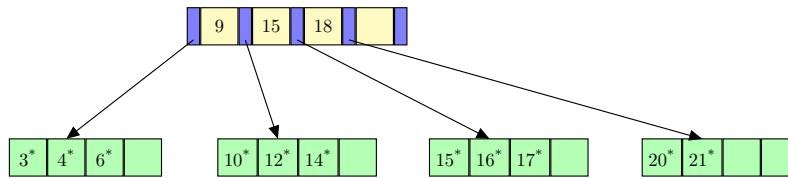
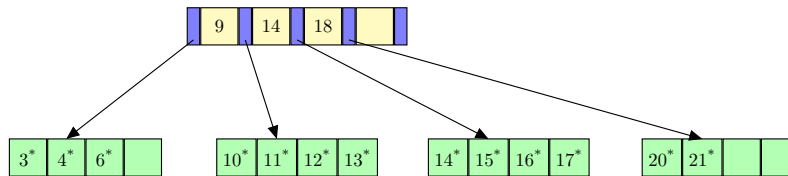


Q1

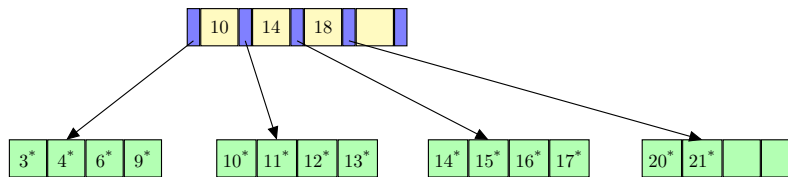
Initial B^+ -tree.



