pratical-12-character

May 9, 2024

```python
import tensorflow
from tensorflow import keras
from tensorflow.keras import Sequential
from tensorflow.keras.layers import Dense,Flatten
```

```python
(X_train,y_train),(X_test,y_test) = keras.datasets.mnist.load_data()
```

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-
datasets/mnist.npz
11490434/11490434 [==============================] - 0s 0us/step
```
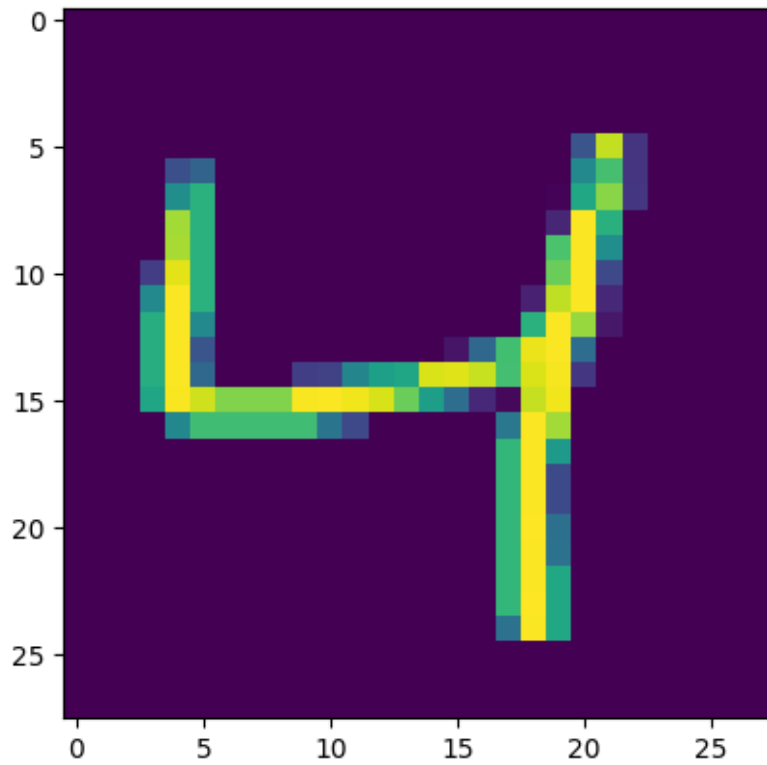
```python
X_test.shape
```

```
(10000, 28, 28)
```

```python
y_train
```

```
array([5, 0, 4, …, 5, 6, 8], dtype=uint8)
```

```python
import matplotlib.pyplot as plt
plt.imshow(X_train[2])
```

```
<matplotlib.image.AxesImage at 0x7d33567e8160>
```

```
X_train = X_train/255
X_test = X_test/255
```

```
X_train[0]
```

```
array([[0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        ],
       [0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        ],
       [0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
```

2

