CSE 331 wrapup

CSE 331
University of Washington

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A huge thanks to the folks who made it work

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Students: **You!**

This course is itself a sophisticated system requiring design, implementation, and testing.

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]

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
- 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
- Proving, testing, debugging: all are intellectually challenging

Getting it right ahead of time

Design: predicting implications

- Example: understanding interconnections, using module dependency diagram (MDD)

Understanding the strengths and weaknesses

- If you don’t understand a design, you can’t use it

Documentation matters!

Documentation

Everyone wants good documentation when using a system

- Not everyone likes writing documentation

Documentation is often the most important part of a user interface

What's obvious to you may not be obvious to others

> An undocumented software system has zero commercial value.
>
> John Chapin
> CTO of Vanu, Inc.

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!
- *Correctness* can be difficult

How to determine the goal?

- Requirements elicitation
- 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

Reuse gave a little practice

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

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
Polymorphism	⇒ Write generic class
Design patterns	⇒ Larger designs
Reasoning, debugging	⇒ Correctness, returnin
Events	⇒ GUIs
System integration	⇒ Campus paths

What you have learned in CSE 331

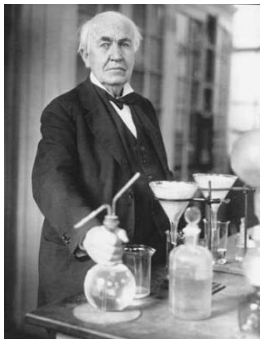
Compare your skills today to 10 weeks ago

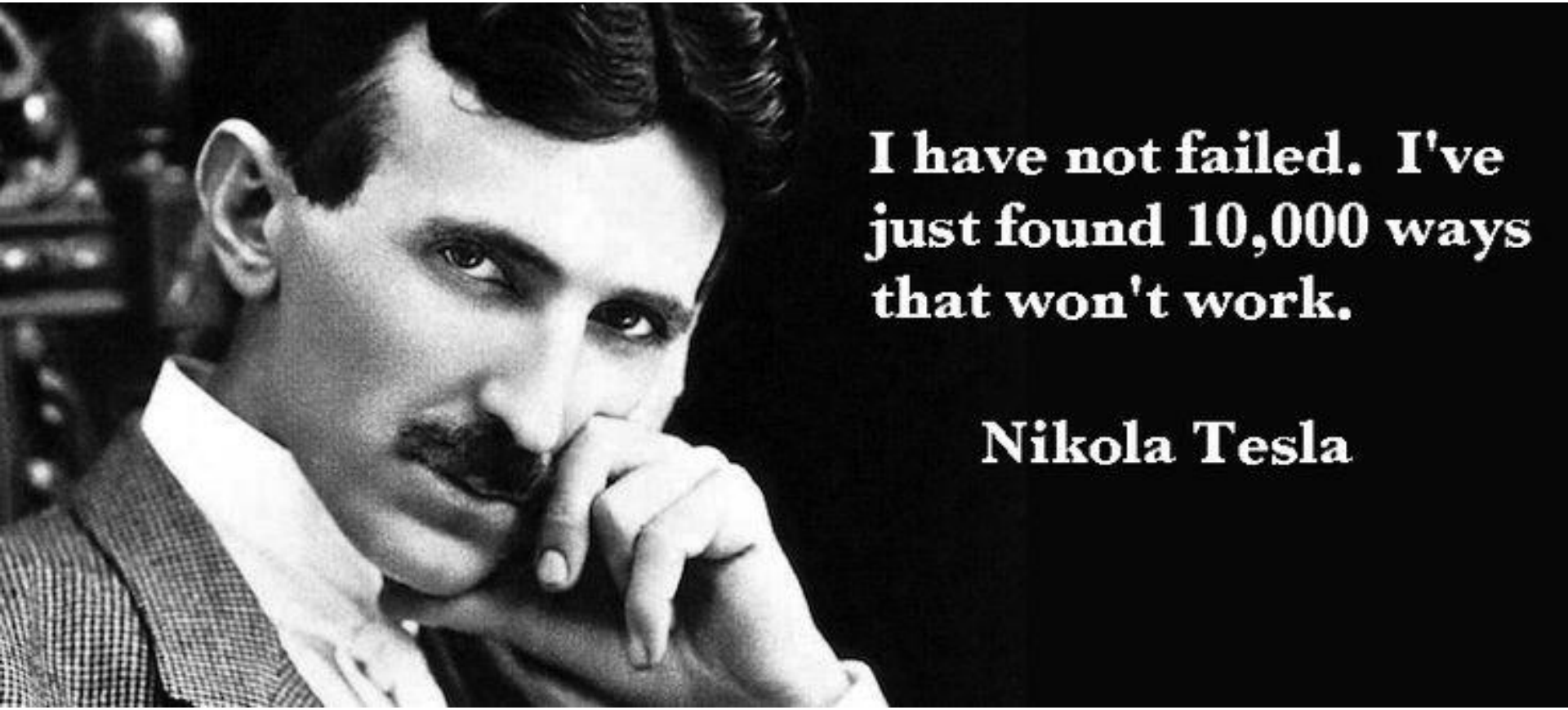
- Theory: abstraction, specification, design
- Practice: implementation, testing
- Theory & practice: correctness
- Bottom line: The assignments would be easy for you today
  - This is a measure of how much you have learned

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




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

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
- CSE 440 User interfaces, CSE 154 Web development, …
- 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

Don't be a stranger: tell me about your successes

> 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