

Pass: BigInteger multiplication

$$\begin{array}{r} (23 \quad 15 \quad 90) \\ \times (88 \quad 37 \quad 46) \end{array}$$

10	7	41	0	
	1058	690	4140	← no-normalize
	1065	731		

$$(10 \quad 65 \quad 31 \quad 40)$$

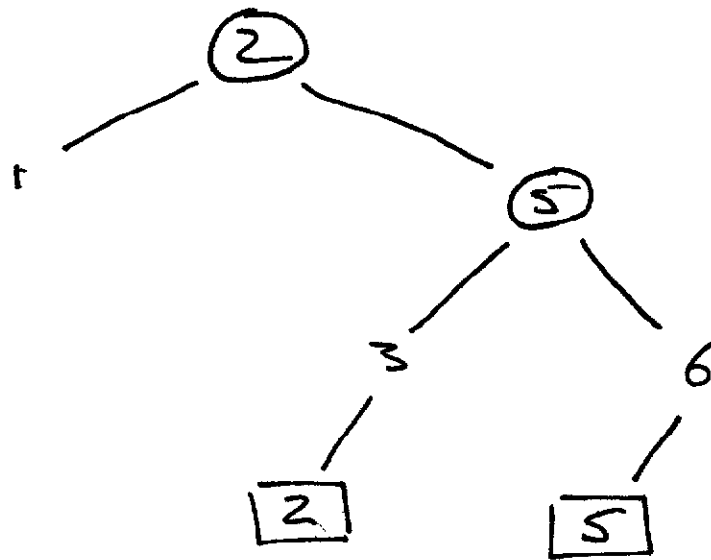
851	555	3330	0
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8	6	33	0	0	
	861	620	3361	40	← no-normalize
	867	653			

$$(8 \quad 67 \quad 53 \quad 61 \quad 40)$$

BST : insert

Ex. ✓ ✓ ✓ ✓ ✓ ✓
 ② ⑤ 1 3 ② 6 ⑤



in order tree walk :

1 ② ② 3 ⑤ ⑤ 6

stable
sort

Pre : ② 1 ⑤ 3 ② 6 ⑤

Post : 1 ② 3 ⑤ 6 ⑤ ②

Deletion in a BST:

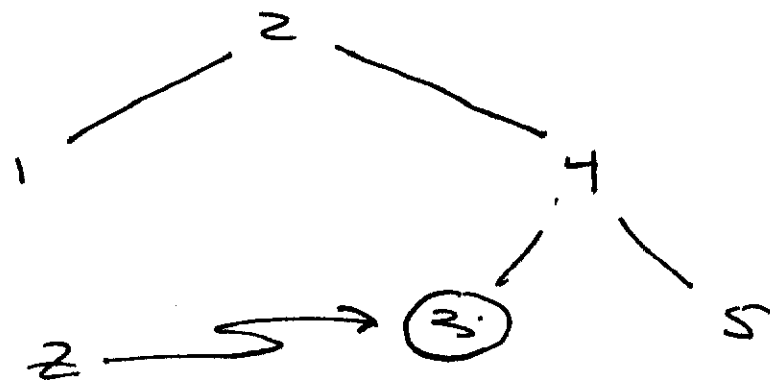
given a node z to be deleted from a BST T .

have 3 cases:

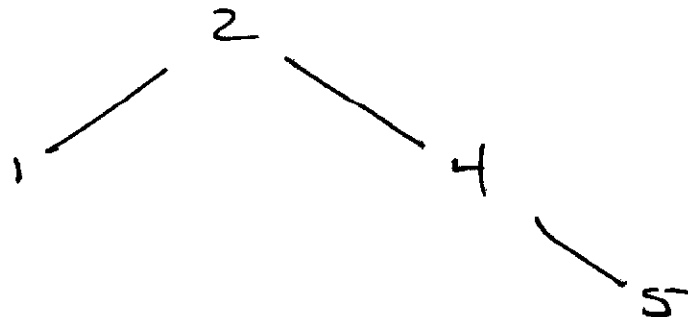
case 1 : z has 0 children (z is a leaf)

detach z from its parent

Ex.



delete(3)

