



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.

Ablauf des Seminars

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Inhalte:

- Ausblick auf den eigentlichen Vortrag geben
- Problemstellung nennen & motivieren
- Wichtigste Resultate nennen & einordnen

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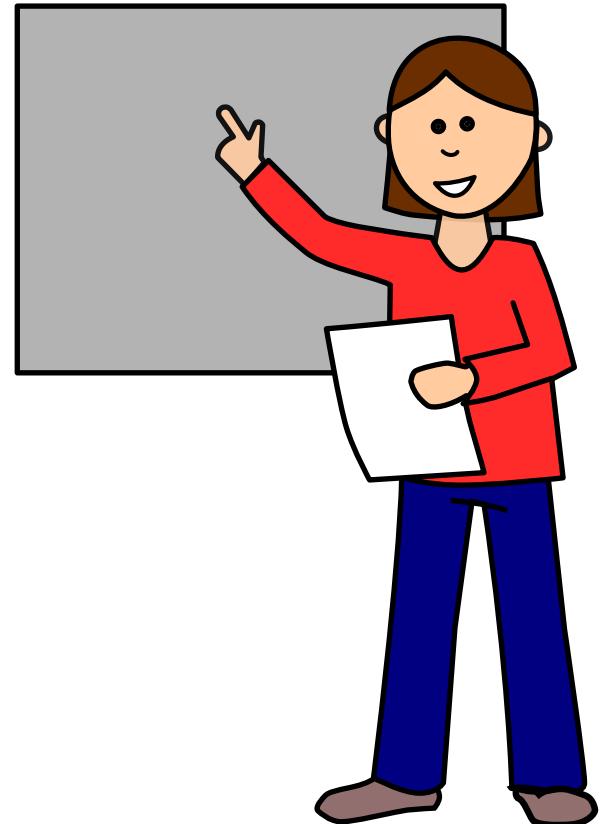
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Ziele:

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

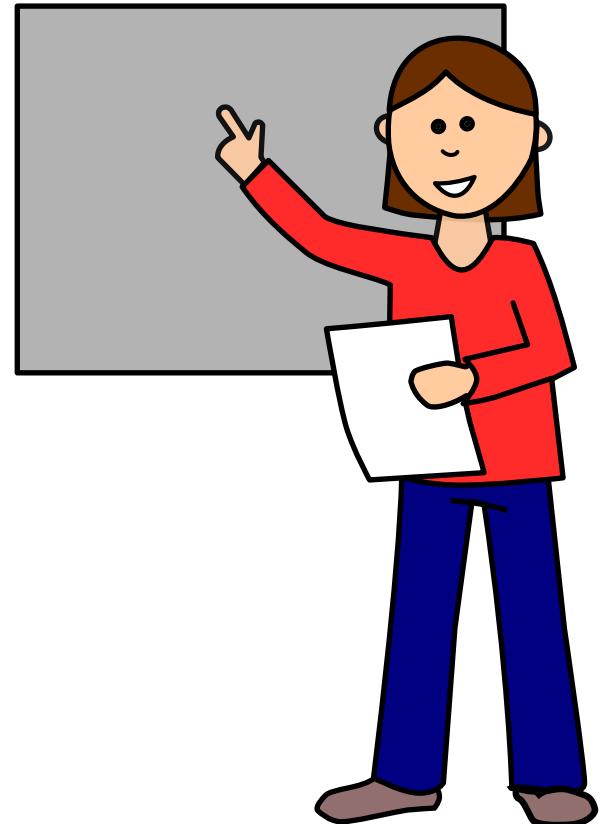
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(i.d.R. einer pro Woche)



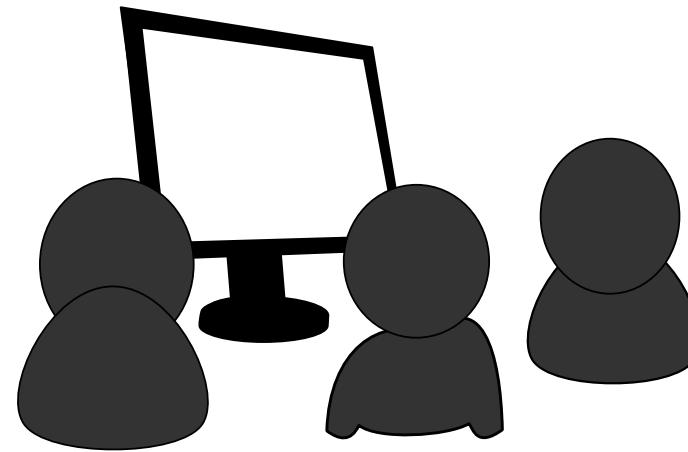
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- Mo, 04.08.2025: **Ausarbeitungen** abgeben



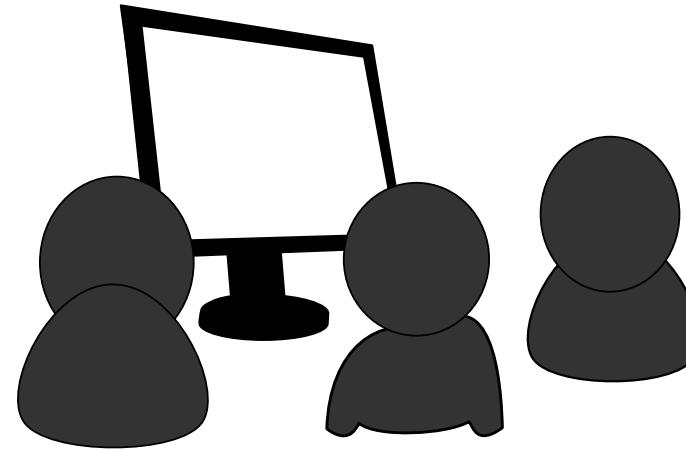
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- etwa 45 Minuten **Vortrag**
(zu zweit etwa 60 Minuten)



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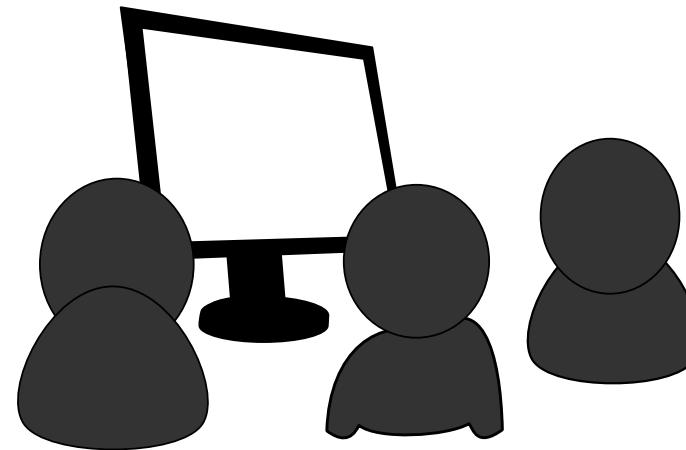


Das reicht i.d.R. nicht um alles im Detail zu besprechen!

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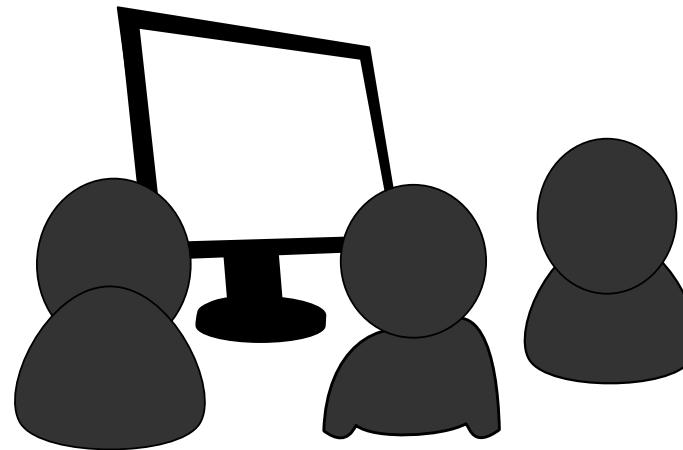
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Ausnahme: Einige Themen sind weniger umfangreich

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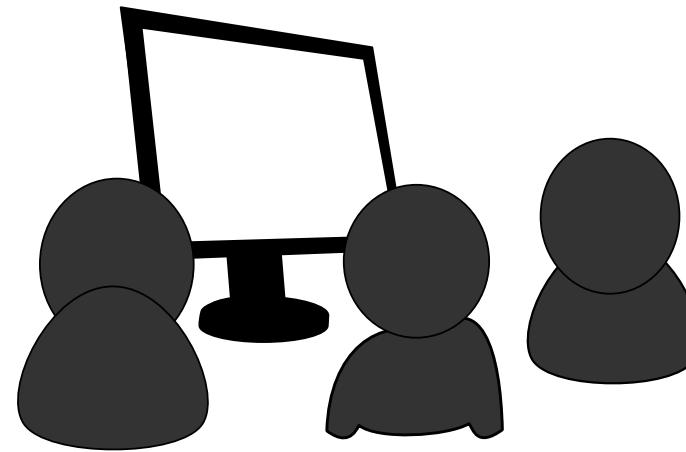
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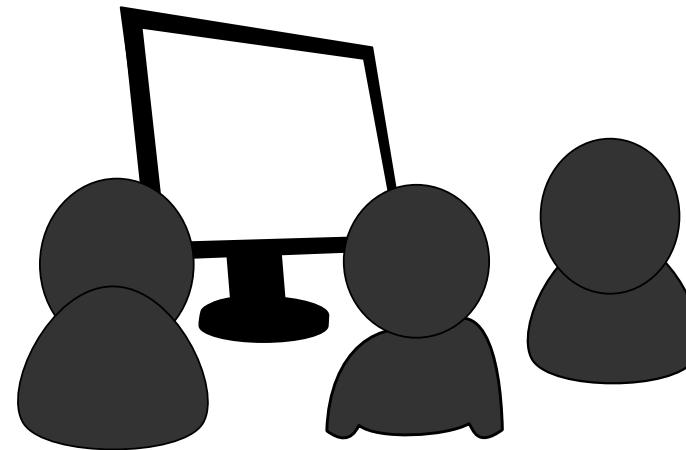
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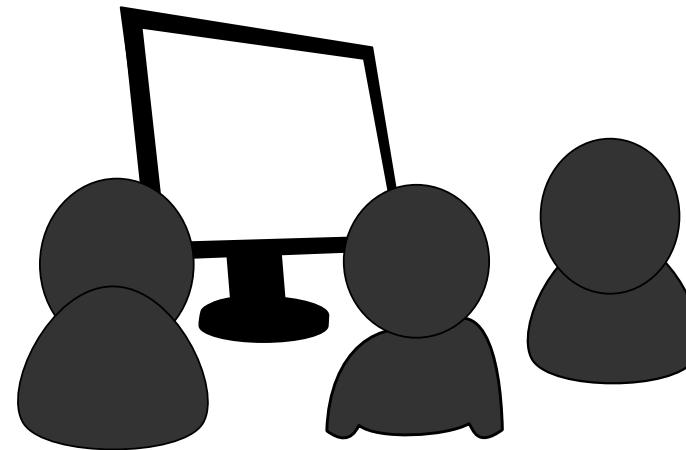
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(Übungsaufgaben, interaktive Beispiele, Besprechung
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Ideen aus der Diskussion in die Ausarbeitung mitaufnehmen!

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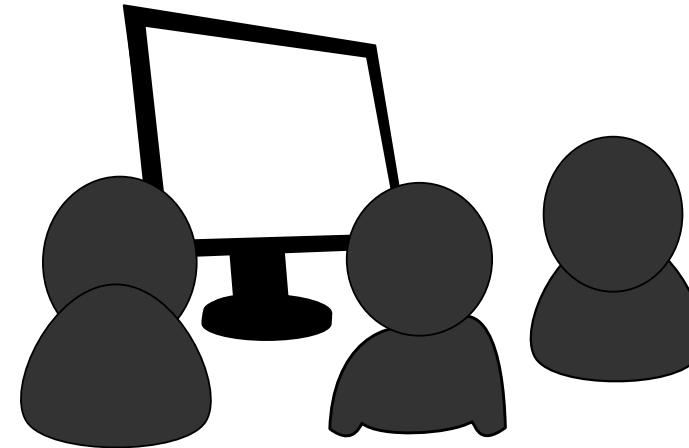


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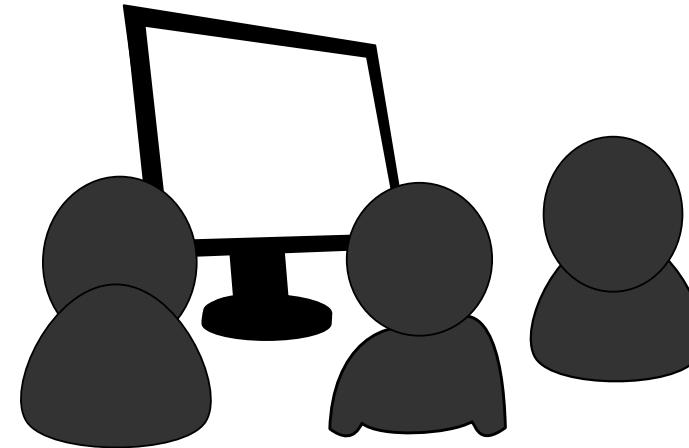
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Diese Termine sind **strikt**
(außer für den 1. Vortrag)!

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- alleine 7–9, zu zweit 11–13 Seiten;



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- L^AT_EX-Vorlage auf der WueCampus Seite!



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- **LAT_EX**-Vorlage auf der WueCampus Seite!
- **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
- Anwesenheit bei den anderen Vorträgen
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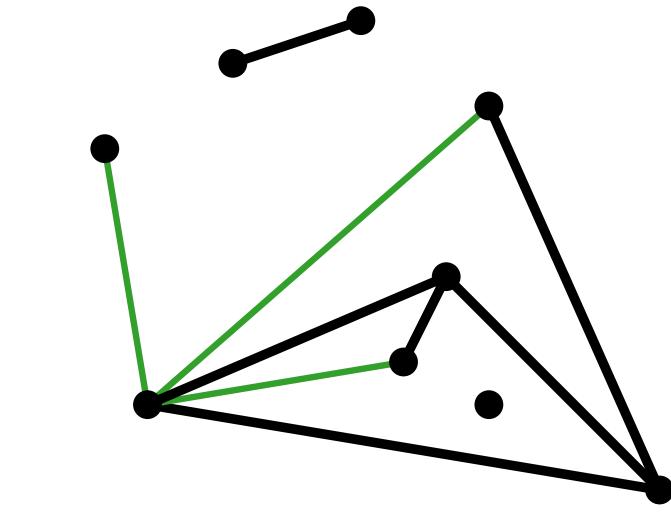
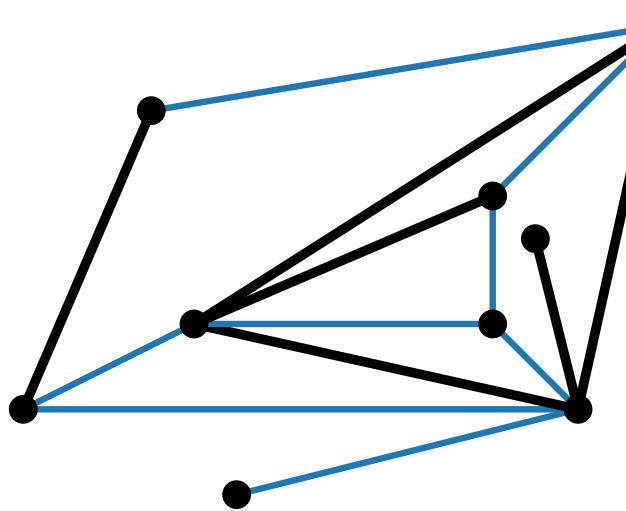
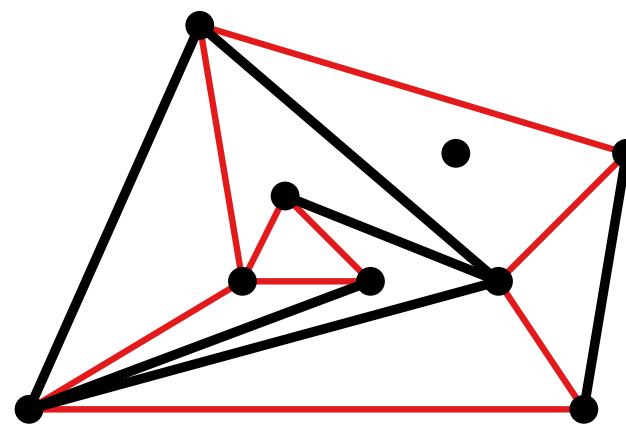
Bewertung

- Vortrag (Inhalte, Gestaltung der Folien, Verständlichkeit, Interaktivität)
- Ausarbeitung (Inhalte, roter Faden, sprachliche Darstellung, Rechtschreibung, eigener Beitrag)
- 50 : 50

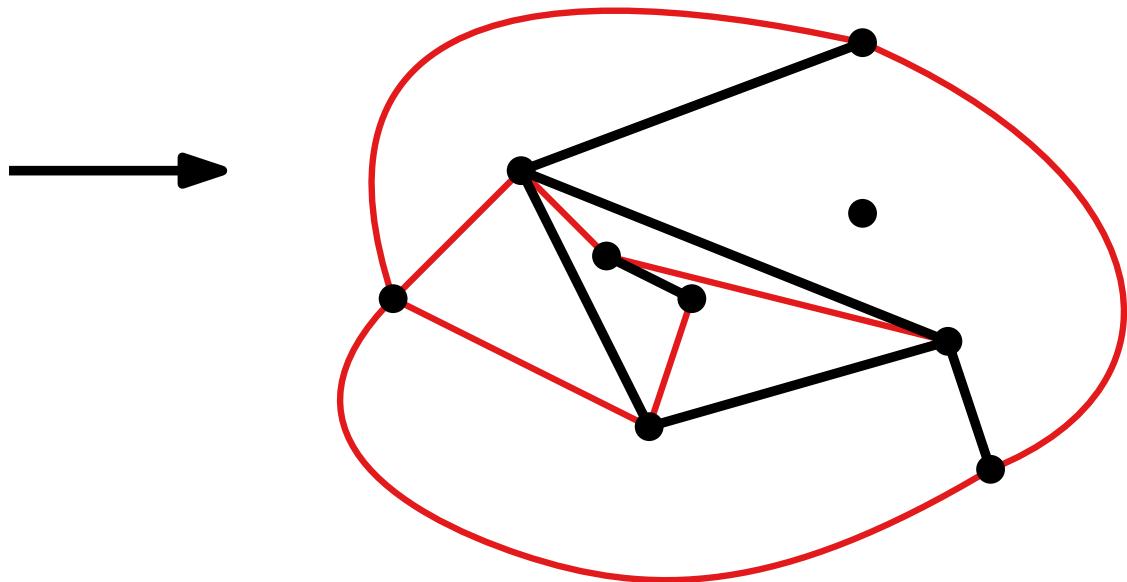
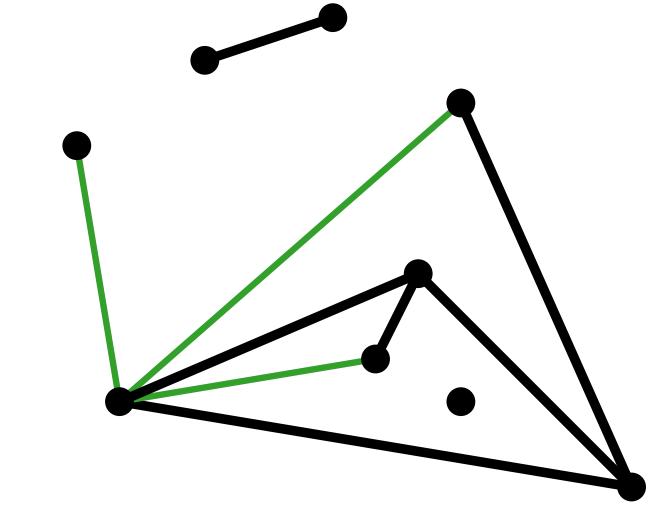
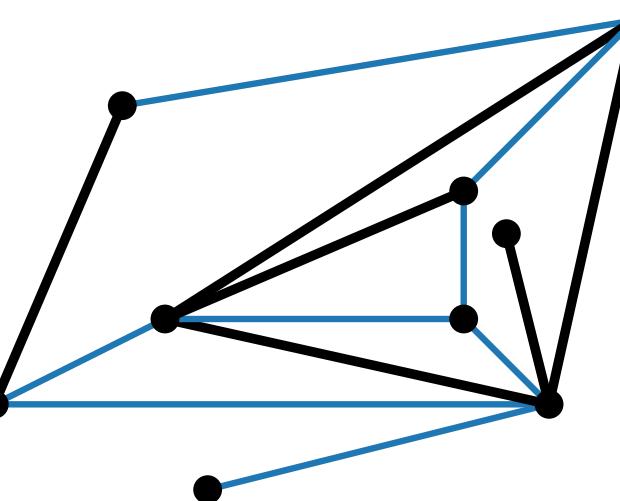
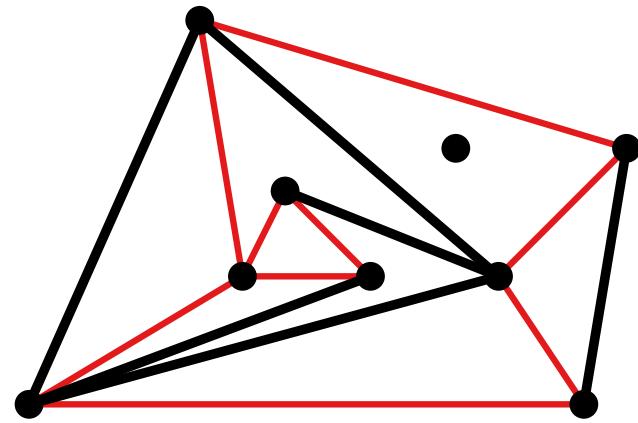
Themenübersicht

