Computer Programming

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Session: Merge Sort - Intuition

Quick Recap of Relevant Topics

- The sorting problem
- Selection sort
  - Intuition
  - C++ implementation
  - Analysis of performance

Overview of This Lecture

- Merge sort
  - Intuition
  - Animated example

Recall: Intuition Behind Selection Sort

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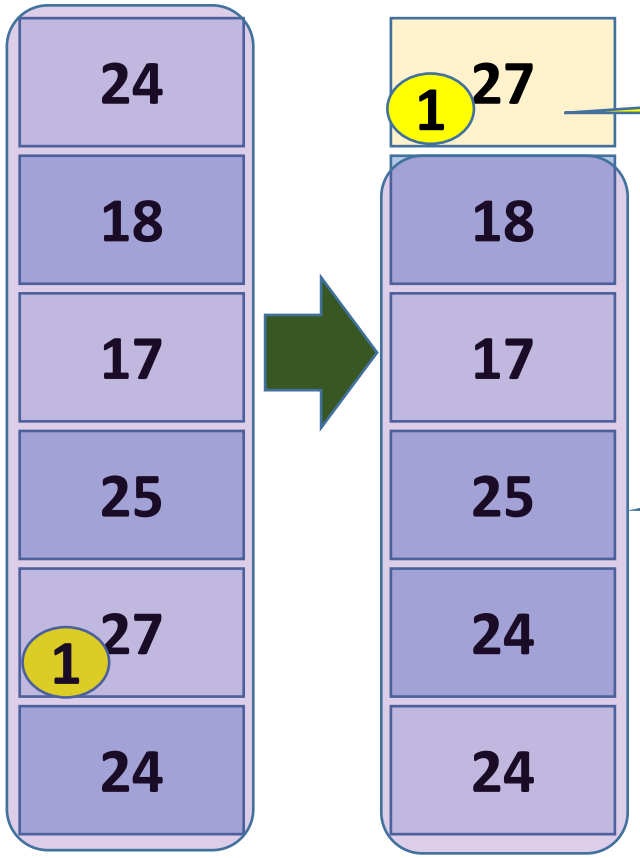

Get only the first element in its right place

Solve part of the problem

Arrive at a similar but "simpler" problem to solve:

Sort remaining marks

A General Paradigm In Computing

- Decompose a larger problem into smaller sub-problems
- Solve each sub-problem separately

  Often using same techniques as used to address the larger problem
- Combine results of sub-problems to obtain solution of larger problem

DIVIDE-AND-CONQUER

Sorting by Divide-and-Conquer

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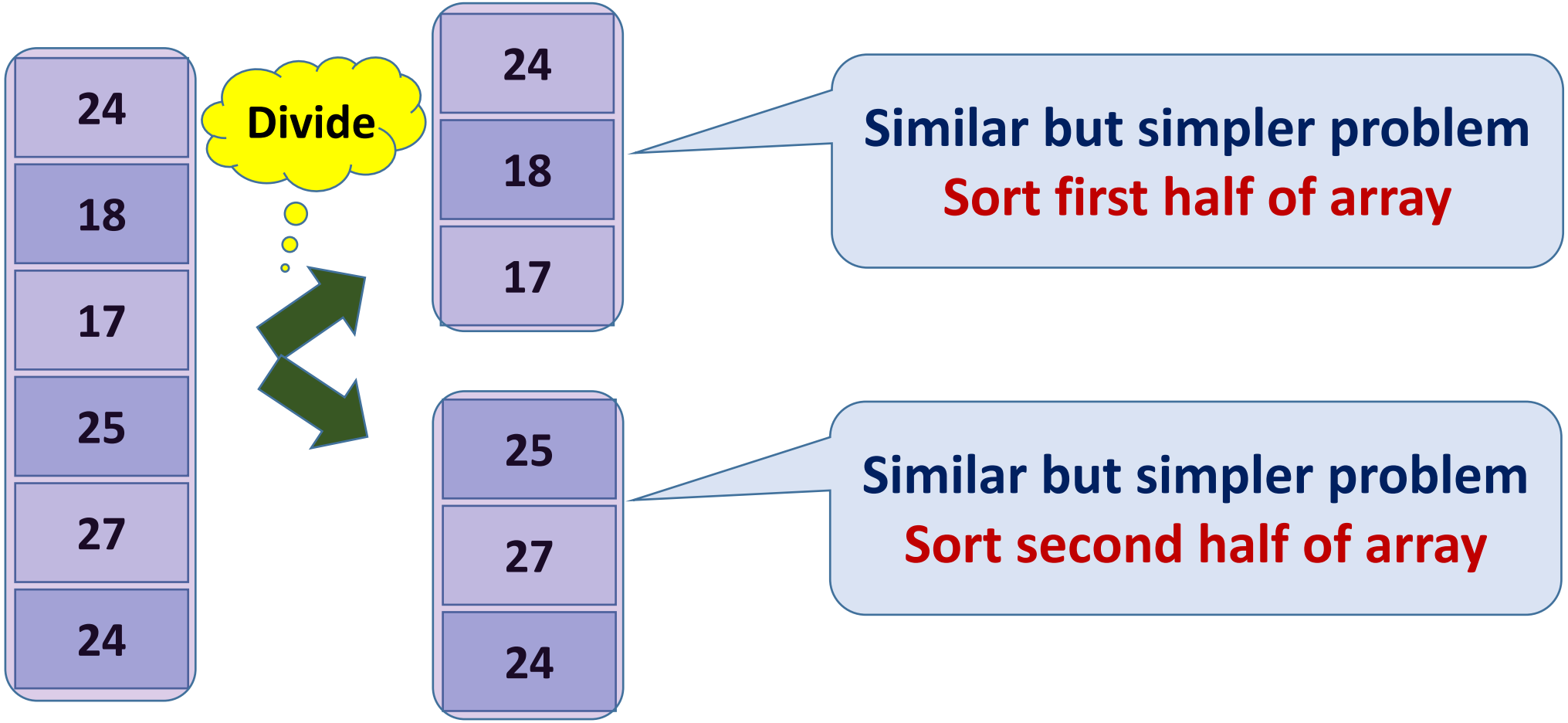

Sorting by Divide-and-Conquer

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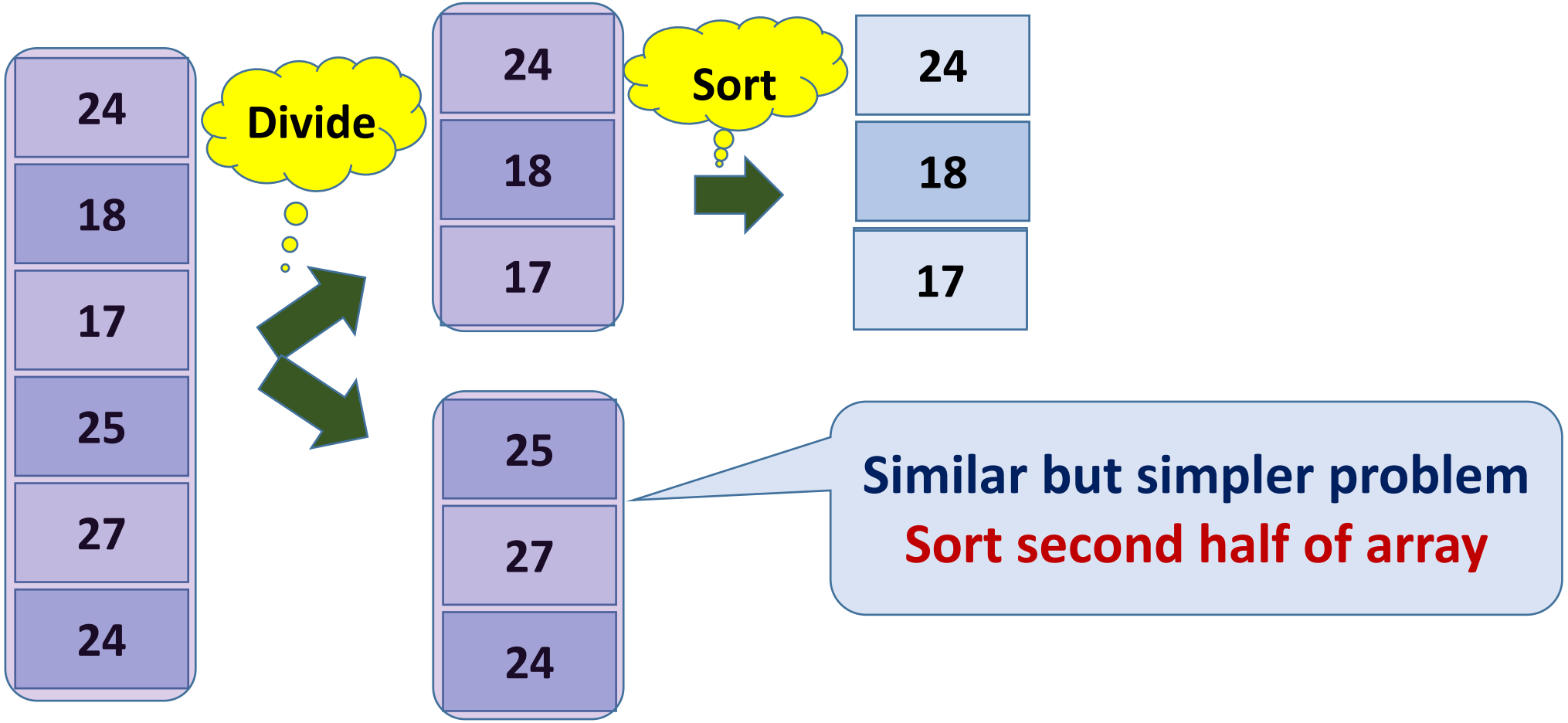

Sorting by Divide-and-Conquer

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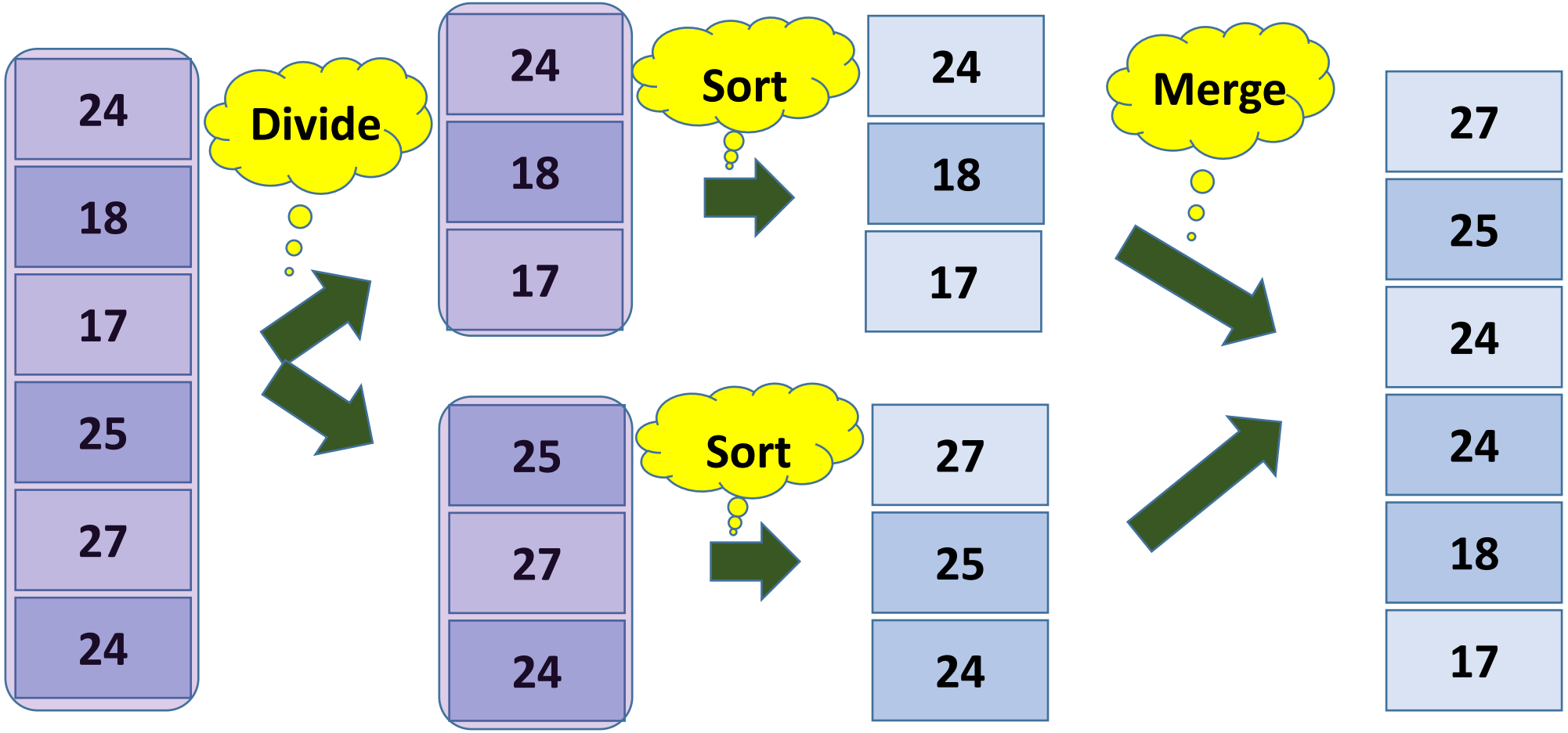

What Were The Steps?

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- Divide an array of size n into two sub-arrays of size ≈ n/2
  - Sub-array sizes may differ by 1 if n is odd
  - Easy!
- Sort each sub-array of size n/2
  - Hmm … how?
  - Selection sort ???
- Merge sorted sub-arrays, each of size n/2
  - Hmm … how?

