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Hash Tables

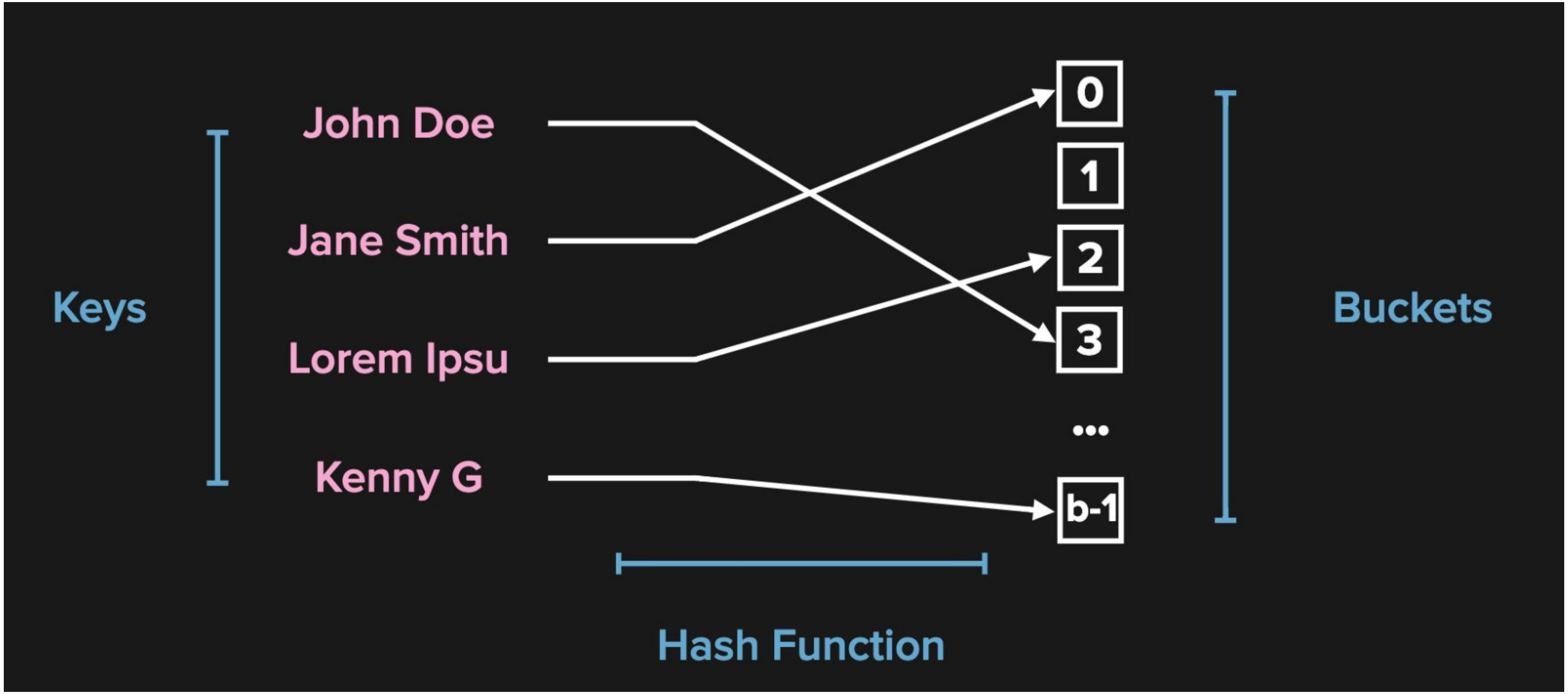
What we’re going to learn

- Understand what a hash table is and applications
- Understand hash table methods
- Understand how we can use the data structures we learned previously to build more complex data structures

Hash Tables

- Maps keys → values (any objects)
- Python’s dict() / {} type is a hash table
- Used because of strong average case performance (time complexity)

