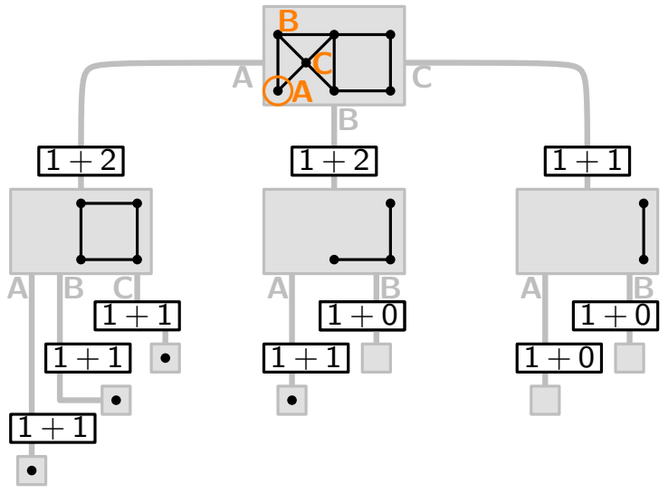
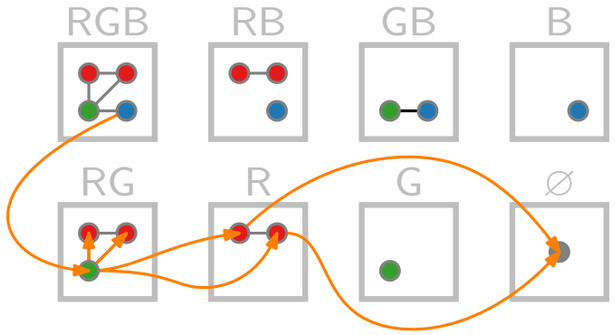
Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

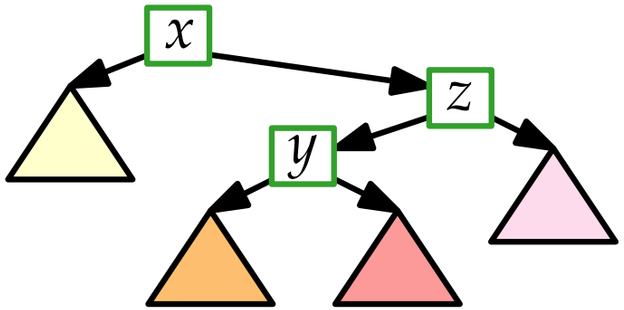
Advanced Algorithms

Introduction

Topics, Course Details, Organizational







Alexander Wolff

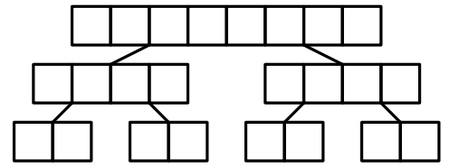
Summer term 2026

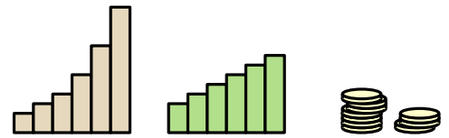
Advanced Algorithms

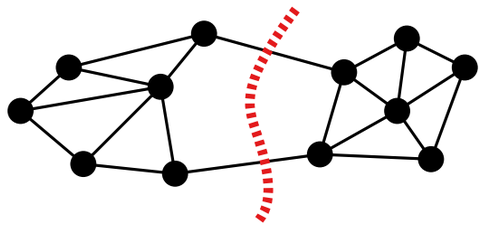
The goal of this course is to offer an overview of advanced algorithmic topics.

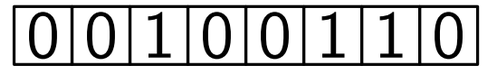
You have already learned a lot about algorithms,
but there is much more left...

- **Types:** incremental, recursive, D&C, greedy, numerical, exact, approx., randomized, parallel, distributed, ...
- **Analysis:** correctness, runtime, space usage, amortized, expected, optimality, benchmarking, ...
- **Problems:** combinatorial, graphs, geometric, strings, biological, geographic, ...
- **Data structures:** lists, binary search trees, dictionaries, succinct, randomized, probabilistic, ...



