USC Dornsife
Dana and David Dornsife
College of Letters, Arts and Sciences
Spatial Sciences Institute

SSCI 383L – GIS Modeling and Customization

Syllabus

Units: 4

Term, Day, Time: Spring, 2018, Monday and Wednesday 2:00 – 4:15 p.m.

Location: AHF 145A

Instructor: Jennifer N Swift, Ph.D. GISP
Office: AHF B57D
Regular Office Hours: Tuesday 10-11 a.m. and Thursday 1-2 p.m. PT, and by appointment
Contact Info: jswift@usc.edu, 213-740-5841

IT Help: Richard Tsung
Office: AHF 145D
Office Hours: By appointment
Contact Info: ctsung@usc.edu, 213-821-4415 (office)

Course Description

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 is 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 as well as 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.

Numerous examples will be used throughout the course to illustrate how spatial modeling helps us to understand spatial phenomena through expressions of how the natural world works, 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 and Minor in Spatial Sciences. Each audience is encouraged to utilize the laboratory experience and team research projects to investigate diverse geospatial resources such as spatial modeling, computer programming, remotely sensed imagery, and 2D and 3D data visualization to advance their own academic and professional goals.

Learning Objectives

Students who excel in SSCI 383L will:

- Understand fundamental spatial science concepts in the context of spatial modeling;
- Explain how spatial models can be used to solve and understand environmental and GeoDesign problems;
- Assess the validity and uncertainty of model results;
- 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 through the combination of spatial modeling and customization using GIS.

Prerequisite(s): SSCI 301L, SSCI 382L or Instructor Permission
Co-Requisite (s): None
Concurrent Enrollment: None
Recommended Preparation**:** None

Course Structure

This is a four-credit course comprised of combined lectures and labs (two per week). The combined lecture and lab sessions are 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 tools of spatial science inquiry and to enhance your problem-solving skills within the framework of the scientific method. The combined lecture and lab sessions are designed to provide you with sound theoretical reasoning and the technical skills to investigate various physical and social processes. Your weekly assignments will be graded and returned, and the mid-term and both projects will have a laboratory component to them.

Please note that all course materials and correspondence will be posted on the course Blackboard website. As a registered student you will find this course available for you to access at 10 a.m. PT on the first day of classes**.**

Technological Proficiency and Hardware/Software Required

The computational software and geospatial data required for course assignments will be accessed using computing resources provided by the Spatial Sciences Institute.

Required Readings

The required textbooks for this course are:

- iCode Academy. 2017. *Python Programming: Your Step By Step Guide To Easily Learn Python in 7 Days*. CreateSpace Independent Publishing Platform.
- Mitchell, Andy. 2012. *The Esri Guide to GIS Analysis, Volume 3: Modeling Suitability, Movement, and Interaction 1st Edition.* Redlands: Esri Press.
- Toms, Silas (2015) *ArcPy and ArcGIS: Geospatial Analysis with Python.* Packt Publishing.

The required tasks will be supplemented with the following materials:

- Clarke, Keith, Bradley O. Parks, and Michael P. Crane. 2002. Ch. 10, "Case Studies in GIS." *Geographic Information Systems and Environmental Modeling*. Printice Hall.
- Law, Michael, and Amy Collins. 2016. Ch. 5. "Facilitating Workflows", in *Getting to Know ArcGIS Pro*. Esri Press.
- Longley, Paul A., Michael F. Goodchild, David J. Maguire, and David W. Rhind. 2015. Ch. 14, "Spatial Analysis and Inference", Ch. 15, "Spatial Modeling with GIS Systems", Ch. 19, "Epilog: GISS in the Service of Humanity", in *Geographic Information Systems and Science*. 4th ed., New York: John Wiley and Sons.
- Miller, Harvey, and Michael F. Goodchild. 2015. *Data Driven Geography.* GeoJournal 80:4 449-461.

- Padmanabhan, Anand, Shaowen Wang, Guofeng Cao, Myunghwa Hwang, Zhenhua Zhang, Yizhao Gao, Kiumars Soltani, and Yan Liu. 2014. "FluMapper: A cyberGIS application for interactive analysis of massive location-based social media." *Concurrency and Computation Practice and Experience* 26: 2253–2265.
- Steinitz, Carl. 2012. Ch. 5. "The Second Iteration Through the Framework: Designing the Study Methodology", Ch. 6, "The Third Iteration Through the Framework: Carrying Out the Study", Ch. 7, "Geodesign with Certianty", Ch. 8, "Geodesign with Uncertianty", Ch. 9, "Geodesign When Knowing the Rules", in *A Framework for Geodesign: Changing Geography by Design.* Esri Press.

