

24<sup>th</sup> January 2021

Master class in D.S. & ALG.

B-tree Removal.

```
int remove_btree ( btree_t * p-btree, key_t k)
{
    btree_node_t * p-node = search_btree_node(
        p-btree->p-root, k);

    assert( p-node != NULL );
```

Remove p-node.

$p\_parent = p\_node \rightarrow p\_parent;$

$p\_parent \rightarrow cn \ ?$

$p\_parent \rightarrow kn < t-1 \ ?$

$p\_parent \rightarrow cn < t \ ?$

① leaf or non-leaf.

② leaf.

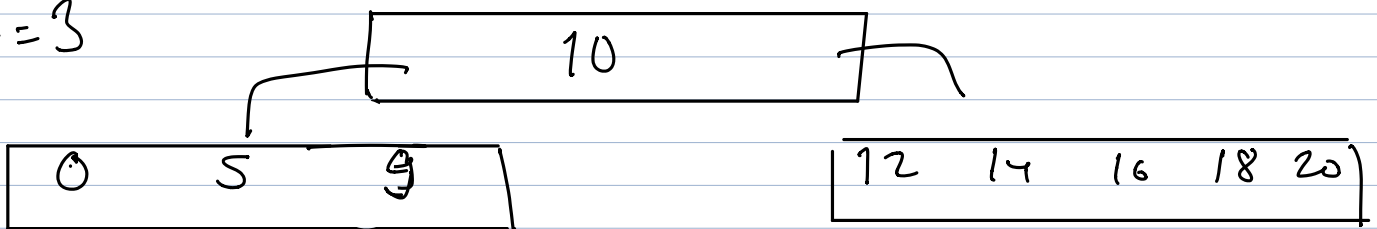
$p\_parent \rightarrow kn < t-1$

?

non-leaf.

$p\_parent \rightarrow k < t-1 \ ?$

$t=3$



Let  $x$  be a node and key is a key to be deleted.

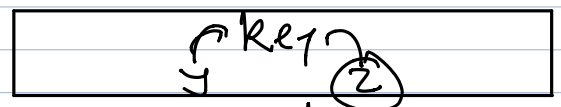
$x.is\_leaf == True.$

Find  $x.key$  in leaf node and remove it.

After removal  $x.cn < t-1$

$x.is\_leaf$  is not true.  
 $x$  is an internal node

$x$



$y.cn \geq t$

Choose a predecessor  $q$  of  $(key)$  from  $Y$

Let that be  $key'$

Replace  $x.key$  by  $y.key'$ .

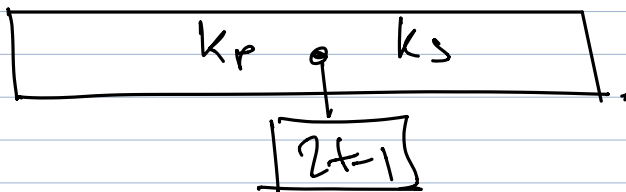
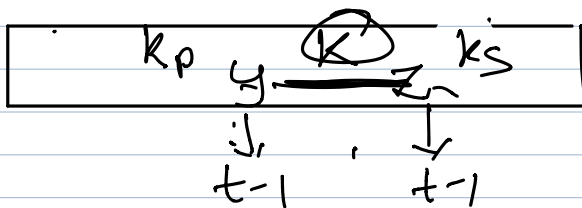
Delete  $key'$  in  $Y$  recursively

OR (if  $y.n = t-1$  then above response is invalid).

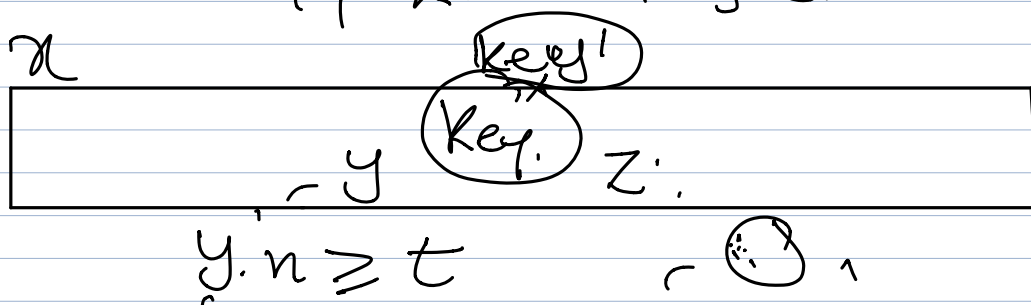
if  $z.n \geq t$  then find successor of  $key$  in  $Z$ , say  $key'$ . & replace  $x.key$  by  $z.key'$  & delete  $key'$  from  $Z$ .