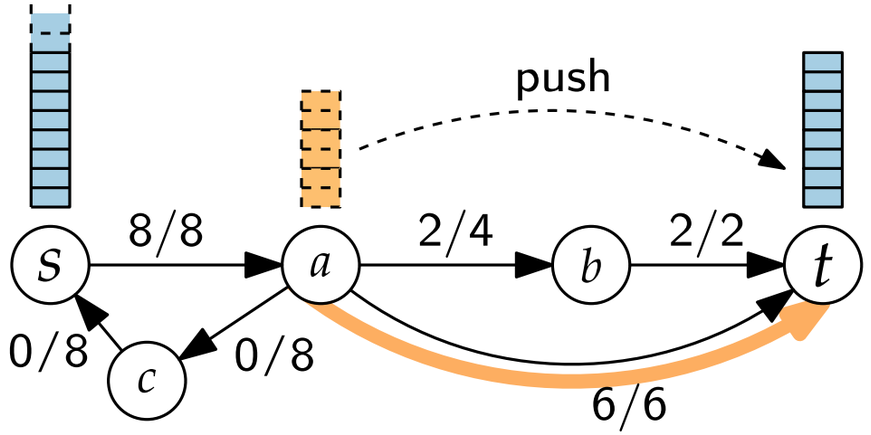






Topics I

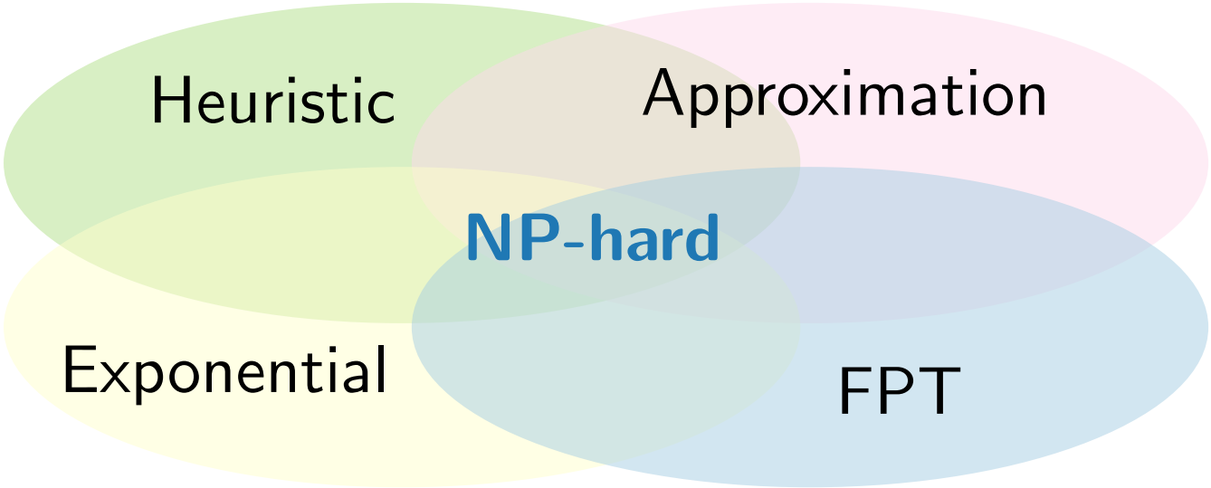
- **Better algorithms** for problems you know
- Maximum flow problem



- Ford–Folkerson algorithm: $\mathcal{O}(|E||f^\star|)$
- Edmonds–Karp algorithm: $\mathcal{O}(|V||E|^2)$
- Push-Relabel algorithm: $\mathcal{O}(|V|^2|E|)$ (or even better)

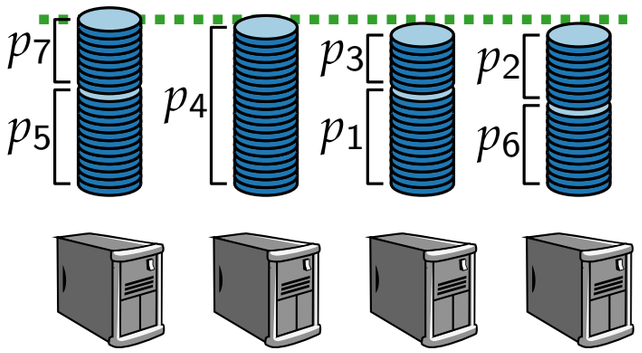
Topics II

- How to deal with **NP-hard problems**



  - Sacrifice quality for speed?
  - Can we still compute optimal solutions?

