01_2_XOR_Keras

December 22, 2020

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

```python
[2]: tf.__version__
```

```
[2]: '2.4.0'
```

```python
[3]: import numpy as np
     import matplotlib.pyplot as plt
```
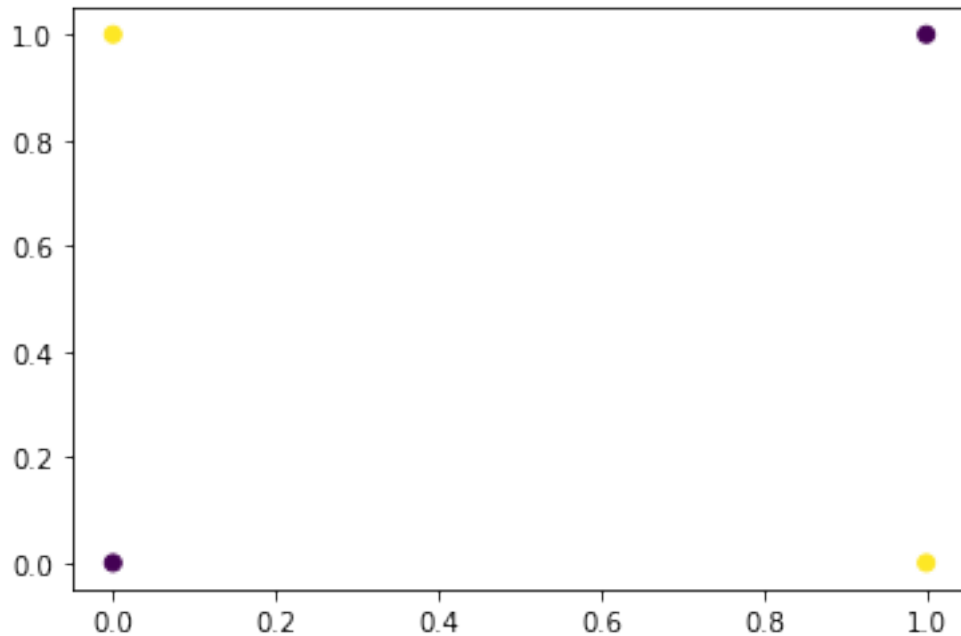
```python
[4]: x_data = [[0, 0],
               [0, 1],
               [1, 0],
               [1, 1]]

     y_data = [0,
               1,
               1,
               0]

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

```python
[5]: plt.scatter(x_data[:, 0], x_data[:, 1], c=y_data)
```

```
[5]: <matplotlib.collections.PathCollection at 0x7f8615dac3c8>
```

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

```
[7]: model = models.Sequential()
     model.add(layers.Dense(2, input_dim=2))
     model.add(layers.Activation('tanh'))
     #model.add(layers.Dense(2)) # comment out
     #model.add(layers.Activation('tanh')) # comment out
     model.add(layers.Dense(1))
     model.add(layers.Activation('sigmoid'))
```

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

```
[9]: 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
_____
```
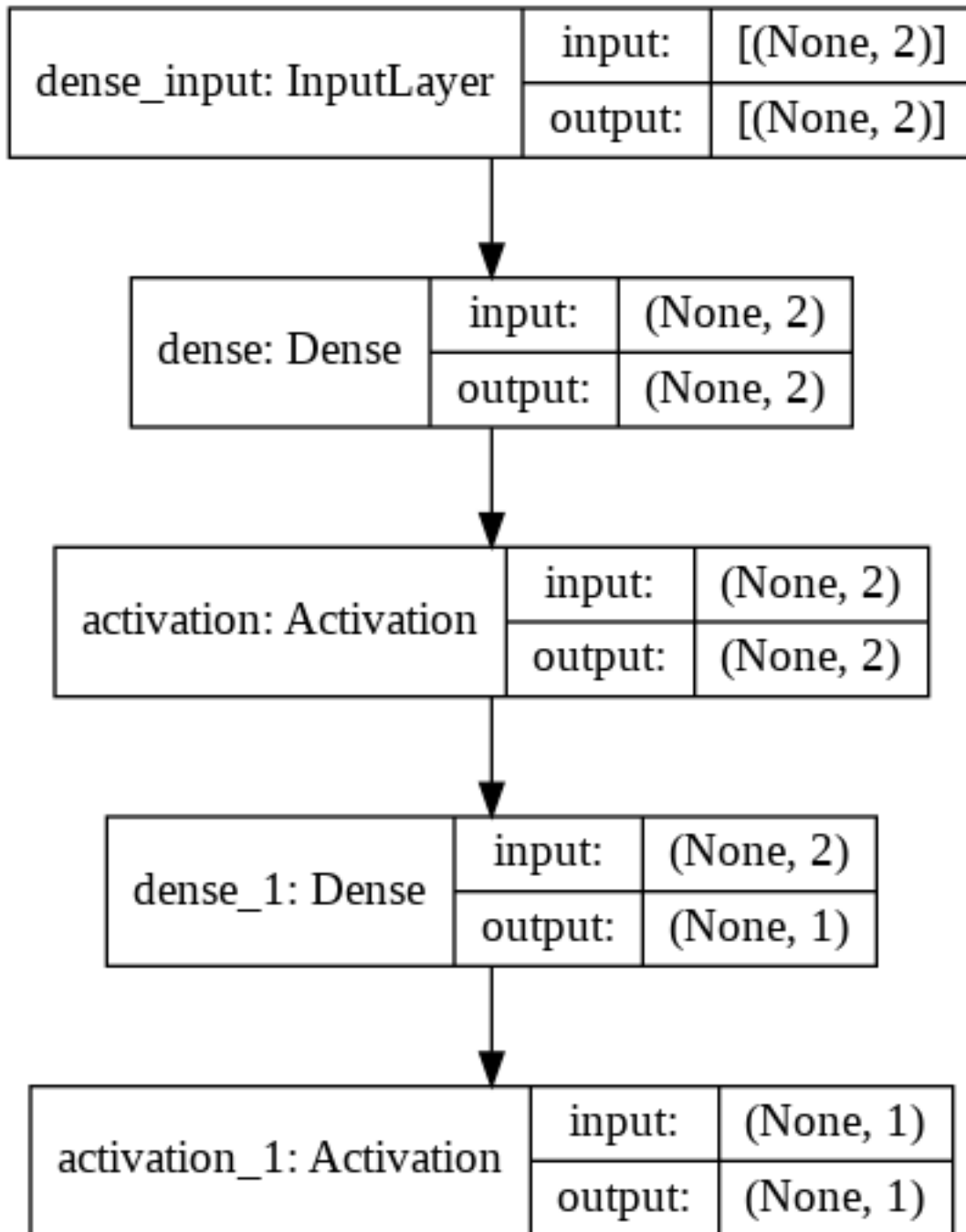
```
activation_1 (Activation)    (None, 1)                   0
================================================================
Total params: 9
Trainable params: 9
Non-trainable params: 0

