

**SSCI 383L, Geographic Information Science:
Geospatial Modeling and Customization**

Syllabus

Units: 4

Term Day Time: Spring, 2023

Lecture: Tuesday and Thursday, 2:00-3:20 pm

Lab: Wednesday 2:00-3:50 pm or Friday 4:00-5:50 pm

Location: Lecture: CPA 205

Lab: CPA 110 or SOS B38

Instructor: Jennifer N Swift, Ph.D. GISP

Office: AHF B57D

Regular Office Hours: Mon 3:00-4:00 pm and Tue 9:00-10:00 am PT. Also available most days and times by appointment via email.

Contact Info: jswift@usc.edu, 213-740-5841 (office), see contact page on Blackboard for Zoom Room

Laboratory Co-Instructor: Xin Yu

Office: AHF

Office Hours: TBA. Available most days and times by appointment via email.

Contact Info: mengyaxu@usc.edu, see contact page on Blackboard for Zoom Room

Library Help: Andy Rutkowski

Office: VKC 36B

Office Hours: Thu 10 am-12 pm PT

Contact Info: arutkows@usc.edu, see contact page on Blackboard for Zoom Room

IT Help: Dornsife Technology Services

Office: SHS 260

Contact Info: spatial_support@usc.edu, 213-740-2775

Course Scope and Purpose

The spatial sciences now require professionals with Geographic Information System (GIS) modeling and customization skills, an essential part of the career portfolio. This course provides the fundamentals of spatial modeling and how to use GIS customization and programming, or scripting, to streamline complex spatial analysis and modeling workflows. An understanding of GIS modeling and how to create and implement customized tools are needed to successfully solve many of the critical societal and environmental challenges we face in today's ever-changing world. Learning to program facilitates understanding of one's use of GIS and how to interact with others who use GIS software. Familiarity with a GIS programming language and how it is implemented also provides in-depth insight into how other programmers create and use these tools. Helping you become comfortable with creating, coding, and documenting GIS modeling workflows is a fundamental goal of this course.

Examples will be used throughout the course to illustrate how spatial modeling helps us to understand spatial phenomena through expressions of how the natural and built environments work and the profound influence we have on our environment. The combination of class and laboratory sessions will show how, for example, effective spatial modeling combined with creative coding requires an informed and intelligent user in addition to the appropriate computer hardware and software tools.

This course is designed to serve several student audiences given its role as a required course in the B.S. in GeoDesign, B.S. in Global Geodesign, B.S. in Human Security and Geospatial Intelligence, the GIS and Sustainability Science minor, and Spatial Sciences minor. Each audience is encouraged to utilize the laboratory experience and research projects to investigate diverse geospatial resources such as spatial modeling, computer programming, and 2D and 3D data visualization to advance their own academic and professional goals.

Learning Objectives

Students who excel in SSCI 383L should be able to:

- Describe fundamental spatial science concepts in the context of spatial modeling;
- Explain how spatial models can be used to solve and understand real-world problems from an interdisciplinary viewpoint;
- Program small-scale GIS-based models in Python, integrated within ArcGIS or some other geospatial software ecosystem;
- Streamline complex workflows using GIS customization techniques;
- Communicate how many of the complex global challenges we face today can be addressed by combining spatial modeling and customization using GIS.

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, SSCI 382L, or Instructor Permission

Co-Requisite (s): None

Concurrent Enrollment: None

Recommended Preparation: SSCI 381

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 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 course is organized into learning modules that build upon core principles of geographic information science by delving into topics including spatial modeling and GIS customization, and the software systems used to explore these topics. The weekly meetings and projects are designed to broaden your practical experience and deepen your understanding of the concepts and tools of spatial science inquiry, and to enhance your problem-solving skills within the

framework of the scientific method. The lecture and laboratory meetings complement each other and are designed to provide you with sound theoretical reasoning and the technical skills to investigate various physical and social processes. It is required that you register for both the lecture and one laboratory session for this course. Course material and assignments will be posted on the course Blackboard; assignments will be graded and returned via Blackboard.

