SSCI 586 – GIS Programming and Customization
Course Syllabus – Spring 2014

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Office Hours: (tentative) Monday – Friday 3 PM to 5 PM Pacific Time.

I am always available via email. Also, available for chats via phone or Skype, audio or video, most days and times *by prior arrangement* via email. Or we can meet in my Adobe Connect room. Just get in touch! In addition, I want to encourage you to post your course related questions on the Blackboard discussion board so that we can share the knowledge among students in the most efficient way. I subscribe to every discussion forum on the Blackboard and I will receive an instant notice once your question is posted. My priority is to answer all discussion board questions and then emails.

Course Scope and Purpose

This course is designed to provide students with the most up-to-date tools and information necessary for building and implementing customized GIS mapping applications and geoprocessing functions according to current industry standards. The tools and concepts we will cover comprise an introduction to programming languages and development practices commonly used to integrate, customize, automate and extend desktop GIS technologies to meet the specific needs of end users. We begin with an overview of GIS modeling and its translation into GIS software development and object-oriented programming. We next cover Python programming language, followed by the use of such tool in developing customized GIS applications directly applicable to the student's field of interest. This course will provide a solid foundation for programmatically interacting with proprietary GIS platforms that allow user-specified automation, customization and extension such as Esri ArcGIS.

We will cover several topics:

Software Development and Object-Oriented Programming – We start with a basic review of modeling in the context of environmental systems analysis, and then programming, which is more than just writing code. In fact writing the code is the easy part – making sure it is done properly is the challenging part. We will also address issues of quality in the context of software development because creating special programs within or for GIS applications must be done quickly, efficiently and accurately. Object-oriented programming (OOP) and the effective use of appropriate software development strategies are two ways to achieve these goals.

Programming Languages for GIS Development – This course contains an introduction to an easily accessible open source and proprietary programming language, Python. The goal is for students to be able to critically evaluate such languages for application development and gain enough proficiency to be able to develop GIS customizations to suit their needs.

Customized GIS Application Development – In this most hands-on part of the course, we will start by analyzing and developing GIS-models interactions as examples of GIS customization. We will next undertake the creation of simple GIS applications with and without desktop GIS interaction. We will cover methods by which students can create customizations and automations within existing GIS software through custom tool development as well as how to extend the set of available tools by building and deploying user-specific extensions.

Learning Outcomes

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

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

Course Formats

This a graduate level course, so you should expect this class to be both academically robust and 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 us is to replicate such an academic experience within the milieu of "distance learning".

All course materials will be organized through Blackboard. The main theoretical concepts will be provided through course notes and assigned readings. Hands-on practical exercises will use various software products accessible over the Internet. Assignments will give students an opportunity to internalize and apply the concepts and theory learned from readings. Some assignments require student interaction, all will benefit from it.

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'll find this course will show up in your available courses at noon Pacific Time on the first day of classes. It is here that the day-to-day flow of the course will be recorded.

Discussion Boards – We will post a number of discussion threads relevant to various sections of the course on the Blackboard site. I may or may not participate in all of these threads but they are vitally important when we get to the hands-on work as we expect students to work "together" on these exercises, sharing hints and help as you would do in a common laboratory classroom. Additional discussion threads will be used to organize asynchronous discussions.

Live meetings and presentations – At USC, we use a browser-based service called Adobe Connect to create synchronous interaction sessions. With voice and webcam capabilities Adobe Connect can be used to share presentations and even our desktops between two or more people.

Individual meetings – While Adobe Connect can be used for one-on-one meetings, we generally find it's easier to use the free VOIP and chat technology, Skype (www.skype.com) for individual chats.

Assessments

Your grade in this class will be determined on the basis of several different assessment tools. Each week, by Monday, we will post a Weekly Assignment outlining the work you are expected to complete that week with the relevant due dates. Assignments will be due on the Friday following the week in which they are assigned.

Reading Assignments – 5 for a total of 10 points (10% of course grade). 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. Late assignments will not be accepted and will receive zero credit.

Modeling/Programming Exercises/Tutorials – 12 for a total of 50 points (50% of course grade). Most weeks you are expected to work through one or more exercises that involve the use of Python and/or ArcGIS. To demonstrate that you have completed each exercise, you will turn in a quick copy of some digital output from the final part of the exercise such as a .jpg at the final step, and/or some combination of a few brief text answers, your code itself or an installation package resulting from your code. Late assignments will not be accepted and will receive zero credit.

Final Project – 2 components for a total of 40 points (40% of course grade). The Final Project is your opportunity to integrate all that you have learned in the semester. It consists of a proposal, and a final report and presentation. In the Final Projects you will:

1. Frame a spatial question or application scenario that can be solved using a customized GIS application, automation, customization or extension.
2. Collect appropriate spatial and non-spatial data to be used as input.
3. Determine the technologies to be used (i.e. language(s), GIS functionalities) to implement the approach.
4. Establish the important intermediate steps in programming and implementation, including testing/debugging.
5. Produce a working application implementing your approach that you will demonstrate (live via Adobe Connect) during your final presentation and submit as an installable application.

