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PYQs - Part I

Course on Data Structure

Pankaj Sharma • Lesson 34 • Aug 16, 2024

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CS & IT Engineering

Data Structure

Hashing

Lecture Number- 34

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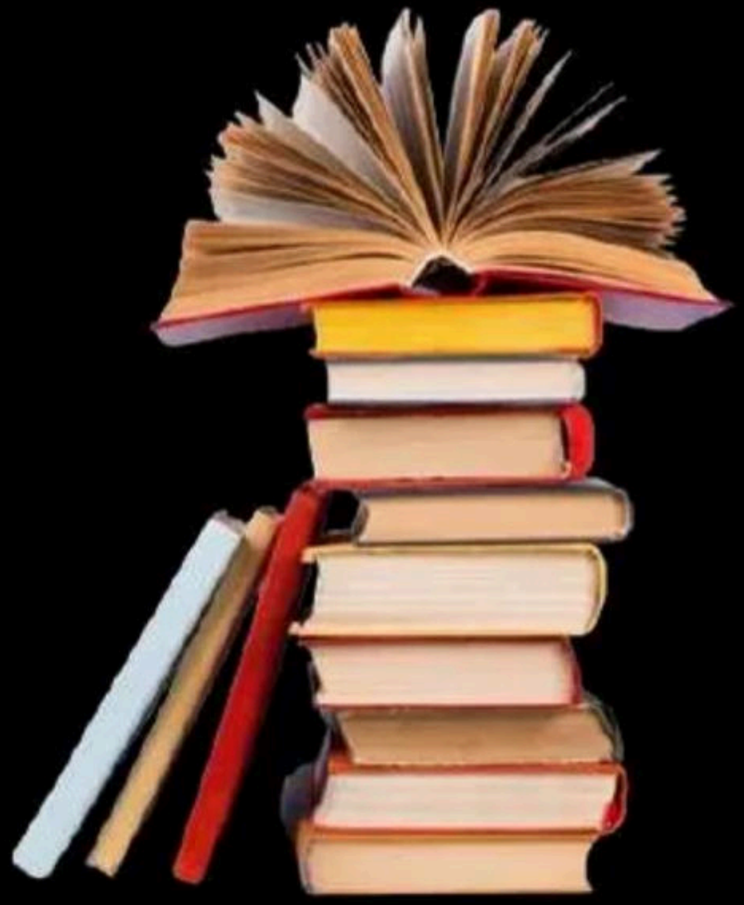
Topics

to be covered



1. Hashing-II

Quadratic Probing

$m = 11$

24, 2, 13

$h(24) = 2$
$h(2) = 2$
$h(13) = 2$
} $i = 1$

$H(24,1) = (h(24)+i^2) \bmod 11 = 3$
$H(2,1) = (h(2)+i^2) \bmod 11 = 3$
$H(13,1) = (h(13)+i^2) \bmod 11 = 3$

$i = 2$

$H(24,2) = (h(24)+2^2) \bmod 11 = 6$
$H(2,2) = (h(2)+2^2) \bmod 11 = 6$
$H(13,2) = (h(13)+2^2) \bmod 11 = 6$

$i = 3$

$H(24,3) = (h(24)+3^2) \bmod 11 = 0$
$H(2,3) = 0$
$H(13,2) = 0$

$i = 4$

$H(24,4) = (h(24)+4^2) \bmod 11 = 7$
$H(2,4) = 7$
$H(13,4) = 7$

$i = 5$

$H(24,5) = (h(24)+5^2) \bmod 11$ = 5
$H(2,5) = 5$
$H(13,5) = 5$

$i = 6$

$H(24,6) = 5$
$H(2,6) = 5$
$H(13,6) = 5$

$i = 7$

$H(24,7) = 7$
$H(2,7) = 7$
$H(13,7) = 7$

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2, 3, 6, 0, 7, 5, 5, 7, 0, 6, 3, 2, ... 24, 2, 13

2 2 2

Keys that are hashed to same locations follow the same resolution path bcz of which we are not able to utilize the table size efficiently.

Inspite of almost 50% available space, we are not able to insert a new element.

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Double Hashing

let $h(k)$ is the function

$h(k) = k \bmod m \Rightarrow$ Collision.

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

$= (h(k) + i^2) \bmod m$ Q.P

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

Primary Hash

Secondary Hash func.

Q- what if the value generated by $h'(k) = 0$?

