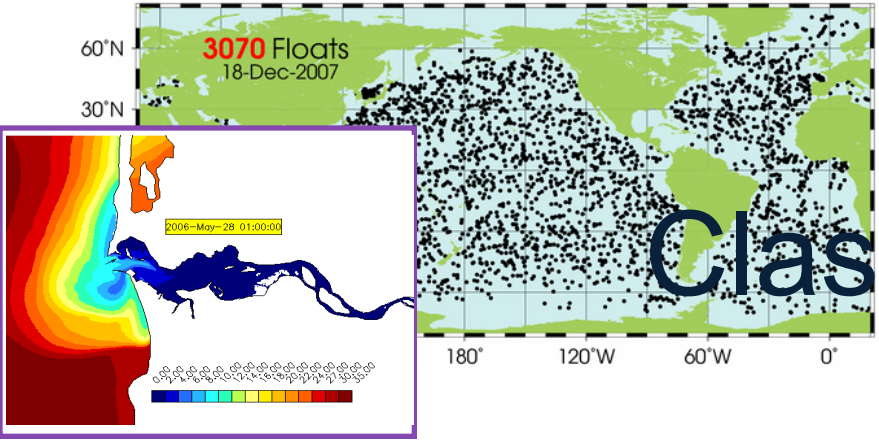
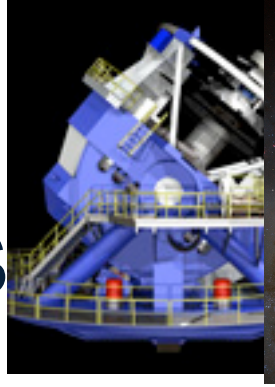
Introduction to Data Management
CSE 344

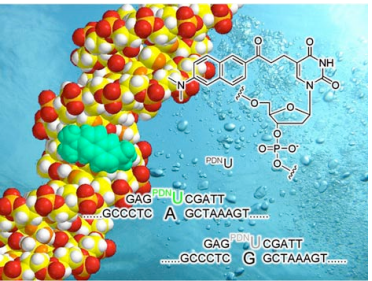
Lecture 1: Introduction

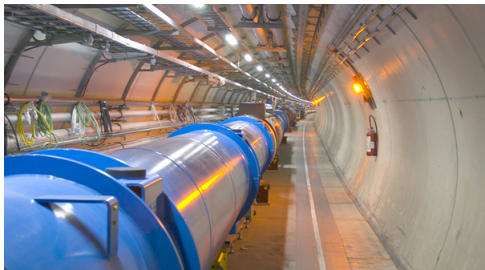




Class Goals

- 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: introduction to data management
  - Learn about existing tools and how to use them
  - Learn data management principles
- CSE 444: how to build data management systems





Staff

- Instructor: Dan Suciu
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  - Office hours: Mon10:30am-11:20pm in CSE 662
- TA: Paris Koutris
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About Me: General

- PhD from UPenn
- Researcher at Bell Labs/ AT&T Labs
- At UW since 2000

- My research:
  - Probabilistic databases
  - Data privacy
  - Big data: parallel query complexity

Course Format

- Lectures MWF, 9:30am-10:20am
- Sections: Th 8:30-9:20, 9:30-10:20
  - Content: exercises, tutorials, questions
  - Location: See course website

- 6 Homeworks assignments
- Lots of short web quizzes

- Midterm and final

Communications

- Web page: http://www.cs.washington.edu/344
  - Lectures will be available there (see calendar)
  - Homeworks will be available there
  - Web quizzes will be available 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

  Second edition.

