AUTHOR COMMENTARIES - 2008

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Professor Jesper Møller

A Featured Scientist from *Essential Science Indicators*SM

According to a recent ScienceWatch.com *analysis, Professor Jesper Møller is a Rising Star in the field of Mathematics, having achieved the highest percent increase in total citations in this field for the October 2007-December 2007 update period. His current record in this field, according to* Essential Science Indicators *from Thomson Reuters, includes 25 papers cited a total of 247 times between January 1, 1998 and February 29, 2008.*

Professor Møller received his Ph.D. in 1988 from the University of Aarhus, and his D.Sc. in 2000 from Aalborg University. He is currently a Professor in the Department of Mathematical Sciences at Aalborg University.

In the interview below, he talks about his highly cited work.

SW: What do you consider the main focus of your research, and what drew your interest to this particular area?

My main focus of research is in mathematical statistics and applied probability, particularly in relation to spatial data sets and computational problems as covered in the research areas known as spatial statistics, stochastic geometry, simulation-based inference, Markov chain Monte Carlo methods, and perfect simulation.

In my Ph.D. thesis and earlier in my career I worked mainly on problems associated with stochastic geometry, where I contributed to the mathematical theory on random tessellations (that is, random space filling structures) with a monograph and various papers on Voronoi tessellations and Johnson-Mehl tessellations, and also developed new models for spatial point processes and random fields.

My later research contributions often still concern spatial processes but more and more from a statistical and computational perspective. Most of my recent books and papers deal with statistical inference and computational methods for spatial and spatio-temporal point processes.

My research is motivated by problems in basic research as well as applications in science, engineering, and medicine. For example, spatial point pattern data occur frequently in a wide variety of scientific disciplines, including seismology, ecology, forestry, geography, spatial epidemiology, and material science.

SW: Several of your highly cited papers deal with log Gaussian Cox processes and the Markov chain Monte Carlo methods. Would you walk our readers through these particular aspects of your research and its applications?

My interest in spatial point processes have concentrated on the two main classes of models, namely Markov (or Gibbs) point processes and Cox point processes. They both apply to a range of applications in astronomy, physics, ecology, epidemiology, etc. Markov point processes are models where interaction between neighboring events is modeled explicitly. Cox processes are constructed from models for "complete spatial randomness" by adding additional variability.

This extra variability may be modeled by a shot-noise process or a log Gaussian process, whereby shot-noise Cox processes and log Gaussian Cox processes appear. In my research I have studied the many appealing mathematical and statistical properties of these point process models. This has furthermore been exploited in connection with developing new statistical methodology and for performing simulation-based inference for various application examples.

My research on Markov chain Monte Carlo (MCMC) methods has been much related to random tessellations, spatial point processes, and Markov random fields. In particular I have been interested in MCMC methods related to simulation-based inference, since this enables us to analyze very complicated stochastic systems for large data sets as appearing in modern statistical applications, including spatial statistics.

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One of the most exciting recent developments in stochastic simulation is perfect (or exact) simulation, which turns out to be particularly applicable for most point process models and many Markov random field models as demonstrated in my work. Recently, in connection to Bayesian inference, the problem with unknown normalizing constants of the likelihood term has been solved using an MCMC auxiliary variable method as introduced in Møller *et al*. (J. Møller, A. N. Pettitt, K. K. Berthelsen and R. W. Reeves, "An efficient MCMC method for distributions with intractable normalising constants", *Biometrika* 93: 451-8, 2006). The method involves perfect simulations.

SW: Would you talk a little about one of your more recent papers, "Modern statistics for spatial point processes" (*Scandinavian Journal of Statistics* 34: 643-711, 2007), and its significance for your field?

The classical spatial point process textbooks usually dealt with relatively small point patterns, where the assumption of stationarity is central and non-parametric methods based on summary statistics played a major role. In recent years, fast computers and advances in computational statistics, particularly Markov chain Monte Carlo methods, have had a major impact on the development of statistics for spatial point processes.

The focus has now changed to likelihood-based inference for flexible parametric models, often depending on covariates, and liberated from restrictive assumptions of stationarity. In short, "Modern statistics for spatial point processes," which we also used as the title of this paper. The paper is followed by various discussion contributions by the leading experts in the field.

SW: Are there other papers you have published that you feel are key to your field, regardless of database restrictions?

The *Biometrika* paper from 2006 noted above is worth mentioning, as is the rather recent research monograph, *Statistical Inference and Simulation for Spatial Point Processes*, by J. Møller and R.P. Waagepetersen. Published in 2004 by Chapman and Hall/CRC, it provides a detailed account on the theory of spatial point process models and simulation-based inference as well as various application examples.

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spatial point processes, log Gaussian Cox processes.

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