You will be expected to implement a working version of your approach and to prepare a brief report, which you will present, describing the steps above and complete with illustrations (models, maps, etc.). Late submissions/presentations will not be accepted/allowed and will receive zero credit.

The Final Project will have 2 components:

1. Proposal (10 points) – a Presentation (live via Adobe Connect) of the problem or scenario you are attempting to address including the data and technologies chosen for the project, your proposed method for implementing a solution, your expected outcomes and deliverables, and any potential problems that you think could arise.
2. Final Project (20 points) and Presentation (10 points) – consists of an installable version of your project implementation along with a report describing your experience including the problem or application scenario you chose to address, a detailed description of how it was implemented and issues encountered while completing the project and how you overcame them. The project implementation must be installable and work as described in the report. The presentation (live via Adobe Connect) will consist of 3-5 slides illustrating highlights from the report followed by a live demonstration of your application. Presentations will be scheduled in groups.

Requirements

Textbooks – The following three books are required for this course. The first and third are available from the USC Bookstore or online outlets such as Amazon.com, while the second is free online (see link below). Be sure to order your textbook to arrive by the fastest method possible as you will need them immediately.

- Allen, David, 2011. Getting to Know ArcGIS ModelBuilder, Esri Press., 336 p. http://esripress.esri.com/display/index.cfm?fuseaction=display&websiteID=195&moduleID=0. We will refer to this as **GTM** in the Course Notes, Tutorials etc.
- Shaw, Zed A., 2012. Learn Python the Hard Way, Second Edition, Shavian Publishing, LLC, 183 p. http://learnpythonthehardway.org/book/. We will refer to this as **LPy** in the Course Notes, etc.
- Zandbergern, Paul A., 2013. Python Scripting for ArcGIS, Esri Press., 368 p. http://esripress.esri.com/display/index.cfm?fuseaction=display&websiteID=224&moduleID=0. We will refer to this as **PSA** in the Course Notes, Tutorials etc.

I also recommend the following. I will provide .pdf's on Blackboard, including those chapters in the following books that I assign as readings:

- Downey, Allen, 2012. Think Python - How to Think Like a Computer Scientist, Version 2.0.1. Green Tea Press. Needham, Massachusetts, 240 p. http://www.greenteapress.com/thinkpython/thinkpython.pdf. We will refer to this as **TPy** in the Course Notes, Tutorials etc.
- Zeiler, Michael, 2010. Modeling our World, Second Edition. Esri Press. http://esripress.esri.com/display/index.cfm?fuseaction=display&websiteID=178&moduleID=0. We will refer to this as **MOW** in the Course Notes, Tutorials etc.

In this course, these textbooks will be supplemented with the Course Notes and a mixture of readings from other books, academic journals, professional reports and authoritative websites.

Readings - The following Readings (in order assigned) are required for this course, and are provided either as pdf's or through links on the course Blackboard.

Allen, D. (2011). Getting to Know ArcGIS ModelBuilder, Esri Press.

Longley, P.A. (2004). Geographical Information Systems: on Modeling and Representation. *Progress in Human Geography*, 28, 108-116

Goodchild M. (2010). *Spatial Analysis and Modeling*, Chapter 29 in Manual of Geospatial Science and Technology, Bossler JD ed. 575-591

Maguire, D.J. (2005). *Towards a GIS Platform for Spatial Analysis and Modeling*. Chapter 2 in GIS, Spatial Analysis, and Modeling, Maguire DJ, Batty M, and Goodchild MF, eds, ESRI Press: 20-39

Batty M. and Xie Y. (2005). Urban Growth Using Cellular Automata Models. In Batty, M. and Goodchild, M.F. (eds) GIS, Spatial Analysis, and Modeling. Chapter 8. Redlands, CA, ESRI Press

Chavez, A., Bahill A.T. (2010). Pilot study uses DEM derived from LiDAR. ArcUser Magazine, Fall 2010, pp 24-27.

Zeiler, M. (2010). Geoprocessing with models and scripts. Chapter 11 in Modeling our World, ESRI, Redlands 266-279.

Allen, D. (2011). Chapters 1 and 2 in Getting to Know ArcGIS ModelBuilder, Esri Press.

Butler, H. (2005). A Guide to the Python Universe for ESRI Users. *ArcUser Magazine*, April-June, pp 34 – 37.

Glennon, A. (2010) Creating and Validating Object-Oriented Geographic Data Models: Modeling Flow within GIS.

Bian, L. (2007) Object-Oriented Representation of Environmental Phenomena: Is Everything Best Represented as an Object?

Ben-Ari, M. (2010) Objects Never? Well, Hardly Ever! Revisiting the Great Objects Debate

Hellmann, D. (2007). Python in Science: How long until a Nobel Prize? *Python Magazine*, Volume 1 Number 11.

Tilton, T. (2011). Charming the Snake, An introduction to Python and the ArcPy site-package, *ArcUser Online, Winter 2011 (pp. 53-54).*

Zou et al. (2007) A GIS Tool to Estimate West Nile Virus Risk Based on a Degree-Day Model. *Environmental Monitoring and Assessment* 129:413-420.

