

Sorting

David Croft

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Bubblesort

Stable sort

In-place

Selection sort

Other
algorithms

Quicksort

Divide & Conquer

Comparing

Recap

Sorting algorithms

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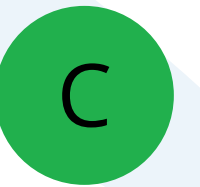
Overview

- 1 Introduction
- 2 Bubblesort
 - Stable sort
 - In-place
- 3 Selection sort
- 4 Other algorithms
- 5 Quicksort
 - Divide & Conquer
- 6 Comparing
- 7 Recap

Sorting is one of the classic problems for learning algorithms.

- Requirement for everything.
- Obvious applications like sorting text, statistics (median calculations).
- Less obvious, sorting objects in games for FOV calculations.
- Route planning.

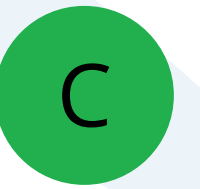
Bubblesort



Very simple sort.

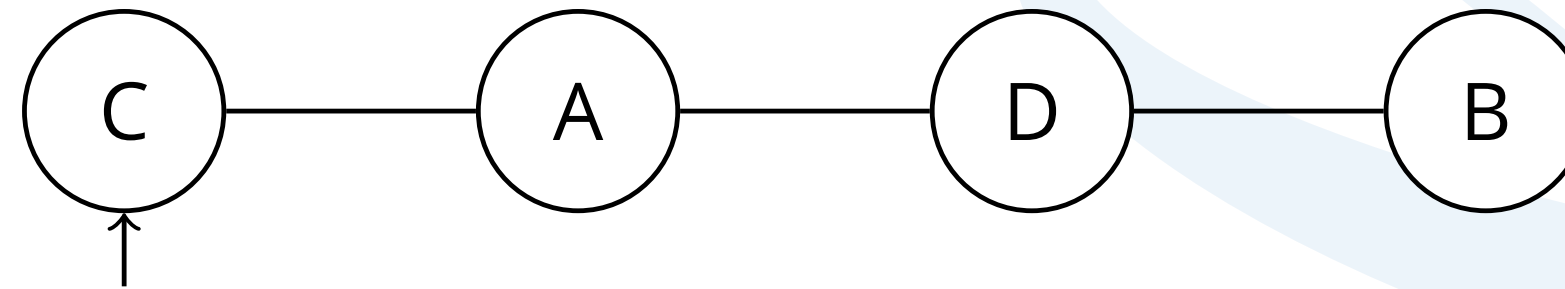
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 - Swap items if in wrong order.

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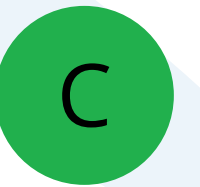


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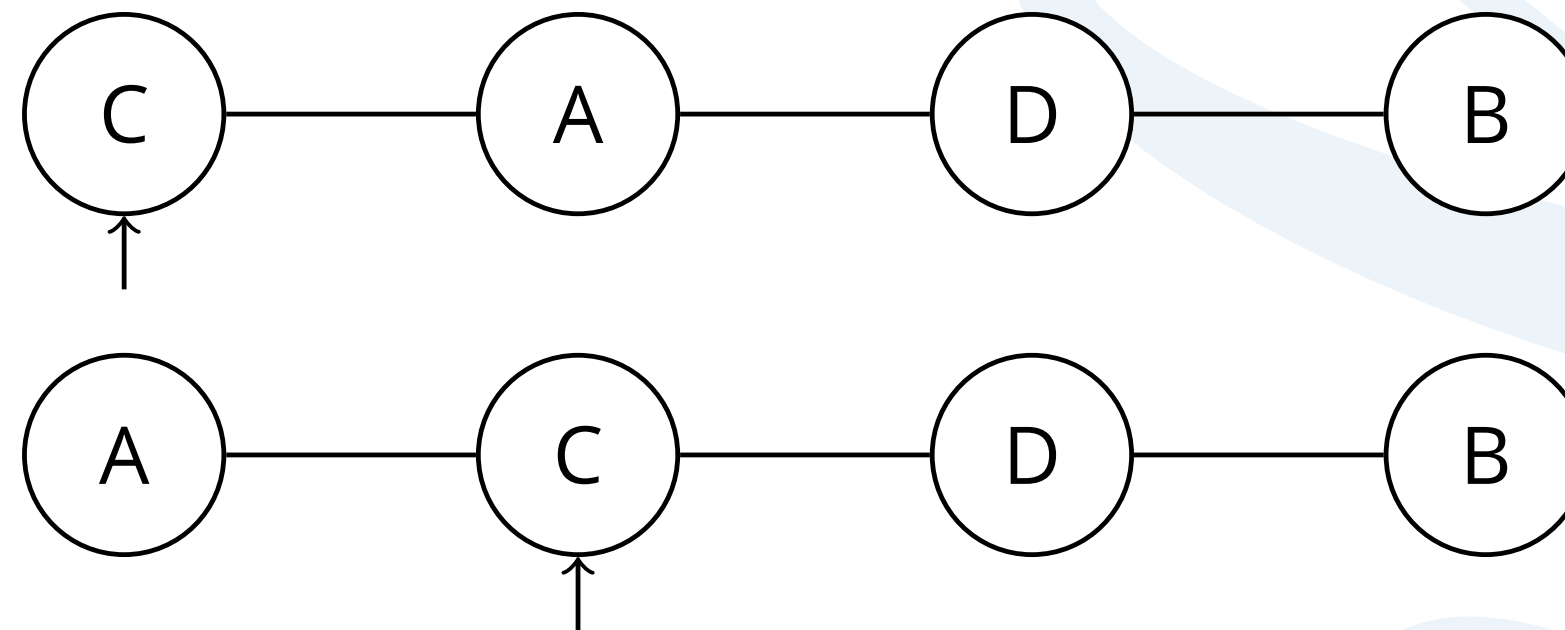


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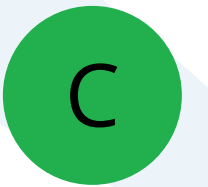


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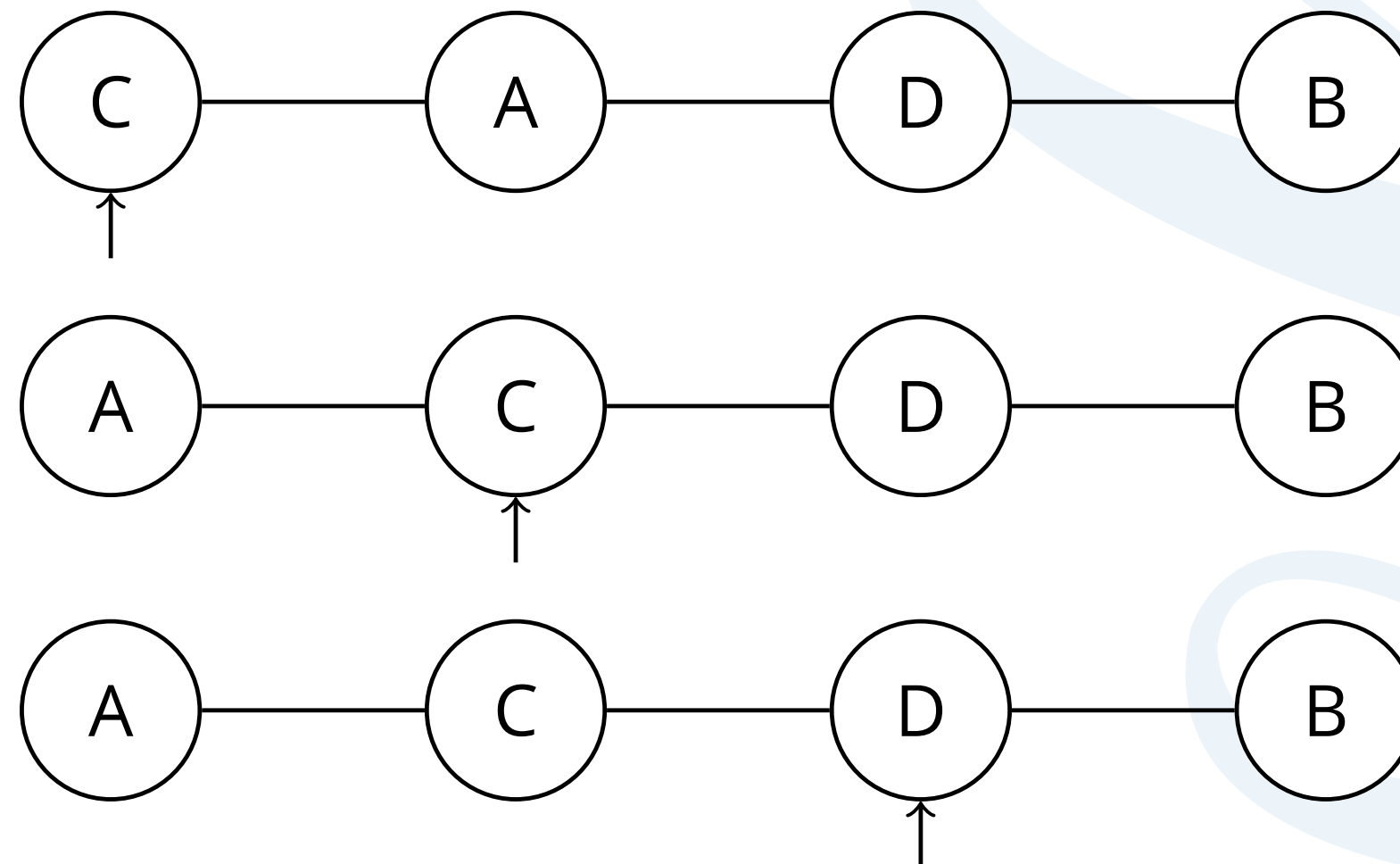


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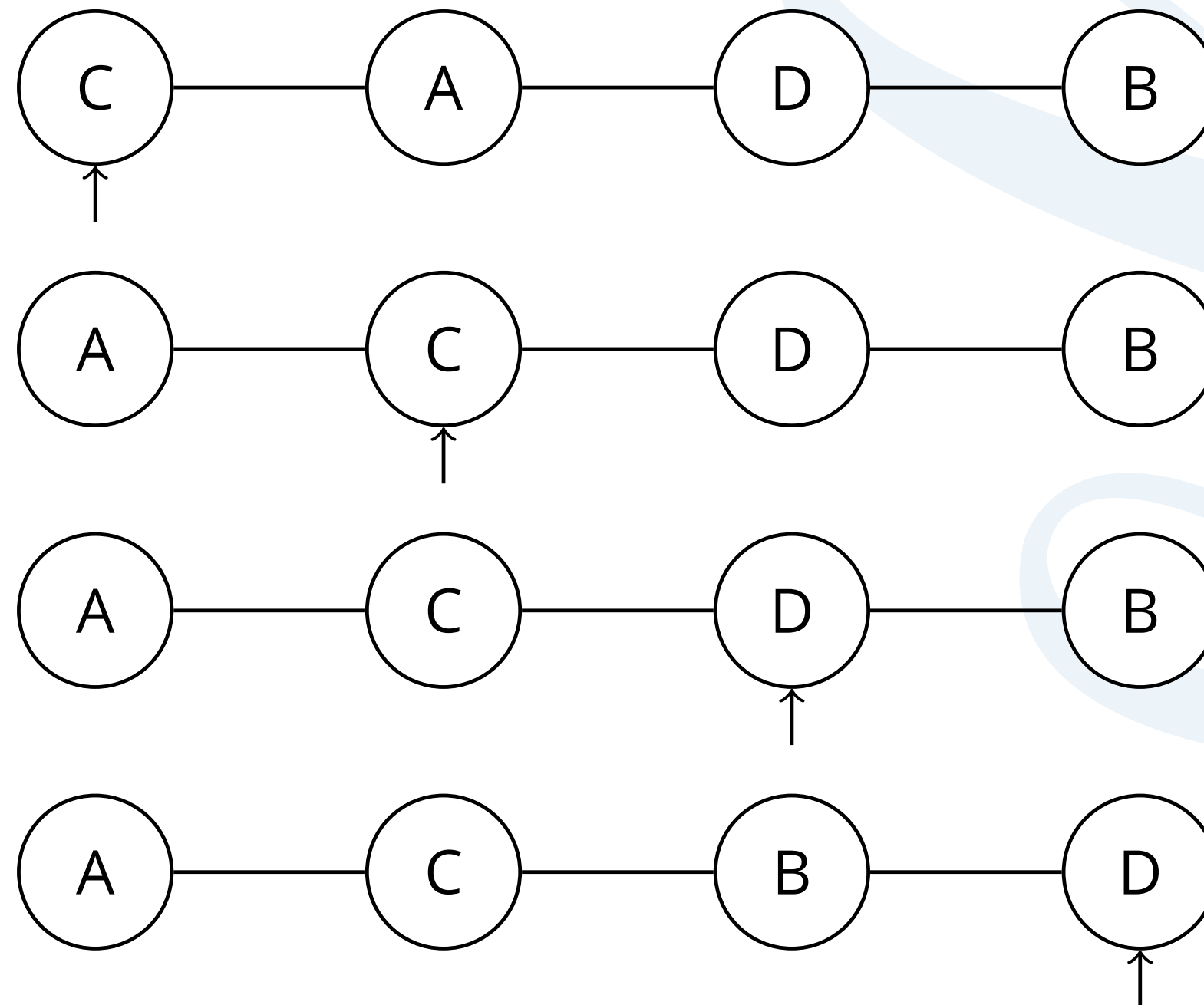
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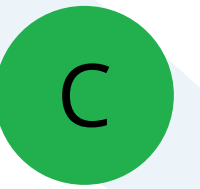


