Exercise #2 Report

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Environment

- OS : macOS Ventura Version 13.4
- compiler version : g++ 2.0.0
- IDE : Visual Studio Code

- how to run :

  用 Vscode 開啟程式碼，在terminal內輸入以下兩行

```
tinghsinchuang@zhuangtingxindeMacBook-Pro algo ex2 % g++ -o main.exe Exercise2_111550057.cpp
tinghsinchuang@zhuangtingxindeMacBook-Pro algo ex2 % ./main.exe
```

  即可執行。

Results

- method

  Follows the pseudo code provided in the textbook.

  - struct Node
    - Datatype of the nodes in the RBT.
    - Comprised of key value (int), color (int), parent (nodeptr), left child (nodeptr) and right child (nodeptr).

  - class RBTree
    - data member
      - root (nodeptr) : the root of the RBT
      - tnil (nodeptr) : nil of the RBT
    - member functions
      - leftrotate(nodeptr x) and rightrotate(nodeptr x)

        Do rotations based on the provided node pointer.
      - rbinsert(int n)

        Find the right place to insert a new node which has key = n. Assign the key with color red.
      - insertfixup(nodeptr z)

        There might be violations due to the insertion of the new node. Fix the RBT for three different cases (mentioned in the code).
      - find(int a)

        Return the node pointer that has key == a.
      - treeminimum(nodeptr x)

        Return the minimum-key node pointer of the tree that has root x.
      - transplant(nodeptr u, nodeptr v)

        Remove u from the RBT and use v to replace its position.

- rbdelete(int n)
  Delete the node that has key==n.
- deletefixup(nodeptr x)
  Fix the violation of the rules after deletion. Fix for four different cases (mentioned in the code).
- inorderprint(nodeptr x)
  Print the RBT in order in the required format.

- results of D1

```
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3
1 8
5 11 9 7 6 12 4 1
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
2 2
11 5
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
1 2
2 3
Insert: 2, 3
key: 1 parent: 2 color: black
key: 2 parent: 6 color: red
key: 3 parent: 4 color: red
key: 4 parent: 2 color: black
key: 6 parent:   color: black
key: 7 parent: 9 color: black
key: 9 parent: 6 color: red
key: 12 parent: 9 color: black
tinghsinchuang@zhuangtingxindeMacBook-Pro algo ex2 %
```