CS & IT ENGINEERING

Data Structure & Programming

Hashing

Lec- 01

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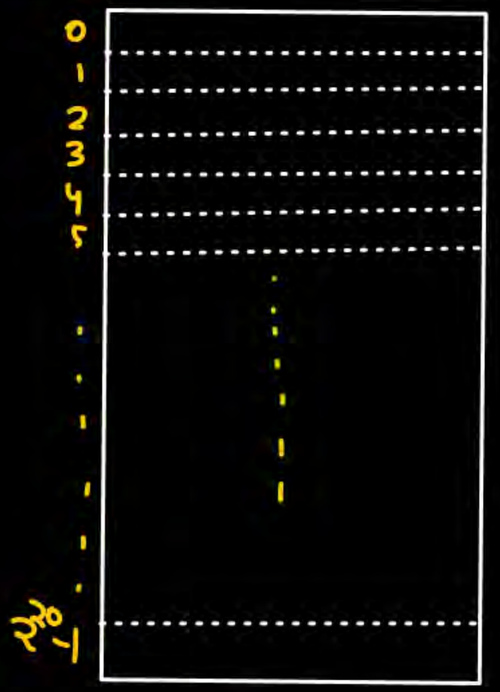
TOPICS TO
BE
COVERED
Hashing 01

DBMS

$n = 2^{20}$ elem $= 2^{10} \times 2^{10} = 1024 \times 1024 \approx 10^6$



no. of comp $= n$

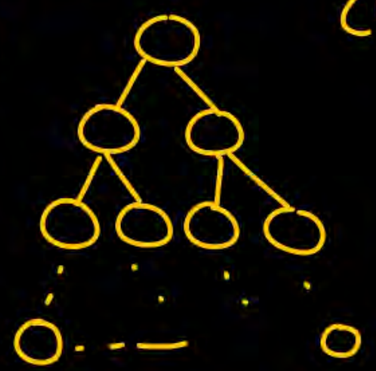
$= O(n)$

$\#ofcomp = 2^{20}$

BST ×

skewed BST

$\#comp = O(n)$



$\#comp = O(\log_2 n)$

AVL tree (height bal. search tree)

↓

n elements

↓

$\#$ of comp $= O(\log_2 n)$

$n = 2^{20}$

$\#$ of comp $= \log_2 2^{20} = 20$

B-tree

$m = 8$

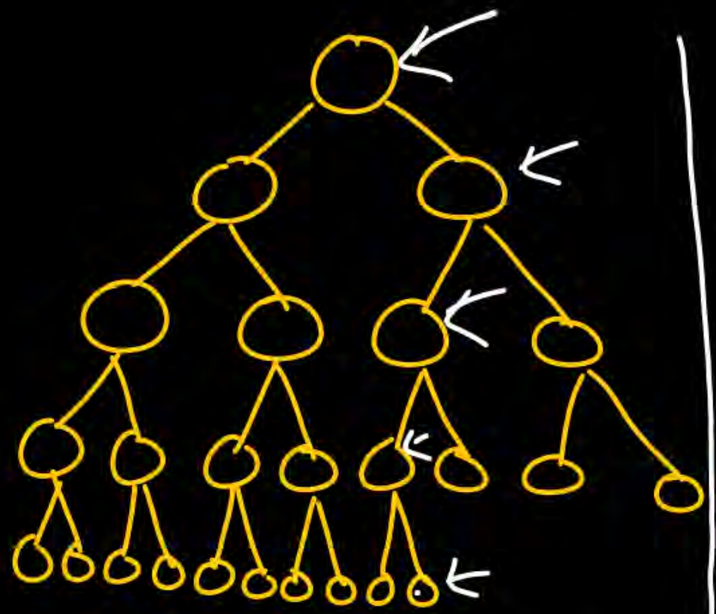
$O(\log_m n)$

$= \log_8 2^{20}$

$= \frac{20}{3} = 7$ comp

better

B-tree / B+-tree



Order of a node = 8

5 comp.

