SSCI 382L – Geographic Information Science: Spatial Analytics

Syllabus

Units: 4

Term-Day-Time: Spring 2023
Lecture: Mondays & Wednesdays 2:00–3:20 p.m.
Labs: See schedule

Location: CPA 201

Co-Instructor: Diana Ter-Ghazaryan, PhD
Office: AHF B55K
Regular Office Hours: Tuesdays 11 a.m. – 1p.m. in-person or via zoom – please contact me via email in advance to ensure I will be available in the format you'd wish to meet. Also available most days between 9 a.m. – 5 p.m. by appointment.
Contact Info: terghaza@usc.edu

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Co-Instructor: An-Min Wu, PhD
Office: AHF B55B
Regular Office Hours: Wednesdays 3:30 –4:30 p.m. and Thursdays 1:00 – 2:00 p.m. in-person or via zoom – please contact me via email in advance to ensure I will be available in the format you'd wish to meet. Also available most days between 9 a.m. – 5 p.m. by appointment.
Contact Info: anminwu@usc.edu

Lab Instructor/Teaching Assistant: Shengjie Liu
Office Hours: Tuesdays 1 – 3 p.m.
Contact info: liusheng@usc.edu

Library Help: Andy Rutkowski
Office: LIPA B40-A
Office Hours: By appointment
Contact Info: arutkows@usc.edu

IT Help: Dornsife Technology Services
Office: SHS 260
Contact Info: spatial_support@usc.edu, 213-740-2775

Course Description

This is the first of the two courses that provide a deeper examination of Geographic Information Science (GIScience) with a focus on database modeling, spatial statistics theoretical foundations, and spatial data analytical methods. The course aims to provide students with the knowledge and skills necessary to manage and analyze geospatial data. As the second or third (following SSCI 301L, or SSCI 301L and SSCI381, respectively) in a four-course sequence in the SSCI 300 series about geographic information, this particular course seeks to elucidate how spatial analytics provide a gateway to the natural and social sciences via their ability to solve many of the societal and environmental problems we face in today's ever-changing world.

The course serves several audiences, given its role as a required course for the B.S. in Geodesign, B.S. in Global Geodesign and B.S. in Human Security and Geospatial Intelligence (HSGI) programs and for minors in GIS and Sustainability Science, and Spatial Studies, as well as an elective course for the minor in HSGI.

Learning Objectives

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

- Describe the key theoretical concepts that support spatial analytics.
- Explain how to use geodatabases and related methodologies to model the complex geographic world in digital forms.
- Analyze vector and raster datasets using relevant geospatial techniques to help solve social and environmental problems.

Students may vary in their competency levels on these abilities. You can expect to acquire these abilities only if you honor all course policies, attend classes regularly, complete all assigned work in good faith and on time, and meet all other course expectations of you as a student.

Prerequisite(s): SSCI 301L
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).

COVID-19 policy -- Students are expected to comply with all aspects of USC's COVID-19 policy including, but not limited to, vaccination, indoor mask mandate, and daily TrojanCheck. Failure to do so may result in removal from the class and referral to Student Judicial Affairs and Community Standards. Students are recommended to keep safe physical distancing, whenever possible, to prevent any possible transmission. Please contact your instructor if you have any safety concerns.

Diversity and Inclusion – It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is also my intent to present materials and activities that are respectful to everyone, and you are also expected to respect of others regardless of their race, ethnicity, gender identity and expressions, cultural beliefs, religion, sexual orientation, national origin, age, abilities, ideas and perspectives, or socioeconomic status. Your suggestions are encouraged and appreciated. Feel free to let me know ways to improve the effectiveness of the course for you personally or for other students.

