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

SSCI 580, Spatial Computing

Syllabus

Units: 4

Term — Day — Time: Fall 2018, Tuesdays and Thursdays, 9:00 a.m. to 10:50 a.m.

Location: AHF 145D

Instructor: Andrew J. Marx, Ph.D
Office: AHF B55
Regular Office Hours: Tuesdays and Thursdays 8-9 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, http://bit.ly/andyhangout

IT Help: Richard Tsung
Office: AHF 145D
Office Hours: By appointment
Contact Info: ctsung@usc.edu, 213-821-4415 (office)

Course Scope and Purpose

Spatial computing is a set of ideas and technologies that will transform our lives by enhancing our understanding of the physical world, knowing and communicating our relation to places in that world, and navigating through those places. It draws upon engineering, computer science, math, and spatial thinking to solve data-intensive, large-scale, and location-based problems. This class will cover the concepts, theory, methods, techniques, and programming for spatial computing. This includes the latest research in a variety of topics that are central to spatial computing, including geospatial mashups, cyberGIS and cloud GIS, spatial data Mining, essential python geospatial libraries, volunteered geographic information (VGI) and big data, geocoding and the geospatial semantic web. Students will also gain a deep understanding and hands-on software experience, including ArcGIS Desktop, Google Map and Google Earth, SPARQL, and CyberGIS applications.

As an example of a typical lab in class, students will install and use an advanced Python Geospatial library - GeoPandas and all its dependencies. They will download European land use and land cover data for large urban zones from the Urban Atlas website. They will use GeoPandas to do spatial operations based on geometric types, such as re-projecting and making choropleth maps of density of the urban fabric, querying the centroid and distance between an airport and a neighborhood, creating a buffer around green urban areas, and selecting cities that all connect to the same railway. With GeoPandas, students can easily do operations for Big Spatial Data in Python that would otherwise be too time-consuming for ArcGIS Desktop or require a spatial database such as PostGIS.

In this way, students will learn how to collect, analyze, and visualize large-scale spatial datasets while avoiding common pitfalls and building better data-intensive applications and location-aware technologies. Students will also gain a deep understanding about related fundamental research questions in individual disciplines and cross-cutting research questions requiring novel, multi-disciplinary solutions.

This is a required course for the M.S. in Spatial Data Science program.

Learning Outcomes

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

- Discuss the relevant web-based geographic information systems and techniques for working with geospatial data;
- Empower high-performance and scalable cyberGIS by exploiting spatial characteristics of data and analytical operations for achieving unprecedented capabilities for geospatial scientific discoveries;
- Build and use cloud services that combine geographic data, application, software, or platform as open source solutions for spatial issues.
- Apply relevant spatial data mining techniques to solve a variety of spatial problems;
- Select and use external Python geospatial libraries to solve real-world problems with greater flexibility;

- Discuss volunteered geographic information and how it relates to big geospatial data and GIS design;
- Exploit methods to geocode text data;
- Discuss how semantic web technology fits into the present and future evolution of GIS, and how it differs from existing data-sharing technologies, such as relational databases and the current state of the World Wide Web.

Prerequisite(s): None
Co-Requisite(s): None
Recommended Preparation: SSCI 581: Concepts for Spatial Thinking

Course Structure

This residential course will unfold on a weekly basis. Each week will be focused on a particular aspect of Spatial Computing, delivered through lectures, reading assignments, class participation, and hands-on computer lab assignments. In addition to the assigned readings, students will receive an extensive list of Supplementary Readings. Students are encouraged to bring questions and problems to class to be explored in that congenial setting. The aim is to encourage deep-learning by active participation. In this class the labs are designed to give students first-hand experience with the wide variety of software and programming packages that can be used for spatial computing. At the end of this semester, students will complete a final project including a 20-minute presentation, a poster, and a report (double-spaced, 12-point font, and no more than 8 pages in length).

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 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.
- 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 packages. 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@dornsife.usc.edu (note underscore), making sure to copy (cc) me on the email.

Discussion forums – On the Blackboard site, I will post weekly discussion threads relevant to the reading and hands-on assignments of the course. Discussions provide a key means for student-to-student discussion and collaboration. Students will post review reports related to the reading assignments and make comments on each other's review reports. Students can also provide support to each other while working on assignments, sharing hints and helpful tips. I monitor the discussion threads and will offer comments when appropriate, but more

importantly, consider the discussion board a key way to connect with your classmates and share your discoveries.