$O(\log_2 n)$

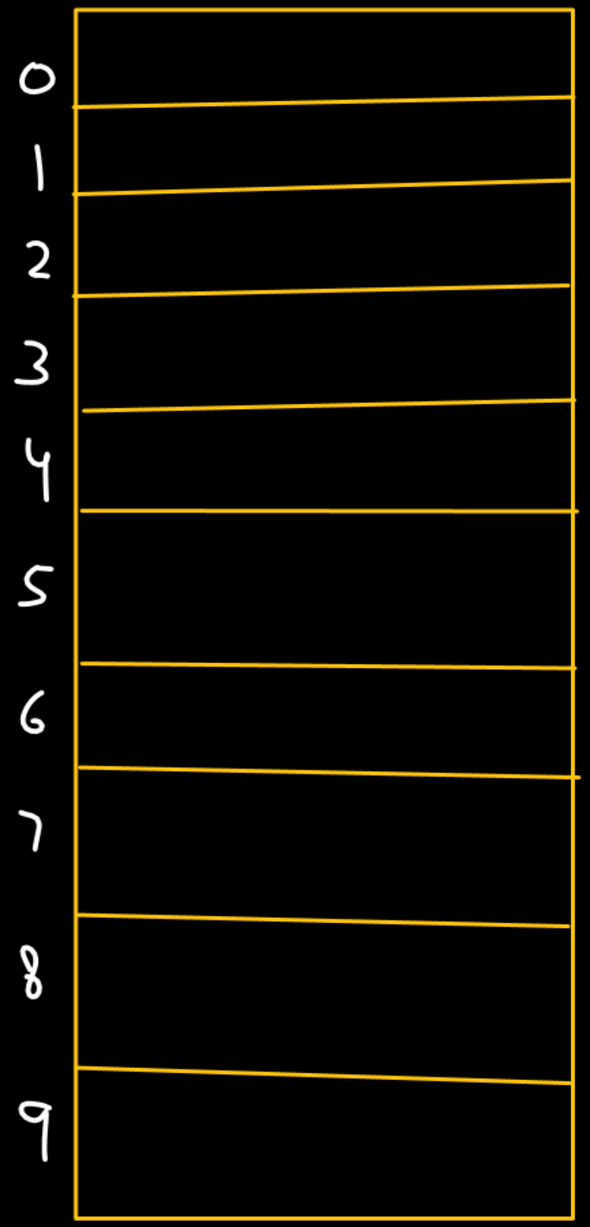
Goal : O(1)

