HABIB UNIVERSITY

Data Structures & Algorithms

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Hash Table Operations – Collision Handling Using Quadratic Probing

Student 1: _____

For a hash table with size = 20, and use Divide Modulo method for hash function to get the slot index. Use Quadratic Probing to resolve Collisions.

1. setitem(5)

- Hash Function= Divide Modulo
- Slot Index = 5 % 20 = 5
- Empty slot, no collision so slot index = 5 gets key = 5

0	
1	
2	
3	
4	
5	**5**
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	

2. setitem(56)

- Hash Function= Divide Modulo
- Slot Index = 56 % 20 = 16
- Empty slot, no collision so slot index = 16 gets key = 56

0	
1	
2	
3	
4	
5	5
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	**56**
17	
18	
19	

3. setitem(61)

- Hash Function= Divide Modulo
- Slot Index = 61 % 20 = 1
- Empty slot, no collision so slot index = 1 gets key = 61

0	
1	**61**
2	
3	
4	
5	5
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	56
17	
18	
19	

4. getitem(15)

- Hash Function= Divide Modulo
- Slot Index = 15 % 20 = 15
- Go to slot index 15 and check if 15 exists. It does not, so try rehashing to check next possible slot
- Use quadratic probing and rehash they key as:

  $h'(k) = [h(k) + 1^2] \bmod N$
- $h'(15) = [h(15) + 1^2] \% 20$
- $h(15) = 15$ (as deduced above)
- $h'(15) = [15 + 1] \bmod 20 = 16$
- Go to slot index 16 and check if 15 exists over there. It does not, so try rehashing to check next possible slot
- This continues until the rehashing results back to slot index 15, by which time all the slots would have been checked and 15 would not have been found, so it gives an error that the key does not exist, and returns **False**
- Hash Table does not change

0	
1	61
2	
3	
4	
5	5
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	56
17	
18	
19	

5. setitem(73)

- Hash Function= Divide Modulo
- Slot Index = 73 % 20 = 13
- Empty slot, no collision so slot index = 13 gets key = 73

0	
1	61
2	
3	
4	
5	5
6	
7	
8	
9	
10	
11	
12	
13	**73**
14	
15	
16	56
17	
18	
19	

6. setitem(96)

- Hash Function= Divide Modulo
- Slot Index = 96 % 20 = 16
- Already a key present at slot index = 16, so use quadratic probing and rehash they key as:

  $h'(k) = [h(k) + 1^2] \bmod N$
- $h'(96) = [h(96) + 1^2] \% 20$
- $h(96) = 16$ (as deduced above)
- $h'(96) = [16 + 1] \bmod 20 = 17$
- Empty slot, no collision so slot index = 17 gets key = 96

0	
1	61
2	
3	
4	
5	5
6	
7	
8	
9	
10	
11	
12	
13	73
14	
15	
16	56
17	**96**
18	
19	

7. setitem(109)

- Hash Function= Divide Modulo
- Slot Index = 109 % 20 = 9
- Empty slot, no collision so slot index = 9 gets key = 109

0	
1	61
2	
3	
4	
5	5
6	
7	
8	
9	**109**
10	
11	
12	
13	73
14	
15	
16	56
17	96
18	
19	

8. setitem(124)

- Hash Function= Divide Modulo
- Slot Index = 124 % 20 = 4
- Empty slot, no collision so slot index = 4 gets key = 124

0	
1	61
2	
3	
4	**124**
5	5
6	
7	
8	
9	109
10	
11	
12	
13	73
14	
15	
16	56
17	96
18	
19	

9. delitem(61)

- Hash Function= Divide Modulo
- Slot Index = 61 % 20 = 1
- Go to slot index 1 and check if 61 exists. It does, so delete the entry from the hash table

0	
1	
2	
3	
4	124
5	5
6	
7	
8	
9	109
10	
11	
12	
13	73
14	
15	
16	56
17	96
18	
19	

10. setitem(130)

- Hash Function= Divide Modulo
- Slot Index = 130 % 20 = 10
- Empty slot, no collision so slot index = 10 gets key = 130

