Bayesian Inference for Brain Source Imaging with Structured Low-rank Noise

Authors:
Sanjay Ghosh[a] , Chang Cai[b] , Ali Hashemi[c], Yijing Gao[a], Stefan Haufe[c], Kensuke Sekihara[d], Ashish Raj[a], Srikantan S. Nagarajan[a]

[a]University of California San Francisco, San Francisco, USA.
[b]Central China Normal University, Wuhan, China.
[c]Technical University Berlin, Berlin, Germany.
[d]Signal Analysis Inc., Tokyo, Japan.

Presenter: Dr. Sanjay Ghosh, Postdoctoral Scholar, University of California San Francisco.
(**Dr. Ghosh would like to be considered for a travel award.**)

Abstract: *Objective*: The inverse problem in brain source imaging is the reconstruction of brain activity from non-invasive recordings of electroencephalography (EEG) and magnetoencephalography (MEG). One key challenge is the efficient recovery of sparse brain activity when the data is corrupted by structured noise that is low-rank noise. This is often the case when there are a few active sources of environmental noise and the MEG/EEG sensor noise is highly correlated. *Approach:* In this work, we propose a novel robust empirical Bayesian framework which provides us a tractable algorithm for jointly estimating a low-rank noise covariance and brain source activity. Specifically, we use a factor analysis model for the structured noise, and infer a sparse set of variance parameters for source activity, while performing Variational Bayesian inference for the noise. *Main results and significance*: We perform exhaustive experiments on both simulated and real datasets. Our algorithm achieves superior performance as compared to several existing benchmark algorithms for brain source imaging. One key aspect of this algorithm is that it does not require any additional baseline measurements to estimate the noise covariance from the sensor data.

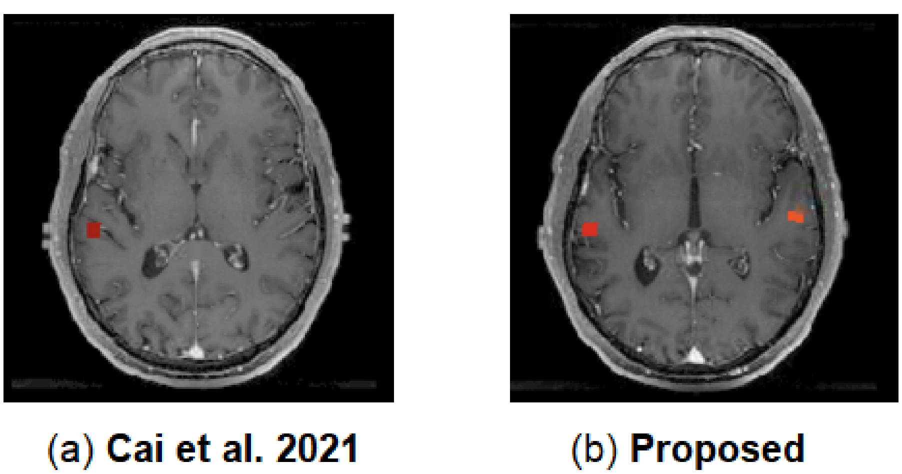

Figure 1: Brain source imaging on real MEG data for auditory evoked field (AEF) stimulation. Notice that the proposed method could localize bilateral auditory activity more efficiently.