

GEORGE MASON UNIVERSITY
Systems Engineering and Operations Research

OR750/610: Deep Learning , Fall Semester 2019: Homework Assignment 2. Due: Sep 25 (before class)

1. Organic DL Without using a deep learning framework, code a one-hidden layer neural network model (multi-layer perceptron) for classification, i.e. the last layer is softmax and with cross-entropy loss function. Implement back-propagation. Use your code to classify MNIST. You can download MNIST data from <http://yann.lecun.com/exdb/mnist/> and read it as a numpy array using the following function.

```
import struct
import numpy as np

def read_idx(filename):
    with open(filename, 'rb') as f:
        zero, data_type, dims = struct.unpack('>HBB', f.read(4))
        shape = tuple(struct.unpack('>I', f.read(4))[0] for d in range(dims))
        return np.fromstring(f.read(), dtype=np.uint8).reshape(shape)
```

Run a few numerical experiments with different non-linear activation functions, different number of neurons and different learning rates.

2. Regularization Add ℓ_2 regularization to your model. Compare the accuracy and training speed.