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

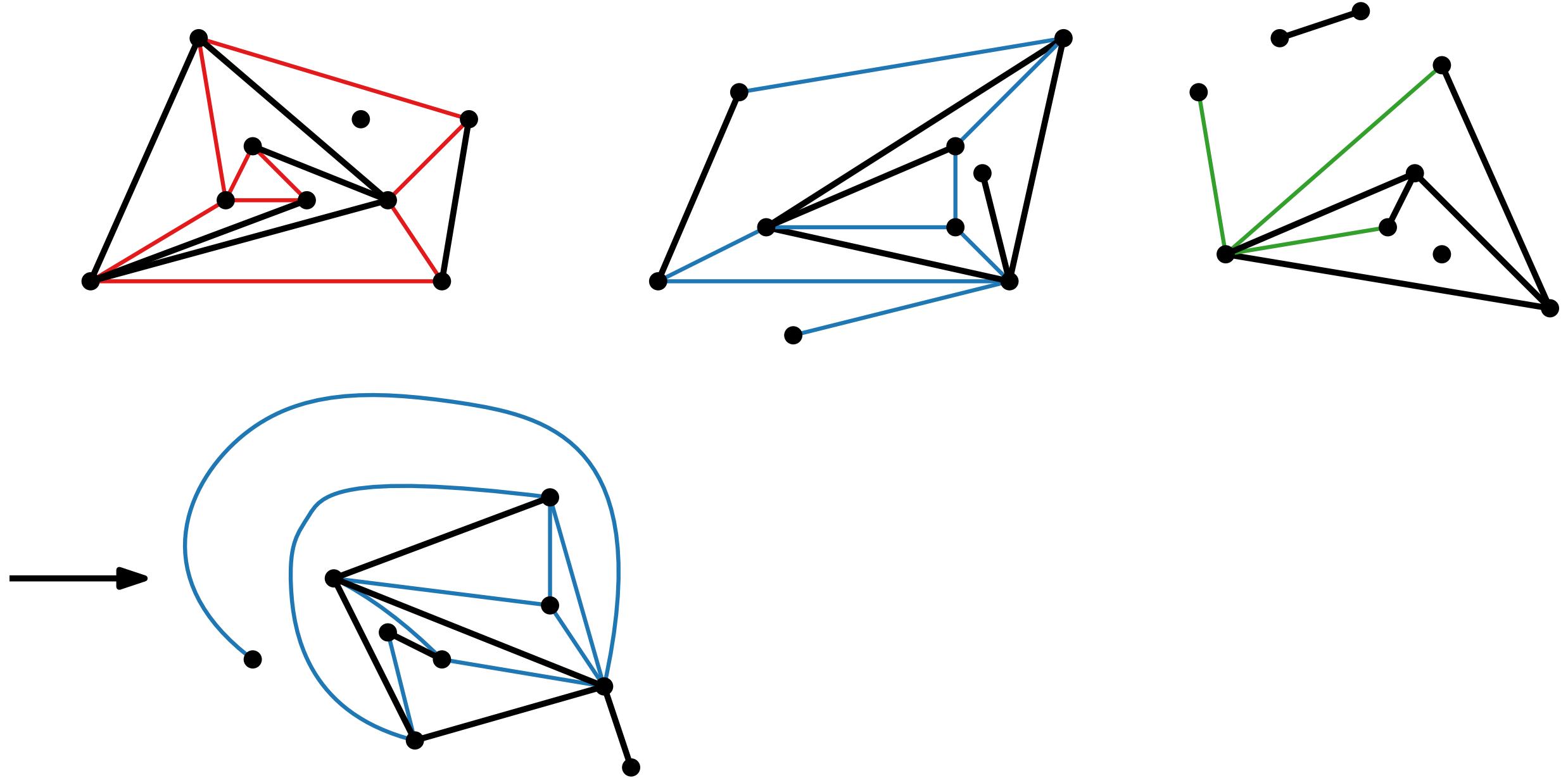
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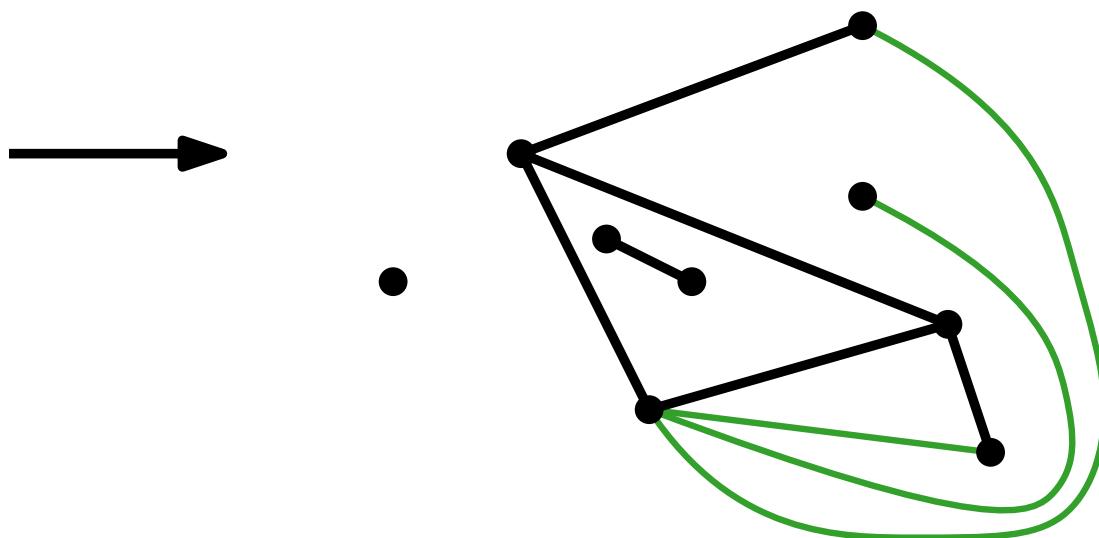
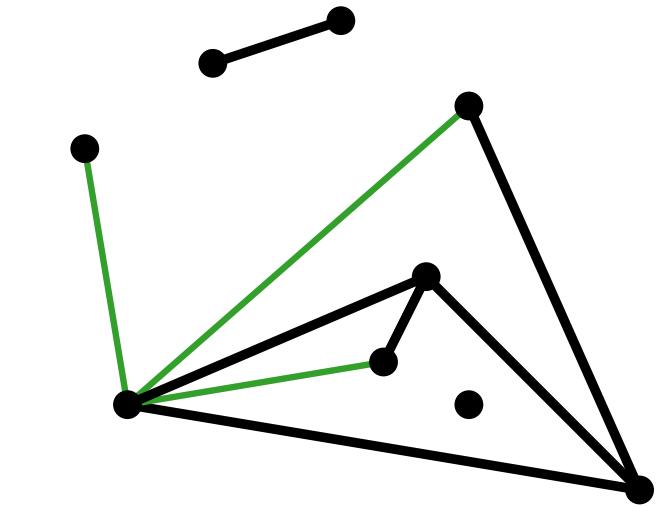
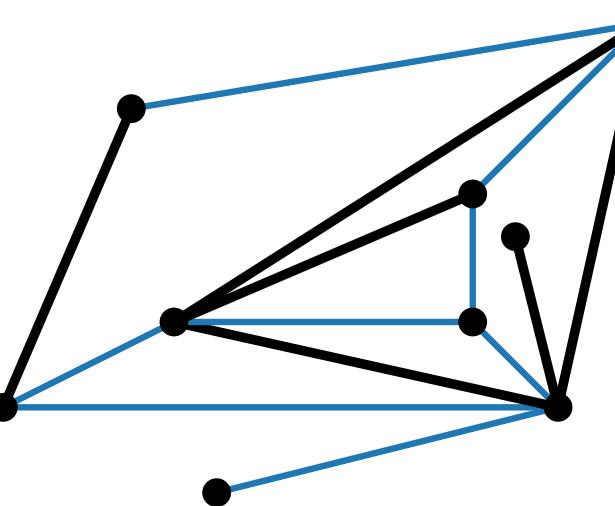
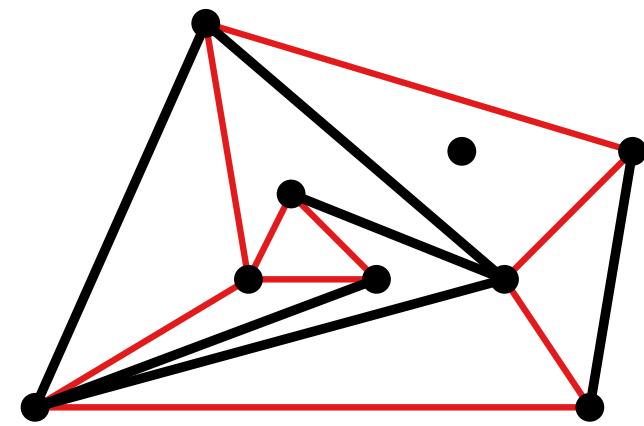
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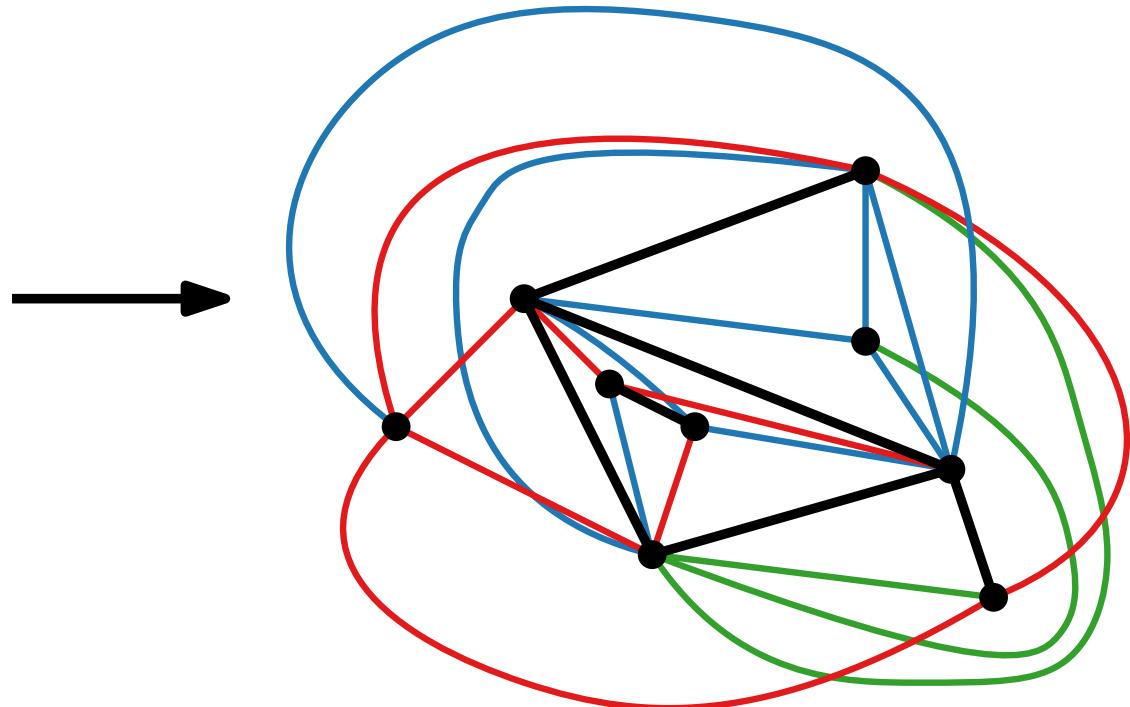
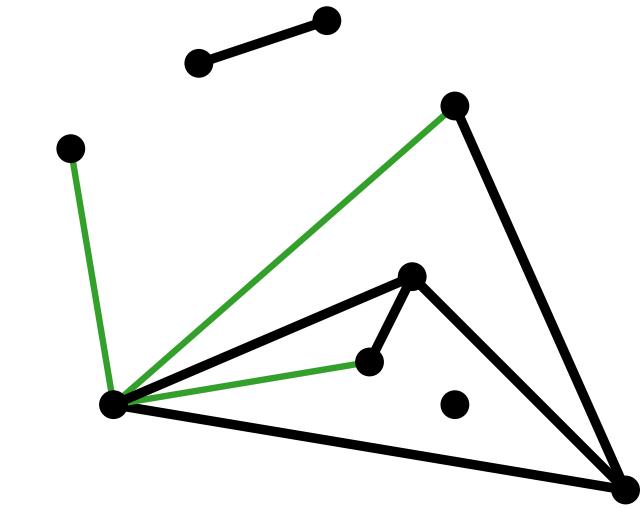
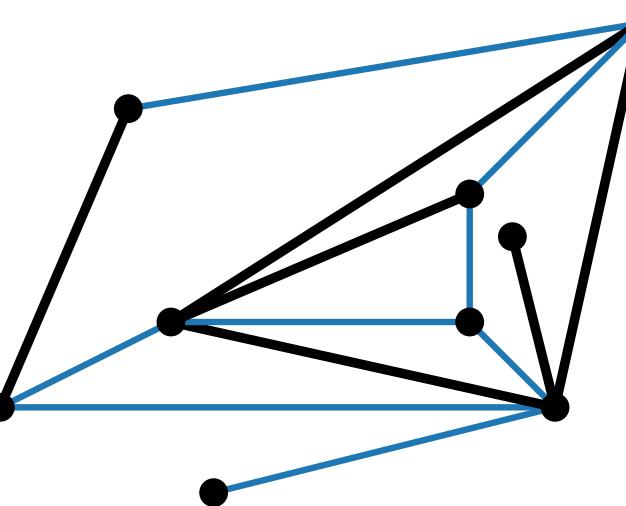
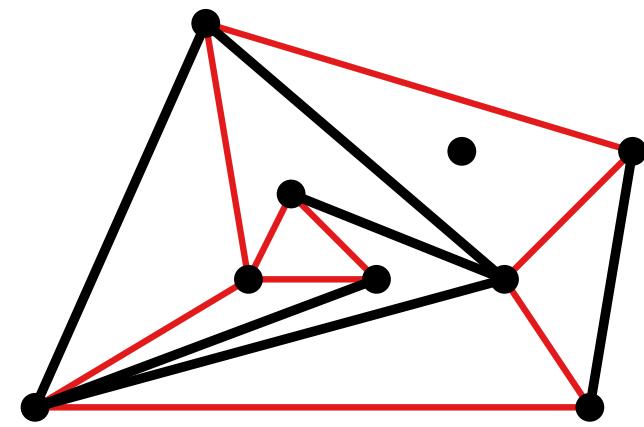
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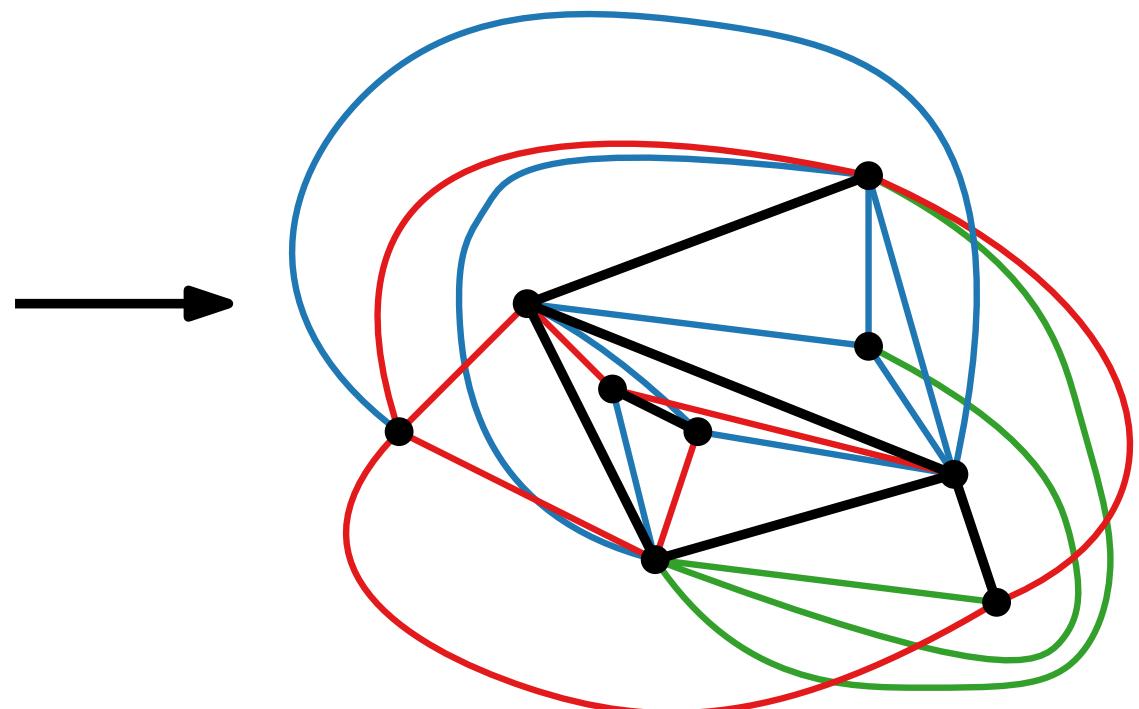
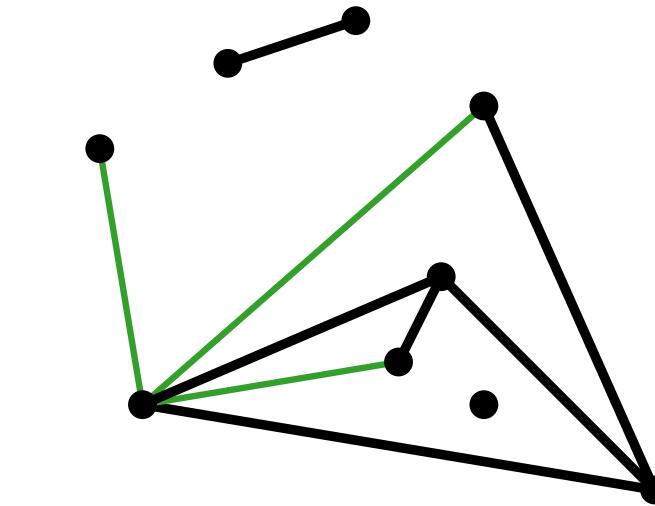
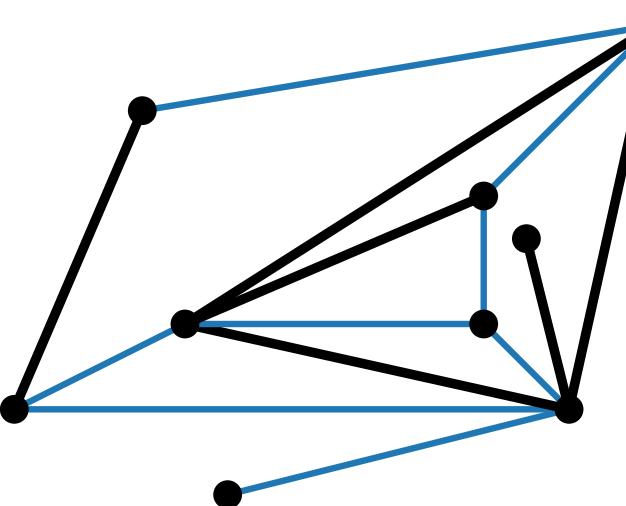
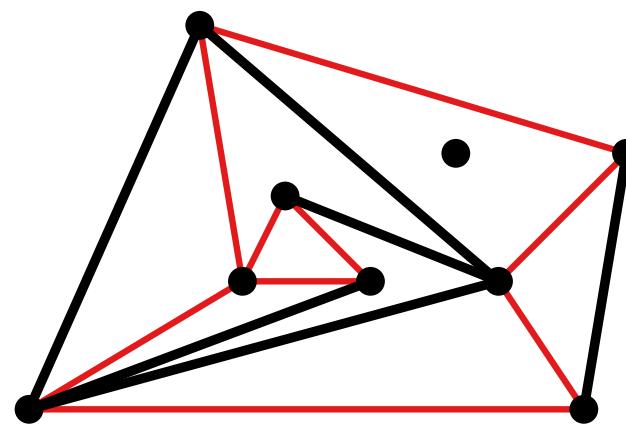
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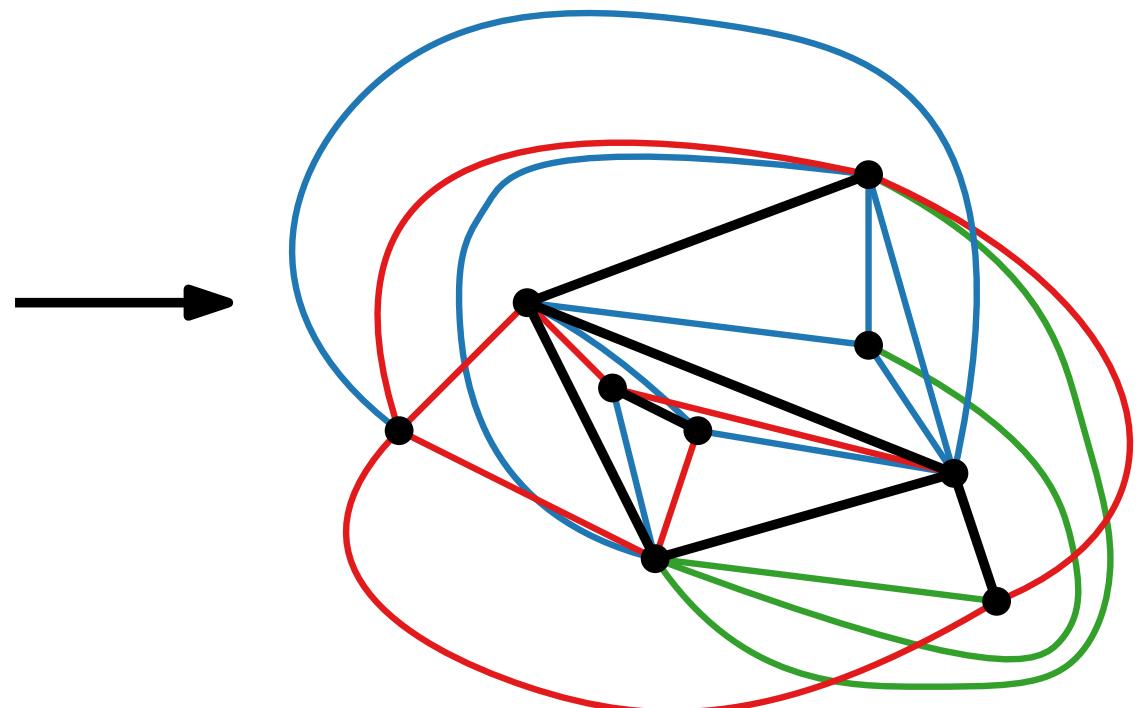
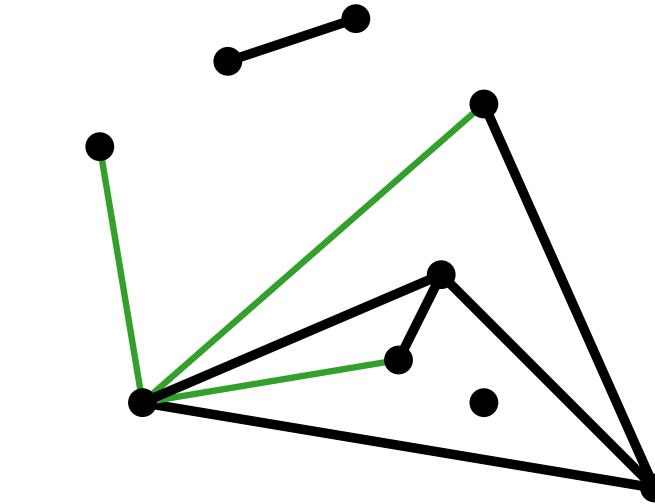
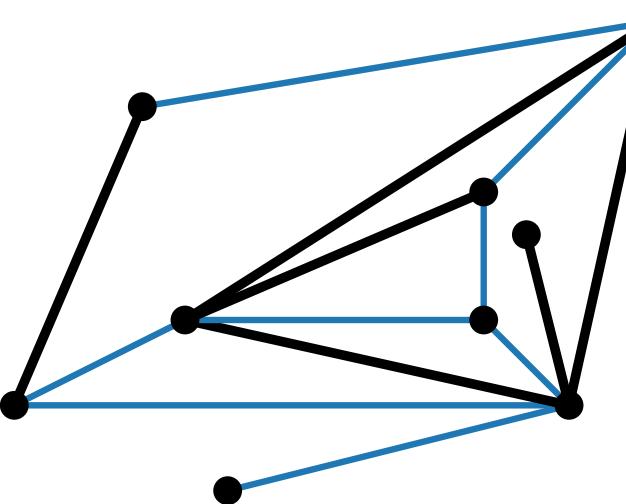
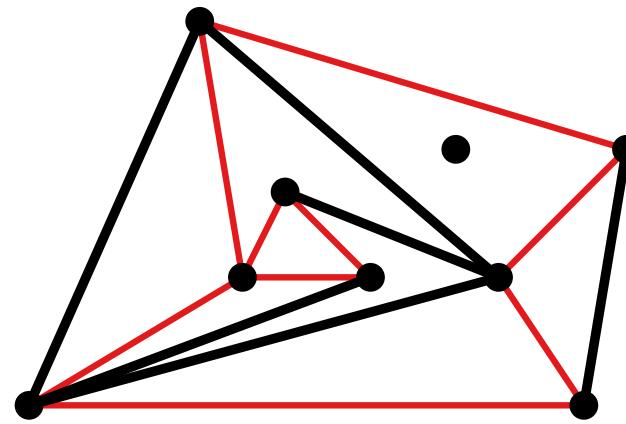


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Eingabe: k planar graphs that have some edges in common.