OR ( $y.n = t-1, z.n = t-1$ )

Merge  $Y$  &  $Z$  together with  $z_{t-1}$  children.

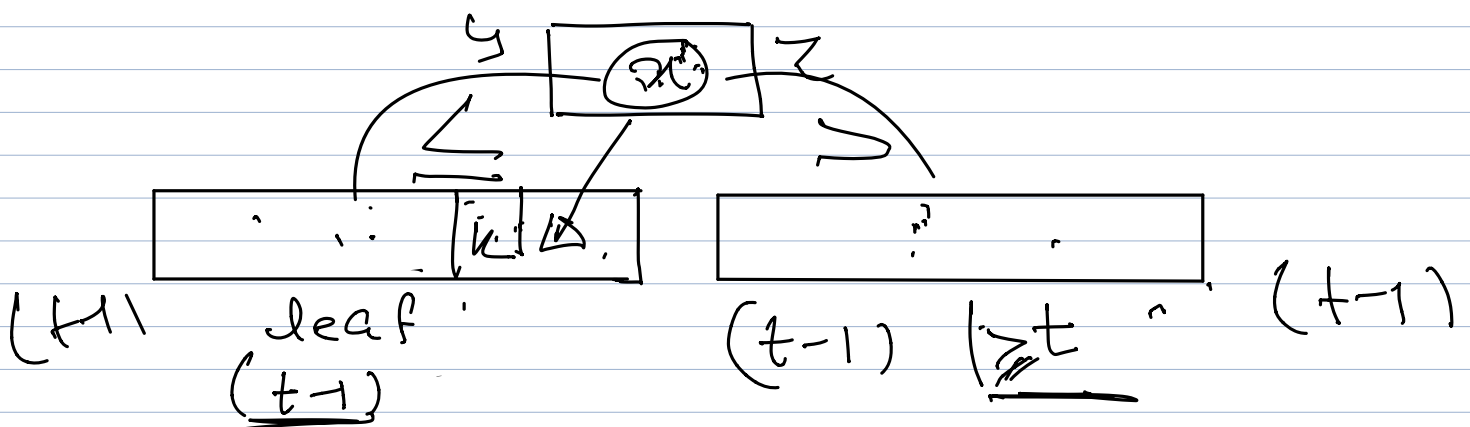
