CS 411 Database Systems **Homework 3**

Spring 2023

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1. Searching B+ Trees

1.1.

SELECT * FROM table WHERE ID = 12

Solution : B0, B1, B3

1.2.

SELECT * FROM table WHERE ID <= 41

Solution : B0, B1, B3, B4, B5

1.3.

SELECT * FROM table WHERE ID > 68

Solution : B0, B2, B6, B7, B8

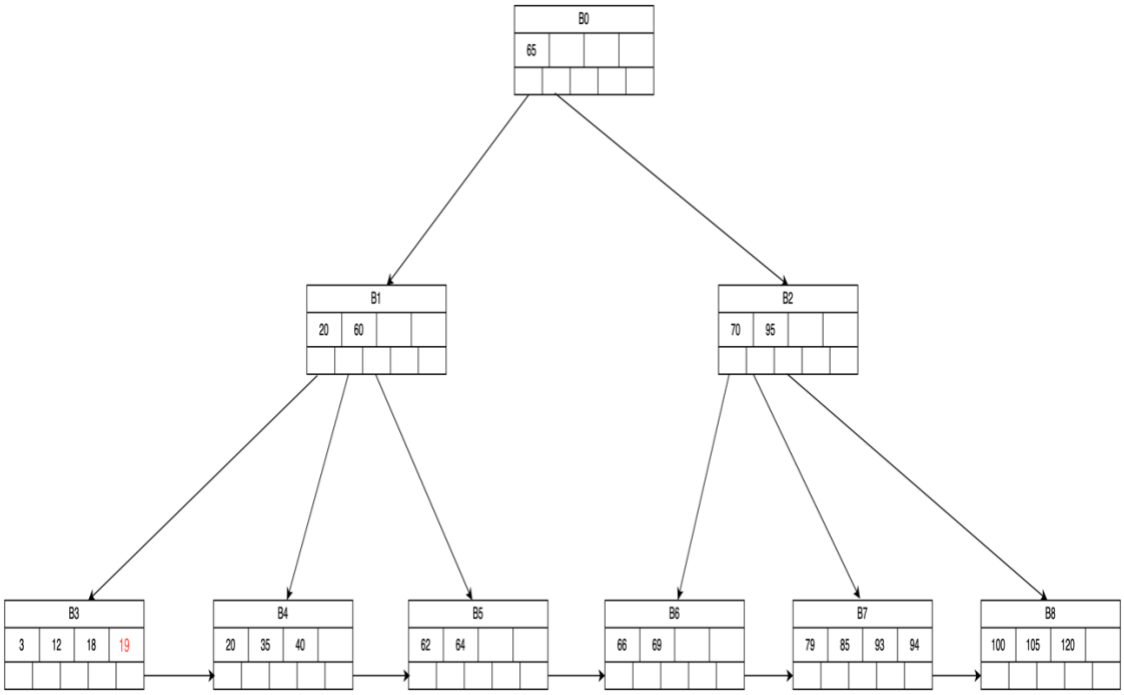
1.4.

