

SSCI 683: Principles of Spatial Data Analysis

Units: 4

Term—Day—Time: Spring 2020, Thursdays, 12-2:50 pm

Location: Spatial Sciences Institute, AHF 145D

Instructor: An-Min Wu, Ph.D.

Office: AHF B55B

Office Hours: Mondays, 3 – 4 p.m. and Tuesdays, 11:30 a.m. – 12:30 p.m. Also available most days and times by appointment via email.

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Course Description

This course explores the theoretical foundations, methods, techniques, and software systems for spatial data analysis. The course aims to provide students with the knowledge and skills necessary to investigate research questions, with a focus on spatial health problems, using spatial analysis methods. Essential concepts of quantitative geographic information are presented, including the fundamental spatial concepts, the core components of geospatial analysis techniques, exploratory spatial data analysis and spatial statistics, surface analysis, and network and locational analysis. The latest research in a variety of topics related to population, health, and place that are central to spatial analysis are also examined. Students will gain an in-depth understanding and hands-on experience in the ways to explore a variety of applications through a combination of homework, presentations and projects. Students will learn about the wide variety of geospatial data and analytical tools available, including how to find relevant data and transform it as needed so that it can be used for solving specific health-related challenges and problems.

Learning Objectives

On completion of this course, students will be able to:

- Describe key theoretical concepts of spatial analysis approaches.
- Evaluate spatial analysis approaches and techniques for working on research that investigate places and their roles in shaping environmental exposures, health-related impacts and outcomes, and the efficacy of health care delivery systems.
- Analyze spatial problems by applying appropriate and relevant spatial analysis techniques.

Prerequisite(s): None.

Co-Requisite (s): Students must be enrolled in an existing USC PhD program

Concurrent Enrollment: None

Recommended Preparation: Some experience in GIS software or GIS coursework (e.g. SSCI 581) is strongly recommended; contact the instructor if you have no prior experience in GIS.

Course Structure

The course will be delivered with multiple methods including lectures, class discussion and hands-on practice. During the first half of each class session, the instructor will present the core topics and selected students will give presentations on some of the subtopics. The remaining time in the class will be group discussions on the readings or hands-on practices related to the lecture topics covered. Student participation is encouraged through reading discussions, hands-on practices, homework assignments, and class presentations.

Throughout the semester, homework assignments provide students first-hand experience in spatial analysis using the software R and ArcGIS Pro, and reading assignments help students evaluate and integrate the information acquired from the weekly readings. Students will design and conduct final projects to learn more in-depth spatial analysis approaches in a specific topic of research interest and demonstrate their ability to apply appropriate spatial analysis methods in resolving problems related to population, health and place.

Technological Requirements

The course will be focused on using R and ArcGIS Pro. Students can access the software for course assignments using computing resources provided by the Spatial Sciences Institute. Students will be given login credentials and instructions to sign-in to the remote Spatial Sciences Institute Server for the required software.

Required Readings and Supplementary Materials

The required textbooks for this course are:

- De Smith, Michael J., Michael F. Goodchild, and Paul A. Longley. 2018. *Geospatial analysis: a comprehensive guide to principles, techniques and software tools* (6th Ed.). Winchelsea, UK: Winchelsea Press. (Available online: <http://www.spatialanalysisonline.com/index.html>.)
- O'Sullivan, David, and David Unwin. 2010. *Geographic Information Analysis*, 2nd Edition. New York, NY: John Wiley & Sons. (Available online via USC Libraries.)

Supplementary readings will be assigned from various sources and will be accessed via the USC Library's electronic collections and/or provided by the instructor via Blackboard, including:

