MARMARA UNIVERSITY
FACULTY of ENGINEERING
COMPUTER ENGINEERING DEPARTMENT

CSE 4094 - Special Topics in Computer Engineering
Advanced Data Structures

Project 2

Cuckoo Hashing

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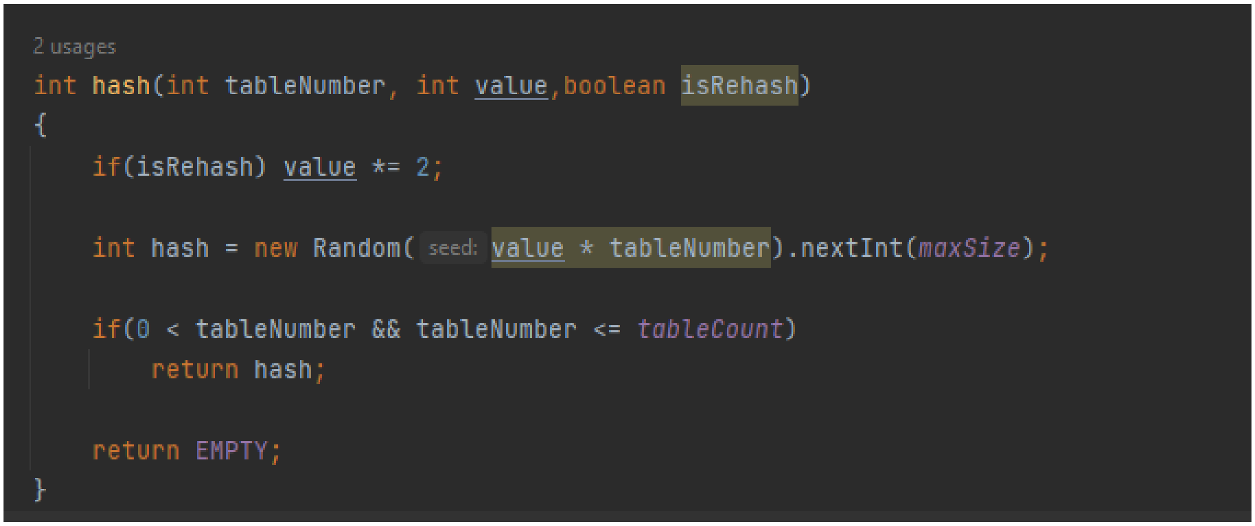
Cuckoo Hashing

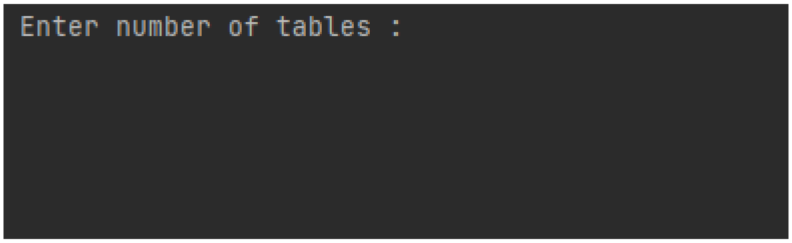
In this project, we have implemented a project that simulates cuckoo hashing visualization to console screen where insertion, deletion and search options are selected and inserted by user and this project is implemented in Java programming language. Cuckoo hashing is a solution for resolving hash collisions of values of hash functions in a table, with worst-case O (1) .

Our hash function is feeding random number generator by value * current table number with constraint of maxSize of table. This gives us the same value for the same input because we have used seed values as variable. If cycle exists in cuckoo hashing, we have a flag named isRehash if it is true then we double the value by 2 then it generates new hash value by changing the feed value of random number generator.



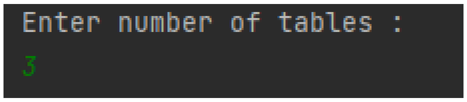
```
2 usages
int hash(int tableNumber, int value,boolean isRehash)
{
    if(isRehash) value *= 2;

    int hash = new Random( seed: value * tableNumber).nextInt(maxSize);

    if(0 < tableNumber && tableNumber <= tableCount)
        return hash;

    return EMPTY;
}
```

In project first program as to enter number of tables will be used in this life cycle of program.



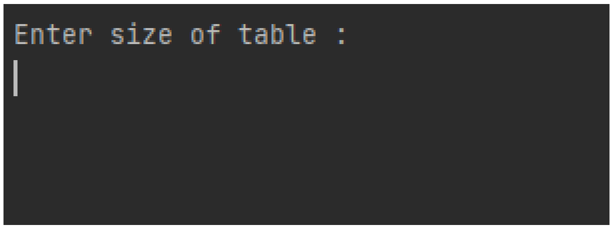
```
Enter number of tables :
```

Let’s enter 3 for the case.



