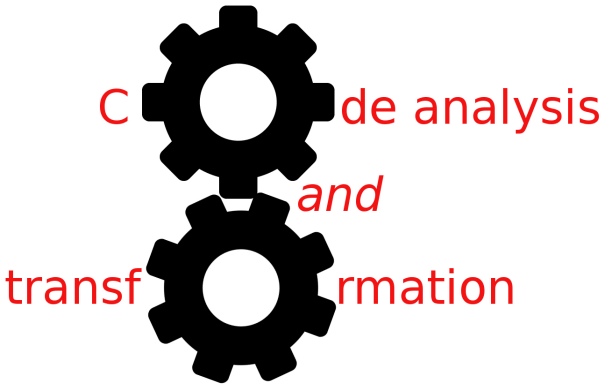

Fast, highly sophisticated code analysis and code transformation tools are essential for modern software development. Before releasing its mobile apps, Facebook submits them to a tool called Infer that finds bugs by static analysis, i.e., without even having to run the code, and guides developers in fixing them. Google Chrome and Mozilla Firefox analyze and optimize JavaScript code to make browsers acceptably responsive. Performance-critical systems and application software would be impossible to build and evolve without compilers that derive highly optimized machine code from high-level source code that humans can understand. Understanding what modern code analysis and transformation techniques can and can't do is a prerequisite for research on both software engineering and computer architecture since hardware relies on software to realize its potential. In this class, you will learn the fundamentals of code analysis and transformation, and you will apply them by extending LLVM, a compiler framework now in production use by Apple, Adobe, Intel and other industrial and academic enterprises.

Course Code: COMP_SCI 323

When: Fall

Instructor:
Simone Campanoni, `simonec@eecs.northwestern.edu`

Website: `www.cs.northwestern.edu/~simonec/CAT.html`

Assignments:
In this class, you will learn how to design code analysis and transformation passes in a production compiler (LLVM). You will have 10 assignments; the first one is an implementation of a trivial code analysis. Subsequent assignments will involve incremental improvement of your first one. The end result of these assignments is an LLVM inter-procedural, state-of-the-art code analysis and transformation driven by an advanced data dependence analysis.

Competition:
Final assigments built by successful teams will compete at the end of the class. The team that has designed and implemented the most performant assignment will win. The students that compose the team that wins the competition will get an A independently on their points they have accumulated. Also, the winners will have the option to include their names and pictures in the **Hall of Fame** of this class (see the winners of prior years here).

Materials:
Course slides
Recommended book: Modern compiler implementation in C (or Java).
Referenced book: Compilers: Principles, Techniques, and Tools (2nd Edition)
Referenced book: Advanced Compiler Design and Implementation
Selected papers for topics not covered by the mentioned books

Grading Policy:

Your grade depends on points you will earn on assigned homework. You can earn up to 10 points for each homework assigned. You can also earn extra points by doing extra homework (on top of the 10 already discussed) as well as by answering correctly questions during special lectures.

The map between points and grades.

A	95 - 100+
A-	90 - 94
B+	83 - 89
B	74 - 82
B-	67 - 73
C+	60 - 66
C	55 - 59
C-	50 - 54
D	40 - 49
F	0 - 39

Pre-requisites:

- CS 213: Introduction to Computer Systems (or equivalent)
- CS 214: Data Structures and Data Management

Other compiler-heavy classes:

- CS 322: Compiler Construction
- CS 397/497: Advanced Topics in Compilers

Academic Integrity Students in this course are required to comply with the policies found in the booklet, "Academic Integrity at Northwestern University: A Basic Guide". All papers submitted for credit in this course must be submitted electronically unless otherwise instructed by the professor. Your written work may be tested for plagiarized content. For details regarding academic integrity at Northwestern or to download the guide, visit: https://www.northwestern.edu/provost/policies/academic-integrity/index.html

Accessibility Northwestern University is committed to providing the most accessible learning environment as possible for students with disabilities. Should you anticipate or experience disability-related barriers in the academic setting, please contact AccessibleNU to move forward with the university's established accommodation process (e: accessiblenu@northwestern.edu; p: 847-467-5530). If you already have established accommodations with AccessibleNU, please let me know as soon as possible, preferably within the first two weeks of the term, so we can work together to implement your disability accommodations. Disability information, including academic accommodations, is confidential under the Family Educational Rights and Privacy Act.

COVID-19 Testing Compliance To protect the health of our community, Northwestern University requires unvaccinated students who are in on-campus programs to be tested for COVID-19 twice per week.

Students who fail to comply with current or future COVID-19 testing protocols will be referred to the Office of Community standards to face disciplinary action, including escalation up to restriction from campus and suspension.

COVID-19 Classroom Expectations Statement Students, faculty, and staff must comply with University expectations regarding appropriate classroom behavior, including those outlined below and in the COVID-19 Code of Conduct. With respect to classroom procedures, this includes:

- Policies regarding masking and social distancing evolve as the public health situation changes. Students are responsible for understanding and complying with current masking, testing, Symptom Tracking, and social distancing requirements.
- In some classes, masking and/or social distancing may be required as a result of an Americans with Disabilities Act (ADA) accommodation for the instructor or a student in the class even when not generally required on campus. In such cases, the instructor will notify the class.
- No food is allowed inside classrooms. Drinks are permitted, but please keep your face covering on and use a straw.
- Faculty may assign seats in some classes to help facilitate contact tracing in the event that a student tests positive for COVID-19. Students must sit in their assigned seats.

If a student fails to comply with the COVID-19 Code of Conduct or other University expectations related to COVID-19, the instructor may ask the student to leave the class. The instructor is asked to report the incident to the Office of Community Standards for additional follow-up.

Exceptions to Class Modality Class sessions for this course will occur in person. Individual students will not be granted permission to attend remotely except as the result of an Americans with Disabilities Act (ADA) accommodation as determined by AccessibleNU.

Prohibition of Recording of Class Sessions by Students Unauthorized student recording of classroom or other academic activities (including advising sessions or office hours) is prohibited. Unauthorized recording is unethical and may also be a violation of University policy and state law. Students requesting the use of assistive technology as an accommodation should contact AccessibleNU. Unauthorized use of classroom recordings – including distributing or posting them – is also prohibited. Under the University's Copyright Policy, faculty own the copyright to instructional materials – including those resources created specifically for the purposes

of instruction, such as syllabi, lectures and lecture notes, and presentations. Students cannot copy, reproduce, display, or distribute these materials. Students who engage in unauthorized recording, unauthorized use of a recording, or unauthorized distribution of instructional materials will be referred to the appropriate University office for follow-up.

Support for Wellness and Mental Health Northwestern University is committed to supporting the wellness of our students. Student Affairs has multiple resources to support student wellness and mental health. If you are feeling distressed or overwhelmed, please reach out for help. Students can access confidential resources through the Counseling and Psychological Services (CAPS), Religious and Spiritual Life (RSL) and the Center for Awareness, Response and Education (CARE). Additional information on all of the resources mentioned above can be found here:

https://www.northwestern.edu/counseling/
https://www.northwestern.edu/religious-life/
https://www.northwestern.edu/care/