Introduction to Database Systems
CSE 444

Lecture 1
Introduction

About Me: General

Prof. Magdalena Balazinska (magda)

- At UW since January 2006
- PhD from MIT
- Born in Poland
- Grew-up in Poland, Algeria, and Canada

About Me: Research

- Past: Stream Processing
  - Distributed stream processing (Borealis)
  - Load management and fault-tolerance
  - RFID data management
  - Probabilistic event processing

- Now: Cloud computing and scientific data mgmt
  - Collaboration with astronomers, oceanographers, etc.
  - Making large-scale data analysis interactive
  - Collaborative query management

Staff

- Instructor: Magdalena Balazinska
  - CSE 550, magda@cs.washington.edu
    Office hours: Mondays 1:30pm-3:20pm
- Grad TA: Nodira Khoussainova
  - nodira@cs.washington.edu
  - Office hours: TBA
- Ugrad TA: Michael Rathanapinta
  - michaelr@cs.washington.edu

Communications

- Web page: http://www.cs.washington.edu/444
  - Lectures will be available there
  - The mini-projects description will be there
  - Homeworks will be posted there

- Mailing list
  - Announcements, group discussions
  - You are already subscribed

Textbook

Main textbook, available at the bookstore:

- *Database Systems: The Complete Book*,
  Hector Garcia-Molina,
  Jeffrey Ullman,
  Jennifer Widom

Most important: COME TO CLASS ! ASK QUESTIONS !

Other Texts

Available at the Engineering Library

(not on reserve):

- *Database Management Systems*, Ramakrishnan
- *XQuery from the Experts*, Katz, Ed.
- *Fundamentals of Database Systems*, Elmasri, Navathe
- *Foundations of Databases*, Abiteboul, Hull, Vianu
- *Data on the Web,* Abiteboul, Buneman, Suciu

Course Format

- Lectures MWF, 12:30-1:20pm
- Quiz sections: Th 9:30-10:20, 10:30-11:20
  - Location to be announced

- 4 Mini-projects
- 3 homework assignments

- Midterm and final

Grading

• Homeworks	30%
• Mini-projects	30%
• Midterm	15%
• Final	25%

Four Mini-Projects

1. SQL
2. SQL in Java
3. Database tuning
4. Parallel processing: MapReduce

Due: Wednesdays every other week

Three Homework Assignments

1. Conceptual Design
2. Transactions
3. Query execution and optimization

Due: Wednesdays every other week

Exams

- Midterm: Friday, May 8, in class
- Final: Thursday, June 11, 8:30-10:20am, in class

Outline of Today's Lecture

1. Overview of a DBMS
2. A DBMS through an example
3. Course content

Database

What is a database ?

Give examples of databases

Database

What is a database ?

- A collection of files storing related data

Give examples of databases

- Accounts database; payroll database; UW’s students database; Amazon’s products database; airline reservation database

Database Management System

What is a DBMS ?

Give examples of DBMSs

Database Management System

What is a DBMS ?

- *A big C program written by someone else that allows us to manage efficiently a large database and allows it to persist over long periods of time*

Give examples of DBMSs

- DB2 (IBM), SQL Server (MS), Oracle, Sybase
- MySQL, PostgreSQL, …

We will focus on relational DBMSs most quarter

Market Shares

From 2004 www.computerworld.com

- IBM: 35% market with $2.5BN in sales
- Oracle: 33% market with $2.3BN in sales
- Microsoft: 19% market with $1.3BN in sales

An Example

The Internet Movie Database

http://www.imdb.com

- Entities:
  Actors (800k), Movies (400k), Directors, …

- Relationships:
  who played where, who directed what, …

Required Data Management Functionality

1. Describe real-world entities in terms of stored data
2. Create & persistently store large datasets
3. Efficiently query & update
    1. Must handle complex questions about data
    2. Must handle sophisticated updates
    3. Performance matters
4. Change structure (e.g., add attributes)
5. Concurrency control: enable simultaneous updates
6. Crash recovery
7. Security and integrity

DBMS Benefits

- Expensive to implement all these features inside the application
- DBMS provides these features (and more)
- DBMS simplifies application development

How to decide what features should go into the DBMS?

Back to Example: Tables

Actor:

id	fName	lName	gender
195428	Tom	Hanks	M
645947	Amy	Hanks	F
. . .			

Cast:

pid	mid
195428	337166
. . .	

Movie:

id	Name	year
337166	Toy Story	1995
. . . .	. . .	. ..

