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Hashing.

Use for impliment dictionary where we have key value pairs.
we can do all operations search, insert, delete all in Big O(1) average.

Hashing Not Use For :-
① Finding closect value
② sorted data
③ Prefic searching.

Application of hashing:

- After Array Hashing is second most used data structure.
- To impliment cache.
- Database indexing.

* – Hashing
Use keys as indexes in Array, & do insert, delete, & Search in O(1) because Array can Access Randomly index.

For hashing we have to create Hash function & hash function should Achive.
① should always map large key to same small keys.
② shoud generate value from 1 to m-1.
③ shoud be fast, O(1) for integer & O(len) for string.
④ should Uniformly distribute large keys into Hash table slots.

→ At the time of insertion you have to check this element is present in Hash or not duplicates not allowed in Hash table.

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Two methods to Avoid colision.

1) Chaining :-

(When Two value comes to same place then it create separate node for that value & Join to that index).

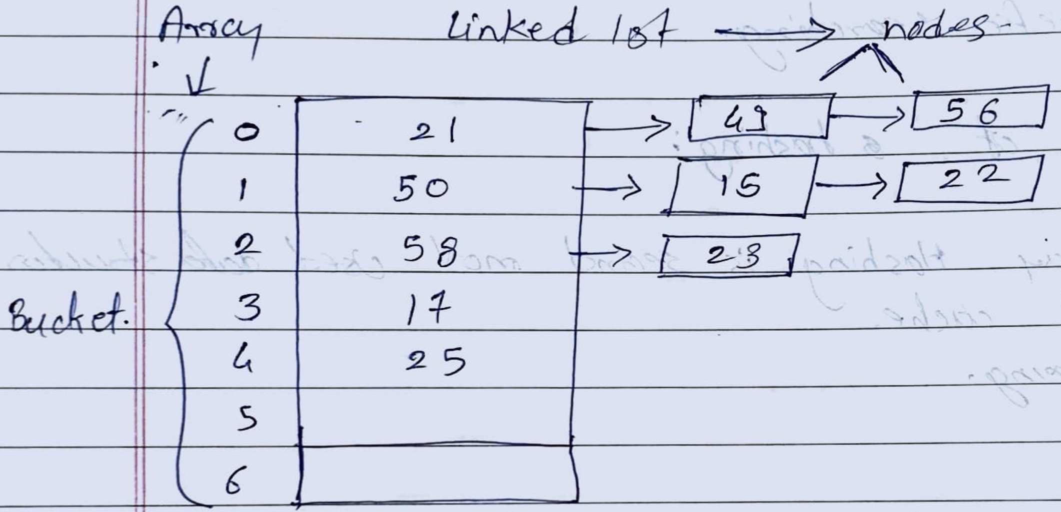
hash (key) = key % 7 (Remainder of 7)

hash function

input Key = 50, 21, 58, 17, 15, 49, 56, 22, 23, 25

key % 7 = 1 0 2 3 1 0 0 1 2 4

Here Divisor is 7 then remainder cannot go above 6.

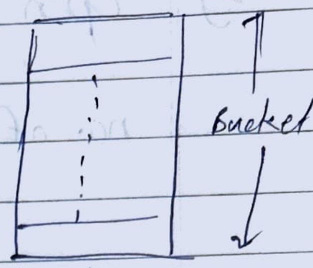


Hash Table (Array of Linked list Headers).

search (15) → True

search (48) → False.

Implementation of chaining:




```
struct MyHash
{ int Bucket;
  list <int> *table;              // creating Pointer
                                     to array
  MyHash (int b)                  // Initializing value
  {                                  by constructor of structure.
      Bucket = b;
      table = new list <int >[b];
  }
  void   insert (int key) { ... }
  bool   search (int key) { ... }
  void   remove (int key) { ... }
};

void insert (int key)
{  int i = key % Bucket;
   table [i]. Pushback (Key);
}

void remove (int key)
{  int i = key % Bucket;
   table [i]. remove (key);
}

bool search (int key)
{
   int i = key % Bucket;
   for ( auto x : table [i] )
        if (x = = key)
              return True;
   return False;
}.
```

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2] Open Addressing :-

no. of ~~start~~ slots in Hash table ≥ No. of keys to be inserted.

hash (key) = key % 7

key = 50, 51, 49, 16, 56, 15, 19.

key % 7 = 1, 2, 0, 2, 0, 1, 5

* #① Here 7 keys then we have to create Array of minimum size 7.

* #② It uses linear probing to enter value when colision occures.

Linear probing : Linear search for ~~fi~~ Next empty slot in Array when there is collision

0	49
1	50
2	51
3	16
4	56
5	15
6	19.

// Here 16 % 7 is 2 but there collision occures then value is stored in next empty slot.

// same for 56. 56 % 7 = 0.

// when 49 enter value & last slot is full then again search from first in circular manner.

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Implementation of open Addressing :-

```
struct Myhash ()
{
    int *arr;
    int cap, size;
    Myhash (int c)
    {
        cap = c;
        size = 0;
        for (int i=0; i<cap; i++)      // initialize all value
            arr[i] = -1                 in Array as -1 for
                                        empty notation
    }
    int hash (int key)
    {
        return key % cap;
    }
    bool search (int key) { - - - - }
    bool insert (int key) { - - - - }
    bool erase (int key) { - - - - }
}.
```

```
bool search (int key)
{
    int h = hash (key);
    int i = h;
    while (arr[i] != -1)
    {
        if (arr[i] == key)
            return True;
        i = (i+1) % cap;
        if (i == h)
            return False;
    }
```

We linearly search in Hash table.
Stop searching.
① when element found in table.
② when empty slot occures having value -1
③ when you traverse through all location

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```
bool insert (int key)
{
    if (size == cap)
        return False;
    int i = hash (key);
    while (arr[i] != -1 && arr[i] != -2 && arr[i] != key)
        i = (i+1) % cap;
    if (arr[i] == key)
        return False;
    else
    {
        arr[i] = key;
        size ++;
        return True;
    }
}
```

when it False for insertion
① when hash table is full
② & key value is already present.

```
bool erase (int key)
{   int h = hash (key);
    int i = h;
    while (arr[i] != -1)
    {   if (arr[i] == key)
        {   arr[i] = -2;
            return True;
        }
        i = (i+1) % cap;
        if (i == h)
            return False;
    }
    return False;
}
```

// if we find key then assign -2 value as deleted

// when we not found key then return False