10 weeks ago…

• We have 10 weeks to move to a level well above novice programmer:
  – Larger programs
  – Principled, systematic programming: What does it mean to get it right? How do we know when we get there? What are best practices for doing this?
  – Effective use of languages and tools: Java, IDEs, debuggers, JUnit, JavaDoc, svn
    • The principles are ultimately more important than the details
A huge thanks to the folks who made it work

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CSE 331 goals

Enable students to
• manage complexity
• ensure correctness
• write modest programs
CSE 331 topics

Manage complexity:
- Abstraction
- Specification
- Modularity
- Program design & organization
  - OO design, dependences, design patterns, tradeoffs
- Subtyping
- Documentation

Ensure correctness:
- Reasoning
- Testing
- Debugging

Write programs:
- Practice (and feedback – we were late on that – sorry!)
- Introduction to: tools (version control, debuggers), understanding libraries, software process, requirements, usability
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 to avoid them in the first place
Getting it right ahead of time

Design: predicting implications

Understanding the strengths and weaknesses
   If you don’t understand a design, you can’t use it

Documentation matters!
   It is often the most important part of a user interface
   What’s obvious to you may not be obvious to others
Testing

Helps you understand what you didn’t understand while designing and implementing

A good test suite exercises each behavior

Theory: revealing subdomains, proves correctness
Practice: code coverage, value coverage, boundary values
Practice: testing reveals errors, never proves correctness

A good test suite makes a developer fearless during maintenance
Maintenance

Maintenance accounts for most of the effort spent on a successful software system

  – often 90% or more

A good design enables the system to adapt to new requirements while maintaining quality

  – Think about the long term, but don’t prematurely optimize

Good documentation enables others to understand the design
Correctness

In the end, only correctness matters

*Near*-correctness is often easy!
Getting it right can be difficult

How to determine the goal?
Requirements
Design documents for the customer

How to increase the likelihood of achieving the goal?
Unlikely without use of modularity, abstraction, specification, documentation, design, …
Doing the job right is usually justified by return on investment (ROI)

How to verify that you achieved it?
Testing
Reasoning (formal or informal) helps!
Use proofs and tools as appropriate
Working in a team

No one person can understand all of a realistic system
  Break the system into pieces
  Use modularity, abstraction, specification, documentation
Different points of view bring value
Work effectively with others
  Sometimes challenging, usually worth it
Manage your resources effectively
  Time, people
  Engineering is about tradeoffs
Both technical and management contributions are critical
What you have learned in CSE 331

Compare your skills today to 3 months ago
  Theory: abstraction, specification, design
  Practice: implementation, testing
  Theory & practice: correctness

Bottom line: 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!
Your next project can be more ambitious

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

Your next project can be much more ambitious
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!
What comes next?

Classes
- 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

The purpose of computing is insight, not numbers.
Richard W. Hamming
*Numerical Methods for Scientists and Engineers*
Go forth and conquer

System building is fun!
   It’s even more fun when you build it successfully
Pay attention to what matters
   Use the techniques and tools of CSE 331 effectively