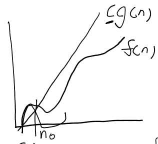
o "size" of the problem value of t
quantity of input in o int
time complexity :
o space "

o asymptotic time(space) complex

$\lim_{n \to \infty} (\ ) = \boxed{\emptyset}$

o Asmptotic notations.
o Big-Oh (asmptotic upperbound)



def > $f(n) \in O(g(n))$
there exists constants n_0 & $c>0$ s.t. for all $n \geq n_0$

$$\underline{0 \leq f(n) \leq c\,g(n)}$$

ex) "running time is $O(n^2)$" = worst case running time is $O(n^2)$.

ex) $f(n) = 2n\lg n + 5n$. $\quad \lg = \log_2$

choose $n_0 = 2$

$\underline{2n\lg n + 5n \leq 2n\lg n + 5n\lg n} = 7n\lg n$

choose $c = 7$ $\quad g(n) = n\lg n$ $\quad \therefore f(n) = O(n\lg n)$

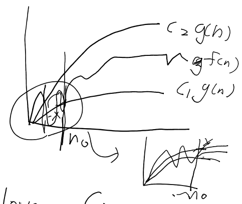
$2n\lg n + 5n \leq 2n^2 + 5n^2 = 7n^2$

$c = 7$, $f(n) = O(n^2)$

o theta Θ (assymtotic tight Bound)

def) $f(n) = \Theta(g(n))$:
there $\exists$ three const. $n_0, c_1>0, c_2>0$ s.t.
for all $n > n_0$

$$c_1 \underline{g(n)} \leq f(n) \leq c_2 \underline{g(n)}$$



ex) $f(n) = 2n\lg n + 5n$

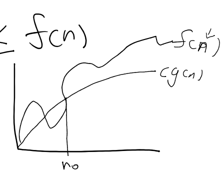
choose $n_0 = 2$ $\quad g(n) = n\lg n$

$\underset{g(n) = n\lg n}{\overset{c_1}{\underline{2n\lg n}}} \leq 2n\lg n + 5n \leq 2n\lg n + 5n\lg n = \overset{c_2}{\underline{7n\lg n}}$

o Big-Omega (Ω) (assymtotic lower-bound)

def > $f(n) = \Omega(g(n))$
there $\exists$ two const. $n_0, c>0$ s.t
for all $n \geq n_0$

$$0 \leq c\,g(n) \leq f(n)$$



o little-o
" " " " " " " "
" $(0 \leq f(n) < c\,g(n))$ $\quad 2n = o(n^2)$
$2n^2 \neq o(n^2)$

$(0 \le f(n) < cg(n))$ $\quad$ $2n = o(n^2)$

$2n^2 \ne o(n^2)$

∘ little-ω

$0 \le cg(n) < f(n)$

ex) $2n^2 + 3n + 1 = 2n^2 + \cancel{\Theta(n)}$ $\quad$ $\Theta(n^2)$

$3n^2 + 5n + 1 = 3n^2 + \Theta(n)$

ex) $T(n) = 2T(n/2) + \Theta(n)$

ex) $2n^2 + \Theta(n) = \Theta(n^2) = O(n^2)$

∘ ~~fun~~ functions of n

- $O(\lg n)$: logorithmic
- $O((\lg n)^k)$: poly logorithmic $\quad$ k const
- $O(\sqrt{n})$:
- $O(n)$: linear
- $O(n^2)$: quadratic
- $O(n^k)$: polynomial (some const. k)

feasible

- $O(c^n)$: exponential $\quad$ $c > 1$
- $O(n!)$