

## PM 569 Spatial Statistics

**Location:** USC Health Science Campus, Soto Building, SSB 301

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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 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 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 the open source GIS tool qGIS, available at <http://www.qgis.org/>

## 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, 2<sup>nd</sup> 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, 2<sup>nd</sup> edition* (2014), Chapman and Hall. (Advanced)

### Description and Assessment of Assignments

**Assignments:** There will be approximately 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	10	10
Homework Assignments (6)	60	60
Final Project <ul style="list-style-type: none"> <li>• Proposal</li> <li>• Report</li> <li>• Presentation</li> </ul>	30	30
TOTAL	100	100

### Assignment Submission Policy

Assignments will be due on days when the class meets and will be submitted by email to Dr. Franklin or in class .

### Additional Policies

Late homework assignments and projects will not be accepted.

### Course Schedule: A Weekly Breakdown

	Topics/Daily Activities	Deliverable/ Due Dates
<b>Week 1</b> August 24	Introduction, review of non-spatial statistics, overview of different types of spatial data	
<b>Week 2</b> August 31	Geostatistics: variograms and covariance functions	
<b>Week 3</b> September 7	Labor Day, no class	
<b>Week 4</b> September 14	Geostatistics: fitting variogram functions, kriging	<b>HW1 Due</b>
<b>Week 5</b> September 21	Geostatistics: spatial regression and smoothing methods	
<b>Week 6</b> September 28	Geostatistics/Areal Data: Mapping in R and Google Maps	<b>HW2 Due</b>
<b>Week 7</b> October 5	Areal data: neighborhoods, testing for spatial association	
<b>Week 8</b> October 12	Areal data: global and local tests of association	<b>HW3 Due</b>
<b>Week 9</b> October 19	Areal data: CAR and SAR models, inference	
<b>Week 10</b> October 26	Areal data: disease mapping; using GIS	<b>HW4 Due</b>
<b>Week 11</b> November 2	Point process data: types of spatial patterns, CSR and tests	<b>Final Project Proposal Due</b>
<b>Week 12</b> November 9	Point process data: health event clustering	<b>HW5 Due</b>
<b>Week 13</b> November 16	Point process data: models and methods in Spatial Epidemiology	
<b>Week 14</b> November 23	Special topics: Bayesian methods for spatial stat, Bayesian disease mapping	<b>HW6 Due</b>
<b>Week 15</b> November 30	Special topics: spatio-temporal modeling	
<b>FINAL</b> December 8	<b>Final Project Presentations</b>	Presentation and report 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/departement-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](mailto: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](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.