Spatio-temporal modeling: a flexible Bayesian approach

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In the disease mapping context, data are typically collected for specific regions over time and modeled using parametric spatio-temporal techniques. Within this approach, the spatial dependency is usually accommodated by using a conditional autoregressive prior, whereas the temporal dependency is modeled as either an autoregressive (AR) or a random walk structure. However, the use of these standard methods can provide unsatisfactory results. Ideally, spatio-temporal methods that guarantee greater flexibility to model random effects, mainly regarding spatial dependence, would be desirable. In addition, it would be also of great interest to develop a strategy for defining spatio-temporal clustering. In this circumstance, a Bayesian nonparametric methodology may be used for offering a more coherent modeling framework. This study aims to develop an effective and flexible model to identify and cluster areas where a certain disease behave similarly. Thereby, estimates of relative risk for each area may be provided. To do so, we establish a spatio-temporal model where temporal dependence is defined for areal clusters induced by product partition models (PPM). Unlike similar methods, the PPM produces more flexible clusters, even allowing them to be non-contiguous. To model the temporal component, we define a structure that considers lagged values of observed data, including also a seasonal effect. Our model also considers a spatial effect following a using directed acyclic graph autoregressive, this structure allows the interpretation of a spatial correlation parameter. For the application, we consider the number of cases of dengue, a tropical disease transmitted by mosquito, for all the 145 microregions in the Brazilian Southeast region over an observational period of 12 years, which totals 626 epidemiological weeks. As covariates, we use seasonal indicators and Human Development Index and temporal trend is modeled as an AR(3) plus a seasonal component, one 53-lagged term.

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