Introduction to Database Systems

CSE 444

Lecture #1
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Staff

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  - Office hours: Tu 9-10am, Fr 10-11am
- NOTE: Your email to either of us **must** have **CSE444** as the **first** word in the **Subject** line. Otherwise, it will be **ignored**

Textbook(s)

- A First Course in Database Systems
  - by Jeff Ullman and Jennifer Widom
- Database Implementation
  - by Hector Garcia-Molina, Jeff Ullman and Jennifer Widom
- Available in a shrink-wrapped package at the book store
  - not available in that form for non-students

Other Reference Books

- Database Management Systems *Ramakrishnan*
- Fundamentals of Database Systems, *Elmasri and Navathe*
- Both are on hold in the library

Misc Administrative Issues

- Homework
  - See homepage for homework deadlines
  - No extension granted
- Course credit
  - Project 25%
  - Homework 15%
  - Programming Assignments 10%
  - Midterm 15%
  - Final 30%
- Prerequisites: CSE-326 or equivalent

5

Resolving Questions

- Follow the Sequence:
  1. Look at the CSE444 Hypermail archive
  2. If unresolved, determine whom you should contact
     - Project, Software, Homework Assignments: **Yana**
     - Concepts, Class Lectures: **Surajit**
  3. Try to come for the office hour of the right contact
  4. Send email to the right contact
     - NOTE: Your email to either of us **must** have **CSE444** as the **first** word in the **Subject** line. Otherwise, it will be **ignored**

6

Wide World of Information

- Text Documents
  - Text, Word, Powerpoint Files, HTML pages
  - Indexed and searched by "Search Engines"
- Structured Information
  - Databases, Spreadsheets
  - Drives businesses
  - Focus of this course
- Future: Richer Integration

7

An Architecture for Structured Information Systems

- *Web Browser* as the user interface
- *Web Server* talks to an *application-server*
  - Supports business objects
- Application Server talks to a *database server*
  - Supports data objects
  - Focus of this course

8

Examples of Structured Information Systems

- Banking System
- Airline Reservation System
- Inventory Management
- Amazon.com, Dell.com, Etrade.com

9

Example: SCBook.com

- Data Structures
  - (Bookid, Publisherid, Title, ISBN, Price, topic)
  - (Bookid, Count)
  - (Publisherid, Pub_Price)
  - (Orderid, Publisherid, Bookid, Order_Count)
  - (Custid, Name, Address1, City)
- Applications
  - Report Sales by City and Topic
  - Order/receive more copies of a book
  - Buy a book

10

Some Characteristics

- Large Volumes of structured data
- Multi-user, Multi-application system
- Key Issues
  - Data structure
  - Application Development
  - Concurrency
  - Recovery
- DBMS: Software to simplify development of information systems

11

Why not use File System?

- Problems with virtual memory
  - Database sizes > 10T
  - Need advanced storage management
- Applications need to be smart to deal with large volumes of data
  - Good performance is crucial
  - Support high degree of parallelism
- Multiple applications
  - Different views to different applications

12

Why not use a File System?

- Data Integrity is key
  - Failure, Concurrency tolerant
  - Fine-Grained security
- Evolution in data structures
  - Need to rewrite applications

13

Key Observations

- Tabular data: simplest, widely used
- Tabular data in, tabular data out
  - Add/Remove/Update rows
  - Select subset of rows and columns
  - Combine information from multiple tables
    - Produce Reports
- Pick data structures carefully
- Serialize all user interactions
  - Success or Failure
  - Successful actions are permanent

14

Services from a DBMS

- High Level Programming on Relations
  - Query language:Set-Oriented Access
    - Data Definition Language - DDL
    - Data Manipulation Language – DML
  - Physical Data Independence
  - Data Integrity
- Transaction Management
  - Concurrency control
  - Recovery
- Storage Management
  - Indexes, Clustering

15

Questions the Course Addresses

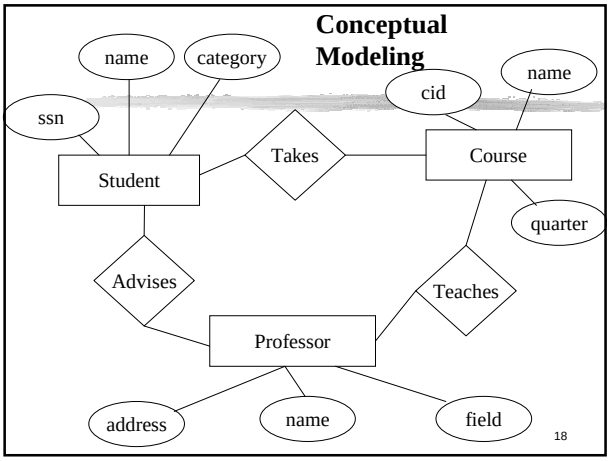
- What are the services rendered by a DBMS?
  - High-Level Programming, Data Integrity
  - Transaction
  - Storage
- How do we use a commercial DBMS to implement an information system?
  - Design and Implementation
  - Web-based application
  - Hands-on experience (The Project)
- How is a DBMS built?