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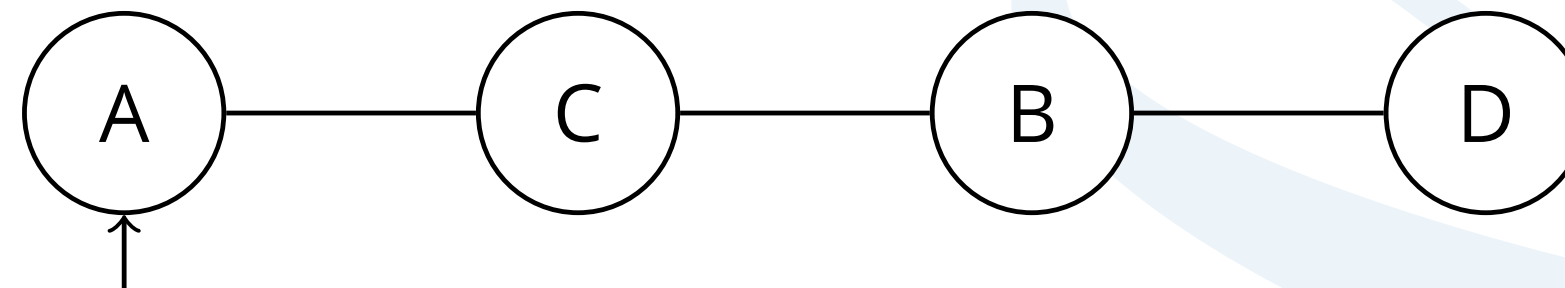


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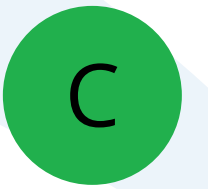


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- Keep iterating over the sequence until elements are sorted.

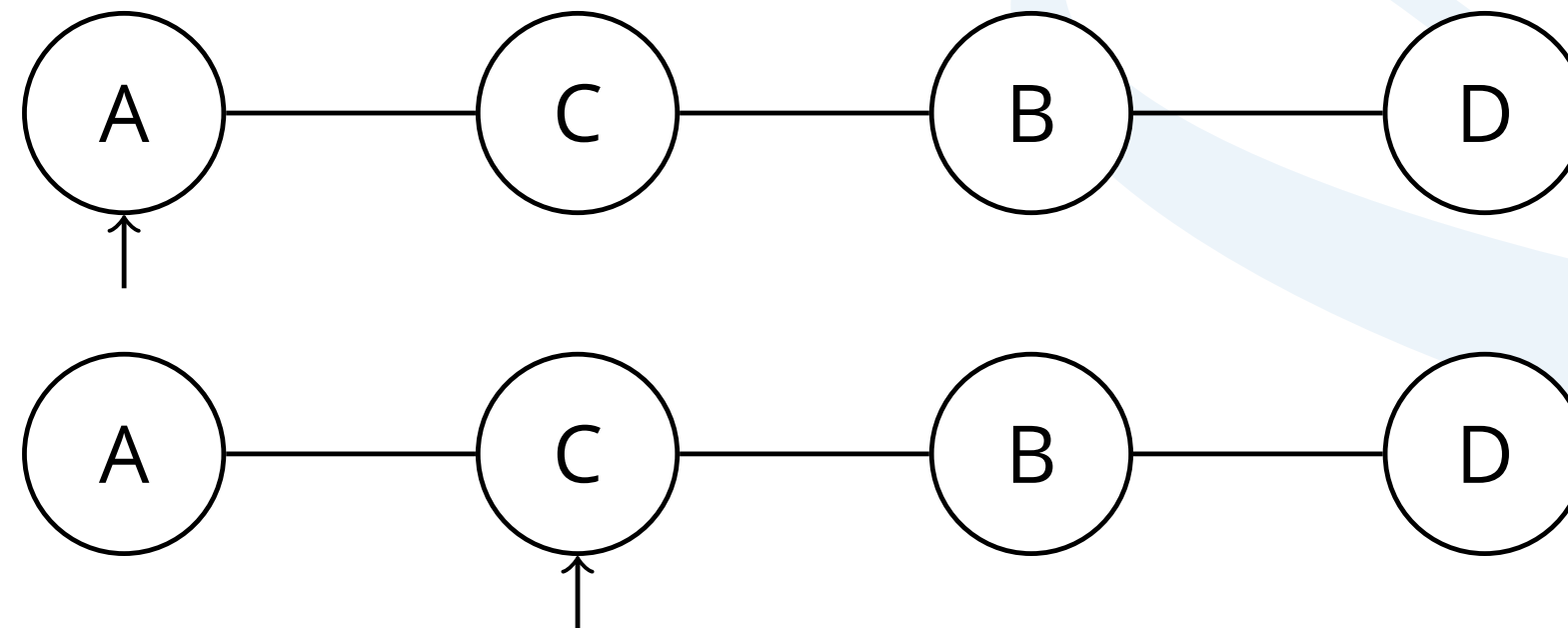


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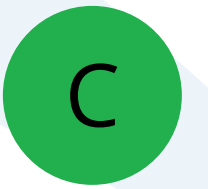


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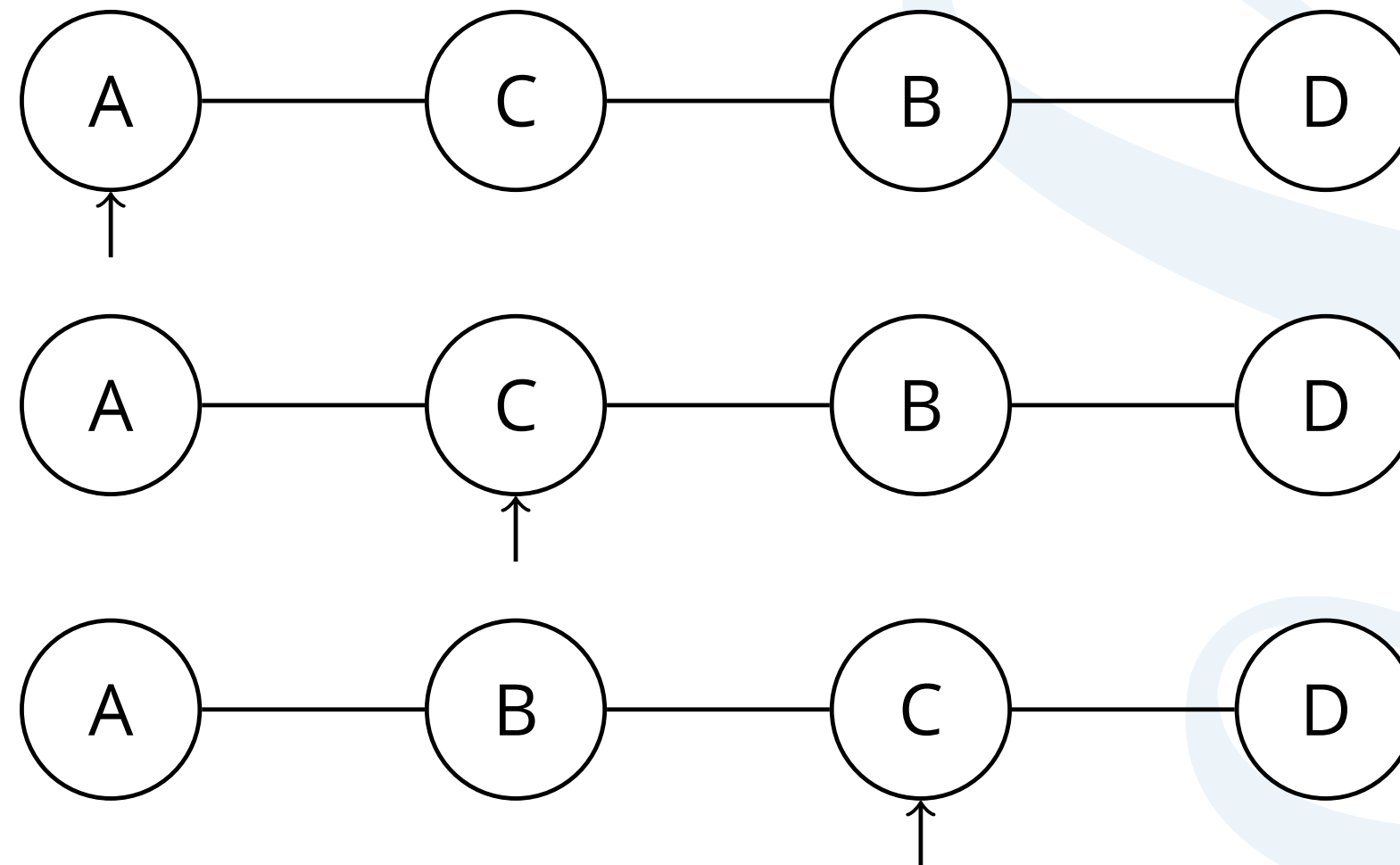


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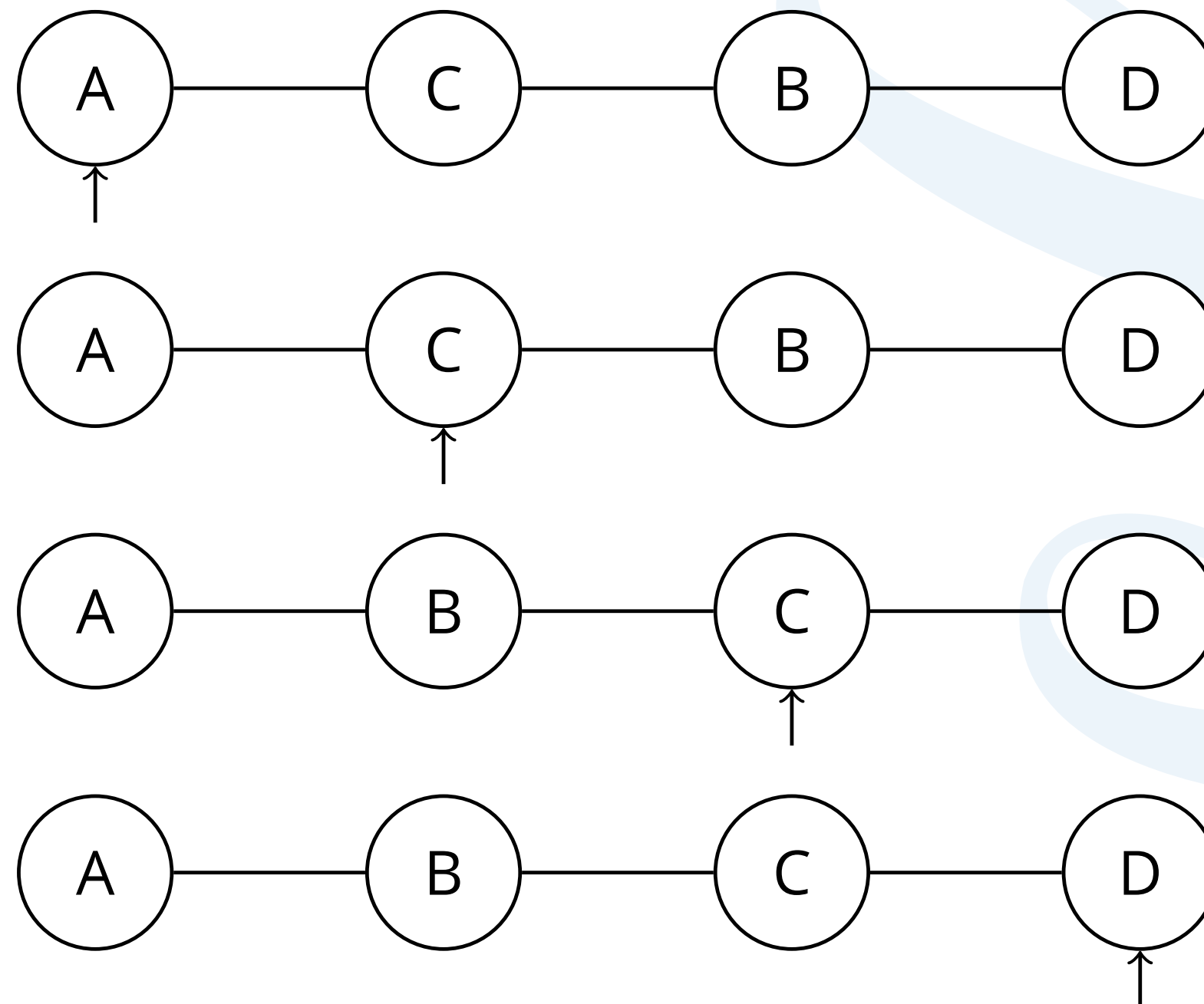
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Stable sort



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Stable meaning that equivalent elements do not change their relative orders.