Course Structure

This is a four-credit course comprised of lectures (two per week) and lab (one per week). The lecture sessions are organized into learning modules that build upon the core principles of GIScience, spatial analysis and the use of various software systems to support the exploration of these topics. The weekly lab meetings and lab assignments are designed to deepen your understanding of the available data management and geoprocessing techniques, broaden your practical experience with geographic information systems (GIS), and enhance your problem-solving skills within the framework of the scientific method. The lectures and lab sessions are designed to complement each other to provide you with sound theoretical reasoning and the technical skills to investigate various physical and/or social processes. Your weekly laboratory reports will be graded and returned via Blackboard, and the mid-term and final exams will cover both the lecture and laboratory components. **It is required that you register for both the lecture and one laboratory session for this course.**

Technological and Communication Requirements

GIS software access will be provided by the Spatial Sciences Institute; 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

If a student does not have access to any of these, please speak with the instructor at the start of the semester to establish a workaround. Also, see the USC ITS Student Toolkit here: https://keepteaching.usc.edu/students/student-toolkit/

SSI Server and Tech Support – This course utilizes the SSI Server, which is a virtual desktop giving access to many different professional software programs. If you are unable to connect to the server, or experience any type of technical issues for software startups, send an email using your USC account to Tech Support at spatial_support@usc.edu; make sure to copy (cc) your instructor on the email. Questions pertaining to lab assignments should be directed to your lab instructor.

Communications – All course materials and correspondence will be posted on the course Blackboard website. Your assignments will be graded and returned via Blackboard. As a registered student you will find this course available for you to access at 10 am PT on the first day of classes**.** In addition to emails about time-sensitive topics, announcements will be posted on Blackboard Announcement page. It is each student's responsibility to stay informed as to course activities and updates. All students are in charge of ensuring that email sent from the USC Blackboard account is not directed to junk mail.

The instructor will endeavor to respond to email within 36 hours of receipt, aiming for no more than a 72-hour delay. An announcement will be posted in the rare instance when an instructor is offline for 72 hours or more.

Required Readings and Supplementary Materials

The required textbooks for this course are:

- Burrough, P.A., R.A. McDonnel, and C.D. Lloyd. 2015. *Principles of geographic information systems* (3rd ed.). Oxford, UK: Oxford University Press.

Supplementary readings will be assigned and provided on Blackboard from various sources including, but not limited to:

- Aljoufie, M., M. Zuidgeest, M. Brussel and M. van Maarseveen. 2013. Spatial–temporal analysis of urban growth and transportation in Jeddah City, Saudi Arabia. *Cities*, *31*, 57-68.
- Bagui, E. and R. Earp. 2012. Chapter 4: The basic ER diagram: A data modeling schema. In *Database Design Using Entity-Relationship Diagrams*. Auerbach Publications (available online via USC Libraries)

- Batra, R. 2018. Chapter 1: An Introduction to SQL. In *SQL Primer:* An Accelerated Introduction to SQL Basics (1st ed.). Berkeley, CA: Apress L. P. (available online via USC Libraries)

- de Smith, M.J., M.F. Goodchild, and P.A. Longley. 2020. *Geospatial analysis: A comprehensive guide to principles, techniques and software tools* (6th ed.). Winchelsea, UK: The Winchelsea Press (available online at http://www.spatialanalysisonline.com)

- Harris, N.L., E. Goldman, C. Gabris, J. Nordling, S. Minnemeyer, S. Ansari, M. Lippmann, L. Bennet, M. Raad, M. Hansen, and P. Potapob. 2017. Using spatial statistics to identify emerging hot spots of forest loss. *Environmental Research Letters* 12: 024012.

- Kim, C. 2016. Land use classification and land use change analysis using satellite images in Lombok Island, Indonesia. *Forest science and technology*, 12(4): 183-191.

- Li, W., M. Batty, and M.F. Goodchild. 2020. Real-time GIS for smart cities. *International Journal of Geographic Information Systems* 34: 311-324.

- Shi, Xun, J. Alford-Teaster, T. Onega, and D. 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.

- Webster, K., J. Arroyo-Mora, O. Coomes, Y. Takasaki, and C. Abizaid. 2016. A cost path and network analysis methodology to calculate distance along a complex river network in Peruvian Amazon. *Applied Geography* 73: 13-25.

- Wright, D.J., and C. Harder. 2019. *GIS for science: Applying mapping and spatial analytics*. Redlands, CA: Esri Press.

- Zeiler, M. 2010. Chapter 1. Inside the geodatabase. In *Modeling our world: The Esri guide to geodatabase concepts* (2nd ed). Redlands, CA: Esri Press.