$m = 10$

Keys : 13, 22, 15, 78, 86, 91, 107

$h(key) = Key \bmod 10$

$h(key) = (key) \bmod m$



$m = 10$

Keys : 13, 22, 15, 78, 86, 91, 107

$h(k) = k \bmod m$

$h(13) = 13 \bmod 10 = 3$

$h(22) = 22 \bmod 10 = 2$

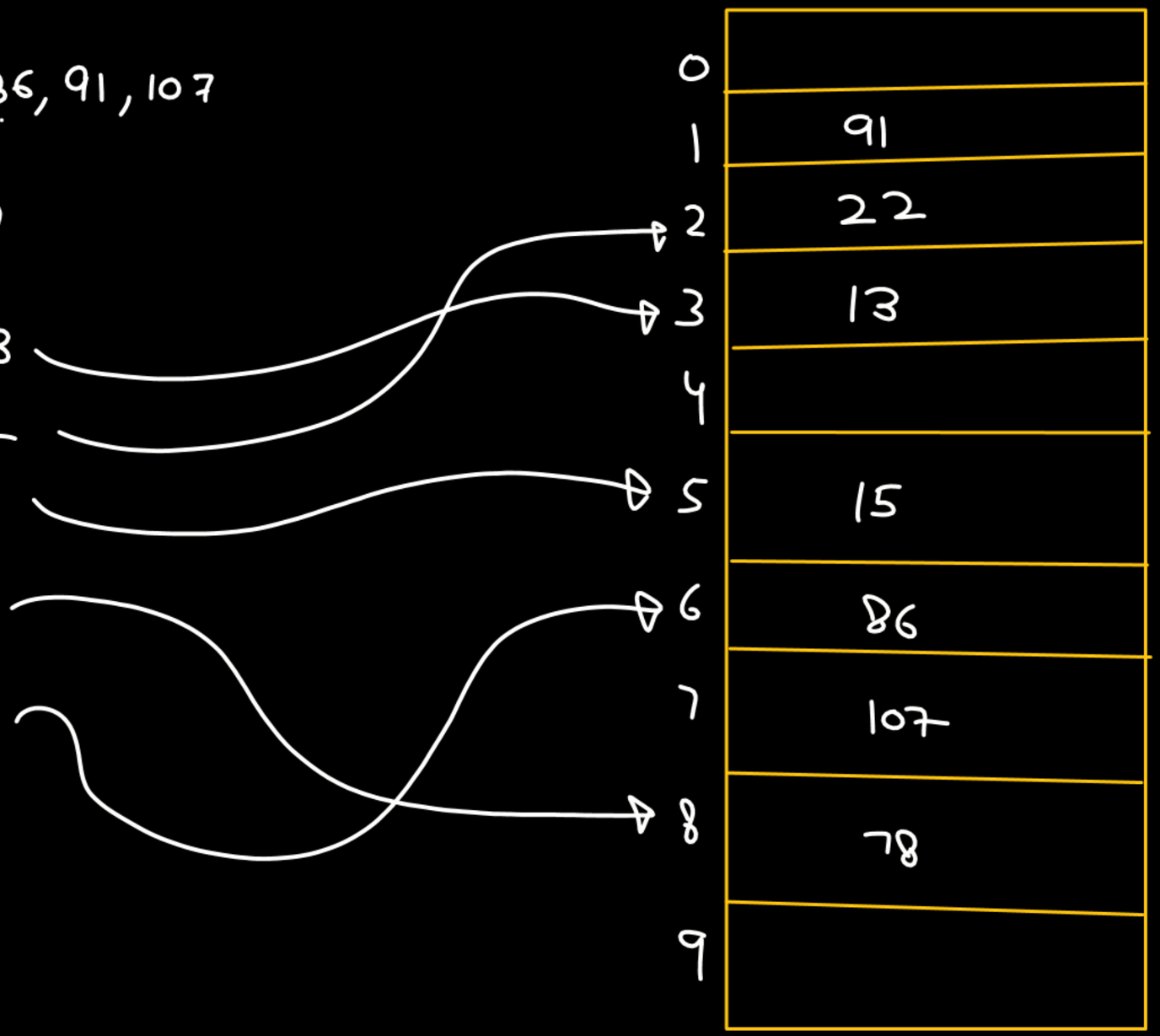
$h(15) = 15 \bmod 10 = 5$

