

## Problem Title: Dynamic Median Finder

### Story Background

In the prosperous kingdom of Mediania, the royal treasurer faces an ever-growing list of treasure values coming in from all corners of the realm. To ensure fairness in the upcoming auctions and to maintain balance in the kingdom's accounts, the treasurer devised a wondrous machine. This magical machine can quickly insert new treasure values, instantly report the “middle” (or median) value of the collection, and even remove the median when a treasure is auctioned off—all while working fast enough to handle millions of transactions a day!

Your mission is to help the treasurer design this machine's core data structure. The machine must be able to:

- Insert a new value in logarithmic time.
- Find (or query) the current median in constant time.
- Remove the median in logarithmic time.

**Important Note: No build it heaps, PQ are to be used. Please use your PQ or Heaps to solve the problem.**

In Mediania the median is defined as the middle element when all values are arranged in sorted order. When there is an even number of treasures, the “median” is taken to be the lower of the two middle numbers.

### Problem Description

You are given a sequence of operations on an initially empty data structure. There are three kinds of operations:

- I x — Insert the integer (x) into the data structure.
- M — Output the current median of the data structure.
- R — Remove the current median from the data structure and output its value.

If an operation M or R is issued when the data structure is empty, print "Invalid" (without quotes).

Your solution must guarantee that each I and R operation works in  $O(\log n)$  time and each M operation works in  $O(1)$  time.

### Input Format

- For each test case:
  - The first line contains an integer (Q) ( $1 < Q < 10^5$ ), the number of operations.
  - Each of the next (Q) lines contains one operation, which is one of:
    - I x where (x) is an integer satisfying  $|x| < 10^9$
    - M where you need to print the current median so far
    - R remove the element and display on console

## Output Format

For each test case, for every operation M or R, print the median (or the removed median) on a new line. If the data structure is empty when an M or R operation is called, output "Invalid".

## Constraints

- $(1 < Q < 10^5)$  per test case
- $(|x| < 10^9)$
- Your solution must use an algorithm with:
  - Insertion in  $(O(\log n))$
  - Median query in  $(O(1))$
  - Median removal in  $(O(\log n))$