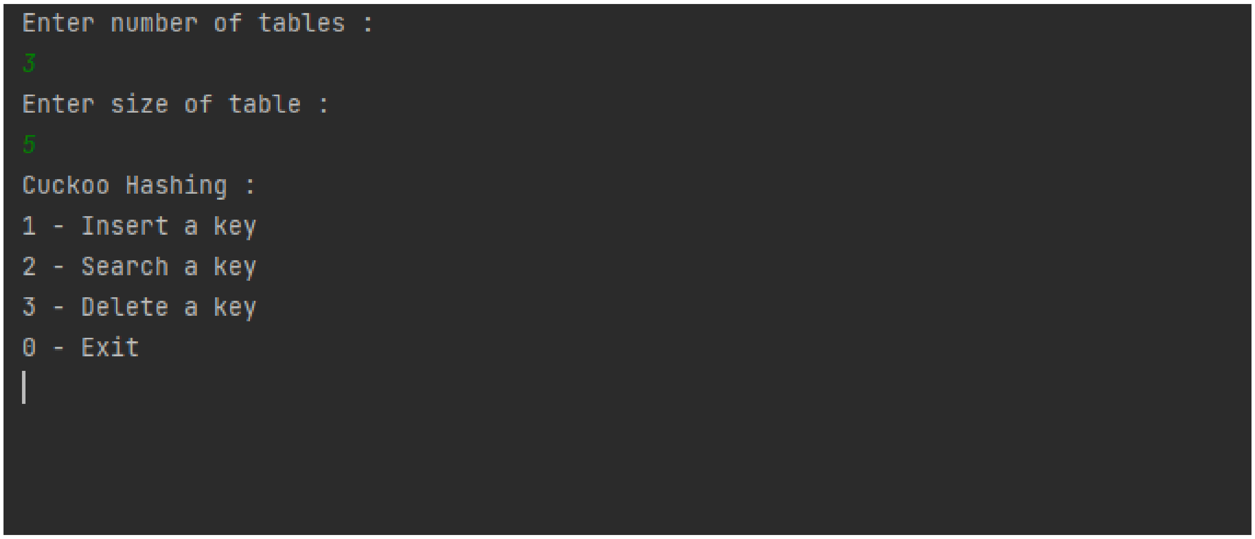
```
Enter number of tables :
3
```

After program ask to enter size of table will be used



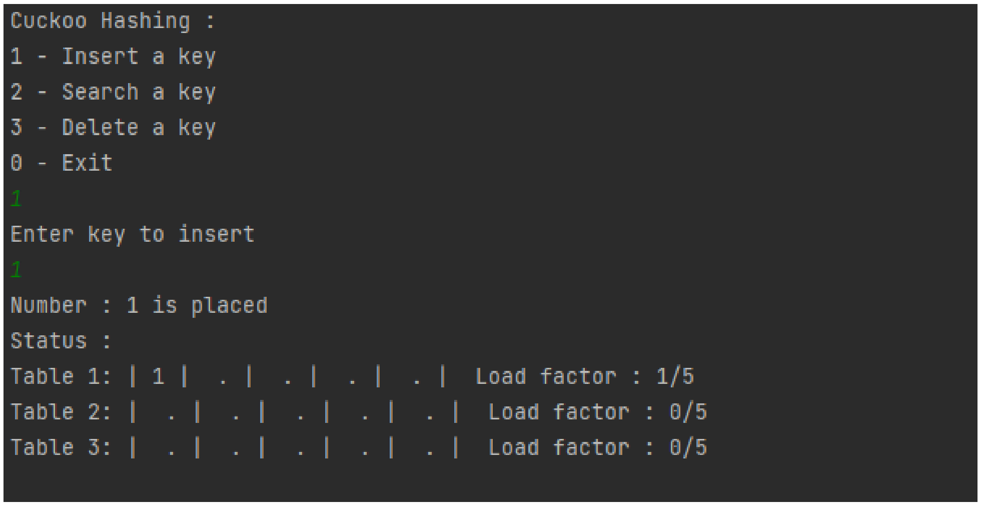
```
Enter size of table :
|
```

Let’s enter 5 for the case.



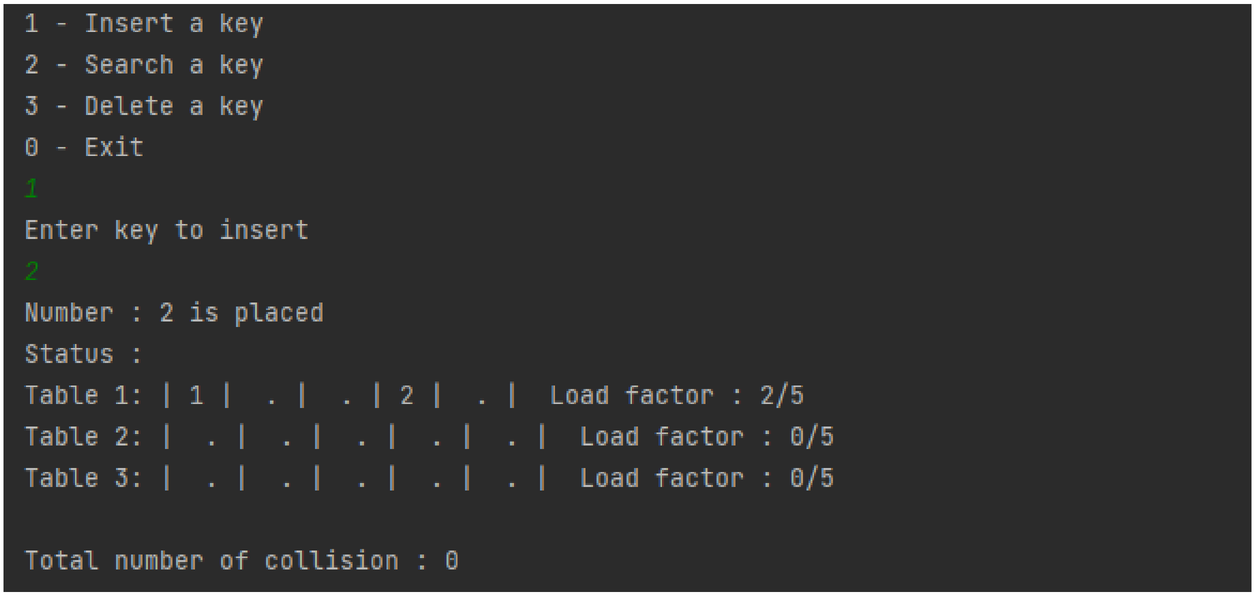
```
Enter number of tables :
3
Enter size of table :
5
Cuckoo Hashing :
1 - Insert a key
2 - Search a key
3 - Delete a key
0 - Exit
|
```

Now we are going to enter number 1 to 9 for our 3 table that have size of 5.



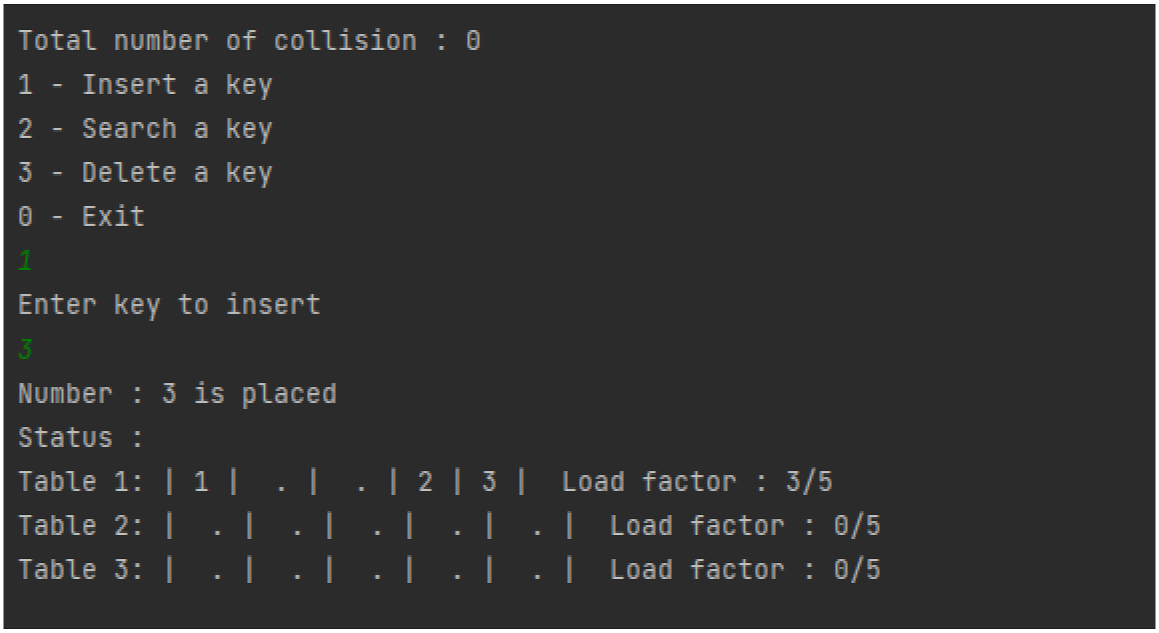
```
Cuckoo Hashing :
1 - Insert a key
2 - Search a key
3 - Delete a key
0 - Exit
1
Enter key to insert
1
Number : 1 is placed
Status :
Table 1: | 1 |  . |  . |  . |  . |  Load factor : 1/5
Table 2: |  . |  . |  . |  . |  . |  Load factor : 0/5
Table 3: |  . |  . |  . |  . |  . |  Load factor : 0/5
```

