Keck School of Medicine of USC

PM 569 Spatial Statistics

Units:	3
Term:	Fall 2019
Time:	Friday 10am-1pm
Location:	USC HSC, Soto Building Room 117
Instructor:	Dr. Meredith Franklin
Office:	SSB 202A
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.

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 • 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 will be penalized by 20% for each day past due, and late final projects will not be accepted.

Tentative Course Schedule: A Weekly Breakdown

	Topics/Daily Activities	Deliverable/ Due Dates
Week 1 August 30	Introduction, overview of different types of spatial data, introduction to R tools needed for spatial analysis, review of non-spatial regression	
Week 2 September 6	Data visualization, mapping, geocoding	**HW0**
Week 3 September 13	Geostatistics: variograms and covariance functions	**HW 1 Due**
Week 4 September 20	Geostatistics: fitting variogram functions	
Week 5 September 27	Geostatistics: kriging	**HW2 Due**
Week 6 October 4	No class (Dr. Franklin at conference)	
Week 7 October 11	Geostatistics: inverse distance weighting, spatial smoothing	
Week 8 October 18	Areal data: neighborhoods, testing for spatial association	**HW3 Due**
Week 9 October 25	Areal data: global and local tests of association	
Week 10 November 1	Areal data: CAR and SAR models, inference	**HW4 Due**
Week 11 November 8	Point process data: types of spatial patterns, spatial randomness	**Final Project Proposal Due**
Week 12 November 15	Point process data: spatial clustering and testing for clustering	
Week 13 November 22	Point process data: models and methods in spatial Epidemiology	**HW5 Due**
Week 14 November 29	Thanksgiving, no class	
Week 15 December 6	Special topics: Spatio-temporal modeling, Bayesian disease mapping	**HW6 Due**
Finals Week December 13	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 Part B, Section 11, "Behavior Violating University Standards" https://policy.usc.edu/scampus-part-b/. 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.

Support Systems:
Student Counseling Services (SCS) - (213) 740-7711 – 24/7 on call
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. https://engemannshc.usc.edu/counseling/

National Suicide Prevention Lifeline - 1-800-273-8255
Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. http://www.suicidepreventionlifeline.org

Relationship & Sexual Violence Prevention Services (RSVP) - (213) 740-4900 - 24/7 on call
Free and confidential therapy services, workshops, and training for situations related to gender-based harm.https://engemannshc.usc.edu/rsvp/

Sexual Assault Resource Center
For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: http://sarc.usc.edu/

Office of Equity and Diversity (OED)/Title IX compliance – (213) 740-5086
Works with faculty, staff, visitors, applicants, and students around issues of protected class. https://equity.usc.edu/

Bias Assessment Response and Support
Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. https://studentaffairs.usc.edu/bias-assessment-response-support/

Student Support & Advocacy – (213) 821-4710
Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. https://studentaffairs.usc.edu/ssa/

Diversity at USC – https://diversity.usc.edu/
Tabs for Events, Programs and Training, Task Force (including representatives for each school), Chronology, Participate, Resources for Students