SSCI 586, GIS Programming and Customization

Syllabus

Units: 4

Term Day Time: Fall 2022, M and W 1:00 pm-2:50 am PT

Location: AHF 145A and DENDornsife

Instructor: Jennifer N Swift, Ph.D. GISP
Office: AHF B57D
Regular Office Hours: T 11:00 am-12:00 pm and
Th 1-2:00 pm PT. Also available most days and times by
appointment via email.
Contact Info: jswift@usc.edu, 213-740-5841 (office),
see contact page on D2L for Zoom Room

Library Help: Andy Rutkowski
Office: LIPA B40-A
Office Hours: Thu 10am - 12 pm or by appointment.
Contact Info: arutkows@usc.edu

IT Help: Dornsife Technology Services
Office Hours: SHS 260
Contact Info: spatial_support@usc.edu,213-740-2775

Course Scope and Purpose

Spatial programming skills are now an essential part of the GIS professional's portfolio. Learning to program facilitates an understanding of one's use of geospatial technologies as well as how to interact with others who use geospatial software. Familiarity with a spatial programming language and how it is implemented also provides deeper insight into how other programmers create and use these tools. The goal of this course is to help students become comfortable with coding and to develop and document novel geospatial tools that can be readily shared with others.

This course will use modern software tools and information to build and implement customized GIS mapping applications and geoprocessing functions. The students taking this course will have varying levels of prior programming experience and may be new to spatial programming and customization. Essential, practical as well as theoretical concepts of spatial analysis and their translation into geospatial software development and object-oriented programming, are covered. In addition, students will learn the Python programming language and its use in developing customized GIS applications directly applicable to one's specific field of interest. Overall, students will gain a deep and solid foundation for interacting with Esri's ArcGIS ecosystem and Jupyter Notebooks.

By both necessity and design, this course serves several different audiences. This course is an elective for the Geographic Information Science & Technology M.S. and Graduate Certificate Programs, the Human Security and Geospatial Intelligence M.S., and the Geospatial Leadership Graduate Certificate Program. This is a required course for the Spatial Data Science M.S. degree.

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 and Notebooks.
- Program small-scale GIS-based models in Python, integrated within ArcGIS and Notebooks.
- Recognize and employ general software engineering concepts and suitable programming methods and practices.
- Critically evaluate different methodologies for developing geospatial applications.

Students may vary in their competency levels on these abilities. You can expect to acquire these abilities only if you honor all course policies, attend classes regularly, complete all assigned work in good faith and on time, and meet all other course expectations of you as a student.

Prerequisite(s): None
Co-Requisite(s): None
Recommended Preparation: SSCI 582: Spatial Databases

Class Conduct

Harassment, sexual misconduct, interpersonal violence, and stalking are not tolerated by the university. All faculty and most staff are considered Responsible Employees by the university and must forward all information they receive about these types of situations to the Title IX Coordinator. The Title IX Coordinator is responsible for assisting students with supportive accommodations, including academic accommodations, as well as investigating these incidents if the reporting student wants an investigation. The Title IX office is also responsible for coordinating supportive measures for transgender and nonbinary students such as faculty notifications, and more. If you need supportive accommodations you may contact the Title IX Coordinator directly (titleix@usc.edu or 213-821-8298) without sharing any personal information with me. If you would like to speak with a confidential counselor, Relationship and Sexual Violence Prevention Services (RSVP) provides 24/7 confidential support for students (213-740-9355 (WELL); press 0 after hours).

COVID-19 policy -- Students are expected to comply with all aspects of USC's COVID-19 policy including, but not limited to, vaccination, indoor mask mandate, and daily TrojanCheck. Failure to do so may result in removal from the class and referral to Student Judicial Affairs and Community Standards. Students are recommended to keep safe physical distancing, whenever possible, to prevent any possible transmission. Please contact your instructor if you have any safety concerns.

