Syllabus

Units: 4

Term Day Time: Spring 2021, Online

Location: Online

Instructor: Orhun Aydin, PhD
Office: AHF B56G
Regular Office Hours: TBD. Also available most days and times by appointment via email.
Contact Info: oaydin@usc.edu, (213) 740-5910, see contact page on Blackboard for Zoom Room

Library Help: Andy Rutkowski
Office: VKC 36B
Office Hours: Tue 11 am-12 pm and Thu 4:30-5:30 pm PT
Contact Info: arutkows@usc.edu, 213-740-6390
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IT Help: Richard Tsung
Office: AHF 145D
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Contact Info: spatial_support@usc.edu, 213-821-4415

Course Scope and Purpose

Space is becoming a predominant dimension in problems our society faces. As a result, spatial data science has been an ever-growing discipline to capture the impact of location with generalizable methods. The expansion of location information and location intelligence to understand human-driven, physical and hybrid systems brings the importance of analyzing spatial data to its fullest potential to the fore.

In this course, students obtain the skills to perform rigorous spatial data science on various problems that range from finding patterns in spatial data to predictive analysis. The course will introduce the spatial data scientific approach to issues and present a holistic generalizable analysis pipeline. Essential underlying theoretical concepts of spatial machine learning methods will be introduced, and the theory will be followed with hands-on examples that leverage geospatial Python, R, and the ArcGIS platform. The course is structured to follow the general data scientific workflow, introducing spatial data types, data engineering (wrangling), pattern mining, predictive analysis, model diagnostics, and, finally, prescriptive analysis for decision-making. Students will be exposed to multi-faceted problem-solving methodologies in spatial data science while using state-of-the-art technology to solve real-world problems in hands-on assignments. In addition, reading assignments from various sources will be assigned to broaden students' horizon on the overarching theory and applications being developed in this rapidly evolving and growing area.

This is a required course for the M.S. in Spatial Data Science and an elective for the Spatial Data Management and Spatial Analytics tracks in the M.S. in Geographic Information Science and Technology, the M.S. in Spatial Economics and Data Analysis, and the Geospatial Leadership and Remote Sensing for Earth Observation Graduate Certificate Programs.

Learning Outcomes

On completion of this course, students should be able to:
- Plan, design and implement a spatial data science workflow to solve real world problems by leveraging relevant methodologies and technologies
- Distinguish distinct stages of the spatial data science workflow, and choose adequate spatial machine learning models
- Communicate sophisticated analysis to a wide audience
- Explain underlying assumptions and limitations of methods introduced in class, and their implications to analysis
- Demonstrate skills to work with various spatial data sources

Prerequisite(s): SSCI 581 or permission of the instructor
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)

Course Structure

The main theoretical concepts are introduced in class via lectures, discussions and after class via reading assignments*.*

Practical exercises utilize R, Python, and the ArcGIS platform for problem-solving. Assignments require coding in both languages, and working knowledge of R and Python will be assumed.

Workload – This is a four credit, one semester course. Students should expect to spend 10-15 hours per week completing the work in this course.

Technological and Communication Requirements

ArcGIS is provided online via the GIST Server; hence, you do not need to install it on your own computer. Instead, every student must have the following technology requirements:

- A computer with a fast Internet connection.
- A functional webcam and a microphone for use whenever a presentation or meeting is scheduled.
- An up-to-date web browser to access the Server

SSI Server and Tech Support – This course utilizes the SSI Server which is a virtual desktop giving access to many different professional software. If you are unable to connect to the server or experience any type of technical issues, send an email using your USC account to SSI Tech Support at spatial_support@usc.edu, making sure to copy (cc) me on the email.

Communications – This is a hybrid course, so most of our interactions will be split between the synchronous and asynchronous (i.e., not at the same time) modalities. All materials to be handed in will be submitted via Blackboard. It is each student's responsibility to stay informed about what is going on in our course. In addition to email about time-sensitive

topics, any important announcements will be posted on the Announcement page in Blackboard. Be sure to check these each time you log onto Blackboard.

