数据结构设计类问题

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最小栈

https://www.lintcode.com/problem/min-stack/

设计一个栈，支持 O(1) push, pop, min

和堆的区别是啥?

代码


```java
public class MinStack {
    Stack<Integer> stack, minStack;

    public MinStack() {
        stack = new Stack<Integer>();
        minStack = new Stack<Integer>();
    }

    public void push(int number) {
        stack.push(number);
        if (minStack.empty() || number < minStack.peek()) {
            minStack.push(number);
        } else {
            minStack.push(minStack.peek());
        }
    }

    public int pop() {
        minStack.pop();
        return stack.pop();
    }

    public int min() {
        return minStack.peek();
    }
}
```

```python
class MinStack:

    def __init__(self):
        self.stack = []
        self.min_stack = []

    def push(self, number):
        self.stack.append(number)
        if self.min_stack and number > self.min_stack[-1]:
            self.min_stack.append(self.min_stack[-1])
        else:
            self.min_stack.append(number)

    def pop(self):
        self.min_stack.pop()
        return self.stack.pop()

    def min(self):
        return self.min_stack[-1]
```

有什么可以优化的地方么？

空间方面

```java
public class MinStack {
    Stack<Integer> stack, minStack;

    public MinStack() {
        stack = new Stack<Integer>();
        minStack = new Stack<Integer>();
    }

    public void push(int number) {
        stack.push(number);
        if (minStack.empty() || number <= minStack.peek()) {
            minStack.push(number);
        }
    }

    public int pop() {
        int number = stack.pop();
        if (number == minStack.peek()) {
            minStack.pop();
        }
        return number;
    }

    public int min() {
        return minStack.peek();
    }
}
```

```python
class MinStack:

    def __init__(self):
        self.stack = []
        self.min_stack = []

    def push(self, number):
        self.stack.append(number)
        if not self.min_stack or self.min_stack[-1] >= number:
            self.min_stack.append(number)

    def pop(self):
        number = self.stack.pop()
        if number == self.min_stack[-1]:
            self.min_stack.pop()
        return number

    def min(self):
        return self.min_stack[-1]
```

最大栈

https://www.lintcode.com/problem/max-stack/

实现 push, pop, top, peekMax, popMax

Java 代码


```java
class MaxStack {
    Stack<Integer> stack;
    Stack<Integer> maxStack;

    public MaxStack() {
        stack = new Stack();
        maxStack = new Stack();
    }

    public void push(int x) {
        int max = maxStack.isEmpty() ? x : maxStack.peek();
        maxStack.push(max > x ? max : x);
        stack.push(x);
    }

    public int pop() {
        maxStack.pop();
        return stack.pop();
    }
```

```java
    public int top() {
        return stack.peek();
    }

    public int peekMax() {
        return maxStack.peek();
    }

    public int popMax() {
        int max = peekMax();
        Stack<Integer> buffer = new Stack();
        while (top() != max) {
            buffer.push(pop());
        }
        pop();
        while (!buffer.isEmpty()) {
            push(buffer.pop());
        }
        return max;
    }
}
```

Python 代码


```python
class MaxStack:

    def __init__(self):
        self.stack = []
        self.max_stack = []

    def push(self, x):
        self.stack.append(x)
        if self.max_stack:
            number = max(self.max_stack[-1], x)
            self.max_stack.append(number)
        else:
            self.max_stack.append(x)

    def pop(self):
        self.max_stack.pop()
        return self.stack.pop()
```

```python
def top(self):
    return self.stack[-1]

def peekMax(self):
    return self.max_stack[-1]

def popMax(self):
    max_number = self.peekMax()
    buffer_stack = []
    while self.top() != max_number:
        buffer_stack.append(self.pop())
    self.pop()
    while buffer_stack:
        self.push(buffer_stack[-1])
        buffer_stack.pop()
    return max_number
```

一个更快的办法

使用 heap + stack + hashset 结合的办法

用 hashset 的作用是标记被 pop 和 popMax 的那些数

用 heap 的作用是为了快速找到大的数

用 stack 的作用是为了找到位置上最大的数

如何处理重复的数?

Python 代码


```python
import heapq

class MaxStack:

    def __init__(self):
        self.heap = []
        self.stack = []
        self.popped_set = set()
        self.count = 0

    def push(self, x):
        item = (-x, -self.count)
        self.stack.append(item)
        heapq.heappush(self.heap, item)
        self.count += 1

    def _clear_popped_in_stack(self):
        while self.stack and self.stack[-1] in self.popped_set:
            self.popped_set.remove(self.stack[-1])
            self.stack.pop()

    def _clear_popped_in_heap(self):
        while self.heap and self.heap[0] in self.popped_set:
            self.popped_set.remove(self.heap[0])
            heapq.heappop(self.heap)
```

```python
def pop(self):
    self._clear_popped_in_stack()
    item = self.stack.pop()
    self.popped_set.add(item)
    return -item[0]

def top(self):
    self._clear_popped_in_stack()
    item = self.stack[-1]
    return -item[0]

def peekMax(self):
    self._clear_popped_in_heap()
    item = self.heap[0]
    return -item[0]

def popMax(self):
    self._clear_popped_in_heap()
    item = heapq.heappop(self.heap)
    self.popped_set.add(item)
    return -item[0]
```

