$6^{\log_6 6} = 6$

$2^{\log_2 N} = N$

$T: (N\log(N) + N)$

$S: O(1)$, inplace

$T(N) = \log(N) + \log(N-1) + \log(N-2) \ldots\ldots \log(2) + \log(1)$

$= \log(N \cdot (N-1)(N-2)(N-3) \cdot (N-4) \ldots\ldots 3 \cdot 2 \cdot 1)$

$= \log(N!)$ $\qquad N! < N^N$

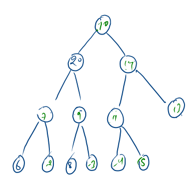
$\approx \log(N^N) \approx N\log(N)$

$= N + N\log(N)$

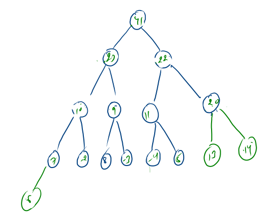
-4	3	-2	5	6	7	8	9	10	11	12	14	20	22	30

10	20	17	7	9	11	12	6	-2	8	-3	-4	5	22	30

Bdx



0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
41	20	22	10	9	11	12	7	-2	8	-3	-4	5	17	14	6



a > b $\quad$ a − b $\rightarrow$ (+)ve $\;|\rightarrow$ (+) $\rightarrow$ a > b $\rightarrow$ swap

a < b $\quad$ a − b $\rightarrow$ (−)ve $\;|\rightarrow$ (−)ve $\rightarrow$ a < b $\rightarrow$ X

a > b $\quad$ b − a $\rightarrow$ (−)ve $\;|\rightarrow$ (−)ve

a < b $\quad$ b − a $\rightarrow$ (+)ve $\;|\rightarrow$ (+)ve $\rightarrow$ a > b $\rightarrow$ swap

$T(N) = 2^H \times 0 + 2^{H-1} \times 1 + 2^{H-2} \times 2 + 2^{H-3} \times 3 + 2^{H-4} \times 4 \ldots\ldots 2^{H-H} \times H$

$= \frac{2^H}{2^1} \times 1 + \frac{2^H}{2^2} \times 2 + \frac{2^H}{2^3} \times 3 + \ldots\ldots \frac{2^H}{2^H} \times H = 2^H\left(\frac{1}{2} + \frac{2}{2^2} + \frac{3}{2^3} + \frac{4}{2^4} + \frac{5}{2^5} + \frac{6}{2^6} \ldots\ldots \frac{H}{2^H}\right)$

$\boxed{T(N) = 2^H \sum \frac{\lambda}{2^\lambda}}$ $\qquad$ let $\frac{1}{2} = x$

$T(N) = N \sum \lambda (x)^\lambda$

$T(N) = N \sum_1^H \lambda x^\lambda \leq N \sum_0^\infty \lambda x^\lambda$

$T(N) \leq N \sum_0^\infty \lambda x^\lambda$

$\boxed{T(N) \leq 2N}$

$\boxed{\sum_0^\infty x^\lambda = \frac{1}{1-x}}$

$\sum_0^\infty \lambda x^{H} = \frac{1}{(1-x)^2}$

$\boxed{\sum_0^\infty \lambda x^\lambda = \frac{x}{(1-x)^2} = 2}$

$S_N = (1 \cdot r + 2r^2 + 3 \cdot r^3 + 4 \cdot r^4 \ldots\ldots H \cdot r^H)$

$r S_N = 0 \cdot r + 1 \cdot r^2 + 2 \cdot r^3 + 3 \cdot r^4 \ldots\ldots (H-1) r^H + H \cdot r^{H+1}$

$S_N(1-r) = r + r^2 + r^3 + r^4 + r^5 \ldots\ldots r^H + H \cdot r^{H+1}$

$S_N(1-r) = (r)\frac{(1-r^H)}{(1-r)} + H \cdot r^{H+1}$

$S_N\left(1-\frac{1}{2}\right) = \left(\frac{1}{2}\right)\frac{\left(1-\left(\frac{1}{2}\right)^H\right)}{\cancel{\left(1-\frac{1}{2}\right)}} + H \cdot r^{H+1}$

$\frac{S_N}{2} = 1 - \left(\frac{1}{2}\right)^H + \log(N) \cdot \left(\frac{1}{2}\right)^{\log_2(N)} \cdot \frac{1}{2}$

$\frac{S_N}{2} = 1 - \frac{1}{2^{\log_2(N)}} + \frac{\log(N)}{2^{\log_2(N)}} \cdot \frac{1}{2}$

$S_N = 2 - \frac{2}{N} + \frac{2\log(N)}{2N}$

$\boxed{S_N = 2 - \left(\frac{2}{N}\right) + \left(\frac{\log(N)}{N}\right)}$

$S_N(1-r) = \frac{1}{1-r}$

$= \frac{1}{1-\frac{1}{2}}$

$= \frac{1}{\left(\frac{1}{2}\right)}$

$\frac{S_N}{2} = 2$

$\boxed{S_N = 4}$