平衡二叉树 (AVL)

1. 原因：二叉排序树无法控制深度

⇒ 平均查找长度：$O(\log_2 n) \longrightarrow O(n)$.

特点：除二叉排序树的左、右子树，都高平衡

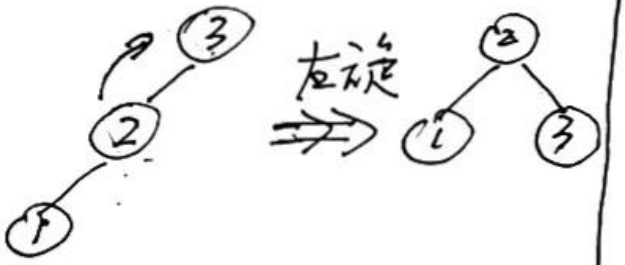
2. 平衡二叉树：平衡因子：一个结点的左、右子树的深度差：$-1, 1, 0$.

好处
- 二叉排序树的深度：可以保证无序序列在 $\log_2 n$ 级别上查找
- 左、右子树平衡

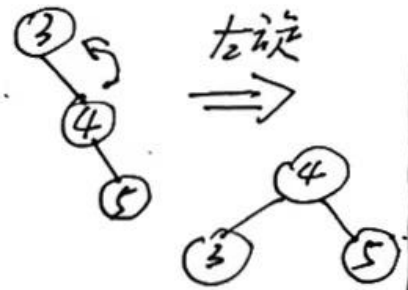