Description and Assessment of Assignments

Your grade in this class will be determined on the basis of several different assessments as follows:

In-Class Work (10%): A grade for the semester will be assigned based on your engagement in class discussion and activities. Students are expected to complete and discuss assigned readings, engage with the lecture materials, share and discuss course assignments and complete in-class assignments, among other forms of active engagement. Students will earn full credit by engaging consistently throughout the entire semester.

Discussion (15%): Five discussions (each worth 3 points) related to course concepts and readings will be required throughout the course period via the Discussion Forum on Blackboard.

Laboratory Reports (40%): Ten laboratory reports (each worth 4 points) This course includes a laboratory meeting each week to develop technical competency with geospatial software platforms and spatial analytic techniques. The weekly laboratory sessions will run 1-2 hours, as

shown in the Schedule of Classes and will entail discussions of the previous and the next week's lab assignments.

Absences from lab sessions must be requested and approved via emails by the laboratory instructor *prior to the lab discussion session you will miss*. Excused absences from lab discussion sections will be granted only for valid reasons via email.

Mid-Term and Final Exams (35%): The mid-term and final exams will contribute 15 and 20% towards your final grades, respectively, and will use a mix of formats and cover both lectures and lab contents. Students are expected to take the exams at the indicated times.

Grading Breakdown

Assessment	Number	Points Each	Total Points
In-class work	--	--	10
Discussion Forums	5	3	15
Laboratory reports	10	4	40
Midterm exam	1	15	15
Final exam	1	20	20
Total	17	--	100

Assignment Submission Policy

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 assignments are *due by 11:59 pm Pacific Time (PT) on the due dates*. Your attention to on-time assignment submission is essential.

Schedule

		Topic	Readings and Assignments	Deliverables/Due Dates
		Intro to Course & Review of SSCI 301		
Week 1				
1/9		Introduction to course	Burrough et al. (2015) Ch. 1	No labs
1/11		Review of 301L	Burrough et al. (2015) Ch. 5	
		Module 1. Data modeling and database management. Use case: Traffic Safety in Los Angeles		
Week 2				

	Topic	Readings and Assignments	Deliverables/Due Dates
1/18* *Monday, 1/16 is university holiday	Spatial data engineering (ETL) & geographic data models	Burrough et al. (2015) Ch.2 & Ch. 4 up to Sec. 4.3 (pp. 69-78)	*Lab 1*: Spatial data engineering
Week 3			
1/23	Database models	Burrough et al. (2015) Ch. 3 up to pp. 49; Bagui (2012) Ch. 4	*Lab 2*: Data modeling using ERD
1/25	Entity-relationship diagrams (ERD) and data schema	Burrough et al. (2015) Ch. 3 pp. 49-67; Discussion 1	
Week 4			
1/30	Geodatabase data integrity and standards	Burrough et al. (2015) Sec. 4.4-4.10	Discussion 1 due: Tuesday, 1/31 *Lab 3*: GDB Creation, Domains and Subtypes
2/1	Spatial database management using SQL	Batra (2018) Ch.1	
Module 2. Spatial statistics: EDA, ESDA, and ESTDA. Use case: Exploration of Crime Data			
Week 5			
2/6	Statistical conceptual framework & exploratory spatial data analysis (ESDA) I	Burrough et al. (2015) Ch. 6 up to Sec. 6.2	*Lab 4*: Introduction to SQL
2/8	ESDA II & Spatial point pattern analysis (PPA): Density-based analysis	de Smith et al. (2020) Sec. 5.2; Burrough et al. (2015) 6.7 pp. 121-123	
Week 6			
2/13	Spatial autocorrelation	Burrough et al. (2015) Sec. 6.3–6.4; de Smith et al. (2020) Sec. 5.5; Discussion 2	*Lab 5*: ESDA
2/15	Space-time analysis I	Harris et al. (2017)	
Week 7			
2/22* *Monday, 2/20 is university holiday	Spatial point pattern analysis (PPA) II: Distance-based analysis	Burrough et al. (2015) 6.7 pp. 123-125	Discussion 2 due: Tuesday, 2/21 *Lab 6*: Space-time analysis
Week 8			