Merging Sorted Sub-arrays

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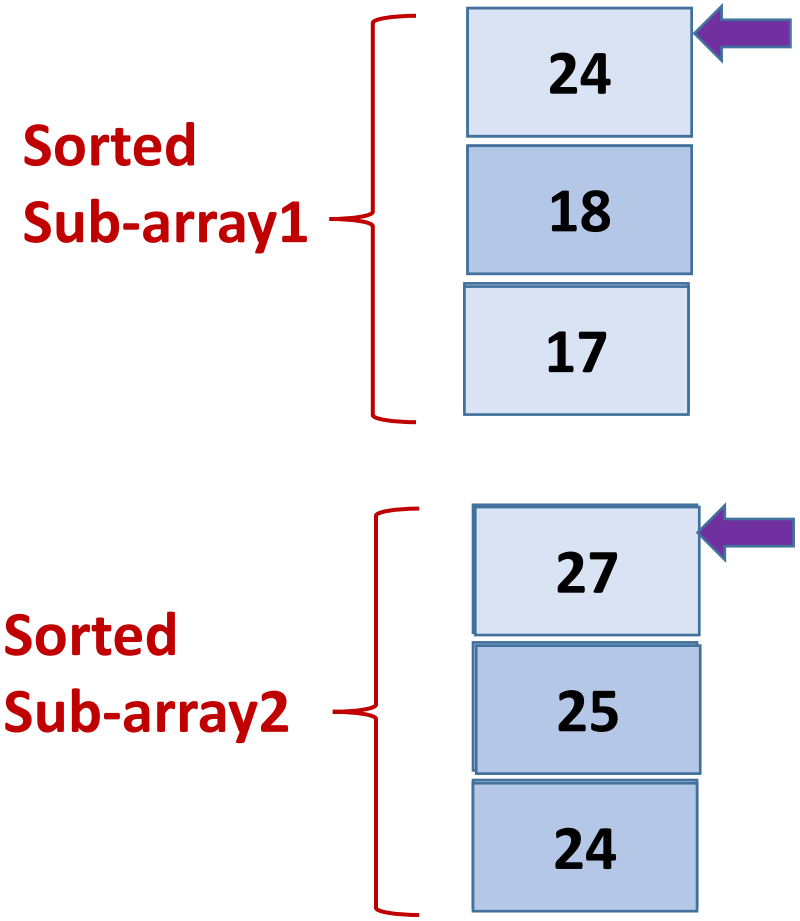

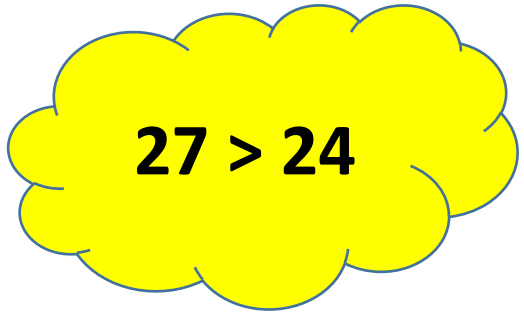

Merging Sorted Sub-arrays

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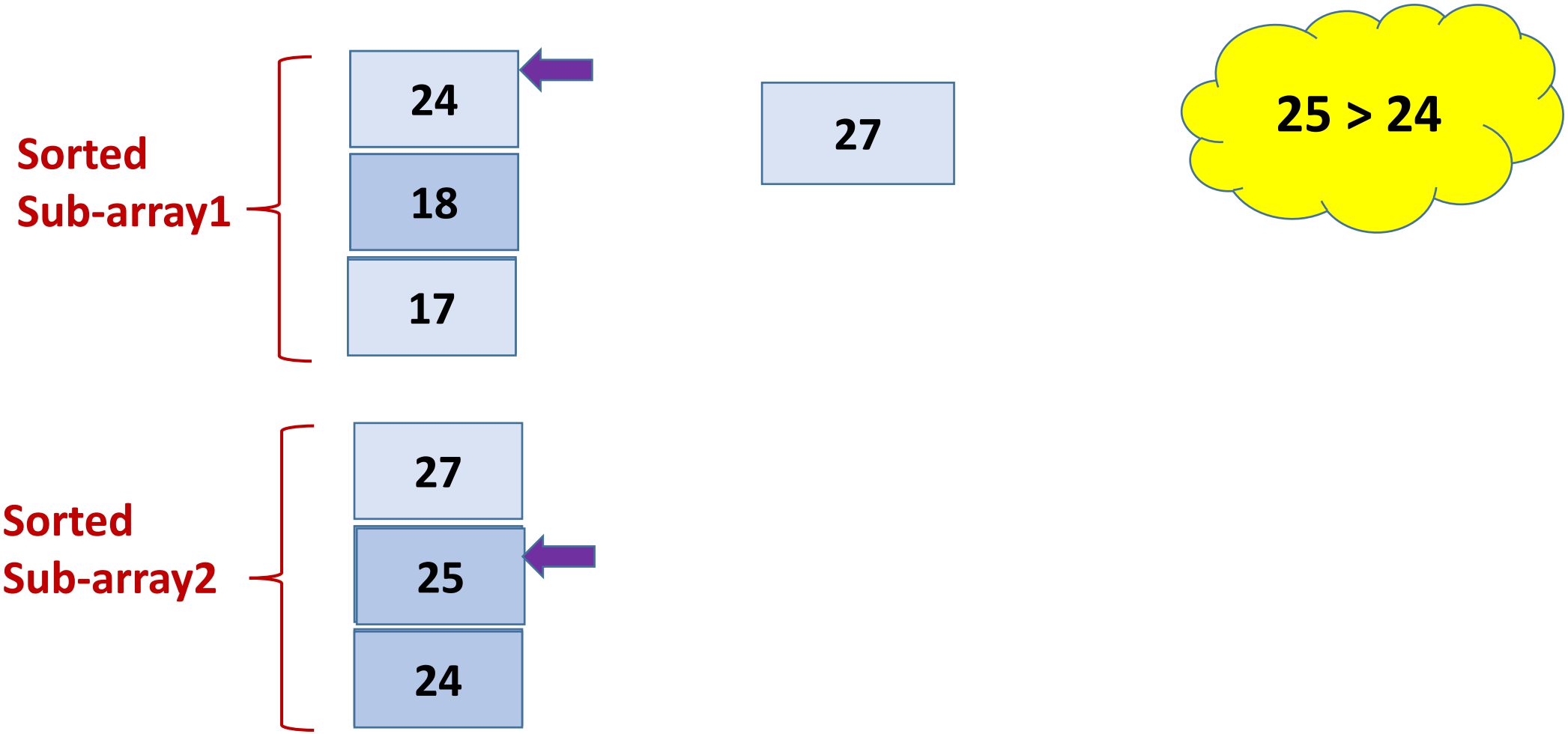

Merging Sorted Sub-arrays

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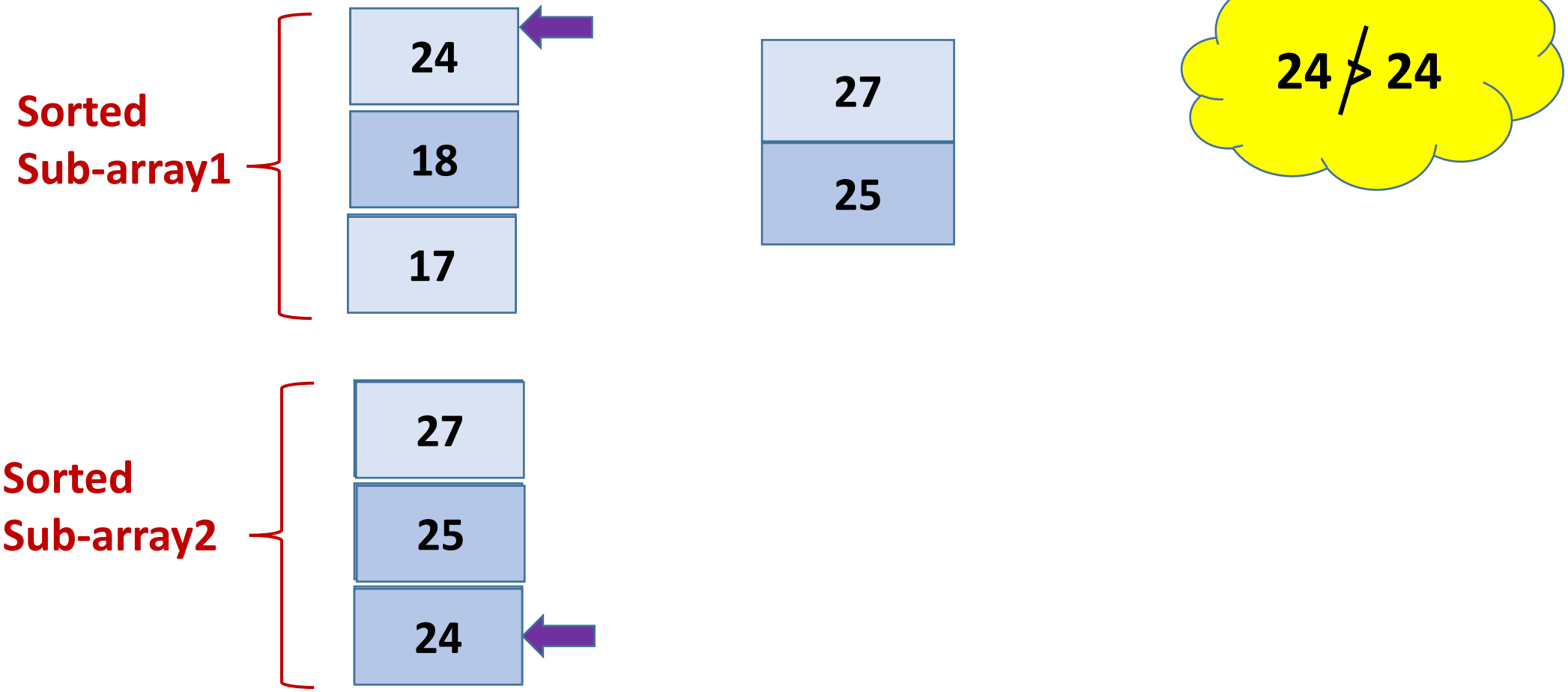

Merging Sorted Sub-arrays

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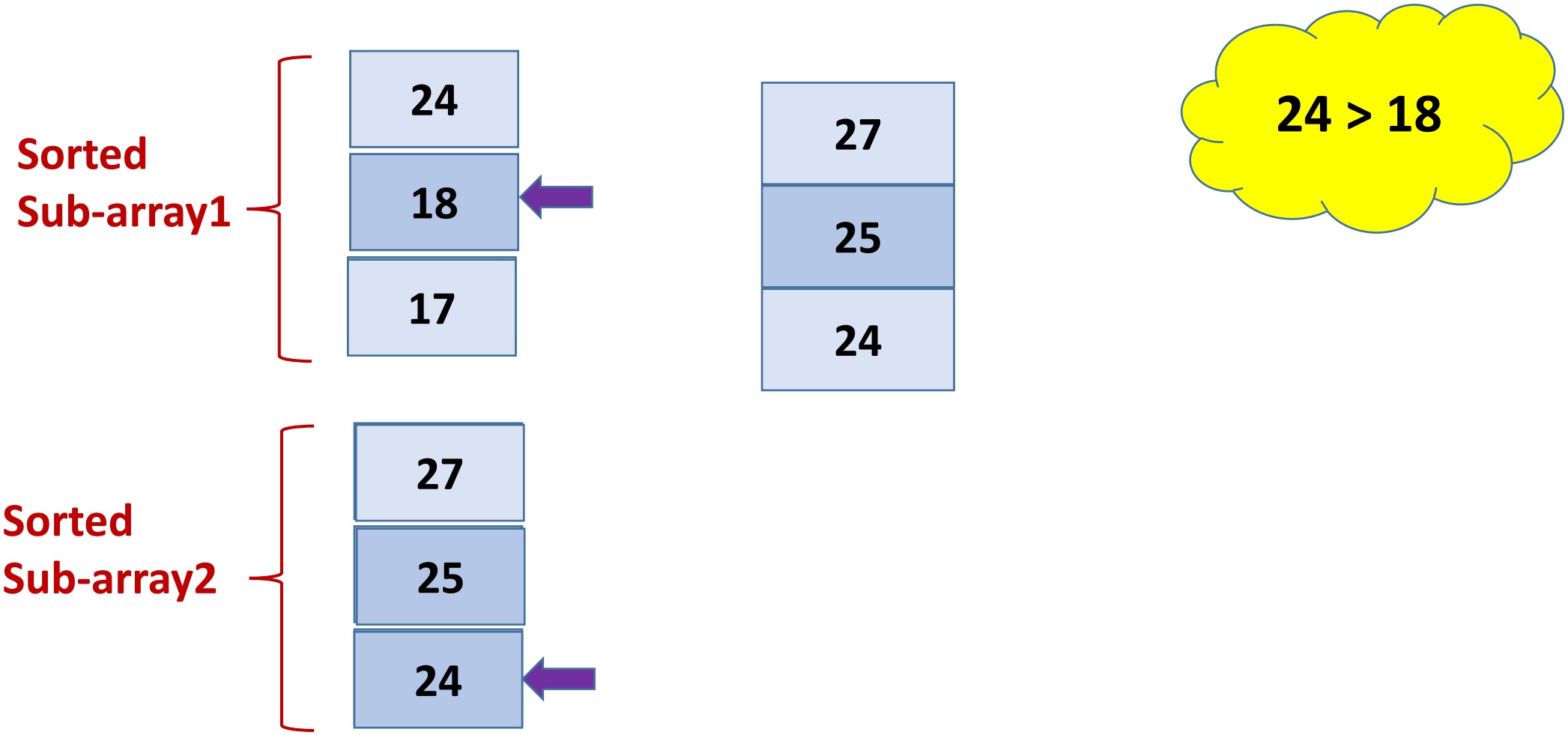
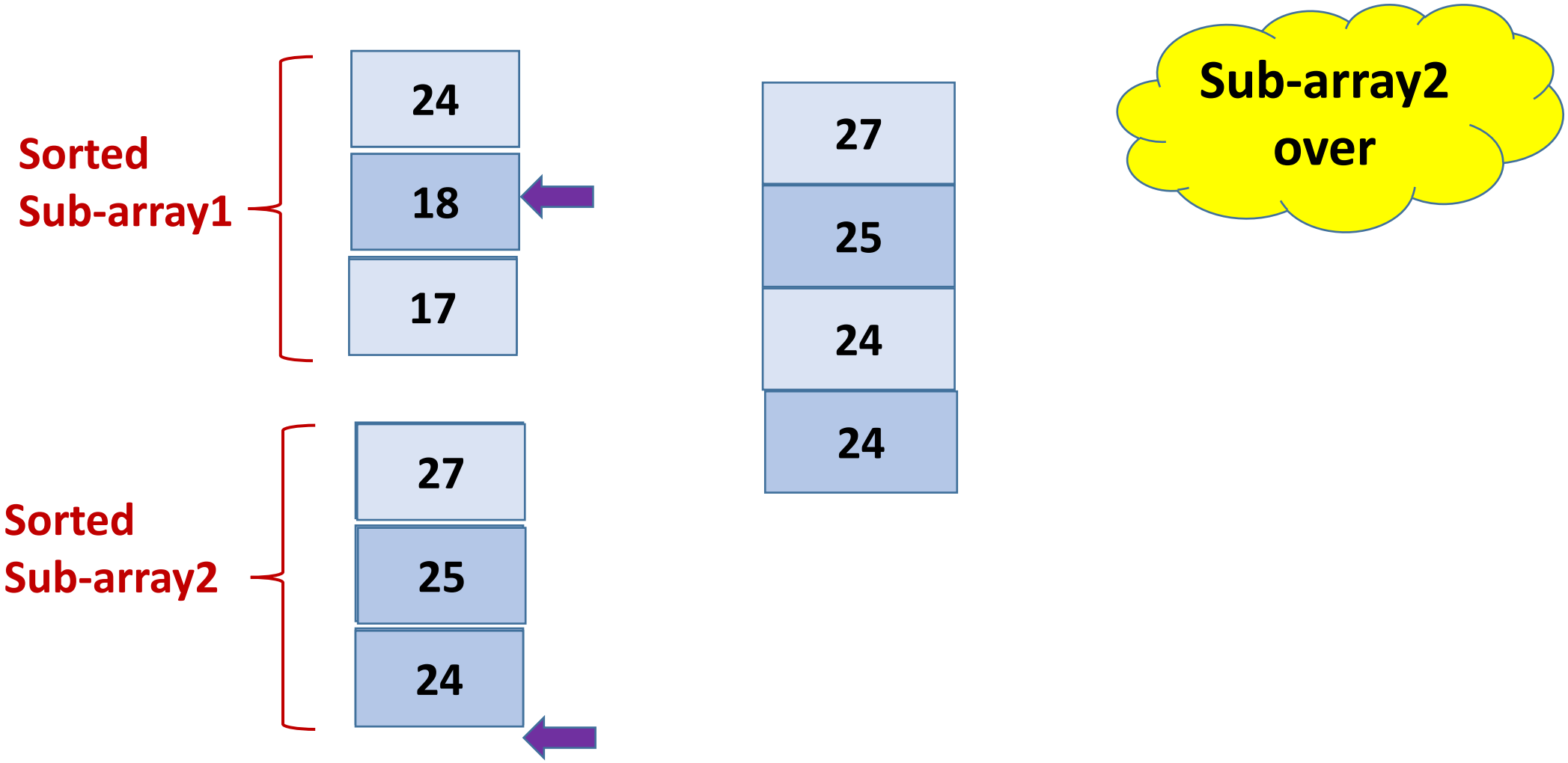


