Welcome to

CMPSCI 445
Information Systems

Instructor:

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Overview of Information Management

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CMPSCI 445 – Information Systems

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Some slide content courtesy of Zack Ives, Ramakrishnan & Gehrke, Dan Suciu, Ullman & Widom

Today

- Overview of data management
- Course topics
- Course requirements
- Student information form

Goals of this course

- Relational databases
  - an introduction to their design and use.
- Web data management
  - an introduction to key technologies for managing data on the WWW.

Databases & DBMS's

- A **database** is a large, integrated collection of data.

- A **database management system (DBMS)** is a software package designed to store and manage databases, allowing:
  - Define the kind of data stored
  - Querying/updating interface
  - Reliable storage & recovery of 100s of GB
  - Control access to data from many concurrent users

Can filesystems do it?

Not really.

- Schema for files is limited
- No query language for data in files
- Files can store large amounts of data, but
  - no recovery from failure
  - no efficient access to items within file
  - buffering in memory
- Concurrent access not safe

Evolution

- Early DBMS’s (1960’s), evolved from file systems.
- Data with many small items & many queries or modifications:
  - Airline reservations
  - Banking

Early DB systems

Data model

The data model includes basic assumptions about what an “item” of data is, how to represent it and interpret it.

- Tree-based *hierarchical* data model
- Graph-based *network* data model

- Encouraged users to think about data the way it was stored.
- No high level query language

The Relational Model

- The relational data model (Codd, 1970):
  - Data independence: details of physical storage are hidden from users
  - High-level declarative query language
    - say **what** you want, not **how** to compute it.
    - mathematical foundation

DBMS Benefit #1: Generality and Declarativity

- The programmer/user does not need to know details:
  - indices, sort orders, machine speeds, disk speeds, concurrent users, etc.
- Instead, the programmer/user programs with a *logical model* in mind
- The DBMS “makes it happen” based on an understanding of relative costs of different methods

Benefit #2: Efficiency and Scale

- Efficient storage of hundreds of GBs of data

- Efficient access to data

- Rapid processing of transactions

Benefit #3: Management of Concurrency and Reliability

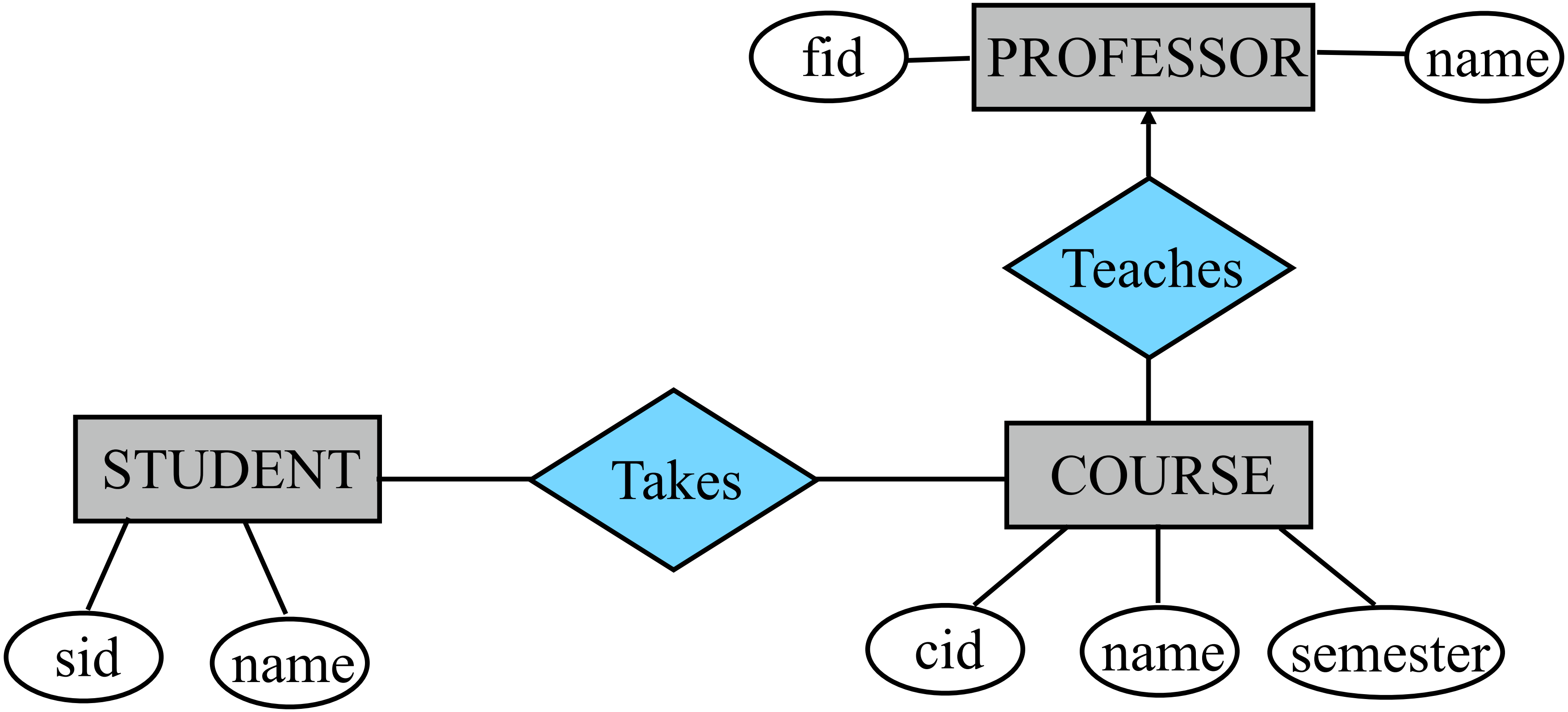
- Simultaneous transactions handled safely.
- Recovery of system data after system failure.

