

## Introduction to Algorithms Exercise 2

### Input:

The first input  $t$  denotes that there are  $t$  tasks in the following inputs.

For each task, the first two inputs  $op$ ,  $n$  denote that this task is either inserting elements ( $op = 1$ ) or deleting elements ( $op = 2$ ), and the number of the following elements is  $n$ .

The next  $n$  inputs are the elements to be operated.

### Output:

Display the tree using **inorder traversal**.

Please output (1) the value, (2) the parent node, and (3) the color of each node.

P.S.

(1) **Do not output NIL.**

(2) **The parent of root is empty.**

(3) TAs will not specify the spaces of outputs, but the order should be right.

### 1. Insert node:

#### Example input:

2 (number of tasks)

1 8 (insert, 8 elements)

5 11 9 7 6 12 4 1

1 2 (insert, 2 elements)

2 3

#### Example output:

Insert: 5, 11, 9, 7, 6, 12, 4, 1

key: 1 parent: 4 color: red

key: 4 parent: 6 color: black

key: 5 parent: 4 color: red

key: 6 parent: 9 color: red

key: 7 parent: 6 color: black

key: 9 parent:     color: black

key: 11 parent: 9 color: black

key: 12 parent: 11 color: red

Insert: 2, 3

key: 1 parent: 2 color: red

key: 2 parent: 4 color: black

key: 3 parent: 2 color: red

key: 4 parent: 6 color: red  
key: 5 parent: 4 color: black  
key: 6 parent:     color: black  
key: 7 parent: 9 color: black  
key: 9 parent: 6 color: red  
key: 11 parent: 9 color: black  
key: 12 parent: 11 color: red

## **2. Delete node:**

### **Example input:**

2 (number of tasks)  
1 8 (insert, 9 elements)  
5 11 9 7 6 12 4 1  
2 2 (delete, 2 elements)  
11 5

### **Example output:**

Insert: 5, 11, 9, 7, 6, 12, 4, 1  
key: 1 parent: 4 color: red  
key: 4 parent: 6 color: black  
key: 5 parent: 4 color: red  
key: 6 parent: 9 color: red  
key: 7 parent: 6 color: black  
key: 9 parent:     color: black  
key: 11 parent: 9 color: black  
key: 12 parent: 11 color: red  
Delete: 11, 5  
key: 1 parent: 4 color: red  
key: 4 parent: 6 color: black  
key: 6 parent: 9 color: red  
key: 7 parent: 6 color: black  
key: 9 parent:     color: black  
key: 12 parent: 9 color: black

**Rules of programing and the datasets:**

- (1) All the datasets will always insert nodes first.
- (2) All the datasets will not delete non-existent elements.
- (3) No duplicate nodes will be in the tree.
- (4)  $0 < t \leq 15$ ,  $0 < n \leq 20$ .
- (5) The data type of every element is Integer.
- (6) **Outputs that don't break the rules of Red-Black Tree will be right.**
- (7) You can only use standard header files.