

# Set 1: Computational Complexity

$$n = 10$$

$$\frac{n=10}{-00001 \text{ sec}}$$

$$A_1(n)$$

$$-00001 \text{ sec}$$

$$A_2(n^2)$$

?

$$A_5(2^n)$$

20 . . .

$$\underline{10 \text{ ops}} \rightarrow \underline{.00001 \text{ sec}}$$

$$\underline{100} \text{ " } \rightarrow \underline{.0001 \text{ sec}}$$

$$\underline{1000} \text{ " } \rightarrow \underline{.001 \text{ sec}}$$

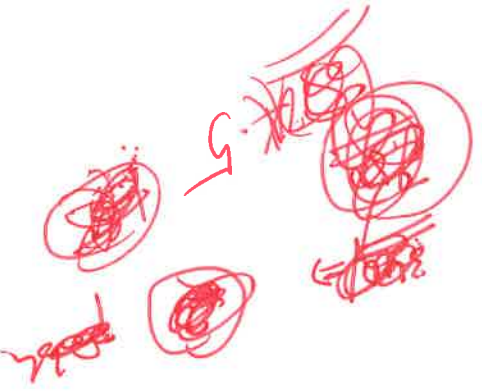
$$n=20$$

$$2^{20}$$

$$2^{10} \cdot 2^{10}$$

$$\underline{1000}$$

$$1 \text{ sec}$$



$$10^0 \rightarrow N_1' \approx 100 N_1 \quad \sim$$

$$10^0 \rightarrow N_1'' \approx 1000 N_1$$

$$N_5' \sim N_5$$

$$N_5'' \sim N_5$$

$N_5' = \log_2^{100} N_5$
$N_5'' = \log_2^{1000} N_5$

\*

---


$$N_5 \rightarrow \text{Origid Med} - 1 \text{ hour} \quad (2^n)$$


---

$$\frac{2^{N_5} \text{ operation}}{\rightarrow 1 \text{ hour}(M)}$$

$$\frac{1 \text{ Hr in } M'' \rightarrow 1000 \text{ hr } M}{\text{fash}} \quad 1000$$

$$1000 \cdot 2^{N_S} \text{ operch}$$

$$\Rightarrow \frac{1000 \text{ Hr} \cdot 2^{N_S}}{1 \text{ Hr} \cdot 2^{N_S}}$$

$$\underbrace{N_S''}_{1 \text{ hour}} \rightarrow N''$$

$$2^{N_S''} \text{ operations}$$

$$\leftarrow 1 \text{ hr} \cdot 2^{N_S''}$$

$$2^{N_S''} = 1000 \cdot 2^{N_S}$$

$$\frac{2^{N_S''}}{2^{N_S}} = 1000$$

$$2^{N_S'' - N_S} = 1000$$

$$N_S'' - N_S = \lg_2 1000 \approx 10$$

$$N_S'' = N_S + 10$$

$$\underline{O(g(n))} = \{ f_1 f_2 \dots \}$$

$$0 \leq f(n) \leq C g(n) \text{ for all } n \geq n_0$$

---

$$f(n) \rightarrow O(g(n))$$

$$0 \leq f(n) \leq C g(n) \text{ for all } n \geq n_0$$

---

$$O(g(n)) =$$

$$g(n) = n^3$$

$$O(n^3) = \left\{ \underbrace{f_1}_{n^2}, \underbrace{f_2}_{\log n}, \underbrace{f_3}_{\cancel{n^2}}, \dots \right\}$$

Then exist +ve const  $C$  &  $n_0$

such that

$$0 \leq \underbrace{f(n)}_{n^2} \leq C g(n) \text{ for all } n \geq n_0$$

$$\boxed{0 \leq n^2 \leq C n^3 \text{ for all } n \geq n_0}$$

$$0 \leq n^2 \leq n^3 \text{ for all } n \geq 1 \quad \uparrow$$

$$0 \leq \lg n \leq C n^3 \text{ for all } n \geq n_0 \quad \uparrow$$

$$0 \leq \lg n \leq n^3 \text{ for all } n \geq 1 \quad \uparrow$$

$$0 \leq n^4 \lg n \leq C \cdot n^3 \text{ for all } n \geq n_0 \quad \uparrow$$

$$\frac{n^4 \lg n}{n^3} \leq C \text{ for all } n \geq n_0$$

$$n \lg n \leq C \text{ for all } n \geq n_0$$

$\uparrow \quad \uparrow$   
 $10^{19} \quad 10^{18}$