Frage: Can the graphs be drawn in a planar way simultaneously?

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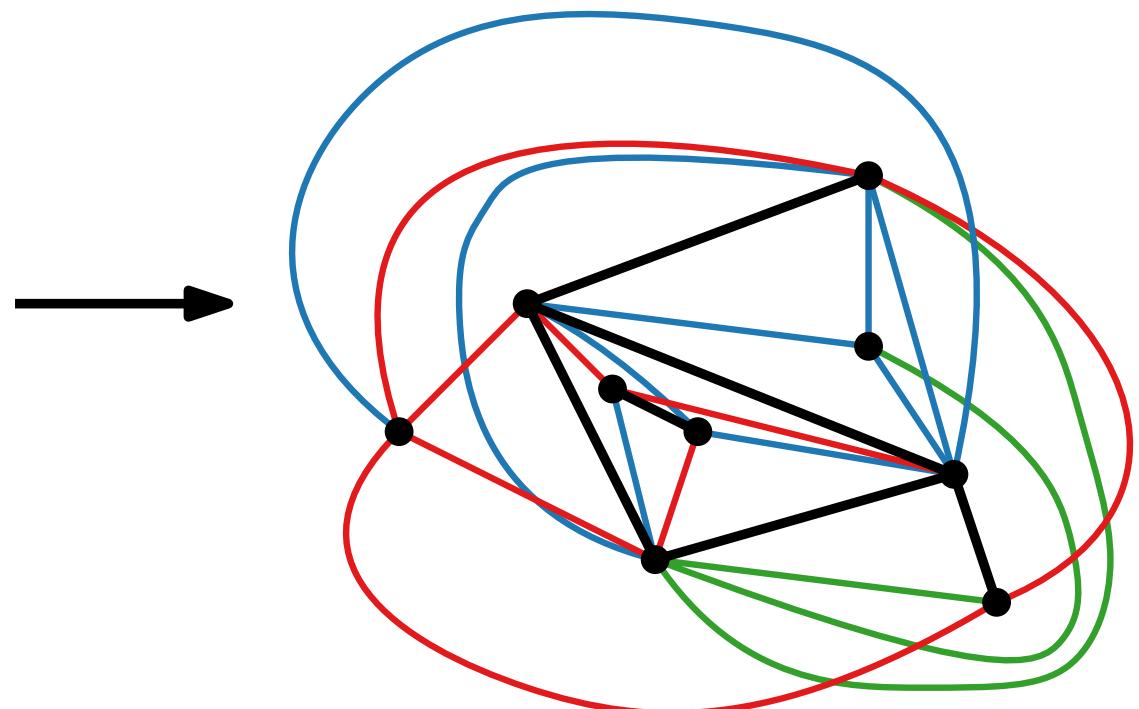
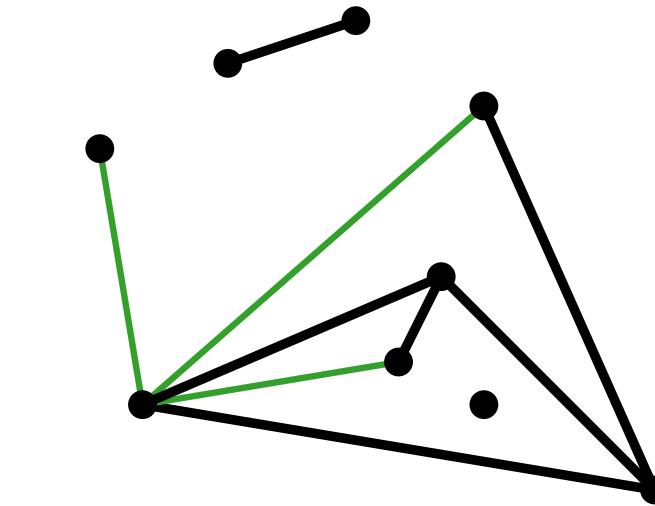
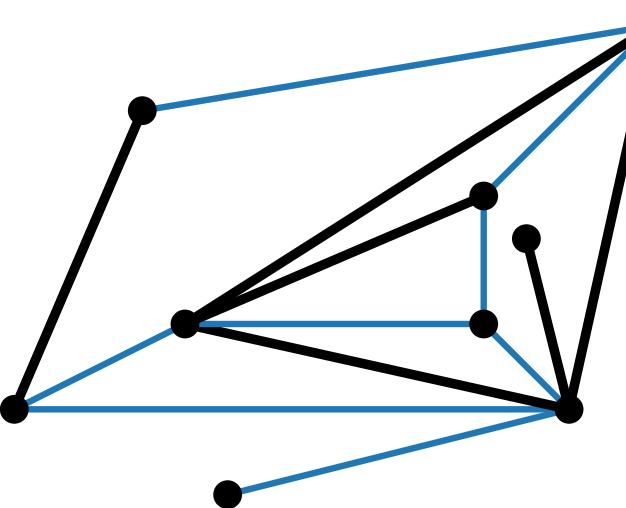
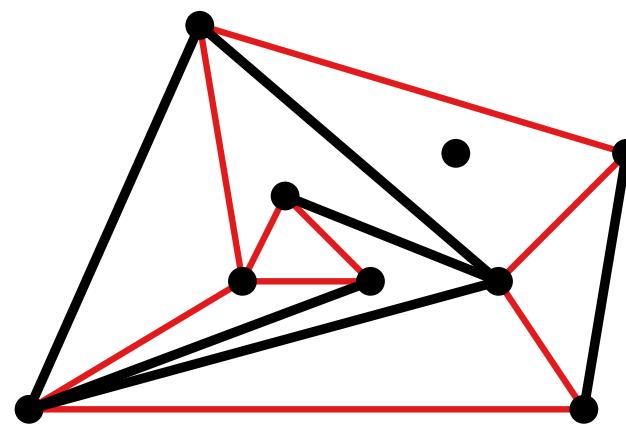
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NP-schwer für $k \geq 3$, nicht bekannt für $k = 2$.

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

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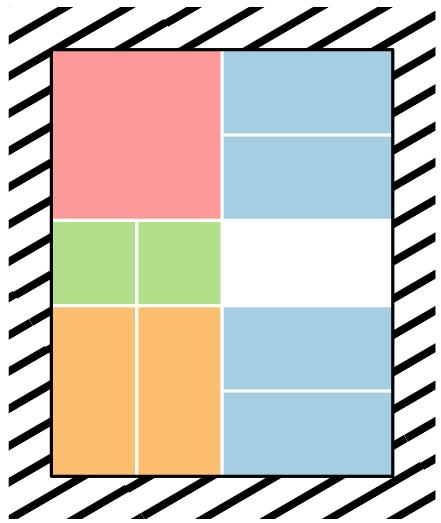
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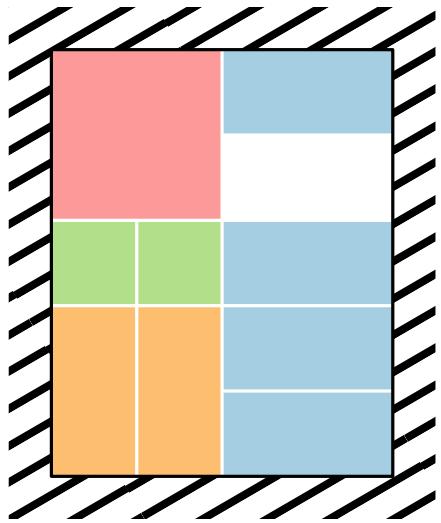
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With a suitable reduction from SATISFIABILITY to some other problem B , we can obtain a similar lower bound for the runtime of B , assuming SETH.

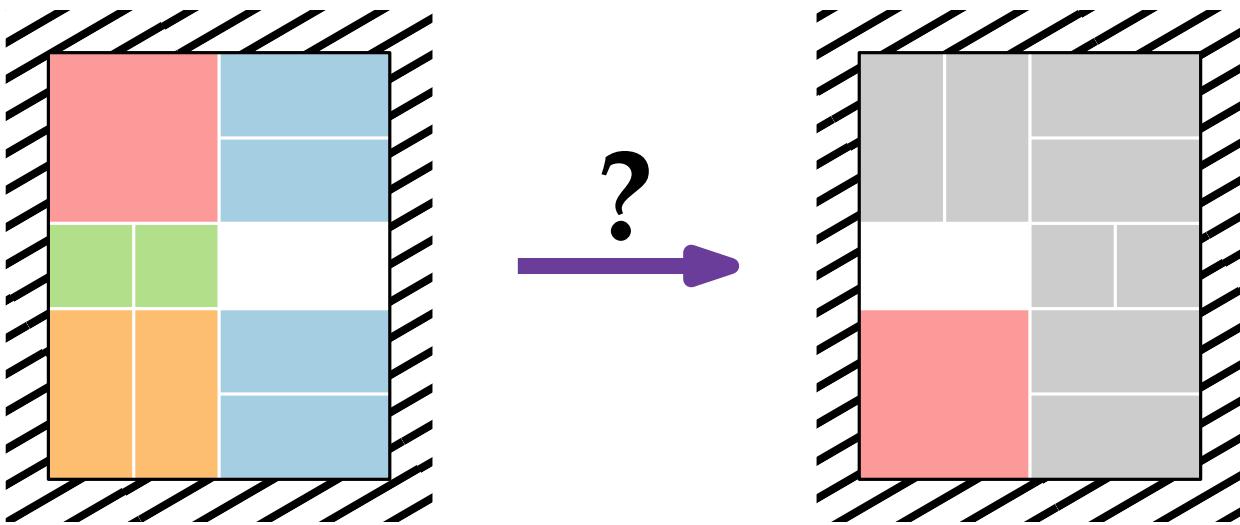
3. Constraint Logic



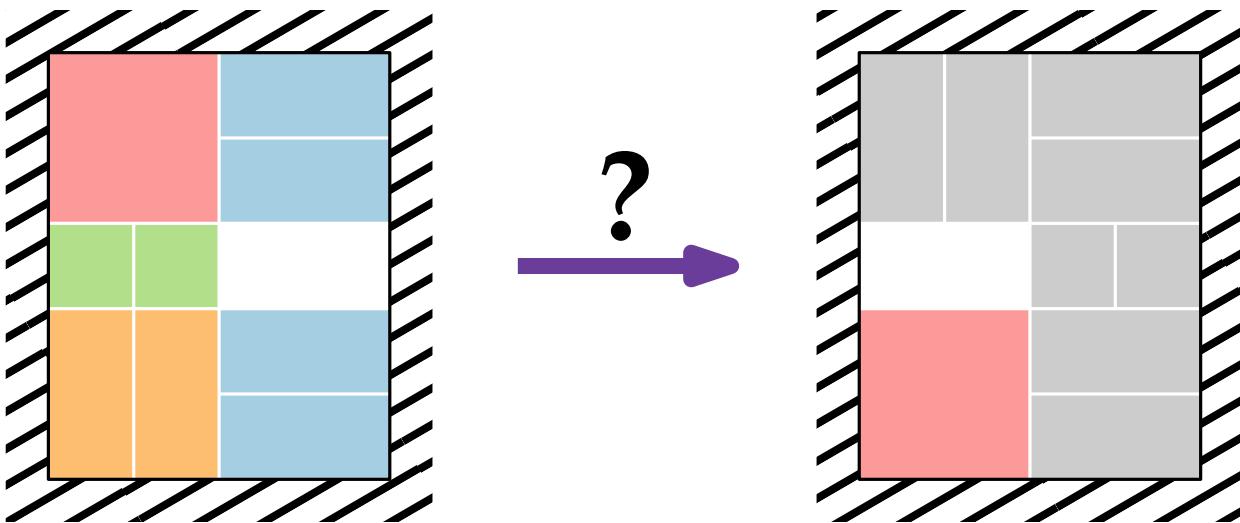
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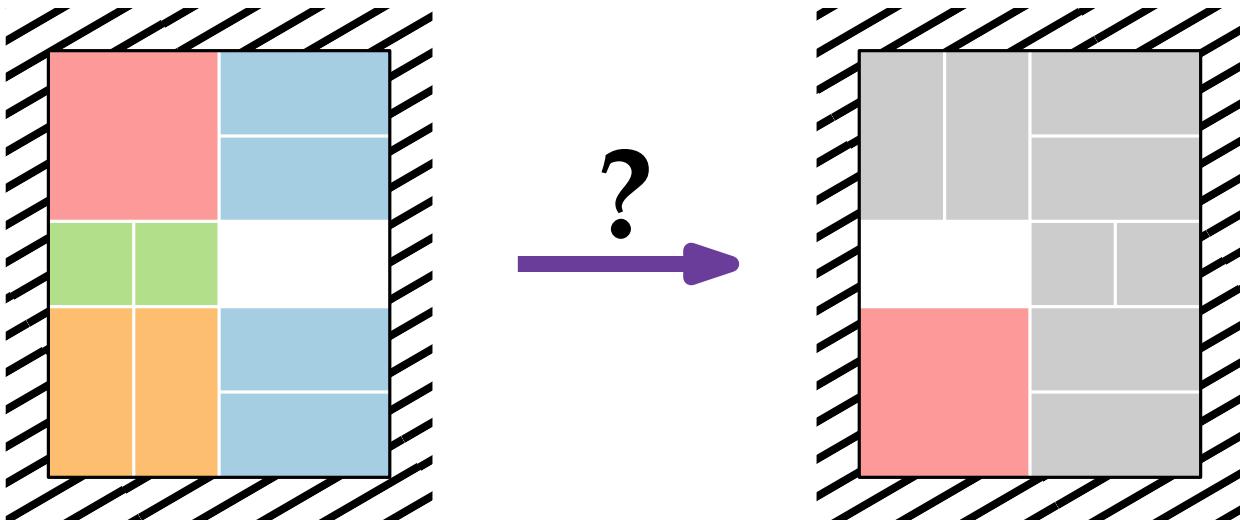


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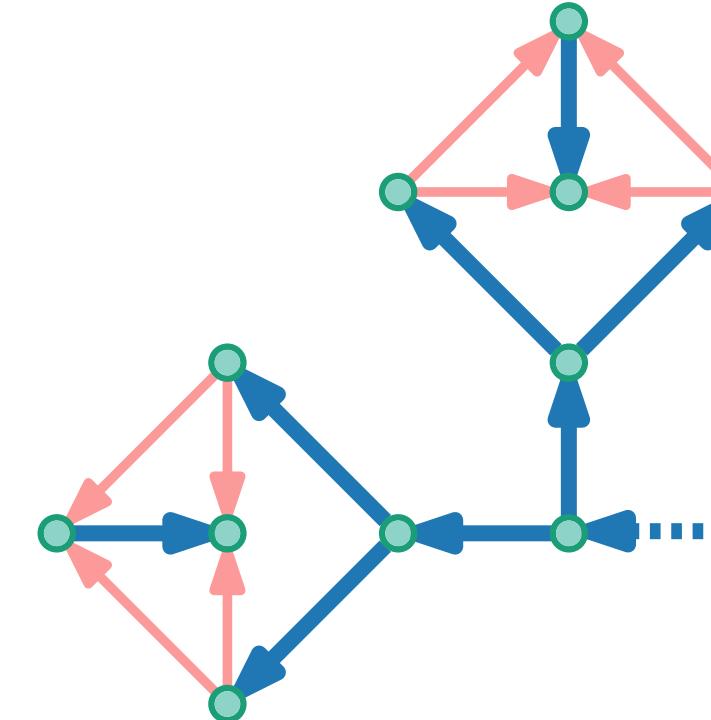


[Hearn, Demaine. TCS, 2005]

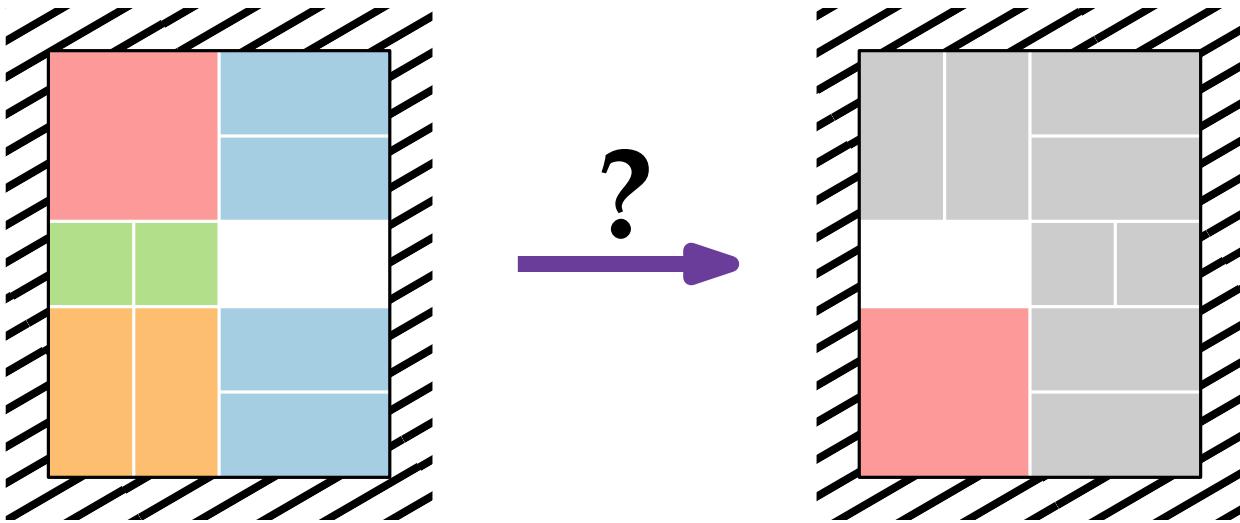
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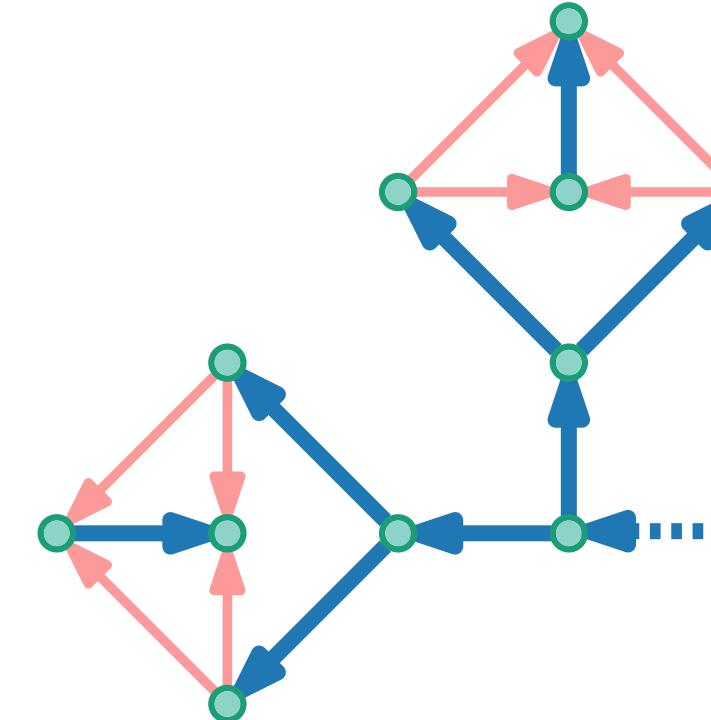
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4. XNLP/XALP-complete Problems for Planar Graphs

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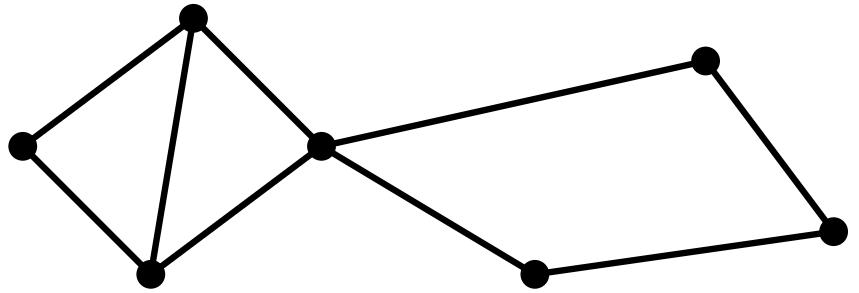
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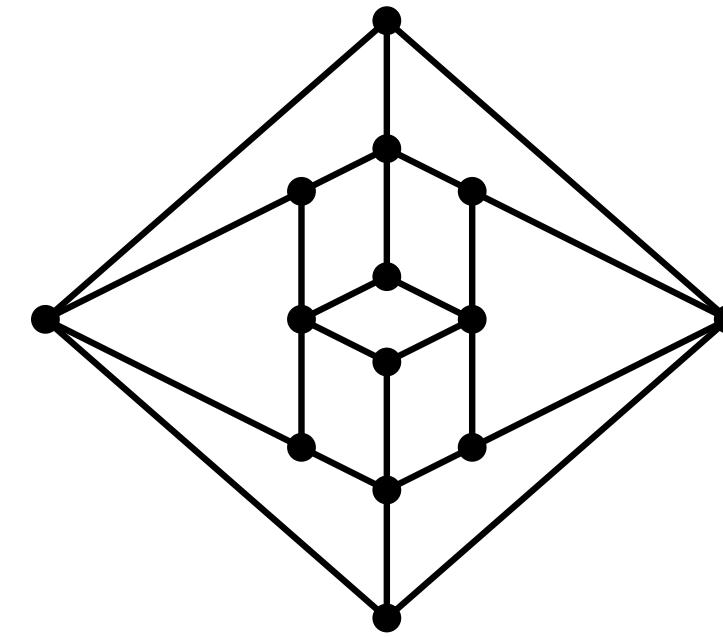
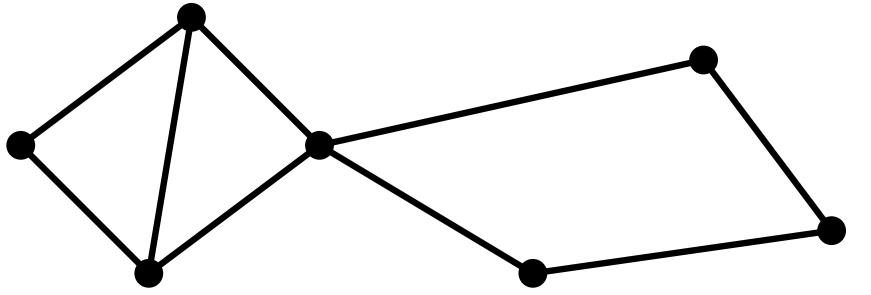
Here: XNLP/XALP-completeness of several problems defined for planar graphs.

