DEEP LEARNING

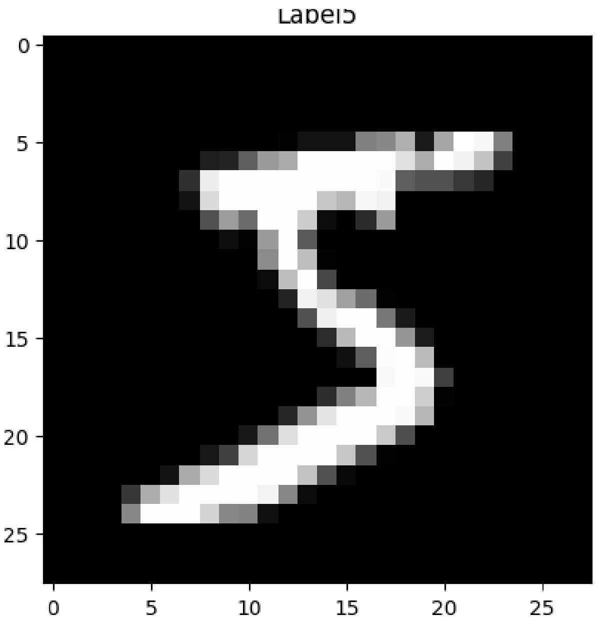
```
import matplotlib.pyplot as plt
import tensorflow as tf
from tensorflow.keras import layers, models
```

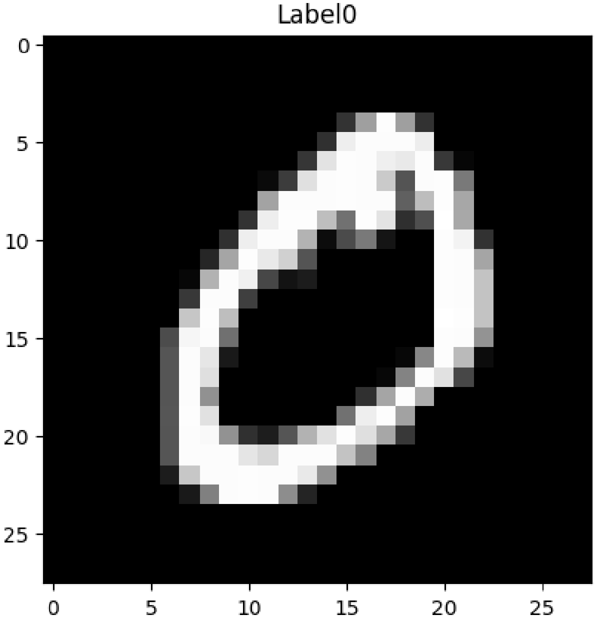
```
#Load the MNIST  dataset
```

```
(x_train,y_train),(x_test,y_test)=tf.keras.datasets.mnist.load_data()
```

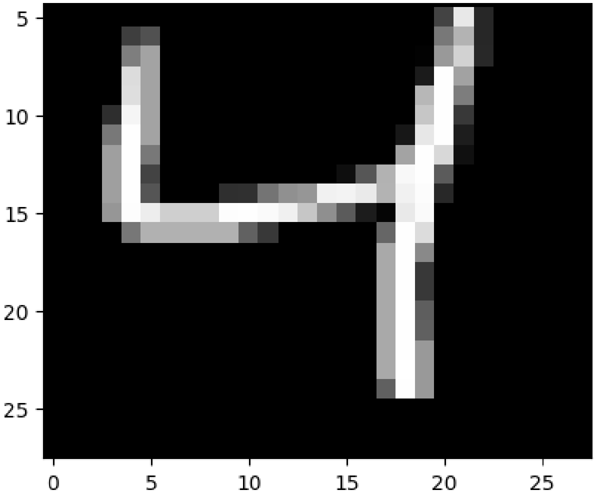
```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/mnist.npz
11490434/11490434 ━━━━━━━━━━━━━━━━━━━━ 0s 0us/step
```

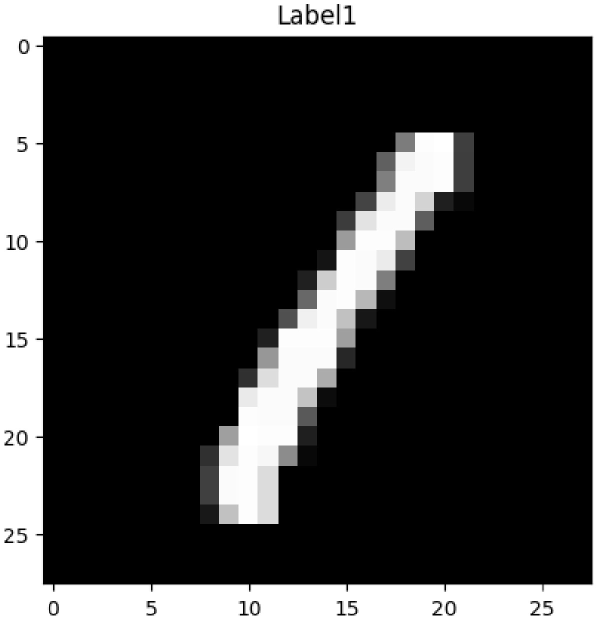
```
#display the first 5 images and label from training set

for i in range(5):
    plt.imshow(x_train[i],cmap='gray')
    plt.title("Label"+ str(y_train[i]))
    plt.show()
```

