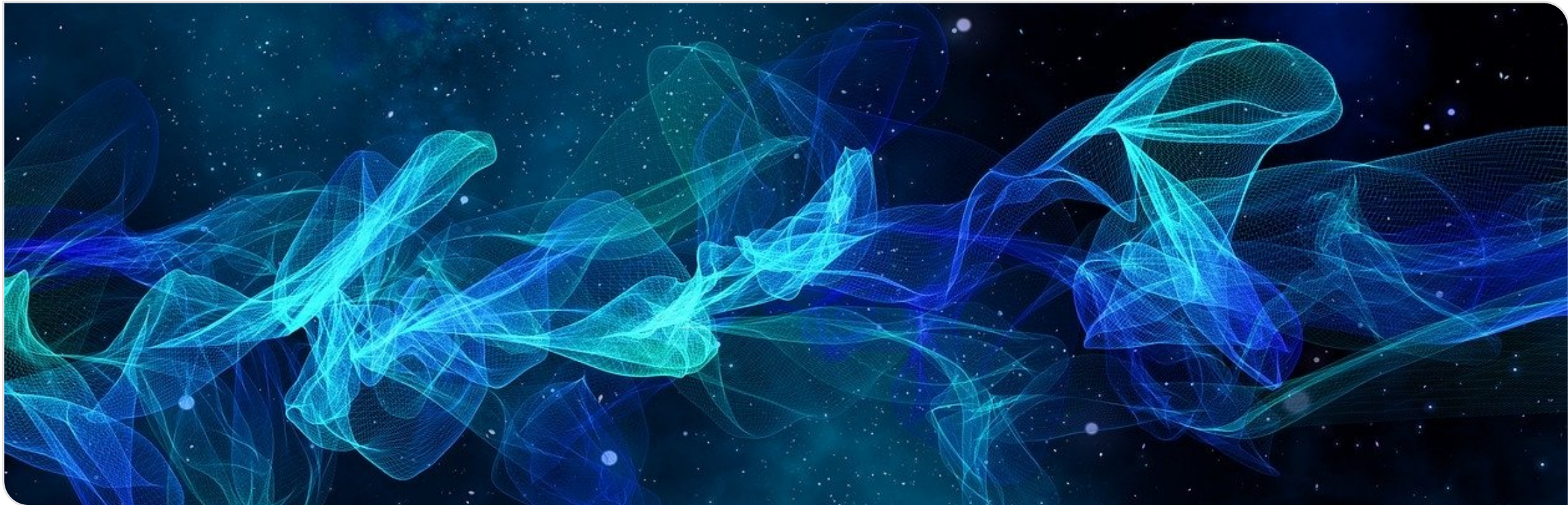# Fine-grained Algorithm Design and Engineering

