

* Merge Sort *

Steps -

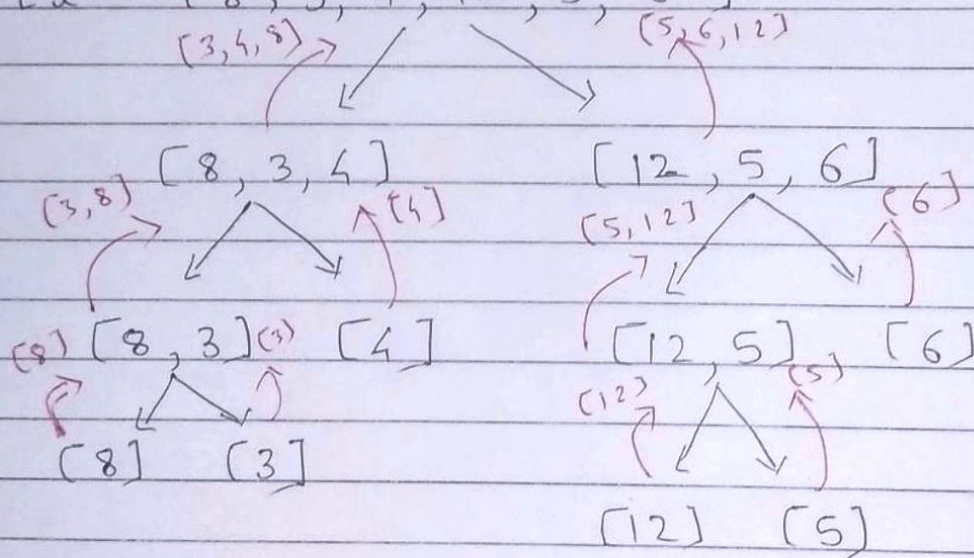
- 1) Divide array into 2 parts
- 2) Get both the parts sorted via recursion
- 3) Merge the sorted parts.

3rd Explanation - arr1 = [3, 5, 9, 19, 32]

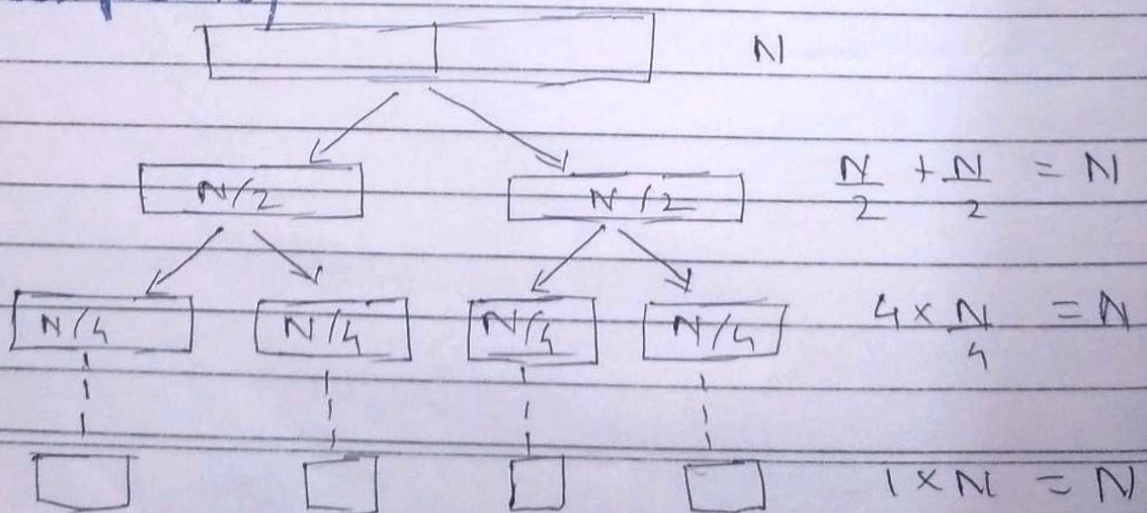
arr2 = [4, 6, 8]

new array = [3, 4, 5, 6, 8, 9, 19, 32]

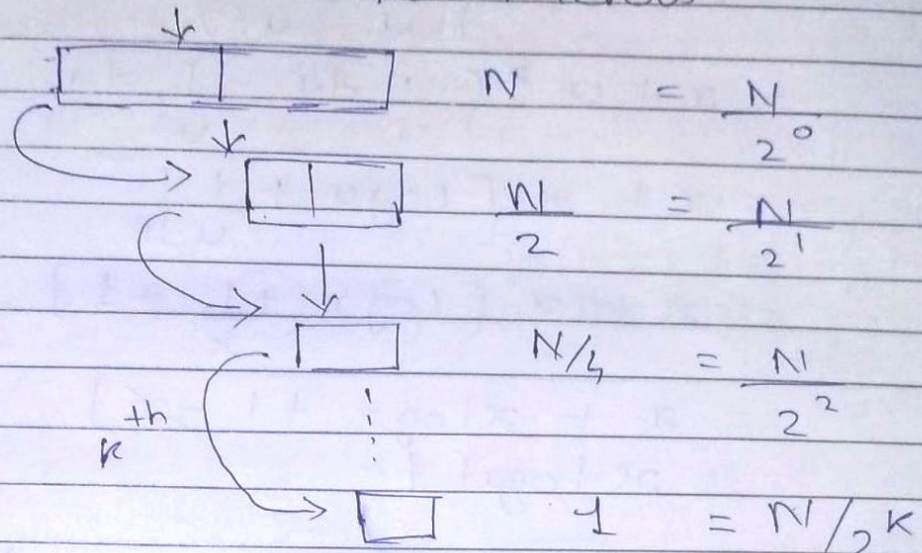
Ex. - [8, 3, 4, 12, 5, 6]



* Time Complexity -



* At every level, N element are being merged.
 How many comparisons at every level? $\rightarrow N$
 & what are total Numbers of levels.



$$1 = \frac{N}{2^k}$$

$$2^k = N$$

taking log

$$k \log_2 = \log N$$

$$k = \log_2 N$$

Time Complexity: $O(N \log N)$

Space complexity: $O(N)$

let's solve it using Ak & a Bazzi

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

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

To find p

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

$$p = 1$$

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

$$= x + x \int_1^x \left(\frac{1}{u} - \frac{1}{u^2} \right) du$$

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

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

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

$$= x + x \log x + 1 - x$$

$$= x \log x + 1$$

$$T(N) = x \log x = O(x \log x)$$