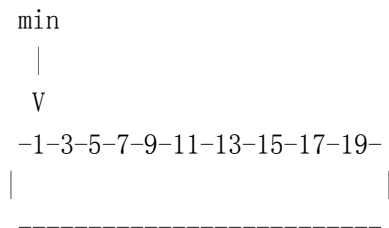


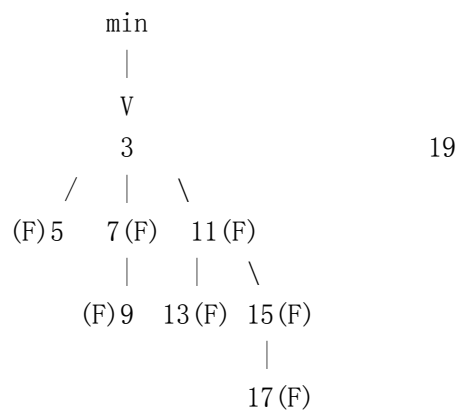
COP 5536/AD 711R Advanced Data Structures  
Spring, 2001

Sample Solutions - Exam 2

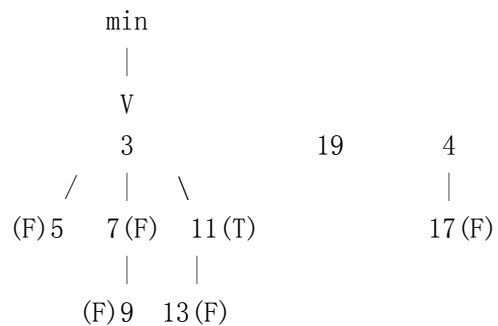
1. (a)



(b) RemoveMin



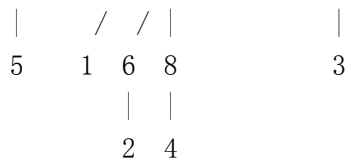
(c) decrease 17 to 4



2.

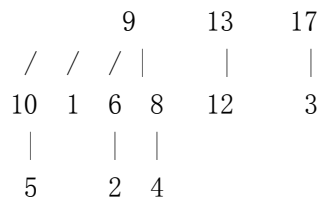
After RemoveMax

10      9      13 12 17

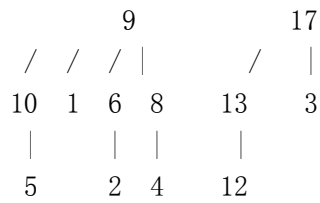


Two passing combine

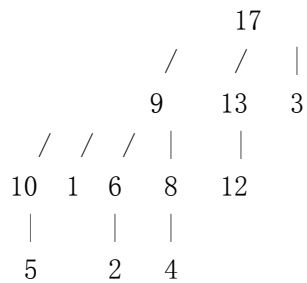
Step 1:



Step 2:



Step 3:

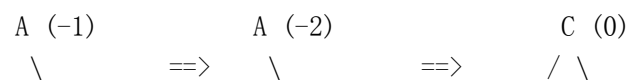


(b)

### 3. RL rotations

Numbers in parentheses represents balance factors.

(1) case 1:



$$\begin{array}{ccccc}
 B(0) & & B(1) & & (0)A \quad B(0) \\
 & & / & & \\
 & & C(0) & &
 \end{array}$$

Before                      Insert C                      After

(2) case 2:

$$\begin{array}{ccccc}
 A(-1) & & A(-2) & & B(0):h+2 \\
 / \quad \backslash & & / \quad \backslash & & / \quad \backslash \\
 h:A1 \quad C(0) & \implies & h:A1 \quad C(1) & \implies & (0)A \quad C(-1) \\
 & & / \quad \backslash & & / \quad \backslash \quad / \quad \backslash \\
 (0)B \quad Cr:h & & (-1)B \quad Cr:h & & A1 \quad B1' Br \quad Cr \\
 / \quad \backslash & & / \quad \backslash & & h \quad h \quad h-1 \quad h \\
 h-1:B1 \quad Br:h-1 & & h:B1' \quad Br:h-1 & &
 \end{array}$$

