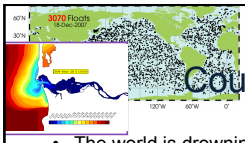
CSE 444: Database Internals

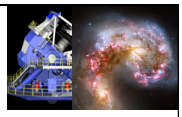
Lecture 1
Introduction

Course Staff

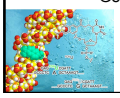
- Instructor: Magdalena (Magda) Balazinska
  - magda@cs.washington.edu OH: Thursdays 4:30-5:20
- TA: Lindsey Nguyen
  - nhlien93@cs, OH: 1:30 - 2:30 on Tuesdays
- TA: Yuqing Guo
  - yu922@cs, OH: 3:30 - 4:30 on Mondays
- TA: Dan Radion
  - daradion@cs, OH: 2:30 – 3:30 on Fridays



Course Goals



- The world is drowning in data!
- Need computer scientists to help manage this data
  - Help domain scientists achieve new discoveries
  - Help companies provide better services (e.g. Facebook)
  - Help governments become more efficient
- This class: **principles of building data mgmt systems**
  - Learn how classical DBMSs are built
  - Learn key principles and techniques
  - Get hands-on experience building a (parallel) DBMS



Course Format

- Lectures MWF, 12:30pm-1:20pm
- Sections: Th 9:30-10:20, 10:30-11:20
- Homeworks
  - 6 Labs + 6 Homeworks
- NO exams

Communication (part 1)

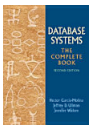
- Web page: http://www.cs.washington.edu/444
  - Lectures/Sections will be available there
  - Homeworks/Labs will be available there
- Mailing list
  - Announcements, group discussions
  - If you are taking CSE444, you are already subscribed
  - If CSEM 544, please add yourselves to the list!

Communication (part 2)

Message Board:

- Ask questions about the course, labs, homeworks
- Do not post any fragments of your code
- Do **not** send questions by email unless
  - You need to discuss a personal matter
  - You want to setup an appointment
  - A question has not been answered on the board

Textbooks



Recommended textbook (pick one)

- Database Management Systems. **Third Ed**. Ramakrishnan and Gehrke. McGraw-Hill.
- *Database Systems: The Complete Book*, Hector Garcia-Molina, Jeffrey Ullman, and Jennifer Widom. **Second edition**.

See course website for recommended chapters

Other Readings

- See Website
- There is a section on reading assignments for 544M only
  - Will need to submit 4 paper reviews throughout the quarter

Grading CSE444

- Lab 1, 2, 3, 5: 40% (10% each)
- Final Lab 4 or Lab 6 (your choice): 15%
- Final project report 10%
- Six written assignments: 35%

Grading CSE 544M

- Same as CSE 444 plus
- Another 10% for the 4 paper reviews
- Then re-normalize to add up to 100%
- Graded separately from CSE 444

Six Labs

- Lab 1: Build a DBMS that can scan a relation on disk
  - **Part 1 of this lab is due on Friday!**
- Lab 2: Build a DBMS that can run simple SQL queries and also supports data updates
- Lab 3: Add a lock manager (transactions)
- Lab 5: Add a write-ahead log (transactions)
- Lab 4: Add a query optimizer
- Lab 6: Make your DBMS parallel

Warning: I **will** run cheating-detecting software!

About the Labs

Logistics:

- To be done **INDIVIDUALLY!**
- Each lab will take a **significant** amount of time
- Labs build on each other

Purpose

- Hands-on experience building a DBMS
- Deepen your understanding significantly
- We will build a *classical* DBMS
- In class we will discuss some *new-types* of DBMSs

Six Homeworks

- Written assignments
- Help review material learned in class
- Prepare you for the labs
  - One homework before each corresponding lab
- Go beyond what we implement in labs
- To be done **INDIVIDUALLY**

Exams

- No exams

Late Days

- Total of **4 late-days**
- Use in 24-hour chunks on hws or labs
- **At most 2 late-days per assignment**
- **No late-days can be applied to the final project due during finals week**

Outline (this lecture and next)

- Review of DBMS goals and features
- Review of relational model
- Review of SQL

Review: DBMS

- What is a database? Give examples
  –
  –
- What is a database management system? Give examples
  –
  –

Review: DBMS

- What is a database? Give examples
  – A collection of related files
  – E.g. payroll, accounting, products
- What is a database management system? Give examples
  – A big C program written by someone else that manages the database; PostgreSQL, Oracle, …
  – In 444 you are that "someone else", implementing SimpleDB

Review: Data Model

- What is a data model?
  –
- What is the relational data model?

Review: Data Model

- What is a data model?
  – A mathematical formalism for data
- What is the relational data model?
  – Data is stored in tables (aka relations)
  – Data is queried via relational queries
  – Queries are *set-at-a-time*

Review: Transactions

- What is a transaction?
  –
- What properties do transactions have?

Review: Transactions

- What is a transaction?
  – A set of instructions that must be executed all or nothing
- What properties do transactions have?
  – ACID
  – Better: Serialization, recovery

Review: Data Independence

The application should not be affected by changes of the physical storage of data

- Indexes
- Physical organization on disk
- Physical plans for accessing the data
- Parallelism: multicore, distributed

Some Key Data Management Concepts

- Data models: Relational, XML, graph data (RDF)
- Schema v.s. Data
- Declarative query languages
  – Say what you want not how to get it
- Data independence
  – Physical: Can change how data is stored on disk without maintenance to applications
- Query compiler and optimizer
- Transactions: isolation and atomicity

Course Content

Focus: how to build a classical relational DBMS

- Review of the relational model (lecture 1 and 2)
- DBMS architecture and deployments (lecture 3)
- Data storage, indexing, and buffer mgmt (lectures 4-6)
- Query evaluation (lectures 7-9)
- Query optimization (lectures 10-13)
- Transactions (lectures 14-19)
- Parallel query processing (lectures 20-22)
- Replication and distribution (lectures 23-25)
- Database as a service and NoSQL (lectures 26 and 27)

Relational Model...

- Let's start our review of the relational model…
- We will continue next lecture