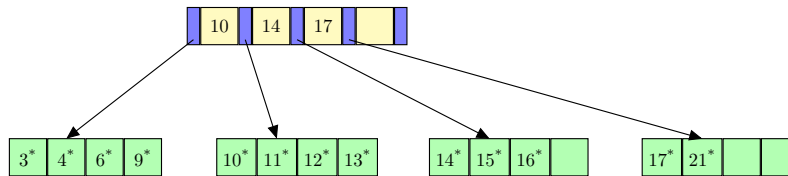
Insert 11^* , 13^*



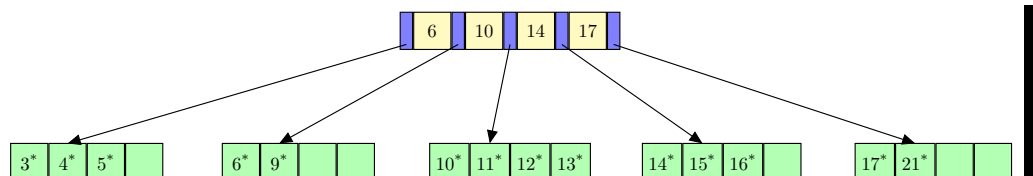
Insert 9^*



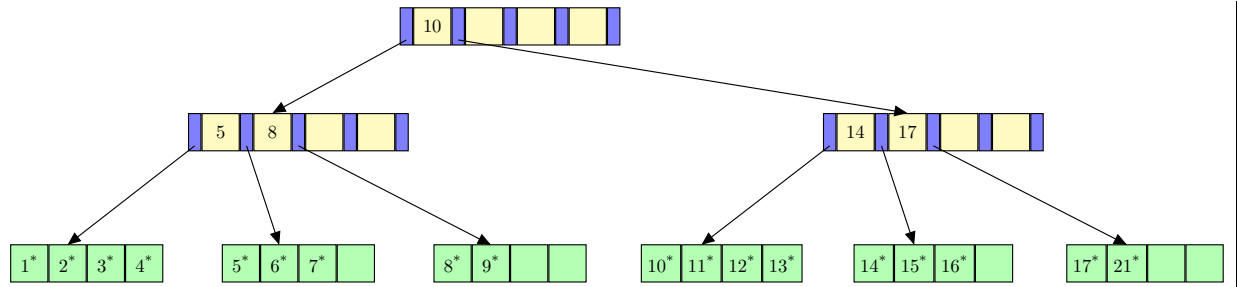
Delete 20^*



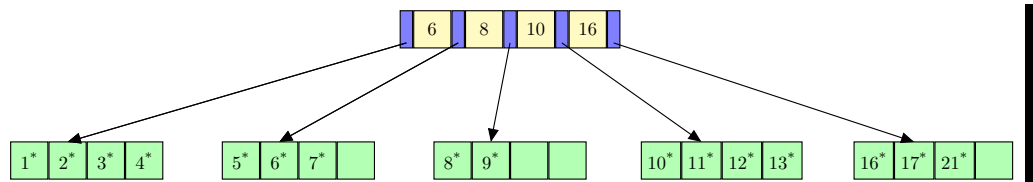
Insert 5^*



Insert 1^* , 2^* , 7^* , 8^*



Delete 14*, 15*



Q2

(1)

Average fanout: $F = \frac{2}{3}(2d + 1) = 6$

Record pages: $\frac{2 \cdot 2^{10}}{4} = 2^9 = 512$

Leaf Nodes: $\frac{2 \cdot 2^{10}}{8 \cdot 67\%} = 383$

Height: $\log_F N = \log_6 2^9 \approx 4$

(2)

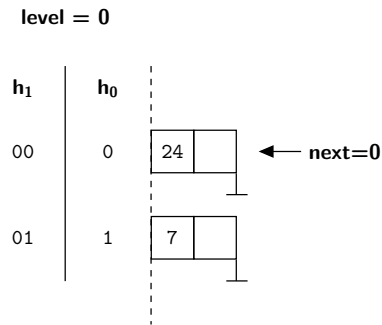
$$512 + 383 + 4 - 1 = 898$$

(3)

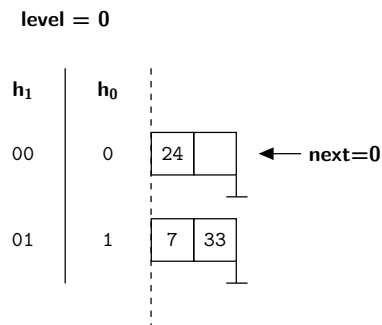
$$2048 + 383 + 4 - 1 = 2434$$

Q3

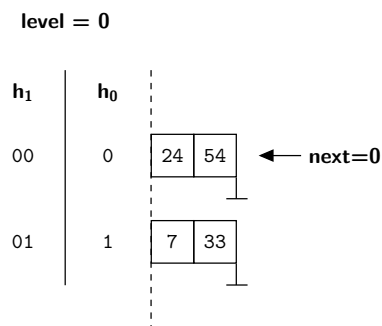
Initial linear hashing indexes



Insert 33 = (100001)

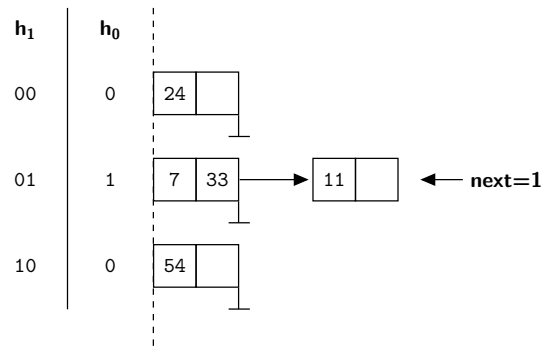


Insert 54 = (110110)