I will send via email through Blackboard any notices that are time sensitive. Please be sure that you read as soon as possible all email sent from Blackboard or from me. Do not ignore course email until the day before assignments are due. Also double check to be sure that email sent from the USC blackboard account does not go into your junk mail!

While I am usually on-line all day and will probably respond to emails from students very quickly, I will endeavor to respond to all email within 24 hours of receipt, aiming for no more than 72 hours delay. In the rare case when I expect to be off-line for more than 72 hours, I will post an announcement on the Blackboard site.

Discussion forums – On the Blackboard site, I will post a series of discussion threads relevant to various sections of the course. Discussions provide a key means for student-to-student discussion and collaboration that can replicate the face-to-face contact you may have experienced in traditional classrooms. Here students can provide support to each other while working on your assignments, sharing hints and helpful tips, as you would in a classroom laboratory. Please post your questions about assignments there, as you would ask them publically in the classroom. I monitor the discussion threads and offer comments when necessary, but more importantly, consider the discussion board a key way to connect with your classmates and share your discoveries.

Required Readings and Supplementary Materials

The required textbooks for this course are:

- Hastie, T., Tibshirani, R., & Friedman, J. (2009). *The elements of statistical learning: Data mining, inference, and prediction*. Berlin, Germany: Springer Science & Business Media. Official Link to PDF
- Haining, R.P. (2003). Spatial data analysis: Theory and practice. Cambridge, UK: Cambridge University Press. (an online copy is available via USC library)

Assigned supplementary readings are below (asterisk (*) indicates optional reading):

- Janowicz, K., Gao, S., McKenzie, G., Hu, Y., & Bhaduri, B. (2019). GeoAI: Spatially explicit artificial intelligence techniques for geographic knowledge discovery and beyond. *International Journal of Geographical Information Science, 34*(4), 625-636.
- Duque, J.C., Ramos, R., & Suriñach, J. (2007). Supervised regionalization methods: A survey. *International Regional Science Review*, *30*(3), 195-220.
- Brunsdon, C., Fotheringham, A.S., & Charlton, M. E. (1996). Geographically weighted regression: a method for exploring spatial nonstationarity. *Geographical Analysis*, *28*(4), 281-298.
- Battaglia, P.W., Hamrick, J. B., Bapst, V., Sanchez-Gonzalez, A., Zambaldi, V., Malinowski, M., ... Gulcehre, C. (2018). *Relational inductive biases, deep learning, and graph networks.* arXiv preprint, arXiv:1806.01261.

- Tong, D., & Murray, A.T. (2012). Spatial optimization in geography. *Annals of the Association of American Geographers*, *102*(6), 1290-1309.

Description and Assessment of Assignments

Weekly Assignments

There are several different kinds of assignments with at least one due weekly. These are described in the Weekly Folders on Blackboard. Due dates are shown in the summary that follows.

Resume Assignments – 2 worth a total of 5 points. All students are required to post and maintain a public resume, biography, and headshot on the SSI Student Community Blackboard site. Unless a student opts out, their resume will be included in the Spatial Sciences Institute Graduate Programs Resume Book, which is used to promote the program and highlight student skills, experiences, and professional aspirations. An updated resume will be submitted at the end of the course of study

Projects – 4 worth a total of 40 points. The projects will be the major tool used to evaluate your learning in this course. The projects will be linked to course Modules. In support of these projects, students will complete end-to-end data science workflows. Students will gain insight to executing a data science workflow with clear deliverables.

Reading and Research Discussions – 5 worth a total of 25 points. These assignments call on students to critically analyze required readings, and discuss them with the instructor and their classmates during synchronous meetings and/or online discussion forums via Blackboard. Students are expected to answer critical thinking questions that provide students with an opportunity to apply their competencies to exploratory, open-ended scenarios.

Mid-Term Exam – 1 worth of a total of 10 points. The mid-term will cover material learned in the first half of the semester. It may be mixed format and may consist of multiple choice, short answer, and hands-on calculations.