Technological and Communications Requirements

ArcGIS and other programming software are provided online via the SSI Server; hence, you do not need to install anything 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. 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. 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 – 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 publicly 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 textbook for this course is:

- Longley, P.A., M.F. Goodchild, D.J. Maguire, and D.W. Rhind. 2015. *Geographic Information Systems and Science*. 4th ed. New York: John Wiley and Sons, Ltd.

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

- Law, M. and A. Collins. 2019. Chapter 5: Facilitating Workflows. In *Getting to Know ArcGIS Pro*, 189-236. Redlands, CA: Esri Press.
- Li, W., M. Batty, and M. Goodchild. 2020. Real-time GIS for smart cities. *International Journal of Geographical Information Science*, 34(2), pp.311-324.
- Li, L. 2017. Spatial Data Uncertainty. *The Geographic Information Science & Technology Body of Knowledge* (4th Quarter 2017 Edition), John P. Wilson (ed).
- Miller, H. and M.F. Goodchild. 2015. Data Driven Geography. *GeoJournal*, 80(4), pp. 449-461.
- Padmanabhan, A., S. Wang, G. Cao, M. Hwang, Z. Zhang, Y. Gao, K. Soltani, and Y. Liu. 2014. FluMapper: A CyberGIS Application for Interactive Analysis of Massive Location-Based Social Media. *Concurrency and Computation Practice and Experience*, 26(13), pp. 2253–2265.
- Steinitz, C. 2012. Chapter 9: Geodesign When Knowing the Rules. In *A Framework for Geodesign: Changing Geography by Design*, pp.139 - 178. Redlands, CA: Esri Press.
- Tsou, M.-H. 2018. The future development of GISystems, GIScience, and GIService. In Bo Huang (Ed.-in-Chief), *Comprehensive Geographic Information Systems*, pp. 1-4. GIS Methods and Techniques, 1. Amsterdam, Netherlands: Elsevier.
- Zent, C. 2018. ArcGIS Pro SDK for .NET: An introduction to Add-Ins and Configurations. Technical workshop. In *Proceedings of the 2018 Esri User Conference*.

In addition, three online courses are supplied with this course:

- Davis, Annyce. 2020. Programming Foundations: Fundamentals.
- Weinman, Bill, 2021. Python Essential Training.
- Tyagi, Harshit. 2021. SQL Data Science Code Challenges.

Description and Assessment of Assignments

Weekly Assignments

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

Discussion Assignments – 3 worth 15 points: Students will be expected to complete three discussion assignments focused on assigned readings, engagement in lectures, sharing and discussion of course assignments, and in-class "worksheets," among other forms of active engagement in the course.

Projects – 4 worth 60 points. This course includes a laboratory component where each week, students work on projects to develop technical competency with geospatial software platforms and analytic tools. Students will be expected to draw upon course lectures, discussions, readings, and outside sources to complete the projects. The deliverables will be final written summaries of the students' goals, methods, data, and results for each project. Though the lab meets weekly, there will be a total of four project submissions over the course of the semester.

Mid-term Exam – 1 worth 10 points. The mid-term exam will consist of multiple-choice, short answer, and simple problem questions. Students will be expected to take the exam at the indicated time.

Final Exam – 1 worth 15 points. The final exam will consist of multiple-choice, short answer, advanced problem questions, and a short essay. Students will be expected to take the exam at the indicated time.

Grading Breakdown

Assessment	Number	Points Each	Total Points
Discussion Assignments	3	5	15
Projects	4	Varies	60
Mid-term Examination	1	10	10
Final Examination	1	15	15
Total	9	-	100 points

Assignment Submission Policy

Students are expected to attend and participate in every class session and unless otherwise noted, assignments must be submitted via Blackboard by the due dates specified in the Course Schedule below and on the assignment instructions. 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. I will post a notice on anticipated delays if needed.