Description and Assessment of Assignments

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

Assignments (9%): Students will be expected to complete three 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.

Laboratory Assignments (21%): This course includes a laboratory component each week to develop technical competency with geospatial software platforms and analytic tools. There will be a total of seven laboratory assignments over the course of the semester.

Group Project (20%): One group project will be used to practice the techniques explored in class and in the laboratory assignments. The project may include primary, and will include secondary data collection. At the completion of the project, students will turn in individual digital outputs to demonstrate that they have completed the required work tasks.

Mid-term Exam (20%): 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 Project (30%) - The final group project is an capstone report and presentation for this course, and students will be expected to draw upon course lectures, discussions, lab assignments, readings, and outside sources to organize and deliver a self-directed study on a topic of interest utilizing advanced spatial analysis and geospatial technologies. The report is limited to 15 pages (with 12-point font, 1 inch margins, single-spacing for text) and will include one or more maps, tables, and other diagrams as well as a list of references. The presentation will include slides and will be limited to 10 minutes per student.

Grading Breakdown

Assessment	Number	Points Each	Total Points
Assignments	3	3	9
Laboratory Assignments	7	3	21
Group Project	1	20	20
Mid-term Examination	1	20	20
Final Project Components			
Final Project Report	1	20	20
Final Project Presentation	1	10	10
Total	14	-	100 points

Assignment Submission Policy

Assignments will be submitted for grading via Blackboard by the due dates specified in the Course Schedule below.

Additional Policies

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. 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.

Course Schedule

	Topic	**Readings and Assignments**	**Deliverables/Due Dates**
Module 1 | Spatial Analysis Fundamentals			
Week 1 1/8 1/10	**Introduction to the Course** Brief introductions coupled with discussions of class goals, lab assignments, projects, and technology. **Review: Spatial Analysis Concepts** Review of core spatial analysis concepts covered in SSCI 382L, including 2D and 3D spatial analysis techniques, and core geospatial datasets.		Complete by 1/15: Assignment 1: Review Core Spatial Analysis Concepts
Module 2 | Introduction to Spatial Modeling			
Week 2 *Monday, 1/15 is University holiday 1/17	**Introduction to Spatial Modeling** Discussion of the core concepts of spatial modeling.	Longley et al. (2015) Ch. 15, pp. 339-351, Mitchell (2012) Ch. 1, pp. 6-30	Complete by 1/22: Lab 1: Basic Spatial Modeling Techniques

	Topic	Readings and Assignments	Deliverables/Due Dates
Week 3 1/22 1/24	**Types of Models** Discussion of the different types of spatial models and why we use them. **Spatial Modeling in GIS** Discussion of what modeling means in the context of geographic information remote sensing systems, potential applications, and software that support modeling.	Longley et al. (2015) Ch. 15, pp. 352-353, Mitchell (2012) Ch. 2,3, pp. 31-68	Complete by 1/29: Lab 2: Spatial Modeling with GIS
Week 4 1/29 1/31	**Spatial Decision Making** Discussion of advanced design methods using geographic information and remote sensing systems, and the relationship of hypothesis testing to geographic information science. **Optimization** Discussion of spatial decision support and methods of statistical inference applied to geographic data.	Longley et al. (2015) Ch. 14, pp., 329-337, Steinitz (2012) Ch. 5 pp. 46-82, Ch. 9, 139-160	Complete by 1/31: Assignment 2: Hypothesis Testing
Week 5 2/5 2/7	**Modeling Paths, Networks and Interactions** Discussion of modeling paths people walk, flow over a network with infrastructure, and interactions between facilities that provide services. **Agent-Based Modeling** Discussion of the fundamentals of agent-based modeling.	Mitchell (2012) Ch. 4,5,6, pp. 169-404, Steinitz (2012) Ch. 9, pp. 161-178	Complete by 2/12: Lab 3: Introduction to Modeling Interactions
Week 6 2/12 2/14	**Uncertainty** Discussion the needs of modeling in understanding model uncertainty. **Accuracy and Validity in Models** Discussion of how accuracy and validity can be addressed using current in geographic information and remote sensing systems.	Longley et al. (2015) Ch. 15, pp. 354-356, Steinitz (2012) Ch. 8, pp. 119-138	Complete by 2/19: Assignment 3: Accuracy and Validity in Models

