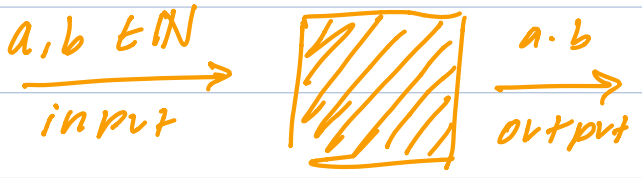
CS121 Lecture 1

September 3, 2019

book: introtcs.org

website: cs121.boazbarak.com

Story of Multiplication



specification

implementation: algorithm

Algo 1: iterative multiplication 10^n operations

Algo 2: digit-by-digit multiplication n^2 operations

Algo 2 → Goren: 30×80^2 sec versus Summit: 10^{80} / 10^{17} sec ← Algo 1

Karatsuba's Algorithm: multiply 2 n-digits using 3 multiplications of n/2 digit #s

Time (2 digit) = 3 · Time (1 digit)

Time (n digit) = 3^ℓ · Time (1 digit) where $n = 2^\ell$

Invert Multiplication (Integer Factoring)

Algo 1: Trial division 10^n digits

Conjecture: every algorithm to factor integers takes exponentially many operations

Other Algo Examples

- backprop: compute derivatives of NNs in $\sim n$ operations
- pagerank: approx eigenvector of huge matrix
- compressed sensing: sparse solutions to n equations with $N > n$ variables

About CS 121

- What is hard?
  - learning new concepts w/ a different kind of math
  - analyze and meta-analyze algorithms
- How to succeed
  - come to lecture
  - Do readings before later lectures (low stakes quiz on fridays)