Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

Lehrstuhl für
INFORMATIK I
Algorithmen & Komplexität

Institut für Informatik

Seminar:
Visualisierung von Graphen

Wintersemster 2022

Einführungsveranstaltung am 18. Oktober 2022

Lehrstuhl für Informatik I

Boris Klemz   Alexander Wolff

Agenda

1. Ablauf des Seminars
2. Kurzübersicht der Themen
3. Themenverteilung
4. Einführung in IPE

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- Di, 18.10.2022: **Einführung**
- Di, 25.10.2022: **Kurzvorträge** zu jedem Thema

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  - Wichtigste Resultate vorstellen

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  Ziele:

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

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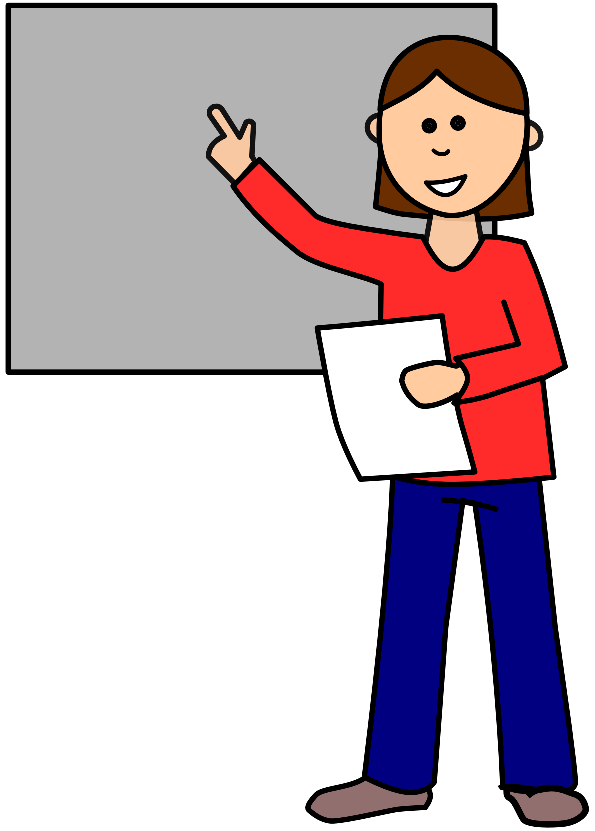
- Di, 08.11.2022: Tipps zum Schreiben von Ausarbeitungen



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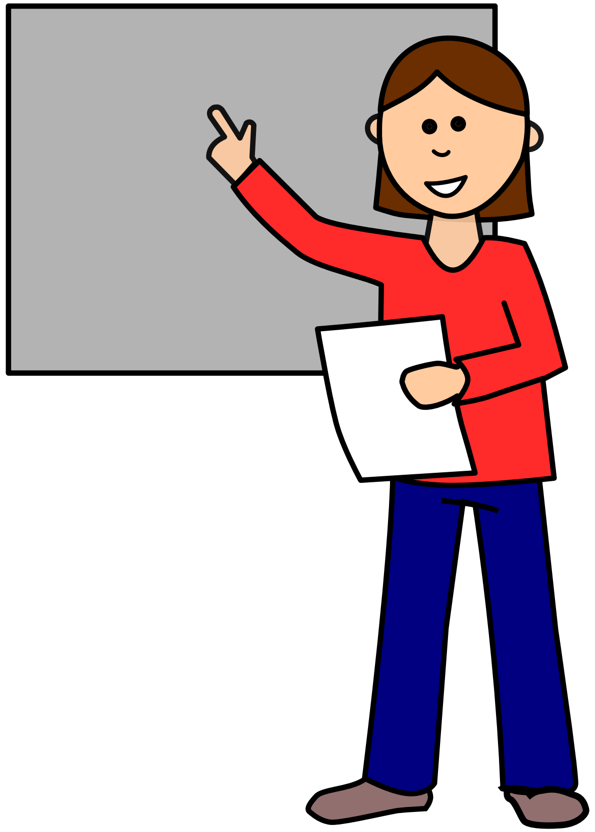

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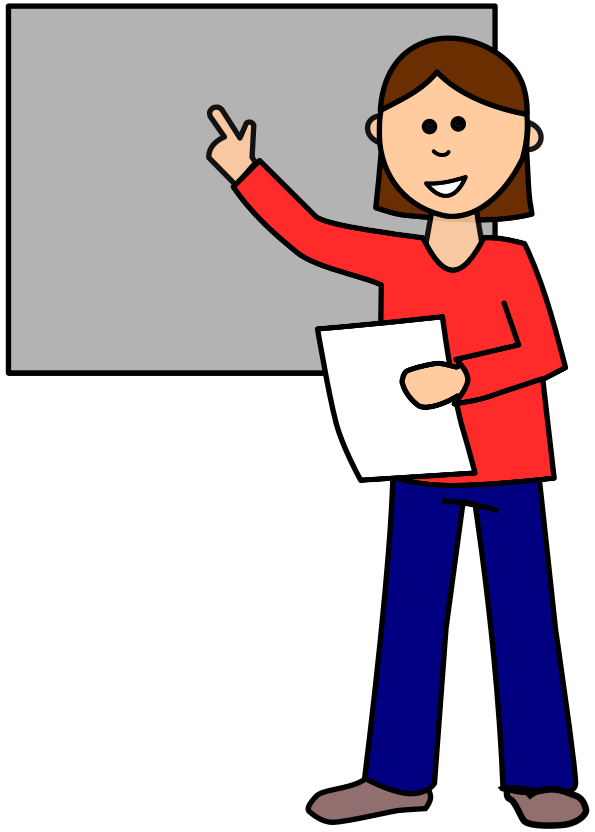
- Mo, 27.02.2023: **Ausarbeitungen** abgeben



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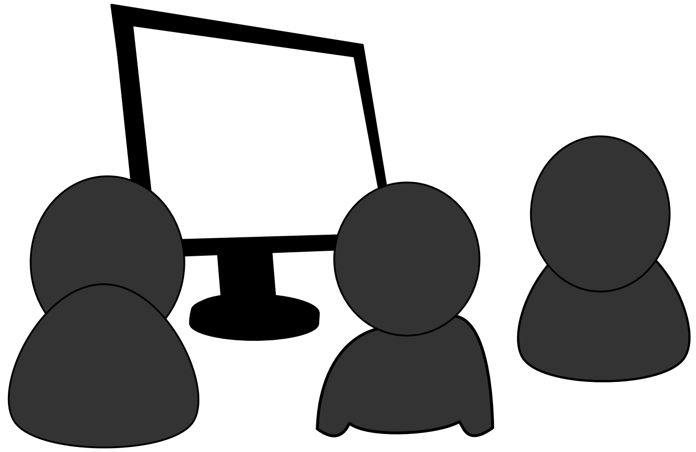

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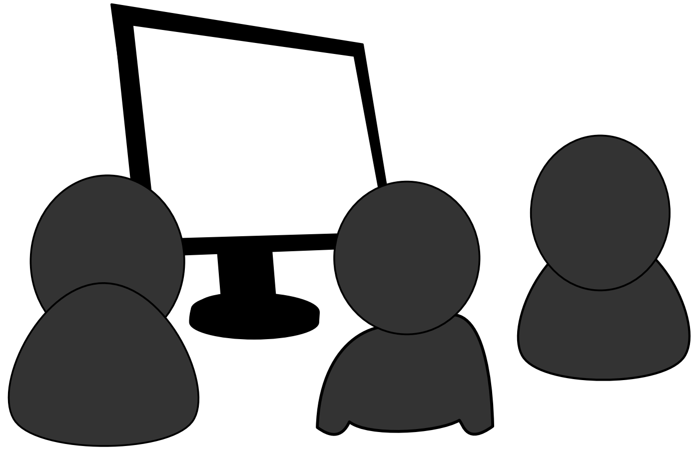

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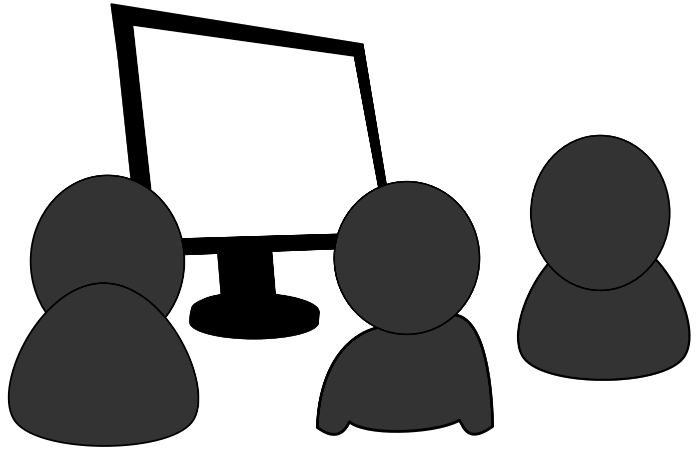

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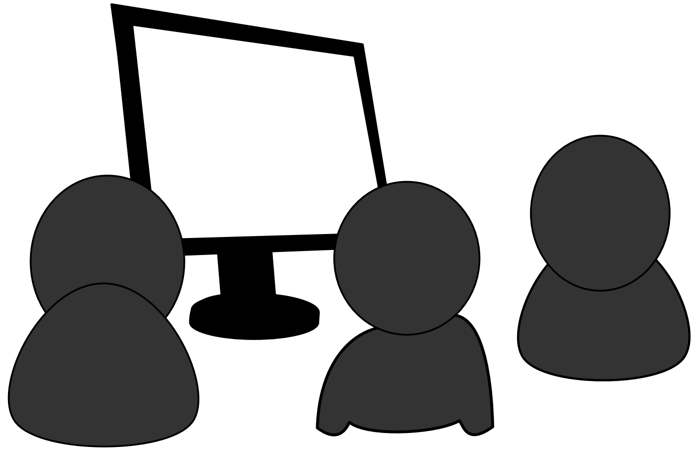

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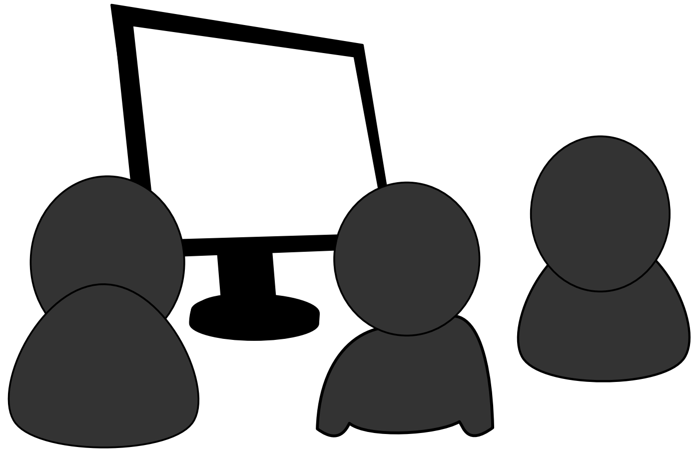

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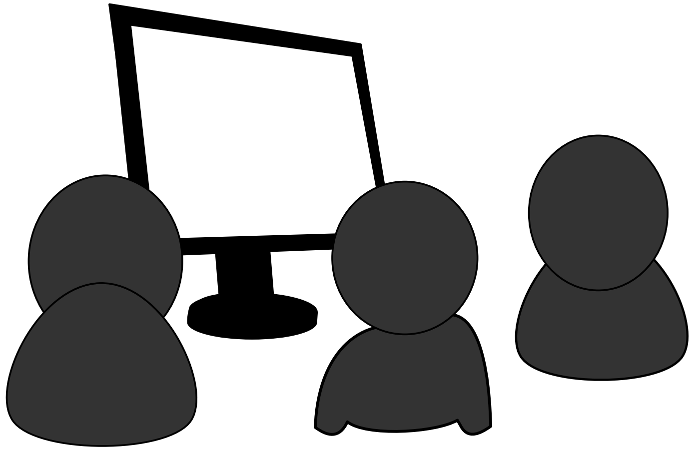

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  Ideen aus der Diskussion in die Ausarbeitung mitaufnehmen!

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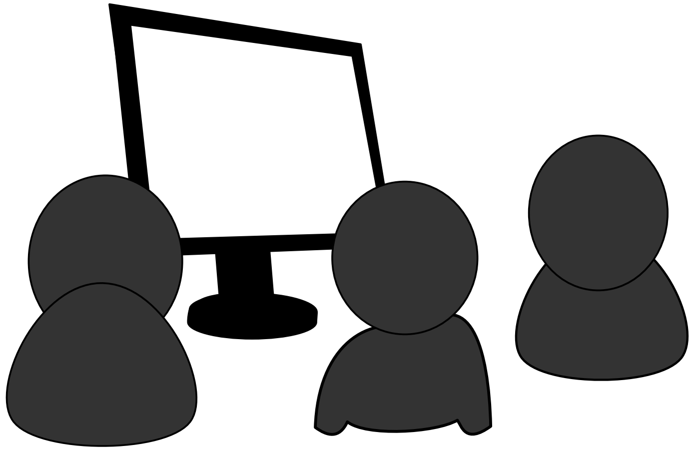

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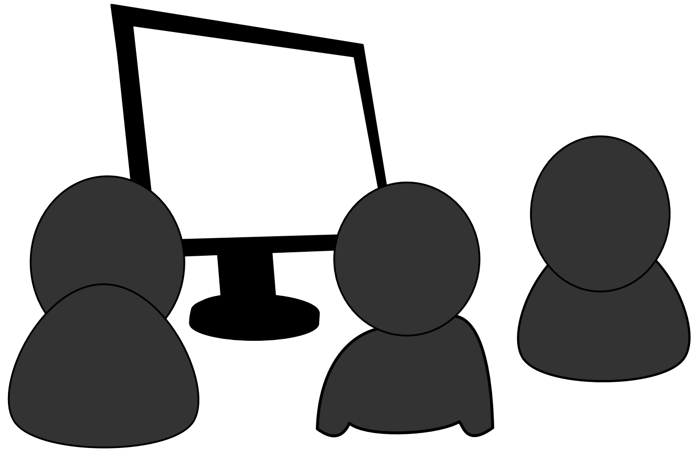

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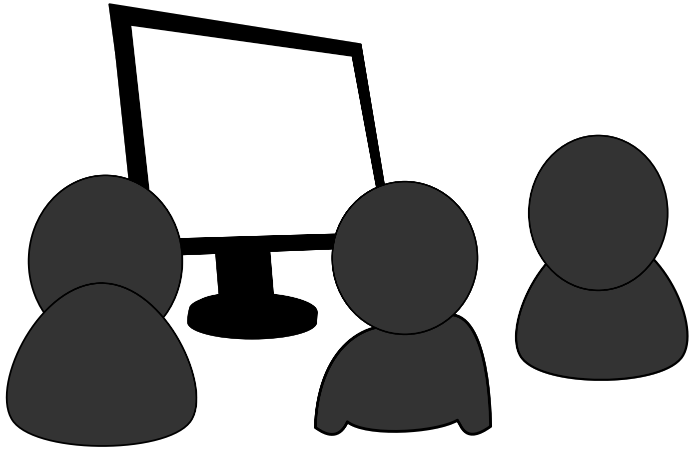

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Diese Termine sind **strikt** (außer für den 1. Vortrag)!

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- LaTeX-Vorlage
- **Vorabversion** der Ausarbeitung bis spätestens 2 Wochen nach dem eigenen Vortrag abgeben

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)
- Ausarbeitung (Inhalte, sprachliche Darstellung, Rechtschreibung, Verbindungen zu anderen Themen)
- 50 : 50

1. Small Point-Sets Supporting Graph Stories
2. On the Complexity of the Storyplan Problem
3. Compatible Spanning Trees in Simple Drawings of K_n
4. Empty Triangles in Generalized Twisted Drawings of K_n
5. Shooting Stars in Simple Drawings of $K_{m,n}$
6. Mutual Witness Gabriel Drawings of Complete Bipartite Graphs
7. FORBID: Fast Overlap Removal By stochastic Gradient Descent for Graph Drawing
8. Planar Confluent Orthogonal Drawings of 4-Modal Digraphs
9. Strictly-Convex Drawings of 3-Connected Planar Graphs
10. st-Orientations with Few Transitive Edges
11. An FPT Algorithm for Bipartite Vertex Splitting
12. Queue Layouts of Two-Dimensional Posets
13. The Rique-Number of Graphs
14. Visibility Representations of Toroidal and Klein-bottle Graphs

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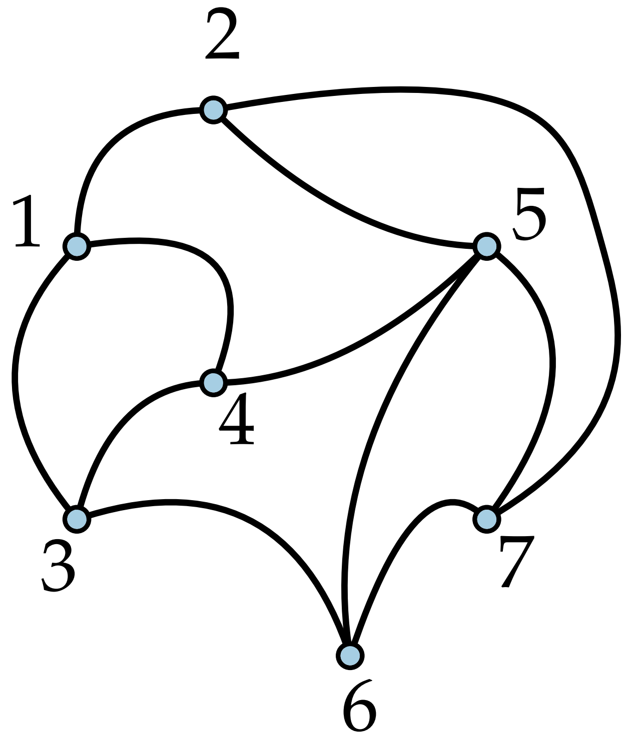

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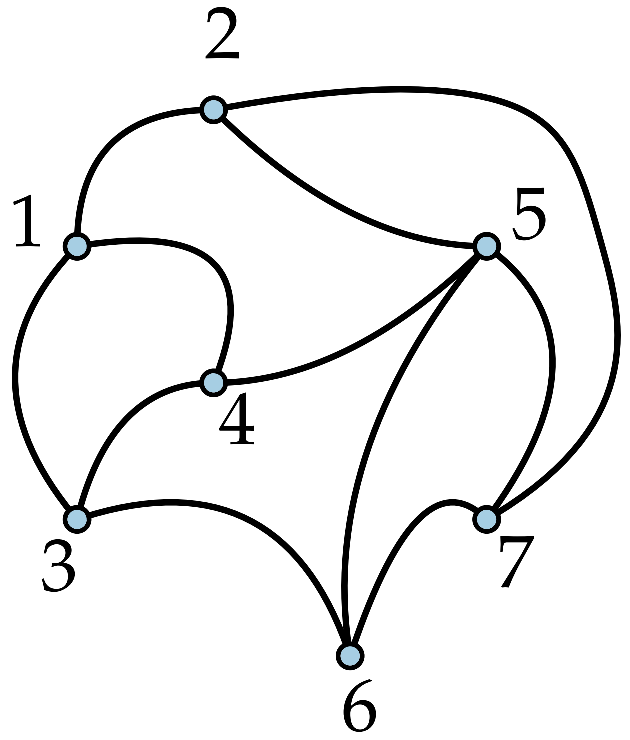

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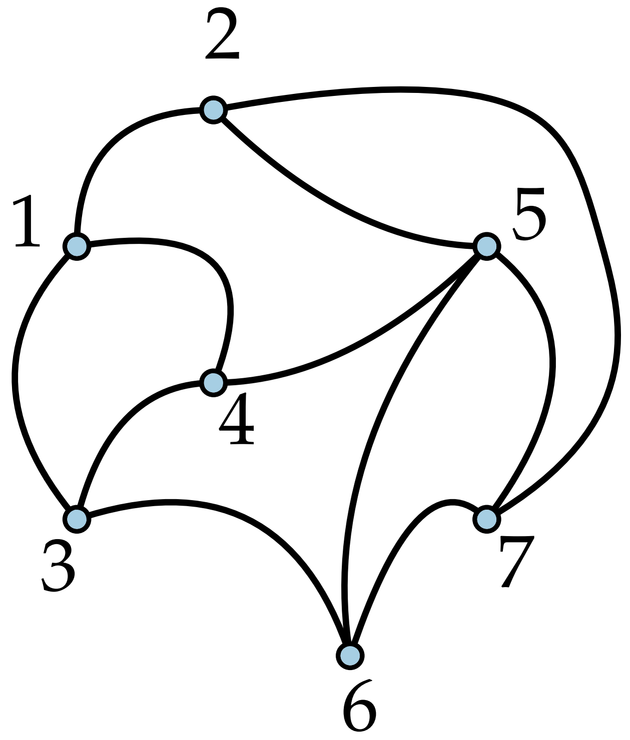

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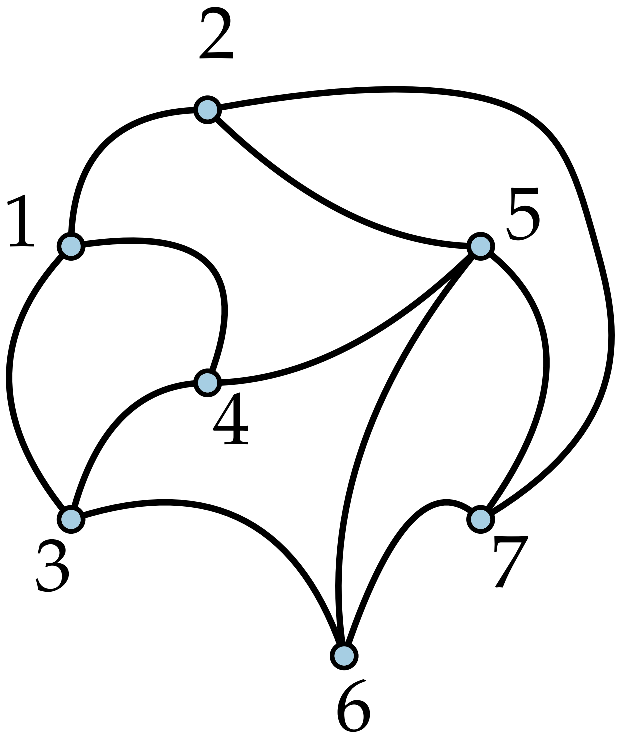

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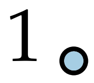

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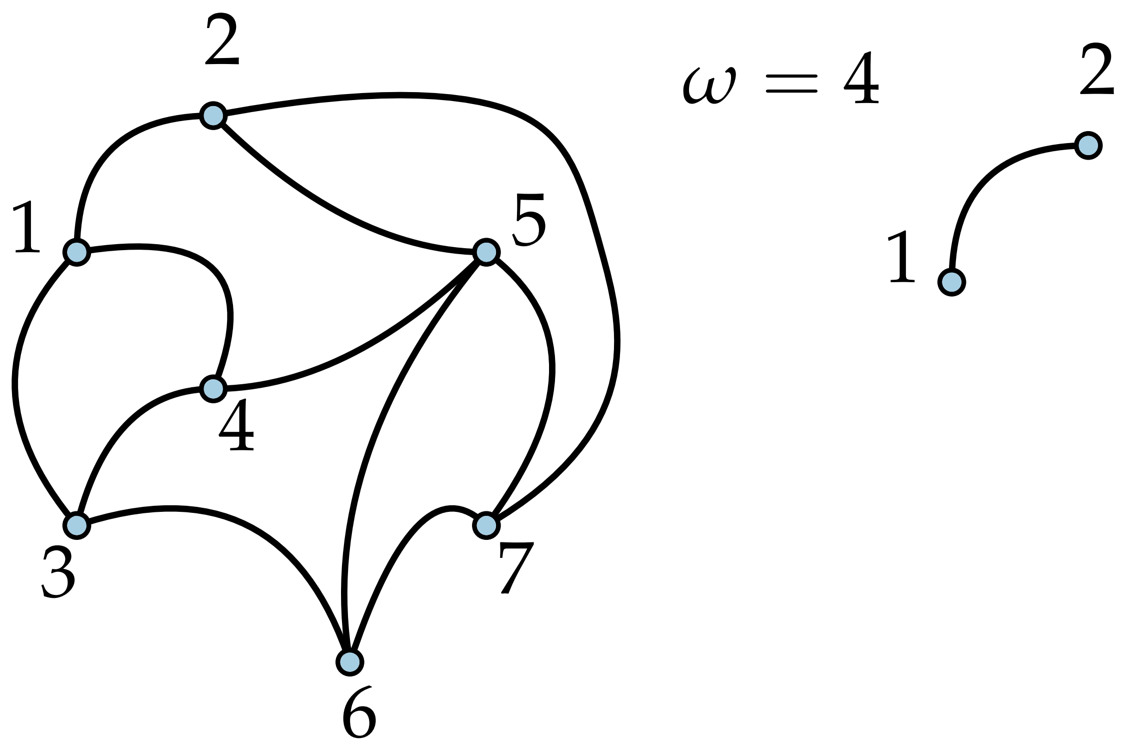

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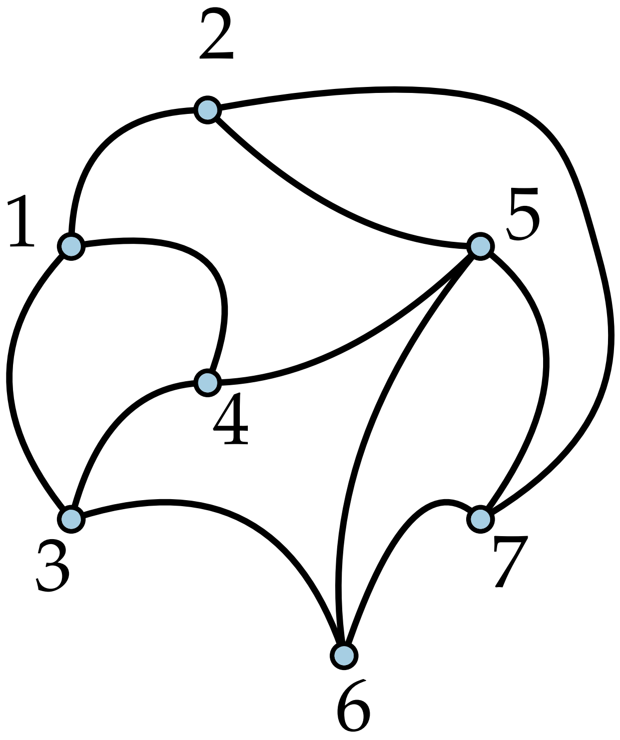

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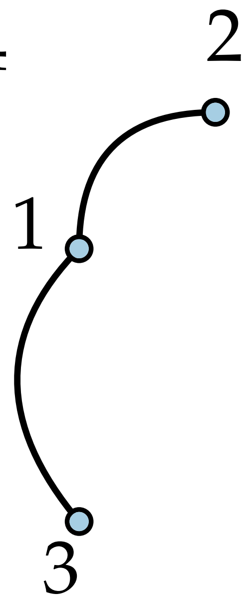

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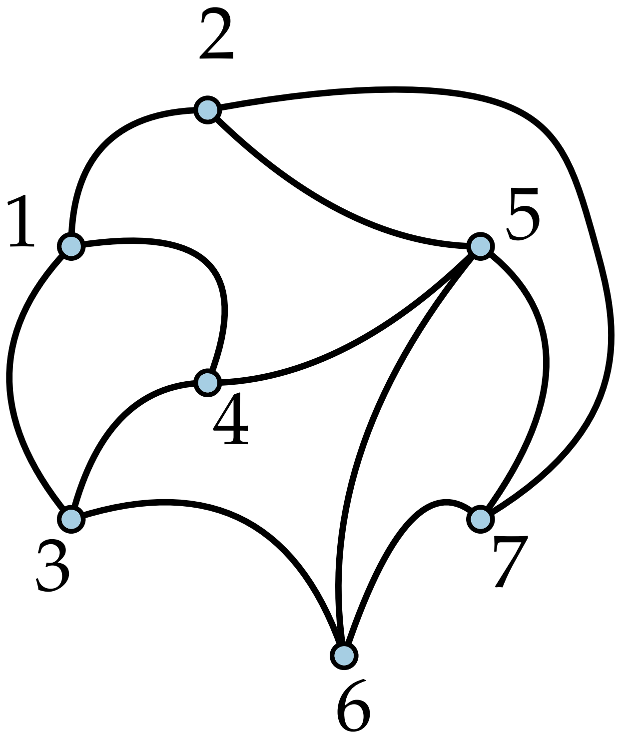

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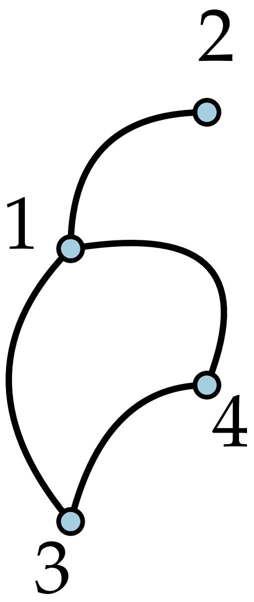

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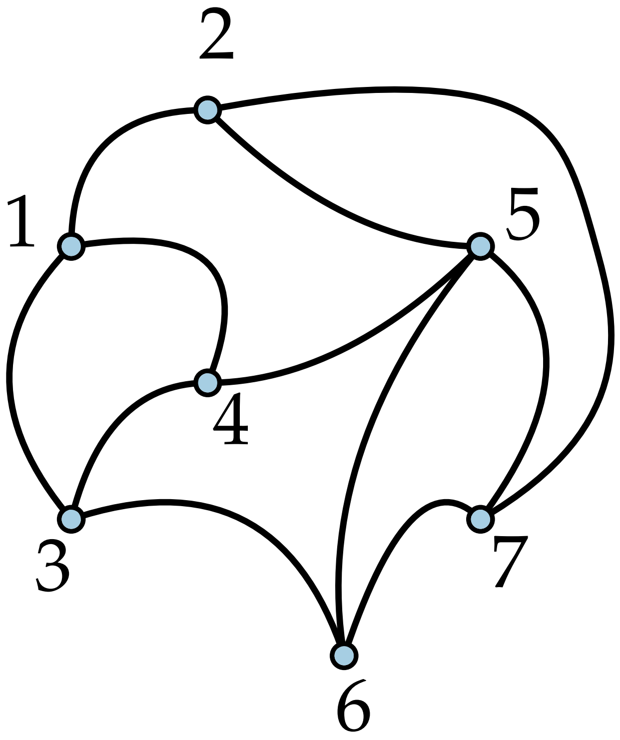

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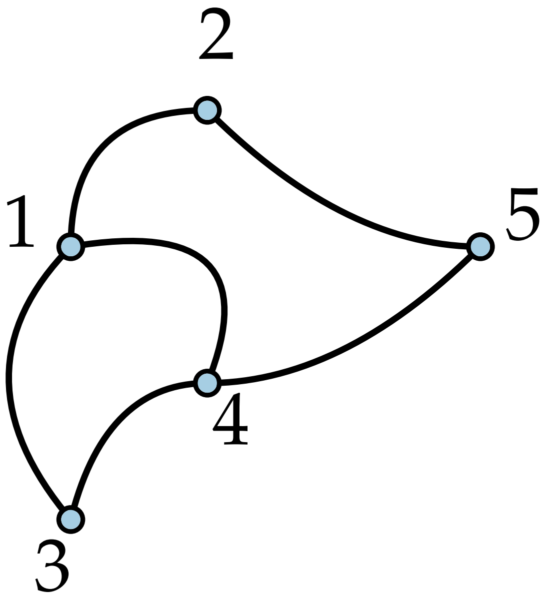

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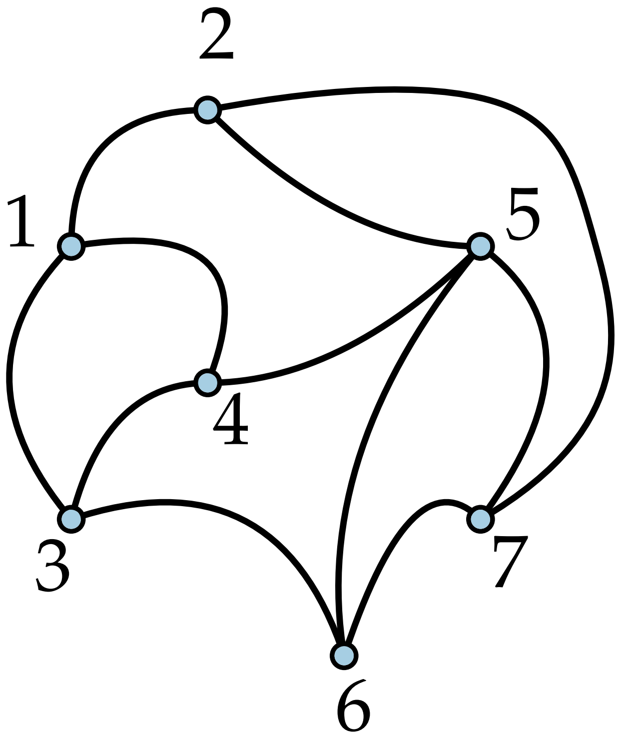

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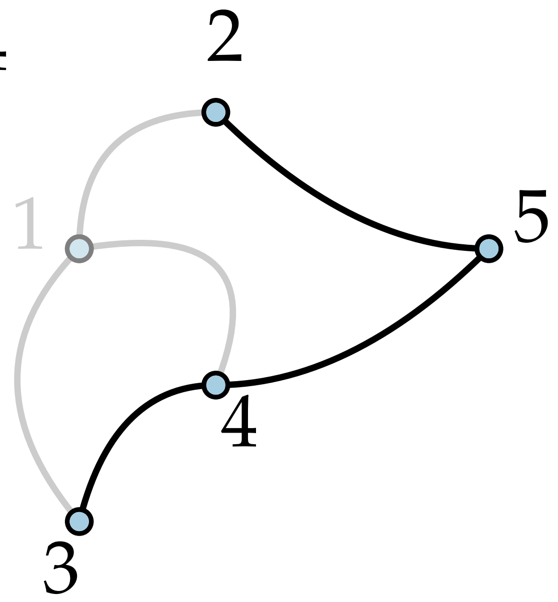

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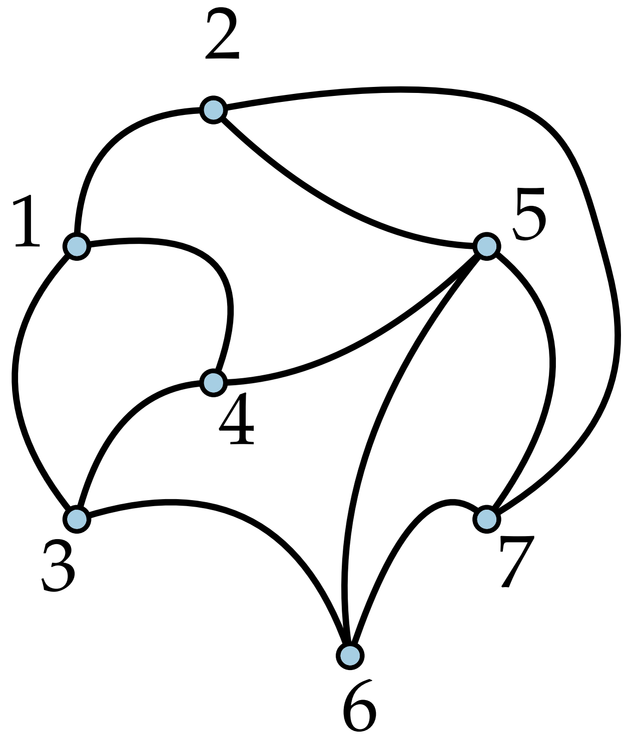

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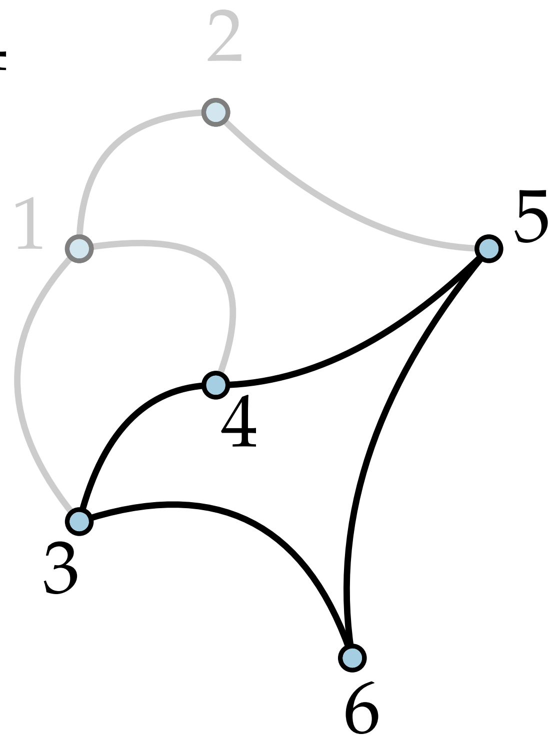

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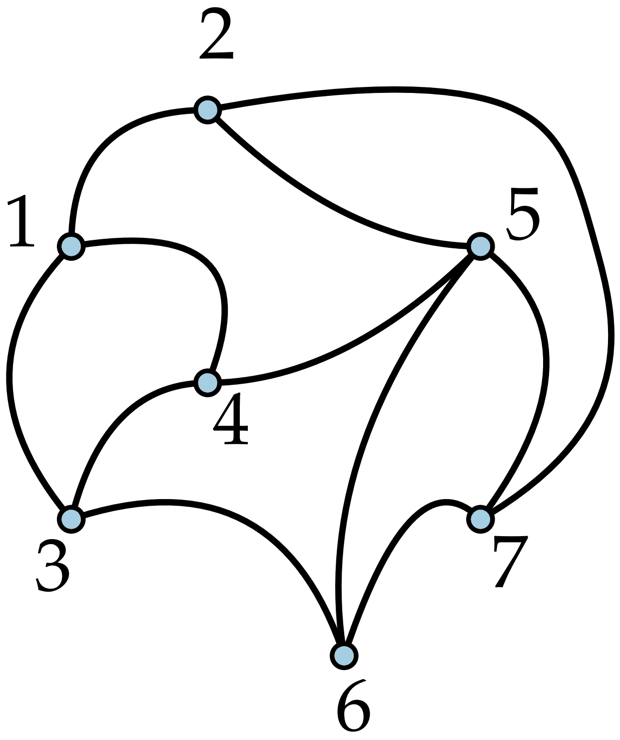

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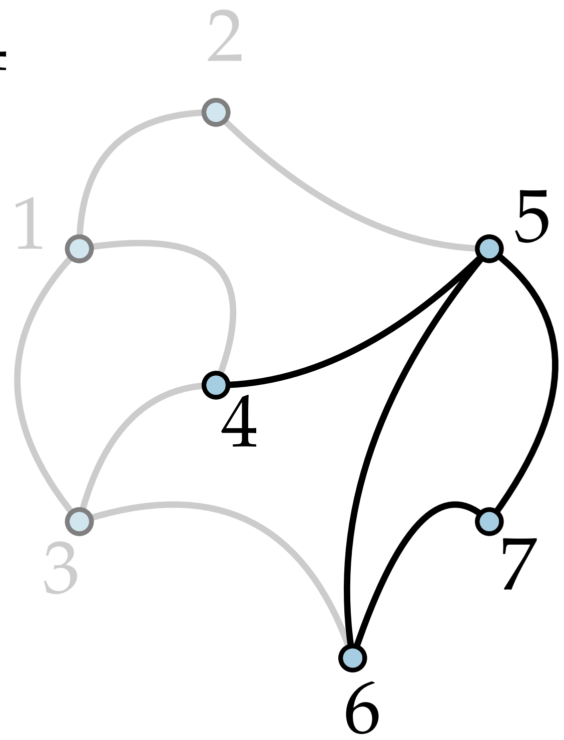

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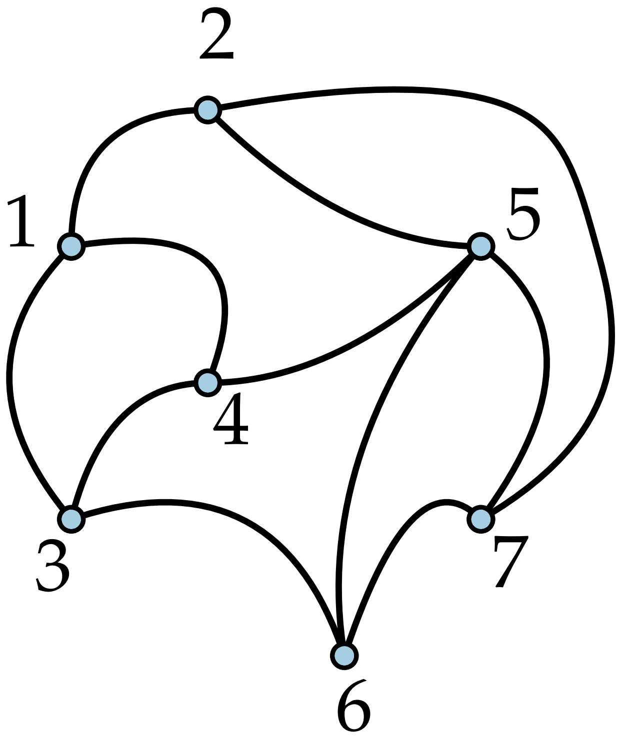

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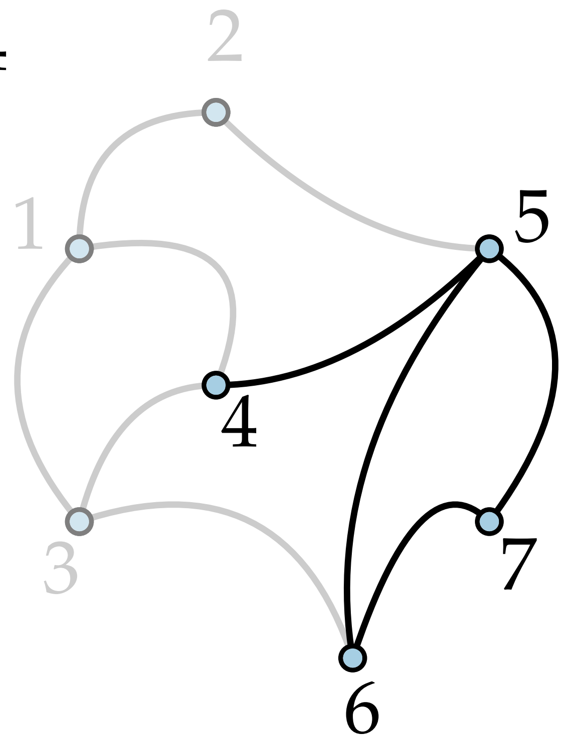

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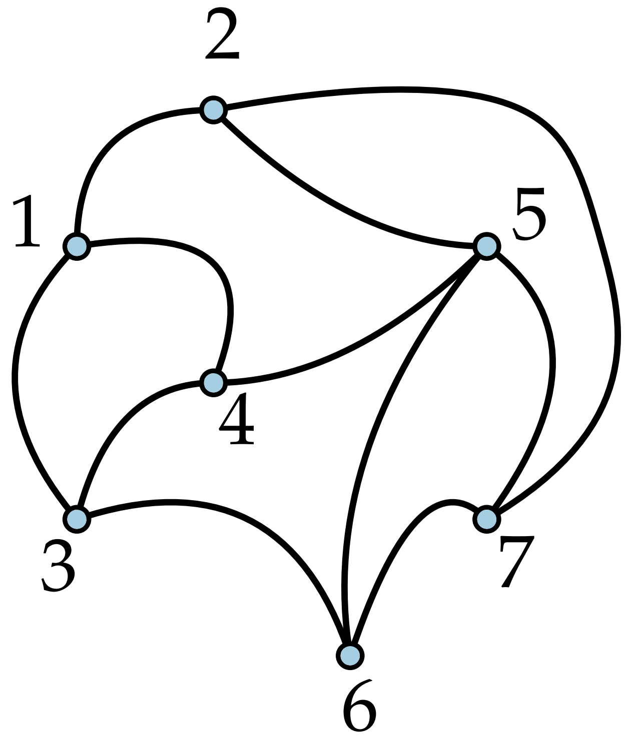

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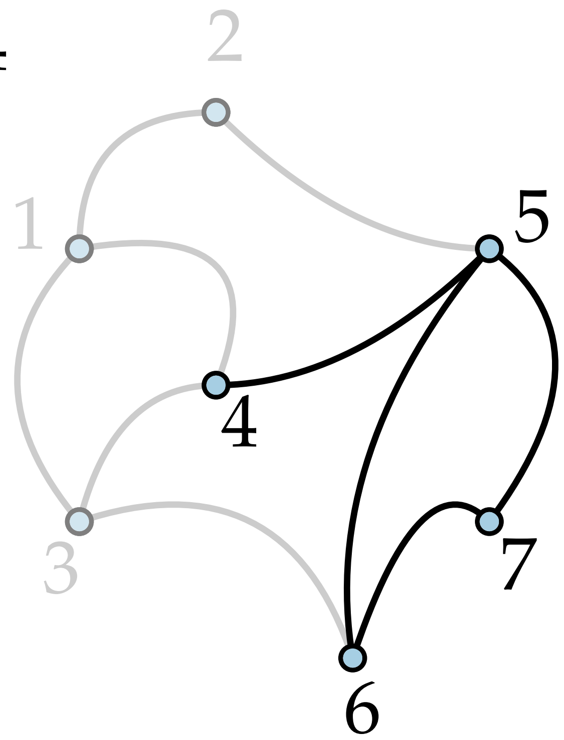