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

$h'(k)$ never generate 0

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Double Hashing

m = 11

Keys: 13, 17, 21, 2, 57, 28, 30, 27

$h(x) = x \bmod 11$

$h'(x) = 7 - (x \bmod 7)$

$h(13) = 2$

$h(17) = 6$

$h(21) = 10$

$h(2) = 2$ ✗

$H(2,1) = (h(2) + 1 \cdot h'(21)) \bmod 11$

$h'(2) = 7 - (2 \bmod 11) = 5$

$H(2,1) = (2 + 1 \cdot 5) \bmod 11 = 7$

$h(57) = 2$ ✗

$H(57,1) = (h(57) + 1 \cdot h'(57)) \bmod 11$

$h'(57) = 7 - 57 \bmod 7 = 7 - 1 = 6$

$H(57,1) = (2 + 6) \bmod 11 = 8$

$h(28) = 6$ ✗

$H(28,1) = (h(28) + h'(28)) \bmod 11$

$= (6 + 7) \bmod 11$

$= 2$ ✗

$H(28,2) = (h(28) + 2 \cdot h'(28)) \bmod 11$

$H(28,2) = (6 + 2 \cdot 7) \bmod 11$

$= (6 + 14) \bmod 11$

$= 9$

$h(30) = 8$ ✗

$H(30,1) = (8 + 1 \cdot h'(30)) \bmod 11$

$= (8 + 5) \bmod 11 = 2$

$H(30,2)$

$= (8 + 2 \cdot 5) \bmod 11$

$= 7$ ✗

$H(30,3) = (8 + 3 \cdot 5) \bmod 11$

$= 1$

$h(27) = 5$

$h(2) = 2$
$h(57) = 2$

$H(2,1) = 7$
$H(57,1) = 8$

Problem

*Overhead

$\Rightarrow$ 2 Hash func.

Computation time

Time Complexity.

Load factor (λ)