Week 0: Organization
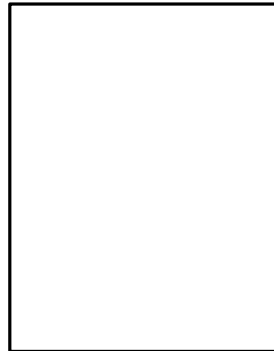**25.10.2024**

Course Details

- 6 ETCS

- Fr 9:45, 50.34 Room 236

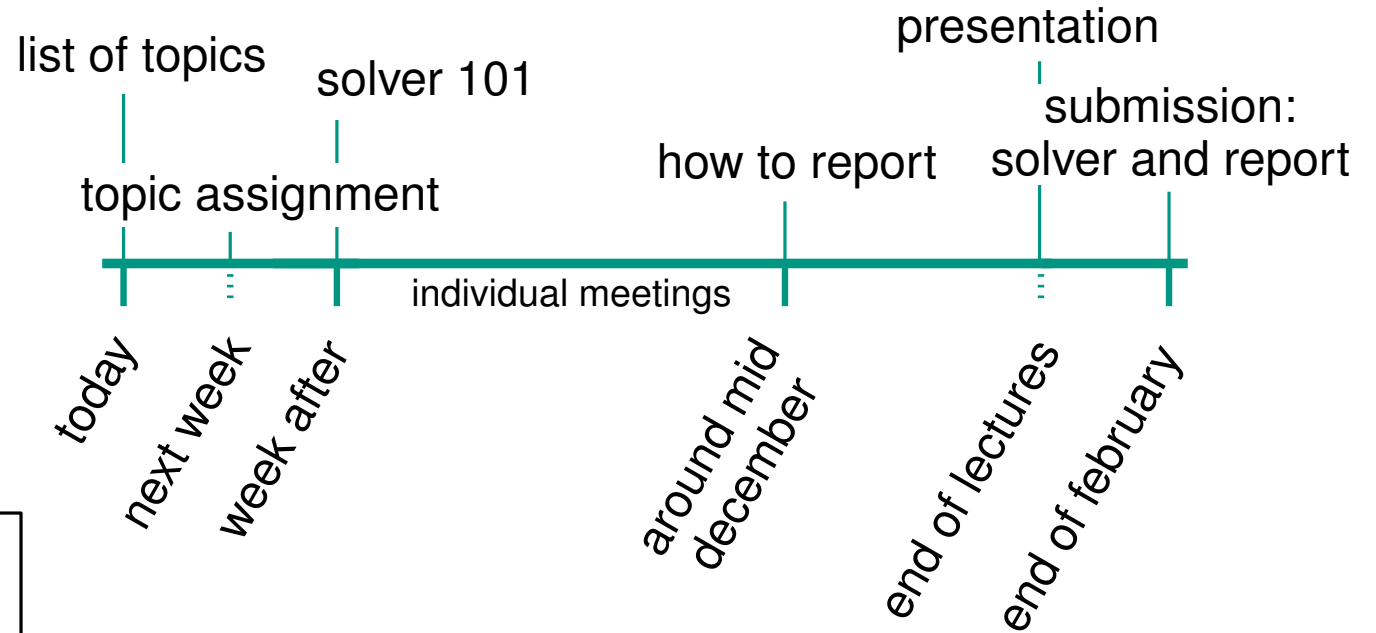 - regular meetings on individual basis

(subject to change)

list of topics
solver 101
presentation
submission:
how to report
solver and report
topic assignment

today — next week — week after — individual meetings — around mid december — end of lectures — end of february

Mirza Redzic
mirza.redzic@kit.edu

Sebastian Angrick
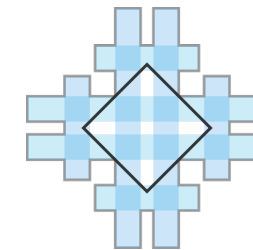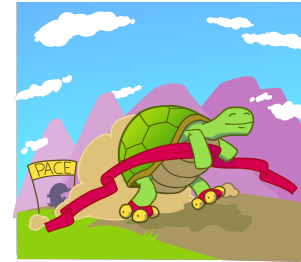sebastian.angrick@kit.edu

Today:
- challenge and expectations

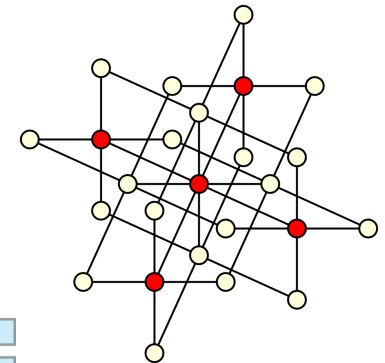- list of topics

- grading and remarks

The Challenge

> Learn how to design & implement fast algorithmic solutions!

- current or past algorithmic challange

- compuationally hard problems

- technical specifications based on challenge

  - limited time, no internet, no GPU

    $\rightarrow$ determine best bounds in theory

    $\rightarrow$ transfer to practice and/or develop new approaches

    $\rightarrow$ evaluate your implementation

    Opportunity to participate in **algorithmic competitions**

PACE challenge

CG:SHOP challenge

List of Topics

- work in groups of 2

- PACE Challenge 2025: Dominating & Hitting Set
    - exact track
    - heuristic track