Required Readings and Supplementary Materials

A mixture of readings from academic journals, professional reports and authoritative websites will be provided for this course. The following readings are required and are listed in course order. **All readings listed in the syllabus are available in the weekly folders on the course Blackboard:**

- Batty, Michael, Andrew Hudson-Smith, Richard Milton, Andrew Crooks. 2010. Map mashups, Web 2.0 and the GIS revolution. *Annals of GIS* 16(1): 1-13.
- Li, Songnian, and Jiansheng Gong. "Mashup: A new way of providing web mapping/GIS services." *ISPRS Congress Beijing.* 2008.
- Liu, Sophia B., and Leysia Palen. "The new cartographers: Crisis map mashups and the emergence of neogeographic practice." *Cartography and Geographic Information Science* 37(1) (2010): 69-90.
- Heipke, Christian. "Crowdsourcing geospatial data." *ISPRS Journal of Photogrammetry and Remote Sensing* 65(6) (2010): 550-557.
- Yang, Chaowei, Robert Raskin, Michael Goodchild, & Mark Gahegan. "Geospatial cyberinfrastructure: past, present and future." *Computers, Environment and Urban Systems,* 34(4) (2010): 264-277.
- Wang, Shaowen. "A CyberGIS framework for the synthesis of cyberinfrastructure, GIS, and spatial analysis." *Annals of the Association of American Geographers,* 100(3) (2010): 535-557.
- Evans, Michael R., Dev Oliver, KwangSoo Yang, Xun Zhou, & Shashi Shekhar. "Enabling spatial big data via CyberGIS: Challenges and opportunities." *CyberGIS: Fostering a New Wave of Geospatial Innovation and Discovery. Springer Book* (2013).
- Padmanabhan, Anand, et al. "FluMapper: A cyberGIS application for interactive analysis of massive location-based social media." *Concurrency and Computation: Practice and Experience* 26.13 (2014): 2253-2265.
- Li, Wenwen, et al. "A geospatial cyberinfrastructure for urban economic analysis and spatial decision-making." *ISPRS International Journal of Geo-Information* 2.2 (2013): 413-431.
- Armstrong, Marc P., Timothy L. Nyerges, Shaowen Wang, & Dawn Wright. "Connecting geospatial information to society through cyberinfrastructure." *The SAGE Handbook of GIS and Society. London, Sage Publications* (2011): 109-22.
- Yang, Chaowei, Michael Goodchild, Qunying Huang, Doug Nebert, Robert Raskin, Yan Xu, Myra Bambacus, & Daniel Fay. "Spatial cloud computing: how can the geospatial

sciences use and help shape cloud computing?" *International Journal of Digital Earth,* 4(4) (2011): 305-329.

