

What Have You Learned in CS1?



MAY 8TH, 2013

Problem Solving and Programming



- Being able to model and solve computational problems via programming is one of the most important skills a young person can have.
- Instead of just being a consumer of digital stuff, you can now be a *creator*.
- Imagine yourself working for Google or Apple or for NASA or for Pfizer or at a startup developing Mobile apps.
- Programming combines mathematical precision with lots of creativity.

Computer Science Ideas we have Touched...



- **Randomization:**
 - Primality testing, quick sort, random walks
 - Generating random input for testing
- **The *Divide-and-Conquer* paradigm**
 - Binary search, merge sort, quick sort
- **Efficiency of Algorithms**
 - Primality testing, quick sort versus selection sort, lists versus dictionaries
- **Storing and exploring networks**
- **Programming paradigms**
 - Functional programming, object-oriented programming

Applications: Cryptography



- **HW 2:** Implemented a fast, randomized, *primality testing* algorithm based on *Fermat's Little Theorem*.
- **Project 1:** Implemented simple decryption schemes.
- Encryption of data exchanged over the web is key to the success of online business.
- Encryption schemes such as RSA rely on the fact that primality testing is fast, but factoring is not.

Applications: Simulation



- **In class Example:** Simulating 1-dimensional random walk.
- *Simulation* has become an important research tool in all areas.
- Researchers simulate epidemics, formation of galaxies, fluctuations in stock markets, etc.
- Much of this was done using differential equations in the past.
- Is this a “new kind of science?” (Stephen Wolfram)

Applications: Text Analysis



- **HW3 and In-class Examples:**
 - Extracted high frequency words from novels.
 - Given the text of a novel we extracted the names of principal characters.
- **Wired (Aug 2012)**

A literature professor has developed software using Google's PageRank algorithm that has identified Jane Austen and Walter Scott as the most influential authors of the 1800s.
- **Digital humanities is a focus area at the University of Iowa.**

Applications: Network Analysis



- **In-class Examples:**
 - Representation and storage of the “word network.”
 - Implementation of algorithms for exploring networks.
- *Network Science* is an emerging area that attempts to study
 - the structure of networks (e.g., Facebook friends structure)
 - along with phenomena that occur over networks (e.g., disease-spread, information-spread).

Applications: Recommender Systems



$$\hat{r}_{ui} = b_{ui} + |\mathbf{N}(u)|^{-\frac{1}{2}} \sum_{j \in \mathbf{N}(u)} e^{-\beta_u \cdot |t_{ui} - t_{uj}|} c_{ij} +$$
$$|\mathbf{R}(u)|^{-\frac{1}{2}} \sum_{j \in \mathbf{R}(u)} e^{-\beta_u \cdot |t_{ui} - t_{uj}|} ((r_{uj} - \tilde{b}_{uj}) w_{ij}) -$$
$$\sum_{j \in \mathbf{R}(u)} e^{-\gamma_u \cdot |t_{ui} - t_{uj}|} ((r_{uj} - \tilde{b}_{uj}) d_{ij}).$$

This equation, from Yehuda Koren's prize-winning documentation, shows the winning team adding a third set of movie-movie weights, and emphasis on adjacent ratings made by a user. (Wired, Sept 2009)

- Bellkor's Pragmatic Chaos, a multi-national team from the US, Austria, Israel, and Canada won the Netflix Prize of 1 million in Sept 2009.