



Julius-Maximilians-

UNIVERSITÄT
WÜRZBURG

Lehrstuhl für

INFORMATIK I

Algorithmen & Komplexität



Institut für Informatik

Seminar: Visualisierung von Graphen

Wintersemester 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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Inhalte:

- Ausblick auf den eigentlichen Vortrag geben
- Problem motivieren
- Wichtigste Resultate vorstellen

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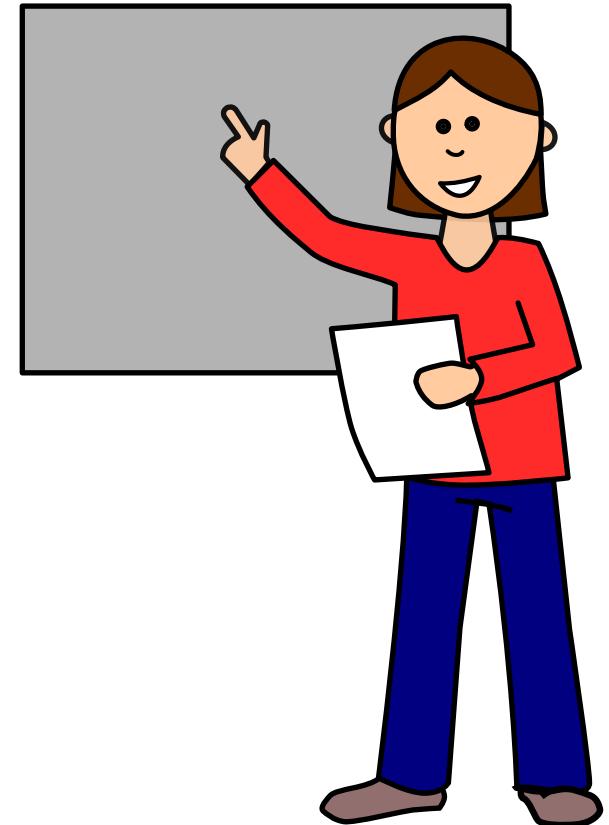
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Ziele:

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

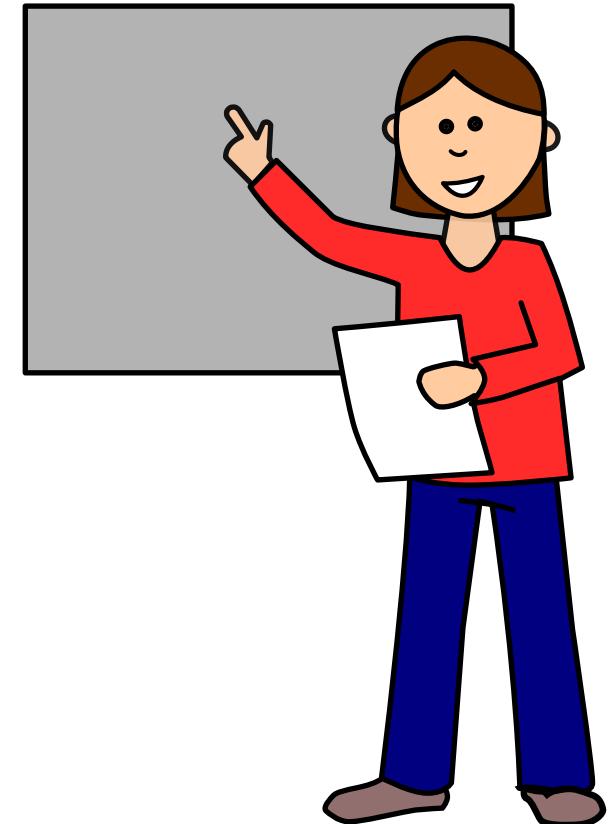
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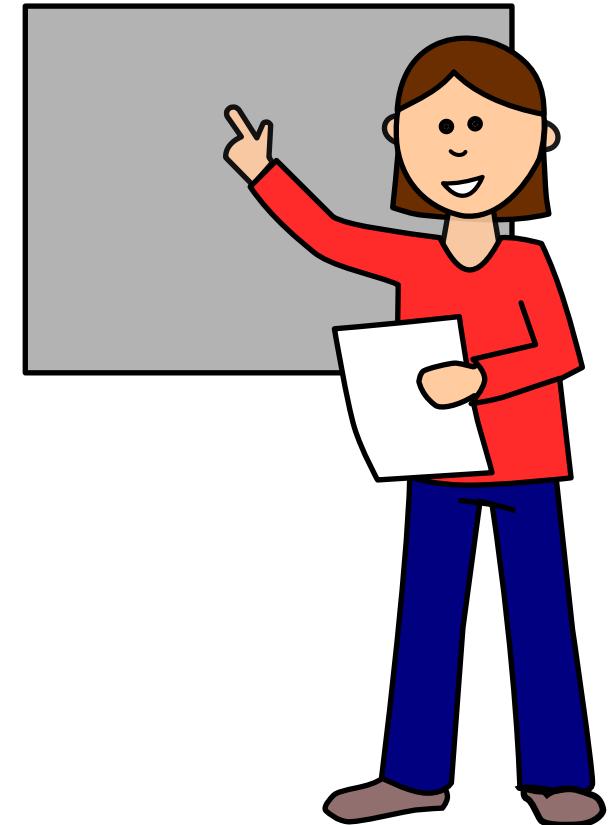
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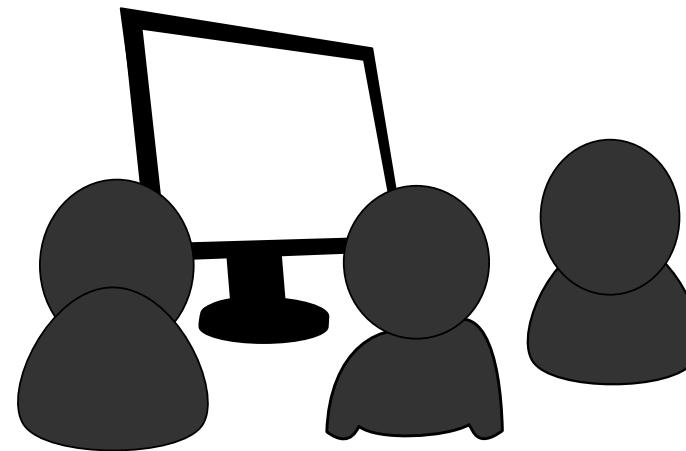
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- Mo, 27.02.2023: **Ausarbeitungen** abgeben



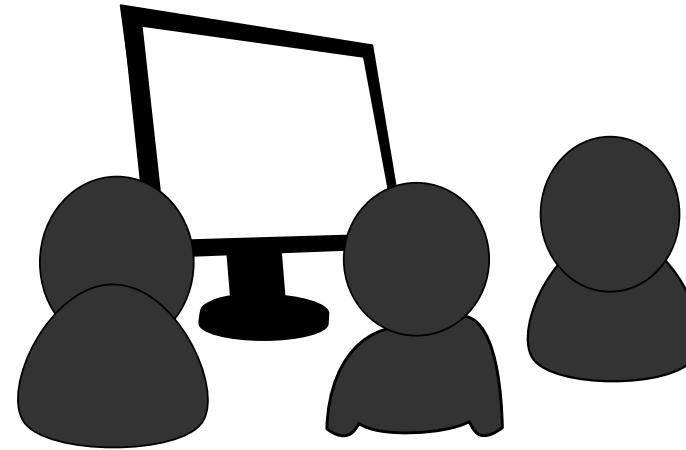
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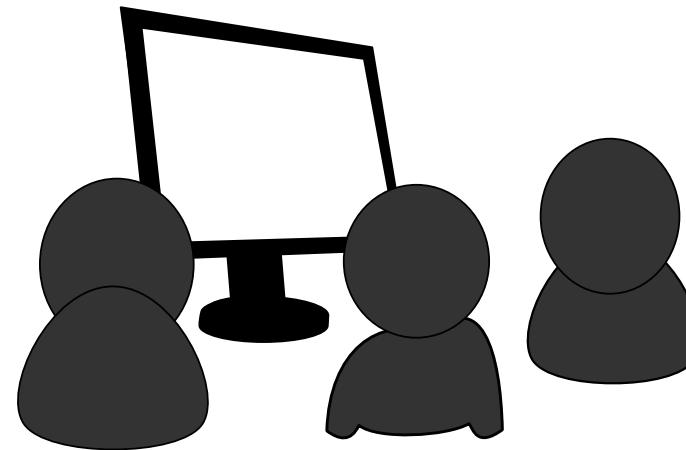


Das reicht i.d.R. nicht um alles im Detail zu besprechen!

