Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

Lehrstuhl für
INFORMATIK I
Algorithmen & Komplexität

Institut für Informatik

Seminar:
Themen der Algorithmik

Sommersemester 2025

Einführungsveranstaltung am 29. April 2025

Lehrstuhl für Informatik I

Alexander Wolff, Boris Klemz, Diana Sieper, Tim Hegemann, Samuel Wolf

Ziele und Inhalte

In diesem Seminar geht es teils um **aktuelle Forschungsthemen** und **neue Trends**, teils **klassische Resultate** aus dem Gebiet **Algorithmik**.

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JedeR TeilnehmerIn arbeitet sich in ein abgegrenztes Thema ein. Dieses ist didaktisch aufzubereiten und den anderen KursteilnehmerInnen in einem **Vortrag** zu vermitteln, sowie in einer **schriftliche Ausarbeitung** darzustellen.

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Ziele:

- Zeitnah einarbeiten
- Themenauswahl prüfen
- Vortragen üben
- Feedback bekommen ohne Bewertung

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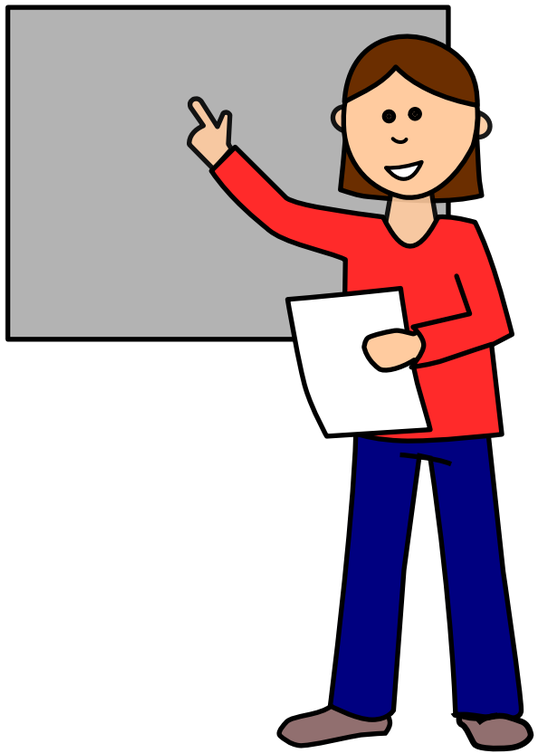

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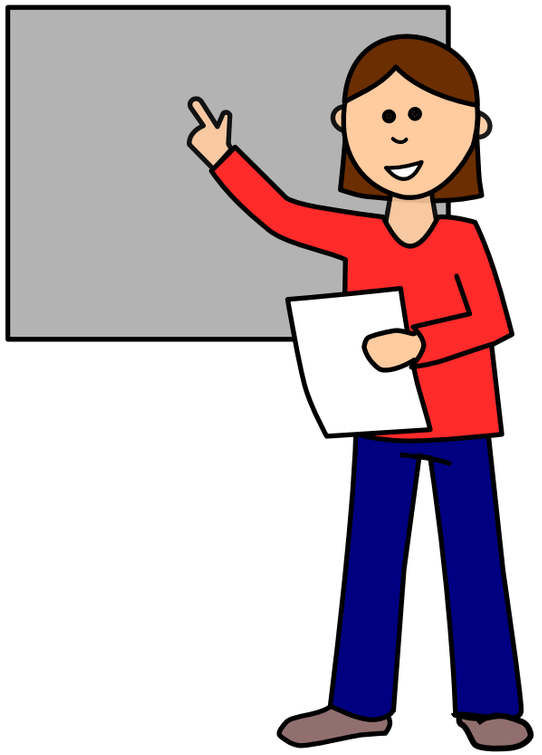
- Mo, 04.08.2025: **Ausarbeitungen** abgeben



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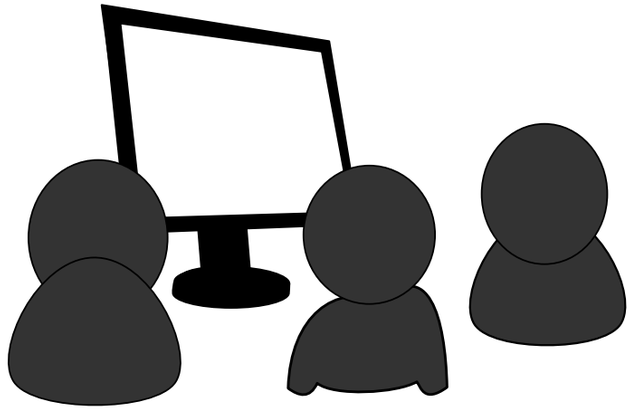

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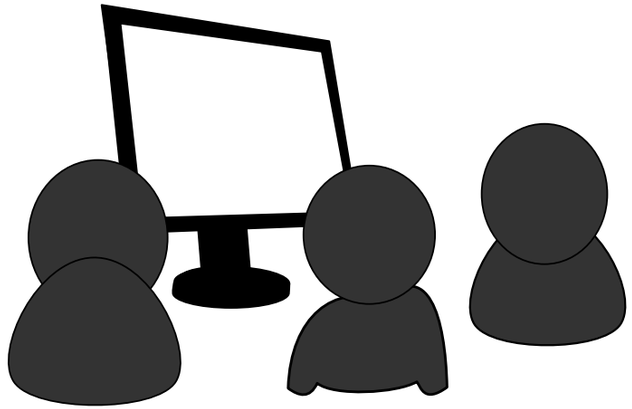

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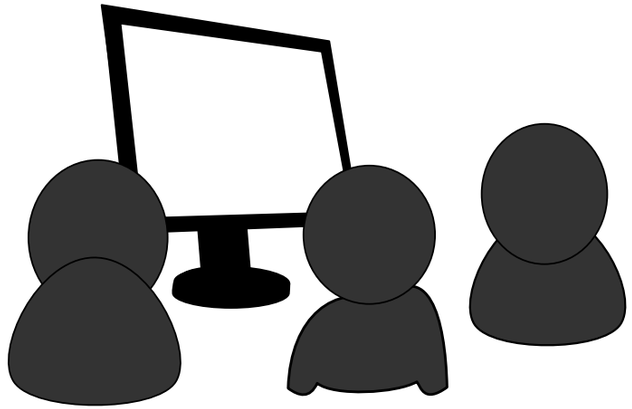

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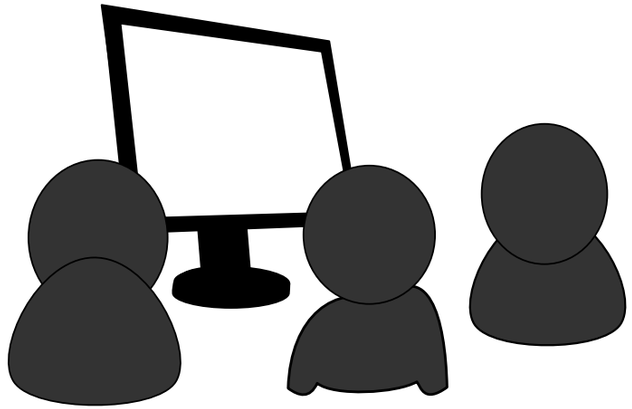

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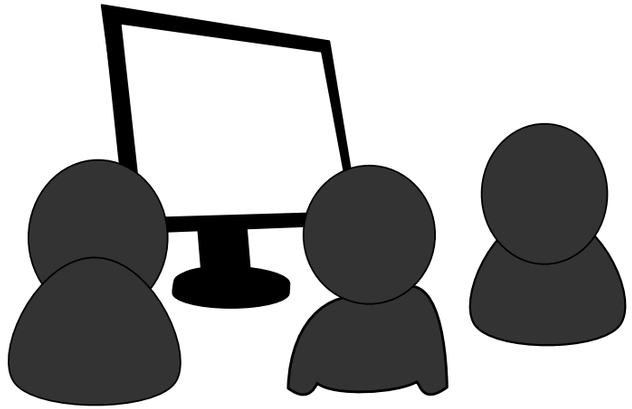

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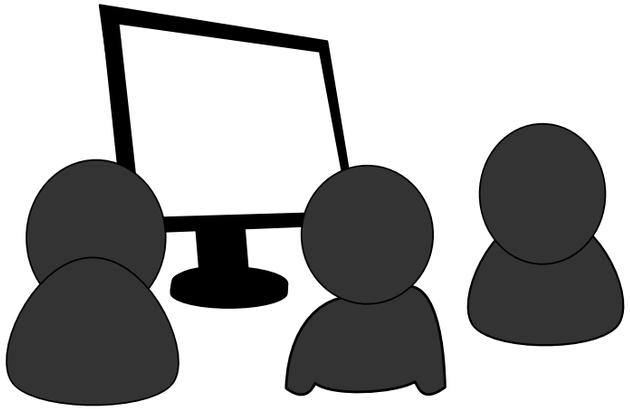

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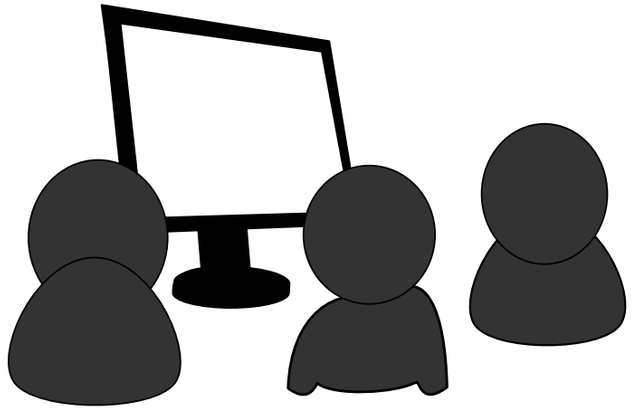

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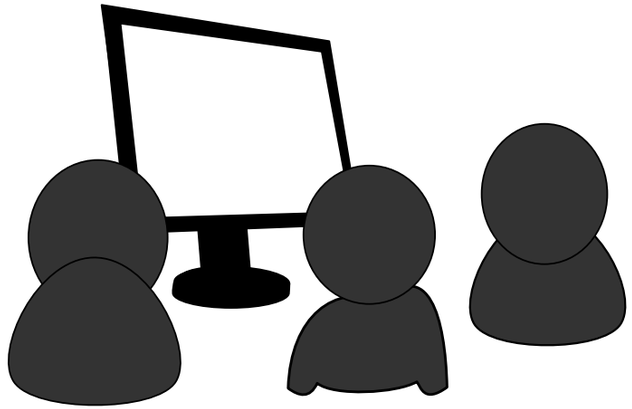

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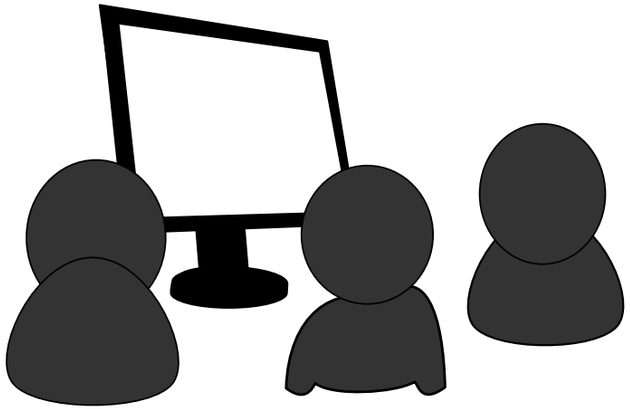

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- **Vorabversion** der Ausarbeitung bis spätestens 2 Wochen nach dem eigenen Vortrag abgeben, um Feedback zu erhalten (freiwillig).

Bestehen & Bewertung

Voraussetzungen für das Bestehen des Seminars

- Halten einer Präsentation zum gewählten Thema
- Anfertigen einer Ausarbeitung
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- Vortrag (Inhalte, Gestaltung der Folien, Verständlichkeit, Interaktivität)
- Ausarbeitung (Inhalte, roter Faden, sprachliche Darstellung, Rechtschreibung, eigener Beitrag)
- 50 : 50

Themenübersicht

1. Parameterized Complexity of Simultaneous Planarity
2. Lower bounds based on the Exponential-Time Hypothesis
3. Constraint Logic: A Uniform Framework for Modeling Computation as Games
4. XALP-completeness of Parameterized Problems on Planar Graphs
5. Approximation Algorithms for NP-complete Problems on Planar Graphs
6. How to Morph Planar Graph Drawings
7. Sliding Squares in Parallel
8. Crossing Number of 3-Plane Drawings
9. Geometric Spanners of Bounded Tree-width
10. Efficient Parameterized Approximation
11. Kuratowski's Theorem

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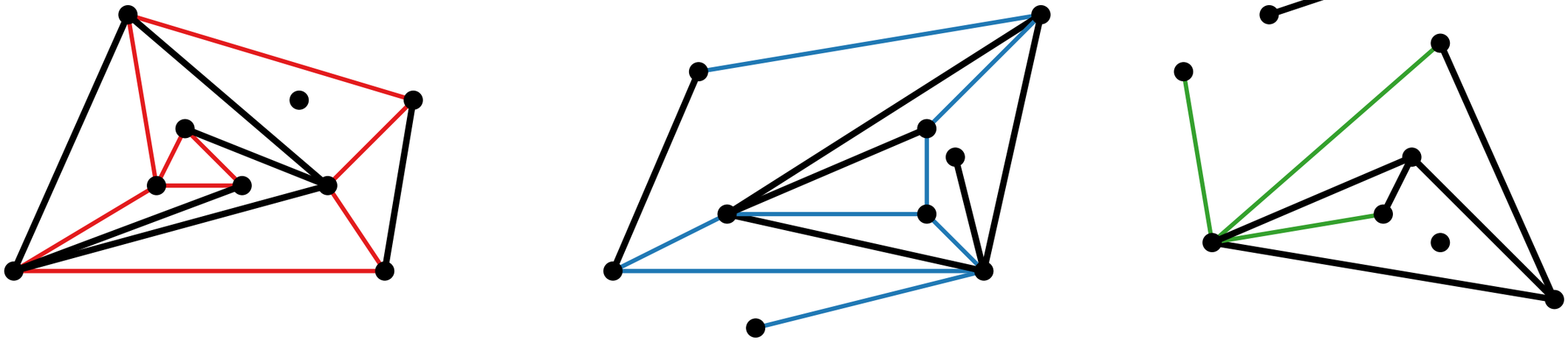

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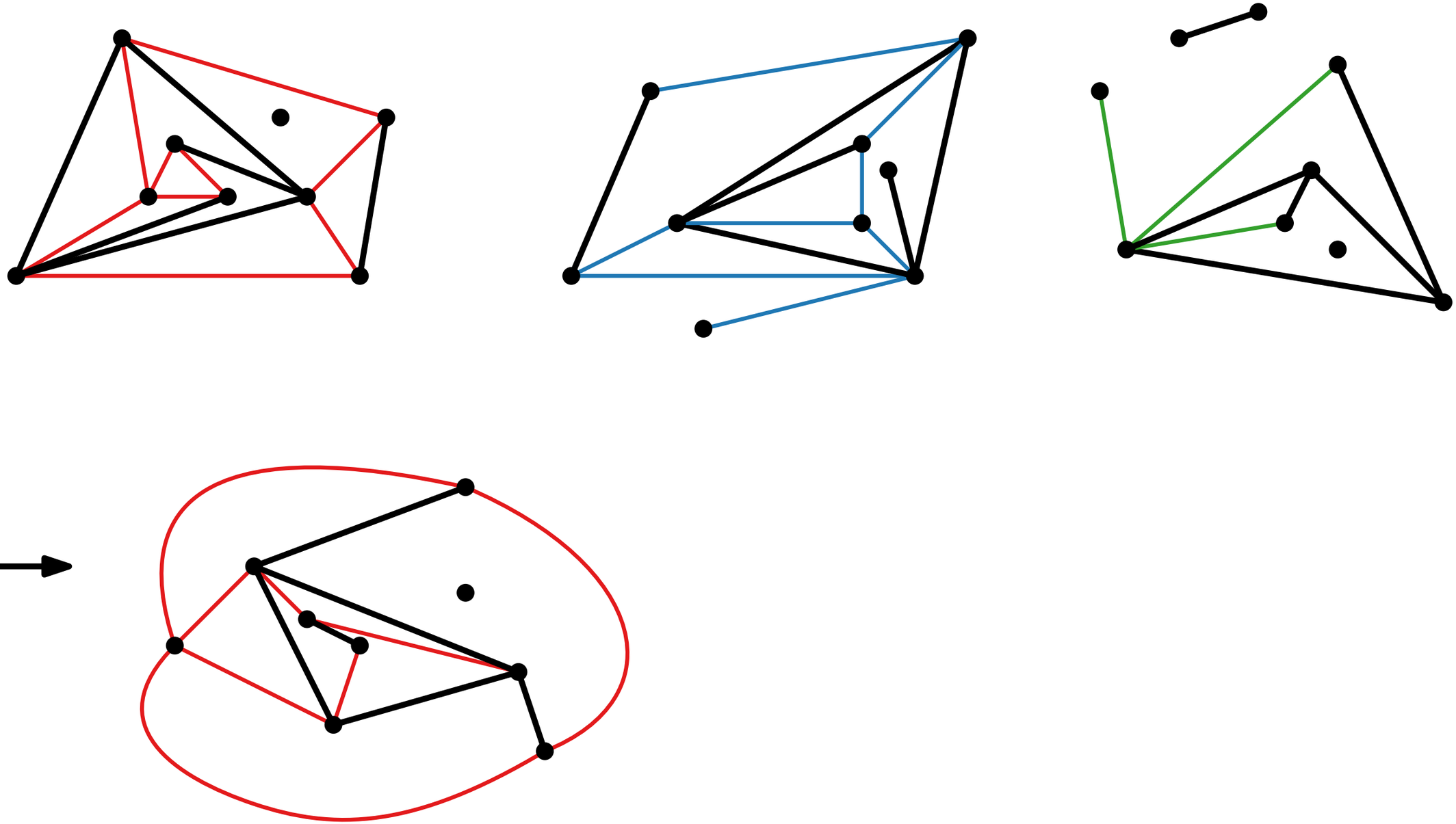

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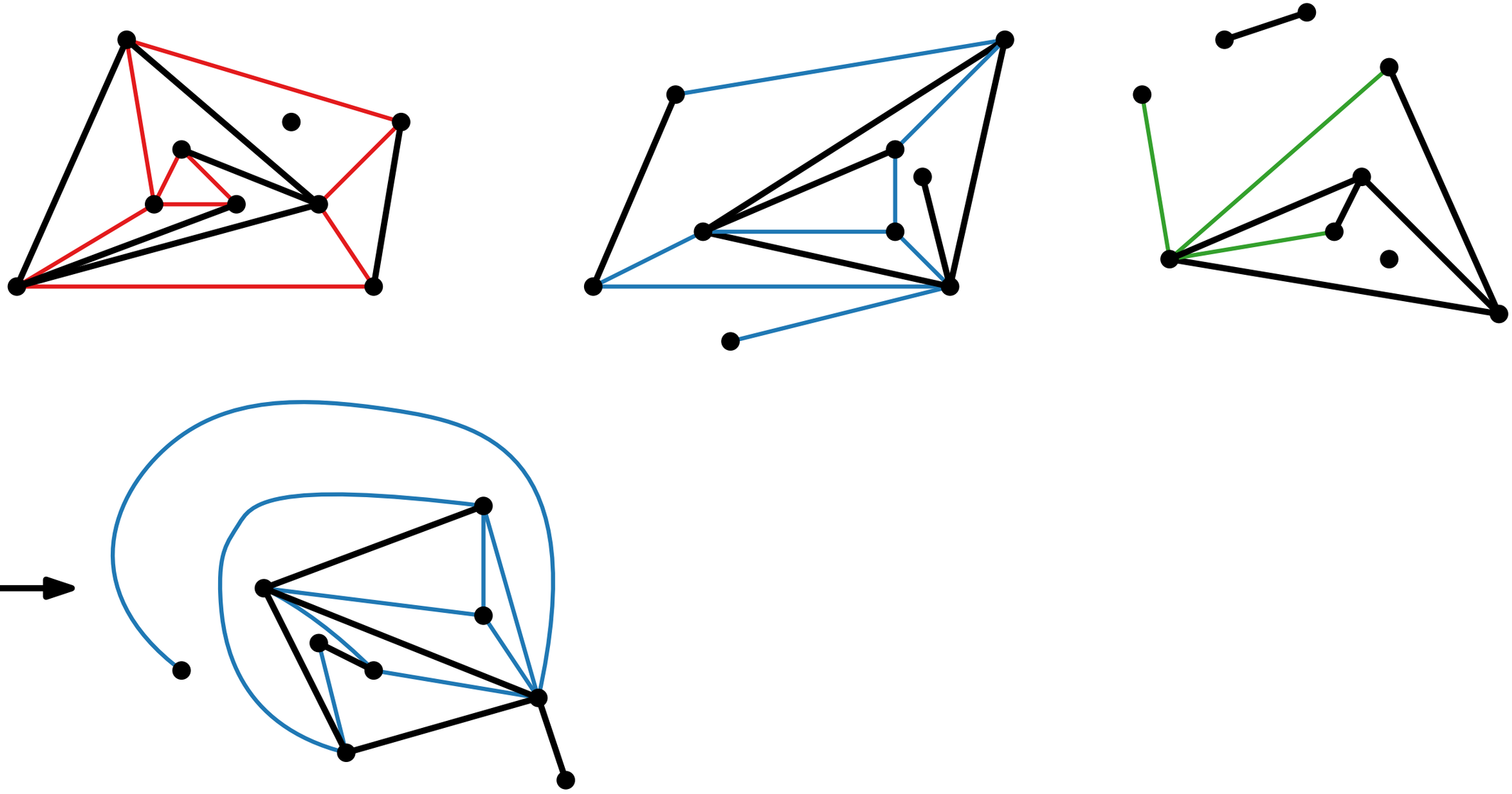