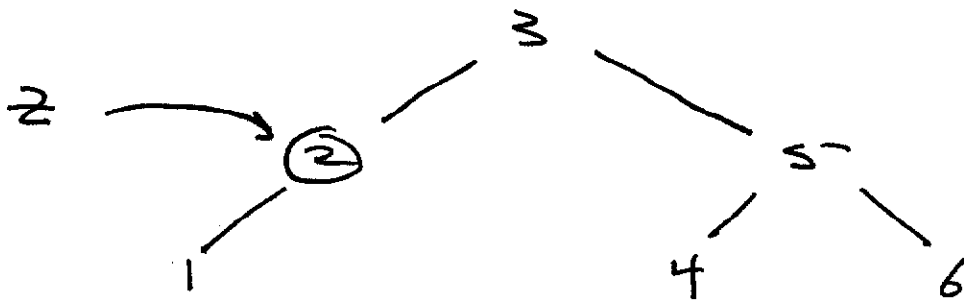


Case 2: z has 1 child

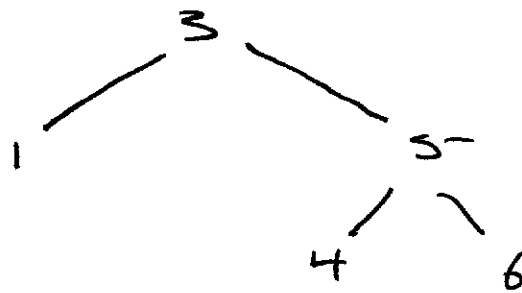
Subcase 2.1 : z has right but no left

" 2.2 : " " left " " right

Ex. (subcase 2.2)



delete(z)

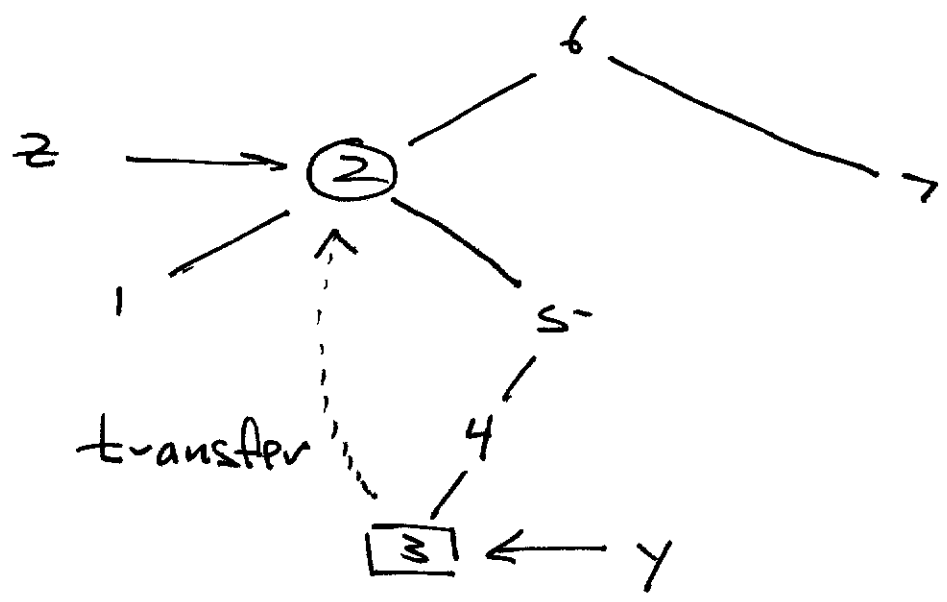


Exercise make up a 2.1 example

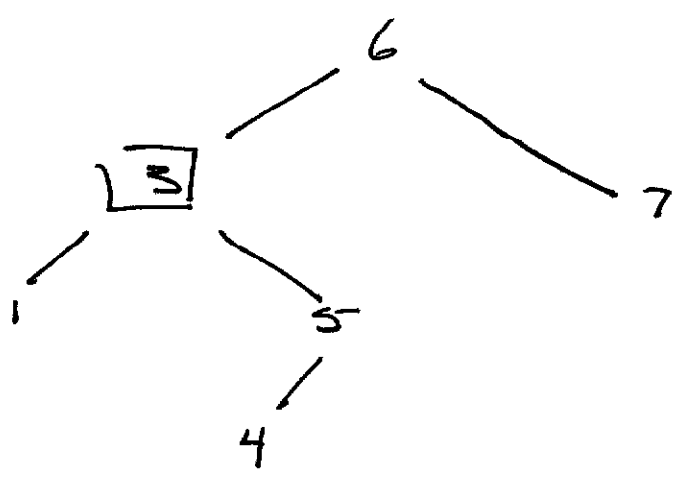
case 3 z has 2 children

splice out z 's successor y
(which has no left child), and
replace z with y .

Ex.

