PC5215, Numerical Recipes with Applications, Lab 3 (due Friday 27 Oct 2023)

In this third lab, we will use the TensorFlow machine learning package within Keras, (https://www.tensorflow.org/) under Python to build a simple neutral network to recognize the handwriting figures 0 to 9. Read up 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 tell 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 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 neutral network, under tensorflow Keras interface. The first layer needs to be 28×28 nodes flattened into 1D, and last output is 10 nodes for 0 to 9. The middle layer(s) are the actual neutral networks. Read the tensorflow online documents and tutorial examples to get familiar with the concept of neutral 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 neutral 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.