CIS 263 Introduction to Data Structures and Algorithms

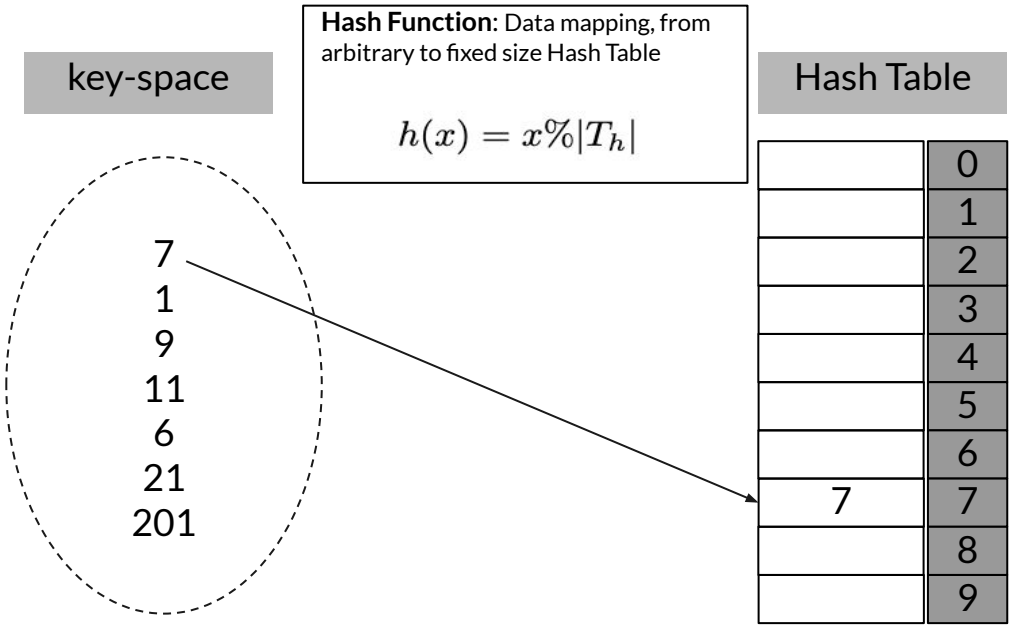
Hashing

Objective

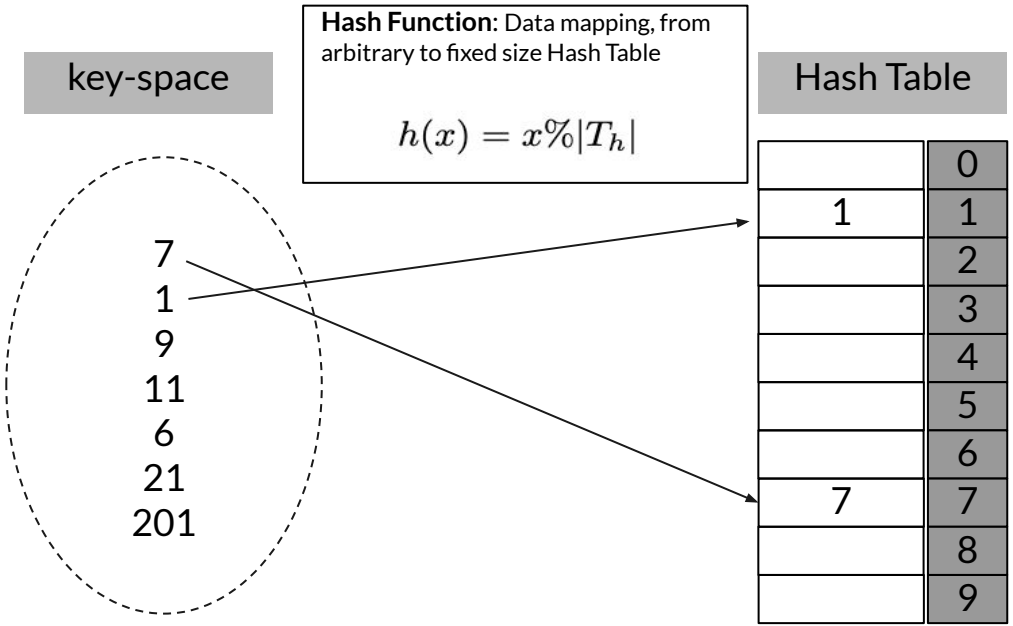
- Improve search time complexity
- Solving certain problems