Then insert 2



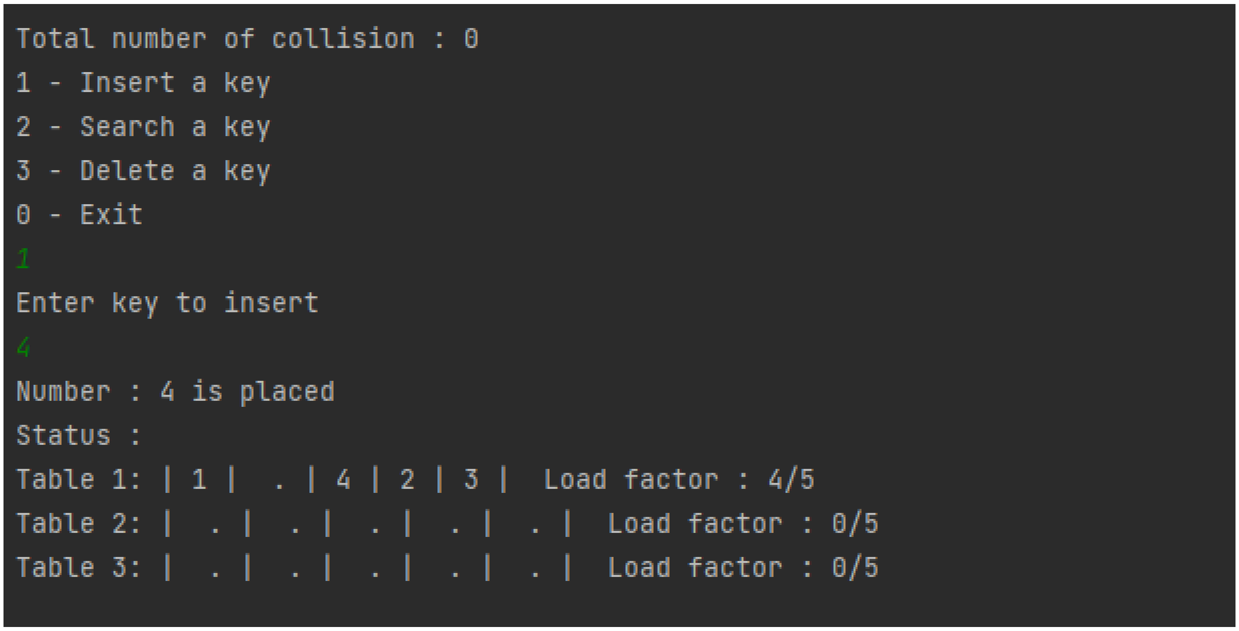
```
1 - Insert a key
2 - Search a key
3 - Delete a key
0 - Exit
1
Enter key to insert
2
Number : 2 is placed
Status :
Table 1: | 1 |  . |  . | 2 |  . |  Load factor : 2/5
Table 2: |  . |  . |  . |  . |  . |  Load factor : 0/5
Table 3: |  . |  . |  . |  . |  . |  Load factor : 0/5

Total number of collision : 0
```

Insert 3



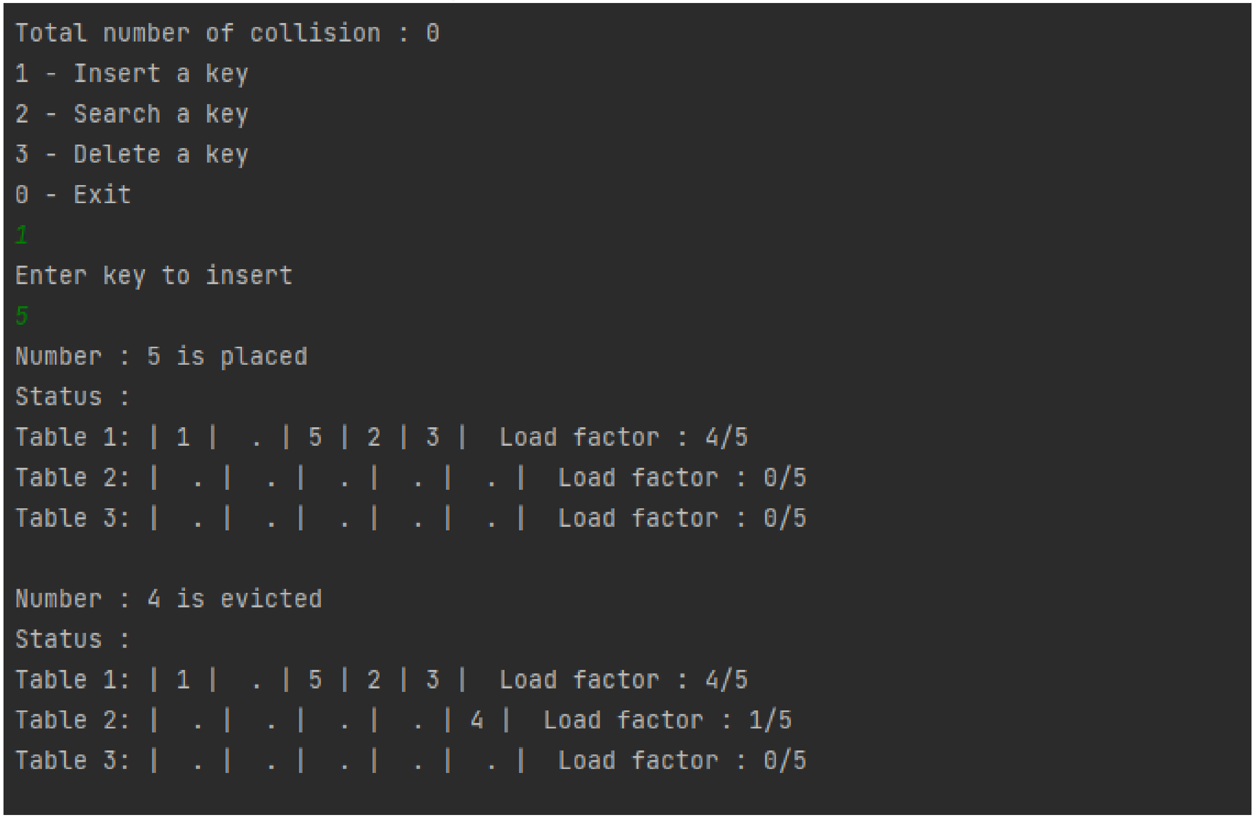
```
Total number of collision : 0
1 - Insert a key
2 - Search a key
3 - Delete a key
0 - Exit
1
Enter key to insert
3
Number : 3 is placed
Status :
Table 1: | 1 |  . |  . | 2 | 3 |  Load factor : 3/5
Table 2: |  . |  . |  . |  . |  . |  Load factor : 0/5
Table 3: |  . |  . |  . |  . |  . |  Load factor : 0/5
```

