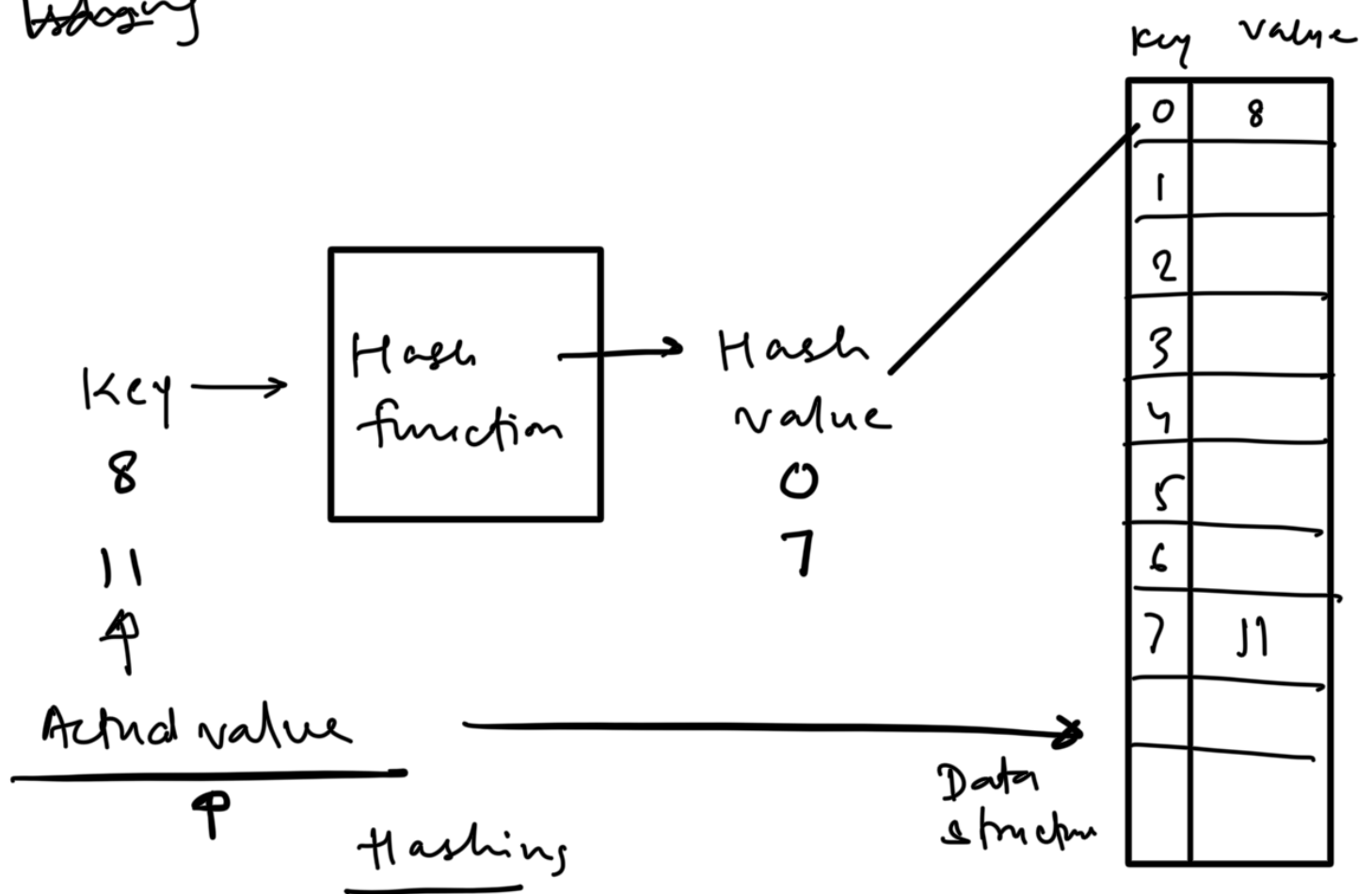


Hashing -



$$f(x) = \text{Key} \% (\text{bucket size})$$

↓  
Answer (Hashvalue)

Hash Table ↑

Hashing → Mapping (Key - value)