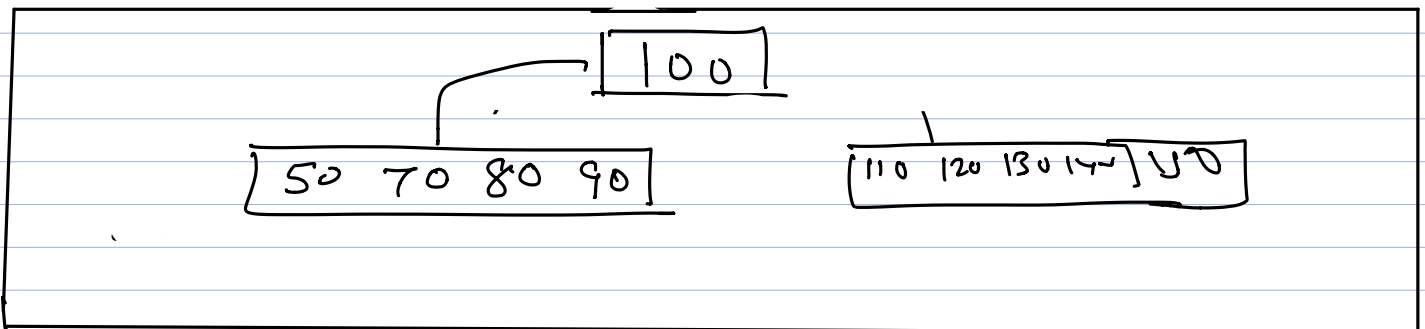
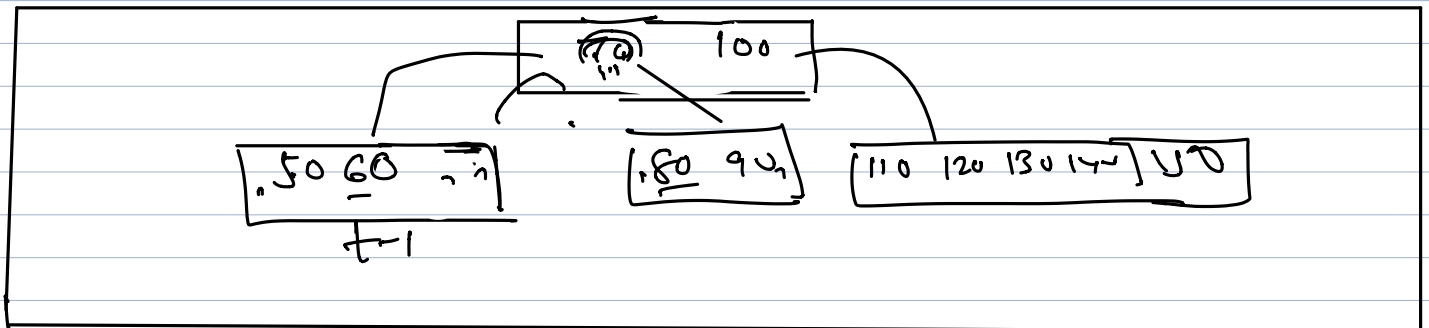
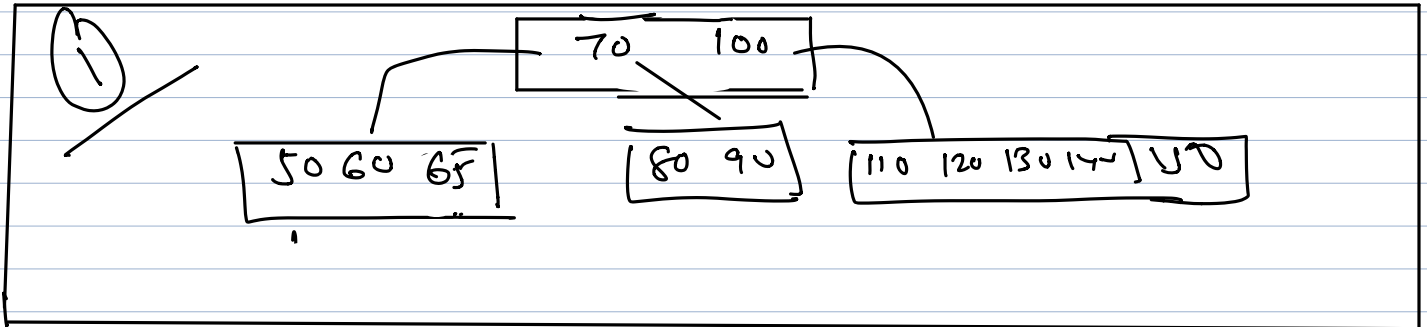
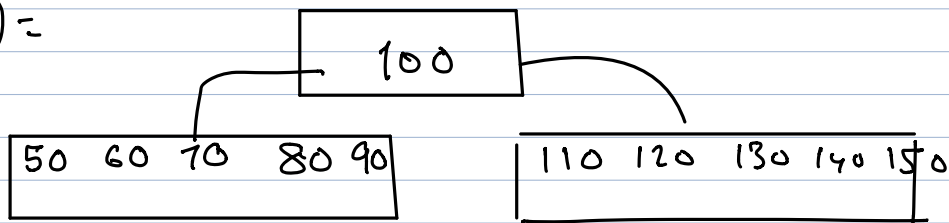


