



## Hashing

$$h_1(k) \leq k \bmod N$$

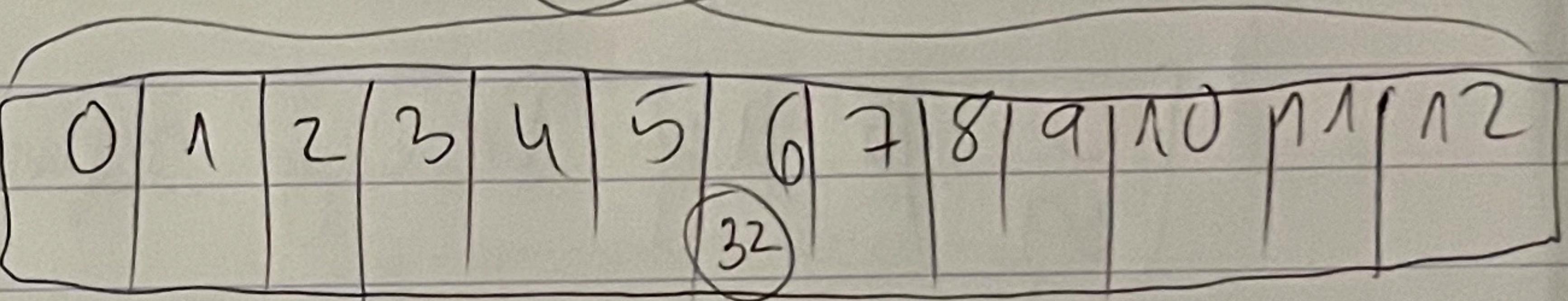
$$h_2(k) \leq 1 + k \bmod (N-1)$$

$$\text{hash} = h_1(k)$$

$$\text{Offset} = h_2(k)$$

$$\text{hash} = h_1(\text{hash} + \text{offset}) \quad (\text{collisions}) \quad \boxed{N=13}$$

insert(32)



(32)

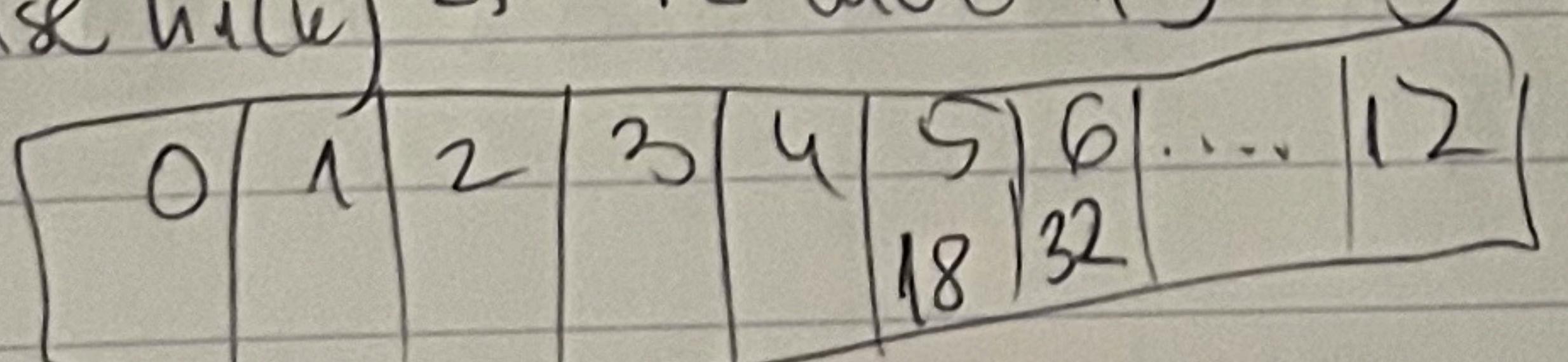
use  $h_1(k)$

$$\hookrightarrow h_1(32) \leq 32 \bmod 13 = 6 \rightarrow \text{store } 32 \text{ at index } 6.$$

Probing sequence: 6 (Since no collisions)

insert(18)

$$\text{use } h_1(k) \rightarrow 18 \bmod 13 = 5 \rightarrow \text{store } 18 \text{ at index } 5$$



18  
32

Probing sequence: 5 (no collisions).



Insert(24)

Use  $h_1(w)$ .  $24 \bmod 13 = 11$  store at index 11.

0	..	10	11	12
		24		

Probing Sequence: 11 (no collision)

Insert(39)

Use  $h_1(w)$ .  $39 \bmod 13 = 0$ . insert at index 0.

0	..	5	..	12
39				

Probing sequence: 0 (no collisions)

Insert(27)  $h_1(w) \leq 27 \bmod 13 = 1$  insert at index 1

0	1	2	3	4	5	6	7	8	9	10	11	12
39	27			18	32				24			

so far.

b) 12334730  $\rightarrow$  insert(7), insert(3), insert(0)

Insert(7)  $\rightarrow$  use  $h_1(w) = 7 \bmod 13 = 7$  insert at index 7

check for collisions: No collisions:

→ insert →	6	7	..	12
	32	7		

Probing sequence: 7



insert(3) use  $h_1(k) \rightarrow 3 \bmod 12 = 3$

Check for collisions: no collisions  $\rightarrow$  insert

2	3	-	12
	3		

Probing sequence: 3.

Insert(0)  $0 \bmod 12 = 0 \rightarrow$  insert at 0.

Check for collisions: Collision at index 0  $\rightarrow$  with 39.

↳ Tabl so far

0	1	2	3	4	5	6	7	8	9	10	11	12
39	27		3		18	32	7			24		

offset:  $h_2(k) \leq 1 + k \bmod (N-1)$

$$= 1 + 0 \bmod 12$$

$$= 1 + 0$$

$$= 1$$

De probing sequence: hash  $\leftarrow h_1(\text{hash} + \text{offset})$

$$\rightarrow \text{hash} \leftarrow h_1(1) \leq 1 \bmod 12 = 1$$

Collision at 1 (with 27)

$h_1(0) \leq 0$   
 $\text{hash} = 0$   
 $\text{offset} = 1$

second probe:  $A+1$

$$\text{hash} = (A+1) \bmod 13$$

$$h_2(A) = A + (A \bmod 12) = A+1 = 2$$

$$\text{hash} \rightarrow h_2(\text{hash} + \text{probe})$$

$$\text{hash} \rightarrow h_2(A+1)$$

$$\rightarrow 2 \bmod 13 = 2.$$

Check index 2: no collisions.

Insert 0 at index 2.

Probing sequence:  $\boxed{0, 1, 2, \dots}$

Table:

0	1	2	3	4	5	6	7	8	9	10	11	12
39	27	0	3	18	32	7				24		

