Homework 6 – Deep Neural Networks (CS525 191N, Whitehill, Spring 2017)

You may complete this homework assignment either individually or in teams up to 2 people.

1. **Implementing a Neural Network with TensorFlow** [40 points]: In this problem you will train a multi-layer feed-forward neural network to classify, once again, images from the MNIST dataset. However, instead of implementing forward- and backward-propagation yourself using numeric Python, you will rely on the highly optimized TensorFlow package, which implements symbolic differentiation and a slew of other nifty features. Your tasks are to do the following:

   (a) Install TensorFlow on your own machine (see `https://www.tensorflow.org/install/` for instructions). Either the CPU- or (if you have one) GPU-based version is completely fine for this assignment.

   (b) Make sure you understand the following tutorial: `https://www.tensorflow.org/get_started/mnist/beginners`.

   (c) Based on the tutorial above, use TensorFlow to create a multi-layer fully-connected neural network to recognize hand-written digits from the MNIST dataset; you should attain a **test** accuracy of at least 97.5%. You are free to optimize the number of layers and the number of units per layer, along with all other hyperparameters (learning rate schedule, momentum, minibatch size, etc.), using only the training and/or validation data. Create a screenshot showing the last 20 SGD iterations on the training set (after performing whatever hyperparameter optimization was necessary on the validation set), along with a screenshot of your final accuracy and cost on the test set.

   (d) Write a **concise** report describing the architecture of your network (i.e., number of layers, number of nodes per layer), the activation functions you used, how you initialized your weights, what learning rate schedule you used, which optimizer you used (SGD, SGD with momentum, Adam, etc.), and all other hyperparameters and design decisions.

   Note 1: In this assignment, you may *not* use a high-level software package such as Keras on top of TensorFlow; you *must* use "regular" TensorFlow (version 1.0).

   Note 2: In this assignment, you may *not* use a convolutional neural network. You should only use fully-connected layers.

In addition to your Python code (`homework6_WPIUSERNAME1.py` or `homework6_WPIUSERNAME1_WPIUSERNAME2.py` for teams), create a PDF file (`homework6_WPIUSERNAME1.pdf` or `homework6_WPIUSERNAME1_WPIUSERNAME2.pdf` for teams) containing the screenshots described above. **Please submit both the PDF and Python files in a single Zip file.**