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

SSCI 580 (35890), Spatial Computing

Syllabus

Units: 4

Term — Day — Time: Fall, 2017, Tue and Thu, 9:00 - 10:50 PT

Location: AHF 145D

Instructor: Andrew J. Marx, Ph.D
Office: AHF B55
Regular Office Hours: Tue and Thur 8-9 am PT; also available most days and times by appointment via email.

Contact Info: marxa@usc.edu, 213-740-2835, https://bluejeans.com/marxa

Library Help: Sherry Mosley
Office: VKC B40C
Office Hours: By appointment
Contact Info: smosley@usc.edu, 213-740-8810 (office)

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, Cyber GIS 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. Students will learn how to collect, transform, analyze, and visualize your own spatial datasets while avoiding common pitfalls and building better location-aware technologies.

For example, in one of the labs, 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 Urlan 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 intersecting cities with the same railway. With GeoPandas, students can easily do operations for Big Spatial Data in Python that would otherwise 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 the 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 Informatics Program.

Learning Outcomes

On completion of this course, students will 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;
- Recognize 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
Concurrent Enrollment: 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) no more than 8 pages in length.

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. 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 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

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 reading listed in the syllabus are available in the weekly folders on the course Blackboard.**

1. Michael Batty, Andrew Hudson-Smith, Richard Milton & Andrew Crooks. “Map mashups, Web 2.0 and the GIS revolution.” *Annals of GIS*, 16:1 (2010): 1-13.
2. Li, Songnian, and Jiansheng Gong. "Mashup: A new way of providing web mapping/GIS services." *ISPRS Congress Beijing.* 2008.
3. 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.
4. Heipke, Christian. “Crowdsourcing geospatial data.” *ISPRS Journal of Photogrammetry and Remote Sensing,* 65(6) (2010): 550-557.
5. Yang, Chaowei, Robert Raskin, Michael Goodchild, & Mark Gahegan. “Geospatial cyberinfrastructure: past, present and future.” *Computers, Environment and Urban Systems,* 34(4) (2010): 264-277.
6. 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.
7. 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).
8. 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.
9. 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.
10. 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.
11. 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.

12. 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.

13. Yang, Chaowei., and R. Raskin. "Introduction to distributed geographic information processing research." *International Journal of Geographical Information* Science, 23(5) (2009): 553-560.

14. 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.

15. Shekhar, Shashi, & Sanjay Chawla. *Spatial Databases: A Tour*. Upper Saddle River, NJ: Prentice Hall, 2003.

16. PySAL Developers. PySAL Online Tutorial. Retrieved from http://pysal.readthedocs.io/en/latest/users/tutorials/intro.html, 2014.

17. GeoPandas Developers. GeoPandas Online Tutorial. Retrieved from http://geopandas.org/index.html, 2016.

18. Sui, Daniel, & Michael Goodchild. “The convergence of GIS and social media: challenges for GIScience.” *International Journal of Geographical Information Science,* 25(11) (2011): 1737-1748.

19. 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.

20. Goodchild, Michael F., and Linna Li. "Assuring the quality of volunteered geographic information." *Spatial Statistics* 1 (2012): 110-120.

21. 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.

22. 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.

23. Krieger, Nancy. "Place, space, and health: GIS and epidemiology." *Epidemiology* 14.4 (2003): 384-385.

24. 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.

25. Goldberg, Daniel W., & Myles G. Cockburn. “Improving geocode accuracy with candidate selection criteria”. *Transactions in GIS,* 14(S1) (2010): 149-176.

26. Fonseca, Frederico. "Geospatial semantic web." *Encyclopedia of GIS*. Springer US (2008), 388-391.

27. Lowe, Jonathan. "A Geospatial Semantic Web." *Geospatial Solutions* 15.6 (2005).

28. 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).

Description and Assessment of Assignments *Weekly Assignments*

Your grade in this class will be determined on the basis of several different assessment tools. These are described in the Weekly Folders on Blackboard. Due dates are shown in the summary that follows.

Resume Assignment – 1 worth 1 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 – 2 worth a total of 8 points. Each student will be responsible for leading two class discussions on the assigned readings. They will do two separate 30-min presentations about the assigned readings and prepare 2-3 questions to lead a 15-min discussion.

