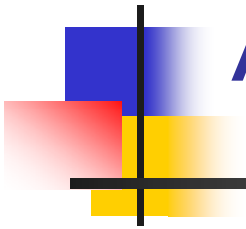
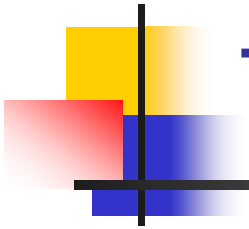


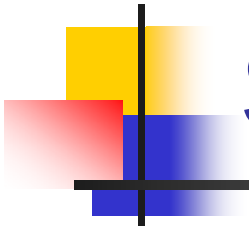
Advanced Data Structures

An introduction



Topics

- Data structures
  - (review) stack, list, array, BST
  - (new) Trees, heaps, union-find, hash tables, specialized (for spatial & strings)
- Algorithm design & analysis
  - Sorting, graph algorithms
- Applications



So, what is a data structure?

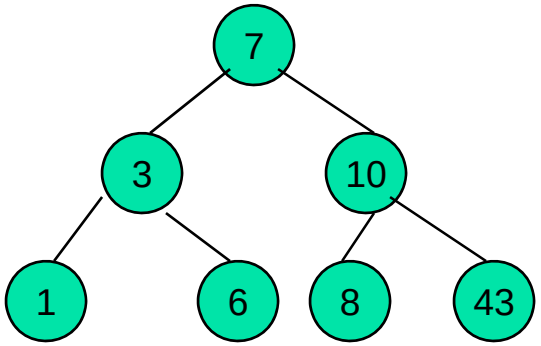
A container for data that allows organized access and manipulation

Why study data structures?

- Example problem
  - Given: a set of N numbers
  - Goal: search for number k
- Solution
  - Store numbers in an array of size N
  - Linearly scan array until k is found or array is exhausted
  - Number of checks
    - Best case: 1
    - Worst case: N
    - Average case: N/2

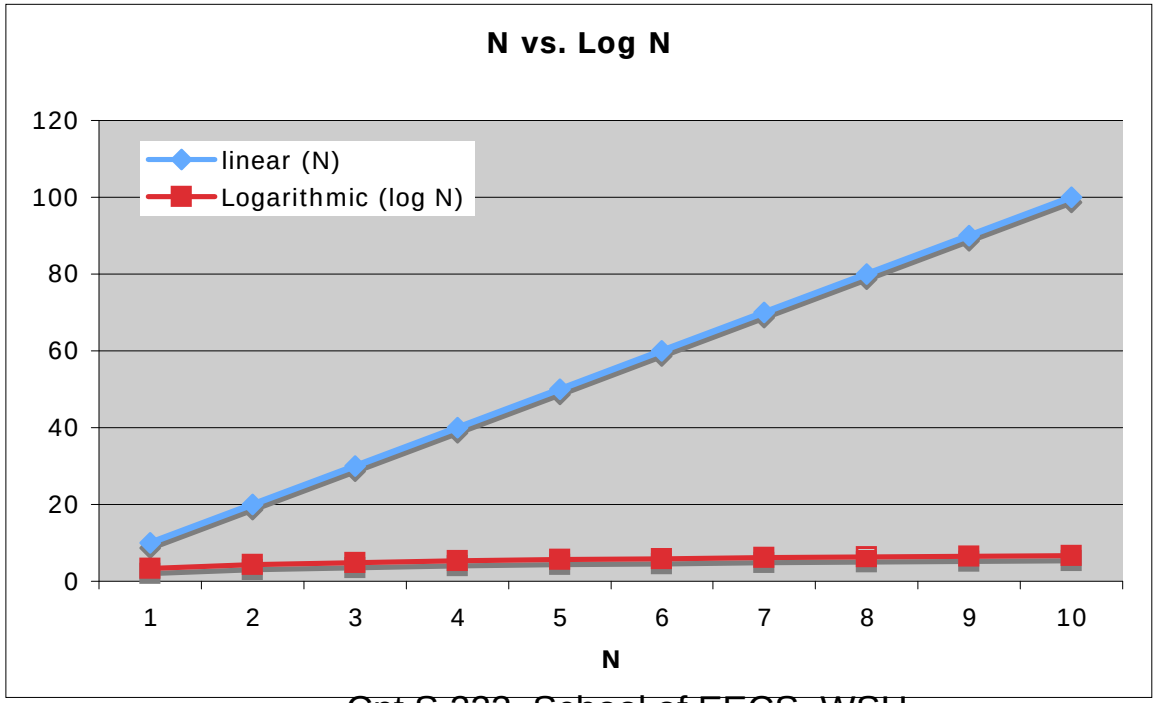
Why study data structures?

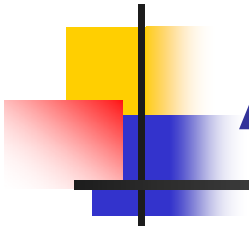
- Solution #2
  - Store numbers in a binary search tree
  - Search tree until find k
  - Number of checks
    - Best case: 1
    - Worst case: $\log_2 N$
    - Average case: $(\log_2 N)/2$



Analysis

- Does it matter?
  - N vs. $\log_2 N$

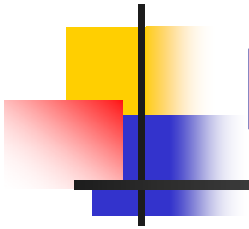




Analysis

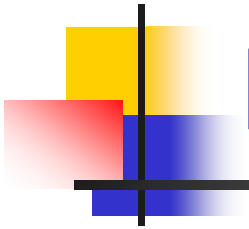
- Assume
  - N = 1,000,000,000
    - 1 billion (Walmart transactions in 100 days)
  - 1 GHz processor = 10^9 cycles per second
- 1 cycle per transaction

- O(N) algorithm
  - 1 billion transactions = > 1 billion clock cycles
- O(lg N) algorithm
  - 1 billion transactions => 30 clock cycles



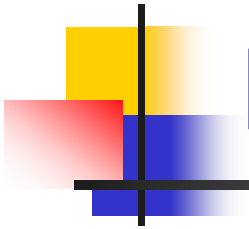
Example 2

- Scheduling job in a printer
  - Write a code to manage the printer queue
  - Functions to support
    - Insert, delete
  - Special accommodations needed for:
    - Priority
    - Dynamic update
    - Scheduling challenges



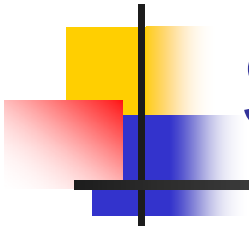
Example 3

- Exploring the Facebook connection network
  - Write a code to tell who is connected to who (directly or indirectly) through your Facebook profile
  - Degrees of separation



Example 4

- Pattern matching
  - Write a code to do Google search on your web database



Summary

- Keep the data organized
- Choice of data structures matters
- Appropriate data structures ease design & improve performance
- Challenge
  - Design appropriate data structure & associated algorithms for a problem
  - Analyze to show improved performance