 0s 252us/step - loss: 0.1036
Epoch 371/400
160/160 [=====] - 0s 249us/step - loss: 0.1137
Epoch 372/400
160/160 [=====] - 0s 249us/step - loss: 0.0741
Epoch 373/400
160/160 [=====] - 0s 249us/step - loss: 0.0946
Epoch 374/400
160/160 [=====] - 0s 249us/step - loss: 0.0806
Epoch 375/400
160/160 [=====] - 0s 256us/step - loss: 0.0875
Epoch 376/400
160/160 [=====] - 0s 262us/step - loss: 0.1190
Epoch 377/400
160/160 [=====] - 0s 256us/step - loss: 0.0925
Epoch 378/400
160/160 [=====] - 0s 262us/step - loss: 0.1101
Epoch 379/400
160/160 [=====] - 0s 287us/step - loss: 0.1048
Epoch 380/400
160/160 [=====] - 0s 293us/step - loss: 0.1107
Epoch 381/400
160/160 [=====] - 0s 274us/step - loss: 0.0917
Epoch 382/400
160/160 [=====] - 0s 262us/step - loss: 0.0895
Epoch 383/400
160/160 [=====] - 0s 249us/step - loss: 0.1002
Epoch 384/400
160/160 [=====] - 0s 274us/step - loss: 0.1177
Epoch 385/400
160/160 [=====] - 0s 274us/step - loss: 0.0790
Epoch 386/400
160/160 [=====] - 0s 281us/step - loss: 0.0809
Epoch 387/400
160/160 [=====] - 0s 268us/step - loss: 0.1021
Epoch 388/400
160/160 [=====] - 0s 262us/step - loss: 0.0989
Epoch 389/400
160/160 [=====] - 0s 256us/step - loss: 0.0696
Epoch 390/400
160/160 [=====] - 0s 256us/step - loss: 0.0819
Epoch 391/400
160/160 [=====] - 0s 256us/step - loss: 0.0956
Epoch 392/400
160/160 [=====] - 0s 265us/step - loss: 0.1017
Epoch 393/400
160/160 [=====] - 0s 268us/step - loss: 0.0877
Epoch 394/400
160/160 [=====] - 0s 246us/step - loss: 0.0874
Epoch 395/400
160/160 [=====] - 0s 249us/step - loss: 0.1064
Epoch 396/400
160/160 [=====] - 0s 256us/step - loss: 0.0713
Epoch 397/400
160/160 [=====] - 0s 256us/step - loss: 0.0897
Epoch 398/400
160/160 [=====] - 0s 262us/step - loss: 0.0899

```

Epoch 399/400
160/160 [=====] - 0s 256us/step - loss: 0.0726
Epoch 400/400
160/160 [=====] - 0s 256us/step - loss: 0.0854
[0.9823026 0.9824751 0.9821686 0.9813417 0.98229086 0.98017657
 0.96831346 0.9826094 0.98261064 0.97683233 0.9813033 0.9825712
 0.981644 0.95358545 0.9826134 0.98240846 0.982277 0.9822005
 0.9818264 0.9812259 0.98256934 0.9824118 0.9826015 0.86901045
 0.98245203 0.9805058 0.9814078 0.9820925 0.9826067 0.92815715
 0.9823192 0.88998425 0.9824368 0.6391865 0.9673516 0.9821507
 0.98170406 0.9825378 0.9825827 0.98055 0.9955136 0.9955455
 0.9954972 0.9953158 0.9955171 0.9950492 0.9924021 0.99556535
 0.9955655 0.9944635 0.9953063 0.99556005 0.9953809 0.9895671
 0.99556595 0.9955356 0.9955155 0.9955029 0.99543816 0.99528944
 0.99555945 0.9955331 0.99556434 0.98273015 0.9955401 0.9951355
 0.995355 0.9954739 0.9955649 0.9850899 0.9955179 0.98418325
 0.9955403 0.9498991 0.9927978 0.99549437 0.9953987 0.99555486
 0.9955616 0.995199 0.0097585 0.01004612 0.0105254 0.0093881
 0.01034587 0.00940109 0.03079598 0.00998178 0.00997497 0.02014928
 0.00953824 0.01001674 0.00956529 0.8162432 0.00997889 0.01016861
 0.01024169 0.01040234 0.01086501 0.00937698 0.00996687 0.00985721
 0.00998625 0.6009992 0.00986263 0.00965412 0.01099369 0.00952604
 0.0099719 0.15365614 0.00971784 0.9134929 0.01017663 0.07570349
 0.03618259 0.0105315 0.00943696 0.00997506 0.01000199 0.01150821
 0.01132832 0.01078834 0.0102564 0.0153989 0.01042358 0.01331775
 0.3149434 0.01088511 0.01089612 0.00950458 0.0120942 0.01083066
 0.011964 0.968872 0.01088973 0.0106231 0.0105348 0.01036686
 0.01001148 0.01475239 0.01091008 0.01110912 0.01087802 0.04144958
 0.0110983 0.02088629 0.00994083 0.01215986 0.01090117 0.74445385
 0.01143708 0.2897329 0.01061224 0.6339732 0.01017091 0.01025108
 0.0128426 0.01089722 0.01085336 0.00971836]
160/160 [=====] - 0s 287us/step

```

In [16]:

```
#five layers, two neurons per layer: loss
scores_lay_five_two, model_lay_five_two.metrics_names
```

Out[16]:

```
(0.09051572307944297, ['loss'])
```

Figure of Loss

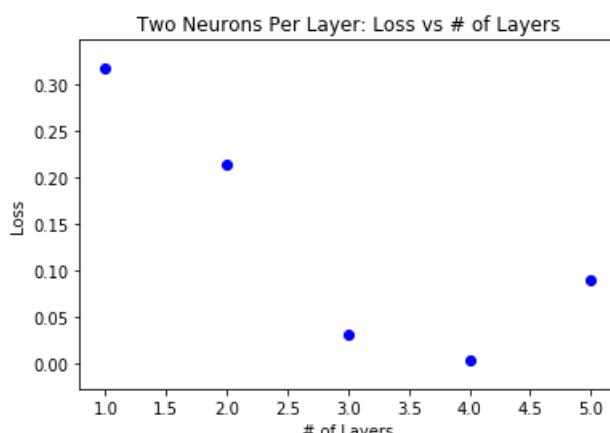
In [17]:

```
#figure of loss vs # of Layers
x_2 = [1,2,3,4,5]
y_2 = [scores_lay_one_two, scores_lay_two_two, scores_lay_three_two, scores_lay_four_two, scores_lay_five_two]

plt.scatter(x_2,y_2, c='blue');
plt.title('Two Neurons Per Layer: Loss vs # of Layers')
plt.xlabel('# of Layers')
plt.ylabel('Loss')
```

Out[17]:

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



Part 1 Question 2: Three Neurons per Layer

One Layer

In [18]:

```
n = 40
xx = np.random.random((n,1))
yy = np.random.random((n,1))

X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [19]:

```
#One layer, three neurons per layer
model_lay_one_three = Sequential()

#hidden layers
model_lay_one_three.add(Dense(3, input_dim=2, activation='tanh'))

#output layer
model_lay_one_three.add(Dense(1, activation='sigmoid'))

sgd = SGD(lr=0.1)
model_lay_one_three.compile(loss='binary_crossentropy', optimizer='sgd')

model_lay_one_three.fit(X, y, batch_size=2, epochs=400)
print(model_lay_one_three.predict_proba(X).reshape(4*n))

#evaluate the model
scores_lay_one_three = model_lay_one_three.evaluate(X, y)
```

```
Epoch 1/400
160/160 [=====] - 0s 1ms/step - loss: 0.7352
Epoch 2/400
160/160 [=====] - 0s 224us/step - loss: 0.7183
Epoch 3/400
160/160 [=====] - 0s 224us/step - loss: 0.7051
Epoch 4/400
160/160 [=====] - 0s 212us/step - loss: 0.6958
Epoch 5/400
160/160 [=====] - 0s 224us/step - loss: 0.6884
Epoch 6/400
160/160 [=====] - 0s 231us/step - loss: 0.6825
Epoch 7/400
160/160 [=====] - 0s 231us/step - loss: 0.6775
Epoch 8/400
160/160 [=====] - 0s 224us/step - loss: 0.6734
Epoch 9/400
160/160 [=====] - 0s 224us/step - loss: 0.6698
Epoch 10/400
160/160 [=====] - 0s 231us/step - loss: 0.6668
Epoch 11/400
160/160 [=====] - 0s 231us/step - loss: 0.6636
Epoch 12/400
160/160 [=====] - 0s 218us/step - loss: 0.6610
Epoch 13/400
160/160 [=====] - 0s 218us/step - loss: 0.6585
Epoch 14/400
160/160 [=====] - 0s 224us/step - loss: 0.6555
Epoch 15/400
160/160 [=====] - 0s 224us/step - loss: 0.6537
Epoch 16/400
160/160 [=====] - 0s 224us/step - loss: 0.6507
Epoch 17/400
160/160 [=====] - 0s 237us/step - loss: 0.6484
Epoch 18/400
160/160 [=====] - 0s 224us/step - loss: 0.6458
Epoch 19/400
160/160 [=====] - 0s 224us/step - loss: 0.6437
Epoch 20/400
160/160 [=====] - 0s 210us/step - loss: 0.6410
```

160/160 [=====] - 0s 218us/step - loss: 0.6410
Epoch 21/400
160/160 [=====] - 0s 224us/step - loss: 0.6389
Epoch 22/400
160/160 [=====] - 0s 224us/step - loss: 0.6362
Epoch 23/400
160/160 [=====] - 0s 218us/step - loss: 0.6337
Epoch 24/400
160/160 [=====] - 0s 231us/step - loss: 0.6315
Epoch 25/400
160/160 [=====] - 0s 224us/step - loss: 0.6288
Epoch 26/400
160/160 [=====] - 0s 218us/step - loss: 0.6261
Epoch 27/400
160/160 [=====] - 0s 231us/step - loss: 0.6238
Epoch 28/400
160/160 [=====] - 0s 231us/step - loss: 0.6210
Epoch 29/400
160/160 [=====] - 0s 224us/step - loss: 0.6186
Epoch 30/400
160/160 [=====] - 0s 218us/step - loss: 0.6159
Epoch 31/400
160/160 [=====] - 0s 218us/step - loss: 0.6133
Epoch 32/400
160/160 [=====] - 0s 218us/step - loss: 0.6105
Epoch 33/400
160/160 [=====] - 0s 218us/step - loss: 0.6082
Epoch 34/400
160/160 [=====] - 0s 215us/step - loss: 0.6051
Epoch 35/400
160/160 [=====] - 0s 231us/step - loss: 0.6026
Epoch 36/400
160/160 [=====] - 0s 224us/step - loss: 0.5997
Epoch 37/400
160/160 [=====] - 0s 221us/step - loss: 0.5970
Epoch 38/400
160/160 [=====] - 0s 224us/step - loss: 0.5945
Epoch 39/400
160/160 [=====] - 0s 228us/step - loss: 0.5911
Epoch 40/400
160/160 [=====] - 0s 218us/step - loss: 0.5886
Epoch 41/400
160/160 [=====] - 0s 224us/step - loss: 0.5857
Epoch 42/400
160/160 [=====] - 0s 221us/step - loss: 0.5826
Epoch 43/400
160/160 [=====] - 0s 231us/step - loss: 0.5799
Epoch 44/400
160/160 [=====] - 0s 243us/step - loss: 0.5768
Epoch 45/400
160/160 [=====] - 0s 228us/step - loss: 0.5735
Epoch 46/400
160/160 [=====] - 0s 224us/step - loss: 0.5707
Epoch 47/400
160/160 [=====] - 0s 224us/step - loss: 0.5672
Epoch 48/400
160/160 [=====] - 0s 218us/step - loss: 0.5636
Epoch 49/400
160/160 [=====] - 0s 231us/step - loss: 0.5605
Epoch 50/400
160/160 [=====] - 0s 237us/step - loss: 0.5569
Epoch 51/400
160/160 [=====] - 0s 231us/step - loss: 0.5535
Epoch 52/400
160/160 [=====] - 0s 224us/step - loss: 0.5497
Epoch 53/400
160/160 [=====] - 0s 224us/step - loss: 0.5458
Epoch 54/400
160/160 [=====] - 0s 243us/step - loss: 0.5420
Epoch 55/400
160/160 [=====] - 0s 237us/step - loss: 0.5378
Epoch 56/400
160/160 [=====] - 0s 224us/step - loss: 0.5337
Epoch 57/400
160/160 [=====] - 0s 218us/step - loss: 0.5296
Epoch 58/400
160/160 [=====] - 0s 224us/step - loss: 0.5255

Epoch 59/400
160/160 [=====] - 0s 231us/step - loss: 0.5214
Epoch 60/400
160/160 [=====] - 0s 218us/step - loss: 0.5173
Epoch 61/400
160/160 [=====] - 0s 218us/step - loss: 0.5125
Epoch 62/400
160/160 [=====] - 0s 224us/step - loss: 0.5079
Epoch 63/400
160/160 [=====] - 0s 218us/step - loss: 0.5034
Epoch 64/400
160/160 [=====] - 0s 212us/step - loss: 0.4991
Epoch 65/400
160/160 [=====] - 0s 212us/step - loss: 0.4943
Epoch 66/400
160/160 [=====] - 0s 231us/step - loss: 0.4902
Epoch 67/400
160/160 [=====] - 0s 218us/step - loss: 0.4853
Epoch 68/400
160/160 [=====] - 0s 231us/step - loss: 0.4810
Epoch 69/400
160/160 [=====] - 0s 218us/step - loss: 0.4766
Epoch 70/400
160/160 [=====] - 0s 231us/step - loss: 0.4720
Epoch 71/400
160/160 [=====] - 0s 243us/step - loss: 0.4677
Epoch 72/400
160/160 [=====] - 0s 231us/step - loss: 0.4640
Epoch 73/400
160/160 [=====] - 0s 218us/step - loss: 0.4596
Epoch 74/400
160/160 [=====] - 0s 224us/step - loss: 0.4554
Epoch 75/400
160/160 [=====] - 0s 231us/step - loss: 0.4511
Epoch 76/400
160/160 [=====] - 0s 224us/step - loss: 0.4473
Epoch 77/400
160/160 [=====] - 0s 224us/step - loss: 0.4432
Epoch 78/400
160/160 [=====] - 0s 237us/step - loss: 0.4392
Epoch 79/400
160/160 [=====] - 0s 218us/step - loss: 0.4361
Epoch 80/400
160/160 [=====] - 0s 218us/step - loss: 0.4320
Epoch 81/400
160/160 [=====] - 0s 218us/step - loss: 0.4281
Epoch 82/400
160/160 [=====] - 0s 231us/step - loss: 0.4252
Epoch 83/400
160/160 [=====] - 0s 215us/step - loss: 0.4219
Epoch 84/400
160/160 [=====] - 0s 218us/step - loss: 0.4184
Epoch 85/400
160/160 [=====] - 0s 218us/step - loss: 0.4149
Epoch 86/400
160/160 [=====] - 0s 215us/step - loss: 0.4115
Epoch 87/400
160/160 [=====] - 0s 218us/step - loss: 0.4089
Epoch 88/400
160/160 [=====] - 0s 212us/step - loss: 0.4057
Epoch 89/400
160/160 [=====] - 0s 212us/step - loss: 0.4026
Epoch 90/400
160/160 [=====] - 0s 218us/step - loss: 0.4000
Epoch 91/400
160/160 [=====] - 0s 218us/step - loss: 0.3973
Epoch 92/400
160/160 [=====] - 0s 218us/step - loss: 0.3946
Epoch 93/400
160/160 [=====] - 0s 224us/step - loss: 0.3922
Epoch 94/400
160/160 [=====] - 0s 218us/step - loss: 0.3897
Epoch 95/400
160/160 [=====] - 0s 212us/step - loss: 0.3869
Epoch 96/400
160/160 [=====] - 0s 218us/step - loss: 0.3847
Epoch 97/400
160/160 [=====] - 0s 212us/step - loss: 0.3827

```
160/160 [=====] - 0s 218us/step - loss: 0.3823
Epoch 98/400
160/160 [=====] - 0s 224us/step - loss: 0.3799
Epoch 99/400
160/160 [=====] - 0s 237us/step - loss: 0.3782
Epoch 100/400
160/160 [=====] - 0s 231us/step - loss: 0.3765
Epoch 101/400
160/160 [=====] - 0s 218us/step - loss: 0.3739
Epoch 102/400
160/160 [=====] - 0s 224us/step - loss: 0.3719
Epoch 103/400
160/160 [=====] - 0s 218us/step - loss: 0.3702
Epoch 104/400
160/160 [=====] - 0s 231us/step - loss: 0.3680
Epoch 105/400
160/160 [=====] - 0s 224us/step - loss: 0.3668
Epoch 106/400
160/160 [=====] - 0s 224us/step - loss: 0.3648
Epoch 107/400
160/160 [=====] - 0s 218us/step - loss: 0.3632
Epoch 108/400
160/160 [=====] - 0s 218us/step - loss: 0.3614
Epoch 109/400
160/160 [=====] - 0s 218us/step - loss: 0.3598
Epoch 110/400
160/160 [=====] - 0s 218us/step - loss: 0.3584
Epoch 111/400
160/160 [=====] - 0s 237us/step - loss: 0.3570
Epoch 112/400
160/160 [=====] - 0s 218us/step - loss: 0.3555
Epoch 113/400
160/160 [=====] - 0s 218us/step - loss: 0.3543
Epoch 114/400
160/160 [=====] - 0s 218us/step - loss: 0.3528
Epoch 115/400
160/160 [=====] - 0s 224us/step - loss: 0.3516
Epoch 116/400
160/160 [=====] - 0s 224us/step - loss: 0.3507
Epoch 117/400
160/160 [=====] - 0s 224us/step - loss: 0.3490
Epoch 118/400
160/160 [=====] - 0s 218us/step - loss: 0.3484
Epoch 119/400
160/160 [=====] - 0s 212us/step - loss: 0.3468
Epoch 120/400
160/160 [=====] - 0s 218us/step - loss: 0.3458
Epoch 121/400
160/160 [=====] - 0s 218us/step - loss: 0.3445
Epoch 122/400
160/160 [=====] - 0s 218us/step - loss: 0.3434
Epoch 123/400
160/160 [=====] - 0s 224us/step - loss: 0.3427
Epoch 124/400
160/160 [=====] - 0s 224us/step - loss: 0.3415
Epoch 125/400
160/160 [=====] - 0s 231us/step - loss: 0.3412
Epoch 126/400
160/160 [=====] - 0s 215us/step - loss: 0.3400
Epoch 127/400
160/160 [=====] - 0s 237us/step - loss: 0.3390
Epoch 128/400
160/160 [=====] - 0s 218us/step - loss: 0.3384
Epoch 129/400
160/160 [=====] - 0s 218us/step - loss: 0.3375
Epoch 130/400
160/160 [=====] - 0s 224us/step - loss: 0.3369
Epoch 131/400
160/160 [=====] - 0s 218us/step - loss: 0.3363
Epoch 132/400
160/160 [=====] - 0s 212us/step - loss: 0.3354
Epoch 133/400
160/160 [=====] - 0s 212us/step - loss: 0.3345
Epoch 134/400
160/160 [=====] - 0s 212us/step - loss: 0.3339
Epoch 135/400
160/160 [=====] - 0s 224us/step - loss: 0.3331
```

Epoch 136/400
160/160 [=====] - 0s 218us/step - loss: 0.3323
Epoch 137/400
160/160 [=====] - 0s 224us/step - loss: 0.3319
Epoch 138/400
160/160 [=====] - 0s 218us/step - loss: 0.3310
Epoch 139/400
160/160 [=====] - 0s 224us/step - loss: 0.3301
Epoch 140/400
160/160 [=====] - 0s 224us/step - loss: 0.3298
Epoch 141/400
160/160 [=====] - 0s 224us/step - loss: 0.3296
Epoch 142/400
160/160 [=====] - 0s 224us/step - loss: 0.3290
Epoch 143/400
160/160 [=====] - 0s 218us/step - loss: 0.3282
Epoch 144/400
160/160 [=====] - 0s 218us/step - loss: 0.3279
Epoch 145/400
160/160 [=====] - 0s 218us/step - loss: 0.3269
Epoch 146/400
160/160 [=====] - 0s 212us/step - loss: 0.3266
Epoch 147/400
160/160 [=====] - 0s 218us/step - loss: 0.3266
Epoch 148/400
160/160 [=====] - 0s 218us/step - loss: 0.3259
Epoch 149/400
160/160 [=====] - 0s 212us/step - loss: 0.3252
Epoch 150/400
160/160 [=====] - 0s 212us/step - loss: 0.3251
Epoch 151/400
160/160 [=====] - 0s 231us/step - loss: 0.3243
Epoch 152/400
160/160 [=====] - 0s 218us/step - loss: 0.3240
Epoch 153/400
160/160 [=====] - 0s 218us/step - loss: 0.3237
Epoch 154/400
160/160 [=====] - 0s 231us/step - loss: 0.3233
Epoch 155/400
160/160 [=====] - 0s 218us/step - loss: 0.3226
Epoch 156/400
160/160 [=====] - 0s 224us/step - loss: 0.3226
Epoch 157/400
160/160 [=====] - 0s 218us/step - loss: 0.3223
Epoch 158/400
160/160 [=====] - 0s 218us/step - loss: 0.3217
Epoch 159/400
160/160 [=====] - 0s 224us/step - loss: 0.3215
Epoch 160/400
160/160 [=====] - 0s 218us/step - loss: 0.3210
Epoch 161/400
160/160 [=====] - 0s 212us/step - loss: 0.3206
Epoch 162/400
160/160 [=====] - 0s 218us/step - loss: 0.3203
Epoch 163/400
160/160 [=====] - 0s 218us/step - loss: 0.3198
Epoch 164/400
160/160 [=====] - 0s 212us/step - loss: 0.3197
Epoch 165/400
160/160 [=====] - 0s 228us/step - loss: 0.3192
Epoch 166/400
160/160 [=====] - 0s 212us/step - loss: 0.3191
Epoch 167/400
160/160 [=====] - 0s 212us/step - loss: 0.3187
Epoch 168/400
160/160 [=====] - 0s 221us/step - loss: 0.3185
Epoch 169/400
160/160 [=====] - 0s 224us/step - loss: 0.3184
Epoch 170/400
160/160 [=====] - 0s 218us/step - loss: 0.3180
Epoch 171/400
160/160 [=====] - 0s 224us/step - loss: 0.3175
Epoch 172/400
160/160 [=====] - 0s 237us/step - loss: 0.3175
Epoch 173/400
160/160 [=====] - 0s 218us/step - loss: 0.3171
Epoch 174/400

160/160 [=====] - 0s 218us/step - loss: 0.3173
Epoch 175/400
160/160 [=====] - 0s 218us/step - loss: 0.3165
Epoch 176/400
160/160 [=====] - 0s 224us/step - loss: 0.3163
Epoch 177/400
160/160 [=====] - 0s 218us/step - loss: 0.3161
Epoch 178/400
160/160 [=====] - 0s 212us/step - loss: 0.3160
Epoch 179/400
160/160 [=====] - 0s 225us/step - loss: 0.3155
Epoch 180/400
160/160 [=====] - 0s 218us/step - loss: 0.3155
Epoch 181/400
160/160 [=====] - 0s 224us/step - loss: 0.3154
Epoch 182/400
160/160 [=====] - 0s 218us/step - loss: 0.3147
Epoch 183/400
160/160 [=====] - 0s 231us/step - loss: 0.3146
Epoch 184/400
160/160 [=====] - 0s 224us/step - loss: 0.3145
Epoch 185/400
160/160 [=====] - 0s 212us/step - loss: 0.3143
Epoch 186/400
160/160 [=====] - 0s 224us/step - loss: 0.3141
Epoch 187/400
160/160 [=====] - 0s 212us/step - loss: 0.3140
Epoch 188/400
160/160 [=====] - 0s 224us/step - loss: 0.3137
Epoch 189/400
160/160 [=====] - 0s 218us/step - loss: 0.3136
Epoch 190/400
160/160 [=====] - 0s 218us/step - loss: 0.3134
Epoch 191/400
160/160 [=====] - 0s 218us/step - loss: 0.3130
Epoch 192/400
160/160 [=====] - 0s 218us/step - loss: 0.3132
Epoch 193/400
160/160 [=====] - 0s 224us/step - loss: 0.3127
Epoch 194/400
160/160 [=====] - 0s 228us/step - loss: 0.3128
Epoch 195/400
160/160 [=====] - 0s 243us/step - loss: 0.3128
Epoch 196/400
160/160 [=====] - 0s 224us/step - loss: 0.3123
Epoch 197/400
160/160 [=====] - 0s 212us/step - loss: 0.3121
Epoch 198/400
160/160 [=====] - 0s 218us/step - loss: 0.3120
Epoch 199/400
160/160 [=====] - 0s 212us/step - loss: 0.3120
Epoch 200/400
160/160 [=====] - 0s 224us/step - loss: 0.3115
Epoch 201/400
160/160 [=====] - 0s 231us/step - loss: 0.3119
Epoch 202/400
160/160 [=====] - 0s 212us/step - loss: 0.3115
Epoch 203/400
160/160 [=====] - 0s 218us/step - loss: 0.3113
Epoch 204/400
160/160 [=====] - 0s 224us/step - loss: 0.3112
Epoch 205/400
160/160 [=====] - 0s 218us/step - loss: 0.3111
Epoch 206/400
160/160 [=====] - 0s 224us/step - loss: 0.3107
Epoch 207/400
160/160 [=====] - 0s 231us/step - loss: 0.3107
Epoch 208/400
160/160 [=====] - 0s 221us/step - loss: 0.3103
Epoch 209/400
160/160 [=====] - 0s 218us/step - loss: 0.3102
Epoch 210/400
160/160 [=====] - 0s 234us/step - loss: 0.3103
Epoch 211/400
160/160 [=====] - 0s 231us/step - loss: 0.3100
Epoch 212/400
160/160 [=====] - 0s 224us/step - loss: 0.3096

Epoch 213/400
160/160 [=====] - 0s 240us/step - loss: 0.3097
Epoch 214/400
160/160 [=====] - 0s 237us/step - loss: 0.3100
Epoch 215/400
160/160 [=====] - 0s 224us/step - loss: 0.3093
Epoch 216/400
160/160 [=====] - 0s 221us/step - loss: 0.3089
Epoch 217/400
160/160 [=====] - 0s 218us/step - loss: 0.3091
Epoch 218/400
160/160 [=====] - 0s 228us/step - loss: 0.3095
Epoch 219/400
160/160 [=====] - 0s 224us/step - loss: 0.3089
Epoch 220/400
160/160 [=====] - 0s 218us/step - loss: 0.3090
Epoch 221/400
160/160 [=====] - 0s 218us/step - loss: 0.3089
Epoch 222/400
160/160 [=====] - 0s 212us/step - loss: 0.3089
Epoch 223/400
160/160 [=====] - 0s 212us/step - loss: 0.3086
Epoch 224/400
160/160 [=====] - 0s 218us/step - loss: 0.3086
Epoch 225/400
160/160 [=====] - 0s 218us/step - loss: 0.3082
Epoch 226/400
160/160 [=====] - 0s 218us/step - loss: 0.3082
Epoch 227/400
160/160 [=====] - 0s 212us/step - loss: 0.3080
Epoch 228/400
160/160 [=====] - 0s 224us/step - loss: 0.3080
Epoch 229/400
160/160 [=====] - 0s 212us/step - loss: 0.3080
Epoch 230/400
160/160 [=====] - 0s 218us/step - loss: 0.3077
Epoch 231/400
160/160 [=====] - 0s 224us/step - loss: 0.3077
Epoch 232/400
160/160 [=====] - 0s 218us/step - loss: 0.3073
Epoch 233/400
160/160 [=====] - 0s 218us/step - loss: 0.3075
Epoch 234/400
160/160 [=====] - 0s 224us/step - loss: 0.3073
Epoch 235/400
160/160 [=====] - 0s 218us/step - loss: 0.3071
Epoch 236/400
160/160 [=====] - 0s 218us/step - loss: 0.3074
Epoch 237/400
160/160 [=====] - 0s 224us/step - loss: 0.3071
Epoch 238/400
160/160 [=====] - 0s 243us/step - loss: 0.3070
Epoch 239/400
160/160 [=====] - 0s 224us/step - loss: 0.3068
Epoch 240/400
160/160 [=====] - 0s 218us/step - loss: 0.3066
Epoch 241/400
160/160 [=====] - 0s 218us/step - loss: 0.3068
Epoch 242/400
160/160 [=====] - 0s 212us/step - loss: 0.3065
Epoch 243/400
160/160 [=====] - 0s 224us/step - loss: 0.3065
Epoch 244/400
160/160 [=====] - 0s 224us/step - loss: 0.3062
Epoch 245/400
160/160 [=====] - 0s 218us/step - loss: 0.3064
Epoch 246/400
160/160 [=====] - 0s 218us/step - loss: 0.3062
Epoch 247/400
160/160 [=====] - 0s 212us/step - loss: 0.3063
Epoch 248/400
160/160 [=====] - 0s 218us/step - loss: 0.3064
Epoch 249/400
160/160 [=====] - 0s 224us/step - loss: 0.3060
Epoch 250/400
160/160 [=====] - 0s 237us/step - loss: 0.3054
Epoch 251/400

160/160 [=====] - 0s 218us/step - loss: 0.3058
Epoch 252/400
160/160 [=====] - 0s 218us/step - loss: 0.3057
Epoch 253/400
160/160 [=====] - 0s 218us/step - loss: 0.3056
Epoch 254/400
160/160 [=====] - 0s 218us/step - loss: 0.3054
Epoch 255/400
160/160 [=====] - 0s 218us/step - loss: 0.3056
Epoch 256/400
160/160 [=====] - 0s 218us/step - loss: 0.3055
Epoch 257/400
160/160 [=====] - 0s 224us/step - loss: 0.3052
Epoch 258/400
160/160 [=====] - 0s 215us/step - loss: 0.3051
Epoch 259/400
160/160 [=====] - 0s 218us/step - loss: 0.3050
Epoch 260/400
160/160 [=====] - 0s 224us/step - loss: 0.3051
Epoch 261/400
160/160 [=====] - 0s 221us/step - loss: 0.3050
Epoch 262/400
160/160 [=====] - 0s 218us/step - loss: 0.3051
Epoch 263/400
160/160 [=====] - 0s 224us/step - loss: 0.3045
Epoch 264/400
160/160 [=====] - 0s 218us/step - loss: 0.3048
Epoch 265/400
160/160 [=====] - 0s 218us/step - loss: 0.3049
Epoch 266/400
160/160 [=====] - 0s 224us/step - loss: 0.3045
Epoch 267/400
160/160 [=====] - 0s 224us/step - loss: 0.3044
Epoch 268/400
160/160 [=====] - 0s 218us/step - loss: 0.3039
Epoch 269/400
160/160 [=====] - 0s 218us/step - loss: 0.3044
Epoch 270/400
160/160 [=====] - 0s 212us/step - loss: 0.3043
Epoch 271/400
160/160 [=====] - 0s 218us/step - loss: 0.3041
Epoch 272/400
160/160 [=====] - 0s 218us/step - loss: 0.3044
Epoch 273/400
160/160 [=====] - 0s 218us/step - loss: 0.3042
Epoch 274/400
160/160 [=====] - 0s 224us/step - loss: 0.3037
Epoch 275/400
160/160 [=====] - 0s 224us/step - loss: 0.3039
Epoch 276/400
160/160 [=====] - 0s 218us/step - loss: 0.3039
Epoch 277/400
160/160 [=====] - 0s 212us/step - loss: 0.3038
Epoch 278/400
160/160 [=====] - 0s 218us/step - loss: 0.3040
Epoch 279/400
160/160 [=====] - 0s 237us/step - loss: 0.3039
Epoch 280/400
160/160 [=====] - 0s 218us/step - loss: 0.3038
Epoch 281/400
160/160 [=====] - 0s 218us/step - loss: 0.3040
Epoch 282/400
160/160 [=====] - 0s 218us/step - loss: 0.3034
Epoch 283/400
160/160 [=====] - 0s 218us/step - loss: 0.3036
Epoch 284/400
160/160 [=====] - 0s 218us/step - loss: 0.3037
Epoch 285/400
160/160 [=====] - 0s 224us/step - loss: 0.3032
Epoch 286/400
160/160 [=====] - 0s 221us/step - loss: 0.3032
Epoch 287/400
160/160 [=====] - 0s 224us/step - loss: 0.3035
Epoch 288/400
160/160 [=====] - 0s 218us/step - loss: 0.3030
Epoch 289/400
160/160 [=====] - 0s 224us/step - loss: 0.3029

Epoch 290/400
160/160 [=====] - 0s 218us/step - loss: 0.3033
Epoch 291/400
160/160 [=====] - 0s 224us/step - loss: 0.3031
Epoch 292/400
160/160 [=====] - 0s 224us/step - loss: 0.3032
Epoch 293/400
160/160 [=====] - 0s 218us/step - loss: 0.3032
Epoch 294/400
160/160 [=====] - 0s 243us/step - loss: 0.3030
Epoch 295/400
160/160 [=====] - 0s 231us/step - loss: 0.3023
Epoch 296/400
160/160 [=====] - 0s 218us/step - loss: 0.3027
Epoch 297/400
160/160 [=====] - 0s 224us/step - loss: 0.3026
Epoch 298/400
160/160 [=====] - 0s 218us/step - loss: 0.3020
Epoch 299/400
160/160 [=====] - 0s 218us/step - loss: 0.3025
Epoch 300/400
160/160 [=====] - 0s 215us/step - loss: 0.3027
Epoch 301/400
160/160 [=====] - 0s 218us/step - loss: 0.3024
Epoch 302/400
160/160 [=====] - 0s 218us/step - loss: 0.3022
Epoch 303/400
160/160 [=====] - 0s 221us/step - loss: 0.3023
Epoch 304/400
160/160 [=====] - 0s 218us/step - loss: 0.3022
Epoch 305/400
160/160 [=====] - 0s 224us/step - loss: 0.3022
Epoch 306/400
160/160 [=====] - 0s 221us/step - loss: 0.3021
Epoch 307/400
160/160 [=====] - 0s 218us/step - loss: 0.3022
Epoch 308/400
160/160 [=====] - 0s 218us/step - loss: 0.3016
Epoch 309/400
160/160 [=====] - 0s 221us/step - loss: 0.3017
Epoch 310/400
160/160 [=====] - 0s 218us/step - loss: 0.3021
Epoch 311/400
160/160 [=====] - 0s 212us/step - loss: 0.3020
Epoch 312/400
160/160 [=====] - 0s 218us/step - loss: 0.3019
Epoch 313/400
160/160 [=====] - 0s 224us/step - loss: 0.3016
Epoch 314/400
160/160 [=====] - 0s 218us/step - loss: 0.3016
Epoch 315/400
160/160 [=====] - 0s 231us/step - loss: 0.3018
Epoch 316/400
160/160 [=====] - 0s 218us/step - loss: 0.3020
Epoch 317/400
160/160 [=====] - 0s 218us/step - loss: 0.3018
Epoch 318/400
160/160 [=====] - 0s 224us/step - loss: 0.3011
Epoch 319/400
160/160 [=====] - 0s 224us/step - loss: 0.3014
Epoch 320/400
160/160 [=====] - 0s 224us/step - loss: 0.3013
Epoch 321/400
160/160 [=====] - 0s 218us/step - loss: 0.3013
Epoch 322/400
160/160 [=====] - 0s 243us/step - loss: 0.3015
Epoch 323/400
160/160 [=====] - 0s 243us/step - loss: 0.3010
Epoch 324/400
160/160 [=====] - 0s 218us/step - loss: 0.3011
Epoch 325/400
160/160 [=====] - 0s 224us/step - loss: 0.3010
Epoch 326/400
160/160 [=====] - 0s 218us/step - loss: 0.3013
Epoch 327/400
160/160 [=====] - 0s 224us/step - loss: 0.3007
Epoch 328/400

160/160 [=====] - 0s 218us/step - loss: 0.3011
Epoch 329/400
160/160 [=====] - 0s 224us/step - loss: 0.3009
Epoch 330/400
160/160 [=====] - 0s 218us/step - loss: 0.3007
Epoch 331/400
160/160 [=====] - 0s 218us/step - loss: 0.3008
Epoch 332/400
160/160 [=====] - 0s 218us/step - loss: 0.3008
Epoch 333/400
160/160 [=====] - 0s 231us/step - loss: 0.3009
Epoch 334/400
160/160 [=====] - 0s 215us/step - loss: 0.3007
Epoch 335/400
160/160 [=====] - 0s 212us/step - loss: 0.3006
Epoch 336/400
160/160 [=====] - 0s 218us/step - loss: 0.3012
Epoch 337/400
160/160 [=====] - 0s 218us/step - loss: 0.3007
Epoch 338/400
160/160 [=====] - 0s 218us/step - loss: 0.3003
Epoch 339/400
160/160 [=====] - 0s 218us/step - loss: 0.3006
Epoch 340/400
160/160 [=====] - 0s 218us/step - loss: 0.3005
Epoch 341/400
160/160 [=====] - 0s 218us/step - loss: 0.3006
Epoch 342/400
160/160 [=====] - 0s 215us/step - loss: 0.3001
Epoch 343/400
160/160 [=====] - 0s 212us/step - loss: 0.3005
Epoch 344/400
160/160 [=====] - 0s 212us/step - loss: 0.3002
Epoch 345/400
160/160 [=====] - 0s 218us/step - loss: 0.3003
Epoch 346/400
160/160 [=====] - 0s 224us/step - loss: 0.3002
Epoch 347/400
160/160 [=====] - 0s 218us/step - loss: 0.3002
Epoch 348/400
160/160 [=====] - 0s 218us/step - loss: 0.3003
Epoch 349/400
160/160 [=====] - 0s 218us/step - loss: 0.3000
Epoch 350/400
160/160 [=====] - 0s 224us/step - loss: 0.2999
Epoch 351/400
160/160 [=====] - 0s 228us/step - loss: 0.3001
Epoch 352/400
160/160 [=====] - 0s 212us/step - loss: 0.3002
Epoch 353/400
160/160 [=====] - 0s 218us/step - loss: 0.3001
Epoch 354/400
160/160 [=====] - 0s 209us/step - loss: 0.3001
Epoch 355/400
160/160 [=====] - 0s 218us/step - loss: 0.3005
Epoch 356/400
160/160 [=====] - 0s 221us/step - loss: 0.3001
Epoch 357/400
160/160 [=====] - 0s 224us/step - loss: 0.2996
Epoch 358/400
160/160 [=====] - 0s 218us/step - loss: 0.3000
Epoch 359/400
160/160 [=====] - 0s 218us/step - loss: 0.3000
Epoch 360/400
160/160 [=====] - 0s 212us/step - loss: 0.2999
Epoch 361/400
160/160 [=====] - 0s 218us/step - loss: 0.2996
Epoch 362/400
160/160 [=====] - 0s 218us/step - loss: 0.2994
Epoch 363/400
160/160 [=====] - 0s 218us/step - loss: 0.2998
Epoch 364/400
160/160 [=====] - 0s 224us/step - loss: 0.2998
Epoch 365/400
160/160 [=====] - 0s 224us/step - loss: 0.2996
Epoch 366/400
160/160 [=====] - 0s 218us/step - loss: 0.2994

Epoch 367/400
160/160 [=====] - 0s 212us/step - loss: 0.2994
Epoch 368/400
160/160 [=====] - 0s 218us/step - loss: 0.2989
Epoch 369/400
160/160 [=====] - 0s 218us/step - loss: 0.2993
Epoch 370/400
160/160 [=====] - 0s 212us/step - loss: 0.2994
Epoch 371/400
160/160 [=====] - 0s 218us/step - loss: 0.2991
Epoch 372/400
160/160 [=====] - 0s 218us/step - loss: 0.2994
Epoch 373/400
160/160 [=====] - 0s 224us/step - loss: 0.2995
Epoch 374/400
160/160 [=====] - 0s 212us/step - loss: 0.2992
Epoch 375/400
160/160 [=====] - 0s 218us/step - loss: 0.2992
Epoch 376/400
160/160 [=====] - 0s 224us/step - loss: 0.2990
Epoch 377/400
160/160 [=====] - 0s 218us/step - loss: 0.2992
Epoch 378/400
160/160 [=====] - 0s 224us/step - loss: 0.2989
Epoch 379/400
160/160 [=====] - 0s 231us/step - loss: 0.2990
Epoch 380/400
160/160 [=====] - 0s 231us/step - loss: 0.2988
Epoch 381/400
160/160 [=====] - 0s 231us/step - loss: 0.2988
Epoch 382/400
160/160 [=====] - 0s 215us/step - loss: 0.2992
Epoch 383/400
160/160 [=====] - 0s 218us/step - loss: 0.2989
Epoch 384/400
160/160 [=====] - 0s 231us/step - loss: 0.2990
Epoch 385/400
160/160 [=====] - 0s 218us/step - loss: 0.2986
Epoch 386/400
160/160 [=====] - 0s 218us/step - loss: 0.2987
Epoch 387/400
160/160 [=====] - 0s 218us/step - loss: 0.2988
Epoch 388/400
160/160 [=====] - 0s 218us/step - loss: 0.2989
Epoch 389/400
160/160 [=====] - 0s 212us/step - loss: 0.2984
Epoch 390/400
160/160 [=====] - 0s 218us/step - loss: 0.2985
Epoch 391/400
160/160 [=====] - 0s 212us/step - loss: 0.2985
Epoch 392/400
160/160 [=====] - 0s 224us/step - loss: 0.2989
Epoch 393/400
160/160 [=====] - 0s 218us/step - loss: 0.2985
Epoch 394/400
160/160 [=====] - 0s 224us/step - loss: 0.2985
Epoch 395/400
160/160 [=====] - 0s 218us/step - loss: 0.2987
Epoch 396/400
160/160 [=====] - 0s 218us/step - loss: 0.2984
Epoch 397/400
160/160 [=====] - 0s 218us/step - loss: 0.2987
Epoch 398/400
160/160 [=====] - 0s 218us/step - loss: 0.2984
Epoch 399/400
160/160 [=====] - 0s 215us/step - loss: 0.2985
Epoch 400/400
160/160 [=====] - 0s 224us/step - loss: 0.2980
[0.96620554 0.9578738 0.09440352 0.8338188 0.98510784 0.9844238
0.5124437 0.9731516 0.94045377 0.06849677 0.9840388 0.9249866
0.9815578 0.9839234 0.9834086 0.9846268 0.98457354 0.7238712
0.9848279 0.7290004 0.07772143 0.9798012 0.40410817 0.984169
0.5950906 0.97473395 0.9705565 0.98435956 0.87939125 0.9808702
0.9757801 0.84341794 0.98331416 0.8129421 0.97528404 0.83942235
0.97206354 0.7069825 0.95675504 0.145414 0.95387036 0.94071627
0.13408442 0.7853959 0.99146515 0.9894516 0.52417654 0.9668628
0.91314733 0.08507919 0.9885118 0.89462394 0.9830215 0.9882621

```
0.987002  0.9899832  0.9898316  0.6881839  0.99054694  0.68950707
0.10512761 0.97941726 0.44382027 0.9888299  0.58518904  0.9695673
0.962137  0.9892674  0.83938223 0.9816815  0.97190195  0.7938524
0.9868702  0.7705965  0.9707121  0.79653645 0.9653456  0.678934
0.9393111  0.20148115 0.5374523  0.07393415 0.07690337 0.33394015
0.07704169 0.06866741 0.06678548 0.06632371 0.10020833 0.06887271
0.0858321  0.76974887 0.10584995 0.23718843 0.13640589 0.06687595
0.07646629 0.07050748 0.06679565 0.36370173 0.06627156 0.15307195
0.0951429  0.10102737 0.09182356 0.1802822  0.06630641 0.11160554
0.48573166 0.06751063 0.10440499 0.8242913  0.14778702 0.17679851
0.08335347 0.21463323 0.4628499  0.2355035 0.15083672 0.10645042
0.53487265 0.06539285 0.06604463 0.37963924 0.06525279 0.06656614
0.07801548 0.07146494 0.13992412 0.0666199  0.06770866 0.80851036
0.14687274 0.16824944 0.1859887  0.06931866 0.09957739 0.08880336
0.07507161 0.4042967  0.07658626 0.20633431 0.07214741 0.07395714
0.12795922 0.23668092 0.07337971 0.15398231 0.4511135  0.06778985
0.07596887 0.77440333 0.10067031 0.12236796 0.1129107  0.15207608
0.4185392  0.17034882 0.10356285 0.15058422]
160/160 [=====] - 0s 284us/step
```

In [20]:

```
#One layer, three neurons per layer: loss
scores_lay_one_three, model_lay_one_three.metrics_names
```

Out[20]:

```
(0.2959216445684433, ['loss'])
```

Two Layers

In [21]:

```
n = 40
xx = np.random.random((n,1))
yy = np.random.random((n,1))

X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [22]:

```
#Two layers, three neurons per layer
model_lay_two_three = Sequential()

#hidden layers
model_lay_two_three.add(Dense(3, input_dim=2, activation='tanh'))
model_lay_two_three.add(Dense(3, activation='tanh'))

#output layer
model_lay_two_three.add(Dense(1, activation='sigmoid'))

sgd = SGD(lr=0.1)
model_lay_two_three.compile(loss='binary_crossentropy', optimizer='sgd')

model_lay_two_three.fit(X, y, batch_size=2, epochs=400)
print(model_lay_two_three.predict_proba(X).reshape(4*n))

#evaluate the model
scores_lay_two_three = model_lay_two_three.evaluate(X, y)
```

```
Epoch 1/400
160/160 [=====] - 0s 2ms/step - loss: 0.7536
Epoch 2/400
160/160 [=====] - 0s 256us/step - loss: 0.7323
Epoch 3/400
160/160 [=====] - 0s 259us/step - loss: 0.7182
Epoch 4/400
160/160 [=====] - 0s 249us/step - loss: 0.7094
Epoch 5/400
160/160 [=====] - 0s 249us/step - loss: 0.7033
Epoch 6/400
160/160 [=====] - 0s 246us/step - loss: 0.6988
Epoch 7/400
160/160 [=====] - 0s 249us/step - loss: 0.6953
Epoch 8/400
160/160 [=====] - 0s 256us/step - loss: 0.6926
```

Epoch 9/400
160/160 [=====] - 0s 249us/step - loss: 0.6901
Epoch 10/400
160/160 [=====] - 0s 246us/step - loss: 0.6882
Epoch 11/400
160/160 [=====] - 0s 237us/step - loss: 0.6864
Epoch 12/400
160/160 [=====] - 0s 243us/step - loss: 0.6844
Epoch 13/400
160/160 [=====] - 0s 237us/step - loss: 0.6825
Epoch 14/400
160/160 [=====] - 0s 240us/step - loss: 0.6804
Epoch 15/400
160/160 [=====] - 0s 224us/step - loss: 0.6786
Epoch 16/400
160/160 [=====] - 0s 246us/step - loss: 0.6767
Epoch 17/400
160/160 [=====] - 0s 237us/step - loss: 0.6746
Epoch 18/400
160/160 [=====] - 0s 237us/step - loss: 0.6726
Epoch 19/400
160/160 [=====] - 0s 256us/step - loss: 0.6703
Epoch 20/400
160/160 [=====] - 0s 256us/step - loss: 0.6677
Epoch 21/400
160/160 [=====] - 0s 237us/step - loss: 0.6655
Epoch 22/400
160/160 [=====] - 0s 240us/step - loss: 0.6632
Epoch 23/400
160/160 [=====] - 0s 237us/step - loss: 0.6605
Epoch 24/400
160/160 [=====] - 0s 243us/step - loss: 0.6582
Epoch 25/400
160/160 [=====] - 0s 237us/step - loss: 0.6553
Epoch 26/400
160/160 [=====] - 0s 237us/step - loss: 0.6525
Epoch 27/400
160/160 [=====] - 0s 249us/step - loss: 0.6499
Epoch 28/400
160/160 [=====] - 0s 231us/step - loss: 0.6473
Epoch 29/400
160/160 [=====] - 0s 246us/step - loss: 0.6443
Epoch 30/400
160/160 [=====] - 0s 237us/step - loss: 0.6413
Epoch 31/400
160/160 [=====] - 0s 243us/step - loss: 0.6379
Epoch 32/400
160/160 [=====] - 0s 249us/step - loss: 0.6349
Epoch 33/400
160/160 [=====] - 0s 231us/step - loss: 0.6320
Epoch 34/400
160/160 [=====] - 0s 237us/step - loss: 0.6290
Epoch 35/400
160/160 [=====] - 0s 246us/step - loss: 0.6258
Epoch 36/400
160/160 [=====] - 0s 243us/step - loss: 0.6223
Epoch 37/400
160/160 [=====] - 0s 237us/step - loss: 0.6196
Epoch 38/400
160/160 [=====] - 0s 243us/step - loss: 0.6158
Epoch 39/400
160/160 [=====] - 0s 243us/step - loss: 0.6123
Epoch 40/400
160/160 [=====] - 0s 246us/step - loss: 0.6088
Epoch 41/400
160/160 [=====] - 0s 243us/step - loss: 0.6057
Epoch 42/400
160/160 [=====] - 0s 231us/step - loss: 0.6020
Epoch 43/400
160/160 [=====] - 0s 249us/step - loss: 0.5986
Epoch 44/400
160/160 [=====] - 0s 252us/step - loss: 0.5951
Epoch 45/400
160/160 [=====] - 0s 274us/step - loss: 0.5917
Epoch 46/400
160/160 [=====] - 0s 268us/step - loss: 0.5880
Epoch 47/400

160/160 [=====] - 0s 268us/step - loss: 0.5844
Epoch 48/400
160/160 [=====] - 0s 249us/step - loss: 0.5813
Epoch 49/400
160/160 [=====] - 0s 243us/step - loss: 0.5777
Epoch 50/400
160/160 [=====] - 0s 249us/step - loss: 0.5744
Epoch 51/400
160/160 [=====] - 0s 243us/step - loss: 0.5713
Epoch 52/400
160/160 [=====] - 0s 243us/step - loss: 0.5682
Epoch 53/400
160/160 [=====] - 0s 243us/step - loss: 0.5650
Epoch 54/400
160/160 [=====] - 0s 237us/step - loss: 0.5618
Epoch 55/400
160/160 [=====] - 0s 237us/step - loss: 0.5590
Epoch 56/400
160/160 [=====] - 0s 243us/step - loss: 0.5560
Epoch 57/400
160/160 [=====] - 0s 231us/step - loss: 0.5530
Epoch 58/400
160/160 [=====] - 0s 243us/step - loss: 0.5501
Epoch 59/400
160/160 [=====] - 0s 231us/step - loss: 0.5477
Epoch 60/400
160/160 [=====] - 0s 237us/step - loss: 0.5448
Epoch 61/400
160/160 [=====] - 0s 243us/step - loss: 0.5423
Epoch 62/400
160/160 [=====] - 0s 237us/step - loss: 0.5399
Epoch 63/400
160/160 [=====] - 0s 231us/step - loss: 0.5380
Epoch 64/400
160/160 [=====] - 0s 224us/step - loss: 0.5354
Epoch 65/400
160/160 [=====] - 0s 249us/step - loss: 0.5332
Epoch 66/400
160/160 [=====] - 0s 237us/step - loss: 0.5315
Epoch 67/400
160/160 [=====] - 0s 224us/step - loss: 0.5293
Epoch 68/400
160/160 [=====] - 0s 237us/step - loss: 0.5269
Epoch 69/400
160/160 [=====] - 0s 237us/step - loss: 0.5247
Epoch 70/400
160/160 [=====] - 0s 249us/step - loss: 0.5232
Epoch 71/400
160/160 [=====] - 0s 246us/step - loss: 0.5214
Epoch 72/400
160/160 [=====] - 0s 237us/step - loss: 0.5197
Epoch 73/400
160/160 [=====] - 0s 231us/step - loss: 0.5186
Epoch 74/400
160/160 [=====] - 0s 231us/step - loss: 0.5164
Epoch 75/400
160/160 [=====] - 0s 231us/step - loss: 0.5146
Epoch 76/400
160/160 [=====] - 0s 231us/step - loss: 0.5134
Epoch 77/400
160/160 [=====] - 0s 231us/step - loss: 0.5118
Epoch 78/400
160/160 [=====] - 0s 224us/step - loss: 0.5109
Epoch 79/400
160/160 [=====] - 0s 234us/step - loss: 0.5095
Epoch 80/400
160/160 [=====] - 0s 224us/step - loss: 0.5085
Epoch 81/400
160/160 [=====] - 0s 231us/step - loss: 0.5068
Epoch 82/400
160/160 [=====] - 0s 228us/step - loss: 0.5053
Epoch 83/400
160/160 [=====] - 0s 237us/step - loss: 0.5045
Epoch 84/400
160/160 [=====] - 0s 231us/step - loss: 0.5031
Epoch 85/400
160/160 [=====] - 0s 228us/step - loss: 0.5023

Epoch 86/400
160/160 [=====] - 0s 224us/step - loss: 0.5007
Epoch 87/400
160/160 [=====] - 0s 224us/step - loss: 0.5006
Epoch 88/400
160/160 [=====] - 0s 240us/step - loss: 0.4990
Epoch 89/400
160/160 [=====] - 0s 237us/step - loss: 0.4980
Epoch 90/400
160/160 [=====] - 0s 237us/step - loss: 0.4973
Epoch 91/400
160/160 [=====] - 0s 231us/step - loss: 0.4962
Epoch 92/400
160/160 [=====] - 0s 231us/step - loss: 0.4951
Epoch 93/400
160/160 [=====] - 0s 237us/step - loss: 0.4946
Epoch 94/400
160/160 [=====] - 0s 237us/step - loss: 0.4936
Epoch 95/400
160/160 [=====] - 0s 237us/step - loss: 0.4928
Epoch 96/400
160/160 [=====] - 0s 237us/step - loss: 0.4915
Epoch 97/400
160/160 [=====] - 0s 243us/step - loss: 0.4916
Epoch 98/400
160/160 [=====] - 0s 243us/step - loss: 0.4903
Epoch 99/400
160/160 [=====] - 0s 234us/step - loss: 0.4896
Epoch 100/400
160/160 [=====] - 0s 231us/step - loss: 0.4890
Epoch 101/400
160/160 [=====] - 0s 237us/step - loss: 0.4879
Epoch 102/400
160/160 [=====] - 0s 234us/step - loss: 0.4875
Epoch 103/400
160/160 [=====] - 0s 231us/step - loss: 0.4865
Epoch 104/400
160/160 [=====] - 0s 231us/step - loss: 0.4857
Epoch 105/400
160/160 [=====] - 0s 243us/step - loss: 0.4853
Epoch 106/400
160/160 [=====] - 0s 237us/step - loss: 0.4852
Epoch 107/400
160/160 [=====] - 0s 237us/step - loss: 0.4839
Epoch 108/400
160/160 [=====] - 0s 237us/step - loss: 0.4836
Epoch 109/400
160/160 [=====] - 0s 237us/step - loss: 0.4829
Epoch 110/400
160/160 [=====] - 0s 243us/step - loss: 0.4825
Epoch 111/400
160/160 [=====] - 0s 231us/step - loss: 0.4817
Epoch 112/400
160/160 [=====] - 0s 237us/step - loss: 0.4811
Epoch 113/400
160/160 [=====] - 0s 231us/step - loss: 0.4810
Epoch 114/400
160/160 [=====] - 0s 224us/step - loss: 0.4806
Epoch 115/400
160/160 [=====] - 0s 243us/step - loss: 0.4795
Epoch 116/400
160/160 [=====] - 0s 237us/step - loss: 0.4793
Epoch 117/400
160/160 [=====] - 0s 234us/step - loss: 0.4786
Epoch 118/400
160/160 [=====] - 0s 231us/step - loss: 0.4777
Epoch 119/400
160/160 [=====] - 0s 243us/step - loss: 0.4776
Epoch 120/400
160/160 [=====] - 0s 237us/step - loss: 0.4765
Epoch 121/400
160/160 [=====] - 0s 231us/step - loss: 0.4770
Epoch 122/400
160/160 [=====] - 0s 224us/step - loss: 0.4761
Epoch 123/400
160/160 [=====] - 0s 243us/step - loss: 0.4756
Epoch 124/400

Epoch 121/400
160/160 [=====] - 0s 249us/step - loss: 0.4753
Epoch 125/400
160/160 [=====] - 0s 231us/step - loss: 0.4743
Epoch 126/400
160/160 [=====] - 0s 237us/step - loss: 0.4741
Epoch 127/400
160/160 [=====] - 0s 231us/step - loss: 0.4740
Epoch 128/400
160/160 [=====] - 0s 237us/step - loss: 0.4740
Epoch 129/400
160/160 [=====] - 0s 231us/step - loss: 0.4728
Epoch 130/400
160/160 [=====] - 0s 237us/step - loss: 0.4721
Epoch 131/400
160/160 [=====] - 0s 237us/step - loss: 0.4719
Epoch 132/400
160/160 [=====] - 0s 224us/step - loss: 0.4720
Epoch 133/400
160/160 [=====] - 0s 228us/step - loss: 0.4715
Epoch 134/400
160/160 [=====] - 0s 243us/step - loss: 0.4706
Epoch 135/400
160/160 [=====] - 0s 234us/step - loss: 0.4713
Epoch 136/400
160/160 [=====] - 0s 224us/step - loss: 0.4703
Epoch 137/400
160/160 [=====] - 0s 231us/step - loss: 0.4702
Epoch 138/400
160/160 [=====] - 0s 231us/step - loss: 0.4690
Epoch 139/400
160/160 [=====] - 0s 224us/step - loss: 0.4691
Epoch 140/400
160/160 [=====] - 0s 224us/step - loss: 0.4689
Epoch 141/400
160/160 [=====] - 0s 231us/step - loss: 0.4683
Epoch 142/400
160/160 [=====] - 0s 237us/step - loss: 0.4679
Epoch 143/400
160/160 [=====] - 0s 249us/step - loss: 0.4671
Epoch 144/400
160/160 [=====] - 0s 287us/step - loss: 0.4673
Epoch 145/400
160/160 [=====] - 0s 256us/step - loss: 0.4670
Epoch 146/400
160/160 [=====] - 0s 256us/step - loss: 0.4662
Epoch 147/400
160/160 [=====] - 0s 243us/step - loss: 0.4664
Epoch 148/400
160/160 [=====] - 0s 256us/step - loss: 0.4654
Epoch 149/400
160/160 [=====] - 0s 237us/step - loss: 0.4657
Epoch 150/400
160/160 [=====] - 0s 249us/step - loss: 0.4655
Epoch 151/400
160/160 [=====] - 0s 231us/step - loss: 0.4654
Epoch 152/400
160/160 [=====] - 0s 231us/step - loss: 0.4649
Epoch 153/400
160/160 [=====] - 0s 224us/step - loss: 0.4641
Epoch 154/400
160/160 [=====] - 0s 231us/step - loss: 0.4640
Epoch 155/400
160/160 [=====] - 0s 243us/step - loss: 0.4632
Epoch 156/400
160/160 [=====] - 0s 231us/step - loss: 0.4633
Epoch 157/400
160/160 [=====] - 0s 224us/step - loss: 0.4629
Epoch 158/400
160/160 [=====] - 0s 224us/step - loss: 0.4624
Epoch 159/400
160/160 [=====] - 0s 237us/step - loss: 0.4629
Epoch 160/400
160/160 [=====] - 0s 231us/step - loss: 0.4624
Epoch 161/400
160/160 [=====] - 0s 224us/step - loss: 0.4619
Epoch 162/400
160/160 [=====] - 0s 224us/step - loss: 0.4619

100%|██████████| 160/160 [=====] - 0s 221us/step - loss: 0.4512
Epoch 163/400
160/160 [=====] - 0s 237us/step - loss: 0.4619
Epoch 164/400
160/160 [=====] - 0s 237us/step - loss: 0.4618
Epoch 165/400
160/160 [=====] - 0s 224us/step - loss: 0.4610
Epoch 166/400
160/160 [=====] - 0s 224us/step - loss: 0.4605
Epoch 167/400
160/160 [=====] - 0s 224us/step - loss: 0.4599
Epoch 168/400
160/160 [=====] - 0s 224us/step - loss: 0.4597
Epoch 169/400
160/160 [=====] - 0s 237us/step - loss: 0.4598
Epoch 170/400
160/160 [=====] - 0s 228us/step - loss: 0.4594
Epoch 171/400
160/160 [=====] - 0s 237us/step - loss: 0.4592
Epoch 172/400
160/160 [=====] - 0s 228us/step - loss: 0.4594
Epoch 173/400
160/160 [=====] - 0s 237us/step - loss: 0.4581
Epoch 174/400
160/160 [=====] - 0s 231us/step - loss: 0.4583
Epoch 175/400
160/160 [=====] - 0s 240us/step - loss: 0.4576
Epoch 176/400
160/160 [=====] - 0s 256us/step - loss: 0.4576
Epoch 177/400
160/160 [=====] - 0s 231us/step - loss: 0.4580
Epoch 178/400
160/160 [=====] - 0s 231us/step - loss: 0.4570
Epoch 179/400
160/160 [=====] - 0s 231us/step - loss: 0.4574
Epoch 180/400
160/160 [=====] - 0s 224us/step - loss: 0.4567
Epoch 181/400
160/160 [=====] - 0s 218us/step - loss: 0.4567
Epoch 182/400
160/160 [=====] - 0s 231us/step - loss: 0.4564
Epoch 183/400
160/160 [=====] - 0s 224us/step - loss: 0.4567
Epoch 184/400
160/160 [=====] - 0s 224us/step - loss: 0.4562
Epoch 185/400
160/160 [=====] - 0s 237us/step - loss: 0.4561
Epoch 186/400
160/160 [=====] - 0s 231us/step - loss: 0.4563
Epoch 187/400
160/160 [=====] - 0s 224us/step - loss: 0.4551
Epoch 188/400
160/160 [=====] - 0s 231us/step - loss: 0.4550
Epoch 189/400
160/160 [=====] - 0s 237us/step - loss: 0.4553
Epoch 190/400
160/160 [=====] - 0s 231us/step - loss: 0.4546
Epoch 191/400
160/160 [=====] - 0s 231us/step - loss: 0.4541
Epoch 192/400
160/160 [=====] - 0s 231us/step - loss: 0.4539
Epoch 193/400
160/160 [=====] - 0s 231us/step - loss: 0.4543
Epoch 194/400
160/160 [=====] - 0s 224us/step - loss: 0.4538
Epoch 195/400
160/160 [=====] - 0s 224us/step - loss: 0.4522
Epoch 196/400
160/160 [=====] - 0s 231us/step - loss: 0.4536
Epoch 197/400
160/160 [=====] - 0s 218us/step - loss: 0.4528
Epoch 198/400
160/160 [=====] - 0s 224us/step - loss: 0.4528
Epoch 199/400
160/160 [=====] - 0s 231us/step - loss: 0.4531
Epoch 200/400
160/160 [=====] - 0s 231us/step - loss: 0.4514
Epoch 201/400

Epoch 201/400
160/160 [=====] - 0s 218us/step - loss: 0.4522
Epoch 202/400
160/160 [=====] - 0s 249us/step - loss: 0.4527
Epoch 203/400
160/160 [=====] - 0s 243us/step - loss: 0.4519
Epoch 204/400
160/160 [=====] - 0s 237us/step - loss: 0.4511
Epoch 205/400
160/160 [=====] - 0s 224us/step - loss: 0.4515
Epoch 206/400
160/160 [=====] - 0s 224us/step - loss: 0.4505
Epoch 207/400
160/160 [=====] - 0s 231us/step - loss: 0.4505
Epoch 208/400
160/160 [=====] - 0s 224us/step - loss: 0.4502
Epoch 209/400
160/160 [=====] - 0s 231us/step - loss: 0.4507
Epoch 210/400
160/160 [=====] - 0s 237us/step - loss: 0.4495
Epoch 211/400
160/160 [=====] - 0s 237us/step - loss: 0.4501
Epoch 212/400
160/160 [=====] - 0s 231us/step - loss: 0.4488
Epoch 213/400
160/160 [=====] - 0s 228us/step - loss: 0.4499
Epoch 214/400
160/160 [=====] - 0s 231us/step - loss: 0.4489
Epoch 215/400
160/160 [=====] - 0s 228us/step - loss: 0.4490
Epoch 216/400
160/160 [=====] - 0s 231us/step - loss: 0.4488
Epoch 217/400
160/160 [=====] - 0s 231us/step - loss: 0.4485
Epoch 218/400
160/160 [=====] - 0s 237us/step - loss: 0.4474
Epoch 219/400
160/160 [=====] - 0s 231us/step - loss: 0.4483
Epoch 220/400
160/160 [=====] - 0s 231us/step - loss: 0.4482
Epoch 221/400
160/160 [=====] - 0s 231us/step - loss: 0.4481
Epoch 222/400
160/160 [=====] - 0s 224us/step - loss: 0.4478
Epoch 223/400
160/160 [=====] - 0s 237us/step - loss: 0.4479
Epoch 224/400
160/160 [=====] - 0s 224us/step - loss: 0.4472
Epoch 225/400
160/160 [=====] - 0s 237us/step - loss: 0.4472
Epoch 226/400
160/160 [=====] - 0s 237us/step - loss: 0.4460
Epoch 227/400
160/160 [=====] - 0s 224us/step - loss: 0.4464
Epoch 228/400
160/160 [=====] - 0s 237us/step - loss: 0.4466
Epoch 229/400
160/160 [=====] - 0s 249us/step - loss: 0.4448
Epoch 230/400
160/160 [=====] - 0s 231us/step - loss: 0.4470
Epoch 231/400
160/160 [=====] - 0s 224us/step - loss: 0.4457
Epoch 232/400
160/160 [=====] - 0s 224us/step - loss: 0.4453
Epoch 233/400
160/160 [=====] - 0s 224us/step - loss: 0.4451
Epoch 234/400
160/160 [=====] - 0s 224us/step - loss: 0.4441
Epoch 235/400
160/160 [=====] - 0s 237us/step - loss: 0.4450
Epoch 236/400
160/160 [=====] - 0s 224us/step - loss: 0.4449
Epoch 237/400
160/160 [=====] - 0s 231us/step - loss: 0.4437
Epoch 238/400
160/160 [=====] - 0s 231us/step - loss: 0.4437
Epoch 239/400
160/160 [=====] - 0s 224us/step - loss: 0.4437

100/100 [=====] - 0s 224us/step - loss: 0.4442
Epoch 240/400
160/160 [=====] - 0s 221us/step - loss: 0.4434
Epoch 241/400
160/160 [=====] - 0s 231us/step - loss: 0.4440
Epoch 242/400
160/160 [=====] - 0s 234us/step - loss: 0.4421
Epoch 243/400
160/160 [=====] - 0s 224us/step - loss: 0.4426
Epoch 244/400
160/160 [=====] - 0s 224us/step - loss: 0.4431
Epoch 245/400
160/160 [=====] - 0s 237us/step - loss: 0.4428
Epoch 246/400
160/160 [=====] - 0s 231us/step - loss: 0.4421
Epoch 247/400
160/160 [=====] - 0s 224us/step - loss: 0.4424
Epoch 248/400
160/160 [=====] - 0s 224us/step - loss: 0.4422
Epoch 249/400
160/160 [=====] - 0s 243us/step - loss: 0.4412
Epoch 250/400
160/160 [=====] - 0s 231us/step - loss: 0.4422
Epoch 251/400
160/160 [=====] - 0s 243us/step - loss: 0.4420
Epoch 252/400
160/160 [=====] - 0s 224us/step - loss: 0.4408
Epoch 253/400
160/160 [=====] - 0s 237us/step - loss: 0.4407
Epoch 254/400
160/160 [=====] - 0s 224us/step - loss: 0.4415
Epoch 255/400
160/160 [=====] - 0s 218us/step - loss: 0.4408
Epoch 256/400
160/160 [=====] - 0s 265us/step - loss: 0.4401
Epoch 257/400
160/160 [=====] - 0s 243us/step - loss: 0.4406
Epoch 258/400
160/160 [=====] - 0s 234us/step - loss: 0.4406
Epoch 259/400
160/160 [=====] - 0s 243us/step - loss: 0.4403
Epoch 260/400
160/160 [=====] - 0s 224us/step - loss: 0.4404
Epoch 261/400
160/160 [=====] - 0s 234us/step - loss: 0.4400
Epoch 262/400
160/160 [=====] - 0s 249us/step - loss: 0.4393
Epoch 263/400
160/160 [=====] - 0s 265us/step - loss: 0.4392
Epoch 264/400
160/160 [=====] - 0s 249us/step - loss: 0.4390
Epoch 265/400
160/160 [=====] - 0s 249us/step - loss: 0.4375
Epoch 266/400
160/160 [=====] - 0s 234us/step - loss: 0.4390
Epoch 267/400
160/160 [=====] - 0s 231us/step - loss: 0.4382
Epoch 268/400
160/160 [=====] - 0s 237us/step - loss: 0.4379
Epoch 269/400
160/160 [=====] - 0s 231us/step - loss: 0.4380
Epoch 270/400
160/160 [=====] - 0s 243us/step - loss: 0.4361
Epoch 271/400
160/160 [=====] - 0s 243us/step - loss: 0.4384
Epoch 272/400
160/160 [=====] - 0s 234us/step - loss: 0.4369
Epoch 273/400
160/160 [=====] - 0s 234us/step - loss: 0.4361
Epoch 274/400
160/160 [=====] - 0s 243us/step - loss: 0.4386
Epoch 275/400
160/160 [=====] - 0s 237us/step - loss: 0.4375
Epoch 276/400
160/160 [=====] - 0s 228us/step - loss: 0.4359
Epoch 277/400
160/160 [=====] - 0s 231us/step - loss: 0.4368
Epoch 278/400

Epoch 270/400
160/160 [=====] - 0s 234us/step - loss: 0.4365
Epoch 279/400
160/160 [=====] - 0s 234us/step - loss: 0.4354
Epoch 280/400
160/160 [=====] - 0s 231us/step - loss: 0.4361
Epoch 281/400
160/160 [=====] - 0s 246us/step - loss: 0.4362
Epoch 282/400
160/160 [=====] - 0s 259us/step - loss: 0.4347
Epoch 283/400
160/160 [=====] - 0s 249us/step - loss: 0.4336
Epoch 284/400
160/160 [=====] - 0s 243us/step - loss: 0.4351
Epoch 285/400
160/160 [=====] - 0s 253us/step - loss: 0.4350
Epoch 286/400
160/160 [=====] - 0s 224us/step - loss: 0.4345
Epoch 287/400
160/160 [=====] - 0s 231us/step - loss: 0.4353
Epoch 288/400
160/160 [=====] - 0s 231us/step - loss: 0.4349
Epoch 289/400
160/160 [=====] - 0s 240us/step - loss: 0.4339
Epoch 290/400
160/160 [=====] - 0s 237us/step - loss: 0.4335
Epoch 291/400
160/160 [=====] - 0s 243us/step - loss: 0.4341
Epoch 292/400
160/160 [=====] - 0s 231us/step - loss: 0.4330
Epoch 293/400
160/160 [=====] - 0s 237us/step - loss: 0.4332
Epoch 294/400
160/160 [=====] - 0s 256us/step - loss: 0.4337
Epoch 295/400
160/160 [=====] - 0s 237us/step - loss: 0.4332
Epoch 296/400
160/160 [=====] - 0s 231us/step - loss: 0.4325
Epoch 297/400
160/160 [=====] - 0s 237us/step - loss: 0.4326
Epoch 298/400
160/160 [=====] - 0s 234us/step - loss: 0.4326
Epoch 299/400
160/160 [=====] - 0s 231us/step - loss: 0.4342
Epoch 300/400
160/160 [=====] - 0s 231us/step - loss: 0.4320
Epoch 301/400
160/160 [=====] - 0s 243us/step - loss: 0.4306
Epoch 302/400
160/160 [=====] - 0s 243us/step - loss: 0.4323
Epoch 303/400
160/160 [=====] - 0s 237us/step - loss: 0.4317
Epoch 304/400
160/160 [=====] - 0s 240us/step - loss: 0.4316
Epoch 305/400
160/160 [=====] - 0s 231us/step - loss: 0.4320
Epoch 306/400
160/160 [=====] - 0s 237us/step - loss: 0.4313
Epoch 307/400
160/160 [=====] - 0s 249us/step - loss: 0.4309
Epoch 308/400
160/160 [=====] - 0s 256us/step - loss: 0.4305
Epoch 309/400
160/160 [=====] - 0s 234us/step - loss: 0.4313
Epoch 310/400
160/160 [=====] - 0s 237us/step - loss: 0.4295
Epoch 311/400
160/160 [=====] - 0s 231us/step - loss: 0.4296
Epoch 312/400
160/160 [=====] - 0s 224us/step - loss: 0.4303
Epoch 313/400
160/160 [=====] - 0s 234us/step - loss: 0.4302
Epoch 314/400
160/160 [=====] - 0s 237us/step - loss: 0.4299
Epoch 315/400
160/160 [=====] - 0s 231us/step - loss: 0.4292
Epoch 316/400

160/160 [=====] - 0s 224us/step - loss: 0.4294
Epoch 317/400
160/160 [=====] - 0s 240us/step - loss: 0.4270
Epoch 318/400
160/160 [=====] - 0s 243us/step - loss: 0.4295
Epoch 319/400
160/160 [=====] - 0s 231us/step - loss: 0.4281
Epoch 320/400
160/160 [=====] - 0s 237us/step - loss: 0.4282
Epoch 321/400
160/160 [=====] - 0s 243us/step - loss: 0.4280
Epoch 322/400
160/160 [=====] - 0s 231us/step - loss: 0.4293
Epoch 323/400
160/160 [=====] - 0s 231us/step - loss: 0.4270
Epoch 324/400
160/160 [=====] - 0s 237us/step - loss: 0.4277
Epoch 325/400
160/160 [=====] - 0s 237us/step - loss: 0.4283
Epoch 326/400
160/160 [=====] - 0s 237us/step - loss: 0.4283
Epoch 327/400
160/160 [=====] - 0s 237us/step - loss: 0.4276
Epoch 328/400
160/160 [=====] - 0s 237us/step - loss: 0.4262
Epoch 329/400
160/160 [=====] - 0s 231us/step - loss: 0.4261
Epoch 330/400
160/160 [=====] - 0s 231us/step - loss: 0.4271
Epoch 331/400
160/160 [=====] - 0s 224us/step - loss: 0.4260
Epoch 332/400
160/160 [=====] - 0s 224us/step - loss: 0.4264
Epoch 333/400
160/160 [=====] - 0s 228us/step - loss: 0.4258
Epoch 334/400
160/160 [=====] - 0s 256us/step - loss: 0.4260
Epoch 335/400
160/160 [=====] - 0s 237us/step - loss: 0.4255
Epoch 336/400
160/160 [=====] - 0s 231us/step - loss: 0.4249
Epoch 337/400
160/160 [=====] - 0s 234us/step - loss: 0.4259
Epoch 338/400
160/160 [=====] - 0s 231us/step - loss: 0.4229
Epoch 339/400
160/160 [=====] - 0s 243us/step - loss: 0.4261
Epoch 340/400
160/160 [=====] - 0s 228us/step - loss: 0.4249
Epoch 341/400
160/160 [=====] - 0s 224us/step - loss: 0.4243
Epoch 342/400
160/160 [=====] - 0s 243us/step - loss: 0.4253
Epoch 343/400
160/160 [=====] - 0s 224us/step - loss: 0.4238
Epoch 344/400
160/160 [=====] - 0s 231us/step - loss: 0.4235
Epoch 345/400
160/160 [=====] - 0s 240us/step - loss: 0.4250
Epoch 346/400
160/160 [=====] - 0s 231us/step - loss: 0.4244
Epoch 347/400
160/160 [=====] - 0s 231us/step - loss: 0.4235
Epoch 348/400
160/160 [=====] - 0s 240us/step - loss: 0.4238
Epoch 349/400
160/160 [=====] - 0s 243us/step - loss: 0.4238
Epoch 350/400
160/160 [=====] - 0s 243us/step - loss: 0.4217
Epoch 351/400
160/160 [=====] - 0s 231us/step - loss: 0.4231
Epoch 352/400
160/160 [=====] - 0s 231us/step - loss: 0.4230
Epoch 353/400
160/160 [=====] - 0s 231us/step - loss: 0.4229
Epoch 354/400
160/160 [=====] - 0s 243us/step - loss: 0.4221

Epoch 355/400
160/160 [=====] - 0s 228us/step - loss: 0.4229
Epoch 356/400
160/160 [=====] - 0s 237us/step - loss: 0.4228
Epoch 357/400
160/160 [=====] - 0s 234us/step - loss: 0.4214
Epoch 358/400
160/160 [=====] - 0s 231us/step - loss: 0.4215
Epoch 359/400
160/160 [=====] - 0s 224us/step - loss: 0.4216
Epoch 360/400
160/160 [=====] - 0s 240us/step - loss: 0.4201
Epoch 361/400
160/160 [=====] - 0s 259us/step - loss: 0.4223
Epoch 362/400
160/160 [=====] - 0s 237us/step - loss: 0.4220
Epoch 363/400
160/160 [=====] - 0s 239us/step - loss: 0.4209
Epoch 364/400
160/160 [=====] - 0s 234us/step - loss: 0.4198
Epoch 365/400
160/160 [=====] - 0s 228us/step - loss: 0.4206
Epoch 366/400
160/160 [=====] - 0s 237us/step - loss: 0.4211
Epoch 367/400
160/160 [=====] - 0s 226us/step - loss: 0.4196
Epoch 368/400
160/160 [=====] - 0s 231us/step - loss: 0.4202
Epoch 369/400
160/160 [=====] - 0s 234us/step - loss: 0.4205
Epoch 370/400
160/160 [=====] - 0s 231us/step - loss: 0.4195
Epoch 371/400
160/160 [=====] - 0s 249us/step - loss: 0.4194
Epoch 372/400
160/160 [=====] - 0s 231us/step - loss: 0.4195
Epoch 373/400
160/160 [=====] - 0s 234us/step - loss: 0.4206
Epoch 374/400
160/160 [=====] - 0s 231us/step - loss: 0.4194
Epoch 375/400
160/160 [=====] - 0s 231us/step - loss: 0.4194
Epoch 376/400
160/160 [=====] - 0s 231us/step - loss: 0.4186
Epoch 377/400
160/160 [=====] - 0s 243us/step - loss: 0.4197
Epoch 378/400
160/160 [=====] - 0s 265us/step - loss: 0.4183
Epoch 379/400
160/160 [=====] - 0s 243us/step - loss: 0.4173
Epoch 380/400
160/160 [=====] - 0s 249us/step - loss: 0.4186
Epoch 381/400
160/160 [=====] - 0s 256us/step - loss: 0.4189
Epoch 382/400
160/160 [=====] - 0s 253us/step - loss: 0.4172
Epoch 383/400
160/160 [=====] - 0s 231us/step - loss: 0.4189
Epoch 384/400
160/160 [=====] - 0s 237us/step - loss: 0.4174
Epoch 385/400
160/160 [=====] - 0s 237us/step - loss: 0.4163
Epoch 386/400
160/160 [=====] - 0s 249us/step - loss: 0.4188
Epoch 387/400
160/160 [=====] - 0s 249us/step - loss: 0.4167
Epoch 388/400
160/160 [=====] - 0s 231us/step - loss: 0.4173
Epoch 389/400
160/160 [=====] - 0s 240us/step - loss: 0.4175
Epoch 390/400
160/160 [=====] - 0s 237us/step - loss: 0.4172
Epoch 391/400
160/160 [=====] - 0s 231us/step - loss: 0.4163
Epoch 392/400
160/160 [=====] - 0s 249us/step - loss: 0.4174
Epoch 393/400

```

160/160 [=====] - 0s 231us/step - loss: 0.4175
Epoch 394/400
160/160 [=====] - 0s 240us/step - loss: 0.4146
Epoch 395/400
160/160 [=====] - 0s 237us/step - loss: 0.4179
Epoch 396/400
160/160 [=====] - 0s 231us/step - loss: 0.4152
Epoch 397/400
160/160 [=====] - 0s 228us/step - loss: 0.4163
Epoch 398/400
160/160 [=====] - 0s 231us/step - loss: 0.4153
Epoch 399/400
160/160 [=====] - 0s 231us/step - loss: 0.4155
Epoch 400/400
160/160 [=====] - 0s 231us/step - loss: 0.4165
[8.4666210e-01 9.9471313e-01 9.7898453e-01 9.9589926e-01 6.1202443e-01
 9.5819879e-01 9.9781501e-01 7.6381326e-01 7.8262115e-01 9.9793363e-01
 9.0822196e-01 8.5054481e-01 9.9824500e-01 9.9738449e-01 8.2042807e-01
 9.9734783e-01 7.7853549e-01 9.9755657e-01 9.9763119e-01 9.9762952e-01
 9.9817967e-01 9.9552035e-01 9.9592257e-01 5.0934792e-01 9.9722099e-01
 7.7880359e-01 9.9737608e-01 9.9770689e-01 9.9766219e-01 9.9888700e-01
 9.1664553e-01 9.9327832e-01 9.1162634e-01 9.5130622e-01 9.9761814e-01
 9.9773186e-01 9.9834442e-01 9.9774915e-01 4.6649364e-01 9.9804950e-01
 4.7547513e-01 4.7862208e-01 4.7524089e-01 4.2001295e-01 4.9696758e-01
 4.9318910e-01 4.9958673e-01 3.1968239e-01 3.5439119e-01 4.9996042e-01
 5.0123835e-01 5.0121653e-01 4.9464989e-01 5.0090772e-01 4.8477551e-01
 4.9981660e-01 5.0031060e-01 5.0065154e-01 5.0045067e-01 4.9891043e-01
 4.9897927e-01 5.0121552e-01 5.0129211e-01 4.9210021e-01 5.0070256e-01
 5.0119317e-01 5.0093204e-01 5.0039953e-01 5.0048387e-01 4.4432843e-01
 5.0134569e-01 4.3440813e-01 4.9865574e-01 4.9708337e-01 5.0048029e-01
 5.0016975e-01 4.9785241e-01 5.0031465e-01 4.5666066e-01 4.9945283e-01
 2.2574125e-01 3.4277409e-02 9.2958011e-02 1.7136483e-02 2.9932943e-01
 1.2904778e-01 8.4809575e-04 2.7070895e-01 2.6146626e-01 9.7644748e-04
 3.3115234e-02 6.8045057e-02 8.8468223e-04 8.5354288e-04 2.2973789e-01
 4.4752983e-03 4.6247202e-01 8.5153145e-04 8.4790372e-04 8.0814362e-03
 1.9804905e-03 1.0557505e-03 9.6533640e-04 3.2916495e-01 1.0460244e-03
 1.2323042e-01 8.5082912e-04 8.7303109e-04 8.6869171e-04 1.2572824e-03
 2.0690726e-02 3.0494658e-02 1.6081886e-01 1.2340198e-01 9.6792518e-04
 8.5124187e-04 2.4781041e-03 8.7777601e-04 4.5492142e-01 9.2556921e-04
 4.9142471e-01 4.9603614e-01 4.9547571e-01 5.3890002e-01 4.9690977e-01
 4.9383515e-01 5.0084990e-01 6.8444943e-01 6.3179308e-01 5.0016159e-01
 5.0122190e-01 5.0120413e-01 4.9976814e-01 5.0120407e-01 4.8974878e-01
 4.9968988e-01 5.0030005e-01 5.0108206e-01 5.0107402e-01 4.9880677e-01
 4.9907452e-01 5.0117868e-01 5.0128633e-01 4.9217042e-01 5.0065595e-01
 5.0118393e-01 5.0128978e-01 5.0073439e-01 5.0080639e-01 5.1207948e-01
 5.0132757e-01 5.2699840e-01 4.9855882e-01 4.9693319e-01 5.0051850e-01
 5.0090736e-01 4.9827784e-01 5.0066292e-01 4.6731317e-01 5.0005168e-01]
160/160 [=====] - 0s 330us/step

```

In [23]:

```
#Two layers, three neurons per layer: loss
scores_lay_two_three, model_lay_two_three.metrics_names
```

Out [23]:

```
(0.41084097921848295, ['loss'])
```

Three Layers

In [24]:

```
n = 40
xx = np.random.random((n,1))
yy = np.random.random((n,1))

X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [25]:

```
#Three layers, three neurons per layer
model_lay_three_three = Sequential()

#hidden layers
model_lay_three_three.add(Dense(3, input_dim=2, activation='tanh'))
model_lay_three_three.add(Dense(3, activation='tanh'))
```

```
model_lay_three.add(Dense(3, activation='tanh'))  
  
#output layer  
model_lay_three.add(Dense(1, activation='sigmoid'))  
  
sgd = SGD(lr=0.1)  
model_lay_three.compile(loss='binary_crossentropy', optimizer='sgd')  
  
model_lay_three.fit(X, y, batch_size=2, epochs=400)  
print(model_lay_three.predict_proba(X).reshape(4*n))  
  
#evaluate the model  
scores_lay_three = model_lay_three.evaluate(X, y)  
  
Epoch 1/400  
160/160 [=====] - 0s 2ms/step - loss: 0.7024  
Epoch 2/400  
160/160 [=====] - 0s 262us/step - loss: 0.6996  
Epoch 3/400  
160/160 [=====] - 0s 265us/step - loss: 0.6968  
Epoch 4/400  
160/160 [=====] - 0s 268us/step - loss: 0.6948  
Epoch 5/400  
160/160 [=====] - 0s 262us/step - loss: 0.6922  
Epoch 6/400  
160/160 [=====] - 0s 274us/step - loss: 0.6898  
Epoch 7/400  
160/160 [=====] - 0s 256us/step - loss: 0.6874  
Epoch 8/400  
160/160 [=====] - 0s 249us/step - loss: 0.6839  
Epoch 9/400  
160/160 [=====] - 0s 243us/step - loss: 0.6814  
Epoch 10/400  
160/160 [=====] - 0s 262us/step - loss: 0.6776  
Epoch 11/400  
160/160 [=====] - 0s 262us/step - loss: 0.6735  
Epoch 12/400  
160/160 [=====] - 0s 268us/step - loss: 0.6681  
Epoch 13/400  
160/160 [=====] - 0s 256us/step - loss: 0.6628  
Epoch 14/400  
160/160 [=====] - 0s 262us/step - loss: 0.6566  
Epoch 15/400  
160/160 [=====] - 0s 249us/step - loss: 0.6511  
Epoch 16/400  
160/160 [=====] - 0s 256us/step - loss: 0.6437  
Epoch 17/400  
160/160 [=====] - 0s 249us/step - loss: 0.6350  
Epoch 18/400  
160/160 [=====] - 0s 256us/step - loss: 0.6267  
Epoch 19/400  
160/160 [=====] - 0s 259us/step - loss: 0.6159  
Epoch 20/400  
160/160 [=====] - 0s 259us/step - loss: 0.6040  
Epoch 21/400  
160/160 [=====] - 0s 256us/step - loss: 0.5896  
Epoch 22/400  
160/160 [=====] - 0s 256us/step - loss: 0.5752  
Epoch 23/400  
160/160 [=====] - 0s 274us/step - loss: 0.5577  
Epoch 24/400  
160/160 [=====] - 0s 256us/step - loss: 0.5366  
Epoch 25/400  
160/160 [=====] - 0s 262us/step - loss: 0.5160  
Epoch 26/400  
160/160 [=====] - 0s 262us/step - loss: 0.4905  
Epoch 27/400  
160/160 [=====] - 0s 246us/step - loss: 0.4673  
Epoch 28/400  
160/160 [=====] - 0s 262us/step - loss: 0.4434  
Epoch 29/400  
160/160 [=====] - 0s 256us/step - loss: 0.4172  
Epoch 30/400  
160/160 [=====] - 0s 256us/step - loss: 0.4011  
Epoch 31/400  
160/160 [=====] - 0s 249us/step - loss: 0.3812  
Epoch 32/400  
160/160 [=====] - 0s 256us/step - loss: 0.3652
```