- CG Challenge 2025: Non-obtuse Triangulation

- Int. Competition on Graph Counting 2024: Counting Paths

- PACE challenge 2023: Twin-Width

Topic #1-2: PACE 2025

- dominating set & hitting set

- future challenge, instances published in early 2025

- well-studied problem, lots of literature

- finding new approaches / improvements harder

- exact track: structurally restricted instances

    - e.g.: planar graphs, small treewidth graphs, …

- heuristic track: large general instances

    - but good approximation sufficient
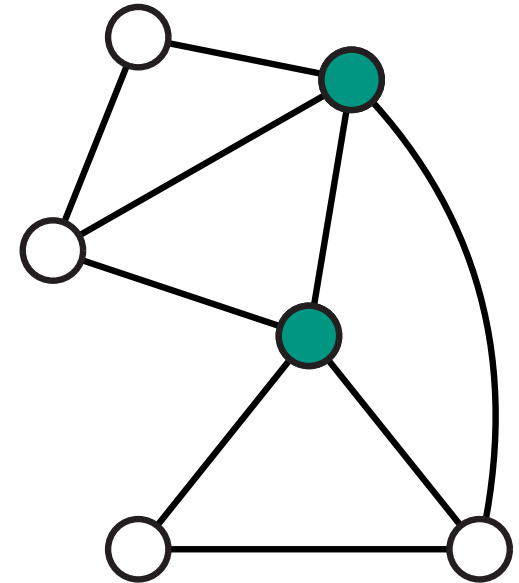
pacechallenge.org

Topic #3: CG 2025

- non-obtuse (planar) graph triangulation

- ongoing challenge, finish in early 2025

- classical problem in computational geometry

- less considered in theory
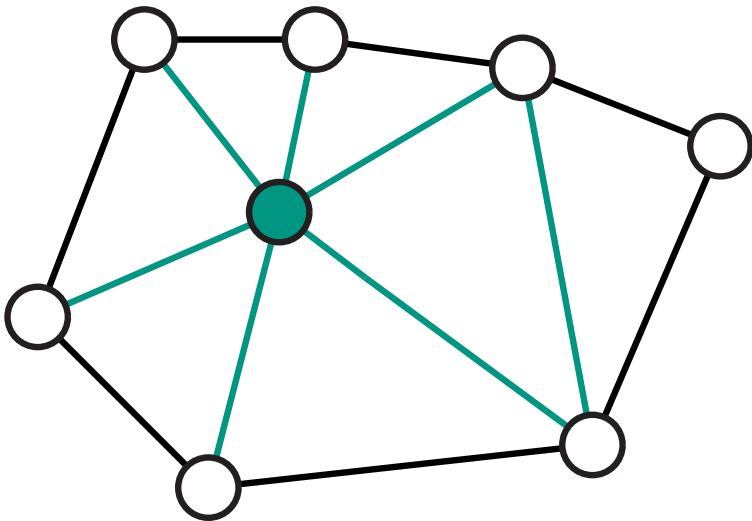
Input: a planar straight line graph

Objective: give a triangulation of the inputs convex hull that minimizes the number of Steiner points

https://cgshop.ibr.cs.tu-bs.de/

Mirza Redzic, Sebastian Angrick – Fine-grained Algorithm Design and Engineering   Institute of Theoretical Informatics, Algorithms & Complexity Theory Group

Topic #4: ICGCA 2024

- counting paths

- $\#P$-hard problem, quite graphical

- directed or undirected graphs

- finished challenge, presentation in December
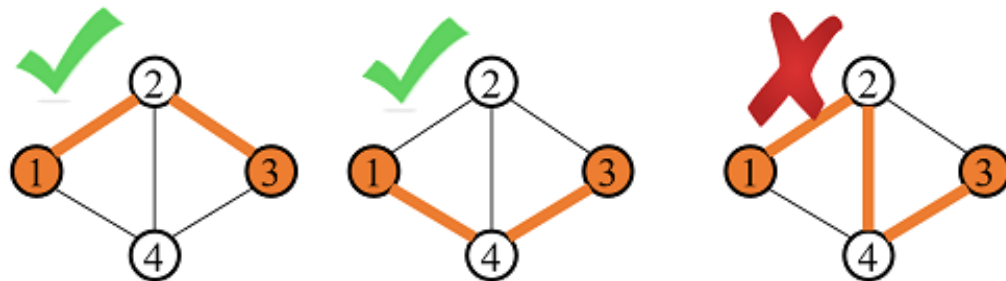
max. path length: 2

