COMP 3270: Introduction to Algorithms



Hugh Kwon

What is an algorithm?

• An algorithm is a well-defined computation procedure (i.e., a <u>finite</u> number of <u>computational steps</u> specified at the required <u>level of detail</u>) that generally (but not always) takes some data as input and generally (but not always) produces some data as output in order to solve a problem.

Different views of algorithms

- They are magical, all powerful and taking over the world!
 - http://www.youtube.com/watch?v=TDaFwnOiKVE
- They are for socially inept nerds...
 - https://www.youtube.com/watch?v=k0xgjUhEG3U
- They are for everybody, and here is why in plain language...
 - https://www.youtube.com/watch?v=vSi6YoTPWLw
- But what we're concerned about is technical stuff, like this...
 - https://www.youtube.com/watch?v=kPRA0W1kECg

Why did I show these videos?

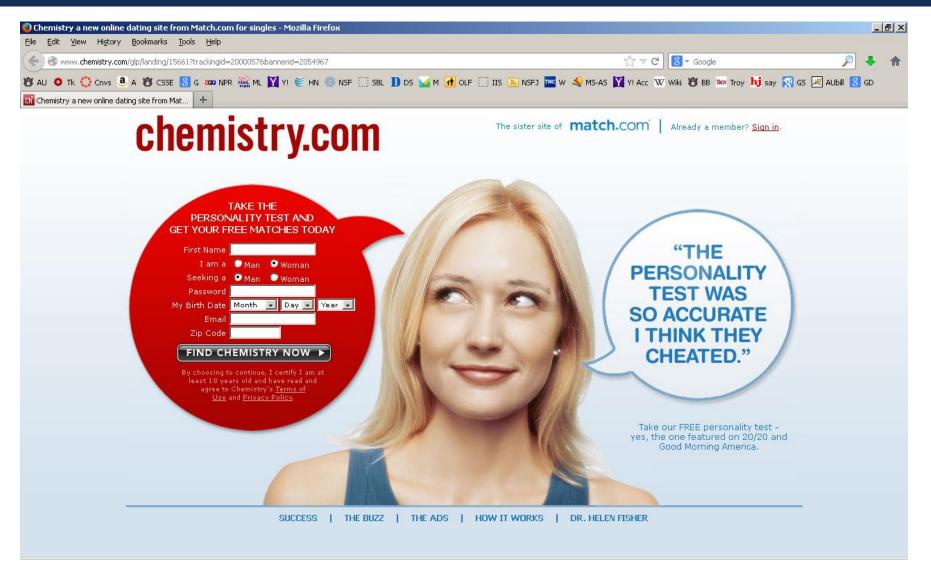
To illustrate how pervasive algorithms have become...

• To emphasize that algorithms may be mysterious/magical, unreadable and uncontrollable to lay people, but you, as students of computing, must develop the skills of algorithmic thinking: being able to understand, design, implement and control them!

Why study algorithms?

