SSCI 381, Statistics for the Spatial Sciences

Syllabus

Units: 4

Term Day Time: Fall 2020, Mon and Wed, 9 am-10:50 am

Location: SLH 102 & Online

Instructor: Orhun Aydin
Office: AHF B56G
Office Hours: Mondays, 11 am -12:50 pm. Virtual office hours (Zoom) available by appointment via email.
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Course Description

This class will be offered in a hybrid format. Lectures will be offered in person and streamed for remote access. One half of the lab/discussion sections will be offered hybrid/in person while the second half of the sections will be offered online to provide students with maximum options and accessibility. Students must enroll in the lecture and one lab/discussion section.

This is an introductory course to statistics fundamentals in spatial analysis. The emphasis will be on the theory and applications of spatial statistics as it pertains to analysis and problem solving. Statistics foundations and their spatial counterparts frequently used in spatial analysis will be introduced with real-world use cases. The course is designed to get you knowledgeable about statistical principles necessary to conduct and understand fundamental analysis methods in spatial problem solving.

Course will assume no prior knowledge of statistics and it will build on the fundamentals with use cases from spatial sciences. Course will focus on descriptive, predictive and inferential spatial statistics. The topics will include descriptive and inferential statistics, sampling, estimation and hypothesis testing. Commonly used spatial analysis methodologies such as spatial centrality and dispersion metrics, hot-spot analysis, and spatial regression will be introduced. Methodologies will be applied to case studies ranging from exploratory crime analysis to understanding earthquake occurrence patterns.

Learning Objectives

Upon successful completion of this course, a student will be able to:

- Describe mathematical and statistical foundations for spatial statistics
- Identify spatial statistical methodologies for solving real-world problems
- Explore the strengths and limitations of statistical methodologies that are frequently used in spatial analysis
- Design a solution for a spatial modelling problem using spatial statistics

Prerequisite(s): None
Co-Requisite(s): None

Class Conduct

Harassment, sexual misconduct, interpersonal violence, and stalking are not tolerated by the university. All faculty and most staff are considered Responsible Employees by the university and must forward all information they receive about these types of situations to the Title IX Coordinator. The Title IX Coordinator is responsible for assisting students with supportive accommodations, including academic accommodations, as well as investigating these incidents if the reporting student wants an investigation. The Title IX office is also responsible for coordinating supportive measures for transgender and nonbinary students such as faculty notifications, and more. If you need supportive accommodations you may contact the Title IX Coordinator directly (titleix@usc.edu or 213-821-8298) without sharing any personal information with me. If you would like to speak with a confidential counselor, Relationship and

Sexual Violence Prevention Services (RSVP) provides 24/7 confidential support for students (213-740-9355 (WELL); press 0 after hours).

Required Readings and Supplementary Materials

Please acquire the text listed below. All other supplementary readings listed in the syllabus are available online through USC Libraries or under the tab marked "Readings" on the course Blackboard.

The required textbook for this course is:

Burt, J. E., Barber, G. M., Rigby, D. L. (2009). Elementary statistics for geographers. Third Edition. Guilford Press.

Supplementary readings for this course are:

Description and Valuation of Assessments

This course includes a variety of assignments that allow students to practice spatial statistics and demonstrate their theoretical grasp of foundations. Assignment types are described below and their point value to final grades are listed in the following Grading Breakdown section.

Hands-On Assignments

A set of 6 hands-on assignments are provided throughout the semester. These hands-on experiences are designed to give students practical experience in utilizing spatial statistics, describe results and quality metrics to perform spatial analysis. Hands-on assignments are linked to the lectures and class discussions and build on the theoretical fundamentals introduced during lectures. ArcGIS Pro and R will be used for hands-on assignments.

Theoretical Assignments

A set of 9 theoretical assignments are provided throughout the semester. Theoretical assignments involve solving spatial analysis problems to reinforce fundamentals of spatial statistics. All theoretical assignments entail solving numerical problems and describing underpinning of methodologies.

Midterm Proposal

A midterm proposal will be assigned for Week 8. Midterm proposal will be a short, written document (max 2 pages) that describes the scope of your final project, methodologies you will explore, reasons for choosing these methodologies and your expected findings. Breakdown of an effective midterm proposal is as follows:

- Research question
- Scope of the project
- Data Sources (You are required to use open data that you can publish)
- Tentative Workflow/Methodology

Midterm Exam

A written midterm exam will be conducted to gauge your understanding of mathematical fundamentals and applications of spatial statistics to GIS problems behind the course.

Final Project Story Map

The final project will be delivered in the form of a Story Map. A Story Map is an online platform that allows for the integration of digital maps with a variety of content such as graphs, text, photographs, video, and audio.

The final project Story Map should consist of Scope, Methodology, Case Study, Results, Conclusions and Future Work. Scope should clearly communicate the research question and data sources with maps. Methodology should detail your approach to solve the research question using techniques learned in class. Case Study should demonstrate application of methods to data that pertains to the research problem. Results should contain maps, charts and statistical diagnostics to present your findings and metrics that support them. Conclusions should map and chart what you have learned about your research question in the light of your statistical analysis. Future work should present the shortcomings of the methods you applied and propose how you can address these shortcomings. Bonus points will be given to final projects that juxtapose spatial statistics to generic statistical methods and showcase the value of spatial approaches to spatial problems. In your Story Map, you are expected to distill your knowledge of spatial statistics and present your analysis clearly to a non-expert.

Grading Breakdown

The table below shows the breakdown of the assessments and their weight in the final grade. The emphasis is on regularly completing a number of short assignments as well as solid performance on the final examination, policy essay, and Story map project.

