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

SSCI 680, Spatial Computing

Tentative Syllabus

Units: 4

Term — Day — Time: TBD

Location: AHF B57J

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Course Description
This class will cover the theoretical foundations, methods, techniques, and software systems for spatial computing. This includes the latest research in a variety of topics that are central to spatial computing, including the geospatial semantic web, geospatial linked data, spatial data mining, geocoding, document linking, location-based services, volunteered geographic-information, feature extraction, layer registration and alignment, and geospatial mashups. Students will also gain a deep understanding and hands-on experience in the software for spatial computing, including geographic information systems (e.g. ArcGIS), online GIS (e.g. ArcGIS Online, Bing Maps, Google Earth), semantic web tools, and spatial databases through a combination of homework and projects. Students will learn about the wide variety of geospatial data and services available, including how to find relevant data and transform it as needed so that it can be used for solving specific problems.

Learning Objectives
On completion of this course, students will be able to:

- Describe the theoretical foundations of geospatial data and its various representations.
- Select and use the appropriate geographic information system to solve any of a variety of real-world problems.
- Build integrated applications that combine geographic data and applications for processing that data.
- Understand, create, and apply semantic descriptions of geographic data which can then be used for searching, integrating, and sharing geographic knowledge.
- Discuss the relevant spatial computing systems and techniques for working with geospatial data.
- Apply relevant spatial computing techniques to solve spatial problems.
- Critically evaluate spatial computing software and systems and determine whether they have been applied in appropriate ways.

Prerequisite(s): None
Co-Requisite (s): None
Concurrent Enrollment: None
Recommended Preparation: Enrollment in a USC PhD Program

Course Notes
The course will be taught using a lecture format where the instructor will present the core topics and the students will participate and give lectures on some of the subtopics. There are weekly quizzes to ensure that students keep up with the material and readings. In the first half of the course there are also weekly homework assignments to give students first-hand experience with the wide variety of software and systems that can be used for spatial computing. In the second half of the course, students will form teams and propose and conduct a class project that will give them more depth in one or more course topics

of interest. The class will encourage student participation with ample discussion time for reviewing readings, homework, quizzes, and other course material.

Technological Proficiency and Hardware/Software Required
The mapping software and geospatial data required for course assignments will be accessed using computing resources provided by the Spatial Sciences Institute.

Required Readings and Supplementary Materials

1. Clarke K C (2011) *Getting Started with Geographic Information Systems* (Fifth Edition). Upper Saddle Creek, NJ, Prentice Hall (Chapters 2 and 3)
2. Clemmer G (2013) *The GIS 20 Essential Skills.* Redlands, CA, Esri Press
3. Google (2013) Google Earth Tutorials. WWW document, http://www.google.com/earth/outreach/tutorials/all.html
4. Microsoft (2013) Bing Maps Videos. WWW document, http://www.microsoft.com/maps/developers/videos.aspx
5. Swartz A (2002) The Semantic Web in Breadth. WWW document, http://logicerror.com/semanticWeb-long
6. Palmer S B (2001) The Semantic Web: An Introduction. WWW document, http://infomesh.net/2001/swintro/
7. Fonseca F T (2008) Geospatial semantic web. In Shekhar S and Xiong H (eds) *Encyclopedia of GIS.* Berlin, Springer: 388-391 (follow the "Open URL", read pp. 367-376 in NetLibrary).
8. Egenhofer M J (2002) Toward the semantic geospatial web. In *Proceedings of the Tenth ACM International Symposium on Advances in Geographic Information Systems,* McLean, Virginia: 1-4
9. Kuhn W (2005) Geospatial semantics: Why, of what, and how? In Spaccapietra S and Zimányi E (eds) *Journal on Data Semantics III.* Berlin, Springer-Verlag Lecture Notes in Computer Science Vol. 3534: 1-24
10. Becker C and Bizer C (2009) Exploring the geospatial semantic web with DBpedia Mobile. *Web Semantics: Science, Services and Agents on the World Wide Web* 7: 278-286
11. Koubarakis M, Kyzirakos K, Karpathiotakis M, Nikolaou Ch, Sioutis M, Garbis G, and Bereta K (2012) Introduction in stRDF and stSPARQL. WWW document, http://www.strabon.di.uoa.gr/files/stSPARQL_tutorial.pdf
12. Parundekar R, Knoblock C A, and Ambite J L (2010) Aligning ontologies of geospatial linked data. WWW document, http://www.isi.edu/integration/papers/parundekar10-lstd.pdf
13. Janowicz K, Scheider S, Pehle T, and Hart G (2012) Geospatial semantics and linked spatiotemporal data: Past, present, and future. Semantic Web 3: 321-332 (available at http://www.semantic-web-journal.net/content/geospatial-semantics-and-linked-spatiotemporal-data-–-past-present-and-future)

