HW Assignment 4 (Due by 10:30am on Oct 12)

1 Theory (100 points)

1. [Fine Tuning in Self-Taught Learning, 30 points] Consider a self-taught learning model with 1 hidden layer and a softmax output layer, that is trained to minimize the regularized negative log-likelihood cost function in which weight decay is applied only to the softmax parameters. Write down the equations for the forward propagation and backpropagation steps, vectorized and non-vectorized.

2. [Tied Weights, 20 points] Write down the gradient computation for a (non-linear) sparse auto-encoder with tied weights i.e., $W^{(2)} = (W^{(1)})^T$. Do the same for the linear auto-encoder from the previous assignment.

2 Implementation (100 points)

Download the skeleton code from http://ace.cs.ohio.edu/~razvan/courses/dl6900/hw/hw04.zip. Implement the Self-Taught learning example, as explained in the UFLDL exercise. Make sure that you organize your code in folders as shown in the table below.

```
dl6900
  hw01
  hw02
  hw03
  hw04
      feedForwardAutoencoder.m
      stlExercise.m
      softmaxCost.m
      softmaxTrain.m
      softmaxPredict.m
      sparseAutoencoderCost.m
      display_network.m
      initializeParameters.m
      minFunc
      mnist
```

Write code in the files indicated in bold. You are encouraged to reuse the code that you have written for the previous assignments.

**Bonus 1:** Fine tune the self-taught learning model, using the backpropagation equations you derived in the theory part above. Evaluate the fine tuned model and compare its performance with the original model.

**Bonus 2:** Implement the non-linear and linear auto-encoders with tied weights, using the backpropagation equations you derived in the theory part above. Compare them with the original sparse auto-encoder that you implemented for the previous assignment, especially in terms of the features they learn.
3 Submission

Turn in a hard copy of your homework report at the beginning of class on the due date. Electronically submit a directory that contains only the required files. Make sure your code runs correctly when used in the architecture shown above. Create a ZIP archive of your directory, and upload it on Blackboard by the due date.

Please observe the following when handing in homework:

1. Structure, indent, and format your code well.

2. Use adequate comments, both block and in-line to document your code.

3. On the theory assignment, clear and complete explanations and proofs of your results are as important as getting the right answer.