SELECT * FROM table WHERE ID > 80 AND ID < 120

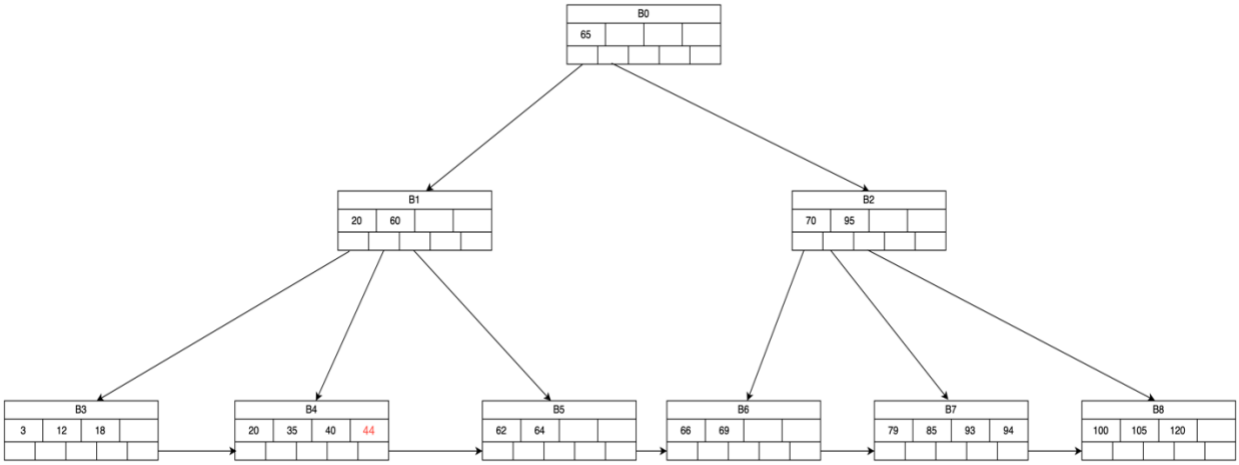
Solution: B0, B2, B7, B8

2. Insertion in a B+ Tree

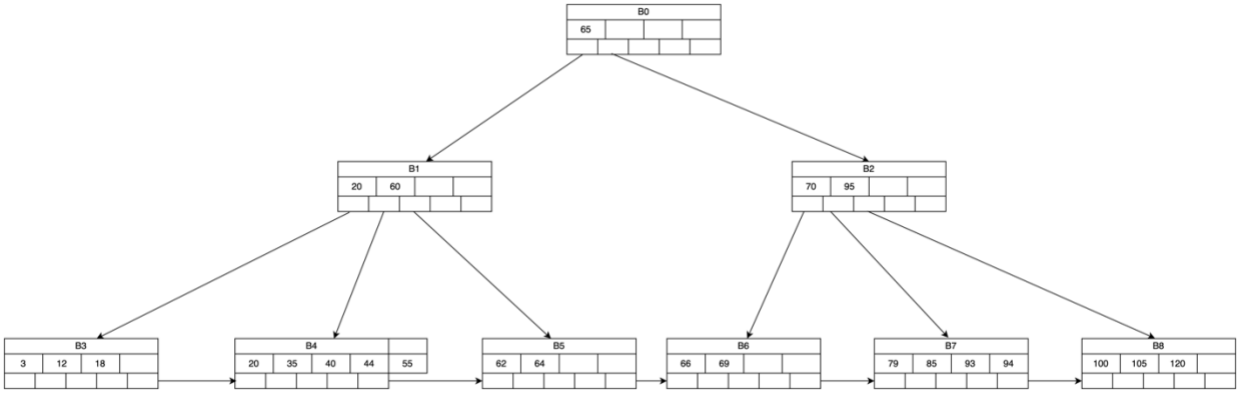
2.1. Insert 19 in B0->B1->B3



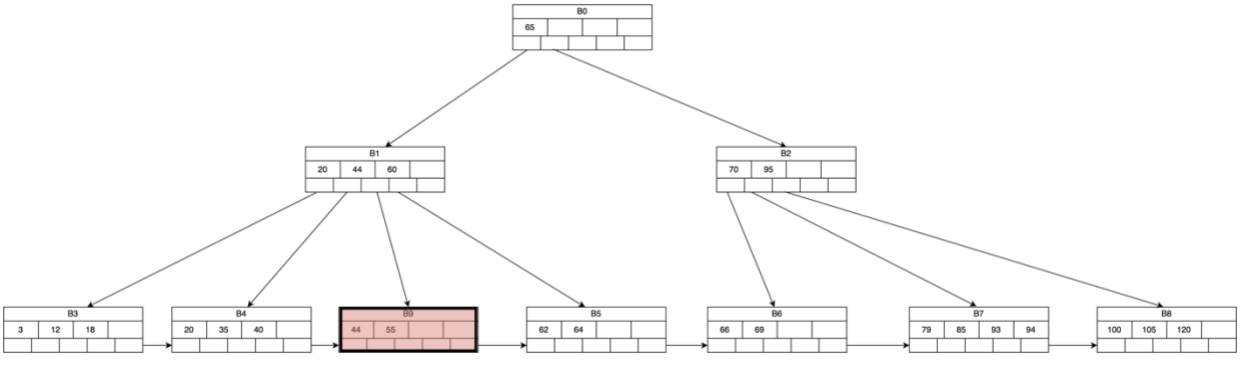
2.2. After inserting 44 -> Insert 44 at B3



