ASSIGNMENT 7

Aim:-

Insert the keys into a hash table of length m using open addressing using double hashing with h(k)=1+(k mod(m-1)).

Objective:-

To Insert the keys into a hash table of length m using open addressing using double hashing with h(k)=1+(k mod(m-1)).

Theory:-

Double hashing is a collision resolving technique in **Open Addressed** Hash tables. Double hashing uses the idea of applying a second hash function to key when a collision occurs.

Double hashing can be done using :
(hash1(key) + i * hash2(key)) % TABLE_SIZE
Here hash1() and hash2() are hash functions and TABLE_SIZE is size of hash table.
(We repeat by increasing i when collision occurs)

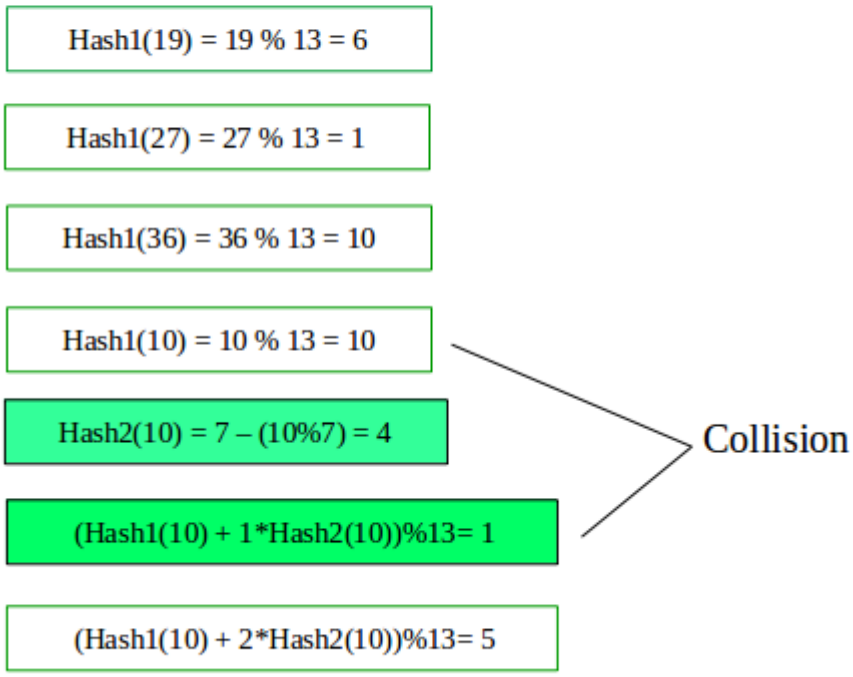
First hash function is typically hash1(key) = key % TABLE_SIZE

A popular second hash function is : **hash2(key) = PRIME – (key % PRIME)** where PRIME is a prime smaller than the TABLE_SIZE.
A good second Hash function is:

- It must never evaluate to zero
- Must make sure that all cells can be probed

Lets say, Hash1 (key) = key % 13

Hash2 (key) = 7 – (key % 7)



Algorithm:-

- Linear probing collision resolution leads to clusters in the table, because if two keys collide, the next position probed will be the same for both of them.
- The idea of double hashing: Make the offset to the next position probed depend on the key value, so it can be different for different keys
    - Need to introduce a second hash function $H_2(K)$, which is used as the offset in the probe sequence (think of linear probing as double hashing with $H_2(K) == 1$)

- For a hash table of size M, $H_2(K)$ should have values in the range 1 through M-1; if M is prime, one common choice is H2(K) = 1 + ((K/M) mod (M-1))

- The insert algorithm for double hashing is then:

  1. Set indx = H(K); offset = $H_2(K)$
  2. If table location indx already contains the key, no need to insert it. Done!
  3. Else if table location indx is empty, insert key there. Done!
  4. Else collision. Set indx = (indx + offset) mod M.
  5. If indx == H(K), table is full! (Throw an exception, or enlarge table.) Else go to 2.

