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

~~8~~ 3 4 ~~8~~  
3, 4, 8

~~12~~ 5 6 ~~12~~  
5, 6, 12

→ After sorted → merge.

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

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

Explain ③ :

$arr1 = [3, 5, 9, 19, 32]$   
 $arr2 = [4, 6, 8]$

size  
(arr1 + arr2)  $[3, 4, 5, 6, 8, 9, 19, 32]$

main

maye

{6, 5, 12}

8, 3, 4, 12, 5, 6

[3, 4, 12]

8, 3, 4

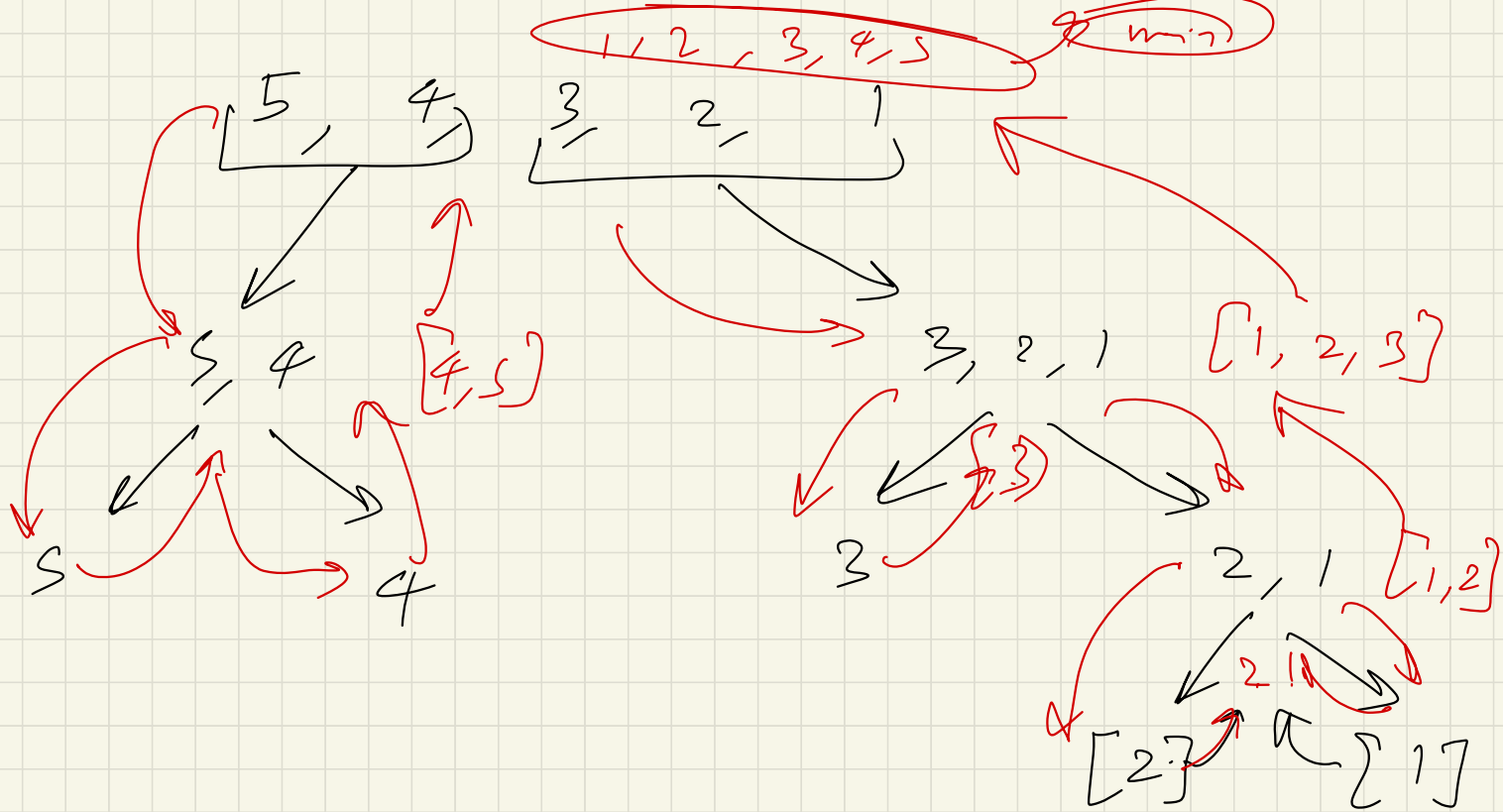
12, 5, 6

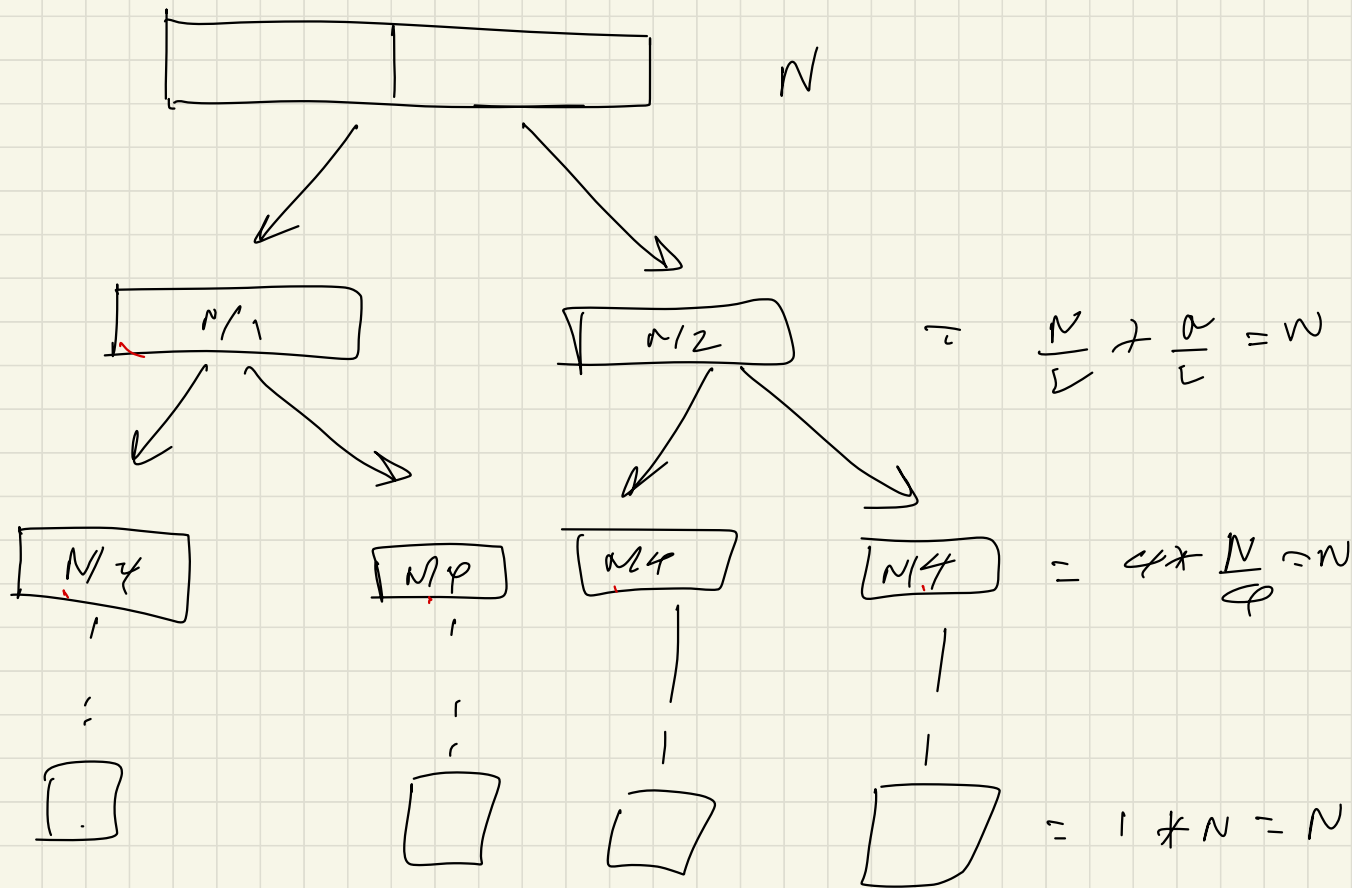
3, 1

8, 3

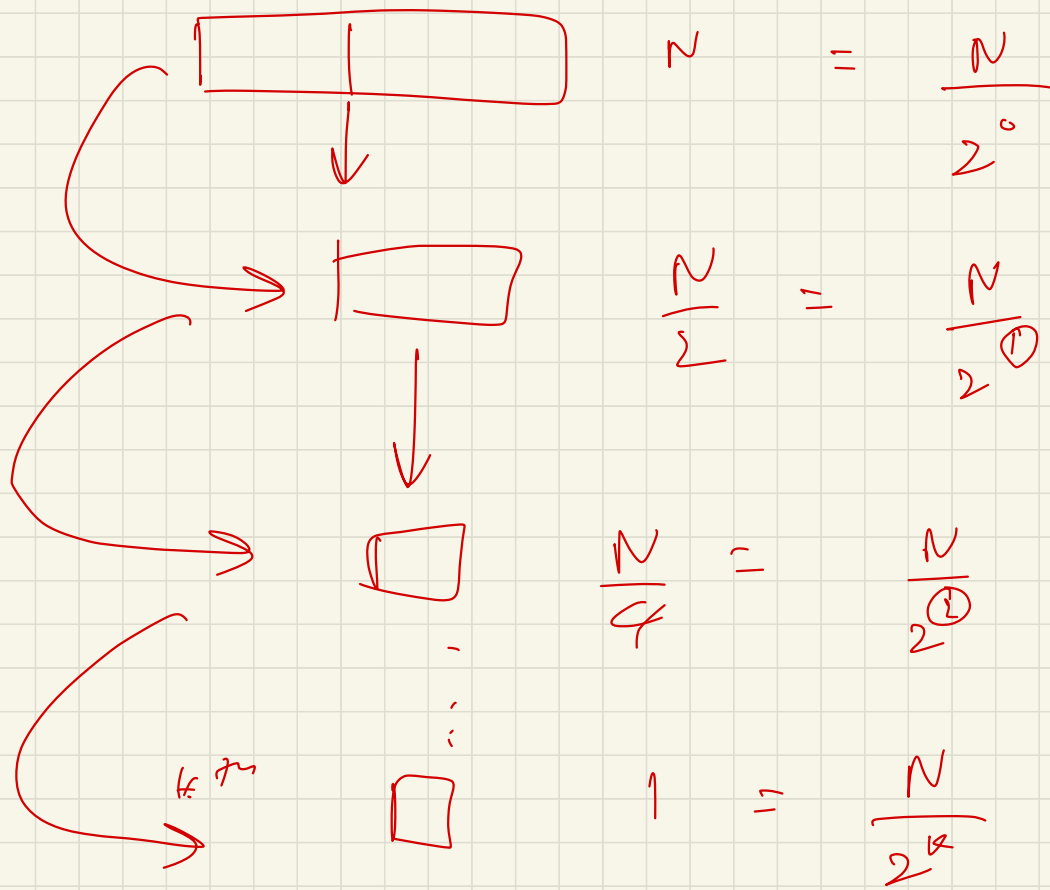
4

8, 3





☆ At every level,  $N$  elements are kept merged.



