

# HW2

助教：

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# HW2 The Apothecary Diaries

# Description

Maomao is an apothecary, but ever since she was abducted by human traffickers and brought to the palace as a maid, she has been unable to put her skills to use.



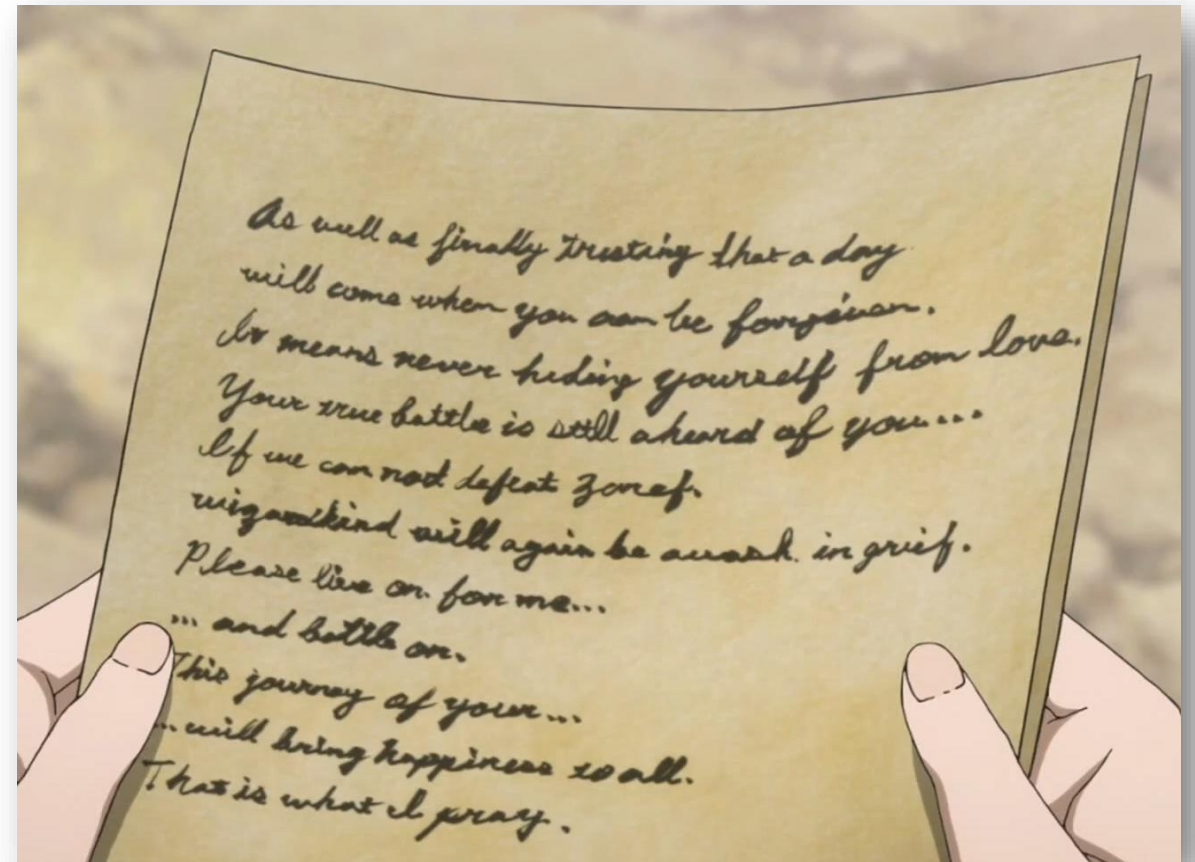
Fortunately, her abilities were discovered by eunuch Jinshi, and she was promoted to become the personal maid and poison tester for precious consort Gyokuyō.



One day, during a palace garden party, it was discovered that someone had poisoned in Gyokuyō's soup.



A note was left at the scene, saying:  
"You must solve the cipher, and then I'll tell  
you who the criminal is."



1 2 3 4 5 6

and here is the content of the note:

Maomao think of that for a long time...

```
((())<-1_b->())<-2_b->(((())<-3_b->())<-4_r->((())<-5_b->((())<-6_r->()))))
```



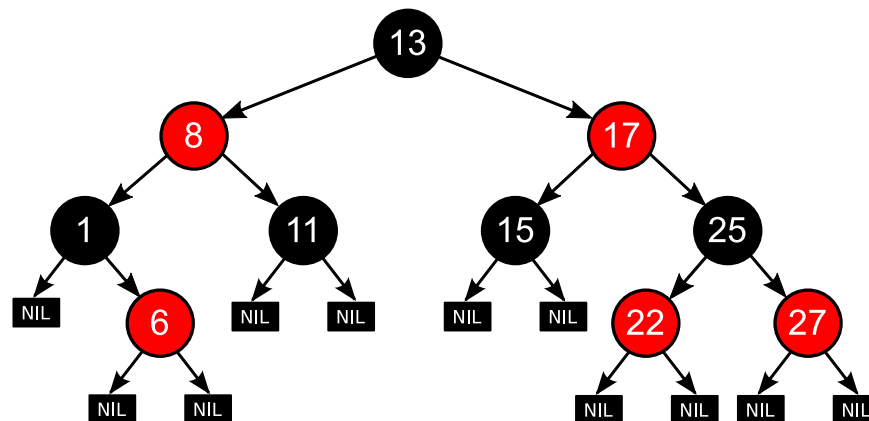
At that moment, Maomao thought of  
a way to crack the cipher

By representing it using a red-black  
tree!





