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 (RFID Ecosystem)
  - Probabilistic event processing (Lahar)

- Now: Cloud computing and scientific data mgmt
  - Collaboration with astronomers, oceanographers, etc.
  - Making large-scale data analysis easier and interactive
  - Helping scientists leverage cloud computing

Staff

- Instructor: Magdalena Balazinska
  - CSE 550, magda@cs.washington.edu
    Office hours: Wednesdays 10:30am-12:20pm
- Ugrad TA: Michael Rathanapinta
  - michaelr@cs.washington.edu
  - Office hours: Thursdays 10:30am-12:00pm in CSE 006
- Ugrad TA: Liem Dinh
  - liemdinh@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
- Message board
  - Great place to ask assignment-related questions

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, 9:30am-10:20am
- Quiz sections: Th 8:30-9:20, 9:30-10:20
  - Location: EEB 025

- 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

Check course website for due dates

Three Homework Assignments

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

Check course website for due dates

Exams

- Midterm: Monday, November 8, in class
- Final: Wednesday, December 15, 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 2006 Gartner report:

- IBM: 21% market with $3.2BN in sales
- Oracle: 47% market with $7.1BN in sales
- Microsoft: 17% market with $2.6BN 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, Casts, Movie
WHERE lname='Hanks' and Actor.id = Casts.pid
  and Casts.mid=Movie.id and Movie.year=1995
```

This query has *selections* and *joins*

817K actors, 3.5M casts, 380K movies;
How long do we expect it to take?

How Can We Evaluate the Query ?

Actor:

id	fName	lName	gender
. . .		Hanks	
. . .			

Cast:

pid	mid
. . .	
. . .	

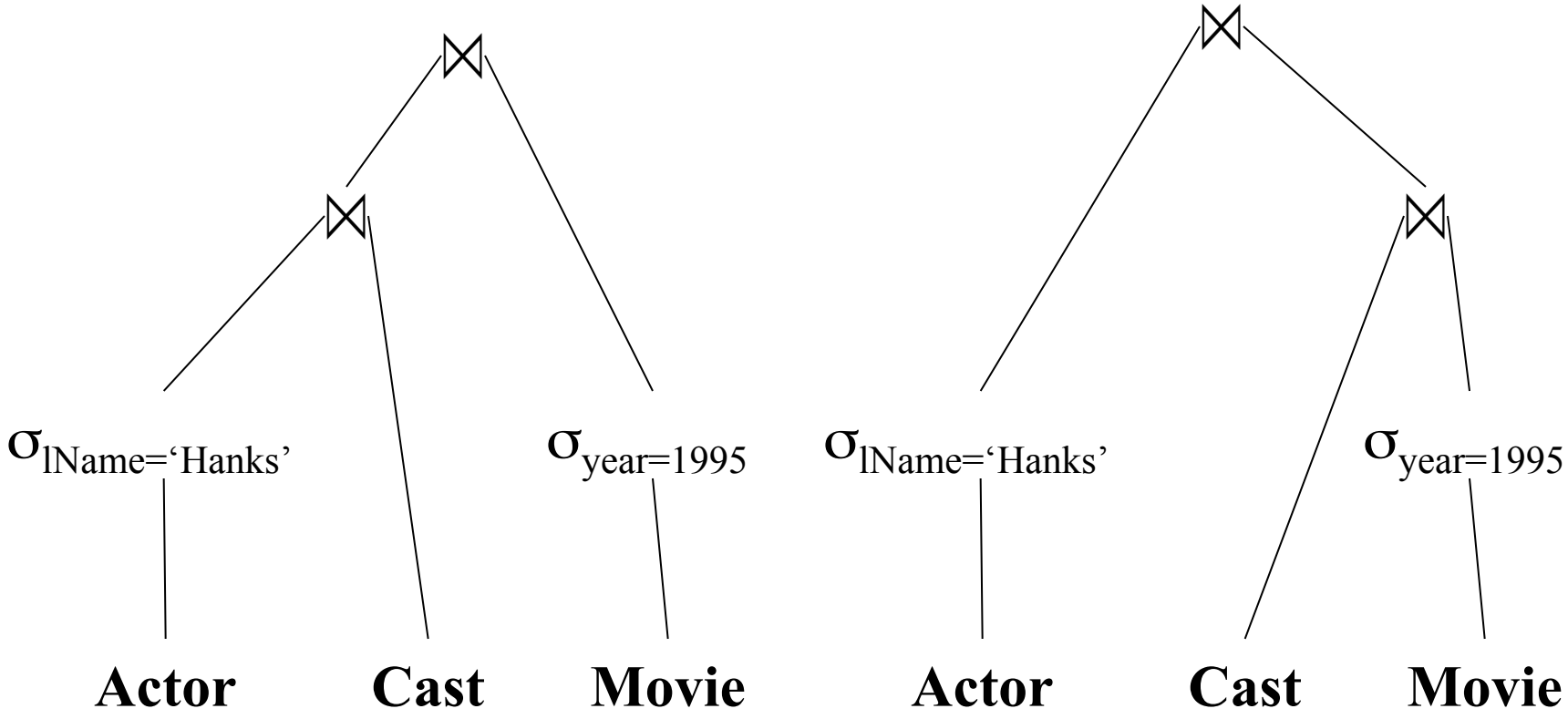
Movie:

id	Name	year
. . .		1995
. . .		

Plan 1: . . . . [in class]

Plan 2: . . . . [in class]

Evaluating Tom Hanks



What an RDBMS Does Well (1/2)

- Indexes: on Actor.lName, on Movie.year
- Multiple implementations of joins
- Query optimization
  - Access path selection
  - Join order
  - Join implementation
- Statistics !

Now Let's See Database Updates

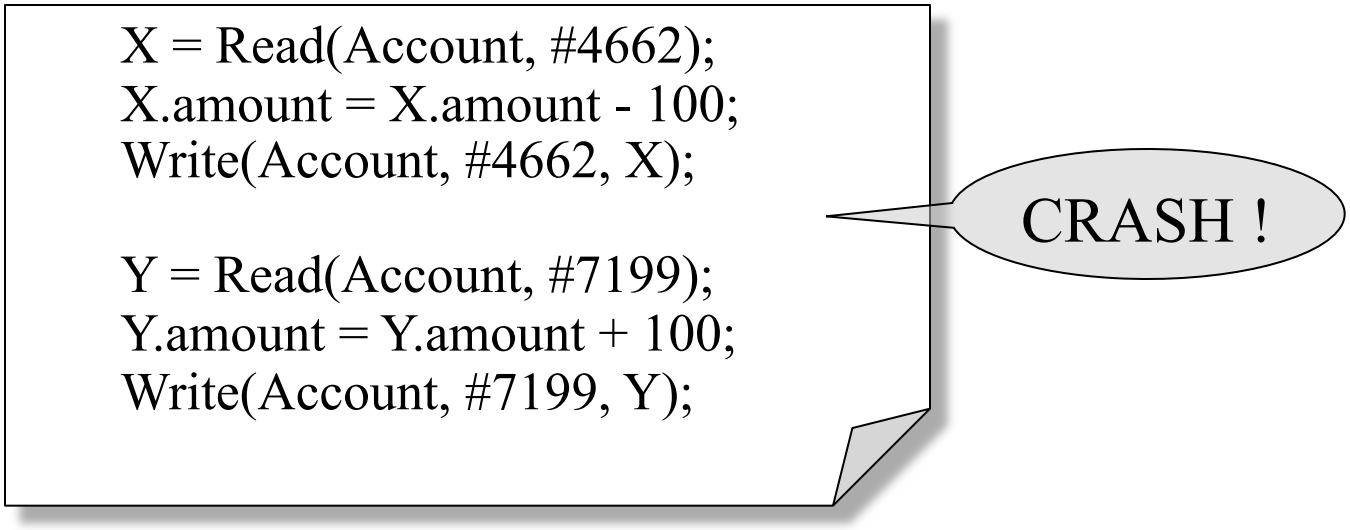
- Transfer $100 from account #4662 to #7199:

```
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:



What is the problem ?

What a RDBMS Does Well (2/2)

Transactions !

- Recovery
- Concurrency control

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

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 = Complex_PASS

Change your password !!

Then play with IMDB, start working on PROJ1