- Example problem:
  Schedule jobs to machines
  approximating the minimum makespan



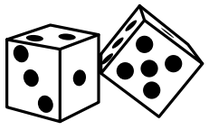
Topics III

- **Special** areas

Randomized algorithms

LongestPath is NP-hard but easy on acyclic digraphs $\Rightarrow$ randomly turn given graph into acyclic digraph

$\Rightarrow$ good idea?



Also

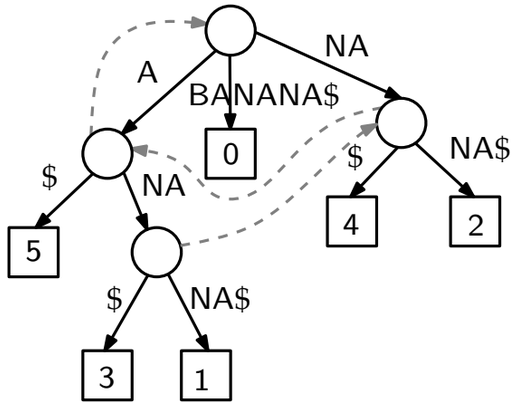
- Online algorithms
- Computational geometry
- Working with strings

Topics IV

- **Advanced data structures**

Searching for strings

Given text S, how can we efficiently find all occurrences of pattern P?



- Suffix trees
- Invest in preprocessing to be faster than full parse

Also

- Succinct data structures
- Splay trees

Lectures

- Alexander Wolff
- Email: firstname.familyname@uni-wuerzburg.de
- Office: Room 01.001, Building M4 (next to computer science building M2)

- In-person lectures: Tue, 10:15–11:45, ÜR I.
- Interactive, with time for questions and discussions.
- 12 or 13 lectures.
- Old videos from 2020 will be made available on WueCampus.

Tutorials

- Samuel Wolf

- Email: firstname.familyname@uni-wuerzburg.de
- Office: Room 01.005, Building M4
- In-person tutorials: Thu, **12:30**–14:00, ÜR I.
- Time for questions and discussions.
- In total, 11 or 12 exercise sheets.

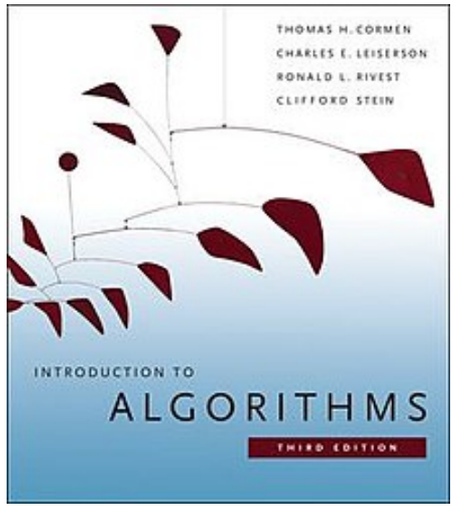
Exercise sheets.

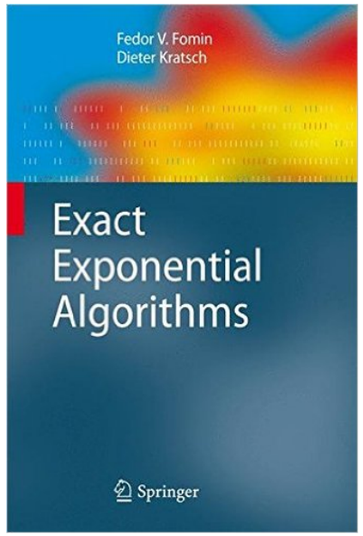
- Weekly exercise sheets
- Released at the lecture day (Tue)
- Prepare ideas / solutions for the tutorial (Thu)
- No submission, no grading.
- . . . in English or German

