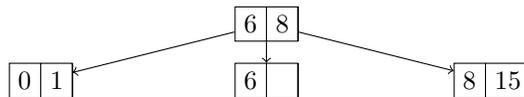


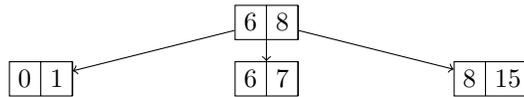
CSE 4/562 - Spring 2018 - Homework 2

Answer Key

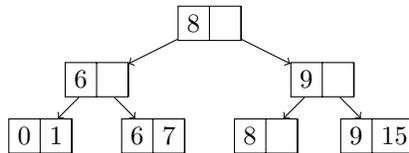
1 B+ Tree



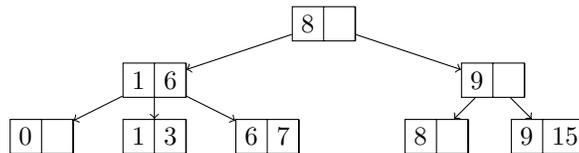
- Insert 7 at the leaf node [6|], the node is not full so we can add it and return



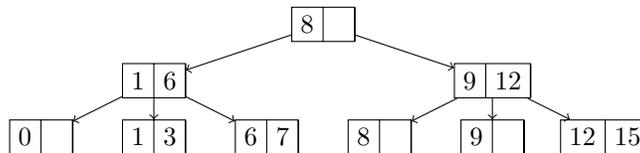
- Insert 9 at the leaf node [8|15], the node is full so we split it into nodes [8|] and [9|15] and add 9 to the root node [6|8]. The root node is full so we split it into child nodes [6|] and [9|] and parent node [8|].



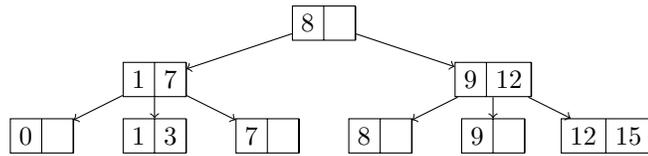
- Insert 3 at the leaf node [0|1], the node is full so we split it into nodes [0|] and [1|3] and add 1 to the root node [6|]



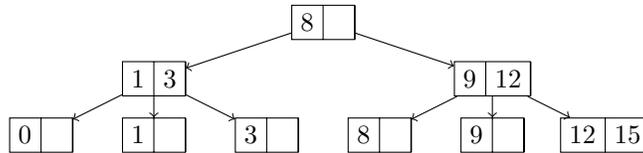
- Insert 12 at the leaf node [9|15], the node is full so we split it into nodes [9|] and [12|15] and add 12 to the root node [9|]



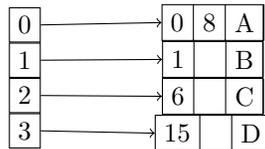
- Remove 6 from the leaf node [6|7] and update the root accordingly, the node is at least half-full so we return



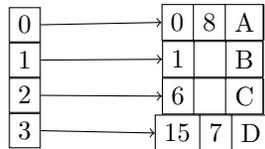
- Remove 7 from the leaf node [7 |], the node is now less than half full so we borrow element 3 from sibling node [1|3] and update the root accordingly



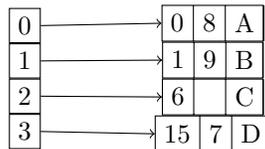
2 Dynamic Hash Index



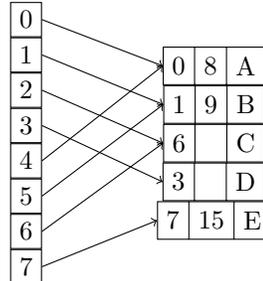
- Insert 7 into bucket D pointed to by field $3 \equiv 7 \pmod{4}$, the bucket is not full so we return



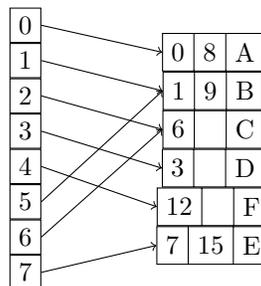
- Insert 9 into bucket B pointed to by field $1 \equiv 9 \pmod{4}$, the bucket is not full so we return



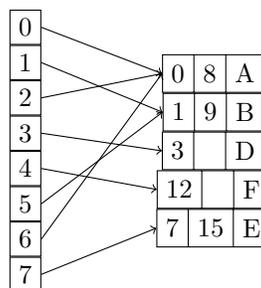
- Insert 3 into bucket D pointed to by field $3 \equiv 3 \pmod{4}$, the bucket is full so we split it. To add the new bucket E we must grow the table's size to the next power of 2 which is 8. We set each new field i to point to the old bucket at field $i \bmod 4$ except for 7 which points to the new bucket E. We redistribute the elements of bucket D, element 3 goes to bucket D pointed to by field $3 \equiv 3 \pmod{8}$ and elements 7 and 15 go to bucket E pointed to by field $7 \equiv 15 \pmod{8}$.



- Insert 12 into bucket A pointed to by field $4 \equiv 12 \pmod{8}$. This bucket is full so we split it, adding new bucket F and setting field 4 to point to it. We redistribute the elements of bucket A. Elements 0 and 8 go to bucket A pointed to by field $0 \equiv 8 \pmod{8}$ and element 12 goes to bucket F pointed to by field $4 \equiv 12 \pmod{8}$



- Remove 6 from bucket C. Bucket C is now empty so merge it into bucket A by updating pointers for fields 6 and 2 to point to bucket A.



- Remove 7 from bucket E. The bucket is not empty so we return.