Merging Sorted Sub-arrays



Merging Sorted Sub-arrays

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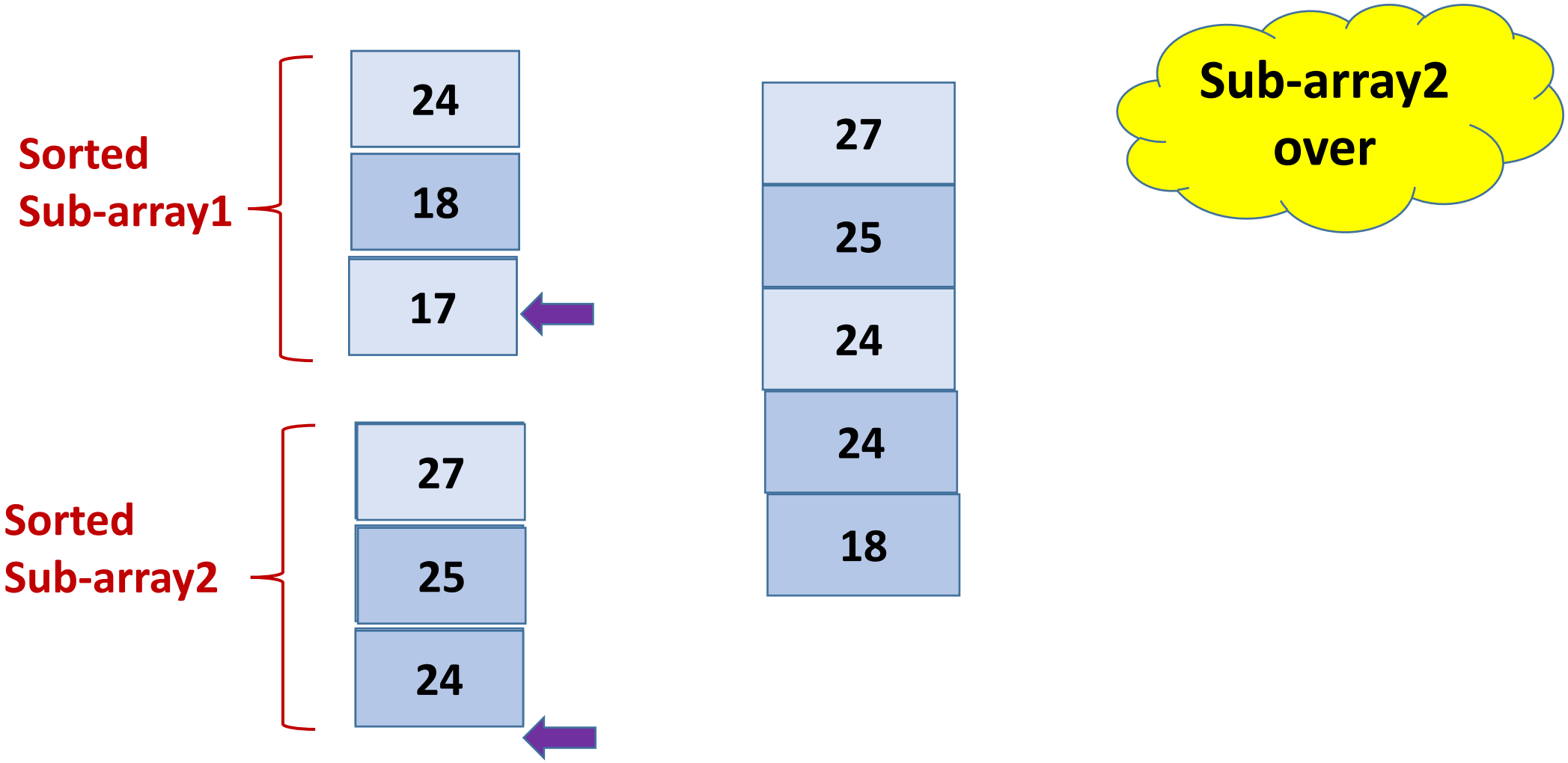

Merging Sorted Sub-arrays

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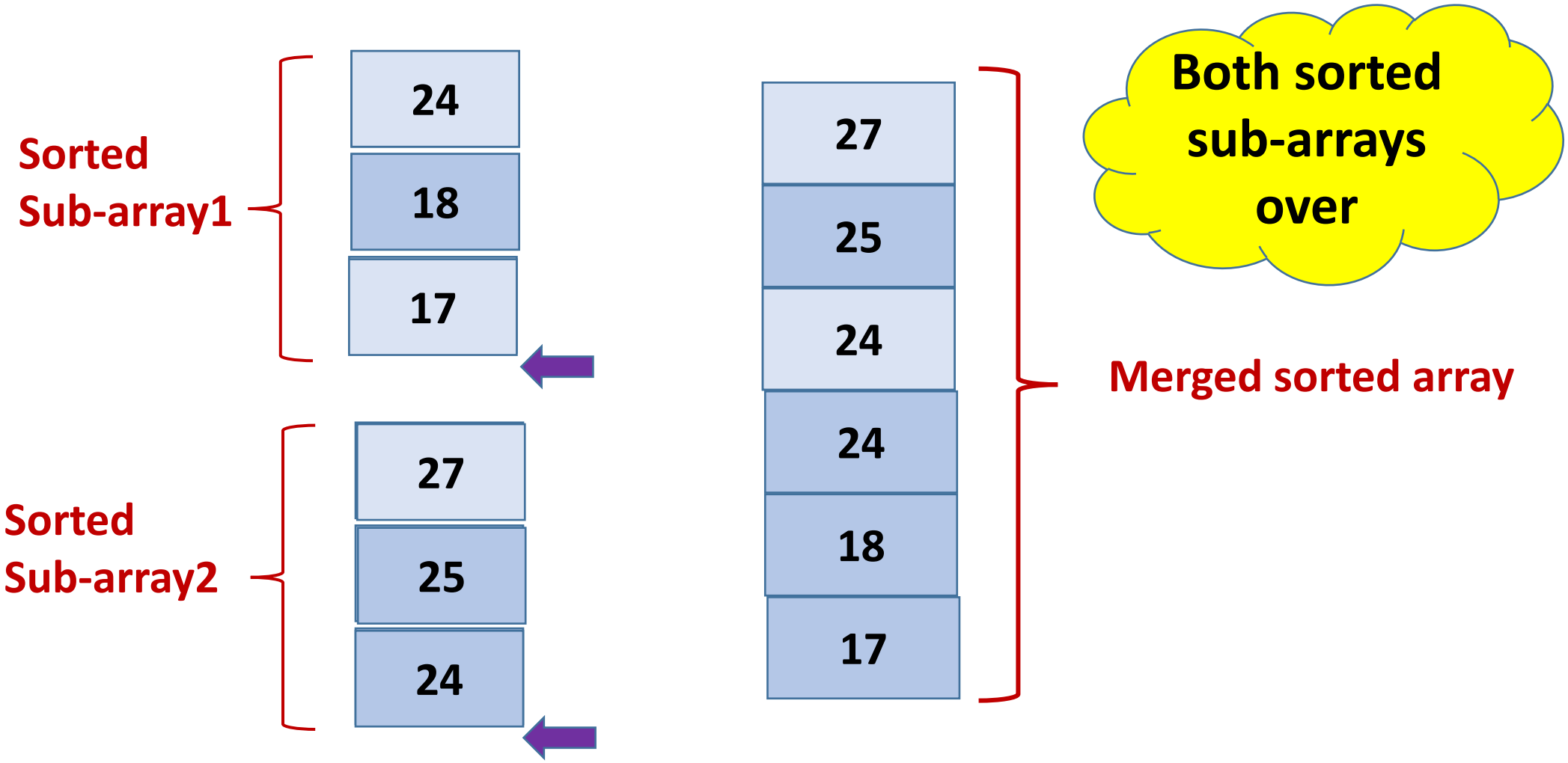

What Were The Steps?

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- Divide an array of size n (assume n is even) into two sub-arrays of size n/2
  - Easy!
- Sort each sub-array of size n/2
  - Hmm … how?
  - Selection sort ???
- Merge sorted sub-arrays, each of size n/2
  - Hmm … how?

We were trying to sort an array of size n

What Were The Steps?

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- Divide an array of size n (assume n is even) into two sub-arrays of size n/2
  - Easy!
- Sort each sub-array of size n/2
  - Hmm … how?
  - Selection sort ???
- Merge sorted sub-arrays, each of size n/2
  - Hmm … how?

Why not try the same steps on each sub-array?

What Were The Steps?

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- Divide an array of size n (assume n is even) into two sub-arrays of size n/2
  - Easy!
- Sort each sub-array of size n/2
  - Hmm … how?
  - Selection sort ???

Recursively sort each sub-array by same method

- **Termination case of recursion:**
  Array of size 1 (i.e. n is 1) is of course sorted !!!

Divide-and-Conquer In Action

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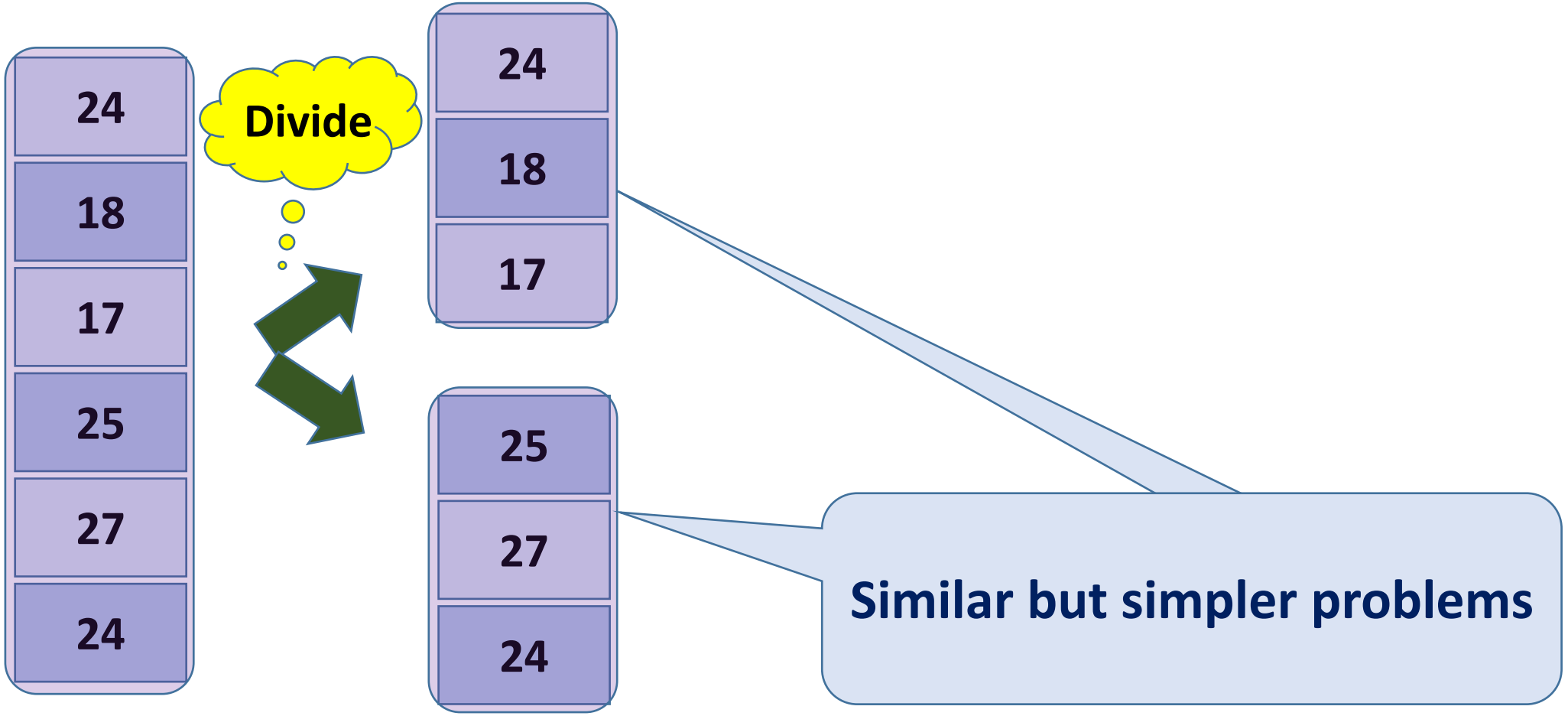