Insert 4



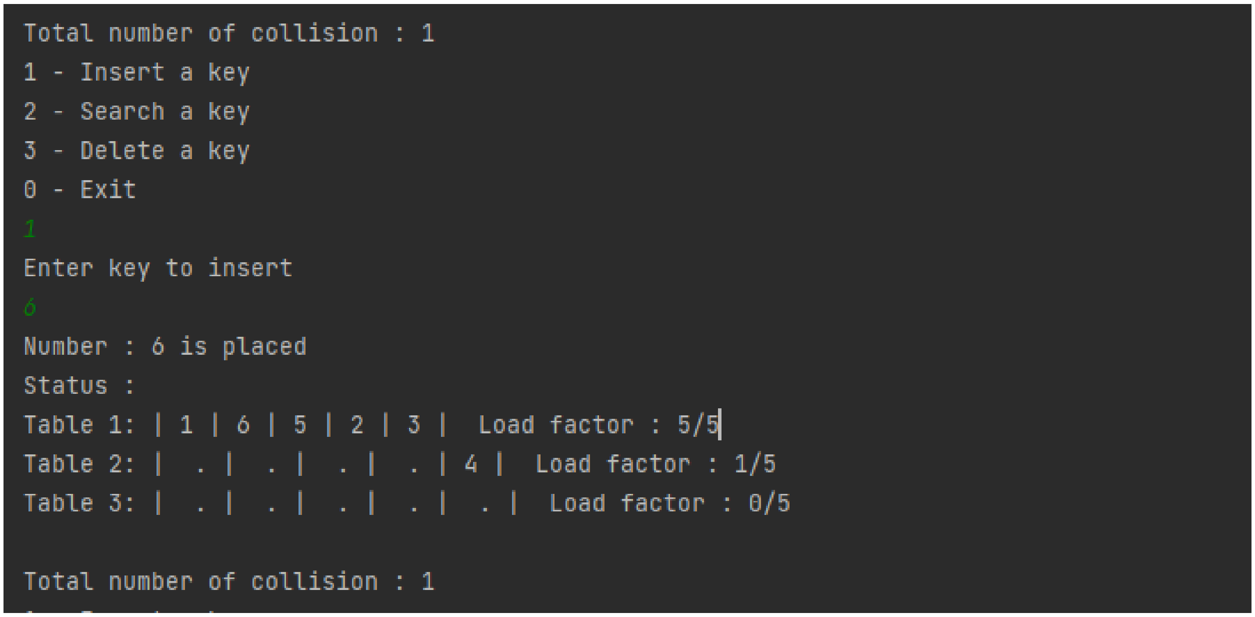
```
Total number of collision : 0
1 - Insert a key
2 - Search a key
3 - Delete a key
0 - Exit
1
Enter key to insert
4
Number : 4 is placed
Status :
Table 1: | 1 |  . | 4 | 2 | 3 |  Load factor : 4/5
Table 2: |  . |  . |  . |  . |  . |  Load factor : 0/5
Table 3: |  . |  . |  . |  . |  . |  Load factor : 0/5
```

Insert 5, but its place is already taken so evict 4 to table 2 and place 5 to table 1



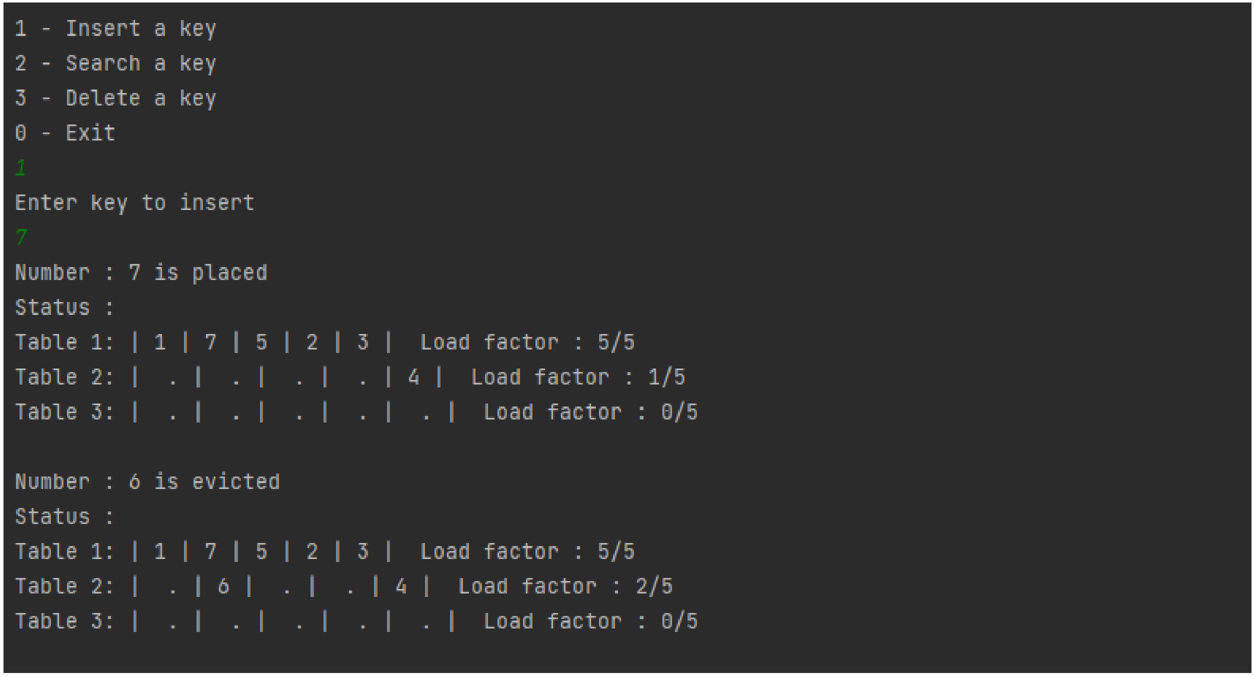
```
Total number of collision : 0
1 - Insert a key
2 - Search a key
3 - Delete a key
0 - Exit
1
Enter key to insert
5
Number : 5 is placed
Status :
Table 1: | 1 |  . | 5 | 2 | 3 |  Load factor : 4/5
Table 2: |  . |  . |  . |  . |  . |  Load factor : 0/5
Table 3: |  . |  . |  . |  . |  . |  Load factor : 0/5

Number : 4 is evicted
Status :
Table 1: | 1 |  . | 5 | 2 | 3 |  Load factor : 4/5
Table 2: |  . |  . |  . |  . | 4 |  Load factor : 1/5
Table 3: |  . |  . |  . |  . |  . |  Load factor : 0/5
```

