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

SSCI 586 (35711), GIS Programming and Customization

Units: 4
Term: Spring 2016
Location: Online, via Blackboard

Instructor: Wei Yang, Ph.D.
Office: AHF B55A
Office Hours: Wednesdays and Fridays 2:00 p.m. - 3 p.m. PT; also available most other days by appointment via email

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BlueJeans: https://bluejeans.com/4900531065/

GIS Librarian Help: Katharin Peter
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IT Help: Richard Tsung
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Course Description

GIS programming skills are now an essential part of the GIS professional's portfolio. 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 coding and thoroughly documenting novel GIS tools that can be readily shared with a crowd is the goal of this course.

Why should you take 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 programmatically 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 fellow classmates. The challenge for the instructor is to replicate such an academic experience within the milieu of "online learning."

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

Learning Objectives

When you have completed this course, you will be able to:

- Familiarize yourself with different programming languages commonly used in GIS customization, and how to use these technologies to expand upon exiting 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). You will finish the course by completing a GIS programming project on a topic of your choice on your own.

Technological Proficiency and Hardware/Software Requirements

We have several technologies that will facilitate our course work and our interactions, despite our dispersed locations. These include:

Blackboard – All course materials and correspondence will be posted on the course Blackboard site. As a registered student, you will find this course will show up in your available classes no later than 12:00 noon, PT on the first day of classes. It is here that the day-to-day flow of the course will be recorded.

Discussion boards – On the Blackboard site, we will post a number of discussion threads related to various course topics. These threads are very important in terms of providing support to each other while working on class exercises to share hints and helpful tips, as you would do in a classroom setting, as in a GIS lab setting. I will check the discussion threads periodically and offer occasional comments. Please send your course instructor an email directly if you have a question or concern that requires immediate attention.

Live meetings and presentations – We will use a browser-based platform called BlueJeans to create synchronous, interactive sessions. With voice and webcam capabilities, this platform can be used to share presentations and even our desktops between two or more people.

Individual meetings – We will use BlueJeans for one-on-one meetings as well.

GIST server and tech support – This course will utilize the SSI GIST Server which is a virtual desktop. You can access the GIST Server at: http://gis-gateway.usc.edu. If you are unable to connect to the server or experience any type of technical issues, send an email using your USC account to GIST Tech Support at gistsupport@dornsife.usc.edu, making sure to copy (cc) me on the email. GIST Tech Support is available Mondays through Fridays, from 10 a.m. to 5 p.m. PT.

Every student should be proficient with the MS Office suite (Excel, PowerPoint, and Word), all of which are available on the GIST Server. Documents in other software formats will not be accepted. In addition, students' personal computer systems must meet several technology requirements:

- An up-to-date computer with a fast Internet connection.
- A functional Web camera together with a microphone or headset for live sessions.
- A modern Web browser (Firefox, IE or Chrome is recommended) to run ArcGIS which is provided online via the GIST Server; you do not need to install ArcGIS on your own computer.

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 as HTML: 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:

- Longley, Paul A. 2004. "Geographical Information Systems: on Modeling and Representation." *Progress in Human Geography* 28: 108-116.
- 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.
- Glennon, Alan. 2010. "Creating and Validating Object-Oriented Geographic Data Models: Modeling Flow within GIS." *Transactions in GIS* 14(1): 23-42.

Description and Assessment of Assignments

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

Resume Assignment (2%) – 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 (12%) – 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.

Discussion Forums (6%) – These will focus on varying combinations of theory and practice and anticipate that you will contribute to and participate in a series of discussion threads at designated times throughout the semester.

Programming Assignments (40%) – 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 quick copy of some digital

output from the final part of the assignment such as a .jpg at the final step, and/or some combination of a few brief text answers, the code itself or an installation package resulting from your code.

Final Project (40%) – To integrate your learning of all the material covered in the course, in the final project you will design, undertake and report on an individually chosen GIS Programming project that will be the context of discussion in several of the assignments. The five components of the Final Project are:

- *Proposal - 10 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 - 4 points.* A presentation made online via BlueJeans, open to all students in the course.
- *Installable Application - 10 points.* The installable will consist of the code, compiled if applicable, and any data required to run your application. The application must work as described in your Final Project Report.
- *Final Project Report - 10 points.* A written report on your project methodology, data and outcomes, including how to install and run your application.
- *Videos – 6 points.* You will create two short videos that describe and demonstrate your project. The first will cover your presentation, and the second will be a live demonstration of your application.

