Seminar *Advanced Topics in Formal Semantics*

Introduction

Winter Semester 2021/22; October 13, 2021

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`https://moves.rwth-aachen.de/teaching/ws-21-22/semantics/`

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Outline

Aspects of Programming Languages

Syntax: “How does a program look like?”

- hierarchical composition of programs from structural components

$\Rightarrow$ *Compiler Construction*

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Pragmatics: “Is the programming language practically usable?”

- length and understandability of programs
- learnability of programming language
- appropriateness for specific applications, ...

$\Rightarrow$ *Software Engineering*

Motivation

Main applications

- Implementation of algorithms and compilers
  - exact understanding of semantics avoids uncertainties and enables correctness proofs
- Design of (new) programming languages
  - missing details, ambiguities and inconsistencies can be recognised
- Formal verification methods
  - Rigorous, mathematically based techniques for the specification, development and verification of software and hardware systems
  - Aim at improving correctness, reliability and robustness of such systems

Areas Covered in this Seminar

Topic areas

- Analysing Heap-Manipulating Programs
- Program Synthesis
- Analysing Probabilistic Systems
- Robotic Applications

Outline

Goals

Aims of this seminar

- Independent understanding of a scientific topic
- Acquiring, reading and understanding scientific literature
  - given reference(s) sufficient in most cases
- Writing of your own report on this topic
  - far more that just a translation/rewording
  - usually an “extended subset” of original literature
    - “subset”: present core ideas and omit too specific details (e.g., related work or optimisations)
    - “extended”: more extensive explanations, examples, ...
    - discuss contents with supervisor!
- Oral presentation of your results
  - can be “proper subset” of report
  - generally: less (detailed) definitions/proofs and more examples

Requirements on Report

Your report

- Independent writing of a report of 12–15 pages
- First milestone: detailed outline
  - not: “1. Introduction/2. Main part/3. Conclusions”
  - rather: overview of structure (section headers, main definitions/theorems) and initial part of main section (one page)
- Correct citation of all consulted literature
- Plagiarism: taking text blocks (from literature or web) without source indication causes immediate exclusion from this seminar
- Font size 12pt with “standard” page layout
  - LaTeX template will be made available on seminar web page
- Language: German or English
- We expect the correct usage of spelling and grammar
  - $\geq$ 10 errors per page $\Longrightarrow$ abortion of correction

Requirements on Talk

Your talk

- Organised as in-person or Zoom meeting
- Talk of 30 minutes
- Focus your talk on the audience
- Descriptive slides:
  - $\leq$ 15 lines of text
  - use (base) colors in a useful manner
  - number your slides
- Language: German or English
- No spelling mistakes please!
- Finish in time. Overtime is bad
- Ask for questions
- Have backup slides ready for expected questions
- LaTeX `beamer` template will be made available on seminar web page

Outline

Important Dates

Deadlines

- October 20: Topic preferences due
- November 15: Detailed outline due
- December 13: Full report due
- January 17: Presentation slides due
- January 31–February 4: Seminar talks (two days)

Important

Missing a deadline causes immediate exclusion from the seminar

Selecting Your Topic

Procedure

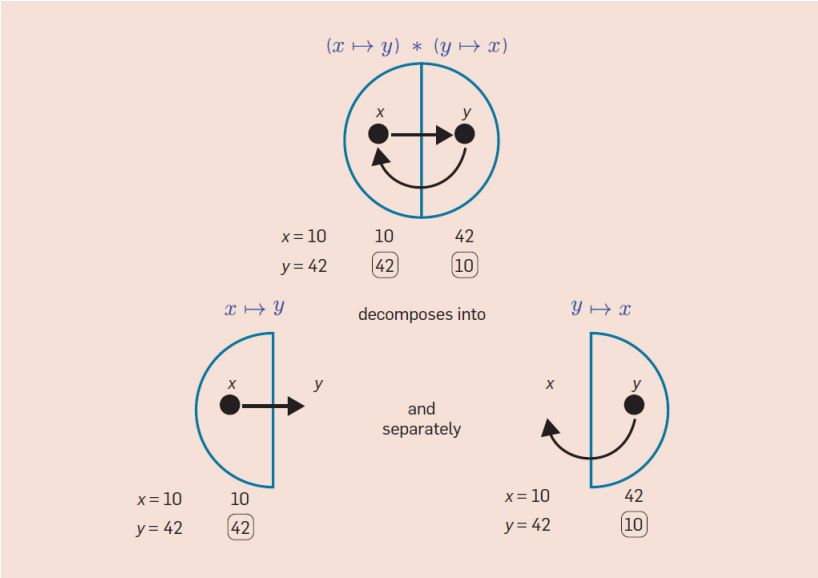
- Check out Foodle poll at `https://terminplaner.dfn.de/yl11dbJGfWCWrZrL`
- Topics classified according to BSc/MSc level
  - MSc students please choose at least one “M-only” topic
- Please give at least three “Yes” votes ✓
- Preferably additional “Maybe” votes (✓)
- Give as comment:
  - preference of topics (if desired)
  - language of report and talk (English/German)
- **Fill form by Wednesday, October 20**
- We do our best to find an adequate topic-student assignment
  - disclaimer: no guarantee for an optimal solution
- Assignment of topics and supervisors will be published on web site by mid next week

