CS 525:
Advanced Database Organization

01: Introduction

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Slides: adapted from a course taught by
Hector Garcia-Molina, Stanford InfoLab

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Advanced Database Organization?

- =Database Implementation
- =How to implement a database system
- … and have fun doing it ;-)

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Isn't Implementing a Database System Simple?

Relations ⟹ Statements ⟹ Results

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Introducing the

MEGATRON 3000

Database Management System

- The latest from Megatron Labs
- Incorporates latest relational technology
- UNIX compatible

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Megatron 3000 Implementation Details

! First sign non-disclosure agreement !

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Megatron 3000 Implementation Details

- Relations stored in files (ASCII)

  e.g., relation R is in /usr/db/R

```
Smith # 123 # CS
Jones # 522 # EE
   :
   :
```

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Megatron 3000 Implementation Details

- Directory file (ASCII) in /usr/db/directory

```
R1 # A # INT # B # STR …
R2 # C # STR # A # INT …
   .
   .
   .
```

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Megatron 3000 Sample Sessions

```
%  MEGATRON3000
     Welcome to MEGATRON 3000!
&
   .
   .
   .
& quit
%
```

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Megatron 3000
Sample Sessions

```
& select *
  from R #

    Relation R
  A         B      C
  SMITH    123    CS


&
```

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Megatron 3000
Sample Sessions

```
& select A,B
  from R,S
  where R.A = S.A and S.C > 100 #

   A    B
  123  CAR
  522  CAT

&
```

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Megatron 3000
Sample Sessions

```
& select *
  from R | LPR #
&
```

Result sent to LPR (printer).

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Megatron 3000
Sample Sessions

```
& select *
  from R
  where R.A < 100 | T #
&
```

New relation T created.

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Megatron 3000

- To execute "`select * from R where condition`":

  (1) Read dictionary to get R attributes

  (2) Read R file, for each line:

  (a) Check condition

  (b) If OK, display

Megatron 3000

- To execute "`select * from R where condition | T`":

    (1) Process select as before

    (2) Write results to new file T

    (3) Append new line to dictionary

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Megatron 3000

- To execute "`select A,B from R,S where condition`":

    (1) Read dictionary to get R,S attributes

    (2) Read R file, for each line:

        (a) Read S file, for each line:

            (i) Create join tuple

            (ii) Check condition

            (iii) Display if OK

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What's wrong with the Megatron 3000 DBMS?

What's wrong with the Megatron 3000 DBMS?

- Tuple layout on disk

e.g.,   - Change string from 'Cat' to 'Cats' and we have to rewrite file

    - ASCII storage is expensive

    - Deletions are expensive

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What's wrong with the Megatron 3000 DBMS?

- Search expensive; no indexes

e.g.,   - Cannot find tuple with given key quickly

      - Always have to read full relation

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What's wrong with the Megatron 3000 DBMS?

- Brute force query processing

e.g., `select *`

`from R,S`

`where R.A = S.A and S.B > 1000`

- Do select first?
- More efficient join?

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What's wrong with the Megatron 3000 DBMS?

- No buffer manager

e.g.,   Need caching

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What's wrong with the Megatron 3000 DBMS?

- No concurrency control

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What's wrong with the Megatron 3000 DBMS?

- No reliability

e.g.,   - Can lose data

         - Can leave operations half done

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What's wrong with the Megatron 3000 DBMS?

- ## No security

e.g.,   - File system insecure

- File system security is coarse

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What's wrong with the Megatron 3000 DBMS?

- No application program interface (API)

e.g.,   How can a payroll program get at the data?

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What's wrong with the Megatron 3000 DBMS?

- Cannot interact with other DBMSs.

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What's wrong with the Megatron 3000 DBMS?

- Poor dictionary facilities

Notes 1 - Introduction

What's wrong with the Megatron 3000 DBMS?

- No GUI

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What's wrong with the Megatron 3000 DBMS?

- Lousy salesman!!

