

PM 569 Spatial Statistics

Units: 3
Term: Fall 2017
Time: Friday 10am-1pm
Location: USC HSC, Soto Building Room 117
Instructor: Dr. Meredith Franklin
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Office Hours: By Appointment
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Course Description

Spatial statistics is a sub-discipline of statistics that includes the analysis of 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 Objectives

The learning objectives of this course are that upon completion, the student 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 methods introduced in lectures 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 geographic information systems.
- Read and discuss new methods in the spatial statistics literature based on an understanding of the basic spatial statistics approaches, principles and main assumptions.

Prerequisite(s): PM511A or equivalent

Recommended Preparation: Courses in regression, knowledge of R programming language

Course Notes

Lecture notes presented in class will be posted on Blackboard.

Technological Proficiency and Hardware/Software Required

The course will involve a great deal of computing, primarily in the statistical language 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. Download R at <http://www.r-project.org/>. 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). We will also introduce ArcGIS. Student licenses are available through the USC Spatial Sciences Institute (<https://software.usc.edu/geospatial-software-esri/>)

Required Readings and Supplementary 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, 2nd edition* (2013), Springer.
- 2) Lance A. Waller and Carol A. Gotway *Applied Spatial Statistics for Public Health Data* (2004), John Wiley & Sons.
- 3) S. Banerjee, B. Carlin, and A. Gelfand. *Bayesian and Hierarchical Modeling of Spatial Data, 2nd edition* (2014), Chapman and Hall. (Advanced)

Description and Assessment of Assignments

Assignments: There will be 6 assignments given throughout the semester. 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.

Project: The final project will be done individually. 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.

Grading Breakdown

Assignment	Points	% of Grade
Weekly Reading Assignment and Discussion	5	5
Homework Assignments (6 @ 10% each)	60	60
Final Project <ul style="list-style-type: none">• Proposal• Report• Presentation	35	35
TOTAL	100	100

Assignment Submission Policy

Assignments will be due on Fridays as per the schedule below and will be uploaded to the course Blackboard. Late homework assignments and projects will not be accepted.

Tentative Course Schedule: A Weekly Breakdown

	Topics/Daily Activities	Deliverable/ Due Dates
Week 1 August 25	Introduction, review of non-spatial statistics, overview of different types of spatial data	
Week 2 September 1	Geostatistics: variograms and covariance functions	
Week 3 September 8	Geostatistics: fitting variogram functions, kriging	
Week 4 September 15	Geostatistics: kriging and spatial regression	HW 1 Due
Week 5 September 22	Geostatistics: spatial smoothing techniques	
Week 6 September 29	ArcGIS and Google Maps API for geocoding	HW2 Due
Week 7 October 6	Areal data: neighborhoods, testing for spatial association	
Week 8 October 13	Areal data: global and local tests of association	HW3 Due
Week 9 October 20	Areal data: CAR and SAR models, inference	
Week 10 October 27	Areal data: disease mapping	HW4 Due; Final Project Proposal Due
Week 11 November 3	Point process data: types of spatial patterns, spatial randomness	
Week 12 November 10	Point process data: spatial clustering and testing for clustering	HW5 Due
Week 13 November 17	Point process data: models and methods in spatial Epidemiology	
Week 14 November 24	Thanksgiving, no class	
Week 15 December 1	Special topics: Spatio-temporal modeling	HW6 Due
Finals Week December 8 th	Final Project Presentations	Final Paper, Presentation Slides Due

Statement on Academic Conduct and Support Systems

Academic Conduct

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Section 11, *Behavior Violating University Standards* <https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions/>. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct/>.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the *Office of Equity and Diversity* <http://equity.usc.edu/> or to the *Department of Public Safety* <http://capsnet.usc.edu/department/department-public-safety/online-forms/contact-us>. This is important for the safety whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of another person. *The Center for Women and Men* <http://www.usc.edu/student-affairs/cwm/> provides 24/7 confidential support, and the sexual assault resource center webpage sarc@usc.edu describes reporting options and other resources.

Support Systems

A number of USC’s schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* <http://dornsife.usc.edu/ali>, which sponsors courses and workshops specifically for international graduate students. *The Office of Disability Services and Programs* http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information* <http://emergency.usc.edu/> will provide safety and other updates, including ways in which instruction will be continued by means of Blackboard, teleconferencing, and other technology.