



Theoretical Computer Science

Introduction

Technische Hochschule Rosenheim
Sommer 2022
Prof. Dr. Jochen Schmidt

- Lecture: 2 SWS (= 2x 45min per week)
- Exercises: 2 SWS, split into groups
 - in English (mainly for AAI students) & German (mainly for INF students)
 - register via Learning Campus
- Workload: 150h (60h lecture/exercises, **90h additionally for studying on your own**)
- Slides, exercises etc.: Download via Learning Campus
- Exam
 - written exam at the end of the semester
 - 90 minutes
 - using any printed or handwritten material (e.g., slides, exercises, books, ...)
 - and a non-programmable calculator (no other devices allowed)

Chapter 1: **Finite Automata** (*Endliche Automaten*)

- Definition and representation of automata
- Recognized language of automata
- Pushdown automata
- Turing Machines

Chapter 2: **Pushdown Automata & Turing Machines** (*Kellerautomaten & Turing-Maschinen*)

- Pushdown automata
- Linear bounded automata
- Turing machines

Chapter 3: **Formal Languages** (*Formale Sprachen*)

- Definition of formal languages
- Chomsky hierarchy
- Pumping lemma

Chapter 4: **Word Problem & Parsing** (*Wortproblem & Parsing*)

- Analysis of words in formal language classes
- CYK-Parser
- Compiler

Chapter 5: **Computability Theory** (*Berechenbarkeit*)

- Decidability and Church-Turing thesis
- Halting problem
- LOOP/WHILE/GOTO computability
- primitive & μ -recursive recursive functions

Chapter 6: **Complexity Theory** (*Komplexitätstheorie*)

- Time and space complexity
- Order of complexity, O-notation
- Optimization example: Divide-and-conquer
- Complexity classes P, NP
- NP-Completeness
- NP-hard Problems & other problem classes

Chapter 7: **Probabilistic Algorithms** (*Probabilistische Algorithmen*)

- Random numbers
- Monte-Carlo methods
- Probabilistic primality tests

- in German
 - H. Ernst, J. Schmidt, G. Beneken. **Grundkurs Informatik**. Springer Vieweg, 7. Aufl. 2020.
 - J. Schmidt. **Grundkurs Informatik – Das Übungsbuch: 148 Aufgaben mit Lösungen**. Springer Vieweg, 2. Auflage 2020.
 - L. Priese und K. Erk: **Theoretische Informatik. Eine umfassende Einführung**. Springer Vieweg, 4. Aufl., 2018.
 - D.W. Hoffmann. **Theoretische Informatik**. Hanser, 4. Aufl., 2018.
- in English
 - M. Sipser: **Introduction to the Theory of Computation**. Cengage Learning, Inc; 3. Edition 2012.
 - J.E. Hopcroft, R. Motwani und J.D. Ullmann: **Introduction to Automata Theory, Languages, and Computation**. Pearson Education Limited, 2013.
- Further Reading in English & German
 - B. Hollas: *Grundkurs Theoretische Informatik: Mit Aufgaben und Anwendungen*. Springer Vieweg, 2. Aufl., 2015.
 - G. Vossen und K.-U. Witt: *Grundkurs Theoretische Informatik: Eine anwendungsbezogene Einführung*. Springer Vieweg, 6. Aufl., 2016.
 - U. Schöning, U.: *Theoretische Informatik – kurz gefasst*. Spektrum Akad. Verlag, 5. Aufl., 2008.
 - A. Aho, M. Lam und R. Sethi. *Compilers*. Addison-Wesley Longman, 2013.
 - D.E. Knuth: *The Art of Computer Programming, Volumes 1-4A*. Addison-Wesley, 2011.
 - W.H. Press et al.: *Numerical Recipes 3rd Edition: The Art of Scientific Computing*. Cambridge University Press, 3. Aufl., 2007.
 - R. Sedgewick: *Algorithms*. Addison-Wesley, 4. Aufl., 2011.
 - R. Sedgewick und P. Flajolet. *An Introduction to the Analysis of Algorithms*. Addison Wesley, 2. Aufl., 2013.