Hash Table

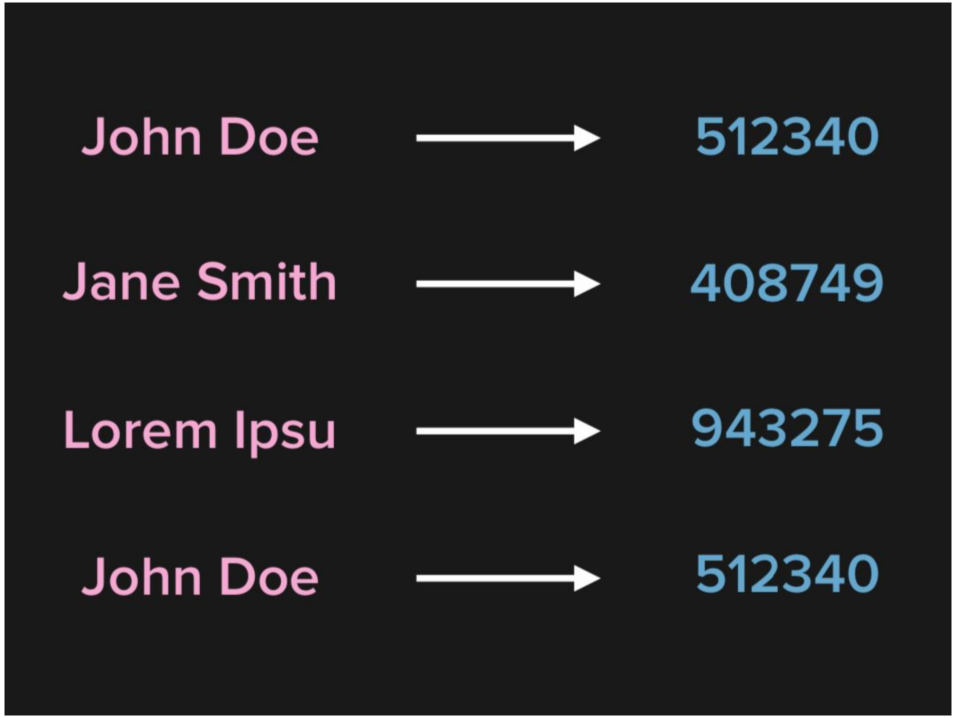

Keys
John Doe
Jane Smith
Lorem Ipsu
Kenny G
0
1
2
3
...
b-1
Buckets
Hash Function

Hash Function

Converts a variable-size input (key) to a fixed-size integer output (hash code)

Same input ➔ same output

Input can be many types: number (int or float), string, or immutable collection



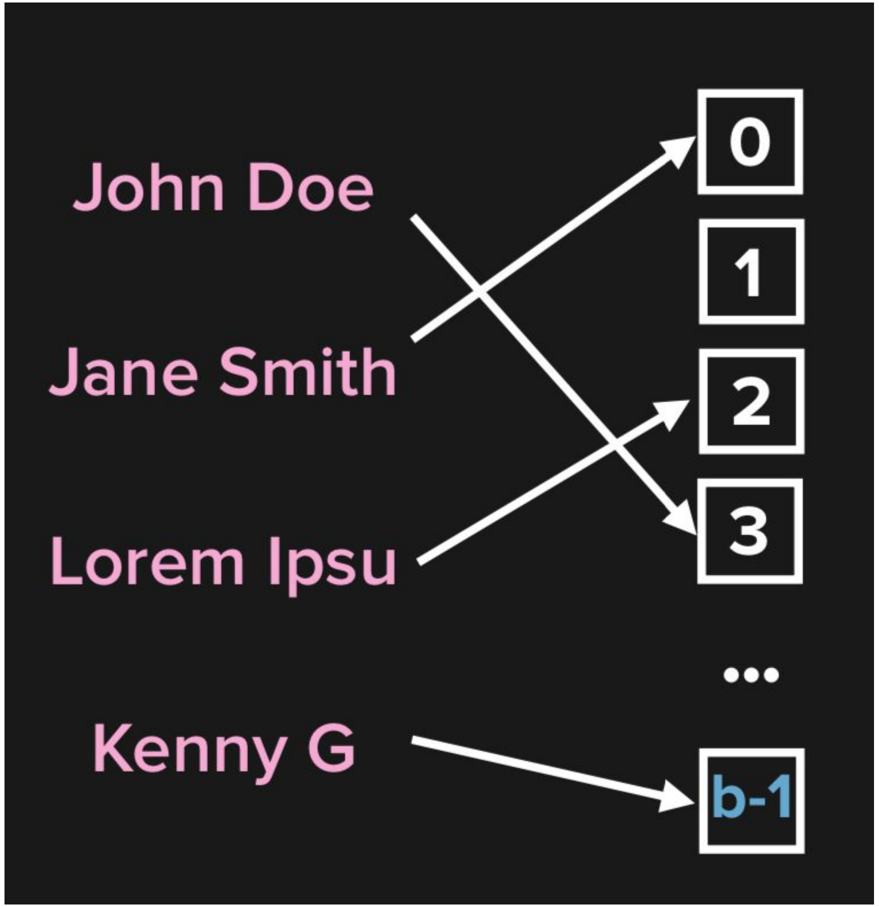
Which Bucket?

