CS 225

#26: Hashing: Collision Handling

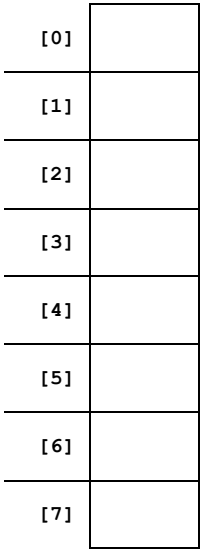
October 22, 2021 · *G Carl Evans*

Every hash table contains three pieces:

1. A **hash function**, **f(k)**: keyspace → integer
2. **An array**.
3. **A collision handling strategy.**

Collision Handling Strategy #1: Separate Chaining

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



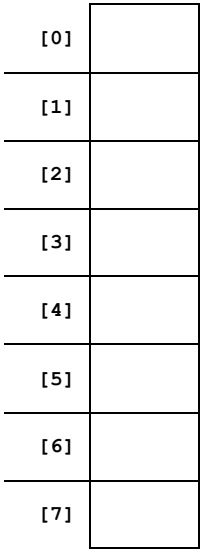
Load Factor:

Running time of Separate Chaining:

	Worst Case	SUHA
Insert		
Remove/Find		

Collision Handling Strategy #2: Probe-based Hashing

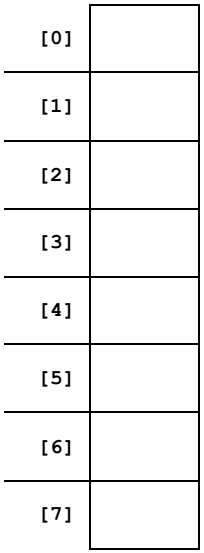
Example: **S = { 16, 8, 4, 13, 29, 11, 22 }, |S| = n**
h(k) = k % 7, |Array| = N



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?

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



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: **½(1 + 1/(1-α))**
- Unsuccessful: **½(1 + 1/(1-α))²**

Double Hashing:

- Successful: **1/α * ln(1/(1-α))**
- Unsuccessful: **1/(1-α)**

Separate Chaining:

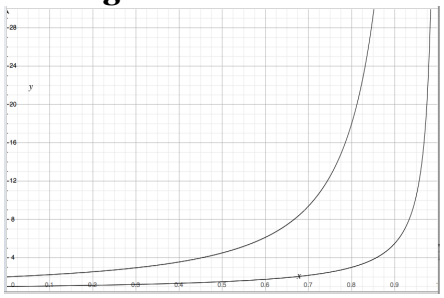
- Successful: **1 + α/2**
- Unsuccessful: **1 + α**

Running Time Observations:

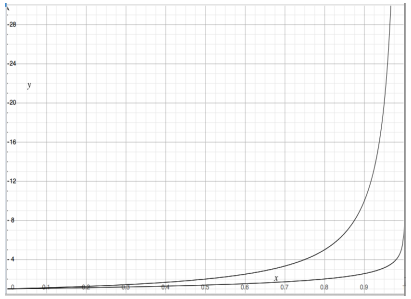
1. As **α** increases:

2. If **α** is held constant:

Running Time Observations:



Linear Probing:
Successful: **½(1 + 1/(1-α))**
Unsuccessful: **½(1 + 1/(1-α))²**



Double Hashing:
Successful: **1/α * ln(1/(1-α))**
Unsuccessful: **1/(1-α)**

ReHashing:

What happens when the array fills?

Better question:

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				

A Secret, Mystery Data Structure:

ADT:

insert

remove

isEmpty

CS 225 – Things To Be Doing:
1. mp_mosaic has been released; EC deadline is Monday night **2.** Final Project Survey due **3.** lab_btree due Sunday **4.** Daily POTDs are ongoing!