② 构造平衡二叉树 ⇒ 1> 以二叉排序树建的结点
2> 若不平衡 ⇒ 调整

① 基本形状：

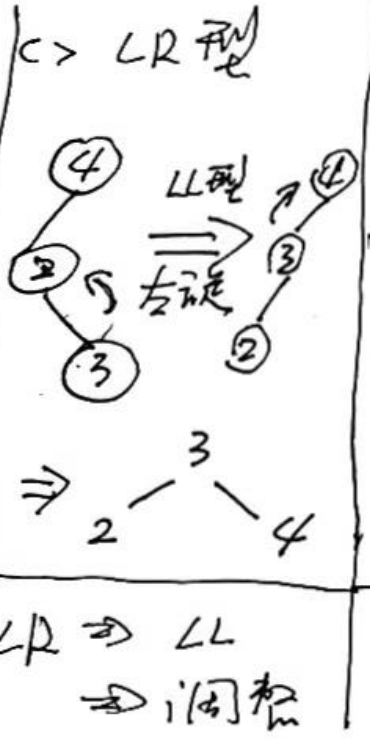
A> LL型



B> RR型

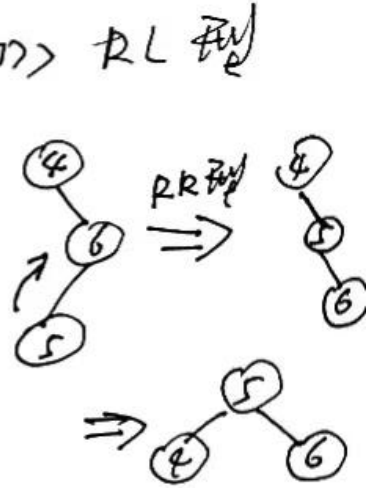


C> LR型



LR ⇒ LL
⇒ 调整

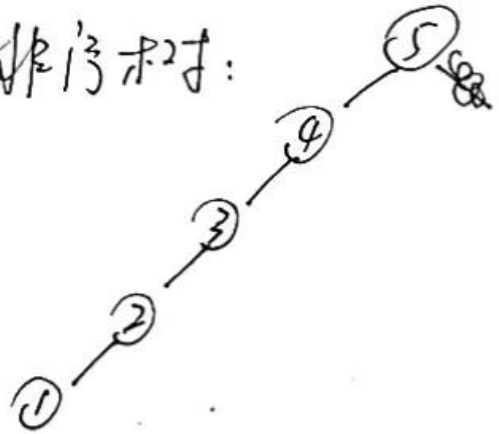
D> RL型



RL ⇒ RR
⇒ 调整

