Department of Electrical and Computer Engineering
The Johns Hopkins University
525.628 Compressed Sensing and Sparse Recovery – Spring 2022

Module 3 - Homework Assignment

Reading Assignment: Lecture Notes, OMP, SP journal papers

Computer Assignment: Sparse Signal Recovery via Matching Pursuit.

1. Implement 2 matching pursuit algorithms as discussed in lectures: Orthogonal Matching Pursuit (OMP) and Subspace Pursuit (SP).

2. Repeat the Recovery Challenge in Assignment I by replacing exhaustive search with 3 matching-pursuit algorithms.

3. Suppose that we have a signal $\mathbf{x}$ of 256 samples ($N = 256$) where only 5 of these samples are nonzero ($S = 5$). The location and magnitude of these nonzero samples are unknown. Let's investigate the recovery of this sparse signal using your greedy methods.

   Generate the signal using the following Matlab commands:

   $$>> x = zeros(N, 1); q = randperm(N); x(q(1 : S)) = randn(S, 1);$$

   Generate the sensing matrix $A \in R^{M \times N}$ from a collection of random Gaussian variables, then the rows are orthonormalized, i.e.,

   $$>> A = randn(M, N); A = orth(A')';$$

   Vary the number of measurements M (say $M = \{10, 20, 30, \ldots, 100\}$), and perform greedy recovery at 100 different instances of the signal $\mathbf{x}$ by varying the location and magnitude of its nonzero samples. Let's say if $||\hat{\mathbf{x}} - \mathbf{x}||_2 \leq 10^{-6}$, then we regard the signal recovery as perfect. Plot the performance curve in which x-axis represents the number of measurements M while y-axis denotes the probability of perfect signal recovery. At each of the 100 instances, the signal should be different and the sensing matrices should be different as well.