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Bayesian Hierarchical Spatial Mixture for Modeling Sparse Data on a Discontinuous and Modestly Large Irregular Lattice

A class of Bayesian hierarchical Bernoulli-Binomial spatial mixture zero-inflated Binomial models is developed for modeling noisy and mostly low small area crude rates. Three spatial prior formulations, the intrinsic conditional autoregressive or iCAR, the BYM, and the modified BYM models, were explored for their performance on modelling sparse data on a modestly large (N in the thousands) and discontinuous irregular lattice. The methods are illustrated via an in-depth Bayesian analysis of postcode-level response rates from a recent recruitment for a physical exercise intervention in Sheffield, UK. With increasing availability of spatial data referenced at fine spatial scales, the sparse-data situation and the Bayesian models and methods discussed herein should have considerable relevance to disease mapping and spatial regression.