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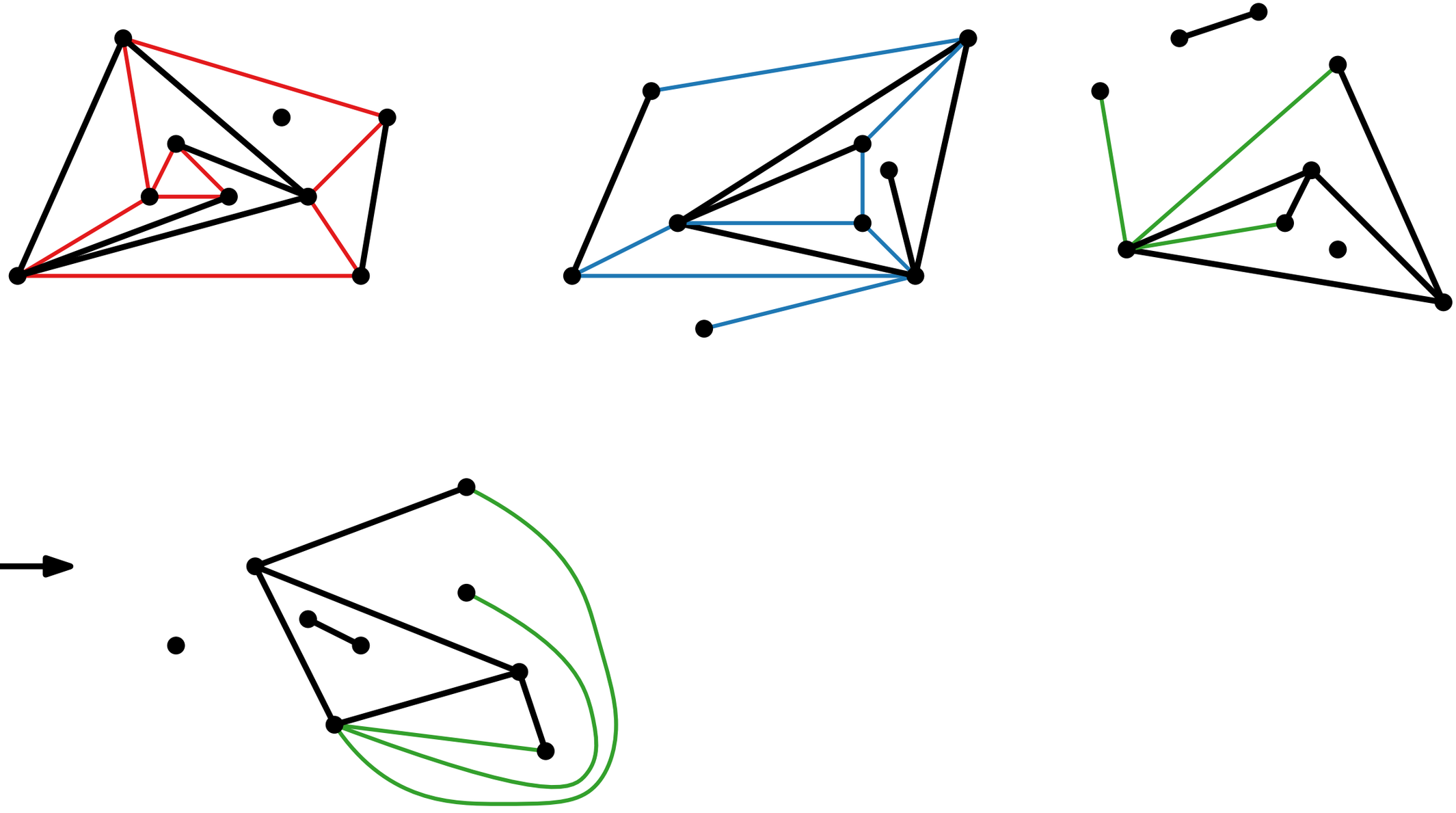

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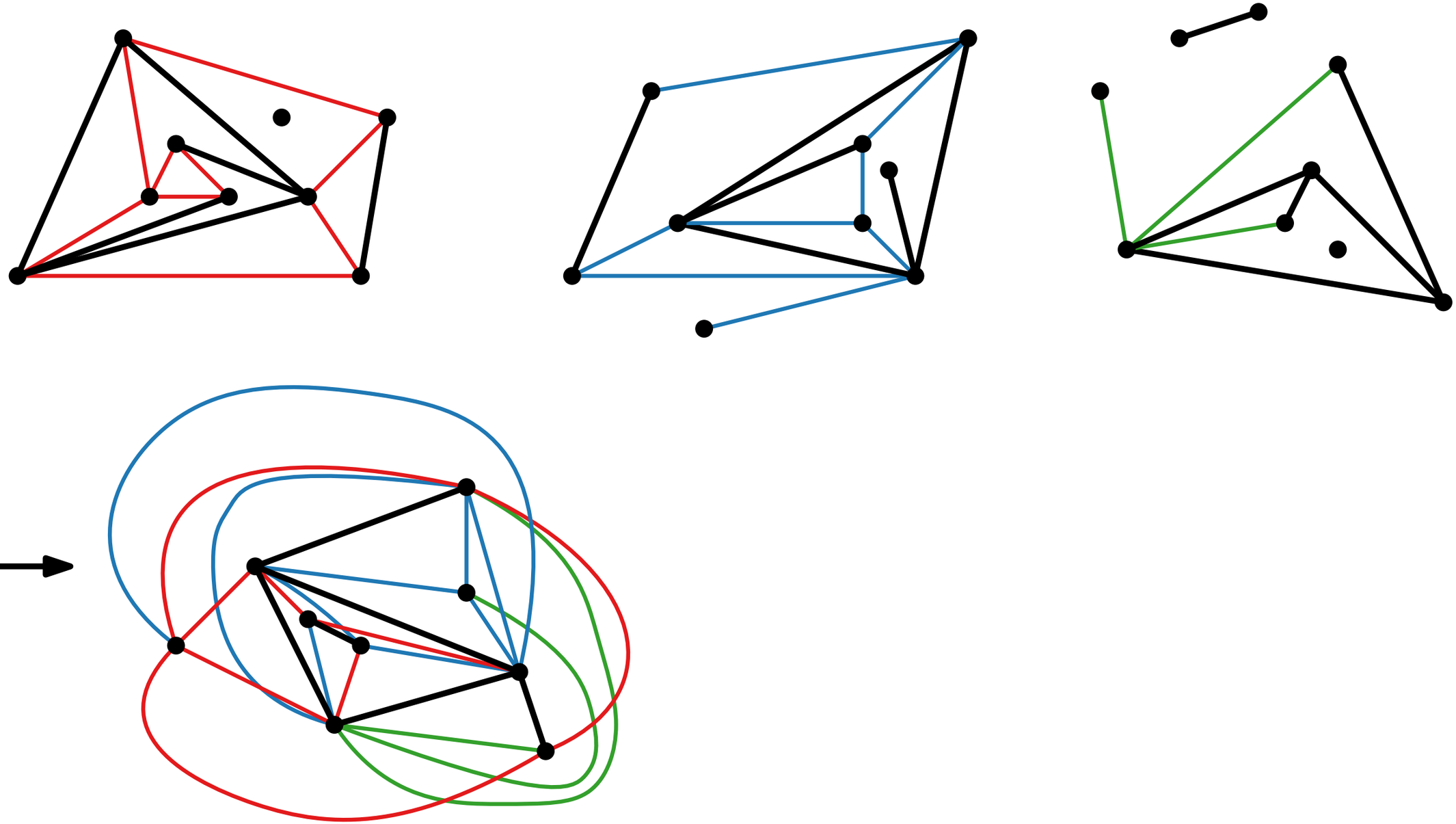

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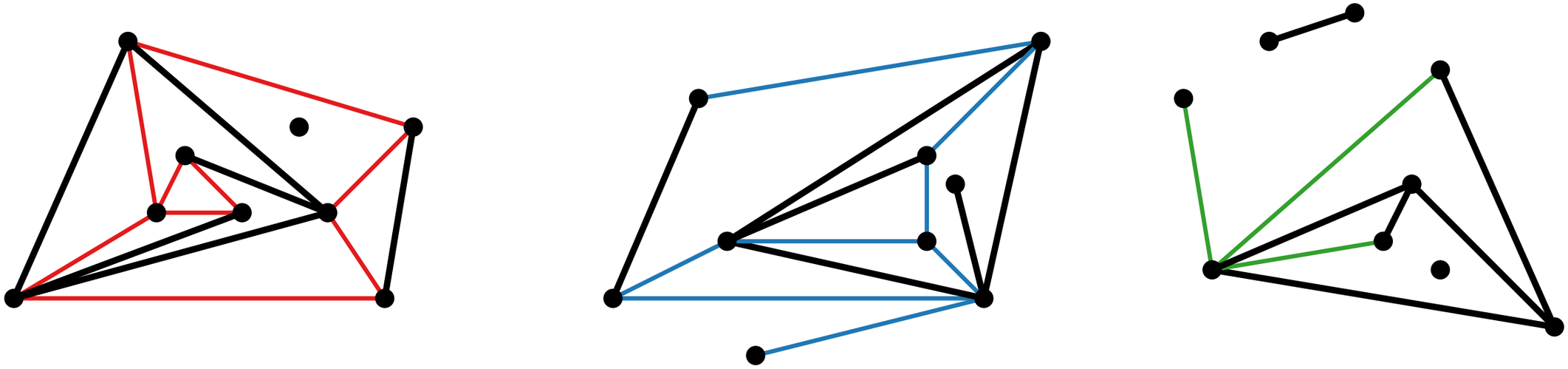

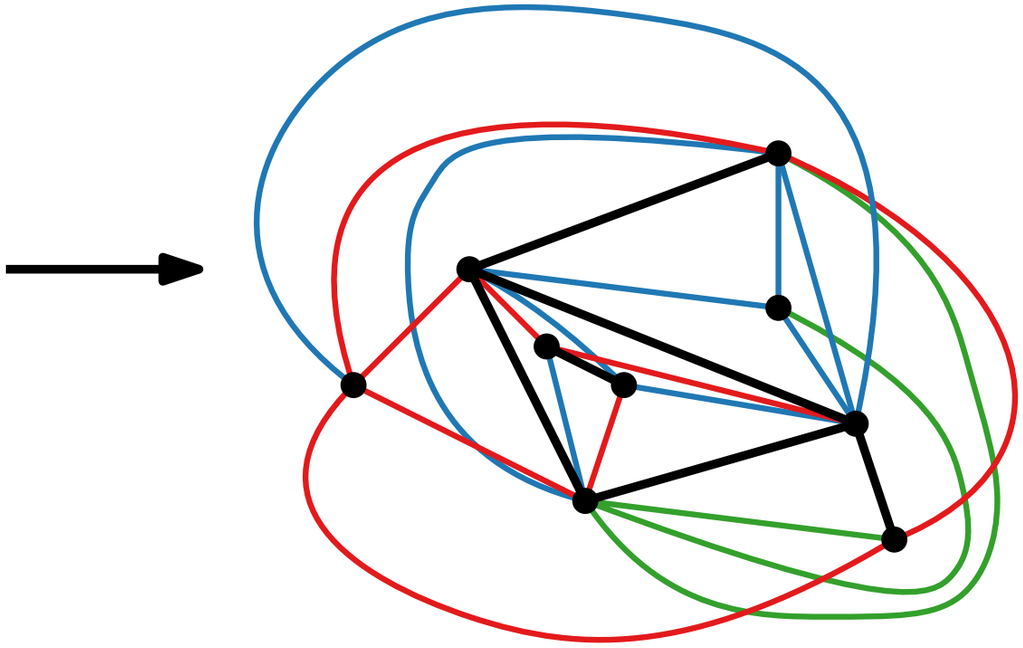

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Eingabe: k planar graphs that have some edges in common.
Frage: Can the graphs be drawn in a planar way simultaneously?

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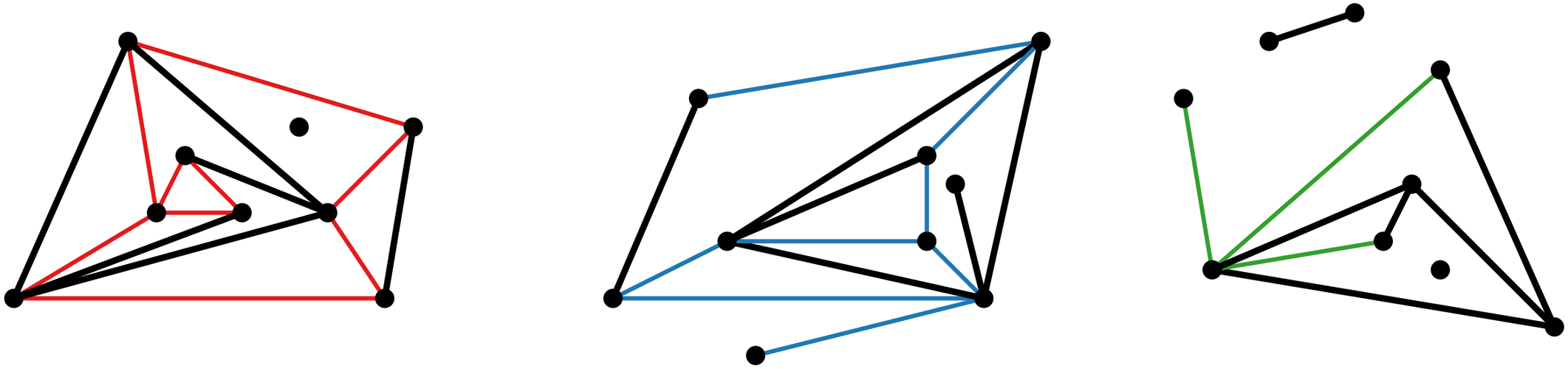

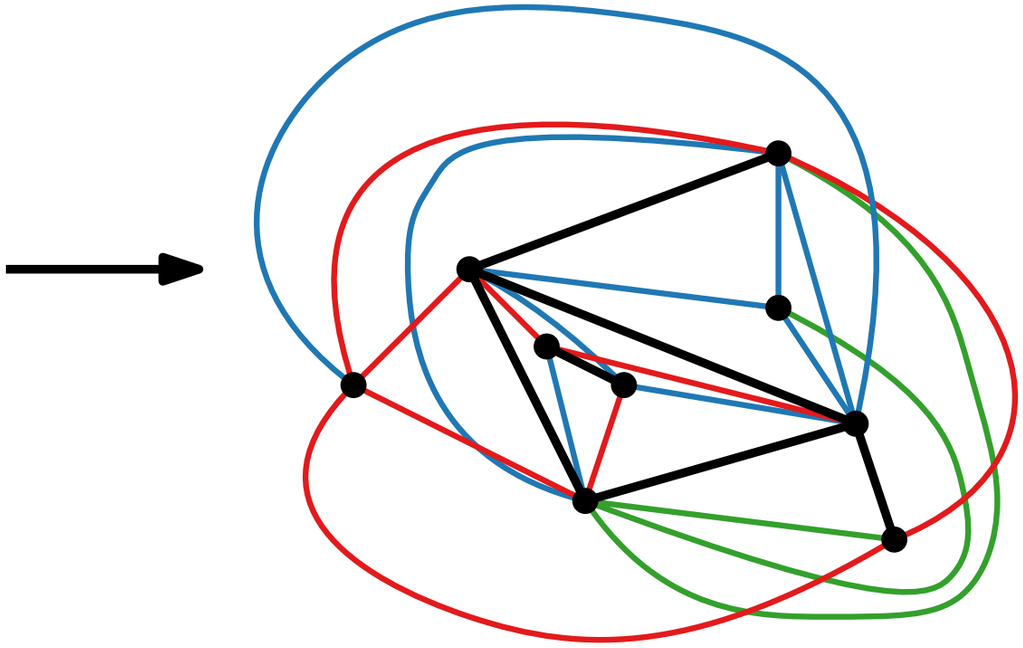

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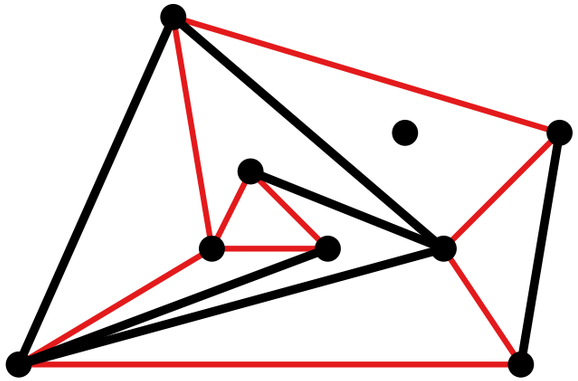

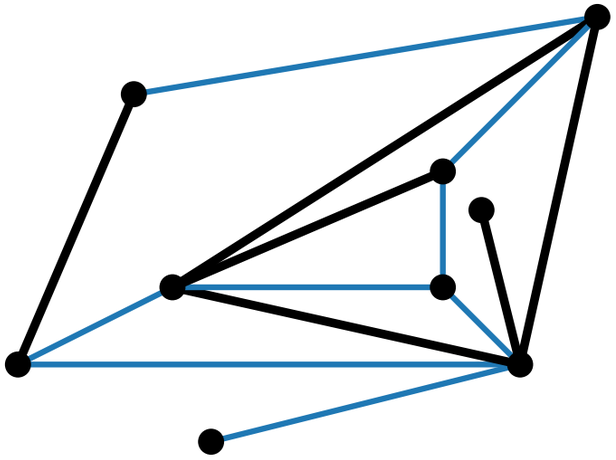

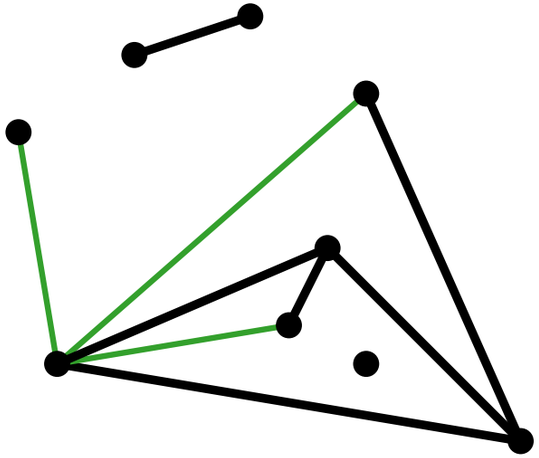

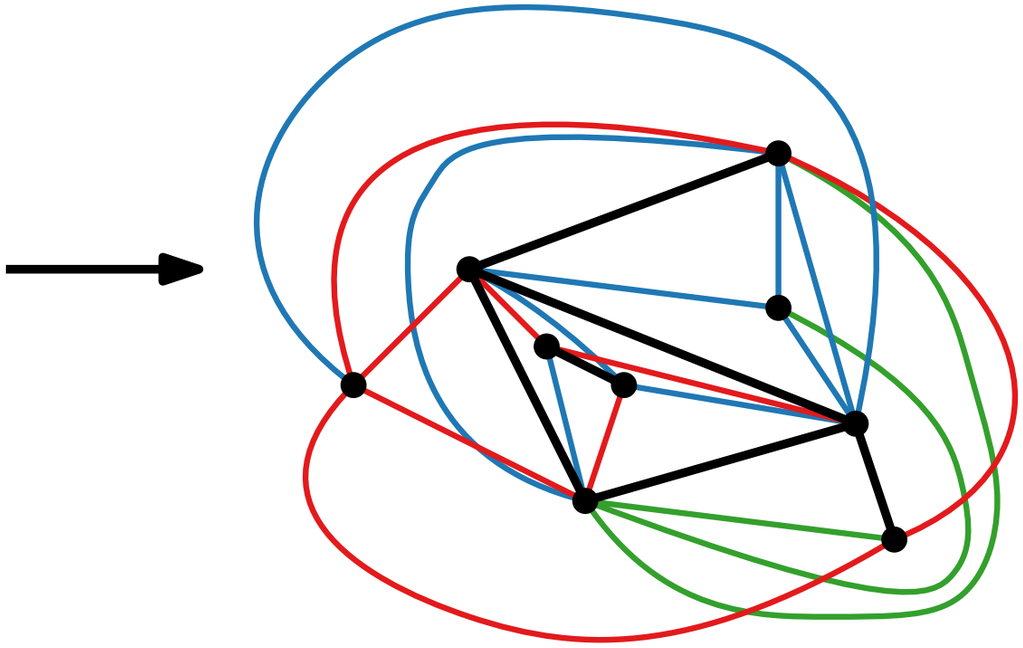

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In this seminar: **What is the parameterized complexity of SEFE?**