例：若序列 {5, 4, 3, 2, 1}

二叉排序树：



不平衡

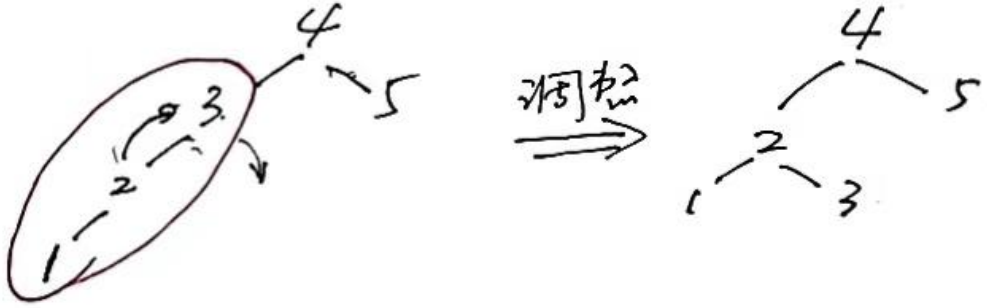
① 什么情况下要调整？

② 调整的子树？⇒最小不平衡子树

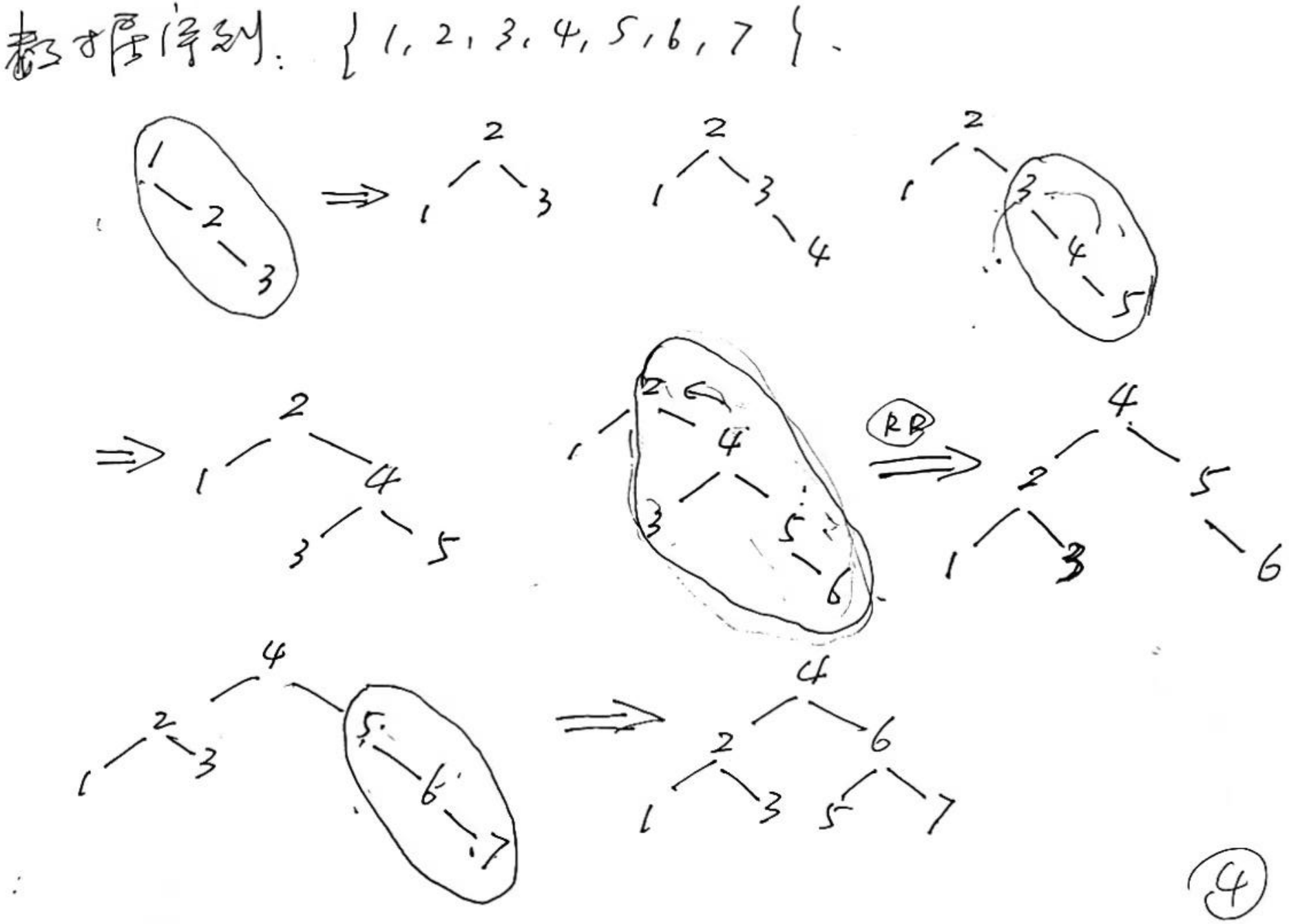
③ 如何调整？一共4种

LL..
RR
LR
RL

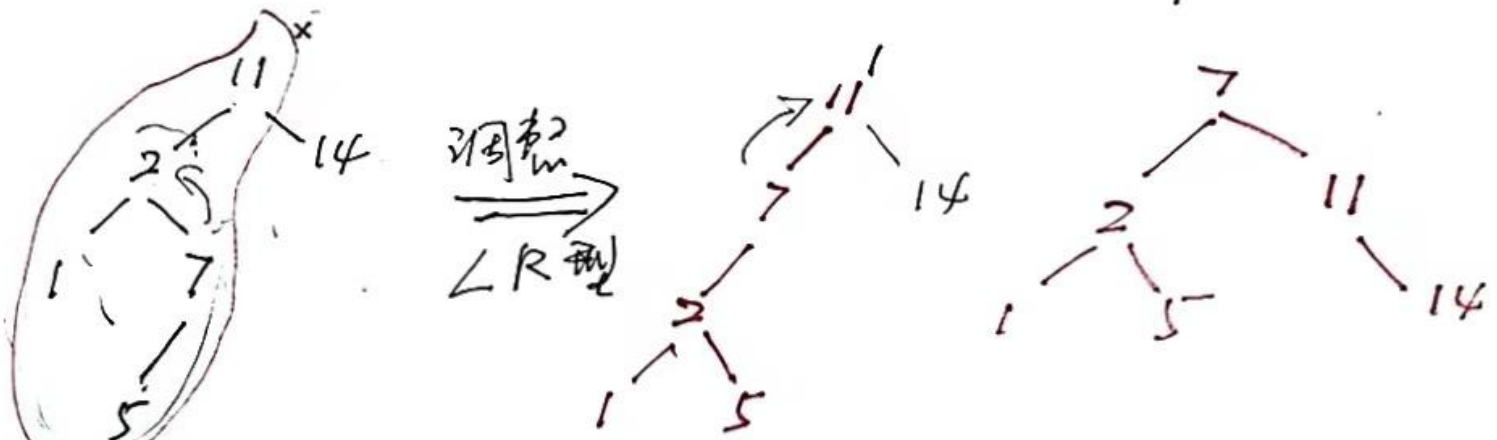
AVL；

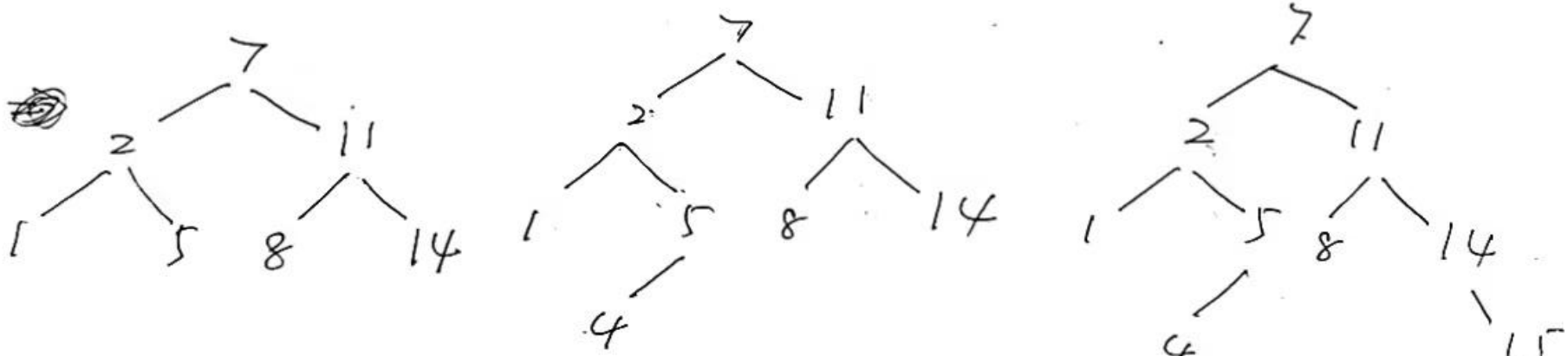