```
160/160 [=====] - 0s 256us/step - loss: 0.3640
Epoch 33/400
160/160 [=====] - 0s 246us/step - loss: 0.3481
Epoch 34/400
160/160 [=====] - 0s 265us/step - loss: 0.3413
Epoch 35/400
160/160 [=====] - 0s 271us/step - loss: 0.3294
Epoch 36/400
160/160 [=====] - 0s 274us/step - loss: 0.3227
Epoch 37/400
160/160 [=====] - 0s 274us/step - loss: 0.3114
Epoch 38/400
160/160 [=====] - 0s 262us/step - loss: 0.3013
Epoch 39/400
160/160 [=====] - 0s 249us/step - loss: 0.3007
Epoch 40/400
160/160 [=====] - 0s 270us/step - loss: 0.2933
Epoch 41/400
160/160 [=====] - 0s 260us/step - loss: 0.2908
Epoch 42/400
160/160 [=====] - 0s 252us/step - loss: 0.2890
Epoch 43/400
160/160 [=====] - 0s 256us/step - loss: 0.2867
Epoch 44/400
160/160 [=====] - 0s 252us/step - loss: 0.2829
Epoch 45/400
160/160 [=====] - 0s 256us/step - loss: 0.2812
Epoch 46/400
160/160 [=====] - 0s 309us/step - loss: 0.2759
Epoch 47/400
160/160 [=====] - 0s 271us/step - loss: 0.2776
Epoch 48/400
160/160 [=====] - 0s 259us/step - loss: 0.2717
Epoch 49/400
160/160 [=====] - 0s 252us/step - loss: 0.2722
Epoch 50/400
160/160 [=====] - 0s 262us/step - loss: 0.2694
Epoch 51/400
160/160 [=====] - 0s 256us/step - loss: 0.2702
Epoch 52/400
160/160 [=====] - 0s 262us/step - loss: 0.2664
Epoch 53/400
160/160 [=====] - 0s 252us/step - loss: 0.2635
Epoch 54/400
160/160 [=====] - 0s 256us/step - loss: 0.2646
Epoch 55/400
160/160 [=====] - 0s 256us/step - loss: 0.2659
Epoch 56/400
160/160 [=====] - 0s 262us/step - loss: 0.2613
Epoch 57/400
160/160 [=====] - 0s 237us/step - loss: 0.2609
Epoch 58/400
160/160 [=====] - 0s 249us/step - loss: 0.2593
Epoch 59/400
160/160 [=====] - 0s 249us/step - loss: 0.2568
Epoch 60/400
160/160 [=====] - 0s 243us/step - loss: 0.2593
Epoch 61/400
160/160 [=====] - 0s 256us/step - loss: 0.2579
Epoch 62/400
160/160 [=====] - 0s 268us/step - loss: 0.2594
Epoch 63/400
160/160 [=====] - 0s 280us/step - loss: 0.2515
Epoch 64/400
160/160 [=====] - 0s 274us/step - loss: 0.2568
Epoch 65/400
160/160 [=====] - 0s 243us/step - loss: 0.2559
Epoch 66/400
160/160 [=====] - 0s 249us/step - loss: 0.2516
Epoch 67/400
160/160 [=====] - 0s 249us/step - loss: 0.2531
Epoch 68/400
160/160 [=====] - 0s 249us/step - loss: 0.2531
Epoch 69/400
160/160 [=====] - 0s 262us/step - loss: 0.2503
Epoch 70/400
160/160 [=====] - 0s 274us/step - loss: 0.2501
```

Epoch 71/400
160/160 [=====] - 0s 262us/step - loss: 0.2504
Epoch 72/400
160/160 [=====] - 0s 243us/step - loss: 0.2480
Epoch 73/400
160/160 [=====] - 0s 243us/step - loss: 0.2479
Epoch 74/400
160/160 [=====] - 0s 243us/step - loss: 0.2486
Epoch 75/400
160/160 [=====] - 0s 256us/step - loss: 0.2448
Epoch 76/400
160/160 [=====] - 0s 249us/step - loss: 0.2423
Epoch 77/400
160/160 [=====] - 0s 243us/step - loss: 0.2464
Epoch 78/400
160/160 [=====] - 0s 237us/step - loss: 0.2427
Epoch 79/400
160/160 [=====] - 0s 231us/step - loss: 0.2427
Epoch 80/400
160/160 [=====] - 0s 237us/step - loss: 0.2422
Epoch 81/400
160/160 [=====] - 0s 243us/step - loss: 0.2422
Epoch 82/400
160/160 [=====] - 0s 249us/step - loss: 0.2385
Epoch 83/400
160/160 [=====] - 0s 243us/step - loss: 0.2416
Epoch 84/400
160/160 [=====] - 0s 262us/step - loss: 0.2381
Epoch 85/400
160/160 [=====] - 0s 249us/step - loss: 0.2401
Epoch 86/400
160/160 [=====] - 0s 246us/step - loss: 0.2412
Epoch 87/400
160/160 [=====] - 0s 243us/step - loss: 0.2389
Epoch 88/400
160/160 [=====] - 0s 246us/step - loss: 0.2392
Epoch 89/400
160/160 [=====] - 0s 243us/step - loss: 0.2350
Epoch 90/400
160/160 [=====] - 0s 243us/step - loss: 0.2387
Epoch 91/400
160/160 [=====] - 0s 243us/step - loss: 0.2365
Epoch 92/400
160/160 [=====] - 0s 243us/step - loss: 0.2384
Epoch 93/400
160/160 [=====] - 0s 243us/step - loss: 0.2321
Epoch 94/400
160/160 [=====] - 0s 249us/step - loss: 0.2371
Epoch 95/400
160/160 [=====] - 0s 249us/step - loss: 0.2383
Epoch 96/400
160/160 [=====] - 0s 256us/step - loss: 0.2316
Epoch 97/400
160/160 [=====] - 0s 249us/step - loss: 0.2366
Epoch 98/400
160/160 [=====] - 0s 253us/step - loss: 0.2357
Epoch 99/400
160/160 [=====] - 0s 243us/step - loss: 0.2339
Epoch 100/400
160/160 [=====] - 0s 243us/step - loss: 0.2306
Epoch 101/400
160/160 [=====] - 0s 249us/step - loss: 0.2331
Epoch 102/400
160/160 [=====] - 0s 256us/step - loss: 0.2335
Epoch 103/400
160/160 [=====] - 0s 243us/step - loss: 0.2317
Epoch 104/400
160/160 [=====] - 0s 243us/step - loss: 0.2281
Epoch 105/400
160/160 [=====] - 0s 243us/step - loss: 0.2315
Epoch 106/400
160/160 [=====] - 0s 249us/step - loss: 0.2246
Epoch 107/400
160/160 [=====] - 0s 243us/step - loss: 0.2324
Epoch 108/400
160/160 [=====] - 0s 249us/step - loss: 0.2300
Epoch 109/400

160/160 [=====] - 0s 249us/step - loss: 0.2303
Epoch 110/400
160/160 [=====] - 0s 243us/step - loss: 0.2289
Epoch 111/400
160/160 [=====] - 0s 234us/step - loss: 0.2267
Epoch 112/400
160/160 [=====] - 0s 237us/step - loss: 0.2270
Epoch 113/400
160/160 [=====] - 0s 243us/step - loss: 0.2232
Epoch 114/400
160/160 [=====] - 0s 240us/step - loss: 0.2232
Epoch 115/400
160/160 [=====] - 0s 243us/step - loss: 0.2208
Epoch 116/400
160/160 [=====] - 0s 249us/step - loss: 0.2310
Epoch 117/400
160/160 [=====] - 0s 243us/step - loss: 0.2208
Epoch 118/400
160/160 [=====] - 0s 243us/step - loss: 0.2266
Epoch 119/400
160/160 [=====] - 0s 256us/step - loss: 0.2249
Epoch 120/400
160/160 [=====] - 0s 268us/step - loss: 0.2228
Epoch 121/400
160/160 [=====] - 0s 262us/step - loss: 0.2283
Epoch 122/400
160/160 [=====] - 0s 243us/step - loss: 0.2247
Epoch 123/400
160/160 [=====] - 0s 243us/step - loss: 0.2245
Epoch 124/400
160/160 [=====] - 0s 249us/step - loss: 0.2240
Epoch 125/400
160/160 [=====] - 0s 243us/step - loss: 0.2183
Epoch 126/400
160/160 [=====] - 0s 243us/step - loss: 0.2261
Epoch 127/400
160/160 [=====] - 0s 249us/step - loss: 0.2232
Epoch 128/400
160/160 [=====] - 0s 249us/step - loss: 0.2229
Epoch 129/400
160/160 [=====] - 0s 246us/step - loss: 0.2232
Epoch 130/400
160/160 [=====] - 0s 249us/step - loss: 0.2242
Epoch 131/400
160/160 [=====] - 0s 240us/step - loss: 0.2221
Epoch 132/400
160/160 [=====] - 0s 243us/step - loss: 0.2246
Epoch 133/400
160/160 [=====] - 0s 237us/step - loss: 0.2245
Epoch 134/400
160/160 [=====] - 0s 237us/step - loss: 0.2223
Epoch 135/400
160/160 [=====] - 0s 249us/step - loss: 0.2216
Epoch 136/400
160/160 [=====] - 0s 243us/step - loss: 0.2198
Epoch 137/400
160/160 [=====] - 0s 243us/step - loss: 0.2207
Epoch 138/400
160/160 [=====] - 0s 237us/step - loss: 0.2131
Epoch 139/400
160/160 [=====] - 0s 243us/step - loss: 0.2196
Epoch 140/400
160/160 [=====] - 0s 237us/step - loss: 0.2181
Epoch 141/400
160/160 [=====] - 0s 256us/step - loss: 0.2195
Epoch 142/400
160/160 [=====] - 0s 256us/step - loss: 0.2192
Epoch 143/400
160/160 [=====] - 0s 249us/step - loss: 0.2185
Epoch 144/400
160/160 [=====] - 0s 237us/step - loss: 0.2179
Epoch 145/400
160/160 [=====] - 0s 249us/step - loss: 0.2173
Epoch 146/400
160/160 [=====] - 0s 249us/step - loss: 0.2162
Epoch 147/400
160/160 [=====] - 0s 243us/step - loss: 0.2196

Epoch 148/400
160/160 [=====] - 0s 249us/step - loss: 0.2112
Epoch 149/400
160/160 [=====] - 0s 237us/step - loss: 0.2208
Epoch 150/400
160/160 [=====] - 0s 237us/step - loss: 0.2180
Epoch 151/400
160/160 [=====] - 0s 249us/step - loss: 0.2155
Epoch 152/400
160/160 [=====] - 0s 243us/step - loss: 0.2179
Epoch 153/400
160/160 [=====] - 0s 237us/step - loss: 0.2171
Epoch 154/400
160/160 [=====] - 0s 240us/step - loss: 0.2136
Epoch 155/400
160/160 [=====] - 0s 243us/step - loss: 0.2157
Epoch 156/400
160/160 [=====] - 0s 237us/step - loss: 0.2165
Epoch 157/400
160/160 [=====] - 0s 237us/step - loss: 0.2137
Epoch 158/400
160/160 [=====] - 0s 243us/step - loss: 0.2175
Epoch 159/400
160/160 [=====] - 0s 243us/step - loss: 0.2132
Epoch 160/400
160/160 [=====] - 0s 249us/step - loss: 0.2134
Epoch 161/400
160/160 [=====] - 0s 243us/step - loss: 0.2186
Epoch 162/400
160/160 [=====] - 0s 249us/step - loss: 0.2159
Epoch 163/400
160/160 [=====] - 0s 237us/step - loss: 0.2174
Epoch 164/400
160/160 [=====] - 0s 243us/step - loss: 0.2139
Epoch 165/400
160/160 [=====] - 0s 237us/step - loss: 0.2135
Epoch 166/400
160/160 [=====] - 0s 237us/step - loss: 0.2170
Epoch 167/400
160/160 [=====] - 0s 246us/step - loss: 0.2159
Epoch 168/400
160/160 [=====] - 0s 249us/step - loss: 0.2131
Epoch 169/400
160/160 [=====] - 0s 253us/step - loss: 0.2115
Epoch 170/400
160/160 [=====] - 0s 262us/step - loss: 0.2121
Epoch 171/400
160/160 [=====] - 0s 274us/step - loss: 0.2172
Epoch 172/400
160/160 [=====] - 0s 252us/step - loss: 0.2094
Epoch 173/400
160/160 [=====] - 0s 243us/step - loss: 0.2067
Epoch 174/400
160/160 [=====] - 0s 249us/step - loss: 0.2117
Epoch 175/400
160/160 [=====] - 0s 243us/step - loss: 0.2151
Epoch 176/400
160/160 [=====] - 0s 243us/step - loss: 0.2120
Epoch 177/400
160/160 [=====] - 0s 256us/step - loss: 0.2122
Epoch 178/400
160/160 [=====] - 0s 237us/step - loss: 0.2115
Epoch 179/400
160/160 [=====] - 0s 243us/step - loss: 0.2130
Epoch 180/400
160/160 [=====] - 0s 243us/step - loss: 0.2103
Epoch 181/400
160/160 [=====] - 0s 243us/step - loss: 0.2124
Epoch 182/400
160/160 [=====] - 0s 243us/step - loss: 0.2098
Epoch 183/400
160/160 [=====] - 0s 243us/step - loss: 0.2171
Epoch 184/400
160/160 [=====] - 0s 243us/step - loss: 0.2110
Epoch 185/400
160/160 [=====] - 0s 243us/step - loss: 0.2147
Epoch 186/400

160/160 [=====] - 0s 243us/step - loss: 0.2120
Epoch 187/400
160/160 [=====] - 0s 262us/step - loss: 0.2131
Epoch 188/400
160/160 [=====] - 0s 256us/step - loss: 0.2108
Epoch 189/400
160/160 [=====] - 0s 262us/step - loss: 0.2176
Epoch 190/400
160/160 [=====] - 0s 243us/step - loss: 0.2087
Epoch 191/400
160/160 [=====] - 0s 237us/step - loss: 0.2123
Epoch 192/400
160/160 [=====] - 0s 243us/step - loss: 0.2075
Epoch 193/400
160/160 [=====] - 0s 249us/step - loss: 0.2102
Epoch 194/400
160/160 [=====] - 0s 243us/step - loss: 0.2119
Epoch 195/400
160/160 [=====] - 0s 256us/step - loss: 0.2093
Epoch 196/400
160/160 [=====] - 0s 268us/step - loss: 0.2121
Epoch 197/400
160/160 [=====] - 0s 249us/step - loss: 0.2105
Epoch 198/400
160/160 [=====] - 0s 243us/step - loss: 0.2114
Epoch 199/400
160/160 [=====] - 0s 243us/step - loss: 0.2098
Epoch 200/400
160/160 [=====] - 0s 249us/step - loss: 0.2171
Epoch 201/400
160/160 [=====] - 0s 262us/step - loss: 0.2110
Epoch 202/400
160/160 [=====] - 0s 249us/step - loss: 0.2146
Epoch 203/400
160/160 [=====] - 0s 243us/step - loss: 0.2122
Epoch 204/400
160/160 [=====] - 0s 262us/step - loss: 0.2078
Epoch 205/400
160/160 [=====] - 0s 256us/step - loss: 0.2096
Epoch 206/400
160/160 [=====] - 0s 262us/step - loss: 0.2092
Epoch 207/400
160/160 [=====] - 0s 246us/step - loss: 0.2097
Epoch 208/400
160/160 [=====] - 0s 243us/step - loss: 0.2076
Epoch 209/400
160/160 [=====] - 0s 246us/step - loss: 0.2155
Epoch 210/400
160/160 [=====] - 0s 243us/step - loss: 0.2104
Epoch 211/400
160/160 [=====] - 0s 249us/step - loss: 0.2126
Epoch 212/400
160/160 [=====] - 0s 240us/step - loss: 0.2094
Epoch 213/400
160/160 [=====] - 0s 237us/step - loss: 0.2086
Epoch 214/400
160/160 [=====] - 0s 249us/step - loss: 0.2143
Epoch 215/400
160/160 [=====] - 0s 249us/step - loss: 0.2056
Epoch 216/400
160/160 [=====] - 0s 243us/step - loss: 0.2100
Epoch 217/400
160/160 [=====] - 0s 249us/step - loss: 0.2121
Epoch 218/400
160/160 [=====] - 0s 237us/step - loss: 0.2031
Epoch 219/400
160/160 [=====] - 0s 249us/step - loss: 0.2121
Epoch 220/400
160/160 [=====] - 0s 249us/step - loss: 0.2069
Epoch 221/400
160/160 [=====] - 0s 256us/step - loss: 0.2017
Epoch 222/400
160/160 [=====] - 0s 243us/step - loss: 0.2073
Epoch 223/400
160/160 [=====] - 0s 243us/step - loss: 0.2048
Epoch 224/400
160/160 [=====] - 0s 249us/step - loss: 0.2071

Epoch 225/400
160/160 [=====] - 0s 249us/step - loss: 0.1979
Epoch 226/400
160/160 [=====] - 0s 243us/step - loss: 0.2121
Epoch 227/400
160/160 [=====] - 0s 249us/step - loss: 0.2086
Epoch 228/400
160/160 [=====] - 0s 243us/step - loss: 0.2071
Epoch 229/400
160/160 [=====] - 0s 243us/step - loss: 0.2102
Epoch 230/400
160/160 [=====] - 0s 249us/step - loss: 0.2093
Epoch 231/400
160/160 [=====] - 0s 249us/step - loss: 0.2064
Epoch 232/400
160/160 [=====] - 0s 243us/step - loss: 0.2053
Epoch 233/400
160/160 [=====] - 0s 240us/step - loss: 0.2064
Epoch 234/400
160/160 [=====] - 0s 243us/step - loss: 0.2086
Epoch 235/400
160/160 [=====] - 0s 256us/step - loss: 0.2105
Epoch 236/400
160/160 [=====] - 0s 256us/step - loss: 0.2066
Epoch 237/400
160/160 [=====] - 0s 243us/step - loss: 0.2060
Epoch 238/400
160/160 [=====] - 0s 243us/step - loss: 0.2018
Epoch 239/400
160/160 [=====] - 0s 243us/step - loss: 0.2092
Epoch 240/400
160/160 [=====] - 0s 243us/step - loss: 0.2000
Epoch 241/400
160/160 [=====] - 0s 243us/step - loss: 0.2106
Epoch 242/400
160/160 [=====] - 0s 249us/step - loss: 0.2091
Epoch 243/400
160/160 [=====] - 0s 252us/step - loss: 0.2084
Epoch 244/400
160/160 [=====] - 0s 237us/step - loss: 0.2054
Epoch 245/400
160/160 [=====] - 0s 262us/step - loss: 0.2059
Epoch 246/400
160/160 [=====] - 0s 256us/step - loss: 0.2070
Epoch 247/400
160/160 [=====] - 0s 237us/step - loss: 0.2059
Epoch 248/400
160/160 [=====] - 0s 246us/step - loss: 0.1969
Epoch 249/400
160/160 [=====] - 0s 243us/step - loss: 0.2043
Epoch 250/400
160/160 [=====] - 0s 256us/step - loss: 0.2138
Epoch 251/400
160/160 [=====] - 0s 243us/step - loss: 0.2026
Epoch 252/400
160/160 [=====] - 0s 240us/step - loss: 0.2061
Epoch 253/400
160/160 [=====] - 0s 237us/step - loss: 0.2075
Epoch 254/400
160/160 [=====] - 0s 243us/step - loss: 0.2047
Epoch 255/400
160/160 [=====] - 0s 246us/step - loss: 0.2060
Epoch 256/400
160/160 [=====] - 0s 256us/step - loss: 0.2059
Epoch 257/400
160/160 [=====] - 0s 243us/step - loss: 0.2097
Epoch 258/400
160/160 [=====] - 0s 243us/step - loss: 0.2006
Epoch 259/400
160/160 [=====] - 0s 243us/step - loss: 0.2145
Epoch 260/400
160/160 [=====] - 0s 249us/step - loss: 0.2043
Epoch 261/400
160/160 [=====] - 0s 240us/step - loss: 0.2089
Epoch 262/400
160/160 [=====] - 0s 256us/step - loss: 0.2055
Epoch 263/400

160/160 [=====] - 0s 249us/step - loss: 0.2077
Epoch 264/400
160/160 [=====] - 0s 249us/step - loss: 0.2041
Epoch 265/400
160/160 [=====] - 0s 243us/step - loss: 0.1998
Epoch 266/400
160/160 [=====] - 0s 256us/step - loss: 0.2077
Epoch 267/400
160/160 [=====] - 0s 237us/step - loss: 0.2023
Epoch 268/400
160/160 [=====] - 0s 243us/step - loss: 0.2133
Epoch 269/400
160/160 [=====] - 0s 243us/step - loss: 0.2051
Epoch 270/400
160/160 [=====] - 0s 262us/step - loss: 0.2027
Epoch 271/400
160/160 [=====] - 0s 249us/step - loss: 0.2079
Epoch 272/400
160/160 [=====] - 0s 256us/step - loss: 0.2086
Epoch 273/400
160/160 [=====] - 0s 249us/step - loss: 0.2128
Epoch 274/400
160/160 [=====] - 0s 249us/step - loss: 0.2108
Epoch 275/400
160/160 [=====] - 0s 243us/step - loss: 0.2064
Epoch 276/400
160/160 [=====] - 0s 256us/step - loss: 0.1963
Epoch 277/400
160/160 [=====] - 0s 243us/step - loss: 0.2074
Epoch 278/400
160/160 [=====] - 0s 246us/step - loss: 0.2016
Epoch 279/400
160/160 [=====] - 0s 237us/step - loss: 0.2042
Epoch 280/400
160/160 [=====] - 0s 240us/step - loss: 0.2059
Epoch 281/400
160/160 [=====] - 0s 249us/step - loss: 0.2033
Epoch 282/400
160/160 [=====] - 0s 243us/step - loss: 0.2057
Epoch 283/400
160/160 [=====] - 0s 234us/step - loss: 0.2121
Epoch 284/400
160/160 [=====] - 0s 243us/step - loss: 0.2064
Epoch 285/400
160/160 [=====] - 0s 249us/step - loss: 0.2102
Epoch 286/400
160/160 [=====] - 0s 256us/step - loss: 0.2017
Epoch 287/400
160/160 [=====] - 0s 243us/step - loss: 0.1991
Epoch 288/400
160/160 [=====] - 0s 243us/step - loss: 0.2043
Epoch 289/400
160/160 [=====] - 0s 249us/step - loss: 0.2152
Epoch 290/400
160/160 [=====] - 0s 243us/step - loss: 0.2047
Epoch 291/400
160/160 [=====] - 0s 243us/step - loss: 0.2069
Epoch 292/400
160/160 [=====] - 0s 243us/step - loss: 0.2021
Epoch 293/400
160/160 [=====] - 0s 243us/step - loss: 0.2079
Epoch 294/400
160/160 [=====] - 0s 237us/step - loss: 0.2072
Epoch 295/400
160/160 [=====] - 0s 246us/step - loss: 0.2054
Epoch 296/400
160/160 [=====] - 0s 262us/step - loss: 0.1992
Epoch 297/400
160/160 [=====] - 0s 256us/step - loss: 0.2054
Epoch 298/400
160/160 [=====] - 0s 252us/step - loss: 0.2028
Epoch 299/400
160/160 [=====] - 0s 256us/step - loss: 0.2112
Epoch 300/400
160/160 [=====] - 0s 240us/step - loss: 0.2062
Epoch 301/400
160/160 [=====] - 0s 237us/step - loss: 0.2053

Epoch 302/400
160/160 [=====] - 0s 243us/step - loss: 0.2058
Epoch 303/400
160/160 [=====] - 0s 252us/step - loss: 0.2054
Epoch 304/400
160/160 [=====] - 0s 249us/step - loss: 0.1955
Epoch 305/400
160/160 [=====] - 0s 243us/step - loss: 0.2005
Epoch 306/400
160/160 [=====] - 0s 243us/step - loss: 0.2037
Epoch 307/400
160/160 [=====] - 0s 249us/step - loss: 0.2062
Epoch 308/400
160/160 [=====] - 0s 243us/step - loss: 0.2008
Epoch 309/400
160/160 [=====] - 0s 237us/step - loss: 0.2085
Epoch 310/400
160/160 [=====] - 0s 249us/step - loss: 0.2048
Epoch 311/400
160/160 [=====] - 0s 249us/step - loss: 0.2055
Epoch 312/400
160/160 [=====] - 0s 237us/step - loss: 0.1985
Epoch 313/400
160/160 [=====] - 0s 249us/step - loss: 0.2104
Epoch 314/400
160/160 [=====] - 0s 243us/step - loss: 0.2032
Epoch 315/400
160/160 [=====] - 0s 249us/step - loss: 0.1978
Epoch 316/400
160/160 [=====] - 0s 243us/step - loss: 0.2073
Epoch 317/400
160/160 [=====] - 0s 243us/step - loss: 0.2019
Epoch 318/400
160/160 [=====] - 0s 243us/step - loss: 0.1994
Epoch 319/400
160/160 [=====] - 0s 249us/step - loss: 0.2150
Epoch 320/400
160/160 [=====] - 0s 237us/step - loss: 0.2005
Epoch 321/400
160/160 [=====] - 0s 274us/step - loss: 0.2133
Epoch 322/400
160/160 [=====] - 0s 249us/step - loss: 0.1936
Epoch 323/400
160/160 [=====] - 0s 243us/step - loss: 0.2072
Epoch 324/400
160/160 [=====] - 0s 249us/step - loss: 0.2025
Epoch 325/400
160/160 [=====] - 0s 243us/step - loss: 0.2031
Epoch 326/400
160/160 [=====] - 0s 240us/step - loss: 0.1930
Epoch 327/400
160/160 [=====] - 0s 262us/step - loss: 0.2115
Epoch 328/400
160/160 [=====] - 0s 240us/step - loss: 0.2067
Epoch 329/400
160/160 [=====] - 0s 237us/step - loss: 0.2055
Epoch 330/400
160/160 [=====] - 0s 249us/step - loss: 0.2004
Epoch 331/400
160/160 [=====] - 0s 249us/step - loss: 0.2050
Epoch 332/400
160/160 [=====] - 0s 243us/step - loss: 0.2095
Epoch 333/400
160/160 [=====] - 0s 237us/step - loss: 0.1957
Epoch 334/400
160/160 [=====] - 0s 237us/step - loss: 0.2022
Epoch 335/400
160/160 [=====] - 0s 256us/step - loss: 0.2073
Epoch 336/400
160/160 [=====] - 0s 249us/step - loss: 0.2004
Epoch 337/400
160/160 [=====] - 0s 249us/step - loss: 0.2049
Epoch 338/400
160/160 [=====] - 0s 237us/step - loss: 0.2049
Epoch 339/400
160/160 [=====] - 0s 249us/step - loss: 0.2006
Epoch 340/400

160/160 [=====] - 0s 243us/step - loss: 0.2200
Epoch 341/400
160/160 [=====] - 0s 240us/step - loss: 0.2031
Epoch 342/400
160/160 [=====] - 0s 243us/step - loss: 0.2062
Epoch 343/400
160/160 [=====] - 0s 240us/step - loss: 0.2049
Epoch 344/400
160/160 [=====] - 0s 243us/step - loss: 0.1987
Epoch 345/400
160/160 [=====] - 0s 243us/step - loss: 0.2052
Epoch 346/400
160/160 [=====] - 0s 265us/step - loss: 0.2004
Epoch 347/400
160/160 [=====] - 0s 249us/step - loss: 0.1985
Epoch 348/400
160/160 [=====] - 0s 249us/step - loss: 0.2100
Epoch 349/400
160/160 [=====] - 0s 243us/step - loss: 0.2007
Epoch 350/400
160/160 [=====] - 0s 243us/step - loss: 0.2045
Epoch 351/400
160/160 [=====] - 0s 249us/step - loss: 0.2001
Epoch 352/400
160/160 [=====] - 0s 249us/step - loss: 0.2014
Epoch 353/400
160/160 [=====] - 0s 243us/step - loss: 0.2126
Epoch 354/400
160/160 [=====] - 0s 243us/step - loss: 0.2047
Epoch 355/400
160/160 [=====] - 0s 237us/step - loss: 0.1972
Epoch 356/400
160/160 [=====] - 0s 243us/step - loss: 0.2095
Epoch 357/400
160/160 [=====] - 0s 243us/step - loss: 0.2000
Epoch 358/400
160/160 [=====] - 0s 243us/step - loss: 0.2001
Epoch 359/400
160/160 [=====] - 0s 237us/step - loss: 0.2014
Epoch 360/400
160/160 [=====] - 0s 256us/step - loss: 0.1961
Epoch 361/400
160/160 [=====] - 0s 243us/step - loss: 0.2095
Epoch 362/400
160/160 [=====] - 0s 243us/step - loss: 0.2036
Epoch 363/400
160/160 [=====] - 0s 243us/step - loss: 0.2014
Epoch 364/400
160/160 [=====] - 0s 243us/step - loss: 0.2013
Epoch 365/400
160/160 [=====] - 0s 243us/step - loss: 0.2011
Epoch 366/400
160/160 [=====] - 0s 249us/step - loss: 0.2043
Epoch 367/400
160/160 [=====] - 0s 243us/step - loss: 0.2030
Epoch 368/400
160/160 [=====] - 0s 243us/step - loss: 0.1999
Epoch 369/400
160/160 [=====] - 0s 246us/step - loss: 0.2068
Epoch 370/400
160/160 [=====] - 0s 243us/step - loss: 0.2002
Epoch 371/400
160/160 [=====] - 0s 249us/step - loss: 0.2042
Epoch 372/400
160/160 [=====] - 0s 256us/step - loss: 0.2037
Epoch 373/400
160/160 [=====] - 0s 243us/step - loss: 0.1946
Epoch 374/400
160/160 [=====] - 0s 256us/step - loss: 0.1991
Epoch 375/400
160/160 [=====] - 0s 237us/step - loss: 0.2019
Epoch 376/400
160/160 [=====] - 0s 249us/step - loss: 0.2020
Epoch 377/400
160/160 [=====] - 0s 249us/step - loss: 0.2050
Epoch 378/400
160/160 [=====] - 0s 262us/step - loss: 0.2034

```
Epoch 379/400
160/160 [=====] - 0s 243us/step - loss: 0.2025
Epoch 380/400
160/160 [=====] - 0s 249us/step - loss: 0.2033
Epoch 381/400
160/160 [=====] - 0s 259us/step - loss: 0.1996
Epoch 382/400
160/160 [=====] - 0s 243us/step - loss: 0.2084
Epoch 383/400
160/160 [=====] - 0s 237us/step - loss: 0.2140
Epoch 384/400
160/160 [=====] - 0s 246us/step - loss: 0.1965
Epoch 385/400
160/160 [=====] - 0s 249us/step - loss: 0.2000
Epoch 386/400
160/160 [=====] - 0s 259us/step - loss: 0.1996
Epoch 387/400
160/160 [=====] - 0s 277us/step - loss: 0.2051
Epoch 388/400
160/160 [=====] - 0s 274us/step - loss: 0.1987
Epoch 389/400
160/160 [=====] - 0s 280us/step - loss: 0.1978
Epoch 390/400
160/160 [=====] - 0s 259us/step - loss: 0.2048
Epoch 391/400
160/160 [=====] - 0s 243us/step - loss: 0.2109
Epoch 392/400
160/160 [=====] - 0s 256us/step - loss: 0.2125
Epoch 393/400
160/160 [=====] - 0s 262us/step - loss: 0.1986
Epoch 394/400
160/160 [=====] - 0s 268us/step - loss: 0.2028
Epoch 395/400
160/160 [=====] - 0s 281us/step - loss: 0.2029
Epoch 396/400
160/160 [=====] - 0s 293us/step - loss: 0.2077
Epoch 397/400
160/160 [=====] - 0s 274us/step - loss: 0.2058
Epoch 398/400
160/160 [=====] - 0s 274us/step - loss: 0.2020
Epoch 399/400
160/160 [=====] - 0s 274us/step - loss: 0.2054
Epoch 400/400
160/160 [=====] - 0s 256us/step - loss: 0.1991
[0.9035968 0.9038389 0.81587255 0.90360093 0.9041638 0.7789857
 0.9038381 0.90352607 0.90383244 0.9037784 0.8868341 0.5073087
 0.90471244 0.90366864 0.9036428 0.9035793 0.9048448 0.90363675
 0.9035894 0.90434223 0.9035937 0.90358955 0.9036314 0.9035685
 0.9035433 0.88722336 0.9038453 0.9047714 0.87145543 0.9037748
 0.90359205 0.90469676 0.90357494 0.90353066 0.90390575 0.9036574
 0.903765 0.90358186 0.9003477 0.90381813 0.9034772 0.9036166
 0.80345225 0.90347576 0.9038602 0.87893075 0.90366197 0.9035151
 0.90367603 0.9036561 0.89954394 0.818332 0.903664 0.903519
 0.9034681 0.903447 0.90402335 0.9034991 0.9034711 0.9030096
 0.90344995 0.90347993 0.9034684 0.9035137 0.90350634 0.8996707
 0.9036323 0.90407944 0.8660266 0.9041207 0.90344054 0.90350604
 0.90351546 0.9035202 0.90370274 0.9035059 0.9036686 0.9034518
 0.90357155 0.90365165 0.00205026 0.00164107 0.00161681 0.0017766
 0.00162976 0.00163477 0.00167494 0.90353894 0.00162241 0.00162739
 0.00930594 0.00164714 0.00192885 0.00213034 0.00163409 0.00163484
 0.00161892 0.00221413 0.00177651 0.00161846 0.00164256 0.00656511
 0.00164537 0.9036665 0.9039558 0.00777336 0.00163786 0.00163243
 0.00162038 0.0773616 0.00163922 0.00162112 0.44387674 0.9035793
 0.00163197 0.00164104 0.00226122 0.00162771 0.00162835 0.00162926
 0.00376164 0.00188341 0.00195913 0.00268629 0.00190062 0.00190684
 0.00227259 0.9035228 0.00193537 0.0020706 0.06879543 0.00212281
 0.00318355 0.00413029 0.00189941 0.00189397 0.00195188 0.00447962
 0.00268555 0.00195174 0.00187688 0.03073413 0.00187258 0.90360177
 0.90401614 0.0527649 0.00189119 0.00189232 0.00204921 0.43564552
 0.0018844 0.00193121 0.7004663 0.90355515 0.00189562 0.00187842
 0.00440584 0.00192209 0.00195787 0.00190398]
160/160 [=====] - 0s 374us/step
```

In [26]:

```
#Three layers, three neurons per layer: loss
scores = np.array([np.mean(score) for score in scores])
```

```
model_lay_three.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accuracy'])
```

Out[26]:

```
(0.19233208596706391, ['loss'])
```

Four Layers

In [27]:

```
n = 40
xx = np.random.random((n,1))
yy = np.random.random((n,1))

X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [28]:

```
#Four layers, three neurons per layer
model_lay_four_three = Sequential()

#hidden layers
model_lay_four_three.add(Dense(3, input_dim=2, activation='tanh'))
model_lay_four_three.add(Dense(3, activation='tanh'))
model_lay_four_three.add(Dense(3, activation='tanh'))
model_lay_four_three.add(Dense(3, activation='tanh'))

#output layer
model_lay_four_three.add(Dense(1, activation='sigmoid'))

sgd = SGD(lr=0.1)
model_lay_four_three.compile(loss='binary_crossentropy', optimizer='sgd')

model_lay_four_three.fit(X, y, batch_size=2, epochs=400)
print(model_lay_four_three.predict_proba(X).reshape(4*n))

#evaluate the model
scores_lay_four_three = model_lay_four_three.evaluate(X, y)
```

```
Epoch 1/400
160/160 [=====] - 0s 2ms/step - loss: 0.6961
Epoch 2/400
160/160 [=====] - 0s 262us/step - loss: 0.6931
Epoch 3/400
160/160 [=====] - 0s 249us/step - loss: 0.6912
Epoch 4/400
160/160 [=====] - 0s 256us/step - loss: 0.6893
Epoch 5/400
160/160 [=====] - 0s 293us/step - loss: 0.6875
Epoch 6/400
160/160 [=====] - 0s 274us/step - loss: 0.6855
Epoch 7/400
160/160 [=====] - 0s 256us/step - loss: 0.6831
Epoch 8/400
160/160 [=====] - 0s 262us/step - loss: 0.6805
Epoch 9/400
160/160 [=====] - 0s 249us/step - loss: 0.6782
Epoch 10/400
160/160 [=====] - 0s 252us/step - loss: 0.6753
Epoch 11/400
160/160 [=====] - 0s 256us/step - loss: 0.6719
Epoch 12/400
160/160 [=====] - 0s 262us/step - loss: 0.6683
Epoch 13/400
160/160 [=====] - 0s 259us/step - loss: 0.6651
Epoch 14/400
160/160 [=====] - 0s 262us/step - loss: 0.6615
Epoch 15/400
160/160 [=====] - 0s 259us/step - loss: 0.6581
Epoch 16/400
160/160 [=====] - 0s 268us/step - loss: 0.6538
Epoch 17/400
160/160 [=====] - 0s 259us/step - loss: 0.6505
Epoch 18/400
160/160 [=====] - 0s 256us/step - loss: 0.6440
Epoch 19/400
160/160 [=====] - 0s 262us/step - loss: 0.6427
```

```
Epoch 20/400
160/160 [=====] - 0s 268us/step - loss: 0.6378
Epoch 21/400
160/160 [=====] - 0s 268us/step - loss: 0.6352
Epoch 22/400
160/160 [=====] - 0s 268us/step - loss: 0.6320
Epoch 23/400
160/160 [=====] - 0s 293us/step - loss: 0.6285
Epoch 24/400
160/160 [=====] - 0s 287us/step - loss: 0.6258
Epoch 25/400
160/160 [=====] - 0s 299us/step - loss: 0.6217
Epoch 26/400
160/160 [=====] - 0s 299us/step - loss: 0.6187
Epoch 27/400
160/160 [=====] - 0s 287us/step - loss: 0.6177
Epoch 28/400
160/160 [=====] - 0s 293us/step - loss: 0.6144
Epoch 29/400
160/160 [=====] - 0s 299us/step - loss: 0.6125
Epoch 30/400
160/160 [=====] - 0s 268us/step - loss: 0.6082
Epoch 31/400
160/160 [=====] - 0s 293us/step - loss: 0.6076
Epoch 32/400
160/160 [=====] - 0s 291us/step - loss: 0.6037
Epoch 33/400
160/160 [=====] - 0s 299us/step - loss: 0.6027
Epoch 34/400
160/160 [=====] - 0s 287us/step - loss: 0.6004
Epoch 35/400
160/160 [=====] - 0s 249us/step - loss: 0.5987
Epoch 36/400
160/160 [=====] - 0s 256us/step - loss: 0.5964
Epoch 37/400
160/160 [=====] - 0s 274us/step - loss: 0.5947
Epoch 38/400
160/160 [=====] - 0s 280us/step - loss: 0.5928
Epoch 39/400
160/160 [=====] - 0s 281us/step - loss: 0.5918
Epoch 40/400
160/160 [=====] - 0s 274us/step - loss: 0.5902
Epoch 41/400
160/160 [=====] - 0s 274us/step - loss: 0.5894
Epoch 42/400
160/160 [=====] - 0s 280us/step - loss: 0.5856
Epoch 43/400
160/160 [=====] - 0s 268us/step - loss: 0.5837
Epoch 44/400
160/160 [=====] - 0s 281us/step - loss: 0.5810
Epoch 45/400
160/160 [=====] - 0s 262us/step - loss: 0.5802
Epoch 46/400
160/160 [=====] - 0s 256us/step - loss: 0.5769
Epoch 47/400
160/160 [=====] - 0s 256us/step - loss: 0.5737
Epoch 48/400
160/160 [=====] - 0s 256us/step - loss: 0.5726
Epoch 49/400
160/160 [=====] - 0s 259us/step - loss: 0.5674
Epoch 50/400
160/160 [=====] - 0s 262us/step - loss: 0.5651
Epoch 51/400
160/160 [=====] - 0s 271us/step - loss: 0.5611
Epoch 52/400
160/160 [=====] - 0s 274us/step - loss: 0.5567
Epoch 53/400
160/160 [=====] - 0s 274us/step - loss: 0.5552
Epoch 54/400
160/160 [=====] - 0s 271us/step - loss: 0.5454
Epoch 55/400
160/160 [=====] - 0s 268us/step - loss: 0.5401
Epoch 56/400
160/160 [=====] - 0s 262us/step - loss: 0.5337
Epoch 57/400
160/160 [=====] - 0s 265us/step - loss: 0.5219
Epoch 58/400
```

```
Epoch 58/400
160/160 [=====] - 0s 256us/step - loss: 0.5158
Epoch 59/400
160/160 [=====] - 0s 262us/step - loss: 0.5019
Epoch 60/400
160/160 [=====] - 0s 262us/step - loss: 0.5004
Epoch 61/400
160/160 [=====] - 0s 268us/step - loss: 0.4894
Epoch 62/400
160/160 [=====] - 0s 249us/step - loss: 0.4798
Epoch 63/400
160/160 [=====] - 0s 262us/step - loss: 0.4723
Epoch 64/400
160/160 [=====] - 0s 256us/step - loss: 0.4581
Epoch 65/400
160/160 [=====] - 0s 256us/step - loss: 0.4445
Epoch 66/400
160/160 [=====] - 0s 281us/step - loss: 0.4432
Epoch 67/400
160/160 [=====] - 0s 256us/step - loss: 0.4349
Epoch 68/400
160/160 [=====] - 0s 268us/step - loss: 0.4359
Epoch 69/400
160/160 [=====] - 0s 268us/step - loss: 0.4267
Epoch 70/400
160/160 [=====] - 0s 262us/step - loss: 0.4190
Epoch 71/400
160/160 [=====] - 0s 268us/step - loss: 0.4134
Epoch 72/400
160/160 [=====] - 0s 256us/step - loss: 0.4150
Epoch 73/400
160/160 [=====] - 0s 256us/step - loss: 0.4118
Epoch 74/400
160/160 [=====] - 0s 274us/step - loss: 0.3946
Epoch 75/400
160/160 [=====] - 0s 271us/step - loss: 0.4023
Epoch 76/400
160/160 [=====] - 0s 256us/step - loss: 0.3981
Epoch 77/400
160/160 [=====] - 0s 259us/step - loss: 0.3926
Epoch 78/400
160/160 [=====] - 0s 256us/step - loss: 0.3966
Epoch 79/400
160/160 [=====] - 0s 256us/step - loss: 0.3938
Epoch 80/400
160/160 [=====] - 0s 256us/step - loss: 0.3869
Epoch 81/400
160/160 [=====] - 0s 262us/step - loss: 0.3832
Epoch 82/400
160/160 [=====] - 0s 256us/step - loss: 0.3751
Epoch 83/400
160/160 [=====] - 0s 256us/step - loss: 0.3599
Epoch 84/400
160/160 [=====] - 0s 262us/step - loss: 0.3634
Epoch 85/400
160/160 [=====] - 0s 256us/step - loss: 0.3689
Epoch 86/400
160/160 [=====] - 0s 249us/step - loss: 0.3623
Epoch 87/400
160/160 [=====] - 0s 256us/step - loss: 0.3503
Epoch 88/400
160/160 [=====] - 0s 249us/step - loss: 0.3483
Epoch 89/400
160/160 [=====] - 0s 262us/step - loss: 0.3379
Epoch 90/400
160/160 [=====] - 0s 274us/step - loss: 0.3370
Epoch 91/400
160/160 [=====] - 0s 256us/step - loss: 0.3329
Epoch 92/400
160/160 [=====] - 0s 259us/step - loss: 0.3216
Epoch 93/400
160/160 [=====] - 0s 256us/step - loss: 0.3205
Epoch 94/400
160/160 [=====] - 0s 252us/step - loss: 0.3100
Epoch 95/400
160/160 [=====] - 0s 256us/step - loss: 0.3035
Epoch 96/400
160/160 [=====] - 0s 256us/step - loss: 0.2832
```

100/100 Epoch 97/400
160/160 [=====] - 0s 260us/step - loss: 0.3022
Epoch 98/400
160/160 [=====] - 0s 268us/step - loss: 0.2938
Epoch 99/400
160/160 [=====] - 0s 274us/step - loss: 0.2788
Epoch 100/400
160/160 [=====] - 0s 262us/step - loss: 0.2659
Epoch 101/400
160/160 [=====] - 0s 262us/step - loss: 0.2625
Epoch 102/400
160/160 [=====] - 0s 299us/step - loss: 0.2696
Epoch 103/400
160/160 [=====] - 0s 293us/step - loss: 0.2561
Epoch 104/400
160/160 [=====] - 0s 274us/step - loss: 0.2323
Epoch 105/400
160/160 [=====] - 0s 268us/step - loss: 0.2447
Epoch 106/400
160/160 [=====] - 0s 268us/step - loss: 0.2411
Epoch 107/400
160/160 [=====] - 0s 256us/step - loss: 0.2434
Epoch 108/400
160/160 [=====] - 0s 262us/step - loss: 0.2386
Epoch 109/400
160/160 [=====] - 0s 280us/step - loss: 0.2326
Epoch 110/400
160/160 [=====] - 0s 274us/step - loss: 0.2373
Epoch 111/400
160/160 [=====] - 0s 268us/step - loss: 0.2226
Epoch 112/400
160/160 [=====] - 0s 274us/step - loss: 0.2264
Epoch 113/400
160/160 [=====] - 0s 268us/step - loss: 0.2114
Epoch 114/400
160/160 [=====] - 0s 256us/step - loss: 0.2083
Epoch 115/400
160/160 [=====] - 0s 252us/step - loss: 0.2224
Epoch 116/400
160/160 [=====] - 0s 249us/step - loss: 0.2259
Epoch 117/400
160/160 [=====] - 0s 249us/step - loss: 0.2050
Epoch 118/400
160/160 [=====] - 0s 252us/step - loss: 0.2113
Epoch 119/400
160/160 [=====] - 0s 249us/step - loss: 0.2044
Epoch 120/400
160/160 [=====] - 0s 249us/step - loss: 0.2067
Epoch 121/400
160/160 [=====] - 0s 268us/step - loss: 0.1955
Epoch 122/400
160/160 [=====] - 0s 293us/step - loss: 0.2073
Epoch 123/400
160/160 [=====] - 0s 274us/step - loss: 0.2045
Epoch 124/400
160/160 [=====] - 0s 299us/step - loss: 0.1979
Epoch 125/400
160/160 [=====] - 0s 281us/step - loss: 0.1968
Epoch 126/400
160/160 [=====] - 0s 293us/step - loss: 0.2083
Epoch 127/400
160/160 [=====] - 0s 287us/step - loss: 0.1981
Epoch 128/400
160/160 [=====] - 0s 262us/step - loss: 0.1977
Epoch 129/400
160/160 [=====] - 0s 265us/step - loss: 0.1898
Epoch 130/400
160/160 [=====] - 0s 268us/step - loss: 0.1886
Epoch 131/400
160/160 [=====] - 0s 277us/step - loss: 0.1845
Epoch 132/400
160/160 [=====] - 0s 274us/step - loss: 0.1885
Epoch 133/400
160/160 [=====] - 0s 271us/step - loss: 0.1817
Epoch 134/400
160/160 [=====] - 0s 262us/step - loss: 0.1976
Epoch 135/400

Epoch 135/400
160/160 [=====] - 0s 274us/step - loss: 0.1784
Epoch 136/400
160/160 [=====] - 0s 252us/step - loss: 0.1942
Epoch 137/400
160/160 [=====] - 0s 268us/step - loss: 0.1807
Epoch 138/400
160/160 [=====] - 0s 274us/step - loss: 0.1726
Epoch 139/400
160/160 [=====] - 0s 268us/step - loss: 0.1902
Epoch 140/400
160/160 [=====] - 0s 256us/step - loss: 0.1892
Epoch 141/400
160/160 [=====] - 0s 262us/step - loss: 0.1724
Epoch 142/400
160/160 [=====] - 0s 256us/step - loss: 0.1845
Epoch 143/400
160/160 [=====] - 0s 249us/step - loss: 0.1626
Epoch 144/400
160/160 [=====] - 0s 268us/step - loss: 0.1709
Epoch 145/400
160/160 [=====] - 0s 268us/step - loss: 0.1786
Epoch 146/400
160/160 [=====] - 0s 256us/step - loss: 0.1636
Epoch 147/400
160/160 [=====] - 0s 256us/step - loss: 0.1800
Epoch 148/400
160/160 [=====] - 0s 262us/step - loss: 0.1642
Epoch 149/400
160/160 [=====] - 0s 256us/step - loss: 0.1732
Epoch 150/400
160/160 [=====] - 0s 262us/step - loss: 0.1601
Epoch 151/400
160/160 [=====] - 0s 249us/step - loss: 0.1782
Epoch 152/400
160/160 [=====] - 0s 249us/step - loss: 0.1720
Epoch 153/400
160/160 [=====] - 0s 256us/step - loss: 0.1520
Epoch 154/400
160/160 [=====] - 0s 262us/step - loss: 0.1561
Epoch 155/400
160/160 [=====] - 0s 262us/step - loss: 0.1786
Epoch 156/400
160/160 [=====] - 0s 274us/step - loss: 0.1594
Epoch 157/400
160/160 [=====] - 0s 284us/step - loss: 0.1514
Epoch 158/400
160/160 [=====] - 0s 268us/step - loss: 0.1563
Epoch 159/400
160/160 [=====] - 0s 281us/step - loss: 0.1682
Epoch 160/400
160/160 [=====] - 0s 290us/step - loss: 0.1652
Epoch 161/400
160/160 [=====] - 0s 293us/step - loss: 0.1512
Epoch 162/400
160/160 [=====] - 0s 274us/step - loss: 0.1632
Epoch 163/400
160/160 [=====] - 0s 262us/step - loss: 0.1606
Epoch 164/400
160/160 [=====] - 0s 262us/step - loss: 0.1598
Epoch 165/400
160/160 [=====] - 0s 262us/step - loss: 0.1572
Epoch 166/400
160/160 [=====] - 0s 249us/step - loss: 0.1483
Epoch 167/400
160/160 [=====] - 0s 262us/step - loss: 0.1620
Epoch 168/400
160/160 [=====] - 0s 280us/step - loss: 0.1594
Epoch 169/400
160/160 [=====] - 0s 256us/step - loss: 0.1594
Epoch 170/400
160/160 [=====] - 0s 249us/step - loss: 0.1552
Epoch 171/400
160/160 [=====] - 0s 259us/step - loss: 0.1377
Epoch 172/400
160/160 [=====] - 0s 256us/step - loss: 0.1460
Epoch 173/400
160/160 [=====] - 0s 262us/step - loss: 0.1565

100/100 [=====] - 0s 262us/step - loss: 0.1500
Epoch 174/400
160/160 [=====] - 0s 259us/step - loss: 0.1428
Epoch 175/400
160/160 [=====] - 0s 268us/step - loss: 0.1367
Epoch 176/400
160/160 [=====] - 0s 259us/step - loss: 0.1479
Epoch 177/400
160/160 [=====] - 0s 249us/step - loss: 0.1591
Epoch 178/400
160/160 [=====] - 0s 252us/step - loss: 0.1773
Epoch 179/400
160/160 [=====] - 0s 262us/step - loss: 0.1495
Epoch 180/400
160/160 [=====] - 0s 256us/step - loss: 0.1484
Epoch 181/400
160/160 [=====] - 0s 262us/step - loss: 0.1448
Epoch 182/400
160/160 [=====] - 0s 262us/step - loss: 0.1391
Epoch 183/400
160/160 [=====] - 0s 262us/step - loss: 0.1393
Epoch 184/400
160/160 [=====] - 0s 249us/step - loss: 0.1353
Epoch 185/400
160/160 [=====] - 0s 249us/step - loss: 0.1494
Epoch 186/400
160/160 [=====] - 0s 265us/step - loss: 0.1299
Epoch 187/400
160/160 [=====] - 0s 256us/step - loss: 0.1535
Epoch 188/400
160/160 [=====] - 0s 256us/step - loss: 0.1398
Epoch 189/400
160/160 [=====] - 0s 262us/step - loss: 0.1498
Epoch 190/400
160/160 [=====] - 0s 256us/step - loss: 0.1543
Epoch 191/400
160/160 [=====] - 0s 256us/step - loss: 0.1211
Epoch 192/400
160/160 [=====] - 0s 281us/step - loss: 0.1552
Epoch 193/400
160/160 [=====] - 0s 274us/step - loss: 0.1727
Epoch 194/400
160/160 [=====] - 0s 274us/step - loss: 0.1413
Epoch 195/400
160/160 [=====] - 0s 249us/step - loss: 0.1548
Epoch 196/400
160/160 [=====] - 0s 256us/step - loss: 0.1608
Epoch 197/400
160/160 [=====] - 0s 249us/step - loss: 0.1393
Epoch 198/400
160/160 [=====] - 0s 256us/step - loss: 0.1671
Epoch 199/400
160/160 [=====] - 0s 249us/step - loss: 0.1473
Epoch 200/400
160/160 [=====] - 0s 246us/step - loss: 0.1212
Epoch 201/400
160/160 [=====] - 0s 256us/step - loss: 0.1316
Epoch 202/400
160/160 [=====] - 0s 256us/step - loss: 0.1297
Epoch 203/400
160/160 [=====] - 0s 252us/step - loss: 0.1499
Epoch 204/400
160/160 [=====] - 0s 262us/step - loss: 0.1552
Epoch 205/400
160/160 [=====] - 0s 256us/step - loss: 0.1394
Epoch 206/400
160/160 [=====] - 0s 262us/step - loss: 0.1332
Epoch 207/400
160/160 [=====] - 0s 249us/step - loss: 0.1390
Epoch 208/400
160/160 [=====] - 0s 268us/step - loss: 0.1251
Epoch 209/400
160/160 [=====] - 0s 262us/step - loss: 0.1628
Epoch 210/400
160/160 [=====] - 0s 256us/step - loss: 0.1428
Epoch 211/400
160/160 [=====] - 0s 256us/step - loss: 0.1259
Epoch 212/400

Epoch 212/400
160/160 [=====] - 0s 268us/step - loss: 0.1660
Epoch 213/400
160/160 [=====] - 0s 268us/step - loss: 0.1522
Epoch 214/400
160/160 [=====] - 0s 277us/step - loss: 0.0948
Epoch 215/400
160/160 [=====] - 0s 299us/step - loss: 0.1105
Epoch 216/400
160/160 [=====] - 0s 309us/step - loss: 0.1359
Epoch 217/400
160/160 [=====] - 0s 274us/step - loss: 0.1227
Epoch 218/400
160/160 [=====] - 0s 284us/step - loss: 0.1113
Epoch 219/400
160/160 [=====] - 0s 274us/step - loss: 0.1177
Epoch 220/400
160/160 [=====] - 0s 274us/step - loss: 0.1257
Epoch 221/400
160/160 [=====] - 0s 252us/step - loss: 0.0989
Epoch 222/400
160/160 [=====] - 0s 262us/step - loss: 0.1357
Epoch 223/400
160/160 [=====] - 0s 287us/step - loss: 0.1247
Epoch 224/400
160/160 [=====] - 0s 296us/step - loss: 0.1119
Epoch 225/400
160/160 [=====] - 0s 268us/step - loss: 0.1324
Epoch 226/400
160/160 [=====] - 0s 268us/step - loss: 0.1168
Epoch 227/400
160/160 [=====] - 0s 274us/step - loss: 0.1130
Epoch 228/400
160/160 [=====] - 0s 355us/step - loss: 0.1500
Epoch 229/400
160/160 [=====] - 0s 299us/step - loss: 0.1128
Epoch 230/400
160/160 [=====] - 0s 281us/step - loss: 0.1182
Epoch 231/400
160/160 [=====] - 0s 271us/step - loss: 0.1166
Epoch 232/400
160/160 [=====] - 0s 268us/step - loss: 0.1008
Epoch 233/400
160/160 [=====] - 0s 299us/step - loss: 0.1096
Epoch 234/400
160/160 [=====] - 0s 299us/step - loss: 0.0965
Epoch 235/400
160/160 [=====] - 0s 287us/step - loss: 0.1062
Epoch 236/400
160/160 [=====] - 0s 265us/step - loss: 0.1265
Epoch 237/400
160/160 [=====] - 0s 281us/step - loss: 0.1016
Epoch 238/400
160/160 [=====] - 0s 296us/step - loss: 0.1203
Epoch 239/400
160/160 [=====] - 0s 256us/step - loss: 0.1269
Epoch 240/400
160/160 [=====] - 0s 262us/step - loss: 0.1233
Epoch 241/400
160/160 [=====] - 0s 265us/step - loss: 0.1272
Epoch 242/400
160/160 [=====] - 0s 262us/step - loss: 0.1119
Epoch 243/400
160/160 [=====] - 0s 259us/step - loss: 0.1123
Epoch 244/400
160/160 [=====] - 0s 249us/step - loss: 0.1189
Epoch 245/400
160/160 [=====] - 0s 256us/step - loss: 0.1020
Epoch 246/400
160/160 [=====] - 0s 256us/step - loss: 0.1219
Epoch 247/400
160/160 [=====] - 0s 280us/step - loss: 0.0925
Epoch 248/400
160/160 [=====] - 0s 284us/step - loss: 0.1201
Epoch 249/400
160/160 [=====] - 0s 287us/step - loss: 0.0907
Epoch 250/400

160/160 [=====] - 0s 293us/step - loss: 0.0953
Epoch 251/400
160/160 [=====] - 0s 287us/step - loss: 0.0817
Epoch 252/400
160/160 [=====] - 0s 299us/step - loss: 0.1228
Epoch 253/400
160/160 [=====] - 0s 290us/step - loss: 0.1125
Epoch 254/400
160/160 [=====] - 0s 256us/step - loss: 0.0852
Epoch 255/400
160/160 [=====] - 0s 268us/step - loss: 0.1069
Epoch 256/400
160/160 [=====] - 0s 249us/step - loss: 0.0976
Epoch 257/400
160/160 [=====] - 0s 262us/step - loss: 0.0907
Epoch 258/400
160/160 [=====] - 0s 249us/step - loss: 0.0972
Epoch 259/400
160/160 [=====] - 0s 256us/step - loss: 0.1124
Epoch 260/400
160/160 [=====] - 0s 305us/step - loss: 0.0802
Epoch 261/400
160/160 [=====] - 0s 287us/step - loss: 0.0973
Epoch 262/400
160/160 [=====] - 0s 287us/step - loss: 0.1114
Epoch 263/400
160/160 [=====] - 0s 281us/step - loss: 0.1114
Epoch 264/400
160/160 [=====] - 0s 262us/step - loss: 0.1046
Epoch 265/400
160/160 [=====] - 0s 249us/step - loss: 0.0833
Epoch 266/400
160/160 [=====] - 0s 268us/step - loss: 0.0980
Epoch 267/400
160/160 [=====] - 0s 287us/step - loss: 0.1133
Epoch 268/400
160/160 [=====] - 0s 312us/step - loss: 0.1030
Epoch 269/400
160/160 [=====] - 0s 337us/step - loss: 0.0933
Epoch 270/400
160/160 [=====] - 0s 312us/step - loss: 0.1032
Epoch 271/400
160/160 [=====] - 0s 268us/step - loss: 0.0841
Epoch 272/400
160/160 [=====] - 0s 268us/step - loss: 0.0700
Epoch 273/400
160/160 [=====] - 0s 268us/step - loss: 0.1027
Epoch 274/400
160/160 [=====] - 0s 274us/step - loss: 0.0960
Epoch 275/400
160/160 [=====] - 0s 256us/step - loss: 0.0714
Epoch 276/400
160/160 [=====] - 0s 256us/step - loss: 0.0939
Epoch 277/400
160/160 [=====] - 0s 256us/step - loss: 0.1138
Epoch 278/400
160/160 [=====] - 0s 256us/step - loss: 0.0889
Epoch 279/400
160/160 [=====] - 0s 265us/step - loss: 0.0668
Epoch 280/400
160/160 [=====] - 0s 274us/step - loss: 0.1094
Epoch 281/400
160/160 [=====] - 0s 268us/step - loss: 0.0905
Epoch 282/400
160/160 [=====] - 0s 265us/step - loss: 0.1014
Epoch 283/400
160/160 [=====] - 0s 280us/step - loss: 0.0914
Epoch 284/400
160/160 [=====] - 0s 271us/step - loss: 0.0761
Epoch 285/400
160/160 [=====] - 0s 274us/step - loss: 0.0948
Epoch 286/400
160/160 [=====] - 0s 271us/step - loss: 0.0923
Epoch 287/400
160/160 [=====] - 0s 274us/step - loss: 0.0839
Epoch 288/400
160/160 [=====] - 0s 268us/step - loss: 0.0956

Epoch 289/400
160/160 [=====] - 0s 262us/step - loss: 0.0864
Epoch 290/400
160/160 [=====] - 0s 262us/step - loss: 0.0835
Epoch 291/400
160/160 [=====] - 0s 268us/step - loss: 0.0934
Epoch 292/400
160/160 [=====] - 0s 274us/step - loss: 0.1042
Epoch 293/400
160/160 [=====] - 0s 287us/step - loss: 0.0850
Epoch 294/400
160/160 [=====] - 0s 262us/step - loss: 0.0873
Epoch 295/400
160/160 [=====] - 0s 262us/step - loss: 0.0926
Epoch 296/400
160/160 [=====] - 0s 256us/step - loss: 0.0728
Epoch 297/400
160/160 [=====] - 0s 268us/step - loss: 0.0889
Epoch 298/400
160/160 [=====] - 0s 268us/step - loss: 0.0881
Epoch 299/400
160/160 [=====] - 0s 268us/step - loss: 0.1105
Epoch 300/400
160/160 [=====] - 0s 262us/step - loss: 0.0767
Epoch 301/400
160/160 [=====] - 0s 281us/step - loss: 0.0683
Epoch 302/400
160/160 [=====] - 0s 262us/step - loss: 0.0737
Epoch 303/400
160/160 [=====] - 0s 274us/step - loss: 0.0713
Epoch 304/400
160/160 [=====] - 0s 274us/step - loss: 0.0830
Epoch 305/400
160/160 [=====] - 0s 268us/step - loss: 0.0794
Epoch 306/400
160/160 [=====] - 0s 287us/step - loss: 0.0801
Epoch 307/400
160/160 [=====] - 0s 268us/step - loss: 0.0712
Epoch 308/400
160/160 [=====] - 0s 268us/step - loss: 0.0948
Epoch 309/400
160/160 [=====] - 0s 280us/step - loss: 0.0803
Epoch 310/400
160/160 [=====] - 0s 268us/step - loss: 0.0758
Epoch 311/400
160/160 [=====] - 0s 268us/step - loss: 0.0833
Epoch 312/400
160/160 [=====] - 0s 262us/step - loss: 0.1060
Epoch 313/400
160/160 [=====] - 0s 256us/step - loss: 0.0985
Epoch 314/400
160/160 [=====] - 0s 256us/step - loss: 0.1014
Epoch 315/400
160/160 [=====] - 0s 256us/step - loss: 0.0734
Epoch 316/400
160/160 [=====] - 0s 265us/step - loss: 0.0739
Epoch 317/400
160/160 [=====] - 0s 262us/step - loss: 0.0849
Epoch 318/400
160/160 [=====] - 0s 262us/step - loss: 0.0804
Epoch 319/400
160/160 [=====] - 0s 252us/step - loss: 0.0788
Epoch 320/400
160/160 [=====] - 0s 256us/step - loss: 0.1025
Epoch 321/400
160/160 [=====] - 0s 252us/step - loss: 0.0866
Epoch 322/400
160/160 [=====] - 0s 262us/step - loss: 0.1084
Epoch 323/400
160/160 [=====] - 0s 256us/step - loss: 0.0659
Epoch 324/400
160/160 [=====] - 0s 265us/step - loss: 0.0904
Epoch 325/400
160/160 [=====] - 0s 262us/step - loss: 0.0814
Epoch 326/400
160/160 [=====] - 0s 268us/step - loss: 0.1015
Epoch 327/400

160/160 [=====] - 0s 262us/step - loss: 0.0791
Epoch 328/400
160/160 [=====] - 0s 262us/step - loss: 0.0885
Epoch 329/400
160/160 [=====] - 0s 280us/step - loss: 0.0625
Epoch 330/400
160/160 [=====] - 0s 281us/step - loss: 0.0942
Epoch 331/400
160/160 [=====] - 0s 256us/step - loss: 0.0932
Epoch 332/400
160/160 [=====] - 0s 249us/step - loss: 0.0781
Epoch 333/400
160/160 [=====] - 0s 268us/step - loss: 0.0640
Epoch 334/400
160/160 [=====] - 0s 268us/step - loss: 0.0953
Epoch 335/400
160/160 [=====] - 0s 262us/step - loss: 0.0714
Epoch 336/400
160/160 [=====] - 0s 262us/step - loss: 0.0678
Epoch 337/400
160/160 [=====] - 0s 249us/step - loss: 0.0432
Epoch 338/400
160/160 [=====] - 0s 249us/step - loss: 0.1048
Epoch 339/400
160/160 [=====] - 0s 249us/step - loss: 0.0619
Epoch 340/400
160/160 [=====] - 0s 243us/step - loss: 0.0669
Epoch 341/400
160/160 [=====] - 0s 256us/step - loss: 0.0752
Epoch 342/400
160/160 [=====] - 0s 268us/step - loss: 0.0614
Epoch 343/400
160/160 [=====] - 0s 256us/step - loss: 0.1046
Epoch 344/400
160/160 [=====] - 0s 268us/step - loss: 0.0645
Epoch 345/400
160/160 [=====] - 0s 268us/step - loss: 0.0851
Epoch 346/400
160/160 [=====] - 0s 256us/step - loss: 0.1019
Epoch 347/400
160/160 [=====] - 0s 249us/step - loss: 0.0685
Epoch 348/400
160/160 [=====] - 0s 256us/step - loss: 0.0873
Epoch 349/400
160/160 [=====] - 0s 249us/step - loss: 0.0594
Epoch 350/400
160/160 [=====] - 0s 256us/step - loss: 0.0773
Epoch 351/400
160/160 [=====] - 0s 249us/step - loss: 0.0841
Epoch 352/400
160/160 [=====] - 0s 249us/step - loss: 0.0739
Epoch 353/400
160/160 [=====] - 0s 280us/step - loss: 0.0907
Epoch 354/400
160/160 [=====] - 0s 256us/step - loss: 0.0724
Epoch 355/400
160/160 [=====] - 0s 252us/step - loss: 0.0640
Epoch 356/400
160/160 [=====] - 0s 249us/step - loss: 0.0635
Epoch 357/400
160/160 [=====] - 0s 252us/step - loss: 0.0573
Epoch 358/400
160/160 [=====] - 0s 249us/step - loss: 0.0682
Epoch 359/400
160/160 [=====] - 0s 243us/step - loss: 0.0460
Epoch 360/400
160/160 [=====] - 0s 252us/step - loss: 0.0766
Epoch 361/400
160/160 [=====] - 0s 256us/step - loss: 0.0600
Epoch 362/400
160/160 [=====] - 0s 252us/step - loss: 0.0764
Epoch 363/400
160/160 [=====] - 0s 249us/step - loss: 0.0483
Epoch 364/400
160/160 [=====] - 0s 243us/step - loss: 0.1075
Epoch 365/400
160/160 [=====] - 0s 246us/step - loss: 0.0658

Epoch 366/400
160/160 [=====] - 0s 243us/step - loss: 0.0906
Epoch 367/400
160/160 [=====] - 0s 256us/step - loss: 0.0550
Epoch 368/400
160/160 [=====] - 0s 262us/step - loss: 0.0792
Epoch 369/400
160/160 [=====] - 0s 262us/step - loss: 0.0795
Epoch 370/400
160/160 [=====] - 0s 262us/step - loss: 0.0601
Epoch 371/400
160/160 [=====] - 0s 256us/step - loss: 0.0663
Epoch 372/400
160/160 [=====] - 0s 256us/step - loss: 0.0691
Epoch 373/400
160/160 [=====] - 0s 268us/step - loss: 0.0657
Epoch 374/400
160/160 [=====] - 0s 256us/step - loss: 0.0767
Epoch 375/400
160/160 [=====] - 0s 262us/step - loss: 0.0854
Epoch 376/400
160/160 [=====] - 0s 256us/step - loss: 0.0782
Epoch 377/400
160/160 [=====] - 0s 262us/step - loss: 0.0488
Epoch 378/400
160/160 [=====] - 0s 274us/step - loss: 0.0750
Epoch 379/400
160/160 [=====] - 0s 249us/step - loss: 0.0683
Epoch 380/400
160/160 [=====] - 0s 256us/step - loss: 0.0436
Epoch 381/400
160/160 [=====] - 0s 249us/step - loss: 0.0831
Epoch 382/400
160/160 [=====] - 0s 256us/step - loss: 0.0462
Epoch 383/400
160/160 [=====] - 0s 268us/step - loss: 0.0681
Epoch 384/400
160/160 [=====] - 0s 268us/step - loss: 0.0702
Epoch 385/400
160/160 [=====] - 0s 262us/step - loss: 0.0925
Epoch 386/400
160/160 [=====] - 0s 252us/step - loss: 0.0563
Epoch 387/400
160/160 [=====] - 0s 256us/step - loss: 0.0658
Epoch 388/400
160/160 [=====] - 0s 249us/step - loss: 0.0551
Epoch 389/400
160/160 [=====] - 0s 256us/step - loss: 0.0859
Epoch 390/400
160/160 [=====] - 0s 256us/step - loss: 0.0669
Epoch 391/400
160/160 [=====] - 0s 249us/step - loss: 0.0520
Epoch 392/400
160/160 [=====] - 0s 256us/step - loss: 0.0925
Epoch 393/400
160/160 [=====] - 0s 256us/step - loss: 0.0729
Epoch 394/400
160/160 [=====] - 0s 262us/step - loss: 0.0550
Epoch 395/400
160/160 [=====] - 0s 249us/step - loss: 0.0571
Epoch 396/400
160/160 [=====] - 0s 249us/step - loss: 0.0590
Epoch 397/400
160/160 [=====] - 0s 262us/step - loss: 0.0520
Epoch 398/400
160/160 [=====] - 0s 256us/step - loss: 0.0531
Epoch 399/400
160/160 [=====] - 0s 256us/step - loss: 0.0667
Epoch 400/400
160/160 [=====] - 0s 249us/step - loss: 0.0603
[0.9838815 0.98462754 0.98579293 0.9863638 0.8294069 0.98625654
0.98638177 0.985039 0.977193 0.9862812 0.97689086 0.969327
0.9863687 0.9864391 0.9852445 0.9864411 0.9864769 0.97564316
0.98640513 0.98637515 0.9861059 0.9863261 0.9863798 0.984183
0.98636764 0.9863804 0.9864977 0.9862434 0.9864065 0.9862964
0.9863355 0.9863688 0.9858365 0.9863783 0.97550505 0.9838495
0.98574567 0.9863505 0.9862487 0.98639226 0.9938998 0.98849994

```
0.99495786 0.9952283 0.9638669 0.9951717 0.9954261 0.9910086
0.9872339 0.9949181 0.9897738 0.23452052 0.9952232 0.99509734
0.99487597 0.9953909 0.9950191 0.9791559 0.99512994 0.99535745
0.99512225 0.99538165 0.9951656 0.98622 0.99521744 0.9953245
0.9949745 0.99536467 0.9953637 0.9951302 0.995411 0.99518293
0.9951454 0.99521387 0.6839329 0.99323326 0.99559504 0.99544334
0.9955022 0.99511695 0.00571105 0.00848796 0.00232916 0.00248398
0.9517814 0.00289858 0.0021247 0.01236842 0.02507259 0.00218632
0.00811749 0.8340351 0.00248101 0.00257548 0.00449896 0.00209077
0.00268326 0.01245089 0.0026342 0.0020838 0.00358982 0.00232424
0.00260535 0.08460488 0.00249796 0.00229354 0.00272446 0.00244123
0.00219861 0.00299678 0.00227287 0.00258647 0.00347804 0.0024698
0.90616226 0.04080333 0.00228038 0.00213513 0.00218859 0.00272753
0.00510573 0.00801121 0.00519308 0.0049854 0.60324144 0.00495395
0.0050962 0.00893676 0.00735715 0.00560193 0.00645705 0.02504328
0.00498581 0.00497714 0.00499425 0.00513079 0.00496991 0.00630336
0.0049717 0.00516401 0.00494973 0.00500936 0.00497352 0.01266474
0.00498386 0.00501794 0.00496784 0.00498772 0.00504935 0.00495121
0.00502184 0.00497495 0.00495121 0.00498723 0.06157095 0.01597615
0.00503344 0.00508822 0.00505322 0.00496448]
160/160 [=====] - 0s 452us/step
```

In [29]:

```
#Four layers, three neurons per layer: loss
scores_lay_four_three, model_lay_four_three.metrics_names
```

Out [29]:

```
(0.0724665665999055, ['loss'])
```

Five Layers

In [30]:

```
n = 40
xx = np.random.random((n,1))
yy = np.random.random((n,1))

X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [31]:

```
#Five layers, three neurons per layer
model_lay_five_three = Sequential()

#hidden layers
model_lay_five_three.add(Dense(3, input_dim=2, activation='tanh'))
model_lay_five_three.add(Dense(3, activation='tanh'))
model_lay_five_three.add(Dense(3, activation='tanh'))
model_lay_five_three.add(Dense(3, activation='tanh'))
model_lay_five_three.add(Dense(3, activation='tanh'))

#output layer
model_lay_five_three.add(Dense(1, activation='sigmoid'))

sgd = SGD(lr=0.1)
model_lay_five_three.compile(loss='binary_crossentropy', optimizer='sgd')

model_lay_five_three.fit(X, y, batch_size=2, epochs=400)
print(model_lay_five_three.predict_proba(X).reshape(4*n))

#evaluate the model
scores_lay_five_three = model_lay_five_three.evaluate(X, y)
```

```
Epoch 1/400
160/160 [=====] - 0s 2ms/step - loss: 0.6956
Epoch 2/400
160/160 [=====] - 0s 305us/step - loss: 0.6947
Epoch 3/400
160/160 [=====] - 0s 293us/step - loss: 0.6946
Epoch 4/400
160/160 [=====] - 0s 268us/step - loss: 0.6936
Epoch 5/400
160/160 [=====] - 0s 281us/step - loss: 0.6933
Epoch 6/400
-----
```

160/160 [=====] - 0s 281us/step - loss: 0.6925
Epoch 7/400
160/160 [=====] - 0s 312us/step - loss: 0.6918
Epoch 8/400
160/160 [=====] - 0s 349us/step - loss: 0.6902
Epoch 9/400
160/160 [=====] - 0s 349us/step - loss: 0.6895
Epoch 10/400
160/160 [=====] - 0s 293us/step - loss: 0.6875
Epoch 11/400
160/160 [=====] - 0s 312us/step - loss: 0.6858
Epoch 12/400
160/160 [=====] - 0s 293us/step - loss: 0.6830
Epoch 13/400
160/160 [=====] - 0s 299us/step - loss: 0.6804
Epoch 14/400
160/160 [=====] - 0s 287us/step - loss: 0.6753
Epoch 15/400
160/160 [=====] - 0s 293us/step - loss: 0.6709
Epoch 16/400
160/160 [=====] - 0s 280us/step - loss: 0.6630
Epoch 17/400
160/160 [=====] - 0s 268us/step - loss: 0.6545
Epoch 18/400
160/160 [=====] - 0s 268us/step - loss: 0.6423
Epoch 19/400
160/160 [=====] - 0s 265us/step - loss: 0.6242
Epoch 20/400
160/160 [=====] - 0s 262us/step - loss: 0.6020
Epoch 21/400
160/160 [=====] - 0s 259us/step - loss: 0.5711
Epoch 22/400
160/160 [=====] - 0s 262us/step - loss: 0.5377
Epoch 23/400
160/160 [=====] - 0s 268us/step - loss: 0.4973
Epoch 24/400
160/160 [=====] - 0s 262us/step - loss: 0.4639
Epoch 25/400
160/160 [=====] - 0s 262us/step - loss: 0.4357
Epoch 26/400
160/160 [=====] - 0s 262us/step - loss: 0.4058
Epoch 27/400
160/160 [=====] - 0s 268us/step - loss: 0.3926
Epoch 28/400
160/160 [=====] - 0s 262us/step - loss: 0.3779
Epoch 29/400
160/160 [=====] - 0s 268us/step - loss: 0.3589
Epoch 30/400
160/160 [=====] - 0s 281us/step - loss: 0.3582
Epoch 31/400
160/160 [=====] - 0s 280us/step - loss: 0.3418
Epoch 32/400
160/160 [=====] - 0s 268us/step - loss: 0.3515
Epoch 33/400
160/160 [=====] - 0s 268us/step - loss: 0.3377
Epoch 34/400
160/160 [=====] - 0s 262us/step - loss: 0.3326
Epoch 35/400
160/160 [=====] - 0s 268us/step - loss: 0.3206
Epoch 36/400
160/160 [=====] - 0s 268us/step - loss: 0.3256
Epoch 37/400
160/160 [=====] - 0s 287us/step - loss: 0.3135
Epoch 38/400
160/160 [=====] - 0s 280us/step - loss: 0.3191
Epoch 39/400
160/160 [=====] - 0s 293us/step - loss: 0.3106
Epoch 40/400
160/160 [=====] - 0s 281us/step - loss: 0.3117
Epoch 41/400
160/160 [=====] - 0s 268us/step - loss: 0.2942
Epoch 42/400
160/160 [=====] - 0s 268us/step - loss: 0.2865
Epoch 43/400
160/160 [=====] - 0s 268us/step - loss: 0.2543
Epoch 44/400
160/160 [=====] - 0s 268us/step - loss: 0.2728

Epoch 45/400
160/160 [=====] - 0s 274us/step - loss: 0.2644
Epoch 46/400
160/160 [=====] - 0s 256us/step - loss: 0.2614
Epoch 47/400
160/160 [=====] - 0s 287us/step - loss: 0.2445
Epoch 48/400
160/160 [=====] - 0s 277us/step - loss: 0.2256
Epoch 49/400
160/160 [=====] - 0s 268us/step - loss: 0.2182
Epoch 50/400
160/160 [=====] - 0s 268us/step - loss: 0.2158
Epoch 51/400
160/160 [=====] - 0s 265us/step - loss: 0.2272
Epoch 52/400
160/160 [=====] - 0s 293us/step - loss: 0.2191
Epoch 53/400
160/160 [=====] - 0s 287us/step - loss: 0.2016
Epoch 54/400
160/160 [=====] - 0s 268us/step - loss: 0.2110
Epoch 55/400
160/160 [=====] - 0s 274us/step - loss: 0.1799
Epoch 56/400
160/160 [=====] - 0s 265us/step - loss: 0.1771
Epoch 57/400
160/160 [=====] - 0s 268us/step - loss: 0.1932
Epoch 58/400
160/160 [=====] - 0s 302us/step - loss: 0.1605
Epoch 59/400
160/160 [=====] - 0s 256us/step - loss: 0.1659
Epoch 60/400
160/160 [=====] - 0s 256us/step - loss: 0.1941
Epoch 61/400
160/160 [=====] - 0s 256us/step - loss: 0.2149
Epoch 62/400
160/160 [=====] - 0s 262us/step - loss: 0.1666
Epoch 63/400
160/160 [=====] - 0s 274us/step - loss: 0.2013
Epoch 64/400
160/160 [=====] - 0s 274us/step - loss: 0.1445
Epoch 65/400
160/160 [=====] - 0s 274us/step - loss: 0.1522
Epoch 66/400
160/160 [=====] - 0s 262us/step - loss: 0.1251
Epoch 67/400
160/160 [=====] - 0s 274us/step - loss: 0.1680
Epoch 68/400
160/160 [=====] - 0s 262us/step - loss: 0.1637
Epoch 69/400
160/160 [=====] - 0s 268us/step - loss: 0.1500
Epoch 70/400
160/160 [=====] - 0s 262us/step - loss: 0.1605
Epoch 71/400
160/160 [=====] - 0s 268us/step - loss: 0.1838
Epoch 72/400
160/160 [=====] - 0s 268us/step - loss: 0.1487
Epoch 73/400
160/160 [=====] - 0s 262us/step - loss: 0.1396
Epoch 74/400
160/160 [=====] - 0s 262us/step - loss: 0.1122
Epoch 75/400
160/160 [=====] - 0s 268us/step - loss: 0.1664
Epoch 76/400
160/160 [=====] - 0s 287us/step - loss: 0.1299
Epoch 77/400
160/160 [=====] - 0s 268us/step - loss: 0.1786
Epoch 78/400
160/160 [=====] - 0s 262us/step - loss: 0.1239
Epoch 79/400
160/160 [=====] - 0s 271us/step - loss: 0.1374
Epoch 80/400
160/160 [=====] - 0s 256us/step - loss: 0.1257
Epoch 81/400
160/160 [=====] - 0s 268us/step - loss: 0.1474
Epoch 82/400
160/160 [=====] - 0s 274us/step - loss: 0.1387
Epoch 83/400

160/160 [=====] - 0s 262us/step - loss: 0.1481
Epoch 84/400
160/160 [=====] - 0s 262us/step - loss: 0.1260
Epoch 85/400
160/160 [=====] - 0s 262us/step - loss: 0.1402
Epoch 86/400
160/160 [=====] - 0s 265us/step - loss: 0.1268
Epoch 87/400
160/160 [=====] - 0s 268us/step - loss: 0.1335
Epoch 88/400
160/160 [=====] - 0s 268us/step - loss: 0.1340
Epoch 89/400
160/160 [=====] - 0s 262us/step - loss: 0.1428
Epoch 90/400
160/160 [=====] - 0s 262us/step - loss: 0.1357
Epoch 91/400
160/160 [=====] - 0s 262us/step - loss: 0.1212
Epoch 92/400
160/160 [=====] - 0s 268us/step - loss: 0.0960
Epoch 93/400
160/160 [=====] - 0s 268us/step - loss: 0.1164
Epoch 94/400
160/160 [=====] - 0s 268us/step - loss: 0.1302
Epoch 95/400
160/160 [=====] - 0s 259us/step - loss: 0.0961
Epoch 96/400
160/160 [=====] - 0s 268us/step - loss: 0.1508
Epoch 97/400
160/160 [=====] - 0s 268us/step - loss: 0.1549
Epoch 98/400
160/160 [=====] - 0s 265us/step - loss: 0.1297
Epoch 99/400
160/160 [=====] - 0s 280us/step - loss: 0.1151
Epoch 100/400
160/160 [=====] - 0s 281us/step - loss: 0.1303
Epoch 101/400
160/160 [=====] - 0s 268us/step - loss: 0.1040
Epoch 102/400
160/160 [=====] - 0s 268us/step - loss: 0.1234
Epoch 103/400
160/160 [=====] - 0s 262us/step - loss: 0.1191
Epoch 104/400
160/160 [=====] - 0s 268us/step - loss: 0.1076
Epoch 105/400
160/160 [=====] - 0s 268us/step - loss: 0.1121
Epoch 106/400
160/160 [=====] - 0s 262us/step - loss: 0.1782
Epoch 107/400
160/160 [=====] - 0s 262us/step - loss: 0.0958
Epoch 108/400
160/160 [=====] - 0s 268us/step - loss: 0.1061
Epoch 109/400
160/160 [=====] - 0s 262us/step - loss: 0.1104
Epoch 110/400
160/160 [=====] - 0s 262us/step - loss: 0.1086
Epoch 111/400
160/160 [=====] - 0s 268us/step - loss: 0.1361
Epoch 112/400
160/160 [=====] - 0s 271us/step - loss: 0.1095
Epoch 113/400
160/160 [=====] - 0s 274us/step - loss: 0.0938
Epoch 114/400
160/160 [=====] - 0s 262us/step - loss: 0.1273
Epoch 115/400
160/160 [=====] - 0s 262us/step - loss: 0.1250
Epoch 116/400
160/160 [=====] - 0s 274us/step - loss: 0.1030
Epoch 117/400
160/160 [=====] - 0s 268us/step - loss: 0.0979
Epoch 118/400
160/160 [=====] - 0s 262us/step - loss: 0.1151
Epoch 119/400
160/160 [=====] - 0s 265us/step - loss: 0.0946
Epoch 120/400
160/160 [=====] - 0s 262us/step - loss: 0.0913
Epoch 121/400
160/160 [=====] - 0s 268us/step - loss: 0.1110

Epoch 122/400
160/160 [=====] - 0s 274us/step - loss: 0.1106
Epoch 123/400
160/160 [=====] - 0s 281us/step - loss: 0.0990
Epoch 124/400
160/160 [=====] - 0s 262us/step - loss: 0.1001
Epoch 125/400
160/160 [=====] - 0s 268us/step - loss: 0.1106
Epoch 126/400
160/160 [=====] - 0s 274us/step - loss: 0.0969
Epoch 127/400
160/160 [=====] - 0s 262us/step - loss: 0.1206
Epoch 128/400
160/160 [=====] - 0s 262us/step - loss: 0.0921
Epoch 129/400
160/160 [=====] - 0s 268us/step - loss: 0.0895
Epoch 130/400
160/160 [=====] - 0s 271us/step - loss: 0.0817
Epoch 131/400
160/160 [=====] - 0s 274us/step - loss: 0.0945
Epoch 132/400
160/160 [=====] - 0s 265us/step - loss: 0.0867
Epoch 133/400
160/160 [=====] - 0s 268us/step - loss: 0.1134
Epoch 134/400
160/160 [=====] - 0s 262us/step - loss: 0.0807
Epoch 135/400
160/160 [=====] - 0s 265us/step - loss: 0.0803
Epoch 136/400
160/160 [=====] - 0s 262us/step - loss: 0.0914
Epoch 137/400
160/160 [=====] - 0s 252us/step - loss: 0.0903
Epoch 138/400
160/160 [=====] - 0s 262us/step - loss: 0.0921
Epoch 139/400
160/160 [=====] - 0s 268us/step - loss: 0.1319
Epoch 140/400
160/160 [=====] - 0s 262us/step - loss: 0.0958
Epoch 141/400
160/160 [=====] - 0s 268us/step - loss: 0.0857
Epoch 142/400
160/160 [=====] - 0s 268us/step - loss: 0.0860
Epoch 143/400
160/160 [=====] - 0s 268us/step - loss: 0.0927
Epoch 144/400
160/160 [=====] - 0s 274us/step - loss: 0.0766
Epoch 145/400
160/160 [=====] - 0s 274us/step - loss: 0.0882
Epoch 146/400
160/160 [=====] - 0s 293us/step - loss: 0.0898
Epoch 147/400
160/160 [=====] - 0s 268us/step - loss: 0.0718
Epoch 148/400
160/160 [=====] - 0s 274us/step - loss: 0.1044
Epoch 149/400
160/160 [=====] - 0s 256us/step - loss: 0.0858
Epoch 150/400
160/160 [=====] - 0s 274us/step - loss: 0.0928
Epoch 151/400
160/160 [=====] - 0s 268us/step - loss: 0.0853
Epoch 152/400
160/160 [=====] - 0s 262us/step - loss: 0.0641
Epoch 153/400
160/160 [=====] - 0s 256us/step - loss: 0.0752
Epoch 154/400
160/160 [=====] - 0s 268us/step - loss: 0.0683
Epoch 155/400
160/160 [=====] - 0s 268us/step - loss: 0.0821
Epoch 156/400
160/160 [=====] - 0s 256us/step - loss: 0.1074
Epoch 157/400
160/160 [=====] - 0s 262us/step - loss: 0.0516
Epoch 158/400
160/160 [=====] - 0s 262us/step - loss: 0.0864
Epoch 159/400
160/160 [=====] - 0s 262us/step - loss: 0.0990
Epoch 160/400

160/160 [=====] - 0s 262us/step - loss: 0.0719
Epoch 161/400
160/160 [=====] - 0s 259us/step - loss: 0.1110
Epoch 162/400
160/160 [=====] - 0s 262us/step - loss: 0.0853
Epoch 163/400
160/160 [=====] - 0s 259us/step - loss: 0.0713
Epoch 164/400
160/160 [=====] - 0s 262us/step - loss: 0.0629
Epoch 165/400
160/160 [=====] - 0s 268us/step - loss: 0.0842
Epoch 166/400
160/160 [=====] - 0s 262us/step - loss: 0.0722
Epoch 167/400
160/160 [=====] - 0s 256us/step - loss: 0.0826
Epoch 168/400
160/160 [=====] - 0s 262us/step - loss: 0.0915
Epoch 169/400
160/160 [=====] - 0s 268us/step - loss: 0.0970
Epoch 170/400
160/160 [=====] - 0s 274us/step - loss: 0.0782
Epoch 171/400
160/160 [=====] - 0s 256us/step - loss: 0.0602
Epoch 172/400
160/160 [=====] - 0s 262us/step - loss: 0.0815
Epoch 173/400
160/160 [=====] - 0s 256us/step - loss: 0.0652
Epoch 174/400
160/160 [=====] - 0s 262us/step - loss: 0.0753
Epoch 175/400
160/160 [=====] - 0s 259us/step - loss: 0.0738
Epoch 176/400
160/160 [=====] - 0s 256us/step - loss: 0.0626
Epoch 177/400
160/160 [=====] - 0s 265us/step - loss: 0.0521
Epoch 178/400
160/160 [=====] - 0s 262us/step - loss: 0.0694
Epoch 179/400
160/160 [=====] - 0s 262us/step - loss: 0.0704
Epoch 180/400
160/160 [=====] - 0s 259us/step - loss: 0.0675
Epoch 181/400
160/160 [=====] - 0s 262us/step - loss: 0.0494
Epoch 182/400
160/160 [=====] - 0s 256us/step - loss: 0.0974
Epoch 183/400
160/160 [=====] - 0s 256us/step - loss: 0.0760
Epoch 184/400
160/160 [=====] - 0s 274us/step - loss: 0.0791
Epoch 185/400
160/160 [=====] - 0s 262us/step - loss: 0.0497
Epoch 186/400
160/160 [=====] - 0s 287us/step - loss: 0.0783
Epoch 187/400
160/160 [=====] - 0s 268us/step - loss: 0.1013
Epoch 188/400
160/160 [=====] - 0s 262us/step - loss: 0.0771
Epoch 189/400
160/160 [=====] - 0s 268us/step - loss: 0.0511
Epoch 190/400
160/160 [=====] - 0s 262us/step - loss: 0.0633
Epoch 191/400
160/160 [=====] - 0s 268us/step - loss: 0.0733
Epoch 192/400
160/160 [=====] - 0s 268us/step - loss: 0.0635
Epoch 193/400
160/160 [=====] - 0s 287us/step - loss: 0.0713
Epoch 194/400
160/160 [=====] - 0s 262us/step - loss: 0.0534
Epoch 195/400
160/160 [=====] - 0s 262us/step - loss: 0.0575
Epoch 196/400
160/160 [=====] - 0s 262us/step - loss: 0.0661
Epoch 197/400
160/160 [=====] - 0s 268us/step - loss: 0.0698
Epoch 198/400
160/160 [=====] - 0s 293us/step - loss: 0.0834

Epoch 199/400
160/160 [=====] - 0s 268us/step - loss: 0.0661
Epoch 200/400
160/160 [=====] - 0s 274us/step - loss: 0.0668
Epoch 201/400
160/160 [=====] - 0s 268us/step - loss: 0.0691
Epoch 202/400
160/160 [=====] - 0s 274us/step - loss: 0.0969
Epoch 203/400
160/160 [=====] - 0s 274us/step - loss: 0.0830
Epoch 204/400
160/160 [=====] - 0s 268us/step - loss: 0.0480
Epoch 205/400
160/160 [=====] - 0s 262us/step - loss: 0.0649
Epoch 206/400
160/160 [=====] - 0s 262us/step - loss: 0.0816
Epoch 207/400
160/160 [=====] - 0s 262us/step - loss: 0.0764
Epoch 208/400
160/160 [=====] - 0s 262us/step - loss: 0.0556
Epoch 209/400
160/160 [=====] - 0s 262us/step - loss: 0.0775
Epoch 210/400
160/160 [=====] - 0s 262us/step - loss: 0.0727
Epoch 211/400
160/160 [=====] - 0s 262us/step - loss: 0.0632
Epoch 212/400
160/160 [=====] - 0s 262us/step - loss: 0.0451
Epoch 213/400
160/160 [=====] - 0s 262us/step - loss: 0.0587
Epoch 214/400
160/160 [=====] - 0s 262us/step - loss: 0.0545
Epoch 215/400
160/160 [=====] - 0s 274us/step - loss: 0.0631
Epoch 216/400
160/160 [=====] - 0s 293us/step - loss: 0.0799
Epoch 217/400
160/160 [=====] - 0s 265us/step - loss: 0.0666
Epoch 218/400
160/160 [=====] - 0s 268us/step - loss: 0.0506
Epoch 219/400
160/160 [=====] - 0s 274us/step - loss: 0.0595
Epoch 220/400
160/160 [=====] - 0s 262us/step - loss: 0.0807
Epoch 221/400
160/160 [=====] - 0s 268us/step - loss: 0.0829
Epoch 222/400
160/160 [=====] - 0s 262us/step - loss: 0.0658
Epoch 223/400
160/160 [=====] - 0s 256us/step - loss: 0.0739
Epoch 224/400
160/160 [=====] - 0s 268us/step - loss: 0.0701
Epoch 225/400
160/160 [=====] - 0s 274us/step - loss: 0.0624
Epoch 226/400
160/160 [=====] - 0s 268us/step - loss: 0.0728
Epoch 227/400
160/160 [=====] - 0s 268us/step - loss: 0.0754
Epoch 228/400
160/160 [=====] - 0s 268us/step - loss: 0.0681
Epoch 229/400
160/160 [=====] - 0s 268us/step - loss: 0.0495
Epoch 230/400
160/160 [=====] - 0s 268us/step - loss: 0.0420
Epoch 231/400
160/160 [=====] - 0s 262us/step - loss: 0.0491
Epoch 232/400
160/160 [=====] - 0s 262us/step - loss: 0.0753
Epoch 233/400
160/160 [=====] - 0s 268us/step - loss: 0.0693
Epoch 234/400
160/160 [=====] - 0s 262us/step - loss: 0.0494
Epoch 235/400
160/160 [=====] - 0s 268us/step - loss: 0.0356
Epoch 236/400
160/160 [=====] - 0s 262us/step - loss: 0.0480
Epoch 237/400

160/160 [=====] - 0s 268us/step - loss: 0.0778
Epoch 238/400
160/160 [=====] - 0s 265us/step - loss: 0.0623
Epoch 239/400
160/160 [=====] - 0s 280us/step - loss: 0.0645
Epoch 240/400
160/160 [=====] - 0s 259us/step - loss: 0.0442
Epoch 241/400
160/160 [=====] - 0s 268us/step - loss: 0.0632
Epoch 242/400
160/160 [=====] - 0s 274us/step - loss: 0.0384
Epoch 243/400
160/160 [=====] - 0s 268us/step - loss: 0.0382
Epoch 244/400
160/160 [=====] - 0s 262us/step - loss: 0.0739
Epoch 245/400
160/160 [=====] - 0s 262us/step - loss: 0.0775
Epoch 246/400
160/160 [=====] - 0s 268us/step - loss: 0.0515
Epoch 247/400
160/160 [=====] - 0s 268us/step - loss: 0.0710
Epoch 248/400
160/160 [=====] - 0s 268us/step - loss: 0.0605
Epoch 249/400
160/160 [=====] - 0s 268us/step - loss: 0.0427
Epoch 250/400
160/160 [=====] - 0s 256us/step - loss: 0.0707
Epoch 251/400
160/160 [=====] - 0s 268us/step - loss: 0.0548
Epoch 252/400
160/160 [=====] - 0s 265us/step - loss: 0.0469
Epoch 253/400
160/160 [=====] - 0s 262us/step - loss: 0.0525
Epoch 254/400
160/160 [=====] - 0s 259us/step - loss: 0.0580
Epoch 255/400
160/160 [=====] - 0s 262us/step - loss: 0.0592
Epoch 256/400
160/160 [=====] - 0s 277us/step - loss: 0.0490
Epoch 257/400
160/160 [=====] - 0s 293us/step - loss: 0.0498
Epoch 258/400
160/160 [=====] - 0s 274us/step - loss: 0.0593
Epoch 259/400
160/160 [=====] - 0s 271us/step - loss: 0.0523
Epoch 260/400
160/160 [=====] - 0s 274us/step - loss: 0.0479
Epoch 261/400
160/160 [=====] - 0s 274us/step - loss: 0.0462
Epoch 262/400
160/160 [=====] - 0s 305us/step - loss: 0.0548
Epoch 263/400
160/160 [=====] - 0s 268us/step - loss: 0.0486
Epoch 264/400
160/160 [=====] - 0s 268us/step - loss: 0.0287
Epoch 265/400
160/160 [=====] - 0s 268us/step - loss: 0.0927
Epoch 266/400
160/160 [=====] - 0s 262us/step - loss: 0.0557
Epoch 267/400
160/160 [=====] - 0s 268us/step - loss: 0.0615
Epoch 268/400
160/160 [=====] - 0s 262us/step - loss: 0.0281
Epoch 269/400
160/160 [=====] - 0s 262us/step - loss: 0.0436
Epoch 270/400
160/160 [=====] - 0s 256us/step - loss: 0.0344
Epoch 271/400
160/160 [=====] - 0s 262us/step - loss: 0.0737
Epoch 272/400
160/160 [=====] - 0s 268us/step - loss: 0.0595
Epoch 273/400
160/160 [=====] - 0s 268us/step - loss: 0.0474
Epoch 274/400
160/160 [=====] - 0s 262us/step - loss: 0.0854
Epoch 275/400
160/160 [=====] - 0s 268us/step - loss: 0.0369

Epoch 276/400
160/160 [=====] - 0s 262us/step - loss: 0.0475
Epoch 277/400
160/160 [=====] - 0s 262us/step - loss: 0.0466
Epoch 278/400
160/160 [=====] - 0s 256us/step - loss: 0.0604
Epoch 279/400
160/160 [=====] - 0s 262us/step - loss: 0.0562
Epoch 280/400
160/160 [=====] - 0s 256us/step - loss: 0.0553
Epoch 281/400
160/160 [=====] - 0s 262us/step - loss: 0.0333
Epoch 282/400
160/160 [=====] - 0s 262us/step - loss: 0.0600
Epoch 283/400
160/160 [=====] - 0s 268us/step - loss: 0.0619
Epoch 284/400
160/160 [=====] - 0s 262us/step - loss: 0.0435
Epoch 285/400
160/160 [=====] - 0s 293us/step - loss: 0.0693
Epoch 286/400
160/160 [=====] - 0s 268us/step - loss: 0.0483
Epoch 287/400
160/160 [=====] - 0s 268us/step - loss: 0.0570
Epoch 288/400
160/160 [=====] - 0s 262us/step - loss: 0.0422
Epoch 289/400
160/160 [=====] - 0s 259us/step - loss: 0.0434
Epoch 290/400
160/160 [=====] - 0s 268us/step - loss: 0.0554
Epoch 291/400
160/160 [=====] - 0s 265us/step - loss: 0.0292
Epoch 292/400
160/160 [=====] - 0s 262us/step - loss: 0.0700
Epoch 293/400
160/160 [=====] - 0s 268us/step - loss: 0.0459
Epoch 294/400
160/160 [=====] - 0s 265us/step - loss: 0.0327
Epoch 295/400
160/160 [=====] - 0s 268us/step - loss: 0.0479
Epoch 296/400
160/160 [=====] - 0s 265us/step - loss: 0.0397
Epoch 297/400
160/160 [=====] - 0s 274us/step - loss: 0.0577
Epoch 298/400
160/160 [=====] - 0s 262us/step - loss: 0.0477
Epoch 299/400
160/160 [=====] - 0s 262us/step - loss: 0.0362
Epoch 300/400
160/160 [=====] - 0s 262us/step - loss: 0.0477
Epoch 301/400
160/160 [=====] - 0s 262us/step - loss: 0.0638
Epoch 302/400
160/160 [=====] - 0s 262us/step - loss: 0.0446
Epoch 303/400
160/160 [=====] - 0s 268us/step - loss: 0.0585
Epoch 304/400
160/160 [=====] - 0s 262us/step - loss: 0.0504
Epoch 305/400
160/160 [=====] - 0s 262us/step - loss: 0.0377
Epoch 306/400
160/160 [=====] - 0s 262us/step - loss: 0.0234
Epoch 307/400
160/160 [=====] - 0s 262us/step - loss: 0.0472
Epoch 308/400
160/160 [=====] - 0s 281us/step - loss: 0.0586
Epoch 309/400
160/160 [=====] - 0s 268us/step - loss: 0.0291
Epoch 310/400
160/160 [=====] - 0s 262us/step - loss: 0.0445
Epoch 311/400
160/160 [=====] - 0s 268us/step - loss: 0.0371
Epoch 312/400
160/160 [=====] - 0s 262us/step - loss: 0.0769
Epoch 313/400
160/160 [=====] - 0s 274us/step - loss: 0.0376
Epoch 314/400

160/160 [=====] - 0s 281us/step - loss: 0.0684
Epoch 315/400
160/160 [=====] - 0s 271us/step - loss: 0.0490
Epoch 316/400
160/160 [=====] - 0s 268us/step - loss: 0.0371
Epoch 317/400
160/160 [=====] - 0s 259us/step - loss: 0.0378
Epoch 318/400
160/160 [=====] - 0s 256us/step - loss: 0.0439
Epoch 319/400
160/160 [=====] - 0s 265us/step - loss: 0.0390
Epoch 320/400
160/160 [=====] - 0s 274us/step - loss: 0.0266
Epoch 321/400
160/160 [=====] - 0s 287us/step - loss: 0.0464
Epoch 322/400
160/160 [=====] - 0s 274us/step - loss: 0.0488
Epoch 323/400
160/160 [=====] - 0s 256us/step - loss: 0.0746
Epoch 324/400
160/160 [=====] - 0s 262us/step - loss: 0.0305
Epoch 325/400
160/160 [=====] - 0s 262us/step - loss: 0.0403
Epoch 326/400
160/160 [=====] - 0s 268us/step - loss: 0.0753
Epoch 327/400
160/160 [=====] - 0s 268us/step - loss: 0.0506
Epoch 328/400
160/160 [=====] - 0s 268us/step - loss: 0.0218
Epoch 329/400
160/160 [=====] - 0s 262us/step - loss: 0.0171
Epoch 330/400
160/160 [=====] - 0s 268us/step - loss: 0.0285
Epoch 331/400
160/160 [=====] - 0s 271us/step - loss: 0.0613
Epoch 332/400
160/160 [=====] - 0s 268us/step - loss: 0.0395
Epoch 333/400
160/160 [=====] - 0s 265us/step - loss: 0.0305
Epoch 334/400
160/160 [=====] - 0s 268us/step - loss: 0.0211
Epoch 335/400
160/160 [=====] - 0s 265us/step - loss: 0.0820
Epoch 336/400
160/160 [=====] - 0s 274us/step - loss: 0.0216
Epoch 337/400
160/160 [=====] - 0s 274us/step - loss: 0.0262
Epoch 338/400
160/160 [=====] - 0s 271us/step - loss: 0.0495
Epoch 339/400
160/160 [=====] - 0s 256us/step - loss: 0.0169
Epoch 340/400
160/160 [=====] - 0s 259us/step - loss: 0.0508
Epoch 341/400
160/160 [=====] - 0s 268us/step - loss: 0.1032
Epoch 342/400
160/160 [=====] - 0s 262us/step - loss: 0.0444
Epoch 343/400
160/160 [=====] - 0s 262us/step - loss: 0.0324
Epoch 344/400
160/160 [=====] - 0s 262us/step - loss: 0.0219
Epoch 345/400
160/160 [=====] - 0s 262us/step - loss: 0.0547
Epoch 346/400
160/160 [=====] - 0s 262us/step - loss: 0.0282
Epoch 347/400
160/160 [=====] - 0s 262us/step - loss: 0.0167
Epoch 348/400
160/160 [=====] - 0s 262us/step - loss: 0.0285
Epoch 349/400
160/160 [=====] - 0s 262us/step - loss: 0.0396
Epoch 350/400
160/160 [=====] - 0s 268us/step - loss: 0.0256
Epoch 351/400
160/160 [=====] - 0s 274us/step - loss: 0.0229
Epoch 352/400
160/160 [=====] - 0s 274us/step - loss: 0.0493

...
Epoch 353/400
160/160 [=====] - 0s 280us/step - loss: 0.0233
Epoch 354/400
160/160 [=====] - 0s 281us/step - loss: 0.0235
Epoch 355/400
160/160 [=====] - 0s 293us/step - loss: 0.0823
Epoch 356/400
160/160 [=====] - 0s 262us/step - loss: 0.0515
Epoch 357/400
160/160 [=====] - 0s 262us/step - loss: 0.0530
Epoch 358/400
160/160 [=====] - 0s 256us/step - loss: 0.0209
Epoch 359/400
160/160 [=====] - 0s 262us/step - loss: 0.0260
Epoch 360/400
160/160 [=====] - 0s 268us/step - loss: 0.0334
Epoch 361/400
160/160 [=====] - 0s 265us/step - loss: 0.0255
Epoch 362/400
160/160 [=====] - 0s 262us/step - loss: 0.0561
Epoch 363/400
160/160 [=====] - 0s 262us/step - loss: 0.0153
Epoch 364/400
160/160 [=====] - 0s 262us/step - loss: 0.0647
Epoch 365/400
160/160 [=====] - 0s 262us/step - loss: 0.0370
Epoch 366/400
160/160 [=====] - 0s 262us/step - loss: 0.0578
Epoch 367/400
160/160 [=====] - 0s 268us/step - loss: 0.0356
Epoch 368/400
160/160 [=====] - 0s 256us/step - loss: 0.0427
Epoch 369/400
160/160 [=====] - 0s 262us/step - loss: 0.0495
Epoch 370/400
160/160 [=====] - 0s 262us/step - loss: 0.0239
Epoch 371/400
160/160 [=====] - 0s 256us/step - loss: 0.0371
Epoch 372/400
160/160 [=====] - 0s 268us/step - loss: 0.0595
Epoch 373/400
160/160 [=====] - 0s 256us/step - loss: 0.0247
Epoch 374/400
160/160 [=====] - 0s 262us/step - loss: 0.0293
Epoch 375/400
160/160 [=====] - 0s 265us/step - loss: 0.0397
Epoch 376/400
160/160 [=====] - 0s 268us/step - loss: 0.0415
Epoch 377/400
160/160 [=====] - 0s 268us/step - loss: 0.0328
Epoch 378/400
160/160 [=====] - 0s 284us/step - loss: 0.0317
Epoch 379/400
160/160 [=====] - 0s 268us/step - loss: 0.0357
Epoch 380/400
160/160 [=====] - 0s 259us/step - loss: 0.0254
Epoch 381/400
160/160 [=====] - 0s 256us/step - loss: 0.0300
Epoch 382/400
160/160 [=====] - 0s 252us/step - loss: 0.0198
Epoch 383/400
160/160 [=====] - 0s 256us/step - loss: 0.0215
Epoch 384/400
160/160 [=====] - 0s 262us/step - loss: 0.0216
Epoch 385/400
160/160 [=====] - 0s 262us/step - loss: 0.0623
Epoch 386/400
160/160 [=====] - 0s 268us/step - loss: 0.0790
Epoch 387/400
160/160 [=====] - 0s 262us/step - loss: 0.0274
Epoch 388/400
160/160 [=====] - 0s 268us/step - loss: 0.0335
Epoch 389/400
160/160 [=====] - 0s 274us/step - loss: 0.0204
Epoch 390/400
160/160 [=====] - 0s 274us/step - loss: 0.0421
Epoch 391/400

