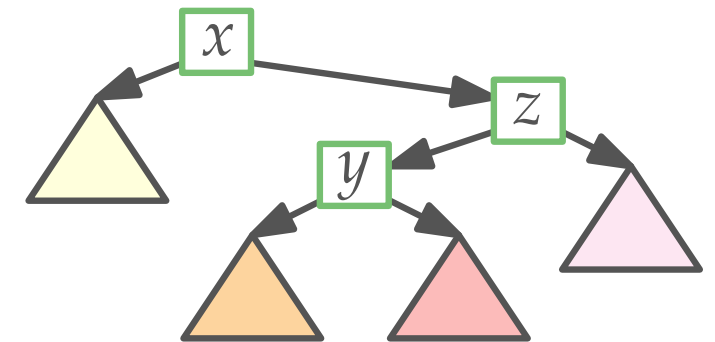
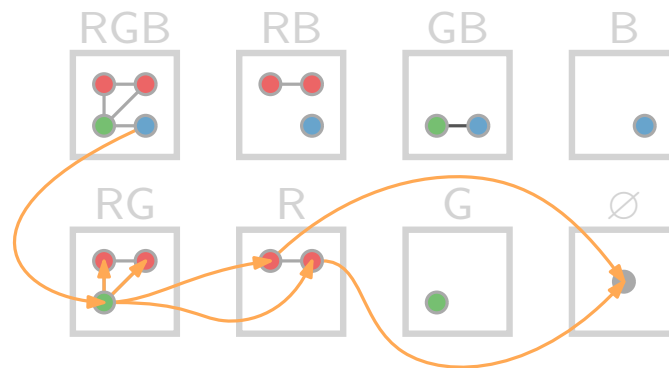
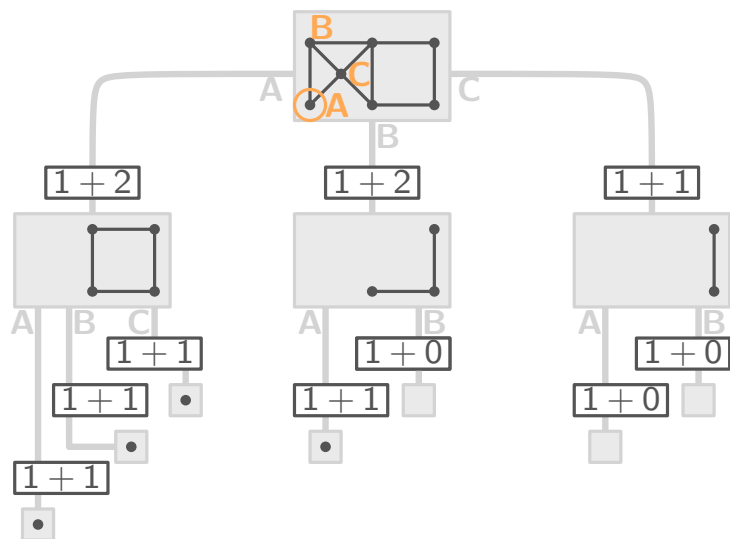


