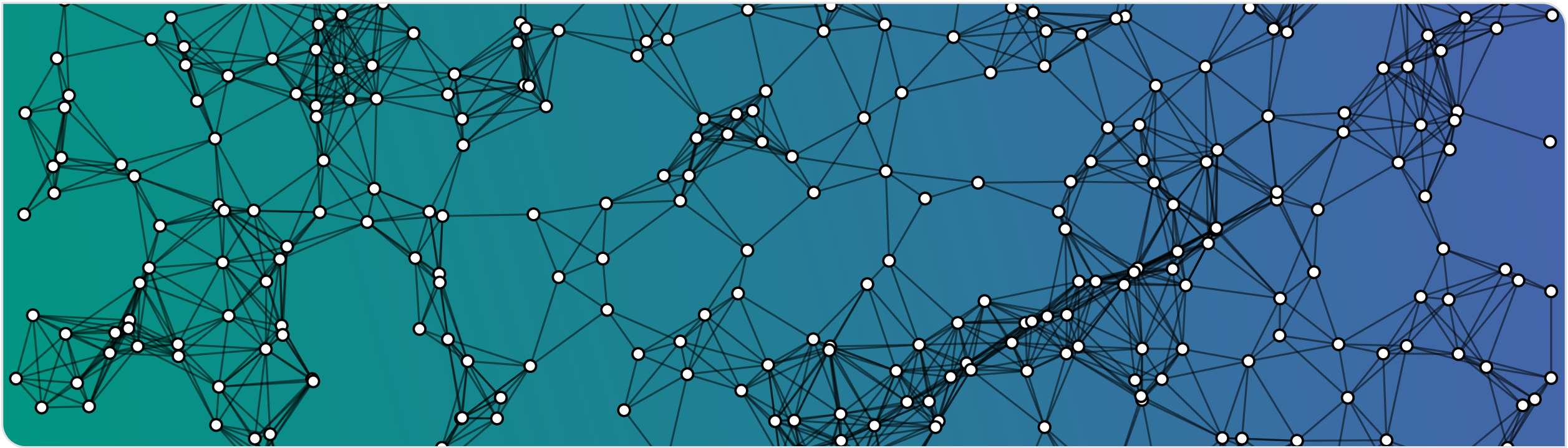
Karlsruher Institut für Technologie

Seminar Algorithmentechnik

Thomas Bläsius, Adrian Feilhauer, Sascha Gritzbach, Paul Jungeblut
Torsten Ueckerdt, Marcus Wilhelm, Matthias Wolf, Tim Zeitz



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- learn something about recent research in algorithms
- see some interesting proofs and proof techniques

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- engaging and fun presentation
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- scientific writing
- understandable but formally correct proofs
- concise presentation

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Practice reviewing
- spot mistakes in other's reports
- give constructive feedback

Learning Objective of the Course

	amount of work
Content ■ learn something about recent research in algorithms ■ see some interesting proofs and proof techniques	10h
Practice reading ■ reading mathy scientific texts ■ searching for additional literature/material	40h
Practice presenting ■ teaching proofs to others ■ making complicated things easy to understand ■ engaging and fun presentation ■ improving tool skills	30h
Practice writing ■ scientific writing ■ understandable but formally correct proofs ■ concise presentation	30h
Practice reviewing ■ spot mistakes in other's reports ■ give constructive feedback	10h
	120h≙4LP

Schedule

22.10.	Introduction
29.10.	[Ipe tutorial]
5.11.	
12.11.	Short presentations (5 min)
19.11.	
26.11.	Your Presentations (35+5 min)
3.12.	
10.12.	
17.12.	
7.1.	
...	
28.1.	First submission of written document
18.2.	Submission of reviews
18.3.	Final submission of written document

Course of Action

Today

- select a topic

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In three weeks (12.11.)

- short presentations (5 min)
  - advertise main presentation
  - motivate topic and intuitively explain highlights

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In three weeks (12.11.)

- short presentations (5 min)
  - advertise main presentation
  - motivate topic and intuitively explain highlights

Two weeks before your presentation (at last)

- you should have
  - read and understood your chapter **in detail**
  - performed a literature review
  - thought about what to present and how to present it

Course of Action continued

One week before your presentation (or earlier)

- you should have
  - **finished** your slides for the presentation
  - send them to your advisor
- meet your advisor to discuss you slides

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First document submission deadline (28.1.)

- submit your document (at most 10 pages)
- receive two documents to review

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Review submission deadline (18.2.)

- submit your reviews, receive other's reviews

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Grading

- Quality of main presentation
- Quality of *final* written document

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Title: Finding Cliques in Social Networks: A New Distribution-Free Model

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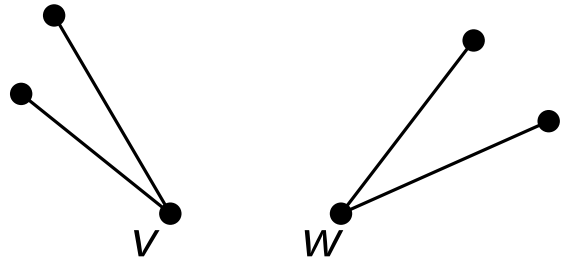

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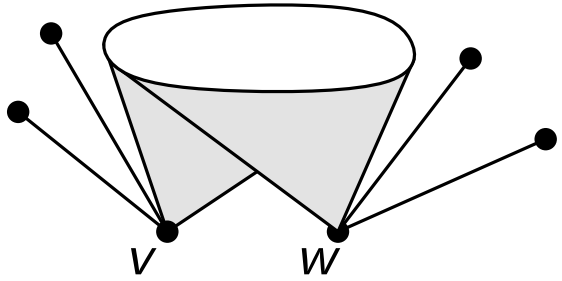

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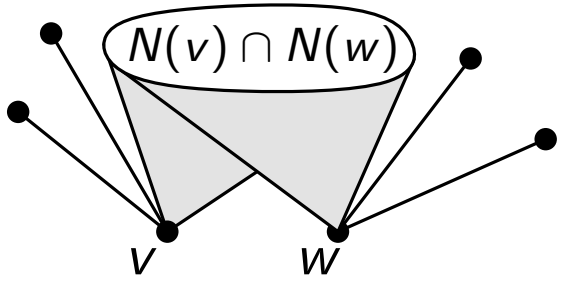

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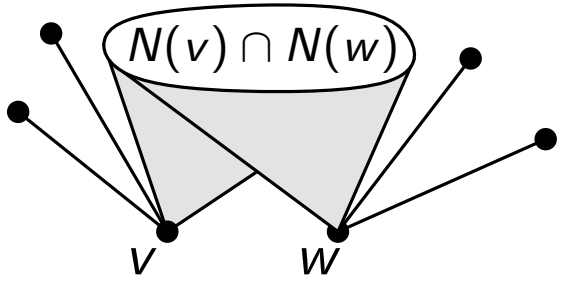

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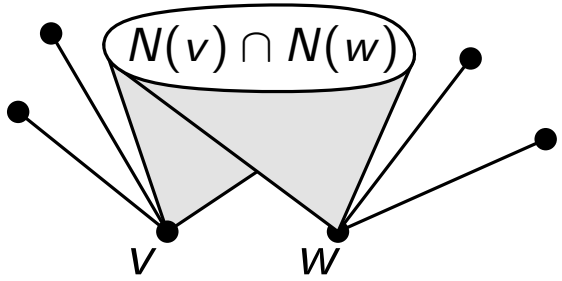

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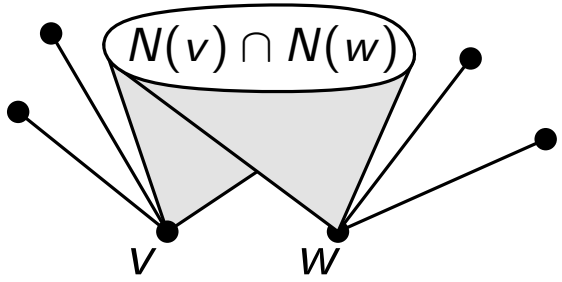
G *weakly* c-closed: ordering $v_1, \ldots, v_n$ s.t. v_i forms no bad pair in $G[v_i, \ldots v_n]$