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

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

$$k = \log_2 N$$

$$O(N \log N)$$

Space Complexity  
 $\text{Aux} = O(N)$



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

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

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

$$p = 1$$

$$T(N) =$$

$$N + N$$

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

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

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

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

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

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

$$= \log n + \frac{1}{n} - 1$$

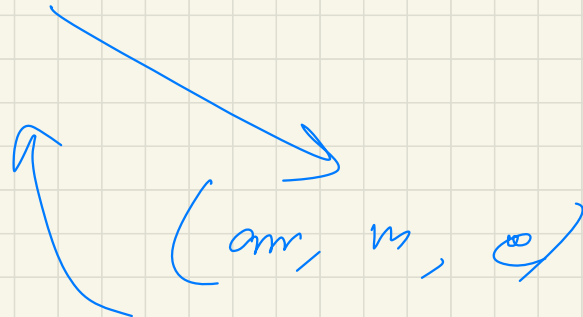
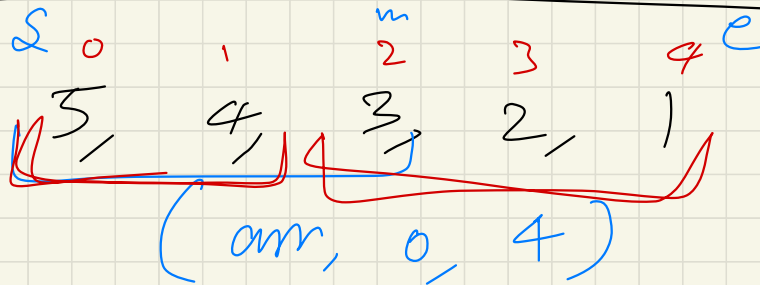
$$= n + n \left[ \log n + \frac{1}{n} - 1 \right]$$

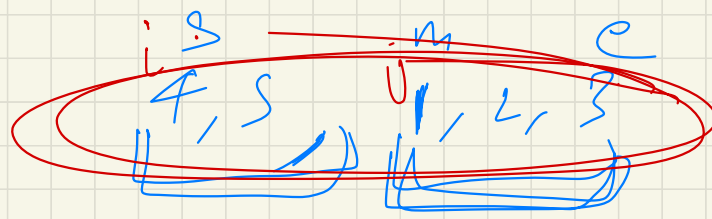
$$= \cancel{n} + n \log n + \cancel{1} - \cancel{n}$$

$$= O(n \log n) \text{ or } \Rightarrow \underline{\underline{O(N \log n)}}$$

Ans

In-place:





$(arr, s, m, e)$

for ( $k=0; k < \text{len}(mix); k++$ )  $\{$   $mix = [1, 4, 3, 4, 5]$   
 $arr[s+k] = mix[k]$

3 4  
 1 2, 1 2

$k$   
 0

$arr[s+0] = 1$

$arr[s+1] = 2$

0, 1

