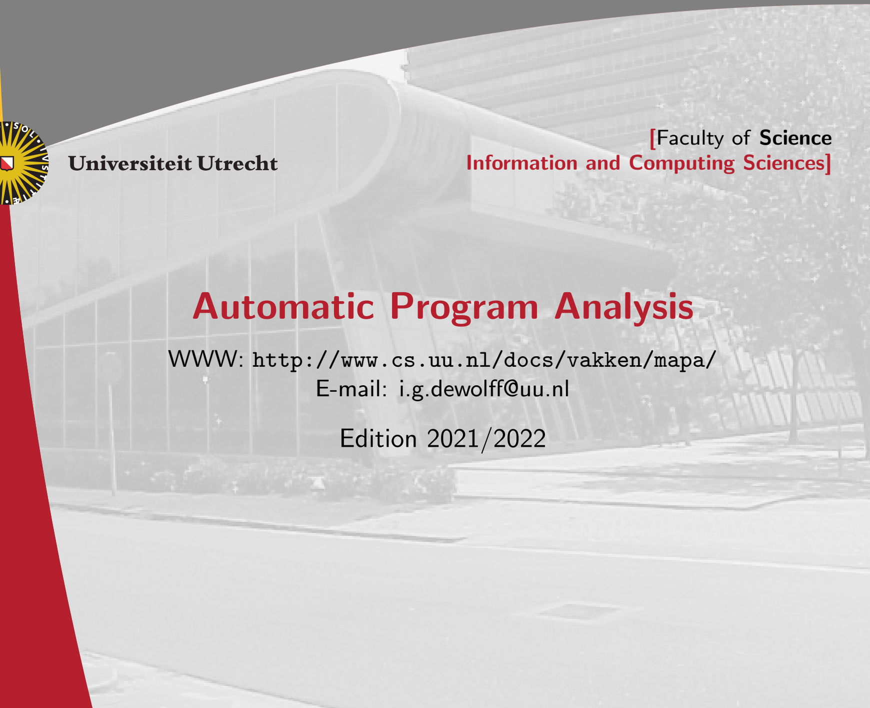

Universiteit Utrecht

[Faculty of **Science**
Information and Computing Sciences]

Automatic Program Analysis

WWW: `http://www.cs.uu.nl/docs/vakken/mapa/`
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Edition 2021/2022

Course overview

What is automatic program analysis about?

- A semantics-based, static approach to the analysis of program artefacts (ie. the source code)
- Generally, it can be much broader than that:
  - dynamic analysis
  - hybrid analysis
  - software comprehension

Why do people study static analysis?

Static analysis is a crucial tool in

- program optimization
  - Which statements will never be executed?
- program validation
  - Is this program type correct?
- program understanding (comprehension)
  - What is the architecture of a 5 mln. Cobol system?
  - Not the focus of this course. Maybe a lecture at the end.

Basic ingredients also useful in other settings.

Themes

- Syntax-driven/tree-oriented programming (attribute grammars).
- Principles of programming languages
- Formal semantics
- Type systems
- Lattice theory, fixpoint iteration and monotone functions
- Theory into practice: everything implemented.

What you can expect to get out of this course

- Syntax-driven/tree-oriented programming (attribute grammars)
- A technical look at typical programming-language constructs.
- Static analysis as an approximation of the meaning of a program
- The analysis of first-order and higher-order languages
- The mathematics in order to understand the technicalities
- Implementation of program analysis and transformation
- Some more advanced topics (tbd).

Course organisation

Course form

- **Lectures:** (about) 2 × 2 hours per week.
  - First: focus on lab exercises
  - Later: capita selecta
- **And:** after each lecture
  - Lab exercises operationalize the theory
  - Organisation: pairs for labs
- Early on in the course more lecture, less lab.
- **Assignments:**
  - Lab: Static analysis of first-order languages (30%)
  - Lab: Static analysis of higher-order languages (30%)
- **Exam:** all material of the course (40%)

Prerequisites

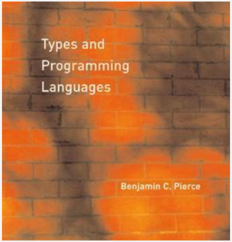
- Participants are assumed to be familiar with the basic concepts of imperative and functional programming.
- Advanced functional programming is not a prerequisite.
- During the course, we will implement everything in Haskell.
  - Deviation is allowed in special circumstances
- Experience with combinator-based parsing is assumed, but not always necessary.

Course material

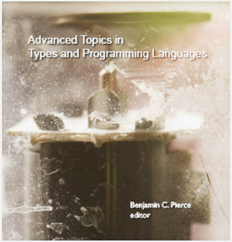
- **Slides/handouts, assignments:** made available on the course website
- **Software:** stack, starting templates will install all dependencies via stack
- **Reading material:** a book, some papers
- **Exercises**: in the book and old exams

Further reading: TAPL

Benjamin C. Pierce. *Types and Programming Languages*. The MIT Press, Cambridge, Massachusetts, 2002.

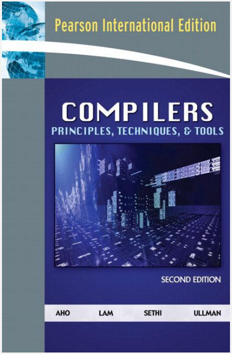


Benjamin C. Pierce, editor. *Advanced Topics in Types and Programming Languages*. The MIT Press, Cambridge, Massachusetts, 2005.



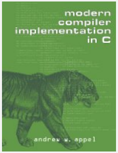
Further reading: Dragon book

Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman. *Compilers. Principles, Techniques, & Tools*. Pearson Education, Boston, Massachusetts, 2nd edition, 2007.


Pearson International Edition
COMPILERS
PRINCIPLES, TECHNIQUES, & TOOLS
SECOND EDITION
AHO
LAM
SETHI
ULLMAN

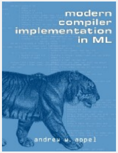
Further reading: Tiger books

Andrew W. Appel. *Modern Compiler Implementation in C*. Cambridge University Press, Cambridge, 1998.



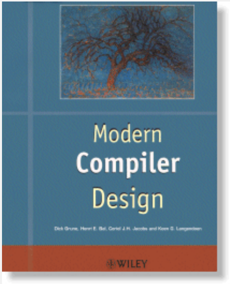
Andrew W. Appel. *Modern Compiler Implementation in Java*. Cambridge University Press, Cambridge, 1998.

Andrew W. Appel. *Modern Compiler Implementation in ML*. Cambridge University Press, Cambridge, 1998.



Further reading: Grune et al.

Dick Grune, Henri E. Bal, Ceriel J. H. Jacobs, and Koen G. Langedoen. *Modern Compiler Design*. John Wiley & Sons, Chichester, 2000.


Modern
Compiler
Design
Dick Grune, Henri E. Bal, Ceriel J.H. Jacobs and Koen G. Langendoen
WILEY

Further reading: Mitchell

John C. Mitchell. *Foundations for Programming Languages*. The MIT Press, Cambridge, Massachusetts, 1996.

John C. Mitchell. *Concepts in Programming Languages*. Cambridge University Press, Cambridge, 2003.