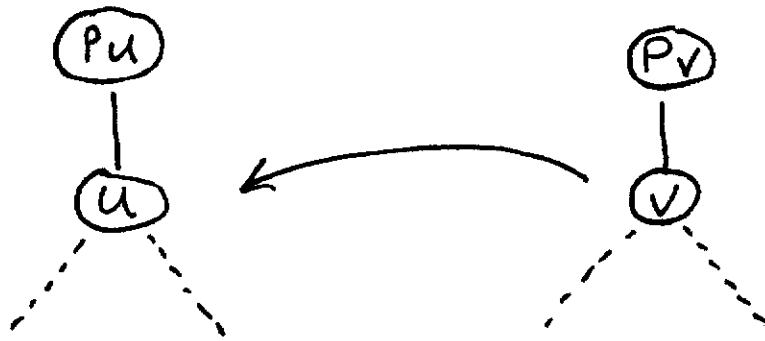


delete(2)

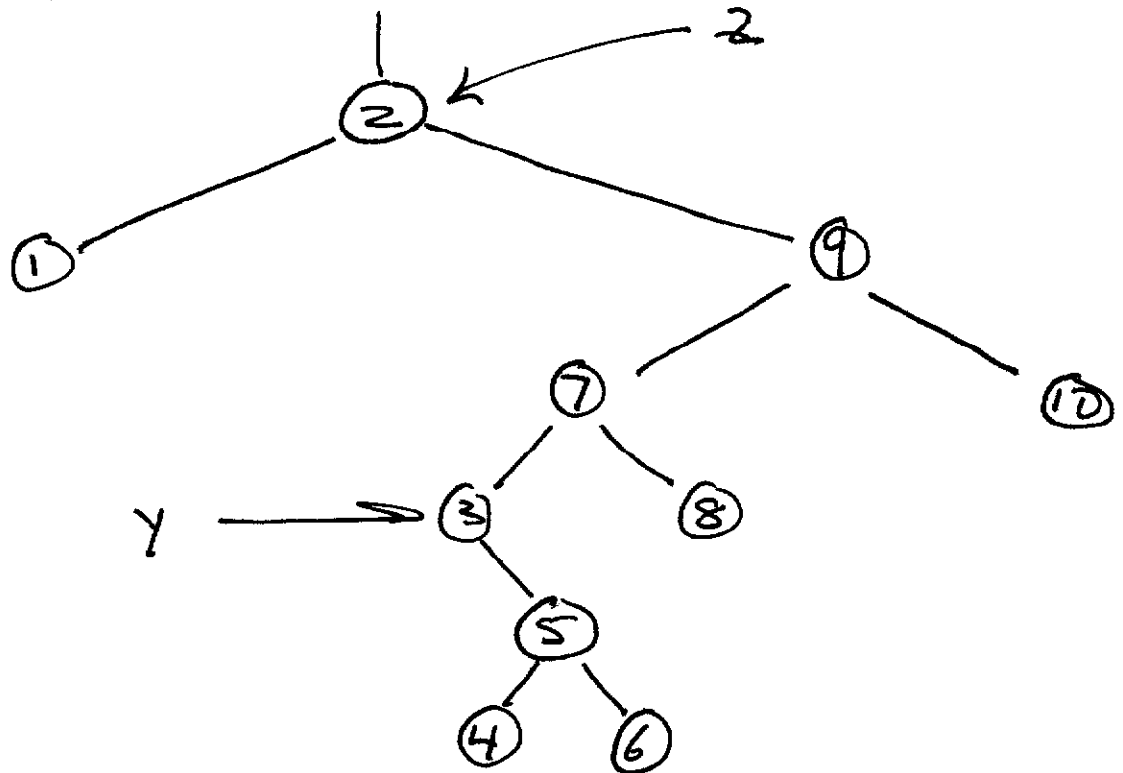


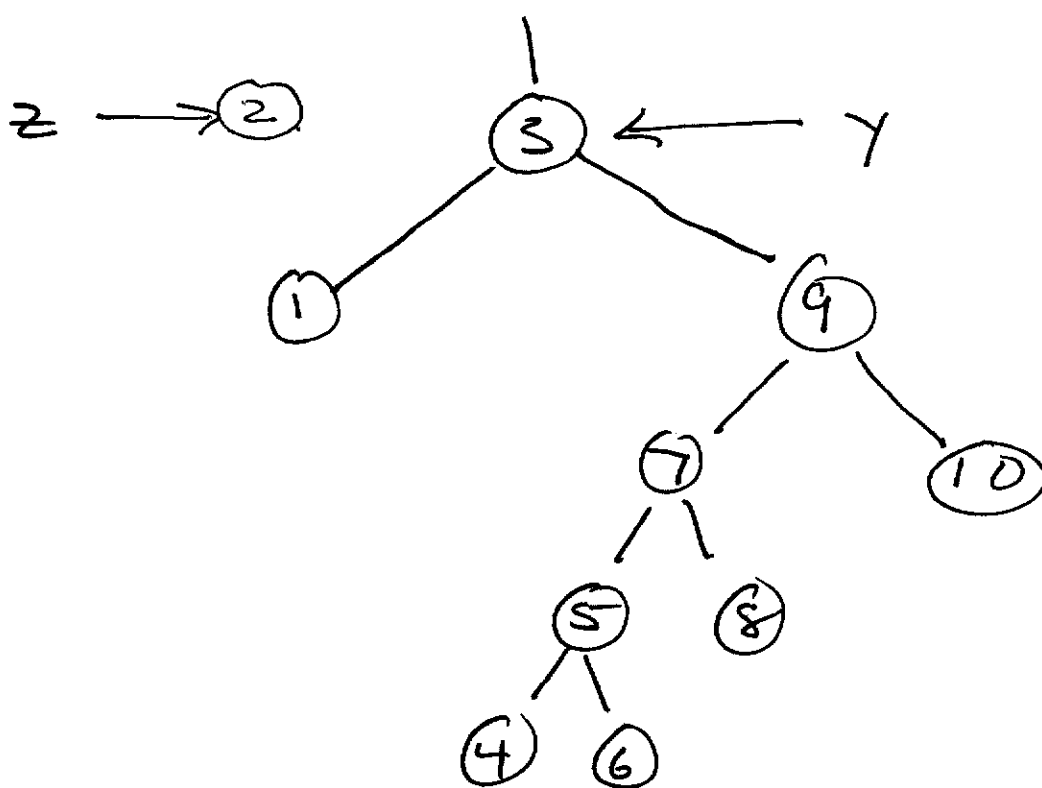
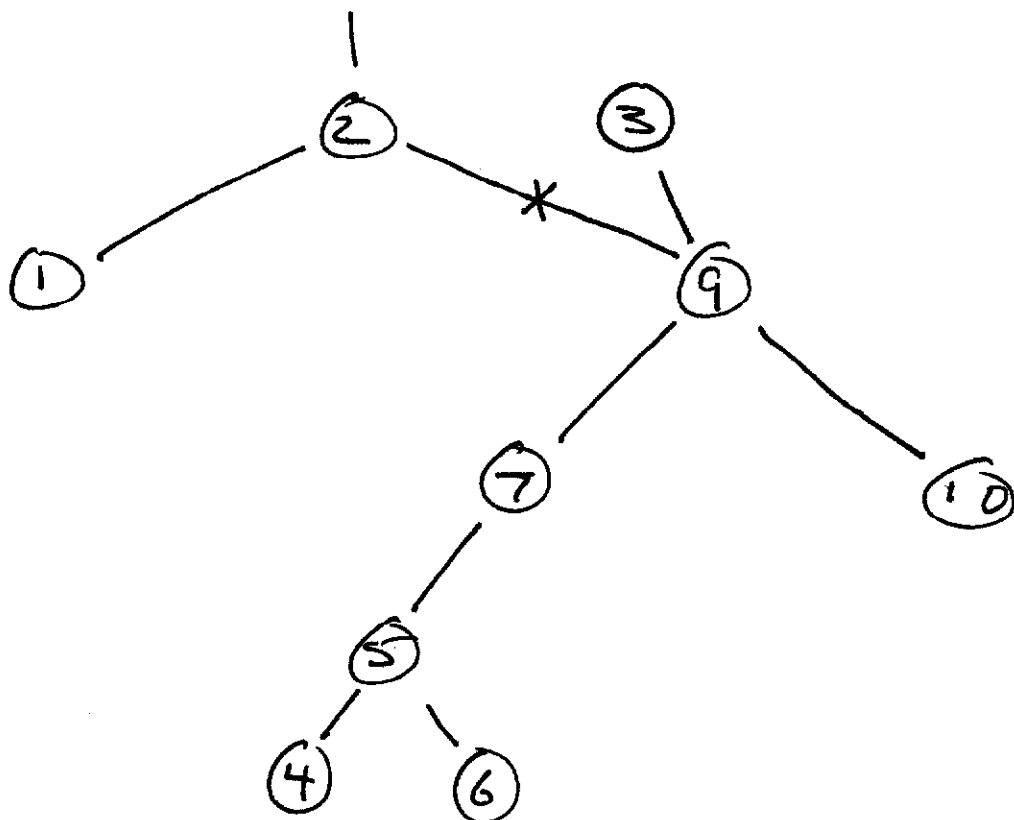
Pseudo-code:

helper : Transplant(T, u, v)



Ex. case 3





BST: still to do

Runtime of insert & delete



Red Black Trees (RBT)

Part 5 : Questions

$A.add(R) \quad // \quad A + R$
 $\nearrow \quad \quad \quad \uparrow$
 $*this \quad \quad \quad N$

$A.sub(R) \quad // \quad A - R$
 $\nearrow \quad \quad \quad \uparrow$
 $*this \quad \quad \quad N$

$A.mult(R) \quad // \quad A * R$
 $\nearrow \quad \quad \quad \uparrow$
 $*this \quad \quad \quad N$