	Topic	Readings and Assignments	Deliverables/Due Dates
2/27	Space-time analysis II & mid-term review	Aljoufie et al. (2013)	No labs
3/1	**Mid-term exam**		
Module 3. Environmental application of GIScience. Use case: Landslides susceptibility & vineyard suitability			
Week 9			
3/6	GIScience applications (**Guest speaker**: TBA)	Wright & Harder (2019) Discussion 3	No labs
3/8	Grid operation I: Digital terrain analysis and focal operations	Burrough et al. (2015) Ch.10 up to Sec. 10., Sec. 10.7 & Ch 11	
3/12-3/19 is Spring Recess			
Week 10			
3/20	Grid operation II: Zonal operations, map algebra and drainage network	Burrough et al. (2015) Sec. 10.6, Sec, 10.8-10.11	Discussion 3 due: Tuesday, 3/21 *Lab 7*: Surface and field analysis
3/22	Polygon operations and distance-based analysis	Burrough et al. (2015) Ch. 7; de Smith et al. (2020) Sec. 4.2	
Week 11			
3/27	Location optimization I: weighted overlay	Discussion 4	*Lab 8*: Site suitability analysis
3/29	Location optimization II: fuzzy overlay	Burrough et al. (2015) Ch. 13	
Module 4. Remote sensing & spatial interpolation techniques. Use case: Climate variability			
Week 12			
4/3	Earth observation & remote sensing data analysis	Kim (2016)	Discussion 4 due: Tuesday, 4/4 No Labs
4/5	Spatial interpolation I	Burrough et al. (2015) Ch.8	
Week 13			
4/10	Spatial interpolation II	Burrough et al. (2015) Ch.9	*Lab 9*: Spatial interpolation
Module 5. Service area and network Analysis. Use case: Public health accessibility			

	Topic	Readings and Assignments	Deliverables/Due Dates
4/12	Spatial accessibility: Two-step floating catchment area (2SFCA)	Shi et al. (2012)	
Week 14			
4/17	Network analysis and O-D matrix (Guest speaker: TBD)	de Smith et al. (2020) Sec. 4.4.1-4.4.4; Webster et al. (2016) Discussion 5	*Lab 10*: 2SFCA
4/19	More on spatial network and locational analysis		
Week 15			
4/24	Real-time data visualization and analytics & summative discussion	Li et al. (2020)	Discussion 5 due: Tuesday, 4/25
4/26* *Friday, 4/28 is last day of class	Looking forward on GIScience: Connecting knowledge to SSCI383L		
Final Exam	Final Exam Monday, May 8 2:00-4:00 pm		

Statement on Academic Conduct and Support Systems

Academic Integrity:

The University of Southern California is a learning community committed to developing successful scholars and researchers dedicated to the pursuit of knowledge and the dissemination of ideas. Academic misconduct, which includes any act of dishonesty in the production or submission of academic work, comprises the integrity of the person who commits the act and can impugn the perceived integrity of the entire university community. It stands in opposition to the university's mission to research, educate, and contribute productively to our community and the world.

All students are expected to submit assignments that represent their own original work, and that have been prepared specifically for the course or section for which they have been submitted. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s).

Other violations of academic integrity include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), collusion, knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university. All incidences of academic misconduct will be reported to the Office of Academic Integrity and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see the student handbook or the Office of Academic Integrity's website, and university policies on Research and Scholarship Misconduct. Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University's educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Support Systems:

Counseling and Mental Health - *(213) 740-9355 – 24/7 on call*

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

988 Suicide and Crisis Lifeline - *988 for both calls and text messages – 24/7 on call*

The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

Relationship and Sexual Violence Prevention Services (RSVP) - *(213) 740-9355(WELL) – 24/7 on call*

Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) - *(213) 740-5086*

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*

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS) - *(213) 740-0776*

OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

USC Campus Support and Intervention - *(213) 740-0411*

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity, Equity and Inclusion - *(213) 740-2101*

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*

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) 442-1200 – 24/7 on call*

Non-emergency assistance or information.

Office of the Ombuds - *(213) 821-9556 (UPC) / (323-442-0382 (HSC)*

A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

Occupational Therapy Faculty Practice - *(323) 442-2850 or* otfp@med.usc.edu

Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.