- Anselin, Luc. 2019. "The Moran scatterplot as an ESDA tool to assess local instability in spatial association." In *Spatial Analytical*, pp. 111-126. Routledge.
- Baker, David M., and Alain-Jacques Valleron. 2014. "An open source software for fast grid-based data-mining in spatial epidemiology (FGBASE)." *International journal of health geographics* 13, (1): 46.
- Barreto, Moises Colares, Doris Kosminsky, and Claudio Esperança. 2018. "Hexagonal hierarchical cartogram: Towards a thematic map of Brazil." *InfoDesign-Revista Brasileira de Design da Informação* 15 (1): 45-62.
- Berrigan, David, Zaria Tatalovich, Linda W. Pickle, Reid Ewing, and Rachel Ballard-Barbash. 2014. "Urban sprawl, obesity, and cancer mortality in the United States: cross-sectional analysis and methodological challenges." *International Journal of Health Geographics* 13 (1): 3.
- Cooper, Crispin HV. 2015. "Spatial localization of closeness and betweenness measures: A self-contradictory but useful form of network analysis." *International Journal of Geographical Information Science* 29 (8): 1293-1309.

- Dogru, Ahmet Ozgur, Ruusa Magano David, Necla Ulugtekin, Cigdem Goksel, Dursun Zafer Seker, and Seval Sözen. 2017. "GIS based spatial pattern analysis: Children with Hepatitis A in Turkey." *Environmental research* 156: 349-357.
- Goovaerts, Pierre. 2005. "Geostatistical analysis of disease data: estimation of cancer mortality risk from empirical frequencies using Poisson kriging." *International Journal of Health Geographics* 4 (1): 1.
- Hanna-Attisha, Mona, Jenny LaChance, Richard Casey Sadler, and Allison Champney Schnepf. 2016. "Elevated blood lead levels in children associated with the Flint drinking water crisis: a spatial analysis of risk and public health response." *American Journal of Public Health* 106 (2): 283-290.
- Hohl, Alexander, Minrui Zheng, Wenwu Tang, Eric Delmelle, and Irene Casas. 2017. "Spatiotemporal point pattern analysis using Ripley's K function." In *Geospatial data science: techniques and applications*. CRC Press, Boca Raton, FL.
- Jia, Tao, Hongbing Tao, Kun Qin, Yulong Wang, Chengkun Liu, and Qili Gao. 2014. "Selecting the optimal healthcare centers with a modified P-median model: a visual analytic perspective." *International journal of health geographics* 13 (1): 42.
- Kwan, Mei-Po. 2018. "The limits of the neighborhood effect: Contextual uncertainties in geographic, environmental health, and social science research." *Annals of the American Association of Geographers* 108 (6): 1482-1490.
- Langford, Mitchel, Gary Higgs, and Richard Fry. 2016. "Multi-modal two-step floating catchment area analysis of primary health care accessibility." *Health & place* 38: 70-81.
- Liu, Qiannan, Zhiyun Ouyang, Ainong Li, and Weihua Xu. 2016. "Spatial Distribution Characteristics of Biomass and Carbon Storage in Forest Vegetation in Chongqing Based on RS and GIS." *Nature Environment and Pollution Technology* 15 (4): 1381.
- Louis, Valérie R., Revati Phalkey, Olaf Horstick, Pitcha Ratanawong, Annelies Wilder-Smith, Yesim Tozan, and Peter Dambach. 2014. "Modeling tools for dengue risk mapping-a systematic review." *International Journal of Health Geographics* 13 (1): 50.
- Martins-Melo, Francisco Rogerlândio, Alberto Novaes Ramos, Carlos Henrique Alencar, Wolfram Lange, and Jorg Heukelbach. 2012. "Mortality of Chagas' disease in Brazil: spatial patterns and definition of high-risk areas." *Tropical Medicine & International Health* 17 (9): 1066-1075.
- Marx, Andrew, and Donald McFarlane. 2019. "Combining Unmanned Aerial Systems and Satellite Data to Monitor Phenological Changes in Tropical Forests: A Case Study from Costa Rica." *Case Studies in the Environment*.
- Mobley, Lee R., Tzy-Mey Kuo, Matthew Urato, Sujha Subramanian, Lisa Watson, and Luc Anselin. 2012. "Spatial heterogeneity in cancer control planning and cancer screening behavior." *Annals of the Association of American Geographers* 102 (5): 1113-1124.

