Hierarchical Models for Spatio-Temporally Correlated Public Health Data

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Abstract:

Statisticians are increasingly faced with the task of analyzing data that are geographically referenced, and often presented in the form of maps. In the past decade, hierarchical Bayesian modeling of such data has been greatly abetted by two significant developments in computing: geographic information systems (GISs) for the simultaneous graphical display and summary of the data, and Markov chain Monte Carlo (MCMC) methods for the estimation of relevant posterior quantities. After a brief review of the various types of spatial data, we survey recent activity in this field, emphasizing spatial and spatio-temporal models appropriate for epidemiological and other public health datasets. It will be shown that many of the analytic challenges in this area arise from the need to analyze multivariate data that are misaligned both in space and in support. Fortunately, a hierarchical framework enables reasonably straightforward solutions to the celebrated modifiable areal unit and change of support problems, while accommodating explanatory covariates and multilevel responses. Throughout the talk we refer to examples drawn from public health practice, including for instance one study attempting to relate radon exposure and lung cancer near a former nuclear weapons facility in southwestern Ohio, and another modeling pediatric emergency room (ER) visit counts for asthma as a function of ozone exposure and a range of sociodemographic variables among children in the Atlanta, Georgia metropolitan area. We close with a brief mention of areas requiring further methodological work (such as spatial survival modeling), as well as recent developments in software that attempts to unify the disparate MCMC and GIS tasks required.