GDSC: Algorithms & Data Structures: Practice

Vladislav Artiukhov

February 2, 2024

Contents

1. Basic Data Structures

1.1 Queue & Deque

Problem. **Maximum of Sliding Window**

Given an array of integers a, there is a sliding window of size k which is moving from the very left of the array to the very right. You can only see the k numbers in the window. Each time the sliding window moves right by one position.

Return the array that contains maximum elements of each position of the sliding window.

Time complexity: $O(n)$.

Space complexity: $O(k)$.

Note: you can solve it on LeetCode

Example 1:

Input: nums = [1,3,-1,-3,5,3,6,7], k = 3
Output: [3,3,5,5,6,7]
Explanation:

Window position	Max
[1 3 -1] -3 5 3 6 7	3
1 [3 -1 -3] 5 3 6 7	3
1 3 [-1 -3 5] 3 6 7	5
1 3 -1 [-3 5 3] 6 7	5
1 3 -1 -3 [5 3 6] 7	6
1 3 -1 -3 5 [3 6 7]	7

Example 2:

Input: nums = [1], k = 1
Output: [1]

Solution.

Problem. **Max Value of Equation**

Given an array p of size $n \leq 10^5$ containing the coordinates of points on a 2D plane, sorted by the x-values, i.e. $\{x_i\}$ form a strictly increasing sequence ($x_i < x_j,\ i < j$), where $p_i = (x_i, y_i)$ ($-10^8 \leq x_i, y_i \leq 10^8$). You are also given an integer $k \leq 2 \cdot 10^8$.

Return the **maximum value of the equation** $y_i + y_j + |x_i - x_j|$ where $|x_i - x_j| \leq k$ and $0 \leq i < j < n$.

It is guaranteed that there exists at least one pair of points that satisfy the constraint $|x_i - x_j| \leq k$.

Time complexity: $O(n)$ or $O(n \cdot \log n)$.

Space complexity: $O(k)$.

Note: you can solve it on LeetCode

Example 1:

Input: points = [[1,3],[2,0],[5,10],[6,-10]], k = 1
Output: 4
Explanation: The first two points satisfy the condition |x_i - x_j| <= 1 and if we calculate the equation we get 3 + 0 + |1 - 2| = 4. Third and fourth points also satisfy the condition and give a value of 10 + -10 + |5 - 6| = 1.
No other pairs satisfy the condition, so we return the max of 4 and 1.

Example 2:

> **Input:** points = [[0,0],[3,0],[9,2]], k = 3
> **Output:** 3
> **Explanation:** Only the first two points have an absolute difference of 3 or less in the x-values, and give the value of 0 + 0 + |0 - 3| = 3.

Solution.