

PC5215, Numerical Recipes with Applications, Lab 3 (due Monday 28 Oct 2024)

In this third lab, we will use the TensorFlow machine learning package within Keras, (<https://www.tensorflow.org/>) under Python to build a simple neural network to recognize the handwriting figures 0 to 9. Read up on the TensorFlow introductory tutorials before you attempt this lab, particularly the section of “TensorFlow 2 quickstart for beginners” <https://www.tensorflow.org/tutorials/quickstart/beginner>

We use the data set known as MNIST, which are 28 by 28 pixels each, an unsigned byte (int value 0 to 255) indicating the grey scale of the drawing. This data set contains 70,000 samples, and is available at Tensor Flow that can be obtained within the package with the script:

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

`x_train`, `y_train`, `x_test`, and `y_test` are numpy N-dimensional arrays. `numpy *.shape` tells you the dimensions; for example `x_train` is (60000,28,28). `x_train` stores the images, `y_train` gives you the correct answer (an integer of the digital figure). The sample code `mnist.py` posted at the course site (<http://phyweb.physics.nus.edu.sg/~phywjs>) shows you how to display one of the images with `matplotlib`. You need to define the model with `tf.keras.models.Sequential(...)`, then compile with `model.compile(...)` and do the fit with `model.fit(...)` and finally evaluate the performance and do the prediction with `model.predict(...)`.

But before we can do this, we need to install tensorflow (as well as `matplotlib`) in your python system. This can be done with the command if you use Windows OS under DOS command prompt (cmd),

```
pip install tensorflow
```

When these are done. We try to design a neural network, under tensorflow Keras interface. The first layer needs to be 28×28 nodes flattened into 1D, and the last output is 10 nodes for 0 to 9. The middle layer(s) are the actual neural networks. Read the Tensorflow online documents and tutorial examples to familiarize yourself with the concept of neural network architecture. You can try the simplest possible first. Then, try to improve if you are able to. Use the train set to train your network and use the test set to test your result (percentage of successful cases).

Lastly, try to use Microsoft paint 3D or other software to generate your own handwritten 28×28 images and see if your neural network can recognize your figures successfully. You need to convert the png format into the format of MNIST (which is just numpy array) with the correct background color.

This lab is somewhat open-ended, and you have to take the initiative to explore.