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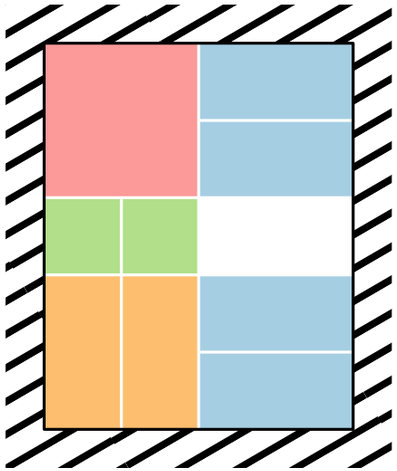

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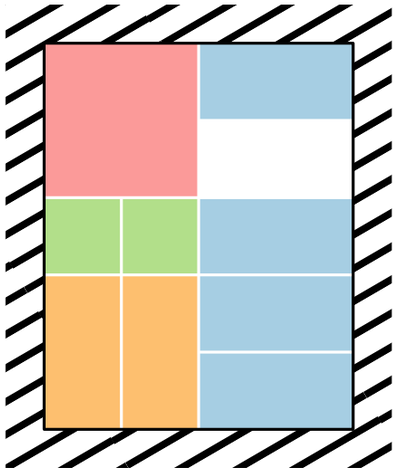

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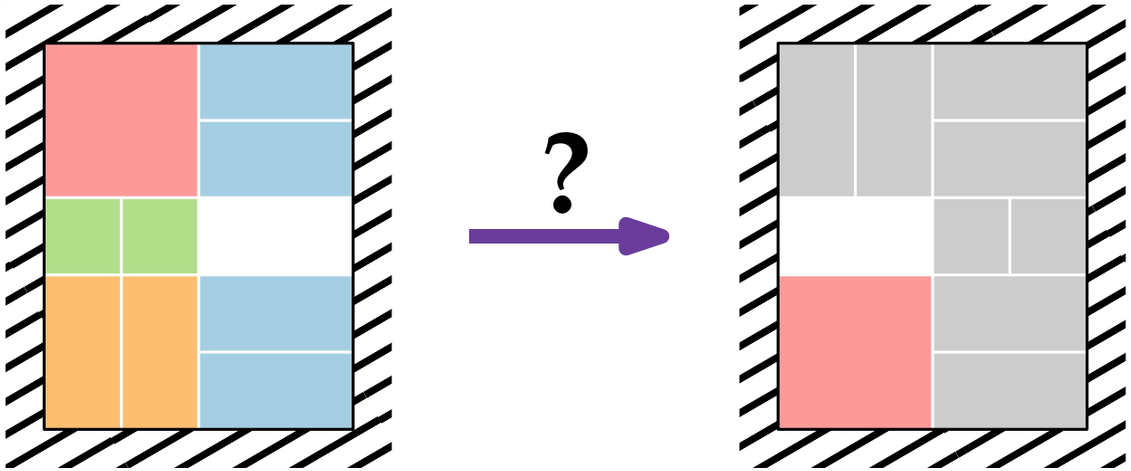

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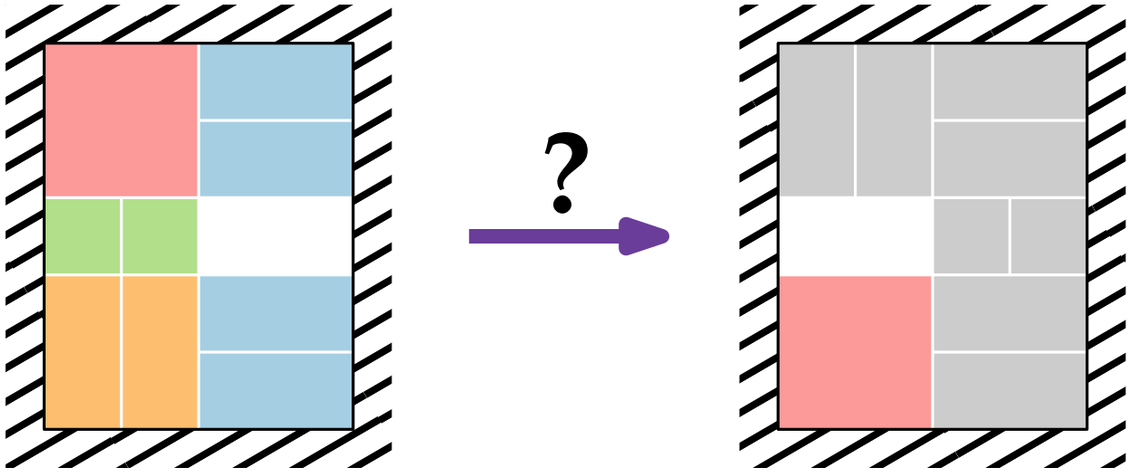

[Hearn, Demaine. TCS, 2005]

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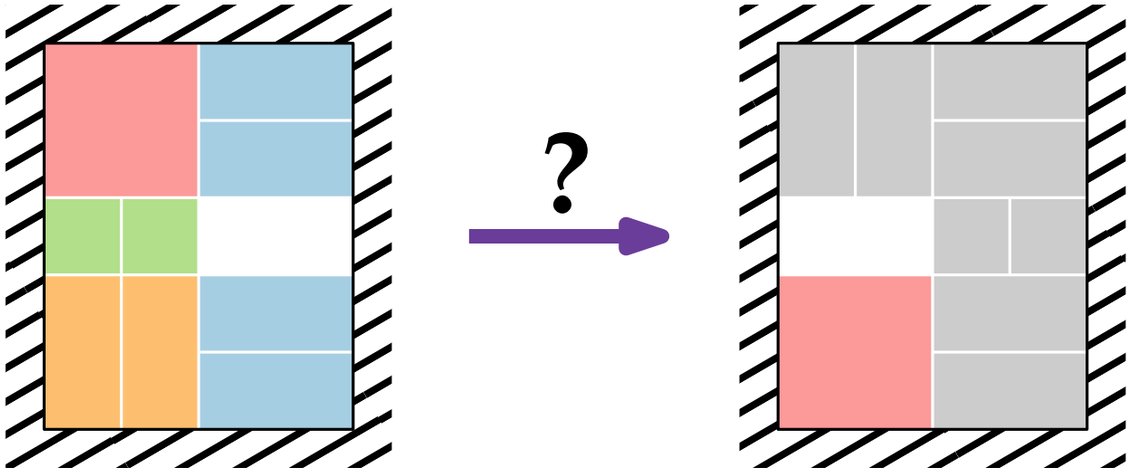

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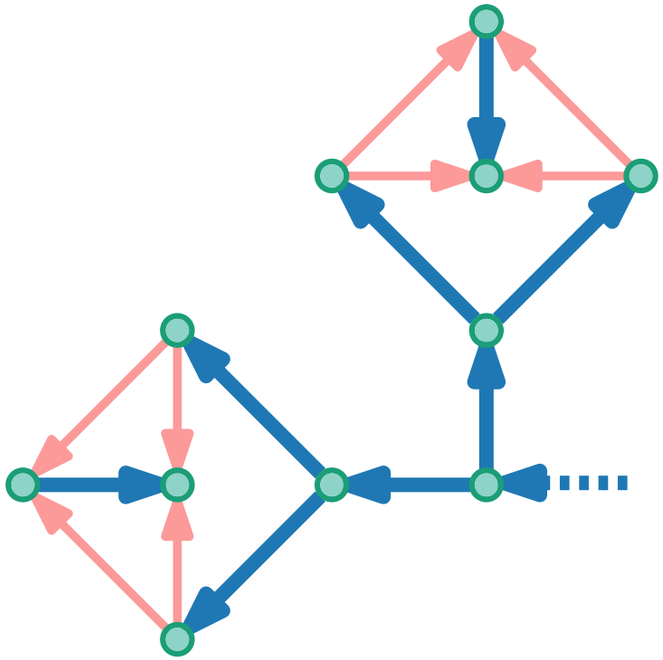

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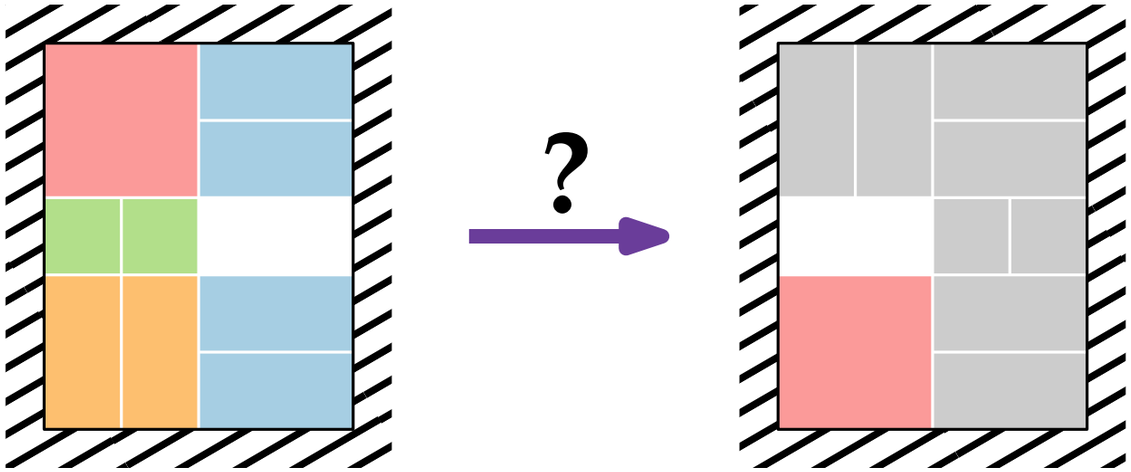

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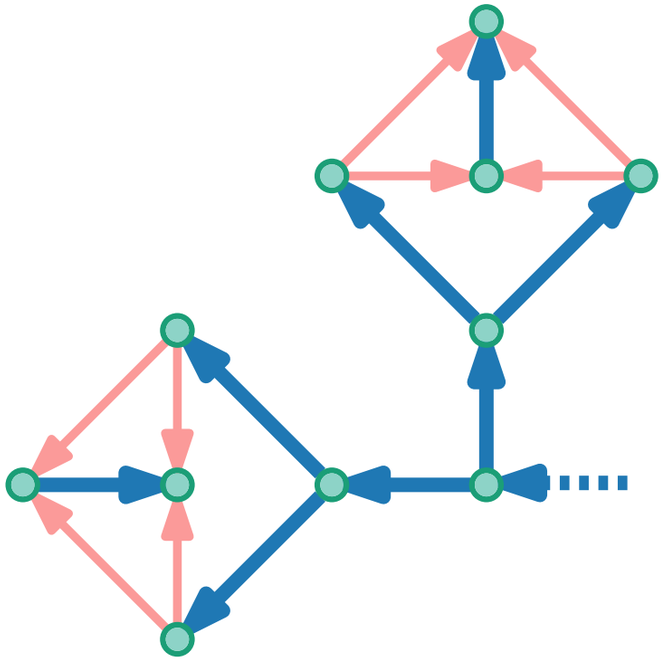

4. XNLP/XALP-complete Problems for Planar Graphs

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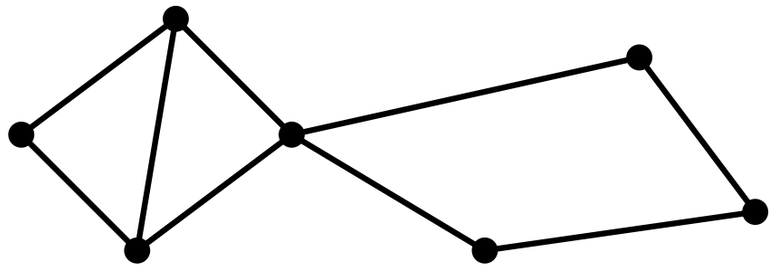
Here: XNLP/XALP-completeness of several problems defined for planar graphs.

5. Baker's Technique



(1-)outerplaner graph

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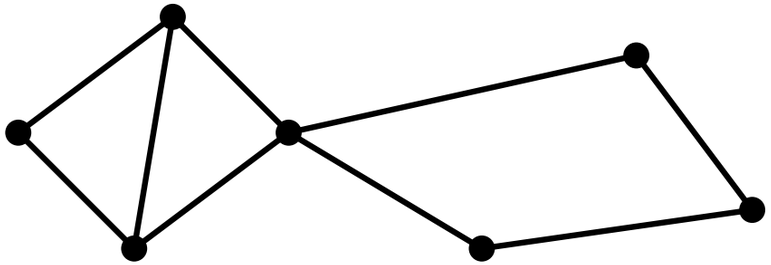

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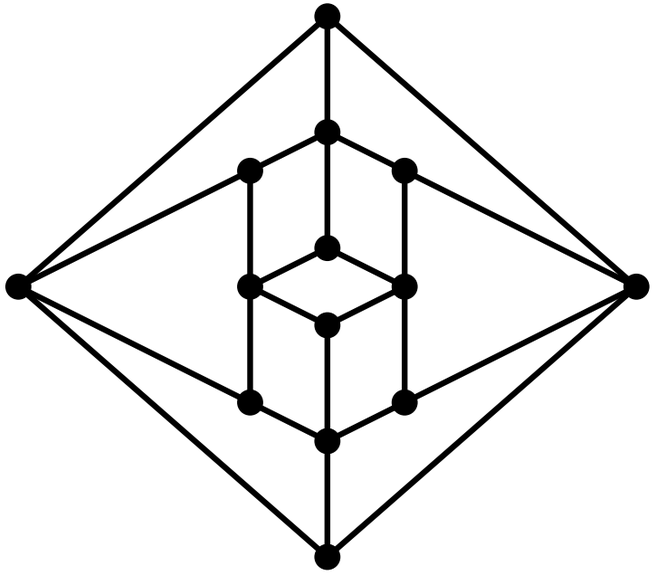

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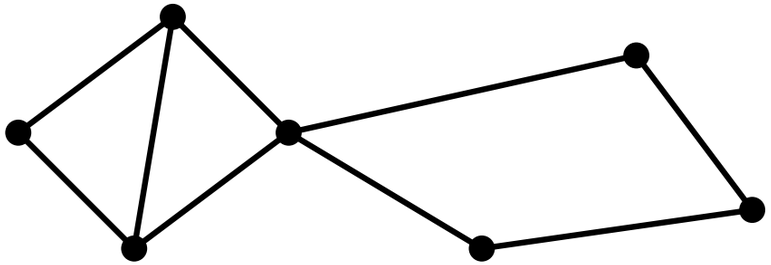

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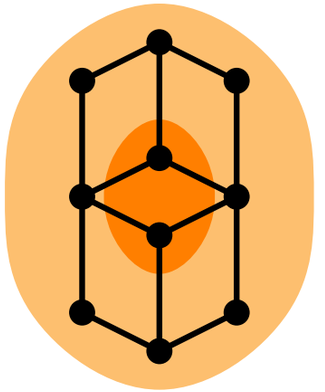

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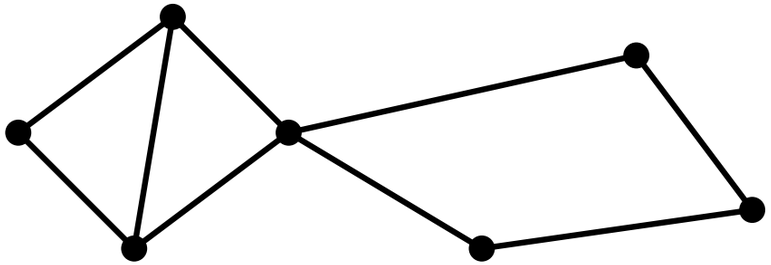

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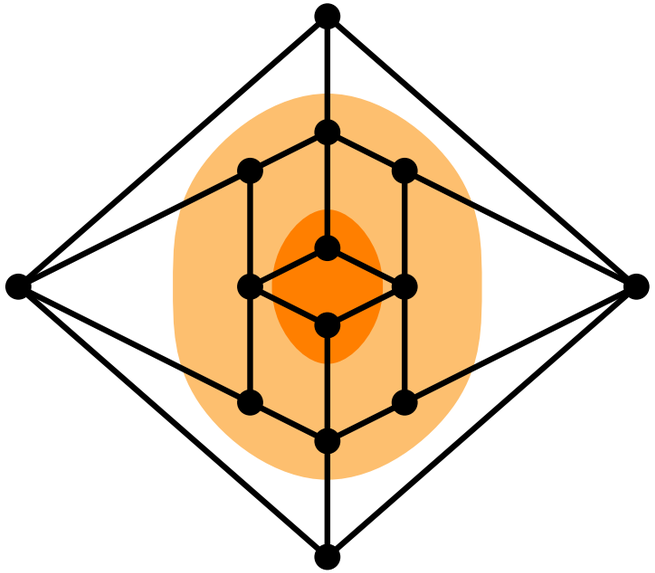

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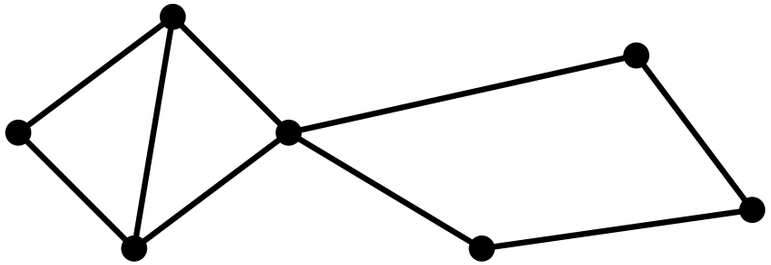

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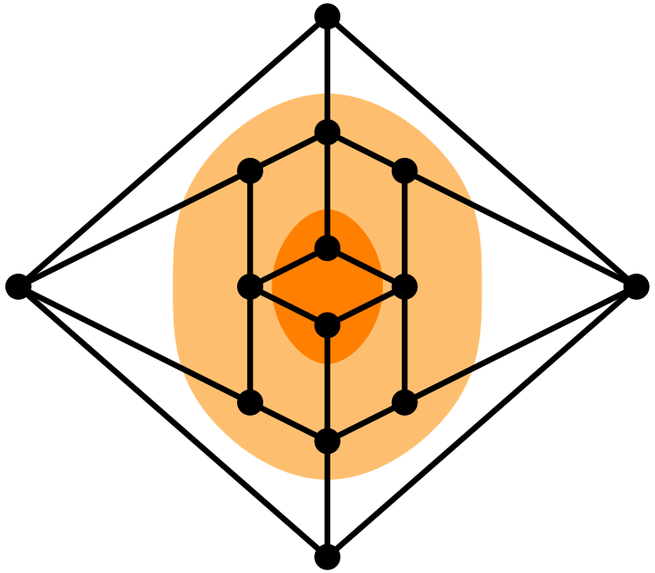