- Zhang, Qi, Lu Cheng, & Raouf Boutaba. "Cloud computing: state-of-the-art and research challenges." *Journal of Internet Services and Applications,* 1(1) (2010): 7-18.
- Yang, Chaowei, and R. Raskin. "Introduction to distributed geographic information processing research." *International Journal of Geographical Information* Science, 23(5) (2009): 553-560.
- Li, Qing-quan, Tong Zhang, and Yang Yu. "Using cloud computing to process intensive floating car data for urban traffic surveillance." *International Journal of Geographical Information Science* 25.8 (2011): 1303-1322.
- Shekhar, Shashi, and Sanjay Chawla. *Spatial Databases: A Tour*. Upper Saddle River, NJ: Prentice Hall, 2003.
- PySAL Developers. PySAL Online Tutorial. Retrieved from http://pysal.readthedocs.io/en/latest/users/tutorials/intro.html, 2014.
- GeoPandas Developers. GeoPandas Online Tutorial. Retrieved from http://geopandas.org/index.html, 2016.
- Sui, Daniel, and Michael Goodchild. "The convergence of GIS and social media: challenges for GIScience." *International Journal of Geographical Information Science,* 25(11) (2011): 1737-1748.
- Sui, D. "Volunteered geographic information: A tetradic analysis using McLuhan's law of the media." *Proceedings of the Workshop on Volunteered Geographic Information*, Santa Barbara, CA, USA, 2007.
- Goodchild, Michael F., and Linna Li. "Assuring the quality of volunteered geographic information." *Spatial Statistics* 1 (2012): 110-120.
- Elwood, Sarah, Michael F. Goodchild, and Daniel Z. Sui. "Researching volunteered geographic information: Spatial data, geographic research, and new social practice." *Annals of the Association of American Geographers* 102(3) (2012): 571-590.
- Jacquez, Geoffrey M. "A research agenda: does geocoding positional error matter in health GIS studies?" *Spatial and Spatio-Temporal Epidemiology* 3.1 (2012): 7-16.
- Krieger, Nancy. "Place, space, and health: GIS and epidemiology." *Epidemiology* 14.4 (2003): 384-385.
- Ward, Mary H., John R. Nuckols, James Giglierano, Matthew R. Bonner, Calvin Wolter, Matthew Airola, Wende Mix, Joanne S. Colt, and Patricia Hartge. "Positional accuracy of two methods of geocoding." *Epidemiology* 16, no. 4 (2005): 542-547.
- Goldberg, Daniel W., & Myles G. Cockburn. "Improving geocode accuracy with candidate selection criteria". *Transactions in GIS,* 14(S1) (2010): 149-176.
- Fonseca, Frederico. "Geospatial semantic web." *Encyclopedia of GIS*. Springer US

(2008), 388-391.

- Lowe, Jonathan. "A Geospatial Semantic Web." *Geospatial Solutions* 15.6 (2005).
- Kuhn, Werner. “Geospatial semantics: why, of what, and how?” *Journal on Data Semantics III* (pp. 1-24). Berlin, Germany, Springer-Verlag Lecture Notes in Computer Science Vol. 3534 (2005).
- Patel, Nirav N., Emanuele Angiuli, Paolo Gamba, Andrea Gaughan, Gianni Lisini, Forrest R. Stevens, Andrew J. Tatem, and Giovanna Trianni. "Multitemporal settlement and population mapping from Landsat using Google Earth Engine." *International Journal of Applied Earth Observation and Geoinformation* 35 (2015): 199-208.
- Vernon, et al. "Unlocking the potential of Google Earth as a tool in invasion science." *Biological invasions* 16.3 (2014): 513-534.

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 point. 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 Responses - 13 worth a total of 26 points. Before the first class each week, students will do the assigned readings and post a response to them on Blackboard. The posting should be less than 200 words and informally discuss what you found interesting in that reading. It may include what you agree/disagree with, what critiques you have, or links to other relevant materials (websites, videos, etc.).

Lead Class Discussion – 4 worth a total of 8 points. Each student will be responsible for leading four class discussions on the assigned readings. They will do four separate 30-min presentations about the assigned readings and prepare 2-3 questions to lead a 15-min discussion.

Lab Assignments –12 worth a total of 36 points. Students will be assigned 12 “hands-on” lab assignments during the entire semester.

Final Project

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 project using spatial computing. The four project components will be due at different times during the semester 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 - 2 points. A brief description of the spatial question(s) you would like to ask or the spatial problem you want to solve and how you plan to solve it.

Project Presentation - 10 points. A presentation of your final project made in class, open to all students. I will give comments and suggestions directly after your presentation. Then, other students will ask questions or make comments on your project.

Project Report - 10 points. A written report of your final project (double-spaced, 12-point font) no more than 8 pages in length on your project methodology and outcomes.

Poster - 6 points. An academic poster of your final project that shows the introduction, background, methods, results, conclusions, discussion, and references. You will share the electronic version of it with the whole class on Bb and provide some comments about the scientific design of your academic poster.

Grading Breakdown

Assignment	Number	Points Each	Total Points
Weekly Assignments			
Resume Assignment	1	2	2
Lead Class Discussion	4	2	8
Reading Responses	13	2	26
Lab Assignments	12	3	36
Final Project Components			
Proposal	1	2	2
Poster and Comments	1	6	6
Presentation	1	10	10
Report	1	10	10
Total	34		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.

