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

SSCI 382L - Principles of Geographic Information Science

Syllabus

Units: 4

Term — Day — Time: Spring, 2018, Lectures: Mon and Wed 2:00-3:20 pm; Labs: Tue 4:00-5:50 pm and Fri 12:00-1:50 pm

Location: Lectures: VKC 261; Labs: AHF 145A

Instructor: Su Jin Lee, PhD, GISP
Office: AHF B55K
Regular Office Hours: Mon 11:00 am-12:00 pm and Tue 2:00-3:00 pm. Also available most days and times by appointment via email.
Contact Info: sujinlee@usc.edu, 213-740-2845

Laboratory Co-Instructor: Lisa Sedano, PhD
Office: AHF B57C
Office Hours: Mon 12:00-1:00 pm and Thur 1:00-2:00 pm. Also available most days and times by appointment via email.
Contact Info: sedano@usc.edu, 213-740-9582

Library Help: Andy Rutkowski
Office: VKC B36B
Office Hours: Tue 10:00 am-12:00 noon and Thur 4:30-5:30 pm
Contact Info: arutkows@usc.edu, 213-740-6390 (office), http://bit.ly/andyhangout

IT Help: Richard Tsung
Office: AHF B57E
Office Hours: By appointment
Contact Info: ctsung@usc.edu, 213-821-4415 (office)

Course Scope and Purpose

The spatial sciences focus on the various ways in which geography can be used to acquire, represent, organize, analyze, model and visualize information. These views of the world are supported by Geographic Information Systems (GISs) and the related geospatial technologies (GPS, remote sensing, etc.) which, in turn, rely on the underlying geographic information science concepts and methods. This much is known from *SSCI 301L: Maps and Spatial Reasoning* and this particular course (the second in a three-course sequence) seeks to elucidate how these systems and the underlying science provide a gateway to the natural and social sciences and problem-solving in general. The next step is to learn spatial analysis in depth, which is the key to successfully solving many of the critical societal and environmental challenges we face in today's ever-changing world.

That said, a large part of this particular course is focused on various kinds of spatial analysis since they constitute the crux of GIS, providing the means of adding value to geographic data obtained from disparate sources and for turning these data into useful and actionable information. Numerous examples will be used throughout the course to illustrate how spatial analysis helps you to understand spatial phenomena through expressions of how the natural world works, and the profound influence we have on our environment. The combination of class and laboratory sessions will show how, for example, effective spatial analysis requires an informed and intelligent user in addition to the appropriate computer hardware and software tools**.**

This course is designed to serve several student audiences given its role as a required course in the B.S. in GeoDesign and Minor in Spatial Sciences, and as an elective in the Human Security and Geospatial Intelligence Minor. Each audience is encouraged to utilize the laboratory experience and research projects to investigate diverse geospatial resources such as spatial databases, spatial analysis, and space-time modeling to advance their own academic and professional goals.

Learning Outcomes

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

- Collect, clean, organize, store, and assess the quality of spatial data acquired from disparate sources;
- Discuss and distinguish the fundamental spatial science concepts in the context of advanced spatial analysis;
- Explain the central role of spatial autocorrelation in spatial analysis and how computational models represent space-time dynamics;
- Conduct spatial analysis utilizing various forms of spatial data and methodologies such as, but not limited to: discrete entities, continuous fields, and grids;
- Perform interpolations using deterministic and geostatistical methods, and ascertain the best approach to solve a given problem;
- Organize, design, and execute a spatial analysis that addresses a particular societal or environment challenge through the application of geographic information science.

Prerequisite(s): SSCI 301L
Co-Requisite(s): None

Course Structure

This is a four-credit course comprised of lectures (two per week) and lab (one per week). The lecture sessions are organized into learning modules that build upon the core principles of geographic information science, spatial analysis and the use of several software systems to explore these topics. The weekly lab meetings and the final project are designed to broaden your practical experience and deepen your understanding of the tools of spatial science inquiry and to enhance your problem-solving skills within the framework of the scientific method. The lecture and lab sessions are designed to complement each other to provide you with sound theoretical reasoning and the technical skills to investigate various physical and social processes. Your weekly laboratory reports will be graded and returned, and the mid-term and final exams will have laboratory components attached to them. **It is required that you register for both the lecture and one laboratory session for this course.**

Please note that all course materials and correspondence will be posted on the course Blackboard website. As a registered student, you will find this course available for you to access at 10:00 am on the first day of classes**.**

Technological Proficiency and Hardware/Software Required

The computational software and geospatial data required for course assignments will be accessed using computing resources provided by the Spatial Sciences Institute.

Required Readings

The required textbook for this course is:

- Burrough, Peter A, Rachael A. McDonnell, and Christopher D. Lloyd 2015. *Principles of Geographic Information Systems*. 3rd ed. New York: Oxford.

