

COM S 413/513 and CPR E 513: Foundations and Applications of Program Analysis

Iowa State University

Spring 2021

Lectures: M W F 3:20am-4:10pm, live at iastate.webex.com/meet/weile (the recorded lectures will be automatically uploaded to Canvas with possible one-day delay)

Instructor: Wei Le (weile@iastate.edu: please preface all email subjects with “413/513: ”)

Office Hours: Th 4:00pm-5:30pm, iastate.webex.com/meet/weile

Lecture notes and homework assignments: <https://github.com/wei-le/programanalysiscourse>

Homework submissions and grades: Canvas

1 Course Description

Algorithms and tools for automatically reasoning about code and program executions to predict software behavior. Theory and foundations related to control flow analysis, dataflow analysis, abstract interpretation and symbolic execution. Applications of program analysis to improve software security, performance and testing. Concepts, algorithms, tools, benchmarks, methodologies for solving problems using program analysis and for preparing research in program analysis —from Iowa State University course catalog.

2 Course Objectives

After accomplishing this course, students will

1. understand basic concepts in program analysis,
2. know and implement program analysis algorithms,
3. learn the frontier of program analysis research,
4. gain experience with open source environment and tools, and
5. improve problem solving skills to address software engineering challenges.

One additional objective for 513 students:

1. get more research experience in program analysis and software engineering

3 Prerequisites

Minimum of C- in COM S 342: Principles of Programming Languages

4 Textbooks and Resources

The course does not have a required text book. We will use lecture notes and papers to teach and learn. The following is a list of additional materials for your reference:

- *Principles of Program Analysis* by Chris Hankin, Flemming Nielson, and Hanne Riis Nielson, published by Springer, ISBN 9783662038116: a theoretical, static analysis book.
- *Advanced Compiler Design and Implementation* by Steven Muchnick, published by Morgan Kaufmann, ISBN 9781558603202: it is a compiler book that covers the topics of control flow analysis, dataflow analysis, alias analysis, and the applications of program analysis in compiler optimizations.
- Alex Aiken, Stanford, CS 357 Techniques for Program Analysis and Verification
- Monica Lam, Stanford, CS243 Program Analysis and Optimization
- Jonathan Aldrich, CMU, 15-819 O Program Analysis
- Jens Palsberg, UCLA, CS232 Static Program Analysis
- Mayur Naik, Georgia Tech, CS6340 Software Analysis and Testing
- Stephen Chong, Harvard, CS252r Advanced Topics in Programming Languages
- Mooly Sagiv, Tel Aviv University, Program Analysis
- Evan Chang, University of Colorado Boulder, CSCI7135 Program Analysis: Theory and Practice

5 Tentative Schedule

Week	Topic	Homework Assignment (due date)
1	everything about bugs	HW1 (Feb 10)
2	control flow analysis	Survey (Feb 24)
3	dataflow analysis	
4	abstract intepretation	Project idea (Mar 3)
5	automatic test input generation	HW2 (Mar 10)
6	symoblic execution	Project proposal (Mar 17)
7	midterm project and catch up	
8	debugging & repair	HW3 (Mar 31)
9	dependencies & slicing	
10	software changes and versions	HW4 (April 14)
10	specification inference	
12	big code analysis	HW5 (April 21)
13	embedding	
14	analyzing and testing AI software and models	
15	final project presentation	final project (May 3rd)

6 Course Work and Evaluation

- Survey (15%)
- Homework assignments (55%)

- Project (30%)

Please submit your homework on time, as we do not grade late submissions. Undergraduate and graduate students will have different requirements for survey and projects. The details will be provided in class.

7 Academic Integrity

For the programming assignments, you are expected to write, debug and submit your own code. You should not copy the code from your classmates or from the Internet. You should not share your code, or edit and debug other people's code. For the written assignments, you should not share or copy solutions. You may discuss the approaches and algorithms with your classmates. You can also ask questions in office hours.

Iowa State University's policy on academic dishonesty: Suspected academic misconduct will be reported to the dean of students office <http://www.dso.iastate.edu/ja/academic/misconduct.html>

8 Accommodations for Disabilities

We would like to hear from you if you have a disability that may require some modification of seating, testing, or other class requirements. If so, please request that the Disability Resources staff send a Student Academic Accommodation Notification form verifying your disability and specifying the accommodation you will need. Then bring the Accommodation Notification form along and talk to the instructor as soon as possible so appropriate arrangements may be made.

9 Free Expression

Iowa State University supports and upholds the First Amendment protection of freedom of speech and the principle of academic freedom in order to foster a learning environment where open inquiry and the vigorous debate of a diversity of ideas are encouraged. Students will not be penalized for the content or viewpoints of their speech as long as student expression in a class context is germane to the subject matter of the class and conveyed in an appropriate manner.