Nell Dale

Plus Data Structures

FIFTH EDITION

Chapter 2
Data Design and Implementation

www.kinnisgosha.com/ds/lecture4.pdf

Data

- The representation of information in a manner suitable for communication or analysis by humans or machines
- Data are the nouns of the programming world:
  - The objects that are manipulated
  - The information that is processed

Data Abstraction

- **Separation of a data type's logical properties from its implementation.**

LOGICAL PROPERTIES	IMPLEMENTATION
What are the possible values?	How can this be done in C++?
What operations will be needed?	How can data types be used?

Data Encapsulation

- **is the separation of the representation of data from the applications that use the data at a logical level; a programming language feature that enforces information hiding.**

APPLICATION

```
int  y;

y = 25;
```

REPRESENTATION

```
0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 1
```

Abstract Data Type (ADT)

- **A data type whose properties (domain and operations) are specified independently of any particular implementation.**


Bank of America
Cash Only
Multi-Check Deposit
Making deposits has never been easier.
8PM

Data Structures

- A collection of data elements whose organization is characterized by accessing operations that are used to store and retrieve the individual data elements; the implementation of the composite data members in an abstract data type

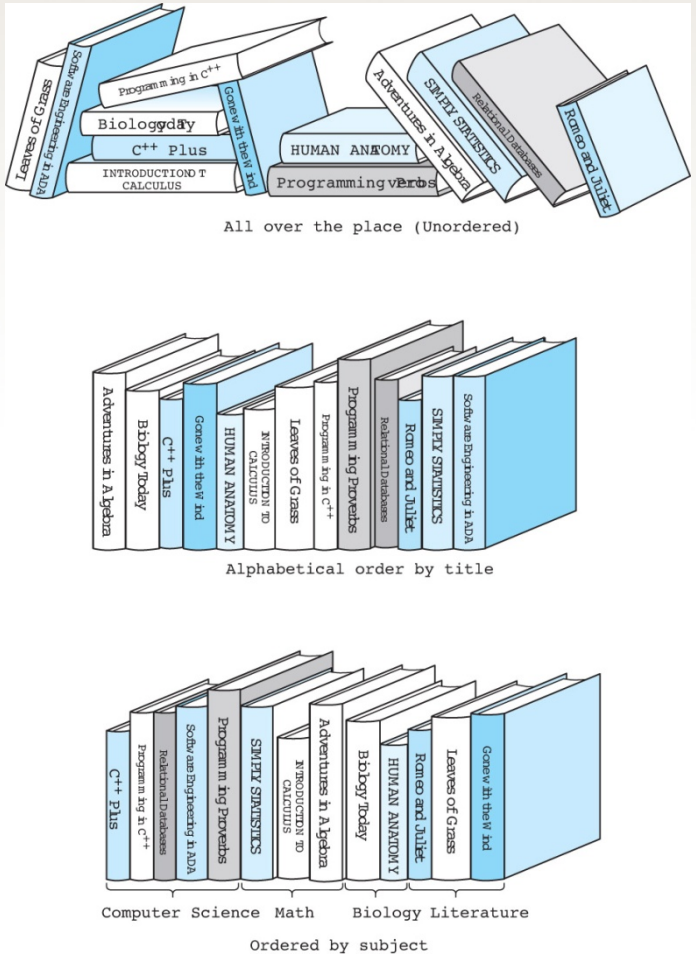
ADT

Data Structure

Data Structures

- 3 Features
  - Can be “Decomposed” into their component elements
  - Arrangement of elements effects HOW each element is accessed
  - Third both the arrangement of elements and how they are accessed can be encapsulated

