Fall 2019
CSs 72030 Database Management Systems
Tuesdays, 9:30am -11:30am

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Course Description

Database Management Systems (DBMS) are vital components of modern information systems. Database applications are pervasive and range in size from small in-memory databases to terra bytes or even larger in various applications domains. The course focuses on the fundamentals of relational database management systems, and the current developments in database theory and its practice.

The course reviews topics such as conceptual data modelling, relational data model, relational query languages, relational database design and transaction processing and current technologies such as noSQL and Blockchain databases. It exposes the student to the fundamental concepts and techniques in database development and use as well as it provides a foundation for research in databases.

The course assumes prior exposure to databases, specifically to the relational data model and it builds new technologies on this foundation. In the first half of the course the relational data model, relational query languages, relational database design and conceptual data modelling are reviewed. It then focuses on XML, and noSQL databases. It also bridges databases and Blockchain, which is the current trend.

The course requires a term project in which the student implements a database application or explores a database topic. We will use PostgresSQL as the database platform for doing the assignments.

Course Objectives

- Help students to raise their understanding of Databases.
- Understand the role that DBMS play in different application domains and how they are used in organizations.
- Identify problems and opportunities that can benefit from Databases support.
- Understand the key DB components such as data modeling, query languages and query processing, etc.
- Develop an understanding of trends in the DBMS field.

- Integration of Cryptography, Blockchain, DBs and other information technology components for trusted data sources.
- Appreciate the crucial role that Databases play in students' career as well as in society in the 21st century.

Learning Goals

The course content is balanced on theory and practice; the course aims at achieving the following learning outcomes:

- An appreciation of pervasive use of DBMS in different application domains.
- Skill for developing database applications.
- Skills for devising data models and query languages.
- Skills for developing web database applications.
- Learning storage and indexing of data.
- Learning transaction processing and database recovery
- Learning how to incorporate trust into a database.
- Skills to integrate encrypted data and provenance into databases.

Course Requirements

Prerequisite: An introductory database course. Students who do not have prior exposure to database will be supported and provided additional material to gain the maximum benefit from the course.

Textbook

- (MUW) H. Garcia-Molina, et al, Database Systems, Complete Book, Prentice Hall, 2009.
- Textbook will be supported with the reading material from the list of supplementary references that will be provided.

Evaluation and Grading

Assessment:

- Class participations, discussions and attendance are a critical component of the course and accounts 10% of the term grade.
- Four written assignments will provide the students the opportunity to appreciate the theoretical underpinnings of the databases systems and comprise 15% of the term grade. These are on data modeling (Entity/Relationship data model), query languages (Relational Algebra and Relational Calculus), and database design.
- Two programming assignments and a term project will provide the opportunity for the students to develop technical skills and they comprise 10% of the term grade. The first project is on Structured Query Language and the second one is on the web database programming. The database project involves a complete database application development from design to implementation or a deeper investigation of a topic in databases or Blockchain. The students will be provided a list of possible research topics from which they can choose or they come up

with their own topic.

- A mid-term and a final exam.

Assignments	25%
Term Projects	25%
Midterm Exams	25%
Final Exam	25%

Course Delivery

The course includes lectures by the instructor. Student participation is expected and encouraged.

Tentative course outline: Following is a tentative course outline. Depending on the students' prior exposure to DBMS and our progress during the term we will rework it as needed.

Week	**Topic**
1	Course introduction and database concepts, Relational data model (MUW Ch. 1, 2)
2	Relational query languages: Relational Algebra and Calculus SQL, QBE and their expressive power (MUW Ch. 2)
3	Relational query languages and SQL continued (MUW Ch. 5, 6) Introduction to Temporal Databases
4	Introduction to Blockchain and Bitcoin scripting language
5	Advanced SQL features:Triggers, Embedded SQL, recursion (MUW Ch. 7, 8, 10.2)
6	Database application development, Web database programming (MUW Ch. 9) Datalog (MUW Ch. 5)
7	Basic data concepts, Conceptual data modelling, E/R data model, OO data model (MUW Ch. 4)
8	Midterm Exam
9	XML, XPath and XQuery (MUW Ch. 11)
10	Relational database design, Normal Forms (NF), 1-4NF, Lossless join decomposition (MUW Ch. 3)
11	Storage and indexing, Query processing and optimization (MUW Ch. 13-15)
12	Storage and indexing, Query processing and optimization (MUW Ch. 13-15) --continued
	NoSQL databases – Lecture notes
13	Transaction processing and database recovery (MUW Ch. 17-19)
14	Database security, Current developments in databases and Big data -- Lecture Notes

Supplementary References:

1. *Database System Concepts*, Avi Silberschatz, Henry F. Korth, S. Sudarshan, Sixth Edition, 2011.
2. *Fundamentals of Database Systems Benjamin Cummings, Elmasri, R., Navathe, S.*, Seventh Edition, 2015.
3. Database Management Systems, R. Ramakrishnan, J. Geherke, McGraw-Hill, Third Edition, August 2003.
4. S.Greco, C. Molinaro, Datalog and Logic Databases (Synthesis Lectures on Data Management) 1st Edition Morgan Kaufman 2015

5. http://www.postgresql.org/.
6. XML tutorial: http://www.stylusstudio.com/sqlxml_tutorial.html
7. XSD Tutorial: XML Schemas For Beginners: http://www.codeguru.com/java/article.php/c13529/XSD-Tutorial-XML-Schemas-For-Beginners.htm
8. We may also read articles from:
   Proc. of SIGMOD Conf: ACM-Special Interest Group on Management of Data
   Proc. of the Very Large DB(VLDB) Conf.
   Proc. of IEEE Data Engineering Conf.
   TODS: ACM Transactions on Database Systems.
   IEEE /KDE: IEEE Trans. on Knowledge and Data Engineering
   TOIS: ACM Transactions on Office Information Systems.
   DBLP: http://dblp.uni-trier.de/