

## GEOGR 5212 Geospatial Databases for GIS - Spring 2016

<b>Instructor</b>	Harvey J. Miller
<b>Lecture/lab meeting time and location</b>	Tuesdays 3:55PM - 5:15PM, Denney Hall 238 (classroom) Thursdays 3:55PM - 5:15PM Derby Hall 0140 (computer lab)
<b>Office hours and location</b>	Tuesdays, Thursdays, 1:30 pm - 3:00pm (or by appointment) Derby Hall 1176
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### 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](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 2016)

<u>Topic</u>	<u>Readings</u>	<u>Date</u>
Course overview	Syllabus	12 Jan 2016
<b>Introduction to spatial databases</b>		
Introduction to databases	WD 1-43 Navathe (1999)	14 Jan 2016
Introduction to spatial databases	SC Chp. 1	19 Jan 2016
<i>Lab 1: Introduction to Arc Geodatabase</i>	Zeiler 1-19	21 Jan 2016
<b>Designing spatial databases</b>		
Conceptual data modeling	WD 43-45 RG Chp. 2	26 Jan 2016
<i>Lab 2: Conceptual data modeling</i>		28 Jan 2016
Logical data modeling and normalization	WD 55-71	2 Feb 2016
<i>Lab 3: Logical data modeling</i>		4 Feb 2016
Object-oriented modeling	WD 71-82	9 Feb 2016
<i>Lab 4: OO modeling</i>		11 Feb 2016
Spatial fields, objects and relations	WD 133-165	16 Feb 2016
<b>Exam 1</b>		<b>18 Feb 2016</b>
<b>Querying spatial databases</b>		
Relational algebra and SQL	WD 46-52 RG Chp. 5 (pp. 119-150 only)	23 Feb 2016
<i>Lab 5: Building a spatial database in postGIS</i>		25 Feb 2016
Spatial queries	SC Chp. 3	1 March 2016
<i>Lab 6: Spatial querying using SQL</i>		3 March 2016
<b>Spatial data storage and access</b>		
Data storage and file structures	WD 221-225 RG Chp. 8	8 March 2015
<i>Lab 7: Building a Geodatabase and spatial querying in ArcGIS</i>		10 March 2016
<b>Spring Break: 14 – 18 March 2016</b>		
Non-spatial database indices	WD 225-229	22 March 2016
2D orderings and indexing raster data	WD 229-239 RG Chp. 26	24 March 2016
No class (AAG meeting)		29 March 2016
No class (AAG meeting)		31 March 2016
Indexing spatial objects	WD 240-258 RG Chp. 26	5 April 2016
<b>Exam 2</b>		<b>7 April 2016</b>

<b>Architectures</b>		
Architectures and data heterogeneity	WD 259-266	12 April 2016
<i>Lab 8: Web-based GIS</i>		14 April 2016
Distributed systems and databases	WD 266-278	19 April 2016
Location-aware computing	WD 278-291	21 April 2016
<b>Exam 3</b>	<b>2 May 2016 6:00pm-7:45pm</b>	