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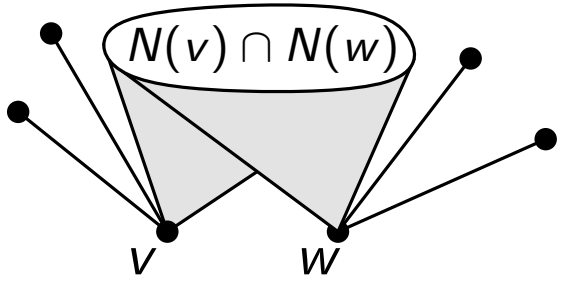

Result: FPT algorithm with parameter c to enumerate all maximal cliques

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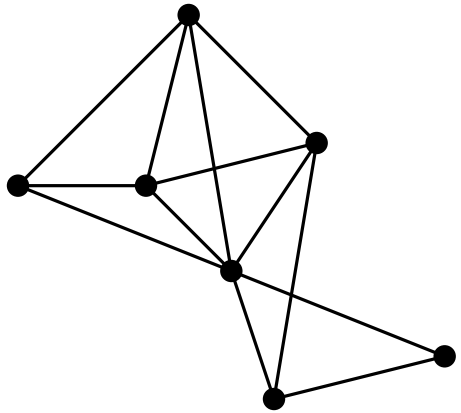

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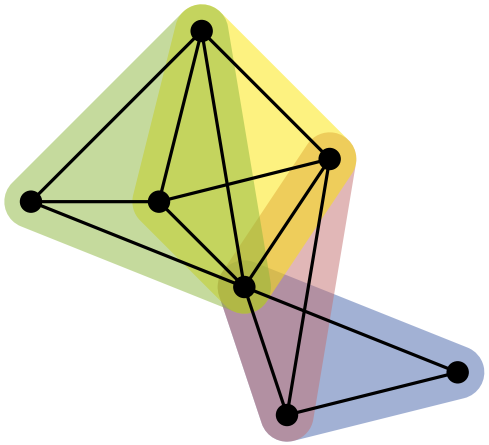

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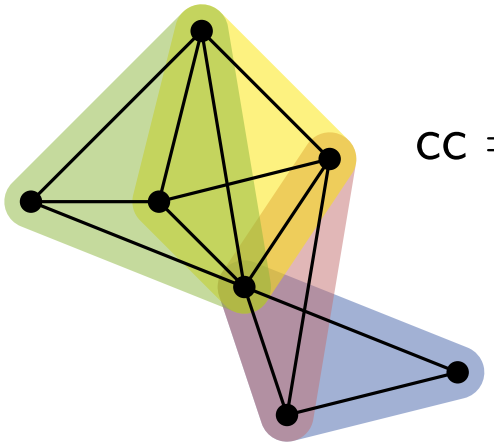

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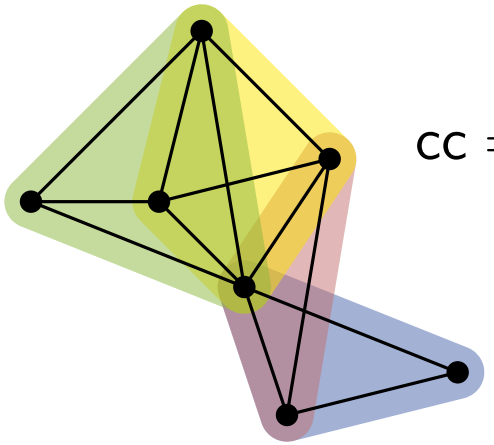

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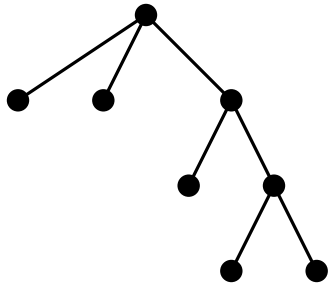

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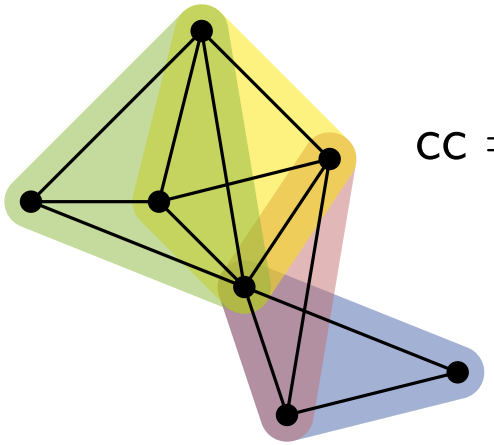

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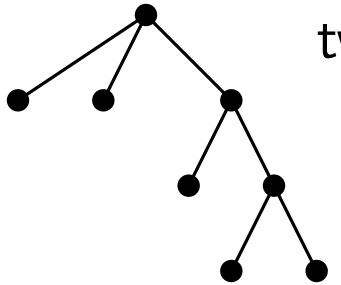

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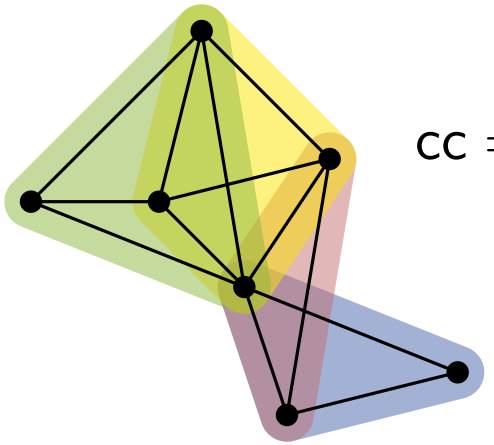

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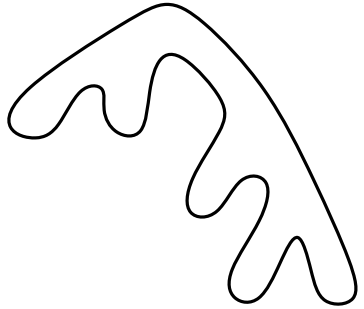

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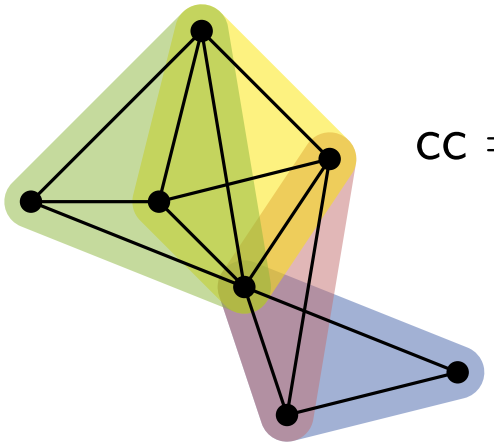

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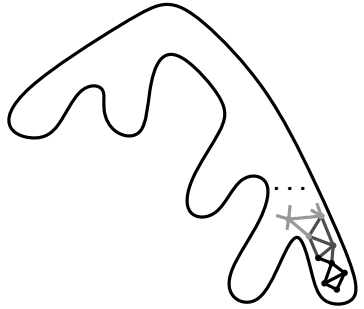

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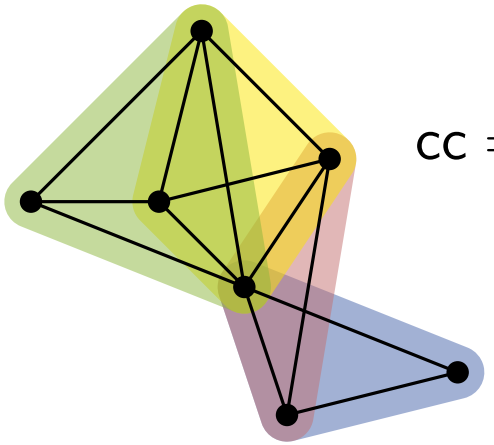