Advanced Algorithms

Introduction

Topics, Course Details, Organizational

Johannes Zink · WS23/24

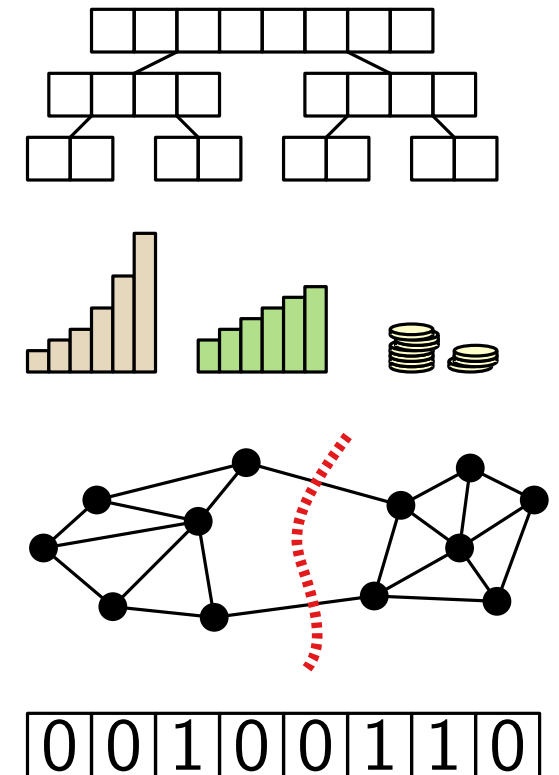


Advanced Algorithms

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

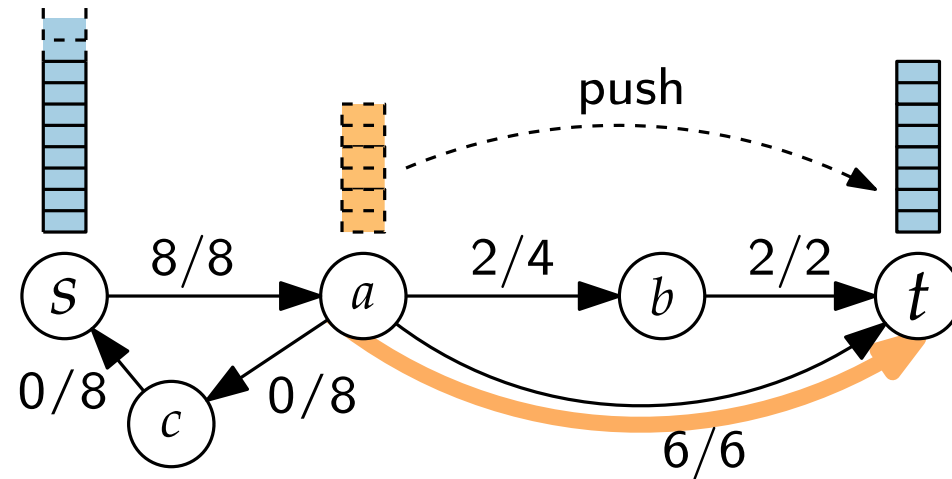
You have already learned a lot about algorithms, but there is much more left...

- **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

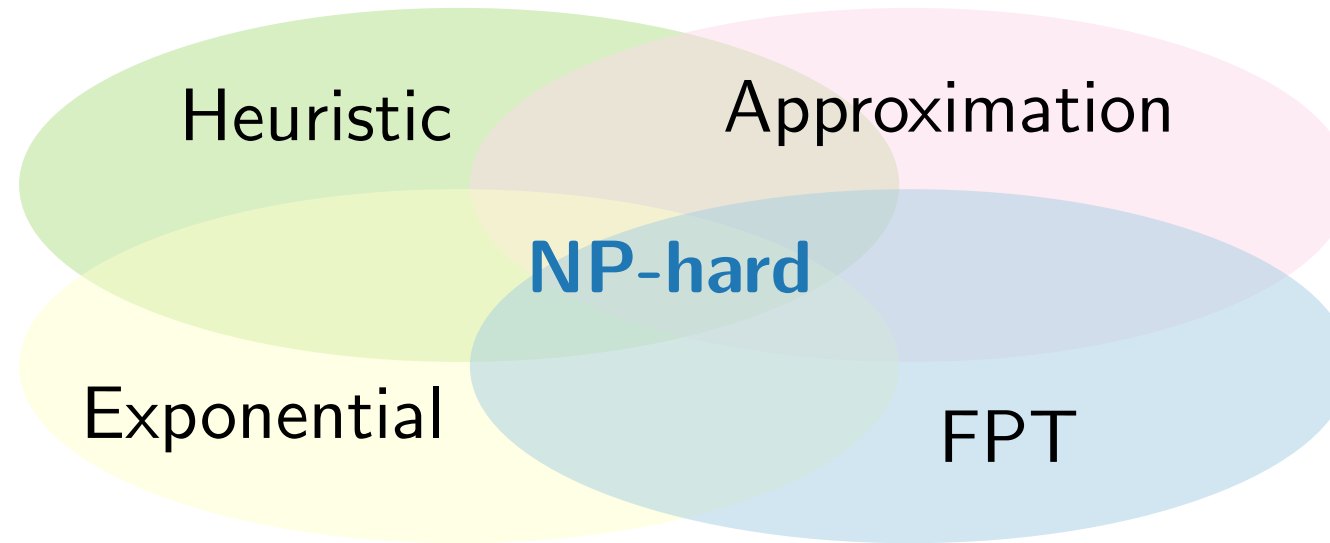
- **Better algorithms** for problems you know
- Maximum flow problem



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

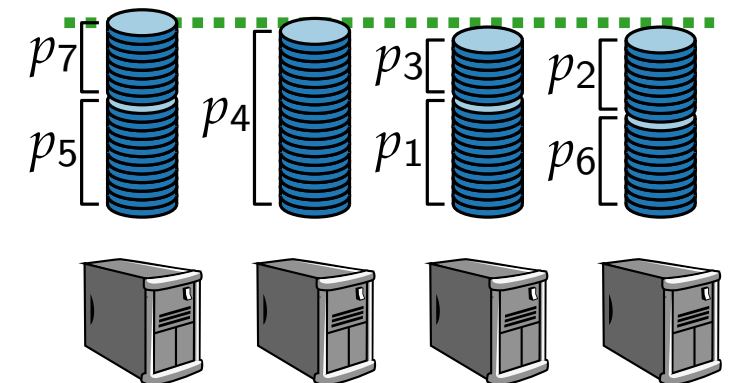
Topics II

■ 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

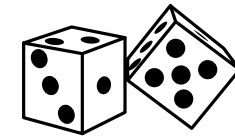
LONGESTPATH
is NP-hard

but easy on
acyclic digraphs

⇒

randomly turn given graph
into acyclic digraph

⇒ good idea?