----------------------------------------------------------------
```

[10]:
```python
from tensorflow.keras.utils import plot_model
plot_model(model, to_file='model_xor.png', show_shapes=True)
```

[10]:

| dense_input: InputLayer | input: | [(None, 2)] |
| | output: | [(None, 2)] |

| dense: Dense | input: | (None, 2) |
| | output: | (None, 2) |

| activation: Activation | input: | (None, 2) |
| | output: | (None, 2) |

| dense_1: Dense | input: | (None, 2) |
| | output: | (None, 1) |

| activation_1: Activation | input: | (None, 1) |
| | output: | (None, 1) |

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

```
Epoch 1/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6672 - accuracy:
0.4667
Epoch 2/500
```

```
4/4 [==============================] - 0s 2ms/step - loss: 0.7226 - accuracy:
0.1667
Epoch 3/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7295 - accuracy:
0.2667
Epoch 4/500
4/4 [==============================] - 0s 1ms/step - loss: 0.6758 - accuracy:
0.4667
Epoch 5/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7365 - accuracy:
0.1000
Epoch 6/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7271 - accuracy:
0.1000
Epoch 7/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6808 - accuracy:
0.4667
Epoch 8/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7189 - accuracy:
0.1000
Epoch 9/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7090 - accuracy:
0.2667
Epoch 10/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7159 - accuracy:
0.2667
Epoch 11/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7068 - accuracy:
0.8333
Epoch 12/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6837 - accuracy:
0.4667
Epoch 13/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6848 - accuracy:
0.4667
Epoch 14/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6915 - accuracy:
0.7333
Epoch 15/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7213 - accuracy:
0.1667
Epoch 16/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7208 - accuracy:
0.1667
Epoch 17/500
4/4 [==============================] - 0s 3ms/step - loss: 0.7233 - accuracy:
0.2667
Epoch 18/500
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4/4 [==============================] - 0s 2ms/step - loss: 0.7080 - accuracy:
0.3667
Epoch 19/500
4/4 [==============================] - 0s 4ms/step - loss: 0.7089 - accuracy:
0.6333
Epoch 20/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7025 - accuracy:
0.8333
Epoch 21/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7239 - accuracy:
0.2667
Epoch 22/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6941 - accuracy:
0.7333
Epoch 23/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7217 - accuracy:
0.1667
Epoch 24/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6952 - accuracy:
0.7333
Epoch 25/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6832 - accuracy:
0.4667
Epoch 26/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6920 - accuracy:
0.4667
Epoch 27/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7012 - accuracy:
0.4333
Epoch 28/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7067 - accuracy:
0.3667
Epoch 29/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7255 - accuracy:
0.1667
Epoch 30/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7246 - accuracy:
0.1000
Epoch 31/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6922 - accuracy:
0.7333
Epoch 32/500
4/4 [==============================] - 0s 7ms/step - loss: 0.7079 - accuracy:
0.3667
Epoch 33/500
4/4 [==============================] - 0s 3ms/step - loss: 0.6864 - accuracy:
0.4667
Epoch 34/500
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4/4 [==============================] - 0s 2ms/step - loss: 0.7268 - accuracy:
0.2667
Epoch 35/500
4/4 [==============================] - 0s 3ms/step - loss: 0.7174 - accuracy:
0.1667
Epoch 36/500
4/4 [==============================] - 0s 3ms/step - loss: 0.6889 - accuracy:
0.4667
Epoch 37/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7085 - accuracy:
0.2667
Epoch 38/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7061 - accuracy:
0.2667
Epoch 39/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6953 - accuracy:
0.4667
Epoch 40/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6958 - accuracy:
0.4667
Epoch 41/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7254 - accuracy:
0.1667
Epoch 42/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7168 - accuracy:
0.4333
Epoch 43/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6873 - accuracy:
0.7333
Epoch 44/500
4/4 [==============================] - 0s 3ms/step - loss: 0.7072 - accuracy:
0.2667
Epoch 45/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7037 - accuracy:
0.3667
Epoch 46/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6983 - accuracy:
0.6333
Epoch 47/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7042 - accuracy:
0.4333
Epoch 48/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6840 - accuracy:
0.4667
Epoch 49/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6875 - accuracy:
0.7333
Epoch 50/500
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4/4 [==============================] - 0s 2ms/step - loss: 0.7063 - accuracy:
0.3667
Epoch 51/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7157 - accuracy:
0.1000
Epoch 52/500
4/4 [==============================] - 0s 3ms/step - loss: 0.6869 - accuracy:
0.4667
Epoch 53/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6889 - accuracy:
0.4667
Epoch 54/500
4/4 [==============================] - 0s 3ms/step - loss: 0.6865 - accuracy:
0.4667
Epoch 55/500
4/4 [==============================] - 0s 3ms/step - loss: 0.7067 - accuracy:
0.3667
Epoch 56/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6893 - accuracy:
0.6333
Epoch 57/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7212 - accuracy:
0.2667
Epoch 58/500
4/4 [==============================] - 0s 3ms/step - loss: 0.7061 - accuracy:
0.4333
Epoch 59/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6997 - accuracy:
0.5667
Epoch 60/500
4/4 [==============================] - 0s 4ms/step - loss: 0.7095 - accuracy:
0.3667
Epoch 61/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7217 - accuracy:
0.1667
Epoch 62/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6839 - accuracy:
0.8333
Epoch 63/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6844 - accuracy:
0.7333
Epoch 64/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6821 - accuracy:
0.7333
Epoch 65/500
4/4 [==============================] - 0s 3ms/step - loss: 0.7020 - accuracy:
0.3667
Epoch 66/500
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4/4 [==============================] - 0s 3ms/step - loss: 0.7043 - accuracy:
0.4333
Epoch 67/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6812 - accuracy:
0.4667
Epoch 68/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7068 - accuracy:
0.4333
Epoch 69/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6802 - accuracy:
0.7333
Epoch 70/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7086 - accuracy:
0.4333
Epoch 71/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7022 - accuracy:
0.3667
Epoch 72/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6795 - accuracy:
0.7333
Epoch 73/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6769 - accuracy:
0.7333
Epoch 74/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7065 - accuracy:
0.3667
Epoch 75/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6829 - accuracy:
0.4667
Epoch 76/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6823 - accuracy:
0.8333
Epoch 77/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7097 - accuracy:
0.3667
Epoch 78/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6809 - accuracy:
0.6333
Epoch 79/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7176 - accuracy:
0.3667
Epoch 80/500
4/4 [==============================] - 0s 3ms/step - loss: 0.6933 - accuracy:
0.5667
Epoch 81/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7258 - accuracy:
0.2667
Epoch 82/500
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4/4 [==============================] - 0s 2ms/step - loss: 0.7168 - accuracy:
0.2667
Epoch 83/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6682 - accuracy:
0.7333
Epoch 84/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6934 - accuracy:
0.5667
Epoch 85/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6743 - accuracy:
0.6333
Epoch 86/500
4/4 [==============================] - 0s 4ms/step - loss: 0.7165 - accuracy:
0.2667
Epoch 87/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7274 - accuracy:
0.2667
Epoch 88/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7159 - accuracy:
0.2667
Epoch 89/500
4/4 [==============================] - 0s 4ms/step - loss: 0.7166 - accuracy:
0.2667
Epoch 90/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6642 - accuracy:
0.7333
Epoch 91/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6658 - accuracy:
0.7333
Epoch 92/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7164 - accuracy:
0.2667
Epoch 93/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6784 - accuracy:
0.5667
Epoch 94/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6641 - accuracy:
0.7333
Epoch 95/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7100 - accuracy:
0.4333
Epoch 96/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7177 - accuracy:
0.3667
Epoch 97/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6707 - accuracy:
0.9000
Epoch 98/500
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4/4 [==============================] - 0s 3ms/step - loss: 0.6712 - accuracy:
0.8333
Epoch 99/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7084 - accuracy:
0.4333
Epoch 100/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6586 - accuracy:
0.7333
Epoch 101/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7120 - accuracy:
0.4333
Epoch 102/500
4/4 [==============================] - 0s 3ms/step - loss: 0.6661 - accuracy:
0.9000
Epoch 103/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6577 - accuracy:
0.7333
Epoch 104/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6677 - accuracy:
0.8333
Epoch 105/500
4/4 [==============================] - 0s 3ms/step - loss: 0.6720 - accuracy:
0.9000
Epoch 106/500
4/4 [==============================] - 0s 3ms/step - loss: 0.6799 - accuracy:
0.6333
Epoch 107/500
4/4 [==============================] - 0s 3ms/step - loss: 0.7335 - accuracy:
0.2667
Epoch 108/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6829 - accuracy:
0.8333
Epoch 109/500
4/4 [==============================] - 0s 3ms/step - loss: 0.6471 - accuracy:
0.9000
Epoch 110/500
4/4 [==============================] - 0s 3ms/step - loss: 0.7310 - accuracy:
0.2667
Epoch 111/500
4/4 [==============================] - 0s 3ms/step - loss: 0.6444 - accuracy:
0.9000
Epoch 112/500
4/4 [==============================] - 0s 3ms/step - loss: 0.7065 - accuracy:
0.7333
Epoch 113/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7094 - accuracy:
0.7333
Epoch 114/500
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4/4 [==============================] - 0s 2ms/step - loss: 0.7058 - accuracy:
0.4333
Epoch 115/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6746 - accuracy:
0.8333
Epoch 116/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7115 - accuracy:
0.3667
Epoch 117/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6518 - accuracy:
0.9000
Epoch 118/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6388 - accuracy:
0.7333
Epoch 119/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6207 - accuracy:
0.6333
Epoch 120/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6684 - accuracy:
0.6333
Epoch 121/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6771 - accuracy:
0.7333
Epoch 122/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6333 - accuracy:
0.8333
Epoch 123/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6957 - accuracy:
0.7333
Epoch 124/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6378 - accuracy:
0.9000
Epoch 125/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6126 - accuracy:
0.7333
Epoch 126/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6925 - accuracy:
0.7333
Epoch 127/500
4/4 [==============================] - 0s 3ms/step - loss: 0.6387 - accuracy:
0.5667
Epoch 128/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6079 - accuracy:
0.8333
Epoch 129/500
4/4 [==============================] - 0s 8ms/step - loss: 0.7381 - accuracy:
0.5333
Epoch 130/500
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4/4 [==============================] - 0s 3ms/step - loss: 0.7124 - accuracy:
0.3667
Epoch 131/500
4/4 [==============================] - 0s 3ms/step - loss: 0.7215 - accuracy:
0.5333
Epoch 132/500
4/4 [==============================] - 0s 3ms/step - loss: 0.6270 - accuracy:
0.8333
Epoch 133/500
4/4 [==============================] - 0s 3ms/step - loss: 0.5831 - accuracy:
0.9000
Epoch 134/500
4/4 [==============================] - 0s 3ms/step - loss: 0.6867 - accuracy:
0.7333
Epoch 135/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7299 - accuracy:
0.5333
Epoch 136/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6234 - accuracy:
0.8333
Epoch 137/500
4/4 [==============================] - 0s 2ms/step - loss: 0.5961 - accuracy:
0.8333
Epoch 138/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6026 - accuracy:
0.9000
Epoch 139/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6010 - accuracy:
0.9000
Epoch 140/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6724 - accuracy:
0.7333
Epoch 141/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6025 - accuracy:
0.7333
Epoch 142/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6188 - accuracy:
0.8333
Epoch 143/500
4/4 [==============================] - 0s 2ms/step - loss: 0.5433 - accuracy:
0.9000
Epoch 144/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6033 - accuracy:
0.7333
Epoch 145/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7246 - accuracy:
0.5333
Epoch 146/500
```

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4/4 [==============================] - 0s 2ms/step - loss: 0.5985 - accuracy:
0.8333
Epoch 147/500
4/4 [==============================] - 0s 3ms/step - loss: 0.6951 - accuracy:
0.5333
Epoch 148/500
4/4 [==============================] - 0s 2ms/step - loss: 0.7280 - accuracy:
0.5333
Epoch 149/500
4/4 [==============================] - 0s 2ms/step - loss: 0.5484 - accuracy:
0.8333
Epoch 150/500
4/4 [==============================] - 0s 2ms/step - loss: 0.5196 - accuracy:
0.9000
Epoch 151/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6175 - accuracy:
0.7333
Epoch 152/500
4/4 [==============================] - 0s 2ms/step - loss: 0.5782 - accuracy:
0.7333
Epoch 153/500
4/4 [==============================] - 0s 2ms/step - loss: 0.5185 - accuracy:
0.9000
Epoch 154/500
4/4 [==============================] - 0s 5ms/step - loss: 0.5404 - accuracy:
0.9000
Epoch 155/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6408 - accuracy:
0.7333
Epoch 156/500
4/4 [==============================] - 0s 4ms/step - loss: 0.6204 - accuracy:
0.7333
Epoch 157/500
4/4 [==============================] - 0s 5ms/step - loss: 0.5761 - accuracy:
0.8333
Epoch 158/500
4/4 [==============================] - 0s 5ms/step - loss: 0.5194 - accuracy:
0.9000
Epoch 159/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6824 - accuracy:
0.5333
Epoch 160/500
4/4 [==============================] - 0s 2ms/step - loss: 0.4937 - accuracy:
0.9000
Epoch 161/500
4/4 [==============================] - 0s 2ms/step - loss: 0.5352 - accuracy:
0.8333
Epoch 162/500
```