Strict penalties apply for late assignments as follows:

- Late work will be assessed a penalty of 10% per day and zero grades will be assigned for work that is more than seven days late.
- Additionally, no written work will be accepted for grading after 5 pm PT on the last day of classes.

Schedule

	Topics	Readings and Assignments	Deliverables/Due Dates
Module 1: Fundamentals of Spatial Modeling			
Week 1 1/10	Introduction to the Course Brief introductions coupled with discussions of class goals, projects, and technologies.	Longley et al. (2015) Ch. 2, pp. 33-53, Ch. 4, pp. 77-98,	No Deliverables.
1/12	Review: Maps and Spatial Reasoning Reexamine basic concepts covered in SSCI 301, including geodesy, projections, scale, cartography, and geocoding.	Ch. 11, pp. 237-265, Ch. 13, pp. 290-317 Discussion Assignment 1	
Week 2* 1/17 *Monday, 1/16 is university holiday	Review: GIS: Spatial Analytics Review of fundamental concepts covered in SSCI 382, including spatial analysis operations, computational models, space-time modeling, fuzzy classification, and uncertainty.	Longley et al. (2015) Ch. 14, pp. 326-337, Ch. 15, pp. 339-351, Li (2017) Discussion Assignment 2	Discussion Assignment 1: Recap: Maps, Spatial Reasoning & GIS: Spatial Analytics Tuesday, 1/17
1/19	Core Concepts of Spatial Modeling & Types of Models Exploration of fundamental concepts of spatial modeling, different types of spatial models and why we use them.		
Module 2: 3D Spatial Modeling			
Week 3 1/24	3D Visualization Investigation of core concepts in creating 3D geographic representations of the real world to facilitate understanding our world.	Longley et al. (2015) Ch. 12, pp. 266-276 Project 1	Discussion Assignment 2: Comparison of different types of spatial models Monday, 1/23
1/26	3D Modeling Fundamentals Building 3D models for design applications, such as urban, suburban and rural communities.		

	Topics	Readings and Assignments	Deliverables/Due Dates
Week 4 1/31	3D Modeling for Design Visualization using different projections, 3D libraries, materials application and texture mapping.	Longley et al. (2015) Ch. 12, pp. 277-288	Project 1, Part 1: 3D Visualization using Esri City Engine Monday, 1/20
2/2	3D Modeling in GIS Creating and editing 3D GIS data, 3D geospatial data collection and storage.		
Week 5 2/7	3D Model Integration Converting 3D geospatial data to multiple formats, i.e. conversion, importing, exporting and sharing, to exchange 3D data between different software.	Longley et al. (2015) Ch. 14, pp. 319-326 Li et al. 2020	Project 1, Part 2: 3D Modeling in GIS using Esri City Engine Monday, 2/6
2/9	3D Smart Cities Understanding, describing, and modeling the geometry and behavior of cities using data collected from IoT sensors.		
Module 3: Geospatial Simulations & Customization			
Week 6 2/14	Geospatial Simulation Exploration of methods using models to quantitatively analyze the spatial behavior of real and simulated objects within 2D and 3D space.	Longley et al. (2015) Ch. 15, pp. 346-348 & 351-356, Steinitz (2012) Ch. 9, pp. 140-178	Project 1, Part 3: 3D Spatial Analysis using Esri City Engine: Monday, 2/13
2/16	Agent-Based Modeling Investigation of fundamental concepts of agent-based modeling.	Project 2	
Week 7* 2/21 *Monday, 2/20 is university holiday	Introduction to GIS Customization Customization of GIS applications to streamline spatial analyses, models and workflows.	Longley et al. (2015) Ch. 6, pp. 131-134	Project 2, Part 1: Agent-based modeling: Monday, 2/20
2/23	Types of Customizations Exploration of different proprietary and open-source options for developing GIS applications that support modeling.		