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	Deliverables/Due Dates
Week 1 8/20	Online GIS and Geospatial Mashups	SSCI 580 Syllabus Batty (2010) Li (2010) Liu (2008)	Week 1 Reading Response: 8/23 Resume Assignment: 8/30 Lab Assignment #1: 8/28
Week 2 8/27	Cyberinfrastructure and CyberGIS (I)	Heipke (2010) Yang (2010) Wang (2010) Evans (2014)	Week 2 Reading Response: 8/28 Week 2 Lab Assignment: 9/4
Week 3 9/4* *9/3 is a university holiday	Cyberinfrastructure and Cyber GIS (II)	Padmanabhan (2014) Li (2013) Armstrong (2011)	Week 3 Reading Response: 9/4 Week 3 Lab Assignment: 9/11
Week 4 9/10	Spatial Cloud Computing (I)	Zang (2010) Yang (2011)	Week 4 Reading Response: 9/11 Week 4 Lab Assignment: 9/18
Week 5 9/17	Spatial Cloud Computing (II)	Yang (2009) Li (2011)	Week 5 Reading Response: 9/18 Week 5 Lab Assignment: 9/25
Week 6 9/24	Spatial Data Mining (I)	Shekhar Ch. 7 (2002), pg 1-26	Week 6 Reading Response: 9/25 Week 6 Lab Assignment: 10/2
Week 7 10/1	Spatial Data Mining (II)	Shekhar Ch. 7 (2002), pg 27-48	Week 7 Reading Response: 10/2 Week 7 Lab Assignment: 10/9
Week 8 10/8	Introduction to Essential Python Geospatial Libraries (I)	GeoPandas Developers (2016)	Week 8 Reading Response: 10/9 Project Proposal: 10/11 Week 8 Lab Assignment: 10/16
Week 9 10/15	Introduction to Essential Python Geospatial Libraries (II)	PySAL Developers (2016)	Week 9 Reading Response: 10/16 Week 9 Lab Assignment: 10/23
Week 10 10/22	Volunteered Geographic Information and Big Data	Sui (2011) Sui (2007) Goodchild (2012) Elwood 2012	Week 10 Reading Response: 10/23 Week 10 Lab Assignment: 10/30
Week 11 10/29	Geocoding and Linking Text to Location	Jacquez (2012) Krieger (2003) Giglierano (2005)	Week 11 Reading Response: 10/30 Week 11 Lab Assignment: 11/6

Week 12 11/5	Geospatial Semantic Web and Spatial Data Reasoning	Fonseca (2011) Lowe (2005) Kuhn (2005)	Week 12 Reading Response: 11/6
Week 13 11/12	Google Earth Engine	Patel (2014) Vernon (2014)	Week 13 Reading Response: 11/13 Week 13 Lab Assignment: 1/20
Week 14 11/19* *11/21-11/25 is a university holiday	Final Project Work	Final Poster and Report Examples	
Week 15 11/26	Final Project	Project Poster Project Slides Project Presentation	Final Project Poster, Presentation and Slides: 11/29
Final Project	Final Class Wrap-Up	Project Report	Final Report: 12/6

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
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. engemannshc.usc.edu/counseling

National Suicide Prevention Lifeline – 1 (800) 273-8255
Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. www.suicidepreventionlifeline.org

Relationship and Sexual Violence Prevention Services (RSVP) – (213) 740-4900 – 24/7 on call
Free and confidential therapy services, workshops, and training for situations related to gender-based harm. engemannshc.usc.edu/rsvp

Sexual Assault Resource Center
For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: sarc.usc.edu

Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086
Works with faculty, staff, visitors, applicants, and students around issues of protected class. equity.usc.edu

Bias Assessment Response and Support
Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. studentaffairs.usc.edu/bias-assessment-response-support

The Office of Disability Services and Programs
Provides certification for students with disabilities and helps arrange relevant accommodations. dsp.usc.edu

Student Support and Advocacy – (213) 821-4710
Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. studentaffairs.usc.edu/ssa

Diversity at USC
Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. diversity.usc.edu

USC Emergency Information
Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible. emergency.usc.edu

USC Department of Public Safety – UPC: (213) 740-4321 – HSC: (323) 442-1000 – 24-hour emergency or to report a crime.
Provides overall safety to USC community. dps.usc.edu

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. This includes instructional videos, remote access to university resources, and other key contact information for distance students.