- Mulrooney, Timothy, Kathi Beratan, Christopher McGinn, and Benjamin Branch. 2017. "A comparison of raster-based travel time surfaces against vector-based network calculations as applied in the study of rural food deserts." *Applied geography* 78: 12-21.
- Pattinson, Woodrow, Ian Longley, and Simon Kingham. 2015. "Proximity to busy highways and local resident perceptions of air quality." *Health & place* 31: 154-162.
- Perchoux, Camille, Basile Chaix, Ruben Brondeel, and Yan Kestens. 2016. "Residential buffer, perceived neighborhood, and individual activity space: New refinements in the definition of exposure areas–The RECORD Cohort Study." *Health and Place* 40: 116-122.
- Rezaeian, Mohsen, Graham Dunn, Selwyn St Leger, and Louis Appleby. 2007. "Geographical epidemiology, spatial analysis and geographical information systems: a multidisciplinary glossary." *Journal of Epidemiology & Community Health* 61 (2): 98-102.
- Robertson, Colin, and Rob Feick. 2018. "Inference and analysis across spatial supports in the big data era: Uncertain point observations and geographic contexts." *Transactions in GIS* 22 (2): 455-476.
- Shi, Xun, Jennifer Alford-Teaster, Tracy Onega, and Dongmei Wang. 2012. "Spatial access and local demand for major cancer care facilities in the United States." *Annals of the Association of American Geographers* 102(5): 1125-1134.
- Spencer, John, and Gustavo Angeles. 2007. "Kernel density estimation as a technique for assessing availability of health services in Nicaragua." *Health Services and Outcomes Research Methodology* 7: 145-157.
- Spielman, Seth E., and John R. Logan. 2013. "Using high-resolution population data to identify neighborhoods and establish their boundaries." *Annals of the Association of American Geographers* 103 (1): 67-84.
- Tatalovich, Zaria, John P. Wilson and Myles Cockburn. 2006a. A comparison of Thiessen polygon, kriging, and spline models of potential UV exposure. *Cartography and Geographic Information Science*, 33 (3): 217-231.
- Tatalovich, Zaria, John P. Wilson, Thomas Mack, Ying Yan, and Myles Cockburn. 2006b. "The objective assessment of lifetime cumulative ultraviolet exposure for determining melanoma risk." *Journal of Photochemistry and Photobiology B: Biology* 85 (3): 198-204.
- Vaz, Eric, Michael Cusimano, and Tony Hernandez. 2015. "Land use perception of self-reported health: Exploratory analysis of anthropogenic land use phenotypes." *Land Use Policy* 46: 232-240.
- VoPham, Trang, John P. Wilson, Darren Ruddell, Tarek Rashed, Maria M. Brooks, Jian-Min Yuan, Evelyn O. Talbott, Chung-Chou H. Chang, and Joel L. Weissfeld. 2015. "Linking pesticides and human health: A geographic information system (GIS) and Landsat remote sensing method to estimate agricultural pesticide exposure." *Applied Geography* 62: 171-181.

- Wan, Neng, Bin Zou, and Troy Sternberg. 2012. "A three-step floating catchment area method for analyzing spatial access to health services." *International Journal of Geographical Information Science* 26 (6): 1073-1089.
- Weiss, D. J.H., A. Nelson, H. S. Gibson, W. Temperley, S. Peedell, A. Lieber, M. Hancher, E. Poyart, S. Belchior, N. Fullman and B. Mappin. 2018. "A global map of travel time to cities to assess inequalities in accessibility in 2015." *Nature* 553 (7688): 333.
- Wu, An-Min, and Karen K. Kemp. 2019. "Global Measures of Spatial Association." *The Geographic Information Science & Technology Body of Knowledge* (1st Quarter 2019 Edition), John P. Wilson (Ed.)
- Yin, Chaohui, Man Yuan, Youpeng Lu, Yaping Huang, and Yanfang Liu. 2018. "Effects of urban form on the urban heat island effect based on spatial regression model." *Science of the Total Environment* 634: 696-704.
- Yu, Wenhao, Tinghua Ai, and Shiwei Shao. 2015. "The analysis and delimitation of Central Business District using network kernel density estimation." *Journal of Transport Geography* 45: 32-47.

Description and Assessment of Assignments

There are several different types of assignments due nearly each week in our course that make up a significant part of your final grade. These different types of assignments are described below.

