Syllabus for ST790-033
Advanced Special Topics – Spatial Statistics
Fall 2016

Course:

Lecture: MW 11:45–1:00, 339 Riddick Hall
Course website: www4.stat.ncsu.edu/~reich/SpatialStats

Instructor: Brian Reich

Office: 5234 SAS Hall
Email: brian_reich@ncsu.edu
Web Page: www4.stat.ncsu.edu/~reich
Office Hours: MW 1:00–2:00

Teaching Assistant: Neal Grantham

Office: 1101 SAS Hall
Email: ngranth@ncsu.edu
Office Hours:

Prerequisites: ST552 - Linear Models and Variance Components.


Computing: The primary computing language will be R, which is freely available at http://www.r-project.org/.

Grading: Final grade will be based on:

\[
\text{Final Semester Score} = \frac{(\text{HW} + 3\times C1 + 3\times C2 + 3\times C3 + 3\times F)}{10},
\]

where CP is class participation, HW is the homework average, C1, C2, C3 are the three challenge problems, and F is the final exam (all out of 100).
Homework: There will be roughly weekly homework assignments. Problems and due dates will be posted on the course webpage. Unexcused late homework will be discounted by 50%. In addition to assigned problems, part of the homework grade will be based on participation in class discussion of research papers assigned by the instructor.

Challenge problems: There will be three data analysis challenges. These will be open-ended assignments based on a spatial dataset. Students will submit a short (3-4 page) report. Problems and due dates will be posted on the course webpage. Unexcused late work will be discounted by 50%.

Final exams The final exam will be held on Friday, Dec 9 at 8AM in 339 Riddick. The final exam will be the take-home project. Any conflicts with the scheduled exam dates must be submitted in writing to the instructor well in advance. Unexcused missing exams, or inadequate notice of missing an exam will result in a grade of 0 for the exam.

Course objectives:

1. Use statistical packages (SAS or R) to visualize spatial data; estimate model parameters; and perform spatial prediction
2. Derive properties (covariance, smoothness, stationarity) of models for spatial and spatiotemporal data
3. Identify appropriate statistical model for complex spatial data, and use graphics and statistical tests to justify model choice
4. Clearly present the results of an independent research project applying the methods learned in class to real data

Policy on Academic Integrity: The University policy on academic integrity is spelled out in Appendix L of the NCSU Code of Student Conduct. For a more details see the NCSU Office of Student Conduct website http://www.ncsu.edu/student_conduct/. For this course group work on homework is encouraged. However copying someone else’s work and calling them your own is plagiarism, so the work you turn in should be your own.

Students with Disabilities: Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with Disability Services for Students (DSS), 1900 Student Health Center, CB 7509, 515-7653.
Central concepts:

<table>
<thead>
<tr>
<th>Section</th>
<th>Key concepts</th>
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<tbody>
<tr>
<td>(1) Introduction</td>
<td>objectives; data types; visualization; map projections</td>
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<tr>
<td>(2) Covariance functions</td>
<td>stationary; isotropic; Matern covariance; smoothness properties; positive definiteness</td>
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<tr>
<td>(3) Gaussian processes</td>
<td>definition; properties; representations such as spectral and convolution</td>
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<tr>
<td>(4) Estimation and prediction</td>
<td>variograms; maximum likelihood; kriging</td>
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<td>(5) Bayesian methods</td>
<td>posterior distributions; MCMC</td>
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<tr>
<td>(6) Non-Gaussian data</td>
<td>hierarchical models</td>
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<tr>
<td>(7) Non-stationarity</td>
<td>EOFs, deformations; locally-stationary processes</td>
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<tr>
<td>(8) Spatiotemporal data</td>
<td>separability; Markov models; non-separable models</td>
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<tr>
<td>(9) Multivariate data</td>
<td>separability; spatial factor analysis</td>
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<tr>
<td>(10) Areal spatial data</td>
<td>Brooks’ Lemma; conditionally autoregressive models; autologistic models</td>
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A week-by-week schedule of the lecture content is available on the course web page.