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Many NP-hard problems can be solved efficiently on k-outerplanar graphs for a fixed k

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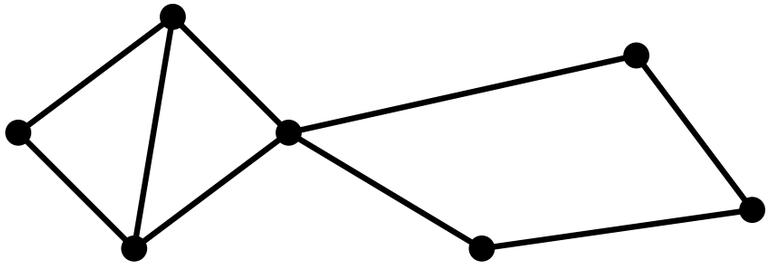

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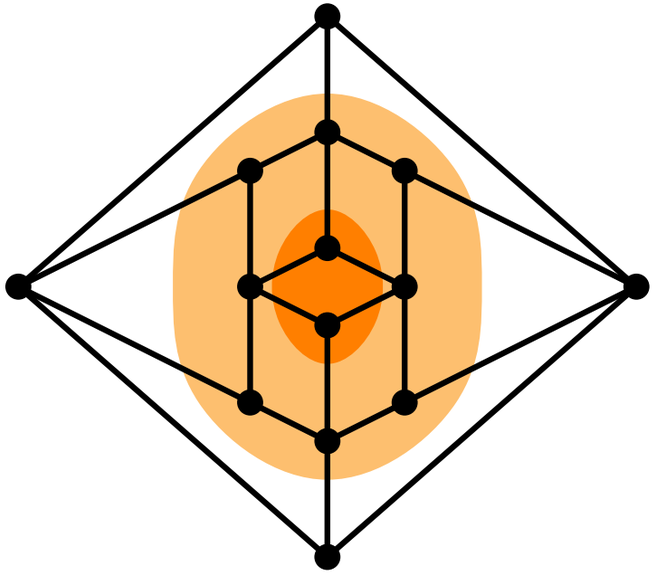

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Baker's Technique: A general approach to use these algorithms to find approximation algorithms for planar graphs

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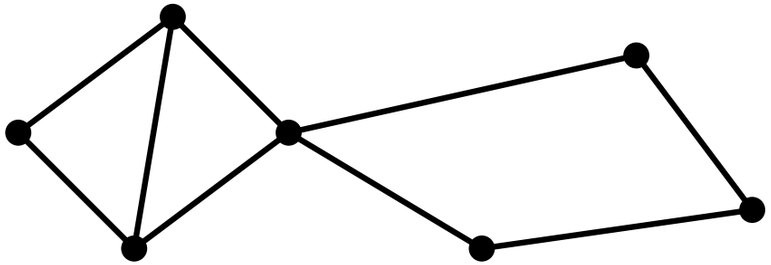

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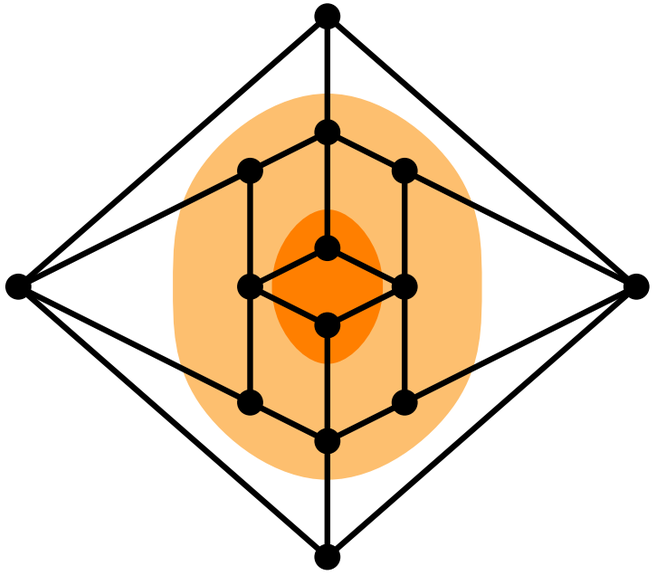

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Task: Explain Baker's Technique with an illustrative example

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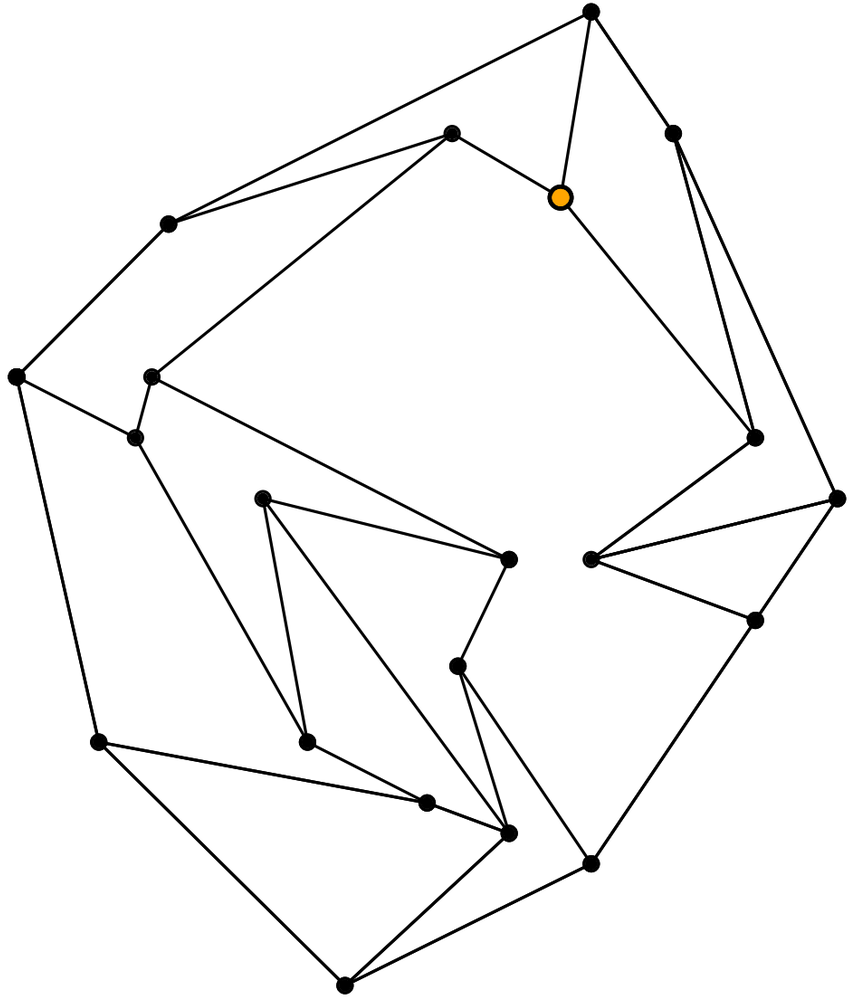
Morph: continuous deformation of a graph drawing that preserves straight-line crossing-free edges.



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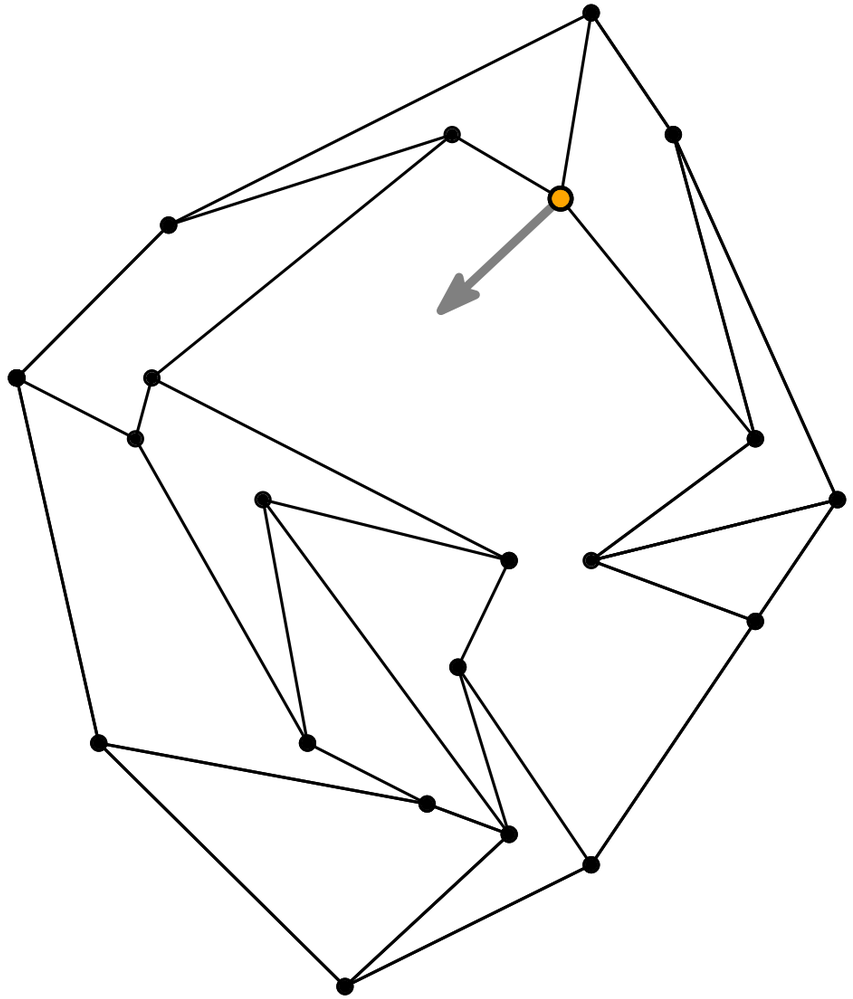

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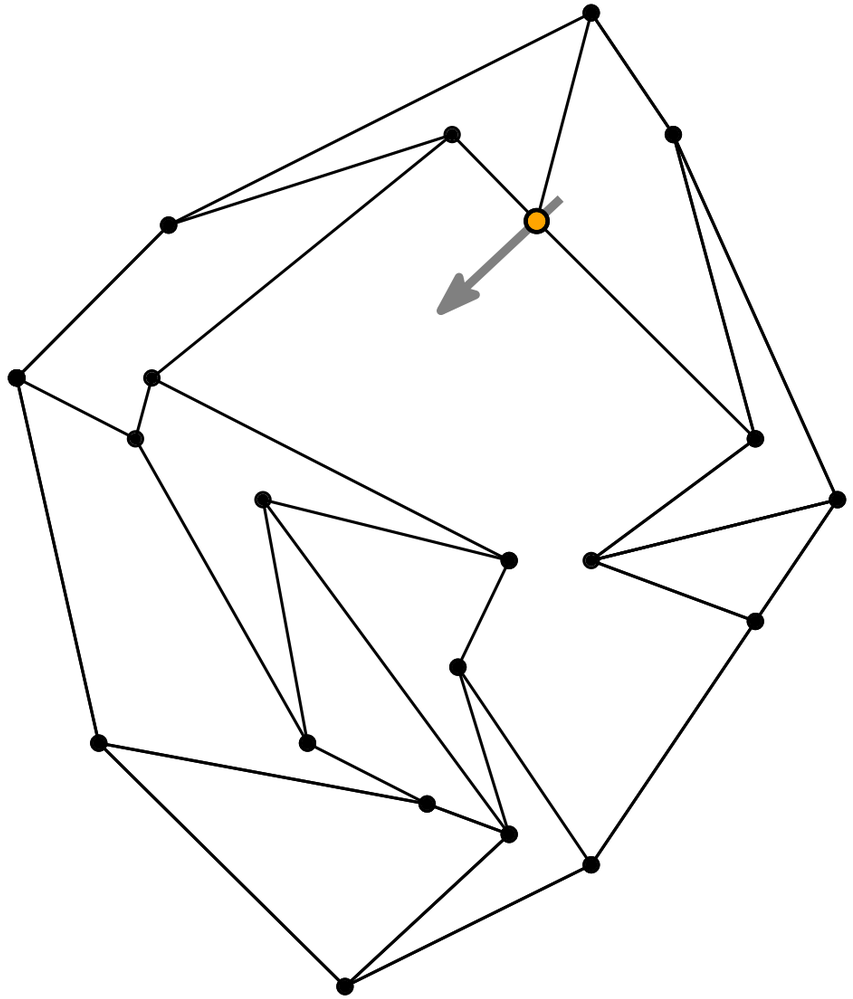

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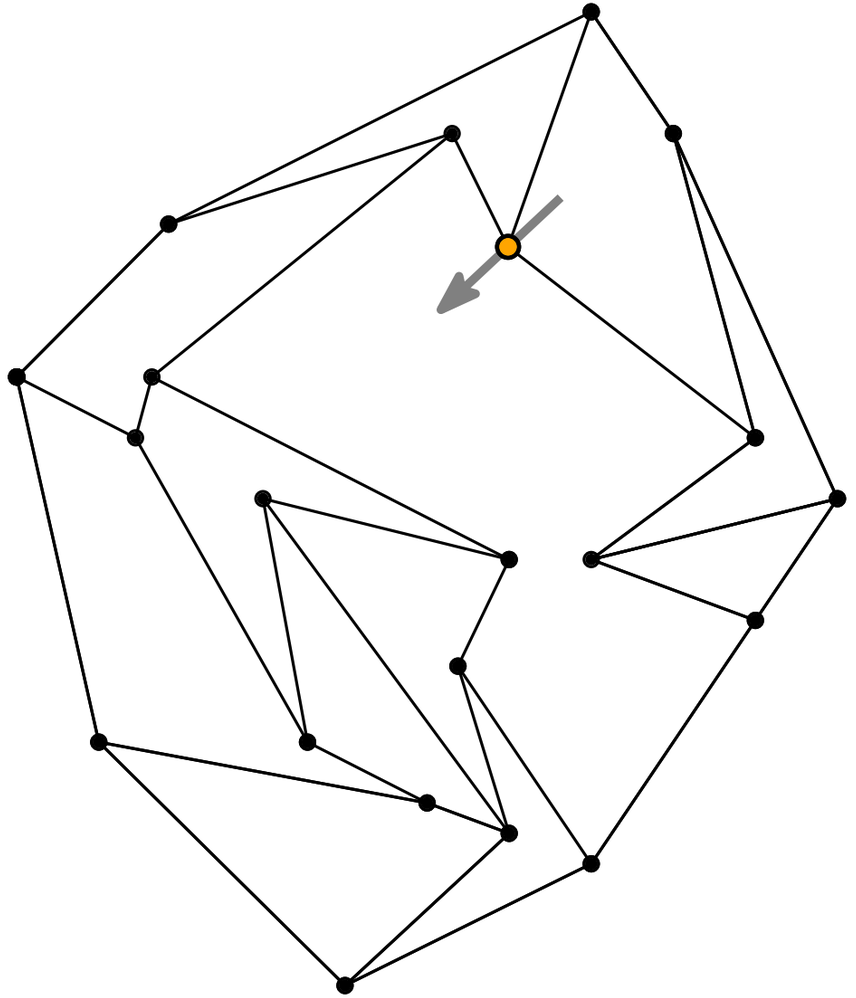

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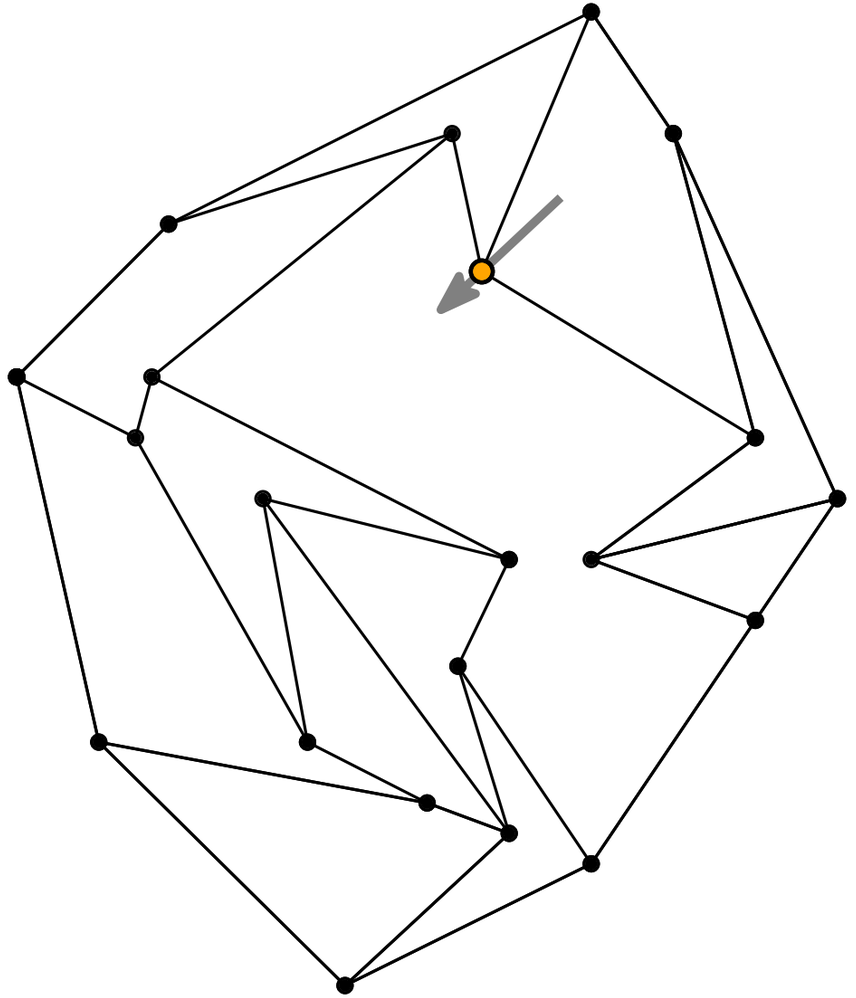

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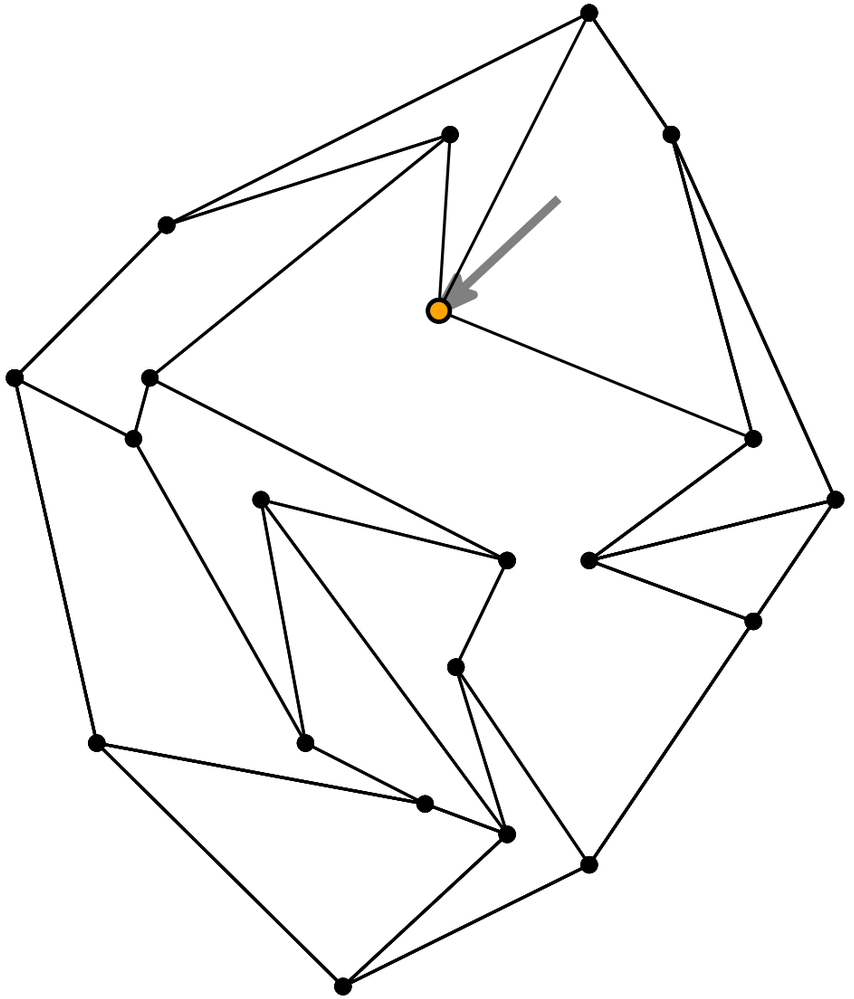

