

## PC5215, Numerical Recipes with Applications, Lab 3 (due Friday 23 Oct 2020)

In this 3<sup>rd</sup> lab, we will use the TensorFlow machine learning package (<https://www.tensorflow.org/>) under Python to build a simple neural network to recognize the handwriting figures 0 to 9. 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 TensorFlow 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 and `numpy *.shape` tell you the dimensions, for example `x_train` is (60000,28,28). The sample code `mnist.py` posted at course site (<http://phyweb.physics.nus.edu.sg/~phywjs>) shows you how to display one of the images.

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 under DOS command prompt (cmd),

```
python -m pip install tensorflow
```

When these are done. We try to design a neural network, under tensorflow Keras interface. The first layer needs to be 28x28 nodes, and last output is 10 nodes for 0 to 9. Read the tensorflow online documents and tutorial examples to get familiar 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 using the test set to test your result (percentage of successful cases).

Lastly, try to use Microsoft paint 3D or other software to generate your 28x28 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).