0	
1	
2	
3	
4	124
5	5
6	
7	
8	
9	109
10	**130**
11	
12	
13	73
14	
15	
16	56
17	96
18	
19	

11. setitem(150)

- Hash Function= Divide Modulo
- Slot Index = 150 % 20 = 10
- Already a key present at slot index = 10, so use quadratic probing and rehash they key as:

  $h'(k) = [h(k) + 1^2] \bmod N$
- $h'(150) = [h(150) + 1^2] \% 20$
- $h(150) = 10$ (as deduced above)
- $h'(150) = [10 + 1] \bmod 20 = 11$
- Empty slot, no collision so slot index = 11 gets key = 150

0	
1	
2	
3	
4	124
5	5
6	
7	
8	
9	109
10	130
11	**150**
12	
13	73
14	
15	
16	56
17	96
18	
19	

12. setitem(185)

- Hash Function= Divide Modulo
- Slot Index = 185 % 20 = 5
- Already a key present at slot index = 5, so use quadratic probing and rehash they key as:

  $h'(k) = [h(k) + 1^2] \bmod N$
- $h'(185) = [h(185) + 1^2] \% 20$
- $h(185) = 5$ (as deduced above)
- $h'(185) = [5 + 1] \bmod 20 = 6$
- Empty slot, no collision so slot index = 6 gets key = 185

0	
1	
2	
3	
4	124
5	5
6	**185**
7	
8	
9	109
10	130
11	150
12	
13	73
14	
15	
16	56
17	96
18	
19	

13. setitem(190)

- Hash Function= Divide Modulo
- Slot Index = 190 % 20 = 10
- Already a key present at slot index = 10, so use quadratic probing and rehash they key as:

$h'(k) = [h(k) + 1^2] \bmod N$

- $h'(190) = [h(190) + 1^2] \% 20$
- $h(190) = 10$ (as deduced above)
- $h'(190) = [10 + 1] \bmod 20 = 11$
- Already a key present at slot index = 11, so use quadratic probing and rehash they key as:

$h'(k) = [h(k) + 2^2] \bmod N$

- $h'(190) = [h(190) + 2^2] \% 20$
- $h(190) = 10$ (as deduced above)
- $h'(190) = [10 + 4] \bmod 20 = 14$
- Empty slot, no collision so slot index = 14 gets key = 190

0	
1	
2	
3	
4	124
5	5
6	185
7	
8	
9	109
10	130
11	150
12	
13	73
14	**190**
15	
16	56
17	96
18	
19	

14. setitem(205)

- Hash Function= Divide Modulo
- Slot Index = 205 % 20 = 5
- Already a key present at slot index = 5, so use quadratic probing and rehash they key as:

$h'(k) = [h(k) + 1^2] \bmod N$

- $h'(205) = [h(205) + 1^2] \% 20$
- $h(205) = 5$ (as deduced above)
- $h'(205) = [5 + 1] \bmod 20 = 6$
- Already a key present at slot index = 6, so use quadratic probing and rehash they key as:

$h'(k) = [h(k) + 2^2] \bmod N$

- $h'(205) = [h(205) + 2^2] \% 20$
- $h(205) = 5$ (as deduced above)
- $h'(205) = [5 + 4] \bmod 20 = 9$
- Already a key present at slot index = 9, so use quadratic probing and rehash they key as:

$h'(k) = [h(k) + 3^2] \bmod N$

- $h'(205) = [h(205) + 3^2] \% 20$
- $h(205) = 5$ (as deduced above)
- $h'(205) = [5 + 9] \bmod 20 = 14$
- Already a key present at slot index = 14, so use quadratic probing and rehash they key as:

$h'(k) = [h(k) + 4^2] \bmod N$

- $h'(205) = [h(205) + 4^2] \% 20$
- $h(205) = 5$ (as deduced above)
- $h'(205) = [5 + 16] \bmod 20 = 1$
- Empty slot, no collision so slot index = 1 gets key = 205

