

# Big O() and containers

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# Before we begin...

- I'm hearing-impaired  
Please speak slowly and clearly
- I'm also looking for a job ;-)

# What is Big O()?

- Time AND Space (memory usage)
- Based on number of items to process

# Why care about Big O()

- Big O() dominates your program speed and memory consumption
- Doesn't matter with hundreds or thousands of items, but does with millions

# Types of Big O()

$O(1)$  - Constant time: dict accesses, sequence lookup

$O(\log N)$  - Searching sorted lists, see `bisect` module

$O(N)$  - Searching unsorted lists

$O(N \log N)$  - Sorting

$O(N^2)$ ,  $O(M \cdot N)$

$O(N!)$ ,  $O(2^N)$

# General Container Info

- Container elements are references
  - Container copy does not double memory use
- Basic types: sequences and maps
  - Sequences: tuples, lists
  - Maps: dicts, sets
- Use the source, Luke
  - `objects/` in python source tree

# Lists

- `list[i]` is  $O(1)$
- Amortized Constant Time
  - Over-allocation memory factor 1.5
  - Can shrink on deleting elements
- Adding/deleting `list[0]` is  $O(N)$

# Dicts

- Good hashing makes everything  $O(1)$
- Bad hashing causes  $O(N)$
- Hashing: can't use lists as keys
  - ...or dicts or sets, but `frozenset()` DOES work as keys
- More over-allocation than list
  - Max 2/3 full; factor is 4 to 50K items, then doubles
  - Dict resizes ONLY on NEW key

# Useful modules

- `collections.deque`

$O(1)$  at both ends

- `heapq`

Fast for  $M$  smallest/biggest of large  $N$

# More on $O(M*N)$

- Code smell:

```
for i in M:  
    for j in N:  
        if i == j:  
            ...
```

- Better:

```
tmp = set(N) # pick the LARGER of M/N  
for i in M:  
    if i in tmp:  
        ...
```

# Some other issues

- += with strings (and other immutables)
- More bad hash