# DATA STRUCTURE AND ALGORITHMS

## LECTURE 9

Maps, Hash Tables and Skip List

# Reference links:

https://cs.nyu.edu/courses/fall17/CSCI-UA.0102-007/notes.php

https://www.comp.nus.edu.sg/~stevenha/cs2040.html

https://visualgo.net/en/hashtable?slide=1

[M.Goodrich, chapter 10]

# Lecture outline

- Maps
  - Definitions
  - Maps ADT
- Hash Tables
  - Hash Function
  - Collition-Handling Shemes
  - Hash Table ADT
- Skip List

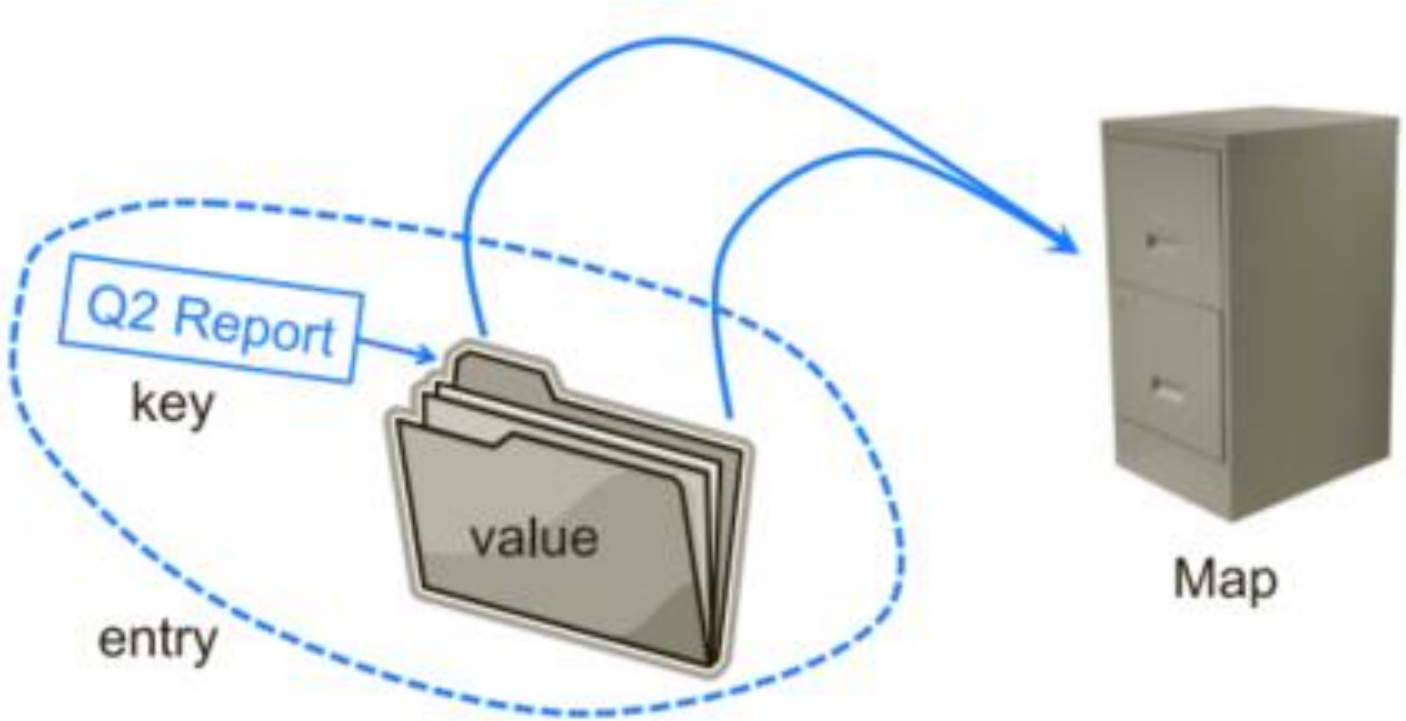
# Lecture outline

- Method to study (understand is ennought)
  - Listen to the skim lecture in class
  - Read book chapter and provided documents
  - Run illustration programs