Withdrawal

- You have up to three weeks to refrain from participating in this seminar.
- Later cancellation (by you or by us) causes a not passed for this seminar and reduces your (three) possibilities by one.

Outline

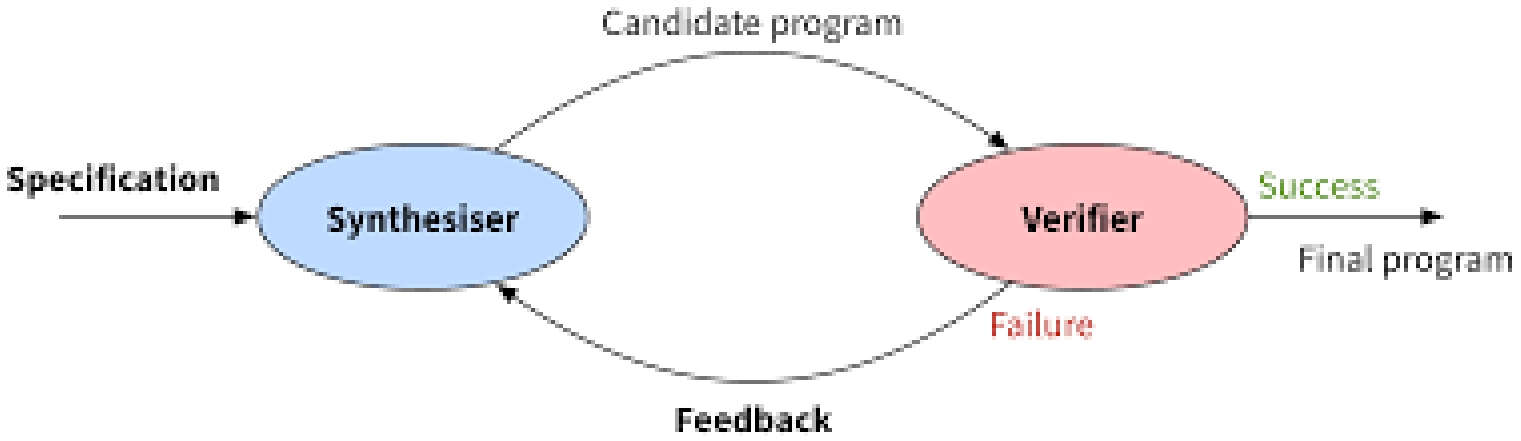
Analysing Heap-Manipulating Programs



$$\text{(frame)}\ \frac{\{A\}\ C\ \{B\} \qquad Mod(c) \cap Free(F) = \emptyset}{\{A * F\}\ C\ \{B * F\}}$$

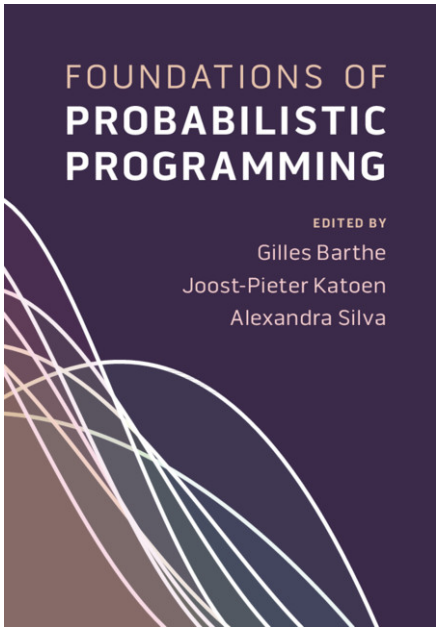
1. Introduction to Separation Logic (B)
2. Formalising Memory Safety (B)
3. Reasoning about Incorrectness (B)
4. Logics for Object-Oriented Programs (B)
5. Semantics of Concurrent Pointer Programs (M)
6. A Meta-Framework: Views (M)