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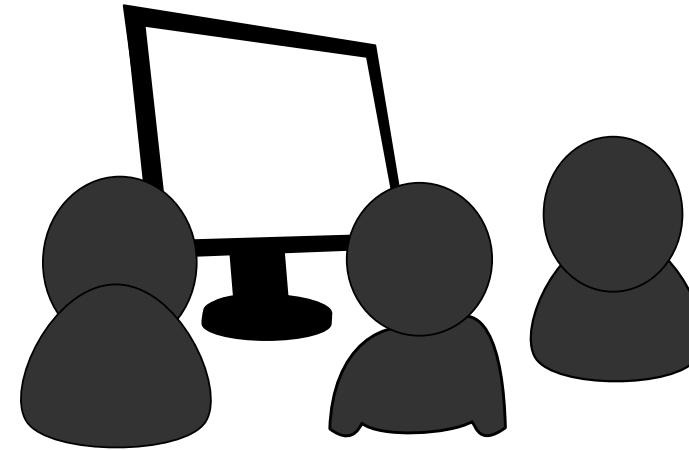
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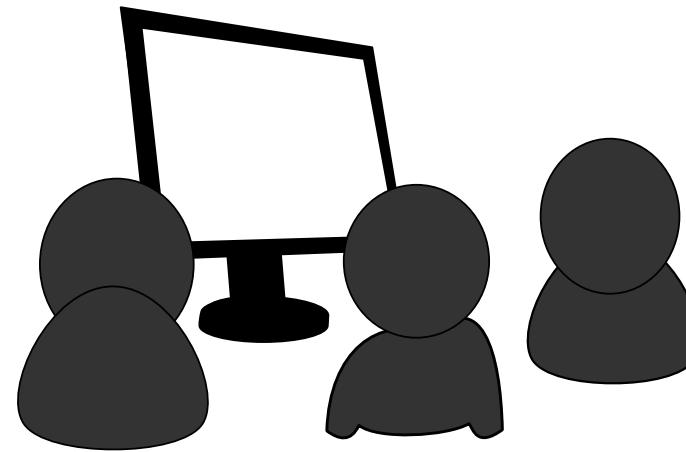
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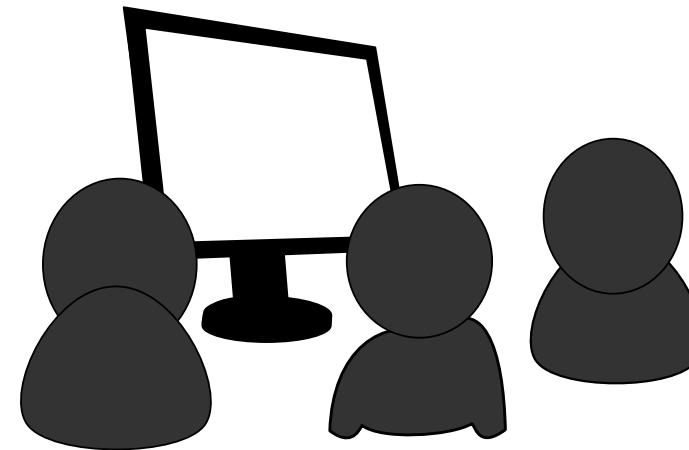
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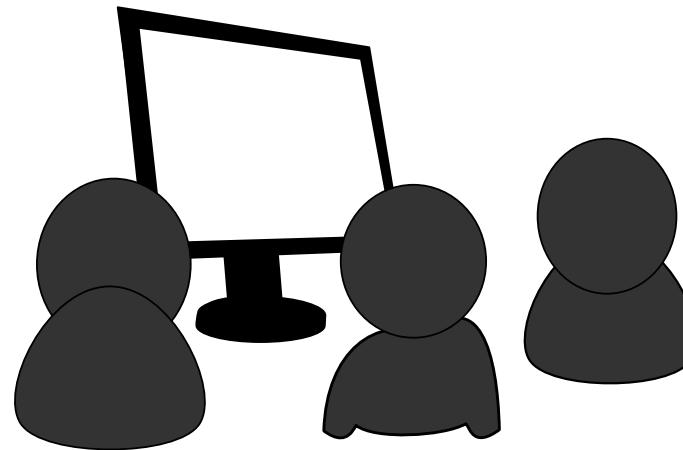
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(Übungsaufgaben, interaktive Beispiele, Besprechung
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Ideen aus der Diskussion in die Ausarbeitung mitaufnehmen!

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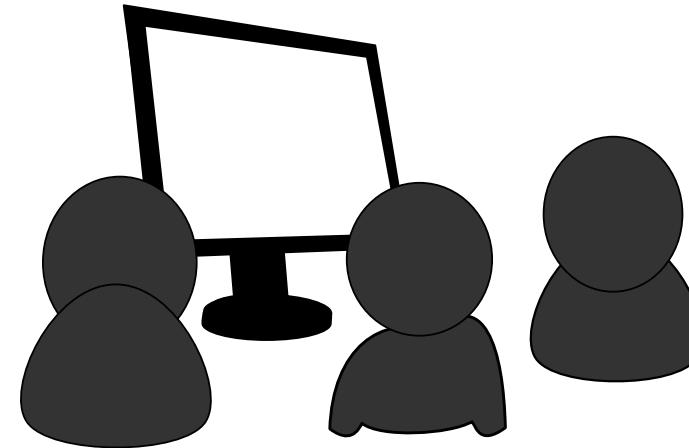
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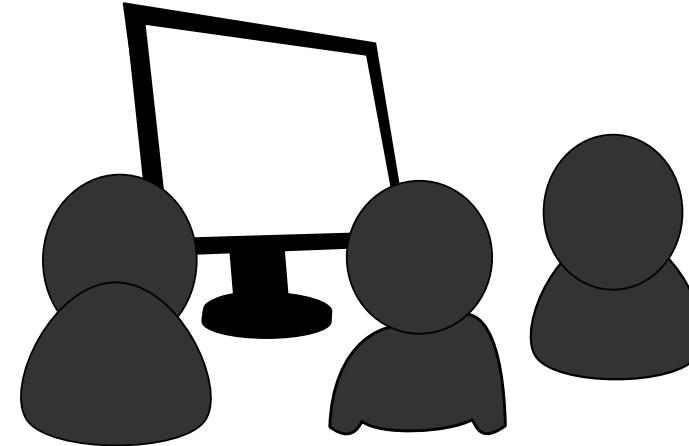
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Diese Termine sind **strikt**
(außer für den 1. Vortrag)!

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- alleine 7–9, zu zweit 11–13 Seiten;



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- Verbindungen zu anderen Vortragsthemen
- L^AT_EX-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
- Einmaliges Fehlen ist erlaubt
- Teilnahme an den Diskussionen

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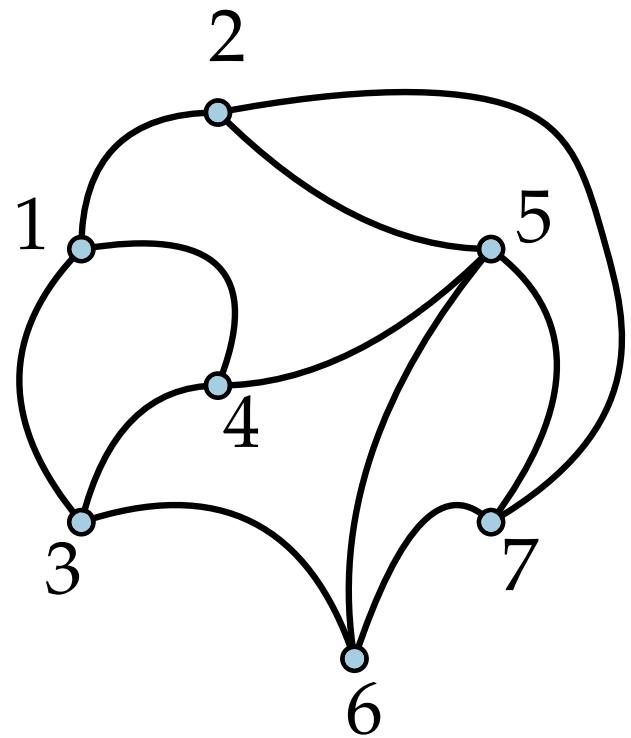
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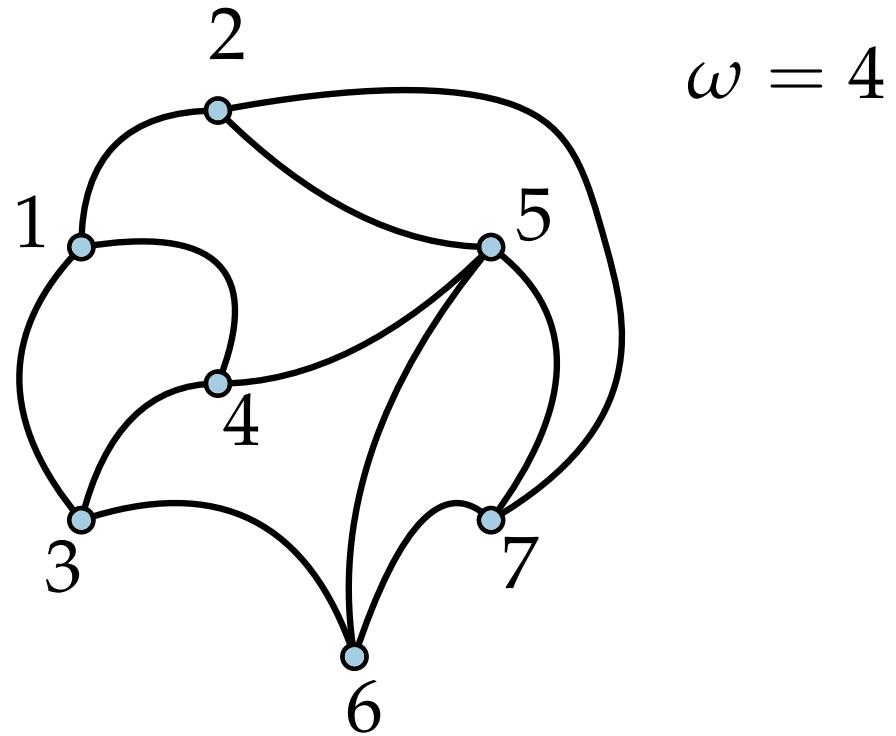
- Vortrag (Inhalte, Gestaltung der Folien, Verständlichkeit)
- Ausarbeitung (Inhalte, sprachliche Darstellung, Rechtschreibung, Verbindungen zu anderen Themen)
- 50 : 50