14. Wong J and Hong J I (2007) *Making Mashups with Marmite: Towards End-User Programming for the Web.* Pittsburgh, PA, Carnegie Mellon University, Human-Computer Interaction Institute Paper No 65 (available at http://repository.cmu.edu/hcii/65)
15. Intel (2012) Mashmaker Intel® Mash Maker: Mashups for the Masses. WWW document, http://software.intel.com/en-us/articles/intel-mash-maker-mashups-for-the-masses
16. Tuchinda R, Szekely P, and Knoblock C A (2008) Building mashups by example. In *Proceedings of the International Conference on Intelligent User Interfaces*, Gran Canaria, Canary Islands, Spain
17. Gupta S and Knoblock C A (2010) Building geospatial mashups to visualize information for crisis management. In *Proceedings of the Seventh International Conference on Information Systems for Crisis Response and Management (ISCRAM 2010),* Seattle, Washington
18. Wang G, Yang S, and Han Y (2009) Mashroom: End-user mashup programming using nested tables. In *Proceedings of the Eighteenth International World Wide Web Conference (WWW 2009),* Madrid, Spain: 861-870
19. Bakshi R, Knoblock C A, and Thakkar S (2004) Exploiting online sources to accurately geocode addresses. In *Proceedings of the Twelfth ACM International Symposium on Advances in Geographic Information Systems,* Washington, DC: 194-203
20. Goldberg D W and Cockburn M G (2010) Improving geocode accuracy with candidate selection criteria. *Transactions in GIS* 14(S1): 129-146
21. Goldberg D W, Wilson J P, and Cockburn M G (2010) Toward quantitative geocode accuracy metrics. In *Proceedings of the Ninth International Symposium on Spatial Accuracy Assessment in Natural Resources and Environmental Sciences,* Leicester, United Kingdom: 329-332
22. Goldberg D W, Knoblock C A, and Wilson J P (2007) From text to geographic coordinates: The current state of geocoding. *Journal of the Urban and Regional Information Systems Association* 19(1): 33-46
23. Zandbergen P A (2008) A comparison of address point, parcel and street geocoding techniques. *Computers, Environment and Urban Systems* 32: 214-232
24. Davis C A Jr, Fonseca F T, and Borges K A V (2003) A flexible addressing system for approximate geocoding. In *Proceedings of the Fifth Brazilian Symposium on GeoInformatics,* Campos do Jordao, Brazil
25. Knoblock C A (2012) Reduce data overload. *Earth Imaging Journal* March/April 2012: 28-30
26. Lieberman M D, Samet H, Sankaranarayanan J, and Sperling J (2007) STEWARD: Architecture of a spatio-textual search engine. In *Proceedings of the Fifteenth ACM*

International Symposium on Advances in Geographic Information Systems, Seattle, Washington: 186-193

