

01_1_AND_Keras

December 22, 2020

```
[1]: import tensorflow as tf
    from tensorflow import keras

[2]: tf.__version__

[2]: '2.4.0'

[3]: import numpy as np
    import matplotlib.pyplot as plt

[4]: x_data = [[0, 0],
               [0, 1],
               [1, 0],
               [1, 1]]

    y_data = [0,
              0,
              0,
              1]

    #x_data = np.array([[1, 2], [1, 5], [2, 2], [3, 3.5], [7, 5], [9, 4], [8, 2]])
    #→#training_points
    #y_data = [1, 1, 1, 1, 0, 0, 0]

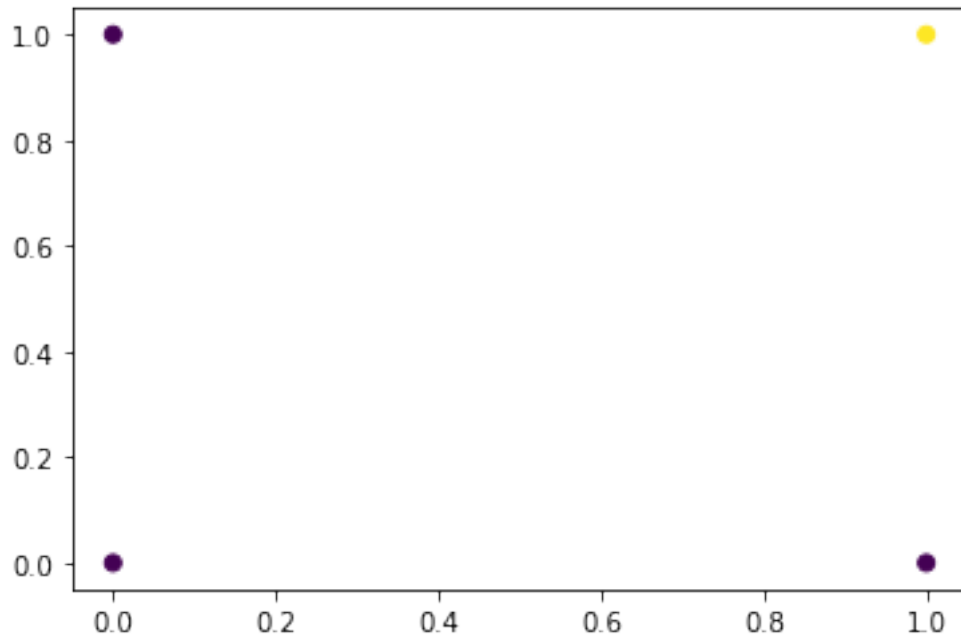
    x_data = np.array(x_data, dtype=np.float32)
    y_data = np.array(y_data, dtype=np.float32)

[5]: x_data.shape, y_data.shape

[5]: ((4, 2), (4,))

[6]: plt.scatter(x_data[:, 0], x_data[:, 1], c=y_data)

[6]: <matplotlib.collections.PathCollection at 0x7f7066bdb4a8>
```



```
[7]: from tensorflow.keras import layers
      from tensorflow.keras import activations
      from tensorflow.keras import optimizers
      from tensorflow.keras import models

[8]: model = models.Sequential()
      model.add(layers.Dense(2, input_dim=2))
      model.add(layers.Activation('tanh'))
      model.add(layers.Dense(1))
      model.add(layers.Activation('sigmoid'))

[9]: sgd = optimizers.SGD(lr=0.1)
      model.compile(loss='binary_crossentropy', optimizer=sgd, metrics=['accuracy'])

[10]: model.summary()
```

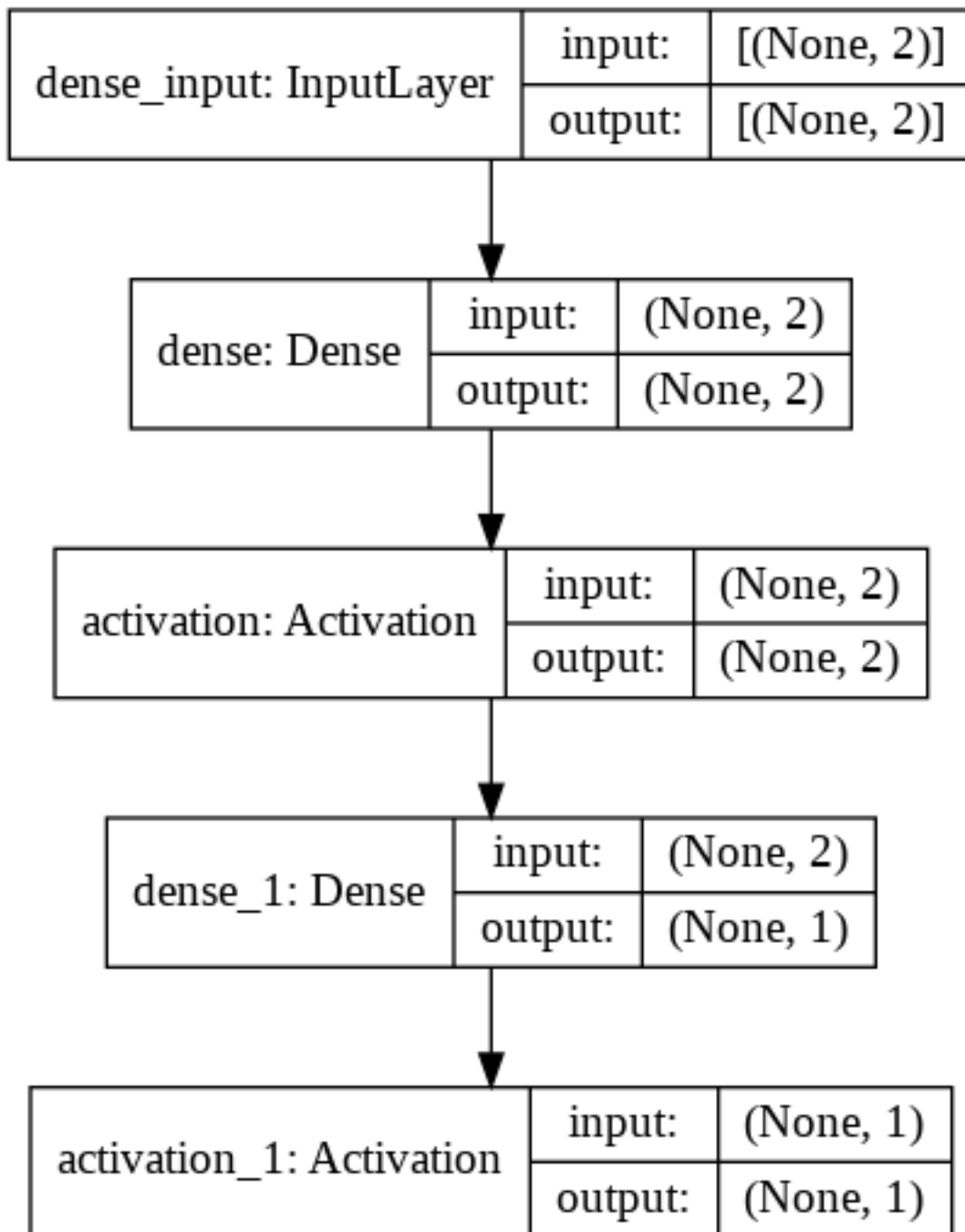
Model: "sequential"

Layer (type)	Output Shape	Param #
dense (Dense)	(None, 2)	6
activation (Activation)	(None, 2)	0
dense_1 (Dense)	(None, 1)	3
activation_1 (Activation)	(None, 1)	0

Total params: 9
Trainable params: 9
Non-trainable params: 0

```
[11]: from tensorflow.keras.utils import plot_model  
plot_model(model, to_file='model_and.png', show_shapes=True)
```

[11]:



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[12]: history = model.fit(x_data, y_data, batch_size=1, epochs=500)
```