- More formally: the ACID properties
  - Atomicity - all or nothing
  - Consistency - sensible state not violated
  - Isolation - separated from effects
  - Durability - once completed, never lost

How Does One Build a Database?

- Start with a conceptual model
- Design & implement schema
- Write applications using DBMS and other tools
  - Many ways of doing this (DBMS, API writers, library authors, web server, etc.)
  - Common applications include PHP/JSP/servlet-driven web sites
- The DBMS takes care of query optimization and execution

Conceptual Design



Designing a Schema (Set of Relations)

STUDENT

sid	name
1	Jill
2	Bo
3	Maya

Takes

sid	cid
1	645
1	683
3	635

COURSE

cid	name	sem
645	DB	F05
683	AI	S05
635	Arch	F05

- Convert to tables + constraints
- Then need to do "physical" design: the layout on disk, indices, etc.

PROFESSOR

fid	name
1	Diao
2	Saul
8	Weems

Teaches

fid	cid
1	645
2	683
8	635

Queries

- Find all courses that “Mary” takes

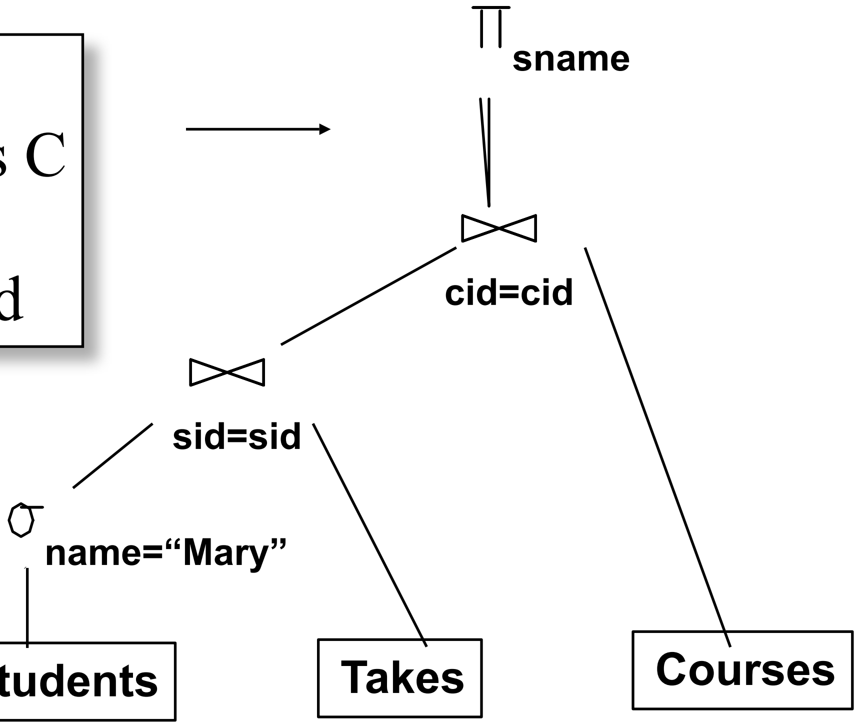
```
SELECT  C.name
FROM    Students S, Takes T, Courses C
WHERE   S.name=“Mary” and
        S.sid = T.sid and T.cid = C.cid
```

- What happens behind the scene ?
  - Query processor figures out how to answer the query efficiently.