27. Amitay E, Har'El N, Sivan R, and Soffer A (2004) Web-a-where: Geotagging Web content. In *Proceedings of Twenty-seventh International Conference of the ACM Special Interest Group on Information Retrieval (ACM SIGIR 2004),* Sheffield, United Kingdom
28. Rauch E, Bukatin M, and Baker K (2003) A confidence-based framework for disambiguating geographic terms. In *Proceedings of the 2003 HLT-NAACL Workshop on Analysis of Geographic References,* Edmonton, Alberta: 50-54
29. McCurley K S (2001) Geospatial mapping and navigation of the Web. In *Proceedings of the Tenth International World Wide Web Conference,* Hong Kong
30. Quercini G, Samet H, Sankaranarayanan J, and Lieberman M D (2010) Determining the spatial reader scopes of news sources using local lexicons. In *Proceedings of the Eighteenth ACM International Conference on Advances in Geographic Information Systems,* San Jose, California: 43-52
31. Lieberman M D, Samet H, and Sankaranarayanan J (2010) Geotagging: Using proximity, sibling, and prominence clues to understand comma groups. In *Proceedings of the Sixth Workshop on Geographic Information Retrieval,* Zurich, Switzerland
32. Güting R H (1994) An introduction to spatial database systems. *VLDB Journal* 3: 357-399
33. BostonGIS (2013) Part 1: Getting Started with PostGIS: An Almost Idiot's Guide (PostGIS 2.0). WWW document, http://www.bostongis.com/?content_name=postgis_tut01#304
34. Chen C-C, Knoblock C A, and Shahabi C (2006) Automatically conflating road vector data with orthoimagery. *GeoInformatica* 10: 495-530
35. Chen C-C, Knoblock C A, and Shahabi C (2008) Automatically and accurately conflating raster maps with orthoimagery. *GeoInformatica* 12: 377-410
36. Wu X, Carceroni R, Fang H, Zelinka S, and Kirmse A (2007) Automatic alignment of large-scale aerial rasters to road-maps. In *Proceedings of the Fifteenth ACM International Symposium on Advances in Geographic Information Systems,* Seattle, Washington: 1–8
37. Zitova B (2003) Image registration methods: A survey. *Image and Vision Computing* 21: 977-1000
38. Chiang Y-Y (2009) Harvesting Geographic Features from Heterogeneous Raster Maps. Unpublished PhD Dissertation, Department of Computer Science, University of Southern California (Chapter 2, pp. 12-57)
39. Li L, Nagy G, Samal A, Seth S C, and Xu Y (2000) Integrated text and line-art extraction from a topographic map. *International Journal of Document Analysis and Recognition* 2: 177-185

40. Kerle N and de Leeuw J (2009) Reviving legacy population maps with object-oriented image processing techniques. *IEEE Transactions on Geoscience and Remote Sensing* 47: 2392-2402
41. Pouderoux J, Gonzato J C, Pereira A, and Guitton P (2007) Toponym recognition in scanned color topo- graphic maps. In *Proceedings of the Ninth International Conference on Document Analysis and Recognition (ICDAR 2007),* Curitiba, Paraná, Brazil: 531-535
42. Leyk S and Boesch R (2010) Colors of the past: color image segmentation in historical topographic maps based on homogeneity. *GeoInformatica* 14: 1-21
43. Shekhar S, Zhang P, Huang Y, and Vatsavai R R (2003) Trends in spatial data mining. In Kargupta H and Joshi A (eds) *Data Mining: Next Generation Challenges and Future Directions.* Cambridge, MA, AAAI/MIT Press: 357-380
44. Gupta S and Knoblock C A (2010) A framework for integrating and reasoning about geospatial data. In *Proceedings of the Sixth International Conference on Geographic Information Science (GIScience 2010)*, Zurich, Switzerland
45. Michalowski M and Knoblock C A (2005) A constraint satisfaction approach to geospatial reasoning. In *Proceedings of the Twentieth National Conference on Artificial Intelligence (AAAI '05)*, Pittsburgh, Pennsylvania
46. O'Brien M A and Irvine J M (2004) Information fusion for feature extraction and the development of geospatial information. In *Proceedings of the Seventh International Conference on Information Fusion,* Stockholm, Sweden
47. Savopol F and Armenakis C (2002) Merging of heterogeneous data for emergency mapping: Data integration or data fusion? *International Archives of Photogrammetry Remote Sensing and Spatial Information Sciences* 34(4/w4): 668-674
48. Jiang B (2012) Volunteered Geographic Information and computational geography: New perspectives. In Sui D, Elwood S, and Goodchild M F (eds) *Crowdsourcing Geographic Knowledge: Volunteered Geographic Information (VGI) in Theory and Practice.* Berlin, Springer: 125-138
49. Goodchild M F and Li L (2012) Assuring the quality of volunteered geographic information. *Spatial Statistics* 1: 110-120
50. Junglas I A and Watson R T 2008 Location-based services. *Communications of the ACM* 51(3): 65-69
51. Dey A K and Abowd G (2000) Towards a better understanding of context and context-awareness. In *Proceedings of the Computer Human Interactions 2000 Workshop on The What, Who, Where, When, and How of Context-Awareness,* The Hague, The Netherlands
52. Myles G, Friday A, and Davies N (2003) Preserving privacy in environments with location-based applications. *Pervasive Computing* 2(1): 56-64

