# mnist

March 13, 2025

[1]:

```
import tensorflow as tf # type: ignore
from tensorflow.keras.datasets import mnist # type: ignore
from tensorflow.keras.models import Sequential # type: ignore
from tensorflow.keras.layers import Dense, Dropout, Flatten, Conv2D,␣
 ↪MaxPooling2D
from tensorflow.keras.utils import to_categorical
import matplotlib.pyplot as plt # type: ignore
```

[2]:

```
#load MNIST dataset
(x_train, y_train), (x_test, y_test) = mnist.load_data()
```

[3]:

```
x_train.shape
```

[3]:

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

[4]:

```
x_test.shape
```

[4]:

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

[5]:

```
print(y_test)
```

```
[7 2 1 … 4 5 6]
```

[6]:

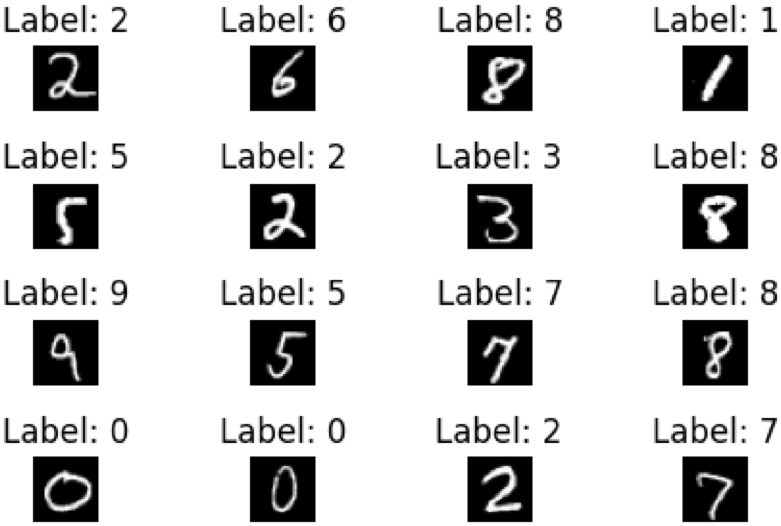
```
#Displaying sample images from MNIST dataset
#select random indices for displaying images
import numpy as np # type: ignore
indices = np.random.randint(0, x_train.shape[0], size = 16)

#create a fig and subplots
fig, axes = plt.subplots(4, 4, figsize=[5, 3])

#flatten the axes array for easy iteration
axes = axes.flatten()

for i,ax in enumerate(axes):
    image = x_train[indices[i]]
    label = y_train[indices[i]]
    ax.imshow(image, cmap='gray')
    ax.set_title(f"Label: {label}")
    ax.axis('off')

plt.tight_layout()
plt.show()
```



[10]:

```
#reshape data for cnn input
img_rows, img_cols = 28, 28
x_train = x_train.reshape(x_train.shape[0], img_rows, img_cols, 1)
x_test = x_test.reshape(x_test.shape[0], img_rows,img_cols,1)
```

[ ]:

```
'''purpose of reshaping
--------------------------
is to transform data into 4d array, which is the std format for img dta in CNN.
the dimension represent:
no of samples - tot no of img in dataset
img height - height of each img in pixels
img width - width of each img in pixels
no of channels - no of color channels in img

'''
```

[ ]:

```
'purpose of reshaping\nis to transform data into 4d array, which is the std
format for img dta in CNN. \nthe dimension represent: \nno of samples - tot no
of img in dataset\nimg height - height of each img in pixels\nimg width - width
of each img in pixels\nno of channels - no of color channels in img\n\n'
```

[ ]:

```
#x_test.shape
x_train.shape
```

[ ]:

```
(60000, 28, 28, 1)
```

[ ]:

```
#normalize pixel values to bw 0 and 1
x_train = x_train / 255.0
x_test = x_test / 255.0
```

[14]:

```
#convert class vectors to binary class matrices
num_classes = 10
y_train = to_categorical(y_train, num_classes)
y_test = to_categorical(y_test, num_classes)
```

[15]:

```
print(y_test)
```

```
[[0. 0. 0. … 1. 0. 0.]
 [0. 0. 1. … 0. 0. 0.]
 [0. 1. 0. … 0. 0. 0.]
 …
 [0. 0. 0. … 0. 0. 0.]
 [0. 0. 0. … 0. 0. 0.]
 [0. 0. 0. … 0. 0. 0.]]
```

[16]:

```
#creat a cnn model
model = Sequential()
model.add(Conv2D(32, kernel_size=(3,3), activation='relu', input_shape =␣
 ↪(28,28,1)))
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Flatten())
model.add(Dense(128, activation='relu'))
model.add(Dense(num_classes, activation='softmax'))
```

```
C:\Users\KH.EN.P2MCA24006\AppData\Local\Packages\PythonSoftwareFoundation.Python
.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\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)
```

[17]:

```
#compile the model
model.compile(loss='categorical_crossentropy', optimizer='adam',␣
 ↪metrics=['accuracy'])
```

[18]:

```
history = model.fit(x_train, y_train, batch_size=128, epochs=10, verbose=1,␣
 ↪validation_data=(x_test, y_test))
```

```
Epoch 1/10
469/469                    16s 31ms/step -
accuracy: 0.8750 - loss: 0.4466 - val_accuracy: 0.9753 - val_loss: 0.0821
Epoch 2/10
469/469                    15s 32ms/step -
accuracy: 0.9788 - loss: 0.0694 - val_accuracy: 0.9831 - val_loss: 0.0538
Epoch 3/10
469/469                    15s 31ms/step -
accuracy: 0.9860 - loss: 0.0481 - val_accuracy: 0.9819 - val_loss: 0.0557
Epoch 4/10
469/469                    15s 32ms/step -
accuracy: 0.9899 - loss: 0.0340 - val_accuracy: 0.9848 - val_loss: 0.0462
Epoch 5/10
469/469                    17s 37ms/step -
accuracy: 0.9934 - loss: 0.0234 - val_accuracy: 0.9833 - val_loss: 0.0495
Epoch 6/10
469/469                    18s 31ms/step -
accuracy: 0.9946 - loss: 0.0183 - val_accuracy: 0.9863 - val_loss: 0.0414
Epoch 7/10
469/469                    14s 30ms/step -
accuracy: 0.9960 - loss: 0.0145 - val_accuracy: 0.9871 - val_loss: 0.0395
Epoch 8/10
469/469                    15s 31ms/step -
accuracy: 0.9973 - loss: 0.0099 - val_accuracy: 0.9862 - val_loss: 0.0462
Epoch 9/10
469/469                    15s 31ms/step -
accuracy: 0.9978 - loss: 0.0086 - val_accuracy: 0.9873 - val_loss: 0.0439
Epoch 10/10
469/469                    14s 30ms/step -
accuracy: 0.9980 - loss: 0.0070 - val_accuracy: 0.9862 - val_loss: 0.0445
```

[19]:

```
model.summary()
```

```
Model: "sequential"


 Layer (type)                      Output Shape                  Param #

 conv2d (Conv2D)                   (None, 26, 26, 32)                320

 max_pooling2d (MaxPooling2D)      (None, 13, 13, 32)                  0

 flatten (Flatten)                 (None, 5408)                        0

 dense (Dense)                     (None, 128)                   692,352

 dense_1 (Dense)                   (None, 10)                      1,290
```

```
Total params: 2,081,888 (7.94 MB)

Trainable params: 693,962 (2.65 MB)

Non-trainable params: 0 (0.00 B)

Optimizer params: 1,387,926 (5.29 MB)
```

```
[ ]:
```