mnist

September 18, 2024

[ ]:

```
from tensorflow.keras.datasets import mnist
from tensorflow import keras
from tensorflow.keras import layers
```

[ ]:

```
(train_images, train_labels), (test_images, test_labels) = mnist.load_data()
print(train_images.shape)
print(test_images.shape)
len(test_labels)
```

```
(60000, 28, 28)
(10000, 28, 28)
```

[ ]:

```
10000
```

[ ]:

```
img_rows = train_images[0].shape[0]
img_cols = train_images[0].shape[1]


train_images = train_images.astype("float32") / 255.0

test_images = test_images.astype("float32") / 255.0

print(train_images.shape)
```

```
(60000, 28, 28)
```

[ ]:

```
model = keras.Sequential([
    layers.Conv2D(10, (5, 5), activation='relu', input_shape=(28, 28, 1)),
    # layers.MaxPooling2D((2, 2)),
    layers.Conv2D(20, (5, 5), activation='relu'),
    layers.MaxPooling2D((2, 2)),
    layers.Flatten(),
    layers.Dense(10, activation='softmax')
])

model.summary()

model.compile(optimizer="sgd", loss="sparse_categorical_crossentropy",␣
  ↪metrics=["accuracy"])
```

```
d:\DataScience\Anaconda3\envs\tensorflow\lib\site-
packages\keras\src\layers\convolutional\base_conv.py:107: 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__(activity_regularizer=activity_regularizer, **kwargs)
```

```
Model: "sequential_2"


 Layer (type)                      Output Shape                  Param #

 conv2d_4 (Conv2D)                 (None, 24, 24, 10)                260

 conv2d_5 (Conv2D)                 (None, 20, 20, 20)              5,020

 max_pooling2d_3 (MaxPooling2D)    (None, 10, 10, 20)                  0

 flatten_2 (Flatten)               (None, 2000)                        0

 dense_2 (Dense)                   (None, 10)                         20,010


 Total params: 25,290 (98.79 KB)

 Trainable params: 25,290 (98.79 KB)

 Non-trainable params: 0 (0.00 B)
```

[ ]:
```
train_images = train_images.reshape(train_images.shape[0], img_rows, img_cols, 1)
test_images = test_images.reshape(test_images.shape[0], img_rows, img_cols, 1)

history = model.fit(train_images, train_labels, epochs=20, batch_size=128)
```

