

## Accepted Manuscript

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PII: S0377-0427(18)30439-4  
DOI: <https://doi.org/10.1016/j.cam.2018.07.019>  
Reference: CAM 11805

To appear in: *Journal of Computational and Applied Mathematics*

Received date: 19 October 2017  
Revised date: 24 April 2018



Please cite this article as: P. Li, W. Chen, Signal recovery under cumulative coherence, *Journal of Computational and Applied Mathematics* (2018), <https://doi.org/10.1016/j.cam.2018.07.019>

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# Signal Recovery under Cumulative Coherence

Peng Li<sup>†</sup> and Wengu Chen<sup>\*†‡</sup>

**Abstract** This paper considers signal recovery in the framework of cumulative coherence. First, we show that the Lasso estimator and the Dantzig selector exhibit similar behavior under the cumulative coherence. Then we estimate the approximation equivalence between the Lasso and the Dantzig selector by calculating prediction loss difference under the condition of cumulative coherence. And we also prove that the cumulative coherence implies the restricted eigenvalue condition. Last, we illustrate the advantages of cumulative coherence condition for three class matrices, in terms of the recovery performance of sparse signals via extensive numerical experiments.

**Keywords** Cumulative coherence · Dantzig selector · Lasso · Oracle inequality · Restricted eigenvalue condition · Closeness of prediction loss

**Mathematics Subject Classification** 62G05 · 94A12

## 1 Introduction

Compressed sensing predicts that sparse signals can be reconstructed from what was previously believed to be incomplete information. Since Candès, Romberg and Tao's seminal works [9, 10] and Donoho's ground-breaking work [18], this new field has triggered a large research in mathematics, engineering and medical image. In such contexts, we often require to recover an unknown signal  $x \in \mathbb{R}^n$  from an underdetermined system of linear equations

$$b = Ax + z, \quad (1.1)$$

where  $b \in \mathbb{R}^m$  are available measurements, the matrix  $A \in \mathbb{R}^{m \times n}$  ( $m < n$ ) models the linear measurement process and  $z \in \mathbb{R}^m$  is a vector of measurement errors.

For the reconstruction of  $x$ , the most intuitive approach is to find the sparsest signal in the feasible set of possible solutions, which leads to an  $\ell_0$ -minimization problem as follows

$$\min_{x \in \mathbb{R}^n} \|x\|_0 \quad \text{subject to } b - Ax \in \mathcal{B},$$

where  $\|x\|_0$  denotes the  $\ell_0$  norm of  $x$ , i.e., the number of nonzero coordinates, and  $\mathcal{B}$  is a bounded set determined by the error structure. However, such method is NP-hard and

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