1: Introduction

CSE326 Spring 2002

April 1, 2002

Administrivia

- Instructor:
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- Text:
  Data Structures and Their Algorithms, Lewis and Denenberg.

What 326 is About

- Formal Study of Algorithms and Data Structures
  - ADT: Abstract Data Type
  - Asymptotic Running-time Analysis
- Become familiar with UNIX development environment
  - C++
  - Linux
  - `g++`, `make`, `gdb`, `ddd`, `emacs`

Policies

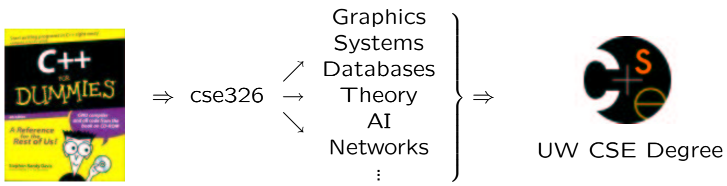
- Written homework due at start of class on the due date.
- Programming assignments
  - 1 day late: 10% off score
- Grading

written homework	15%	
programming assignments	30%	
midterm	20%	May 8
final	30%	June 12
etc.	5%	

Mechanics

- Home Page: www/326
  - Slides of current lectures
- Directory: /cse/courses/cse326/02sp
  - Reachable from IWS servers
- Mailing Lists: cse326ta@cs, cse326@cs
  - Important announcements on cse326ta@cs
  - Discussion on cse326@cs
- Lab: 329 Sieg
  - All programing assignments should be done on Linux
  - Windows Boxes with Xserver access to instructional workstation servers
  - IWS servers are: `fiji`, `sumatra`, `ceylon`, `tahiti`

CSE326 & The CSE Program



Course Overview

Writing computer programs is an *engineering* activity.

- Concerned about *efficiency*.
- Need to trade-off *detail* with *abstraction*.
- Concerned about *elegance*.

Course Overview

- Efficiency
  - *Asymptotic run-time analysis*
  - Quantify algorithm performance independent from the machine the algorithm runs on.
- Abstraction
  - Encapsulate bookkeeping details of program with *Abstract Data Type*
  - Stack, Queue, Dictionary,. . .
- Elegance
  - We'll study elegent implementations of ADTs

Course Outline

- Review
- Analysis
  - How to compare and evaluate algorithms
  - Will learn sorting algorithms in the process
- ADTs
  - The common ADTs that are used to solve most computer programming problems
    - Dictionary, Priority Queue, Set. . .
  - Efficient algorithms that implement these ADTs
    - Lists, Trees, Balanced Trees, Hashes, Tries. . .
- Applications
  - Graphs
  - Range Searching, Geographic Databases, Compression. . .
    - Depends on how much time we have

Prerequisites: Programming

- C++?
  - Recursion?
- Arrays?
- Lists?
- Trees?
  - Binary Trees?
- Searching?
  - Binary Search? Hashes?
- Sorting?
  - Bubble Sort? Insertion Sort? Mergesort? Shell Sort?
- ADTs?
  - Stack? Queue? Dictionary? Priority Queue? Set?

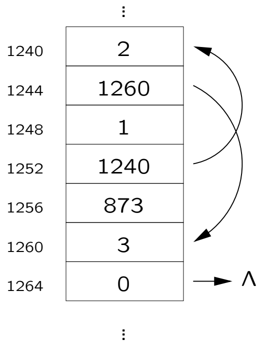
Our Model of a Computer

	⋮
1240	2
1244	1260
1248	1
1252	1240
1256	873
1260	3
1264	0
	⋮

- Computer memory is list of *cells*
- Each cell has an *address*
- Cells hold a number or an address (i. e. a *pointer*)

Von Neumann Definition of a Computer

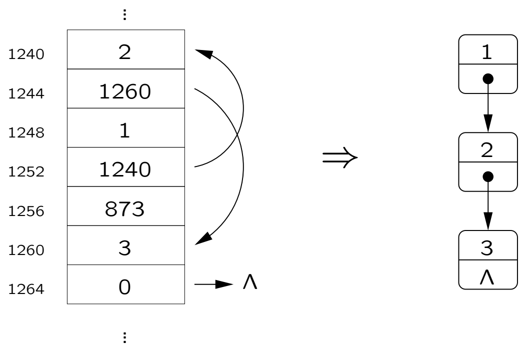
Our Model of a Computer



	⋮
1240	2
1244	1260
1248	1
1252	1240
1256	873
1260	3
1264	0
	⋮

- Draw pointers as arrows
- Λ denotes a NULL pointer

Our Model of a Computer



1240 2
1244 1260
1248 1
1252 1240
1256 873
1260 3
1264 0

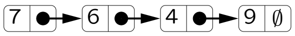
⇒

1 → 2 → 3 Λ

Memory Viewed as List

Implementation Techniques You Know

- List

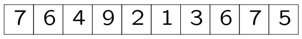


7 → 6 → 4 → 9 ∅

```
struct ListNode {


};
```

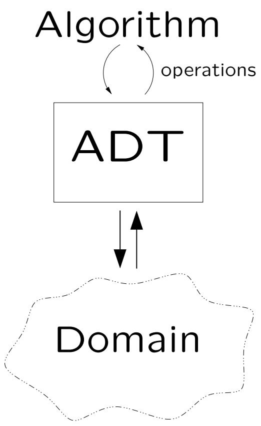
- Array



7	6	4	9	2	1	3	6	7	5

```
int *array; int n;
```

ADTs



Algorithm

operations

ADT

Domain

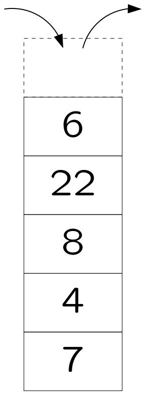
An *Abstract Data Type* is:

- A *Domain*, and
- a set of *Operations* on the domain.

Algorithms use *implementations* of ADTs to solve problems

ADTs You Know

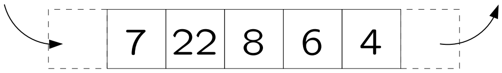
Stack (LIFO)



- Domain:
- Operations:
- Implementations:

ADTs You Know

Queue (FIFO)



- Domain:
- Operations:
- Implementations:

ADTs You Know

List (Array)

7, 22, 8, 6, 4. . .

- Domain:
  - Numbers
  - Strings
  - Lists. . .
- Operations:
  - Access(i)
  - Length()
  - Concat(L_1, L_2)
  - MakeEmptyList()
  - IsEmptyList()
- Implementation:

Prerequisites: Mathematics

- Methods of proof?
- $\sum_{i=1}^{n} i = ?$
- $\mathrm{O}(n^2)$ vs. $\Omega(n \log n)$?
- Probability?
  - Expectation?

Recurrence Relations

- $T(n) = c + T(n-1),\ T(0) = a$
- $T(n) = c + 2T(n-1),\ T(0) = a$
- $T(n) = c + T(n/2),\ T(0) = a$

Rules for Logorithms

- $\log a = x \Leftrightarrow 2^x = a$
- $\log a + \log b = \log ab$
- $\log a - \log b = \log \frac{a}{b}$
- $\log a^c = c \cdot \log a$
- $\log_b a = \frac{\log a}{\log b}$

See §1.3 in the textbook