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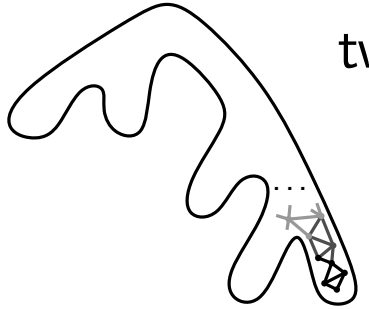

tw $\approx$ size of separators

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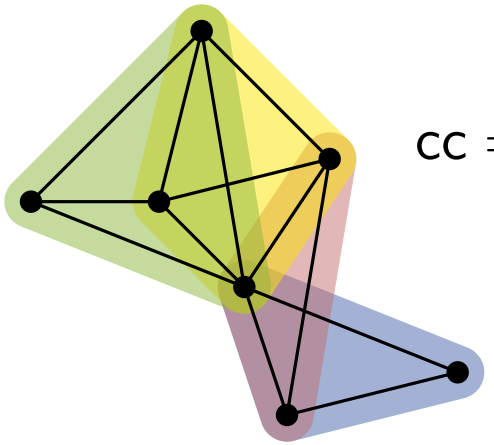

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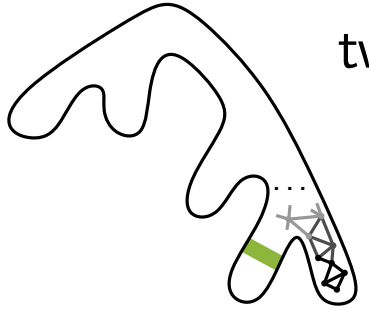

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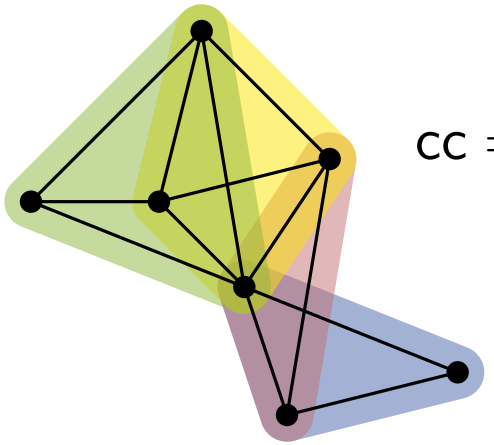

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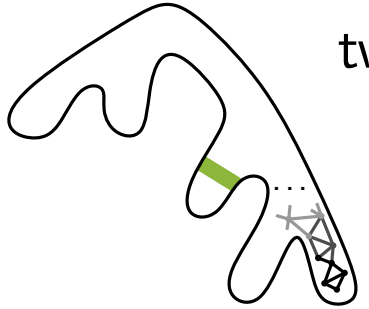

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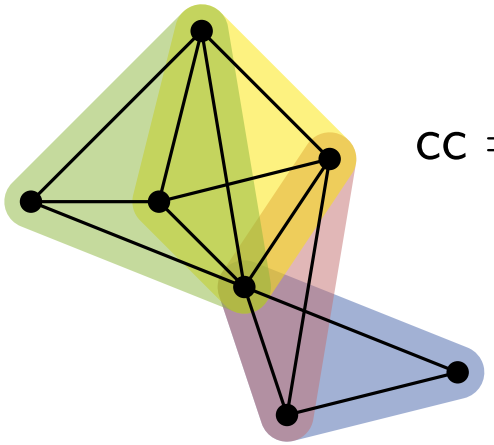

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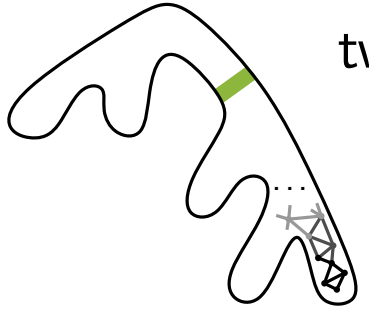

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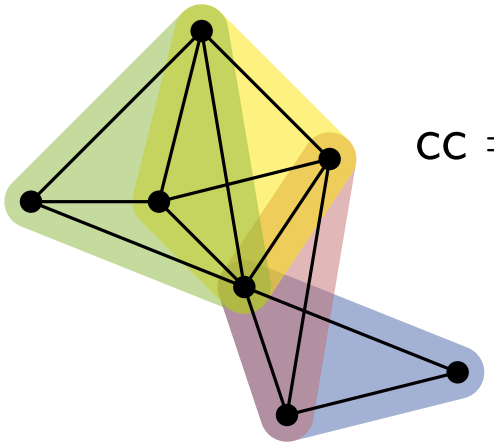

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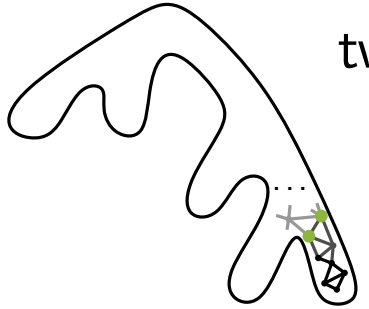

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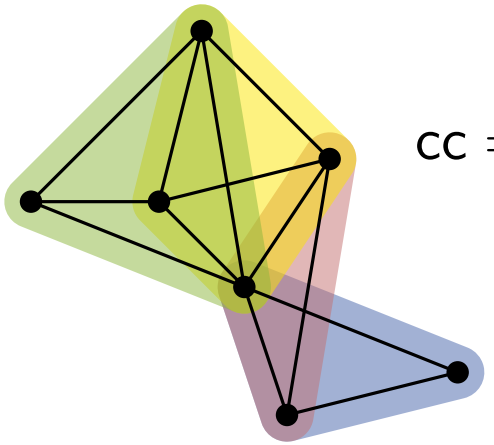

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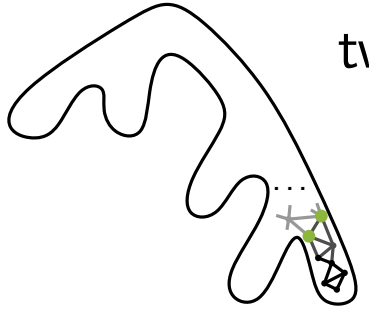

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Contribution: upper bounds for minimal separators and potential maximal cliques using edge clique cover

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Contribution:

- first known 2-approximation with running time $2^{O(k)} \cdot n$
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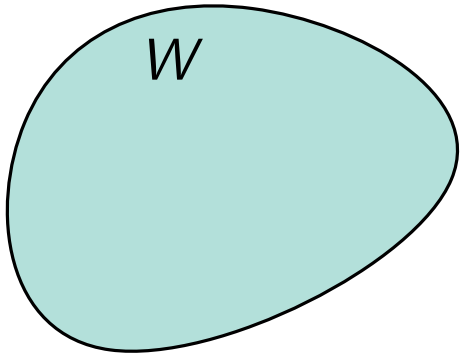

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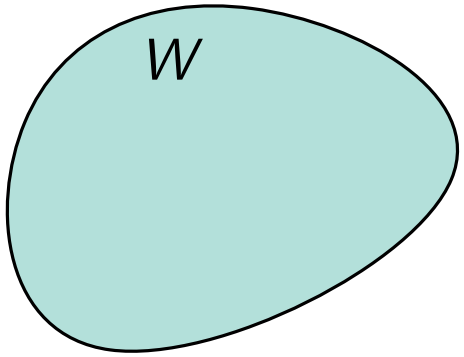