```

Epoch 391/400
160/160 [=====] - 0s 268us/step - loss: 0.0672
Epoch 392/400
160/160 [=====] - 0s 268us/step - loss: 0.0317
Epoch 393/400
160/160 [=====] - 0s 274us/step - loss: 0.0141
Epoch 394/400
160/160 [=====] - 0s 268us/step - loss: 0.0440
Epoch 395/400
160/160 [=====] - 0s 262us/step - loss: 0.0265
Epoch 396/400
160/160 [=====] - 0s 274us/step - loss: 0.0469
Epoch 397/400
160/160 [=====] - 0s 268us/step - loss: 0.0787
Epoch 398/400
160/160 [=====] - 0s 268us/step - loss: 0.0239
Epoch 399/400
160/160 [=====] - 0s 262us/step - loss: 0.0152
Epoch 400/400
160/160 [=====] - 0s 262us/step - loss: 0.0120
[0.9978436 0.9978388 0.9968928 0.9961922 0.99775356 0.9978472
 0.9978355 0.9978137 0.99781525 0.997776 0.99721044 0.997844
 0.99785185 0.9697813 0.99785006 0.99778676 0.99784327 0.9974827
 0.92202646 0.9978383 0.99784195 0.99784434 0.997849 0.9977877
 0.9978375 0.9978188 0.99758434 0.9978514 0.9977697 0.99782866
 0.9926555 0.9978436 0.994586 0.99784315 0.99784756 0.9978409
 0.9978296 0.9975026 0.99784386 0.9136098 0.9986325 0.99866104
 0.9986356 0.99864227 0.9986689 0.9986148 0.9986634 0.99842405
 0.9986659 0.99866724 0.9976331 0.9986308 0.9986094 0.83868647
 0.9985929 0.9986689 0.99862695 0.99865746 0.9985631 0.9986613
 0.9986444 0.99862146 0.9986395 0.9984256 0.9986608 0.99867046
 0.99866533 0.9985417 0.99866056 0.99866796 0.9758866 0.9986255
 0.991379 0.99864584 0.9985771 0.9986519 0.99864835 0.99853516
 0.9986211 0.7533883 0.0016122 0.00161006 0.0016249 0.00161071
 0.00160324 0.00161353 0.00160723 0.0017078 0.00160519 0.00160329
 0.03179715 0.00161223 0.00163061 0.02658676 0.00161596 0.00160398
 0.00161257 0.00160505 0.00164532 0.00160808 0.00161226 0.00161257
 0.00161387 0.00178958 0.00160835 0.00160865 0.00160128 0.00162972
 0.00160877 0.00160798 0.00450008 0.00161252 0.0482889 0.00161125
 0.00165444 0.001612 0.00163386 0.00401085 0.00161261 0.01333379
 0.00167189 0.00167701 0.0020694 0.00193884 0.00170504 0.00167212
 0.00170231 0.00175551 0.00171337 0.00171687 0.00477094 0.00167191
 0.00169771 0.22628169 0.00167203 0.00170197 0.00167083 0.00180786
 0.00302859 0.0016938 0.00167143 0.00167108 0.00168918 0.00185401
 0.00170405 0.00167934 0.00173541 0.0016814 0.00177734 0.00168271
 0.01044646 0.001671 0.29907078 0.00167476 0.00171572 0.00167193
 0.00180624 0.01013806 0.0016708 0.07753163]
160/160 [=====] - 0s 477us/step

```

In [32]:

```
#Five layers, three neurons per layer: loss
scores_lay_five_three, model_lay_five_three.metrics_names
```

Out[32]:

```
(0.011262303916737437, ['loss'])
```

Figure of Loss

In [33]:

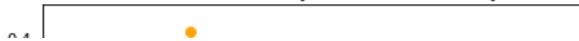
```
#figure of loss vs # of Layers
x_3 = [1,2,3,4,5]
y_3 = [scores_lay_one_three, scores_lay_two_three, scores_lay_three_three, scores_lay_four_three, scores_lay_five_three]

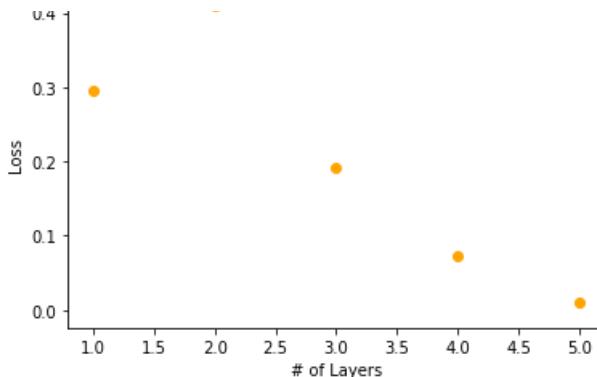
plt.scatter(x_3,y_3, c='orange');
plt.title('Three Neurons Per Layer: Loss vs # of Layers')
plt.xlabel('# of Layers')
plt.ylabel('Loss')
```

Out[33]:

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

Three Neurons Per Layer: Loss vs # of Layers





Part 1 Question 2: Four Neurons per Layer

One Layer

In [34]:

```
n = 40
xx = np.random.random((n,1))
yy = np.random.random((n,1))

X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [35]:

```
#One layer, four neurons per layer
model_lay_one_four = Sequential()

#hidden layers
model_lay_one_four.add(Dense(4, input_dim=2, activation='tanh'))

#output layer
model_lay_one_four.add(Dense(1, activation='sigmoid'))

sgd = SGD(lr=0.1)
model_lay_one_four.compile(loss='binary_crossentropy', optimizer='sgd')

model_lay_one_four.fit(X, y, batch_size=2, epochs=400)
print(model_lay_one_four.predict_proba(X).reshape(4*n))

#evaluate the model
scores_lay_one_four = model_lay_one_four.evaluate(X, y)
```

```
Epoch 1/400
160/160 [=====] - 0s 2ms/step - loss: 0.6965
Epoch 2/400
160/160 [=====] - 0s 240us/step - loss: 0.6956
Epoch 3/400
160/160 [=====] - 0s 231us/step - loss: 0.6951
Epoch 4/400
160/160 [=====] - 0s 234us/step - loss: 0.6943
Epoch 5/400
160/160 [=====] - 0s 237us/step - loss: 0.6937
Epoch 6/400
160/160 [=====] - 0s 231us/step - loss: 0.6930
Epoch 7/400
160/160 [=====] - 0s 240us/step - loss: 0.6923
Epoch 8/400
160/160 [=====] - 0s 243us/step - loss: 0.6916
Epoch 9/400
160/160 [=====] - 0s 237us/step - loss: 0.6912
Epoch 10/400
160/160 [=====] - 0s 252us/step - loss: 0.6905
Epoch 11/400
160/160 [=====] - 0s 237us/step - loss: 0.6899
Epoch 12/400
160/160 [=====] - 0s 237us/step - loss: 0.6892
Epoch 13/400
160/160 [=====] - 0s 231us/step - loss: 0.6882
Epoch 14/400
```

160/160 [=====] - 0s 237us/step - loss: 0.6875
Epoch 15/400
160/160 [=====] - 0s 249us/step - loss: 0.6869
Epoch 16/400
160/160 [=====] - 0s 256us/step - loss: 0.6860
Epoch 17/400
160/160 [=====] - 0s 249us/step - loss: 0.6851
Epoch 18/400
160/160 [=====] - 0s 243us/step - loss: 0.6842
Epoch 19/400
160/160 [=====] - 0s 256us/step - loss: 0.6834
Epoch 20/400
160/160 [=====] - 0s 249us/step - loss: 0.6823
Epoch 21/400
160/160 [=====] - 0s 237us/step - loss: 0.6811
Epoch 22/400
160/160 [=====] - 0s 249us/step - loss: 0.6801
Epoch 23/400
160/160 [=====] - 0s 243us/step - loss: 0.6790
Epoch 24/400
160/160 [=====] - 0s 243us/step - loss: 0.6777
Epoch 25/400
160/160 [=====] - 0s 256us/step - loss: 0.6763
Epoch 26/400
160/160 [=====] - 0s 249us/step - loss: 0.6748
Epoch 27/400
160/160 [=====] - 0s 243us/step - loss: 0.6734
Epoch 28/400
160/160 [=====] - 0s 249us/step - loss: 0.6716
Epoch 29/400
160/160 [=====] - 0s 237us/step - loss: 0.6699
Epoch 30/400
160/160 [=====] - 0s 240us/step - loss: 0.6679
Epoch 31/400
160/160 [=====] - 0s 243us/step - loss: 0.6660
Epoch 32/400
160/160 [=====] - 0s 243us/step - loss: 0.6641
Epoch 33/400
160/160 [=====] - 0s 252us/step - loss: 0.6619
Epoch 34/400
160/160 [=====] - 0s 237us/step - loss: 0.6596
Epoch 35/400
160/160 [=====] - 0s 262us/step - loss: 0.6574
Epoch 36/400
160/160 [=====] - 0s 243us/step - loss: 0.6549
Epoch 37/400
160/160 [=====] - 0s 243us/step - loss: 0.6521
Epoch 38/400
160/160 [=====] - 0s 237us/step - loss: 0.6493
Epoch 39/400
160/160 [=====] - 0s 243us/step - loss: 0.6466
Epoch 40/400
160/160 [=====] - 0s 237us/step - loss: 0.6435
Epoch 41/400
160/160 [=====] - 0s 231us/step - loss: 0.6405
Epoch 42/400
160/160 [=====] - 0s 231us/step - loss: 0.6368
Epoch 43/400
160/160 [=====] - 0s 243us/step - loss: 0.6335
Epoch 44/400
160/160 [=====] - 0s 243us/step - loss: 0.6298
Epoch 45/400
160/160 [=====] - 0s 246us/step - loss: 0.6266
Epoch 46/400
160/160 [=====] - 0s 249us/step - loss: 0.6226
Epoch 47/400
160/160 [=====] - 0s 237us/step - loss: 0.6189
Epoch 48/400
160/160 [=====] - 0s 246us/step - loss: 0.6147
Epoch 49/400
160/160 [=====] - 0s 256us/step - loss: 0.6105
Epoch 50/400
160/160 [=====] - 0s 240us/step - loss: 0.6063
Epoch 51/400
160/160 [=====] - 0s 249us/step - loss: 0.6022
Epoch 52/400
160/160 [=====] - 0s 243us/step - loss: 0.5975

Epoch 53/400
160/160 [=====] - 0s 250us/step - loss: 0.5928
Epoch 54/400
160/160 [=====] - 0s 237us/step - loss: 0.5886
Epoch 55/400
160/160 [=====] - 0s 249us/step - loss: 0.5836
Epoch 56/400
160/160 [=====] - 0s 237us/step - loss: 0.5786
Epoch 57/400
160/160 [=====] - 0s 237us/step - loss: 0.5735
Epoch 58/400
160/160 [=====] - 0s 243us/step - loss: 0.5686
Epoch 59/400
160/160 [=====] - 0s 243us/step - loss: 0.5635
Epoch 60/400
160/160 [=====] - 0s 249us/step - loss: 0.5585
Epoch 61/400
160/160 [=====] - 0s 249us/step - loss: 0.5531
Epoch 62/400
160/160 [=====] - 0s 237us/step - loss: 0.5478
Epoch 63/400
160/160 [=====] - 0s 237us/step - loss: 0.5427
Epoch 64/400
160/160 [=====] - 0s 231us/step - loss: 0.5371
Epoch 65/400
160/160 [=====] - 0s 237us/step - loss: 0.5318
Epoch 66/400
160/160 [=====] - 0s 231us/step - loss: 0.5269
Epoch 67/400
160/160 [=====] - 0s 224us/step - loss: 0.5211
Epoch 68/400
160/160 [=====] - 0s 231us/step - loss: 0.5160
Epoch 69/400
160/160 [=====] - 0s 237us/step - loss: 0.5107
Epoch 70/400
160/160 [=====] - 0s 237us/step - loss: 0.5050
Epoch 71/400
160/160 [=====] - 0s 231us/step - loss: 0.5001
Epoch 72/400
160/160 [=====] - 0s 231us/step - loss: 0.4947
Epoch 73/400
160/160 [=====] - 0s 237us/step - loss: 0.4897
Epoch 74/400
160/160 [=====] - 0s 224us/step - loss: 0.4843
Epoch 75/400
160/160 [=====] - 0s 231us/step - loss: 0.4790
Epoch 76/400
160/160 [=====] - 0s 231us/step - loss: 0.4742
Epoch 77/400
160/160 [=====] - 0s 237us/step - loss: 0.4692
Epoch 78/400
160/160 [=====] - 0s 231us/step - loss: 0.4639
Epoch 79/400
160/160 [=====] - 0s 228us/step - loss: 0.4592
Epoch 80/400
160/160 [=====] - 0s 231us/step - loss: 0.4546
Epoch 81/400
160/160 [=====] - 0s 231us/step - loss: 0.4497
Epoch 82/400
160/160 [=====] - 0s 224us/step - loss: 0.4448
Epoch 83/400
160/160 [=====] - 0s 231us/step - loss: 0.4402
Epoch 84/400
160/160 [=====] - 0s 237us/step - loss: 0.4356
Epoch 85/400
160/160 [=====] - 0s 231us/step - loss: 0.4311
Epoch 86/400
160/160 [=====] - 0s 237us/step - loss: 0.4265
Epoch 87/400
160/160 [=====] - 0s 256us/step - loss: 0.4215
Epoch 88/400
160/160 [=====] - 0s 231us/step - loss: 0.4177
Epoch 89/400
160/160 [=====] - 0s 231us/step - loss: 0.4130
Epoch 90/400
160/160 [=====] - 0s 237us/step - loss: 0.4091
Epoch 91/400

```
Epoch 12/400
160/160 [=====] - 0s 231us/step - loss: 0.4049
Epoch 92/400
160/160 [=====] - 0s 246us/step - loss: 0.4006
Epoch 93/400
160/160 [=====] - 0s 237us/step - loss: 0.3967
Epoch 94/400
160/160 [=====] - 0s 224us/step - loss: 0.3926
Epoch 95/400
160/160 [=====] - 0s 228us/step - loss: 0.3891
Epoch 96/400
160/160 [=====] - 0s 237us/step - loss: 0.3850
Epoch 97/400
160/160 [=====] - 0s 231us/step - loss: 0.3811
Epoch 98/400
160/160 [=====] - 0s 228us/step - loss: 0.3775
Epoch 99/400
160/160 [=====] - 0s 231us/step - loss: 0.3740
Epoch 100/400
160/160 [=====] - 0s 234us/step - loss: 0.3702
Epoch 101/400
160/160 [=====] - 0s 231us/step - loss: 0.3662
Epoch 102/400
160/160 [=====] - 0s 237us/step - loss: 0.3628
Epoch 103/400
160/160 [=====] - 0s 231us/step - loss: 0.3594
Epoch 104/400
160/160 [=====] - 0s 231us/step - loss: 0.3562
Epoch 105/400
160/160 [=====] - 0s 237us/step - loss: 0.3528
Epoch 106/400
160/160 [=====] - 0s 231us/step - loss: 0.3492
Epoch 107/400
160/160 [=====] - 0s 231us/step - loss: 0.3461
Epoch 108/400
160/160 [=====] - 0s 231us/step - loss: 0.3429
Epoch 109/400
160/160 [=====] - 0s 231us/step - loss: 0.3397
Epoch 110/400
160/160 [=====] - 0s 237us/step - loss: 0.3365
Epoch 111/400
160/160 [=====] - 0s 237us/step - loss: 0.3338
Epoch 112/400
160/160 [=====] - 0s 231us/step - loss: 0.3305
Epoch 113/400
160/160 [=====] - 0s 237us/step - loss: 0.3276
Epoch 114/400
160/160 [=====] - 0s 268us/step - loss: 0.3246
Epoch 115/400
160/160 [=====] - 0s 237us/step - loss: 0.3222
Epoch 116/400
160/160 [=====] - 0s 237us/step - loss: 0.3191
Epoch 117/400
160/160 [=====] - 0s 237us/step - loss: 0.3164
Epoch 118/400
160/160 [=====] - 0s 243us/step - loss: 0.3135
Epoch 119/400
160/160 [=====] - 0s 231us/step - loss: 0.3109
Epoch 120/400
160/160 [=====] - 0s 237us/step - loss: 0.3082
Epoch 121/400
160/160 [=====] - 0s 231us/step - loss: 0.3056
Epoch 122/400
160/160 [=====] - 0s 237us/step - loss: 0.3030
Epoch 123/400
160/160 [=====] - 0s 237us/step - loss: 0.3008
Epoch 124/400
160/160 [=====] - 0s 231us/step - loss: 0.2984
Epoch 125/400
160/160 [=====] - 0s 237us/step - loss: 0.2961
Epoch 126/400
160/160 [=====] - 0s 249us/step - loss: 0.2936
Epoch 127/400
160/160 [=====] - 0s 231us/step - loss: 0.2912
Epoch 128/400
160/160 [=====] - 0s 231us/step - loss: 0.2889
Epoch 129/400
160/160 [=====] - 0s 237us/step - loss: 0.2868
```

100/100 - 0s 237us/step - loss: 0.2200
Epoch 130/400
160/160 [=====] - 0s 231us/step - loss: 0.2849
Epoch 131/400
160/160 [=====] - 0s 231us/step - loss: 0.2825
Epoch 132/400
160/160 [=====] - 0s 237us/step - loss: 0.2799
Epoch 133/400
160/160 [=====] - 0s 231us/step - loss: 0.2783
Epoch 134/400
160/160 [=====] - 0s 243us/step - loss: 0.2761
Epoch 135/400
160/160 [=====] - 0s 224us/step - loss: 0.2742
Epoch 136/400
160/160 [=====] - 0s 231us/step - loss: 0.2719
Epoch 137/400
160/160 [=====] - 0s 240us/step - loss: 0.2699
Epoch 138/400
160/160 [=====] - 0s 237us/step - loss: 0.2688
Epoch 139/400
160/160 [=====] - 0s 249us/step - loss: 0.2663
Epoch 140/400
160/160 [=====] - 0s 246us/step - loss: 0.2643
Epoch 141/400
160/160 [=====] - 0s 231us/step - loss: 0.2629
Epoch 142/400
160/160 [=====] - 0s 237us/step - loss: 0.2611
Epoch 143/400
160/160 [=====] - 0s 234us/step - loss: 0.2589
Epoch 144/400
160/160 [=====] - 0s 231us/step - loss: 0.2576
Epoch 145/400
160/160 [=====] - 0s 224us/step - loss: 0.2558
Epoch 146/400
160/160 [=====] - 0s 243us/step - loss: 0.2543
Epoch 147/400
160/160 [=====] - 0s 231us/step - loss: 0.2528
Epoch 148/400
160/160 [=====] - 0s 231us/step - loss: 0.2511
Epoch 149/400
160/160 [=====] - 0s 237us/step - loss: 0.2494
Epoch 150/400
160/160 [=====] - 0s 231us/step - loss: 0.2477
Epoch 151/400
160/160 [=====] - 0s 237us/step - loss: 0.2467
Epoch 152/400
160/160 [=====] - 0s 243us/step - loss: 0.2447
Epoch 153/400
160/160 [=====] - 0s 249us/step - loss: 0.2437
Epoch 154/400
160/160 [=====] - 0s 237us/step - loss: 0.2420
Epoch 155/400
160/160 [=====] - 0s 231us/step - loss: 0.2406
Epoch 156/400
160/160 [=====] - 0s 231us/step - loss: 0.2393
Epoch 157/400
160/160 [=====] - 0s 231us/step - loss: 0.2380
Epoch 158/400
160/160 [=====] - 0s 231us/step - loss: 0.2364
Epoch 159/400
160/160 [=====] - 0s 237us/step - loss: 0.2355
Epoch 160/400
160/160 [=====] - 0s 237us/step - loss: 0.2337
Epoch 161/400
160/160 [=====] - 0s 237us/step - loss: 0.2325
Epoch 162/400
160/160 [=====] - 0s 231us/step - loss: 0.2314
Epoch 163/400
160/160 [=====] - 0s 231us/step - loss: 0.2304
Epoch 164/400
160/160 [=====] - 0s 231us/step - loss: 0.2289
Epoch 165/400
160/160 [=====] - 0s 231us/step - loss: 0.2280
Epoch 166/400
160/160 [=====] - 0s 274us/step - loss: 0.2268
Epoch 167/400
160/160 [=====] - 0s 231us/step - loss: 0.2257
Epoch 168/400

Epoch 160/400
160/160 [=====] - 0s 243us/step - loss: 0.2244
Epoch 169/400
160/160 [=====] - 0s 231us/step - loss: 0.2234
Epoch 170/400
160/160 [=====] - 0s 237us/step - loss: 0.2221
Epoch 171/400
160/160 [=====] - 0s 231us/step - loss: 0.2214
Epoch 172/400
160/160 [=====] - 0s 231us/step - loss: 0.2201
Epoch 173/400
160/160 [=====] - 0s 237us/step - loss: 0.2189
Epoch 174/400
160/160 [=====] - 0s 231us/step - loss: 0.2179
Epoch 175/400
160/160 [=====] - 0s 224us/step - loss: 0.2169
Epoch 176/400
160/160 [=====] - 0s 231us/step - loss: 0.2157
Epoch 177/400
160/160 [=====] - 0s 234us/step - loss: 0.2150
Epoch 178/400
160/160 [=====] - 0s 237us/step - loss: 0.2139
Epoch 179/400
160/160 [=====] - 0s 224us/step - loss: 0.2131
Epoch 180/400
160/160 [=====] - 0s 234us/step - loss: 0.2122
Epoch 181/400
160/160 [=====] - 0s 231us/step - loss: 0.2112
Epoch 182/400
160/160 [=====] - 0s 252us/step - loss: 0.2103
Epoch 183/400
160/160 [=====] - 0s 249us/step - loss: 0.2096
Epoch 184/400
160/160 [=====] - 0s 243us/step - loss: 0.2087
Epoch 185/400
160/160 [=====] - 0s 240us/step - loss: 0.2081
Epoch 186/400
160/160 [=====] - 0s 231us/step - loss: 0.2067
Epoch 187/400
160/160 [=====] - 0s 240us/step - loss: 0.2062
Epoch 188/400
160/160 [=====] - 0s 243us/step - loss: 0.2053
Epoch 189/400
160/160 [=====] - 0s 237us/step - loss: 0.2043
Epoch 190/400
160/160 [=====] - 0s 249us/step - loss: 0.2036
Epoch 191/400
160/160 [=====] - 0s 243us/step - loss: 0.2028
Epoch 192/400
160/160 [=====] - 0s 249us/step - loss: 0.2018
Epoch 193/400
160/160 [=====] - 0s 231us/step - loss: 0.2014
Epoch 194/400
160/160 [=====] - 0s 237us/step - loss: 0.2005
Epoch 195/400
160/160 [=====] - 0s 243us/step - loss: 0.2000
Epoch 196/400
160/160 [=====] - 0s 249us/step - loss: 0.1991
Epoch 197/400
160/160 [=====] - 0s 249us/step - loss: 0.1983
Epoch 198/400
160/160 [=====] - 0s 237us/step - loss: 0.1974
Epoch 199/400
160/160 [=====] - 0s 243us/step - loss: 0.1967
Epoch 200/400
160/160 [=====] - 0s 246us/step - loss: 0.1963
Epoch 201/400
160/160 [=====] - 0s 237us/step - loss: 0.1953
Epoch 202/400
160/160 [=====] - 0s 231us/step - loss: 0.1947
Epoch 203/400
160/160 [=====] - 0s 237us/step - loss: 0.1942
Epoch 204/400
160/160 [=====] - 0s 231us/step - loss: 0.1934
Epoch 205/400
160/160 [=====] - 0s 231us/step - loss: 0.1929
Epoch 206/400
160/160 [=====] - 0s 243us/step - loss: 0.1923

100/100 [=====] - 0s 249us/step - loss: 0.1920
Epoch 207/400
160/160 [=====] - 0s 237us/step - loss: 0.1919
Epoch 208/400
160/160 [=====] - 0s 231us/step - loss: 0.1910
Epoch 209/400
160/160 [=====] - 0s 231us/step - loss: 0.1899
Epoch 210/400
160/160 [=====] - 0s 237us/step - loss: 0.1897
Epoch 211/400
160/160 [=====] - 0s 246us/step - loss: 0.1890
Epoch 212/400
160/160 [=====] - 0s 256us/step - loss: 0.1881
Epoch 213/400
160/160 [=====] - 0s 246us/step - loss: 0.1880
Epoch 214/400
160/160 [=====] - 0s 237us/step - loss: 0.1875
Epoch 215/400
160/160 [=====] - 0s 243us/step - loss: 0.1866
Epoch 216/400
160/160 [=====] - 0s 243us/step - loss: 0.1862
Epoch 217/400
160/160 [=====] - 0s 249us/step - loss: 0.1856
Epoch 218/400
160/160 [=====] - 0s 249us/step - loss: 0.1850
Epoch 219/400
160/160 [=====] - 0s 231us/step - loss: 0.1848
Epoch 220/400
160/160 [=====] - 0s 231us/step - loss: 0.1840
Epoch 221/400
160/160 [=====] - 0s 231us/step - loss: 0.1834
Epoch 222/400
160/160 [=====] - 0s 237us/step - loss: 0.1829
Epoch 223/400
160/160 [=====] - 0s 237us/step - loss: 0.1821
Epoch 224/400
160/160 [=====] - 0s 231us/step - loss: 0.1815
Epoch 225/400
160/160 [=====] - 0s 237us/step - loss: 0.1814
Epoch 226/400
160/160 [=====] - 0s 234us/step - loss: 0.1807
Epoch 227/400
160/160 [=====] - 0s 231us/step - loss: 0.1802
Epoch 228/400
160/160 [=====] - 0s 231us/step - loss: 0.1797
Epoch 229/400
160/160 [=====] - 0s 221us/step - loss: 0.1793
Epoch 230/400
160/160 [=====] - 0s 231us/step - loss: 0.1787
Epoch 231/400
160/160 [=====] - 0s 231us/step - loss: 0.1784
Epoch 232/400
160/160 [=====] - 0s 228us/step - loss: 0.1777
Epoch 233/400
160/160 [=====] - 0s 224us/step - loss: 0.1774
Epoch 234/400
160/160 [=====] - 0s 234us/step - loss: 0.1770
Epoch 235/400
160/160 [=====] - 0s 237us/step - loss: 0.1765
Epoch 236/400
160/160 [=====] - 0s 231us/step - loss: 0.1760
Epoch 237/400
160/160 [=====] - 0s 231us/step - loss: 0.1754
Epoch 238/400
160/160 [=====] - 0s 243us/step - loss: 0.1748
Epoch 239/400
160/160 [=====] - 0s 237us/step - loss: 0.1749
Epoch 240/400
160/160 [=====] - 0s 237us/step - loss: 0.1742
Epoch 241/400
160/160 [=====] - 0s 237us/step - loss: 0.1736
Epoch 242/400
160/160 [=====] - 0s 234us/step - loss: 0.1730
Epoch 243/400
160/160 [=====] - 0s 237us/step - loss: 0.1730
Epoch 244/400
160/160 [=====] - 0s 256us/step - loss: 0.1726

Epoch 245/400

Epoch 245/400
160/160 [=====] - 0s 231us/step - loss: 0.1722
Epoch 246/400
160/160 [=====] - 0s 231us/step - loss: 0.1718
Epoch 247/400
160/160 [=====] - 0s 231us/step - loss: 0.1712
Epoch 248/400
160/160 [=====] - 0s 237us/step - loss: 0.1707
Epoch 249/400
160/160 [=====] - 0s 243us/step - loss: 0.1707
Epoch 250/400
160/160 [=====] - 0s 237us/step - loss: 0.1700
Epoch 251/400
160/160 [=====] - 0s 231us/step - loss: 0.1700
Epoch 252/400
160/160 [=====] - 0s 237us/step - loss: 0.1696
Epoch 253/400
160/160 [=====] - 0s 237us/step - loss: 0.1691
Epoch 254/400
160/160 [=====] - 0s 231us/step - loss: 0.1686
Epoch 255/400
160/160 [=====] - 0s 231us/step - loss: 0.1682
Epoch 256/400
160/160 [=====] - 0s 231us/step - loss: 0.1680
Epoch 257/400
160/160 [=====] - 0s 231us/step - loss: 0.1677
Epoch 258/400
160/160 [=====] - 0s 228us/step - loss: 0.1672
Epoch 259/400
160/160 [=====] - 0s 243us/step - loss: 0.1668
Epoch 260/400
160/160 [=====] - 0s 243us/step - loss: 0.1662
Epoch 261/400
160/160 [=====] - 0s 240us/step - loss: 0.1662
Epoch 262/400
160/160 [=====] - 0s 237us/step - loss: 0.1657
Epoch 263/400
160/160 [=====] - 0s 237us/step - loss: 0.1652
Epoch 264/400
160/160 [=====] - 0s 231us/step - loss: 0.1652
Epoch 265/400
160/160 [=====] - 0s 237us/step - loss: 0.1648
Epoch 266/400
160/160 [=====] - 0s 231us/step - loss: 0.1642
Epoch 267/400
160/160 [=====] - 0s 224us/step - loss: 0.1640
Epoch 268/400
160/160 [=====] - 0s 231us/step - loss: 0.1637
Epoch 269/400
160/160 [=====] - 0s 237us/step - loss: 0.1633
Epoch 270/400
160/160 [=====] - 0s 243us/step - loss: 0.1631
Epoch 271/400
160/160 [=====] - 0s 243us/step - loss: 0.1626
Epoch 272/400
160/160 [=====] - 0s 224us/step - loss: 0.1625
Epoch 273/400
160/160 [=====] - 0s 231us/step - loss: 0.1620
Epoch 274/400
160/160 [=====] - 0s 237us/step - loss: 0.1618
Epoch 275/400
160/160 [=====] - 0s 237us/step - loss: 0.1611
Epoch 276/400
160/160 [=====] - 0s 243us/step - loss: 0.1613
Epoch 277/400
160/160 [=====] - 0s 234us/step - loss: 0.1612
Epoch 278/400
160/160 [=====] - 0s 237us/step - loss: 0.1608
Epoch 279/400
160/160 [=====] - 0s 237us/step - loss: 0.1602
Epoch 280/400
160/160 [=====] - 0s 231us/step - loss: 0.1601
Epoch 281/400
160/160 [=====] - 0s 231us/step - loss: 0.1596
Epoch 282/400
160/160 [=====] - 0s 237us/step - loss: 0.1592
Epoch 283/400

160/160 [=====] - 0s 224us/step - loss: 0.1592
Epoch 284/400
160/160 [=====] - 0s 224us/step - loss: 0.1590
Epoch 285/400
160/160 [=====] - 0s 224us/step - loss: 0.1584
Epoch 286/400
160/160 [=====] - 0s 231us/step - loss: 0.1583
Epoch 287/400
160/160 [=====] - 0s 237us/step - loss: 0.1574
Epoch 288/400
160/160 [=====] - 0s 243us/step - loss: 0.1578
Epoch 289/400
160/160 [=====] - 0s 249us/step - loss: 0.1573
Epoch 290/400
160/160 [=====] - 0s 243us/step - loss: 0.1573
Epoch 291/400
160/160 [=====] - 0s 249us/step - loss: 0.1564
Epoch 292/400
160/160 [=====] - 0s 231us/step - loss: 0.1567
Epoch 293/400
160/160 [=====] - 0s 237us/step - loss: 0.1563
Epoch 294/400
160/160 [=====] - 0s 249us/step - loss: 0.1561
Epoch 295/400
160/160 [=====] - 0s 237us/step - loss: 0.1558
Epoch 296/400
160/160 [=====] - 0s 249us/step - loss: 0.1556
Epoch 297/400
160/160 [=====] - 0s 237us/step - loss: 0.1553
Epoch 298/400
160/160 [=====] - 0s 237us/step - loss: 0.1550
Epoch 299/400
160/160 [=====] - 0s 249us/step - loss: 0.1548
Epoch 300/400
160/160 [=====] - 0s 246us/step - loss: 0.1545
Epoch 301/400
160/160 [=====] - 0s 249us/step - loss: 0.1544
Epoch 302/400
160/160 [=====] - 0s 249us/step - loss: 0.1541
Epoch 303/400
160/160 [=====] - 0s 249us/step - loss: 0.1536
Epoch 304/400
160/160 [=====] - 0s 237us/step - loss: 0.1536
Epoch 305/400
160/160 [=====] - 0s 237us/step - loss: 0.1533
Epoch 306/400
160/160 [=====] - 0s 237us/step - loss: 0.1531
Epoch 307/400
160/160 [=====] - 0s 237us/step - loss: 0.1527
Epoch 308/400
160/160 [=====] - 0s 231us/step - loss: 0.1522
Epoch 309/400
160/160 [=====] - 0s 237us/step - loss: 0.1523
Epoch 310/400
160/160 [=====] - 0s 243us/step - loss: 0.1520
Epoch 311/400
160/160 [=====] - 0s 231us/step - loss: 0.1519
Epoch 312/400
160/160 [=====] - 0s 237us/step - loss: 0.1518
Epoch 313/400
160/160 [=====] - 0s 231us/step - loss: 0.1511
Epoch 315/400
160/160 [=====] - 0s 243us/step - loss: 0.1508
Epoch 316/400
160/160 [=====] - 0s 240us/step - loss: 0.1506
Epoch 317/400
160/160 [=====] - 0s 243us/step - loss: 0.1502
Epoch 318/400
160/160 [=====] - 0s 234us/step - loss: 0.1503
Epoch 319/400
160/160 [=====] - 0s 243us/step - loss: 0.1501
Epoch 320/400
160/160 [=====] - 0s 231us/step - loss: 0.1498
Epoch 321/400
160/160 [=====] - 0s 234us/step - loss: 0.1498

Epoch 322/400
160/160 [=====] - 0s 256us/step - loss: 0.1496
Epoch 323/400
160/160 [=====] - 0s 243us/step - loss: 0.1491
Epoch 324/400
160/160 [=====] - 0s 243us/step - loss: 0.1489
Epoch 325/400
160/160 [=====] - 0s 243us/step - loss: 0.1487
Epoch 326/400
160/160 [=====] - 0s 249us/step - loss: 0.1486
Epoch 327/400
160/160 [=====] - 0s 252us/step - loss: 0.1478
Epoch 328/400
160/160 [=====] - 0s 243us/step - loss: 0.1481
Epoch 329/400
160/160 [=====] - 0s 262us/step - loss: 0.1481
Epoch 330/400
160/160 [=====] - 0s 237us/step - loss: 0.1476
Epoch 331/400
160/160 [=====] - 0s 243us/step - loss: 0.1477
Epoch 332/400
160/160 [=====] - 0s 256us/step - loss: 0.1475
Epoch 333/400
160/160 [=====] - 0s 265us/step - loss: 0.1472
Epoch 334/400
160/160 [=====] - 0s 262us/step - loss: 0.1469
Epoch 335/400
160/160 [=====] - 0s 265us/step - loss: 0.1469
Epoch 336/400
160/160 [=====] - 0s 249us/step - loss: 0.1467
Epoch 337/400
160/160 [=====] - 0s 249us/step - loss: 0.1463
Epoch 338/400
160/160 [=====] - 0s 243us/step - loss: 0.1461
Epoch 339/400
160/160 [=====] - 0s 249us/step - loss: 0.1460
Epoch 340/400
160/160 [=====] - 0s 249us/step - loss: 0.1460
Epoch 341/400
160/160 [=====] - 0s 243us/step - loss: 0.1457
Epoch 342/400
160/160 [=====] - 0s 237us/step - loss: 0.1455
Epoch 343/400
160/160 [=====] - 0s 231us/step - loss: 0.1455
Epoch 344/400
160/160 [=====] - 0s 231us/step - loss: 0.1452
Epoch 345/400
160/160 [=====] - 0s 243us/step - loss: 0.1448
Epoch 346/400
160/160 [=====] - 0s 262us/step - loss: 0.1448
Epoch 347/400
160/160 [=====] - 0s 249us/step - loss: 0.1443
Epoch 348/400
160/160 [=====] - 0s 249us/step - loss: 0.1443
Epoch 349/400
160/160 [=====] - 0s 237us/step - loss: 0.1440
Epoch 350/400
160/160 [=====] - 0s 231us/step - loss: 0.1440
Epoch 351/400
160/160 [=====] - 0s 243us/step - loss: 0.1438
Epoch 352/400
160/160 [=====] - 0s 249us/step - loss: 0.1435
Epoch 353/400
160/160 [=====] - 0s 256us/step - loss: 0.1437
Epoch 354/400
160/160 [=====] - 0s 249us/step - loss: 0.1431
Epoch 355/400
160/160 [=====] - 0s 243us/step - loss: 0.1433
Epoch 356/400
160/160 [=====] - 0s 237us/step - loss: 0.1429
Epoch 357/400
160/160 [=====] - 0s 243us/step - loss: 0.1429
Epoch 358/400
160/160 [=====] - 0s 243us/step - loss: 0.1427
Epoch 359/400
160/160 [=====] - 0s 243us/step - loss: 0.1425
Epoch 360/400

160/160 [=====] - 0s 237us/step - loss: 0.1421
Epoch 361/400
160/160 [=====] - 0s 234us/step - loss: 0.1421
Epoch 362/400
160/160 [=====] - 0s 237us/step - loss: 0.1419
Epoch 363/400
160/160 [=====] - 0s 237us/step - loss: 0.1419
Epoch 364/400
160/160 [=====] - 0s 234us/step - loss: 0.1417
Epoch 365/400
160/160 [=====] - 0s 237us/step - loss: 0.1412
Epoch 366/400
160/160 [=====] - 0s 243us/step - loss: 0.1411
Epoch 367/400
160/160 [=====] - 0s 237us/step - loss: 0.1409
Epoch 368/400
160/160 [=====] - 0s 243us/step - loss: 0.1409
Epoch 369/400
160/160 [=====] - 0s 231us/step - loss: 0.1408
Epoch 370/400
160/160 [=====] - 0s 237us/step - loss: 0.1406
Epoch 371/400
160/160 [=====] - 0s 231us/step - loss: 0.1406
Epoch 372/400
160/160 [=====] - 0s 262us/step - loss: 0.1404
Epoch 373/400
160/160 [=====] - 0s 249us/step - loss: 0.1403
Epoch 374/400
160/160 [=====] - 0s 231us/step - loss: 0.1400
Epoch 375/400
160/160 [=====] - 0s 249us/step - loss: 0.1399
Epoch 376/400
160/160 [=====] - 0s 237us/step - loss: 0.1396
Epoch 377/400
160/160 [=====] - 0s 237us/step - loss: 0.1397
Epoch 378/400
160/160 [=====] - 0s 262us/step - loss: 0.1392
Epoch 379/400
160/160 [=====] - 0s 249us/step - loss: 0.1397
Epoch 380/400
160/160 [=====] - 0s 274us/step - loss: 0.1390
Epoch 381/400
160/160 [=====] - 0s 262us/step - loss: 0.1389
Epoch 382/400
160/160 [=====] - 0s 262us/step - loss: 0.1387
Epoch 383/400
160/160 [=====] - 0s 262us/step - loss: 0.1387
Epoch 384/400
160/160 [=====] - 0s 262us/step - loss: 0.1387
Epoch 385/400
160/160 [=====] - 0s 243us/step - loss: 0.1384
Epoch 386/400
160/160 [=====] - 0s 234us/step - loss: 0.1383
Epoch 387/400
160/160 [=====] - 0s 243us/step - loss: 0.1379
Epoch 388/400
160/160 [=====] - 0s 249us/step - loss: 0.1380
Epoch 389/400
160/160 [=====] - 0s 243us/step - loss: 0.1380
Epoch 390/400
160/160 [=====] - 0s 237us/step - loss: 0.1377
Epoch 391/400
160/160 [=====] - 0s 243us/step - loss: 0.1376
Epoch 392/400
160/160 [=====] - 0s 243us/step - loss: 0.1374
Epoch 393/400
160/160 [=====] - 0s 243us/step - loss: 0.1372
Epoch 394/400
160/160 [=====] - 0s 237us/step - loss: 0.1373
Epoch 395/400
160/160 [=====] - 0s 240us/step - loss: 0.1370
Epoch 396/400
160/160 [=====] - 0s 231us/step - loss: 0.1367
Epoch 397/400
160/160 [=====] - 0s 249us/step - loss: 0.1367
Epoch 398/400
160/160 [=====] - 0s 274us/step - loss: 0.1364

```

Epoch 399/400
160/160 [=====] - 0s 243us/step - loss: 0.1363
Epoch 400/400
160/160 [=====] - 0s 237us/step - loss: 0.1361
[9.99515176e-01 9.99130666e-01 9.95429397e-01 9.96148109e-01
 9.99283969e-01 4.82996076e-01 9.97793078e-01 9.99376357e-01
 9.85910177e-01 9.99607980e-01 9.84942675e-01 6.98240697e-01
 9.19197977e-01 5.67911446e-01 7.80165851e-01 9.96805906e-01
 9.89144862e-01 6.91017389e-01 9.99540091e-01 5.77432334e-01
 8.96594107e-01 7.59865046e-01 6.77231371e-01 9.96630609e-01
 9.93904293e-01 9.99219537e-01 8.70823801e-01 8.98095906e-01
 5.42204320e-01 9.77391124e-01 9.34181094e-01 9.42567885e-01
 9.95391369e-01 9.99157071e-01 9.21337843e-01 9.33493614e-01
 9.85666573e-01 9.18472528e-01 5.45762837e-01 9.98874485e-01
 9.99623418e-01 9.99335587e-01 9.95871365e-01 9.96037066e-01
 9.99564946e-01 5.52042127e-01 9.97802794e-01 9.99362528e-01
 9.87509847e-01 9.99631405e-01 9.96426284e-01 6.94320917e-01
 8.80398691e-01 5.34609020e-01 8.06402922e-01 9.98127162e-01
 9.96517897e-01 8.37327003e-01 9.99622107e-01 5.44791996e-01
 8.68480682e-01 7.70231128e-01 6.90348446e-01 9.96875525e-01
 9.95755196e-01 9.99564111e-01 8.27648401e-01 8.51535976e-01
 5.81684947e-01 9.69425559e-01 9.15479958e-01 9.69099760e-01
 9.92975473e-01 9.98938143e-01 9.24722254e-01 9.14988101e-01
 9.85716164e-01 9.42608237e-01 6.66995645e-01 9.99407291e-01
 7.32251676e-04 1.14490686e-03 6.48574671e-03 3.76018882e-03
 1.12725992e-03 5.21630406e-01 2.58975336e-03 8.59874999e-04
 1.23518836e-02 5.56907326e-04 1.91528331e-02 2.95929372e-01
 1.04018740e-01 4.21178371e-01 2.14361951e-01 3.85864102e-03
 1.32539421e-02 2.96104461e-01 6.78596494e-04 4.13979948e-01
 9.85970423e-02 2.40241259e-01 3.30498368e-01 4.30797599e-03
 6.69993041e-03 1.27134216e-03 1.22383192e-01 1.25347733e-01
 4.33401525e-01 2.00850926e-02 8.16579312e-02 5.67571744e-02
 4.13951371e-03 9.37491481e-04 7.12994039e-02 8.21770206e-02
 1.91441365e-02 7.00484961e-02 4.35546994e-01 1.68115622e-03
 5.66195871e-04 9.04431625e-04 4.42360016e-03 4.80778562e-03
 6.19036669e-04 4.53313887e-01 2.73091882e-03 9.20344261e-04
 1.39627000e-02 5.69465104e-04 3.54641560e-03 2.83797592e-01
 1.06369853e-01 4.09825325e-01 1.98123410e-01 2.12693168e-03
 3.56126833e-03 1.78907692e-01 5.71612851e-04 4.05243814e-01
 1.21865518e-01 2.33258963e-01 3.15934211e-01 3.59924324e-03
 4.31076903e-03 6.13720738e-04 1.47480458e-01 1.33836746e-01
 4.06463176e-01 3.08997761e-02 7.47925416e-02 2.63450537e-02
 7.84576405e-03 1.47701509e-03 7.75080919e-02 7.52678588e-02
 1.35415085e-02 5.86681515e-02 4.21006769e-01 7.89301703e-04]
160/160 [=====] - 0s 489us/step

```

In [36]:

```
#One layer, four neurons per layer: loss
scores_lay_one_four, model_lay_one_four.metrics_names
```

Out[36]:

```
(0.13428999334573746, ['loss'])
```

Two Layers

In [37]:

```
n = 40
xx = np.random.random((n,1))
yy = np.random.random((n,1))

X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [38]:

```
#Two layers, four neurons per layer
model_lay_two_four = Sequential()

#hidden layers
model_lay_two_four.add(Dense(4, input_dim=2, activation='tanh'))
model_lay_two_four.add(Dense(4, activation='tanh'))

#output layer
model_lay_two_four.add(Dense(1, activation='sigmoid'))
```

```

sgd = SGD(lr=0.1)
model_lay_two_four.compile(loss='binary_crossentropy', optimizer='sgd')

model_lay_two_four.fit(X, y, batch_size=2, epochs=400)
print(model_lay_two_four.predict_proba(X).reshape(4*n))

#evaluate the model
scores_lay_two_four = model_lay_two_four.evaluate(X, y)

```

Epoch 1/400
160/160 [=====] - 0s 2ms/step - loss: 0.6977
Epoch 2/400
160/160 [=====] - 0s 259us/step - loss: 0.6955
Epoch 3/400
160/160 [=====] - 0s 256us/step - loss: 0.6936
Epoch 4/400
160/160 [=====] - 0s 262us/step - loss: 0.6916
Epoch 5/400
160/160 [=====] - 0s 256us/step - loss: 0.6895
Epoch 6/400
160/160 [=====] - 0s 265us/step - loss: 0.6873
Epoch 7/400
160/160 [=====] - 0s 268us/step - loss: 0.6852
Epoch 8/400
160/160 [=====] - 0s 268us/step - loss: 0.6833
Epoch 9/400
160/160 [=====] - 0s 256us/step - loss: 0.6809
Epoch 10/400
160/160 [=====] - 0s 274us/step - loss: 0.6780
Epoch 11/400
160/160 [=====] - 0s 281us/step - loss: 0.6761
Epoch 12/400
160/160 [=====] - 0s 280us/step - loss: 0.6731
Epoch 13/400
160/160 [=====] - 0s 287us/step - loss: 0.6702
Epoch 14/400
160/160 [=====] - 0s 280us/step - loss: 0.6675
Epoch 15/400
160/160 [=====] - 0s 262us/step - loss: 0.6637
Epoch 16/400
160/160 [=====] - 0s 256us/step - loss: 0.6603
Epoch 17/400
160/160 [=====] - 0s 262us/step - loss: 0.6568
Epoch 18/400
160/160 [=====] - 0s 249us/step - loss: 0.6530
Epoch 19/400
160/160 [=====] - 0s 256us/step - loss: 0.6485
Epoch 20/400
160/160 [=====] - 0s 237us/step - loss: 0.6443
Epoch 21/400
160/160 [=====] - 0s 237us/step - loss: 0.6393
Epoch 22/400
160/160 [=====] - 0s 262us/step - loss: 0.6344
Epoch 23/400
160/160 [=====] - 0s 249us/step - loss: 0.6299
Epoch 24/400
160/160 [=====] - 0s 256us/step - loss: 0.6243
Epoch 25/400
160/160 [=====] - 0s 259us/step - loss: 0.6192
Epoch 26/400
160/160 [=====] - 0s 262us/step - loss: 0.6137
Epoch 27/400
160/160 [=====] - 0s 262us/step - loss: 0.6075
Epoch 28/400
160/160 [=====] - 0s 252us/step - loss: 0.6015
Epoch 29/400
160/160 [=====] - 0s 256us/step - loss: 0.5956
Epoch 30/400
160/160 [=====] - 0s 252us/step - loss: 0.5902
Epoch 31/400
160/160 [=====] - 0s 268us/step - loss: 0.5841
Epoch 32/400
160/160 [=====] - 0s 256us/step - loss: 0.5775
Epoch 33/400
160/160 [=====] - 0s 259us/step - loss: 0.5711
Epoch 34/400
...

```
160/160 [=====] - 0s 256us/step - loss: 0.5651
Epoch 35/400
160/160 [=====] - 0s 262us/step - loss: 0.5588
Epoch 36/400
160/160 [=====] - 0s 256us/step - loss: 0.5523
Epoch 37/400
160/160 [=====] - 0s 249us/step - loss: 0.5458
Epoch 38/400
160/160 [=====] - 0s 243us/step - loss: 0.5389
Epoch 39/400
160/160 [=====] - 0s 256us/step - loss: 0.5329
Epoch 40/400
160/160 [=====] - 0s 262us/step - loss: 0.5261
Epoch 41/400
160/160 [=====] - 0s 256us/step - loss: 0.5197
Epoch 42/400
160/160 [=====] - 0s 268us/step - loss: 0.5121
Epoch 43/400
160/160 [=====] - 0s 262us/step - loss: 0.5060
Epoch 44/400
160/160 [=====] - 0s 268us/step - loss: 0.4995
Epoch 45/400
160/160 [=====] - 0s 262us/step - loss: 0.4930
Epoch 46/400
160/160 [=====] - 0s 262us/step - loss: 0.4859
Epoch 47/400
160/160 [=====] - 0s 256us/step - loss: 0.4790
Epoch 48/400
160/160 [=====] - 0s 262us/step - loss: 0.4720
Epoch 49/400
160/160 [=====] - 0s 268us/step - loss: 0.4650
Epoch 50/400
160/160 [=====] - 0s 249us/step - loss: 0.4577
Epoch 51/400
160/160 [=====] - 0s 262us/step - loss: 0.4511
Epoch 52/400
160/160 [=====] - 0s 262us/step - loss: 0.4436
Epoch 53/400
160/160 [=====] - 0s 249us/step - loss: 0.4363
Epoch 54/400
160/160 [=====] - 0s 259us/step - loss: 0.4294
Epoch 55/400
160/160 [=====] - 0s 287us/step - loss: 0.4205
Epoch 56/400
160/160 [=====] - 0s 256us/step - loss: 0.4143
Epoch 57/400
160/160 [=====] - 0s 256us/step - loss: 0.4069
Epoch 58/400
160/160 [=====] - 0s 243us/step - loss: 0.3996
Epoch 59/400
160/160 [=====] - 0s 249us/step - loss: 0.3918
Epoch 60/400
160/160 [=====] - 0s 249us/step - loss: 0.3841
Epoch 61/400
160/160 [=====] - 0s 249us/step - loss: 0.3770
Epoch 62/400
160/160 [=====] - 0s 249us/step - loss: 0.3699
Epoch 63/400
160/160 [=====] - 0s 249us/step - loss: 0.3614
Epoch 64/400
160/160 [=====] - 0s 243us/step - loss: 0.3547
Epoch 65/400
160/160 [=====] - 0s 249us/step - loss: 0.3478
Epoch 66/400
160/160 [=====] - 0s 243us/step - loss: 0.3411
Epoch 67/400
160/160 [=====] - 0s 252us/step - loss: 0.3341
Epoch 68/400
160/160 [=====] - 0s 243us/step - loss: 0.3266
Epoch 69/400
160/160 [=====] - 0s 252us/step - loss: 0.3207
Epoch 70/400
160/160 [=====] - 0s 256us/step - loss: 0.3148
Epoch 71/400
160/160 [=====] - 0s 249us/step - loss: 0.3078
Epoch 72/400
160/160 [=====] - 0s 253us/step - loss: 0.3006
```

Epoch 73/400
160/160 [=====] - 0s 243us/step - loss: 0.2958
Epoch 74/400
160/160 [=====] - 0s 240us/step - loss: 0.2889
Epoch 75/400
160/160 [=====] - 0s 249us/step - loss: 0.2828
Epoch 76/400
160/160 [=====] - 0s 243us/step - loss: 0.2785
Epoch 77/400
160/160 [=====] - 0s 252us/step - loss: 0.2716
Epoch 78/400
160/160 [=====] - 0s 249us/step - loss: 0.2660
Epoch 79/400
160/160 [=====] - 0s 262us/step - loss: 0.2607
Epoch 80/400
160/160 [=====] - 0s 262us/step - loss: 0.2547
Epoch 81/400
160/160 [=====] - 0s 243us/step - loss: 0.2508
Epoch 82/400
160/160 [=====] - 0s 249us/step - loss: 0.2453
Epoch 83/400
160/160 [=====] - 0s 256us/step - loss: 0.2406
Epoch 84/400
160/160 [=====] - 0s 256us/step - loss: 0.2361
Epoch 85/400
160/160 [=====] - 0s 256us/step - loss: 0.2313
Epoch 86/400
160/160 [=====] - 0s 256us/step - loss: 0.2266
Epoch 87/400
160/160 [=====] - 0s 256us/step - loss: 0.2214
Epoch 88/400
160/160 [=====] - 0s 249us/step - loss: 0.2184
Epoch 89/400
160/160 [=====] - 0s 262us/step - loss: 0.2140
Epoch 90/400
160/160 [=====] - 0s 280us/step - loss: 0.2094
Epoch 91/400
160/160 [=====] - 0s 281us/step - loss: 0.2058
Epoch 92/400
160/160 [=====] - 0s 262us/step - loss: 0.2013
Epoch 93/400
160/160 [=====] - 0s 262us/step - loss: 0.1976
Epoch 94/400
160/160 [=====] - 0s 268us/step - loss: 0.1952
Epoch 95/400
160/160 [=====] - 0s 262us/step - loss: 0.1912
Epoch 96/400
160/160 [=====] - 0s 249us/step - loss: 0.1882
Epoch 97/400
160/160 [=====] - 0s 249us/step - loss: 0.1853
Epoch 98/400
160/160 [=====] - 0s 246us/step - loss: 0.1812
Epoch 99/400
160/160 [=====] - 0s 280us/step - loss: 0.1788
Epoch 100/400
160/160 [=====] - 0s 274us/step - loss: 0.1758
Epoch 101/400
160/160 [=====] - 0s 249us/step - loss: 0.1723
Epoch 102/400
160/160 [=====] - 0s 256us/step - loss: 0.1706
Epoch 103/400
160/160 [=====] - 0s 274us/step - loss: 0.1679
Epoch 104/400
160/160 [=====] - 0s 256us/step - loss: 0.1650
Epoch 105/400
160/160 [=====] - 0s 268us/step - loss: 0.1623
Epoch 106/400
160/160 [=====] - 0s 268us/step - loss: 0.1598
Epoch 107/400
160/160 [=====] - 0s 249us/step - loss: 0.1568
Epoch 108/400
160/160 [=====] - 0s 256us/step - loss: 0.1550
Epoch 109/400
160/160 [=====] - 0s 256us/step - loss: 0.1536
Epoch 110/400
160/160 [=====] - 0s 246us/step - loss: 0.1496
Epoch 111/400

160/160 [=====] - 0s 249us/step - loss: 0.1490
Epoch 112/400
160/160 [=====] - 0s 243us/step - loss: 0.1458
Epoch 113/400
160/160 [=====] - 0s 246us/step - loss: 0.1449
Epoch 114/400
160/160 [=====] - 0s 268us/step - loss: 0.1415
Epoch 115/400
160/160 [=====] - 0s 271us/step - loss: 0.1415
Epoch 116/400
160/160 [=====] - 0s 268us/step - loss: 0.1389
Epoch 117/400
160/160 [=====] - 0s 262us/step - loss: 0.1374
Epoch 118/400
160/160 [=====] - 0s 256us/step - loss: 0.1363
Epoch 119/400
160/160 [=====] - 0s 249us/step - loss: 0.1347
Epoch 120/400
160/160 [=====] - 0s 249us/step - loss: 0.1324
Epoch 121/400
160/160 [=====] - 0s 262us/step - loss: 0.1291
Epoch 122/400
160/160 [=====] - 0s 249us/step - loss: 0.1294
Epoch 123/400
160/160 [=====] - 0s 268us/step - loss: 0.1280
Epoch 124/400
160/160 [=====] - 0s 256us/step - loss: 0.1262
Epoch 125/400
160/160 [=====] - 0s 268us/step - loss: 0.1248
Epoch 126/400
160/160 [=====] - 0s 268us/step - loss: 0.1237
Epoch 127/400
160/160 [=====] - 0s 293us/step - loss: 0.1206
Epoch 128/400
160/160 [=====] - 0s 262us/step - loss: 0.1221
Epoch 129/400
160/160 [=====] - 0s 262us/step - loss: 0.1188
Epoch 130/400
160/160 [=====] - 0s 262us/step - loss: 0.1179
Epoch 131/400
160/160 [=====] - 0s 256us/step - loss: 0.1172
Epoch 132/400
160/160 [=====] - 0s 243us/step - loss: 0.1162
Epoch 133/400
160/160 [=====] - 0s 243us/step - loss: 0.1143
Epoch 134/400
160/160 [=====] - 0s 262us/step - loss: 0.1141
Epoch 135/400
160/160 [=====] - 0s 256us/step - loss: 0.1125
Epoch 136/400
160/160 [=====] - 0s 237us/step - loss: 0.1116
Epoch 137/400
160/160 [=====] - 0s 240us/step - loss: 0.1102
Epoch 138/400
160/160 [=====] - 0s 249us/step - loss: 0.1088
Epoch 139/400
160/160 [=====] - 0s 249us/step - loss: 0.1065
Epoch 140/400
160/160 [=====] - 0s 256us/step - loss: 0.1072
Epoch 141/400
160/160 [=====] - 0s 249us/step - loss: 0.1065
Epoch 142/400
160/160 [=====] - 0s 249us/step - loss: 0.1044
Epoch 143/400
160/160 [=====] - 0s 256us/step - loss: 0.1046
Epoch 144/400
160/160 [=====] - 0s 256us/step - loss: 0.1028
Epoch 145/400
160/160 [=====] - 0s 256us/step - loss: 0.1017
Epoch 146/400
160/160 [=====] - 0s 243us/step - loss: 0.1029
Epoch 147/400
160/160 [=====] - 0s 249us/step - loss: 0.1003
Epoch 148/400
160/160 [=====] - 0s 243us/step - loss: 0.0997
Epoch 149/400
160/160 [=====] - 0s 240us/step - loss: 0.0987

Epoch 150/400
160/160 [=====] - 0s 243us/step - loss: 0.0980
Epoch 151/400
160/160 [=====] - 0s 262us/step - loss: 0.0964
Epoch 152/400
160/160 [=====] - 0s 246us/step - loss: 0.0971
Epoch 153/400
160/160 [=====] - 0s 243us/step - loss: 0.0950
Epoch 154/400
160/160 [=====] - 0s 246us/step - loss: 0.0956
Epoch 155/400
160/160 [=====] - 0s 243us/step - loss: 0.0944
Epoch 156/400
160/160 [=====] - 0s 249us/step - loss: 0.0937
Epoch 157/400
160/160 [=====] - 0s 252us/step - loss: 0.0926
Epoch 158/400
160/160 [=====] - 0s 256us/step - loss: 0.0925
Epoch 159/400
160/160 [=====] - 0s 249us/step - loss: 0.0916
Epoch 160/400
160/160 [=====] - 0s 243us/step - loss: 0.0917
Epoch 161/400
160/160 [=====] - 0s 249us/step - loss: 0.0892
Epoch 162/400
160/160 [=====] - 0s 249us/step - loss: 0.0895
Epoch 163/400
160/160 [=====] - 0s 243us/step - loss: 0.0886
Epoch 164/400
160/160 [=====] - 0s 243us/step - loss: 0.0895
Epoch 165/400
160/160 [=====] - 0s 243us/step - loss: 0.0877
Epoch 166/400
160/160 [=====] - 0s 249us/step - loss: 0.0860
Epoch 167/400
160/160 [=====] - 0s 243us/step - loss: 0.0882
Epoch 168/400
160/160 [=====] - 0s 243us/step - loss: 0.0858
Epoch 169/400
160/160 [=====] - 0s 256us/step - loss: 0.0853
Epoch 170/400
160/160 [=====] - 0s 243us/step - loss: 0.0844
Epoch 171/400
160/160 [=====] - 0s 256us/step - loss: 0.0845
Epoch 172/400
160/160 [=====] - 0s 243us/step - loss: 0.0836
Epoch 173/400
160/160 [=====] - 0s 249us/step - loss: 0.0833
Epoch 174/400
160/160 [=====] - 0s 249us/step - loss: 0.0817
Epoch 175/400
160/160 [=====] - 0s 243us/step - loss: 0.0822
Epoch 176/400
160/160 [=====] - 0s 246us/step - loss: 0.0812
Epoch 177/400
160/160 [=====] - 0s 249us/step - loss: 0.0813
Epoch 178/400
160/160 [=====] - 0s 249us/step - loss: 0.0811
Epoch 179/400
160/160 [=====] - 0s 243us/step - loss: 0.0796
Epoch 180/400
160/160 [=====] - 0s 243us/step - loss: 0.0790
Epoch 181/400
160/160 [=====] - 0s 249us/step - loss: 0.0793
Epoch 182/400
160/160 [=====] - 0s 243us/step - loss: 0.0784
Epoch 183/400
160/160 [=====] - 0s 256us/step - loss: 0.0768
Epoch 184/400
160/160 [=====] - 0s 243us/step - loss: 0.0773
Epoch 185/400
160/160 [=====] - 0s 249us/step - loss: 0.0768
Epoch 186/400
160/160 [=====] - 0s 249us/step - loss: 0.0759
Epoch 187/400
160/160 [=====] - 0s 243us/step - loss: 0.0773
Epoch 188/400

160/160 [=====] - 0s 256us/step - loss: 0.0762
Epoch 189/400
160/160 [=====] - 0s 249us/step - loss: 0.0733
Epoch 190/400
160/160 [=====] - 0s 249us/step - loss: 0.0758
Epoch 191/400
160/160 [=====] - 0s 243us/step - loss: 0.0756
Epoch 192/400
160/160 [=====] - 0s 237us/step - loss: 0.0738
Epoch 193/400
160/160 [=====] - 0s 243us/step - loss: 0.0736
Epoch 194/400
160/160 [=====] - 0s 249us/step - loss: 0.0744
Epoch 195/400
160/160 [=====] - 0s 246us/step - loss: 0.0723
Epoch 196/400
160/160 [=====] - 0s 256us/step - loss: 0.0728
Epoch 197/400
160/160 [=====] - 0s 246us/step - loss: 0.0717
Epoch 198/400
160/160 [=====] - 0s 243us/step - loss: 0.0725
Epoch 199/400
160/160 [=====] - 0s 249us/step - loss: 0.0713
Epoch 200/400
160/160 [=====] - 0s 246us/step - loss: 0.0712
Epoch 201/400
160/160 [=====] - 0s 256us/step - loss: 0.0694
Epoch 202/400
160/160 [=====] - 0s 256us/step - loss: 0.0710
Epoch 203/400
160/160 [=====] - 0s 249us/step - loss: 0.0692
Epoch 204/400
160/160 [=====] - 0s 249us/step - loss: 0.0698
Epoch 205/400
160/160 [=====] - 0s 243us/step - loss: 0.0698
Epoch 206/400
160/160 [=====] - 0s 256us/step - loss: 0.0700
Epoch 207/400
160/160 [=====] - 0s 243us/step - loss: 0.0691
Epoch 208/400
160/160 [=====] - 0s 249us/step - loss: 0.0676
Epoch 209/400
160/160 [=====] - 0s 237us/step - loss: 0.0668
Epoch 210/400
160/160 [=====] - 0s 237us/step - loss: 0.0689
Epoch 211/400
160/160 [=====] - 0s 237us/step - loss: 0.0678
Epoch 212/400
160/160 [=====] - 0s 243us/step - loss: 0.0659
Epoch 213/400
160/160 [=====] - 0s 249us/step - loss: 0.0672
Epoch 214/400
160/160 [=====] - 0s 249us/step - loss: 0.0674
Epoch 215/400
160/160 [=====] - 0s 249us/step - loss: 0.0661
Epoch 216/400
160/160 [=====] - 0s 243us/step - loss: 0.0660
Epoch 217/400
160/160 [=====] - 0s 237us/step - loss: 0.0663
Epoch 218/400
160/160 [=====] - 0s 249us/step - loss: 0.0642
Epoch 219/400
160/160 [=====] - 0s 249us/step - loss: 0.0663
Epoch 220/400
160/160 [=====] - 0s 249us/step - loss: 0.0649
Epoch 221/400
160/160 [=====] - 0s 243us/step - loss: 0.0642
Epoch 222/400
160/160 [=====] - 0s 243us/step - loss: 0.0634
Epoch 223/400
160/160 [=====] - 0s 243us/step - loss: 0.0656
Epoch 224/400
160/160 [=====] - 0s 256us/step - loss: 0.0644
Epoch 225/400
160/160 [=====] - 0s 249us/step - loss: 0.0633
Epoch 226/400
160/160 [=====] - 0s 256us/step - loss: 0.0641

Epoch 227/400
160/160 [=====] - 0s 256us/step - loss: 0.0635
Epoch 228/400
160/160 [=====] - 0s 237us/step - loss: 0.0629
Epoch 229/400
160/160 [=====] - 0s 243us/step - loss: 0.0620
Epoch 230/400
160/160 [=====] - 0s 243us/step - loss: 0.0603
Epoch 231/400
160/160 [=====] - 0s 237us/step - loss: 0.0625
Epoch 232/400
160/160 [=====] - 0s 243us/step - loss: 0.0611
Epoch 233/400
160/160 [=====] - 0s 256us/step - loss: 0.0612
Epoch 234/400
160/160 [=====] - 0s 256us/step - loss: 0.0609
Epoch 235/400
160/160 [=====] - 0s 246us/step - loss: 0.0611
Epoch 236/400
160/160 [=====] - 0s 243us/step - loss: 0.0592
Epoch 237/400
160/160 [=====] - 0s 246us/step - loss: 0.0616
Epoch 238/400
160/160 [=====] - 0s 243us/step - loss: 0.0609
Epoch 239/400
160/160 [=====] - 0s 243us/step - loss: 0.0604
Epoch 240/400
160/160 [=====] - 0s 256us/step - loss: 0.0594
Epoch 241/400
160/160 [=====] - 0s 243us/step - loss: 0.0576
Epoch 242/400
160/160 [=====] - 0s 243us/step - loss: 0.0595
Epoch 243/400
160/160 [=====] - 0s 243us/step - loss: 0.0598
Epoch 244/400
160/160 [=====] - 0s 243us/step - loss: 0.0587
Epoch 245/400
160/160 [=====] - 0s 249us/step - loss: 0.0586
Epoch 246/400
160/160 [=====] - 0s 243us/step - loss: 0.0590
Epoch 247/400
160/160 [=====] - 0s 237us/step - loss: 0.0580
Epoch 248/400
160/160 [=====] - 0s 237us/step - loss: 0.0578
Epoch 249/400
160/160 [=====] - 0s 249us/step - loss: 0.0577
Epoch 250/400
160/160 [=====] - 0s 249us/step - loss: 0.0581
Epoch 251/400
160/160 [=====] - 0s 256us/step - loss: 0.0584
Epoch 252/400
160/160 [=====] - 0s 268us/step - loss: 0.0571
Epoch 253/400
160/160 [=====] - 0s 256us/step - loss: 0.0565
Epoch 254/400
160/160 [=====] - 0s 243us/step - loss: 0.0552
Epoch 255/400
160/160 [=====] - 0s 243us/step - loss: 0.0569
Epoch 256/400
160/160 [=====] - 0s 249us/step - loss: 0.0562
Epoch 257/400
160/160 [=====] - 0s 243us/step - loss: 0.0537
Epoch 258/400
160/160 [=====] - 0s 262us/step - loss: 0.0571
Epoch 259/400
160/160 [=====] - 0s 256us/step - loss: 0.0563
Epoch 260/400
160/160 [=====] - 0s 246us/step - loss: 0.0552
Epoch 261/400
160/160 [=====] - 0s 243us/step - loss: 0.0548
Epoch 262/400
160/160 [=====] - 0s 237us/step - loss: 0.0552
Epoch 263/400
160/160 [=====] - 0s 243us/step - loss: 0.0531
Epoch 264/400
160/160 [=====] - 0s 237us/step - loss: 0.0548
Epoch 265/400

160/160 [=====] - 0s 237us/step - loss: 0.0544
Epoch 266/400
160/160 [=====] - 0s 249us/step - loss: 0.0548
Epoch 267/400
160/160 [=====] - 0s 243us/step - loss: 0.0547
Epoch 268/400
160/160 [=====] - 0s 237us/step - loss: 0.0535
Epoch 269/400
160/160 [=====] - 0s 243us/step - loss: 0.0548
Epoch 270/400
160/160 [=====] - 0s 243us/step - loss: 0.0539
Epoch 271/400
160/160 [=====] - 0s 262us/step - loss: 0.0542
Epoch 272/400
160/160 [=====] - 0s 237us/step - loss: 0.0531
Epoch 273/400
160/160 [=====] - 0s 240us/step - loss: 0.0545
Epoch 274/400
160/160 [=====] - 0s 243us/step - loss: 0.0518
Epoch 275/400
160/160 [=====] - 0s 246us/step - loss: 0.0531
Epoch 276/400
160/160 [=====] - 0s 256us/step - loss: 0.0534
Epoch 277/400
160/160 [=====] - 0s 277us/step - loss: 0.0523
Epoch 278/400
160/160 [=====] - 0s 243us/step - loss: 0.0526
Epoch 279/400
160/160 [=====] - 0s 256us/step - loss: 0.0517
Epoch 280/400
160/160 [=====] - 0s 246us/step - loss: 0.0524
Epoch 281/400
160/160 [=====] - 0s 249us/step - loss: 0.0522
Epoch 282/400
160/160 [=====] - 0s 237us/step - loss: 0.0527
Epoch 283/400
160/160 [=====] - 0s 246us/step - loss: 0.0521
Epoch 284/400
160/160 [=====] - 0s 243us/step - loss: 0.0525
Epoch 285/400
160/160 [=====] - 0s 237us/step - loss: 0.0511
Epoch 286/400
160/160 [=====] - 0s 243us/step - loss: 0.0518
Epoch 287/400
160/160 [=====] - 0s 249us/step - loss: 0.0513
Epoch 288/400
160/160 [=====] - 0s 243us/step - loss: 0.0507
Epoch 289/400
160/160 [=====] - 0s 243us/step - loss: 0.0517
Epoch 290/400
160/160 [=====] - 0s 243us/step - loss: 0.0508
Epoch 291/400
160/160 [=====] - 0s 243us/step - loss: 0.0508
Epoch 292/400
160/160 [=====] - 0s 243us/step - loss: 0.0490
Epoch 293/400
160/160 [=====] - 0s 249us/step - loss: 0.0507
Epoch 294/400
160/160 [=====] - 0s 249us/step - loss: 0.0509
Epoch 295/400
160/160 [=====] - 0s 249us/step - loss: 0.0495
Epoch 296/400
160/160 [=====] - 0s 262us/step - loss: 0.0514
Epoch 297/400
160/160 [=====] - 0s 262us/step - loss: 0.0497
Epoch 298/400
160/160 [=====] - 0s 256us/step - loss: 0.0506
Epoch 299/400
160/160 [=====] - 0s 243us/step - loss: 0.0495
Epoch 300/400
160/160 [=====] - 0s 249us/step - loss: 0.0503
Epoch 301/400
160/160 [=====] - 0s 262us/step - loss: 0.0500
Epoch 302/400
160/160 [=====] - 0s 262us/step - loss: 0.0485
Epoch 303/400
160/160 [=====] - 0s 249us/step - loss: 0.0505

Epoch 304/400
160/160 [=====] - 0s 249us/step - loss: 0.0489
Epoch 305/400
160/160 [=====] - 0s 252us/step - loss: 0.0482
Epoch 306/400
160/160 [=====] - 0s 249us/step - loss: 0.0472
Epoch 307/400
160/160 [=====] - 0s 249us/step - loss: 0.0480
Epoch 308/400
160/160 [=====] - 0s 252us/step - loss: 0.0482
Epoch 309/400
160/160 [=====] - 0s 243us/step - loss: 0.0479
Epoch 310/400
160/160 [=====] - 0s 249us/step - loss: 0.0490
Epoch 311/400
160/160 [=====] - 0s 249us/step - loss: 0.0482
Epoch 312/400
160/160 [=====] - 0s 256us/step - loss: 0.0478
Epoch 313/400
160/160 [=====] - 0s 268us/step - loss: 0.0477
Epoch 314/400
160/160 [=====] - 0s 262us/step - loss: 0.0483
Epoch 315/400
160/160 [=====] - 0s 274us/step - loss: 0.0472
Epoch 316/400
160/160 [=====] - 0s 249us/step - loss: 0.0481
Epoch 317/400
160/160 [=====] - 0s 256us/step - loss: 0.0472
Epoch 318/400
160/160 [=====] - 0s 243us/step - loss: 0.0475
Epoch 319/400
160/160 [=====] - 0s 249us/step - loss: 0.0474
Epoch 320/400
160/160 [=====] - 0s 246us/step - loss: 0.0471
Epoch 321/400
160/160 [=====] - 0s 249us/step - loss: 0.0457
Epoch 322/400
160/160 [=====] - 0s 246us/step - loss: 0.0476
Epoch 323/400
160/160 [=====] - 0s 262us/step - loss: 0.0459
Epoch 324/400
160/160 [=====] - 0s 243us/step - loss: 0.0468
Epoch 325/400
160/160 [=====] - 0s 246us/step - loss: 0.0462
Epoch 326/400
160/160 [=====] - 0s 268us/step - loss: 0.0470
Epoch 327/400
160/160 [=====] - 0s 249us/step - loss: 0.0461
Epoch 328/400
160/160 [=====] - 0s 256us/step - loss: 0.0452
Epoch 329/400
160/160 [=====] - 0s 243us/step - loss: 0.0449
Epoch 330/400
160/160 [=====] - 0s 243us/step - loss: 0.0462
Epoch 331/400
160/160 [=====] - 0s 243us/step - loss: 0.0452
Epoch 332/400
160/160 [=====] - 0s 256us/step - loss: 0.0464
Epoch 333/400
160/160 [=====] - 0s 243us/step - loss: 0.0455
Epoch 334/400
160/160 [=====] - 0s 256us/step - loss: 0.0462
Epoch 335/400
160/160 [=====] - 0s 237us/step - loss: 0.0448
Epoch 336/400
160/160 [=====] - 0s 243us/step - loss: 0.0450
Epoch 337/400
160/160 [=====] - 0s 249us/step - loss: 0.0458
Epoch 338/400
160/160 [=====] - 0s 249us/step - loss: 0.0453
Epoch 339/400
160/160 [=====] - 0s 243us/step - loss: 0.0453
Epoch 340/400
160/160 [=====] - 0s 243us/step - loss: 0.0442
Epoch 341/400
160/160 [=====] - 0s 243us/step - loss: 0.0453
Epoch 342/400

160/160 [=====] - 0s 249us/step - loss: 0.0443
Epoch 343/400
160/160 [=====] - 0s 256us/step - loss: 0.0450
Epoch 344/400
160/160 [=====] - 0s 249us/step - loss: 0.0440
Epoch 345/400
160/160 [=====] - 0s 243us/step - loss: 0.0436
Epoch 346/400
160/160 [=====] - 0s 237us/step - loss: 0.0434
Epoch 347/400
160/160 [=====] - 0s 243us/step - loss: 0.0408
Epoch 348/400
160/160 [=====] - 0s 246us/step - loss: 0.0449
Epoch 349/400
160/160 [=====] - 0s 237us/step - loss: 0.0447
Epoch 350/400
160/160 [=====] - 0s 243us/step - loss: 0.0440
Epoch 351/400
160/160 [=====] - 0s 262us/step - loss: 0.0434
Epoch 352/400
160/160 [=====] - 0s 262us/step - loss: 0.0429
Epoch 353/400
160/160 [=====] - 0s 249us/step - loss: 0.0438
Epoch 354/400
160/160 [=====] - 0s 243us/step - loss: 0.0439
Epoch 355/400
160/160 [=====] - 0s 237us/step - loss: 0.0448
Epoch 356/400
160/160 [=====] - 0s 243us/step - loss: 0.0428
Epoch 357/400
160/160 [=====] - 0s 249us/step - loss: 0.0440
Epoch 358/400
160/160 [=====] - 0s 256us/step - loss: 0.0425
Epoch 359/400
160/160 [=====] - 0s 256us/step - loss: 0.0438
Epoch 360/400
160/160 [=====] - 0s 240us/step - loss: 0.0418
Epoch 361/400
160/160 [=====] - 0s 243us/step - loss: 0.0429
Epoch 362/400
160/160 [=====] - 0s 243us/step - loss: 0.0427
Epoch 363/400
160/160 [=====] - 0s 259us/step - loss: 0.0425
Epoch 364/400
160/160 [=====] - 0s 249us/step - loss: 0.0433
Epoch 365/400
160/160 [=====] - 0s 246us/step - loss: 0.0424
Epoch 366/400
160/160 [=====] - 0s 243us/step - loss: 0.0429
Epoch 367/400
160/160 [=====] - 0s 243us/step - loss: 0.0436
Epoch 368/400
160/160 [=====] - 0s 240us/step - loss: 0.0425
Epoch 369/400
160/160 [=====] - 0s 249us/step - loss: 0.0419
Epoch 370/400
160/160 [=====] - 0s 243us/step - loss: 0.0419
Epoch 371/400
160/160 [=====] - 0s 249us/step - loss: 0.0417
Epoch 372/400
160/160 [=====] - 0s 243us/step - loss: 0.0410
Epoch 373/400
160/160 [=====] - 0s 249us/step - loss: 0.0413
Epoch 374/400
160/160 [=====] - 0s 237us/step - loss: 0.0421
Epoch 375/400
160/160 [=====] - 0s 249us/step - loss: 0.0421
Epoch 376/400
160/160 [=====] - 0s 271us/step - loss: 0.0424
Epoch 377/400
160/160 [=====] - 0s 243us/step - loss: 0.0420
Epoch 378/400
160/160 [=====] - 0s 243us/step - loss: 0.0415
Epoch 379/400
160/160 [=====] - 0s 243us/step - loss: 0.0424
Epoch 380/400
160/160 [=====] - 0s 243us/step - loss: 0.0413

Epoch 381/400
160/160 [=====] - 0s 243us/step - loss: 0.0393
Epoch 382/400
160/160 [=====] - 0s 243us/step - loss: 0.0401
Epoch 383/400
160/160 [=====] - 0s 243us/step - loss: 0.0413
Epoch 384/400
160/160 [=====] - 0s 249us/step - loss: 0.0410
Epoch 385/400
160/160 [=====] - 0s 243us/step - loss: 0.0416
Epoch 386/400
160/160 [=====] - 0s 243us/step - loss: 0.0412
Epoch 387/400
160/160 [=====] - 0s 243us/step - loss: 0.0411
Epoch 388/400
160/160 [=====] - 0s 249us/step - loss: 0.0417
Epoch 389/400
160/160 [=====] - 0s 237us/step - loss: 0.0392
Epoch 390/400
160/160 [=====] - 0s 240us/step - loss: 0.0411
Epoch 391/400
160/160 [=====] - 0s 243us/step - loss: 0.0409
Epoch 392/400
160/160 [=====] - 0s 249us/step - loss: 0.0413
Epoch 393/400
160/160 [=====] - 0s 246us/step - loss: 0.0414
Epoch 394/400
160/160 [=====] - 0s 256us/step - loss: 0.0410
Epoch 395/400
160/160 [=====] - 0s 249us/step - loss: 0.0409
Epoch 396/400
160/160 [=====] - 0s 256us/step - loss: 0.0408
Epoch 397/400
160/160 [=====] - 0s 249us/step - loss: 0.0403
Epoch 398/400
160/160 [=====] - 0s 249us/step - loss: 0.0398
Epoch 399/400
160/160 [=====] - 0s 256us/step - loss: 0.0402
Epoch 400/400
160/160 [=====] - 0s 243us/step - loss: 0.0408
[9.98847365e-01 9.93842006e-01 9.98809338e-01 9.44917619e-01
9.97380674e-01 9.98793483e-01 9.92092669e-01 9.98333395e-01
9.98823941e-01 9.98675048e-01 9.98797297e-01 9.98794794e-01
9.44224358e-01 9.96299446e-01 9.98680770e-01 9.98796105e-01
8.38719368e-01 9.98743117e-01 9.98643458e-01 9.98150349e-01
9.98674273e-01 9.98839915e-01 6.22169375e-01 9.98765349e-01
9.50197518e-01 9.98845458e-01 9.98036087e-01 9.79977787e-01
9.98776615e-01 9.93088186e-01 7.53385842e-01 9.92752194e-01
9.96082008e-01 9.98812437e-01 9.98450994e-01 9.98840034e-01
9.98783886e-01 9.98875439e-01 9.87112582e-01 9.98710036e-01
9.98748541e-01 9.90364492e-01 9.98767138e-01 9.12383676e-01
9.96770024e-01 9.98793602e-01 9.86987114e-01 9.98080015e-01
9.98763442e-01 9.98595774e-01 9.98793483e-01 9.98794675e-01
9.29700017e-01 9.94455278e-01 9.98583674e-01 9.98793483e-01
8.55321705e-01 9.98681605e-01 9.98514354e-01 9.98018622e-01
9.98558223e-01 9.98755097e-01 3.92842323e-01 9.98697102e-01
8.95520568e-01 9.98768032e-01 9.97918427e-01 9.64499176e-01
9.98646796e-01 9.92178321e-01 8.39446425e-01 9.88475919e-01
9.94490862e-01 9.98755097e-01 9.98204827e-01 9.98780549e-01
9.98797536e-01 9.98765230e-01 9.76390958e-01 9.98579741e-01
8.60971224e-04 6.33252133e-03 8.38922570e-04 2.17866730e-02
2.26204586e-03 8.19147273e-04 8.16941354e-03 1.32215454e-03
8.43756716e-04 9.34280455e-04 8.14243685e-04 8.16626067e-04
4.27208208e-02 3.72191705e-03 9.50082962e-04 8.17611814e-04
1.19740233e-01 8.89356830e-04 1.00306026e-03 1.30601833e-03
9.74109746e-04 8.53724254e-04 3.32247287e-01 8.83866625e-04
1.00430444e-01 8.44069524e-04 1.36386428e-03 1.64123587e-02
9.14248580e-04 5.48130181e-03 9.85315368e-02 5.97540522e-03
3.56853637e-03 8.48356751e-04 1.25052978e-03 8.25563446e-04
8.19284644e-04 8.52554513e-04 1.91031750e-02 9.73437098e-04
1.24049815e-03 8.35272856e-03 1.21816422e-03 2.44471133e-02
3.60056176e-03 1.20928779e-03 1.11931572e-02 2.08132411e-03
1.22302293e-03 1.29819300e-03 1.20933622e-03 1.20899873e-03
5.34779467e-02 5.38786547e-03 1.31143432e-03 1.20897801e-03
1.60736084e-01 1.25632598e-03 1.36179675e-03 2.05737446e-03
1.33327977e-03 1.23309658e-03 5.56251287e-01 1.25077274e-03
1.76002055e-01 1.22824940e-03 2.15616589e-03 2.00515632e-02

```
1.38372602e-03 8.72311927e-03 1.63189933e-01 8.12664535e-03  
4.49344981e-03 1.22459186e-03 1.61913014e-03 1.222601585e-03  
1.21042877e-03 1.26209622e-03 2.82434542e-02 1.33164146e-03  
160/160 [=====] - 0s 511us/step
```

In [39]:

```
#Two layers, four neurons per layer: loss  
scores_lay_two_four, model_lay_two_four.metrics_names
```

Out[39]:

```
(0.03355945982038975, ['loss'])
```

Three Layers

In [40]:

```
n = 40  
xx = np.random.random((n,1))  
yy = np.random.random((n,1))  
  
X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T  
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [41]:

```
#Three layers, four neurons per layer  
model_lay_three_four = Sequential()  
  
#hidden layers  
model_lay_three_four.add(Dense(4, input_dim=2, activation='tanh'))  
model_lay_three_four.add(Dense(4, activation='tanh'))  
model_lay_three_four.add(Dense(4, activation='tanh'))  
  
#output layer  
model_lay_three_four.add(Dense(1, activation='sigmoid'))  
  
sgd = SGD(lr=0.1)  
model_lay_three_four.compile(loss='binary_crossentropy', optimizer='sgd')  
  
model_lay_three_four.fit(X, y, batch_size=2, epochs=400)  
print(model_lay_three_four.predict_proba(X).reshape(4*n))  
  
#evaluate the model  
scores_lay_three_four = model_lay_three_four.evaluate(X, y)
```

```
Epoch 1/400  
160/160 [=====] - 0s 2ms/step - loss: 0.6973  
Epoch 2/400  
160/160 [=====] - 0s 268us/step - loss: 0.6967  
Epoch 3/400  
160/160 [=====] - 0s 268us/step - loss: 0.6959  
Epoch 4/400  
160/160 [=====] - 0s 293us/step - loss: 0.6952  
Epoch 5/400  
160/160 [=====] - 0s 299us/step - loss: 0.6937  
Epoch 6/400  
160/160 [=====] - 0s 277us/step - loss: 0.6937  
Epoch 7/400  
160/160 [=====] - 0s 274us/step - loss: 0.6932  
Epoch 8/400  
160/160 [=====] - 0s 281us/step - loss: 0.6922  
Epoch 9/400  
160/160 [=====] - 0s 315us/step - loss: 0.6915  
Epoch 10/400  
160/160 [=====] - 0s 277us/step - loss: 0.6896  
Epoch 11/400  
160/160 [=====] - 0s 271us/step - loss: 0.6893  
Epoch 12/400  
160/160 [=====] - 0s 277us/step - loss: 0.6875  
Epoch 13/400  
160/160 [=====] - 0s 281us/step - loss: 0.6862  
Epoch 14/400  
160/160 [=====] - 0s 274us/step - loss: 0.6834  
Epoch 15/400  
160/160 [=====] - 0s 287us/step - loss: 0.6813
```

Epoch 16/400
160/160 [=====] - 0s 287us/step - loss: 0.6779
Epoch 17/400
160/160 [=====] - 0s 293us/step - loss: 0.6761
Epoch 18/400
160/160 [=====] - 0s 337us/step - loss: 0.6717
Epoch 19/400
160/160 [=====] - 0s 291us/step - loss: 0.6679
Epoch 20/400
160/160 [=====] - 0s 302us/step - loss: 0.6629
Epoch 21/400
160/160 [=====] - 0s 280us/step - loss: 0.6573
Epoch 22/400
160/160 [=====] - 0s 296us/step - loss: 0.6514
Epoch 23/400
160/160 [=====] - 0s 287us/step - loss: 0.6453
Epoch 24/400
160/160 [=====] - 0s 312us/step - loss: 0.6382
Epoch 25/400
160/160 [=====] - 0s 299us/step - loss: 0.6305
Epoch 26/400
160/160 [=====] - 0s 305us/step - loss: 0.6230
Epoch 27/400
160/160 [=====] - 0s 287us/step - loss: 0.6143
Epoch 28/400
160/160 [=====] - 0s 274us/step - loss: 0.6070
Epoch 29/400
160/160 [=====] - 0s 280us/step - loss: 0.5975
Epoch 30/400
160/160 [=====] - 0s 293us/step - loss: 0.5886
Epoch 31/400
160/160 [=====] - 0s 293us/step - loss: 0.5796
Epoch 32/400
160/160 [=====] - 0s 277us/step - loss: 0.5687
Epoch 33/400
160/160 [=====] - 0s 274us/step - loss: 0.5588
Epoch 34/400
160/160 [=====] - 0s 277us/step - loss: 0.5478
Epoch 35/400
160/160 [=====] - 0s 281us/step - loss: 0.5363
Epoch 36/400
160/160 [=====] - 0s 281us/step - loss: 0.5240
Epoch 37/400
160/160 [=====] - 0s 287us/step - loss: 0.5112
Epoch 38/400
160/160 [=====] - 0s 280us/step - loss: 0.4954
Epoch 39/400
160/160 [=====] - 0s 284us/step - loss: 0.4798
Epoch 40/400
160/160 [=====] - 0s 299us/step - loss: 0.4633
Epoch 41/400
160/160 [=====] - 0s 299us/step - loss: 0.4435
Epoch 42/400
160/160 [=====] - 0s 299us/step - loss: 0.4305
Epoch 43/400
160/160 [=====] - 0s 293us/step - loss: 0.4149
Epoch 44/400
160/160 [=====] - 0s 287us/step - loss: 0.4026
Epoch 45/400
160/160 [=====] - 0s 293us/step - loss: 0.3892
Epoch 46/400
160/160 [=====] - 0s 312us/step - loss: 0.3771
Epoch 47/400
160/160 [=====] - 0s 274us/step - loss: 0.3657
Epoch 48/400
160/160 [=====] - 0s 280us/step - loss: 0.3536
Epoch 49/400
160/160 [=====] - 0s 281us/step - loss: 0.3503
Epoch 50/400
160/160 [=====] - 0s 287us/step - loss: 0.3402
Epoch 51/400
160/160 [=====] - 0s 287us/step - loss: 0.3349
Epoch 52/400
160/160 [=====] - 0s 280us/step - loss: 0.3244
Epoch 53/400
160/160 [=====] - 0s 268us/step - loss: 0.3239
Epoch 54/400