$$\lambda = \frac{n}{m}$$

n → no. of keys

m → Table size

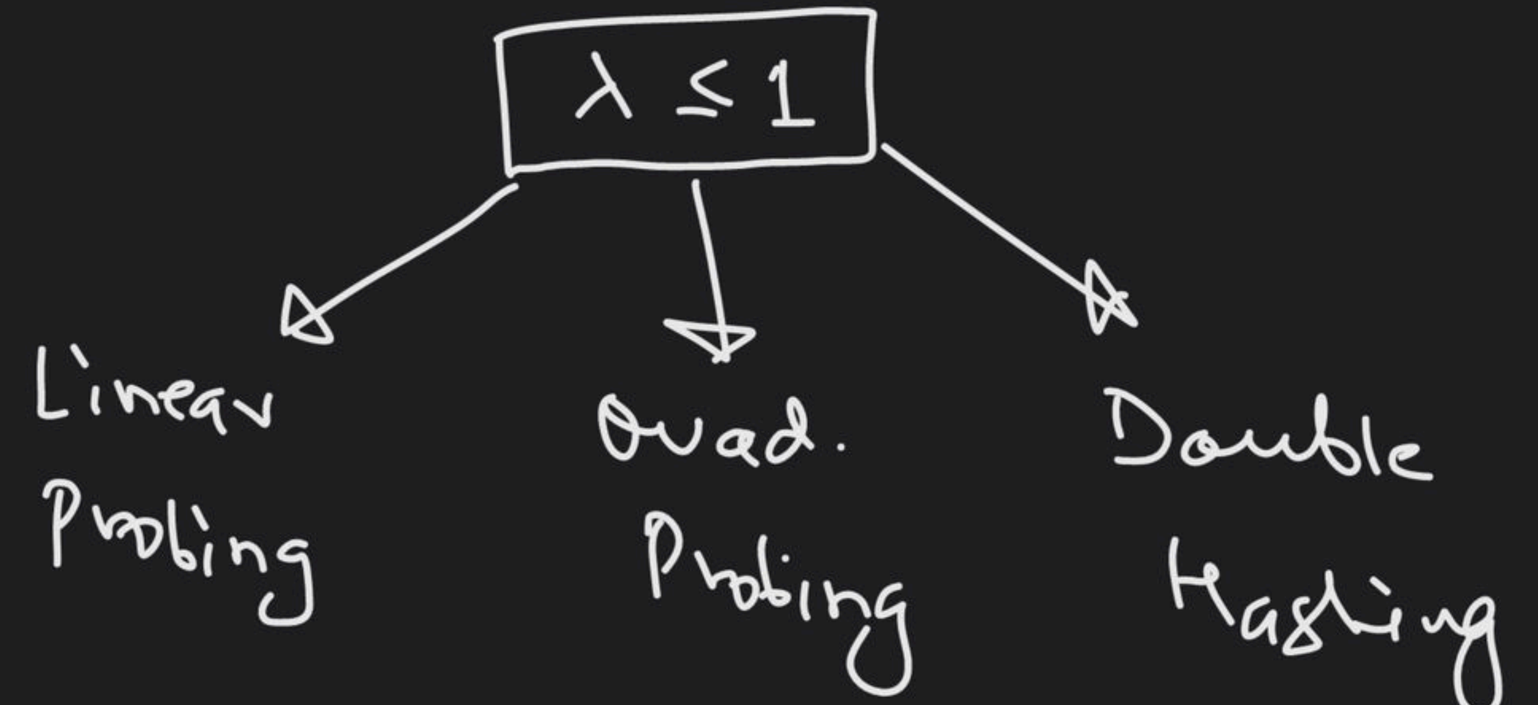
$n = 20$

$m = 40$

$$\lambda = \frac{20}{40} = \frac{1}{2}$$

$n = 40$

$m = 30$



Separate chaining $\Rightarrow$ $\lambda > 1$

Collision resolve