5. Baker's Technique



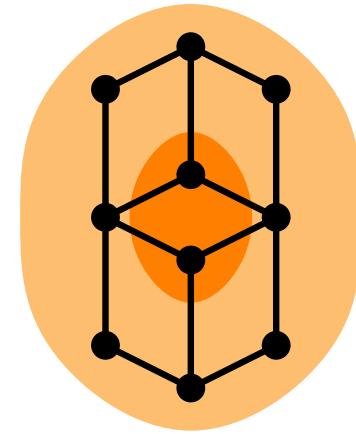
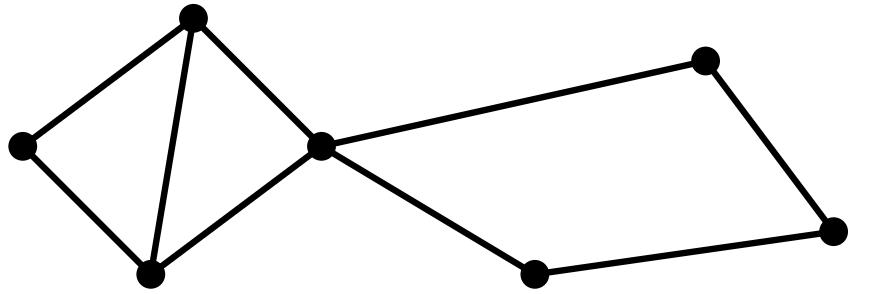
(1-)outerplaner graph

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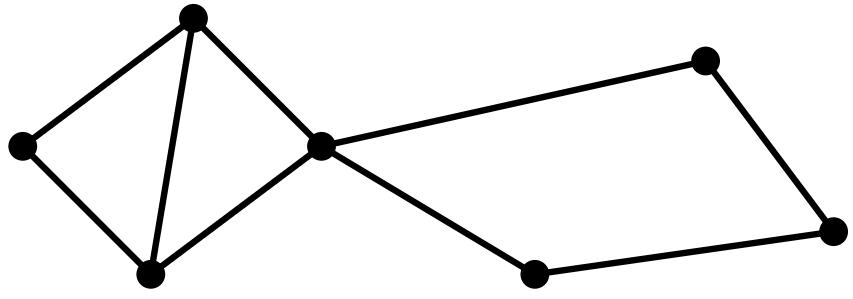
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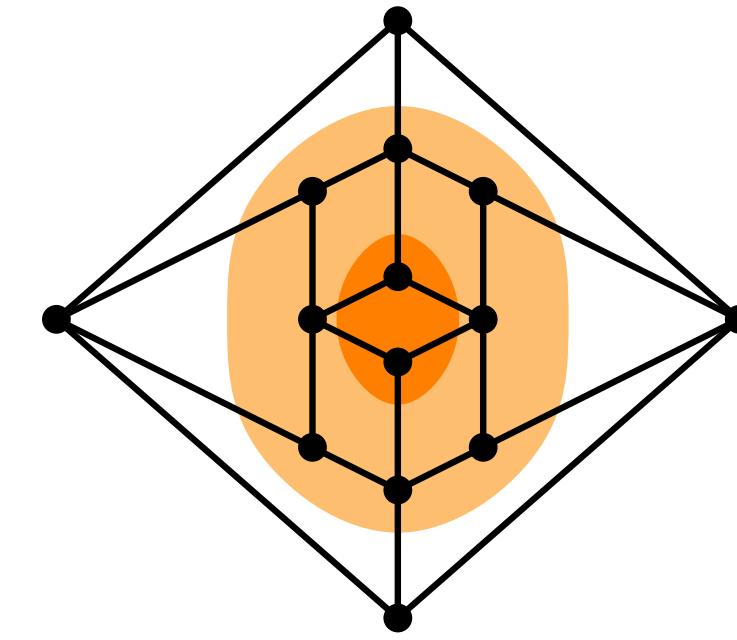


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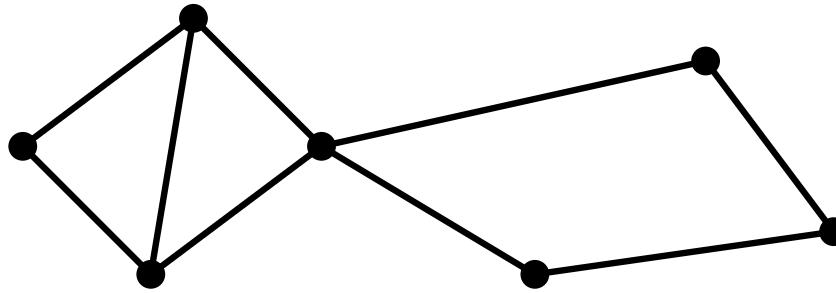


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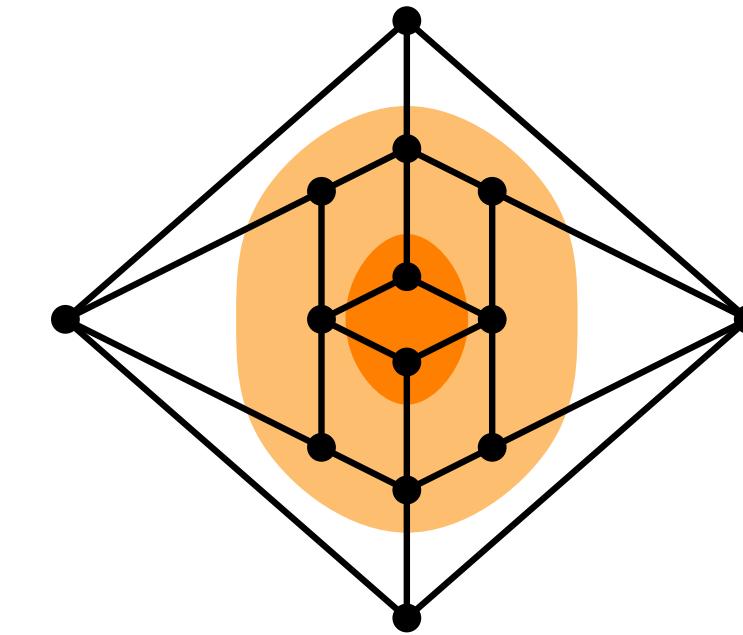


3-outerplanar

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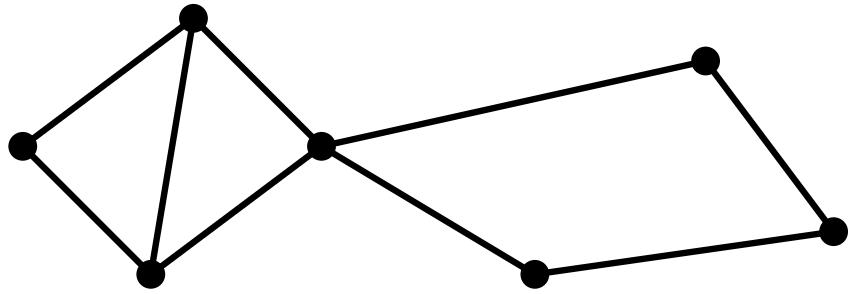
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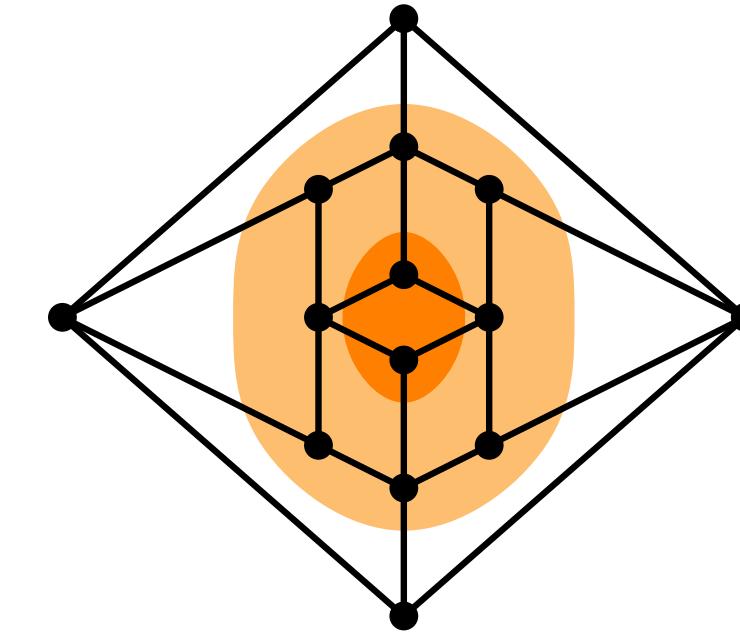
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Many NP-hard problems can be solved efficiently on k -outerplanar graphs for a fixed k

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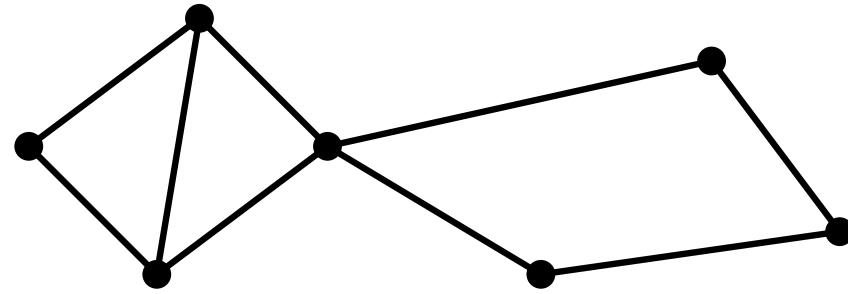


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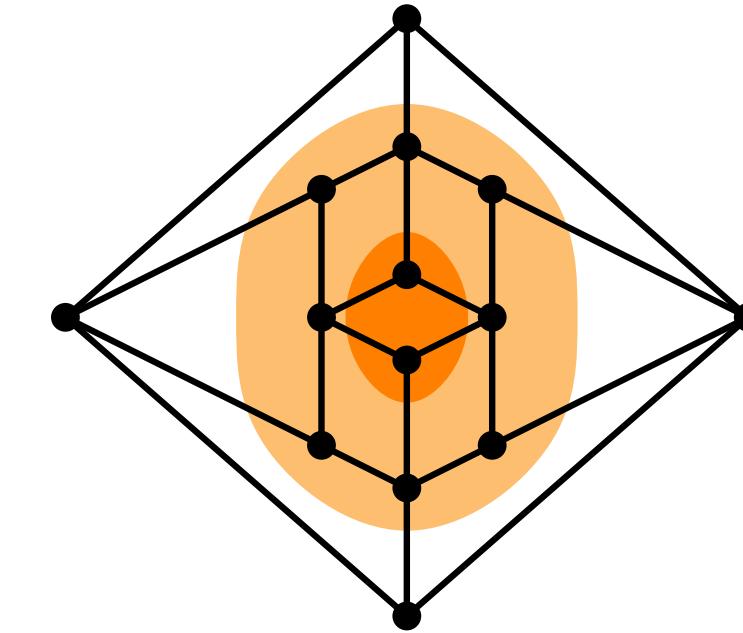
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Baker's Technique: A general approach to use these algorithms to find approximation algorithms for planar graphs

5. Baker's Technique



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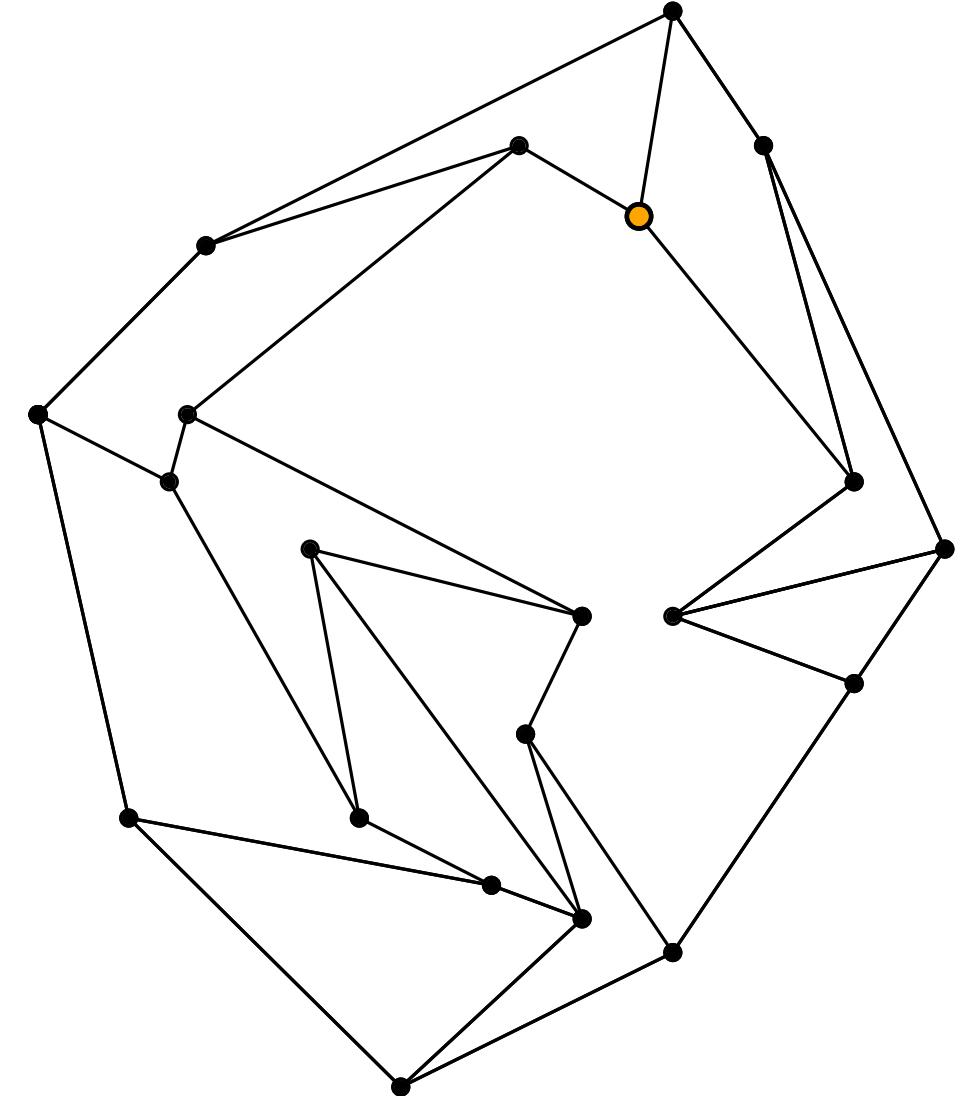
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Baker's Technique: A general approach to use these algorithms to find approximation algorithms for planar graphs

