

**USC**Dornsife

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

## **SSCI 582, Spatial Databases**

### *Syllabus*

**Units:** 4

**Term Day Time:** Spring 2023, Mondays & Thursdays from 11:00 a.m. - 12:50 p.m.

**Location:** AHF 145A and DEN@Dornsife

**Instructor:** An-Min Wu, PhD

**Office:** AHF B55B

**Regular Office Hours:** Wednesdays 3:30 –4:30 p.m. and Thursdays 1:00 – 2:00 p.m. in-person or via zoom – please contact me via email in advance to ensure I will be available in the format you'd wish to meet. Also available most days between 9 a.m. – 5 p.m. by appointment.

**Contact Info:** [anminwu@usc.edu](mailto:anminwu@usc.edu)

**Library Help:** Andy Rutkowski

**Office:** LIPA B40-A

**Office Hours:** Thu 10am - 12 pm or by appointment.

**Contact Info:** [arutkows@usc.edu](mailto:arutkows@usc.edu)

**IT Help:** Dornsife Technology Services

**Office:** SHS 260

**Contact Info:** [spatial\\_support@usc.edu](mailto:spatial_support@usc.edu), 213-740-2775

## **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 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.

By both necessity and design, this course serves several different audiences. This course is a required course for the Spatial Data Management and Spatial Computing tracks in the M.S. in Geographic Information Science & Technology, the GIS track in the M.S. in Transportation Systems Management, and as an elective course in the M.S. in Spatial Economics and Data Analysis, M.S. in Spatial Data Science, and Geographic Information Science & Technology and the Geospatial Leadership Graduate Certificate Programs. 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.

### ***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.

Students may vary in their competency levels on these abilities. You can expect to acquire these abilities only if you honor all course policies, attend classes regularly, complete all assigned work in good faith and on time, and meet all other course expectations of you as a student.

**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 nonbinary students such as faculty notifications, and more. If you need supportive accommodations, you may contact the Title IX Coordinator directly ([titleix@usc.edu](mailto: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).

**COVID-19 policy** -- Students are expected to comply with all aspects of USC's COVID-19 policy including, but not limited to, vaccination, indoor mask mandate, and daily TrojanCheck. Failure to do so may result in removal from the class and referral to Student Judicial Affairs and Community Standards. Students are recommended to keep safe physical distancing, whenever possible, to prevent any possible transmission. Please contact your instructor if you have any safety concerns.

**Diversity and Inclusion** – It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful to everyone, and you are also expected to respect of others regardless of their race, ethnicity, gender identity and expressions, cultural beliefs, religion, sexual orientation, national origin, age, abilities, ideas and perspectives, or socioeconomic status. Your suggestions are encouraged and appreciated. Feel free to let me know ways to improve the effectiveness of the course for you personally or for other students.

## Course Structure

The main theoretical concepts are provided through lectures, discussion and a directed reading of the textbooks and supplementary readings. Additional readings will be assigned to expand on the text when needed. The course will generally unfold on a biweekly or triweekly basis. When possible, assignments will be given in advance, but usually they will be posted on or before Mondays.

*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 these systems 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.

If a student does not have access to any of these, please speak with the instructor at the start of the semester. Also, see the USC ITS Student Toolkit here:

<https://keepteaching.usc.edu/students/student-toolkit/>.

*Desire2Learn (D2L)* – This course will utilize the Desire2Learn (D2L) learning management system which allows students to access course content, upload assignments, participate in discussion forms, among other learning experiences. The D2L platform provides flexibility in the learning experience where students can participate in the course residentially or remotely, synchronously (meeting together at the same time) or asynchronously (accessing videos and course content outside of class).

*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](mailto:spatial_support@usc.edu) making sure to copy (cc) me on the email.

*Communications* – All assignments given and all materials to be handed in will be submitted via D2L. The instructor will also create and monitor discussion forums through which students can discuss issues and assignments as needed. Students should read all email sent from D2L or from course instructor(s) as soon as possible. Also, students who do not regularly use their USC email accounts should double-check to be sure that mail sent from both the D2L accounts and the instructor's account (noted above) to your USC account is forwarded to an address used regularly and does not go into junk mail. The instructor will endeavor to respond to all email within 24 hours of receipt, aiming for no more than 72 hours delay.