16

Building a Database for an Information System

- Model data from an information-centric viewpoint
  - Conceptual Database Design (ER Diagrams)
- Define Relational Schema
- Develop Application(s) using Query Languages
  - Views (virtual schema)
  - Stored Procedures
- Physical Database Design (indexes, clustering)

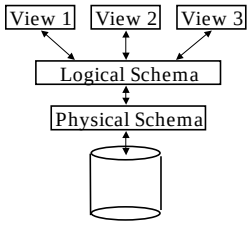
17



18

Abstraction: Logical Schema and Views

- Views describe how users see the data.
- Logical schema defines logical structure using relational data model
- Physical schema describes the files and indices used.



19

Example: University Database

- Logical Schema:
  - *Students(sid: string, name: string, login: string, age: integer, gpa:real)*
  - *Courses(cid: string, cname:string, credits:integer)*
  - *Enrolled(sid:string, cid:string, grade:string)*
- A possible Physical Schema:
  - Relations stored as unordered files.
  - Index on first column of Students.
- An External Schema (View):
  - *Course_info(cid:string,enrollment:integer)*

20

Schema Design and Implementation

- Tables:

Students:

SSN	Name	Category
123-45-6789	Charles	undergrad
234-56-7890	Dan	grad
	…	…

Takes:

SSN	CID
123-45-6789	CSE444
123-45-6789	CSE444
234-56-7890	CSE142
	…

Courses:

CID	Name	Quarter
CSE444	Databases	fall
CSE541	Operating systems	winter

- Separates the logical view from the physical view of the data
  - Build appropriate indexes

21

Data Independence

- Applications insulated from how data is structured and stored.
- *Logical data independence*: Protects views from changes in *logical* (conceptual) structure of data.
- *Physical data independence*: Protects conceptual schema from changes in *physical* structure of data.
  - *One of the most important benefits of using a DBMS!*

22

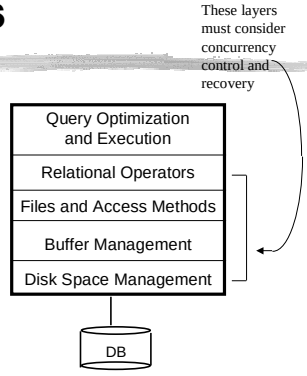
Building Applications: Querying a Database

- Find all courses that "Mary" takes
- S(tructured) Q(uery) L(anguage)
  - **select** C.name
  - **from** Students S, Takes T, Courses C
  - **where** S.name="Mary" and
  - S.ssn = T.ssn and T.cid = C.cid

23

Inside a DBMS

- A typical DBMS has a layered architecture.
- The figure does not show the concurrency control and recovery components.
- This is one of several possible architectures; each system has its own variations.



24

Looking Ahead: Role of XML

- XML as the universal transport
  - Semi-structured and hierarchical
  - Efficient publishing of information in XML
  - Efficient storage of information in XML
    - "XML Stores" and/or "Native Stores"

25

Database Professionals

- Server Implementers
- *Application Developers*
- Database Administrators
  - Use knowledge of server and applications to tune databases
    - Physical design, security,..
- End-Users of Applications

26

Database Industry

- Relational databases are a great success
- Servers
  - Oracle, IBM, Microsoft, Sybase, Informix, SQL, Compaq,..
- Client Tools for Database development
  - Many ISV-s
- Major Application vendors
  - SAP, Peoplesoft, ..

27

Course Outline

- High-Level Programming on Databases using SQL
  - Query Language (including views)
  - Web-based end-to-end application
- Database Design
  - Entity Relationship diagrams
  - Transforming E/R models to relational schemas
  - Normalization

28

Course Outline (2)

- Transactions
- Inside a DBMS
  - Storage and Indexes
  - Query Processing
  - Query Optimization
- Information Exchange on Internet: XML
- Special Topics

29

Course Project

- Goal: design a database application using ASP
- Choose topic on your own.
  - Some service projects available.
- Work in groups of 3-4 (start forming now)

30