SSCI 586, GIS Programming and Customization

Syllabus

Units: 4

Term Day Time: Spring 2021, Online
Lecture: Mondays and Wednesdays, 12:00 pm-1:50 pm PT

Location: Hybrid and Online. USC Zoom Meeting link accessible via course Blackboard.

Instructor: Jennifer N Swift, Ph.D. GISP
Office: AHF B57D
Regular Office Hours: Mon and Wed 5:00-6:00 pm PT. Also available most days and times by appointment via email.
Contact Info: jswift@usc.edu
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Library Help: Andy Rutkowski
Office: VKC 36B
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IT Help: Richard Tsung
Office: AHF 145D
Office Hours: By appointment
Contact Info: spatial_support@usc.edu

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 thoroughly 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 good programming methods and practices.
- Critically evaluate different methodologies for developing geospatial applications.

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).

Course Structure

The main theoretical concepts are provided through a 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 biweekly 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 use whenever a presentation or meeting is scheduled.
- An up-to-date web browser to access the 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, 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:

- 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.

Supplementary readings will be assigned from various sources including but not limited to:

- Anselin, L. 2020. Pysal and GeoDa Repositories. (available at https://github.com/lanselin).
- Bebortta, S., Das, S.K., Kandpal, M., Barik, R.K., & Dubey, H. 2020. Geospatial Serverless Computing: Architectures, Tools and Future Directions. *International Journal of Geo-Information,* 9(311), pp.1-26
- Goodchild, M.F. (2018) Big Geodata. In B. Huang (Ed.-in-Chief), *Comprehensive Geographic Information Systems,* pp. 1-4. GIS Methods and Techniques, 1. Amsterdam, Netherlands: Elsevier.
- Novo, A., Fariñas-Álvarez, N., Martínez-Sánchez, J., González-Jorge, H., & Lorenzo, H. 2020. Automatic Processing of Aerial LiDAR Data to Detect Vegetation Continuity in the Surroundings of Roads. *Remote Sensing*, *12*(1677), 1-14.
- Reike, C. (2018). Essential geospatial Python libraries (available at https://medium.com/@chrieke/essential-geospatial-python-libraries-5d82fcc38731).
- Rey, S.J. 2017. Python for GIS. *The Geographic Information Science & Technology Body of Knowledge,* (3rd Quarter 2017 Edition). J.P. Wilson (Ed).

- Rey, S.J. 2019. PySAL: the first 10 years. *Spatial Economic Analysis,* 14:3, pp.273-282, DOI: 10.1080/17421772.2019.1593495

- Ricker, B.A., Rickles, P.R., Fagg G.A., & Haklay, M.E. 2020. Tool, toolmaker, and scientist: case study experiences using GIS in interdisciplinary research. *Cartography and Geographic Information Science,* 47(4), pp.350-366.

- Shao, H., Li, W., Kang, W., & Rey, S. 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), pp.1-16. https://doi.org/10.1007/s41651-020-00056-5.

- Vance, T.C., Wengren, M., Burger, E., Hernandez, D., Kearns, T., Medina-Lopez, E., Merati, N., O'Brien, K., O'Neil, J., Potemra, J.T., Signell, R.P., & Wilcox, K. 2019. From the Oceans to the Cloud: Opportunities and Challenges for Data, Models, Computation and Workflows. *Frontiers in Marine Science,* 6, pp.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

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.

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 identify relevant research case studies employing the methodologies and concepts we cover in class and to discuss them with the instructor and their classmates during course meetings and in online discussion forums.

Final Exam - 1 worth 20 points. The final exam will cover material learned throughout the duration of the semester. It will include 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
Final Exam	1	20	20
Total	14		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.

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

Week	Topic	Readings and Assignments	Deliverables: Due Dates
Module 1 | Introduction to GIS Customization and Python			
Week 1* 1/18 *Monday, 1/18 is university holiday	What is GIS Programming and Customization?	Resume Assignment Reading & Research Discussion (RRD) 1 Project 1 Rey 2017 Ricker et al. 2020 Zandbergen 2020a, Chs.1-5	No deliverables.
Week 2 1/25	Introduction to Programming and the Python Language in GIS		Resume Assignment 1: Monday, 1/25
Module 2 | Fundamentals of Programming Python in GIS			
Week 3 2/1	Vector Data Manipulation with Python	Project 2 Python Tutorial 1 Amos 2020 Novo et al. 2020 Zandbergen 2020a, Chs.6-11	Project 1: Monday, 2/1
Week 4 2/8	Raster Data Processing Techniques using Python		RRD1: Monday, 2/8
Module 3 | Programming Spatial Analysis using Python			
Week 5* 2/15 *Monday, 2/15 is university holiday	Essential Python Geospatial Libraries	Project 3 Python Tutorial 2 RRD2 Anselin 2020 Bebortta et al. 2020 Reike 2018 Rey 2019 Vance et al. 2019	Project 2: Tuesday, 2/16*
Week 6 2/22	Interactive Computational Geospatial Programming		Python Tutorial 1: Monday, 2/22
Week 7 3/1	Cloud-Based Computing Trends in Spatial Computing		Python Tutorial 2: Monday, 3/1
Module 4 | Python Geospatial Modules and Packages			
Week 8* 3/8 *Friday, 3/12 is a wellness day	Python Scripting for GIS	Project 4 Python Tutorial 3 Zandbergen 2020b, Chs.2-7	Project 3: Monday, 3/8
Week 9 3/15	Integrating Python ArcGIS Packages with Third Party Software		RRD 2: Monday, 3/15

Week	Topic	Readings and Assignments	Deliverables: Due Dates
Week 10* 3/22 ***Tuesday, 3/23 is a wellness day**	Expanding on Python Scripting into Web GIS using Notebooks		No deliverables.
Module 5 | Innovative Geospatial Programming			
Week 11 3/29	Open Source VS Commercial Spatial Programming Tools	Project 5 RRD3 Enescu et al. 2019 Goodchild 2018 Shao, Li, Kang & Rey 2020 Zandbergen 2020b, Ch. 9	Project 4: Monday, 3/29
Week 12* 4/5 *Wednesday, 4/7 is a wellness day	Real-Time Spatial Data Access and Manipulation		Python Tutorial 3: Monday, 4/5
Week 13 4/12	Big Spatial Data in an IoT Era		RRD3: Monday, 4/12
Week 14* 4/19 *Thursday, 4/22 is a wellness day	Future of Spatial Programming and Customization		Resume Assignment 2: Monday, 4/19
Week 15* 4/26 *Thursday, 4/29 is the last day of classes *Friday, 4/30 is a wellness day	Final Exam Review		Project 5: Monday, 4/26 All assignments must be submitted no later than 5:00 PM PT on 4/29
Exam Week 5/5-12	**Final Exam** Students complete an asynchronous Final Exam.		Friday, May 7, 11 a.m.-1 p.m.

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

Counseling and Mental Health– (213) 740-9355 – 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
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 of Equity and Diversity (OED) – (213) 740-5086 |Title IX Compliance – (213) 821-8298
equity.usc.edu, titleix.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 of Equity and Diversity | Title IX for appropriate investigation, supportive measures, 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.

USC Campus Support and Intervention – (213) 821-4710
uscsa.usc.edu
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
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.

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.