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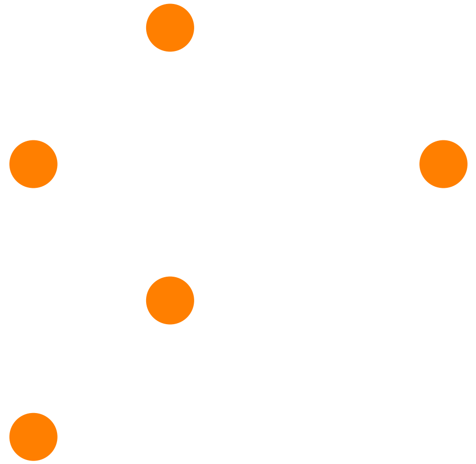

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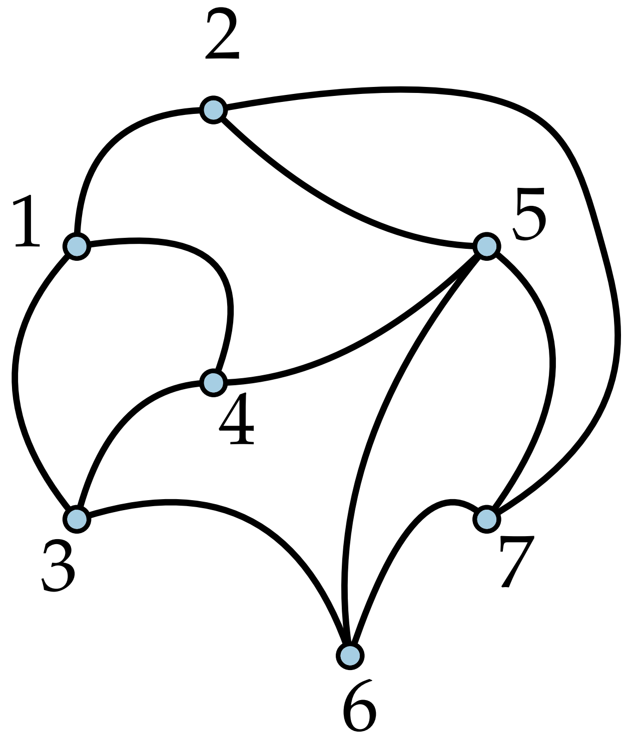

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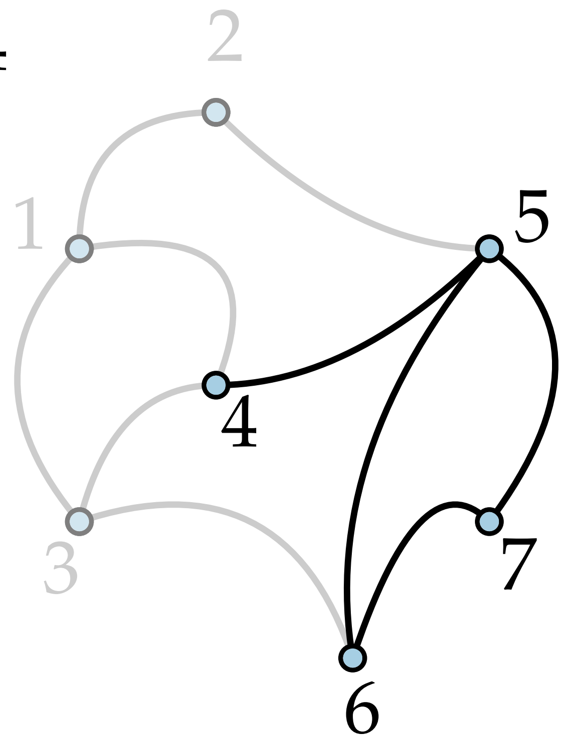

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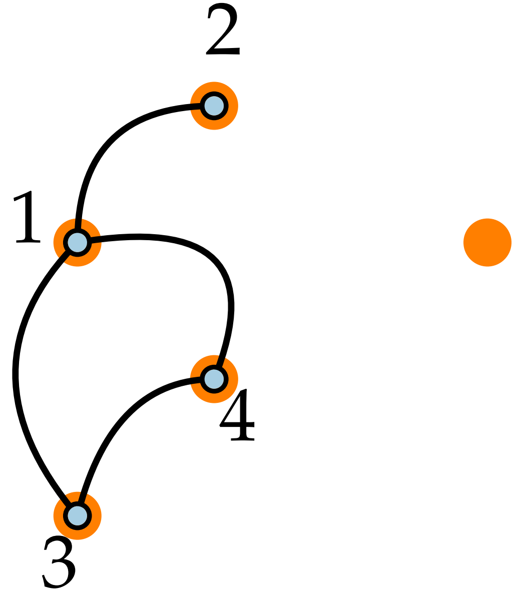

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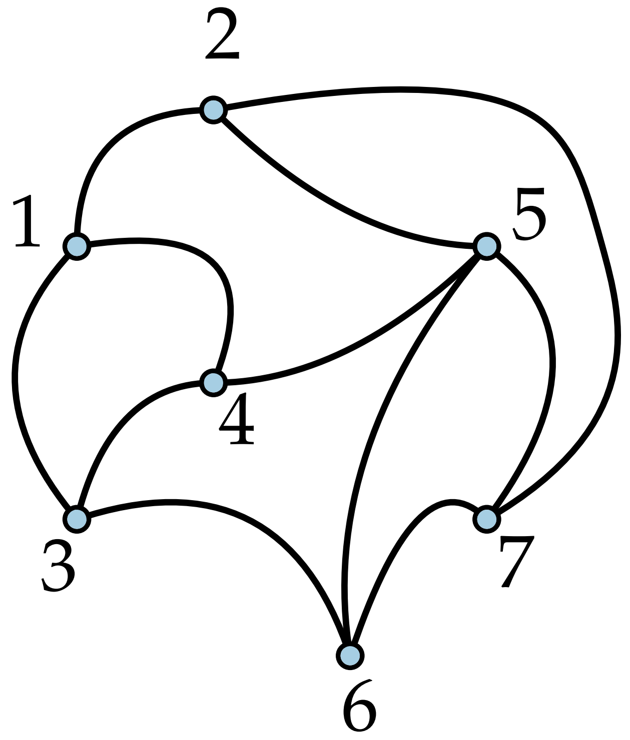
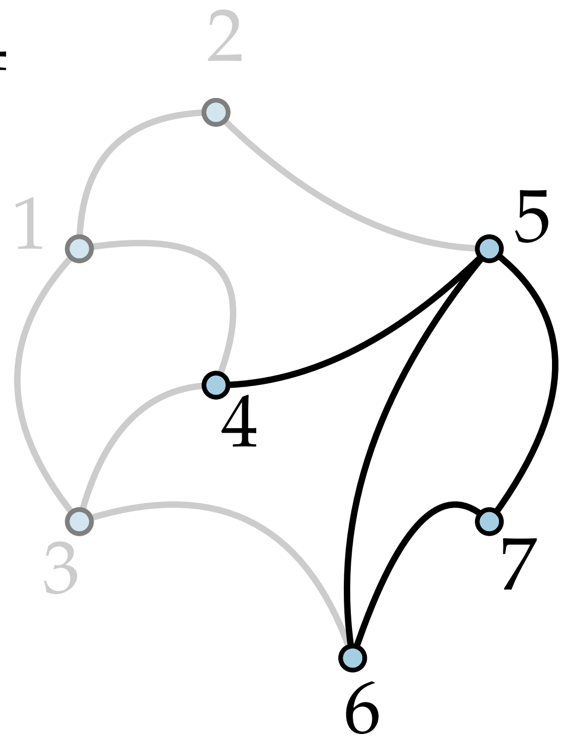
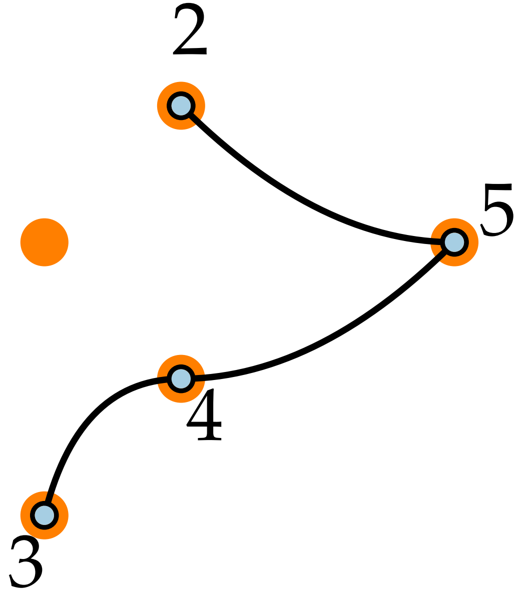


$\omega = 4$



$\omega + k = 5$



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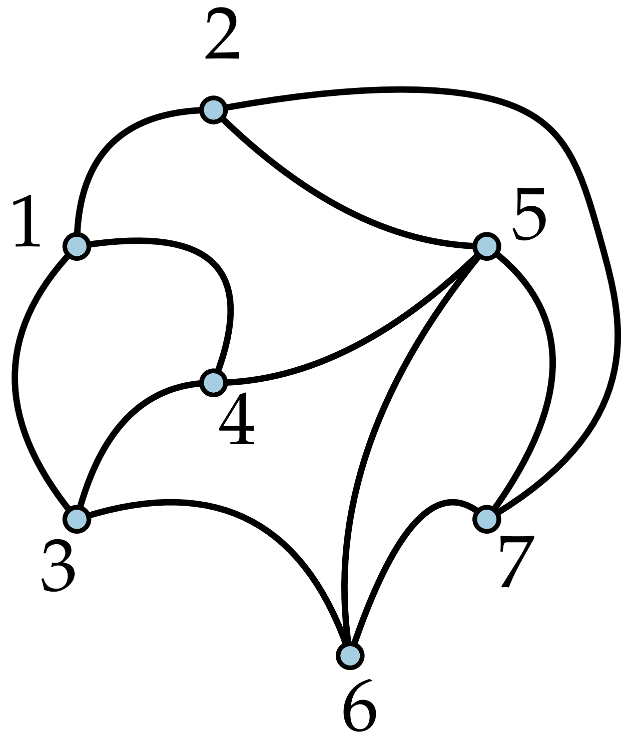

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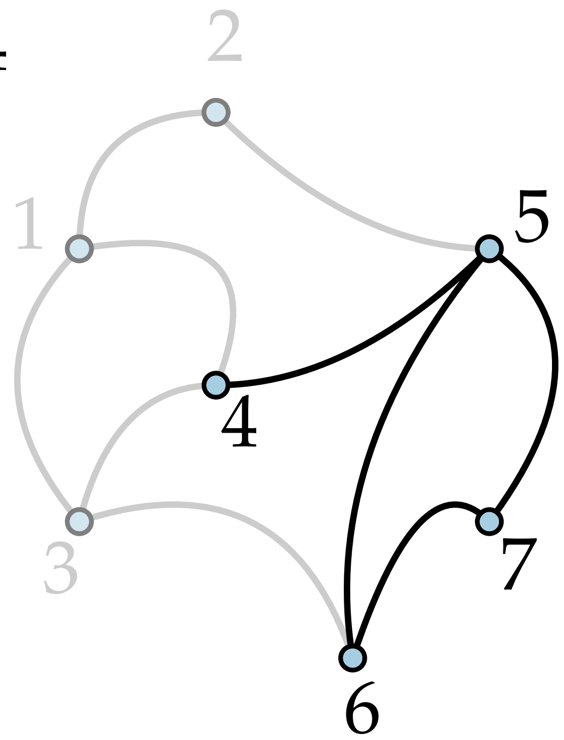

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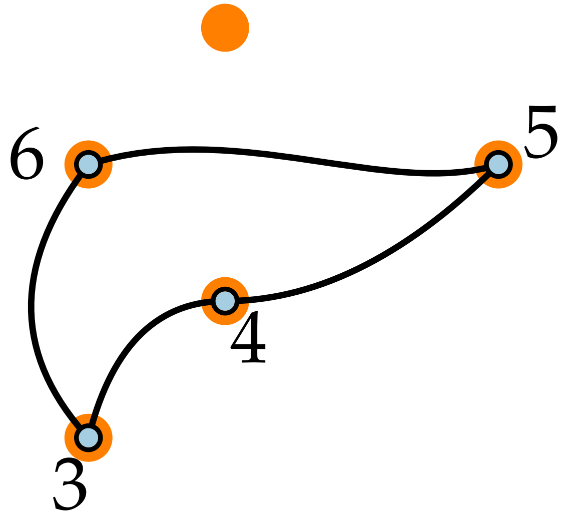

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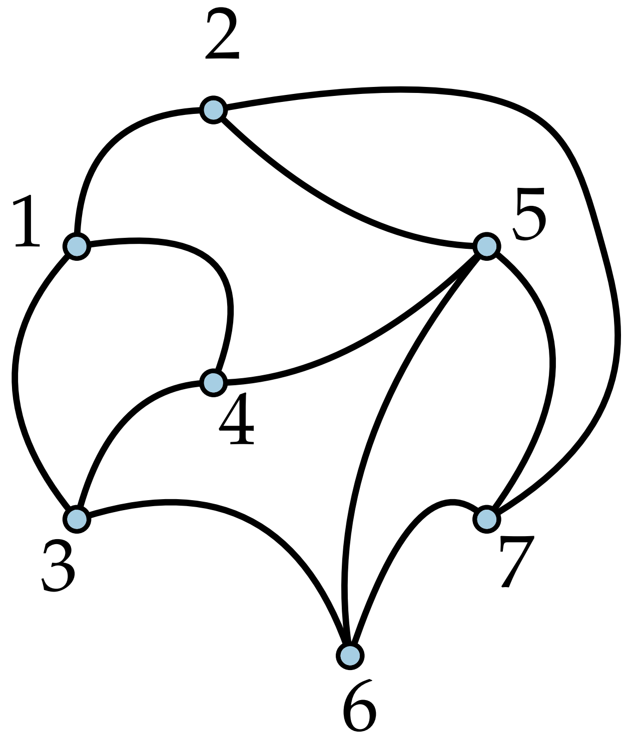

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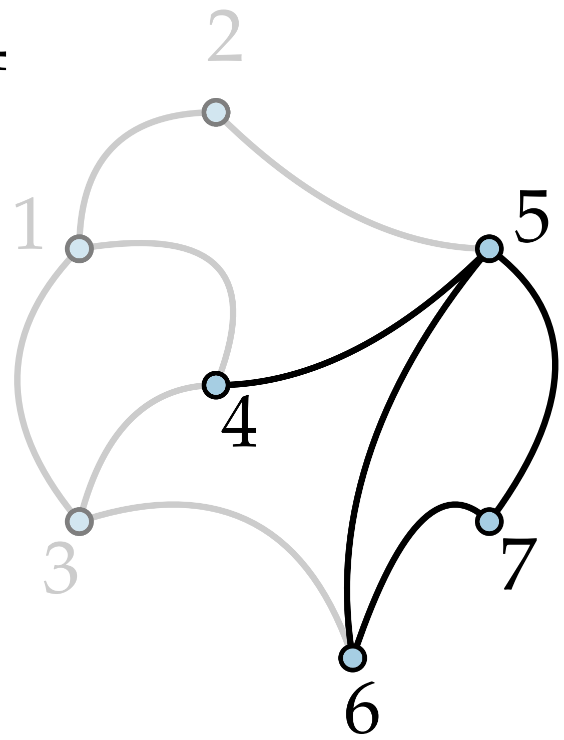

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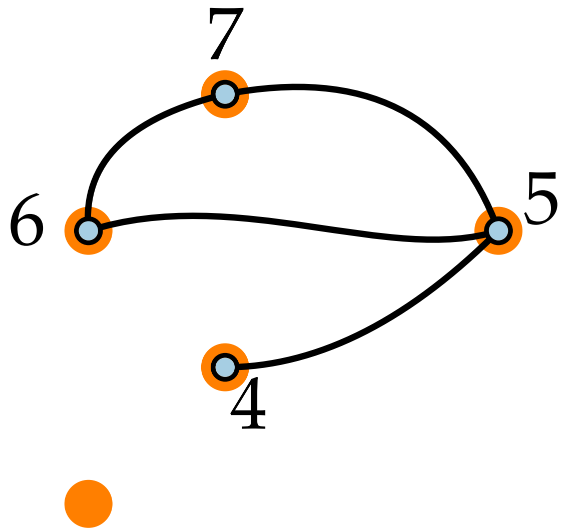

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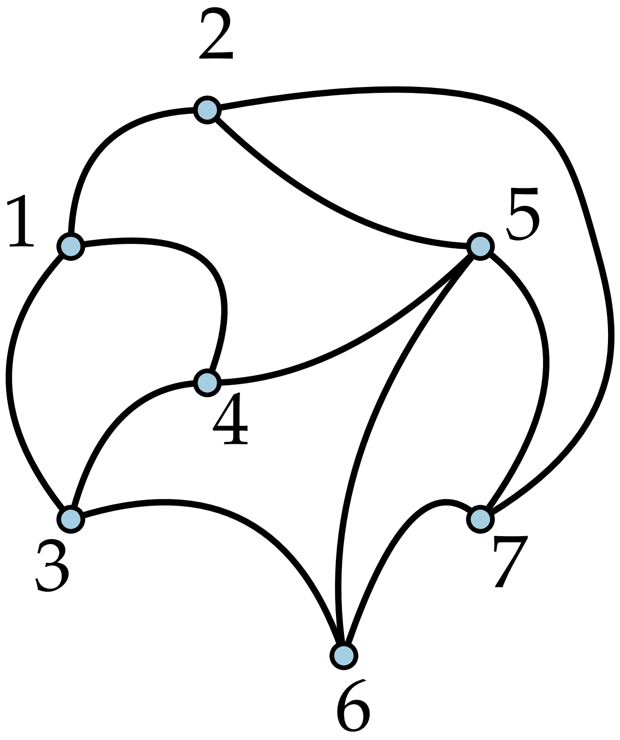

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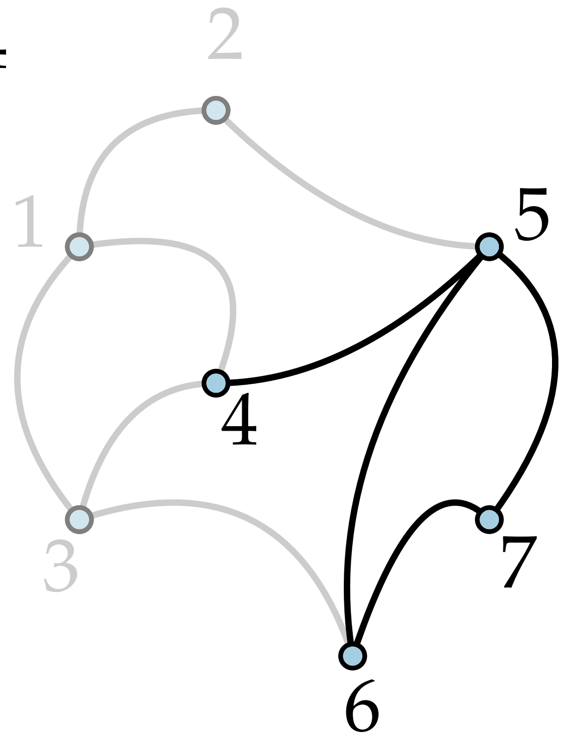

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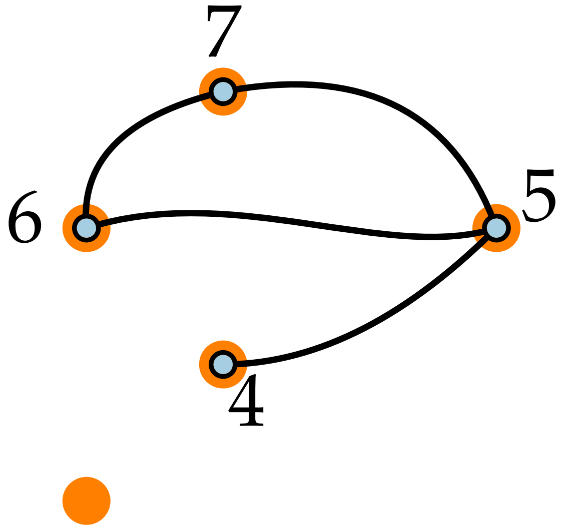
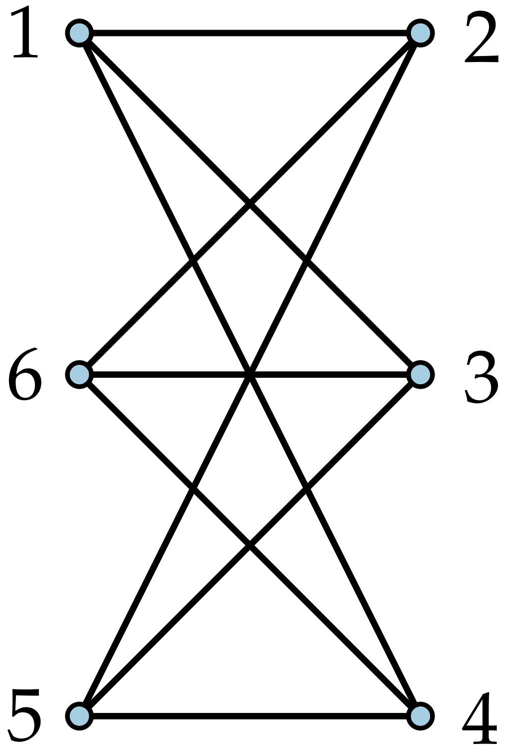


Find minimal k such that all drawings are planar.

2. On the Complexity of the Storyplan Problem



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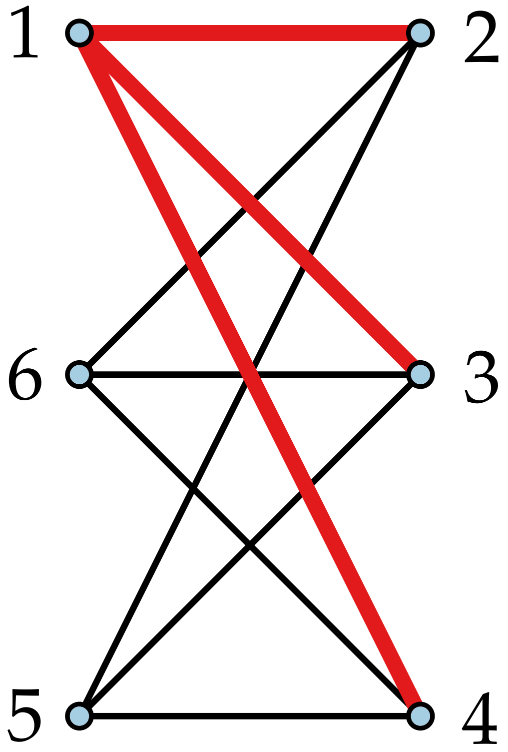

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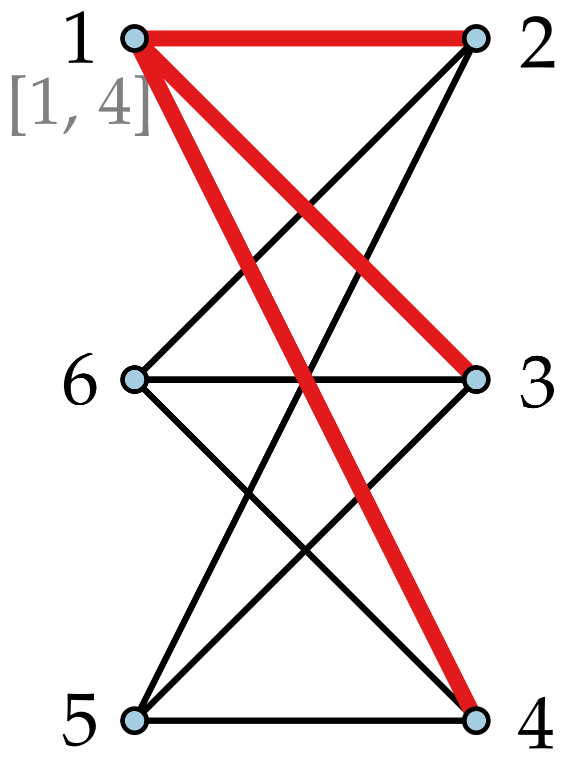

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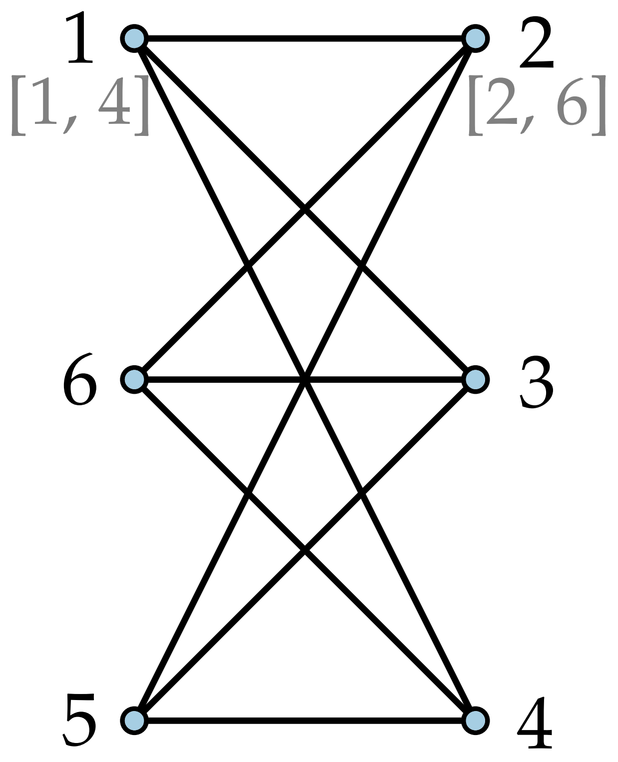

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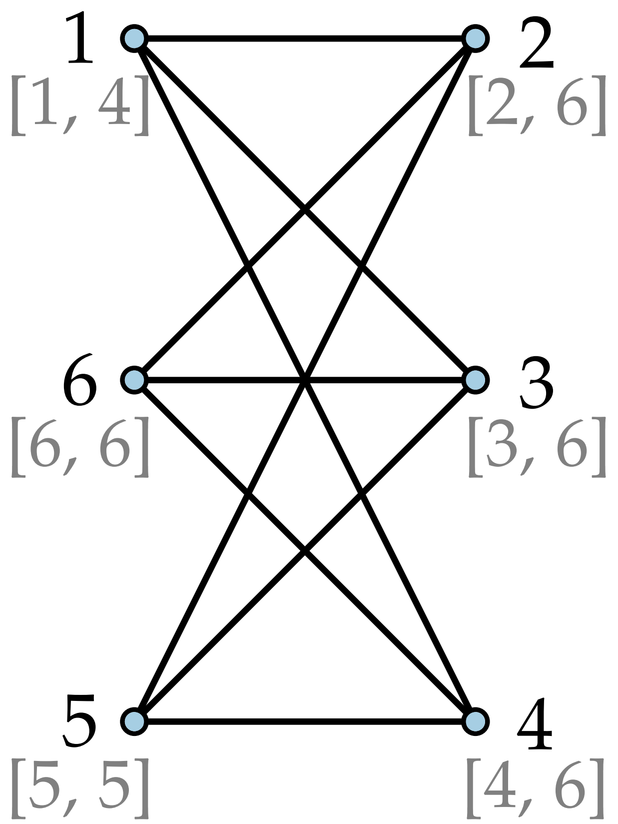

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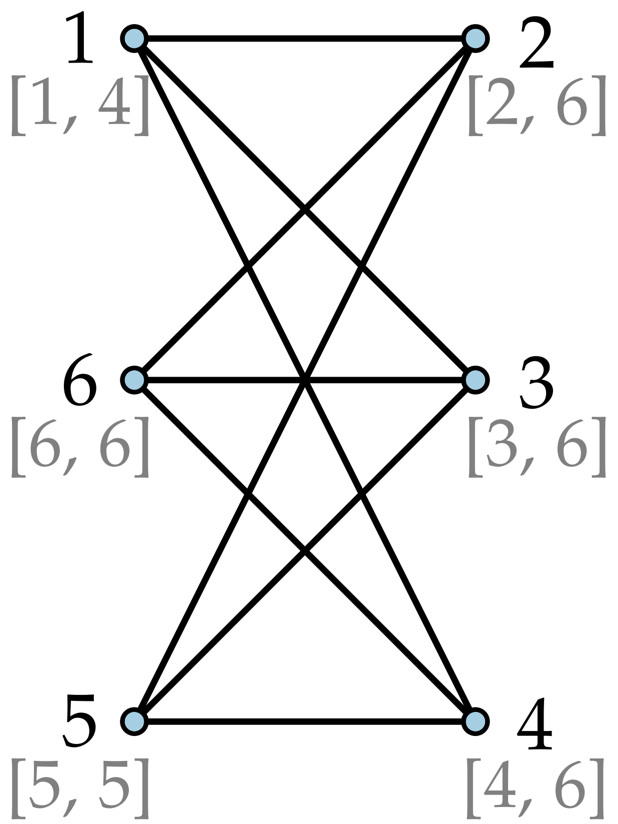

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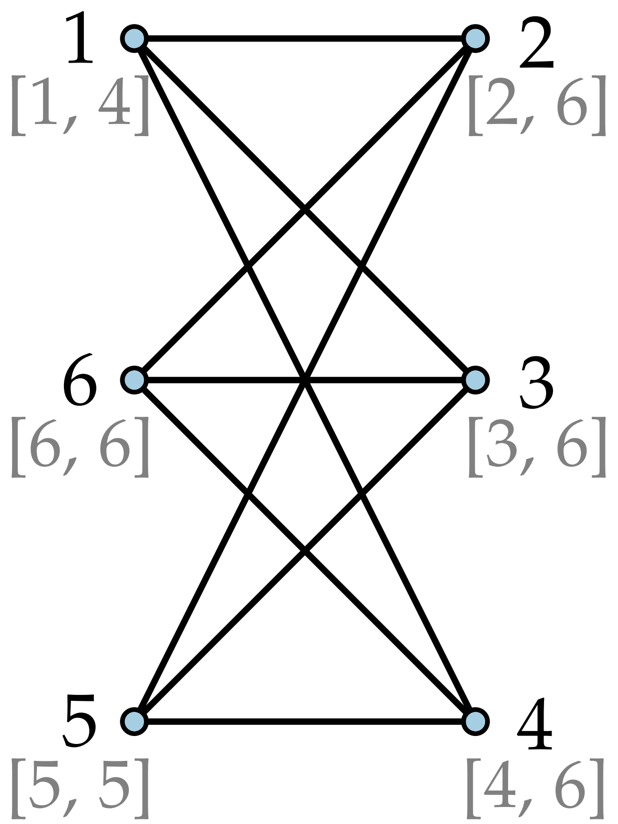

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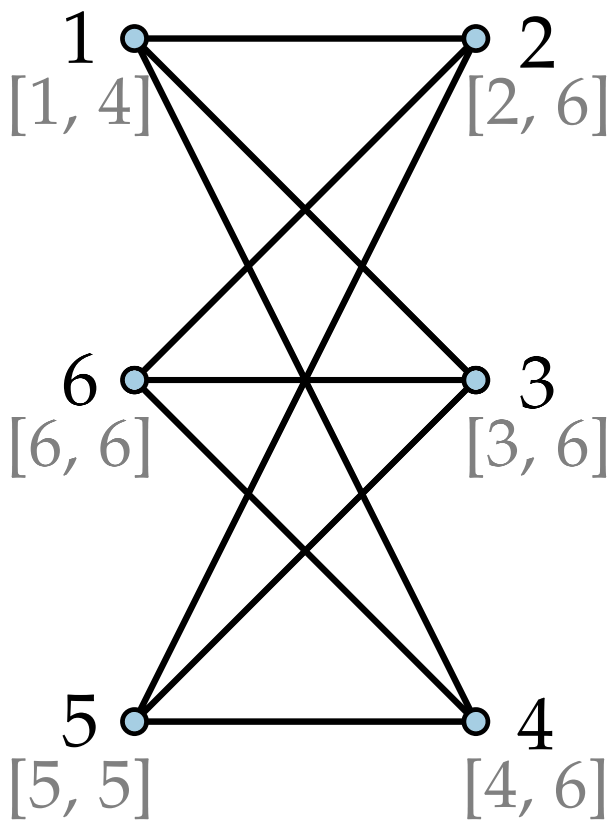

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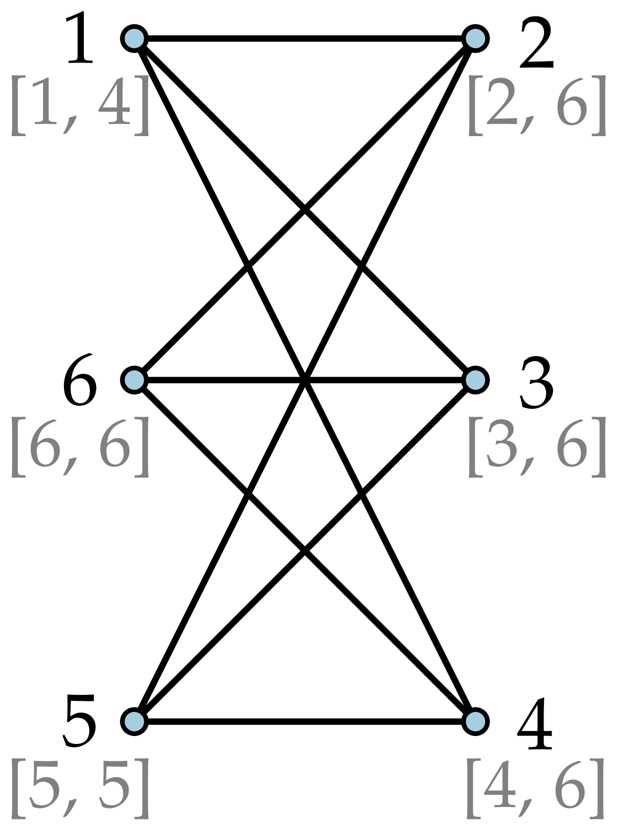

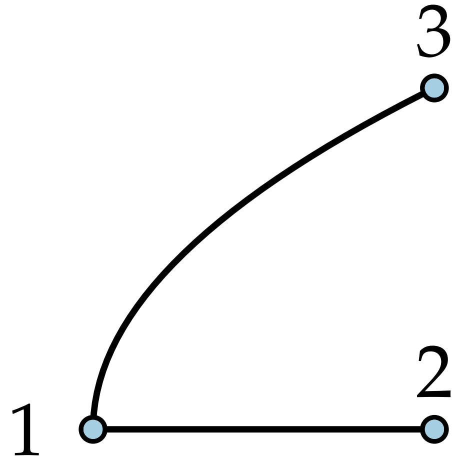

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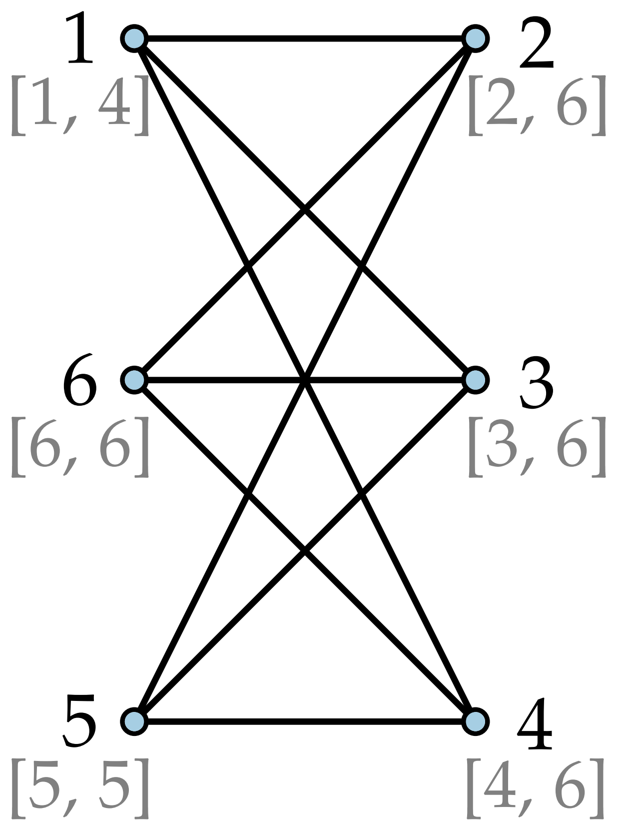

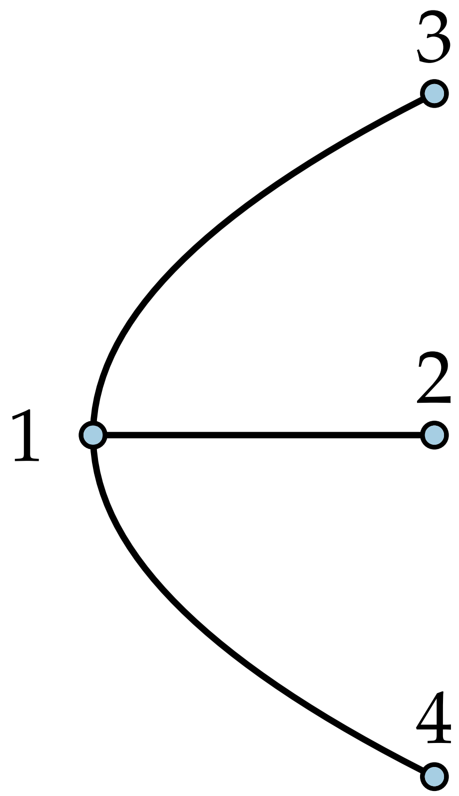

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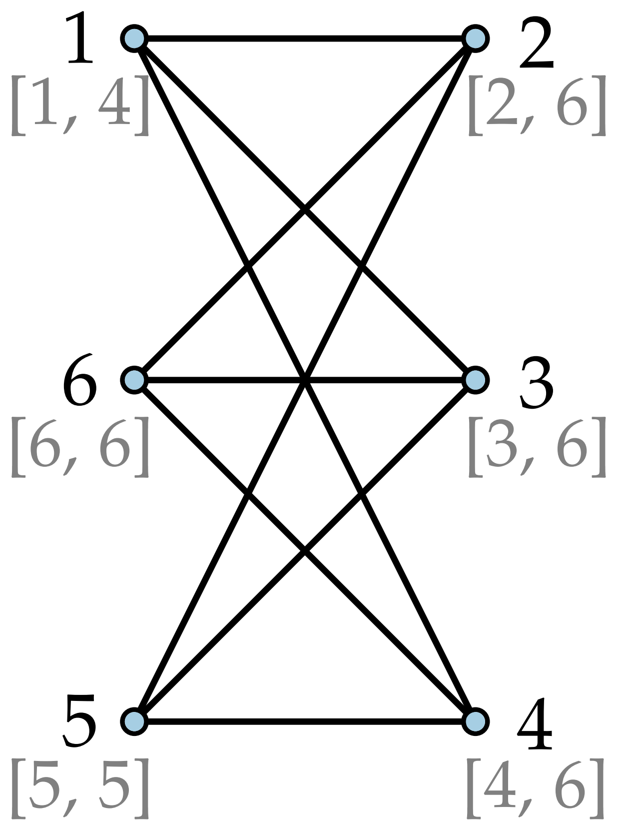

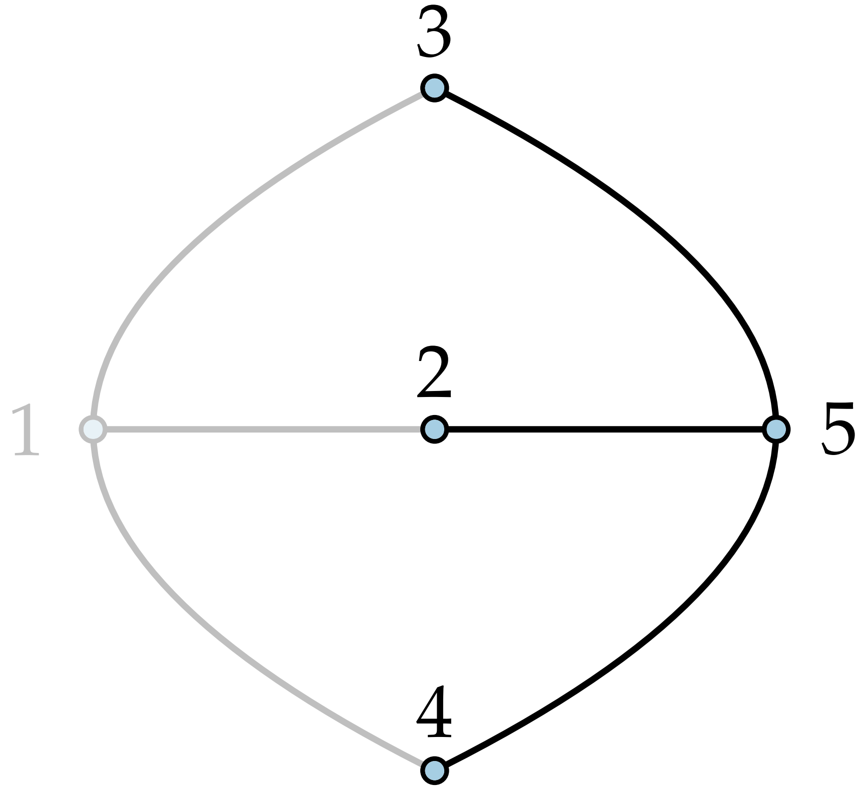

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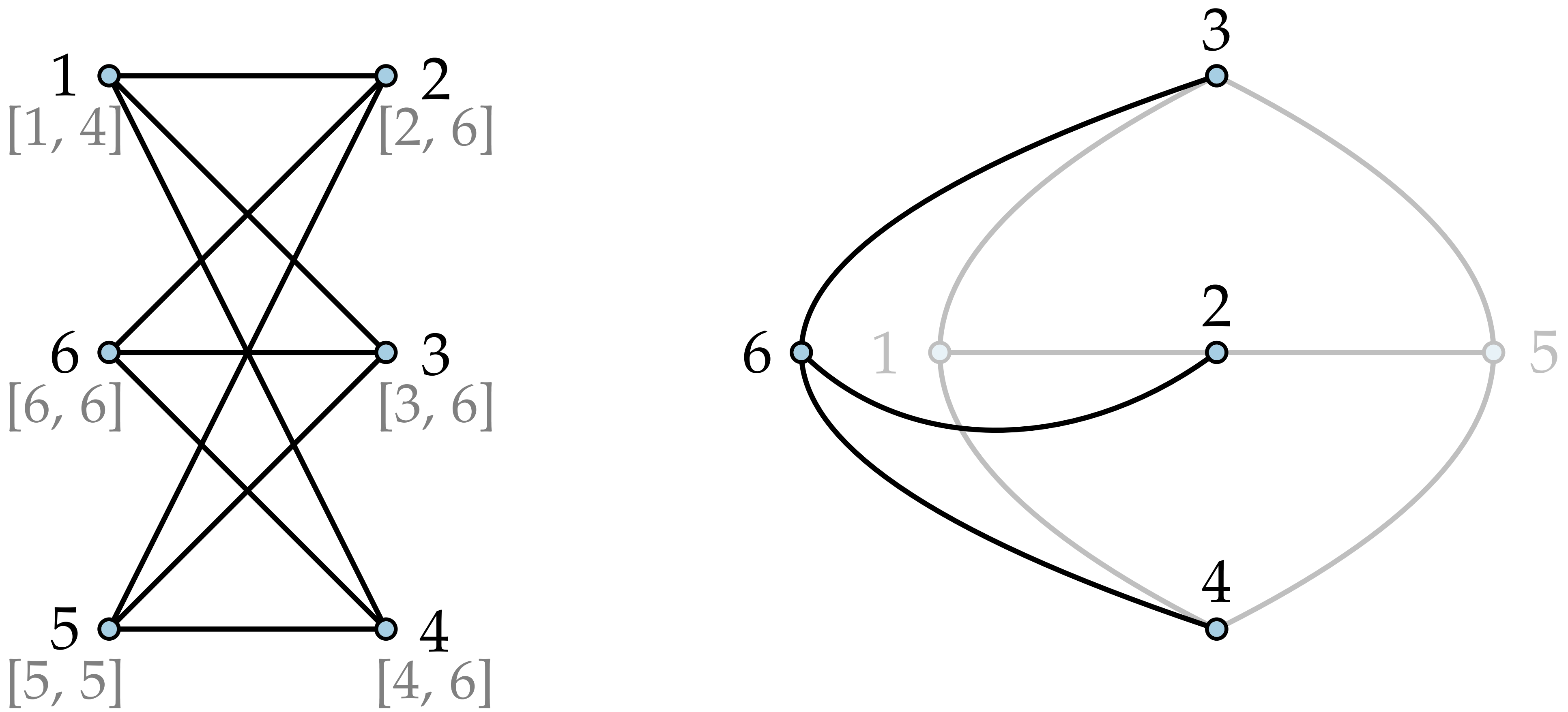

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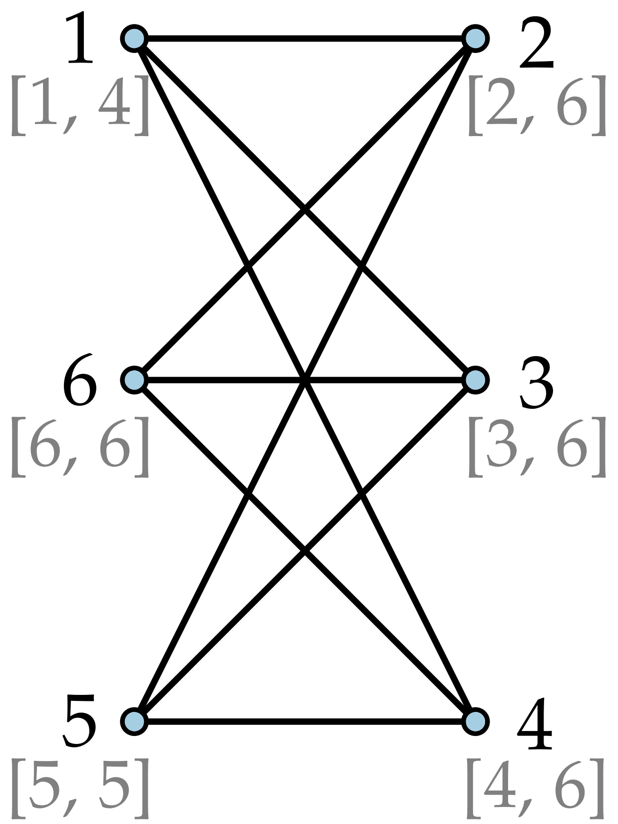
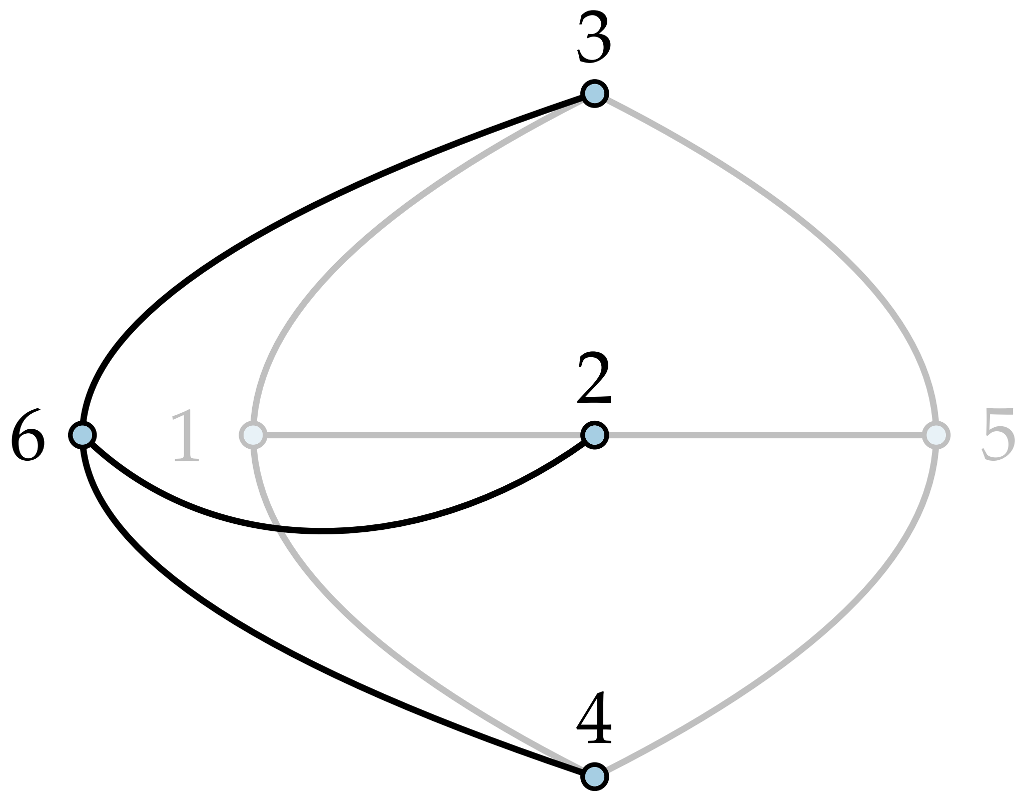
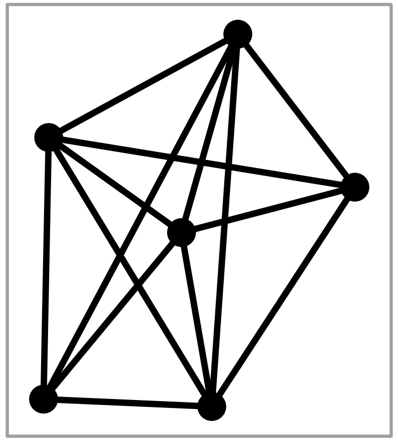




Does a given graph admit a storyplan (i.e., a sequence of planar partial drawings)?

