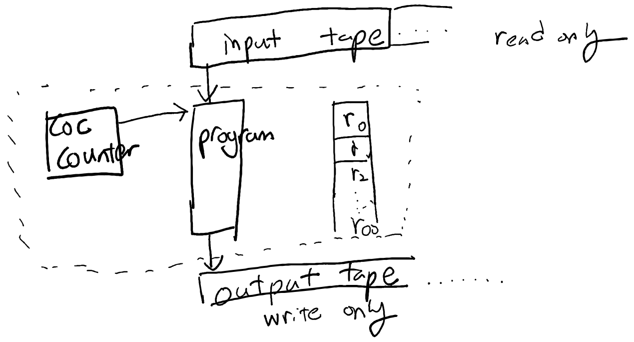
Random access machine (RAM)



* assumptions about memory
① reg. can hold integers of arbitrary size
② # reg. infinite

○ * assumption about program.
① program dose not modify itself
② program is seq of opperation (instructions)

○ two complexities in RAM
- uniform cost criterion for time :
→ instructions req. one unit of time
- logarithmic cost criterion for time
a instruction req. $l(i)$ time on integer i

$$l(i) = \begin{cases} 1 & i = 0 \\ \lfloor \lg |i| \rfloor + 1 & (i \neq 0) \end{cases}$$

○ uniform cost criterion for space
: each reg. used one unit of space

○ log. cost criterion for space

$\sum_{\text{location } i} l(x_i)$ where x_i is the largest value ever stored in i

ex) Factoring n by "trial division"
$m \leftarrow n$

$F \leftarrow \phi$
$i \leftarrow 2$
While $i \le \lfloor \sqrt{n} \rfloor$ do

if i divides evenly into m
then insert i into F
$m \leftarrow m/i$
else $i \leftarrow i+1$
endif
endwhile

if $m > 1$, then insert m into F

$n = 48$ $F = 2, 2, 2, 2, 3$

$i = 2 \times \underline{24}_m$

$i = 2 \times 12$

$i = 2 \quad \underline{\times 6}$

$i = 2 \quad \underline{3}$

$m = 3 > 1$

* ab.

- # times through the while loop

$\le \lfloor \sqrt{n} \rfloor + \lg n$

ex) $2^4 = \cancel{16 \times 16} = 2 \times 2 \times 2 \times 2$

$i = 2 \quad m = 2 \times 2 \times 2 \times 2$
$i = 2 \quad m = 2 \times 2 \times 2$
$\lfloor \lg 2^4 \rfloor$ $i = 2 \quad m = 2 \times 2$
$\lg 2^4$ $i = 2 \quad m = 2$
$= 4$ $i = \cancel{2} \quad m = 1$
$i = 3$
$\sqrt{2^4}$ $i = \cancel{4}$

$\sqrt{2^4} = 4$

- max # of factor? $\lg n$

- uniform cost

time $O(\lfloor \sqrt{n} \rfloor + \lg n) = O(\sqrt{n})$

space $O(\lg n)$

- logarithmic cost

trial division

- logarithmic cost

time : worst loop tme for each ~~loop~~ trial division

is when m never gets updated

$\rightarrow$ $\lg(n)$ for each trial division $(\sqrt{n})$

$\therefore O(\sqrt{n} * \lg(n))$

space :

$F = (\quad n = f_1 \times f_2 \times \cdots \times f_K$

$\lg n = \lg f_1 + \lg f_2 + \cdots + \lg f_K \quad) \; O(\lg n)$

$m \Rightarrow \lg n$

~~n~~

$i = \lg\sqrt{n} = \frac{1}{2}\lg n$

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$\therefore$ space $O(\lg n)$