Diversity and Inclusion – It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful to everyone, and you are also expected to respect of others regardless of their race, ethnicity, gender identity and expressions, cultural beliefs, religion, sexual orientation, national origin, age, abilities, ideas and perspectives, or socioeconomic status. Your suggestions are encouraged and appreciated. Feel free to let me know ways to improve the effectiveness of the course for you personally or for other students.

Course Structure

The main theoretical concepts are provided through in-class lectures, instructor-guided peer-peer activities and discussions during class meetings, simultaneously conducted online through class meeting links in D2L, and directed reading of the textbooks and supplementary readings. Additional readings will be assigned to expand on the text when needed. The course will generally unfold on a multi-weekly basis. When possible, assignments will be given in advance, but usually they will be posted on or before Mondays.

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 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 all class meetings and presentations.
- An up-to-date web browser to access the Server.

If a student does not have access to any of these, please speak with the instructor at the start of the semester. Also, see the USC ITS Student Toolkit here: https://keepteaching.usc.edu/students/student-toolkit/

Desire2Learn (D2L) – This course will utilize the Desire2Learn (D2L) learning management system which allows students to access course content, upload assignments, participate in discussion forms, among other learning experiences. The D2L platform provides flexibility in the learning experience where students can participate in the course residentially or remotely, synchronously (meeting together at the same time) or asynchronously (accessing videos and course content outside of class).

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

Communications – All assignments given and all materials to be handed in will be submitted via D2L. The instructor will also create and monitor discussion forums through which students can discuss issues and assignments as needed. Students should read all email sent from D2L or from course instructor(s) as soon as possible. Also, students who do not regularly use their USC email accounts should double-check to be sure that mail sent from both the D2L accounts and the instructor's account (noted above) to your USC account is forwarded to an address used regularly and does not go into junk mail. The instructor will endeavor to respond to all email within 24 hours of receipt, aiming for no more than 72 hours delay. In the rare case that an instructor is off-line for an extended periodof time, an announcement

will be posted to the class D2L site. Due to the synchronous and asynchronous nature of this course, it is each student's responsibility to stay informed and connected with others in our course. In addition to email, students are expectedto login to D2L regularly to check for announcements.

Discussion forums – On the D2L 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 publically 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:

- Zandbergen, P. A. 2020a. Python Scripting for ArcGIS Pro (1st Ed.). Redlands, CA: Esri Press.
- Zandbergen, P. A. 2020b. Advanced Python Scripting for ArcGIS Pro (1st Ed.). Redlands, CA: Esri Press.

While you may purchase these books if you wish to own a bound copy, both are available online through the USC Libraries. Sign on to the USC Libraries and search for these titles. Used copies of these books are widely available online, so there is no need to pay the full retail price.

Supplementary readings will be assigned from various sources including:

- Anselin, Luc. 2022. "Pysal and GeoDa Repositories." Accessed August 20, 2022. https://github.com/lanselin.

- Bebortta, Sunjit, Saneev Kumar Das, Meenaskshi Kandpal, Rabindra Kumar Barik, and Harishchandra Dubey. 2020. "Geospatial Serverless Computing: Architectures, Tools and Future Directions." *International Journal of Geo-Information* 9(311): 1-26.

- Boeing, Geoff. 2020. "The right tools for the job: The case for spatial science tool-building." *Transactions in GIS,* 24, 1299-1314.

- Goodchild, Michael F. 2018. "Big Geodata." In *Comprehensive Geographic Information Systems, GIS Methods and Techniques, 1*, 19-25. Editor in Chief B. Huang. Amsterdam, Netherlands: Elsevier.

- Novo, Ana, Noelia Fariñas-Álvarez, Joaquin Martínez-Sánchez, Higinio González-Jorge, and Henrique Lorenzo. 2020. "Automatic Processing of Aerial LiDAR Data to Detect Vegetation Continuity in the Surroundings of Roads." *Remote Sensing* 12(1677): 1-14.