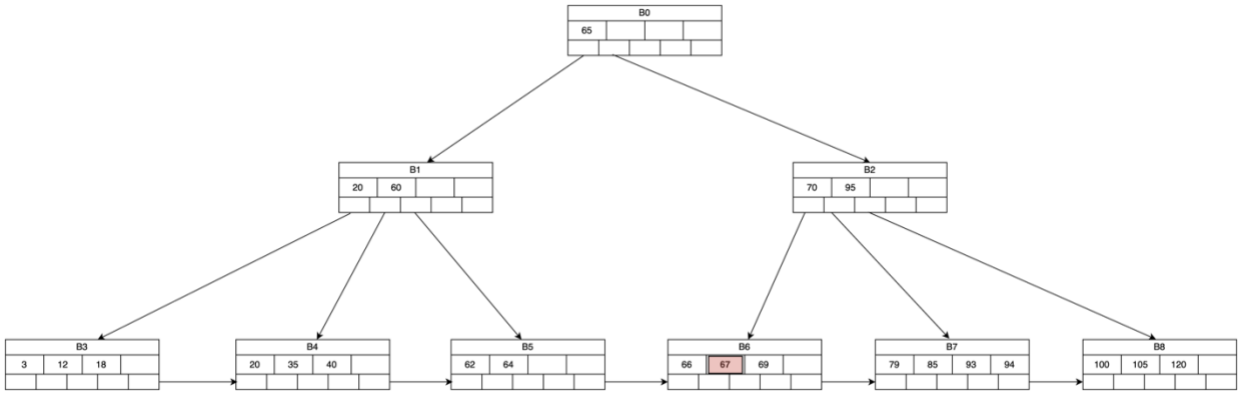
After inserting 55



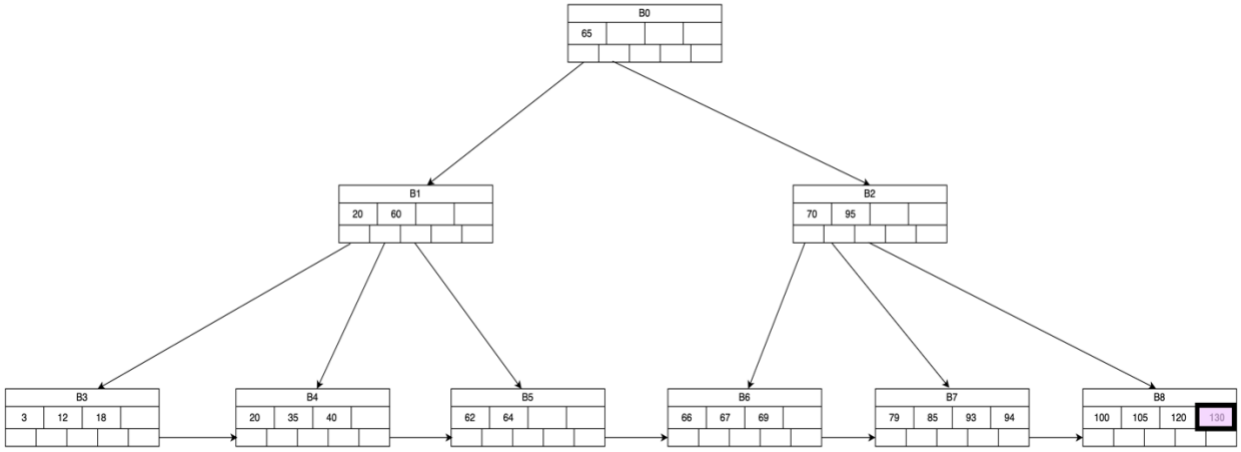
Splitting



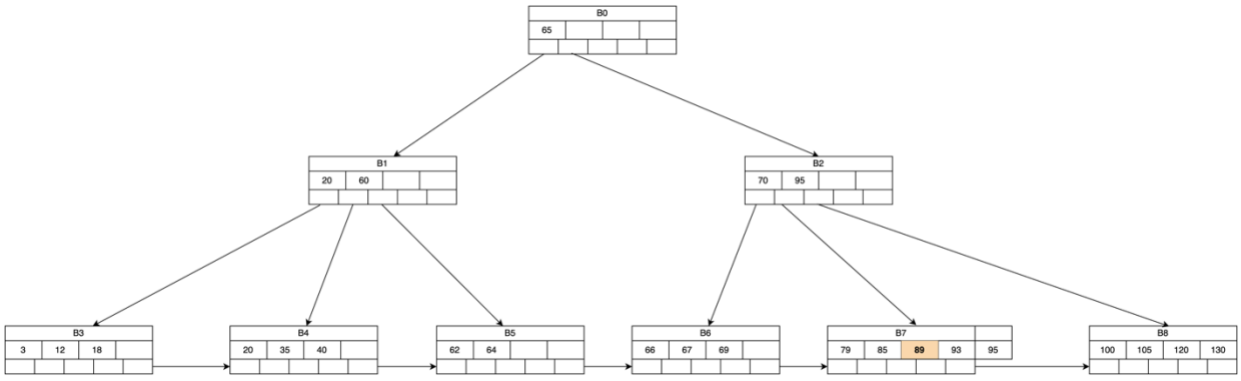
2.3. After inserting 67



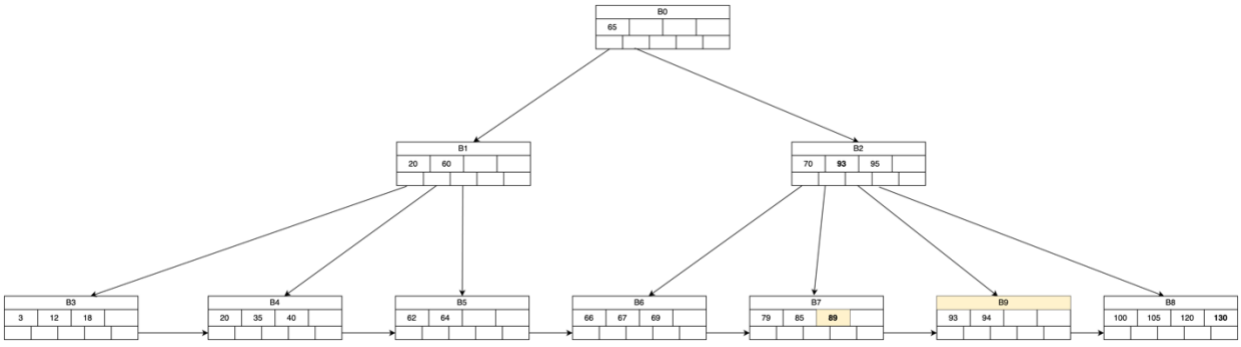
After inserting 130



After inserting 89

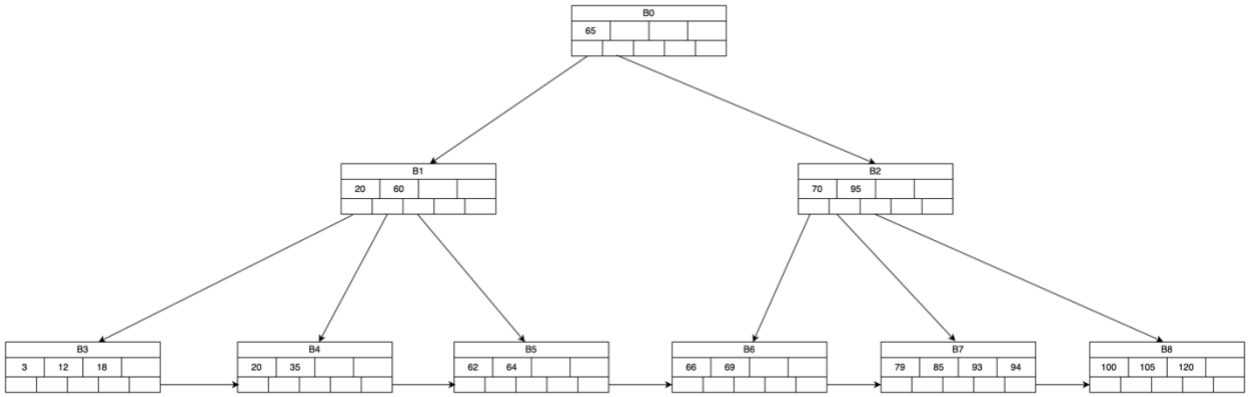


Now we have to split the block B7

