CSE 331
Software Design & Implementation

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Fall 2014

Lecture 1 – Introduction & Overview

Welcome!

We have 10 weeks to move well beyond novice *programmer*:

- Larger programs
  - Small programs are easy: “code it up”
  - Complexity changes everything: “design an artifact”
  - Analogy: using hammers and saws vs. making cabinets (but not yet building houses)
- Principled, systematic software: What does “it’s right” mean? How do we know “it’s right”? What are best practices for “getting it right”?
- Effective use of languages and tools: Java, IDEs, debuggers, JUnit, JavaDoc, Subversion, …
  - Principles are ultimately more important than details
    - You will forever learn details of new tools/versions

Concise to-do list

By tomorrow night:

1. Familiarize yourself with website
   http://courses.cs.washington.edu/courses/cse331/14au/

2. Read syllabus and academic-integrity policy

3. Email-list settings

4. Take survey (in homework section)

5. Do Homework 0 (in homework section), due 2PM Friday!

Who: Course staff

- Lecturer:
  - Dan Grossman: Faculty since 2003, 2nd time teaching CSE331
- TAs:
  - Meg Cambell
  - Christopher Chen
  - Aaron Nech
  - Whitney Schmidt
  - Ben Tebbs
  - Xin (Cindy) Yi
- Office hours will be figured out ASAP

Get to know us!

- Make sure this *feels like* a 40-person class with 80 students
- We're here to help you succeed

Acknowledgments

- Course designed/created/evolved/edited by others
  - Michael D. Ernst
  - Hal Perkins
  - David Notkin
  - A couple dozen amazing TAs

- Hoping my own perspective offer benefits

- [Because you are unlikely to care, I won’t carefully attribute authorship of course materials]

Staying in touch

- Course email list: **`cse331a_au14@u.washington.edu`**
  - Students and staff already subscribed
  - You must get announcements sent there
  - Fairly low traffic
- Course staff: **`cse331-staff@cs.washington.edu`**
- Message Board
  - For appropriate discussions; TAs will monitor
  - Recommended/optional: won't use for announcements
- Anonymous feedback link on webpage
  - For good and bad: If you don't tell me, I don't know

Lecture and section

- Both required

- All materials posted, but they are visual aids
  - Arrive punctually and pay attention
  - If doing so doesn't save you time, one of us is messing up (!)

- Section will often be more tools and homework-details focused
  - Especially this week and next: preparing for projects

- Other posted handouts that relate to class material

Homeworks

- Biggest misconception about CSE331 (?)

  “Homework was programming projects that seemed disconnected from lecture”

  - If you think so, you are making them harder!
    - Reconsider
    - Seek out the connections by thinking-before-typing
    - Approaching them as CSE143 homework won’t work well
    - Don’t keep cutting with a dull blade

- First couple assignments are “more on paper”, followed by software development that is increasingly substantial

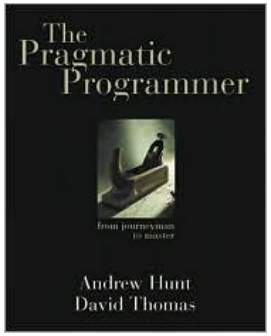
- Four late days for the quarter: save for emergencies

Resources – Books

Required:

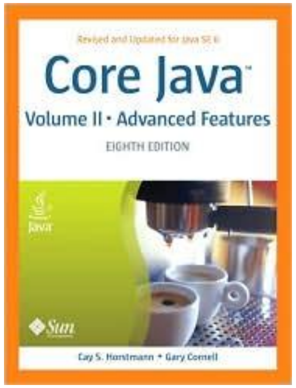
- *Pragmatic Programmer*, Hunt & Thomas
- *Effective Java* 2nd ed, Bloch

Serious programmers
should study these



Decent “Java book” is a wise thing to have

- *Core Java* Vol I, Horstmann


Core Java
Volume II • Advanced Features
EIGHTH EDITION
Cay S. Horstmann • Gary Cornell

And use the Java API Docs

Readings (and quizzes)

- These are “real” books about software, approachable in 331
  - Occasionally slight reach: accept the challenge

- Overlap only partial with lectures

- Want to make sure you “do it”
  - Reading and thinking about software design is essential
    - Books seem expensive given your budget, but very cheap as a time-constrained professional
  - Will have some simple online reading quizzes
    - In a few batches; no late days
  - Material is fair-game for exams

Books? In 2014?