- With prime table size, double hashing works very well in practice

Code:-

```
        #include <iostream>
using namespace std;
class dr
{
    int n=10;
    int arr[100][3];
    int c;
public:
    dr()
    {
        cout<<"Table of size "<<n<<" created\n";
        for(int i=0;i<n;i++)
        {
            arr[i][0]=0;
            arr[i][1]=-1;
            arr[i][2]=-1;
        }
        c=0;
    }
    void add(int,int);
    int find_key(int);
    void display();
    void update_val(int,int);
};
void dr::add(int key,int value)
{
    int new_hash_addr1,new_hash_addr2,main_hash_addr=-1,j=0;
    if(this->find_key(key)!=-1)
```

```
    {
        cout<<"Key already exists\n";
        return;
    }
    if(c==(n-1))
    {
        cout<<"Table full, request denied\n";
    }
    new_hash_addr1=(key)%n;
    new_hash_addr1=1+(key%(n-1));
    if(arr[new_hash_addr1][1]==-1)
    {
        arr[new_hash_addr1][0]=key;
        arr[new_hash_addr1][1]=value;
    }
    else if(arr[new_hash_addr2][1]==-1)
    {
        arr[new_hash_addr2][0]=key;
        arr[new_hash_addr2][1]=value;
    }
    else
    {
        while(arr[new_hash_addr2][2]!=-1)
        {
            main_hash_addr=new_hash_addr2;
            new_hash_addr2=arr[main_hash_addr][2];
        }
        main_hash_addr=new_hash_addr2;
        for(int i=0;i<n;i++)
        {
            new_hash_addr2=(main_hash_addr+i)%n;
            if(arr[new_hash_addr2][1]==-1)
            {
                arr[new_hash_addr2][0]=key;
                arr[new_hash_addr2][1]=value;
                arr[main_hash_addr][2]=new_hash_addr2;
                c++;
                break;
            }
        }
    }
}
void dr::display()
{
    cout<<"Key\t\tValue\t\tChain\n";
    for(int i=0;i<n;i++)
    {
        cout<<arr[i][0]<<"\t\t"<<arr[i][1]<<"\t\t"<<arr[i][2]<<endl;
    }
}
int dr::find_key(int key)
{
    int search_addr=key%n,f=0;
    while(arr[search_addr][0]!=key && arr[search_addr][2]!=-1)
```

```
    {
        search_addr=arr[search_addr][2];
    }
    if(arr[search_addr][0]==key)
    {
        return arr[search_addr][1];
    }
    else if(arr[search_addr][2]==-1)
    {
        return -1;
    }
}
int main()
{
    char r;
    do
    {
        char op;
        dr table;
        int c;
        do
        {
            cout<<"--------------------Menu--------------------\n";
            cout<<"1] Insert value\n2] Display\n";
            cout<<"_____________________________________________\n";
            cout<<"Enter your choice: ";
            cin>>c;
            switch(c)
            {
                case 1: {
                            int key,val;
                            cout<<"Enter key: ";
                            cin>>key;
                            cout<<"Enter value: ";
                            cin>>val;
                            table.add(key,val);
                        }
                        break;
                case 2: table.display();
                        break;
                default:cout<<"Invalid\n";
            }
            cout<<"\nDo you wish to go again? ";
            cin>>op;
        }while(op=='y' || op=='Y');
        cout << "Test pass?(y/n): " << endl;
        cin>>r;
    }while(r=='n' || r=='N');
    cout<<"*****************\n";
    cout<<"*   Thank You!   *\n";
    cout<<"*****************\n";
    return 0;
}
```

Output Screenshot:-

"C:\Users\Dell\Downloads\main (4).exe"

```
Enter value: 2

Do you wish to go again? y
--------------------Menu--------------------
1] Insert value
2] Display
________________________________________________
Enter your choice: 1
Enter key: 6
Enter value: 5

Do you wish to go again? y
--------------------Menu--------------------
1] Insert value
2] Display
________________________________________________
Enter your choice: 2
Key             Value           Chain
0               -1              -1
0               -1              -1
1               2               -1
0               -1              -1
0               -1              -1
0               -1              -1
0               -1              -1
6               5               -1
0               -1              -1
0               -1              -1

Do you wish to go again?
```

Conclusion:-

We Successfully implemented the Heap datastructure.