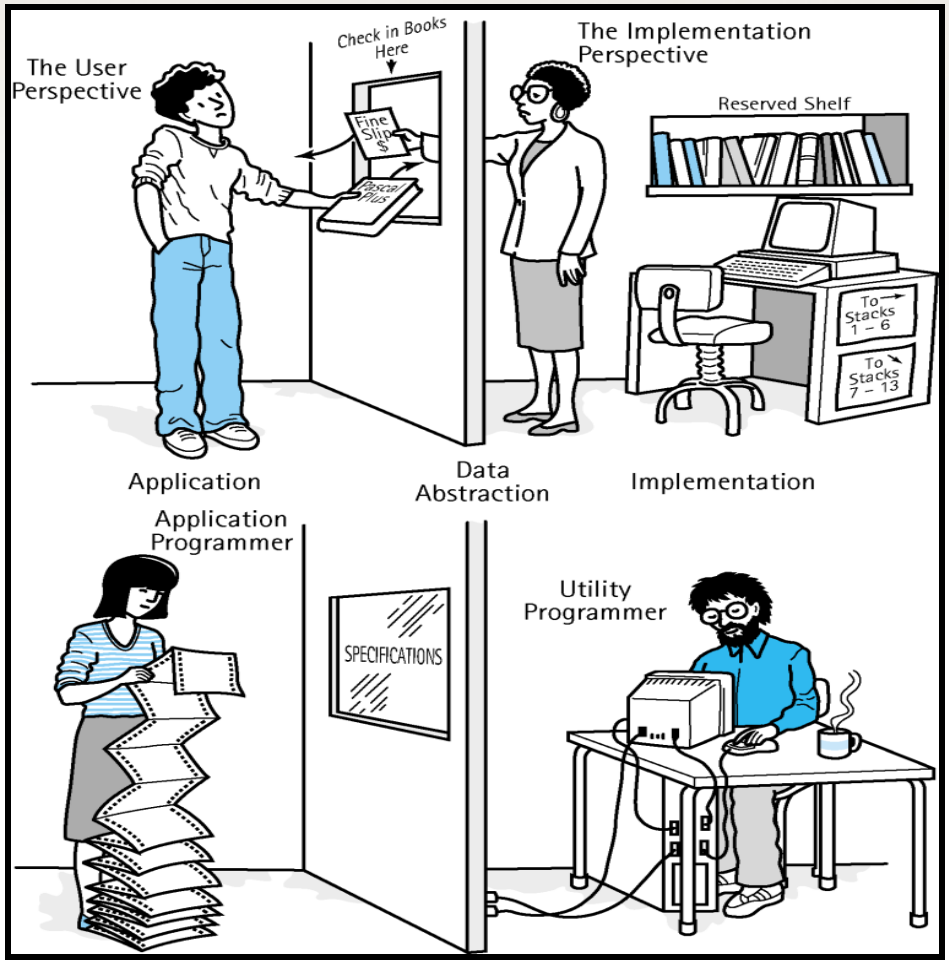
Collection ordered in different ways



Data from 3 different levels

- ***Application (or user) level:*** **modeling real-life data in a specific context.**
- ***Logical (or ADT) level:*** **abstract view of the domain and operations.** **WHAT**
- ***Implementation level:*** **specific representation of the structure to hold the data items, and the coding for operations.** **HOW**

Communication between the Application Level and Implementation Level



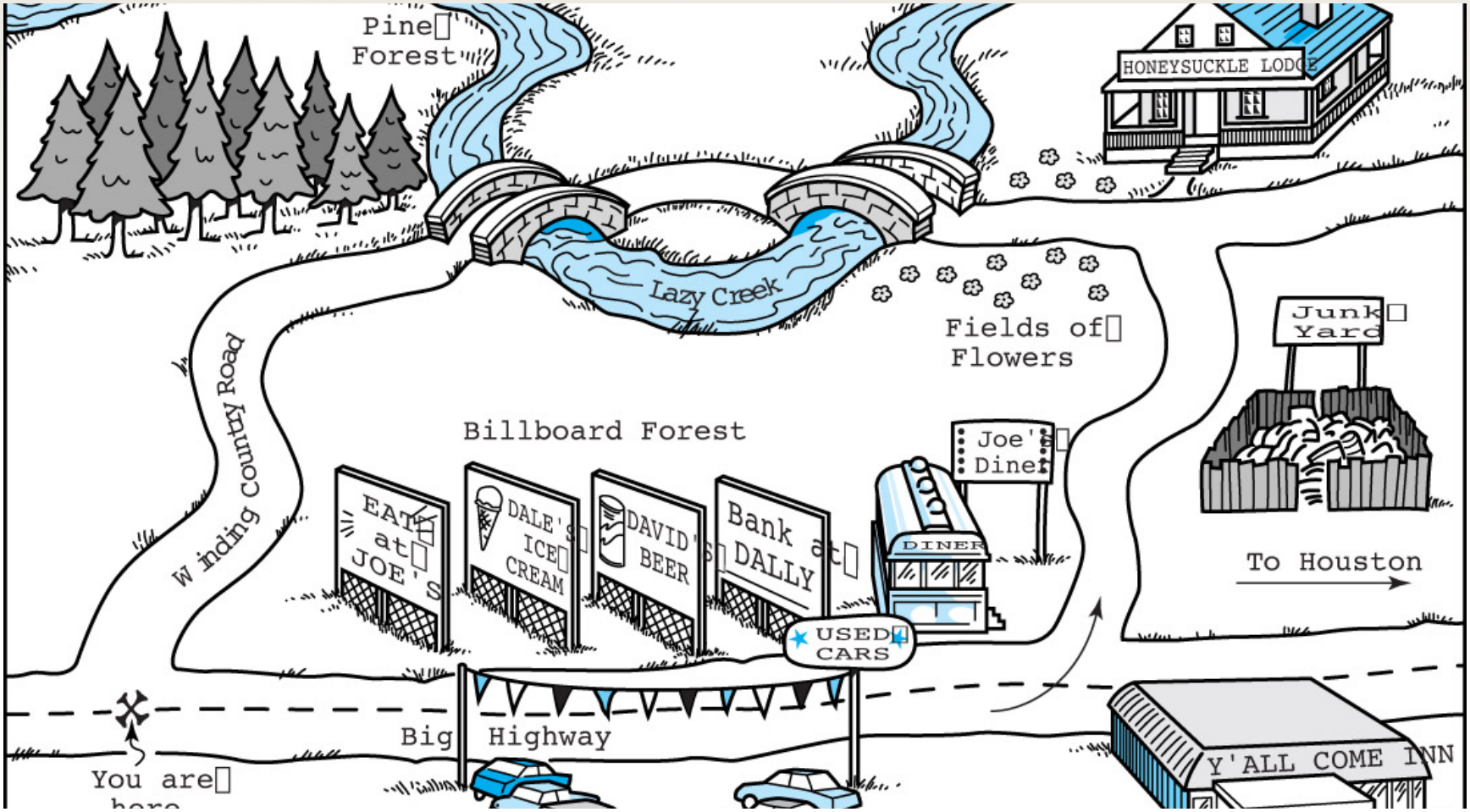
Viewing a library from 3 different levels