```
    0.        , 0.        , 0.        ],
   [0.        , 0.        , 0.        , 0.        , 0.        ,
    0.        , 0.        , 0.        , 0.        , 0.        ,
    0.        , 0.        , 0.        , 0.        , 0.        ,
    0.        , 0.        , 0.        , 0.        , 0.        ,
    0.        , 0.        , 0.        , 0.        , 0.        ,
    0.        , 0.        , 0.        ],
   [0.        , 0.        , 0.        , 0.        , 0.        ,
    0.        , 0.        , 0.        , 0.        , 0.        ,
    0.        , 0.        , 0.        , 0.        , 0.        ,
    0.        , 0.        , 0.        , 0.        , 0.        ,
    0.        , 0.        , 0.        , 0.        , 0.        ,
    0.        , 0.        , 0.        ],
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    0.        , 0.        , 0.01176471, 0.07058824, 0.07058824,
    0.07058824, 0.49411765, 0.53333333, 0.68627451, 0.10196078,
    0.65098039, 1.        , 0.96862745, 0.49803922, 0.        ,
    0.        , 0.        , 0.        ],
   [0.        , 0.        , 0.        , 0.        , 0.        ,
    0.        , 0.        , 0.        , 0.11764706, 0.14117647,
    0.36862745, 0.60392157, 0.66666667, 0.99215686, 0.99215686,
    0.99215686, 0.99215686, 0.99215686, 0.88235294, 0.6745098 ,
    0.99215686, 0.94901961, 0.76470588, 0.25098039, 0.        ,
    0.        , 0.        , 0.        ],
   [0.        , 0.        , 0.        , 0.        , 0.        ,
    0.        , 0.        , 0.19215686, 0.93333333, 0.99215686,
    0.99215686, 0.99215686, 0.99215686, 0.99215686, 0.99215686,
    0.99215686, 0.99215686, 0.98431373, 0.36470588, 0.32156863,
    0.32156863, 0.21960784, 0.15294118, 0.        , 0.        ,
    0.        , 0.        , 0.        ],
   [0.        , 0.        , 0.        , 0.        , 0.        ,
    0.        , 0.        , 0.07058824, 0.85882353, 0.99215686,
    0.99215686, 0.99215686, 0.99215686, 0.99215686, 0.77647059,
    0.71372549, 0.96862745, 0.94509804, 0.        , 0.        ,
    0.        , 0.        , 0.        , 0.        , 0.        ,
    0.        , 0.        , 0.        ],
   [0.        , 0.        , 0.        , 0.        , 0.        ,
    0.        , 0.        , 0.        , 0.31372549, 0.61176471,
    0.41960784, 0.99215686, 0.99215686, 0.80392157, 0.04313725,
    0.        , 0.16862745, 0.60392157, 0.        , 0.        ,
    0.        , 0.        , 0.        , 0.        , 0.        ,
    0.        , 0.        , 0.        ],
   [0.        , 0.        , 0.        , 0.        , 0.        ,
    0.        , 0.        , 0.        , 0.        , 0.05490196,
    0.00392157, 0.60392157, 0.99215686, 0.35294118, 0.        ,
    0.        , 0.        , 0.        , 0.        , 0.        ,
```

```
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 0.        , 0.        , 0.        ],
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 0.        , 0.        , 0.        ],
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 0.        , 0.        , 0.        ],
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 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.0627451 , 0.36470588, 0.98823529, 0.99215686, 0.73333333,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
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 0.        , 0.        , 0.97647059, 0.99215686, 0.97647059,
 0.25098039, 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.18039216,
```

```
      0.50980392, 0.71764706, 0.99215686, 0.99215686, 0.81176471,
      0.00784314, 0.        , 0.        , 0.        , 0.        ,
      0.        , 0.        , 0.        ],
     [0.        , 0.        , 0.        , 0.        , 0.        ,
      0.        , 0.        , 0.        , 0.        , 0.        ,
      0.        , 0.        , 0.15294118, 0.58039216, 0.89803922,
      0.99215686, 0.99215686, 0.99215686, 0.98039216, 0.71372549,
      0.        , 0.        , 0.        , 0.        , 0.        ,
      0.        , 0.        , 0.        ],
     [0.        , 0.        , 0.        , 0.        , 0.        ,
      0.        , 0.        , 0.        , 0.        , 0.        ,
      0.09411765, 0.44705882, 0.86666667, 0.99215686, 0.99215686,
      0.99215686, 0.99215686, 0.78823529, 0.30588235, 0.        ,
      0.        , 0.        , 0.        , 0.        , 0.        ,
      0.        , 0.        , 0.        ],
     [0.        , 0.        , 0.        , 0.        , 0.        ,
      0.        , 0.        , 0.        , 0.09019608, 0.25882353,
      0.83529412, 0.99215686, 0.99215686, 0.99215686, 0.99215686,
      0.77647059, 0.31764706, 0.00784314, 0.        , 0.        ,
      0.        , 0.        , 0.        , 0.        , 0.        ,
      0.        , 0.        , 0.        ],
     [0.        , 0.        , 0.        , 0.        , 0.        ,
      0.        , 0.07058824, 0.67058824, 0.85882353, 0.99215686,
      0.99215686, 0.99215686, 0.99215686, 0.76470588, 0.31372549,
      0.03529412, 0.        , 0.        , 0.        , 0.        ,
      0.        , 0.        , 0.        , 0.        , 0.        ,
      0.        , 0.        , 0.        ],
     [0.        , 0.        , 0.        , 0.        , 0.21568627,
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      0.99215686, 0.95686275, 0.52156863, 0.04313725, 0.        ,
      0.        , 0.        , 0.        , 0.        , 0.        ,
      0.        , 0.        , 0.        , 0.        , 0.        ,
      0.        , 0.        , 0.        ],
     [0.        , 0.        , 0.        , 0.        , 0.53333333,
      0.99215686, 0.99215686, 0.99215686, 0.83137255, 0.52941176,
      0.51764706, 0.0627451 , 0.        , 0.        , 0.        ,
      0.        , 0.        , 0.        , 0.        , 0.        ,
      0.        , 0.        , 0.        , 0.        , 0.        ,
      0.        , 0.        , 0.        ],
     [0.        , 0.        , 0.        , 0.        , 0.        ,
      0.        , 0.        , 0.        , 0.        , 0.        ,
      0.        , 0.        , 0.        , 0.        , 0.        ,
      0.        , 0.        , 0.        , 0.        , 0.        ,
      0.        , 0.        , 0.        , 0.        , 0.        ,
      0.        , 0.        , 0.        ],
     [0.        , 0.        , 0.        , 0.        , 0.        ,
      0.        , 0.        , 0.        , 0.        , 0.        ,
```

