

USC Dornsife

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

SSCI 582 (35695), Spatial Databases

Syllabus

Units: 4

Term – Day – Time: Fall 2020

Location: Online

Instructor: An-Min Wu, PhD

Office: AHF B55B

Office Hours: Mondays, 2 - 3 p.m. and Tuesdays, 11:30 a.m. – 12:30 p.m. PT via zoom – please contact me via email in advance to ensure I will be online. Also available most days and times by appointment via email

Contact Info: anminwu@usc.edu, 213-740-2876 (office). A secured zoom meeting link will be provided via email when I confirm with you the appointment date/time.

Library Help: Andy Rutkowski

Office: VKC B36B

Office Hours: By appointment

Contact Info: arutkows@usc.edu, 213-740-6390 (office), <http://bit.ly/andyhangout>

IT Help: Richard Tsung

Office: AHF B57E

Regular Office Hours: By appointment

Contact Info: ctsung@usc.edu, 213-821-4415 (office)

Course Scope and Purpose

Geographic information systems (GIS) are fundamentally information systems, typically built on database management technologies. Although GIS offers special facilities for storing and manipulating spatial data, much of the functionality provided by GIS is shared with conventional database software and its ubiquitous Structured Query Language (SQL). Thus, understanding database principles is the foundation for mastering the technical aspects of GIS.

This course provides a high-level tour of the theoretical underpinnings of databases containing both spatial and tabular data, as these are integrated into GIS. The core objective of the course is a practical one: to understand the fundamental principles of the design and implementation of well-conceived spatial databases, especially Esri geodatabases and SQL server databases, and be able to manipulate them both inside and outside of GIS.

In addition, this course serves a diverse audience given its role as a required course for the M.S. and Graduate Certificate Programs in Geographic Information Science & Technology and the M.S. Program in Transportation Systems Management with the specialization in GIS, and as an elective course in the M.S. Program in Spatial Economics and Data Analysis and the M.S. Program in Spatial Data Science. The different student audiences are provided with a variety of options to work with core geospatial datasets throughout the semester that best coincide with their personal academic and career goals.

In this course we examine the fundamentals of relational, object-oriented, and unstructured databases. A major benefit of the relational model is that it provides a metaphor that is closer to the way humans think about data than did previous database models. Yet within GIS, some authors have argued that the object-oriented model provides an inherently more suitable basis for storing geographical data than the relational model. The unstructured model is increasingly being used to support applications including big data storage and retrieval (e.g. Twitter, Facebook, Google). The influence of object-oriented concepts has become steadily more dominant throughout virtually every aspect of modern computing. Anyone wishing to pursue a career in GIS, in fact in any aspect of computing, should gain an understanding of both the relational and object-oriented models with respect to spatial databases.

Learning Objectives

When you have completed this course, you will be able to:

- Define a geographical realm of interest, model that realm diagrammatically and narratively, and implement the model in a geodatabase.
- Use SQL statements to interrogate spatial databases to accomplish data loading, maintenance, map production, and analysis.
- Discuss the complexity of the geographic world and techniques for modeling it in a computer.
- Explain the strengths and limitations of various databases and non-relational structures for spatial data, including those supported by Esri's ArcGIS platform and open source systems.

Prerequisite(s): SSCI 581 or permission of the instructor

Co-Requisite(s): None

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 non-binary 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 text *Spatial Database Systems: Design, Implementation and Project Management*. The course readings will emerge as a collection of reading notes that provide the basis for an informed review of most chapters. Additional readings are assigned to expand on the text, particularly toward the topics of advanced databases.

This course will unfold on a weekly basis. When possible, assignments will be given in advance, but usually they will be posted on Mondays. Practical exercises utilize unpublished and published tutorial materials using the ArcGIS platform, and project-based homework assignments allow students to demonstrate their abilities to apply spatial database tools in an appropriate, informed manner.

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 Pro, MS SQL Server Management Studio, and PostGIS are 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.
- A functional webcam and a microphone for use whenever a presentation or meeting is scheduled.
- An up-to-date web browser to access the SSI Server.

You might need to record short videos explaining your project work, but I will show you how to use free, available online tools to do so.

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 emails 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 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 textbook for this course is:

- Yeung, Albert K. W., and G. Brent Hall. 2007. *Spatial Database Systems: Design, Implementation and Project Management*. Dordrecht: Springer. While you may purchase this book if you wish to own a bound copy, it is available online through the USC Libraries. Sign on to the USC Libraries and search for this title. Used copies of this book are widely available online, so there is no need to pay the full retail price.

