Bayesian Small Area Estimation for Circular Data

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Abstract: The impetus for this work was the need to predict time-of-day distributions for departures of recreational anglers from fishing sites along the East coast of the US, based on a very large survey dataset of fishing trips. After explaining the background of this application, regression models based on the projected normal distribution are developed, and Bayesian estimation and prediction are considered. We construct a type of Fay-Herriott small area estimation approach to predict the distributions for a large number of domains. We also describe a model extension that allows for mixtures of project normal distributions. Because of the size of the dataset, traditional Markov Chain Monte Carlo methods are impractical here, and are replaced by variational Bayes, a relatively new and promising class of tools to obtain numerical approximations to posterior distributions. Along the way, we develop a number of improvements to variational methods that are more generally applicable. Finally, we describe the application of these methods to the original survey dataset.