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

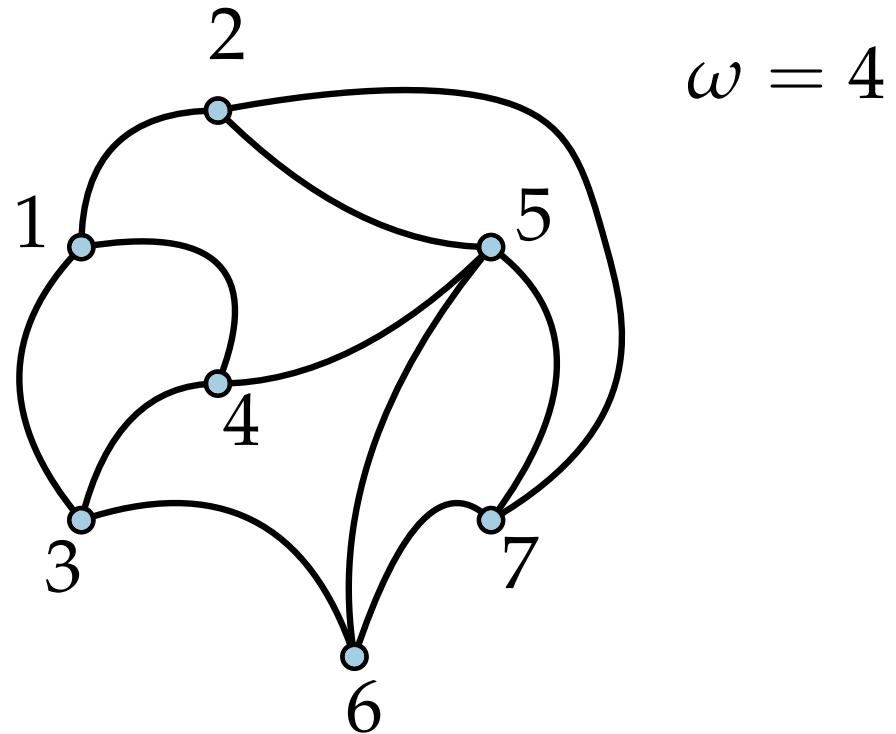
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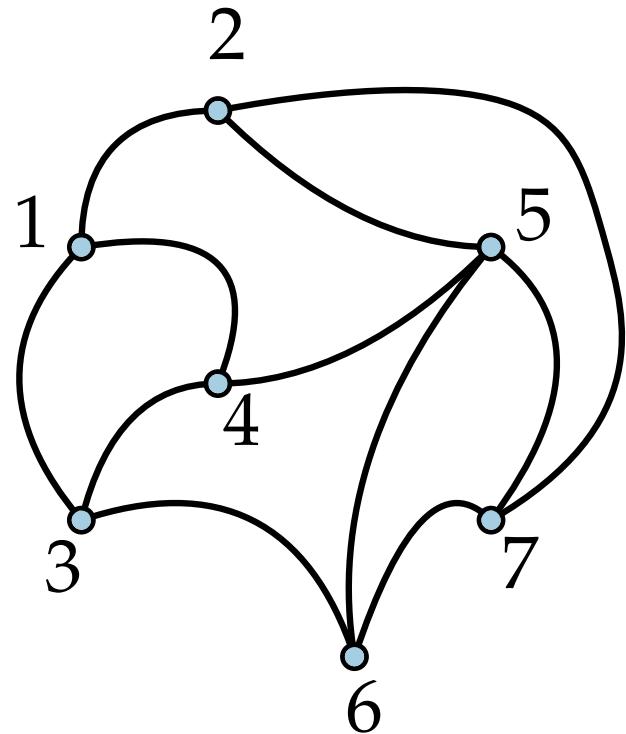