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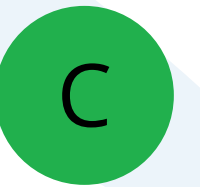
With unstable sorting algorithm the relative orders of equivalent elements can be changed.



In-place meaning that it only needs a small amount of additional memory in order to work.

- More memory efficient than the alternative.
- Can be important if...
 - ...dealing with large amounts of data.
 - ...have limited resources (i.e. embedded systems).
- Bubble sort only needs a few extra variables to swap the elements and to step through the sequence.

Bubblesort



One of the simplest sorting algorithms.

- Explained here to introduce you to sorting concepts.
 - In-place, stable.

Bubblesort

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- Is rubbish.
 - Horrible performance, average is $O(n^2)$.
 - But best case is only $O(n)$.



The time taken to sort a sequence depends on:

- The starting order of the sequence.

For example, Bubblesorting a 100 elements:

So sorting algorithms have 3 $O()$ values.



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- Average case, random order.
 - Somewhere in between.

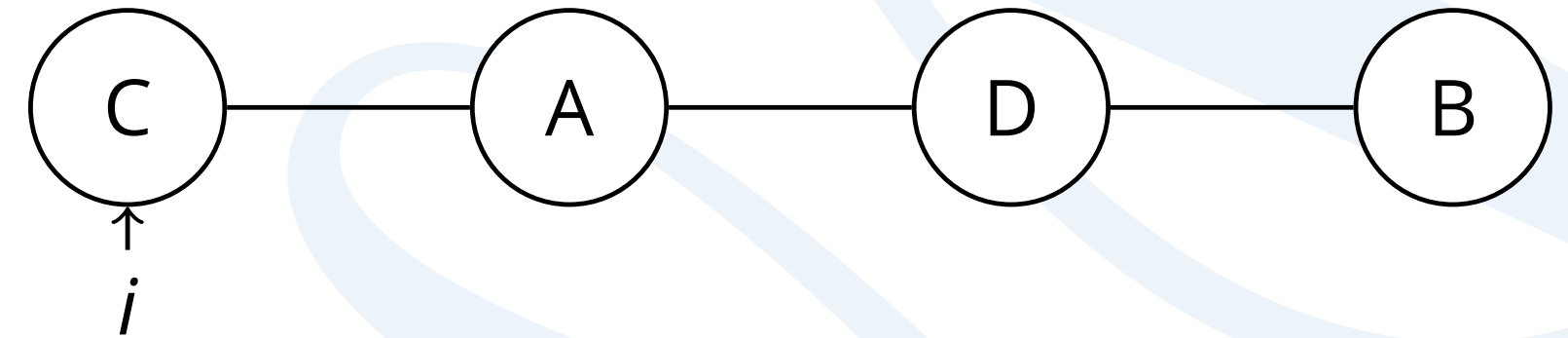
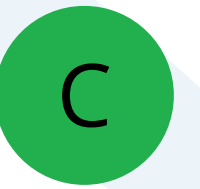
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Selection sort

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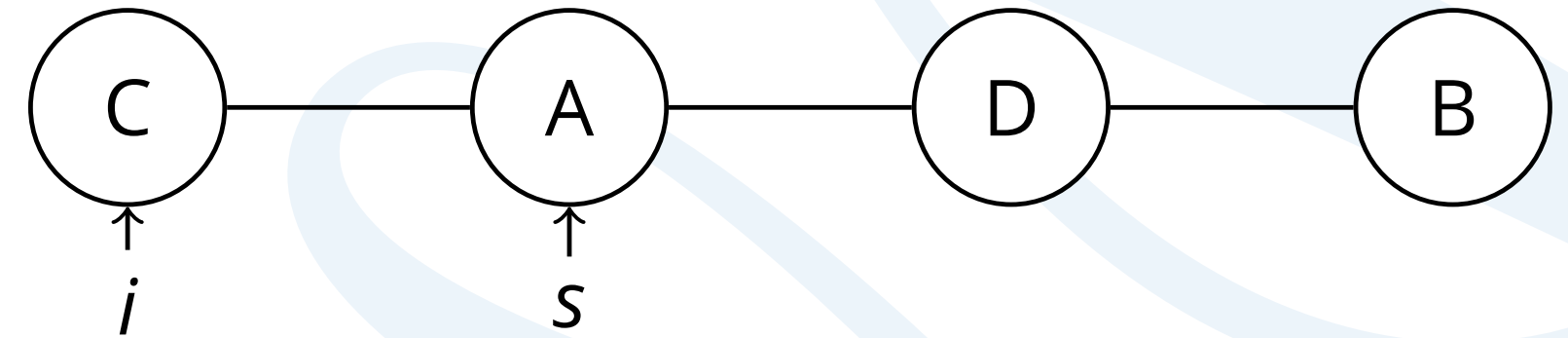
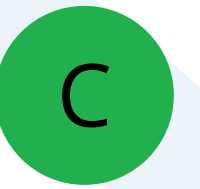
- Divides sequence into sorted and unsorted regions.
 - Not stable.
 - In place.
- 1 Iterate over sequence.
 - 2 For each element search the remaining elements on its right for the smallest value.
 - 3 Swap smallest element with current element.

Selection sort II



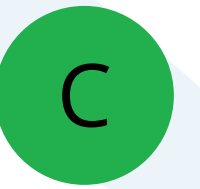
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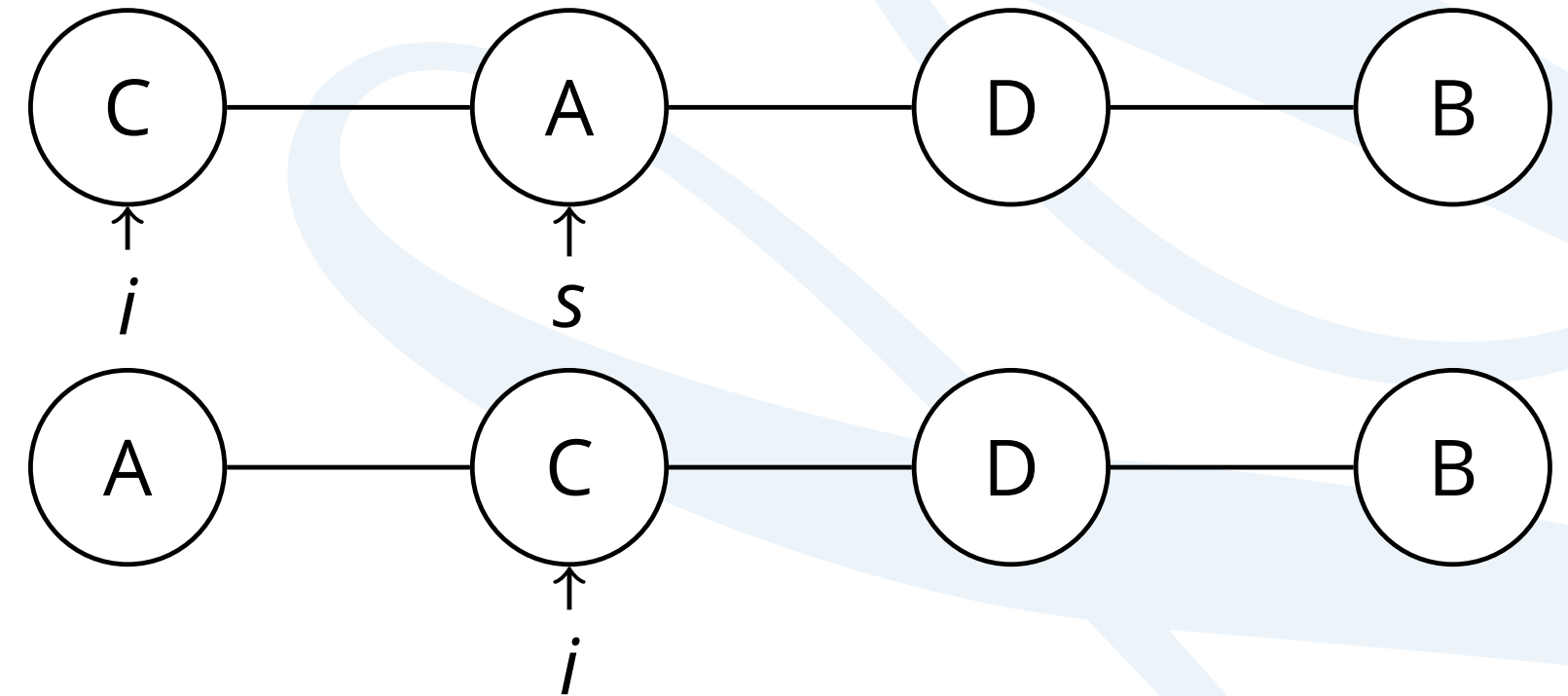


