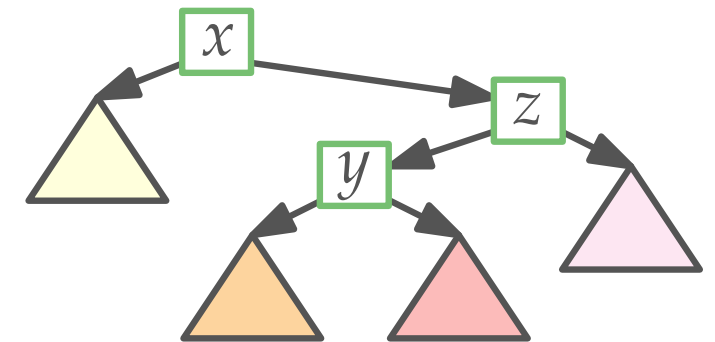
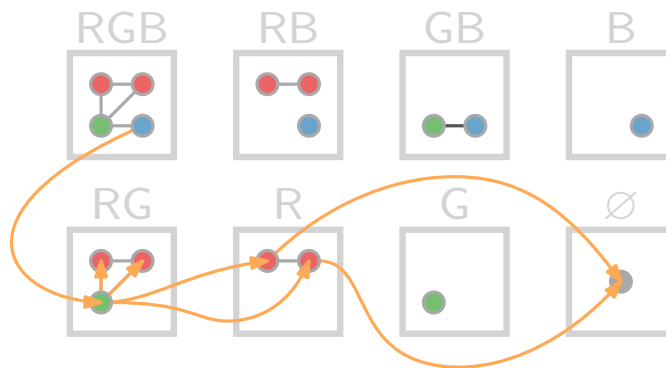
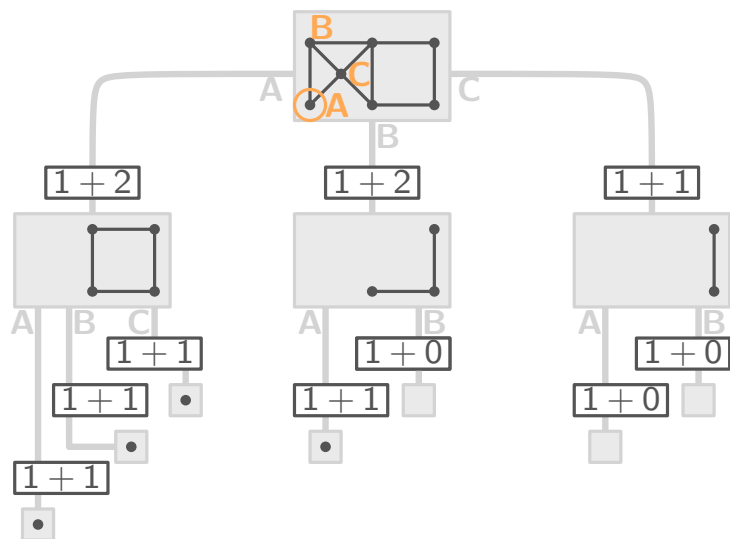