- **Linear Search**: O(n)
- **Binary Search**: O(log(n)); also requires sorting of data
- Target: **~ O(1)**

Hashing


key-space
Hash Function: Data mapping, from arbitrary to fixed size Hash Table
$h(x) = x\%|T_h|$
Hash Table
7
1
9
11
6
21
201
0
1
2
3
4
5
6
7
8
9
7

Hashing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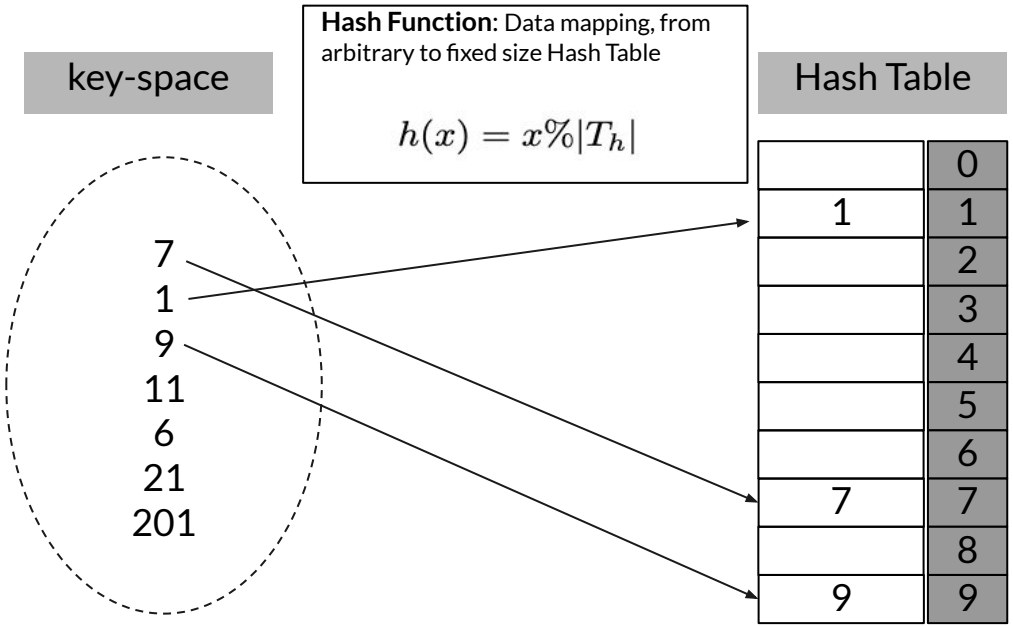