Keys: 400, 500, 635, 425, 36, 86, 126, 16

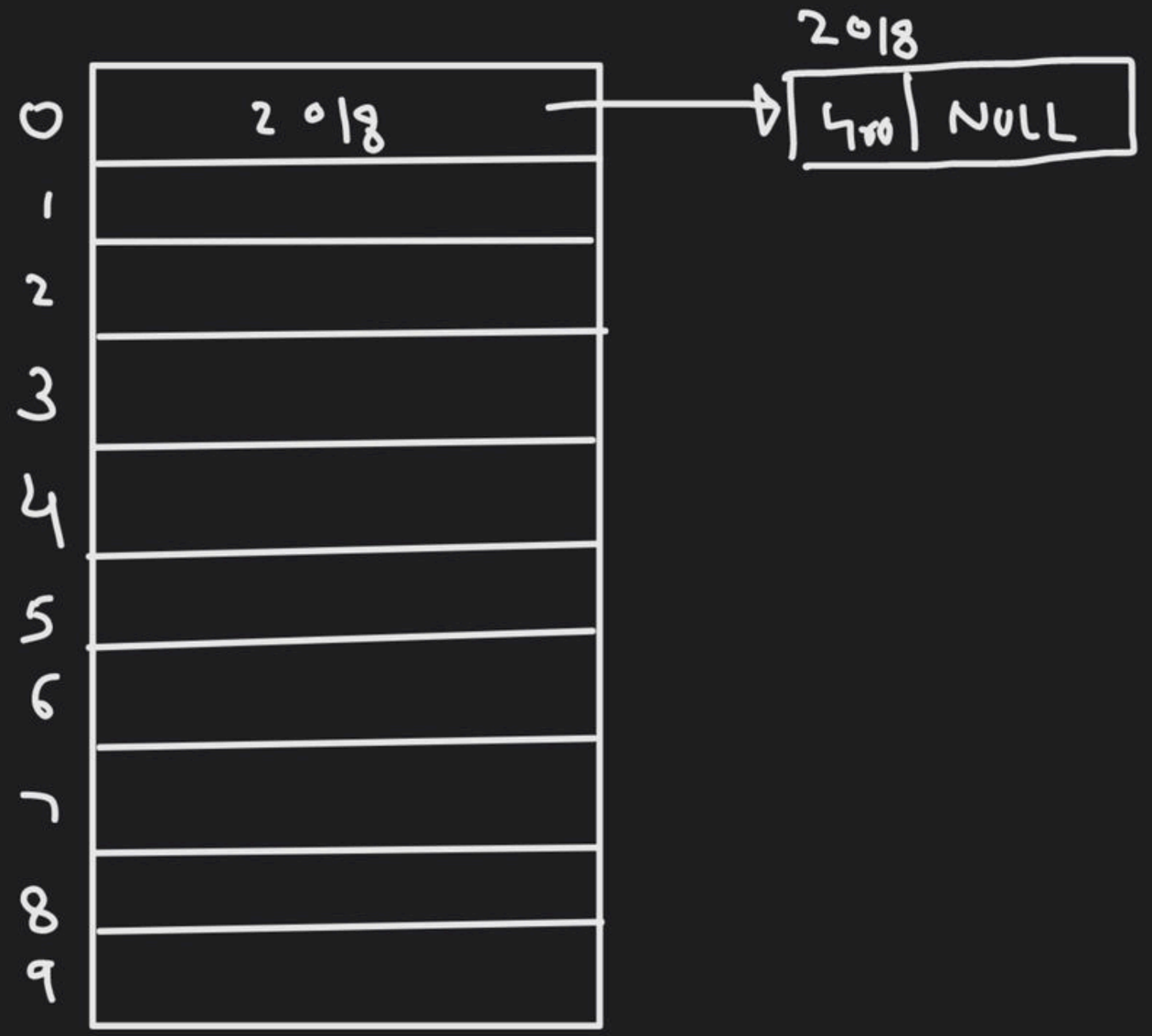
m = 10

$h(400) = 400 \bmod 10$

$= 0$

$h(500) = 500 \bmod 16$

$= 0$



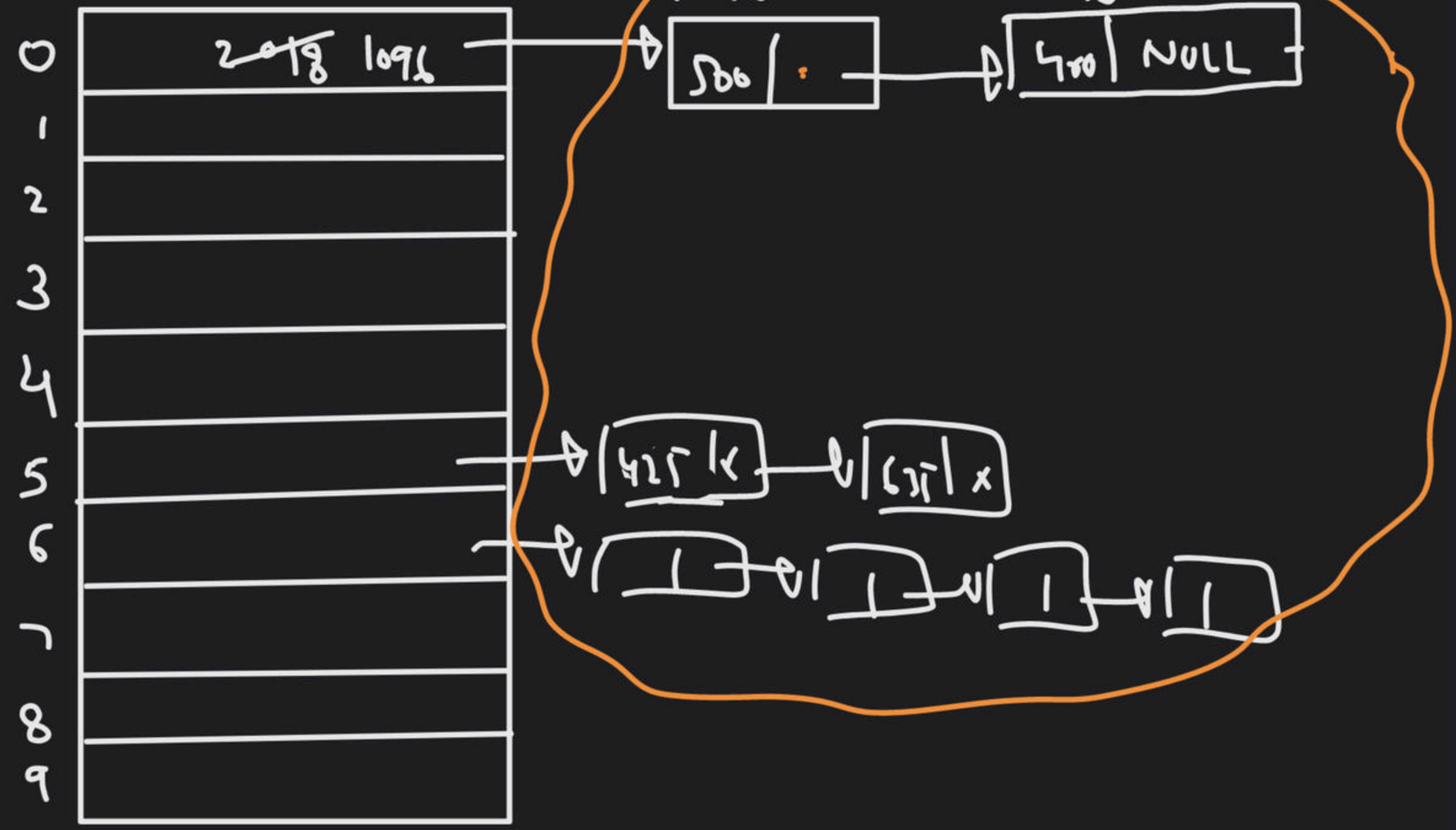
Keys: 400, 500, 635, 425, 36, 86, 126, 16