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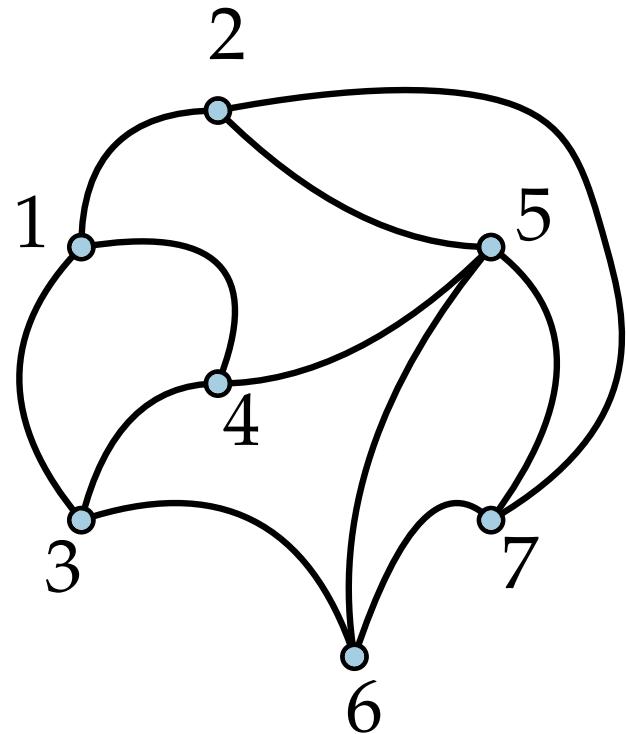
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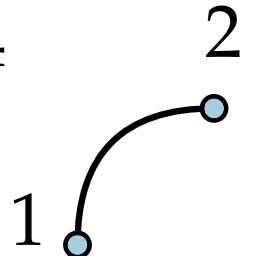
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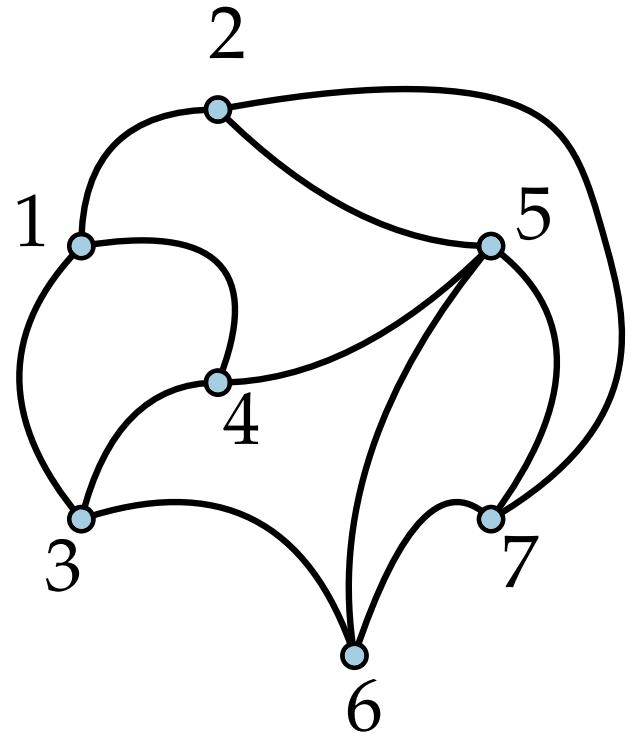
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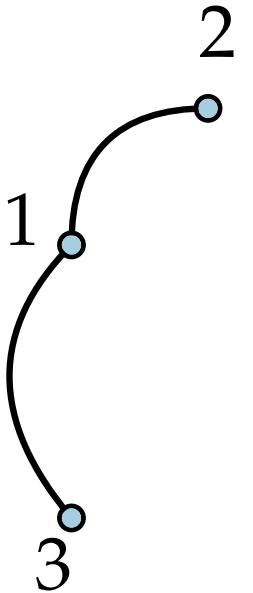
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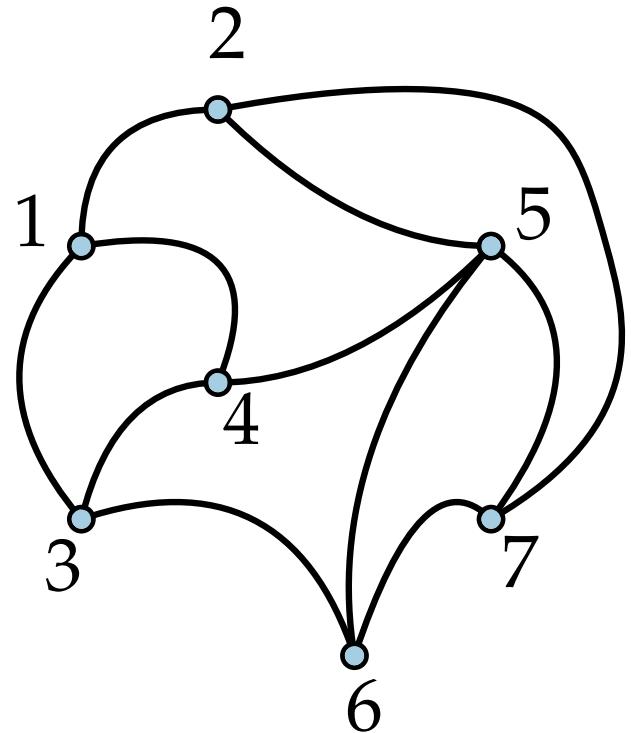
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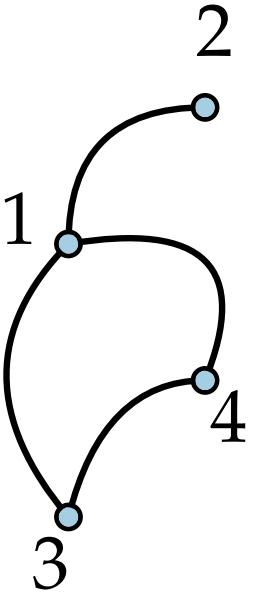
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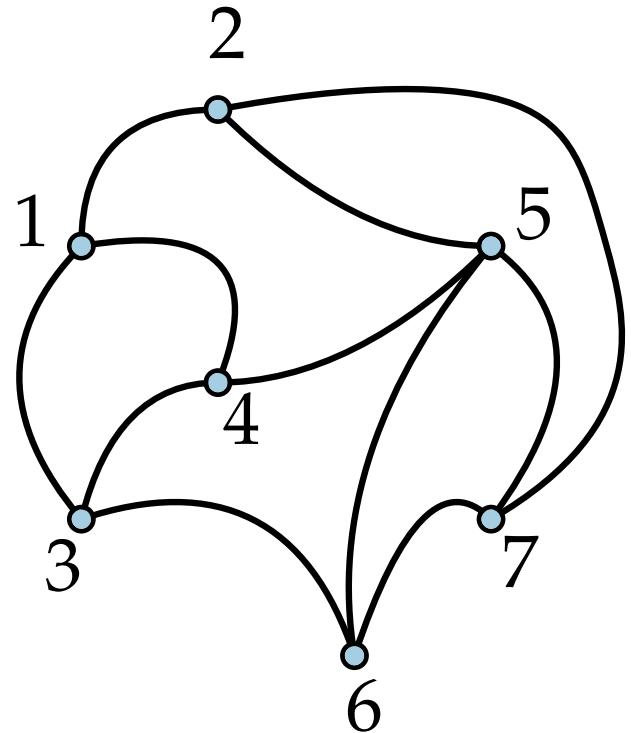
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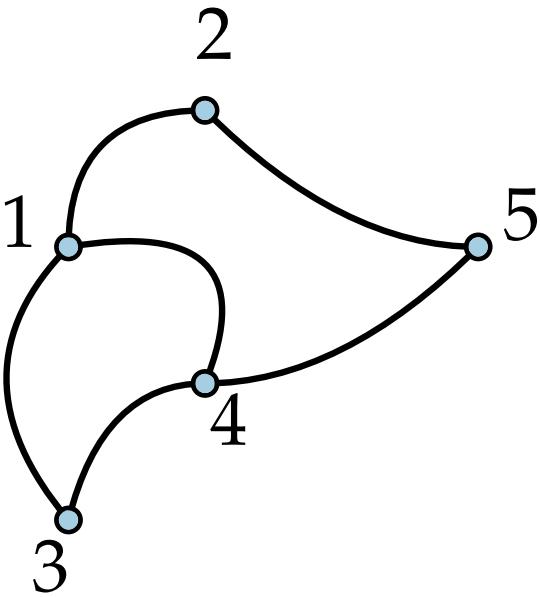
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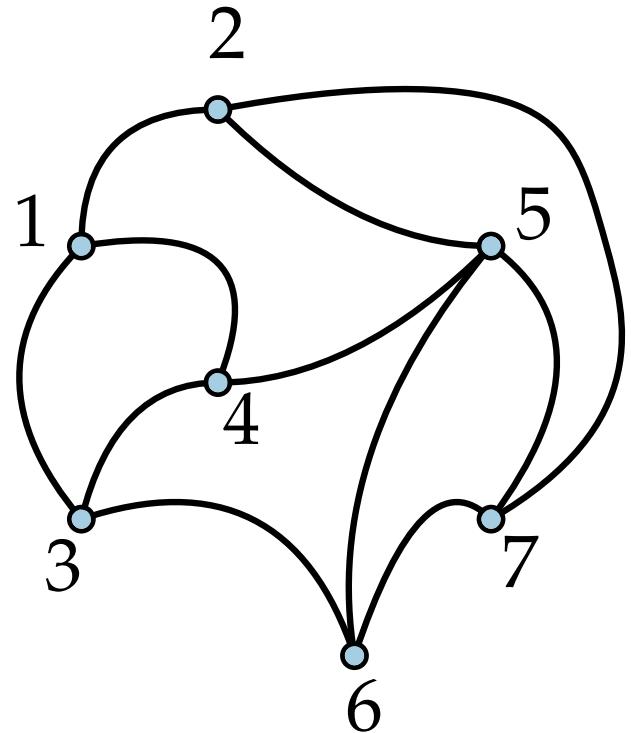