Hashing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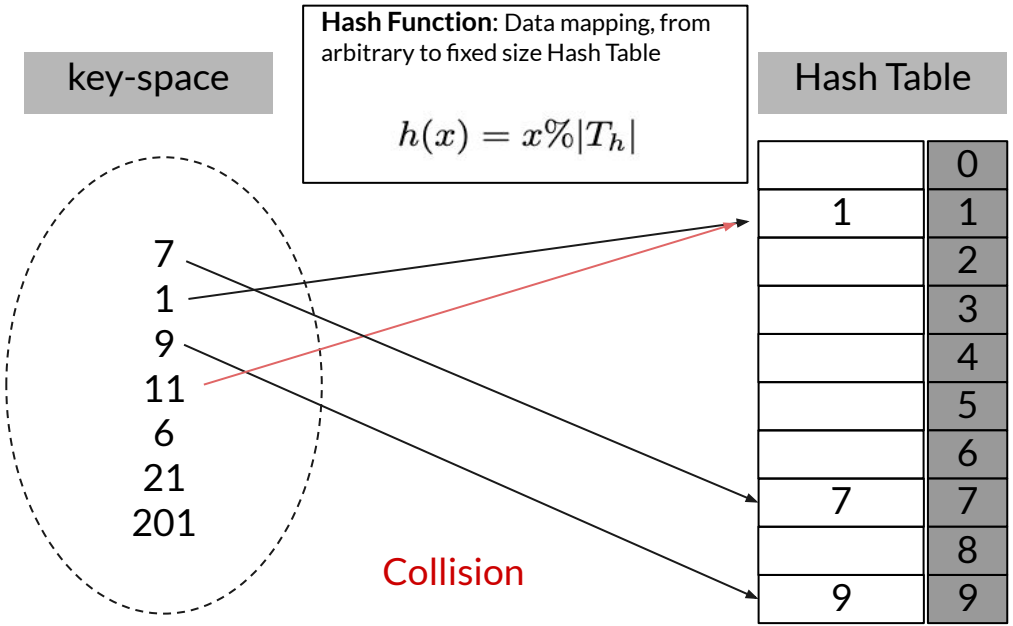
Hashing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Collision
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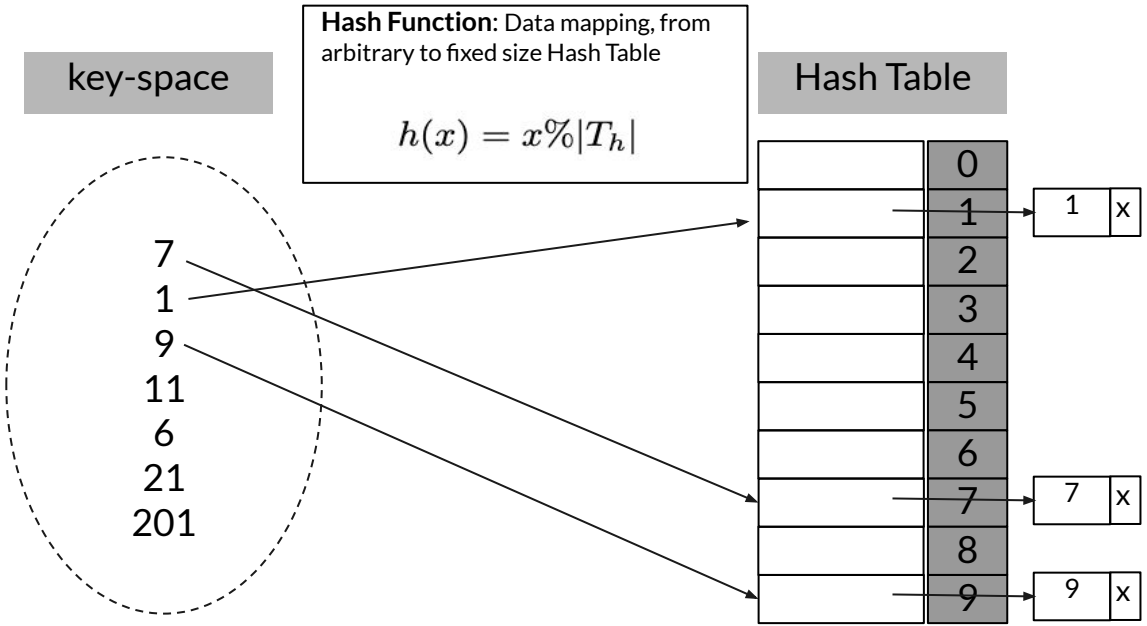
Collision resolution

