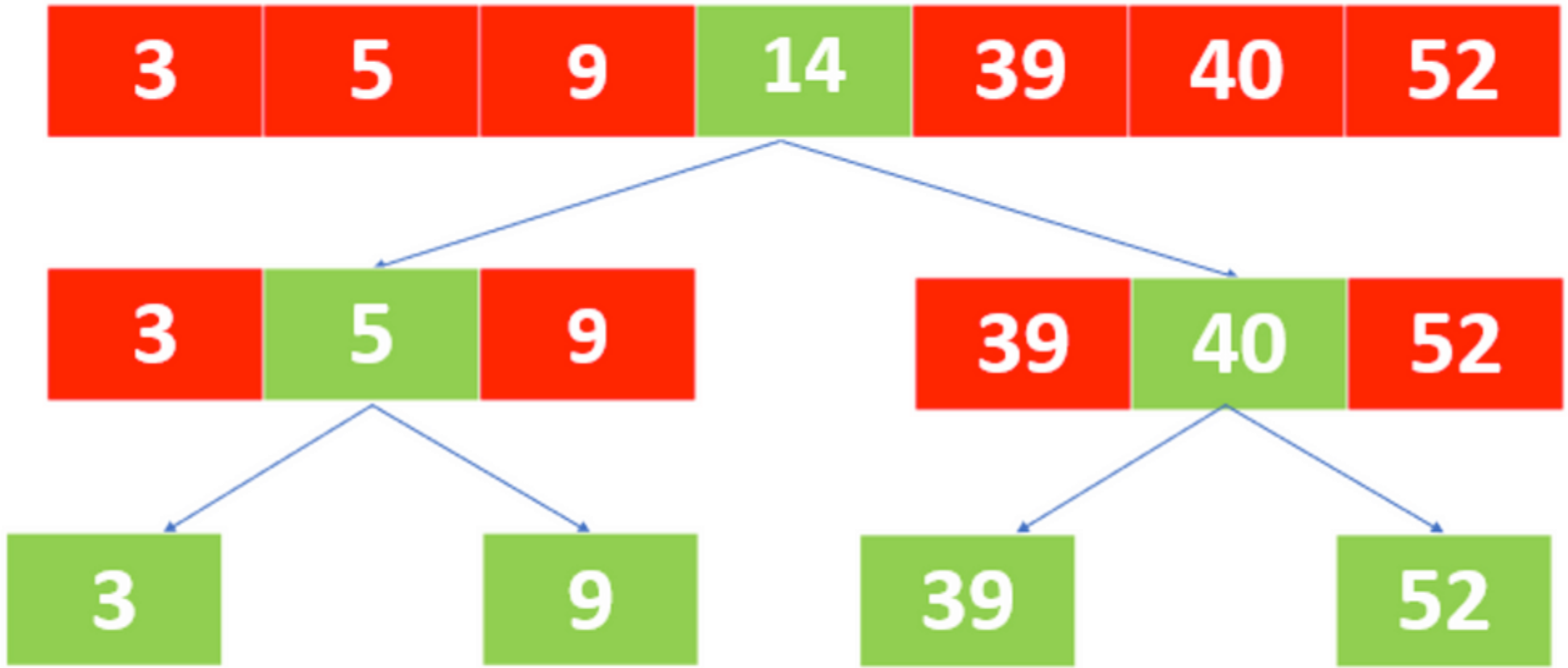
# Binary Search

# 例題：對輸入做二分搜

- 給定一個長度爲 N（N <= 1e5）的陣列，裏面的元素介在 [-1e9, 1e9] 之間，以及 Q 次詢問（Q <= 1e5），每次詢問輸入一個 x，請輸出 x 是否存在在陣列中。

- 每次詢問都掃描一次陣列，複雜度是 O(QN)，顯然會超時。

# Binary Search – Recursion Tree




Green is marked as mid where division of array takes place

# 例題：對答案做二分搜

- 輸入一個數字 x，x 介在 [0, 1e9] 之間，求 x 的三次立方根，輸出與誤差小於 1e-5 內都可以被接受。

- 利用指數和對數運算，需要用到泰勒展開？

# Easy Search Problems

# Distinct Numbers (EXTREMELY EASY)

- You are given a list of n integers, and your task is to calculate the number of *distinct* values in the list.

## Constraints

- $1 \leq n \leq 2 \cdot 10^5$
- $1 \leq x_i \leq 10^9$

- https://cses.fi/problemset/task/1621

# Stick Lengths (EASY)

There are $n$ sticks with some lengths. Your task is to modify the sticks so that each stick has the same length.

You can either lengthen and shorten each stick. Both operations cost $x$ where $x$ is the difference between the new and original length.

What is the minimum total cost?

- https://cses.fi/problemset/task/1074

# Best Meeting Point (EASY)

Given an `m x n` binary grid `grid` where each `1` marks the home of one friend, return *the minimal* ***total travel distance***.

The **total travel distance** is the sum of the distances between the houses of the friends and the meeting point.

The distance is calculated using Manhattan Distance, where `distance(p1, p2) = |p2.x - p1.x| + |p2.y - p1.y|`.

| | | | | |
|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 |

- https://leetcode.com/problems/best-meeting-point

# Missing Coin Sum (MEDIUM)

You have $n$ coins with positive integer values. What is the smallest sum you cannot create using a subset of the coins?

**Input**

The first input line has an integer $n$: the number of coins.

The second line has $n$ integers $x_1, x_2, \ldots, x_n$: the value of each coin.

**Output**

Print one integer: the smallest coin sum.

**Constraints**

- $1 \leq n \leq 2 \cdot 10^5$
- $1 \leq x_i \leq 10^9$

- https://cses.fi/problemset/task/2183

# Split Array Largest Sum (MEDIUM)

Given an integer array `nums` and an integer `k`, split `nums` into `k` non-empty subarrays such that the largest sum of any subarray is **minimized**.

Return *the minimized largest sum of the split*.

A **subarray** is a contiguous part of the array.

**Example 1:**

```
Input: nums = [7,2,5,10,8], k = 2
Output: 18
Explanation: There are four ways to split nums into two subarrays.
The best way is to split it into [7,2,5] and [10,8], where the largest sum among the two subarrays is only 18.
```

- https://leetcode.com/problems/split-array-largest-sum
- 類似題：
  - https://leetcode.com/problems/divide-chocolate
  - https://leetcode.com/problems/maximum-average-subarray-ii (Harder)

# Inversion Pair (MEDIUM)

- 給定一個陣列 a，如果 a[i] > a[j] 且 i < j，則稱 (i, j) 是一組逆序數對，試求陣列 a 有多少組逆序數對。

- https://tioj.ck.tp.edu.tw/problems/1080
- 類似題：
  - https://leetcode.com/problems/reverse-pairs/
  - https://leetcode.com/problems/count-of-smaller-numbers-after-self

# Median of Two Sorted Arrays (HARD)

- 給定兩個排序好的陣列，長度分別是 m 和 n，回傳兩個陣列的中位數，你需要在 O(log(m+n)) 的時間內做到。

- https://leetcode.com/problems/median-of-two-sorted-arrays

# Sorted GCD Pair Queries (Extremely HARD + Rrefix Sum)

- 給定一個陣列 A，求出所有 C(n, 2) 個 pairs 的 GCD，將之排序後行程陣列 B；會有 q 次詢問，每次詢問 B[x]。

- https://leetcode.com/problems/sorted-gcd-pair-queries