```
           0.        , 0.        , 0.        , 0.        , 0.        ,
           0.        , 0.        , 0.        , 0.        , 0.        ,
           0.        , 0.        , 0.        , 0.        , 0.        ,
           0.        , 0.        , 0.        ],
          [0.        , 0.        , 0.        , 0.        , 0.        ,
           0.        , 0.        , 0.        , 0.        , 0.        ,
           0.        , 0.        , 0.        , 0.        , 0.        ,
           0.        , 0.        , 0.        , 0.        , 0.        ,
           0.        , 0.        , 0.        , 0.        , 0.        ,
           0.        , 0.        , 0.        ]])
```

```python
[ ]: model = Sequential()

     model.add(Flatten(input_shape=(28,28)))
     model.add(Dense(128,activation='relu'))
     model.add(Dense(32,activation='relu'))
     model.add(Dense(10,activation='softmax'))
```

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

```
Model: "sequential"

_____
 Layer (type)                Output Shape              Param #
=================================================================
 flatten (Flatten)           (None, 784)               0

 dense (Dense)               (None, 128)               100480

 dense_1 (Dense)             (None, 32)                4128

 dense_2 (Dense)             (None, 10)                330

=================================================================
Total params: 104938 (409.91 KB)
Trainable params: 104938 (409.91 KB)
Non-trainable params: 0 (0.00 Byte)
_____
```

```python
[ ]: model.
     ↪compile(loss='sparse_categorical_crossentropy',optimizer='Adam',metrics=['accuracy'])
```

```python
[ ]: history = model.fit(X_train,y_train,epochs=25,validation_split=0.2)
```

```
Epoch 1/25
1500/1500 [==============================] - 8s 5ms/step - loss: 0.2850 -
accuracy: 0.9177 - val_loss: 0.1462 - val_accuracy: 0.9571
Epoch 2/25
```