3. Compatible Spanning Trees in Simple Drawings of K_n

A drawing of K_6:



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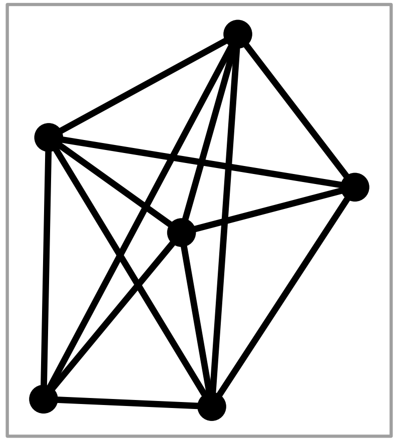

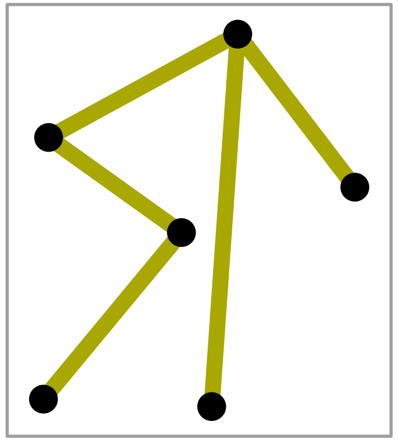

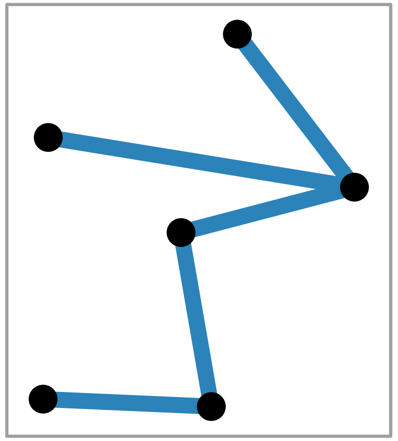

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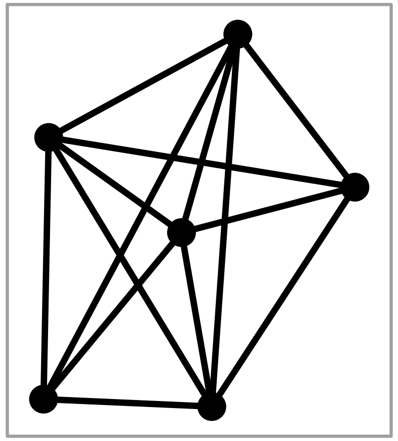

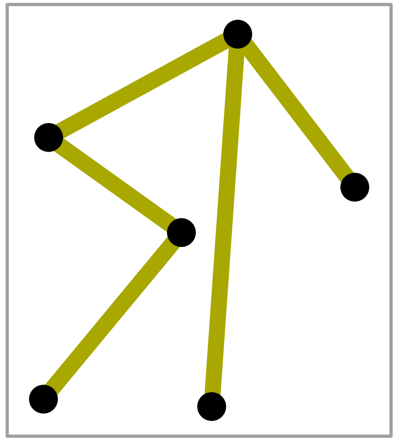

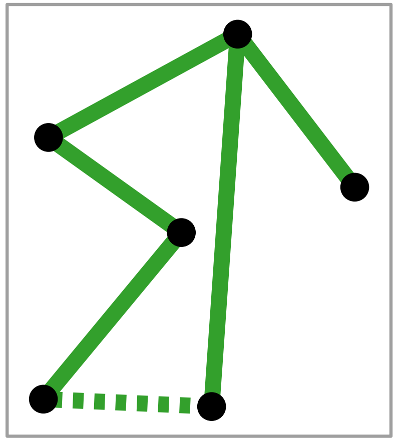

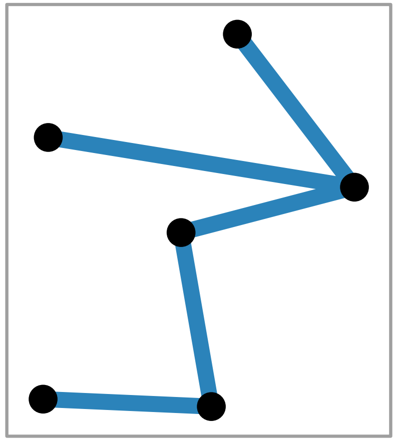

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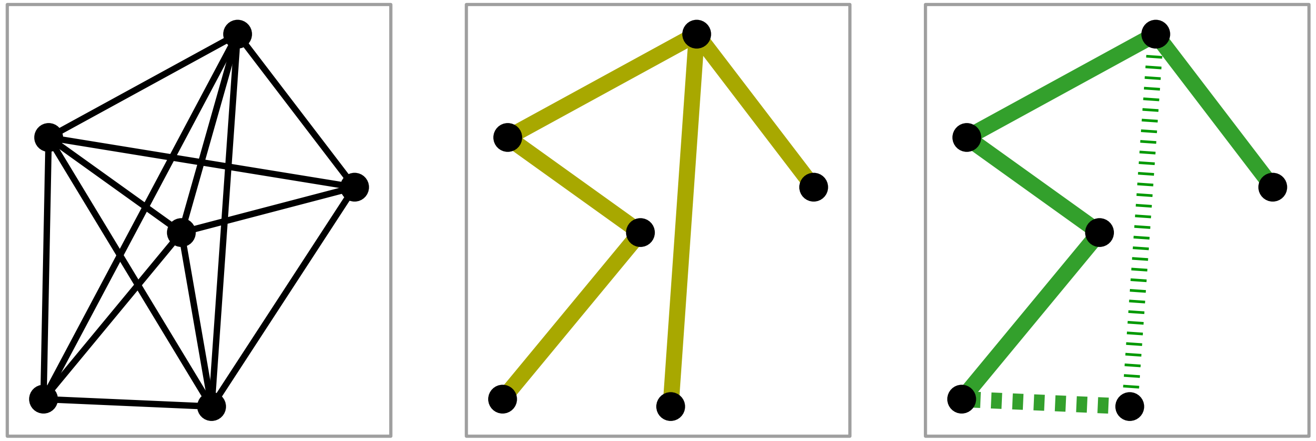

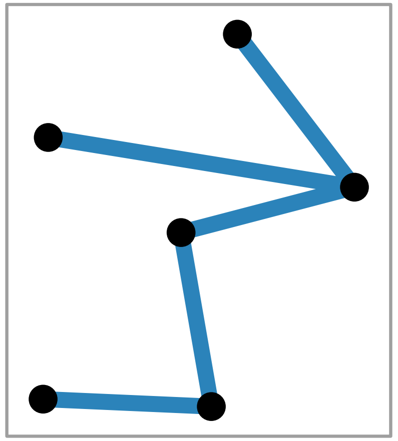

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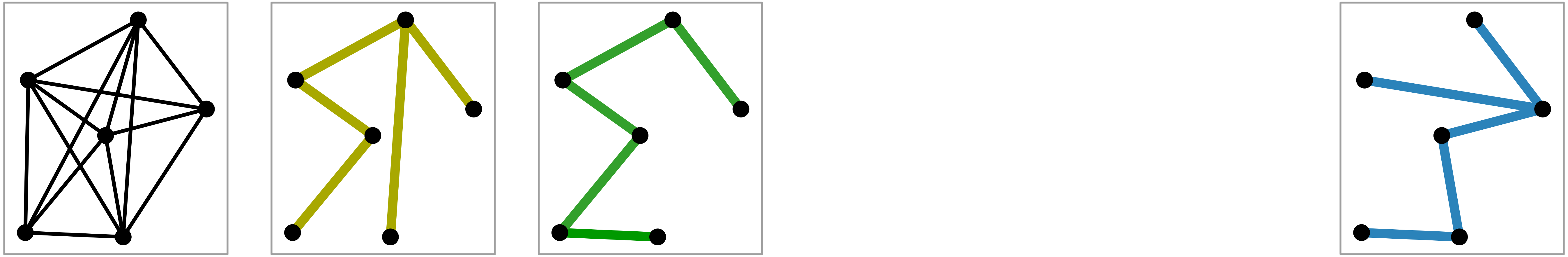

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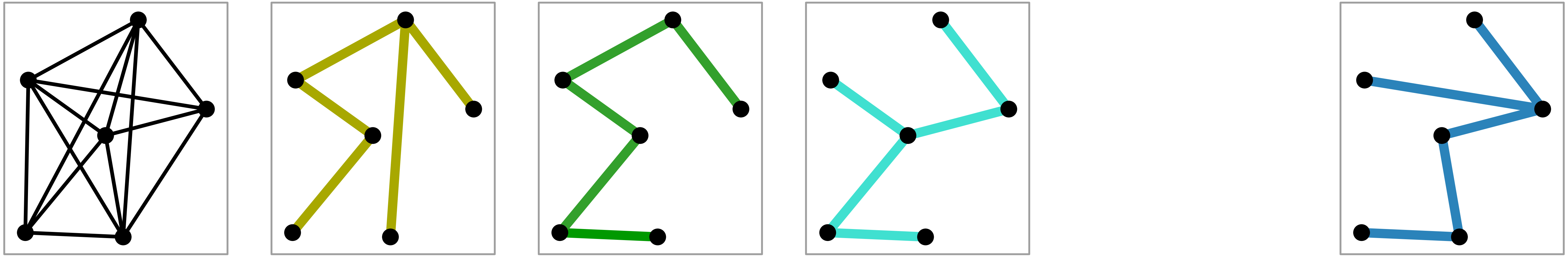

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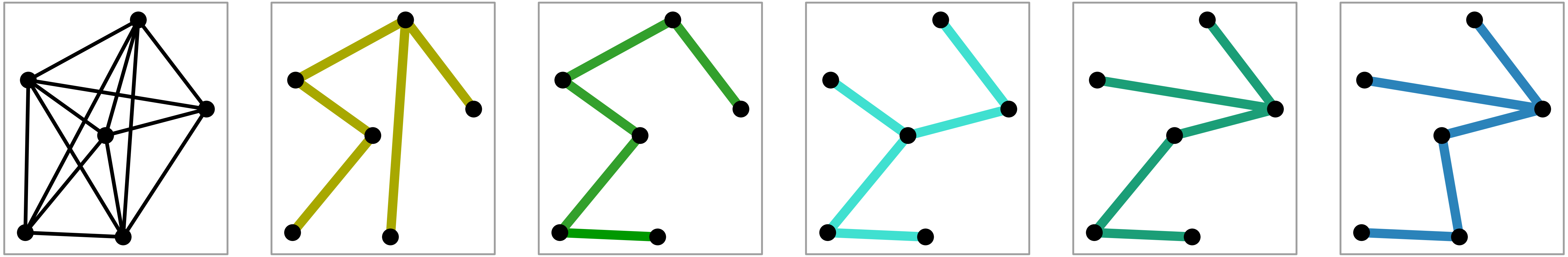

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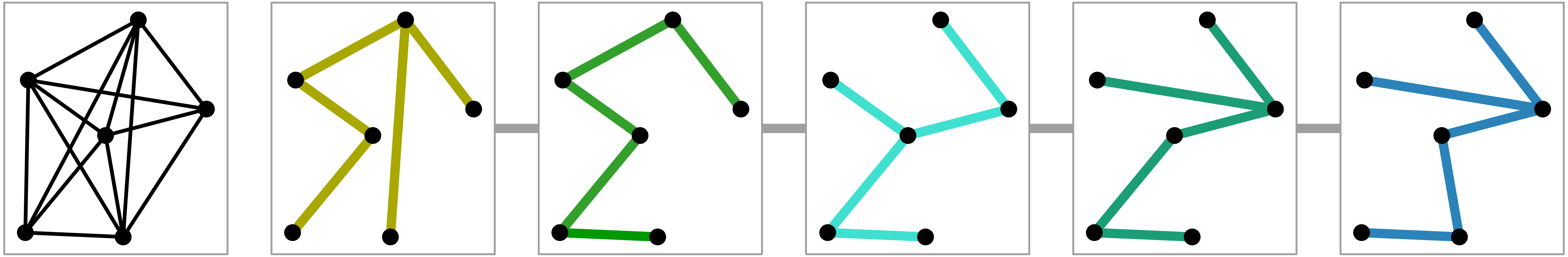

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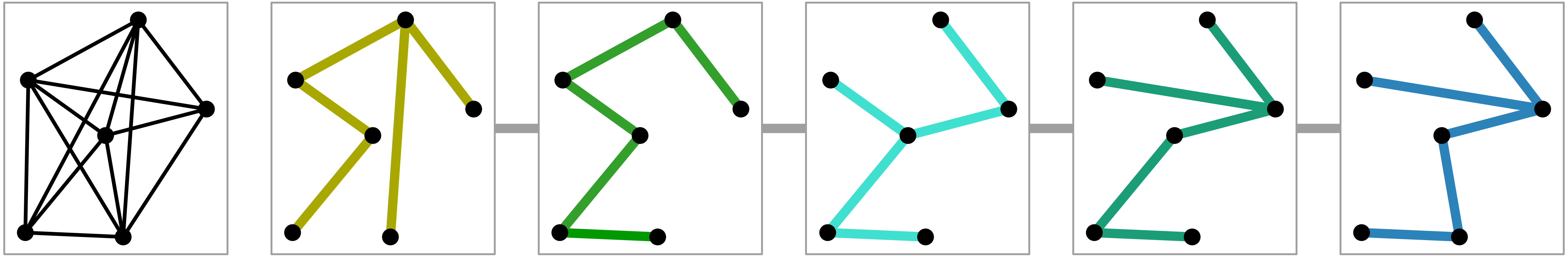

Theorem 1. Let D be a cylindrical, monotone, or strongly c-monotone drawing of K_n, and let $\mathcal{T}_D$ be the set of all plane spanning trees of D. Then, the compatibility graph $\mathcal{F}(\mathcal{T}_D)$ is connected.

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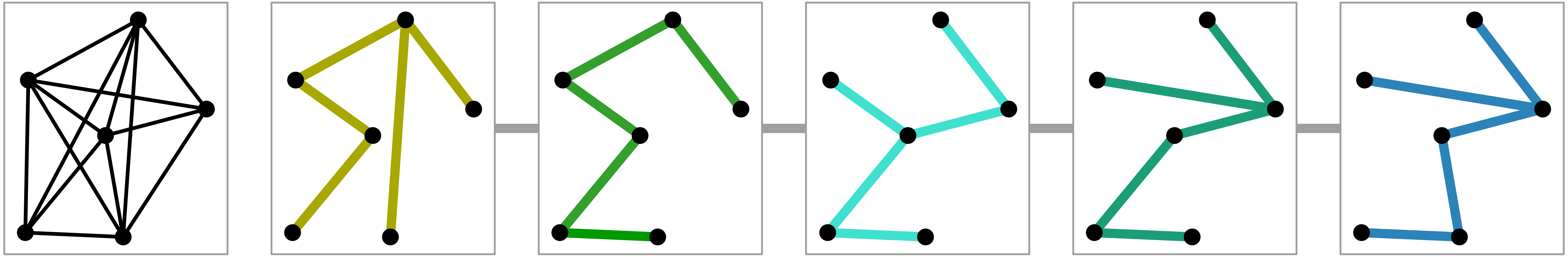

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Theorem 2. Let D be a simple drawing of K_n, and let $\mathcal{T}_D^*$ be the set of all plane spanning stars, double stars, and twin stars on D. Then, the compatibility graph $\mathcal{F}(\mathcal{T}_D^*)$ is connected.

4. Empty Triangles in Generalized Twisted Drawings

In einer **einfachen** Zeichnung teilt sich jedes Kantenpaar ≤ 1 Punkt.

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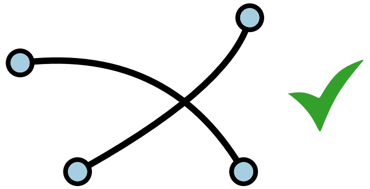

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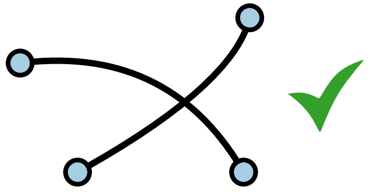

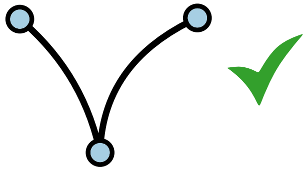

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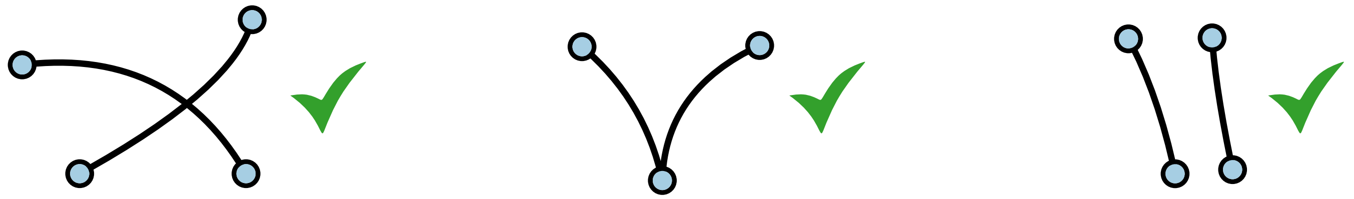

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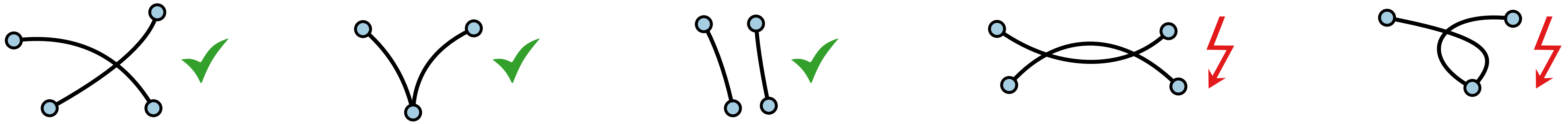

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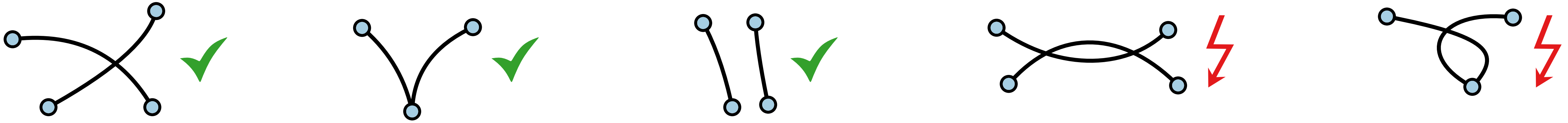
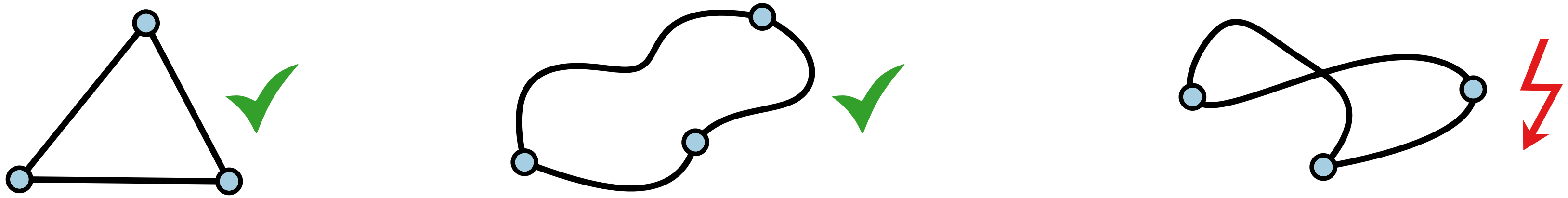


$\Rightarrow$ jedes **Dreieck** (Kreis der Länge 3) ist frei von Selbstüberschneidungen



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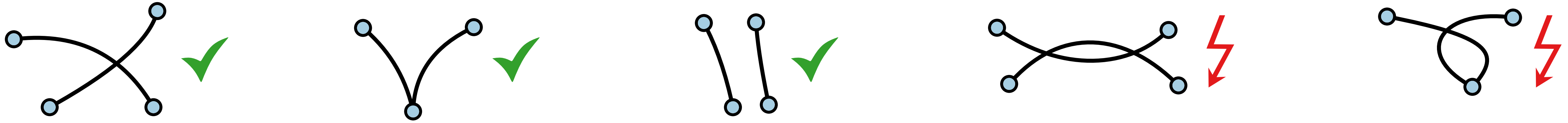

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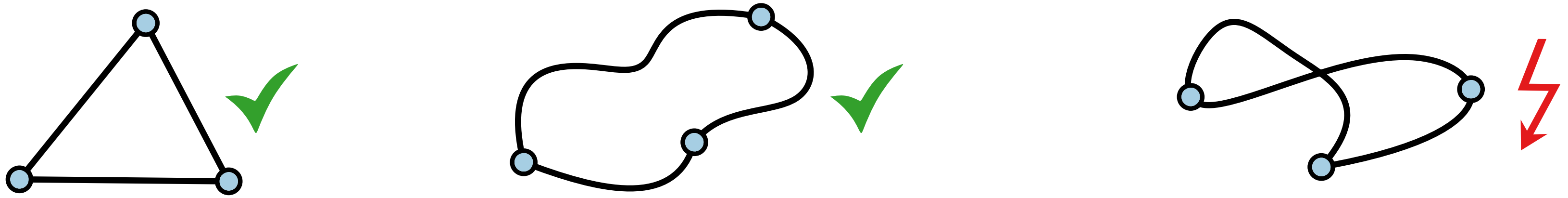
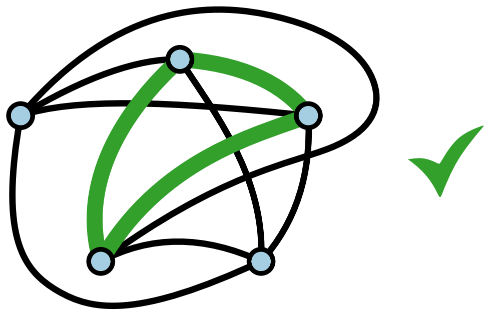


Ein Dreieck ist **leer**, falls sein Inneres oder sein Äußeres keinen Knoten enthält.



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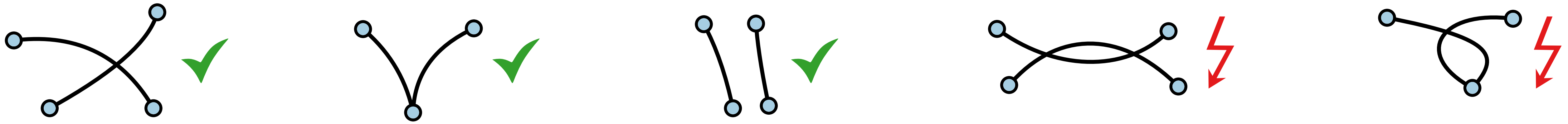

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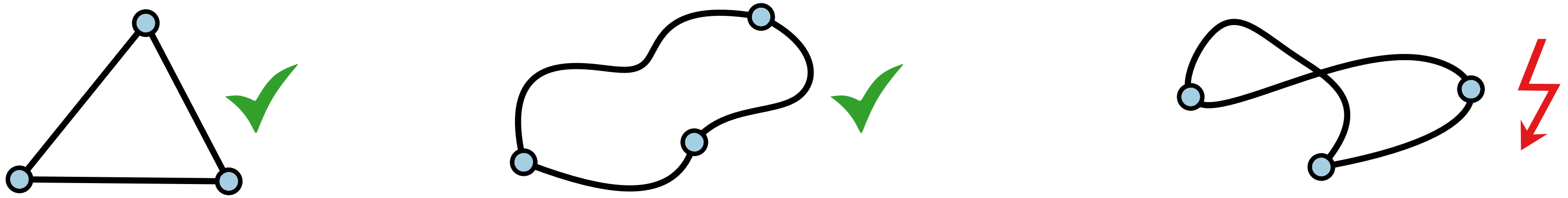

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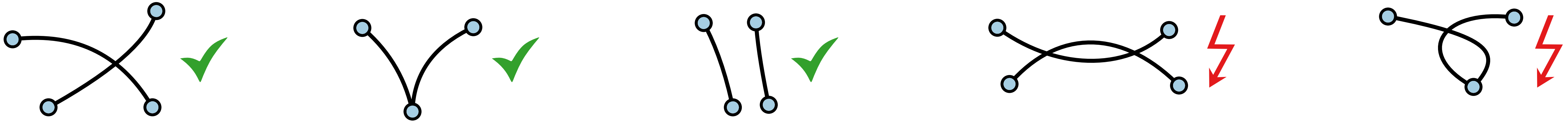

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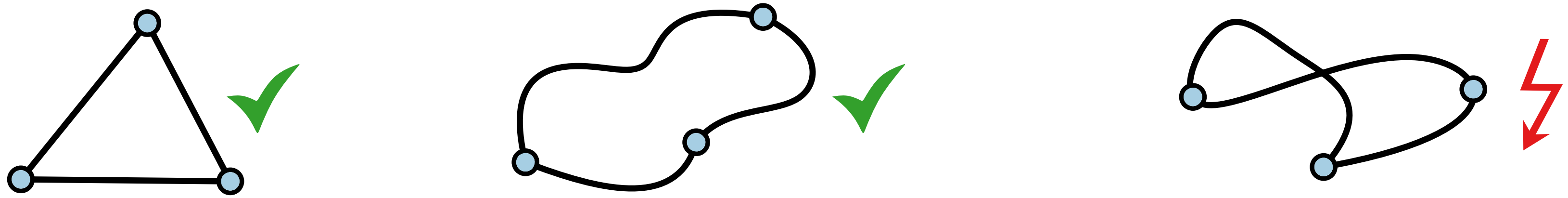

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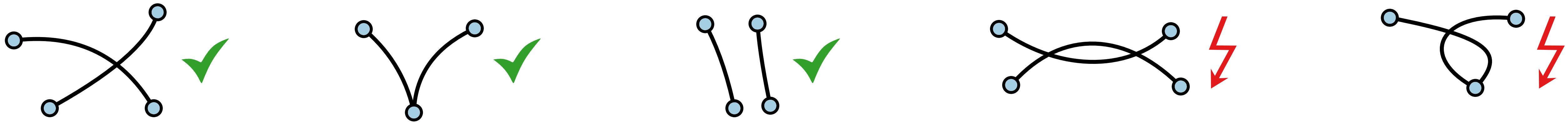

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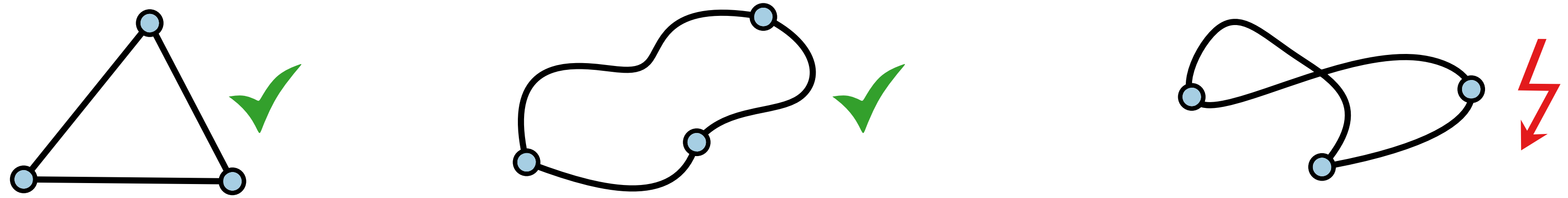

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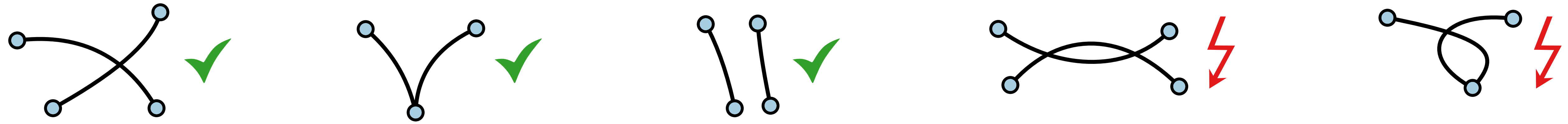
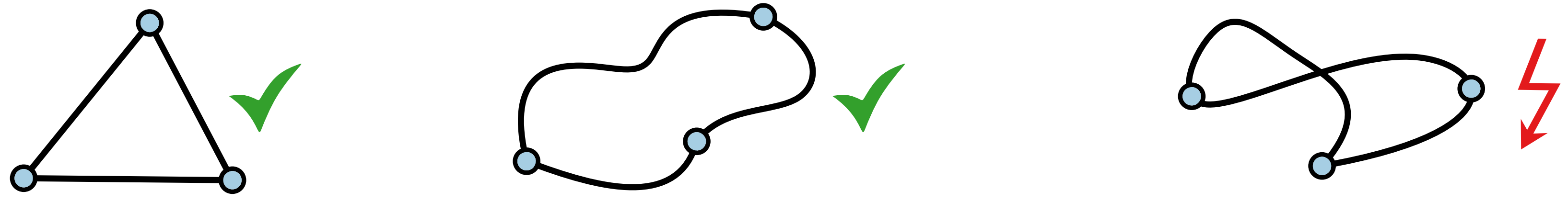
Vermutung: Jede einfache Zeichnung von K_n hat $\geq 2n - 4$ leere Dreicke.

4. Empty Triangles in Generalized Twisted Drawings

In einer **einfachen** Zeichnung teilt sich jedes Kantenpaar ≤ 1 Punkt.



$\Rightarrow$ jedes **Dreieck** (Kreis der Länge 3) ist frei von Selbstüberschneidungen

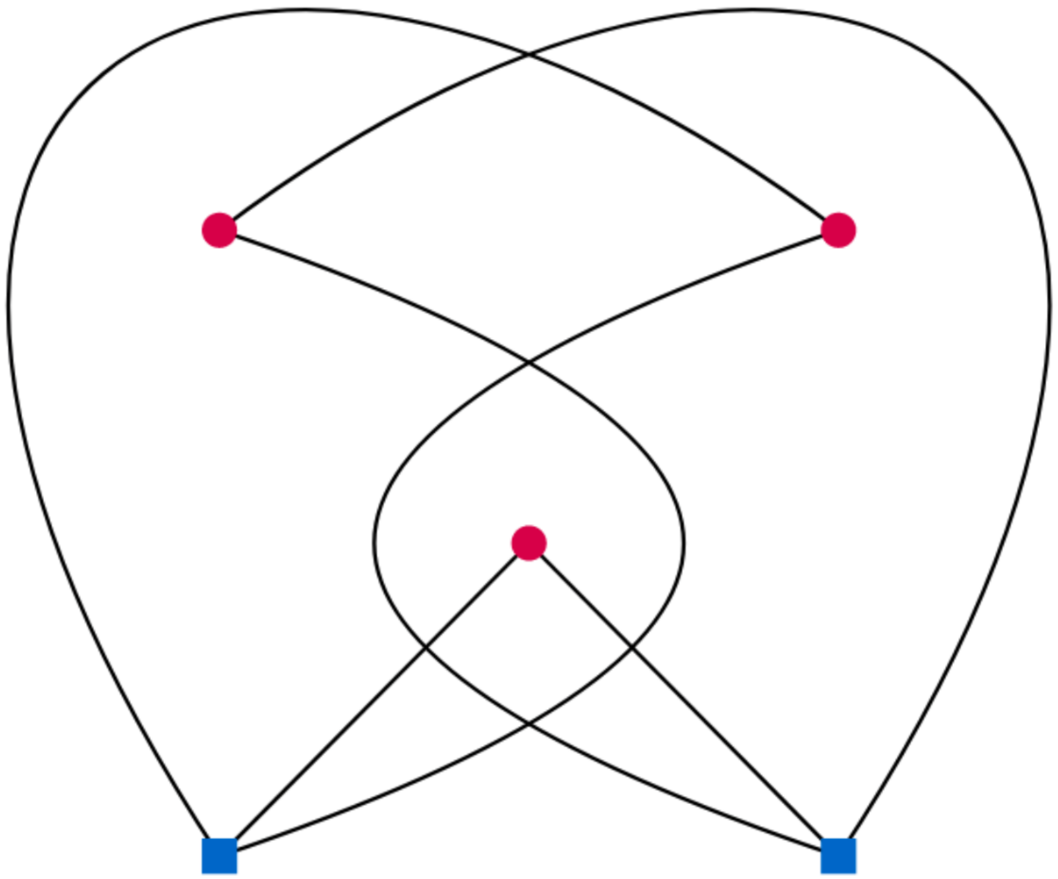


Ein Dreieck ist **leer**, falls sein Inneres oder sein Äußeres keinen Knoten enthält.

Vermutung: Jede einfache Zeichnung von K_n hat $\geq 2n - 4$ leere Dreiecke.

Hier: Beweis für den Spezialfall von **verallgemeinert verdrehten** Zeichnungen.

5. Shooting Stars in Simple Drawings of $K_{m,n}$



Does this drawing of $K_{2,3}$ contain a plane spanning tree?

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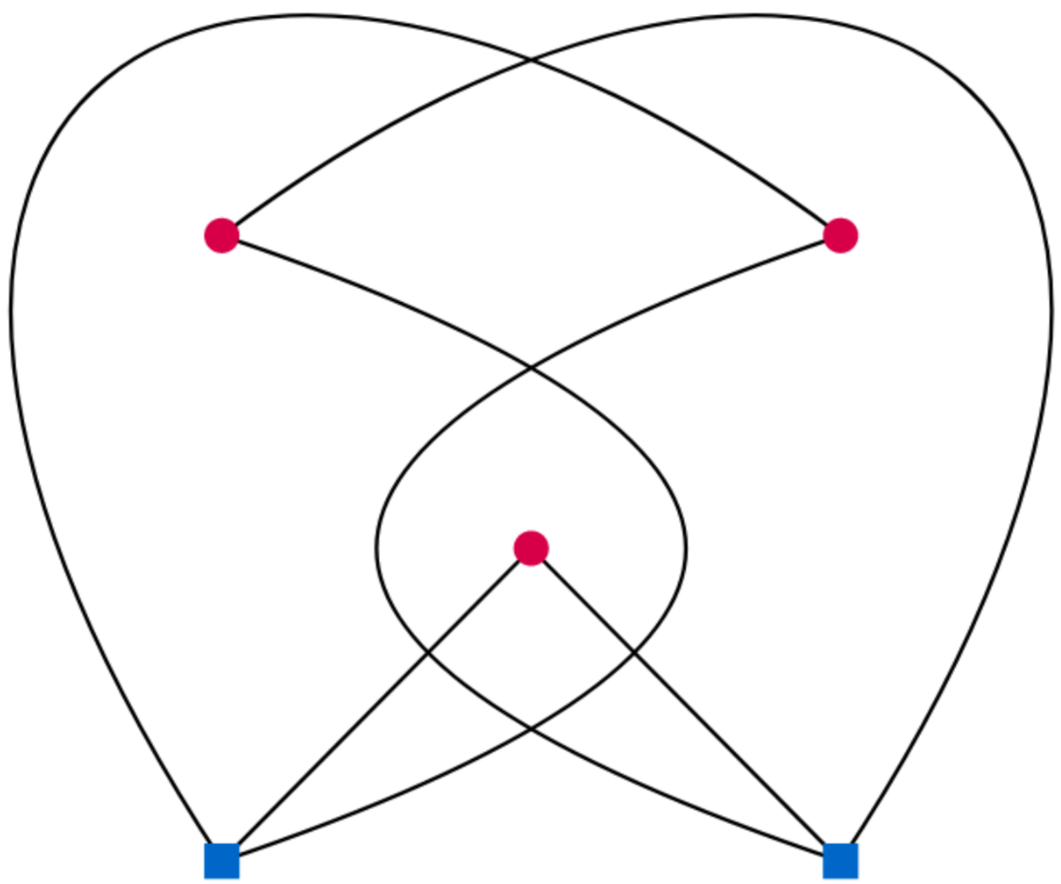

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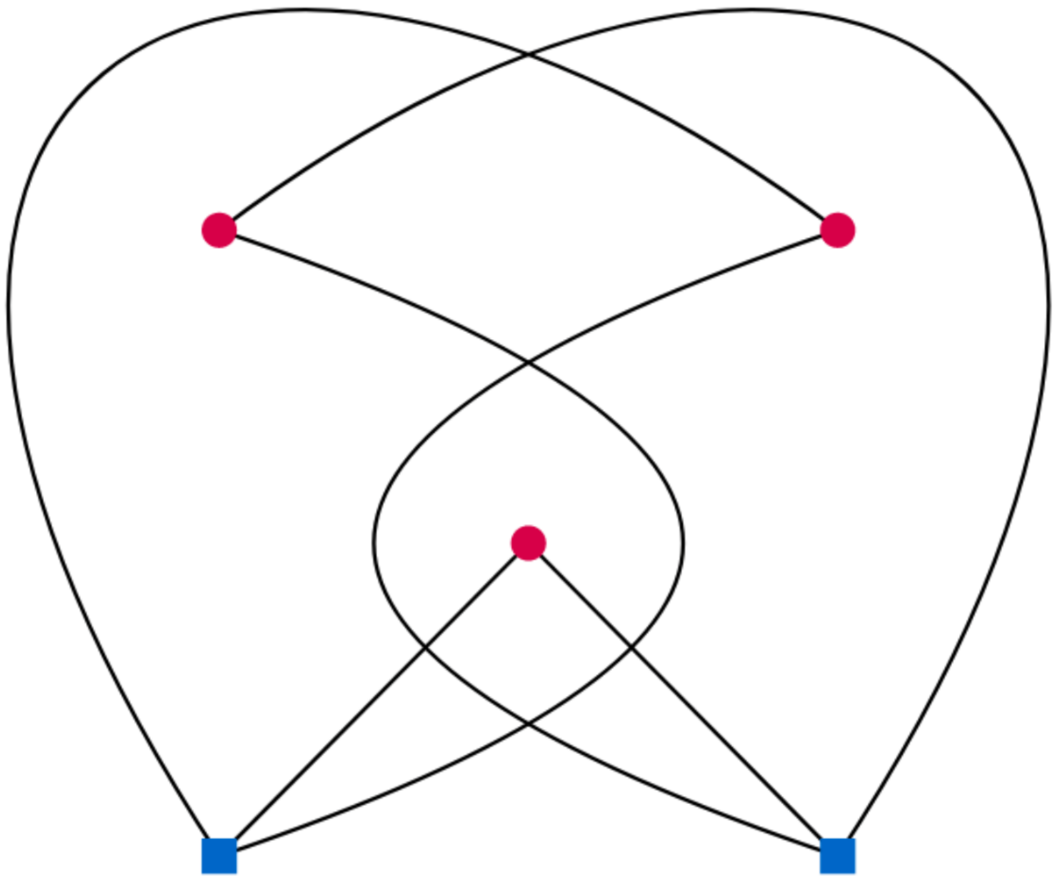

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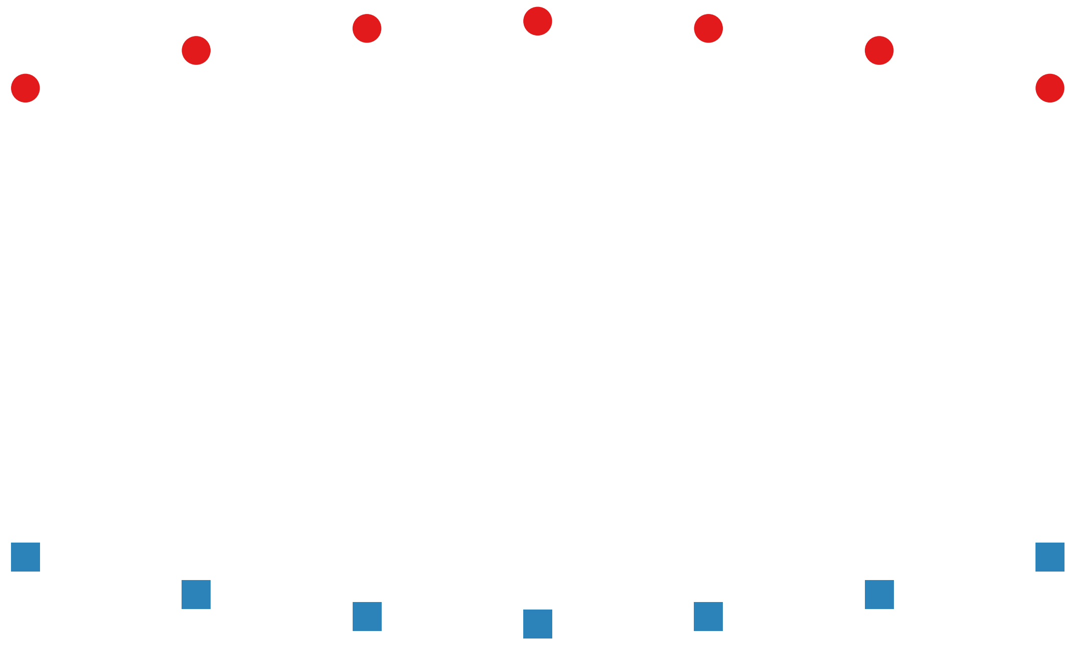

