Spatial Databases

Course Outline

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Lab/Office Hours: 8:30-10:00am Tues. and 12:30-2:00pm Wed. or by Appointment

Lab Hours: 08:30-10:20am Tues., EV1-240; 12:30-2:20pm Wed., EV1-240

Overview

Geospatial data and information are used in a wide variety of planning, facilities management, business, resource management, location based services, and applied research applications. A key component of any spatially enabled solution is the underlying geospatial database that must be designed to support efficient data maintenance and analysis in a heterogeneous operating environment (i.e., different users sharing common data but have differing end uses and technology to access, create, analyze, and generate information with the geospatial data).

Presently, vast quantities (> exabytes) of geospatial data and information at local, regional and global scales are continuously being collected, created, managed and used by the private and public sector, academic research communities and the broader public for spatial decision support and location based services. This requires highly scalable, highly available, secure, open, standards-based geospatially enabled Database Management Systems (DBMS).

This course is an introductory-level geospatial database design, implementation, management, and access course for students interested in organizing spatial and non-spatial data in geospatially enabled enterprise Database Management Systems (DBMS). Students will gain a basic understanding of database systems terminology, design principles, and issues facing database managers and analysts. They will gain practical database experience utilizing commercial database management system software and geographic information systems software to design and use spatial and non-spatial data.
This course is a prerequisite to the Geography / Planning 487 courses and part of the requirements for the Diploma of Excellence in GIS. **Prerequisite:** Successful completion of Geography or Planning 281.

**Objectives**

The overarching goal of this course are: to develop a sound understanding of the principles and techniques of database design and development as they apply to geospatial data; apply these principles and techniques in designing and building geospatial databases; use geospatial databases to perform common types of queries and geospatial analyses; and publish spatial data to the internet.

Specifically, the objectives of this course are as follows:

1. To introduce students to enterprise geospatial database management systems, principles, terminology, architecture and technology,
2. To provide students with experience creating, documenting, editing, managing a geospatial database using a variety of software systems and tools, including:
   - ArcGIS, ArcCatalog
   - Safe Software’s Feature Manipulation Engine (FME)
   - Oracle Spatial, Oracle SQL Developer, Oracle SQL Modeler
3. To introduce students to ArcGIS’ and Oracle’s commonly-used spatial analysis, query and information production procedures.
4. To provide students with an introduction to the fundamental social and managerial dimensions of geospatial data creation and use.

Upon completing this course, students will be able to:

- Create, edit and document geospatial datasets,
- Develop and document a conceptual design a geospatial database for a specific applied problem.
- Populate a geospatial database through a variety of means (e.g., data migration, conflation, GPS, and creation via analysis)
- Build and use key geodatabase components (e.g. attribute domains, topology rules, relationship classes) to maintain data integrity and facilitate database queries,
- Possess knowledge regarding the development, operation and application of Enterprise Geospatial Database Management Systems for managing geospatial data originating from a variety of sources (CAD, GIS, GPS, Imagery & Open Source).

**Pre-requisite**

GEOG / Plan 281

**Text and Readings**

There is no text for this course. Course notes, lecture presentations, links to recommended readings and tutorials will be provided in this syllabus and on the Desire2Learn course website (http://learn.uwaterloo.ca). Students are expected to make extensive use of the ArcGIS, Oracle Spatial and FME on-line help and web resources. Selected links will be provided on the course website.

**Schedule**

The class meets from 1:30 to 3:20 on Thursdays in EV1-132. Class time will be used to introduce concepts and techniques related to spatial database design and development, demonstrate methods needed for the lab
assignments, and deal with questions related to the lab exercises. Table 1., details the course schedule, lecture topics, suggested readings, resources, tutorials and assignment hand out and submission dates.

Learning modes and course format

This course builds upon the understanding of GIS concepts you gained in Geography / Planning 281 through a series of compulsory lectures, tutorials and lab sessions. Lectures will be used to discuss concepts, principles and technics of geospatial database analysis, design and implementation coupled with access, query, analysis and reporting processes using data held in a database. The third hour of the class will be used for workshops, lab demonstrations and/or for you to work on your assignments.

Hands-on work with ArcGIS, FME and Oracle Spatial, SQL Developer/Modeler will take place in the Galileo GIS lab (EV1-240). The lab assignments are designed to build your skills in using GIS and database software systems and tools to strengthen your understanding of how geospatial analytics can be properly applied to real world problems. The Galileo lab (EV1-240) has been reserved 10:30-11:30am Mondays and Thursdays for GEOG 387.