- Why not just use Google, Stack Overflow, Reddit, Quora, …?
- Web-search good for:
  - Quick reference (What is the name of the function that does …? What are its parameters?)
  - Links to a good reference
- (can be) Bad for
  - Why does it work this way?
  - What is the intended use?
  - How does my issue fit into the bigger picture?
- Beware:
  - Random code blobs cut-and-paste into your code (why does it work? what does it do?)
  - This inscrutable incantation solved my problem on an unstated version for no known reason

Exams

- Midterm: October 31, in class
- Final: Tuesday December 9, 2:30-4:20PM
- All the concepts, different format than homework
  - Will post old exams from various instructors later

One Last Requirement

- 0.5% of your grade for attending a *talk-to-the-professor session* in my office
- Why?
  - Communicating is important
  - Professors are approachable human beings
- What?
  - 20 minutes – don't be 1-minute late
  - Groups of 4 (less intimidating and more efficient)
  - Sign-ups posted soon
  - Will ask about your courses, goals, background and leave time for you to ask me anything
  - A conversation, not an interview

Academic Integrity

- Read the course policy carefully
  - Clearly explains how you can and cannot get/provide help on homework and projects

- Always explain any unconventional action

- I have promoted and enforced academic integrity since I was a freshman
  - Great trust with little sympathy for violations
  - Honest work is the most important feature of a university (or engineering or business). Anything less disrespects your colleagues (including me) and yourself.

Questions?

Anything I forgot about course mechanics before we discuss, you know, software?

Goals

- CSE 331 will teach you to how to write correct programs
- What does it mean for a program to be correct?
  - Specifications
- What are ways to achieve correctness?
  - Principled design and development
  - Abstraction and modularity
  - Documentation
- What are ways to verify correctness?
  - Testing
  - Reasoning and verification

Main topic: Managing complexity

- Abstraction and specification
  - Procedural, data, and control flow abstractions
  - Why they are useful and how to use them
- Writing, understanding, and reasoning about code
  - Will use Java, but the issues apply in all languages
  - Some focus on object-oriented programming
- Program design and documentation
  - What makes a design good or bad (example: modularity)
  - Design processes and tools
- Pragmatic considerations
  - Testing
  - Debugging and defensive programming
  - [more in CSE403: Managing software projects]

The goal of system building

- To create a correctly functioning artifact

- All other matters are secondary
  - Many of them are ***essential*** to producing a correct system

- We insist that you learn to create correct systems
  - This is hard (but fun and rewarding!)

Related skill: *communication*

- Can you convince yourself and others something is correct via precise, coherent explanations?

Why is building good software hard?

- Large software systems are enormously complex
  - Millions of “moving parts”
- People expect software to be malleable
  - After all, it’s “only software”
- We are always trying to do new things with software
  - Relevant experience often missing

- Software engineering is about:
  - Managing complexity
  - Managing change
  - Coping with potential defects
    - Customers, developers, environment, software

Programming is hard

- It is surprisingly difficult to specify, design, implement, test, debug, and maintain even a simple program

- CSE331 will challenge you

- If you are having trouble, *think* before you act
  - Then, look for help

- We strive to create assignments that are reasonable if you apply the techniques taught in class…

  … but likely hard to do in a brute-force manner

  … and almost certainly impossible to finish if you put them off until a few days before they're due

Prerequisites

- Knowing Java is a prerequisite
  - We assume you have mastered CSE142 and CSE143

Examples:

- Sharing:
  - Distinction between `==` and `equals()`
  - Aliasing: multiple references to the same object
- Object-oriented dispatch:
  - Inheritance and overriding
  - Objects/values have a run-time type
- Subtyping
  - Expressions have a compile-time type
  - Subtyping via `extends` (classes) and `implements` (interfaces)

You have homework!

- Homework 0, due online by 2PM Friday
  - Write (don't run!) an algorithm to rearrange (swap) the elements in an array
  - And argue (prove) in concise, convincing English that your solution is correct!

- Purpose:
  - Great practice
  - Surprisingly difficult
  - So we can build up to reasoning about large designs, not just 5-10 line programs

CSE331 is hard!

- You will learn a lot!
- Be prepared to work and to think
- The staff will help you learn
  - And will be working hard, too

- So let’s get going…
  - Before we create masterpieces we need to hone our ability to reason very precisely about code…

Example

"Complete this method such that it returns the index of the max of the first **`n`** elements of the array **`arr`**."

```
int index_of_max(int[] arr, int n) {
    …
}
```

Example

“Complete this method such that it returns the index of the max of the first **`n`** elements of the array **`arr`**.”

```
int index_of_max(int[] arr, int n) {
    …
}
```

What questions do you have about the *specification*?

Given a (better) specification, is there 1 *implementation*?

Moral

- You can all write the code

- More interesting in CSE331:
  - What if n is 0?
  - What if n is less than 0?
  - What if n is greater than array length
  - What if there are “ties”?
  - Ways to indicate errors: exceptions, return value, …
  - Weaker versus stronger specifications?
  - Hard to write English specifications (n vs. n-1)