

kmestcbcy

March 25, 2025

```
[1]: import tensorflow
      from tensorflow import keras
      from tensorflow.keras import Sequential
      from tensorflow.keras.layers import Dense, Flatten
```

```
[2]: (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
```

```
[3]: X_test.shape
```

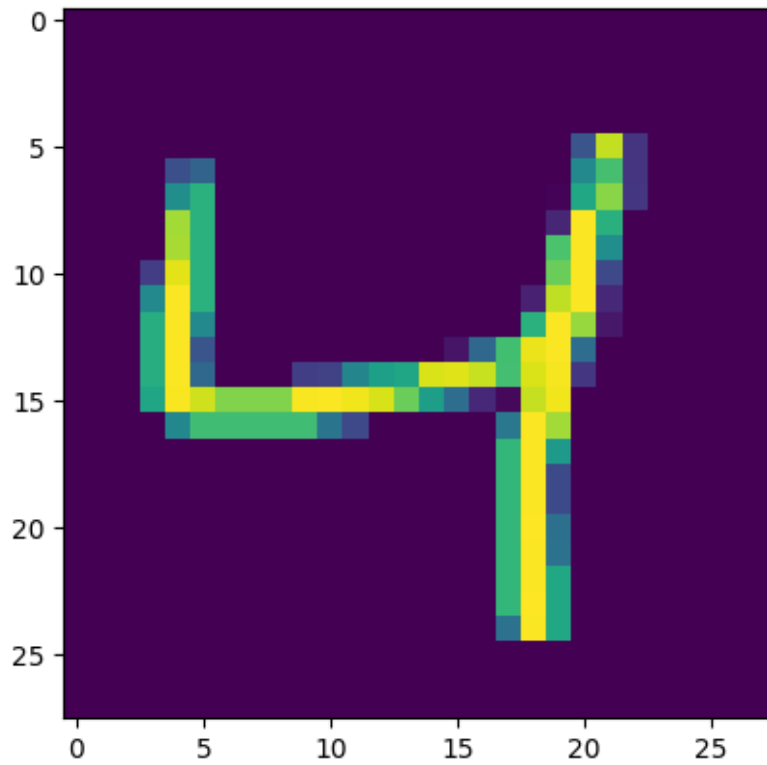
```
[3]: (10000, 28, 28)
```

```
[4]: y_train
```

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

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

```
[5]: <matplotlib.image.AxesImage at 0x7f529df874d0>
```



```
[6]: X_train = X_train/255
      X_test = X_test/255
```

```
[7]: X_train[0]
```

```
[7]: array([[0.      , 0.      , 0.      , 0.      , 0.      ,
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            0.      , 0.      , 0.      ]])
```

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```

```
[8]: 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'))
```

```

/usr/local/lib/python3.11/dist-
packages/keras/src/layers/resizing/flatten.py:37: UserWarning: Do not pass an
`input_shape`/`input_dim` argument to a layer. When using Sequential models,
prefer using an `Input(shape)` object as the first layer in the model instead.
super().__init__(**kwargs)

```

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

Model: "sequential"

Layer (type)	Output Shape	
Param #		
flatten (Flatten)	(None, 784)	
↪ 0		
dense (Dense)	(None, 128)	
↪ 100,480		
dense_1 (Dense)	(None, 32)	
↪ 4,128		
dense_2 (Dense)	(None, 10)	
↪ 330		

Total params: 104,938 (409.91 KB)

Trainable params: 104,938 (409.91 KB)

Non-trainable params: 0 (0.00 B)

