practical-3-dl

[1]:
```
#Name: Subodh Chaudhari
 #Roll No:13
#Batch: B1 [IT]
```

[3]:
```
#Build the Image classification model by dividing the model into following 4 stages:
#1.Loading and preprocessing the image data
#2.Defining the model's architecture
#3.Training the model
#4.Estimating the model's performance
```

[6]:
```
import numpy as np
import pandas as pd
import random
import tensorflow as tf
import matplotlib.pyplot as plt
from sklearn.metrics import accuracy_score
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Flatten, Conv2D, Dense, MaxPooling2D
from tensorflow.keras.optimizers import SGD
from tensorflow.keras.utils import to_categorical
from tensorflow.keras.datasets import mnist
```

[8]:
```
# Loading and preprocessing the image data
(X_train, y_train), (X_test, y_test) = mnist.load_data()
```

[9]:
```
print(X_train.shape)
(60000, 28, 28)
```

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

[9]:
```
(60000, 28, 28)
```

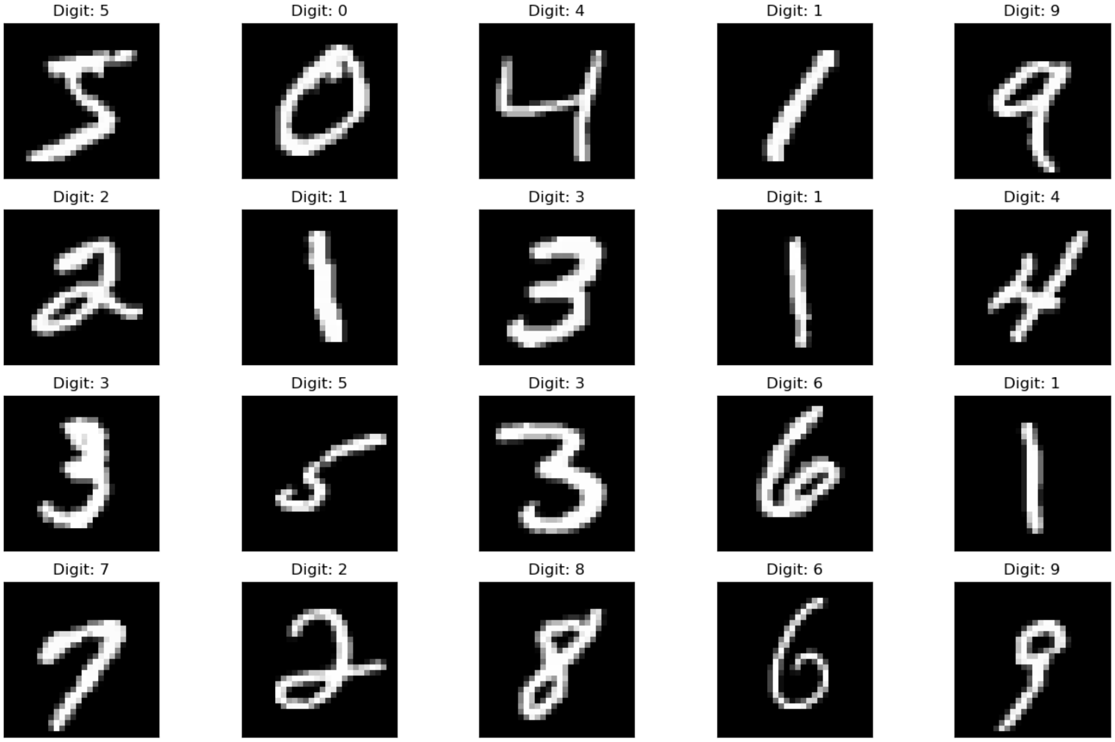
[10]:
```
X_train[0].min(), X_train[0].max()
```

[10]:
```
(0, 255)
```

[11]:
```
X_train = (X_train - 0.0) / (255.0 - 0.0)
X_test = (X_test - 0.0) / (255.0 - 0.0)
X_train[0].min(), X_train[0].max()
(0.0, 1.0)
```

[11]:
```
(0.0, 1.0)
```

[18]:
```
def plot_digit(image, digit, plt, i):
 plt.subplot(4, 5, i + 1)
 plt.imshow(image, cmap=plt.get_cmap('gray'))
 plt.title(f"Digit: {digit}")
 plt.xticks([])
 plt.yticks([])
plt.figure(figsize=(16, 10))
for i in range(20):
 plot_digit(X_train[i], y_train[i], plt, i)
plt.show()
```



[19]:
```
X_train = X_train.reshape((X_train.shape + (1,)))
X_test = X_test.reshape((X_test.shape + (1,)))
```

