Course Syllabus

SIE 555 Spatial Database Systems

Course Description (expanded)

Due to modern technology such as high-resolution raster satellite images of the earth, inexpensive Global Positioning System (GPS), wireless communication ability of powerful small computers and sensors in the field, vastly growing amounts of geo-spatial data are available in digital form today. The objective of this course is to provide an understanding of the role of spatial database systems in managing, organizing, sharing, and querying this data. This course introduces spatial database system as a combination of spatial data collections and appropriate management software. The main part of the course focuses on the database management system (DBMS). A DBMS offers a data model and query language to structure and query data collections, and shields a user from implementation and execution details. The course introduces several data models and query languages for spatial data collections. Following, the course looks 'behind the covers' of a DBMS, and investigates the processing of spatial data and spatial data queries from the bottom up. This includes the storage hierarchy in DBMS, file organizations, the use of spatial index structures, the implementation of single relational and spatial operators, and the processing and optimization of spatial query consisting of a set of spatial operators. Furthermore, the aspect of transaction management and crash recovery is handled, considering both a centralized and distributed DBMS. The course balances academic insights, and principles with real-world, commercially available spatial database systems. Lec 3. Cr.3

Prerequisites: SIE550, programming experience in Java, or C++

Course Goals and Objectives:

- Introduce students to principles of spatial database systems
- Develop an understanding of spatial data storage, management and efficient processing in database systems
- Expose students to spatial database systems as efficient software tools for management, retrieval and sharing of massive spatial data

Expected Outcomes:

- Understand underlying architecture of spatial database systems
- Understand roles and functions of components in spatial database systems
- Understand core technologies and standards
- Understand factors involved in performance, integration, and evaluation of systems

Contact Information:

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Office Hours:
Office hours for this course will be announced at the beginning of the semester. Alternatively, contact me

Instructional Materials and Methods

Philippe Rigaux, Michel Scholl, Agnes Voisard, *Spatial Databases,* Morgan Kaufmann Publishers.
Raghu Ramakrishnan, Johannes Gehrke, *Database Management Systems*, McGraw Hill.

The text will be supplemented with additional reading materials on emerging topics.

Grading and Course Expectations

Grading criteria:

Assignments – 30%
Midterm –30%
Final Exam – 30%
Class participation 10%

If you are absent due to illness or similar valid excuse, please notify me of your situation at nittel@spatial.maine.edu immediately prior to or after your absence.

Tentative exam schedule:

Tentative times for exams are listed on the schedule below

Course Schedule

See the attached tentative schedule of class session topics, reading assignment due dates, and dates for exams.

Class Policies

Attendance and class participation are expected. Ten percent of the course grade is dependent on participation in class.

Late assignments, make-up, retake and rescheduled exams, and extra credit:

Assignments submitted after the due date are docked 10 percent per day and will not be accepted for credit after a week. If you miss an exam due to an illness or emergency, you must send notification prior to the exam by email and special arrangements must be made with the instructor to consider your situation.

Incomplete work:

Incomplete or insufficient work may not be made up. It merely receives a low grade.

Academic honesty:

Academic honesty is expected. Plagiarism is unacceptable in this course and will result in a failing grade. "Although a writer may use other persons' words and thoughts, they must be acknowledged as such." Joseph Gibaldi and Walter S. Achtert, MLA Handbook (Modern Language Association) 1977, p. 4.

Students with disabilities:

If you have a disability for which you may be requesting an accommodation, please contact Ann Smith, Coordinator of Services for Students with Disabilities (Onward Building, 581-2319), as early as possible in the term.

Extended disruption:

In the event of an extended disruption of normal classroom activities, the format for this course may be modified to enable its completion within its programmed time frame. In that event, you will be provided an addendum to the syllabus that will supersede this version.

UMaine's Sexual Discrimination Reporting:
The University of Maine is committed to making campus a safe place for students. Because of this commitment, if you tell a teacher about an experience of sexual assault, sexual harassment, stalking, relationship abuse (dating violence and domestic violence), sexual misconduct or any form of gender discrimination involving members of the campus, your teacher is required to report this information to the campus Office of Sexual Assault & Violence Prevention or the Office of Equal Opportunity.

If you want to talk in confidence to someone about an experience of sexual discrimination, please contact these resources:

For confidential resources on campus: Counseling Center: 207-581-1392 or Cutler Health Center: 207-581-4000.

- For confidential resources on campus: Rape Response Services: 1-800-310-0000 or Spruce Run: 1-800-863-9909.
- The following resources on campus can offer support but may have to report the incident to others who can help: Office of Sexual Assault & Violence Prevention: 207-581-1406, Office of Community Standards: 207-581-1409, University of Maine Police: 207-581-4040 or 911.

See the OSAVP website for a complete list of services at http://www.umaine.edu/osavp/

Course Schedule

Week 1
- Course Introduction – What are Database Systems?
- Layered Database Architecture
- Data Independence

Week 2
- DBMS Technology for Spatial Database System
- Spatial Data Models and Query Languages (Spatial SQL)

Week 3
- Spatial Data Models and Query Languages (Realms)
- Spatial Data Models and Query Languages (Constraint Data Model)

Week 4
- Storage Structures
- File Organization for Non-Spatial and Spatial Data

Week 5
- Non-Spatial Index Structures (Tree-Structured)
- Non-Spatial Index Structures (Hash-Based)

Week 6
- Spatial Index Structures (Data-Driven, R-Tree, R*-Tree)
- Spatial Index Structures (Space-Driven, Grid File)

Week 7:
- Spatial Index Structures (Space-Driven, Quadtree, z-Ordering Tree)
- Optimal I/O Algorithms (External Sort/Merge, Distribution Sweeping)

Week 8
- Implementation of Relational Operators (Joins)
- Implementation of Spatial Join Operators (z-Ordering Spatial Join, Joining 2 R-Trees)
- **Midterm**

Week 9
- Implementation of Spatial Join Operators (Spatial Hash Join)
- Query Processing and Optimization

Week 10
- Spatial Query Processing
- Spatial Query Processing (Multiway Joins)

Week 11
- Transaction Management (Schedules)
- Transaction Management (Lock-based Transactions)

Week 12
- Crash Recovery (Logging)
- Crash Recovery (Recovery Protocol)

Week 13
- Distributed DBMS (Data Replication)
- Distributed DBMS (Distributed Transaction Management)

Week 14
- Distributed DBMS (Distributed Recovery)
- Integrating Heterogeneous Spatial DBMS (Syntactic Integration)

Week 15
- Integrating Heterogeneous Spatial DBMS (Structural Integration)
- Integrating Heterogeneous Spatial DBMS (Semantic Integration)

Week 16
- **Final Exam**