Introduction and Course Overview
CSE 373

Yang Li
University of Washington
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Staff

- Instructor
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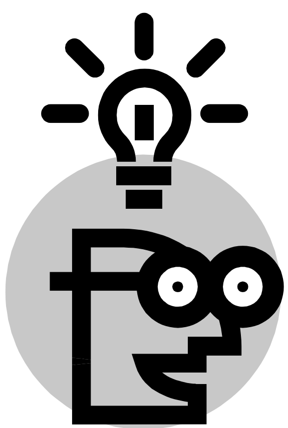
- TAs
  - › Cam Thach Nguyen (ncthach@cs.washington.edu)
  - › Sierra Michels-Slettvet (sierra@cs.washington.edu)

Yang Li

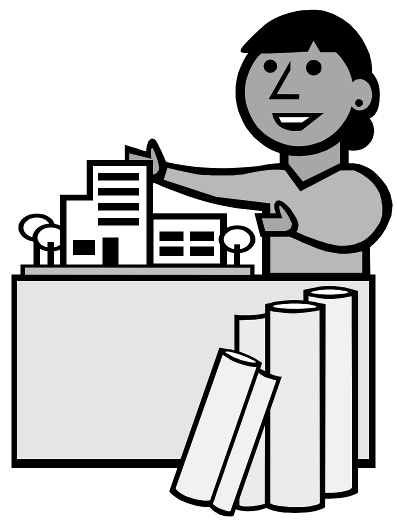
- Currently a Research Associate at ***UW CSE***
  - › Ubiquitous Computing & Pen-based Computing
  - › http://www.cs.washington.edu/homes/yangli
- Previously a Postdoc at ***UC Berkeley EECS***
  - › Ubiquitous Computing & Pen-based Computing
- Acquired a PhD from ***Chinese Academy of Sciences***
  - › Computer Science
  - › Pen-based Computing

Data Structures: Why?

We need *clever* ways to organize information in order to enable *efficient* computation.



Data Structures: What & How?



Using Appropriate Abstractions is the Key!

Course Website

- **http://www.cs.washington.edu/373**
- All the information for the course
  - › Contact information & announcements
  - › Assignments
  - › Schedules & lectures
  - › Links to discussion boards and mailing lists
  - › Handouts
  - › Links to computing resources

Office Hours

- Yang Li – CSE212 (Allen Center)
  - Monday & Wednesday, 2:00-3:00
  - Or by appointment
- Cam Thach Nguyen – CSE218
  - Tuesday & Thursday, 9:30 to 10:20
- Sierra Michels-Slettvet – TBA
  - Thursday, 3:30

CSE 373 E-mail List

- Automatically subscribed if you are registered for the course
  - › Otherwise, subscribe via the class web page
- Use
  - › Posting announcements by instructor & TAs

CSE 373 Discussion Board

- Subscribe through the course website
- Use
  - › General discussion of class contents
  - › Hints and ideas about assignments
    - but **not** detailed code or solutions
  - › Other topics related to the course

Computer Lab

- College of Arts & Sciences Instructional Computing Lab
  - http://depts.washington.edu/aslab/

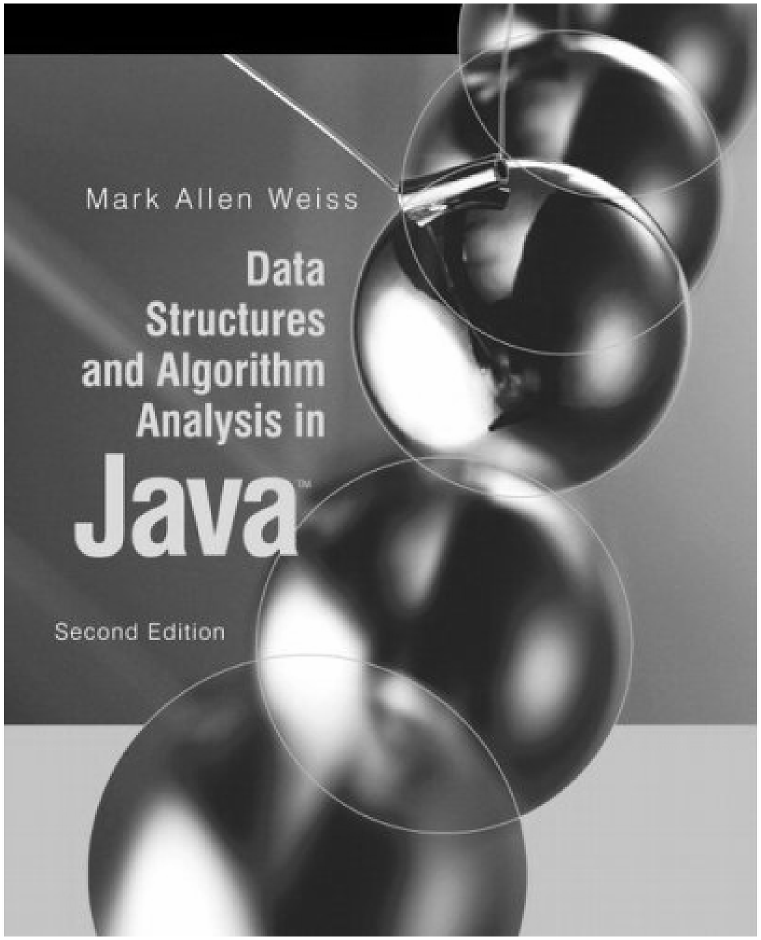
- Programming language: Java 5 or 6

Programming Tools

- **Eclipse**
  - The best IDE I’ve ever used!
  - Or whatever editor that allow you to type in code!
- Stay away from code-generating “wizards”
- Most tools are freely available on the web
  - Easy to set up at home

Textbook

Data Structures and Algorithm Analysis in Java, Mark Weiss, 2nd edition, Addison-Wesley, 2007.



