Why study databases?



#### \$ 200 000 000 + \$ 13 000 000 / year

# \$ 200 000 000 USA 8 Allianz @ ORACLE

Both owned by Larry Ellison, CEO of Oracle It pays to know databases !

# Why go through all this?

- Database administrators are paid well
- Databases are everywhere (i.e. lots of job opportunities)
  - E.g. Google
  - at the doctor's office
  - payroll systems
  - on Wall Street
  - government (e.g. CIA)
  - scientific data
- Database research offers many exciting opportunities
  - Internet technologies
  - handling huge amounts of data
  - etc.

## Databases in the wild

- Database assembles US warnings of Saddam threat Reuters (1/23/2008)
  - can search by keywords
  - summarizes statistics
  - assembled from a number of sources
  - manual curation/entry
- Google

— ...

- database of searches (google trends)
- database of emails (gmail)
- database of publications (google scholar)
- privacy issues
- Bio-medical databases
  - doctor's office, lab providers, hospitals, research institutes
  - insurance companies
  - who/how/when/how much information shared?

#### Data overload

- Commerce/e-commerce (Walmart > 500 TB of product data, 1 billion records added / day, also customer preferences, etc.)
- Library of congress (> 20TB)
- Scientific data
  - Sloan Digital Sky Survey (15 TB)
  - Biological Data (> 1 TB generated / day)
  - Climate data
- Surveillance data (e.g. sensor networks, traffic cameras)

#### **Complex questions**

- How do you get to Hershey Park from College Park given traffic, tolls, etc.
- Structure of terrorist networks: who will replace Osama Bin Laden if he is captured?
- Biological data: how do genes work together to create a living organism?

# Efficiency

- Given a bank with millions of ATMs how quickly can each transaction be made?
- Given a large biological dataset (e.g. 6TB Human Microbiome Data) – how quickly can you find all the genes and organisms?

### **Robustness and Concurrency**

- What do you do if systems crash?
- How do you manage many (millions) of simultaneous queries (e.g. google)?
- How do you build a database on thousands of computers?
- How can you ensure privacy and security?

## Database Management Systems

- Provide a means to address the questions we just raised
- Primarily deal with structured data (e.g. data that can be stored in spreadsheets)
- More advanced versions deal with graphs, plain text (e.g. searching/processing blogs), etc.
- We'll primarily focus on the former

Account		
bname	acct_no	balance
Downtown Mianus Perry R.H	A-101 A-215 A-102 A-305	500 700 400 350

Customer			
cname	cstreet	ccity	
Jones Smith Hayes Curry Lindsay	Main North Main North Park	Harrison Rye Harrison Rye Pittsfield	

#### What we will cover...

- representing information
  - data modeling
- languages and systems for querying data
  - complex queries & query semantics
  - over massive data sets
- concurrency control for data manipulation
  - controlling concurrent access
  - ensuring transactional semantics
- reliable data storage
  - maintain data semantics even if you pull the plug