Description and Assessment of Assignments
Students must prepare a lecture, participate in a team project, participate in class discussion, take weekly quizzes, and turn in weekly homework assignments.

Class Participation (10%): As a graduate seminar, participation will be assessed based upon how actively students engage in the course. Students will be required to read all material outlined for each week of the course, and be prepared to contribute substantively in group discussions about the readings in class.

Class Presentation (10%): Students will conduct a seminar on a topic determined in consultation with the instructor. Students will be expected to become an expert on that topic and present a short lecture of 30-45 minutes on the topic.

Quizzes (30%): There will be weekly quizzes on the lectures and readings from the previous week. There is no final, so this is the assessment of how well the students have learned the material.

Homework (20%): Students will be assigned weekly homework during the first half of the course.

Team Project (30%): In the second half of the course, students will work in teams on projects determined in consultation with the instructor. The team will propose their own projects based on the topics covered in class.

Grading Breakdown

Assignment	Points	% of Grade
Class Participation	150	10
Class Presentation	10	10
Quizzes	150	30
Homework	200	20
Team Project	100	30
TOTAL	**610**	**100**

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

Additional Policies
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. No late work is accepted.

Course Schedule: A Weekly Breakdown

	Topics/Daily Activities	Readings and Homework	Deliverables/ Due Dates
Week 1 8/25	**Introduction/Spatial Data Basics:** Brief introductions with a discussion of	Clark (2011)	Group discussion based on reading

