Database Management Systems

Module 01: Course Overview

Partha Pratim Das

Department of Computer Science and Engineering
Indian Institute of Technology, Kharagpur

ppd@cse.iitkgp.ac.in

Module Objectives

- To understand the importance of database management systems in modern day applications
- To Know Your Course

Module Outline

- Why Databases?
- KYC: Know Your Course
  - Course Prerequisite
  - Course Outline
  - Course Text Book

Why Databases?

Database Management System (DBMS)

- DBMS contains information about a particular **enterprise**
  - Collection of interrelated data
  - Set of programs to access the data
  - An environment that is both *convenient* and *efficient* to use
- Database Applications:
  - Banking: transactions
  - Airlines: reservations, schedules
  - Universities: registration, grades
  - Sales: customers, products, purchases
  - Online retailers: order tracking, customized recommendations
  - Manufacturing: production, inventory, orders, supply chain
  - Human resources: employee records, salaries, tax deductions
  - ...
- Databases can be very large
- Databases touch all aspects of our lives

University Database Example

- Application program examples
  - Add new students, instructors, and courses
  - Register students for courses, and generate class rosters
  - Assign grades to students, compute grade point averages (GPA) and generate transcripts
- In the early days, database applications were built directly on top of file systems

Drawbacks of using file systems to store data

- Data **redundancy** and **inconsistency**
  - Multiple file formats, duplication of information in different files
- Difficulty in **accessing data**
  - Need to write a new program to carry out each new task
- Data **isolation**
  - Multiple files and formats
- **Integrity** problems
  - Integrity constraints (e.g., account balance > 0) become "buried" in program code rather than being stated explicitly
  - Hard to add new constraints or change existing ones

Drawbacks of using file systems to store data (2)

- **Atomicity** of updates
  - Failures may leave database in an inconsistent state with partial updates carried out
  - Example: Transfer of funds from one account to another should either complete or not happen at all
- **Concurrent access** by multiple users
  - Concurrent access needed for performance
  - Uncontrolled concurrent accesses can lead to inconsistencies
    - Example: Two people reading a balance (say 100) and updating it by withdrawing money (say 50 each) at the same time
- **Security** problems
  - Hard to provide user access to some, but not all, data

Database systems offer solutions to all the above problems

Know Your Course

Course Prerequisites: Essential

- **Set Theory**
  - Definition of a Set
    - Intensional Definition
    - Extensional Definition
    - Set-builder Notation
  - Membership, Subset, Superset, Power Set, Universal Set
  - Operations on sets:
    - Union, Intersection, Complement, Difference, Cartesian Product
  - De Morgan's Law
  - **Courses**
    - **MOOCs: Discrete Mathematics:**
      https://nptel.ac.in/courses/111/106/111106086/
    - **Online Degree Foundational Course: Mathematics for Data Science I**
      https://onlinedegree.iitm.ac.in/course_pages/BSCMA1001.html

Course Prerequisites: Essential

- **Relations and Functions**
  - Definition of Relations
  - Ordered Pairs and Binary Relations
    - Domain and Range
    - Image, Preimage, Inverse
    - Properties: Reflexive, Symmetric, Antisymmetric, Transitive, Total
  - Definition of Functions
  - Properties of Functions: Injective, Surjective, Bijective
  - Composition of Functions
  - Inverse of a Function
  - **Courses**
    - **MOOCs: Discrete Mathematics:**
      https://nptel.ac.in/courses/111/106/111106086/
    - **Online Degree Foundational Course: Mathematics for Data Science I**
      https://onlinedegree.iitm.ac.in/course_pages/BSCMA1001.html

Course Prerequisites: Essential

- **Propositional Logic**
  - Truth Values & Truth Tables
  - Operators: conjunction (and), disjunction (or), negation (not), implication, equivalence
  - Closure under Operations
  - **Courses**
    - **MOOCs: Discrete Mathematics:**
      https://nptel.ac.in/courses/111/106/111106086/

Course Prerequisites: Essential

- **Predicate Logic**
  - Predicates
  - Quantification
    - Existential
    - Universal
  - **Courses**
    - **MOOCs: Discrete Mathematics:**
      https://nptel.ac.in/courses/111/106/111106086/

Course Prerequisites: Essential

- **Data Structures**
  - Array
  - List
  - Binary Search Tree
    - Balanced Tree
  - B-Tree
  - Hash Table / Map
  - **Courses**
    - **MOOCs: Design and Analysis of Algorithms:**
      https://nptel.ac.in/courses/106/106/106106131/
    - **MOOCs: Fundamental Algorithms – Design and Analysis:**
      https://nptel.ac.in/courses/106/105/106105157/

Course Prerequisites: Essential

- **Programming in Python**
  - **Courses**
    - **Online Degree Foundational Course - Programming in Python**

      https://onlinedegree.iitm.ac.in/course_pages/BSCCS1002.html

Course Prerequisites: Desirable

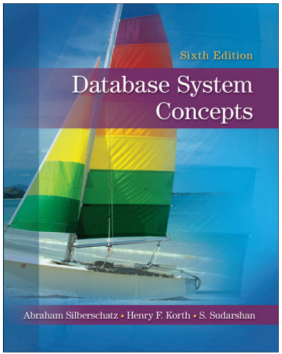
- **Algorithms and Programming in C**
  - Sorting
    - Merge Sort
    - Quick Sort
  - Search
    - Linear Search
    - Binary Search
    - Interpolation Search
  - **Courses**
    - **MOOCs: Design and Analysis of Algorithms:** https://nptel.ac.in/courses/106/106/106106131/
    - **MOOCs: Introduction to Programming in C:** https://nptel.ac.in/courses/106/104/106104128/

- **Object-Oriented Analysis and Design**
  - **Courses**
    - **MOOCs: Object-Oriented Analysis and Design:**
      https://nptel.ac.in/courses/106/105/106105153/

Course Outline

Week No.	Topics
Week 1	Course Overview, Introduction
Week 2	Basic Structured Query Language
Week 3	Advanced Structured Query Language
Week 4	Relational Algebra, Entity Relationship Model
Week 5	Normal Forms and Functional Dependency
Week 6	Normal Forms and Functional Dependency
Week 7	Application Development
Week 8	Storage Management
Week 9	Indexing and Hashing
Week 10	Transactions
Week 11	Backup and Recovery
Week 12	Query Optimization, Conclusion

Course Textbook



Database System Concepts,
Sixth Edition,

Abraham Silberschatz,
Henry Korth,
S. Sudarshan,

Publisher: McGraw Hill Education
ISBN: 0073523321

Website: `http://db-book.com/`

7th Edition will also do

Module Summary

- Elucidates the importance of database management systems in modern day applications
- Introduced various aspects of the Course

Slides used in this presentation are borrowed from http://db-book.com/ with kind permission of the authors.

Edited and new slides are marked with "PPD".