$h(78) = 78 \bmod 10 = 8$

$h(86) = 86 \bmod 10 = 6$

$h(91) = 91 \bmod 10 = 1$

$h(107) = 107 \bmod 10 = 7$



$m = 10$

Keys : 12, 14, 16, 22, 38, 47

$h(k) = k \bmod m$

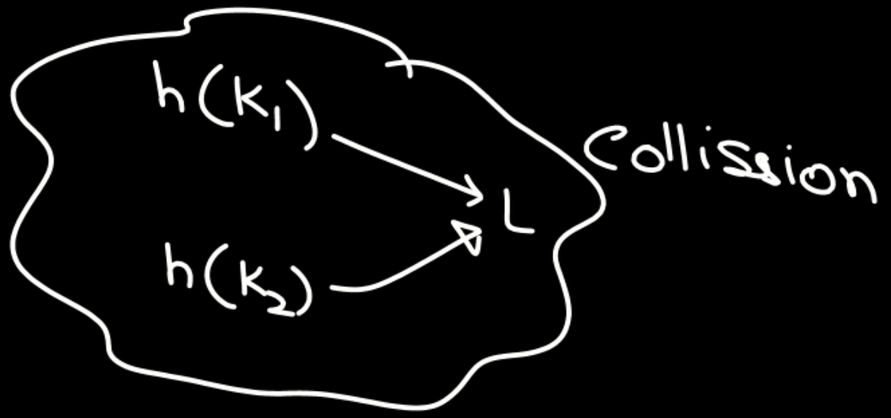
$h(12) = 2$

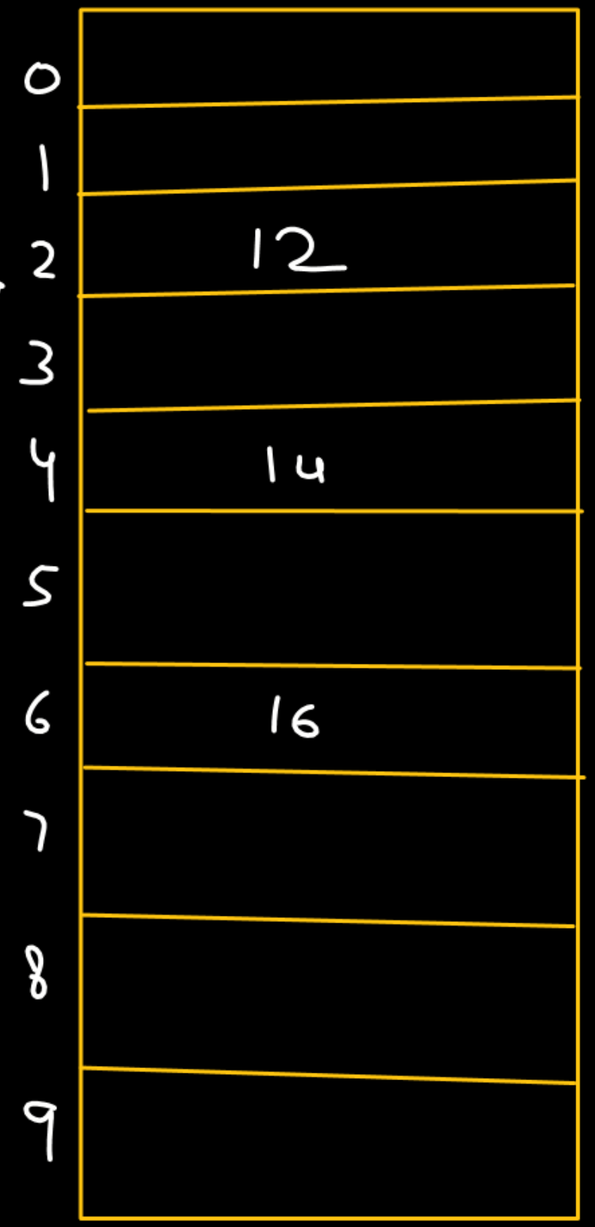
$h(14) = 4$

$h(16) = 6$