Hash codes are very large integers, but we want the index of a bucket

We can use the modulus operator %

index = hash(key) % buckets

index ranges from 0 to buckets-1



Hash Collisions

It is impossible to map all possible inputs to a fixed output space without some inputs generating the same output (hash code)

Different inputs (keys) generating the same output (hash code) is called a hash collision

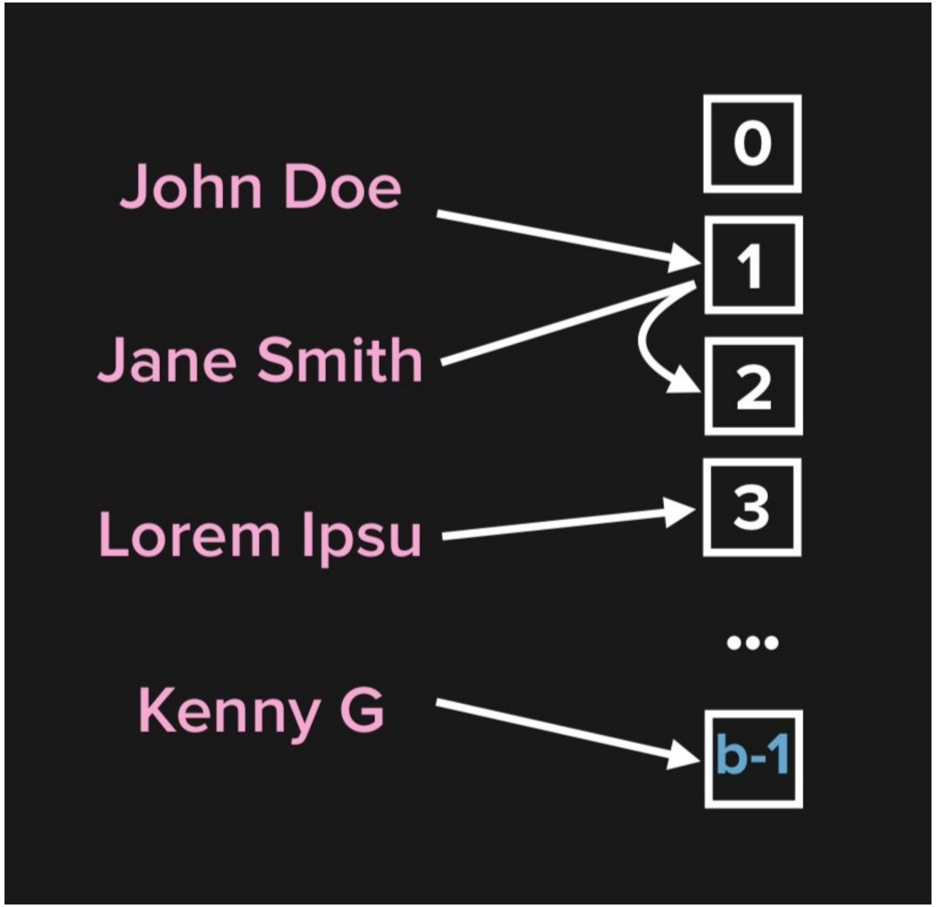
Linear Probing

Each bucket contains at most one entry

On collision - find next open bucket, add entry there

To retrieve - find bucket, if that’s not entry, try next bucket until you find entry or empty bucket

