
CSE 331

Software Design & Implementation

Dan Grossman
Fall 2014
Lecture 1 – Introduction & Overview

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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

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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!

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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

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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]

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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

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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

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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

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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



And use the Java API Docs

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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

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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

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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

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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

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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.

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Questions?

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

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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

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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]

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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?

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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

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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

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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)

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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

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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...

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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) {  
    ...  
}
```

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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. $n-1$)