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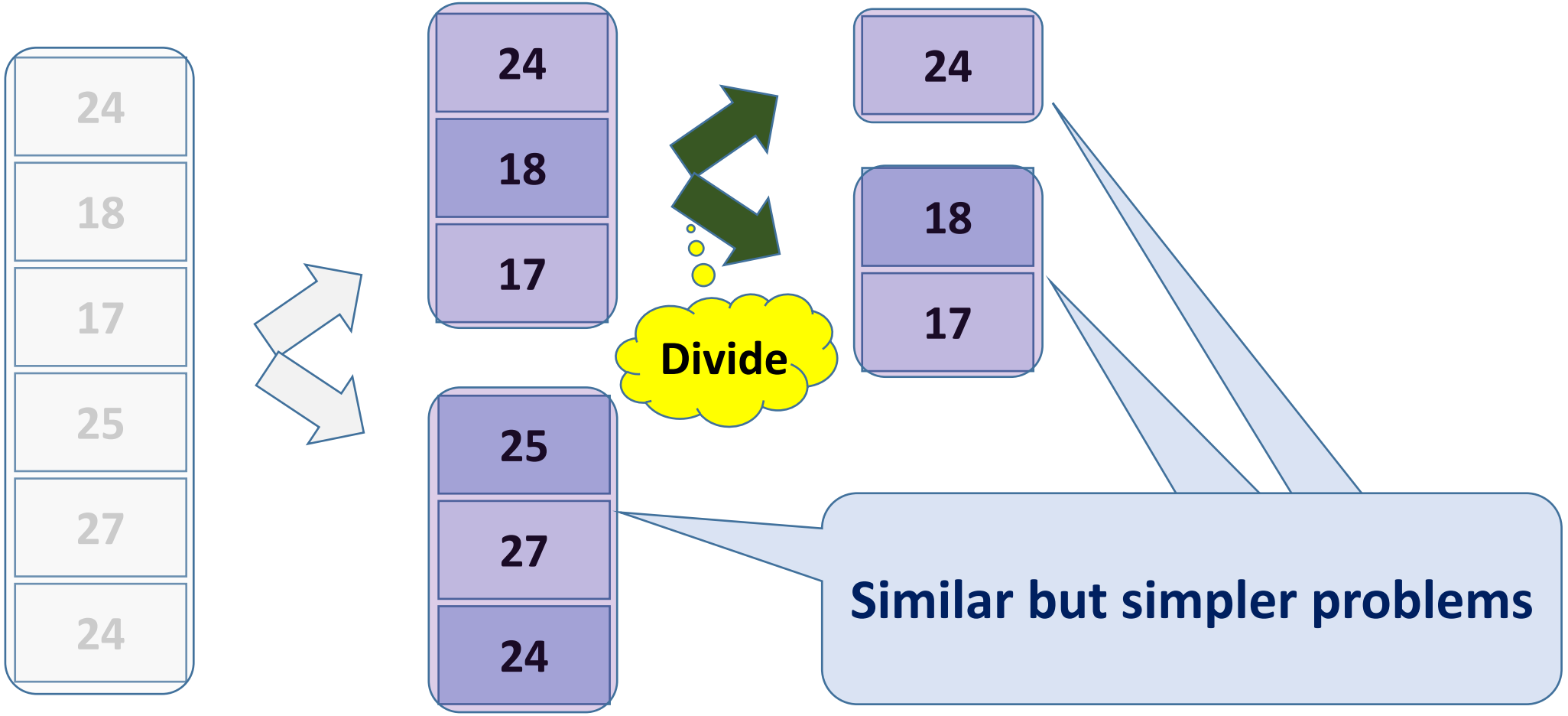

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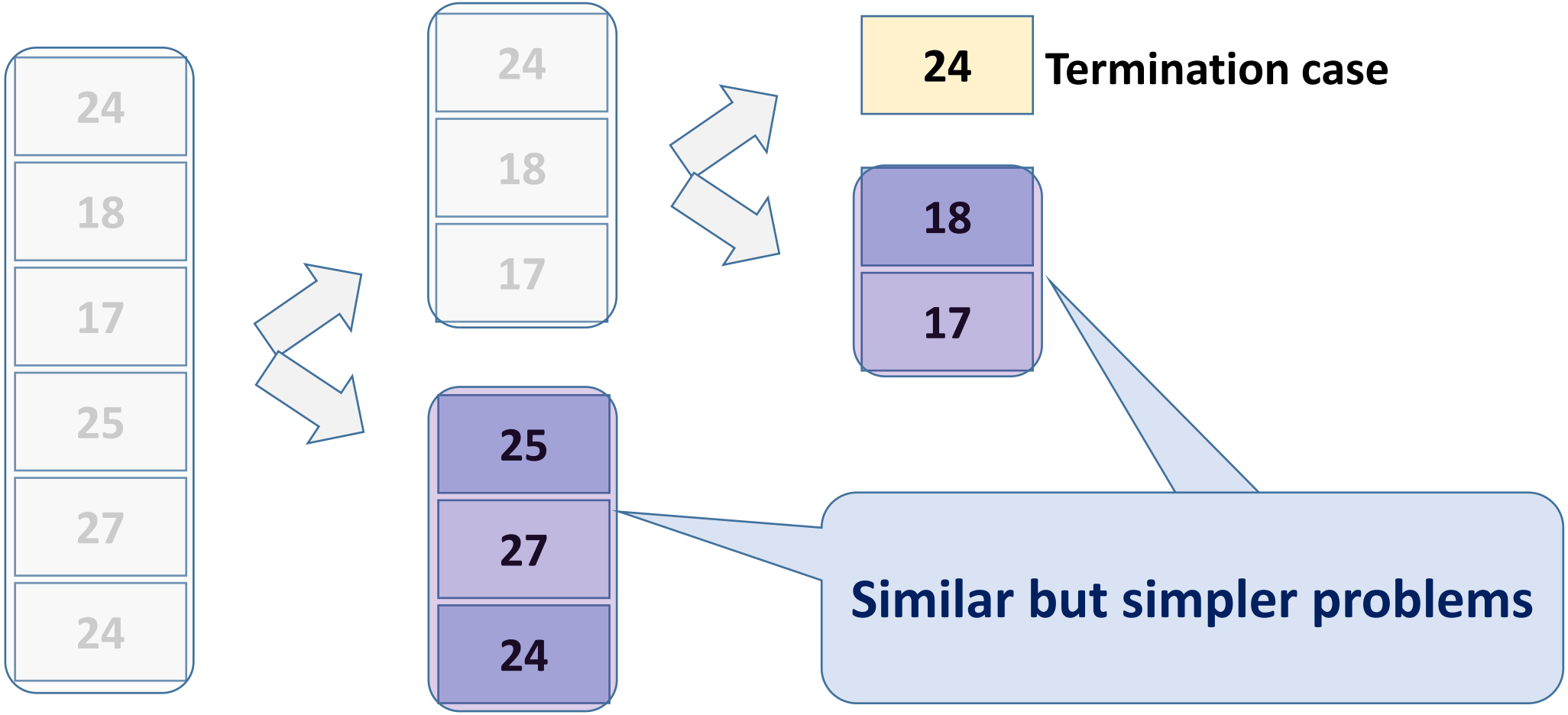

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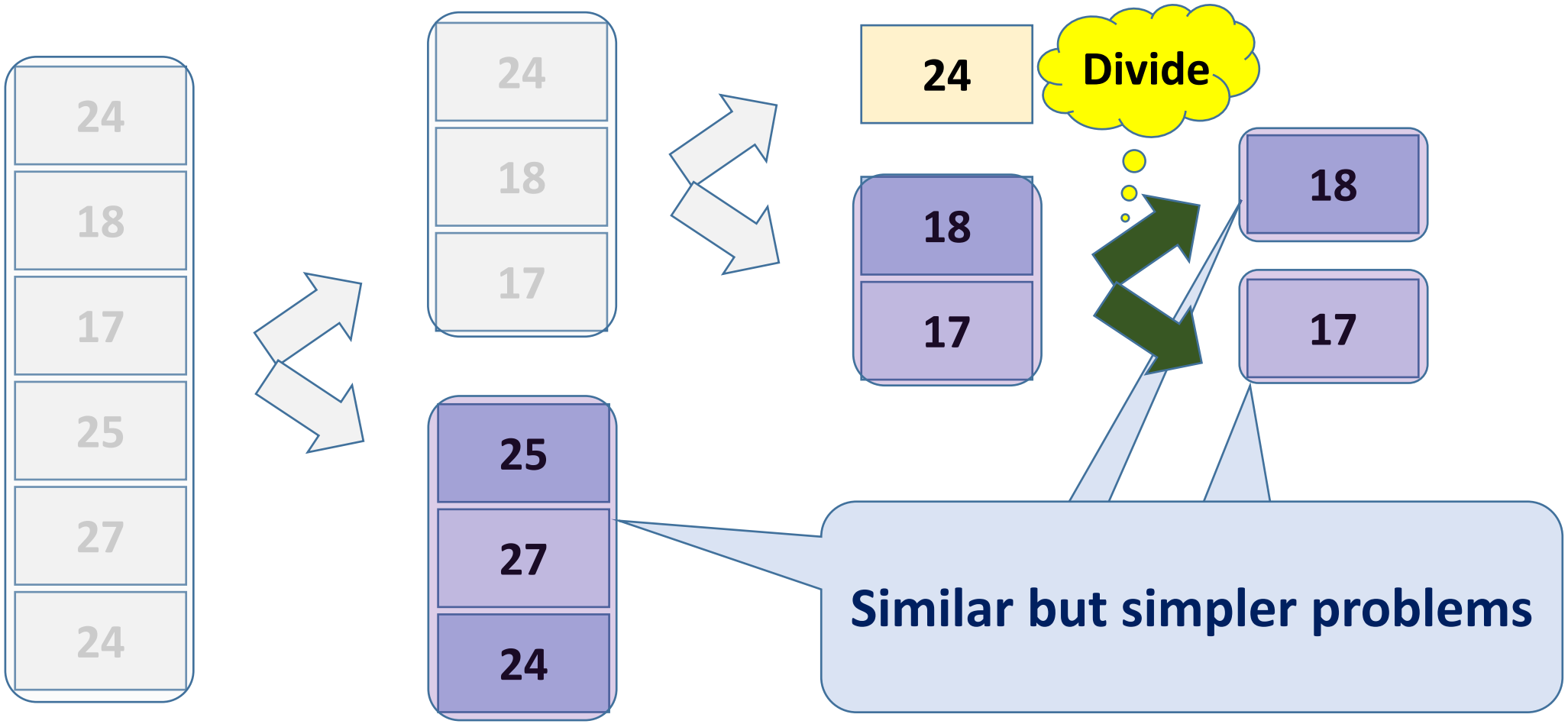

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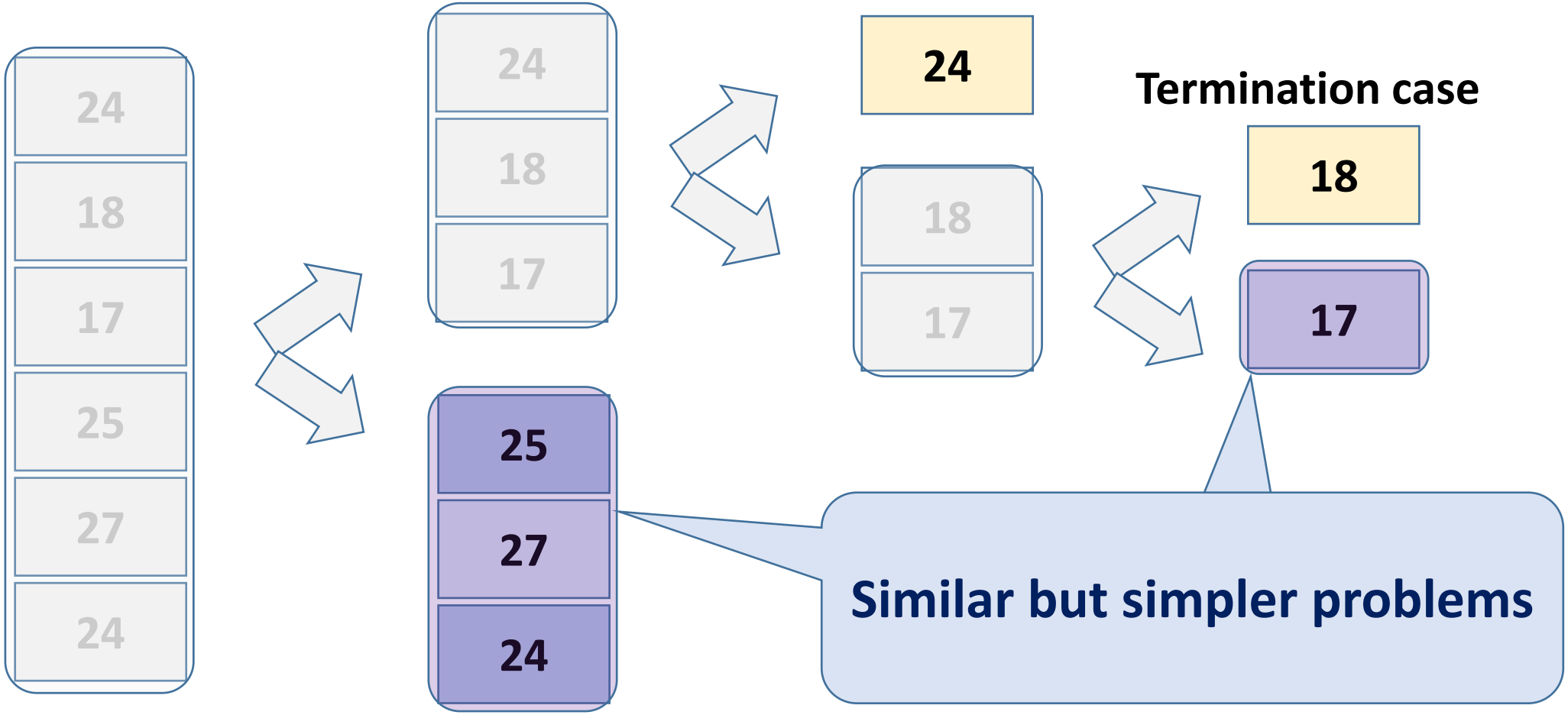