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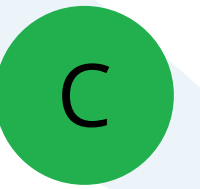
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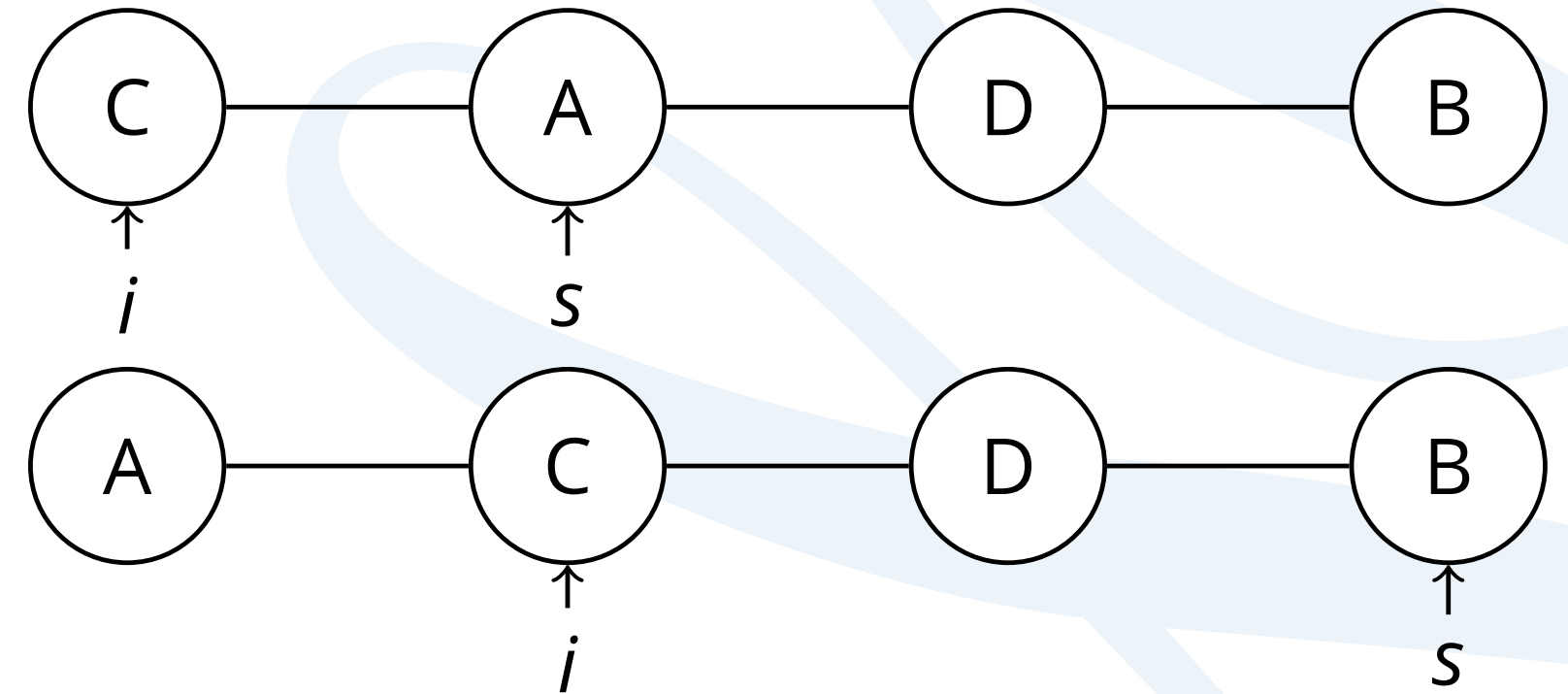
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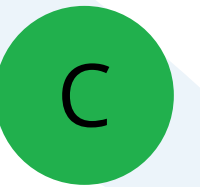
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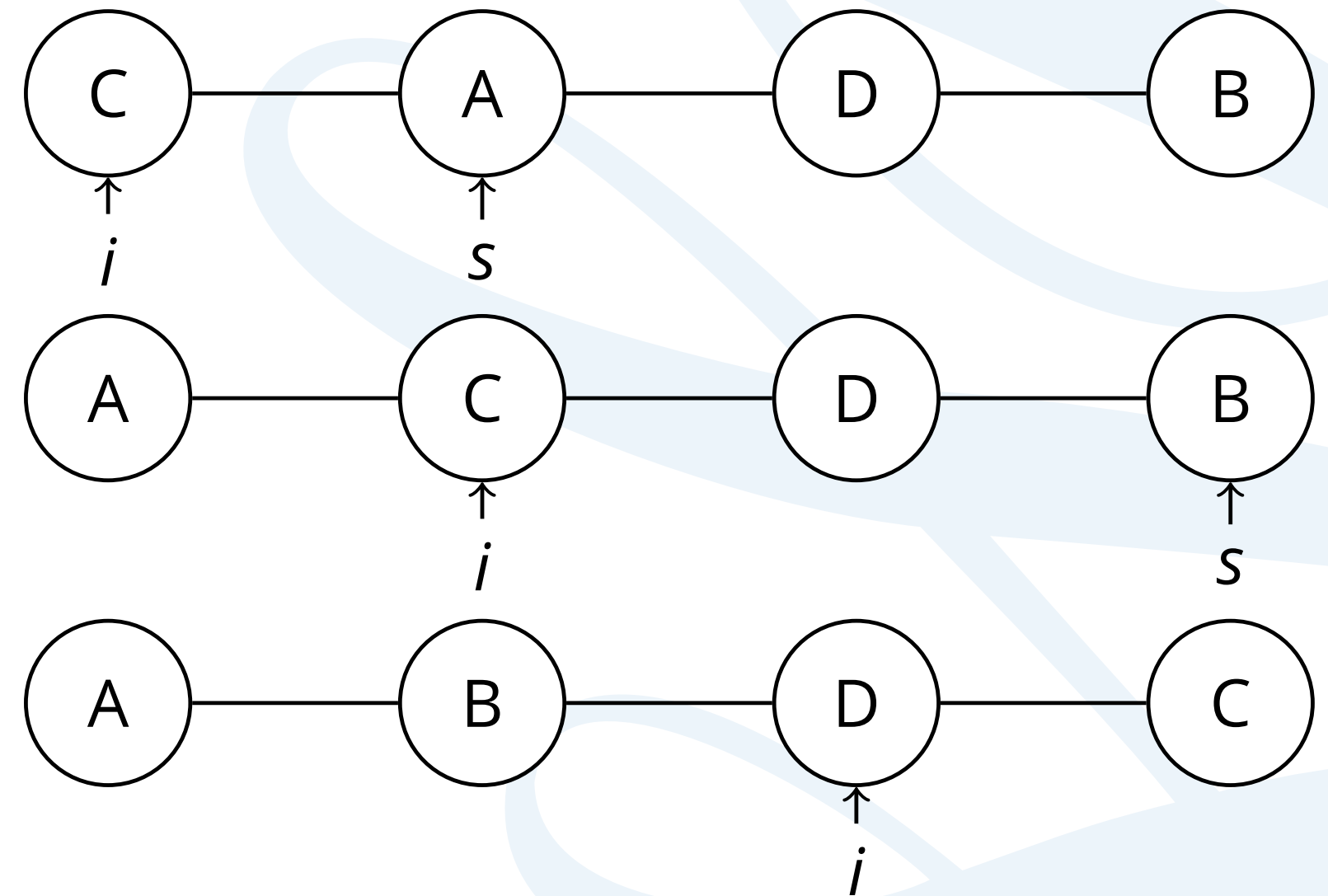
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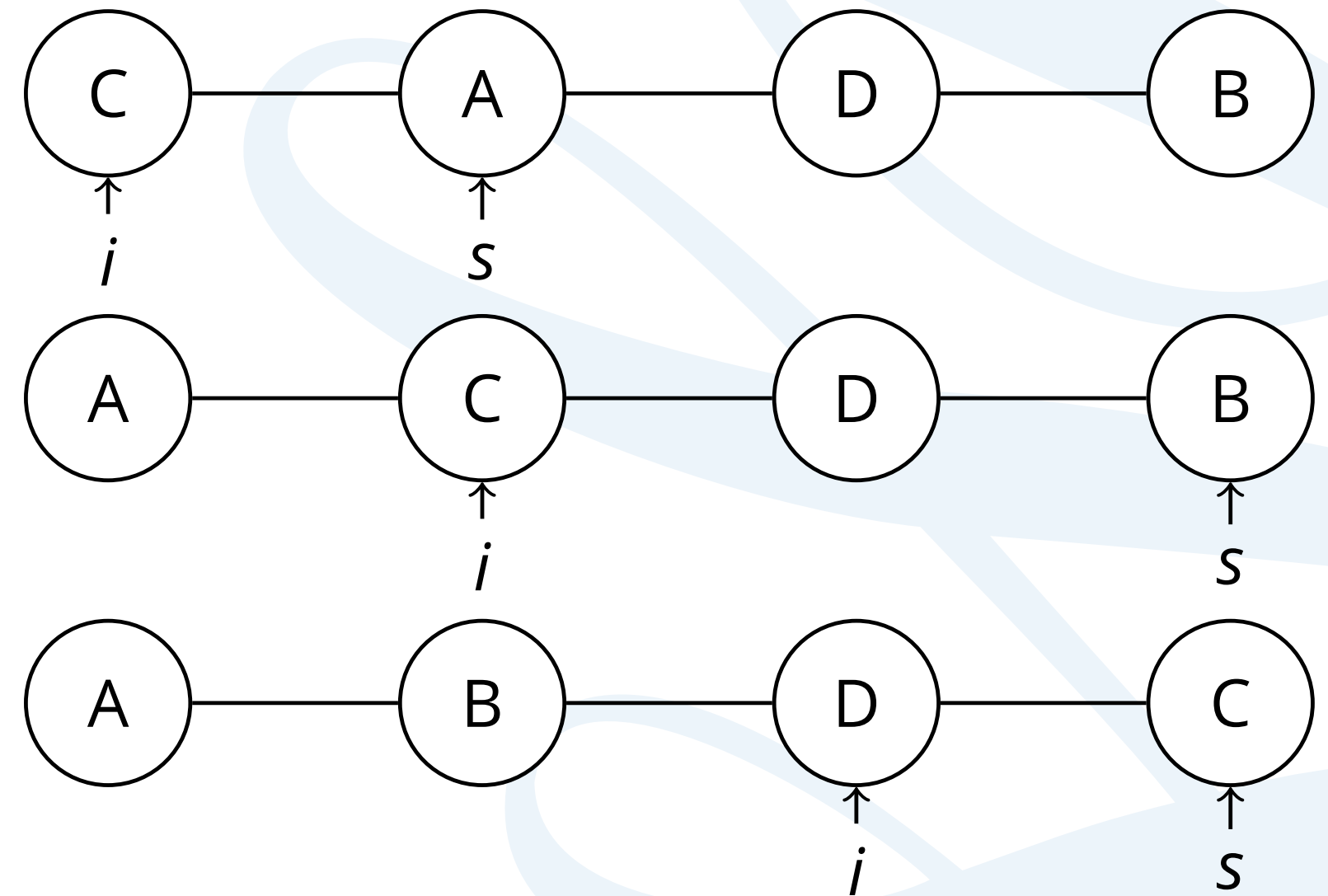
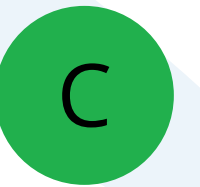


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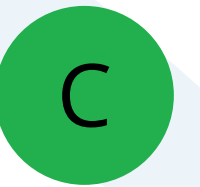


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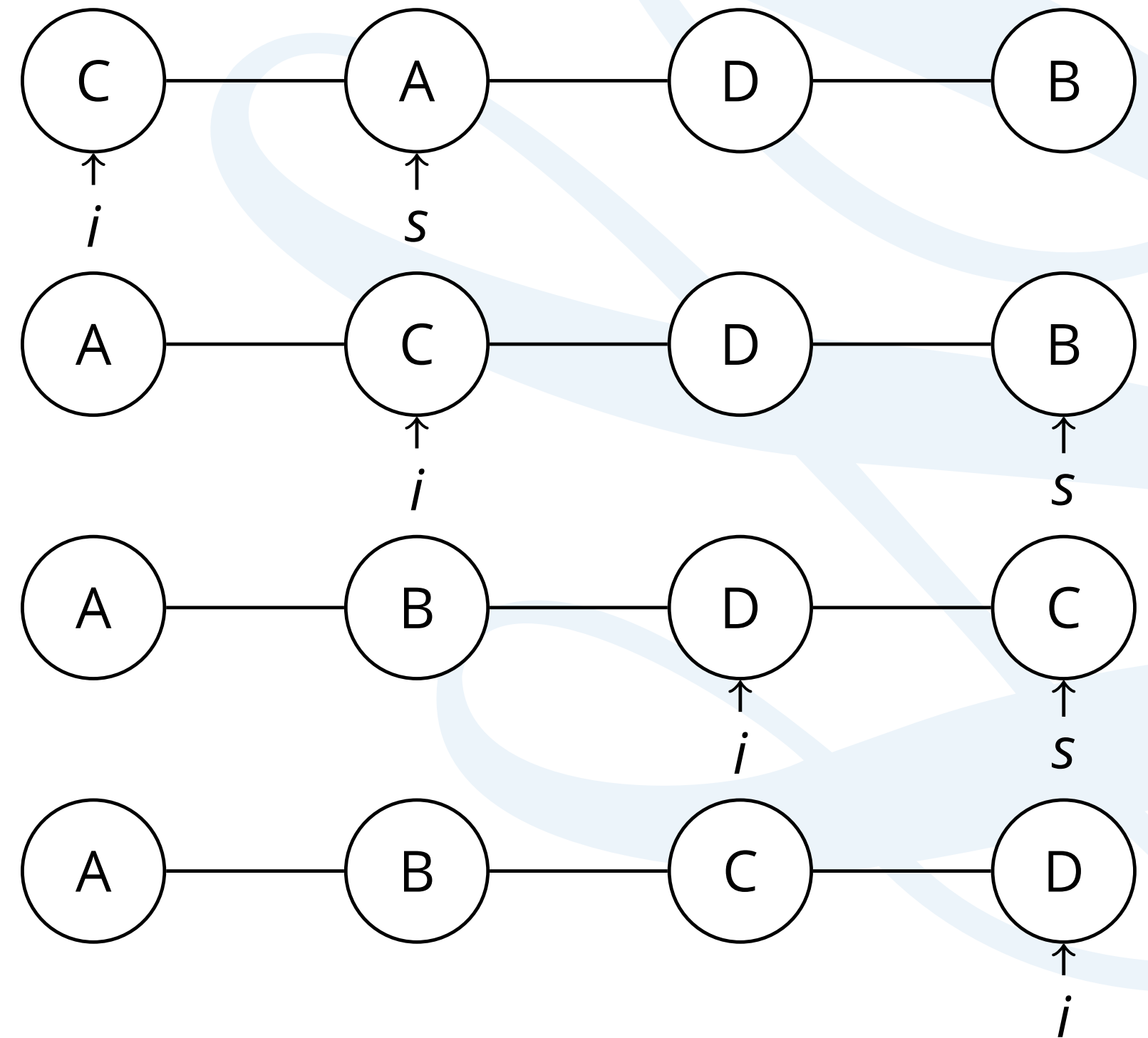
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$O()$

A

Bubblesort is $O(n^2)$.

Selection sort is $O(n^2)$.