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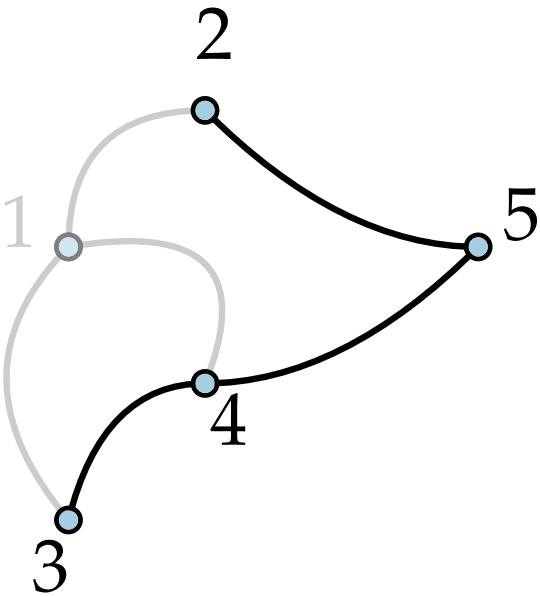
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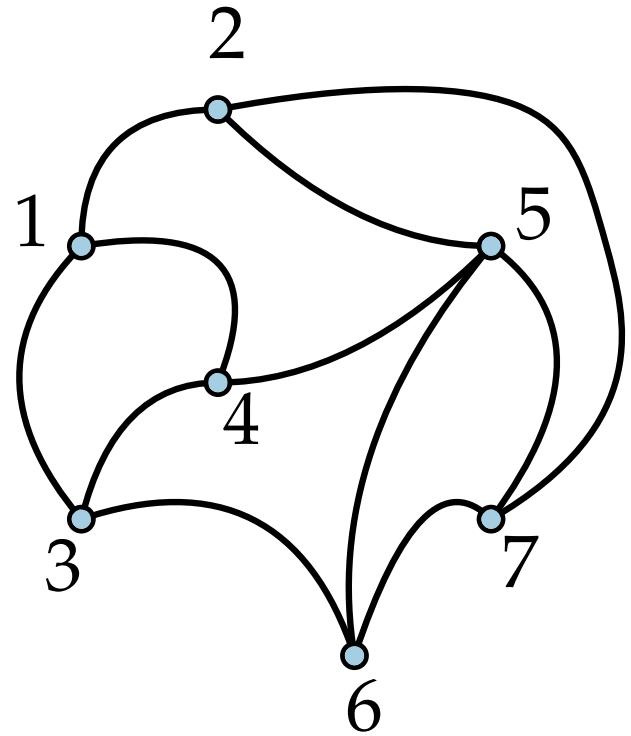
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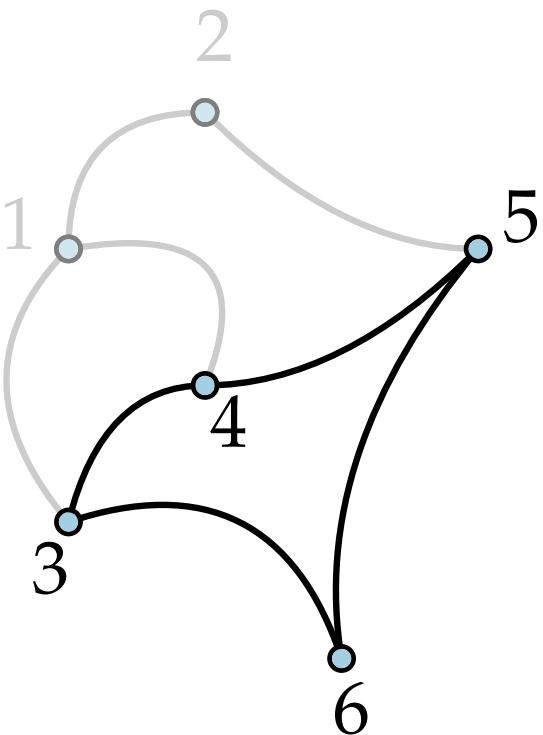
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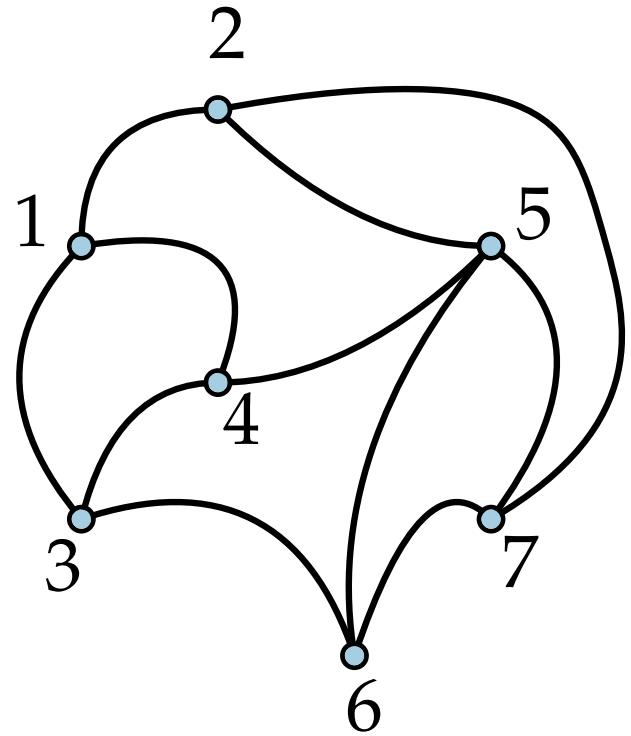
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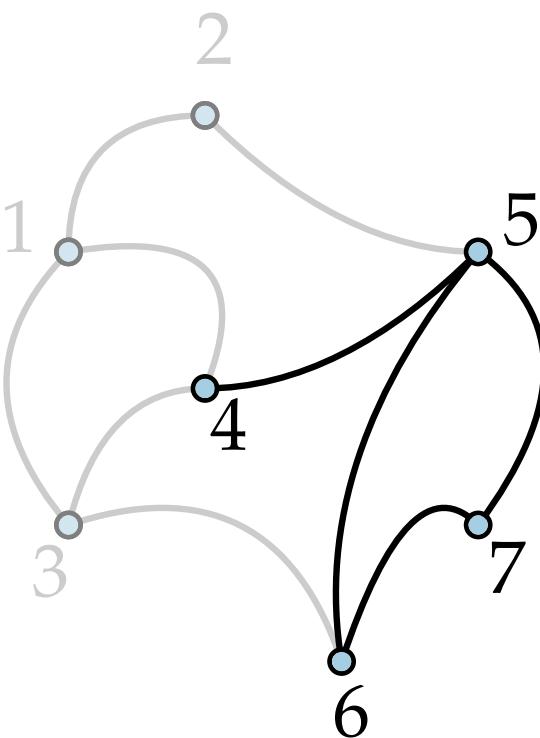
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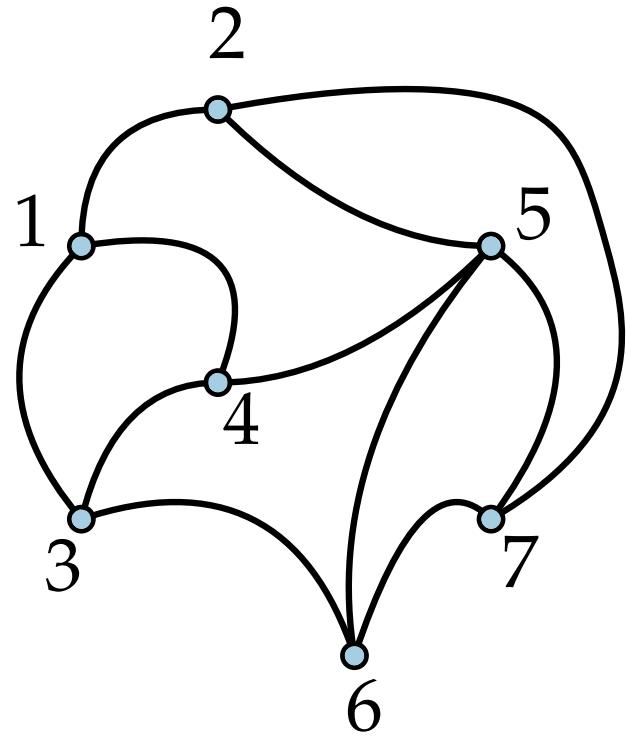
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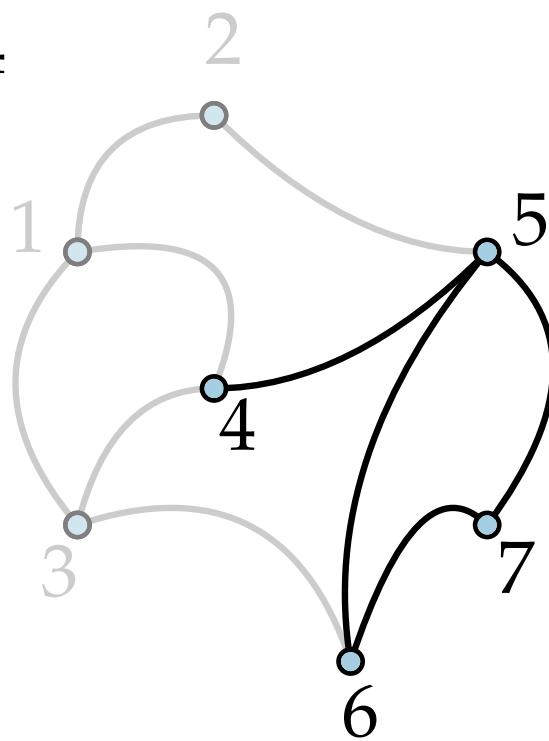
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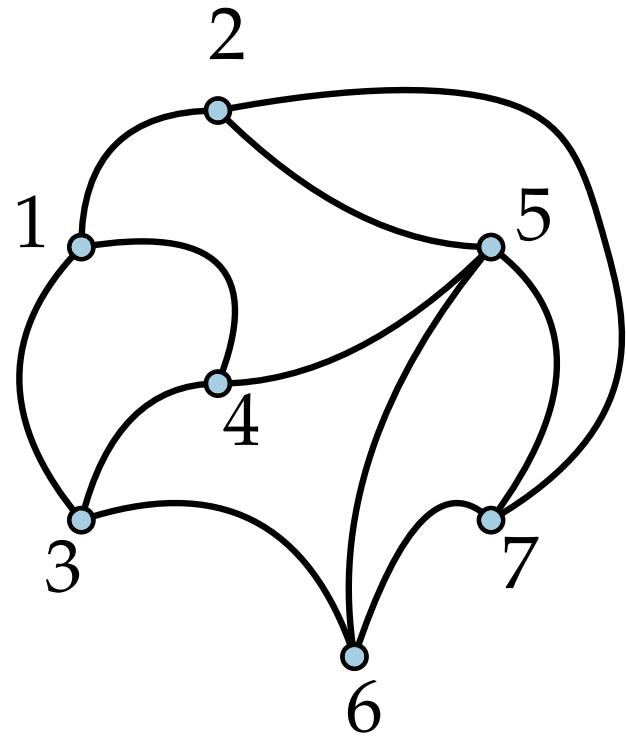