[20]:
```
y_train[0:20]
```

```
c=np.array([5, 0, 4, 1, 9, 2, 1, 3, 1, 4, 3, 5, 3, 6, 1, 7, 2, 8, 6,␣
 ↪9],dtype='u1')
```

[21]:

```
# Defining the model's architecture
model = Sequential([
 Conv2D(32, (3, 3), activation="relu", input_shape=(28, 28, 1)),
 MaxPooling2D((2, 2)),
 Flatten(),
 Dense(100, activation="relu"),
 Dense(10, activation="softmax")
])
```

[22]:

```
optimizer = SGD(learning_rate=0.01, momentum=0.9)
model.compile(
 optimizer=optimizer,
 loss="sparse_categorical_crossentropy",
 metrics=["accuracy"]
)
```

[23]:

```
model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 26, 26, 32)        320

 max_pooling2d (MaxPooling2  (None, 13, 13, 32)        0
 D)

 flatten (Flatten)           (None, 5408)              0

 dense (Dense)               (None, 100)               540900

 dense_1 (Dense)             (None, 10)                1010

=================================================================
Total params: 542230 (2.07 MB)
Trainable params: 542230 (2.07 MB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

[37]:

```
#Training and testing the model
Model_log=model.fit(X_train, y_train, epochs=10, batch_size=15,␣
 ↪verbose=1,validation_data=0);
```

```
Epoch 1/10
```

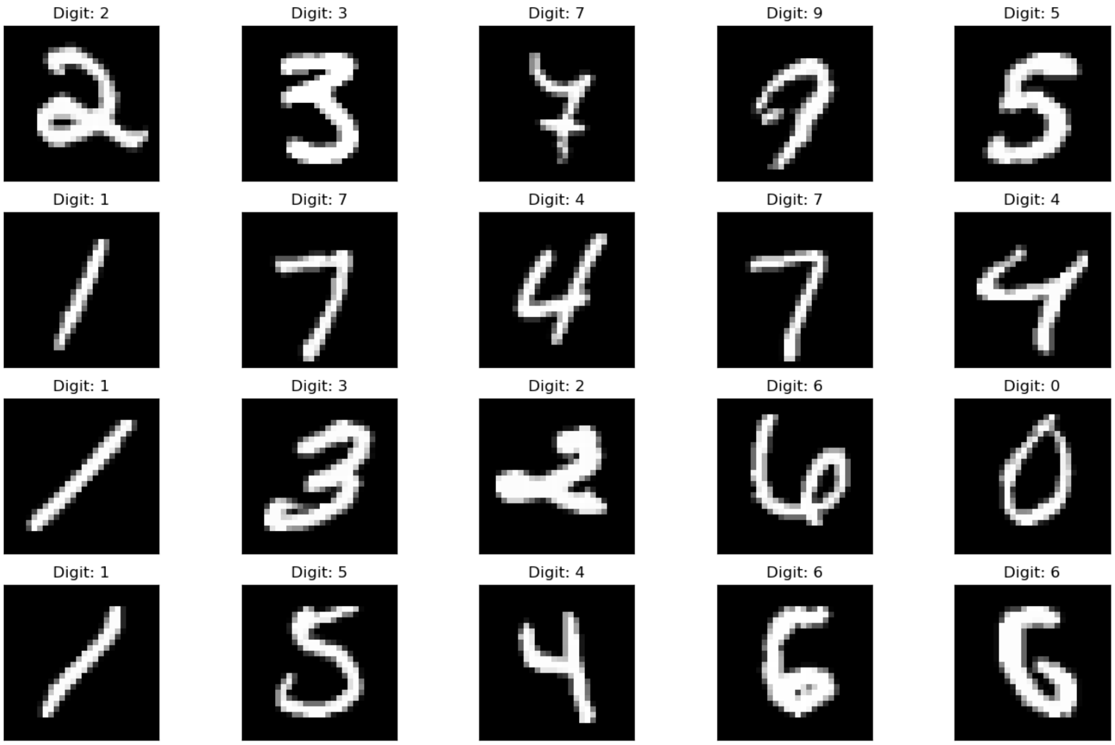
```
4000/4000 [==============================] - 26s 6ms/step - loss: 0.0044 -
accuracy: 0.9989
Epoch 2/10
4000/4000 [==============================] - 24s 6ms/step - loss: 0.0020 -
accuracy: 0.9996
Epoch 3/10
4000/4000 [==============================] - 27s 7ms/step - loss: 0.0018 -
accuracy: 0.9996
Epoch 4/10
4000/4000 [==============================] - 27s 7ms/step - loss: 8.3403e-04 -
accuracy: 0.9998
Epoch 5/10
4000/4000 [==============================] - 25s 6ms/step - loss: 4.2142e-04 -
accuracy: 0.9999
Epoch 6/10
4000/4000 [==============================] - 26s 7ms/step - loss: 1.9528e-04 -
accuracy: 1.0000
Epoch 7/10
4000/4000 [==============================] - 30s 7ms/step - loss: 1.3558e-04 -
accuracy: 1.0000
Epoch 8/10
4000/4000 [==============================] - 33s 8ms/step - loss: 1.0930e-04 -
accuracy: 1.0000
Epoch 9/10
4000/4000 [==============================] - 34s 9ms/step - loss: 9.6641e-05 -
accuracy: 1.0000
Epoch 10/10
4000/4000 [==============================] - 25s 6ms/step - loss: 8.5826e-05 -
accuracy: 1.0000
```

[41]:

```
plt.figure(figsize=(16, 10))
for i in range(20):
 image = random.choice(X_test).squeeze()
 digit = np.argmax(model.predict(image.reshape((1, 28, 28, 1)))[0], axis=-1)
 plot_digit(image, digit, plt, i)
plt.show()
```

```
1/1 [==============================] - 0s 16ms/step
1/1 [==============================] - 0s 17ms/step
1/1 [==============================] - 0s 17ms/step
1/1 [==============================] - 0s 18ms/step
1/1 [==============================] - 0s 17ms/step
1/1 [==============================] - 0s 17ms/step
1/1 [==============================] - 0s 18ms/step
1/1 [==============================] - 0s 18ms/step
1/1 [==============================] - 0s 16ms/step
1/1 [==============================] - 0s 17ms/step
1/1 [==============================] - 0s 17ms/step
```

```
1/1 [==============================] - 0s 17ms/step
1/1 [==============================] - 0s 20ms/step
1/1 [==============================] - 0s 23ms/step
1/1 [==============================] - 0s 20ms/step
1/1 [==============================] - 0s 19ms/step
1/1 [==============================] - 0s 21ms/step
1/1 [==============================] - 0s 21ms/step
1/1 [==============================] - 0s 18ms/step
1/1 [==============================] - 0s 20ms/step
```



[42]:

```
predictions = np.argmax(model.predict(X_test), axis=-1)
accuracy_score(y_test, predictions)
```

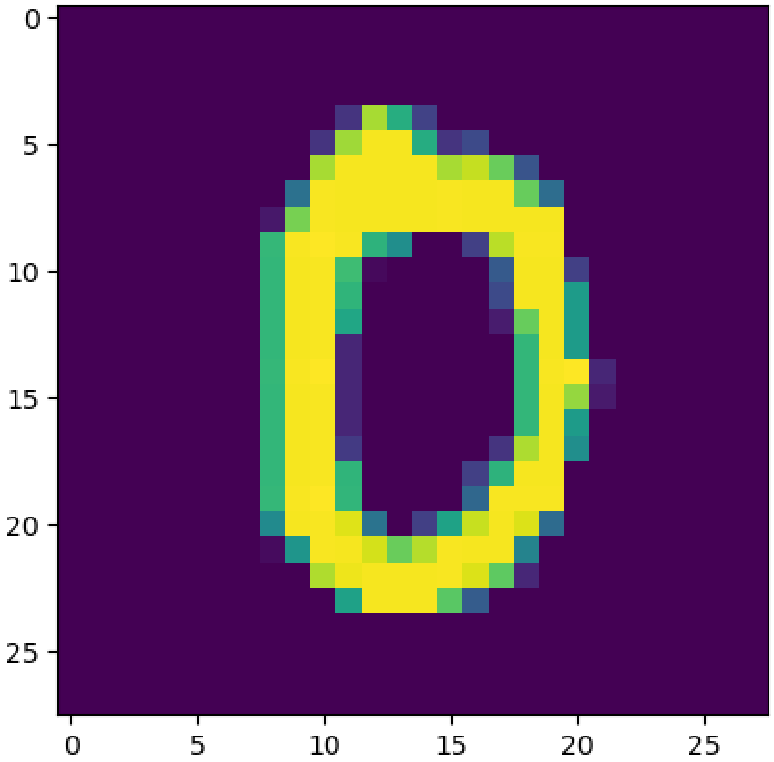
```
313/313 [==============================] - 1s 3ms/step
```

[42]:

```
0.9896
```

[43]:

```
n=random.randint(0,9999)
plt.imshow(X_test[n])
plt.show()
```



[44]:

```
predicted_value=model.predict(X_test)
print("Handwritten number in the image is= %d" %np.argmax(predicted_value[n]))
```

```
313/313 [==============================] - 1s 3ms/step
Handwritten number in the image is= 0
```

[45]:

```
# Estimating the model's performance
score = model.evaluate(X_test, y_test, verbose=0)
print('Test loss:', score[0])
print('Test accuracy:', score[1])
```

```
Test loss: 0.045085225254297256
Test accuracy: 0.9896000027656555
```

[ ]:

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