Module 3 | Customization in GIS			
Week 7 2/20* *Monday, 2/19 is University holiday 2/21	**Programming for GIS** Discussion of different programming languages used in geographic information science application development.	iCode Academy (2017)	Complete by 2/26: Lab 4: Introduction to Python
Week 8 2/26 2/28	**Introduction to GIS Automation & Customization** Discussion of different customization techniques used in geographic information system application development to streamline spatial analyses and models. **Spatial Modeling Programming Workflows** Discussion of geographic information science and remote sensing to guide choice of GIS tools and programming languages to handle complex spatial models.	Law and Collins (2016), Ch. 5, 181-224, Toms (2015) Ch. 3, pp. 41-48	Complete by 3/5: Lab 5: Automating Processes in GIS
Week 9 3/5	**Mid-Semester Review**		No Lab. Review for Mid-Term
3/7	**Mid-Term Exam** (2:00-3:20 PM)		
3/11-3/18	***Spring Recess***		
Week 10 3/19 3/21	**GIS Add-Ins** Discussion of geographic information system customization through development of add-ins to create applications that can extend the software to bundle complex spatial analyses and models into convenient tools. **Wrapping Models in GIS Add-Ins** Discussion of how programming can enhance development of add-ins in geographic information systems.	Toms (2015) Ch. 3, pp. 49-59	Complete by 3/26: Lab 6: Customizing Add-Ins in GIS
Week 11 3/26	**Extending GIS** Discussion of extending the capabilities of geographic information systems through programming, such as through an API (application programming interface) and a SDK (software development kit).	Toms (2015) Ch. 4,5, pp. 61-94	Complete by 4/2: Lab 7: Customizing Extensions in GIS

3/28	**Implementing Spatial Modeling Workflows** Discussion of how programming can enhance building geographic information systems tools for desktop and web-based geographic information systems.		
Module 4 | Group Projects			
Week 12 4/2 4/4	**Group Project** Overview of content, tasks and deliverables of a modeling project to be completed in Week 12. **Spatial Modeling of Environmental Systems** Discussion of project goals, data needs, spatial modeling decision points and outputs of environmental applications. Students work in teams to complete a project that uses remote sensing as well as other types of geographic information.	Steinitz (2012) Ch. 6, pp. 83-92, Clark et al. (2002)	Complete by 4/9: Group Project: Environmental Modeling in GIS
Week 13 4/9 4/11	**Spatial Modeling in GeoDesign** Discussion of project goals, data needs, spatial modeling decision points and outputs of a GeoDesign project. Students work in teams to complete a project. **Final Project** Overview of content, tasks and deliverables of a modeling, programming and customization project to be completed in Weeks 14 through 15.	Steinitz (2012) Ch. 7, pp. 95-118	Complete by 4/18: Final Project: Programming and Customization for Modeling with TerrSet
Week 14 4/16 4/18	**Environmental, Societal & Big Data Challenges** Discussion of the many important social, economic, and environmental challenges faced today and in the future, and how we can harness "Big Data" sets such as social media feeds using high performance computing to help address these challenges. Students continue to work in teams on a project. **Overview: GeoDesign Practicum** Overview of SSCI 412 topics, including working as a professional team and interacting and communicating with clients on a real world project.	Longley et al. (2015) Ch. 19, pp. 435-460, Padmanabhan et al. (2014); Miller and Goodchild (2015)	Complete by 4/25: Complete Final Project Deliverables

Week 15 4/23* 4/25 ***Friday, 4/27 is last day of class**	**Final Projects** Students present Final projects. Complete Final Project spatial analysis and report. **Final Project Presentations** Students present Final projects.		 No Lab. Final Project Presentations
TBD	**Final Project** (2:00-4:00p.m.)		Final Project Report

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 Section 11, *Behavior Violating University Standards* https://policy.usc.edu/student/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.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the *Office of Equity and Diversity* http://equity.usc.edu or to the *Department of Public Safety* http://adminopsnet.usc.edu/department/department-public-safety. This is important for the safety of the whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of another person. *The Relationship and Sexual Violence Prevention Services* http://engemannshc.usc.edu/rsvp/ provides 24/7 confidential support, and the sexual assault resource center webpage http://sarc.usc.edu describes reporting options and other resources.

Support Systems

A number of USC's schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* http://dornsife.usc.edu/ali, which sponsors courses and workshops specifically for international graduate students. *The Office of Disability Services and Programs* http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information* http://emergency.usc.edu will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.

Academic Accommodations

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP and it should be delivered to me early in the semester. DSP is located in STU 301 and is open from 8:30am to 5:00pm, Monday through Friday (213-740-0776; study@usc.edu).