Task: Explain Baker's Technique with an illustrative example

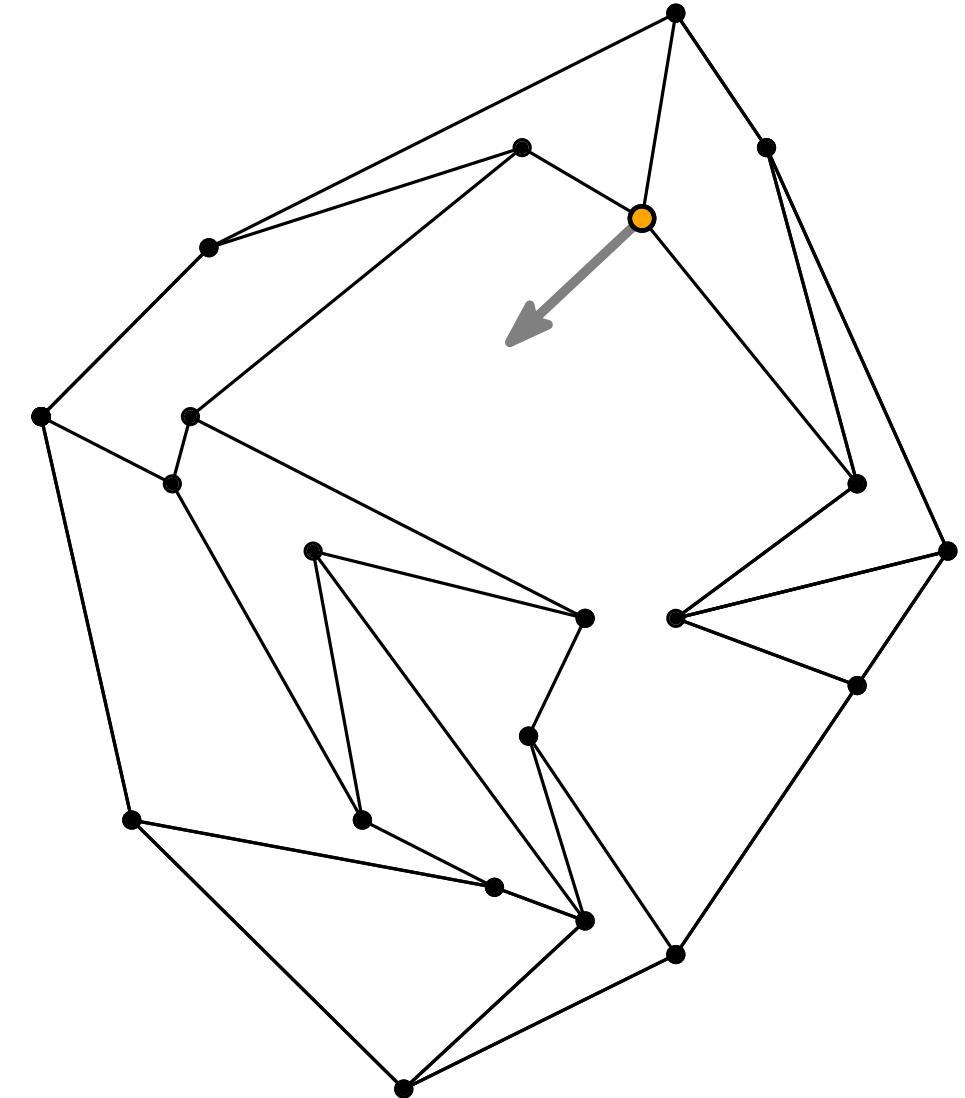
6. How to Morph Planar Graph Drawings

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



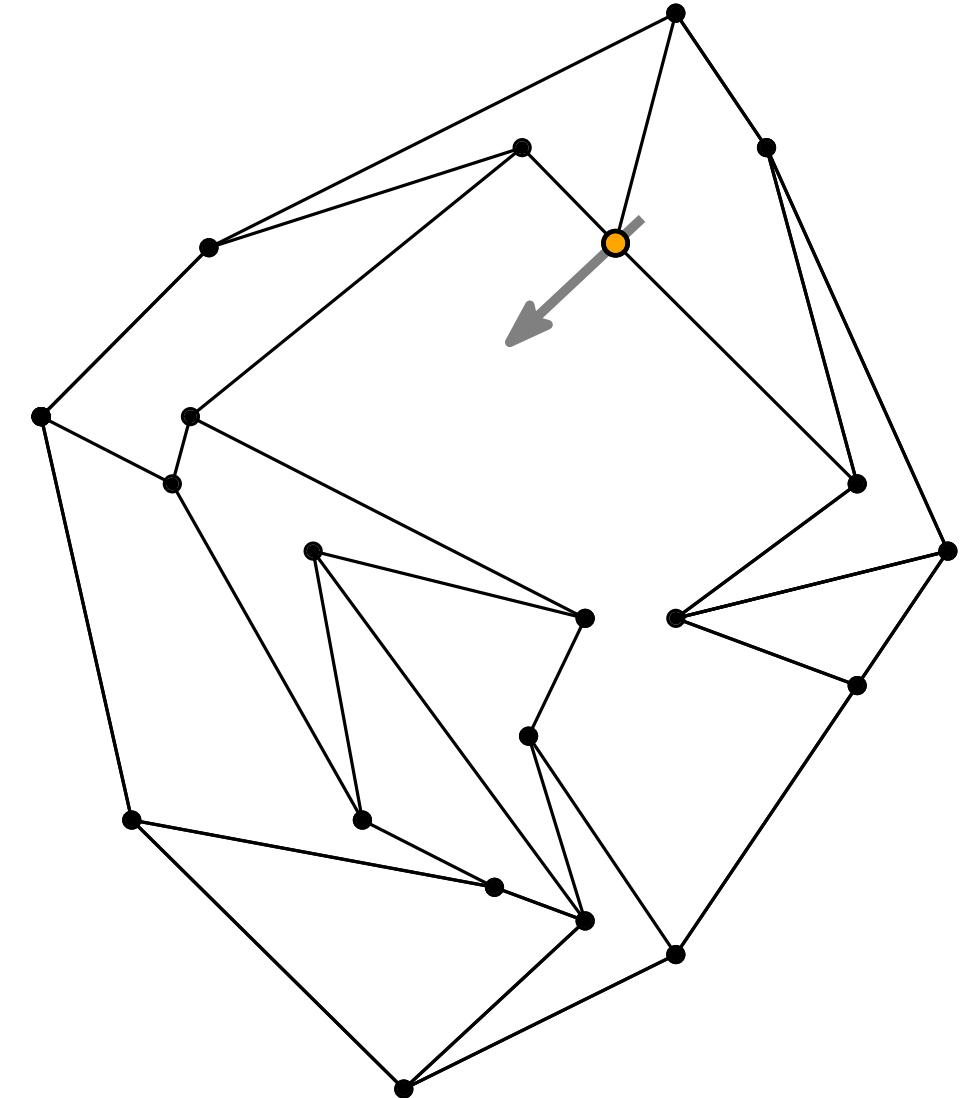
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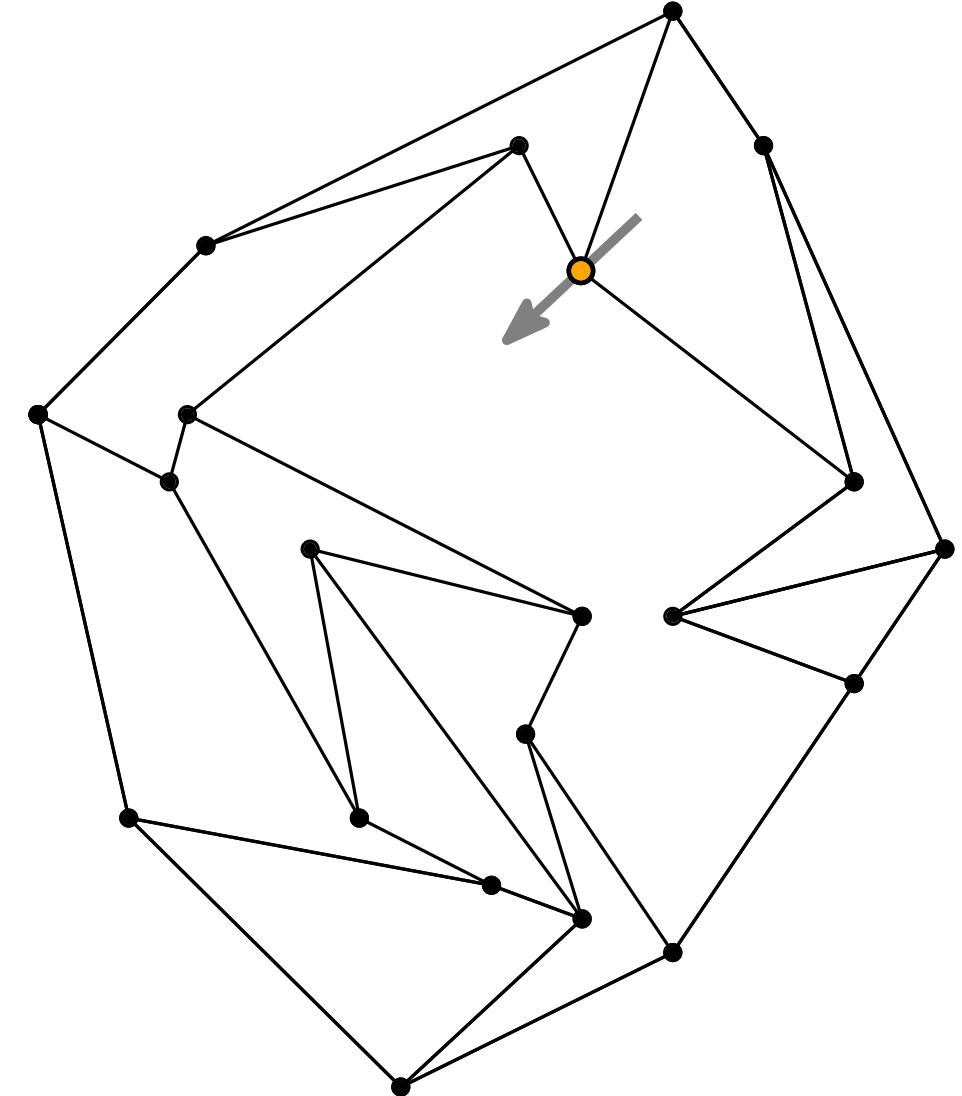
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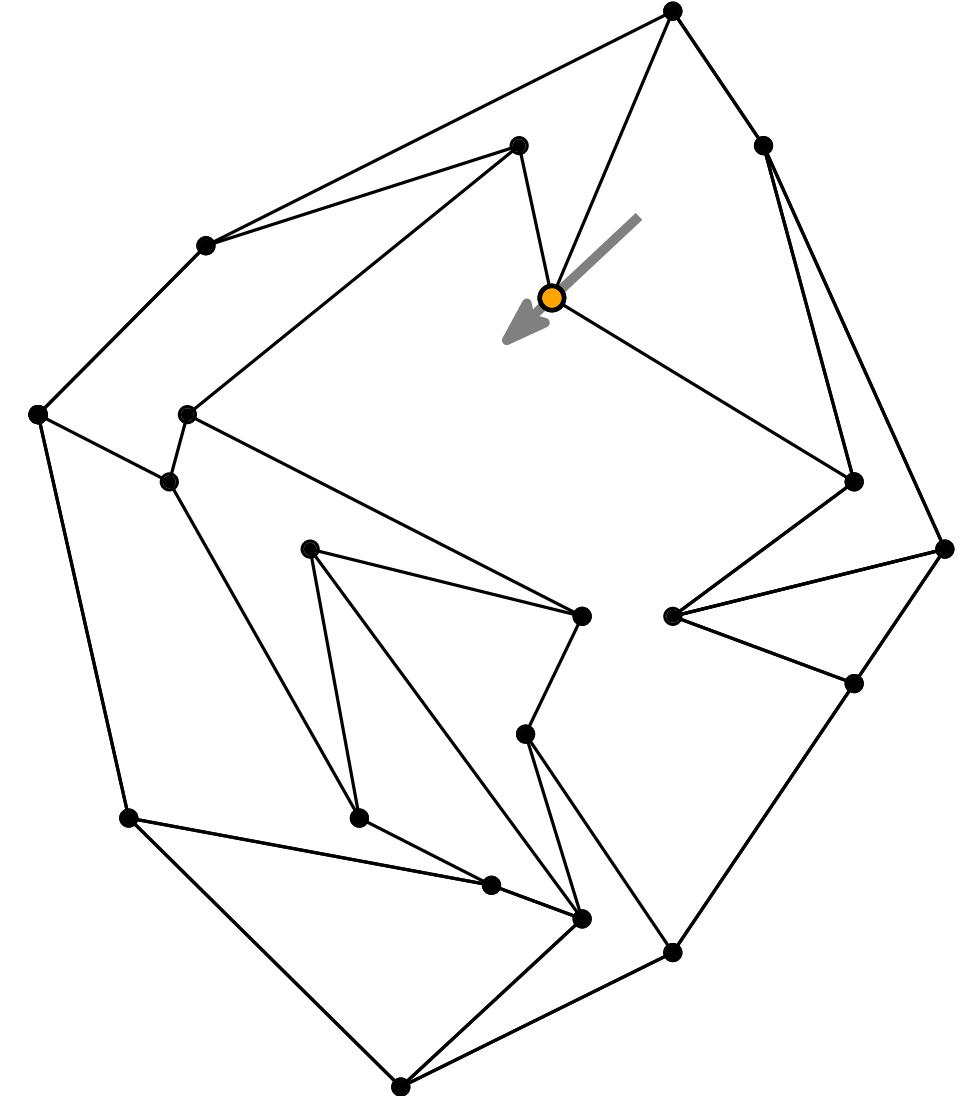
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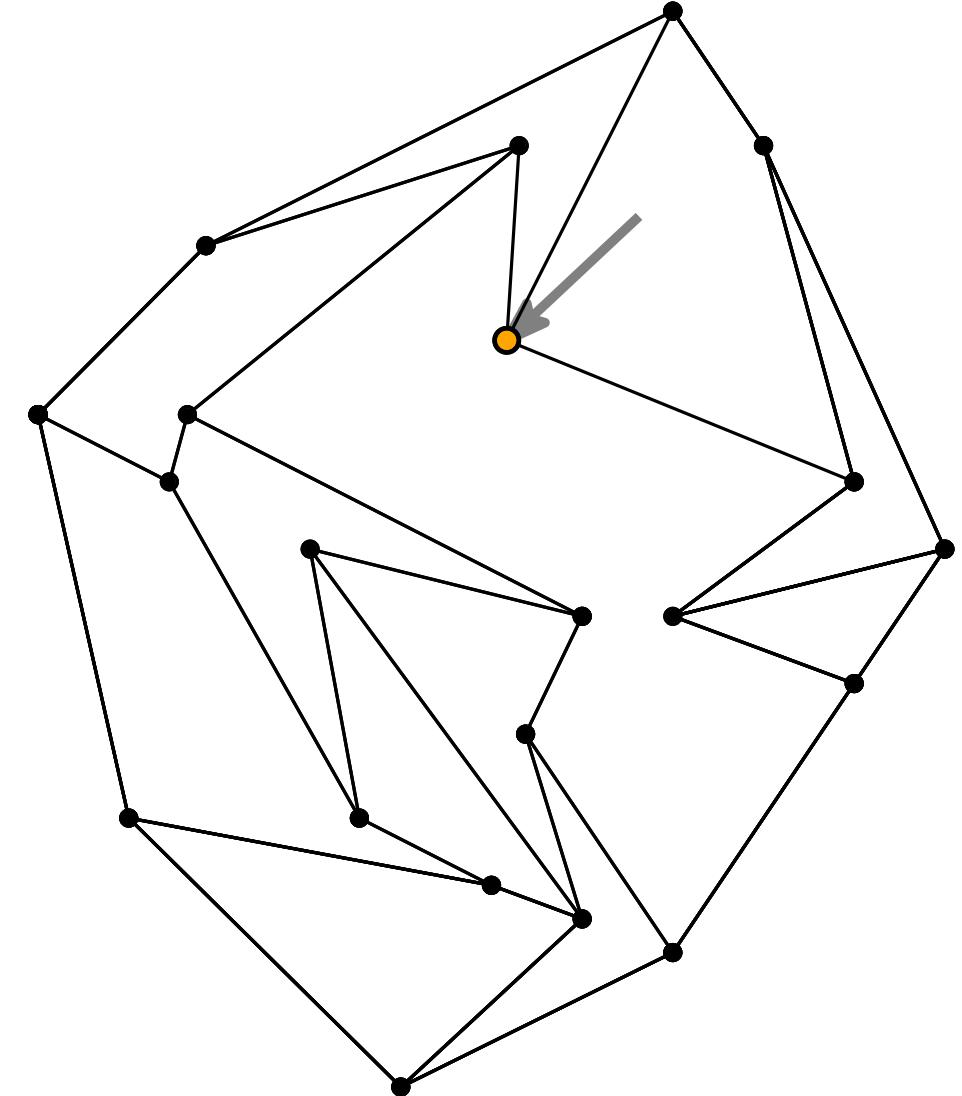
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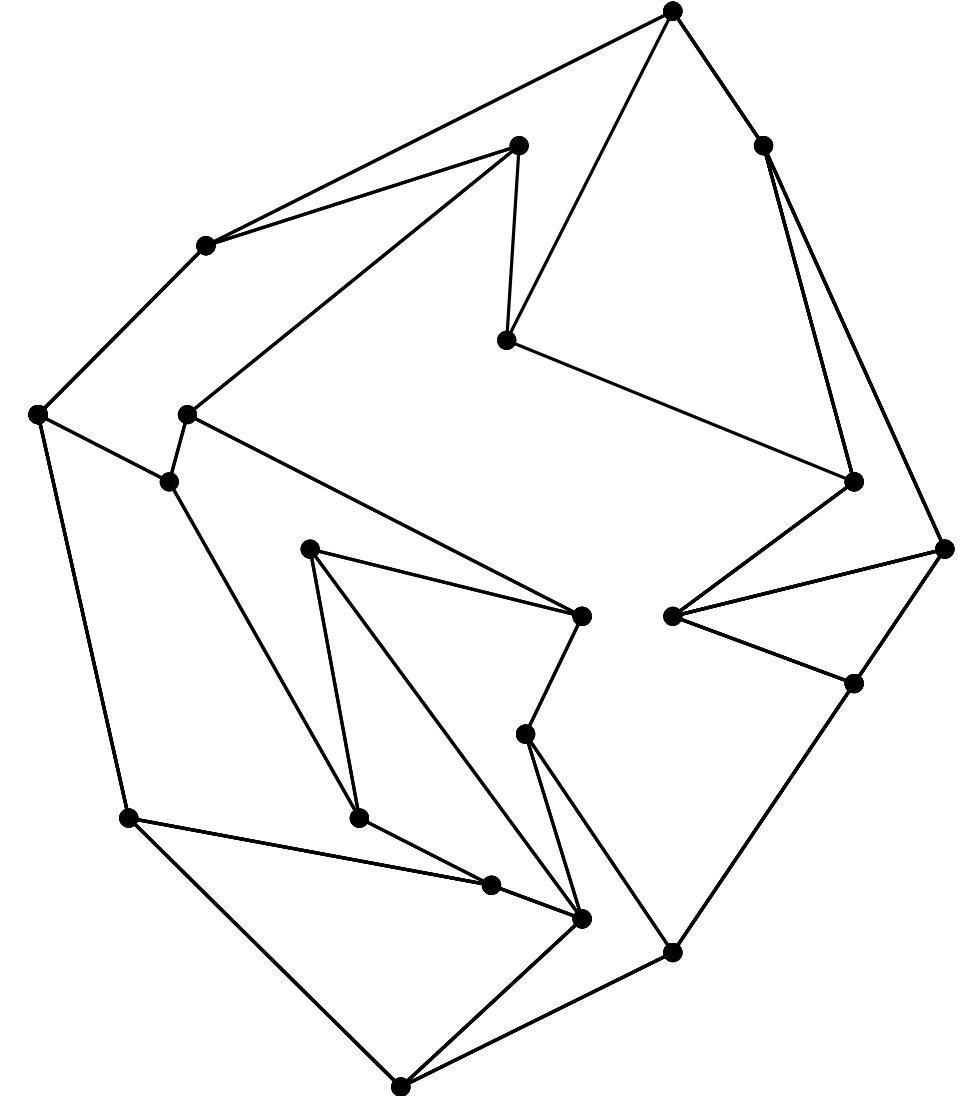
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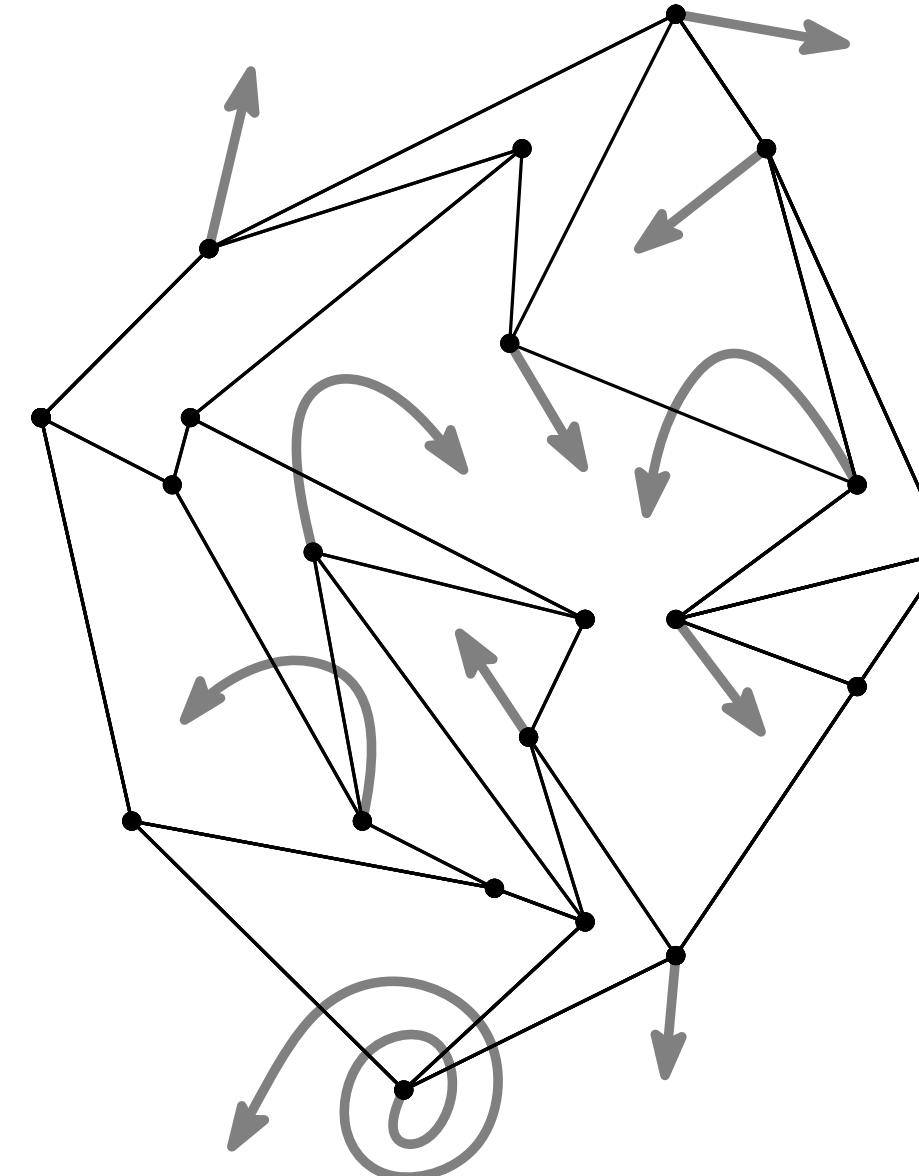
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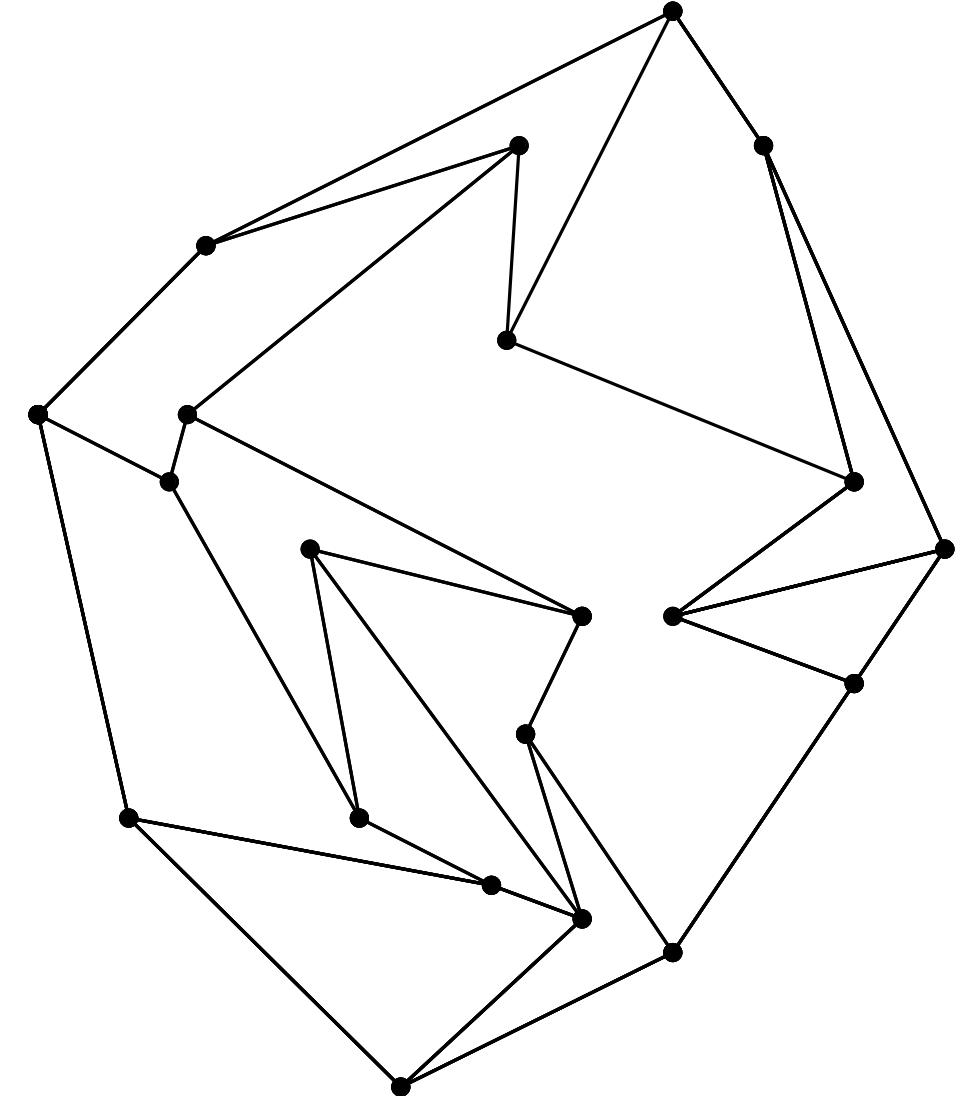
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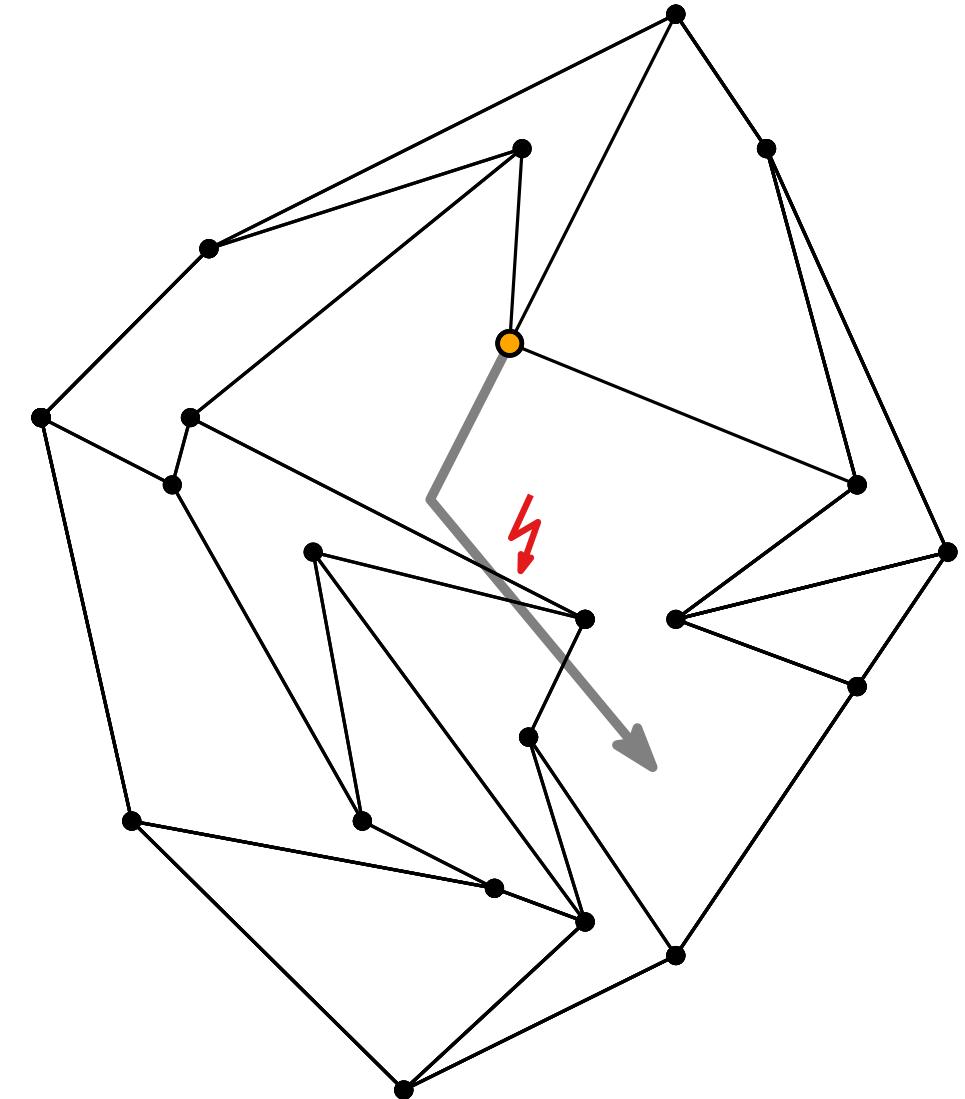
