

Assignment  
Hash Table Insertion Using Linear  
Probing

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## Problem Analysis

Consider a hash table consisting of  $M=11$  slots, and suppose non-negative integer key values are hashed into the table using the hash function  $h_1$ . Collisions are resolved using linear probing. The integer key values listed below are to be inserted in the given order:

Key values: 43, 23, 1, 0, 15, 31, 4, 7, 11, 3

## Analysis and Calculation

The keys are inserted into the hash table using the provided hash function and linear probing. The home slot, probe sequence (if any), and the final contents of the hash table are determined for each key.

### **Calculations and Insertion Steps:**

#### **1. Key = 43**

- Home Slot Calculation:

- $x=(43+7)*(43+7)=50*50=2500$   
 $x = (43 + 7) * (43 + 7) = 50 * 50 = 2500$
- $x=2500/16=156$   
 $x = 2500 / 16 = 156$
- $x=156+43=199$   
 $x = 156 + 43 = 199$
- $x=199\%11=1$   
 $x = 199 \% 11 = 1$

- Probe Sequence: None (No collision)

- Inserted at slot 1.

#### **2. Key = 23**

- Home Slot Calculation:

- $x=(23+7)*(23+7)=30*30=900$   
 $x = (23 + 7) * (23 + 7) = 30 * 30 = 900$
- $x=900/16=56$   
 $x = 900 / 16 = 56$
- $x=56+23=79$   
 $x = 56 + 23 = 79$

$$\blacksquare x=79\%11=2x = 79 \% 11 = 2x=79\%11=2$$

- Probe Sequence: None (No collision)
- Inserted at slot 2.

### 3. **Key = 1**

- Home Slot Calculation:
  - $x=(1+7)*(1+7)=8*8=64x = (1 + 7) * (1 + 7) = 8 * 8 = 64x=(1+7)*(1+7)=8*8=64$
  - $x=64/16=4x = 64 / 16 = 4x=64/16=4$
  - $x=4+1=5x = 4 + 1 = 5x=4+1=5$
  - $x=5\%11=5x = 5 \% 11 = 5x=5\%11=5$
- Probe Sequence: None (No collision)
- Inserted at slot 5.

### 4. **Key = 0**

- Home Slot Calculation:
  - $x=(0+7)*(0+7)=7*7=49x = (0 + 7) * (0 + 7) = 7 * 7 = 49x=(0+7)*(0+7)=7*7=49$
  - $x=49/16=3x = 49 / 16 = 3x=49/16=3$
  - $x=3+0=3x = 3 + 0 = 3x=3+0=3$
  - $x=3\%11=3x = 3 \% 11 = 3x=3\%11=3$
- Probe Sequence: None (No collision)
- Inserted at slot 3.

### 5. **Key = 15**

- Home Slot Calculation:
  - $x=(15+7)*(15+7)=22*22=484x = (15 + 7) * (15 + 7) = 22 * 22 = 484x=(15+7)*(15+7)=22*22=484$
  - $x=484/16=30x = 484 / 16 = 30x=484/16=30$
  - $x=30+15=45x = 30 + 15 = 45x=30+15=45$
  - $x=45\%11=1x = 45 \% 11 = 1x=45\%11=1$
- Probe Sequence: 1 (collision), 2 (collision), 3 (collision), 4 (inserted)
- Inserted at slot 4.

### 6. **Key = 31**

- Home Slot Calculation:

- $x=(31+7)*(31+7)=38*38=1444$   
 $x = (31 + 7) * (31 + 7) = 38 * 38 = 1444$   
 $x=(31+7)*(31+7)=38*38=1444$
- $x=1444/16=90$   
 $x = 1444 / 16 = 90$   
 $x=1444/16=90$
- $x=90+31=121$   
 $x = 90 + 31 = 121$   
 $x=90+31=121$
- $x=121\%11=0$   
 $x = 121 \% 11 = 0$   
 $x=121\%11=0$

- Probe Sequence: None (No collision)
- Inserted at slot 0.

#### 7. Key = 4

- Home Slot Calculation:
  - $x=(4+7)*(4+7)=11*11=121$   
 $x = (4 + 7) * (4 + 7) = 11 * 11 = 121$   
 $x=(4+7)*(4+7)=11*11=121$
  - $x=121/16=7$   
 $x = 121 / 16 = 7$   
 $x=121/16=7$
  - $x=7+4=11$   
 $x = 7 + 4 = 11$   
 $x=7+4=11$
  - $x=11\%11=0$   
 $x = 11 \% 11 = 0$   
 $x=11\%11=0$
- Probe Sequence: 0 (collision), 1 (collision), 2 (collision), 3 (collision), 4 (collision), 5 (collision), 6 (inserted)
- Inserted at slot 6.

#### 8. Key = 7

- Home Slot Calculation:
  - $x=(7+7)*(7+7)=14*14=196$   
 $x = (7 + 7) * (7 + 7) = 14 * 14 = 196$   
 $x=(7+7)*(7+7)=14*14=196$
  - $x=196/16=12$   
 $x = 196 / 16 = 12$   
 $x=196/16=12$
  - $x=12+7=19$   
 $x = 12 + 7 = 19$   
 $x=12+7=19$
  - $x=19\%11=8$   
 $x = 19 \% 11 = 8$   
 $x=19\%11=8$
- Probe Sequence: None (No collision)
- Inserted at slot 8.

#### 9. Key = 11

- Home Slot Calculation:
  - $x=(11+7)*(11+7)=18*18=324$   
 $x = (11 + 7) * (11 + 7) = 18 * 18 = 324$   
 $x=(11+7)*(11+7)=18*18=324$
  - $x=324/16=20$   
 $x = 324 / 16 = 20$   
 $x=324/16=20$
  - $x=20+11=31$   
 $x = 20 + 11 = 31$   
 $x=20+11=31$
  - $x=31\%11=9$   
 $x = 31 \% 11 = 9$   
 $x=31\%11=9$

- Probe Sequence: None (No collision)
- Inserted at slot 9.

#### 10. Key = 3

- Home Slot Calculation:
  - $x = (3+7) * (3+7) = 10 * 10 = 100$   
 $x = (3 + 7) * (3 + 7) = 10 * 10 = 100$
  - $x = 100 / 16 = 6$   
 $x = 100 / 16 = 6$
  - $x = 6 + 3 = 9$   
 $x = 6 + 3 = 9$
  - $x = 9 \% 11 = 9$   
 $x = 9 \% 11 = 9$
- Probe Sequence: 9 (collision), 10 (inserted)
- Inserted at slot 10.

## Final Hash Table:

Slot    0 1 2 3 4 5 6 7 8 9 10

Contents 31 43 23 0 15 1 4 7 11 3

## Conclusion

In this problem, we successfully demonstrated the insertion of keys into a hash table with  $M=11$  slots using a custom hash function and linear probing to resolve collisions. The process involved calculating the home slot for each key and managing collisions by probing sequentially until an empty slot was found.