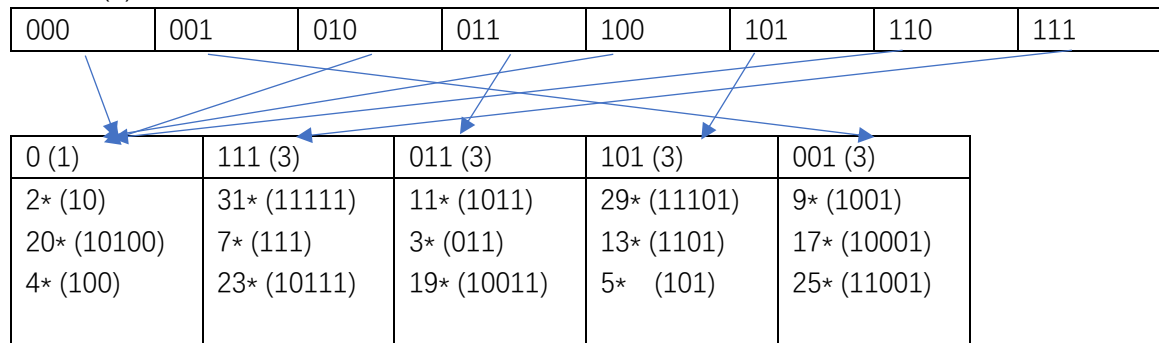


CS2055 HW8

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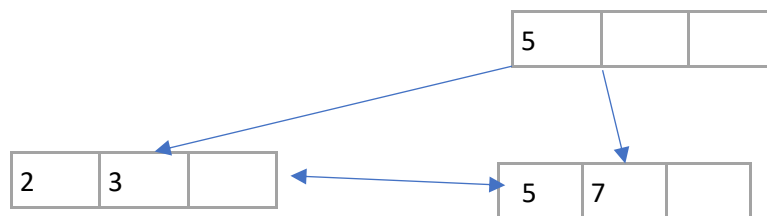
1. Extendible hashing structure:

Global: (3)

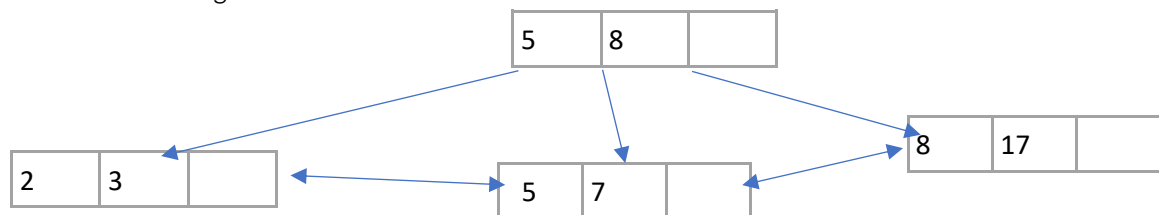


2. B+ tree:

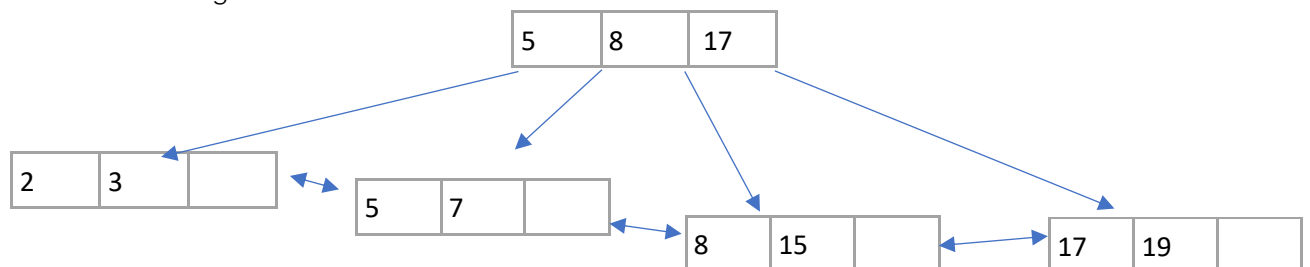
After inserting 7:



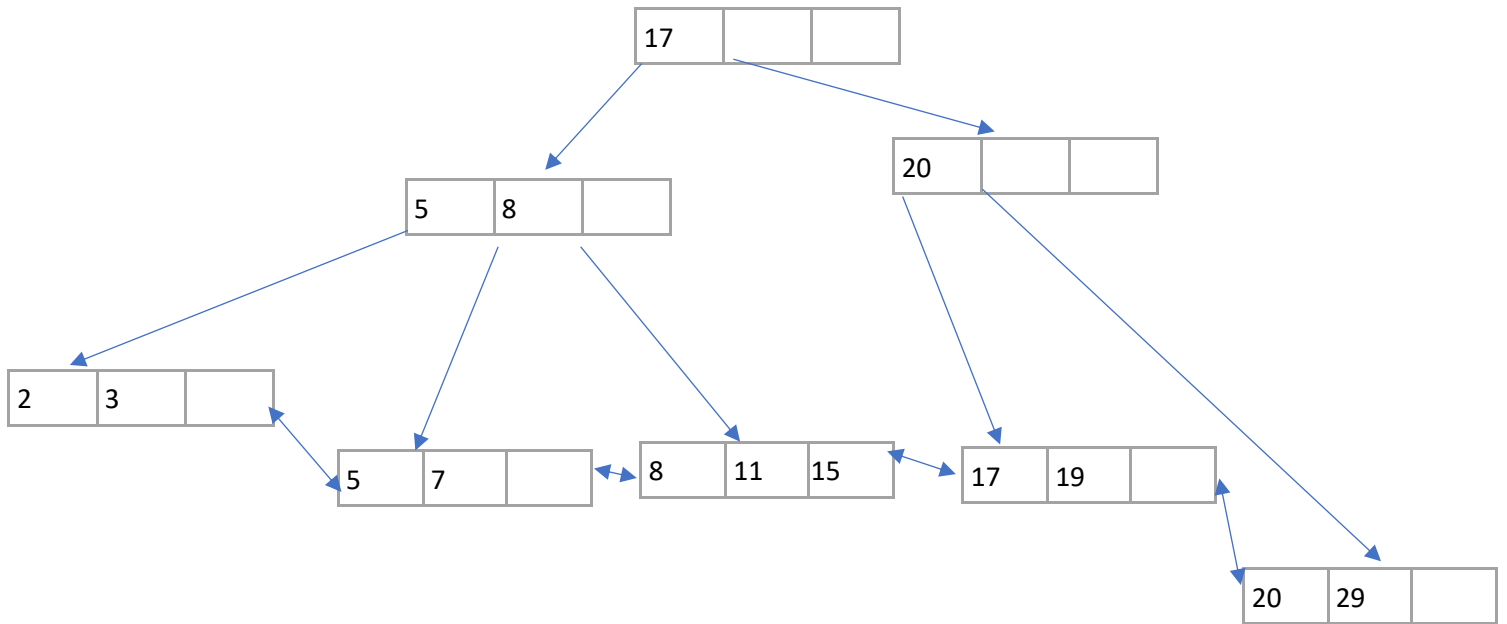
After inserting 17:



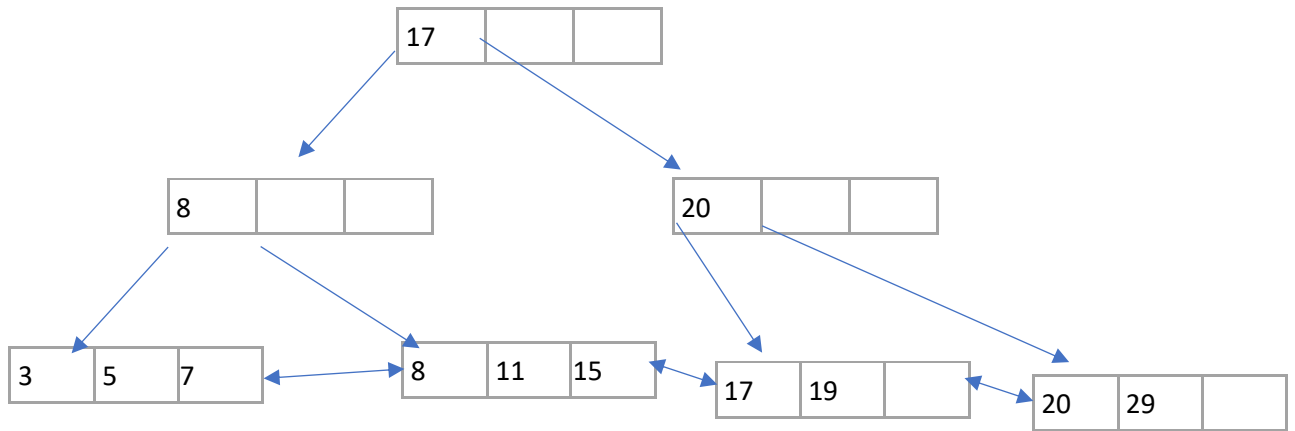
After inserting 19:



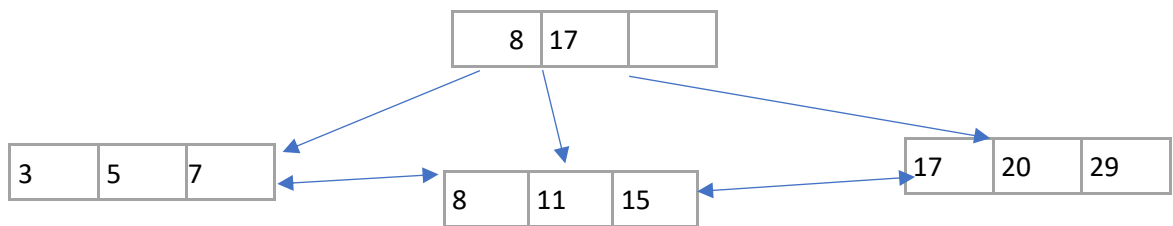
After inserting 29:



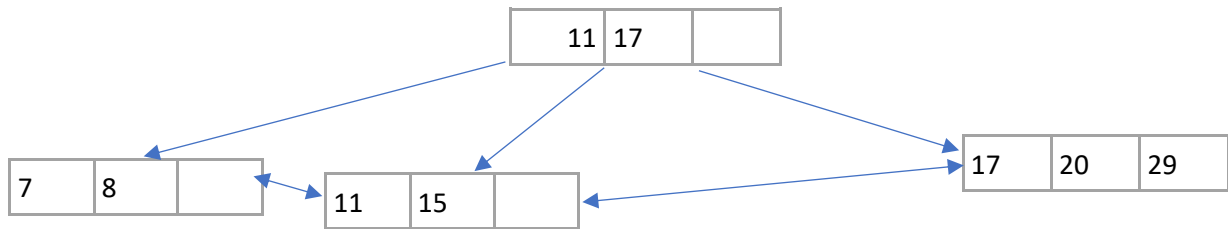
3. B+ steps:
 - a. delete 2:



- b. Delete 19



Delete 3 and 5:



4. Number of levels:

Since for a b^+ -tree with max pointers as 9, at level d the maximum total amount of the nodes is 9^d . Since there are maximum 8 keys in each node, the total number of leaves is $9^d \cdot 8$. This happens when each node is full. Thus, given a certain number of leaves, the fuller the nodes are the fewer the levels there are in the tree. Thus, we will calculate the number of levels when each node has 9 child nodes, which will be $\log_9(5127 / 8) = 2.94136$, which rounds to 3.

5.

a.

$H_1 = R_3(z)W_2(x)R_2(z)W_2(y)R_1(x)R_3(x)R_3(y)W_1(x)$

Conflicting ops:

$W_2(x) < R_1(x)$ $W_2(x) < R_3(x)$ $W_2(x) < W_1(x)$

$W_2(y) < R_3(y)$

$H_2 = W_2(x)W_2(y)W_1(x)R_3(x)R_1(x)R_3(z)R_3(y)R_2(z)$

Conflicting ops:

$W_2(x) < W_1(x)$ $W_2(x) < R_3(x)$ $W_2(x) < R_1(x)$

$W_2(y) < R_3(y)$

$W_1(x) < R_3(x)$

$H_3 = W_2(y)W_2(x)W_1(x)R_3(y)R_2(z)R_1(x)R_3(x)R_3(z)$

Conflicting ops:

$W_2(y) < R_3(y)$

$W_2(x) < W_1(x)$ $W_2(x) < R_1(x)$ $W_2(x) < R_3(x)$

$W_1(x) < R_3(x)$

$H_4 = R_3(y)W_2(y)R_2(z)W_1(x)R_3(x)W_2(x)R_3(z)R_1(x)$

Conflicting ops:

$R_3(y) < W_2(y)$

$W_1(x) < R_3(x)$ $W_1(x) < W_2(x)$

$R_3(x) < W_2(x)$

$W_2(x) < R_1(x)$

H2 and H3 have their conflicting operations in the same order.

They are conflict equivalent

b.

$H_1 = R_3(z)W_2(x)R_2(z)W_2(y)R_1(x)R_3(x)R_3(y)W_1(x)$

$W_2(x) < R_1(x)$: T2 -> T1

$W_2(x) < R_3(x)$: T2 -> T3

Serializable, serial history: T2 -> T1 -> T3

$H_2 = W_2(x)W_2(y)W_1(x)R_3(x)R_1(x)R_3(z)R_3(y)R_2(z)$

$W_2(x) < W_1(x)$: T2 -> T1

$W_2(x) < R_3(x)$: T2 -> T3

$W_1(x) < R_3(x)$: T1 -> T3

Serializable, serial history: T2 -> T1 -> T3

$H_3 = W_2(y)W_2(x)W_1(x)R_3(y)R_2(z)R_1(x)R_3(x)R_3(z)$

$W_2(y) < R_3(y)$: T2 -> T3

$W_2(x) < W_1(x)$: T2 -> T1

$W_1(x) < R_3(x)$: T1 -> T3

Serializable, serial history: T2 -> T1 -> T3

$H_4 = R_3(y)W_2(y)R_2(z)W_1(x)R_3(x)W_2(x)R_3(z)R_1(x)$

$R_3(y) < W_2(y)$: T3 -> T2

$W_1(x) < R_3(x)$: T1 -> T3

$W_1(x) < W_2(x)$: T1 -> T2

$R_3(x) < W_2(x)$: T3 -> T2

Not serializable

c. H2, H3

$H_1 = R_3(z)W_2(x)R_2(z)W_2(y)R_1(x)R_3(x)R_3(y)W_1(x)$

T1 T2 T3

wlock(x)

rlock(z)

rlock(x)

rlock(z)

R3(z)

W2(x)

R2(z)

wlock(y)

W2(y)

R1(x)

R3(x)

R3(y)

W1(x)