Nonparametric inference for continuous-time event counting and link-based dynamic network models

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A flexible approach for modelling both dynamic event counting and dynamic link-based networks based on counting processes is proposed. For the event counting, we consider a network of actors (e.g. people in a social network) who can interact with each other along the edges of the network. The model considers for each pair \((i, j)\) of actors a counting process \(N_{i,j}(t)\) which counts the number of observations. Each \(N_{i,j}\) is assumed to have an intensity function of the form
\[
C_{i,j}(t) \exp \left( \theta(t)^T Y_{i,j}(t) \right),
\]
where \(C_{i,j}(t)\) is a predictable indicator function which is one if there can be interactions between \(i\) and \(j\). The vector \(Y_{i,j}(t)\) is a vector of covariates which possibly have an impact on the probability of an interaction. Finally, \(\theta(t)\) is a vector of parameter functions we want to estimate, it quantifies the impact of the covariates \(Y_{i,j}\) on the intensity function. For dynamic link-based networks we consider the appearance and disappearance of an edge as events (then we have two types of events), and then we adopt the previously described model to this new situation.

Estimation in these models is studied. We consider non-parametric likelihood based estimation of parameter functions via kernel smoothing. The asymptotic behaviour of these estimators is rigorously analysed by allowing the number of nodes to tend to infinity. To prove the asymptotic normality we require next to some regularity assumptions also a notion of asymptotic uncorrelatedness among separated edges.

The finite sample performance of the estimators is illustrated through an empirical analysis of bike share data.