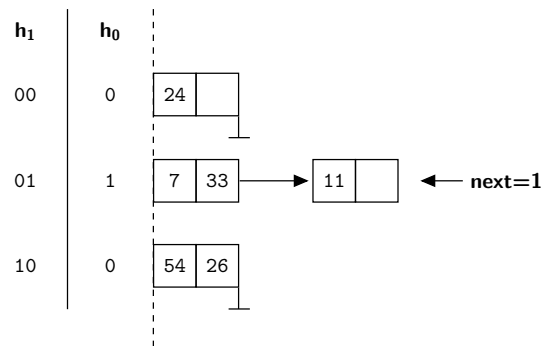
Insert 11 = (001011)

level = 0



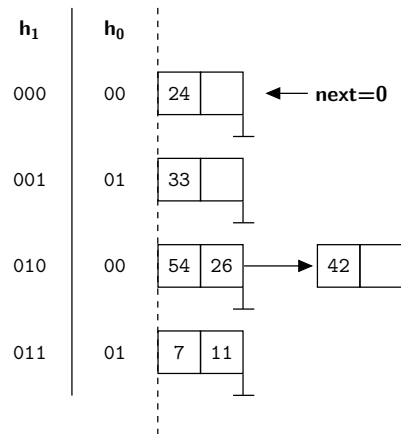
Insert 26 = (011010)

level = 0



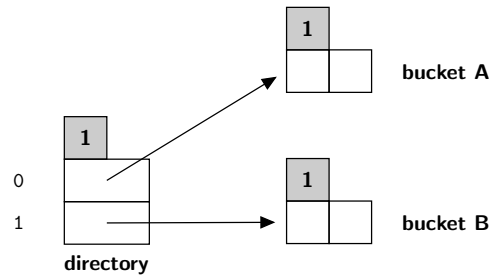
Insert 42 = (101010)

level = 1

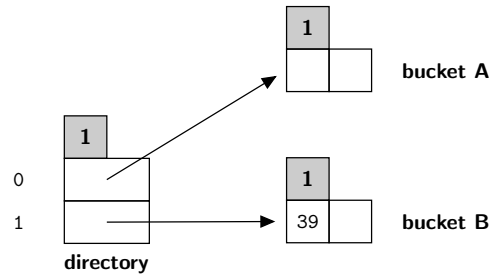


Q4

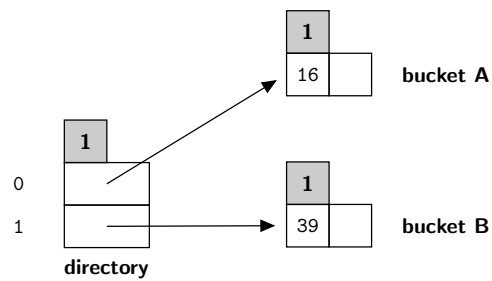
Original



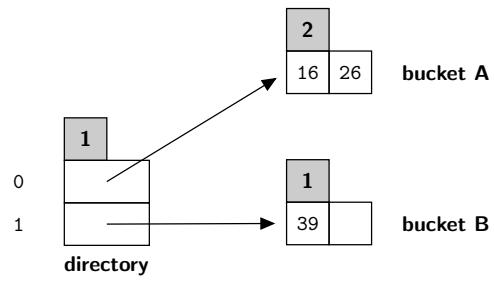
Insert 39 = (100111)



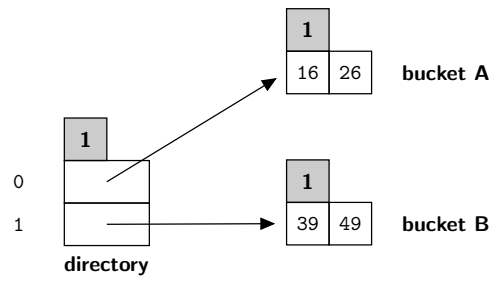
Insert 16 = (010000)



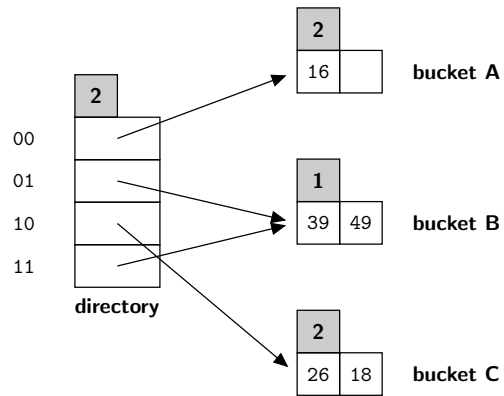
Insert 26 = (011010)



