CS 120: Intro to Algorithms and their Limitations

Lecture 6: — Thursday September 21, 2023

Pset Due: September 27, 2023 **Denny Cao**

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§1 RAM Model

§1.1 Goals

- Unambiguous: Know what a step is
- Expressivity: Capture what we think of as algorithm
- Mathematical Simplicity: Not too many operations
- Technical Relevances: One model applies to all languages

Definition 1.1 (RAM Model)**.** A program consists of:

- A set V of variables
- Commands $C_0, C_1, \ldots, C_n$ each:
  - $\text{var}_i = c$, $\text{var}_i \in V, c \in nats$
  - $\text{var}_0 = \text{var}_1$ op var_2, $\text{var}_0, \text{var}_1, \text{var}_2 \in V$, op $\in \{+, -, \times, \div\}$
  - $\text{var}_0 = M[\text{var}_1]$
  - $M[\text{var}_0] = \text{var}_1$
  - If var $== 0$, GO TO K, $K \in \{0_1, \ldots l\}$

Definition 1.2 (Computation w/RAM Program)**.**
Initialize: Encode input in memory $M[0], \ldots, M[n-1]$ (input is size n) and $M[k] = 0$ if $k \geq n$.

Execution: Execute $C_0, C_1, C_2, \ldots$ except that GOTO commands change order.

Output: When the program reaches line l, output $:= M[\text{output\_ptr}], \ldots, M[\text{output} + \text{output\_len}]$ $P(x) = \perp$ if it halts, $\text{Time}_p(x) = \#$ commands executed