COMP2012
Object-Oriented Programming and Data Structures

Hashing (Supplementary Notes)

Linear Probing: Example

- hash(k) = k mod 10
- f(i) = i
- $h_i(k) = (k \bmod 10 + i) \bmod 10$

- $h_0(89) = (89 \bmod 10 + 0) \bmod 10 = 9$ (OK)
- $h_0(18) = (18 \bmod 10 + 0) \bmod 10 = 8$ (OK)
- $h_0(49) = (49 \bmod 10 + 0) \bmod 10 = 9$ (Collision occurs)
  $h_1(49) = (49 \bmod 10 + 1) \bmod 10 = 0$ (OK)
- $h_0(58) = (58 \bmod 10 + 0) \bmod 10 = 8$ (Collision occurs)
  $h_1(58) = (58 \bmod 10 + 1) \bmod 10 = 9$ (Collision occurs)
  $h_2(58) = (58 \bmod 10 + 2) \bmod 10 = 0$ (Collision occurs)
  $h_3(58) = (58 \bmod 10 + 3) \bmod 10 = 1$ (OK)
- $h_0(69) = (69 \bmod 10 + 0) \bmod 10 = 9$ (Collision occurs)
  $h_1(69) = (69 \bmod 10 + 1) \bmod 10 = 0$ (Collision occurs)
  $h_2(69) = (69 \bmod 10 + 2) \bmod 10 = 1$ (Collision occurs)
  $h_3(69) = (69 \bmod 10 + 3) \bmod 10 = 2$ (OK)

Table Index	Insert 89	Insert 18	Insert 49	Insert 58	Insert 69
0			49	49	49
1				58	58
2					69
3					
4					
5					
6					
7					
8		18	18	18	18
9	89	89	89	89	89

Quadratic Probing: Example

- hash(k) = k mod 10
- f(i) = i^2
- $h_i(k) = (k \bmod 10 + i^2) \bmod 10$

- $h_0(89) = (89 \bmod 10 + 0^2) \bmod 10 = 9$ (OK)
- $h_0(18) = (18 \bmod 10 + 0^2) \bmod 10 = 8$ (OK)
- $h_0(49) = (49 \bmod 10 + 0^2) \bmod 10 = 9$ (Collision occurs)
  $h_1(49) = (49 \bmod 10 + 1^2) \bmod 10 = 0$ (OK)
- $h_0(58) = (58 \bmod 10 + 0^2) \bmod 10 = 8$ (Collision occurs)
  $h_1(58) = (58 \bmod 10 + 1^2) \bmod 10 = 9$ (Collision occurs)
  $h_2(58) = (58 \bmod 10 + 2^2) \bmod 10 = 2$ (OK)
- $h_0(69) = (69 \bmod 10 + 0^2) \bmod 10 = 9$ (Collision occurs)
  $h_1(69) = (69 \bmod 10 + 1^2) \bmod 10 = 0$ (Collision occurs)
  $h_2(69) = (69 \bmod 10 + 2^2) \bmod 10 = 3$ (OK)

Table Index	Insert 89	Insert 18	Insert 49	Insert 58	Insert 69
0			49	49	49
1					
2				58	58
3					69
4					
5					
6					
7					
8		18	18	18	18
9	89	89	89	89	89

Double Hashing: Example

- hash(k) = k mod 10
- $hash_2(k) = 7 - (k \bmod 7)$
- $h_i(k) = (k \bmod 10 + i \times (7 - (k \bmod 7))) \bmod 10$

- $h_0(89) = (89 \bmod 10 + 0 \times (7 - (89 \bmod 7))) \bmod 10 = 9$ (OK)
- $h_0(18) = (18 \bmod 10 + 0 \times (7 - (18 \bmod 7))) \bmod 10 = 8$ (OK)
- $h_0(49) = (49 \bmod 10 + 0 \times (7 - (49 \bmod 7))) \bmod 10 = 9$ (Collision occurs)
  $h_1(49) = (49 \bmod 10 + 1 \times (7 - (49 \bmod 7))) \bmod 10 = 6$ (OK)
- $h_0(58) = (58 \bmod 10 + 0 \times (7 - (58 \bmod 7))) \bmod 10 = 8$ (Collision occurs)
  $h_1(58) = (58 \bmod 10 + 1 \times (7 - (58 \bmod 7))) \bmod 10 = 3$ (OK)
- $h_0(69) = (69 \bmod 10 + 0 \times (7 - (69 \bmod 7))) \bmod 10 = 9$ (Collision occurs)
  $h_1(69) = (69 \bmod 10 + 1 \times (7 - (69 \bmod 7))) \bmod 10 = 0$ (OK)

Table Index	Insert 89	Insert 18	Insert 49	Insert 58	Insert 69
0					69
1					
2					
3				58	58
4					
5					
6			49	49	49
7					
8		18	18	18	18
9	89	89	89	89	89