# Maps

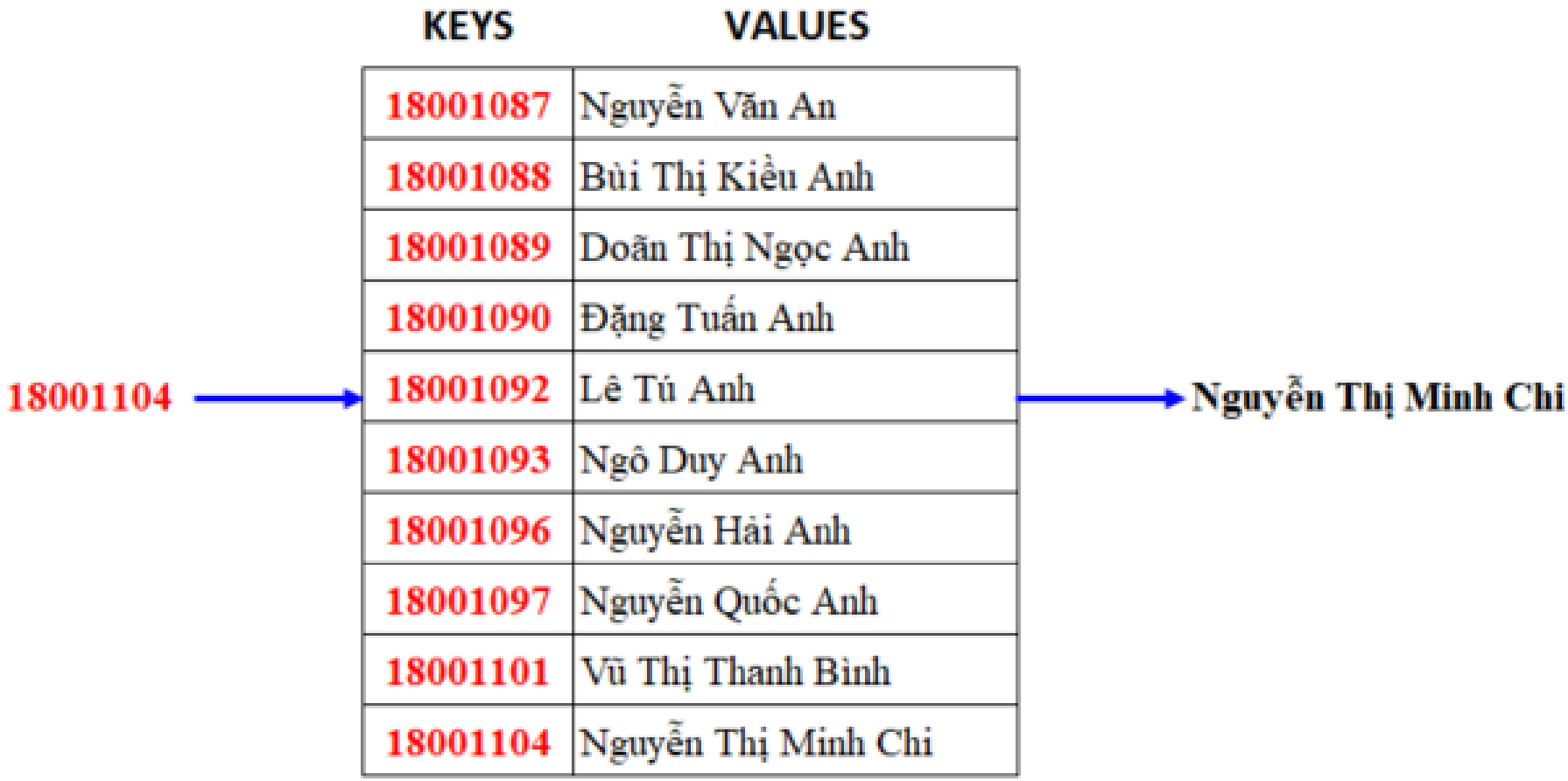
- Iilustrations
- Maps ADT

# Maps: Illustration




[M.Goodrich, sec. 10.1, p. 402]

# Maps: Illustration



# Maps ADT

| | |
|---|---|
| size( ): | Returns the number of entries in $M$. |
| isEmpty( ): | Returns a boolean indicating whether $M$ is empty. |
| get($k$): | Returns the value $v$ associated with key $k$, if such an entry exists; otherwise returns null. |
| put($k$, $v$): | If $M$ does not have an entry with key equal to $k$, then adds entry $(k,v)$ to $M$ and returns null; else, replaces with $v$ the existing value of the entry with key equal to $k$ and returns the old value. |
| remove($k$): | Removes from $M$ the entry with key equal to $k$, and returns its value; if $M$ has no such entry, then returns null. |
| keySet( ): | Returns an iterable collection containing all the keys stored in $M$. |
| values( ): | Returns an iterable collection containing all the *values* of entries stored in $M$ (with repetition if multiple keys map to the same value). |
| entrySet( ): | Returns an iterable collection containing all the key-value entries in $M$. |