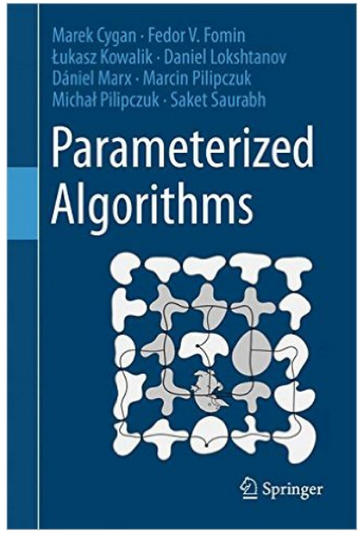
Exam

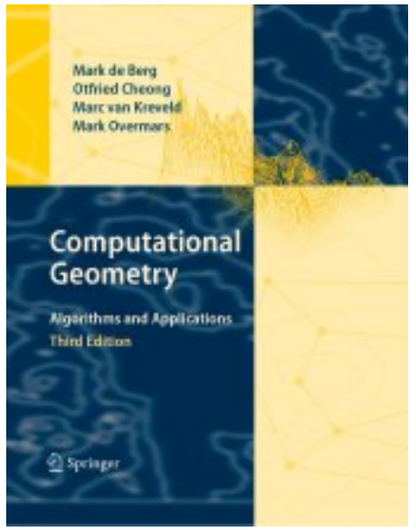
- Oral exam
- $\approx$ 20min
- Date will be announced during the semester
- Don't forget to register in WueStudy:
  "Ausgewählte Kapitel der ..." / "Selected Topics in ..."

Literature



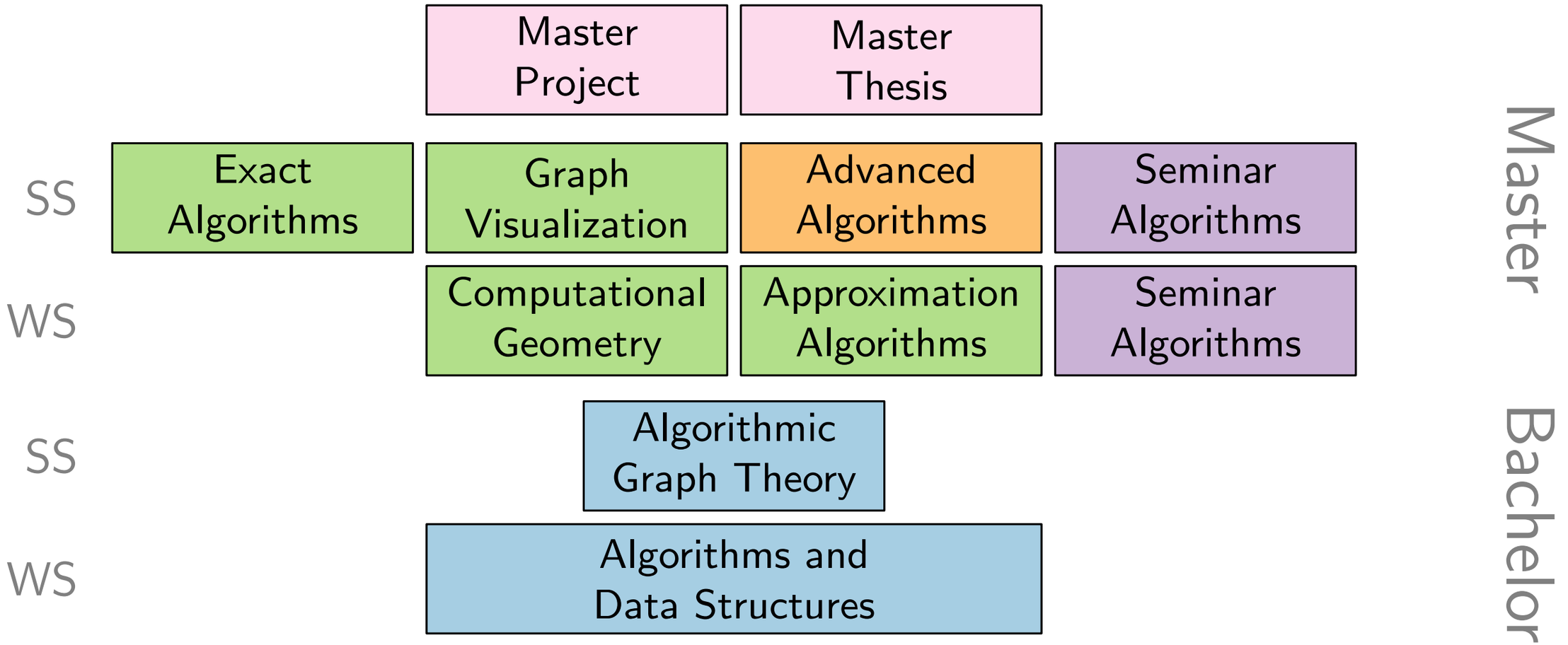






- References at the end of every lecture
- Links to further interesting stuff

Our Lectures and Seminars



Thanks

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