



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

SSCI 586, GIS Programming and Customization

Syllabus

Units: 4

Term — Day — Time: Spring 2019, Online

Location: Online

Instructor: Andrew J. Marx, Ph.D

Office: AHF B55

Regular Office Hours: Wednesdays and Fridays 9-10 a.m.
PT. Also available most days and times by appointment via
email.

Contact Info: marxa@usc.edu, 213-740-2835 (Pacific),
<https://bluejeans.com/marxa>

Library Help: Andy Rutkowski

Office: VKC 36B

Office Hours: Tuesdays, 10 a.m.-12 p.m. and Thursdays,
4:30-5:30 p.m. PT

Contact Info: arutkows@usc.edu, 213-740-6390,
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IT Help: Richard Tsung

Office: AHF 145D

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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 spatial analysis 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 is 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."

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

Learning Outcomes

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

- Employ different programming languages commonly used in GIS customization, and describe 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 procedures and interactions for workflows within ArcGIS.
- 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

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 on Blackboard.

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 published literature and information found on the web, and through hands-on experimentation with various tools and technologies. You will finish the course by completing your own GIS programming project on a topic of your choice, pending instructor approval.

Workload – This is a four credit, one semester course. Students should expect to spend 10-15 hours per week completing the work in this course.

Technological and Communication Requirements

ArcGIS is provided online via the SSI GIST 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 ssi_support@usc.edu, making sure to copy (cc) me on the email.

Communications – This is a distance learning course, so most of our interactions will be asynchronous (not at the same time). 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 textbooks for this course are:

- (Optional) Allen, David. 2011. *Getting to Know ArcGIS ModelBuilder*. Redlands: Esri Press, 276 pp.
- Zandbergen, 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. Relevant chapters are available for free at <http://learnpythonthehardway.org/book/>.

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.

Supplementary readings will be assigned from various sources including:

- 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: Esri 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.
- Doan, John 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.

- Jeffrey C. Carver and Tom Epperly. 2014. "Software Engineering for Computational Science and Engineering". *Computing in Science and Engineering*, 16(3), 6-10.
- Longley, Paul A. 2004. "Geographical Information Systems: On Modeling and Representation." *Progress in Human Geography* 28: 108-116.
- Zou, Li, Scott N. Miller and Edward T. Schmidtmann. 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.

As well, for several of the assignments in this course, you will conduct online library research to find articles that apply specific techniques in an application area of your choice.

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 summary that follows.

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 – 5 worth a total of 10 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 project components will be due at different times during the term to build gradually on the material presented in the course. All points for project components will be assigned using a grading rubric provided at the time the project assignment is posted. The four components of the Project are:

Proposal - 4 points. Two meetings (live via BlueJeans) and brief written descriptions 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 - 12 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 | 5 | 2 | 10 |
| Discussions | 6 | 1 | 6 |
| Programming Assignments | 10 | 4 | 40 |
| Project Components | | | |
| Proposal | 2 | 2 | 4 |
| Presentation | 1 | 10 | 10 |
| Final Report | 1 | 16 | 16 |
| Poster | 1 | 12 | 12 |
| Total | 27 | | 100 |

Assignment Submission Policy

Unless otherwise noted, assignments must be submitted via Blackboard by the due dates specified in the Course Schedule below and on the assignment instructions.

Unless otherwise noted, all Reading Assignments and Tutorials are *due by 11:59 pm Pacific Time (PT) on Sundays*. 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:

- All assignments will be penalized 2 points up to FOUR days late. No points will be given for submissions more than FOUR days late. Note that all assignments worth 2 points will receive 0 points if submitted late.
- Additionally, no written work will be accepted for grading after 5 pm PT on the last day of classes.