Input: simple graph, terminal vertices, maximum path length

Objective: count the number of valid paths between the terminal vertices

https://afsa.jp/icgca2024/

Topic #5: PACE 2023

- computing twin-width

- finished challenge, published results

- technical problem definition
  - people* are excited about this

- new approaches harder to get
  - relatively recent parameter

*at least theoreticians

pacechallenge.org
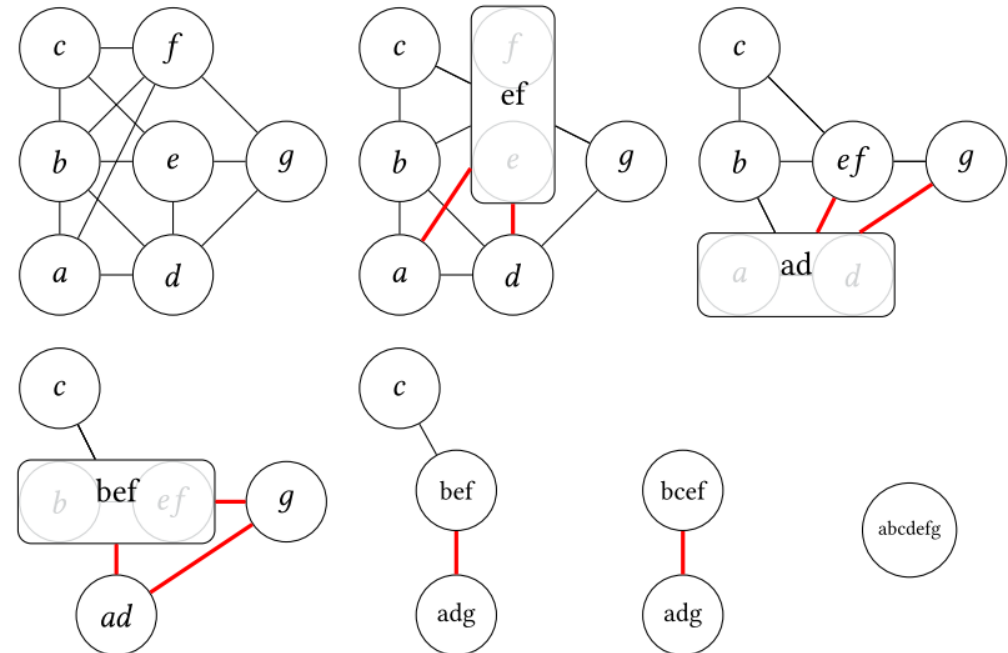
sequence for twin-width 2 [Bonnet et al., '21]

Expectations and Grading

- (more or less) continuous work, regular attendance in meetings

- independent theoretical and practical work

- open communication about achievements **and problems**

- we do not expect a winning solver!

- give improvements over current solvers **in some cases**

- you may (and should) use existing approaches or solvers
  - own contribution is important

Mirza Redzic, Sebastian Angrick – Fine-grained Algorithm Design and Engineering   Institute of Theoretical Informatics, Algorithms & Complexity Theory Group

Grading

Grading based on ...

- solver

- report

- final presentation

- overall impression

Reasons to fail:

- plagiarism (deception)

For an optimal grade ...

- (believed to be) "competitive" solver

- decent own contribution, some novel improvements

- thorough empirical and theoretical analysis of approach (if applicable)

- well-comprehensible presentation

- independent work

Mirza Redzic, Sebastian Angrick – Fine-grained Algorithm Design and Engineering   Institute of Theoretical Informatics, Algorithms & Complexity Theory Group

What's next?

- send an email with your 3 ranked preferences until 28.10 (23:59) to

  mirza.redzic@kit.edu and sebastian.angrick@kit.edu

- we notify you via email about your topic & coordinate meeting times

  - get familiar with definition, start with literature

- next week: Allerheiligen

- week after (early November): Solver 101, start of individual meetings

Questions?