Also

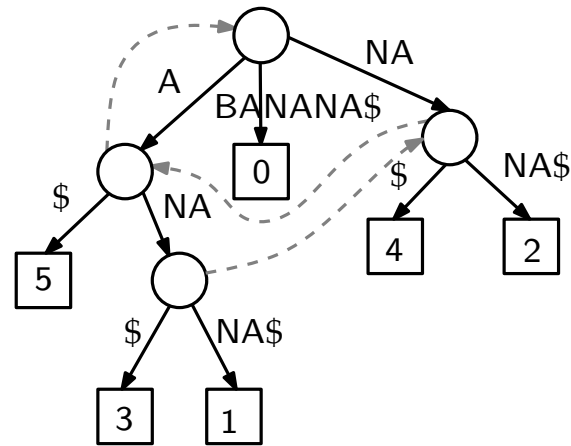
- Online algorithms
- Computational geometry
- Working with strings

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

- Johannes Zink



- Email: johannes.zink@uni-wuerzburg.de
- Office: Room 01.007, Building M4 (next to computer science building)
- In-person lectures Wed, 14:15–15:45, ÜR I
- With time for questions and discussions
- 12 or 13 lectures
- Old videos from 2020 will be made available on WueCampus

Tutorials

■ Oksana Firman



- Email: oksana.firman@uni-wuerzburg.de
- Office: Room 01.005, Building M4
- In-person tutorials Mon, 16:00–17:30, HS 4, Physics building
- With time for questions and discussions
- 11 or 12 exercise sheets

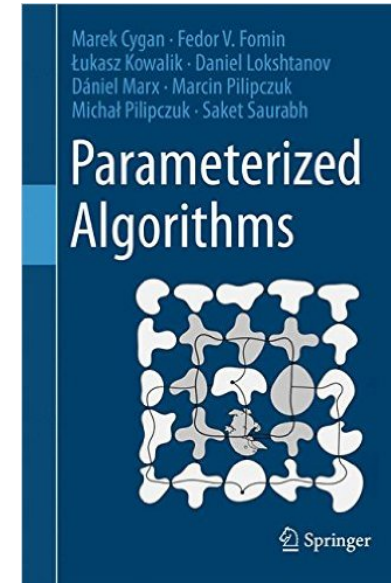
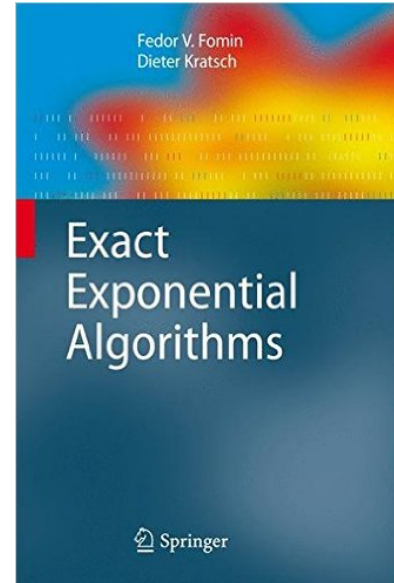
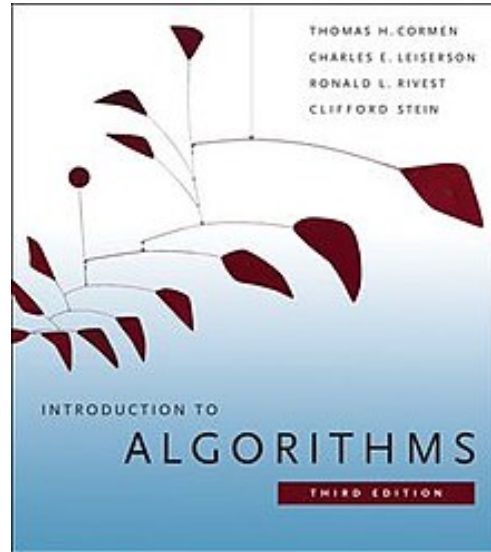
Exercise sheets.

