STANFORD UNIVERSITY

DEPARTMENT OF STATISTICS

DEPARTMENTAL SEMINAR

4:15 p.m., Tuesday, November 30, 1999
Sequoia Hall Rm. 200
(Cookies at 3:45 in 1st Floor Lounge)

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Stochastic inversion using Markov chain Monte Carlo simulation

Stochastic inversion is an increasingly important topic in the modeling and analysis of Earth science data or spatially varying phenomena in general. The geologist/engineer/statistician is charged with the difficult task of constructing a set of "equi-probable" million cell three dimensional Earth models (of rock properties) based on a large variety of usually remotely sensed data (or indirect measurements) such as geophysical surveys. Furthermore, these 3D models should depict realistic geological scenarios.

Most current inverse methods either neglect the stochastic part (the ill-posedness of the problem), do not account for realistic spatial variation of the phenomenon or their computational aspect prohibits them from being implemented for actual day-to-day application. The latter is caused by the fact that the forward model, relating the indirect measurements to the rock properties, is usually a finite element/difference formulation.

In this seminar, I present a Markov chain Monte Carlo simulation approach to sampling such 3D models conditioned to indirect measurements. First, a new MCMC method is presented for estimating and sampling from a Gauss-Markov random field and its is shown how models can be conditioned to the indirect measurements. The CPU-limitation due to computationally demanding finite element/difference formulations is circumvented by using neural networks. Next, it is shown how the Markov chain formulation can be extended to sample more realistic spatial variation than the geologically unrealistic maximum entropy Gaussian fields. I formulate this problem as an image analysis (pattern recognition) and image construction (pattern reproduction or sampling) problem. Several case studies are presented to illustrate the application of these methods.