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4/4 [==============================] - 0s 3ms/step - loss: 0.5621 - accuracy:
0.8333
Epoch 163/500
4/4 [==============================] - 0s 2ms/step - loss: 0.4843 - accuracy:
0.9000
Epoch 164/500
4/4 [==============================] - 0s 3ms/step - loss: 0.4737 - accuracy:
0.9000
Epoch 165/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6522 - accuracy:
0.5333
Epoch 166/500
4/4 [==============================] - 0s 2ms/step - loss: 0.5507 - accuracy:
0.8333
Epoch 167/500
4/4 [==============================] - 0s 2ms/step - loss: 0.4640 - accuracy:
0.9000
Epoch 168/500
4/4 [==============================] - 0s 2ms/step - loss: 0.5445 - accuracy:
0.8333
Epoch 169/500
4/4 [==============================] - 0s 3ms/step - loss: 0.6577 - accuracy:
0.5333
Epoch 170/500
4/4 [==============================] - 0s 4ms/step - loss: 0.6043 - accuracy:
0.7333
Epoch 171/500
4/4 [==============================] - 0s 3ms/step - loss: 0.4982 - accuracy:
0.9000
Epoch 172/500
4/4 [==============================] - 0s 3ms/step - loss: 0.5987 - accuracy:
0.7333
Epoch 173/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6312 - accuracy:
0.5333
Epoch 174/500
4/4 [==============================] - 0s 3ms/step - loss: 0.4477 - accuracy:
0.9000
Epoch 175/500
4/4 [==============================] - 0s 2ms/step - loss: 0.4799 - accuracy:
0.8333
Epoch 176/500
4/4 [==============================] - 0s 2ms/step - loss: 0.5146 - accuracy:
0.8333
Epoch 177/500
4/4 [==============================] - 0s 2ms/step - loss: 0.4289 - accuracy:
0.9000
Epoch 178/500
```

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4/4 [==============================] - 0s 2ms/step - loss: 0.5722 - accuracy:
0.7333
Epoch 179/500
4/4 [==============================] - 0s 2ms/step - loss: 0.6009 - accuracy:
0.5333
Epoch 180/500
4/4 [==============================] - 0s 2ms/step - loss: 0.4856 - accuracy:
0.8333
Epoch 181/500
4/4 [==============================] - 0s 2ms/step - loss: 0.4906 - accuracy:
0.7333
Epoch 182/500
4/4 [==============================] - 0s 2ms/step - loss: 0.5908 - accuracy:
0.5333
Epoch 183/500
4/4 [==============================] - 0s 2ms/step - loss: 0.4680 - accuracy:
0.8333
Epoch 184/500
4/4 [==============================] - 0s 2ms/step - loss: 0.4468 - accuracy:
0.9000
Epoch 185/500
4/4 [==============================] - 0s 2ms/step - loss: 0.4774 - accuracy:
0.8333
Epoch 186/500
4/4 [==============================] - 0s 2ms/step - loss: 0.4785 - accuracy:
0.8333
Epoch 187/500
4/4 [==============================] - 0s 2ms/step - loss: 0.5878 - accuracy:
0.5333
Epoch 188/500
4/4 [==============================] - 0s 2ms/step - loss: 0.4594 - accuracy:
0.7333
Epoch 189/500
4/4 [==============================] - 0s 2ms/step - loss: 0.3912 - accuracy:
0.9000
Epoch 190/500
4/4 [==============================] - 0s 2ms/step - loss: 0.4045 - accuracy:
0.8333
Epoch 191/500
4/4 [==============================] - 0s 2ms/step - loss: 0.4589 - accuracy:
0.7333
Epoch 192/500
4/4 [==============================] - 0s 2ms/step - loss: 0.5542 - accuracy:
0.5333
Epoch 193/500
4/4 [==============================] - 0s 2ms/step - loss: 0.5225 - accuracy:
0.5333
Epoch 194/500
```

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4/4 [==============================] - 0s 3ms/step - loss: 0.5437 - accuracy:
0.5333
Epoch 195/500
4/4 [==============================] - 0s 5ms/step - loss: 0.3864 - accuracy:
0.9000
Epoch 196/500
4/4 [==============================] - 0s 3ms/step - loss: 0.3644 - accuracy:
0.9000
Epoch 197/500
4/4 [==============================] - 0s 3ms/step - loss: 0.3484 - accuracy:
0.9000
Epoch 198/500
4/4 [==============================] - 0s 2ms/step - loss: 0.3671 - accuracy:
0.8333
Epoch 199/500
4/4 [==============================] - 0s 2ms/step - loss: 0.3710 - accuracy:
0.9000
Epoch 200/500
4/4 [==============================] - 0s 2ms/step - loss: 0.3373 - accuracy:
0.9000
Epoch 201/500
4/4 [==============================] - 0s 2ms/step - loss: 0.3422 - accuracy:
1.0000
Epoch 202/500
4/4 [==============================] - 0s 2ms/step - loss: 0.3383 - accuracy:
1.0000
Epoch 203/500
4/4 [==============================] - 0s 2ms/step - loss: 0.3732 - accuracy:
1.0000
Epoch 204/500
4/4 [==============================] - 0s 2ms/step - loss: 0.3365 - accuracy:
1.0000
Epoch 205/500
4/4 [==============================] - 0s 2ms/step - loss: 0.3145 - accuracy:
1.0000
Epoch 206/500
4/4 [==============================] - 0s 3ms/step - loss: 0.3347 - accuracy:
1.0000
Epoch 207/500
4/4 [==============================] - 0s 4ms/step - loss: 0.3810 - accuracy:
1.0000
Epoch 208/500
4/4 [==============================] - 0s 3ms/step - loss: 0.3145 - accuracy:
1.0000
Epoch 209/500
4/4 [==============================] - 0s 4ms/step - loss: 0.3374 - accuracy:
1.0000
Epoch 210/500
```