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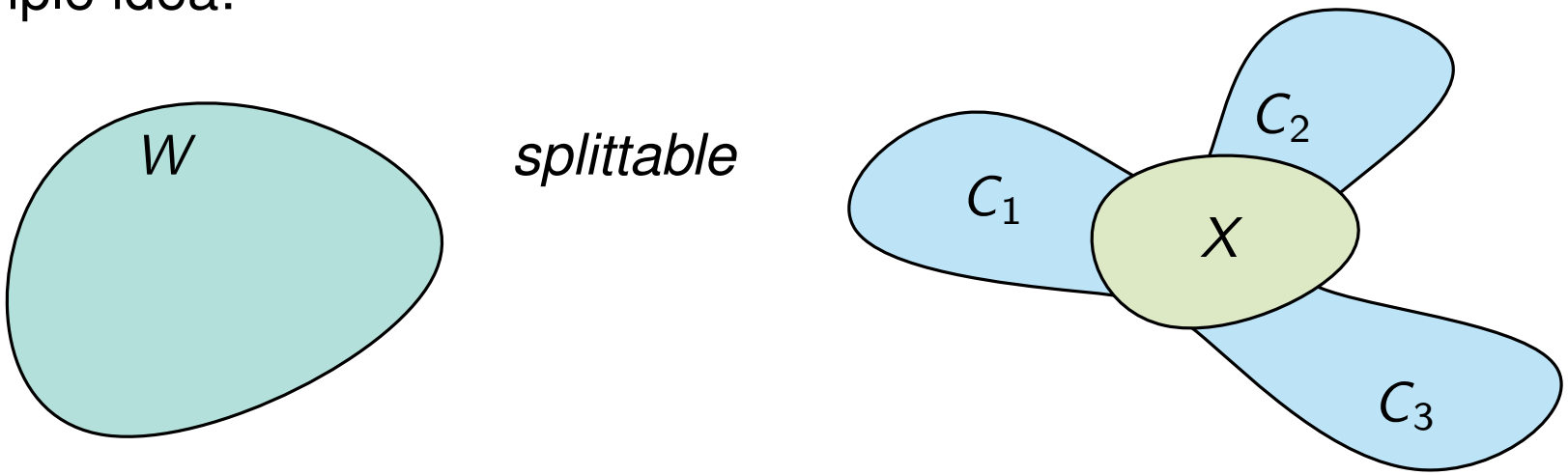

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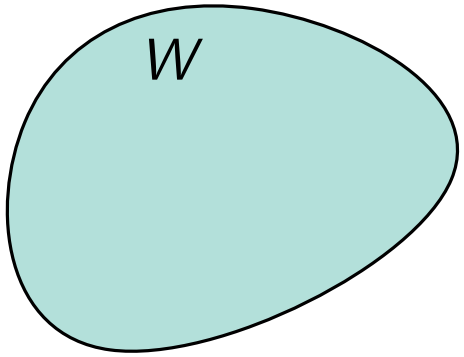

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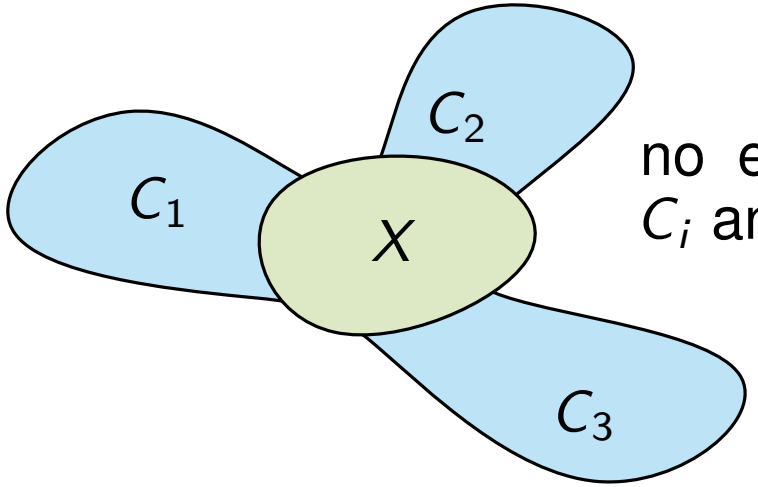

no edges between C_i and C_j

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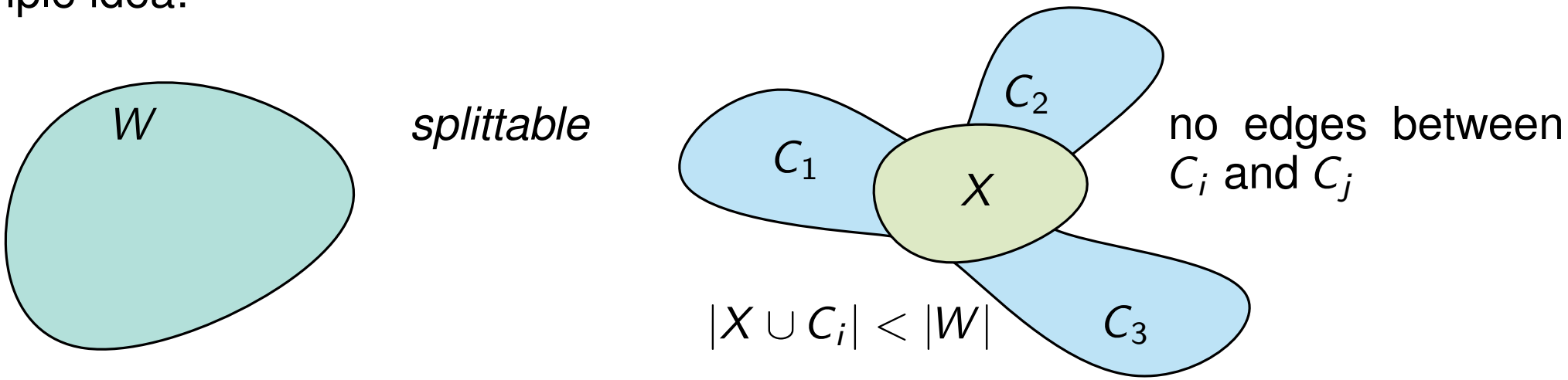

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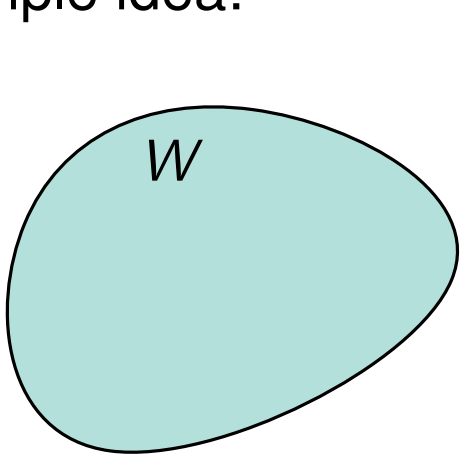
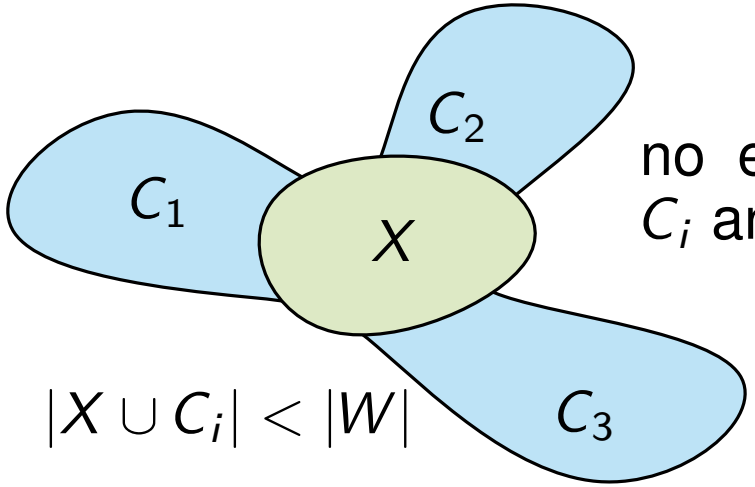


splittable



no edges between C_i and C_j

Lemma: Assume $\mathrm{tw}(G) \leq k$. If $|W| \geq 2k + 3$, then W is splittable.