- Selection sort is generally faster than bubble.
 - But have same $O()$ complexity.
 - WTF?
- $O()$ notation describes how an algorithm will grow.
- Not good at absolute performances.
- Selection sort typically does fewer comparisons and swaps than bubblesort.
 - Therefore faster.

Sorting Algorithms

Many sorting algorithms

- Different trade-offs, performances. <https://www.youtube.com/watch?v=ZZuD6iUe3Pc>
- Some are just jokes.

1 Bead

2 Bogo

3 Bubble

4 Circle

5 Cocktail

6 Comb

7 Counting

8 Cycle

9 Gnome

10 Heap

11 Insert

12 Merge

13 Pancake

14 Patience

15 Permutation

16 Quick

17 Radix

18 Selection

19 Shell

20 Sleep

21 Stooge

22 Strand

23 Tree

Quicksort

C

Neither bubble or selection sort are very good.

- Simple algorithms but slow.
- Not used in real life.

One of the fastest sorting algorithms.

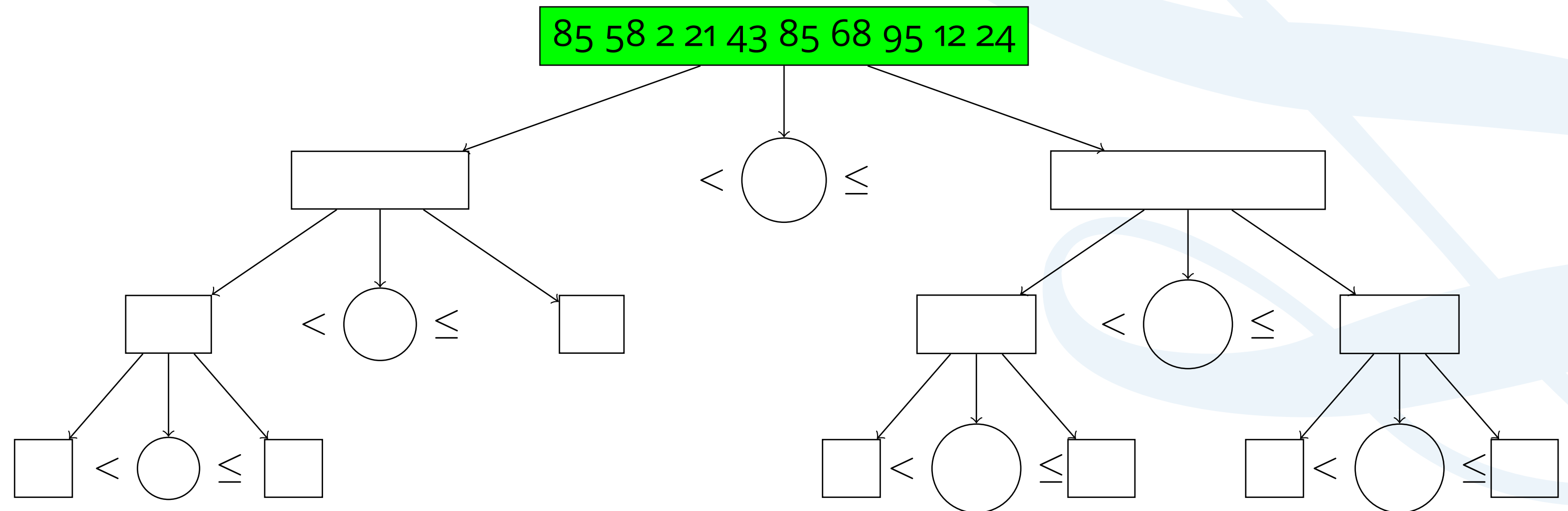
- Used in real life.
- Recursively breaks the sequence in half.
 - Divide & Conquer.

