Bayesian Flexibility Modelling of the Conditional Autoregressive Prior in a Disease Mapping Model

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Abstract : The basic model usually used in disease mapping, is the Besag, York and Mollie (BYM) model and which combines the spatially structured and spatially unstructured priors as random effects. Bayesian Conditional Autoregressive (CAR) model is a disease mapping method that is commonly used for smoothening the relative risk of any disease as used in the Besag, York and Mollie (BYM) model. This model (CAR), which is also usually assigned as a prior to one of the spatial random effects in the BYM model, successfully uses information from adjacent sites to improve estimates for individual sites. To our knowledge, there are some unrealistic or counter-intuitive consequences on the posterior covariance matrix of the CAR prior for the spatial random effects. In the conventional BYM (Besag, York and Mollie) model, the spatially structured and the unstructured random components cannot be seen independently, and which challenges the prior definitions for the hyperparameters of the two random effects. Therefore, the main objective of this study is to construct and utilize an extended Bayesian spatial CAR model for studying tuberculosis patterns in the Eastern Cape Province of South Africa, and then compare for flexibility with some existing CAR models. The results of the study revealed the flexibility and robustness of this alternative extended CAR to the commonly used CAR models by comparison, using the deviance information criteria. The extended Bayesian spatial CAR model is proved to be a useful and robust tool for disease modeling and as a prior for the structured spatial random effects because of the inclusion of an extra hyperparameter.

Keywords : Besag2, CAR models, disease mapping, INLA, spatial models