$h(22) = 2$

Collission

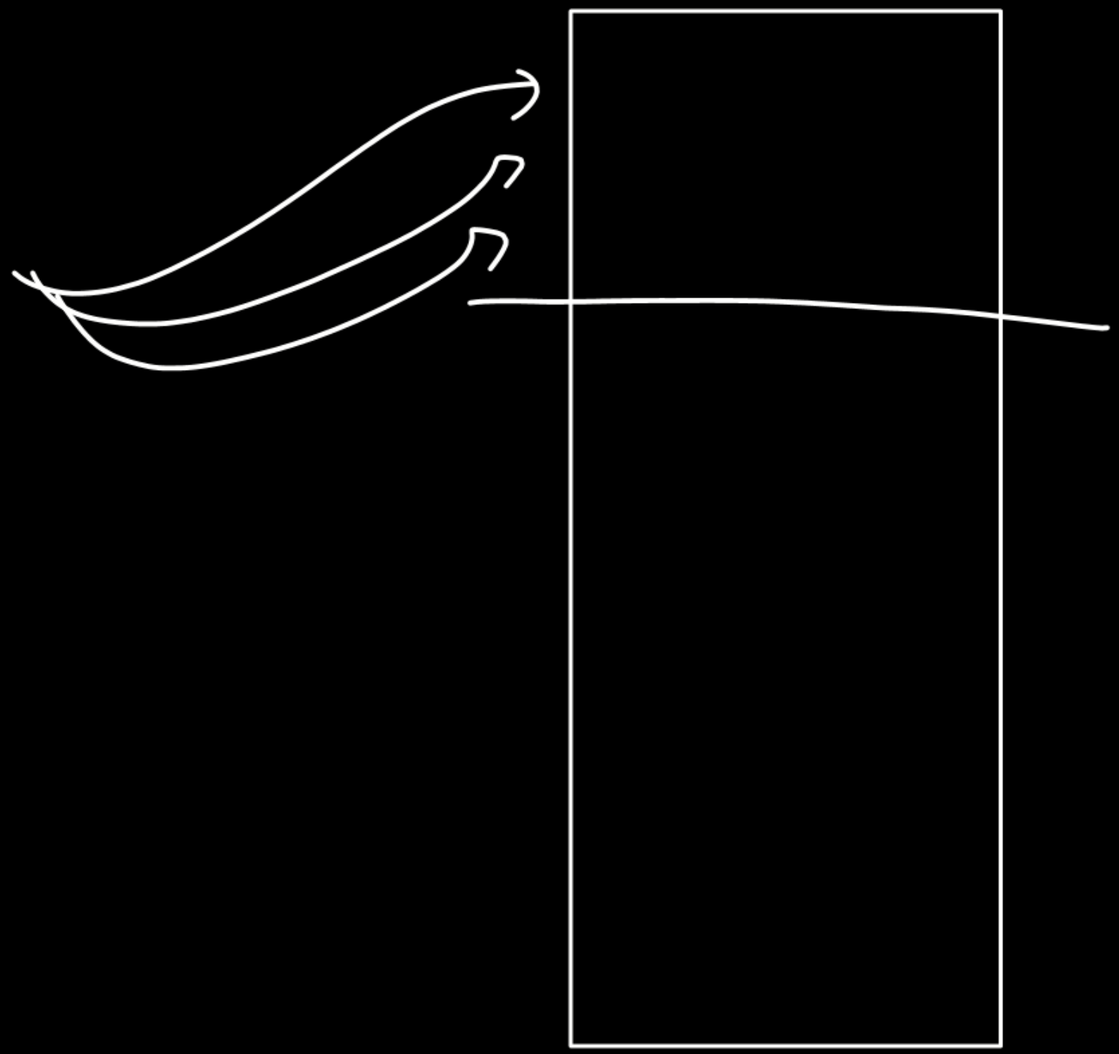




Good hash function

(i) Easy to compute

(ii) Uniformly distribute



Collission

↓

Collission resolution Tech.

not hashing tech

(i) Linear Probing
(ii) Quadratic Probing
(iii) Double hashing
(iv) Separate chaining