Python’s dict uses probing



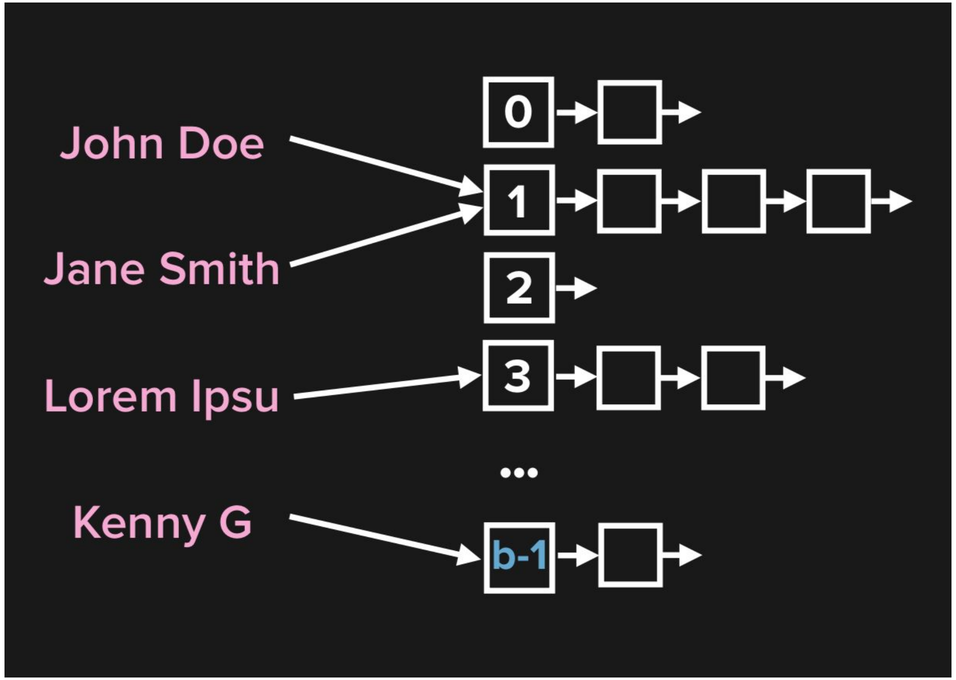
Chaining

Each bucket contains a linked list of entries

On collision - add to the bucket's linked list

To retrieve - find bucket, find entry in linked list

We will use chaining to implement our hash table



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Let’s Draw a Hash Table

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Let’s Code a Hash Table

Students browse: repl.it/@MakeSchool/HashTable?lite=true

Pear Deck Interactive Slide
Do not remove this bar

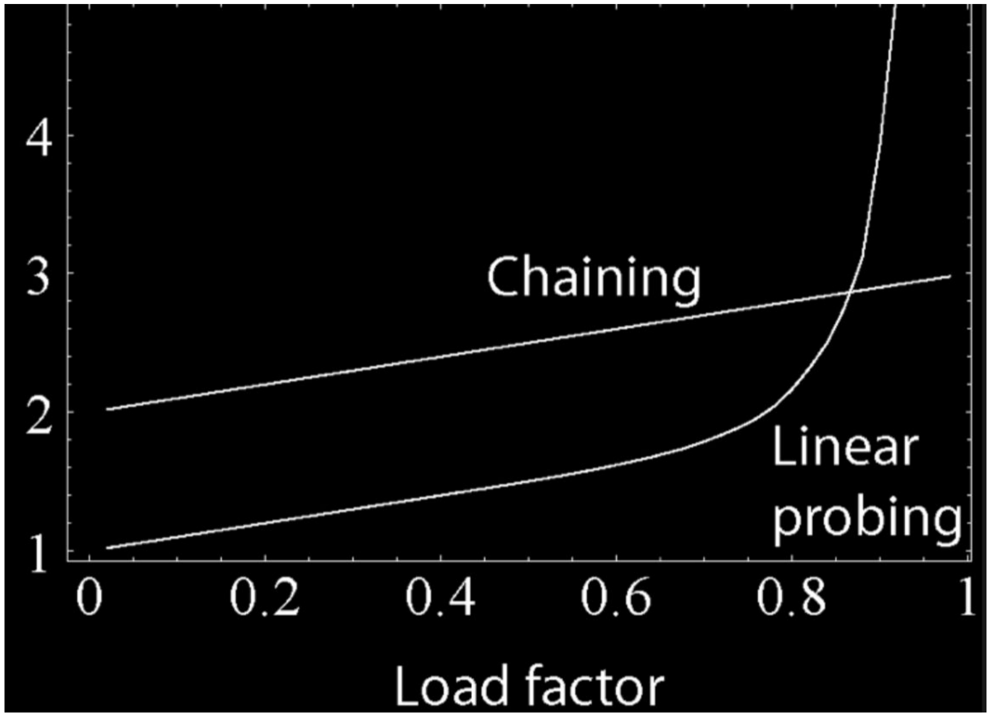
Load Factor

Load Factor = entries / buckets

Load Factor affects performance

Collision Resolution method also

affects performance



Amortized Time Complexity

“Amortized time is the way to express the time complexity when an algorithm has the very bad time complexity only once in a while besides the time complexity that happens most of time”

O(1)*

https://medium.com/@satorusasozaki/amortized-time-in-the-time-complexity-of-an-algorithm-6dd9a5d38045

Time Complexity Analysis Review

- items
- get
- set
- delete

Hash table with chaining animation

Time Complexity Analysis Review

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Operation	Amortized	Worst
items()	O(n)	O(n)
get()	O(1)	O(n)
set()	O(1)	O(n)
delete()	O(1)	O(n)

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Hash Table Method Analysis

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Shout Outs