GEOGR 5223 – Design and Implementation of GIS - Spring 2015

Instructor	Harvey J. Miller
Lecture/lab meeting time and location	Mondays, Wednesdays 3:55PM - 5:15PM Derby Hall 0140
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Course prerequisite

GEOG 5210 Fundamentals of GIS

Texts

1. Required
   - (WD) Worboys, M. and Duckham, M. (2004) *GIS: A Computing Perspective.*
   - Other readings – see course outline and schedule**.**
2. Optional
   - (SC) Shekhar, S. and Chawla, S. (2003) *Spatial Databases: A Tour.*
   - Zeiler, M. (2010) *Modeling Our World: The ESRI Guide to Geodatabase Concepts*, second edition.

Course description

The future will be data-driven. Most scientific and professional enterprises, as well as consumers, are generating and using data in most activities. Much of these data will be georeferenced and have geospatial footprints.

This course focuses on designing, implementing, querying and managing *spatial 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 technology

The most common *spatial database management system* (SDBMS) technology is a specialized type of *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* (points, lines, polygons, fields), *spatial operations* (e.g., queries that consider distance, direction, connectivity and inclusion in space) and *spatial indexing (fast access to spatial data based on location).* Data streams from *geosensors* (georeferenced sensors) and mobile devices such as GPS receivers, mobile phones and other *location-aware technologies* is also leading to development of spatio-temporal and mobile objects databases.

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. 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;
5. Have practical GIS data skills

Evaluation

Examinations: 50% of the final grade
Assignments: 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 5 short midterm examinations, consisting of 20-25 multiple choice, matching and true/false questions.

Assignments

There will be a series of assignments this semester. Some assignments will involve ESRI online courses to help familiarize you with Arc Geodatabase. Other assignments will focus on the activities of designing, building, querying and maintaining a spatial database using Geodatabase.

I will announce assignments and provide material via Carmen. You will also turn in assignments via Carmen. Some assignments will involve an in-class demonstration and supervised activity, followed by tasks 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. 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 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.
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.

Course outline and schedule - Spring 2015 (subject to change)

Topic	**Readings**	**Date**
Course overview	Syllabus	12 Jan
Introduction		
Introduction to databases	WD 1-43	14 Jan
No class – MLK Day		19 Jan
Introduction to spatial databases	SC 1-20	21 Jan
Spatial object-relational databases	Zeiler 1-19	21 Jan
Exam 1: 26 Jan 2015		
Object-relational databases and spatial objects		
Relational databases	WD 43-45	28 Jan
Database design	WD 55-71	28 Jan & 2 Feb
Object-orientation and spatial objects	WD 71-82	4 Feb & 9 Feb
Relational algebra and SQL		
Overview of relational algebra and SQL	WD 46-52	11 Feb
Examples	SC 52-82	11 Feb
Exam 2: 16 Feb 2015		
Structures and access methods		
General database structures and access	WD 221-229	18 Feb
From one to two dimensions	WD 229-234	23 Feb
Raster structures	WD 234-240	25 Feb
Point structures	WD 240-248	25 Feb
Linear objects	WD 248-250	2 March
Object collections	WD 250-255	4 March
Spherical data structures	WD 255-258	9 March
Exam 3: 11 March 2015		
Spring Break 16 – 20 March 2015		
Architectures		
Hybrid, integrated and composable architectures for geospatial data	WD 259-262	23 March
Syntactic and semantic heterogeneity	WD 262-266	25 March
Distributing systems over	WD 266-278	30 March
Location-aware computing	WD 278-291	1 April
Exam 4: 6 April 2015		

Time		
Introduction	WD 359-367	8 April
Temporal databases and versioning	WD 367-371	13 April
Spatio-temporal databases	WD 371-382	15 April
Moving objects concepts	Andrienko et al. (2008)	20 April
Moving objects databases	Frentzos et al. (2008)	22 April
Exam 5: 27 April 2015		

Readings:

Andrienko et al. (2008): Andrienko, N., Andrienko, G., Peelkis, N. and Spaccapetra, S. (2008) "Basic concepts of movement data," in F. Gianotti and D. Pedreschi (eds.) *Mobility, Data Mining and Privacy*, Springer.

Frentzos et al. (2008): Frentzos, E., Pelekis, N., Ntoutsi, I. and Theodoridis, Y. (2008) "Trajectory database systems," in in F. Gianotti and D. Pedreschi (eds.) *Mobility, Data Mining and Privacy*, Springer

SC 1-20: Chapter 1 of Shekhar and Chawla.

SC 52-82: Chapter 3 of Shekhar and Chawla.

WD : Worboys and Duckham

Zeiler 1-19: Chapter 1 of Zeiler (2010)