
# Lecture 12:

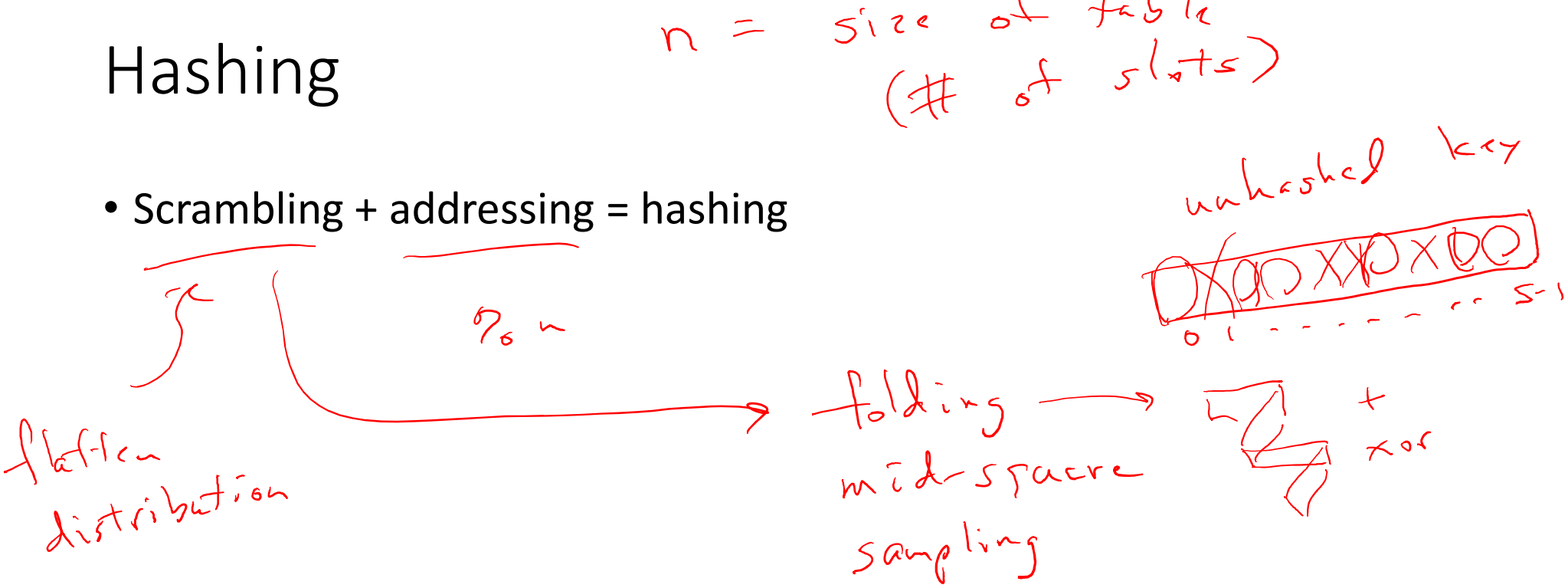
## Sorting and Searching Continued

# Objectives

- Be able to define the terms hashing, hash table, perfect hash function, uniform key distribution
- Be able to comment on how hash tables achieve a constant-time (O(1)) performance for the search problem
- Be able to talk about various scrambling strategies for hash functions
- Be able to discuss hash table sizes and how they relate to key distributions
- Be able to define what a probe is, and to discuss probe sequences
- Be able to define and illustrate linear open addressing
- Be able to define quadratic open addressing
- Be able to do an analysis of hash table efficiency, based on load factor λ, of a linear open addressing hash table and of a separate chaining hash table
- Be able to discuss how *dict* and *set* achieve their ability to store any Python object