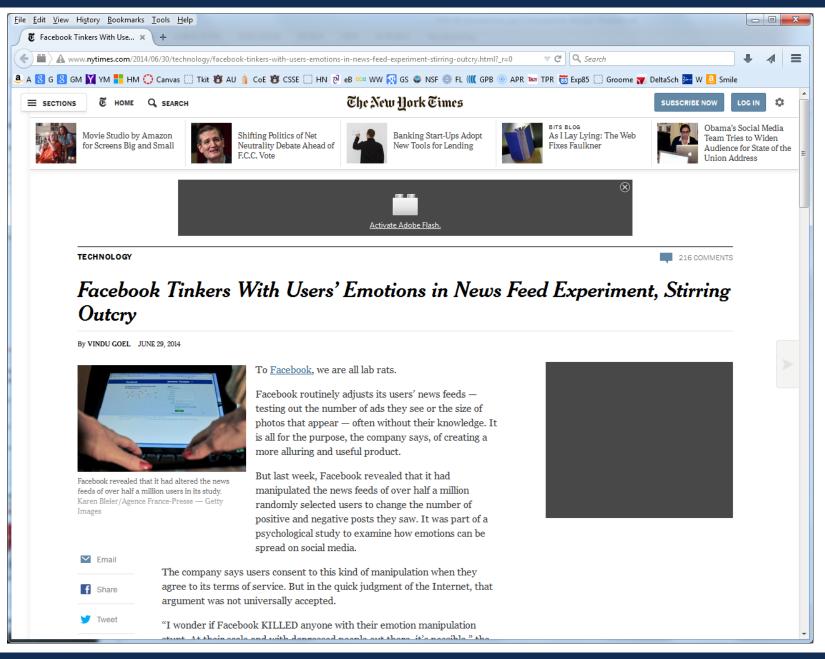
- Algorithms affect ALL FACETS of your life!
 - your romantic life
 - your social life
 - your financial transactions
 - how you entertain yourself
 - your privacy (or lack of it)

