* (Recursion - Merge Sort) *

① divide and conquer.

8, 3, 4, 12, 5, 6

3, 4, 8 | 5, 6, 12

After sorted → merge then

[3, 4, 5, 6, 8, 12]

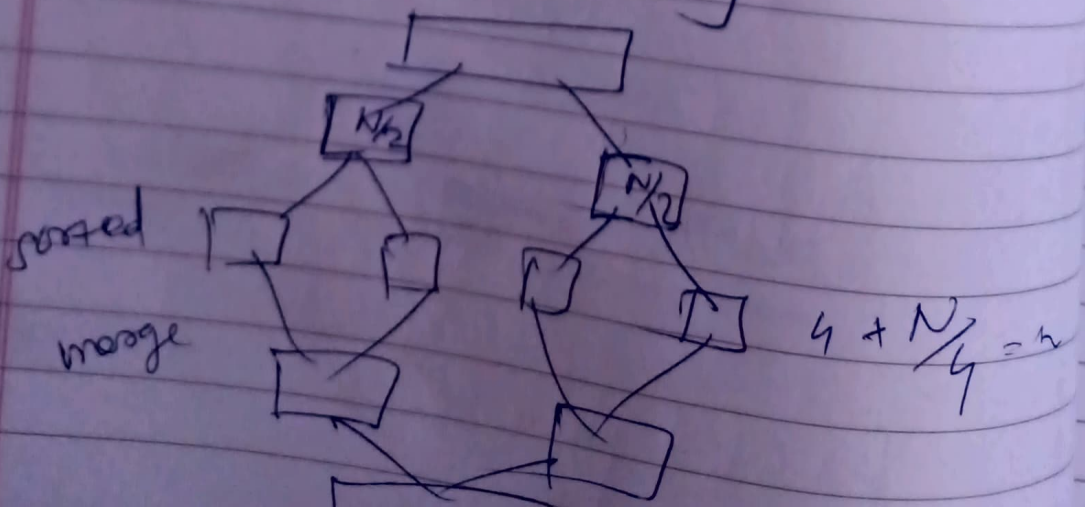
Step :-

① Divide array into two parts.
② Get both parts are sorted using recursion
③ merge into sorted parts

arr [3, 5, 9, 8, 18]

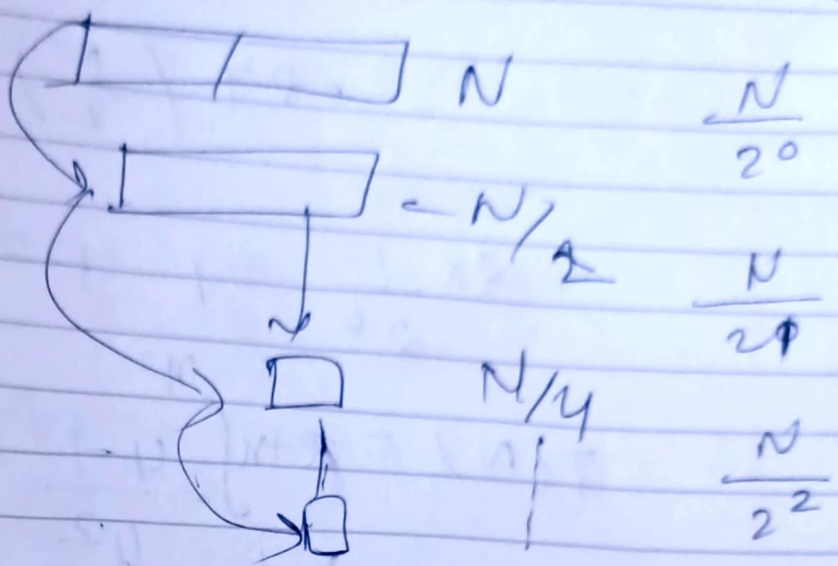
arr [5, 6, 8]

[3, 4, 5, 6, 8, 18]



* **Complexity**

at every level N element are being merged



$$l = \frac{N}{2^k}$$

$$l = \frac{N}{2^k} \Rightarrow 2^k = N$$

$$k \log 2 = \log N$$

$$k = \log_2 N$$

Complexity :. $O(N * \log N)$

$$T(N) = T\left(\frac{N}{2}\right) + T\left(\frac{N}{2}\right) + (N-1)$$

$$= 2T\left(\frac{N}{2}\right) + (N-1)$$

$$2 \times \frac{1}{2^0} = 1 \quad p = 1$$

$$T(N) = x + x\int_1^x \frac{u-1}{u^2}$$

$$\int_1^x \frac{1}{u} - \frac{1}{u^2}$$

$$= \int \frac{du}{u} - \int \frac{du}{u^2}$$

$$= \log u - \int u^{-2} \cdot du$$

$$= \log u + u^{-1}$$

$$\left[= \log u + \frac{1}{u} \right]_1^x$$

$$\log x + \frac{1}{x} - 1$$

$$x + x\left[\log x + \frac{1}{x} - 1\right]$$

$x + x\log x + 1 \rightarrow x$

$O(x \log x)$ or

$\Rightarrow O(N \cdot \log N)$

* Inplace

s 0 1 2 3 e

5, 4, 3, 2, 1

(arr, s, m, e)

[arr, 0, 2, 4]

(arr, 0, mid) (arr, mid, ...

i j

(4, 5) (2, 3) [arr, s, m, e]

s m e