Lab Assignments – 11 worth a total of 33 points. Students will be assigned 11 “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 spatial computing project. 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 to 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 - 10 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 make some comments about the scientific design of your academic posters too.

Grading Breakdown

Assignment	Number	Points Each	Total Points
Weekly Assignments			
Resume Assignment	1	1	1
Lead Class Discussion	2	7	8
Reading Responses	13	2	26
Lab Assignments	11	3	33
Final Project Components			
Proposal	1	2	2
Poster and Comments	1	10	10
Presentation	1	10	10
Report	1	10	10
Total			100

Assignment Submission Policy

Assignments will be submitted for grading via Blackboard using the due dates specified in the Course Schedule below.

Students are expected to attend and participate in every class session and to complete and upload all assignments before the deadlines detailed in the Course Schedule. Students can turn in a lab assignment up to seven days late with a 20% penalty.

Schedule

	Topic	Readings	Deliverables / Due Dates
Week 1 8/22	Online GIS and Geospatial Mashups	SSCI 580 Syllabus Batty (2010) Li (2010) Liu (2008)	Week 1 Reading Response: 8/24 Resume Assignment: 8/27 Week 1 Lab Assignment: 8/31
Week 2 8/29	Cyberinfrastructure and CyberGIS (I)	Heipke (2010) Yang (2010) Wang (2010) Evans (2014)	Week 2 Reading Response: 8/29 Week 2 Lab Assignment: 9/7
Week 3 9/5* * Sept.4, university holiday	Cyberinfrastructure and Cyber GIS (II)	Padmanabhan (2014) Li (2013) Armstrong (2011)	Week 3 Reading Response: 9/5 Week 3 Lab Assignment: 9/14
Week 4 9/12	Spatial Cloud Computing (I)	Zang (2010) Yang (2011)	Week 4 Reading Response: 9/12 Week 4 Lab Assignment: 9/21
Week 5 9/19	Spatial Cloud Computing (II)	Yang (2009) Li (2011)	Week 5 Reading Response: 9/19 Week 5 Lab Assignment: 9/28
Week 6 9/26	Spatial Data Mining (I)	Shekhar Ch. 7 (2002), pg 1-26	Week 6 Reading Response: 9/26 Week 6 Lab Assignment: 10/5
Week 7 10/3	Spatial Data Mining (II)	Shekhar Ch. 7 (2002), pg 27-48	Week 7 Reading Response: 10/3 Week 7 Lab Assignment: 10/12
Week 8 10/10	Introduction to Essential Python Geospatial Libraries (I)	GeoPandas Developers (2016)	Week 8 Reading Response: 10/10 Project Proposal: 10/12 Week 8 Lab Assignment: 10/19
Week 9 10/17	Introduction to Essential Python Geospatial Libraries (II)	PySAL Developers (2016)	Week 9 Reading Response: 10/17 Week 9 Lab Assignment: 10/26
Week 10 10/24	Volunteered Geographic Information and Big Data	Sui (2011) Sui (2007) Goodchild (2012) Elwood 2012	Week 10 Reading Response: 10/24 Week 10 Lab Assignment: 11/2

Week 11 10/31	Geocoding and Linking Text to Location	Jacquez (2012) Krieger (2003) Giglierano (2005)	Week 11 Reading Response: 10/31 Week 11 Lab Assignment: 11/9
Week 12 11/7	Geospatial Semantic Web and Spatial Data Reasoning (I)	Fonseca (2011) Lowe (2005) Kuhn (2005)	Week 12 Reading Response: 11/7
Week 13 11/14	Final Project Work Session		Week 13 Reading Response: 11/14
Week 14 11/21* *11/22, 11/23 and 11/24 are university holidays	Holiday Session		
Week 15 11/28	Final Project	Project Poster Project Presentation	Final Project Poster and Presentation: 11/30
Week 16 12/5	Final Project	Project Report	Final Report: No later than 05:00 pm PT on 12/7

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 https://policy.usc.edu/student/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. https://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. http://www.suicidepreventionlifeline.org.

Relationship & 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. https://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: http://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. https://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. https://studentaffairs.usc.edu/bias-assessmentresponse-support/.

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

Diversity at USC – https://diversity.usc.edu/
Tabs for Events, Programs and Training, Task Force (including representatives for each school), Chronology, Participate, Resources for Students.

Resources for Online Students
The Course Blackboard page and the SSI 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.