Quicksort II

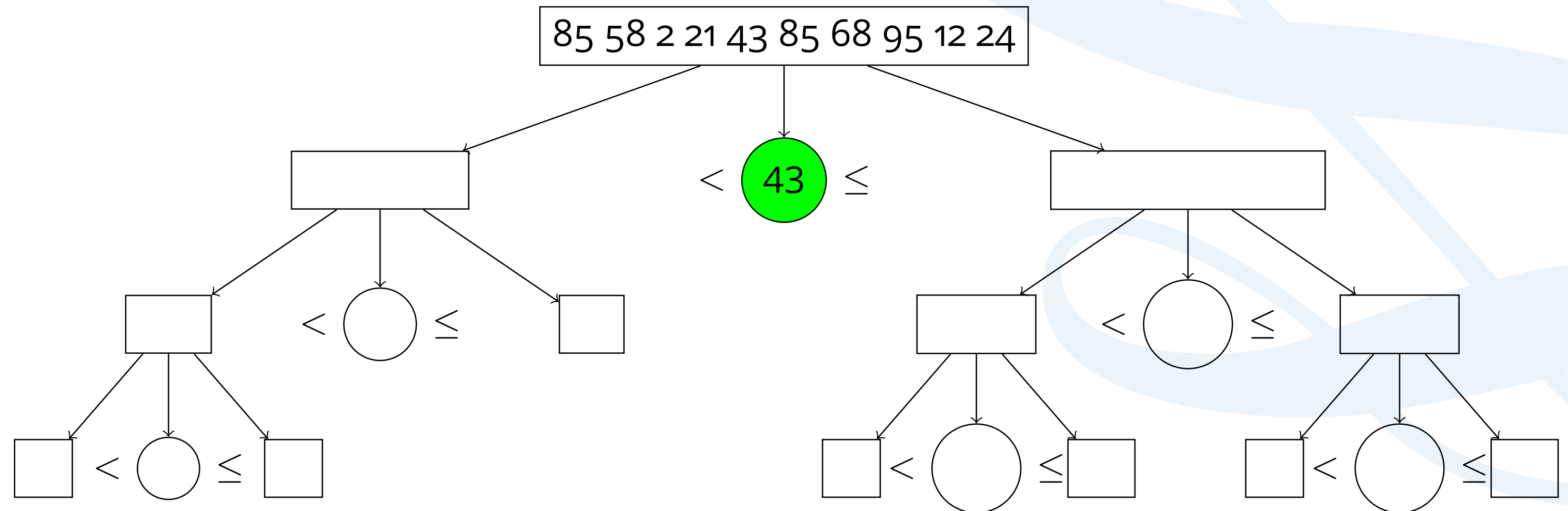
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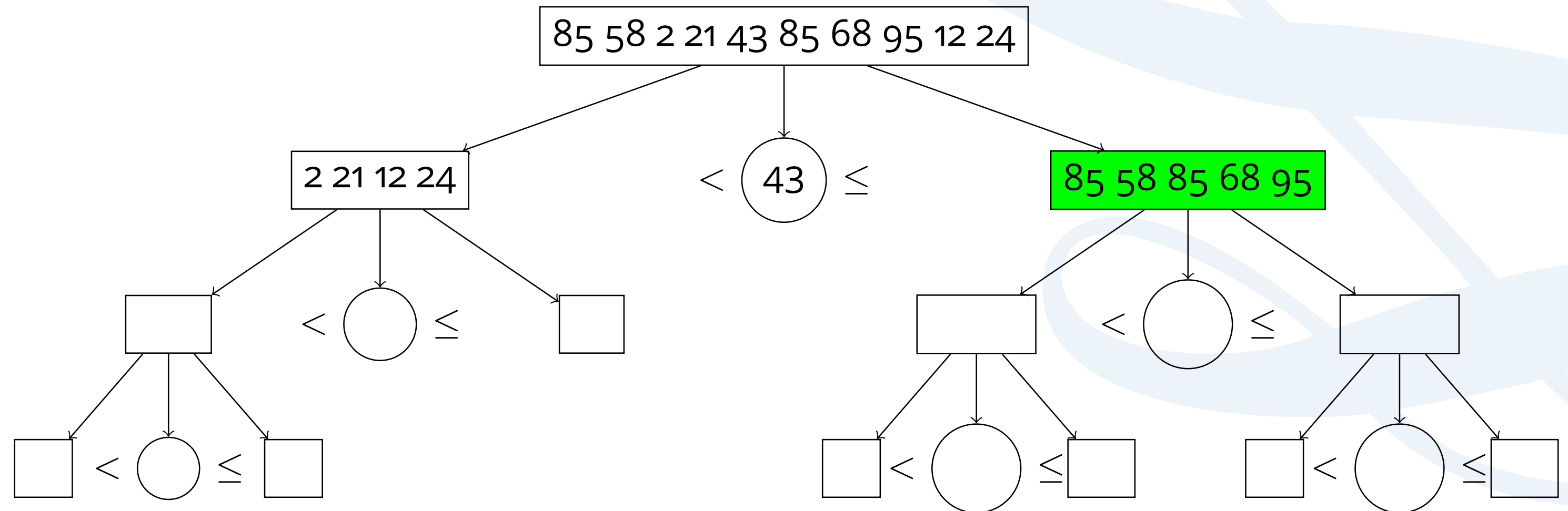
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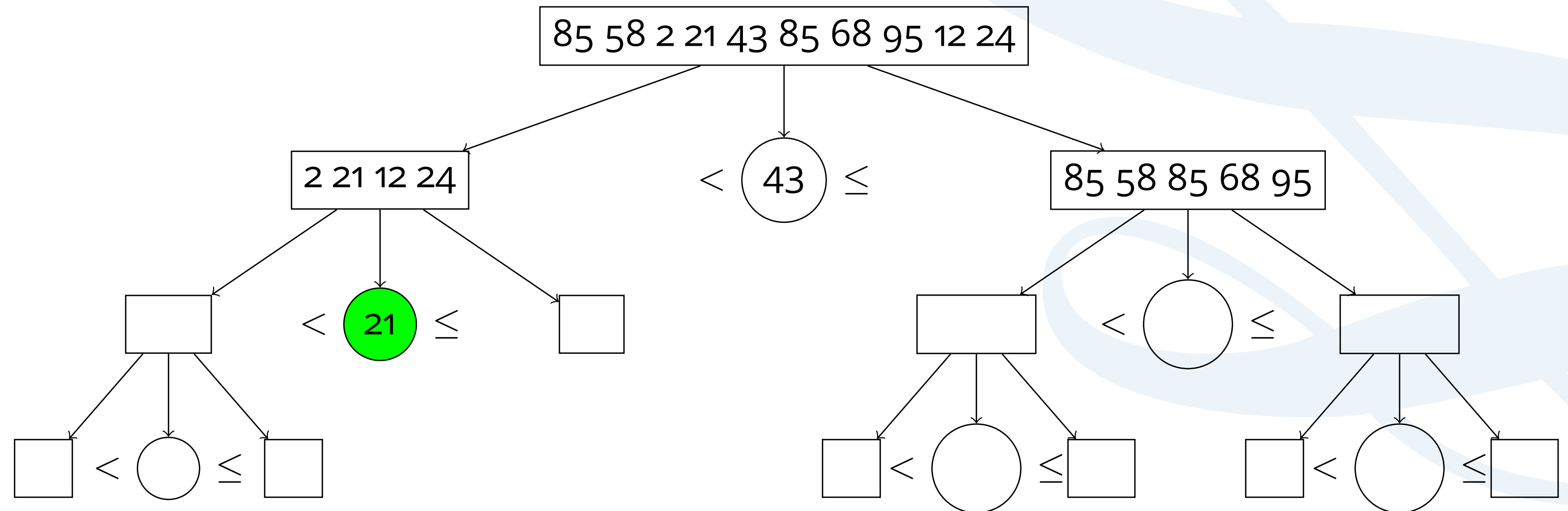
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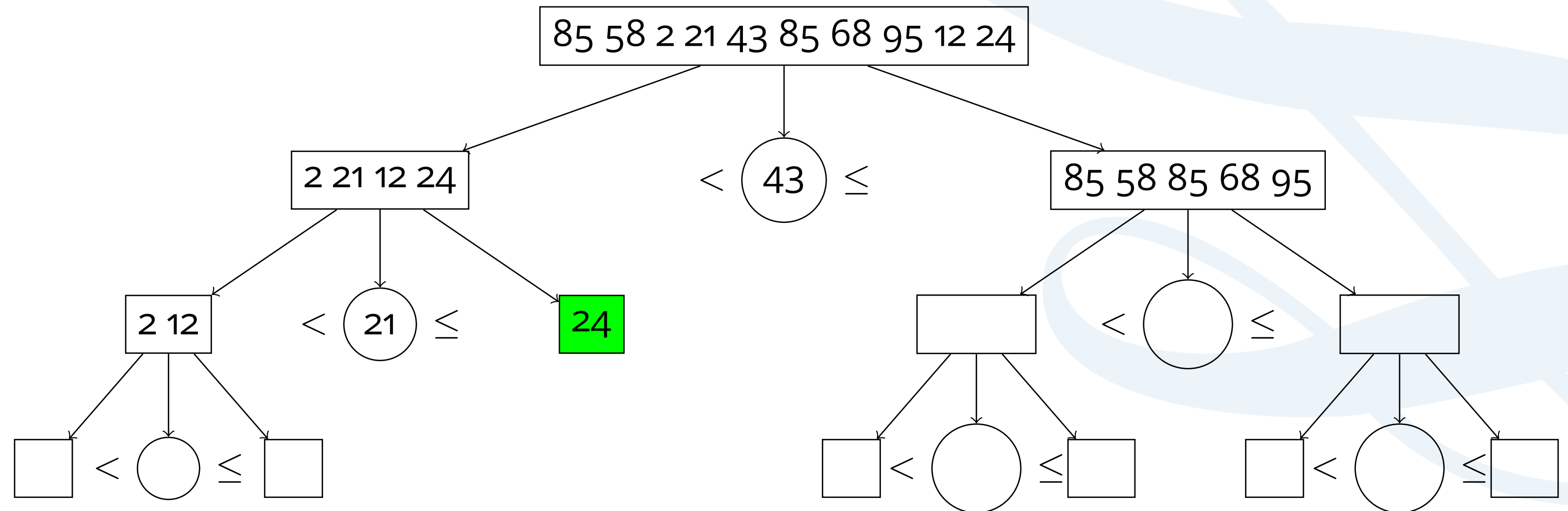
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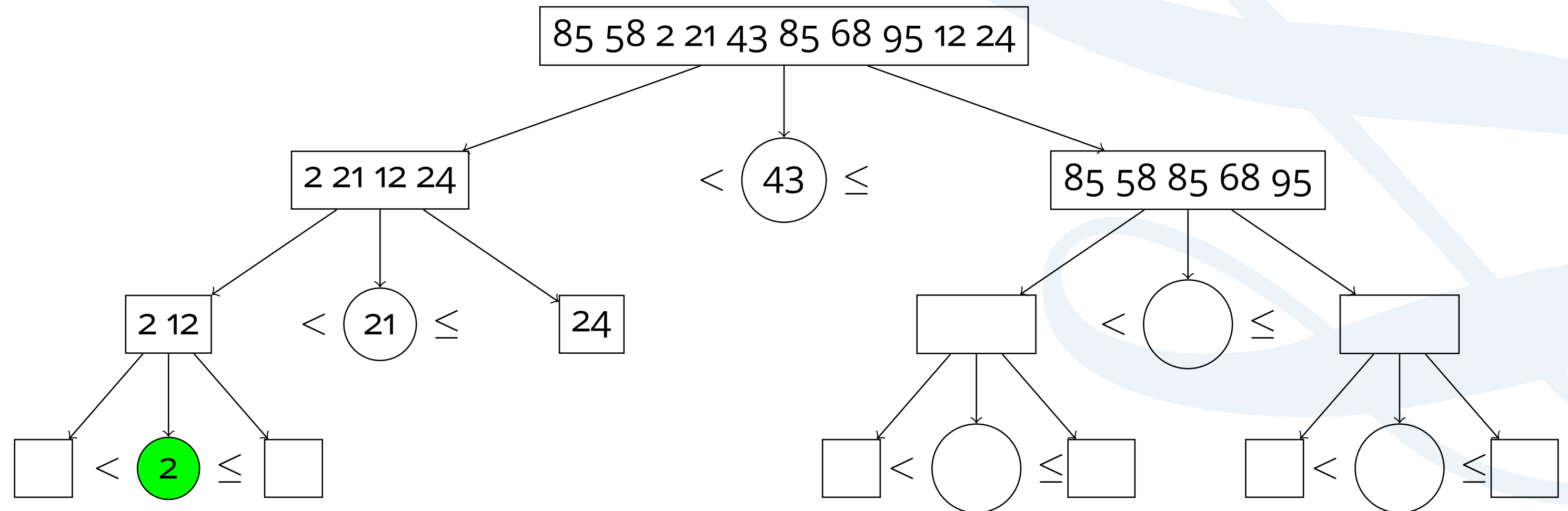
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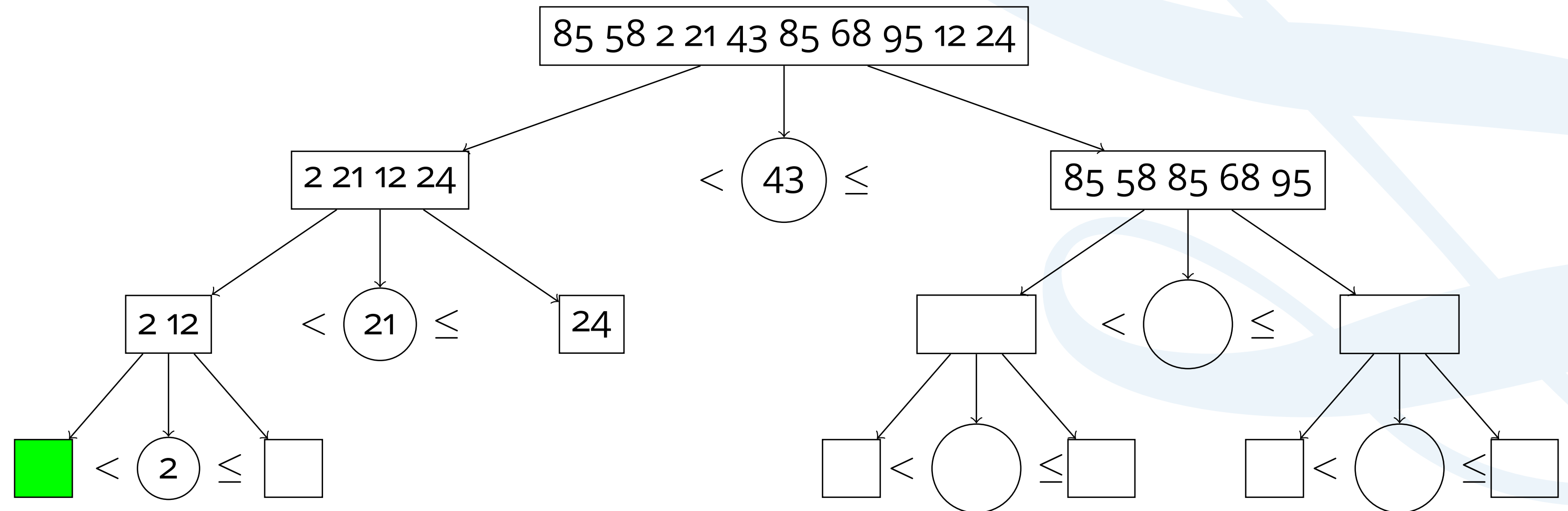
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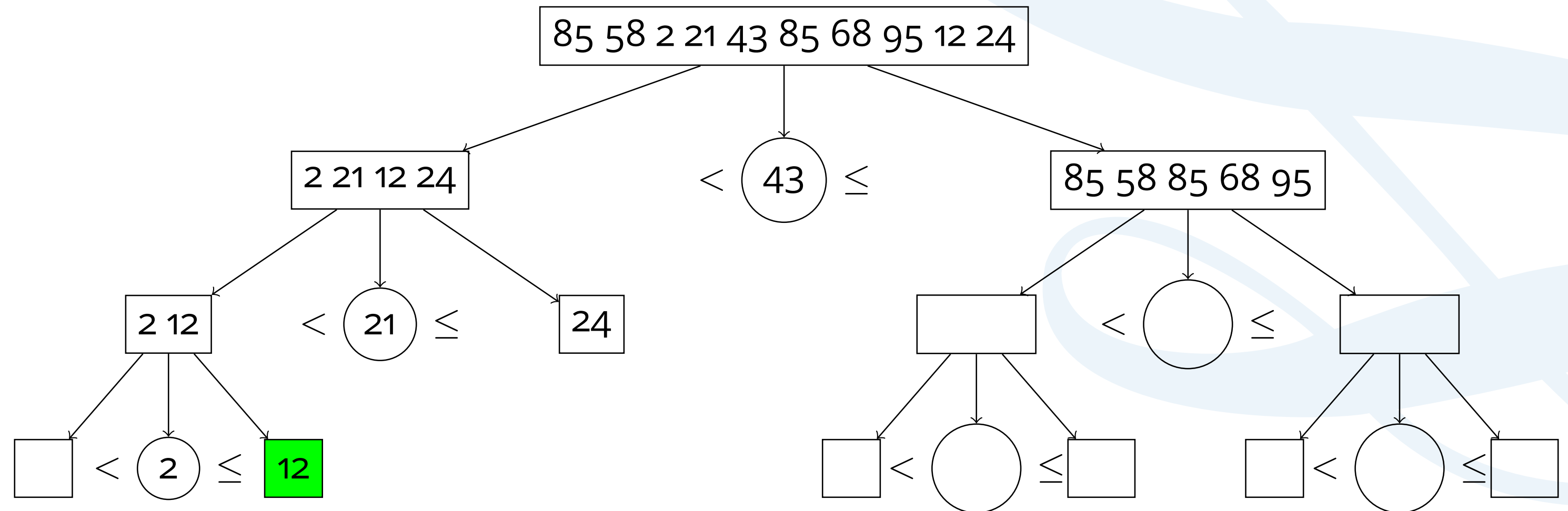
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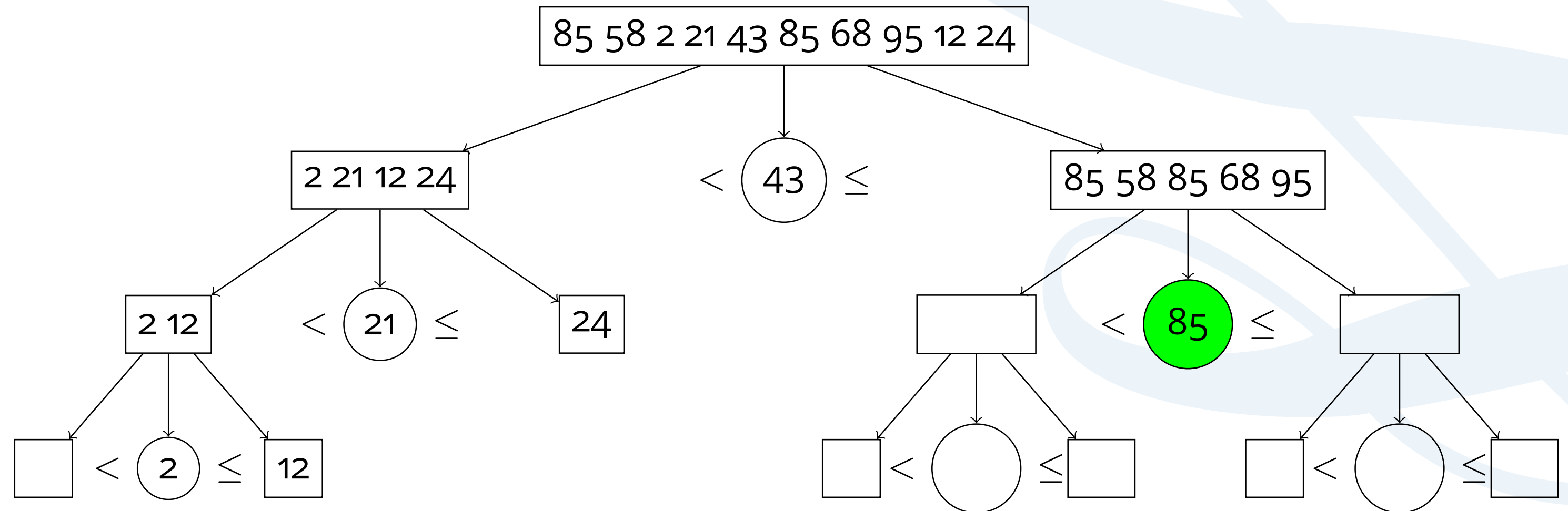
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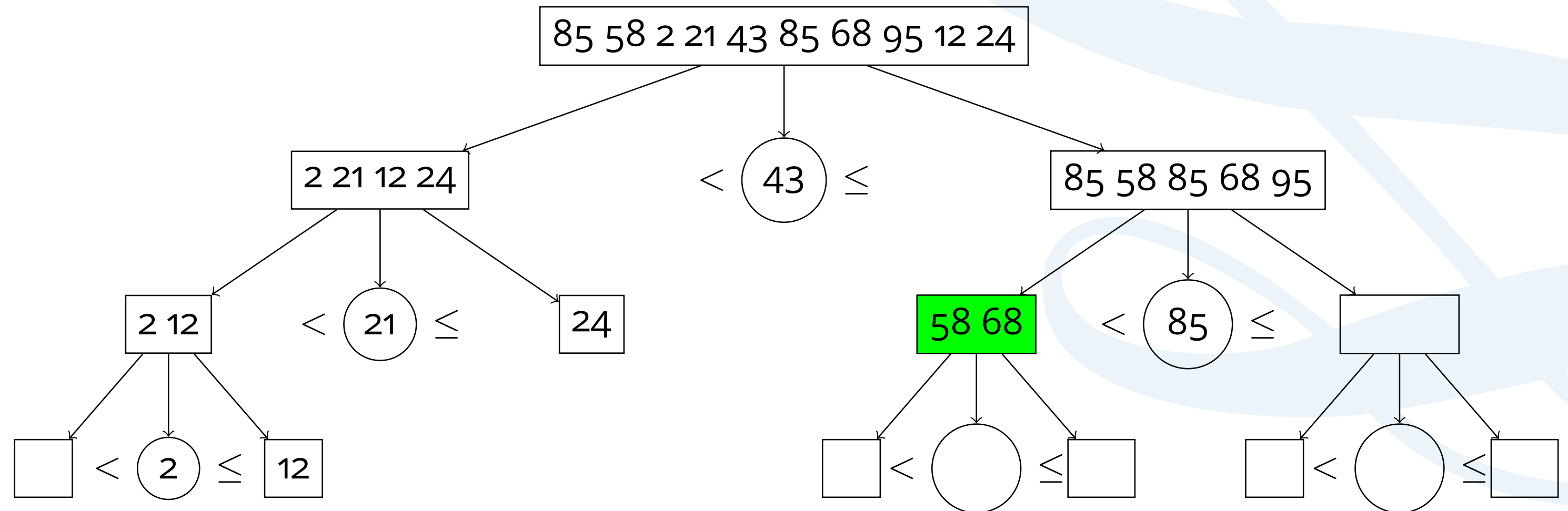
