Asymptotic Inference for Partially Observed Branching Processes

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Technical Report # 01/10, October 2010
Chair of Mathematical Statistics

Abstract

We consider the problem of estimation in an incompletely observed discrete-time Galton–Watson branching process, focusing on the first two moments of the offspring distribution. Our study is motivated by the problem of modeling the counts of new infections at the onset of a stochastic epidemic, allowing for the fact that only a part of infections is detected, and that the observation mechanism may affect the evolution of the epidemic. In this setting, the offspring mean is closely related to the spreading potential of the disease, while the second moment is connected with the variability of the mean estimator. We propose nonparametric estimators related to those used when the underlying process is fully observed but suitably modified to take into account the perturbed dependence structure induced by the partial observation and interaction scheme. We show that the estimators are consistent and derive limiting Gaussian laws conditionally on the explosion set. Further, we construct asymptotic confidence intervals valid conditionally on the explosion set. The relationship between these estimators and those based on the assumption that the process is fully observed is investigated.

Keywords: *Epidemic model; Galton–Watson branching process; partial observation; consistency; asymptotic distribution; martingales; stable convergence*