SSCI 382L – Geographic Information Science: Spatial Analytics

Syllabus

Units: 4

Term-Day-Time: Fall 2021
Lecture: Mondays & Wednesdays 12-1:20 p.m.
Labs: See schedule

Location: VHE 217

Instructor: An-Min Wu, PhD
Office: AHF B55B
Regular Office Hours: Mondays 2 – 3 p.m. and Wednesdays 3 - 4 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 via email.
Contact Info: anminwu@usc.edu

Lab Instructor/Teaching Assistant: Michelle Livings, MPH
Office Hours: Wednesdays 3 - 4 p.m. via Zoom (See Blackboard for Zoom link)
Contact info: livings@usc.edu

Library Help: Andy Rutkowski
Office: VKC 36B
Office Hours: Thursdays 10 a.m.-12 p.m. Pacific Time via Zoom (See Blackboard for Zoom link)
Contact Info: arutkows@usc.edu

IT Help: Richard Tsung
Office: AHF 145D
Office Hours: By appointment
Contact Info: spatial_support@usc.edu

Course Description

This is the first of the two courses that provide an overview of Geographic Information Science (GIScience) and covers the theoretical foundations, data models and analytical methods used for GIScience. 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 B.S. in Geodesign, B.S. in Global Geodesign and B.S. in Human Security and Geospatial Intelligence (HSGI), the Minors in GIS and Sustainability Science and Spatial Studies, as well as an elective course in 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 we 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.

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.

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.

SSI Server and Tech Support – This course utilizes the SSI Server, which is a virtual desktop giving access to many different professional software programs, and Apache Guacamole, a remote desktop program giving access to computing services physically located in the SSI computing lab. If you are unable to connect to the server or remote desktop, or experience any type of technical issues, send an email using your USC account to Tech Support at

spatial_support@usc.edu, making sure to copy (cc) your instructor on the email. Questions pertaining to specific 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 email about time-sensitive topics, announcements will be posted on Blackboard. 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 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)
- Chaikaew, P., O. Adeyemi, A.O. Hamilton, & O. Clifford. 2020. Spatial characteristics and economic value of threatened species (Khaya ivorensis). *Scientific Reports*, *10*(1): 1-8.
- 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, & 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 Forums (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%): This course includes a laboratory meeting each week to develop technical competency with geospatial software platforms and spatial analytic techniques. There will be a total of 10 laboratory reports (each worth 4 points) due over the course of the semester. 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 synchronous 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; please notify us of the reason for your absence in your 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 labs. Students are expected to take the exams at the indicated times.

Grading Breakdown

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

Schedule

	Topic	Readings and Assignments	Deliverables/Due Dates
Intro to Course & Review of SSCI 301			
Week 1			
8/23	Introduction to course & Review on 301L I	Burrough et al. (2015) Ch. 1	No labs
8/25	Review on 301L II	Burrough et al. (2015) Ch. 5	
Module 1. Data modeling and database management. Use case: Traffic Safety in Los Angeles			
Week 2			
8/30	Spatial Data Engineering: Extract, Transform, and Load (ETL)	Burrough et al. (2015) Ch. 4 up to Sec. 4.3 (pp. 69-78)	Lab 1: spatial data engineering
9/01	Geographic data models and data models	Burrough et al. (2015) Ch. 2 and Ch. 3 up to pp. 49 Bagui (2012) Ch. 4	
Week 3			
9/8* *9/6 is a University holiday	Entity-relationship diagrams (ERD) and data schema	Burrough et al. (2015) Ch. 3 pp. 49-67 Zeiler (2010) Discussion 1	Lab 2: Data modeling using ERD
Week 4			
9/13	Geodatabase data integrity and standards	Burrough et al. (2015) Sec. 4.4-4.10	Discussion 1 due: Tuesday, 9/14 Lab 3: GDB creation and relationship
9/15	Spatial database management using SQL	Batra (2018) Ch.1	

	Topic	Readings and Assignments	Deliverables/Due Dates
Module 2. Spatial statistics, EDA and ESDA. Use case: Exploration of Crime Data
Week 5
9/20	Statistical methods and analytical processes	Burrough et al. (2015) Ch. 6 up to Sec. 6.2 de Smith et al. (2020) Sec. 3.1	Lab 4: GDB domains and subtypes
9/22	Exploratory spatial data analysis (ESDA)	de Smith et al. (2020) Sec. 5.2	
Week 6
9/27	Spatial point pattern analysis (PPA): Density-based analysis	Burrough et al. (2015) 6.7-6.8 Discussion 2	Lab 5: ESDA
9/29	Spatial autocorrelation & distance-based PPA	Burrough et al. (2015) Sec. 6.3–6.4 de Smith et al. (2020) Sec. 5.5	
Week 7
10/4	Space-time analysis I	Harris et al. (2017)	Discussion 2 due: Tuesday, 10/5 Lab 6: Space-time analysis
10/6	Space-time analysis II	Aljoufie et al. (2013)	
Week 8
10/11	Mid-term exam		No Labs
Module 3. Environmental application of GIScience. Use case: Landslides susceptibility & vineyard suitability
10/13* *10/14-15 are Fall Recess	Environmental applications of GIScience (Guest speaker: TBD)	Wright & Harder (2019) Chaikaew et al. (2020)	
Week 9
10/18	Grid operation I: Digital terrain analysis and focal operations	Burrough et al. (2015) Ch.10 up to Sec. 10., Sec. 10.7 & Ch 11 Discussion 3	Lab 7: Surface and field analysis
10/20	Grid operation II: Zonal operations, map algebra and drainage network	Burrough et al. (2015) Sec. 10.6, Sec, 10.8-10.11	
Week 10
10/25	Polygon operations and distance-based analysis	Burrough et al. (2015) Ch. 7 de Smith et al. (2020) Sec. 4.2	Discussion 3 due: Tuesday, 10/26

	Topic	Readings and Assignments	Deliverables/Due Dates
10/27	Location optimization: weighted overlay & fuzzy overlay	Burrough et al. (2015) Ch. 13	No lab
Module 4. Remote sensing & spatial interpolation techniques. Use case: Smart farming			
Week 11			
11/1	Earth observation & remote sensing data analysis	Kim (2016) Discussion 4	Lab 8: Site suitability analysis
11/3	Spatial interpolation I	Burrough et al. (2015) Ch.8	
Week 12			
11/8	Spatial interpolation II	Burrough et al. (2015) Ch.9	Discussion 4 due: Tuesday, 11/9 Lab 9: Spatial interpolation
Module 5. Service area and network Analysis. Use case: Public health accessibility			
11/10	Spatial accessibility: Two-step floating catchment area (2SFCA)	Shi et al. (2012)	
Week 13			
11/15	Network analysis and O-D matrix	de Smith et al. (2020) Sec. 4.4.1-4.4.4 Webster et al. (2016)	Lab 10: 2SFCA
11/17	Spatial network and health access (Guest speaker TBD)	Discussion 5	
Week 14			
11/22* *11/24-28 are University holidays	Real-time data visualization and analytics	Li et al. (2020)	No labs
Week 15			
11/29	Course review		Discussion 5 due: 9am PT, Monday, 11/29
12/1* *Friday, 12/3 is last day of class	Looking forward on GIScience: Connecting knowledge to SSCI383L		
Final Exam	Final Exam follows the university exam schedule		

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 https://policy.usc.edu/files/2020/07/SCampus-Part-B-1.pdf. 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.