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

SSCI 586 (35711), GIS Programming and Customization

Syllabus

Units: 4

Term — Day — Time: Fall, 2017, Online

Location: Blackboard

Instructor: Andrew J. Marx, Ph.D
Office: AHF B55
Regular Office Hours: Tue and Thur 8-9 am PT;
also available most days and times by appointment via email.

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Library Help: Sherry Mosley
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Course Scope and Purpose

GIS programming skills are now an essential part of the GIS professional's portfolio. Learning to program facilitates an 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 deeper insight into how other programmers create and use these tools. Helping you become comfortable with coding and thoroughly documenting novel GIS tools that can be readily shared with a crowd is the goal of this course.

This course will provide you with the most up-to-date software tools and information necessary for building and implementing customized GIS mapping applications and geoprocessing functions according to current industry standards. It is assumed that students taking this course are new to programming and have no prior experience. Essential practical as well as theoretical concepts of GIS modeling and its translation into GIS software development and object-oriented programming are covered. In addition, you will learn the Python programming language and its use in developing customized GIS applications directly applicable to your own field of interest. Overall, you will gain a deep and solid foundation for interacting with Esri's ArcGIS ecosystem.

This course is on elective for the Geographic Information Science & Technology M.S. and Graduate Certificate Programs and the Geospatial Leadership Graduate Certificate Program.

This is also a graduate level course, so you should expect this class to be intellectually challenging. As graduate students, you are expected to engage with the information you are learning and to explore the heady cauldron of ideas, opinion, and analysis that describe our collective effort to thoroughly interrogate the subject at hand. Learning arises from active engagement with the knowledge found in our reading materials and with one another. As in any graduate class, the instructor's role is that of a guide who keeps you on this path of discovery and you will find that you will learn much from your classmates. The challenge for the instructor is to replicate such an academic experience within the milieu of "online learning."

Learning Outcomes

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

- Familiarize yourself with different programming languages commonly used in GIS customization, and how to use these technologies to expand upon existing GIS software functionality.
- Perform object-oriented programming tasks using various programming languages, such as Python.
- Analyze design procedures and interactions for modeling with GIS.
- Program small-scale GIS-based models in Python, integrated within ArcGIS.
- Understand general software engineering concepts and good programming methods and practices.
- Critically evaluate different methodologies for developing applications in GIS.
- Conceptualize, plan, implement, and write up the results of an original GIS programming application, customization, automation and/or extension.

Prerequisite(s): None

Co-Requisite (s): None

Concurrent Enrollment: None

Recommended Preparation: SSCI 581: Concepts for Spatial Thinking

Course Structure

The course will unfold on a weekly basis. Each week will be focused on a particular aspect of GIS programming and customization. In order to encourage collaboration, the class will be divided into small groups to work on several programming assignments. Group members will share and test each other's work in brief Discussion threads (online).

All course materials will be organized through Blackboard. The main theoretical concepts will be provided through text readings and self-directed research you will conduct using the published literature and on the web and through hands-on experimentation with various tools and technologies.

You will finish the course by completing a GIS programming project on a topic of your choice on your own.

Technological and Communication Requirements

ArcGIS is provided online via the SSI Server; 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 SSI Server

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, (note underscore) making sure to copy (cc) me on the email.

Communications – This is a distance learning course, so most of our interactions will be asynchronous. 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. 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 offline 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 the 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 will offer comments when appropriate, 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 textbooks for this course are:

- Allen, David. 2011. *Getting to Know ArcGIS ModelBuilder*. Redlands, Esri Press, 336 pp.
- Zandbergern, Paul A. 2013. *Python Scripting for ArcGIS*. Redlands, Esri Press, 368 pp.
- (Optional) Shaw, Zed. 2013. *Learn Python the Hard Way*. 3rd Ed. Addison Wesley Professional, 320 pp. Also available for free at http://learnpythonthehardway.org/book/ (7/2015).

The aforementioned textbooks will be supplemented with Course Notes and a mixture of readings from academic journals, professional reports and authoritative websites. Additional readings relevant to students' interests as well as course themes will be identified as part of the literature search components.

Readings – To be posted to Blackboard under Course Documents:

- Batty, Michael and Yichun Xie. 2005. "Urban Growth Using Cellular Automata Models". In *GIS, Spatial Analysis, and Modeling*, edited by David J. Maguire, Michael Batty and Michael F. Goodchild, 151-172. Redlands, CA: Ersi Press.
- Bian, Ling. 2007. "Object-Oriented Representation of Environmental Phenomena: Is Everything Best Represented as an Object?". *Annals of the Association of American Geographers,* 97(2): 267-281.
- Jeffrey C. Carver and Tom Epperly. 2014. "Software Engineering for Computational Science and Engineering". *Computing in Science and Engineering*, 16(3), 6-10.
- Doan, J. H. 2000. "Hydrologic Model of the Buffalo Bayou Using GIS". *Hydrologic and Hydraulic Modeling Support with Geographic Information Systems,* edited by David Maidment and Dean Djokic, 113-143. Redlands, CA: Esri Press.
- Glennon, Alan. 2010. "Creating and Validating Object-Oriented Geographic Data Models: Modeling Flow within GIS." *Transactions in GIS* 14(1): 23-42.
- Longley, Paul A. 2004. "Geographical Information Systems: On Modeling and Representation". *Progress in Human Geography* 28: 108-116.

