Introduction

CSE 373
Data Structures & Algorithms
Ruth Anderson
Winter 2012

Today's Outline

- Introductions
- Administrative Info
- What is this course about?
- Review: Stacks and Queues

Staff

- Instructor
  - Ruth Anderson, (rea at cs.washington.edu)
- TA's
  - Jijiang "Johnny" Yan, (jjyan at cs.washington.edu)
  - Laura Dong, (ledong at cs.washington.edu)
  - Anton Osobov, (aosobov at cs.washington.edu)
  - Ian Talarico, (talarico at cs.washington.edu)

Me (Ruth Anderson)

- Grad Student at UW in Programming Languages, Compilers, Parallel Computing
- Taught Computer Science at the University of Virginia for 5 years
- Grad Student at UW: PhD in Educational Technology, Pen Computing
- Current Research: Computing and the Developing World
- Recently Taught: majors and non-majors data structures, architecture, compilers, programming languages, cse143, Designing Technology for Resource-Constrained Environments

Web Page

- All info is on the web page for CSE 373
  - http://www.cs.washington.edu/373
  - also known as
    - http://www.cs.washington.edu/education/courses/373/12wi
- Look there for schedules, contact information, assignments, links to discussion boards and mailing lists, etc.

Office Hours

- Ruth Anderson– 360 CSE (Allen Center)
  - Monday 3:30-4:30pm,
    Thursday 10:45-11:45am
    or by appointment

CSE 373 E-mail List

- If you are registered for the course, you will be automatically subscribed.
- The E-mail list is used for posting announcements by instructor and TAs.
- You are responsible for anything sent here

CSE 373 Discussion Board

- The course will have a Catalyst Go-Post message board
- Use for:
  - General discussion of class contents
  - Hints and ideas about assignments (but **not** detailed code or solutions)
  - Other topics related to the course.

Computer Lab for homework and Help sessions

- College of Arts & Sciences Instructional Computing Lab
  - http://depts.washington.edu/aslab/
- We'll be using Java for the programming assignments.
- Eclipse is recommended programming environment.

Textbook

- *Data Structures and Algorithm Analysis in Java,* by Mark Allen Weiss, 3nd edition, Addison-Wesley, 2012.
- We will also try to support the 2nd edition (2007).

Grading
Estimated Breakdown:

- Assignments 50%
  - Weights may differ to account for relative difficulty of assignments
  - Assignments will be a mix of shorter written exercises and longer programming projects
- Midterms 30% (Two, 15% each)
- Final Exam 20%
  - 2:30-4:20pm Tuesday, March 13, 2012.

Deadlines & Late Policy

- Assignments generally due Thursday evenings via the web
  - Exact times and dates will be given for each assignment
- Late policy: 20% off per 24hrs late
  - Note: ALL parts of the assignment must be received by that time (may require you to make an electronic version of written assignments).
    (Talk to the instructor if something truly outside your control causes problems here)

Academic (Mis-)Conduct

- You are expected to do your own work
  - › Exceptions (group work), if any, will be clearly announced
- Sharing solutions, doing work for or accepting work from others will be penalized
- Referring to solutions from this or other courses from previous quarters is cheating.
- Integrity is a fundamental principle in the academic world (and elsewhere) – we and your classmates trust you; don't abuse that trust

Policy on collaboration

- "Gilligan's Island" rule:
  - › You may discuss problems with your classmates to your heart's content.
  - › After you have solved a problem, *discard all written notes* about the solution.
  - › Go watch TV for a ½ hour (or more). Preferably *Gilligan's Island*.
  - › *Then* write your solution.

Homework for Today!!

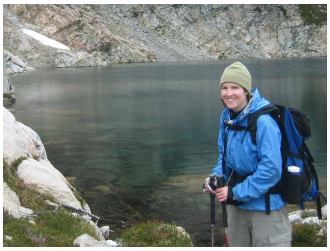
0) **Review Java & Explore Eclipse**
1) **Assignment #1:** (posted soon)
2) **Preliminary Survey**: fill out by evening of Thursday Jan 5th
3) **Information Sheet**: bring to lecture on Friday Jan 6th
4) **Reading** in Weiss (see next slide)

Reading

- Reading in *Data Structures and Algorithm Analysis in Java*, by Weiss
- For this week:
  - › Chapter 1 – (review) Mathematics and Java
  - › Chapter 3 – (Assign #1) Lists, Stacks, & Queues
  - › Chapter 2 – (Topic next week) Algorithm Analysis

Bring to Class on Friday:

- Name
- Email address
- Year (1,2,3,4)
- Major
- Hometown
- Interesting Fact or what I did over break.



