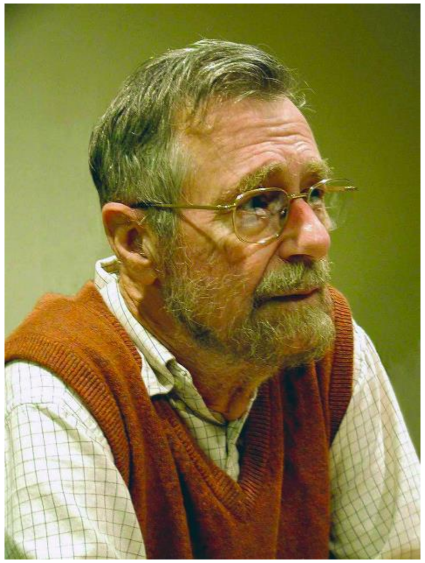
Object-Oriented Programming

CSCI-UA 0470-001

Instructor: Thomas Wies

Fall 2017

Class 1 - Introduction

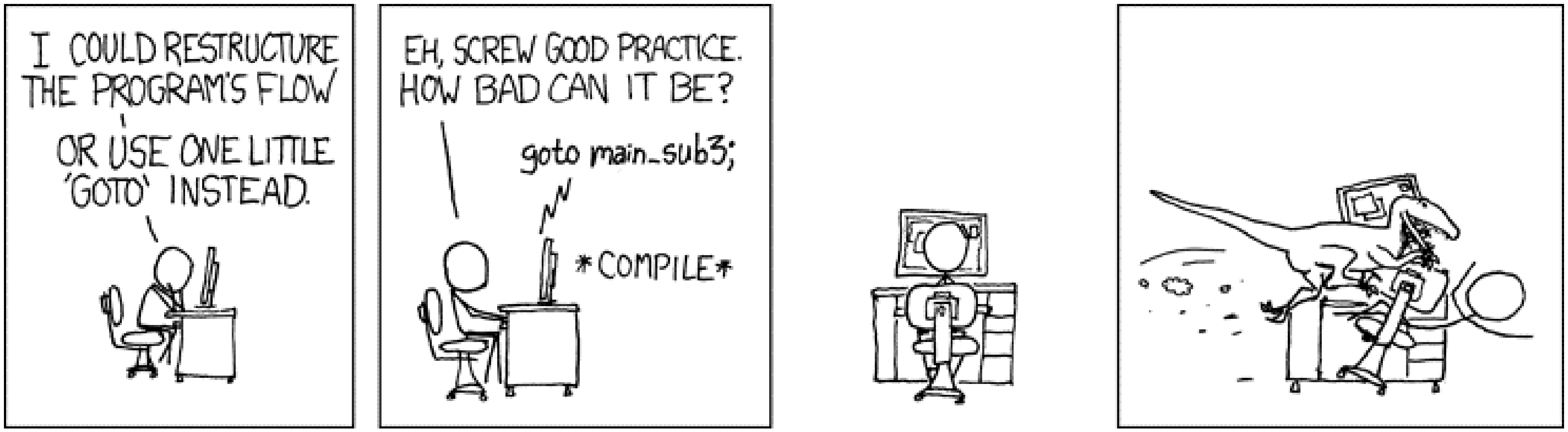


Object-oriented programming is an exceptionally bad idea which could only have originated in California.

Edsger Dijkstra

Object-Oriented Programming (OOP)

Object-oriented programming is claimed to promote greater flexibility and maintainability in programming, and is widely popular in large-scale software engineering. Wikipedia


I COULD RESTRUCTURE THE PROGRAM'S FLOW
OR USE ONE LITTLE 'GOTO' INSTEAD.
EH, SCREW GOOD PRACTICE. HOW BAD CAN IT BE?
goto main_sub3;
COMPILE

http://xkcd.com/292/

The Goal of this Course

- Learn how to build and evolve large-scale programs using object-oriented programming
  - Design:
    How do we think in objects?
    - design patterns
  - Language Primitives:
    How do we express object orientation?
    - classes, interfaces, inheritance, method dispatch, generics, operator overloading, and reflection
  - Language Implementation:
    How do we realize OO primitives?
    - virtual method dispatch with vtables, static overloading resolution, and automatic memory management

How Do We Achieve This Goal?

- In-class lectures and discussions
  - lectures to introduce topics and techniques
  - in-class exercises to deepen understanding
- Individual homework assignments that give a structured introduction to tools and concepts.
- Course project: A translator from Java to C++
  - Written in Java, using the XTC toolkit for source-to-source transformers
  - Two versions, with second version improving on first version
  - Teams of 4-6 students

From Java to C++

- **Input:** Java with inheritance and virtual methods
  - But without interfaces, nested classes, enums, generics, ...
- **Output:** C++ without inheritance and virtual methods
  - I.e., a better C with namespaces, classes, operator overloading

Two Versions

- Version 1
  - Challenge: Implement inheritance and virtual methods in translator
  - Due mid-term, with in-class presentation and written report
- Version 2
  - Challenge: Implement method overloading and automatic memory management
  - Due end-of-term, again with presentation and written report

Don't Panic

- I will try and structure your approach to the project such that you are not overwhelmed
- We will have regular meetings
- XTC provides a lot of functionality
  - Though you need to learn how to use it

But Why?