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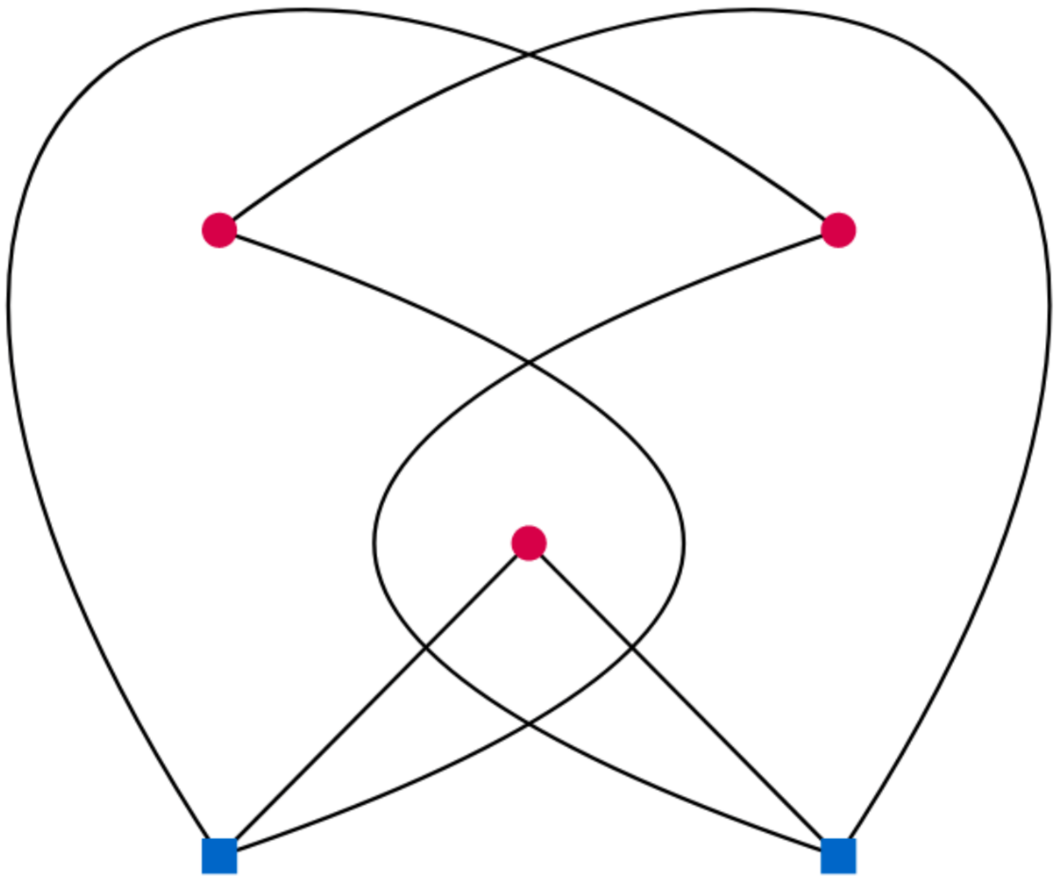

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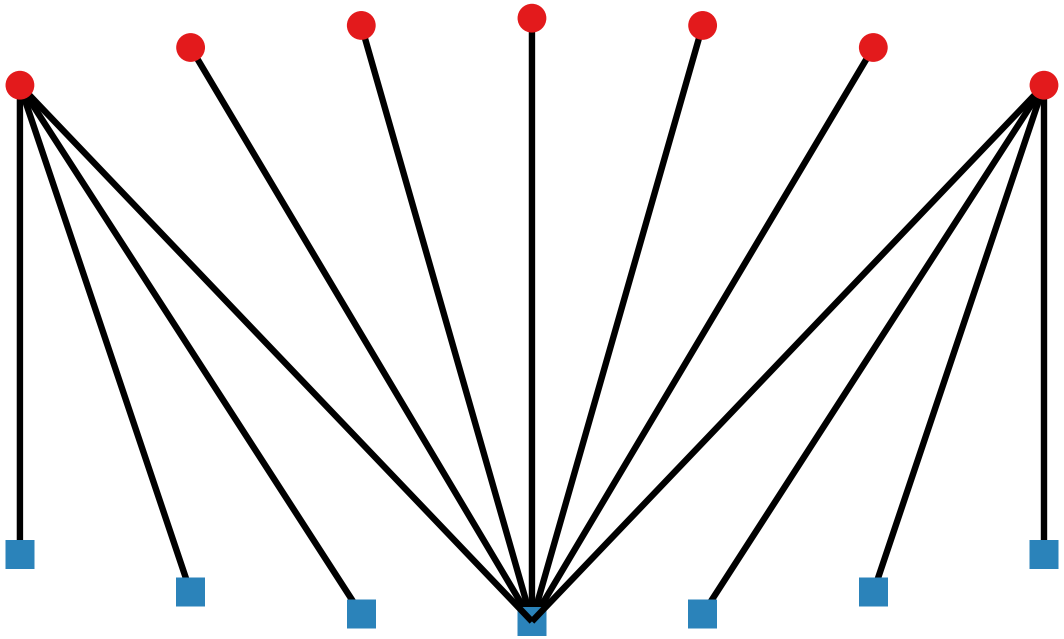

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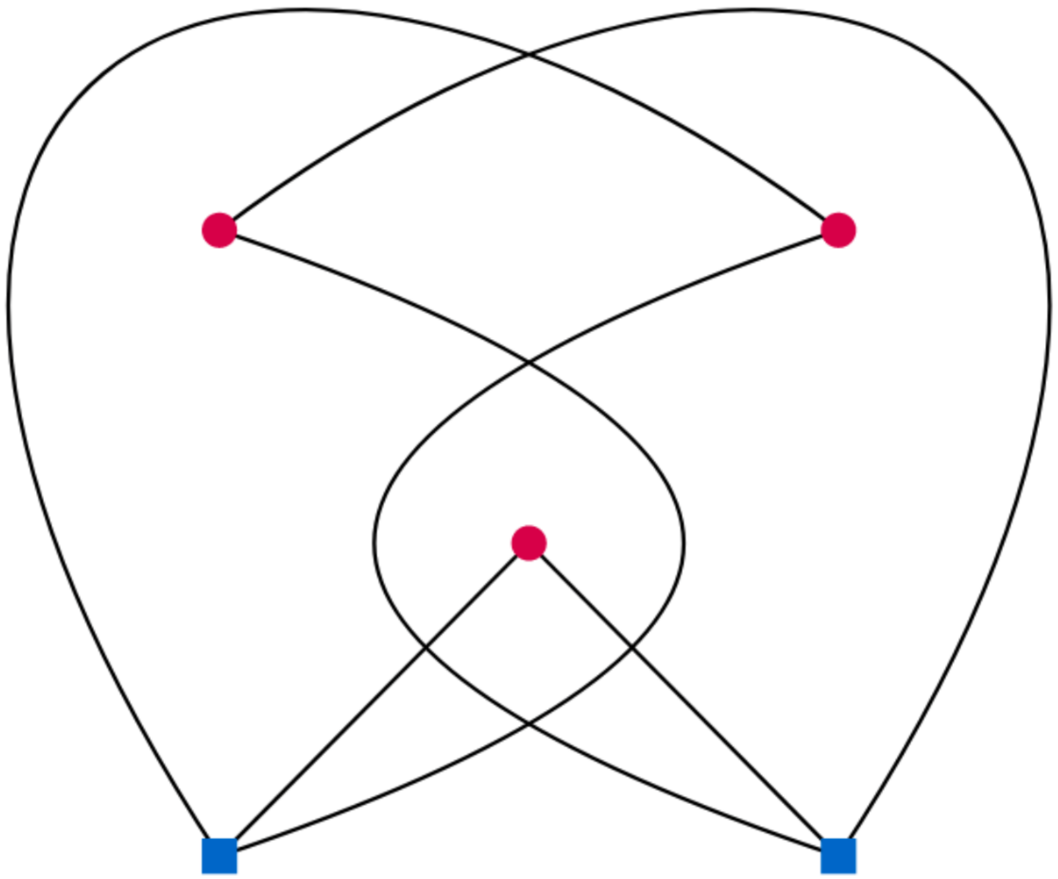

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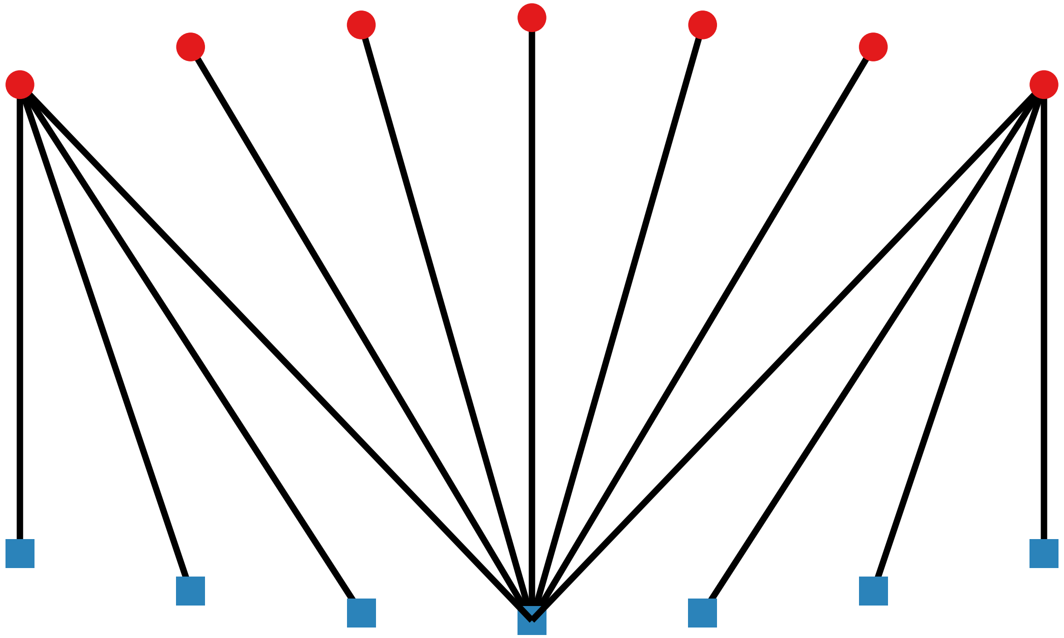

Thm. Let D be a simple drawing of $K_{m,n}$, and let r be an arbitrary vertex of $K_{m,n}$. Then D contains a shooting star rooted at r.

6. Mutual Witness Gabriel Drawings

Given two vertex-disjoint graph drawings Γ_0 and Γ_1:

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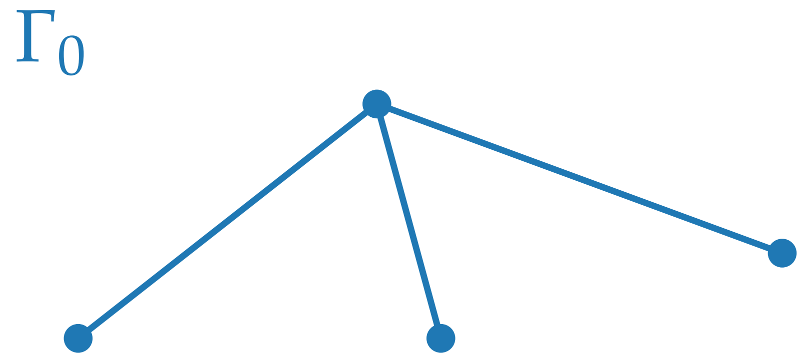

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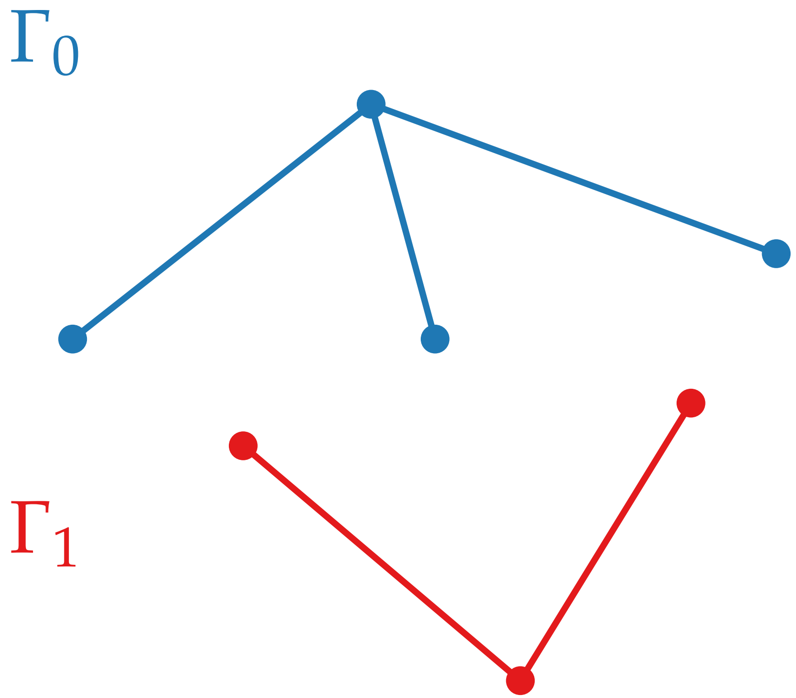

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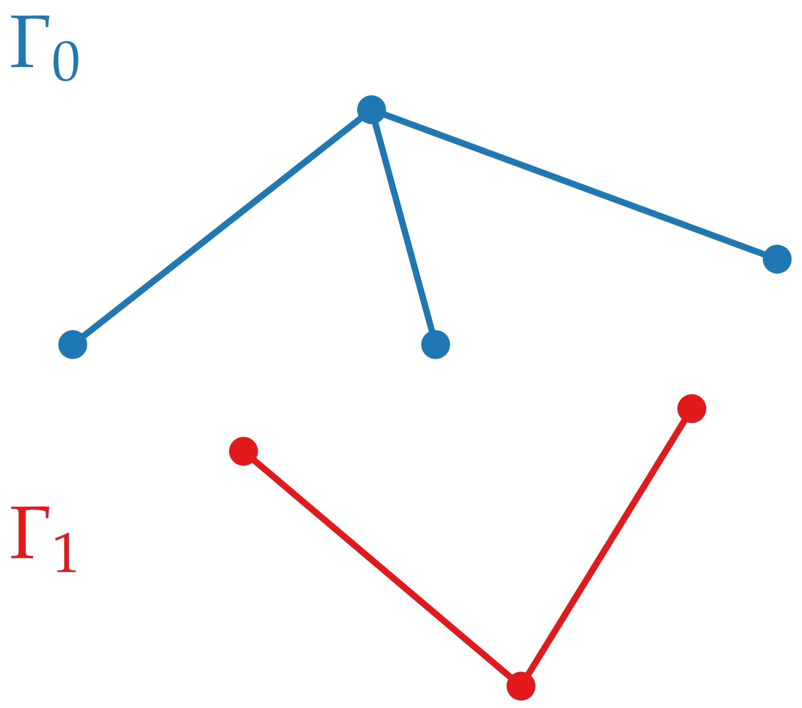

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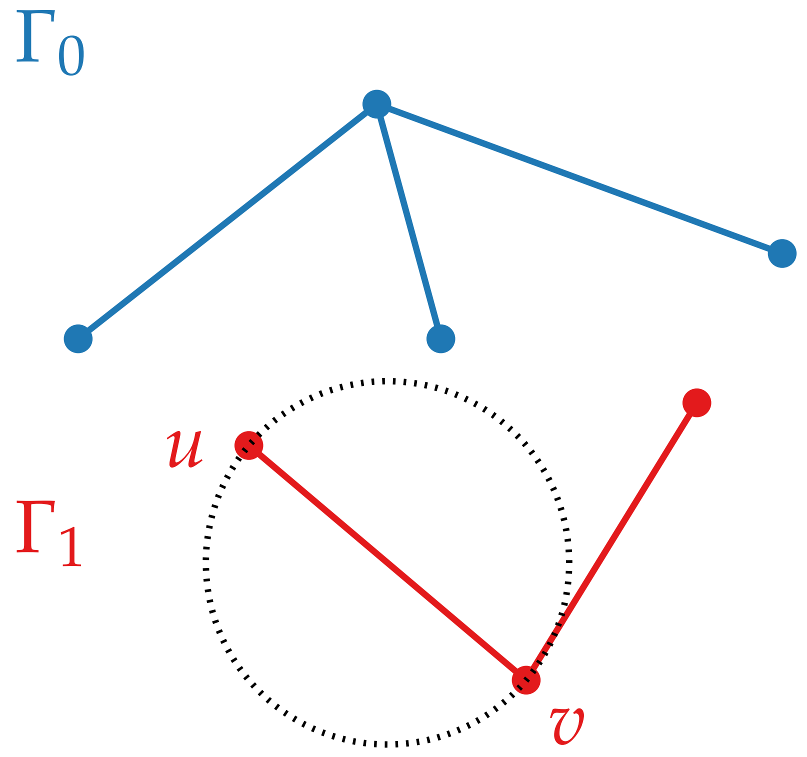

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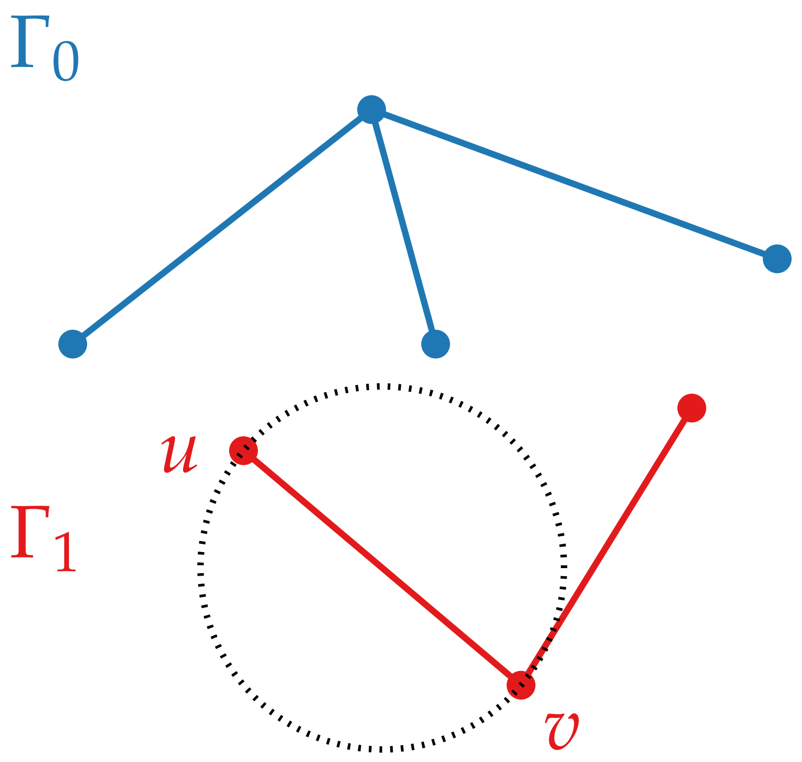

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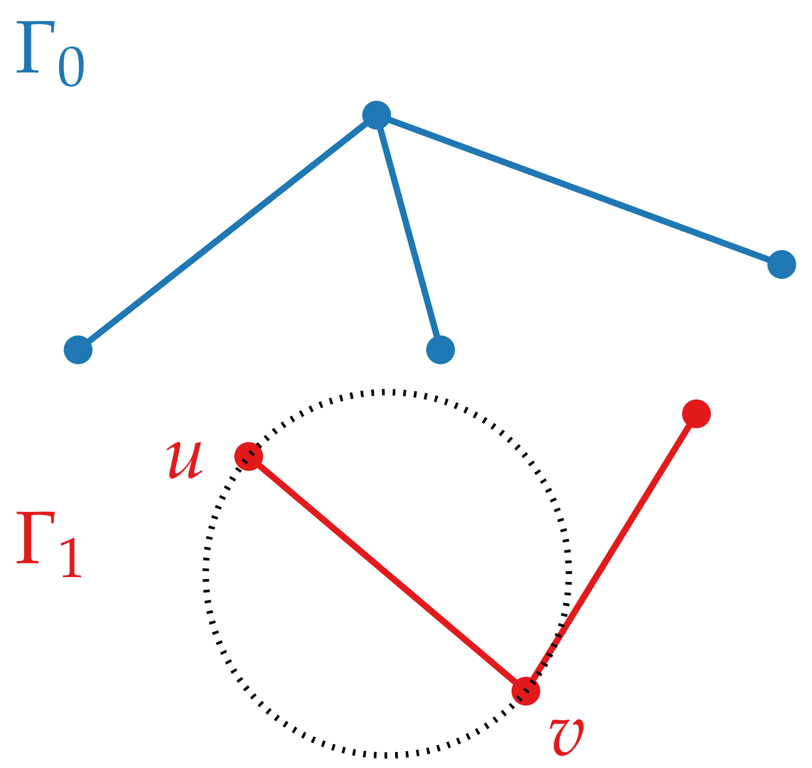

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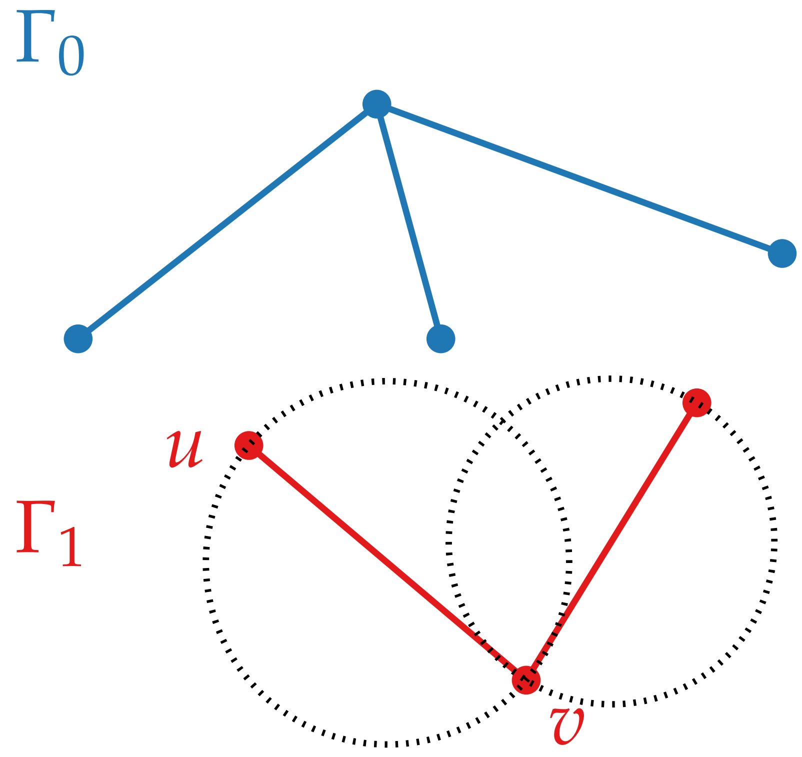

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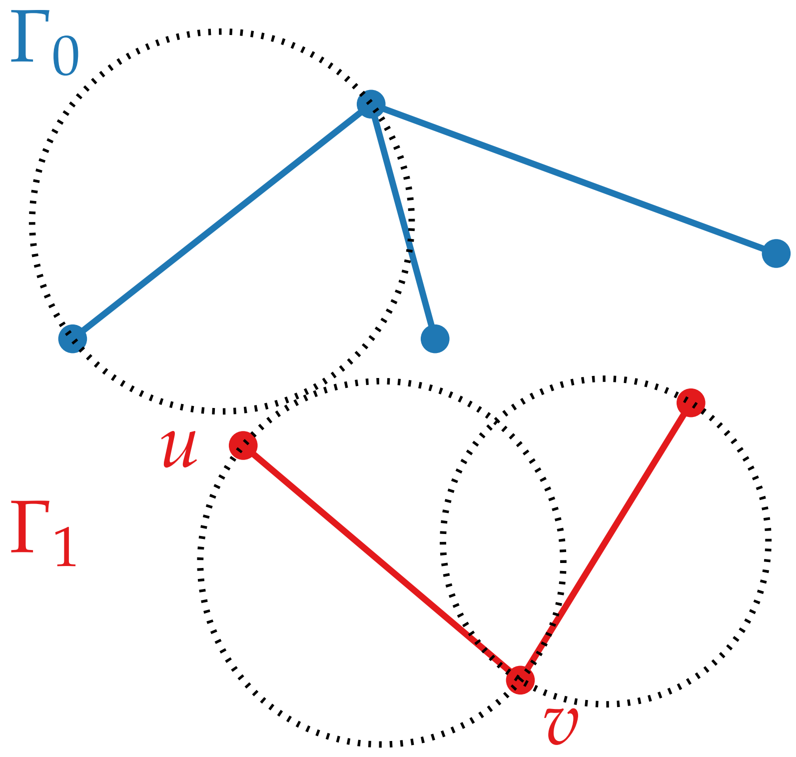

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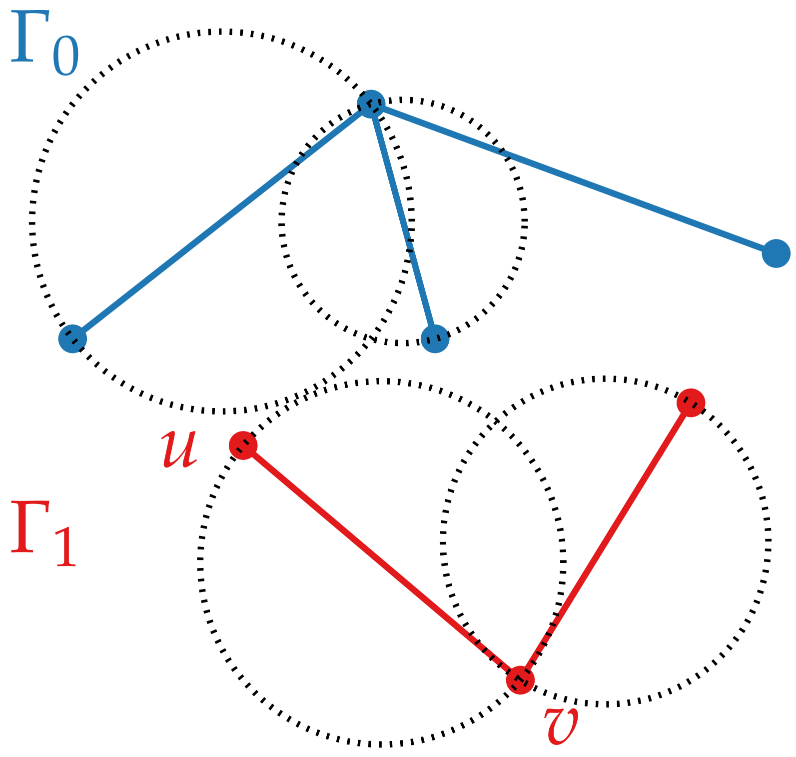

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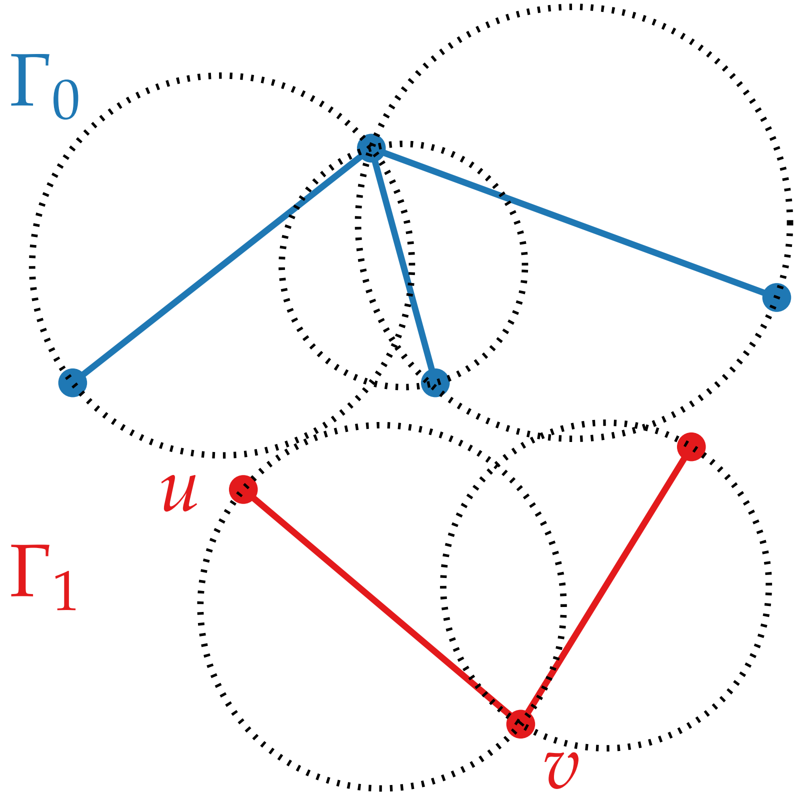

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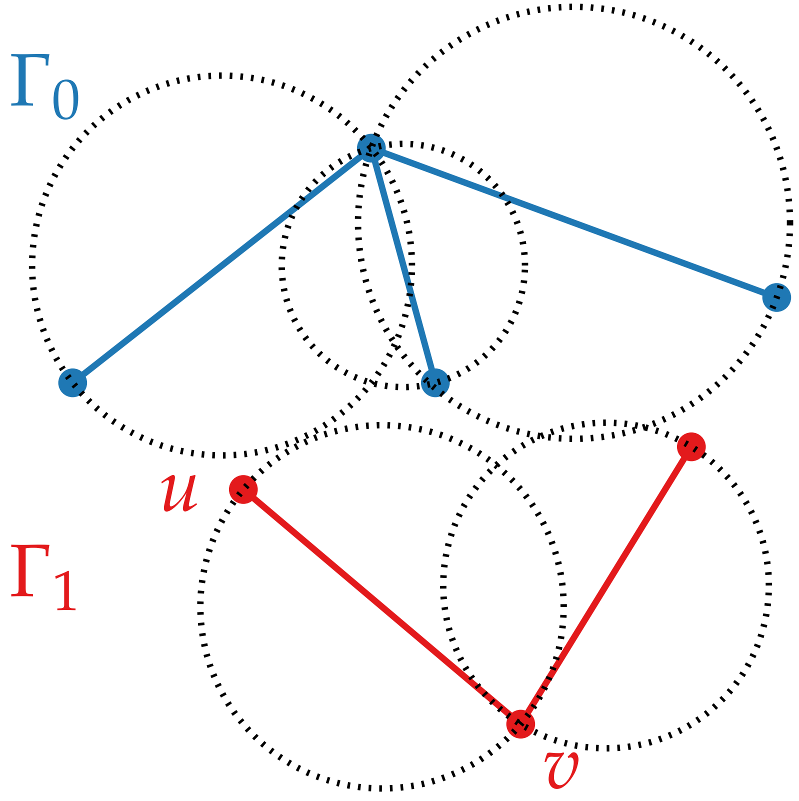

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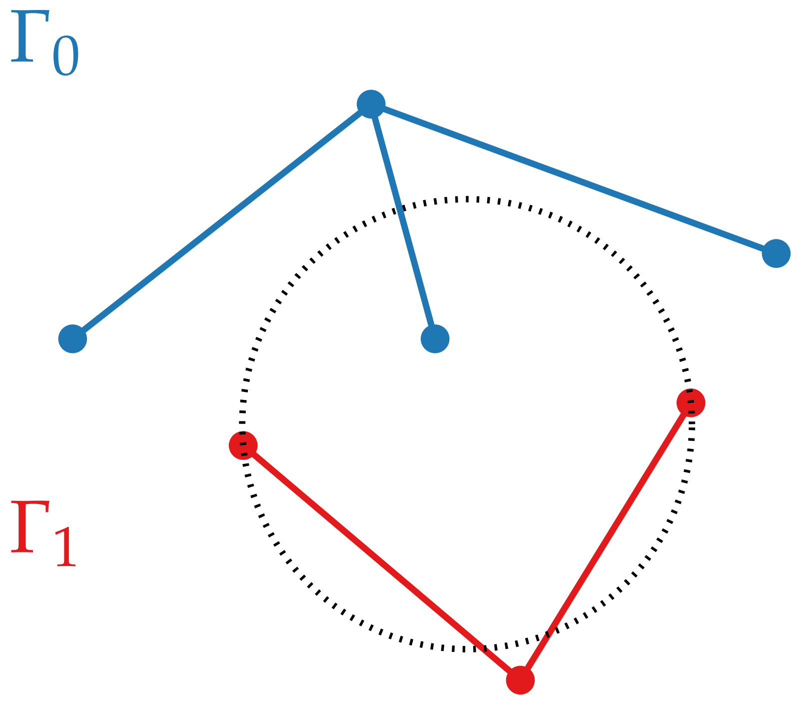

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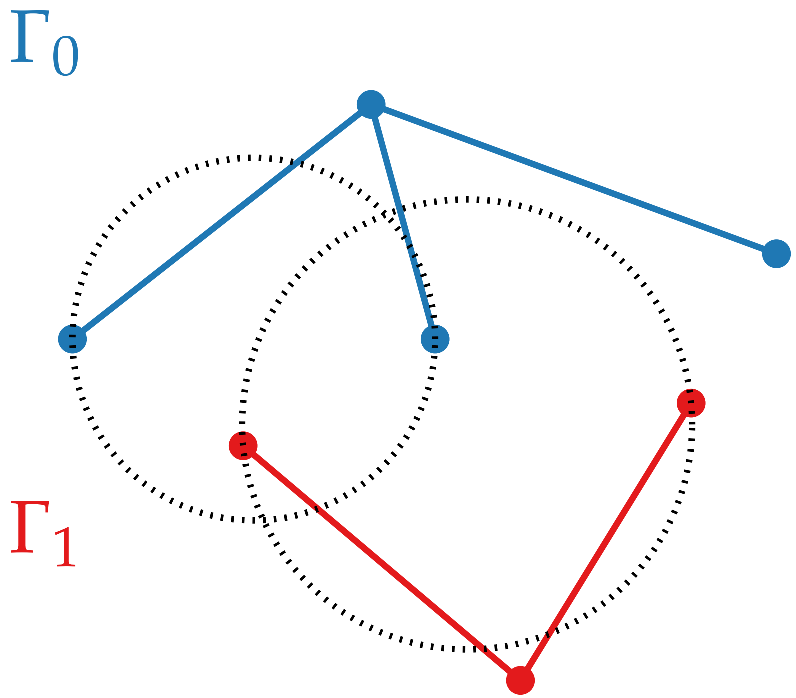

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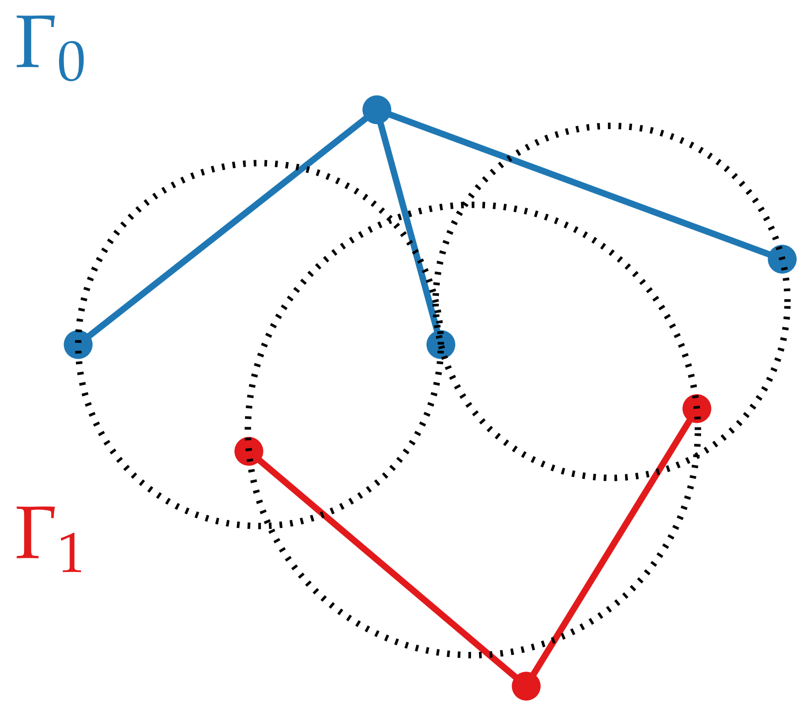

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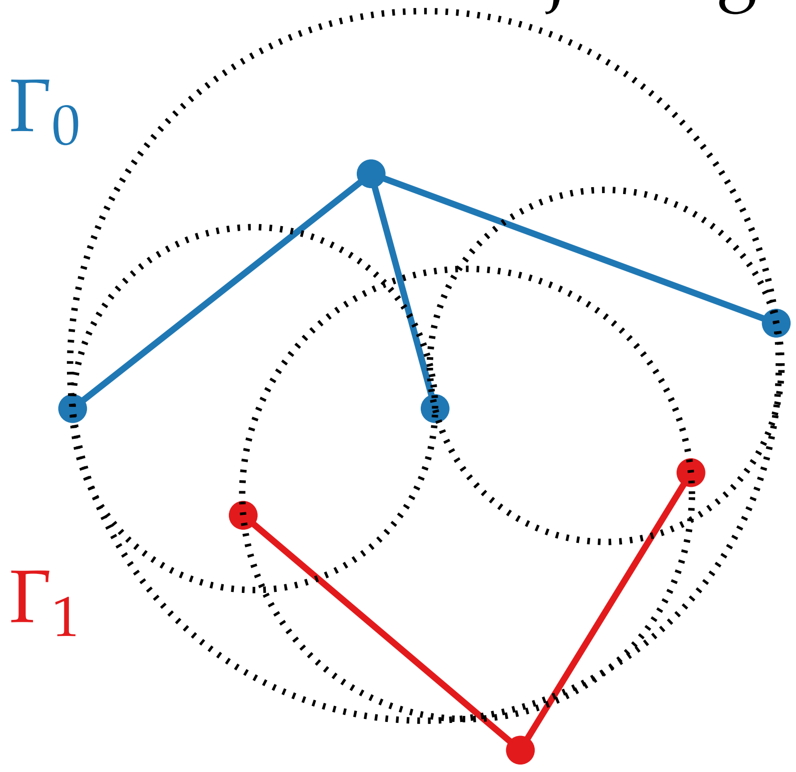

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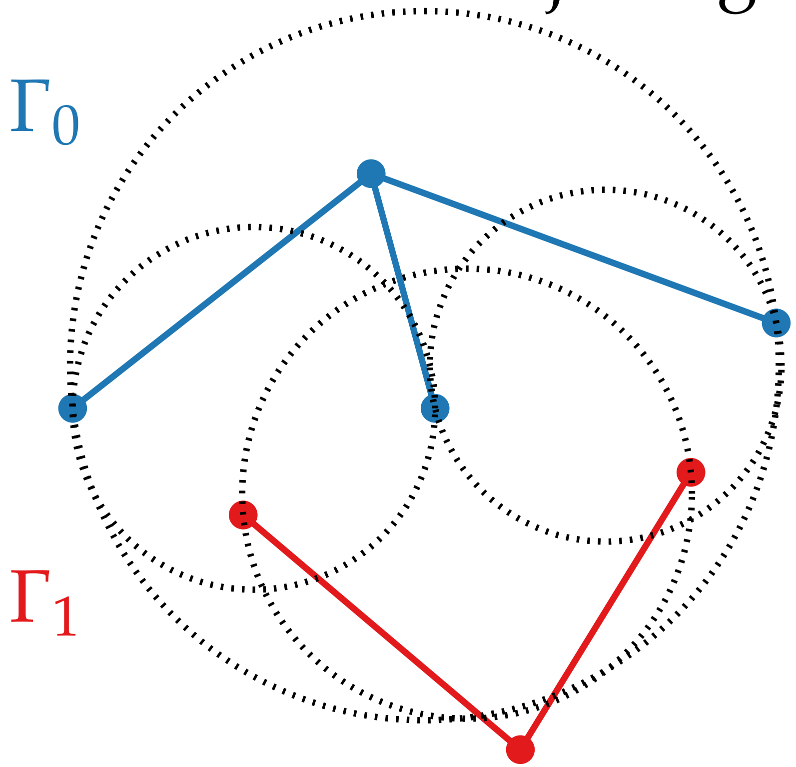

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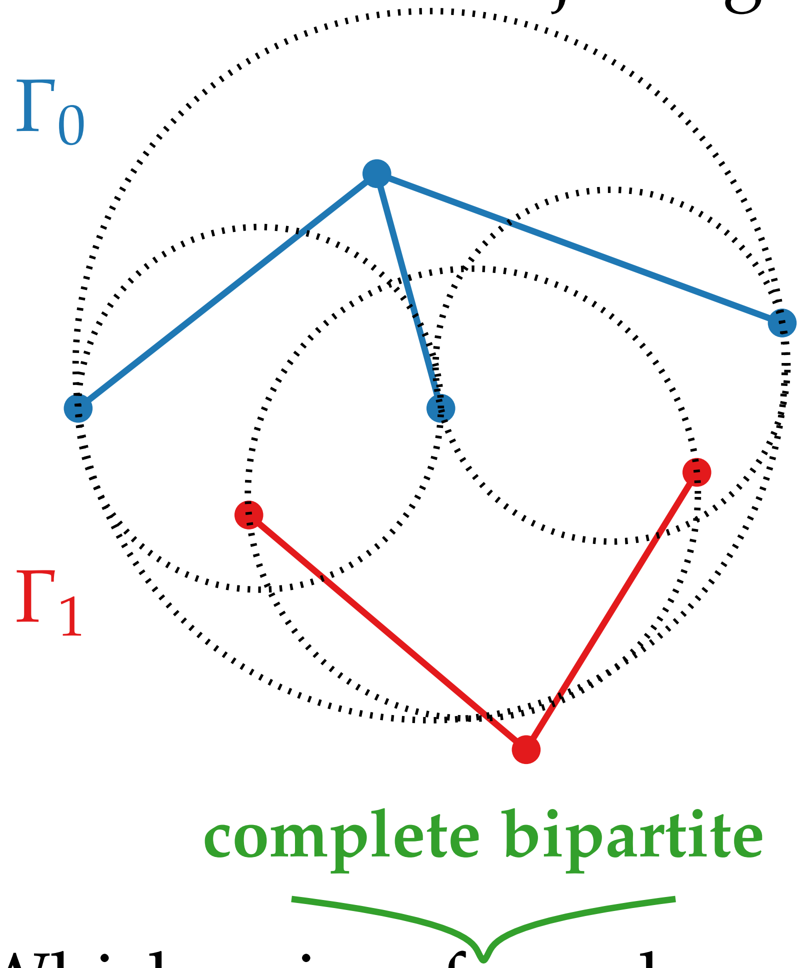

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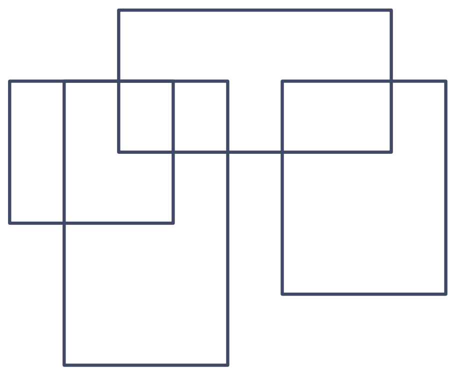
7. FORBID: Fast Overlap Removal By Gradient Descent

Eingabe: Hindernisse (achsenparallele Rechtecke), potentiell überlappend



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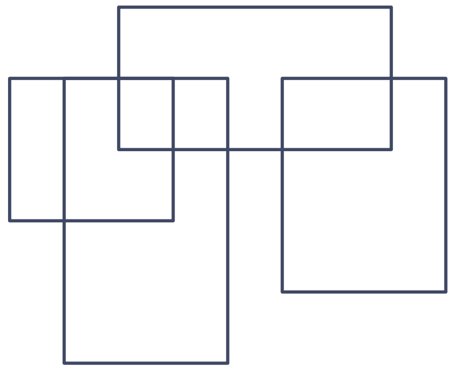

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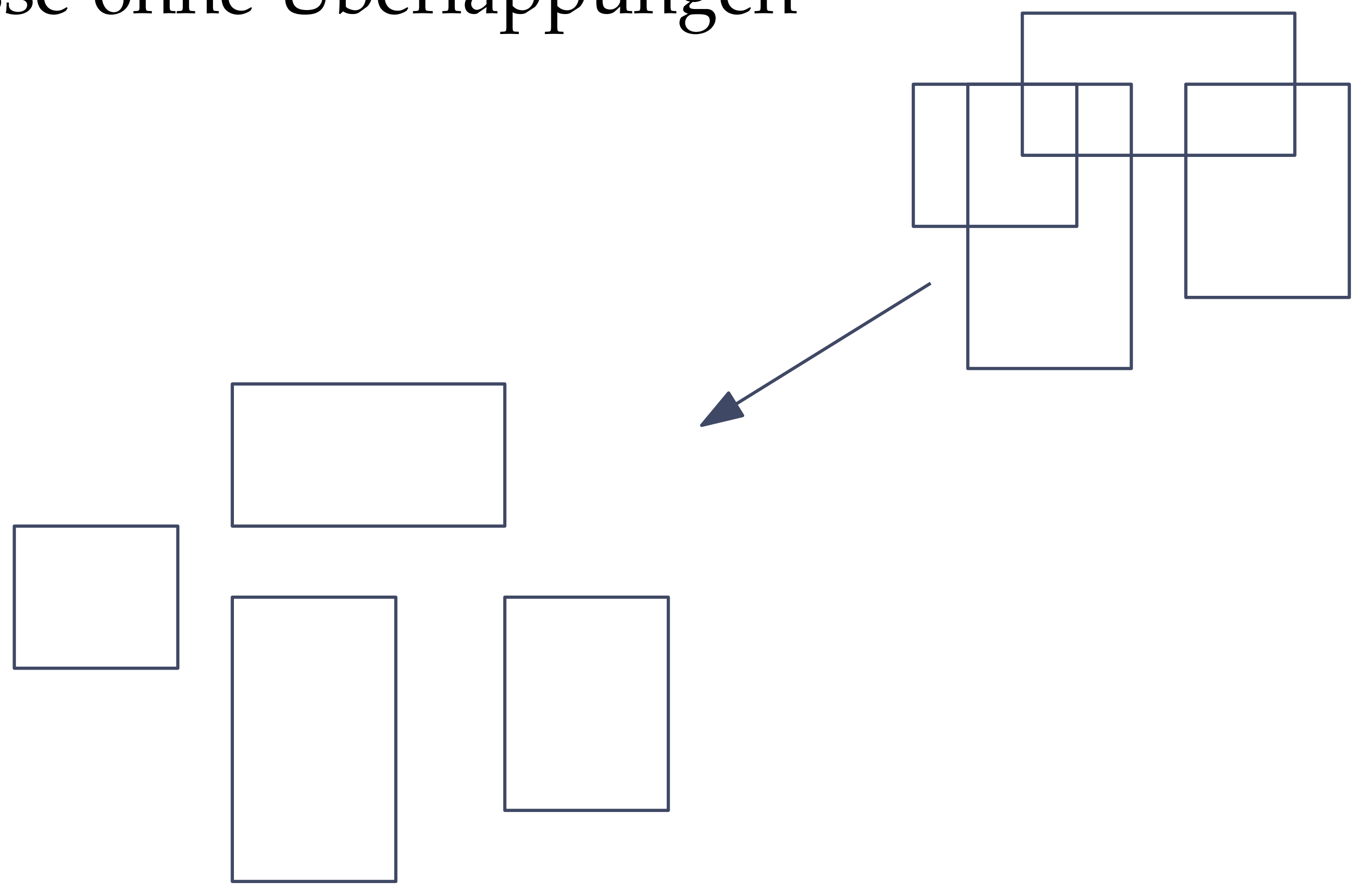

