



HABIB UNIVERSITY

Data Structures & Algorithms

CS/CE 102/171 Spring 2023

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Hash Table Operations – Collision Handling Using Linear Probing

Student 1: _____

For a hash table with size = 17, and use Digit Extraction method for hash function – Combine 2nd and 4th digits of the given key to get the slot index. Use Linear Probing to resolve Collisions.

<p>1. setitem(5007)</p> <ul style="list-style-type: none">Hash Function = Extract digits 2nd and 4thHash Function = <u>5007</u>Slot Index = 07Empty slot, no collision so slot index = 07 gets key = 5007 <div><div>0</div><div></div><div>1</div><div></div><div>2</div><div></div><div>3</div><div></div><div>4</div><div></div><div>5</div><div></div><div>6</div><div></div><div>7</div><div>5007</div><div>8</div><div></div><div>9</div><div></div><div>10</div><div></div><div>11</div><div></div><div>12</div><div></div><div>13</div><div></div><div>14</div><div></div><div>15</div><div></div><div>16</div><div></div></div>	<p>2. setitem(4012)</p> <ul style="list-style-type: none">Hash Function = Extract digits 2nd and 4thHash Function = <u>4012</u>Slot Index = 02Empty slot, no collision so slot index = 02 gets key = 4012 <div><div>0</div><div></div><div>1</div><div></div><div>2</div><div>4012</div><div>3</div><div></div><div>4</div><div></div><div>5</div><div></div><div>6</div><div></div><div>7</div><div>5007</div><div>8</div><div></div><div>9</div><div></div><div>10</div><div></div><div>11</div><div></div><div>12</div><div></div><div>13</div><div></div><div>14</div><div></div><div>15</div><div></div><div>16</div><div></div></div>	<p>3. setitem(1097)</p> <ul style="list-style-type: none">Hash Function = Extract digits 2nd and 4thHash Function = <u>1097</u>Slot Index = 07Already a key present at slot index = 7, so use linear probing and rehash they key as: $h'(k) = [h(k) + 1] \bmod N$$h'(1097) = [h(1097) + 1] \% 17$$h(1097) = 7$ (as deduced above)$h'(1097) = [7 + 1] \bmod 17 = 8$Empty slot, no collision so slot index = 08 gets key = 1097 <div><div>0</div><div></div><div>1</div><div></div><div>2</div><div>4012</div><div>3</div><div></div><div>4</div><div></div><div>5</div><div></div><div>6</div><div></div><div>7</div><div>5007</div><div>8</div><div>1097</div><div>9</div><div></div><div>10</div><div></div><div>11</div><div></div><div>12</div><div></div><div>13</div><div></div><div>14</div><div></div><div>15</div><div></div><div>16</div><div></div></div>
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4. setitem(115566)

- Hash Function = Extract digits 2nd and 4th
- Hash Function = 115566
- Slot Index = 15
- Empty slot, no collision so slot index = 15 gets key = 115566

0	
1	
2	4012
3	
4	
5	
6	
7	5007
8	1097
9	
10	
11	
12	
13	
14	
15	115566
16	

5. setitem(300100)

- Hash Function = Extract digits 2nd and 4th
- Hash Function = 300100
- Slot Index = 01
- Empty slot, no collision so slot index = 01 gets key = 300100

0	
1	300100
2	4012
3	
4	
5	
6	
7	5007
8	1097
9	
10	
11	
12	
13	
14	
15	115566
16	

6. setitem(37)

- Hash Function = Extract digits 2nd and 4th
- Hash Function = 37
- Slot Index = 7
- Already a key present at slot index = 7, so use linear probing and rehash they key as:

$$h'(k) = [h(k) + 1] \bmod N$$
 - $h'(37) = [h(37) + 1] \% 17$
 - $h(37) = 7$ (as deduced above)
 - $h'(37) = [7 + 1] \bmod 17 = 8$
- Already a key present at slot index = 8, so use linear probing and rehash they key as:

$$h'(k) = [h(k) + 2] \bmod N$$
 - $h'(37) = [h(37) + 2] \% 17$
 - $h(37) = 7$ (as deduced above)
 - $h'(37) = [7 + 2] \bmod 17 = 9$
- Empty slot, no collision so slot index = 9 gets key = 37

0	
1	300100
2	4012
3	
4	
5	
6	
7	5007
8	1097
9	37
10	
11	
12	
13	
14	
15	115566
16	

7. getitem(1097)

- Hash Function = Extract digits 2nd and 4th
- Hash Function = 1097
- Slot Index = 07
- Go to slot index 7 and check if 1097 exists. It does not, so try rehashing to check next possible slot
- Use linear probing and rehash they key as:

$$h'(k) = [h(k) + 1] \bmod N$$
- $h'(1097) = [h(1097) + 1] \% 17$
- $h(1097) = 7$ (as deduced above)
- $h'(1097) = [7 + 1] \bmod 17 = 8$
- Go to slot index 8 and check if 1097 exists over there. It does, so returns **True**.
- Hash table does not change

0	
1	300100
2	4012
3	
4	
5	
6	
7	5007
8	1097
9	37
10	
11	
12	
13	
14	
15	115566
16	

8. setitem(3146)