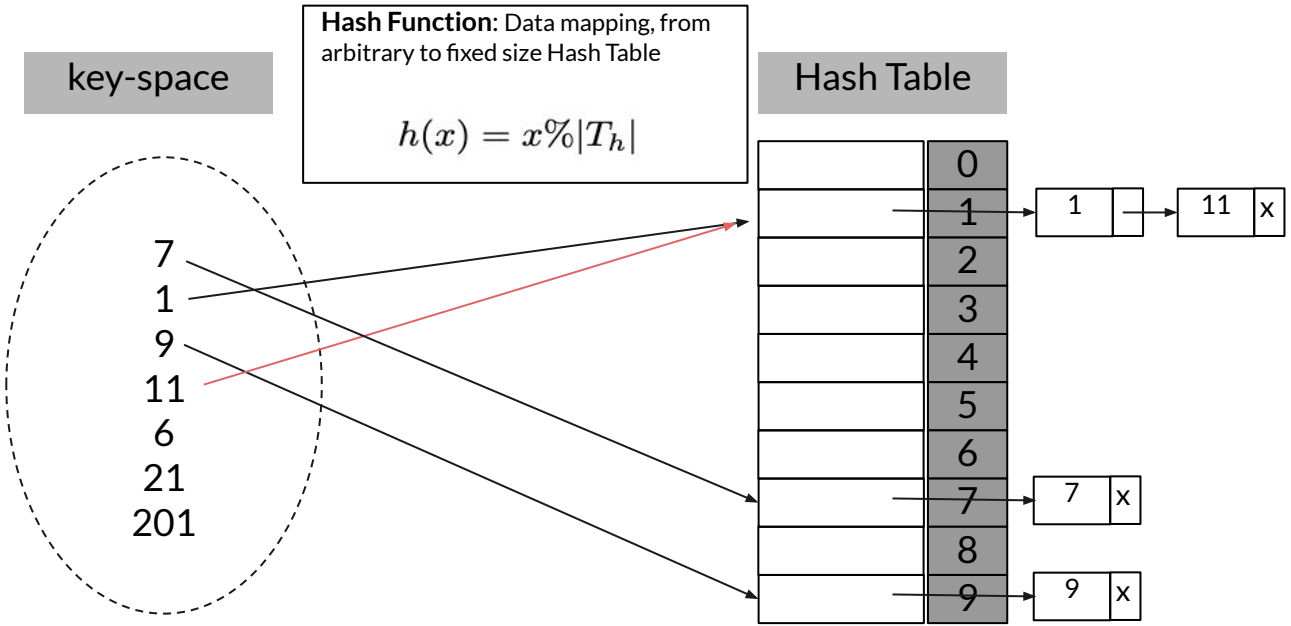
Chaining

Collision resolution: Chaining



Chaining

Collision resolution: Chaining

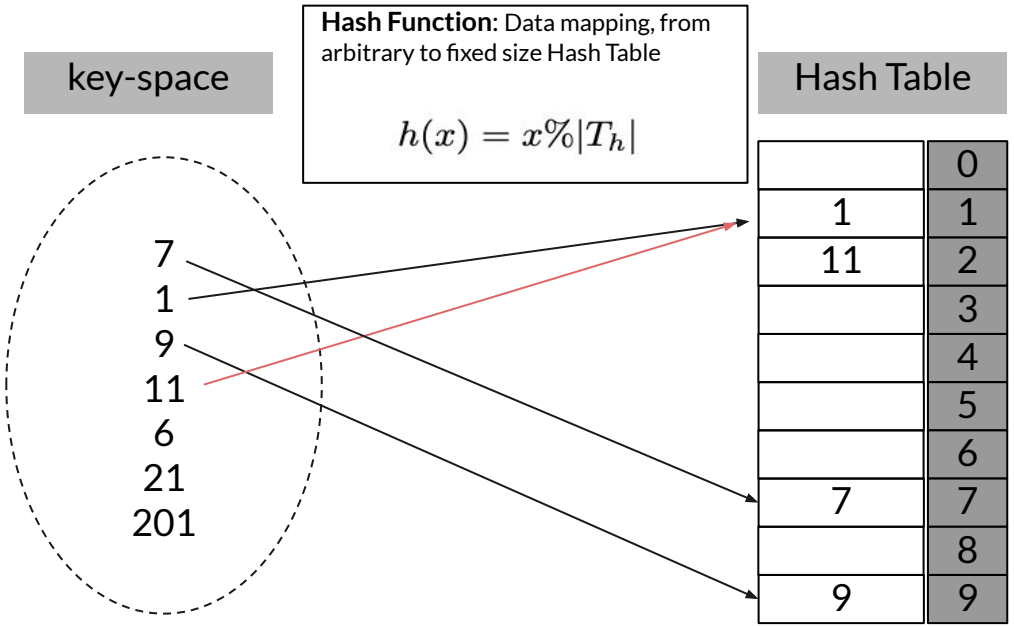


Collision resolution

- We want to avoid Linked List