```
4/4 [==============================] - 0s 2ms/step - loss: 0.3569 - accuracy:
1.0000
Epoch 211/500
4/4 [==============================] - 0s 3ms/step - loss: 0.3017 - accuracy:
1.0000
Epoch 212/500
4/4 [==============================] - 0s 2ms/step - loss: 0.3808 - accuracy:
1.0000
Epoch 213/500
4/4 [==============================] - 0s 2ms/step - loss: 0.3779 - accuracy:
1.0000
Epoch 214/500
4/4 [==============================] - 0s 3ms/step - loss: 0.2954 - accuracy:
1.0000
Epoch 215/500
4/4 [==============================] - 0s 2ms/step - loss: 0.2810 - accuracy:
1.0000
Epoch 216/500
4/4 [==============================] - 0s 3ms/step - loss: 0.2744 - accuracy:
1.0000
Epoch 217/500
4/4 [==============================] - 0s 2ms/step - loss: 0.3117 - accuracy:
1.0000
Epoch 218/500
4/4 [==============================] - 0s 2ms/step - loss: 0.2846 - accuracy:
1.0000
Epoch 219/500
4/4 [==============================] - 0s 2ms/step - loss: 0.2544 - accuracy:
1.0000
Epoch 220/500
4/4 [==============================] - 0s 2ms/step - loss: 0.2512 - accuracy:
1.0000
Epoch 221/500
4/4 [==============================] - 0s 2ms/step - loss: 0.2360 - accuracy:
1.0000
Epoch 222/500
4/4 [==============================] - 0s 2ms/step - loss: 0.2787 - accuracy:
1.0000
Epoch 223/500
4/4 [==============================] - 0s 2ms/step - loss: 0.2274 - accuracy:
1.0000
Epoch 224/500
4/4 [==============================] - 0s 2ms/step - loss: 0.2948 - accuracy:
1.0000
Epoch 225/500
4/4 [==============================] - 0s 2ms/step - loss: 0.2841 - accuracy:
1.0000
Epoch 226/500
```

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4/4 [==============================] - 0s 9ms/step - loss: 0.2212 - accuracy:
1.0000
Epoch 227/500
4/4 [==============================] - 0s 3ms/step - loss: 0.2284 - accuracy:
1.0000
Epoch 228/500
4/4 [==============================] - 0s 3ms/step - loss: 0.2367 - accuracy:
1.0000
Epoch 229/500
4/4 [==============================] - 0s 2ms/step - loss: 0.2134 - accuracy:
1.0000
Epoch 230/500
4/4 [==============================] - 0s 4ms/step - loss: 0.2563 - accuracy:
1.0000
Epoch 231/500
4/4 [==============================] - 0s 5ms/step - loss: 0.2589 - accuracy:
1.0000
Epoch 232/500
4/4 [==============================] - 0s 3ms/step - loss: 0.2556 - accuracy:
1.0000
Epoch 233/500
4/4 [==============================] - 0s 2ms/step - loss: 0.2535 - accuracy:
1.0000
Epoch 234/500
4/4 [==============================] - 0s 3ms/step - loss: 0.2490 - accuracy:
1.0000
Epoch 235/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1805 - accuracy:
1.0000
Epoch 236/500
4/4 [==============================] - 0s 3ms/step - loss: 0.2089 - accuracy:
1.0000
Epoch 237/500
4/4 [==============================] - 0s 2ms/step - loss: 0.2096 - accuracy:
1.0000
Epoch 238/500
4/4 [==============================] - 0s 3ms/step - loss: 0.1910 - accuracy:
1.0000
Epoch 239/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1996 - accuracy:
1.0000
Epoch 240/500
4/4 [==============================] - 0s 2ms/step - loss: 0.2205 - accuracy:
1.0000
Epoch 241/500
4/4 [==============================] - 0s 2ms/step - loss: 0.2172 - accuracy:
1.0000
Epoch 242/500
```

```
4/4 [==============================] - 0s 6ms/step - loss: 0.1764 - accuracy:
1.0000
Epoch 243/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1755 - accuracy:
1.0000
Epoch 244/500
4/4 [==============================] - 0s 3ms/step - loss: 0.2062 - accuracy:
1.0000
Epoch 245/500
4/4 [==============================] - 0s 3ms/step - loss: 0.1770 - accuracy:
1.0000
Epoch 246/500
4/4 [==============================] - 0s 6ms/step - loss: 0.1877 - accuracy:
1.0000
Epoch 247/500
4/4 [==============================] - 0s 3ms/step - loss: 0.1678 - accuracy:
1.0000
Epoch 248/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1923 - accuracy:
1.0000
Epoch 249/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1819 - accuracy:
1.0000
Epoch 250/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1626 - accuracy:
1.0000
Epoch 251/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1586 - accuracy:
1.0000
Epoch 252/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1755 - accuracy:
1.0000
Epoch 253/500
4/4 [==============================] - 0s 5ms/step - loss: 0.1329 - accuracy:
1.0000
Epoch 254/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1781 - accuracy:
1.0000
Epoch 255/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1675 - accuracy:
1.0000
Epoch 256/500
4/4 [==============================] - 0s 4ms/step - loss: 0.1563 - accuracy:
1.0000
Epoch 257/500
4/4 [==============================] - 0s 4ms/step - loss: 0.1411 - accuracy:
1.0000
Epoch 258/500
```

```
4/4 [==============================] - 0s 5ms/step - loss: 0.1320 - accuracy:
1.0000
Epoch 259/500
4/4 [==============================] - 0s 5ms/step - loss: 0.1579 - accuracy:
1.0000
Epoch 260/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1620 - accuracy:
1.0000
Epoch 261/500
4/4 [==============================] - 0s 4ms/step - loss: 0.1540 - accuracy:
1.0000
Epoch 262/500
4/4 [==============================] - 0s 3ms/step - loss: 0.1244 - accuracy:
1.0000
Epoch 263/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1158 - accuracy:
1.0000
Epoch 264/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1316 - accuracy:
1.0000
Epoch 265/500
4/4 [==============================] - 0s 4ms/step - loss: 0.1460 - accuracy:
1.0000
Epoch 266/500
4/4 [==============================] - 0s 3ms/step - loss: 0.1326 - accuracy:
1.0000
Epoch 267/500
4/4 [==============================] - 0s 3ms/step - loss: 0.1406 - accuracy:
1.0000
Epoch 268/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1389 - accuracy:
1.0000
Epoch 269/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1232 - accuracy:
1.0000
Epoch 270/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1433 - accuracy:
1.0000
Epoch 271/500
4/4 [==============================] - 0s 3ms/step - loss: 0.1104 - accuracy:
1.0000
Epoch 272/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1198 - accuracy:
1.0000
Epoch 273/500
4/4 [==============================] - 0s 3ms/step - loss: 0.1262 - accuracy:
1.0000
Epoch 274/500
```

```
4/4 [==============================] - 0s 3ms/step - loss: 0.1189 - accuracy:
1.0000
Epoch 275/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1235 - accuracy:
1.0000
Epoch 276/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1283 - accuracy:
1.0000
Epoch 277/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1315 - accuracy:
1.0000
Epoch 278/500
4/4 [==============================] - 0s 3ms/step - loss: 0.1003 - accuracy:
1.0000
Epoch 279/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1283 - accuracy:
1.0000
Epoch 280/500
4/4 [==============================] - 0s 5ms/step - loss: 0.1203 - accuracy:
1.0000
Epoch 281/500
4/4 [==============================] - 0s 3ms/step - loss: 0.1101 - accuracy:
1.0000
Epoch 282/500
4/4 [==============================] - 0s 5ms/step - loss: 0.1164 - accuracy:
1.0000
Epoch 283/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0999 - accuracy:
1.0000
Epoch 284/500
4/4 [==============================] - 0s 3ms/step - loss: 0.1119 - accuracy:
1.0000
Epoch 285/500
4/4 [==============================] - 0s 3ms/step - loss: 0.1162 - accuracy:
1.0000
Epoch 286/500
4/4 [==============================] - 0s 3ms/step - loss: 0.1142 - accuracy:
1.0000
Epoch 287/500
4/4 [==============================] - 0s 5ms/step - loss: 0.1059 - accuracy:
1.0000
Epoch 288/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1014 - accuracy:
1.0000
Epoch 289/500
4/4 [==============================] - 0s 2ms/step - loss: 0.1113 - accuracy:
1.0000
Epoch 290/500
```

```
4/4 [==============================] - 0s 5ms/step - loss: 0.1065 - accuracy:
1.0000
Epoch 291/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0873 - accuracy:
1.0000
Epoch 292/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0972 - accuracy:
1.0000
Epoch 293/500
4/4 [==============================] - 0s 5ms/step - loss: 0.0883 - accuracy:
1.0000
Epoch 294/500
4/4 [==============================] - 0s 4ms/step - loss: 0.1031 - accuracy:
1.0000
Epoch 295/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0875 - accuracy:
1.0000
Epoch 296/500
4/4 [==============================] - 0s 4ms/step - loss: 0.1069 - accuracy:
1.0000
Epoch 297/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0793 - accuracy:
1.0000
Epoch 298/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0972 - accuracy:
1.0000
Epoch 299/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0871 - accuracy:
1.0000
Epoch 300/500
4/4 [==============================] - 0s 5ms/step - loss: 0.0847 - accuracy:
1.0000
Epoch 301/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0763 - accuracy:
1.0000
Epoch 302/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0846 - accuracy:
1.0000
Epoch 303/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0965 - accuracy:
1.0000
Epoch 304/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0898 - accuracy:
1.0000
Epoch 305/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0858 - accuracy:
1.0000
Epoch 306/500
```

```
4/4 [==============================] - 0s 2ms/step - loss: 0.0916 - accuracy:
1.0000
Epoch 307/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0875 - accuracy:
1.0000
Epoch 308/500
4/4 [==============================] - 0s 6ms/step - loss: 0.0899 - accuracy:
1.0000
Epoch 309/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0767 - accuracy:
1.0000
Epoch 310/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0730 - accuracy:
1.0000
Epoch 311/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0724 - accuracy:
1.0000
Epoch 312/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0735 - accuracy:
1.0000
Epoch 313/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0746 - accuracy:
1.0000
Epoch 314/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0694 - accuracy:
1.0000
Epoch 315/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0688 - accuracy:
1.0000
Epoch 316/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0781 - accuracy:
1.0000
Epoch 317/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0854 - accuracy:
1.0000
Epoch 318/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0780 - accuracy:
1.0000
Epoch 319/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0649 - accuracy:
1.0000
Epoch 320/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0704 - accuracy:
1.0000
Epoch 321/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0827 - accuracy:
1.0000
Epoch 322/500
```

```
4/4 [==============================] - 0s 2ms/step - loss: 0.0688 - accuracy:
1.0000
Epoch 323/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0835 - accuracy:
1.0000
Epoch 324/500
4/4 [==============================] - 0s 7ms/step - loss: 0.0777 - accuracy:
1.0000
Epoch 325/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0771 - accuracy:
1.0000
Epoch 326/500
4/4 [==============================] - 0s 5ms/step - loss: 0.0632 - accuracy:
1.0000
Epoch 327/500
4/4 [==============================] - 0s 7ms/step - loss: 0.0741 - accuracy:
1.0000
Epoch 328/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0746 - accuracy:
1.0000
Epoch 329/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0778 - accuracy:
1.0000
Epoch 330/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0792 - accuracy:
1.0000
Epoch 331/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0643 - accuracy:
1.0000
Epoch 332/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0583 - accuracy:
1.0000
Epoch 333/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0761 - accuracy:
1.0000
Epoch 334/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0720 - accuracy:
1.0000
Epoch 335/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0699 - accuracy:
1.0000
Epoch 336/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0756 - accuracy:
1.0000
Epoch 337/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0625 - accuracy:
1.0000
Epoch 338/500
```

```
4/4 [==============================] - 0s 2ms/step - loss: 0.0575 - accuracy:
1.0000
Epoch 339/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0589 - accuracy:
1.0000
Epoch 340/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0728 - accuracy:
1.0000
Epoch 341/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0607 - accuracy:
1.0000
Epoch 342/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0541 - accuracy:
1.0000
Epoch 343/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0563 - accuracy:
1.0000
Epoch 344/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0547 - accuracy:
1.0000
Epoch 345/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0636 - accuracy:
1.0000
Epoch 346/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0577 - accuracy:
1.0000
Epoch 347/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0582 - accuracy:
1.0000
Epoch 348/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0536 - accuracy:
1.0000
Epoch 349/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0593 - accuracy:
1.0000
Epoch 350/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0669 - accuracy:
1.0000
Epoch 351/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0560 - accuracy:
1.0000
Epoch 352/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0635 - accuracy:
1.0000
Epoch 353/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0550 - accuracy:
1.0000
Epoch 354/500
```

```
4/4 [==============================] - 0s 2ms/step - loss: 0.0660 - accuracy:
1.0000
Epoch 355/500
4/4 [==============================] - 0s 5ms/step - loss: 0.0635 - accuracy:
1.0000
Epoch 356/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0649 - accuracy:
1.0000
Epoch 357/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0488 - accuracy:
1.0000
Epoch 358/500
4/4 [==============================] - 0s 5ms/step - loss: 0.0576 - accuracy:
1.0000
Epoch 359/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0631 - accuracy:
1.0000
Epoch 360/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0635 - accuracy:
1.0000
Epoch 361/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0551 - accuracy:
1.0000
Epoch 362/500
4/4 [==============================] - 0s 5ms/step - loss: 0.0469 - accuracy:
1.0000
Epoch 363/500
4/4 [==============================] - 0s 5ms/step - loss: 0.0573 - accuracy:
1.0000
Epoch 364/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0510 - accuracy:
1.0000
Epoch 365/500
4/4 [==============================] - 0s 5ms/step - loss: 0.0572 - accuracy:
1.0000
Epoch 366/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0472 - accuracy:
1.0000
Epoch 367/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0469 - accuracy:
1.0000
Epoch 368/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0542 - accuracy:
1.0000
Epoch 369/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0475 - accuracy:
1.0000
Epoch 370/500
```

```
4/4 [==============================] - 0s 4ms/step - loss: 0.0566 - accuracy:
1.0000
Epoch 371/500
4/4 [==============================] - 0s 6ms/step - loss: 0.0492 - accuracy:
1.0000
Epoch 372/500
4/4 [==============================] - 0s 6ms/step - loss: 0.0587 - accuracy:
1.0000
Epoch 373/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0545 - accuracy:
1.0000
Epoch 374/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0436 - accuracy:
1.0000
Epoch 375/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0505 - accuracy:
1.0000
Epoch 376/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0444 - accuracy:
1.0000
Epoch 377/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0514 - accuracy:
1.0000
Epoch 378/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0540 - accuracy:
1.0000
Epoch 379/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0425 - accuracy:
1.0000
Epoch 380/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0445 - accuracy:
1.0000
Epoch 381/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0443 - accuracy:
1.0000
Epoch 382/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0537 - accuracy:
1.0000
Epoch 383/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0443 - accuracy:
1.0000
Epoch 384/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0454 - accuracy:
1.0000
Epoch 385/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0452 - accuracy:
1.0000
Epoch 386/500
```

```
4/4 [==============================] - 0s 2ms/step - loss: 0.0449 - accuracy:
1.0000
Epoch 387/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0502 - accuracy:
1.0000
Epoch 388/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0404 - accuracy:
1.0000
Epoch 389/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0538 - accuracy:
1.0000
Epoch 390/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0398 - accuracy:
1.0000
Epoch 391/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0461 - accuracy:
1.0000
Epoch 392/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0482 - accuracy:
1.0000
Epoch 393/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0405 - accuracy:
1.0000
Epoch 394/500
4/4 [==============================] - 0s 5ms/step - loss: 0.0483 - accuracy:
1.0000
Epoch 395/500
4/4 [==============================] - 0s 5ms/step - loss: 0.0500 - accuracy:
1.0000
Epoch 396/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0478 - accuracy:
1.0000
Epoch 397/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0511 - accuracy:
1.0000
Epoch 398/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0492 - accuracy:
1.0000
Epoch 399/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0480 - accuracy:
1.0000
Epoch 400/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0390 - accuracy:
1.0000
Epoch 401/500
4/4 [==============================] - 0s 9ms/step - loss: 0.0477 - accuracy:
1.0000
Epoch 402/500
```

```
4/4 [==============================] - 0s 3ms/step - loss: 0.0448 - accuracy:
1.0000