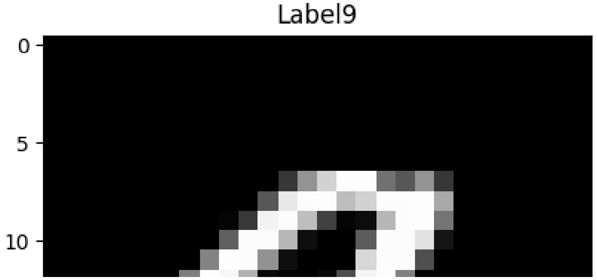

Label5
0
5
10
15
20
25
0
5
10
15
20
25

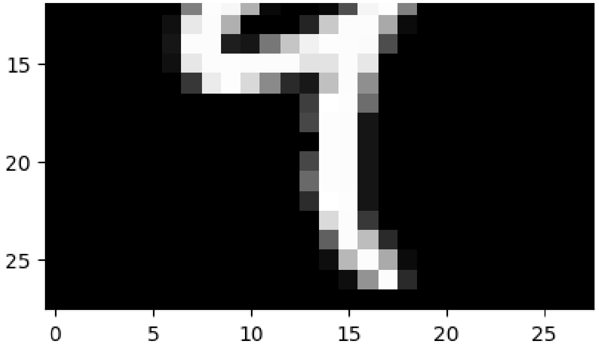

Label0
0
5
10
15
20
25
0
5
10
15
20
25

Label4
0


5
10
15
20
25
0
5
10
15
20
25


Label1
0
5
10
15
20
25
0
5
10
15
20
25


Label9
0
5
10


15
20
25
0
5
10
15
20
25

```
#Normalize the images (from [0,255] to [0,1])

x_train=x_train.astype('float32')/255.0
x_test=x_test.reshape((x_test.shape[0],28,28,1))


#Check the shapes of the data
print(f'Training data shape:{x_train.shape},Label shape:{y_train.shape}')
```

```
Training data shape:(60000, 28, 28),Label shape:(60000,)
```

```
print(f'Test data shape:{x_test.shape},Label shape:{y_test.shape}')
```

```
Test data shape:(10000, 28, 28, 1),Label shape:(10000,)
```

```
#one-hot encode the labels

y_train=tf.keras.utils.to_categorical(y_train,10)
y_test=tf.keras.utils.to_categorical(y_test,10)


#Buid the CNN model

model= models.Sequential()


#First convolutional layer with 32 filters, 3x3 kernel size, and ReLu activation

model.add(layers.Conv2D(32,(3,3),activation='relu',input_shape=(28,28,1)))
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/convolutional/base_conv.py:107: UserWarning: Do not pass an `input_shape`/`input_dim` argument to a layer. When using
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
```

```
##second convolutional layer with 64 filters, 3x3 kernel size, and ReLu activation

model.add(layers.Conv2D(64,(3,3),activation='relu'))


#maxpooling layer to downsample by 2x2

model.add(layers.MaxPooling2D((2,2)))


#dropout layer for regularization

model.add(layers.Dropout(0.25))
```

```
#flatten the feature maps into a 1D feature vector

model.add(layers.Flatten())


#fully connected dense layer with 128 units and relu activation

model.add(layers.Dense(128,activation='relu'))


#Dropout layer to prevent overfitting

model.add(layers.Dropout(0.5))


#Output layer with 10 units (one for each class) and softmax activation

model.add(layers.Dense(10,activation='softmax'))


#Compile the model

model.compile(optimizer='adam',loss='categorical_crossentropy',metrics=['accuracy'])


#display the summary of model

model.summary()
```

```
Model: "sequential"
┏━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━┓
┃ Layer (type)                         ┃ Output Shape                ┃         Param # ┃
┡━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━┩
│ conv2d (Conv2D)                      │ (None, 26, 26, 32)          │             320 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ conv2d_1 (Conv2D)                    │ (None, 24, 24, 64)          │          18,496 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ max_pooling2d (MaxPooling2D)         │ (None, 12, 12, 64)          │               0 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ dropout (Dropout)                    │ (None, 12, 12, 64)          │               0 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ flatten (Flatten)                    │ (None, 9216)                │               0 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ dense (Dense)                        │ (None, 10)                  │          92,170 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ dense_1 (Dense)                      │ (None, 128)                 │           1,408 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ dropout_1 (Dropout)                  │ (None, 128)                 │               0 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ dense_2 (Dense)                      │ (None, 10)                  │           1,290 │
└──────────────────────────────────────┴─────────────────────────────┴─────────────────┘
 Total params: 113,684 (444.08 KB)
```

```
#train the model
```