	class goals, projects, technology, plans, and expectations. Basics of spatial data, incl. representations of spatial data, coordinate systems, datums, projections, etc.		
Week 2 9/1	**Geographic Information Systems:** Hands-on use of ArcGIS to develop familiarity with the basic capabilities of GIS systems.	Clemmer (2013)	Quiz Assignment 1 Group discussion based on reading
Week 3 9/8	**Online GIS:** A discussion and hands-on training with online GIS software, with a particular focus on Bing Maps and Google Earth.	Microsoft (2013) and Google (2013)	Quiz Assignment 2 Group discussion based on readings
Week 4 9/15	**Geospatial Semantic Web:** Methods for representing and reasoning about geospatial data using the infrastructure of the Semantic Web. Hands-on use of tools for creating and using geospatial semantic data.	Swartz (2002); Palmer (2001); Fonseca (2008); Egenhofer (2002); Kuhn (2005); Becker & Bizer (2009)	Quiz Assignment 3 Group discussion based on readings
Week 5 9/22	**Geospatial Linked Data:** Research and techniques for creating and using geospatial linked data.	Koubarakis et al. (2012); Parundekar et al. (2010); Janowicz et al. (2012)	Quiz Assignment 4 Group discussion based on readings
Week 6 9/29	**Geospatial Mashups:** Introduction to the research, tools, and techniques for building online integrated applications with geospatial data, focusing on the ability to rapidly compose new applications from available sources and services.	Wong & Hong (2007); Intel (2012); Tuchinda et al. (2008); Gupta & Knoblock (2010); Wang et al. (2009)	Quiz Assignment 5 Group discussion based on readings
Week 7 10/6	**Geocoding:** Methods and approaches to linking addresses to location	Bakshi et al. (2004); Goldberg & Cockburn (2010); Goldberg et al. (2007, 2010); Davis et al. (2003); Zandbergen (2008)	Quiz Assignment 6 Group discussion based on readings
Week 8 10/13	**Linking Text to Location:** Methods and approaches for linking textual information to geographic locations.	Knoblock (2012); Lieberman et al. (2007, 2010); Amitay et al. (2004); Rauch et al. (2003); McCurley (2001); Ouercini et al. (2010)	Quiz Group discussion based on readings Identify teams and propose team presentation topics
Week 9	**Spatial Databases and Streaming**	Güting (1994) &	Quiz

10/20	**Spatial Data:** Capabilities of spatial database systems; hands-on use of the Postgres PostGIS spatial database.	BostonGIS (2012)	Group discussion based on readings
Week 10 10/27	**Registering and Aligning Geospatial Layers:** Discussion of techniques for automatically aligning various geospatial layers, including both vector and raster layers.	Chen et al. (2006, 2008); Wu et al. (2007); Zitova (2003)	Quiz Group discussion based on readings
Week 11 11/3	**Extracting Features from Raster Maps:** Methods for extracting features from scanned raster maps.	Chiang (2009); Li et al. (2000); Kerle & de Leeuw (2009); Pouderoux et al. (2007); Leyk & Boesch (2010)	Quiz Group discussion based on readings
Week 12 11/10	**Spatial Data Mining and Reasoning:** Introduction to some techniques for spatial data mining and reasoning.	Shekhar et al. (2003); Gupta & Knoblock (2010); Michalowski & Knoblock (2005); O'Brien & Irvine (2004); Savopol & Armenakis (2002)	Quiz Group discussion based on readings
Week 13 11/17	**Volunteered Geographic Information (VGI):** Recent developments in volunteered geographic information (VGI) including the widely used sources, techniques for crowd-sourcing data, and attempts to evaluate the quality of VGI data.	Jiang (2012); Goodchild & Li (2012)	Quiz Group discussion based on readings
Week 14 11/24	**Location-based Services and Privacy:** Various features of successful modeling applications, including the need for authenticity (i.e., the evaluation of the model relative to the real system), parsimony (i.e., the desirability of keeping things simple and avoiding unnecessary complications), transparency (i.e., the need for clear documentation and user-friendly organization of both the model and the documentation), and patience (i.e., the fact that it takes time to construct and/or implement a model).	Junglas & Watson (2008); Dey & Abowd (2000); Myles et al. (2003)	Quiz Group discussion based on readings
Week 15 12/1	**Final presentations:** Team presentations summarizing		Team presentations

	results and what was learned from the projects.		

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://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions. 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.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the *Office of Equity and Diversity* http://equity.usc.edu or to the *Department of Public Safety* http://capsnet.usc.edu/department/department-public-safety/online-forms/contact-us. This is important for the safety of the whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of another person. *The Center for Women and Men* http://www.usc.edu/student-affairs/cwm/ provides 24/7 confidential support, and the sexual assault resource center webpage http://sarc.usc.edu describes reporting options and other resources.

Support Systems

A number of USC's schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* http://dornsife.usc.edu/ali, which sponsors courses and workshops specifically for international graduate students. *The Office of Disability Services and Programs* http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information http://emergency.usc.edu* will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.