In-Class Engagement - 13 worth a total of 13%. An in-class engagement grade for the semester will be assigned based upon student engagement in the class sessions. The activities of in-class engagement can be, but not limited to, one-minute writing, quiz, group discussion, or hands-on practice. Failure to participate in in-class engagement activities will receive no grade for that week.

Reading Assignments – 6 worth a total of 12%. These will focus on the theory portion of the course as presented in the weekly readings. The objective is to help you evaluate and integrate the information you have acquired from the course readings. You are strongly recommended to read all material outlined for each week before the class session, but are free to choose to submit any six of the 13 subsequent assignments. You must complete and submit them for grading in the weeks specified in the Course Schedule at the end of this syllabus.

Homework Assignments -- 4, worth a total of 28%: Students will be assigned a total of 4 homework assignments in this course. These hands-on assignments are to practice spatial analysis techniques explored in theory in the texts. You will analyze the data of your own choice using ArcGIS and/or R scripts, and write a short report to answer the questions in each assignment.

Class Presentation - 1 worth a total of 12%: Students will conduct a mini-lecture based on topics determined in consultation with the instructor. Students will be expected to become an expert on that topic and present a lecture of 30-40 minutes on the topic.

Final Project

To integrate your learning of all the material covered in the course, in the final project, you will design, undertake, and report on a spatial analysis research project that will be the context of the assignments throughout the semester. Students can conduct either an independent or 2-person team projects. The four components of the project will be due at different times throughout the semester. The grading rubric for each project component will be provided at the time the assignment is released. The four final project components include:

Project Idea Presentation & Discussion - 5%. An in-class presentation for your final project idea, including the spatial questions you would like to investigate, how you plan to solve them, the data to be used for analysis, and expected outcomes.

Proposal - 5%. A proposal document developed from the project idea presentation and the feedback received.

Final Presentation - 10%. A final presentation during the final week of the class session.

Report - 15%. A written report in the format of a research paper on your final project methodology and outcomes.

Grading Breakdown

Assessments	Number	% Each	Total % of Grade
In-Class Engagement	13	1	13
Reading Assignments	6	2	12
Homework Assignments	4	7	28
Class Presentation	1	12	12
Project Components			
Idea Presentation & Discussion	1	5	5
Final Project Proposal	1	5	5
Final Project Presentation	1	10	10
Final Project Report	1	15	15
Total	36	-	100

Assignment Submission Policy

Unless otherwise noted, assignments must be submitted via Blackboard by the due dates specified in the Course Schedule below and on the assignment instructions.

Additional Policies

Students are expected to attend and participate in every class session and to complete and upload all assignments before the deadlines detailed in the Course Schedule. Late work will be assessed a penalty of 10% per day and zero grades will be assigned for work that is more than one week late.

Course Schedule: A Weekly Breakdown

	Topics	Readings and Homework Assignments	Deliverables/Dues
<i>Module 1: Concept Framework for Spatial Data Analysis</i>			
Week 1 1/16	Conceptual Framework and Methodological Context	de Smith et al. (2018) Ch. 2 O'Sullivan & Unwin (2010) Ch.1 Rezaeian et al. (2007) Perchoux et al. (2016)	No deliverables
Week 2 1/23	Geospatial Data Analysis Potentials and Problems	O'Sullivan & Unwin (2010) Ch.2 Robertson and Feick (2018) Kwan (2018) Homework Assignment 1	Sign-up for class presentations Reading Assignment 1: due Wednesday, 1/22
Week 3 1/30	Maps for Spatial Analysis and Processes	O'Sullivan & Unwin (2010) Ch.3 & 4 de Smith et al. (2018). §5.3-5.3.3 Mobley et al. (2012) Barreto et al. (2018)	Reading Assignment 2: due Wednesday, 1/29
<i>Module 2: Exploratory Spatial Data Analysis</i>			
Week 4 2/6	Point Pattern Analysis	de Smith et al. (2018). Ch. 5-§5.2 & §5.4 Spencer and Angeles (2007) Yu et al. (2015) Hohl et al. (2017) Homework Assignment #2	Homework Assignment 1: due Tuesday, 2/4 Reading Assignment 3: due Wednesday, 2/5
Week 5 2/13	Spatial Autocorrelation I: Global Measures	O'Sullivan & Unwin (2010) Ch. 7 Wu & Kemp (2019) Martins-Melo et al. (2012) Vaz et al. (2015)	Reading Assignment 4: due Wednesday, 2/12
Week 6 2/20	Spatial Autocorrelation II: Local Measures	O'Sullivan & Unwin (2010) Ch.8-§8.4 Anselin (2019) Harris et al. (2017)	Reading Assignment 5: due Wednesday, 2/19 Final project idea presentation: Thursday, 2/20
<i>Module 3: Regression and Spatial Regression Analysis</i>			
Week 7 2/27	Regression analysis in GIS	De Smith et al. (2018). §5.6.1-5.6.2 Berrigan et al. (2014) Pattinson et al. (2015) Homework Assignment #3	Homework Assignment #2: due Tuesday, 2/25 Reading Assignment 6: due Wednesday, 2/26
Week 8 3/5	Spatial Regression	De Smith et al. (2018). §5.6.3-5.6.4 Yin et al. (2018) Dogru et al. (2017) Matthew and Yang (2012)	Reading Assignment 7: due Wednesday, 3/4