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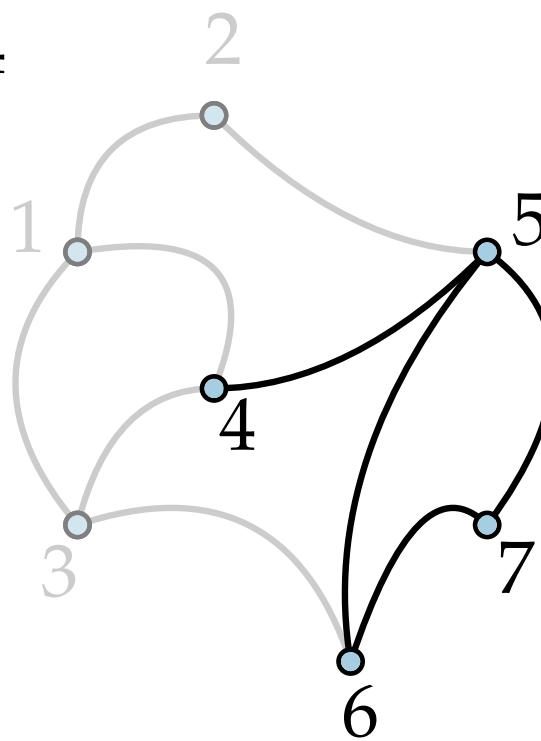