Supplementary readings will be assigned from various sources including:

- Ainārs, Auziņš, Eiduks Jānis, Vasiļevska Alīna, and Dzenis Reinis. 2018. "Object-Relational Database Structure Model and Structure Optimisation." *Applied Computer Systems* 23, no. 1: 28–36.
- Blaser, Mario. 2014. "Ontology and indigeneity: on the political ontology of heterogeneous assemblages." *Cultural geographies* 21, no. 1: 49-58.
- Burrough, Peter A., Rachael McDonnell, Rachael A. McDonnell, and Christopher D. Lloyd. 2015. "Spatial data and their models: formal abstractions of reality." In *Principles of geographical information systems, 21-44. 3rd ed.* Oxford, United Kingdom: Oxford university press.
- Couclelis, Helen. 1992. "People Manipulate Objects (But Cultivate Fields): Beyond the Raster-Vector Debate in GIS." In *Theories and Methods of Spatio-Temporal Reasoning in Geographic Space*. Edited by Andrew U. Frank, Irene Campari, and Ubaldo Formentini, 65-77. London: Springer.
- Dietrich, Suzanne W. and Susan D. Urban. 2011. Chapter 1 Introduction to Object Database. In: *Fundamentals of Object Databases Object-Oriented and Object-Relational Design*. Vol 2. San Rafael, Calif.: Morgan & Claypool; 2011:1-30. doi:10.2200/S00315ED1V01Y201012DTM012
- Harrington, Jan L. 2011. "Chapter 4: Simple SQL Retrieval" In *SQL Clearly Explained* 77-105 and 363-399. 3rd ed. Morgan Kaufmann.
- Hunter, Gary J. 2002. "Understanding Semantics and Ontologies: They're Quite Simple, Really - If You Know What I Mean." *Transactions in GIS* 6, no. 2 (March): 83-87.
- Lee, Jae-Gil and Minseo Kang. 2015. "Geospatial Big Data: Challenges and Opportunities." *Big Data Research* 2: 74-81.
- Li, Z. 2018. "NoSQL Databases". *The Geographic Information Science & Technology Body of Knowledge* (2nd Quarter 2018 Edition) John P. Wilson (Ed). DOI:10.22224/gistbok/2018.2.10.
- Parent, Christine, Stefano Spaccapietra, and Esteban Zimányi. 2006. "Chapter1 Introduction" In *Conceptual modeling for traditional and spatio-temporal applications: The MADS approach*. Springer Science & Business Media.
- Shekhar, Shashi, and Sanjay Chawla. 2003. "Chapter 2: Spatial Concepts and Data Models", "Chapter 3: Spatial Query Languages", and "Chapter 4: Spatial Storage and Indexing". In *Spatial Databases: A Tour*, 22-51, 52-82, and 83-113. 1st ed. Upper Saddle River, NJ: Prentice Hall.
- Zeiler, Michael. 2010. "Chapter 1: Inside the Geodatabase." In *Modeling Our World: The Esri Guide to Geodatabase Concepts*, 1-22. 2nd ed. Redlands, CA: Esri Press.

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

Your grade in this course will be determined on the basis of several different assessments.

Resume Assignments – 2 worth a total of 5 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. A second resume assignment provides you a chance to add any newly learned tools and project products in this course to your resume.

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.

Homework Assignments – 5 worth a total of 40 points. The hands-on, project-based homework assignments will be used to practice the techniques explored in theory in the text. At the completion of each homework assignment, you will prepare a brief written report to demonstrate that you have completed it.

Reading Assignments – 5 worth a total of 20 points. These will focus on the text and other assigned readings. Their objective is to help you evaluate and integrate the information you have acquired from the course readings. Some of these will involve discussions and collaborative work, most will be individual efforts. Others will stimulate in-depth investigation into the ontology and semantics of core geospatial datasets integrated into tutorials.

Discussions – 5 worth a total of 15 points. Structured discussions will focus on combinations of theory and practice. You will post new message and replies to messages posted by your classmates (i.e. two per forum) at specified times throughout the semester.

Comprehensive Exam – 1 worth a total of 20 points.

Grading Breakdown

| Assessment | Number | Points Each | Total Points |
|----------------------|--------|-------------|--------------|
| Resume Assignment 1 | 1 | 2 | 2 |
| Resume Assignment 2 | 1 | 3 | 3 |
| Homework Assignments | 5 | 8 | 40 |
| Reading Assignments | 5 | 4 | 20 |
| Discussions | 5 | 3 | 15 |
| Comprehensive Exam | 1 | 20 | 20 |
| Total | 18 | - | 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. Unless otherwise noted, all Reading Assignments and Homework Assignments are *due by 11:59 pm Pacific Time (PT) on the due date*. Your attention to on-time assignment submission is essential.