In the rare case that an instructor is off-line for an extended period of time, an announcement will be posted to the class D2L site. Due to the synchronous and asynchronous nature of this course, it is each student's responsibility to stay informed and connected with others in our course. In addition to email, students are expected to login to D2L regularly to check for announcements.

*Discussion forums* – On the D2L 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, A. K. W., and G. B. 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:

- Auziņš, A., E. Jānis, V. Alīna, and D. Reinis. 2018. Object-Relational Database Structure Model and Structure Optimisation. *Applied Computer Systems* 23(1): 28-36.
- Blaser, M. 2014. Ontology and indigeneity: on the political ontology of heterogeneous assemblages. *Cultural Geographies* 21(1): 49-58.
- Burrough, P. A., R. McDonnell, R. A. McDonnell, and C. D. Lloyd. 2015. Spatial data and their models: formal abstractions of reality. In *Principles of geographical information systems, 3<sup>rd</sup> ed.* (pp. 21-44). Oxford, UK: Oxford University Press.
- Couclelis, H. 1992. People Manipulate Objects (But Cultivate Fields): Beyond the Raster-Vector Debate in GIS. In A.U. Frank, I. Campari, and U. Formentini (Eds.), *Theories and methods of spatio-temporal reasoning in geographic space* (pp. 65-77). London, UK: Springer.
- Dangermond, J., and M. F. Goodchild. 2020. Building Geospatial Infrastructure. *Geo-spatial Information Science* 23 (1): 1-9

- Dietrich, S. W., and S. D. Urban. 2011. Introduction to Object Database. In *Fundamentals of Object Databases Object-Oriented and Object-Relational Design* (pp. 1-30). San Rafael, California: Morgan & Claypool.
- Harrington, J. L. 2011. Simple SQL Retrieval In *SQL Clearly Explained, 3<sup>rd</sup> ed.* (pp. 77-105 and pp. 363-399). Amsterdam, Netherlands: Morgan Kaufmann Elsevier.
- Hunter, G. J. 2002. Understanding Semantics and Ontologies: They're Quite Simple, Really - If You Know What I Mean. *Transactions in GIS* 6(2): 83-87.
- Lee, J.-G. and M. Kang. 2015. Geospatial Big Data: Challenges and Opportunities. *Big Data Research* 2(2): 74-81.
- Li, Z. 2018. NoSQL Databases. *The Geographic Information Science & Technology Body of Knowledge, 2<sup>nd</sup> Quarter 2018 ed.* John P. Wilson (Ed).
- Li, W., M. Batty, and M. F. Goodchild. 2020. Real-Time GIS for Smart Cities. *International Journal of Geographic Information Science* 34(2): 311-324.
- Parent, C., S. Spaccapietra, and E. Zimányi. 2006. Introduction. In *Conceptual modeling for traditional and spatio-temporal applications: The MADS approach*. Berlin, Germany: Springer Science & Business Media.
- Shekhar, S., and S. Chawla. 2003. Spatial Concepts and Data Models. In *Spatial Databases: A Tour, 1<sup>st</sup> ed.* (pp. 22-51). Upper Saddle River, NJ: Prentice Hall.
- Shekhar, S., and S. Chawla. 2003. Spatial Query Languages. In *Spatial Databases: A Tour, 1<sup>st</sup> ed.* (pp. 52-82) Upper Saddle River, NJ: Prentice Hall.
- Shekhar, S., and S. Chawla. 2003. Spatial Storage and Indexing. In *Spatial Databases: A Tour, 1<sup>st</sup> ed.* (pp. 83-113). Upper Saddle River, NJ: Prentice Hall.

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 2 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.

*Projects – 5 worth a total of 40 points.* The hands-on, project-based Projects will be used to practice the techniques discussed in abstract terms in the text. At the completion of each Project, you will prepare a brief written report to demonstrate that you have completed it.