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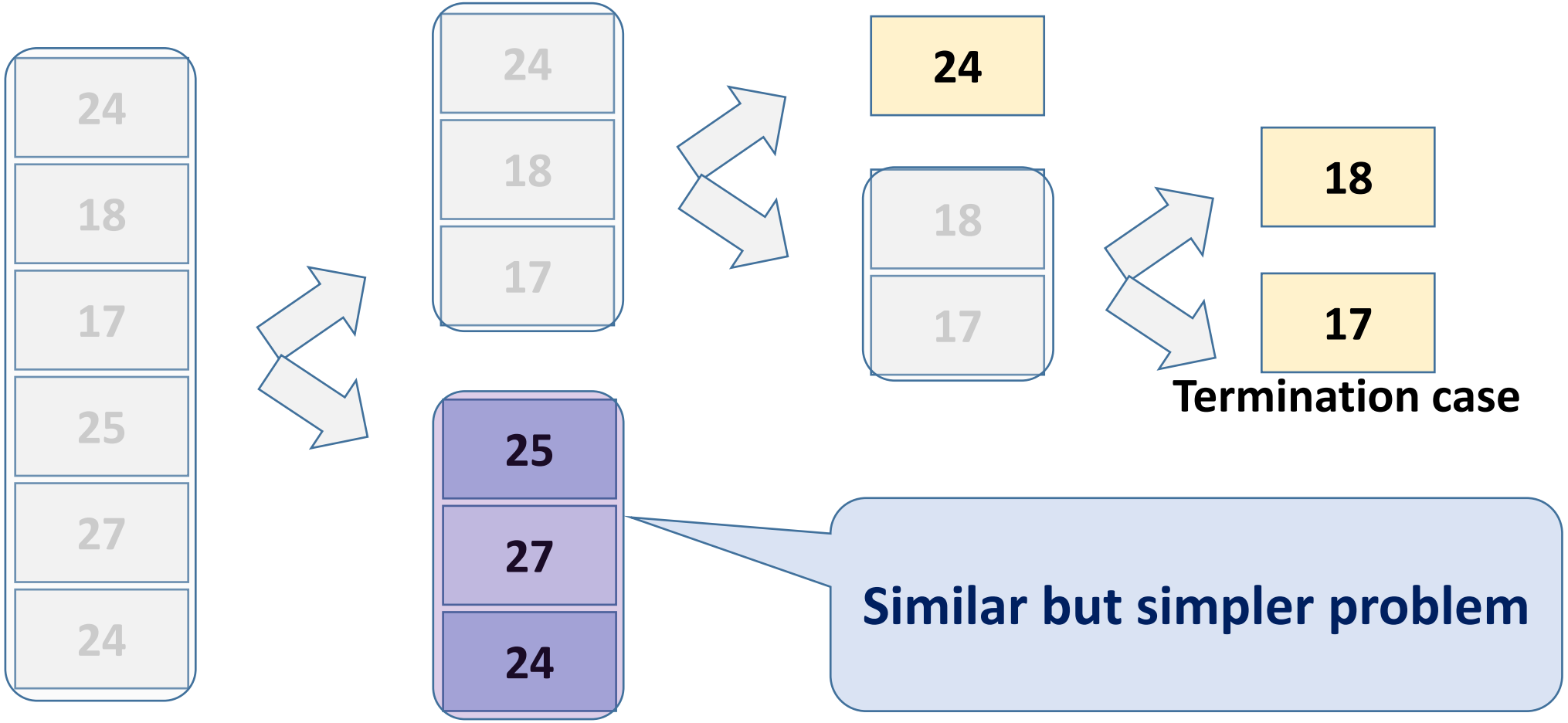

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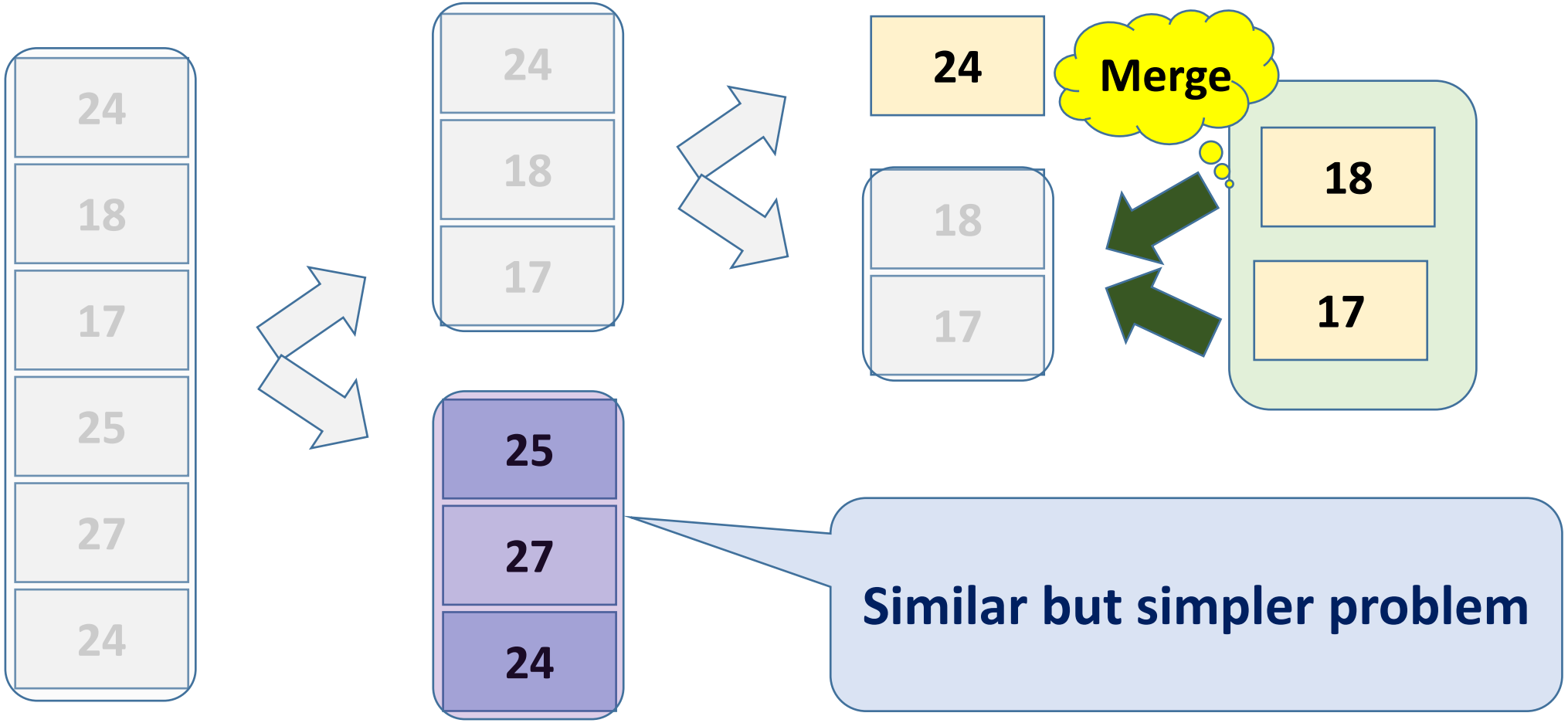

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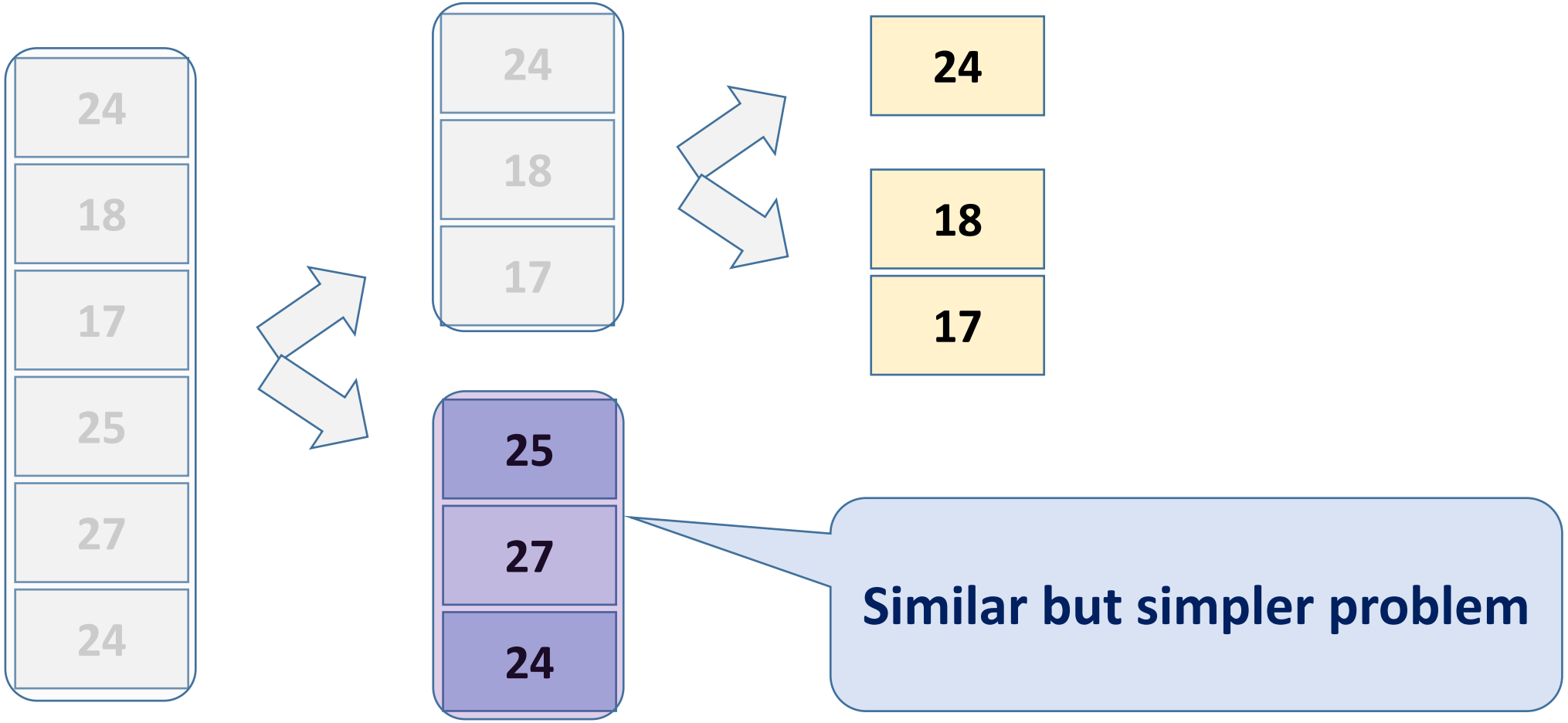

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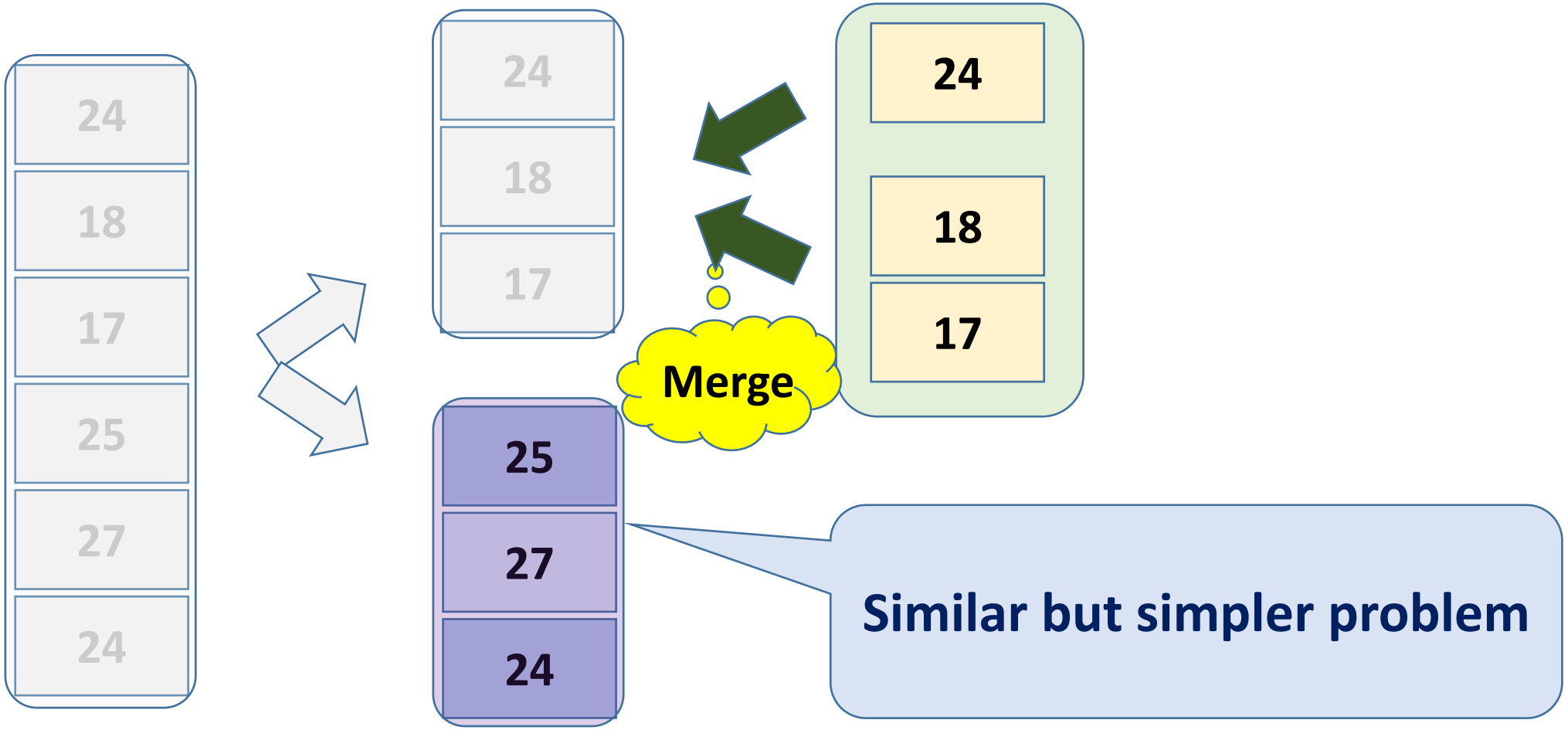