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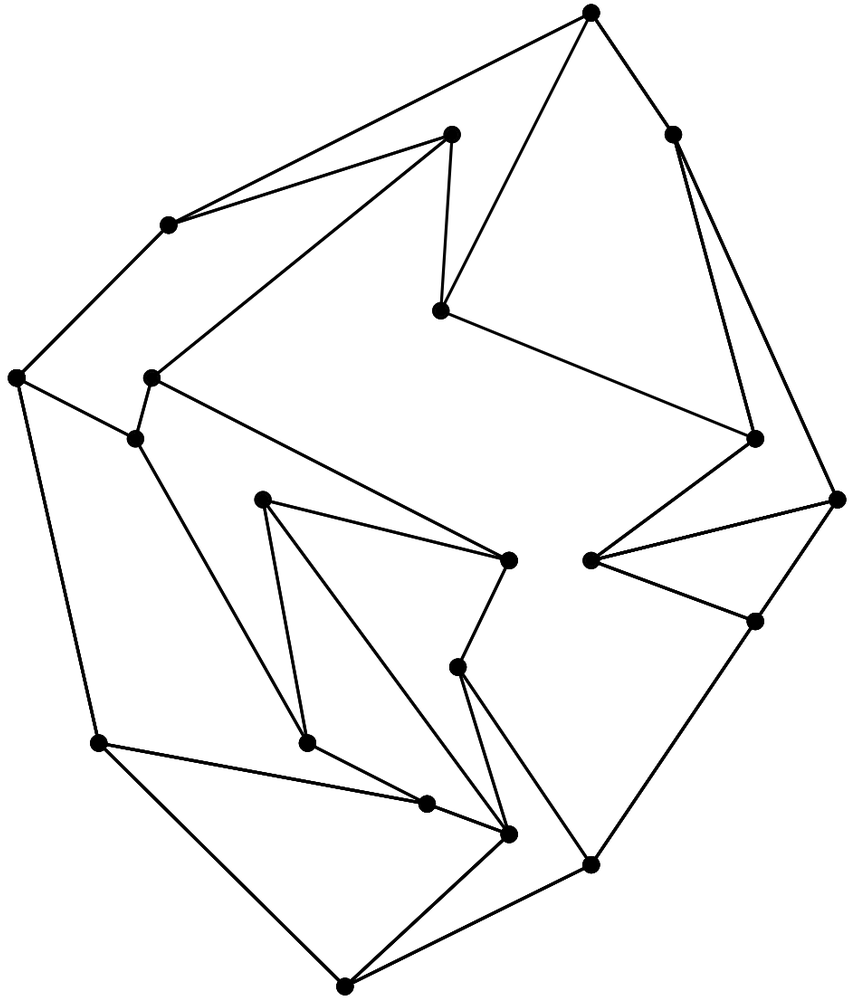

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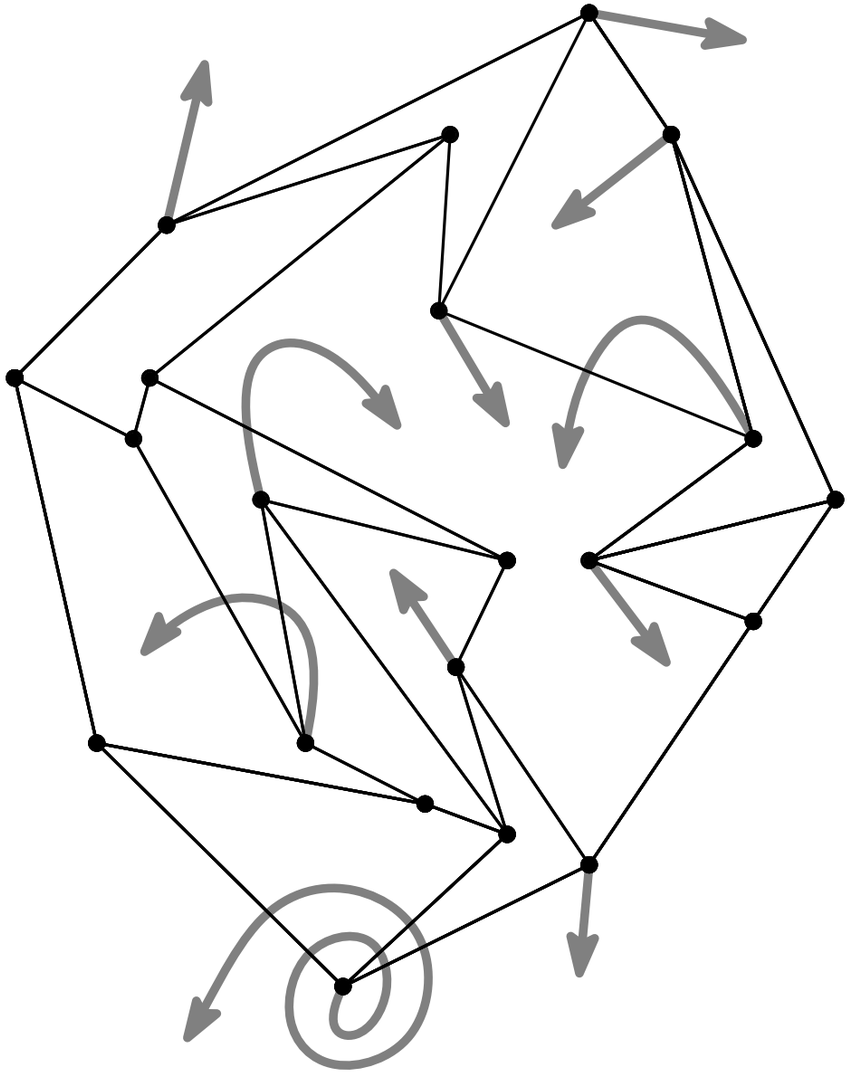

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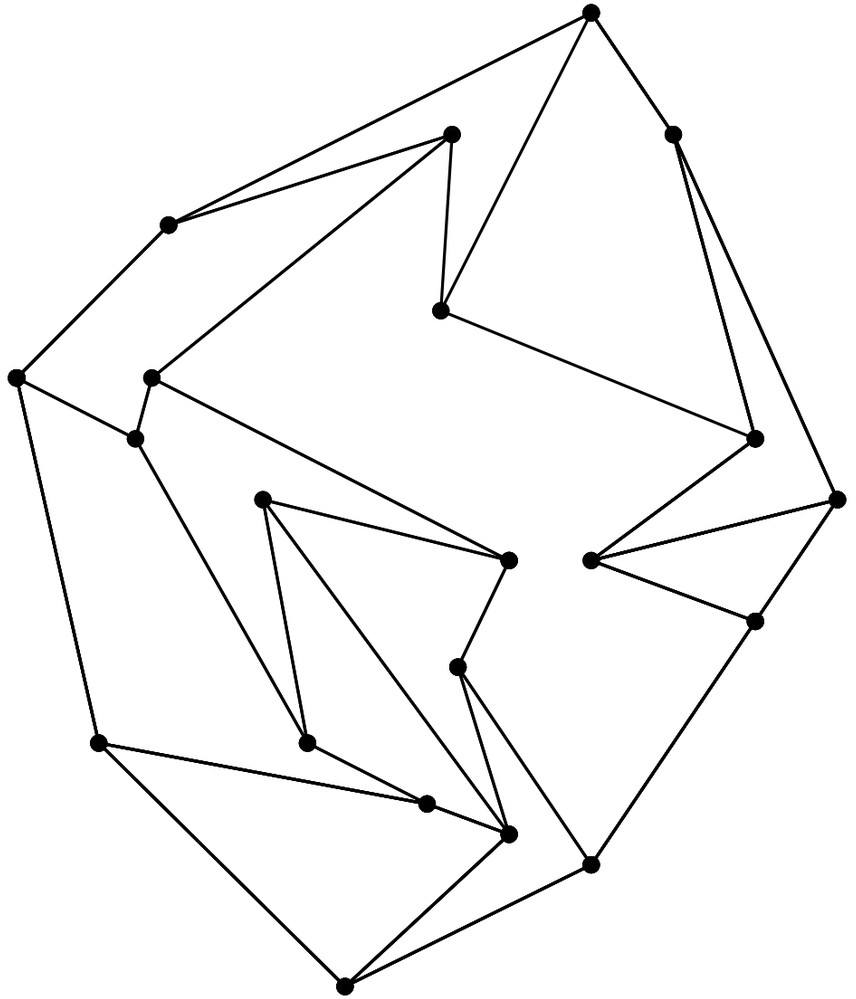

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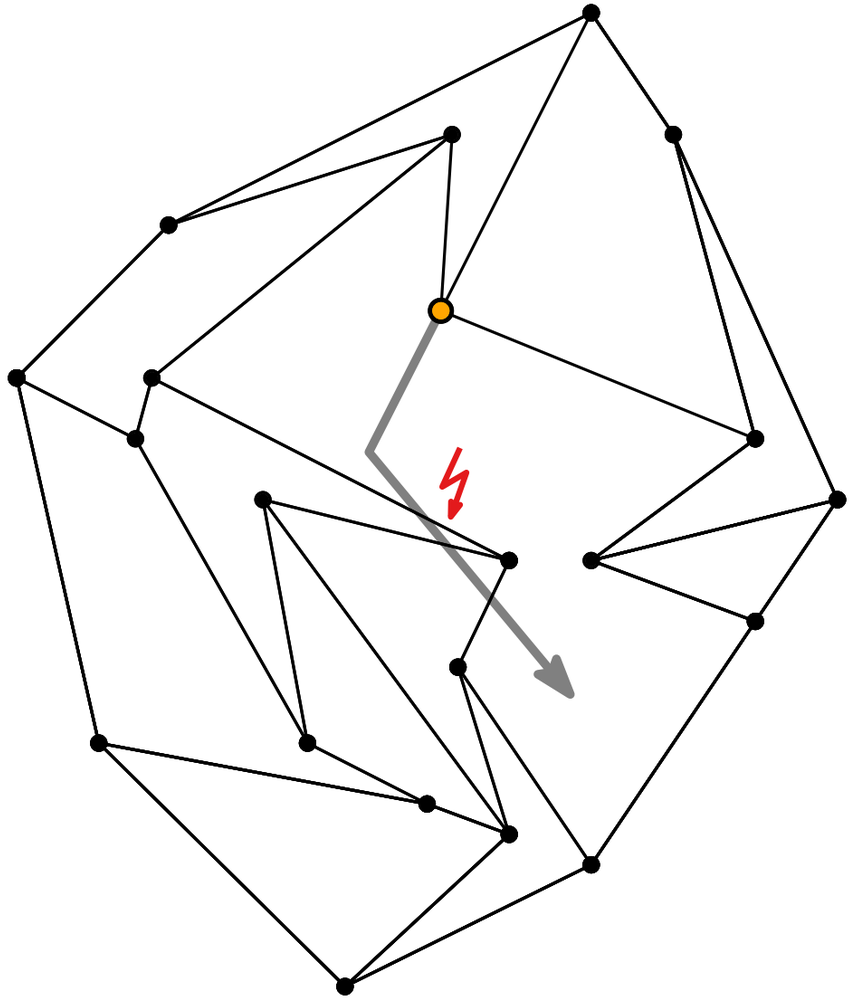

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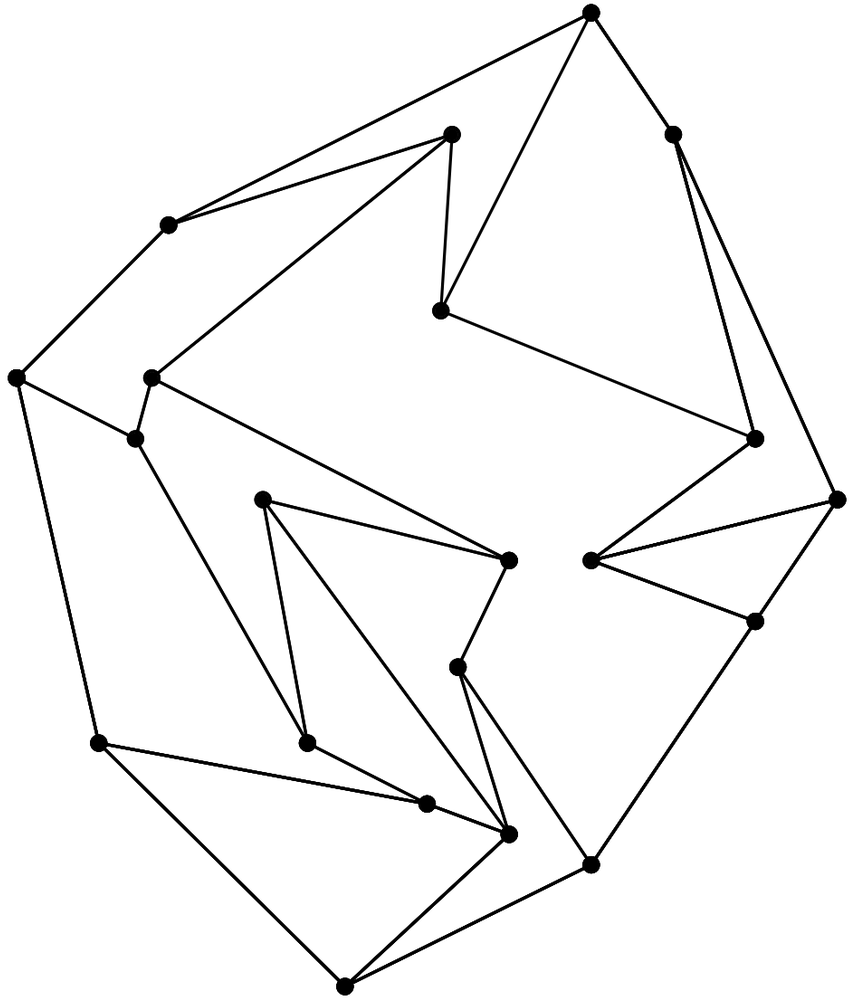

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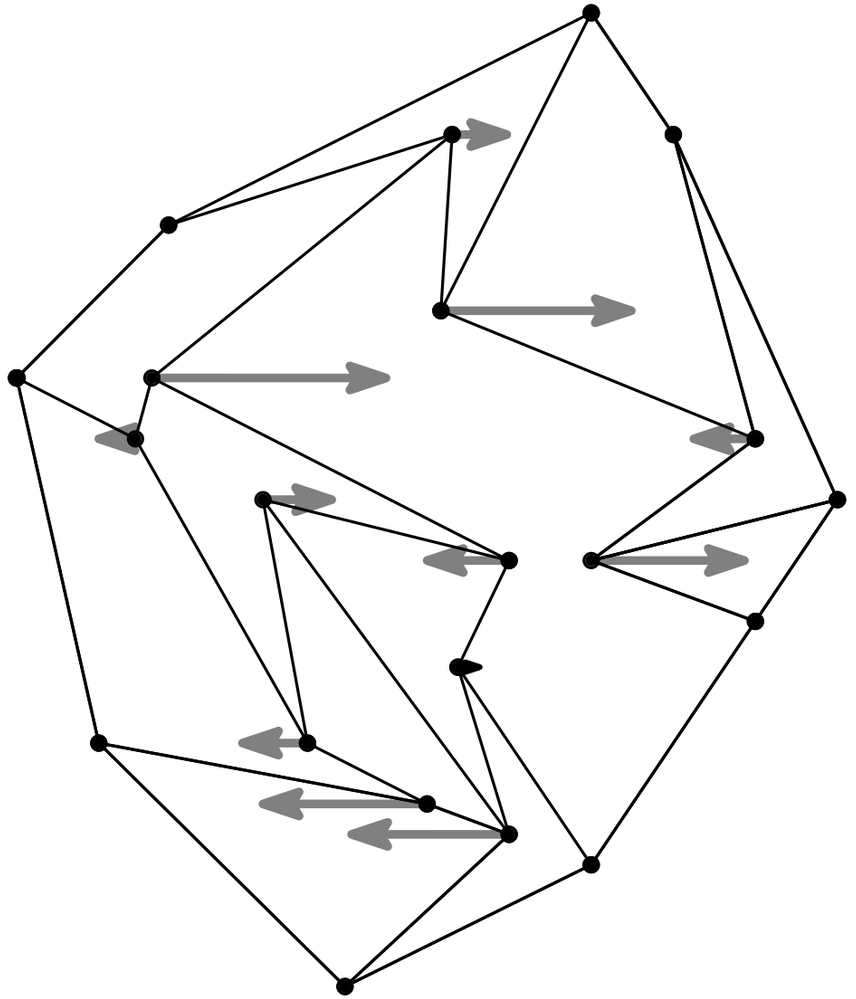

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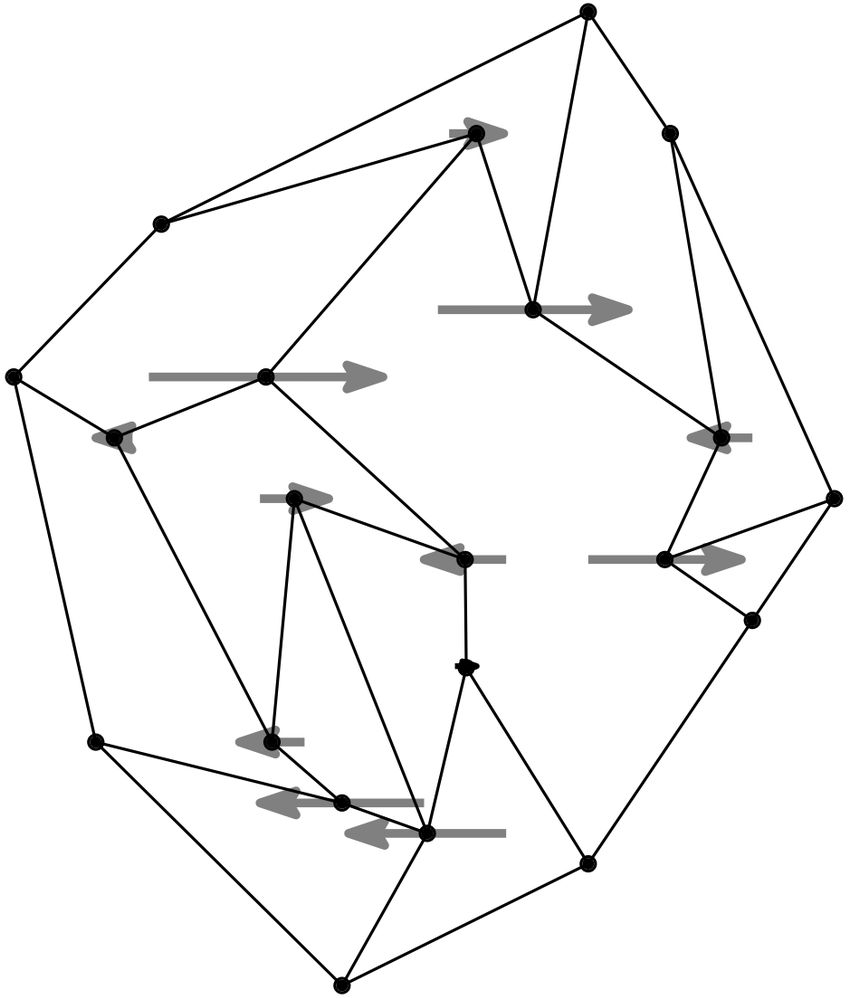