Hash function

$h(k) = k \bmod m$

$0, 1, \ldots m-1$

$h(k) = (k \bmod m) + 1$

$1, 2, \ldots m$

Linear Probing

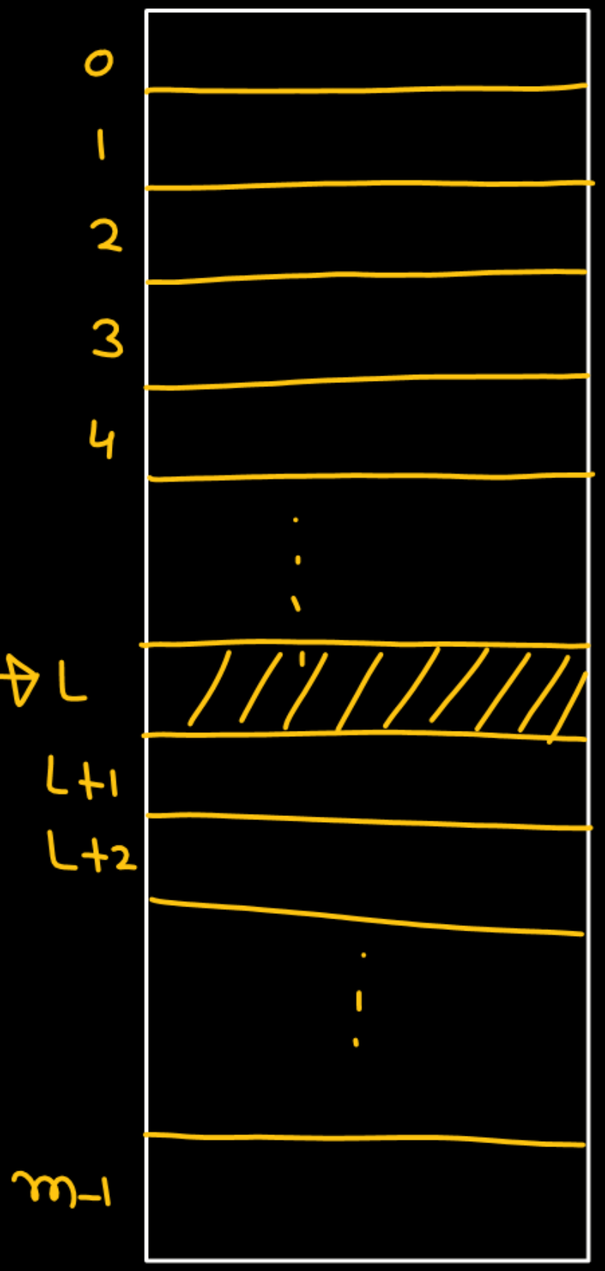
Let $h(k) = k \bmod m$

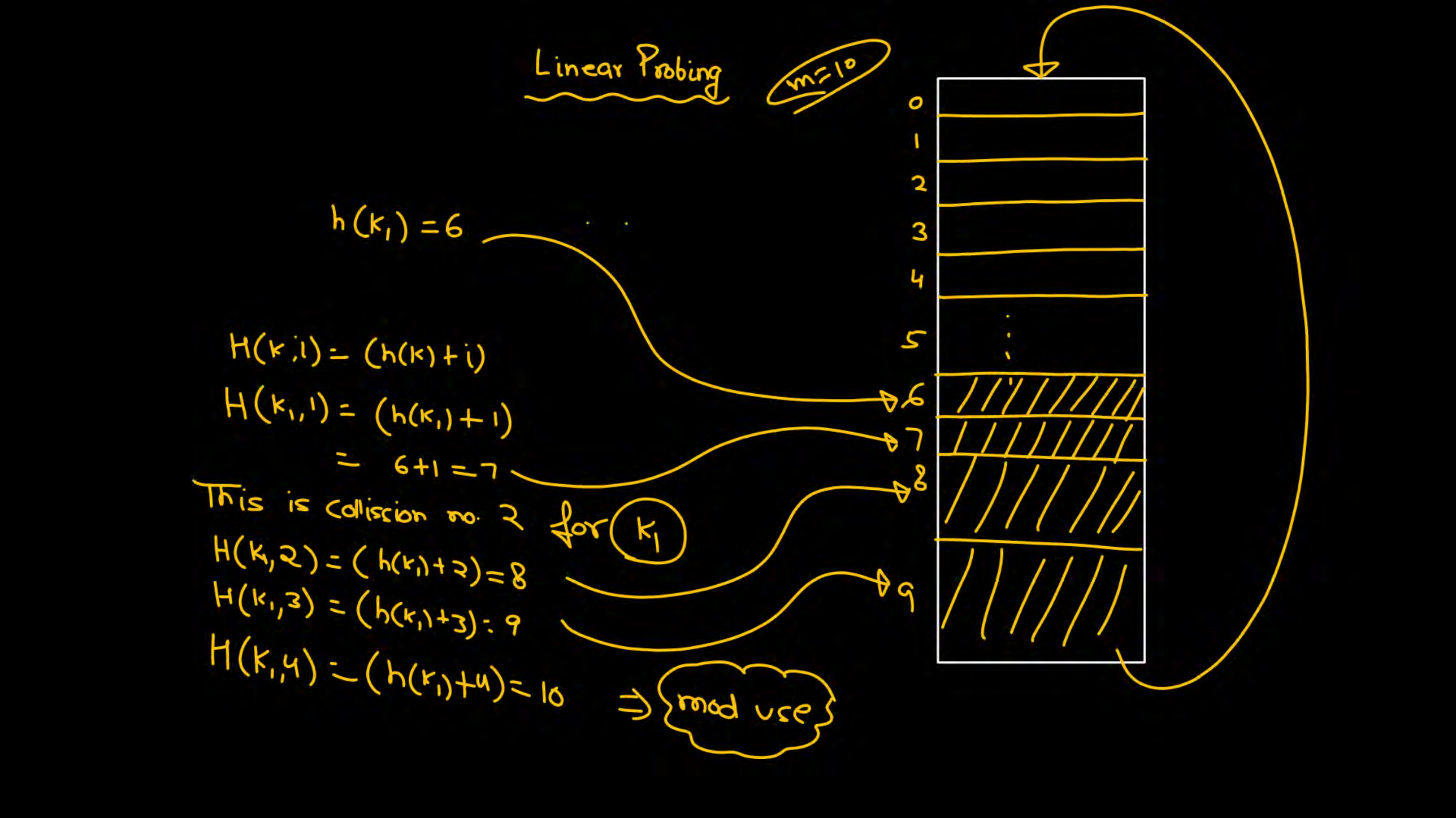
$h(k_1) = L$] collission occur

$H(k, i) = (h(k) + i) \bmod m$

key — collission no.

