

# Bayesian Analysis of Spatial Point Patterns

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Spatial point patterns arise in many contexts. Examples include: ecological processes, e.g., the pattern of trees in a forest; spatial epidemiology, pattern in disease cases, perhaps different patterns for cases vs. controls; *syndromic surveillance* to identify disease outbreaks, e.g., clustering of cases; the evolution/growth of a city, i.e., urban development.

There is a rich probabilistic literature on stochastic process modeling for point patterns. With regard to spatial point patterns, more recently, there has been consequential attention paid to the applied side - fitting of models and data analysis. Notable contributors in this regard are Adrian Baddeley, Peter Diggle, Jesper Møller, and Janine Illian.

From the Bayesian perspective, this area of spatial analysis has lagged in development behind geostatistical/point referenced effort using Gaussian processes and the lattice/areal unit effort using Markov random fields. However, recently, we have seen substantial progress in Bayesian fitting of spatial point pattern models. Given such models can be fitted, the contribution here concerns development of a strategy for Bayesian inference with regard to model adequacy, model comparison, and full inference under a selected model.

Our approach rests on posterior simulation, as in most of contemporary Bayesian analysis. Here, we need posterior simulation of point patterns from which we can extract posterior inference for features. For us, the bottom line is: if you can simulate point patterns, you can carry out the foregoing inference. Much of our work draws upon variants of the Georgii-Nguyen-Zessin (GNZ) formula which, for us, immediately supplies posterior Monte Carlo integrations for many features of interest. We illustrate the above using examples involving nonhomogeneous Poisson processes, log Gaussian Cox processes, Strauss processes, and Poisson-Gamma processes.