Multivariate Hawkes processes with spatial covariates for spatiotemporal event data analysis

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Abstract

Spatiotemporal events occur in many disciplines, including economics, sociology, criminology, and seismology, with different patterns in space and time related to environmental characteristics, policing, and human behavior. In this paper, we propose a class of multivariate Hawkes processes with spatial covariates to consider the influence structure of spatial features in spatiotemporal events and the spatiotemporal patterns such as clustering. Baseline intensities are assumed to be a spatial Poisson regression model to explain spatial feature influence. The transfer functions are considered unknown but smooth and decreasing to explain the clustering phenomena. A semiparametric estimation method based on time discretization and local constant approximation is introduced. Transfer function estimators are shown to be consistent, and baseline intensity estimators are consistent and asymptotically normal. We examine the numerical performance of the proposed estimators with extensive simulation and illustrate the application of the proposed model to crime data obtained from Pittsburgh, Pennsylvania.

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