

Program Analysis

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"Science attempts to find logics and simplicity in nature; mathematics attempts to establish order and simplicity in human thoughts"

- Edward Teller

The Instructor

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Research Area: program analysis, trustworthy AI and software

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Course Objectives

- ▶ terminologies and concepts in program analysis and software engineering
- ▶ understand and implement program analysis algorithms
- ▶ big ideas in computer science, e.g., abstraction, graph reachability
- ▶ applications: quality assurance of software engineering and AI-engineering
- ▶ open source tools and environment
- ▶ research frontier and problem solving

How do I run the course

Syllabus

Program

Programs exist in the following format:

- ▶ source code
- ▶ binary code
- ▶ execution traces
- ▶ output during runtime: e.g., values and data structures in the heap memory
- ▶ software repositories: e.g., bugs, patches, makefile, tests
- ▶ machine learning code (applications, libraries), trained models
- ▶ python Jupyter books

Program Analysis

Program analysis: analyzing programs to predict values and *program properties*, answer questions (as we typically cannot run code with all the inputs)

program properties: conditions of a program

Example:

Property: this buffer access is safe

Condition: buffer size $>$ string length

This area interfaces with discrete maths, AI algorithms, graph algorithms, programming languages and compilers, security

Slides from Anders Møller & Michael I. Schwartzbach

Applications in Software and AI: a Summary

- ▶ bug and vulnerability discoveries
- ▶ automatically generate test inputs
- ▶ debugging: automatically locate the faults in the code
- ▶ automatic repair programs
- ▶ test prioritization: select which tests to run first when software changes
- ▶ reverse engineering: generating assertions and comments
- ▶ is AI model robust?
- ▶ how to correct AI models for a particular input?