What is the world record?

For the standard 3x3x3 cube...

- 56.12 s
- 14.76 s
- 7.96 s
- 5.66 s
- 3.31 s

What is an algorithm?

- An algorithm is any well-defined computational procedure that takes an input and produces an output.
- The concept is older than digital computers.

Algorithms Everywhere

- Dances
- Ceremonies
- Recipes
- Building techniques

All are conceptually similar to algorithms!

Algorithms You’ve Seen

- Subtract each digit from the one above, moving from least to greatest place value, “borrowing from the neighbor” if necessary to get a positive result

\[
\begin{array}{c}
6728 \\
- 51 \\
\hline
677
\end{array}
\]
Algorithms You’ve Seen

- Length of word
- Does a word appear in a list?
- Is a list sorted?
- Pick a random word of length x from a list

Commonly-Used Algorithms

- Luhn algorithm
  - credit card validation
- Damereau-Levenshtein
  - distance
  - Spell checking
- PageRank
  - Google’s way of determining the relevance of a page to a search term
- EdgeRank
  - Facebook’s way of determining what appears in your news feed

Choosing a Technique

- Most problems can be solved >1 way
  - Multiple algorithms will give a solution
  - But all algorithms are not created equal
- Trade-offs
  - Time
  - Space

Three Ways to Attack Problems

- Brute Force
  - Keep trying stuff until something works
- Bottom-up
  - Start with a simple solution and elaborate it until the full problem is solved
- Top-down
  - Divide the problems up into smaller problems, solve them, combine the answers

Algorithms vs. Functions / Procedures

- An algorithm is a conceptual definition of how to accomplish a task
- A function or procedure is an implementation of an algorithm
- Language agnostic
- Written in a particular language, can be run

Example: Finding the Maximum

Scratch

```plaintext
define (find-max X)
  if [null] (return 1)
  if (>[max] (find-max (tail X)))
    [max]
  (find-max (tail X))
```

Scheme

```plaintext
(define (find-max X)
  (cond ((null? X) 1)
        ((> (max) (find-max (rest X))) max)
        (else (find-max (rest X))))
```

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### Correctness

- **Total Correctness**
  - Always reports, and is always correct
- **Partial Correctness**
  - Sometimes reports, and the answer is correct when it reports
- **Probabilistic**
  - A certain probability of returning the right answer

### Summary

- **Algorithms** are an old idea, integral to CS
- **Definition**: well-defined procedure that takes inputs and produces output
- **Trade-offs usually can’t be avoided**
- **Correctness is important**, and testing is a practical strategy to ensure this