- Weekly exercise sheets, ≈ 20 points/sheet
- Scoring 50 % of the points grants a bonus of 0.3 to the final grade of the exam (if one passes)
- Released at the lecture day (Wed)
- Submission deadline next lecture (Wed, 14:15)
- Digital submission as pdf; recommended to use our \LaTeX template
- Submission in teams of two ...
- ... in English (preferred) or German

Exam

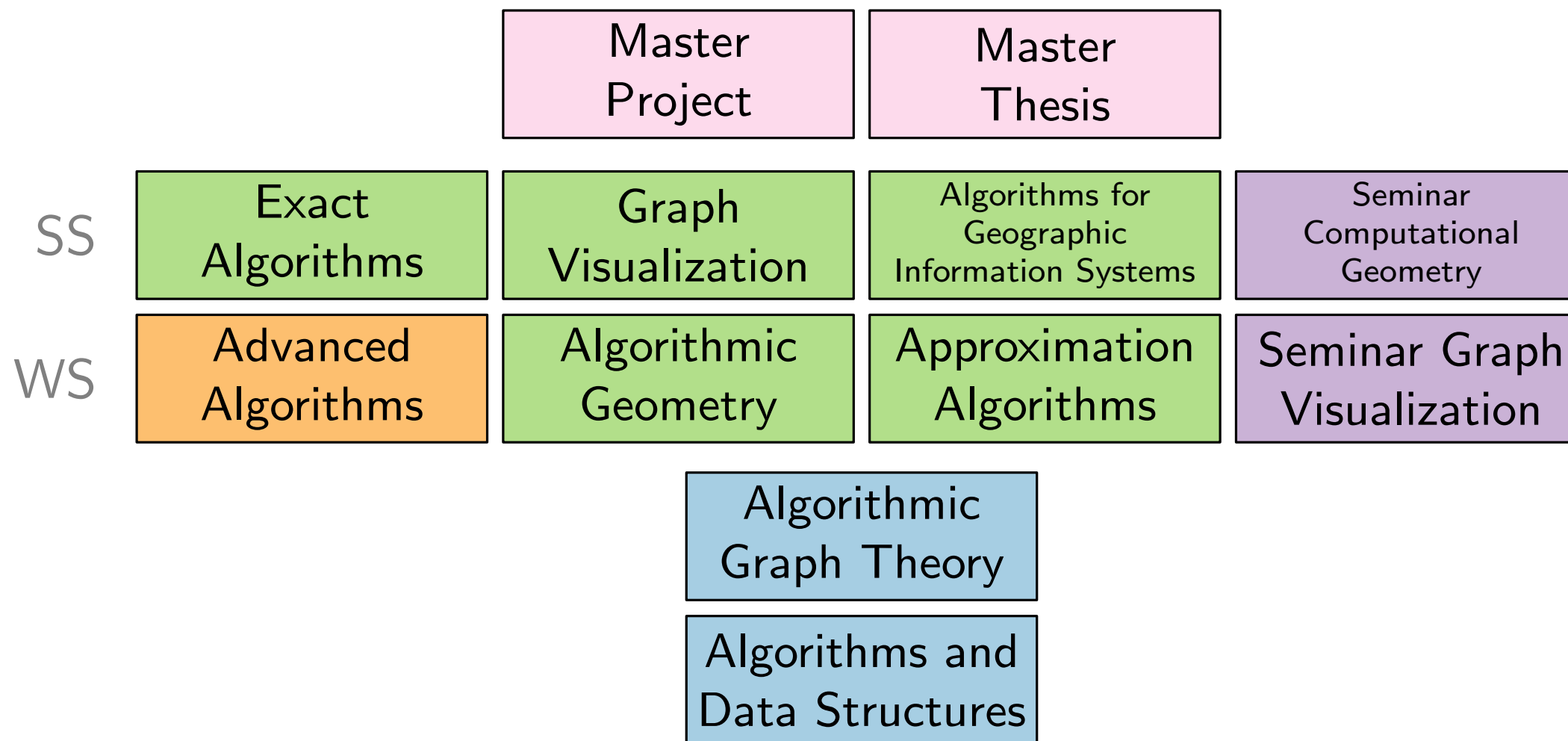
- Oral exam
- \approx 20min
- Bonus for points on the exercise sheets (see previous page)
- Date will be announced during the semester
- Don't forget to register in WueStudy:
“Ausgewählte Kapitel der ...”

Literature



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

Our Lectures and Seminars



Master

Bachelor

Thanks

Material and slides provided in this lecture have been compiled by many different people. Special thanks to:

Jonathan Klawitter, Boris Klemz, Steven Chaplick,
Thomas van Dijk, Philipp Kindermann, Joachim Spoerhase,
Sabine Storandt, Dorothea Wagner, Tim Hegemann,
Alexander Wolff, ...