

Project #1 Due date: 2022/03/15

1. This homework is based on the code, `fcnn-core.py`, of a fully-connected neural network. Based the framework of this code, we plan to develop a multi-layer neural network to classify the MNIST dataset of the hand-written digits: <http://yann.lecun.com/exdb/mnist/>.

From keras, this database can be loaded directly:

```
# TensorFlow and tf.keras
import tensorflow as tf
import tensorflow.keras

import os
os.environ["KMP_DUPLICATE_LIB_OK"]="TRUE"

(x_train, y_train), (x_test, y_test) = keras.datasets.mnist.load_data()
assert x_train.shape == (60000, 28, 28)
assert x_test.shape == (10000, 28, 28)
assert y_train.shape == (60000,)
assert y_test.shape == (10000,)
```

Modify the `fcnn-core.py` code so that the program can load both training and testing data, execute the model fitting, and evaluate the accuracy.

2. The code, `fcnn-core.py`, actually implement a three-layer fully-connected network (FCNN) which consists of one input layer, one hidden layer, and one output layer. Please design another two FCNN networks: one with 2 hidden layers, the other with three hidden layers. In other word, the two FCC networks of yours are 4- and 5-layers FCNN, respectively. You may change the epochs to fine-tune the performance of your two classifiers. Please provide a detailed descriptions of your design parameters and discussions of performance
3. Use a white paper to write down your name, student id number, and digits 0, 1, 2, ..., 9 as shown in Fig. 1. Use any image processing toolkits (like gimp or imagej) to cut 10 digits and save them separately. Use your two FCNN classify the 10 digits of yours. Comment your results including accuracy and any possible improvement.

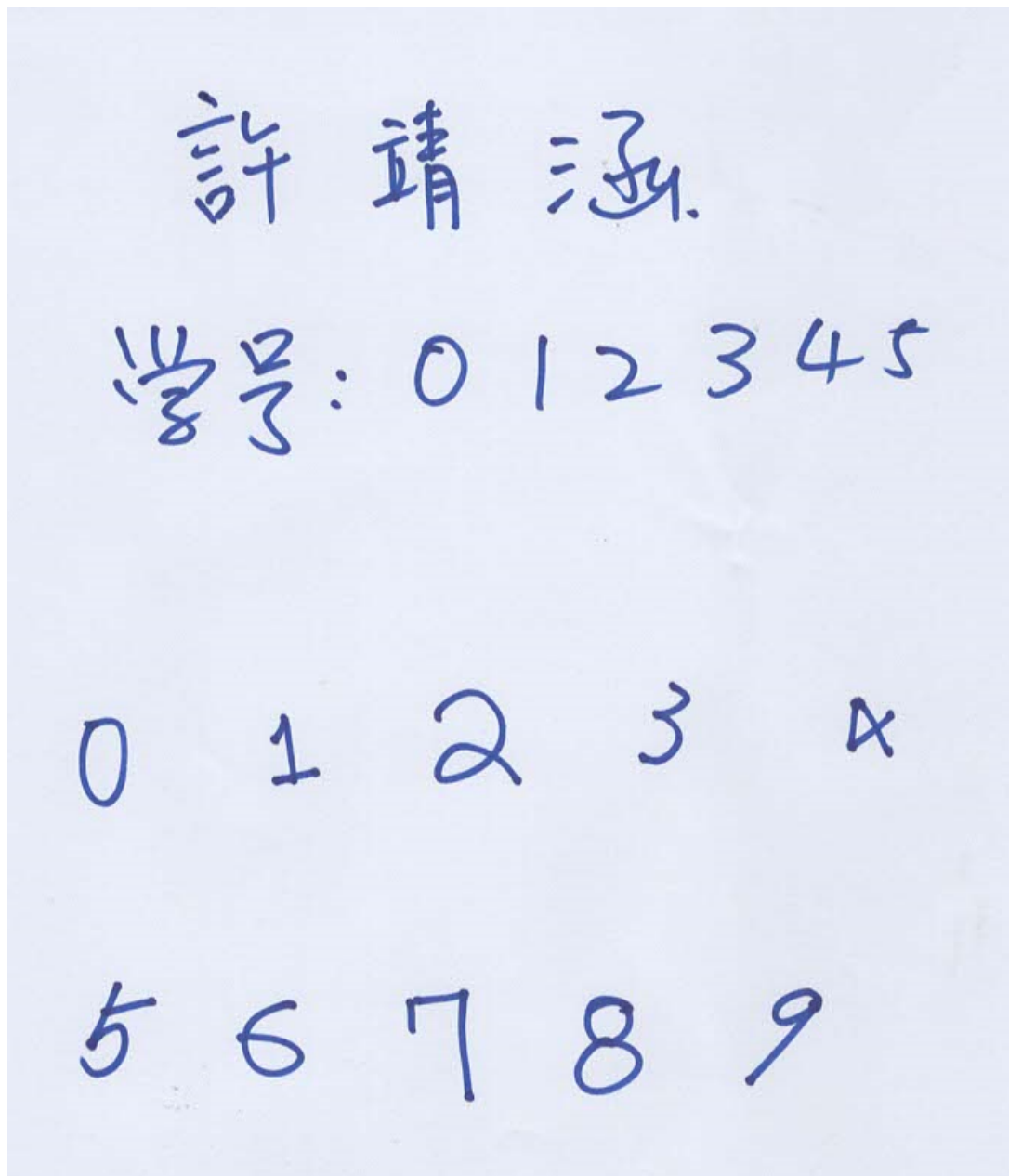


Figure 1: My test data of digits.