

CSc 81040 Theory of Database Systems

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Course Description

Database and Systems (DBMS) are vital components of modern information systems serving every type of organizations. We can hardly envision any computer application that does not utilize a DBMS. Thus, database applications are pervasive and range in size from in-memory databases to terra bytes or even larger in various applications domains such as commercial, spatial, biological, scientific applications. The course is designed to develop an understanding of the fundamental concepts and issues in database research and extend it to knowledge representation.

Course Objectives

- Help students to raise their understanding of Knowledgebase and Databases.
- Understand the role that DBMS play in different application domains and how they are used.
- Identify problems and opportunities that can benefit from Knowledgebase and Databases support.
- Understand the key DB components such as data modeling, query languages and query processing, etc and identify the issues in them.
- Understand key concepts in knowledge representation, ontologies and inferencing.
- Develop an understanding of trends in the DBMS field.
- Prepare students to do research in DBMS and/or knowledge representation.
- Appreciate the crucial role that Knowledgebase and Databases play in students' career as well as in society in the 21st century.

Course Content

The course focuses on the fundamentals of knowledgebase and relational database management systems, and the current developments in database theory and their practice. We will focus on theoretical aspects of the important issues in DBMS and knowledge representation. However, we will also give a chance to students who are interested in the practical and implementation aspects of DBMS.

Issues in database design, implementation, and application such as SQL, conceptual data modeling, data integrity and security, query processing and optimization, temporal databases, XML, ontologies, RDF, OWL, Medical Informatics and Diagnostic and Treatment systems are among the topics to be discussed.

Learning Goals

Because of its content and its emphasis on research, the course aims at achieving the following learning outcomes:

- An appreciation of pervasive use of Knowledgebase and DBMS in different application domains.
- Skills for devising data models and query languages.
- Integration of Knowledgebase, DBs and other information technology components.
- Skills to survey a DBMS topic and identify the issues and open problems.
- Learning knowledge representation and inference methods.
- Skills to formulate possible solutions and evaluate the performance of these solutions.
- Ability to write a research report.

Course Requirements

The course does not require any exams. Each student will prepare a research report that surveys an issue in Knowledgebase or DBMS and tackles a possible problem in that area. Grading will be based on the attendance, student presentation, monthly progress reports and the final research report. Students can work in groups if they desire so, upon the consent of the instructor. I will provide a list of possible research problems that can reasonably be handled in a term. Student can pick a topic from this list or can also work on any database related topic approved by the instructor. Although it is not required we will consider worthy reports for possible conference or journal publications.

Course Delivery

The course includes in the first half of the term lectures by the instructor about the essential topics to provide the students the necessary base for further research. In the second half we will read articles, students will present these articles and their surveys.

Please feel free to contact me via email or phone to discuss possible research topics or any other issues related with this course.

Tentative course outline: Following is a tentative course outline. Depending on the student interest and their prior exposure to DBMS we will rework it at the beginning of the term and may shift the course to more student presentations. Depending on our progress we can mix the lecture and student presentations.

Week	Topic
1	Course introduction and database concepts (RG Ch 1, U Ch 1) – by the instructor
2	Basic data concepts, E/R data model, relational data model, OO data models (RG Ch 2, U Ch 2) – by the instructor
3	Relational query languages: Relational Algebra and Calculus, Datalog, SQL and their expressive power (RG Ch 3,4,5, U Ch 3) – by the instructor
4	Relational query languages continued (RG Ch 3, 4, 5, U Ch 3). Nested relations and object relational databases (RG Ch 24) – by the instructor
5	Temporal databases and temporal data modeling – by the instructor
6	Temporal query languages and their expressive power – by the instructor, Temporal SQL
7	Implementation of a temporal database of Temporal Relational Algebra operations, PostgreSQL -- by the instructor
8	XML, XPath and XQuery (RG Ch 27) – by the instructor
	Semantic Web, RDF, RDF Schema, and OWL – by the instructor
	Temporality in Semantic Web, RDF, RDF Schema, and OWL – by the instructor, Temporal SPARQL
9	Ontologies Logic and Medical Ontology (PDF) Boolean Algebra and Predicate Knowledge (PDF) Ontology and Data Model (PDF)
10	Medical Vocabulary Representation and Survey of Medical Coding Systems (PDF) Medical Coding Systems (continued) and UMLS (PDF) Major KR Schemes (PDF) Process (PDF)
10	Big data, Graph Databases, Cray XMT
11	Big data, Graph Databases
12	Student presentation -
13	Student presentation -
14	Current developments in knowledgebase and database developments and the future – by the instructor

Reference books:

1. [Database Management Systems](#), R. Ramakrishnan, *McGraw-Hill*, Second Edition, August 1999.

2. Database System: The Complete Book, H. Garcia-Molina, J. Ullman, J. Widom, *Prentice Hall*, June 2002.
3. Principles of Database and Knowledge-Base Systems, Vol. 1, J. Ullman, Computer Science Press, 1988.
4. <http://www.postgresql.org/>.
5. XML tutorial: http://www.stylusstudio.com/sqlxml_tutorial.html
6. XSD Tutorial: XML Schemas For Beginners:
<http://www.codeguru.com/java/article.php/c13529/XSD-Tutorial-XML-Schemas-For-Beginners.htm>

List of research papers – to follow.