Course Overview

- ## File & System Structure

  Records in blocks, dictionary, buffer management,…

- ## Indexing & Hashing

  B-Trees, hashing,…

- ## Query Processing

  Query costs, join strategies,…

- ## Crash Recovery

  Failures, stable storage,…

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Course Overview

- ## Concurrency Control

  Correctness, locks,…

- ## Transaction Processing

  Logs, deadlocks,…

- ## Security & Integrity

  Authorization, encryption,…

- ## Advanced Topics

  Distribution, More Fancy Optimizations, …

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System Structure

Notes 1 - Introduction
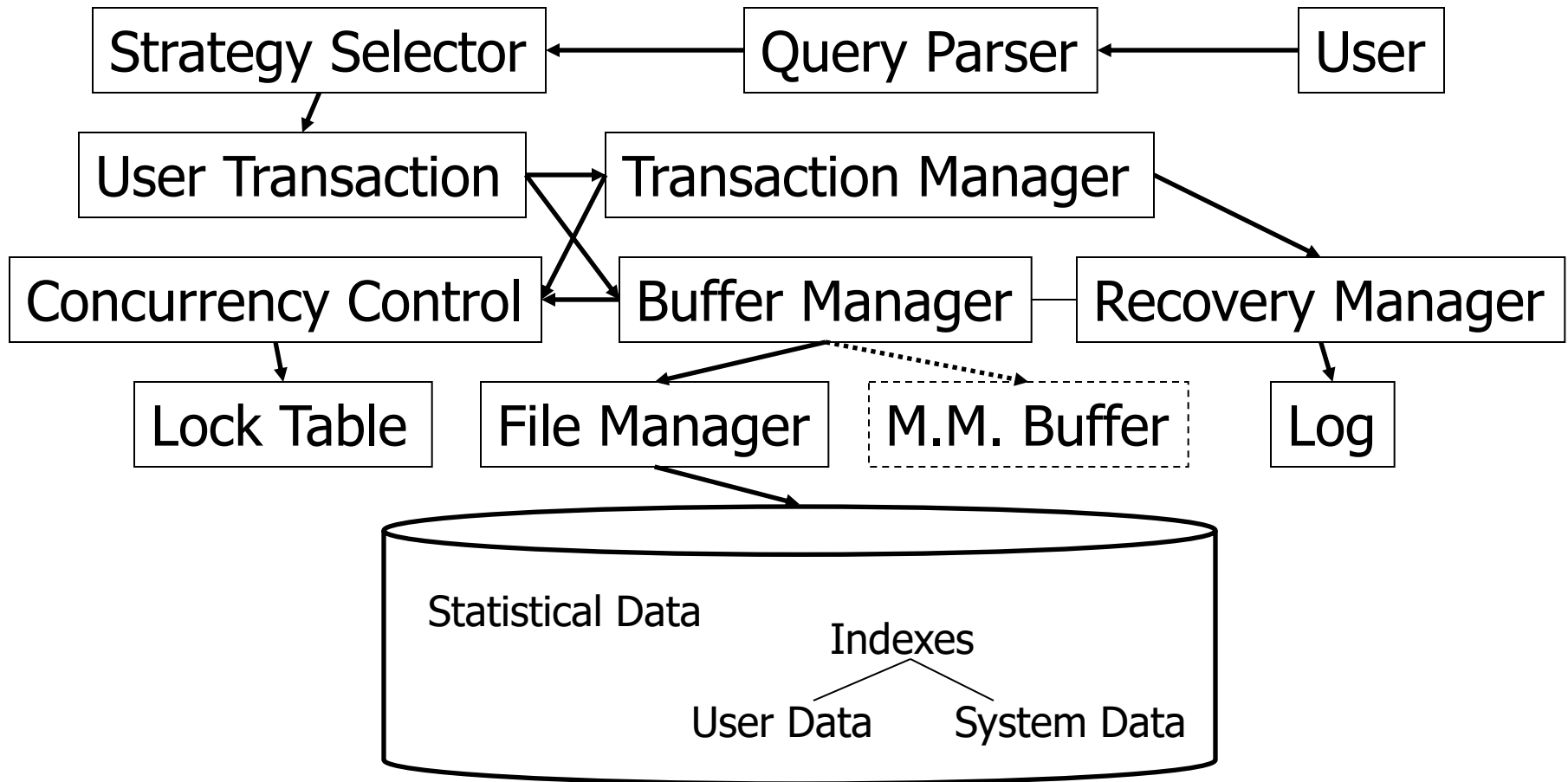
Some Terms

- Database system
- Transaction processing system
- File access system
- Information retrieval system

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Instructor Info

- **Webpage**: http://www.cs.iit.edu/~glavic/cs525/

- **Instructor**: Boris Glavic
  - **http://www.cs.iit.edu/~glavic/**
  - **DBGroup: http://www.cs.iit.edu/~dbgroup/**
  - **Office Hours: Wednesdays, 1pm-2pm**
    - **https://meet.google.com/pqy-qnyd-kqf**

- **TA: TBA**

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Course Information

- **Time:** Mon + Wed 5:10pm – 8:30pm

- **Live Video Call**:

  - **https://meet.google.com/siw-youu-kme**

- **Live Lectures will be recorded and uploaded to blackboard and to**

  - **https://drive.google.com/drive/folders/1CxZy2sXe8 v1dOb4WrNufJ0uMkwbjjKRd?usp=sharing**

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Piazza

- https://piazza.com/class/kdapgqw7az2vq

- Announcements

- Discussion forum
  - Student - Instructor/TA
  - Student – Student

- ->please join piazza to keep up to date

Workload and Grading

- Schedule and Important Dates
  - On webpage & updated there

- Programming Assignments (50%)
  - 4 Assignments
  - Groups of 3 students
  - Plagiarism -> 0 points and administrative action

- Quizzes (10%)

- Mid Term (20%) and Final Exam (20%)

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Textbooks

- Elmasri and Navathe , **Fundamentals of Database Systems**, 6th Edition , Addison-Wesley , 2003

- Garcia-Molina, Ullman, and Widom, **Database Systems: The Complete Book**, 2nd Edition, Prentice Hall, 2008

- Ramakrishnan and Gehrke , **Database Management Systems**, 3nd Edition , McGraw-Hill , 2002

- Silberschatz, Korth, and Sudarshan , **Database System Concepts**, 6th Edition , McGraw Hill , 2010

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Programming Assignments

- 4 assignments one on-top of the other
- Optional 5th assignment for extra credit
- Code has to compile & run on server account
  - **Email-ID**@fourier.cs.iit.edu
  - Linux machine
  - SSH with X-forwarding
- Source code managed in **git** repository on Bitbucket.org
  - Handing in assignments = submit (push) to repository
  - One repository per student
  - You should have gotten an invitation (if not, contact me/TA)
  - Git tutorials linked on course webpage!

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Next:

- Hardware

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