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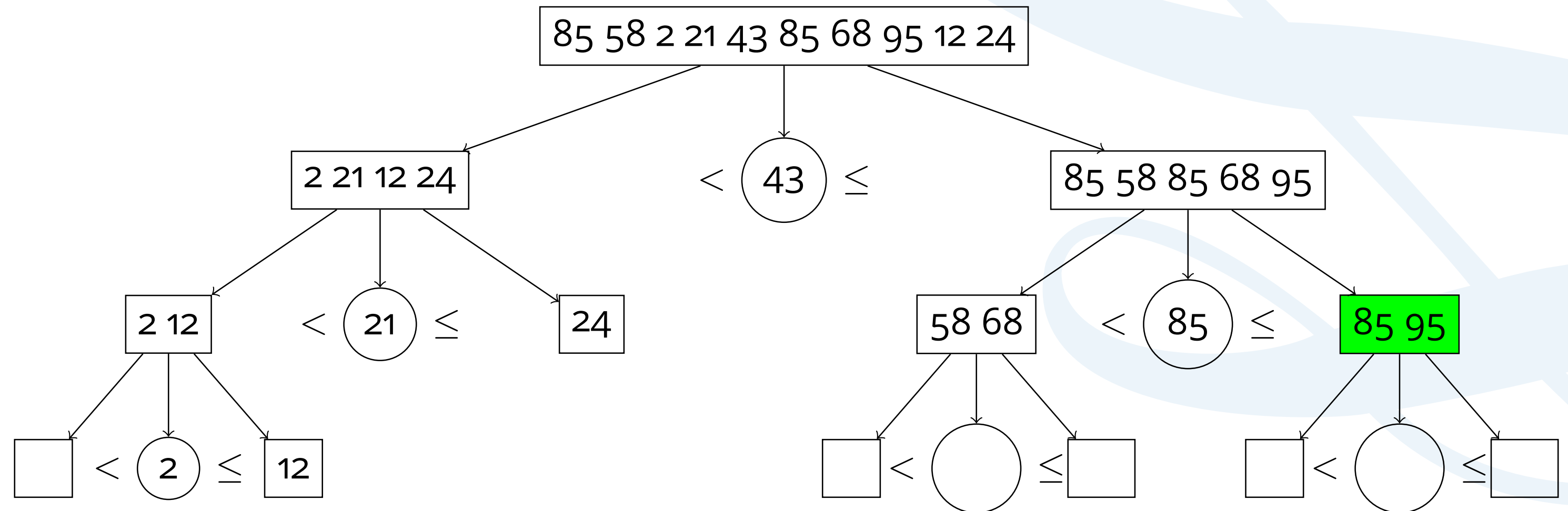
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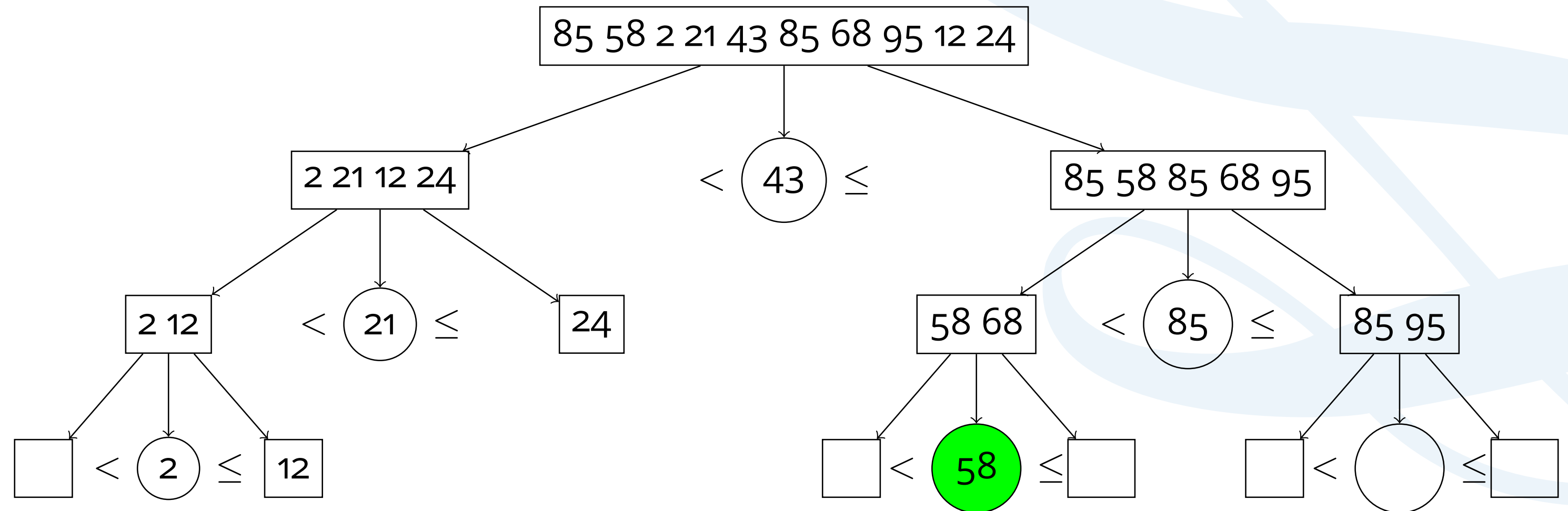
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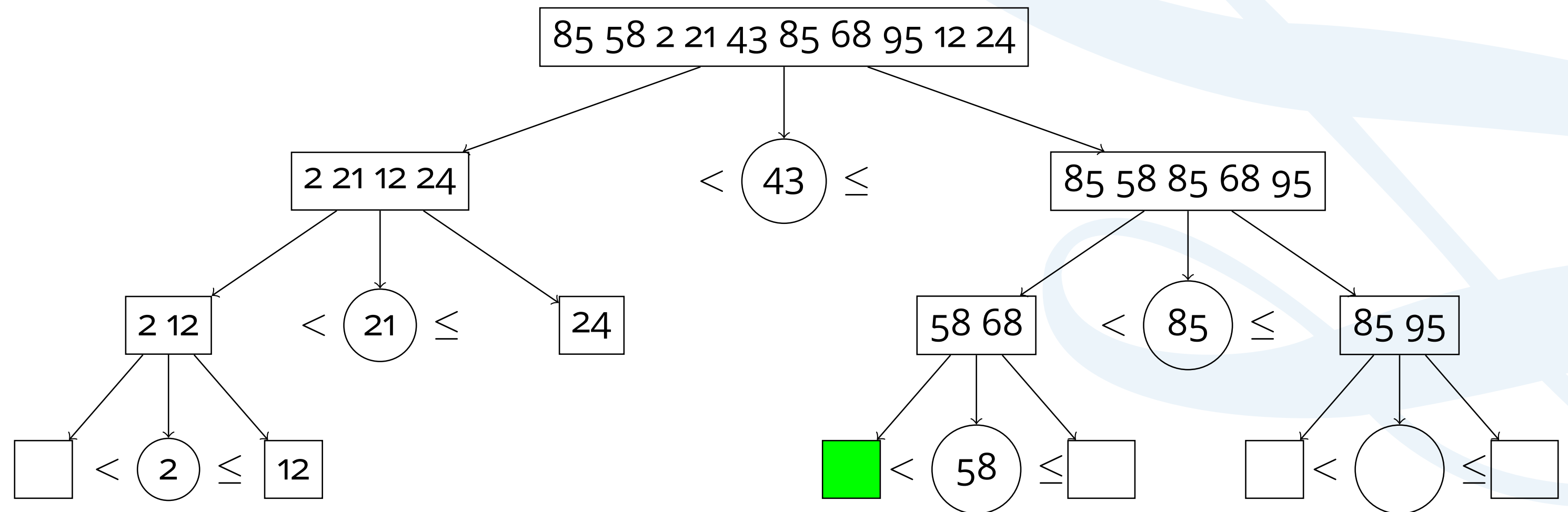
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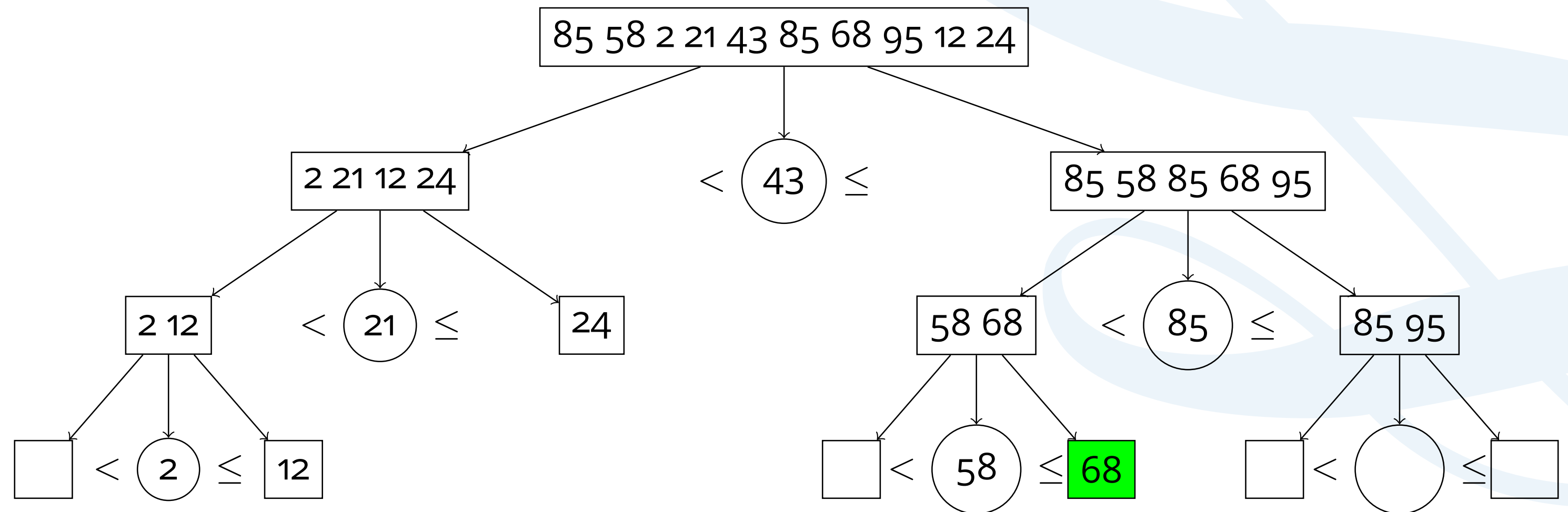
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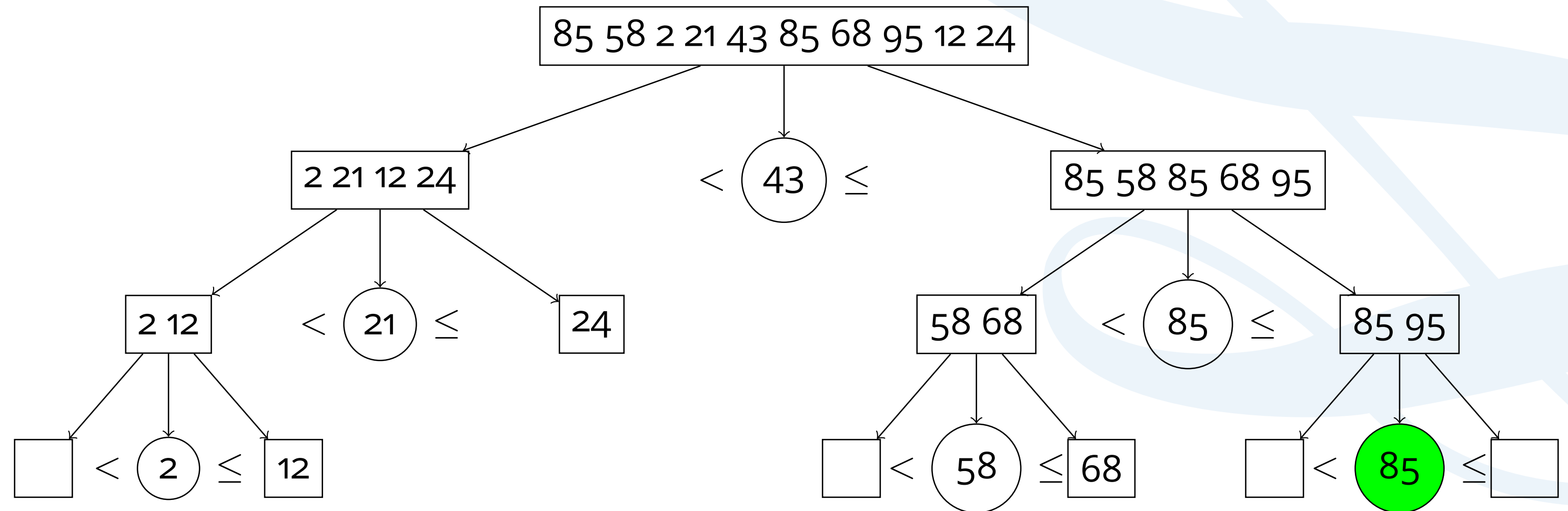
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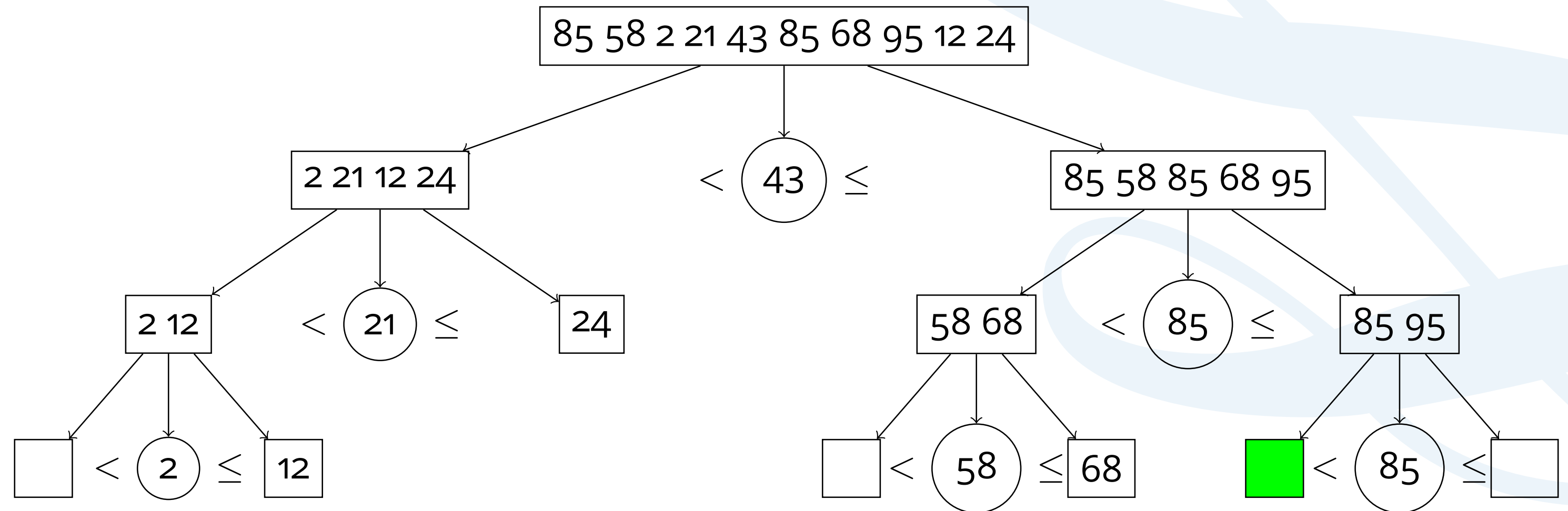
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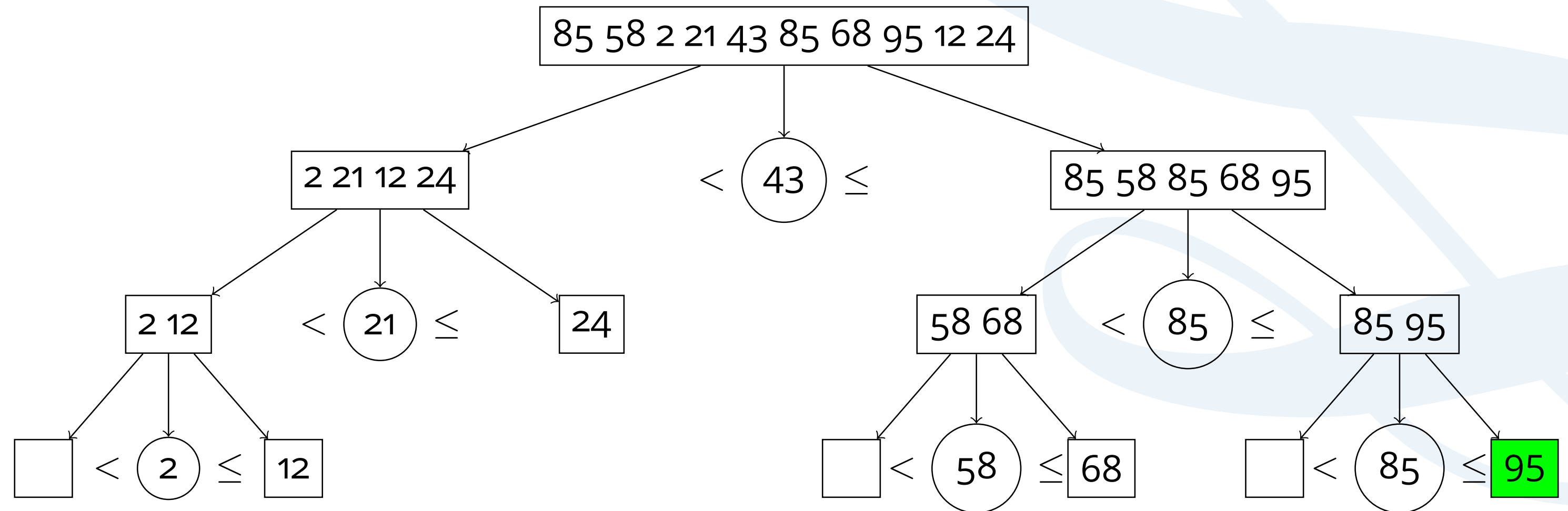
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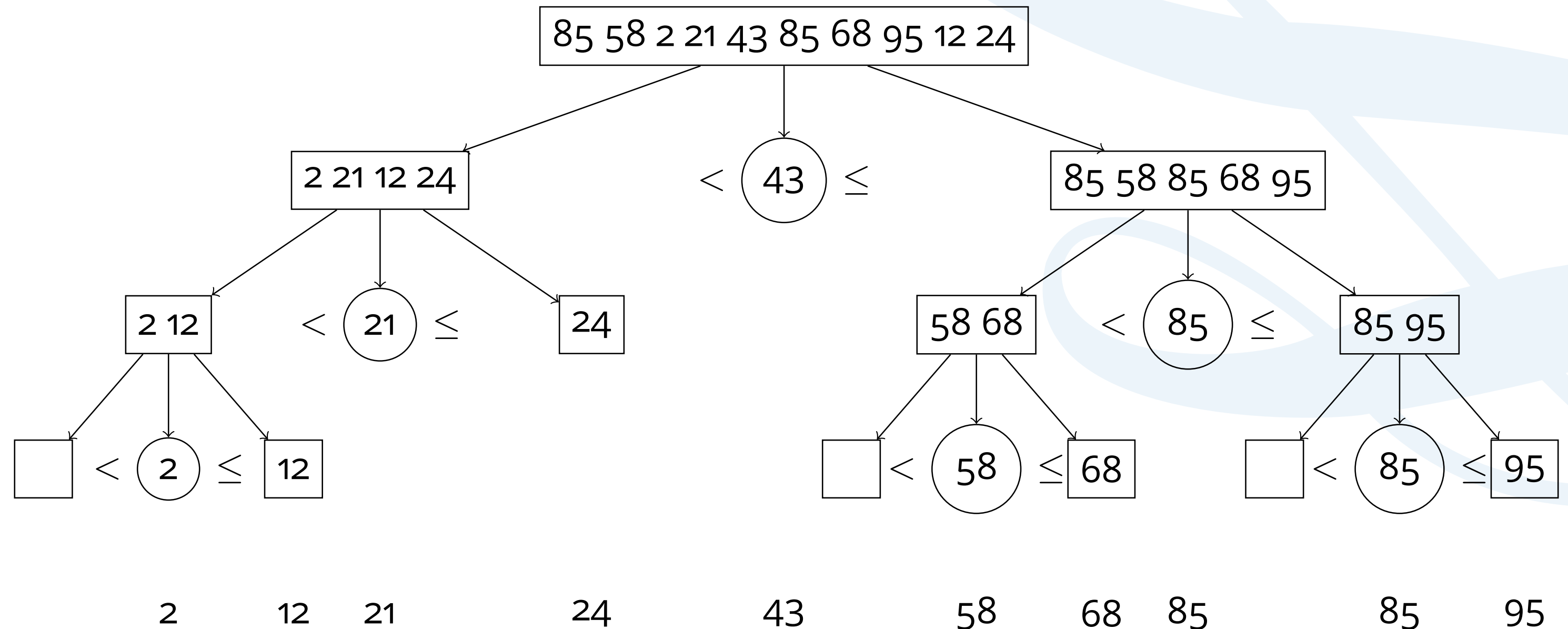
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Quicksort is...