- *Application (or user) level:* **Library of Congress, or Baltimore County Public Library.**
- *Logical (or ADT) level:* **domain is a collection of books; operations include: check book out, check book in, pay fine, reserve a book.**
- *Implementation level:* **representation of the structure to hold the "books", and the coding for operations.**

4 Basic Kinds of ADT Operations

- **Constructor -- creates a new instance (object) of an ADT.**
- **Transformer -- changes the state of one or more of the data values of an instance.**
- **Observer -- allows us to observe the state of one or more of the data values without changing them.**
- **Iterator -- allows us to process all the components in a data structure sequentially.**

Map to Joe's Diner



How do we compare algorithms?

- Code both and compare run times?
- Count the number of statements executed?
- Isolate a particular operation fundamental to the algorithm and count the number of times it is performed?

Which Store is the Cheapest?

Order of Magnitude of a Function

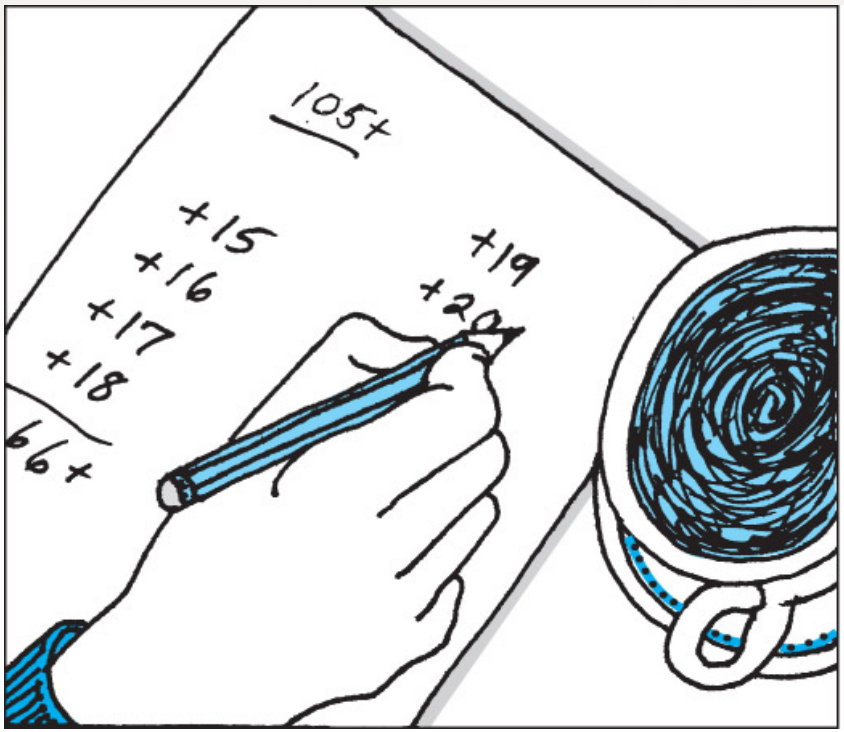
The order of magnitude, or Big-O notation, of a function expresses the computing time of a problem as the term in a function that increases most rapidly relative to the size of a problem.

