

July 2017							August 2017							September 2017						
M	31	3	10	17	24	M		7	14	21	28	M		4	11	18	25			
T		4	11	18	25	T	1	8	15	22	29	T		5	12	19	26			
W		5	12	19	26	W	2	9	16	23	30	W		6	13	20	27			
T		6	13	20	27	T	3	10	17	24	31	T		7	14	21	28			
F		7	14	21	28	F	4	11	18	25		F	1	8	15	22	29			
S	1	8	15	22	29	S	5	12	19	26		S	2	9	16	23	30			
S	2	9	16	23	30	S	6	13	20	27		S	3	10	17	24				

June  
WEEK 26

179/186 Wednesday 28

8.00 am for  $i=2$  to 7

do  $c[i] = c[i] + c[i-1]$

8.30

$\Theta = (n+k)$  times

9.00

Binary Tree (and) Red black Tree

9.30

Lecture #10

10.00

Binary Tree

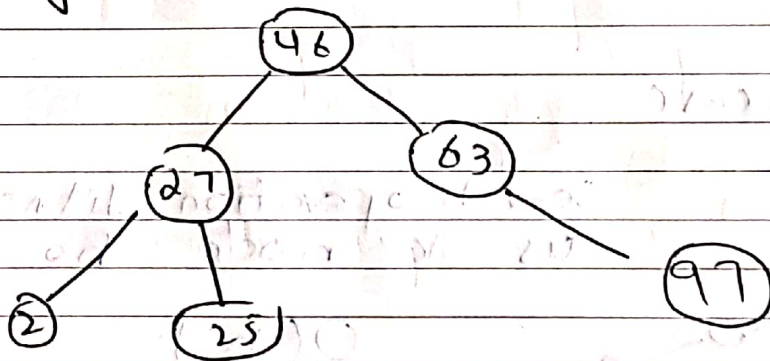
10.30

unique value

11.00

11.30

Noon



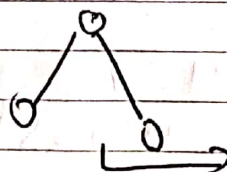
12.30

In-order Travel

1.00

→ give us Sorted Array

1.30



2.00

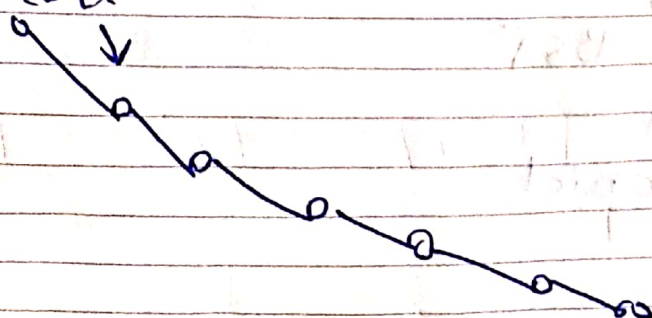
twice recursively

2.30

because of n node and twice recursive and find here then  $\Theta(n)$

3.00

worst case

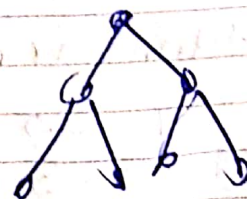


3.30

4.00

4.30

5.00



6.00 pm

June  
Week 26

April 2017							May 2017							June 2017						
M	3	10	17	24	M	1	8	15	22	29	M	5	12	19	26					
T	4	11	18	25	T	2	9	16	23	30	T	6	13	20	27					
W	5	12	19	26	W	3	10	17	24	31	W	7	14	21	28					
T	6	13	20	27	T	4	11	18	25		T	1	8	15	22	29				
F	7	14	21	28	F	5	12	19	26		F	2	9	16	23	30				
S	8	15	22	29	S	6	13	20	27		S	3	10	17	24					
S	9	16	23	30	S	7	14	21	28		S	4	11	18	25					

29 Thursday

8:00 am

8:30

9:00

9:30

10:00

10:30

11:00

11:30

Noon

12:30

1:00

1:30

2:00

2:30

3:00

3:30

4:00

4:30

5:00

5:30

6:00 pm

Search operation  
Height ho ghi

par jitni us ki

$O(\log n)$  X

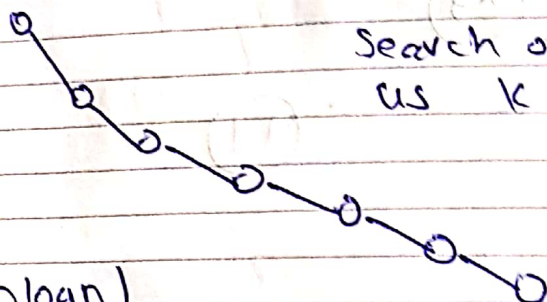
search operation take the  
time  $O(n)$



in case worst case

Search operation jitni  
us k node ho gyi  
 $O(n)$

$O(n \log n)$

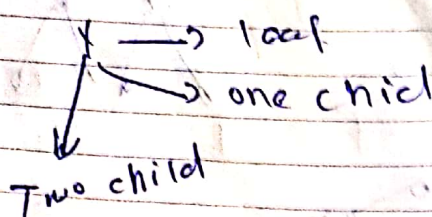


Insert

If we insert ( E M O P T U )  
then we will have the worst  
balanced tree

that will create a free  
edge. linked list and  
that  $O(n)$

Deletion From a BST





# June

WEEK 26

$y$  - loop  
 $x \rightarrow$  left child (one child)  
 $x \rightarrow$  both child

