

✓  $5^{16} \Rightarrow 5 \times 5 \times 5 \times \dots \times 5$

~~Brute Force~~ →

2 ✓  $5^4 \Rightarrow (25)^4$

3 ✓  $5^4 \Rightarrow (625)^2$

$$+ \begin{array}{r} 1 \\ 3 \\ \hline \end{array}$$

$$\textcircled{4}$$

$$+ \begin{array}{r} 3 \\ 1 \\ \hline \end{array}$$

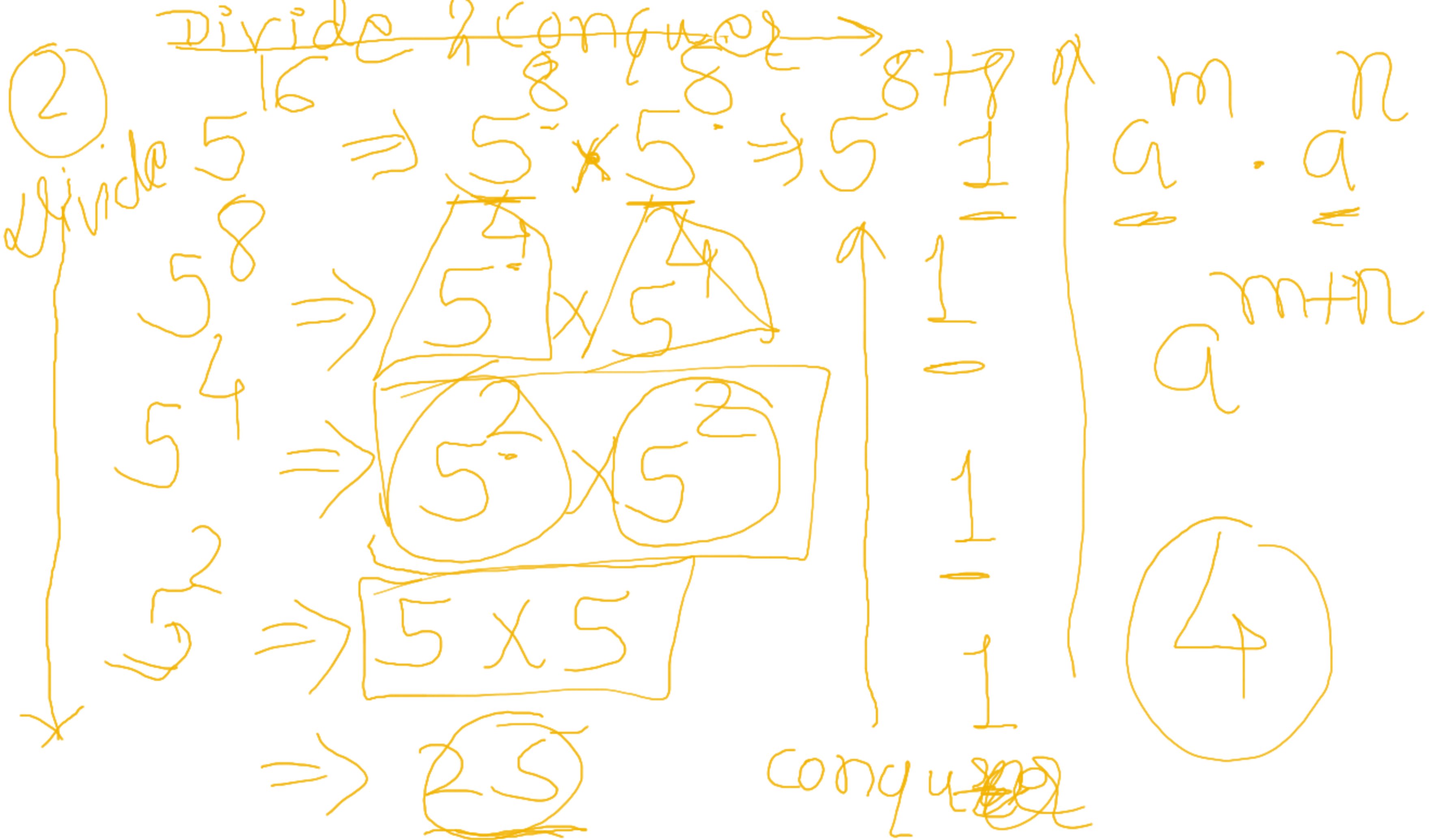
$$\textcircled{4}$$

Number of mlt-  
15 times

~~$m^3 \times 9$~~   
 $(m^p)^q$

$2 \times 4$

$4 \times 2$



# Sorting

✓ Non Decreasing

$1 \rightarrow 2 \rightarrow 2 \rightarrow 3$   
~~1~~ ~~2~~

✓ Non Increasing

$3 \rightarrow 2 \rightarrow 2 \rightarrow 1$   
~~2~~

- Datatypes

- Ascending

$A \rightarrow B \rightarrow C$

$1 \rightarrow 2 \rightarrow 3$

- Descending

$C \rightarrow B \rightarrow A$

$3 \rightarrow 2 \rightarrow 1$

← Duplicates

- Stability
- In Place
- Online
- ABMS
- External

(outside of RAM)

properties  
of  
Sorting



Input | 3 | 2 | 9 | 7 | 11 | 10 |  
 Find min | 2 | 3 | 9 | 7 | 11 | 10 |  
 place | 2 | 3 | 9 | 7 | 11 | 10 |  $O(n^2)$   
 Selection | 2 | 3 | 7 | 9 | 11 | 10 |  
 Sort | 2 | 3 | 7 | 9 | 11 | 10 |  
 Brute Force | 2 | 3 | 7 | 9 | 10 | 11 |

# Selection Sort

|| without loss of  
generality

ND  
(Ascending)

