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A Bayesian approach to inverse problems in scalar transport
YOUSSEF M. MARZOUK, HABIB N. NAJM, Sandia National Laboratories; Livermore, CA — Estimating the initial conditions or source term of a scalar transport equation from a sparse set of noisy measurements has practical relevance to the environmental dispersion of contaminants, as well as more fundamental connections to fluid mixing. We present a Bayesian approach to this *inverse problem*, in which the posterior distribution provides a quantitative assessement of uncertainty in the inverse solution, conditioned on the available data. Features that are underdetermined by the prior and the data are endowed with broad posterior variability, reflecting ill-posedness of the inversion. We also present new algorithmic developments for Bayesian inference in this context, showing connections between the Bayesian solution of the inverse problem and the forward propagation of uncertainty through the corresponding advection-diffusion equations. These connections underlie a stochastic spectral formulation that substantially accelerates the Bayesian solution of certain inverse problems.

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