GEOGR 5212 Geospatial Databases for GIS - Spring 2017

Instructor	Harvey J. Miller
Lecture/lab meeting time and location	Tuesdays 3:55PM - 5:15PM, Caldwell Lab 120 (classroom) Thursdays 3:55PM - 5:15PM Derby Hall 135 (computer lab)
Office hours and location	Tuesdays, Thursdays, 2:00 pm - 3:30pm (or by appointment) Derby Hall 1176
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Graduate Teaching Associate:	**Hui Kong** (kong.174@osu.edu). Ms. Kong is a PhD student focusing on quantitative urban studies, urban development, and spatial simulation and modeling.

Course prerequisite

GEOG 5210 Fundamentals of GIS

Texts

1. Required
   - Worboys, M. and Duckham, M. (2004) *GIS: A Computing Perspective.*
   - Other readings – see course schedule**.**

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 the geospatial 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;
5. Have practical data modeling and GIS database skills

Evaluation

Examinations: 50% of the final grade
Labs: 50% of the final grade
Grading scale: (OSU standard scale) A 93-100%; A- 90-92%; B+ 87-89%; B 83-86%; B- 80-82%; C+ 77-79%; C 73-76%; C- 70-72%; D+ 67-69%; D 60-66%; E 0-59%

Examinations

Examinations will be administered using CARMEN during regular class time using the computers in Derby 0140. There will be 3 midterm examinations, consisting of 20-25 multiple choice, matching and true/false questions

Labs

The labs will involve the process of designing, building, querying and maintaining a spatial database. These will be software-based, focusing on the ArcGIS Geodatabase technology from ESRI, Inc as well as PostGreSQL/PostGIS, an open source alternative. The labs will involve an in-class demonstration, followed by an assignment to be completed on your own within a designated time limit.

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. Assignments policy: Assignments will be penalized 10% for each day late and will not be accepted after the third day.

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:

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?

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 kitten videos will likely distract others. Complaints about inappropriate technology use in class will result in your privileges being curtailed or revoked.

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.

Carmen

You are responsible for all announcements, additional reading, assignments and other material posted at the Carmen site, so be sure to check it frequently. I will also be posting PDFs of the slides I use in the lectures, as well as links to helpful and interesting websites.

Readings

All of the readings below (with the exception of Worboys and Duckham) are available at Carmen. There are also other readings and web resources at Carmen. All readings mentioned explicitly in the course schedule are required. All other readings and web resources are optional – please use these for additional background or additional information.

- **Navathe (1999)**: Navathe, S. B. (1992) "Evolution of data modeling for databases," *Communications of the ACM*, 35(9), 112-123.
- **RG**: Ramakrishnan, R. and Gehrke, J. (1999) *Database Management Systems*, second edition.
- **SC:** Shekhar, S. and Chawla, S. (2003) *Spatial Databases: A Tour*. Chapters 1, 3
- **WD**: Worboys and Duckham
- **Zeiler 1-19**: Chapter 1 of Zeiler, M. (2010) *Modeling Our World: The ESRI Guide to Geodatabase Concepts*, second edition.

Course schedule (Spring 2017)

Topic	**Readings**	**Date**
Course overview	Syllabus	10 January
Introduction to spatial databases		
Introduction to databases	WD 1-43 Navathe (1999)	12 January
Introduction to spatial databases	SC Chp. 1; Zeiler 1-19	17 January
Lab 1: Introduction to Geodatabase		19 January
Designing spatial databases		
Conceptual data modeling	WD 43-45 RG Chp. 2	24 January
Lab 2: Conceptual data modeling		26 January
Logical data modeling and normalization	WD 55-71	31 January
Lab 3: Logical data modeling		2 February
Object-oriented modeling	WD 71-82	7 February
Lab 4: OO modeling		9 February
Spatial fields, objects and relations	WD 133-165	14 February
Exam 1		**16 February**
Querying spatial databases		
Querying and relational algebra	WD 46-52 RG Chp. 5 (pp. 119-150 only)	21 February
Lab 5: Building a Geodatabase in ArcGIS		23 February
SQL and spatial querying	SC Chp. 3	28 February
Lab 6: Querying in ArcGIS		2 March
Spatial data storage and access		
Data storage and file structures	WD 221-225 RG Chp. 8	7 March
Lab 7: Building a spatial database in PostgreSQL		9 March
Spring Break: 14 – 18 March 2016		
Non-spatial database indices	WD 225-229	21 March
2D orderings and indexing raster data	WD 229-239 RG Chp. 26	23 March
Indexing spatial objects	WD 240-258 RG Chp. 26	28 March
Exam 2		**30 March**
No class (AAG meeting)		4 April
No class (AAG meeting)		6 April
Architectures		
Architectures and data heterogeneity	WD 259-266	11 April
Lab 8: Querying in PostgreSQL		13 April

Distributed systems and databases	WD 266-278	18 April
Location-aware computing	WD 278-291	20 April
Exam 3	**1 May 6:00pm-7:45pm**	

Assignments		
Topic	**Assigned date**	**Due date (by noon)**
Lab 1: Introduction to Geodatabase	19 January	26 January
Lab 2: Conceptual data modeling	26 January	2 February
Lab 3: Logical data modeling	2 February	9 February
Lab 4: OO modeling	9 February	16 February
Lab 5: Building a Geodatabase in ArcGIS	23 February	2 March
Lab 6: Querying in ArcGIS	2 March	9 March
Lab 7: Building a spatial database in PostgreSQL	9 March	16 March
Lab 8: Querying in PostgreSQL	13 April	20 April