- Can we use the Hash Table (say Array) itself?

Linear Probing

Collision resolution: Linear Probing



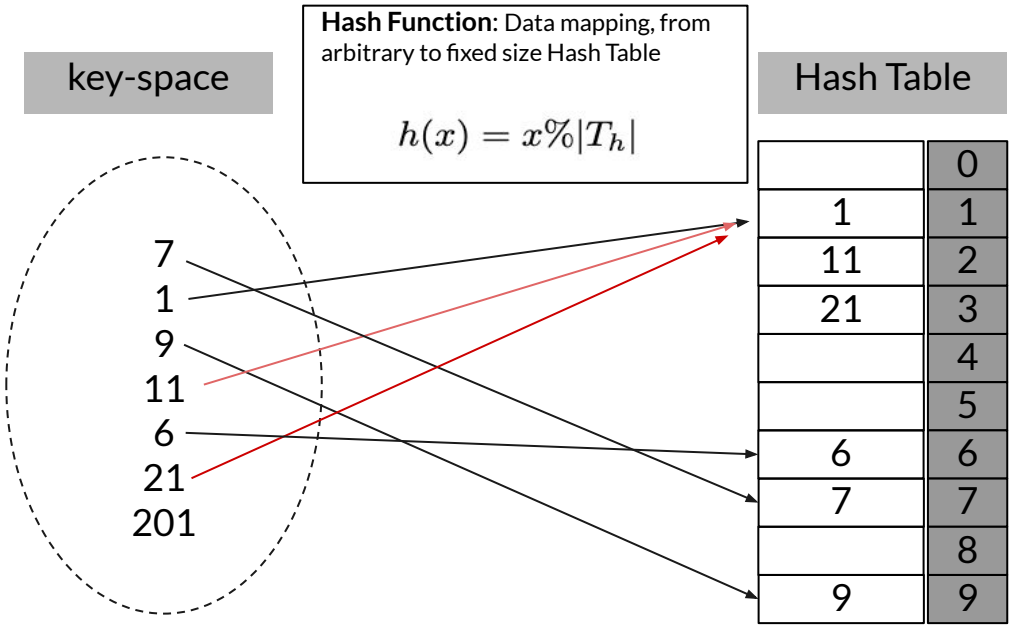
$$\hat{h}(x) = \Big[h(x) + f(i)\Big]\%|T_h|$$