☆ 调整不平衡的最小子树

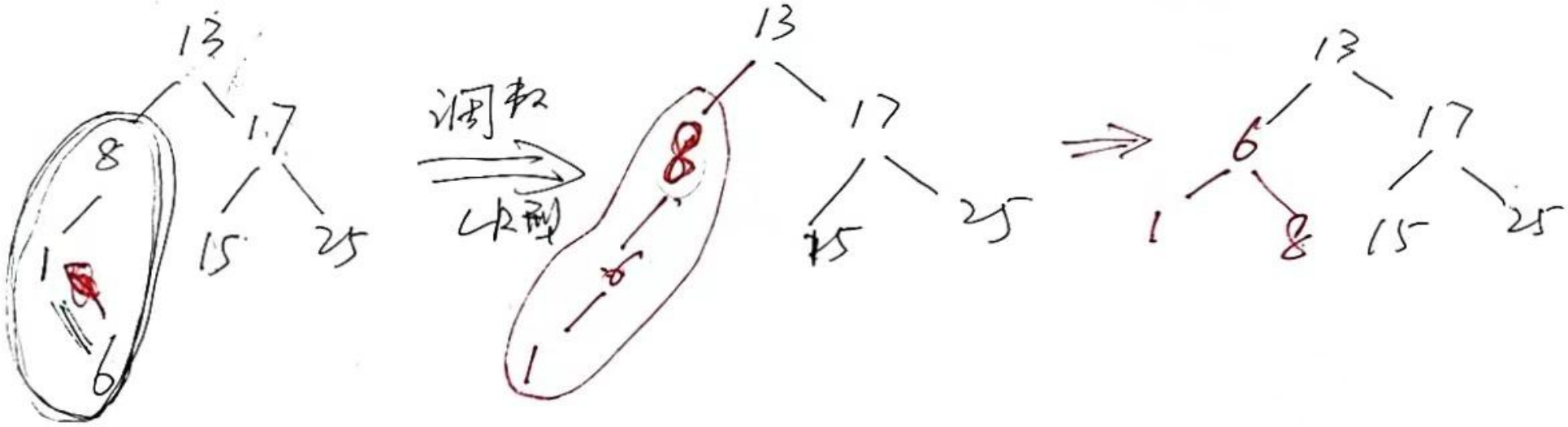

数字序列：{1, 2, 3, 4, 5, 6, 7}。
RR
4

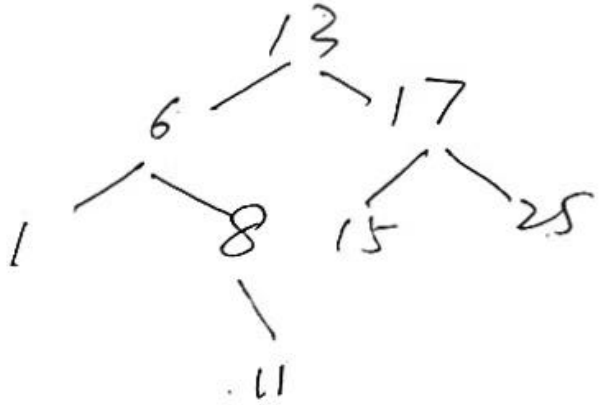
数据序列：{11, 2, 14, 1, 7, 5, 8, 4, 15}

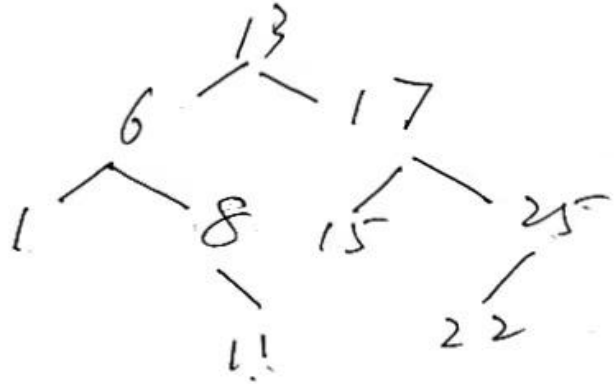




序列：{13, 17, 8, 15, 25, 1, 6, 11, 22}.