- Zou, Li, Miller, Scott N., and Schmidtmann, Edward T. 2007. “A GIS Tool to Estimate West Nile Virus Risk Based on a Degree-Day Model”. *Environmental Monitoring and Assessment*, 129: 413-420.
- Miller, Harvey J., and Michael F. Goodchild. 2015. "Data-driven geography." *GeoJournal* 80(4): 449-461.

Description and Assessment of Assignments

Weekly Assignments

Your grade in this course will be determined based on several different assessments:

Resume Assignment – 1 worth 2 points. We require all current students to post and maintain a public resume, short biography and recent photo on our shared SSI Student Community Blackboard site. Please prepare your resume in the SSI template which will be provided to you. Unless you opt out, your resume will be included in the Spatial Sciences Institute Graduate Programs Resume Book. This resume book is compiled annually and, along with our web presence, is used to promote our programs, and more importantly, your skills, experience and professional aspirations.

Reading Assignments – 6 worth a total of 12 points. These will focus on the theory portion of the course as presented in the weekly readings. Their objective is to help you evaluate and integrate the information you have acquired from the course readings. Some of these will involve discussions and collaborative work and some will be individual efforts.

Discussions – 6 worth a total of 6 points. Structured discussions will focus on combinations of theory and practice. You will post new messages and replies to messages posted by your classmates (i.e. two per forum) at specified times throughout the class.

Programming Assignments – 10 worth a total of 40 points. In order to demonstrate that you understand the basic concepts and skills learned in the class, you will complete 10 Programming assignments that involve the use of Python and/or ArcGIS. Once you have completed each assignment, you will turn in a word document with maps, workflows, illustrations, and code itself, or an installation package to show your work. Usually, there are several questions for each assignment. Each question corresponds to a different step during the hands-on assignment process, and has varying credits attached to it.

Final Project

To integrate your learning of the material covered in the course, you will design, undertake, and report on an individually chosen Python programming or Esri Modelbuilder project. The four components of the Final Project are:

Proposal - 4 points. Two meetings (live via BlueJeans) and a brief written description of the GIS programming and customization application(s) you would like to build and how you plan to do it.

Presentation - 10 points. A presentation on the individual final project made online via BlueJeans, open to all students in the course.

Final Report - 16 points. A written report (double-spaced, 12-point font) of no more than 12 pages in length (not counting figures, tables and references) on your project methodology and outcomes.

Poster - 10 points. An academic poster of your final report that shows the introduction, background, methods, results, conclusions, limitations, and references. You are encouraged to display your project poster at the Esri User Conference or the Annual Meeting of the Association of American Geographers. You will share the electronic version of it with the whole class on Bb, and make some comments on your classmates' posters.

Grading Breakdown

Assessment	Number	Points Each	Total Points
Weekly Assignments			
Resume Assignment	1	2	2
Reading Assignments	6	2	12
Discussions	6	1	6
Programming Assignments	10	4	40
Project Components			
Proposal	1	4	4
Presentation	1	10	10
Poster	1	10	10
Final Report	1	16	16
Total	27	-	100

Assignment Submission Policy

Assignments will be submitted for grading via Blackboard using the due dates specified in the Course Schedule below. And finally, it is important to note from the outset that: (1) late postings and assignments will be docked one letter grade and no grade will be given for postings or assignments turned in more than seven days late; and (2) no written work other than the final project posters and project poster discussion will be accepted for grading after 5:00 pm PT on Friday, Dec. 8.

Schedule

	Topic	Readings	Deliverables/Due Dates
Week 1 8/21	**Introduction:** Introduction to the theory of spatial representation and modeling	Longley (2004) Doan (2000) (optional)	Resume Assignment: 8/27 Week 1 Reading Assignment: 8/27 Week 1 Discussion Forum: 8/27
Week 2 8/28	**Practical Modeling:** Introduction to Esri Modelbuilder	Batty & Xie (2005) Allen (2011) Ch.1	Week 2 Reading Assignment: 9/3 Week 2 Discussion Forum: 9/3 Week 2 Programming Assignment: 9/3
Week 3 9/4 *9/4 is a university holiday	**Applied Modeling In GIS:** Building interactive models using Esri Modelbuilder	Allen (2011) Ch.2 Shaw (2013) Sec.1-6 (Optional)	Week 3 Programming Assignment: 9/10
Week 4 9/11	**Programming Basics – Part 1:** Fundamental Python concepts & flow control in Esri Modelbuilder	Esri Online Help Allen (2011) Ch.3 Esri Web Campus: Python for Everyone LPy (optional)	Proposal Meeting: TBD Week 4 Reading Assignment: 9/17 Week 4 Programming Assignment: 9/17
Week 5 9/18	**Programming Basics – Part 2:** Introduction to ArcMap Python window & Python language fundamentals	Allen (2011) Ch.4&5 Zandbergern (2013) Ch.3&4 Shaw (2013) Sec.27-38 (optional)	Week 5 Programming Assignment: 9/24
Week 6 9/25	**Object-Oriented Programming & Workflows:** Utilizing model iterations & geoprocessing using Python in ArcMap	Glennon (2010) Bian (2007) Allen (2011) Ch.6 Zandbergern (2013) Ch.5 Esri Blog: GIS Workflow Automation	Week 6 Discussion Forum: 10/1 Week 6 Programming Assignment: 10/1 Week 6 Reading Assignment: 10/1 Project Proposal Meeting: TBD