- Reike, Christoph. 2018. "Essential geospatial Python libraries." Accessed March 15, 2021. https://medium.com/@chrieke/essential-geospatial-python-libraries-5d82fcc38731.
- Rey, Sergio J. 2017. "Python for GIS." *The Geographic Information Science & Technology Body of Knowledge, 3rd Quarter 2017 ed*. John P. Wilson (Ed).
- Rey, Sergio J. 2019. "PySAL: the first 10 years." *Spatial Economic Analysis* 14(3): 273-282.
- Ricker, Britta A., Patrick R. Rickles, Gretchen A. Fagg, and Mukey E. Haklay. 2020. "Tool, toolmaker, and scientist: case study experiences using GIS in interdisciplinary research." *Cartography and Geographic Information Science* 47(4): 350-366.
- Shao, Hu, Wenwen Li, Wei Kang, and Sergio J. Rey. 2020. "When Spatial Analytics Meets Cyberinfrastructure: an Interoperable and Replicable Platform for Online Spatial-Statistical-Visual Analytics." *Journal of Geovisualization and Spatial Analysis* 4(17): 1-16.
- Vance, Tiffany C., Micah Wengren, Eugene Burger, Debrah Hernandez, Timothy Kearns, Encarnia Medina-Lopez, Nazila Merati, Kevin O'Brien, Jon O'Neil, James T. Potemra, Richard P. Signell, and Kyle Wilcox. 2019. "From the Oceans to the Cloud: Opportunities and Challenges for Data, Models, Computation and Workflows." *Frontiers in Marine Science* 6:1-18.

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

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

Resume Assignment - 2 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. A second resume assignment provides you a chance to add any newly learned tools and project products in this course to your resume. 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.

Projects - 5 worth a total of 60 points. These assignments require students to complete the basic types of programming projects asked of professional geospatial application developers in real world settings. Prompts will list helpful resources, such as Esri and Python tutorials, for becoming familiar with ways that concepts learned in the course are implemented in

various geospatial software packages. The deliverables will be final written summaries of the students' goals, methods, data, and results for each project.

Python Tutorials – 3 worth a total of 6 points. These assignments help students gain familiarity with the Python programming language and different Python coding environments, which they can then use to program their class projects.

Reading and Research Discussions - 3 worth a total of 12 points. These assignments call on students to critically analyze required readings, identify relevant case studies employing the methodologies and concepts we cover in class, and to discuss them with the instructor and their classmates during synchronous meetings and/or online discussion forums via D2L.

Comprehensive Exam - 1 worth 20 points. The comprehensive exam will cover material learned throughout the duration of the semester. It may be mixed format and may consist of multiple choice, short answer, and simple problem questions.

Grading Breakdown

Assessment	Number	Points Each	Total Points
Resume Assignment	2	1	2
Reading and Research Assignments	3	4	12
Tutorials	3	2	6
Projects	5	12	60
Comprehensive Exam	1	20	20
Total	14		100

Assignment Submission Policy

Unless otherwise noted, assignments must be submitted via D2L by the due dates specified in the Course Schedule below and on the assignment instructions.

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.

