CS 225

#36: Hashing: Collision Handling

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Every hash table contains three pieces:

1. A **hash function**, **f(k)**: keyspace → integer
2. **A data storage structure**. (Usually an array)
3. A method of handling **hash collisions**.

Dealing with hashing depends on which type of storage structure you are using.

Open Hashing:

Closed Hashing:

Collision Handling Strategy #1: Linear Probing

Example: **S = { 16, 8, 4, 13, 29, 11, 22 }, |S| = n**
h(k) = k % 7, **|Array| = N**

[0]	
[1]	
[2]	
[3]	
[4]	
[5]	
[6]	
[7]	

Linear Probing:
Try h(k) = (k + 0) % 7, if full...
Try h(k) = (k + 1) % 7, if full...
Try h(k) = (k + 2) % 7, if full...
...

What problem occurs?

Collision Handling Strategy #2: Quadratic Probing

Example: **S = { 16, 8, 4, 13, 29, 11, 22 }, |S| = n**
h(k) = k % 7, **|Array| = N**

[0]	
[1]	
[2]	
[3]	
[4]	
[5]	
[6]	
[7]	

Quadratic Probing:
Try h(k) = (k + 0) % 7, if full...
Try h(k) = (k + 1*1) % 7, if full...
Try h(k) = (k + 2*2) % 7, if full...
...

What problem occurs?

Collision Handling Strategy #3: Double Hashing:

Example: **S = { 16, 8, 4, 13, 29, 11, 22 }, |S| = n**
$h_1(k)$ = k % 7, $h_2(k)$ = 5 – (k % 5), |Array| = N

[0]	
[1]	
[2]	
[3]	
[4]	
[5]	
[6]	
[7]	

Double Hashing:
Try h(k) = (k + + 0*$h_2(k)$) % 7, if full...
Try h(k) = (k + + 1*$h_2(k)$) % 7, if full...
Try h(k) = (k + + 2*$h_2(k)$) % 7, if full...
...

$h(k, i) = (h_1(k) + i*h_2(k)) \% 7$

Running Time:

Linear Probing:
- Successful: **$\frac{1}{2}(1 + 1/(1-\alpha))$**
- Unsuccessful: **$\frac{1}{2}(1 + 1/(1-\alpha))^2$**

Double Hashing:
- Successful: **$1/\alpha * \ln(1/(1-\alpha))$**
- Unsuccessful: **$1/(1-\alpha)$**

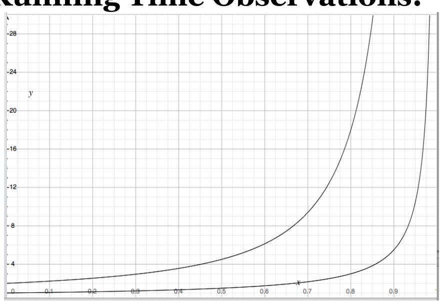
Separate Chaining:
- Successful: **$1 + \alpha/2$**
- Unsuccessful: **$1 + \alpha$**

Running Time Observations:

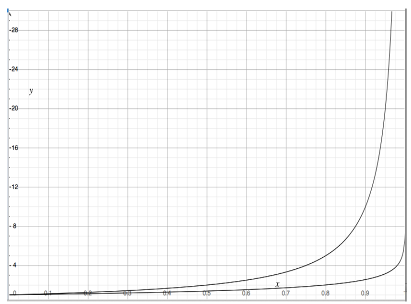
1. As **α** increases:

2. If **α** is held constant:

Running Time Observations:



Linear Probing:
Successful: **$\frac{1}{2}(1 + 1/(1-\alpha))$**
Unsuccessful: **$\frac{1}{2}(1 + 1/(1-\alpha))^2$**



Double Hashing:
Successful: **$1/\alpha * \ln(1/(1-\alpha))$**
Unsuccessful: **$1/(1-\alpha)$**

ReHashing:

When do we want to resize?

How do we resize?

Algorithm:

Which collision resolution strategy is better?
- Big Records:
- Structure Speed:

What structure do hash tables replace?

What constraint exists on hashing that doesn't exist with BSTs?

Why talk about BSTs at all?

Analysis of Dictionary-based Data Structures

	Hash Table		AVL	List
	Amortized	Worst Case		
Find				
Insert				
Storage Space				