$$f(i) = i$$

$$i = 0, 1, 2, \ldots$$

Linear Probing

Collision resolution: Linear Probing



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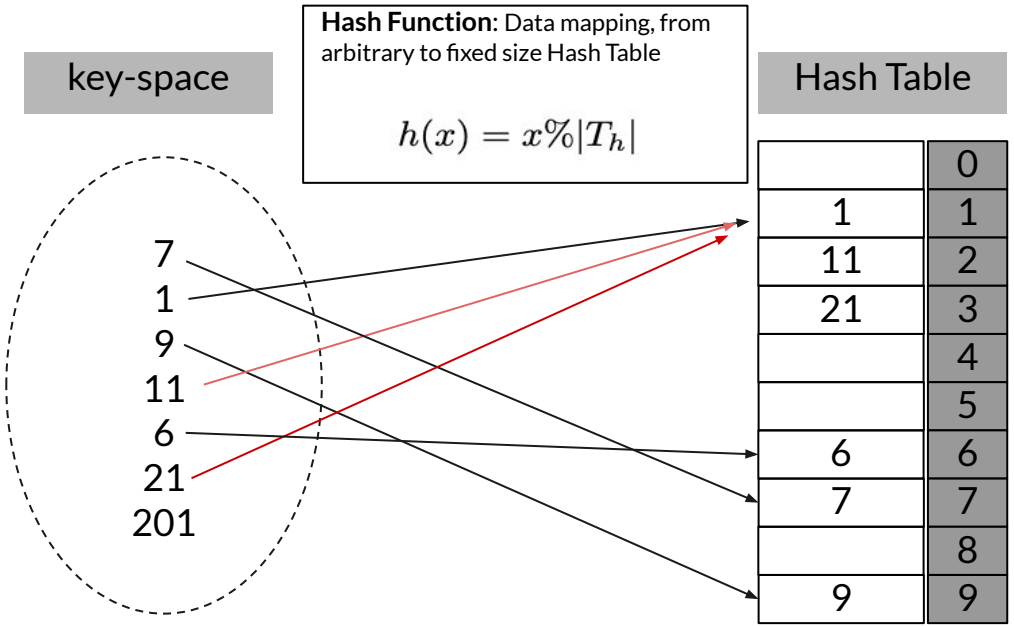
Query (31)

Collision resolution: Linear Probing



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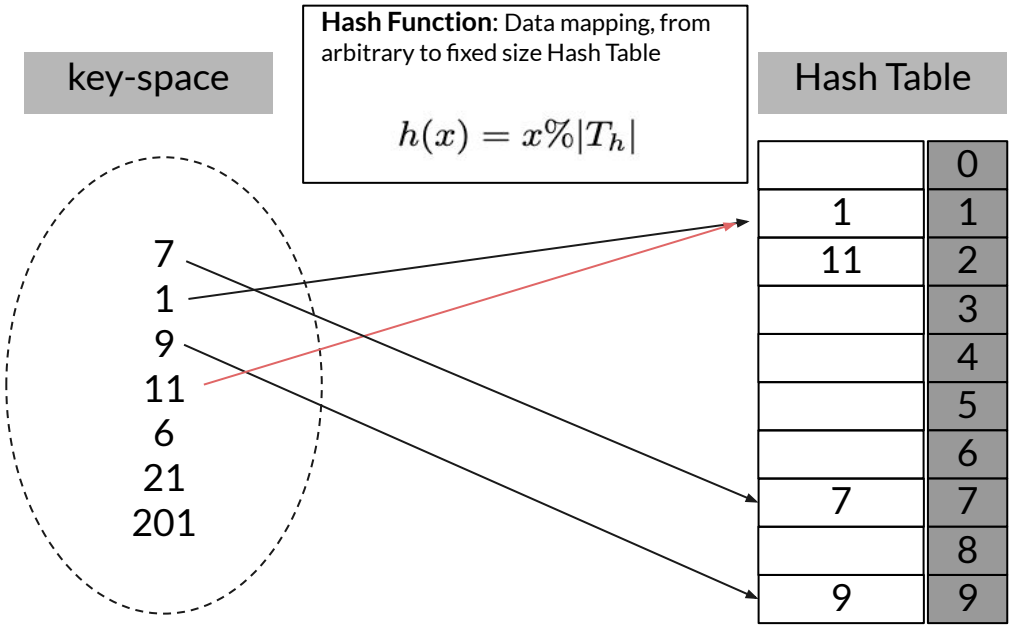
Quadratic Probing