$H(k_1, 1) = (h(k) + 1) \bmod m = (L + 1) \bmod m$




Linear Probing
m=10
h(k1) = 6
H(k,i) = (h(k) + i)
H(k1,1) = (h(k1) + 1)
= 6+1 = 7
This is collision no. 2
for k1
H(k1,2) = (h(k1)+2) = 8
H(k1,3) = (h(k1)+3) = 9
H(k1,4) = (h(k1)+4) = 10
⇒ mod use
0
1
2
3
4
5
6
7
8
9

$h(K) = K \bmod m$

Keys: 31, 26, 43, 27, 34, 46, 14, 58, 13

$m = 12$

(i) $h(31) = 31 \bmod 12 = 7$

(ii) $h(26) = 26 \bmod 12 = 2$

(iii) $h(43) = 43 \bmod 12 = 7$ collission

$i = 1$

$H(K,i) = (h(K)+i) \bmod m$

$H(43,1) = (h(43)+1) \bmod 12$

$= (7+1) \bmod 12 = 8$ ✓

(iv) $h(27) = 27 \bmod 12 = 3$

(v) $h(34) = 34 \bmod 12 = 10$

(vi) $h(46) = 46 \bmod 12$

$= 10$ collission

$H(46,1) = (h(46)+1) \bmod 12$

$= 11$

(vii) $h(14) = 14 \bmod 12 = 2$ collission

$H(14,1) = (h(14)+1) \bmod 12$

$= 3$ collission

$H(14,2) = (h(14)+2) \bmod 12$

$= 4$ ✓

(viii) $h(58) = 58 \bmod 12 = 10$ collission

$H(58,1) = (h(58)+1) \bmod 12 = 11$ coll.