Program Synthesis



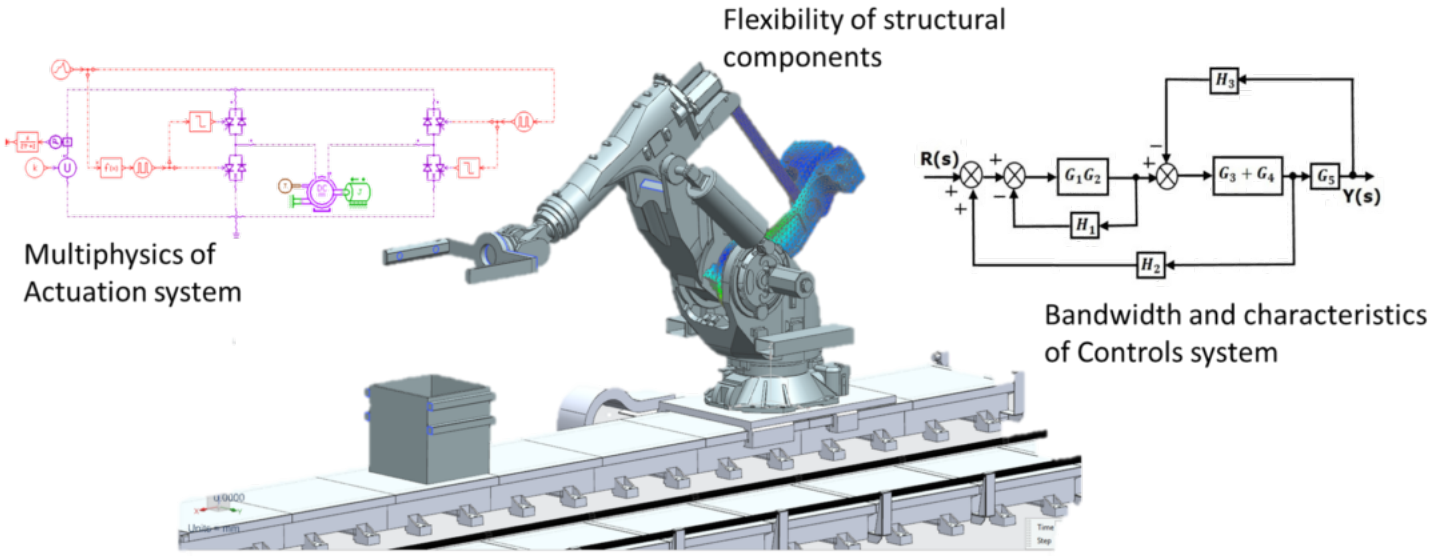
7. Applications of Program Synthesis (B)
8. Synthesis as Verification (B)
9. Syntax-Guided Synthesis (B)
10. Program Sketching (B)
11. Component-Based Synthesis (B)
12. Synthesising Pointer Programs (M)
13. Synthesising Probabilistic Programs (M)

Analysing Probabilistic Systems



14. Slicing Probabilistic Programs (B)
15. Probabilistic Termination (M)
16. Moment Analysis (M)
17. Runtime Monitoring of Probabilistic Systems (M)
18. Model Checking of Probabilistic Systems (M)

Robotic Applications



19. A Modelling Language for Robotic Systems (B)
20. Generation of Mobile Robot Controllers (M)

Outline

Some Final Hints

Hints

- Take your time to understand your literature.
- Be proactive! Look for additional literature and information.
- Discuss the content of your report with other students.
- Be proactive! Contact your supervisor on time.
- Prepare the meeting(s) with your supervisor.
- Forget the idea that you can prepare a talk in a day or two.

We wish you success and look forward to an enjoyable and high-quality seminar!