Translator from Java to C++?

- Is a real, large-scale program (and not just a toy)
  - Domain with biggest promised impact of OOP

- Exposes you to implementation of OOP primitives
  - While also integrating Java and C++

- Requires you to learn and build on existing tools
  - Common scenario in practice

Two Versions of Translator?

- Educational best practice
  - “Students can try, fail, receive feedback, and try again without impact on grade.” (Ken Bains)

- Software engineering best practice
  - “Plan to throw one away; you will, anyhow.” (Frederick Brooks Jr.)

Teams of Students?

- Places emphasis on collaborative learning
- Prepares you for reality in industry and academia
- Helps me keep the feedback process manageable
- Allows for ‘Pair Programming’

Pair Programming

- Programming is sometimes thought of as a solitary act. It doesn’t have to be!
- Programming in pairs
  - yields more readable code
  - fewer bugs
  - is more productive (!!)
  - shares knowledge
  - is more fun

Test-driven Development

- This course is, in part, emulating real software engineering.
- Write test for small parts of your application, end-to-end tests on every additional feature is inefficient and a difficult way to debug.
- Test-driven approach using JUnit and sbt

Operational Details

Important Dates

- Class: M & W 2:00 - 3:15pm in Silv 206
- Office hour: W 4:00 - 5:00pm in 60FA 403
- Midterm Presentations: Wednesday, Nov 1
- Final Exam: Monday, Dec 13 (no midterm exam)
- Final Presentations: Monday, Dec 18

Textbooks (not strictly required)

- Rather than making you buy more books I will rely on free online resources where I can
- For Java, “Object-Oriented Design & Patterns”
  - 2nd edition by Cay Horstmann
- For C++, “C++ for Java Programmers”
  - 1st edition by Mark Weiss
- In the long term, you may want a good reference for C++
  - “The C++ Programming Language.”, by Bjarne Stroustrup

Online Resources

- **Piazza -** Online discussion and announcements
- **NYU Classes -** Grade posting
- **Github –** Homework assignments, project, and class notes and source code
- **Website**
  - Shows requirements for project
  - Lists reading assignments, class notes
  - Provides links to useful material

Grading

- 50% for group projects
  - Typically, same grade assigned to all members of group
  - Every group will grade all other groups; peer grades are advisory
- 20% for individual assignments
- 30% for final exam

Homework Policies

- Grading criteria for project and homework assignments will be published.
- Homework must be submitted before the announced date and time deadline for full credit.
- For every 24 hours late you lose 10%
- Late homework will not be accepted after the late deadline. (usually a week)
- If you turn in a homework that does not compile, it will not be accepted. You can resubmit according to the above rules.

Expectations

- Course is a lot of work, but will be fun and rewarding
- Attendance is important. Not everything discussed will be captured online.
- You drive your project's development! No handholding.

Rules & Resources

- You must do all assignments on your own, without any collaboration!
- You must do the projects as a group, but not with other groups and without consulting previous years' students, code, etc.
- You should help other students and groups on specific technical issues, but you must acknowledge such interactions in code comments.
- If you need help, first stop is Piazza. If you have the question, then almost certainly someone else does.
  - If a student does not give a satisfactory answer, I will chime in.
  - If that does not solve your issue, visit me or a grader in office hours.
- Teams can make appointments with me any time.
  - We will schedule some required meetings throughout the semester.

Three Languages

- *Source Language* – Java 1.6
  - No nested classes, anonymous classes, interfaces, enums, annotations, generics, the enhanced for loop varargs, automatic boxing and unboxing, synchronization, strictfp, transient and volatile fields and no new Java 8 features
  - Assume good input
- *Target Language* – C++
  - No virtual methods, inheritance, templates (mostly) and no new C++11 features
  - Support for basic classes, exceptions, and name spaces
- *Translator language* – Java 1.8
  - The kitchen sink

Toolchain

- Linux or OS X.
  - Windows is not advised. I will give instructions and support for Ubuntu and OS X.
  - I will provide instructions on installing a VM for Ubuntu on Windows.
- IntelliJ & CLion.
  - In a project this complex, you really need good tools.
  - These IDEs are very good. While its not strictly mandatory, I recommend to use these as much of the project will utilize their capabilities.
  - Full versions are available for free under a student license.
- Sbt, XTC, Git, JUnit, Astyle…
  - Real software engineering tools!
  - Your first homework will be a detailed guide on installing most of these tools.
  - You will need them!!
- Homework 1 will deal with setting up the toolchain.

Challenges

- How to translate Java class hierarchies into C++ without inheritance
- How to implement Java's virtual method dispatch in C++ without virtual method dispatch
- How to select the right overloaded method (using a symbol table)
- How to automatically manage memory without an existing garbage collector (using smart pointers)

Team make-up

- 4-6 students
- one *speaker*
  - main contact point with me
  - ceremonial role
- key to success is to divide and conquer.

Team Selection

- At the end of class, we will take a few minutes to go around and introduce ourselves to each and chat a bit.
- You may want to look for students with complementary expertise. Java? C++? Git? etc..
- Use Piazza to "advertise" yourself to potential teammates.
- **Important**: fill out the survey that I sent out.
- I will select the teams.