```
1500/1500 [==============================] - 6s 4ms/step - loss: 0.1228 -
accuracy: 0.9634 - val_loss: 0.1319 - val_accuracy: 0.9593
Epoch 3/25
1500/1500 [==============================] - 7s 4ms/step - loss: 0.0862 -
accuracy: 0.9745 - val_loss: 0.1081 - val_accuracy: 0.9688
Epoch 4/25
1500/1500 [==============================] - 5s 4ms/step - loss: 0.0643 -
accuracy: 0.9794 - val_loss: 0.1023 - val_accuracy: 0.9728
Epoch 5/25
1500/1500 [==============================] - 7s 5ms/step - loss: 0.0507 -
accuracy: 0.9841 - val_loss: 0.0941 - val_accuracy: 0.9737
Epoch 6/25
1500/1500 [==============================] - 5s 4ms/step - loss: 0.0395 -
accuracy: 0.9876 - val_loss: 0.1084 - val_accuracy: 0.9706
Epoch 7/25
1500/1500 [==============================] - 7s 4ms/step - loss: 0.0344 -
accuracy: 0.9891 - val_loss: 0.1202 - val_accuracy: 0.9697
Epoch 8/25
1500/1500 [==============================] - 6s 4ms/step - loss: 0.0266 -
accuracy: 0.9912 - val_loss: 0.1071 - val_accuracy: 0.9748
Epoch 9/25
1500/1500 [==============================] - 7s 5ms/step - loss: 0.0232 -
accuracy: 0.9925 - val_loss: 0.1168 - val_accuracy: 0.9720
Epoch 10/25
1500/1500 [==============================] - 5s 4ms/step - loss: 0.0219 -
accuracy: 0.9926 - val_loss: 0.1360 - val_accuracy: 0.9711
Epoch 11/25
1500/1500 [==============================] - 6s 4ms/step - loss: 0.0181 -
accuracy: 0.9940 - val_loss: 0.1127 - val_accuracy: 0.9740
Epoch 12/25
1500/1500 [==============================] - 5s 4ms/step - loss: 0.0157 -
accuracy: 0.9950 - val_loss: 0.1206 - val_accuracy: 0.9753
Epoch 13/25
1500/1500 [==============================] - 6s 4ms/step - loss: 0.0137 -
accuracy: 0.9957 - val_loss: 0.1224 - val_accuracy: 0.9755
Epoch 14/25
1500/1500 [==============================] - 6s 4ms/step - loss: 0.0134 -
accuracy: 0.9953 - val_loss: 0.1414 - val_accuracy: 0.9732
Epoch 15/25
1500/1500 [==============================] - 6s 4ms/step - loss: 0.0131 -
accuracy: 0.9956 - val_loss: 0.1207 - val_accuracy: 0.9771
Epoch 16/25
1500/1500 [==============================] - 7s 4ms/step - loss: 0.0092 -
accuracy: 0.9971 - val_loss: 0.1608 - val_accuracy: 0.9729
Epoch 17/25
1500/1500 [==============================] - 6s 4ms/step - loss: 0.0144 -
accuracy: 0.9950 - val_loss: 0.1378 - val_accuracy: 0.9741
Epoch 18/25
```

```
1500/1500 [==============================] - 7s 4ms/step - loss: 0.0102 -
accuracy: 0.9965 - val_loss: 0.1451 - val_accuracy: 0.9754
Epoch 19/25
1500/1500 [==============================] - 5s 4ms/step - loss: 0.0106 -
accuracy: 0.9958 - val_loss: 0.1571 - val_accuracy: 0.9737
Epoch 20/25
1500/1500 [==============================] - 7s 4ms/step - loss: 0.0112 -
accuracy: 0.9960 - val_loss: 0.1470 - val_accuracy: 0.9747
Epoch 21/25
1500/1500 [==============================] - 5s 4ms/step - loss: 0.0068 -
accuracy: 0.9979 - val_loss: 0.1562 - val_accuracy: 0.9753
Epoch 22/25
1500/1500 [==============================] - 7s 4ms/step - loss: 0.0091 -
accuracy: 0.9971 - val_loss: 0.1507 - val_accuracy: 0.9773
Epoch 23/25
1500/1500 [==============================] - 5s 4ms/step - loss: 0.0066 -
accuracy: 0.9978 - val_loss: 0.1569 - val_accuracy: 0.9783
Epoch 24/25
1500/1500 [==============================] - 7s 5ms/step - loss: 0.0108 -
accuracy: 0.9963 - val_loss: 0.1622 - val_accuracy: 0.9758
Epoch 25/25
1500/1500 [==============================] - 5s 4ms/step - loss: 0.0077 -
accuracy: 0.9974 - val_loss: 0.1702 - val_accuracy: 0.9745
```

[ ]:
```python
y_prob = model.predict(X_test)
```

