

IOI Training Camp 2011 – Test 5, 15 June, 2011

Problem 2 Move to Front [RunC]

A *dynamically ordered set* is one whose elements are linearly ordered, but whose order can change. Let U be a dynamically ordered set of N elements $\{0, 1, 2, \dots, N-1\}$, containing a dynamic subset $S \subseteq U$. We wish to support the following operations on U and S :

- **INSERT**(x), where $x \in U \setminus S$. This transforms S to $S \cup \{x\}$.
- **DELETE**(x), where $x \in S$. This transforms S to $S \setminus \{x\}$.
- **MOVETOFRONT**(x), where $x \in U$. This makes x the smallest element of U in the linear order, while leaving all other elements in the same relative order that they were earlier.
- **MINIMUM**(): Return the minimum element of S according to the current linear order of U .

Devise an efficient data structure to support these operations. Your implementation should be called `front.cpp` and should include code for the following functions.

- **void Init(int N)** : Called exactly once, before all other calls, and provides the value N . Initially, $U = \{0, 1, 2, \dots, N-1\}$ with the order $0 < 1 < \dots < N-1$ and $S = \emptyset$.
- **void Insert(int x)** : Inserts x into S , where x is guaranteed to currently be outside S .
- **void Delete(int x)** : Removes x from S , where x is guaranteed to currently belong to S .
- **void MoveToFront(int x)** : Makes x the new minimum element in U as described above.
- **int Min()** : Returns the minimum value in S according to the current linear order of U . When **Min()** is called, S is guaranteed to be nonempty.

Limits

In all subtasks, $1 \leq N \leq 100000$.

Subtask 1 [20 points]

$1 \leq N \leq 1000$. The total number of calls to **Insert**, **Delete**, **MoveToFront** and **Min** will be between 0 and 4000, inclusive.

Subtask 2 [80 points]

$1 \leq N \leq 10^5$. The total number of calls to **Insert**, **Delete**, **MoveToFront** and **Min** will be between 0 and 4×10^5 , inclusive.

Time and memory limits

The time limit for this task is 2 seconds. The memory limit is 64MB.