Hash Table -

- data structure, that stores elements and allows insertions, lookups (search) and deletion to be performed in  $O(1)$  time.
- A hash table is an alternative method for representing a dictionary.
- A hash function is used to map keys into the position in a table. This is called as hashing.
- Operations -

Insert  $\rightarrow O(1)$

Delete  $\rightarrow O(1)$

Search  $\rightarrow O(1)$

Ex: Keys - 8, 3, 13, 6, 4, 10, 50

$$h(x) = \text{key} \% 10$$

↑  
bucket size  
↑  
(size of array)

$$8 \% 10 = 8$$

$$3 \% 10 = 3$$

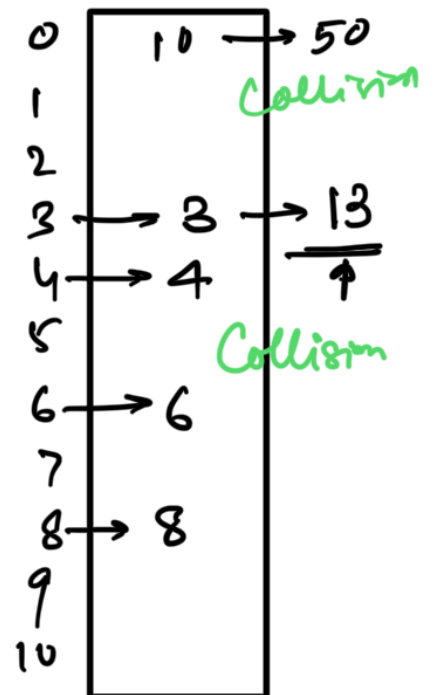
$$13 \% 10 = 3$$

$$6 \% 10 = 6$$

$$4 \% 10 = 4$$

$$10 \% 10 = 0$$

$$50 \% 10 = 0$$



one key  $\rightarrow$  one location

① 1 to 1 mapping

Many key  $\rightarrow$  one location

② Many to one Mapping

Many key - Many location

③ Many to Many Mapping

Hashing — Mapping

Application

- Database System
- Symbols tables
- Data dictionaries
- Network algorithm

Hashing Techniques

① Direct Hashing -

- Each key is mapped directly to a specific index in the hash table

$$42 \% 10 \rightarrow 2$$



Drawback - large hash table size required  
- inefficient in memory usage.

## ② Division Method or Modulo Method

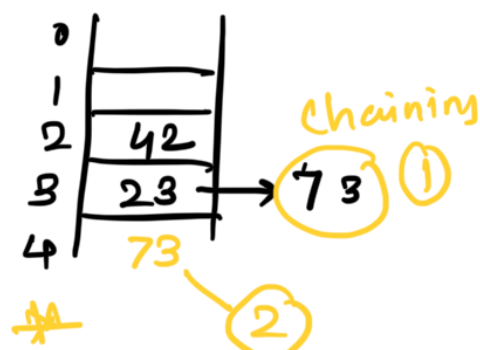
formula  $h(\text{key}) = \text{key} \% \text{table size}$

Ex  $42, 23, 73, \dots$  Size = 10

$$42 \% 10 = 2$$

$$23 \% 10 = 3$$

$$73 \% 10 = 3$$



- key is divided by the table size

Linear probing

## ③ Multiplicative Hashing

Formula -  $h(\text{key}) = \text{floor}(\text{table size} * (\text{key} * A \% 1))$ ,

where  $A = \text{Constant}$  (0 & 1)

Ex Key = 42

$A = 0.6180339887$

← 0 to 1 →

$$h(\text{key}) = \text{floor}(10 * (42 * 0.618))$$

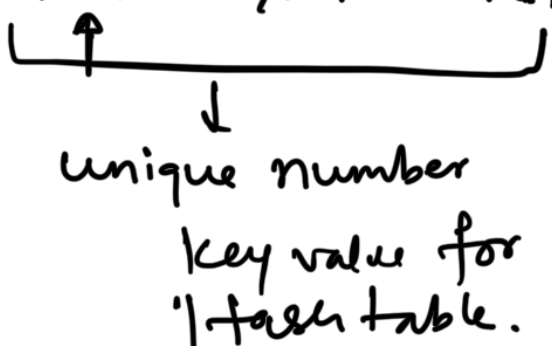
=  unique key value

- Multiplied by a Constant value and the fractional part of the result is multiplied by the table size to get the index value.

