GEOG 5212 Geospatial Databases for GIS – Fall 2016

Meeting Times: Tuesdays & Thursdays, 8:00am – 9:20am; Derby Hall 135

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Course Prerequisite: GEOG 5210 Fundamentals of GIS

Course Description: This course focuses on designing, implementing, querying and managing geospatial databases or persistent data stores where most entities have footprints in geographic space and time. This is critical for designing and implementing GIS for projects and organizations. It is also crucial for moving beyond GIS to the bigger world of geographic information services.

In designing any GIS project, a fundamental decision is how to represent the world of interest in the computer. This is critical since no GIS or spatial analysis tools – no matter how powerful – can extract more information than is designed in the database representation. The growing size of geospatial databases requires these databases to support efficient querying and searching. A well designed spatial database can also evolve as the questions in the project or organization change over time. A poorly designed spatial database is difficult to rewind and fix.

Understanding spatial database design and management is not only essential for designing and implementing GIS, but also to support a much wider range of geographic information services such as Google Maps and location-based services such as the location apps on your smartphone. This is a much bigger market than the market for professional GIS services.

Database Technologies: The most common spatial database management system (SDBMS) technology is a specialized object-relational database management system (ORDBMS). An ORDBMS supports objects within a relational (table-based) database and its associated query language, Structured Query Language (SQL). An ORDBMS is a SDBMS if it also supports spatial objects through spatial indexing and spatial (geometric) operations.

ORDBMS with spatial objects is the approach used by ESRI's Geodatabase as well as open-source software such as PostGreSQL/PostGIS. It is also supported by other major vendors such as IBM.

In this course, we will be working with ESRI's ArcGIS Geodatabase and PostGreSQL/PostGIS. There will be a series of assignments using this technology. These will be provided via Carmen and discussed in class.

Learning Objectives: After successful completion of this course, you should:

1. Understand database design with spatial objects,
2. Be able to write spatial queries,
3. Understand physical data storage and performance tuning,
4. Understand spatio-temporal and moving objects data, and
5. Have practical GIS data skills.

Texts (required):

- Worboys, M. & Duckham, M. (2004) *GIS: A Computing Perspective*, 2nd edition.
  - Available at Student Book Exchange (SBX), Barnes & Noble The Ohio State University Bookstore, or Amazon (see https://amzn.com/0415283752).
- Other Readings – Available on Canvas. See course schedule.

Evaluation:

- *Labs*: 50%
  - The labs will involve the process of designing, building, querying and maintaining a spatial database.
  - You will have at least 1 week to complete each lab. Dates relevant to labs (assigned dates and due dates) will be announced as the semester progresses.
  - Do not expect to complete all of your lab work during the scheduled lab time. You may need to dedicate time outside of class to completing your labs.
- *Examinations*: 45%
  - There will be 3 examinations, consisting of multiple choice, matching, true/false, and other questions. Dates of examinations will be announced as the semester progresses.
- *Other*: 5%
  - There may be other tasks/activities you are expected to do or complete as a participant in this course. This other category is intended to reflect your participation in and completion of these tasks/activities.
- *Grading Scale* (OSU standard scale):

A	93-100%	B-	80-82%	D+	67-69%
A-	90-92%	C+	77-79%	D	60-66%
B+	87-89%	C	73-76%	E	0-59%
B	83-86%	C-	70-72%		

Policies:

1. *Disability services*. Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD 292-0901; http://www.ods.ohio-state.edu/
2. *Academic misconduct*. It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of

student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct: http://studentlife.osu.edu/pdfs/csc_12-31-07.pdf

3. *Examination policy*. Exams must be taken at the scheduled time, unless you have a documented reason for your absence at the regular scheduled exam time. You also must contact me in advance of the scheduled exam, except in the case of emergency.
4. *Labs policy*. Assignments will be penalized 10% for each day late and will not be accepted after the third day. Do NOT keep your work on the lab computers only! You are responsible for backing up your work (via BuckeyeBox, flash drive, external hard drive, or other method). Extensions will not be granted due to lost work.
5. *Technology policy*. This is the 21st century, so I will not ban the use of laptops, tablets and other digital devices. However, there are some guidelines and restrictions:
   a. Be mindful – when you are emailing, tweeting, texting, updating, surfing, etc. you are not paying attention. Research shows that no one can multitask that well – not even you. Paying attention and taking good notes is essential to success in this course. Why are you here?
   b. Be courteous – your use of digital devices should not distract other students in the class. It is unlikely that taking notes or searching class-relevant topics will be distracting. However, viewing videos of kittens or ice bucket challenges will likely distract others. Complaints about inappropriate technology use in class will result in your privileges being curtailed or revoked.
   c. Be honest - emailing, surfing, and the use of any other applications or technologies is not allowed during the computer-based examinations. Be aware that your activity on the lab desktop computers may be monitored during exams.

Canvas:
You are responsible for all announcements, additional reading, assignments and other material posted at the Canvas site, so be sure to check it frequently.

Other Readings: All of the readings below (with the exception of Worboys and Duckham) are available on Canvas. All readings mentioned explicitly in the course schedule are required. Any other readings and web resources are optional, but they may be useful for additional background or additional information.

- N: Navathe, S. B. (1992). Evolution of data modeling for databases. *Communications of the ACM, 35*(9), 112-123.
- RG: Ramakrishnan, R. & Gehrke, J. (1999) *Database Management Systems*, 2nd edition.
- SC: Shekhar, S. & Chawla, S. (2003) *Spatial Databases: A Tour*. Chapters 1 & 3.
- WD: Worboys and Duckham
- Z: Zeiler, M. (2010) *Modeling Our World: The ESRI Guide to Geodatabase Concepts*, 2nd edition. Chapter 1.

Course Outline:

TOPIC	READINGS
Course overview	Syllabus
Section 1: Introduction to spatial databases	
Introduction to databases	WD 1-43 & N
Introduction to spatial databases	SC Chapter 1
Lab 1: Introduction to Arc Geodatabase	Z
Section 2: Designing spatial databases	
Conceptual data modeling	WD 43-45 & RG Chapter 2
Lab 2: Conceptual data modeling	
Logical data modeling and normalization	WD 55-71
Lab 3: Logical data modeling	
Object-oriented modeling	WD 71-82
Lab 4: OO modeling	
Spatial fields, objects and relations	WD 133-165
Exam 1 (Sections 1 & 2)	
Section 3: Querying spatial databases	
Querying and relational algebra	WD 46-52 & RG Chapter 5 (pp. 119-150 only)
Lab 5: Building a Geodatabase in ArcGIS	
SQL and spatial querying	SC Chapter 3
Lab 6: Querying in ArcGIS	
Section 4: Spatial data storage and access	
Data storage and file structures	WD 221-225 & RG Chapter 8
Lab 7: Building a spatial database in PostgreSQL	
Non-spatial database indices	WD 225-229
2D orderings and indexing raster data	WD 229-239 & RG Chapter 26
Indexing spatial objects	WD 240-258 & RG Chapter 26
Exam 2 (Sections 3 & 4)	
Section 5: Architectures	
Architectures and data heterogeneity	WD 259-266
Lab 8: Querying in PostgreSQL	
Distributed systems and databases and location-aware computing	WD 266-278 & WD 278-291
Exam 3 (cumulative, emphasis on Section 5)	Tuesday, December 13th 8:00am – 9:45am

Disclaimer: This course syllabus provides a general plan for the course; deviations may be necessary. Any changes will be announced by the instructor with as much advance notice as possible.