Queries, behind the scene

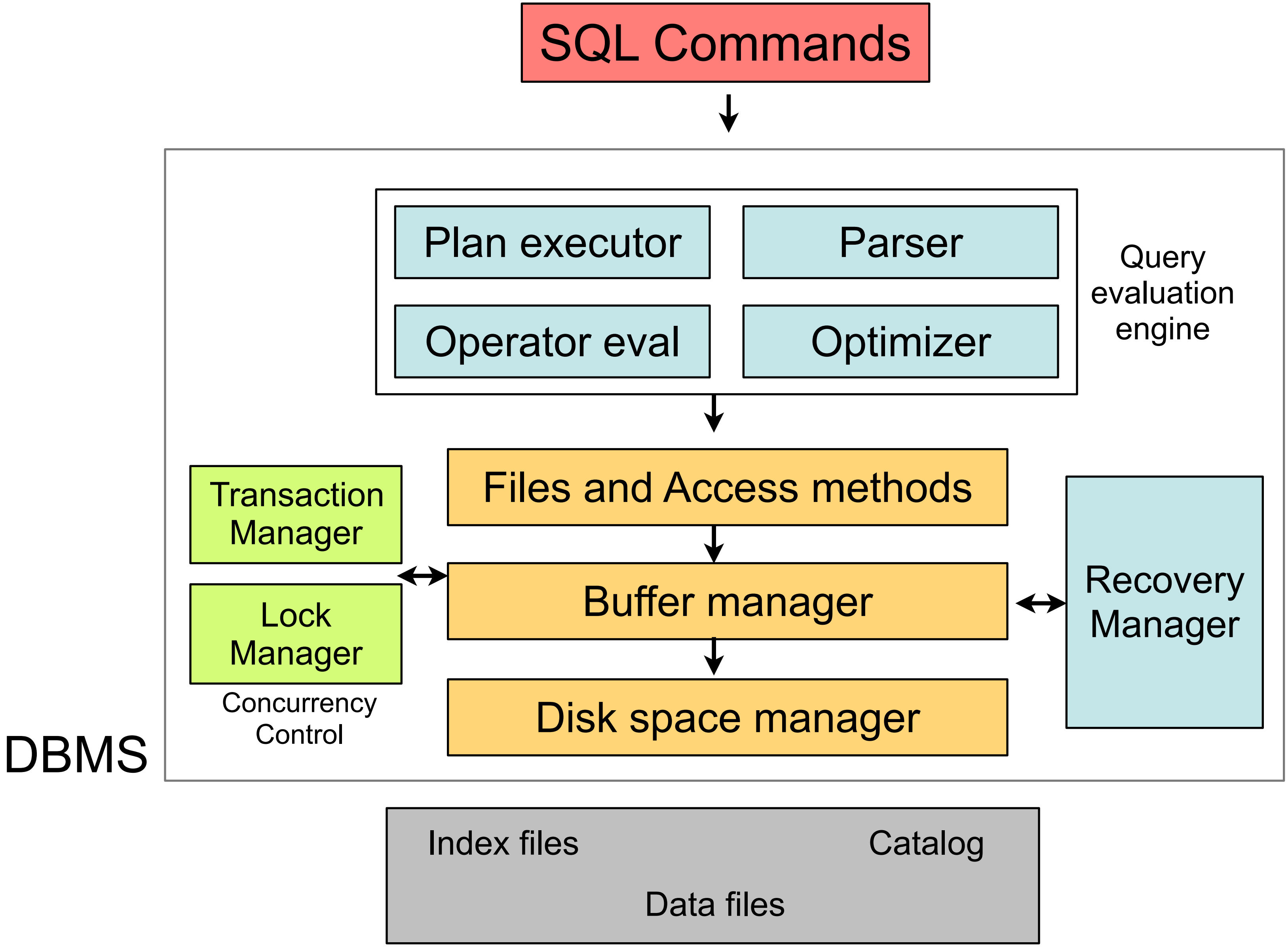
Declarative SQL query → *Query execution plan:*

```
SELECT  C.name
FROM Students S, Takes T, Courses C
WHERE S.name="Mary" and
        S.sid = T.sid and T.cid = C.cid
```



The **optimizer** chooses the best execution plan for a query

Architecture of DBMS



An Issue: 80% of the World’s Data is Not in a DB!