Technology – There are several technology requirements:

- Python 2.7.3 or greater (installs automatically with ArcGIS 10.2): http://www.python.org/download/. ArcGIS is provided on-line via the GIST Server, you do not need to install it on your own computer.
- Every student must have a computer with a fast Internet connection (DSL at a minimum). Since we now serve the key software from the Server, you can use either a Mac or a PC.
- Every student MUST have a functional webcam for use whenever a presentation or meeting is scheduled.

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 at least one Blackboard (BB) discussion forum at the start of the semester and I may create and/or monitor additional BB discussion forums through which we can discuss issues and comments on the course assignments, exercises and project as the need arises.

Any notices that are time sensitive will be sent via email through Blackboard. Please be sure that you read all email sent from Blackboard or from me as soon as possible. Also, double check to be sure that mail sent from both the USC blackboard account and my private domain does not go into your junk mail!

While I am usually online 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 36 hours delay. In the rare case when I expect to be off-line for more than 24 hours, I will post an announcement on the Blackboard site.

Your responsibility: 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.

Workload – This is a four credits, one semester course. Students should expect to spend 10-12 hours per week completing the work in this course.

Students with Disabilities

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. More information about academic accommodations based on a disability can be found at: http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to an instructor as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.–5:00 p.m., Monday-Friday. The phone number for DSP is (213) 740-0776.

Statement on Academic Integrity

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. Scampus, the Student Guidebook, contains the Student Conduct Code in Section 11.00, while the recommended sanctions can be found at: http://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions/.

Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at: http://www.usc.edu/student-affairs/SJACS/.

*Important Administrative Dates**

1/13: Spring semester classes begin
1/20: Martin Luther King Day, university holiday
1/31: Last day to register and add classes
1/31: Last day to drop a class without a mark of "W" and receive a 100% refund
2/17: Presidents' Day, university holiday
3/17-22: Spring recess
3/25: Deadline to submit signed Approval to Submit form to the Graduate School**
4/1: Deadline to upload thesis or dissertation manuscript**
4/11: Last day to drop a class with a mark of W
5/2: Spring semester classes end
5/3-6: Study days
5/14: Final Examinations end
5/16: Commencement

*http://www.usc.edu/academics/classes/term_20141/calendar.html

**http://www.usc.edu/schools/GraduateSchool/current_thesis_dissert_03.html

In addition to the usual Monday due dates for Readings and Friday due dates for Hands-On Assignments as indicated in the table on the next page, the following special due dates have been set:

- Individual Project Proposal Meetings – time slots will be scheduled by February 14th for February 18th- 21nd.
- Individual Project Progress Meetings – time slots will be scheduled by April 4th for April 7th- 11th.
- Presentation of Final Project – time slots will be scheduled by May 2nd for May 7th- 9th.
- Submission of Final Project Report and Installable – May 13th.

Tentative Course Schedule – Next Page

Tentative Course Schedule

Week #	Week Begins (Monday)	Theme	Week's Readings and Practice		Assessments due the following:		
					Friday	Monday	See previous page and Project Doc
			Reading	Hands-on	Exercises	Reading Assign.	Project
1	13-Jan	Introduction & Modeling Theory	Notes, papers			1	
2	21-Jan*	Practical Modeling	MOW, GIST intro, GTM		1		
3	27-Jan	Applied Modeling In GIS	Notes, GTM, Lpy		2	2	
4	3-Feb	Programming Basics	Notes, GTM, Lpy	Model-builder and Geo-processing	3		
5	10-Feb				4		
6	18-Feb**	Object-Oriented Programming	Notes, GTM, Lpy. PSA	Building Blocks of Application Development and GIS Customization	5		Individual Meetings
7	24-Feb		GTM, PSA		6		Proposal
8	3-Mar	Computing with Data	Notes, papers, PSA		7	3	
9	10-Mar	Programming for GIS	Notes, PSA	Bending and Extending a GIS to Meet Your Needs	8		
	17-Mar	*Spring recess (17-22)*					
10	24-Mar	GIS Automation and Customization	Notes		9		
11	31-Mar	GIS Extensions	Notes	Bending and Extending a GIS to Meet Your Needs	10		
12	7-Apr	Consuming and Distributing Code	Notes		11		Individual Progress Meetings
13	14-Apr	Consuming and Distributing Code	Notes		12		
14	21-Apr	Principles and Practices of Software Development	Notes	Working Smarter, not Harder			
15	28-Apr	Future of GIS Programming	Notes			4	
***	5-May	Final Projects and Presentations					Final Projects Presentations
****	12-May	Final Projects & Wrap-up	Notes			5	Installable and Final Report
****	14-May	End of Term					

*Monday January 20 is Martin Luther King Day, USC Holiday
**Monday February 17 is President's Day, USC Holiday
***May 3-6 listed as "Study Days" on USC calendar – No assignments or presentations due on these dates / 4 days, in order to follow the university policy
****May 7-14 – listed as "Final Exams" on USC calendar