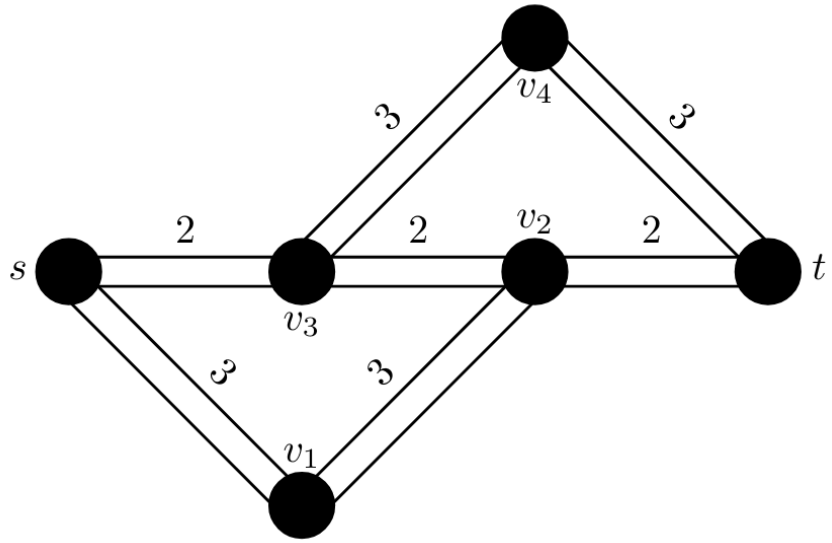
Topic 4: Flows Over Time

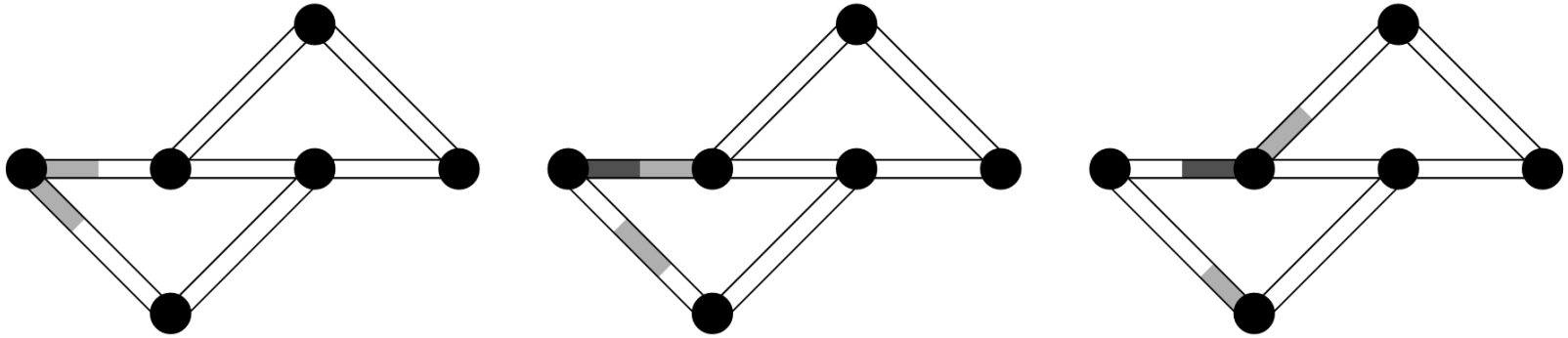
Problem:

- Route flow from s to t
- Traversing edges takes time

Results:

- Temporally repeated flows
- Generalized cut-flow duality



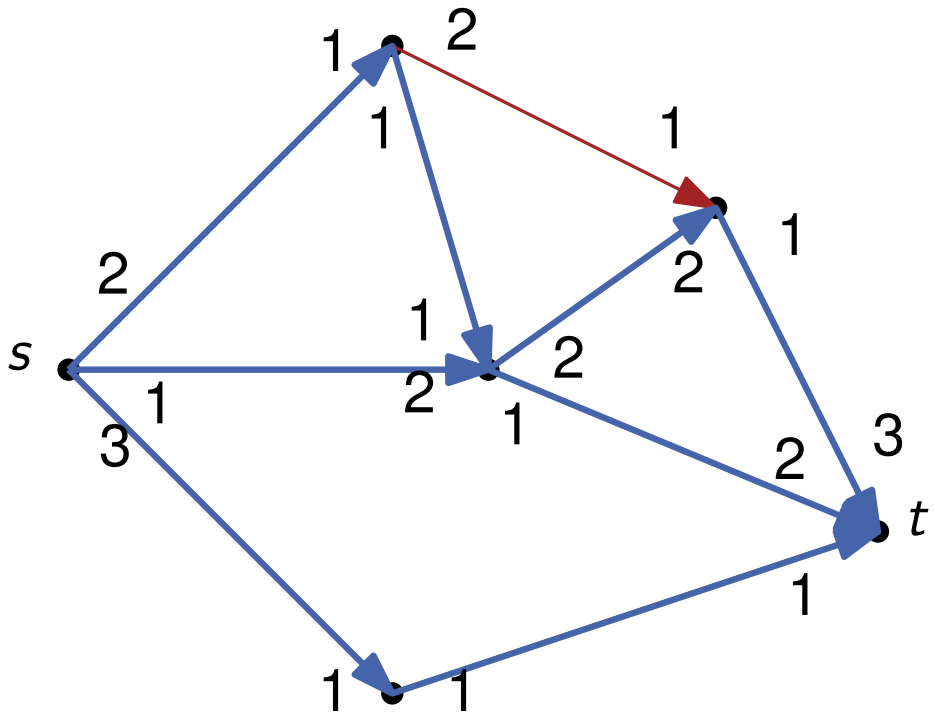


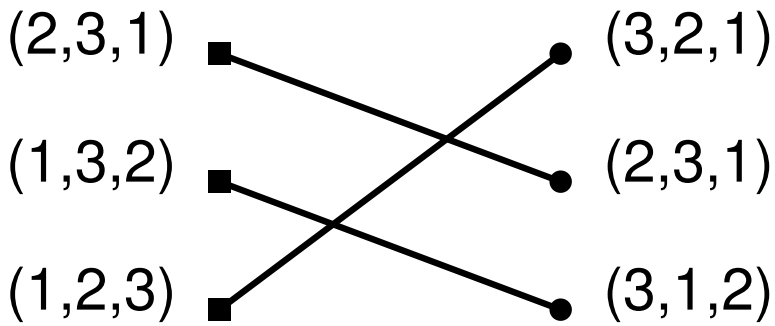
$\theta = 1$ $\theta = 2$ $\theta = 3$

Topic 5: Stable Matchings and Flows

Problem:

- Generalized stable marriage problem
- Matchings under vertex preferences
- No better matching for any vertex