Copy  $z.key$  in  $y.key$  & remove  $z$ .  
Copy  $z.C$  in  $y.C$ .



find predecessor of  $key$  in  $z$ . |  $key'$ .

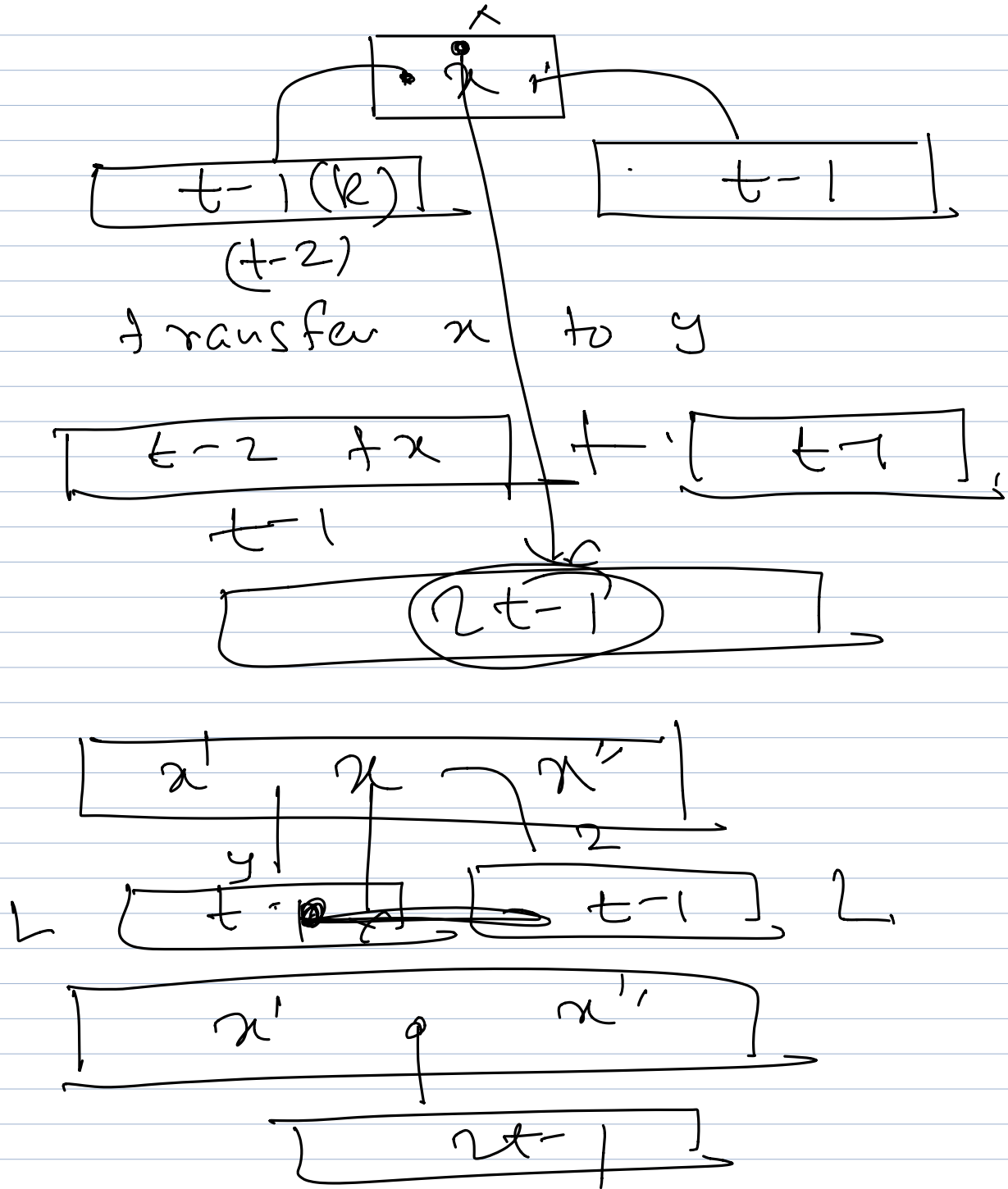
$t=3$  |  $t=1$  =  
2 keys



Find Successor of  $x$  from ②

Replace  $x$  with  $z$

Put  $x$  in  $y$



While removing key from leaf node.

$P.C_i = \text{leaf node}$

$P.C_{i+1}$

$P.C_i$

$t-1$

$t-1$

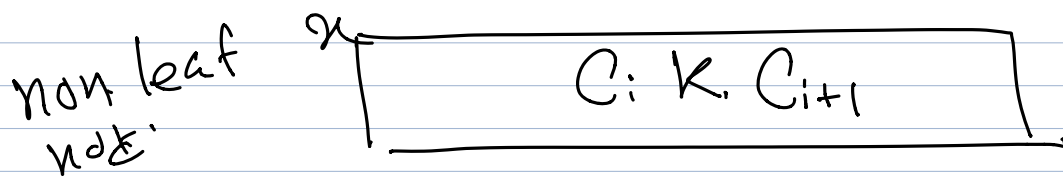
$\geq t$

$P.C_{i+1}$

$\geq t$

$t-1$

Not required



$$C_i, n \geq t.$$

$\text{Pred}(k)$  in  $C_i$  is to be found

$$x.\text{key} = \text{Pred}_k(C_i).$$

Recursive delete on  $(C_i)$

$$\text{if } C_i, n = t-1 \quad C_{i+1}, n \geq t.$$

find  $\text{Succ}(k)$  in  $C_{i+1}$ ,

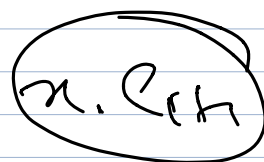
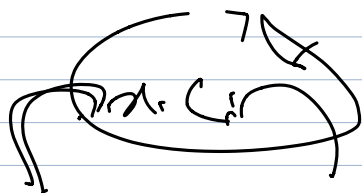
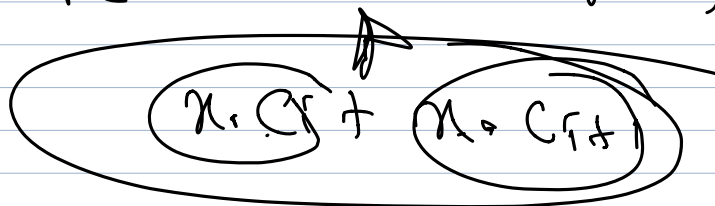
$$x.\text{key} \leftarrow \text{Succ}_k(x.C_{i+1}).$$

