

Hashing Lab

1. Given the following key values, show what the data structures would look like after insertions

27 53 13 10 138 109 49 174 26 24

(no preprocessing necessary: $p_k = \text{key}$)

a. Linear array of 10 elements using division hashing and the linear-quotient collision path algorithm

$N = 13$, $4k+3$ prime = 19

LQHashing:

1. $ip = pk \% N$

2. $q = pk / N$

if ($q \% N \neq 0$)

offset = q

else

offset = $4k+3$ prime

3. While collisions:

$ip' = (ip + \text{offset}) \% N$

4. Set $\text{Array}[ip] = \text{key}$

Array:

0	13
1	27
2	26
3	109
4	
5	53
6	49
7	
8	138
9	
10	10
11	174
12	24

b. Bucket hashing of 10 elements ($N=10$)

$ip = (p_k) \% N$

Array:

0	→ 10
1	
2	
3	→ 53 → 13
4	→ 174 → 24
5	
6	→ 26
7	→ 27
8	→ 138
9	→ 109 → 49

$$ip = 27 \% 13 = 1$$

$$q = 27 / 13 = 2 \neq 0$$

offset = 1 (1st key)

$$53 \% 13 = 1 \quad q = 53 / 13 = 4$$

$\neq 0 \rightarrow 4$ ip + offset

$$\text{offset} = (1+4) \% 13$$

$$ip = 5$$

$$49 \% 13 = 10 = ip \quad \text{offset} = 3 \quad (1+3) \% 13 = 3$$

$$49 / 13 = 3 = q \quad \text{while } (10+3) \% 13 = 0 \quad (3+3) \% 13 = 6$$

$$138 \% 13 = 8 = ip$$

$$138 / 13 = 10 = q$$

offset = 8 (1st key)

$$109 \% 13 = 5 = ip$$

$$109 / 13 = 8 = q$$

offset = $4k+3=11$ while $(5+8) \% 13 = 0$

$$8 \% 13 = 8$$

$$8 + 0 \% 13 = 8$$

$$174 \% 13 = 5 = ip$$

$$174 / 13 = 13 = q$$

$$(5+13) \% 13 = 11$$

$$26 \% 13 = 0 = ip \quad \text{offset} = 2$$

$$26 / 13 = 2 = q \quad (0+2) \% 13 = 2$$

$$26 \% 13 = 0 = ip \quad \text{offset} = 2$$

$$26 / 13 = 2 = q \quad (0+2) \% 13 = 2$$

$$13 \% 13 = 0 \quad 24 \% 13 = 11 = ip$$

$$24 / 13 = 1 = q \quad 12 \% 13 = 12$$

$$109 \% 13 = 5 = ip \quad \text{offset} = 11$$

$$(5+11) \% 13 = 11$$

2. Fill in the table based on exercise 1

Number of comparisons to retrieve this element

Key	Linear array - (Length of Collision Path +1)	Buckets - (# of elements in linked list compared)
53	2	1
138	1	1
109	4	1
49	4	2
174	2	1
26	2	1