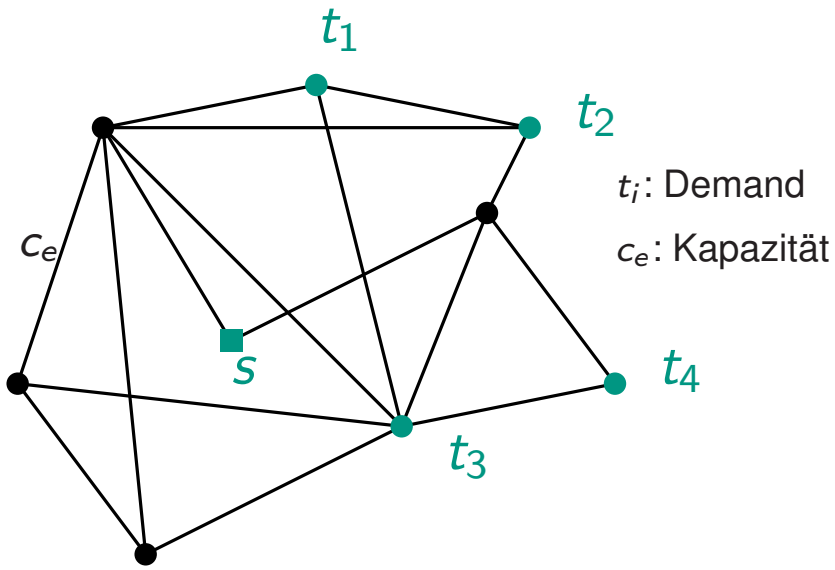


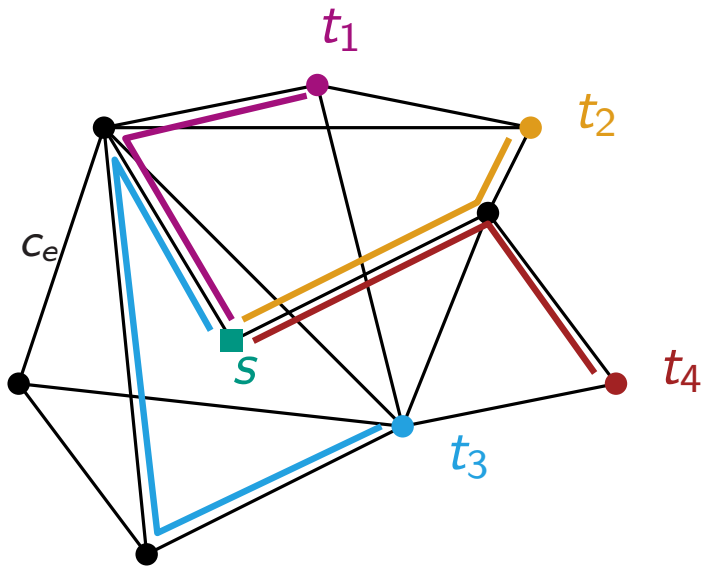


Results:

- Stable allocations and flows exist
- Integral capacities $\rightarrow$ integral flow

Topic 6: (Single-Source) Unsplittable Flow Problem





Finde Fluss-Pfade von t_i zu s

(unter Kapazitätsbedingungen).

$\rightarrow$ Verschiedene Zielfunktionen

Als Seminarthema:

Geeignete Auswahl von Approximations-algorithmen und Techniken aus [0].

[0] Kleinberg, Jon M. “Single-source unsplittable flow."*Processings of 37th Conference on Foundations of Computer Science.* IEEE, 1996.

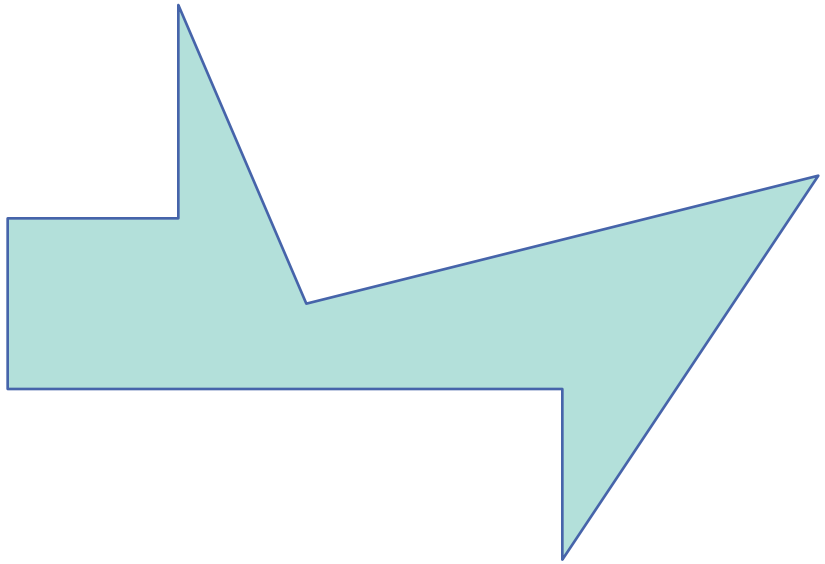
Topic 7: Irrational Guards are Sometimes Needed

setting

- ▷ polygonal region P
- ▷ place k guards surveying P
- ▷ minimize k

results

- ▷ integral region P
- ▷ guards at irrational points in every optimal solution



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Karlsruher Institut für Technologie

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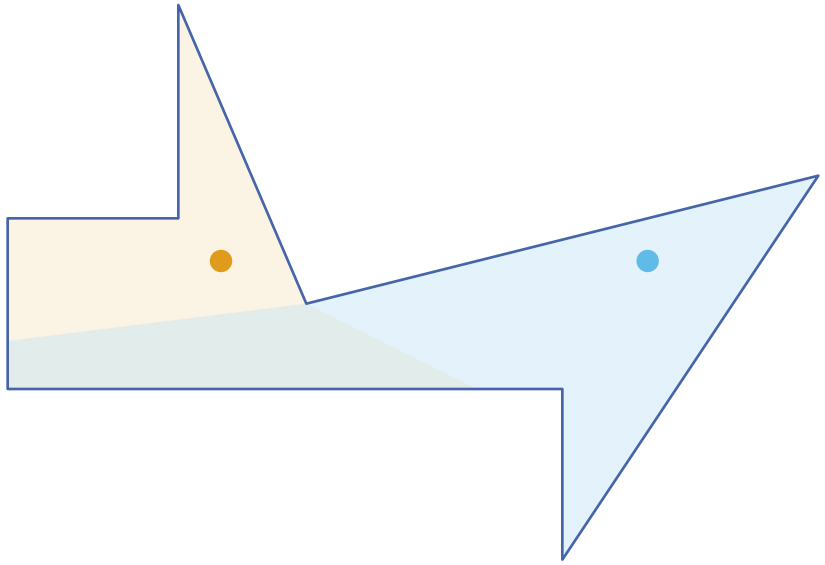

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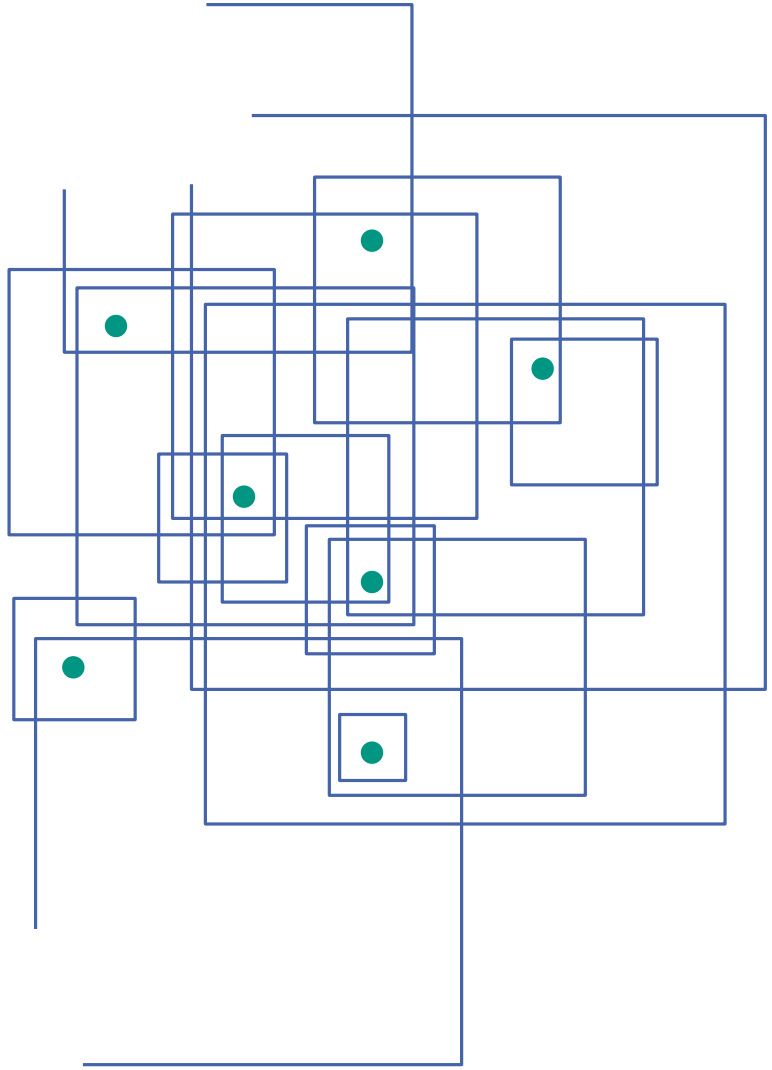
Topic 8: VC-Dimension of Geometric Set Systems



setting

- ▷ finite set X, family of subsets $\mathcal{R}$
- ▷ Y shattered: subsets captured by $\mathcal{R}$
- ▷ VC-dim$(\mathcal{R}) = \max |Y|$, Y shattered
- ▷ $\mathcal{R}^{\cup k}$, $\mathcal{R}^{\cap k}$ k-fold union/intersection

