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Latent Gaussian Importance Sampling for Thinned Poisson Autoregressions

Count time series have gained popularity in infectious disease modelling due to their connection to traditional mechanistic transmission models and their straightforward implementation using both maximum likelihood and Bayesian paradigms. However, observed data corresponding to daily infections is subject to under-reporting, where fewer than the true number of infected individuals are reported as sick. Thus, for each time series of data, Y , we have an associated time series of unknown true counts, X .

Conducting inference on these unknown counts is challenging as the X 's are serially correlated integer-valued unknowns. State-of-the-art methods like Hamiltonian Monte Carlo utilize gradient-based optimization and thus do not apply due to the count-valued unknowns. We consider an approximate model defined by a latent Gaussian time series that imposes continuity in the parameter space and a non-bijective mapping that recovers the intended discrete marginal distributions of the target model whilst preserving the autocorrelation structure in the approximate model. We further introduce a self-normalized importance sampling approach to weight these observations to improve the estimation of expectations under the target posterior distribution.