- or
- 1) Find minimum
  - 2) Find maximum

Place  
from beg

place  
from  
end

Divide & Conquer Approach for  
Sorting

✓ merge sort | ✓ Quick Sort

Divide

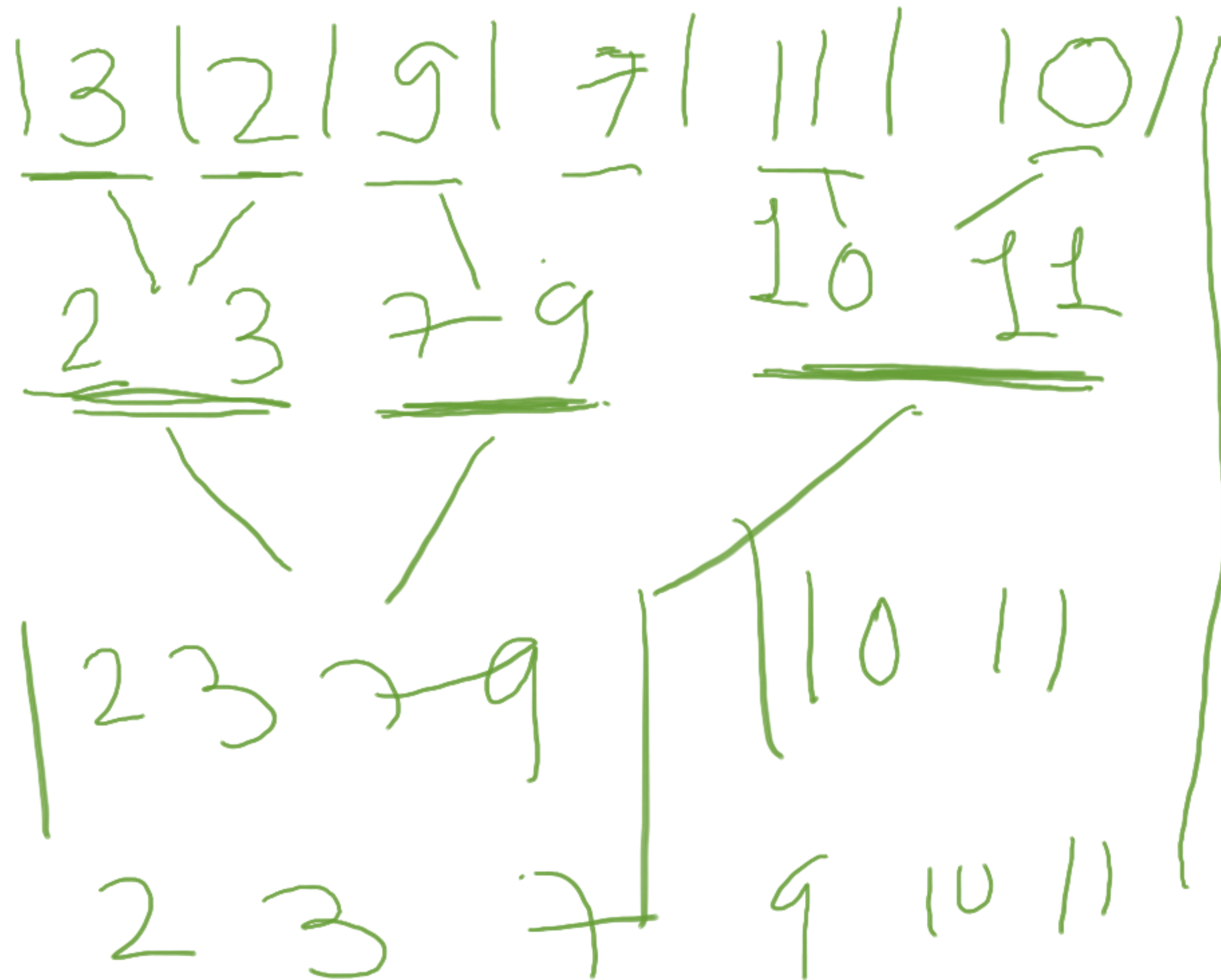
Conquer