Note that developing a strong understanding of geospatial database concepts and the corresponding practical skills necessary to complete the assignments requires a significant investment of time. In addition to the scheduled class and lab time, student should expect to spend a least 5 hours per week working on course assignments. These time requirements will vary from student-to-student. Students who are unwilling or unable to make this time commitment should consider other courses.

Resources

Computer Labs
You can use the Galileo (EV1-240), Geddes (EV2-1002A) or Magellan (EV2-1014) labs for practical work in this course when they are not booked for other courses. The required software is also available in the main MAD lab (via festerm1.uwaterloo.ca) and can be accessed from off-campus by logging in to the terminal server (festerm1.uwaterloo.ca).

Note: No food or drink is allowed in the labs. Failure to abide by this rule may result in your computer accounts being suspended.

Course Website
A website for this course has been created as part of the Desire2Learn (D2L) system. Students in the course can access the course website by going to the D2L homepage (http://learn.uwaterloo.ca) and entering their UW userid and password in the logon form displayed on this page. Once you are logged on to D2L, you will see a list of courses that you are registered in. Click on GEOG/Plan 387 to select this course.

The course website provides access to lecture presentations, course notes on selected topics, tutorials, assignment scripts and datasets needed for the assignments. These documents can be opened or downloaded by clicking on the appropriate link. In addition, the course website supports announcements, discussion groups and e-mail.
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<tr>
<th>Date</th>
<th>Lectures</th>
<th>Workshops/Demos</th>
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<tr>
<td>May 03</td>
<td>Course Overview</td>
<td>Brief History of GIS &amp; Future Trends</td>
<td>ArcGIS 10 Assignment 1 briefing</td>
<td>Building a GeoDB 1-4</td>
<td>Hand out. Assignment 1. (20%) Geodatabase Basics:</td>
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<td>Why a Geodatabase? Definition &amp; key terms</td>
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<td>Introduction to Editing 1-2</td>
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<td>May 10</td>
<td>Spatial Data Modeling</td>
<td>Data Standards Coordinate Reference Systems</td>
<td>Creating a Geodatabase in ArcCatalog Loading External Data FME Workbench</td>
<td>Introduction to Editing 4-5</td>
<td>Building a Geodatabase 8</td>
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<td>Spatial Data Models</td>
<td>Spatial Metadata</td>
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<td>May 17</td>
<td>Geodatabase Design Strategies</td>
<td>Database Models Entity-Relationship (E-R) Models Normalization Data Dictionary</td>
<td>Assignment 2 briefing Spatial Data Input &amp; Editing, Geocoding, GPS Data, Metadata FME Workbench</td>
<td>FME Workbench</td>
<td>Assignment 1 Due 11:59am</td>
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<td>Safe FME <a href="http://fmepedia.safe.com/">http://fmepedia.safe.com/</a></td>
<td>Restructuring</td>
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<td>FME Workbench</td>
<td><a href="http://safe.com/learning/training/training-catalog/#desktoptutorial">http://safe.com/learning/training/training-catalog/#desktoptutorial</a></td>
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<td>May 24</td>
<td>Spatial vs Non spatial databases? Database Types</td>
<td>Database management system architecture: conceptual, logical, and physical</td>
<td>Introduction to Oracle Spatial SQL Developer SQL Modeler</td>
<td>FME Workbench</td>
<td>Hand out. Assignment 2 Due 11:59am</td>
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<td>Chapter 4: Content Trans. Chapter 5: Data</td>
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<td>catalog/#desktoptutorial</td>
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<td>May 31</td>
<td>Structured Query Language (SQL)</td>
<td>Non Spatial and Spatial Indexes</td>
<td>Assignment 3 briefing Advanced Oracle Spatial SQL Developer SQL Modeler</td>
<td>Tutorial: Getting Started with Oracle Spatial</td>
<td>Hand out. Assignment 3. (20%) Building and query/</td>
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<td>Spatial query/analysis w/ SQL</td>
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<td>Open Geospatial Consortium <a href="http://www.opengeospatial.org/">http://www.opengeospatial.org/</a></td>
<td>SQL Reference tool</td>
<td>analysis of a Spatial Database using Oracle</td>
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<td>Jun 07</td>
<td>Spatial Operators</td>
<td>Short &amp; Long Transactions Version Management</td>
<td>Smallworld Technical Paper No. 4 - Version Management in GIS - Applications and Techniques</td>
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### Table 1. Continued... Course Schedule