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

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

```
Epoch 1/25  
1500/1500          31s 19ms/step -  
accuracy: 0.8534 - loss: 0.5003 - val_accuracy: 0.9592 - val_loss: 0.1450  
Epoch 2/25  
1500/1500          27s 10ms/step -  
accuracy: 0.9621 - loss: 0.1287 - val_accuracy: 0.9664 - val_loss: 0.1150  
Epoch 3/25  
1500/1500          11s 7ms/step -  
accuracy: 0.9732 - loss: 0.0862 - val_accuracy: 0.9685 - val_loss: 0.1105  
Epoch 4/25  
1500/1500           7s 5ms/step -  
accuracy: 0.9818 - loss: 0.0606 - val_accuracy: 0.9715 - val_loss: 0.0990  
Epoch 5/25  
1500/1500           8s 6ms/step -  
accuracy: 0.9857 - loss: 0.0473 - val_accuracy: 0.9736 - val_loss: 0.0936  
Epoch 6/25  
1500/1500           7s 5ms/step -  
accuracy: 0.9891 - loss: 0.0353 - val_accuracy: 0.9723 - val_loss: 0.1043  
Epoch 7/25  
1500/1500          10s 5ms/step -  
accuracy: 0.9897 - loss: 0.0318 - val_accuracy: 0.9744 - val_loss: 0.1004  
Epoch 8/25  
1500/1500           8s 6ms/step -  
accuracy: 0.9921 - loss: 0.0238 - val_accuracy: 0.9763 - val_loss: 0.0905  
Epoch 9/25  
1500/1500           8s 6ms/step -  
accuracy: 0.9926 - loss: 0.0217 - val_accuracy: 0.9764 - val_loss: 0.1013  
Epoch 10/25  
1500/1500           8s 5ms/step -  
accuracy: 0.9952 - loss: 0.0156 - val_accuracy: 0.9718 - val_loss: 0.1261  
Epoch 11/25  
1500/1500           8s 5ms/step -  
accuracy: 0.9940 - loss: 0.0173 - val_accuracy: 0.9772 - val_loss: 0.1032  
Epoch 12/25  
1500/1500          14s 8ms/step -  
accuracy: 0.9949 - loss: 0.0168 - val_accuracy: 0.9777 - val_loss: 0.1108
```

```

Epoch 13/25
1500/1500          10s 7ms/step -
accuracy: 0.9957 - loss: 0.0124 - val_accuracy: 0.9728 - val_loss: 0.1305
Epoch 14/25
1500/1500          7s 5ms/step -
accuracy: 0.9956 - loss: 0.0134 - val_accuracy: 0.9730 - val_loss: 0.1385
Epoch 15/25
1500/1500         11s 5ms/step -
accuracy: 0.9960 - loss: 0.0124 - val_accuracy: 0.9762 - val_loss: 0.1269
Epoch 16/25
1500/1500          8s 6ms/step -
accuracy: 0.9957 - loss: 0.0134 - val_accuracy: 0.9741 - val_loss: 0.1323
Epoch 17/25
1500/1500          9s 5ms/step -
accuracy: 0.9970 - loss: 0.0102 - val_accuracy: 0.9751 - val_loss: 0.1407
Epoch 18/25
1500/1500          7s 5ms/step -
accuracy: 0.9957 - loss: 0.0129 - val_accuracy: 0.9767 - val_loss: 0.1283
Epoch 19/25
1500/1500          8s 5ms/step -
accuracy: 0.9970 - loss: 0.0093 - val_accuracy: 0.9772 - val_loss: 0.1403
Epoch 20/25
1500/1500         10s 5ms/step -
accuracy: 0.9971 - loss: 0.0083 - val_accuracy: 0.9743 - val_loss: 0.1572
Epoch 21/25
1500/1500          7s 5ms/step -
accuracy: 0.9968 - loss: 0.0106 - val_accuracy: 0.9773 - val_loss: 0.1382
Epoch 22/25
1500/1500          8s 5ms/step -
accuracy: 0.9979 - loss: 0.0066 - val_accuracy: 0.9768 - val_loss: 0.1466
Epoch 23/25
1500/1500         10s 5ms/step -
accuracy: 0.9985 - loss: 0.0049 - val_accuracy: 0.9745 - val_loss: 0.1645
Epoch 24/25
1500/1500         10s 5ms/step -
accuracy: 0.9967 - loss: 0.0090 - val_accuracy: 0.9751 - val_loss: 0.1560
Epoch 25/25
1500/1500         10s 5ms/step -
accuracy: 0.9983 - loss: 0.0058 - val_accuracy: 0.9756 - val_loss: 0.1640

