STATISTICS COLLOQUIUM

WEDNESDAY, SEPTEMBER 24, 2008
Talk: 4:00 PM – *Science Center B-10*
Reception: 5:15 PM – *Science Center, 7th Floor*

"Methods of Approximate Inference: Applications to Stochastic Differential Equations, Video Microscopy, and Network Data"

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ABSTRACT

The large and high-dimensional data sets typically seen in contemporary science and engineering applications often preclude the direct application of optimal inference procedures. Here we describe three example scenarios in which exact inference is unachievable, and present alternative strategies that yield approximate results in a computationally efficient manner:

1) Stochastic Differential Equations (SDEs) are widely used as probability models in science, engineering, and financial mathematics. As such models are specified in continuous time, any inference based on discretely-observed data necessitates the integration of the model over the elapsed time between observations. We present a new multiresolution Markov chain Monte Carlo sampler which relies on the use of multiple approximations and on Richardson extrapolation. This sampler is significantly faster than known strategies based on Gibbs sampling.

2) Video microscopy is often used in experimental biology, particularly to study intracellular calcium dynamics. Though calcium is known to play a central role in cell physiology, researchers are still uncertain of the role that calcium "sparks" – localized releases of free calcium ions into a cell's cytosol – play in cell regulation. We present a model for their observation via a digital video camera. Though exact inference is readily achieved for small sample sizes, the sheer number of dependent observations prevalent in video data sets necessitates approximate methods. We utilize a two-stage approach to hypothesis testing which reduces the computational burden of likelihood evaluations, yet retains much of the exact test's power.

3) Graph-valued data sets are increasingly prevalent across a variety of fields. A typical inferential task is to detect group structure within a graph's adjacency matrix. Calculating the usual test statistic of the likelihood ratio, however, is computationally infeasible. As an alternative, we describe how algorithms for graph cuts can be used to obtain fast approximations to the likelihood ratio test statistic for the case of popular random graph models, and how in turn the power of such approximations can be evaluated through the use of stochastic simulation tools.