*Reading and Research Assignments – 4 worth a total of 20 points.* These assignments call on students to critically analyze required readings, identify relevant case studies employing the methodologies and concepts we cover in class, and to discuss them with the instructor and their classmates during synchronous meetings and/or online discussion forums via D2L.

*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.* The comprehensive exam will cover material learned throughout the duration of the semester. It may be mixed format and may consist of multiple choice, short answer, and simple problem questions.

## Grading Breakdown

Assessment	Number	Points Each	Total Points
Resume Assignment 1	1	2	2
Resume Assignment 2	1	3	3
Projects	5	8	40
Reading & Research Assignments	4	5	20
Discussions	5	3	15
Comprehensive Exam	1	20	20
Total	17	-	100

## Assignment Submission Policy

Unless otherwise noted, assignments must be submitted via D2L by the due dates specified in the Course Schedule below and on the assignment instructions.

Project components have different due dates as indicated on the Course Schedule below. Your attention to on-time assignment submission is essential if I am to meet my goal to return comments on your submitted assignments before the next one is due. Sometimes this is impossible, so I will post a notice on anticipated delays if needed.

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

Week	Topic	Readings and Assignments	Deliverables/Due Dates
<b>Weeks 1 -2: Module 1   Database Fundamentals</b>			
<b>Week 1</b> 1/9 & 1/12	Introduction	Burrough et al. (2015) Yeung & Hall (2007), Ch. 1 Resume Assignment 1 Reading & Research Assignment 1	Resume Assignment 1: Thursday, 1/12
<b>Week 2</b> 1/19* *Monday, 1/16 is a university holiday	Elements and concepts of database management systems	Yeung & Hall (2007), Ch. 2 p. 21-40 Discussion 1 Project 1	Reading & Research Assignment 1: Tuesday, 1/17 @9am
<b>Weeks 3 – 5: Module 2   Database Design and Management</b>			
<b>Week 3</b> 1/23 & 1/26	Database architecture and data models	Couclelis (1992) Dietrich and Urban (2011) Yeung & Hall (2007), Ch. 2 p. 41-54 and Ch. 3 p. 55-78 Project 2 Discussion 2	Discussion 1: Monday, 1/23 @9am Project 1: Thursday, 1/26 @9am
<b>Week 4</b> 1/30 & 2/2	Data modeling: entity- relationship diagrams	Yeung & Hall (2007), Ch. 3 p. 65-79 Shekhar & Chawla (2003), p. 22-51 Reading & Research Assignment 2	Discussion 2: Monday, 1/30 @9am
<b>Week 5</b> 2/6 & 2/9	Use of Structured Query Language (SQL)	Harrington (2011), Ch. 4 Auziņš et al. (2018) Discussion 3	Reading & Research Assignment 2: Monday, 2/6 @9am
<b>Weeks 6 – 7: Module 3   Basics of Spatial Databases</b>			
<b>Week 6</b> 2/13 & 2/16	Semantics, ontology and spatial database infrastructure: Esri geodatabases (I)	Blaser (2014) Hunter (2002) Yeung & Hall (2007), Ch. 4 p. 93-114 Project 3 Reading & Research Assignment 3	Discussion 3: Monday, 2/13 @9am Project 2: Thursday, 2/16 @9am