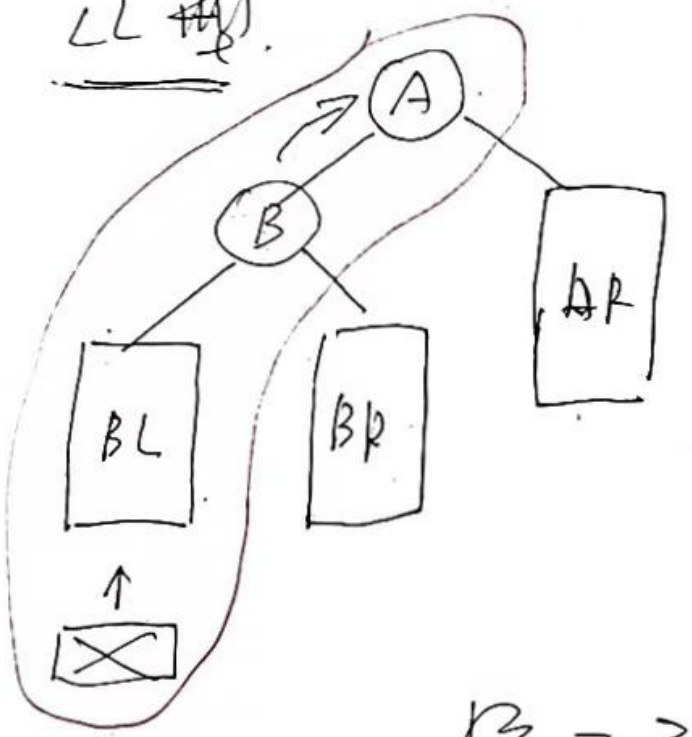


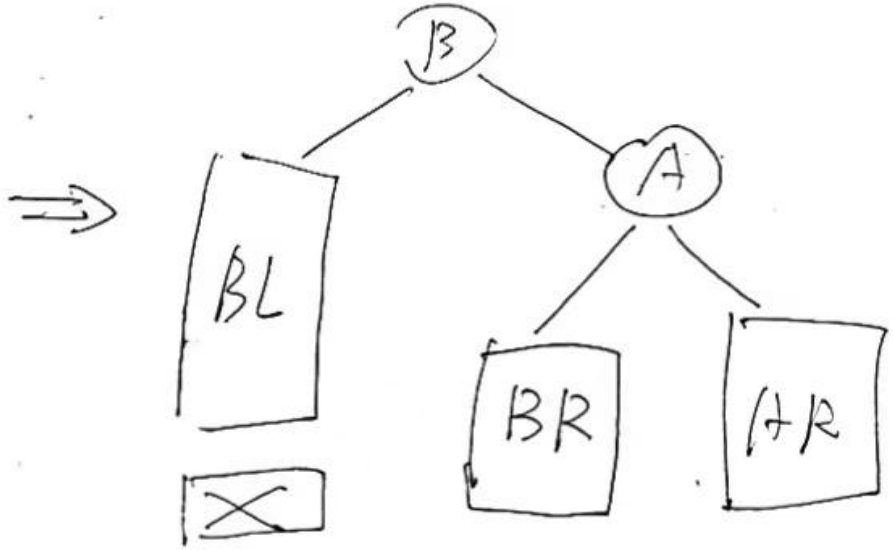




多层调整

LL型