# Advanced Algorithms

## Introduction

Topics, Course Details, Organizational

Johannes Zink · Alexander Wolff · WS22/23

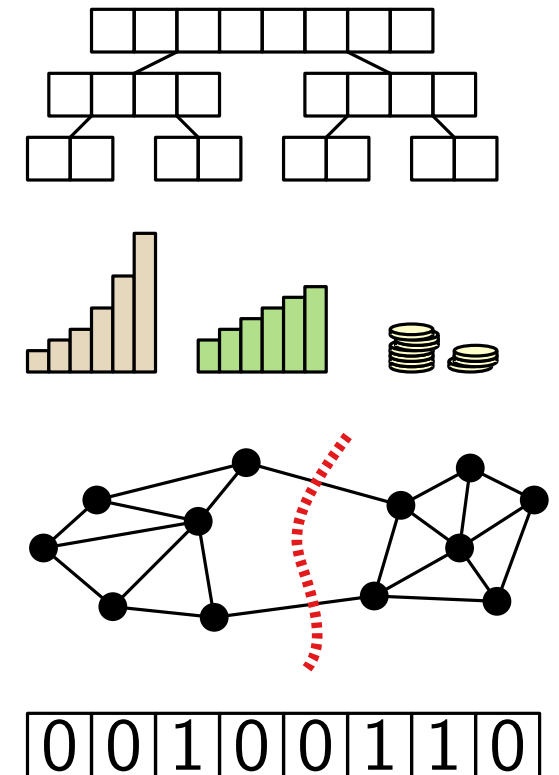


# Advanced Algorithms

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

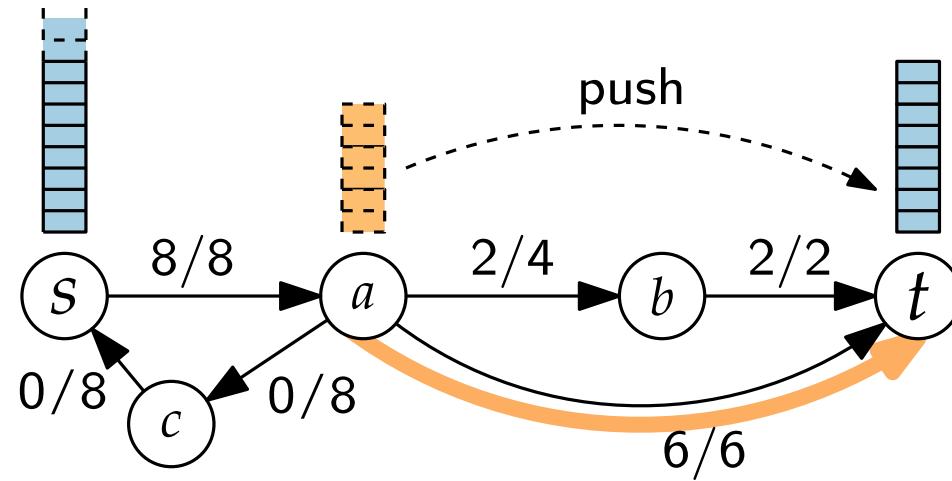
You have already learned a lot about algorithms, but there is much more left...

- **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, succinctness, ...



# Topics I

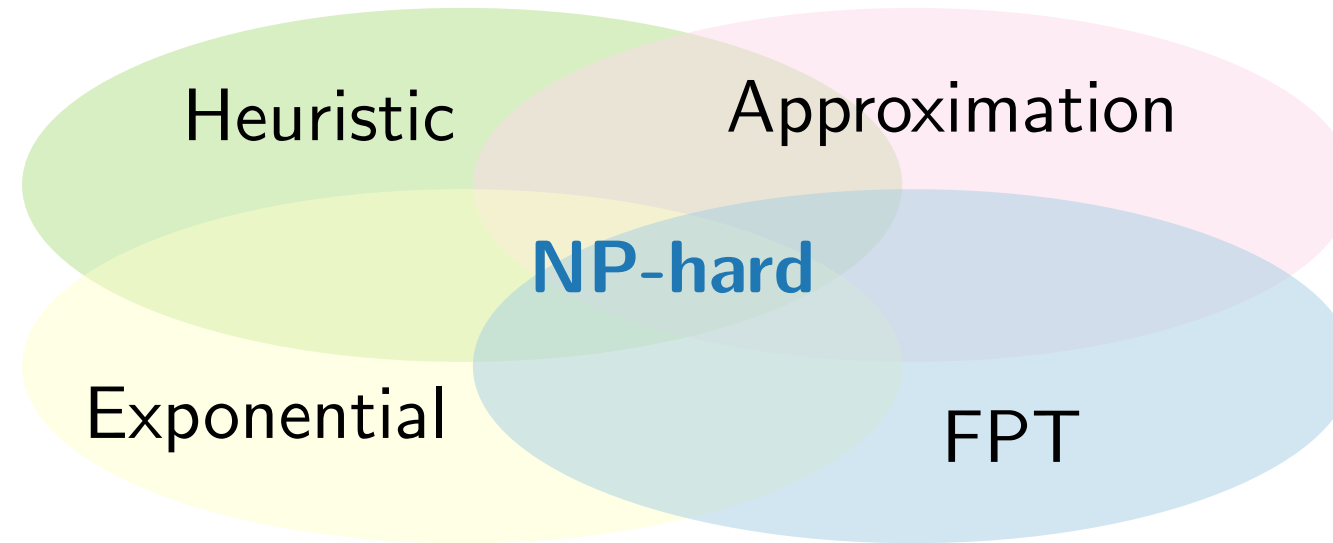
- **Better algorithms** for problems you know
- Maximum flow problem



- 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)
- Shortest paths in graph with negative edge weights

