Homework# 3: Short course on sparse recovery and compressed sensing

October 2013

Reading:

Lec. 6,7,8: The line of argumentation we use is very similar to that in Candes, Romberg, Tao, *Stable Signal Recovery from Incomplete and Inaccurate Measurements*, http://bit.ly/UfCvlJ

Problems:

1. Write a one paragraph summary of what we talked about today. Use complete sentences, and avoid equations as much as possible.

2. Let $\Phi = \begin{bmatrix} 4 & 1 \end{bmatrix}$ and $y = 1$.

   (a) Solve
   $$\min_{x \in \mathbb{R}^2} \ \|x\|_2 \quad \text{subject to} \quad \Phi x = y.$$

   (b) Solve
   $$\min_{x \in \mathbb{R}^2} \ \|x\|_1 \quad \text{subject to} \quad \Phi x = y.$$

3. Let Φ be an $M \times N$ random matrix. Here we consider three different methods for generating Φ: iid Gaussian, random rows of a discrete cosine transform, and consecutive rows of a random Toeplitz matrix. In each of these three cases, set $N = 1024$ and use simulation to determine values of M and S such that we can reliably say an S sparse vector can be recovered from observations through Φ. (You can create sparse vectors at random for the simulation using any model you find reasonable.) You will find the files `l1eq_pd.m`, `Gaussian_Phi.m`, `SubDCT_Phi.m`, and `SubToep_Phi.m` useful.