Insert 6



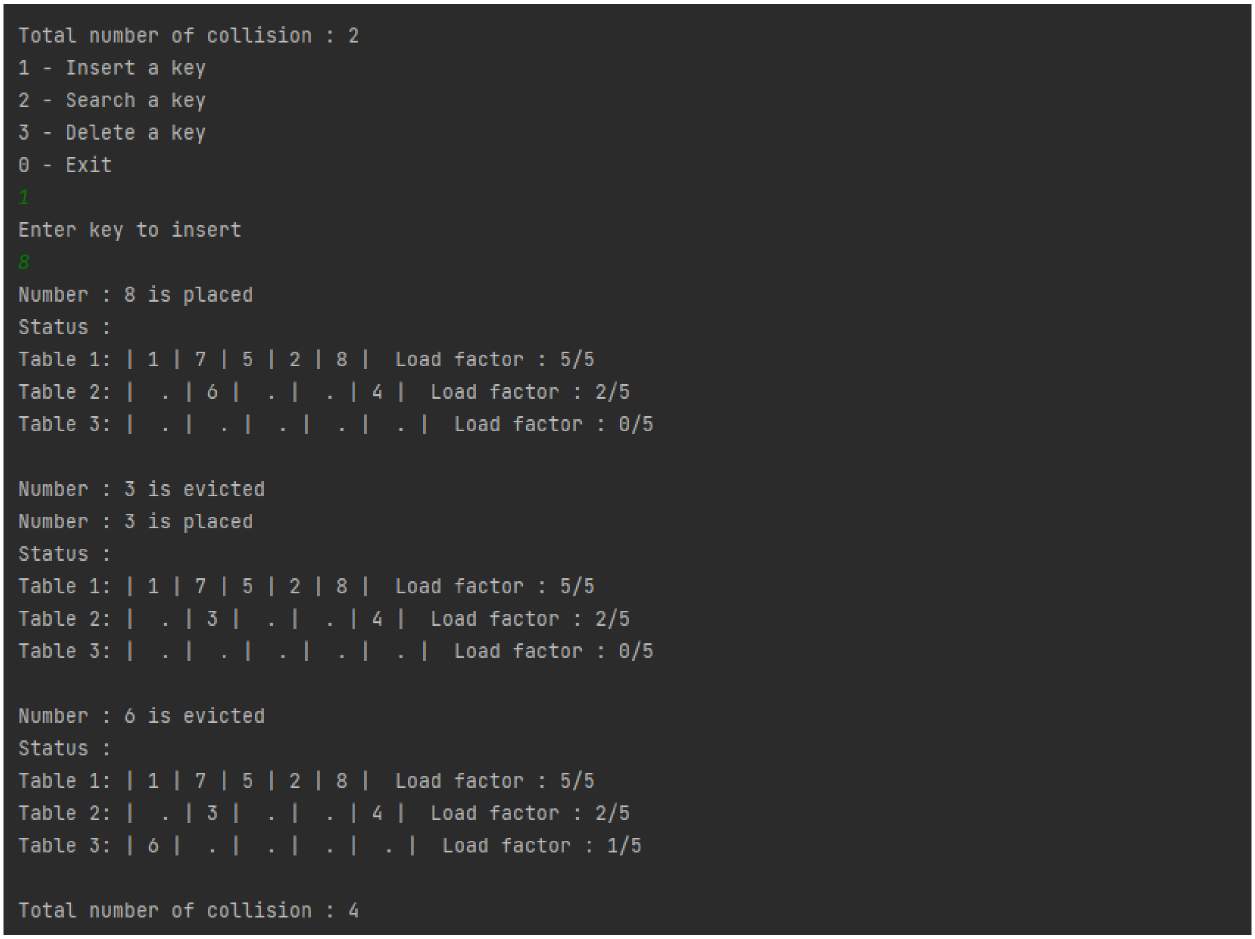
```
Total number of collision : 1
1 - Insert a key
2 - Search a key
3 - Delete a key
0 - Exit
1
Enter key to insert
6
Number : 6 is placed
Status :
Table 1: | 1 | 6 | 5 | 2 | 3 |  Load factor : 5/5
Table 2: |  . |  . |  . |  . | 4 |  Load factor : 1/5
Table 3: |  . |  . |  . |  . |  . |  Load factor : 0/5

Total number of collision : 1
```