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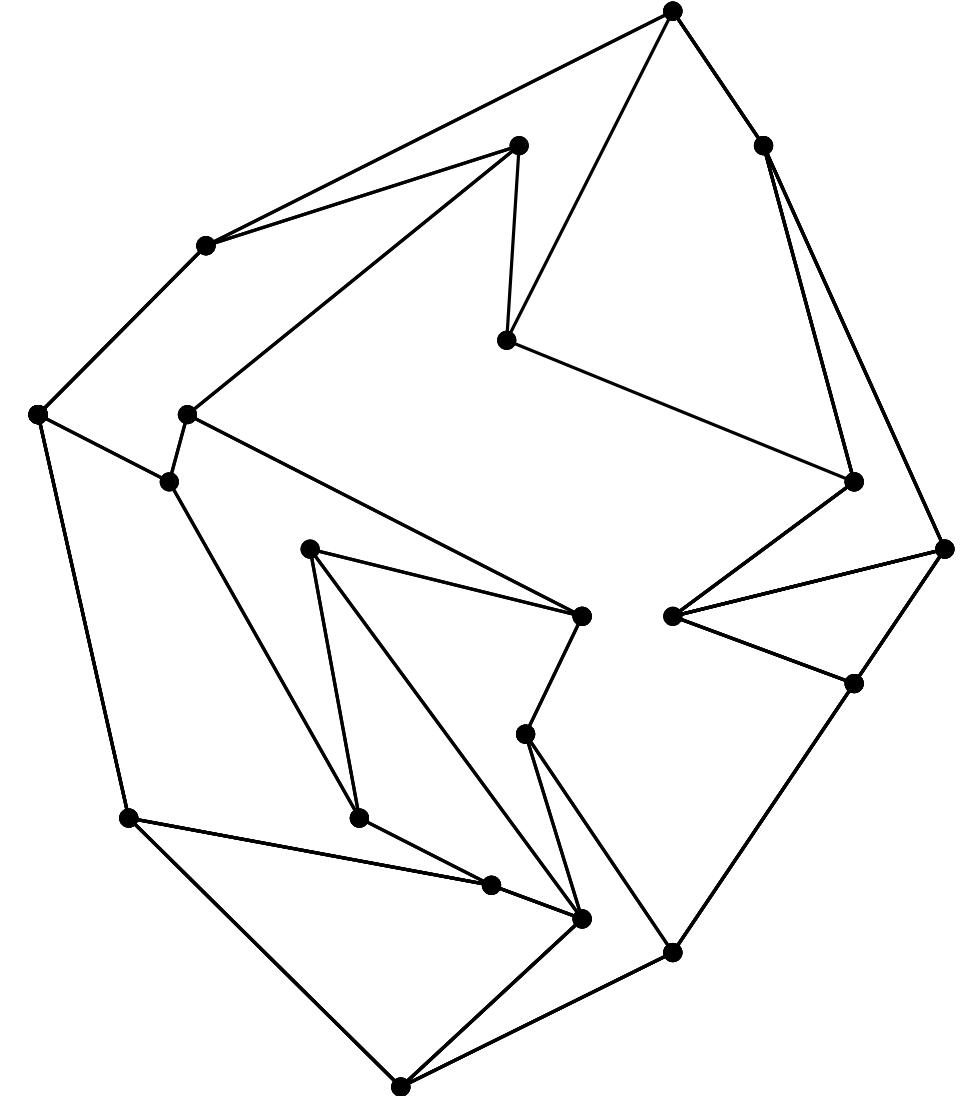
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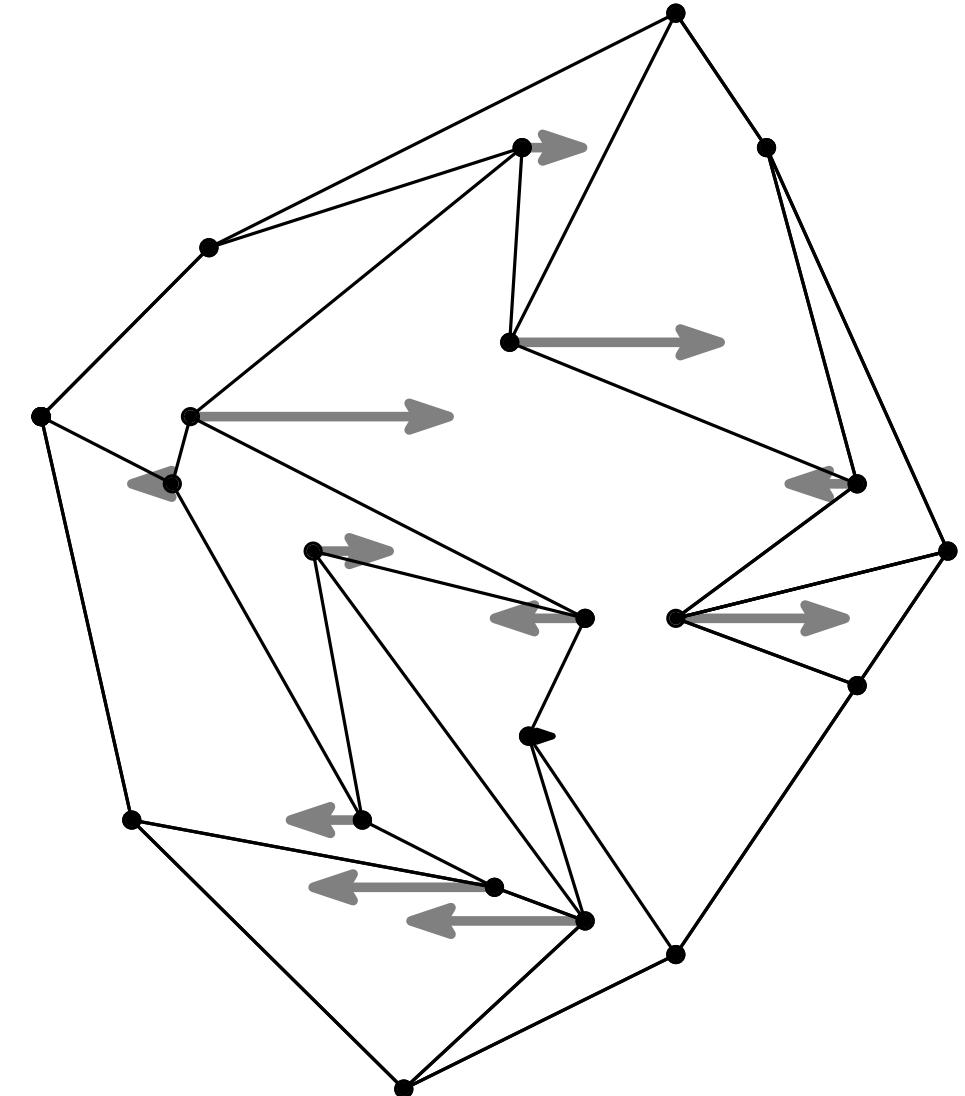
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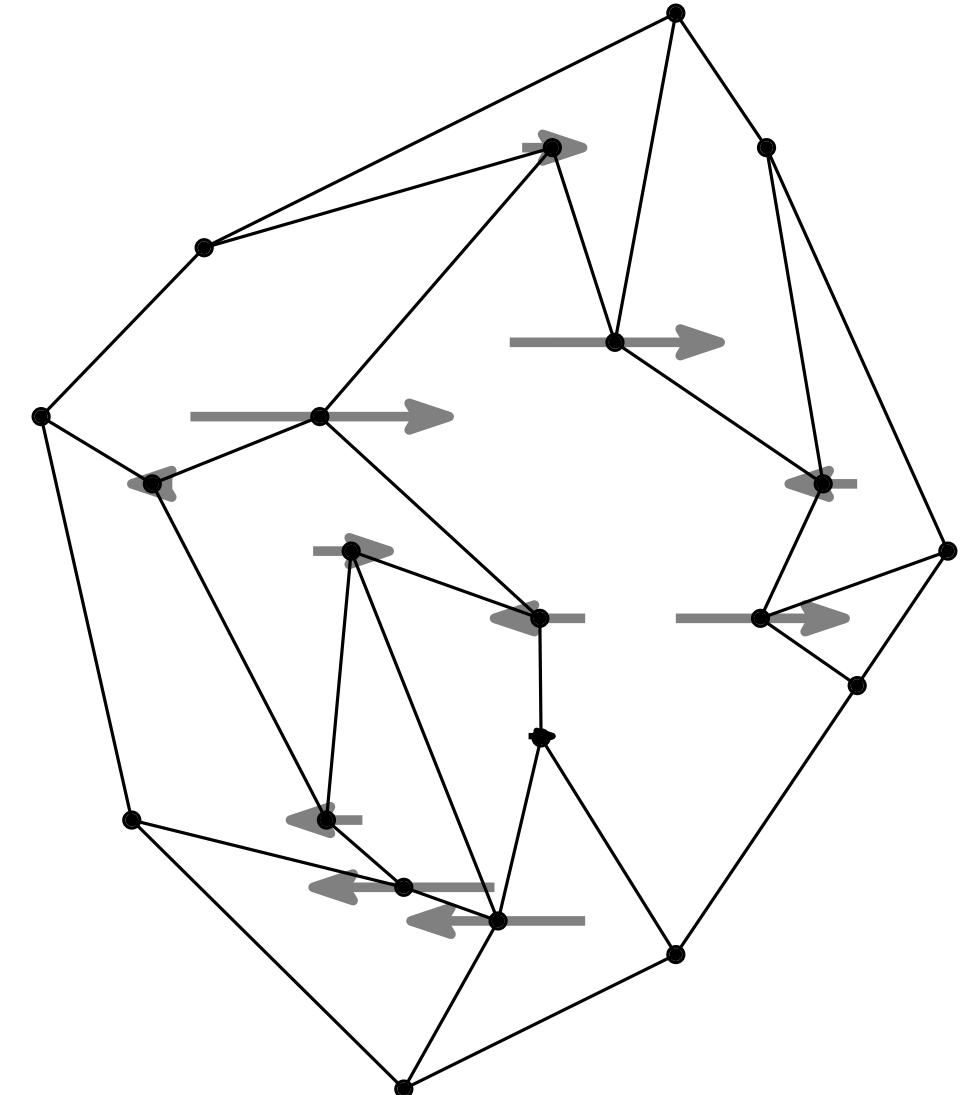
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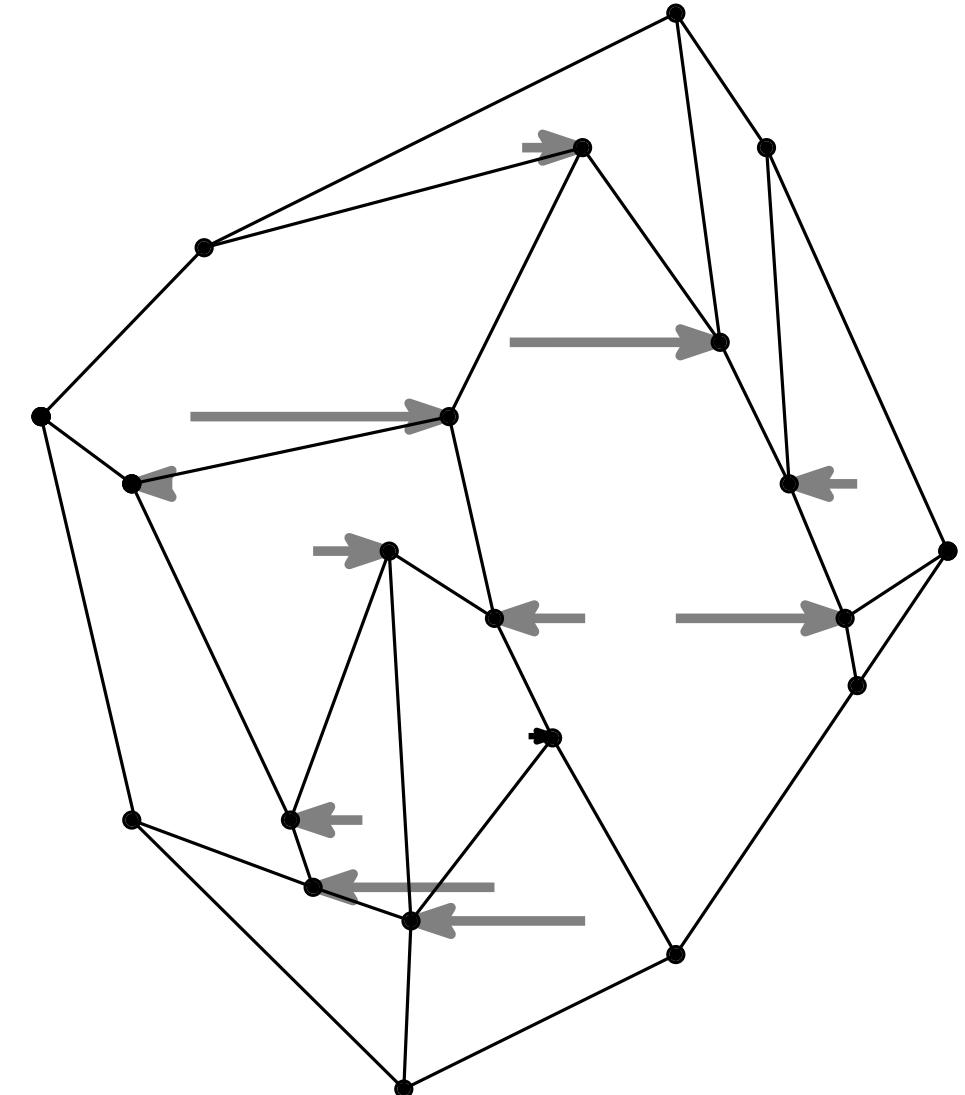
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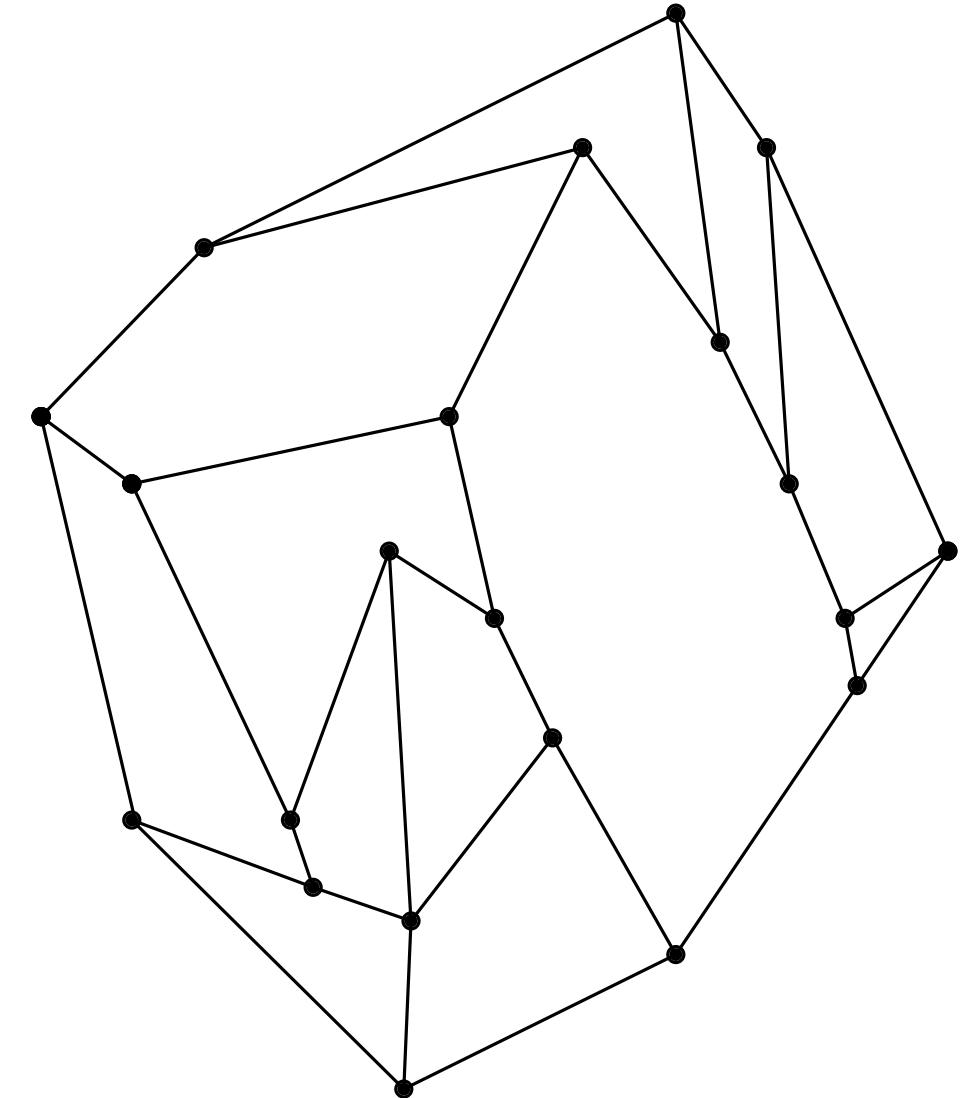
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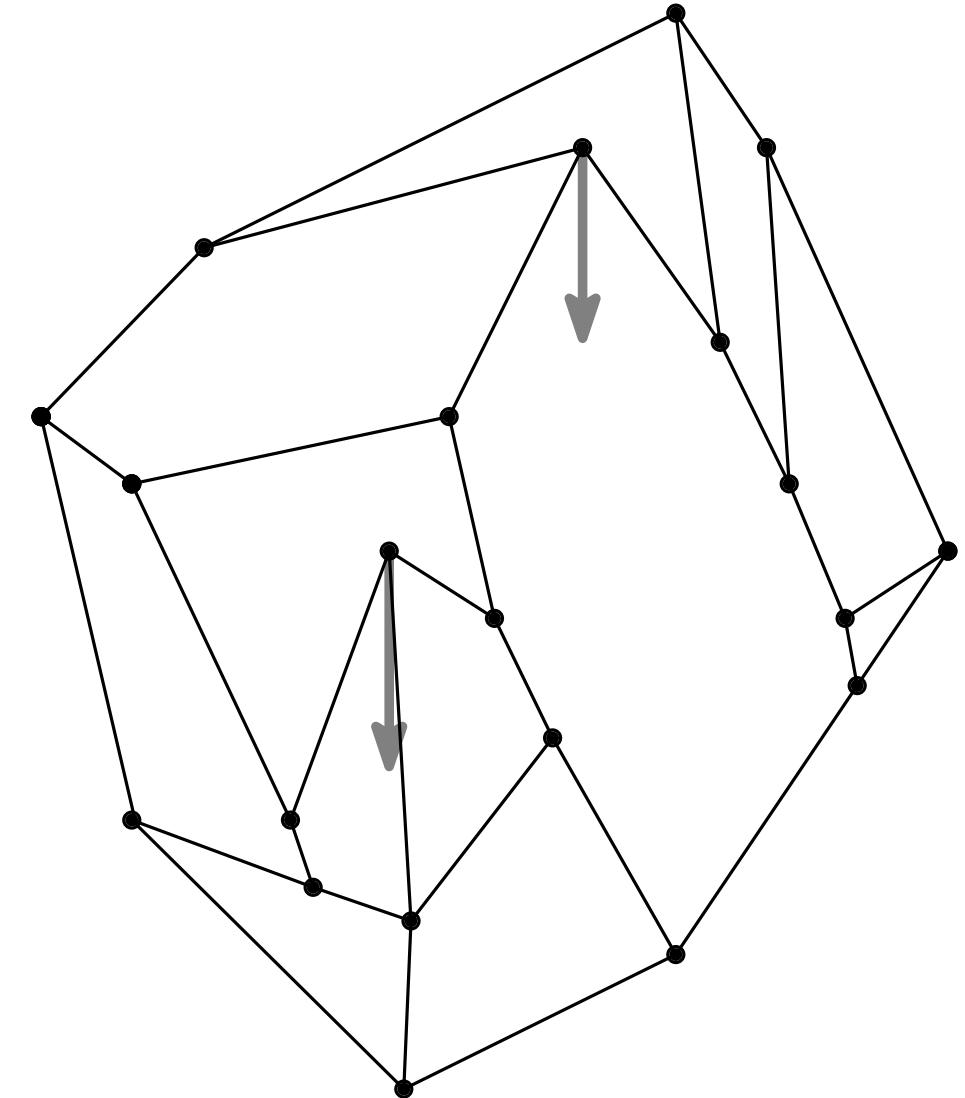
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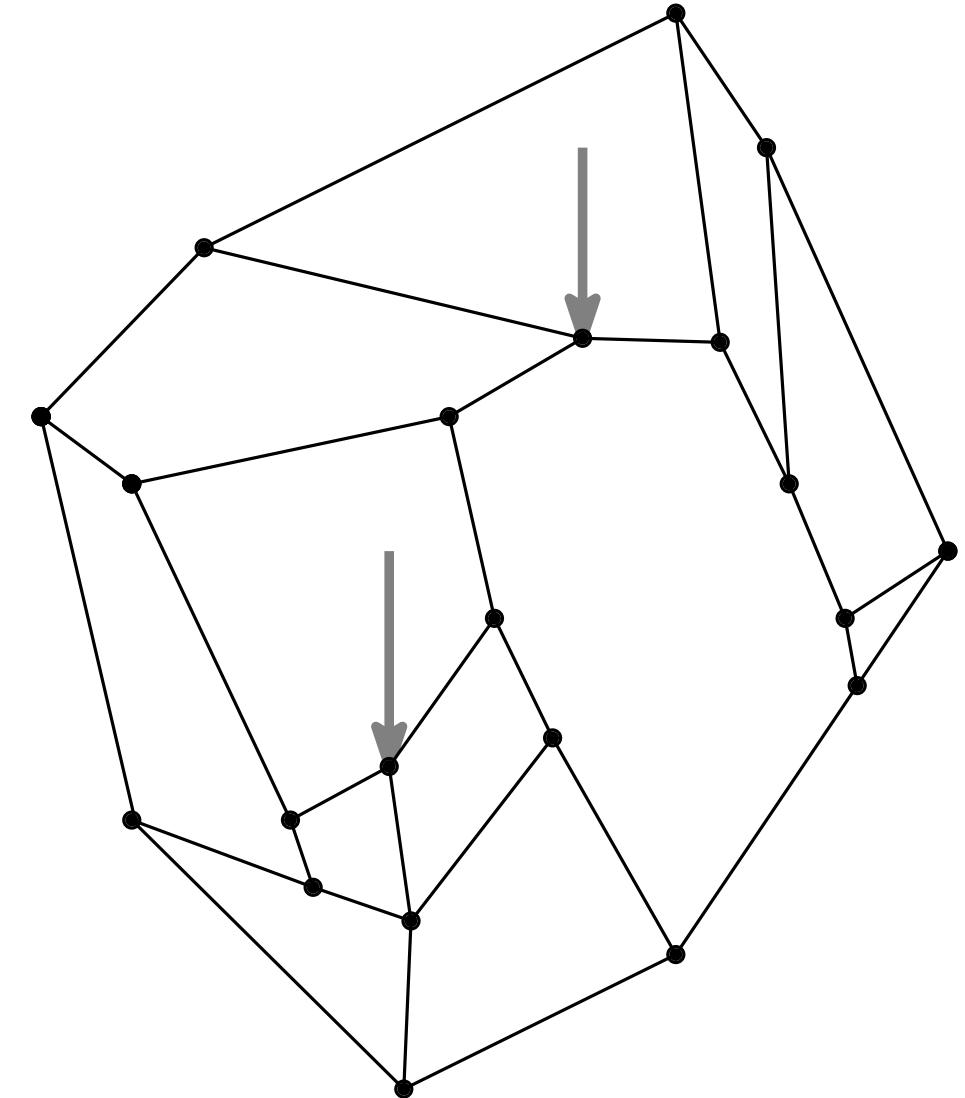
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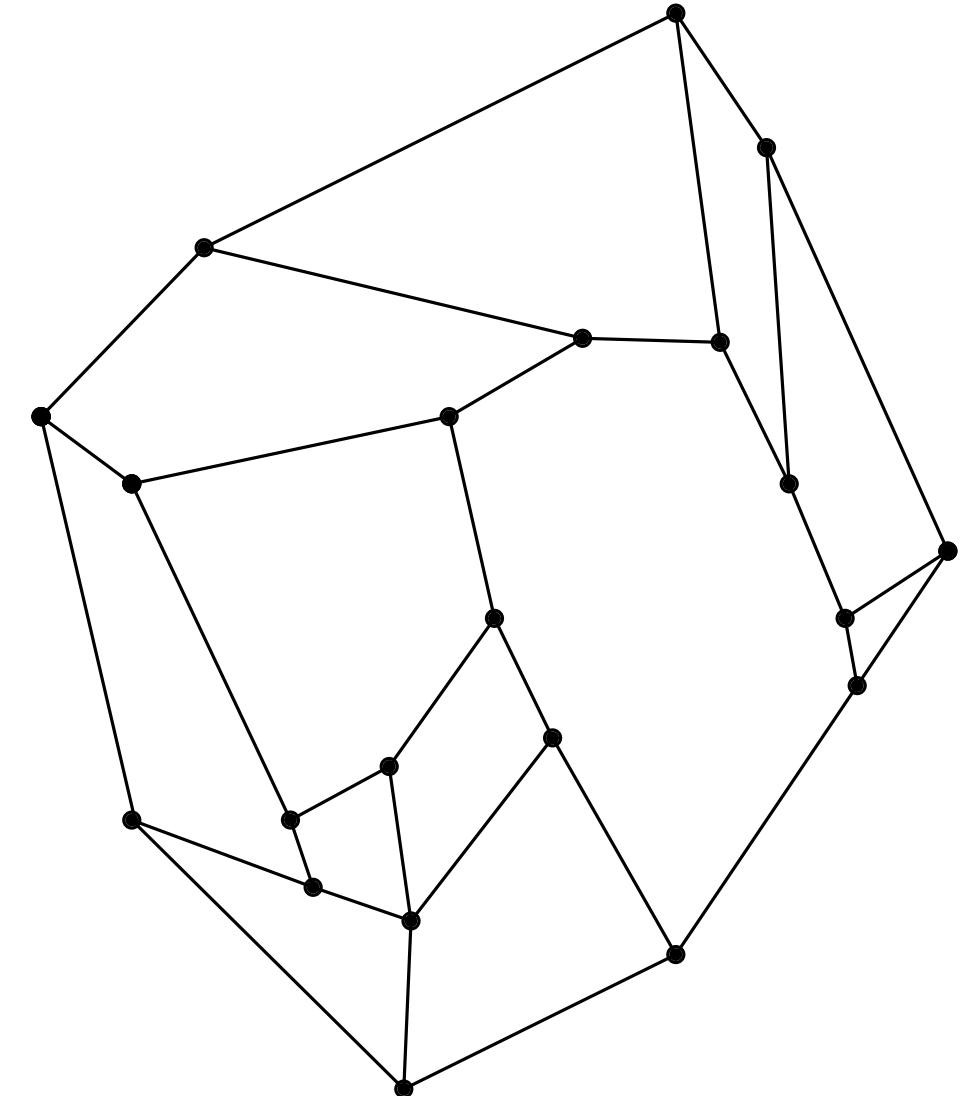
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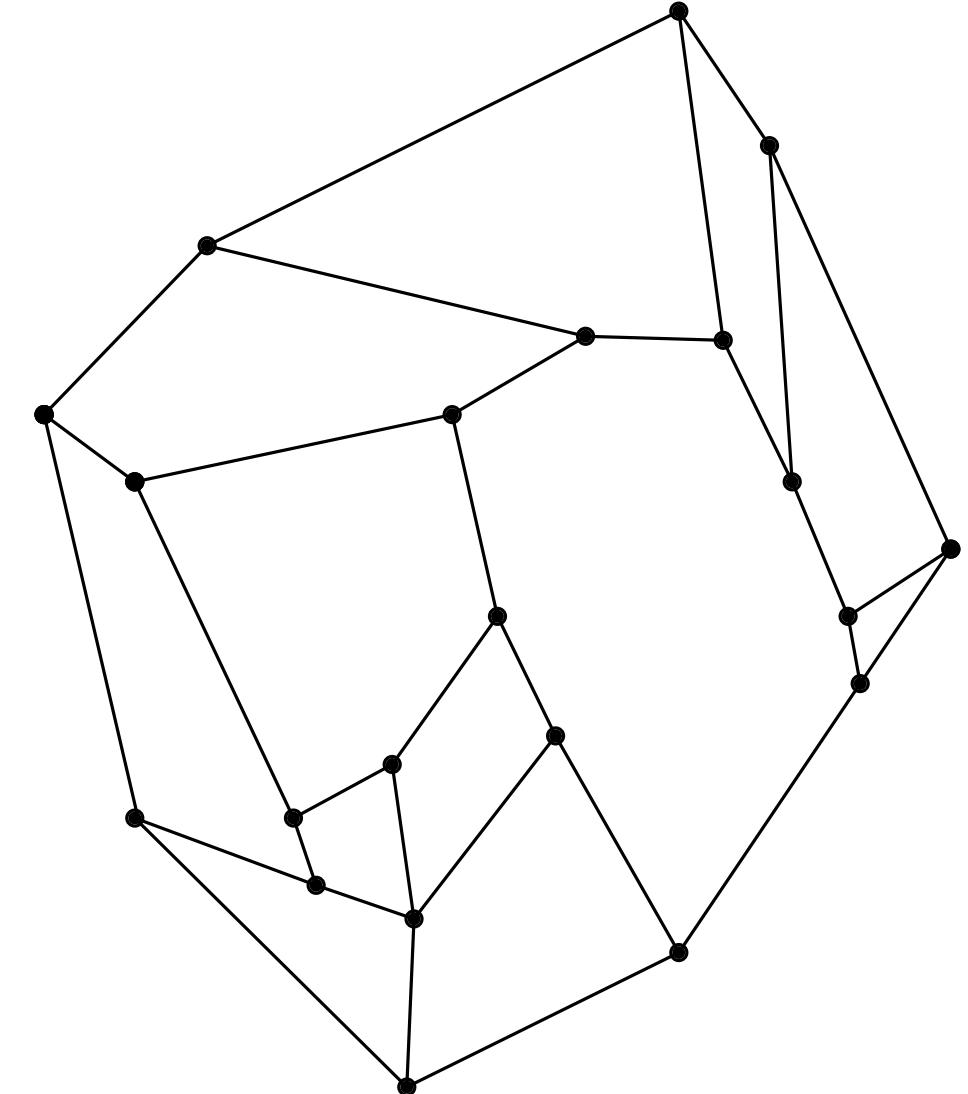