Final Exam – 1 worth a total of 20 points. The final exam will cover material learned over the duration of the semester. It may be mixed format and may consist of multiple choice, short answer, and hands-on calculations.

Grading Breakdown

Assessment	Number	Points Each	Total Points
Weekly Assignments			
Resume Assignment	2	2.5	5
Projects	4	10	40
Reading Assignments	5	5	25
Mid-Term Exam	1	10	10
Final Exam	1	20	20
Total	13	--	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.

Unless otherwise noted, all Reading Assignments and Tutorials are *due by 11:59 pm Pacific Time (PT) on Mondays*. Project components have different due dates as indicated on the Course Schedule below. Your attention to on-time assignment submission is essential if I am to meet my goal to return comments on your submitted assignments before the next one is due. Sometimes this is impossible, so I will post a notice on anticipated delays if needed.

Strict penalties apply for late assignments as follows:

- All assignments will be penalized 2 points up to FOUR days late. No points will be given for submissions more than FOUR days late. Note that all assignments worth 2 points will receive 0 points if submitted late.
- Additionally, no written work will be accepted for grading after 5 pm PT on the last day of classes.

Schedule

	Topic	Readings and Assignments	Deliverables/Due Dates
Week 1 1/13	Is Spatial Special? Introduction to Spatial Data Science and GeoAI	Resume Assignment 1	No deliverables
Week 2 1/20	Introduction to the Spatial Data Science Workflow	Reading & Research Discussion 1 (RRD 1)	Resume Assignment 1 Due: Friday - 1/22
Week 3 1/27	Spatial Data Representation	Project 1	
Week 4 2/3	Spatial Data Wrangling		RRD 1 Due: Friday - 2/5 RRD 1 (synchronously, in class; asynchronously, before and after class session)
Week 5 2/10	Exploratory Spatial Data Analysis		
Week 6 2/17	Spatially Explicit Unsupervised Learning	Reading & Research Discussion 2 (RRD 2)	Project 1 Due: Friday - 2/19
Week 7 2/24	Spatially Explicit Supervised Learning (Linear Models)	Project 2	
Week 8 3/3	Spatially Explicit Neural Networks I	Reading & Research Discussion 3 (RRD 3)	RRD 2 Due: Friday - 3/5 RRD 2 (synchronously, in class; asynchronously, before and after class session)
Week 9 3/10	Spatially Explicit Neural Networks II		Mid-Term Exam (asynchronous)

	Topic	Readings and Assignments	Deliverables/Due Dates
Week 10 **3**/17	Model Assessment and Selection	Project 3	Mid-Term Exam (asynchronous)
Week 11 3/24	Spatial Optimization	Reading & Research Discussion 4 (RRD 4)	RRD 3 Due: Friday - 3/26 RRD 3 (synchronously, in class; asynchronously, before and after class session)
Week 12 3/31	Prescriptive Spatial Machine Learning	Reading & Research Discussion 5 (RRD 5)	Project 2 Due: Friday - 4/2
Week 13 4/7	Data Mining for Emerging Data Sources		
Week 14 4/14	Sentiment Analysis in Spatial Analysis	Project 4	Project 3, RRD 4 Due: Friday - 4/16 RRD 4 (synchronously, in class; asynchronously, before and after class session)
Week 15 4/21	Course Review	Resume Assignment 2	RRD 5 Due: Friday - 4/23 RRD 5 (synchronously, in class; asynchronously, before and after class session)
Week 16 **4/28*** *Friday, 4/30 is last day of class	Course Review		Project 4 Due: Friday – 4/30
Asynchronous Final Exam – Date TBD			

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
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

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) 740-9355(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 Compliance – (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.

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 Campus Support and Intervention – (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.

Resources for Online Students

The Course Blackboard page and the GIST Community Blackboard page have many resources available for distance students enrolled in our graduate programs. In addition, all registered students can access electronic library resources through the link libraries.usc.edu/. Also, the USC Libraries have many important resources available for distance students through the link: libraries.usc.edu/faculty-students/distance-learners. These include instructional videos, remote access to university resources, and other key contact information for distance students.