Please construct a red-black trees to arranged these clues and show them with the sample input and output.



# Input/output

- Input:

- The test case contains lines of following commands.
- The input form will be `<COMMAND> <VAL>`
- Command:
  - Insert: Insert the val into the RB-trees
  - Print: Print the current RB-tree with the given form
- VAL:
  - Integer
  - Char: please convert them to decimal numbers by using ASCII code table. (A <= CHAR <= z)

- Output:

- When **Print** is encountered, please print the current RB-trees with the following form.  
-> `(LEFT_CHILDNODE)<-VAL_COLOR->(RIGHT_CHILDNODE)`

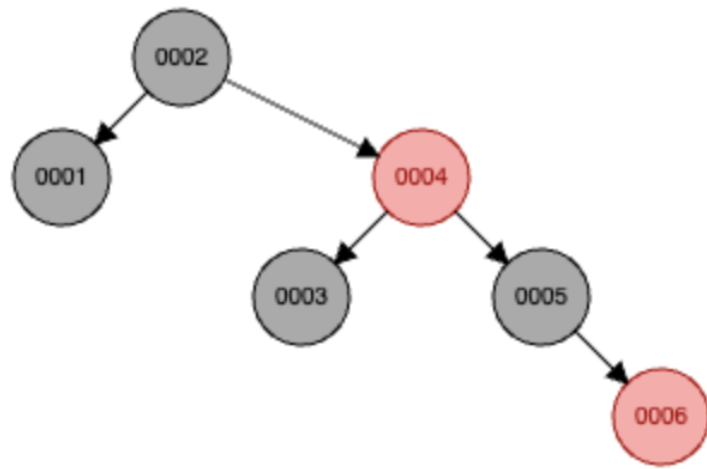
# Sample

## Sample Input 1

```
Insert 1
Insert 2
Insert 3
Insert 4
Insert 5
Insert 6
Print
```

## Sample Output 1

```
(( )<-1_b->( )<-2_b->((( )<-3_b->( )<-4_r->
(( )<-5_b->(( )<-6_r->()))))
```



#### Sample Input 1

```
Insert 1
Insert 2
Insert 3
Insert 4
Insert 5
Insert 6
Print
```

#### Sample Output 1

```
((()<-1_b->())<-2_b->(((()<-3_b->())<-4_r->
(()<-5_b->(()<-6_r->()))))
```

# Sample

## Sample Input 2

```
Insert D
Insert a
Insert t
Insert a
Insert S
Insert t
Insert r
Insert u
Insert c
Insert t
Insert u
Insert r
Insert e
Print
Insert I
Insert s
Insert T
Insert o
Insert o
Insert D
Insert i
Insert f
Insert f
Insert i
Insert c
Insert u
Insert l
Insert t
Print
```

## Sample Output 2

```
(((<-68_b->(<(-83_r->()))<-97_b->(((<-97_b->(<(-99_r->(((<-101_r->(<(-114_b->(<(-114_r->()))))<-116_b->(((<-116_b->(<-16_b->(<(-117_b->(<(-117_r->()))))(((<(-68_b->(<(-68_r->()))<-73_r->(<(-83_b->(<(-84_r->()))))<-97_b->(<(-97_b->()))<-99_b->(((<(-99_r->(<-101_b->(<-102_b->(((<(-102_b->(<-105_r->(<(-105_b->(<(-108_r->())))))<-111_b->(((<(-111_b->(<(-114_b->(<(-114_b->(<(-115_r->()))))<-116_b->(((<(-116_b->(<-116_b->(((<(-116_r->(<-117_b->(<-117_r->(<(-117_b->())))))
```

# Insertion in a Red-Black Tree

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- In a binary search tree, we always add the new node as a leaf, while in a red-black tree, leaf nodes contain no data
  - For a given data (Top-down Method)
    1. Searching the correct position for the data
    2. In the searching process, if there is a node with two red children
      - a) Perform color change algorithm
      - b) Check whether there are two consequent red nodes in the path
        - ① If yes, do rotation!
    3. Insert the data and set to a red node
    4. Check whether there are two consequent red nodes in the path
      - a) If yes, do rotation!
    5. Root should be black

Color Change → Rotation → Insert → Rotation → Check Root

# Notes

- You **don't have to** print the NULL leaves in this problem.
- The process of constructing a red-black tree **should** follow the method explained by the professor during the lecture.
- Please check your input and output processing, especially for spaces and `\n`, or it will cause **WA**.
- Maintain a happy mood to solve this problem :).



# 作業規定

- 分數：7%
- 密碼：10231106
- OJ 網址: <https://nlp.csie.ntust.edu.tw:2021/contest>
- OJ 截止日期：**2024/11/06 11:00** (截止前無限制上傳次數)
- 請將上傳到OJ的程式碼壓縮成 zip 檔，並命名為「學號\_姓名.zip」(例如：b1234567890\_王小明.zip)上傳至 Moodle，**遲交 0 分**。
- 程式語言開放使用 C (gcc 5.4)、C++ (g++ 5.4)，除了標準輸入輸出 (例如：stdio.h)和字串 (例如：string.h)相關的 library，**請勿使用其他 library，請自行實作基礎資料結構。**
- **請勿抄襲他人程式碼**