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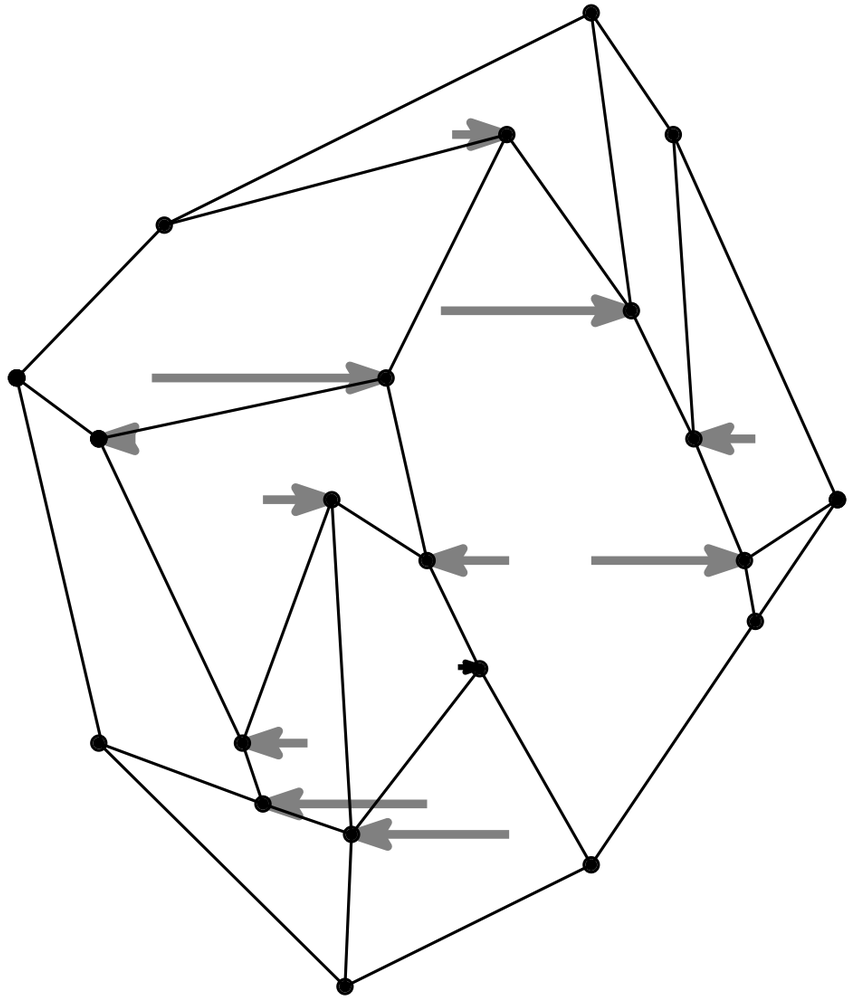

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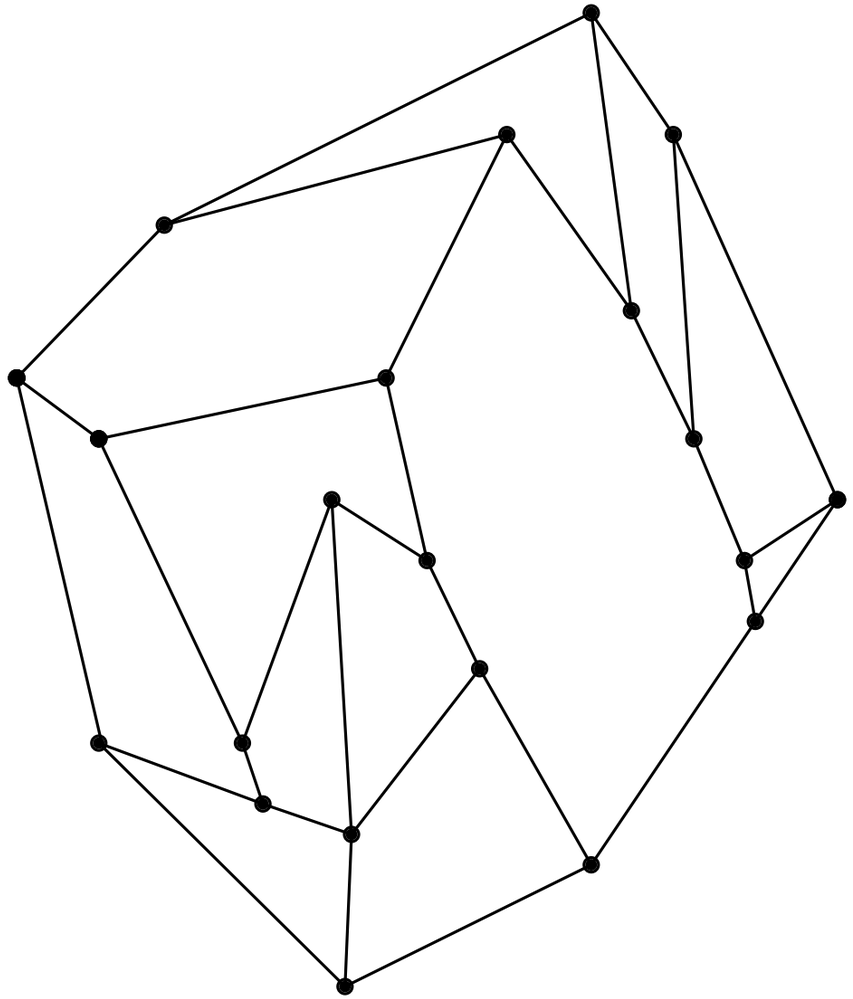

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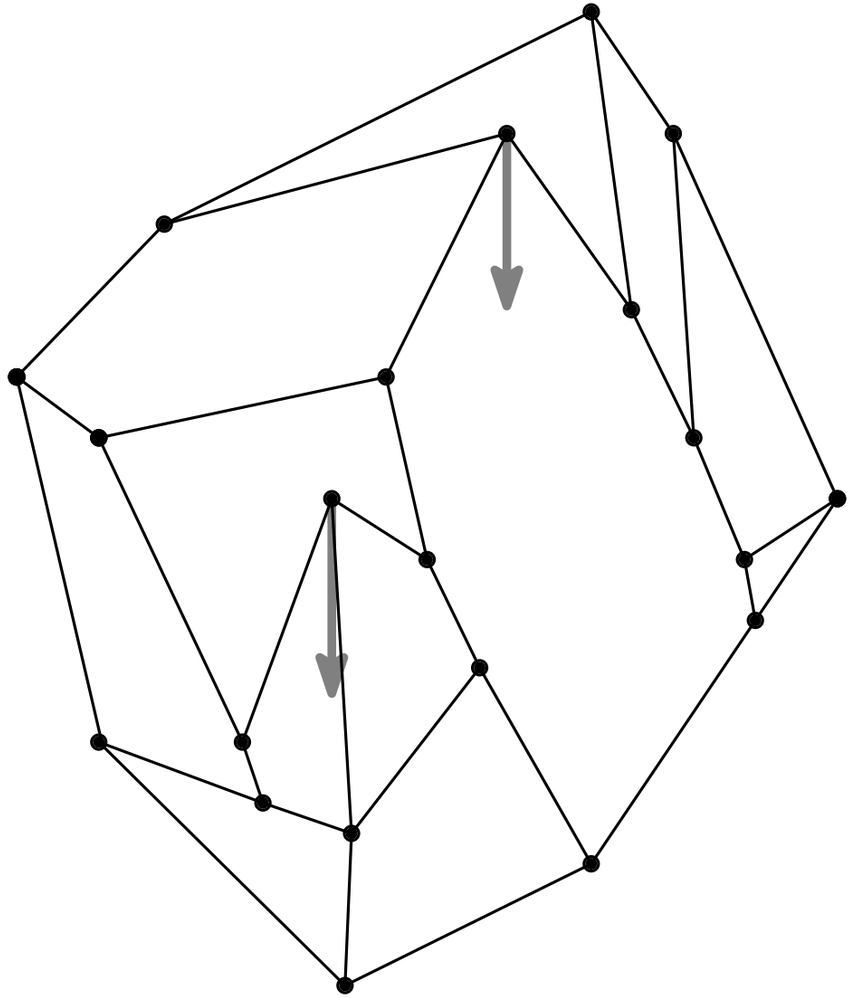

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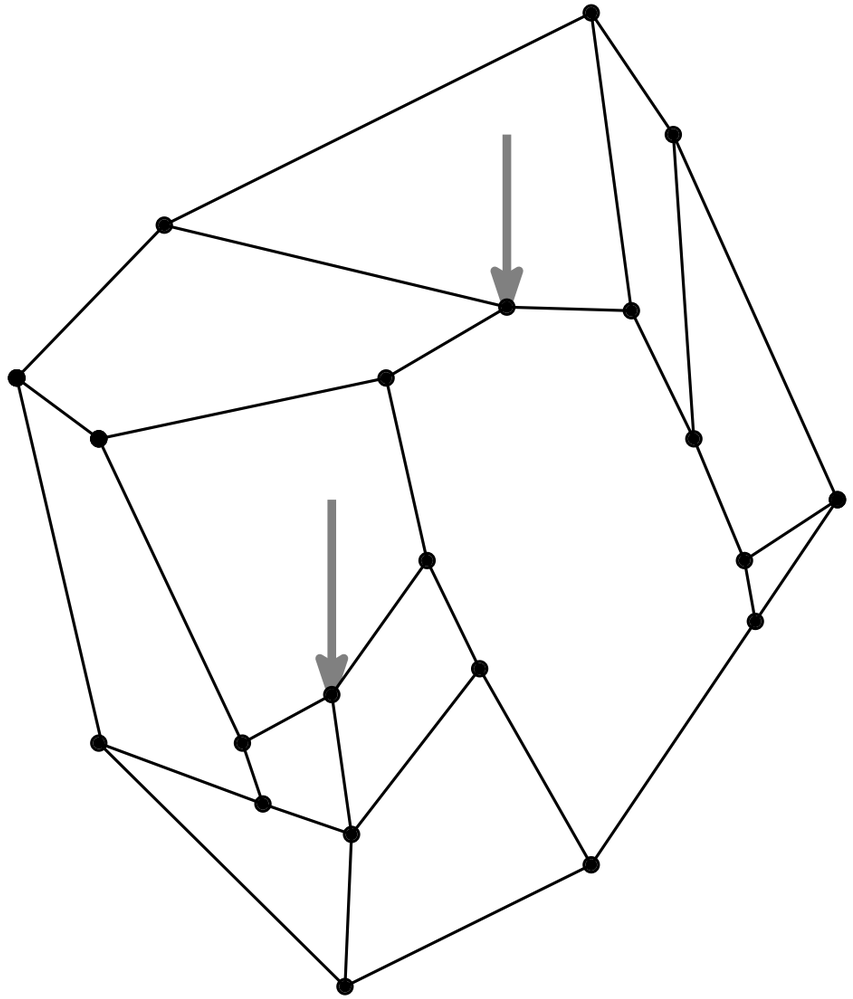

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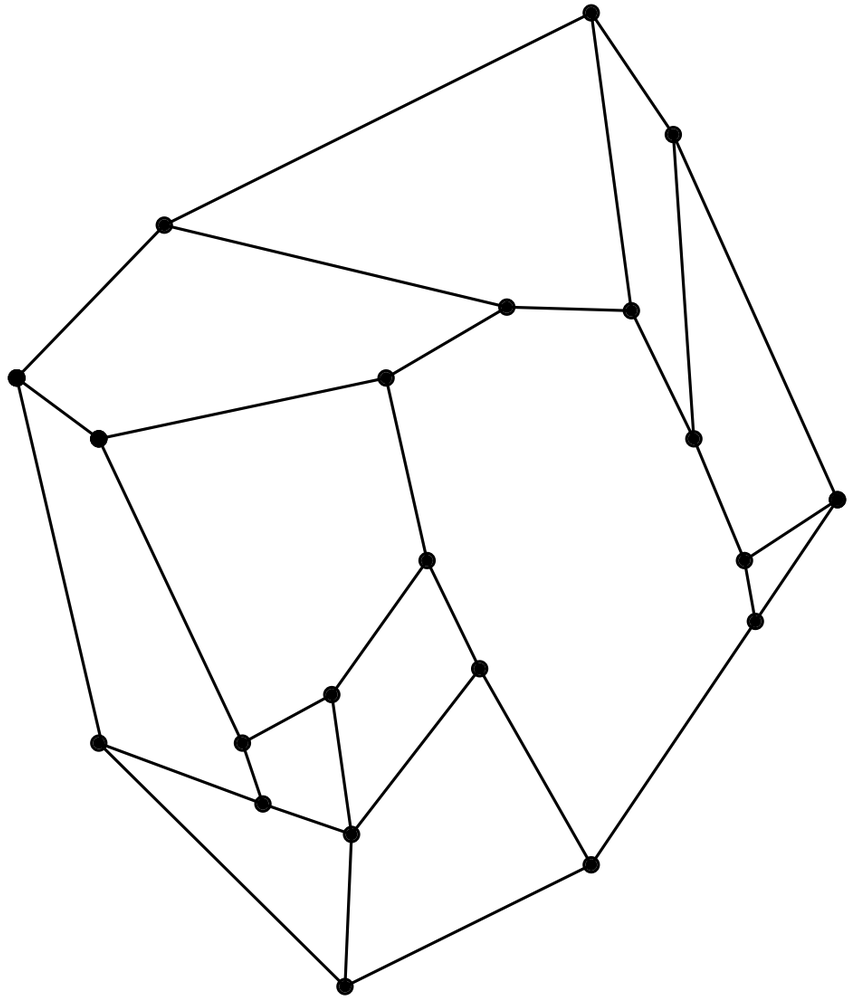

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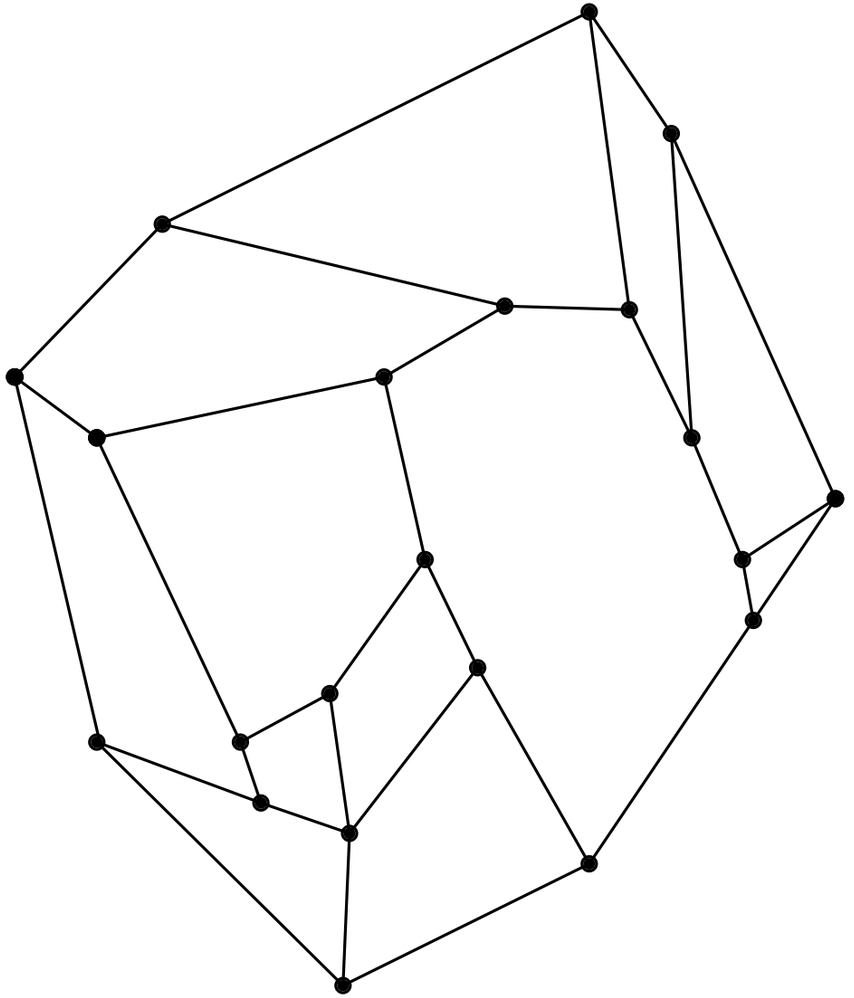

Questions:

- Does there always exist a morph between two crossing-free drawings of the same graph?
- How can it be computed and encoded?

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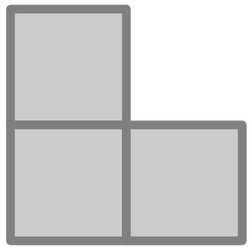

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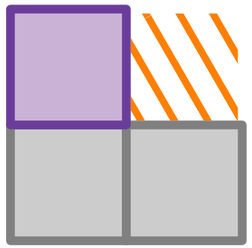

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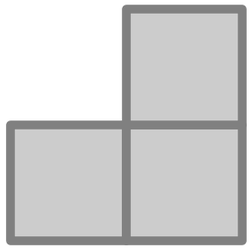

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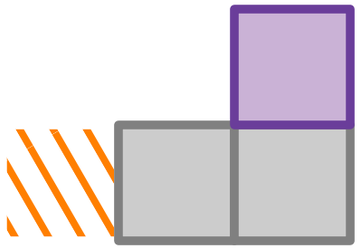

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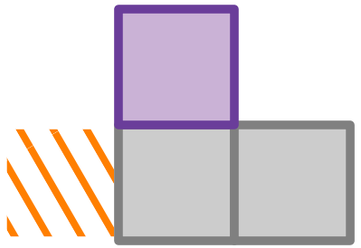

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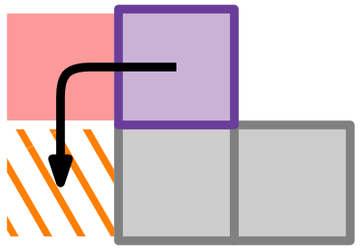

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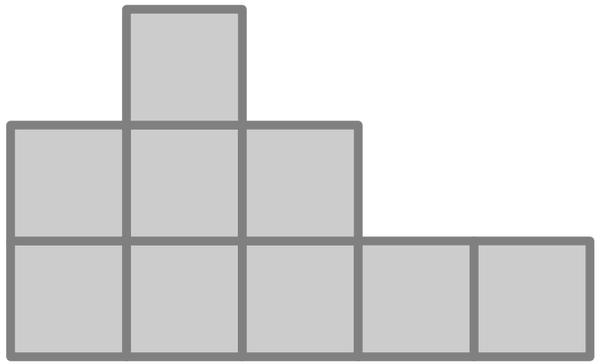

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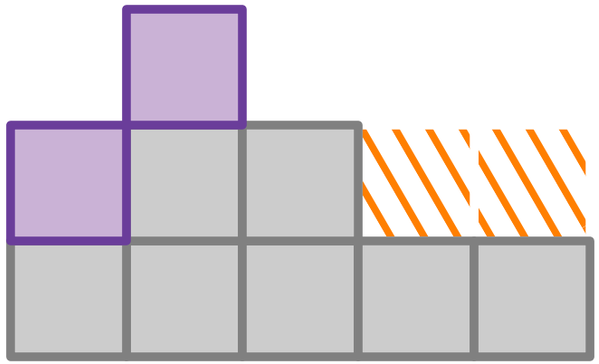

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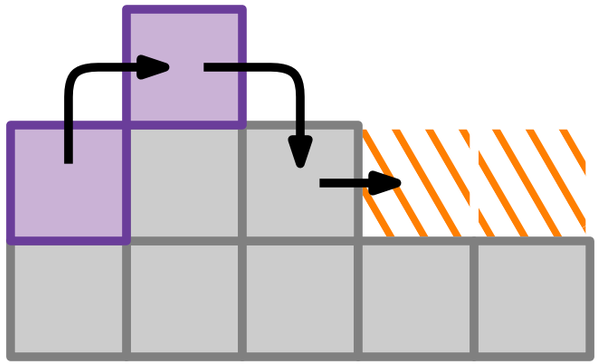

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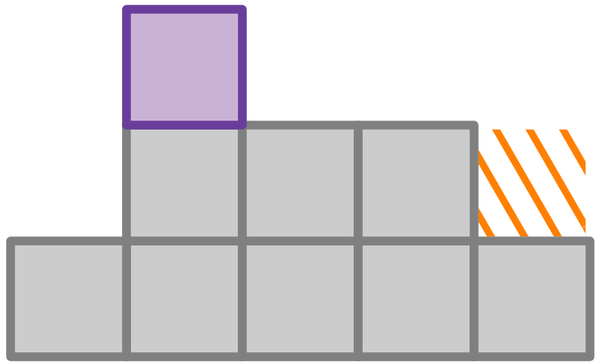

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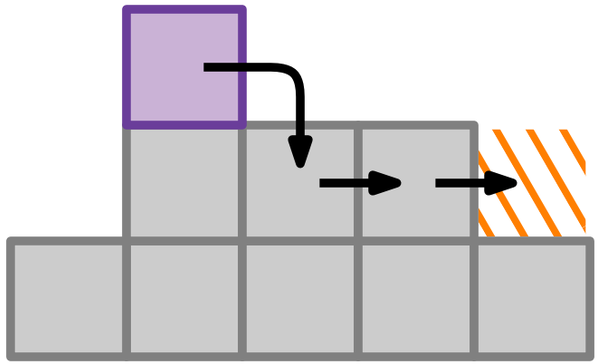

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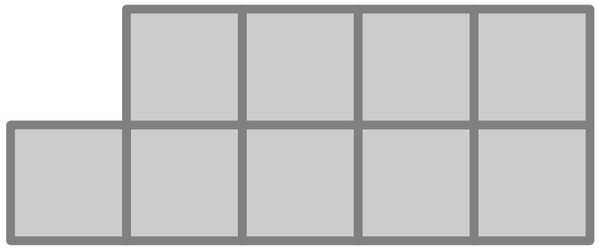
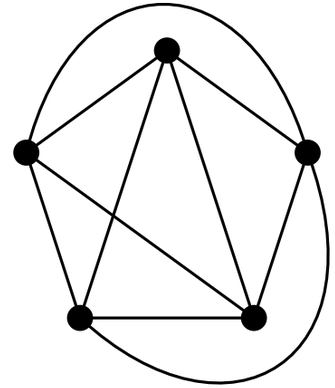


8. Crossing Number of 3-Plane Drawings



How many edges can a 1-planar graph have?

