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

Syllabus

Units: 4

Term Day Time: Spring, 2021
Lecture: Tuesdays and Thursdays, 12-1:20 pm PT
Lab: See Schedule of classes.

Location: Hybrid and Online. USC Zoom Meeting link accessible via course Blackboard.

Instructor: Jennifer N. Swift, PhD GISP
Office: AHF B57D
Regular Office Hours: Mon and Wed 5-6 pm PT. Also available most days and times by appointment via email.
Contact Info: jswift@usc.edu
Zoom: Provided via Blackboard

Laboratory Co-Instructor: Mengya Xu
Office: AHF
Regular Office Hours: Fri 10 am – 11 am and 7 pm – 8pm PT. Available most days and times by appointment via email.
Contact Info: mengyaxu@usc.edu
Zoom: Provided via Blackboard

Library Help: Andy Rutkowski
Office: VKC 36B
Office Hours: Thu 10 am-12 pm PT
Contact Info: arutkows@usc.edu
Zoom: Provided via Blackboard

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

Course Scope and Purpose

The spatial sciences now require professionals with 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:

- Understand 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;
- Describe 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)

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 are designed to provide you with sound theoretical reasoning and the technical skills to investigate various physical and social processes and complement each other. 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 necessary software is provided online via the Spatial Sciences Virtual Machine (SSI VM); hence, you do not need to install it on your own computer. In addition to the SSI computing resources, 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 SSI Server.

If a student does not have access to the requirements noted above, please speak with the instructor at the start of the semester.

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 ssi_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 online daily 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.

Required Readings and Supplementary Materials

The required textbook for this course is:

- Longley, P.A., Goodchild, M.F., Maguire, D.J. and Rhind, D.W. 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 Iformation 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.
- Pierson, Lillian, 2020a. Python for Data Science Essential Training Part 1.
- Pierson, Lillian, 2020b. Python for Data Science Essential Training Part 2.

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 Schedule that 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. There will be a total of four projects over the course of the semester.

Mid-term Exam – 1 worth 10 points. The mid-term exam will be asynchronous and 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 be asynchronous and 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	15	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 to complete and upload all assignments before the deadlines detailed in the Course Schedule.

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. Sometimes this is impossible, so 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 1/19* *Monday, 1/18 is university holiday 1/21	**Introduction to the Course** Brief introductions coupled with discussions of class goals, projects, and technologies. **Review: Maps and Spatial Reasoning** Reexamine basic concepts covered in SSCI 301, including geodesy, projections, scale, cartography, and geocoding.	Longley et al. (2015) Ch. 2, pp. 33-53, Ch. 4, pp. 77-98, Ch. 11, pp. 237-265, Ch. 13, pp. 290-317 Discussion Assignment 1	No Deliverable

	Topics	Readings and Assignments	Deliverables/Due Dates
Week 2 1/26	**Review: Geographic Information Science** 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 & Geographic Information Science Wednesday, 1/27
1/28	**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 2/2	**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 Wednesday, 2/3
2/4	**3D Modeling Fundamentals** Building 3D models for design applications, such as urban, suburban and rural communities.		
Week 4 2/9	**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, 2/8
2/11	**3D Modeling in GIS** Creating and editing 3D GIS data, 3D geospatial data collection and storage.		
Week 5* 2/16 *Monday, 2/15 is a university holiday	**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 Tuesday, 2/16*
2/18	**3D Smart Cities** Understanding, describing, and modeling the geometry and behavior of cities using data collected from IoT sensors.		

	Topics	Readings and Assignments	Deliverables/Due Dates
Module 3: Geospatial Simulations & Customization			
Week 6 2/23	**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, 2/22
2/25	**Agent-Based Modeling** Investigation of fundamental concepts of agent-based modeling.	Project 2	
Week 7 3/2	**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, 3/1
3/4	**Types of Customizations** Exploration of different proprietary and open source options for developing GIS applications that support modeling.		
Week 8* 3/9 *Friday, 3/12 is a wellness day 3/11	**Mid-Semester Review** **Mid-term Exam** Students complete an asynchronous Mid-term Exam.		Project 2, Part 2: Exploration of options for customizing GIS modeling applications: Monday, 3/8
Module 4: Fundamentals of Geospatial Programming			
Week 9 3/16	**Introduction to Python** An overview of programming in Python. Exploration of Jupyter Notebooks, including generating visualizations and programming documentation.	Annyce (2020) Project 3	No deliverables
3/18	**Fundamentals of Programming** The role of Python in geographic information science and systems.		
Week 10* 3/23 *Tuesday, 3/23 is a wellness day	**Wellness Day**		Project 3, Part 1: Programming in Python Monday, 3/22

	Topics	Readings and Assignments	Deliverables/Due Dates
3/25	**Cloud Computing Tools for GIS** Exploration of JupyterLab and Esri-based Notebooks using Python to create and share code and equations.	Pierson (2020a), Padmanabhan et al. (2014)	
Week 11 3/30	**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, 3/29
4/1	**Open Source Automation and Customization** Exploration of open source GIS programing options for developing automated and customized solutions, such as Whitebox GAT, GRASS and QGIS		
Week 12* 4/6 *Wednesday, 4/7 is a wellness day	**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 (2018) Ch. 5, pp. 189-236, Zent (2018)	Project 3, Part 3: Programming and customization using open source GIS tools: Monday, 4/5
4/8	**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 4/13	**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, 4/12
4/15	**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* 4/20 *Thursday, 4/22 is a wellness day	**Fundamentals of Web and Mobile GIS** Customizing and programming web and mobile 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 and mobile GIS projects.	Tsou, M.-H. 2018 Discussion Assignment 3	Project 4: Demonstration of programmatic use of geospatial web maps and web services: Monday, 4/19

	Topics	Readings and Assignments	Deliverables/Due Dates
4/22	**Wellness Day**		
Week 15* 4/27 *Thursday, 4/29 is the last day of classes *Friday, 4/30 is a wellness day 4/29	**Scientific Communication Skills & Cross-Disciplinary Collaboration** Exploration of communications skills and technologies required to excel in collaboration across different scientific communities. **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.		Discussion Assignment 3: Developing Science Communication Skills Wednesday, 4/28 All assignments must be submitted no later than 5:00 PM PT on 4/29
Exam Week 5/5-12	**Final Exam** Students complete an asynchronous Final Exam.		Wednesday, May 12, 2 p.m.-4 p.m.

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, http://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 https://libraries.usc.edu/. Also, the USC Libraries have many important resources available for distance students through the link: https://libraries.usc.edu/faculty-students/distance-learners. These include instructional videos, remote access to university resources, and other key contact information for distance students.