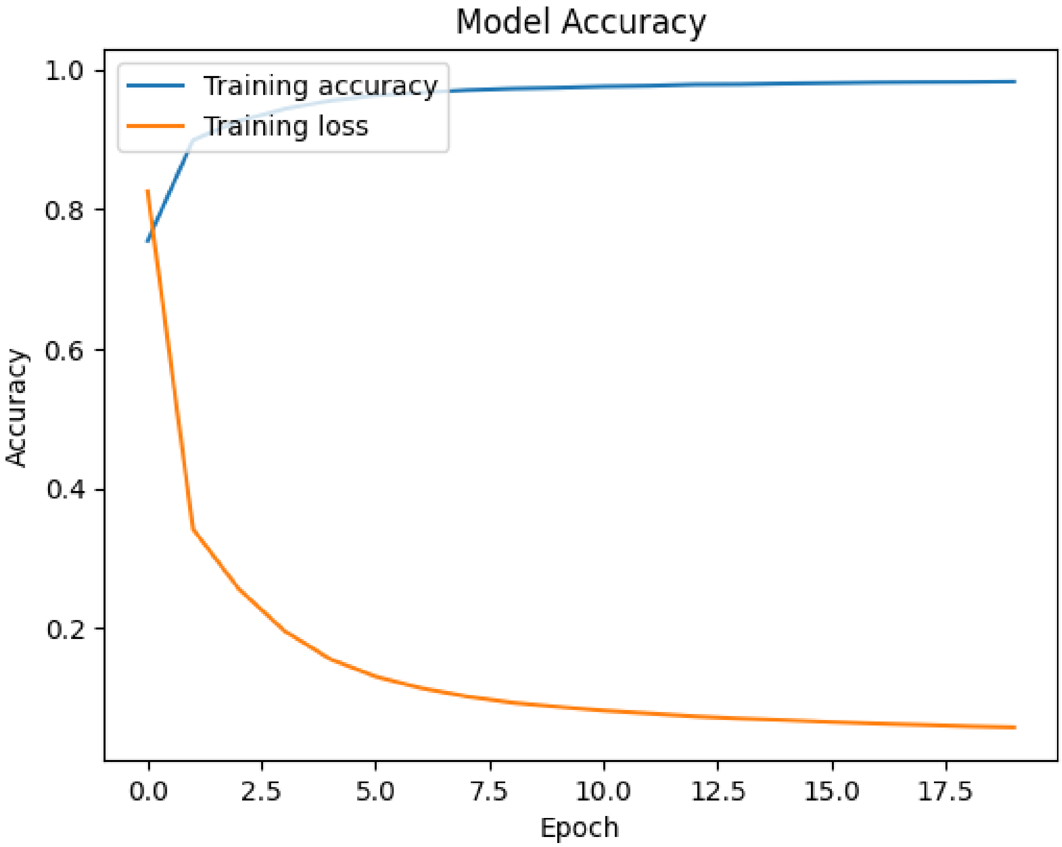
```
Epoch 1/20
469/469             7s 14ms/step -
accuracy: 0.5600 - loss: 1.4025
Epoch 2/20
469/469             6s 14ms/step -
accuracy: 0.8934 - loss: 0.3570
Epoch 3/20
469/469             6s 14ms/step -
accuracy: 0.9222 - loss: 0.2674
Epoch 4/20
```

```
469/469              6s 14ms/step -
accuracy: 0.9413 - loss: 0.2038
Epoch 5/20
469/469              6s 14ms/step -
accuracy: 0.9542 - loss: 0.1582
Epoch 6/20
469/469              6s 14ms/step -
accuracy: 0.9626 - loss: 0.1325
Epoch 7/20
469/469              7s 14ms/step -
accuracy: 0.9666 - loss: 0.1130
Epoch 8/20
469/469              7s 14ms/step -
accuracy: 0.9700 - loss: 0.1053
Epoch 9/20
469/469              7s 14ms/step -
accuracy: 0.9726 - loss: 0.0930
Epoch 10/20
469/469              7s 14ms/step -
accuracy: 0.9751 - loss: 0.0847
Epoch 11/20
469/469              7s 14ms/step -
accuracy: 0.9761 - loss: 0.0801
Epoch 12/20
469/469              7s 14ms/step -
accuracy: 0.9780 - loss: 0.0742
Epoch 13/20
469/469              7s 14ms/step -
accuracy: 0.9781 - loss: 0.0718
Epoch 14/20
469/469              7s 15ms/step -
accuracy: 0.9784 - loss: 0.0716
Epoch 15/20
469/469              7s 14ms/step -
accuracy: 0.9810 - loss: 0.0648
Epoch 16/20
469/469              7s 14ms/step -
accuracy: 0.9802 - loss: 0.0665
Epoch 17/20
469/469              7s 15ms/step -
accuracy: 0.9807 - loss: 0.0664
Epoch 18/20
469/469              7s 14ms/step -
accuracy: 0.9822 - loss: 0.0607
Epoch 19/20
469/469              7s 14ms/step -
accuracy: 0.9825 - loss: 0.0573
Epoch 20/20
```

```
469/469              7s 15ms/step -
accuracy: 0.9834 - loss: 0.0557
```

```
[ ]: import matplotlib.pyplot as plt


     plt.plot(history.history['accuracy'], label='Training accuracy')
     plt.plot(history.history['loss'], label='Training loss')
     plt.title('Model Accuracy')
     plt.xlabel('Epoch')
     plt.ylabel('Accuracy')
     plt.legend(loc='upper left')
     plt.show()
```



I used the same model architecture we used in the lab.