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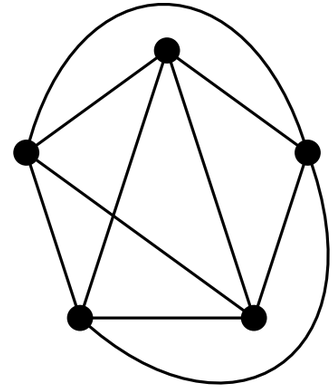

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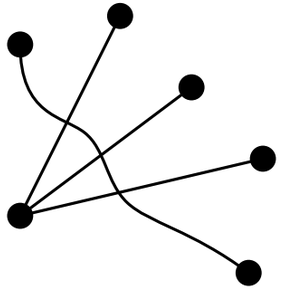

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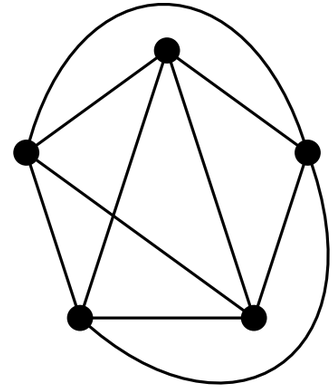

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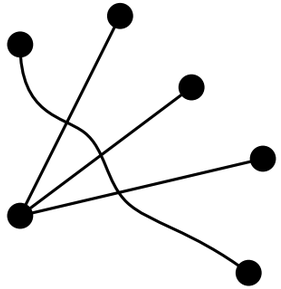

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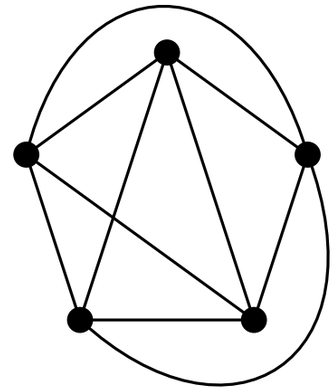

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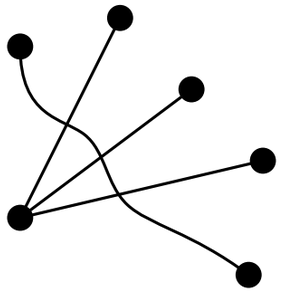

General: How many edges can . . . have?

The density formula:

$$|E| = t(|V| - 2) - \sum_{c \in \mathcal{C}} \left(\frac{t-1}{4} \|c\| - t \right) - |\mathcal{X}|$$

9. Geometric Spanners of Bounded Tree-width

- Tree-width: Measure for how tree-like a graph is.

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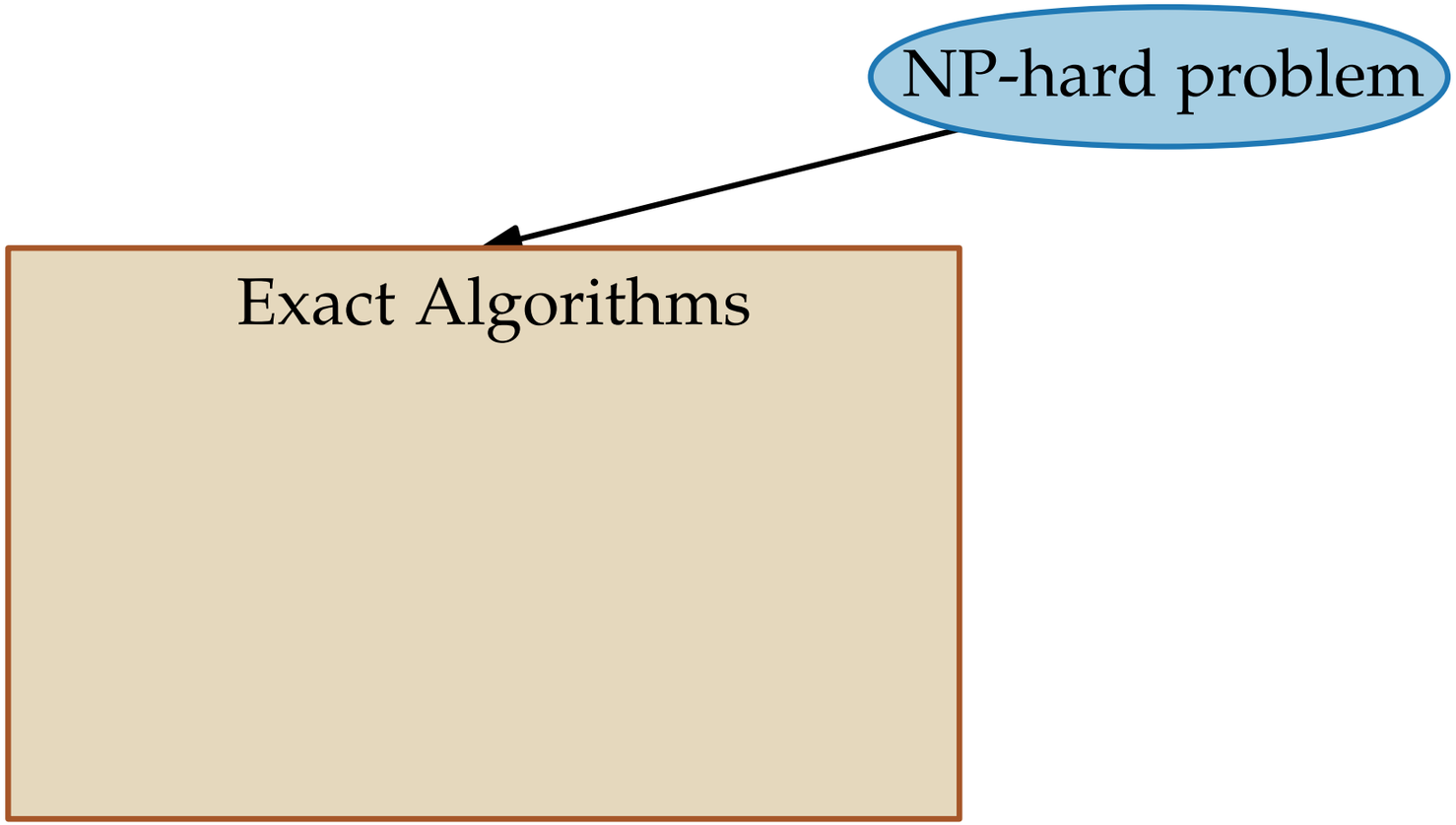

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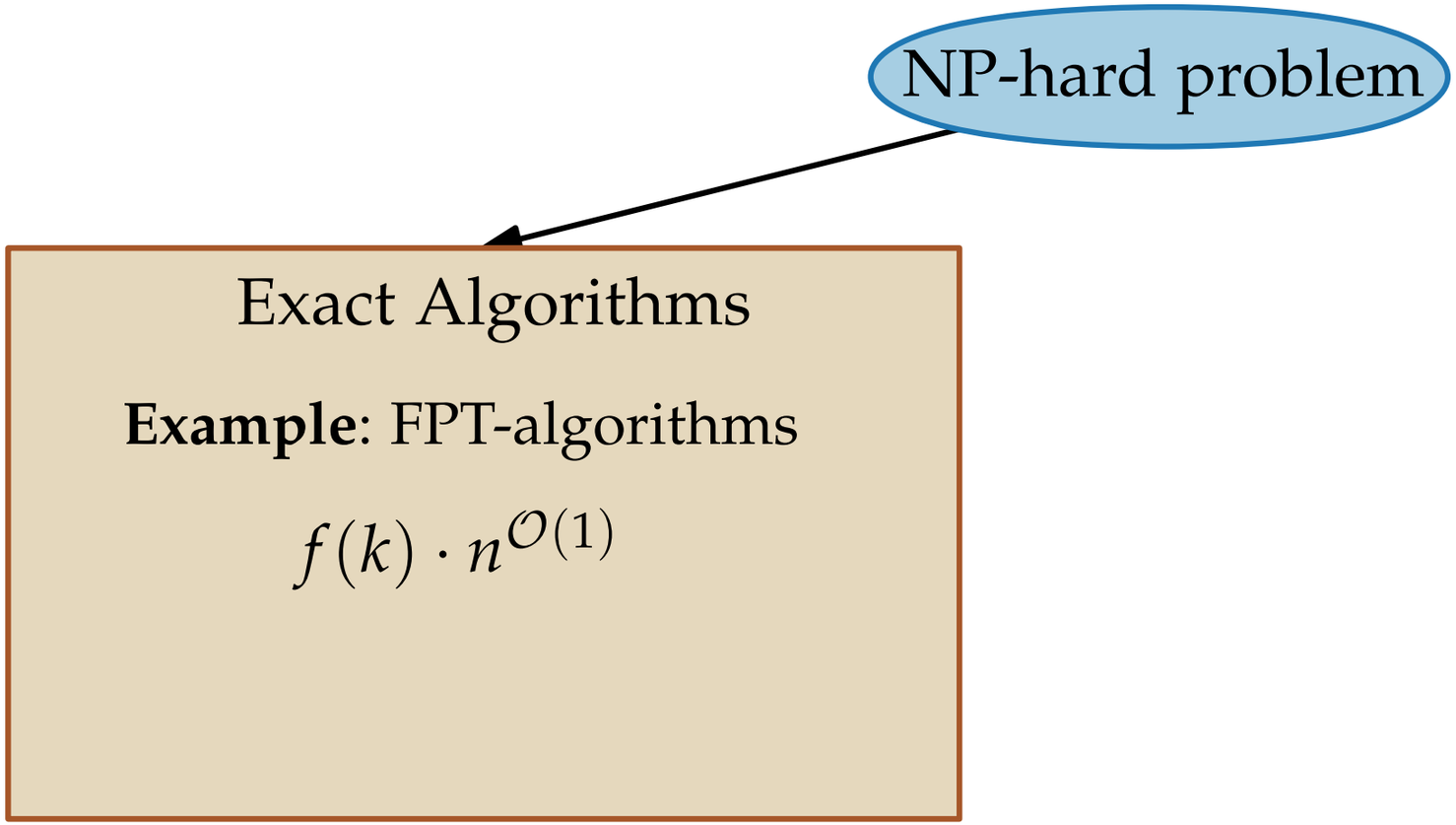

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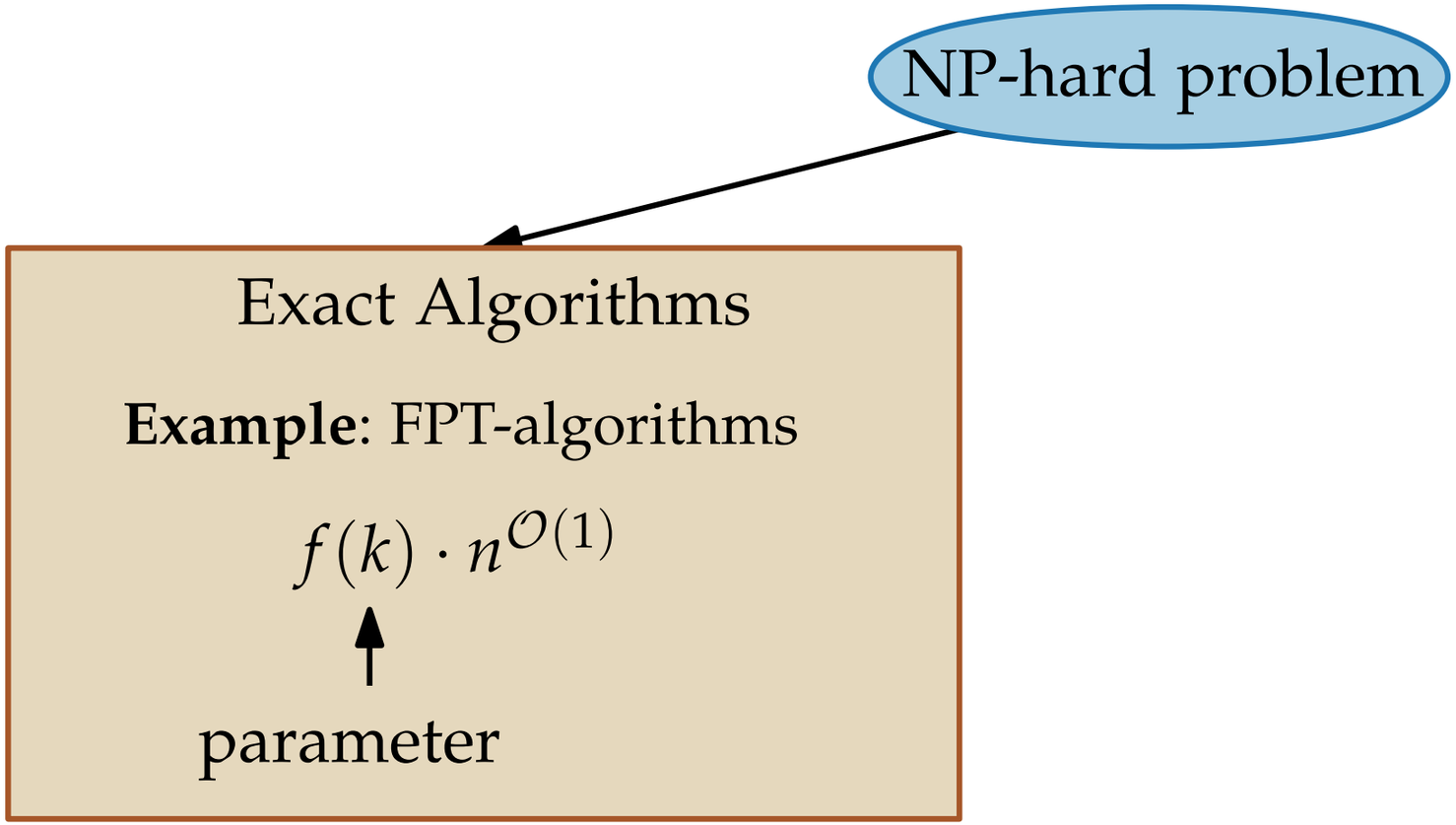

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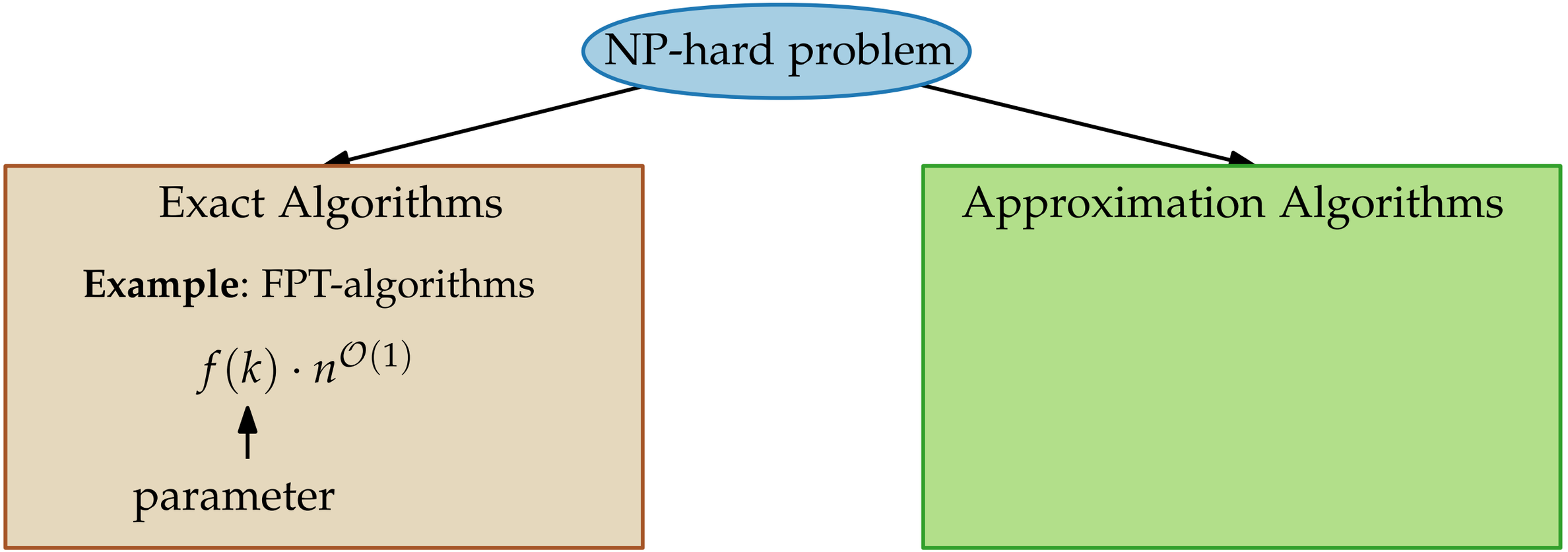

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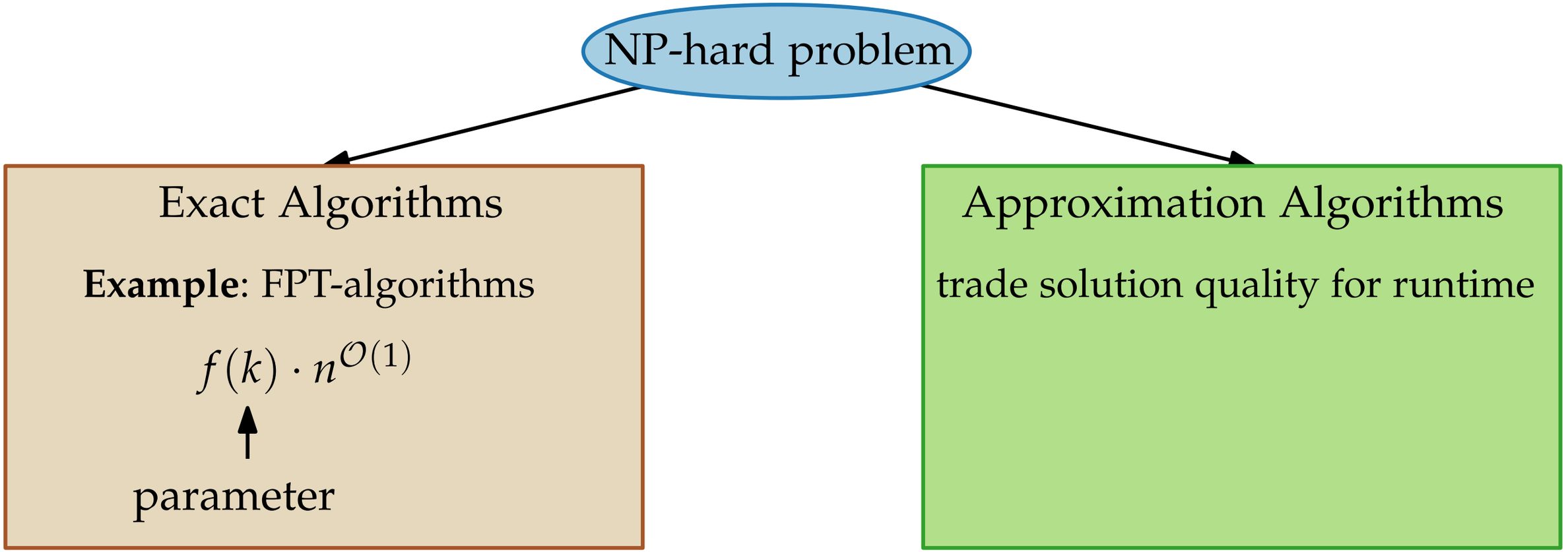