- Examples:
  - Scientific data
    (large images, complex programs that analyze the data)
  - Personal data
  - WWW and email
    (some of it is stored in something resembling a DBMS)
- Data management is expanding to tackle these problems
  - XML data enables exchange across systems
  - Integration of diverse data sets
  - Structured queries replaced by search & approximate answers.

Why study data management ?

- One of the broadest, most exciting areas in CS!
- A microcosm of CS in general
  - languages, operating systems, concurrent programming, data structures, algorithms, theory, distributed systems, statistical techniques.

Course topics and Requirements

Course topics

- **Fundamentals**: relational design, query languages, SQL.
- **Database internals**: storage, indexing, query processing, query optimization, transaction management.
- **XML** and semi-structured data models.
- **Security:** access control, privacy.
- **Other topics**: Information retrieval, advanced data types, performance tuning
- **Skills:** Postgres and PHP for web development.

Prerequisites

- CMPSCI 287: Programming Language Paradigms.
- Or consent of the instructor

Grading

- Homework: 25%
- Course Project: 20%
- Midterm: 20%
- Final: 25%
- Attendance, Participation: 10%

Homework: 25%

- Several assignments throughout the course
  - Written problem sets
  - Programming exercises with SQL, XQuery

Project: 20%

- General theme: build a web application using Postgres and PHP.
- Groups of 2-3 preferred.
- Project work will include:
  - Schema design, DB implementation
  - Web site design.
  - Multiple milestones, status report.
  - In-class presentation.

Exams

- Midterm (20%)
  - in-class around the 8th week.
- Final (25%)
  - not yet determined by registrar

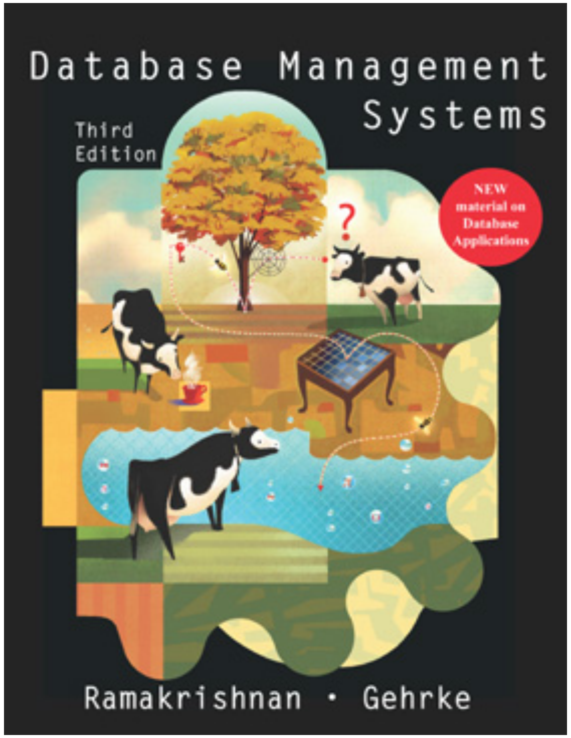
Attendance & Participation

- Attend every class.
- Ask questions, contribute to answers.
- Participate in in-class exercises.

Academic honesty

- All submitted work must be your own.
  - Although students are encouraged to study together, each student is expected to produce his or her own solution to the homework problems.
  - **Copying or using sections of someone else's program or assignment, even if it has been modified by you, is not acceptable.**
  - The University has very clear guidelines for academic misconduct and **the staff of CS 445 will be vigorous in enforcing them**. Please see the UMass policy on academic honesty here: www.umass.edu/dean_students/code_conduct/acad_honest.htm

Textbook


Database Management Systems
Third Edition
NEW material on Database Applications
Ramakrishnan • Gehrke

Database Management Systems

Ramakrishnan and Gehrke

Readings posted on the website before class.

Communication

- Instructor
  - Office hours:
    - Mon 9-10am, or by appointment
    - Held in CS building, Rm 208.
  - Email: miklau at cs.umass.edu
- Check the course webpage often
  - http://avid.cs.umass.edu/courses/445/f2008/
- Mailing list
  - For help: cs445-help AT edlab-mail.cs.umass.edu
  - Class list: cs445 AT edlab-mail.cs.umass.edu

Information about you

- Please fill out a student information form.

Questions about the course?