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

# SSCI 582 (35785), Spatial Databases

*Syllabus*

**Units:** 4

**Term — Day — Time:** Fall 2016, Online

**Location:** Online

**Instructor:** An-Min Wu, PhD
**Office:** AHF B55B
**Regular Office Hours:** Tues 11 am -12 noon PT and Thurs 1-2 pm PT via Blue Jeans – 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

**Library Help:** Katharin Peter
**Office:** VKC B40A
**Office Hours:** By appointment
**Contact Info:** klpeter@usc.edu, 213-740-1700 (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

Geographic information systems (GIS) are fundamentally information systems, typically built on database management technologies. Although GIS offer specialist 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. However, 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 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 Geographic Information Science & Technology M.S. and Graduate Certificate Programs, and because it is an elective course in the Spatial Informatics M.S. Program. The different student audiences are provided a variety of options in working 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 Outcomes*

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

- 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 the open source systems such as QGIS.
- Use SQL fragments and/or statements as appropriate to interrogate spatial databases to accomplish data loading, maintenance, map production, and analysis.
- Define a geographical realm of interest, model that realm diagrammatically and narratively, and implement the model in a geodatabase.

**Prerequisite(s)**: SSCI 581 or permission of the instructor
**Co-Requisite(s)**: None

## 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 reader will emerge as a collection of reading notes that provide the basis for an informed review of most chapters. Additional readings will be assigned to expand on the text when needed. The course will generally unfold on a biweekly basis. When possible, assignments will be given in advance, but usually they will be posted on or before Mondays. Practical exercises utilize published tutorial materials using ArcGIS and a final project allows students to demonstrate their ability to apply spatial analytical 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 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.
- 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

*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.

*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 email 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 all day 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 publically 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, 553 pp. 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 these books are widely available online, so there is no need to pay the full retail price.

Supplementary readings will be assigned from various sources including:

- Couclelis, Helen. 1992. "People manipulate objects (but cultivate fields): Beyond the raster-vector debate in GIS", in *Therories and Methods of Spatio-Temporal Reasoning in Geographic Space*, edited by Andrew U. Frank, Irene Campari, and Ubaldo Formentini, 65-77. London: Springer.
- Hunter, Gary J. 2002. "Understanding semantics and ontologies: They're quite simple, really - If you know what I mean." *Transactions in GIS* 6: 83-87.
- Longley, Paul A., Michael F. Goodchild, David J. Maguire, and David W. Rhind. 2005. *Geographical Information Systems and Science,* 2nd ed., Ch.3, 63-83. Hoboken, NJ: Wiley.
- Peuquet, Donna J. 1999. "Time in GIS and geographical databases", in *Geographical Information Systems: Principles, Techniques, Management, and Applications*, 2nd ed., edited by Paul A. Longley, Michael F. Goodchild, David J. Maguire, and David W. Rhind, 91-103. Hoboken, NJ: Wiley.
- Shekhar, Shashi, and S. Chawla. 2003. “Spatial Concepts and Data Models”, 1, “Spatial Query Languages”, 2, and “Spatial Storage and Indexing” 3 in *Spatial Databases: A Tour*, Prentice Hall, 288 pp.
- Wilson, John P., and John C. Gallant. 2000. "Digital Terrain Analysis", in *Terrain Analysis: Principles and Applications*, edited by John P. Wilson and John C. Gallant, 1-26. Hoboken, NJ: Wiley.
- Zeiler, Michael. 2010. “Inside the Geodatabase”, 1 in *Modeling Our World: The Esri Guide to Geodatabase Concepts*, 2nd ed., Redlands, CA: Esri Press, 308 pp.

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.

In addition, four Esri Web Campus (http://training.esri.com) courses and one Esri tutorial, for a total of five, are supplied with this course.

- Getting Started with the Geodatabase
- Getting Started with Geodatabase Topology
- Working with Geodatabase Domains and Subtypes
- Multidimensional Scientific Data Tools Esri Tutorial
- Creating and Editing Metadata in ArcGIS

## Description and Assessment of Assignments

### *Weekly Assignments*

There are several different kinds of assignments with at least one due weekly. These are described in the Weekly Folders on Blackboard. Due dates are shown in the summary that follows.

*Resume Assignment – 1 worth 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. 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.

*Tutorials – 5 worth a total of 35 points*. Due in the weeks between Reading Assignments, hands-on Tutorials will be used to practice the techniques explored in theory in the text. At the completion of each tutorial, you will prepare a brief written report to demonstrate that you have completed it.

*Esri Assignments – 5 worth a total of 15 points.* Due in the weeks between Tutorials, students work concurrently to complete one online Esri Tutorial and four Esri Virtual Campus modules on geodatabases, during the first 10 weeks of the class.

*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 sill stimulate in-depth investigation into the ontology and semantics of core geospatial datasets integrated into tutorials.

*Discussions – 4 worth a total of 8 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 class.

***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 database project that will be the context of discussion in several of the assignments. The project components will be due at different times near the end of the term 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 briefly how you plan to solve it.

*Geodatabase Design & Implementation Video – 5 points.* A video illustrating your overall spatial database design and functionality.

*Presentation - 5 points*. A presentation made on-line via Blue Jeans, open to all students in the course.

*Geodatabase Project Report - 8 points*. A written report on methods, data sources, and resulting database structure.

