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

# SSCI 582 (35696), Spatial Databases

*Syllabus*

**Units:** 4

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

**Location:** Blackboard

**Instructor:** Wei Yang, PhD
**Office**: AHF B55A
**Office Hours**: Tue 10-11 am PT, and Thur 1-2 pm PT. Also available most days and times by appointment via email.

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**GIS Librarian Help:** Katharin Peter
**Office:** VKC B40a
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## 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 open source systems.
- 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 Proficiency and Hardware/Software Required

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

*GIST server and tech support* – This course will utilize the SSI GIST Server to provide you with your own virtual desktop. You can access the GIST Server using VMware. If you are unable to connect to the server or experience any type of technical issues, send an email using your USC account to GIST Tech Support at gistsupport@dornsife.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 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 their 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

There is one required and one recommended text for this course, available from the USC Bookstore or online outlets such as Amazon. Note also that the first text is required and is available *free* through the USC Libraries as an e-Book.

- Yeung, Albert K. W. and G. Brent Hall. 2007. *Spatial Database Systems: Design, Implementation and Project Management*. Dordrecht: Springer, 553 pp.

- Zeiler, Michael. 2010. *Modeling Our World: The Esri Guide to Geodatabase Concepts*, 2nd ed. Redlands, CA: Esri Press, 308 pp.

There are several supplementary readings, also supplied by the instructor on Blackboard.

- 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 Sanjay Chawla. 2003. Ch.1, 1-21, Ch.2, 22-51, Ch.3, 52-82. in *Spatial Databases: A Tour*, Upper Saddle River, NJ: 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

Performance in this course is determined on the basis of several assessment tools. Students update their student resume, prepare a set of research assignments and review blogs on database theory, and complete a set of practical Esri Web training courses during the first 10 weeks of class; thus prepared, they undertake the Final Project during the final weeks of the semester.

Student Resume (2%): The GIST Programs require all current students to post and maintain a public resume, short biography and recent photo on our shared GIST 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.

Reading Assignments (16%): Students complete reading and writing assignments throughout the class. These assignments cover essential theoretical material and perspectives, intended to help integrate practical aspects of Esri geodatabases (below).

Discussion Forums (8%): These structured discussions and blogs 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.

Self-Check Assignments (11%): These structured online assignments focus on combinations of theory and practice. The questions will serve as a guide in your reading and as a basis for online discussions, blogs and spatial database tutorials. The goal is to have informed class activity, and to use your time to focus on applying, analyzing and evaluating the material with the aid of fellow students and with your instructor's guidance.

Tutorial Assignments (28%): Students work four hands-on tutorials with databases and ArcGIS on the GIST Server.

Esri Assignments (15%): 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.

Final Project (20%):

The Final Project involves building a geodatabase for a practical GIS application. This project has two main components: (1) a formal report (~2,000 words, excluding figures, tables, references, and map) that documents your project professionally – this must include a graphical geodatabase design, tabular data dictionary, sample data and queries; and (2) a succinct (~15-minutes) oral presentation of the project, as at a professional conference.

Students will work in small teams (2-5 max) on projects determined in consultation with the instructor, to develop and populate a practical geodatabase design with sample data. Team projects are emphasized to share the intellectual discovery process that inevitably accompanies geodatabase development, as well as to accomplish more substantial work in the time available, i.e. collecting the spatial and non-spatial data, importing those data into a suitably designed geodatabase, producing and interpreting maps, etc. During the last weeks of the class, students will be mostly doing work on Final Projects; the instructor may also participate. During this period, students maintain a Journal or Wiki on Blackboard discussing their progress and challenges during this period.

## Grading Breakdown

| Assignments | Number | Points Each | % of Grade |
|---|---|---|---|
| | | | |
| Student Resume | 1 | 2 | 2 |
| Reading Assignments | 4 | 4 | 16 |
| Discussion Forums | 4 | 2 | 8 |
| Self-Check Assignments | 11 | 1 | 11 |
| Esri Assignments | 5 | 3 | 15 |
| Tutorial Assignments | 4 | 7 | 28 |
| Final Project, components | | | |
| - Final Project Proposal | 1 | 2 | 2 |
| - GeoDB design | 1 | 5 | 5 |
| - GeoDB implementation video | 1 | 5 | 5 |
| - GeoDB report | 1 | 5 | 5 |
| - Oral presentation | 1 | 3 | 3 |
| Totals | 34 | - | 100 |

## Assignment Submission Policy

Unless otherwise noted, assignments will be submitted for grading via Blackboard using the due dates specified in the Course Schedule below. And finally, it is important to note from the outset that: (1) you are expected to attend and participate in pre-arranged online meetings and to complete and upload all assignments before the deadlines detailed in the Course Schedule; (2) late postings and assignments will be docked one letter grade and no grade will be given for postings or assignments turned in more than one week late; and (3) no written work will be accepted for grading after 5:00 pm PT on Fri. Aug. 12.

