Hashing

Why hashing?
When we want to map some data(information) to a certain key, we use hashing. It is not always possible to use separate array for hashing, hence we use hashmaps.

Applications

- Play with element's index
  We have two options to do this:
  - Traverse the whole array and access the element's
    For each element's accessing, we have to incur O(n) time complexity.
  - Map indices to their elements
    This requires little extra memory, but optimizes the time complexity to O(1) {unordered_map} or O(log(n)) {ordered_map}.

  Second option is better.

Another problem with option one
Storing indices of such large elements is not possible as we can declare only array of size 10^8 (that too global).

Here is where **hashing** comes into picture

Hashing
Converting elements into smaller elements using special functions known as Hash functions.

Example: We have to map the following elements with their indices

123456787	123456788	123456789
(0)	(1)	(2)

Let us consider a hash function

h(x) = x%10

After applying hash function on each element we get,

7	8	9
(0)	(1)	(2)

Key	Value
7	0
8	1
9	2

It might happen that while compressing elements, some keys result in the same values. This is called **collision**.

Collision Handling

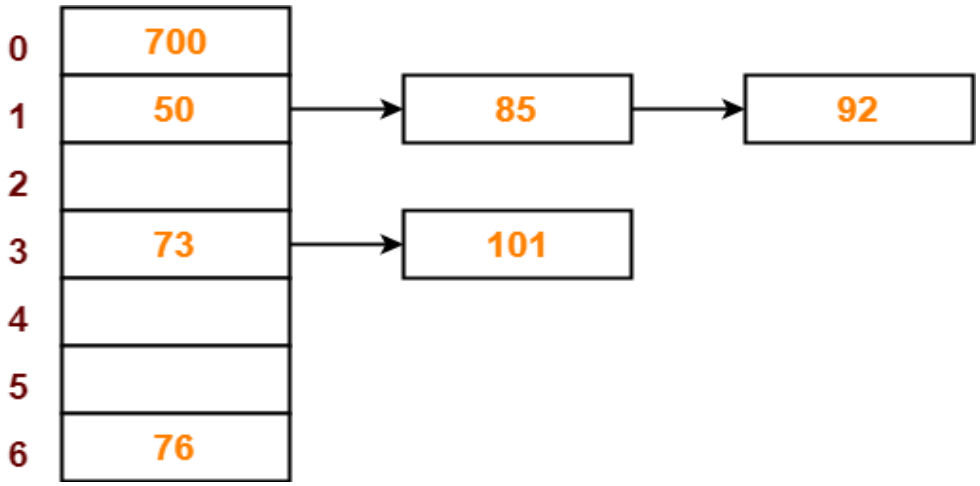
The methods to solve this problem comes under collision handling. There are mainly two methods

1. Separate Chaining
2. Open Addressing

Separate Chaining

If a collision occurs, create a chain of values at the same key using a linked list.

Example



In the above example, a chain of values is being made at keys *1, 3.*

Search Time Complexity: O(n)

Load Factor

Average amount of load at each key is called load factor.

Let the number of elements: *n*

Let the number of key on which values are to be mapped: *b*

Therefore the load factor of this combination is *n/b.*

Example:

In the given array, the number of keys on which we need to map the elements be 3.

9053805	9438590	74634728	82734283	87528435	8473289

Ans:

Number of elements = 6

Number of keys = 3

Load factor = 6/3 = 2.

Open Addressing

If a collision occurs, do probing.

Probing

In probing, we use a second argument probe number in the hash function. Probe number depends on the key, hence it is written as P(k).

There are three types of probing:

1. Linear Probing:
   Probe number is a linear function of key.
   Example: $P(k) = ak + b$.
2. Quadratic Probing

Probe number is a quadratic function of key.
   Example: $P(k) = ak^2 + bk + c$.

3. Double Hashing

In double hashing, we use a secondary hash function.
   Example: $P(k,x) = k*h_2(x)$, $h_2(x)$ is a secondary hash function.