Java 代码


```java
class Item implements Comparable<Item> {
    public int val, id;

    public Item(int val, int id) {
        this.val = val;
        this.id = id;
    }

    public int compareTo(Item another) {
        if (this.val != another.val) {
            return another.val - this.val;
        }
        return another.id - this.id;
    }
}

class MaxStack {
    private Queue<Item> heap;
    private Stack<Item> stack;
    private HashSet<Item> poppedSet;
    private int globalId;

    public MaxStack() {
        this.globalId = 0;
        this.heap  = new PriorityQueue<>();
        this.stack = new Stack<>();
        this.poppedSet = new HashSet<>();
    }
```

```java
public void push(int x) {
    Item item = new Item(x, globalId);
    stack.push(item);
    heap.offer(item);
    globalId++;
}

private void clearPoppedInStack() {
    while (!stack.isEmpty() && poppedSet.contains(stack.peek())) {
        Item item = stack.pop();
        poppedSet.remove(item);
    }
}

private void clearPoppedInHeap() {
    while (!heap.isEmpty() && poppedSet.contains(heap.peek())) {
        Item item = heap.poll();
        poppedSet.remove(item);
    }
}
```

```java
public int pop() {
    clearPoppedInStack();
    Item item = stack.pop();
    poppedSet.add(item);
    return item.val;
}

public int top() {
    clearPoppedInStack();
    Item item = stack.peek();
    return item.val;
}

public int peekMax() {
    clearPoppedInHeap();
    Item item = heap.peek();
    return item.val;
}

public int popMax() {
    clearPoppedInHeap();
    Item item = heap.poll();
    poppedSet.add(item);
    return item.val;
}
```

时间复杂度是多少?

数据结构设计类问题需要分别说明不同函数的时间复杂度

时间复杂度分析

因为每个数只进入 stack/heap/hashset 各一次。所以平均下来，时间复杂度是：

- push O(logN)
- pop O(1)
- top O(1)
- popMax O(logN)
- peekMax O(logN)

两个栈实现队列

https://www.lintcode.com/problem/implement-queue-by-two-stacks/

除了栈以外不能使用其他数据结构

代码


```java
public class MyQueue {
    private Stack<Integer> stack1;
    private Stack<Integer> stack2;

    public MyQueue() {
       stack1 = new Stack<Integer>();
       stack2 = new Stack<Integer>();
    }

    private void stack2ToStack1(){
        while(! stack2.isEmpty()){
            stack1.push(stack2.pop());
        }
    }

    public void push(int element) {
        stack2.push(element);
    }

    public int pop() {
        if(stack1.empty() == true){
            this.stack2ToStack1();
        }
        return stack1.pop();
    }

    public int top() {
        if(stack1.empty() == true){
            this.stack2ToStack1();
        }
        return stack1.peek();
    }
}
```

```python
class MyQueue:

    def __init__(self):
        self.stack1 = []
        self.stack2 = []

    def stack1_to_stack2(self):
        # 如果 stack2 非空的话，不把 stack1 倒过去
        if self.stack2:
            return
        while self.stack1:
            self.stack2.append(self.stack1.pop())

    def push(self, element):
        self.stack1.append(element)

    def top(self):
        self.stack1_to_stack2()
        return self.stack2[-1]

    def pop(self):
        self.stack1_to_stack2()
        return self.stack2.pop()
```

时间复杂度是多少?

数据结构设计类问题需要分别说明不同函数的时间复杂度

两个队列实现栈

https://www.lintcode.com/problem/implement-stack-by-two-queues/

只能使用队列，不能使用其他数据结构

Java 代码


```java
public class Stack {
    private Queue<Integer> queue1;
    private Queue<Integer> queue2;

    public Stack() {
        queue1 = new LinkedList<Integer>();
        queue2 = new LinkedList<Integer>();
    }

    private void moveItems() {
        while (queue1.size() != 1) {
            queue2.offer(queue1.poll());
        }
    }

    private void swapQueues() {
        Queue<Integer> temp = queue1;
        queue1 = queue2;
        queue2 = temp;
    }

    /**
     * push a new item into the stack
     */
    public void push(int value) {
        queue1.offer(value);
    }
```

```java
    /**
     * return the top of the stack
     */
    public int top() {
        int item = pop();
        queue1.offer(item);
        return item;
    }

    /**
     * pop the top of the stack and return it
     */
    public int pop() {
        moveItems();
        int item = queue1.poll();
        swapQueues();
        return item;
    }

    /**
     * check the stack is empty or not.
     */
    public boolean isEmpty() {
        return queue1.isEmpty();
    }
}
```

Python 代码


```python
class Stack:

    def __init__(self):
        self.queue1 = deque()
        self.queue2 = deque()

    """
    @param: x: An integer
    @return: nothing
    """
    def push(self, x):
        self.queue1.append(x)

    """
    @return: nothing
    """
    def pop(self):
        for _ in range(len(self.queue1) - 1):
            val = self.queue1.popleft()
            self.queue2.append(val)

        val = self.queue1.popleft()
        self.queue1, self.queue2 = self.queue2, self.queue1
        return val
```

```python
    """
    @return: An integer
    """
    def top(self):
        val = self.pop()
        self.push(val)
        return val

    """
    @return: True if the stack is empty
    """
    def isEmpty(self):
        return not self.queue1
```

时间复杂度是多少?

数据结构设计类问题需要分别说明不同函数的时间复杂度