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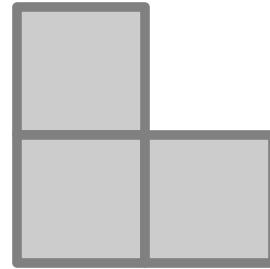
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Questions:

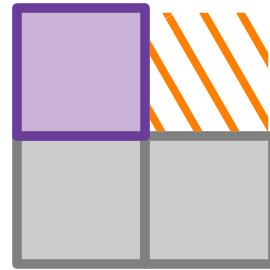
- Does there always exist a morph between two crossing-free drawings of the same graph?
- How can it be computed and encoded?



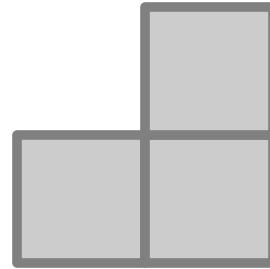
7. Sliding Squares in Parallel



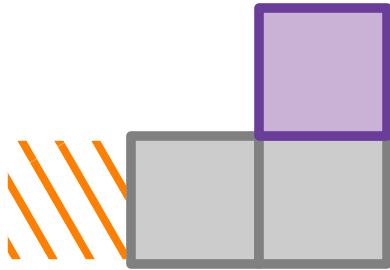
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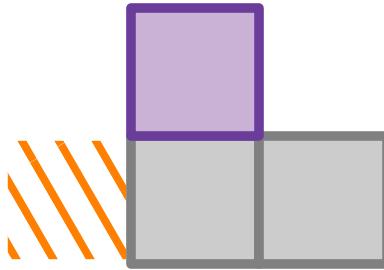
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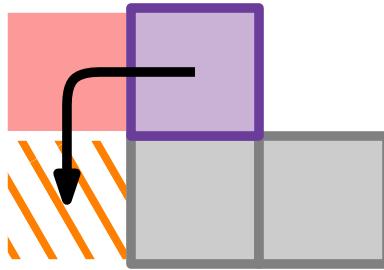
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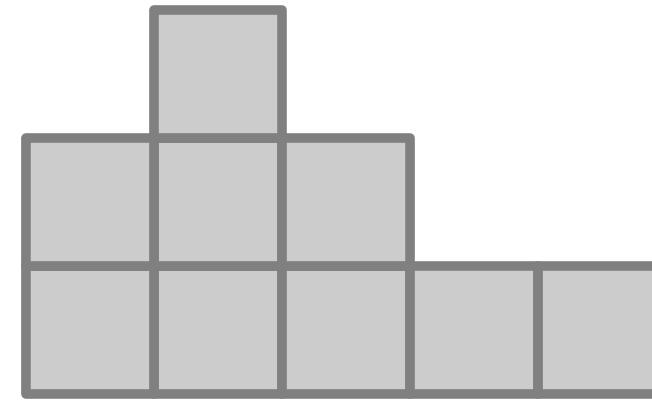
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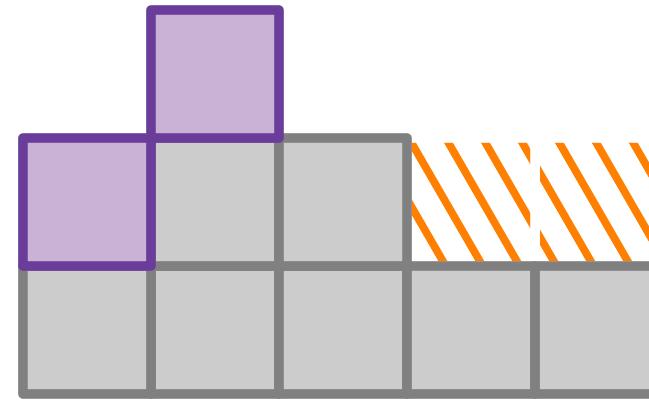
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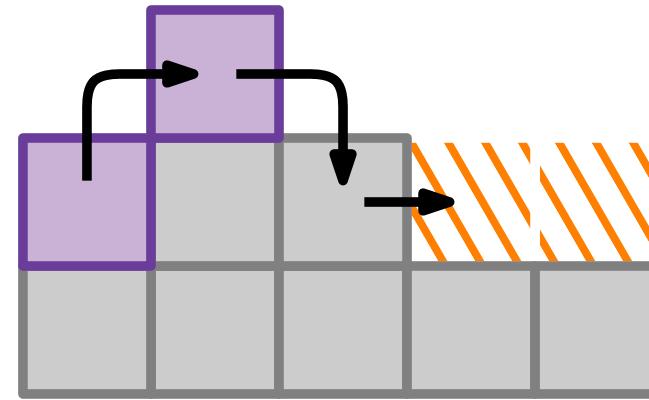
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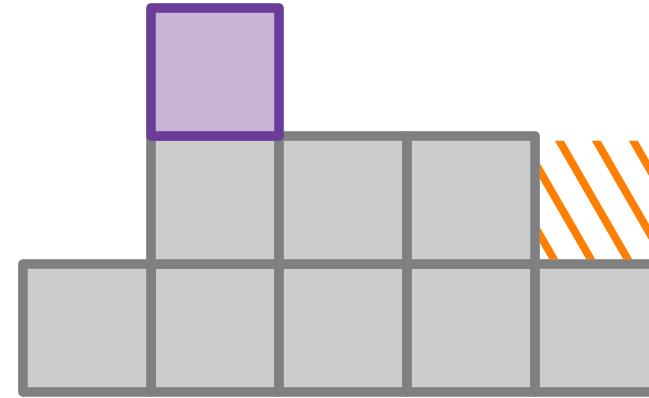
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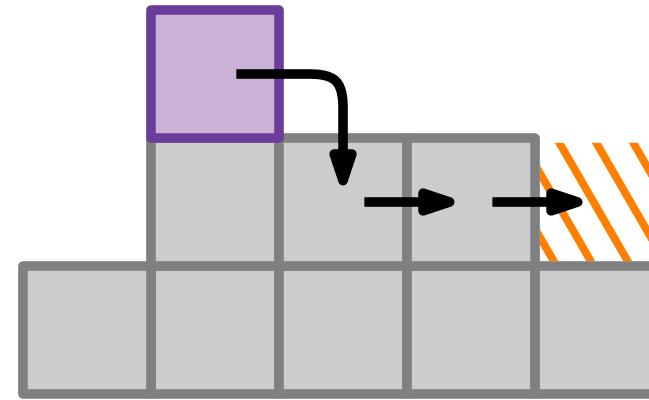
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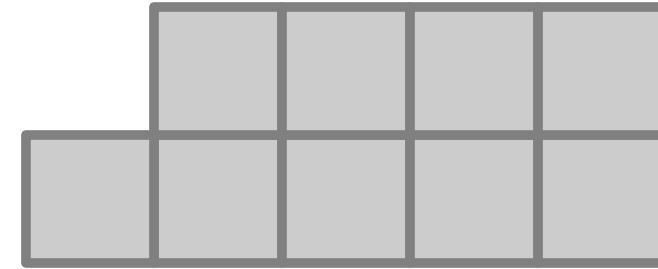
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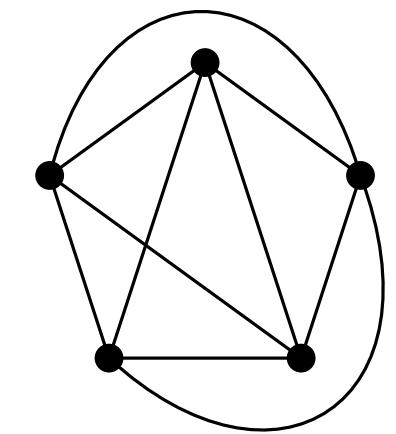


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8. Crossing Number of 3-Plane Drawings

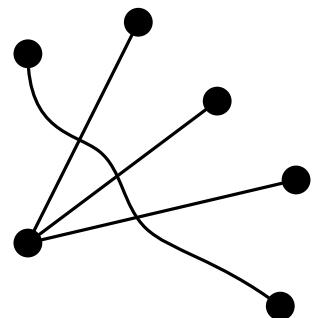
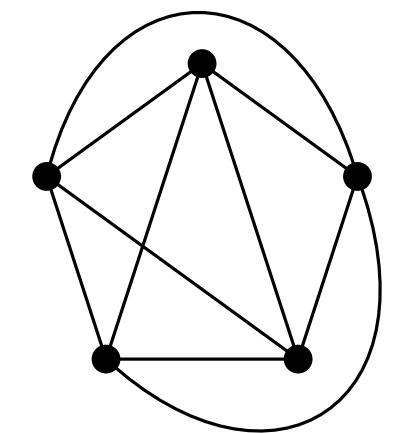
How many edges can a 1-planar graph have?



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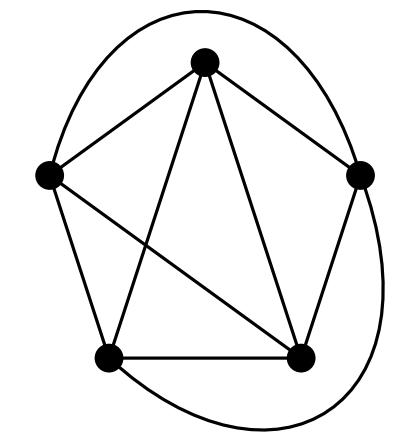
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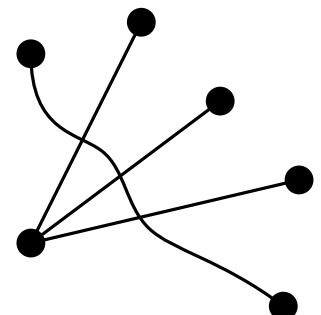
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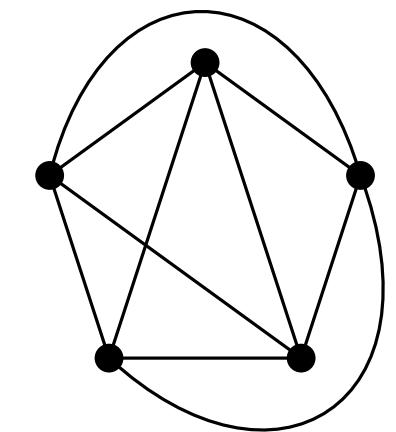
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General: How many edges can ... have?

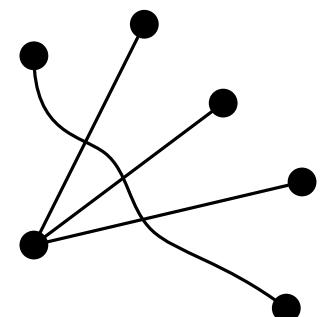


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General: How many edges can ... have?

The density formula:

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

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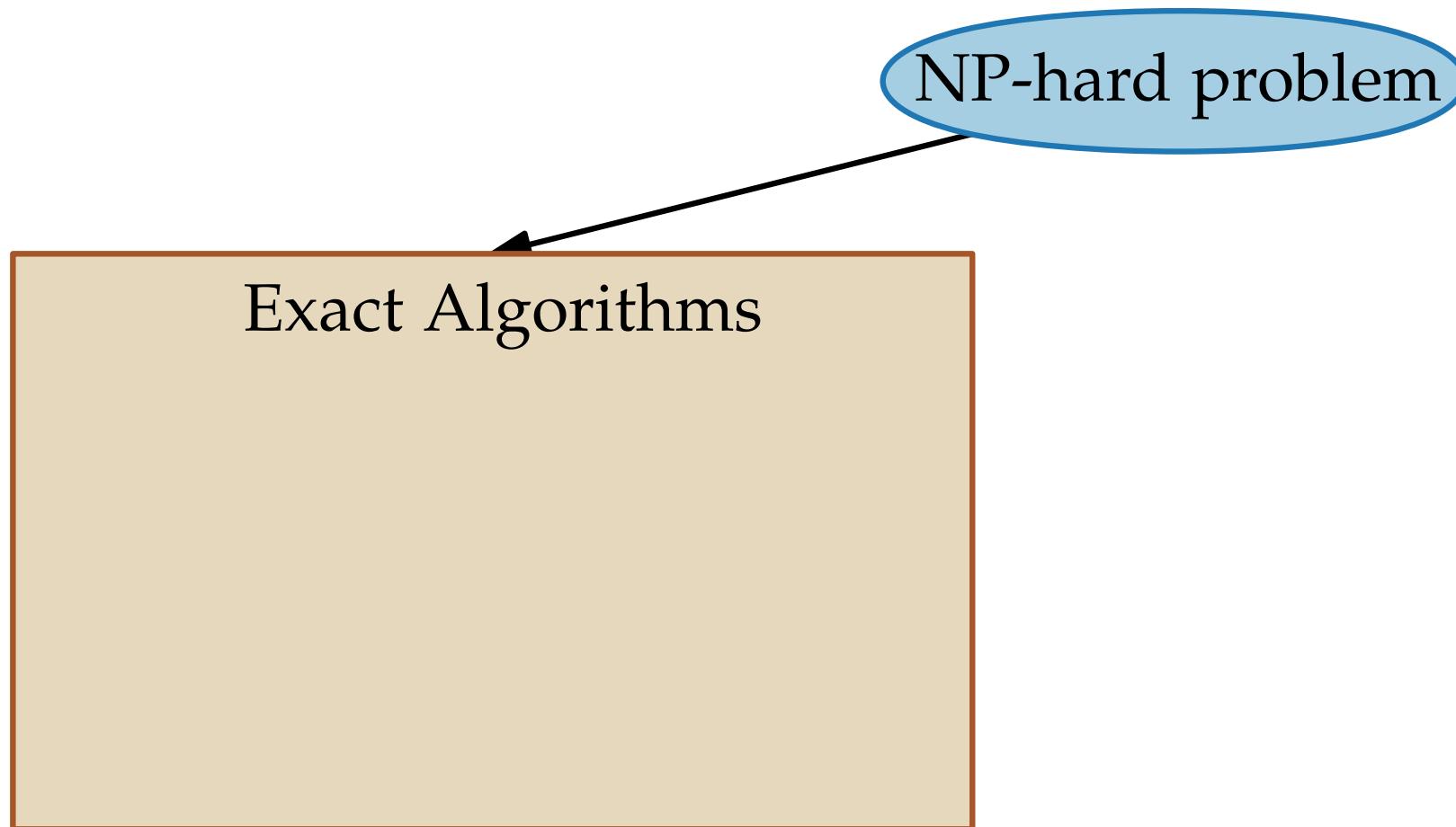
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The result is asymptotically worst-case optimal.