Schedule

| | Topic | Readings and Assignments | Deliverables/Due Dates |
|--|--|---|---|
| Week 1 1/7 | Introduction: Introduction to the theory of spatial representation and modeling | Longley (2004) Doan (2000) (optional) | Resume Assignment: 1/22 Reading #1: 1/13 Discussion #1: 1/13 |
| Week 2 1/14 | Practical Modeling: Introduction to Esri Modelbuilder | Batty & Xie (2005) Allen (2011) Ch.1 | Reading #2: 1/20 Discussion #2: 1/20 Programming #1: 1/20 |
| Week 3 1/22* *Monday, 1/21 is university holiday | Applied Modeling In GIS: Building interactive models using Esri Modelbuilder | Allen (2011) Ch.2 Shaw (2013) Sec.1-6 (Optional) | Programming #2: 1/27 |
| Week 4 1/28 | Programming Basics – Part 1: Fundamental Python concepts & flow control in Esri Modelbuilder | Esri Online Help Allen (2011) Ch.3 Esri Web Campus: Building Models for GIS Analysis Using ArcGIS LPy (optional) | Project Proposal Meeting 1: TBD Project Proposal/Discussion #3: 2/1 Programming #3: 2/3 |
| Week 5 2/4 | 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) | Programming #4: 2/10 |
| Week 6 2/11 | 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 | Programming #5: 2/17 Reading #3: 2/17 |

| | Topic | Readings and Assignments | Deliverables/Due Dates |
|--|--|---|--|
| Week 7 2/19* *Monday, 2/18 is university holiday | Computing with Data – Part1: Building model documentation & manipulation of spatial data in models | Allen (2011) Ch.7 Zandbergen (2013) Ch.6.7&8 Hellman (2007) (skim) Tilton (2011) (skim) | Programming #6: 2/24 |
| Week 8 2/25 | Computing with Data – Part 2: Creating & sharing geoprocessing packages | Esri Web Campus: 2. Sharing Workflows Using Geoprocessing Packages Zandbergen (2013) Ch.9 | Programming #7: 3/3 |
| Week 9 3/4 | Programming for GIS: Programming in GIS using the ArcPy mapping module & ArcMap Python window | Esri Web Campus: 3. Python for Everyone Zou (2007) (skim) | Programming #8: 3/10 |
| 3/11* *3/10-3/19 is Spring Recess | | | |
| Week 10 3/18 | 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 | Reading #4: 3/24 Programming #9: 3/24 Project Proposal 2 Meeting: TBD |
| Week 11 3/25 | GIS Automation and Customization – Extensions: Building & sharing ArcMap extensions | Esri Guide Book: Using Extensions in ArcGIS | Programming #10: 3/31 |
| Week 12 4/1 | Consuming and Distributing Code: Exploring Esri GitHub & Esri Development Summit Proceedings | ESRI Blogs and Articles | Discussion #4: 4/7 |
| Week 13 4/8 | Principles & Practices of Software Development: Exploring Esri ArcPy Cafe & GeoNet | Carver & Epperly (2014) | Reading #5: 4/14 Discussion #5: 4/14 |
| Week 14 4/15 | Future of GIS Programming: Thinking about data-driven geography | Miller & Goodchild (2015) (optional) | Discussion #6: 4/21 |
| Week 15 4/22* Friday, 4/26 is the last day of class | Final Project Poster and Presentation | Final project presentation (4/25 or 4/26) | Submit final project PPT before your presentation. Submit the final project poster no later than 4/26 |

| | Topic | Readings and Assignments | Deliverables/Due Dates |
|--------------------------------|----------------------------|---------------------------------|---|
| Final Exams 5/1-5/8 | Final Project Paper | Classmates' posters | Comments on your classmates' posters no later than 5/1 Submit a final version of your final report no later than 5/5 |

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

Student Counseling Services (SCS) – (213) 740-7711 – 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

Provides 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) 740-4900 – 24/7 on call
engemannshc.usc.edu/rsvp

Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086
equity.usc.edu, titleix.usc.edu

Information about how to get help or help a survivor of harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants. The university prohibits discrimination or harassment based on the following protected characteristics: race, color, national origin, ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age, physical disability, medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and

any other characteristic which may be specified in applicable laws and governmental regulations.

Bias Assessment Response and Support – (213) 740-2421
studentaffairs.usc.edu/bias-assessment-response-support

Avenue to report incidents of bias, hate crimes, and microaggressions for appropriate investigation 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.

Student Support and Advocacy – (213) 821-4710
studentaffairs.usc.edu/ssa

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

Provides safety and other updates, 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.