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- ▷ construction of points in $\mathbb{R}^p$ and half-spaces
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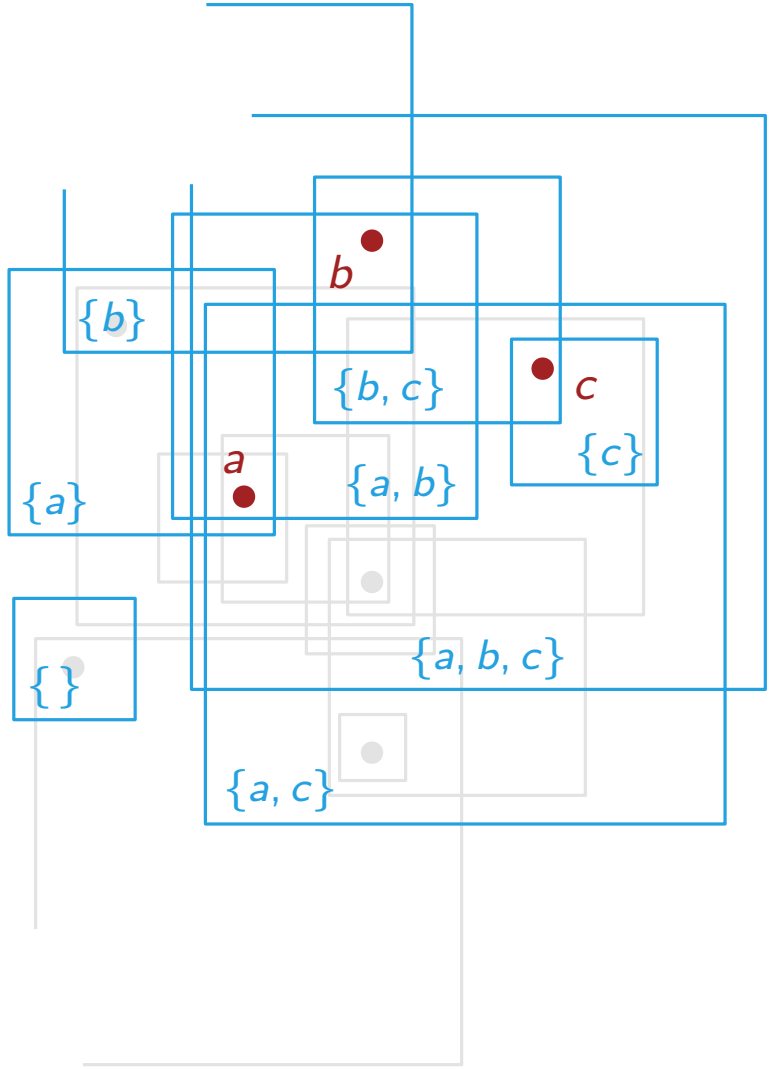

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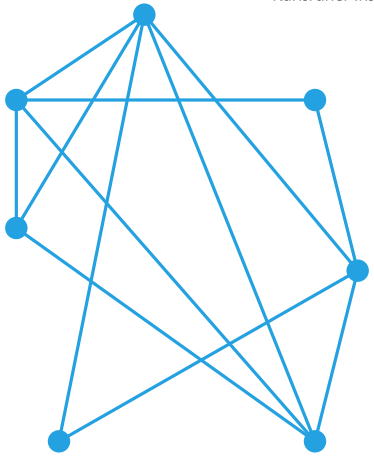
Topic 9: The Utility of Untangling



setting

- straightline drawing D with crossings
- move few vertices to get planar
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- upper and lower bounds
- applications:
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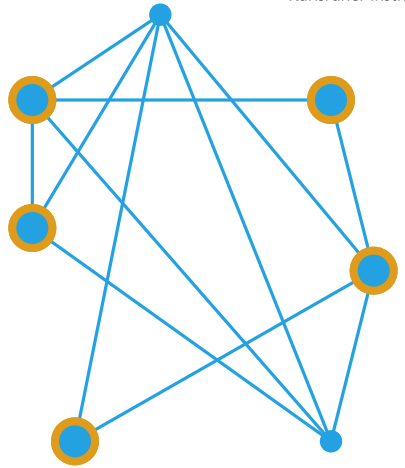

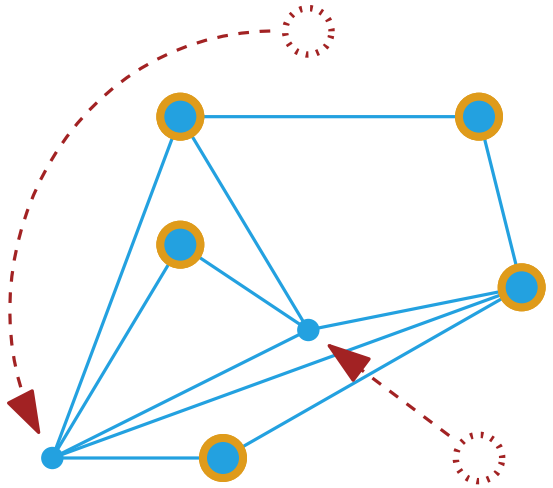

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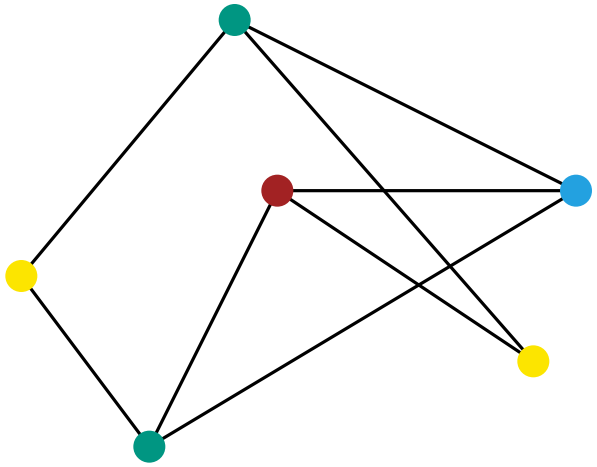
Topic 10: Dynamic Algorithms for Graph Coloring



setting

- ▷ dynamic graph with edge insertions and edge deletions
- ▷ maintain proper vertex coloring
- ▷ minimize # colors and update time

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- ▷ random $\Delta + 1$ colors, $O(\log \Delta)$ updates
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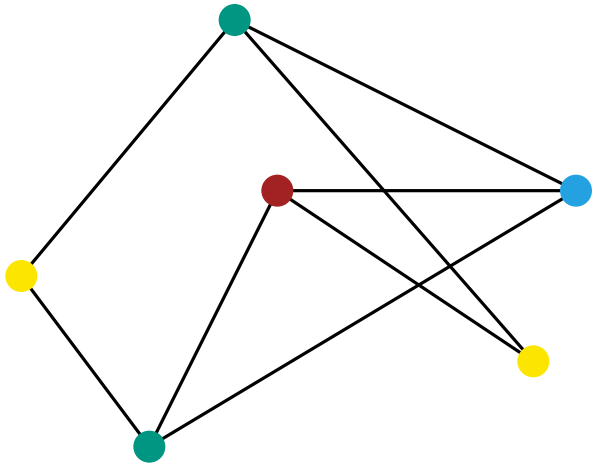

