Sparsity promoting reconstructions via hierarchical prior models in diffuse optical tomography

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Abstract

Diffuse optical tomography (DOT) is a severely ill-posed nonlinear inverse problem that seeks to estimate optical parameters from boundary measurements. In the Bayesian framework, the ill-posedness is diminished by incorporating *a priori* information of the optical parameters via the prior distribution. In case the target is sparse or sharp-edged, the common choice as the prior model are non-differentiable total variation and ℓ^1 priors. Alternatively, one can hierarchically extend the variances of a Gaussian prior to obtain differentiable sparsity promoting priors. By doing this, the variances are treated as unknowns allowing the estimation to locate the discontinuities.

Previous work with hierarchical models was focused on linear inverse problems. In this work we extended the use of hierarchical models to the nonlinear inverse problem of DOT. To compute the MAP estimates, a previously proposed alternating algorithm was adapted to work with the nonlinear model. The performance of the hyperpriors was evaluated in numerical simulations, demonstrating their ability to promote reconstructions of sparse and sharp-edged targets.