HW Assignment 7 (Due by 10:30am on Nov 5)

1 Theory (40 points)

1. [Sparse Coder] Derive the gradients of the sparse coder objective, as shown on slide 12 from lecture 5, in vectorized form. There are two possible approaches:

   (a) Compute $\frac{\delta J(A, \Theta)}{\delta \Theta_{ij}}$ and $\frac{\delta J(A, \Theta)}{\delta A_{ij}}$ and then infer the corresponding vectorized form.

   (b) Compute $\nabla_{\Theta}J(A, \Theta)$ and $\nabla_{A}J(A, \Theta)$ directly in vectorized form, by using properties of derivatives with respect to matrices.

   If you choose the second approach, make sure that at every derivation step you specify what matrix computation rule you use. Include references for all matrix computations steps used in your derivation.

2 Implementation (100 points)

Download the skeleton code from http://ace.cs.ohio.edu/~razvan/courses/dl6900/hw/hw07.zip. Implement the non-topographic sparse coder, 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
   hw05
   hw06
   hw07
   sparseCodingExercise.m
   sparseCodingFeatureCost.m
   sparseCodingWeightCost.m
   computeNumericalGradient.m
   checkNumericalGradient.m
   display_network.m
   sampleImages.m
   IMAGES.mat
   minFunc
   mnist
```

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

**Bonus 1** [20 points]: Derive the vectorized form of the gradients of the sparse coder objective for the topographic version, where the topography is specified through a grouping matrix. Explain each derivation step, as in the theory exercise above.
**Bonus 2** [20 points]: Implement the topographic sparse coder, as explained in the UFLDL exercise.

### 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 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.