Insert 7 but its place already taken so evict 6 to table 2, place 7 to table 1



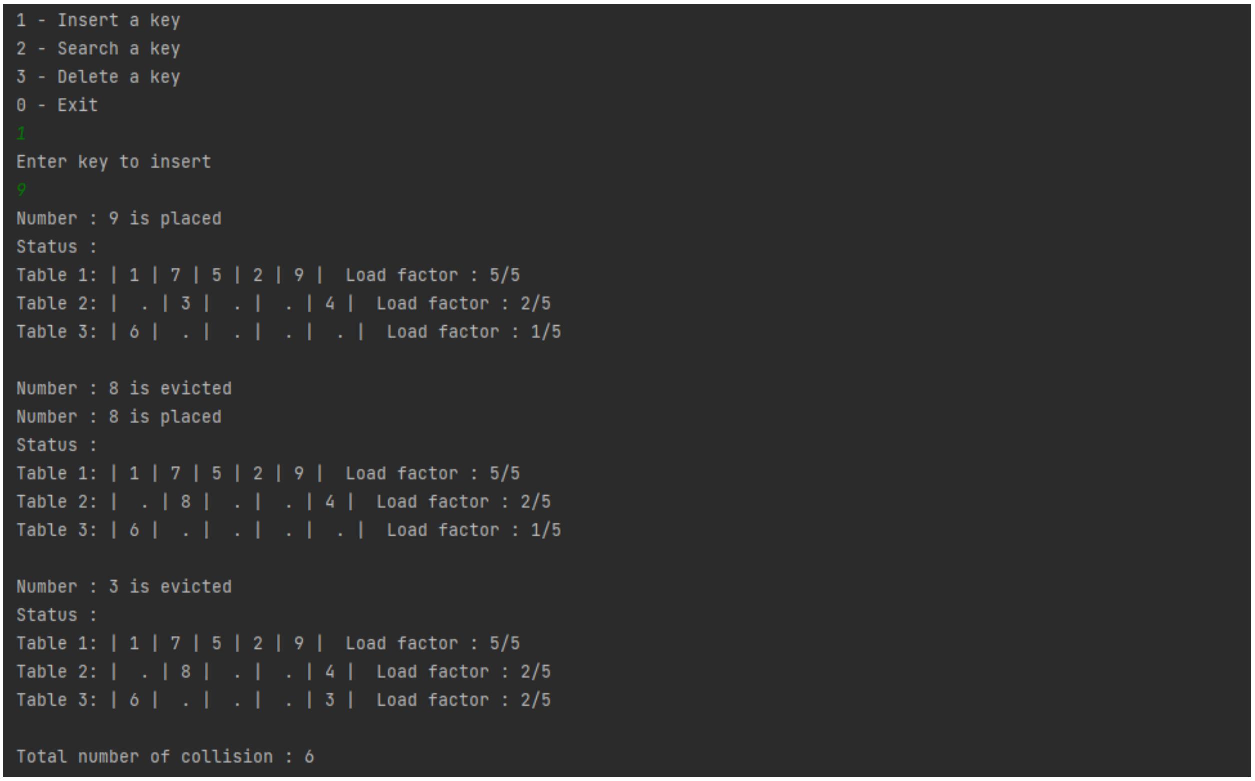
```
1 - Insert a key
2 - Search a key
3 - Delete a key
0 - Exit
1
Enter key to insert
7
Number : 7 is placed
Status :
Table 1: | 1 | 7 | 5 | 2 | 3 |  Load factor : 5/5
Table 2: |  . |  . |  . |  . | 4 |  Load factor : 1/5
Table 3: |  . |  . |  . |  . |  . |  Load factor : 0/5

Number : 6 is evicted
Status :
Table 1: | 1 | 7 | 5 | 2 | 3 |  Load factor : 5/5
Table 2: |  . | 6 |  . |  . | 4 |  Load factor : 2/5
Table 3: |  . |  . |  . |  . |  . |  Load factor : 0/5
```

Insert 8 but its place is taken, but 3 is there so evict 3 to table 2, but its place also taken so evict 6 to table 3.



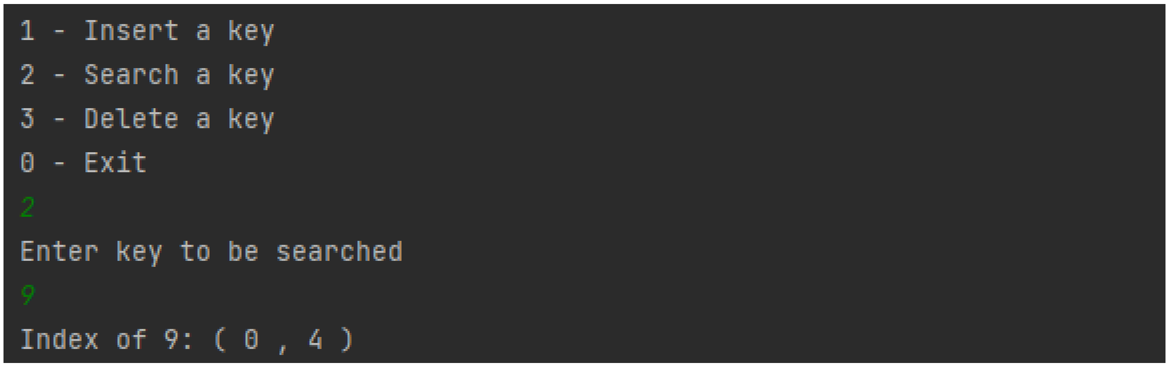
```
Total number of collision : 2
1 - Insert a key
2 - Search a key
3 - Delete a key
0 - Exit
1
Enter key to insert
8
Number : 8 is placed
Status :
Table 1: | 1 | 7 | 5 | 2 | 8 |  Load factor : 5/5
Table 2: |  . | 6 |  . |  . | 4 |  Load factor : 2/5
Table 3: |  . |  . |  . |  . |  . |  Load factor : 0/5

Number : 3 is evicted
Number : 3 is placed
Status :
Table 1: | 1 | 7 | 5 | 2 | 8 |  Load factor : 5/5
Table 2: |  . | 3 |  . |  . | 4 |  Load factor : 2/5
Table 3: |  . |  . |  . |  . |  . |  Load factor : 0/5

Number : 6 is evicted
Status :
Table 1: | 1 | 7 | 5 | 2 | 8 |  Load factor : 5/5
Table 2: |  . | 3 |  . |  . | 4 |  Load factor : 2/5
Table 3: | 6 |  . |  . |  . |  . |  Load factor : 1/5

Total number of collision : 4
```

Insert 9, but 8 is exist so evict 8 to table 2, its place also taken so evict 3 to table 3.



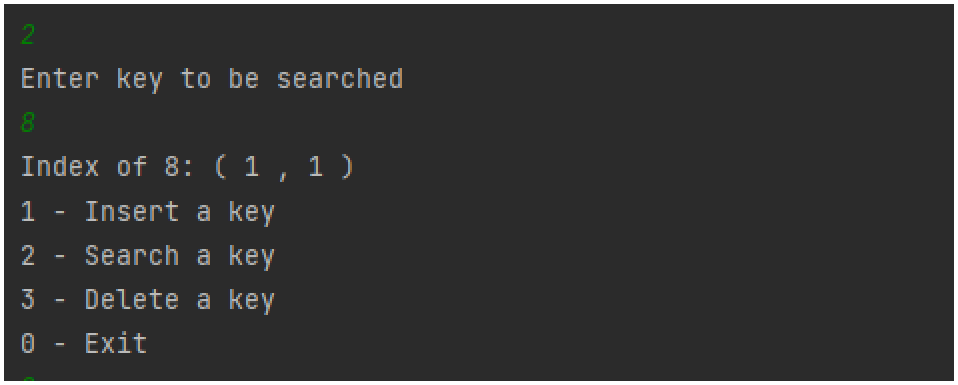
```
1 - Insert a key
2 - Search a key
3 - Delete a key
0 - Exit
1
Enter key to insert
9
Number : 9 is placed
Status :
Table 1: | 1 | 7 | 5 | 2 | 9 |  Load factor : 5/5
Table 2: |  . | 3 |  . |  . | 4 |  Load factor : 2/5
Table 3: | 6 |  . |  . |  . |  . |  Load factor : 1/5

Number : 8 is evicted
Number : 8 is placed
Status :
Table 1: | 1 | 7 | 5 | 2 | 9 |  Load factor : 5/5
Table 2: |  . | 8 |  . |  . | 4 |  Load factor : 2/5
Table 3: | 6 |  . |  . |  . |  . |  Load factor : 1/5

Number : 3 is evicted
Status :
Table 1: | 1 | 7 | 5 | 2 | 9 |  Load factor : 5/5
Table 2: |  . | 8 |  . |  . | 4 |  Load factor : 2/5
Table 3: | 6 |  . |  . |  . | 3 |  Load factor : 2/5

Total number of collision : 6
```