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<td>Jun 14</td>
<td>Spatial Joins Topology</td>
<td>Guest Lecture TBD</td>
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<td>Assignment 3 Due 11:59am</td>
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<td>Jun 21</td>
<td>3D/4D Terrain and Surface Modelling</td>
<td>TINs, DEMs, Point Clouds</td>
<td>Assignment 4 briefing Searching and retrieving Open Source Geospatial Data</td>
<td>OSGeo <a href="http://www.osgeo.org/">http://www.osgeo.org/</a>  &lt;br&gt; <a href="http://www.openstreetmap.org/">OpenStreetMap</a></td>
<td>3D Analyst Tutorial 1, 4 &lt;br&gt; Hand out. Assignment 4. (20%) Building a Spatial Database Using Open Data Sources with Oracle</td>
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<td>Jun 28</td>
<td>Network Modeling Schematics</td>
<td>Enterprise Geo DBMS for Network Utilities</td>
<td>GE Smallworld, Physical Network Inventory (for Telecom) Demonstration</td>
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<td>Assignment 4 Due 11:59am</td>
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<td>July 05</td>
<td>Modeling the Built Environment</td>
<td>Building Info Models (BIMs) 3D City GML</td>
<td>CityGML <a href="http://www.citygml.org/">http://www.citygml.org/</a>&lt;br&gt;<a href="http://www.3dcitydb.net/">3D City GML Database</a></td>
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<td>Assignment 4 Due 11:59am</td>
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<td>July 19</td>
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<td>Take home exam due 5:00pm</td>
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<td>July 19</td>
<td>Brief Course Summary</td>
<td>Course Evaluation In class, online Quiz</td>
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<td>Term Test: Take home + Quiz = (20%)</td>
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Getting Help
Students are expected to get into the habit of using the on-line resources as the first source of help. I will be available in my office for consultation during regular office hours or by appointment. Additional help is available during the scheduled lab sessions and from the MAD help desk.

Evaluation
Lab assignments will account for 80% of the final mark and will be weighted as indicated in the course schedule table. There will be a test at the end of the term which will count for 20% of the final mark in the course.

Assignments must be submitted to the appropriate digital drop box on the course website by 11:55 p.m. on the specified due date. Any hardcopy portions of the assignment must be turned in at the beginning of class (Jan.23, Feb.06, Mar.05, Mar.26). Every student will be permitted to submit one assignment late without penalty within seven (7) days of original due date, else a mark of 0. Otherwise, late assignments will not be accepted and will receive a mark of 0. Exceptions may be made for documented medical reasons.

The term test will count for 20% of your final mark. The final course evaluation will consist of a take-home test that will be assigned on Monday March 26 and must be submitted by 11:55pm Sunday April 01, 2012 and an on-line quiz written during the regular class time on Monday April 02, 2012. The two parts of the test will be equally weighted.

UW Policies

**Academic Integrity:** To create and promote a culture of academic integrity, the behaviour of all members of the University of Waterloo is based on honesty, trust, fairness, respect and responsibility.

**Grievance:** A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70 - Student Petitions and Grievances, Section 4, [http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm)

**Discipline:** A student is expected to know what constitutes academic integrity, to avoid committing academic offenses, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offense, or who needs help in learning how to avoid offenses (e.g., plagiarism, cheating) or about “rules” for group work/collaboration should seek guidance from the course professor, academic advisor, or the Undergraduate Associate Dean. When misconduct has been found to have occurred, disciplinary penalties will be imposed under Policy 71 – Student Discipline. For information on categories of offenses and types of penalties, students should refer to Policy 71 - Student Discipline, [http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm)

**Appeals:** A student may appeal the finding and/or penalty in a decision made under Policy 70 - Student Petitions and Grievances (other than regarding a petition) or Policy 71 - Student Discipline if a ground for an appeal can be established. Read Policy 72 - Student Appeals, [http://secretariat.uwaterloo.ca/Policies/policy72.htm](http://secretariat.uwaterloo.ca/Policies/policy72.htm)