Assessment	Number	Points Each	Total Points (% of Grade)
Hands-On Assignments	5	3.75	18.75
Theoretical Assignments	7	3.75	26.25
Midterm Proposal	1	10	10
Midterm Exam	1	15	15
Final Project Story Map	1	30	30
Totals	18	--	100

Schedule

Date	Topics	Readings	Deliverables/Due Dates
Module 1 | Descriptive Spatial Statistics			
Week 1			
8/17	Introduction to Statistics in GIS Preliminary Mathematical notation	Burt et al, Chapter 1, Sections 2.2, 3.1, 3.2	Assignment 1: Due 9/4 in class
8/19	Descriptive statistics Measures of Central Tendency-Variation Descriptive Statistics for Spatial Data	Burt et al, Chapter 5	
Week 2*			
8/24 *Monday 9/2 is a university holiday	Measures of Spatial Autocorrelation Measures of Spatial Clustering (Heterogeneity)	Burt et al, Ch. 14.2, 14.3 Legendre, P. (1993). Spatial autocorrelation: trouble or new paradigm?. Ecology, 74(6), 1659-1673.	Assignment 2: Due 9/11 in class
8/26	Point-pattern analysis	Burt et al, Ch. 14.1	
Week 3			
8/31	Hot-Spot Analysis	Getis, A., & Ord, J. K. (2010). The analysis of spatial association by use of distance statistics. In Perspectives on Spatial Data Analysis (pp. 127-145). Springer, Berlin, Heidelberg.	Hands-On Assignment 1: Due 9/18 online
9/2	Spatial Statistics in Action: Earthquakes in Oklahoma	No reading assignment	
Week 4			

| 9/7 | Labor Day- No Class | | Hands-On Assignment 2: Due 9/25 online |
| 9/9 | Introduction to R in GIS

Introduction to the R-ArcGIS Bridge | https://github.com/R-ArcGIS/R-Bridge-Tutorial-Notebooks | |

Module 2 | Spatial Statistical Modelling			

Week 5			
9/14	Random Variables Discrete Probability Distributions	Burt et al, 5.1, 5.2, 5.3, Appendix 5.a, Appendix 5.b	Assignment 3: Due 10/2 in class
9/16	Continuous Probability Distributions The Gaussian Distribution	Burt et al, 5.4	

Week 6			
9/21	Estimation Point Estimation	Burt et al., 7.1, 7.2	Assignment 4: Due 10/9 in class
9/23	Confidence Interval Classical Hypothesis Testing	Burt et al., 7.3, 8.1	

Week 7			
9/28	The P-value One sample Z-test and t-test	Burt et al., Chapter 8.2, 8.3, 8.4, 8.5	Midterm Proposal Due 10/9
9/30	Spatial Hypothesis Testing	Ripley, B. D. (1979). Tests of randomness for spatial point patterns. Journal of the Royal Statistical Society: Series B (Methodological), 41(3), 368-374.	

Week 8*			
10/5	Spatial Statistics in Action: Inferring spatial distribution of diseases outbreak patterns	No reading assignment	Hands-On Assignment 3: Due 10/23 online
10/7	Midterm Examination	No reading assignment	

Module 3 | Modeling Spatial Relationships			
Week 9			
10/12	Pearson's correlation coefficient Linear Regression	Burt et al, 12.1, 12.2., 12.3	Assignment 5: Due 10/30 in class
10/14	Bivariate Regression	Burt et al, 13.1	
Week 10			
10/19	Bivariate Association	Guo, D. (2010). Local entropy map: A nonparametric approach to detecting spatially varying multivariate relationships. International Journal of Geographical Information Science, 24(9), 1367-1389.	Hands-On Assignment 4: Due 11/6 online
10/21	Geographically Weighted Regression	Brunsdon, C., Fotheringham, A. S., & Charlton, M. E. (1996). Geographically weighted regression: a method for exploring spatial nonstationarity. Geographical analysis, 28(4), 281-298.	
Week 11			
10/26	Spatial Statistics in Action: Understanding House Prices in King County, WA	No reading assignment	
Module 4 | Spatial Data Collection & Wrangling			
10/28	Sampling Geographic Sampling	Burt et al, Chapter 6	Assignment 6: Due 11/13 in class
Week 12			
11/2	Bridging the Scale Gap: Interpolation	Lecture Notes	Assignment 7: Due 11/20 in class
11/4	Wrangling Missing Values in Spatial Data	Lecture Notes	

Week 13			
11/9	Geoenrichment in GIS	Lecture Notes	Hands-On Assignment 5: Due 12/2 online
11/11	Spatial Statistics in Action: Wrangling San Francisco Crime Data	No reading assignment	
Final			
11/23	Course Review		Final Week. No Assignments

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" 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
engemannshc.usc.edu/counseling
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

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

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

Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086
equity.usc.edu, titleix.usc.edu
Information about how to get help or help a survivor of harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants. The university prohibits discrimination or harassment based on the

following protected characteristics: race, color, national origin, ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age, physical disability, medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and any other characteristic which may be specified in applicable laws and governmental regulations.

Bias Assessment Response and Support – (213) 740-2421
studentaffairs.usc.edu/bias-assessment-response-support
Avenue to report incidents of bias, hate crimes, and microaggressions for appropriate investigation and response.

The Office of Disability Services and Programs – (213) 740-0776
dsp.usc.edu
Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

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

Diversity at USC – (213) 740-2101
diversity.usc.edu
Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
dps.usc.edu, emergency.usc.edu
Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety – - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call
dps.usc.edu
Non-emergency assistance or information.