Epoch 403/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0430 - accuracy:
1.0000
Epoch 404/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0395 - accuracy:
1.0000
Epoch 405/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0458 - accuracy:
1.0000
Epoch 406/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0387 - accuracy:
1.0000
Epoch 407/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0446 - accuracy:
1.0000
Epoch 408/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0403 - accuracy:
1.0000
Epoch 409/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0372 - accuracy:
1.0000
Epoch 410/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0478 - accuracy:
1.0000
Epoch 411/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0472 - accuracy:
1.0000
Epoch 412/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0375 - accuracy:
1.0000
Epoch 413/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0411 - accuracy:
1.0000
Epoch 414/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0362 - accuracy:
1.0000
Epoch 415/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0421 - accuracy:
1.0000
Epoch 416/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0383 - accuracy:
1.0000
Epoch 417/500
4/4 [==============================] - 0s 5ms/step - loss: 0.0347 - accuracy:
1.0000
Epoch 418/500
```

```
4/4 [==============================] - 0s 4ms/step - loss: 0.0456 - accuracy:
1.0000
Epoch 419/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0353 - accuracy:
1.0000
Epoch 420/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0341 - accuracy:
1.0000
Epoch 421/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0429 - accuracy:
1.0000
Epoch 422/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0349 - accuracy:
1.0000
Epoch 423/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0389 - accuracy:
1.0000
Epoch 424/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0444 - accuracy:
1.0000
Epoch 425/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0344 - accuracy:
1.0000
Epoch 426/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0414 - accuracy:
1.0000
Epoch 427/500
4/4 [==============================] - 0s 7ms/step - loss: 0.0382 - accuracy:
1.0000
Epoch 428/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0415 - accuracy:
1.0000
Epoch 429/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0394 - accuracy:
1.0000
Epoch 430/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0399 - accuracy:
1.0000
Epoch 431/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0325 - accuracy:
1.0000
Epoch 432/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0416 - accuracy:
1.0000
Epoch 433/500
4/4 [==============================] - 0s 5ms/step - loss: 0.0414 - accuracy:
1.0000
Epoch 434/500
```

```
4/4 [==============================] - 0s 4ms/step - loss: 0.0431 - accuracy:
1.0000
Epoch 435/500
4/4 [==============================] - 0s 5ms/step - loss: 0.0327 - accuracy:
1.0000
Epoch 436/500
4/4 [==============================] - 0s 8ms/step - loss: 0.0424 - accuracy:
1.0000
Epoch 437/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0402 - accuracy:
1.0000
Epoch 438/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0348 - accuracy:
1.0000
Epoch 439/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0395 - accuracy:
1.0000
Epoch 440/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0311 - accuracy:
1.0000
Epoch 441/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0320 - accuracy:
1.0000
Epoch 442/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0317 - accuracy:
1.0000
Epoch 443/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0317 - accuracy:
1.0000
Epoch 444/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0339 - accuracy:
1.0000
Epoch 445/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0354 - accuracy:
1.0000
Epoch 446/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0366 - accuracy:
1.0000
Epoch 447/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0320 - accuracy:
1.0000
Epoch 448/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0332 - accuracy:
1.0000
Epoch 449/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0330 - accuracy:
1.0000
Epoch 450/500
```

```
4/4 [==============================] - 0s 5ms/step - loss: 0.0345 - accuracy:
1.0000
Epoch 451/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0344 - accuracy:
1.0000
Epoch 452/500
4/4 [==============================] - 0s 6ms/step - loss: 0.0342 - accuracy:
1.0000
Epoch 453/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0342 - accuracy:
1.0000
Epoch 454/500
4/4 [==============================] - 0s 6ms/step - loss: 0.0392 - accuracy:
1.0000
Epoch 455/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0325 - accuracy:
1.0000
Epoch 456/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0321 - accuracy:
1.0000
Epoch 457/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0354 - accuracy:
1.0000
Epoch 458/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0386 - accuracy:
1.0000
Epoch 459/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0384 - accuracy:
1.0000
Epoch 460/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0305 - accuracy:
1.0000
Epoch 461/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0330 - accuracy:
1.0000
Epoch 462/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0362 - accuracy:
1.0000
Epoch 463/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0350 - accuracy:
1.0000
Epoch 464/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0374 - accuracy:
1.0000
Epoch 465/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0355 - accuracy:
1.0000
Epoch 466/500
```

```
4/4 [==============================] - 0s 2ms/step - loss: 0.0346 - accuracy:
1.0000
Epoch 467/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0279 - accuracy:
1.0000
Epoch 468/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0350 - accuracy:
1.0000
Epoch 469/500
4/4 [==============================] - 0s 5ms/step - loss: 0.0356 - accuracy:
1.0000
Epoch 470/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0304 - accuracy:
1.0000
Epoch 471/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0292 - accuracy:
1.0000
Epoch 472/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0341 - accuracy:
1.0000
Epoch 473/500
4/4 [==============================] - 0s 5ms/step - loss: 0.0364 - accuracy:
1.0000
Epoch 474/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0279 - accuracy:
1.0000
Epoch 475/500
4/4 [==============================] - 0s 5ms/step - loss: 0.0334 - accuracy:
1.0000
Epoch 476/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0333 - accuracy:
1.0000
Epoch 477/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0295 - accuracy:
1.0000
Epoch 478/500
4/4 [==============================] - 0s 5ms/step - loss: 0.0340 - accuracy:
1.0000
Epoch 479/500
4/4 [==============================] - 0s 9ms/step - loss: 0.0308 - accuracy:
1.0000
Epoch 480/500
4/4 [==============================] - 0s 2ms/step - loss: 0.0331 - accuracy:
1.0000
Epoch 481/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0350 - accuracy:
1.0000
Epoch 482/500
```

```
4/4 [==============================] - 0s 2ms/step - loss: 0.0289 - accuracy:
1.0000
Epoch 483/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0353 - accuracy:
1.0000
Epoch 484/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0278 - accuracy:
1.0000
Epoch 485/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0277 - accuracy:
1.0000
Epoch 486/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0276 - accuracy:
1.0000
Epoch 487/500
4/4 [==============================] - 0s 5ms/step - loss: 0.0285 - accuracy:
1.0000
Epoch 488/500
4/4 [==============================] - 0s 5ms/step - loss: 0.0344 - accuracy:
1.0000
Epoch 489/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0255 - accuracy:
1.0000
Epoch 490/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0281 - accuracy:
1.0000
Epoch 491/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0253 - accuracy:
1.0000
Epoch 492/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0309 - accuracy:
1.0000
Epoch 493/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0278 - accuracy:
1.0000
Epoch 494/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0337 - accuracy:
1.0000
Epoch 495/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0276 - accuracy:
1.0000
Epoch 496/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0276 - accuracy:
1.0000
Epoch 497/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0288 - accuracy:
1.0000
Epoch 498/500
```

```
4/4 [==============================] - 0s 4ms/step - loss: 0.0255 - accuracy:
1.0000
Epoch 499/500
4/4 [==============================] - 0s 4ms/step - loss: 0.0263 - accuracy:
1.0000
Epoch 500/500
4/4 [==============================] - 0s 3ms/step - loss: 0.0311 - accuracy:
1.0000
```
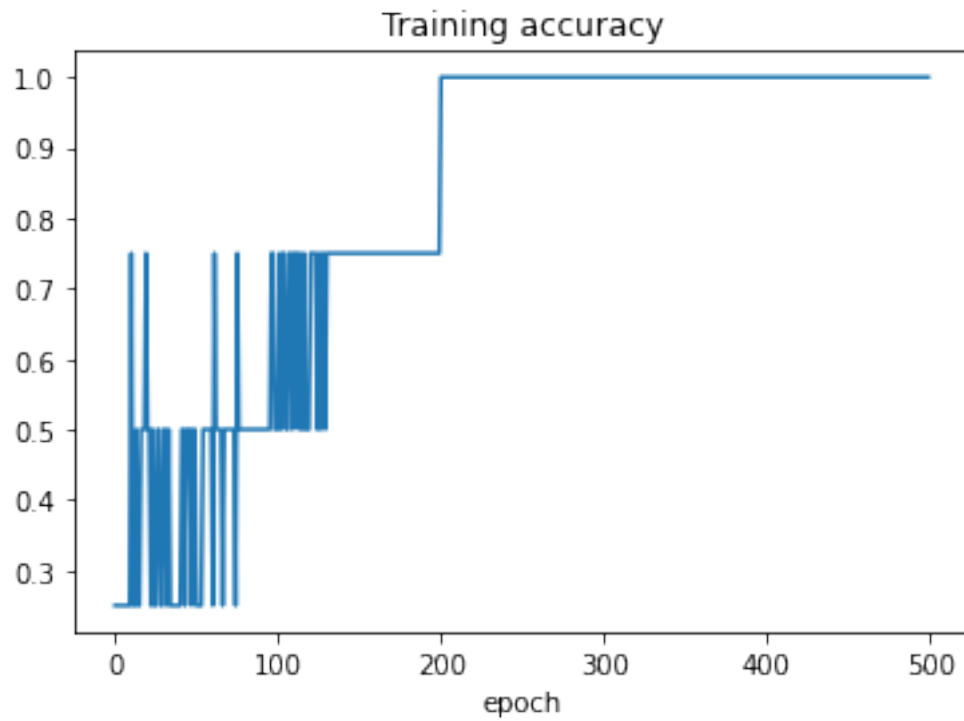
[12]:
```python
plt.plot(history.history['loss'])
plt.title('Loss')
plt.xlabel('epoch')
```

