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.
Contact Info: anminwu@usc.edu, 213-740-2876 (office)

Library Help: Andrzej (Andy) Rutkowski
Office: VKC Library 36B
Office Hours: By appointment
Contact Info: arutkows@usc.edu, 213-740-6390 (office), http://bit.ly/andyhangout

IT Help: Richard Tsung
Office: AHF B57E
Office Hours: By appointment
Contact Info: ctsung@usc.edu, 213-821-4415 (office)
**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-Require(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:


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:


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

<table>
<thead>
<tr>
<th>Assessments</th>
<th>Number</th>
<th>% Each</th>
<th>Total % of Grade</th>
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</thead>
<tbody>
<tr>
<td>In-Class Engagement</td>
<td>13</td>
<td>1</td>
<td>13</td>
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<tr>
<td>Reading Assignments</td>
<td>6</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>Homework Assignments</td>
<td>4</td>
<td>7</td>
<td>28</td>
</tr>
<tr>
<td>Class Presentation</td>
<td>1</td>
<td>12</td>
<td>12</td>
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<tr>
<td>Project Components</td>
<td></td>
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<tr>
<td>Idea Presentation &amp; Discussion</td>
<td>1</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Final Project Proposal</td>
<td>1</td>
<td>5</td>
<td>5</td>
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<tr>
<td>Final Project Presentation</td>
<td>1</td>
<td>10</td>
<td>10</td>
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<tr>
<td>Final Project Report</td>
<td>1</td>
<td>15</td>
<td>15</td>
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<tr>
<td>Total</td>
<td>36</td>
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<td>100</td>
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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

<table>
<thead>
<tr>
<th>Week</th>
<th>Topics</th>
<th>Readings and Homework Assignments</th>
<th>Deliverables/Dues</th>
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</thead>
<tbody>
<tr>
<td><strong>Module 1: Concept Framework for Spatial Data Analysis</strong></td>
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| **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 |
| **Module 2: Exploratory Spatial Data Analysis** |
| **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 |
| **Module 3: Regression and Spatial Regression Analysis** |
| **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 |
<table>
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<tr>
<th>Module 4: Raster Analysis</th>
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<tbody>
<tr>
<td><strong>Week 9</strong> 3/12</td>
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</tbody>
</table>
| 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                 |
| **Spring Recess**         |
| **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 |
| **Module 5: Spatial Interpolations** |
| **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 |
| **Module 6: Network and Spatial Accessibility** |
| **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 Presentations |
| Final Presentation: Thursday, 4/30 |
| **FINAL** 5/6-5/13         |
| Final Project Completion   | 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.