CCO '23 P2 - Real Mountains

Time limit: 5.0s **Memory limit:** 1G

Canadian Computing Olympiad: 2023 Day 1, Problem 2

Thanks to your help with cropping her picture, Rebecca's scenic photo is now featured on the front cover of the newest issue of her magazine. However, it seems that some of her readers still aren't pleased with the picture. In particular, they seem to believe that the mountain in the picture is fake!

For simplicity, we can describe the picture as a sequence of N columns of pixels. In the i-th column, the first h_i pixels from the bottom are of mountains. Her readers will only believe that the picture contains a real mountain if it contains a single (possibly wide) peak. That is, if there exists some index p with $1 \leq p \leq N$ such that $h_1 \leq h_2 \leq \ldots \leq h_p \geq \ldots \geq h_{N-1} \geq h_N$.

Luckily, Rebecca can still pay her editors to modify the picture and reprint the magazine. Unfortunately for her though, the editors have a very peculiar pricing scheme for their work. The only way Rebecca can edit the picture is by sending emails to her editors containing the integers (i, j, k) such that $1 \leq i < j < k \leq N$ and $h_i > h_j < h_k$. The editors will then add an extra pixel of mountains in the j-th column (i.e. increment h_j by 1) for a cost of $h_i + h_j + h_k$ cents. Note that the change in h_j may affect the costs of future edits.

To please her readers, Rebecca would like to edit the picture so that they believe it contains a real mountain. Can you tell her the minimum cost required to do so?

Input Specification

The first line of input contains an integer N.

The second line of input contains N space-separated integers $h_1, h_2, \ldots, h_N$.

Marks Awarded	Bounds on N	Bounds and constraints on h_i
3 marks	$3 \leq N \leq 5\,000$	$1 \leq h_i \leq 100$; $h_1 \geq h_2 \geq \ldots \geq h_p \leq \ldots \leq h_{N-1} \leq h_N$ for some $p, 1 \leq p \leq N$
3 marks	$3 \leq N \leq 5\,000$	$1 \leq h_i \leq 100$
3 marks	$3 \leq N \leq 5\,000$	$1 \leq h_i \leq 10^6$
3 marks	$3 \leq N \leq 5\,000$	$1 \leq h_i \leq 10^9$
4 marks	$3 \leq N \leq 10^6$	$1 \leq h_i \leq 100$
5 marks	$3 \leq N \leq 10^6$	$1 \leq h_i \leq 10^6$
4 marks	$3 \leq N \leq 10^6$	$1 \leq h_i \leq 10^9$

Output Specification

Output the remainder of T divided by the prime number $10^6 + 3$ where T is the minimum cost (in cents) that Rebecca would need to incur in order to please her readers.

Sample Input

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8
3 2 4 5 4 1 2 1
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Output for Sample Input

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14
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Explanation for Output for Sample Input

Rebecca can send two emails, the first containing the integers $(2, 6, 7)$ and the second containing the integers $(1, 2, 5)$. The first email costs 5 cents and increases h_6 by 1, while the second email costs 9 cents and increases h_2 by 1.

The h_i values in the final picture will be $[3, 3, 4, 5, 4, 2, 2, 1]$. Her readers will believe this final picture contains a real mountain.