

# Theory of Computer Science

## A1. Organizational Matters

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February 20, 2023

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## A1.1 About this Course

## A1.2 Organizational Matters

# A1.1 About this Course

# Main Objectives

We would like to understand what can be computed

- ▶ **in principle**: decidability/computability
- ▶ **efficiently**: complexity theory

# Uncomputable Problems?

Consider functions whose inputs are strings:

```
def program_returns_true_on_input(prog_code, input_str):  
    ...  
    # returns True if prog_code run on input_str returns True  
    # returns False if not  
  
def weird_program(prog_code):  
    if program_returns_true_on_input(prog_code, prog_code):  
        return False  
    else:  
        return True
```



What is the return value of `weird_program`  
if we run it on its own source code?

# Why should we Study the Theory of Computation?

- ▶ Theory is useful
  - ▶ If we want to solve a problem with a computer we need to know what is achievable. Computable? Tractable?
  - ▶ If the problem is not tractable, we might want to consider alternatives, e.g. a tractable variant or an approximation.
  - ▶ Some theoretical concepts have practical applications, e.g. regular expressions.
  
- ▶ Theory is fun
  - ▶ Often like a brainteaser: E.g. how can we solve a problem exploiting a solver for some other problem?

# Content: Theoretical Foundations of Computer Science

- A. **background**
  - ▷ mathematical foundations and proof techniques
- B. **automata theory and formal languages**  
(Automatentheorie und formale Sprachen)
  - ▷ What is a computation?
- C. **Turing computability** (Turing-Berechenbarkeit)
  - ▷ What can be computed at all?
- D. **complexity theory** (Komplexitätstheorie)
  - ▷ What can be computed efficiently?
- E. **more computability theory** (mehr Berechenbarkeitstheorie)
  - ▷ Other models of computability

# Learning Goals

- ▶ understanding the **capabilities and limitations** of computers
- ▶ working with **formal systems**
  - ▶ comprehending formal **definitions and theorems**
  - ▶ **precise formulation** of definitions, theorems and proofs
  - ▶ analyzing formal problems **precisely**



## A1.2 Organizational Matters

# People

## Lecturer

Gabi Röger

- ▶ **email:** `gabriele.roeger@unibas.ch`
- ▶ **office:** room 04.005, Spiegelgasse 1

## Assistant

Salomé Eriksson

- ▶ **email:** `salome.eriksson@unibas.ch`
- ▶ **office:** room 04.003, Spiegelgasse 5

# People

## Tutors

Renato Farruggio

- ▶ [email: renato.farruggio@stud.unibas.ch](mailto:renato.farruggio@stud.unibas.ch)

Esther Mugdan

- ▶ [email: esther.mugdan@unibas.ch](mailto:esther.mugdan@unibas.ch)

Mario Tachikawa

- ▶ [email: mario.tachikawa@stud.unibas.ch](mailto:mario.tachikawa@stud.unibas.ch)

# Time & Place

## Lectures

- ▶ **Monday:** 14:15–16:00, Biozentrum, lecture hall U1.141
- ▶ **Wednesday:** 16:15–18:00, Alte Universität, lecture hall -101

## Exercise Sessions (starting March 6/7)

- ▶ **Monday 16:15–18:00**
  - ▶ With Renato: ~~Kollegienhaus, lecture hall 116~~  
Biozentrum, seminar room 02.054
  - ▶ With Esther: Alte Universität, lecture hall -201
- ▶ **Tuesday 12:15–14:00**
  - ▶ With Mario: Spiegelgasse 1, room U1.001

**important:** please send Salomé an email with your exercise partner and preferred slot until **Wednesday 23:59** (February 22).

# Exercises

## Exercise sheets (homework assignments):

- ▶ mostly theoretical exercises
- ▶ on ADAM every Wednesday
- ▶ may be solved in **groups of 2**
- ▶ due Wednesday the following week  
(upload to Adam at <https://adam.unibas.ch/>)
- ▶ submission PDFs must be created with  $\text{\LaTeX}$   
→ **ADAM workspace: template and introduction to  $\text{\LaTeX}$**

# Exercises

## Exercise sessions:

- ▶ discussion of previous exercise sheet (common problems)
- ▶ questions about current exercise sheet
- ▶ questions about the course
- ▶ if time: work on the homework assignment
- ▶ participation voluntary but highly recommended

# Revised Course Format since 2022

- ▶ **previously:** 8 CP for lectures and exercises
- ▶ **new:** 6 CP main course + 2 CP for exercises
- ▶ separate enrolment and evaluation
- ▶ can and should be taken in parallel

# Enrolment

- ▶ MOnA: <https://services.unibas.ch/>
- ▶ **deadline:** March 20
- ▶ better today for the course, so that you get all relevant emails and access to the ADAM workspace
- ▶ enrolment for exercise after we made the group assignment



# Evaluation of Main Course (6 CP)

- ▶ **written exam**, 6 ECTS credits, graded 1-6
- ▶ 29 June 2023, 14:00-16:00
- ▶ admission to exam: **no prerequisites**
- ▶ must **register** for exam during April 3 – April 17  
↪ see <https://philnat.unibas.ch/de/examen/>
- ▶ grade for course determined exclusively by the exam
- ▶ if you fail: **one** repeat attempt (within one year)

Last lecture (May 31): Q&A session for exam preparation

# Evaluation of Exercises (2 CP)

- ▶ pass/fail evaluation
- ▶ to pass the exercises, you need **50% of the exercise marks**

# Resources

- ▶ **Adam:** central starting point and exercises  
<https://adam.unibas.ch/>
- ▶ **Website:** course information, slides
- ▶ **Discord:** for your interaction with each other  
feel free to use a **pseudonym**

# Course Material

## course material:

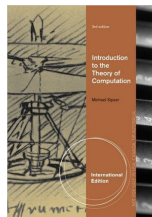
- ▶ slides (online)
- ▶ textbooks (see next slides)
- ▶ additional material **on request**

# Course Material

## Textbooks (English)

Introduction to the Theory of Computation  
by Michael Sipser (3rd edition)

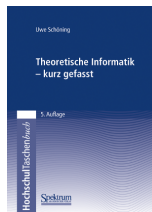
- ▶ covers most of the course
- ▶ also contains advanced topics beyond the scope of this course



## Textbook (German)

Theoretische Informatik – kurz gefasst  
by Uwe Schöning (5th edition)

- ▶ covers the course
- ▶ some concepts defined a bit differently (e.g. PDAs)



# Prerequisites

- ▶ basic proof techniques  
(mathematical induction, proof by contradiction, ...)
- ▶ basic programming skills

# Plagiarism

## Plagiarism (Wikipedia)

*Plagiarism is the “wrongful appropriation” and “stealing and publication” of another author’s “language, thoughts, ideas, or expressions” and the representation of them as one’s own original work.*

### consequences:

- ▶ 0 marks for the exercise sheet (first time)
- ▶ exercises failed (second time)

if in doubt: check with us what is (and isn't) OK before submitting exercises too difficult? we are happy to help!