Advanced Database Applications

2024-2025 Spring Semester

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Course Description:

This course provides a comprehensive introduction to database systems, followed by advanced topics in database design and implementation. Students will gain theoretical knowledge and practical skills in relational database design, SQL, normalization, indexing, transaction management, and NoSQL databases.

Course Objectives:

1. Understand the fundamental concepts of database systems and their architecture.

2. Develop proficiency in Structured Query Language (SQL) for database manipulation.

3. Apply database normalization techniques to optimize database design.

4. Explore advanced topics such as indexing, transaction management, and NoSQL databases.

5. Implement and manage databases in real-world scenarios.

Textbooks and Resources:

Recommended:

- Elmasri, R., & Navathe, S. B. (2015). Fundamentals of Database Systems (7th Edition). Pearson.

- Date, C. J. (2020). An Introduction to Database Systems (8th Edition). Pearson.

- O'Reilly Media. Learning SQL (3rd Edition).

Course Schedule:

Week 1: Introduction to Databases

- Course overview and syllabus discussion

- Importance of databases in modern applications

- Database models and architecture

Week 2: The Relational Model
- Relational data model concepts

- Keys and constraints

- Relational algebra

Week 3: SQL Basics
- Introduction to SQL

- Basic queries: SELECT, INSERT, UPDATE, DELETE

- Filtering and sorting data

Week 4: Advanced SQL
- Joins: INNER, OUTER, CROSS

- Subqueries and nested queries

- Aggregate functions and GROUP BY

Week 5: Database Design and ER Modeling
- Entity-Relationship (ER) diagrams

- Mapping ER diagrams to relational schemas

- Assignment: Designing a sample database

Week 6: Normalization and Schema Refinement
- Functional dependencies

- Normal forms: 1NF, 2NF, 3NF, BCNF

- Denormalization considerations

Week 7: Midterm Exam Review and Preparation
- Review of Weeks 1-6 content

- Q&A session

Week 8: Midterm Exam
- In-class written exam covering Weeks 1-6

Week 9: Indexing and Query Optimization
- Index structures: B-trees, hash indexes

- Query optimization techniques

- Execution plans

Week 10: Transactions and Concurrency Control
- ACID properties

- Transaction management

- Concurrency control mechanisms

Week 11: Database Security
- User roles and privileges

- Data encryption and access control

- Backup and recovery strategies

Week 12: Introduction to NoSQL Databases
- NoSQL vs. relational databases

- Key-value, document, column-family, and graph databases

Week 13: Exploring NoSQL Features
- Indexing in NoSQL databases

- Sharding and replication

- Use cases for NoSQL

Week 14: Modern Database Concepts
- Distributed database concepts

- CAP theorem and eventual consistency

- Introduction to big data systems (e.g., Hadoop, Spark)

- Cloud databases and database-as-a-service (DBaaS)

- Performance tuning and scalability strategies

- Real-time databases and applications

Week 15: Course Wrap-Up
- Course reflection and feedback session

Week 16: Final Exam
- Final Exam

Grading Policy:

- Midterm Exam: 40%

- Final Exam: 60%

Good luck, and let's have a great semester exploring the world of databases!

Wish all of you a successful, happy and healthy academic year.

Please send your questions and suggestions to my e-mail.