MICHIGAN STATE UNIVERSITY
Department of Statistics and Probability

COLLOQUIUM

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Adventures in Bayesian Statistical Inversion: Theory, Computation and Applications

Tuesday, March 27, 2018
10:20 AM - 11:10 AM
Refreshments 10:00 AM
C405 Wells Hall

Abstract

A common theme throughout the physical and social sciences is the need to make effective inferences concerning unknowns in a model from noisy and sparse measurements. Consider the question of quantifying the degree of uncertainty in **u** from

$$Y = \mathcal{G}(\mathbf{u}) + \eta. \tag{1}$$

We observe the data Y in the presence of an observation noise η. In many applications we are concerned with forward models $\mathcal{G}$ which involve systems of partial differential equations. Furthermore, $\mathcal{G}$ may be a nonlinear function of the unknown parameters, **u** which sit in a large or infinite dimensional space.
A Bayesian approach provides a powerful and effective paradigm to treat inversion problems like (1). In this setting our knowledge of **u** is given by a `posterior probability distribution', which typically takes the form

$$\mu(d\mathbf{u}) \sim \exp\big(-\phi(\mathbf{u}; Y)\big)\mu_0(d\mathbf{u}). \tag{2}$$

Here μ_0 is a measure representing prior knowledge about u before measurements Y are taken into account and $\phi(\cdot; Y)$ is a likelihood function whose form is determined by the distribution of observation noise η.
This talk will describe recent work on two different geophysical problems which we formulate according to (1), (2). The first problem concerns the estimation of a velocity field **u** from sparse observations of a scalar θ, e.g. concentration of a solute, passively advected and diffusing in the fluid medium. The second problem concerns the usage of historical records to provide improved understanding of a series of seismic events which produced Tsunamis in the Indonesian basin.
Beyond the inherent interest for applications, these two problems raise theoretical questions of broader statistical, computational and mathematical interest. We will present results concerning consistency and describe some novel Markov Chain Monte Carlo (MCMC) algorithms to sample from classes of measures of the form (2) as arise in our examples.
This is work in collaboration with Jeff Borggaard (VT), Ron Harris (BYU), Justin Krometis(VT) and Jared Whitehead (BYU).