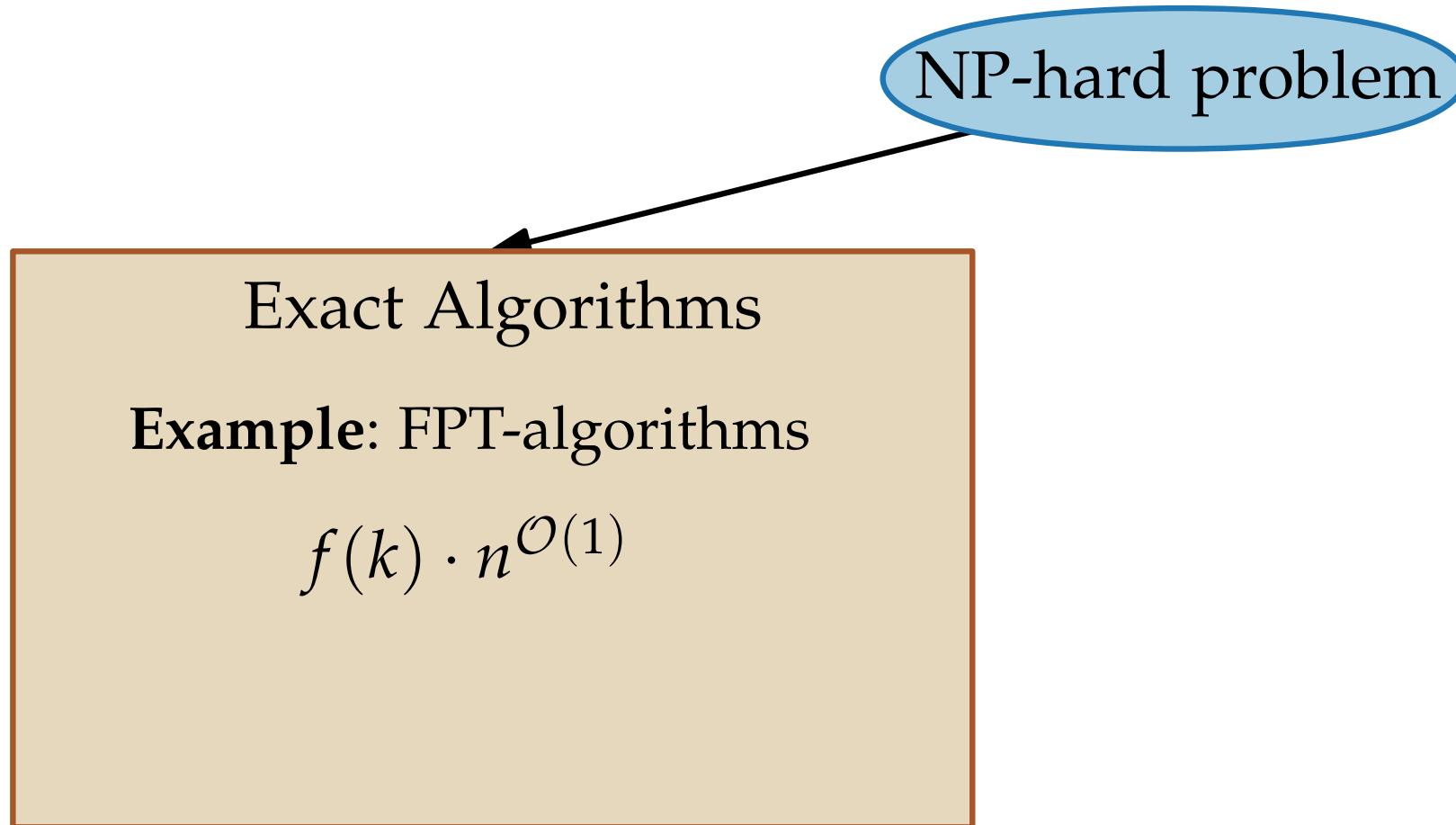
10. Efficient Parameterized Approximation

NP-hard problem

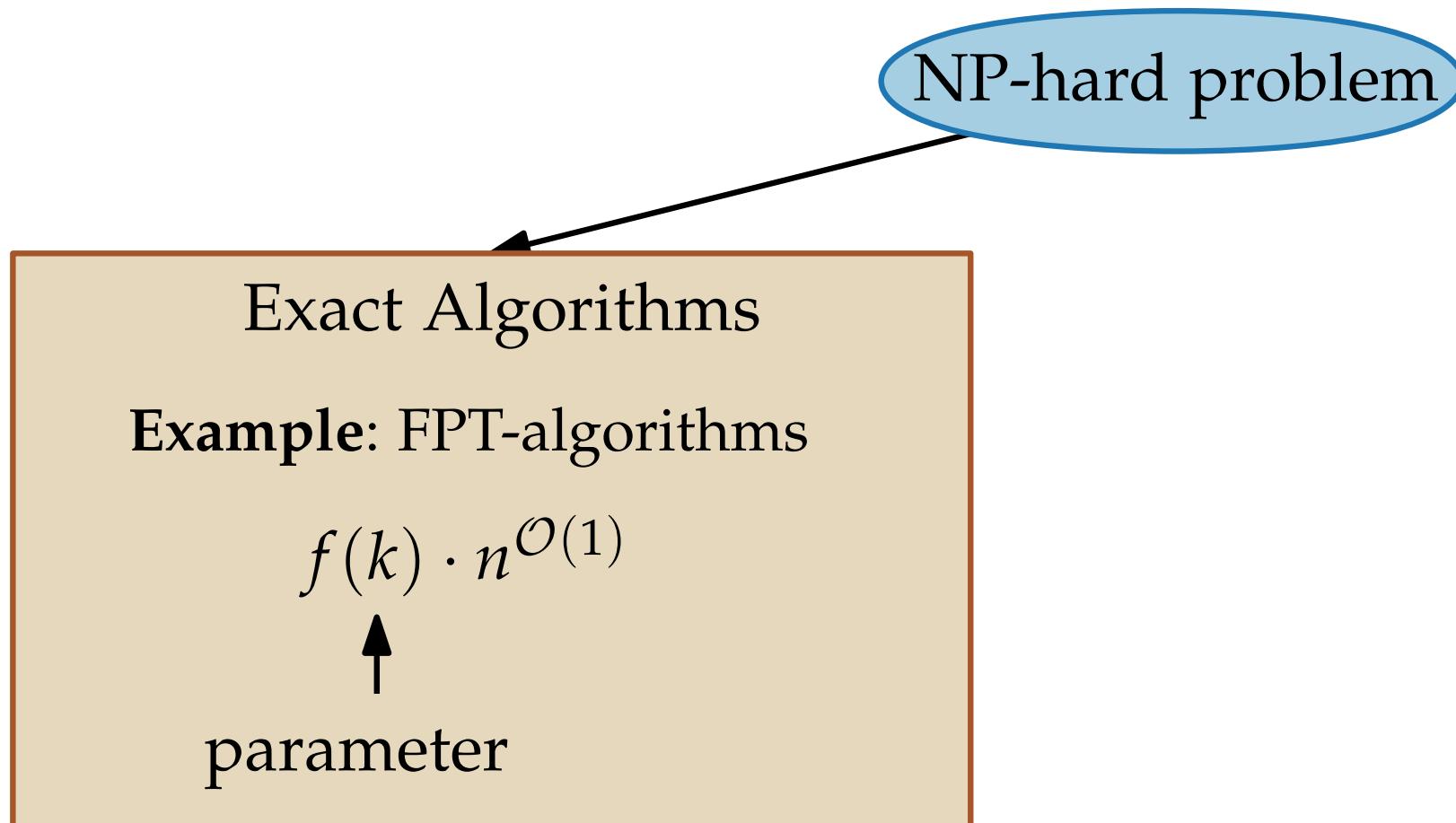
10. Efficient Parameterized Approximation



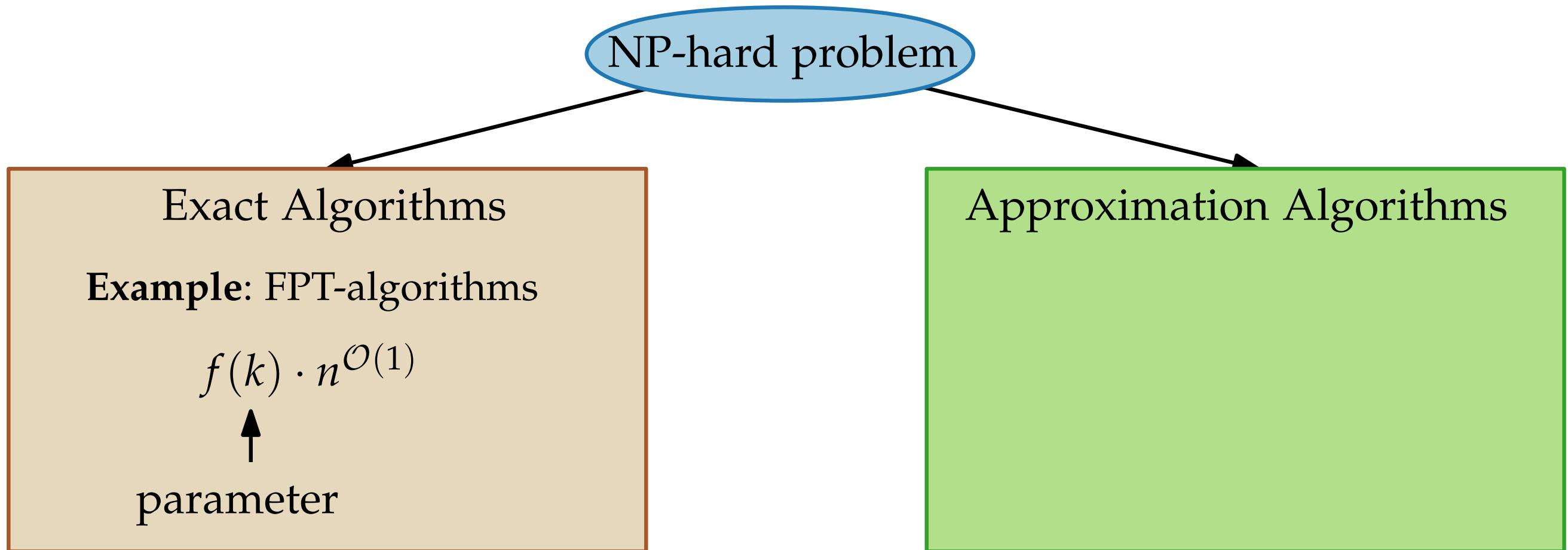
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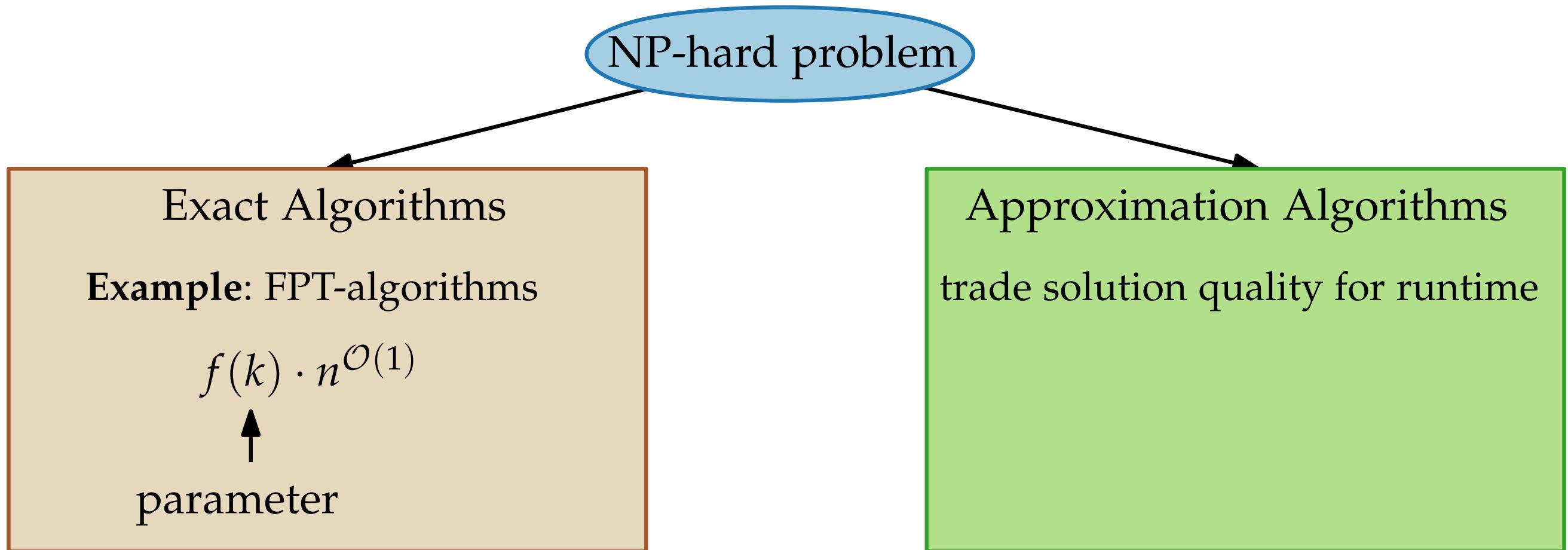
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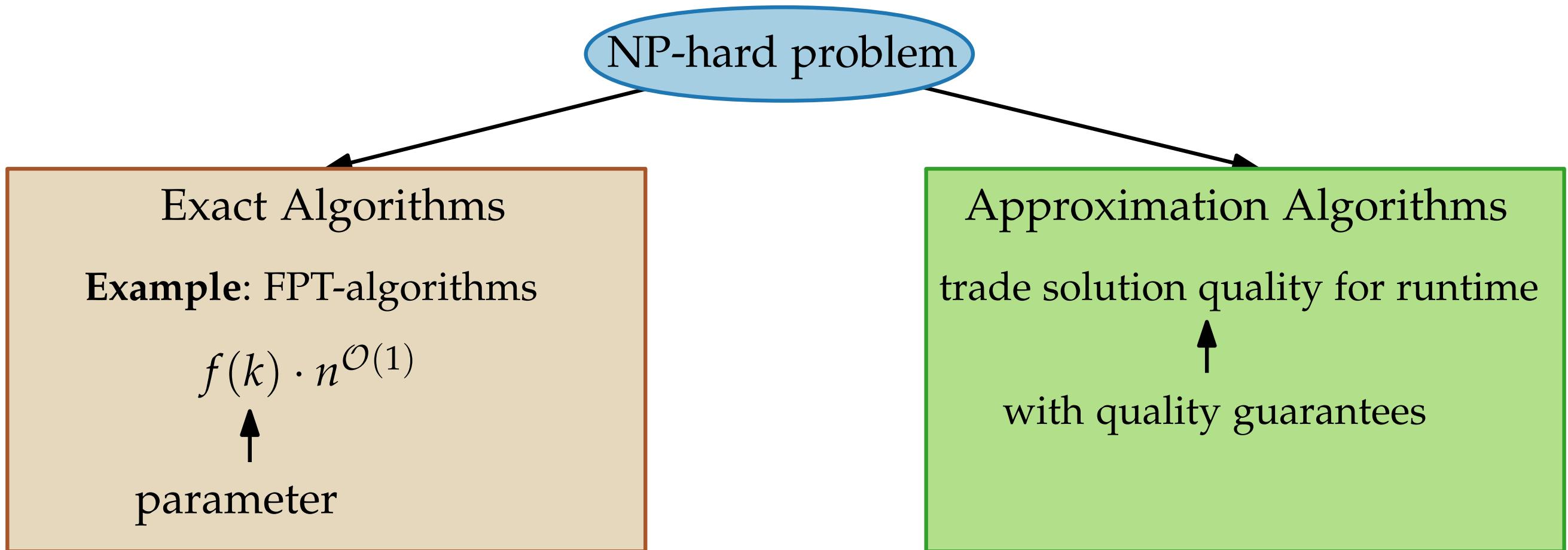
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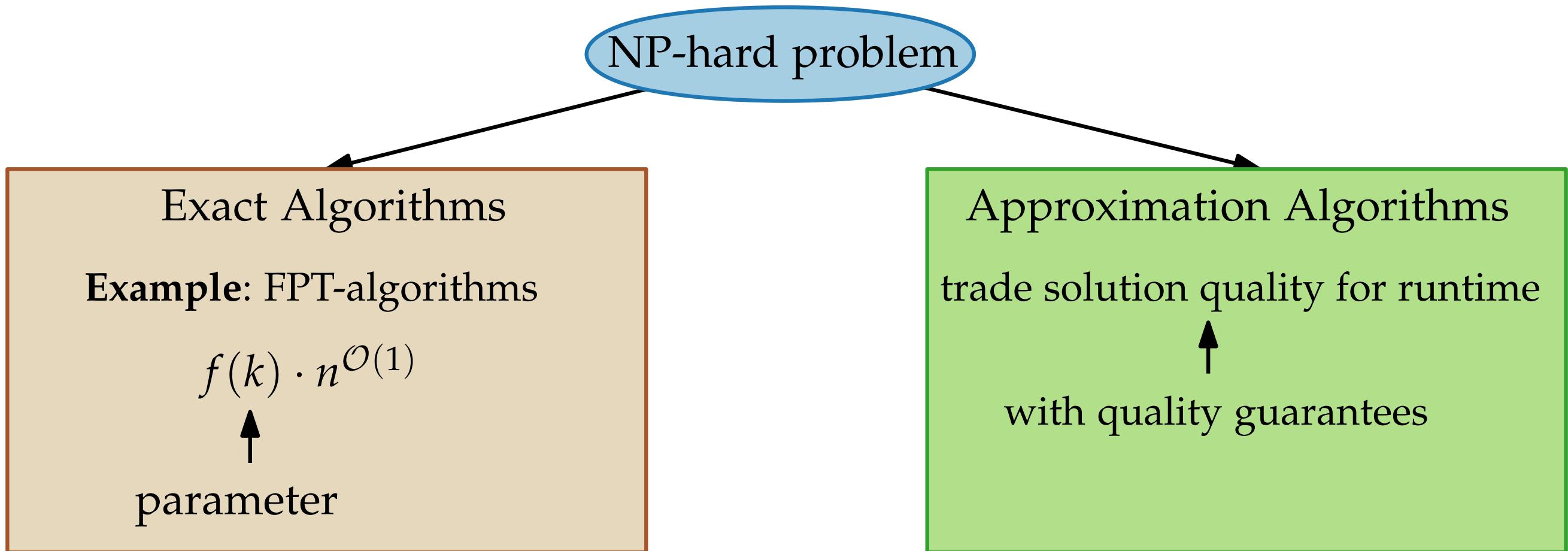
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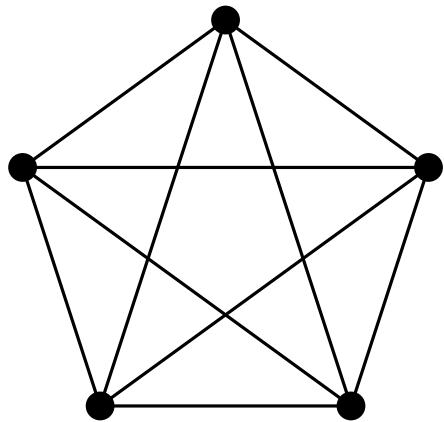
Here: Polynomial-time algorithms that produce a solution of value at most/least $c\text{OPT} \pm f(k)$

11. Kuratowski's Theorem

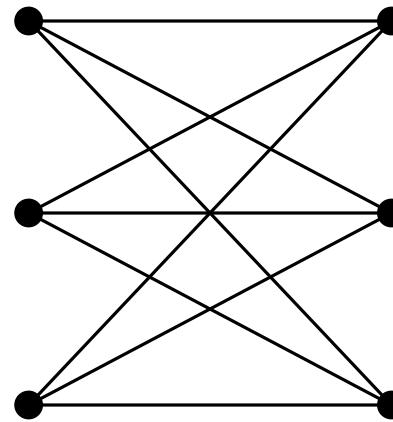
When is a graph planar?

11. Kuratowski's Theorem

When is a graph planar?



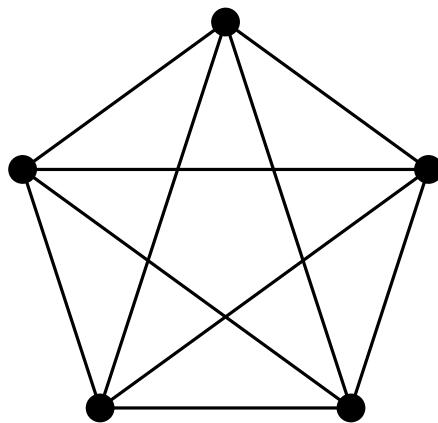
K_5



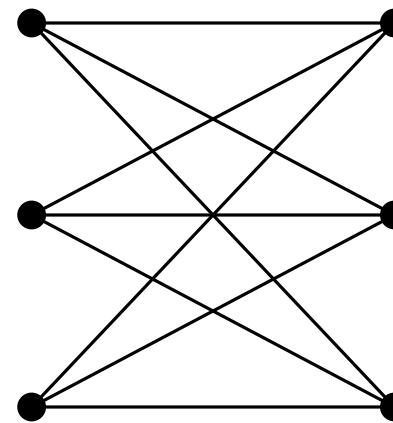
$K_{3,3}$

11. Kuratowski's Theorem

When is a graph planar?



K_5



$K_{3,3}$

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
10. Efficient Parameterized Approximation
11. Kuratowski's Theorem

Nächste Schritte

- In WueCampus anmelden

Nächste Schritte

- In WueCampus anmelden

The screenshot shows the WueCampus website interface. At the top, there is a navigation bar with the logo "wuecampus", "Dashboard", "Meine Kurse", and a user icon for TH. Below the header is a large banner image of frost on a tree branch. Underneath the banner, the breadcrumb navigation shows "Wintersemester 2022/2023 > Master- und Aufbaustudiengänge". The main title of the course is "WS22: Seminar Visualisierung von Graphen". Below the title, there are four buttons: "Kurs", "Bewertungen", "Kompetenzen", and "Mich in diesem Kurs einschreiben". A blue button labeled "▼ Allgemeines" is currently selected, showing a red message icon and the text "Ankündigungen FORUM". Another blue button labeled "▼ Seminar: Visualisierung von Graphen" is also visible. At the bottom, it says "Umfang: 5 ECTS, 2 SWS".

Nächste Schritte

- In WueCampus anmelden

The screenshot shows the WueCampus course registration interface. At the top, there is a navigation bar with the WueCampus logo, a dashboard link, and a "Meine Kurse" dropdown. Below the navigation is a large banner image of frost on a tree branch. Underneath the banner, the course title "WS22: Seminar Visualisierung von Graphen" is displayed. A red arrow points to the "Mich in diesem Kurs einschreiben" button, which is highlighted with a red oval. The page also includes tabs for "Kurs", "Bewertungen", "Kompetenzen", and the highlighted button. Below these tabs, there are sections for "Allgemeines" and "Seminar: Visualisierung von Graphen". The "Allgemeines" section contains a "FORUM" link. At the bottom, it specifies the course details: "Umfang: 5 ECTS, 2 SWS".

Nächste Schritte

- In WueCampus anmelden

The screenshot shows the wuecampus website interface. At the top, there is a navigation bar with the wuecampus logo, a dashboard link, and a "Meine Kurse" dropdown menu. On the right side of the header are icons for notifications, messaging, and user settings. The main content area features a large banner image of a tree branch with ice crystals. Below the banner, a breadcrumb navigation path reads: Wintersemester 2022/2023 > Master- und Aufbaustudiengänge > Einschreibeoptionen. The title of the page is "WS22: Seminar Visualisierung von Graphen". Underneath the title, the section "Einschreibeoptionen" is displayed. A sub-section titled "WS22: Seminar Visualisierung von Graphen" includes a lock icon and a link icon. Below this, there is a text input field for describing the course, followed by the names of the professors: Dozent: Boris Klemz and Dozent: Alexander Wolff. A section titled "Selbsteinschreibung (Student)" is shown with the note "Kein Einstreibeschlüssel notwendig". At the bottom, a blue button labeled "Einschreiben" is highlighted with a red arrow pointing to it.

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Nächste Schritte

- In WueCampus anmelden
- In WueStudy anmelden

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Bei allgemeinen Fragen kann gerne das **Diskussionsforum** im WueCampus genutzt werden!

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Zum Abschluss:

Demonstration des Programms IPE
zum Erstellen von Abbildungen und Folien

<http://ipe.otfried.org/>

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