Collision resolution: Quadratic Probing



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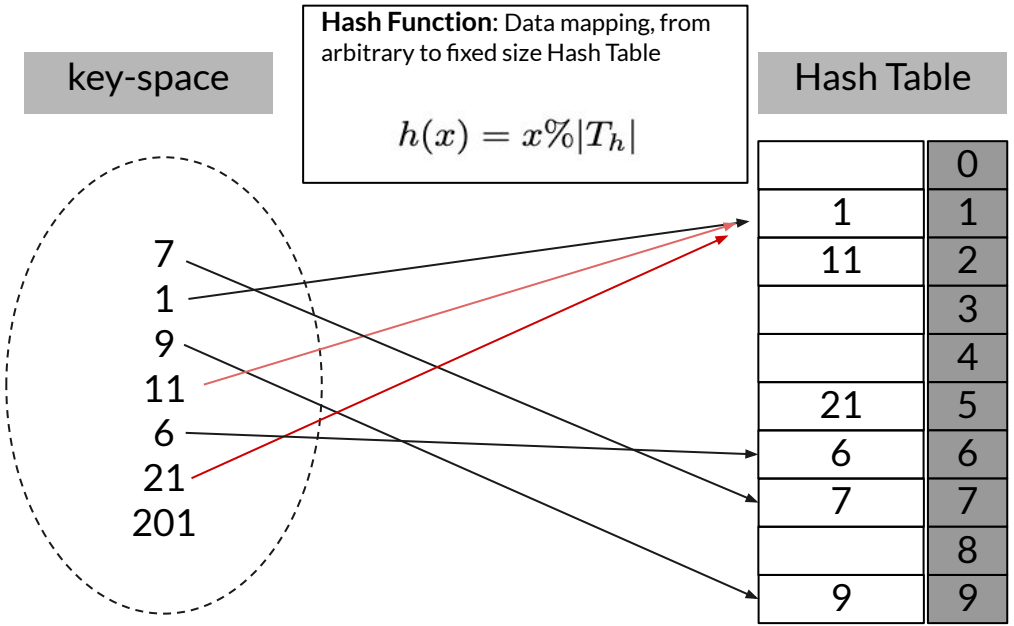

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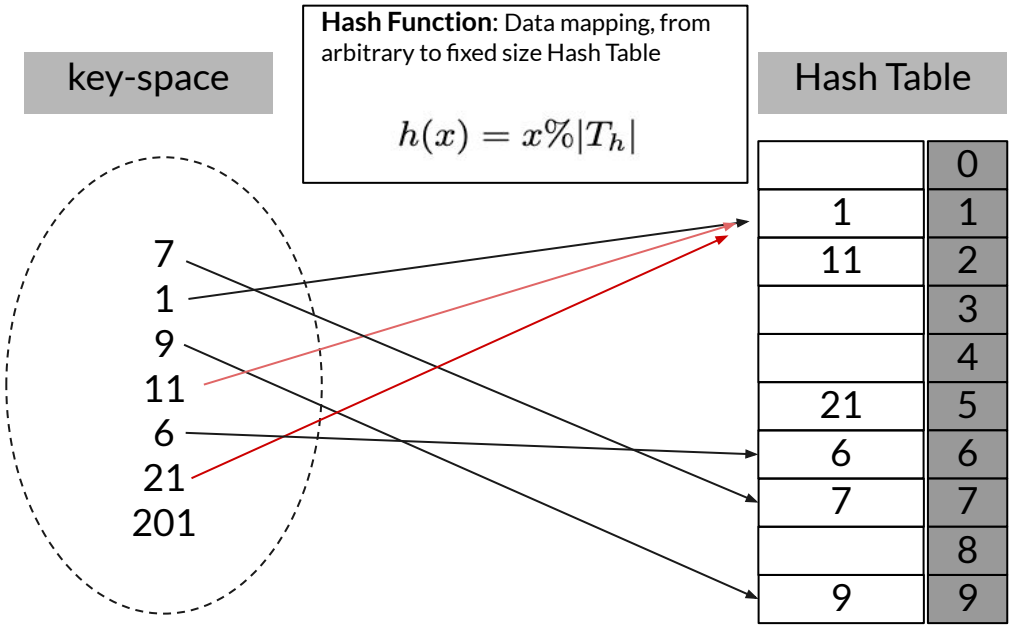

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- Improves on the clustering effect

QA