Epoch 54/400
160/160 [=====] - 0s 290us/step - loss: 0.3186
Epoch 55/400
160/160 [=====] - 0s 287us/step - loss: 0.3164
Epoch 56/400
160/160 [=====] - 0s 271us/step - loss: 0.3126
Epoch 57/400
160/160 [=====] - 0s 249us/step - loss: 0.3049
Epoch 58/400
160/160 [=====] - 0s 268us/step - loss: 0.3029
Epoch 59/400
160/160 [=====] - 0s 262us/step - loss: 0.2987
Epoch 60/400
160/160 [=====] - 0s 262us/step - loss: 0.2980
Epoch 61/400
160/160 [=====] - 0s 262us/step - loss: 0.2914
Epoch 62/400
160/160 [=====] - 0s 274us/step - loss: 0.2958
Epoch 63/400
160/160 [=====] - 0s 256us/step - loss: 0.2915
Epoch 64/400
160/160 [=====] - 0s 262us/step - loss: 0.2849
Epoch 65/400
160/160 [=====] - 0s 256us/step - loss: 0.2867
Epoch 66/400
160/160 [=====] - 0s 268us/step - loss: 0.2837
Epoch 67/400
160/160 [=====] - 0s 256us/step - loss: 0.2770
Epoch 68/400
160/160 [=====] - 0s 252us/step - loss: 0.2797
Epoch 69/400
160/160 [=====] - 0s 249us/step - loss: 0.2742
Epoch 70/400
160/160 [=====] - 0s 259us/step - loss: 0.2756
Epoch 71/400
160/160 [=====] - 0s 256us/step - loss: 0.2694
Epoch 72/400
160/160 [=====] - 0s 256us/step - loss: 0.2661
Epoch 73/400
160/160 [=====] - 0s 252us/step - loss: 0.2637
Epoch 74/400
160/160 [=====] - 0s 249us/step - loss: 0.2594
Epoch 75/400
160/160 [=====] - 0s 265us/step - loss: 0.2487
Epoch 76/400
160/160 [=====] - 0s 274us/step - loss: 0.2504
Epoch 77/400
160/160 [=====] - 0s 262us/step - loss: 0.2438
Epoch 78/400
160/160 [=====] - 0s 268us/step - loss: 0.2425
Epoch 79/400
160/160 [=====] - 0s 274us/step - loss: 0.2339
Epoch 80/400
160/160 [=====] - 0s 262us/step - loss: 0.2298
Epoch 81/400
160/160 [=====] - 0s 274us/step - loss: 0.2212
Epoch 82/400
160/160 [=====] - 0s 262us/step - loss: 0.2174
Epoch 83/400
160/160 [=====] - 0s 262us/step - loss: 0.2094
Epoch 84/400
160/160 [=====] - 0s 271us/step - loss: 0.2062
Epoch 85/400
160/160 [=====] - 0s 249us/step - loss: 0.1989
Epoch 86/400
160/160 [=====] - 0s 262us/step - loss: 0.1922
Epoch 87/400
160/160 [=====] - 0s 256us/step - loss: 0.1871
Epoch 88/400
160/160 [=====] - 0s 262us/step - loss: 0.1808
Epoch 89/400
160/160 [=====] - 0s 256us/step - loss: 0.1754
Epoch 90/400
160/160 [=====] - 0s 249us/step - loss: 0.1690
Epoch 91/400
160/160 [=====] - 0s 256us/step - loss: 0.1609
Epoch 92/400
160/160 [=====] - 0s 256us/step - loss: 0.1543

100/100 [=====] - 0s 250us/step - loss: 0.1549
Epoch 93/400
160/160 [=====] - 0s 256us/step - loss: 0.1524
Epoch 94/400
160/160 [=====] - 0s 256us/step - loss: 0.1427
Epoch 95/400
160/160 [=====] - 0s 249us/step - loss: 0.1420
Epoch 96/400
160/160 [=====] - 0s 268us/step - loss: 0.1340
Epoch 97/400
160/160 [=====] - 0s 249us/step - loss: 0.1249
Epoch 98/400
160/160 [=====] - 0s 256us/step - loss: 0.1241
Epoch 99/400
160/160 [=====] - 0s 293us/step - loss: 0.1173
Epoch 100/400
160/160 [=====] - 0s 287us/step - loss: 0.1155
Epoch 101/400
160/160 [=====] - 0s 249us/step - loss: 0.1125
Epoch 102/400
160/160 [=====] - 0s 256us/step - loss: 0.1040
Epoch 103/400
160/160 [=====] - 0s 256us/step - loss: 0.0987
Epoch 104/400
160/160 [=====] - 0s 256us/step - loss: 0.0991
Epoch 105/400
160/160 [=====] - 0s 256us/step - loss: 0.0934
Epoch 106/400
160/160 [=====] - 0s 262us/step - loss: 0.0931
Epoch 107/400
160/160 [=====] - 0s 256us/step - loss: 0.0883
Epoch 108/400
160/160 [=====] - 0s 256us/step - loss: 0.0862
Epoch 109/400
160/160 [=====] - 0s 259us/step - loss: 0.0819
Epoch 110/400
160/160 [=====] - 0s 256us/step - loss: 0.0793
Epoch 111/400
160/160 [=====] - 0s 246us/step - loss: 0.0800
Epoch 112/400
160/160 [=====] - 0s 249us/step - loss: 0.0763
Epoch 113/400
160/160 [=====] - 0s 256us/step - loss: 0.0741
Epoch 114/400
160/160 [=====] - 0s 265us/step - loss: 0.0722
Epoch 115/400
160/160 [=====] - 0s 256us/step - loss: 0.0690
Epoch 116/400
160/160 [=====] - 0s 252us/step - loss: 0.0667
Epoch 117/400
160/160 [=====] - 0s 262us/step - loss: 0.0660
Epoch 118/400
160/160 [=====] - 0s 259us/step - loss: 0.0624
Epoch 119/400
160/160 [=====] - 0s 262us/step - loss: 0.0590
Epoch 120/400
160/160 [=====] - 0s 262us/step - loss: 0.0567
Epoch 121/400
160/160 [=====] - 0s 274us/step - loss: 0.0594
Epoch 122/400
160/160 [=====] - 0s 274us/step - loss: 0.0535
Epoch 123/400
160/160 [=====] - 0s 281us/step - loss: 0.0535
Epoch 124/400
160/160 [=====] - 0s 256us/step - loss: 0.0563
Epoch 125/400
160/160 [=====] - 0s 268us/step - loss: 0.0516
Epoch 126/400
160/160 [=====] - 0s 256us/step - loss: 0.0522
Epoch 127/400
160/160 [=====] - 0s 262us/step - loss: 0.0486
Epoch 128/400
160/160 [=====] - 0s 268us/step - loss: 0.0496
Epoch 129/400
160/160 [=====] - 0s 268us/step - loss: 0.0490
Epoch 130/400
160/160 [=====] - 0s 262us/step - loss: 0.0486
Epoch 131/400

Epoch 131/400
160/160 [=====] - 0s 249us/step - loss: 0.0502
Epoch 132/400
160/160 [=====] - 0s 256us/step - loss: 0.0477
Epoch 133/400
160/160 [=====] - 0s 256us/step - loss: 0.0455
Epoch 134/400
160/160 [=====] - 0s 262us/step - loss: 0.0469
Epoch 135/400
160/160 [=====] - 0s 268us/step - loss: 0.0435
Epoch 136/400
160/160 [=====] - 0s 262us/step - loss: 0.0473
Epoch 137/400
160/160 [=====] - 0s 256us/step - loss: 0.0434
Epoch 138/400
160/160 [=====] - 0s 256us/step - loss: 0.0391
Epoch 139/400
160/160 [=====] - 0s 256us/step - loss: 0.0400
Epoch 140/400
160/160 [=====] - 0s 259us/step - loss: 0.0392
Epoch 141/400
160/160 [=====] - 0s 256us/step - loss: 0.0427
Epoch 142/400
160/160 [=====] - 0s 268us/step - loss: 0.0440
Epoch 143/400
160/160 [=====] - 0s 262us/step - loss: 0.0413
Epoch 144/400
160/160 [=====] - 0s 262us/step - loss: 0.0368
Epoch 145/400
160/160 [=====] - 0s 256us/step - loss: 0.0384
Epoch 146/400
160/160 [=====] - 0s 274us/step - loss: 0.0383
Epoch 147/400
160/160 [=====] - 0s 274us/step - loss: 0.0409
Epoch 148/400
160/160 [=====] - 0s 256us/step - loss: 0.0401
Epoch 149/400
160/160 [=====] - 0s 262us/step - loss: 0.0350
Epoch 150/400
160/160 [=====] - 0s 262us/step - loss: 0.0356
Epoch 151/400
160/160 [=====] - 0s 268us/step - loss: 0.0347
Epoch 152/400
160/160 [=====] - 0s 256us/step - loss: 0.0390
Epoch 153/400
160/160 [=====] - 0s 268us/step - loss: 0.0378
Epoch 154/400
160/160 [=====] - 0s 259us/step - loss: 0.0341
Epoch 155/400
160/160 [=====] - 0s 256us/step - loss: 0.0441
Epoch 156/400
160/160 [=====] - 0s 259us/step - loss: 0.0363
Epoch 157/400
160/160 [=====] - 0s 256us/step - loss: 0.0406
Epoch 158/400
160/160 [=====] - 0s 256us/step - loss: 0.0331
Epoch 159/400
160/160 [=====] - 0s 249us/step - loss: 0.0395
Epoch 160/400
160/160 [=====] - 0s 249us/step - loss: 0.0377
Epoch 161/400
160/160 [=====] - 0s 249us/step - loss: 0.0328
Epoch 162/400
160/160 [=====] - 0s 256us/step - loss: 0.0373
Epoch 163/400
160/160 [=====] - 0s 262us/step - loss: 0.0321
Epoch 164/400
160/160 [=====] - 0s 249us/step - loss: 0.0324
Epoch 165/400
160/160 [=====] - 0s 256us/step - loss: 0.0342
Epoch 166/400
160/160 [=====] - 0s 256us/step - loss: 0.0344
Epoch 167/400
160/160 [=====] - 0s 256us/step - loss: 0.0329
Epoch 168/400
160/160 [=====] - 0s 256us/step - loss: 0.0355
Epoch 169/400
160/160 [=====] - 0s 262us/step - loss: 0.0352

160/160 [=====] - 0s 262us/step - loss: 0.0355
Epoch 170/400
160/160 [=====] - 0s 274us/step - loss: 0.0311
Epoch 171/400
160/160 [=====] - 0s 268us/step - loss: 0.0303
Epoch 172/400
160/160 [=====] - 0s 256us/step - loss: 0.0348
Epoch 173/400
160/160 [=====] - 0s 252us/step - loss: 0.0341
Epoch 174/400
160/160 [=====] - 0s 256us/step - loss: 0.0371
Epoch 175/400
160/160 [=====] - 0s 249us/step - loss: 0.0355
Epoch 176/400
160/160 [=====] - 0s 249us/step - loss: 0.0359
Epoch 177/400
160/160 [=====] - 0s 256us/step - loss: 0.0346
Epoch 178/400
160/160 [=====] - 0s 259us/step - loss: 0.0278
Epoch 179/400
160/160 [=====] - 0s 256us/step - loss: 0.0305
Epoch 180/400
160/160 [=====] - 0s 262us/step - loss: 0.0279
Epoch 181/400
160/160 [=====] - 0s 252us/step - loss: 0.0349
Epoch 182/400
160/160 [=====] - 0s 256us/step - loss: 0.0350
Epoch 183/400
160/160 [=====] - 0s 262us/step - loss: 0.0292
Epoch 184/400
160/160 [=====] - 0s 256us/step - loss: 0.0297
Epoch 185/400
160/160 [=====] - 0s 256us/step - loss: 0.0334
Epoch 186/400
160/160 [=====] - 0s 262us/step - loss: 0.0293
Epoch 187/400
160/160 [=====] - 0s 268us/step - loss: 0.0298
Epoch 188/400
160/160 [=====] - 0s 262us/step - loss: 0.0321
Epoch 189/400
160/160 [=====] - 0s 268us/step - loss: 0.0348
Epoch 190/400
160/160 [=====] - 0s 268us/step - loss: 0.0276
Epoch 191/400
160/160 [=====] - 0s 262us/step - loss: 0.0325
Epoch 192/400
160/160 [=====] - 0s 262us/step - loss: 0.0332
Epoch 193/400
160/160 [=====] - 0s 268us/step - loss: 0.0286
Epoch 194/400
160/160 [=====] - 0s 268us/step - loss: 0.0331
Epoch 195/400
160/160 [=====] - 0s 252us/step - loss: 0.0349
Epoch 196/400
160/160 [=====] - 0s 262us/step - loss: 0.0359
Epoch 197/400
160/160 [=====] - 0s 259us/step - loss: 0.0316
Epoch 198/400
160/160 [=====] - 0s 256us/step - loss: 0.0405
Epoch 199/400
160/160 [=====] - 0s 268us/step - loss: 0.0322
Epoch 200/400
160/160 [=====] - 0s 259us/step - loss: 0.0356
Epoch 201/400
160/160 [=====] - 0s 256us/step - loss: 0.0235
Epoch 202/400
160/160 [=====] - 0s 256us/step - loss: 0.0340
Epoch 203/400
160/160 [=====] - 0s 249us/step - loss: 0.0267
Epoch 204/400
160/160 [=====] - 0s 256us/step - loss: 0.0380
Epoch 205/400
160/160 [=====] - 0s 256us/step - loss: 0.0297
Epoch 206/400
160/160 [=====] - 0s 256us/step - loss: 0.0405
Epoch 207/400
160/160 [=====] - 0s 262us/step - loss: 0.0257

Epoch 208/400
160/160 [=====] - 0s 249us/step - loss: 0.0349
Epoch 209/400
160/160 [=====] - 0s 262us/step - loss: 0.0330
Epoch 210/400
160/160 [=====] - 0s 256us/step - loss: 0.0289
Epoch 211/400
160/160 [=====] - 0s 256us/step - loss: 0.0314
Epoch 212/400
160/160 [=====] - 0s 262us/step - loss: 0.0363
Epoch 213/400
160/160 [=====] - 0s 262us/step - loss: 0.0350
Epoch 214/400
160/160 [=====] - 0s 256us/step - loss: 0.0290
Epoch 215/400
160/160 [=====] - 0s 281us/step - loss: 0.0261
Epoch 216/400
160/160 [=====] - 0s 293us/step - loss: 0.0220
Epoch 217/400
160/160 [=====] - 0s 262us/step - loss: 0.0238
Epoch 218/400
160/160 [=====] - 0s 280us/step - loss: 0.0321
Epoch 219/400
160/160 [=====] - 0s 268us/step - loss: 0.0257
Epoch 220/400
160/160 [=====] - 0s 268us/step - loss: 0.0306
Epoch 221/400
160/160 [=====] - 0s 259us/step - loss: 0.0334
Epoch 222/400
160/160 [=====] - 0s 256us/step - loss: 0.0368
Epoch 223/400
160/160 [=====] - 0s 299us/step - loss: 0.0339
Epoch 224/400
160/160 [=====] - 0s 274us/step - loss: 0.0341
Epoch 225/400
160/160 [=====] - 0s 271us/step - loss: 0.0249
Epoch 226/400
160/160 [=====] - 0s 268us/step - loss: 0.0294
Epoch 227/400
160/160 [=====] - 0s 268us/step - loss: 0.0292
Epoch 228/400
160/160 [=====] - 0s 262us/step - loss: 0.0359
Epoch 229/400
160/160 [=====] - 0s 293us/step - loss: 0.0297
Epoch 230/400
160/160 [=====] - 0s 293us/step - loss: 0.0216
Epoch 231/400
160/160 [=====] - 0s 293us/step - loss: 0.0347
Epoch 232/400
160/160 [=====] - 0s 299us/step - loss: 0.0342
Epoch 233/400
160/160 [=====] - 0s 305us/step - loss: 0.0267
Epoch 234/400
160/160 [=====] - 0s 296us/step - loss: 0.0250
Epoch 235/400
160/160 [=====] - 0s 293us/step - loss: 0.0341
Epoch 236/400
160/160 [=====] - 0s 284us/step - loss: 0.0283
Epoch 237/400
160/160 [=====] - 0s 280us/step - loss: 0.0356
Epoch 238/400
160/160 [=====] - 0s 299us/step - loss: 0.0395
Epoch 239/400
160/160 [=====] - 0s 305us/step - loss: 0.0234
Epoch 240/400
160/160 [=====] - 0s 374us/step - loss: 0.0252
Epoch 241/400
160/160 [=====] - 0s 315us/step - loss: 0.0307
Epoch 242/400
160/160 [=====] - 0s 293us/step - loss: 0.0298
Epoch 243/400
160/160 [=====] - 0s 287us/step - loss: 0.0239
Epoch 244/400
160/160 [=====] - 0s 293us/step - loss: 0.0328
Epoch 245/400
160/160 [=====] - 0s 290us/step - loss: 0.0293
Epoch 246/400

160/160 [=====] - 0s 293us/step - loss: 0.0224
Epoch 247/400
160/160 [=====] - 0s 312us/step - loss: 0.0298
Epoch 248/400
160/160 [=====] - 0s 287us/step - loss: 0.0324
Epoch 249/400
160/160 [=====] - 0s 305us/step - loss: 0.0255
Epoch 250/400
160/160 [=====] - 0s 299us/step - loss: 0.0274
Epoch 251/400
160/160 [=====] - 0s 299us/step - loss: 0.0234
Epoch 252/400
160/160 [=====] - 0s 418us/step - loss: 0.0374
Epoch 253/400
160/160 [=====] - 0s 318us/step - loss: 0.0375
Epoch 254/400
160/160 [=====] - 0s 299us/step - loss: 0.0367
Epoch 255/400
160/160 [=====] - 0s 274us/step - loss: 0.0320
Epoch 256/400
160/160 [=====] - 0s 281us/step - loss: 0.0330
Epoch 257/400
160/160 [=====] - 0s 268us/step - loss: 0.0305
Epoch 258/400
160/160 [=====] - 0s 262us/step - loss: 0.0306
Epoch 259/400
160/160 [=====] - 0s 362us/step - loss: 0.0375
Epoch 260/400
160/160 [=====] - 0s 467us/step - loss: 0.0243
Epoch 261/400
160/160 [=====] - 0s 399us/step - loss: 0.0310
Epoch 262/400
160/160 [=====] - 0s 405us/step - loss: 0.0211
Epoch 263/400
160/160 [=====] - 0s 355us/step - loss: 0.0240
Epoch 264/400
160/160 [=====] - 0s 305us/step - loss: 0.0348
Epoch 265/400
160/160 [=====] - 0s 287us/step - loss: 0.0329
Epoch 266/400
160/160 [=====] - 0s 277us/step - loss: 0.0324
Epoch 267/400
160/160 [=====] - 0s 262us/step - loss: 0.0250
Epoch 268/400
160/160 [=====] - 0s 271us/step - loss: 0.0269
Epoch 269/400
160/160 [=====] - 0s 280us/step - loss: 0.0378
Epoch 270/400
160/160 [=====] - 0s 309us/step - loss: 0.0303
Epoch 271/400
160/160 [=====] - 0s 268us/step - loss: 0.0383
Epoch 272/400
160/160 [=====] - 0s 265us/step - loss: 0.0330
Epoch 273/400
160/160 [=====] - 0s 262us/step - loss: 0.0344
Epoch 274/400
160/160 [=====] - 0s 256us/step - loss: 0.0239
Epoch 275/400
160/160 [=====] - 0s 274us/step - loss: 0.0341
Epoch 276/400
160/160 [=====] - 0s 280us/step - loss: 0.0308
Epoch 277/400
160/160 [=====] - 0s 268us/step - loss: 0.0368
Epoch 278/400
160/160 [=====] - 0s 262us/step - loss: 0.0295
Epoch 279/400
160/160 [=====] - 0s 281us/step - loss: 0.0225
Epoch 280/400
160/160 [=====] - 0s 287us/step - loss: 0.0325
Epoch 281/400
160/160 [=====] - 0s 318us/step - loss: 0.0222
Epoch 282/400
160/160 [=====] - 0s 287us/step - loss: 0.0367
Epoch 283/400
160/160 [=====] - 0s 324us/step - loss: 0.0284
Epoch 284/400
160/160 [=====] - 0s 280us/step - loss: 0.0368
- 100/400

Epoch 285/400
160/160 [=====] - 0s 274us/step - loss: 0.0234
Epoch 286/400
160/160 [=====] - 0s 312us/step - loss: 0.0356
Epoch 287/400
160/160 [=====] - 0s 312us/step - loss: 0.0239
Epoch 288/400
160/160 [=====] - 0s 274us/step - loss: 0.0305
Epoch 289/400
160/160 [=====] - 0s 262us/step - loss: 0.0222
Epoch 290/400
160/160 [=====] - 0s 268us/step - loss: 0.0309
Epoch 291/400
160/160 [=====] - 0s 262us/step - loss: 0.0252
Epoch 292/400
160/160 [=====] - 0s 252us/step - loss: 0.0321
Epoch 293/400
160/160 [=====] - 0s 262us/step - loss: 0.0340
Epoch 294/400
160/160 [=====] - 0s 262us/step - loss: 0.0222
Epoch 295/400
160/160 [=====] - 0s 256us/step - loss: 0.0425
Epoch 296/400
160/160 [=====] - 0s 262us/step - loss: 0.0288
Epoch 297/400
160/160 [=====] - 0s 262us/step - loss: 0.0365
Epoch 298/400
160/160 [=====] - 0s 256us/step - loss: 0.0192
Epoch 299/400
160/160 [=====] - 0s 256us/step - loss: 0.0367
Epoch 300/400
160/160 [=====] - 0s 262us/step - loss: 0.0360
Epoch 301/400
160/160 [=====] - 0s 256us/step - loss: 0.0285
Epoch 302/400
160/160 [=====] - 0s 256us/step - loss: 0.0202
Epoch 303/400
160/160 [=====] - 0s 274us/step - loss: 0.0361
Epoch 304/400
160/160 [=====] - 0s 262us/step - loss: 0.0270
Epoch 305/400
160/160 [=====] - 0s 262us/step - loss: 0.0330
Epoch 306/400
160/160 [=====] - 0s 256us/step - loss: 0.0304
Epoch 307/400
160/160 [=====] - 0s 265us/step - loss: 0.0370
Epoch 308/400
160/160 [=====] - 0s 262us/step - loss: 0.0334
Epoch 309/400
160/160 [=====] - 0s 252us/step - loss: 0.0251
Epoch 310/400
160/160 [=====] - 0s 256us/step - loss: 0.0299
Epoch 311/400
160/160 [=====] - 0s 262us/step - loss: 0.0271
Epoch 312/400
160/160 [=====] - 0s 268us/step - loss: 0.0263
Epoch 313/400
160/160 [=====] - 0s 249us/step - loss: 0.0333
Epoch 314/400
160/160 [=====] - 0s 256us/step - loss: 0.0256
Epoch 315/400
160/160 [=====] - 0s 249us/step - loss: 0.0260
Epoch 316/400
160/160 [=====] - 0s 256us/step - loss: 0.0332
Epoch 317/400
160/160 [=====] - 0s 256us/step - loss: 0.0306
Epoch 318/400
160/160 [=====] - 0s 249us/step - loss: 0.0355
Epoch 319/400
160/160 [=====] - 0s 262us/step - loss: 0.0300
Epoch 320/400
160/160 [=====] - 0s 256us/step - loss: 0.0325
Epoch 321/400
160/160 [=====] - 0s 262us/step - loss: 0.0382
Epoch 322/400
160/160 [=====] - 0s 256us/step - loss: 0.0306
Epoch 323/400

160/160 [=====] - 0s 262us/step - loss: 0.0253
Epoch 324/400
160/160 [=====] - 0s 262us/step - loss: 0.0277
Epoch 325/400
160/160 [=====] - 0s 268us/step - loss: 0.0190
Epoch 326/400
160/160 [=====] - 0s 268us/step - loss: 0.0340
Epoch 327/400
160/160 [=====] - 0s 274us/step - loss: 0.0244
Epoch 328/400
160/160 [=====] - 0s 274us/step - loss: 0.0230
Epoch 329/400
160/160 [=====] - 0s 274us/step - loss: 0.0357
Epoch 330/400
160/160 [=====] - 0s 280us/step - loss: 0.0203
Epoch 331/400
160/160 [=====] - 0s 271us/step - loss: 0.0315
Epoch 332/400
160/160 [=====] - 0s 262us/step - loss: 0.0335
Epoch 333/400
160/160 [=====] - 0s 256us/step - loss: 0.0216
Epoch 334/400
160/160 [=====] - 0s 256us/step - loss: 0.0368
Epoch 335/400
160/160 [=====] - 0s 256us/step - loss: 0.0303
Epoch 336/400
160/160 [=====] - 0s 262us/step - loss: 0.0324
Epoch 337/400
160/160 [=====] - 0s 256us/step - loss: 0.0197
Epoch 338/400
160/160 [=====] - 0s 268us/step - loss: 0.0226
Epoch 339/400
160/160 [=====] - 0s 268us/step - loss: 0.0311
Epoch 340/400
160/160 [=====] - 0s 256us/step - loss: 0.0360
Epoch 341/400
160/160 [=====] - 0s 256us/step - loss: 0.0266
Epoch 342/400
160/160 [=====] - 0s 256us/step - loss: 0.0320
Epoch 343/400
160/160 [=====] - 0s 252us/step - loss: 0.0370
Epoch 344/400
160/160 [=====] - 0s 256us/step - loss: 0.0220
Epoch 345/400
160/160 [=====] - 0s 265us/step - loss: 0.0318
Epoch 346/400
160/160 [=====] - 0s 249us/step - loss: 0.0260
Epoch 347/400
160/160 [=====] - 0s 259us/step - loss: 0.0298
Epoch 348/400
160/160 [=====] - 0s 262us/step - loss: 0.0237
Epoch 349/400
160/160 [=====] - 0s 249us/step - loss: 0.0313
Epoch 350/400
160/160 [=====] - 0s 259us/step - loss: 0.0246
Epoch 351/400
160/160 [=====] - 0s 281us/step - loss: 0.0358
Epoch 352/400
160/160 [=====] - 0s 281us/step - loss: 0.0335
Epoch 353/400
160/160 [=====] - 0s 262us/step - loss: 0.0339
Epoch 354/400
160/160 [=====] - 0s 268us/step - loss: 0.0286
Epoch 355/400
160/160 [=====] - 0s 256us/step - loss: 0.0299
Epoch 356/400
160/160 [=====] - 0s 256us/step - loss: 0.0378
Epoch 357/400
160/160 [=====] - 0s 249us/step - loss: 0.0318
Epoch 358/400
160/160 [=====] - 0s 262us/step - loss: 0.0254
Epoch 359/400
160/160 [=====] - 0s 274us/step - loss: 0.0269
Epoch 360/400
160/160 [=====] - 0s 287us/step - loss: 0.0282
Epoch 361/400
160/160 [=====] - 0s 268us/step - loss: 0.0306

Epoch 362/400
160/160 [=====] - 0s 274us/step - loss: 0.0191
Epoch 363/400
160/160 [=====] - 0s 274us/step - loss: 0.0352
Epoch 364/400
160/160 [=====] - 0s 362us/step - loss: 0.0316
Epoch 365/400
160/160 [=====] - 0s 293us/step - loss: 0.0343
Epoch 366/400
160/160 [=====] - 0s 287us/step - loss: 0.0277
Epoch 367/400
160/160 [=====] - 0s 299us/step - loss: 0.0279
Epoch 368/400
160/160 [=====] - 0s 287us/step - loss: 0.0283
Epoch 369/400
160/160 [=====] - 0s 368us/step - loss: 0.0286
Epoch 370/400
160/160 [=====] - 0s 330us/step - loss: 0.0333
Epoch 371/400
160/160 [=====] - 0s 293us/step - loss: 0.0350
Epoch 372/400
160/160 [=====] - 0s 293us/step - loss: 0.0331
Epoch 373/400
160/160 [=====] - 0s 299us/step - loss: 0.0260
Epoch 374/400
160/160 [=====] - 0s 287us/step - loss: 0.0197
Epoch 375/400
160/160 [=====] - 0s 293us/step - loss: 0.0179
Epoch 376/400
160/160 [=====] - 0s 312us/step - loss: 0.0336
Epoch 377/400
160/160 [=====] - 0s 527us/step - loss: 0.0369
Epoch 378/400
160/160 [=====] - 0s 458us/step - loss: 0.0241
Epoch 379/400
160/160 [=====] - 0s 355us/step - loss: 0.0382
Epoch 380/400
160/160 [=====] - 0s 337us/step - loss: 0.0211
Epoch 381/400
160/160 [=====] - 0s 296us/step - loss: 0.0333
Epoch 382/400
160/160 [=====] - 0s 340us/step - loss: 0.0229
Epoch 383/400
160/160 [=====] - 0s 287us/step - loss: 0.0308
Epoch 384/400
160/160 [=====] - 0s 268us/step - loss: 0.0242
Epoch 385/400
160/160 [=====] - 0s 259us/step - loss: 0.0306
Epoch 386/400
160/160 [=====] - 0s 274us/step - loss: 0.0217
Epoch 387/400
160/160 [=====] - 0s 262us/step - loss: 0.0257
Epoch 388/400
160/160 [=====] - 0s 256us/step - loss: 0.0215
Epoch 389/400
160/160 [=====] - 0s 256us/step - loss: 0.0236
Epoch 390/400
160/160 [=====] - 0s 259us/step - loss: 0.0349
Epoch 391/400
160/160 [=====] - 0s 256us/step - loss: 0.0262
Epoch 392/400
160/160 [=====] - 0s 287us/step - loss: 0.0296
Epoch 393/400
160/160 [=====] - 0s 268us/step - loss: 0.0314
Epoch 394/400
160/160 [=====] - 0s 249us/step - loss: 0.0300
Epoch 395/400
160/160 [=====] - 0s 256us/step - loss: 0.0314
Epoch 396/400
160/160 [=====] - 0s 256us/step - loss: 0.0307
Epoch 397/400
160/160 [=====] - 0s 256us/step - loss: 0.0253
Epoch 398/400
160/160 [=====] - 0s 262us/step - loss: 0.0281
Epoch 399/400
160/160 [=====] - 0s 268us/step - loss: 0.0258
Epoch 400/400

```

160/160 [=====] - 0s 262us/step - loss: 0.0235
[9.9796128e-01 9.9869835e-01 9.7841197e-01 9.9870360e-01 9.9873871e-01
 9.9865806e-01 9.9870372e-01 3.2273045e-01 9.9827850e-01 9.9875677e-01
 9.9874747e-01 9.9875975e-01 9.9845588e-01 9.9748009e-01 9.9590451e-01
 9.9874556e-01 9.9870694e-01 9.9866259e-01 9.9850035e-01 9.9870574e-01
 9.9871218e-01 9.9875128e-01 9.9867672e-01 9.9877900e-01 9.9561250e-01
 9.9874181e-01 9.9848902e-01 9.5893258e-01 9.9843031e-01 9.9874735e-01
 9.9861586e-01 9.9859720e-01 9.9877042e-01 9.9875748e-01 9.7156388e-01
 9.9823320e-01 9.9877280e-01 9.9872261e-01 9.9845278e-01 9.9873787e-01
 9.9755198e-01 9.9844533e-01 9.8704696e-01 9.9844849e-01 9.9839717e-01
 9.9837971e-01 9.9845266e-01 5.6488651e-01 9.9793482e-01 9.9844128e-01
 9.9844414e-01 9.9843746e-01 9.9803597e-01 9.9721909e-01 9.9586004e-01
 9.9845076e-01 9.9839324e-01 9.9831921e-01 9.9835891e-01 9.9845231e-01
 9.9844521e-01 9.9844688e-01 9.9835902e-01 9.9841464e-01 9.9556512e-01
 9.9845183e-01 9.9815339e-01 9.5134908e-01 9.9804330e-01 9.9844944e-01
 9.9839658e-01 9.9840349e-01 9.9842680e-01 9.9844140e-01 9.8552543e-01
 9.9788731e-01 9.9842429e-01 9.9842203e-01 9.9830985e-01 9.9845278e-01
 8.8520249e-04 6.4628827e-04 3.0457161e-03 6.1977666e-04 5.0644978e-04
 5.1815825e-04 5.9796107e-04 1.9496229e-01 8.0168399e-04 5.5322668e-04
 5.7680113e-04 5.6586863e-04 7.5552403e-04 1.0146033e-03 3.7064713e-03
 5.7747937e-04 5.0987239e-04 6.8382814e-04 6.0465606e-04 6.3977222e-04
 6.2779535e-04 5.7863805e-04 6.7537412e-04 5.3076673e-04 4.7332770e-03
 6.0684187e-04 7.3481159e-04 1.5671819e-02 7.8550872e-04 5.9163617e-04
 5.4640329e-04 5.6435296e-04 5.4650562e-04 5.7085435e-04 5.2416380e-03
 8.1513647e-04 5.3105870e-04 6.5389316e-04 5.7339633e-04 6.1546982e-04
 3.4220729e-03 2.7915556e-03 9.1629270e-03 2.7767231e-03 2.8014146e-03
 2.8395918e-03 2.7638306e-03 1.0372362e-01 3.2457276e-03 2.7857623e-03
 2.7543341e-03 2.7609812e-03 3.0960317e-03 3.7314843e-03 1.0573252e-02
 2.7717259e-03 2.8155325e-03 2.8792350e-03 2.8827088e-03 2.7809646e-03
 2.7771059e-03 2.7649479e-03 2.8539952e-03 2.7829437e-03 1.2863402e-02
 2.7536624e-03 3.0662930e-03 2.3842884e-02 3.1846687e-03 2.7579868e-03
 2.8259836e-03 2.8221416e-03 2.7738500e-03 2.7640893e-03 9.6466858e-03
 3.2782867e-03 2.7979051e-03 2.7849795e-03 2.9094892e-03 2.7548908e-03]
160/160 [=====] - 0s 573us/step

```

In [42]:

```
#Three layers, four neurons per layer: loss
scores_lay_three_four, model_lay_three_four.metrics_names
```

Out [42]:

```
(0.01588033838197589, ['loss'])
```

Four Layers

In [43]:

```
n = 40
xx = np.random.random((n,1))
yy = np.random.random((n,1))

X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [44]:

```
#Four layers, four neurons per layer
model_lay_four_four = Sequential()

#hidden layers
model_lay_four_four.add(Dense(4, input_dim=2, activation='tanh'))
model_lay_four_four.add(Dense(4, activation='tanh'))
model_lay_four_four.add(Dense(4, activation='tanh'))
model_lay_four_four.add(Dense(4, activation='tanh'))

#output layer
model_lay_four_four.add(Dense(1, activation='sigmoid'))

sgd = SGD(lr=0.1)
model_lay_four_four.compile(loss='binary_crossentropy', optimizer='sgd')

model_lay_four_four.fit(X, y, batch_size=2, epochs=400)
print(model_lay_four_four.predict_proba(X).reshape(4*n))

#evaluate the model
scores_lay_four_four = model_lay_four_four.evaluate(X, y)
```

Epoch 1/400
160/160 [=====] - 0s 2ms/step - loss: 0.6946
Epoch 2/400
160/160 [=====] - 0s 281us/step - loss: 0.6939
Epoch 3/400
160/160 [=====] - 0s 281us/step - loss: 0.6931
Epoch 4/400
160/160 [=====] - 0s 277us/step - loss: 0.6924
Epoch 5/400
160/160 [=====] - 0s 281us/step - loss: 0.6920
Epoch 6/400
160/160 [=====] - 0s 284us/step - loss: 0.6911
Epoch 7/400
160/160 [=====] - 0s 274us/step - loss: 0.6903
Epoch 8/400
160/160 [=====] - 0s 271us/step - loss: 0.6889
Epoch 9/400
160/160 [=====] - 0s 274us/step - loss: 0.6883
Epoch 10/400
160/160 [=====] - 0s 262us/step - loss: 0.6868
Epoch 11/400
160/160 [=====] - 0s 274us/step - loss: 0.6857
Epoch 12/400
160/160 [=====] - 0s 280us/step - loss: 0.6839
Epoch 13/400
160/160 [=====] - 0s 268us/step - loss: 0.6820
Epoch 14/400
160/160 [=====] - 0s 274us/step - loss: 0.6803
Epoch 15/400
160/160 [=====] - 0s 274us/step - loss: 0.6771
Epoch 16/400
160/160 [=====] - 0s 287us/step - loss: 0.6743
Epoch 17/400
160/160 [=====] - 0s 281us/step - loss: 0.6716
Epoch 18/400
160/160 [=====] - 0s 281us/step - loss: 0.6675
Epoch 19/400
160/160 [=====] - 0s 274us/step - loss: 0.6632
Epoch 20/400
160/160 [=====] - 0s 274us/step - loss: 0.6595
Epoch 21/400
160/160 [=====] - 0s 274us/step - loss: 0.6544
Epoch 22/400
160/160 [=====] - 0s 274us/step - loss: 0.6489
Epoch 23/400
160/160 [=====] - 0s 287us/step - loss: 0.6441
Epoch 24/400
160/160 [=====] - 0s 274us/step - loss: 0.6379
Epoch 25/400
160/160 [=====] - 0s 274us/step - loss: 0.6316
Epoch 26/400
160/160 [=====] - 0s 271us/step - loss: 0.6241
Epoch 27/400
160/160 [=====] - 0s 274us/step - loss: 0.6175
Epoch 28/400
160/160 [=====] - 0s 271us/step - loss: 0.6095
Epoch 29/400
160/160 [=====] - 0s 293us/step - loss: 0.6029
Epoch 30/400
160/160 [=====] - 0s 299us/step - loss: 0.5951
Epoch 31/400
160/160 [=====] - 0s 299us/step - loss: 0.5880
Epoch 32/400
160/160 [=====] - 0s 281us/step - loss: 0.5801
Epoch 33/400
160/160 [=====] - 0s 281us/step - loss: 0.5725
Epoch 34/400
160/160 [=====] - 0s 274us/step - loss: 0.5650
Epoch 35/400
160/160 [=====] - 0s 280us/step - loss: 0.5589
Epoch 36/400
160/160 [=====] - 0s 274us/step - loss: 0.5516
Epoch 37/400
160/160 [=====] - 0s 274us/step - loss: 0.5457
Epoch 38/400
160/160 [=====] - 0s 268us/step - loss: 0.5379

Epoch 39/400
160/160 [=====] - 0s 268us/step - loss: 0.5333
Epoch 40/400
160/160 [=====] - 0s 281us/step - loss: 0.5288
Epoch 41/400
160/160 [=====] - 0s 274us/step - loss: 0.5209
Epoch 42/400
160/160 [=====] - 0s 277us/step - loss: 0.5149
Epoch 43/400
160/160 [=====] - 0s 274us/step - loss: 0.5091
Epoch 44/400
160/160 [=====] - 0s 290us/step - loss: 0.5016
Epoch 45/400
160/160 [=====] - 0s 293us/step - loss: 0.4959
Epoch 46/400
160/160 [=====] - 0s 277us/step - loss: 0.4879
Epoch 47/400
160/160 [=====] - 0s 299us/step - loss: 0.4743
Epoch 48/400
160/160 [=====] - 0s 299us/step - loss: 0.4706
Epoch 49/400
160/160 [=====] - 0s 299us/step - loss: 0.4636
Epoch 50/400
160/160 [=====] - 0s 299us/step - loss: 0.4512
Epoch 51/400
160/160 [=====] - 0s 287us/step - loss: 0.4454
Epoch 52/400
160/160 [=====] - 0s 368us/step - loss: 0.4354
Epoch 53/400
160/160 [=====] - 0s 305us/step - loss: 0.4235
Epoch 54/400
160/160 [=====] - 0s 305us/step - loss: 0.4136
Epoch 55/400
160/160 [=====] - 0s 318us/step - loss: 0.4058
Epoch 56/400
160/160 [=====] - 0s 315us/step - loss: 0.3970
Epoch 57/400
160/160 [=====] - 0s 380us/step - loss: 0.3870
Epoch 58/400
160/160 [=====] - 0s 355us/step - loss: 0.3796
Epoch 59/400
160/160 [=====] - 0s 293us/step - loss: 0.3667
Epoch 60/400
160/160 [=====] - 0s 299us/step - loss: 0.3664
Epoch 61/400
160/160 [=====] - 0s 293us/step - loss: 0.3599
Epoch 62/400
160/160 [=====] - 0s 321us/step - loss: 0.3429
Epoch 63/400
160/160 [=====] - 0s 287us/step - loss: 0.3434
Epoch 64/400
160/160 [=====] - 0s 312us/step - loss: 0.3343
Epoch 65/400
160/160 [=====] - 0s 315us/step - loss: 0.3353
Epoch 66/400
160/160 [=====] - 0s 318us/step - loss: 0.3274
Epoch 67/400
160/160 [=====] - 0s 318us/step - loss: 0.3254
Epoch 68/400
160/160 [=====] - 0s 496us/step - loss: 0.3189
Epoch 69/400
160/160 [=====] - 0s 415us/step - loss: 0.3156
Epoch 70/400
160/160 [=====] - 0s 443us/step - loss: 0.3048
Epoch 71/400
160/160 [=====] - 0s 399us/step - loss: 0.3037
Epoch 72/400
160/160 [=====] - 0s 324us/step - loss: 0.3046
Epoch 73/400
160/160 [=====] - 0s 280us/step - loss: 0.3037
Epoch 74/400
160/160 [=====] - 0s 281us/step - loss: 0.2982
Epoch 75/400
160/160 [=====] - 0s 268us/step - loss: 0.2840
Epoch 76/400
160/160 [=====] - 0s 280us/step - loss: 0.2910
Epoch 77/400

160/160 [=====] - 0s 268us/step - loss: 0.2886
Epoch 78/400
160/160 [=====] - 0s 262us/step - loss: 0.2893
Epoch 79/400
160/160 [=====] - 0s 265us/step - loss: 0.2836
Epoch 80/400
160/160 [=====] - 0s 274us/step - loss: 0.2785
Epoch 81/400
160/160 [=====] - 0s 302us/step - loss: 0.2589
Epoch 82/400
160/160 [=====] - 0s 268us/step - loss: 0.2541
Epoch 83/400
160/160 [=====] - 0s 274us/step - loss: 0.2592
Epoch 84/400
160/160 [=====] - 0s 277us/step - loss: 0.2674
Epoch 85/400
160/160 [=====] - 0s 268us/step - loss: 0.2552
Epoch 86/400
160/160 [=====] - 0s 262us/step - loss: 0.2619
Epoch 87/400
160/160 [=====] - 0s 262us/step - loss: 0.2555
Epoch 88/400
160/160 [=====] - 0s 274us/step - loss: 0.2478
Epoch 89/400
160/160 [=====] - 0s 293us/step - loss: 0.2597
Epoch 90/400
160/160 [=====] - 0s 274us/step - loss: 0.2395
Epoch 91/400
160/160 [=====] - 0s 268us/step - loss: 0.2206
Epoch 92/400
160/160 [=====] - 0s 268us/step - loss: 0.2370
Epoch 93/400
160/160 [=====] - 0s 274us/step - loss: 0.2280
Epoch 94/400
160/160 [=====] - 0s 274us/step - loss: 0.2236
Epoch 95/400
160/160 [=====] - 0s 268us/step - loss: 0.2363
Epoch 96/400
160/160 [=====] - 0s 268us/step - loss: 0.2272
Epoch 97/400
160/160 [=====] - 0s 274us/step - loss: 0.2289
Epoch 98/400
160/160 [=====] - 0s 274us/step - loss: 0.2319
Epoch 99/400
160/160 [=====] - 0s 262us/step - loss: 0.2183
Epoch 100/400
160/160 [=====] - 0s 268us/step - loss: 0.2210
Epoch 101/400
160/160 [=====] - 0s 274us/step - loss: 0.2181
Epoch 102/400
160/160 [=====] - 0s 274us/step - loss: 0.1976
Epoch 103/400
160/160 [=====] - 0s 274us/step - loss: 0.2209
Epoch 104/400
160/160 [=====] - 0s 271us/step - loss: 0.2131
Epoch 105/400
160/160 [=====] - 0s 262us/step - loss: 0.1920
Epoch 106/400
160/160 [=====] - 0s 281us/step - loss: 0.1990
Epoch 107/400
160/160 [=====] - 0s 305us/step - loss: 0.2040
Epoch 108/400
160/160 [=====] - 0s 277us/step - loss: 0.1972
Epoch 109/400
160/160 [=====] - 0s 274us/step - loss: 0.2028
Epoch 110/400
160/160 [=====] - 0s 274us/step - loss: 0.2086
Epoch 111/400
160/160 [=====] - 0s 274us/step - loss: 0.1931
Epoch 112/400
160/160 [=====] - 0s 274us/step - loss: 0.1940
Epoch 113/400
160/160 [=====] - 0s 268us/step - loss: 0.1868
Epoch 114/400
160/160 [=====] - 0s 274us/step - loss: 0.1940
Epoch 115/400
160/160 [=====] - 0s 268us/step - loss: 0.1886

Epoch 116/400
160/160 [=====] - 0s 274us/step - loss: 0.1975
Epoch 117/400
160/160 [=====] - 0s 268us/step - loss: 0.1949
Epoch 118/400
160/160 [=====] - 0s 271us/step - loss: 0.1709
Epoch 119/400
160/160 [=====] - 0s 268us/step - loss: 0.1814
Epoch 120/400
160/160 [=====] - 0s 277us/step - loss: 0.1692
Epoch 121/400
160/160 [=====] - 0s 274us/step - loss: 0.1885
Epoch 122/400
160/160 [=====] - 0s 271us/step - loss: 0.1974
Epoch 123/400
160/160 [=====] - 0s 268us/step - loss: 0.1822
Epoch 124/400
160/160 [=====] - 0s 274us/step - loss: 0.1840
Epoch 125/400
160/160 [=====] - 0s 274us/step - loss: 0.1822
Epoch 126/400
160/160 [=====] - 0s 280us/step - loss: 0.1867
Epoch 127/400
160/160 [=====] - 0s 280us/step - loss: 0.1761
Epoch 128/400
160/160 [=====] - 0s 284us/step - loss: 0.1768
Epoch 129/400
160/160 [=====] - 0s 284us/step - loss: 0.1710
Epoch 130/400
160/160 [=====] - 0s 281us/step - loss: 0.1654
Epoch 131/400
160/160 [=====] - 0s 268us/step - loss: 0.1831
Epoch 132/400
160/160 [=====] - 0s 268us/step - loss: 0.1674
Epoch 133/400
160/160 [=====] - 0s 262us/step - loss: 0.1523
Epoch 134/400
160/160 [=====] - 0s 268us/step - loss: 0.1688
Epoch 135/400
160/160 [=====] - 0s 287us/step - loss: 0.1579
Epoch 136/400
160/160 [=====] - 0s 287us/step - loss: 0.1619
Epoch 137/400
160/160 [=====] - 0s 274us/step - loss: 0.1776
Epoch 138/400
160/160 [=====] - 0s 262us/step - loss: 0.1563
Epoch 139/400
160/160 [=====] - 0s 262us/step - loss: 0.1891
Epoch 140/400
160/160 [=====] - 0s 268us/step - loss: 0.1808
Epoch 141/400
160/160 [=====] - 0s 268us/step - loss: 0.1661
Epoch 142/400
160/160 [=====] - 0s 262us/step - loss: 0.1678
Epoch 143/400
160/160 [=====] - 0s 268us/step - loss: 0.1424
Epoch 144/400
160/160 [=====] - 0s 262us/step - loss: 0.1699
Epoch 145/400
160/160 [=====] - 0s 268us/step - loss: 0.1474
Epoch 146/400
160/160 [=====] - 0s 274us/step - loss: 0.1537
Epoch 147/400
160/160 [=====] - 0s 268us/step - loss: 0.1730
Epoch 148/400
160/160 [=====] - 0s 268us/step - loss: 0.1830
Epoch 149/400
160/160 [=====] - 0s 274us/step - loss: 0.1332
Epoch 150/400
160/160 [=====] - 0s 274us/step - loss: 0.1523
Epoch 151/400
160/160 [=====] - 0s 274us/step - loss: 0.1449
Epoch 152/400
160/160 [=====] - 0s 277us/step - loss: 0.1313
Epoch 153/400
160/160 [=====] - 0s 293us/step - loss: 0.1588
Epoch 154/400

160/160 [=====] - 0s 277us/step - loss: 0.1553
Epoch 155/400
160/160 [=====] - 0s 281us/step - loss: 0.1390
Epoch 156/400
160/160 [=====] - 0s 287us/step - loss: 0.1563
Epoch 157/400
160/160 [=====] - 0s 265us/step - loss: 0.1606
Epoch 158/400
160/160 [=====] - 0s 281us/step - loss: 0.1598
Epoch 159/400
160/160 [=====] - 0s 277us/step - loss: 0.1470
Epoch 160/400
160/160 [=====] - 0s 287us/step - loss: 0.1837
Epoch 161/400
160/160 [=====] - 0s 277us/step - loss: 0.1330
Epoch 162/400
160/160 [=====] - 0s 274us/step - loss: 0.1426
Epoch 163/400
160/160 [=====] - 0s 268us/step - loss: 0.1509
Epoch 164/400
160/160 [=====] - 0s 274us/step - loss: 0.1708
Epoch 165/400
160/160 [=====] - 0s 274us/step - loss: 0.1549
Epoch 166/400
160/160 [=====] - 0s 293us/step - loss: 0.1519
Epoch 167/400
160/160 [=====] - 0s 271us/step - loss: 0.1472
Epoch 168/400
160/160 [=====] - 0s 262us/step - loss: 0.1582
Epoch 169/400
160/160 [=====] - 0s 268us/step - loss: 0.1418
Epoch 170/400
160/160 [=====] - 0s 268us/step - loss: 0.1517
Epoch 171/400
160/160 [=====] - 0s 274us/step - loss: 0.1451
Epoch 172/400
160/160 [=====] - 0s 271us/step - loss: 0.1366
Epoch 173/400
160/160 [=====] - 0s 274us/step - loss: 0.1382
Epoch 174/400
160/160 [=====] - 0s 359us/step - loss: 0.1701
Epoch 175/400
160/160 [=====] - 0s 399us/step - loss: 0.1579
Epoch 176/400
160/160 [=====] - 0s 268us/step - loss: 0.1470
Epoch 177/400
160/160 [=====] - 0s 355us/step - loss: 0.1342
Epoch 178/400
160/160 [=====] - 0s 362us/step - loss: 0.1202
Epoch 179/400
160/160 [=====] - 0s 305us/step - loss: 0.1643
Epoch 180/400
160/160 [=====] - 0s 277us/step - loss: 0.1318
Epoch 181/400
160/160 [=====] - 0s 287us/step - loss: 0.1408
Epoch 182/400
160/160 [=====] - 0s 299us/step - loss: 0.1504
Epoch 183/400
160/160 [=====] - 0s 268us/step - loss: 0.1321
Epoch 184/400
160/160 [=====] - 0s 268us/step - loss: 0.1700
Epoch 185/400
160/160 [=====] - 0s 274us/step - loss: 0.1358
Epoch 186/400
160/160 [=====] - 0s 274us/step - loss: 0.1327
Epoch 187/400
160/160 [=====] - 0s 299us/step - loss: 0.1469
Epoch 188/400
160/160 [=====] - 0s 293us/step - loss: 0.1346
Epoch 189/400
160/160 [=====] - 0s 271us/step - loss: 0.1508
Epoch 190/400
160/160 [=====] - 0s 274us/step - loss: 0.1501
Epoch 191/400
160/160 [=====] - 0s 268us/step - loss: 0.1640
Epoch 192/400
160/160 [=====] - 0s 274us/step - loss: 0.1240

Epoch 193/400
160/160 [=====] - 0s 268us/step - loss: 0.1158
Epoch 194/400
160/160 [=====] - 0s 274us/step - loss: 0.1427
Epoch 195/400
160/160 [=====] - 0s 284us/step - loss: 0.1373
Epoch 196/400
160/160 [=====] - 0s 284us/step - loss: 0.1134
Epoch 197/400
160/160 [=====] - 0s 290us/step - loss: 0.1382
Epoch 198/400
160/160 [=====] - 0s 277us/step - loss: 0.1540
Epoch 199/400
160/160 [=====] - 0s 274us/step - loss: 0.1372
Epoch 200/400
160/160 [=====] - 0s 277us/step - loss: 0.1164
Epoch 201/400
160/160 [=====] - 0s 293us/step - loss: 0.1429
Epoch 202/400
160/160 [=====] - 0s 265us/step - loss: 0.1283
Epoch 203/400
160/160 [=====] - 0s 274us/step - loss: 0.1438
Epoch 204/400
160/160 [=====] - 0s 262us/step - loss: 0.1247
Epoch 205/400
160/160 [=====] - 0s 268us/step - loss: 0.1599
Epoch 206/400
160/160 [=====] - 0s 274us/step - loss: 0.1170
Epoch 207/400
160/160 [=====] - 0s 277us/step - loss: 0.1235
Epoch 208/400
160/160 [=====] - 0s 268us/step - loss: 0.2127
Epoch 209/400
160/160 [=====] - 0s 334us/step - loss: 0.1162
Epoch 210/400
160/160 [=====] - 0s 299us/step - loss: 0.1196
Epoch 211/400
160/160 [=====] - 0s 284us/step - loss: 0.1482
Epoch 212/400
160/160 [=====] - 0s 324us/step - loss: 0.1326
Epoch 213/400
160/160 [=====] - 0s 296us/step - loss: 0.1436
Epoch 214/400
160/160 [=====] - 0s 287us/step - loss: 0.1383
Epoch 215/400
160/160 [=====] - 0s 274us/step - loss: 0.1206
Epoch 216/400
160/160 [=====] - 0s 393us/step - loss: 0.1623
Epoch 217/400
160/160 [=====] - 0s 293us/step - loss: 0.1592
Epoch 218/400
160/160 [=====] - 0s 305us/step - loss: 0.1346
Epoch 219/400
160/160 [=====] - 0s 324us/step - loss: 0.1194
Epoch 220/400
160/160 [=====] - 0s 343us/step - loss: 0.1157
Epoch 221/400
160/160 [=====] - 0s 312us/step - loss: 0.1521
Epoch 222/400
160/160 [=====] - 0s 318us/step - loss: 0.1256
Epoch 223/400
160/160 [=====] - 0s 287us/step - loss: 0.1061
Epoch 224/400
160/160 [=====] - 0s 299us/step - loss: 0.1097
Epoch 225/400
160/160 [=====] - 0s 268us/step - loss: 0.1396
Epoch 226/400
160/160 [=====] - 0s 262us/step - loss: 0.1362
Epoch 227/400
160/160 [=====] - 0s 268us/step - loss: 0.1578
Epoch 228/400
160/160 [=====] - 0s 268us/step - loss: 0.1483
Epoch 229/400
160/160 [=====] - 0s 268us/step - loss: 0.1365
Epoch 230/400
160/160 [=====] - 0s 274us/step - loss: 0.1132
Epoch 231/400

160/160 [=====] - 0s 280us/step - loss: 0.1357
Epoch 232/400
160/160 [=====] - 0s 293us/step - loss: 0.1268
Epoch 233/400
160/160 [=====] - 0s 274us/step - loss: 0.1288
Epoch 234/400
160/160 [=====] - 0s 268us/step - loss: 0.1429
Epoch 235/400
160/160 [=====] - 0s 268us/step - loss: 0.1026
Epoch 236/400
160/160 [=====] - 0s 287us/step - loss: 0.1125
Epoch 237/400
160/160 [=====] - 0s 268us/step - loss: 0.1227
Epoch 238/400
160/160 [=====] - 0s 287us/step - loss: 0.1774
Epoch 239/400
160/160 [=====] - 0s 281us/step - loss: 0.1119
Epoch 240/400
160/160 [=====] - 0s 274us/step - loss: 0.1200
Epoch 241/400
160/160 [=====] - 0s 271us/step - loss: 0.1255
Epoch 242/400
160/160 [=====] - 0s 274us/step - loss: 0.1299
Epoch 243/400
160/160 [=====] - 0s 265us/step - loss: 0.1104
Epoch 244/400
160/160 [=====] - 0s 262us/step - loss: 0.1388
Epoch 245/400
160/160 [=====] - 0s 268us/step - loss: 0.1342
Epoch 246/400
160/160 [=====] - 0s 271us/step - loss: 0.1141
Epoch 247/400
160/160 [=====] - 0s 262us/step - loss: 0.1206
Epoch 248/400
160/160 [=====] - 0s 259us/step - loss: 0.1094
Epoch 249/400
160/160 [=====] - 0s 268us/step - loss: 0.1434
Epoch 250/400
160/160 [=====] - 0s 256us/step - loss: 0.1158
Epoch 251/400
160/160 [=====] - 0s 268us/step - loss: 0.1205
Epoch 252/400
160/160 [=====] - 0s 281us/step - loss: 0.1405
Epoch 253/400
160/160 [=====] - 0s 262us/step - loss: 0.1213
Epoch 254/400
160/160 [=====] - 0s 274us/step - loss: 0.1112
Epoch 255/400
160/160 [=====] - 0s 268us/step - loss: 0.1177
Epoch 256/400
160/160 [=====] - 0s 256us/step - loss: 0.0993
Epoch 257/400
160/160 [=====] - 0s 349us/step - loss: 0.1195
Epoch 258/400
160/160 [=====] - 0s 386us/step - loss: 0.1146
Epoch 259/400
160/160 [=====] - 0s 305us/step - loss: 0.1196
Epoch 260/400
160/160 [=====] - 0s 367us/step - loss: 0.1209
Epoch 261/400
160/160 [=====] - 0s 299us/step - loss: 0.1061
Epoch 262/400
160/160 [=====] - 0s 293us/step - loss: 0.1275
Epoch 263/400
160/160 [=====] - 0s 287us/step - loss: 0.1550
Epoch 264/400
160/160 [=====] - 0s 280us/step - loss: 0.1288
Epoch 265/400
160/160 [=====] - 0s 293us/step - loss: 0.1242
Epoch 266/400
160/160 [=====] - 0s 284us/step - loss: 0.1127
Epoch 267/400
160/160 [=====] - 0s 287us/step - loss: 0.1084
Epoch 268/400
160/160 [=====] - 0s 287us/step - loss: 0.1154
Epoch 269/400
160/160 [=====] - 0s 302us/step - loss: 0.0959

```
Epoch 270/400
160/160 [=====] - 0s 305us/step - loss: 0.1038
Epoch 271/400
160/160 [=====] - 0s 327us/step - loss: 0.1076
Epoch 272/400
160/160 [=====] - 0s 415us/step - loss: 0.1166
Epoch 273/400
160/160 [=====] - 0s 318us/step - loss: 0.1043
Epoch 274/400
160/160 [=====] - 0s 293us/step - loss: 0.1210
Epoch 275/400
160/160 [=====] - 0s 305us/step - loss: 0.1365
Epoch 276/400
160/160 [=====] - 0s 281us/step - loss: 0.1005
Epoch 277/400
160/160 [=====] - 0s 268us/step - loss: 0.1310
Epoch 278/400
160/160 [=====] - 0s 268us/step - loss: 0.1400
Epoch 279/400
160/160 [=====] - 0s 262us/step - loss: 0.1496
Epoch 280/400
160/160 [=====] - 0s 268us/step - loss: 0.0954
Epoch 281/400
160/160 [=====] - 0s 274us/step - loss: 0.1437
Epoch 282/400
160/160 [=====] - 0s 271us/step - loss: 0.1065
Epoch 283/400
160/160 [=====] - 0s 268us/step - loss: 0.1360
Epoch 284/400
160/160 [=====] - 0s 271us/step - loss: 0.1221
Epoch 285/400
160/160 [=====] - 0s 280us/step - loss: 0.1171
Epoch 286/400
160/160 [=====] - 0s 309us/step - loss: 0.1183
Epoch 287/400
160/160 [=====] - 0s 280us/step - loss: 0.1317
Epoch 288/400
160/160 [=====] - 0s 274us/step - loss: 0.1039
Epoch 289/400
160/160 [=====] - 0s 281us/step - loss: 0.1333
Epoch 290/400
160/160 [=====] - 0s 274us/step - loss: 0.1272
Epoch 291/400
160/160 [=====] - 0s 268us/step - loss: 0.1021
Epoch 292/400
160/160 [=====] - 0s 268us/step - loss: 0.1105
Epoch 293/400
160/160 [=====] - 0s 274us/step - loss: 0.1063
Epoch 294/400
160/160 [=====] - 0s 268us/step - loss: 0.1183
Epoch 295/400
160/160 [=====] - 0s 262us/step - loss: 0.0935
Epoch 296/400
160/160 [=====] - 0s 262us/step - loss: 0.0995
Epoch 297/400
160/160 [=====] - 0s 268us/step - loss: 0.1208
Epoch 298/400
160/160 [=====] - 0s 262us/step - loss: 0.1078
Epoch 299/400
160/160 [=====] - 0s 268us/step - loss: 0.1054
Epoch 300/400
160/160 [=====] - 0s 274us/step - loss: 0.0926
Epoch 301/400
160/160 [=====] - 0s 274us/step - loss: 0.1035
Epoch 302/400
160/160 [=====] - 0s 274us/step - loss: 0.1018
Epoch 303/400
160/160 [=====] - 0s 299us/step - loss: 0.1005
Epoch 304/400
160/160 [=====] - 0s 284us/step - loss: 0.1168
Epoch 305/400
160/160 [=====] - 0s 281us/step - loss: 0.1047
Epoch 306/400
160/160 [=====] - 0s 268us/step - loss: 0.1095
Epoch 307/400
160/160 [=====] - 0s 274us/step - loss: 0.1649
Epoch 308/400
```

Epoch 300/400
160/160 [=====] - 0s 274us/step - loss: 0.1250
Epoch 309/400
160/160 [=====] - 0s 287us/step - loss: 0.1171
Epoch 310/400
160/160 [=====] - 0s 274us/step - loss: 0.1256
Epoch 311/400
160/160 [=====] - 0s 274us/step - loss: 0.1444
Epoch 312/400
160/160 [=====] - 0s 262us/step - loss: 0.1191
Epoch 313/400
160/160 [=====] - 0s 268us/step - loss: 0.1086
Epoch 314/400
160/160 [=====] - 0s 268us/step - loss: 0.1038
Epoch 315/400
160/160 [=====] - 0s 268us/step - loss: 0.1247
Epoch 316/400
160/160 [=====] - 0s 268us/step - loss: 0.1155
Epoch 317/400
160/160 [=====] - 0s 349us/step - loss: 0.0950
Epoch 318/400
160/160 [=====] - 0s 390us/step - loss: 0.1399
Epoch 319/400
160/160 [=====] - 0s 290us/step - loss: 0.1083
Epoch 320/400
160/160 [=====] - 0s 299us/step - loss: 0.1013
Epoch 321/400
160/160 [=====] - 0s 299us/step - loss: 0.1061
Epoch 322/400
160/160 [=====] - 0s 296us/step - loss: 0.1247
Epoch 323/400
160/160 [=====] - 0s 299us/step - loss: 0.1249
Epoch 324/400
160/160 [=====] - 0s 312us/step - loss: 0.1137
Epoch 325/400
160/160 [=====] - 0s 299us/step - loss: 0.1129
Epoch 326/400
160/160 [=====] - 0s 299us/step - loss: 0.0828
Epoch 327/400
160/160 [=====] - 0s 312us/step - loss: 0.1246
Epoch 328/400
160/160 [=====] - 0s 284us/step - loss: 0.1010
Epoch 329/400
160/160 [=====] - 0s 262us/step - loss: 0.1316
Epoch 330/400
160/160 [=====] - 0s 262us/step - loss: 0.1354
Epoch 331/400
160/160 [=====] - 0s 268us/step - loss: 0.1165
Epoch 332/400
160/160 [=====] - 0s 268us/step - loss: 0.1128
Epoch 333/400
160/160 [=====] - 0s 268us/step - loss: 0.1257
Epoch 334/400
160/160 [=====] - 0s 262us/step - loss: 0.1015
Epoch 335/400
160/160 [=====] - 0s 262us/step - loss: 0.1136
Epoch 336/400
160/160 [=====] - 0s 268us/step - loss: 0.1209
Epoch 337/400
160/160 [=====] - 0s 268us/step - loss: 0.1067
Epoch 338/400
160/160 [=====] - 0s 268us/step - loss: 0.1123
Epoch 339/400
160/160 [=====] - 0s 280us/step - loss: 0.1152
Epoch 340/400
160/160 [=====] - 0s 268us/step - loss: 0.1002
Epoch 341/400
160/160 [=====] - 0s 268us/step - loss: 0.1025
Epoch 342/400
160/160 [=====] - 0s 268us/step - loss: 0.1050
Epoch 343/400
160/160 [=====] - 0s 280us/step - loss: 0.0963
Epoch 344/400
160/160 [=====] - 0s 262us/step - loss: 0.1109
Epoch 345/400
160/160 [=====] - 0s 268us/step - loss: 0.1347
Epoch 346/400
160/160 [=====] - 0s 262us/step - loss: 0.1079

100%|██████████| 160/160 [=====] - 0s 287us/step - loss: 0.0954
Epoch 347/400
160/160 [=====] - 0s 268us/step - loss: 0.1001
Epoch 348/400
160/160 [=====] - 0s 274us/step - loss: 0.1287
Epoch 350/400
160/160 [=====] - 0s 268us/step - loss: 0.1065
Epoch 351/400
160/160 [=====] - 0s 262us/step - loss: 0.1087
Epoch 352/400
160/160 [=====] - 0s 268us/step - loss: 0.0918
Epoch 353/400
160/160 [=====] - 0s 271us/step - loss: 0.1053
Epoch 354/400
160/160 [=====] - 0s 268us/step - loss: 0.1172
Epoch 355/400
160/160 [=====] - 0s 280us/step - loss: 0.1203
Epoch 356/400
160/160 [=====] - 0s 271us/step - loss: 0.1028
Epoch 357/400
160/160 [=====] - 0s 281us/step - loss: 0.1105
Epoch 358/400
160/160 [=====] - 0s 271us/step - loss: 0.1152
Epoch 359/400
160/160 [=====] - 0s 274us/step - loss: 0.1200
Epoch 360/400
160/160 [=====] - 0s 271us/step - loss: 0.1022
Epoch 361/400
160/160 [=====] - 0s 268us/step - loss: 0.0976
Epoch 362/400
160/160 [=====] - 0s 268us/step - loss: 0.0920
Epoch 363/400
160/160 [=====] - 0s 265us/step - loss: 0.1287
Epoch 364/400
160/160 [=====] - 0s 274us/step - loss: 0.1023
Epoch 365/400
160/160 [=====] - 0s 274us/step - loss: 0.1057
Epoch 366/400
160/160 [=====] - 0s 274us/step - loss: 0.0938
Epoch 367/400
160/160 [=====] - 0s 268us/step - loss: 0.1285
Epoch 368/400
160/160 [=====] - 0s 274us/step - loss: 0.1263
Epoch 369/400
160/160 [=====] - 0s 280us/step - loss: 0.1044
Epoch 370/400
160/160 [=====] - 0s 293us/step - loss: 0.1273
Epoch 371/400
160/160 [=====] - 0s 281us/step - loss: 0.0997
Epoch 372/400
160/160 [=====] - 0s 280us/step - loss: 0.0943
Epoch 373/400
160/160 [=====] - 0s 262us/step - loss: 0.0919
Epoch 374/400
160/160 [=====] - 0s 268us/step - loss: 0.1056
Epoch 375/400
160/160 [=====] - 0s 268us/step - loss: 0.1071
Epoch 376/400
160/160 [=====] - 0s 268us/step - loss: 0.0958
Epoch 377/400
160/160 [=====] - 0s 262us/step - loss: 0.1176
Epoch 378/400
160/160 [=====] - 0s 274us/step - loss: 0.1164
Epoch 379/400
160/160 [=====] - 0s 262us/step - loss: 0.1080
Epoch 380/400
160/160 [=====] - 0s 268us/step - loss: 0.0847
Epoch 381/400
160/160 [=====] - 0s 274us/step - loss: 0.1028
Epoch 382/400
160/160 [=====] - 0s 274us/step - loss: 0.1018
Epoch 383/400
160/160 [=====] - 0s 268us/step - loss: 0.1087
Epoch 384/400
160/160 [=====] - 0s 268us/step - loss: 0.1352
Epoch 385/400

```

Epoch 385/400
160/160 [=====] - 0s 318us/step - loss: 0.1387
Epoch 386/400
160/160 [=====] - 0s 386us/step - loss: 0.1287
Epoch 387/400
160/160 [=====] - 0s 305us/step - loss: 0.1117
Epoch 388/400
160/160 [=====] - 0s 293us/step - loss: 0.0884
Epoch 389/400
160/160 [=====] - 0s 312us/step - loss: 0.0870
Epoch 390/400
160/160 [=====] - 0s 305us/step - loss: 0.0924
Epoch 391/400
160/160 [=====] - 0s 318us/step - loss: 0.1201
Epoch 392/400
160/160 [=====] - 0s 337us/step - loss: 0.1193
Epoch 393/400
160/160 [=====] - 0s 315us/step - loss: 0.0953
Epoch 394/400
160/160 [=====] - 0s 371us/step - loss: 0.1181
Epoch 395/400
160/160 [=====] - 0s 362us/step - loss: 0.1037
Epoch 396/400
160/160 [=====] - 0s 305us/step - loss: 0.1051
Epoch 397/400
160/160 [=====] - 0s 299us/step - loss: 0.0950
Epoch 398/400
160/160 [=====] - 0s 305us/step - loss: 0.1025
Epoch 399/400
160/160 [=====] - 0s 374us/step - loss: 0.0914
Epoch 400/400
160/160 [=====] - 0s 355us/step - loss: 0.1009
[0.3045636 0.9822811 0.9822912 0.98190683 0.9822359 0.9823545
 0.98229665 0.98304766 0.9779571 0.97664386 0.98227894 0.0540893
 0.9822457 0.9716574 0.98227906 0.982284 0.9823214 0.9802843
 0.9822665 0.9821279 0.9823537 0.98149145 0.9811947 0.9736395
 0.9822013 0.9818724 0.9822681 0.43539688 0.14813352 0.9821671
 0.9831215 0.98214036 0.9822949 0.97775304 0.9759665 0.98231536
 0.98324674 0.9824086 0.9822704 0.98278 0.5207132 0.9987821
 0.9987618 0.9982743 0.99890757 0.9991578 0.9987766 0.99480504
 0.9911143 0.9797467 0.9986217 0.14461417 0.99896276 0.97530377
 0.9986713 0.99858665 0.99901533 0.989527 0.9988226 0.998553
 0.99919015 0.9976393 0.98908687 0.8826623 0.99855 0.9980381
 0.9986078 0.8765261 0.39550108 0.99908745 0.9986487 0.99903107
 0.9987889 0.9992354 0.9833024 0.9991186 0.9979755 0.999253
 0.99860233 0.99911433 0.02283049 0.01441566 0.01441342 0.01444339
 0.0144224 0.01444493 0.01441296 0.03806391 0.01485987 0.14392231
 0.01441463 0.04653908 0.01442432 0.01528759 0.01441421 0.01441395
 0.01442512 0.07824047 0.01441833 0.01442492 0.01445725 0.01449175
 0.09123912 0.735888 0.01442328 0.01445096 0.0144179 0.03428526
 0.04609951 0.01443355 0.01589695 0.01443085 0.01441368 0.01503196
 0.01502935 0.01443804 0.01778838 0.01450433 0.01441774 0.01498395
 0.04256903 0.00163301 0.00168931 0.00170348 0.00154263 0.00153179
 0.00171777 0.12629578 0.00313025 0.5706692 0.00163073 0.122671
 0.00152605 0.00443987 0.00164253 0.00164171 0.00163387 0.3165176
 0.00158788 0.00160292 0.0014489 0.00189479 0.5204308 0.9660638
 0.00157205 0.00171847 0.00158737 0.03531237 0.1131408 0.00146248
 0.0017239 0.00149323 0.00169812 0.00204243 0.0034162 0.00148335
 0.00277042 0.00137694 0.00158892 0.00125569]
160/160 [=====] - 0s 630us/step

```

In [45]:

```
#Four layers, four neurons per layer: loss
scores_lay_four_four, model_lay_four_four.metrics_names
```

Out [45]:

```
(0.12261393815279006, ['loss'])
```

Five Layers

In [46]:

```
n = 40
xx = np.random.random((n,1))
yy = np.random.random((n,1))
```

```
X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [47]:

```
#Five layers, four neurons per layer
model_lay_five_four = Sequential()

#hidden layers
model_lay_five_four.add(Dense(4, input_dim=2, activation='tanh'))
model_lay_five_four.add(Dense(4, activation='tanh'))
model_lay_five_four.add(Dense(4, activation='tanh'))
model_lay_five_four.add(Dense(4, activation='tanh'))
model_lay_five_four.add(Dense(4, activation='tanh'))

#output layer
model_lay_five_four.add(Dense(1, activation='sigmoid'))

sgd = SGD(lr=0.1)
model_lay_five_four.compile(loss='binary_crossentropy', optimizer='sgd')

model_lay_five_four.fit(X, y, batch_size=2, epochs=400)
print(model_lay_five_four.predict_proba(X).reshape(4*n))

#evaluate the model
scores_lay_five_four = model_lay_five_four.evaluate(X, y)
```

```
Epoch 1/400
160/160 [=====] - 0s 2ms/step - loss: 0.7170
Epoch 2/400
160/160 [=====] - 0s 280us/step - loss: 0.6952
Epoch 3/400
160/160 [=====] - 0s 274us/step - loss: 0.6844
Epoch 4/400
160/160 [=====] - 0s 281us/step - loss: 0.6742
Epoch 5/400
160/160 [=====] - 0s 305us/step - loss: 0.6619
Epoch 6/400
160/160 [=====] - 0s 293us/step - loss: 0.6438
Epoch 7/400
160/160 [=====] - 0s 293us/step - loss: 0.6331
Epoch 8/400
160/160 [=====] - 0s 290us/step - loss: 0.6049
Epoch 9/400
160/160 [=====] - 0s 296us/step - loss: 0.5686
Epoch 10/400
160/160 [=====] - 0s 287us/step - loss: 0.5323
Epoch 11/400
160/160 [=====] - 0s 287us/step - loss: 0.4647
Epoch 12/400
160/160 [=====] - 0s 268us/step - loss: 0.4218
Epoch 13/400
160/160 [=====] - 0s 277us/step - loss: 0.3762
Epoch 14/400
160/160 [=====] - 0s 281us/step - loss: 0.3370
Epoch 15/400
160/160 [=====] - 0s 293us/step - loss: 0.3106
Epoch 16/400
160/160 [=====] - 0s 280us/step - loss: 0.2902
Epoch 17/400
160/160 [=====] - 0s 299us/step - loss: 0.2734
Epoch 18/400
160/160 [=====] - 0s 280us/step - loss: 0.2703
Epoch 19/400
160/160 [=====] - 0s 274us/step - loss: 0.2427
Epoch 20/400
160/160 [=====] - 0s 274us/step - loss: 0.2492
Epoch 21/400
160/160 [=====] - 0s 274us/step - loss: 0.2169
Epoch 22/400
160/160 [=====] - 0s 274us/step - loss: 0.2316
Epoch 23/400
160/160 [=====] - 0s 281us/step - loss: 0.2040
Epoch 24/400
160/160 [=====] - 0s 274us/step - loss: 0.2215
Epoch 25/400
160/160 [=====] - 0s 281us/step - loss: 0.1827
```

100/100 [=====] - 0s 201us/step - loss: 0.1021
Epoch 26/400
160/160 [=====] - 0s 280us/step - loss: 0.2023
Epoch 27/400
160/160 [=====] - 0s 281us/step - loss: 0.1963
Epoch 28/400
160/160 [=====] - 0s 274us/step - loss: 0.1686
Epoch 29/400
160/160 [=====] - 0s 274us/step - loss: 0.1544
Epoch 30/400
160/160 [=====] - 0s 281us/step - loss: 0.1761
Epoch 31/400
160/160 [=====] - 0s 268us/step - loss: 0.1427
Epoch 32/400
160/160 [=====] - 0s 268us/step - loss: 0.1511
Epoch 33/400
160/160 [=====] - 0s 277us/step - loss: 0.1493
Epoch 34/400
160/160 [=====] - 0s 274us/step - loss: 0.1495
Epoch 35/400
160/160 [=====] - 0s 284us/step - loss: 0.1411
Epoch 36/400
160/160 [=====] - 0s 281us/step - loss: 0.1530
Epoch 37/400
160/160 [=====] - 0s 287us/step - loss: 0.1536
Epoch 38/400
160/160 [=====] - 0s 293us/step - loss: 0.1306
Epoch 39/400
160/160 [=====] - 0s 274us/step - loss: 0.1216
Epoch 40/400
160/160 [=====] - 0s 281us/step - loss: 0.1358
Epoch 41/400
160/160 [=====] - 0s 281us/step - loss: 0.1366
Epoch 42/400
160/160 [=====] - 0s 274us/step - loss: 0.1327
Epoch 43/400
160/160 [=====] - 0s 274us/step - loss: 0.1268
Epoch 44/400
160/160 [=====] - 0s 280us/step - loss: 0.1172
Epoch 45/400
160/160 [=====] - 0s 287us/step - loss: 0.1253
Epoch 46/400
160/160 [=====] - 0s 284us/step - loss: 0.1203
Epoch 47/400
160/160 [=====] - 0s 274us/step - loss: 0.1108
Epoch 48/400
160/160 [=====] - 0s 265us/step - loss: 0.1056
Epoch 49/400
160/160 [=====] - 0s 268us/step - loss: 0.1023
Epoch 50/400
160/160 [=====] - 0s 274us/step - loss: 0.1188
Epoch 51/400
160/160 [=====] - 0s 284us/step - loss: 0.1199
Epoch 52/400
160/160 [=====] - 0s 274us/step - loss: 0.1107
Epoch 53/400
160/160 [=====] - 0s 265us/step - loss: 0.1275
Epoch 54/400
160/160 [=====] - 0s 274us/step - loss: 0.1140
Epoch 55/400
160/160 [=====] - 0s 281us/step - loss: 0.0935
Epoch 56/400
160/160 [=====] - 0s 280us/step - loss: 0.1192
Epoch 57/400
160/160 [=====] - 0s 274us/step - loss: 0.1307
Epoch 58/400
160/160 [=====] - 0s 280us/step - loss: 0.1215
Epoch 59/400
160/160 [=====] - 0s 293us/step - loss: 0.0961
Epoch 60/400
160/160 [=====] - 0s 287us/step - loss: 0.0815
Epoch 61/400
160/160 [=====] - 0s 274us/step - loss: 0.1188
Epoch 62/400
160/160 [=====] - 0s 281us/step - loss: 0.0881
Epoch 63/400
160/160 [=====] - 0s 274us/step - loss: 0.0803
Epoch 64/400

Epoch 64/400
160/160 [=====] - 0s 281us/step - loss: 0.1004
Epoch 65/400
160/160 [=====] - 0s 274us/step - loss: 0.1608
Epoch 66/400
160/160 [=====] - 0s 274us/step - loss: 0.1142
Epoch 67/400
160/160 [=====] - 0s 274us/step - loss: 0.0787
Epoch 68/400
160/160 [=====] - 0s 280us/step - loss: 0.0667
Epoch 69/400
160/160 [=====] - 0s 268us/step - loss: 0.0710
Epoch 70/400
160/160 [=====] - 0s 268us/step - loss: 0.0952
Epoch 71/400
160/160 [=====] - 0s 271us/step - loss: 0.0704
Epoch 72/400
160/160 [=====] - 0s 287us/step - loss: 0.0786
Epoch 73/400
160/160 [=====] - 0s 271us/step - loss: 0.1015
Epoch 74/400
160/160 [=====] - 0s 268us/step - loss: 0.0785
Epoch 75/400
160/160 [=====] - 0s 280us/step - loss: 0.0744
Epoch 76/400
160/160 [=====] - 0s 268us/step - loss: 0.0625
Epoch 77/400
160/160 [=====] - 0s 274us/step - loss: 0.0899
Epoch 78/400
160/160 [=====] - 0s 274us/step - loss: 0.1041
Epoch 79/400
160/160 [=====] - 0s 268us/step - loss: 0.0858
Epoch 80/400
160/160 [=====] - 0s 274us/step - loss: 0.0919
Epoch 81/400
160/160 [=====] - 0s 280us/step - loss: 0.0879
Epoch 82/400
160/160 [=====] - 0s 281us/step - loss: 0.0935
Epoch 83/400
160/160 [=====] - 0s 281us/step - loss: 0.0795
Epoch 84/400
160/160 [=====] - 0s 287us/step - loss: 0.0928
Epoch 85/400
160/160 [=====] - 0s 268us/step - loss: 0.0796
Epoch 86/400
160/160 [=====] - 0s 287us/step - loss: 0.0970
Epoch 87/400
160/160 [=====] - 0s 277us/step - loss: 0.0687
Epoch 88/400
160/160 [=====] - 0s 274us/step - loss: 0.0803
Epoch 89/400
160/160 [=====] - 0s 271us/step - loss: 0.1054
Epoch 90/400
160/160 [=====] - 0s 274us/step - loss: 0.0783
Epoch 91/400
160/160 [=====] - 0s 287us/step - loss: 0.0779
Epoch 92/400
160/160 [=====] - 0s 281us/step - loss: 0.0745
Epoch 93/400
160/160 [=====] - 0s 280us/step - loss: 0.0985
Epoch 94/400
160/160 [=====] - 0s 274us/step - loss: 0.1047
Epoch 95/400
160/160 [=====] - 0s 274us/step - loss: 0.0409
Epoch 96/400
160/160 [=====] - 0s 268us/step - loss: 0.0639
Epoch 97/400
160/160 [=====] - 0s 274us/step - loss: 0.0790
Epoch 98/400
160/160 [=====] - 0s 274us/step - loss: 0.0875
Epoch 99/400
160/160 [=====] - 0s 274us/step - loss: 0.0584
Epoch 100/400
160/160 [=====] - 0s 274us/step - loss: 0.0425
Epoch 101/400
160/160 [=====] - 0s 268us/step - loss: 0.0758
Epoch 102/400
160/160 [=====] - 0s 274us/step - loss: 0.1007

100/100 [=====] - 0s 274us/step - loss: 0.1000
Epoch 103/400
160/160 [=====] - 0s 274us/step - loss: 0.0476
Epoch 104/400
160/160 [=====] - 0s 293us/step - loss: 0.0797
Epoch 105/400
160/160 [=====] - 0s 287us/step - loss: 0.0707
Epoch 106/400
160/160 [=====] - 0s 281us/step - loss: 0.0410
Epoch 107/400
160/160 [=====] - 0s 280us/step - loss: 0.0825
Epoch 108/400
160/160 [=====] - 0s 274us/step - loss: 0.0871
Epoch 109/400
160/160 [=====] - 0s 271us/step - loss: 0.0615
Epoch 110/400
160/160 [=====] - 0s 280us/step - loss: 0.0594
Epoch 111/400
160/160 [=====] - 0s 284us/step - loss: 0.0582
Epoch 112/400
160/160 [=====] - 0s 268us/step - loss: 0.0516
Epoch 113/400
160/160 [=====] - 0s 274us/step - loss: 0.0509
Epoch 114/400
160/160 [=====] - 0s 274us/step - loss: 0.0688
Epoch 115/400
160/160 [=====] - 0s 274us/step - loss: 0.0573
Epoch 116/400
160/160 [=====] - 0s 274us/step - loss: 0.0858
Epoch 117/400
160/160 [=====] - 0s 274us/step - loss: 0.0690
Epoch 118/400
160/160 [=====] - 0s 274us/step - loss: 0.0641
Epoch 119/400
160/160 [=====] - 0s 274us/step - loss: 0.0536
Epoch 120/400
160/160 [=====] - 0s 268us/step - loss: 0.0692
Epoch 121/400
160/160 [=====] - 0s 274us/step - loss: 0.0694
Epoch 122/400
160/160 [=====] - 0s 274us/step - loss: 0.0699
Epoch 123/400
160/160 [=====] - 0s 277us/step - loss: 0.0492
Epoch 124/400
160/160 [=====] - 0s 280us/step - loss: 0.0672
Epoch 125/400
160/160 [=====] - 0s 277us/step - loss: 0.0536
Epoch 126/400
160/160 [=====] - 0s 293us/step - loss: 0.0663
Epoch 127/400
160/160 [=====] - 0s 284us/step - loss: 0.0534
Epoch 128/400
160/160 [=====] - 0s 287us/step - loss: 0.0371
Epoch 129/400
160/160 [=====] - 0s 271us/step - loss: 0.0498
Epoch 130/400
160/160 [=====] - 0s 280us/step - loss: 0.0433
Epoch 131/400
160/160 [=====] - 0s 281us/step - loss: 0.0567
Epoch 132/400
160/160 [=====] - 0s 274us/step - loss: 0.0497
Epoch 133/400
160/160 [=====] - 0s 274us/step - loss: 0.0624
Epoch 134/400
160/160 [=====] - 0s 274us/step - loss: 0.0606
Epoch 135/400
160/160 [=====] - 0s 274us/step - loss: 0.0683
Epoch 136/400
160/160 [=====] - 0s 274us/step - loss: 0.0575
Epoch 137/400
160/160 [=====] - 0s 274us/step - loss: 0.0478
Epoch 138/400
160/160 [=====] - 0s 280us/step - loss: 0.0549
Epoch 139/400
160/160 [=====] - 0s 280us/step - loss: 0.0711
Epoch 140/400
160/160 [=====] - 0s 268us/step - loss: 0.0571

Epoch 141/400
160/160 [=====] - 0s 274us/step - loss: 0.0546
Epoch 142/400
160/160 [=====] - 0s 274us/step - loss: 0.0461
Epoch 143/400
160/160 [=====] - 0s 274us/step - loss: 0.0629
Epoch 144/400
160/160 [=====] - 0s 280us/step - loss: 0.0429
Epoch 145/400
160/160 [=====] - 0s 274us/step - loss: 0.0406
Epoch 146/400
160/160 [=====] - 0s 281us/step - loss: 0.0733
Epoch 147/400
160/160 [=====] - 0s 280us/step - loss: 0.0342
Epoch 148/400
160/160 [=====] - 0s 305us/step - loss: 0.0214
Epoch 149/400
160/160 [=====] - 0s 312us/step - loss: 0.0437
Epoch 150/400
160/160 [=====] - 0s 305us/step - loss: 0.0465
Epoch 151/400
160/160 [=====] - 0s 312us/step - loss: 0.0641
Epoch 152/400
160/160 [=====] - 0s 287us/step - loss: 0.0524
Epoch 153/400
160/160 [=====] - 0s 305us/step - loss: 0.0386
Epoch 154/400
160/160 [=====] - 0s 293us/step - loss: 0.0997
Epoch 155/400
160/160 [=====] - 0s 281us/step - loss: 0.0580
Epoch 156/400
160/160 [=====] - 0s 281us/step - loss: 0.0497
Epoch 157/400
160/160 [=====] - 0s 287us/step - loss: 0.0531
Epoch 158/400
160/160 [=====] - 0s 271us/step - loss: 0.0471
Epoch 159/400
160/160 [=====] - 0s 274us/step - loss: 0.0479
Epoch 160/400
160/160 [=====] - 0s 277us/step - loss: 0.0818
Epoch 161/400
160/160 [=====] - 0s 287us/step - loss: 0.0645
Epoch 162/400
160/160 [=====] - 0s 271us/step - loss: 0.0384
Epoch 163/400
160/160 [=====] - 0s 280us/step - loss: 0.0319
Epoch 164/400
160/160 [=====] - 0s 290us/step - loss: 0.0576
Epoch 165/400
160/160 [=====] - 0s 287us/step - loss: 0.0425
Epoch 166/400
160/160 [=====] - 0s 281us/step - loss: 0.0635
Epoch 167/400
160/160 [=====] - 0s 277us/step - loss: 0.0381
Epoch 168/400
160/160 [=====] - 0s 280us/step - loss: 0.0372
Epoch 169/400
160/160 [=====] - 0s 268us/step - loss: 0.0387
Epoch 170/400
160/160 [=====] - 0s 290us/step - loss: 0.0445
Epoch 171/400
160/160 [=====] - 0s 315us/step - loss: 0.0518
Epoch 172/400
160/160 [=====] - 0s 405us/step - loss: 0.0312
Epoch 173/400
160/160 [=====] - 0s 362us/step - loss: 0.0601
Epoch 174/400
160/160 [=====] - 0s 312us/step - loss: 0.0369
Epoch 175/400
160/160 [=====] - 0s 299us/step - loss: 0.0663
Epoch 176/400
160/160 [=====] - 0s 312us/step - loss: 0.0327
Epoch 177/400
160/160 [=====] - 0s 271us/step - loss: 0.0375
Epoch 178/400
160/160 [=====] - 0s 274us/step - loss: 0.0374
Epoch 179/400

160/160 [=====] - 0s 280us/step - loss: 0.0361
Epoch 180/400
160/160 [=====] - 0s 293us/step - loss: 0.0596
Epoch 181/400
160/160 [=====] - 0s 330us/step - loss: 0.0723
Epoch 182/400
160/160 [=====] - 0s 302us/step - loss: 0.0508
Epoch 183/400
160/160 [=====] - 0s 274us/step - loss: 0.0532
Epoch 184/400
160/160 [=====] - 0s 274us/step - loss: 0.0295
Epoch 185/400
160/160 [=====] - 0s 290us/step - loss: 0.0339
Epoch 186/400
160/160 [=====] - 0s 274us/step - loss: 0.0630
Epoch 187/400
160/160 [=====] - 0s 281us/step - loss: 0.0754
Epoch 188/400
160/160 [=====] - 0s 277us/step - loss: 0.0387
Epoch 189/400
160/160 [=====] - 0s 274us/step - loss: 0.0451
Epoch 190/400
160/160 [=====] - 0s 287us/step - loss: 0.0446
Epoch 191/400
160/160 [=====] - 0s 293us/step - loss: 0.0486
Epoch 192/400
160/160 [=====] - 0s 281us/step - loss: 0.0334
Epoch 193/400
160/160 [=====] - 0s 277us/step - loss: 0.0461
Epoch 194/400
160/160 [=====] - 0s 287us/step - loss: 0.0306
Epoch 195/400
160/160 [=====] - 0s 287us/step - loss: 0.0288
Epoch 196/400
160/160 [=====] - 0s 268us/step - loss: 0.0575
Epoch 197/400
160/160 [=====] - 0s 274us/step - loss: 0.0515
Epoch 198/400
160/160 [=====] - 0s 274us/step - loss: 0.0207
Epoch 199/400
160/160 [=====] - 0s 274us/step - loss: 0.0233
Epoch 200/400
160/160 [=====] - 0s 274us/step - loss: 0.0484
Epoch 201/400
160/160 [=====] - 0s 274us/step - loss: 0.0460
Epoch 202/400
160/160 [=====] - 0s 280us/step - loss: 0.0430
Epoch 203/400
160/160 [=====] - 0s 277us/step - loss: 0.0247
Epoch 204/400
160/160 [=====] - 0s 281us/step - loss: 0.0319
Epoch 205/400
160/160 [=====] - 0s 277us/step - loss: 0.0442
Epoch 206/400
160/160 [=====] - 0s 280us/step - loss: 0.0340
Epoch 207/400
160/160 [=====] - 0s 277us/step - loss: 0.0588
Epoch 208/400
160/160 [=====] - 0s 268us/step - loss: 0.0545
Epoch 209/400
160/160 [=====] - 0s 281us/step - loss: 0.0426
Epoch 210/400
160/160 [=====] - 0s 302us/step - loss: 0.0297
Epoch 211/400
160/160 [=====] - 0s 281us/step - loss: 0.0417
Epoch 212/400
160/160 [=====] - 0s 299us/step - loss: 0.0398
Epoch 213/400
160/160 [=====] - 0s 293us/step - loss: 0.0254
Epoch 214/400
160/160 [=====] - 0s 299us/step - loss: 0.0417
Epoch 215/400
160/160 [=====] - 0s 281us/step - loss: 0.0297
Epoch 216/400
160/160 [=====] - 0s 299us/step - loss: 0.0221
Epoch 217/400
160/160 [=====] - 0s 287us/step - loss: 0.0219
- 0s 287us/step - loss: 0.0219