SQL

```
SELECT *
FROM  Actor
```

SQL

```
SELECT count(*)
FROM  Actor
```

This is an *aggregate query*

SQL

```
SELECT *
FROM  Actor
WHERE lName = ‘Hanks’
```

This is a *selection query*

SQL

```
SELECT *
FROM  Actor, Cast, Movie
WHERE lname='Hanks' and Actor.id = Cast.pid
  and Cast.mid=Movie.id and Movie.year=1995
```

This query has *selections* and *joins*

We will learn SQL in all its glory in 4 lectures !

How Can We Evaluate the Query ?

Actor:

id	fName	lName	gender
. . .		Hanks	
. . .			

Cast:

pid	mid
. . .	
. . .	

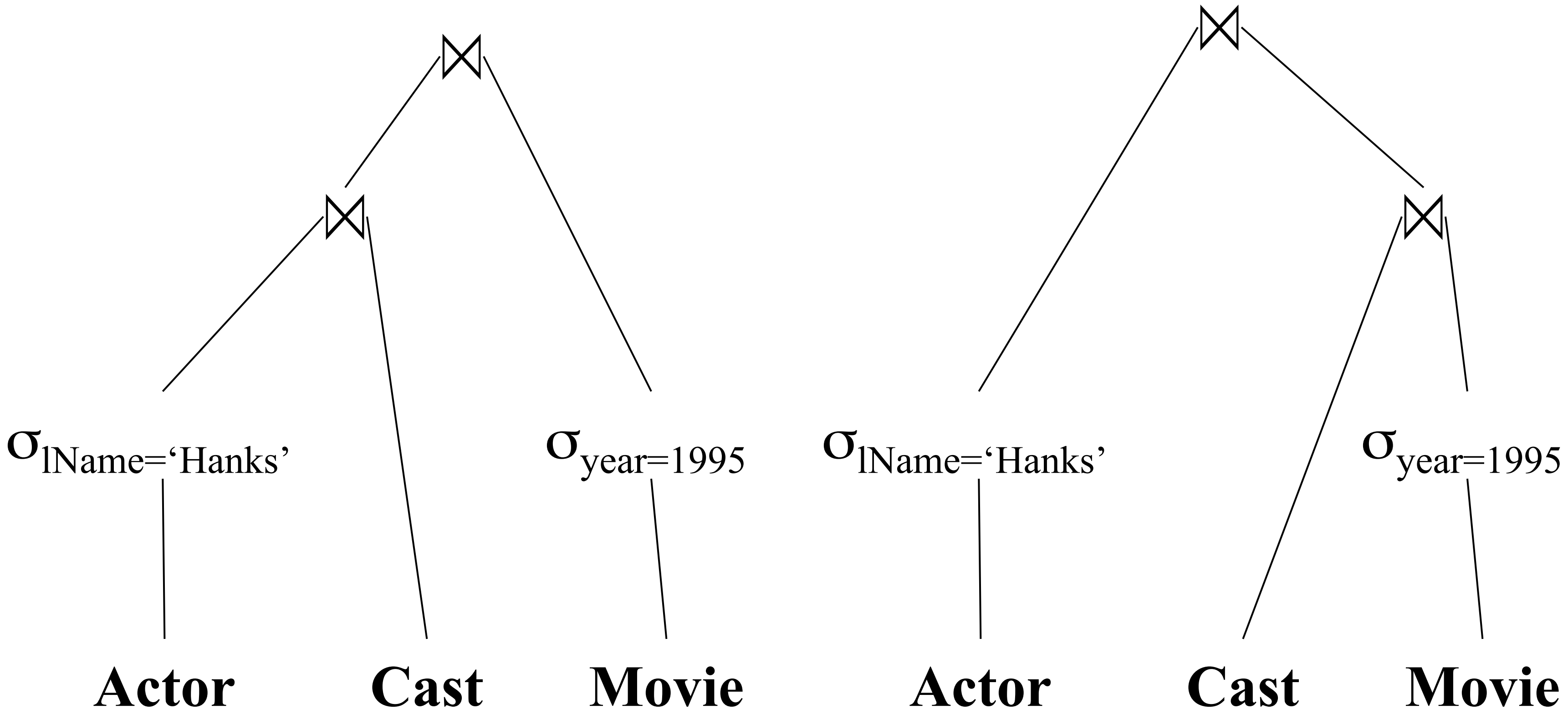
Movie:

id	Name	year
. . .		1995
. . .		

Plan 1: . . . . [in class]

Plan 2: . . . . [in class]

Evaluating Tom Hanks



$\bowtie$

$\bowtie$

$\sigma_{\text{lName='Hanks'}}$ $\sigma_{\text{year=1995}}$

Actor **Cast** **Movie**

$\bowtie$

$\bowtie$

$\sigma_{\text{lName='Hanks'}}$ $\sigma_{\text{year=1995}}$

Actor **Cast** **Movie**

What an RDBMS Does Well (1/2)

- Indexes: on Actor.lName, on Movie.year
- Multiple implementations of joins
- Query optimization (which join order ?)
- Statistics !