Grading Breakdown

The table below summarizes the SSCI 586 course assessments and their point distribution:

Assignments	**Numbers**	**Points**	**% of Grade**
Resume Assignment	1	2	2
Reading Assignments	6	2	12
Discussions	6	1	6
Programming Assignments	10	4	40
Final Project, components			
- Final Project Proposal	1	10	10
- Final Project Presentation	1	4	4
- Installable Application	1	10	10
- Final Project Report	1	10	10
- Videos	2	3	6
Totals	**29**	**-**	**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 grade and no grade will be given for postings or assignments turned in more than seven days late; and (2) no written work will be accepted for grading after 5:00 p.m. PT on the last day of classes (see the Course Schedule section).

Additional Policies

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 the Blackboard Assessment link. I will also create multiple Blackboard discussion forums throughout the semester that we will use for the aforementioned assignments and so we can discuss issues and comments on the course assignments, exercises and projects as the need arises.

In addition, I will send via e-mail through Blackboard any notices that are time sensitive. Please be sure that you read as soon as possible all e-mail sent from Blackboard or from me. Check now to make sure that mail sent from both the USC blackboard accounts and my private domain (yang474@usc.edu) does not go into your junk mail! While I am usually online and will probably respond to e-mails from students relatively quickly, I will endeavor to respond to all e-mail within 24 hours of receipt, aiming for no more than 48 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.

That said, it is each student's responsibility to stay informed about what is going on in our course. In addition to e-mail 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.

Workload – This is a four credit, one semester course. Students should expect to spend 12-15 hours per week completing the work in this course.

Course Schedule

	Topics/Daily Activities	**Readings and Homework**	**Deliverables/Due Dates**
Week 1 Jan. 11	**Introduction & Modeling Theory** Introduction to the course & modeling using GIS	Longley (2004) Student Resume & Job Post	No deliverables.
Week 2 Jan. 19*	**Practical Modeling** Introduction to Esri Modelbuilder, Python & geoprocessing workflows	Batty M. and Xie Y. (2005) Allen (2011) - Ch. 1 Explore GeoNet Introduction to Esri Modelbuilder	Submit Resume Assignment 1, Access GIST Server Assignment and Discussion Forum 1 no later than 5:00 p.m. on Tuesday, Jan. 19

Week 3 Jan. 25	**Applied Modeling In GIS** Applied aspects of building & executing models in a GIS	Allen (2011) - Ch.2 Shaw (2013) Sec.1-6 (Optional) Building interactive models using Esri Modelbuilder	Submit Reading Assignment 2, Access GIST Server Discussion Forum 2 no later than 5:00 p.m. on Tuesday, Jan. 26 Submit Programming Assignment 1 no later than 5:00 p.m. on Friday, Jan. 29
Week 4 Feb. 1	**Programming Basics – Part 1** Introduction to programming languages	Allen (2011) - Ch.3, Esri Web Campus: 1. Python for Everyone Shaw (2013) Sec.15-21 (Optional) Fundamental Python concepts & flow control in Esri Modelbuilder	Submit Programming Assignment 2 & optional Lpy no later than 5:00 p.m. on Friday, Feb. 5
Week 5 Feb. 8	**Programming Basics – Part 2** Data representation and data types, program structures	Allen (2011) - Ch.4&5 Zandbergern (2013) Ch.3&4 Shaw (2013) Sec.27-38 (Optional) Introduction to ArcMap Python window & Python language fundamentals	Submit Programming Assignment 3 & optional Lpy no later than 5:00 p.m. on Friday, Feb. 12
Week 6 Feb. 16*	**Object-Oriented Programming & Workflows** Basics of Object Oriented languages	Glennon (2010), Bian (2007), Allen (2011) - Ch.6 Zandbergern (2013) Ch.5 Esri Blog: GIS Workflow Automation Utilize model iterations & geoprocessing using Python in ArcMap	Submit Programming Assignment 4 & optional Lpy no later than 5:00 p.m. on Friday, Feb. 19 Project Proposal Meeting

