CONSISTENT AND FAST INFERENCE IN COMPARTMENTAL MODELS OF EPIDEMICS USING POISSON APPROXIMATE LIKELIHOODS

NICK WHITELEY

Addressing the challenge of scaling-up epidemiological inference to complex and heterogeneous models, we introduce Poisson approximate likelihood (PAL) methods. In contrast to the popular ordinary differential equation (ODE) approach to compartmental modelling, in which a large population limit is used to motivate a deterministic model, PALs are derived from approximate filtering equations for finite-population, stochastic compartmental models, and the large population limit drives consistency of maximum PAL estimators. Our theoretical results appear to be the first likelihood-based parameter estimation consistency results which apply to a broad class of partially observed stochastic compartmental models and address the large population limit. PALs are simple to implement, involving only elementary arithmetic operations and no tuning parameters, and fast to evaluate, requiring no simulation from the model and having computational cost independent of population size.