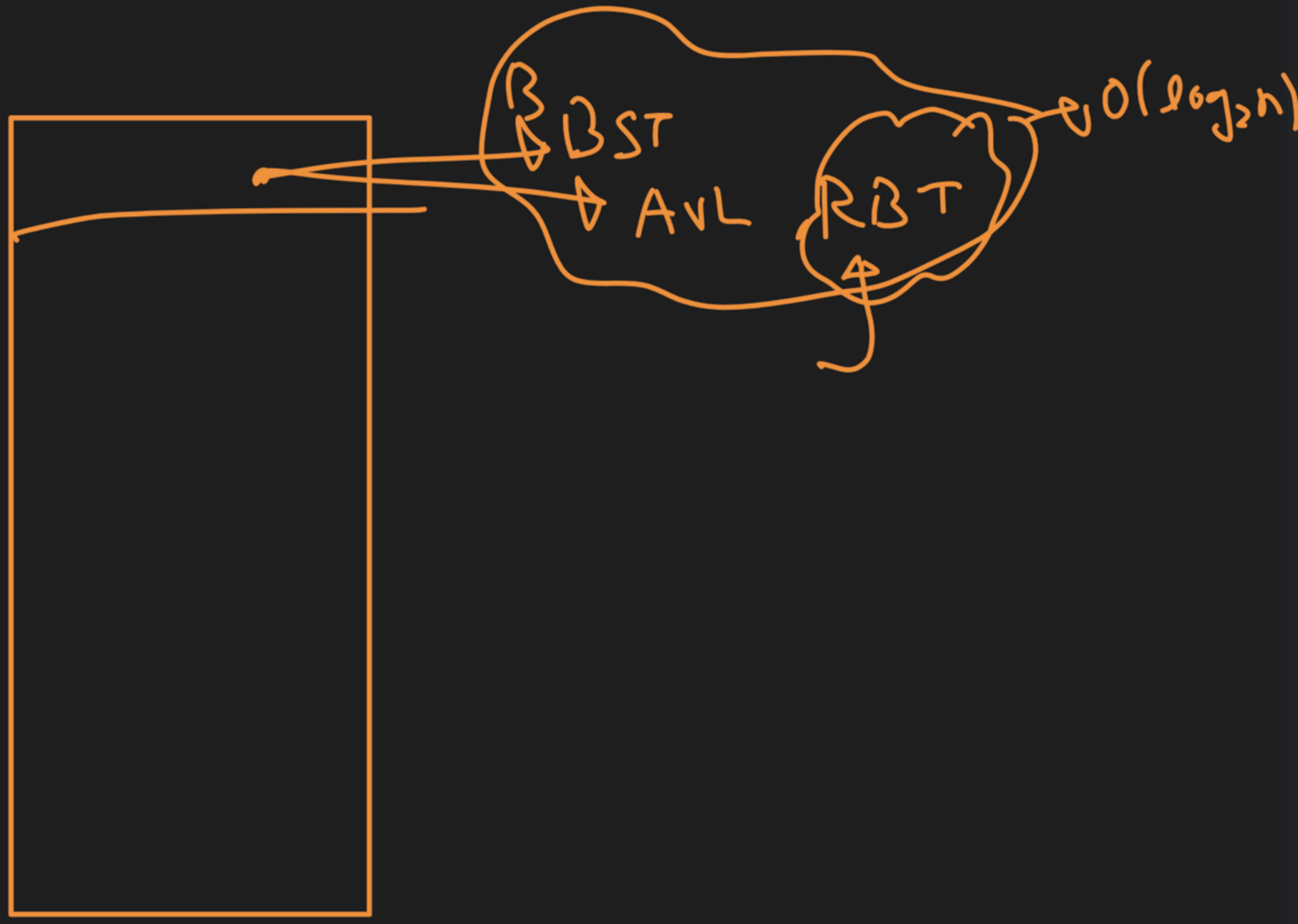
m = 10

$h(400) = 400 \bmod 10$
$= 0$

$h(500) = 500 \bmod 10$
$= 0$

(n+m)