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 Breakdown

| | Topic | Readings and Assignments | Deliverables/Due Dates |
|---|--|---|--|
| Module 1: Database Fundamentals | | | |
| Week 1 8/24 | Introduction | Burrough et al. (2015) Yeung & Hall (2007) Ch1 Resume Assignment 1 Reading Assignment 1 | Resume Assignment 1: Thursday, 8/27 |
| Week 2 8/31 | Elements and concepts of database management systems | Yeung & Hall (2007) Ch2 p. 21-40 Zeiler (2010) Ch.1 Homework Assignment 1 Discussion 1 | Reading Assignment 1: Tuesday, 9/1 Discussion 1: Thursday, 9/3 Introduction meeting with instructor: Wednesday, 9/2 to Friday, 9/4 |
| Module 2: Database Design and Management | | | |
| Week 3 9/8* *Monday, 9/7 is university holiday | Database architecture and data models | Yeung & Hall (2007) Ch2 p. 41-54 and Ch3 p. 55-65 Couclelis (1992) (optional) Dietrich and Urban (2010) Discussion 2 | Homework Assignment 1: Thursday, 9/10 |
| Week 4 9/14 | Data modeling: Entity-relationship diagrams | Yeung & Hall (2007) p. 65-79 Shekhar & Chawla (2003) Ch2 Reading Assignment 2 Homework Assignment 2 | Discussion 2: Tuesday, 9/15 |
| Week 5 9/21 | Use of Structured Query Language (SQL) | Harrington (2011) Ch.4 Discussion 3 | Reading Assignment 2: Tuesday, 9/22 |
| Module 3: Basics of Spatial Databases | | | |

| | Topic | Readings and Assignments | Deliverables/Due Dates |
|---|---|--|--|
| Week 6 9/28 | Semantic, Ontology and Spatial database infrastructure: Esri Geodatabases (I) | Hunter (2002) Blaser (2014) Yeung & Hall (2007) Ch4 p. 93-114 Ainārs et al. (2018) Reading Assignment 3 Homework Assignment 3 | Discussion 3: Tuesday, 9/29 Homework Assignment 2: Thursday, 10/1 |
| Week 7 10/5 | Database mechanics | Yeung & Hall (2007) Ch.3 p. 68-72, 79-92 Reading Assignment 4 | Reading Assignment 3: Tuesday, 10/6 |
| Module 4: Spatial Data Optimization and Spatial Access | | | |
| Week 8 10/12 | Spatial data quality and standard: Esri Geodatabases (II) | Yeung & Hall (2007) Ch 5 Guptill (1999) Homework Assignment 4 | Reading Assignment 4: Tuesday, 10/13 Homework Assignment 3: Thursday, 10/15 |
| Week 9 10/19 | Spatial queries and spatial indexing | Yeung & Hall (2007) p.115 - 125 Shekhar & Chawla (2003) Ch 3 & 4 | Check-in meeting |
| Week 10 10/26 | Time in the database | Parent et al. (2006) Ch1 Reading Assignment 5 | Homework Assignment 4: Thursday, 10/29 |
| Module 5: Modern Databases | | | |
| Week 11 11/2 | Introduction to NoSQL databases | Li (2018) Homework Assignment 5 | Reading Assignment 5: Tuesday, 11/3 |
| Week 12 11/9 | Introduction to Spatial Big Data | Lee & Kang (2015) Discussion 4 | |
| Week 13 11/16 | More on Big Data and Data Warehouses | Discussion 5 | Discussion 4: Tuesday, 11/17 Homework Assignment 5: Thursday, 11/19 |
| Week 14 11/23* *Class ends on 11/24 | Review | | Discussion 5: Tuesday, 11/24 at 5pm PT |
| Final Exam Week 12/9-12/16 | Comprehensive Exam | | Exam date/time will follow the university exam schedule |

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, policy.usc.edu/scientific-misconduct.

Support Systems

Counseling and Mental Health - (213) 740-9355 – 24/7 on call
studenthealth.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
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 and 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 – (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. The university prohibits discrimination or harassment based on the following protected characteristics: race, color, national origin, ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age, physical disability, medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and any other characteristic which may be specified in applicable laws and governmental regulations. The university also prohibits sexual assault, non-consensual sexual contact, sexual misconduct, intimate partner violence, stalking, malicious dissuasion, retaliation, and violation of interim measures.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298
usc-advocate.symlicity.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 Support and Advocacy - (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.