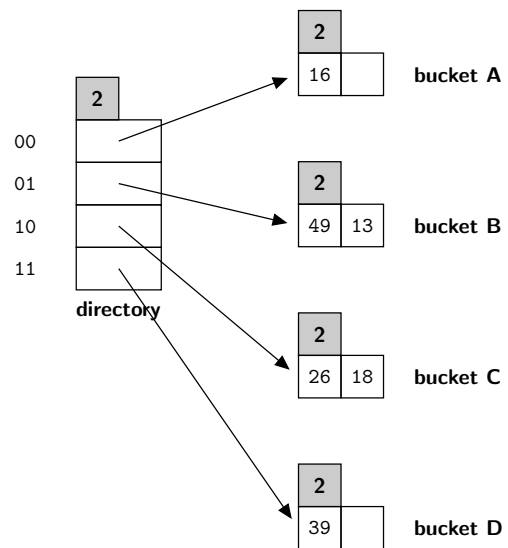
Insert 49 = (110001)



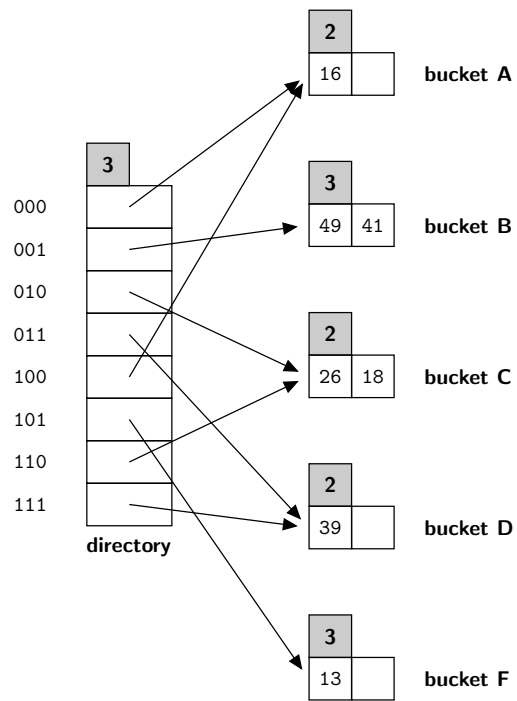
Insert 18 = (010010)



Insert 13 = (001101)



Insert 41 (101001)



Q5

$$N = 1T \div 32KB = 2^{30} \div 2^5 = 2^{25}$$

$$B = 2^{23} \div 2^5 = 2^{18}$$

$$b = 32KB = 2^5$$

(1)

$$Pass = 1 + \text{ceil}\left(\log_{B-1} \text{ceil}\left(\frac{N}{2B-4}\right)\right) = 2$$

(2)

$$2N * 15 = 15 * 2^{26}$$

(3)

$$1 + \text{ceil}\left(\log_{\text{floor}(\frac{B}{b})-1} \text{ceil}\left(\frac{N}{B}\right)\right) = 1 + \log_{2^{13}-1} 2^7 = 2$$

Q6

Page size = 1KB

$$8 + 16x + 8 < 1024$$

63 records per page

$$N = \frac{10000}{63} \approx 159$$

$$\text{Height} = 2$$

$$B = 3$$

(1)

$$IO = 2N \left(1 + \text{ceil}\left(\log_{B-1} \text{ceil}\left(\frac{N}{B}\right)\right) \right) = 2226$$

(2)

Leaf node = 159

Non-leaf node = 13

Root = 1

$$IO = 159 + 13 + 1 = 173$$

(3)

$$\text{Average number of IOs for repeated insert} = \frac{2}{2} = 1$$

$$\text{Total IOs for repeated insert} = 10000 * 1 = 10000$$

Bulk loading requires fewer ISs by 9827