[12]: Text(0.5, 0, 'epoch')
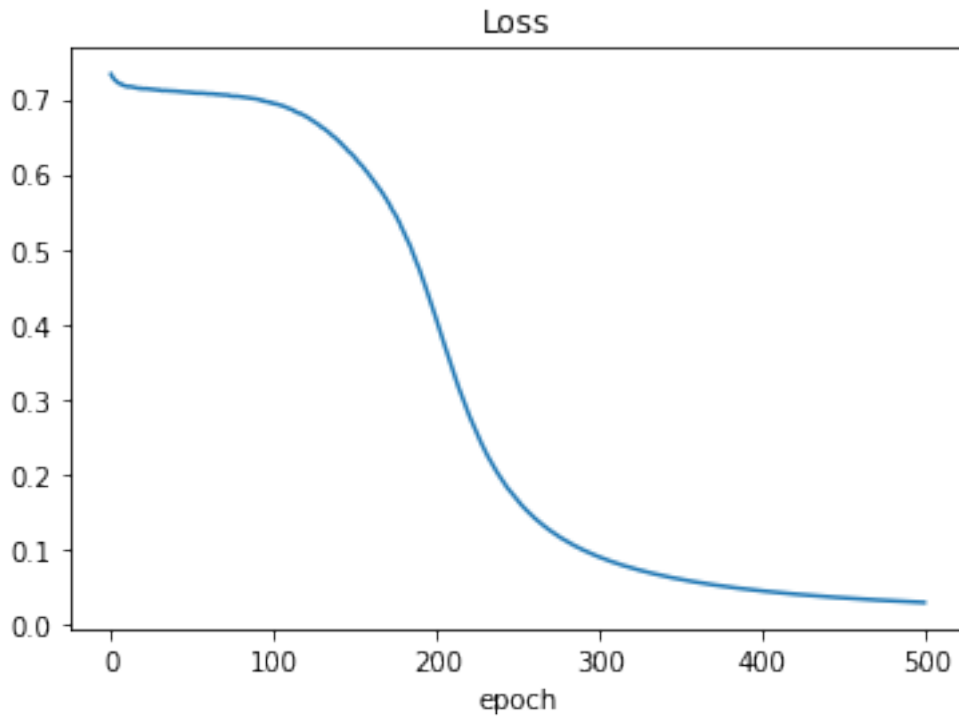
[13]:
```python
plt.plot(history.history['accuracy'])
plt.title('Training accuracy')
plt.xlabel('epoch')
```

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

Training accuracy

[14]:
```
hypothesis = model.predict(x_data)
print(hypothesis)
```

```
[[0.02181283]
 [0.9629215 ]
 [0.96389496]
 [0.01831132]]
```

[15]:
```
predicted = hypothesis > 0.5
print(predicted)
```

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

75 ? 100 75