A Bayesian Hierarchical Spatial Model for Dental Caries Assessment Using Non-gaussian Markov Random Fields

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Abstract

In dental research, the data generated consist of two levels of hierarchy, a tooth-level and a surface-level, and dental caries outcomes exhibit spatial structures among neighboring teeth and surfaces, i.e., the disease/decay status of a tooth or surface might be influenced by the decay status of a group of neighboring teeth/surfaces. Assessments of dental caries at the tooth level yield binary outcomes, indicating presence/absence of teeth, and at the surface level yield trinary outcomes, indicating the healthy, decayed, or filled surfaces. Under a Bayesian paradigm, we develop a hierarchical spatial random effects model that accommodates the hierarchy from tooth-level to surface-level of the mixed discrete responses. At the first level, we focus on estimating the degree of spatial association between existing and missing teeth using an autologistic model. At the second level, conditioned on a tooth being non-missing, we analyze the extent of spatial-referencing for the non-missing tooth using a Potts model. Computational difficulty in the Bayesian estimation scheme due to the intractable normalizing constant is tackled using a double Metropolis-Hastings sampler. Using data from a clinical study on dental caries conducted at the Medical University of South Carolina, we compare our model to alternative models to demonstrate the improvement in predictions, and to assess the effect of important covariates on caries experience.

Some Key Words: Dental Caries; Bayesian Spatial Analysis; Autologistic Models; Potts Models; Intractable Normalizing Constant; Markov Chain Monte Carlo.

Biography: Ick Hoon Jin received his Ph.D degree in Statistics from Texas A&M University under the guidance of Prof. Faming Liang in 2011. His dissertation topic is "Statistical inference for models with intractable normalizing constants with applications to spatial models and network data analysis". He currently works as a postdoctoral fellow in the University of Texas MD Anderson Cancer Center with Prof. Yuan and Prof. Thall. His current research interests are: Bayesian inferences for spatial data; statistical analysis of network data, especially, exponential random graph model; Bayesian dose-finding studies; and, Bayesian functional and spatio-temporal mediation analyses with missing data imputation.