Today's Outline

- Introductions
- Administrative Info
- What is this course about?
- Review: Stacks and Queues

Course Topics

- Introduction to Algorithm Analysis
- Lists, Stacks, Queues
- Trees, Hashing, Dictionaries
- Heaps, Priority Queues
- Sorting
- Disjoint Sets
- Graph Algorithms

Background

- Prerequisite is CSE 143
- Topics you should have a basic understanding of:
  - Variables, conditionals, loops, methods (functions), fundamentals of defining classes and inheritance, arrays, single linked lists, simple binary trees, recursion, some sorting and searching algorithms, basic algorithm analysis (e.g., O(n) vs $O(n^2)$ and similar things)
- We can fill in gaps as needed, but if any topics are new, plan on some extra studying

Okay, so what is 373 about?

- Introduction to many of the basic data structures and algorithms used in computer software:
  - Understand the data structures and the **trade-offs** they make
  - Rigorously **analyze** the algorithms that use them (math!)
  - Learn how to **pick "the right data structure for the job"**
  - More thorough and rigorous take on topics introduced in CSE 143 (plus more new topics)
- Practice design and analysis of data structures/algorithms
- Practice implementing and using these data structures by writing programs

Goals

- You will understand:
  - what the tools are for storing and processing common data types
  - which tools are appropriate for which need
- So that you will be able to:
  - make good design choices as a developer, project manager, or system customer
  - justify and communicate your design decisions

Data structures?

"Clever" ways to organize information in order to enable *efficient* computation over that information.

Data structures!

A data structure supports certain *operations*, each with a:

- **Meaning**: what does the operation do/return?
- **Performance**: how efficient is the operation?

Examples:

- ***List*** with operations **`insert`** and **`delete`**
- ***Stack*** with operations **`push`** and **`pop`**

Picking the best data structure for the job

Things we care about:

- Does this data structure support the operations I need?
  - e.g. find an item quickly, insert in any location, print in sorted order, delete?
- Does it support them in an ***efficient*** manner?
  - Time (Speed)
  - Space (Memory)
- How easy will it be to implement, debug, and test it?

Implementation Trade-offs

A data structure tries to provide many useful, efficient operations.

But there are unavoidable trade-offs:

- Time vs. Space – use more memory to make some operations faster
- Making one operation more efficient may make another operation less efficient
- Providing more operations (making the data structure more general) may force some operations to be less efficient.

This is why there are many data structures!

In this class we will discuss their trade-offs and techniques.

Terminology

- Abstract Data Type (ADT): Mathematical description of an object and a set of operations on the object
- Algorithm: A high level, language-independent description of a step-by-step process
- Data structure: A specific *organization of data* and family of algorithms for implementing an ADT
- Implementation of a data structure: A specific implementation in a specific language

Terminology examples

- A stack is an *abstract data type* supporting push, pop and isEmpty operations
- A stack *data structure* could use an array, a linked list, or anything that can hold data
- One stack *implementation* is found in the java.util.Stack class

ADTs and Interfaces in Java

- Abstract Data Type (ADT):
  - Describes *what* you can do to a collection, not *how* it does it
- Can think of Java interfaces as describing an ADT
  - e.g., `List`, `Map`, `Set` interfaces
  - Separate from class **implementations**
- Java interfaces and classes that implement them:
  - `ArrayList` and `LinkedList` implement `List` interface
  - `HashMap` and `TreeMap` implement `Map` interface
  - `HashSet` and `TreeSet` implement `Set` interface
    - Aside: There is also a Queue interface. They messed up on Stack; there's no Stack interface, just a class.

Java's `List` Interface

Operations described in Java's `List` interface (subset):

`add(`**`el`**`, `**`index`**`)`	inserts the element at the specified position in the list
`remove(`**`index`**`)`	removes the element at the specified position
`get(`**`index`**`)`	returns the element at the specified position
`set(`**`index`**`, `**`el`**`)`	replaces the element at the specified position with the specified element
`contains(`**`el`**`)`	returns true if the list contains the element
`size()`	returns the number of elements in the list

`ArrayList` and `LinkedList` are Java classes that implement the `List` interface

Homework for Today!!

0) **Review Java & Explore Eclipse**
1) **Assignment #1:** (posted soon)
2) **Preliminary Survey**: fill out by evening of Thursday Jan 5th
3) **Information Sheet**: bring to lecture on Friday Jan 6th
4) **Reading** in Weiss (see next slide)