Scanned with CamScanner

WEEK 26

8.00 am

8.30

9.00

9.30

10.00

10.30

11.00

11.30

Noon

12.30

1.00

1.30

205

3)

2

—

—

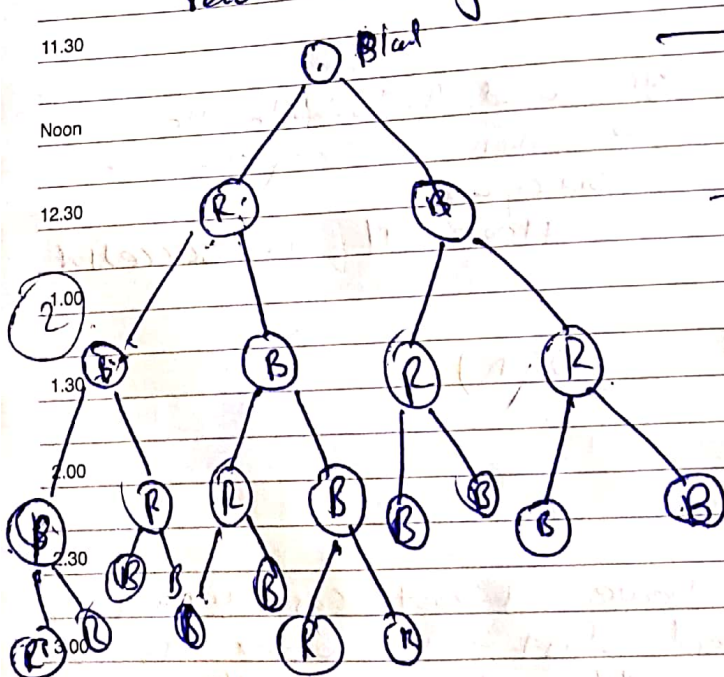
—

Red-black tree  
 ↳ Take  $O(\log n)$  in worst case

Blade Height 777

Height may be Half of the

Black Height  
Voul Height



3.30 What is the minimum of  $B-H$  of node with height  $h$ ?



August 2017						
M	7	14	21	28		
T	1	8	15	22	29	
W	2	9	16	23	30	
T	3	10	17	24	31	
F	4	11	18	25		
S	5	12	19	26		
S	6	13	20	27		

September 2017

M	4	11	18	25
T	5	12	19	26
W	6	13	20	27
T	7	14	21	28
F	1	8	15	22
S	2	9	16	23
S	3	10	17	24

October 2017

M	30	2	9	16	23
T	31	3	10	17	24
W		4	11	18	25
T		5	12	19	26
F		6	13	20	27
S		7	14	21	28
S	1	8	15	22	29

July  
WEEK 26

18/12 Sunday 2

8.00 am

Theorem :

8.30

A Red black tree with  $n$  internal nodes has height  $h \leq 2 \log(n+1)$

9.00

(internal nodes does not include leaves)

9.30

10.00

1. Define

10.30

$$F(n) \leq (2^n)$$

11.00

$$n \leq 2 \log(n+1)$$

11.30

Noon



height

$$2^1 - 1 = 1$$

12.30

At least one node =

$$2^1 - 1 = 1$$

1.00

1.30

$$2^1 - 1 = 1 \Rightarrow \text{At least one node in tree}$$

$$2^2 - 1 = 3 \rightarrow 11$$

2.00

$$2^0 - 1 = 0 \rightarrow 0 \text{ internal nodes (True)}$$

2.30

3.00

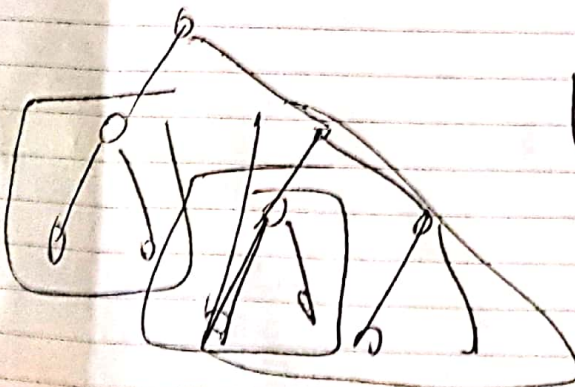
3.30

4.00

4.30

5.00

6.00 pm



$$1 + (2^{bh(u)} - 1) + (2^{bh(u)} - 1) + \dots + 1$$

Root

July  
WEEK 27

May 2017						
M	1	8	15	22	29	
T	2	9	16	23	30	
W	3	10	17	24	31	
T	4	11	18	25		
F	5	12	19	26		
S	6	13	20	27		
S	7	14	21	28		

June 2017						
M		5	12	19	26	
T		6	13	20	27	
W		7	14	21	28	
T	1	8	15	22	29	
F	2	9	16	23	30	
S	3	10	17	24		
S	4	11	18	25		

July 2017						
M	31	3	10	17	24	
T		4	11	18	25	
W		5	12	19	26	
T		6	13	20	27	
F		7	14	21	28	
S	1	8	15	22	29	
S	2	9	16	23	30	

3 Monday 18/181

8.00 am

Online class

8.30

Best case  $\rightarrow$  CBT

9.00

Worst case  $\rightarrow$  like linked list

9.30

AVL Similar to Red Black Tree

10.00

10.30

Theorem

Null external node  
other internal node

11.00

$$n \leq 2(\log(n+1))$$

11.30

$$\log_2(n+1) \geq \log_2 2^{n/2}$$

Noon

12.30

$$\log_2(n+1) \geq n/2$$

1.00