Hashing

Tuesday, April 29, 2025 3:38 PM

1. **Why hashing?**
2. **Hashing Techniques**
   - 1.1 Division (Modulo) Method
   - 1.2 Multiplication Method
   - 1.3 Mid-Square Method
   - 1.4 Folding Method

2. Collision Resolution Techniques

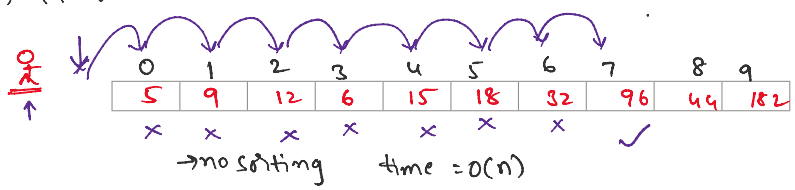
- 2.1 What is a Collision?
- 2.2 Types of Collision Resolution
  - 2.2.1 Closed Hashing (Open Addressing)
    - 2.2.1.1 Linear Probing
    - 2.2.1.2 Quadratic Probing
    - 2.2.1.3 Double Hashing
  - 2.2.2 Open Hashing (Separate Chaining)
    - 2.2.2.1 Linked List Chaining
    - 2.2.2.2 Binary Tree Chaining

Why hashing ?

↳ Speed of accessing the data

Linear Search :-

→ list of element → find the element- SE=96 n=10

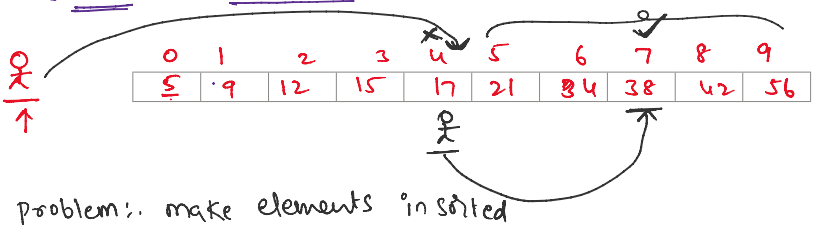


→ no sorting time = O(n)

Max → O(n) → max time

Binary Search :-

Condition :- Sorted order



Problem :- make elements in sorted

time = O(nlogn)

$T(n) = T(\frac{n}{2}) + 1$

Se = 38

O(log n)

To improve the speed of searching → better than linear & binary

hashing → O(1) → fixed time.

Hashing :-

Key → data

↳ apply → hashingfunction → position

↳ apply → hashing function → position

- → division method
- → multiplication
- → folding
- → mid squares

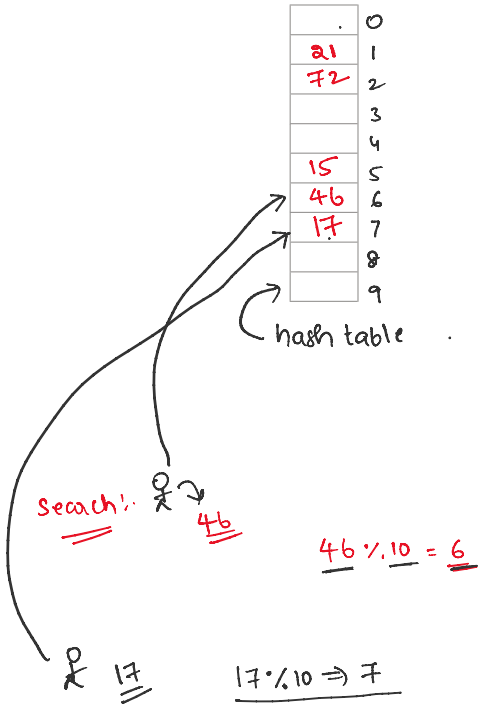
(i) division method :- Equation $h(K) = K \bmod size$

h(K) → hashing function

K → Key (data)

size → size of array

n = 10



n = 10

elements / keys →

15, 17, 21, 46, 72

K= K

Keys = 5

index

h(15) = 15 % 10 = 5

h(17) = 17 % 10 = 7

h(21) = 21 % 10 = 1

h(46) = 46 % 10 = 6

h(72) = 72 % 10 = 2

46 % 10 = 6

17 % 10 ⇒ 7

10) 15 (1
10
(5)

10) 17 (1
10
(7)

(ii) Mid - Square method :-

$h(K) = (\text{mid of } K^2) \bmod size$

h(K) → hashing function on K

K^2 → Key value × Key value

mid of K^2 → K^2 mid value

Size → Size of Array ⇒ n = 10

data / keys = {12, 22, 32, 42, 52}

12
12
144

52	0
	1
32	2

data/keys = {12, 22, 32, 42, 52}

(i) K = 12 K^2 = 144

mid of K^2 = 144 ⇒ (4) mod 10 = 4

(ii) K = 22 K^2 = 484

mid of (484) = (8) % 10 = 8

(iii) K = 32 K^2 = 1024

mid of K^2 = (02) % 10 = 2

(iv) K = 42 K^2 = 1764.

mid of (1764) = 76 % 10 ⇒ 6

(v) K = 52 K^2 = 2704

mid of (2704) ⇒ 70 % 10 ⇒ "0" → index

52	0
	1
32	2
	3
12	4
	5
42	6
	7
22	8
	9

hash table

10) 2 (0
0
(2)

10) 76 (7
70
(6)

10) 70 (7
70
(0)

(iii) Multiplication method:

A = 0.6180 $A = \left[\frac{\sqrt{5}-1}{2}\right]$

$h(K) = (\text{Size} \times K \times A \bmod \text{Size})$

h(K) = hash function

K = key value

$A = \frac{\sqrt{5}-1}{2} = 0.6180$

Size = Size of Array

K = 12

K × A = 12 × 0.6180 = 7.416

size × K × A = 10 × 7.416 ⇒ ⌊74.16⌋ = 74

74 % 10 ⇒ 4

10) 74 (7
70
(4)

	0
	1
	2
	3
12	4
	5
	6
	7
	8
	9

(iv) folding method:- $h(K) = (\sum \text{parts of } K) \% \text{ size}$

this method is used when your key value is large

{ 1234, 15692, 91011 }

K = 1234

12 | 34

12
34
(46) % 10 => 6

10) 46 (4
40
(6)

91011	0
	1
	2
	3
	4
	5
1234	6
	7
	8
	9

hash table

Rules:

(i) divid the given number in two digit pieces.

(ii) apply any Arithmatic operator (+)

(iii) apply mod on generated number with the size. = 10

K = 91011

=> 9 | 10 | 11 => 9+10+11 = 30

=> 30 % 10 => 0

---

problem:- Collision

(i) division method:- $h(K) = K \% \text{ size}$

K = 12 index

h(K) = 12 % 10 → 2

K = 13 index

h(K) = 13 % 10 → 3

K = 22 index

h(K) = 22 % 10 → 2

	0
	1
12	2
13	3
	4
	5
	6
	7
	8
	9

22

in the above example Key = 12 and Key = 22 has same index.

this is called Collision

Collision:-

more than 2 keys having same index is called Collision