<b>Week</b>	<b>Topic</b>	<b>Readings and Assignments</b>	<b>Deliverables/Due Dates</b>
<b>Week 7</b> 2/23* *Monday, 2/20 is a university holiday	Database mechanics	Yeung & Hall (2007), Ch. 3 p. 79-92	Reading & Research Assignment 3: Monday, 2/20 @9am
<b>Weeks 8 – 10: Module 4   Spatial Data Optimization and Spatial Access</b>			
<b>Week 8</b> 2/27 & 3/2	Spatial data quality and standards: Esri geodatabases (II)	Yeung & Hall (2007), Ch. 5 Reading & Research Assignment 4 Project 4	Project 3: Thursday, 3/2 @9am
<b>Week 9</b> 3/6 & 3/9	Spatial queries and spatial indexing	Shekhar & Chawla (2003), p. 52-113 Yeung & Hall (2007), Ch. 4 p. 115-125 Discussion 4	Reading & Research Assignment 4: Monday, 3/6 @9am
<b>3/14</b> *3/12-3/19 is Spring Recess			
<b>Week 10</b> 3/20 & 3/23	Time in spatial databases	Parent et al. (2006)	Discussion 4: Monday, 3/20 @9am
<b>Weeks 11 – 15: Module 5   Modern Databases</b>			
<b>Week 11</b> 3/27 & 3/30	Introduction to open-source object-oriented databases and NoSQL databases	Li (2018) Project 5 Discussion 5	Project 4: Thursday, 3/30 @9am
<b>Week 12</b> 4/3 & 4/6	Spatial big data	Lee & Kang (2015)	Discussion 5: Monday, 4/2 @9am
<b>Week 13</b> 4/10 & 4/13	GIS for smart cities	Li et al. (2020) Resume Assignment 2	
<b>Week 14</b> 4/17 & 4/20	Geospatial infrastructure	Dangermond & Goodchild (2020)	Project 5: Thursday, 4/20 @9am
<b>Week 15</b> 4/24 & 4/27* *Friday, 4/28 is the last day of class	Future of spatial databases & comprehensive exam review		Resume Assignment 2 Monday, 4/24 @9am

Week	Topic	Readings and Assignments	Deliverables/Due Dates
			All assignments must be submitted no later than 5:00 PM PT on 4/28
<b>Final Exams</b> 5/3-5/10	Comprehensive Exam		Comprehensive Exam Friday, 5/5 at 2:00-4:00 PM PT

## Statement on Academic Conduct and Support Systems

### Academic Integrity:

The University of Southern California is a learning community committed to developing successful scholars and researchers dedicated to the pursuit of knowledge and the dissemination of ideas. Academic misconduct, which includes any act of dishonesty in the production or submission of academic work, comprises the integrity of the person who commits the act and can impugn the perceived integrity of the entire university community. It stands in opposition to the university's mission to research, educate, and contribute productively to our community and the world.

All students are expected to submit assignments that represent their own original work, and that have been prepared specifically for the course or section for which they have been submitted. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s).

Other violations of academic integrity include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), collusion, knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university. All incidences of academic misconduct will be reported to the Office of Academic Integrity and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see [the student handbook](#) or the [Office of Academic Integrity's website](#), and university policies on [Research and Scholarship Misconduct](#).

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

## **Students and Disability Accommodations:**

USC welcomes students with disabilities into all of the University's educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at [osas.usc.edu](https://osas.usc.edu). You may contact OSAS at (213) 740-0776 or via email at [osasfrontdesk@usc.edu](mailto:osasfrontdesk@usc.edu).

## **Support Systems:**

*[Counseling and Mental Health](#) - (213) 740-9355 – 24/7 on call*

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

*[988 Suicide and Crisis Lifeline](#) - 988 for both calls and text messages – 24/7 on call*

The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

*[Relationship and Sexual Violence Prevention Services \(RSVP\)](#) - (213) 740-9355(WELL) – 24/7 on call*

Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

*[Office for Equity, Equal Opportunity, and Title IX \(EEO-TIX\)](#) - (213) 740-5086*

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.

*[Reporting Incidents of Bias or Harassment](#) - (213) 740-5086 or (213) 821-8298*

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title IX for appropriate investigation, supportive measures, and response.

*The Office of Student Accessibility Services (OSAS)* - (213) 740-0776

OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

*USC Campus Support and Intervention* - (213) 740-0411

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

*Diversity, Equity and Inclusion* - (213) 740-2101

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

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) 442-1200 – 24/7 on call

Non-emergency assistance or information.

*Office of the Ombuds* - (213) 821-9556 (UPC) / (323-442-0382 (HSC)

A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

*Occupational Therapy Faculty Practice* - (323) 442-2850 or [otfp@med.usc.edu](mailto:otfp@med.usc.edu)

Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.