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

Grading

- Homeworks 30%
- Web quizzes 20%
- Midterm 20%
- Final 30%

Six Homeworks

H1 and H2: Basic SQL with SQLite

H3: Advanced SQL with SQL Server

H4: XML and XQuery with Saxon

H5: SQL in Java (JDBC)

H6: Parallel processing with MapReduce

Due date: Wednesdays, but check website

About the Homeworks

- Homeworks will take a significant amount of time but most time should be spent *learning*
- Very practical assignments
- Put everything on your resume!!!
  - SQL, SQLite, SQL Server, JDBC, XML, XQuery, Saxon, Amazon Elastic MapReduce, Pig Latin, …

Many Web Quizzes

- Class token on the white board: write it down
- Very short online tests
- Can take many times: best score counts!
- Provide explanations for wrong answers
- Will help you
  - Test your knowledge
  - Stay in synch with class
  - Get ready for homeworks

Due date: Saturdays, but check website

Exams

- Midterm and Final

- Check course website for dates
- Location: in class

- Check past offerings of 344 and 444 for practice exams with solutions

Outline of Today's Lecture

1. Overview of database management systems
   1. Why they are helpful
   2. What are some of their key features
   3. What are some of their key concepts

2. 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

- Oracle, IBM (DB2, Informix), Microsoft (SQL Server, Access)
- Sybase
- Open source: MySQL (Sun/Oracle), PostgreSQL
- Open source library: SQLite

We will focus on relational DBMSs most quarter

An Example: Online Bookseller

- What data do we need?
  - Data: Information on books, customers, pending orders, order histories, trends, preferences, etc. Massive data: hundreds of GB and growing!
- What capabilities on the data do we need?
  - Find specific book, list all books in a certain category and price range, generate an order history, produce sales figures grouped by state, etc
- Data is persistent: outlives application
- Data is safe: from failures, malicious users etc
- Multi-user access

Multi-user discussion

- Jane and John both have ID number for gift certificate (credit) of $200 they got as a wedding gift
  - Jane @ her office orders "The Selfish Gene, R. Dawkins" ($80)
  - John @ his office orders "Guns and Steel, J. Diamond" ($100)

- Questions:
  - What is the ending credit?
  - What if second book costs $130?
  - What if system crashes?

Summary Required Data Management Functionality

1. Describe real-world entities in terms of stored data
2. 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

Discussion

- Did you ever encounter a data management problem?
  - Experimental data from a homework?
  - Personal data?
  - Other data?
- How did you manage your data?

DBMS Benefits

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

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 PostgreSQL)
  - More realistically some Java or C++ program
- Clients "talk" to server using JDBC protocol

Key Data Mngmt Concepts

- **Data models**: how to describe real-world data
  - Relational, XML, graph data (RDF)
- **Schema v.s. data**
- **Declarative query language**
  - Say what you want not how to get it
- **Data independence**
  - Physical independence: Can change how data is stored on disk without maintenance to applications
  - Logical independence: can change schema w/o affecting apps
- **Query optimizer** and compiler
- **Transactions**: isolation and atomicity

People

- **DB application developer**: writes programs that query and modify data (344)
- **DB designer**: establishes schema (344)
- **DB administrator**: loads data, tunes system, keeps whole thing running (344, 444)
- **Data analyst**: data mining, data integration (344, 446)
- **DBMS implementor**: builds the DBMS (444)

What This Course Contains

- **Focus: Using DBMSs**
- Relational Data Model
  - SQL, Relational Algebra, Relational Calculus, datalog
- Semistructured Data Model
  - XML, XPath, and XQuery
- Conceptual design
  - E/R diagrams, Views, and Database normalization
- Transactions
- Parallel databases, MapReduce, and Pig-Latin
- Data integration and data cleaning

Content through Homeworks

H1 and H2: Basic SQL with SQLite

H3: Advanced SQL with SQL Server

H4: XML and XQuery with Saxon

H5: SQL in Java (JDBC)

H6: Parallel processing with MapReduce

What to Do Now

http://www.cs.washington.edu/344

- Homework 1 is posted!
  - Simple queries in SQL Lite
  - See tomorrow's sections
  - Homework due next Wednesday
- Webquiz 1 is open!
  - Create account at http://newgradiance.com/
  - Use course token
  - Webquiz due next Saturday