Epoch 218/400
160/160 [=====] - 0s 274us/step - loss: 0.0395
Epoch 219/400
160/160 [=====] - 0s 293us/step - loss: 0.0288
Epoch 220/400
160/160 [=====] - 0s 280us/step - loss: 0.0290
Epoch 221/400
160/160 [=====] - 0s 293us/step - loss: 0.0115
Epoch 222/400
160/160 [=====] - 0s 274us/step - loss: 0.0258
Epoch 223/400
160/160 [=====] - 0s 287us/step - loss: 0.0517
Epoch 224/400
160/160 [=====] - 0s 281us/step - loss: 0.0268
Epoch 225/400
160/160 [=====] - 0s 281us/step - loss: 0.0191
Epoch 226/400
160/160 [=====] - 0s 280us/step - loss: 0.0304
Epoch 227/400
160/160 [=====] - 0s 287us/step - loss: 0.0304
Epoch 228/400
160/160 [=====] - 0s 274us/step - loss: 0.0197
Epoch 229/400
160/160 [=====] - 0s 281us/step - loss: 0.0239
Epoch 230/400
160/160 [=====] - 0s 274us/step - loss: 0.0303
Epoch 231/400
160/160 [=====] - 0s 268us/step - loss: 0.0447
Epoch 232/400
160/160 [=====] - 0s 293us/step - loss: 0.0253
Epoch 233/400
160/160 [=====] - 0s 281us/step - loss: 0.0259
Epoch 234/400
160/160 [=====] - 0s 299us/step - loss: 0.0142
Epoch 235/400
160/160 [=====] - 0s 312us/step - loss: 0.0802
Epoch 236/400
160/160 [=====] - 0s 312us/step - loss: 0.0545
Epoch 237/400
160/160 [=====] - 0s 281us/step - loss: 0.0784
Epoch 238/400
160/160 [=====] - 0s 277us/step - loss: 0.0164
Epoch 239/400
160/160 [=====] - 0s 274us/step - loss: 0.0354
Epoch 240/400
160/160 [=====] - 0s 284us/step - loss: 0.0343
Epoch 241/400
160/160 [=====] - 0s 268us/step - loss: 0.0316
Epoch 242/400
160/160 [=====] - 0s 277us/step - loss: 0.0389
Epoch 243/400
160/160 [=====] - 0s 274us/step - loss: 0.0236
Epoch 244/400
160/160 [=====] - 0s 268us/step - loss: 0.0391
Epoch 245/400
160/160 [=====] - 0s 277us/step - loss: 0.0371
Epoch 246/400
160/160 [=====] - 0s 274us/step - loss: 0.0465
Epoch 247/400
160/160 [=====] - 0s 274us/step - loss: 0.0189
Epoch 248/400
160/160 [=====] - 0s 281us/step - loss: 0.0375
Epoch 249/400
160/160 [=====] - 0s 274us/step - loss: 0.0294
Epoch 250/400
160/160 [=====] - 0s 274us/step - loss: 0.0238
Epoch 251/400
160/160 [=====] - 0s 268us/step - loss: 0.0259
Epoch 252/400
160/160 [=====] - 0s 280us/step - loss: 0.0155
Epoch 253/400
160/160 [=====] - 0s 287us/step - loss: 0.0225
Epoch 254/400
160/160 [=====] - 0s 274us/step - loss: 0.0162
Epoch 255/400
160/160 [=====] - 0s 268us/step - loss: 0.0137
Epoch 256/400

160/160 [=====] - 0s 274us/step - loss: 0.0145
Epoch 257/400
160/160 [=====] - 0s 287us/step - loss: 0.0190
Epoch 258/400
160/160 [=====] - 0s 293us/step - loss: 0.0139
Epoch 259/400
160/160 [=====] - 0s 274us/step - loss: 0.0159
Epoch 260/400
160/160 [=====] - 0s 287us/step - loss: 0.0158
Epoch 261/400
160/160 [=====] - 0s 274us/step - loss: 0.0467
Epoch 262/400
160/160 [=====] - 0s 293us/step - loss: 0.0228
Epoch 263/400
160/160 [=====] - 0s 274us/step - loss: 0.0449
Epoch 264/400
160/160 [=====] - 0s 274us/step - loss: 0.0679
Epoch 265/400
160/160 [=====] - 0s 287us/step - loss: 0.0296
Epoch 266/400
160/160 [=====] - 0s 281us/step - loss: 0.0306
Epoch 267/400
160/160 [=====] - 0s 268us/step - loss: 0.0558
Epoch 268/400
160/160 [=====] - 0s 274us/step - loss: 0.0399
Epoch 269/400
160/160 [=====] - 0s 268us/step - loss: 0.0396
Epoch 270/400
160/160 [=====] - 0s 274us/step - loss: 0.0459
Epoch 271/400
160/160 [=====] - 0s 280us/step - loss: 0.0104
Epoch 272/400
160/160 [=====] - 0s 274us/step - loss: 0.0104
Epoch 273/400
160/160 [=====] - 0s 274us/step - loss: 0.0116
Epoch 274/400
160/160 [=====] - 0s 271us/step - loss: 0.0109
Epoch 275/400
160/160 [=====] - 0s 274us/step - loss: 0.0096
Epoch 276/400
160/160 [=====] - 0s 277us/step - loss: 0.0115
Epoch 277/400
160/160 [=====] - 0s 287us/step - loss: 0.0098
Epoch 278/400
160/160 [=====] - 0s 277us/step - loss: 0.0138
Epoch 279/400
160/160 [=====] - 0s 287us/step - loss: 0.0079
Epoch 280/400
160/160 [=====] - 0s 287us/step - loss: 0.0061
Epoch 281/400
160/160 [=====] - 0s 296us/step - loss: 0.0064
Epoch 282/400
160/160 [=====] - 0s 293us/step - loss: 0.0058
Epoch 283/400
160/160 [=====] - 0s 296us/step - loss: 0.0055
Epoch 284/400
160/160 [=====] - 0s 274us/step - loss: 0.0054
Epoch 285/400
160/160 [=====] - 0s 274us/step - loss: 0.0061
Epoch 286/400
160/160 [=====] - 0s 281us/step - loss: 0.0051
Epoch 287/400
160/160 [=====] - 0s 274us/step - loss: 0.0053
Epoch 288/400
160/160 [=====] - 0s 287us/step - loss: 0.0051
Epoch 289/400
160/160 [=====] - 0s 268us/step - loss: 0.0051
Epoch 290/400
160/160 [=====] - 0s 262us/step - loss: 0.0047
Epoch 291/400
160/160 [=====] - 0s 287us/step - loss: 0.0046
Epoch 292/400
160/160 [=====] - 0s 280us/step - loss: 0.0045
Epoch 293/400
160/160 [=====] - 0s 293us/step - loss: 0.0043
Epoch 294/400
160/160 [=====] - 0s 337us/step - loss: 0.0043

Epoch 295/400
160/160 [=====] - 0s 318us/step - loss: 0.0040
Epoch 296/400
160/160 [=====] - 0s 280us/step - loss: 0.0041
Epoch 297/400
160/160 [=====] - 0s 287us/step - loss: 0.0040
Epoch 298/400
160/160 [=====] - 0s 268us/step - loss: 0.0039
Epoch 299/400
160/160 [=====] - 0s 274us/step - loss: 0.0038
Epoch 300/400
160/160 [=====] - 0s 281us/step - loss: 0.0038
Epoch 301/400
160/160 [=====] - 0s 305us/step - loss: 0.0036
Epoch 302/400
160/160 [=====] - 0s 296us/step - loss: 0.0036
Epoch 303/400
160/160 [=====] - 0s 287us/step - loss: 0.0035
Epoch 304/400
160/160 [=====] - 0s 280us/step - loss: 0.0036
Epoch 305/400
160/160 [=====] - 0s 274us/step - loss: 0.0035
Epoch 306/400
160/160 [=====] - 0s 274us/step - loss: 0.0033
Epoch 307/400
160/160 [=====] - 0s 287us/step - loss: 0.0033
Epoch 308/400
160/160 [=====] - 0s 281us/step - loss: 0.0033
Epoch 309/400
160/160 [=====] - 0s 287us/step - loss: 0.0031
Epoch 310/400
160/160 [=====] - 0s 274us/step - loss: 0.0031
Epoch 311/400
160/160 [=====] - 0s 281us/step - loss: 0.0031
Epoch 312/400
160/160 [=====] - 0s 268us/step - loss: 0.0030
Epoch 313/400
160/160 [=====] - 0s 280us/step - loss: 0.0030
Epoch 314/400
160/160 [=====] - 0s 287us/step - loss: 0.0030
Epoch 315/400
160/160 [=====] - 0s 280us/step - loss: 0.0030
Epoch 316/400
160/160 [=====] - 0s 277us/step - loss: 0.0029
Epoch 317/400
160/160 [=====] - 0s 268us/step - loss: 0.0029
Epoch 318/400
160/160 [=====] - 0s 277us/step - loss: 0.0028
Epoch 319/400
160/160 [=====] - 0s 274us/step - loss: 0.0028
Epoch 320/400
160/160 [=====] - 0s 274us/step - loss: 0.0028
Epoch 321/400
160/160 [=====] - 0s 274us/step - loss: 0.0027
Epoch 322/400
160/160 [=====] - 0s 293us/step - loss: 0.0027
Epoch 323/400
160/160 [=====] - 0s 305us/step - loss: 0.0026
Epoch 324/400
160/160 [=====] - 0s 274us/step - loss: 0.0026
Epoch 325/400
160/160 [=====] - 0s 287us/step - loss: 0.0026
Epoch 326/400
160/160 [=====] - 0s 281us/step - loss: 0.0026
Epoch 327/400
160/160 [=====] - 0s 274us/step - loss: 0.0025
Epoch 328/400
160/160 [=====] - 0s 281us/step - loss: 0.0025
Epoch 329/400
160/160 [=====] - 0s 287us/step - loss: 0.0025
Epoch 330/400
160/160 [=====] - 0s 274us/step - loss: 0.0025
Epoch 331/400
160/160 [=====] - 0s 274us/step - loss: 0.0024
Epoch 332/400
160/160 [=====] - 0s 268us/step - loss: 0.0024
Epoch 333/400

160/160 [=====] - 0s 274us/step - loss: 0.0024
Epoch 334/400
160/160 [=====] - 0s 274us/step - loss: 0.0023
Epoch 335/400
160/160 [=====] - 0s 287us/step - loss: 0.0023
Epoch 336/400
160/160 [=====] - 0s 281us/step - loss: 0.0023
Epoch 337/400
160/160 [=====] - 0s 274us/step - loss: 0.0023
Epoch 338/400
160/160 [=====] - 0s 274us/step - loss: 0.0023
Epoch 339/400
160/160 [=====] - 0s 274us/step - loss: 0.0022
Epoch 340/400
160/160 [=====] - 0s 268us/step - loss: 0.0022
Epoch 341/400
160/160 [=====] - 0s 281us/step - loss: 0.0022
Epoch 342/400
160/160 [=====] - 0s 293us/step - loss: 0.0022
Epoch 343/400
160/160 [=====] - 0s 287us/step - loss: 0.0021
Epoch 344/400
160/160 [=====] - 0s 287us/step - loss: 0.0021
Epoch 345/400
160/160 [=====] - 0s 287us/step - loss: 0.0021
Epoch 346/400
160/160 [=====] - 0s 274us/step - loss: 0.0021
Epoch 347/400
160/160 [=====] - 0s 268us/step - loss: 0.0021
Epoch 348/400
160/160 [=====] - 0s 287us/step - loss: 0.0021
Epoch 349/400
160/160 [=====] - 0s 277us/step - loss: 0.0020
Epoch 350/400
160/160 [=====] - 0s 287us/step - loss: 0.0020
Epoch 351/400
160/160 [=====] - 0s 271us/step - loss: 0.0020
Epoch 352/400
160/160 [=====] - 0s 274us/step - loss: 0.0020
Epoch 353/400
160/160 [=====] - 0s 281us/step - loss: 0.0020
Epoch 354/400
160/160 [=====] - 0s 280us/step - loss: 0.0020
Epoch 355/400
160/160 [=====] - 0s 281us/step - loss: 0.0019
Epoch 356/400
160/160 [=====] - 0s 280us/step - loss: 0.0019
Epoch 357/400
160/160 [=====] - 0s 280us/step - loss: 0.0019
Epoch 358/400
160/160 [=====] - 0s 281us/step - loss: 0.0019
Epoch 359/400
160/160 [=====] - 0s 280us/step - loss: 0.0019
Epoch 360/400
160/160 [=====] - 0s 274us/step - loss: 0.0019
Epoch 361/400
160/160 [=====] - 0s 281us/step - loss: 0.0019
Epoch 362/400
160/160 [=====] - 0s 281us/step - loss: 0.0019
Epoch 363/400
160/160 [=====] - 0s 287us/step - loss: 0.0018
Epoch 364/400
160/160 [=====] - 0s 299us/step - loss: 0.0018
Epoch 365/400
160/160 [=====] - 0s 287us/step - loss: 0.0018
Epoch 366/400
160/160 [=====] - 0s 287us/step - loss: 0.0018
Epoch 367/400
160/160 [=====] - 0s 293us/step - loss: 0.0018
Epoch 368/400
160/160 [=====] - 0s 287us/step - loss: 0.0018
Epoch 369/400
160/160 [=====] - 0s 287us/step - loss: 0.0018
Epoch 370/400
160/160 [=====] - 0s 287us/step - loss: 0.0017
Epoch 371/400
160/160 [=====] - 0s 268us/step - loss: 0.0017

Epoch 372/400
160/160 [=====] - 0s 268us/step - loss: 0.0017
Epoch 373/400
160/160 [=====] - 0s 274us/step - loss: 0.0017
Epoch 374/400
160/160 [=====] - 0s 268us/step - loss: 0.0017
Epoch 375/400
160/160 [=====] - 0s 274us/step - loss: 0.0017
Epoch 376/400
160/160 [=====] - 0s 281us/step - loss: 0.0017
Epoch 377/400
160/160 [=====] - 0s 274us/step - loss: 0.0017
Epoch 378/400
160/160 [=====] - 0s 274us/step - loss: 0.0017
Epoch 379/400
160/160 [=====] - 0s 281us/step - loss: 0.0016
Epoch 380/400
160/160 [=====] - 0s 287us/step - loss: 0.0016
Epoch 381/400
160/160 [=====] - 0s 312us/step - loss: 0.0016
Epoch 382/400
160/160 [=====] - 0s 299us/step - loss: 0.0016
Epoch 383/400
160/160 [=====] - 0s 280us/step - loss: 0.0016
Epoch 384/400
160/160 [=====] - 0s 330us/step - loss: 0.0016
Epoch 385/400
160/160 [=====] - 0s 299us/step - loss: 0.0016
Epoch 386/400
160/160 [=====] - 0s 330us/step - loss: 0.0016
Epoch 387/400
160/160 [=====] - 0s 281us/step - loss: 0.0016
Epoch 388/400
160/160 [=====] - 0s 293us/step - loss: 0.0016
Epoch 389/400
160/160 [=====] - 0s 290us/step - loss: 0.0015
Epoch 390/400
160/160 [=====] - 0s 287us/step - loss: 0.0015
Epoch 391/400
160/160 [=====] - 0s 287us/step - loss: 0.0015
Epoch 392/400
160/160 [=====] - 0s 281us/step - loss: 0.0015
Epoch 393/400
160/160 [=====] - 0s 274us/step - loss: 0.0015
Epoch 394/400
160/160 [=====] - 0s 287us/step - loss: 0.0015
Epoch 395/400
160/160 [=====] - 0s 305us/step - loss: 0.0015
Epoch 396/400
160/160 [=====] - 0s 296us/step - loss: 0.0015
Epoch 397/400
160/160 [=====] - 0s 330us/step - loss: 0.0015
Epoch 398/400
160/160 [=====] - 0s 315us/step - loss: 0.0015
Epoch 399/400
160/160 [=====] - 0s 274us/step - loss: 0.0015
Epoch 400/400
160/160 [=====] - 0s 287us/step - loss: 0.0014
[9.9914896e-01 9.9917561e-01 9.9915957e-01 9.9918407e-01 9.9917322e-01
9.9912149e-01 9.9916434e-01 9.9917787e-01 9.9917114e-01 9.9881375e-01
9.9912876e-01 9.9917358e-01 9.9917221e-01 9.9910033e-01 9.9917620e-01
9.9917763e-01 9.9917334e-01 9.9916470e-01 9.9916995e-01 9.9916947e-01
9.9917656e-01 9.9917346e-01 9.9019605e-01 9.9916255e-01 9.9765825e-01
9.9916756e-01 9.9917799e-01 9.9912733e-01 9.9283159e-01 9.9915075e-01
9.9917501e-01 9.9916756e-01 9.9918324e-01 9.9917442e-01 9.9700934e-01
9.9917078e-01 9.9916887e-01 9.9911004e-01 9.9917054e-01 9.9916947e-01
9.9920696e-01 9.9922514e-01 9.9922287e-01 9.9921584e-01 9.9922597e-01
9.9899513e-01 9.9921179e-01 9.9921358e-01 9.9920851e-01 9.9901938e-01
9.9905890e-01 9.9922264e-01 9.9922228e-01 9.9918944e-01 9.9922431e-01
9.9922359e-01 9.9922717e-01 9.9921501e-01 9.9919587e-01 9.9919313e-01
9.9922407e-01 9.9922705e-01 9.9077529e-01 9.9921978e-01 9.9891019e-01
9.9919385e-01 9.9922121e-01 9.9919587e-01 9.8510551e-01 9.9919969e-01
9.9922645e-01 9.9922657e-01 9.9921942e-01 9.9922693e-01 9.9874181e-01
9.9922252e-01 9.9913931e-01 9.9920923e-01 9.9922514e-01 9.9921751e-01
9.5560722e-04 9.2284998e-04 9.2567899e-04 9.2795724e-04 9.2306588e-04
1.0044982e-03 9.2765409e-04 9.3357486e-04 9.2366495e-04 1.0640332e-03
9.8545698e-04 9.2529319e-04 9.2628336e-04 9.5803890e-04 9.2306547e-04

```

9.2296209e-04 9.2269032e-04 9.3997968e-04 9.2517282e-04 9.2611916e-04
9.2304911e-04 9.2272286e-04 8.1425011e-03 9.2651637e-04 1.6697786e-03
9.2858437e-04 9.2508254e-04 9.6114521e-04 8.6373528e-03 9.7122439e-04
9.2260243e-04 9.2387444e-04 9.2462427e-04 9.2250580e-04 2.6320259e-03
9.2651637e-04 9.4126438e-04 9.2805806e-04 9.2305348e-04 9.2359900e-04
9.4614405e-04 9.1778208e-04 9.1315131e-04 9.2935486e-04 9.1641548e-04
1.0019639e-03 9.1603823e-04 9.3424617e-04 9.1135810e-04 1.2562890e-03
9.9016773e-04 9.1883639e-04 9.1914198e-04 9.4092003e-04 9.1832009e-04
9.1918057e-04 9.1586640e-04 9.3270134e-04 9.1035222e-04 9.1110589e-04
9.1852649e-04 9.1607409e-04 1.2200400e-02 9.1524480e-04 1.4057917e-03
9.1504736e-04 9.2100305e-04 9.6605084e-04 1.2919573e-02 9.7245548e-04
9.1718498e-04 9.1364299e-04 9.2359056e-04 9.1628713e-04 1.8440711e-03
9.1859174e-04 9.2392589e-04 9.1853621e-04 9.1326697e-04 9.1180624e-04]
160/160 [=====] - 0s 695us/step

```

In [48]:

```
#Five layers, four neurons per layer: loss
scores_lay_five_four, model_lay_five_four.metrics_names
```

Out[48]:

```
(0.0014098705491051079, ['loss'])
```

Figure of Loss

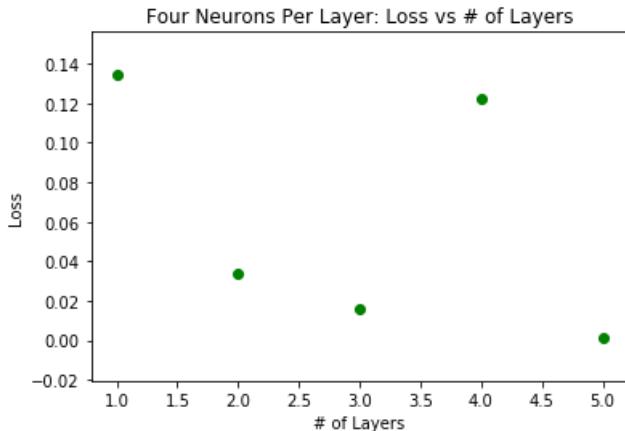
In [49]:

```
#figure of loss vs # of Layers
x_4 = [1,2,3,4,5]
y_4 = [scores_lay_one_four, scores_lay_two_four, scores_lay_three_four, scores_lay_four_four, scores_lay_five_four]

plt.scatter(x_4,y_4, c='g');
plt.title('Four Neurons Per Layer: Loss vs # of Layers')
plt.xlabel('# of Layers')
plt.ylabel('Loss')
```

Out[49]:

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



Part 1 Question 2: Observations

In [50]:

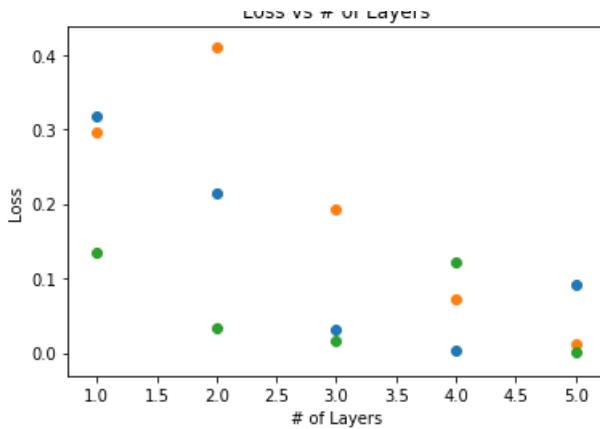
```
#Summary plot of Layer/Neuron Modulation

plt.scatter(x_2,y_2)
plt.scatter(x_3,y_3)
plt.scatter(x_4,y_4)
plt.title('Loss vs # of Layers')
plt.xlabel('# of Layers')
plt.ylabel('Loss')
```

Out[50]:

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

Loss vs # of Layers



Observations: Collectively speaking, the more layers and neurons the lower the loss.

Selection: 5 layers, 4 neurons in each layer.

Part 1 Question 3: compare Activators tanh, sigmoid, softplus, relu

Activation Tanh:

In [51]:

```
n = 40
xx = np.random.random((n,1))
yy = np.random.random((n,1))

X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [52]:

```
#Five layers, four neurons per layer
optimal_tanh = Sequential()

#hidden layers
optimal_tanh.add(Dense(4, input_dim=2, activation='tanh'))
optimal_tanh.add(Dense(4, activation='tanh'))
optimal_tanh.add(Dense(4, activation='tanh'))
optimal_tanh.add(Dense(4, activation='tanh'))
optimal_tanh.add(Dense(4, activation='tanh'))

#output layer
optimal_tanh.add(Dense(1, activation='tanh'))

sgd = SGD(lr=0.1)
optimal_tanh.compile(loss='binary_crossentropy', optimizer='sgd')

optimal_tanh.fit(X, y, batch_size=2, epochs=400)
print(optimal_tanh.predict_proba(X).reshape(4*n))

#evaluate the model
scores_optimal_tanh = optimal_tanh.evaluate(X, y)
```

```
Epoch 1/400
160/160 [=====] - 0s 3ms/step - loss: 8.0700
Epoch 2/400
160/160 [=====] - 0s 309us/step - loss: 8.0590
Epoch 3/400
160/160 [=====] - 0s 299us/step - loss: 8.0590
Epoch 4/400
160/160 [=====] - 0s 290us/step - loss: 8.0590
Epoch 5/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 6/400
160/160 [=====] - 0s 299us/step - loss: 8.0590
Epoch 7/400
160/160 [=====] - 0s 302us/step - loss: 8.0590
Epoch 8/400
```

```
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 9/400
160/160 [=====] - 0s 296us/step - loss: 8.0590
Epoch 10/400
160/160 [=====] - 0s 305us/step - loss: 8.0590
Epoch 11/400
160/160 [=====] - 0s 296us/step - loss: 8.0590
Epoch 12/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 13/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 14/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 15/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 16/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 17/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 18/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 19/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 20/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 21/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 22/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 23/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 24/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 25/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 26/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 27/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 28/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 29/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 30/400
160/160 [=====] - 0s 305us/step - loss: 8.0590
Epoch 31/400
160/160 [=====] - 0s 290us/step - loss: 8.0590
Epoch 32/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 33/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 34/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 35/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 36/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 37/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 38/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 39/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 40/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 41/400
160/160 [=====] - 0s 290us/step - loss: 8.0590
Epoch 42/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 43/400
160/160 [=====] - 0s 290us/step - loss: 8.0590
Epoch 44/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 45/400
160/160 [=====] - 0s 296us/step - loss: 8.0590
Epoch 46/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
```

```
Epoch 47/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 48/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 49/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 50/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 51/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 52/400
160/160 [=====] - 0s 299us/step - loss: 8.0590
Epoch 53/400
160/160 [=====] - 0s 299us/step - loss: 8.0590
Epoch 54/400
160/160 [=====] - 0s 343us/step - loss: 8.0590
Epoch 55/400
160/160 [=====] - 0s 299us/step - loss: 8.0590
Epoch 56/400
160/160 [=====] - 0s 299us/step - loss: 8.0590
Epoch 57/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 58/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 59/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 60/400
160/160 [=====] - 0s 268us/step - loss: 8.0590
Epoch 61/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 62/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 63/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 64/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 65/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 66/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 67/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 68/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 69/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 70/400
160/160 [=====] - 0s 268us/step - loss: 8.0590
Epoch 71/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 72/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 73/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 74/400
160/160 [=====] - 0s 302us/step - loss: 8.0590
Epoch 75/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 76/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 77/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 78/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 79/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 80/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 81/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 82/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 83/400
160/160 [=====] - 0s 268us/step - loss: 8.0590
Epoch 84/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 85/400
```

Epoch 85/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 86/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 87/400
160/160 [=====] - 0s 290us/step - loss: 8.0590
Epoch 88/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 89/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 90/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 91/400
160/160 [=====] - 0s 312us/step - loss: 8.0590
Epoch 92/400
160/160 [=====] - 0s 318us/step - loss: 8.0590
Epoch 93/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 94/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 95/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 96/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 97/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 98/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 99/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 100/400
160/160 [=====] - 0s 277us/step - loss: 8.0590
Epoch 101/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 102/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 103/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 104/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 105/400
160/160 [=====] - 0s 277us/step - loss: 8.0590
Epoch 106/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 107/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 108/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 109/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 110/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 111/400
160/160 [=====] - 0s 284us/step - loss: 8.0590
Epoch 112/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 113/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 114/400
160/160 [=====] - 0s 284us/step - loss: 8.0590
Epoch 115/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 116/400
160/160 [=====] - 0s 277us/step - loss: 8.0590
Epoch 117/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 118/400
160/160 [=====] - 0s 290us/step - loss: 8.0590
Epoch 119/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 120/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 121/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 122/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 123/400
160/160 [=====] - 0s 281us/step - loss: 8.0590

100% | Epoch 124/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 125/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 126/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 127/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 128/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 129/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 130/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 131/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 132/400
160/160 [=====] - 0s 268us/step - loss: 8.0590
Epoch 133/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 134/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 135/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 136/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 137/400
160/160 [=====] - 0s 268us/step - loss: 8.0590
Epoch 138/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 139/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 140/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 141/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 142/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 143/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 144/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 145/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 146/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 147/400
160/160 [=====] - 0s 284us/step - loss: 8.0590
Epoch 148/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 149/400
160/160 [=====] - 0s 271us/step - loss: 8.0590
Epoch 150/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 151/400
160/160 [=====] - 0s 290us/step - loss: 8.0590
Epoch 152/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 153/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 154/400
160/160 [=====] - 0s 277us/step - loss: 8.0590
Epoch 155/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 156/400
160/160 [=====] - 0s 271us/step - loss: 8.0590
Epoch 157/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 158/400
160/160 [=====] - 0s 299us/step - loss: 8.0590
Epoch 159/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 160/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 161/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 162/400

Epoch 162/400
160/160 [=====] - 0s 299us/step - loss: 8.0590
Epoch 163/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 164/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 165/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 166/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 167/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 168/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 169/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 170/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 171/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 172/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 173/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 174/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 175/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 176/400
160/160 [=====] - 0s 277us/step - loss: 8.0590
Epoch 177/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 178/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 179/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 180/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 181/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 182/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 183/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 184/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 185/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 186/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 187/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 188/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 189/400
160/160 [=====] - 0s 310us/step - loss: 8.0590
Epoch 190/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 191/400
160/160 [=====] - 0s 327us/step - loss: 8.0590
Epoch 192/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 193/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 194/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 195/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 196/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 197/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 198/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 199/400
160/160 [=====] - 0s 377us/step - loss: 8.0590
Epoch 200/400
160/160 [=====] - 0s 374us/step - loss: 8.0590

100/100 [=====] - 0s 314us/step - loss: 8.0590
Epoch 201/400
160/160 [=====] - 0s 312us/step - loss: 8.0590
Epoch 202/400
160/160 [=====] - 0s 299us/step - loss: 8.0590
Epoch 203/400
160/160 [=====] - 0s 318us/step - loss: 8.0590
Epoch 204/400
160/160 [=====] - 0s 299us/step - loss: 8.0590
Epoch 205/400
160/160 [=====] - 0s 299us/step - loss: 8.0590
Epoch 206/400
160/160 [=====] - 0s 334us/step - loss: 8.0590
Epoch 207/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 208/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 209/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 210/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 211/400
160/160 [=====] - 0s 299us/step - loss: 8.0590
Epoch 212/400
160/160 [=====] - 0s 296us/step - loss: 8.0590
Epoch 213/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 214/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 215/400
160/160 [=====] - 0s 296us/step - loss: 8.0590
Epoch 216/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 217/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 218/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 219/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 220/400
160/160 [=====] - 0s 299us/step - loss: 8.0590
Epoch 221/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 222/400
160/160 [=====] - 0s 268us/step - loss: 8.0590
Epoch 223/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 224/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 225/400
160/160 [=====] - 0s 302us/step - loss: 8.0590
Epoch 226/400
160/160 [=====] - 0s 349us/step - loss: 8.0590
Epoch 227/400
160/160 [=====] - 0s 321us/step - loss: 8.0590
Epoch 228/400
160/160 [=====] - 0s 299us/step - loss: 8.0590
Epoch 229/400
160/160 [=====] - 0s 290us/step - loss: 8.0590
Epoch 230/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 231/400
160/160 [=====] - 0s 284us/step - loss: 8.0590
Epoch 232/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 233/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 234/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 235/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 236/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 237/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 238/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 239/400

Epoch 259/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 240/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 241/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 242/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 243/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 244/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 245/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 246/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 247/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 248/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 249/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 250/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 251/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 252/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 253/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 254/400
160/160 [=====] - 0s 268us/step - loss: 8.0590
Epoch 255/400
160/160 [=====] - 0s 268us/step - loss: 8.0590
Epoch 256/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 257/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 258/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 259/400
160/160 [=====] - 0s 284us/step - loss: 8.0590
Epoch 260/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 261/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 262/400
160/160 [=====] - 0s 277us/step - loss: 8.0590
Epoch 263/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 264/400
160/160 [=====] - 0s 277us/step - loss: 8.0590
Epoch 265/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 266/400
160/160 [=====] - 0s 284us/step - loss: 8.0590
Epoch 267/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 268/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 269/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 270/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 271/400
160/160 [=====] - 0s 305us/step - loss: 8.0590
Epoch 272/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 273/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 274/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 275/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 276/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 277/400

160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 278/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 279/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 280/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 281/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 282/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 283/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 284/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 285/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 286/400
160/160 [=====] - 0s 277us/step - loss: 8.0590
Epoch 287/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 288/400
160/160 [=====] - 0s 277us/step - loss: 8.0590
Epoch 289/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 290/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 291/400
160/160 [=====] - 0s 284us/step - loss: 8.0590
Epoch 292/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 293/400
160/160 [=====] - 0s 299us/step - loss: 8.0590
Epoch 294/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 295/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 296/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 297/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 298/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 299/400
160/160 [=====] - 0s 268us/step - loss: 8.0590
Epoch 300/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 301/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 302/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 303/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 304/400
160/160 [=====] - 0s 277us/step - loss: 8.0590
Epoch 305/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 306/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 307/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 308/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 309/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 310/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 311/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 312/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 313/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 314/400
160/160 [=====] - 0s 299us/step - loss: 8.0590
Epoch 315/400
160/160 [=====] - 0s 293us/step - loss: 8.0590

Epoch 316/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 317/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 318/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 319/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 320/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 321/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 322/400
160/160 [=====] - 0s 271us/step - loss: 8.0590
Epoch 323/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 324/400
160/160 [=====] - 0s 284us/step - loss: 8.0590
Epoch 325/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 326/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 327/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 328/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 329/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 330/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 331/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 332/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 333/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 334/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 335/400
160/160 [=====] - 0s 290us/step - loss: 8.0590
Epoch 336/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 337/400
160/160 [=====] - 0s 284us/step - loss: 8.0590
Epoch 338/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 339/400
160/160 [=====] - 0s 277us/step - loss: 8.0590
Epoch 340/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 341/400
160/160 [=====] - 0s 277us/step - loss: 8.0590
Epoch 342/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 343/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 344/400
160/160 [=====] - 0s 268us/step - loss: 8.0590
Epoch 345/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 346/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 347/400
160/160 [=====] - 0s 268us/step - loss: 8.0590
Epoch 348/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 349/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 350/400
160/160 [=====] - 0s 268us/step - loss: 8.0590
Epoch 351/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 352/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 353/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 354/400
160/160 [=====] - 0s 274us/step - loss: 8.0590

160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 355/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 356/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 357/400
160/160 [=====] - 0s 312us/step - loss: 8.0590
Epoch 358/400
160/160 [=====] - 0s 324us/step - loss: 8.0590
Epoch 359/400
160/160 [=====] - 0s 305us/step - loss: 8.0590
Epoch 360/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 361/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 362/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 363/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 364/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 365/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 366/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 367/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 368/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 369/400
160/160 [=====] - 0s 268us/step - loss: 8.0590
Epoch 370/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 371/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 372/400
160/160 [=====] - 0s 268us/step - loss: 8.0590
Epoch 373/400
160/160 [=====] - 0s 284us/step - loss: 8.0590
Epoch 374/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 375/400
160/160 [=====] - 0s 277us/step - loss: 8.0590
Epoch 376/400
160/160 [=====] - 0s 274us/step - loss: 8.0590
Epoch 377/400
160/160 [=====] - 0s 277us/step - loss: 8.0590
Epoch 378/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 379/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 380/400
160/160 [=====] - 0s 299us/step - loss: 8.0590
Epoch 381/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 382/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 383/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 384/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 385/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 386/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 387/400
160/160 [=====] - 0s 299us/step - loss: 8.0590
Epoch 388/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 389/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 390/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 391/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
Epoch 392/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
...

```
Epoch 393/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 394/400
160/160 [=====] - 0s 281us/step - loss: 8.0590
Epoch 395/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 396/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 397/400
160/160 [=====] - 0s 292us/step - loss: 8.0590
Epoch 398/400
160/160 [=====] - 0s 280us/step - loss: 8.0590
Epoch 399/400
160/160 [=====] - 0s 287us/step - loss: 8.0590
Epoch 400/400
160/160 [=====] - 0s 293us/step - loss: 8.0590
[-0.6309207 -0.32926622 -0.7215993 -0.41063094 -0.5662767 -0.42692667
 -0.5867827 -0.6326842 -0.41198635 -0.6482686 -0.5062726 -0.39431998
 -0.6241399 -0.59204984 -0.6303018 -0.75302774 -0.4727816 -0.3356588
 -0.5524091 -0.5450216 -0.48412916 -0.51198995 -0.36199844 -0.56996036
 -0.7004492 -0.5485102 -0.66158414 -0.46987352 -0.6210448 -0.6423521
 -0.37392652 -0.63010323 -0.54362476 -0.6676403 -0.64820725 -0.616927
 -0.49989927 -0.5582813 -0.5800775 -0.6261797 -0.51794875 -0.67318475
 -0.31910676 -0.63264436 -0.57662416 -0.6363122 -0.57680094 -0.49256858
 -0.65127546 -0.42971218 -0.5670675 -0.6253133 -0.47856045 -0.5720629
 -0.5214701 -0.21793652 -0.6268188 -0.6625045 -0.4821039 -0.5696692
 -0.5544757 -0.6120801 -0.6611471 -0.45438513 -0.34268785 -0.55571544
 -0.44112736 -0.5870454 -0.46431494 -0.45966175 -0.6400036 -0.5019214
 -0.5246214 -0.34593925 -0.41349632 -0.5063644 -0.53433067 -0.5120621
 -0.5222018 -0.40575397 -0.4823899 -0.28927168 -0.27190018 -0.2920659
 -0.47924381 -0.36677298 -0.5614596 -0.40137103 -0.40494868 -0.27287173
 -0.27437848 -0.16210039 -0.33339348 -0.5702104 -0.4955822 -0.18638222
 -0.4400143 -0.21628778 -0.05580373 -0.4000893 -0.10115931 -0.47263822
 -0.3151386 -0.01425614 -0.23793568 -0.36012334 -0.349852 -0.24000427
 -0.28142372 -0.33683556 -0.1898711 -0.421814 -0.22196208 -0.11258125
 -0.22718301 -0.39391494 -0.05517566 -0.22608794 -0.33576015 -0.11332057
 -0.6603845 -0.69446945 -0.7488416 -0.7032166 -0.65345186 -0.6761268
 -0.601635 -0.7008903 -0.656056 -0.74651796 -0.723168 -0.74317765
 -0.72478104 -0.5938509 -0.652118 -0.7689873 -0.6517636 -0.72147775
 -0.7835253 -0.6856617 -0.766947 -0.64452887 -0.68796897 -0.7932629
 -0.7601223 -0.70183057 -0.7235206 -0.7285011 -0.7402122 -0.7261654
 -0.7332472 -0.69175506 -0.7441176 -0.7862591 -0.7585893 -0.70179874
 -0.7785673 -0.74524164 -0.7164111 -0.7809615 ]
```

```
160/160 [=====] - 0s 736us/step
```

```
d:\python365\lib\site-packages\keras\engine\sequential.py:247: UserWarning: Network returning invalid probability values. The last layer might not normalize predictions into probabilities (like softmax or sigmoid would).
```

```
    warnings.warn('Network returning invalid probability values. '
```

In [53]:

```
#Five layers, four neurons per layer: loss
scores_optimal_tanh, optimal_tanh.metrics_names
```

Out[53]:

```
(8.059047738974616, ['loss'])
```

Activation sigmoid:

In [54]:

```
n = 40
xx = np.random.random((n,1))
yy = np.random.random((n,1))

X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [55]:

```
#Five layers, four neurons per layer
optimal_sigmoid = Sequential()

#hidden layers
optimal_sigmoid.add(Dense(4, input_dim=2, activation='sigmoid'))
```

```
optimal_sigmoid.add(Dense(4, activation='sigmoid'))
optimal_sigmoid.add(Dense(4, activation='sigmoid'))
optimal_sigmoid.add(Dense(4, activation='sigmoid'))
optimal_sigmoid.add(Dense(4, activation='sigmoid'))

#output layer
optimal_sigmoid.add(Dense(1, activation='sigmoid'))

sgd = SGD(lr=0.1)
optimal_sigmoid.compile(loss='binary_crossentropy', optimizer='sgd')

optimal_sigmoid.fit(X, y, batch_size=2, epochs=400)
print(optimal_sigmoid.predict_proba(X).reshape(4*n))

#evaluate the model
scores_optimal_sigmoid = optimal_sigmoid.evaluate(X, y)

Epoch 1/400
160/160 [=====] - 0s 3ms/step - loss: 0.7021
Epoch 2/400
160/160 [=====] - 0s 309us/step - loss: 0.6979
Epoch 3/400
160/160 [=====] - 0s 312us/step - loss: 0.6961
Epoch 4/400
160/160 [=====] - 0s 309us/step - loss: 0.6948
Epoch 5/400
160/160 [=====] - 0s 293us/step - loss: 0.6946
Epoch 6/400
160/160 [=====] - 0s 299us/step - loss: 0.6943
Epoch 7/400
160/160 [=====] - 0s 280us/step - loss: 0.6943
Epoch 8/400
160/160 [=====] - 0s 293us/step - loss: 0.6940
Epoch 9/400
160/160 [=====] - 0s 299us/step - loss: 0.6946
Epoch 10/400
160/160 [=====] - 0s 299us/step - loss: 0.6945
Epoch 11/400
160/160 [=====] - 0s 299us/step - loss: 0.6944
Epoch 12/400
160/160 [=====] - 0s 299us/step - loss: 0.6943
Epoch 13/400
160/160 [=====] - 0s 287us/step - loss: 0.6945
Epoch 14/400
160/160 [=====] - 0s 299us/step - loss: 0.6944
Epoch 15/400
160/160 [=====] - 0s 281us/step - loss: 0.6944
Epoch 16/400
160/160 [=====] - 0s 287us/step - loss: 0.6942
Epoch 17/400
160/160 [=====] - 0s 287us/step - loss: 0.6945
Epoch 18/400
160/160 [=====] - 0s 299us/step - loss: 0.6942
Epoch 19/400
160/160 [=====] - 0s 281us/step - loss: 0.6941
Epoch 20/400
160/160 [=====] - 0s 293us/step - loss: 0.6944
Epoch 21/400
160/160 [=====] - 0s 290us/step - loss: 0.6945
Epoch 22/400
160/160 [=====] - 0s 281us/step - loss: 0.6944
Epoch 23/400
160/160 [=====] - 0s 296us/step - loss: 0.6946
Epoch 24/400
160/160 [=====] - 0s 305us/step - loss: 0.6947
Epoch 25/400
160/160 [=====] - 0s 305us/step - loss: 0.6943
Epoch 26/400
160/160 [=====] - 0s 293us/step - loss: 0.6944
Epoch 27/400
160/160 [=====] - 0s 293us/step - loss: 0.6942
Epoch 28/400
160/160 [=====] - 0s 293us/step - loss: 0.6942
Epoch 29/400
160/160 [=====] - 0s 293us/step - loss: 0.6941
Epoch 30/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 31/400
```

Epoch 31/400
160/160 [=====] - 0s 293us/step - loss: 0.6944
Epoch 32/400
160/160 [=====] - 0s 299us/step - loss: 0.6943
Epoch 33/400
160/160 [=====] - 0s 287us/step - loss: 0.6946
Epoch 34/400
160/160 [=====] - 0s 280us/step - loss: 0.6944
Epoch 35/400
160/160 [=====] - 0s 299us/step - loss: 0.6945
Epoch 36/400
160/160 [=====] - 0s 284us/step - loss: 0.6943
Epoch 37/400
160/160 [=====] - 0s 299us/step - loss: 0.6940
Epoch 38/400
160/160 [=====] - 0s 290us/step - loss: 0.6943
Epoch 39/400
160/160 [=====] - 0s 293us/step - loss: 0.6945
Epoch 40/400
160/160 [=====] - 0s 293us/step - loss: 0.6945
Epoch 41/400
160/160 [=====] - 0s 290us/step - loss: 0.6942
Epoch 42/400
160/160 [=====] - 0s 299us/step - loss: 0.6942
Epoch 43/400
160/160 [=====] - 0s 280us/step - loss: 0.6944
Epoch 44/400
160/160 [=====] - 0s 293us/step - loss: 0.6945
Epoch 45/400
160/160 [=====] - 0s 299us/step - loss: 0.6945
Epoch 46/400
160/160 [=====] - 0s 312us/step - loss: 0.6944
Epoch 47/400
160/160 [=====] - 0s 305us/step - loss: 0.6943
Epoch 48/400
160/160 [=====] - 0s 299us/step - loss: 0.6943
Epoch 49/400
160/160 [=====] - 0s 293us/step - loss: 0.6944
Epoch 50/400
160/160 [=====] - 0s 281us/step - loss: 0.6943
Epoch 51/400
160/160 [=====] - 0s 287us/step - loss: 0.6944
Epoch 52/400
160/160 [=====] - 0s 293us/step - loss: 0.6944
Epoch 53/400
160/160 [=====] - 0s 299us/step - loss: 0.6944
Epoch 54/400
160/160 [=====] - 0s 293us/step - loss: 0.6943
Epoch 55/400
160/160 [=====] - 0s 299us/step - loss: 0.6943
Epoch 56/400
160/160 [=====] - 0s 281us/step - loss: 0.6944
Epoch 57/400
160/160 [=====] - 0s 280us/step - loss: 0.6944
Epoch 58/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 59/400
160/160 [=====] - 0s 280us/step - loss: 0.6944
Epoch 60/400
160/160 [=====] - 0s 281us/step - loss: 0.6946
Epoch 61/400
160/160 [=====] - 0s 280us/step - loss: 0.6943
Epoch 62/400
160/160 [=====] - 0s 280us/step - loss: 0.6942
Epoch 63/400
160/160 [=====] - 0s 299us/step - loss: 0.6946
Epoch 64/400
160/160 [=====] - 0s 287us/step - loss: 0.6942
Epoch 65/400
160/160 [=====] - 0s 281us/step - loss: 0.6943
Epoch 66/400
160/160 [=====] - 0s 287us/step - loss: 0.6941
Epoch 67/400
160/160 [=====] - 0s 280us/step - loss: 0.6944
Epoch 68/400
160/160 [=====] - 0s 293us/step - loss: 0.6942
Epoch 69/400

160/160 [=====] - 0s 287us/step - loss: 0.6941

100/100 [=====] - 0s 20us/step - loss: 0.6941
Epoch 70/400
160/160 [=====] - 0s 309us/step - loss: 0.6944
Epoch 71/400
160/160 [=====] - 0s 281us/step - loss: 0.6946
Epoch 72/400
160/160 [=====] - 0s 277us/step - loss: 0.6944
Epoch 73/400
160/160 [=====] - 0s 281us/step - loss: 0.6943
Epoch 74/400
160/160 [=====] - 0s 274us/step - loss: 0.6942
Epoch 75/400
160/160 [=====] - 0s 293us/step - loss: 0.6945
Epoch 76/400
160/160 [=====] - 0s 293us/step - loss: 0.6943
Epoch 77/400
160/160 [=====] - 0s 280us/step - loss: 0.6946
Epoch 78/400
160/160 [=====] - 0s 281us/step - loss: 0.6946
Epoch 79/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 80/400
160/160 [=====] - 0s 280us/step - loss: 0.6945
Epoch 81/400
160/160 [=====] - 0s 280us/step - loss: 0.6946
Epoch 82/400
160/160 [=====] - 0s 287us/step - loss: 0.6942
Epoch 83/400
160/160 [=====] - 0s 287us/step - loss: 0.6945
Epoch 84/400
160/160 [=====] - 0s 287us/step - loss: 0.6942
Epoch 85/400
160/160 [=====] - 0s 287us/step - loss: 0.6944
Epoch 86/400
160/160 [=====] - 0s 287us/step - loss: 0.6945
Epoch 87/400
160/160 [=====] - 0s 280us/step - loss: 0.6944
Epoch 88/400
160/160 [=====] - 0s 299us/step - loss: 0.6943
Epoch 89/400
160/160 [=====] - 0s 293us/step - loss: 0.6945
Epoch 90/400
160/160 [=====] - 0s 299us/step - loss: 0.6943
Epoch 91/400
160/160 [=====] - 0s 287us/step - loss: 0.6945
Epoch 92/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 93/400
160/160 [=====] - 0s 274us/step - loss: 0.6945
Epoch 94/400
160/160 [=====] - 0s 281us/step - loss: 0.6944
Epoch 95/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 96/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 97/400
160/160 [=====] - 0s 280us/step - loss: 0.6942
Epoch 98/400
160/160 [=====] - 0s 287us/step - loss: 0.6944
Epoch 99/400
160/160 [=====] - 0s 280us/step - loss: 0.6944
Epoch 100/400
160/160 [=====] - 0s 281us/step - loss: 0.6944
Epoch 101/400
160/160 [=====] - 0s 284us/step - loss: 0.6945
Epoch 102/400
160/160 [=====] - 0s 280us/step - loss: 0.6943
Epoch 103/400
160/160 [=====] - 0s 284us/step - loss: 0.6941
Epoch 104/400
160/160 [=====] - 0s 281us/step - loss: 0.6942
Epoch 105/400
160/160 [=====] - 0s 277us/step - loss: 0.6945
Epoch 106/400
160/160 [=====] - 0s 281us/step - loss: 0.6943
Epoch 107/400
160/160 [=====] - 0s 274us/step - loss: 0.6944

Epoch 108/400
160/160 [=====] - 0s 293us/step - loss: 0.6944
Epoch 109/400
160/160 [=====] - 0s 305us/step - loss: 0.6942
Epoch 110/400
160/160 [=====] - 0s 299us/step - loss: 0.6944
Epoch 111/400
160/160 [=====] - 0s 330us/step - loss: 0.6945
Epoch 112/400
160/160 [=====] - 0s 299us/step - loss: 0.6942
Epoch 113/400
160/160 [=====] - 0s 330us/step - loss: 0.6944
Epoch 114/400
160/160 [=====] - 0s 305us/step - loss: 0.6943
Epoch 115/400
160/160 [=====] - 0s 293us/step - loss: 0.6943
Epoch 116/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 117/400
160/160 [=====] - 0s 287us/step - loss: 0.6945
Epoch 118/400
160/160 [=====] - 0s 293us/step - loss: 0.6945
Epoch 119/400
160/160 [=====] - 0s 281us/step - loss: 0.6943
Epoch 120/400
160/160 [=====] - 0s 287us/step - loss: 0.6942
Epoch 121/400
160/160 [=====] - 0s 281us/step - loss: 0.6943
Epoch 122/400
160/160 [=====] - 0s 281us/step - loss: 0.6943
Epoch 123/400
160/160 [=====] - 0s 281us/step - loss: 0.6944
Epoch 124/400
160/160 [=====] - 0s 284us/step - loss: 0.6941
Epoch 125/400
160/160 [=====] - 0s 287us/step - loss: 0.6946
Epoch 126/400
160/160 [=====] - 0s 277us/step - loss: 0.6943
Epoch 127/400
160/160 [=====] - 0s 287us/step - loss: 0.6944
Epoch 128/400
160/160 [=====] - 0s 293us/step - loss: 0.6942
Epoch 129/400
160/160 [=====] - 0s 280us/step - loss: 0.6946
Epoch 130/400
160/160 [=====] - 0s 287us/step - loss: 0.6944
Epoch 131/400
160/160 [=====] - 0s 287us/step - loss: 0.6944
Epoch 132/400
160/160 [=====] - 0s 305us/step - loss: 0.6944
Epoch 133/400
160/160 [=====] - 0s 287us/step - loss: 0.6945
Epoch 134/400
160/160 [=====] - 0s 287us/step - loss: 0.6944
Epoch 135/400
160/160 [=====] - 0s 287us/step - loss: 0.6940
Epoch 136/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 137/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 138/400
160/160 [=====] - 0s 280us/step - loss: 0.6942
Epoch 139/400
160/160 [=====] - 0s 284us/step - loss: 0.6944
Epoch 140/400
160/160 [=====] - 0s 299us/step - loss: 0.6945
Epoch 141/400
160/160 [=====] - 0s 284us/step - loss: 0.6945
Epoch 142/400
160/160 [=====] - 0s 281us/step - loss: 0.6944
Epoch 143/400
160/160 [=====] - 0s 287us/step - loss: 0.6941
Epoch 144/400
160/160 [=====] - 0s 290us/step - loss: 0.6940
Epoch 145/400
160/160 [=====] - 0s 287us/step - loss: 0.6944
Epoch 146/400

160/160 [=====] - 0s 281us/step - loss: 0.6943
Epoch 147/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 148/400
160/160 [=====] - 0s 280us/step - loss: 0.6944
Epoch 149/400
160/160 [=====] - 0s 293us/step - loss: 0.6943
Epoch 150/400
160/160 [=====] - 0s 280us/step - loss: 0.6942
Epoch 151/400
160/160 [=====] - 0s 287us/step - loss: 0.6944
Epoch 152/400
160/160 [=====] - 0s 274us/step - loss: 0.6945
Epoch 153/400
160/160 [=====] - 0s 287us/step - loss: 0.6941
Epoch 154/400
160/160 [=====] - 0s 299us/step - loss: 0.6940
Epoch 155/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 156/400
160/160 [=====] - 0s 281us/step - loss: 0.6945
Epoch 157/400
160/160 [=====] - 0s 274us/step - loss: 0.6945
Epoch 158/400
160/160 [=====] - 0s 280us/step - loss: 0.6941
Epoch 159/400
160/160 [=====] - 0s 281us/step - loss: 0.6941
Epoch 160/400
160/160 [=====] - 0s 287us/step - loss: 0.6941
Epoch 161/400
160/160 [=====] - 0s 293us/step - loss: 0.6944
Epoch 162/400
160/160 [=====] - 0s 280us/step - loss: 0.6940
Epoch 163/400
160/160 [=====] - 0s 287us/step - loss: 0.6942
Epoch 164/400
160/160 [=====] - 0s 287us/step - loss: 0.6941
Epoch 165/400
160/160 [=====] - 0s 287us/step - loss: 0.6944
Epoch 166/400
160/160 [=====] - 0s 280us/step - loss: 0.6944
Epoch 167/400
160/160 [=====] - 0s 281us/step - loss: 0.6944
Epoch 168/400
160/160 [=====] - 0s 274us/step - loss: 0.6945
Epoch 169/400
160/160 [=====] - 0s 281us/step - loss: 0.6943
Epoch 170/400
160/160 [=====] - 0s 280us/step - loss: 0.6944
Epoch 171/400
160/160 [=====] - 0s 287us/step - loss: 0.6942
Epoch 172/400
160/160 [=====] - 0s 290us/step - loss: 0.6944
Epoch 173/400
160/160 [=====] - 0s 287us/step - loss: 0.6940
Epoch 174/400
160/160 [=====] - 0s 309us/step - loss: 0.6946
Epoch 175/400
160/160 [=====] - 0s 287us/step - loss: 0.6944
Epoch 176/400
160/160 [=====] - 0s 305us/step - loss: 0.6941
Epoch 177/400
160/160 [=====] - 0s 293us/step - loss: 0.6944
Epoch 178/400
160/160 [=====] - 0s 293us/step - loss: 0.6944
Epoch 179/400
160/160 [=====] - 0s 293us/step - loss: 0.6945
Epoch 180/400
160/160 [=====] - 0s 287us/step - loss: 0.6945
Epoch 181/400
160/160 [=====] - 0s 337us/step - loss: 0.6942
Epoch 182/400
160/160 [=====] - 0s 430us/step - loss: 0.6943
Epoch 183/400
160/160 [=====] - 0s 324us/step - loss: 0.6942
Epoch 184/400
160/160 [=====] - 0s 305us/step - loss: 0.6941

Epoch 185/400
160/160 [=====] - 0s 318us/step - loss: 0.6945
Epoch 186/400
160/160 [=====] - 0s 318us/step - loss: 0.6945
Epoch 187/400
160/160 [=====] - 0s 330us/step - loss: 0.6942
Epoch 188/400
160/160 [=====] - 0s 324us/step - loss: 0.6942
Epoch 189/400
160/160 [=====] - 0s 324us/step - loss: 0.6945
Epoch 190/400
160/160 [=====] - 0s 355us/step - loss: 0.6940
Epoch 191/400
160/160 [=====] - 0s 343us/step - loss: 0.6943
Epoch 192/400
160/160 [=====] - 0s 284us/step - loss: 0.6943
Epoch 193/400
160/160 [=====] - 0s 281us/step - loss: 0.6944
Epoch 194/400
160/160 [=====] - 0s 287us/step - loss: 0.6942
Epoch 195/400
160/160 [=====] - 0s 287us/step - loss: 0.6944
Epoch 196/400
160/160 [=====] - 0s 299us/step - loss: 0.6944
Epoch 197/400
160/160 [=====] - 0s 293us/step - loss: 0.6944
Epoch 198/400
160/160 [=====] - 0s 281us/step - loss: 0.6945
Epoch 199/400
160/160 [=====] - 0s 287us/step - loss: 0.6946
Epoch 200/400
160/160 [=====] - 0s 287us/step - loss: 0.6945
Epoch 201/400
160/160 [=====] - 0s 287us/step - loss: 0.6942
Epoch 202/400
160/160 [=====] - 0s 280us/step - loss: 0.6940
Epoch 203/400
160/160 [=====] - 0s 281us/step - loss: 0.6941
Epoch 204/400
160/160 [=====] - 0s 293us/step - loss: 0.6946
Epoch 205/400
160/160 [=====] - 0s 296us/step - loss: 0.6944
Epoch 206/400
160/160 [=====] - 0s 293us/step - loss: 0.6945
Epoch 207/400
160/160 [=====] - 0s 293us/step - loss: 0.6944
Epoch 208/400
160/160 [=====] - 0s 287us/step - loss: 0.6944
Epoch 209/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 210/400
160/160 [=====] - 0s 287us/step - loss: 0.6944
Epoch 211/400
160/160 [=====] - 0s 287us/step - loss: 0.6944
Epoch 212/400
160/160 [=====] - 0s 293us/step - loss: 0.6942
Epoch 213/400
160/160 [=====] - 0s 287us/step - loss: 0.6941
Epoch 214/400
160/160 [=====] - 0s 281us/step - loss: 0.6941
Epoch 215/400
160/160 [=====] - 0s 293us/step - loss: 0.6944
Epoch 216/400
160/160 [=====] - 0s 287us/step - loss: 0.6942
Epoch 217/400
160/160 [=====] - 0s 312us/step - loss: 0.6944
Epoch 218/400
160/160 [=====] - 0s 305us/step - loss: 0.6939
Epoch 219/400
160/160 [=====] - 0s 305us/step - loss: 0.6939
Epoch 220/400
160/160 [=====] - 0s 299us/step - loss: 0.6947
Epoch 221/400
160/160 [=====] - 0s 293us/step - loss: 0.6941
Epoch 222/400
160/160 [=====] - 0s 293us/step - loss: 0.6943
Epoch 223/400

160/160 [=====] - 0s 305us/step - loss: 0.6943
Epoch 224/400
160/160 [=====] - 0s 293us/step - loss: 0.6944
Epoch 225/400
160/160 [=====] - 0s 280us/step - loss: 0.6941
Epoch 226/400
160/160 [=====] - 0s 284us/step - loss: 0.6943
Epoch 227/400
160/160 [=====] - 0s 293us/step - loss: 0.6942
Epoch 228/400
160/160 [=====] - 0s 284us/step - loss: 0.6945
Epoch 229/400
160/160 [=====] - 0s 281us/step - loss: 0.6942
Epoch 230/400
160/160 [=====] - 0s 293us/step - loss: 0.6941
Epoch 231/400
160/160 [=====] - 0s 287us/step - loss: 0.6942
Epoch 232/400
160/160 [=====] - 0s 287us/step - loss: 0.6945
Epoch 233/400
160/160 [=====] - 0s 274us/step - loss: 0.6944
Epoch 234/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 235/400
160/160 [=====] - 0s 305us/step - loss: 0.6942
Epoch 236/400
160/160 [=====] - 0s 337us/step - loss: 0.6943
Epoch 237/400
160/160 [=====] - 0s 306us/step - loss: 0.6943
Epoch 238/400
160/160 [=====] - 0s 318us/step - loss: 0.6942
Epoch 239/400
160/160 [=====] - 0s 306us/step - loss: 0.6943
Epoch 240/400
160/160 [=====] - 0s 312us/step - loss: 0.6942
Epoch 241/400
160/160 [=====] - 0s 296us/step - loss: 0.6941
Epoch 242/400
160/160 [=====] - 0s 299us/step - loss: 0.6943
Epoch 243/400
160/160 [=====] - 0s 293us/step - loss: 0.6943
Epoch 244/400
160/160 [=====] - 0s 340us/step - loss: 0.6944
Epoch 245/400
160/160 [=====] - 0s 293us/step - loss: 0.6943
Epoch 246/400
160/160 [=====] - 0s 287us/step - loss: 0.6942
Epoch 247/400
160/160 [=====] - 0s 287us/step - loss: 0.6945
Epoch 248/400
160/160 [=====] - 0s 293us/step - loss: 0.6943
Epoch 249/400
160/160 [=====] - 0s 296us/step - loss: 0.6943
Epoch 250/400
160/160 [=====] - 0s 305us/step - loss: 0.6947
Epoch 251/400
160/160 [=====] - 0s 305us/step - loss: 0.6944
Epoch 252/400
160/160 [=====] - 0s 293us/step - loss: 0.6943
Epoch 253/400
160/160 [=====] - 0s 287us/step - loss: 0.6942
Epoch 254/400
160/160 [=====] - 0s 274us/step - loss: 0.6942
Epoch 255/400
160/160 [=====] - 0s 474us/step - loss: 0.6942
Epoch 256/400
160/160 [=====] - 0s 362us/step - loss: 0.6943
Epoch 257/400
160/160 [=====] - 0s 380us/step - loss: 0.6941
Epoch 258/400
160/160 [=====] - 0s 424us/step - loss: 0.6943
Epoch 259/400
160/160 [=====] - 0s 365us/step - loss: 0.6943
Epoch 260/400
160/160 [=====] - 0s 330us/step - loss: 0.6944
Epoch 261/400
160/160 [=====] - 0s 362us/step - loss: 0.6943

Epoch 262/400
160/160 [=====] - 0s 368us/step - loss: 0.6946
Epoch 263/400
160/160 [=====] - 0s 337us/step - loss: 0.6945
Epoch 264/400
160/160 [=====] - 0s 312us/step - loss: 0.6946
Epoch 265/400
160/160 [=====] - 0s 309us/step - loss: 0.6941
Epoch 266/400
160/160 [=====] - 0s 299us/step - loss: 0.6946
Epoch 267/400
160/160 [=====] - 0s 290us/step - loss: 0.6941
Epoch 268/400
160/160 [=====] - 0s 281us/step - loss: 0.6944
Epoch 269/400
160/160 [=====] - 0s 293us/step - loss: 0.6943
Epoch 270/400
160/160 [=====] - 0s 293us/step - loss: 0.6941
Epoch 271/400
160/160 [=====] - 0s 293us/step - loss: 0.6944
Epoch 272/400
160/160 [=====] - 0s 299us/step - loss: 0.6943
Epoch 273/400
160/160 [=====] - 0s 287us/step - loss: 0.6944
Epoch 274/400
160/160 [=====] - 0s 299us/step - loss: 0.6942
Epoch 275/400
160/160 [=====] - 0s 318us/step - loss: 0.6941
Epoch 276/400
160/160 [=====] - 0s 293us/step - loss: 0.6946
Epoch 277/400
160/160 [=====] - 0s 302us/step - loss: 0.6942
Epoch 278/400
160/160 [=====] - 0s 290us/step - loss: 0.6942
Epoch 279/400
160/160 [=====] - 0s 299us/step - loss: 0.6940
Epoch 280/400
160/160 [=====] - 0s 290us/step - loss: 0.6940
Epoch 281/400
160/160 [=====] - 0s 281us/step - loss: 0.6942
Epoch 282/400
160/160 [=====] - 0s 290us/step - loss: 0.6943
Epoch 283/400
160/160 [=====] - 0s 293us/step - loss: 0.6942
Epoch 284/400
160/160 [=====] - 0s 299us/step - loss: 0.6945
Epoch 285/400
160/160 [=====] - 0s 281us/step - loss: 0.6942
Epoch 286/400
160/160 [=====] - 0s 274us/step - loss: 0.6945
Epoch 287/400
160/160 [=====] - 0s 293us/step - loss: 0.6943
Epoch 288/400
160/160 [=====] - 0s 281us/step - loss: 0.6943
Epoch 289/400
160/160 [=====] - 0s 287us/step - loss: 0.6942
Epoch 290/400
160/160 [=====] - 0s 280us/step - loss: 0.6944
Epoch 291/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 292/400
160/160 [=====] - 0s 280us/step - loss: 0.6945
Epoch 293/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 294/400
160/160 [=====] - 0s 280us/step - loss: 0.6944
Epoch 295/400
160/160 [=====] - 0s 281us/step - loss: 0.6943
Epoch 296/400
160/160 [=====] - 0s 280us/step - loss: 0.6945
Epoch 297/400
160/160 [=====] - 0s 280us/step - loss: 0.6945
Epoch 298/400
160/160 [=====] - 0s 293us/step - loss: 0.6944
Epoch 299/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 300/400

160/160 [=====] - 0s 287us/step - loss: 0.6942
Epoch 301/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 302/400
160/160 [=====] - 0s 277us/step - loss: 0.6942
Epoch 303/400
160/160 [=====] - 0s 274us/step - loss: 0.6940
Epoch 304/400
160/160 [=====] - 0s 281us/step - loss: 0.6945
Epoch 305/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 306/400
160/160 [=====] - 0s 287us/step - loss: 0.6942
Epoch 307/400
160/160 [=====] - 0s 280us/step - loss: 0.6943
Epoch 308/400
160/160 [=====] - 0s 281us/step - loss: 0.6943
Epoch 309/400
160/160 [=====] - 0s 280us/step - loss: 0.6941
Epoch 310/400
160/160 [=====] - 0s 287us/step - loss: 0.6944
Epoch 311/400
160/160 [=====] - 0s 287us/step - loss: 0.6944
Epoch 312/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 313/400
160/160 [=====] - 0s 293us/step - loss: 0.6944
Epoch 314/400
160/160 [=====] - 0s 293us/step - loss: 0.6944
Epoch 315/400
160/160 [=====] - 0s 296us/step - loss: 0.6944
Epoch 316/400
160/160 [=====] - 0s 287us/step - loss: 0.6941
Epoch 317/400
160/160 [=====] - 0s 296us/step - loss: 0.6941
Epoch 318/400
160/160 [=====] - 0s 280us/step - loss: 0.6942
Epoch 319/400
160/160 [=====] - 0s 287us/step - loss: 0.6942
Epoch 320/400
160/160 [=====] - 0s 299us/step - loss: 0.6942
Epoch 321/400
160/160 [=====] - 0s 281us/step - loss: 0.6943
Epoch 322/400
160/160 [=====] - 0s 287us/step - loss: 0.6942
Epoch 323/400
160/160 [=====] - 0s 280us/step - loss: 0.6943
Epoch 324/400
160/160 [=====] - 0s 287us/step - loss: 0.6944
Epoch 325/400
160/160 [=====] - 0s 280us/step - loss: 0.6942
Epoch 326/400
160/160 [=====] - 0s 293us/step - loss: 0.6943
Epoch 327/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 328/400
160/160 [=====] - 0s 280us/step - loss: 0.6941
Epoch 329/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 330/400
160/160 [=====] - 0s 274us/step - loss: 0.6943
Epoch 331/400
160/160 [=====] - 0s 287us/step - loss: 0.6944
Epoch 332/400
160/160 [=====] - 0s 287us/step - loss: 0.6945
Epoch 333/400
160/160 [=====] - 0s 293us/step - loss: 0.6942
Epoch 334/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 335/400
160/160 [=====] - 0s 287us/step - loss: 0.6945
Epoch 336/400
160/160 [=====] - 0s 287us/step - loss: 0.6941
Epoch 337/400
160/160 [=====] - 0s 346us/step - loss: 0.6942
Epoch 338/400
160/160 [=====] - 0s 305us/step - loss: 0.6941

Epoch 339/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 340/400
160/160 [=====] - 0s 280us/step - loss: 0.6946
Epoch 341/400
160/160 [=====] - 0s 393us/step - loss: 0.6946
Epoch 342/400
160/160 [=====] - 0s 306us/step - loss: 0.6942
Epoch 343/400
160/160 [=====] - 0s 330us/step - loss: 0.6940
Epoch 344/400
160/160 [=====] - 0s 355us/step - loss: 0.6942
Epoch 345/400
160/160 [=====] - 0s 349us/step - loss: 0.6944
Epoch 346/400
160/160 [=====] - 0s 324us/step - loss: 0.6942
Epoch 347/400
160/160 [=====] - 0s 468us/step - loss: 0.6942
Epoch 348/400
160/160 [=====] - 0s 312us/step - loss: 0.6944
Epoch 349/400
160/160 [=====] - 0s 346us/step - loss: 0.6945
Epoch 350/400
160/160 [=====] - 0s 393us/step - loss: 0.6941
Epoch 351/400
160/160 [=====] - 0s 383us/step - loss: 0.6941
Epoch 352/400
160/160 [=====] - 0s 337us/step - loss: 0.6942
Epoch 353/400
160/160 [=====] - 0s 346us/step - loss: 0.6946
Epoch 354/400
160/160 [=====] - 0s 330us/step - loss: 0.6944
Epoch 355/400
160/160 [=====] - 0s 318us/step - loss: 0.6943
Epoch 356/400
160/160 [=====] - 0s 343us/step - loss: 0.6943
Epoch 357/400
160/160 [=====] - 0s 318us/step - loss: 0.6945
Epoch 358/400
160/160 [=====] - 0s 330us/step - loss: 0.6945
Epoch 359/400
160/160 [=====] - 0s 433us/step - loss: 0.6942
Epoch 360/400
160/160 [=====] - 0s 374us/step - loss: 0.6944
Epoch 361/400
160/160 [=====] - 0s 337us/step - loss: 0.6944
Epoch 362/400
160/160 [=====] - 0s 324us/step - loss: 0.6942
Epoch 363/400
160/160 [=====] - 0s 305us/step - loss: 0.6942
Epoch 364/400
160/160 [=====] - 0s 293us/step - loss: 0.6944
Epoch 365/400
160/160 [=====] - 0s 293us/step - loss: 0.6941
Epoch 366/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 367/400
160/160 [=====] - 0s 305us/step - loss: 0.6944
Epoch 368/400
160/160 [=====] - 0s 299us/step - loss: 0.6942
Epoch 369/400
160/160 [=====] - 0s 305us/step - loss: 0.6941
Epoch 370/400
160/160 [=====] - 0s 337us/step - loss: 0.6944
Epoch 371/400
160/160 [=====] - 0s 346us/step - loss: 0.6942
Epoch 372/400
160/160 [=====] - 0s 315us/step - loss: 0.6942
Epoch 373/400
160/160 [=====] - 0s 327us/step - loss: 0.6941
Epoch 374/400
160/160 [=====] - 0s 290us/step - loss: 0.6941
Epoch 375/400
160/160 [=====] - 0s 293us/step - loss: 0.6940
Epoch 376/400
160/160 [=====] - 0s 293us/step - loss: 0.6946
Epoch 377/400

160/160 [=====] - 0s 287us/step - loss: 0.6942
Epoch 378/400
160/160 [=====] - 0s 305us/step - loss: 0.6944
Epoch 379/400
160/160 [=====] - 0s 305us/step - loss: 0.6941
Epoch 380/400
160/160 [=====] - 0s 290us/step - loss: 0.6942
Epoch 381/400
160/160 [=====] - 0s 299us/step - loss: 0.6943
Epoch 382/400
160/160 [=====] - 0s 299us/step - loss: 0.6942
Epoch 383/400
160/160 [=====] - 0s 280us/step - loss: 0.6945
Epoch 384/400
160/160 [=====] - 0s 281us/step - loss: 0.6946
Epoch 385/400
160/160 [=====] - 0s 277us/step - loss: 0.6943
Epoch 386/400
160/160 [=====] - 0s 287us/step - loss: 0.6941
Epoch 387/400
160/160 [=====] - 0s 284us/step - loss: 0.6943
Epoch 388/400
160/160 [=====] - 0s 280us/step - loss: 0.6943
Epoch 389/400
160/160 [=====] - 0s 284us/step - loss: 0.6945
Epoch 390/400
160/160 [=====] - 0s 280us/step - loss: 0.6943
Epoch 391/400
160/160 [=====] - 0s 280us/step - loss: 0.6942
Epoch 392/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 393/400
160/160 [=====] - 0s 305us/step - loss: 0.6943
Epoch 394/400
160/160 [=====] - 0s 293us/step - loss: 0.6942
Epoch 395/400
160/160 [=====] - 0s 293us/step - loss: 0.6944
Epoch 396/400
160/160 [=====] - 0s 287us/step - loss: 0.6941
Epoch 397/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 398/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 399/400
160/160 [=====] - 0s 287us/step - loss: 0.6943
Epoch 400/400
160/160 [=====] - 0s 312us/step - loss: 0.6943
[0.49671146 0.49676523 0.49674344 0.49675956 0.4967337 0.49672532
0.49675992 0.49674615 0.49670404 0.49676445 0.49676082 0.49670392
0.49673933 0.49672297 0.49673563 0.49675864 0.496747 0.49674687
0.49672627 0.4967304 0.49672934 0.49670973 0.49674922 0.4967665
0.49672192 0.4967451 0.49675852 0.4967377 0.49673828 0.49675685
0.49672815 0.49672216 0.49671793 0.49673644 0.49670786 0.49672434
0.49675733 0.4967574 0.49672234 0.4967121 0.49686974 0.4968137
0.4968357 0.4968196 0.49684596 0.4968549 0.4968191 0.49683312
0.4968778 0.4968144 0.49681813 0.49687797 0.49684066 0.49685785
0.49684432 0.49682042 0.4968319 0.49683273 0.49685413 0.49685007
0.49685115 0.49687198 0.49682984 0.49681228 0.49685866 0.4968342
0.49682054 0.4968423 0.49684113 0.49682224 0.4968522 0.49685872
0.49686325 0.4968429 0.49687392 0.49685642 0.49682146 0.4968217
0.49685854 0.4968694 0.4967817 0.49680498 0.49676204 0.4968063
0.49676275 0.4967781 0.49681583 0.4967711 0.49678782 0.49677876
0.4967793 0.4967937 0.4968316 0.49681288 0.49679205 0.496793
0.49675027 0.49680963 0.4967918 0.49683547 0.496813 0.4968077
0.49676445 0.4967917 0.49678734 0.49677023 0.49678335 0.49681148
0.4967644 0.49679682 0.49678877 0.49681866 0.49681675 0.496759
0.49680263 0.49681187 0.4967638 0.4967898 0.49682006 0.4968037
0.49679622 0.4967737 0.49681643 0.49677253 0.4968156 0.4968
0.4967631 0.49680734 0.49679005 0.49679983 0.49679923 0.49678427
0.4967479 0.49676582 0.49678636 0.49678552 0.4968284 0.4967691
0.49678642 0.49674416 0.4967657 0.49677062 0.49681407 0.49678692
0.49679077 0.49680817 0.49679524 0.49676728 0.49681395 0.49678183
0.49678946 0.49676022 0.49676204 0.4968194 0.49677557 0.49676675
0.49681482 0.4967887 0.49675888 0.49677464]
160/160 [=====] - 0s 767us/step

```
In [55]:
```

```
#Five layers, four neurons per layer: loss
scores_optimal_sigmoid, optimal_sigmoid.metrics_names
```

```
Out[56]:
```

```
(0.6931670546531677, ['loss'])
```

Activation softplus:

```
In [57]:
```

```
n = 40
xx = np.random.random((n,1))
yy = np.random.random((n,1))

X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

```
In [58]:
```

```
#Five layers, four neurons per layer
optimal_softplus = Sequential()

#hidden layers
optimal_softplus.add(Dense(4, input_dim=2, activation='softplus'))
optimal_softplus.add(Dense(4, activation='softplus'))
optimal_softplus.add(Dense(4, activation='softplus'))
optimal_softplus.add(Dense(4, activation='softplus'))
optimal_softplus.add(Dense(4, activation='softplus'))

#output layer
optimal_softplus.add(Dense(1, activation='softplus'))

sgd = SGD(lr=0.1)
optimal_softplus.compile(loss='binary_crossentropy', optimizer='sgd')

optimal_softplus.fit(X, y, batch_size=2, epochs=400)
print(optimal_softplus.predict_proba(X).reshape(4*n))

#evaluate the model
scores_optimal_softplus = optimal_softplus.evaluate(X, y)
```

```
Epoch 1/400
160/160 [=====] - 0s 3ms/step - loss: 0.7063
Epoch 2/400
160/160 [=====] - 0s 305us/step - loss: 0.7022
Epoch 3/400
160/160 [=====] - 0s 299us/step - loss: 0.7030
Epoch 4/400
160/160 [=====] - 0s 305us/step - loss: 0.7013
Epoch 5/400
160/160 [=====] - 0s 299us/step - loss: 0.6990
Epoch 6/400
160/160 [=====] - 0s 305us/step - loss: 0.7033
Epoch 7/400
160/160 [=====] - 0s 299us/step - loss: 0.7022
Epoch 8/400
160/160 [=====] - 0s 293us/step - loss: 0.7035
Epoch 9/400
160/160 [=====] - 0s 293us/step - loss: 0.6991
Epoch 10/400
160/160 [=====] - 0s 299us/step - loss: 0.6855
Epoch 11/400
160/160 [=====] - 0s 293us/step - loss: 0.7038
Epoch 12/400
160/160 [=====] - 0s 299us/step - loss: 0.7016
Epoch 13/400
160/160 [=====] - 0s 299us/step - loss: 0.7052
Epoch 14/400
160/160 [=====] - 0s 299us/step - loss: 0.7031
Epoch 15/400
160/160 [=====] - 0s 287us/step - loss: 0.7024
Epoch 16/400
160/160 [=====] - 0s 293us/step - loss: 0.7029
Epoch 17/400
160/160 [=====] - 0s 299us/step - loss: 0.7009
```

Epoch 18/400
160/160 [=====] - 0s 299us/step - loss: 0.7036
Epoch 19/400
160/160 [=====] - 0s 299us/step - loss: 0.6967
Epoch 20/400
160/160 [=====] - 0s 302us/step - loss: 0.7022
Epoch 21/400
160/160 [=====] - 0s 299us/step - loss: 0.6987
Epoch 22/400
160/160 [=====] - 0s 321us/step - loss: 0.6986
Epoch 23/400
160/160 [=====] - 0s 299us/step - loss: 0.7022
Epoch 24/400
160/160 [=====] - 0s 299us/step - loss: 0.6975
Epoch 25/400
160/160 [=====] - 0s 293us/step - loss: 0.7023
Epoch 26/400
160/160 [=====] - 0s 299us/step - loss: 0.7014
Epoch 27/400
160/160 [=====] - 0s 299us/step - loss: 0.7021
Epoch 28/400
160/160 [=====] - 0s 299us/step - loss: 0.7009
Epoch 29/400
160/160 [=====] - 0s 318us/step - loss: 0.6999
Epoch 30/400
160/160 [=====] - 0s 293us/step - loss: 0.7006
Epoch 31/400
160/160 [=====] - 0s 305us/step - loss: 0.7023
Epoch 32/400
160/160 [=====] - 0s 296us/step - loss: 0.6985
Epoch 33/400
160/160 [=====] - 0s 299us/step - loss: 0.6993
Epoch 34/400
160/160 [=====] - 0s 299us/step - loss: 0.7030
Epoch 35/400
160/160 [=====] - 0s 290us/step - loss: 0.6993
Epoch 36/400
160/160 [=====] - 0s 299us/step - loss: 0.7021
Epoch 37/400
160/160 [=====] - 0s 302us/step - loss: 0.6891
Epoch 38/400
160/160 [=====] - 0s 293us/step - loss: 0.7013
Epoch 39/400
160/160 [=====] - 0s 299us/step - loss: 0.7023
Epoch 40/400
160/160 [=====] - 0s 299us/step - loss: 0.6996
Epoch 41/400
160/160 [=====] - 0s 299us/step - loss: 0.7000
Epoch 42/400
160/160 [=====] - 0s 299us/step - loss: 0.6966
Epoch 43/400
160/160 [=====] - 0s 318us/step - loss: 0.7034
Epoch 44/400
160/160 [=====] - 0s 293us/step - loss: 0.7000
Epoch 45/400
160/160 [=====] - 0s 299us/step - loss: 0.6996
Epoch 46/400
160/160 [=====] - 0s 305us/step - loss: 0.6964
Epoch 47/400
160/160 [=====] - 0s 305us/step - loss: 0.7035
Epoch 48/400
160/160 [=====] - 0s 305us/step - loss: 0.7005
Epoch 49/400
160/160 [=====] - 0s 299us/step - loss: 0.6973
Epoch 50/400
160/160 [=====] - 0s 299us/step - loss: 0.6988
Epoch 51/400
160/160 [=====] - 0s 299us/step - loss: 0.6983
Epoch 52/400
160/160 [=====] - 0s 299us/step - loss: 0.7030
Epoch 53/400
160/160 [=====] - 0s 299us/step - loss: 0.6951
Epoch 54/400
160/160 [=====] - 0s 293us/step - loss: 0.6954
Epoch 55/400
160/160 [=====] - 0s 299us/step - loss: 0.7008
Epoch 56/400

160/160 [=====] - 0s 293us/step - loss: 0.7005
Epoch 57/400
160/160 [=====] - 0s 293us/step - loss: 0.6985
Epoch 58/400
160/160 [=====] - 0s 299us/step - loss: 0.6987
Epoch 59/400
160/160 [=====] - 0s 293us/step - loss: 0.6987
Epoch 60/400
160/160 [=====] - 0s 287us/step - loss: 0.6985
Epoch 61/400
160/160 [=====] - 0s 287us/step - loss: 0.6916
Epoch 62/400
160/160 [=====] - 0s 299us/step - loss: 0.7038
Epoch 63/400
160/160 [=====] - 0s 312us/step - loss: 0.6997
Epoch 64/400
160/160 [=====] - 0s 299us/step - loss: 0.6968
Epoch 65/400
160/160 [=====] - 0s 305us/step - loss: 0.7016
Epoch 66/400
160/160 [=====] - 0s 296us/step - loss: 0.7000
Epoch 67/400
160/160 [=====] - 0s 293us/step - loss: 0.6975
Epoch 68/400
160/160 [=====] - 0s 296us/step - loss: 0.7007
Epoch 69/400
160/160 [=====] - 0s 293us/step - loss: 0.7015
Epoch 70/400
160/160 [=====] - 0s 290us/step - loss: 0.6916
Epoch 71/400
160/160 [=====] - 0s 280us/step - loss: 0.7001
Epoch 72/400
160/160 [=====] - 0s 280us/step - loss: 0.6990
Epoch 73/400
160/160 [=====] - 0s 293us/step - loss: 0.6996
Epoch 74/400
160/160 [=====] - 0s 293us/step - loss: 0.6993
Epoch 75/400
160/160 [=====] - 0s 287us/step - loss: 0.7006
Epoch 76/400
160/160 [=====] - 0s 293us/step - loss: 0.6995
Epoch 77/400
160/160 [=====] - 0s 287us/step - loss: 0.6988
Epoch 78/400
160/160 [=====] - 0s 287us/step - loss: 0.6980
Epoch 79/400
160/160 [=====] - 0s 287us/step - loss: 0.6982
Epoch 80/400
160/160 [=====] - 0s 287us/step - loss: 0.6986
Epoch 81/400
160/160 [=====] - 0s 305us/step - loss: 0.6980
Epoch 82/400
160/160 [=====] - 0s 293us/step - loss: 0.6987
Epoch 83/400
160/160 [=====] - 0s 287us/step - loss: 0.6988
Epoch 84/400
160/160 [=====] - 0s 287us/step - loss: 0.6973
Epoch 85/400
160/160 [=====] - 0s 305us/step - loss: 0.6983
Epoch 86/400
160/160 [=====] - 0s 293us/step - loss: 0.6959
Epoch 87/400
160/160 [=====] - 0s 293us/step - loss: 0.7001
Epoch 88/400
160/160 [=====] - 0s 287us/step - loss: 0.6968
Epoch 89/400
160/160 [=====] - 0s 290us/step - loss: 0.6993
Epoch 90/400
160/160 [=====] - 0s 287us/step - loss: 0.6989
Epoch 91/400
160/160 [=====] - 0s 284us/step - loss: 0.6986
Epoch 92/400
160/160 [=====] - 0s 287us/step - loss: 0.7000
Epoch 93/400
160/160 [=====] - 0s 287us/step - loss: 0.6970
Epoch 94/400
160/160 [=====] - 0s 287us/step - loss: 0.6987

Epoch 95/400
160/160 [=====] - 0s 305us/step - loss: 0.6944
Epoch 96/400
160/160 [=====] - 0s 287us/step - loss: 0.6992
Epoch 97/400
160/160 [=====] - 0s 280us/step - loss: 0.6995
Epoch 98/400
160/160 [=====] - 0s 299us/step - loss: 0.6975
Epoch 99/400
160/160 [=====] - 0s 287us/step - loss: 0.6992
Epoch 100/400
160/160 [=====] - 0s 281us/step - loss: 0.6993
Epoch 101/400
160/160 [=====] - 0s 293us/step - loss: 0.6989
Epoch 102/400
160/160 [=====] - 0s 302us/step - loss: 0.6998
Epoch 103/400
160/160 [=====] - 0s 293us/step - loss: 0.6997
Epoch 104/400
160/160 [=====] - 0s 284us/step - loss: 0.6983
Epoch 105/400
160/160 [=====] - 0s 287us/step - loss: 0.6971
Epoch 106/400
160/160 [=====] - 0s 321us/step - loss: 0.6972
Epoch 107/400
160/160 [=====] - 0s 299us/step - loss: 0.7001
Epoch 108/400
160/160 [=====] - 0s 305us/step - loss: 0.6987
Epoch 109/400
160/160 [=====] - 0s 287us/step - loss: 0.6973
Epoch 110/400
160/160 [=====] - 0s 293us/step - loss: 0.6981
Epoch 111/400
160/160 [=====] - 0s 293us/step - loss: 0.6983
Epoch 112/400
160/160 [=====] - 0s 318us/step - loss: 0.6970
Epoch 113/400
160/160 [=====] - 0s 299us/step - loss: 0.7001
Epoch 114/400
160/160 [=====] - 0s 281us/step - loss: 0.6970
Epoch 115/400
160/160 [=====] - 0s 287us/step - loss: 0.7005
Epoch 116/400
160/160 [=====] - 0s 287us/step - loss: 0.6978
Epoch 117/400
160/160 [=====] - 0s 299us/step - loss: 0.6995
Epoch 118/400
160/160 [=====] - 0s 287us/step - loss: 0.6977
Epoch 119/400
160/160 [=====] - 0s 293us/step - loss: 0.6951
Epoch 120/400
160/160 [=====] - 0s 293us/step - loss: 0.6970
Epoch 121/400
160/160 [=====] - 0s 312us/step - loss: 0.6974
Epoch 122/400
160/160 [=====] - 0s 299us/step - loss: 0.6983
Epoch 123/400
160/160 [=====] - 0s 290us/step - loss: 0.6973
Epoch 124/400
160/160 [=====] - 0s 287us/step - loss: 0.6954
Epoch 125/400
160/160 [=====] - 0s 321us/step - loss: 0.6994
Epoch 126/400
160/160 [=====] - 0s 305us/step - loss: 0.6959
Epoch 127/400
160/160 [=====] - 0s 305us/step - loss: 0.6991
Epoch 128/400
160/160 [=====] - 0s 299us/step - loss: 0.6973
Epoch 129/400
160/160 [=====] - 0s 305us/step - loss: 0.6972
Epoch 130/400
160/160 [=====] - 0s 287us/step - loss: 0.6954
Epoch 131/400
160/160 [=====] - 0s 293us/step - loss: 0.6966
Epoch 132/400
160/160 [=====] - 0s 293us/step - loss: 0.6940
Epoch 133/400

160/160 [=====] - 0s 299us/step - loss: 0.6982
Epoch 134/400
160/160 [=====] - 0s 312us/step - loss: 0.6960
Epoch 135/400
160/160 [=====] - 0s 293us/step - loss: 0.6968
Epoch 136/400
160/160 [=====] - 0s 287us/step - loss: 0.6976
Epoch 137/400
160/160 [=====] - 0s 299us/step - loss: 0.6963
Epoch 138/400
160/160 [=====] - 0s 296us/step - loss: 0.6971
Epoch 139/400
160/160 [=====] - 0s 287us/step - loss: 0.7000
Epoch 140/400
160/160 [=====] - 0s 296us/step - loss: 0.6980
Epoch 141/400
160/160 [=====] - 0s 293us/step - loss: 0.6960
Epoch 142/400
160/160 [=====] - 0s 296us/step - loss: 0.6972
Epoch 143/400
160/160 [=====] - 0s 293us/step - loss: 0.6969
Epoch 144/400
160/160 [=====] - 0s 296us/step - loss: 0.6966
Epoch 145/400
160/160 [=====] - 0s 293us/step - loss: 0.6979
Epoch 146/400
160/160 [=====] - 0s 299us/step - loss: 0.6967
Epoch 147/400
160/160 [=====] - 0s 318us/step - loss: 0.6976
Epoch 148/400
160/160 [=====] - 0s 305us/step - loss: 0.6961
Epoch 149/400
160/160 [=====] - 0s 299us/step - loss: 0.6958
Epoch 150/400
160/160 [=====] - 0s 312us/step - loss: 0.6949
Epoch 151/400
160/160 [=====] - 0s 293us/step - loss: 0.6961
Epoch 152/400
160/160 [=====] - 0s 293us/step - loss: 0.6969
Epoch 153/400
160/160 [=====] - 0s 293us/step - loss: 0.6971
Epoch 154/400
160/160 [=====] - 0s 293us/step - loss: 0.6958
Epoch 155/400
160/160 [=====] - 0s 287us/step - loss: 0.6968
Epoch 156/400
160/160 [=====] - 0s 287us/step - loss: 0.6965
Epoch 157/400
160/160 [=====] - 0s 299us/step - loss: 0.6949
Epoch 158/400
160/160 [=====] - 0s 293us/step - loss: 0.6965
Epoch 159/400
160/160 [=====] - 0s 293us/step - loss: 0.6963
Epoch 160/400
160/160 [=====] - 0s 287us/step - loss: 0.6924
Epoch 161/400
160/160 [=====] - 0s 281us/step - loss: 0.6983
Epoch 162/400
160/160 [=====] - 0s 287us/step - loss: 0.6963
Epoch 163/400
160/160 [=====] - 0s 284us/step - loss: 0.6960
Epoch 164/400
160/160 [=====] - 0s 299us/step - loss: 0.6944
Epoch 165/400
160/160 [=====] - 0s 293us/step - loss: 0.6972
Epoch 166/400
160/160 [=====] - 0s 293us/step - loss: 0.6971
Epoch 167/400
160/160 [=====] - 0s 287us/step - loss: 0.6951
Epoch 168/400
160/160 [=====] - 0s 299us/step - loss: 0.6965
Epoch 169/400
160/160 [=====] - 0s 299us/step - loss: 0.6962
Epoch 170/400
160/160 [=====] - 0s 287us/step - loss: 0.6959
Epoch 171/400
160/160 [=====] - 0s 287us/step - loss: 0.6965

