CS 520
Theory and Practice of Software Engineering
Fall 2020

Course introduction
August 25, 2020

The CS 520 team
Instructor
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Lectures: Tu/Th 10-11:15 AM over Zoom will be recorded
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Graders
- Mitali Dave
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Today
- What is Software Engineering?
- Why is Software Engineering important?
- Your expectations
- Course overview
- Our expectations
- Logistics

What is Software Engineering?
What is Software Engineering?

- Developing in an IDE and software ecosystem?
- Coding and debugging?
- Deploying and running a software system?
- Empirical evaluations?
- Modeling and designing?

All of the above -- much more than just writing code!

What is Software Engineering?

More than just writing code

The complete process of specifying, designing, developing, analyzing, deploying, and maintaining a software system.

- Common Software Engineering tasks include:
  - Requirements engineering
  - Specification writing and documentation
  - Software architecture and design
  - Programming
  - Verification (e.g., testing, model checking, theorem proving)
  - Software debugging and repair

Just one out of many important tasks!
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Why is Software Engineering important?

Software is everywhere...
Why is Software Engineering important?

**Software is complex!**

- Aircraft: ~15 million lines of code

How complex is software?

- Measures of complexity:
  - lines of code
  - number of classes
  - number of modules
  - module interconnections and dependencies
  - time to understand
  - # of authors
  - ... many more

How big is 324 MSLoC?

- Windows Server 2003: 50 MSLoC
- Debian 5.0: 324 MSLoC

- 50 lines/page ⇒ 6.5M pages
- 1K pages/ream ⇒ 6.5K reams
- 2 inches/ream ⇒ 13K inches
- 13K inches ≈ four times the height of the CS building
- 5 words/LoC @ 50 wpm ⇒ 32M min ≈ 61 years

And we don’t just want random words, we want compiling code!
Why is Software Engineering important?

Infrastructure is software, too!

Example: Design space exploration

1. 0.34 0.81
2. 0.32 0.32
3. 0.21 0.53
4. 0.81 0.22

Parallel executions of all possible configurations

Why is Software Engineering important?

Infrastructure is software, too!

Example: Design space exploration

1. 0.34 0.81
2. 0.32 0.32
3. 0.21 0.53
4. 0.81 0.22

Parallel executions of all possible configurations

- 150 configurations, 1000+ benchmarks
- 1-85 hours per execution
- 200,000+ CPU hours (~23 CPU years)

Summary: Software Engineering

What is Software Engineering?
The complete process of specifying, designing, developing, analyzing, deploying, and maintaining a software system.

Why is it important?
- Software is everywhere and complex.
- Software defects are expensive and range from annoying to life threatening.

Goals
- Decompose a complex engineering problem.
- Organize processes and effort.
- Improve software reliability.
- Improve developer productivity.

Your expectations

Introduction and a brief (5 minute) survey
- Why are you taking this course?
- What do you expect from this course?
- What are your learning goals (theory and practice)?
Course overview: the big picture

- **Software architecture and design**
  - Software modeling and UML crash course.
  - Best practices and OO design principles.
  - Architecture and Design patterns.

- **Empirical Software Engineering**
  - Reasoning about experimental designs and studies.
  - Understanding and reasoning about threats to validity.

- **Software verification, debugging, and repair**
  - Learning about cutting-edge research.
  - Hands-on experience, using verification and debugging techniques.

- **Class project**
  - Design, development, and testing of a research prototype, etc.

Goal: no more spaghetti code!

Course overview: rough timeline

**August/September**
- Software architecture and design

**September**
- Empirical Software Engineering
- Software testing
- Class project: Topic selection

**October**
- Software debugging and repair
- Verification of programs (e.g., model checking, theorem proving)
- Class project: Mid-date report

**November**
- Reasoning about programs
- Collaboration and teamwork
- Class project: Completion

Anything wrong with the following conclusions?
- Not using Internet Explorer makes the world a safer place/reduces murder rates.
- Spending more time on learning a programming language makes you a worse programmer.

Goal: properly reason about research studies and findings
Our expectations

- Programming experience
- Familiarity with an OO programming language (e.g., Java, C++, etc.)
- Active participation in discussions and group work
- Reading research papers

Gain experience applying SE tools and techniques

- Architecture and design patterns
- Specifications as UML diagrams (e.g., class diagrams)
- Program in an OO programming language (e.g., javac, java)
- Document source code (e.g., javadoc)
- xUnit testing framework (e.g., JUnit)
- Debugging techniques
- Version Control system (e.g., git)

Exposure to cutting-edge research

- We will have 1 or more guest lectures on research
  - These will be held in class
  - Alternatively, these will be held out of class. Videos will be available.
- We might have 1 guest lecture on what it’s like to work in industry

Course overview: grading

Grading

- 25% Class project
- 35% In-class exercises
- 30% Homework
- 10% Participation
Logistics

- Will meet live over Zoom on Tuesday and Thursday, 10 AM – 11:15 AM EDT and will also be recorded
  - Lectures, in-class exercises
- Course material, policies, and schedule on web site: https://people.cs.umass.edu/~hconboy/class/2020Fall/CS520/
- Submission of assignments via Moodle: https://moodle.umass.edu/course/view.php?id=70653
- Access to Unix-like operating system with edlab accounts: https://www-edlab.cs.umass.edu/