0	
1	**205**
2	
3	
4	124
5	5
6	185
7	
8	
9	109
10	130
11	150
12	
13	73
14	190
15	
16	56
17	96
18	
19	

15. delitem(195)

- Hash Function= Divide Modulo
- Slot Index = 195 % 20 = 15
- Go to slot index 15 and check if 195 exists. It does not, so try rehashing to check next possible slot
- Use quadratic probing and rehash they key as:

$h'(k) = [h(k) + 1^2] \bmod N$

- $h'(195) = [h(195) + 1^2] \% 20$
- $h(195) = 15$ (as deduced above)
- $h'(195) = [15 + 1] \bmod 20 = 16$
- Go to slot index 16 and check if 195 exists over there. It does not, so try rehashing to check next possible slot
- This continues until the rehashing results back to slot index 15, by which time all the slots would have been checked and 195 would not have been found, so it gives an error that the key does not exist, and does not delete anything
- Hash Table does not change

0	
1	205
2	
3	
4	124
5	5
6	185
7	
8	
9	109
10	130
11	150
12	
13	73
14	190
15	
16	56
17	96
18	
19	

16. setitem(231)

- Hash Function= Divide Modulo
- Slot Index = 231 % 20 = 11
- Already a key present at slot index = 11, so use quadratic probing and rehash they key as:
  $h'(k) = [h(k) + 1^2] \bmod N$
- $h'(231) = [h(231) + 1^2] \% 20$
- h(231) = 11 (as deduced above)
- $h'(231) = [11 + 1] \bmod 20 = 12$
- Already a key present at slot index = 12, so use quadratic probing and rehash they key as:
  $h'(k) = [h(k) + 2^2] \bmod N$
- $h'(231) = [h(231) + 2^2] \% 20$
- h(231) = 11 (as deduced above)
  $h'(231) = [11 + 4] \bmod 20 = 15$
- Empty slot, no collision so slot index = 15 gets key = 231

0	
1	205
2	
3	
4	124
5	5
6	185
7	
8	
9	109
10	130
11	150
12	
13	73
14	190
15	**231**
16	56
17	96
18	
19	

17. getitem(205)

- Hash Function= Divide Modulo
- Slot Index = 205 % 20 = 5
- Go to slot index 5 and check if 205 exists. It does not, so try rehashing to check next possible slot
- Use quadratic probing and rehash they key as: **$h'(k) = [h(k) + 1^2] \bmod N$**
- $h'(205) = [h(205) + 1^2] \% 20$
- h(205) = 5 (as deduced above)
- $h'(205) = [5 + 1] \bmod 20 = 6$
- Go to slot index 6 and check if 205 exists. It does not, so try rehashing to check next possible slot
- Use quadratic probing and rehash they key as: **$h'(k) = [h(k) + 2^2] \bmod N$**
- $h'(205) = [h(205) + 2^2] \% 20$
- h(205) = 5 (as deduced above)
- $h'(205) = [5 + 4] \bmod 20 = 9$
- Go to slot index 9 and check if 205 exists. It does not, so try rehashing to check next possible slot
- Use quadratic probing and rehash they key as: **$h'(k) = [h(k) + 3^2] \bmod N$**
- $h'(205) = [h(205) + 3^2] \% 20$
- h(205) = 5 (as deduced above)
- $h'(205) = [5 + 9] \bmod 20 = 14$
- Go to slot index 14 and check if 205 exists. It does not, so try rehashing to check next possible slot
- Use quadratic probing and rehash they key as: **$h'(k) = [h(k) + 4^2] \bmod N$**
- $h'(205) = [h(205) + 4^2] \% 20$
- h(205) = 5 (as deduced above)
- $h'(205) = [5 + 16] \bmod 20 = 1$
- Go to slot index 1 and check if 205 exists. It does, so the key is found and it returns **True**
- Hash table does not change

0	
1	205
2	
3	
4	124
5	5
6	185
7	
8	
9	109
10	130
11	150
12	
13	73
14	190
15	231
16	56
17	96
18	
19	