Robust Estimation of a Spatiotemporal Model in Epidemics

Rowena F. Bastero

A thesis submitted in partial fulfilment of the
requirements for the degree of

Master of Science (Statistics)

School of Statistics,
University of the Philippines,
Diliman, Quezon City.

November 2009

Abstract

A generalized spatiotemporal model in epidemics is postulated, taking into account possible structural changes in the presence of outbreaks. The proposed epidemic model considers the prediction of disease prevalence, a time and space indexed quantity, jointly determined by physical and geophysical conditions known as the covariates. A procedure that infuses the forward search algorithm and maximum likelihood estimation into the backfitting framework is proposed as an estimation procedure that possesses robustness even under cases of model misspecifications and during the volatile periods of outbreaks. The forward search algorithm guarantees robustness of estimates, filtering the effect of temporary structural changes in the estimation of covariate and spatial parameters. The maximum likelihood method facilitates the estimation of the outbreak parameter, defined to have an exponential disease dynamics. Given the closed-form nature of the outbreak dynamics, optimal results are generated through the MLE. Furthermore, the use of the backfitting algorithm provides computational efficiency and fast convergence for the additive spatiotemporal model. Using simulation studies, the proposed hybrid estimation method is shown to be capable of producing robust estimates even in the presence of structural changes, induced by the temporary epidemic outbreak. The estimation procedure likewise provides good model fit given small sample sizes and short time points, which is common in many epidemiological investigations. The model also produces good predictions for a wide range of lengths of contamination periods and levels of contamination severity.