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A moment generating function inference framework for thinned Poisson autoregressions

Count time series models are popular for modelling surveillance data of infectious diseases, such as COVID-19 and influenza, due to their flexibility and interpretability. However, observed data on daily infections is subject to underreporting, as not every infected individual seeks medical care. One such model with an underreporting mechanism is the binomially-thinned Poisson autoregression. This model is challenging to fit since it involves high-dimensional and serially correlated integer-valued unknowns. We propose a novel inference framework that uses moment generating functions (MGFs) to encode an entire binomially-thinned Poisson autoregression into a single object. We recursively define this MGF using induction and subsequently condition it on the observed data using their Fourier series representation. We further propose an implementation through Monte Carlo integration with a novel approach to parameter estimation.