# Hashing

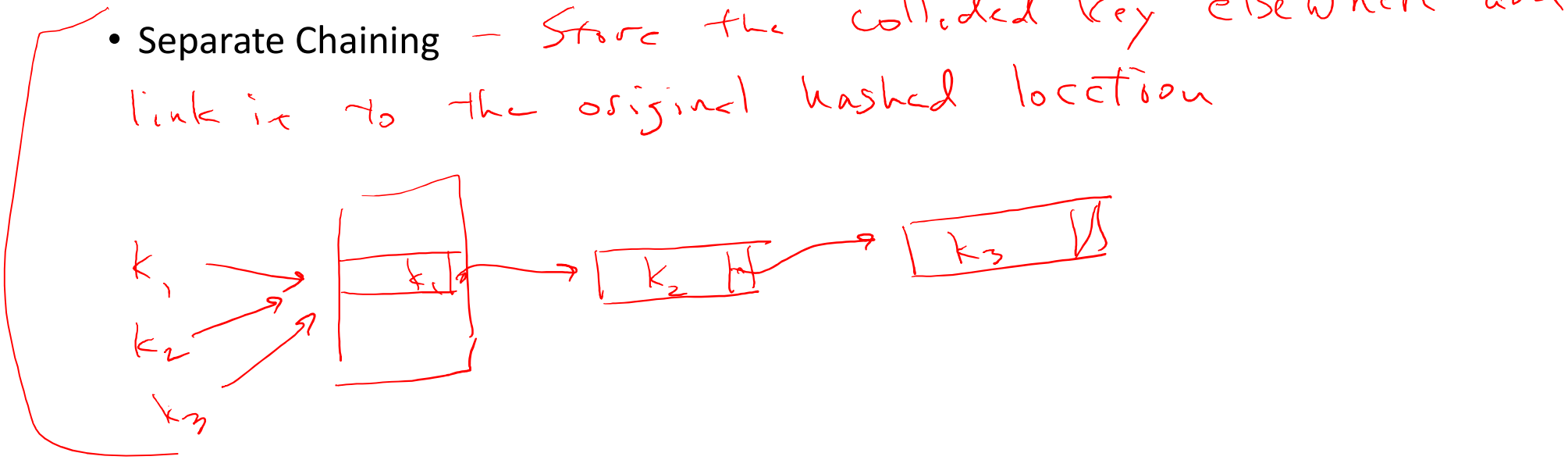
- Scrambling + addressing = hashing



Chaining refers to using pointers to linked stored items

# Collisions and Collision Resolution

- There are two general approaches:
  - Open Addressing – Store the collided key in the primary table area
  - Separate Chaining – Store the collided key elsewhere and link it to the original hashed location

