CSE 331
Software Design and Implementation

Lecture 24
Wrap Up

Zach Tatlock / Spring 2018

Final Logistics

Wednesday, 8:30 - 10:20 AM

Comprehensive, weighted towards 2nd half

Old exams on the web; some questions won't apply if we didn't do similar things

Today

Course Reviews

Project demos

Final logistics (here at 8:30am on Wednesday!)

A look back at CSE 331

- High-level overview of main ideas and goals
- Connection to homework and broader context

Also: THANK YOU :)

CSE 331

What was it all about?

But first….

Huge thanks to the folks who made it work

Course staff:

Weifan Jiang, Cody Kesting, Tim Chirananthavat, Alexey Beall, Hongtao Huang, Jake Sippy, Chen (Jason) Qiu, Leah Perlmutter, Zhu (Ruby) Li, Yifan (Vanadis) Xu

Special thanks to all of you :)

*This course is itself a sophisticated system requiring design, implementation, and **debugging** ;)*

Credits

Great course material based on work by:

- Michael Ernst
- Hal Perkins
- Dan Grossman
- David Notkin
- Dozens of amazing TAs
- Hundreds of incredible students (you!)

From our first lecture…

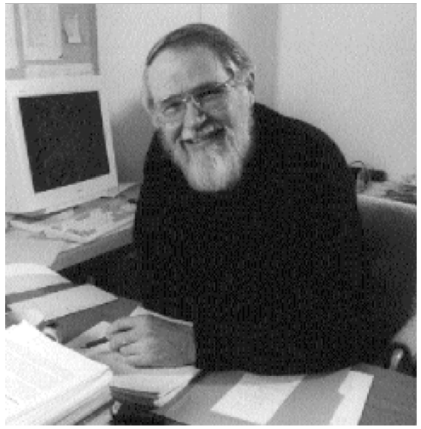
The Big Picture

Welcome!

10 week study of the craft of programming

How do we build good programs?

"Controlling complexity is the essence of computer programming."



-- Brian Kernighan

(UNIX, AWK, C, ...)

Controlling Complexity

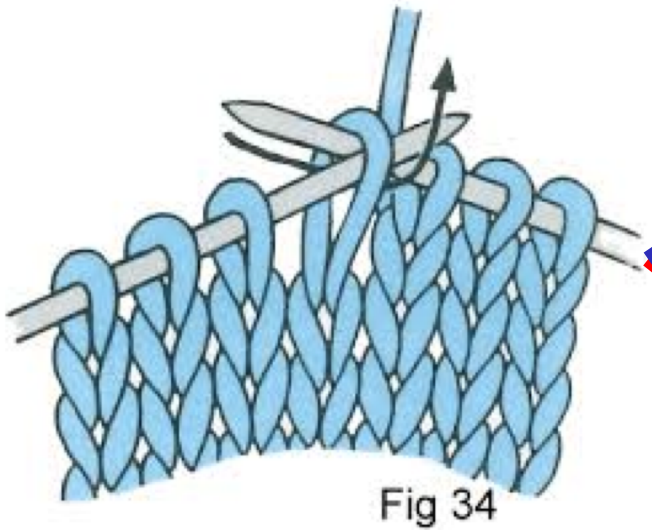
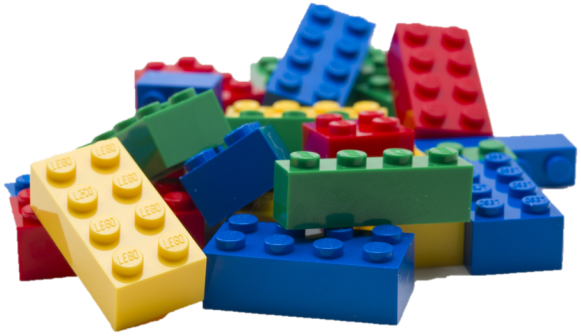
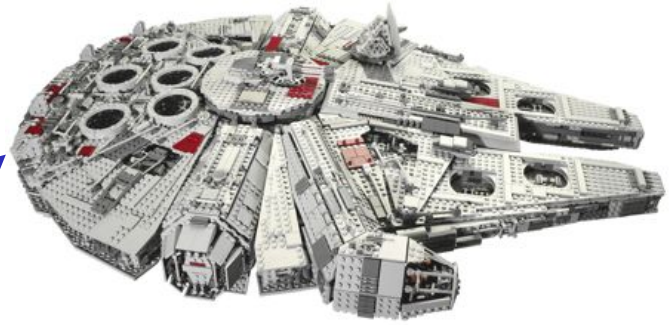


Fig 34

Controlling Complexity





Learning to Control Complexity

First, we need to refine our goals:

- What quality makes a program good?
- How can we tell if a program is good?
- How do we build good programs?

