

CSCI 241

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Hash Tables: Open Addressing

Goals

Know how to use **open addressing** with **linear or quadratic probing** for collision resolution.

Load Factor: Performance Implications

$$\text{Load factor } \lambda = \frac{\text{\# entries in table}}{\text{size of the array}}$$

If λ is large, runtime is slow.

If λ is small, memory is wasted.

If the memory's sitting there wasted... why not use it?

Open Addressing with Linear Probing

- **Open Addressing** - use empty buckets to store things that belong in other buckets.
- Which empty bucket? Using the next empty one is called **Linear Probing**

```
put(1, "dog");  
put(11, "auk");  
put(10, "bear");  
put(14, "cat");  
put(24, "ape");
```

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1	
2	
3	
4	

```
put(key):  
    h = hash(key);  
    while A[h] is full:  
        h = (h+1) % N  
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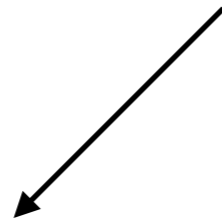
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Open Addressing with Linear Probing

(e.g., 1, 1, 3, 2, 3, 4, 6, 4, 5)

Problem:



Clustered hash values will result in a lot of searching.

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put (key) :  
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Open Addressing with Quadratic Probing

Quadratic Probing: Jump further ahead to avoid clustering of full buckets.

Linear probing looks at $H, H+1, H+2, H+3, H+4, \dots$

Quadratic probing looks at $H, H+1, H+4, H+9, H+16, \dots$

```
put (1, "dog");  
put (11, "auk");  
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put (14, "cat");  
put (24, "ape");
```

0	(10, bear)
1	(1, dog)
2	(11, auk)
3	(24, ape)
4	(14, cat)

```
put (key) :
```

```
H = hash(key);  
i = 0;  
while A[h] is full:  
    h = (H + i2) % N  
    i++;  
A[h] = value
```

Open Addressing: Runtime

- May be faster, but may not be. Depends on keys.
- There's no free lunch: worst-case is always $O(n)$.
- In practice, average-case is $O(1)$ if you make good design decisions and insertions are not done by someone who wants to ruin your day.