## Grading Breakdown

| Assessment | Number | Points Each | Total Points |
|---|---|---|---|
| Weekly Assignments | | | |
| Resume Assignment | 1 | 2 | 2 |
| Tutorials | 5 | 7 | 35 |
| Esri Assignments | 5 | 3 | 15 |
| Reading Assignments | 5 | 4 | 20 |
| Discussions | 4 | 2 | 8 |
| Project Components | | | |
| Proposal | 1 | 2 | 2 |
| Geodatabase Video | 1 | 5 | 5 |
| Presentation | 1 | 5 | 5 |
| Final Report | 1 | 8 | 8 |
| | | | |
| Total | 24 | - | 100 points |

## 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 Assignments are *due by 11:59 pm Pacific Time (PT) on Tuesdays or Thursdays*. 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.

Strict 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

| | Topic | Readings and Assignments | Deliverables/Due Dates |
|---|---|---|---|
| **Week 1**<br>8/22 | Getting Started | Longley et al. (2005) Ch.3, pp. 63-83<br>Resume Assignment<br>Reading Assignment 1: What is a Lake? | Resume Assignment:<br>Thursday, 8/25 |
| **Week 2**<br>8/29 | Technological Context | Yeung & Hall (2007) Ch.1<br>Zeiler (2010) Ch.1<br>Tutorial 1<br>Discussion 1 | Reading Assignment 1:<br>Tuesday, 8/30<br>Discussion 1:<br>Thursday, 9/1 |
| **Week 3**<br>9/6*<br>*Monday, 9/5 is university holiday | Fields as Objects | Yeung & Hall (2007) Ch.2, to p. 34, and Ch3. to p. 78<br>Discussion 2 | Tutorial 1:<br>Thursday, 9/8 |
| **Week 4**<br>9/12 | Semantics and Ontology | Hunter (2002)<br>Tutorial 2<br>Reading Assignment 2 | Discussion 2:<br>Tuesday, 9/13 |
| **Week 5**<br>9/19 | Representing Terrain | Yeung & Hall (2007) Ch.2, from p.35<br>Wilson & Gallant (2000) | Reading Assignment 2:<br>Tuesday, 9/20<br>Tutorial 2:<br>Thursday, 9/22 |
| **Week 6**<br>9/26 | Data Modeling | Yeung & Hall (2007) Ch.3, to p. 79<br>Shekhar & Chawla (2003) Ch 2<br>Discussion 3<br>Reading Assignment 3: E-R Diagramming | Discussion 3:<br>Thursday, 9/29 |
| **Week 7**<br>10/3 | Esri Geodatabases (I)<br>Final Project – kick-off | Esri Certificate 1 (C1): Getting Started with the Geodatabase<br>Tutorial 3 | Reading Assignment 3:<br>Tuesday, 10/4<br>Certificate 1:<br>Thursday, 10/6 |
| **Week 8**<br>10/10 | Database Mechanics<br>Final Project – Week 1 | Yeung & Hall (2007) Ch.3, from p. 79<br>Discussion 4<br>Reading Assignment 4: Normalization & Generalization | Discussion 4, Tutorial 3:<br>Thursday, 10/13 |
| **Week 9**<br>10/17 | Esri Geodatabases (II)<br>Final Project – Week 2 | Esri Certificates 2 (C2): Topology & (C3): Domains<br>Tutorial 4 | Reading Assignment 4:<br>Tuesday, 10/18<br>Certificates 2 & 3:<br>Thursday, 10/20 |
| **Week 10**<br>10/24 | Representing Time<br>Final Project – Week 3 | Peuquet (1999)<br>Esri Tutorial: Multidimensional Tools | Final Project Proposal:<br>Tuesday, 10/25<br>Tutorial 4:<br>Thursday, 10/27 |

| | Topic | Readings and Assignments | Deliverables/Due Dates |
|---|---|---|---|
| **Week 11**<br>10/31 | Legacy Geodata<br>Final Project – Week 4 | Yeung & Hall (2007) Ch.4<br>Shekhar & Chawla (2003) Ch 3 & 4<br>Esri Cert4: Creating and Editing Metadata in ArcGIS<br>Reading Assignment 5<br>Tutorial 5 | Esri Tutorial:<br>Tuesday, 11/1<br>Certificate 4:<br>Thursday, 11/3 |
| **Week 12**<br>11/7 | Documentation<br>Final Project – Week 5 | Yeung & Hall (2007) Ch.5 | Reading Assignment 5:<br>Tuesday, 11/8<br>Tutorial 5:<br>Thursday, 11/10 |
| **Week 13**<br>11/14 | Final Project – Week 6 | Final Project Geodatabase – Develop design, spatial data, queries and maps | Work on Final Project |
| **Week 14**<br>11/21 | Final Project – Week 7 | Thanksgiving Break (23-25) | Work on Final Project |
| **Week 15**<br>11/28*<br>Friday, 12/2 is the last day of classes | Final Project | Final Project Completion | Geodatabase Design Implementation & Video: No later than 05:00 pm PT on Thursday, 12/1<br><br>Final Report: No later than 11:59 PM pm PT on 12/2 |
| **Final Exam Week**<br>12/7-12/14 | Final Project | | Final Project Presentation: Wednesday, 12/7-Thursday, 12/8 |

## 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.

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://adminopsnet.usc.edu/department/department-public-safety. 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 Relationship and Sexual Violence Prevention Services* http://engemannshc.usc.edu/rsvp/ 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.

***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.