```

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

```
313/313          1s 2ms/step
```

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

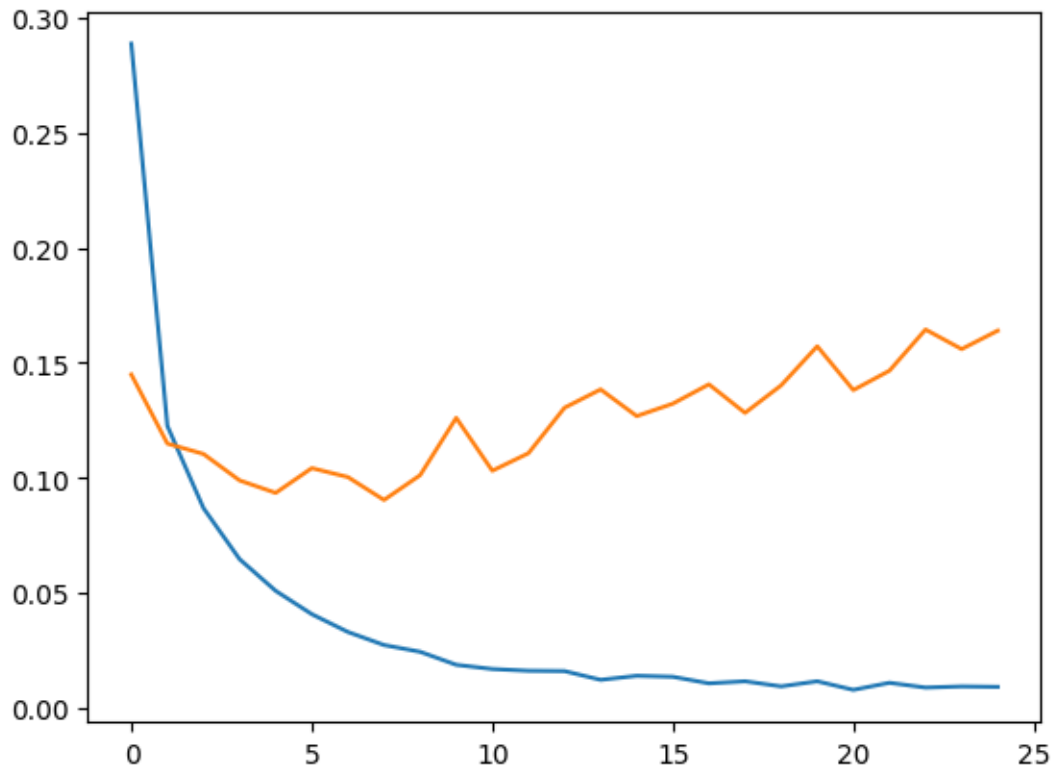


```
[21]: from sklearn.metrics import accuracy_score
accuracy_score(y_test,y_pred)
```