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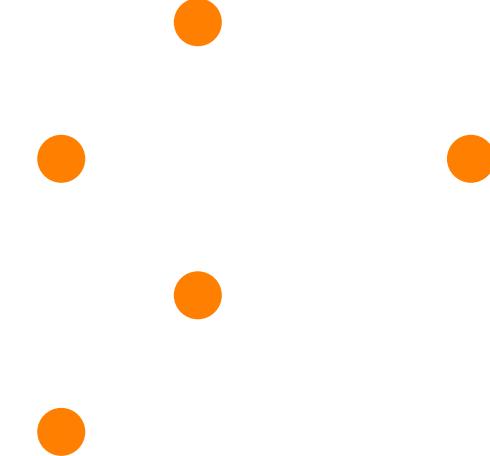
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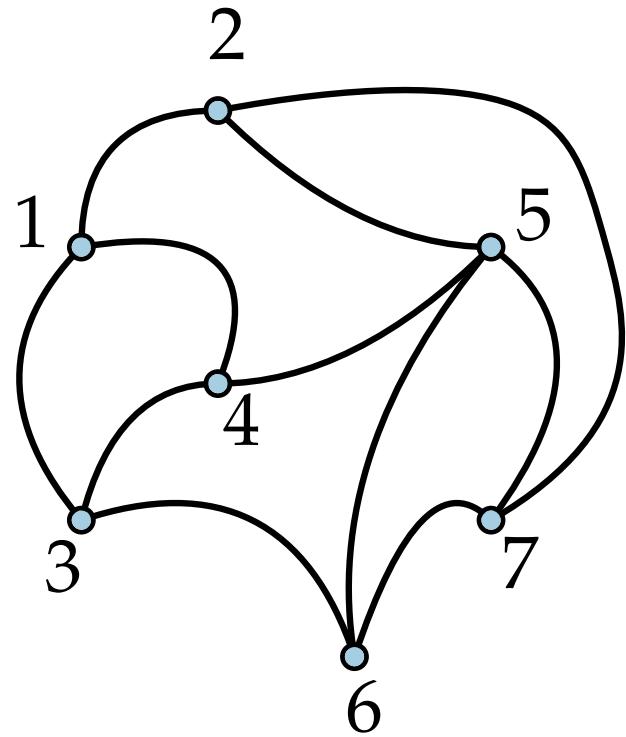
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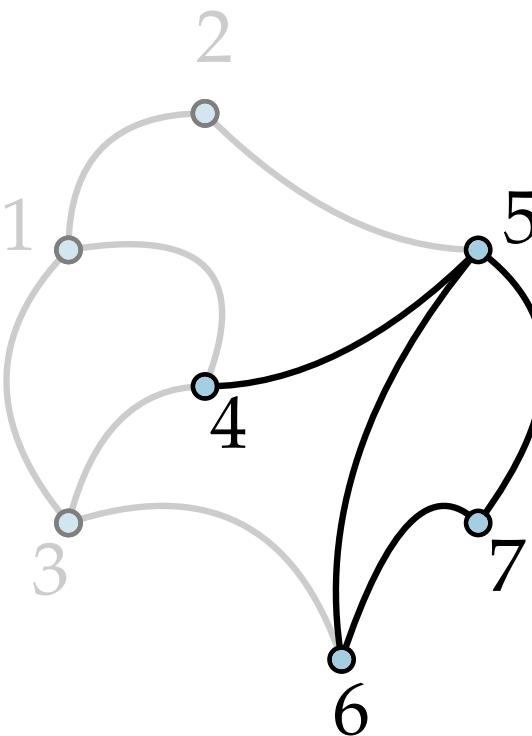
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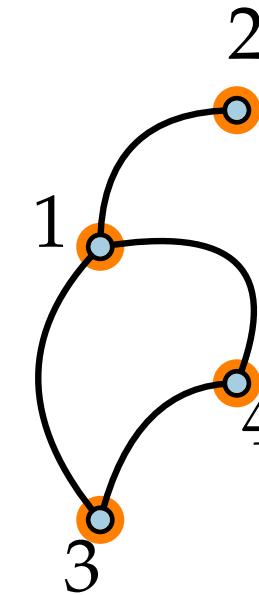
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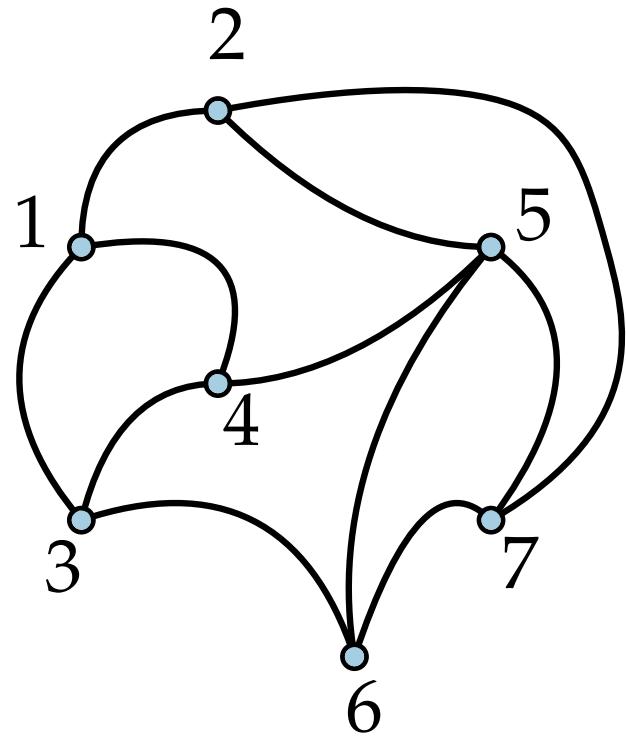
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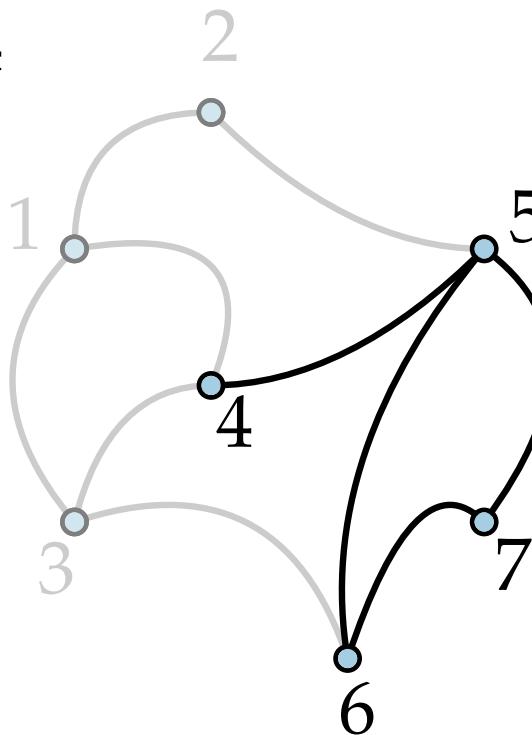
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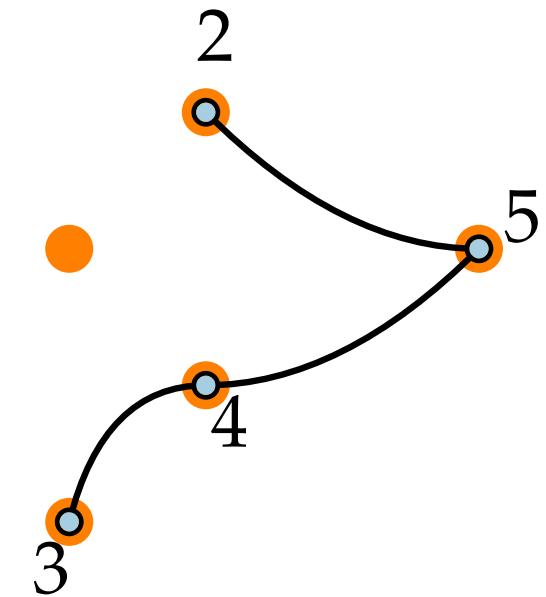
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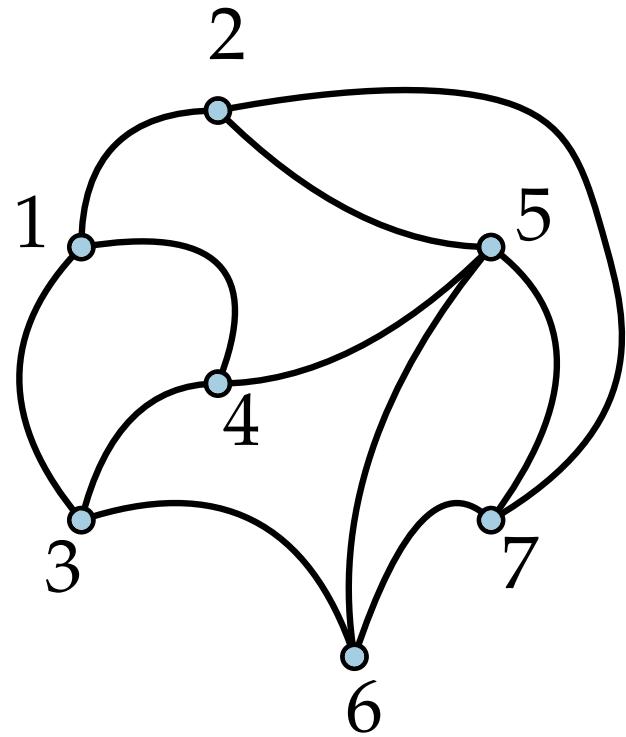
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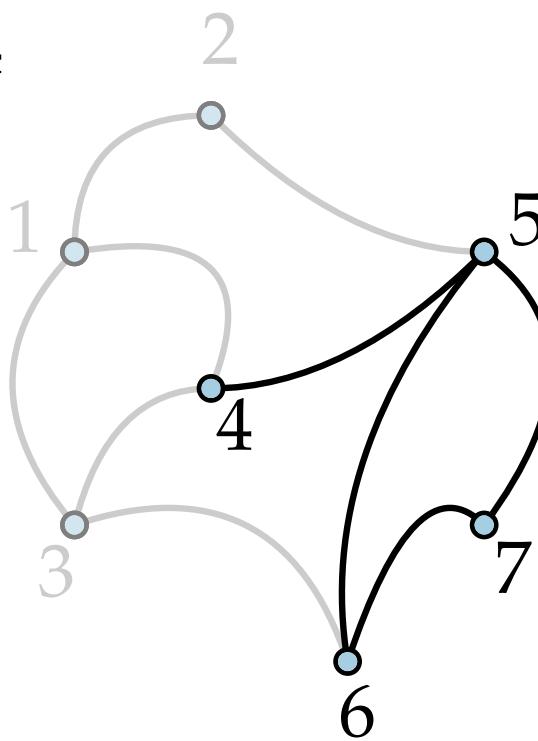
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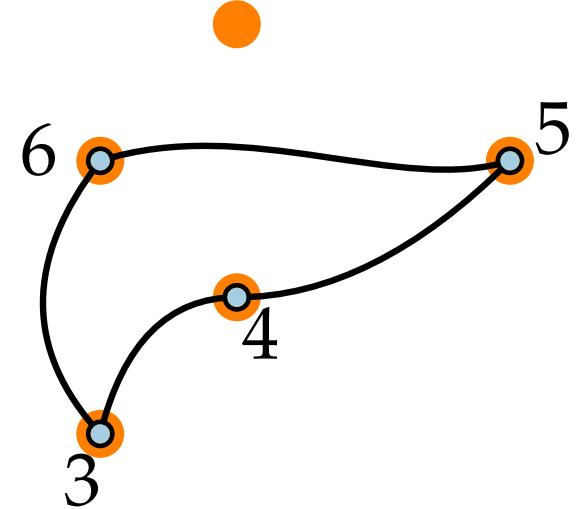
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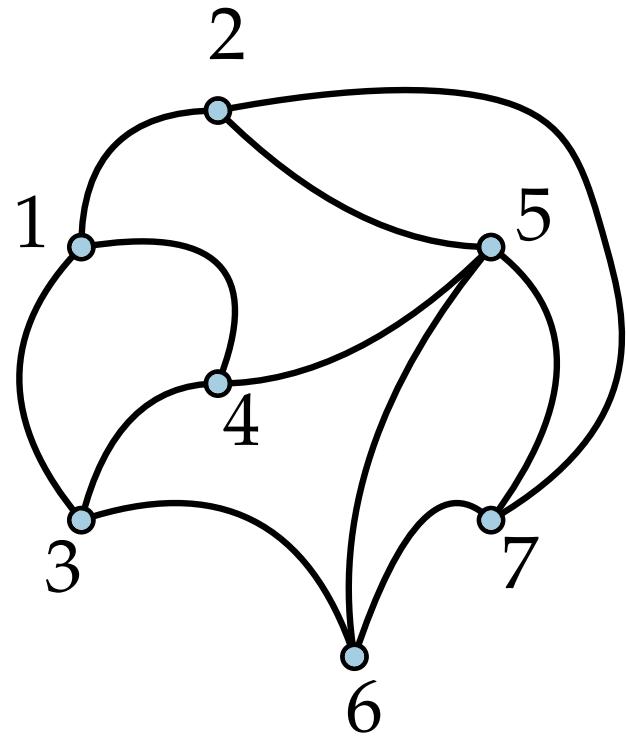
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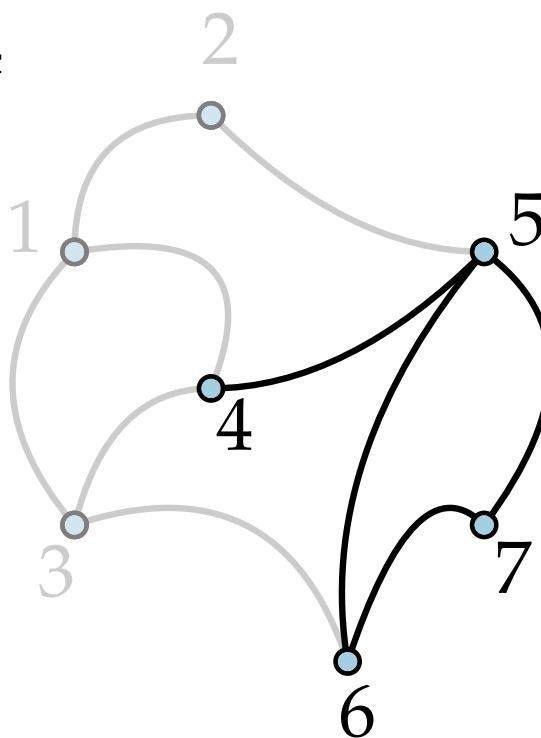
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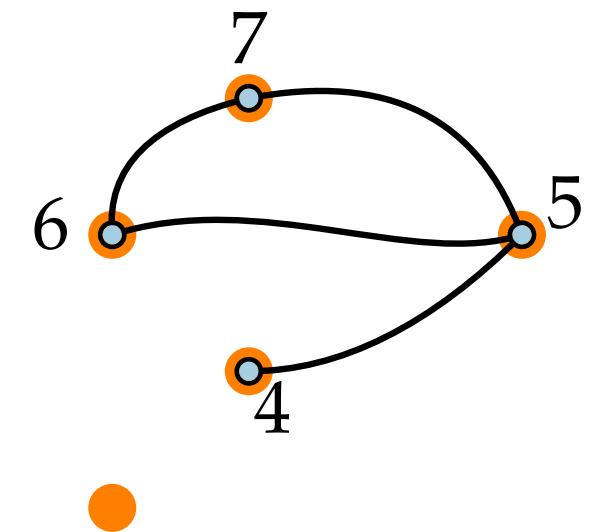
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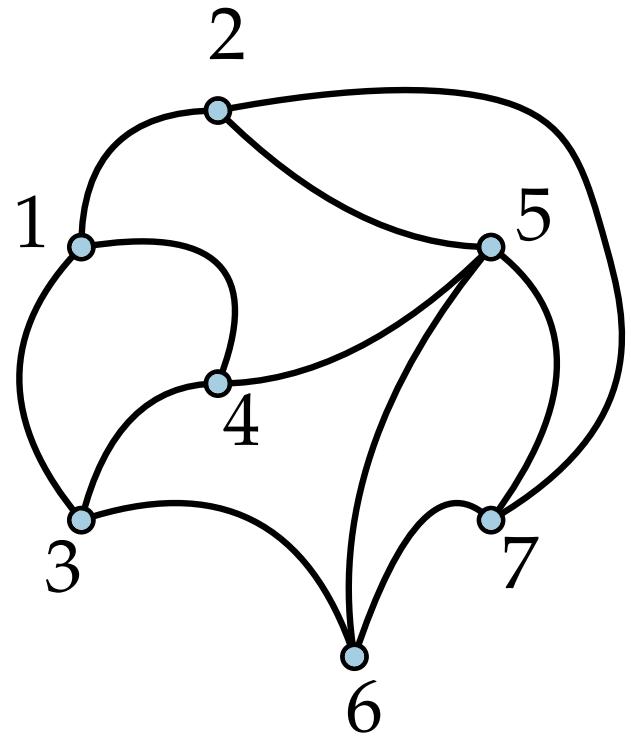
$$\omega = 4$$



