

An approach to the analysis of spatially correlated multilevel functional data

Ana-Maria Staicu¹, Ciprian M. Crainiceanu² and Raymond J. Carroll³

¹ Department of Mathematics, University of Bristol, UK

² Department of Biostatistics, Bloomberg School of Public Health, Johns Hopkins University, USA

³ Department of Statistics, Texas A&M University, USA

Advances in modern technology have facilitated the collection of data that are measured over a number of randomly distributed points (e.g. time) on the same subject, or experimental unit. Such data often referred to as "functional data", arise commonly in health sciences research. We describe the framework and inferential tools for hierarchical functional data where the functions at the lowest hierarchy level are spatially correlated. Previous literature to analyze such settings includes a Bayesian wavelet-based procedure (Morris and Carroll, 2006) as well as a Bayesian semiparametric method based on regression splines (Baladandayuthapani et al., 2007), both computationally intensive techniques. We present a new approach in which the hierarchical functions are modelled nonparametrically using multilevel eigenfunction bases, which appear in a multilevel functional principal component scenario, plus a weakly stationary process to account for the spatial correlation. For each level, the eigenfunction basis is estimated from the data and the functional principal component score estimates are obtained by a conditional step; a method which is conceptually simple and straightforward to implement. A second novelty of our methodology is in using kernel smoothing estimation to estimate the spatial covariance function. The proposed procedure is illustrated with a simulation study and p27 measurements data over relative cell position for a sample of rodents, in a colon carcinogenesis study.

References

- [1] Baladandayuthapani V, Mallick BK, Hong MY, Lupton JR, Turner ND and Carroll RJ (2007) Bayesian Hierarchical Spatially Correlated Functional Data Analysis with Application to Colon Carcinogenesis. *Biometrics* 1-10.
- [2] Di C, Crainiceanu CM, Caffo B and Punjabi N (2007) Multilevel functional data analysis. Under revision.
- [3] Morris JS and Carroll RJ (2006) Wavelet-based functional mixed models. *Journal of the Royal Statistical Society, Series B*, 68: 179-199.
- [4] Yao F, Müller HG, Clifford AJ, Dueker SR, Follett J, Lin Y, Buchholz BA and Vogel JS (2003) Shrinkage estimation for functional principal component scores with application to the population kinetics of plasma folate. *Biometrics* 59: 676-685.