```
Epoch 172/400
160/160 [=====] - 0s 305us/step - loss: 0.6953
Epoch 173/400
160/160 [=====] - 0s 305us/step - loss: 0.6932
Epoch 174/400
160/160 [=====] - 0s 299us/step - loss: 0.6953
Epoch 175/400
160/160 [=====] - 0s 312us/step - loss: 0.6944
Epoch 176/400
160/160 [=====] - 0s 315us/step - loss: 0.6947
Epoch 177/400
160/160 [=====] - 0s 305us/step - loss: 0.6954
Epoch 178/400
160/160 [=====] - 0s 302us/step - loss: 0.6962
Epoch 179/400
160/160 [=====] - 0s 299us/step - loss: 0.6941
Epoch 180/400
160/160 [=====] - 0s 309us/step - loss: 0.6934
Epoch 181/400
160/160 [=====] - 0s 305us/step - loss: 0.6940
Epoch 182/400
160/160 [=====] - 0s 287us/step - loss: 0.6937
Epoch 183/400
160/160 [=====] - 0s 293us/step - loss: 0.6942
Epoch 184/400
160/160 [=====] - 0s 293us/step - loss: 0.6902
Epoch 185/400
160/160 [=====] - 0s 293us/step - loss: 0.6949
Epoch 186/400
160/160 [=====] - 0s 293us/step - loss: 0.6932
Epoch 187/400
160/160 [=====] - 0s 293us/step - loss: 0.6924
Epoch 188/400
160/160 [=====] - 0s 287us/step - loss: 0.6935
Epoch 189/400
160/160 [=====] - 0s 299us/step - loss: 0.6891
Epoch 190/400
160/160 [=====] - 0s 305us/step - loss: 0.6946
Epoch 191/400
160/160 [=====] - 0s 324us/step - loss: 0.6933
Epoch 192/400
160/160 [=====] - 0s 293us/step - loss: 0.6931
Epoch 193/400
160/160 [=====] - 0s 287us/step - loss: 0.6899
Epoch 194/400
160/160 [=====] - 0s 287us/step - loss: 0.6916
Epoch 195/400
160/160 [=====] - 0s 293us/step - loss: 0.6886
Epoch 196/400
160/160 [=====] - 0s 293us/step - loss: 0.6918
Epoch 197/400
160/160 [=====] - 0s 280us/step - loss: 0.6913
Epoch 198/400
160/160 [=====] - 0s 293us/step - loss: 0.6895
Epoch 199/400
160/160 [=====] - 0s 280us/step - loss: 0.6890
Epoch 200/400
160/160 [=====] - 0s 287us/step - loss: 0.6878
Epoch 201/400
160/160 [=====] - 0s 293us/step - loss: 0.6890
Epoch 202/400
160/160 [=====] - 0s 299us/step - loss: 0.6867
Epoch 203/400
160/160 [=====] - 0s 299us/step - loss: 0.6887
Epoch 204/400
160/160 [=====] - 0s 299us/step - loss: 0.6857
Epoch 205/400
160/160 [=====] - 0s 299us/step - loss: 0.6858
Epoch 206/400
160/160 [=====] - 0s 299us/step - loss: 0.6862
Epoch 207/400
160/160 [=====] - 0s 296us/step - loss: 0.6790
Epoch 208/400
160/160 [=====] - 0s 293us/step - loss: 0.6835
Epoch 209/400
160/160 [=====] - 0s 296us/step - loss: 0.6822
Epoch 210/400
```

Epoch 210/400
160/160 [=====] - 0s 305us/step - loss: 0.6801
Epoch 211/400
160/160 [=====] - 0s 321us/step - loss: 0.6746
Epoch 212/400
160/160 [=====] - 0s 305us/step - loss: 0.6823
Epoch 213/400
160/160 [=====] - 0s 302us/step - loss: 0.6719
Epoch 214/400
160/160 [=====] - 0s 293us/step - loss: 0.6780
Epoch 215/400
160/160 [=====] - 0s 305us/step - loss: 0.6755
Epoch 216/400
160/160 [=====] - 0s 281us/step - loss: 0.6774
Epoch 217/400
160/160 [=====] - 0s 299us/step - loss: 0.6742
Epoch 218/400
160/160 [=====] - 0s 287us/step - loss: 0.6723
Epoch 219/400
160/160 [=====] - 0s 293us/step - loss: 0.6708
Epoch 220/400
160/160 [=====] - 0s 287us/step - loss: 0.6692
Epoch 221/400
160/160 [=====] - 0s 299us/step - loss: 0.6667
Epoch 222/400
160/160 [=====] - 0s 287us/step - loss: 0.6661
Epoch 223/400
160/160 [=====] - 0s 287us/step - loss: 0.6649
Epoch 224/400
160/160 [=====] - 0s 293us/step - loss: 0.6606
Epoch 225/400
160/160 [=====] - 0s 293us/step - loss: 0.6607
Epoch 226/400
160/160 [=====] - 0s 287us/step - loss: 0.6590
Epoch 227/400
160/160 [=====] - 0s 293us/step - loss: 0.6566
Epoch 228/400
160/160 [=====] - 0s 299us/step - loss: 0.6539
Epoch 229/400
160/160 [=====] - 0s 293us/step - loss: 0.6516
Epoch 230/400
160/160 [=====] - 0s 299us/step - loss: 0.6497
Epoch 231/400
160/160 [=====] - 0s 305us/step - loss: 0.6486
Epoch 232/400
160/160 [=====] - 0s 284us/step - loss: 0.6425
Epoch 233/400
160/160 [=====] - 0s 293us/step - loss: 0.6435
Epoch 234/400
160/160 [=====] - 0s 287us/step - loss: 0.6382
Epoch 235/400
160/160 [=====] - 0s 287us/step - loss: 0.6333
Epoch 236/400
160/160 [=====] - 0s 287us/step - loss: 0.6269
Epoch 237/400
160/160 [=====] - 0s 287us/step - loss: 0.6324
Epoch 238/400
160/160 [=====] - 0s 293us/step - loss: 0.6321
Epoch 239/400
160/160 [=====] - 0s 299us/step - loss: 0.6293
Epoch 240/400
160/160 [=====] - 0s 299us/step - loss: 0.6271
Epoch 241/400
160/160 [=====] - 0s 281us/step - loss: 0.6214
Epoch 242/400
160/160 [=====] - 0s 281us/step - loss: 0.6219
Epoch 243/400
160/160 [=====] - 0s 284us/step - loss: 0.6192
Epoch 244/400
160/160 [=====] - 0s 281us/step - loss: 0.6163
Epoch 245/400
160/160 [=====] - 0s 290us/step - loss: 0.6143
Epoch 246/400
160/160 [=====] - 0s 293us/step - loss: 0.6082
Epoch 247/400
160/160 [=====] - 0s 296us/step - loss: 0.5996
Epoch 248/400
160/160 [=====] - 0s 293us/step - loss: 0.6036

100%|██████████| 287/400 [00:00:00, 0.00us/step - loss: 0.4519
Epoch 249/400
160/160 [=====] - 0s 290us/step - loss: 0.5961
Epoch 250/400
160/160 [=====] - 0s 287us/step - loss: 0.5873
Epoch 251/400
160/160 [=====] - 0s 299us/step - loss: 0.5867
Epoch 252/400
160/160 [=====] - 0s 309us/step - loss: 0.5821
Epoch 253/400
160/160 [=====] - 0s 287us/step - loss: 0.5654
Epoch 254/400
160/160 [=====] - 0s 293us/step - loss: 0.5656
Epoch 255/400
160/160 [=====] - 0s 299us/step - loss: 0.5520
Epoch 256/400
160/160 [=====] - 0s 293us/step - loss: 0.5405
Epoch 257/400
160/160 [=====] - 0s 293us/step - loss: 0.5161
Epoch 258/400
160/160 [=====] - 0s 287us/step - loss: 0.5132
Epoch 259/400
160/160 [=====] - 0s 281us/step - loss: 0.5034
Epoch 260/400
160/160 [=====] - 0s 280us/step - loss: 0.6118
Epoch 261/400
160/160 [=====] - 0s 287us/step - loss: 0.5071
Epoch 262/400
160/160 [=====] - 0s 287us/step - loss: 0.5023
Epoch 263/400
160/160 [=====] - 0s 293us/step - loss: 0.4859
Epoch 264/400
160/160 [=====] - 0s 287us/step - loss: 0.5039
Epoch 265/400
160/160 [=====] - 0s 287us/step - loss: 0.6906
Epoch 266/400
160/160 [=====] - 0s 287us/step - loss: 0.4840
Epoch 267/400
160/160 [=====] - 0s 287us/step - loss: 0.5989
Epoch 268/400
160/160 [=====] - 0s 287us/step - loss: 0.5080
Epoch 269/400
160/160 [=====] - 0s 280us/step - loss: 0.4943
Epoch 270/400
160/160 [=====] - 0s 293us/step - loss: 0.4697
Epoch 271/400
160/160 [=====] - 0s 293us/step - loss: 0.6355
Epoch 272/400
160/160 [=====] - 0s 287us/step - loss: 0.4866
Epoch 273/400
160/160 [=====] - 0s 305us/step - loss: 0.4789
Epoch 274/400
160/160 [=====] - 0s 312us/step - loss: 0.4718
Epoch 275/400
160/160 [=====] - 0s 299us/step - loss: 0.4713
Epoch 276/400
160/160 [=====] - 0s 293us/step - loss: 0.4727
Epoch 277/400
160/160 [=====] - 0s 287us/step - loss: 0.4797
Epoch 278/400
160/160 [=====] - 0s 287us/step - loss: 0.4912
Epoch 279/400
160/160 [=====] - 0s 290us/step - loss: 0.6544
Epoch 280/400
160/160 [=====] - 0s 281us/step - loss: 0.4824
Epoch 281/400
160/160 [=====] - 0s 302us/step - loss: 0.4650
Epoch 282/400
160/160 [=====] - 0s 293us/step - loss: 0.4623
Epoch 283/400
160/160 [=====] - 0s 293us/step - loss: 0.4676
Epoch 284/400
160/160 [=====] - 0s 290us/step - loss: 0.4796
Epoch 285/400
160/160 [=====] - 0s 312us/step - loss: 0.4549
Epoch 286/400
160/160 [=====] - 0s 290us/step - loss: 0.4519
Epoch 287/400

Epoch 200/400
160/160 [=====] - 0s 281us/step - loss: 0.4552
Epoch 288/400
160/160 [=====] - 0s 287us/step - loss: 0.5982
Epoch 289/400
160/160 [=====] - 0s 287us/step - loss: 0.6432
Epoch 290/400
160/160 [=====] - 0s 293us/step - loss: 0.4775
Epoch 291/400
160/160 [=====] - 0s 287us/step - loss: 0.4640
Epoch 292/400
160/160 [=====] - 0s 287us/step - loss: 0.4477
Epoch 293/400
160/160 [=====] - 0s 293us/step - loss: 0.4500
Epoch 294/400
160/160 [=====] - 0s 299us/step - loss: 0.4487
Epoch 295/400
160/160 [=====] - 0s 312us/step - loss: 0.5303
Epoch 296/400
160/160 [=====] - 0s 299us/step - loss: 0.4464
Epoch 297/400
160/160 [=====] - 0s 293us/step - loss: 0.4373
Epoch 298/400
160/160 [=====] - 0s 299us/step - loss: 0.4712
Epoch 299/400
160/160 [=====] - 0s 287us/step - loss: 0.4453
Epoch 300/400
160/160 [=====] - 0s 287us/step - loss: 0.4395
Epoch 301/400
160/160 [=====] - 0s 287us/step - loss: 0.4448
Epoch 302/400
160/160 [=====] - 0s 293us/step - loss: 0.4404
Epoch 303/400
160/160 [=====] - 0s 293us/step - loss: 0.4514
Epoch 304/400
160/160 [=====] - 0s 287us/step - loss: 0.4405
Epoch 305/400
160/160 [=====] - 0s 290us/step - loss: 0.4359
Epoch 306/400
160/160 [=====] - 0s 287us/step - loss: 0.4336
Epoch 307/400
160/160 [=====] - 0s 284us/step - loss: 0.4341
Epoch 308/400
160/160 [=====] - 0s 293us/step - loss: 0.4413
Epoch 309/400
160/160 [=====] - 0s 287us/step - loss: 0.4315
Epoch 310/400
160/160 [=====] - 0s 293us/step - loss: 0.4356
Epoch 311/400
160/160 [=====] - 0s 287us/step - loss: 0.4363
Epoch 312/400
160/160 [=====] - 0s 293us/step - loss: 0.4247
Epoch 313/400
160/160 [=====] - 0s 293us/step - loss: 0.4314
Epoch 314/400
160/160 [=====] - 0s 281us/step - loss: 0.4271
Epoch 315/400
160/160 [=====] - 0s 299us/step - loss: 0.4341
Epoch 316/400
160/160 [=====] - 0s 312us/step - loss: 0.4262
Epoch 317/400
160/160 [=====] - 0s 287us/step - loss: 0.4240
Epoch 318/400
160/160 [=====] - 0s 305us/step - loss: 0.4294
Epoch 319/400
160/160 [=====] - 0s 293us/step - loss: 0.4293
Epoch 320/400
160/160 [=====] - 0s 296us/step - loss: 0.4267
Epoch 321/400
160/160 [=====] - 0s 293us/step - loss: 0.4317
Epoch 322/400
160/160 [=====] - 0s 293us/step - loss: 0.4177
Epoch 323/400
160/160 [=====] - 0s 293us/step - loss: 0.4315
Epoch 324/400
160/160 [=====] - 0s 293us/step - loss: 0.4278
Epoch 325/400
160/160 [=====] - 0s 293us/step - loss: 0.4212

100/100 [=====] - 0s 290us/step - loss: 0.4242
Epoch 326/400
160/160 [=====] - 0s 287us/step - loss: 0.4211
Epoch 327/400
160/160 [=====] - 0s 293us/step - loss: 0.4256
Epoch 328/400
160/160 [=====] - 0s 287us/step - loss: 0.4186
Epoch 329/400
160/160 [=====] - 0s 281us/step - loss: 0.4194
Epoch 330/400
160/160 [=====] - 0s 293us/step - loss: 0.4128
Epoch 331/400
160/160 [=====] - 0s 293us/step - loss: 0.4174
Epoch 332/400
160/160 [=====] - 0s 287us/step - loss: 0.4181
Epoch 333/400
160/160 [=====] - 0s 293us/step - loss: 0.4290
Epoch 334/400
160/160 [=====] - 0s 293us/step - loss: 0.4173
Epoch 335/400
160/160 [=====] - 0s 287us/step - loss: 0.4237
Epoch 336/400
160/160 [=====] - 0s 299us/step - loss: 0.4197
Epoch 337/400
160/160 [=====] - 0s 324us/step - loss: 0.4247
Epoch 338/400
160/160 [=====] - 0s 287us/step - loss: 0.4231
Epoch 339/400
160/160 [=====] - 0s 299us/step - loss: 0.4148
Epoch 340/400
160/160 [=====] - 0s 293us/step - loss: 0.4161
Epoch 341/400
160/160 [=====] - 0s 293us/step - loss: 0.4209
Epoch 342/400
160/160 [=====] - 0s 287us/step - loss: 0.4173
Epoch 343/400
160/160 [=====] - 0s 299us/step - loss: 0.4175
Epoch 344/400
160/160 [=====] - 0s 299us/step - loss: 0.4146
Epoch 345/400
160/160 [=====] - 0s 305us/step - loss: 0.4205
Epoch 346/400
160/160 [=====] - 0s 287us/step - loss: 0.4155
Epoch 347/400
160/160 [=====] - 0s 302us/step - loss: 0.4162
Epoch 348/400
160/160 [=====] - 0s 293us/step - loss: 0.4158
Epoch 349/400
160/160 [=====] - 0s 293us/step - loss: 0.4171
Epoch 350/400
160/160 [=====] - 0s 284us/step - loss: 0.4140
Epoch 351/400
160/160 [=====] - 0s 280us/step - loss: 0.4182
Epoch 352/400
160/160 [=====] - 0s 284us/step - loss: 0.4128
Epoch 353/400
160/160 [=====] - 0s 287us/step - loss: 0.4174
Epoch 354/400
160/160 [=====] - 0s 296us/step - loss: 0.4211
Epoch 355/400
160/160 [=====] - 0s 299us/step - loss: 0.4136
Epoch 356/400
160/160 [=====] - 0s 287us/step - loss: 0.4088
Epoch 357/400
160/160 [=====] - 0s 293us/step - loss: 0.4184
Epoch 358/400
160/160 [=====] - 0s 312us/step - loss: 0.4043
Epoch 359/400
160/160 [=====] - 0s 287us/step - loss: 0.4172
Epoch 360/400
160/160 [=====] - 0s 299us/step - loss: 0.4190
Epoch 361/400
160/160 [=====] - 0s 287us/step - loss: 0.4153
Epoch 362/400
160/160 [=====] - 0s 287us/step - loss: 0.4164
Epoch 363/400
160/160 [=====] - 0s 287us/step - loss: 0.4152

Epoch 364/400

Epoch 364/400
160/160 [=====] - 0s 287us/step - loss: 0.4123
Epoch 365/400
160/160 [=====] - 0s 287us/step - loss: 0.4147
Epoch 366/400
160/160 [=====] - 0s 287us/step - loss: 0.4152
Epoch 367/400
160/160 [=====] - 0s 299us/step - loss: 0.4099
Epoch 368/400
160/160 [=====] - 0s 287us/step - loss: 0.4171
Epoch 369/400
160/160 [=====] - 0s 293us/step - loss: 0.4173
Epoch 370/400
160/160 [=====] - 0s 287us/step - loss: 0.4128
Epoch 371/400
160/160 [=====] - 0s 296us/step - loss: 0.4144
Epoch 372/400
160/160 [=====] - 0s 293us/step - loss: 0.4123
Epoch 373/400
160/160 [=====] - 0s 299us/step - loss: 0.4145
Epoch 374/400
160/160 [=====] - 0s 293us/step - loss: 0.4115
Epoch 375/400
160/160 [=====] - 0s 296us/step - loss: 0.4134
Epoch 376/400
160/160 [=====] - 0s 305us/step - loss: 0.4130
Epoch 377/400
160/160 [=====] - 0s 305us/step - loss: 0.4064
Epoch 378/400
160/160 [=====] - 0s 299us/step - loss: 0.4115
Epoch 379/400
160/160 [=====] - 0s 312us/step - loss: 0.4110
Epoch 380/400
160/160 [=====] - 0s 293us/step - loss: 0.4154
Epoch 381/400
160/160 [=====] - 0s 305us/step - loss: 0.4140
Epoch 382/400
160/160 [=====] - 0s 299us/step - loss: 0.4142
Epoch 383/400
160/160 [=====] - 0s 299us/step - loss: 0.4128
Epoch 384/400
160/160 [=====] - 0s 293us/step - loss: 0.4122
Epoch 385/400
160/160 [=====] - 0s 290us/step - loss: 0.4129
Epoch 386/400
160/160 [=====] - 0s 293us/step - loss: 0.4124
Epoch 387/400
160/160 [=====] - 0s 293us/step - loss: 0.4123
Epoch 388/400
160/160 [=====] - 0s 284us/step - loss: 0.4056
Epoch 389/400
160/160 [=====] - 0s 293us/step - loss: 0.4121
Epoch 390/400
160/160 [=====] - 0s 284us/step - loss: 0.4097
Epoch 391/400
160/160 [=====] - 0s 287us/step - loss: 0.4162
Epoch 392/400
160/160 [=====] - 0s 284us/step - loss: 0.4122
Epoch 393/400
160/160 [=====] - 0s 299us/step - loss: 0.4135
Epoch 394/400
160/160 [=====] - 0s 296us/step - loss: 0.4076
Epoch 395/400
160/160 [=====] - 0s 293us/step - loss: 0.4078
Epoch 396/400
160/160 [=====] - 0s 287us/step - loss: 0.4104
Epoch 397/400
160/160 [=====] - 0s 293us/step - loss: 0.4067
Epoch 398/400
160/160 [=====] - 0s 287us/step - loss: 0.4104
Epoch 399/400
160/160 [=====] - 0s 293us/step - loss: 0.4084
Epoch 400/400
160/160 [=====] - 0s 299us/step - loss: 0.4152
[7.82463253e-01 8.13689530e-01 7.56421506e-01 4.56284404e-01
7.73159564e-01 8.22919488e-01 5.04784703e-01 7.99376845e-01
3.63939315e-01 7.85788834e-01 5.93029320e-01 8.20225894e-01
2.77207615e-01 4.05050100e-01 2.01011000e-01 2.11205042e-01

```

3.21391645e-01 4.85958129e-01 8.04044008e-01 8.11395943e-01
7.49491572e-01 5.58598518e-01 6.96432650e-01 8.13236058e-01
7.32671797e-01 8.02192867e-01 7.79479086e-01 4.32857335e-01
7.81952679e-01 8.17292035e-01 5.88509858e-01 8.23599696e-01
5.03673315e-01 5.14815092e-01 8.16815495e-01 8.22446108e-01
7.74362683e-01 8.24220479e-01 7.59804368e-01 8.24023485e-01
7.86440372e-01 7.56849647e-01 7.75266051e-01 7.99890935e-01
7.97280669e-01 8.14268112e-01 7.78081059e-01 4.10242260e-01
7.48925865e-01 8.19526017e-01 4.66627240e-01 8.07853401e-01
4.64852691e-01 7.98838377e-01 5.45233905e-01 8.21856439e-01
4.29980338e-01 5.60107887e-01 8.13352704e-01 7.95388758e-01
7.67298818e-01 5.24032950e-01 7.29005694e-01 8.19307089e-01
7.57971704e-01 8.06059480e-01 7.96152592e-01 5.19403696e-01
7.90468156e-01 8.06381226e-01 6.41587555e-01 8.12042534e-01
5.75087190e-01 4.73259598e-01 8.18640530e-01 8.20271969e-01
7.50853360e-01 8.13030124e-01 7.37067163e-01 8.18739295e-01
7.98924387e-01 7.76550353e-01 7.51307189e-01 8.11114371e-01
5.24776936e-01 3.21864559e-06 7.45182931e-01 3.65518266e-03
4.43118870e-01 1.86900375e-03 6.89983717e-04 3.36652510e-02
7.87942336e-05 1.88056186e-01 4.48103368e-01 8.18246245e-01
2.19728723e-01 2.68915832e-01 7.23552823e-01 4.32159490e-04
9.32173207e-05 6.00396132e-04 4.34203118e-01 7.94259667e-01
3.74865711e-01 1.31130128e-06 7.66826749e-01 1.58970302e-03
8.24164317e-07 7.35800326e-01 3.13873705e-03 4.32981949e-07
1.28581012e-02 3.57096805e-03 4.56270985e-02 2.93368012e-01
6.34571686e-02 2.01480745e-07 6.38941347e-05 3.76931834e-03
8.92094672e-02 1.68431073e-01 6.07512414e-01 7.85048723e-01
5.88366270e-01 2.24684263e-04 7.69207060e-01 1.75125729e-02
5.09295404e-01 1.39133083e-02 5.78194996e-03 9.58142206e-02
2.16476107e-03 2.91839093e-01 5.08095801e-01 8.21775079e-01
3.32439691e-01 3.76418471e-01 7.52046168e-01 4.91422927e-03
2.17510969e-03 5.34059480e-03 5.15341163e-01 8.07703912e-01
4.64883089e-01 1.23731588e-04 7.86535263e-01 1.48580614e-02
9.60780744e-05 7.62400210e-01 2.24202648e-02 5.41195514e-05
5.58682904e-02 1.74556393e-02 1.14311256e-01 3.85783792e-01
1.30864367e-01 3.27820162e-05 1.31068123e-03 2.18141694e-02
1.80418789e-01 2.73525268e-01 6.52118921e-01 8.00725698e-01]
160/160 [=====] - 0s 810us/step

```

In [59]:

```
#Five layers, four neurons per layer: loss
scores_optimal_softplus, optimal_softplus.metrics_names
```

Out[59]:

```
(0.3957903027534485, ['loss'])
```

Activation relu:

In [60]:

```
n = 40
xx = np.random.random((n,1))
yy = np.random.random((n,1))

X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [61]:

```
#Five layers, four neurons per layer
optimal_relu = Sequential()

#hidden layers
optimal_relu.add(Dense(4, input_dim=2, activation='relu'))
optimal_relu.add(Dense(4, activation='relu'))
optimal_relu.add(Dense(4, activation='relu'))
optimal_relu.add(Dense(4, activation='relu'))
optimal_relu.add(Dense(4, activation='relu'))

#output layer
optimal_relu.add(Dense(1, activation='relu'))

sgd = SGD(lr=0.1)
optimal_relu.compile(loss='binary_crossentropy', optimizer='sgd')
```

```
optimal_relu.fit(X, y, batch_size=2, epochs=400)
print(optimal_relu.predict_proba(X).reshape(4*n))

#evaluate the model
scores_optimal_relu = optimal_relu.evaluate(X, y)

Epoch 1/400
160/160 [=====] - 0s 3ms/step - loss: 8.0771
Epoch 2/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 3/400
160/160 [=====] - 0s 337us/step - loss: 7.9712
Epoch 4/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 5/400
160/160 [=====] - 0s 318us/step - loss: 7.9712
Epoch 6/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 7/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 8/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 9/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 10/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 11/400
160/160 [=====] - 0s 318us/step - loss: 7.9712
Epoch 12/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 13/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 14/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 15/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 16/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 17/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 18/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 19/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 20/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 21/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 22/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 23/400
160/160 [=====] - 0s 318us/step - loss: 7.9712
Epoch 24/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 25/400
160/160 [=====] - 0s 318us/step - loss: 7.9712
Epoch 26/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 27/400
160/160 [=====] - 0s 315us/step - loss: 7.9712
Epoch 28/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 29/400
160/160 [=====] - 0s 309us/step - loss: 7.9712
Epoch 30/400
160/160 [=====] - 0s 318us/step - loss: 7.9712
Epoch 31/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 32/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 33/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 34/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 35/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 36/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
160/160 [=====] - 0s 305us/step - loss: 7.9712
```

160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 37/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 38/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 39/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 40/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 41/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 42/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 43/400
160/160 [=====] - 0s 334us/step - loss: 7.9712
Epoch 44/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 45/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 46/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 47/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 48/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 49/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 50/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 51/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 52/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 53/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 54/400
160/160 [=====] - 0s 309us/step - loss: 7.9712
Epoch 55/400
160/160 [=====] - 0s 318us/step - loss: 7.9712
Epoch 56/400
160/160 [=====] - 0s 330us/step - loss: 7.9712
Epoch 57/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 58/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 59/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 60/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 61/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 62/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 63/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 64/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 65/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 66/400
160/160 [=====] - 0s 309us/step - loss: 7.9712
Epoch 67/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 68/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 69/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 70/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 71/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 72/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 73/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 74/400
160/160 [=====] - 0s 293us/step - loss: 7.9712

Epoch 15/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 76/400
160/160 [=====] - 0s 290us/step - loss: 7.9712
Epoch 77/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 78/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 79/400
160/160 [=====] - 0s 290us/step - loss: 7.9712
Epoch 80/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 81/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 82/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 83/400
160/160 [=====] - 0s 290us/step - loss: 7.9712
Epoch 84/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 85/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 86/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 87/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 88/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 89/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 90/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 91/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 92/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 93/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 94/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 95/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 96/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 97/400
160/160 [=====] - 0s 280us/step - loss: 7.9712
Epoch 98/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 99/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 100/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 101/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 102/400
160/160 [=====] - 0s 284us/step - loss: 7.9712
Epoch 103/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 104/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 105/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 106/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 107/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 108/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 109/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 110/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 111/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 112/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 113/400

160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 114/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 115/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 116/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 117/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 118/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 119/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 120/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 121/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 122/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 123/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 124/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 125/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 126/400
160/160 [=====] - 0s 330us/step - loss: 7.9712
Epoch 127/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 128/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 129/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 130/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 131/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 132/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 133/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 134/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 135/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 136/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 137/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 138/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 139/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 140/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 141/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 142/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 143/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 144/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 145/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 146/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 147/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 148/400
160/160 [=====] - 0s 290us/step - loss: 7.9712
Epoch 149/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 150/400
160/160 [=====] - 0s 284us/step - loss: 7.9712
Epoch 151/400
160/160 [=====] - 0s 287us/step - loss: 7.9712

Epoch 152/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 153/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 154/400
160/160 [=====] - 0s 290us/step - loss: 7.9712
Epoch 155/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 156/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 157/400
160/160 [=====] - 0s 355us/step - loss: 7.9712
Epoch 158/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 159/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 160/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 161/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 162/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 163/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 164/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 165/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 166/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 167/400
160/160 [=====] - 0s 330us/step - loss: 7.9712
Epoch 168/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 169/400
160/160 [=====] - 0s 324us/step - loss: 7.9712
Epoch 170/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 171/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 172/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 173/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 174/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 175/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 176/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 177/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 178/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 179/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 180/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 181/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 182/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 183/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 184/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 185/400
160/160 [=====] - 0s 315us/step - loss: 7.9712
Epoch 186/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 187/400
160/160 [=====] - 0s 340us/step - loss: 7.9712
Epoch 188/400
160/160 [=====] - 0s 334us/step - loss: 7.9712
Epoch 189/400
160/160 [=====] - 0s 343us/step - loss: 7.9712
Epoch 190/400

160/160 [=====] - 0s 334us/step - loss: 7.9712
Epoch 191/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 192/400
160/160 [=====] - 0s 324us/step - loss: 7.9712
Epoch 193/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 194/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 195/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 196/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 197/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 198/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 199/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 200/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 201/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 202/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 203/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 204/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 205/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 206/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 207/400
160/160 [=====] - 0s 324us/step - loss: 7.9712
Epoch 208/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 209/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 210/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 211/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 212/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 213/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 214/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 215/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 216/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 217/400
160/160 [=====] - 0s 290us/step - loss: 7.9712
Epoch 218/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 219/400
160/160 [=====] - 0s 290us/step - loss: 7.9712
Epoch 220/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 221/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 222/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 223/400
160/160 [=====] - 0s 290us/step - loss: 7.9712
Epoch 224/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 225/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 226/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 227/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 228/400
160/160 [=====] - 0s 349us/step - loss: 7.9712

Epoch 229/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 230/400
160/160 [=====] - 0s 318us/step - loss: 7.9712
Epoch 231/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 232/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 233/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 234/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 235/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 236/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 237/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 238/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 239/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 240/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 241/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 242/400
160/160 [=====] - 0s 290us/step - loss: 7.9712
Epoch 243/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 244/400
160/160 [=====] - 0s 290us/step - loss: 7.9712
Epoch 245/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 246/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 247/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 248/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 249/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 250/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 251/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 252/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 253/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 254/400
160/160 [=====] - 0s 309us/step - loss: 7.9712
Epoch 255/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 256/400
160/160 [=====] - 0s 309us/step - loss: 7.9712
Epoch 257/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 258/400
160/160 [=====] - 0s 315us/step - loss: 7.9712
Epoch 259/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 260/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 261/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 262/400
160/160 [=====] - 0s 315us/step - loss: 7.9712
Epoch 263/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 264/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 265/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 266/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 267/400

160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 268/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 269/400
160/160 [=====] - 0s 318us/step - loss: 7.9712
Epoch 270/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 271/400
160/160 [=====] - 0s 368us/step - loss: 7.9712
Epoch 272/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 273/400
160/160 [=====] - 0s 346us/step - loss: 7.9712
Epoch 274/400
160/160 [=====] - 0s 461us/step - loss: 7.9712
Epoch 275/400
160/160 [=====] - 0s 380us/step - loss: 7.9712
Epoch 276/400
160/160 [=====] - 0s 358us/step - loss: 7.9712
Epoch 277/400
160/160 [=====] - 0s 368us/step - loss: 7.9712
Epoch 278/400
160/160 [=====] - 0s 355us/step - loss: 7.9712
Epoch 279/400
160/160 [=====] - 0s 330us/step - loss: 7.9712
Epoch 280/400
160/160 [=====] - 0s 374us/step - loss: 7.9712
Epoch 281/400
160/160 [=====] - 0s 355us/step - loss: 7.9712
Epoch 282/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 283/400
160/160 [=====] - 0s 324us/step - loss: 7.9712
Epoch 284/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 285/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 286/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 287/400
160/160 [=====] - 0s 324us/step - loss: 7.9712
Epoch 288/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 289/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 290/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 291/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 292/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 293/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 294/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 295/400
160/160 [=====] - 0s 290us/step - loss: 7.9712
Epoch 296/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 297/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 298/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 299/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 300/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 301/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 302/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 303/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 304/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 305/400
160/160 [=====] - 0s 299us/step - loss: 7.9712

Epoch 306/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 307/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 308/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 309/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 310/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 311/400
160/160 [=====] - 0s 281us/step - loss: 7.9712
Epoch 312/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 313/400
160/160 [=====] - 0s 281us/step - loss: 7.9712
Epoch 314/400
160/160 [=====] - 0s 290us/step - loss: 7.9712
Epoch 315/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 316/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 317/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 318/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 319/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 320/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 321/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 322/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 323/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 324/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 325/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 326/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 327/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 328/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 329/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 330/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 331/400
160/160 [=====] - 0s 315us/step - loss: 7.9712
Epoch 332/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 333/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 334/400
160/160 [=====] - 0s 349us/step - loss: 7.9712
Epoch 335/400
160/160 [=====] - 0s 337us/step - loss: 7.9712
Epoch 336/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 337/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 338/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 339/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 340/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 341/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 342/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 343/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 344/400

160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 345/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 346/400
160/160 [=====] - 0s 374us/step - loss: 7.9712
Epoch 347/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 348/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 349/400
160/160 [=====] - 0s 346us/step - loss: 7.9712
Epoch 350/400
160/160 [=====] - 0s 318us/step - loss: 7.9712
Epoch 351/400
160/160 [=====] - 0s 349us/step - loss: 7.9712
Epoch 352/400
160/160 [=====] - 0s 386us/step - loss: 7.9712
Epoch 353/400
160/160 [=====] - 0s 374us/step - loss: 7.9712
Epoch 354/400
160/160 [=====] - 0s 324us/step - loss: 7.9712
Epoch 355/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 356/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 357/400
160/160 [=====] - 0s 337us/step - loss: 7.9712
Epoch 358/400
160/160 [=====] - 0s 315us/step - loss: 7.9712
Epoch 359/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 360/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 361/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 362/400
160/160 [=====] - 0s 327us/step - loss: 7.9712
Epoch 363/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 364/400
160/160 [=====] - 0s 309us/step - loss: 7.9712
Epoch 365/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 366/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 367/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 368/400
160/160 [=====] - 0s 330us/step - loss: 7.9712
Epoch 369/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 370/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 371/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 372/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 373/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 374/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 375/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 376/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 377/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 378/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 379/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 380/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 381/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 382/400
160/160 [=====] - 0s 305us/step - loss: 7.9712

```
Epoch 383/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 384/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 385/400
160/160 [=====] - 0s 290us/step - loss: 7.9712
Epoch 386/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 387/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 388/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 389/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 390/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 391/400
160/160 [=====] - 0s 318us/step - loss: 7.9712
Epoch 392/400
160/160 [=====] - 0s 287us/step - loss: 7.9712
Epoch 393/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 394/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 395/400
160/160 [=====] - 0s 290us/step - loss: 7.9712
Epoch 396/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 397/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 398/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 399/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 400/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
[62.628593 62.628662 62.620354 62.614075 62.617737 62.618744 62.63858
 62.632595 62.613907 62.623787 62.638893 62.622154 62.620483 62.61779
 62.62504 62.613678 62.628983 62.645348 62.619507 62.632797 62.613316
 62.617695 62.62538 62.63263 62.64111 62.612427 62.62859 62.628307
 62.620907 62.625736 62.612873 62.63191 62.615585 62.620453 62.620193
 62.613483 62.639618 62.629845 62.629837 62.63772 62.602043 62.60244
 62.602325 62.60284 62.60279 62.602295 62.602043 62.60191 62.602486
 62.602165 62.602028 62.602432 62.60257 62.602535 62.602417 62.602367
 62.602413 62.601772 62.602318 62.601967 62.602448 62.602646 62.60213
 62.60208 62.601868 62.60719 62.60212 62.60222 62.6027 62.602116
 62.60266 62.602028 62.602394 62.602413 62.602425 62.60262 62.6018
 62.602016 62.602043 62.601818 62.61325 62.60253 62.604153 62.61281
 62.610134 62.604626 62.602127 62.612183 62.606792 62.60563 62.602036
 62.61332 62.613087 62.607265 62.612244 62.606575 62.60244 62.60218
 62.604412 62.611443 62.607216 62.61341 62.608982 62.611626 62.602325
 62.61277 62.61258 62.611885 62.604652 62.609238 62.608414 62.61154
 62.60489 62.609055 62.608807 62.60769 62.61101 62.612923 62.61261
 62.61116 62.602707 62.6258 62.602688 62.606514 62.617798 62.602592
 62.636147 62.60717 62.602608 62.602627 62.638638 62.6065 62.6143
 62.602795 62.619797 62.602493 62.628136 62.63443 62.60264 62.61503
 62.602554 62.604404 62.60261 62.62258 62.630646 62.609756 62.60839
 62.616985 62.62005 62.602604 62.602737 62.616 62.602577 62.60275
 62.602757 62.602722 62.627342 62.60289 62.606216 62.62201 ]
```

160/160 [=====] - 0s 845us/step

In [62]:

```
#Five layers, four neurons per layer: loss
scores_optimal_relu, optimal_relu.metrics_names
```

Out [62]:

```
(7.971192407608049, ['loss'])
```

Activation softmax:

In [63]:

```
n = 40
xx = np.random.random((n,1))
vv = np.random.random((n,1))
```

```
X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [64]:

```
#Five layers, four neurons per layer
optimal_softmax = Sequential()

#hidden layers
optimal_softmax.add(Dense(4, input_dim=2, activation='softmax'))
optimal_softmax.add(Dense(4, activation='softmax'))
optimal_softmax.add(Dense(4, activation='softmax'))
optimal_softmax.add(Dense(4, activation='softmax'))
optimal_softmax.add(Dense(4, activation='softmax'))

#output layer
optimal_softmax.add(Dense(1, activation='softmax'))

sgd = SGD(lr=0.1)
optimal_softmax.compile(loss='binary_crossentropy', optimizer='sgd')

optimal_softmax.fit(X, y, batch_size=2, epochs=400)
print(optimal_softmax.predict_proba(X).reshape(4*n))

#evaluate the model
scores_optimal_softmax = optimal_softmax.evaluate(X, y)
```

```
Epoch 1/400
160/160 [=====] - 0s 3ms/step - loss: 7.9712
Epoch 2/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 3/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 4/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 5/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 6/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 7/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 8/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 9/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 10/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 11/400
160/160 [=====] - 0s 321us/step - loss: 7.9712
Epoch 12/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 13/400
160/160 [=====] - 0s 315us/step - loss: 7.9712
Epoch 14/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 15/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 16/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 17/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 18/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 19/400
160/160 [=====] - 0s 315us/step - loss: 7.9712
Epoch 20/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 21/400
160/160 [=====] - 0s 330us/step - loss: 7.9712
Epoch 22/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 23/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 24/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 25/400
```

160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 26/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 27/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 28/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 29/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 30/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 31/400
160/160 [=====] - 0s 330us/step - loss: 7.9712
Epoch 32/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 33/400
160/160 [=====] - 0s 330us/step - loss: 7.9712
Epoch 34/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 35/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 36/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 37/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 38/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 39/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 40/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 41/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 42/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 43/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 44/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 45/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 46/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 47/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 48/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 49/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 50/400
160/160 [=====] - 0s 309us/step - loss: 7.9712
Epoch 51/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 52/400
160/160 [=====] - 0s 309us/step - loss: 7.9712
Epoch 53/400
160/160 [=====] - 0s 337us/step - loss: 7.9712
Epoch 54/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 55/400
160/160 [=====] - 0s 318us/step - loss: 7.9712
Epoch 56/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 57/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 58/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 59/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 60/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 61/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 62/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 63/400
160/160 [=====] - 0s 299us/step - loss: 7.9712

Epoch 64/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 65/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 66/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 67/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 68/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 69/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 70/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 71/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 72/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 73/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 74/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 75/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 76/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 77/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 78/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 79/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 80/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 81/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 82/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 83/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 84/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 85/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 86/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 87/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 88/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 89/400
160/160 [=====] - 0s 318us/step - loss: 7.9712
Epoch 90/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 91/400
160/160 [=====] - 0s 321us/step - loss: 7.9712
Epoch 92/400
160/160 [=====] - 0s 324us/step - loss: 7.9712
Epoch 93/400
160/160 [=====] - 0s 309us/step - loss: 7.9712
Epoch 94/400
160/160 [=====] - 0s 318us/step - loss: 7.9712
Epoch 95/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 96/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 97/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 98/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 99/400
160/160 [=====] - 0s 318us/step - loss: 7.9712
Epoch 100/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 101/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 102/400

160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 103/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 104/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 105/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 106/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 107/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 108/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 109/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 110/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 111/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 112/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 113/400
160/160 [=====] - 0s 309us/step - loss: 7.9712
Epoch 114/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 115/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 116/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 117/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 118/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 119/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 120/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 121/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 122/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 123/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 124/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 125/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 126/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 127/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 128/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 129/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 130/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 131/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 132/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 133/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 134/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 135/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 136/400
160/160 [=====] - 0s 309us/step - loss: 7.9712
Epoch 137/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 138/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 139/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 140/400
160/160 [=====] - 0s 299us/step - loss: 7.9712

100/100 Epoch 141/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 142/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 143/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 144/400
160/160 [=====] - 0s 318us/step - loss: 7.9712
Epoch 145/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 146/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 147/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 148/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 149/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 150/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 151/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 152/400
160/160 [=====] - 0s 309us/step - loss: 7.9712
Epoch 153/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 154/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 155/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 156/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 157/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 158/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 159/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 160/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 161/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 162/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 163/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 164/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 165/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 166/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 167/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 168/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 169/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 170/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 171/400
160/160 [=====] - 0s 309us/step - loss: 7.9712
Epoch 172/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 173/400
160/160 [=====] - 0s 327us/step - loss: 7.9712
Epoch 174/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 175/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 176/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 177/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 178/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 179/400

Epoch 170/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 180/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 181/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 182/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 183/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 184/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 185/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 186/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 187/400
160/160 [=====] - 0s 309us/step - loss: 7.9712
Epoch 188/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 189/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 190/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 191/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 192/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 193/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 194/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 195/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 196/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 197/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 198/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 199/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 200/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 201/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 202/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 203/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 204/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 205/400
160/160 [=====] - 0s 324us/step - loss: 7.9712
Epoch 206/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 207/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 208/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 209/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 210/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 211/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 212/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 213/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 214/400
160/160 [=====] - 0s 324us/step - loss: 7.9712
Epoch 215/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 216/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 217/400
160/160 [=====] - 0s 324us/step - loss: 7.9712

100/100 [=====] - 0s 324us/step - loss: 7.9712
Epoch 218/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 219/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 220/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 221/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 222/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 223/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 224/400
160/160 [=====] - 0s 309us/step - loss: 7.9712
Epoch 225/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 226/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 227/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 228/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 229/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 230/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 231/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 232/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 233/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 234/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 235/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 236/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 237/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 238/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 239/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 240/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 241/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 242/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 243/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 244/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 245/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 246/400
160/160 [=====] - 0s 318us/step - loss: 7.9712
Epoch 247/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 248/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 249/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 250/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 251/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 252/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 253/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 254/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 255/400
160/160 [=====] - 0s 315us/step - loss: 7.9712
Epoch 256/400

Epoch 255/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 257/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 258/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 259/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 260/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 261/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 262/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 263/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 264/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 265/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 266/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 267/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 268/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 269/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 270/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 271/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 272/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 273/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 274/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 275/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 276/400
160/160 [=====] - 0s 318us/step - loss: 7.9712
Epoch 277/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 278/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 279/400
160/160 [=====] - 0s 318us/step - loss: 7.9712
Epoch 280/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 281/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 282/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 283/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 284/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 285/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 286/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 287/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 288/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 289/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 290/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 291/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 292/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 293/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 294/400
160/160 [=====] - 0s 293us/step - loss: 7.9712

160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 295/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 296/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 297/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 298/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 299/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 300/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 301/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 302/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 303/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 304/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 305/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 306/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 307/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 308/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 309/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 310/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 311/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 312/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 313/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 314/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 315/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 316/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 317/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 318/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 319/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 320/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 321/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 322/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 323/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 324/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 325/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 326/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 327/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 328/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 329/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 330/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 331/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 332/400
160/160 [=====] - 0s 299us/step - loss: 7.9712

Epoch 333/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 334/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 335/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 336/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 337/400
160/160 [=====] - 0s 318us/step - loss: 7.9712
Epoch 338/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 339/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 340/400
160/160 [=====] - 0s 324us/step - loss: 7.9712
Epoch 341/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 342/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 343/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 344/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 345/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 346/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 347/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 348/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 349/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 350/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 351/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 352/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 353/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 354/400
160/160 [=====] - 0s 296us/step - loss: 7.9712
Epoch 355/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 356/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 357/400
160/160 [=====] - 0s 318us/step - loss: 7.9712
Epoch 358/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 359/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 360/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 361/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 362/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 363/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 364/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 365/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 366/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 367/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 368/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 369/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 370/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 371/400

```
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 372/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 373/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 374/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 375/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 376/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 377/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 378/400
160/160 [=====] - 0s 312us/step - loss: 7.9712
Epoch 379/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 380/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 381/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 382/400
160/160 [=====] - 0s 330us/step - loss: 7.9712
Epoch 383/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 384/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 385/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 386/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 387/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 388/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 389/400
160/160 [=====] - 0s 302us/step - loss: 7.9712
Epoch 390/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 391/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 392/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 393/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 394/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 395/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 396/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 397/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
Epoch 398/400
160/160 [=====] - 0s 299us/step - loss: 7.9712
Epoch 399/400
160/160 [=====] - 0s 305us/step - loss: 7.9712
Epoch 400/400
160/160 [=====] - 0s 293us/step - loss: 7.9712
[1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.]
```

160/160 [=====] - 0s 910us/step

In [65]:

```
#Five layers, four neurons per layer: loss
scores_optimal_softmax, optimal_softmax.metrics_names
```

Out[65]:

```
(7.971192407608049, ['loss'])
```

Tn [661]

```
In [66]:
```

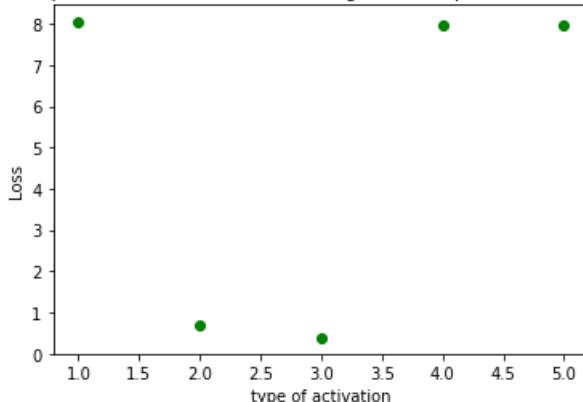
```
#Summary plot of Layer/Neuron Modulation
#figure of loss vs # of Layers
x_compare = [1,2,3,4,5]
y_compare = [scores_optimal_tanh, scores_optimal_sigmoid, scores_optimal_softplus, scores_optimal_relu,
scores_optimal_softmax]

plt.scatter(x_compare,y_compare, c='g');
plt.title('Comparison of Activations: tanh, sigmoid, softplus, relu, softmax')
plt.xlabel('type of activation')
plt.ylabel('Loss')
```

```
Out[66]:
```

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

Comparison of Activations: tanh, sigmoid, softplus, relu, softmax



Observation: If just using one activation type, in this situation go with softplus.

Part 1 Question 4: Compare alternative optimizers RMSprop, Adagrad, Adadelta, Adam, Adamax, Nadam

(Using Optimal from Questions 1-3)

RMSprop

```
In [67]:
```

```
n = 40
xx = np.random.random((n,1))
yy = np.random.random((n,1))

X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

```
In [68]:
```

```
#Five layers, four neurons per layer
optimal_RMSprop = Sequential()

#hidden layers
optimal_RMSprop.add(Dense(4, input_dim=2, activation='tanh'))
optimal_RMSprop.add(Dense(4, activation='tanh'))
optimal_RMSprop.add(Dense(4, activation='tanh'))
optimal_RMSprop.add(Dense(4, activation='tanh'))
optimal_RMSprop.add(Dense(4, activation='tanh'))

#output layer
optimal_RMSprop.add(Dense(1, activation='sigmoid'))

RMSprop = RMSprop(lr=0.1)
optimal_RMSprop.compile(loss='binary_crossentropy', optimizer='RMSprop')

optimal_RMSprop.fit(X, y, batch_size=2, epochs=400)
print(optimal_RMSprop.predict_proba(X).reshape(4*n))

#evaluate the model
```

```
scores_optimal_RMSprop = optimal_RMSprop.evaluate(X, y)

Epoch 1/400
160/160 [=====] - 1s 3ms/step - loss: 0.6985
Epoch 2/400
160/160 [=====] - 0s 334us/step - loss: 0.6854
Epoch 3/400
160/160 [=====] - 0s 343us/step - loss: 0.6758
Epoch 4/400
160/160 [=====] - 0s 330us/step - loss: 0.6662
Epoch 5/400
160/160 [=====] - 0s 343us/step - loss: 0.6558
Epoch 6/400
160/160 [=====] - 0s 337us/step - loss: 0.6435
Epoch 7/400
160/160 [=====] - 0s 324us/step - loss: 0.6281
Epoch 8/400
160/160 [=====] - 0s 343us/step - loss: 0.6089
Epoch 9/400
160/160 [=====] - 0s 330us/step - loss: 0.5884
Epoch 10/400
160/160 [=====] - 0s 343us/step - loss: 0.5631
Epoch 11/400
160/160 [=====] - 0s 337us/step - loss: 0.5364
Epoch 12/400
160/160 [=====] - 0s 337us/step - loss: 0.5058
Epoch 13/400
160/160 [=====] - 0s 330us/step - loss: 0.4729
Epoch 14/400
160/160 [=====] - 0s 362us/step - loss: 0.4473
Epoch 15/400
160/160 [=====] - 0s 330us/step - loss: 0.4229
Epoch 16/400
160/160 [=====] - 0s 330us/step - loss: 0.4003
Epoch 17/400
160/160 [=====] - 0s 324us/step - loss: 0.3814
Epoch 18/400
160/160 [=====] - 0s 374us/step - loss: 0.3688
Epoch 19/400
160/160 [=====] - 0s 334us/step - loss: 0.3578
Epoch 20/400
160/160 [=====] - 0s 334us/step - loss: 0.3461
Epoch 21/400
160/160 [=====] - 0s 343us/step - loss: 0.3416
Epoch 22/400
160/160 [=====] - 0s 330us/step - loss: 0.3369
Epoch 23/400
160/160 [=====] - 0s 343us/step - loss: 0.3325
Epoch 24/400
160/160 [=====] - 0s 330us/step - loss: 0.3252
Epoch 25/400
160/160 [=====] - 0s 349us/step - loss: 0.3229
Epoch 26/400
160/160 [=====] - 0s 405us/step - loss: 0.3206
Epoch 27/400
160/160 [=====] - 0s 337us/step - loss: 0.3178
Epoch 28/400
160/160 [=====] - 0s 343us/step - loss: 0.3147
Epoch 29/400
160/160 [=====] - 0s 337us/step - loss: 0.3136
Epoch 30/400
160/160 [=====] - 0s 346us/step - loss: 0.3130
Epoch 31/400
160/160 [=====] - 0s 318us/step - loss: 0.3080
Epoch 32/400
160/160 [=====] - 0s 355us/step - loss: 0.3074
Epoch 33/400
160/160 [=====] - 0s 330us/step - loss: 0.3040
Epoch 34/400
160/160 [=====] - 0s 330us/step - loss: 0.2978
Epoch 35/400
160/160 [=====] - 0s 337us/step - loss: 0.2971
Epoch 36/400
160/160 [=====] - 0s 349us/step - loss: 0.2940
Epoch 37/400
160/160 [=====] - 0s 330us/step - loss: 0.2933
Epoch 38/400
- - - - -
```

160/160 [=====] - 0s 337us/step - loss: 0.2902
Epoch 39/400
160/160 [=====] - 0s 337us/step - loss: 0.2821
Epoch 40/400
160/160 [=====] - 0s 330us/step - loss: 0.2831
Epoch 41/400
160/160 [=====] - 0s 343us/step - loss: 0.2814
Epoch 42/400
160/160 [=====] - 0s 343us/step - loss: 0.2793
Epoch 43/400
160/160 [=====] - 0s 337us/step - loss: 0.2761
Epoch 44/400
160/160 [=====] - 0s 337us/step - loss: 0.2732
Epoch 45/400
160/160 [=====] - 0s 337us/step - loss: 0.2735
Epoch 46/400
160/160 [=====] - 0s 337us/step - loss: 0.2701
Epoch 47/400
160/160 [=====] - 0s 337us/step - loss: 0.2546
Epoch 48/400
160/160 [=====] - 0s 330us/step - loss: 0.2651
Epoch 49/400
160/160 [=====] - 0s 330us/step - loss: 0.2589
Epoch 50/400
160/160 [=====] - 0s 349us/step - loss: 0.2557
Epoch 51/400
160/160 [=====] - 0s 343us/step - loss: 0.2530
Epoch 52/400
160/160 [=====] - 0s 349us/step - loss: 0.2529
Epoch 53/400
160/160 [=====] - 0s 330us/step - loss: 0.2488
Epoch 54/400
160/160 [=====] - 0s 337us/step - loss: 0.2450
Epoch 55/400
160/160 [=====] - 0s 343us/step - loss: 0.2438
Epoch 56/400
160/160 [=====] - 0s 327us/step - loss: 0.2413
Epoch 57/400
160/160 [=====] - 0s 334us/step - loss: 0.2357
Epoch 58/400
160/160 [=====] - 0s 330us/step - loss: 0.2333
Epoch 59/400
160/160 [=====] - 0s 355us/step - loss: 0.2298
Epoch 60/400
160/160 [=====] - 0s 368us/step - loss: 0.2259
Epoch 61/400
160/160 [=====] - 0s 436us/step - loss: 0.2260
Epoch 62/400
160/160 [=====] - 0s 499us/step - loss: 0.2217
Epoch 63/400
160/160 [=====] - 0s 592us/step - loss: 0.2222
Epoch 64/400
160/160 [=====] - 0s 492us/step - loss: 0.2176
Epoch 65/400
160/160 [=====] - 0s 486us/step - loss: 0.2147
Epoch 66/400
160/160 [=====] - 0s 499us/step - loss: 0.2121
Epoch 67/400
160/160 [=====] - 0s 480us/step - loss: 0.2129
Epoch 68/400
160/160 [=====] - 0s 436us/step - loss: 0.2081
Epoch 69/400
160/160 [=====] - 0s 430us/step - loss: 0.2091
Epoch 70/400
160/160 [=====] - 0s 439us/step - loss: 0.2019
Epoch 71/400
160/160 [=====] - 0s 386us/step - loss: 0.2033
Epoch 72/400
160/160 [=====] - 0s 415us/step - loss: 0.2029
Epoch 73/400
160/160 [=====] - 0s 377us/step - loss: 0.2010
Epoch 74/400
160/160 [=====] - 0s 386us/step - loss: 0.2000
Epoch 75/400
160/160 [=====] - 0s 386us/step - loss: 0.1940
Epoch 76/400
160/160 [=====] - 0s 399us/step - loss: 0.1927

Epoch 77/400
160/160 [=====] - 0s 380us/step - loss: 0.1918
Epoch 78/400
160/160 [=====] - 0s 362us/step - loss: 0.1885
Epoch 79/400
160/160 [=====] - 0s 380us/step - loss: 0.1873
Epoch 80/400
160/160 [=====] - 0s 330us/step - loss: 0.1861
Epoch 81/400
160/160 [=====] - 0s 352us/step - loss: 0.1865
Epoch 82/400
160/160 [=====] - 0s 355us/step - loss: 0.1756
Epoch 83/400
160/160 [=====] - 0s 334us/step - loss: 0.1820
Epoch 84/400
160/160 [=====] - 0s 343us/step - loss: 0.1816
Epoch 85/400
160/160 [=====] - 0s 334us/step - loss: 0.1792
Epoch 86/400
160/160 [=====] - 0s 343us/step - loss: 0.1757
Epoch 87/400
160/160 [=====] - 0s 337us/step - loss: 0.1749
Epoch 88/400
160/160 [=====] - 0s 330us/step - loss: 0.1772
Epoch 89/400
160/160 [=====] - 0s 368us/step - loss: 0.1748
Epoch 90/400
160/160 [=====] - 0s 355us/step - loss: 0.1723
Epoch 91/400
160/160 [=====] - 0s 368us/step - loss: 0.1721
Epoch 92/400
160/160 [=====] - 0s 368us/step - loss: 0.1667
Epoch 93/400
160/160 [=====] - 0s 324us/step - loss: 0.1701
Epoch 94/400
160/160 [=====] - 0s 324us/step - loss: 0.1638
Epoch 95/400
160/160 [=====] - 0s 330us/step - loss: 0.1640
Epoch 96/400
160/160 [=====] - 0s 318us/step - loss: 0.1655
Epoch 97/400
160/160 [=====] - 0s 330us/step - loss: 0.1639
Epoch 98/400
160/160 [=====] - 0s 330us/step - loss: 0.1642
Epoch 99/400
160/160 [=====] - 0s 324us/step - loss: 0.1647
Epoch 100/400
160/160 [=====] - 0s 349us/step - loss: 0.1656
Epoch 101/400
160/160 [=====] - 0s 324us/step - loss: 0.1603
Epoch 102/400
160/160 [=====] - 0s 340us/step - loss: 0.1613
Epoch 103/400
160/160 [=====] - 0s 318us/step - loss: 0.1597
Epoch 104/400
160/160 [=====] - 0s 337us/step - loss: 0.1573
Epoch 105/400
160/160 [=====] - 0s 324us/step - loss: 0.1577
Epoch 106/400
160/160 [=====] - 0s 324us/step - loss: 0.1548
Epoch 107/400
160/160 [=====] - 0s 324us/step - loss: 0.1554
Epoch 108/400
160/160 [=====] - 0s 324us/step - loss: 0.1536
Epoch 109/400
160/160 [=====] - 0s 324us/step - loss: 0.1536
Epoch 110/400
160/160 [=====] - 0s 337us/step - loss: 0.1523
Epoch 111/400
160/160 [=====] - 0s 315us/step - loss: 0.1488
Epoch 112/400
160/160 [=====] - 0s 337us/step - loss: 0.1492
Epoch 113/400
160/160 [=====] - 0s 321us/step - loss: 0.1526
Epoch 114/400
160/160 [=====] - 0s 330us/step - loss: 0.1475
Epoch 115/400

160/160 [=====] - 0s 309us/step - loss: 0.1454
Epoch 116/400
160/160 [=====] - 0s 318us/step - loss: 0.1503
Epoch 117/400
160/160 [=====] - 0s 315us/step - loss: 0.1485
Epoch 118/400
160/160 [=====] - 0s 330us/step - loss: 0.1484
Epoch 119/400
160/160 [=====] - 0s 355us/step - loss: 0.1439
Epoch 120/400
160/160 [=====] - 0s 330us/step - loss: 0.1456
Epoch 121/400
160/160 [=====] - 0s 318us/step - loss: 0.1449
Epoch 122/400
160/160 [=====] - 0s 330us/step - loss: 0.1415
Epoch 123/400
160/160 [=====] - 0s 324us/step - loss: 0.1460
Epoch 124/400
160/160 [=====] - 0s 337us/step - loss: 0.1428
Epoch 125/400
160/160 [=====] - 0s 337us/step - loss: 0.1386
Epoch 126/400
160/160 [=====] - 0s 330us/step - loss: 0.1417
Epoch 127/400
160/160 [=====] - 0s 330us/step - loss: 0.1377
Epoch 128/400
160/160 [=====] - 0s 318us/step - loss: 0.1382
Epoch 129/400
160/160 [=====] - 0s 324us/step - loss: 0.1390
Epoch 130/400
160/160 [=====] - 0s 318us/step - loss: 0.1367
Epoch 131/400
160/160 [=====] - 0s 343us/step - loss: 0.1370
Epoch 132/400
160/160 [=====] - 0s 330us/step - loss: 0.1349
Epoch 133/400
160/160 [=====] - 0s 318us/step - loss: 0.1361
Epoch 134/400
160/160 [=====] - 0s 324us/step - loss: 0.1326
Epoch 135/400
160/160 [=====] - 0s 324us/step - loss: 0.1316
Epoch 136/400
160/160 [=====] - 0s 324us/step - loss: 0.1313
Epoch 137/400
160/160 [=====] - 0s 312us/step - loss: 0.1302
Epoch 138/400
160/160 [=====] - 0s 337us/step - loss: 0.1359
Epoch 139/400
160/160 [=====] - 0s 318us/step - loss: 0.1336
Epoch 140/400
160/160 [=====] - 0s 330us/step - loss: 0.1310
Epoch 141/400
160/160 [=====] - 0s 330us/step - loss: 0.1278
Epoch 142/400
160/160 [=====] - 0s 346us/step - loss: 0.1238
Epoch 143/400
160/160 [=====] - 0s 337us/step - loss: 0.1225
Epoch 144/400
160/160 [=====] - 0s 321us/step - loss: 0.1253
Epoch 145/400
160/160 [=====] - 0s 318us/step - loss: 0.1259
Epoch 146/400
160/160 [=====] - 0s 327us/step - loss: 0.1261
Epoch 147/400
160/160 [=====] - 0s 321us/step - loss: 0.1204
Epoch 148/400
160/160 [=====] - 0s 330us/step - loss: 0.1214
Epoch 149/400
160/160 [=====] - 0s 330us/step - loss: 0.1143
Epoch 150/400
160/160 [=====] - 0s 330us/step - loss: 0.1216
Epoch 151/400
160/160 [=====] - 0s 324us/step - loss: 0.1184
Epoch 152/400
160/160 [=====] - 0s 343us/step - loss: 0.1188
Epoch 153/400
160/160 [=====] - 0s 343us/step - loss: 0.1143

Epoch 154/400
160/160 [=====] - 0s 324us/step - loss: 0.1155
Epoch 155/400
160/160 [=====] - 0s 318us/step - loss: 0.1172
Epoch 156/400
160/160 [=====] - 0s 330us/step - loss: 0.1138
Epoch 157/400
160/160 [=====] - 0s 349us/step - loss: 0.1132
Epoch 158/400
160/160 [=====] - 0s 324us/step - loss: 0.1164
Epoch 159/400
160/160 [=====] - 0s 337us/step - loss: 0.1167
Epoch 160/400
160/160 [=====] - 0s 324us/step - loss: 0.1139
Epoch 161/400
160/160 [=====] - 0s 337us/step - loss: 0.1087
Epoch 162/400
160/160 [=====] - 0s 343us/step - loss: 0.1178
Epoch 163/400
160/160 [=====] - 0s 324us/step - loss: 0.1091
Epoch 164/400
160/160 [=====] - 0s 334us/step - loss: 0.1113
Epoch 165/400
160/160 [=====] - 0s 330us/step - loss: 0.1097
Epoch 166/400
160/160 [=====] - 0s 340us/step - loss: 0.1078
Epoch 167/400
160/160 [=====] - 0s 330us/step - loss: 0.1100
Epoch 168/400
160/160 [=====] - 0s 324us/step - loss: 0.1054
Epoch 169/400
160/160 [=====] - 0s 312us/step - loss: 0.0971
Epoch 170/400
160/160 [=====] - 0s 318us/step - loss: 0.1070
Epoch 171/400
160/160 [=====] - 0s 337us/step - loss: 0.1042
Epoch 172/400
160/160 [=====] - 0s 337us/step - loss: 0.1057
Epoch 173/400
160/160 [=====] - 0s 330us/step - loss: 0.1050
Epoch 174/400
160/160 [=====] - 0s 330us/step - loss: 0.0988
Epoch 175/400
160/160 [=====] - 0s 343us/step - loss: 0.1022
Epoch 176/400
160/160 [=====] - 0s 334us/step - loss: 0.0998
Epoch 177/400
160/160 [=====] - 0s 330us/step - loss: 0.0985
Epoch 178/400
160/160 [=====] - 0s 334us/step - loss: 0.0937
Epoch 179/400
160/160 [=====] - 0s 330us/step - loss: 0.0983
Epoch 180/400
160/160 [=====] - 0s 327us/step - loss: 0.0966
Epoch 181/400
160/160 [=====] - 0s 327us/step - loss: 0.0932
Epoch 182/400
160/160 [=====] - 0s 337us/step - loss: 0.0935
Epoch 183/400
160/160 [=====] - 0s 330us/step - loss: 0.0949
Epoch 184/400
160/160 [=====] - 0s 349us/step - loss: 0.0959
Epoch 185/400
160/160 [=====] - 0s 337us/step - loss: 0.0880
Epoch 186/400
160/160 [=====] - 0s 337us/step - loss: 0.0950
Epoch 187/400
160/160 [=====] - 0s 337us/step - loss: 0.0910
Epoch 188/400
160/160 [=====] - 0s 349us/step - loss: 0.0924
Epoch 189/400
160/160 [=====] - 0s 337us/step - loss: 0.0891
Epoch 190/400
160/160 [=====] - 0s 337us/step - loss: 0.0893
Epoch 191/400
160/160 [=====] - 0s 330us/step - loss: 0.0878
Epoch 192/400

160/160 [=====] - 0s 337us/step - loss: 0.0851
Epoch 193/400
160/160 [=====] - 0s 318us/step - loss: 0.0881
Epoch 194/400
160/160 [=====] - 0s 343us/step - loss: 0.0840
Epoch 195/400
160/160 [=====] - 0s 318us/step - loss: 0.0876
Epoch 196/400
160/160 [=====] - 0s 324us/step - loss: 0.0850
Epoch 197/400
160/160 [=====] - 0s 324us/step - loss: 0.0834
Epoch 198/400
160/160 [=====] - 0s 337us/step - loss: 0.0876
Epoch 199/400
160/160 [=====] - 0s 324us/step - loss: 0.0814
Epoch 200/400
160/160 [=====] - 0s 330us/step - loss: 0.0804
Epoch 201/400
160/160 [=====] - 0s 330us/step - loss: 0.0859
Epoch 202/400
160/160 [=====] - 0s 324us/step - loss: 0.0828
Epoch 203/400
160/160 [=====] - 0s 318us/step - loss: 0.0824
Epoch 204/400
160/160 [=====] - 0s 330us/step - loss: 0.0806
Epoch 205/400
160/160 [=====] - 0s 324us/step - loss: 0.0799
Epoch 206/400
160/160 [=====] - 0s 330us/step - loss: 0.0790
Epoch 207/400
160/160 [=====] - 0s 337us/step - loss: 0.0754
Epoch 208/400
160/160 [=====] - 0s 327us/step - loss: 0.0739
Epoch 209/400
160/160 [=====] - 0s 324us/step - loss: 0.0804
Epoch 210/400
160/160 [=====] - 0s 334us/step - loss: 0.0735
Epoch 211/400
160/160 [=====] - 0s 330us/step - loss: 0.0732
Epoch 212/400
160/160 [=====] - 0s 324us/step - loss: 0.0799
Epoch 213/400
160/160 [=====] - 0s 343us/step - loss: 0.0725
Epoch 214/400
160/160 [=====] - 0s 318us/step - loss: 0.0778
Epoch 215/400
160/160 [=====] - 0s 330us/step - loss: 0.0746
Epoch 216/400
160/160 [=====] - 0s 318us/step - loss: 0.0747
Epoch 217/400
160/160 [=====] - 0s 374us/step - loss: 0.0747
Epoch 218/400
160/160 [=====] - 0s 399us/step - loss: 0.0751
Epoch 219/400
160/160 [=====] - 0s 330us/step - loss: 0.0742
Epoch 220/400
160/160 [=====] - 0s 324us/step - loss: 0.0703
Epoch 221/400
160/160 [=====] - 0s 324us/step - loss: 0.0710
Epoch 222/400
160/160 [=====] - 0s 324us/step - loss: 0.0754
Epoch 223/400
160/160 [=====] - 0s 324us/step - loss: 0.0671
Epoch 224/400
160/160 [=====] - 0s 330us/step - loss: 0.0732
Epoch 225/400
160/160 [=====] - 0s 330us/step - loss: 0.0706
Epoch 226/400
160/160 [=====] - 0s 318us/step - loss: 0.0704
Epoch 227/400
160/160 [=====] - 0s 327us/step - loss: 0.0701
Epoch 228/400
160/160 [=====] - 0s 324us/step - loss: 0.0694
Epoch 229/400
160/160 [=====] - 0s 309us/step - loss: 0.0591
Epoch 230/400
160/160 [=====] - 0s 337us/step - loss: 0.0692

Epoch 231/400
160/160 [=====] - 0s 337us/step - loss: 0.0690
Epoch 232/400
160/160 [=====] - 0s 337us/step - loss: 0.0720
Epoch 233/400
160/160 [=====] - 0s 324us/step - loss: 0.0722
Epoch 234/400
160/160 [=====] - 0s 330us/step - loss: 0.0686
Epoch 235/400
160/160 [=====] - 0s 330us/step - loss: 0.0719
Epoch 236/400
160/160 [=====] - 0s 330us/step - loss: 0.0620
Epoch 237/400
160/160 [=====] - 0s 337us/step - loss: 0.0674
Epoch 238/400
160/160 [=====] - 0s 334us/step - loss: 0.0695
Epoch 239/400
160/160 [=====] - 0s 330us/step - loss: 0.0675
Epoch 240/400
160/160 [=====] - 0s 315us/step - loss: 0.0718
Epoch 241/400
160/160 [=====] - 0s 330us/step - loss: 0.0705
Epoch 242/400
160/160 [=====] - 0s 334us/step - loss: 0.0683
Epoch 243/400
160/160 [=====] - 0s 324us/step - loss: 0.0695
Epoch 244/400
160/160 [=====] - 0s 346us/step - loss: 0.0680
Epoch 245/400
160/160 [=====] - 0s 337us/step - loss: 0.0684
Epoch 246/400
160/160 [=====] - 0s 330us/step - loss: 0.0685
Epoch 247/400
160/160 [=====] - 0s 330us/step - loss: 0.0666
Epoch 248/400
160/160 [=====] - 0s 324us/step - loss: 0.0663
Epoch 249/400
160/160 [=====] - 0s 312us/step - loss: 0.0702
Epoch 250/400
160/160 [=====] - 0s 337us/step - loss: 0.0673
Epoch 251/400
160/160 [=====] - 0s 343us/step - loss: 0.0659
Epoch 252/400
160/160 [=====] - 0s 337us/step - loss: 0.0683
Epoch 253/400
160/160 [=====] - 0s 337us/step - loss: 0.0647
Epoch 254/400
160/160 [=====] - 0s 330us/step - loss: 0.0689
Epoch 255/400
160/160 [=====] - 0s 337us/step - loss: 0.0701
Epoch 256/400
160/160 [=====] - 0s 324us/step - loss: 0.0635
Epoch 257/400
160/160 [=====] - 0s 330us/step - loss: 0.0713
Epoch 258/400
160/160 [=====] - 0s 318us/step - loss: 0.0684
Epoch 259/400
160/160 [=====] - 0s 324us/step - loss: 0.0685
Epoch 260/400
160/160 [=====] - 0s 330us/step - loss: 0.0668
Epoch 261/400
160/160 [=====] - 0s 330us/step - loss: 0.0650
Epoch 262/400
160/160 [=====] - 0s 330us/step - loss: 0.0720
Epoch 263/400
160/160 [=====] - 0s 330us/step - loss: 0.0673
Epoch 264/400
160/160 [=====] - 0s 337us/step - loss: 0.0661
Epoch 265/400
160/160 [=====] - 0s 324us/step - loss: 0.0627
Epoch 266/400
160/160 [=====] - 0s 330us/step - loss: 0.0686
Epoch 267/400
160/160 [=====] - 0s 330us/step - loss: 0.0723
Epoch 268/400
160/160 [=====] - 0s 324us/step - loss: 0.0621
Epoch 269/400

```
160/160 [=====] - 0s 343us/step - loss: 0.0615
Epoch 270/400
160/160 [=====] - 0s 334us/step - loss: 0.0494
Epoch 271/400
160/160 [=====] - 0s 330us/step - loss: 0.0706
Epoch 272/400
160/160 [=====] - 0s 321us/step - loss: 0.0645
Epoch 273/400
160/160 [=====] - 0s 330us/step - loss: 0.0685
Epoch 274/400
160/160 [=====] - 0s 327us/step - loss: 0.0686
Epoch 275/400
160/160 [=====] - 0s 337us/step - loss: 0.0720
Epoch 276/400
160/160 [=====] - 0s 324us/step - loss: 0.0707
Epoch 277/400
160/160 [=====] - 0s 337us/step - loss: 0.0689
Epoch 278/400
160/160 [=====] - 0s 337us/step - loss: 0.0756
Epoch 279/400
160/160 [=====] - 0s 337us/step - loss: 0.0690
Epoch 280/400
160/160 [=====] - 0s 330us/step - loss: 0.0742
Epoch 281/400
160/160 [=====] - 0s 324us/step - loss: 0.0710
Epoch 282/400
160/160 [=====] - 0s 318us/step - loss: 0.0701
Epoch 283/400
160/160 [=====] - 0s 324us/step - loss: 0.0722
Epoch 284/400
160/160 [=====] - 0s 330us/step - loss: 0.0698
Epoch 285/400
160/160 [=====] - 0s 337us/step - loss: 0.0748
Epoch 286/400
160/160 [=====] - 0s 330us/step - loss: 0.0651
Epoch 287/400
160/160 [=====] - 0s 337us/step - loss: 0.0722
Epoch 288/400
160/160 [=====] - 0s 343us/step - loss: 0.0689
Epoch 289/400
160/160 [=====] - 0s 324us/step - loss: 0.0661
Epoch 290/400
160/160 [=====] - 0s 324us/step - loss: 0.0699
Epoch 291/400
160/160 [=====] - 0s 318us/step - loss: 0.0669
Epoch 292/400
160/160 [=====] - 0s 324us/step - loss: 0.0683
Epoch 293/400
160/160 [=====] - 0s 330us/step - loss: 0.0677
Epoch 294/400
160/160 [=====] - 0s 318us/step - loss: 0.0702
Epoch 295/400
160/160 [=====] - 0s 324us/step - loss: 0.0762
Epoch 296/400
160/160 [=====] - 0s 318us/step - loss: 0.0696
Epoch 297/400
160/160 [=====] - 0s 324us/step - loss: 0.0700
Epoch 298/400
160/160 [=====] - 0s 324us/step - loss: 0.0678
Epoch 299/400
160/160 [=====] - 0s 321us/step - loss: 0.0647
Epoch 300/400
160/160 [=====] - 0s 330us/step - loss: 0.0720
Epoch 301/400
160/160 [=====] - 0s 340us/step - loss: 0.0674
Epoch 302/400
160/160 [=====] - 0s 327us/step - loss: 0.0718
Epoch 303/400
160/160 [=====] - 0s 318us/step - loss: 0.0666
Epoch 304/400
160/160 [=====] - 0s 318us/step - loss: 0.0700
Epoch 305/400
160/160 [=====] - 0s 324us/step - loss: 0.0743
Epoch 306/400
160/160 [=====] - 0s 324us/step - loss: 0.0723
Epoch 307/400
160/160 [=====] - 0s 349us/step - loss: 0.0674
```

Epoch 308/400
160/160 [=====] - 0s 318us/step - loss: 0.0729
Epoch 309/400
160/160 [=====] - 0s 324us/step - loss: 0.0673
Epoch 310/400
160/160 [=====] - 0s 330us/step - loss: 0.0719
Epoch 311/400
160/160 [=====] - 0s 337us/step - loss: 0.0756
Epoch 312/400
160/160 [=====] - 0s 330us/step - loss: 0.0692
Epoch 313/400
160/160 [=====] - 0s 318us/step - loss: 0.0733
Epoch 314/400
160/160 [=====] - 0s 324us/step - loss: 0.0710
Epoch 315/400
160/160 [=====] - 0s 337us/step - loss: 0.0687
Epoch 316/400
160/160 [=====] - 0s 324us/step - loss: 0.0693
Epoch 317/400
160/160 [=====] - 0s 337us/step - loss: 0.0727
Epoch 318/400
160/160 [=====] - 0s 330us/step - loss: 0.0697
Epoch 319/400
160/160 [=====] - 0s 324us/step - loss: 0.0734
Epoch 320/400
160/160 [=====] - 0s 327us/step - loss: 0.0697
Epoch 321/400
160/160 [=====] - 0s 330us/step - loss: 0.0704
Epoch 322/400
160/160 [=====] - 0s 330us/step - loss: 0.0751
Epoch 323/400
160/160 [=====] - 0s 318us/step - loss: 0.0677
Epoch 324/400
160/160 [=====] - 0s 324us/step - loss: 0.0722
Epoch 325/400
160/160 [=====] - 0s 330us/step - loss: 0.0716
Epoch 326/400
160/160 [=====] - 0s 349us/step - loss: 0.0750
Epoch 327/400
160/160 [=====] - 0s 330us/step - loss: 0.0740
Epoch 328/400
160/160 [=====] - 0s 343us/step - loss: 0.0731
Epoch 329/400
160/160 [=====] - 0s 324us/step - loss: 0.0718
Epoch 330/400
160/160 [=====] - 0s 337us/step - loss: 0.0725
Epoch 331/400
160/160 [=====] - 0s 334us/step - loss: 0.0725
Epoch 332/400
160/160 [=====] - 0s 330us/step - loss: 0.0681
Epoch 333/400
160/160 [=====] - 0s 327us/step - loss: 0.0631
Epoch 334/400
160/160 [=====] - 0s 324us/step - loss: 0.0751
Epoch 335/400
160/160 [=====] - 0s 330us/step - loss: 0.0724
Epoch 336/400
160/160 [=====] - 0s 318us/step - loss: 0.0696
Epoch 337/400
160/160 [=====] - 0s 330us/step - loss: 0.0684
Epoch 338/400
160/160 [=====] - 0s 324us/step - loss: 0.0698
Epoch 339/400
160/160 [=====] - 0s 318us/step - loss: 0.0752
Epoch 340/400
160/160 [=====] - 0s 337us/step - loss: 0.0739
Epoch 341/400
160/160 [=====] - 0s 337us/step - loss: 0.0711
Epoch 342/400
160/160 [=====] - 0s 330us/step - loss: 0.0718
Epoch 343/400
160/160 [=====] - 0s 337us/step - loss: 0.0739
Epoch 344/400
160/160 [=====] - 0s 337us/step - loss: 0.0728
Epoch 345/400
160/160 [=====] - 0s 368us/step - loss: 0.0731
Epoch 346/400

160/160 [=====] - 0s 330us/step - loss: 0.0716
Epoch 347/400
160/160 [=====] - 0s 337us/step - loss: 0.0723
Epoch 348/400
160/160 [=====] - 0s 324us/step - loss: 0.0681
Epoch 349/400
160/160 [=====] - 0s 355us/step - loss: 0.0715
Epoch 350/400
160/160 [=====] - 0s 358us/step - loss: 0.0721
Epoch 351/400
160/160 [=====] - 0s 358us/step - loss: 0.0693
Epoch 352/400
160/160 [=====] - 0s 361us/step - loss: 0.0661
Epoch 353/400
160/160 [=====] - 0s 349us/step - loss: 0.0738
Epoch 354/400
160/160 [=====] - 0s 355us/step - loss: 0.0698
Epoch 355/400
160/160 [=====] - 0s 330us/step - loss: 0.0640
Epoch 356/400
160/160 [=====] - 0s 330us/step - loss: 0.0708
Epoch 357/400
160/160 [=====] - 0s 337us/step - loss: 0.0691
Epoch 358/400
160/160 [=====] - 0s 343us/step - loss: 0.0636
Epoch 359/400
160/160 [=====] - 0s 337us/step - loss: 0.0732
Epoch 360/400
160/160 [=====] - 0s 337us/step - loss: 0.0682
Epoch 361/400
160/160 [=====] - 0s 340us/step - loss: 0.0692
Epoch 362/400
160/160 [=====] - 0s 340us/step - loss: 0.0676
Epoch 363/400
160/160 [=====] - 0s 349us/step - loss: 0.0705
Epoch 364/400
160/160 [=====] - 0s 340us/step - loss: 0.0681
Epoch 365/400
160/160 [=====] - 0s 340us/step - loss: 0.0683
Epoch 366/400
160/160 [=====] - 0s 330us/step - loss: 0.0666
Epoch 367/400
160/160 [=====] - 0s 337us/step - loss: 0.0737
Epoch 368/400
160/160 [=====] - 0s 337us/step - loss: 0.0700
Epoch 369/400
160/160 [=====] - 0s 343us/step - loss: 0.0699
Epoch 370/400
160/160 [=====] - 0s 349us/step - loss: 0.0656
Epoch 371/400
160/160 [=====] - 0s 362us/step - loss: 0.0649
Epoch 372/400
160/160 [=====] - 0s 343us/step - loss: 0.0738
Epoch 373/400
160/160 [=====] - 0s 330us/step - loss: 0.0723
Epoch 374/400
160/160 [=====] - 0s 330us/step - loss: 0.0710
Epoch 375/400
160/160 [=====] - 0s 337us/step - loss: 0.0755
Epoch 376/400
160/160 [=====] - 0s 318us/step - loss: 0.0715
Epoch 377/400
160/160 [=====] - 0s 337us/step - loss: 0.0682
Epoch 378/400
160/160 [=====] - 0s 337us/step - loss: 0.0715
Epoch 379/400
160/160 [=====] - 0s 349us/step - loss: 0.0676
Epoch 380/400
160/160 [=====] - 0s 349us/step - loss: 0.0745
Epoch 381/400
160/160 [=====] - 0s 362us/step - loss: 0.0648
Epoch 382/400
160/160 [=====] - 0s 349us/step - loss: 0.0722
Epoch 383/400
160/160 [=====] - 0s 343us/step - loss: 0.0700
Epoch 384/400
160/160 [=====] - 0s 337us/step - loss: 0.0643

```
..., ...
Epoch 385/400
160/160 [=====] - 0s 343us/step - loss: 0.0696
Epoch 386/400
160/160 [=====] - 0s 343us/step - loss: 0.0747
Epoch 387/400
160/160 [=====] - 0s 337us/step - loss: 0.0678
Epoch 388/400
160/160 [=====] - 0s 337us/step - loss: 0.0735
Epoch 389/400
160/160 [=====] - 0s 330us/step - loss: 0.0680
Epoch 390/400
160/160 [=====] - 0s 334us/step - loss: 0.0675
Epoch 391/400
160/160 [=====] - 0s 324us/step - loss: 0.0754
Epoch 392/400
160/160 [=====] - 0s 327us/step - loss: 0.0665
Epoch 393/400
160/160 [=====] - 0s 330us/step - loss: 0.0688
Epoch 394/400
160/160 [=====] - 0s 340us/step - loss: 0.0644
Epoch 395/400
160/160 [=====] - 0s 337us/step - loss: 0.0706
Epoch 396/400
160/160 [=====] - 0s 340us/step - loss: 0.0623
Epoch 397/400
160/160 [=====] - 0s 330us/step - loss: 0.0692
Epoch 398/400
160/160 [=====] - 0s 343us/step - loss: 0.0707
Epoch 399/400
160/160 [=====] - 0s 349us/step - loss: 0.0710
Epoch 400/400
160/160 [=====] - 0s 343us/step - loss: 0.0728
[7.5171608e-01 9.9973351e-01 9.9978179e-01 9.5874649e-01 9.9975771e-01
 9.9982423e-01 9.9927419e-01 9.9978191e-01 9.9967313e-01 9.9753678e-01
 9.9983239e-01 9.9981898e-01 9.9981827e-01 9.9963379e-01 9.9978191e-01
 9.9975044e-01 9.9913138e-01 9.9961722e-01 9.9885988e-01 9.9983323e-01
 9.9941766e-01 9.9976331e-01 9.9970752e-01 9.9976927e-01 9.9959427e-01
 9.9978894e-01 9.9958152e-01 9.9583936e-01 9.9210209e-01 9.9948847e-01
 9.9976236e-01 9.9978310e-01 9.9982399e-01 9.9175632e-01 9.9975902e-01
 8.6549109e-01 9.9981505e-01 9.9957389e-01 9.9975914e-01 9.9919766e-01
 6.8197703e-01 9.9990904e-01 9.9982494e-01 9.9491763e-01 9.9987447e-01
 9.9972504e-01 9.9990988e-01 9.9986923e-01 9.9991024e-01 2.5744414e-01
 9.9851710e-01 9.9849594e-01 9.9964893e-01 9.9991226e-01 9.9990308e-01
 9.9987900e-01 9.9981207e-01 9.9991322e-01 9.9991179e-01 9.9885571e-01
 9.9984539e-01 9.9985778e-01 9.9990523e-01 9.9990237e-01 9.9970382e-01
 9.9987745e-01 9.9991393e-01 9.9892455e-01 9.9574274e-01 9.9991477e-01
 9.9990690e-01 9.9990082e-01 9.9975699e-01 9.9989033e-01 9.9987662e-01
 9.9943525e-01 9.9983716e-01 9.9991417e-01 9.9986362e-01 9.9729258e-01
 4.0771884e-01 6.8487301e-05 6.5747547e-05 6.5345797e-03 6.6510896e-05
 6.6946406e-05 8.7474051e-05 6.6033252e-05 7.1185590e-05 9.8969415e-02
 6.5318971e-05 6.4910884e-05 6.5507600e-05 7.2550603e-05 7.1033763e-05
 6.6741784e-05 3.3299960e-04 7.3091491e-05 1.0443139e-04 6.5568849e-05
 2.1787925e-04 6.6242137e-05 6.8741305e-05 6.7168803e-05 1.6400692e-04
 6.6148779e-05 7.4850155e-05 1.8321295e-04 1.0800760e-03 7.9121739e-05
 6.8335561e-05 7.4598967e-05 7.0890645e-05 3.7946724e-04 6.6508488e-05
 2.6083993e-02 7.1788760e-05 7.5318349e-05 6.6379165e-05 8.7196880e-05
 3.5715097e-01 4.1832838e-05 4.0789961e-05 1.0336041e-02 4.0861207e-05
 4.1026371e-05 5.9458009e-05 4.0855950e-05 4.4521999e-05 9.9749148e-01
 4.1331259e-05 4.1025589e-05 4.0885687e-05 4.3769083e-05 4.1831241e-05
 4.0872939e-05 4.5729659e-05 4.1936768e-05 6.0369177e-05 4.1365998e-05
 4.4707584e-05 4.0820003e-05 4.1138104e-05 4.1211533e-05 6.3331303e-05
 4.0892668e-05 4.2095438e-05 5.9018321e-03 1.9571716e-03 4.3196316e-05
 4.1791012e-05 4.1895157e-05 4.1652631e-05 2.7357115e-04 4.0870484e-05
 1.0782736e-02 4.1163810e-05 4.1998723e-05 4.0829738e-05 1.2007550e-03]
160/160 [=====] - 0s 972us/step
```

In [69]:

```
#Five layers, four neurons per layer: loss
scores_optimal_RMSprop, optimal_RMSprop.metrics_names
```

Out [69]:

```
(0.05872122924774885, ['loss'])
```

Adagrad

In [70]:

```
n = 40
xx = np.random.random((n,1))
yy = np.random.random((n,1))

X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [71]:

```
#Five layers, four neurons per layer
optimal_Adagrad = Sequential()

#hidden layers
optimal_Adagrad.add(Dense(4, input_dim=2, activation='tanh'))
optimal_Adagrad.add(Dense(4, activation='tanh'))
optimal_Adagrad.add(Dense(4, activation='tanh'))
optimal_Adagrad.add(Dense(4, activation='tanh'))
optimal_Adagrad.add(Dense(4, activation='tanh'))

#output layer
optimal_Adagrad.add(Dense(1, activation='sigmoid'))

Adagrad = Adagrad(lr=0.1)
optimal_Adagrad.compile(loss='binary_crossentropy', optimizer='RMSprop')

optimal_Adagrad.fit(X, y, batch_size=2, epochs=400)
print(optimal_Adagrad.predict_proba(X).reshape(4*n))