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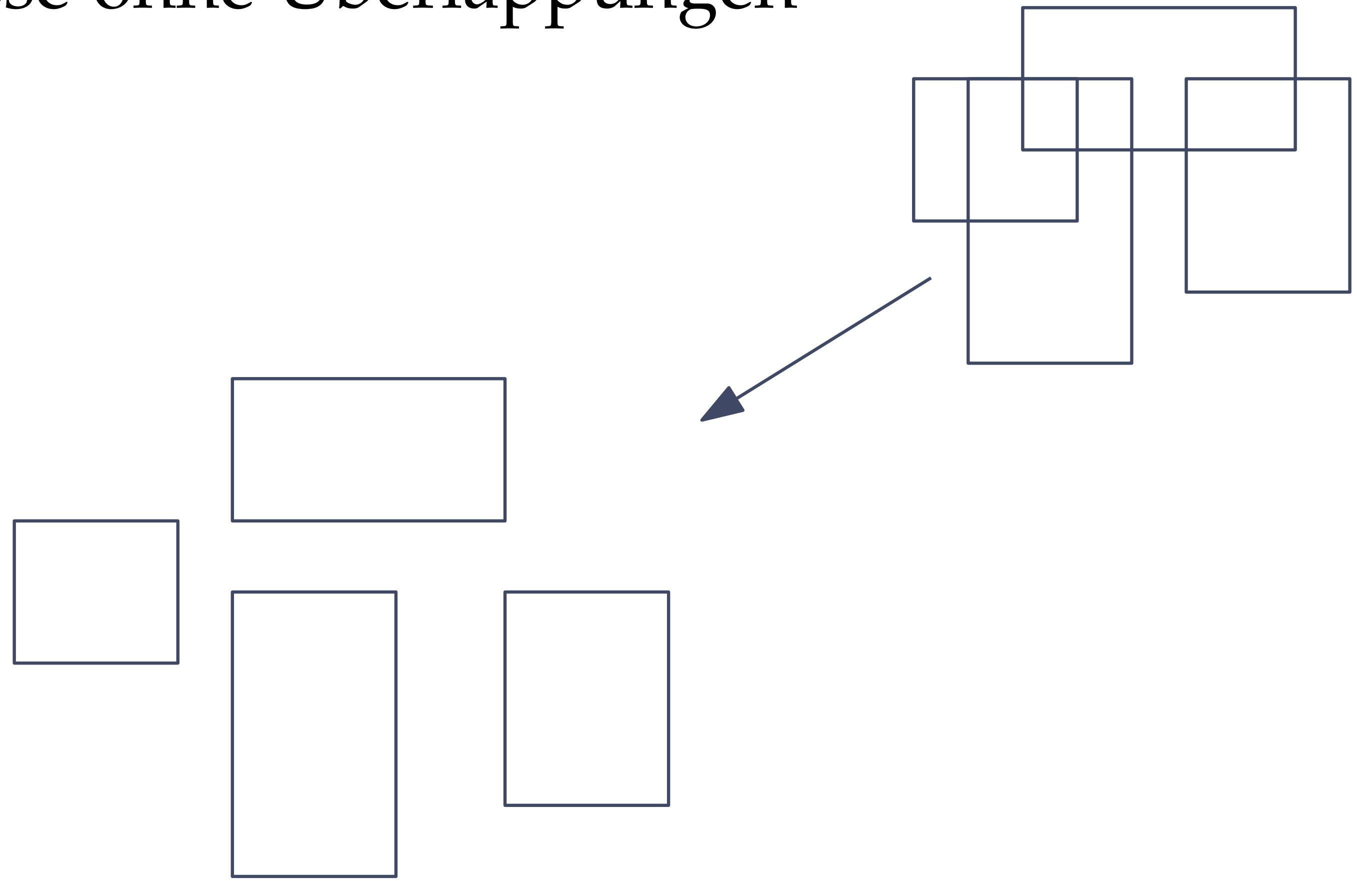

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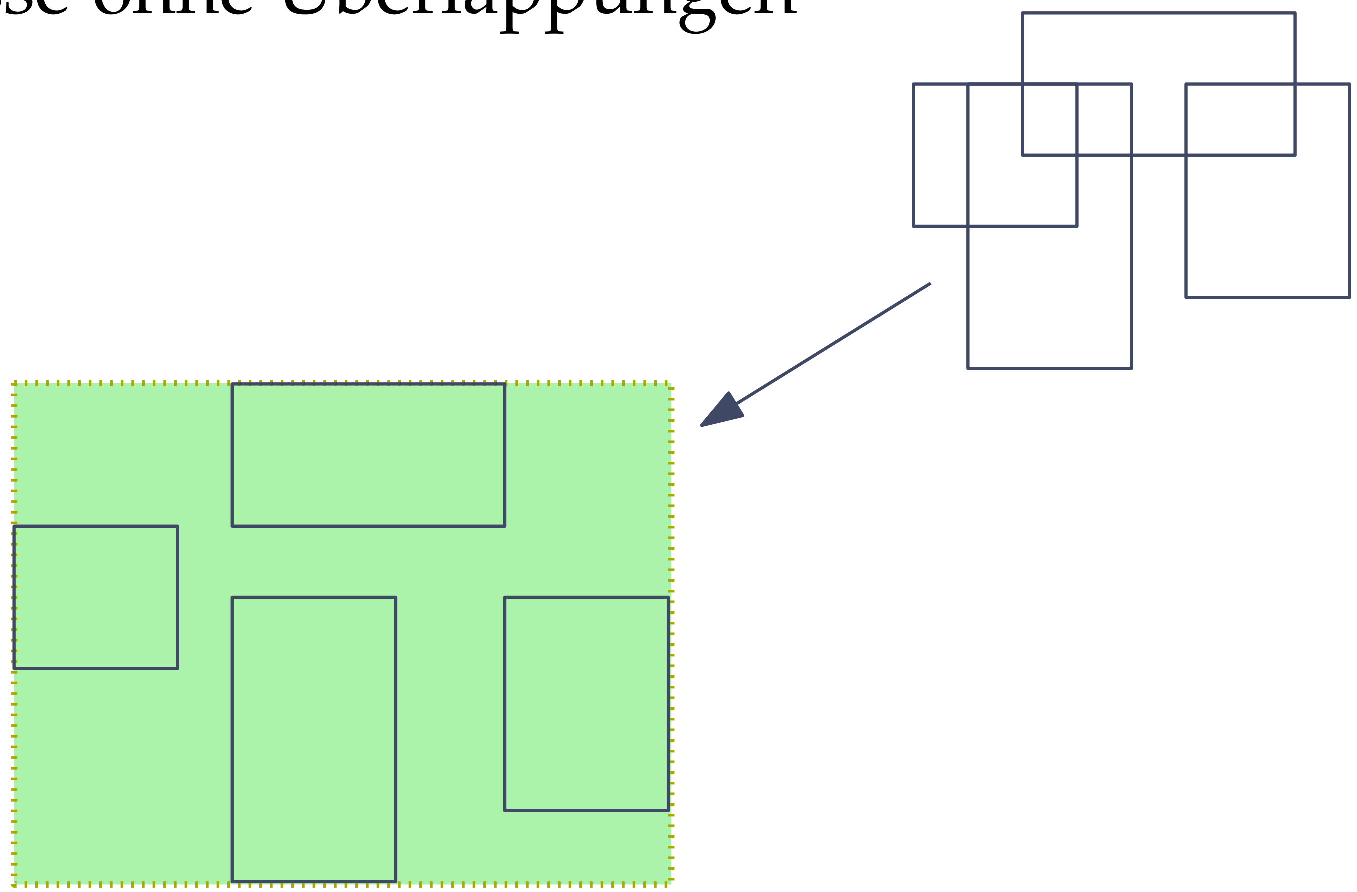

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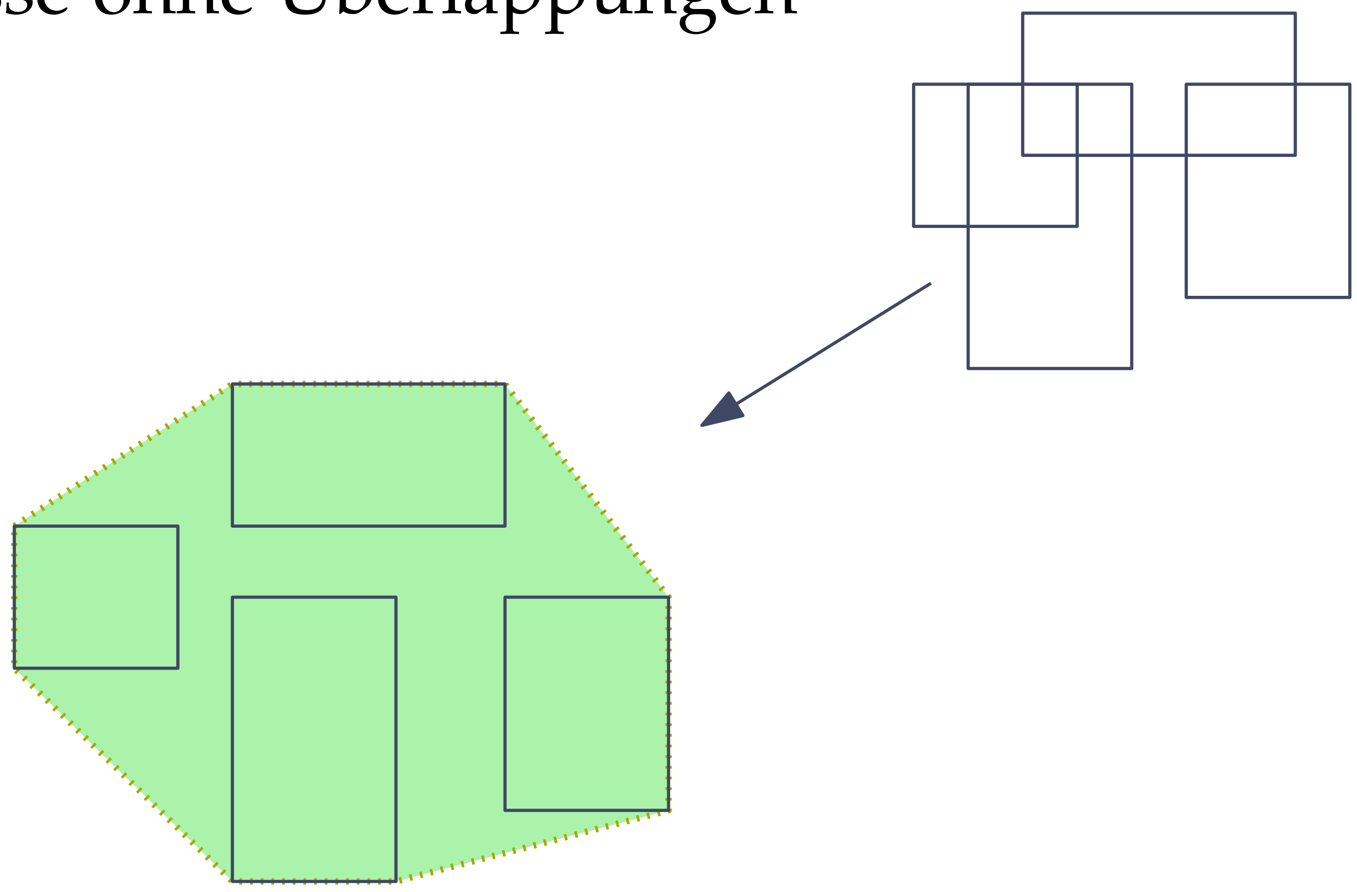

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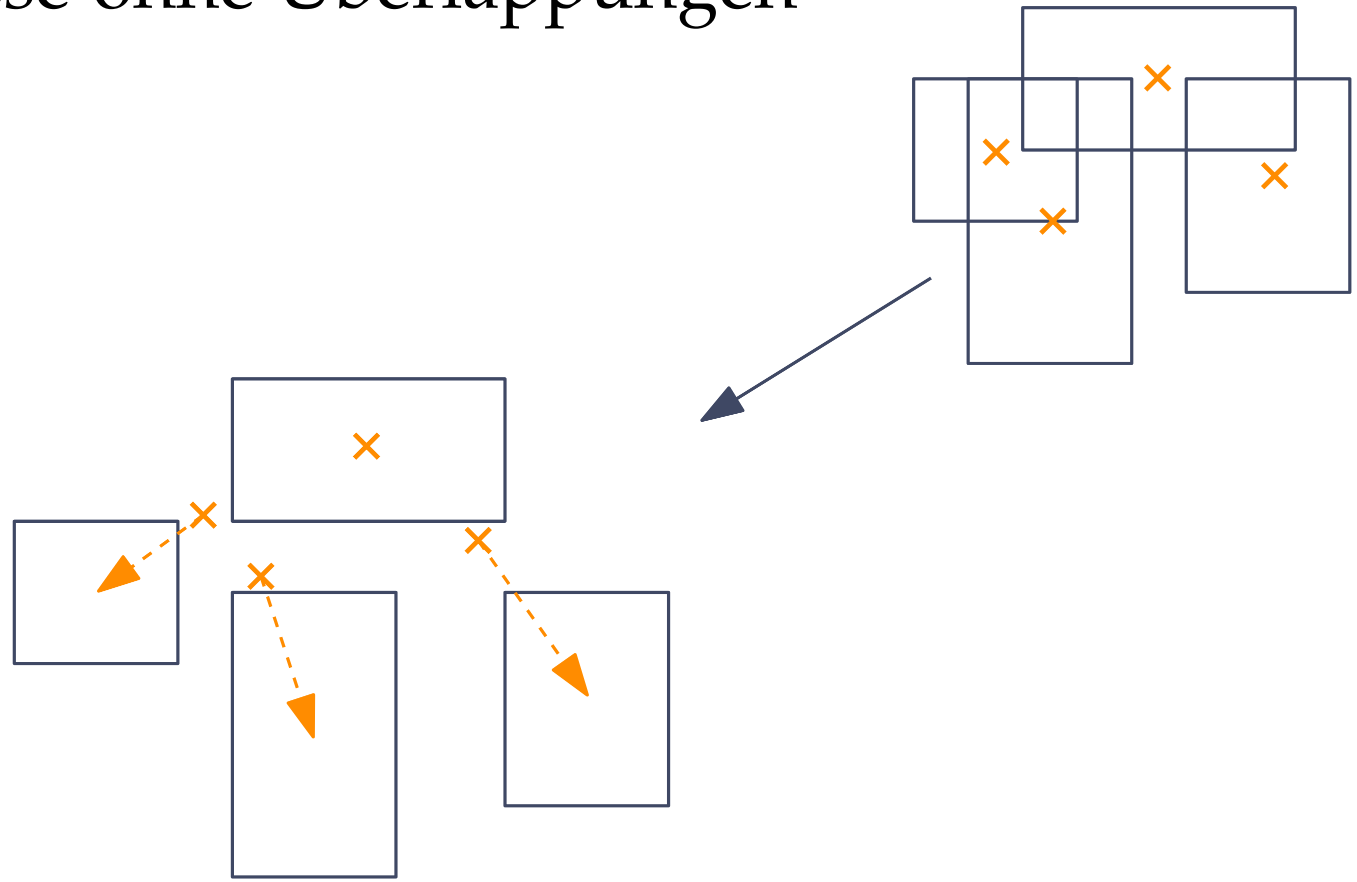

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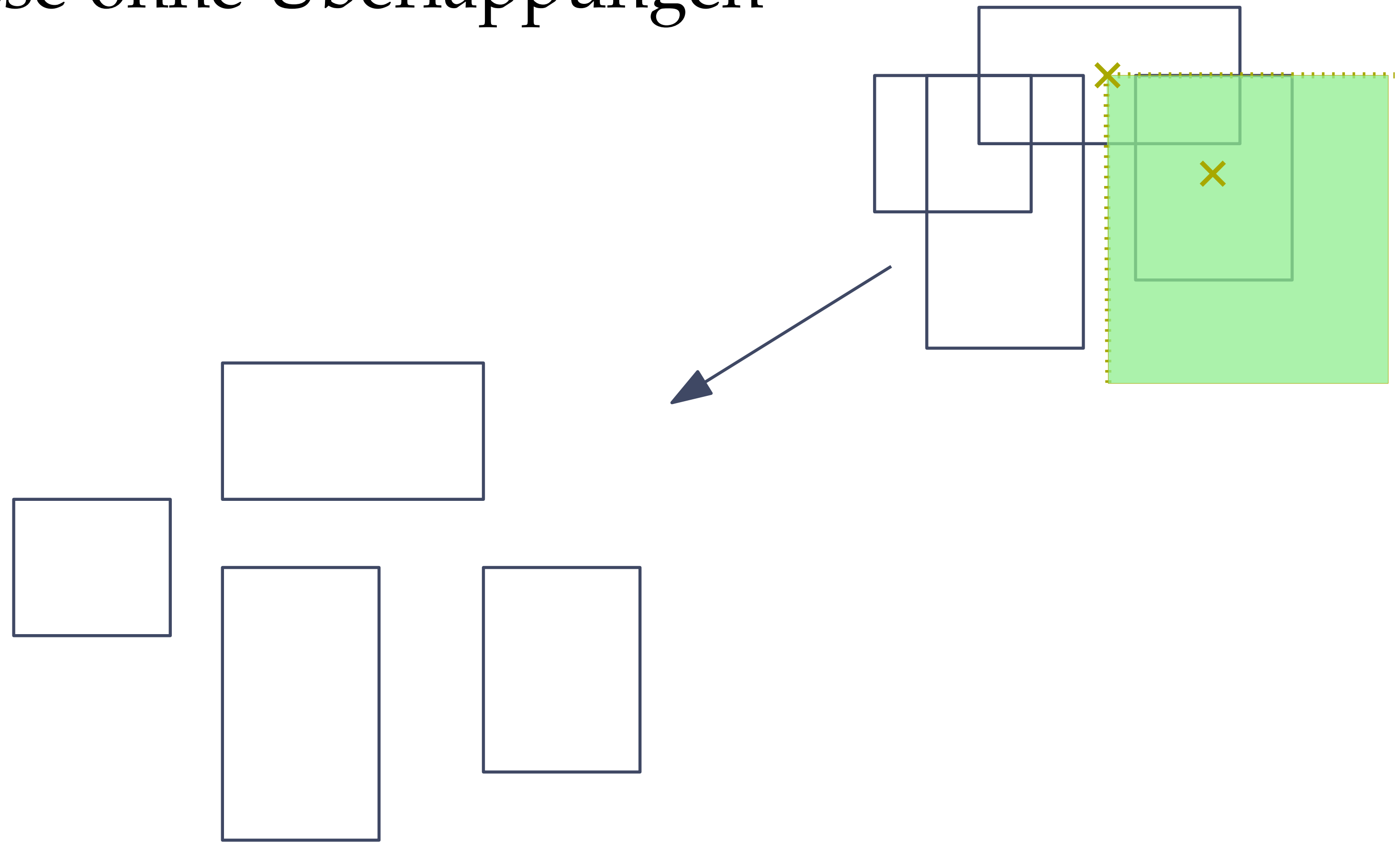

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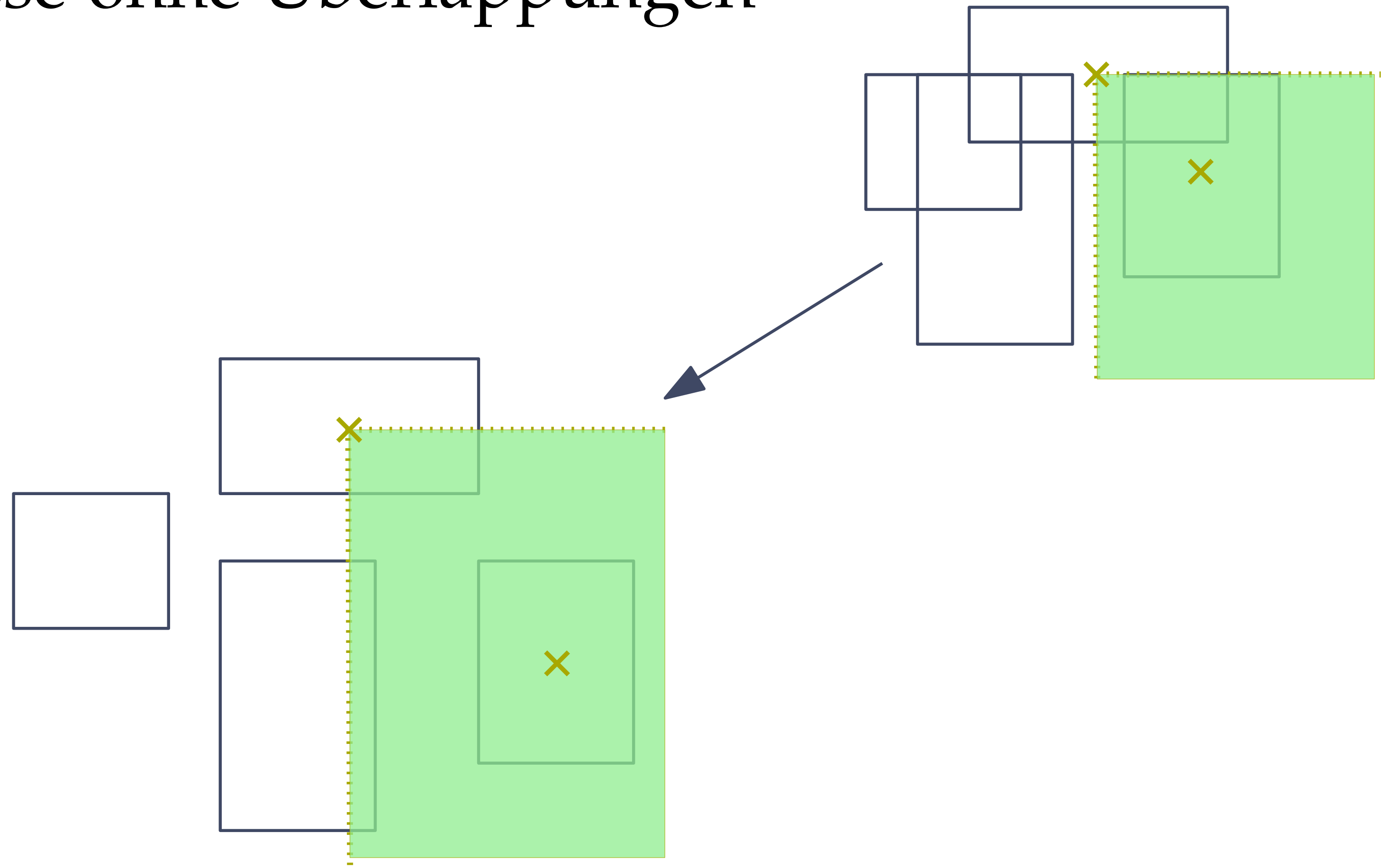

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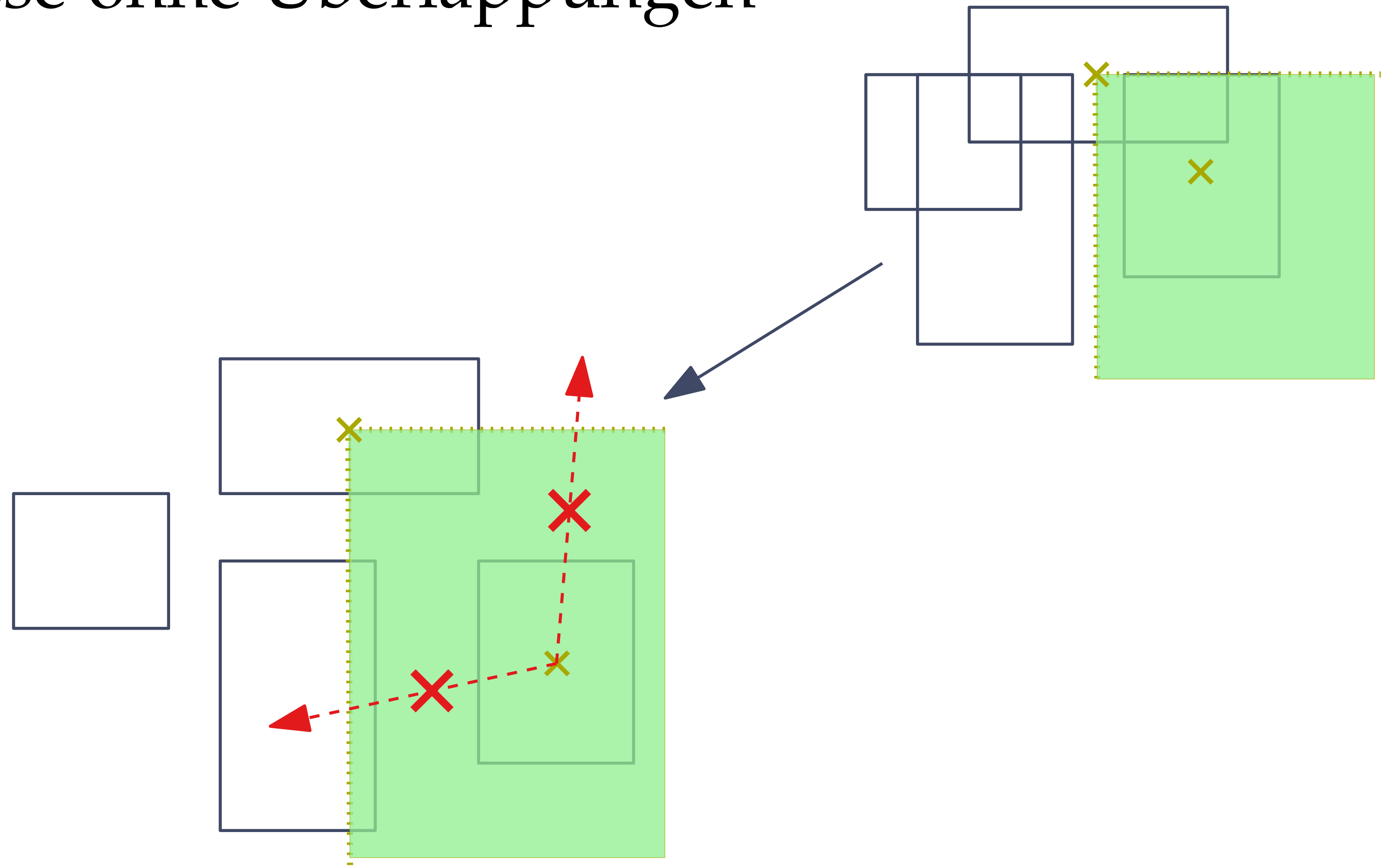

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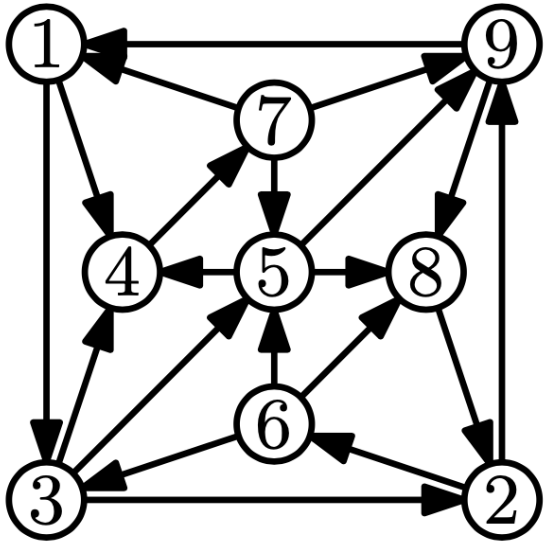
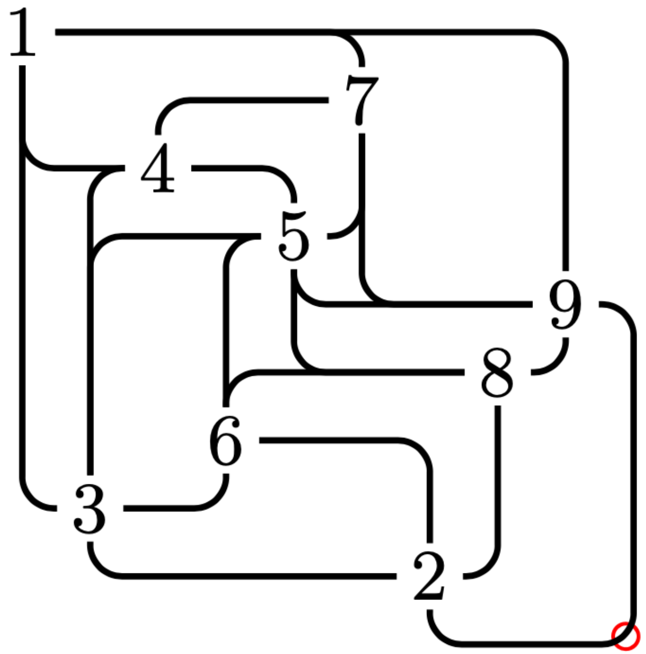
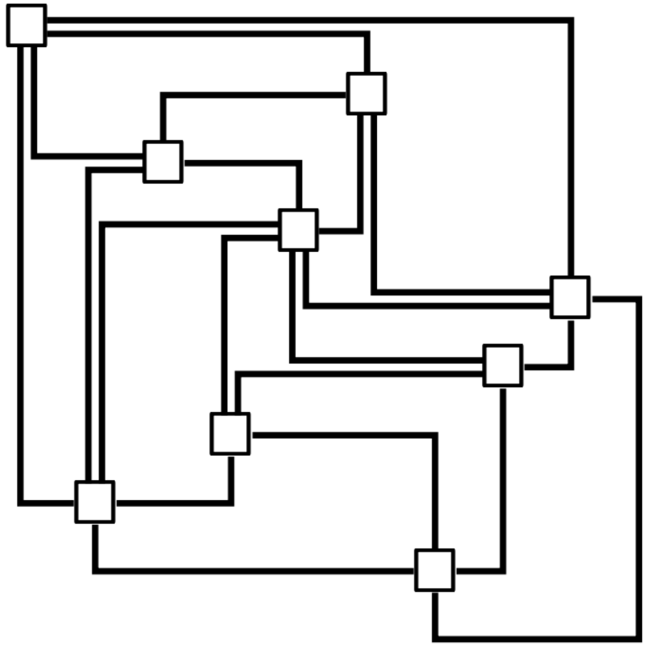
8. Planar Confluent Orthogonal Drawings



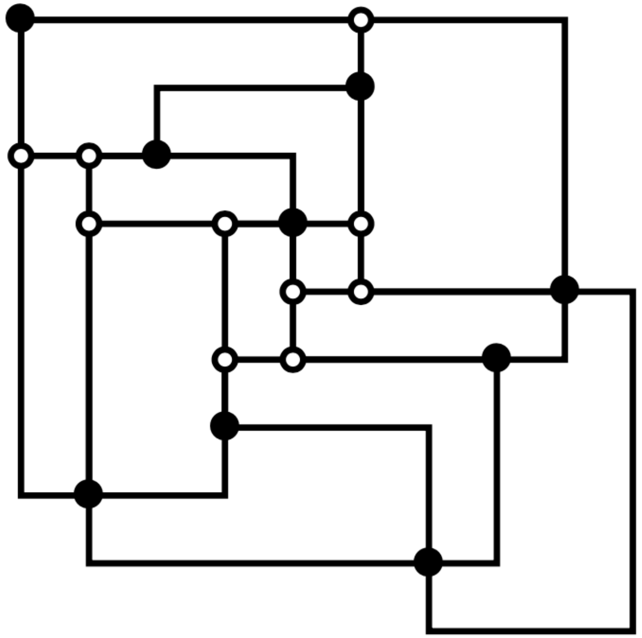
node-link diagram



PCOD



Kandinsky drawing



orthogonal drawing

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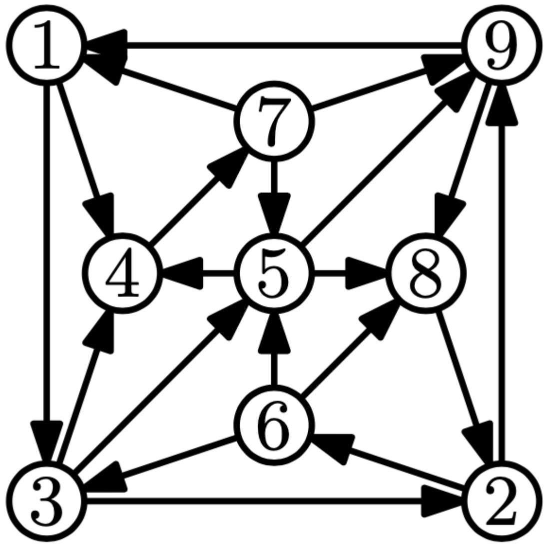

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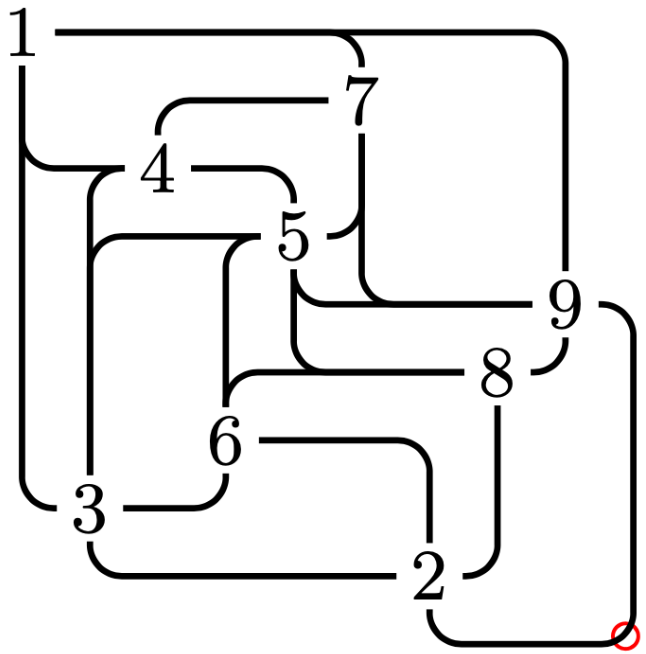

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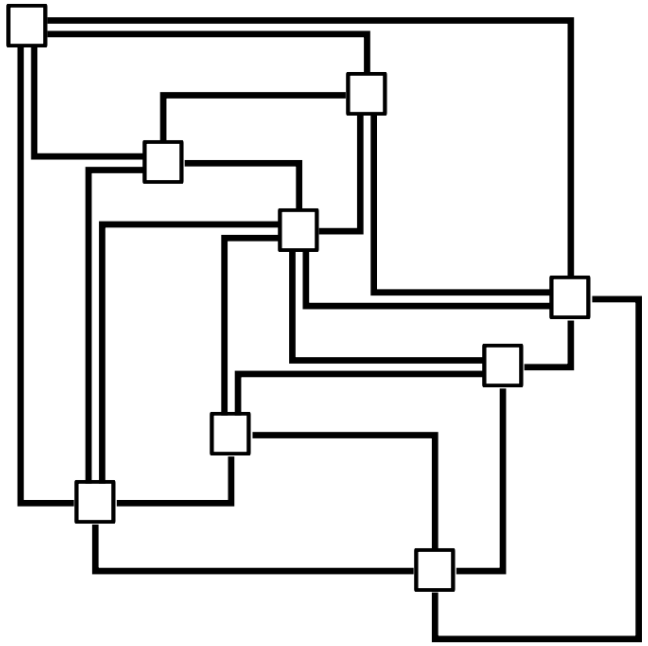

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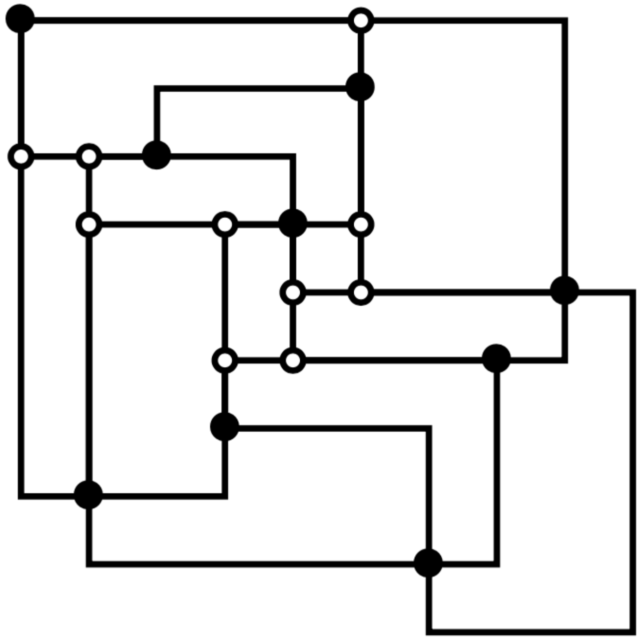
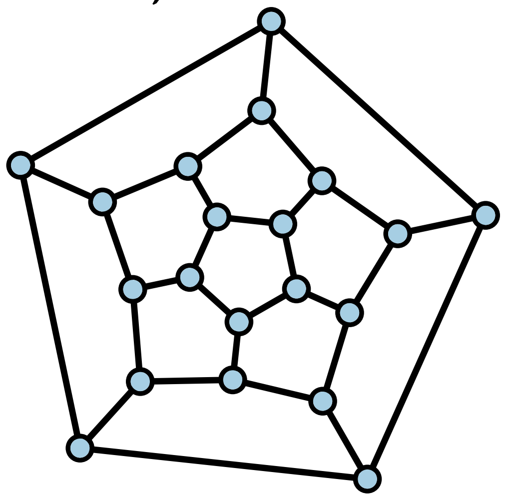


orthogonal drawing

Theorem. Every 4-modal irreducible triangulation has a PCOD with split complexity at most one; and such a drawing can be computed in linear time.

9. Strictly-Convex Drawings of 3-Connected Graphs

Eine kreuzungsfreie Graphzeichung Γ zerlegt die Ebene in Regionen, genannt **Facetten**.