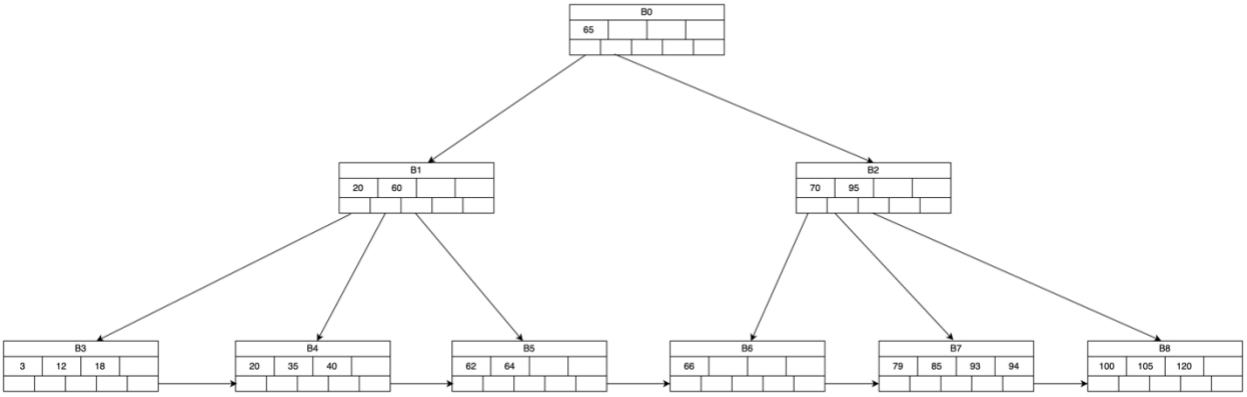


3. Deletion from a B+ Tree

3.1. Deletion of 40 – traverse B0->B1->B4

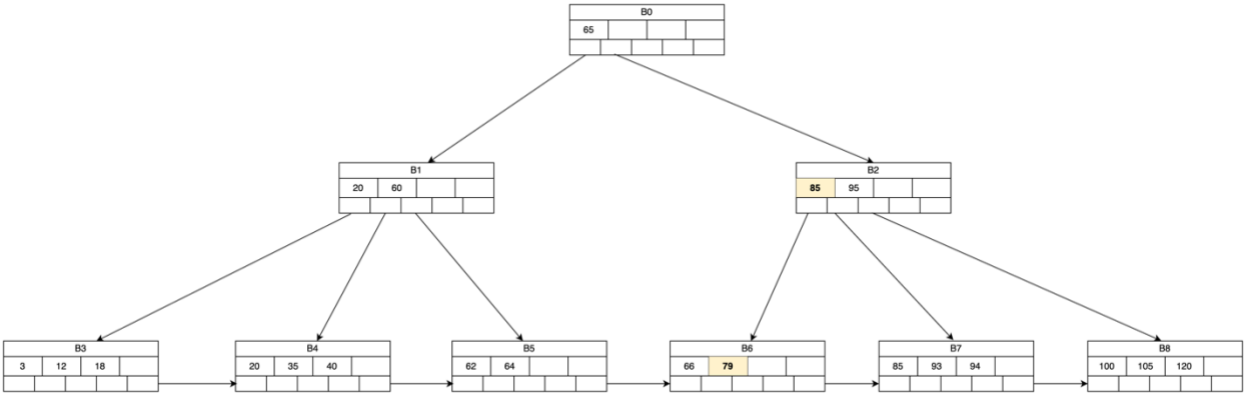


3.2. Remove 69- Traverse B0->B1->B6



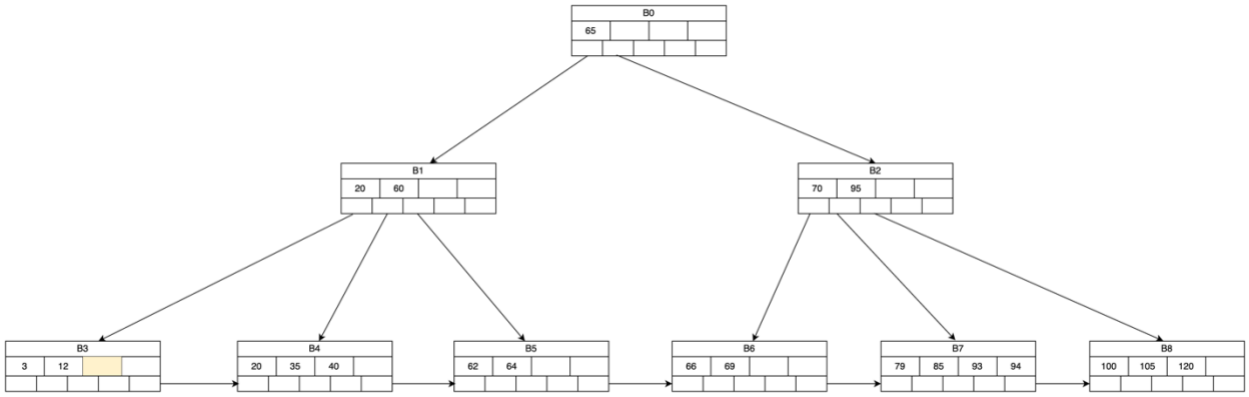
Since B6 has only one value , it will borrow from right sibling

After Rotation

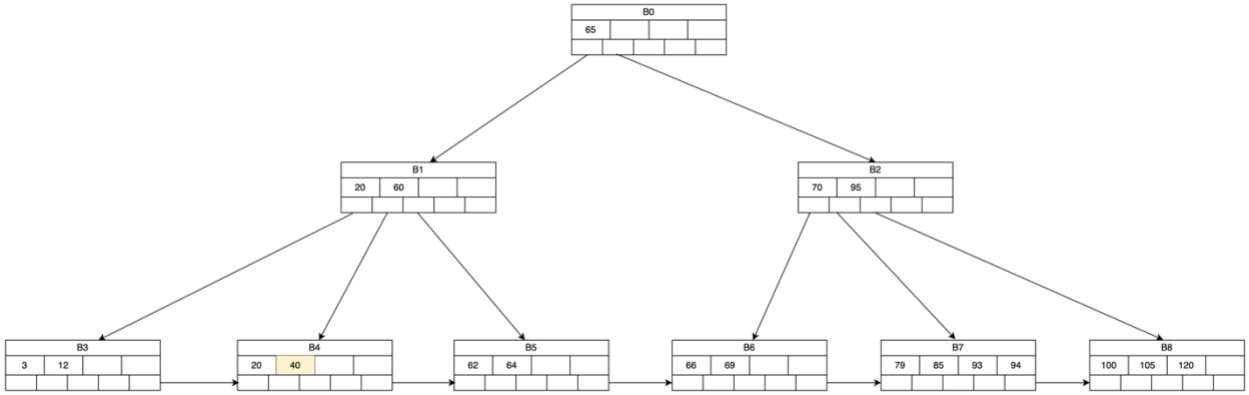


3.3.