	Topics	Readings and Assignments	Deliverables/Due Dates
Week 8 2/28	Mid-Semester Review		Project 2, Part 2: Exploration of options for customizing GIS modeling applications: Monday, 2/27
3/2	Mid-term Exam Students complete a Mid-term Exam.		
Module 4: Fundamentals of Geospatial Programming			
Week 9 3/7	Fundamentals of Programming The role of Python in geographic information science and systems.	Davis (2020)	No deliverables
3/9	Introduction to Python An overview of programming in Python. Exploration of Jupyter Notebooks, including generating visualizations and programming documentation.	Project 3	
3/14 *3/12-3/19 is Spring Recess	<i>Spring Recess</i>		
Week 10 3/21	Introduction to Cloud Computing Cloud-based computing trends and options in spatial computing. Overview of e.g., AWS, Project Jupyter, and Google Cloud & Colab.	Pierson (2020a), Padmanabhan et al. (2014)	Project 3, Part 1: Programming in Python Monday, 3/20
3/23	Cloud Computing Tools for GIS Exploration of Esri-based Notebooks using Python to create and share code interactively within a GIS.		
Week 11 3/28	GIS Automation and Customization Overview of spatial modeling methods to process spatial data to handle important social, economic, and environmental challenges faced today and in the future.	Longley et al. (2015) Ch. 6, pp. 134-147, Pierson (2020b)	Project 3, Part 2: Notebooks for spatial science problem-solving in GIS: Monday, 3/27
3/30	Open-Source Automation and Customization Exploration of open source GIS programming options for developing automated and customized solutions, such as Whitebox GAT, GRASS and QGIS.		

	Topics	Readings and Assignments	Deliverables/Due Dates
Week 12 4/4	Extending GIS Through Programming Investigation of GIS programming that can extend the software to bundle spatial analyses and models into convenient tools.	Law and Collins (2020) Ch. 5, pp. 189-236, Zent (2018)	Project 3, Part 3: Programming and customization using open source GIS tools: Monday, 4/3
4/6	Wrapping Models in GIS Add-Ins Exploration of how programming can enhance development of functionality add-ins in geographic information systems.		
Module 5: Web GIS Programming Fundamentals			
Week 13 4/11	Portals Overview of geospatial web portals, from setup and design to data collection, formatting, archiving, and dissemination.	Longley et al. (2015) Ch. 10, pp. 217-235, Miller and Goodchild (2015)	Project 3, Part 4: Designing Esri ModelBuilder Models using Python Monday, 4/10
4/13	Web Services Review different data formats that are often used in geospatial Web services to transport geospatial feature information between Web services and clients.	Project 4	
Week 14 4/18	Fundamentals of Web GIS Customizing and programming web GIS applications using Esri and open-source technologies, and the ways these tools can enhance collaborative problem solving and decision support across disciplines. Students learn how to test and document web GIS projects.	Tsou, M.-H. 2018 Discussion Assignment 3	Project 4: Demonstration of programmatic use of geospatial web maps and web services: Monday, 4/17
4/20	Fundamentals of Mobile GIS Overview of ways to customize and program mobile GIS projects using proprietary and open-source technologies. Students learn different ways to develop mobile GIS applications.		
Week 15 4/25	Scientific Communication Skills & Cross-Disciplinary Collaboration Exploration of communications skills and technologies required to excel in collaboration across different scientific communities.		Discussion Assignment 3: Developing Science Communication Skills Monday, 4/24

	Topics	Readings and Assignments	Deliverables/Due Dates
4/27	Future of Geospatial Modeling and Customization & Final Exam Review Investigation of current trends and future needs in geospatial modeling, programming, customization, and cloud computing. Students review for Final Exam.		All assignments must be submitted no later than 5:00 PM PT on 4/28
Exam Week 5/3-5/10	Final Exam		Thursday, 5/4, 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.