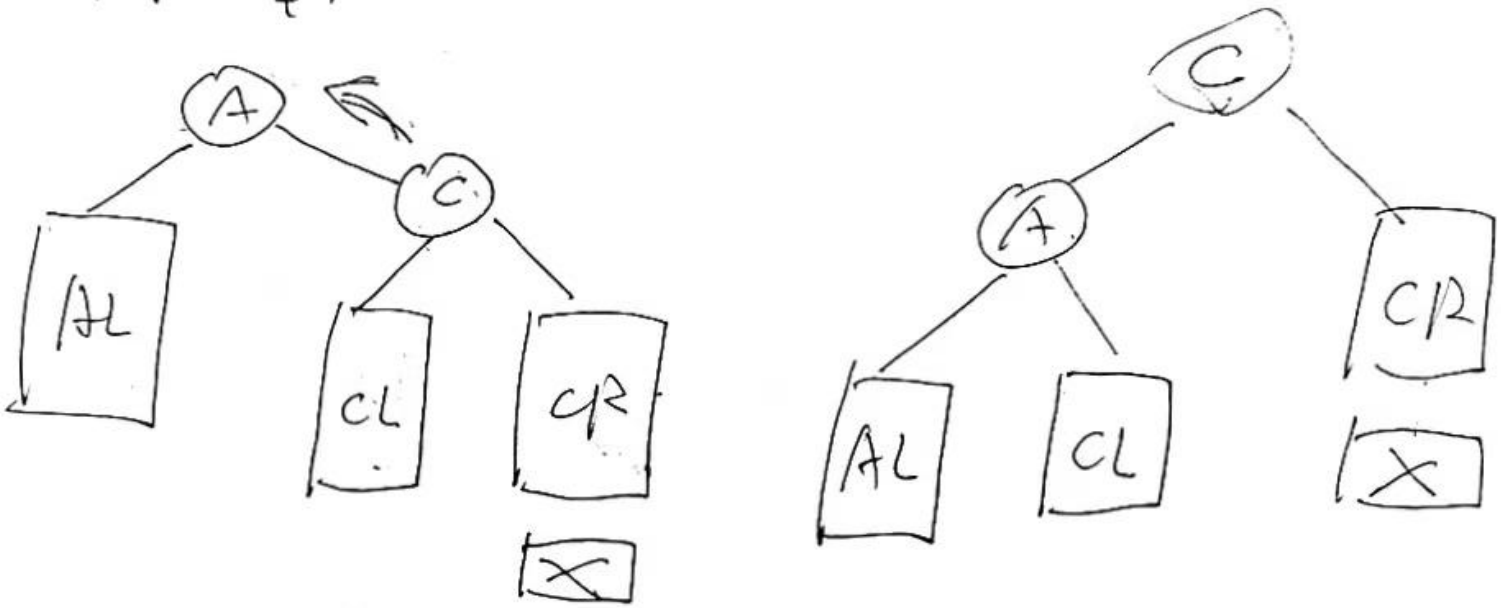




降不平衡子树的根的左子树

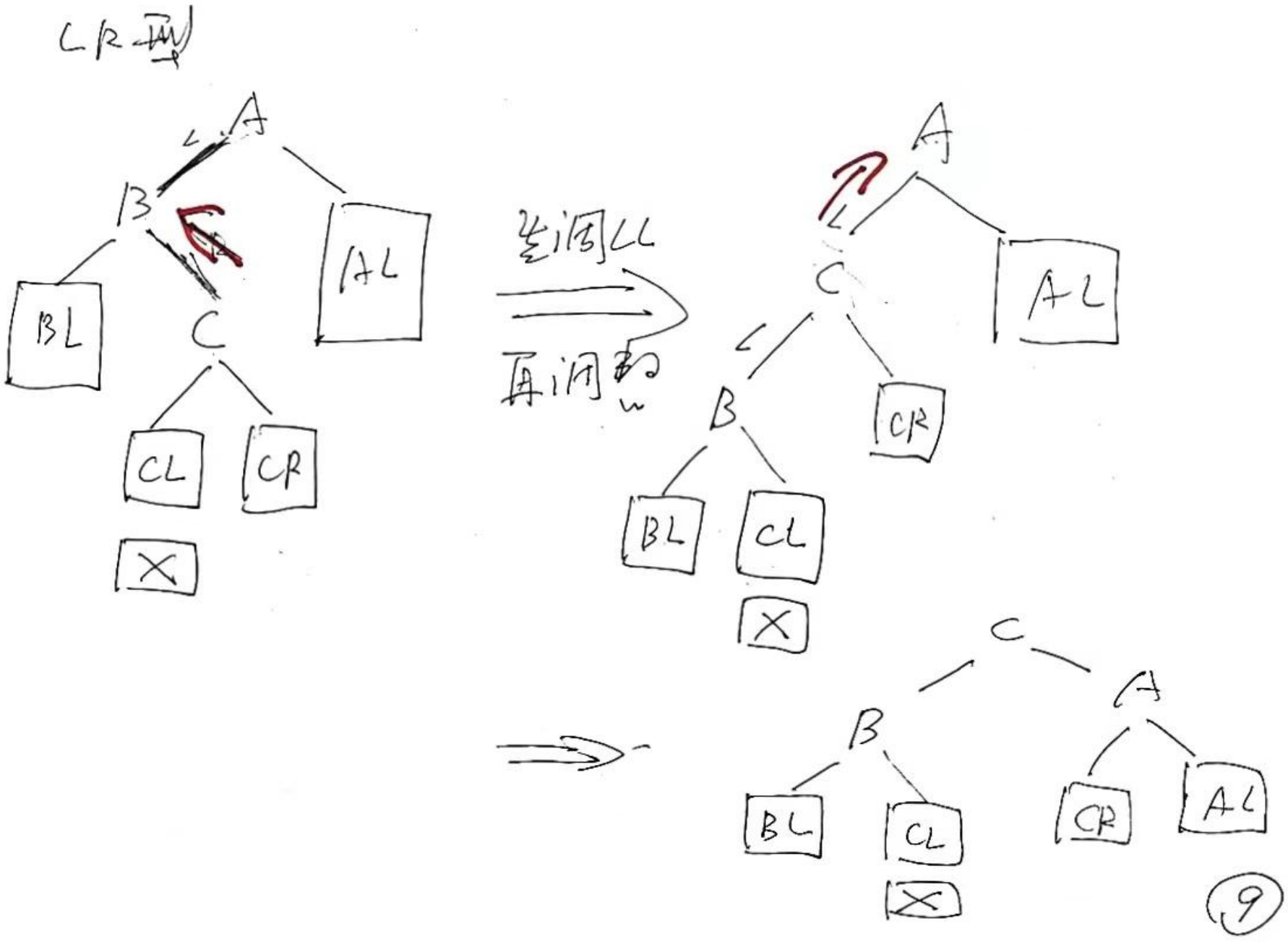
右旋(调整)的根结点.