Grading & Estimated Breakdown

- Two Midterms 30% (15% each)
- Final 20%
  - 10:30-12:20 pm, Wednesday, Dec 12
- Assignments 50%
  - Weights differ to account for difficulty of assignments
  - A mix of written exercises and programming projects

Deadlines & Late Policy

- Assignments generally due Thursday evenings
  - › Turnin via the web
  - › Exact times/dates will be given for each assignment
- Late policy: NONE
  - › As in, no late assignments accepted
  - › 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 will be clearly announced
- Misconducts will be penalized
  - Sharing solutions
  - Doing work for or accepting work from others

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

- Assignment #1
  - Posted in the next day or so
- Reading in Weiss
  - Chapter 1 – Mathematics and Java
  - Chapter 2 – Algorithm Analysis
  - Chapter 3 – Lists, Stacks, & Queues

Class Overview

- Be exposed to a variety of data structures
- Know when to use them
- Apply mathematical techniques for analysis
- Practice implementing them by writing programs

Goal:

Be able to make good design choices as a developer, project manager, or system customer

Good Designs

Program design depends crucially on how data is structured for use by the program

- Speed of program may dramatically decrease or increase
- Memory used may increase or decrease
- Implementation of some operations may become easier or harder
- Debugging may be become easier or harder

Course Topics

- Introduction to Algorithm Analysis
- Lists, Stacks, Queues (mostly review)
- Search Algorithms & Trees
- Hashing & Heaps
- Sorting
- Disjoint Sets
- Graph Algorithms

Picking the best Data Structure for the job

- The data structure you pick needs to *support* the operations you need
- Ideally it supports the operations you will use most often in an *efficient* manner
- Examples of operations
  - › List with operations **`insert`** and **`delete`**
  - › Stack with operations **`push`** and **`pop`**

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

Terminology

- Abstract Data Type (ADT)
  - › Mathematical description of a computational object
  - › Useful building block
- Algorithm
  - › A high level, language independent, description of a step-by-step process
- Data structure
  - › A specific family of algorithms for implementing an abstract data type
- Implementation of data structure
  - › A specific implementation in a specific language

A Terminology Example

- A stack is an *abstract data type (ADT)*
  - › Supporting push, pop and isEmpty operations
- A stack *data structure*
  - › Use an array or a linked list
  - › Or anything that can hold data
- One stack *implementation*
  - › See java.util.Stack

Why Algorithm Analysis

- Correctness
  - › Does the algorithm do what is intended
- Performance
  - › What is the running time of the algorithm
  - › How much storage does it consume
- Choose among different data structures
  - › All correctly solves a given task
  - › Which should we use? When?

Iterative Algorithm for Sum

Problem: Find the sum of the first *num* integers stored in an array v.

```
sum(v[ ]: integer array, num: integer): integer
{
    temp_sum: integer ;
    temp_sum := 0;
    for i = 0 to num – 1 do
        temp_sum := v[i] + temp_sum;
    return temp_sum;
}
```

Programming via Recursion

Problem: Write a recursive function to find the sum of the first num integers stored in array v.

```
sum (v[ ]: integer array, num: integer): integer
{
    if num = 0 then
        return 0                          } base case
    else
        return v[num-1] + sum(v,num-1);   } recursive case
}
```

Pseudocode

Algorithms will (often) be presented in "pseudocode"

- Common in the computer science literature
- Easy to translate to real code
- Independent of particular programming language
- Informal but precise: there is no "official" language definition for pseudocode

Proof by Induction

- Basis Step
  - The algorithm is correct for a base case or two by inspection
- Inductive Hypothesis (n=k)
  - Assume that the algorithm works correctly for the first k cases, for any k
- Inductive Step (n=k+1)
  - Given the hypothesis above, show that the k+1 case will be calculated correctly

Program Correctness by Induction

- Basis Step
  - › sum(v,0) = 0 ✓
- Inductive Hypothesis (n=k)
  - › Assume sum(v,k) correctly returns sum of first k elements of v, i.e. v[0]+v[1]+…+v[k-1]
- Inductive Step (n=k+1)
  - › sum(v,n) returns v[k]+sum(v,k) which is the sum of first k+1 elements of v. ✓

Algorithms vs. Programs

- Proving correctness of an algorithm is very important
  - a well designed algorithm is guaranteed to work correctly and its performance can be estimated
- Proving correctness of a program (an implementation) is fraught with weird bugs
  - Abstract Data Types are a way to bridge the gap between mathematical algorithms and programs