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Multi-dimensional signal approximation with sparse structured priors using split Bregman iterations ☆

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Abstract

This paper addresses the structurally-constrained sparse decomposition of multi-dimensional signals onto overcomplete families of vectors, called dictionaries. The contribution of the paper is threefold. Firstly, a generic spatio-temporal regularization term is designed and used together with the standard ℓ_1 regularization term to enforce a sparse decomposition preserving the spatio-temporal structure of the signal. Secondly, an optimization algorithm based on the split Bregman approach is proposed to handle the associated optimization problem, and its convergence is analyzed. Our well-founded approach yields same accuracy as the other algorithms at the state of the art, with significant gains in terms of convergence speed. Thirdly, the empirical validation of the approach on artificial and real-world problems demonstrates the generality and effectiveness of the method. On artificial problems, the proposed regularization subsumes the Total Variation minimization and recovers the expected decomposition. On the real-world problem of electro-encephalography brainwave decomposition, the approach outperforms similar approaches in terms of P300 evoked potentials detection, using structured spatial priors to guide the decomposition.

Keywords: Structured sparsity, overcomplete representations, analysis prior, split Bregman, fused-LASSO, EEG denoising.

1. Introduction

In the last two decades, dictionary-based representations have been applied with success on a number of tasks, e.g. robust transmission with compressed

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