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Two - way regularization for MEG source reconstruction via multilevel coordinate descent

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Abstract

Magnetoencephalography (MEG) source reconstruction refers to the inverse problem of recovering the neural activity from the MEG time course measurements. A spatiotemporal two - way regularization (TWR) method was recently proposed by Tian *et al.* to solve this inverse problem and was shown to outperform several one - way regularization methods and spatiotemporal methods. This TWR method is a two - stage procedure that first obtains a raw estimate of the source signals and then refines the raw estimate to ensure spatial focality and temporal smoothness using spatiotemporal regularized matrix decomposition. Although proven to be effective, the performance of two - stage TWR depends on the quality of the raw estimate. In this paper we directly solve the MEG source reconstruction problem using a multivariate penalized regression where the number of variables is much larger than the number of cases. A special feature of this regression is that the regression coefficient matrix has a spatiotemporal two - way structure that naturally invites a two - way penalty. Making use of this structure, we develop a computationally efficient multilevel coordinate descent algorithm to implement the method. This new one - stage TWR method has shown its superiority to the two - stage TWR method in three simulation studies with different levels of complexity and a real - world MEG data analysis. © 2013 Wiley Periodicals, Inc. Statistical Analysis and Data Mining, 2013