- ...sometimes in-place.
 - Depends on implementation.
- ...sometimes stable.
 - Depends on implementation.

Some issues with the original algorithms (1959).

- Choosing the pivot.
 - First element.
 - Middle element.
 - Average of first, middle and last.
- Repeated elements.
 - Fat partition.

Divide and Conquer

C

Quicksort is a divide and conquer algorithm.

- Too hard to sort the whole sequence?
- Divide the problem.
 - Still too hard?
 - Divide the problem.
 - Still too hard?
 - Divide the problem.
 - Etc, etc, etc.

Naturally suited for parallelism.

Comparing algorithms

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Have seen there are many ways to sort.

- Best sorting algorithm depends on multiple factors.
- Good in one situation is bad in another.

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- What are you sorting?
 - Linked lists?
 - Sequential memory (arrays)?

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 - EEPROM? cheap to read, expensive to write.

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- Size of n .
 - Insertion sort with small n .

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- Stability? In place?
- What are you sorting?
 - Linked lists?
 - Sequential memory (arrays)?
- Where are you sorting?
 - RAM?
 - EEPROM? cheap to read, expensive to write.
- Size of n .
 - Insertion sort with small n .
- Consistent performance.
 - Selection sort.

Comparing algorithms

I

Have seen there are many ways to sort.

- Best sorting algorithm depends on multiple factors.
- Good in one situation is bad in another.
- Stability? In place?
- What are you sorting?
 - Linked lists?
 - Sequential memory (arrays)?
- Where are you sorting?
 - RAM?
 - EEPROM? cheap to read, expensive to write.
- Size of n .
 - Insertion sort with small n .
- Consistent performance.
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Quiz

Recap

- Many sorting algorithms.
- Bubblesort.
- Selection sort.
- Quicksort
- Advantages/disadvantages.
 - In place.
 - In order.
 - Divide and Conquer.
- Performance
 - $O()$
 - Sequence type.
 - Read/writes.
 - Size of n .

The End