```
313/313 [==============================] - 1s 2ms/step
```

[ ]:
```python
y_pred = y_prob.argmax(axis=1)
```

[ ]:
```python
from sklearn.metrics import accuracy_score
accuracy_score(y_test,y_pred)
```
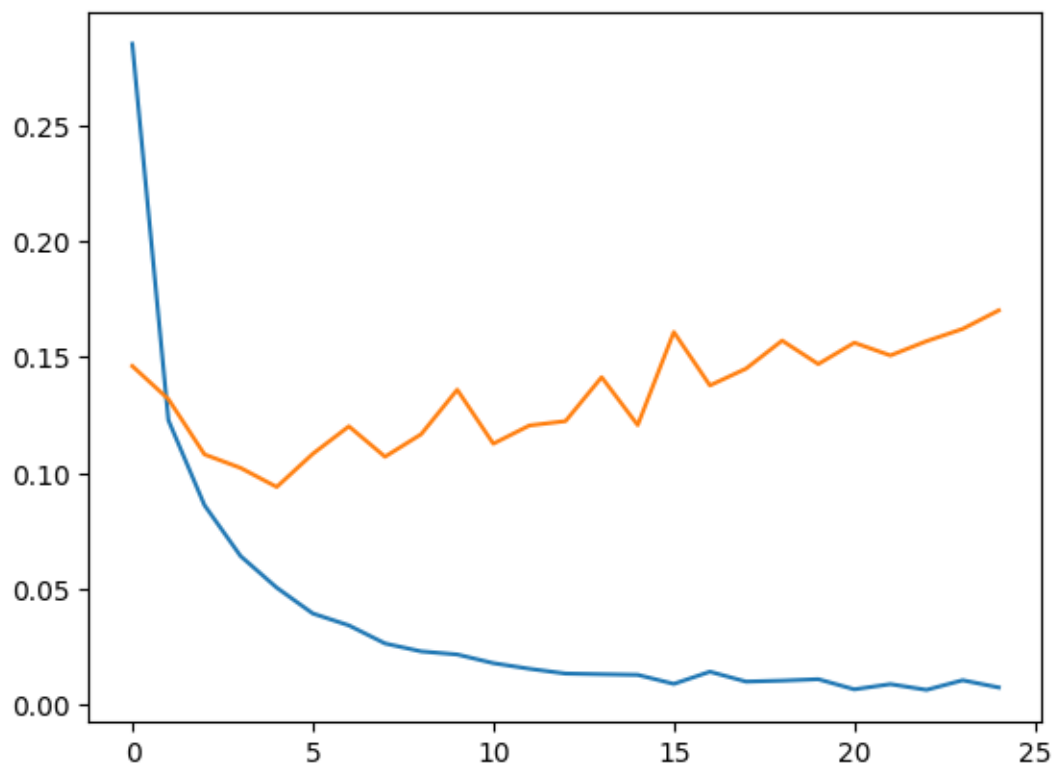
[ ]: 0.9768

[ ]:
```python
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
```

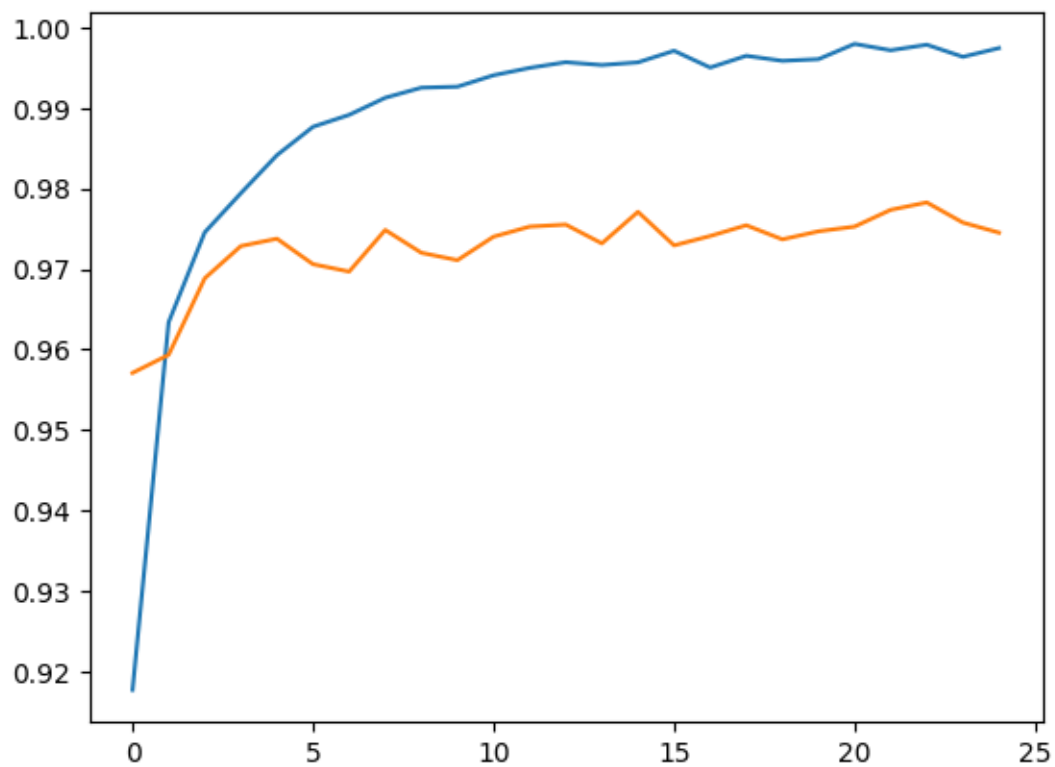[ ]: [<matplotlib.lines.Line2D at 0x7d33507c1570>]
