What Have You Learned in CS1?
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

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

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.