The required texts will be supplemented with the following materials:

- de Smith, Michael J, Michael F. Goodchild, and Paul A. Longley. 2015. *Geospatial Analysis*. 5th ed. Winchelsea, UK: The Winchelsea Press. Also at www.spatialanalysisonline.com.
- Aubrya, Thierry, Luis Luis, and Luca A. Dimuccio. 2012. "Nature vs. culture: Present-day spatial distribution and preservation of open-air rock art in the Coa and Douro River Valleys (Portugal)". *Journal of Archaeological Science* 39, no. 4 (April): 848-866.
- Goswami, Rajasmita, Simon H. Brocklehurst, and Neil C. Mitchell. 2012. "Erosion of a tectonically uplifting coastal landscape, NE Sicily, Italy." *Geomorphology* 171-172: 114-126.
- Kang, Bin, Daming He, Lisa Perrett, Hongyuan Wang, Wenxian Hu, Weide Deng, and Yunfei Wu. 2009. "Fish and fisheries in the Upper Mekong: Current assessment of the fish community, threats and conservation." *Reviews in Fish Biology and Fisheries* 19, no. 4 (April): 465-480.

Description and Assessment of Assignments

Your grade in this class will be determined on the basis of several different assessments:

Writing Assignments – 3 worth a total of 15 points. Students will be expected to complete three written assignments focused on assigned readings while including reflections on lecture material and in-class activities.

Laboratory Reports – 10 worth a total of 30 points. This course includes a laboratory meeting each week to develop technical competency with geospatial software platforms and analytic tools. There will be 10 laboratory reports over the course of the semester.

Mid-term Examination – 1 worth 15 points. The mid-term examination will consist of multiple-choice, short answer, and essay questions. Students will be expected to take the exam at the indicated time.

Final Project – 1 worth 20 points. The final project is an individual capstone report and presentation for this course. Students will be expected to draw upon course lectures, discussions, lab reports, readings, and outside sources to organize and deliver a self-directed study on a topic of interest utilizing advanced spatial analysis and methods. The report is limited to 10 pages (with 12-point font, 1-inch margins, single-spacing for text) and will include one or more maps, tables, and other diagrams as well as a list of references. The presentation will include slides and will be limited to 10 minutes per student.

Final Examination – 1 worth 20 points. The final examination will consist of multiple-choice, short answer, and essay questions. Students will be expected to take the exam at the indicated time.

Grading Breakdown

Assessment	Number	Points Each	Total Points
Writing Assignments	3	5	15
Laboratory Reports	10	3	30
Mid-term Examination	1	15	15
Final Examination	1	20	20
Project Components			
Final Project Report	1	15	15
Final Project Presentation	1	5	5
Total	17	-	100 points

Assignment Submission Policy

Assignments will be submitted for grading via Blackboard by 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. Late work will be assessed a penalty of 10% per day and zero grades will be assigned for work that is more than seven days late.

Schedule

	Topics	Readings and Assignments	Deliverables/ Due Dates
Week 1 1/8	**Introduction to Class** Introductions coupled with discussion of class goals, lab assignments, projects, and technology options.		No deliverables
1/10	**Summarizing and Analyzing Spatial Data** Introduction to spatial data and spatial analysis techniques.	Burrough et al. (2015) Ch. 6, pp. 111-117 Writing Assignment 1	Complete by 1/21: Writing Assignment 1: Introduction to spatial data and spatial analysis techniques
Week 2 1/15 is a university holiday	Martin Luther King Day (No Class)		
1/17	**Spatial Autocorrelation** Introduction to spatial autocorrelation based on feature locations and attribute values.	Burrough et al. (2015) Ch. 6, pp. 117-121 de Smith et al. (2015) Ch. 5	
Week 3 1/22	**Point Pattern Analysis** Discussion of how point patterns can be identified and understood as realizations of spatial processes.	Burrough et al. (2015) Ch. 6, pp. 121-125	Complete within 48 hours after your lab: Lab 1: Measuring spatial autocorrelation using Moran's I and incremental distances
1/24	**Analysis of Discrete Entities in Space** Introduction of various methods to select crisp entities from attribute tables.	Burrough et al. (2015) Ch. 7, pp. 127-138	

	Topics	Readings and Assignments	Deliverables/ Due Dates
Week 4 1/29	**Operations on Attributes of Multiple Entities** Discussion of how to compute or model new attributes using the rules of Boolean logic.	Burrough et al. (2015) Ch. 7, pp. 139-145	Complete within 48 hours after your lab: Lab 2: Analyzing frequency and density of patterns of events relative to location
1/31	**Deterministic and Spline-based Approaches** Introduction to the creation of surfaces from points or areas.	Burrough et al. (2015) Ch. 8, pp. 147-151	
Week 5 2/5	**Global Interpolation and Prediction** Discussion of global interpolation for examining and removing the effects of global variations caused by major trends.	Burrough et al. (2015) Ch. 8, pp. 151-166	Complete within 48 hours after your lab: Lab 3: Overlay operations on multiple entities to modify spatial features
2/7	**A Comparison of Interpolation Techniques** Introduction to the cross-validation method to assess the performance of alternative interpolation methods.	Burrough et al. (2015) Ch. 8, pp. 166-169	
Week 6 2/12	**Regionalized Variable Theory** Introduction to geostatistical approaches to interpolation.	Burrough et al. (2015) Ch. 9, pp. 172-174 de Smith et al. (2015) Ch. 6.7.1	Complete within 48 hours after your lab: Lab 4: Creating continuous surfaces using deterministic interpolation
2/14	**Variogram Models** Discussion of determining optimal weights of variables for interpolation.	Burrough et al. (2015) Ch. 9, pp. 174-177 de Smith et al. (2015) Ch. 6.7.2	
Week 7 2/19 is a university holiday	Presidents Day (No Class)		
2/21	**Using the Variogram for Interpolation** Introduction to ordinary kriging and validation of variogram models.	Burrough et al. (2015) Ch. 9, pp. 177-179 de Smith et al. (2015) Ch. 6 Writing Assignment 2	Complete by 2/26: Writing Assignment 2: A comparison of deterministic and geostatistical interpolation methods

