Spatial Statistics
Fall 2013
Course Syllabus

Course: PM 599
Room: SSB 303
Time: Mondays 1-4pm
Instructor: Meredith Franklin
Office Hours: By appointment
Office Location: SSB 202A (Keck) AHF B57E (College)
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Website: Blackboard and http://www-hsc.usc.edu/~mereditf/

Course Scope and Purpose
Spatial statistics is a branch of statistics used to analyze data that are observed on a 2 or 3-dimensional surface. Spatial data arise in almost every field of study--examples include meteorological measurements from weather stations, demographics from the census, and incidence of disease over a particular geographic area.

This course is intended as an introduction to spatial statistics and aims to provide students with the background necessary to investigate geographically represented data. There are numerous research questions involving spatial data, but in this course focus will be placed on methods that are relevant in the fields of public health, environmental science, and social science. Lectures will cover the three main areas of spatial statistics: geostatistical data, lattice (areal) data, and point patterns.

Learning Outcomes

Upon completion of this course, students should be able to:

- Distinguish different types of spatial data (geostatistical, areal, point process) and understand how spatial autocorrelation plays a role in statistical modeling.
- Use existing methods to investigate spatial autocorrelation in example datasets provided as exercises.
- Determine which spatial methods to use to in their own research and implement them using statistical software and GIS.
- Read and discuss new methods in the spatial statistics literature based on an understanding of the basic spatial statistics approaches, principles and main assumptions.

Course Requirements
Prerequisites
Students should have a background in statistics at the level of regression as well as in statistical computing. The course will involve a great deal of computing, primarily in R. Students without the computing prerequisite may be allowed to take the course but should be aware that they will need to become familiar with R on their own.

There will not be a separate computer lab time for going through examples, but some lecture time will be set aside to go through code and procedures to familiarize students with the implementation of various spatial methods using statistical software (R) and GIS software (ArcGIS).

Materials
Lecture notes and handouts will be the primary source of information for this course. Several textbooks on spatial data analysis will prove to be useful, but lectures will be primarily based on material presented in the following (Note these are NOT REQUIRED):

1) Roger S. Bivand, Edzer J. Pebesma and Virgilio Gómez-Rubio *Applied Spatial Data Analysis with R* (2008), Springer.

2) Lance A. Waller and Carol A. Gotway *Applied Spatial Statistics for Public Health Data* (2004), John Wiley & Sons.

Other useful references are:
O. Schabenberger and C. A Gotway. *Statistical Methods for Spatial Data Analysis* (2005), Chapman & Hall.

S. Banerjee, B. Carlin, and A. Gelfand. *Bayesian and Hierarchical Modeling of Spatial Data: Hierarchical Modeling and Analysis for Spatial Data* (2004), Chapman and Hall.

Computing
The course will primarily use R, a statistical computing environment and language. It is free and available for all operating systems via www.r-project.org.

For the computing component of this course, students are encouraged to use the following as references:

1) W. N. Venables and B. D. Ripley *Modern Applied Statistics with S*. Fourth Edition (2002), Springer.

2) T. Ormsby, E. Napoleon, R. Burke, C. Groessl, L. Bowden *Getting to Know ArcGIS Desktop* Second Edition (2010), Redlands: ESRI Press.

Assessment

Task	% of total grade
Assignments (5)	60%
Final Project (proposal, presentation, paper)	40%

Assignments: There will be approximately 5 assignments given throughout the semester with more frequency at the beginning. Students may discuss the problems with one another, however, individual solutions must be submitted and copying will not be

tolerated. Late assignments will be penalized by 20% for each day past the due date.
Exam: The take home midterm will be given approximately half way through the course and will be due at the beginning of the class after it is handed out.

Project: The final project can be done individually or in a group of up to 3 people. A proposal must be submitted one month before the project is due. The project must consist of statistical analysis of a real dataset and a written report in the form of a scientific paper that summarizes the project. The report must have an abstract, introduction, methods, results and discussion.
The project topic is up to the student but should draw from his or her own research. It may also involve data from the census, surveys, simulations or a paper on spatial statistics from the literature.

Tentative Schedule:

Date	Topic	HW	Suggested Reading
8/26/13	Introduction, review of non-spatial statistics, overview of different types of spatial data		C Ch 1
9/2/13	Labour day – no class		
9/9/13	Geostatistics: variograms and covariance functions		C Ch 2.1-2.4, 2.6, WG Ch 8.1-8.2
9/16/13	Geostatistics: fitting variogram functions, kriging, spatial regression		C Ch 2.6, 3.1-3.4, WG Ch 8.2-8.3,9.1-9.2
9/23/13	Geostatistics: spatial regression and smoothing methods	HW1 due	Handouts on smoothing, GAM
9/30/13	Areal data: neighborhoods, testing for spatial association		C Ch 6.1,6.3, WG Ch 7.4-7.5
10/7/13	President's Day - No class		
10/14/13	Areal data: Global and local tests of association	HW2 due	C Ch 6.5, WG Ch 9.3
10/21/13	Areal data: CAR and SAR models, inference		C Ch 7.4, WG Ch 9.4, handout
10/28/13	Areal data: disease mapping; using GIS	HW3 due	WG Ch 9.5, handouts
11/4/13	Point process data: types of spatial patterns, CSR and tests		C Ch 8.1-8.4, WG Ch 5.1-5.3
11/11/13	Point process data: Health event clustering	HW4 due Proj.proposal	WG Ch 6
11/18/13	Special topics:Bayesian methods for spatial stat, Bayesian disease mapping		WG Ch 7.1-7.3
11/25/13	Special topics: Spatio-temporal modeling	HW5 due	WG Ch 9.5
12/2/13	Final project presentations	Proj. paper	

Statement for Students with Disabilities

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.

Statement on Academic Integrity

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. *Scampus,* the Student Guidebook, contains the Student Conduct Code in Section 11.00, while the recommended sanctions are located in Appendix A: http://www.usc.edu/dept/publications/SCAMPUS/gov/. Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at: http://www.usc.edu/student-affairs/SJACS/.