

Accepted Manuscript

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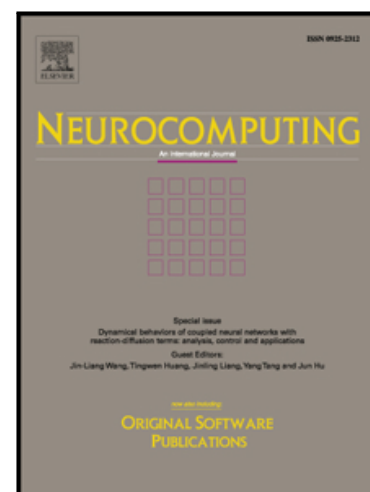
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PII: S0925-2312(17)30284-9
DOI: [10.1016/j.neucom.2017.02.014](https://doi.org/10.1016/j.neucom.2017.02.014)
Reference: NEUCOM 18080

To appear in: *Neurocomputing*

Received date: 27 June 2016
Revised date: 15 November 2016
Accepted date: 4 February 2017

Please cite this article as: Zhenni Li, Shuxue Ding, Takafumi Hayashi, Yujie Li, Analysis Dictionary Learning Using Block Coordinate Descent Framework with Proximal Operators, *Neurocomputing* (2017), doi: [10.1016/j.neucom.2017.02.014](https://doi.org/10.1016/j.neucom.2017.02.014)



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Analysis Dictionary Learning Using Block Coordinate Descent Framework with Proximal Operators

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Abstract

In this study, we propose two analysis dictionary learning algorithms for sparse representation with analysis model. The problem is formulated with the ℓ_1 -norm regularizer and with two penalty terms on the analysis dictionary: the term of $-\log \det(\mathbf{\Omega}^T \mathbf{\Omega})$ and the coherence penalty term. As the processing scheme, we employ a block coordinate descent framework, so that the overall problem is transformed into a set of minimizations of univariate subproblems with respect to a single-vector variable. Each subproblem is still nonsmooth, but it can be solved by a proximal operator and then the closed-form solutions can be obtained directly and explicitly. In particular, the coherence penalty, excluding excessively similar or repeated dictionary atoms, is solved at the same time as the dictionary update, thereby reducing the complexity. Furthermore, a scheme with a group of atoms is introduced in one proposed algorithm, which has a lower complexity. According to our analysis and simulation study, the main advantages of the proposed algorithms are their greater dictionary recovery ratios especially in the low-cosparsity case, and their faster running time of reaching the stable values of the dictionary recovery ratios and the recovery cosparsity compared with state-of-the-art algorithms. In addition, one proposed algorithm performs well in image denoising and in noise cancellation.

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Preprint submitted to Elsevier

February 16, 2017

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