Before                      Insert to B1                      After

(3) case 3:

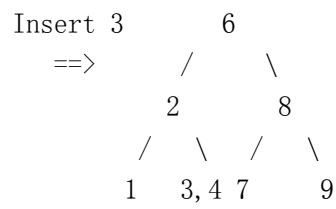
$$\begin{array}{ccccc}
 A(-1) & & A(-2) & & B(0):h+2 \\
 / \quad \backslash & & / \quad \backslash & & / \quad \backslash \\
 h:A1 \quad C(0) & \implies & h:A1 \quad C(1) & \implies & (1)A \quad C(0) \\
 & & / \quad \backslash & & / \quad \backslash \quad / \quad \backslash \\
 (0)B \quad Cr:h & & (-1)B \quad Cr:h & & A1 \quad B1 Br' \quad Cr \\
 / \quad \backslash & & / \quad \backslash & & h \quad h-1 \quad h \quad h \\
 h-1:B1 \quad Br:h-1 & & h-1:B1 \quad Br':h & &
 \end{array}$$

Before                      Insert to Br                      After

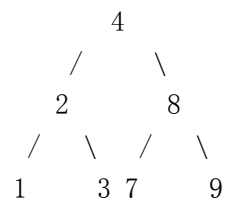
4.

(a)

$$\begin{array}{ccccc}
 & \text{Insert 8} & & \text{Insert 7} & & \text{Insert 2} \\
 9 & \implies & 8,9 & \implies & 8 & \implies & 8 \\
 & & & & / \quad \backslash & & / \quad \backslash \\
 & & & & 7 \quad 9 & & 2,7 \quad 9 \\
 \\
 \text{Insert 6} & 6,8 & \text{Insert 1} & 6,8 & \text{Insert 4} & 6 \\
 \implies & / \quad | \quad \backslash & \implies & / \quad | \quad \backslash & \implies & / \quad \backslash \\
 & 2 \quad 7 \quad 9 & & 1,2 \quad 7 \quad 9 & & 2 \quad 8 \\
 & & & & & / \quad \backslash \quad / \quad \backslash \\
 & & & & & 1 \quad 4 \quad 7 \quad 9
 \end{array}$$

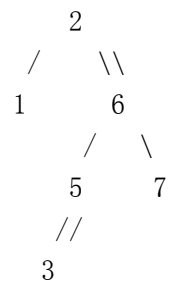


(b) Delete 6



5.

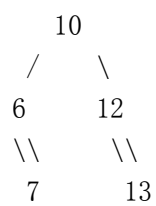
(a) Lbl rotation



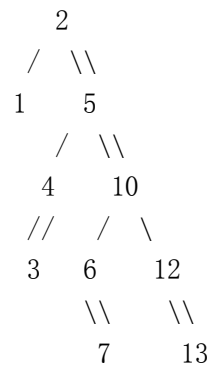
(b) Numbers in parentheses represent ranks.

i: Follow the right child pointer until  $\text{rank}(B) = \text{rank}(x)$ , where  $\text{rank}(B) = 1$ ,  $x$  is a node pointer of tree  $S$ .

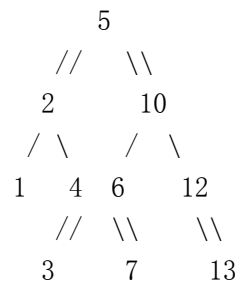
ii: Combine subtree  $x$ , 10, and  $B$



iii: Combine the result of ii to node 5 through a red pointer



iv: Perform a RR rotation



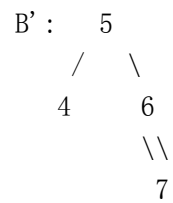
(c)

i: Search node 3

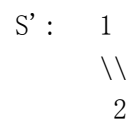
ii: Perform Join(B', 4, null)

B' : 4

iii: Join (B', 5, right-subtree of node 5)



iv: Join (left-subtree of node 2, 2, S')



Result:

