Numerical Analysis and Scientific Computing Seminar

Gaussian Markov Random Field Priors and MCMC for Inverse Problems

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Abstract: In this talk I will explore the connections between Bayesian statistics and inverse problems. In particular, I will show how familiar quadratic regularization functions can be viewed as prior probability densities arising from Gaussian Markov Random Fields (GMRFs). GMRFs, in turn, correspond to concrete probabilistic assumptions regarding the value of the unknown image at a specific pixel based on the value of its neighbors. With a GMRF prior in hand, I will then show how to perform MCMC sampling of the unknown image and of the noise and prior precision values. The image sampling step is a large-scale structured linear algebra problem that has seen little attention by the numerical linear algebra community. The samples outputted by the MCMC method can be used to compute a reconstructed image, e.g. the sample mean, as well as estimates of the precision parameters, which can in turn be used to estimate the regularization parameter.

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