CS2233: Data Structures
Assignment 4
2nd October, 2018

Problem Statement

- Input: A sequence $a_1, a_2, \ldots, a_n$ of distinct natural numbers that indicates the **pre-order** traversal of a BST. Additionally, several requests to restructure B or print relevant data.
- Goal: Build a Binary Search Tree B that has its pre-order traversal as the input sequence. In addition to the requests specified in Assignment 2B and 3, serve the following requests with respect to B:
  1. Print children of a specified node.
  2. Print Uncle of a specified node.
  3. Left rotate at a specified node.
  4. Right rotate at a specified node.

Input Format

Input lines start with one of the following symbols:

- 'N', '+', '>', '–', 'S', 'P' from assignment 2B and 3.
- 'C' (Print children)
- 'U' (Print Uncle)
- 'B' (Build the BST specified by the pre-order traversal)
- 'L' (Left rotate)
- 'R' (Right rotate)

Format in detail: For lines starting with 'N', '+', '>', '–', 'S', or 'P', refer to format specification in Assignment 2B and 3. For the remaining, if the input line starts with:

- 'C', 'U', 'L', or 'R': It is followed by an $a \in \mathbb{N}$
- 'B': It is followed by a sequence $a_1, \ldots, a_n$ of distinct natural numbers as a space-separated list.
- End of input is indicated by EOF.

All input lines end with a `\n` character.

Output Format

If the input line was:

- ‘N’, ‘+’, ‘>’, ‘–’, ‘S’, or ‘P’ , the output format is exactly as per specification in Assignment 2B and 3.
- “C a”: If value a does not exist in the set, then output -1.
  Else, let node A hold value a. Output the values of the two children of A separated by a space. If a child does not exist, output “Nil” in its place.
- “U a”: If a node with value a does not exist in the set or its uncle does not exist, then output -1.
  Else, let node A hold value a. Output the value of the uncle (sibling of parent) of A.
- “B $a_1\ a_2\ \cdots\ a_n$”: No output. You are expected to construct a BST whose pre-order traversal is precisely $a_1, a_2, \ldots, a_n$.
- “L a”: No output. If a node A with value a exists and left rotation is possible at A, then perform the left rotation. Else do nothing.
- “R a”: No output. If a node A with value a exists and right rotation is possible at A, then perform the right rotation. Else do nothing.

Implementation rules

In addition to rules specified in Assignment 2B and 3:

- Reconstruct the BST from the pre-order traversal using any reasonable way. One possibility is the procedure we discussed in class that takes as input a pre-order and an in-order traversal and reconstructs a binary tree.

Other Remarks

- All numbers in the test cases will fit into `int`.
- To build a BST from the pre-order traversal, use the fact that inorder traversal of a BST is always sorted.
- **Deadline:** 10th October, 2018.

Example

Input:

```
--------------------------
B 12 9 8 3 10 15 14 34 78
S 16
S 14
> 12
> 11
C 15
- 14
C 15
C 34
L 15
C 15
C 34
C 12
L 12
C 12
U 9
U 34
U 12
U 8
C 9
R 9
C 9
C 8
R 9
C 8
P

--------------------------
```

Output:

```
--------------------------
-1
10
14
12
14 34
Nil 34
Nil 78
Nil Nil
15 78
9 34
9 15
78
-1
-1
15
8 10
Nil 10
3 9
3 9
34 12 8 3 9 10 15 78

--------------------------
```

Note: The BST constructed in the first line is the same as the one in the example of Assignment 3.