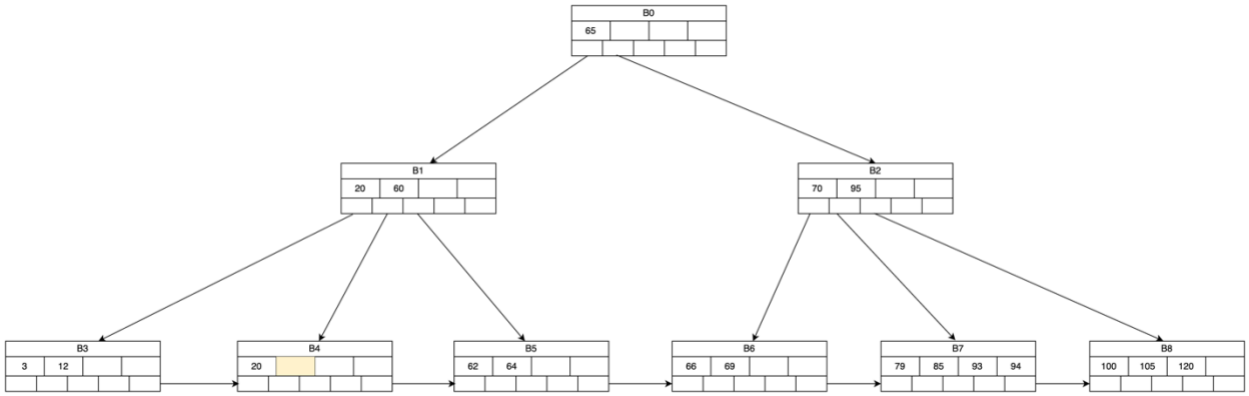
Remove 18 from B3



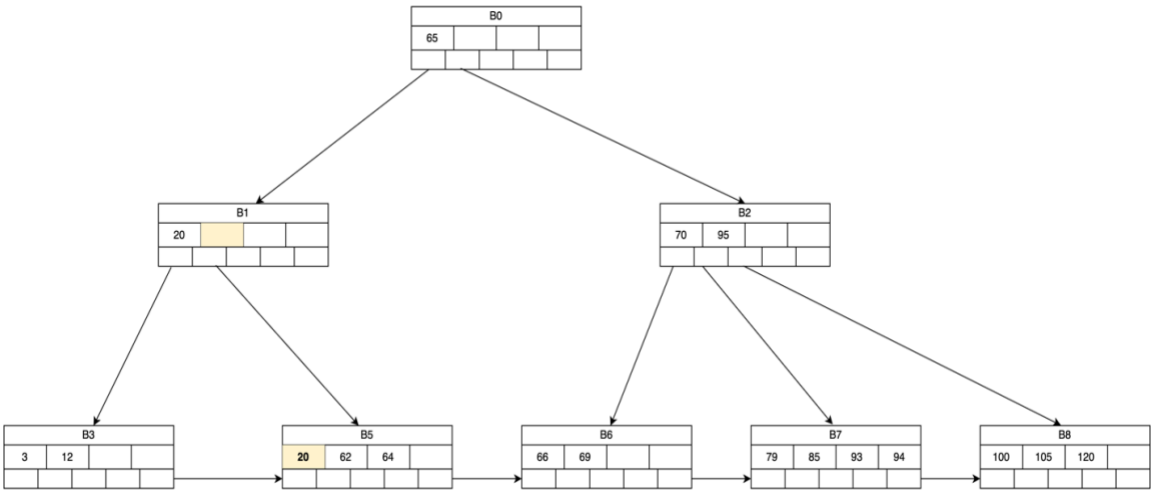
Delete 35 from B4



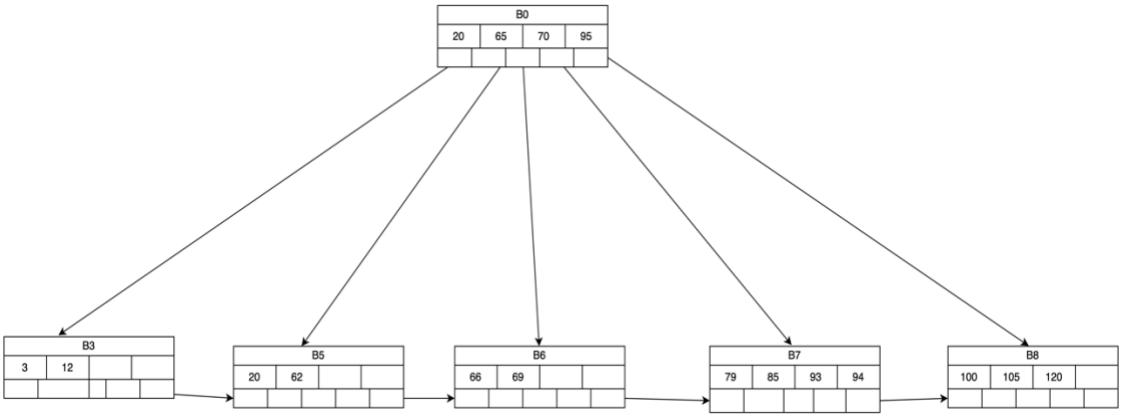
Delete 40 – B4 becomes unbalanced



Rotation not possible. So Nodes B4 and B5 are merged.
Parent Node is updated

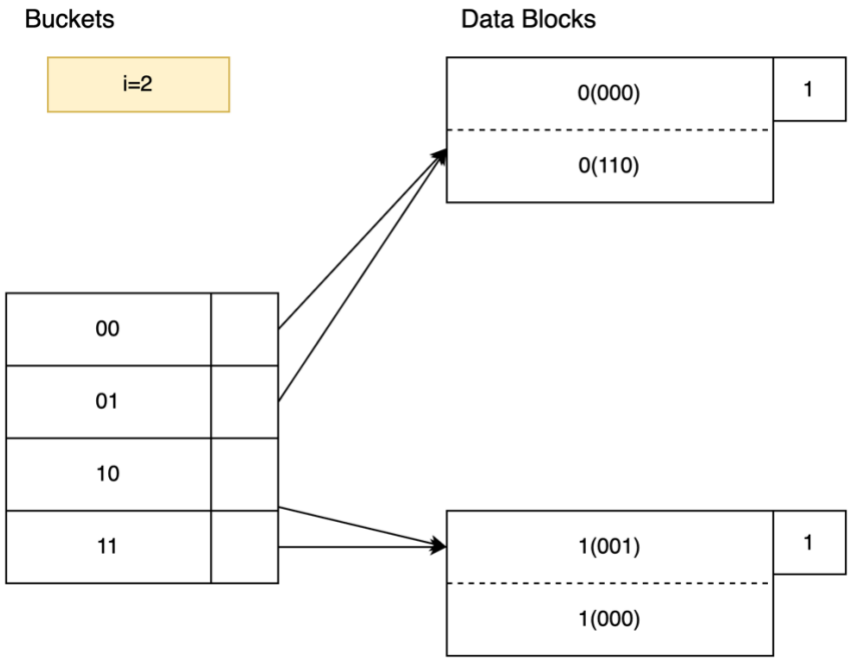


Now B1 is unbalanced. Hence merge B1, B0, B2

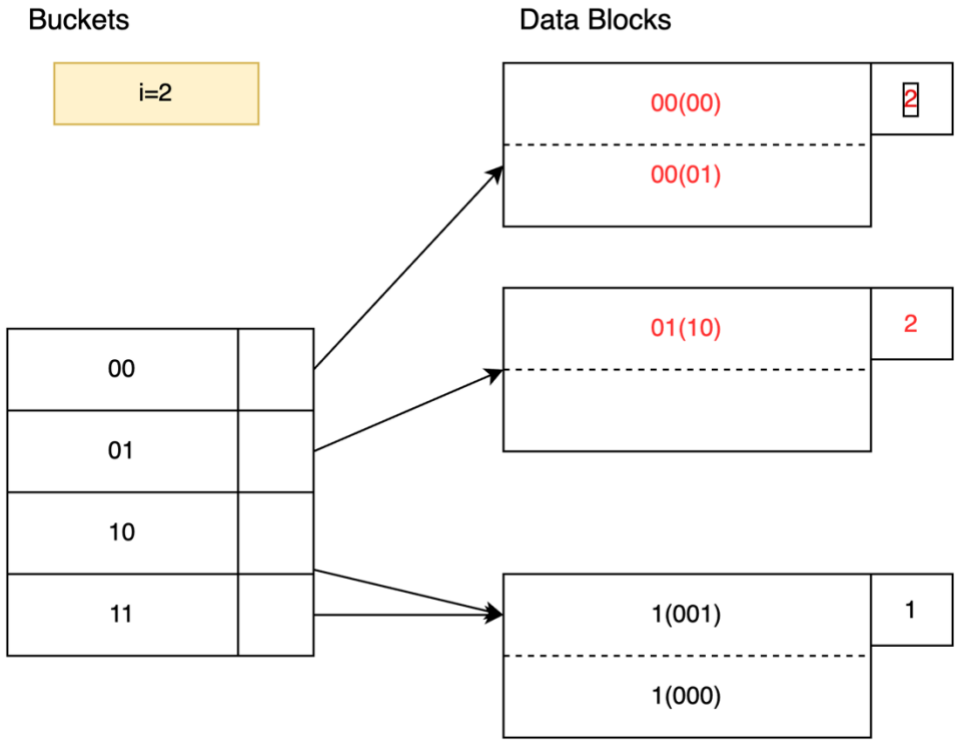


4. Extensible Hash Table

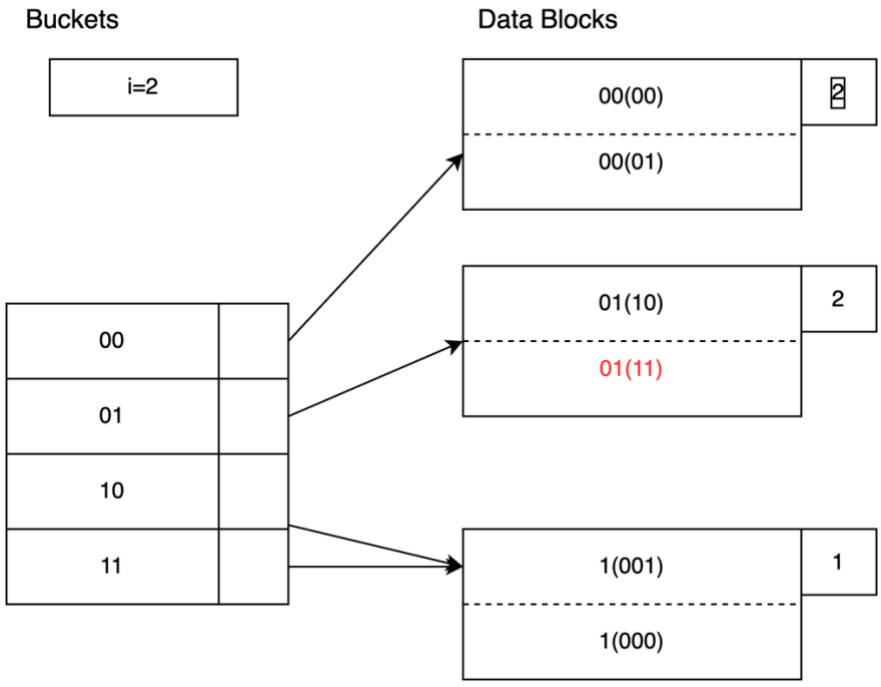
4.1. Insert 0001 – Step 1: increase buckets i=2