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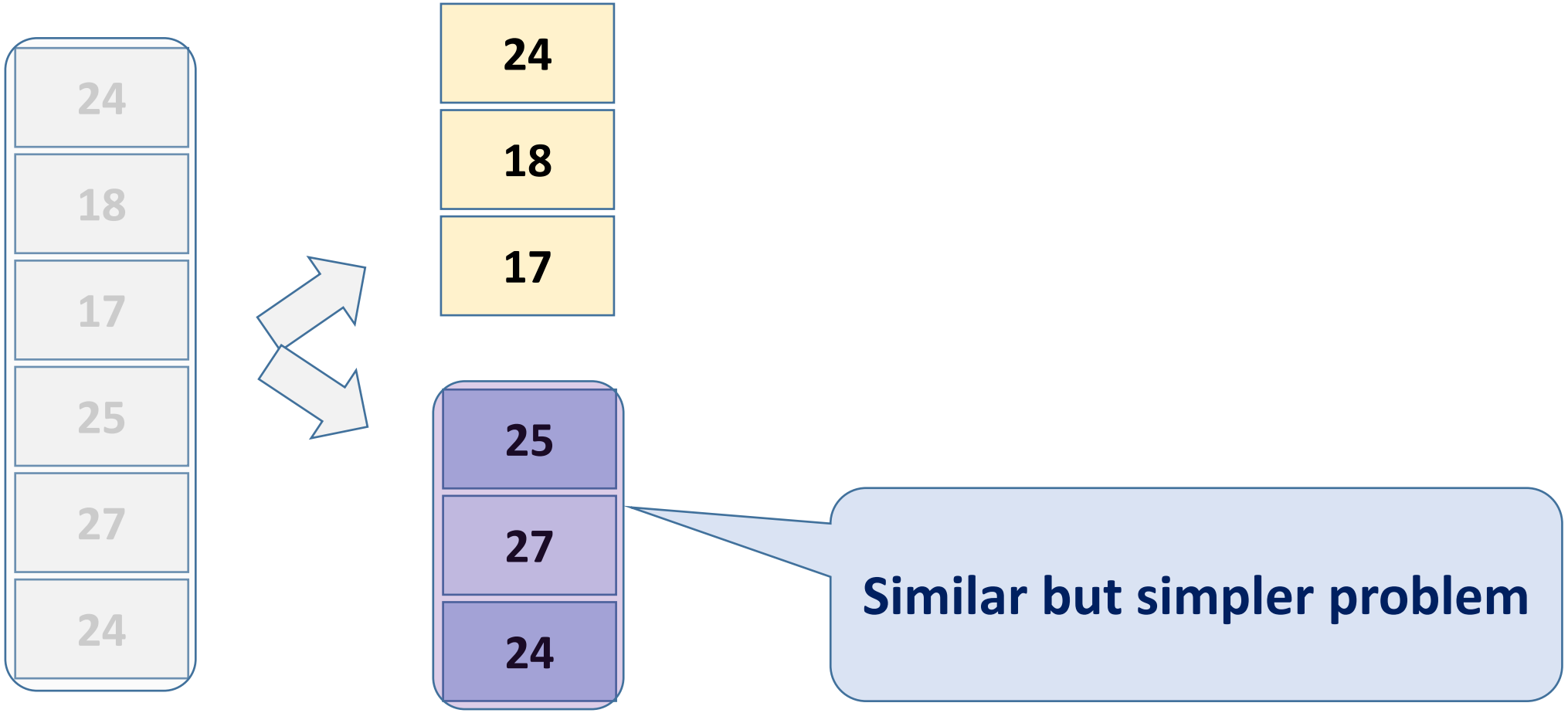

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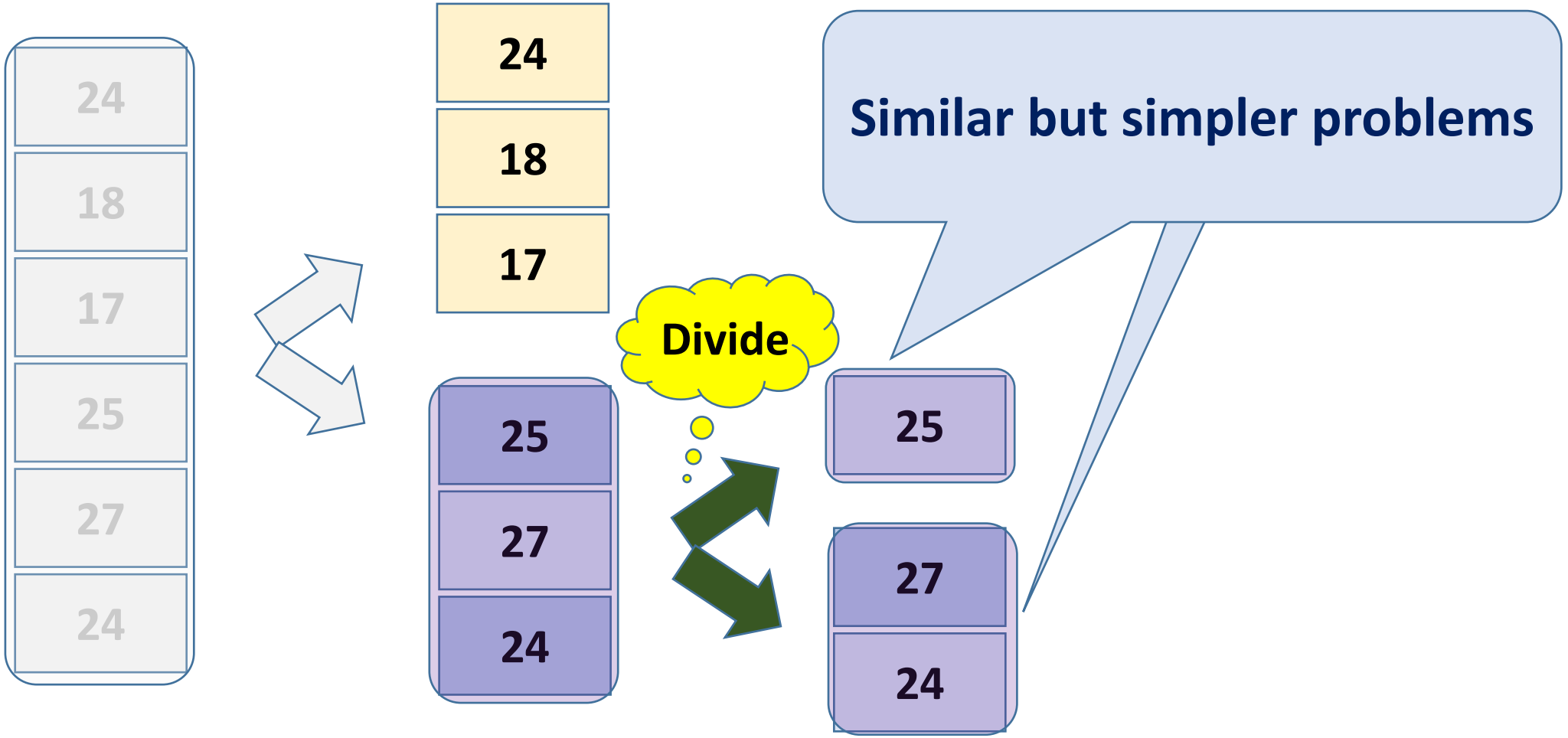

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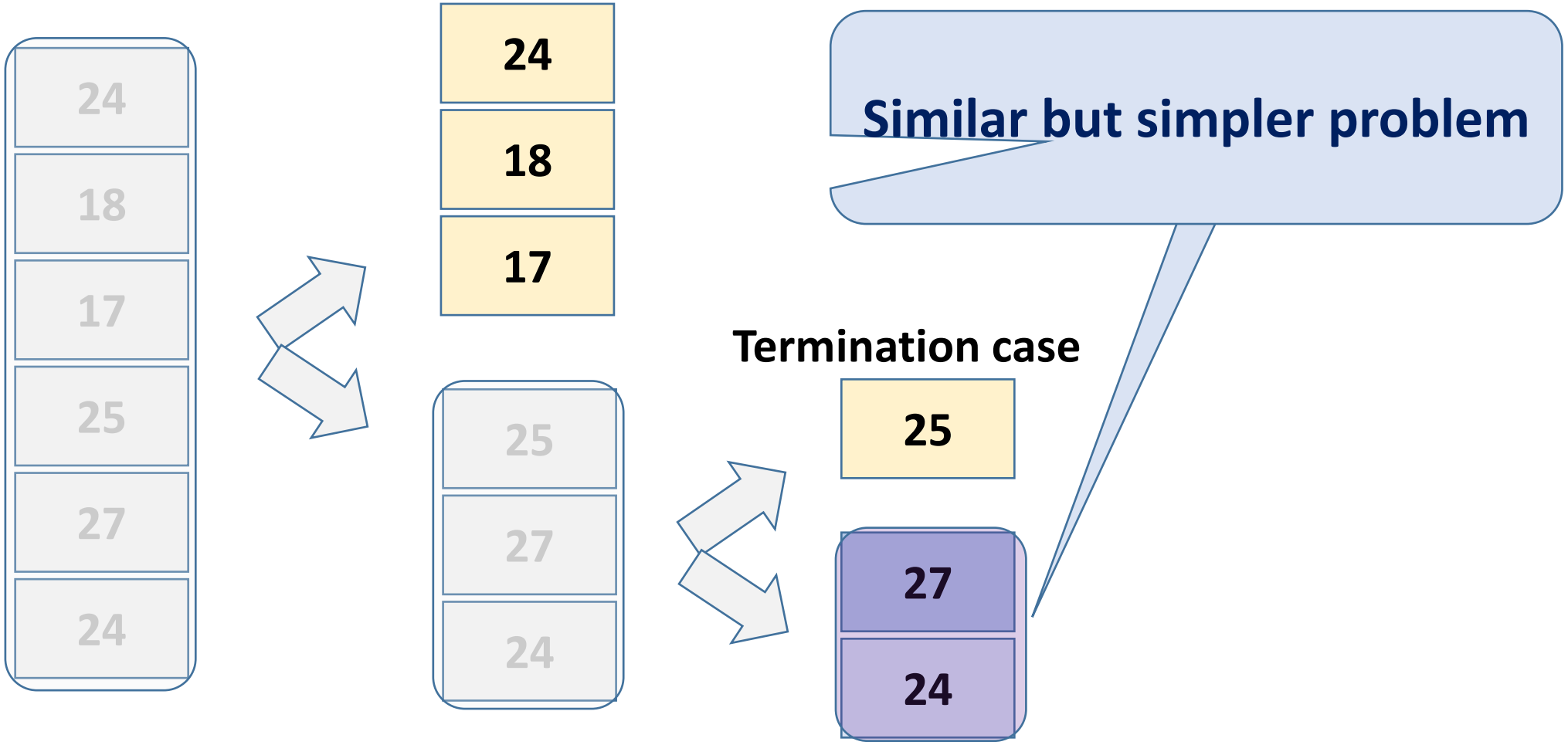

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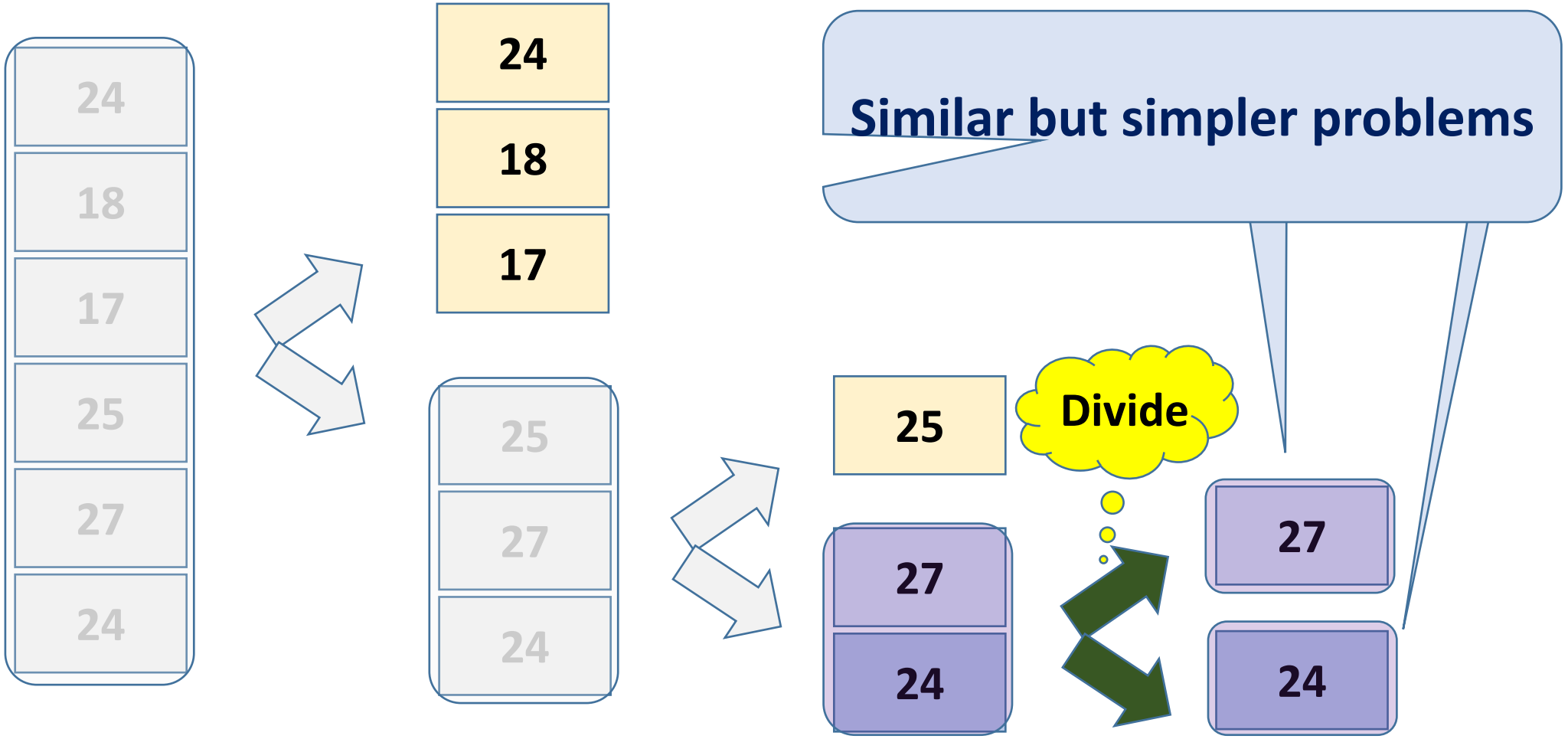

