Spatial Models (Stat 597A)
Fall 2007

Instructor: Murali Haran
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Office Hours: M: 11:30-12:30 or by appointment

Class Times: MW 10:10-11:25 in 327 Thomas.

Textbook: *Statistical Methods for Spatial Data Analysis* by Schabenberger and Gotway: Chapman and Hall, 2005 and *Hierarchical Modeling and Analysis for Spatial Data* by S. Banerjee, B.P. Carlin and A.E. Gelfand: Chapman and Hall/CRC Press, 2004.

Website: `http://www.stat.psu.edu/~mharan/spatial/spatial.html`

Course Description: Spatial data (data that are geographically referenced) appear in areas as diverse as ecology, environmental statistics, public health, climatology, crime mapping, forestry and demography. A knowledge of spatial or spatio-temporal modeling (when data are also temporally correlated) is therefore vital for analyzing such data.

This course will cover modern approaches for modeling spatial data. Coverage will include geostatistical (point level) and lattice (including spatially aggregated) data and spatial point processes. Also, spatial misalignment, spatio-temporal problems, nonstationary models and other advanced topics and current research problems will be discussed. Both frequentist and Bayesian approaches will be discussed, though the emphasis will be on modern hierarchical Bayesian methods. A minimum of a Masters level understanding of basic probability and mathematical statistics is assumed, as is familiarity with computer programming. Prior knowledge of stochastic processes and Monte Carlo (as covered in Stat 515) will be advantageous. *However, I will attempt to accomodate interested advanced graduate students from other fields who may not completely meet these requirements, provided they contact me ahead of time.*

Computing: We will use `R` and `WINBugs`.

Targeted Coverage:

- Understanding the nature of spatial data and basic types of spatial data. Exploratory data analysis for spatial data.
- Geostatistics: Classical kriging-based approaches, Gaussian processes, theory of spatial processes. Bayesian approaches.
- Areal/lattice data basics: theory of Markov random fields, classical and Bayesian approaches.
- Modeling spatially misaligned data.
- Spatio-temporal modeling: theory and computational issues.
- Multivariate spatial data models.
- Spatial point processes.
- Nonstationary space-time models, dynamic space-time models and other advanced topics.

Course Requirements:

- Assigned readings, class participation (10%).
- Project + presentation (60%): I expect this to be a substantial project based on roughly 8-10 weeks of effort. Students are encouraged to bring in any projects/data sets related to their current research or pursue more theoretical/computationally oriented topics. I will, however, want to talk to you to make sure the scope of your project is appropriate for this course.
- Homework (30%). I will assign some homework problems, mainly designed to help students get some practical experience with the methods and/or theory. You may discuss them and turn in joint work (up to 2 people per assignment), provided you acknowledge your collaborators.

Academic Integrity: All Penn State and Eberly College of Science policies regarding academic integrity apply to this course. Please see `http://www.science.psu.edu/academic/Integrity/index.html`.