- Hash Function = Extract digits 2nd and 4th
- Hash Function = 3146
- Slot Index = 16
- Empty slot, no collision so slot index = 16 gets key = 3146

0	
1	300100
2	4012
3	
4	
5	
6	
7	5007
8	1097
9	37
10	
11	
12	
13	
14	
15	115566
16	3146

9. setitem(8134567)

- Hash Function = Extract digits 2nd and 4th
- Hash Function = 8134567
- Slot Index = 14
- Empty slot, no collision so slot index = 14 gets key = 8134567

0	
1	300100
2	4012
3	
4	
5	
6	
7	5007
8	1097
9	37
10	
11	
12	
13	
14	8134567
15	115566
16	3146

10. delitem(8134567)

- Hash Function = Extract digits 2nd and 4th
- Hash Function = 8134567
- Slot Index = 14
- Go to slot index 14 and check if 8134567 exists. It does, so delete the entry from the hash table

0	
1	300100
2	4012
3	
4	
5	
6	
7	5007
8	1097
9	37
10	
11	
12	
13	
14	
15	115566
16	3146

11. setitem(7122)

- Hash Function = Extract digits 2nd and 4th
- Hash Function = 7122
- Slot Index = 12
- Empty slot, no collision so slot index = 12 gets key = 7122

0	
1	300100
2	4012
3	
4	
5	
6	
7	5007
8	1097
9	37
10	
11	
12	7122
13	
14	
15	115566
16	3146

12. delitem(1144)

- Hash Function = Extract digits 2nd and 4th
- Hash Function = 1144
- Slot Index = 14
- Go to slot index 14 and check if 1144 exists. It does not, so try rehashing to check next possible slot
- Use linear probing and rehash they key as:

$$h'(k) = [h(k) + 1] \bmod N$$
 - $h'(1144) = [h(1144) + 1] \% 17$
 - $h(1144) = 14$ (as deduced above)
 - $h'(1144) = [14 + 1] \bmod 17 = 15$
 - Go to slot index 15 and check if 1144 exists over there. It does not, so try rehashing to check next possible slot
 - This continues until the rehashing results back to slot index 14, by which time all the slots would have been checked and 1144 would not have been found, so it gives an error that the key does not exist, and does not perform deletion either
- Hash Table does not change

0	
1	300100
2	4012
3	
4	
5	
6	
7	5007
8	1097
9	37
10	
11	
12	7122
13	
14	
15	115566
16	3146

13. setitem(914399)

- Hash Function = Extract digits 2nd and 4th
- Hash Function = 914399
- Slot Index = 13
- Empty slot, as it was recently emptied, no collision so slot index = 13 gets key = 914399

0	
1	300100
2	4012
3	
4	
5	
6	
7	5007
8	1097
9	37
10	
11	
12	7122
13	914399
14	
15	115566
16	3146

14. setitem(9192)

- Hash Function = Extract digits 2nd and 4th
- Hash Function = 9192
- Slot Index = 12
- Already a key present at slot index = 12, so use linear probing and rehash they key as:

$$h'(k) = [h(k) + 1] \bmod N$$
 - $h'(9192) = [h(9192) + 1] \% 17$
 - $h(9192) = 12$ (as deduced above)
 - $h'(9192) = [12 + 1] \bmod 17 = 13$
- Already a key present at slot index = 13, so use linear probing and rehash they key as:

$$h'(k) = [h(k) + 2] \bmod N$$
 - $h'(9192) = [h(9192) + 2] \% 17$
 - $h(9192) = 12$ (as deduced above)
 - $h'(9192) = [12 + 2] \bmod 17 = 14$
- Empty slot, no collision so slot index = 14 gets key = 9192

0	
1	300100
2	4012
3	
4	
5	
6	
7	5007
8	1097
9	37
10	
11	
12	7122
13	914399
14	9192
15	115566
16	3146

15. getitem(4136)

- Hash Function = Extract digits 2nd and 4th
- Hash Function = 4136
- Slot Index = 16
- Go to slot index 16 and check if 4136 exists. It does not, so try rehashing to check next possible slot
- Use linear probing and rehash they key as:

$$h'(k) = [h(k) + 1] \bmod N$$
 - $h'(4136) = [h(4136) + 1] \% 17$
 - $h(4136) = 16$ (as deduced above)
 - $h'(4136) = [16 + 1] \bmod 17 = 0$
- Go to slot index 0 and check if 4136 exists over there. It does not, so try rehashing to check next possible slot
- This continues until the rehashing results back to slot index 16, by which time all the slots would have been checked and 4136 would not have been found, so it gives an error that the key does not exist, so returns **False**
- Hash Table does not change

0	
1	300100
2	4012
3	
4	
5	
6	
7	5007
8	1097
9	37
10	
11	
12	7122
13	914399
14	9192
15	115566
16	3146

16. setitem(115566)

- Hash Function = Extract digits 2nd and 4th
- Hash Function = 15566
- Slot Index = 15
- Key already present at slot index = 15, so no need to insert
- Hash Table does not change

0	
1	300100
2	4012
3	
4	
5	
6	
7	5007
8	1097
9	37
10	
11	
12	7122
13	914399
14	9192
15	115566
16	3146