```
Epoch 1/500
4/4 [=====] - 1s 2ms/step - loss: 0.6975 - accuracy:
0.7333
Epoch 2/500
4/4 [=====] - 0s 2ms/step - loss: 0.6788 - accuracy:
0.5667
Epoch 3/500
4/4 [=====] - 0s 1ms/step - loss: 0.6069 - accuracy:
0.7333
Epoch 4/500
4/4 [=====] - 0s 2ms/step - loss: 0.6434 - accuracy:
1.0000
Epoch 5/500
4/4 [=====] - 0s 2ms/step - loss: 0.5916 - accuracy:
0.7333
Epoch 6/500
4/4 [=====] - 0s 4ms/step - loss: 0.5682 - accuracy:
0.7333
Epoch 7/500
4/4 [=====] - 0s 2ms/step - loss: 0.4984 - accuracy:
0.8333
Epoch 8/500
4/4 [=====] - 0s 2ms/step - loss: 0.4204 - accuracy:
0.9000
Epoch 9/500
4/4 [=====] - 0s 2ms/step - loss: 0.4730 - accuracy:
0.7333
Epoch 10/500
4/4 [=====] - 0s 3ms/step - loss: 0.4648 - accuracy:
0.8333
Epoch 11/500
4/4 [=====] - 0s 2ms/step - loss: 0.4942 - accuracy:
0.7333
Epoch 12/500
4/4 [=====] - 0s 2ms/step - loss: 0.3760 - accuracy:
0.9000
Epoch 13/500
4/4 [=====] - 0s 2ms/step - loss: 0.4283 - accuracy:
0.8333
Epoch 14/500
4/4 [=====] - 0s 2ms/step - loss: 0.5565 - accuracy:
0.5333
Epoch 15/500
4/4 [=====] - 0s 1ms/step - loss: 0.5527 - accuracy:
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0.5333
Epoch 16/500
4/4 [=====] - 0s 2ms/step - loss: 0.5588 - accuracy:
0.5333
Epoch 17/500
4/4 [=====] - 0s 2ms/step - loss: 0.5447 - accuracy:
0.5333
Epoch 18/500
4/4 [=====] - 0s 2ms/step - loss: 0.3257 - accuracy:
0.8333
Epoch 19/500
4/4 [=====] - 0s 2ms/step - loss: 0.3687 - accuracy:
0.7333
Epoch 20/500
4/4 [=====] - 0s 2ms/step - loss: 0.5228 - accuracy:
0.5333
Epoch 21/500
4/4 [=====] - 0s 4ms/step - loss: 0.4055 - accuracy:
0.7333
Epoch 22/500
4/4 [=====] - 0s 2ms/step - loss: 0.3406 - accuracy:
0.8333
Epoch 23/500
4/4 [=====] - 0s 2ms/step - loss: 0.4457 - accuracy:
0.5333
Epoch 24/500
4/4 [=====] - 0s 2ms/step - loss: 0.3786 - accuracy:
0.7333
Epoch 25/500
4/4 [=====] - 0s 2ms/step - loss: 0.3748 - accuracy:
0.7333
Epoch 26/500
4/4 [=====] - 0s 2ms/step - loss: 0.4132 - accuracy:
1.0000
Epoch 27/500
4/4 [=====] - 0s 2ms/step - loss: 0.2949 - accuracy:
1.0000
Epoch 28/500
4/4 [=====] - 0s 2ms/step - loss: 0.4323 - accuracy:
1.0000
Epoch 29/500
4/4 [=====] - 0s 2ms/step - loss: 0.2277 - accuracy:
0.9000
Epoch 30/500
4/4 [=====] - 0s 2ms/step - loss: 0.2036 - accuracy:
1.0000
Epoch 31/500
4/4 [=====] - 0s 2ms/step - loss: 0.3813 - accuracy:

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1.0000
Epoch 32/500
4/4 [=====] - 0s 2ms/step - loss: 0.2713 - accuracy:
1.0000
Epoch 33/500
4/4 [=====] - 0s 2ms/step - loss: 0.2452 - accuracy:
1.0000
Epoch 34/500
4/4 [=====] - 0s 2ms/step - loss: 0.2609 - accuracy:
1.0000
Epoch 35/500
4/4 [=====] - 0s 2ms/step - loss: 0.2910 - accuracy:
1.0000
Epoch 36/500
4/4 [=====] - 0s 2ms/step - loss: 0.2197 - accuracy:
1.0000
Epoch 37/500
4/4 [=====] - 0s 2ms/step - loss: 0.2392 - accuracy:
1.0000
Epoch 38/500
4/4 [=====] - 0s 3ms/step - loss: 0.2347 - accuracy:
1.0000
Epoch 39/500
4/4 [=====] - 0s 2ms/step - loss: 0.2568 - accuracy:
1.0000
Epoch 40/500
4/4 [=====] - 0s 2ms/step - loss: 0.2201 - accuracy:
1.0000
Epoch 41/500
4/4 [=====] - 0s 2ms/step - loss: 0.1757 - accuracy:
1.0000
Epoch 42/500
4/4 [=====] - 0s 2ms/step - loss: 0.2360 - accuracy:
1.0000
Epoch 43/500
4/4 [=====] - 0s 2ms/step - loss: 0.1807 - accuracy:
1.0000
Epoch 44/500
4/4 [=====] - 0s 5ms/step - loss: 0.1765 - accuracy:
1.0000
Epoch 45/500
4/4 [=====] - 0s 2ms/step - loss: 0.1670 - accuracy:
1.0000
Epoch 46/500
4/4 [=====] - 0s 2ms/step - loss: 0.1650 - accuracy:
1.0000
Epoch 47/500
4/4 [=====] - 0s 2ms/step - loss: 0.2451 - accuracy:

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1.0000
Epoch 48/500
4/4 [=====] - 0s 2ms/step - loss: 0.1462 - accuracy:
1.0000
Epoch 49/500
4/4 [=====] - 0s 2ms/step - loss: 0.1829 - accuracy:
1.0000
Epoch 50/500
4/4 [=====] - 0s 2ms/step - loss: 0.1121 - accuracy:
1.0000
Epoch 51/500
4/4 [=====] - 0s 2ms/step - loss: 0.1382 - accuracy:
1.0000
Epoch 52/500
4/4 [=====] - 0s 2ms/step - loss: 0.1254 - accuracy:
1.0000
Epoch 53/500
4/4 [=====] - 0s 2ms/step - loss: 0.1253 - accuracy:
1.0000
Epoch 54/500
4/4 [=====] - 0s 2ms/step - loss: 0.1133 - accuracy:
1.0000
Epoch 55/500
4/4 [=====] - 0s 2ms/step - loss: 0.1103 - accuracy:
1.0000
Epoch 56/500
4/4 [=====] - 0s 2ms/step - loss: 0.0949 - accuracy:
1.0000
Epoch 57/500
4/4 [=====] - 0s 2ms/step - loss: 0.1171 - accuracy:
1.0000
Epoch 58/500
4/4 [=====] - 0s 2ms/step - loss: 0.1151 - accuracy:
1.0000
Epoch 59/500
4/4 [=====] - 0s 2ms/step - loss: 0.1321 - accuracy:
1.0000
Epoch 60/500
4/4 [=====] - 0s 3ms/step - loss: 0.1368 - accuracy:
1.0000
Epoch 61/500
4/4 [=====] - 0s 5ms/step - loss: 0.0939 - accuracy:
1.0000
Epoch 62/500
4/4 [=====] - 0s 2ms/step - loss: 0.1073 - accuracy:
1.0000
Epoch 63/500
4/4 [=====] - 0s 2ms/step - loss: 0.0953 - accuracy:

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1.0000
Epoch 64/500
4/4 [=====] - 0s 2ms/step - loss: 0.1513 - accuracy:
1.0000
Epoch 65/500
4/4 [=====] - 0s 2ms/step - loss: 0.1123 - accuracy:
1.0000
Epoch 66/500
4/4 [=====] - 0s 2ms/step - loss: 0.1301 - accuracy:
1.0000
Epoch 67/500
4/4 [=====] - 0s 2ms/step - loss: 0.0714 - accuracy:
1.0000
Epoch 68/500
4/4 [=====] - 0s 2ms/step - loss: 0.0787 - accuracy:
1.0000
Epoch 69/500
4/4 [=====] - 0s 2ms/step - loss: 0.1356 - accuracy:
1.0000
Epoch 70/500
4/4 [=====] - 0s 2ms/step - loss: 0.1122 - accuracy:
1.0000
Epoch 71/500
4/4 [=====] - 0s 2ms/step - loss: 0.1308 - accuracy:
1.0000
Epoch 72/500
4/4 [=====] - 0s 2ms/step - loss: 0.1289 - accuracy:
1.0000
Epoch 73/500
4/4 [=====] - 0s 2ms/step - loss: 0.0926 - accuracy:
1.0000
Epoch 74/500
4/4 [=====] - 0s 2ms/step - loss: 0.0981 - accuracy:
1.0000
Epoch 75/500
4/4 [=====] - 0s 4ms/step - loss: 0.1148 - accuracy:
1.0000
Epoch 76/500
4/4 [=====] - 0s 2ms/step - loss: 0.1179 - accuracy:
1.0000
Epoch 77/500
4/4 [=====] - 0s 2ms/step - loss: 0.1053 - accuracy:
1.0000
Epoch 78/500
4/4 [=====] - 0s 3ms/step - loss: 0.0718 - accuracy:
1.0000
Epoch 79/500
4/4 [=====] - 0s 2ms/step - loss: 0.0668 - accuracy:

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1.0000
Epoch 80/500
4/4 [=====] - 0s 3ms/step - loss: 0.0714 - accuracy:
1.0000
Epoch 81/500
4/4 [=====] - 0s 3ms/step - loss: 0.0898 - accuracy:
1.0000
Epoch 82/500
4/4 [=====] - 0s 3ms/step - loss: 0.0984 - accuracy:
1.0000
Epoch 83/500
4/4 [=====] - 0s 3ms/step - loss: 0.0915 - accuracy:
1.0000
Epoch 84/500
4/4 [=====] - 0s 2ms/step - loss: 0.0558 - accuracy:
1.0000
Epoch 85/500
4/4 [=====] - 0s 2ms/step - loss: 0.0489 - accuracy:
1.0000
Epoch 86/500
4/4 [=====] - 0s 2ms/step - loss: 0.0543 - accuracy:
1.0000
Epoch 87/500
4/4 [=====] - 0s 2ms/step - loss: 0.0755 - accuracy:
1.0000
Epoch 88/500
4/4 [=====] - 0s 2ms/step - loss: 0.0519 - accuracy:
1.0000
Epoch 89/500
4/4 [=====] - 0s 2ms/step - loss: 0.0905 - accuracy:
1.0000
Epoch 90/500
4/4 [=====] - 0s 2ms/step - loss: 0.0589 - accuracy:
1.0000
Epoch 91/500
4/4 [=====] - 0s 3ms/step - loss: 0.0703 - accuracy:
1.0000
Epoch 92/500
4/4 [=====] - 0s 3ms/step - loss: 0.0487 - accuracy:
1.0000
Epoch 93/500
4/4 [=====] - 0s 2ms/step - loss: 0.0573 - accuracy:
1.0000
Epoch 94/500
4/4 [=====] - 0s 4ms/step - loss: 0.0678 - accuracy:
1.0000
Epoch 95/500
4/4 [=====] - 0s 4ms/step - loss: 0.0626 - accuracy:

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1.0000
Epoch 96/500
4/4 [=====] - 0s 4ms/step - loss: 0.0802 - accuracy:
1.0000
Epoch 97/500
4/4 [=====] - 0s 2ms/step - loss: 0.0482 - accuracy:
1.0000
Epoch 98/500
4/4 [=====] - 0s 3ms/step - loss: 0.0442 - accuracy:
1.0000
Epoch 99/500
4/4 [=====] - 0s 2ms/step - loss: 0.0737 - accuracy:
1.0000
Epoch 100/500
4/4 [=====] - 0s 2ms/step - loss: 0.0571 - accuracy:
1.0000
Epoch 101/500
4/4 [=====] - 0s 2ms/step - loss: 0.0422 - accuracy:
1.0000
Epoch 102/500
4/4 [=====] - 0s 2ms/step - loss: 0.0658 - accuracy:
1.0000
Epoch 103/500
4/4 [=====] - 0s 3ms/step - loss: 0.0616 - accuracy:
1.0000
Epoch 104/500
4/4 [=====] - 0s 2ms/step - loss: 0.0397 - accuracy:
1.0000
Epoch 105/500
4/4 [=====] - 0s 2ms/step - loss: 0.0464 - accuracy:
1.0000
Epoch 106/500
4/4 [=====] - 0s 2ms/step - loss: 0.0552 - accuracy:
1.0000
Epoch 107/500
4/4 [=====] - 0s 2ms/step - loss: 0.0346 - accuracy:
1.0000
Epoch 108/500
4/4 [=====] - 0s 2ms/step - loss: 0.0446 - accuracy:
1.0000
Epoch 109/500
4/4 [=====] - 0s 2ms/step - loss: 0.0450 - accuracy:
1.0000
Epoch 110/500
4/4 [=====] - 0s 2ms/step - loss: 0.0332 - accuracy:
1.0000
Epoch 111/500
4/4 [=====] - 0s 2ms/step - loss: 0.0616 - accuracy:

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1.0000
Epoch 112/500
4/4 [=====] - 0s 2ms/step - loss: 0.0395 - accuracy:
1.0000
Epoch 113/500
4/4 [=====] - 0s 2ms/step - loss: 0.0350 - accuracy:
1.0000
Epoch 114/500
4/4 [=====] - 0s 2ms/step - loss: 0.0411 - accuracy:
1.0000
Epoch 115/500
4/4 [=====] - 0s 2ms/step - loss: 0.0405 - accuracy:
1.0000
Epoch 116/500
4/4 [=====] - 0s 2ms/step - loss: 0.0600 - accuracy:
1.0000
Epoch 117/500
4/4 [=====] - 0s 2ms/step - loss: 0.0380 - accuracy:
1.0000
Epoch 118/500
4/4 [=====] - 0s 2ms/step - loss: 0.0531 - accuracy:
1.0000
Epoch 119/500
4/4 [=====] - 0s 2ms/step - loss: 0.0526 - accuracy:
1.0000
Epoch 120/500
4/4 [=====] - 0s 2ms/step - loss: 0.0378 - accuracy:
1.0000
Epoch 121/500
4/4 [=====] - 0s 2ms/step - loss: 0.0431 - accuracy:
1.0000
Epoch 122/500
4/4 [=====] - 0s 2ms/step - loss: 0.0475 - accuracy:
1.0000
Epoch 123/500
4/4 [=====] - 0s 5ms/step - loss: 0.0495 - accuracy:
1.0000
Epoch 124/500
4/4 [=====] - 0s 2ms/step - loss: 0.0521 - accuracy:
1.0000
Epoch 125/500
4/4 [=====] - 0s 2ms/step - loss: 0.0516 - accuracy:
1.0000
Epoch 126/500
4/4 [=====] - 0s 1ms/step - loss: 0.0401 - accuracy:
1.0000
Epoch 127/500
4/4 [=====] - 0s 2ms/step - loss: 0.0403 - accuracy:

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1.0000
Epoch 128/500
4/4 [=====] - 0s 2ms/step - loss: 0.0518 - accuracy:
1.0000
Epoch 129/500
4/4 [=====] - 0s 2ms/step - loss: 0.0430 - accuracy:
1.0000
Epoch 130/500
4/4 [=====] - 0s 2ms/step - loss: 0.0337 - accuracy:
1.0000
Epoch 131/500
4/4 [=====] - 0s 2ms/step - loss: 0.0256 - accuracy:
1.0000
Epoch 132/500
4/4 [=====] - 0s 2ms/step - loss: 0.0378 - accuracy:
1.0000
Epoch 133/500
4/4 [=====] - 0s 2ms/step - loss: 0.0485 - accuracy:
1.0000
Epoch 134/500
4/4 [=====] - 0s 2ms/step - loss: 0.0322 - accuracy:
1.0000
Epoch 135/500
4/4 [=====] - 0s 2ms/step - loss: 0.0306 - accuracy:
1.0000
Epoch 136/500
4/4 [=====] - 0s 2ms/step - loss: 0.0323 - accuracy:
1.0000
Epoch 137/500
4/4 [=====] - 0s 2ms/step - loss: 0.0286 - accuracy:
1.0000
Epoch 138/500
4/4 [=====] - 0s 2ms/step - loss: 0.0310 - accuracy:
1.0000
Epoch 139/500
4/4 [=====] - 0s 2ms/step - loss: 0.0292 - accuracy:
1.0000
Epoch 140/500
4/4 [=====] - 0s 2ms/step - loss: 0.0407 - accuracy:
1.0000
Epoch 141/500
4/4 [=====] - 0s 3ms/step - loss: 0.0274 - accuracy:
1.0000
Epoch 142/500
4/4 [=====] - 0s 3ms/step - loss: 0.0355 - accuracy:
1.0000
Epoch 143/500
4/4 [=====] - 0s 2ms/step - loss: 0.0294 - accuracy:

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1.0000
Epoch 144/500
4/4 [=====] - 0s 2ms/step - loss: 0.0267 - accuracy:
1.0000
Epoch 145/500
4/4 [=====] - 0s 2ms/step - loss: 0.0265 - accuracy:
1.0000
Epoch 146/500
4/4 [=====] - 0s 2ms/step - loss: 0.0326 - accuracy:
1.0000
Epoch 147/500
4/4 [=====] - 0s 3ms/step - loss: 0.0347 - accuracy:
1.0000
Epoch 148/500
4/4 [=====] - 0s 2ms/step - loss: 0.0215 - accuracy:
1.0000
Epoch 149/500
4/4 [=====] - 0s 3ms/step - loss: 0.0262 - accuracy:
1.0000
Epoch 150/500
4/4 [=====] - 0s 2ms/step - loss: 0.0313 - accuracy:
1.0000
Epoch 151/500
4/4 [=====] - 0s 2ms/step - loss: 0.0402 - accuracy:
1.0000
Epoch 152/500
4/4 [=====] - 0s 4ms/step - loss: 0.0307 - accuracy:
1.0000
Epoch 153/500
4/4 [=====] - 0s 4ms/step - loss: 0.0268 - accuracy:
1.0000
Epoch 154/500
4/4 [=====] - 0s 5ms/step - loss: 0.0262 - accuracy:
1.0000
Epoch 155/500
4/4 [=====] - 0s 2ms/step - loss: 0.0388 - accuracy:
1.0000
Epoch 156/500
4/4 [=====] - 0s 2ms/step - loss: 0.0260 - accuracy:
1.0000
Epoch 157/500
4/4 [=====] - 0s 4ms/step - loss: 0.0384 - accuracy:
1.0000
Epoch 158/500
4/4 [=====] - 0s 2ms/step - loss: 0.0195 - accuracy:
1.0000
Epoch 159/500
4/4 [=====] - 0s 2ms/step - loss: 0.0374 - accuracy:

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1.0000
Epoch 160/500
4/4 [=====] - 0s 2ms/step - loss: 0.0335 - accuracy:
1.0000
Epoch 161/500
4/4 [=====] - 0s 2ms/step - loss: 0.0353 - accuracy:
1.0000
Epoch 162/500
4/4 [=====] - 0s 2ms/step - loss: 0.0315 - accuracy:
1.0000
Epoch 163/500
4/4 [=====] - 0s 2ms/step - loss: 0.0248 - accuracy:
1.0000
Epoch 164/500
4/4 [=====] - 0s 2ms/step - loss: 0.0239 - accuracy:
1.0000
Epoch 165/500
4/4 [=====] - 0s 3ms/step - loss: 0.0278 - accuracy:
1.0000
Epoch 166/500
4/4 [=====] - 0s 2ms/step - loss: 0.0297 - accuracy:
1.0000
Epoch 167/500
4/4 [=====] - 0s 2ms/step - loss: 0.0289 - accuracy:
1.0000
Epoch 168/500
4/4 [=====] - 0s 2ms/step - loss: 0.0277 - accuracy:
1.0000
Epoch 169/500
4/4 [=====] - 0s 2ms/step - loss: 0.0192 - accuracy:
1.0000
Epoch 170/500
4/4 [=====] - 0s 2ms/step - loss: 0.0236 - accuracy:
1.0000
Epoch 171/500
4/4 [=====] - 0s 2ms/step - loss: 0.0189 - accuracy:
1.0000
Epoch 172/500
4/4 [=====] - 0s 2ms/step - loss: 0.0268 - accuracy:
1.0000
Epoch 173/500
4/4 [=====] - 0s 2ms/step - loss: 0.0280 - accuracy:
1.0000
Epoch 174/500
4/4 [=====] - 0s 2ms/step - loss: 0.0253 - accuracy:
1.0000
Epoch 175/500
4/4 [=====] - 0s 2ms/step - loss: 0.0183 - accuracy:

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1.0000
Epoch 176/500
4/4 [=====] - 0s 2ms/step - loss: 0.0168 - accuracy:
1.0000
Epoch 177/500
4/4 [=====] - 0s 2ms/step - loss: 0.0184 - accuracy:
1.0000
Epoch 178/500
4/4 [=====] - 0s 2ms/step - loss: 0.0321 - accuracy:
1.0000
Epoch 179/500
4/4 [=====] - 0s 2ms/step - loss: 0.0319 - accuracy:
1.0000
Epoch 180/500
4/4 [=====] - 0s 2ms/step - loss: 0.0317 - accuracy:
1.0000
Epoch 181/500
4/4 [=====] - 0s 2ms/step - loss: 0.0259 - accuracy:
1.0000
Epoch 182/500
4/4 [=====] - 0s 2ms/step - loss: 0.0248 - accuracy:
1.0000
Epoch 183/500
4/4 [=====] - 0s 2ms/step - loss: 0.0295 - accuracy:
1.0000
Epoch 184/500
4/4 [=====] - 0s 2ms/step - loss: 0.0297 - accuracy:
1.0000
Epoch 185/500
4/4 [=====] - 0s 3ms/step - loss: 0.0262 - accuracy:
1.0000
Epoch 186/500
4/4 [=====] - 0s 3ms/step - loss: 0.0272 - accuracy:
1.0000
Epoch 187/500
4/4 [=====] - 0s 3ms/step - loss: 0.0287 - accuracy:
1.0000
Epoch 188/500
4/4 [=====] - 0s 2ms/step - loss: 0.0191 - accuracy:
1.0000
Epoch 189/500
4/4 [=====] - 0s 2ms/step - loss: 0.0268 - accuracy:
1.0000
Epoch 190/500
4/4 [=====] - 0s 2ms/step - loss: 0.0228 - accuracy:
1.0000
Epoch 191/500
4/4 [=====] - 0s 2ms/step - loss: 0.0222 - accuracy:

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1.0000
Epoch 192/500
4/4 [=====] - 0s 2ms/step - loss: 0.0176 - accuracy:
1.0000
Epoch 193/500
4/4 [=====] - 0s 2ms/step - loss: 0.0163 - accuracy:
1.0000
Epoch 194/500
4/4 [=====] - 0s 2ms/step - loss: 0.0238 - accuracy:
1.0000
Epoch 195/500
4/4 [=====] - 0s 2ms/step - loss: 0.0187 - accuracy:
1.0000
Epoch 196/500
4/4 [=====] - 0s 2ms/step - loss: 0.0282 - accuracy:
1.0000
Epoch 197/500
4/4 [=====] - 0s 2ms/step - loss: 0.0222 - accuracy:
1.0000
Epoch 198/500
4/4 [=====] - 0s 2ms/step - loss: 0.0239 - accuracy:
1.0000
Epoch 199/500
4/4 [=====] - 0s 2ms/step - loss: 0.0274 - accuracy:
1.0000
Epoch 200/500
4/4 [=====] - 0s 2ms/step - loss: 0.0213 - accuracy:
1.0000
Epoch 201/500
4/4 [=====] - 0s 2ms/step - loss: 0.0179 - accuracy:
1.0000
Epoch 202/500
4/4 [=====] - 0s 3ms/step - loss: 0.0165 - accuracy:
1.0000
Epoch 203/500
4/4 [=====] - 0s 2ms/step - loss: 0.0242 - accuracy:
1.0000
Epoch 204/500
4/4 [=====] - 0s 2ms/step - loss: 0.0148 - accuracy:
1.0000
Epoch 205/500
4/4 [=====] - 0s 4ms/step - loss: 0.0206 - accuracy:
1.0000
Epoch 206/500
4/4 [=====] - 0s 6ms/step - loss: 0.0254 - accuracy:
1.0000
Epoch 207/500
4/4 [=====] - 0s 2ms/step - loss: 0.0172 - accuracy:

```



```

1.0000
Epoch 208/500
4/4 [=====] - 0s 2ms/step - loss: 0.0198 - accuracy:
1.0000
Epoch 209/500
4/4 [=====] - 0s 2ms/step - loss: 0.0147 - accuracy:
1.0000
Epoch 210/500
4/4 [=====] - 0s 2ms/step - loss: 0.0163 - accuracy:
1.0000
Epoch 211/500
4/4 [=====] - 0s 2ms/step - loss: 0.0145 - accuracy:
1.0000
Epoch 212/500
4/4 [=====] - 0s 2ms/step - loss: 0.0130 - accuracy:
1.0000
Epoch 213/500
4/4 [=====] - 0s 6ms/step - loss: 0.0249 - accuracy:
1.0000
Epoch 214/500
4/4 [=====] - 0s 4ms/step - loss: 0.0208 - accuracy:
1.0000
Epoch 215/500
4/4 [=====] - 0s 2ms/step - loss: 0.0141 - accuracy:
1.0000
Epoch 216/500
4/4 [=====] - 0s 2ms/step - loss: 0.0156 - accuracy:
1.0000
Epoch 217/500
4/4 [=====] - 0s 3ms/step - loss: 0.0194 - accuracy:
1.0000
Epoch 218/500
4/4 [=====] - 0s 2ms/step - loss: 0.0155 - accuracy:
1.0000
Epoch 219/500
4/4 [=====] - 0s 3ms/step - loss: 0.0159 - accuracy:
1.0000
Epoch 220/500
4/4 [=====] - 0s 3ms/step - loss: 0.0133 - accuracy:
1.0000
Epoch 221/500
4/4 [=====] - 0s 5ms/step - loss: 0.0121 - accuracy:
1.0000
Epoch 222/500
4/4 [=====] - 0s 4ms/step - loss: 0.0225 - accuracy:
1.0000
Epoch 223/500
4/4 [=====] - 0s 5ms/step - loss: 0.0149 - accuracy:

```

```

1.0000
Epoch 224/500
4/4 [=====] - 0s 3ms/step - loss: 0.0194 - accuracy:
1.0000
Epoch 225/500
4/4 [=====] - 0s 2ms/step - loss: 0.0157 - accuracy:
1.0000
Epoch 226/500
4/4 [=====] - 0s 2ms/step - loss: 0.0161 - accuracy:
1.0000
Epoch 227/500
4/4 [=====] - 0s 2ms/step - loss: 0.0131 - accuracy:
1.0000
Epoch 228/500
4/4 [=====] - 0s 2ms/step - loss: 0.0205 - accuracy:
1.0000
Epoch 229/500
4/4 [=====] - 0s 2ms/step - loss: 0.0206 - accuracy:
1.0000
Epoch 230/500
4/4 [=====] - 0s 3ms/step - loss: 0.0227 - accuracy:
1.0000
Epoch 231/500
4/4 [=====] - 0s 3ms/step - loss: 0.0155 - accuracy:
1.0000
Epoch 232/500
4/4 [=====] - 0s 3ms/step - loss: 0.0175 - accuracy:
1.0000
Epoch 233/500
4/4 [=====] - 0s 2ms/step - loss: 0.0142 - accuracy:
1.0000
Epoch 234/500
4/4 [=====] - 0s 3ms/step - loss: 0.0126 - accuracy:
1.0000
Epoch 235/500
4/4 [=====] - 0s 2ms/step - loss: 0.0113 - accuracy:
1.0000
Epoch 236/500
4/4 [=====] - 0s 2ms/step - loss: 0.0152 - accuracy:
1.0000
Epoch 237/500
4/4 [=====] - 0s 2ms/step - loss: 0.0146 - accuracy:
1.0000
Epoch 238/500
4/4 [=====] - 0s 2ms/step - loss: 0.0214 - accuracy:
1.0000
Epoch 239/500
4/4 [=====] - 0s 2ms/step - loss: 0.0111 - accuracy:

```

