Prefix Sum — Complete Explanation

■ What is Prefix Sum?

The Prefix Sum is a technique used to quickly calculate the sum of elements in a range of an array. It precomputes cumulative sums so that any range query can be answered in O(1) time.

■ Example: 5 Days of Profit

Suppose profits = [10, 20, 30, 40, 50]

We want to find total profit from Day 2 to Day 4. Without prefix sum, we sum manually (20+30+40 = 90).

■ Step 1: Build Prefix Sum Array

prefix[i] = sum of all elements from index 0 to i

Example:
prefix = [10, 30, 60, 100, 150]

■ Step 2: Find Range Sum Efficiently

Formula: sum(L, R) = prefix[R] - prefix[L - 1]

Example: Profit from Day 2 to Day 4 (index 1–3):
sum(1,3) = 100 - 10 = 90

■ Java Code Example

```
int[] profits = {10, 20, 30, 40, 50};
int n = profits.length;
int[] prefix = new int[n];

prefix[0] = profits[0];
for (int i = 1; i < n; i++) {
prefix[i] = prefix[i - 1] + profits[i];
}

int L = 1, R = 3;
int total = prefix[R] - (L > 0 ? prefix[L - 1] : 0);
```

System.out.println("Total profit: " + total);

■■ Disadvantages of Prefix Sum

- Works only for static arrays (no updates)
- Only useful for sum queries
- Extra memory for prefix array
- No real-time updates

■ Real-Time Example: YouTube Views Count

Daily views = [100, 200, 150, 300, 250]
Prefix = [100, 300, 450, 750, 1000]
Views from Day 2 to Day 5 = prefix[4] - prefix[0] = 900
YouTube uses prefix sum logic to quickly show total views gained over any period.

■ Top 10 Prefix Sum Problems on LeetCode

1■■ [Range Sum Query - Immutable](https://leetcode.com/problems/range-sum-query-immutable/)
2■■ [Subarray Sum Equals K](https://leetcode.com/problems/subarray-sum-equals-k/)
3■■ [Find Pivot Index](https://leetcode.com/problems/find-pivot-index/)
4■■ [Minimum Value to Get Positive Step by Step Sum](https://leetcode.com/problems/minimum-value-to-get-positive-step-by-step-sum/)
5■■ [Continuous Subarray Sum](https://leetcode.com/problems/continuous-subarray-sum/)
6■■ [Maximum Size Subarray Sum Equals k](https://leetcode.com/problems/maximum-size-subarray-sum-equals-k/)
7■■ [Subarray Sums Divisible by K](https://leetcode.com/problems/subarray-sums-divisible-by-k/)
8■■ [Sum of All Odd Length Subarrays](https://leetcode.com/problems/sum-of-all-odd-length-subarrays/)
9■■ [Product of Array Except Self](https://leetcode.com/problems/product-of-array-except-self/)
■ [Range Sum Query 2D - Immutable](https://leetcode.com/problems/range-sum-query-2d-immutable/)

■ Summary

■ Prefix Sum helps compute range sums in O(1)
■ Best for static data like profits or view counts
■ Used in problems like Kadane’s Algorithm and HashMap Prefix Sums
■ Also extends to 2D Prefix Sums for matrix problems