To answer, we'll learn *principles* and use tools:

- Modularity, documentation, testing, verification
- Tools: *Java, IDEs, debuggers, JUnit, JavaDoc, git*

Tools change, principles are forever.

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, Checker Framework, …

- 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

We've come far in CSE 331!

Compare your skills today to 10 weeks ago

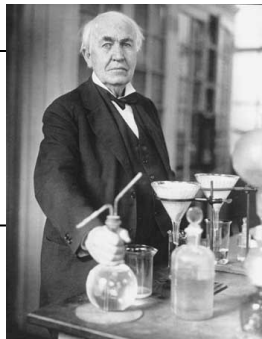
- Theory: abstraction, specification, design
- Practice: implementation, testing
- Theory & practice: correctness

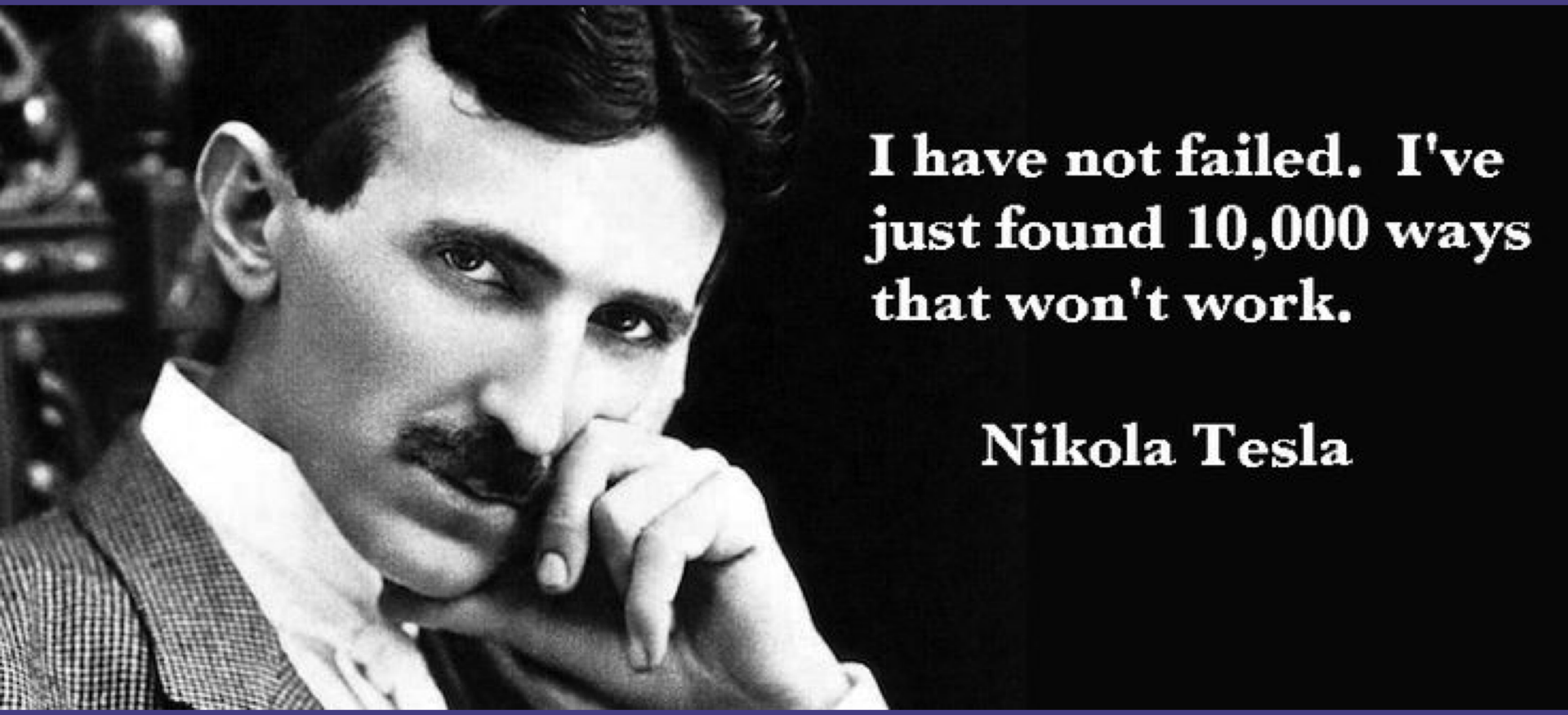
Bottom line aspiration: Much of what we've done would be *easy* for you today

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




I have not failed. I've just found 10,000 ways that won't work.
Nikola Tesla

DEMOS

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 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

Final slide

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?