[M.Goodrich, sec. 10.1.1, p.403]

# Hash Tables

- Introduction and Definitions
- Hashing and Hash function
- Collision Handling Schemes
- Hash Tables ADT
- Demo

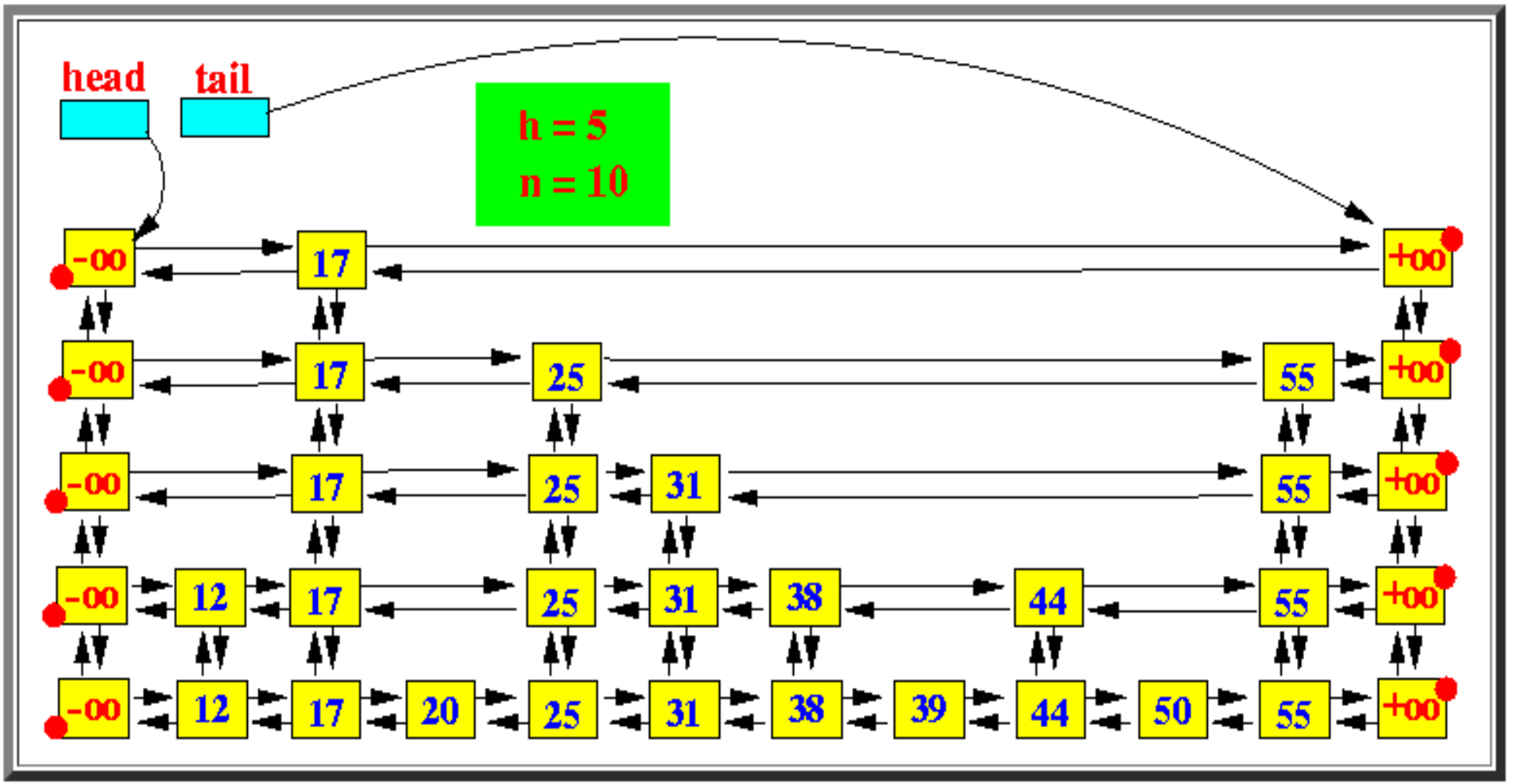
# Hash Table ADT: Implementation

- Hash Tables using Separate chaining
- Hash Tables using Linear Probing
- Hash Tables using Quadratic Probing
- Hash Tables using Double Hashing

