

## Some Hashing Practice

CSE 373  
April 27, 2013

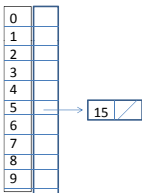
### What happens when there is a collision with separate chaining?

- Example:  $N = 10$ , insert keys 15, 17, 85, 93, 27, 65, 44, 83, 95, 41

0	
1	
2	
3	
4	
5	
6	
7	
8	
9	

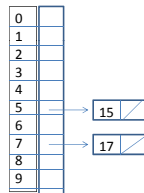
### Separate Chaining

- Example:  $N = 10$ , insert keys 15, 17, 85, 93, 27, 65, 44, 83, 95, 41



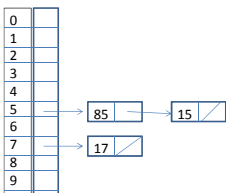
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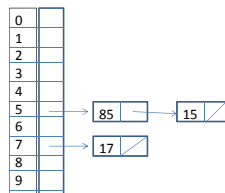
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### Separate Chaining

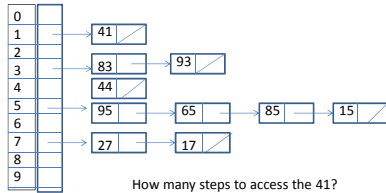
- Example:  $N = 10$ , insert keys 15, 17, 85, 93, 27, 65, 44, 83, 95, 41



Where does 93 go?  
Where does 27 go?  
Where does 65 go?

### Separate Chaining

- Example:  $N = 10$ , insert keys 15, 17, 85, 93, 27, 65, 44, 83, 95, 41



How many steps to access the 41?  
 How many steps to access the 15?  
 If they all end up in one "bucket" and there are  $M$  keys?

### What happens when there is a collision with open addressing?

- Simplest form: linear probing
- At step  $i$  after a collision, try to put it in position  $\text{hash}(\text{key}) + i$ ,  $i = 1, 2, 3, 4, 5$  etc. circularly.

### Linear Probing

	0	1	2	3	4	5	6	7	8	9
15						15				
17						15		17		
85						15	85	17		
93				93		15	85	17		
27				93		15	85	17	27	
65				93		15	85	17	27	65
44				93	44	15	85	17	27	65
83	83			93	44	15	85	17	27	65
95										
41										

You do the rest.

### More Open Addressing

- Next to try: quadratic probing
- At step  $i$  after a collision, try to put it in position  $\text{hash}(\text{key}) + i^2$ ,  $i = 1, 2, 3, 4, 5, \dots$
- So  $i^2 = 1, 4, 9, 16, 25, \dots$

### Quadratic Probing:

Tries to find an empty space with less probes

	0	1	2	3	4	5	6	7	8	9
15						15				
17						15		17		
85						15	85	17		
93				93		15	85	17		
27				93		15	85	17	27	
65				93		15	85	17	27	65
44				93	44	15	85	17	27	65
83	83			93	44	15	85	17	27	65
95										
41										

position 5  
 position 7  
 position  $5 + 1^2$   
 position 3  
 position  $7 + 1^2$   
 position  $5 + 2^2$   
 position 4  
 position  $3 + 3^2 \% 10$

You do the rest.

### More Open Addressing

- Double hashing
- At each step, if there is a collision, apply a second hash function.
- $\text{hash1}(\text{key}) + i \times \text{hash2}(\text{key})$
- Example:  $\text{hash1}(\text{key}) = \text{key} \% 11$   
 $\text{hash2}(\text{key}) = \text{key} \% 7$

You try it.