<i>Module 4: Raster Analysis</i>			
Week 9 3/12	Surface and Field Analysis	O'Sullivan & Unwin (2010) §9.4-9.5 Baker and Valleron (2014) Mulrooney et al. (2017)	Reading Assignment 8: due Wednesday, 3/11 Homework Assignment #3: Friday, 3/13
3/15-3/22	<i>Spring Recess</i>		
Week 10 3/26	Remote sensing for GIS Application	VoPham et al. (2015) Liu et al. (2016) Marx and McFarland (2019)	Final Project Proposal due Monday, 3/23 Reading Assignment 9: due Wednesday, 3/25
<i>Module 5: Spatial Interpolations</i>			
Week 11 4/2	Deterministic Interpolations	de Smith et al. (2018). §6.5-§6.6 Tatalovich et al. (2006a) Tatalovich et al. (2006b) Homework Assignment #4	Reading Assignment 10: due Wednesday, 4/1
Week 12 4/9* *AAG week; schedule might change	Geostatistical Interpolations	O'Sullivan & Unwin (2010) §10.3-§10.4 Louis et al. (2014) Goovaerts (2005) Hanna-Attisha et al. (2016)	Reading Assignment 11: due Wednesday, 4/1
<i>Module 6: Network and Spatial Accessibility</i>			
Week 13 4/16	Introduction to Network and Location Analysis	de Smith et al. (2018). §7.1-§7.2 & §7.4 Cooper (2015) Weiss et al. (2018)	Homework Assignment #4: Tuesday, 4/14 Reading Assignment 12: due Wednesday, 4/15
Week 14 4/23	Spatial Health Access	Jia et al. (2014) Shi et al. (2012) Wan et al. (2012) Landford et al. (2016)	Reading Assignment 13: due Wednesday, 4/22
Week 15 4/30* *Friday, 5/1 is the last day of class	Final Presentations	Final Presentations	Final Presentation: Thursday, 4/30
FINAL 5/6-5/13	Final Project Completion		Final Report: Friday, 5/8

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, policy.usc.edu/scientific-misconduct.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call
studenthealth.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
suicidepreventionlifeline.org

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 and Services (RSVP) - (213) 740-9355(WELL), press “0” after hours – 24/7 on call
studenthealth.usc.edu/sexual-assault

Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED)- (213) 740-5086 | Title IX – (213) 821-8298
equity.usc.edu, titleix.usc.edu

Information about how to get help or help someone affected by 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. The university also prohibits sexual assault, non-consensual sexual contact, sexual misconduct, intimate partner violence, stalking, malicious dissuasion, retaliation, and violation of interim measures.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298
usc-advocate.symplicity.com/care_report

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity | Title IX for appropriate investigation, supportive measures, 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

USC Support and Advocacy - (213) 821-4710

uscsa.usc.edu

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

Emergency assistance and avenue to report a crime. Latest updates regarding safety, 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.