your romantic life

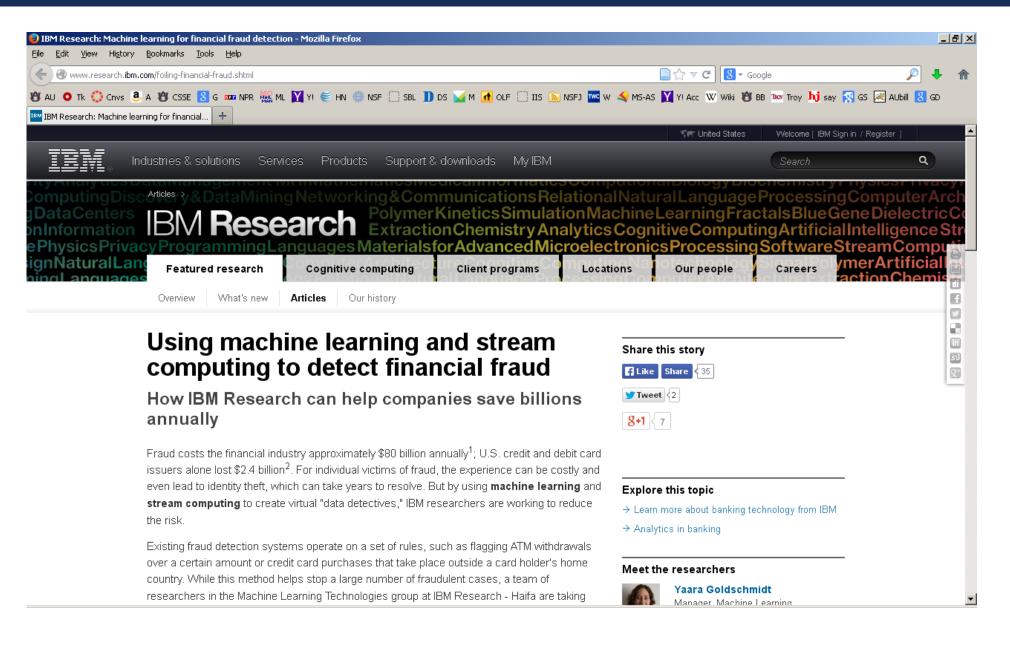


http://en.wikipedia.org/wiki/Stable_marriage_problem#Algorithm

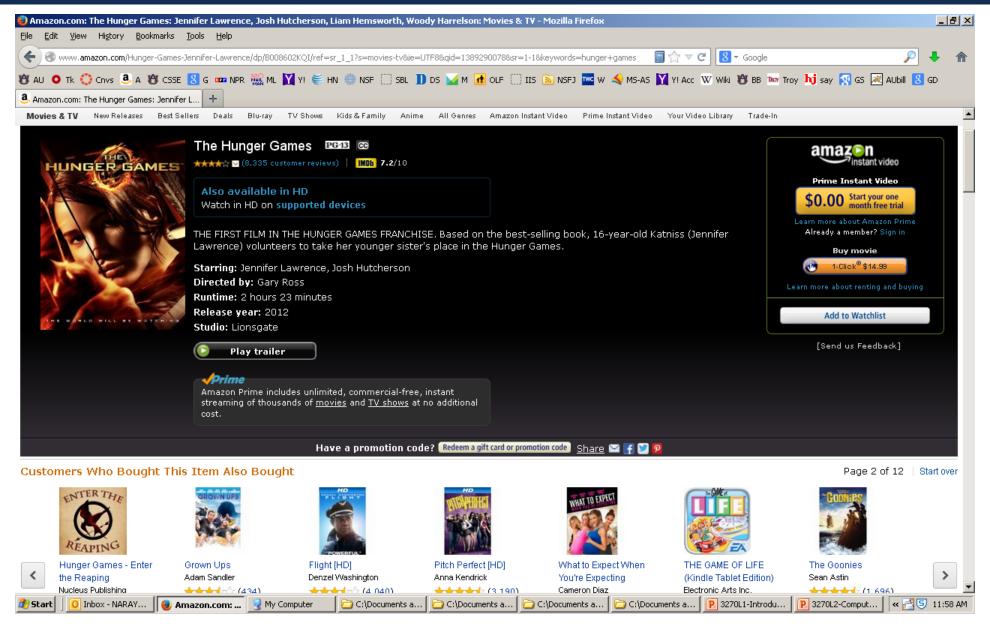
your online social life



your financial transactions



your entertainment



www.cs.carleton.edu/cs comps/0607/recommend/recommender/index.html

your privacy (actually, lack of it)



http://en.wikipedia.org/wiki/Cryptography

Why study algorithms?

- Algorithms form the backbone of all computations.
- And, as students majoring in a computing-related discipline, you must develop skills to <u>understand</u> and <u>analyze</u> computation, and know how to <u>design</u> computations to solve problems!
- So really, this course is actually about **Computational Problem Solving** Algorithms are the products of computational problem solving.

Computational Problem Solving

• Computational Problem Solving is the art of coming up with a correct AND efficient computational solution (i.e., one or more algorithms) to a given problem.

Problems and Problem Instances

- An <u>instance of a problem</u> consists of <u>one set of valid inputs</u> from which a solution to the problem can be computed.
- "How to sort a set of numbers in the ascending order" is a problem.
- "Sorting the set of numbers 4,5,7,1,2,0 in the ascending order" is a problem instance.

Steps of Computational Problem Solving

- Problem specification
- Designing solution strategies
- Developing corresponding algorithms
 - Understand existing algorithms and modify/reuse, or
 - Design new algorithms
- Understanding the algorithms by simulating their operation on inputs
- Ensuring/proving correctness of the algorithms
- Analyzing and comparing the performance/efficiency of algorithms
 - Theoretically: Using a variety of mathematical tools
 - Empirically: Code, run and collect performance data
- Choosing the best algorithm to code

More on why study algorithms?

- You could make a good living (or even become one of the richest persons on earth) if you know how to design algorithms!
- Or get hired by big tech companies like Google.
- Or convince some investors to fund your startup.

What have we covered so far?

- Different perspectives on algorithms
 - And what perspective we should take as serious students of computing.
- Discussion of why algorithms are important
- Problems and Problem Instances
- The process of Computational Problem Solving
- We will begin to delve into the technical material next
- Meanwhile, a warm-up reading/watching assignment
 - "How algorithms rule the world": https://www.theguardian.com/science/2013/jul/01/howalgorithms-rule-world-nsa
 - "How Google's algorithm rules the web": https://www.wired.com/2010/02/ff google algorithm/
 - Another TED talk: https://www.youtube.com/watch?v=H aLU-NOdHM



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