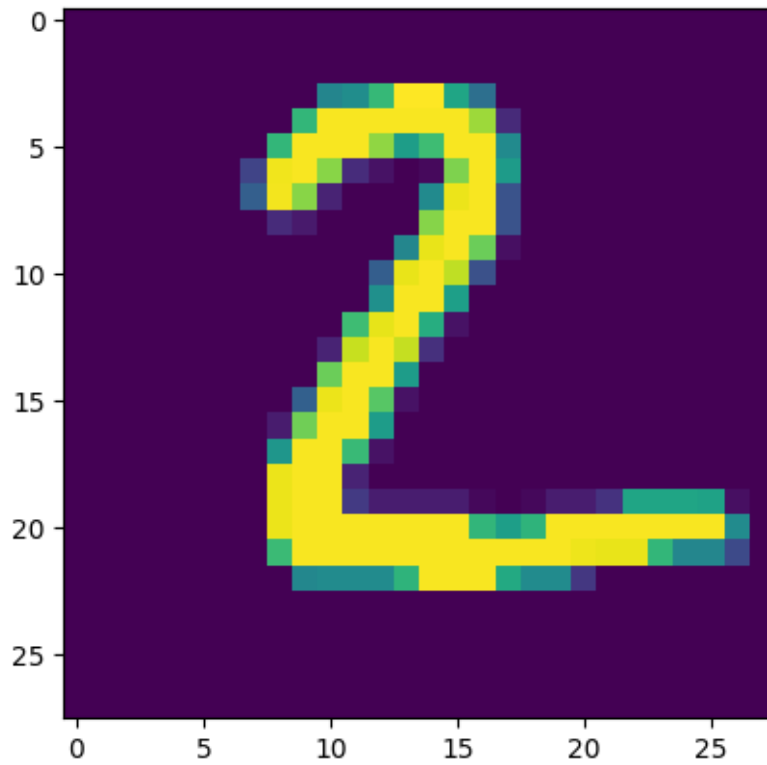
```
[ ]: plt.plot(history.history['accuracy'])
     plt.plot(history.history['val_accuracy'])
```

```
[ ]: [<matplotlib.lines.Line2D at 0x7d3330a6d5d0>]
```

```
[ ]: plt.imshow(X_test[1])
```

```
[ ]: <matplotlib.image.AxesImage at 0x7d33303b3850>
```

```
model.predict(X_test[1].reshape(1,28,28)).argmax(axis=1)
```

```
1/1 [==============================] - 0s 89ms/step
```

```
array([2])
```