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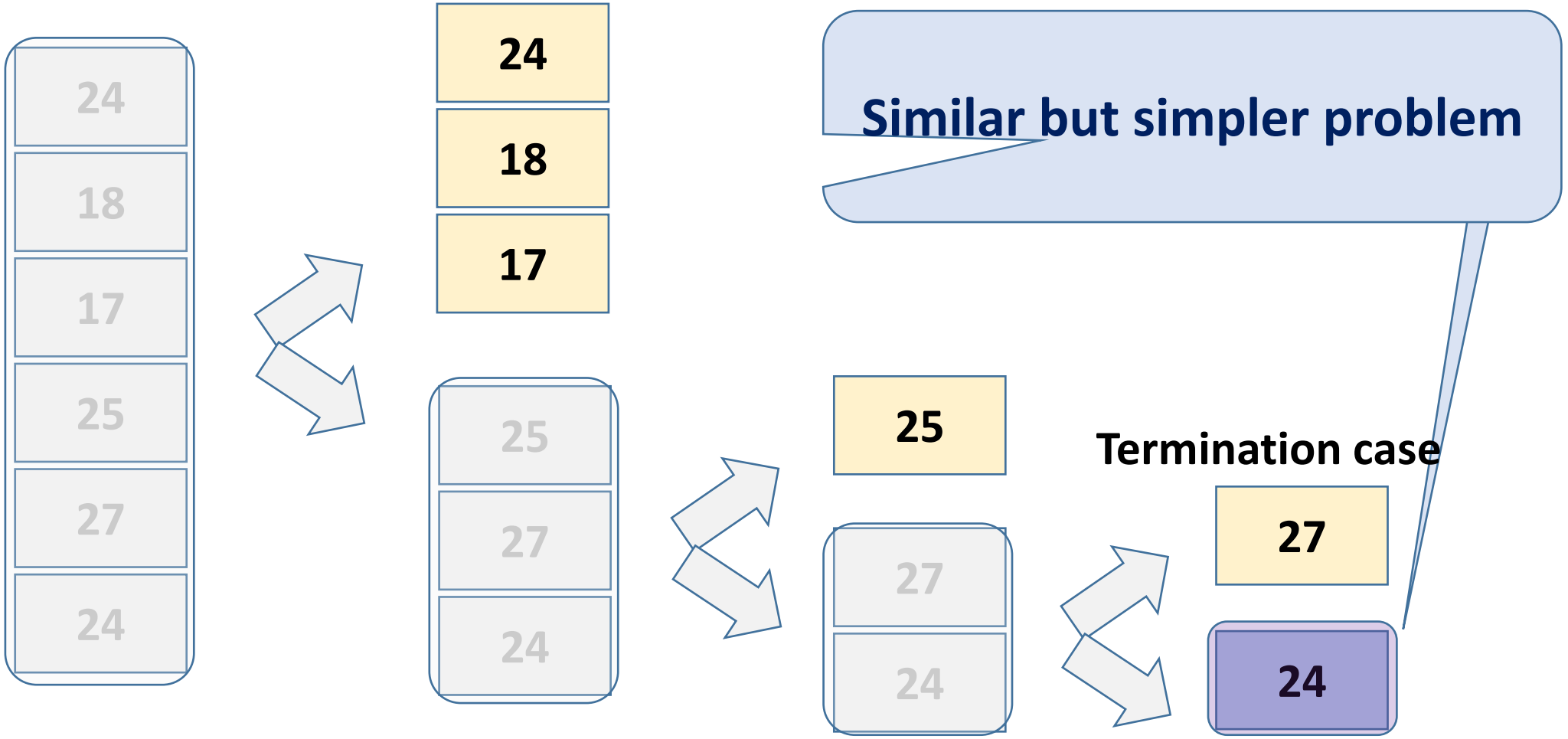

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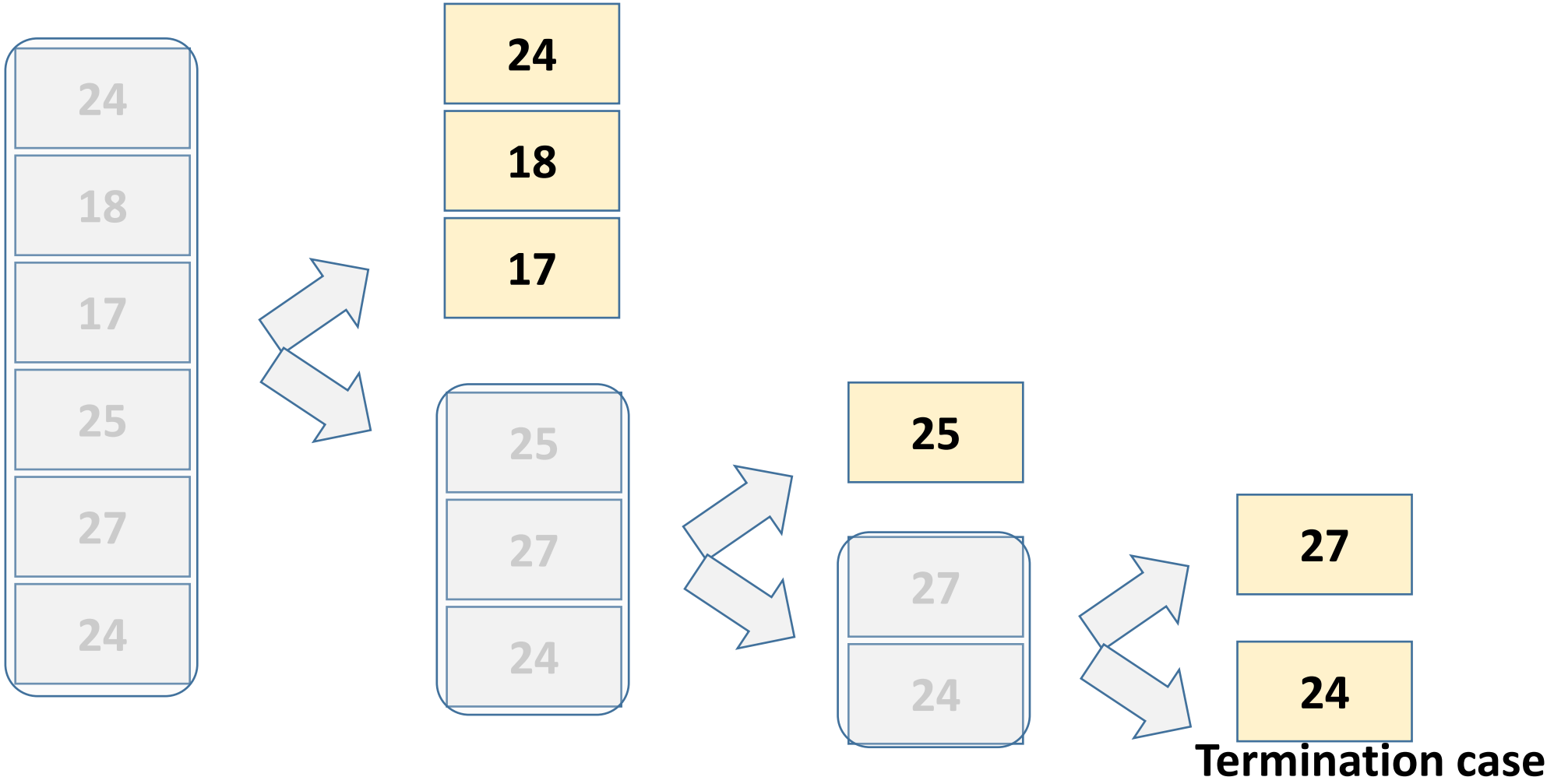

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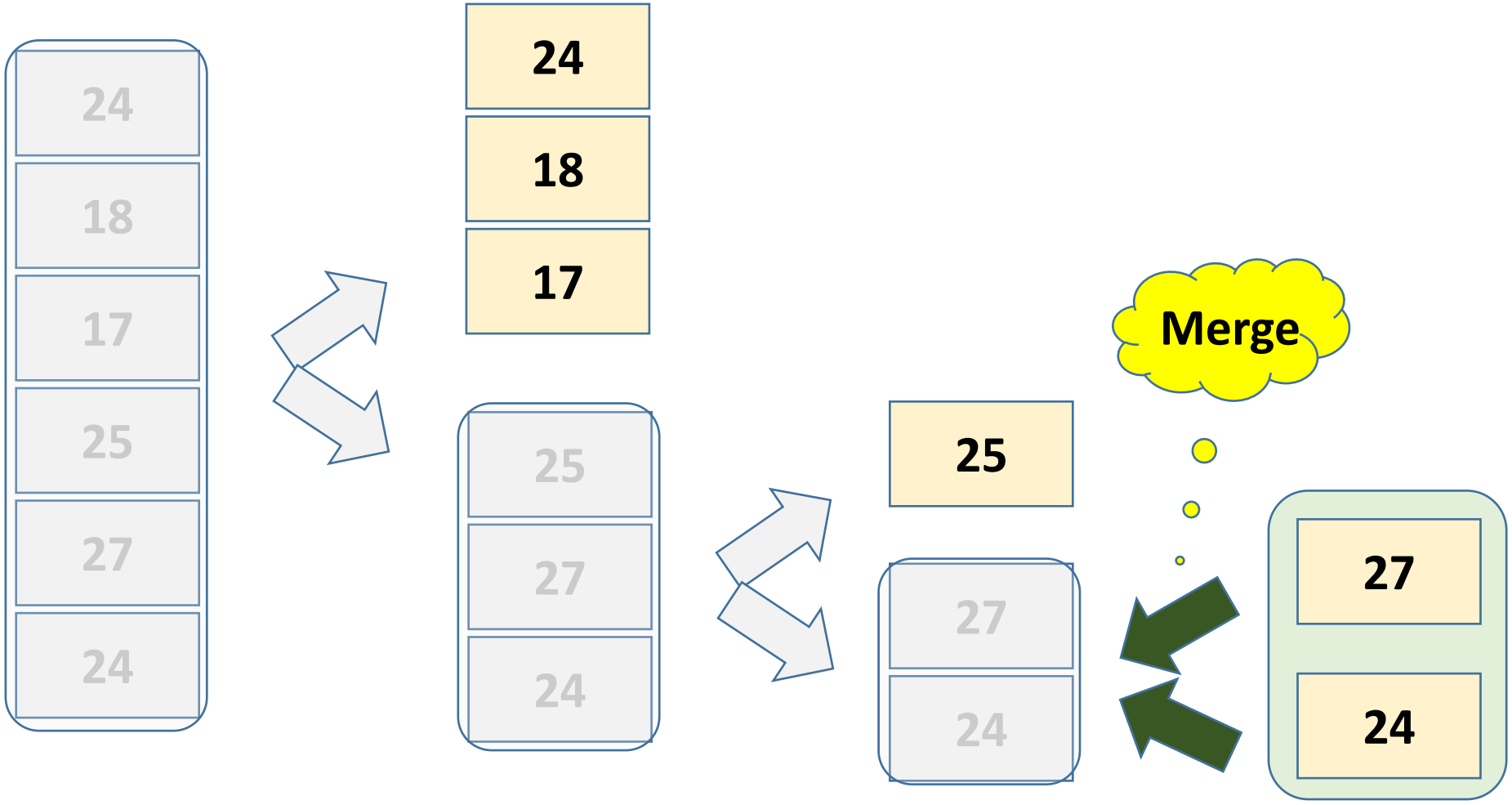