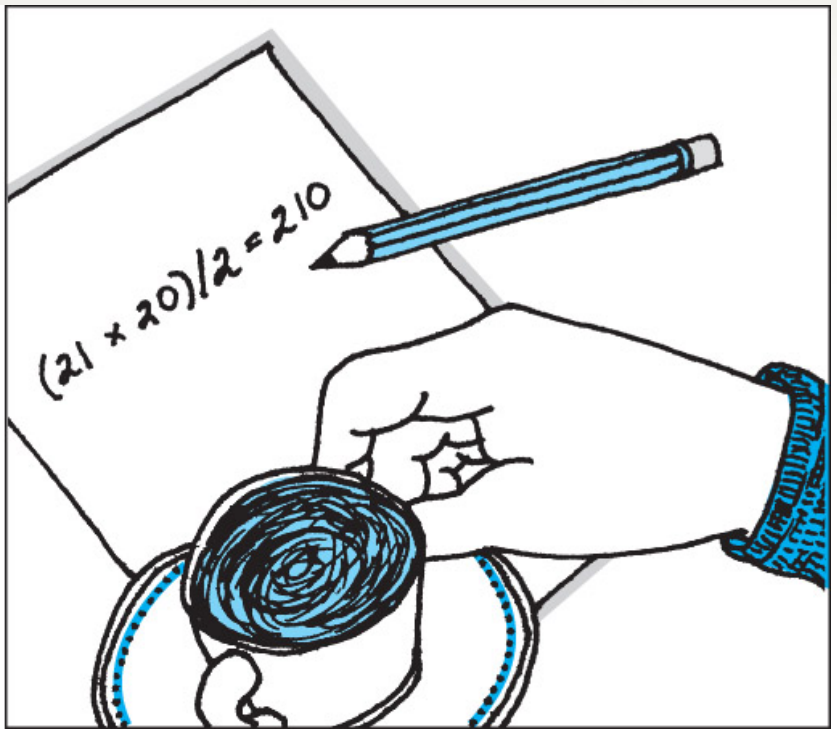
Names of Orders of Magnitude

$O(1)$	bounded (by a constant) time
$O(\log_2 N)$	logarithmic time
$O(N)$	linear time
$O(N*\log_2 N)$	$N*\log_2 N$ time
$O(N^2)$	quadratic time
$O(2^N)$	exponential time

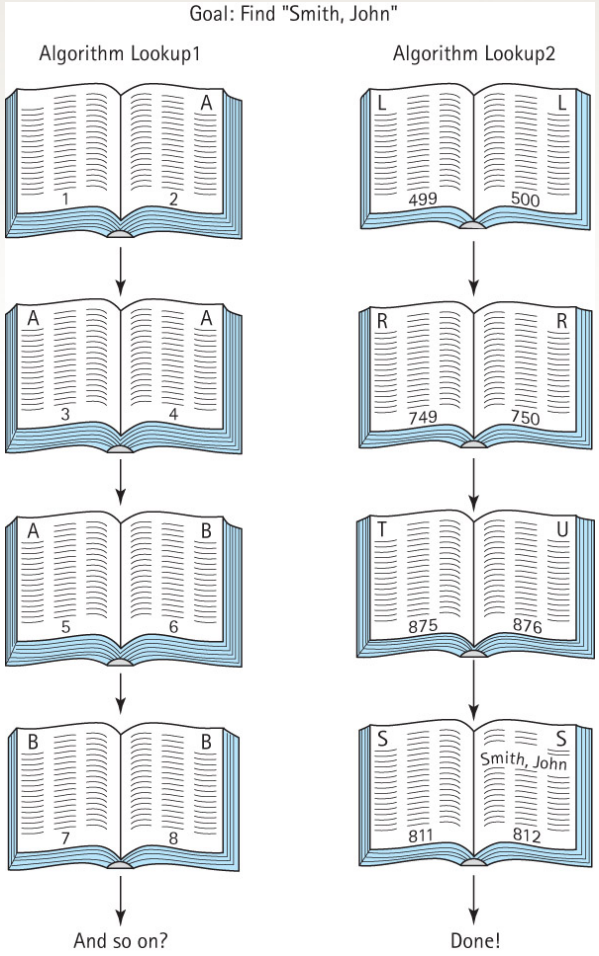
N	$\log_2 N$	$N*\log_2 N$	N^2	2^N
1	0	0	1	2
2	1	2	4	4
4	2	8	16	16
8	3	24	64	256
16	4	64	256	65,536
32	5	160	1024	4,294,967,296
64	6	384	4096	
128	7	896	16,384	

Comparison of Two Algorithms





Find “John Smith”



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