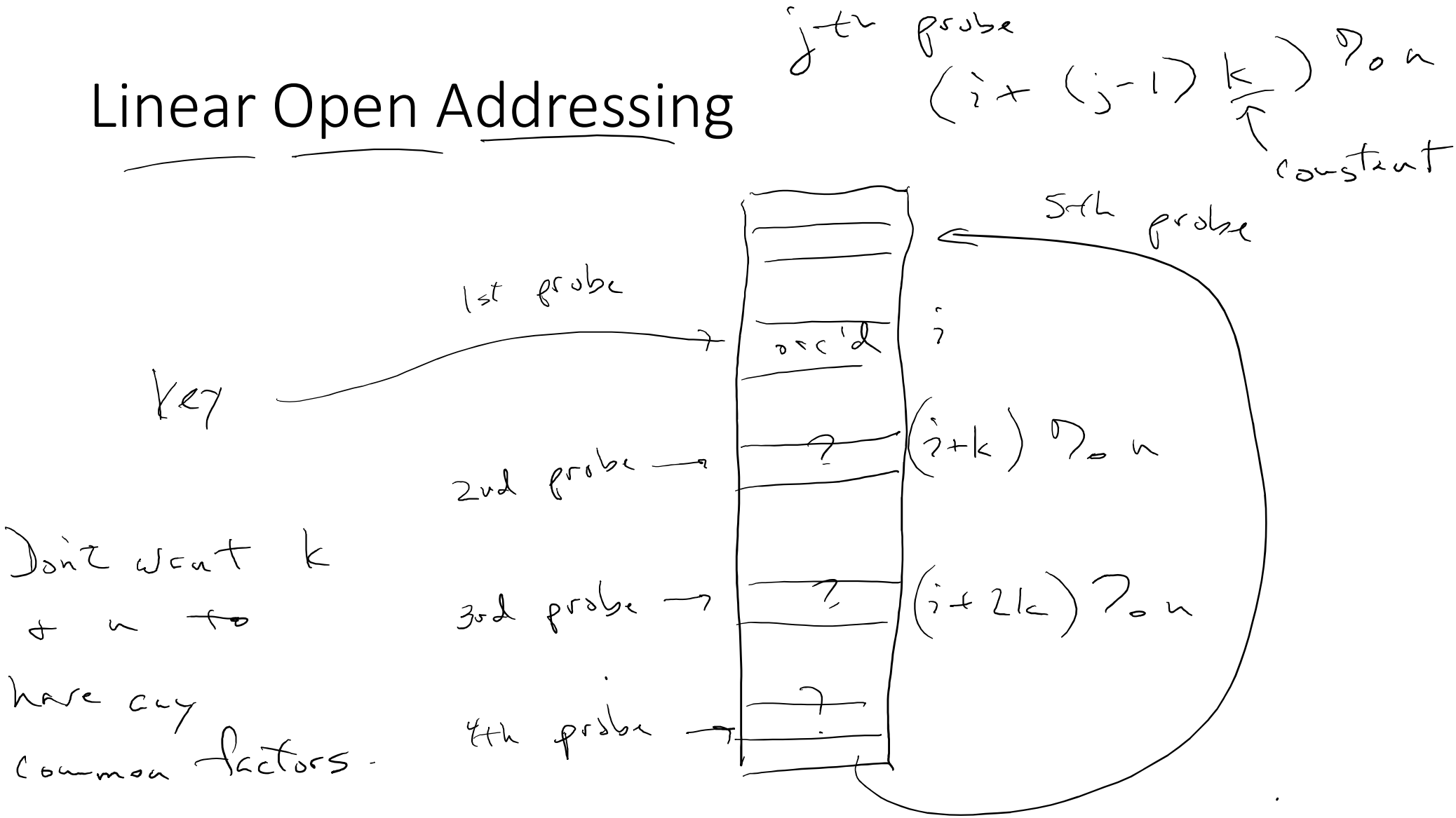


# Probes and Probe Sequences

Clustering is where probe sequences become unduly long. Degrades efficiency

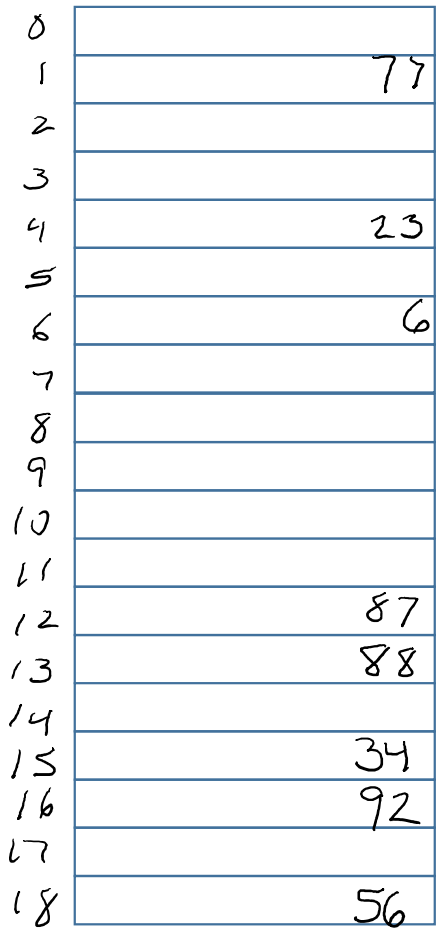
A probe is an investigation of a hash table position or an item in a chained list. It can either be (1) investigating whether the slot is occupied & finding out it is not, or (2) a check of the value of what is stored there. To find a collided value will necessitate, potentially, a whole sequence of such probes.

# Linear Open Addressing



# Example: Load a table of size 19, using k = 5

- Keys 34, 56, 88, 23, 92, 77, 6, 87, 32, 70, 30, 49



# Deleting from a hash table

# Primary and Secondary Clustering

- Primary clustering occurs when many keys hash to the same address

- Secondary clustering occurs when probe sequences merge in other ways

Why does the book advocate making the size of the table a prime number?

# Quadratic Open Addressing

# Separate Chaining

# Hash Table Analysis

# dict and set

- Variable-sized hash tables