Week 7 Feb. 22	**Computing with Data – Part 1** Explore different methods to document models	Allen (2011) - Ch.7 Zandbergern (2013) Ch.6.7&8 Build model documentation & manipulate spatial data in models	Submit Reading Assignment 3, Access GIST Server Discussion Forum no later than 5:00 p.m. on Tuesday, Feb. 23 Submit Programming Assignment 5 no later than 5:00 p.m. on Friday, Feb. 26
Week 8 Feb. 29	**Computing with Data – Part 2** Explore different methods to store and access data	Esri Web Campus: 2. Sharing Workflows Using Geoprocessing Packages Zandbergern (2013) Ch.9 Create & share geoprocessing packages	Submit Programming Assignment 6 no later than 5:00 p.m. on Friday, Mar. 4
Week 9 Mar.7	**Programming for GIS** Introduction to programming GIS using Python	Zou et al. (2007,) Esri Web Campus: 3. Using Python in ArcGIS 10 Program GIS using the ArcPy mapping module & ArcMap Python window	Submit Programming Assignment 7 no later than 5:00 p.m. on Friday, Mar. 11 Project Proposal
Week 10 Mar. 21	**GIS Automation and Customization – Add-Ins** Compile, install, and configure ArcGIS Add-Ins	Esri Web Campus: 4. Creating Add-Ins using Python, Esri Guide Book: add-ins Test example code, create & share ArcMap Add-In's	Submit Programming Assignment 8 no later than 5:00 p.m. on Friday, Mar. 25

Week 11 Mar. 28	**GIS Automation and Customization – Extensions** Develop functionality not native in off-the-shelf ArcGIS	Esri Guide Book: extensions Build & share ArcMap extensions	Submit Reading Assignment 4, Access GIST Server Discussion Forum no later than 5:00 p.m. on Tuesday, Mar. 29 Submit Programming Assignment 9 no later than 5:00 p.m. on Friday, Apr. 1
Week 12 Apr. 4	**Consuming and Distributing Code** Issues and solutions in software development	Blog: Open Source, Video: Cameron (2013) social coding for developers Explore Esri GitHub & Esri Dev Summit Proceedings	Submit Programming Assignment 10 no later than 5:00 p.m. on Friday, Apr. 8
Week 13 Apr. 11	**Principles and Practices of Software Development** Overview of the software engineering lifecycle	Carver & Epperly (2014) Explore Esri ArcPyCafe & GeoNet, & work on Final Projects	Submit Reading Assignment 5, Access GIST Server Discussion Forum no later than 5:00 p.m. on Tuesday, Apr. 12 Project Progress Meeting
Week 14 Apr. 18	**Future of GIS Programming** Feedback and Evaluations	Prepare final project components	Submit Reading Assignment 6, Access GIST Server Discussion Forum no later than 5:00 p.m. on Tuesday, Apr. 19
Week 15 Apr. 25	**Final Project** Final Presentations	Prepare final project components All work must be submitted by 5:00 p.m. PT on Fri Dec. 3, the last day of classes	Access GIST Server Discussion Forum no later than 5:00 p.m. on Tuesday, Apr. 26 Submit a final version of your final report no later than 5:00 p.m. on Friday, Apr. 29

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* http://studentaffairs.usc.edu/scampus/. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, http://www.usc.edu/schools/GraduateSchool/academic_conduct.html.

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://capsnet.usc.edu/department/department-public-safety/online-forms/contact-us. 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 Center for Women and Men* http://www.usc.edu/student-affairs/cwm/ 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* https://dsp.usc.edu/ 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.

Resources for Online Students

Our course Blackboard site provides links to several different resources that you may need. In particular, you will be making frequent use of the online USC Library that is available to all registered students through the link http://www.usc.edu/libraries. Once on this site, you can find additional resources for distance students under the link "Library Services". Many other resources and links to key people you may need to contact are also listed on the Blackboard site under Other Resources and Contacts.