Using Markov chain Monte Carlo to solve a time-varying stat-space model for Magnetoencephalography inverse problem

by
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Abstract

Magnetoencephalography(MEG) is an imaging technique used to measure the magnetic signals outside the head produced by the electrical activity inside the brain. The MEG inverse problem, localizing the electrical source from the magnetic signal measurements, is ill-posed, that is, there are an infinite number of correct solutions. The common source localization methods assume the source does not vary with time and do not provide estimates of the variability of the fitted model. In this paper, we consider time-varying sources in the MEG inverse problem and model the time evolution using a state space model. Based on our new model, we investigate the inverse problem by finding the posterior source distribution given the multiple channels of observations at each time rather than fitting fixed source estimates. Our new model is more realistic than common models and estimates of the variation of the sources. The computational challenge happens when the number of states is very hig! h and the slow convergence of the posterior distribution occurs when the source states are highly variable or the data likelihood is very flat. First, we change the regular Gibbs sampler by adding a conditional prior of the source proposal with a single/block move to find the posterior distribution for each state of the source. Second, to improve the computational efficiency and control the sampling variation for each state of the source, we develop an improved algorithm based on sequential importance sampling, where we use the local resampling scheme to avoid weight estimation for each source state. Third, to further improve the performance, we propose a dynamic sequential importance sampling with improved resampling; We throw away a significant amount of unnecessary weights and reduce dimension for each source state and also use a new weight function. These three algorithms are applied to simulated data, unlike the usual MCMC sampling scheme, these new methods converge.