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

Week	Topic	Readings and Assignments	Deliverables: Due Dates
Module 1 | Introduction to GIS Customization and Python			
Week 1 8/22	Introduction to GIS Programming and Customization	Resume Assignment Reading & Research Discussion (RRD) 1 Project 1 Rey (2017) Ricker et al. (2020) Zandbergen (2020a), Ch.1-5	Resume Assignment 1: Monday, 8/29 RRD1 Forum Posts: See Prompt Project 1 Workflow: Wednesday, 8/31
Week 2 8/29	Introduction to the Python Language in GIS		
Module 2 | Fundamentals of Programming Python in GIS			
Week 3 9/6 *Monday, 9/5 is university holiday (labor day)	Vector Data Manipulation with Python	Project 2 Python Tutorial 1 Amos (2020) Novo et al. (2019) Zandbergen (2020a), Ch.6-11	Project 1 Report: Tuesday, 9/6 RRD1 Synchronous Discussion: Wednesday, 9/7 Python Tutorial 1: Monday, 9/12 Project 2 Workflow: Wednesday, 9/14
Week 4 9/12	Raster Data Processing Techniques using Python		
Module 3 | Programming Spatial Analysis using Python			
Week 5 9/19	Essential Python Geospatial Libraries	Project 3 Python Tutorial 2 RRD2 Anselin (2021_ Bebortta et al. (2020) Reike (2018) Rey (2019) Vance et al. (2019)	Project 2 Report: Monday, 9/19 RRD2 Forum Posts: See Prompt Python Tutorial 2: Monday, 9/26 Project 3 Workflow: Monday, 10/3 RRD2 Synchronous Discussion: Wednesday, 10/5
Week 6 9/26	Interactive Computational Geospatial Programming		
Week 7 10/3	Cloud-Based Computing Trends in Spatial Computing		
Module 4 | Python Geospatial Modules and Packages			
Week 8* 10/10* *10/13-10/14 is a university holiday	Python Scripting for GIS	Project 4 Python Tutorial 3 Zandbergen (2020b), Ch. 2-7	Project 3 Report: Monday, 10/10

Week	Topic	Readings and Assignments	Deliverables: Due Dates
Week 9 10/17	Integrating Python ArcGIS Packages with Third Party Software		Python Tutorial 3: Monday, 10/17 Project 4 Workflow: Wednesday, 10/26
Week 10 10/24	Expanding on Python Scripting into Web GIS using Notebooks		
Module 5 | Innovative Geospatial Programming			
Week 11 10/31	Open Source VS Commercial Spatial Programming Tools	Project 5 RRD3 Boeing (2020) Enescu et al. (2019) Goodchild (2018) Shao et al. (2020) Zandbergen (2020b) Ch. 9	Project 4 Report: Monday, 10/31 RRD3 Forum Posts: See Prompt Project 5 Workflow: Monday, 11/21 Project 5 Report: Monday, 11/28 Resume Assignment 2: Wednesday, 11/30 RRD3 Synchronous Discussion: Wednesday, 11/30 All assignments must be submitted no later than 5:00 PM PT on 12/2
Week 12 11/7	Real-Time Spatial Data Access and Manipulation		
Week 13 11/14	Big Spatial Data in an IoT Era		
Week 14 11/21 *11/23-11/24 is a university holiday (Thanksgiving)	Future of Spatial Programming and Customization, Work on Project 5		
Week 15 11/28 Friday, 12/2 is the last day of class, 12/3-12/6 study days	Resume Workshop & Comprehensive Exam Review		
Final Exams 12/7-12/14	Comprehensive Exam		Wednesday, December 14, 11:00 AM – 1:00 PM 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 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 Research and Scholarship Misconduct.

Students and Disability Accommodations

USC welcomes students with disabilities into all of the University's educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu

Support Systems

Counseling and Mental Health - (213) 740-9355 – 24/7 on call
studenthealth.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
suicidepreventionlifeline.org
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) 740-9355(WELL), press "0" after hours – 24/7 on call
studenthealth.usc.edu/sexual-assault
Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) - (213) 740-5086
eeotix.usc.edu
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298
usc-advocate.symplicity.com/care_report
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS) - (213) 740-0776
osas.usc.edu
OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

USC Campus Support and Intervention - (213) 821-4710
campussupport.usc.edu
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity, Equity, and Inclusion - (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
Emergency assistance and avenue to report a crime. Latest updates regarding safety, 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.

Office of the Ombuds - (213) 821-9556 (UPC) / (323-442-0382 (HSC)
ombuds.usc.edu
A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

*Occupational Therapy Faculty Practice - (323) 442-33*40 or otfp@med.usc.edu
chan.usc.edu/otfp
Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.

Resources for Online Students

The Course D2L 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.