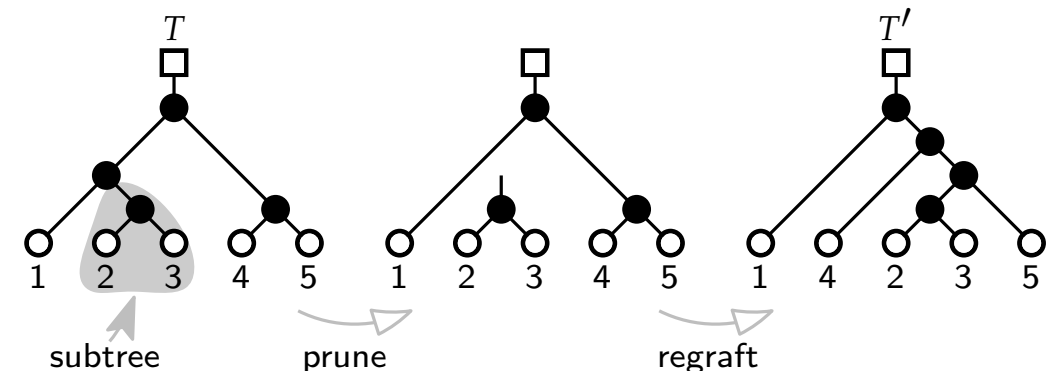
# Topics II

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



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

## ■ Example problem: Rearrangement distance of phylogenetic trees



# Topics III

## ■ Special areas

### Randomized algorithms

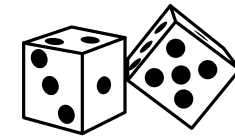
LONGESTPATH  
is NP-hard

but easy on  
acyclic digraphs

⇒

randomly turn given graph  
into acyclic digraph

⇒ good idea?



Also

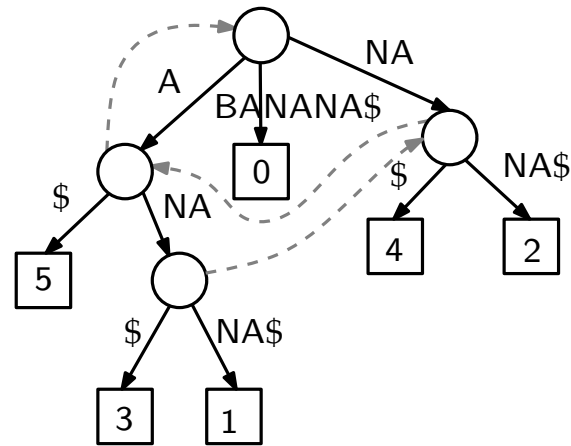
- Online algorithms
- Approximation algorithms
- Computational geometry
- Working with strings

# Topics IV

- (Algorithms for) **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 (primarily)



- Alexander Wolff (at the beginning)



- Guests: Diana Sieper, Tim Hegemann
- In-person lectures Wed, 14:15–15:45, ÜR I
- With time for questions and discussions
- Contact also via email: [firstname.lastname@uni-wuerzburg.de](mailto:firstname.lastname@uni-wuerzburg.de)
- 13–15 lectures
- Old videos from 2020 will be made available on WueCampus

# Tutorials

- Oksana Firman



## Exercise sheets.

- Weekly exercise sheets,  $\approx$  20 points/sheet
- Released at the lecture day (Wed)
- Submission deadline next lecture (Wed, 14:15)
- Digital submission
  - Recommended to use our LaTeX template
- Submission in teams of two
- Submissions in English (preferred) or German

## Tutorials.

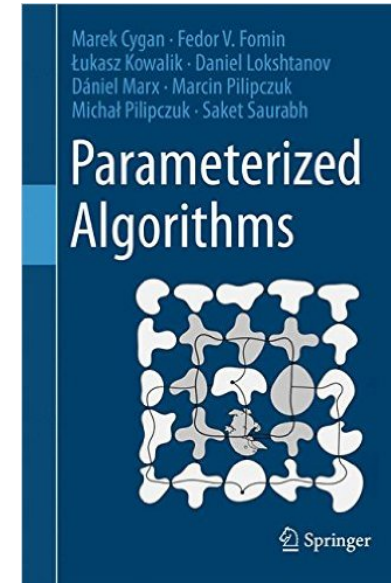
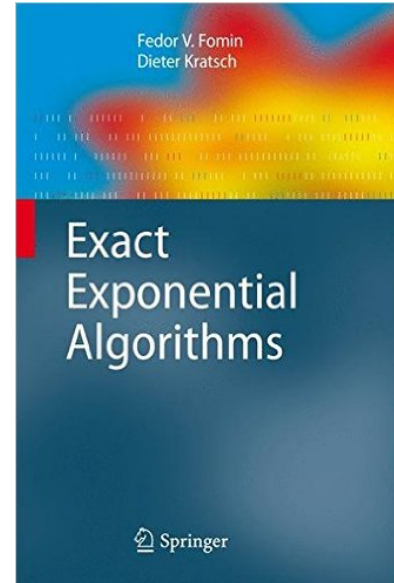
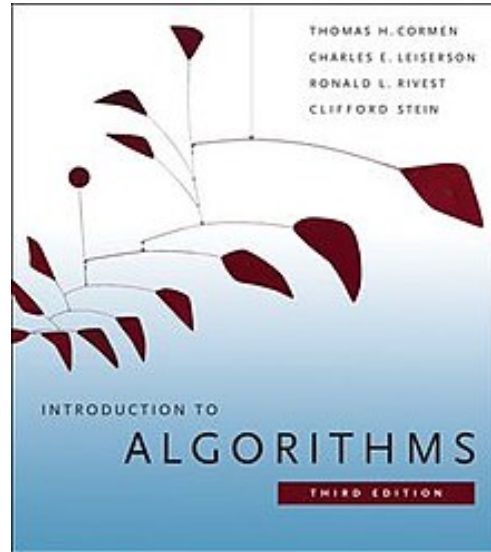
- In-person Mon 10:15–11:45
- ÜR I
- Discussion of the previous exercise sheet
- Time to work on & ask about the current exercise sheet
- Questions and discussions