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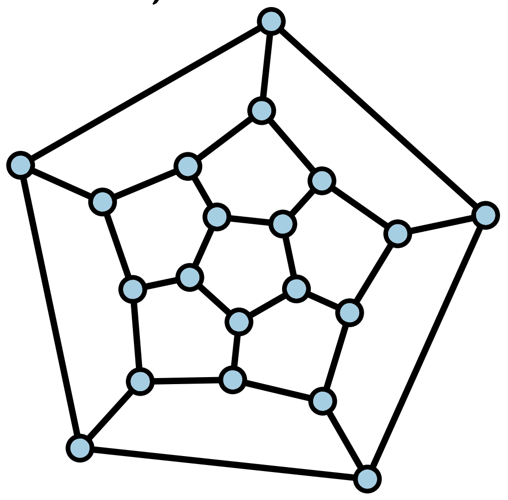

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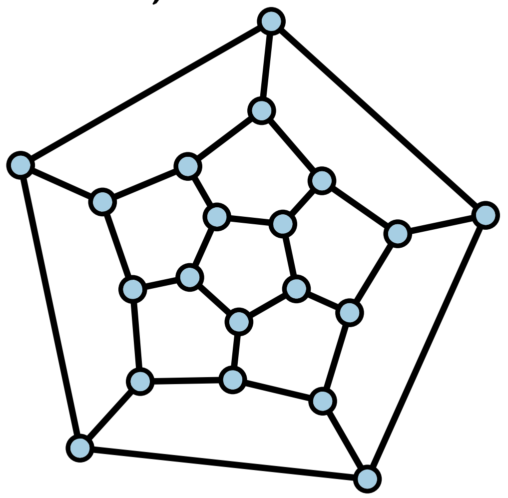

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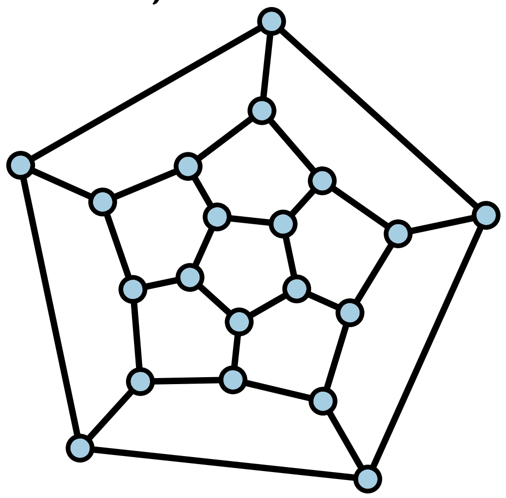

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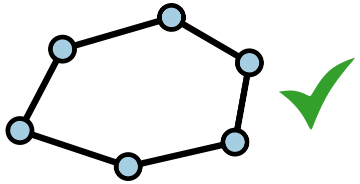

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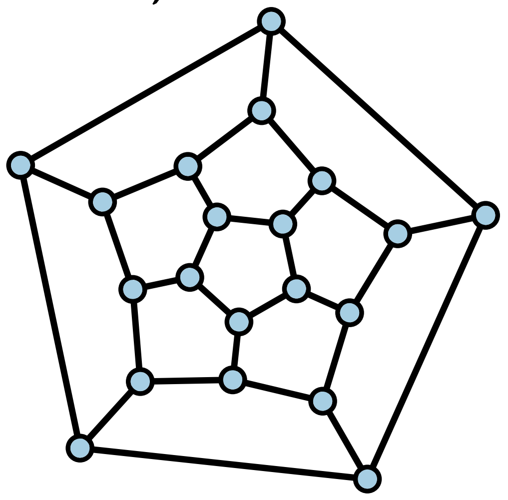

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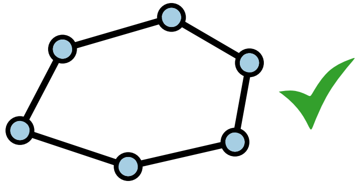

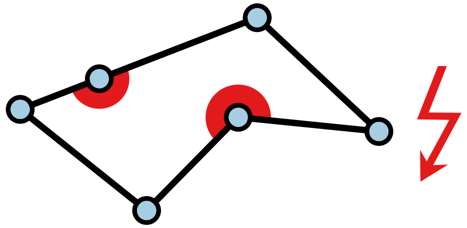

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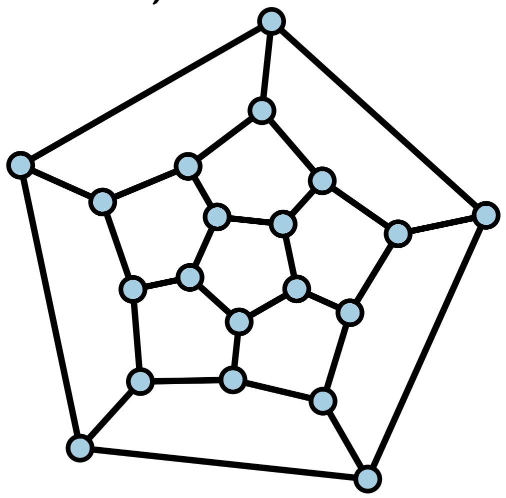

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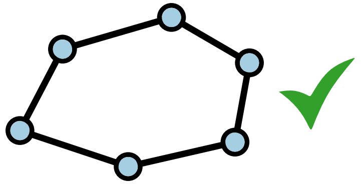

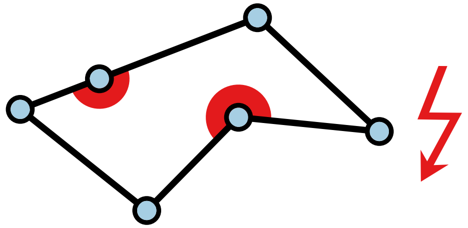

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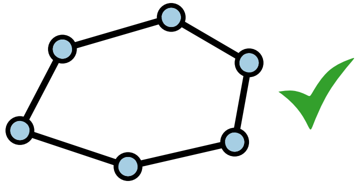

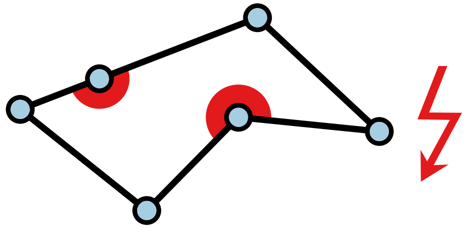

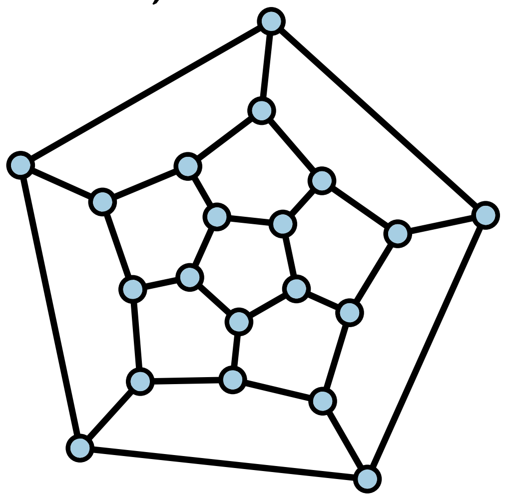

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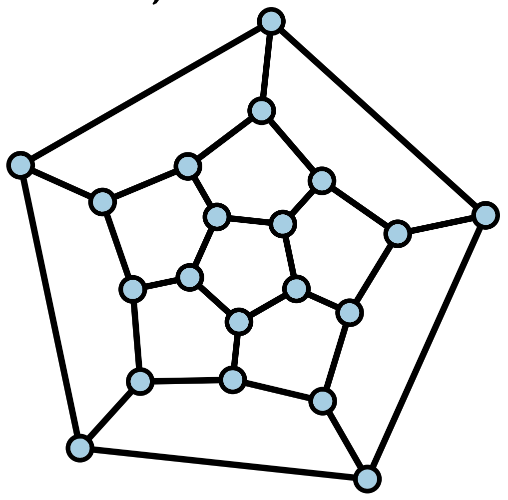

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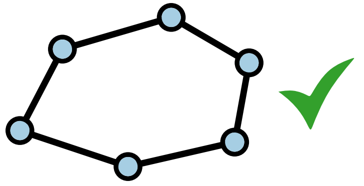

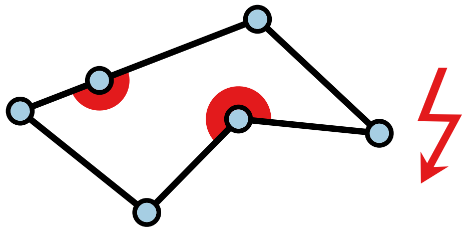

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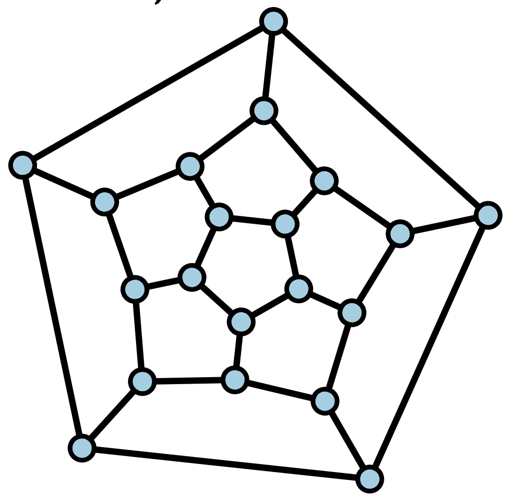

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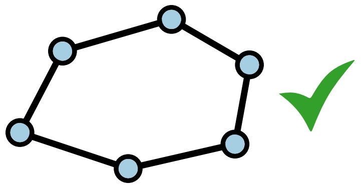

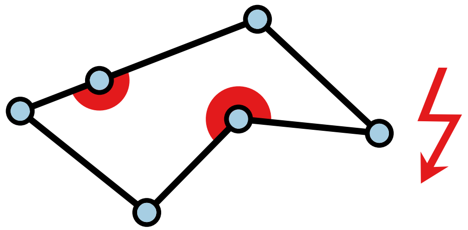

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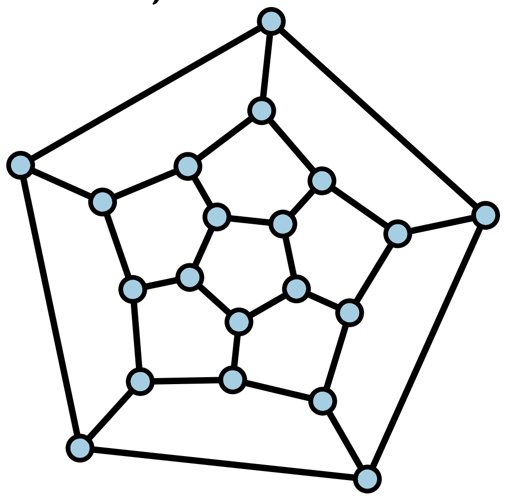

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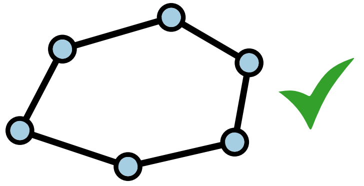

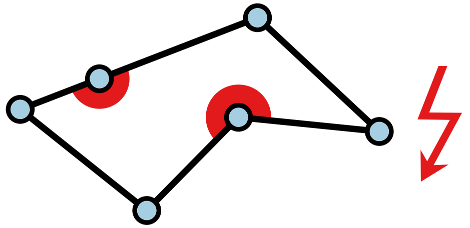

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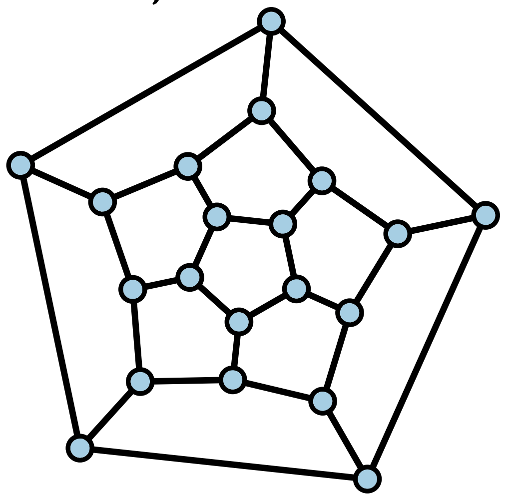

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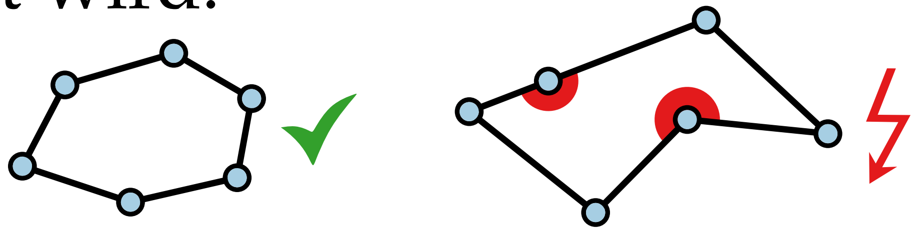

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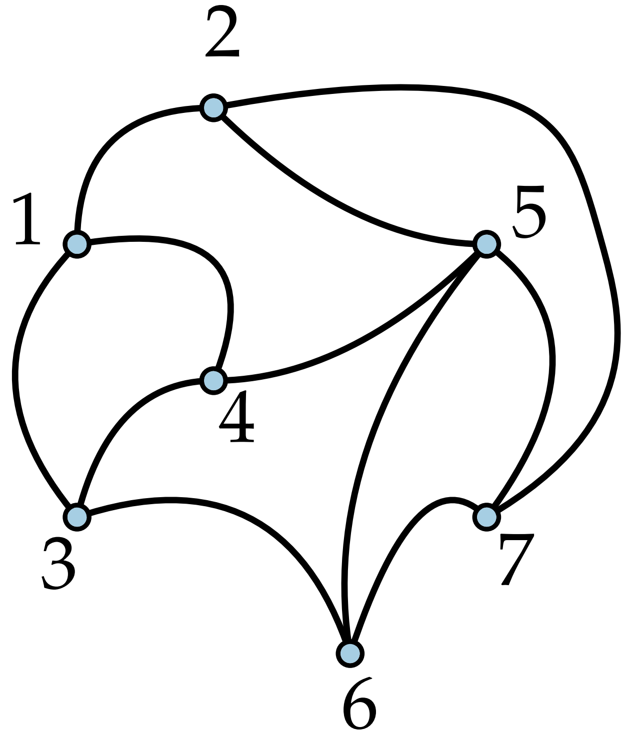
Verwendete Techniken: Kanonische Ordnung + Shift-Methode

(→ GraphVis-Vorlesung)

10. st-Orientations with Few Transitive Edges

Eingabe: ein ungerichteter Graph $G = (V, E)$



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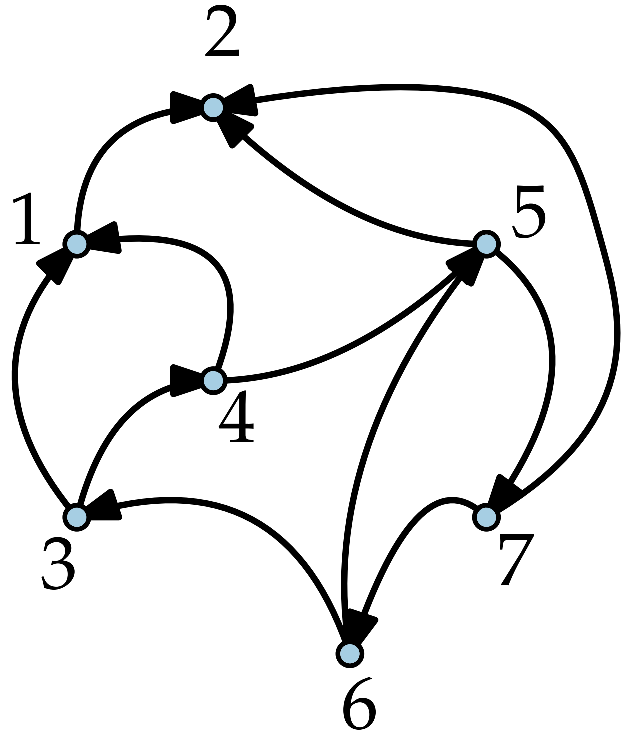

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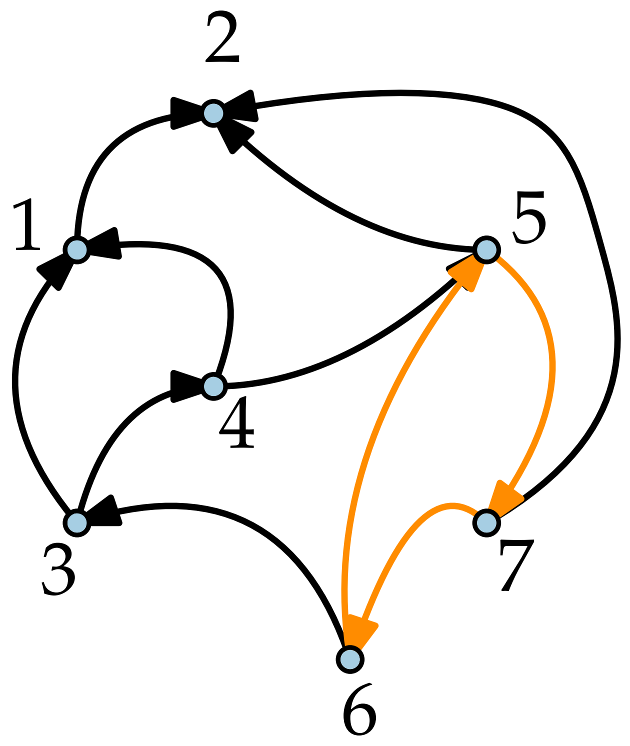

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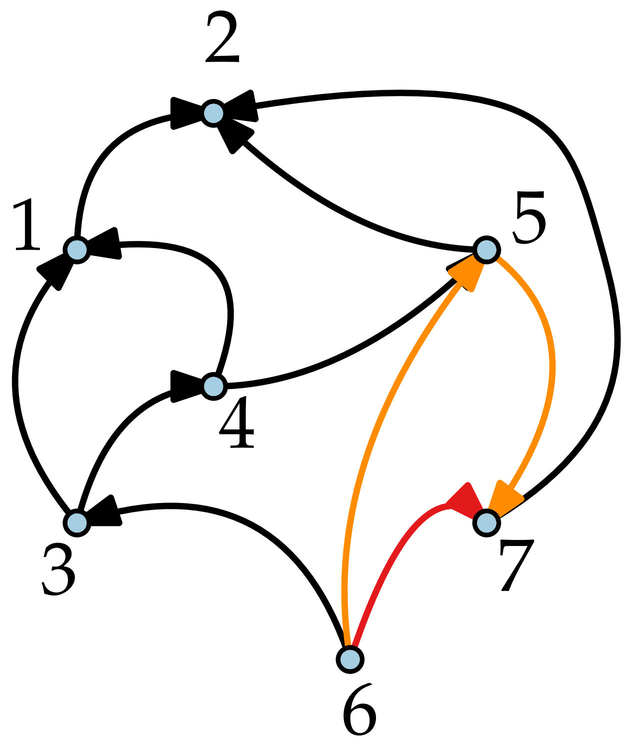

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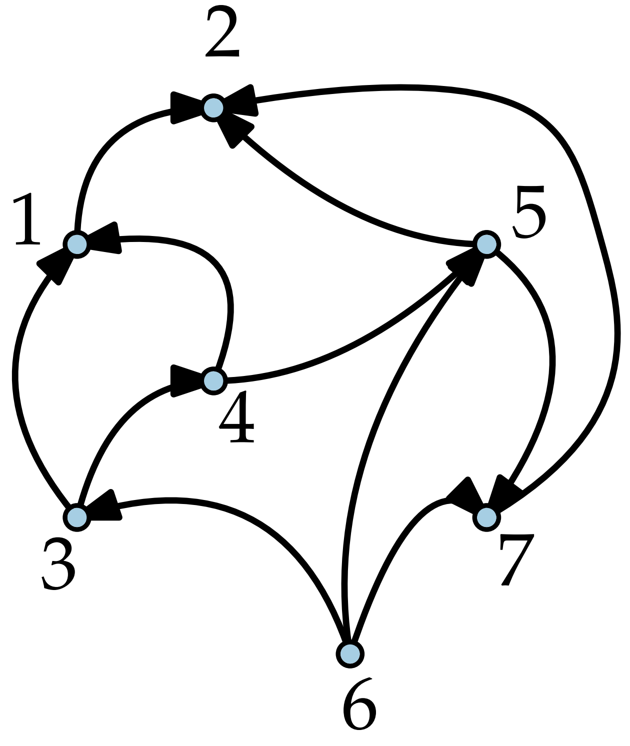

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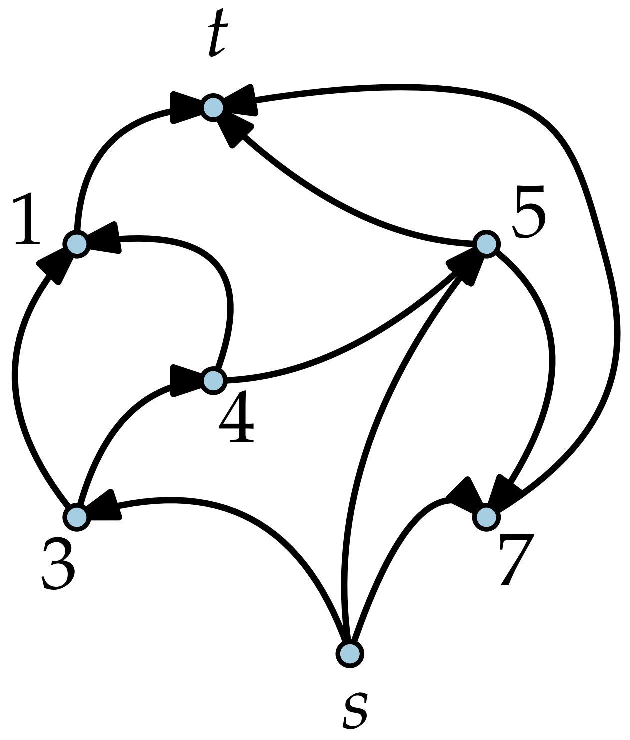

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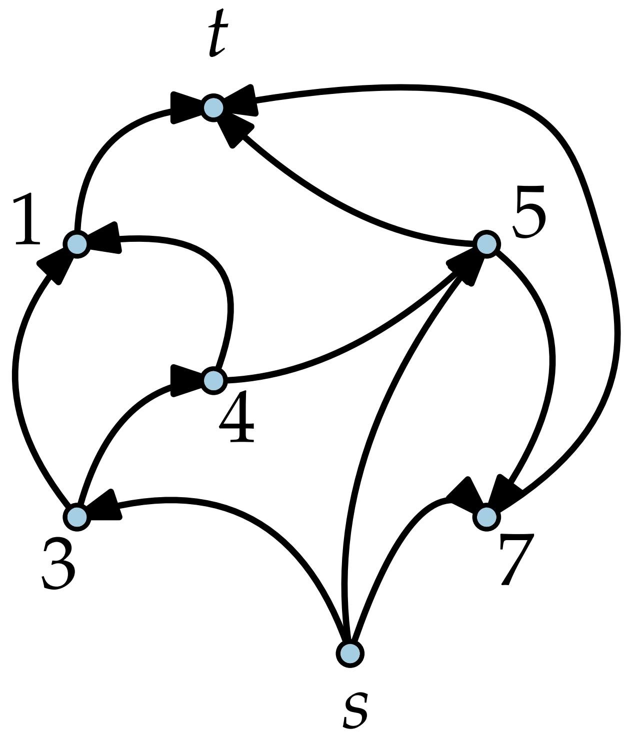

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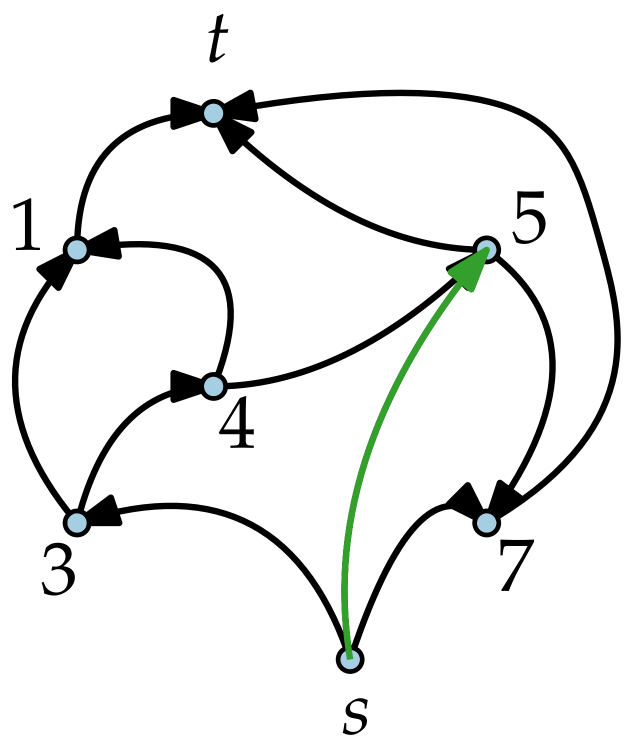

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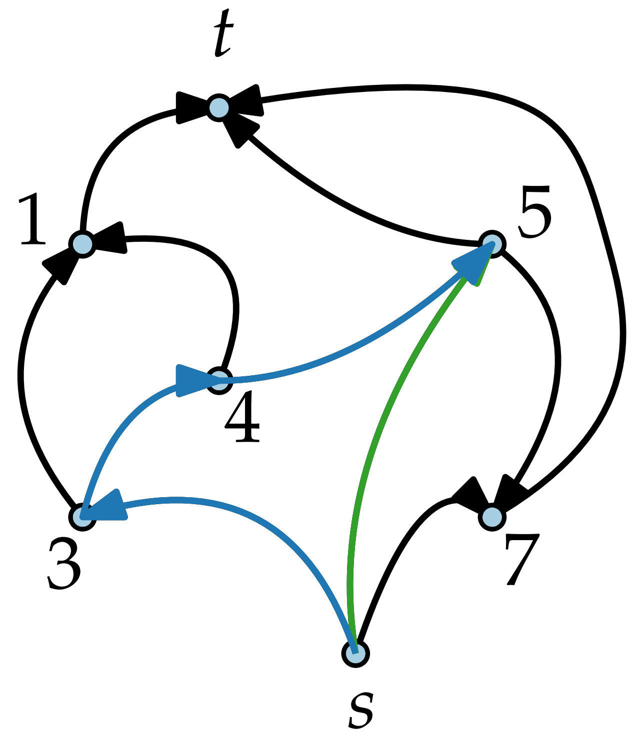

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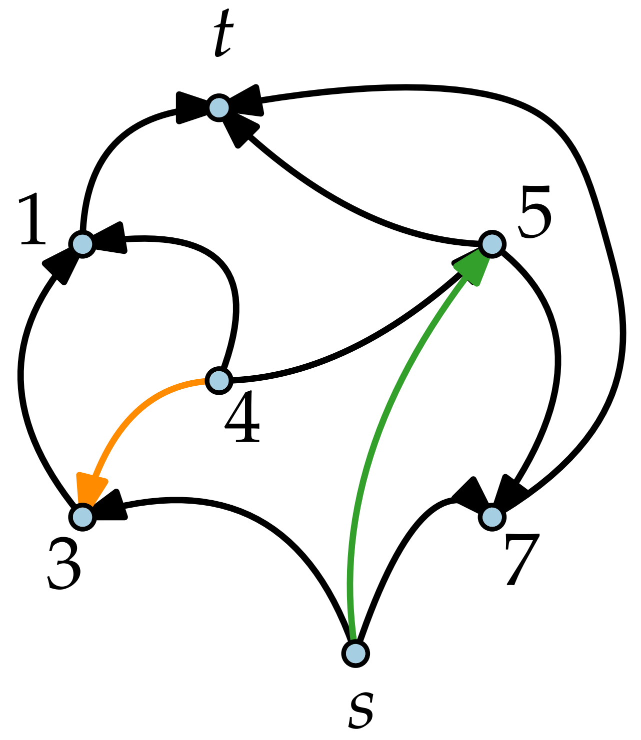

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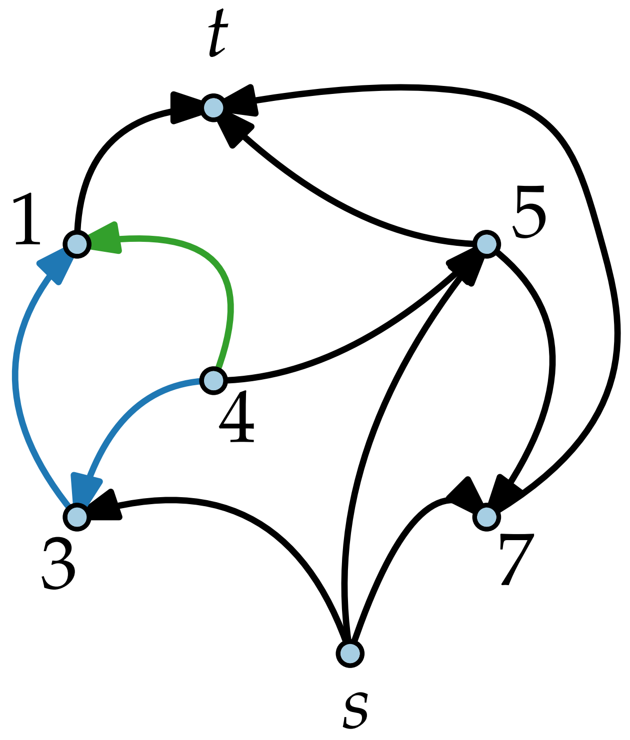

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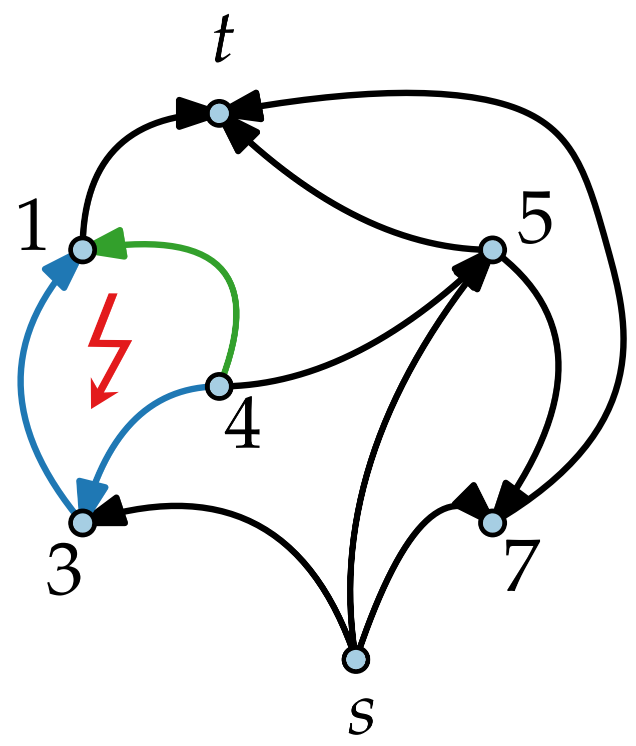

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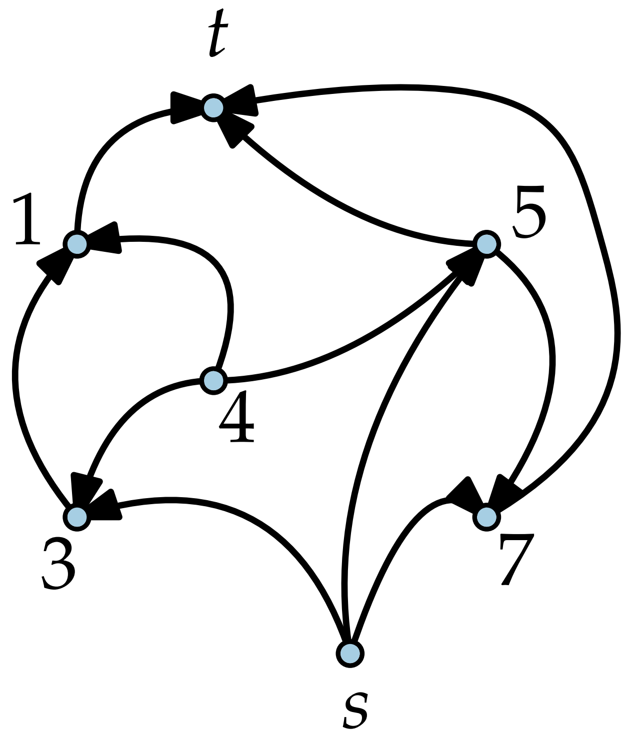

Spoiler: ist NP-schwer

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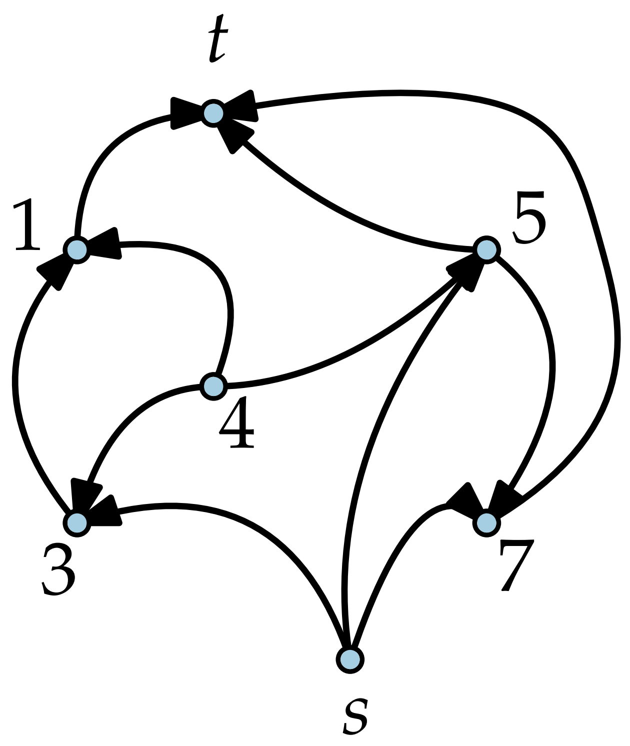

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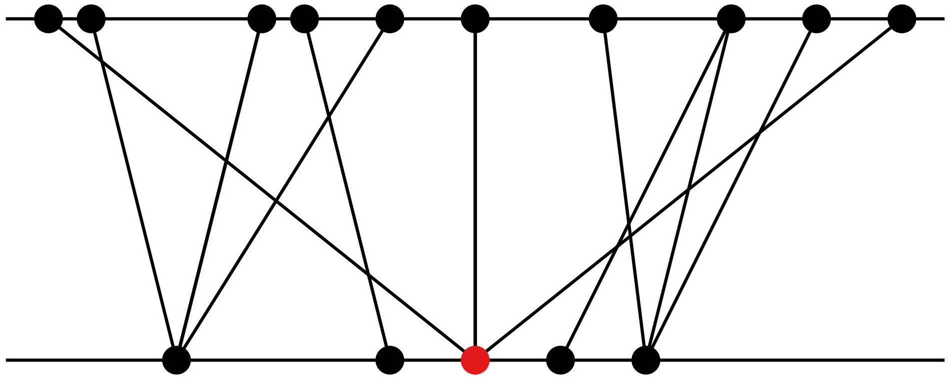
11. An FPT Algorithm for Bipartite Vertex Splitting



2-layer drawing of a bipartite graph
with fixed vertex order.

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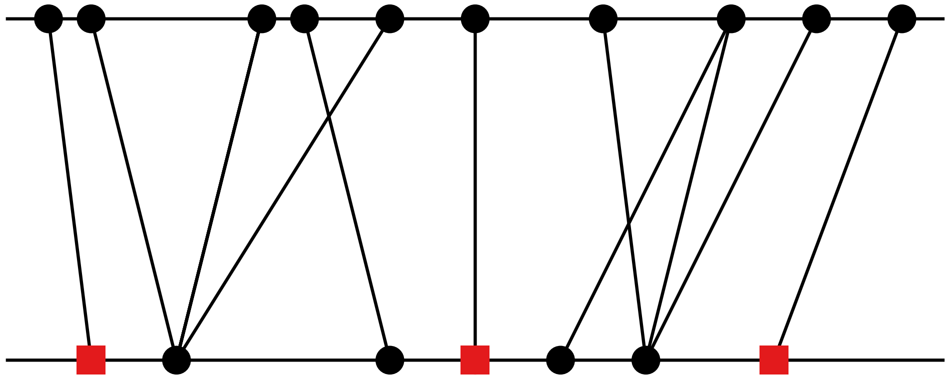

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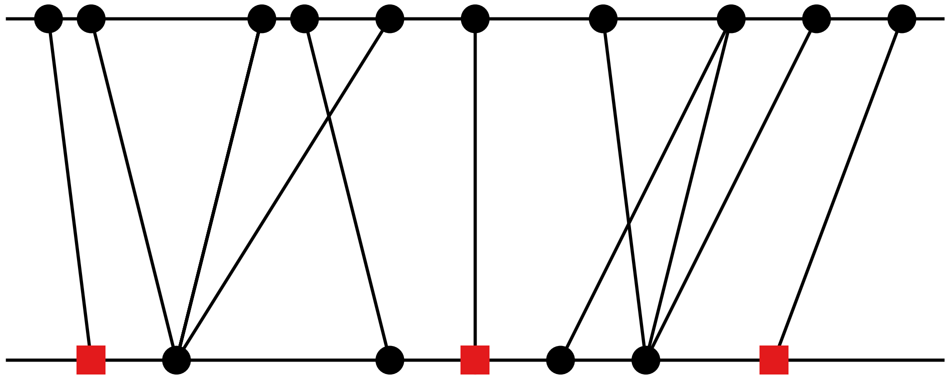

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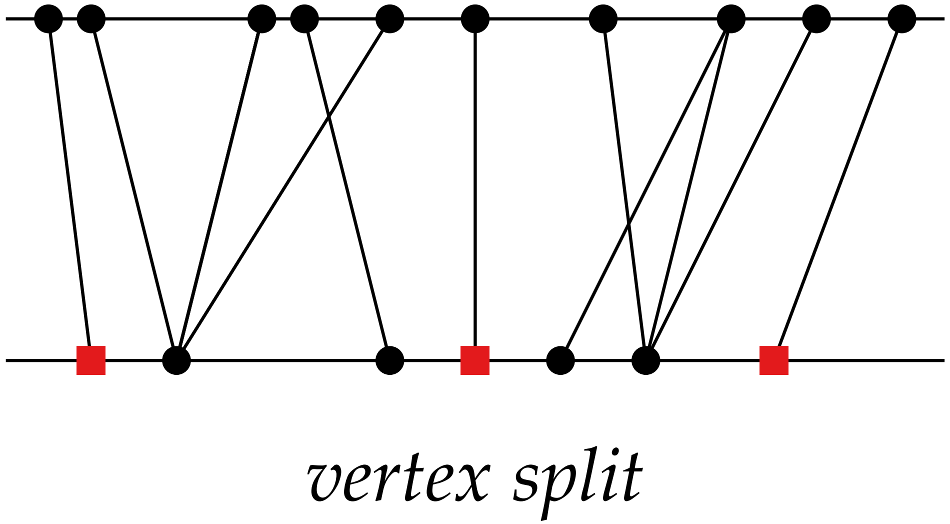

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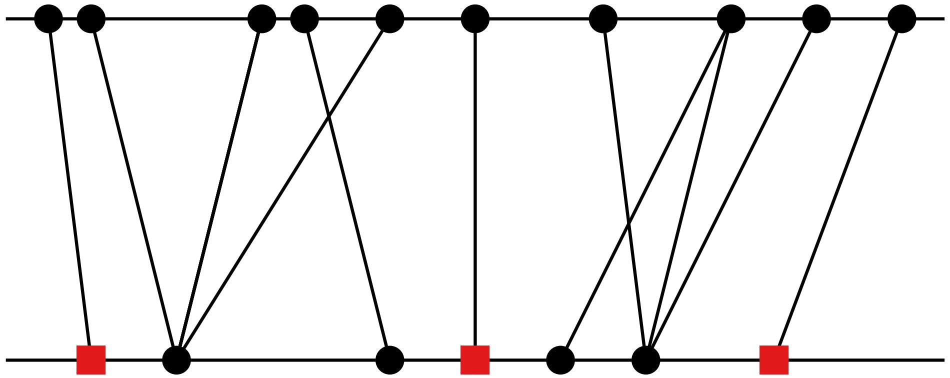

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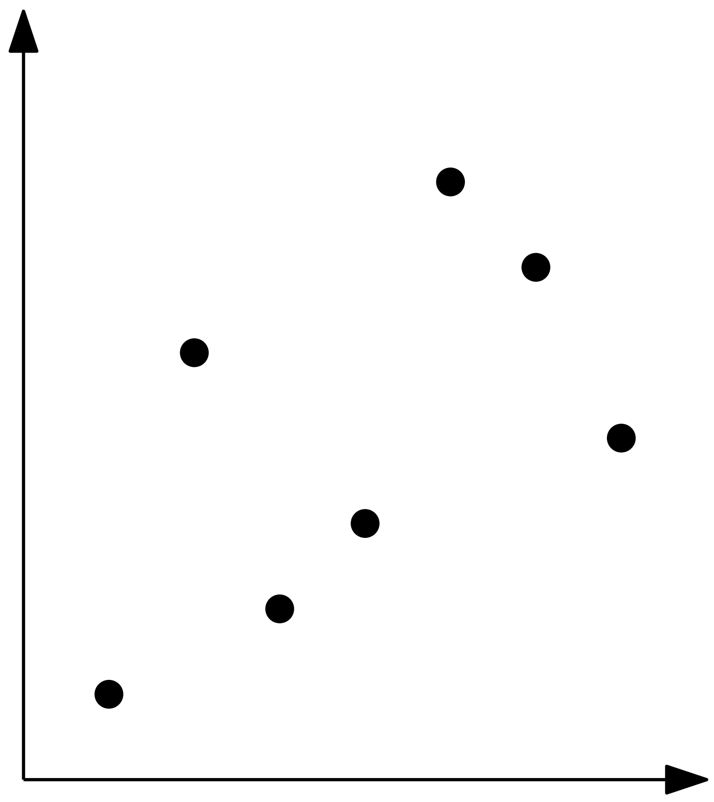
Here: FPT algorithm for Bipartite Vertex Splitting parameterized by the minimum number of vertex splits.

12. Queue Layouts of Two-Dimensional Posets

2-dimension poset
(partially ordered set):



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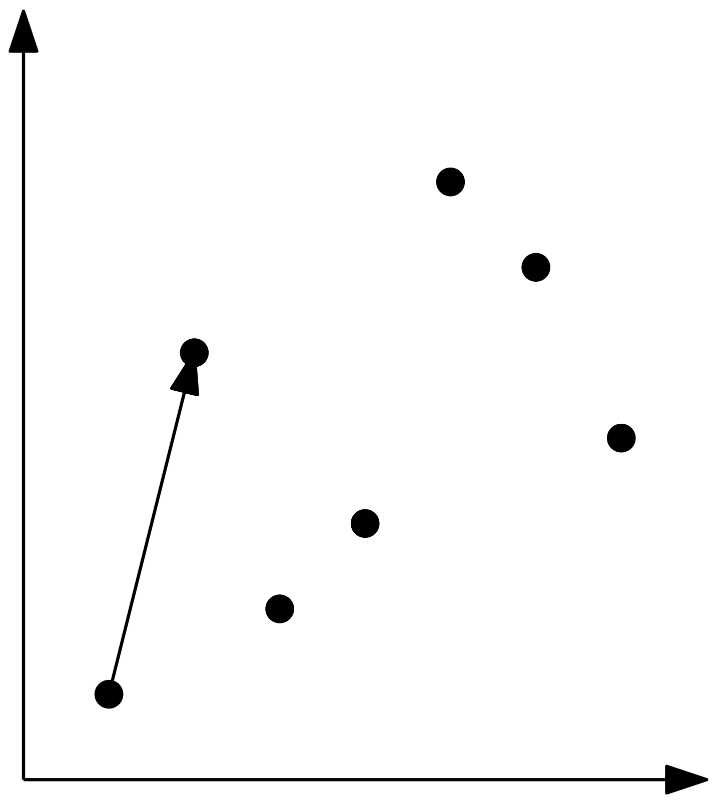

Edge from u to v
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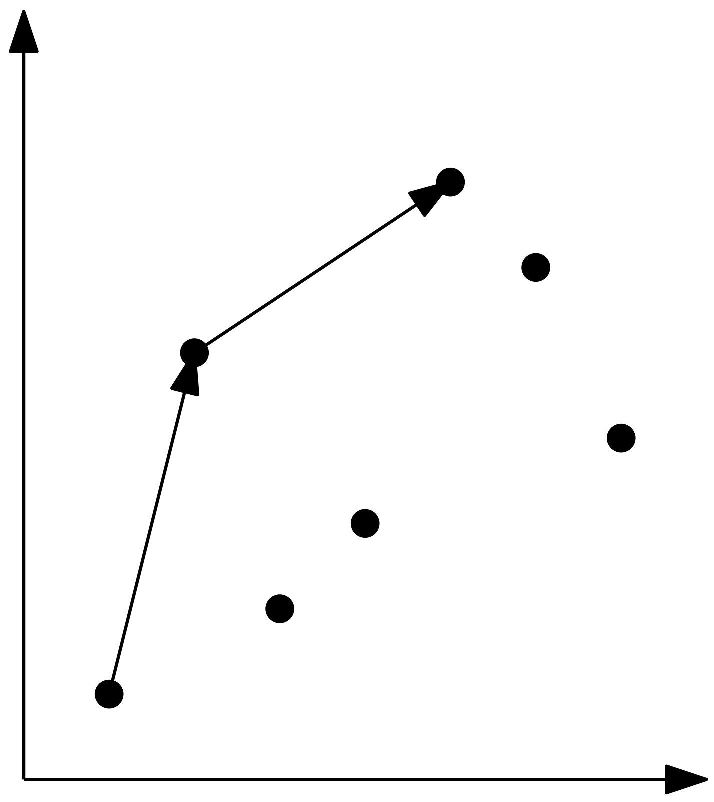

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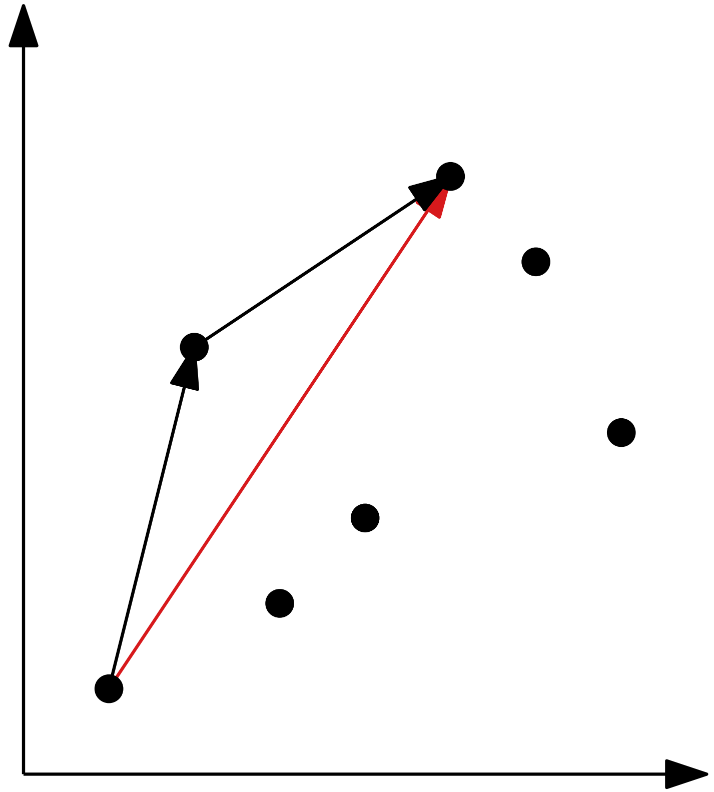

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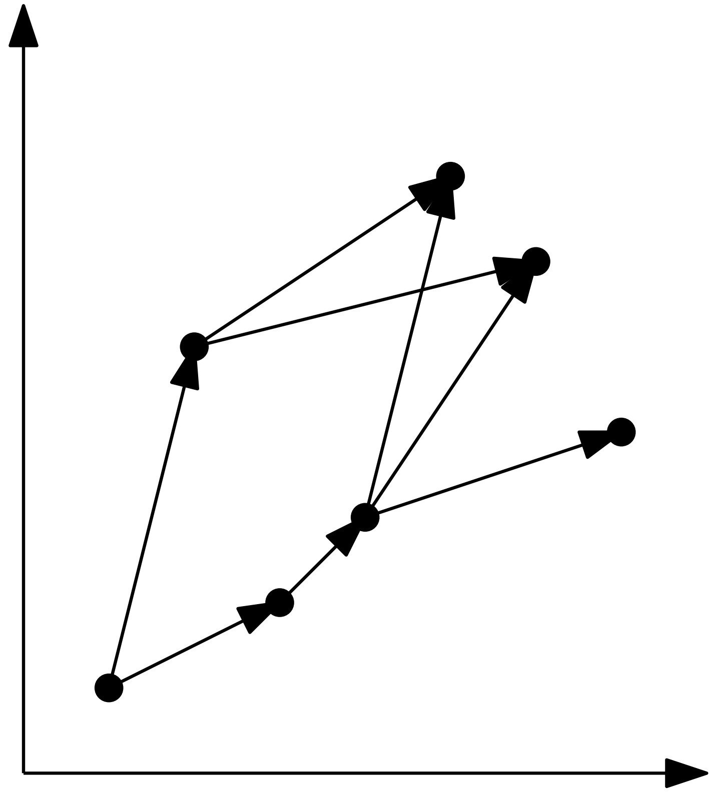

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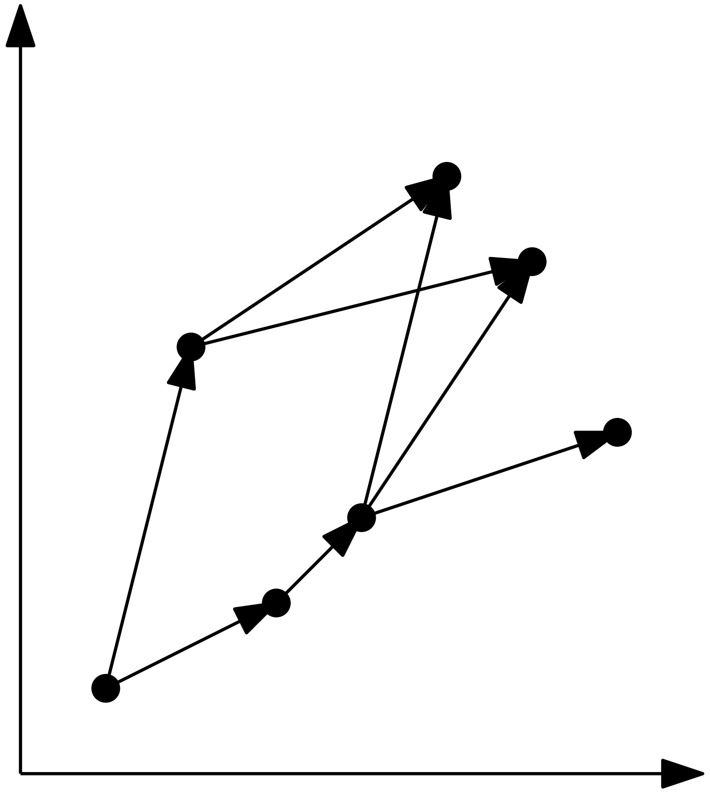
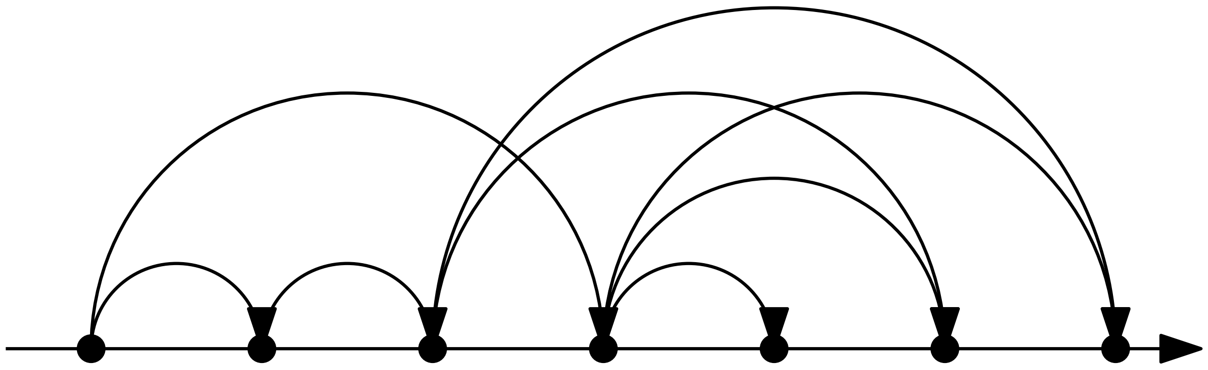


Edge from u to v if v is right and above u.

