716. Max Stack

Easy 1237 346 Add to List Share

Design a max stack data structure that supports the stack operations and supports finding the stack's maximum element.

Implement the `MaxStack` class:

- `MaxStack()` Initializes the stack object.
- `void push(int x)` Pushes element `x` onto the stack.
- `int pop()` Removes the element on top of the stack and returns it.
- `int top()` Gets the element on the top of the stack without removing it.
- `int peekMax()` Retrieves the maximum element in the stack without removing it.
- `int popMax()` Retrieves the maximum element in the stack and removes it. If there is more than one maximum element, only remove the **top-most** one.

Example 1:

```
Input
["MaxStack", "push", "push", "push", "top", "popMax", "top", "peekMax", "pop", "top"]
[[], [5], [1], [5], [], [], [], [], [], []]
Output
[null, null, null, null, 5, 5, 1, 5, 1, 5]

Explanation
MaxStack stk = new MaxStack();
stk.push(5);   // [5] the top of the stack and the maximum number is 5.
stk.push(1);   // [5, 1] the top of the stack is 1, but the maximum is 5.
stk.push(5);   // [5, 1, 5] the top of the stack is 5, which is also the maximum, because it is the top most one.
stk.top();     // return 5, [5, 1, 5] the stack did not change.
stk.popMax();  // return 5, [5, 1] the stack is changed now, and the top is different from the max.
stk.top();     // return 1, [5, 1] the stack did not change.
stk.peekMax(); // return 5, [5, 1] the stack did not change.
stk.pop();     // return 1, [5] the top of the stack and the max element is now 5.
stk.top();     // return 5, [5] the stack did not change.
```

Constraints:

- $-10^7 <= x <= 10^7$
- At most 10^4 calls will be made to `push`, `pop`, `top`, `peekMax`, and `popMax`.
- There will be **at least one element** in the stack when `pop`, `top`, `peekMax`, or `popMax` is called.

Follow up: Could you come up with a solution that supports `O(1)` for each `top` call and `O(logn)` for each other call?

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```java
class MaxStack {
    TreeMap<Integer, List<Node>> map;
    DoubleLinkedList dll;

    public MaxStack() {
        map = new TreeMap();
        dll = new DoubleLinkedList();
    }

    public void push(int x) {
        Node node = dll.add(x);
        if(!map.containsKey(x))
            map.put(x, new ArrayList<Node>());
        map.get(x).add(node);
    }

    public int pop() {
        int val = dll.pop();
        List<Node> L = map.get(val);
        L.remove(L.size() - 1);
        if (L.isEmpty()) map.remove(val);
        return val;
    }

    public int top() {
        return dll.peek();
    }

    public int peekMax() {
        return map.lastKey();
    }

    public int popMax() {
        int max = peekMax();
        List<Node> L = map.get(max);
        Node node = L.remove(L.size() - 1);
        dll.unlink(node);
        if (L.isEmpty()) map.remove(max);
        return max;
    }
}

class DoubleLinkedList {
    Node head, tail;

    public DoubleLinkedList() {
        head = new Node(0);
        tail = new Node(0);
        head.next = tail;
        tail.prev = head;
    }

    public Node add(int val) {
        Node x = new Node(val);
        x.next = tail;
        x.prev = tail.prev;
        tail.prev = tail.prev.next = x;
```