	Topics	Readings and Assignments	Deliverables/ Due Dates
Week 8 2/26	**Block Kriging and Probabilistic Kriging** Introduction to other key kriging methods to compute prediction surfaces.	Burrough et al. (2015) Ch. 9, pp. 179-188 de Smith et al. (2015) Ch. 6	Complete within 48 hours after your lab: Lab 5: Exploring variograms for interpolation, sampling optimization, and description of spatial patterns
2/28	**Stochastic Simulation** Introduction to conditional simulation in spatial analysis.	Burrough et al. (2015) Ch. 9, pp. 188-199 de Smith et al. (2015) Ch. 6	
Week 9 3/5	Mid-term Examination Review		No lab
3/7	Mid-term Examination		
Week 10 3/19	**Analysis of Continuous Fields** Introduction to map algebra and cartographic modeling.	Burrough et al. (2015) Ch. 10, pp.201-207	Complete within 48 hours after your lab: Lab 6: Exploring use of map algebra and cartographic modeling in spatial analysis
3/21	**Modifying the Characteristics of Raster Data** Discussion of case studies using spatial filtering to smooth images or enhance contrast.	Burrough et al. (2015) Ch. 10, pp.207-222	
Week 11 3/26	**Deriving Surface Topology and Drainage Networks** Introduction to automatic derivation of surfaces and drainage networks.	Burrough et al. (2015) Ch. 10, pp.223-230	Complete within 48 hours after your lab: Lab 7: Low-pass and high-pass spatial filtering of elevation data
3/28	**Methods of Representing Digital Elevation Models** Introduction to regular grid and triangulated irregular networks to build digital elevation models.	Burrough et al. (2015) Ch. 11, pp.231-247	

	Topics	Readings and Assignments	Deliverables/ Due Dates
Week 12 4/2	**Applications of Digital Elevation Models** Exploration of different applications of digital elevation models.	Burrough et al. (2015) Ch. 11, pp.247-249 Goswami et al.. (2012) Kang et al.. (2009) Aubrya et al. (2012)	Complete within 48 hours after your lab: Lab 8: Understanding digital elevation models and identifying drainage systems and stream networks
4/4	**Introduction to Space-time Modeling** Exploring various components and inputs in computational models and how dynamics over time can be included in spatial analysis and modeling.	Burrough et al. (2015) Ch. 12, pp.251-261	
Week 13 4/9	**Accounting for Errors in Spatio-temporal Modeling** Understanding how errors in spatial data and spatial analyses propagate and the impacts on resulting outputs.	Burrough et al. (2015) Ch. 12, pp.261-266	Complete within 48 hours after your lab: Lab 9: Exploring image time series with IDRISI Earth Trends Modeler
4/11	**Fuzzy Sets and Fuzzy Geographic Objects** Introduction to imprecision in overlapping attribute classes.	Burrough et al. (2015) Ch. 13, pp.267-272	
Week 14 4/16	**Operations on Fuzzy Sets** Manipulation of fuzzy sets using logical query methods to select and combine data.	Burrough et al. (2015) Ch. 13, pp.272-284 Writing Assignment 3	Complete within 48 hours after your lab: Lab 10: Applying fuzzy logic to overlay operations
4/18	**Advantages, Disadvantages, and Applications of Fuzzy Classification** Discussion of imprecision in overlapping attribute classes, the SI approach and fuzzy *k*-means classification over conventional data retrieval and classification methods.	Burrough et al. (2015) Ch. 13, pp.284-286	Complete by 4/23: Writing Assignment 3: Extension of fuzzy membership functions to geographic phenomena expressed either as continuous fields or discrete entities

	Topics	Readings and Assignments	Deliverables/ Due Dates
Week 15 4/23	**Final Project** Students work on final projects. Complete final spatial analysis project and report. Students present final projects.	Final Project Report	Final project report: Complete no later than Friday, 4/27, 5:00 pm
4/25	**Final Project Presentations** Students present final projects.	Final Project Presentation	Final project presentation slides: Complete no later than Monday, 4/23, 9:00 am
Exam Week 5/2-5/9	**Final Examination**		Final Examination: Monday, 5/7, 2:00-4:00 pm

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