L.P

keys: 31, 26, 43, 27, 34, 12, 46, 14, 58

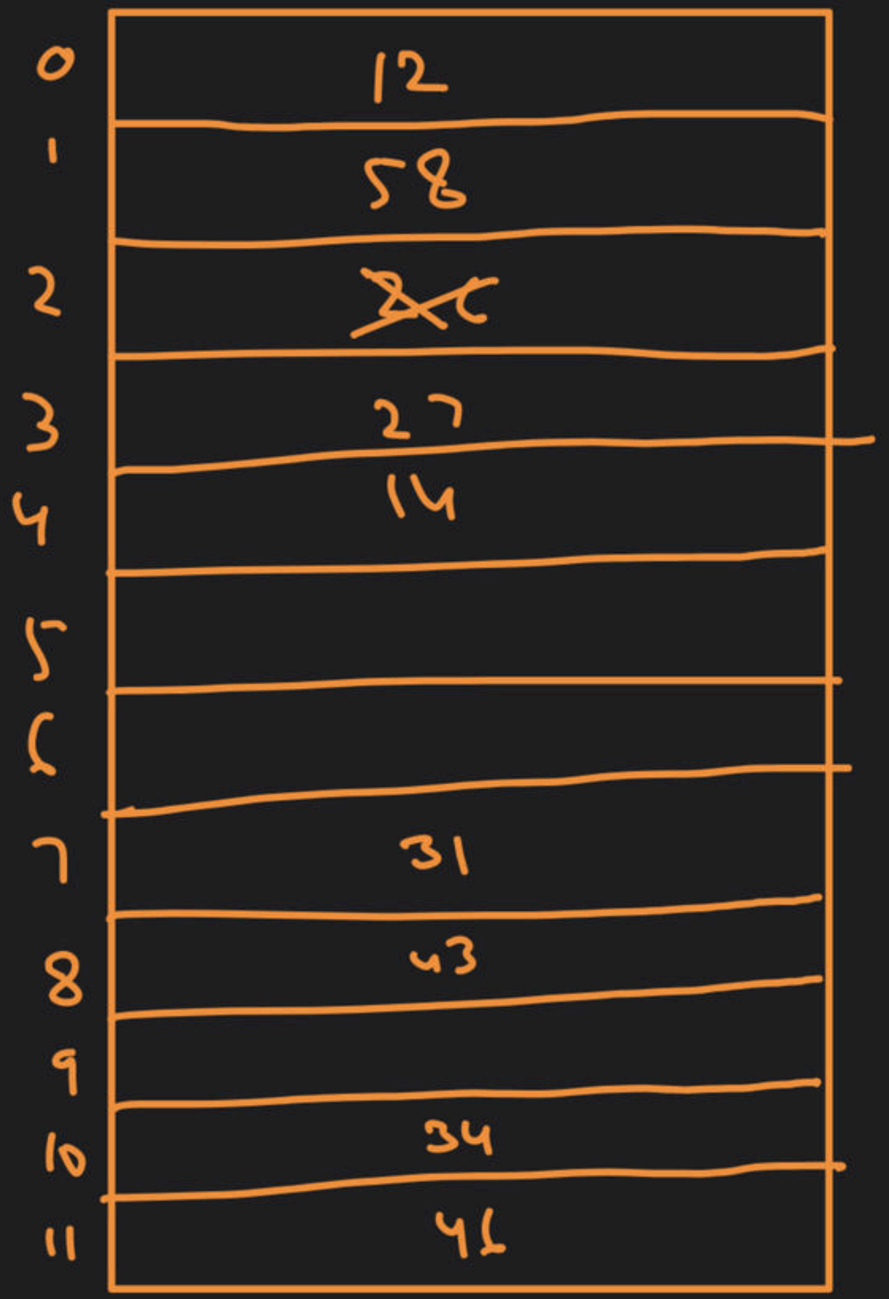
m = 12

delete 26

Search 14 → 14 mod 12 = 2

after deletion

↳ Re-Hash all remaining keys



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Delete

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THANK YOU!

Here's to a cracking journey ahead!