[21]: 0.9763

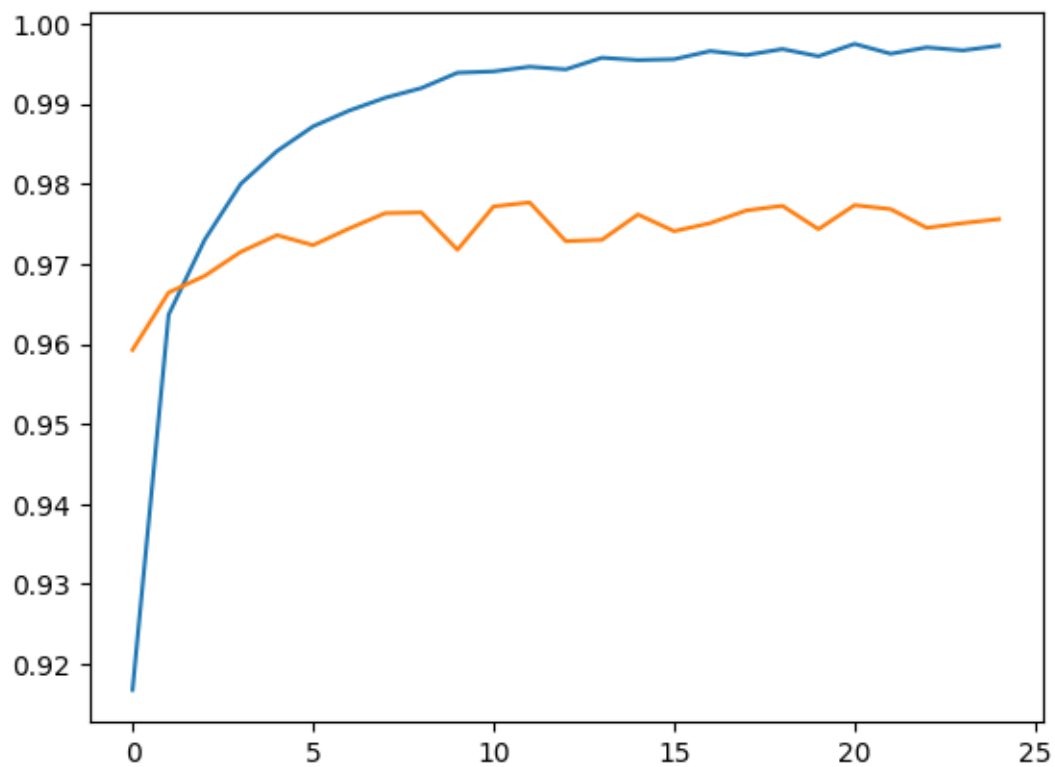
```
[15]: plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
```

[15]: [<matplotlib.lines.Line2D at 0x7f51fad79d10>]



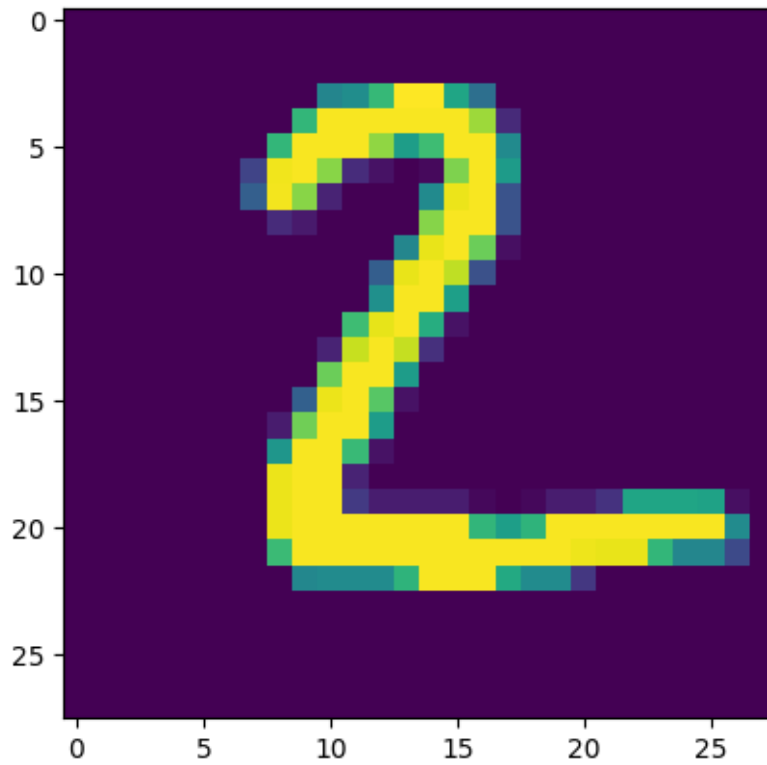
```
[16]: plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
```

[16]: [<matplotlib.lines.Line2D at 0x7f51fad1cf50>]



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

```
[17]: <matplotlib.image.AxesImage at 0x7f51fdd41150>
```



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

1/1      0s 39ms/step

```
[18]: array([2])
```

```
[18]:
```