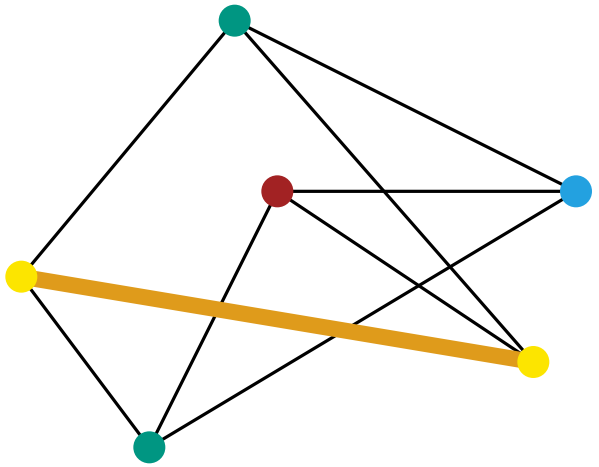

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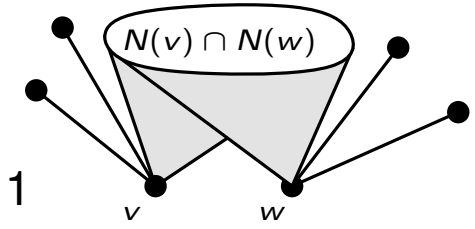
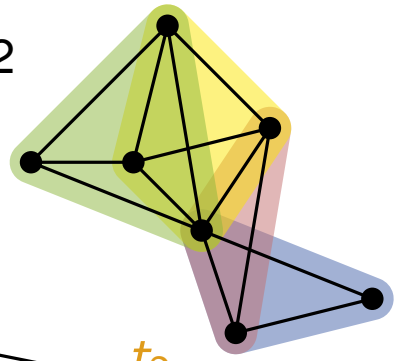
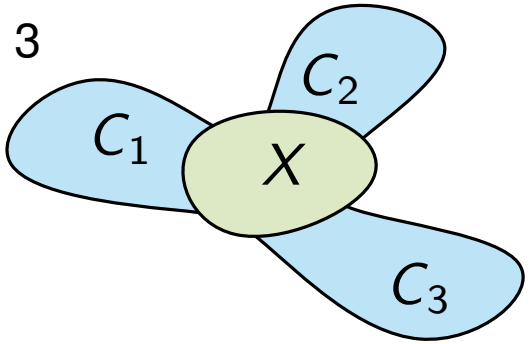
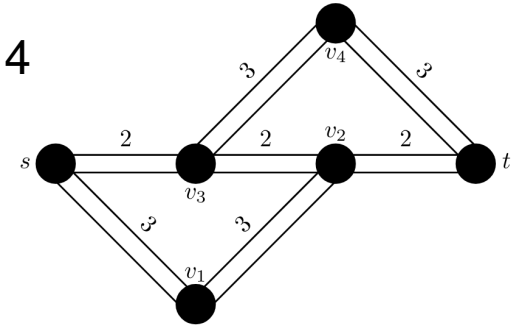
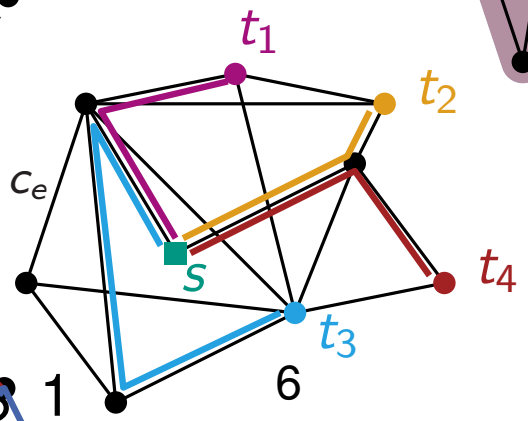
Topics: overview

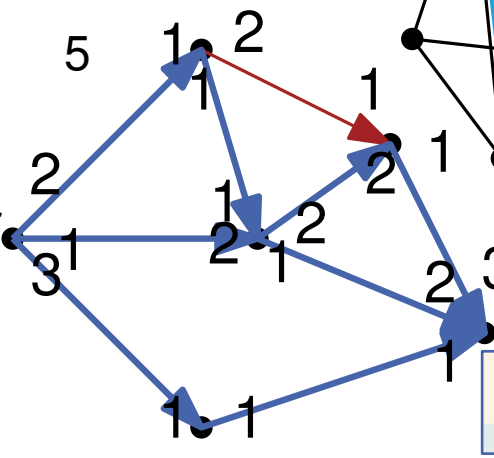


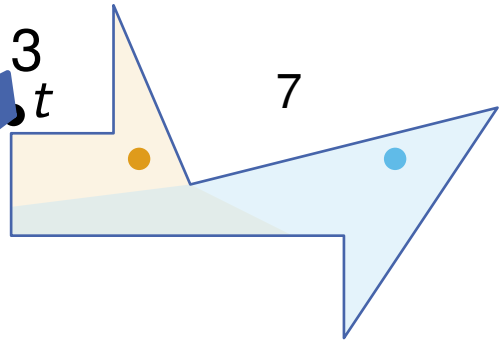


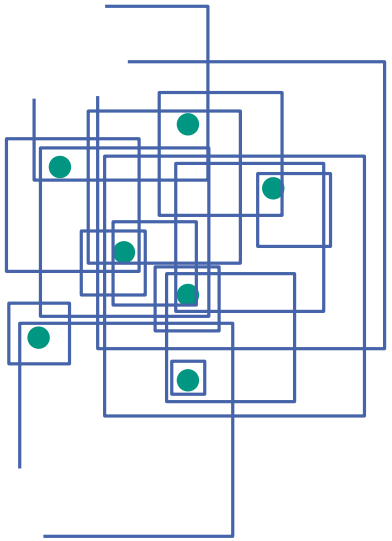


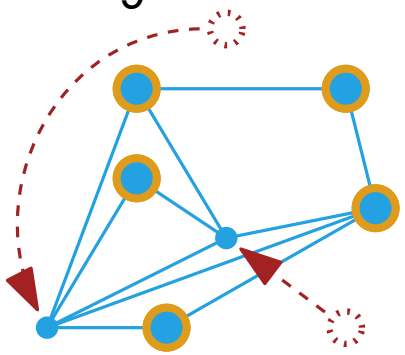


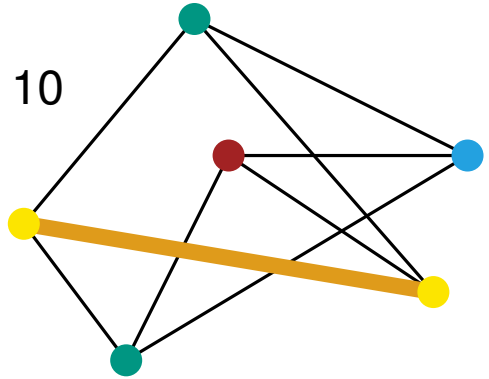












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More comments

Presentation

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- Can some arguments be simplified?
- Is your presentation fun? Interactive?

Some more comments

Written Document

Some more comments

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- Structure:

Some more comments

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- Structure:
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  - introduction, related work, (applications)
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  - regularly read what you just wrote
    - check correctnes, clarity
    - what is the purpose of a sentence / paragraph?
  - should sentences / paragraphs be rearranged?

Even more comments

Mutual Reviews

- written statement (form provided)
- optionally: annotations
- Structure:
  - short summary of the content
  - strengths and weaknesses of the work
  - review of the text (comprehensibility, structure, accuracy, language, topic coverage, ambiguities, . . .)
- be constructive: detailed comments and correction instructions
- as detailed as you would like to get review for your work
- objective and fair

Organization

Website

- `https://scale.iti.kit.edu/teaching/2021ws/seminar`
- you find these slides there
- other information like dates of the talks
- slides of all participants

Next week: Ipe tutorial

- install ipe and make sure it works
  - get and install ipe: ipe.otfried.org
  - make sure LaTeX is installed
  - open Ipe and check whether LaTeX works: press “ℓ”; click somewhere in the drawing area; insert some text; click Ok; check whether it nicely rendered your text (it might be necessary to press “Ctrl+ℓ” to make sure it renders correctly)
- bring a laptop and a mouse