## Schedule

| | **Topics/Daily Activities** | **Readings and Assignments** | **Deliverables Due** |
|---|---|---|---|
| **Week 1**<br>5/18*<br>*Class starts on Wednesday, 5/18 | **Getting Started** | Longley et al. (2005) *Geographical Information Systems and Science*. Hoboken, NJ: Wiley - Ch.3, pp. 63-83<br><br>Student Resume (SR)<br>Self-Check Assignment 1<br>Reading Assignment 1: What is a Lake? | Wed 5/18, Introductions<br><br>Fri 5/20, Student Resume, Self-Check Assignment 1 |
| **Week 2**<br>5/23 | **Technological Context** | Yeung & Hall (2007) *Spatial Database Systems: Design, Implementation and Project Management*. Dordrecht: Springer - Ch.1<br>Zeiler (2010) *Modeling Our World: The Esri Guide to Geodatabase Concepts,* 2nd ed. Redlands, CA - Ch.1<br>Self-Check Assignment 2<br><br>Tutorial 1: SQL<br>Discussion 1 | Tues 5/24, Reading Assignment 1, Self-Check Assignment 2<br><br>Thurs 5/26, Discussion 1 |

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| **Week 3**<br>5/31*<br>*Monday , 5/30 is a university holiday | **Fields as Objects** | Yeung & Hall (2007) *Spatial Database Systems: Design, Implementation and Project Management*. Dordrecht: Springer - Ch.2, to p. 34, and Ch3. to p. 78<br>Couclelis (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.<br>Self-Check Assignment 3 | Tues 5/31, Tutorial 1<br>Thurs 6/2, Self-Check Assignment 3 |
| **Week 4**<br>6/6 | **Semantics and Ontology** | Hunter (2002) "Understanding semantics and ontologies: They're quite simple, really - If you know what I mean." *Transactions in GIS* 6: 83-87.<br>Self-Check Assignment 4<br>Tutorial 2<br>Discussion 2 | Tues 6/7, Self-Check Assignment 4<br>Thurs 6/9, Discussion 2 |
| **Week 5**<br>6/13 | **Representing Terrain** | Yeung & Hall (2007) *Spatial Database Systems: Design, Implementation and Project Management*. Dordrecht: Springer - Ch.2, from p.35<br>Wilson & 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.<br>Self-Check Assignment 5 | Tues 6/14, Tutorial 2<br>Thurs 6/16, Self-Check Assignment 5 |

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| **Week 6**<br>6/20 | **Data Modeling** | Yeung & Hall (2007) *Spatial Database Systems: Design, Implementation and Project Management*. Dordrecht: Springer - Ch.3, to p. 79<br>Self-Check Assignment 6<br>Discussion 3<br>Reading Assignment 2: E-R Diagramming | Tues 6/21, Self-Check Assignment 6<br>Thurs 6/23, Discussion 3 |
| **Week 7**<br>6/27 | **Esri Geodatabases (I)**<br>**Final Project – kick-off** | Esri Certificate 1 (C1): Getting Started with the Geodatabase<br>Self-Check Assignment 7<br>Tutorial 3 | Tues 6/28, Self-Check Assignment 7, Reading Assignment 2<br>Thurs 6/30, Certificate 1 |
| **Week 8**<br>7/5*<br>*Monday, 7/4 is a university holiday | **Database Mechanics**<br>**Final Project** – week 1 | Yeung & Hall (2007) *Spatial Database Systems: Design, Implementation and Project Management*. Dordrecht: Springer - Ch.3, from p. 79<br>Self-Check Assignment 8<br>Reading Assignment 3: Normalization<br>Discussion 4 | Wed 7/6, Self-Check Assignment 8, Tutorial 3<br>Fri 7/8, Reading Assignment 3, Discussion 4 |
| **Week 9**<br>7/11 | **Esri Geodatabases (II)**<br>**Final Project** – week 2 | Self-Check Assignment 9<br>Esri Certificates 2 (C2): Topology & (C3): Domains<br>Tutorial 4 | Tues 7/12, Self-Check Assignment 9<br>Thurs 7/14, Certificates 2 & 3 |

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| **Week 10**<br>7/18 | **Representing Time**<br>**Final Project** – week 3 | Peuquet (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.<br>Self-Check Assignment 10<br>Esri Tutorial: Multidimensional Tools | Tues 7/19, Self-Check Assignment 10, Tutorial 4<br>Thurs 7/21, Final Project Proposal |
| **Week 11**<br>7/25 | **Legacy Geodata**<br>**Final Project** – week 4 | Yeung & Hall (2007) *Spatial Database Systems: Design, Implementation and Project Management*. Dordrecht: Springer - Ch.4<br>Self-Check Assignment 11<br>Esri Cert4 (C4): Transforming Data w/ETL<br>Reading Assignment 4 | Tues 7/26, Self-Check Assignment 11, Esri Tutorial<br>Thurs 7/28, Certificate 4 |
| **Week 12**<br>8/1 | **Documentation**<br>**Final Project** – week 5 | Yeung & Hall (2007) *Spatial Database Systems: Design, Implementation and Project Management*. Dordrecht: Springer - Ch.5<br>Guptill, Stephen C. 1999. "Metadata and data catalogs", 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, 677-692. Hoboken, NJ: Wiley. | Tues 8/2, Reading Assignment 4<br>Thurs 8/4 & Fri 8/5, Final Project Presentations |

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| **Week 13*** 8/8 *Friday, 8/12 is the last day of classes | **Working on Final Project** – week 6 | Final Project | Due on Fri 8/12, 5:00 pm PT, Final Project Reports, Video |

## 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.