#evaluate the model
scores_optimal_Adagrad = optimal_Adagrad.evaluate(X, y)
```

```
Epoch 1/400
160/160 [=====] - 1s 4ms/step - loss: 0.7074
Epoch 2/400
160/160 [=====] - 0s 355us/step - loss: 0.7003
Epoch 3/400
160/160 [=====] - 0s 349us/step - loss: 0.6970
Epoch 4/400
160/160 [=====] - 0s 340us/step - loss: 0.6950
Epoch 5/400
160/160 [=====] - 0s 337us/step - loss: 0.6932
Epoch 6/400
160/160 [=====] - 0s 340us/step - loss: 0.6918
Epoch 7/400
160/160 [=====] - 0s 343us/step - loss: 0.6892
Epoch 8/400
160/160 [=====] - 0s 340us/step - loss: 0.6862
Epoch 9/400
160/160 [=====] - 0s 352us/step - loss: 0.6814
Epoch 10/400
160/160 [=====] - 0s 343us/step - loss: 0.6753
Epoch 11/400
160/160 [=====] - 0s 349us/step - loss: 0.6665
Epoch 12/400
160/160 [=====] - 0s 343us/step - loss: 0.6565
Epoch 13/400
160/160 [=====] - 0s 330us/step - loss: 0.6451
Epoch 14/400
160/160 [=====] - 0s 337us/step - loss: 0.6319
Epoch 15/400
160/160 [=====] - 0s 355us/step - loss: 0.6188
Epoch 16/400
160/160 [=====] - 0s 330us/step - loss: 0.6061
Epoch 17/400
160/160 [=====] - 0s 330us/step - loss: 0.5923
Epoch 18/400
160/160 [=====] - 0s 343us/step - loss: 0.5798
Epoch 19/400
160/160 [=====] - 0s 324us/step - loss: 0.5662
Epoch 20/400
160/160 [=====] - 0s 343us/step - loss: 0.5534
Epoch 21/400
160/160 [=====] - 0s 337us/step - loss: 0.5407
Epoch 22/400
160/160 [=====] - 0s 343us/step - loss: 0.5302
```

Epoch 23/400
160/160 [=====] - 0s 337us/step - loss: 0.5169
Epoch 24/400
160/160 [=====] - 0s 330us/step - loss: 0.5064
Epoch 25/400
160/160 [=====] - 0s 330us/step - loss: 0.4944
Epoch 26/400
160/160 [=====] - 0s 334us/step - loss: 0.4840
Epoch 27/400
160/160 [=====] - 0s 330us/step - loss: 0.4721
Epoch 28/400
160/160 [=====] - 0s 330us/step - loss: 0.4603
Epoch 29/400
160/160 [=====] - 0s 337us/step - loss: 0.4508
Epoch 30/400
160/160 [=====] - 0s 355us/step - loss: 0.4365
Epoch 31/400
160/160 [=====] - 0s 330us/step - loss: 0.4243
Epoch 32/400
160/160 [=====] - 0s 343us/step - loss: 0.4088
Epoch 33/400
160/160 [=====] - 0s 337us/step - loss: 0.3970
Epoch 34/400
160/160 [=====] - 0s 355us/step - loss: 0.3841
Epoch 35/400
160/160 [=====] - 0s 334us/step - loss: 0.3708
Epoch 36/400
160/160 [=====] - 0s 337us/step - loss: 0.3589
Epoch 37/400
160/160 [=====] - 0s 334us/step - loss: 0.3460
Epoch 38/400
160/160 [=====] - 0s 343us/step - loss: 0.3379
Epoch 39/400
160/160 [=====] - 0s 346us/step - loss: 0.3274
Epoch 40/400
160/160 [=====] - 0s 337us/step - loss: 0.3215
Epoch 41/400
160/160 [=====] - 0s 340us/step - loss: 0.3116
Epoch 42/400
160/160 [=====] - 0s 346us/step - loss: 0.3090
Epoch 43/400
160/160 [=====] - 0s 343us/step - loss: 0.3023
Epoch 44/400
160/160 [=====] - 0s 337us/step - loss: 0.2973
Epoch 45/400
160/160 [=====] - 0s 337us/step - loss: 0.2917
Epoch 46/400
160/160 [=====] - 0s 330us/step - loss: 0.2901
Epoch 47/400
160/160 [=====] - 0s 343us/step - loss: 0.2888
Epoch 48/400
160/160 [=====] - 0s 330us/step - loss: 0.2843
Epoch 49/400
160/160 [=====] - 0s 330us/step - loss: 0.2798
Epoch 50/400
160/160 [=====] - 0s 337us/step - loss: 0.2786
Epoch 51/400
160/160 [=====] - 0s 330us/step - loss: 0.2757
Epoch 52/400
160/160 [=====] - 0s 355us/step - loss: 0.2723
Epoch 53/400
160/160 [=====] - 0s 337us/step - loss: 0.2698
Epoch 54/400
160/160 [=====] - 0s 343us/step - loss: 0.2681
Epoch 55/400
160/160 [=====] - 0s 343us/step - loss: 0.2651
Epoch 56/400
160/160 [=====] - 0s 349us/step - loss: 0.2646
Epoch 57/400
160/160 [=====] - 0s 355us/step - loss: 0.2658
Epoch 58/400
160/160 [=====] - 0s 343us/step - loss: 0.2599
Epoch 59/400
160/160 [=====] - 0s 349us/step - loss: 0.2563
Epoch 60/400
160/160 [=====] - 0s 343us/step - loss: 0.2551
Epoch 61/400

Epoch 61/400
160/160 [=====] - 0s 343us/step - loss: 0.2545
Epoch 62/400
160/160 [=====] - 0s 349us/step - loss: 0.2498
Epoch 63/400
160/160 [=====] - 0s 330us/step - loss: 0.2513
Epoch 64/400
160/160 [=====] - 0s 337us/step - loss: 0.2492
Epoch 65/400
160/160 [=====] - 0s 337us/step - loss: 0.2475
Epoch 66/400
160/160 [=====] - 0s 337us/step - loss: 0.2450
Epoch 67/400
160/160 [=====] - 0s 324us/step - loss: 0.2427
Epoch 68/400
160/160 [=====] - 0s 321us/step - loss: 0.2411
Epoch 69/400
160/160 [=====] - 0s 337us/step - loss: 0.2428
Epoch 70/400
160/160 [=====] - 0s 346us/step - loss: 0.2375
Epoch 71/400
160/160 [=====] - 0s 337us/step - loss: 0.2350
Epoch 72/400
160/160 [=====] - 0s 324us/step - loss: 0.2344
Epoch 73/400
160/160 [=====] - 0s 330us/step - loss: 0.2326
Epoch 74/400
160/160 [=====] - 0s 337us/step - loss: 0.2287
Epoch 75/400
160/160 [=====] - 0s 337us/step - loss: 0.2314
Epoch 76/400
160/160 [=====] - 0s 343us/step - loss: 0.2307
Epoch 77/400
160/160 [=====] - 0s 330us/step - loss: 0.2298
Epoch 78/400
160/160 [=====] - 0s 343us/step - loss: 0.2291
Epoch 79/400
160/160 [=====] - 0s 337us/step - loss: 0.2239
Epoch 80/400
160/160 [=====] - 0s 330us/step - loss: 0.2278
Epoch 81/400
160/160 [=====] - 0s 330us/step - loss: 0.2211
Epoch 82/400
160/160 [=====] - 0s 337us/step - loss: 0.2249
Epoch 83/400
160/160 [=====] - 0s 330us/step - loss: 0.2204
Epoch 84/400
160/160 [=====] - 0s 337us/step - loss: 0.2162
Epoch 85/400
160/160 [=====] - 0s 337us/step - loss: 0.2169
Epoch 86/400
160/160 [=====] - 0s 337us/step - loss: 0.2179
Epoch 87/400
160/160 [=====] - 0s 337us/step - loss: 0.2143
Epoch 88/400
160/160 [=====] - 0s 337us/step - loss: 0.2161
Epoch 89/400
160/160 [=====] - 0s 362us/step - loss: 0.2138
Epoch 90/400
160/160 [=====] - 0s 355us/step - loss: 0.2121
Epoch 91/400
160/160 [=====] - 0s 346us/step - loss: 0.2093
Epoch 92/400
160/160 [=====] - 0s 349us/step - loss: 0.2103
Epoch 93/400
160/160 [=====] - 0s 330us/step - loss: 0.2065
Epoch 94/400
160/160 [=====] - 0s 362us/step - loss: 0.2047
Epoch 95/400
160/160 [=====] - 0s 355us/step - loss: 0.2041
Epoch 96/400
160/160 [=====] - 0s 352us/step - loss: 0.2003
Epoch 97/400
160/160 [=====] - 0s 330us/step - loss: 0.2044
Epoch 98/400
160/160 [=====] - 0s 340us/step - loss: 0.2009
Epoch 99/400
160/160 [=====] - 0s 334us/step - loss: 0.1987

100/100 [=====] - 0s 334us/step - loss: 0.1901
Epoch 100/400
160/160 [=====] - 0s 337us/step - loss: 0.2015
Epoch 101/400
160/160 [=====] - 0s 337us/step - loss: 0.1981
Epoch 102/400
160/160 [=====] - 0s 349us/step - loss: 0.1968
Epoch 103/400
160/160 [=====] - 0s 337us/step - loss: 0.1954
Epoch 104/400
160/160 [=====] - 0s 337us/step - loss: 0.1938
Epoch 105/400
160/160 [=====] - 0s 349us/step - loss: 0.1911
Epoch 106/400
160/160 [=====] - 0s 343us/step - loss: 0.1909
Epoch 107/400
160/160 [=====] - 0s 361us/step - loss: 0.1883
Epoch 108/400
160/160 [=====] - 0s 343us/step - loss: 0.1873
Epoch 109/400
160/160 [=====] - 0s 334us/step - loss: 0.1891
Epoch 110/400
160/160 [=====] - 0s 330us/step - loss: 0.1841
Epoch 111/400
160/160 [=====] - 0s 337us/step - loss: 0.1817
Epoch 112/400
160/160 [=====] - 0s 343us/step - loss: 0.1822
Epoch 113/400
160/160 [=====] - 0s 324us/step - loss: 0.1760
Epoch 114/400
160/160 [=====] - 0s 330us/step - loss: 0.1810
Epoch 115/400
160/160 [=====] - 0s 337us/step - loss: 0.1780
Epoch 116/400
160/160 [=====] - 0s 337us/step - loss: 0.1769
Epoch 117/400
160/160 [=====] - 0s 337us/step - loss: 0.1773
Epoch 118/400
160/160 [=====] - 0s 324us/step - loss: 0.1737
Epoch 119/400
160/160 [=====] - 0s 324us/step - loss: 0.1737
Epoch 120/400
160/160 [=====] - 0s 330us/step - loss: 0.1709
Epoch 121/400
160/160 [=====] - 0s 324us/step - loss: 0.1710
Epoch 122/400
160/160 [=====] - 0s 330us/step - loss: 0.1667
Epoch 123/400
160/160 [=====] - 0s 337us/step - loss: 0.1643
Epoch 124/400
160/160 [=====] - 0s 330us/step - loss: 0.1679
Epoch 125/400
160/160 [=====] - 0s 362us/step - loss: 0.1676
Epoch 126/400
160/160 [=====] - 0s 349us/step - loss: 0.1651
Epoch 127/400
160/160 [=====] - 0s 327us/step - loss: 0.1617
Epoch 128/400
160/160 [=====] - 0s 337us/step - loss: 0.1644
Epoch 129/400
160/160 [=====] - 0s 340us/step - loss: 0.1633
Epoch 130/400
160/160 [=====] - 0s 337us/step - loss: 0.1605
Epoch 131/400
160/160 [=====] - 0s 330us/step - loss: 0.1586
Epoch 132/400
160/160 [=====] - 0s 324us/step - loss: 0.1551
Epoch 133/400
160/160 [=====] - 0s 337us/step - loss: 0.1556
Epoch 134/400
160/160 [=====] - 0s 362us/step - loss: 0.1566
Epoch 135/400
160/160 [=====] - 0s 337us/step - loss: 0.1547
Epoch 136/400
160/160 [=====] - 0s 337us/step - loss: 0.1510
Epoch 137/400
160/160 [=====] - 0s 330us/step - loss: 0.1534
Epoch 138/400

Epoch 150/400
160/160 [=====] - 0s 330us/step - loss: 0.1506
Epoch 139/400
160/160 [=====] - 0s 337us/step - loss: 0.1453
Epoch 140/400
160/160 [=====] - 0s 318us/step - loss: 0.1505
Epoch 141/400
160/160 [=====] - 0s 343us/step - loss: 0.1475
Epoch 142/400
160/160 [=====] - 0s 343us/step - loss: 0.1480
Epoch 143/400
160/160 [=====] - 0s 343us/step - loss: 0.1464
Epoch 144/400
160/160 [=====] - 0s 374us/step - loss: 0.1452
Epoch 145/400
160/160 [=====] - 0s 330us/step - loss: 0.1435
Epoch 146/400
160/160 [=====] - 0s 327us/step - loss: 0.1454
Epoch 147/400
160/160 [=====] - 0s 324us/step - loss: 0.1405
Epoch 148/400
160/160 [=====] - 0s 330us/step - loss: 0.1424
Epoch 149/400
160/160 [=====] - 0s 355us/step - loss: 0.1402
Epoch 150/400
160/160 [=====] - 0s 349us/step - loss: 0.1423
Epoch 151/400
160/160 [=====] - 0s 330us/step - loss: 0.1399
Epoch 152/400
160/160 [=====] - 0s 349us/step - loss: 0.1349
Epoch 153/400
160/160 [=====] - 0s 343us/step - loss: 0.1377
Epoch 154/400
160/160 [=====] - 0s 355us/step - loss: 0.1369
Epoch 155/400
160/160 [=====] - 0s 358us/step - loss: 0.1378
Epoch 156/400
160/160 [=====] - 0s 349us/step - loss: 0.1333
Epoch 157/400
160/160 [=====] - 0s 365us/step - loss: 0.1329
Epoch 158/400
160/160 [=====] - 0s 340us/step - loss: 0.1361
Epoch 159/400
160/160 [=====] - 0s 349us/step - loss: 0.1325
Epoch 160/400
160/160 [=====] - 0s 346us/step - loss: 0.1302
Epoch 161/400
160/160 [=====] - 0s 362us/step - loss: 0.1307
Epoch 162/400
160/160 [=====] - 0s 436us/step - loss: 0.1320
Epoch 163/400
160/160 [=====] - 0s 343us/step - loss: 0.1304
Epoch 164/400
160/160 [=====] - 0s 337us/step - loss: 0.1285
Epoch 165/400
160/160 [=====] - 0s 343us/step - loss: 0.1298
Epoch 166/400
160/160 [=====] - 0s 337us/step - loss: 0.1240
Epoch 167/400
160/160 [=====] - 0s 355us/step - loss: 0.1273
Epoch 168/400
160/160 [=====] - 0s 324us/step - loss: 0.1270
Epoch 169/400
160/160 [=====] - 0s 334us/step - loss: 0.1266
Epoch 170/400
160/160 [=====] - 0s 324us/step - loss: 0.1216
Epoch 171/400
160/160 [=====] - 0s 337us/step - loss: 0.1208
Epoch 172/400
160/160 [=====] - 0s 349us/step - loss: 0.1183
Epoch 173/400
160/160 [=====] - 0s 318us/step - loss: 0.1216
Epoch 174/400
160/160 [=====] - 0s 318us/step - loss: 0.1222
Epoch 175/400
160/160 [=====] - 0s 324us/step - loss: 0.1209
Epoch 176/400
160/160 [=====] - 0s 324us/step - loss: 0.1220

160/160 [=====] - 0s 324us/step - loss: 0.1220
Epoch 177/400
160/160 [=====] - 0s 343us/step - loss: 0.1198
Epoch 178/400
160/160 [=====] - 0s 337us/step - loss: 0.1160
Epoch 179/400
160/160 [=====] - 0s 343us/step - loss: 0.1208
Epoch 180/400
160/160 [=====] - 0s 355us/step - loss: 0.1160
Epoch 181/400
160/160 [=====] - 0s 330us/step - loss: 0.1169
Epoch 182/400
160/160 [=====] - 0s 337us/step - loss: 0.1179
Epoch 183/400
160/160 [=====] - 0s 343us/step - loss: 0.1140
Epoch 184/400
160/160 [=====] - 0s 337us/step - loss: 0.1119
Epoch 185/400
160/160 [=====] - 0s 343us/step - loss: 0.1096
Epoch 186/400
160/160 [=====] - 0s 334us/step - loss: 0.1165
Epoch 187/400
160/160 [=====] - 0s 337us/step - loss: 0.1146
Epoch 188/400
160/160 [=====] - 0s 334us/step - loss: 0.1116
Epoch 189/400
160/160 [=====] - 0s 337us/step - loss: 0.1101
Epoch 190/400
160/160 [=====] - 0s 334us/step - loss: 0.1029
Epoch 191/400
160/160 [=====] - 0s 371us/step - loss: 0.1118
Epoch 192/400
160/160 [=====] - 0s 349us/step - loss: 0.1026
Epoch 193/400
160/160 [=====] - 0s 349us/step - loss: 0.1112
Epoch 194/400
160/160 [=====] - 0s 337us/step - loss: 0.1084
Epoch 195/400
160/160 [=====] - 0s 337us/step - loss: 0.1051
Epoch 196/400
160/160 [=====] - 0s 337us/step - loss: 0.1059
Epoch 197/400
160/160 [=====] - 0s 374us/step - loss: 0.1015
Epoch 198/400
160/160 [=====] - 0s 386us/step - loss: 0.0993
Epoch 199/400
160/160 [=====] - 0s 349us/step - loss: 0.1014
Epoch 200/400
160/160 [=====] - 0s 349us/step - loss: 0.0990
Epoch 201/400
160/160 [=====] - 0s 330us/step - loss: 0.1055
Epoch 202/400
160/160 [=====] - 0s 337us/step - loss: 0.0990
Epoch 203/400
160/160 [=====] - 0s 486us/step - loss: 0.1004
Epoch 204/400
160/160 [=====] - 0s 418us/step - loss: 0.1016
Epoch 205/400
160/160 [=====] - 0s 374us/step - loss: 0.0966
Epoch 206/400
160/160 [=====] - 0s 377us/step - loss: 0.0962
Epoch 207/400
160/160 [=====] - 0s 349us/step - loss: 0.0986
Epoch 208/400
160/160 [=====] - 0s 355us/step - loss: 0.0902
Epoch 209/400
160/160 [=====] - 0s 355us/step - loss: 0.0992
Epoch 210/400
160/160 [=====] - 0s 374us/step - loss: 0.0949
Epoch 211/400
160/160 [=====] - 0s 396us/step - loss: 0.0943
Epoch 212/400
160/160 [=====] - 0s 461us/step - loss: 0.0960
Epoch 213/400
160/160 [=====] - 0s 380us/step - loss: 0.0954
Epoch 214/400
160/160 [=====] - 0s 427us/step - loss: 0.0890

Epoch 215/400
160/160 [=====] - 0s 810us/step - loss: 0.0957
Epoch 216/400
160/160 [=====] - 0s 499us/step - loss: 0.0940
Epoch 217/400
160/160 [=====] - 0s 365us/step - loss: 0.0889
Epoch 218/400
160/160 [=====] - 0s 458us/step - loss: 0.0871
Epoch 219/400
160/160 [=====] - 0s 424us/step - loss: 0.0906
Epoch 220/400
160/160 [=====] - 0s 411us/step - loss: 0.0930
Epoch 221/400
160/160 [=====] - 0s 418us/step - loss: 0.0934
Epoch 222/400
160/160 [=====] - 0s 393us/step - loss: 0.0828
Epoch 223/400
160/160 [=====] - 0s 374us/step - loss: 0.0895
Epoch 224/400
160/160 [=====] - 0s 393us/step - loss: 0.0858
Epoch 225/400
160/160 [=====] - 0s 399us/step - loss: 0.0910
Epoch 226/400
160/160 [=====] - 0s 399us/step - loss: 0.0888
Epoch 227/400
160/160 [=====] - 0s 380us/step - loss: 0.0836
Epoch 228/400
160/160 [=====] - 0s 436us/step - loss: 0.0876
Epoch 229/400
160/160 [=====] - 0s 492us/step - loss: 0.0802
Epoch 230/400
160/160 [=====] - 0s 480us/step - loss: 0.0861
Epoch 231/400
160/160 [=====] - 0s 505us/step - loss: 0.0868
Epoch 232/400
160/160 [=====] - 0s 468us/step - loss: 0.0881
Epoch 233/400
160/160 [=====] - 0s 598us/step - loss: 0.0888
Epoch 234/400
160/160 [=====] - 0s 424us/step - loss: 0.0863
Epoch 235/400
160/160 [=====] - 0s 411us/step - loss: 0.0792
Epoch 236/400
160/160 [=====] - 0s 368us/step - loss: 0.0825
Epoch 237/400
160/160 [=====] - 0s 368us/step - loss: 0.0829
Epoch 238/400
160/160 [=====] - 0s 386us/step - loss: 0.0780
Epoch 239/400
160/160 [=====] - 0s 402us/step - loss: 0.0817
Epoch 240/400
160/160 [=====] - 0s 464us/step - loss: 0.0809
Epoch 241/400
160/160 [=====] - 0s 396us/step - loss: 0.0755
Epoch 242/400
160/160 [=====] - 0s 467us/step - loss: 0.0778
Epoch 243/400
160/160 [=====] - 0s 461us/step - loss: 0.0790
Epoch 244/400
160/160 [=====] - 0s 393us/step - loss: 0.0787
Epoch 245/400
160/160 [=====] - 0s 411us/step - loss: 0.0785
Epoch 246/400
160/160 [=====] - 0s 411us/step - loss: 0.0757
Epoch 247/400
160/160 [=====] - 0s 468us/step - loss: 0.0691
Epoch 248/400
160/160 [=====] - 0s 393us/step - loss: 0.0779
Epoch 249/400
160/160 [=====] - 0s 374us/step - loss: 0.0817
Epoch 250/400
160/160 [=====] - 0s 349us/step - loss: 0.0761
Epoch 251/400
160/160 [=====] - 0s 393us/step - loss: 0.0775
Epoch 252/400
160/160 [=====] - 0s 330us/step - loss: 0.0759
Epoch 253/400

160/160 [=====] - 0s 355us/step - loss: 0.0806
Epoch 254/400
160/160 [=====] - 0s 346us/step - loss: 0.0786
Epoch 255/400
160/160 [=====] - 0s 368us/step - loss: 0.0751
Epoch 256/400
160/160 [=====] - 0s 346us/step - loss: 0.0754
Epoch 257/400
160/160 [=====] - 0s 343us/step - loss: 0.0809
Epoch 258/400
160/160 [=====] - 0s 371us/step - loss: 0.0738
Epoch 259/400
160/160 [=====] - 0s 380us/step - loss: 0.0704
Epoch 260/400
160/160 [=====] - 0s 368us/step - loss: 0.0753
Epoch 261/400
160/160 [=====] - 0s 393us/step - loss: 0.0776
Epoch 262/400
160/160 [=====] - 0s 368us/step - loss: 0.0725
Epoch 263/400
160/160 [=====] - 0s 380us/step - loss: 0.0744
Epoch 264/400
160/160 [=====] - 0s 405us/step - loss: 0.0781
Epoch 265/400
160/160 [=====] - 0s 380us/step - loss: 0.0769
Epoch 266/400
160/160 [=====] - 0s 396us/step - loss: 0.0768
Epoch 267/400
160/160 [=====] - 0s 383us/step - loss: 0.0748
Epoch 268/400
160/160 [=====] - 0s 449us/step - loss: 0.0738
Epoch 269/400
160/160 [=====] - 0s 368us/step - loss: 0.0719
Epoch 270/400
160/160 [=====] - 0s 349us/step - loss: 0.0705
Epoch 271/400
160/160 [=====] - 0s 368us/step - loss: 0.0723
Epoch 272/400
160/160 [=====] - 0s 365us/step - loss: 0.0716
Epoch 273/400
160/160 [=====] - 0s 368us/step - loss: 0.0724
Epoch 274/400
160/160 [=====] - 0s 415us/step - loss: 0.0708
Epoch 275/400
160/160 [=====] - 0s 427us/step - loss: 0.0707
Epoch 276/400
160/160 [=====] - 0s 386us/step - loss: 0.0728
Epoch 277/400
160/160 [=====] - 0s 390us/step - loss: 0.0646
Epoch 278/400
160/160 [=====] - 0s 405us/step - loss: 0.0674
Epoch 279/400
160/160 [=====] - 0s 418us/step - loss: 0.0707
Epoch 280/400
160/160 [=====] - 0s 399us/step - loss: 0.0730
Epoch 281/400
160/160 [=====] - 0s 393us/step - loss: 0.0650
Epoch 282/400
160/160 [=====] - 0s 362us/step - loss: 0.0691
Epoch 283/400
160/160 [=====] - 0s 380us/step - loss: 0.0695
Epoch 284/400
160/160 [=====] - 0s 380us/step - loss: 0.0674
Epoch 285/400
160/160 [=====] - 0s 380us/step - loss: 0.0691
Epoch 286/400
160/160 [=====] - 0s 424us/step - loss: 0.0670
Epoch 287/400
160/160 [=====] - 0s 380us/step - loss: 0.0675
Epoch 288/400
160/160 [=====] - 0s 355us/step - loss: 0.0633
Epoch 289/400
160/160 [=====] - 0s 355us/step - loss: 0.0708
Epoch 290/400
160/160 [=====] - 0s 355us/step - loss: 0.0685
Epoch 291/400
160/160 [=====] - 0s 421us/step - loss: 0.0677
- 100/400

```
Epoch 292/400
160/160 [=====] - 0s 386us/step - loss: 0.0683
Epoch 293/400
160/160 [=====] - 0s 368us/step - loss: 0.0671
Epoch 294/400
160/160 [=====] - 0s 337us/step - loss: 0.0658
Epoch 295/400
160/160 [=====] - 0s 337us/step - loss: 0.0644
Epoch 296/400
160/160 [=====] - 0s 365us/step - loss: 0.0641
Epoch 297/400
160/160 [=====] - 0s 355us/step - loss: 0.0634
Epoch 298/400
160/160 [=====] - 0s 343us/step - loss: 0.0669
Epoch 299/400
160/160 [=====] - 0s 368us/step - loss: 0.0631
Epoch 300/400
160/160 [=====] - 0s 355us/step - loss: 0.0581
Epoch 301/400
160/160 [=====] - 0s 343us/step - loss: 0.0672
Epoch 302/400
160/160 [=====] - 0s 340us/step - loss: 0.0641
Epoch 303/400
160/160 [=====] - 0s 346us/step - loss: 0.0618
Epoch 304/400
160/160 [=====] - 0s 355us/step - loss: 0.0625
Epoch 305/400
160/160 [=====] - 0s 334us/step - loss: 0.0637
Epoch 306/400
160/160 [=====] - 0s 330us/step - loss: 0.0614
Epoch 307/400
160/160 [=====] - 0s 334us/step - loss: 0.0585
Epoch 308/400
160/160 [=====] - 0s 362us/step - loss: 0.0624
Epoch 309/400
160/160 [=====] - 0s 343us/step - loss: 0.0632
Epoch 310/400
160/160 [=====] - 0s 349us/step - loss: 0.0642
Epoch 311/400
160/160 [=====] - 0s 330us/step - loss: 0.0627
Epoch 312/400
160/160 [=====] - 0s 337us/step - loss: 0.0616
Epoch 313/400
160/160 [=====] - 0s 355us/step - loss: 0.0643
Epoch 314/400
160/160 [=====] - 0s 337us/step - loss: 0.0593
Epoch 315/400
160/160 [=====] - 0s 330us/step - loss: 0.0605
Epoch 316/400
160/160 [=====] - 0s 343us/step - loss: 0.0613
Epoch 317/400
160/160 [=====] - 0s 349us/step - loss: 0.0640
Epoch 318/400
160/160 [=====] - 0s 337us/step - loss: 0.0573
Epoch 319/400
160/160 [=====] - 0s 349us/step - loss: 0.0620
Epoch 320/400
160/160 [=====] - 0s 343us/step - loss: 0.0575
Epoch 321/400
160/160 [=====] - 0s 337us/step - loss: 0.0599
Epoch 322/400
160/160 [=====] - 0s 330us/step - loss: 0.0628
Epoch 323/400
160/160 [=====] - 0s 337us/step - loss: 0.0639
Epoch 324/400
160/160 [=====] - 0s 340us/step - loss: 0.0588
Epoch 325/400
160/160 [=====] - 0s 337us/step - loss: 0.0559
Epoch 326/400
160/160 [=====] - 0s 362us/step - loss: 0.0627
Epoch 327/400
160/160 [=====] - 0s 343us/step - loss: 0.0654
Epoch 328/400
160/160 [=====] - 0s 349us/step - loss: 0.0636
Epoch 329/400
160/160 [=====] - 0s 337us/step - loss: 0.0555
Epoch 330/400
```

160/160 [=====] - 0s 349us/step - loss: 0.0644
Epoch 331/400
160/160 [=====] - 0s 337us/step - loss: 0.0553
Epoch 332/400
160/160 [=====] - 0s 349us/step - loss: 0.0563
Epoch 333/400
160/160 [=====] - 0s 334us/step - loss: 0.0591
Epoch 334/400
160/160 [=====] - 0s 327us/step - loss: 0.0583
Epoch 335/400
160/160 [=====] - 0s 343us/step - loss: 0.0592
Epoch 336/400
160/160 [=====] - 0s 340us/step - loss: 0.0615
Epoch 337/400
160/160 [=====] - 0s 343us/step - loss: 0.0578
Epoch 338/400
160/160 [=====] - 0s 349us/step - loss: 0.0539
Epoch 339/400
160/160 [=====] - 0s 337us/step - loss: 0.0561
Epoch 340/400
160/160 [=====] - 0s 337us/step - loss: 0.0554
Epoch 341/400
160/160 [=====] - 0s 340us/step - loss: 0.0532
Epoch 342/400
160/160 [=====] - 0s 330us/step - loss: 0.0570
Epoch 343/400
160/160 [=====] - 0s 337us/step - loss: 0.0499
Epoch 344/400
160/160 [=====] - 0s 362us/step - loss: 0.0527
Epoch 345/400
160/160 [=====] - 0s 355us/step - loss: 0.0520
Epoch 346/400
160/160 [=====] - 0s 343us/step - loss: 0.0542
Epoch 347/400
160/160 [=====] - 0s 343us/step - loss: 0.0567
Epoch 348/400
160/160 [=====] - 0s 324us/step - loss: 0.0525
Epoch 349/400
160/160 [=====] - 0s 330us/step - loss: 0.0549
Epoch 350/400
160/160 [=====] - 0s 337us/step - loss: 0.0555
Epoch 351/400
160/160 [=====] - 0s 349us/step - loss: 0.0550
Epoch 352/400
160/160 [=====] - 0s 337us/step - loss: 0.0475
Epoch 353/400
160/160 [=====] - 0s 346us/step - loss: 0.0516
Epoch 354/400
160/160 [=====] - 0s 343us/step - loss: 0.0509
Epoch 355/400
160/160 [=====] - 0s 334us/step - loss: 0.0547
Epoch 356/400
160/160 [=====] - 0s 349us/step - loss: 0.0544
Epoch 357/400
160/160 [=====] - 0s 349us/step - loss: 0.0544
Epoch 358/400
160/160 [=====] - 0s 343us/step - loss: 0.0554
Epoch 359/400
160/160 [=====] - 0s 349us/step - loss: 0.0483
Epoch 360/400
160/160 [=====] - 0s 343us/step - loss: 0.0525
Epoch 361/400
160/160 [=====] - 0s 343us/step - loss: 0.0552
Epoch 362/400
160/160 [=====] - 0s 337us/step - loss: 0.0554
Epoch 363/400
160/160 [=====] - 0s 355us/step - loss: 0.0523
Epoch 364/400
160/160 [=====] - 0s 343us/step - loss: 0.0555
Epoch 365/400
160/160 [=====] - 0s 334us/step - loss: 0.0485
Epoch 366/400
160/160 [=====] - 0s 343us/step - loss: 0.0557
Epoch 367/400
160/160 [=====] - 0s 358us/step - loss: 0.0516
Epoch 368/400
160/160 [=====] - 0s 349us/step - loss: 0.0521

Epoch 369/400
160/160 [=====] - 0s 374us/step - loss: 0.0489
Epoch 370/400
160/160 [=====] - 0s 343us/step - loss: 0.0510
Epoch 371/400
160/160 [=====] - 0s 343us/step - loss: 0.0523
Epoch 372/400
160/160 [=====] - 0s 337us/step - loss: 0.0503
Epoch 373/400
160/160 [=====] - 0s 349us/step - loss: 0.0526
Epoch 374/400
160/160 [=====] - 0s 337us/step - loss: 0.0461
Epoch 375/400
160/160 [=====] - 0s 343us/step - loss: 0.0506
Epoch 376/400
160/160 [=====] - 0s 327us/step - loss: 0.0497
Epoch 377/400
160/160 [=====] - 0s 330us/step - loss: 0.0498
Epoch 378/400
160/160 [=====] - 0s 337us/step - loss: 0.0498
Epoch 379/400
160/160 [=====] - 0s 337us/step - loss: 0.0491
Epoch 380/400
160/160 [=====] - 0s 349us/step - loss: 0.0454
Epoch 381/400
160/160 [=====] - 0s 349us/step - loss: 0.0487
Epoch 382/400
160/160 [=====] - 0s 346us/step - loss: 0.0481
Epoch 383/400
160/160 [=====] - 0s 337us/step - loss: 0.0454
Epoch 384/400
160/160 [=====] - 0s 337us/step - loss: 0.0495
Epoch 385/400
160/160 [=====] - 0s 343us/step - loss: 0.0424
Epoch 386/400
160/160 [=====] - 0s 330us/step - loss: 0.0554
Epoch 387/400
160/160 [=====] - 0s 343us/step - loss: 0.0486
Epoch 388/400
160/160 [=====] - 0s 343us/step - loss: 0.0511
Epoch 389/400
160/160 [=====] - 0s 343us/step - loss: 0.0476
Epoch 390/400
160/160 [=====] - 0s 343us/step - loss: 0.0495
Epoch 391/400
160/160 [=====] - 0s 324us/step - loss: 0.0415
Epoch 392/400
160/160 [=====] - 0s 337us/step - loss: 0.0487
Epoch 393/400
160/160 [=====] - 0s 337us/step - loss: 0.0474
Epoch 394/400
160/160 [=====] - 0s 330us/step - loss: 0.0483
Epoch 395/400
160/160 [=====] - 0s 343us/step - loss: 0.0460
Epoch 396/400
160/160 [=====] - 0s 368us/step - loss: 0.0417
Epoch 397/400
160/160 [=====] - 0s 343us/step - loss: 0.0444
Epoch 398/400
160/160 [=====] - 0s 349us/step - loss: 0.0487
Epoch 399/400
160/160 [=====] - 0s 360us/step - loss: 0.0451
Epoch 400/400
160/160 [=====] - 0s 343us/step - loss: 0.0456
[9.9997580e-01 9.9969137e-01 9.9985743e-01 9.9997771e-01 9.9992859e-01
9.9663264e-01 9.9567789e-01 9.9997437e-01 9.9969363e-01 9.9954730e-01
5.2432948e-01 9.9981552e-01 9.9997807e-01 9.9997640e-01 9.9948066e-01
9.9857676e-01 9.9998152e-01 9.9997318e-01 9.9997354e-01 9.9997818e-01
1.9330913e-01 9.9986196e-01 9.3997675e-01 9.9989212e-01 9.9997544e-01
9.9994111e-01 9.9988818e-01 9.9901307e-01 9.9987781e-01 9.9997175e-01
8.1986111e-01 9.9995255e-01 9.9988914e-01 9.9998152e-01 9.9989474e-01
9.9988484e-01 9.9997795e-01 9.9979967e-01 9.9995196e-01 9.9996293e-01
9.9956566e-01 9.9954909e-01 9.9956244e-01 9.9956006e-01 9.9958462e-01
9.7376347e-01 9.6060777e-01 9.9849653e-01 9.9935704e-01 9.9942493e-01
1.4975439e-01 9.9955672e-01 9.9955970e-01 9.9956006e-01 9.9922502e-01
9.8368907e-01 9.9942881e-01 9.9954373e-01 9.9883312e-01 9.9954885e-01
7.6914603e-01 9.9747688e-01 9.9536246e-01 9.9958700e-01 9.9955934e-01

```
9.9957138e-01 9.9958724e-01 9.8666799e-01 9.9958688e-01 9.9957317e-01  
8.3607626e-01 9.9957460e-01 9.9948871e-01 9.9945253e-01 9.9958271e-01  
9.9952388e-01 9.9955946e-01 9.9956161e-01 9.9957973e-01 9.9953365e-01  
1.5888121e-05 2.9572132e-06 4.6853702e-06 1.6130873e-05 1.6095282e-05  
5.5248331e-02 1.5536763e-01 2.5500741e-04 1.1703094e-06 8.5560310e-07  
1.4362569e-01 3.6955619e-06 1.6603328e-05 1.3703005e-05 2.2634479e-06  
2.1681222e-04 1.9862951e-05 4.5581169e-06 8.9953182e-06 1.2391887e-05  
1.7444396e-02 8.1813698e-05 2.1586254e-04 1.6634041e-05 1.1695122e-05  
8.0430682e-06 1.6677230e-05 1.7105127e-04 1.6129272e-05 1.6322259e-05  
5.0493069e-02 1.0505009e-05 8.9267462e-07 1.8377703e-05 1.3184267e-05  
1.2937129e-06 1.6315847e-05 4.6183823e-06 1.4135309e-05 1.9566539e-06  
2.6299866e-05 2.5918247e-05 2.5861857e-05 2.6389533e-05 2.6075279e-05  
1.2076499e-03 5.2665100e-03 2.7950531e-05 2.9640927e-05 2.8092831e-05  
5.0065631e-01 2.5871033e-05 2.6390515e-05 2.6352214e-05 3.3278047e-05  
5.6413625e-04 2.9196653e-05 2.6135327e-05 3.3926062e-05 2.6510659e-05  
6.6635661e-02 1.1995343e-04 2.8857234e-04 2.6069411e-05 2.6299842e-05  
2.5943349e-05 2.6069189e-05 4.3088372e-04 2.6052710e-05 2.6200760e-05  
1.8564392e-02 2.6010159e-05 2.6643240e-05 2.8726448e-05 2.5993126e-05  
2.6142679e-05 2.6397385e-05 2.5855594e-05 2.6071004e-05 2.6010532e-05]  
160/160 [=====] - 0s 1ms/step
```

In [72]:

```
#Five layers, four neurons per layer: loss  
scores_optimal_Adagrad, optimal_Adagrad.metrics_names
```

Out[72]:

```
(0.03916203724220395, ['loss'])
```

Adadelta

In [73]:

```
n = 40  
xx = np.random.random((n,1))  
yy = np.random.random((n,1))  
  
X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T  
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [74]:

```
#Five layers, four neurons per layer  
optimal_Adadelta = Sequential()  
  
#hidden layers  
optimal_Adadelta.add(Dense(4, input_dim=2, activation='tanh'))  
optimal_Adadelta.add(Dense(4, activation='tanh'))  
optimal_Adadelta.add(Dense(4, activation='tanh'))  
optimal_Adadelta.add(Dense(4, activation='tanh'))  
optimal_Adadelta.add(Dense(4, activation='tanh'))  
  
#output layer  
optimal_Adadelta.add(Dense(1, activation='sigmoid'))  
  
Adadelta = Adadelta(lr=0.1)  
optimal_Adadelta.compile(loss='binary_crossentropy', optimizer='RMSprop')  
  
optimal_Adadelta.fit(X, y, batch_size=2, epochs=400)  
print(optimal_Adadelta.predict_proba(X).reshape(4*n))  
  
#evaluate the model  
scores_optimal_Adadelta = optimal_Adadelta.evaluate(X, y)
```

```
Epoch 1/400  
160/160 [=====] - 1s 4ms/step - loss: 0.6959  
Epoch 2/400  
160/160 [=====] - 0s 346us/step - loss: 0.6946  
Epoch 3/400  
160/160 [=====] - 0s 368us/step - loss: 0.6935  
Epoch 4/400  
160/160 [=====] - 0s 390us/step - loss: 0.6925  
Epoch 5/400  
160/160 [=====] - 0s 368us/step - loss: 0.6908  
Epoch 6/400  
160/160 [=====] - 0s 362us/step - loss: 0.6891
```

Epoch 7/400
160/160 [=====] - 0s 358us/step - loss: 0.6864
Epoch 8/400
160/160 [=====] - 0s 349us/step - loss: 0.6839
Epoch 9/400
160/160 [=====] - 0s 399us/step - loss: 0.6801
Epoch 10/400
160/160 [=====] - 0s 377us/step - loss: 0.6755
Epoch 11/400
160/160 [=====] - 0s 374us/step - loss: 0.6698
Epoch 12/400
160/160 [=====] - 0s 405us/step - loss: 0.6630
Epoch 13/400
160/160 [=====] - 0s 374us/step - loss: 0.6554
Epoch 14/400
160/160 [=====] - 0s 362us/step - loss: 0.6485
Epoch 15/400
160/160 [=====] - 0s 377us/step - loss: 0.6426
Epoch 16/400
160/160 [=====] - 0s 374us/step - loss: 0.6368
Epoch 17/400
160/160 [=====] - 0s 374us/step - loss: 0.6315
Epoch 18/400
160/160 [=====] - 0s 380us/step - loss: 0.6299
Epoch 19/400
160/160 [=====] - 0s 386us/step - loss: 0.6250
Epoch 20/400
160/160 [=====] - 0s 355us/step - loss: 0.6226
Epoch 21/400
160/160 [=====] - 0s 355us/step - loss: 0.6210
Epoch 22/400
160/160 [=====] - 0s 361us/step - loss: 0.6191
Epoch 23/400
160/160 [=====] - 0s 377us/step - loss: 0.6170
Epoch 24/400
160/160 [=====] - 0s 362us/step - loss: 0.6157
Epoch 25/400
160/160 [=====] - 0s 362us/step - loss: 0.6137
Epoch 26/400
160/160 [=====] - 0s 355us/step - loss: 0.6125
Epoch 27/400
160/160 [=====] - 0s 362us/step - loss: 0.6104
Epoch 28/400
160/160 [=====] - 0s 349us/step - loss: 0.6081
Epoch 29/400
160/160 [=====] - 0s 380us/step - loss: 0.6061
Epoch 30/400
160/160 [=====] - 0s 362us/step - loss: 0.6046
Epoch 31/400
160/160 [=====] - 0s 358us/step - loss: 0.6011
Epoch 32/400
160/160 [=====] - 0s 355us/step - loss: 0.5974
Epoch 33/400
160/160 [=====] - 0s 352us/step - loss: 0.5937
Epoch 34/400
160/160 [=====] - 0s 362us/step - loss: 0.5899
Epoch 35/400
160/160 [=====] - 0s 355us/step - loss: 0.5841
Epoch 36/400
160/160 [=====] - 0s 359us/step - loss: 0.5785
Epoch 37/400
160/160 [=====] - 0s 346us/step - loss: 0.5717
Epoch 38/400
160/160 [=====] - 0s 349us/step - loss: 0.5661
Epoch 39/400
160/160 [=====] - 0s 362us/step - loss: 0.5581
Epoch 40/400
160/160 [=====] - 0s 346us/step - loss: 0.5492
Epoch 41/400
160/160 [=====] - 0s 352us/step - loss: 0.5382
Epoch 42/400
160/160 [=====] - 0s 349us/step - loss: 0.5287
Epoch 43/400
160/160 [=====] - 0s 387us/step - loss: 0.5176
Epoch 44/400
160/160 [=====] - 0s 349us/step - loss: 0.5071
Epoch 45/400

160/160 [=====] - 0s 349us/step - loss: 0.4959
Epoch 46/400
160/160 [=====] - 0s 358us/step - loss: 0.4861
Epoch 47/400
160/160 [=====] - 0s 355us/step - loss: 0.4735
Epoch 48/400
160/160 [=====] - 0s 362us/step - loss: 0.4649
Epoch 49/400
160/160 [=====] - 0s 355us/step - loss: 0.4573
Epoch 50/400
160/160 [=====] - 0s 358us/step - loss: 0.4501
Epoch 51/400
160/160 [=====] - 0s 362us/step - loss: 0.4434
Epoch 52/400
160/160 [=====] - 0s 362us/step - loss: 0.4396
Epoch 53/400
160/160 [=====] - 0s 390us/step - loss: 0.4331
Epoch 54/400
160/160 [=====] - 0s 362us/step - loss: 0.4281
Epoch 55/400
160/160 [=====] - 0s 362us/step - loss: 0.4256
Epoch 56/400
160/160 [=====] - 0s 371us/step - loss: 0.4173
Epoch 57/400
160/160 [=====] - 0s 368us/step - loss: 0.4206
Epoch 58/400
160/160 [=====] - 0s 352us/step - loss: 0.4175
Epoch 59/400
160/160 [=====] - 0s 352us/step - loss: 0.4137
Epoch 60/400
160/160 [=====] - 0s 355us/step - loss: 0.4126
Epoch 61/400
160/160 [=====] - 0s 355us/step - loss: 0.4098
Epoch 62/400
160/160 [=====] - 0s 358us/step - loss: 0.4090
Epoch 63/400
160/160 [=====] - 0s 352us/step - loss: 0.4070
Epoch 64/400
160/160 [=====] - 0s 355us/step - loss: 0.4015
Epoch 65/400
160/160 [=====] - 0s 352us/step - loss: 0.4063
Epoch 66/400
160/160 [=====] - 0s 343us/step - loss: 0.4023
Epoch 67/400
160/160 [=====] - 0s 349us/step - loss: 0.4005
Epoch 68/400
160/160 [=====] - 0s 346us/step - loss: 0.3963
Epoch 69/400
160/160 [=====] - 0s 349us/step - loss: 0.3977
Epoch 70/400
160/160 [=====] - 0s 355us/step - loss: 0.3942
Epoch 71/400
160/160 [=====] - 0s 337us/step - loss: 0.3947
Epoch 72/400
160/160 [=====] - 0s 346us/step - loss: 0.3902
Epoch 73/400
160/160 [=====] - 0s 349us/step - loss: 0.3889
Epoch 74/400
160/160 [=====] - 0s 343us/step - loss: 0.3881
Epoch 75/400
160/160 [=====] - 0s 349us/step - loss: 0.3838
Epoch 76/400
160/160 [=====] - 0s 358us/step - loss: 0.3853
Epoch 77/400
160/160 [=====] - 0s 343us/step - loss: 0.3799
Epoch 78/400
160/160 [=====] - 0s 349us/step - loss: 0.3754
Epoch 79/400
160/160 [=====] - 0s 343us/step - loss: 0.3722
Epoch 80/400
160/160 [=====] - 0s 346us/step - loss: 0.3701
Epoch 81/400
160/160 [=====] - 0s 362us/step - loss: 0.3645
Epoch 82/400
160/160 [=====] - 0s 337us/step - loss: 0.3600
Epoch 83/400
160/160 [=====] - 0s 343us/step - loss: 0.3515

Epoch 84/400
160/160 [=====] - 0s 343us/step - loss: 0.3522
Epoch 85/400
160/160 [=====] - 0s 337us/step - loss: 0.3452
Epoch 86/400
160/160 [=====] - 0s 349us/step - loss: 0.3454
Epoch 87/400
160/160 [=====] - 0s 355us/step - loss: 0.3343
Epoch 88/400
160/160 [=====] - 0s 343us/step - loss: 0.3343
Epoch 89/400
160/160 [=====] - 0s 349us/step - loss: 0.3287
Epoch 90/400
160/160 [=====] - 0s 349us/step - loss: 0.3208
Epoch 91/400
160/160 [=====] - 0s 337us/step - loss: 0.3159
Epoch 92/400
160/160 [=====] - 0s 349us/step - loss: 0.3088
Epoch 93/400
160/160 [=====] - 0s 355us/step - loss: 0.3011
Epoch 94/400
160/160 [=====] - 0s 349us/step - loss: 0.2979
Epoch 95/400
160/160 [=====] - 0s 355us/step - loss: 0.2913
Epoch 96/400
160/160 [=====] - 0s 362us/step - loss: 0.2871
Epoch 97/400
160/160 [=====] - 0s 355us/step - loss: 0.2801
Epoch 98/400
160/160 [=====] - 0s 337us/step - loss: 0.2698
Epoch 99/400
160/160 [=====] - 0s 349us/step - loss: 0.2694
Epoch 100/400
160/160 [=====] - 0s 343us/step - loss: 0.2606
Epoch 101/400
160/160 [=====] - 0s 343us/step - loss: 0.2546
Epoch 102/400
160/160 [=====] - 0s 337us/step - loss: 0.2463
Epoch 103/400
160/160 [=====] - 0s 346us/step - loss: 0.2483
Epoch 104/400
160/160 [=====] - 0s 349us/step - loss: 0.2407
Epoch 105/400
160/160 [=====] - 0s 340us/step - loss: 0.2341
Epoch 106/400
160/160 [=====] - 0s 365us/step - loss: 0.2306
Epoch 107/400
160/160 [=====] - 0s 337us/step - loss: 0.2260
Epoch 108/400
160/160 [=====] - 0s 334us/step - loss: 0.2192
Epoch 109/400
160/160 [=====] - 0s 355us/step - loss: 0.2162
Epoch 110/400
160/160 [=====] - 0s 343us/step - loss: 0.2100
Epoch 111/400
160/160 [=====] - 0s 337us/step - loss: 0.2005
Epoch 112/400
160/160 [=====] - 0s 340us/step - loss: 0.2052
Epoch 113/400
160/160 [=====] - 0s 343us/step - loss: 0.1986
Epoch 114/400
160/160 [=====] - 0s 337us/step - loss: 0.1992
Epoch 115/400
160/160 [=====] - 0s 343us/step - loss: 0.1941
Epoch 116/400
160/160 [=====] - 0s 343us/step - loss: 0.1876
Epoch 117/400
160/160 [=====] - 0s 355us/step - loss: 0.1881
Epoch 118/400
160/160 [=====] - 0s 343us/step - loss: 0.1870
Epoch 119/400
160/160 [=====] - 0s 343us/step - loss: 0.1792
Epoch 120/400
160/160 [=====] - 0s 343us/step - loss: 0.1770
Epoch 121/400
160/160 [=====] - 0s 343us/step - loss: 0.1749
Epoch 122/400

160/160 [=====] - 0s 349us/step - loss: 0.1760
Epoch 123/400
160/160 [=====] - 0s 343us/step - loss: 0.1729
Epoch 124/400
160/160 [=====] - 0s 349us/step - loss: 0.1688
Epoch 125/400
160/160 [=====] - 0s 346us/step - loss: 0.1640
Epoch 126/400
160/160 [=====] - 0s 330us/step - loss: 0.1670
Epoch 127/400
160/160 [=====] - 0s 330us/step - loss: 0.1636
Epoch 128/400
160/160 [=====] - 0s 343us/step - loss: 0.1610
Epoch 129/400
160/160 [=====] - 0s 343us/step - loss: 0.1606
Epoch 130/400
160/160 [=====] - 0s 330us/step - loss: 0.1542
Epoch 131/400
160/160 [=====] - 0s 337us/step - loss: 0.1567
Epoch 132/400
160/160 [=====] - 0s 343us/step - loss: 0.1488
Epoch 133/400
160/160 [=====] - 0s 337us/step - loss: 0.1534
Epoch 134/400
160/160 [=====] - 0s 343us/step - loss: 0.1526
Epoch 135/400
160/160 [=====] - 0s 362us/step - loss: 0.1477
Epoch 136/400
160/160 [=====] - 0s 349us/step - loss: 0.1501
Epoch 137/400
160/160 [=====] - 0s 343us/step - loss: 0.1467
Epoch 138/400
160/160 [=====] - 0s 355us/step - loss: 0.1488
Epoch 139/400
160/160 [=====] - 0s 340us/step - loss: 0.1408
Epoch 140/400
160/160 [=====] - 0s 334us/step - loss: 0.1422
Epoch 141/400
160/160 [=====] - 0s 347us/step - loss: 0.1457
Epoch 142/400
160/160 [=====] - 0s 368us/step - loss: 0.1412
Epoch 143/400
160/160 [=====] - 0s 352us/step - loss: 0.1416
Epoch 144/400
160/160 [=====] - 0s 355us/step - loss: 0.1393
Epoch 145/400
160/160 [=====] - 0s 349us/step - loss: 0.1380
Epoch 146/400
160/160 [=====] - 0s 349us/step - loss: 0.1400
Epoch 147/400
160/160 [=====] - 0s 343us/step - loss: 0.1372
Epoch 148/400
160/160 [=====] - 0s 337us/step - loss: 0.1366
Epoch 149/400
160/160 [=====] - 0s 330us/step - loss: 0.1351
Epoch 150/400
160/160 [=====] - 0s 343us/step - loss: 0.1345
Epoch 151/400
160/160 [=====] - 0s 362us/step - loss: 0.1288
Epoch 152/400
160/160 [=====] - 0s 343us/step - loss: 0.1340
Epoch 153/400
160/160 [=====] - 0s 355us/step - loss: 0.1277
Epoch 154/400
160/160 [=====] - 0s 349us/step - loss: 0.1276
Epoch 155/400
160/160 [=====] - 0s 349us/step - loss: 0.1261
Epoch 156/400
160/160 [=====] - 0s 349us/step - loss: 0.1281
Epoch 157/400
160/160 [=====] - 0s 349us/step - loss: 0.1242
Epoch 158/400
160/160 [=====] - 0s 355us/step - loss: 0.1225
Epoch 159/400
160/160 [=====] - 0s 337us/step - loss: 0.1244
Epoch 160/400
160/160 [=====] - 0s 355us/step - loss: 0.1233

Epoch 161/400
160/160 [=====] - 0s 343us/step - loss: 0.1207
Epoch 162/400
160/160 [=====] - 0s 343us/step - loss: 0.1206
Epoch 163/400
160/160 [=====] - 0s 343us/step - loss: 0.1222
Epoch 164/400
160/160 [=====] - 0s 349us/step - loss: 0.1102
Epoch 165/400
160/160 [=====] - 0s 349us/step - loss: 0.1221
Epoch 166/400
160/160 [=====] - 0s 346us/step - loss: 0.1192
Epoch 167/400
160/160 [=====] - 0s 349us/step - loss: 0.1027
Epoch 168/400
160/160 [=====] - 0s 337us/step - loss: 0.1233
Epoch 169/400
160/160 [=====] - 0s 349us/step - loss: 0.1200
Epoch 170/400
160/160 [=====] - 0s 364us/step - loss: 0.1122
Epoch 171/400
160/160 [=====] - 0s 362us/step - loss: 0.1160
Epoch 172/400
160/160 [=====] - 0s 343us/step - loss: 0.1138
Epoch 173/400
160/160 [=====] - 0s 352us/step - loss: 0.1045
Epoch 174/400
160/160 [=====] - 0s 343us/step - loss: 0.1147
Epoch 175/400
160/160 [=====] - 0s 346us/step - loss: 0.1145
Epoch 176/400
160/160 [=====] - 0s 337us/step - loss: 0.1061
Epoch 177/400
160/160 [=====] - 0s 337us/step - loss: 0.1100
Epoch 178/400
160/160 [=====] - 0s 349us/step - loss: 0.1087
Epoch 179/400
160/160 [=====] - 0s 349us/step - loss: 0.1079
Epoch 180/400
160/160 [=====] - 0s 343us/step - loss: 0.1070
Epoch 181/400
160/160 [=====] - 0s 355us/step - loss: 0.1084
Epoch 182/400
160/160 [=====] - 0s 362us/step - loss: 0.1057
Epoch 183/400
160/160 [=====] - 0s 343us/step - loss: 0.1065
Epoch 184/400
160/160 [=====] - 0s 343us/step - loss: 0.1042
Epoch 185/400
160/160 [=====] - 0s 355us/step - loss: 0.1025
Epoch 186/400
160/160 [=====] - 0s 349us/step - loss: 0.1067
Epoch 187/400
160/160 [=====] - 0s 349us/step - loss: 0.1019
Epoch 188/400
160/160 [=====] - 0s 362us/step - loss: 0.1021
Epoch 189/400
160/160 [=====] - 0s 358us/step - loss: 0.0994
Epoch 190/400
160/160 [=====] - 0s 350us/step - loss: 0.1032
Epoch 191/400
160/160 [=====] - 0s 345us/step - loss: 0.0971
Epoch 192/400
160/160 [=====] - 0s 349us/step - loss: 0.0965
Epoch 193/400
160/160 [=====] - 0s 355us/step - loss: 0.0988
Epoch 194/400
160/160 [=====] - 0s 343us/step - loss: 0.0909
Epoch 195/400
160/160 [=====] - 0s 340us/step - loss: 0.0999
Epoch 196/400
160/160 [=====] - 0s 349us/step - loss: 0.0968
Epoch 197/400
160/160 [=====] - 0s 349us/step - loss: 0.0952
Epoch 198/400
160/160 [=====] - 0s 349us/step - loss: 0.0939
Epoch 199/400

```
160/160 [=====] - 0s 355us/step - loss: 0.0961
Epoch 200/400
160/160 [=====] - 0s 371us/step - loss: 0.0938
Epoch 201/400
160/160 [=====] - 0s 386us/step - loss: 0.0940
Epoch 202/400
160/160 [=====] - 0s 358us/step - loss: 0.0952
Epoch 203/400
160/160 [=====] - 0s 362us/step - loss: 0.0928
Epoch 204/400
160/160 [=====] - 0s 362us/step - loss: 0.0908
Epoch 205/400
160/160 [=====] - 0s 355us/step - loss: 0.0898
Epoch 206/400
160/160 [=====] - 0s 368us/step - loss: 0.0876
Epoch 207/400
160/160 [=====] - 0s 362us/step - loss: 0.0915
Epoch 208/400
160/160 [=====] - 0s 349us/step - loss: 0.0888
Epoch 209/400
160/160 [=====] - 0s 343us/step - loss: 0.0869
Epoch 210/400
160/160 [=====] - 0s 343us/step - loss: 0.0931
Epoch 211/400
160/160 [=====] - 0s 343us/step - loss: 0.0864
Epoch 212/400
160/160 [=====] - 0s 337us/step - loss: 0.0859
Epoch 213/400
160/160 [=====] - 0s 374us/step - loss: 0.0814
Epoch 214/400
160/160 [=====] - 0s 368us/step - loss: 0.0860
Epoch 215/400
160/160 [=====] - 0s 364us/step - loss: 0.0891
Epoch 216/400
160/160 [=====] - 0s 362us/step - loss: 0.0852
Epoch 217/400
160/160 [=====] - 0s 345us/step - loss: 0.0878
Epoch 218/400
160/160 [=====] - 0s 343us/step - loss: 0.0844
Epoch 219/400
160/160 [=====] - 0s 358us/step - loss: 0.0848
Epoch 220/400
160/160 [=====] - 0s 362us/step - loss: 0.0855
Epoch 221/400
160/160 [=====] - 0s 374us/step - loss: 0.0875
Epoch 222/400
160/160 [=====] - 0s 362us/step - loss: 0.0860
Epoch 223/400
160/160 [=====] - 0s 362us/step - loss: 0.0872
Epoch 224/400
160/160 [=====] - 0s 362us/step - loss: 0.0849
Epoch 225/400
160/160 [=====] - 0s 343us/step - loss: 0.0855
Epoch 226/400
160/160 [=====] - 0s 334us/step - loss: 0.0896
Epoch 227/400
160/160 [=====] - 0s 343us/step - loss: 0.0753
Epoch 228/400
160/160 [=====] - 0s 358us/step - loss: 0.0880
Epoch 229/400
160/160 [=====] - 0s 343us/step - loss: 0.0805
Epoch 230/400
160/160 [=====] - 0s 340us/step - loss: 0.0815
Epoch 231/400
160/160 [=====] - 0s 355us/step - loss: 0.0800
Epoch 232/400
160/160 [=====] - 0s 346us/step - loss: 0.0819
Epoch 233/400
160/160 [=====] - 0s 349us/step - loss: 0.0835
Epoch 234/400
160/160 [=====] - 0s 343us/step - loss: 0.0845
Epoch 235/400
160/160 [=====] - 0s 355us/step - loss: 0.0745
Epoch 236/400
160/160 [=====] - 0s 343us/step - loss: 0.0724
Epoch 237/400
160/160 [=====] - 0s 349us/step - loss: 0.0767
```

Epoch 238/400
160/160 [=====] - 0s 343us/step - loss: 0.0769
Epoch 239/400
160/160 [=====] - 0s 349us/step - loss: 0.0796
Epoch 240/400
160/160 [=====] - 0s 362us/step - loss: 0.0791
Epoch 241/400
160/160 [=====] - 0s 358us/step - loss: 0.0734
Epoch 242/400
160/160 [=====] - 0s 390us/step - loss: 0.0694
Epoch 243/400
160/160 [=====] - 0s 355us/step - loss: 0.0761
Epoch 244/400
160/160 [=====] - 0s 358us/step - loss: 0.0752
Epoch 245/400
160/160 [=====] - 0s 355us/step - loss: 0.0695
Epoch 246/400
160/160 [=====] - 0s 365us/step - loss: 0.0765
Epoch 247/400
160/160 [=====] - 0s 346us/step - loss: 0.0745
Epoch 248/400
160/160 [=====] - 0s 365us/step - loss: 0.0774
Epoch 249/400
160/160 [=====] - 0s 362us/step - loss: 0.0706
Epoch 250/400
160/160 [=====] - 0s 358us/step - loss: 0.0738
Epoch 251/400
160/160 [=====] - 0s 365us/step - loss: 0.0713
Epoch 252/400
160/160 [=====] - 0s 340us/step - loss: 0.0710
Epoch 253/400
160/160 [=====] - 0s 386us/step - loss: 0.0710
Epoch 254/400
160/160 [=====] - 0s 365us/step - loss: 0.0716
Epoch 255/400
160/160 [=====] - 0s 349us/step - loss: 0.0739
Epoch 256/400
160/160 [=====] - 0s 340us/step - loss: 0.0698
Epoch 257/400
160/160 [=====] - 0s 362us/step - loss: 0.0728
Epoch 258/400
160/160 [=====] - 0s 343us/step - loss: 0.0703
Epoch 259/400
160/160 [=====] - 0s 380us/step - loss: 0.0639
Epoch 260/400
160/160 [=====] - 0s 337us/step - loss: 0.0741
Epoch 261/400
160/160 [=====] - 0s 337us/step - loss: 0.0680
Epoch 262/400
160/160 [=====] - 0s 362us/step - loss: 0.0666
Epoch 263/400
160/160 [=====] - 0s 337us/step - loss: 0.0660
Epoch 264/400
160/160 [=====] - 0s 362us/step - loss: 0.0683
Epoch 265/400
160/160 [=====] - 0s 346us/step - loss: 0.0714
Epoch 266/400
160/160 [=====] - 0s 349us/step - loss: 0.0687
Epoch 267/400
160/160 [=====] - 0s 358us/step - loss: 0.0734
Epoch 268/400
160/160 [=====] - 0s 343us/step - loss: 0.0690
Epoch 269/400
160/160 [=====] - 0s 352us/step - loss: 0.0647
Epoch 270/400
160/160 [=====] - 0s 355us/step - loss: 0.0632
Epoch 271/400
160/160 [=====] - 0s 334us/step - loss: 0.0644
Epoch 272/400
160/160 [=====] - 0s 358us/step - loss: 0.0650
Epoch 273/400
160/160 [=====] - 0s 355us/step - loss: 0.0642
Epoch 274/400
160/160 [=====] - 0s 349us/step - loss: 0.0643
Epoch 275/400
160/160 [=====] - 0s 355us/step - loss: 0.0713
Epoch 276/400

160/160 [=====] - 0s 355us/step - loss: 0.0669
Epoch 277/400
160/160 [=====] - 0s 358us/step - loss: 0.0629
Epoch 278/400
160/160 [=====] - 0s 362us/step - loss: 0.0641
Epoch 279/400
160/160 [=====] - 0s 346us/step - loss: 0.0653
Epoch 280/400
160/160 [=====] - 0s 358us/step - loss: 0.0683
Epoch 281/400
160/160 [=====] - 0s 340us/step - loss: 0.0626
Epoch 282/400
160/160 [=====] - 0s 337us/step - loss: 0.0639
Epoch 283/400
160/160 [=====] - 0s 349us/step - loss: 0.0647
Epoch 284/400
160/160 [=====] - 0s 346us/step - loss: 0.0581
Epoch 285/400
160/160 [=====] - 0s 343us/step - loss: 0.0664
Epoch 286/400
160/160 [=====] - 0s 349us/step - loss: 0.0565
Epoch 287/400
160/160 [=====] - 0s 337us/step - loss: 0.0582
Epoch 288/400
160/160 [=====] - 0s 352us/step - loss: 0.0697
Epoch 289/400
160/160 [=====] - 0s 349us/step - loss: 0.0589
Epoch 290/400
160/160 [=====] - 0s 343us/step - loss: 0.0638
Epoch 291/400
160/160 [=====] - 0s 337us/step - loss: 0.0549
Epoch 292/400
160/160 [=====] - 0s 346us/step - loss: 0.0656
Epoch 293/400
160/160 [=====] - 0s 337us/step - loss: 0.0559
Epoch 294/400
160/160 [=====] - 0s 343us/step - loss: 0.0606
Epoch 295/400
160/160 [=====] - 0s 362us/step - loss: 0.0580
Epoch 296/400
160/160 [=====] - 0s 340us/step - loss: 0.0605
Epoch 297/400
160/160 [=====] - 0s 343us/step - loss: 0.0566
Epoch 298/400
160/160 [=====] - 0s 343us/step - loss: 0.0523
Epoch 299/400
160/160 [=====] - 0s 355us/step - loss: 0.0575
Epoch 300/400
160/160 [=====] - 0s 355us/step - loss: 0.0562
Epoch 301/400
160/160 [=====] - 0s 355us/step - loss: 0.0623
Epoch 302/400
160/160 [=====] - 0s 355us/step - loss: 0.0536
Epoch 303/400
160/160 [=====] - 0s 340us/step - loss: 0.0583
Epoch 304/400
160/160 [=====] - 0s 337us/step - loss: 0.0543
Epoch 305/400
160/160 [=====] - 0s 340us/step - loss: 0.0545
Epoch 306/400
160/160 [=====] - 0s 358us/step - loss: 0.0561
Epoch 307/400
160/160 [=====] - 0s 337us/step - loss: 0.0546
Epoch 308/400
160/160 [=====] - 0s 349us/step - loss: 0.0491
Epoch 309/400
160/160 [=====] - 0s 349us/step - loss: 0.0499
Epoch 310/400
160/160 [=====] - 0s 355us/step - loss: 0.0554
Epoch 311/400
160/160 [=====] - 0s 362us/step - loss: 0.0530
Epoch 312/400
160/160 [=====] - 0s 362us/step - loss: 0.0475
Epoch 313/400
160/160 [=====] - 0s 349us/step - loss: 0.0546
Epoch 314/400
160/160 [=====] - 0s 343us/step - loss: 0.0530

...
Epoch 315/400
160/160 [=====] - 0s 337us/step - loss: 0.0480
Epoch 316/400
160/160 [=====] - 0s 355us/step - loss: 0.0512
Epoch 317/400
160/160 [=====] - 0s 352us/step - loss: 0.0512
Epoch 318/400
160/160 [=====] - 0s 337us/step - loss: 0.0513
Epoch 319/400
160/160 [=====] - 0s 362us/step - loss: 0.0526
Epoch 320/400
160/160 [=====] - 0s 349us/step - loss: 0.0507
Epoch 321/400
160/160 [=====] - 0s 352us/step - loss: 0.0464
Epoch 322/400
160/160 [=====] - 0s 355us/step - loss: 0.0530
Epoch 323/400
160/160 [=====] - 0s 343us/step - loss: 0.0472
Epoch 324/400
160/160 [=====] - 0s 355us/step - loss: 0.0431
Epoch 325/400
160/160 [=====] - 0s 343us/step - loss: 0.0470
Epoch 326/400
160/160 [=====] - 0s 349us/step - loss: 0.0391
Epoch 327/400
160/160 [=====] - 0s 355us/step - loss: 0.0477
Epoch 328/400
160/160 [=====] - 0s 343us/step - loss: 0.0458
Epoch 329/400
160/160 [=====] - 0s 343us/step - loss: 0.0499
Epoch 330/400
160/160 [=====] - 0s 374us/step - loss: 0.0428
Epoch 331/400
160/160 [=====] - 0s 337us/step - loss: 0.0425
Epoch 332/400
160/160 [=====] - 0s 337us/step - loss: 0.0448
Epoch 333/400
160/160 [=====] - 0s 355us/step - loss: 0.0405
Epoch 334/400
160/160 [=====] - 0s 355us/step - loss: 0.0495
Epoch 335/400
160/160 [=====] - 0s 399us/step - loss: 0.0443
Epoch 336/400
160/160 [=====] - 0s 334us/step - loss: 0.0445
Epoch 337/400
160/160 [=====] - 0s 374us/step - loss: 0.0529
Epoch 338/400
160/160 [=====] - 0s 349us/step - loss: 0.0477
Epoch 339/400
160/160 [=====] - 0s 349us/step - loss: 0.0400
Epoch 340/400
160/160 [=====] - 0s 337us/step - loss: 0.0501
Epoch 341/400
160/160 [=====] - 0s 337us/step - loss: 0.0401
Epoch 342/400
160/160 [=====] - 0s 368us/step - loss: 0.0384
Epoch 343/400
160/160 [=====] - 0s 343us/step - loss: 0.0433
Epoch 344/400
160/160 [=====] - 0s 337us/step - loss: 0.0430
Epoch 345/400
160/160 [=====] - 0s 346us/step - loss: 0.0376
Epoch 346/400
160/160 [=====] - 0s 349us/step - loss: 0.0387
Epoch 347/400
160/160 [=====] - 0s 343us/step - loss: 0.0485
Epoch 348/400
160/160 [=====] - 0s 368us/step - loss: 0.0397
Epoch 349/400
160/160 [=====] - 0s 343us/step - loss: 0.0404
Epoch 350/400
160/160 [=====] - 0s 352us/step - loss: 0.0346
Epoch 351/400
160/160 [=====] - 0s 343us/step - loss: 0.0440
Epoch 352/400
160/160 [=====] - 0s 349us/step - loss: 0.0337
Epoch 353/400

Epoch 353/400
160/160 [=====] - 0s 349us/step - loss: 0.0428
Epoch 354/400
160/160 [=====] - 0s 340us/step - loss: 0.0397
Epoch 355/400
160/160 [=====] - 0s 355us/step - loss: 0.0487
Epoch 356/400
160/160 [=====] - 0s 340us/step - loss: 0.0428
Epoch 357/400
160/160 [=====] - 0s 337us/step - loss: 0.0393
Epoch 358/400
160/160 [=====] - 0s 337us/step - loss: 0.0470
Epoch 359/400
160/160 [=====] - 0s 349us/step - loss: 0.0366
Epoch 360/400
160/160 [=====] - 0s 346us/step - loss: 0.0390
Epoch 361/400
160/160 [=====] - 0s 349us/step - loss: 0.0350
Epoch 362/400
160/160 [=====] - 0s 349us/step - loss: 0.0386
Epoch 363/400
160/160 [=====] - 0s 340us/step - loss: 0.0388
Epoch 364/400
160/160 [=====] - 0s 362us/step - loss: 0.0328
Epoch 365/400
160/160 [=====] - 0s 349us/step - loss: 0.0385
Epoch 366/400
160/160 [=====] - 0s 352us/step - loss: 0.0375
Epoch 367/400
160/160 [=====] - 0s 349us/step - loss: 0.0333
Epoch 368/400
160/160 [=====] - 0s 343us/step - loss: 0.0368
Epoch 369/400
160/160 [=====] - 0s 355us/step - loss: 0.0391
Epoch 370/400
160/160 [=====] - 0s 355us/step - loss: 0.0313
Epoch 371/400
160/160 [=====] - 0s 349us/step - loss: 0.0371
Epoch 372/400
160/160 [=====] - 0s 402us/step - loss: 0.0318
Epoch 373/400
160/160 [=====] - 0s 362us/step - loss: 0.0397
Epoch 374/400
160/160 [=====] - 0s 346us/step - loss: 0.0352
Epoch 375/400
160/160 [=====] - 0s 337us/step - loss: 0.0374
Epoch 376/400
160/160 [=====] - 0s 346us/step - loss: 0.0338
Epoch 377/400
160/160 [=====] - 0s 346us/step - loss: 0.0396
Epoch 378/400
160/160 [=====] - 0s 349us/step - loss: 0.0286
Epoch 379/400
160/160 [=====] - 0s 349us/step - loss: 0.0316
Epoch 380/400
160/160 [=====] - 0s 337us/step - loss: 0.0432
Epoch 381/400
160/160 [=====] - 0s 337us/step - loss: 0.0327
Epoch 382/400
160/160 [=====] - 0s 355us/step - loss: 0.0323
Epoch 383/400
160/160 [=====] - 0s 365us/step - loss: 0.0328
Epoch 384/400
160/160 [=====] - 0s 343us/step - loss: 0.0295
Epoch 385/400
160/160 [=====] - 0s 355us/step - loss: 0.0269
Epoch 386/400
160/160 [=====] - 0s 343us/step - loss: 0.0428
Epoch 387/400
160/160 [=====] - 0s 349us/step - loss: 0.0339
Epoch 388/400
160/160 [=====] - 0s 337us/step - loss: 0.0294
Epoch 389/400
160/160 [=====] - 0s 343us/step - loss: 0.0347
Epoch 390/400
160/160 [=====] - 0s 349us/step - loss: 0.0324
Epoch 391/400
160/160 [=====] - 0s 355us/step - loss: 0.0208

```

100/100 [=====] - 0s 333us/step - loss: 0.0200
Epoch 392/400
160/160 [=====] - 0s 343us/step - loss: 0.0375
Epoch 393/400
160/160 [=====] - 0s 343us/step - loss: 0.0278
Epoch 394/400
160/160 [=====] - 0s 337us/step - loss: 0.0263
Epoch 395/400
160/160 [=====] - 0s 337us/step - loss: 0.0314
Epoch 396/400
160/160 [=====] - 0s 355us/step - loss: 0.0313
Epoch 397/400
160/160 [=====] - 0s 337us/step - loss: 0.0263
Epoch 398/400
160/160 [=====] - 0s 330us/step - loss: 0.0310
Epoch 399/400
160/160 [=====] - 0s 337us/step - loss: 0.0273
Epoch 400/400
160/160 [=====] - 0s 349us/step - loss: 0.0281
[9.9999702e-01 9.9999690e-01 9.9999607e-01 9.9999678e-01 9.9999642e-01
 9.9999654e-01 9.9999595e-01 9.9999690e-01 9.9999678e-01 9.9998367e-01
 9.9992025e-01 9.9999607e-01 9.9999702e-01 9.9999654e-01 9.7215909e-01
 9.9999690e-01 9.9999666e-01 9.9999690e-01 9.9317110e-01 9.9999690e-01
 9.6223819e-01 9.9999666e-01 9.9999702e-01 9.9999142e-01 9.9999702e-01
 9.9999607e-01 9.5449525e-01 9.9999249e-01 9.9993932e-01 9.9999464e-01
 9.9999547e-01 9.9999702e-01 9.9984694e-01 9.6544635e-01 9.9999702e-01
 9.9999571e-01 9.9997079e-01 9.9999702e-01 9.9990499e-01 9.9999595e-01
 9.9999332e-01 9.9999022e-01 9.9999559e-01 9.9999595e-01 9.9999404e-01
 9.9999726e-01 9.9999344e-01 9.9999404e-01 9.9999583e-01 9.9998891e-01
 9.9996364e-01 9.9999690e-01 9.9999428e-01 9.9999368e-01 9.9821031e-01
 9.9999189e-01 9.9999547e-01 9.9999321e-01 9.9892718e-01 9.9999380e-01
 7.8086901e-01 9.9999702e-01 9.9999177e-01 9.9999130e-01 9.9999201e-01
 9.9999619e-01 9.7039336e-01 9.9999464e-01 9.9998200e-01 9.9999297e-01
 9.9999309e-01 9.9999416e-01 9.9998033e-01 9.9832517e-01 9.9999118e-01
 9.9999380e-01 9.9997640e-01 9.9999225e-01 9.9998283e-01 9.9999428e-01
 9.7204713e-07 1.0493319e-06 1.3742127e-06 1.0038121e-06 9.8951887e-07
 1.0795502e-06 1.0231412e-06 9.5631083e-07 1.0460835e-06 8.4635103e-06
 9.4013565e-05 1.2650960e-06 9.7153918e-07 9.7468148e-07 2.6616937e-01
 9.7541431e-07 1.0029921e-06 9.6742122e-07 8.1146963e-02 9.6580527e-07
 7.8150976e-01 1.0589808e-06 9.8383452e-07 2.4754636e-05 9.8127271e-07
 1.3432564e-06 2.0538297e-01 4.0748591e-06 4.0442836e-05 1.1060260e-06
 1.0490596e-06 9.8080864e-07 2.2727684e-06 1.2675341e-03 9.8192231e-07
 1.0632735e-06 2.5472986e-05 9.7719817e-07 2.1152212e-06 1.0556633e-06
 1.1957966e-06 1.0473922e-06 1.0306672e-06 1.2273887e-06 1.4606100e-06
 1.0811822e-06 1.6729498e-06 1.2971722e-06 1.0274601e-06 7.6127399e-06
 1.0439942e-05 1.2722974e-06 1.1487466e-06 1.4401062e-06 8.5712960e-03
 1.2214975e-06 1.2993971e-06 1.2910409e-06 3.7115721e-03 1.2953783e-06
 2.5710124e-01 1.1124949e-06 1.1605986e-06 2.0415446e-06 1.1724911e-06
 1.0402349e-06 2.6456293e-01 2.2566951e-06 8.7336512e-06 2.1031103e-06
 1.8360304e-06 1.1179286e-06 2.1931623e-05 4.0597674e-02 1.1805528e-06
 1.7748266e-06 4.2764223e-06 1.1968701e-06 1.6406470e-05 1.6637772e-06]
160/160 [=====] - 0s 1ms/step

```

In [75]:

```
#Five layers, four neurons per layer: loss
scores_optimal_Adadelta, optimal_Adadelta.metrics_names
```

Out[75]:

```
(0.020268671819940208, ['loss'])
```

Adam

In [76]:

```
n = 40
xx = np.random.random((n,1))
yy = np.random.random((n,1))

X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [77]:

```
#Five layers, four neurons per layer
optimal_Adam = Sequential()
```

```

#hidden layers
optimal_Adam.add(Dense(4, input_dim=2, activation='tanh'))
optimal_Adam.add(Dense(4, activation='tanh'))
optimal_Adam.add(Dense(4, activation='tanh'))
optimal_Adam.add(Dense(4, activation='tanh'))
optimal_Adam.add(Dense(4, activation='tanh'))

#output layer
optimal_Adam.add(Dense(1, activation='sigmoid'))

Adam = Adam(lr=0.1)
optimal_Adam.compile(loss='binary_crossentropy', optimizer='RMSprop')

optimal_Adam.fit(X, y, batch_size=2, epochs=400)
print(optimal_Adam.predict_proba(X).reshape(4*n))

#evaluate the model
scores_optimal_Adam = optimal_Adam.evaluate(X, y)

```

```

Epoch 1/400
160/160 [=====] - 1s 4ms/step - loss: 0.6950
Epoch 2/400
160/160 [=====] - 0s 352us/step - loss: 0.6941
Epoch 3/400
160/160 [=====] - 0s 365us/step - loss: 0.6934
Epoch 4/400
160/160 [=====] - 0s 352us/step - loss: 0.6925
Epoch 5/400
160/160 [=====] - 0s 374us/step - loss: 0.6912
Epoch 6/400
160/160 [=====] - 0s 355us/step - loss: 0.6894
Epoch 7/400
160/160 [=====] - 0s 380us/step - loss: 0.6866
Epoch 8/400
160/160 [=====] - 0s 405us/step - loss: 0.6833
Epoch 9/400
160/160 [=====] - 0s 368us/step - loss: 0.6780
Epoch 10/400
160/160 [=====] - 0s 374us/step - loss: 0.6711
Epoch 11/400
160/160 [=====] - 0s 349us/step - loss: 0.6624
Epoch 12/400
160/160 [=====] - 0s 358us/step - loss: 0.6527
Epoch 13/400
160/160 [=====] - 0s 355us/step - loss: 0.6409
Epoch 14/400
160/160 [=====] - 0s 362us/step - loss: 0.6289
Epoch 15/400
160/160 [=====] - 0s 386us/step - loss: 0.6146
Epoch 16/400
160/160 [=====] - 0s 355us/step - loss: 0.5998
Epoch 17/400
160/160 [=====] - 0s 355us/step - loss: 0.5806
Epoch 18/400
160/160 [=====] - 0s 362us/step - loss: 0.5607
Epoch 19/400
160/160 [=====] - 0s 362us/step - loss: 0.5438
Epoch 20/400
160/160 [=====] - 0s 362us/step - loss: 0.5242
Epoch 21/400
160/160 [=====] - 0s 355us/step - loss: 0.5092
Epoch 22/400
160/160 [=====] - 0s 362us/step - loss: 0.4964
Epoch 23/400
160/160 [=====] - 0s 349us/step - loss: 0.4839
Epoch 24/400
160/160 [=====] - 0s 362us/step - loss: 0.4730
Epoch 25/400
160/160 [=====] - 0s 374us/step - loss: 0.4623
Epoch 26/400
160/160 [=====] - 0s 374us/step - loss: 0.4546
Epoch 27/400
160/160 [=====] - 0s 362us/step - loss: 0.4480
Epoch 28/400
160/160 [=====] - 0s 355us/step - loss: 0.4440
Epoch 29/400
160/160 [=====] - 0s 362us/step - loss: 0.4374

```

100/100 [=====] - 0s 302us/step - loss: 0.4074
Epoch 30/400
160/160 [=====] - 0s 374us/step - loss: 0.4352
Epoch 31/400
160/160 [=====] - 0s 374us/step - loss: 0.4311
Epoch 32/400
160/160 [=====] - 0s 380us/step - loss: 0.4298
Epoch 33/400
160/160 [=====] - 0s 355us/step - loss: 0.4235
Epoch 34/400
160/160 [=====] - 0s 355us/step - loss: 0.4233
Epoch 35/400
160/160 [=====] - 0s 377us/step - loss: 0.4236
Epoch 36/400
160/160 [=====] - 0s 362us/step - loss: 0.4219
Epoch 37/400
160/160 [=====] - 0s 362us/step - loss: 0.4206
Epoch 38/400
160/160 [=====] - 0s 368us/step - loss: 0.4200
Epoch 39/400
160/160 [=====] - 0s 377us/step - loss: 0.4181
Epoch 40/400
160/160 [=====] - 0s 362us/step - loss: 0.4168
Epoch 41/400
160/160 [=====] - 0s 383us/step - loss: 0.4172
Epoch 42/400
160/160 [=====] - 0s 355us/step - loss: 0.4193
Epoch 43/400
160/160 [=====] - 0s 362us/step - loss: 0.4128
Epoch 44/400
160/160 [=====] - 0s 368us/step - loss: 0.4156
Epoch 45/400
160/160 [=====] - 0s 368us/step - loss: 0.4151
Epoch 46/400
160/160 [=====] - 0s 362us/step - loss: 0.4145
Epoch 47/400
160/160 [=====] - 0s 362us/step - loss: 0.4144
Epoch 48/400
160/160 [=====] - 0s 377us/step - loss: 0.4136
Epoch 49/400
160/160 [=====] - 0s 380us/step - loss: 0.4138
Epoch 50/400
160/160 [=====] - 0s 362us/step - loss: 0.4143
Epoch 51/400
160/160 [=====] - 0s 358us/step - loss: 0.4138
Epoch 52/400
160/160 [=====] - 0s 371us/step - loss: 0.4120
Epoch 53/400
160/160 [=====] - 0s 362us/step - loss: 0.4112
Epoch 54/400
160/160 [=====] - 0s 365us/step - loss: 0.4115
Epoch 55/400
160/160 [=====] - 0s 368us/step - loss: 0.4121
Epoch 56/400
160/160 [=====] - 0s 365us/step - loss: 0.4100
Epoch 57/400
160/160 [=====] - 0s 343us/step - loss: 0.4090
Epoch 58/400
160/160 [=====] - 0s 349us/step - loss: 0.4126
Epoch 59/400
160/160 [=====] - 0s 343us/step - loss: 0.4112
Epoch 60/400
160/160 [=====] - 0s 349us/step - loss: 0.4110
Epoch 61/400
160/160 [=====] - 0s 355us/step - loss: 0.4124
Epoch 62/400
160/160 [=====] - 0s 349us/step - loss: 0.4116
Epoch 63/400
160/160 [=====] - 0s 355us/step - loss: 0.4114
Epoch 64/400
160/160 [=====] - 0s 355us/step - loss: 0.4110
Epoch 65/400
160/160 [=====] - 0s 343us/step - loss: 0.4117
Epoch 66/400
160/160 [=====] - 0s 374us/step - loss: 0.4103
Epoch 67/400
160/160 [=====] - 0s 343us/step - loss: 0.4076
Epoch 68/400

Epoch 68/400
160/160 [=====] - 0s 355us/step - loss: 0.4091
Epoch 69/400
160/160 [=====] - 0s 343us/step - loss: 0.4062
Epoch 70/400
160/160 [=====] - 0s 343us/step - loss: 0.4095
Epoch 71/400
160/160 [=====] - 0s 349us/step - loss: 0.4067
Epoch 72/400
160/160 [=====] - 0s 340us/step - loss: 0.4058
Epoch 73/400
160/160 [=====] - 0s 380us/step - loss: 0.4079
Epoch 74/400
160/160 [=====] - 0s 352us/step - loss: 0.4071
Epoch 75/400
160/160 [=====] - 0s 355us/step - loss: 0.4054
Epoch 76/400
160/160 [=====] - 0s 349us/step - loss: 0.4091
Epoch 77/400
160/160 [=====] - 0s 349us/step - loss: 0.4097
Epoch 78/400
160/160 [=====] - 0s 355us/step - loss: 0.4040
Epoch 79/400
160/160 [=====] - 0s 349us/step - loss: 0.4074
Epoch 80/400
160/160 [=====] - 0s 355us/step - loss: 0.4099
Epoch 81/400
160/160 [=====] - 0s 343us/step - loss: 0.4057
Epoch 82/400
160/160 [=====] - 0s 343us/step - loss: 0.4077
Epoch 83/400
160/160 [=====] - 0s 340us/step - loss: 0.4075
Epoch 84/400
160/160 [=====] - 0s 377us/step - loss: 0.4085
Epoch 85/400
160/160 [=====] - 0s 349us/step - loss: 0.4053
Epoch 86/400
160/160 [=====] - 0s 358us/step - loss: 0.4084
Epoch 87/400
160/160 [=====] - 0s 368us/step - loss: 0.4064
Epoch 88/400
160/160 [=====] - 0s 358us/step - loss: 0.4085
Epoch 89/400
160/160 [=====] - 0s 362us/step - loss: 0.4044
Epoch 90/400
160/160 [=====] - 0s 355us/step - loss: 0.4085
Epoch 91/400
160/160 [=====] - 0s 349us/step - loss: 0.4061
Epoch 92/400
160/160 [=====] - 0s 355us/step - loss: 0.4057
Epoch 93/400
160/160 [=====] - 0s 349us/step - loss: 0.4036
Epoch 94/400
160/160 [=====] - 0s 355us/step - loss: 0.4057
Epoch 95/400
160/160 [=====] - 0s 362us/step - loss: 0.4026
Epoch 96/400
160/160 [=====] - 0s 349us/step - loss: 0.4057
Epoch 97/400
160/160 [=====] - 0s 362us/step - loss: 0.4033
Epoch 98/400
160/160 [=====] - 0s 343us/step - loss: 0.4057
Epoch 99/400
160/160 [=====] - 0s 349us/step - loss: 0.4060
Epoch 100/400
160/160 [=====] - 0s 368us/step - loss: 0.4046
Epoch 101/400
160/160 [=====] - 0s 368us/step - loss: 0.4046
Epoch 102/400
160/160 [=====] - 0s 346us/step - loss: 0.4011
Epoch 103/400
160/160 [=====] - 0s 337us/step - loss: 0.4046
Epoch 104/400
160/160 [=====] - 0s 358us/step - loss: 0.4038
Epoch 105/400
160/160 [=====] - 0s 337us/step - loss: 0.4037
Epoch 106/400
160/160 [=====] - 0s 343us/step - loss: 0.4020

160/160 [=====] - 0s 345us/step - loss: 0.4029
Epoch 107/400
160/160 [=====] - 0s 337us/step - loss: 0.4054
Epoch 108/400
160/160 [=====] - 0s 355us/step - loss: 0.4015
Epoch 109/400
160/160 [=====] - 0s 374us/step - loss: 0.4043
Epoch 110/400
160/160 [=====] - 0s 343us/step - loss: 0.4016
Epoch 111/400
160/160 [=====] - 0s 343us/step - loss: 0.4017
Epoch 112/400
160/160 [=====] - 0s 349us/step - loss: 0.4017
Epoch 113/400
160/160 [=====] - 0s 343us/step - loss: 0.4023
Epoch 114/400
160/160 [=====] - 0s 352us/step - loss: 0.4042
Epoch 115/400
160/160 [=====] - 0s 355us/step - loss: 0.4033
Epoch 116/400
160/160 [=====] - 0s 346us/step - loss: 0.4049
Epoch 117/400
160/160 [=====] - 0s 337us/step - loss: 0.4018
Epoch 118/400
160/160 [=====] - 0s 343us/step - loss: 0.4016
Epoch 119/400
160/160 [=====] - 0s 362us/step - loss: 0.3993
Epoch 120/400
160/160 [=====] - 0s 337us/step - loss: 0.4011
Epoch 121/400
160/160 [=====] - 0s 362us/step - loss: 0.4010
Epoch 122/400
160/160 [=====] - 0s 362us/step - loss: 0.3988
Epoch 123/400
160/160 [=====] - 0s 355us/step - loss: 0.4041
Epoch 124/400
160/160 [=====] - 0s 337us/step - loss: 0.4013
Epoch 125/400
160/160 [=====] - 0s 346us/step - loss: 0.4003
Epoch 126/400
160/160 [=====] - 0s 349us/step - loss: 0.4029
Epoch 127/400
160/160 [=====] - 0s 349us/step - loss: 0.4012
Epoch 128/400
160/160 [=====] - 0s 352us/step - loss: 0.3994
Epoch 129/400
160/160 [=====] - 0s 343us/step - loss: 0.4001
Epoch 130/400
160/160 [=====] - 0s 340us/step - loss: 0.4000
Epoch 131/400
160/160 [=====] - 0s 355us/step - loss: 0.4006
Epoch 132/400
160/160 [=====] - 0s 355us/step - loss: 0.4002
Epoch 133/400
160/160 [=====] - 0s 349us/step - loss: 0.3998
Epoch 134/400
160/160 [=====] - 0s 346us/step - loss: 0.3998
Epoch 135/400
160/160 [=====] - 0s 343us/step - loss: 0.3991
Epoch 136/400
160/160 [=====] - 0s 337us/step - loss: 0.3991
Epoch 137/400
160/160 [=====] - 0s 362us/step - loss: 0.3988
Epoch 138/400
160/160 [=====] - 0s 340us/step - loss: 0.4006
Epoch 139/400
160/160 [=====] - 0s 337us/step - loss: 0.3974
Epoch 140/400
160/160 [=====] - 0s 361us/step - loss: 0.3959
Epoch 141/400
160/160 [=====] - 0s 343us/step - loss: 0.3966
Epoch 142/400
160/160 [=====] - 0s 355us/step - loss: 0.3957
Epoch 143/400
160/160 [=====] - 0s 349us/step - loss: 0.3963
Epoch 144/400
160/160 [=====] - 0s 362us/step - loss: 0.3980

Epoch 145/400
160/160 [=====] - 0s 349us/step - loss: 0.3953
Epoch 146/400
160/160 [=====] - 0s 349us/step - loss: 0.3946
Epoch 147/400
160/160 [=====] - 0s 346us/step - loss: 0.3968
Epoch 148/400
160/160 [=====] - 0s 346us/step - loss: 0.3958
Epoch 149/400
160/160 [=====] - 0s 362us/step - loss: 0.3966
Epoch 150/400
160/160 [=====] - 0s 371us/step - loss: 0.3952
Epoch 151/400
160/160 [=====] - 0s 349us/step - loss: 0.3932
Epoch 152/400
160/160 [=====] - 0s 346us/step - loss: 0.3938
Epoch 153/400
160/160 [=====] - 0s 355us/step - loss: 0.3943
Epoch 154/400
160/160 [=====] - 0s 393us/step - loss: 0.3921
Epoch 155/400
160/160 [=====] - 0s 355us/step - loss: 0.3932
Epoch 156/400
160/160 [=====] - 0s 362us/step - loss: 0.3917
Epoch 157/400
160/160 [=====] - 0s 362us/step - loss: 0.3916
Epoch 158/400
160/160 [=====] - 0s 374us/step - loss: 0.3948
Epoch 159/400
160/160 [=====] - 0s 362us/step - loss: 0.3923
Epoch 160/400
160/160 [=====] - 0s 371us/step - loss: 0.3888
Epoch 161/400
160/160 [=====] - 0s 374us/step - loss: 0.3903
Epoch 162/400
160/160 [=====] - 0s 355us/step - loss: 0.3921
Epoch 163/400
160/160 [=====] - 0s 355us/step - loss: 0.3873
Epoch 164/400
160/160 [=====] - 0s 349us/step - loss: 0.3898
Epoch 165/400
160/160 [=====] - 0s 343us/step - loss: 0.3872
Epoch 166/400
160/160 [=====] - 0s 355us/step - loss: 0.3864
Epoch 167/400
160/160 [=====] - 0s 346us/step - loss: 0.3823
Epoch 168/400
160/160 [=====] - 0s 355us/step - loss: 0.3898
Epoch 169/400
160/160 [=====] - 0s 355us/step - loss: 0.3851
Epoch 170/400
160/160 [=====] - 0s 368us/step - loss: 0.3869
Epoch 171/400
160/160 [=====] - 0s 365us/step - loss: 0.3834
Epoch 172/400
160/160 [=====] - 0s 355us/step - loss: 0.3792
Epoch 173/400
160/160 [=====] - 0s 355us/step - loss: 0.3816
Epoch 174/400
160/160 [=====] - 0s 355us/step - loss: 0.3798
Epoch 175/400
160/160 [=====] - 0s 358us/step - loss: 0.3813
Epoch 176/400
160/160 [=====] - 0s 343us/step - loss: 0.3777
Epoch 177/400
160/160 [=====] - 0s 355us/step - loss: 0.3769
Epoch 178/400
160/160 [=====] - 0s 346us/step - loss: 0.3755
Epoch 179/400
160/160 [=====] - 0s 356us/step - loss: 0.3756
Epoch 180/400
160/160 [=====] - 0s 355us/step - loss: 0.3752
Epoch 181/400
160/160 [=====] - 0s 340us/step - loss: 0.3711
Epoch 182/400
160/160 [=====] - 0s 337us/step - loss: 0.3706
Epoch 183/400

160/160 [=====] - 0s 358us/step - loss: 0.3682
Epoch 184/400
160/160 [=====] - 0s 355us/step - loss: 0.3694
Epoch 185/400
160/160 [=====] - 0s 362us/step - loss: 0.3681
Epoch 186/400
160/160 [=====] - 0s 362us/step - loss: 0.3657
Epoch 187/400
160/160 [=====] - 0s 355us/step - loss: 0.3632
Epoch 188/400
160/160 [=====] - 0s 349us/step - loss: 0.3622
Epoch 189/400
160/160 [=====] - 0s 368us/step - loss: 0.3584
Epoch 190/400
160/160 [=====] - 0s 362us/step - loss: 0.3603
Epoch 191/400
160/160 [=====] - 0s 349us/step - loss: 0.3556
Epoch 192/400
160/160 [=====] - 0s 368us/step - loss: 0.3553
Epoch 193/400
160/160 [=====] - 0s 362us/step - loss: 0.3512
Epoch 194/400
160/160 [=====] - 0s 362us/step - loss: 0.3467
Epoch 195/400
160/160 [=====] - 0s 349us/step - loss: 0.3473
Epoch 196/400
160/160 [=====] - 0s 362us/step - loss: 0.3423
Epoch 197/400
160/160 [=====] - 0s 393us/step - loss: 0.3402
Epoch 198/400
160/160 [=====] - 0s 368us/step - loss: 0.3365
Epoch 199/400
160/160 [=====] - 0s 346us/step - loss: 0.3331
Epoch 200/400
160/160 [=====] - 0s 355us/step - loss: 0.3291
Epoch 201/400
160/160 [=====] - 0s 343us/step - loss: 0.3276
Epoch 202/400
160/160 [=====] - 0s 355us/step - loss: 0.3207
Epoch 203/400
160/160 [=====] - 0s 355us/step - loss: 0.3189
Epoch 204/400
160/160 [=====] - 0s 346us/step - loss: 0.3151
Epoch 205/400
160/160 [=====] - 0s 362us/step - loss: 0.3102
Epoch 206/400
160/160 [=====] - 0s 355us/step - loss: 0.3059
Epoch 207/400
160/160 [=====] - 0s 362us/step - loss: 0.3010
Epoch 208/400
160/160 [=====] - 0s 396us/step - loss: 0.2996
Epoch 209/400
160/160 [=====] - 0s 352us/step - loss: 0.2924
Epoch 210/400
160/160 [=====] - 0s 355us/step - loss: 0.2896
Epoch 211/400
160/160 [=====] - 0s 340us/step - loss: 0.2830
Epoch 212/400
160/160 [=====] - 0s 343us/step - loss: 0.2794
Epoch 213/400
160/160 [=====] - 0s 352us/step - loss: 0.2753
Epoch 214/400
160/160 [=====] - 0s 355us/step - loss: 0.2711
Epoch 215/400
160/160 [=====] - 0s 343us/step - loss: 0.2662
Epoch 216/400
160/160 [=====] - 0s 343us/step - loss: 0.2578
Epoch 217/400
160/160 [=====] - 0s 352us/step - loss: 0.2541
Epoch 218/400
160/160 [=====] - 0s 343us/step - loss: 0.2480
Epoch 219/400
160/160 [=====] - 0s 349us/step - loss: 0.2431
Epoch 220/400
160/160 [=====] - 0s 355us/step - loss: 0.2421
Epoch 221/400
160/160 [=====] - 0s 343us/step - loss: 0.2318
- 100/400

Epoch 222/400
160/160 [=====] - 0s 349us/step - loss: 0.2305
Epoch 223/400
160/160 [=====] - 0s 349us/step - loss: 0.2184
Epoch 224/400
160/160 [=====] - 0s 374us/step - loss: 0.2161
Epoch 225/400
160/160 [=====] - 0s 337us/step - loss: 0.2140
Epoch 226/400
160/160 [=====] - 0s 343us/step - loss: 0.2108
Epoch 227/400
160/160 [=====] - 0s 349us/step - loss: 0.1926
Epoch 228/400
160/160 [=====] - 0s 358us/step - loss: 0.2029
Epoch 229/400
160/160 [=====] - 0s 349us/step - loss: 0.1947
Epoch 230/400
160/160 [=====] - 0s 346us/step - loss: 0.1904
Epoch 231/400
160/160 [=====] - 0s 340us/step - loss: 0.1871
Epoch 232/400
160/160 [=====] - 0s 362us/step - loss: 0.1752
Epoch 233/400
160/160 [=====] - 0s 349us/step - loss: 0.1784
Epoch 234/400
160/160 [=====] - 0s 349us/step - loss: 0.1691
Epoch 235/400
160/160 [=====] - 0s 349us/step - loss: 0.1684
Epoch 236/400
160/160 [=====] - 0s 343us/step - loss: 0.1602
Epoch 237/400
160/160 [=====] - 0s 340us/step - loss: 0.1574
Epoch 238/400
160/160 [=====] - 0s 355us/step - loss: 0.1596
Epoch 239/400
160/160 [=====] - 0s 349us/step - loss: 0.1489
Epoch 240/400
160/160 [=====] - 0s 349us/step - loss: 0.1481
Epoch 241/400
160/160 [=====] - 0s 346us/step - loss: 0.1436
Epoch 242/400
160/160 [=====] - 0s 374us/step - loss: 0.1417
Epoch 243/400
160/160 [=====] - 0s 346us/step - loss: 0.1348
Epoch 244/400
160/160 [=====] - 0s 349us/step - loss: 0.1336
Epoch 245/400
160/160 [=====] - 0s 355us/step - loss: 0.1321
Epoch 246/400
160/160 [=====] - 0s 349us/step - loss: 0.1257
Epoch 247/400
160/160 [=====] - 0s 356us/step - loss: 0.1284
Epoch 248/400
160/160 [=====] - 0s 349us/step - loss: 0.1241
Epoch 249/400
160/160 [=====] - 0s 355us/step - loss: 0.1216
Epoch 250/400
160/160 [=====] - 0s 352us/step - loss: 0.1186
Epoch 251/400
160/160 [=====] - 0s 349us/step - loss: 0.1142
Epoch 252/400
160/160 [=====] - 0s 374us/step - loss: 0.1185
Epoch 253/400
160/160 [=====] - 0s 349us/step - loss: 0.1113
Epoch 254/400
160/160 [=====] - 0s 349us/step - loss: 0.1111
Epoch 255/400
160/160 [=====] - 0s 355us/step - loss: 0.1086
Epoch 256/400
160/160 [=====] - 0s 355us/step - loss: 0.1048
Epoch 257/400
160/160 [=====] - 0s 355us/step - loss: 0.1020
Epoch 258/400
160/160 [=====] - 0s 355us/step - loss: 0.1020
Epoch 259/400
160/160 [=====] - 0s 377us/step - loss: 0.0990
Epoch 260/400
...

160/160 [=====] - 0s 349us/step - loss: 0.0984
Epoch 261/400
160/160 [=====] - 0s 355us/step - loss: 0.0973
Epoch 262/400
160/160 [=====] - 0s 355us/step - loss: 0.0914
Epoch 263/400
160/160 [=====] - 0s 365us/step - loss: 0.0913
Epoch 264/400
160/160 [=====] - 0s 351us/step - loss: 0.0911
Epoch 265/400
160/160 [=====] - 0s 349us/step - loss: 0.0903
Epoch 266/400
160/160 [=====] - 0s 358us/step - loss: 0.0895
Epoch 267/400
160/160 [=====] - 0s 368us/step - loss: 0.0879
Epoch 268/400
160/160 [=====] - 0s 355us/step - loss: 0.0873
Epoch 269/400
160/160 [=====] - 0s 340us/step - loss: 0.0847
Epoch 270/400
160/160 [=====] - 0s 349us/step - loss: 0.0842
Epoch 271/400
160/160 [=====] - 0s 358us/step - loss: 0.0810
Epoch 272/400
160/160 [=====] - 0s 343us/step - loss: 0.0811
Epoch 273/400
160/160 [=====] - 0s 343us/step - loss: 0.0809
Epoch 274/400
160/160 [=====] - 0s 368us/step - loss: 0.0790
Epoch 275/400
160/160 [=====] - 0s 349us/step - loss: 0.0776
Epoch 276/400
160/160 [=====] - 0s 349us/step - loss: 0.0768
Epoch 277/400
160/160 [=====] - 0s 374us/step - loss: 0.0773
Epoch 278/400
160/160 [=====] - 0s 368us/step - loss: 0.0766
Epoch 279/400
160/160 [=====] - 0s 343us/step - loss: 0.0723
Epoch 280/400
160/160 [=====] - 0s 352us/step - loss: 0.0742
Epoch 281/400
160/160 [=====] - 0s 349us/step - loss: 0.0741
Epoch 282/400
160/160 [=====] - 0s 365us/step - loss: 0.0733
Epoch 283/400
160/160 [=====] - 0s 355us/step - loss: 0.0706
Epoch 284/400
160/160 [=====] - 0s 352us/step - loss: 0.0704
Epoch 285/400
160/160 [=====] - 0s 352us/step - loss: 0.0723
Epoch 286/400
160/160 [=====] - 0s 358us/step - loss: 0.0732
Epoch 287/400
160/160 [=====] - 0s 355us/step - loss: 0.0700
Epoch 288/400
160/160 [=====] - 0s 343us/step - loss: 0.0705
Epoch 289/400
160/160 [=====] - 0s 349us/step - loss: 0.0649
Epoch 290/400
160/160 [=====] - 0s 349us/step - loss: 0.0691
Epoch 291/400
160/160 [=====] - 0s 337us/step - loss: 0.0679
Epoch 292/400
160/160 [=====] - 0s 337us/step - loss: 0.0707
Epoch 293/400
160/160 [=====] - 0s 352us/step - loss: 0.0652
Epoch 294/400
160/160 [=====] - 0s 358us/step - loss: 0.0685
Epoch 295/400
160/160 [=====] - 0s 352us/step - loss: 0.0704
Epoch 296/400
160/160 [=====] - 0s 343us/step - loss: 0.0687
Epoch 297/400
160/160 [=====] - 0s 343us/step - loss: 0.0685
Epoch 298/400
160/160 [=====] - 0s 355us/step - loss: 0.0667

Epoch 299/400
160/160 [=====] - 0s 349us/step - loss: 0.0673
Epoch 300/400
160/160 [=====] - 0s 343us/step - loss: 0.0677
Epoch 301/400
160/160 [=====] - 0s 355us/step - loss: 0.0625
Epoch 302/400
160/160 [=====] - 0s 371us/step - loss: 0.0723
Epoch 303/400
160/160 [=====] - 0s 355us/step - loss: 0.0700
Epoch 304/400
160/160 [=====] - 0s 340us/step - loss: 0.0653
Epoch 305/400
160/160 [=====] - 0s 349us/step - loss: 0.0648
Epoch 306/400
160/160 [=====] - 0s 343us/step - loss: 0.0655
Epoch 307/400
160/160 [=====] - 0s 340us/step - loss: 0.0672
Epoch 308/400
160/160 [=====] - 0s 355us/step - loss: 0.0712
Epoch 309/400
160/160 [=====] - 0s 348us/step - loss: 0.0664
Epoch 310/400
160/160 [=====] - 0s 346us/step - loss: 0.0642
Epoch 311/400
160/160 [=====] - 0s 358us/step - loss: 0.0693
Epoch 312/400
160/160 [=====] - 0s 393us/step - loss: 0.0668
Epoch 313/400
160/160 [=====] - 0s 362us/step - loss: 0.0662
Epoch 314/400
160/160 [=====] - 0s 352us/step - loss: 0.0662
Epoch 315/400
160/160 [=====] - 0s 355us/step - loss: 0.0678
Epoch 316/400
160/160 [=====] - 0s 355us/step - loss: 0.0648
Epoch 317/400
160/160 [=====] - 0s 355us/step - loss: 0.0661
Epoch 318/400
160/160 [=====] - 0s 343us/step - loss: 0.0638
Epoch 319/400
160/160 [=====] - 0s 349us/step - loss: 0.0663
Epoch 320/400
160/160 [=====] - 0s 346us/step - loss: 0.0666
Epoch 321/400
160/160 [=====] - 0s 346us/step - loss: 0.0645
Epoch 322/400
160/160 [=====] - 0s 349us/step - loss: 0.0616
Epoch 323/400
160/160 [=====] - 0s 349us/step - loss: 0.0680
Epoch 324/400
160/160 [=====] - 0s 343us/step - loss: 0.0677
Epoch 325/400
160/160 [=====] - 0s 343us/step - loss: 0.0626
Epoch 326/400
160/160 [=====] - 0s 352us/step - loss: 0.0651
Epoch 327/400
160/160 [=====] - 0s 349us/step - loss: 0.0659
Epoch 328/400
160/160 [=====] - 0s 362us/step - loss: 0.0660
Epoch 329/400
160/160 [=====] - 0s 349us/step - loss: 0.0647
Epoch 330/400
160/160 [=====] - 0s 390us/step - loss: 0.0630
Epoch 331/400
160/160 [=====] - 0s 349us/step - loss: 0.0640
Epoch 332/400
160/160 [=====] - 0s 343us/step - loss: 0.0654
Epoch 333/400
160/160 [=====] - 0s 349us/step - loss: 0.0684
Epoch 334/400
160/160 [=====] - 0s 362us/step - loss: 0.0668
Epoch 335/400
160/160 [=====] - 0s 349us/step - loss: 0.0620
Epoch 336/400
160/160 [=====] - 0s 349us/step - loss: 0.0653
Epoch 337/400

160/160 [=====] - 0s 368us/step - loss: 0.0641
Epoch 338/400
160/160 [=====] - 0s 346us/step - loss: 0.0650
Epoch 339/400
160/160 [=====] - 0s 349us/step - loss: 0.0624
Epoch 340/400
160/160 [=====] - 0s 349us/step - loss: 0.0635
Epoch 341/400
160/160 [=====] - 0s 337us/step - loss: 0.0634
Epoch 342/400
160/160 [=====] - 0s 349us/step - loss: 0.0610
Epoch 343/400
160/160 [=====] - 0s 362us/step - loss: 0.0611
Epoch 344/400
160/160 [=====] - 0s 346us/step - loss: 0.0615
Epoch 345/400
160/160 [=====] - 0s 355us/step - loss: 0.0681
Epoch 346/400
160/160 [=====] - 0s 349us/step - loss: 0.0656
Epoch 347/400
160/160 [=====] - 0s 362us/step - loss: 0.0621
Epoch 348/400
160/160 [=====] - 0s 374us/step - loss: 0.0616
Epoch 349/400
160/160 [=====] - 0s 352us/step - loss: 0.0625
Epoch 350/400
160/160 [=====] - 0s 349us/step - loss: 0.0638
Epoch 351/400
160/160 [=====] - 0s 349us/step - loss: 0.0602
Epoch 352/400
160/160 [=====] - 0s 355us/step - loss: 0.0657
Epoch 353/400
160/160 [=====] - 0s 352us/step - loss: 0.0596
Epoch 354/400
160/160 [=====] - 0s 362us/step - loss: 0.0618
Epoch 355/400
160/160 [=====] - 0s 355us/step - loss: 0.0635
Epoch 356/400
160/160 [=====] - 0s 352us/step - loss: 0.0634
Epoch 357/400
160/160 [=====] - 0s 352us/step - loss: 0.0587
Epoch 358/400
160/160 [=====] - 0s 352us/step - loss: 0.0584
Epoch 359/400
160/160 [=====] - 0s 358us/step - loss: 0.0569
Epoch 360/400
160/160 [=====] - 0s 349us/step - loss: 0.0564
Epoch 361/400
160/160 [=====] - 0s 337us/step - loss: 0.0577
Epoch 362/400
160/160 [=====] - 0s 362us/step - loss: 0.0578
Epoch 363/400
160/160 [=====] - 0s 349us/step - loss: 0.0626
Epoch 364/400
160/160 [=====] - 0s 358us/step - loss: 0.0593
Epoch 365/400
160/160 [=====] - 0s 394us/step - loss: 0.0562
Epoch 366/400
160/160 [=====] - 0s 344us/step - loss: 0.0573
Epoch 367/400
160/160 [=====] - 0s 349us/step - loss: 0.0567
Epoch 368/400
160/160 [=====] - 0s 355us/step - loss: 0.0612
Epoch 369/400
160/160 [=====] - 0s 390us/step - loss: 0.0542
Epoch 370/400
160/160 [=====] - 0s 349us/step - loss: 0.0558
Epoch 371/400
160/160 [=====] - 0s 343us/step - loss: 0.0569
Epoch 372/400
160/160 [=====] - 0s 362us/step - loss: 0.0540
Epoch 373/400
160/160 [=====] - 0s 349us/step - loss: 0.0583
Epoch 374/400
160/160 [=====] - 0s 349us/step - loss: 0.0527
Epoch 375/400
160/160 [=====] - 0s 362us/step - loss: 0.0550

Epoch 376/400
160/160 [=====] - 0s 343us/step - loss: 0.0576
Epoch 377/400
160/160 [=====] - 0s 343us/step - loss: 0.0472
Epoch 378/400
160/160 [=====] - 0s 349us/step - loss: 0.0577
Epoch 379/400
160/160 [=====] - 0s 349us/step - loss: 0.0530
Epoch 380/400
160/160 [=====] - 0s 355us/step - loss: 0.0526
Epoch 381/400
160/160 [=====] - 0s 349us/step - loss: 0.0539
Epoch 382/400
160/160 [=====] - 0s 377us/step - loss: 0.0505
Epoch 383/400
160/160 [=====] - 0s 399us/step - loss: 0.0521
Epoch 384/400
160/160 [=====] - 0s 343us/step - loss: 0.0479
Epoch 385/400
160/160 [=====] - 0s 349us/step - loss: 0.0512
Epoch 386/400
160/160 [=====] - 0s 343us/step - loss: 0.0442
Epoch 387/400
160/160 [=====] - 0s 349us/step - loss: 0.0511
Epoch 388/400
160/160 [=====] - 0s 343us/step - loss: 0.0483
Epoch 389/400
160/160 [=====] - 0s 355us/step - loss: 0.0471
Epoch 390/400
160/160 [=====] - 0s 349us/step - loss: 0.0501
Epoch 391/400
160/160 [=====] - 0s 337us/step - loss: 0.0469
Epoch 392/400
160/160 [=====] - 0s 343us/step - loss: 0.0494
Epoch 393/400
160/160 [=====] - 0s 346us/step - loss: 0.0452
Epoch 394/400
160/160 [=====] - 0s 337us/step - loss: 0.0473
Epoch 395/400
160/160 [=====] - 0s 340us/step - loss: 0.0446
Epoch 396/400
160/160 [=====] - 0s 349us/step - loss: 0.0490
Epoch 397/400
160/160 [=====] - 0s 346us/step - loss: 0.0393
Epoch 398/400
160/160 [=====] - 0s 343us/step - loss: 0.0415
Epoch 399/400
160/160 [=====] - 0s 346us/step - loss: 0.0441
Epoch 400/400
160/160 [=====] - 0s 362us/step - loss: 0.0453
[9.99724329e-01 9.94610190e-01 9.98700500e-01 8.77192616e-01
9.98365939e-01 9.99704063e-01 9.99082327e-01 9.99681592e-01
9.99738038e-01 9.99562800e-01 9.96963680e-01 9.98944104e-01
9.99024034e-01 9.99605119e-01 9.99260247e-01 9.99560535e-01
9.99702275e-01 9.95250821e-01 9.99583066e-01 9.99596894e-01
9.99625444e-01 9.53503072e-01 9.99738395e-01 9.98008788e-01
9.99715030e-01 9.99368608e-01 9.99327898e-01 9.98319805e-01
9.99722421e-01 9.99554574e-01 9.99347389e-01 9.99491215e-01
9.99679804e-01 9.99674439e-01 9.99713719e-01 9.99586284e-01
9.99655604e-01 9.99427199e-01 9.69165504e-01 9.99395013e-01
9.96722281e-01 9.99894381e-01 9.99923348e-01 8.46643507e-01
9.99770582e-01 9.99461353e-01 9.99935031e-01 9.99879241e-01
9.99815047e-01 9.99903917e-01 9.99905825e-01 9.99929905e-01
9.99927521e-01 9.99909878e-01 9.99935746e-01 9.99729574e-01
9.99463856e-01 9.99920249e-01 9.99912500e-01 9.99946833e-01
9.99934554e-01 9.99762595e-01 9.99786317e-01 9.23211217e-01
9.99937296e-01 9.99938846e-01 9.99934673e-01 9.99593794e-01
9.99932051e-01 9.99920964e-01 9.99937654e-01 9.84845102e-01
9.99907374e-01 9.99878168e-01 9.99863148e-01 9.99934554e-01
9.99933481e-01 9.99937892e-01 9.76280272e-01 9.99932170e-01
1.97939517e-05 8.51689401e-05 2.26636621e-05 2.89370120e-01
7.59408867e-05 1.96936326e-05 1.78463306e-05 1.93638880e-05
2.09206355e-05 4.11127294e-05 4.72772299e-05 1.90851861e-05
1.98073958e-05 1.91701547e-05 1.81368741e-05 2.77687504e-05
1.96877736e-05 3.70506350e-05 1.94742624e-05 2.05042670e-05
1.84154924e-05 2.89277290e-03 2.07920712e-05 9.85854447e-01
2.43064987e-05 2.56850381e-05 1.83180018e-05 5.98988670e-04