Now we are in seach phase. Lets search for number 9. Its index is table 0, 4th index



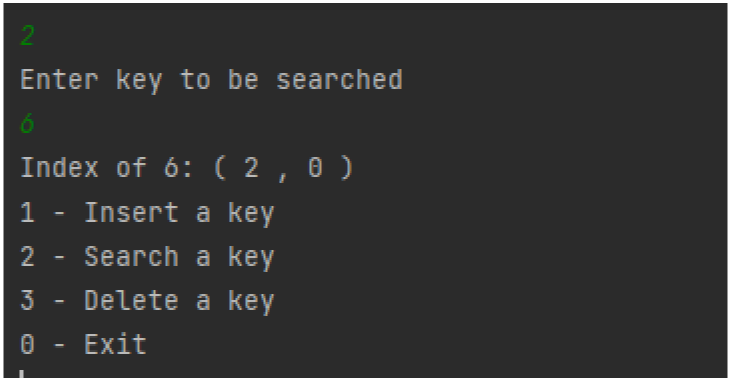
```
1 - Insert a key
2 - Search a key
3 - Delete a key
0 - Exit
2
Enter key to be searched
9
Index of 9: ( 0 , 4 )
```

Search for number 8, its index table 1, 1th index



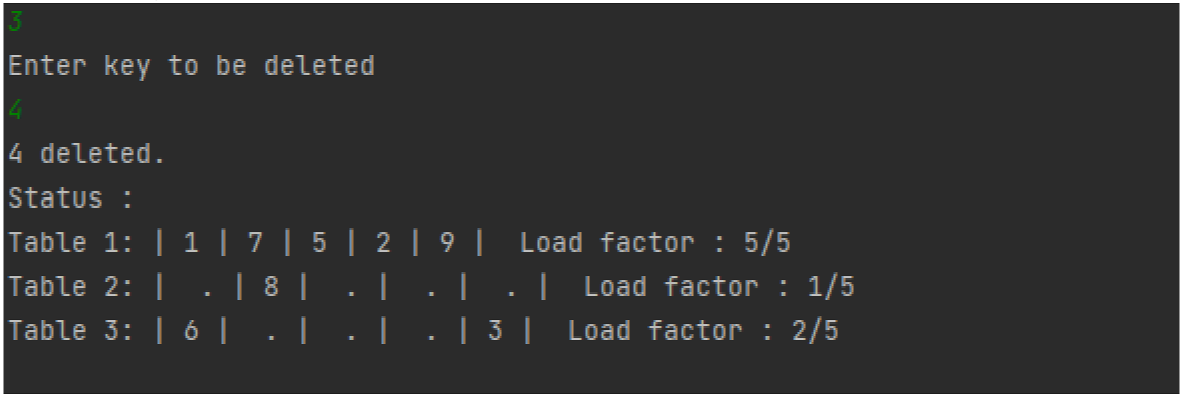
```
2
Enter key to be searched
8
Index of 8: ( 1 , 1 )
1 - Insert a key
2 - Search a key
3 - Delete a key
0 - Exit
```

Search for number 6, its index table 2, index 0 (first place)



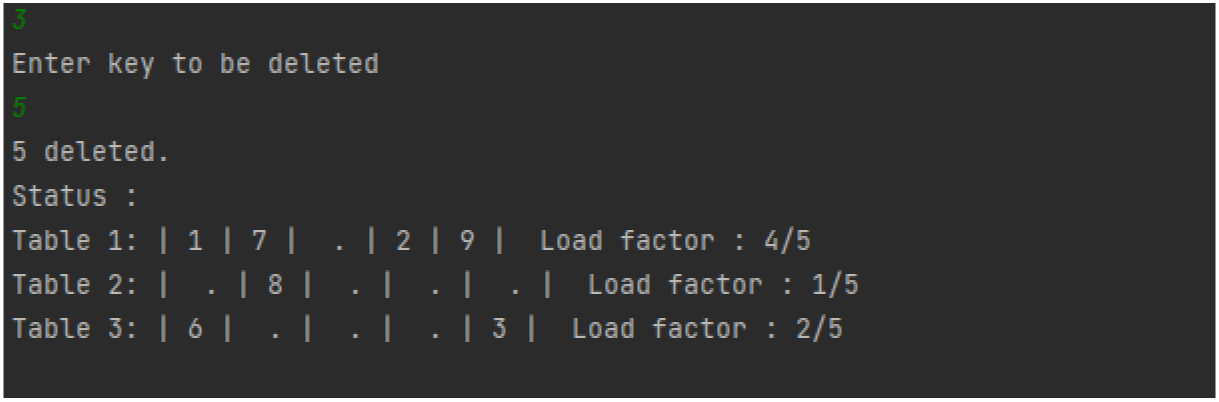
```
2
Enter key to be searched
6
Index of 6: ( 2 , 0 )
1 - Insert a key
2 - Search a key
3 - Delete a key
0 - Exit
```

Now lets delete a number 4. Number 4 from second table last index is deleted succesfully



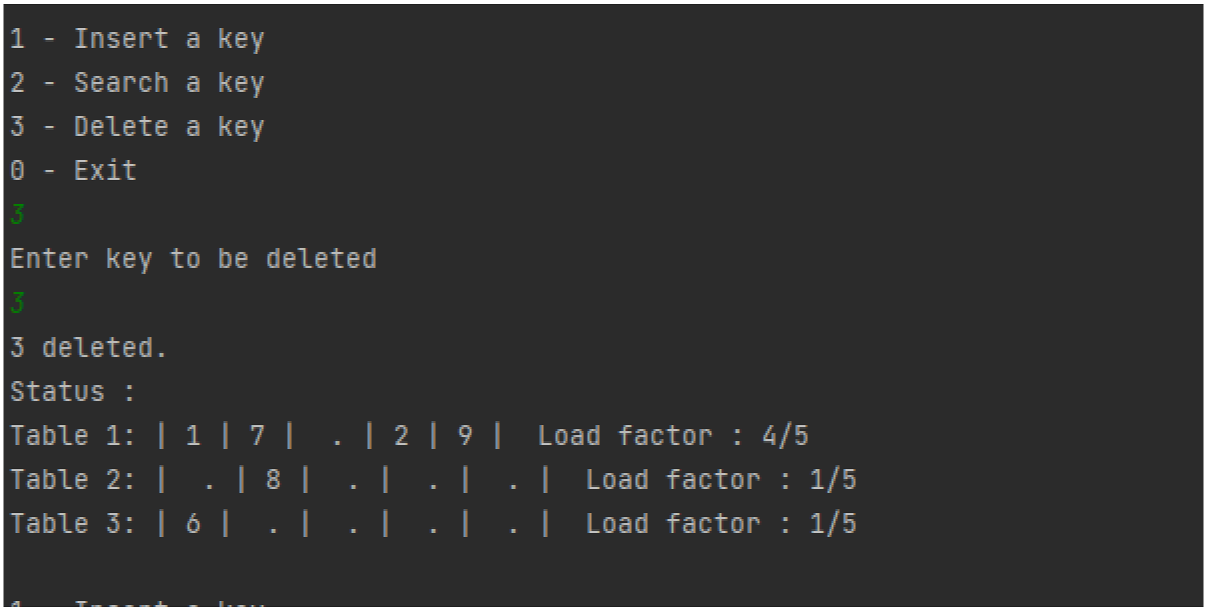
```
3
Enter key to be deleted
4
4 deleted.
Status :
Table 1: | 1 | 7 | 5 | 2 | 9 |  Load factor : 5/5
Table 2: |  . | 8 |  . |  . |  . |  Load factor : 1/5
Table 3: | 6 |  . |  . |  . | 3 |  Load factor : 2/5
```