RR 型.

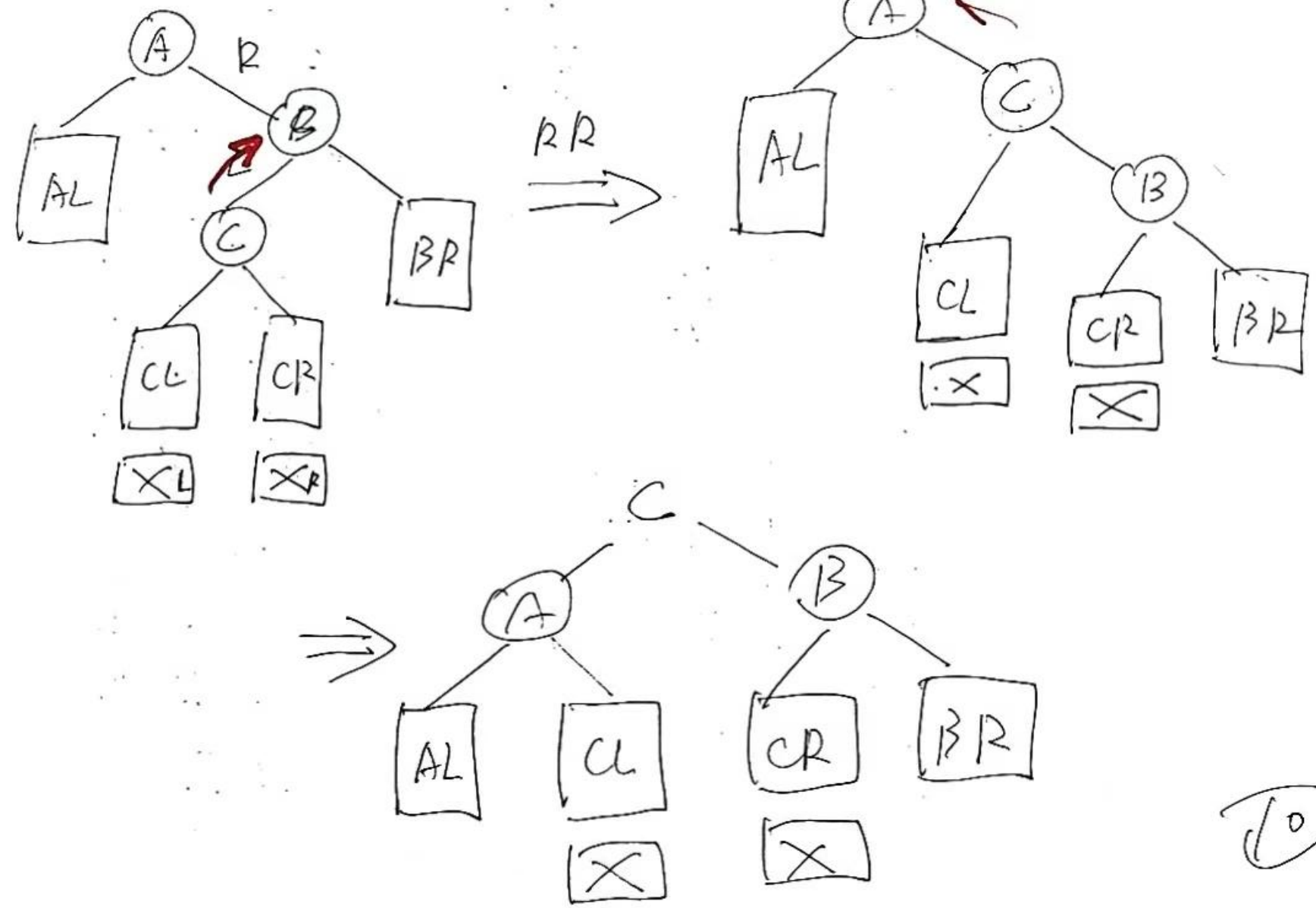


降不平衡子树的根的右子树

调整到根.

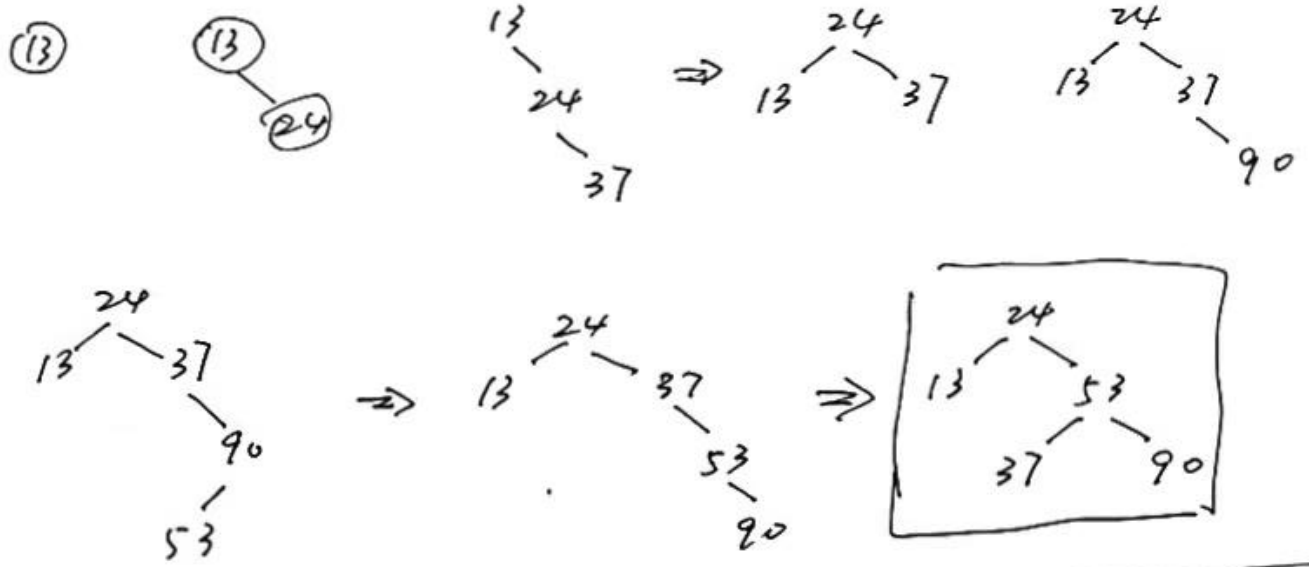

LR-双旋
A
B
AL
BL
C
CL
CR
X
先调LL
再调RR
A
C
AL
B
CR
BL
CL
X
C
B
A
BL
CL
CR
AL
X
9

RL 插入



AVL

① 13 24 37 90 53



② 11 2 14 1 7 5 8 4 15