```

1.0000
Epoch 240/500
4/4 [=====] - 0s 2ms/step - loss: 0.0167 - accuracy:
1.0000
Epoch 241/500
4/4 [=====] - 0s 2ms/step - loss: 0.0192 - accuracy:
1.0000
Epoch 242/500
4/4 [=====] - 0s 2ms/step - loss: 0.0134 - accuracy:
1.0000
Epoch 243/500
4/4 [=====] - 0s 2ms/step - loss: 0.0209 - accuracy:
1.0000
Epoch 244/500
4/4 [=====] - 0s 3ms/step - loss: 0.0199 - accuracy:
1.0000
Epoch 245/500
4/4 [=====] - 0s 3ms/step - loss: 0.0165 - accuracy:
1.0000
Epoch 246/500
4/4 [=====] - 0s 3ms/step - loss: 0.0118 - accuracy:
1.0000
Epoch 247/500
4/4 [=====] - 0s 3ms/step - loss: 0.0161 - accuracy:
1.0000
Epoch 248/500
4/4 [=====] - 0s 3ms/step - loss: 0.0171 - accuracy:
1.0000
Epoch 249/500
4/4 [=====] - 0s 3ms/step - loss: 0.0176 - accuracy:
1.0000
Epoch 250/500
4/4 [=====] - 0s 2ms/step - loss: 0.0130 - accuracy:
1.0000
Epoch 251/500
4/4 [=====] - 0s 2ms/step - loss: 0.0158 - accuracy:
1.0000
Epoch 252/500
4/4 [=====] - 0s 2ms/step - loss: 0.0139 - accuracy:
1.0000
Epoch 253/500
4/4 [=====] - 0s 3ms/step - loss: 0.0173 - accuracy:
1.0000
Epoch 254/500
4/4 [=====] - 0s 2ms/step - loss: 0.0197 - accuracy:
1.0000
Epoch 255/500
4/4 [=====] - 0s 4ms/step - loss: 0.0102 - accuracy:

```

```

1.0000
Epoch 256/500
4/4 [=====] - 0s 2ms/step - loss: 0.0101 - accuracy:
1.0000
Epoch 257/500
4/4 [=====] - 0s 2ms/step - loss: 0.0128 - accuracy:
1.0000
Epoch 258/500
4/4 [=====] - 0s 2ms/step - loss: 0.0125 - accuracy:
1.0000
Epoch 259/500
4/4 [=====] - 0s 2ms/step - loss: 0.0152 - accuracy:
1.0000
Epoch 260/500
4/4 [=====] - 0s 2ms/step - loss: 0.0152 - accuracy:
1.0000
Epoch 261/500
4/4 [=====] - 0s 2ms/step - loss: 0.0099 - accuracy:
1.0000
Epoch 262/500
4/4 [=====] - 0s 2ms/step - loss: 0.0151 - accuracy:
1.0000
Epoch 263/500
4/4 [=====] - 0s 2ms/step - loss: 0.0125 - accuracy:
1.0000
Epoch 264/500
4/4 [=====] - 0s 2ms/step - loss: 0.0179 - accuracy:
1.0000
Epoch 265/500
4/4 [=====] - 0s 2ms/step - loss: 0.0148 - accuracy:
1.0000
Epoch 266/500
4/4 [=====] - 0s 3ms/step - loss: 0.0130 - accuracy:
1.0000
Epoch 267/500
4/4 [=====] - 0s 2ms/step - loss: 0.0129 - accuracy:
1.0000
Epoch 268/500
4/4 [=====] - 0s 2ms/step - loss: 0.0096 - accuracy:
1.0000
Epoch 269/500
4/4 [=====] - 0s 2ms/step - loss: 0.0102 - accuracy:
1.0000
Epoch 270/500
4/4 [=====] - 0s 6ms/step - loss: 0.0105 - accuracy:
1.0000
Epoch 271/500
4/4 [=====] - 0s 2ms/step - loss: 0.0127 - accuracy:

```

1.0000
Epoch 272/500
4/4 [=====] - 0s 2ms/step - loss: 0.0126 - accuracy:
1.0000
Epoch 273/500
4/4 [=====] - 0s 2ms/step - loss: 0.0093 - accuracy:
1.0000
Epoch 274/500
4/4 [=====] - 0s 4ms/step - loss: 0.0170 - accuracy:
1.0000
Epoch 275/500
4/4 [=====] - 0s 5ms/step - loss: 0.0099 - accuracy:
1.0000
Epoch 276/500
4/4 [=====] - 0s 3ms/step - loss: 0.0124 - accuracy:
1.0000
Epoch 277/500
4/4 [=====] - 0s 5ms/step - loss: 0.0160 - accuracy:
1.0000
Epoch 278/500
4/4 [=====] - 0s 3ms/step - loss: 0.0138 - accuracy:
1.0000
Epoch 279/500
4/4 [=====] - 0s 2ms/step - loss: 0.0166 - accuracy:
1.0000
Epoch 280/500
4/4 [=====] - 0s 2ms/step - loss: 0.0110 - accuracy:
1.0000
Epoch 281/500
4/4 [=====] - 0s 3ms/step - loss: 0.0137 - accuracy:
1.0000
Epoch 282/500
4/4 [=====] - 0s 3ms/step - loss: 0.0144 - accuracy:
1.0000
Epoch 283/500
4/4 [=====] - 0s 4ms/step - loss: 0.0143 - accuracy:
1.0000
Epoch 284/500
4/4 [=====] - 0s 2ms/step - loss: 0.0135 - accuracy:
1.0000
Epoch 285/500
4/4 [=====] - 0s 4ms/step - loss: 0.0098 - accuracy:
1.0000
Epoch 286/500
4/4 [=====] - 0s 3ms/step - loss: 0.0097 - accuracy:
1.0000
Epoch 287/500
4/4 [=====] - 0s 1ms/step - loss: 0.0085 - accuracy:

1.0000
Epoch 288/500
4/4 [=====] - 0s 3ms/step - loss: 0.0132 - accuracy:
1.0000
Epoch 289/500
4/4 [=====] - 0s 2ms/step - loss: 0.0140 - accuracy:
1.0000
Epoch 290/500
4/4 [=====] - 0s 7ms/step - loss: 0.0117 - accuracy:
1.0000
Epoch 291/500
4/4 [=====] - 0s 2ms/step - loss: 0.0138 - accuracy:
1.0000
Epoch 292/500
4/4 [=====] - 0s 2ms/step - loss: 0.0095 - accuracy:
1.0000
Epoch 293/500
4/4 [=====] - 0s 6ms/step - loss: 0.0094 - accuracy:
1.0000
Epoch 294/500
4/4 [=====] - 0s 3ms/step - loss: 0.0115 - accuracy:
1.0000
Epoch 295/500
4/4 [=====] - 0s 3ms/step - loss: 0.0082 - accuracy:
1.0000
Epoch 296/500
4/4 [=====] - 0s 4ms/step - loss: 0.0099 - accuracy:
1.0000
Epoch 297/500
4/4 [=====] - 0s 2ms/step - loss: 0.0128 - accuracy:
1.0000
Epoch 298/500
4/4 [=====] - 0s 2ms/step - loss: 0.0162 - accuracy:
1.0000
Epoch 299/500
4/4 [=====] - 0s 3ms/step - loss: 0.0103 - accuracy:
1.0000
Epoch 300/500
4/4 [=====] - 0s 2ms/step - loss: 0.0088 - accuracy:
1.0000
Epoch 301/500
4/4 [=====] - 0s 2ms/step - loss: 0.0125 - accuracy:
1.0000
Epoch 302/500
4/4 [=====] - 0s 5ms/step - loss: 0.0106 - accuracy:
1.0000
Epoch 303/500
4/4 [=====] - 0s 3ms/step - loss: 0.0137 - accuracy:

1.0000
Epoch 304/500
4/4 [=====] - 0s 2ms/step - loss: 0.0087 - accuracy:
1.0000
Epoch 305/500
4/4 [=====] - 0s 2ms/step - loss: 0.0079 - accuracy:
1.0000
Epoch 306/500
4/4 [=====] - 0s 2ms/step - loss: 0.0081 - accuracy:
1.0000
Epoch 307/500
4/4 [=====] - 0s 4ms/step - loss: 0.0078 - accuracy:
1.0000
Epoch 308/500
4/4 [=====] - 0s 3ms/step - loss: 0.0097 - accuracy:
1.0000
Epoch 309/500
4/4 [=====] - 0s 2ms/step - loss: 0.0094 - accuracy:
1.0000
Epoch 310/500
4/4 [=====] - 0s 3ms/step - loss: 0.0099 - accuracy:
1.0000
Epoch 311/500
4/4 [=====] - 0s 2ms/step - loss: 0.0145 - accuracy:
1.0000
Epoch 312/500
4/4 [=====] - 0s 4ms/step - loss: 0.0096 - accuracy:
1.0000
Epoch 313/500
4/4 [=====] - 0s 2ms/step - loss: 0.0119 - accuracy:
1.0000
Epoch 314/500
4/4 [=====] - 0s 2ms/step - loss: 0.0105 - accuracy:
1.0000
Epoch 315/500
4/4 [=====] - 0s 4ms/step - loss: 0.0114 - accuracy:
1.0000
Epoch 316/500
4/4 [=====] - 0s 3ms/step - loss: 0.0148 - accuracy:
1.0000
Epoch 317/500
4/4 [=====] - 0s 3ms/step - loss: 0.0085 - accuracy:
1.0000
Epoch 318/500
4/4 [=====] - 0s 3ms/step - loss: 0.0104 - accuracy:
1.0000
Epoch 319/500
4/4 [=====] - 0s 4ms/step - loss: 0.0104 - accuracy:

```

1.0000
Epoch 320/500
4/4 [=====] - 0s 3ms/step - loss: 0.0132 - accuracy:
1.0000
Epoch 321/500
4/4 [=====] - 0s 2ms/step - loss: 0.0142 - accuracy:
1.0000
Epoch 322/500
4/4 [=====] - 0s 2ms/step - loss: 0.0102 - accuracy:
1.0000
Epoch 323/500
4/4 [=====] - 0s 2ms/step - loss: 0.0101 - accuracy:
1.0000
Epoch 324/500
4/4 [=====] - 0s 2ms/step - loss: 0.0130 - accuracy:
1.0000
Epoch 325/500
4/4 [=====] - 0s 3ms/step - loss: 0.0079 - accuracy:
1.0000
Epoch 326/500
4/4 [=====] - 0s 2ms/step - loss: 0.0136 - accuracy:
1.0000
Epoch 327/500
4/4 [=====] - 0s 2ms/step - loss: 0.0128 - accuracy:
1.0000
Epoch 328/500
4/4 [=====] - 0s 4ms/step - loss: 0.0090 - accuracy:
1.0000
Epoch 329/500
4/4 [=====] - 0s 2ms/step - loss: 0.0091 - accuracy:
1.0000
Epoch 330/500
4/4 [=====] - 0s 3ms/step - loss: 0.0111 - accuracy:
1.0000
Epoch 331/500
4/4 [=====] - 0s 3ms/step - loss: 0.0137 - accuracy:
1.0000
Epoch 332/500
4/4 [=====] - 0s 2ms/step - loss: 0.0071 - accuracy:
1.0000
Epoch 333/500
4/4 [=====] - 0s 2ms/step - loss: 0.0071 - accuracy:
1.0000
Epoch 334/500
4/4 [=====] - 0s 5ms/step - loss: 0.0106 - accuracy:
1.0000
Epoch 335/500
4/4 [=====] - 0s 2ms/step - loss: 0.0090 - accuracy:

```


1.0000
Epoch 336/500
4/4 [=====] - 0s 4ms/step - loss: 0.0076 - accuracy:
1.0000
Epoch 337/500
4/4 [=====] - 0s 2ms/step - loss: 0.0079 - accuracy:
1.0000
Epoch 338/500
4/4 [=====] - 0s 6ms/step - loss: 0.0138 - accuracy:
1.0000
Epoch 339/500
4/4 [=====] - 0s 3ms/step - loss: 0.0089 - accuracy:
1.0000
Epoch 340/500
4/4 [=====] - 0s 3ms/step - loss: 0.0088 - accuracy:
1.0000
Epoch 341/500
4/4 [=====] - 0s 4ms/step - loss: 0.0122 - accuracy:
1.0000
Epoch 342/500
4/4 [=====] - 0s 2ms/step - loss: 0.0134 - accuracy:
1.0000
Epoch 343/500
4/4 [=====] - 0s 4ms/step - loss: 0.0082 - accuracy:
1.0000
Epoch 344/500
4/4 [=====] - 0s 2ms/step - loss: 0.0106 - accuracy:
1.0000
Epoch 345/500
4/4 [=====] - 0s 3ms/step - loss: 0.0133 - accuracy:
1.0000
Epoch 346/500
4/4 [=====] - 0s 2ms/step - loss: 0.0090 - accuracy:
1.0000
Epoch 347/500
4/4 [=====] - 0s 3ms/step - loss: 0.0111 - accuracy:
1.0000
Epoch 348/500
4/4 [=====] - 0s 3ms/step - loss: 0.0115 - accuracy:
1.0000
Epoch 349/500
4/4 [=====] - 0s 4ms/step - loss: 0.0115 - accuracy:
1.0000
Epoch 350/500
4/4 [=====] - 0s 4ms/step - loss: 0.0103 - accuracy:
1.0000
Epoch 351/500
4/4 [=====] - 0s 4ms/step - loss: 0.0085 - accuracy:

```

1.0000
Epoch 352/500
4/4 [=====] - 0s 2ms/step - loss: 0.0082 - accuracy:
1.0000
Epoch 353/500
4/4 [=====] - 0s 2ms/step - loss: 0.0123 - accuracy:
1.0000
Epoch 354/500
4/4 [=====] - 0s 2ms/step - loss: 0.0065 - accuracy:
1.0000
Epoch 355/500
4/4 [=====] - 0s 2ms/step - loss: 0.0087 - accuracy:
1.0000
Epoch 356/500
4/4 [=====] - 0s 5ms/step - loss: 0.0086 - accuracy:
1.0000
Epoch 357/500
4/4 [=====] - 0s 3ms/step - loss: 0.0107 - accuracy:
1.0000
Epoch 358/500
4/4 [=====] - 0s 3ms/step - loss: 0.0077 - accuracy:
1.0000
Epoch 359/500
4/4 [=====] - 0s 2ms/step - loss: 0.0115 - accuracy:
1.0000
Epoch 360/500
4/4 [=====] - 0s 3ms/step - loss: 0.0105 - accuracy:
1.0000
Epoch 361/500
4/4 [=====] - 0s 4ms/step - loss: 0.0069 - accuracy:
1.0000
Epoch 362/500
4/4 [=====] - 0s 4ms/step - loss: 0.0096 - accuracy:
1.0000
Epoch 363/500
4/4 [=====] - 0s 2ms/step - loss: 0.0076 - accuracy:
1.0000
Epoch 364/500
4/4 [=====] - 0s 5ms/step - loss: 0.0079 - accuracy:
1.0000
Epoch 365/500
4/4 [=====] - 0s 4ms/step - loss: 0.0112 - accuracy:
1.0000
Epoch 366/500
4/4 [=====] - 0s 4ms/step - loss: 0.0087 - accuracy:
1.0000
Epoch 367/500
4/4 [=====] - 0s 4ms/step - loss: 0.0108 - accuracy:

```

1.0000
Epoch 368/500
4/4 [=====] - 0s 4ms/step - loss: 0.0097 - accuracy:
1.0000
Epoch 369/500
4/4 [=====] - 0s 2ms/step - loss: 0.0124 - accuracy:
1.0000
Epoch 370/500
4/4 [=====] - 0s 4ms/step - loss: 0.0103 - accuracy:
1.0000
Epoch 371/500
4/4 [=====] - 0s 5ms/step - loss: 0.0063 - accuracy:
1.0000
Epoch 372/500
4/4 [=====] - 0s 3ms/step - loss: 0.0121 - accuracy:
1.0000
Epoch 373/500
4/4 [=====] - 0s 3ms/step - loss: 0.0078 - accuracy:
1.0000
Epoch 374/500
4/4 [=====] - 0s 4ms/step - loss: 0.0081 - accuracy:
1.0000
Epoch 375/500
4/4 [=====] - 0s 3ms/step - loss: 0.0073 - accuracy:
1.0000
Epoch 376/500
4/4 [=====] - 0s 3ms/step - loss: 0.0121 - accuracy:
1.0000
Epoch 377/500
4/4 [=====] - 0s 3ms/step - loss: 0.0078 - accuracy:
1.0000
Epoch 378/500
4/4 [=====] - 0s 2ms/step - loss: 0.0066 - accuracy:
1.0000
Epoch 379/500
4/4 [=====] - 0s 2ms/step - loss: 0.0065 - accuracy:
1.0000
Epoch 380/500
4/4 [=====] - 0s 3ms/step - loss: 0.0080 - accuracy:
1.0000
Epoch 381/500
4/4 [=====] - 0s 4ms/step - loss: 0.0076 - accuracy:
1.0000
Epoch 382/500
4/4 [=====] - 0s 2ms/step - loss: 0.0071 - accuracy:
1.0000
Epoch 383/500
4/4 [=====] - 0s 3ms/step - loss: 0.0114 - accuracy:

1.0000
Epoch 384/500
4/4 [=====] - 0s 4ms/step - loss: 0.0074 - accuracy:
1.0000
Epoch 385/500
4/4 [=====] - 0s 4ms/step - loss: 0.0116 - accuracy:
1.0000
Epoch 386/500
4/4 [=====] - 0s 4ms/step - loss: 0.0081 - accuracy:
1.0000
Epoch 387/500
4/4 [=====] - 0s 2ms/step - loss: 0.0073 - accuracy:
1.0000
Epoch 388/500
4/4 [=====] - 0s 2ms/step - loss: 0.0063 - accuracy:
1.0000
Epoch 389/500
4/4 [=====] - 0s 2ms/step - loss: 0.0060 - accuracy:
1.0000
Epoch 390/500
4/4 [=====] - 0s 2ms/step - loss: 0.0074 - accuracy:
1.0000
Epoch 391/500
4/4 [=====] - 0s 3ms/step - loss: 0.0073 - accuracy:
1.0000
Epoch 392/500
4/4 [=====] - 0s 3ms/step - loss: 0.0089 - accuracy:
1.0000
Epoch 393/500
4/4 [=====] - 0s 2ms/step - loss: 0.0090 - accuracy:
1.0000
Epoch 394/500
4/4 [=====] - 0s 3ms/step - loss: 0.0102 - accuracy:
1.0000
Epoch 395/500
4/4 [=====] - 0s 2ms/step - loss: 0.0112 - accuracy:
1.0000
Epoch 396/500
4/4 [=====] - 0s 2ms/step - loss: 0.0102 - accuracy:
1.0000
Epoch 397/500
4/4 [=====] - 0s 3ms/step - loss: 0.0068 - accuracy:
1.0000
Epoch 398/500
4/4 [=====] - 0s 3ms/step - loss: 0.0093 - accuracy:
1.0000
Epoch 399/500
4/4 [=====] - 0s 3ms/step - loss: 0.0100 - accuracy:

```

1.0000
Epoch 400/500
4/4 [=====] - 0s 2ms/step - loss: 0.0064 - accuracy:
1.0000
Epoch 401/500
4/4 [=====] - 0s 6ms/step - loss: 0.0093 - accuracy:
1.0000
Epoch 402/500
4/4 [=====] - 0s 3ms/step - loss: 0.0110 - accuracy:
1.0000
Epoch 403/500
4/4 [=====] - 0s 3ms/step - loss: 0.0109 - accuracy:
1.0000
Epoch 404/500
4/4 [=====] - 0s 3ms/step - loss: 0.0092 - accuracy:
1.0000
Epoch 405/500
4/4 [=====] - 0s 3ms/step - loss: 0.0071 - accuracy:
1.0000
Epoch 406/500
4/4 [=====] - 0s 2ms/step - loss: 0.0104 - accuracy:
1.0000
Epoch 407/500
4/4 [=====] - 0s 3ms/step - loss: 0.0071 - accuracy:
1.0000
Epoch 408/500
4/4 [=====] - 0s 3ms/step - loss: 0.0056 - accuracy:
1.0000
Epoch 409/500
4/4 [=====] - 0s 3ms/step - loss: 0.0090 - accuracy:
1.0000
Epoch 410/500
4/4 [=====] - 0s 2ms/step - loss: 0.0070 - accuracy:
1.0000
Epoch 411/500
4/4 [=====] - 0s 4ms/step - loss: 0.0089 - accuracy:
1.0000
Epoch 412/500
4/4 [=====] - 0s 3ms/step - loss: 0.0084 - accuracy:
1.0000
Epoch 413/500
4/4 [=====] - 0s 2ms/step - loss: 0.0084 - accuracy:
1.0000
Epoch 414/500
4/4 [=====] - 0s 2ms/step - loss: 0.0093 - accuracy:
1.0000
Epoch 415/500
4/4 [=====] - 0s 3ms/step - loss: 0.0055 - accuracy:

```

```

1.0000
Epoch 416/500
4/4 [=====] - 0s 4ms/step - loss: 0.0095 - accuracy:
1.0000
Epoch 417/500
4/4 [=====] - 0s 3ms/step - loss: 0.0068 - accuracy:
1.0000
Epoch 418/500
4/4 [=====] - 0s 3ms/step - loss: 0.0068 - accuracy:
1.0000
Epoch 419/500
4/4 [=====] - 0s 3ms/step - loss: 0.0100 - accuracy:
1.0000
Epoch 420/500
4/4 [=====] - 0s 3ms/step - loss: 0.0066 - accuracy:
1.0000
Epoch 421/500
4/4 [=====] - 0s 4ms/step - loss: 0.0104 - accuracy:
1.0000
Epoch 422/500
4/4 [=====] - 0s 3ms/step - loss: 0.0054 - accuracy:
1.0000
Epoch 423/500
4/4 [=====] - 0s 4ms/step - loss: 0.0081 - accuracy:
1.0000
Epoch 424/500
4/4 [=====] - 0s 2ms/step - loss: 0.0067 - accuracy:
1.0000
Epoch 425/500
4/4 [=====] - 0s 7ms/step - loss: 0.0065 - accuracy:
1.0000
Epoch 426/500
4/4 [=====] - 0s 3ms/step - loss: 0.0090 - accuracy:
1.0000
Epoch 427/500
4/4 [=====] - 0s 3ms/step - loss: 0.0085 - accuracy:
1.0000
Epoch 428/500
4/4 [=====] - 0s 4ms/step - loss: 0.0053 - accuracy:
1.0000
Epoch 429/500
4/4 [=====] - 0s 3ms/step - loss: 0.0062 - accuracy:
1.0000
Epoch 430/500
4/4 [=====] - 0s 3ms/step - loss: 0.0096 - accuracy:
1.0000
Epoch 431/500
4/4 [=====] - 0s 3ms/step - loss: 0.0084 - accuracy:

```

```

1.0000
Epoch 432/500
4/4 [=====] - 0s 4ms/step - loss: 0.0092 - accuracy:
1.0000
Epoch 433/500
4/4 [=====] - 0s 3ms/step - loss: 0.0065 - accuracy:
1.0000
Epoch 434/500
4/4 [=====] - 0s 3ms/step - loss: 0.0076 - accuracy:
1.0000
Epoch 435/500
4/4 [=====] - 0s 4ms/step - loss: 0.0061 - accuracy:
1.0000
Epoch 436/500
4/4 [=====] - 0s 3ms/step - loss: 0.0052 - accuracy:
1.0000
Epoch 437/500
4/4 [=====] - 0s 2ms/step - loss: 0.0063 - accuracy:
1.0000
Epoch 438/500
4/4 [=====] - 0s 4ms/step - loss: 0.0082 - accuracy:
1.0000
Epoch 439/500
4/4 [=====] - 0s 3ms/step - loss: 0.0079 - accuracy:
1.0000
Epoch 440/500
4/4 [=====] - 0s 3ms/step - loss: 0.0083 - accuracy:
1.0000
Epoch 441/500
4/4 [=====] - 0s 2ms/step - loss: 0.0057 - accuracy:
1.0000
Epoch 442/500
4/4 [=====] - 0s 2ms/step - loss: 0.0078 - accuracy:
1.0000
Epoch 443/500
4/4 [=====] - 0s 2ms/step - loss: 0.0054 - accuracy:
1.0000
Epoch 444/500
4/4 [=====] - 0s 3ms/step - loss: 0.0097 - accuracy:
1.0000
Epoch 445/500
4/4 [=====] - 0s 3ms/step - loss: 0.0098 - accuracy:
1.0000
Epoch 446/500
4/4 [=====] - 0s 3ms/step - loss: 0.0053 - accuracy:
1.0000
Epoch 447/500
4/4 [=====] - 0s 6ms/step - loss: 0.0088 - accuracy:

```

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1.0000
Epoch 448/500
4/4 [=====] - 0s 2ms/step - loss: 0.0062 - accuracy:
1.0000
Epoch 449/500
4/4 [=====] - 0s 3ms/step - loss: 0.0063 - accuracy:
1.0000
Epoch 450/500
4/4 [=====] - 0s 3ms/step - loss: 0.0081 - accuracy:
1.0000
Epoch 451/500
4/4 [=====] - 0s 3ms/step - loss: 0.0075 - accuracy:
1.0000
Epoch 452/500
4/4 [=====] - 0s 4ms/step - loss: 0.0084 - accuracy:
1.0000
Epoch 453/500
4/4 [=====] - 0s 3ms/step - loss: 0.0091 - accuracy:
1.0000
Epoch 454/500
4/4 [=====] - 0s 3ms/step - loss: 0.0084 - accuracy:
1.0000
Epoch 455/500
4/4 [=====] - 0s 2ms/step - loss: 0.0083 - accuracy:
1.0000
Epoch 456/500
4/4 [=====] - 0s 3ms/step - loss: 0.0086 - accuracy:
1.0000
Epoch 457/500
4/4 [=====] - 0s 3ms/step - loss: 0.0066 - accuracy:
1.0000
Epoch 458/500
4/4 [=====] - 0s 3ms/step - loss: 0.0086 - accuracy:
1.0000
Epoch 459/500
4/4 [=====] - 0s 3ms/step - loss: 0.0075 - accuracy:
1.0000
Epoch 460/500
4/4 [=====] - 0s 3ms/step - loss: 0.0066 - accuracy:
1.0000
Epoch 461/500
4/4 [=====] - 0s 3ms/step - loss: 0.0066 - accuracy:
1.0000
Epoch 462/500
4/4 [=====] - 0s 3ms/step - loss: 0.0079 - accuracy:
1.0000
Epoch 463/500
4/4 [=====] - 0s 2ms/step - loss: 0.0053 - accuracy:

```


1.0000
Epoch 464/500
4/4 [=====] - 0s 3ms/step - loss: 0.0078 - accuracy:
1.0000
Epoch 465/500
4/4 [=====] - 0s 3ms/step - loss: 0.0066 - accuracy:
1.0000
Epoch 466/500
4/4 [=====] - 0s 3ms/step - loss: 0.0090 - accuracy:
1.0000
Epoch 467/500
4/4 [=====] - 0s 2ms/step - loss: 0.0072 - accuracy:
1.0000
Epoch 468/500
4/4 [=====] - 0s 4ms/step - loss: 0.0073 - accuracy:
1.0000
Epoch 469/500
4/4 [=====] - 0s 2ms/step - loss: 0.0061 - accuracy:
1.0000
Epoch 470/500
4/4 [=====] - 0s 5ms/step - loss: 0.0065 - accuracy:
1.0000
Epoch 471/500
4/4 [=====] - 0s 3ms/step - loss: 0.0069 - accuracy:
1.0000
Epoch 472/500
4/4 [=====] - 0s 3ms/step - loss: 0.0090 - accuracy:
1.0000
Epoch 473/500
4/4 [=====] - 0s 3ms/step - loss: 0.0069 - accuracy:
1.0000
Epoch 474/500
4/4 [=====] - 0s 4ms/step - loss: 0.0075 - accuracy:
1.0000
Epoch 475/500
4/4 [=====] - 0s 5ms/step - loss: 0.0057 - accuracy:
1.0000
Epoch 476/500
4/4 [=====] - 0s 4ms/step - loss: 0.0070 - accuracy:
1.0000
Epoch 477/500
4/4 [=====] - 0s 3ms/step - loss: 0.0091 - accuracy:
1.0000
Epoch 478/500
4/4 [=====] - 0s 4ms/step - loss: 0.0057 - accuracy:
1.0000
Epoch 479/500
4/4 [=====] - 0s 3ms/step - loss: 0.0087 - accuracy:

```

1.0000
Epoch 480/500
4/4 [=====] - 0s 4ms/step - loss: 0.0088 - accuracy:
1.0000
Epoch 481/500
4/4 [=====] - 0s 3ms/step - loss: 0.0088 - accuracy:
1.0000
Epoch 482/500
4/4 [=====] - 0s 6ms/step - loss: 0.0058 - accuracy:
1.0000
Epoch 483/500
4/4 [=====] - 0s 3ms/step - loss: 0.0057 - accuracy:
1.0000
Epoch 484/500
4/4 [=====] - 0s 2ms/step - loss: 0.0044 - accuracy:
1.0000
Epoch 485/500
4/4 [=====] - 0s 2ms/step - loss: 0.0056 - accuracy:
1.0000
Epoch 486/500
4/4 [=====] - 0s 2ms/step - loss: 0.0059 - accuracy:
1.0000
Epoch 487/500
4/4 [=====] - 0s 2ms/step - loss: 0.0045 - accuracy:
1.0000
Epoch 488/500
4/4 [=====] - 0s 4ms/step - loss: 0.0083 - accuracy:
1.0000
Epoch 489/500
4/4 [=====] - 0s 4ms/step - loss: 0.0050 - accuracy:
1.0000
Epoch 490/500
4/4 [=====] - 0s 3ms/step - loss: 0.0085 - accuracy:
1.0000
Epoch 491/500
4/4 [=====] - 0s 2ms/step - loss: 0.0078 - accuracy:
1.0000
Epoch 492/500
4/4 [=====] - 0s 4ms/step - loss: 0.0087 - accuracy:
1.0000
Epoch 493/500
4/4 [=====] - 0s 3ms/step - loss: 0.0050 - accuracy:
1.0000
Epoch 494/500
4/4 [=====] - 0s 2ms/step - loss: 0.0043 - accuracy:
1.0000
Epoch 495/500
4/4 [=====] - 0s 3ms/step - loss: 0.0045 - accuracy:

```

```

1.0000
Epoch 496/500
4/4 [=====] - 0s 2ms/step - loss: 0.0043 - accuracy:
1.0000
Epoch 497/500
4/4 [=====] - 0s 3ms/step - loss: 0.0047 - accuracy:
1.0000
Epoch 498/500
4/4 [=====] - 0s 3ms/step - loss: 0.0072 - accuracy:
1.0000
Epoch 499/500
4/4 [=====] - 0s 2ms/step - loss: 0.0055 - accuracy:
1.0000
Epoch 500/500
4/4 [=====] - 0s 2ms/step - loss: 0.0046 - accuracy:
1.0000

```

```

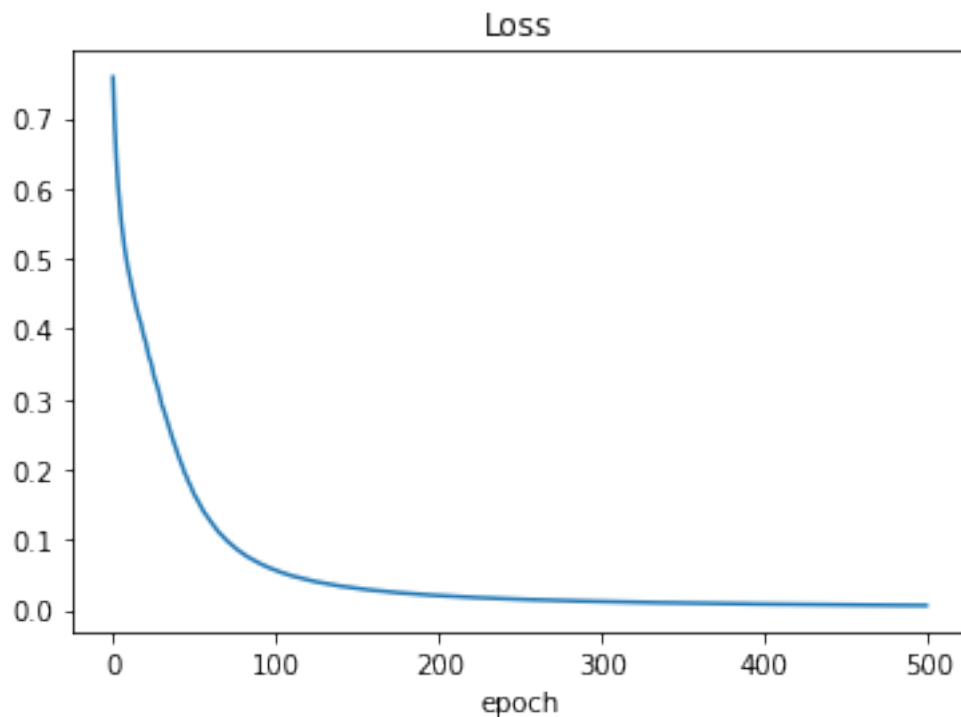
[13]: plt.plot(history.history['loss'])
      plt.title('Loss')
      plt.xlabel('epoch')

```

```

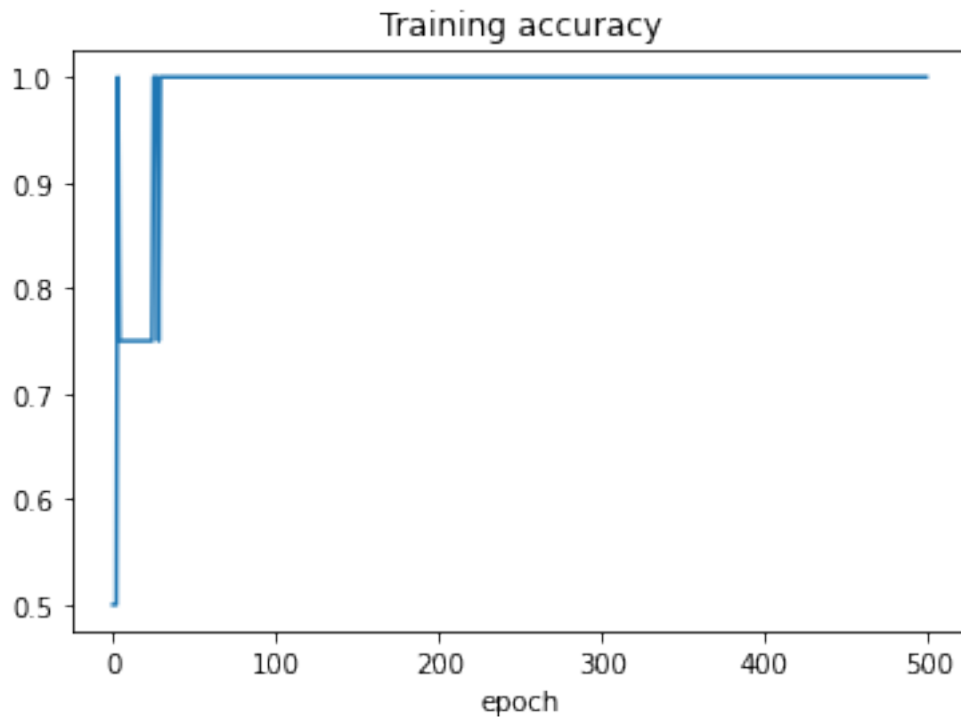
[13]: Text(0.5, 0, 'epoch')

```



```
[14]: plt.plot(history.history['accuracy'])  
plt.title('Training accuracy')  
plt.xlabel('epoch')
```

```
[14]: Text(0.5, 0, 'epoch')
```



```
[15]: hypothesis = model.predict(x_data)  
print(hypothesis)
```

```
[[0.00102407]  
 [0.00672129]  
 [0.00525442]  
 [0.9877707 ]]
```

```
[16]: predicted = hypothesis > 0.5  
print(predicted)
```

```
[[False]  
 [False]  
 [False]  
 [ True]]
```