#### 4. Folding Method

Ex:     987654

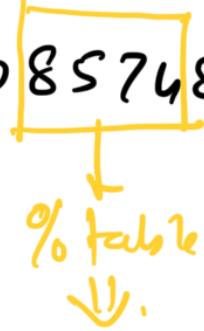
$$987 + 654 = 1641 \quad \% \text{ table size}$$




- key is divided into equal parts and the parts are added to get the hash index.

#### 5. Mid square Method

Ex:     4567  $\rightarrow (4567)^2 = 20857489$

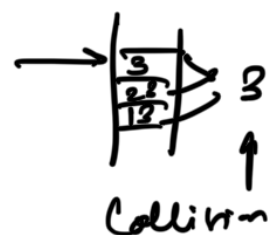
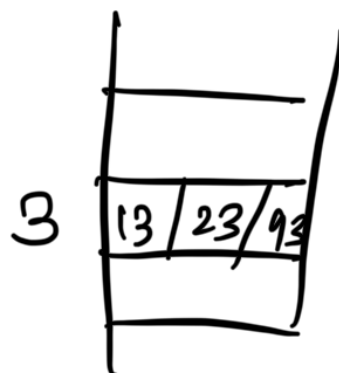




$$13 \% 10 = 3$$

$$23 \% 10 = 3$$

$$93 \% 10 = 3$$

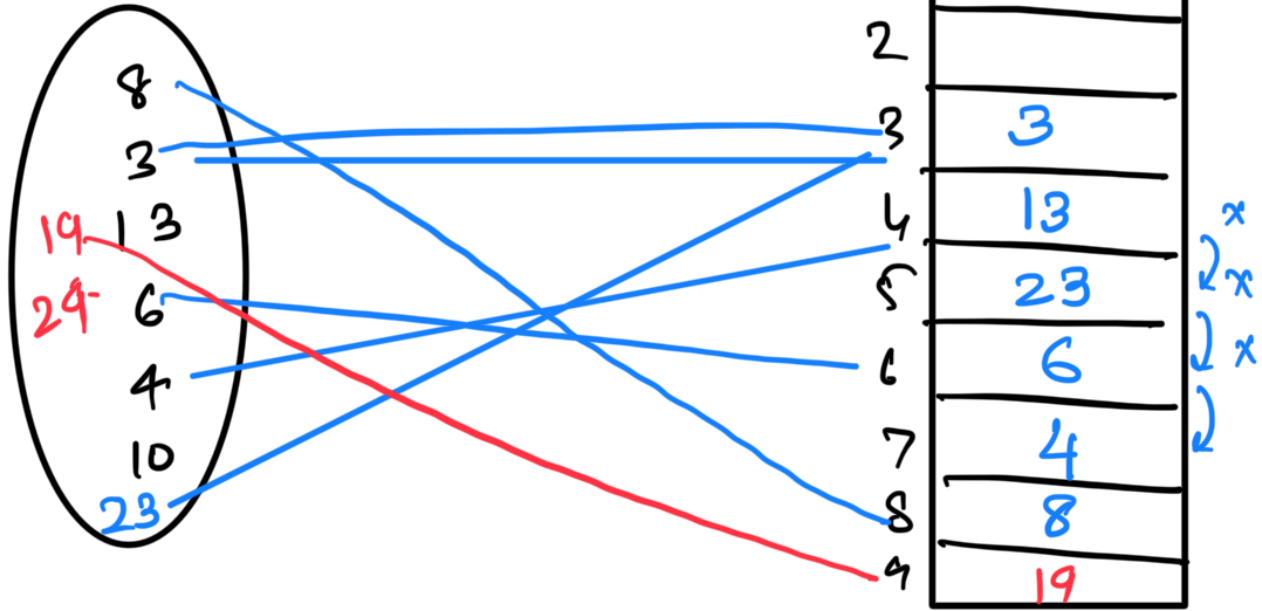




\_\_\_\_\_ )

$$h(x) = x \% 10$$

8, 3, 13, 6, 4, 10



Linear probing