```
2.35574698e-05 1.91572144e-05 2.57648662e-05 3.49000584e-05  
1.92165353e-05 1.93259584e-05 1.99226542e-05 2.69616885e-05  
1.87047044e-05 2.10810158e-05 5.62943518e-02 1.80015704e-05  
1.47688379e-05 5.33139028e-05 1.72624277e-05 3.32708925e-01  
1.61690659e-05 1.47784194e-05 1.51844652e-05 1.47722476e-05  
1.46236143e-05 1.84293713e-05 2.75435177e-05 1.59181200e-05  
1.60972177e-05 1.48075651e-05 1.49145390e-05 2.85650276e-05  
1.47801666e-05 3.09582174e-05 1.47957653e-05 1.47806177e-05  
1.48146000e-05 3.04265339e-02 1.46354178e-05 4.55066934e-02  
1.45528847e-05 1.52809516e-05 1.48833642e-05 6.32325173e-05  
1.45416188e-05 1.48103045e-05 1.53477249e-05 2.37907545e-04  
1.47571545e-05 1.47817182e-05 1.47123565e-05 1.64528774e-05  
1.47539449e-05 1.52261991e-05 3.02976370e-02 1.49570415e-05]  
160/160 [=====] - 0s 1ms/step
```

In [78]:

```
#Five layers, four neurons per layer: loss  
scores_optimal_Adam, optimal_Adam.metrics_names
```

Out[78]:

```
(0.03571049175225198, ['loss'])
```

Adamax

In [79]:

```
n = 40  
xx = np.random.random((n,1))  
yy = np.random.random((n,1))  
  
X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T  
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [80]:

```
#Five layers, four neurons per layer  
optimal_Adamax = Sequential()  
  
#hidden layers  
optimal_Adamax.add(Dense(4, input_dim=2, activation='tanh'))  
optimal_Adamax.add(Dense(4, activation='tanh'))  
optimal_Adamax.add(Dense(4, activation='tanh'))  
optimal_Adamax.add(Dense(4, activation='tanh'))  
optimal_Adamax.add(Dense(4, activation='tanh'))  
  
#output layer  
optimal_Adamax.add(Dense(1, activation='sigmoid'))  
  
Adamax = Adamax(lr=0.1)  
optimal_Adamax.compile(loss='binary_crossentropy', optimizer='RMSprop')  
  
optimal_Adamax.fit(X, y, batch_size=2, epochs=400)  
print(optimal_Adamax.predict_proba(X).reshape(4*n))  
  
#evaluate the model  
scores_optimal_Adamax = optimal_Adamax.evaluate(X, y)
```

```
Epoch 1/400  
160/160 [=====] - 1s 4ms/step - loss: 0.7023  
Epoch 2/400  
160/160 [=====] - 0s 362us/step - loss: 0.6991  
Epoch 3/400  
160/160 [=====] - 0s 368us/step - loss: 0.6969  
Epoch 4/400  
160/160 [=====] - 0s 355us/step - loss: 0.6953  
Epoch 5/400  
160/160 [=====] - 0s 355us/step - loss: 0.6937  
Epoch 6/400  
160/160 [=====] - 0s 368us/step - loss: 0.6921  
Epoch 7/400  
160/160 [=====] - 0s 365us/step - loss: 0.6903  
Epoch 8/400  
160/160 [=====] - 0s 368us/step - loss: 0.6883  
Epoch 9/400  
160/160 [=====] - 0s 358us/step - loss: 0.6859
```

Epoch 10/400
160/160 [=====] - 0s 360us/step - loss: 0.6824
Epoch 11/400
160/160 [=====] - 0s 362us/step - loss: 0.6779
Epoch 12/400
160/160 [=====] - 0s 355us/step - loss: 0.6726
Epoch 13/400
160/160 [=====] - 0s 390us/step - loss: 0.6650
Epoch 14/400
160/160 [=====] - 0s 362us/step - loss: 0.6555
Epoch 15/400
160/160 [=====] - 0s 362us/step - loss: 0.6448
Epoch 16/400
160/160 [=====] - 0s 371us/step - loss: 0.6300
Epoch 17/400
160/160 [=====] - 0s 355us/step - loss: 0.6118
Epoch 18/400
160/160 [=====] - 0s 368us/step - loss: 0.5901
Epoch 19/400
160/160 [=====] - 0s 355us/step - loss: 0.5645
Epoch 20/400
160/160 [=====] - 0s 368us/step - loss: 0.5346
Epoch 21/400
160/160 [=====] - 0s 355us/step - loss: 0.5018
Epoch 22/400
160/160 [=====] - 0s 374us/step - loss: 0.4647
Epoch 23/400
160/160 [=====] - 0s 355us/step - loss: 0.4301
Epoch 24/400
160/160 [=====] - 0s 368us/step - loss: 0.3913
Epoch 25/400
160/160 [=====] - 0s 355us/step - loss: 0.3545
Epoch 26/400
160/160 [=====] - 0s 368us/step - loss: 0.3197
Epoch 27/400
160/160 [=====] - 0s 362us/step - loss: 0.2897
Epoch 28/400
160/160 [=====] - 0s 368us/step - loss: 0.2579
Epoch 29/400
160/160 [=====] - 0s 374us/step - loss: 0.2431
Epoch 30/400
160/160 [=====] - 0s 374us/step - loss: 0.2256
Epoch 31/400
160/160 [=====] - 0s 362us/step - loss: 0.2098
Epoch 32/400
160/160 [=====] - 0s 349us/step - loss: 0.1936
Epoch 33/400
160/160 [=====] - 0s 365us/step - loss: 0.1871
Epoch 34/400
160/160 [=====] - 0s 368us/step - loss: 0.1652
Epoch 35/400
160/160 [=====] - 0s 368us/step - loss: 0.1698
Epoch 36/400
160/160 [=====] - 0s 362us/step - loss: 0.1562
Epoch 37/400
160/160 [=====] - 0s 368us/step - loss: 0.1502
Epoch 38/400
160/160 [=====] - 0s 377us/step - loss: 0.1458
Epoch 39/400
160/160 [=====] - 0s 368us/step - loss: 0.1402
Epoch 40/400
160/160 [=====] - 0s 358us/step - loss: 0.1347
Epoch 41/400
160/160 [=====] - 0s 362us/step - loss: 0.1263
Epoch 42/400
160/160 [=====] - 0s 371us/step - loss: 0.1273
Epoch 43/400
160/160 [=====] - 0s 371us/step - loss: 0.1206
Epoch 44/400
160/160 [=====] - 0s 374us/step - loss: 0.1192
Epoch 45/400
160/160 [=====] - 0s 443us/step - loss: 0.1181
Epoch 46/400
160/160 [=====] - 0s 380us/step - loss: 0.1137
Epoch 47/400
160/160 [=====] - 0s 380us/step - loss: 0.1076
Epoch 48/400

160/160 [=====] - 0s 386us/step - loss: 0.1065
Epoch 49/400
160/160 [=====] - 0s 355us/step - loss: 0.1000
Epoch 50/400
160/160 [=====] - 0s 362us/step - loss: 0.1066
Epoch 51/400
160/160 [=====] - 0s 368us/step - loss: 0.1028
Epoch 52/400
160/160 [=====] - 0s 374us/step - loss: 0.0998
Epoch 53/400
160/160 [=====] - 0s 368us/step - loss: 0.1014
Epoch 54/400
160/160 [=====] - 0s 380us/step - loss: 0.1012
Epoch 55/400
160/160 [=====] - 0s 377us/step - loss: 0.0979
Epoch 56/400
160/160 [=====] - 0s 355us/step - loss: 0.1003
Epoch 57/400
160/160 [=====] - 0s 362us/step - loss: 0.0973
Epoch 58/400
160/160 [=====] - 0s 346us/step - loss: 0.0959
Epoch 59/400
160/160 [=====] - 0s 362us/step - loss: 0.0936
Epoch 60/400
160/160 [=====] - 0s 358us/step - loss: 0.0936
Epoch 61/400
160/160 [=====] - 0s 349us/step - loss: 0.0790
Epoch 62/400
160/160 [=====] - 0s 368us/step - loss: 0.0958
Epoch 63/400
160/160 [=====] - 0s 343us/step - loss: 0.0914
Epoch 64/400
160/160 [=====] - 0s 374us/step - loss: 0.0833
Epoch 65/400
160/160 [=====] - 0s 362us/step - loss: 0.0936
Epoch 66/400
160/160 [=====] - 0s 362us/step - loss: 0.0911
Epoch 67/400
160/160 [=====] - 0s 355us/step - loss: 0.0957
Epoch 68/400
160/160 [=====] - 0s 358us/step - loss: 0.0895
Epoch 69/400
160/160 [=====] - 0s 343us/step - loss: 0.0865
Epoch 70/400
160/160 [=====] - 0s 343us/step - loss: 0.0918
Epoch 71/400
160/160 [=====] - 0s 362us/step - loss: 0.0906
Epoch 72/400
160/160 [=====] - 0s 374us/step - loss: 0.0905
Epoch 73/400
160/160 [=====] - 0s 349us/step - loss: 0.0852
Epoch 74/400
160/160 [=====] - 0s 349us/step - loss: 0.0868
Epoch 75/400
160/160 [=====] - 0s 355us/step - loss: 0.0950
Epoch 76/400
160/160 [=====] - 0s 355us/step - loss: 0.0850
Epoch 77/400
160/160 [=====] - 0s 368us/step - loss: 0.0781
Epoch 78/400
160/160 [=====] - 0s 362us/step - loss: 0.0797
Epoch 79/400
160/160 [=====] - 0s 355us/step - loss: 0.0900
Epoch 80/400
160/160 [=====] - 0s 349us/step - loss: 0.0900
Epoch 81/400
160/160 [=====] - 0s 365us/step - loss: 0.0812
Epoch 82/400
160/160 [=====] - 0s 368us/step - loss: 0.0793
Epoch 83/400
160/160 [=====] - 0s 358us/step - loss: 0.0874
Epoch 84/400
160/160 [=====] - 0s 355us/step - loss: 0.0901
Epoch 85/400
160/160 [=====] - 0s 368us/step - loss: 0.0852
Epoch 86/400
160/160 [=====] - 0s 377us/step - loss: 0.0834

Epoch 87/400
160/160 [=====] - 0s 362us/step - loss: 0.0902
Epoch 88/400
160/160 [=====] - 0s 362us/step - loss: 0.0846
Epoch 89/400
160/160 [=====] - 0s 371us/step - loss: 0.0900
Epoch 90/400
160/160 [=====] - 0s 368us/step - loss: 0.0785
Epoch 91/400
160/160 [=====] - 0s 380us/step - loss: 0.0883
Epoch 92/400
160/160 [=====] - 0s 355us/step - loss: 0.0826
Epoch 93/400
160/160 [=====] - 0s 352us/step - loss: 0.0909
Epoch 94/400
160/160 [=====] - 0s 368us/step - loss: 0.0793
Epoch 95/400
160/160 [=====] - 0s 349us/step - loss: 0.0906
Epoch 96/400
160/160 [=====] - 0s 362us/step - loss: 0.0879
Epoch 97/400
160/160 [=====] - 0s 368us/step - loss: 0.0909
Epoch 98/400
160/160 [=====] - 0s 368us/step - loss: 0.0850
Epoch 99/400
160/160 [=====] - 0s 386us/step - loss: 0.0859
Epoch 100/400
160/160 [=====] - 0s 355us/step - loss: 0.0918
Epoch 101/400
160/160 [=====] - 0s 349us/step - loss: 0.0884
Epoch 102/400
160/160 [=====] - 0s 355us/step - loss: 0.0960
Epoch 103/400
160/160 [=====] - 0s 352us/step - loss: 0.0837
Epoch 104/400
160/160 [=====] - 0s 349us/step - loss: 0.0879
Epoch 105/400
160/160 [=====] - 0s 365us/step - loss: 0.0861
Epoch 106/400
160/160 [=====] - 0s 362us/step - loss: 0.0885
Epoch 107/400
160/160 [=====] - 0s 349us/step - loss: 0.0812
Epoch 108/400
160/160 [=====] - 0s 349us/step - loss: 0.0940
Epoch 109/400
160/160 [=====] - 0s 362us/step - loss: 0.0916
Epoch 110/400
160/160 [=====] - 0s 362us/step - loss: 0.0805
Epoch 111/400
160/160 [=====] - 0s 349us/step - loss: 0.0778
Epoch 112/400
160/160 [=====] - 0s 349us/step - loss: 0.0902
Epoch 113/400
160/160 [=====] - 0s 349us/step - loss: 0.0862
Epoch 114/400
160/160 [=====] - 0s 362us/step - loss: 0.0875
Epoch 115/400
160/160 [=====] - 0s 355us/step - loss: 0.0825
Epoch 116/400
160/160 [=====] - 0s 368us/step - loss: 0.0768
Epoch 117/400
160/160 [=====] - 0s 346us/step - loss: 0.0735
Epoch 118/400
160/160 [=====] - 0s 362us/step - loss: 0.0792
Epoch 119/400
160/160 [=====] - 0s 355us/step - loss: 0.0774
Epoch 120/400
160/160 [=====] - 0s 358us/step - loss: 0.0777
Epoch 121/400
160/160 [=====] - 0s 355us/step - loss: 0.0875
Epoch 122/400
160/160 [=====] - 0s 349us/step - loss: 0.0737
Epoch 123/400
160/160 [=====] - 0s 383us/step - loss: 0.0824
Epoch 124/400
160/160 [=====] - 0s 355us/step - loss: 0.0772
Epoch 125/400

160/160 [=====] - 0s 362us/step - loss: 0.0918
Epoch 126/400
160/160 [=====] - 0s 365us/step - loss: 0.0884
Epoch 127/400
160/160 [=====] - 0s 365us/step - loss: 0.0772
Epoch 128/400
160/160 [=====] - 0s 343us/step - loss: 0.0778
Epoch 129/400
160/160 [=====] - 0s 358us/step - loss: 0.0763
Epoch 130/400
160/160 [=====] - 0s 352us/step - loss: 0.0799
Epoch 131/400
160/160 [=====] - 0s 352us/step - loss: 0.0791
Epoch 132/400
160/160 [=====] - 0s 355us/step - loss: 0.0873
Epoch 133/400
160/160 [=====] - 0s 355us/step - loss: 0.0882
Epoch 134/400
160/160 [=====] - 0s 368us/step - loss: 0.0778
Epoch 135/400
160/160 [=====] - 0s 343us/step - loss: 0.0815
Epoch 136/400
160/160 [=====] - 0s 358us/step - loss: 0.0807
Epoch 137/400
160/160 [=====] - 0s 349us/step - loss: 0.0831
Epoch 138/400
160/160 [=====] - 0s 358us/step - loss: 0.0908
Epoch 139/400
160/160 [=====] - 0s 343us/step - loss: 0.0765
Epoch 140/400
160/160 [=====] - 0s 346us/step - loss: 0.0752
Epoch 141/400
160/160 [=====] - 0s 362us/step - loss: 0.0738
Epoch 142/400
160/160 [=====] - 0s 355us/step - loss: 0.0825
Epoch 143/400
160/160 [=====] - 0s 355us/step - loss: 0.0751
Epoch 144/400
160/160 [=====] - 0s 349us/step - loss: 0.0784
Epoch 145/400
160/160 [=====] - 0s 355us/step - loss: 0.0786
Epoch 146/400
160/160 [=====] - 0s 349us/step - loss: 0.0683
Epoch 147/400
160/160 [=====] - 0s 362us/step - loss: 0.0730
Epoch 148/400
160/160 [=====] - 0s 349us/step - loss: 0.0810
Epoch 149/400
160/160 [=====] - 0s 355us/step - loss: 0.0728
Epoch 150/400
160/160 [=====] - 0s 362us/step - loss: 0.0712
Epoch 151/400
160/160 [=====] - 0s 383us/step - loss: 0.0779
Epoch 152/400
160/160 [=====] - 0s 362us/step - loss: 0.0908
Epoch 153/400
160/160 [=====] - 0s 340us/step - loss: 0.0774
Epoch 154/400
160/160 [=====] - 0s 362us/step - loss: 0.0789
Epoch 155/400
160/160 [=====] - 0s 355us/step - loss: 0.0870
Epoch 156/400
160/160 [=====] - 0s 377us/step - loss: 0.0836
Epoch 157/400
160/160 [=====] - 0s 349us/step - loss: 0.0894
Epoch 158/400
160/160 [=====] - 0s 386us/step - loss: 0.0768
Epoch 159/400
160/160 [=====] - 0s 362us/step - loss: 0.0873
Epoch 160/400
160/160 [=====] - 0s 358us/step - loss: 0.0797
Epoch 161/400
160/160 [=====] - 0s 355us/step - loss: 0.0640
Epoch 162/400
160/160 [=====] - 0s 355us/step - loss: 0.0848
Epoch 163/400
160/160 [=====] - 0s 355us/step - loss: 0.0795

Epoch 164/400
160/160 [=====] - 0s 365us/step - loss: 0.0769
Epoch 165/400
160/160 [=====] - 0s 355us/step - loss: 0.0979
Epoch 166/400
160/160 [=====] - 0s 362us/step - loss: 0.0591
Epoch 167/400
160/160 [=====] - 0s 358us/step - loss: 0.0907
Epoch 168/400
160/160 [=====] - 0s 368us/step - loss: 0.0779
Epoch 169/400
160/160 [=====] - 0s 362us/step - loss: 0.0674
Epoch 170/400
160/160 [=====] - 0s 368us/step - loss: 0.0791
Epoch 171/400
160/160 [=====] - 0s 352us/step - loss: 0.0775
Epoch 172/400
160/160 [=====] - 0s 357us/step - loss: 0.0854
Epoch 173/400
160/160 [=====] - 0s 352us/step - loss: 0.0694
Epoch 174/400
160/160 [=====] - 0s 355us/step - loss: 0.0990
Epoch 175/400
160/160 [=====] - 0s 368us/step - loss: 0.0624
Epoch 176/400
160/160 [=====] - 0s 355us/step - loss: 0.0894
Epoch 177/400
160/160 [=====] - 0s 365us/step - loss: 0.0758
Epoch 178/400
160/160 [=====] - 0s 355us/step - loss: 0.0864
Epoch 179/400
160/160 [=====] - 0s 368us/step - loss: 0.0788
Epoch 180/400
160/160 [=====] - 0s 359us/step - loss: 0.0731
Epoch 181/400
160/160 [=====] - 0s 368us/step - loss: 0.1006
Epoch 182/400
160/160 [=====] - 0s 374us/step - loss: 0.0766
Epoch 183/400
160/160 [=====] - 0s 365us/step - loss: 0.0662
Epoch 184/400
160/160 [=====] - 0s 362us/step - loss: 0.0835
Epoch 185/400
160/160 [=====] - 0s 368us/step - loss: 0.0809
Epoch 186/400
160/160 [=====] - 0s 355us/step - loss: 0.0846
Epoch 187/400
160/160 [=====] - 0s 368us/step - loss: 0.0791
Epoch 188/400
160/160 [=====] - 0s 349us/step - loss: 0.0937
Epoch 189/400
160/160 [=====] - 0s 362us/step - loss: 0.0819
Epoch 190/400
160/160 [=====] - 0s 355us/step - loss: 0.0783
Epoch 191/400
160/160 [=====] - 0s 362us/step - loss: 0.0978
Epoch 192/400
160/160 [=====] - 0s 358us/step - loss: 0.0861
Epoch 193/400
160/160 [=====] - 0s 362us/step - loss: 0.0749
Epoch 194/400
160/160 [=====] - 0s 343us/step - loss: 0.0739
Epoch 195/400
160/160 [=====] - 0s 343us/step - loss: 0.0916
Epoch 196/400
160/160 [=====] - 0s 362us/step - loss: 0.0903
Epoch 197/400
160/160 [=====] - 0s 349us/step - loss: 0.0803
Epoch 198/400
160/160 [=====] - 0s 358us/step - loss: 0.0881
Epoch 199/400
160/160 [=====] - 0s 349us/step - loss: 0.0871
Epoch 200/400
160/160 [=====] - 0s 349us/step - loss: 0.0807
Epoch 201/400
160/160 [=====] - 0s 383us/step - loss: 0.0815
Epoch 202/400

160/160 [=====] - 0s 386us/step - loss: 0.0727
Epoch 203/400
160/160 [=====] - 0s 399us/step - loss: 0.0859
Epoch 204/400
160/160 [=====] - 0s 383us/step - loss: 0.0690
Epoch 205/400
160/160 [=====] - 0s 368us/step - loss: 0.0815
Epoch 206/400
160/160 [=====] - 0s 365us/step - loss: 0.0886
Epoch 207/400
160/160 [=====] - 0s 374us/step - loss: 0.0698
Epoch 208/400
160/160 [=====] - 0s 377us/step - loss: 0.0848
Epoch 209/400
160/160 [=====] - 0s 374us/step - loss: 0.0724
Epoch 210/400
160/160 [=====] - 0s 372us/step - loss: 0.0770
Epoch 211/400
160/160 [=====] - 0s 368us/step - loss: 0.0725
Epoch 212/400
160/160 [=====] - 0s 352us/step - loss: 0.0902
Epoch 213/400
160/160 [=====] - 0s 349us/step - loss: 0.0740
Epoch 214/400
160/160 [=====] - 0s 362us/step - loss: 0.0880
Epoch 215/400
160/160 [=====] - 0s 349us/step - loss: 0.0788
Epoch 216/400
160/160 [=====] - 0s 355us/step - loss: 0.0817
Epoch 217/400
160/160 [=====] - 0s 355us/step - loss: 0.0816
Epoch 218/400
160/160 [=====] - 0s 358us/step - loss: 0.0854
Epoch 219/400
160/160 [=====] - 0s 352us/step - loss: 0.0712
Epoch 220/400
160/160 [=====] - 0s 362us/step - loss: 0.0696
Epoch 221/400
160/160 [=====] - 0s 352us/step - loss: 0.0891
Epoch 222/400
160/160 [=====] - 0s 362us/step - loss: 0.0775
Epoch 223/400
160/160 [=====] - 0s 355us/step - loss: 0.0779
Epoch 224/400
160/160 [=====] - 0s 362us/step - loss: 0.0810
Epoch 225/400
160/160 [=====] - 0s 358us/step - loss: 0.0816
Epoch 226/400
160/160 [=====] - 0s 362us/step - loss: 0.0614
Epoch 227/400
160/160 [=====] - 0s 374us/step - loss: 0.0871
Epoch 228/400
160/160 [=====] - 0s 346us/step - loss: 0.0718
Epoch 229/400
160/160 [=====] - 0s 362us/step - loss: 0.0762
Epoch 230/400
160/160 [=====] - 0s 365us/step - loss: 0.0635
Epoch 231/400
160/160 [=====] - 0s 362us/step - loss: 0.0746
Epoch 232/400
160/160 [=====] - 0s 355us/step - loss: 0.0760
Epoch 233/400
160/160 [=====] - 0s 371us/step - loss: 0.0757
Epoch 234/400
160/160 [=====] - 0s 352us/step - loss: 0.0878
Epoch 235/400
160/160 [=====] - 0s 365us/step - loss: 0.0743
Epoch 236/400
160/160 [=====] - 0s 362us/step - loss: 0.0819
Epoch 237/400
160/160 [=====] - 0s 402us/step - loss: 0.0639
Epoch 238/400
160/160 [=====] - 0s 358us/step - loss: 0.0853
Epoch 239/400
160/160 [=====] - 0s 352us/step - loss: 0.0755
Epoch 240/400
160/160 [=====] - 0s 362us/step - loss: 0.0683

..., ...
Epoch 241/400
160/160 [=====] - 0s 390us/step - loss: 0.0777
Epoch 242/400
160/160 [=====] - 0s 368us/step - loss: 0.0709
Epoch 243/400
160/160 [=====] - 0s 371us/step - loss: 0.0842
Epoch 244/400
160/160 [=====] - 0s 387us/step - loss: 0.0759
Epoch 245/400
160/160 [=====] - 0s 368us/step - loss: 0.0741
Epoch 246/400
160/160 [=====] - 0s 374us/step - loss: 0.0733
Epoch 247/400
160/160 [=====] - 0s 383us/step - loss: 0.0782
Epoch 248/400
160/160 [=====] - 0s 362us/step - loss: 0.0574
Epoch 249/400
160/160 [=====] - 0s 380us/step - loss: 0.0811
Epoch 250/400
160/160 [=====] - 0s 368us/step - loss: 0.0810
Epoch 251/400
160/160 [=====] - 0s 362us/step - loss: 0.0794
Epoch 252/400
160/160 [=====] - 0s 368us/step - loss: 0.0825
Epoch 253/400
160/160 [=====] - 0s 405us/step - loss: 0.0781
Epoch 254/400
160/160 [=====] - 0s 449us/step - loss: 0.0561
Epoch 255/400
160/160 [=====] - 0s 386us/step - loss: 0.0744
Epoch 256/400
160/160 [=====] - 0s 362us/step - loss: 0.0747
Epoch 257/400
160/160 [=====] - 0s 386us/step - loss: 0.0764
Epoch 258/400
160/160 [=====] - 0s 359us/step - loss: 0.0759
Epoch 259/400
160/160 [=====] - 0s 362us/step - loss: 0.0789
Epoch 260/400
160/160 [=====] - 0s 390us/step - loss: 0.0783
Epoch 261/400
160/160 [=====] - 0s 362us/step - loss: 0.0733
Epoch 262/400
160/160 [=====] - 0s 474us/step - loss: 0.0763
Epoch 263/400
160/160 [=====] - 0s 393us/step - loss: 0.0794
Epoch 264/400
160/160 [=====] - 0s 390us/step - loss: 0.0748
Epoch 265/400
160/160 [=====] - 0s 424us/step - loss: 0.0798
Epoch 266/400
160/160 [=====] - 0s 396us/step - loss: 0.0739
Epoch 267/400
160/160 [=====] - 0s 393us/step - loss: 0.0699
Epoch 268/400
160/160 [=====] - 0s 399us/step - loss: 0.0713
Epoch 269/400
160/160 [=====] - 0s 427us/step - loss: 0.0795
Epoch 270/400
160/160 [=====] - 0s 386us/step - loss: 0.0713
Epoch 271/400
160/160 [=====] - 0s 390us/step - loss: 0.0690
Epoch 272/400
160/160 [=====] - 0s 393us/step - loss: 0.0855
Epoch 273/400
160/160 [=====] - 0s 386us/step - loss: 0.0692
Epoch 274/400
160/160 [=====] - 0s 386us/step - loss: 0.0820
Epoch 275/400
160/160 [=====] - 0s 380us/step - loss: 0.0704
Epoch 276/400
160/160 [=====] - 0s 393us/step - loss: 0.0767
Epoch 277/400
160/160 [=====] - 0s 380us/step - loss: 0.0611
Epoch 278/400
160/160 [=====] - 0s 389us/step - loss: 0.0721
Epoch 279/400

Epoch 270/400
160/160 [=====] - 0s 374us/step - loss: 0.0802
Epoch 280/400
160/160 [=====] - 0s 396us/step - loss: 0.0746
Epoch 281/400
160/160 [=====] - 0s 380us/step - loss: 0.0727
Epoch 282/400
160/160 [=====] - 0s 374us/step - loss: 0.0867
Epoch 283/400
160/160 [=====] - 0s 386us/step - loss: 0.0726
Epoch 284/400
160/160 [=====] - 0s 365us/step - loss: 0.0779
Epoch 285/400
160/160 [=====] - 0s 390us/step - loss: 0.0789
Epoch 286/400
160/160 [=====] - 0s 365us/step - loss: 0.0873
Epoch 287/400
160/160 [=====] - 0s 358us/step - loss: 0.0761
Epoch 288/400
160/160 [=====] - 0s 362us/step - loss: 0.0721
Epoch 289/400
160/160 [=====] - 0s 365us/step - loss: 0.0759
Epoch 290/400
160/160 [=====] - 0s 349us/step - loss: 0.0695
Epoch 291/400
160/160 [=====] - 0s 343us/step - loss: 0.0845
Epoch 292/400
160/160 [=====] - 0s 362us/step - loss: 0.0721
Epoch 293/400
160/160 [=====] - 0s 358us/step - loss: 0.0829
Epoch 294/400
160/160 [=====] - 0s 346us/step - loss: 0.0772
Epoch 295/400
160/160 [=====] - 0s 358us/step - loss: 0.0749
Epoch 296/400
160/160 [=====] - 0s 346us/step - loss: 0.0675
Epoch 297/400
160/160 [=====] - 0s 343us/step - loss: 0.0795
Epoch 298/400
160/160 [=====] - 0s 352us/step - loss: 0.0831
Epoch 299/400
160/160 [=====] - 0s 340us/step - loss: 0.0739
Epoch 300/400
160/160 [=====] - 0s 352us/step - loss: 0.0727
Epoch 301/400
160/160 [=====] - 0s 355us/step - loss: 0.0710
Epoch 302/400
160/160 [=====] - 0s 352us/step - loss: 0.0678
Epoch 303/400
160/160 [=====] - 0s 380us/step - loss: 0.0706
Epoch 304/400
160/160 [=====] - 0s 368us/step - loss: 0.0698
Epoch 305/400
160/160 [=====] - 0s 358us/step - loss: 0.0732
Epoch 306/400
160/160 [=====] - 0s 358us/step - loss: 0.0838
Epoch 307/400
160/160 [=====] - 0s 362us/step - loss: 0.0728
Epoch 308/400
160/160 [=====] - 0s 355us/step - loss: 0.0685
Epoch 309/400
160/160 [=====] - 0s 362us/step - loss: 0.0718
Epoch 310/400
160/160 [=====] - 0s 346us/step - loss: 0.0789
Epoch 311/400
160/160 [=====] - 0s 362us/step - loss: 0.0902
Epoch 312/400
160/160 [=====] - 0s 355us/step - loss: 0.0703
Epoch 313/400
160/160 [=====] - 0s 355us/step - loss: 0.0736
Epoch 314/400
160/160 [=====] - 0s 362us/step - loss: 0.0859
Epoch 315/400
160/160 [=====] - 0s 355us/step - loss: 0.0811
Epoch 316/400
160/160 [=====] - 0s 352us/step - loss: 0.0885
Epoch 317/400
160/160 [=====] - 0s 355us/step - loss: 0.0795

100/100 [=====] - 0s 355us/step - loss: 0.0720
Epoch 318/400
160/160 [=====] - 0s 362us/step - loss: 0.0781
Epoch 319/400
160/160 [=====] - 0s 355us/step - loss: 0.0737
Epoch 320/400
160/160 [=====] - 0s 393us/step - loss: 0.0760
Epoch 321/400
160/160 [=====] - 0s 353us/step - loss: 0.0873
Epoch 322/400
160/160 [=====] - 0s 368us/step - loss: 0.0676
Epoch 323/400
160/160 [=====] - 0s 362us/step - loss: 0.0538
Epoch 324/400
160/160 [=====] - 0s 368us/step - loss: 0.0790
Epoch 325/400
160/160 [=====] - 0s 349us/step - loss: 0.0730
Epoch 326/400
160/160 [=====] - 0s 368us/step - loss: 0.0953
Epoch 327/400
160/160 [=====] - 0s 362us/step - loss: 0.0839
Epoch 328/400
160/160 [=====] - 0s 355us/step - loss: 0.0723
Epoch 329/400
160/160 [=====] - 0s 346us/step - loss: 0.0806
Epoch 330/400
160/160 [=====] - 0s 362us/step - loss: 0.0716
Epoch 331/400
160/160 [=====] - 0s 340us/step - loss: 0.0756
Epoch 332/400
160/160 [=====] - 0s 343us/step - loss: 0.0889
Epoch 333/400
160/160 [=====] - 0s 365us/step - loss: 0.0868
Epoch 334/400
160/160 [=====] - 0s 352us/step - loss: 0.0747
Epoch 335/400
160/160 [=====] - 0s 355us/step - loss: 0.0753
Epoch 336/400
160/160 [=====] - 0s 349us/step - loss: 0.0880
Epoch 337/400
160/160 [=====] - 0s 368us/step - loss: 0.0863
Epoch 338/400
160/160 [=====] - 0s 368us/step - loss: 0.0666
Epoch 339/400
160/160 [=====] - 0s 368us/step - loss: 0.0989
Epoch 340/400
160/160 [=====] - 0s 362us/step - loss: 0.0871
Epoch 341/400
160/160 [=====] - 0s 349us/step - loss: 0.0762
Epoch 342/400
160/160 [=====] - 0s 362us/step - loss: 0.0735
Epoch 343/400
160/160 [=====] - 0s 374us/step - loss: 0.0880
Epoch 344/400
160/160 [=====] - 0s 355us/step - loss: 0.0882
Epoch 345/400
160/160 [=====] - 0s 362us/step - loss: 0.0793
Epoch 346/400
160/160 [=====] - 0s 362us/step - loss: 0.0734
Epoch 347/400
160/160 [=====] - 0s 355us/step - loss: 0.0923
Epoch 348/400
160/160 [=====] - 0s 368us/step - loss: 0.0929
Epoch 349/400
160/160 [=====] - 0s 374us/step - loss: 0.0876
Epoch 350/400
160/160 [=====] - 0s 358us/step - loss: 0.0920
Epoch 351/400
160/160 [=====] - 0s 362us/step - loss: 0.0778
Epoch 352/400
160/160 [=====] - 0s 368us/step - loss: 0.0818
Epoch 353/400
160/160 [=====] - 0s 349us/step - loss: 0.0931
Epoch 354/400
160/160 [=====] - 0s 374us/step - loss: 0.0871
Epoch 355/400
160/160 [=====] - 0s 362us/step - loss: 0.0720
Epoch 356/400

Epoch 356/400
160/160 [=====] - 0s 368us/step - loss: 0.0968
Epoch 357/400
160/160 [=====] - 0s 349us/step - loss: 0.0933
Epoch 358/400
160/160 [=====] - 0s 368us/step - loss: 0.0847
Epoch 359/400
160/160 [=====] - 0s 371us/step - loss: 0.0876
Epoch 360/400
160/160 [=====] - 0s 371us/step - loss: 0.0788
Epoch 361/400
160/160 [=====] - 0s 362us/step - loss: 0.0767
Epoch 362/400
160/160 [=====] - 0s 383us/step - loss: 0.0884
Epoch 363/400
160/160 [=====] - 0s 362us/step - loss: 0.0703
Epoch 364/400
160/160 [=====] - 0s 358us/step - loss: 0.0872
Epoch 365/400
160/160 [=====] - 0s 355us/step - loss: 0.0884
Epoch 366/400
160/160 [=====] - 0s 355us/step - loss: 0.0906
Epoch 367/400
160/160 [=====] - 0s 362us/step - loss: 0.0816
Epoch 368/400
160/160 [=====] - 0s 362us/step - loss: 0.1017
Epoch 369/400
160/160 [=====] - 0s 355us/step - loss: 0.0911
Epoch 370/400
160/160 [=====] - 0s 362us/step - loss: 0.0931
Epoch 371/400
160/160 [=====] - 0s 362us/step - loss: 0.0901
Epoch 372/400
160/160 [=====] - 0s 374us/step - loss: 0.0723
Epoch 373/400
160/160 [=====] - 0s 349us/step - loss: 0.0906
Epoch 374/400
160/160 [=====] - 0s 362us/step - loss: 0.0721
Epoch 375/400
160/160 [=====] - 0s 355us/step - loss: 0.0896
Epoch 376/400
160/160 [=====] - 0s 362us/step - loss: 0.0773
Epoch 377/400
160/160 [=====] - 0s 355us/step - loss: 0.0814
Epoch 378/400
160/160 [=====] - 0s 368us/step - loss: 0.0784
Epoch 379/400
160/160 [=====] - 0s 371us/step - loss: 0.0856
Epoch 380/400
160/160 [=====] - 0s 355us/step - loss: 0.0958
Epoch 381/400
160/160 [=====] - 0s 368us/step - loss: 0.0772
Epoch 382/400
160/160 [=====] - 0s 368us/step - loss: 0.0743
Epoch 383/400
160/160 [=====] - 0s 355us/step - loss: 0.0843
Epoch 384/400
160/160 [=====] - 0s 355us/step - loss: 0.0790
Epoch 385/400
160/160 [=====] - 0s 349us/step - loss: 0.0769
Epoch 386/400
160/160 [=====] - 0s 337us/step - loss: 0.0597
Epoch 387/400
160/160 [=====] - 0s 349us/step - loss: 0.0829
Epoch 388/400
160/160 [=====] - 0s 355us/step - loss: 0.0881
Epoch 389/400
160/160 [=====] - 0s 386us/step - loss: 0.0804
Epoch 390/400
160/160 [=====] - 0s 346us/step - loss: 0.0803
Epoch 391/400
160/160 [=====] - 0s 358us/step - loss: 0.0734
Epoch 392/400
160/160 [=====] - 0s 349us/step - loss: 0.0930
Epoch 393/400
160/160 [=====] - 0s 374us/step - loss: 0.0840
Epoch 394/400
160/160 [=====] - 0s 349us/step - loss: 0.0930

```

100/100 [=====] - 0s 349us/step - loss: 0.0902
Epoch 395/400
160/160 [=====] - 0s 368us/step - loss: 0.0749
Epoch 396/400
160/160 [=====] - 0s 355us/step - loss: 0.0929
Epoch 397/400
160/160 [=====] - 0s 349us/step - loss: 0.0783
Epoch 398/400
160/160 [=====] - 0s 355us/step - loss: 0.0913
Epoch 399/400
160/160 [=====] - 0s 343us/step - loss: 0.0777
Epoch 400/400
160/160 [=====] - 0s 349us/step - loss: 0.0824
[9.9996507e-01 9.9723935e-01 9.9996579e-01 9.9996614e-01 9.9996519e-01
 9.9996555e-01 9.9574655e-01 9.9996209e-01 9.9922192e-01 9.9988472e-01
 9.9988449e-01 9.9993217e-01 9.9996626e-01 9.9996448e-01 9.9995685e-01
 9.9993742e-01 9.9996603e-01 9.9996185e-01 9.9996483e-01 9.9808443e-01
 9.9996266e-01 9.9996591e-01 9.9996603e-01 9.9996436e-01 9.9996233e-01
 9.9996591e-01 9.9996543e-01 9.9977618e-01 9.9994552e-01 6.8590707e-01
 9.9995375e-01 9.9982649e-01 9.6950161e-01 9.9995399e-01 9.9996448e-01
 9.9993920e-01 9.9900752e-01 9.9996543e-01 9.9996066e-01 9.9996412e-01
 9.9995625e-01 9.5807284e-01 9.9996078e-01 9.9996185e-01 9.9995160e-01
 9.9993360e-01 9.1604692e-01 9.9989092e-01 9.0009916e-01 9.9900645e-01
 9.9721450e-01 9.9941289e-01 9.9995708e-01 9.9994838e-01 9.9977547e-01
 9.9986064e-01 9.9996293e-01 9.9995303e-01 9.9996114e-01 8.0061316e-01
 9.9995434e-01 9.9995804e-01 9.9995315e-01 9.9996018e-01 9.9984121e-01
 9.9994802e-01 9.9995649e-01 9.3562269e-01 9.9990892e-01 9.7364908e-01
 9.9988711e-01 9.9949110e-01 9.6745324e-01 9.9968851e-01 9.9994409e-01
 9.9966729e-01 7.7412355e-01 9.9994934e-01 9.9986970e-01 9.9993694e-01
 2.8456789e-05 8.2618011e-05 2.8472588e-05 2.8486491e-05 2.9553683e-05
 7.7051489e-05 1.4122001e-04 2.9209130e-05 1.6461967e-02 2.8208589e-05
 2.8393573e-05 5.2060630e-05 3.0055853e-05 2.8541177e-05 4.7414669e-05
 2.8155055e-05 2.8344984e-05 2.8206034e-05 2.8257000e-05 7.5513661e-01
 3.1262283e-05 2.8729190e-05 3.1713811e-05 2.8238950e-05 1.6119650e-03
 3.8293878e-05 2.8555876e-05 3.5732875e-05 2.8151964e-05 3.7835866e-02
 2.8212087e-05 1.6298860e-03 3.4567831e-05 1.2895090e-02 3.0320796e-05
 2.8221613e-05 6.2431568e-01 2.9692812e-05 5.4078421e-04 2.8891402e-05
 2.8589529e-05 4.3112981e-05 2.8619235e-05 2.8730285e-05 2.9494162e-05
 3.4293043e-05 5.7320103e-05 3.0643547e-05 9.5233582e-02 4.1955089e-05
 5.6220873e-05 3.5685436e-05 2.8686372e-05 2.8745797e-05 6.0981863e-05
 3.0755295e-05 2.9193285e-05 2.9085964e-05 2.9026613e-05 1.0903938e-01
 2.9176475e-05 2.8551249e-05 2.9074650e-05 2.9048791e-05 2.6203014e-04
 3.0115529e-05 2.8574455e-05 2.2406039e-04 3.0295330e-05 2.6609907e-01
 2.9766898e-05 1.7040961e-03 7.1797989e-02 2.3903912e-03 2.9710574e-05
 3.2437481e-05 9.9794477e-01 2.9060484e-05 9.9854878e-05 2.9221055e-05]
160/160 [=====] - 0s 1ms/step

```

In [81]:

```
#Five layers, four neurons per layer: loss
scores_optimal_Adamax, optimal_Adamax.metrics_names
```

Out[81]:

```
(0.0657503429800272, ['loss'])
```

Nadam

In [82]:

```
n = 40
xx = np.random.random((n,1))
yy = np.random.random((n,1))

X = np.array([np.array([xx,-xx,-xx,xx]),np.array([yy,-yy,yy,-yy])]).reshape(2,4*n).T
y = np.array([np.ones([2*n]),np.zeros([2*n])]).reshape(4*n)
```

In [83]:

```
#Five layers, four neurons per layer
optimal_Nadam = Sequential()

#hidden layers
optimal_Nadam.add(Dense(4, input_dim=2, activation='tanh'))
optimal_Nadam.add(Dense(4, activation='tanh'))
optimal_Nadam.add(Dense(4, activation='tanh'))
optimal_Nadam.add(Dense(4, activation='tanh'))
```

```
optimal_Nadam.add(Dense(4, activation='tanh'))

#output layer
optimal_Nadam.add(Dense(1, activation='sigmoid'))

Nadam = Nadam(lr=0.1)
optimal_Nadam.compile(loss='binary_crossentropy', optimizer='RMSprop')

optimal_Nadam.fit(X, y, batch_size=2, epochs=400)
print(optimal_Nadam.predict_proba(X).reshape(4*n))

#evaluate the model
scores_optimal_Nadam = optimal_Nadam.evaluate(X, y)

Epoch 1/400
160/160 [=====] - 1s 4ms/step - loss: 0.6947
Epoch 2/400
160/160 [=====] - 0s 393us/step - loss: 0.6767
Epoch 3/400
160/160 [=====] - 0s 374us/step - loss: 0.6616
Epoch 4/400
160/160 [=====] - 0s 399us/step - loss: 0.6446
Epoch 5/400
160/160 [=====] - 0s 415us/step - loss: 0.6283
Epoch 6/400
160/160 [=====] - 0s 415us/step - loss: 0.6138
Epoch 7/400
160/160 [=====] - 0s 380us/step - loss: 0.5998
Epoch 8/400
160/160 [=====] - 0s 380us/step - loss: 0.5870
Epoch 9/400
160/160 [=====] - ETA: 0s - loss: 0.570 - 0s 377us/step - loss: 0.5727
Epoch 10/400
160/160 [=====] - 0s 386us/step - loss: 0.5580
Epoch 11/400
160/160 [=====] - 0s 399us/step - loss: 0.5415
Epoch 12/400
160/160 [=====] - 0s 387us/step - loss: 0.5245
Epoch 13/400
160/160 [=====] - 0s 371us/step - loss: 0.5068
Epoch 14/400
160/160 [=====] - 0s 371us/step - loss: 0.4851
Epoch 15/400
160/160 [=====] - 0s 368us/step - loss: 0.4604
Epoch 16/400
160/160 [=====] - 0s 380us/step - loss: 0.4354
Epoch 17/400
160/160 [=====] - 0s 387us/step - loss: 0.4113
Epoch 18/400
160/160 [=====] - 0s 405us/step - loss: 0.3905
Epoch 19/400
160/160 [=====] - 0s 383us/step - loss: 0.3708
Epoch 20/400
160/160 [=====] - 0s 362us/step - loss: 0.3494
Epoch 21/400
160/160 [=====] - 0s 371us/step - loss: 0.3380
Epoch 22/400
160/160 [=====] - 0s 371us/step - loss: 0.3260
Epoch 23/400
160/160 [=====] - 0s 386us/step - loss: 0.3129
Epoch 24/400
160/160 [=====] - 0s 399us/step - loss: 0.3082
Epoch 25/400
160/160 [=====] - 0s 443us/step - loss: 0.3027
Epoch 26/400
160/160 [=====] - 0s 386us/step - loss: 0.3002
Epoch 27/400
160/160 [=====] - 0s 393us/step - loss: 0.2950
Epoch 28/400
160/160 [=====] - 0s 374us/step - loss: 0.2937
Epoch 29/400
160/160 [=====] - 0s 386us/step - loss: 0.2909
Epoch 30/400
160/160 [=====] - 0s 393us/step - loss: 0.2879
Epoch 31/400
160/160 [=====] - 0s 393us/step - loss: 0.2894
Epoch 32/400
160/160 [=====] - 0s 393us/step - loss: 0.2852
```

160/160 [=====] - 0s 377us/step - loss: 0.2827
Epoch 34/400
160/160 [=====] - 0s 411us/step - loss: 0.2821
Epoch 35/400
160/160 [=====] - 0s 377us/step - loss: 0.2831
Epoch 36/400
160/160 [=====] - 0s 415us/step - loss: 0.2832
Epoch 37/400
160/160 [=====] - 0s 386us/step - loss: 0.2829
Epoch 38/400
160/160 [=====] - 0s 377us/step - loss: 0.2791
Epoch 39/400
160/160 [=====] - 0s 380us/step - loss: 0.2838
Epoch 40/400
160/160 [=====] - 0s 380us/step - loss: 0.2796
Epoch 41/400
160/160 [=====] - 0s 368us/step - loss: 0.2791
Epoch 42/400
160/160 [=====] - 0s 386us/step - loss: 0.2782
Epoch 43/400
160/160 [=====] - 0s 374us/step - loss: 0.2776
Epoch 44/400
160/160 [=====] - 0s 374us/step - loss: 0.2761
Epoch 45/400
160/160 [=====] - 0s 368us/step - loss: 0.2712
Epoch 46/400
160/160 [=====] - 0s 383us/step - loss: 0.2732
Epoch 47/400
160/160 [=====] - 0s 380us/step - loss: 0.2725
Epoch 48/400
160/160 [=====] - 0s 365us/step - loss: 0.2695
Epoch 49/400
160/160 [=====] - 0s 368us/step - loss: 0.2693
Epoch 50/400
160/160 [=====] - 0s 405us/step - loss: 0.2672
Epoch 51/400
160/160 [=====] - 0s 368us/step - loss: 0.2664
Epoch 52/400
160/160 [=====] - 0s 374us/step - loss: 0.2660
Epoch 53/400
160/160 [=====] - 0s 362us/step - loss: 0.2639
Epoch 54/400
160/160 [=====] - 0s 368us/step - loss: 0.2650
Epoch 55/400
160/160 [=====] - 0s 377us/step - loss: 0.2626
Epoch 56/400
160/160 [=====] - 0s 374us/step - loss: 0.2592
Epoch 57/400
160/160 [=====] - 0s 386us/step - loss: 0.2596
Epoch 58/400
160/160 [=====] - 0s 368us/step - loss: 0.2587
Epoch 59/400
160/160 [=====] - 0s 368us/step - loss: 0.2568
Epoch 60/400
160/160 [=====] - 0s 358us/step - loss: 0.2554
Epoch 61/400
160/160 [=====] - 0s 352us/step - loss: 0.2519
Epoch 62/400
160/160 [=====] - 0s 355us/step - loss: 0.2518
Epoch 63/400
160/160 [=====] - 0s 349us/step - loss: 0.2505
Epoch 64/400
160/160 [=====] - 0s 368us/step - loss: 0.2491
Epoch 65/400
160/160 [=====] - 0s 362us/step - loss: 0.2466
Epoch 66/400
160/160 [=====] - 0s 383us/step - loss: 0.2487
Epoch 67/400
160/160 [=====] - 0s 408us/step - loss: 0.2441
Epoch 68/400
160/160 [=====] - 0s 368us/step - loss: 0.2423
Epoch 69/400
160/160 [=====] - 0s 374us/step - loss: 0.2389
Epoch 70/400
160/160 [=====] - 0s 377us/step - loss: 0.2395

Epoch 11/400
160/160 [=====] - 0s 368us/step - loss: 0.2369
Epoch 72/400
160/160 [=====] - 0s 362us/step - loss: 0.2341
Epoch 73/400
160/160 [=====] - 0s 362us/step - loss: 0.2333
Epoch 74/400
160/160 [=====] - 0s 374us/step - loss: 0.2318
Epoch 75/400
160/160 [=====] - 0s 368us/step - loss: 0.2281
Epoch 76/400
160/160 [=====] - 0s 374us/step - loss: 0.2265
Epoch 77/400
160/160 [=====] - 0s 374us/step - loss: 0.2235
Epoch 78/400
160/160 [=====] - 0s 362us/step - loss: 0.2225
Epoch 79/400
160/160 [=====] - 0s 374us/step - loss: 0.2193
Epoch 80/400
160/160 [=====] - 0s 368us/step - loss: 0.2168
Epoch 81/400
160/160 [=====] - 0s 399us/step - loss: 0.2088
Epoch 82/400
160/160 [=====] - 0s 386us/step - loss: 0.2105
Epoch 83/400
160/160 [=====] - 0s 405us/step - loss: 0.2070
Epoch 84/400
160/160 [=====] - 0s 418us/step - loss: 0.2061
Epoch 85/400
160/160 [=====] - 0s 424us/step - loss: 0.2017
Epoch 86/400
160/160 [=====] - 0s 411us/step - loss: 0.2003
Epoch 87/400
160/160 [=====] - 0s 408us/step - loss: 0.1954
Epoch 88/400
160/160 [=====] - 0s 393us/step - loss: 0.1912
Epoch 89/400
160/160 [=====] - 0s 365us/step - loss: 0.1903
Epoch 90/400
160/160 [=====] - 0s 399us/step - loss: 0.1856
Epoch 91/400
160/160 [=====] - 0s 386us/step - loss: 0.1789
Epoch 92/400
160/160 [=====] - 0s 396us/step - loss: 0.1729
Epoch 93/400
160/160 [=====] - 0s 380us/step - loss: 0.1682
Epoch 94/400
160/160 [=====] - 0s 377us/step - loss: 0.1628
Epoch 95/400
160/160 [=====] - 0s 368us/step - loss: 0.1541
Epoch 96/400
160/160 [=====] - 0s 365us/step - loss: 0.1491
Epoch 97/400
160/160 [=====] - 0s 365us/step - loss: 0.1429
Epoch 98/400
160/160 [=====] - 0s 368us/step - loss: 0.1351
Epoch 99/400
160/160 [=====] - 0s 390us/step - loss: 0.1292
Epoch 100/400
160/160 [=====] - 0s 386us/step - loss: 0.1244
Epoch 101/400
160/160 [=====] - 0s 383us/step - loss: 0.1216
Epoch 102/400
160/160 [=====] - 0s 380us/step - loss: 0.1141
Epoch 103/400
160/160 [=====] - 0s 371us/step - loss: 0.1060
Epoch 104/400
160/160 [=====] - 0s 368us/step - loss: 0.1063
Epoch 105/400
160/160 [=====] - 0s 390us/step - loss: 0.1006
Epoch 106/400
160/160 [=====] - 0s 387us/step - loss: 0.0967
Epoch 107/400
160/160 [=====] - 0s 371us/step - loss: 0.0901
Epoch 108/400
160/160 [=====] - 0s 368us/step - loss: 0.0881
Epoch 109/400

160/160 [=====] - 0s 362us/step - loss: 0.083 /
Epoch 110/400
160/160 [=====] - 0s 362us/step - loss: 0.0820
Epoch 111/400
160/160 [=====] - 0s 355us/step - loss: 0.0802
Epoch 112/400
160/160 [=====] - 0s 362us/step - loss: 0.0779
Epoch 113/400
160/160 [=====] - 0s 430us/step - loss: 0.0722
Epoch 114/400
160/160 [=====] - 0s 384us/step - loss: 0.0697
Epoch 115/400
160/160 [=====] - 0s 368us/step - loss: 0.0678
Epoch 116/400
160/160 [=====] - 0s 393us/step - loss: 0.0676
Epoch 117/400
160/160 [=====] - 0s 355us/step - loss: 0.0673
Epoch 118/400
160/160 [=====] - 0s 368us/step - loss: 0.0610
Epoch 119/400
160/160 [=====] - 0s 358us/step - loss: 0.0587
Epoch 120/400
160/160 [=====] - 0s 374us/step - loss: 0.0669
Epoch 121/400
160/160 [=====] - 0s 365us/step - loss: 0.0610
Epoch 122/400
160/160 [=====] - 0s 362us/step - loss: 0.0574
Epoch 123/400
160/160 [=====] - 0s 374us/step - loss: 0.0577
Epoch 124/400
160/160 [=====] - 0s 358us/step - loss: 0.0587
Epoch 125/400
160/160 [=====] - 0s 349us/step - loss: 0.0518
Epoch 126/400
160/160 [=====] - 0s 362us/step - loss: 0.0546
Epoch 127/400
160/160 [=====] - 0s 362us/step - loss: 0.0525
Epoch 128/400
160/160 [=====] - 0s 368us/step - loss: 0.0507
Epoch 129/400
160/160 [=====] - 0s 368us/step - loss: 0.0458
Epoch 130/400
160/160 [=====] - 0s 362us/step - loss: 0.0428
Epoch 131/400
160/160 [=====] - 0s 365us/step - loss: 0.0440
Epoch 132/400
160/160 [=====] - 0s 358us/step - loss: 0.0437
Epoch 133/400
160/160 [=====] - 0s 380us/step - loss: 0.0418
Epoch 134/400
160/160 [=====] - 0s 371us/step - loss: 0.0410
Epoch 135/400
160/160 [=====] - 0s 368us/step - loss: 0.0375
Epoch 136/400
160/160 [=====] - 0s 352us/step - loss: 0.0394
Epoch 137/400
160/160 [=====] - 0s 371us/step - loss: 0.0396
Epoch 138/400
160/160 [=====] - 0s 362us/step - loss: 0.0382
Epoch 139/400
160/160 [=====] - 0s 362us/step - loss: 0.0414
Epoch 140/400
160/160 [=====] - 0s 380us/step - loss: 0.0344
Epoch 141/400
160/160 [=====] - 0s 355us/step - loss: 0.0363
Epoch 142/400
160/160 [=====] - 0s 362us/step - loss: 0.0361
Epoch 143/400
160/160 [=====] - 0s 368us/step - loss: 0.0353
Epoch 144/400
160/160 [=====] - 0s 371us/step - loss: 0.0320
Epoch 145/400
160/160 [=====] - 0s 349us/step - loss: 0.0353
Epoch 146/400
160/160 [=====] - 0s 355us/step - loss: 0.0357
Epoch 147/400
160/160 [=====] - 0s 362us/step - loss: 0.0340

Epoch 148/400
160/160 [=====] - 0s 374us/step - loss: 0.0366
Epoch 149/400
160/160 [=====] - 0s 368us/step - loss: 0.0327
Epoch 150/400
160/160 [=====] - 0s 386us/step - loss: 0.0358
Epoch 151/400
160/160 [=====] - 0s 365us/step - loss: 0.0366
Epoch 152/400
160/160 [=====] - 0s 371us/step - loss: 0.0317
Epoch 153/400
160/160 [=====] - 0s 362us/step - loss: 0.0360
Epoch 154/400
160/160 [=====] - 0s 362us/step - loss: 0.0363
Epoch 155/400
160/160 [=====] - 0s 380us/step - loss: 0.0360
Epoch 156/400
160/160 [=====] - 0s 365us/step - loss: 0.0340
Epoch 157/400
160/160 [=====] - 0s 362us/step - loss: 0.0377
Epoch 158/400
160/160 [=====] - 0s 368us/step - loss: 0.0343
Epoch 159/400
160/160 [=====] - 0s 362us/step - loss: 0.0396
Epoch 160/400
160/160 [=====] - 0s 358us/step - loss: 0.0368
Epoch 161/400
160/160 [=====] - 0s 355us/step - loss: 0.0344
Epoch 162/400
160/160 [=====] - 0s 355us/step - loss: 0.0328
Epoch 163/400
160/160 [=====] - 0s 368us/step - loss: 0.0350
Epoch 164/400
160/160 [=====] - 0s 368us/step - loss: 0.0371
Epoch 165/400
160/160 [=====] - 0s 374us/step - loss: 0.0344
Epoch 166/400
160/160 [=====] - 0s 362us/step - loss: 0.0385
Epoch 167/400
160/160 [=====] - 0s 390us/step - loss: 0.0383
Epoch 168/400
160/160 [=====] - 0s 365us/step - loss: 0.0353
Epoch 169/400
160/160 [=====] - 0s 371us/step - loss: 0.0348
Epoch 170/400
160/160 [=====] - 0s 365us/step - loss: 0.0363
Epoch 171/400
160/160 [=====] - 0s 368us/step - loss: 0.0349
Epoch 172/400
160/160 [=====] - 0s 383us/step - loss: 0.0345
Epoch 173/400
160/160 [=====] - 0s 377us/step - loss: 0.0366
Epoch 174/400
160/160 [=====] - 0s 374us/step - loss: 0.0373
Epoch 175/400
160/160 [=====] - 0s 368us/step - loss: 0.0371
Epoch 176/400
160/160 [=====] - 0s 380us/step - loss: 0.0389
Epoch 177/400
160/160 [=====] - 0s 368us/step - loss: 0.0394
Epoch 178/400
160/160 [=====] - 0s 355us/step - loss: 0.0408
Epoch 179/400
160/160 [=====] - 0s 362us/step - loss: 0.0382
Epoch 180/400
160/160 [=====] - 0s 355us/step - loss: 0.0410
Epoch 181/400
160/160 [=====] - 0s 368us/step - loss: 0.0377
Epoch 182/400
160/160 [=====] - 0s 362us/step - loss: 0.0386
Epoch 183/400
160/160 [=====] - 0s 362us/step - loss: 0.0400
Epoch 184/400
160/160 [=====] - 0s 393us/step - loss: 0.0363
Epoch 185/400
160/160 [=====] - 0s 365us/step - loss: 0.0408
Epoch 186/400

160/160 [=====] - 0s 411us/step - loss: 0.0366
Epoch 187/400
160/160 [=====] - 0s 352us/step - loss: 0.0391
Epoch 188/400
160/160 [=====] - 0s 362us/step - loss: 0.0417
Epoch 189/400
160/160 [=====] - 0s 368us/step - loss: 0.0387
Epoch 190/400
160/160 [=====] - 0s 365us/step - loss: 0.0348
Epoch 191/400
160/160 [=====] - 0s 380us/step - loss: 0.0412
Epoch 192/400
160/160 [=====] - 0s 365us/step - loss: 0.0367
Epoch 193/400
160/160 [=====] - 0s 352us/step - loss: 0.0428
Epoch 194/400
160/160 [=====] - 0s 368us/step - loss: 0.0390
Epoch 195/400
160/160 [=====] - 0s 368us/step - loss: 0.0368
Epoch 196/400
160/160 [=====] - 0s 374us/step - loss: 0.0405
Epoch 197/400
160/160 [=====] - 0s 362us/step - loss: 0.0366
Epoch 198/400
160/160 [=====] - 0s 362us/step - loss: 0.0385
Epoch 199/400
160/160 [=====] - 0s 365us/step - loss: 0.0355
Epoch 200/400
160/160 [=====] - 0s 380us/step - loss: 0.0322
Epoch 201/400
160/160 [=====] - 0s 355us/step - loss: 0.0392
Epoch 202/400
160/160 [=====] - 0s 362us/step - loss: 0.0350
Epoch 203/400
160/160 [=====] - 0s 349us/step - loss: 0.0349
Epoch 204/400
160/160 [=====] - 0s 377us/step - loss: 0.0325
Epoch 205/400
160/160 [=====] - 0s 362us/step - loss: 0.0351
Epoch 206/400
160/160 [=====] - 0s 371us/step - loss: 0.0322
Epoch 207/400
160/160 [=====] - 0s 346us/step - loss: 0.0310
Epoch 208/400
160/160 [=====] - 0s 380us/step - loss: 0.0362
Epoch 209/400
160/160 [=====] - 0s 349us/step - loss: 0.0314
Epoch 210/400
160/160 [=====] - 0s 368us/step - loss: 0.0325
Epoch 211/400
160/160 [=====] - 0s 362us/step - loss: 0.0375
Epoch 212/400
160/160 [=====] - 0s 358us/step - loss: 0.0334
Epoch 213/400
160/160 [=====] - 0s 352us/step - loss: 0.0351
Epoch 214/400
160/160 [=====] - 0s 368us/step - loss: 0.0347
Epoch 215/400
160/160 [=====] - 0s 399us/step - loss: 0.0338
Epoch 216/400
160/160 [=====] - 0s 368us/step - loss: 0.0311
Epoch 217/400
160/160 [=====] - 0s 371us/step - loss: 0.0336
Epoch 218/400
160/160 [=====] - 0s 355us/step - loss: 0.0331
Epoch 219/400
160/160 [=====] - 0s 368us/step - loss: 0.0286
Epoch 220/400
160/160 [=====] - 0s 362us/step - loss: 0.0315
Epoch 221/400
160/160 [=====] - 0s 368us/step - loss: 0.0257
Epoch 222/400
160/160 [=====] - 0s 362us/step - loss: 0.0287
Epoch 223/400
160/160 [=====] - 0s 358us/step - loss: 0.0311
Epoch 224/400
160/160 [=====] - 0s 368us/step - loss: 0.0256

Epoch 225/400
160/160 [=====] - 0s 362us/step - loss: 0.0288
Epoch 226/400
160/160 [=====] - 0s 358us/step - loss: 0.0270
Epoch 227/400
160/160 [=====] - 0s 368us/step - loss: 0.0245
Epoch 228/400
160/160 [=====] - 0s 365us/step - loss: 0.0253
Epoch 229/400
160/160 [=====] - 0s 362us/step - loss: 0.0224
Epoch 230/400
160/160 [=====] - 0s 355us/step - loss: 0.0177
Epoch 231/400
160/160 [=====] - 0s 368us/step - loss: 0.0174
Epoch 232/400
160/160 [=====] - 0s 355us/step - loss: 0.0238
Epoch 233/400
160/160 [=====] - 0s 368us/step - loss: 0.0180
Epoch 234/400
160/160 [=====] - 0s 368us/step - loss: 0.0140
Epoch 235/400
160/160 [=====] - 0s 374us/step - loss: 0.0188
Epoch 236/400
160/160 [=====] - 0s 377us/step - loss: 0.0204
Epoch 237/400
160/160 [=====] - 0s 374us/step - loss: 0.0134
Epoch 238/400
160/160 [=====] - 0s 365us/step - loss: 0.0124
Epoch 239/400
160/160 [=====] - 0s 355us/step - loss: 0.0134
Epoch 240/400
160/160 [=====] - 0s 358us/step - loss: 0.0184
Epoch 241/400
160/160 [=====] - 0s 355us/step - loss: 0.0118
Epoch 242/400
160/160 [=====] - 0s 383us/step - loss: 0.0135
Epoch 243/400
160/160 [=====] - 0s 358us/step - loss: 0.0082
Epoch 244/400
160/160 [=====] - 0s 362us/step - loss: 0.0121
Epoch 245/400
160/160 [=====] - 0s 362us/step - loss: 0.0064
Epoch 246/400
160/160 [=====] - 0s 362us/step - loss: 0.0124
Epoch 247/400
160/160 [=====] - 0s 362us/step - loss: 0.0101
Epoch 248/400
160/160 [=====] - 0s 362us/step - loss: 0.0058
Epoch 249/400
160/160 [=====] - 0s 368us/step - loss: 0.0076
Epoch 250/400
160/160 [=====] - 0s 362us/step - loss: 0.0044
Epoch 251/400
160/160 [=====] - 0s 380us/step - loss: 0.0037
Epoch 252/400
160/160 [=====] - 0s 374us/step - loss: 0.0067
Epoch 253/400
160/160 [=====] - 0s 362us/step - loss: 0.0085
Epoch 254/400
160/160 [=====] - 0s 368us/step - loss: 0.0028
Epoch 255/400
160/160 [=====] - 0s 362us/step - loss: 0.0037
Epoch 256/400
160/160 [=====] - 0s 365us/step - loss: 0.0017
Epoch 257/400
160/160 [=====] - 0s 358us/step - loss: 0.0041
Epoch 258/400
160/160 [=====] - 0s 362us/step - loss: 0.0036
Epoch 259/400
160/160 [=====] - 0s 365us/step - loss: 0.0016
Epoch 260/400
160/160 [=====] - 0s 362us/step - loss: 0.0012
Epoch 261/400
160/160 [=====] - 0s 418us/step - loss: 0.0026
Epoch 262/400
160/160 [=====] - 0s 396us/step - loss: 0.0013
Epoch 263/400

160/160 [=====] - 0s 362us/step - loss: 0.0012
Epoch 264/400
160/160 [=====] - 0s 368us/step - loss: 0.0011
Epoch 265/400
160/160 [=====] - 0s 365us/step - loss: 0.0018
Epoch 266/400
160/160 [=====] - 0s 368us/step - loss: 7.5675e-04
Epoch 267/400
160/160 [=====] - 0s 362us/step - loss: 7.2806e-04
Epoch 268/400
160/160 [=====] - 0s 380us/step - loss: 0.0011
Epoch 269/400
160/160 [=====] - 0s 368us/step - loss: 5.0764e-04
Epoch 270/400
160/160 [=====] - 0s 368us/step - loss: 7.2133e-04
Epoch 271/400
160/160 [=====] - 0s 368us/step - loss: 6.5217e-04
Epoch 272/400
160/160 [=====] - 0s 383us/step - loss: 5.1645e-04
Epoch 273/400
160/160 [=====] - 0s 362us/step - loss: 3.8579e-04
Epoch 274/400
160/160 [=====] - 0s 362us/step - loss: 2.4898e-04
Epoch 275/400
160/160 [=====] - 0s 365us/step - loss: 2.1896e-04
Epoch 276/400
160/160 [=====] - 0s 380us/step - loss: 2.5824e-04
Epoch 277/400
160/160 [=====] - 0s 365us/step - loss: 1.6561e-04
Epoch 278/400
160/160 [=====] - 0s 368us/step - loss: 4.7588e-04
Epoch 279/400
160/160 [=====] - 0s 355us/step - loss: 1.8066e-04
Epoch 280/400
160/160 [=====] - 0s 362us/step - loss: 1.3477e-04
Epoch 281/400
160/160 [=====] - 0s 355us/step - loss: 1.9289e-04
Epoch 282/400
160/160 [=====] - 0s 368us/step - loss: 1.0292e-04
Epoch 283/400
160/160 [=====] - 0s 368us/step - loss: 8.9236e-05
Epoch 284/400
160/160 [=====] - 0s 365us/step - loss: 2.0130e-04
Epoch 285/400
160/160 [=====] - 0s 380us/step - loss: 4.8282e-05
Epoch 286/400
160/160 [=====] - 0s 371us/step - loss: 8.6127e-05
Epoch 287/400
160/160 [=====] - 0s 364us/step - loss: 4.9632e-05
Epoch 288/400
160/160 [=====] - 0s 374us/step - loss: 3.7402e-05
Epoch 289/400
160/160 [=====] - 0s 362us/step - loss: 5.6560e-05
Epoch 290/400
160/160 [=====] - 0s 362us/step - loss: 2.4924e-05
Epoch 291/400
160/160 [=====] - 0s 368us/step - loss: 2.4256e-05
Epoch 292/400
160/160 [=====] - 0s 362us/step - loss: 2.0457e-05
Epoch 293/400
160/160 [=====] - 0s 371us/step - loss: 1.5617e-05
Epoch 294/400
160/160 [=====] - 0s 362us/step - loss: 1.6004e-05
Epoch 295/400
160/160 [=====] - 0s 352us/step - loss: 9.8079e-06
Epoch 296/400
160/160 [=====] - 0s 349us/step - loss: 1.2202e-05
Epoch 297/400
160/160 [=====] - 0s 374us/step - loss: 8.0925e-06
Epoch 298/400
160/160 [=====] - 0s 365us/step - loss: 6.5245e-06
Epoch 299/400
160/160 [=====] - 0s 355us/step - loss: 5.9179e-06
Epoch 300/400
160/160 [=====] - 0s 359us/step - loss: 8.9042e-06
Epoch 301/400
160/160 [=====] - 0s 355us/step - loss: 3.9435e-06

Epoch 302/400
160/160 [=====] - 0s 374us/step - loss: 4.3244e-06
Epoch 303/400
160/160 [=====] - 0s 373us/step - loss: 3.4239e-06
Epoch 304/400
160/160 [=====] - 0s 374us/step - loss: 3.8198e-06
Epoch 305/400
160/160 [=====] - 0s 357us/step - loss: 1.7119e-06
Epoch 306/400
160/160 [=====] - 0s 366us/step - loss: 3.8834e-06
Epoch 307/400
160/160 [=====] - 0s 362us/step - loss: 1.1365e-06
Epoch 308/400
160/160 [=====] - 0s 355us/step - loss: 5.0320e-06
Epoch 309/400
160/160 [=====] - 0s 352us/step - loss: 8.4755e-07
Epoch 310/400
160/160 [=====] - 0s 371us/step - loss: 7.7116e-07
Epoch 311/400
160/160 [=====] - 0s 368us/step - loss: 9.7246e-07
Epoch 312/400
160/160 [=====] - 0s 368us/step - loss: 5.6639e-07
Epoch 313/400
160/160 [=====] - 0s 359us/step - loss: 5.7972e-07
Epoch 314/400
160/160 [=====] - 0s 355us/step - loss: 3.0282e-07
Epoch 315/400
160/160 [=====] - 0s 362us/step - loss: 3.5073e-07
Epoch 316/400
160/160 [=====] - 0s 355us/step - loss: 2.5886e-07
Epoch 317/400
160/160 [=====] - 0s 365us/step - loss: 3.1720e-07
Epoch 318/400
160/160 [=====] - 0s 358us/step - loss: 1.8286e-07
Epoch 319/400
160/160 [=====] - 0s 377us/step - loss: 2.3076e-07
Epoch 320/400
160/160 [=====] - 0s 355us/step - loss: 1.7136e-07
Epoch 321/400
160/160 [=====] - 0s 355us/step - loss: 2.6729e-07
Epoch 322/400
160/160 [=====] - 0s 374us/step - loss: 1.5689e-07
Epoch 323/400
160/160 [=====] - 0s 358us/step - loss: 1.3637e-07
Epoch 324/400
160/160 [=====] - 0s 355us/step - loss: 1.4815e-07
Epoch 325/400
160/160 [=====] - 0s 358us/step - loss: 1.4552e-07
Epoch 326/400
160/160 [=====] - 0s 355us/step - loss: 1.3026e-07
Epoch 327/400
160/160 [=====] - 0s 365us/step - loss: 1.2559e-07
Epoch 328/400
160/160 [=====] - 0s 352us/step - loss: 1.2041e-07
Epoch 329/400
160/160 [=====] - 0s 346us/step - loss: 1.2042e-07
Epoch 330/400
160/160 [=====] - 0s 368us/step - loss: 1.1651e-07
Epoch 331/400
160/160 [=====] - 0s 358us/step - loss: 1.2087e-07
Epoch 332/400
160/160 [=====] - 0s 368us/step - loss: 1.1585e-07
Epoch 333/400
160/160 [=====] - 0s 355us/step - loss: 1.1566e-07
Epoch 334/400
160/160 [=====] - 0s 362us/step - loss: 1.1546e-07
Epoch 335/400
160/160 [=====] - 0s 358us/step - loss: 1.1378e-07
Epoch 336/400
160/160 [=====] - 0s 368us/step - loss: 1.1405e-07
Epoch 337/400
160/160 [=====] - 0s 355us/step - loss: 1.1170e-07
Epoch 338/400
160/160 [=====] - 0s 368us/step - loss: 1.1255e-07
Epoch 339/400
160/160 [=====] - 0s 374us/step - loss: 1.1090e-07
Epoch 340/400

160/160 [=====] - 0s 368us/step - loss: 1.1162e-07
Epoch 341/400
160/160 [=====] - 0s 368us/step - loss: 1.1054e-07
Epoch 342/400
160/160 [=====] - 0s 362us/step - loss: 1.1087e-07
Epoch 343/400
160/160 [=====] - 0s 352us/step - loss: 1.1004e-07
Epoch 344/400
160/160 [=====] - 0s 377us/step - loss: 1.1103e-07
Epoch 345/400
160/160 [=====] - 0s 349us/step - loss: 1.1015e-07
Epoch 346/400
160/160 [=====] - 0s 374us/step - loss: 1.1057e-07
Epoch 347/400
160/160 [=====] - 0s 362us/step - loss: 1.0988e-07
Epoch 348/400
160/160 [=====] - 0s 355us/step - loss: 1.1019e-07
Epoch 349/400
160/160 [=====] - 0s 375us/step - loss: 1.1038e-07
Epoch 350/400
160/160 [=====] - 0s 367us/step - loss: 1.0982e-07
Epoch 351/400
160/160 [=====] - 0s 362us/step - loss: 1.0985e-07
Epoch 352/400
160/160 [=====] - 0s 358us/step - loss: 1.1015e-07
Epoch 353/400
160/160 [=====] - 0s 374us/step - loss: 1.0978e-07
Epoch 354/400
160/160 [=====] - 0s 377us/step - loss: 1.0962e-07
Epoch 355/400
160/160 [=====] - 0s 374us/step - loss: 1.0963e-07
Epoch 356/400
160/160 [=====] - 0s 368us/step - loss: 1.0981e-07
Epoch 357/400
160/160 [=====] - 0s 358us/step - loss: 1.0975e-07
Epoch 358/400
160/160 [=====] - 0s 355us/step - loss: 1.0966e-07
Epoch 359/400
160/160 [=====] - 0s 374us/step - loss: 1.0960e-07
Epoch 360/400
160/160 [=====] - 0s 355us/step - loss: 1.0961e-07
Epoch 361/400
160/160 [=====] - 0s 377us/step - loss: 1.0960e-07
Epoch 362/400
160/160 [=====] - 0s 368us/step - loss: 1.0962e-07
Epoch 363/400
160/160 [=====] - 0s 365us/step - loss: 1.0963e-07
Epoch 364/400
160/160 [=====] - 0s 368us/step - loss: 1.0960e-07
Epoch 365/400
160/160 [=====] - 0s 362us/step - loss: 1.0960e-07
Epoch 366/400
160/160 [=====] - 0s 368us/step - loss: 1.0960e-07
Epoch 367/400
160/160 [=====] - 0s 368us/step - loss: 1.0960e-07
Epoch 368/400
160/160 [=====] - 0s 368us/step - loss: 1.0960e-07
Epoch 369/400
160/160 [=====] - 0s 355us/step - loss: 1.0960e-07
Epoch 370/400
160/160 [=====] - 0s 368us/step - loss: 1.0960e-07
Epoch 371/400
160/160 [=====] - 0s 358us/step - loss: 1.0960e-07
Epoch 372/400
160/160 [=====] - 0s 368us/step - loss: 1.0960e-07
Epoch 373/400
160/160 [=====] - 0s 358us/step - loss: 1.0960e-07
Epoch 374/400
160/160 [=====] - 0s 374us/step - loss: 1.0960e-07
Epoch 375/400
160/160 [=====] - 0s 358us/step - loss: 1.0960e-07
Epoch 376/400
160/160 [=====] - 0s 362us/step - loss: 1.0960e-07
Epoch 377/400
160/160 [=====] - 0s 358us/step - loss: 1.0960e-07
Epoch 378/400
160/160 [=====] - 0s 368us/step - loss: 1.0960e-07

Epoch 379/400
160/160 [=====] - 0s 362us/step - loss: 1.0960e-07
Epoch 380/400
160/160 [=====] - 0s 352us/step - loss: 1.0960e-07
Epoch 381/400
160/160 [=====] - 0s 349us/step - loss: 1.0960e-07
Epoch 382/400
160/160 [=====] - 0s 358us/step - loss: 1.0960e-07
Epoch 383/400
160/160 [=====] - 0s 352us/step - loss: 1.0960e-07
Epoch 384/400
160/160 [=====] - 0s 355us/step - loss: 1.0960e-07
Epoch 385/400
160/160 [=====] - 0s 358us/step - loss: 1.0960e-07
Epoch 386/400
160/160 [=====] - 0s 355us/step - loss: 1.0960e-07
Epoch 387/400
160/160 [=====] - 0s 368us/step - loss: 1.0960e-07
Epoch 388/400
160/160 [=====] - 0s 380us/step - loss: 1.0960e-07
Epoch 389/400
160/160 [=====] - 0s 368us/step - loss: 1.0960e-07
Epoch 390/400
160/160 [=====] - 0s 362us/step - loss: 1.0960e-07
Epoch 391/400
160/160 [=====] - 0s 374us/step - loss: 1.0960e-07
Epoch 392/400
160/160 [=====] - 0s 362us/step - loss: 1.0960e-07
Epoch 393/400
160/160 [=====] - 0s 362us/step - loss: 1.0960e-07
Epoch 394/400
160/160 [=====] - 0s 358us/step - loss: 1.0960e-07
Epoch 395/400
160/160 [=====] - 0s 368us/step - loss: 1.0960e-07
Epoch 396/400
160/160 [=====] - 0s 393us/step - loss: 1.0960e-07
Epoch 397/400
160/160 [=====] - 0s 355us/step - loss: 1.0960e-07
Epoch 398/400
160/160 [=====] - 0s 355us/step - loss: 1.0960e-07
Epoch 399/400
160/160 [=====] - 0s 349us/step - loss: 1.0960e-07
Epoch 400/400
160/160 [=====] - 0s 368us/step - loss: 1.0960e-07
[1.0000000e+00 1.0000000e+00 1.0000000e+00 1.0000000e+00 1.0000000e+00
1.0000000e+00 1.0000000e+00 1.0000000e+00 1.0000000e+00 1.0000000e+00
2.4126912e-08 2.4547509e-08 2.4157533e-08 8.7973923e-08 2.5206731e-08
4.0795108e-08 2.4146521e-08 4.0974538e-08 3.1584978e-08 2.3956421e-08
3.1943156e-08 2.4001332e-08 2.3953449e-08 3.0394801e-08 3.5918493e-08
4.5960604e-08 3.9673761e-08 2.4067255e-08 2.6854289e-08 8.2220595e-08
4.2220414e-08 2.3934131e-08 2.3943493e-08 2.4322402e-08 2.5821576e-08
2.3993826e-08 2.7661061e-08 2.4129351e-08 2.5112769e-08 2.9110105e-08
3.3167513e-08 3.6884419e-08 4.0226880e-08 2.4061055e-08 3.2674169e-08
3.8059390e-08 2.3956236e-08 4.0906915e-08 2.7397890e-08 2.6279432e-08
2.4486436e-08 2.4460482e-08 2.4484148e-08 2.4441736e-08 2.4460997e-08
2.4428218e-08 9.0656648e-08 2.4429431e-08 2.4443507e-08 2.8034455e-08
2.4442434e-08 2.4519338e-08 2.5006564e-08 2.4437865e-08 2.4430037e-08
4.9356050e-08 2.4429756e-08 2.4496385e-08 2.4452413e-08 9.4465982e-08
2.4428873e-08 2.6188765e-08 2.7341926e-08 2.4475510e-08 2.4464729e-08
2.5326729e-08 2.4449662e-08 2.4488166e-08 2.4450173e-08 2.4446770e-08
2.4435675e-08 2.4435023e-08 2.4433717e-08 2.4483823e-08 2.4437165e-08
2.4429617e-08 2.4562963e-08 2.4439638e-08 2.4441453e-08 2.4442855e-08]
160/160 [=====] - 0s 1ms/step

In [84]:

```
#Five layers, four neurons per layer: loss
scores_optimal_Nadam, optimal_Nadam.metrics_names
```

Out[84]:

```
(1.0960467449194766e-07, ['loss'])
```

In [85]:

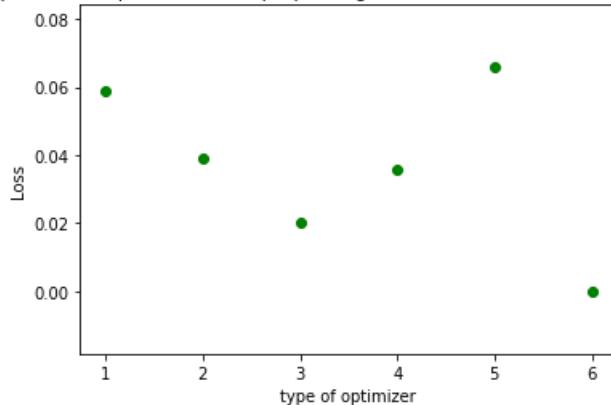
```
#Summary plot of Layer/Neuron Modulation
#figure of loss vs # of Layers
x_compare = [1,2,3,4,5,6]
y_compare = [scores_optimal_RMSprop, scores_optimal_Adagrad, scores_optimal_Adadelta, scores_optimal_Adam, scores_optimal_Adamax, scores_optimal_Nadam]

plt.scatter(x_compare,y_compare, c='g');
plt.title('Comparison of Optimizers: RMSprop, Adagrad, Adadelta, Adam, Adamax, Nadam')
plt.xlabel('type of optimizer')
plt.ylabel('Loss')
```

Out[85]:

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

Comparison of Optimizers: RMSprop, Adagrad, Adadelta, Adam, Adamax, Nadam



Observation: Nadam lowest loss in optimized neural network of 5 layers and 4 neurons per layer.

Part 2 - BYOD

<https://www.youtube.com/watch?v=wQ8BIBpya2k&t=802s>

In [86]:

```
import tensorflow as tf

mnist = tf.keras.datasets.mnist # 28x28 images of hand-written digits 0-9

(x_train, y_train) , (x_test, y_test) = mnist.load_data()
```

In [87]:

```
#normalize/scale data
x_train = tf.keras.utils.normalize(x_train, axis=1)
x_test = tf.keras.utils.normalize(x_test, axis=1)
```

In [88]:

```
#model
model = tf.keras.models.Sequential()

#input layer
model.add(tf.keras.layers.Flatten())

#hidden layers
model.add(tf.keras.layers.Dense(128, activation=tf.nn.relu))
model.add(tf.keras.layers.Dense(128, activation=tf.nn.relu))
```

```
#output layer
model.add(tf.keras.layers.Dense(10, activation=tf.nn.softmax))

#training
model.compile(optimizer='adam' , loss='sparse_categorical_crossentropy',metrics=['accuracy'])

model.fit(x_train, y_train, epochs=3)
```

```
Epoch 1/3
60000/60000 [=====] - 3s 52us/step - loss: 0.2676 - acc: 0.9214
Epoch 2/3
60000/60000 [=====] - 3s 42us/step - loss: 0.1088 - acc: 0.9668
Epoch 3/3
60000/60000 [=====] - 2s 42us/step - loss: 0.0757 - acc: 0.9765
```

Out[88]:

```
<tensorflow.python.keras.callbacks.History at 0x1d6afa84668>
```

In [89]:

```
val_loss, val_acc = model.evaluate(x_test, y_test)
print(val_loss, val_acc)
```

```
10000/10000 [=====] - 0s 39us/step
0.08536097722416744 0.9751
```