$H(58,2) = (h(58)+2) \bmod 12 = 0$

(ix) $h(13) = 13 \bmod 12 = 1$

0	58
1	13
2	26
3	27
4	14
5	
6	
7	31
8	43
9	
10	34
11	46

$h(K) = K \bmod m$

Keys: 31, 26, 43, 27, 34, 46, 14, 58, 13

$m = 12$

7, 2, 8, 3, 10, 11, 4, 1, 0

$h(K) = K \bmod m$

Keys: 31, 26, 43, 27, 34, 46, 14, 58, 13

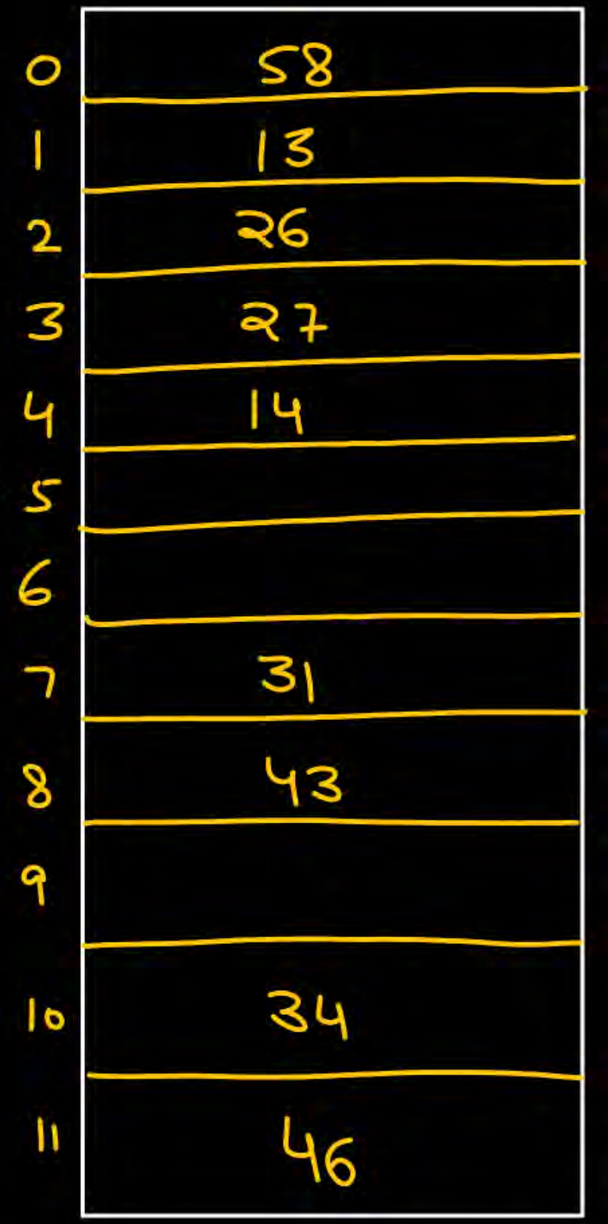
$m = 12$

Primary clustering Problem

Prob. that new key will get this slot $\left(\frac{8}{12}\right)$

(i) 5, 10, 11, 0, 1, 2, 3, 4

$\frac{8}{12}$

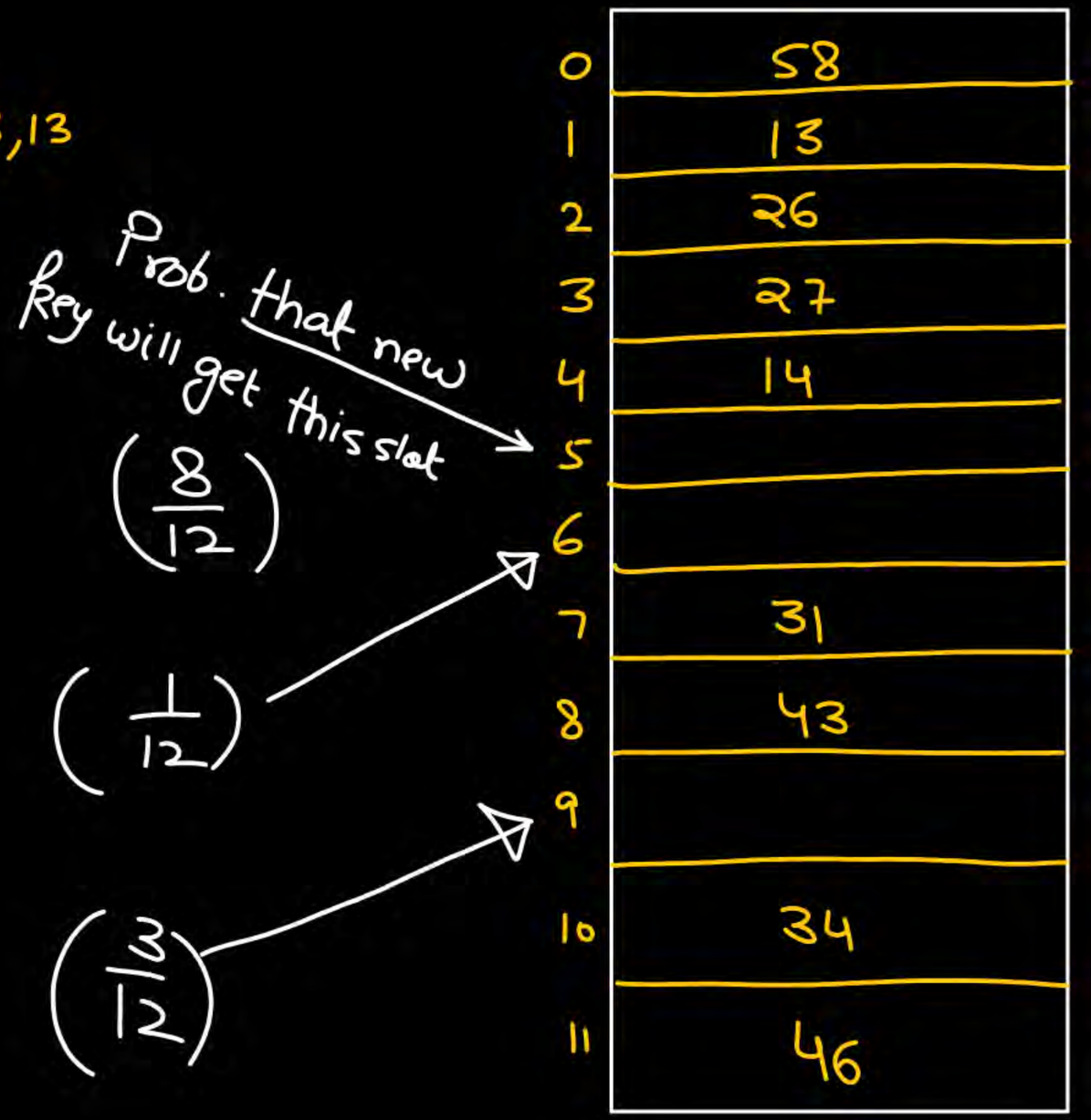


$h(K) = K \bmod m$

Keys: 31, 26, 43, 27, 34, 46, 14, 58, 13

$m = 12$

Primary clustering Problem



DS : 5:00 - 7:00

CRT

Open addressing

Sep. chaining

(i) Linear Probing : Prim. clustering

(ii) Quadratic Probing : Secondary clustering

(iii) Double hashing :


THANK YOU GW
SOLDIERS !