Today

• Reminder: Do your course evaluations (!)
• Project demos
• Final exam information

• A look back at CSE 331
  – High-level overview of main ideas and goals
  – Connection to homeworks
  – Context

• Also:
  – Thank-yous
Final exam information

• Monday, 12:30-2:20, Kane 110

• Comprehensive but reasonably strongly weighted towards the 2nd half of the course

• Old exams on the web
  – Some questions won’t apply if we didn’t do similar things this quarter

• Last-minute Q&A review Sunday, 2 pm, EEB 037
  – Bring your questions!
What was it all about?

But first....
Huge thanks to the folks who made it work

Course staff: Alexey, Natalie, Weifan, Martin, Jason, Laura, Yifan, Amy, Nate, & Sarah

This course is itself a sophisticated
(or at least really, really complicated) system
requiring savvy design and implementation
3 slides from Lecture 1…
10 weeks ago: 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, git, …
  - Principles are ultimately more important than details
    - You will forever learn details of new tools/versions
10 weeks ago: 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
10 weeks ago: 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]
Some new slides to tie the pieces together…
Divide and conquer: Modularity, abstraction, specs

No one person can understand all of a realistic system

• **Modularity** permits focusing on just one part

• **Abstraction** enables ignoring detail

• **Specifications** (and documentation) formally describe behavior

• **Reasoning** relies on all three to understand/fix errors
  – Or avoid them in the first place
  – **Proving, testing, debugging**: all are intellectually challenging
How CSE 331 fits together

Lectures: ideas  ⇒ Assignments: get practice

Specifications  ⇒ Design classes
Testing  ⇒ Write tests
Subtyping  ⇒ Write subclasses
Equality & identity  ⇒ Override equals, use collections
Generics  ⇒ Write generic classes
Design patterns  ⇒ Larger designs; MVC
Reasoning, debugging  ⇒ Correctness, testing
Events  ⇒ GUIs
Systems integration  ⇒ N/A
What you have learned in CSE 331

Compare your skills today to 10 weeks ago
- Theory: abstraction, specification, design
- Practice: implementation, testing
- Theory & practice: correctness

Bottom line aspiration: Much of what we’ve done would be easy for you today
   This is a measure of how much you have learned

There is no such thing as a “born” programmer!

Genius is 1% inspiration and 99% perspiration.
   Thomas A. Edison
What you will learn later

• Your next project can be much more ambitious
  – But beware of “second system” effect

• Know your limits
  – Be humble (reality helps you with this)

• You will continue to learn
  – Building interesting systems is never easy
    • Like any worthwhile endeavor
    • Practice is a good teacher
      • Requires thoughtful introspection
      • Don’t learn only by trial and error!
  – Voraciously consume ideas and tools
What comes next?

Courses
- CSE 403 Software Engineering
  - Focuses more on requirements, software lifecycle, teamwork
- Capstone projects
- Any class that requires software design and implementation

Research
- In software engineering & programming systems
- In any topic that involves software

Having an impact on the world
- Jobs (and job interviews)
- Larger programming projects
• System building is fun!
  – It’s even more fun when you’re successful!!

• Pay attention to what matters
  – Take advantage of the techniques and tools you’ve learned (and will learn!)

• On a personal note:
  – Don’t be a stranger: I love to hear how you do in CSE and beyond as alumni

• Closing thoughts?