The Beauty and Joy of Computing

Lecture #6
Algorithms

Quest REVIEW in 8 days!

Quest (first exam) in in 9 days!

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PREDICTING THE FUTURE?

MIT researchers recently created an algorithm which they say will be able to predict what topics will "trend" or go viral on Twitter hours before they do. Its accuracy expected to get better with time. They are using Aritifical Intelligence (Machine Learning) to get better results.

http://web.mit.edu/newsoffice/2012/predicting-twitter-trending-topics-1101.html

World record for solving a 3x3x3 Rubik's cube?

a) 12 minutes, 3 seconds
b) 58.1 seconds
c) 7.96 seconds
d) 5.66 seconds
e) 3.31 seconds

www.youtube.com/watch?v=3v_Km6cv6DU

Rubik's Cube Champion

Feliks Zemdegs (b 1995)
5.66 seconds, Melbourne Winter Open

What is an algorithm?

- An **algorithm** is any well-defined computational procedure that takes some value or set of values as input and produces some value or set of values as output.
- The concept of algorithms, however, is far older than computers.

Early Algorithms

- Dances, ceremonies, recipes, and building instructions are all conceptually similar to algorithms.
- Babylonians defined some fundamental mathematical procedures ~3,600 years ago.

Photo credit: Daniel Niles

Algorithms You've Seen

- Multiplication algorithm (for humans)

```
                            2
 187       187            187
X 53      X 53           X 53
-----     -----          -----
             1              1
```

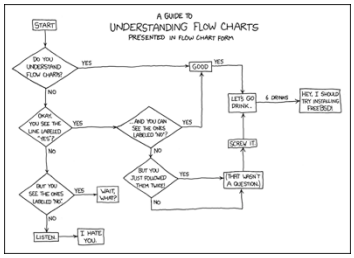
Algorithms You've Seen in CS10

- Length of word
- Whether a word appears in a list
- Whether a list is sorted
- Greet a List of People (Last Lab)
- Word Comparisons (You wrote one for HW1!)
- Sort a List (Next lab!)

http://xkcd.com/518/

How much money is an Algorithm worth?

a) Nothing!
b) $1000 or less
c) $1 Million
d) $1 Billion
e) More than $1 Billion!



Commonly-Used Algorithms

Luhn algorithm
Credit card number validation

Deflate
Lossless data compression

PageRank
Google's way of measuring "reputation" of web pages

EdgeRank
Facebook's method for determining what is highest up on your news feed

Choosing a Technique

- Most problems can be solved in more than one way, i.e., multiple algorithms exist to describe how to find the solution.
- Not all of these algorithms are created equal. Very often we have to make some trade-offs when we select a particular one.
- We'll talk more about these next time.

Ways to Attack Problems

- Many ways to approach an algorithm!
- **Top-down**
  - Starting from the top, divide the full problem up into smaller subproblems, working your way down.
  - You often write "stubs" for missing parts below to test your code before it's done
- **Bottom-up**
  - work your way up, building your way up.
  - Your system always "works" as you build layers on top of working (smaller) pieces.

Top-down vs Bottom-up example

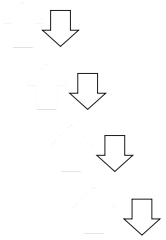
HTML5 front-end

Server

Database

Solver

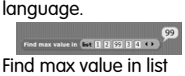
Game



Algorithms vs. Functions & Procedures

- Algorithms are conceptual definitions of how to accomplish a task and are language agnostic, usually written in pseudo-code.
- Find max value in list
  - Set (a temporary variable) the max as the first element
  - Go through every element, compare to max, and if it's bigger, replace the max
  - Return the max

- A function or procedure is an implementation of an algorithm, in a particular language.



- Find max value in list

Algorithm Correctness

We don't only want algorithms to be fast and efficient; we also want them to be ***correct!***

TOTAL Correctness	**PARTIAL Correctness**
Always reports, and the answer is always correct.	Sometimes reports, and the answer is always correct *reports*.

We also have *probabilistic* algorithms that have a certain *probability* of returning the right answer.

Summary

- The concept of an algorithm has been around forever, and is an integral topic in CS.
- Algorithms are well-defined procedures that can take inputs and produce output (or have side-effects).
- We're constantly dealing with trade-offs when selecting / building algorithms.
- Correctness is particularly important and testing is the most practical strategy to ensure it.
  - Many write tests first!