No transitive edges.

Queue layout of a poset:



Order vertices such that the partial order is respected.

12. Queue Layouts of Two-Dimensional Posets

2-dimension poset
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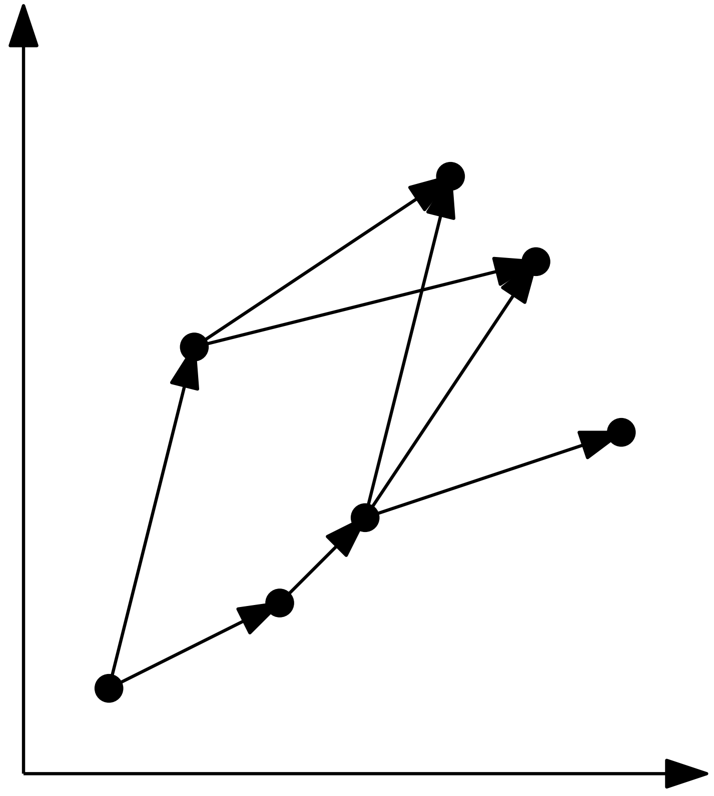

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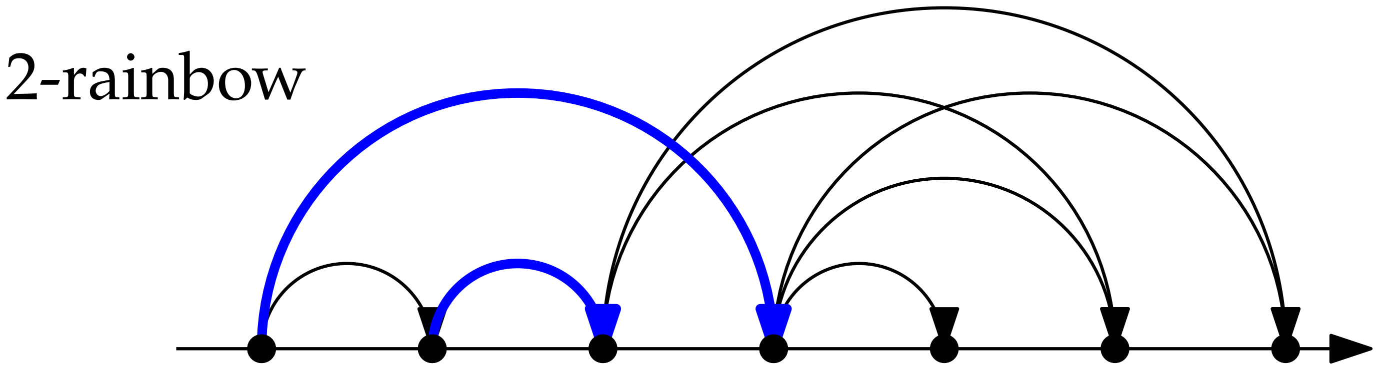

Order vertices such that the partial order is respected.

We want to minimize maximum number of nested edges.

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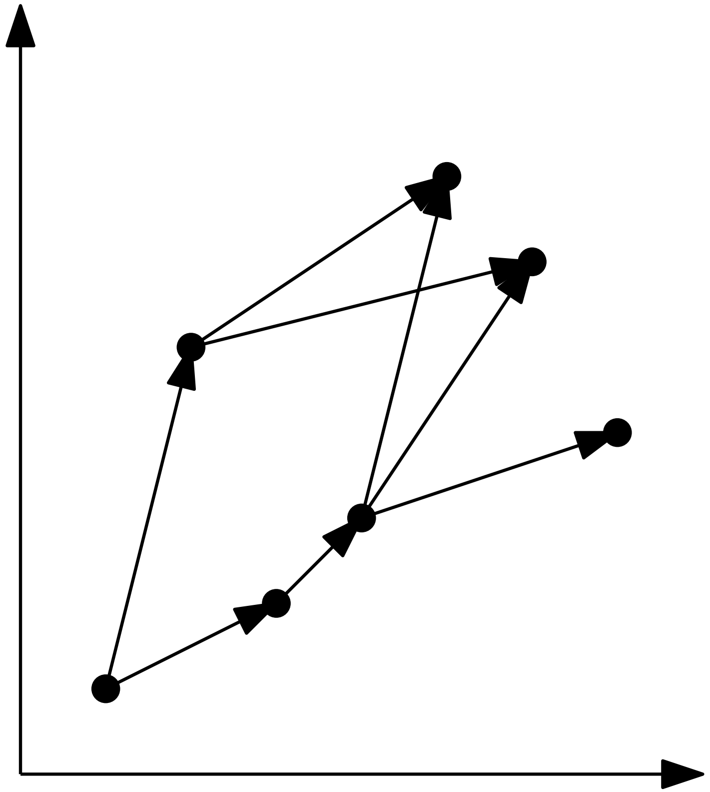

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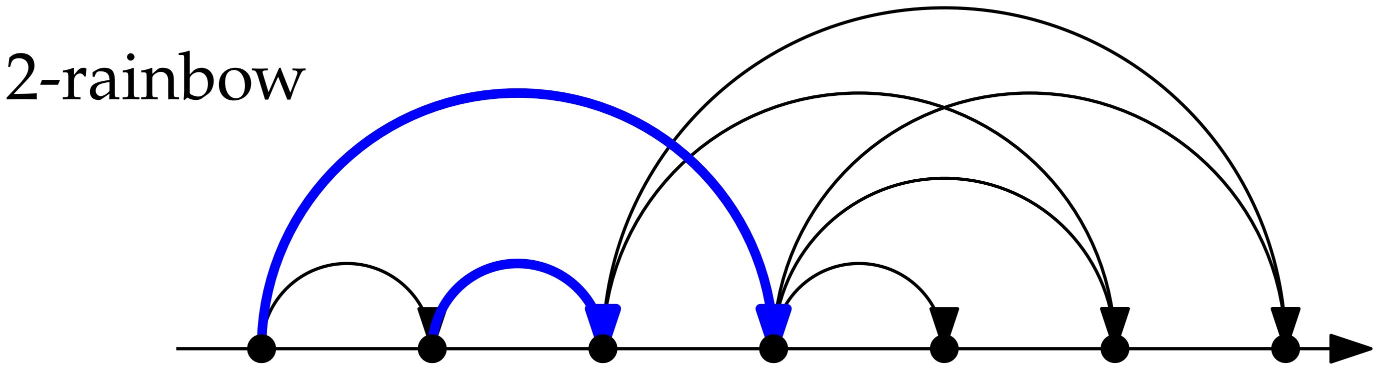

Order vertices such that the partial order is respected.

We want to minimize maximum number of nested edges.

Queue number: minimum k such that the poset admits a queue layout with rainbows of size at most k.

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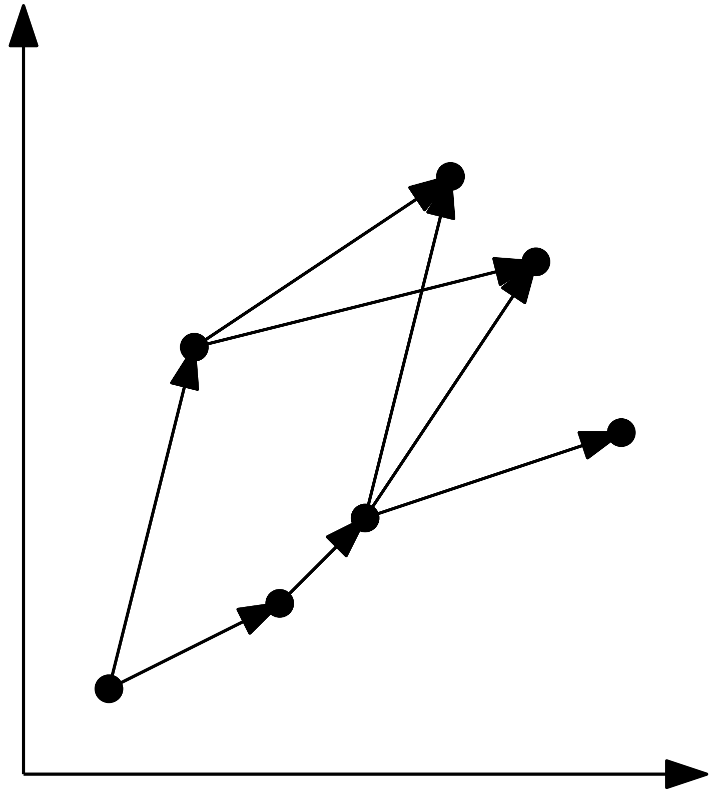
(partially ordered set):



Edge from u to v if v is right and above u.

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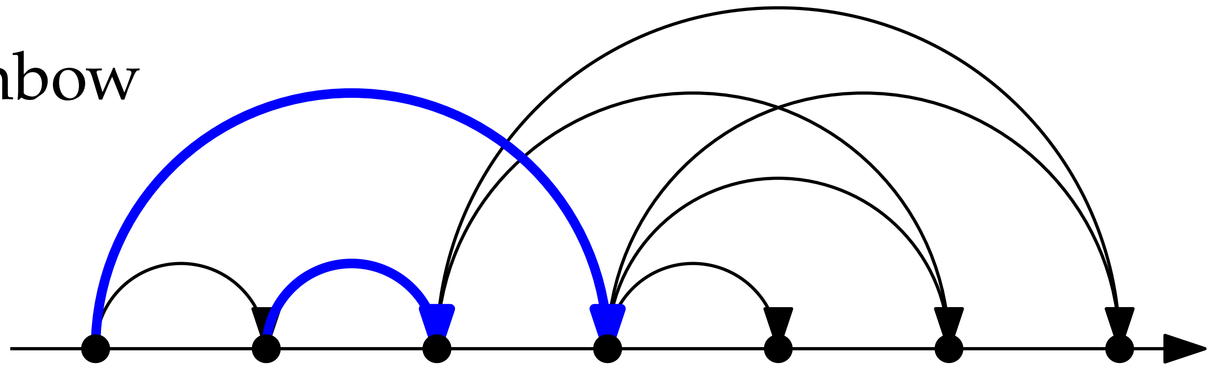
Queue layout of a poset:

2-rainbow



Order vertices such that the partial order is respected.

We want to minimize maximum number of nested edges.

Queue number: minimum k such that the poset admits a queue layout with rainbows of size at most k.
What are bounds on the Queue-Number of a Poset?

13. The Rique-Number of Graphs

This is about *linear layouts*, where all vertices are arranged on a horizontal line.

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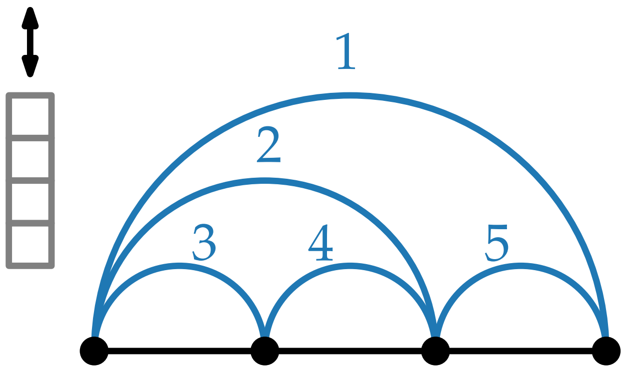

1-page *stack*-layout

13. The Rique-Number of Graphs

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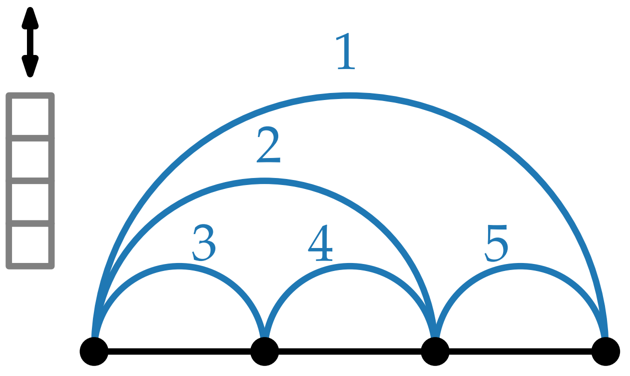

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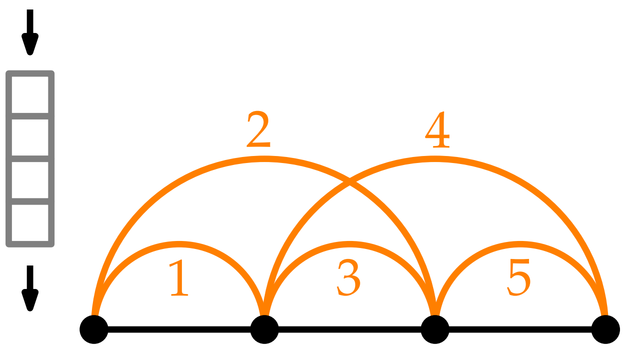

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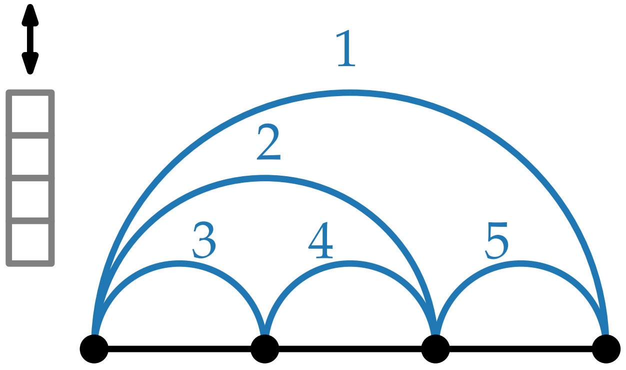

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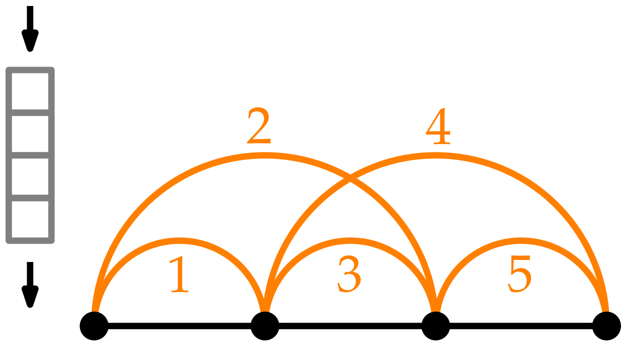

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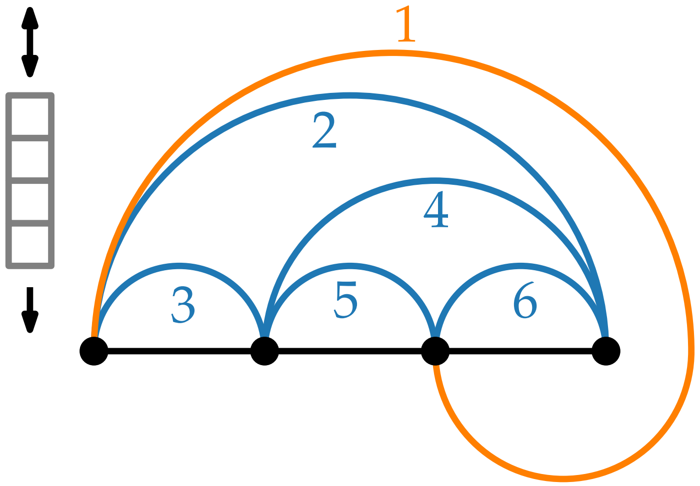

1-page `RIQ`-layout

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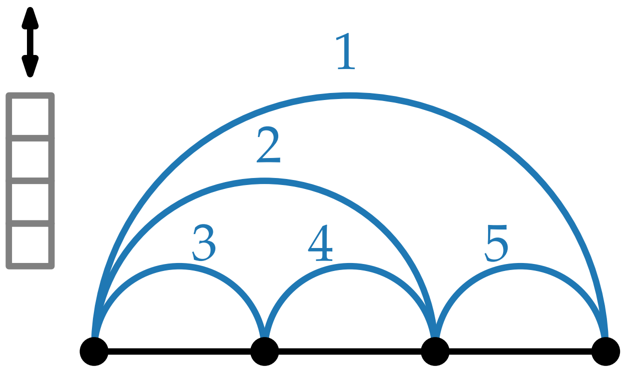

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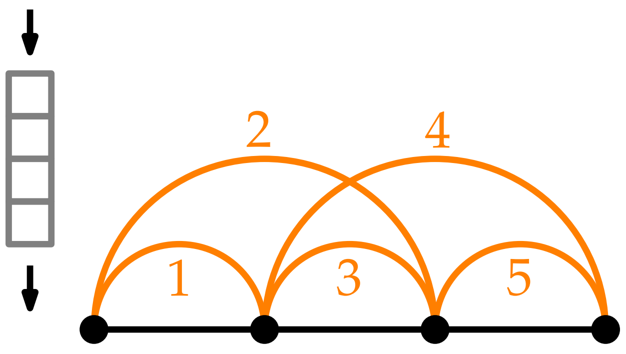

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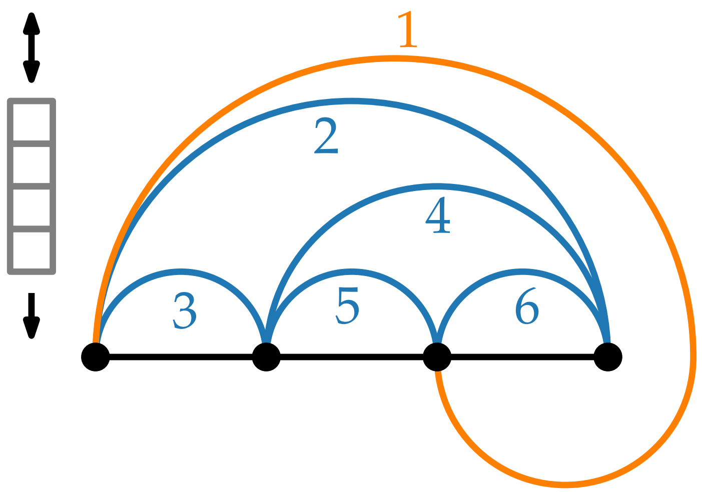
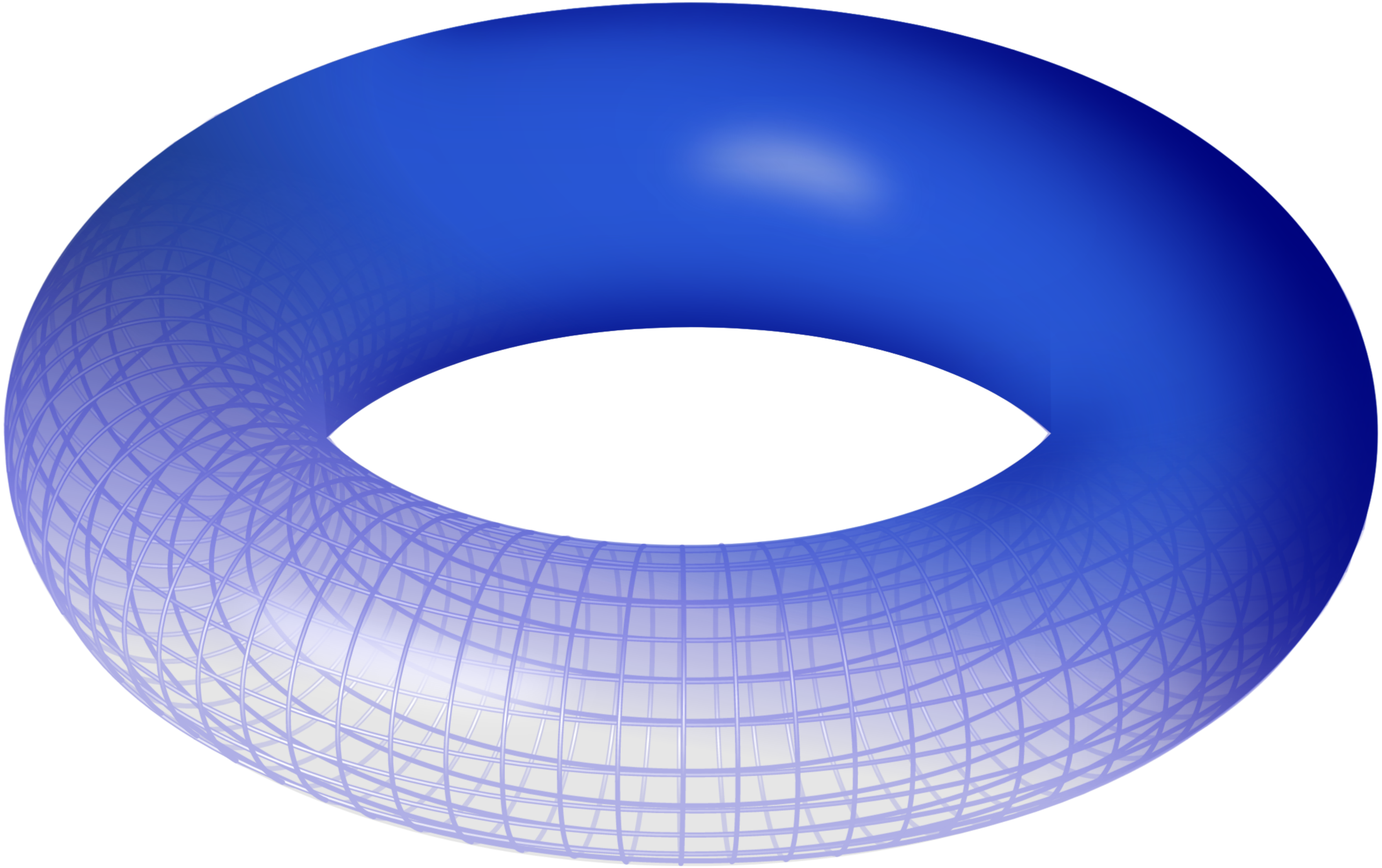


1-page `RIQ`-layout

- `RIQ` stands for *restricted-input queue*: insertions are only allowed at the head, while removals can occur at the head and the tail.

14. Visibility Representations of Toroidal Graphs



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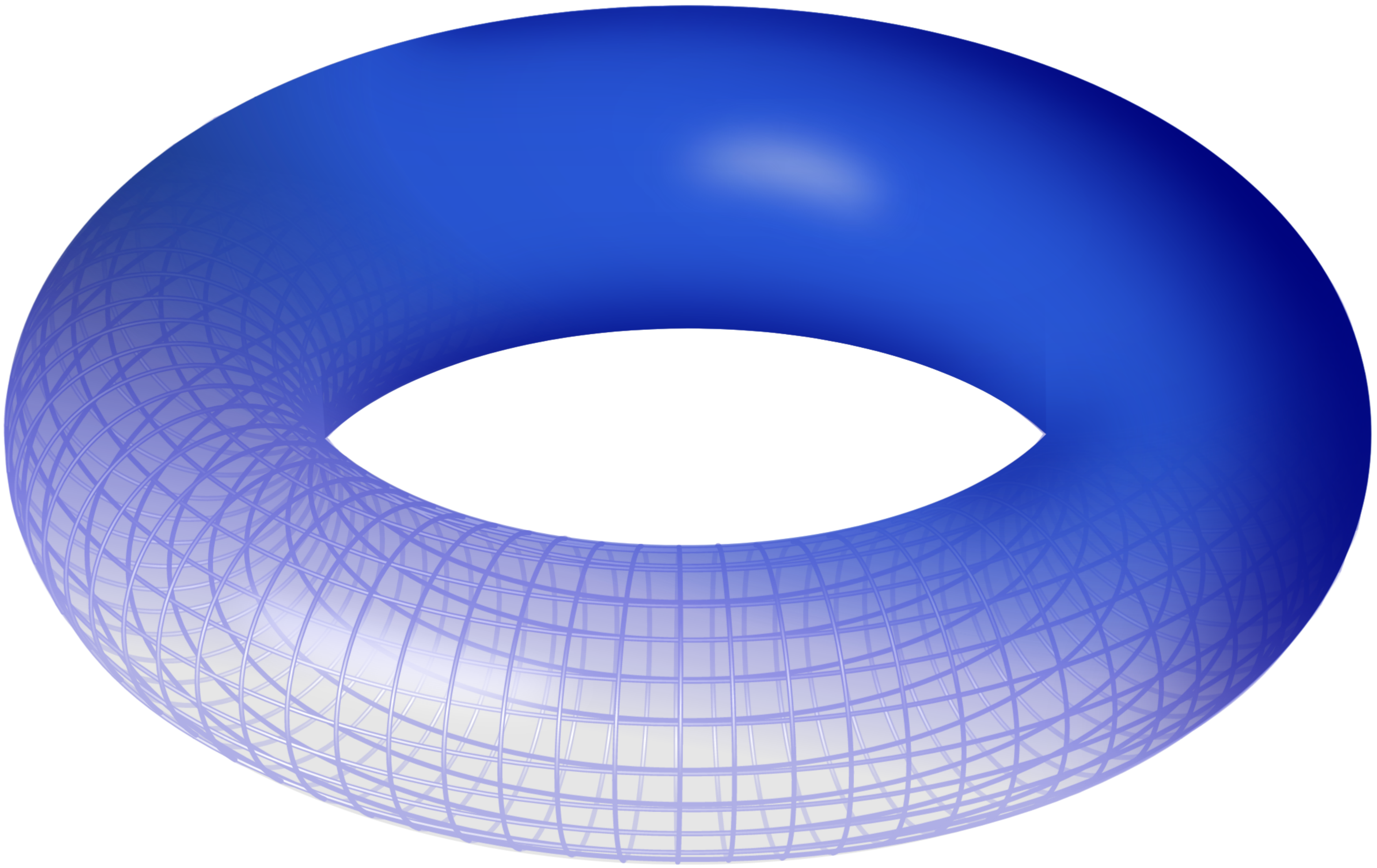

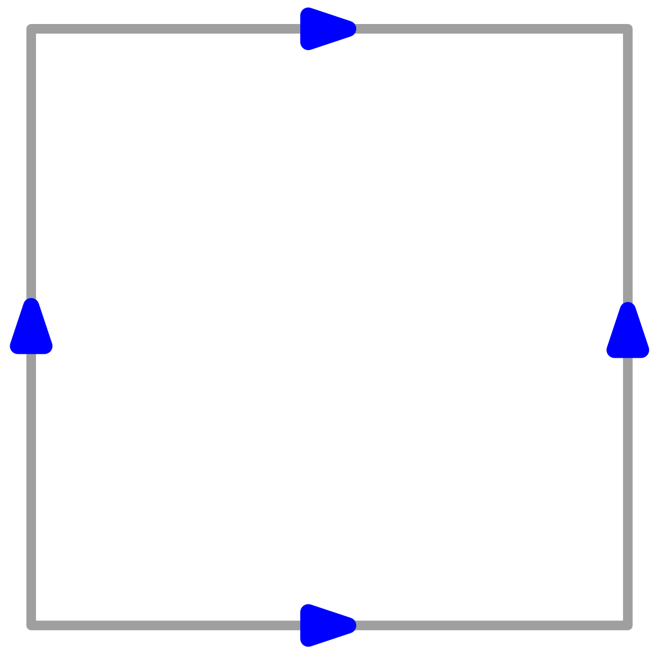

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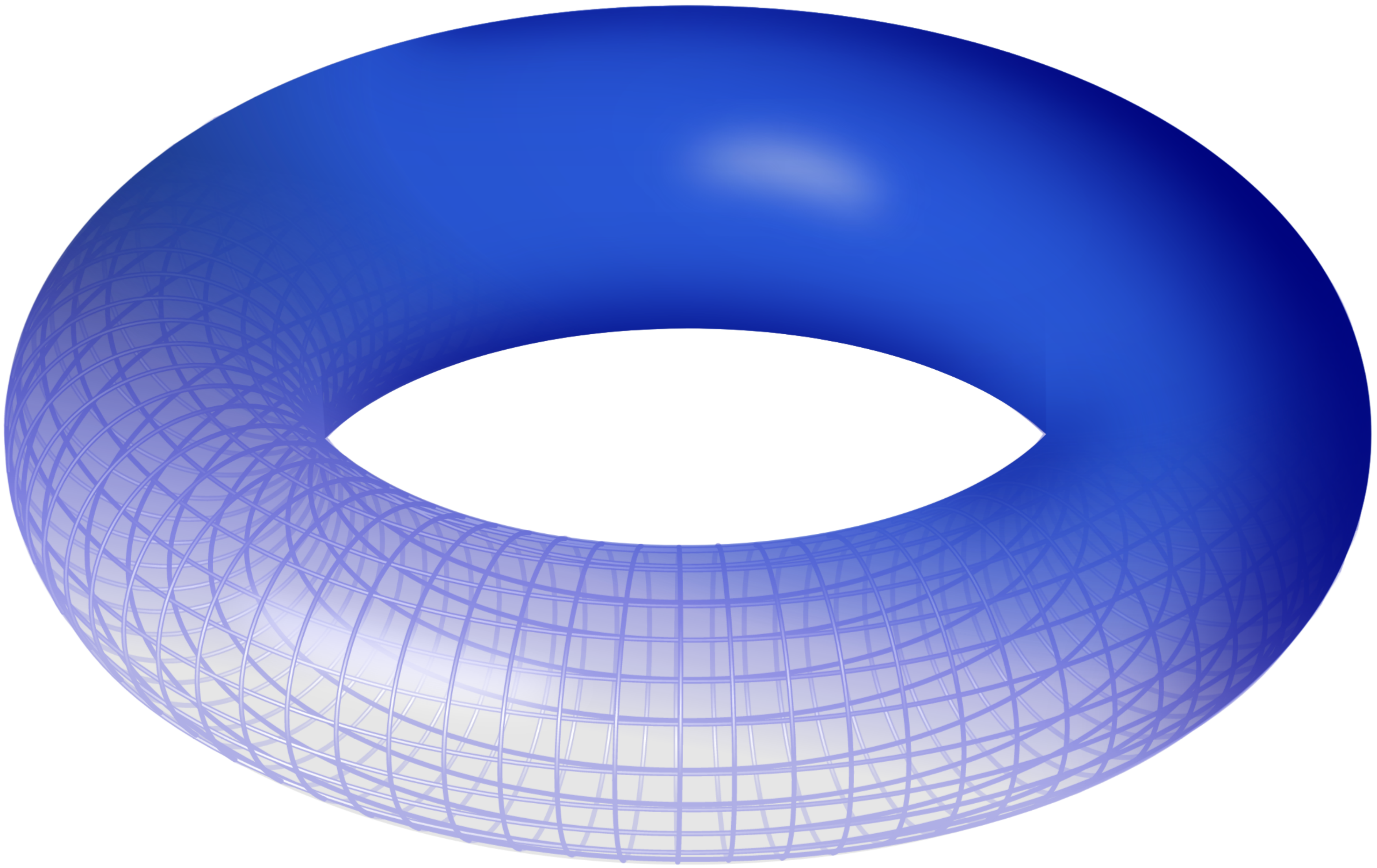

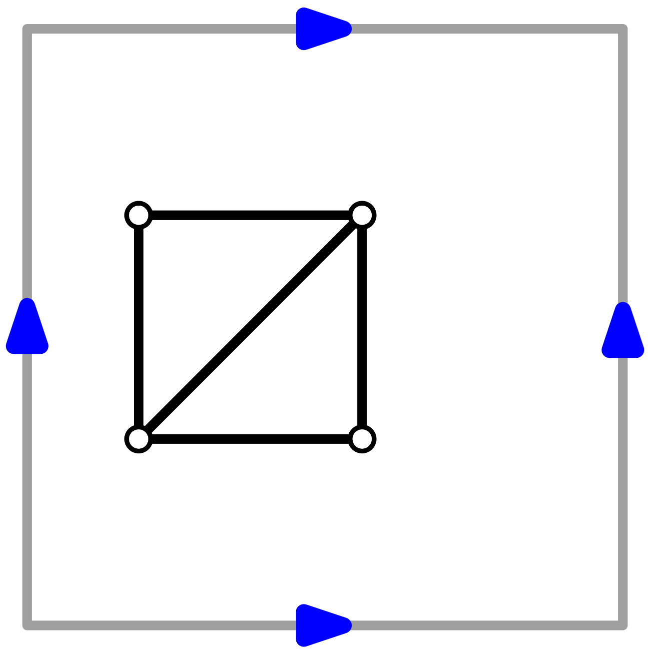

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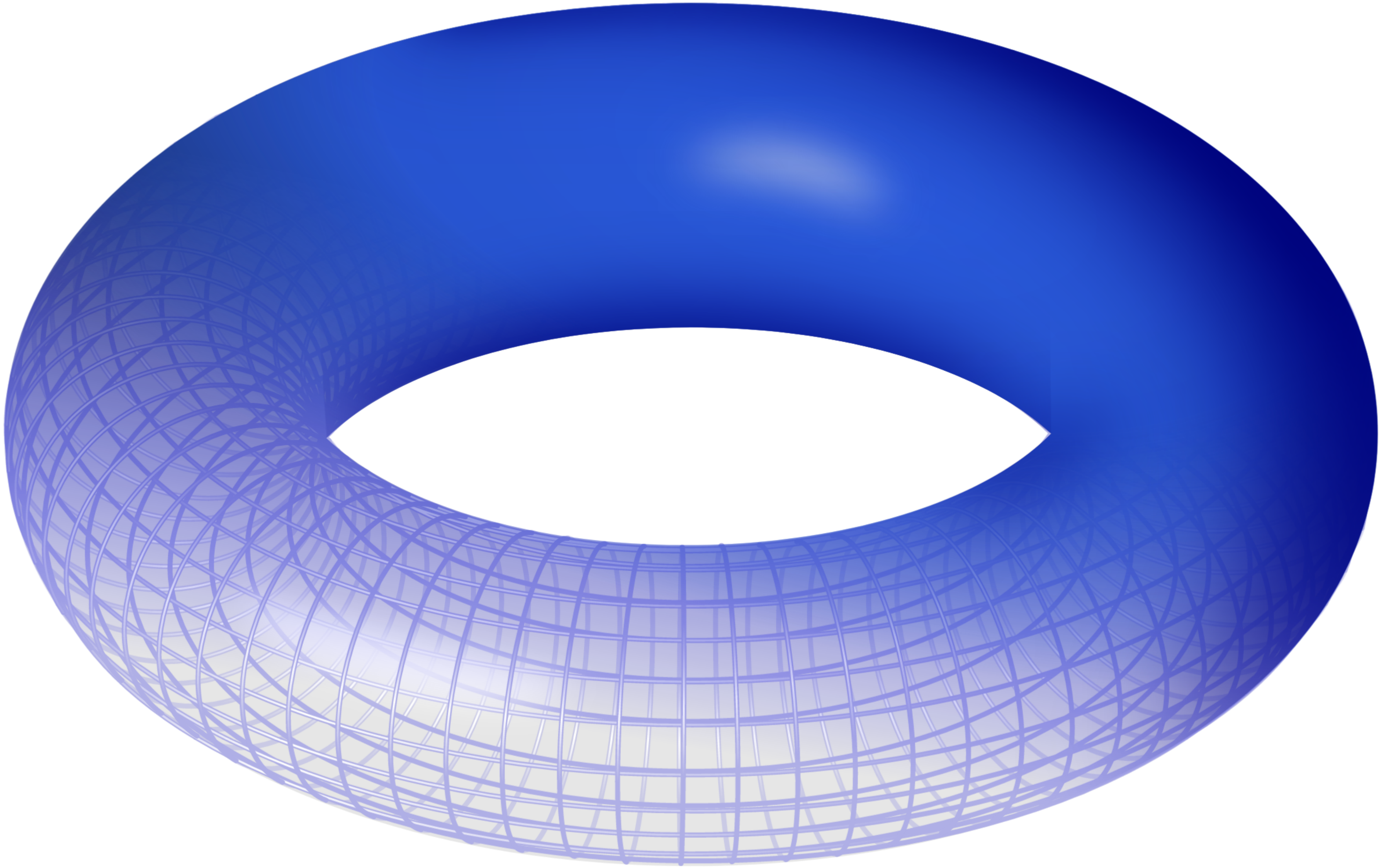

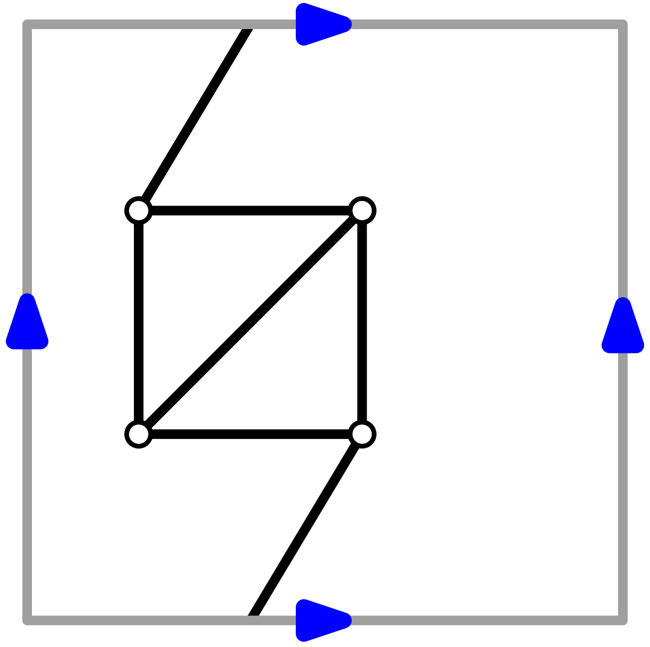

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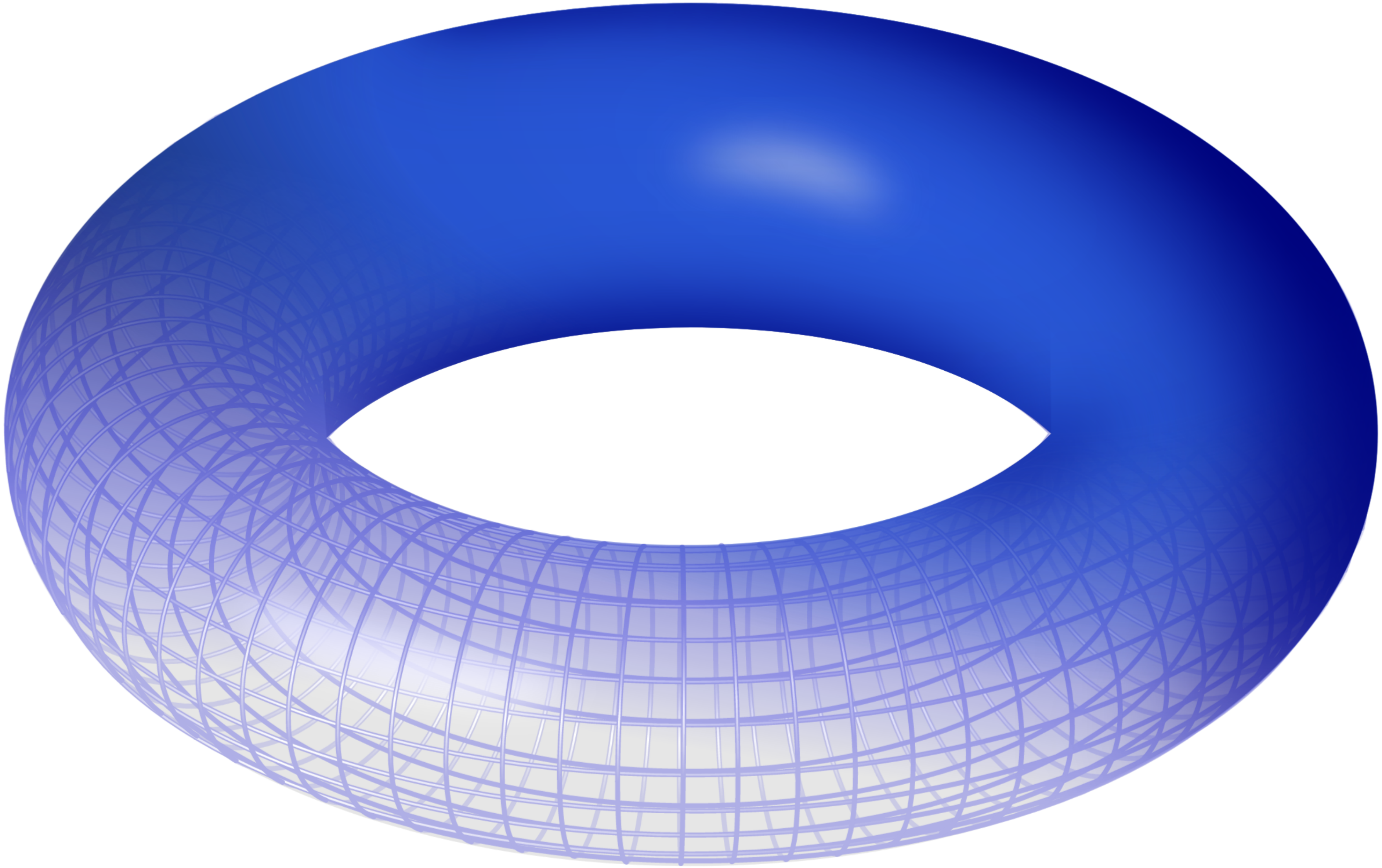