Recursively delete  $(x.C_{i+1})$ .

$$\text{if } x.C_i, n = t-1 \wedge x.C_{i+1}, n = t-1$$

Remove  $k$  from  $x$ .

Reduce number of keys in  $x$  by 1



$$t-1 \geq t$$

$$\begin{aligned} t-1 &\geq t-1 \\ t-1 &\geq t-1 \\ t-1 &\geq t-1 \end{aligned}$$

$$\geq t$$

Secondary Storage ??

(46ib) 3 4ib.

$$3 \times 2^{30}$$

1

4.  
4.  
4.  
4.  
4.

(20)

$$3 \times 2^{30} - 2^{22}$$

$$2^{22} (3 \times 2^8 - 1)$$

$$2^{22} (768 - 1) \quad \underline{767 \times 2^{22}}$$

20.

~~$$767 \times 2^{22}$$~~

$2 \times 4 \times 5$

$$2^{20} \times \frac{767}{5}$$

$$153 \times 2^{20}$$

(46ib)

153

1 million 70 L.

153 million  $153 \times 10 L.$

64

153 crore (Integer)

12  
(256 4)

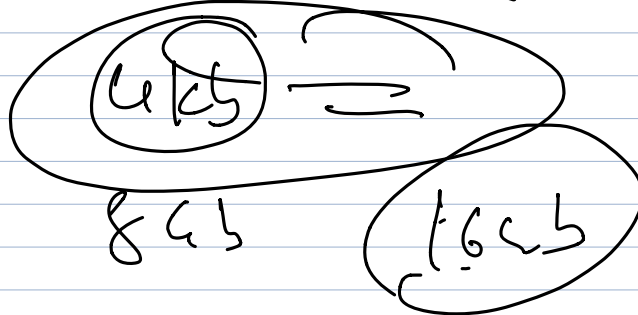
(8B)

$$2^8 \times 2^{32} = 2^{40} = 8$$

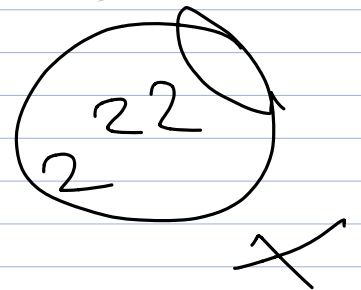
4kb

4kb

4



$$2^4 \times 2^{30} = 2^{34}$$



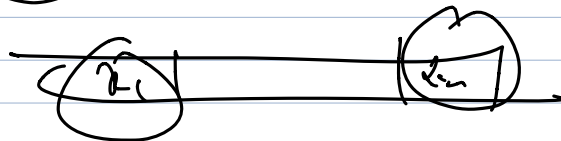
4 million

1B 2B 3B - 4B

4kb

key-t \* ka

Size-t ka

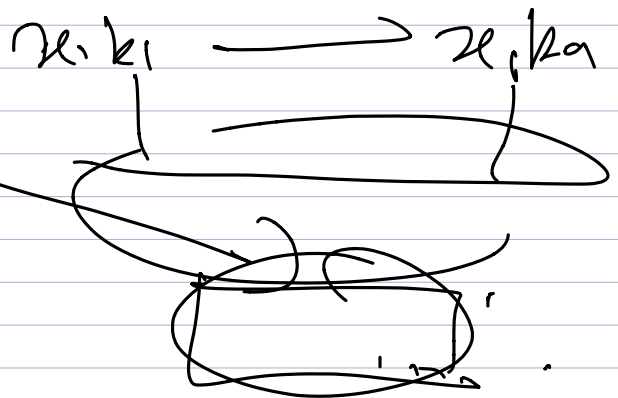
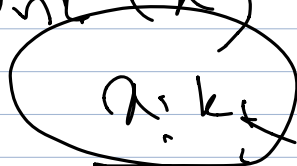


DiskRead(k)

DiskRead(a)

DiskWrite(b)

DiskWrite(a)



x.k1 - x.ka



Disle

0