https://visualgo.net/en/hashtable?slide=1

# Skip Lists

# Skip Lists: Illustration

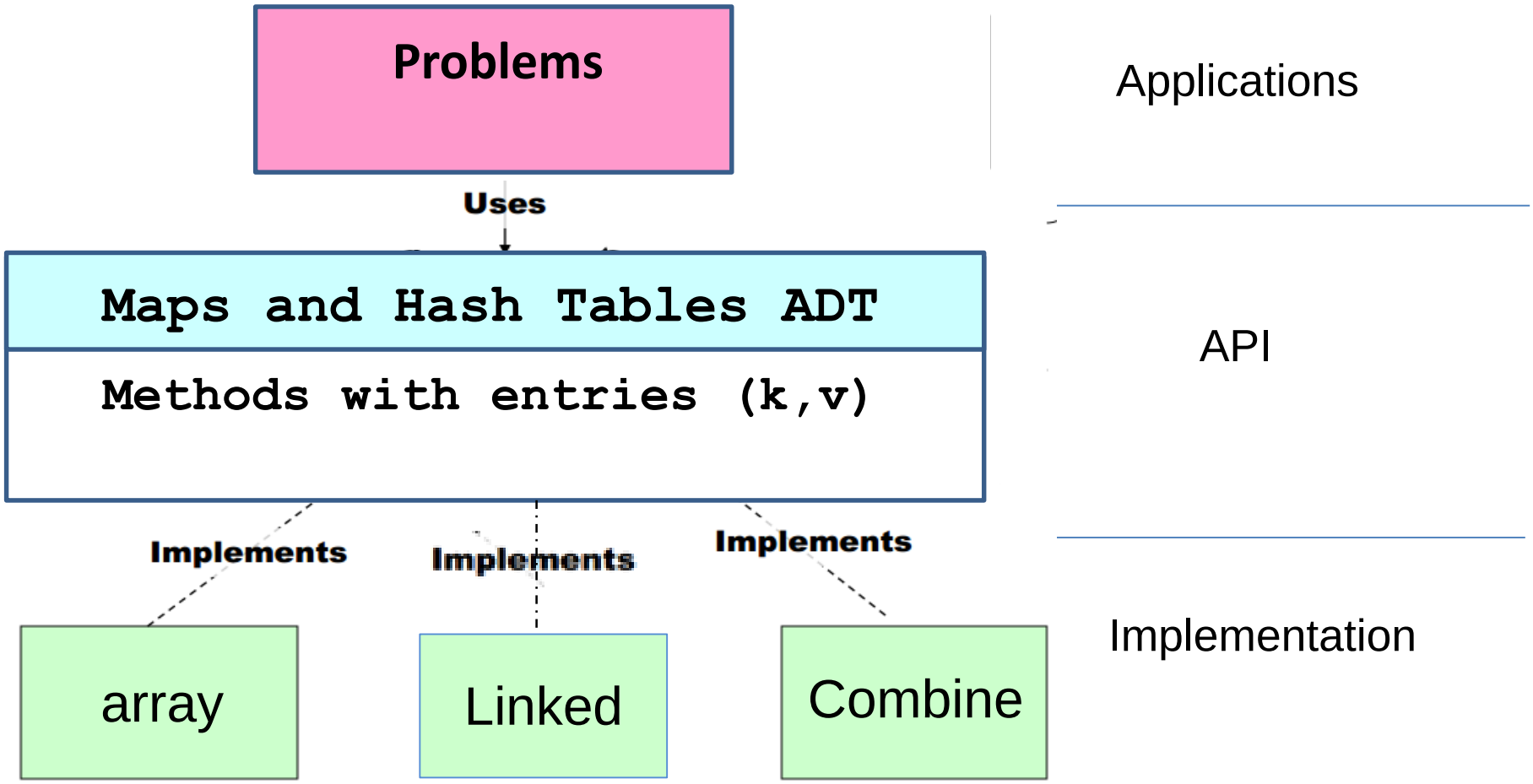


# Skip Lists: Specification

next($p$): Returns the position following $p$ on the same level.
prev($p$): Returns the position preceding $p$ on the same level.
above($p$): Returns the position above $p$ in the same tower.
below($p$): Returns the position below $p$ in the same tower.

[M.Goodrich, sec. 10.4, p.436]

# Summary


Problems
Uses
Maps and Hash Tables ADT
Methods with entries (k,v)
Implements
Implements
Implements
array
Linked
Combine
Applications
API
Implementation