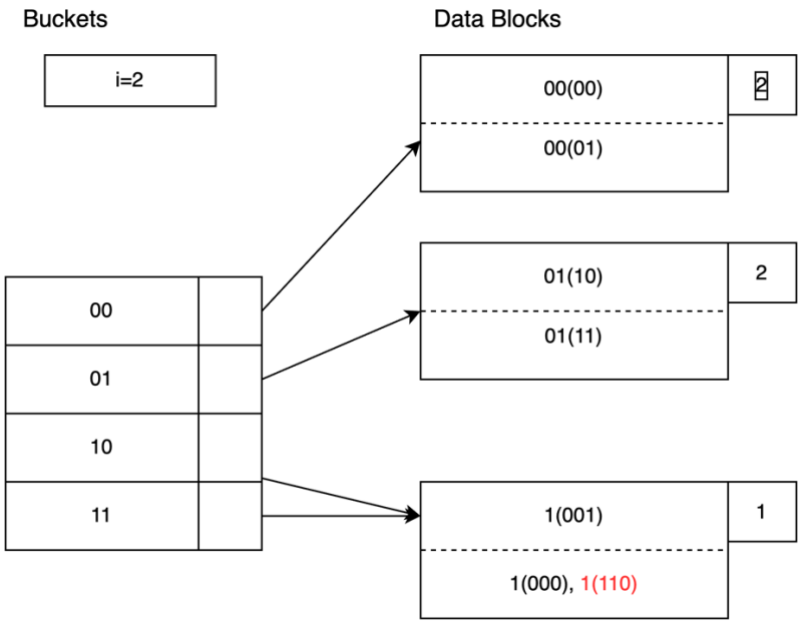
Step 2: Insert 0001



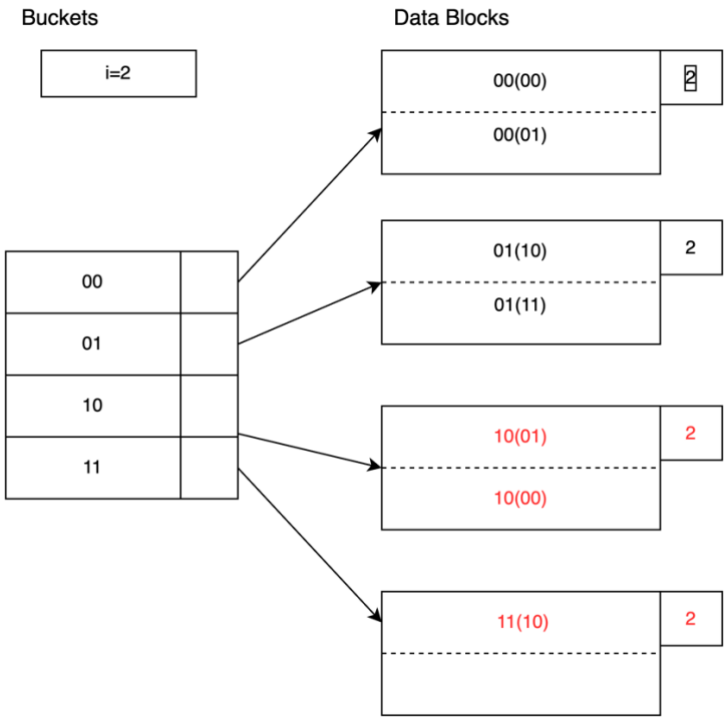
4.2. Insert 0111



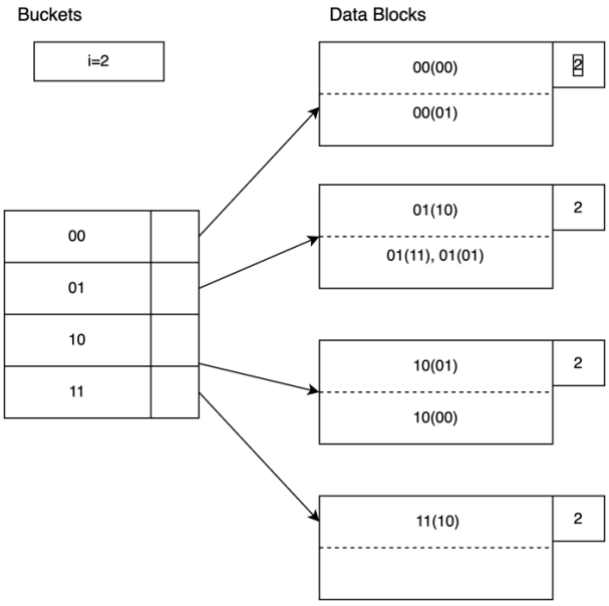
4.3. Insert 1110



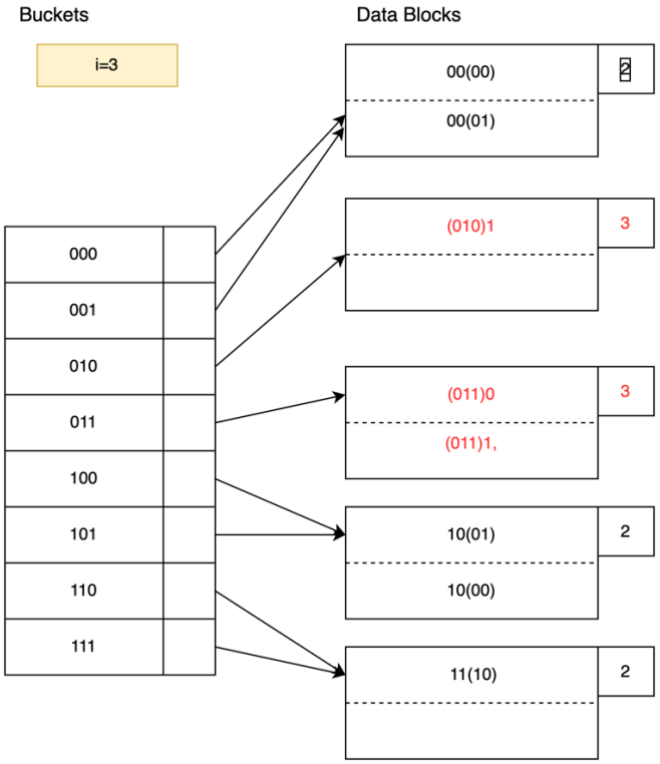
Need to add a new block



4.4. Insert 0101

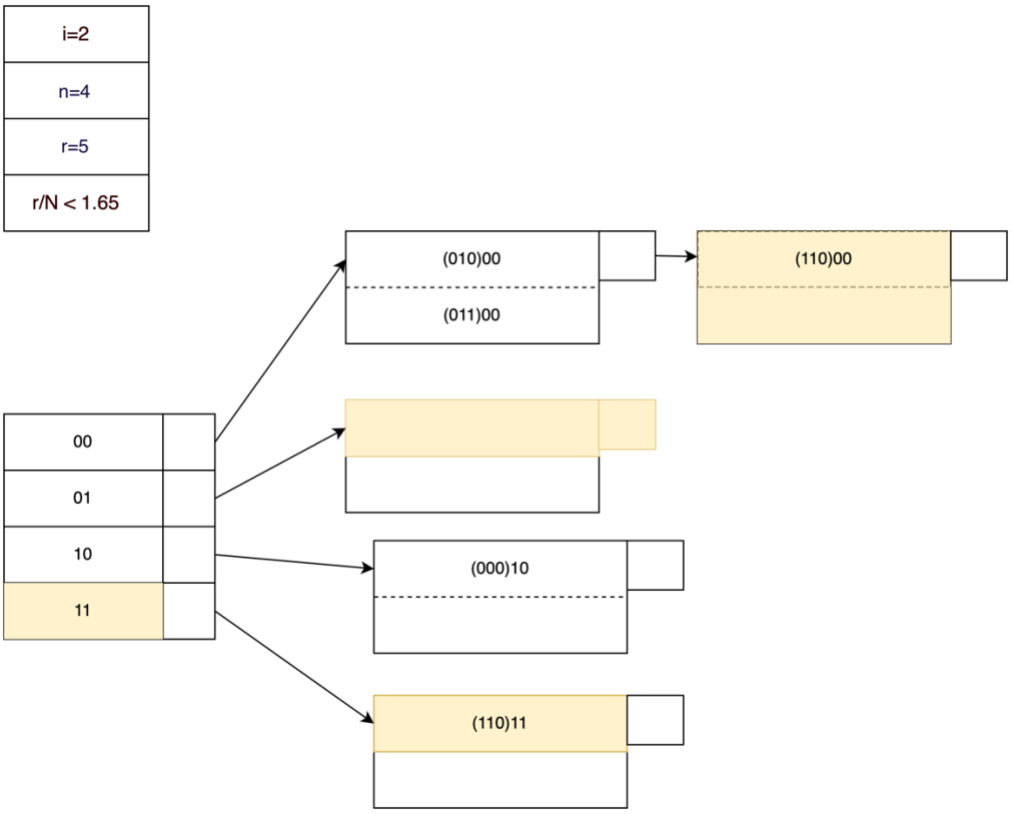


Need to extend the buckets as block is full, make i=3

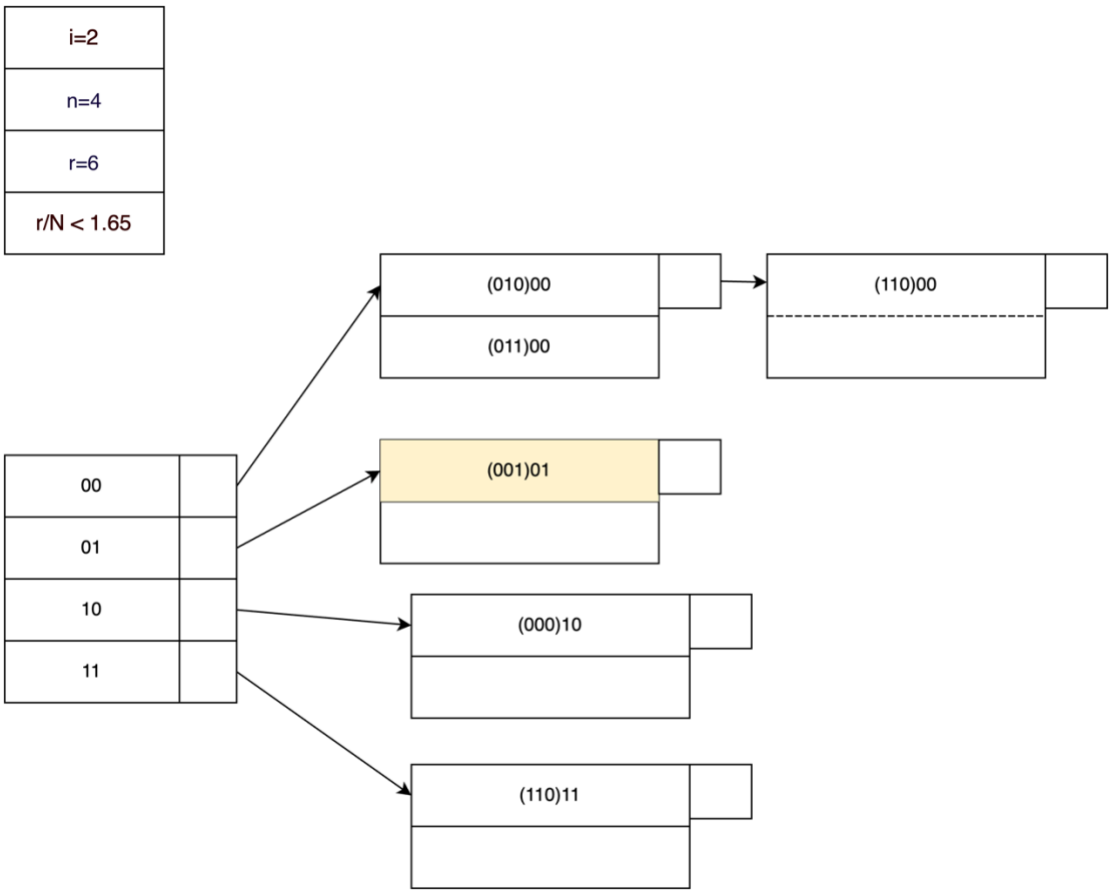