Combine

Map

Reduce

Combiner



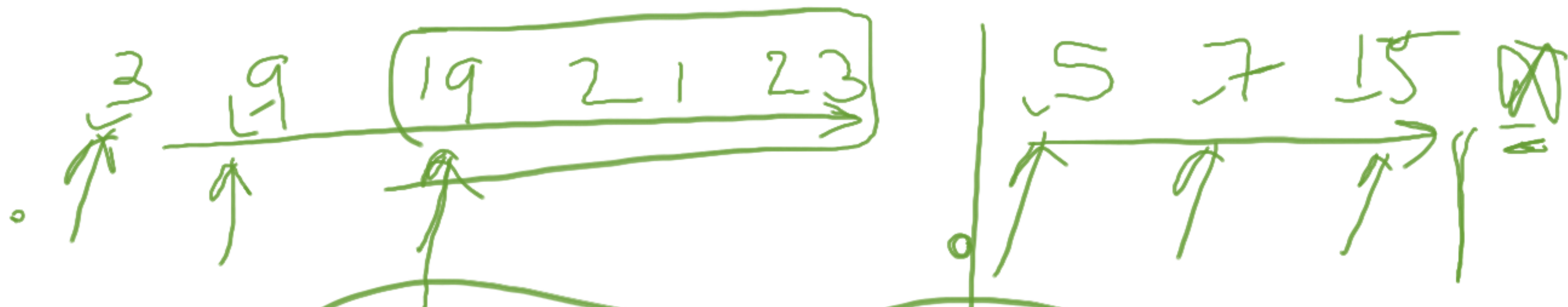
Combine

Given two  
sorted  
arrays

Can I generate  
Final sorted  
array?

Yes





Simple merge sort

3 5 7 9 15 19 21 23

# QuickSort