We'll learn all about this in May

Now Let’s See Database Updates

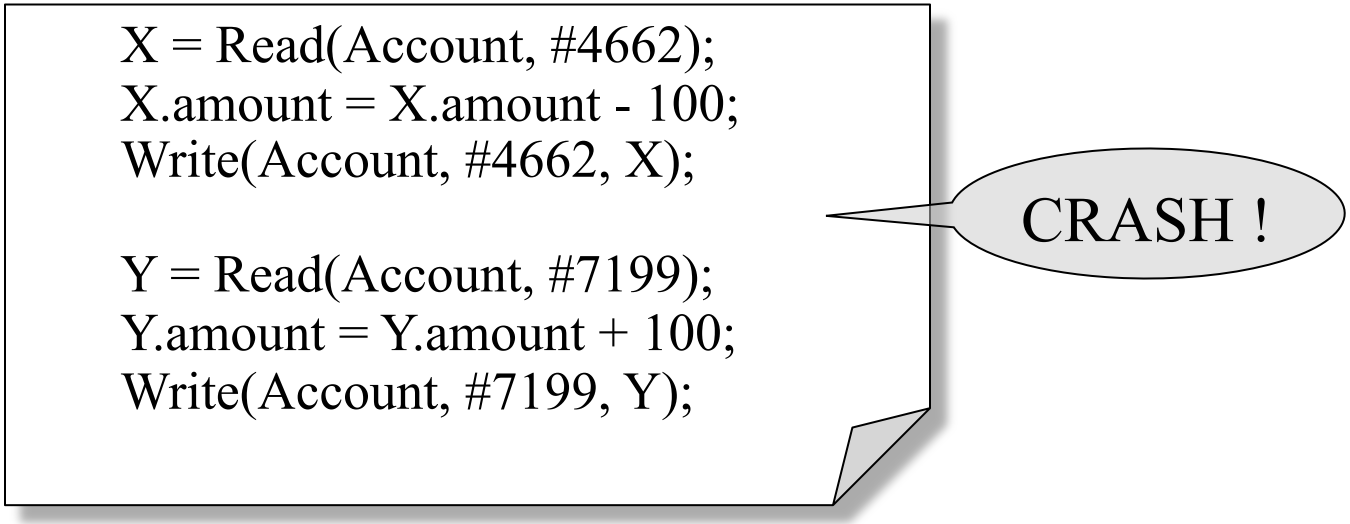
- Transfer $100 from account #4662 to #7199:

```
X = Read(Account, #4662);
X.amount = X.amount - 100;
Write(Account, #4662, X);

Y = Read(Account, #7199);
Y.amount = Y.amount + 100;
Write(Account, #7199, Y);
```

Now Let’s See Database Updates

- Transfer $100 from account #4662 to #7199:



```
X = Read(Account, #4662);
X.amount = X.amount - 100;
Write(Account, #4662, X);

Y = Read(Account, #7199);
Y.amount = Y.amount + 100;
Write(Account, #7199, Y);
```

What is the problem ?

What a RDBMS Does Well (2/2)

Transactions !

- Recovery
- Concurrency control

We will learn all that in April

Client/Server Architecture

- There is a single *server* that stores the database (called DBMS or RDBMS):
  - Usually a beefy system, e.g. IISQLSRV1
  - But can be your own desktop…
  - … or a huge cluster running a parallel dbms
- Many *clients* run apps and connect to DBMS
  - E.g. Microsoft's Management Studio
  - Or psql (for postgres)
  - More realistically some Java or C++ program
- Clients "talk" to server using JDBC protocol

Data Management v.s. Databases

- There is more to Data Management !

A Data Management QUIZ:

- Alice sends Bob in random order all the numbers 1, 2, 3, …, 100000000000000000000
- She does not repeat any number
- But she misses *exactly one* !
- Help Bob find out which one is missing !

What This Course Contains

- SQL
- Conceptual Design
- Transactions
- Database tuning and internals (very little)
- Distributed databases: a taste of *MapReduce*
- More data management
  - Sampling, data cleaning, etc.
- XML: Xpath, Xquery

Accessing SQL Server

SQL Server Management Studio

- Server Type = Database Engine
- Server Name = IISQLSRV
- Authentication = SQL Server Authentication
  - Login = your UW email address (*not* CSE email)
  - Password = seattle

Change your password !!

Then play with IMDB, start working on PROJ1