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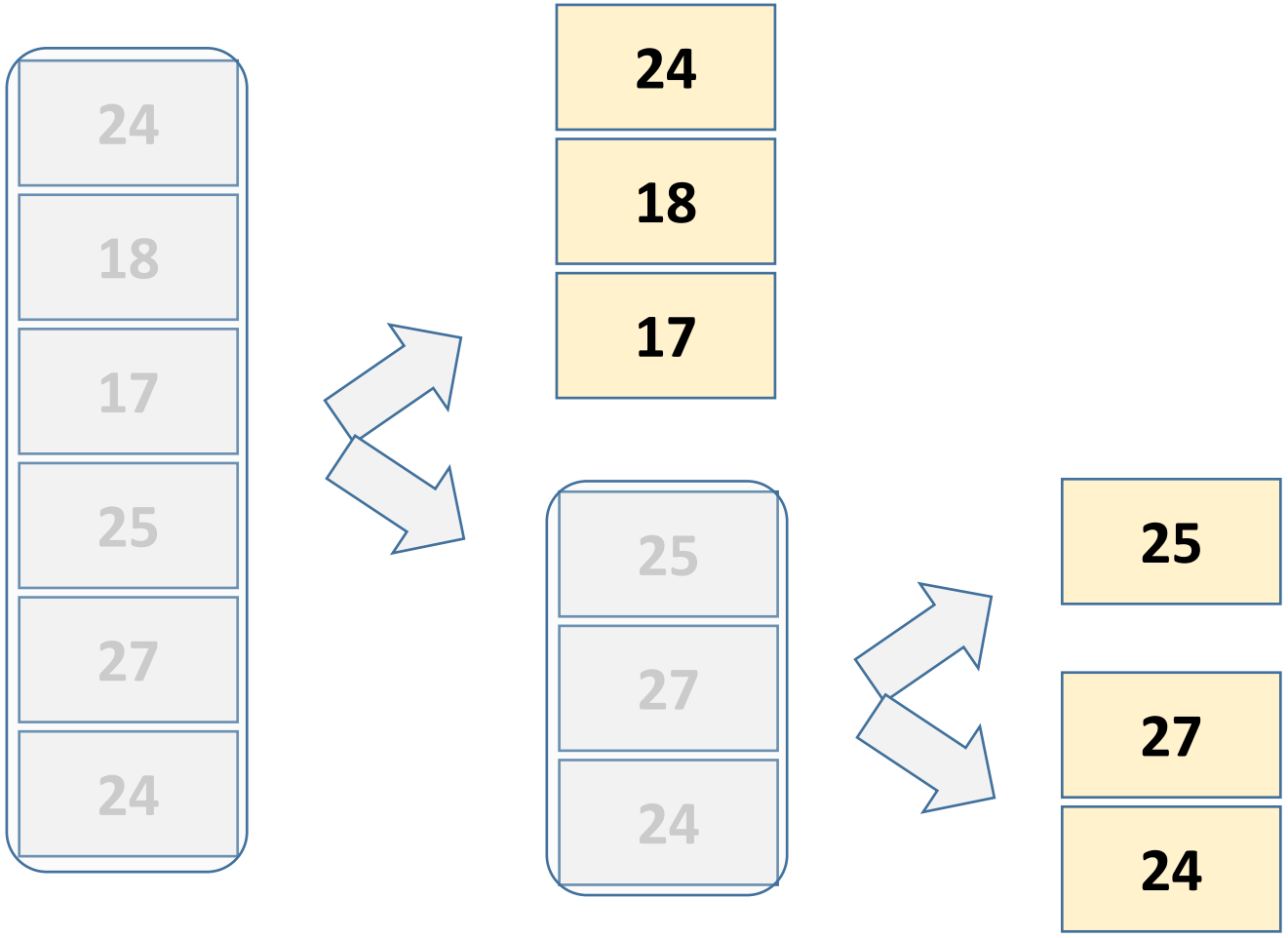

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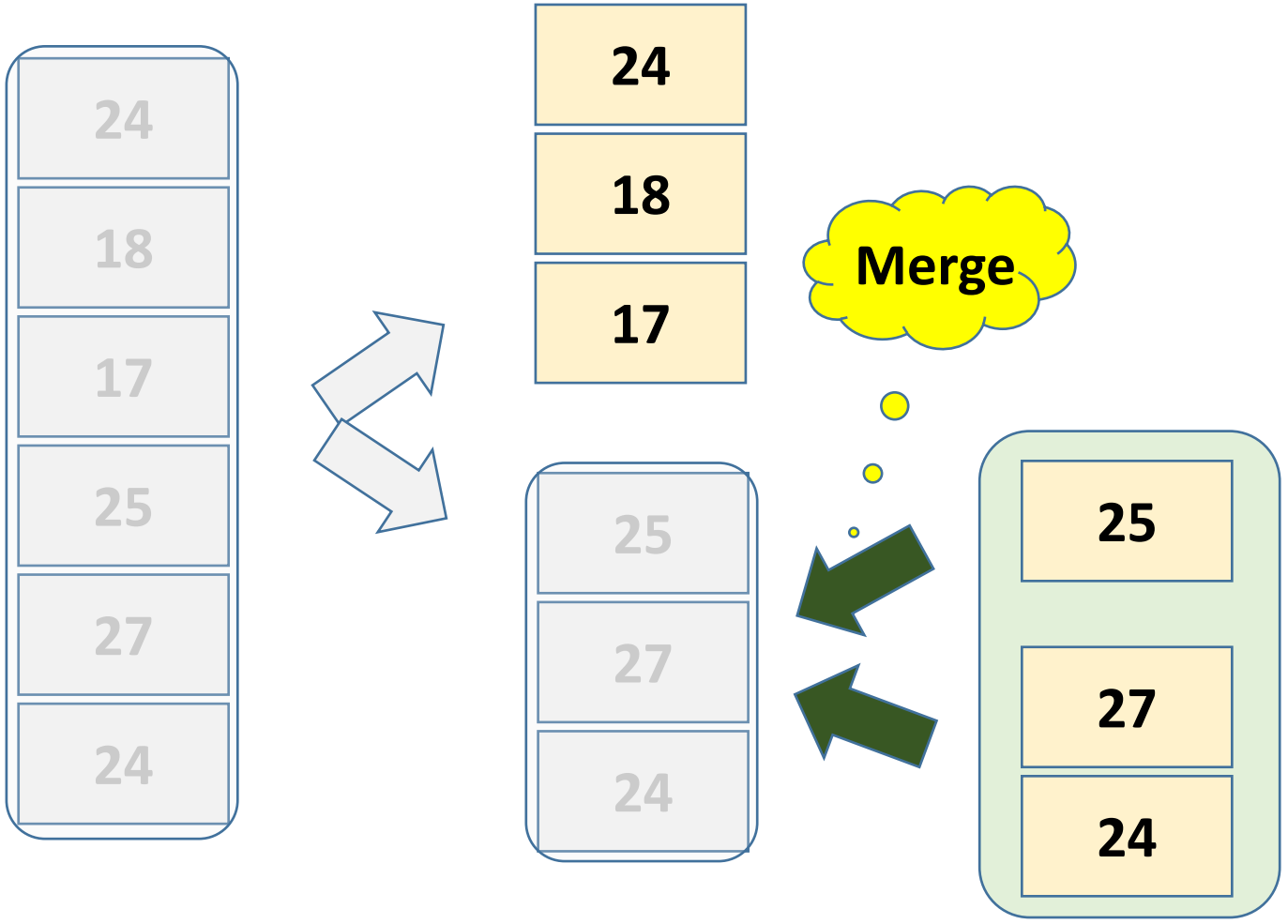

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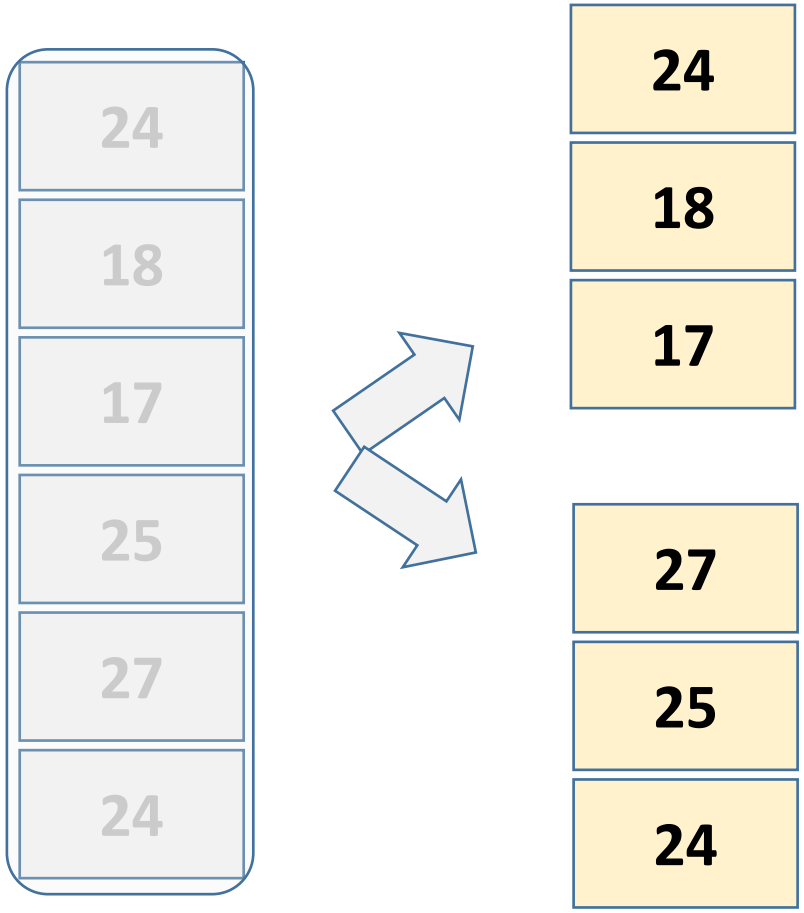

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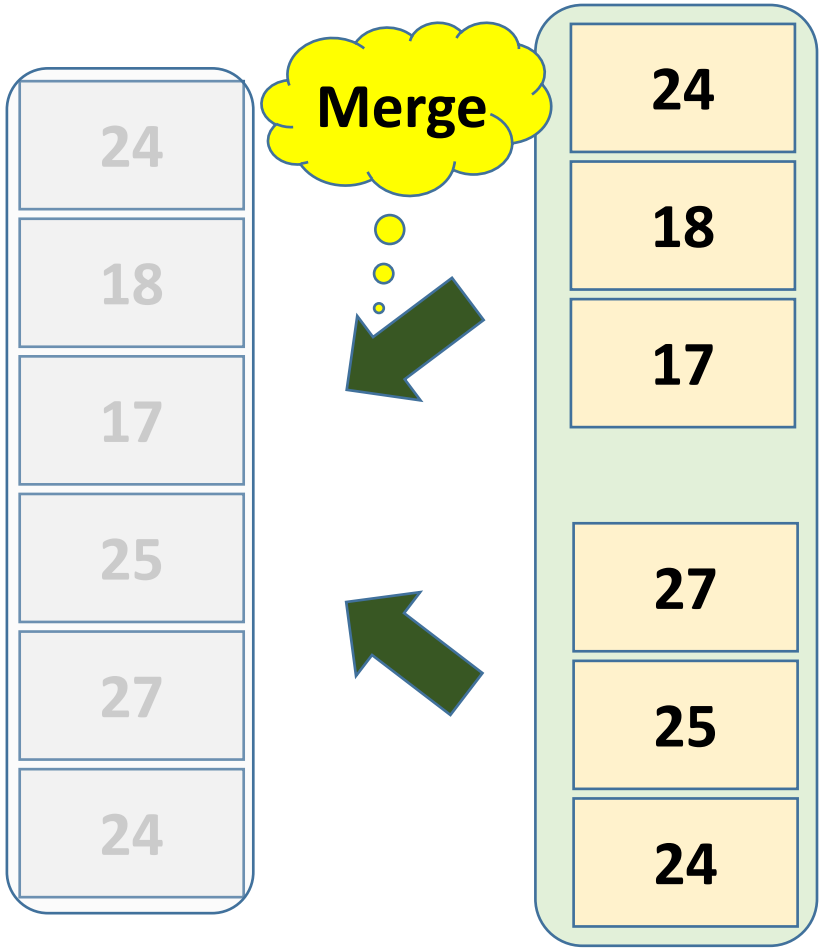

Divide-and-Conquer In Action

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24
24
18
17

Merge Sort

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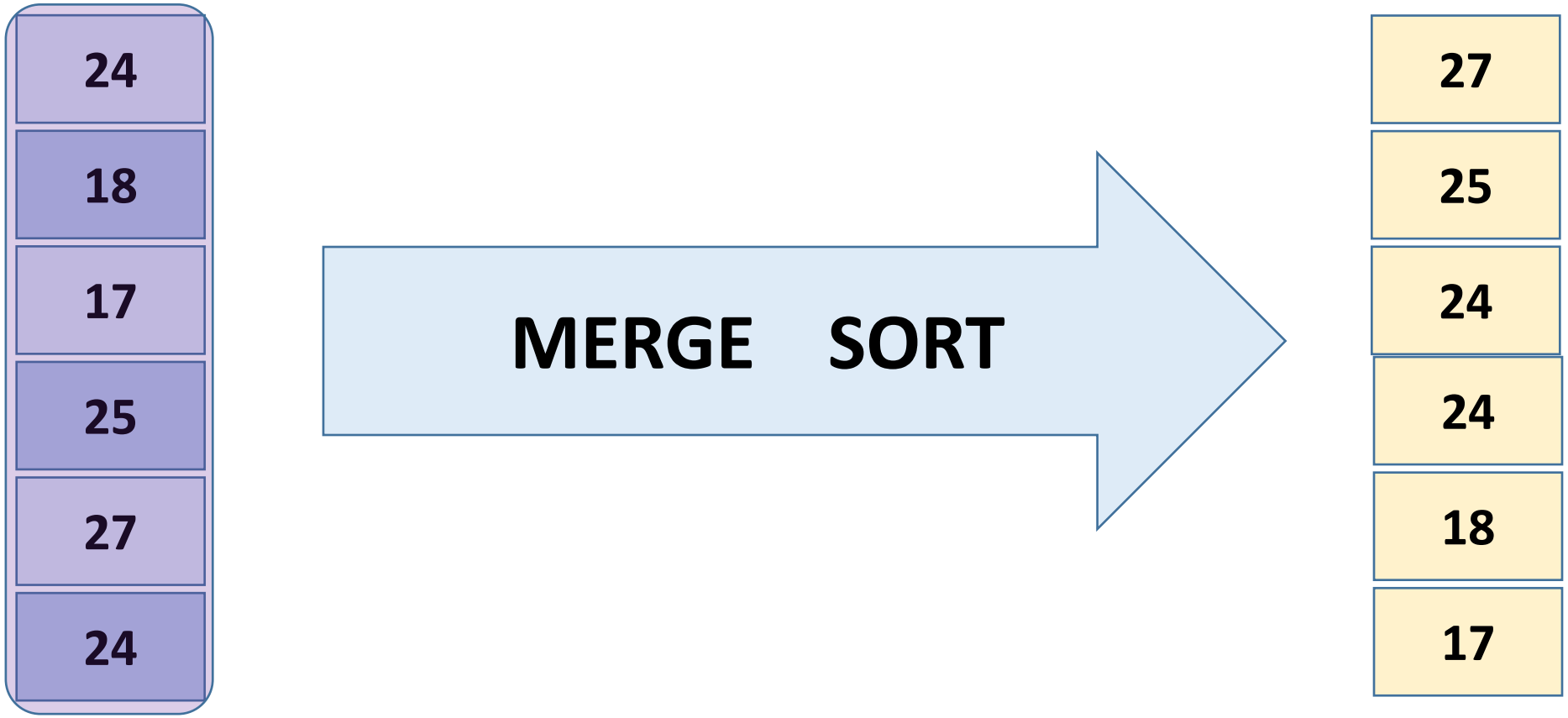

Summary

- Merge sort
  - Intuition
  - Divide-and-conquer approach, leading to recursive formulation
  - Key role of merging sorted sub-arrays