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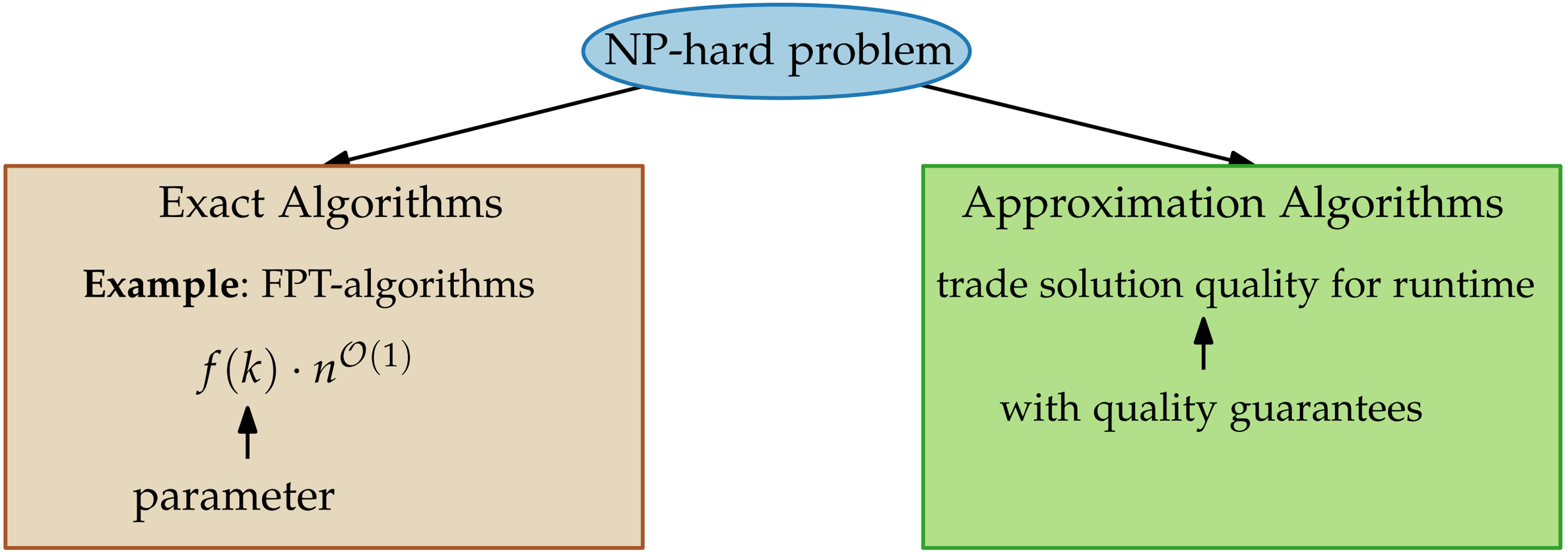

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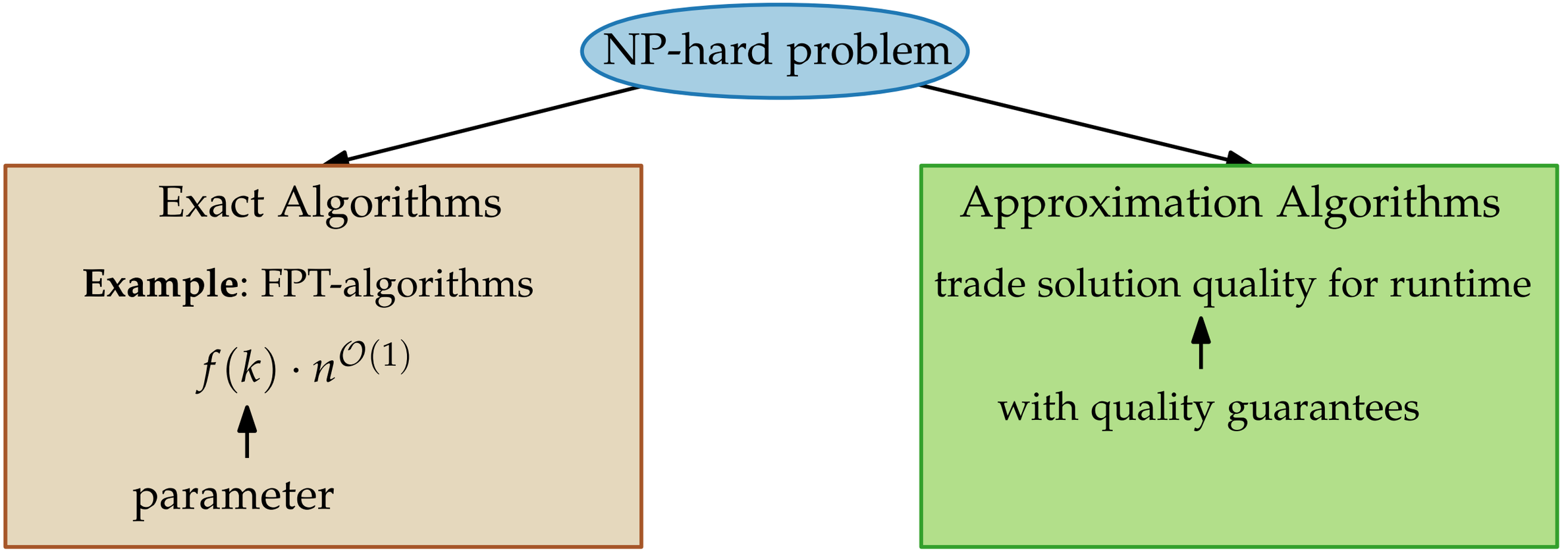

Here: Polynomial-time algorithms that produce a solution of value at most/least $c\mathrm{OPT} \pm f(k)$

11. Kuratowski's Theorem

When is a graph planar?

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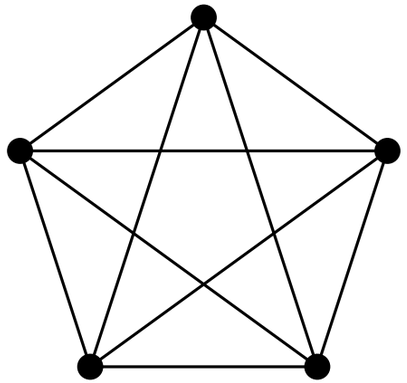
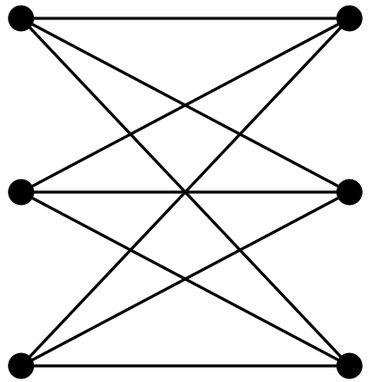


K_5



$K_{3,3}$

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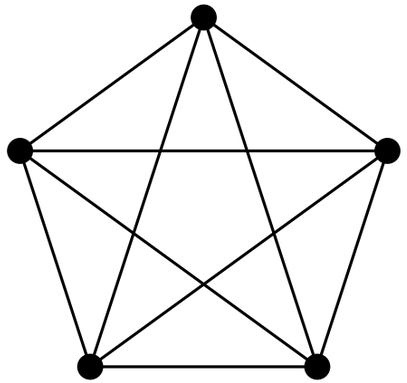

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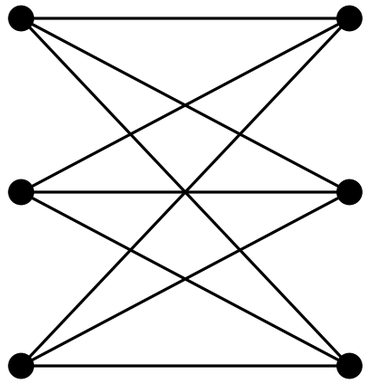

$K_{3,3}$

Kuratowski's Theorem:
A graph is planar if and only if it does not contain K_5 or $K_{3,3}$ as a minor.

Themenverteilung

1. Parameterized Complexity of Simultaneous Planarity
2. Lower bounds based on the Exponential-Time Hypothesis
3. Constraint Logic: A Uniform Framework for Modeling Computation as Games
4. XALP-completeness of Parameterized Problems on Planar Graphs
5. Approximation Algorithms for NP-complete Problems on Planar Graphs
6. How to Morph Planar Graph Drawings
7. Sliding Squares in Parallel
8. Crossing Number of 3-Plane Drawings
9. Geometric Spanners of Bounded Tree-width
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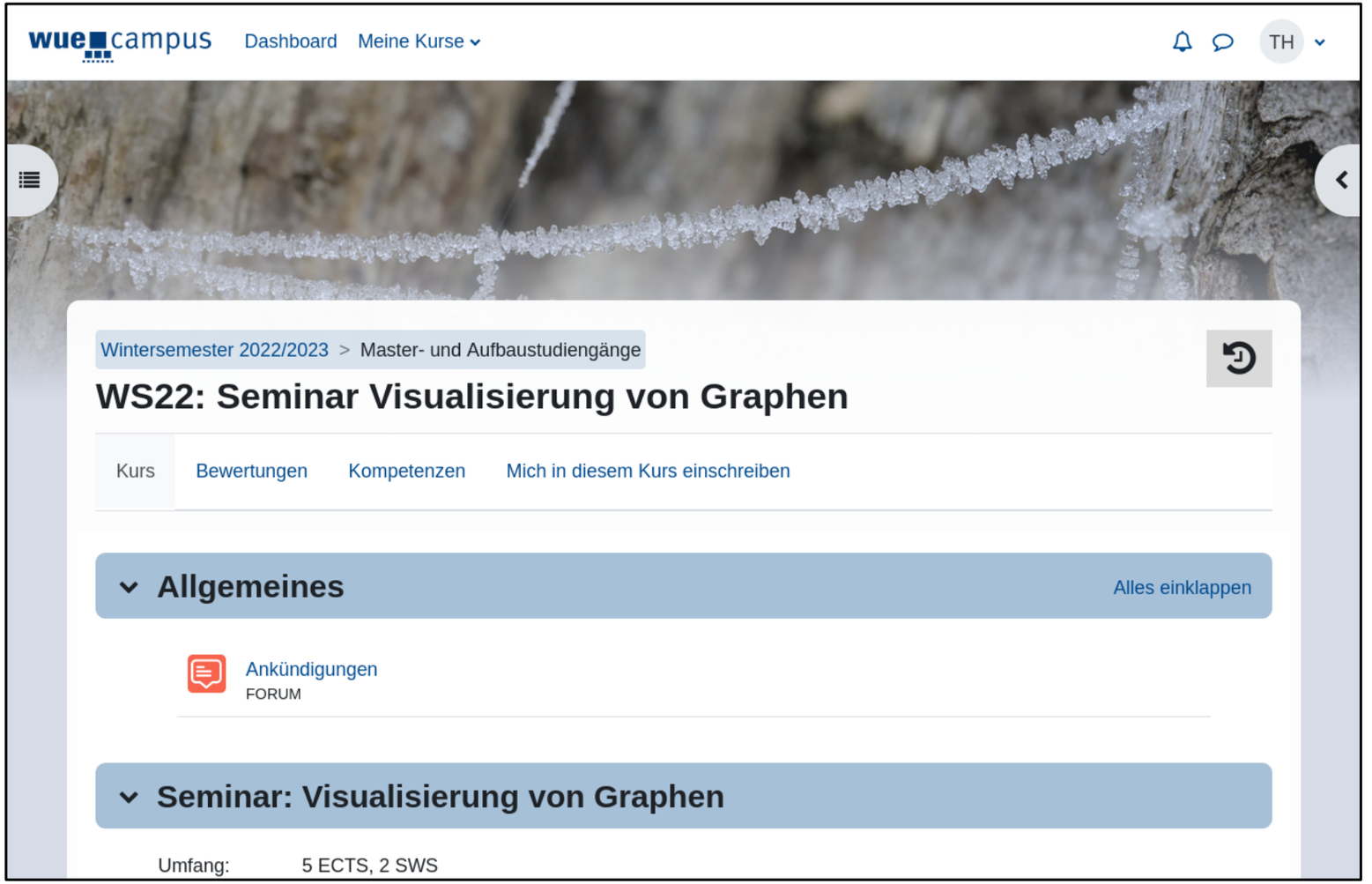

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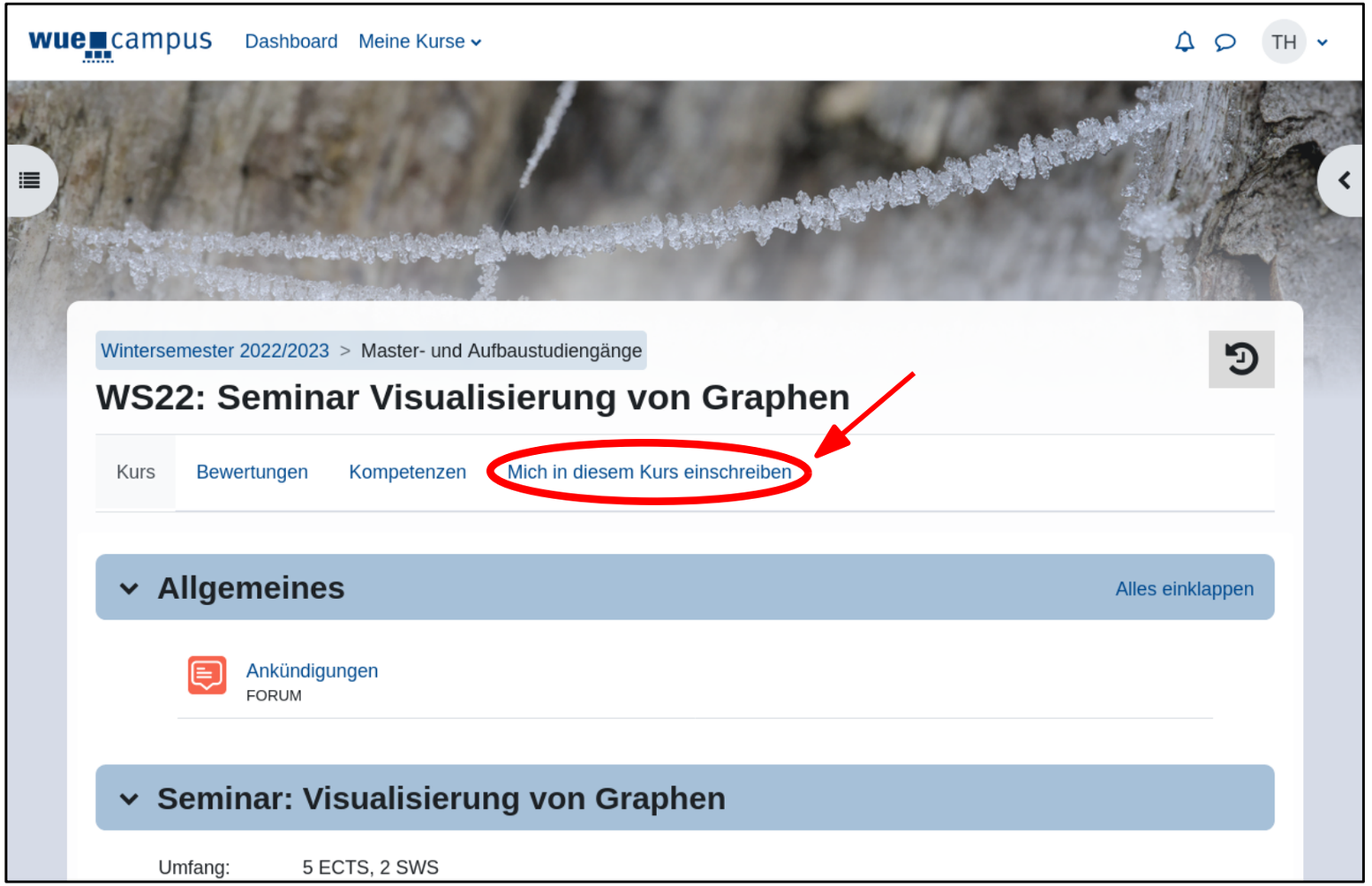

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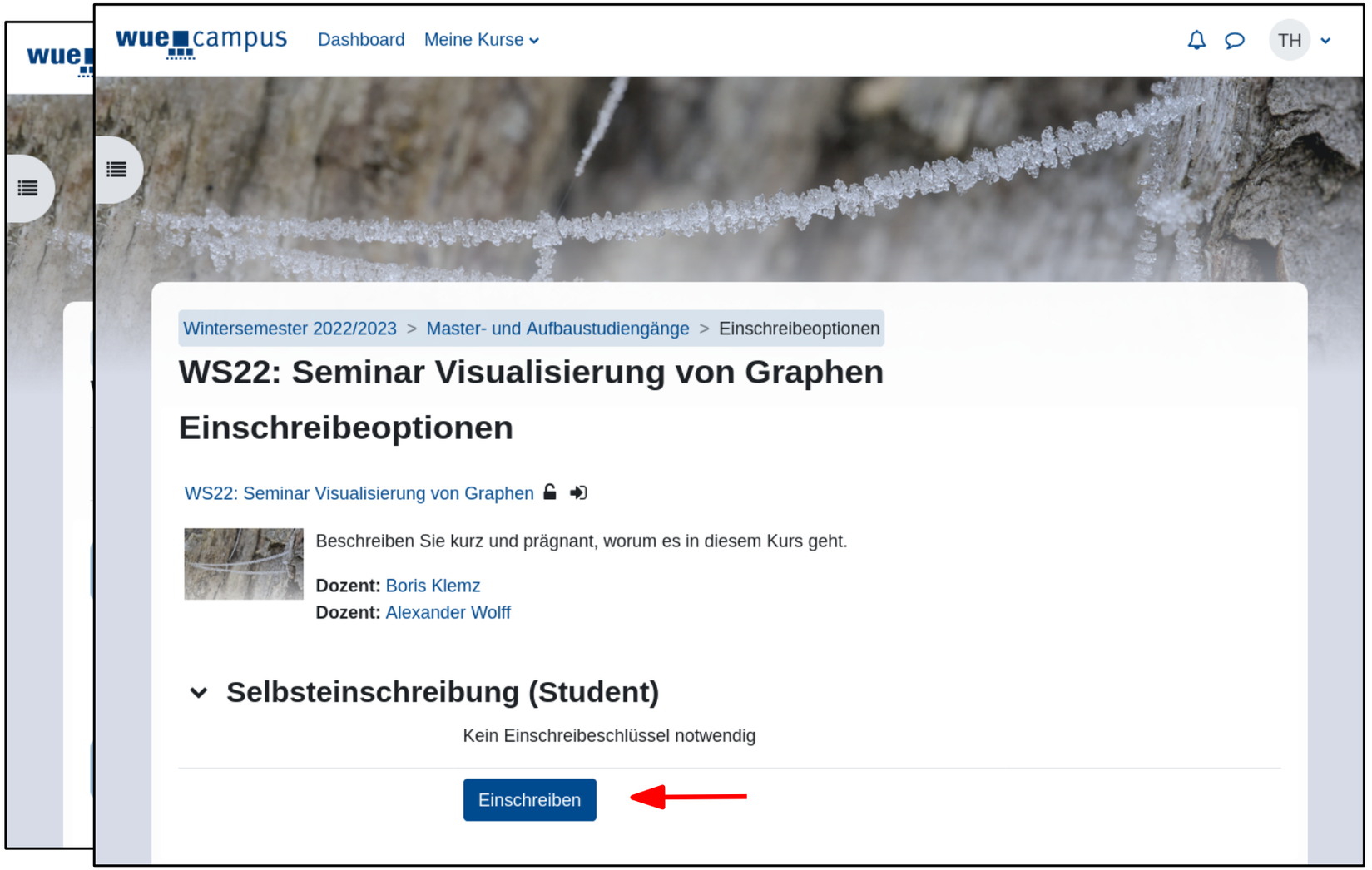

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Zum Abschluss:

Demonstration des Programms IPE
zum Erstellen von Abbildungen und Folien

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