Number 5 from first table index 2 is deleted succesfully



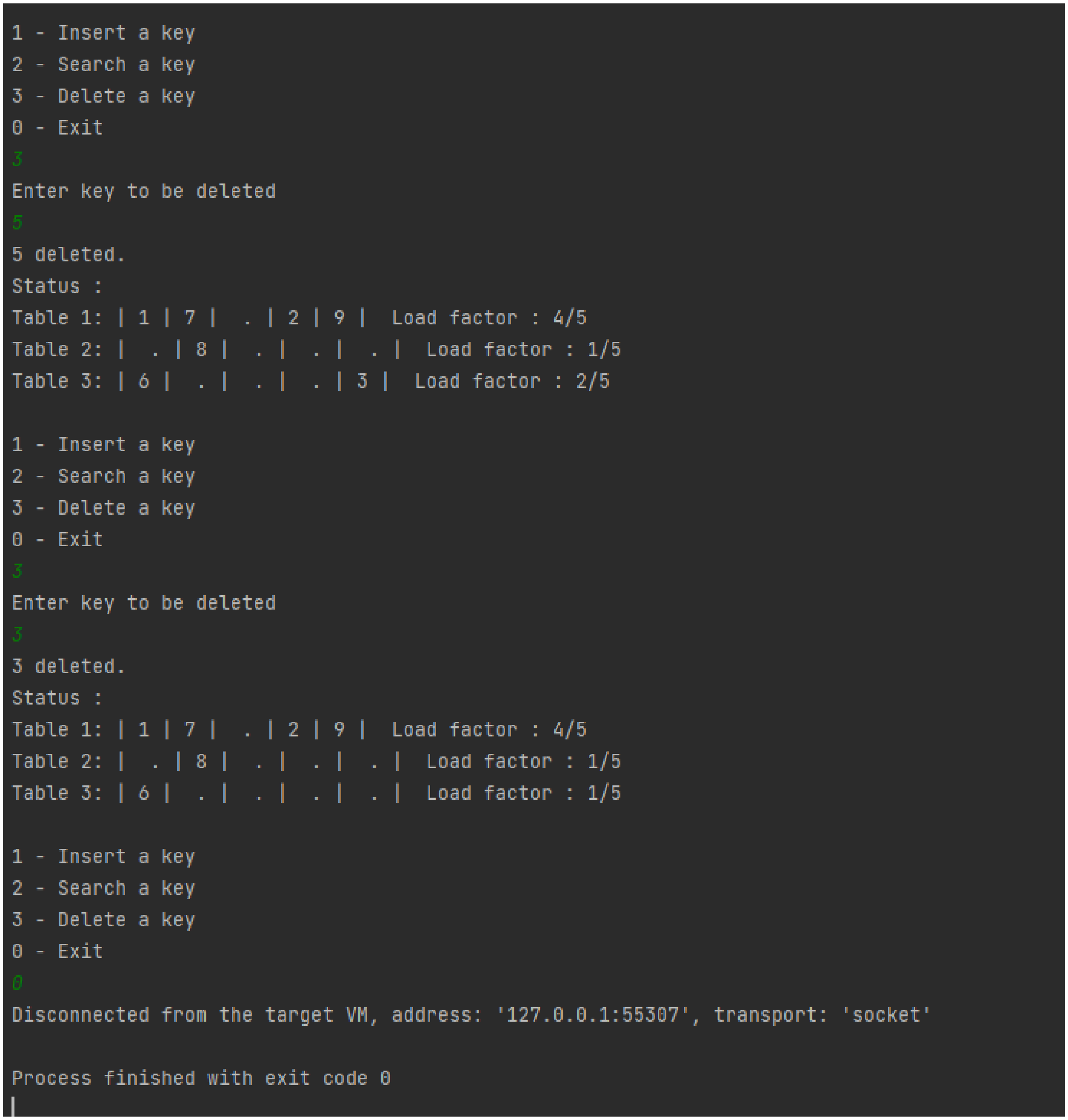
```
3
Enter key to be deleted
5
5 deleted.
Status :
Table 1: | 1 | 7 |  . | 2 | 9 |  Load factor : 4/5
Table 2: |  . | 8 |  . |  . |  . |  Load factor : 1/5
Table 3: | 6 |  . |  . |  . | 3 |  Load factor : 2/5
```

Number 3 from third table last index is deleted succesfully



```
1 - Insert a key
2 - Search a key
3 - Delete a key
0 - Exit
3
Enter key to be deleted
3
3 deleted.
Status :
Table 1: | 1 | 7 |  . | 2 | 9 |  Load factor : 4/5
Table 2: |  . | 8 |  . |  . |  . |  Load factor : 1/5
Table 3: | 6 |  . |  . |  . |  . |  Load factor : 1/5

1 - Insert a key
```

And this is the last snapshot from the program.



```
1 - Insert a key
2 - Search a key
3 - Delete a key
0 - Exit
3
Enter key to be deleted
5
5 deleted.
Status :
Table 1: | 1 | 7 |  . | 2 | 9 |  Load factor : 4/5
Table 2: |  . | 8 |  . |  . |  . |  Load factor : 1/5
Table 3: | 6 |  . |  . |  . | 3 |  Load factor : 2/5

1 - Insert a key
2 - Search a key
3 - Delete a key
0 - Exit
3
Enter key to be deleted
3
3 deleted.
Status :
Table 1: | 1 | 7 |  . | 2 | 9 |  Load factor : 4/5
Table 2: |  . | 8 |  . |  . |  . |  Load factor : 1/5
Table 3: | 6 |  . |  . |  . |  . |  Load factor : 1/5

1 - Insert a key
2 - Search a key
3 - Delete a key
0 - Exit
0
Disconnected from the target VM, address: '127.0.0.1:55307', transport: 'socket'

Process finished with exit code 0
```