5. Linear HashTable

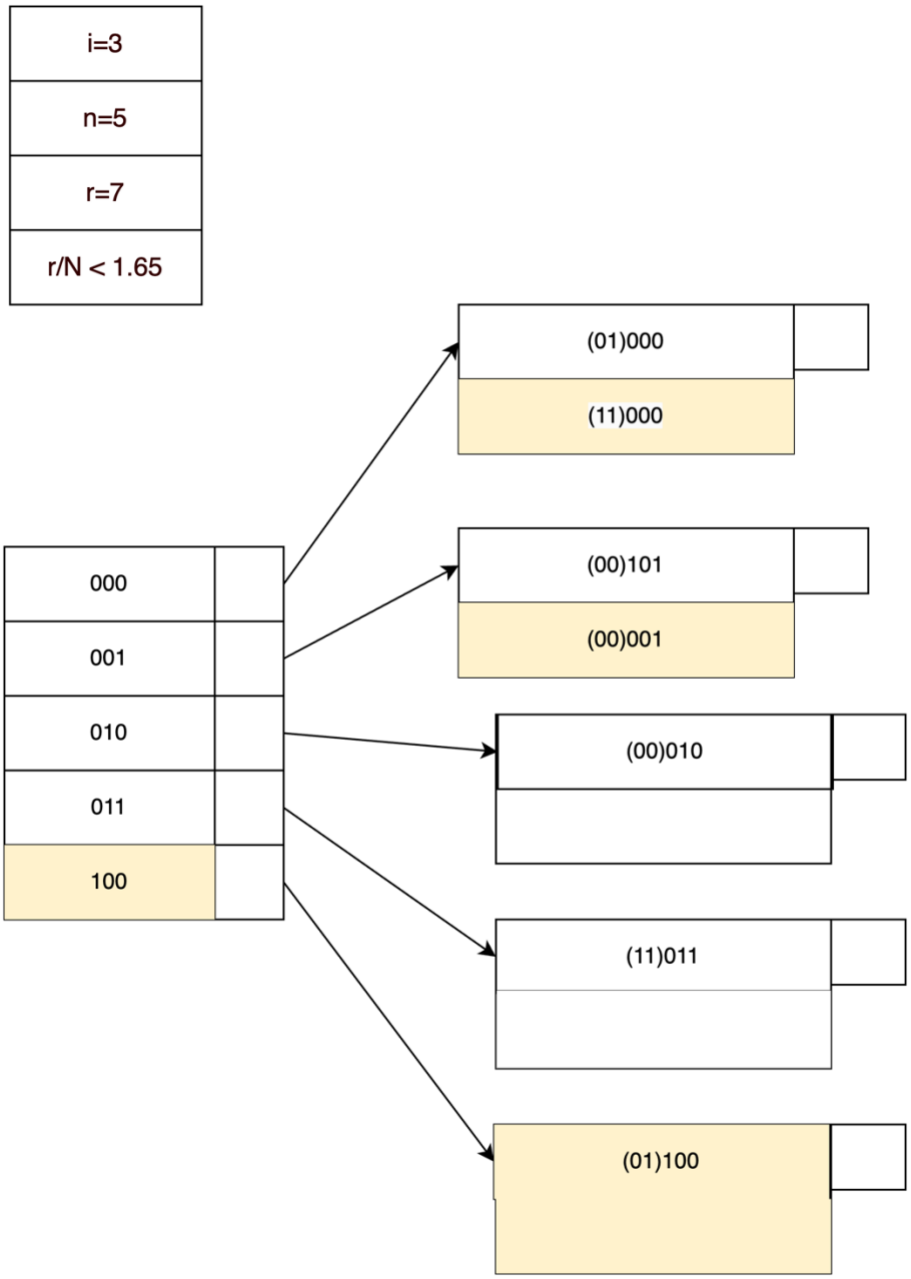
- **Insert 11000**
  r = 5 n=3 ; r/n = 5/3 = 1.67> 1.65
  Hence introduce a new bucket 11 . Rearrange the entries from MSB flipped bucket (01) and add the new entry 11000 in 00 bucket as overflow block .



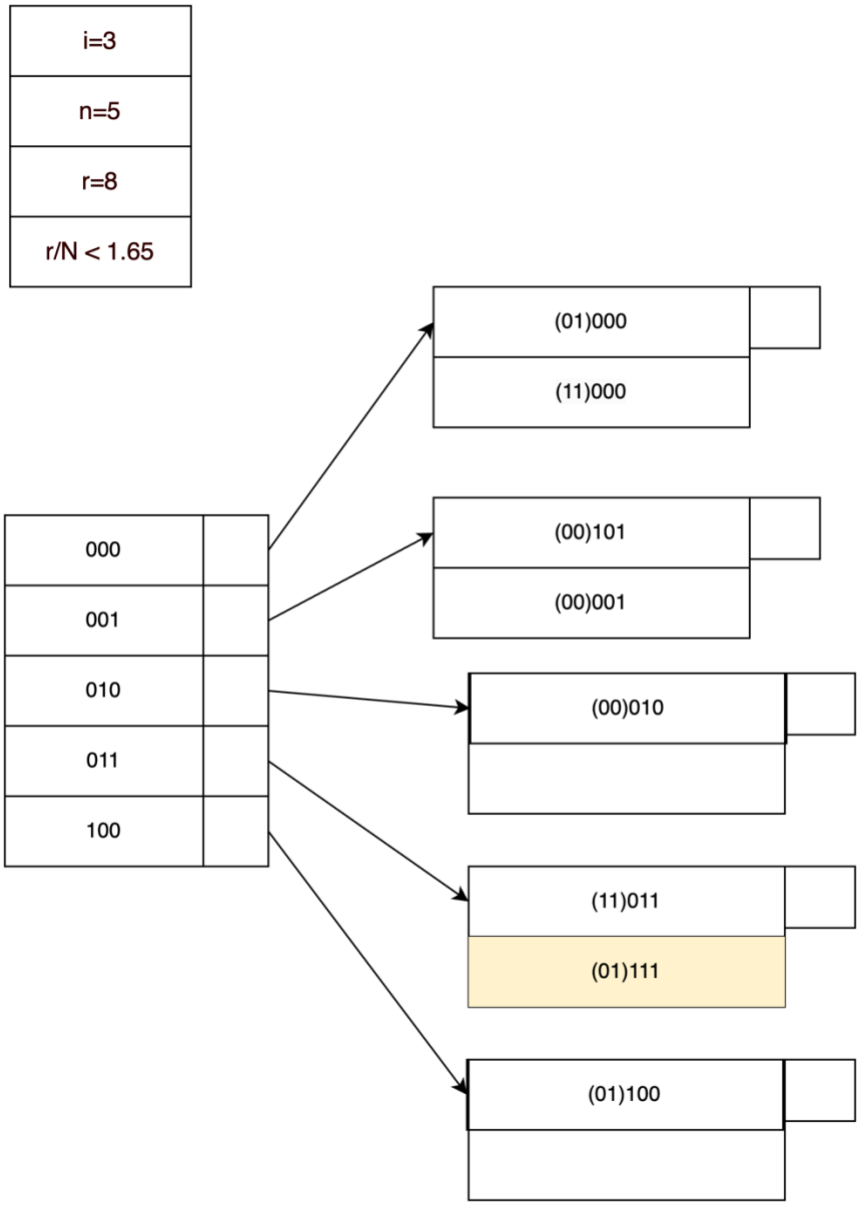
- **Insert 00101**
  r=6 n=4; r/n = 6/4= 1.5 <1.65 . Hence directly insert in 01 bucket


i=2
n=4
r=6
r/N < 1.65
(010)00
(011)00
(110)00
00
01
10
11
(001)01
(000)10
(110)11

- Insert 00001
  r=7; n=4; r/n = 7/4 =1.75 >1.65
  hence need to extend bucket array to add a new bucket 100. Rearrange entries from 000 - move 00100 from 000 to 100 bucket.
  Now insert 00001 to bucket 001



- Insert 01111
  r=8 n=5; r/n = 8/5 = 1.6 < 1.65
  As bucket 111 isn't present , flip MSB to get 011 and now insert it in bucket 011



6.