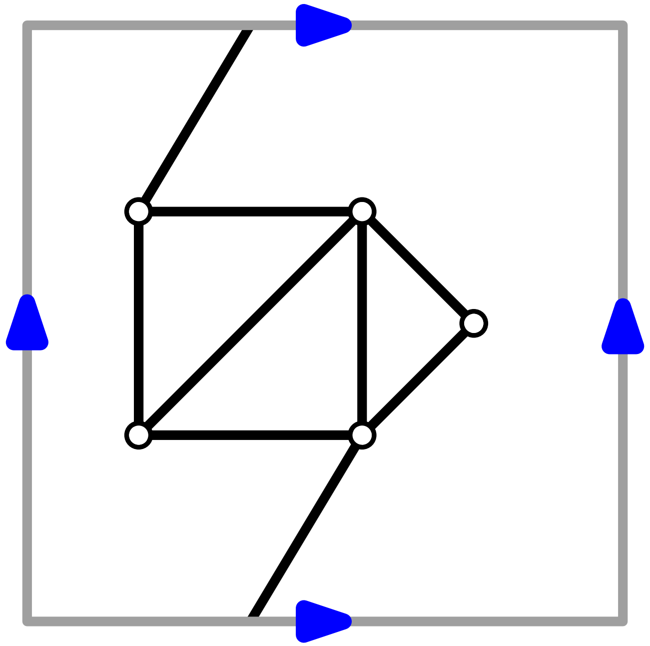

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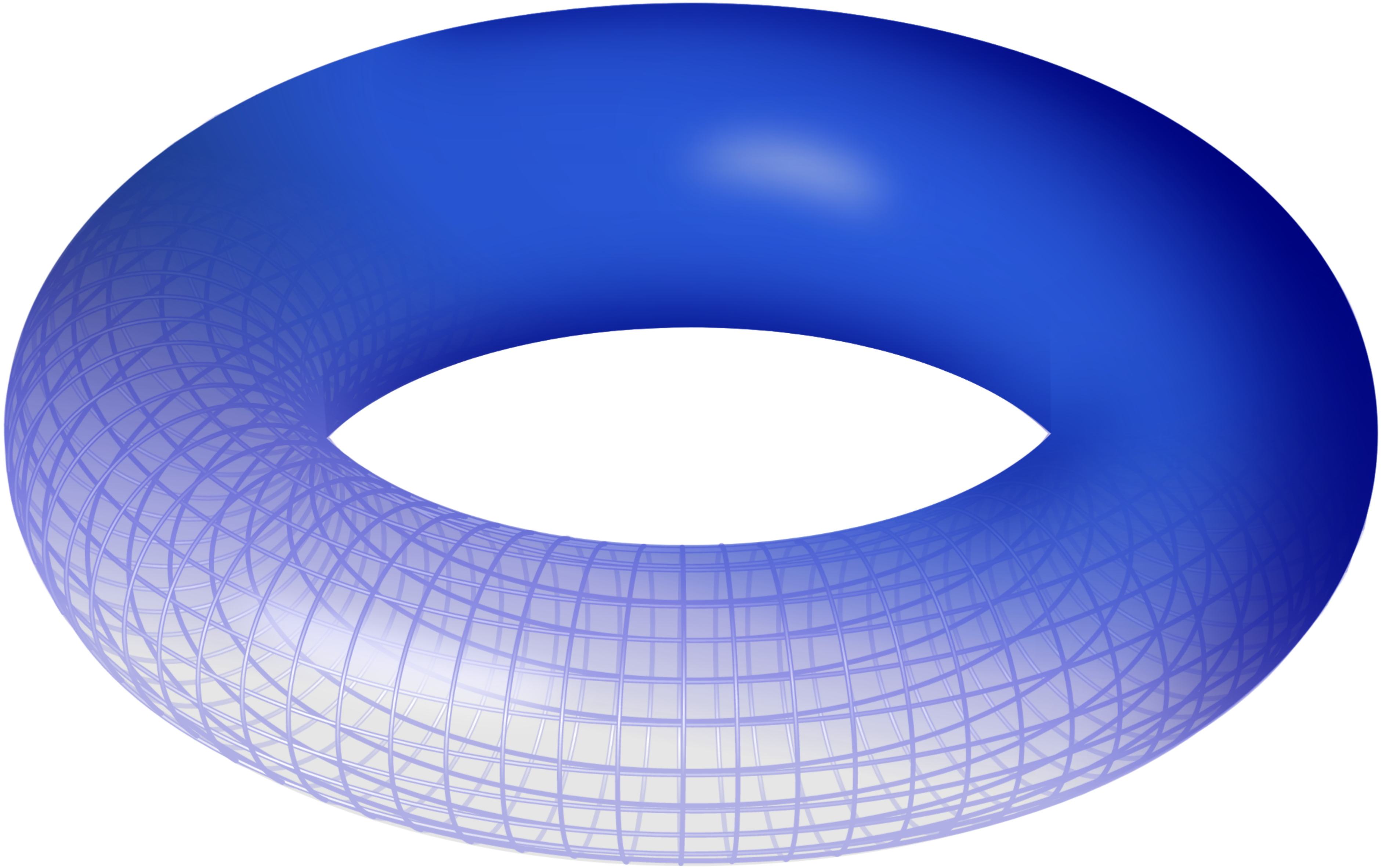

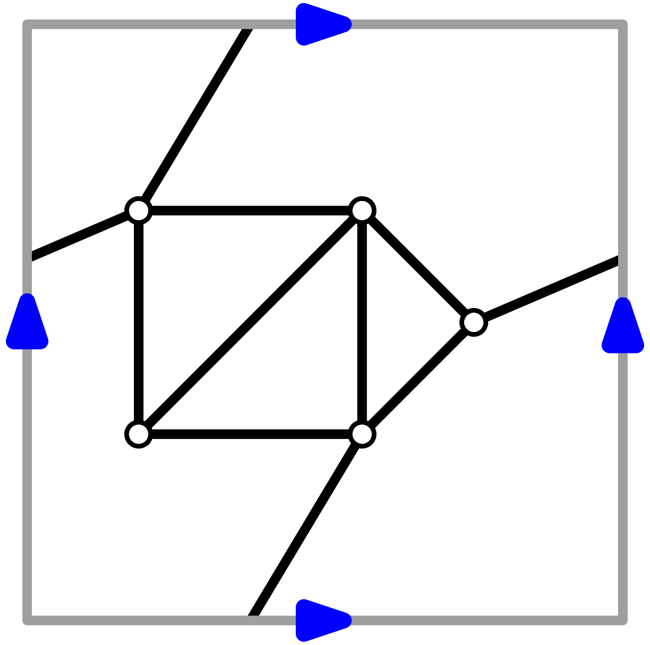

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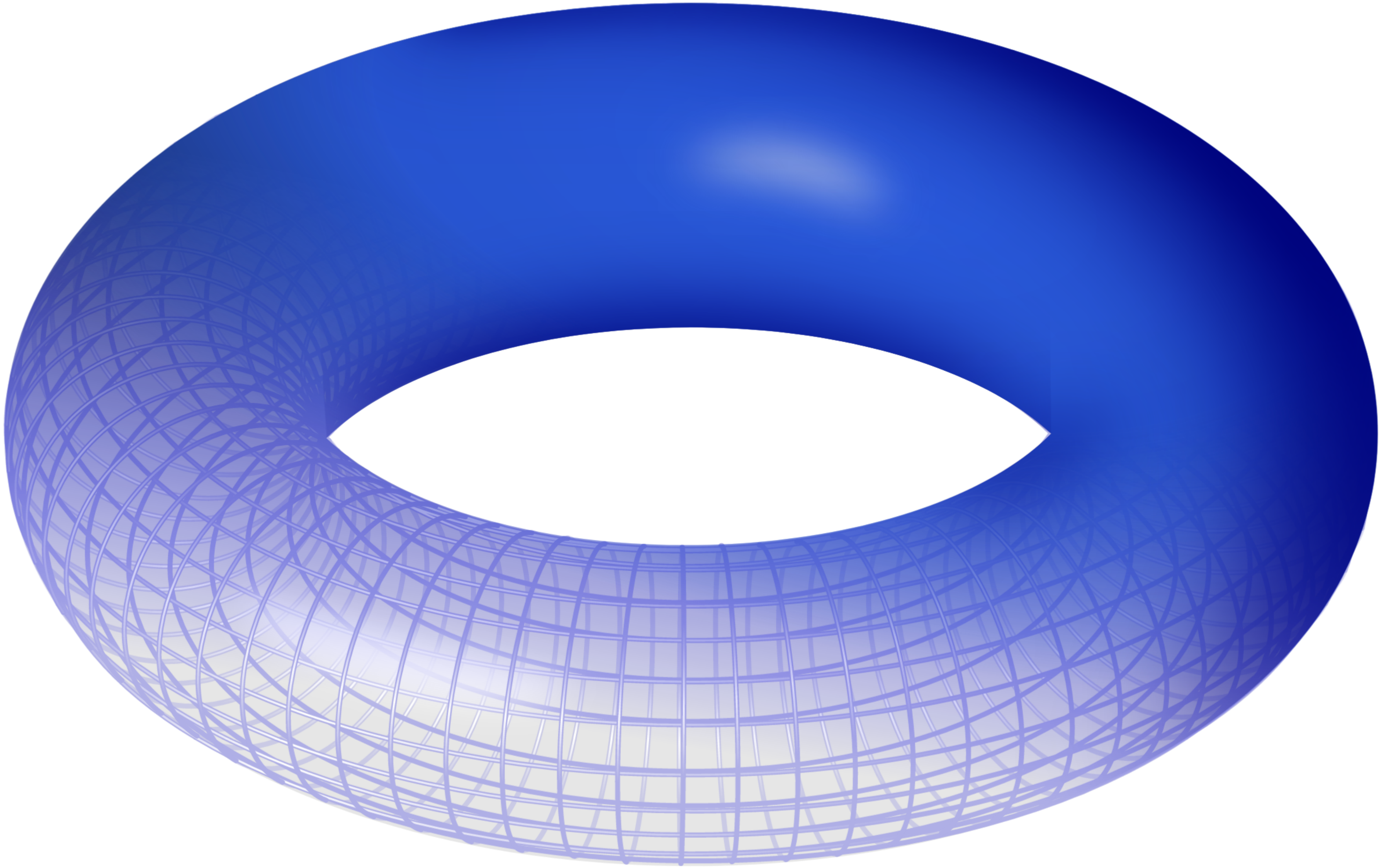

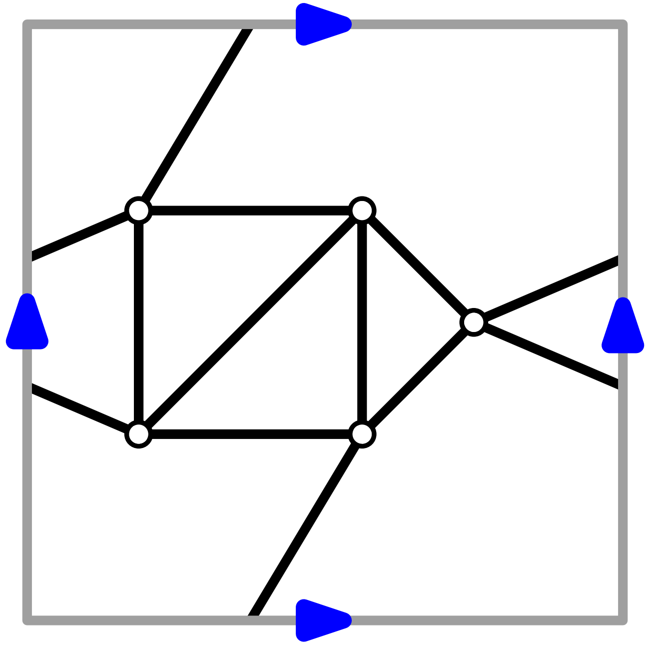

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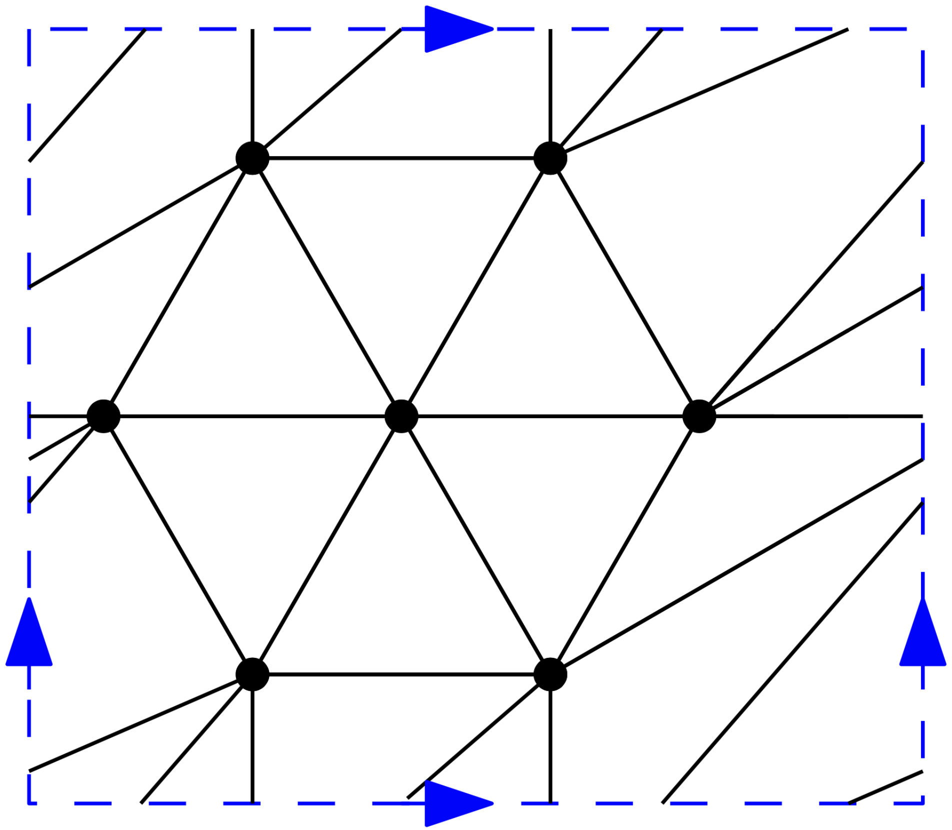
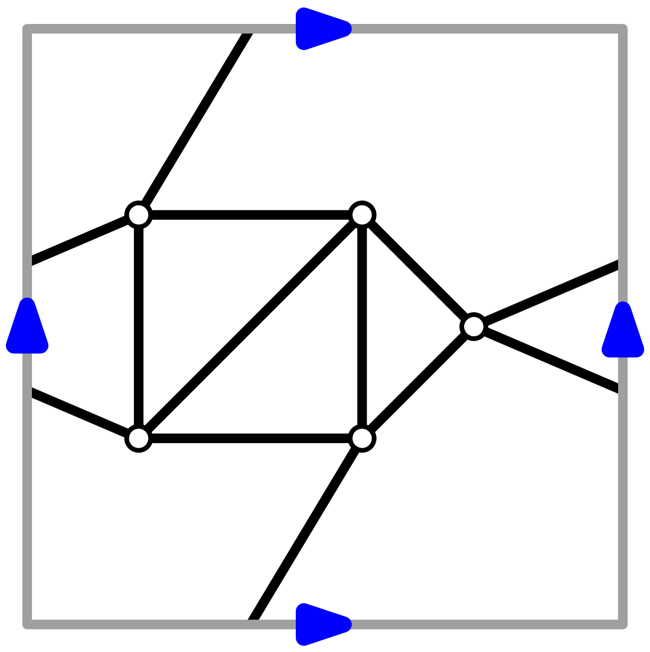


K_5 is toroidal.



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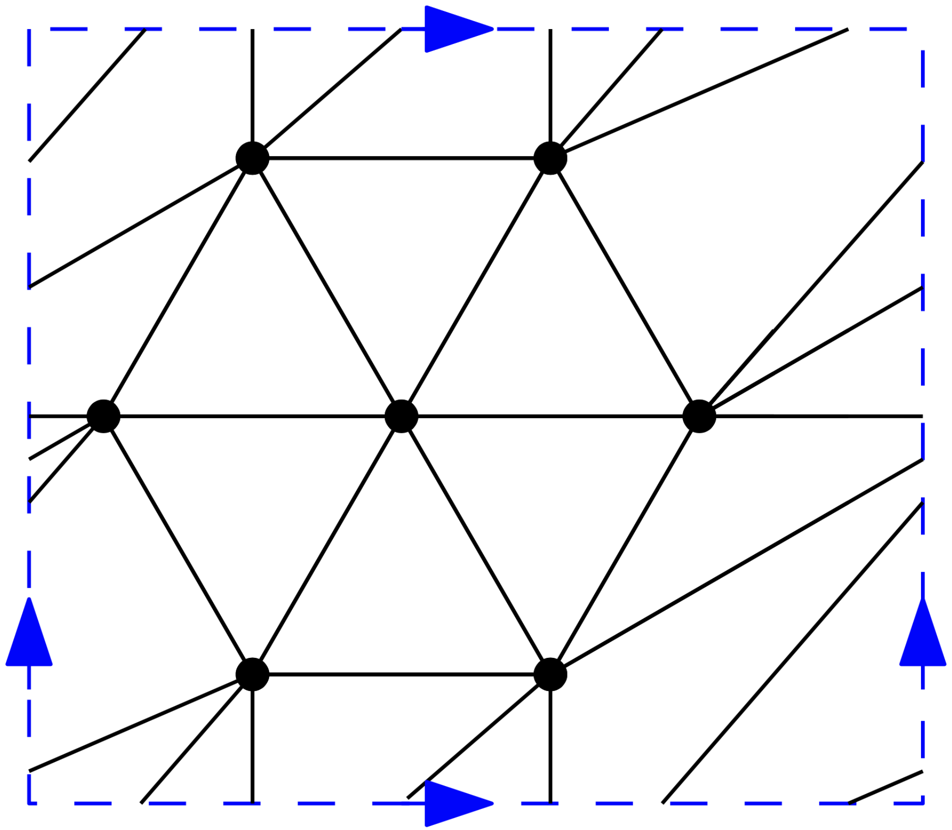

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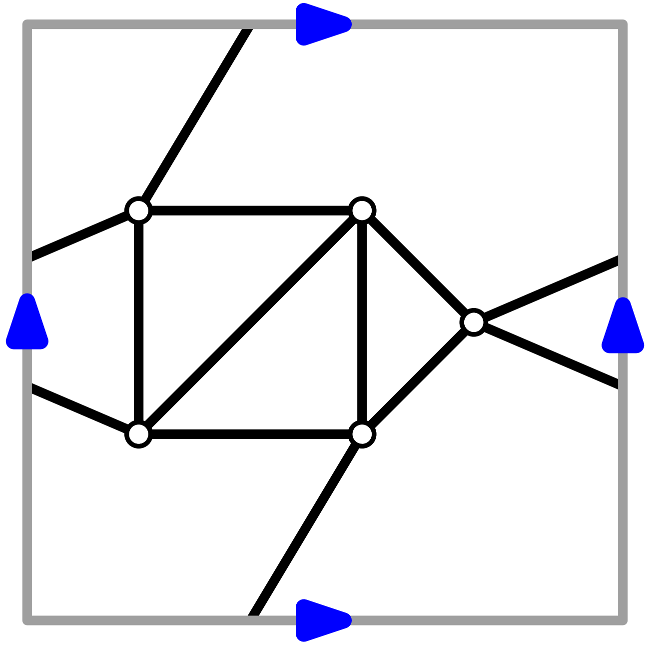

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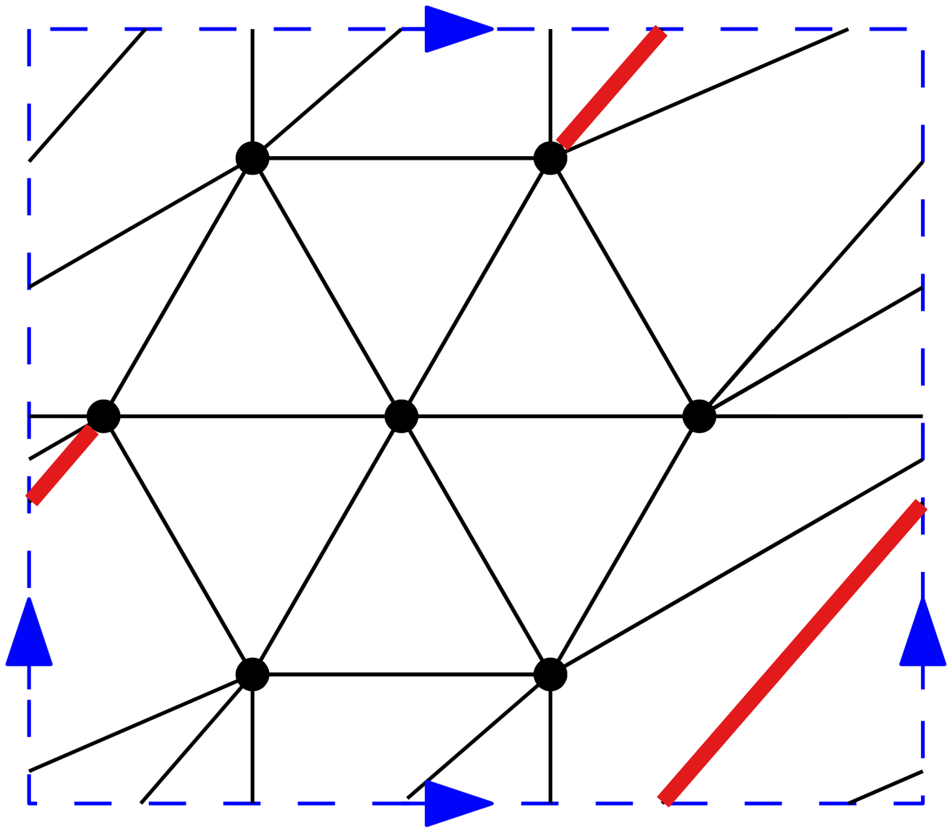

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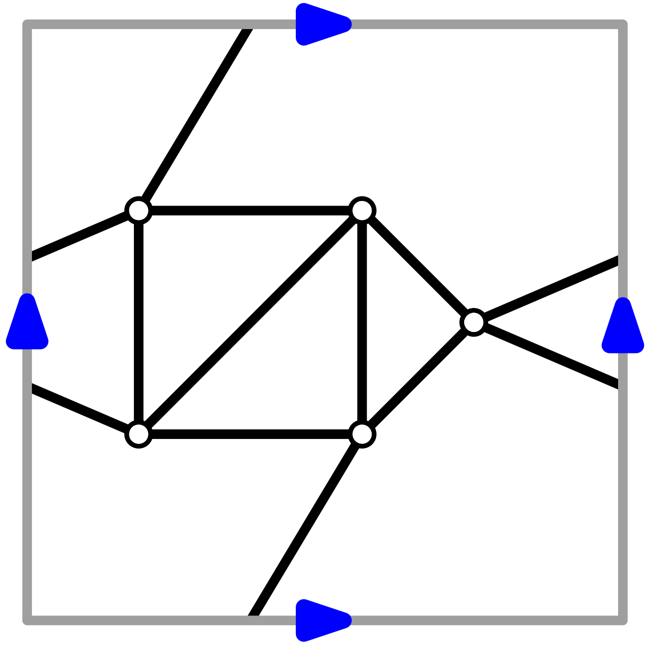

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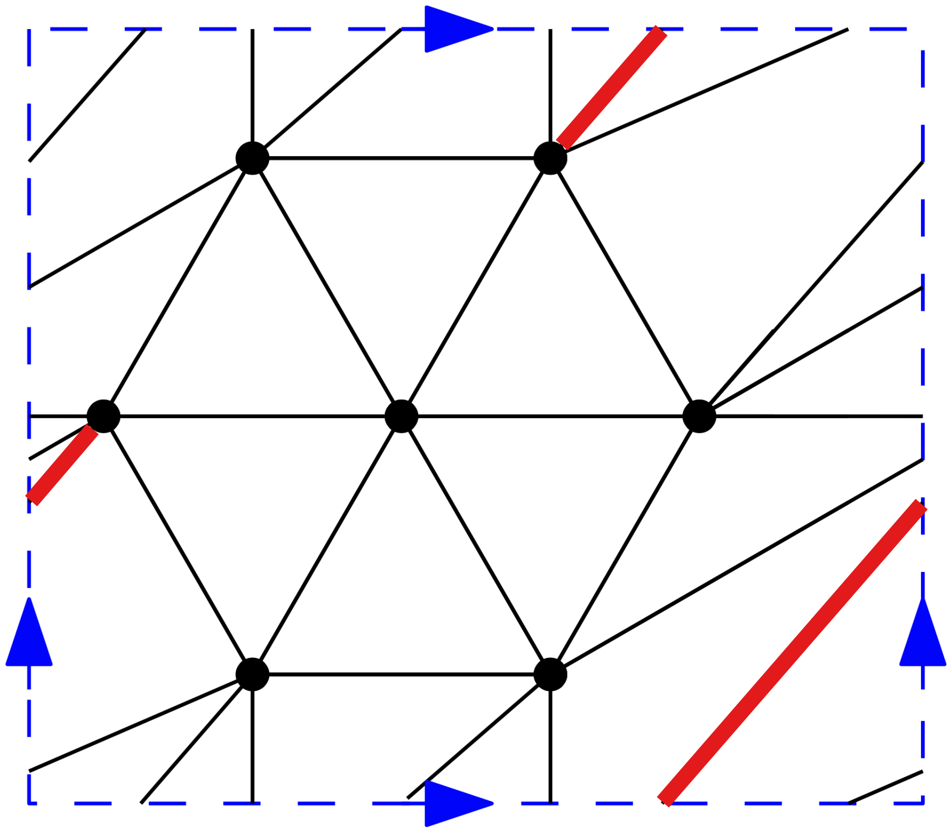

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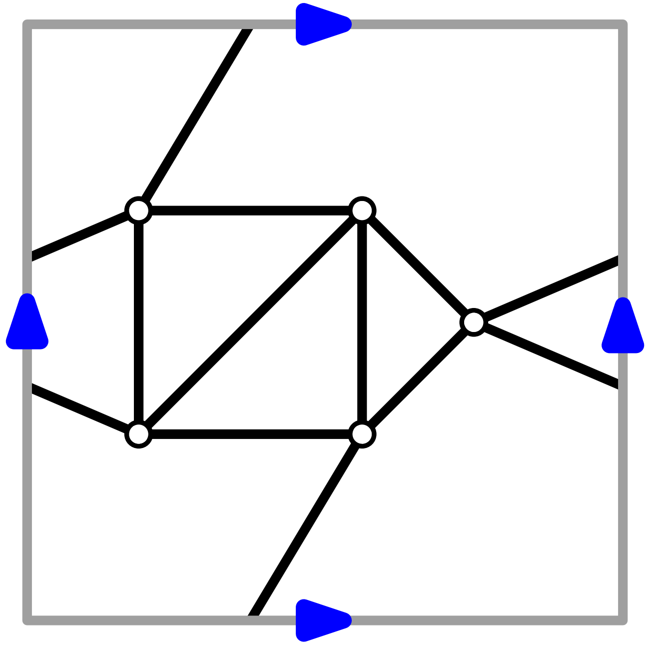
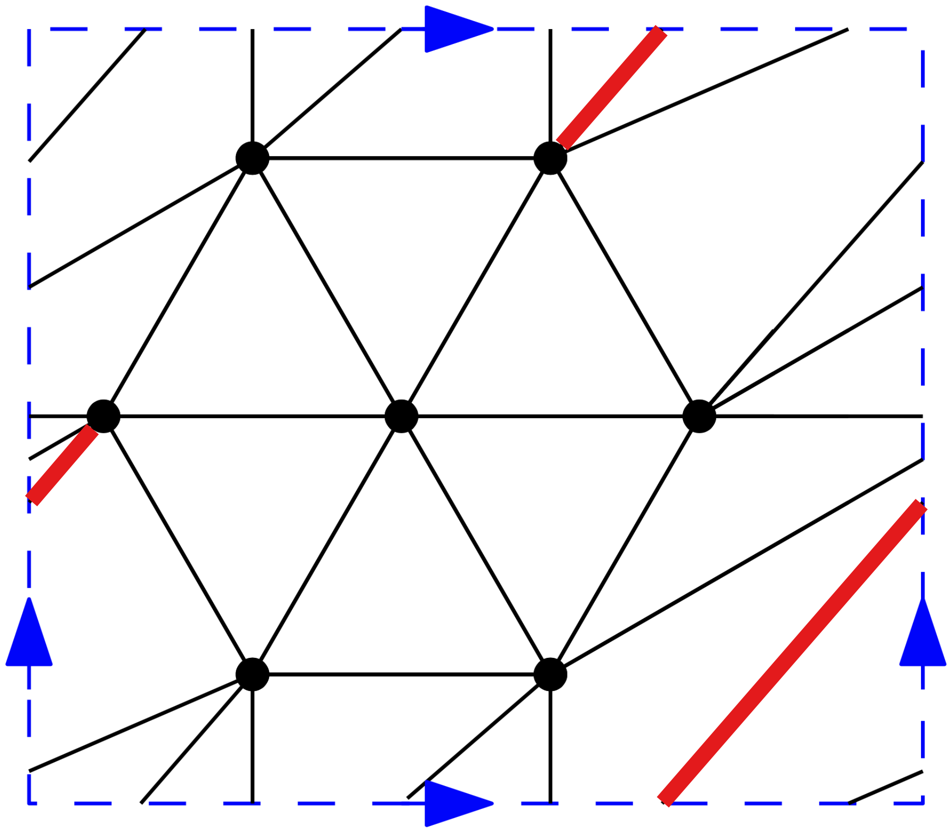


Theorem 1. Let G be a toroidal graph without loops. Then G has a visibility representation on the flat torus. [Mohar & Rosenstiehl, 1998]

14. Visibility Representations of Toroidal Graphs



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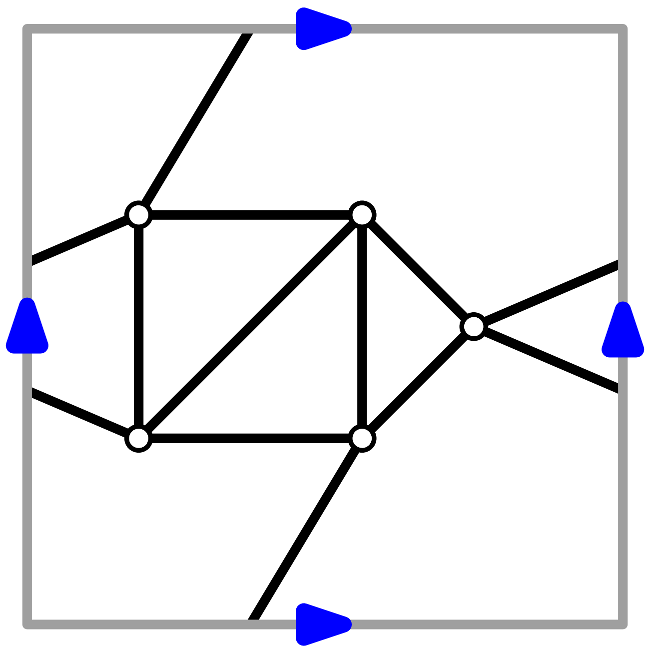
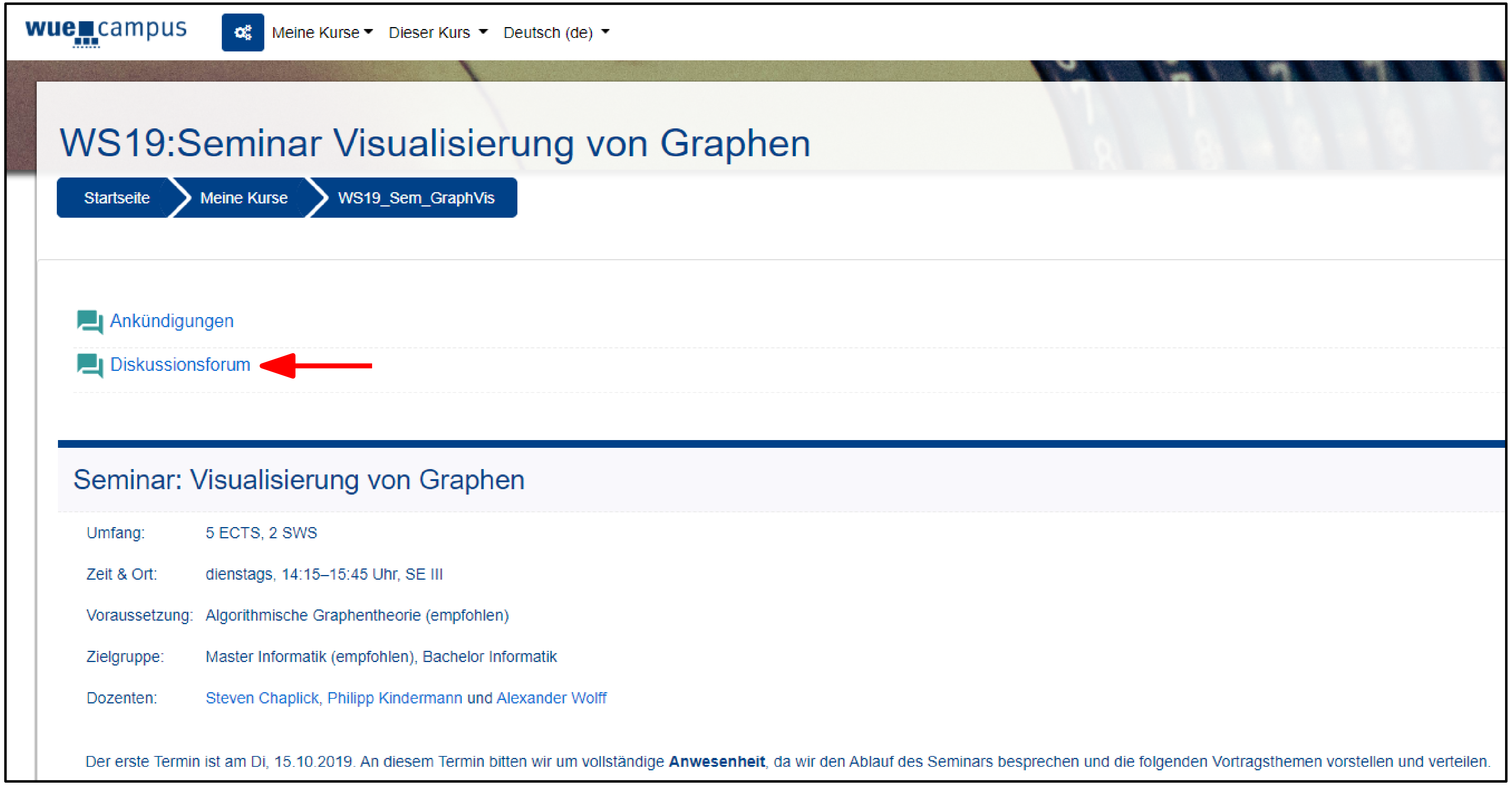


Theorem 1. Let G be a toroidal graph without loops. Then G has a visibility representation on the flat torus. [Mohar & Rosenstiehl, 1998]

Theorem 2. Let G be a toroidal graph without loops. Then G has a visibility representation on the *rectangular* flat torus. [Biedl, 2022]

1. Small Point-Sets Supporting Graph Stories
2. On the Complexity of the Storyplan Problem
3. Compatible Spanning Trees in Simple Drawings of K_n
4. Empty Triangles in Generalized Twisted Drawings of K_n
5. Shooting Stars in Simple Drawings of $K_{m,n}$
6. Mutual Witness Gabriel Drawings of Complete Bipartite Graphs
7. FORBID: Fast Overlap Removal By stochastic Gradient Descent for Graph Drawing
8. Planar Confluent Orthogonal Drawings of 4-Modal Digraphs
9. Strictly-Convex Drawings of 3-Connected Planar Graphs
10. st-Orientations with Few Transitive Edges
11. An FPT Algorithm for Bipartite Vertex Splitting
12. Queue Layouts of Two-Dimensional Posets
13. The Rique-Number of Graphs
14. Visibility Representations of Toroidal and Klein-bottle Graphs

Diskussionsforum



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- In den Kurs einschreiben

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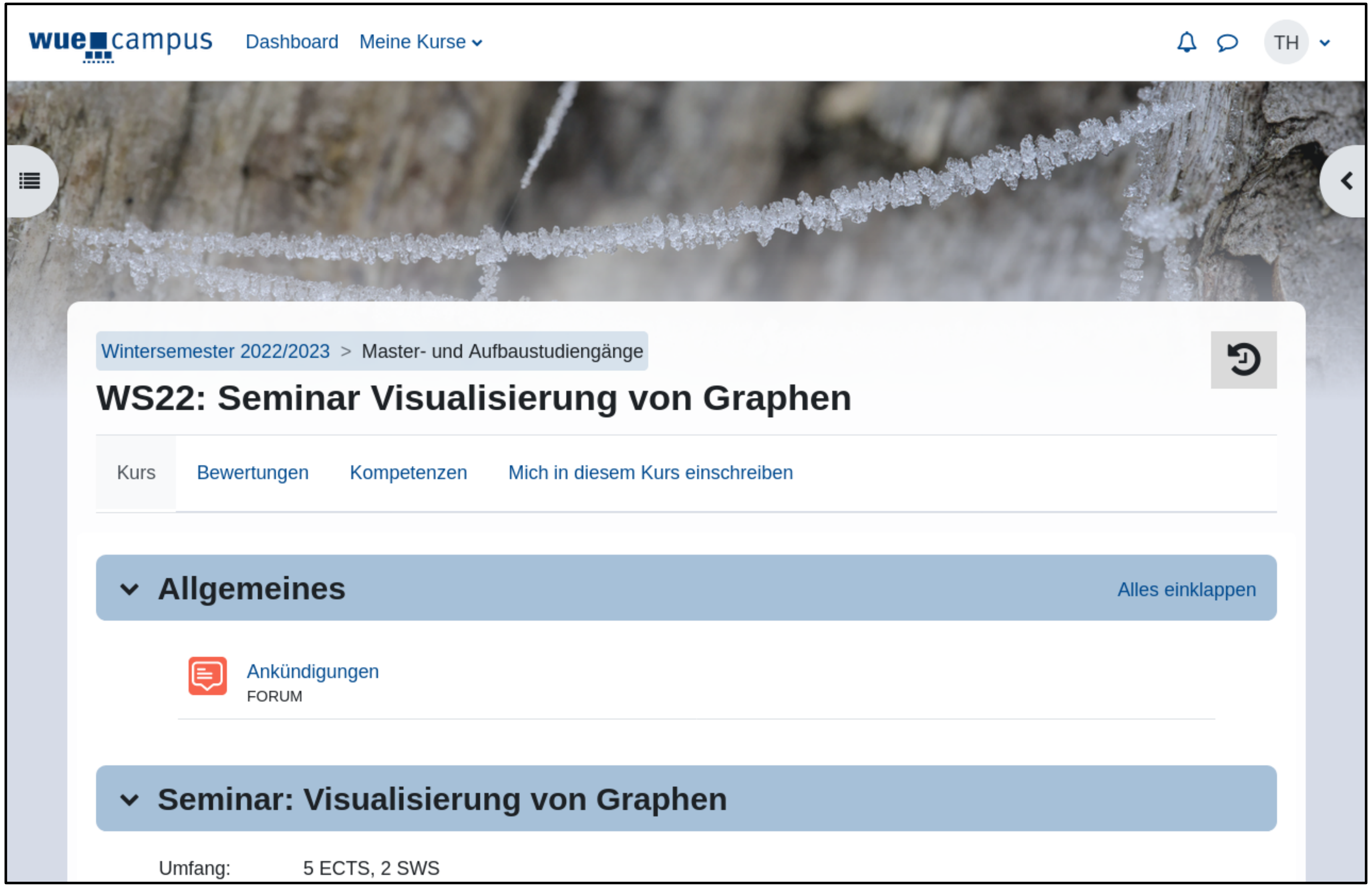

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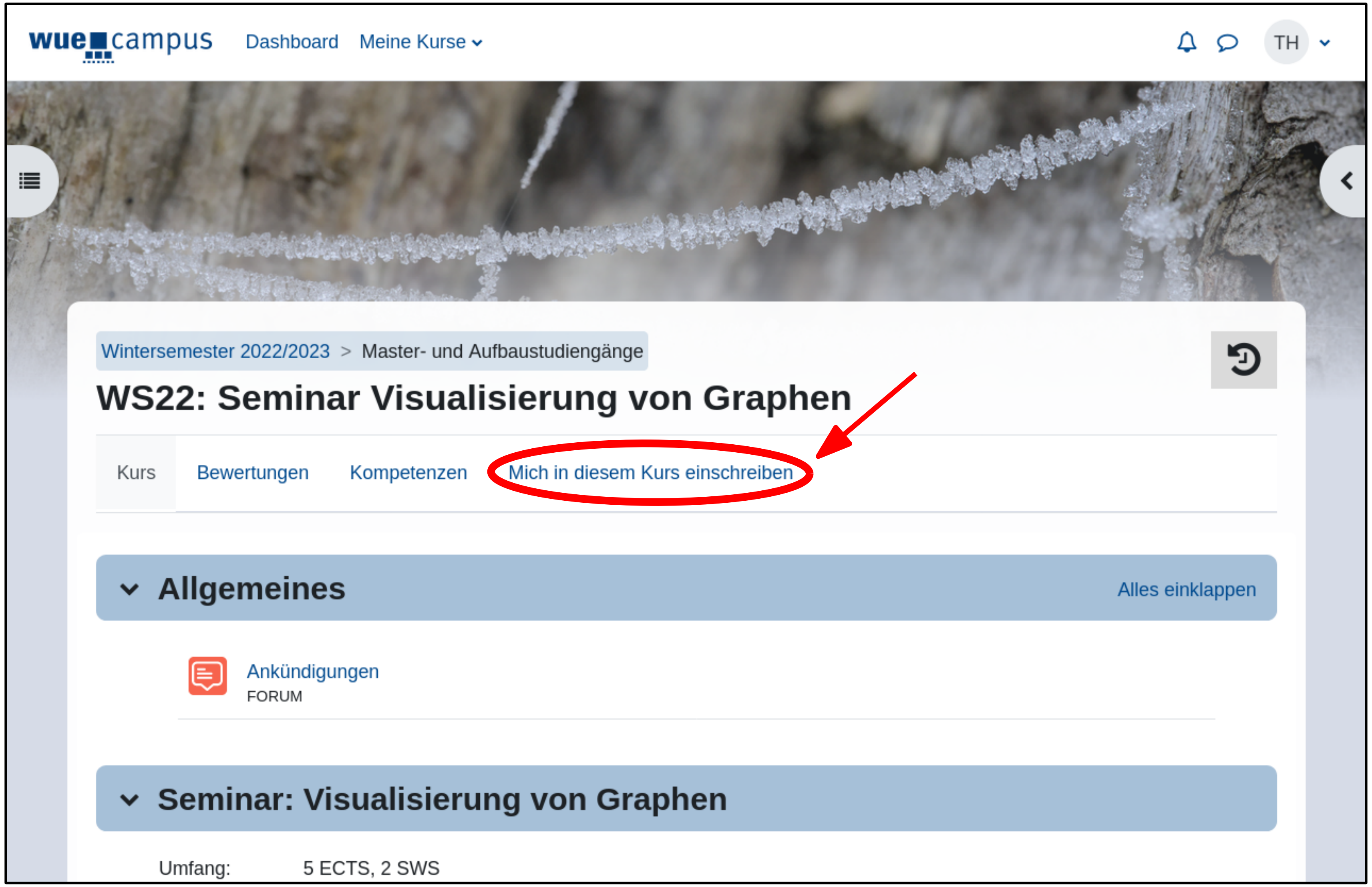

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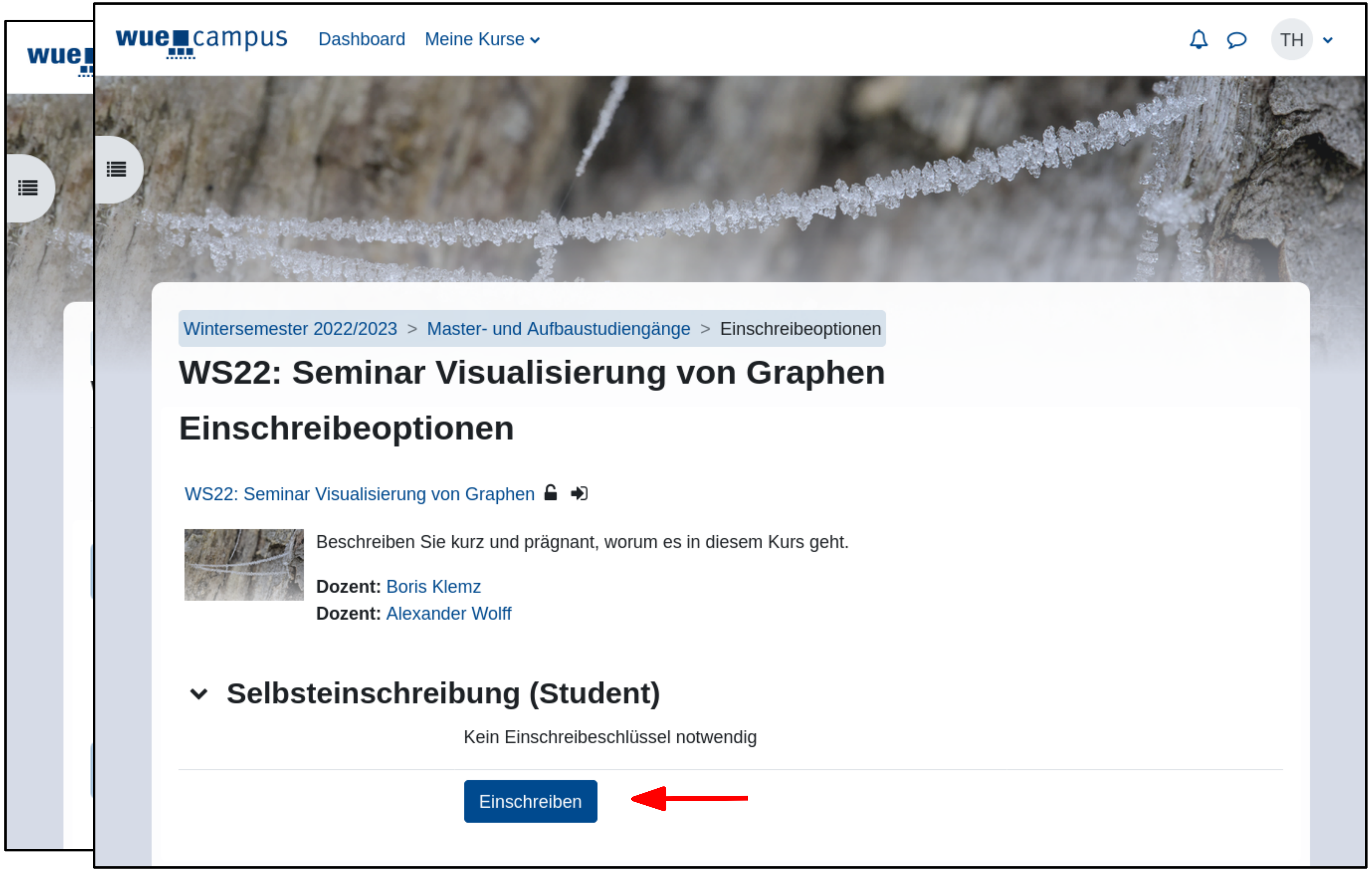

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Zum Abschluß: Demonstration des Programms IPE

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