# Exam

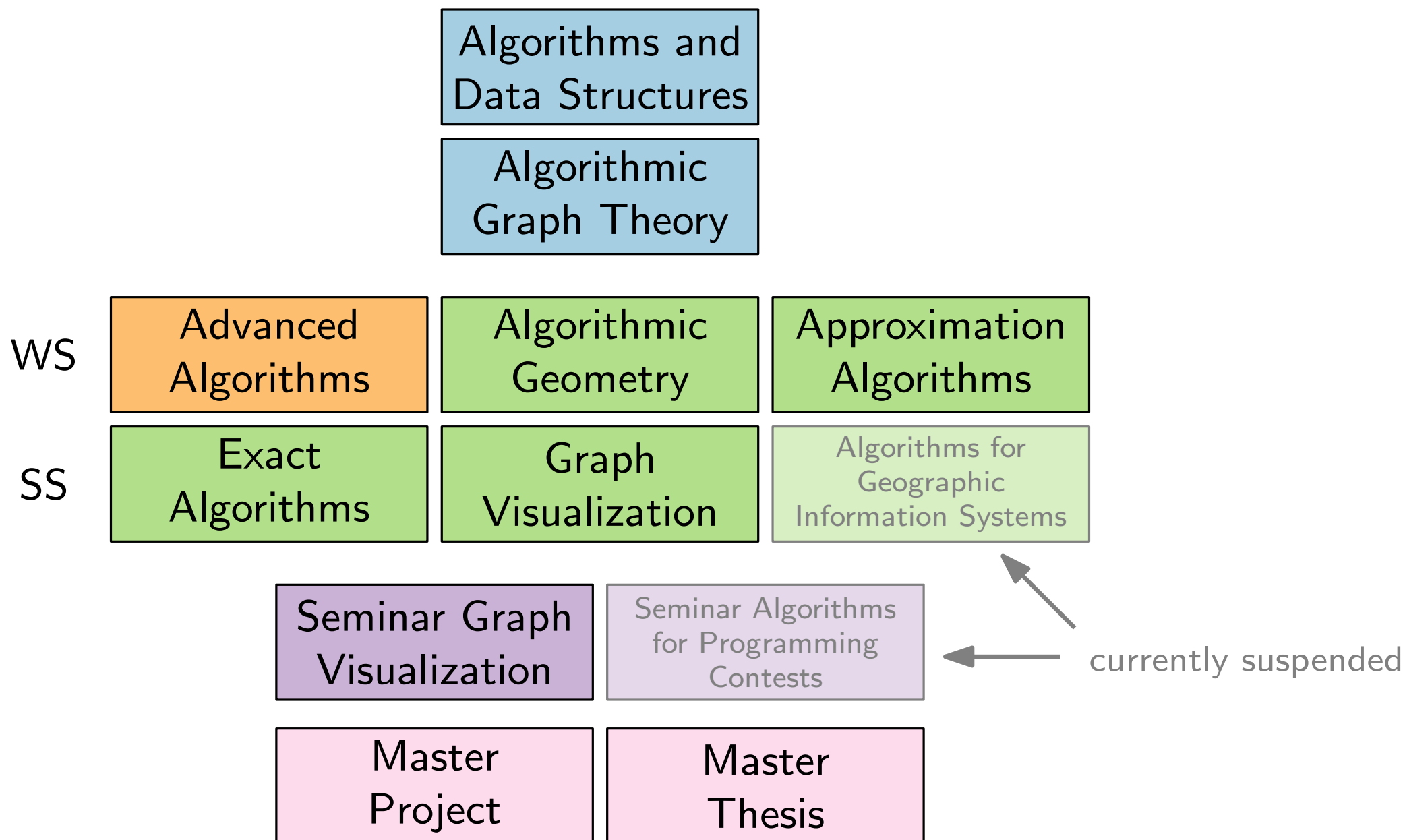
- Oral exam
- $\approx$  20min
- $\geq$  50% points on exercises sheets gives one grading level bonus (if passed)
- Date will be announced during the semester
- Don't forget to register in WueStudy:  
"Ausgewählte Kapitel der ..."

# Literature



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

# Our Lectures and Seminars



# 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, ...