Week 7 10/2	**Computing with Data – Part 1:** Building model documentation & manipulation of spatial data in models	Allen (2011) Ch.7 Zandbergern (2013) Ch.6.7&8 Hellman (2007) (skim) Tilton (2011) (skim)	Week 7 Programming Assignment: 10/8
Week 8 10/9	**Computing with Data – Part 2:** Creating & sharing geoprocessing packages	Esri Web Campus: 2. Sharing Workflows Using Geoprocessing Packages Zandbergern (2013) Ch.9	Week 8 Programming Assignment: 10/15
Week 9 10/16	**Programming for GIS**: Programming in GIS using the ArcPy mapping module & ArcMap Python window	Esri Web Campus: 3. Using Python in ArcGIS 10 Zou (2007) (skim)	Week 9 Programming Assignment: 10/22
Week 10 10/23	**GIS Automation and Customization – Add-Ins:** Testing example code, creating & sharing ArcMap add-in's	Esri Web Campus: 4. Creating Add-Ins using Python Esri Guide Book: ArcGIS Desktop Python add-ins	Week 10 Reading Assignment: 10/29 Week 10 Programming Assignment: 10/29 Project Progress Meeting: TDB
Week 11 10/30	**GIS Automation and Customization – Extensions:** Building & sharing ArcMap extensions	Esri Guide Book: Using Extensions in ArcGIS	Week 11 Programming Assignment: 11/5
Week 12 11/6	**Consuming and Distributing Code:** Exploring Esri GitHub & Esri Development Summit Proceedings	ESRI Blogs and Articles	Week 12 Discussion Forum: 11/12
Week 13 11/13	**Principles and Practices of Software Development:** Exploring Esri ArcPy Cafe & GeoNet	Carver & Epperly (2014)	Week 13 Reading Assignment: 11/19 Week 13 Discussion Forum: 11/19

Week 14 11/20 *11/22 to 11/24 is a university holiday	**Future of GIS Programming:** Thinking about data-driven geography	Miller & Goodchild (2015) (optional)	Week 14 Discussion Forum: 11/26
Week 15 11/27 *Friday, 12/1 is last day of class	**Final Project Poster and Presentation**	Final project presentation (11/27 or 11/28)	Submit final project PPT before your presentation. Submit the final project poster no later than 5:00 p.m. PT on Friday, 12/1
Final Exam 12/6 to 12/8 *12/2 to 12/5 are Study Days	**Final Project Paper and Poster Discussion**	Classmates' posters	Comments on your classmates' posters no later than 5:00 p.m. PT on Wednesday, 12/6 Submit a final version of your report no later than Friday 12/8 at 5:00 p.m. PT

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.

Support Systems

Student Counseling Services (SCS) - (213) 740-7711 – 24/7 on call
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.
https://engemannshc.usc.edu/counseling/.

National Suicide Prevention Lifeline - 1-800-273-8255
Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. http://www.suicidepreventionlifeline.org.

Relationship & Sexual Violence Prevention Services (RSVP) - (213) 740-4900 - 24/7 on call
Free and confidential therapy services, workshops, and training for situations related to gender based harm. https://engemannshc.usc.edu/rsvp/.

Sexual Assault Resource Center
For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: http://sarc.usc.edu/.

Office of Equity and Diversity (OED)/Title IX compliance – (213) 740-5086
Works with faculty, staff, visitors, applicants, and students around issues of protected class. https://equity.usc.edu/.

Bias Assessment Response and Support
Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. https://studentaffairs.usc.edu/bias-assessmentresponse-support/.

Student Support & Advocacy – (213) 821-4710
Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. https://studentaffairs.usc.edu/ssa/.

Diversity at USC – https://diversity.usc.edu/
Tabs for Events, Programs and Training, Task Force (including representatives for each school), Chronology, Participate, Resources for Students.

Resources for Online Students

The Course Blackboard page and the SSI 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. This includes instructional videos, remote access to university resources, and other key contact information for distance students.