SSCI 582, Spatial Databases

Syllabus

Units: 4

Term Day Time: Summer 2021, Online
 Lecture: 1-2:50pm PT Tuesday and Thursday

Location: Online

Instructor: Jennifer N Swift, Ph.D. GISP
Office: AHF B57D
Regular Office Hours: Mon and Wed 5:00-6:00 pm PT. Also available most days and times by appointment via email.
Contact Info: jswift@usc.edu
Zoom: Provided via Blackboard

Library Help: Andy Rutkowski
Office: VKC 36B
Office Hours: Thu 10:00 am-12:00 pm PT
Contact Info: arutkows@usc.edu
Zoom: Provided via Blackboard

IT Help: Richard Tsung
Office: AHF 145D
Office Hours: By appointment
Contact Info: spatial_support@usc.edu
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.
**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 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 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.

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 course will be conducted online, and our interactions will be synchronous and 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:

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
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 discussed in abstract terms 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 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 Blackboard.

**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

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Number</th>
<th>Points Each</th>
<th>Total Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resume Assignment 1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Resume Assignment 2</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Homework Assignments</td>
<td>5</td>
<td>8</td>
<td>40</td>
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<tr>
<td>Reading &amp; Research Assignments</td>
<td>4</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>Discussions</td>
<td>5</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Comprehensive Exam</td>
<td>1</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>17</td>
<td>-</td>
<td><strong>100</strong></td>
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### 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 & Research 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

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Readings and Assignments</th>
<th>Deliverables/Due Dates</th>
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</thead>
</table>
| **Module 1: Database Fundamentals**

- **Week 1** 5/19
  - Introduction
  - Burrough et al. (2015)
  - Yeung & Hall (2007) Ch1
  - Resume Assignment 1
  - Reading & Research Assignment 1
  - Discussion 1
  - Resume Assignment 1: Friday, 5/21
  - Introduction meeting with instructor

- **Week 2** 5/24
  - Elements and concepts of database management systems
  - Zeiler (2010)
  - Homework Assignment 1
  - Reading & Research Assignment 1: Tuesday, 5/25
  - Discussion 1: Thursday, 5/27

| **Module 2: Database Design and Management**

- **Week 3** 6/1*
  *Monday, 5/31 is university holiday
  - Database architecture and data models
  - Couclelis (1992)
  - Dietrich and Urban (2011)
  - Discussion 2
  - Homework Assignment 1: Thursday, 6/3

- **Week 4** 6/7
  - Data modeling: Entity-relationship diagrams
  - Reading & Research Assignment 2
  - Homework Assignment 2
  - Discussion 2: Tuesday, 6/8

- **Week 5** 6/14
  - Use of Structured Query Language (SQL)
  - Harrington (2011) Ch.4
  - Auzinš et al. (2018)
  - Discussion 3
  - Reading & Research Assignment 2: Tuesday, 6/15

| **Module 3: Basics of Spatial Databases**

- **Week 6** 6/21
  - Semantic, Ontology and Spatial database infrastructure: Esri Geodatabases (I)
  - Blaser (2014)
  - Hunter (2002)
  - Reading & Research Assignment 3
  - Homework Assignment 3
  - Discussion 3: Tuesday, 6/22
  - Homework Assignment 2: Thursday, 6/24
<table>
<thead>
<tr>
<th>Topic</th>
<th>Readings and Assignments</th>
<th>Deliverables/Due Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Week 7</strong>&lt;br&gt;6/28</td>
<td>Database mechanics</td>
<td>Yeung &amp; Hall (2007) Ch3 p. 79-92</td>
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<td><strong>Module 4: Spatial Data Optimization and Spatial Access</strong></td>
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<tr>
<td><strong>Week 8</strong>&lt;br&gt;7/6*&lt;br&gt;7/5 is university holiday</td>
<td>Spatial data quality and standards: Esri Geodatabases (II)</td>
<td>Yeung &amp; Hall (2007) Ch5&lt;br&gt;Homework Assignment 4&lt;br&gt;Reading &amp; Research Assignment 4</td>
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<tr>
<td><strong>Week 9</strong>&lt;br&gt;7/12</td>
<td>Spatial queries and spatial indexing</td>
<td>Shekhar &amp; Chawla (2003) p. 52-113&lt;br&gt;Yeung &amp; Hall (2007) Ch4 p. 115-125&lt;br&gt;Discussion 4</td>
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<tr>
<td><strong>Week 10</strong>&lt;br&gt;7/19</td>
<td>Time in spatial databases</td>
<td>Parent et al. (2006)</td>
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<td><strong>Module 5: Modern Databases</strong></td>
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<tr>
<td><strong>Week 11</strong>&lt;br&gt;7/26</td>
<td>Introduction to NoSQL databases</td>
<td>Li (2018)&lt;br&gt;Homework Assignment 5&lt;br&gt;Discussion 5</td>
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<tr>
<td><strong>Week 12</strong>&lt;br&gt;8/2</td>
<td>Spatial Big Data and GIS for Smart Cities and Exam Review</td>
<td>Lee &amp; Kang (2015)&lt;br&gt;Li et al. (2020)</td>
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<tr>
<td><strong>Week 13</strong>&lt;br&gt;8/9*&lt;br&gt;*Class ends on 8/13</td>
<td>Geospatial Infrastructure and Comprehensive Exam</td>
<td>Dangermond &amp; Goodchild (2020)</td>
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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](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](policy.usc.edu/scientific-misconduct).

**Support Systems:**

*Counseling and Mental Health* - (213) 740-9355 – 24/7 on call  
[studenthealth.usc.edu/counseling](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](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 Services (RSVP)* - (213) 740-9355(WELL), press “0” after hours – 24/7 on call  
[studenthealth.usc.edu/sexual-assault](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](equity.usc.edu), [titleix.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.

*Reporting Incidents of Bias or Harassment* - (213) 740-5086 or (213) 821-8298  
[usc-advocate.symplicity.com/care_report](usc-advocate.symplicity.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](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 Campus Support and Intervention - (213) 821-4710**
campusupport.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.