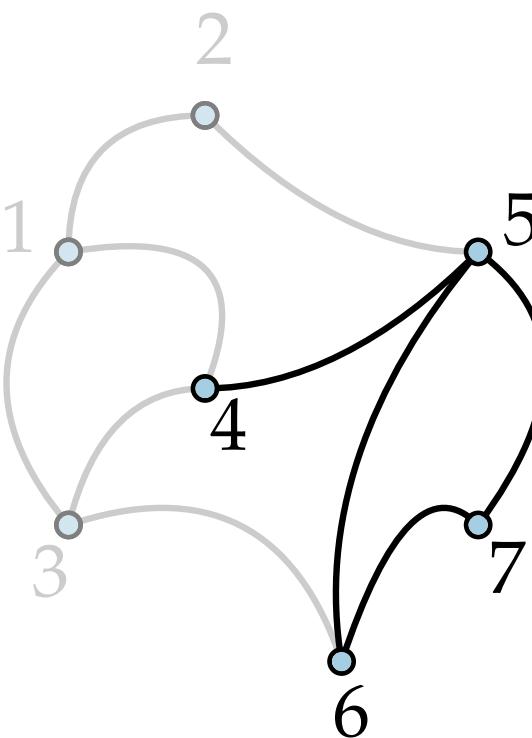
$$\omega + k = 5$$



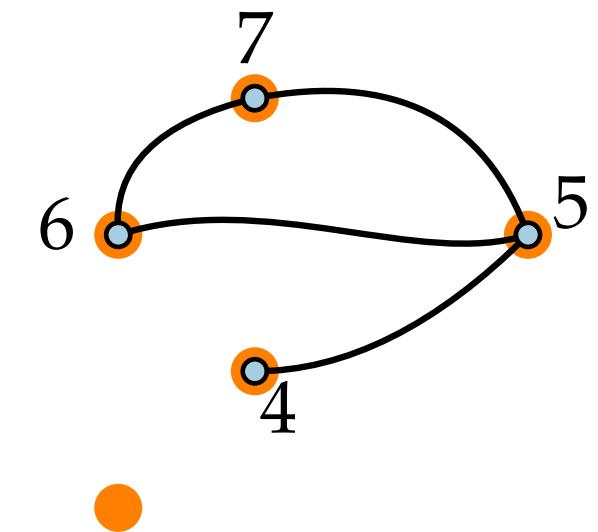
1. Small Point-Sets Supporting Graph Stories



$$\omega = 4$$

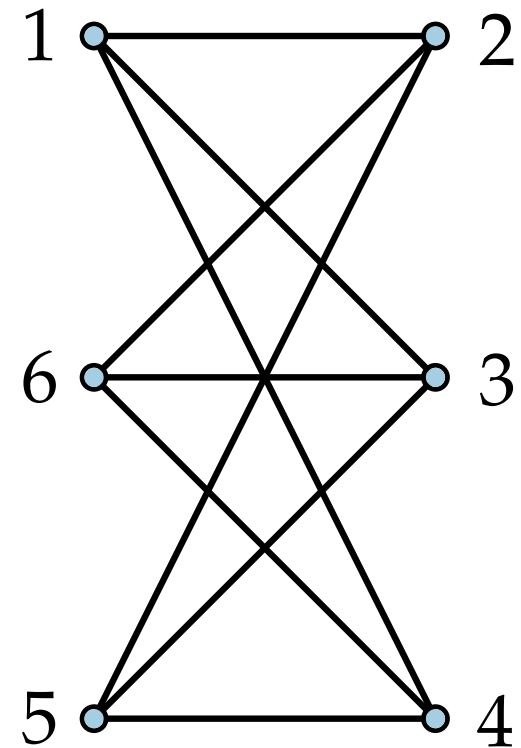


$$\omega + k = 5$$

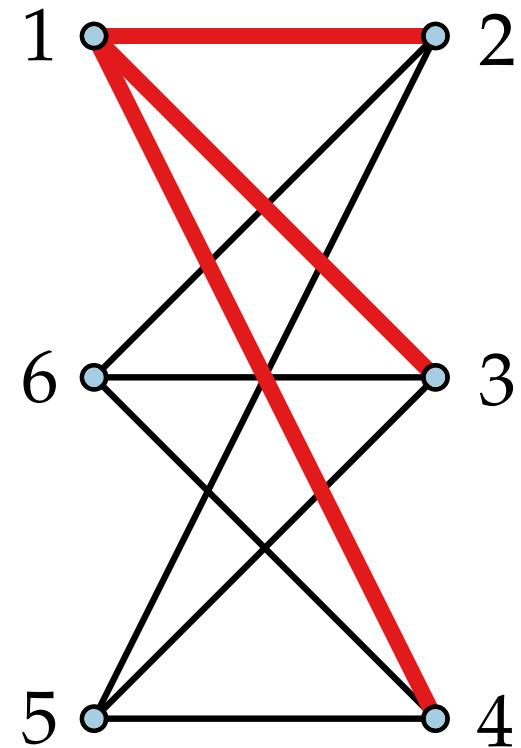


Find minimal k such that all drawings are planar.

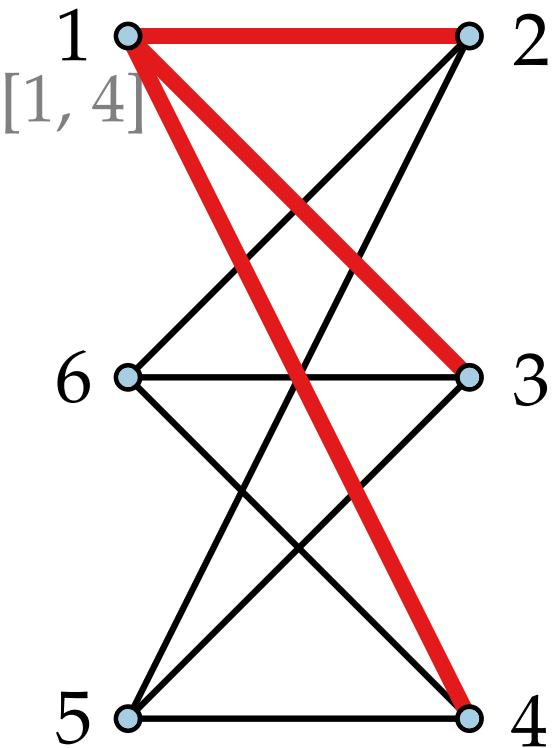
2. On the Complexity of the Storyplan Problem



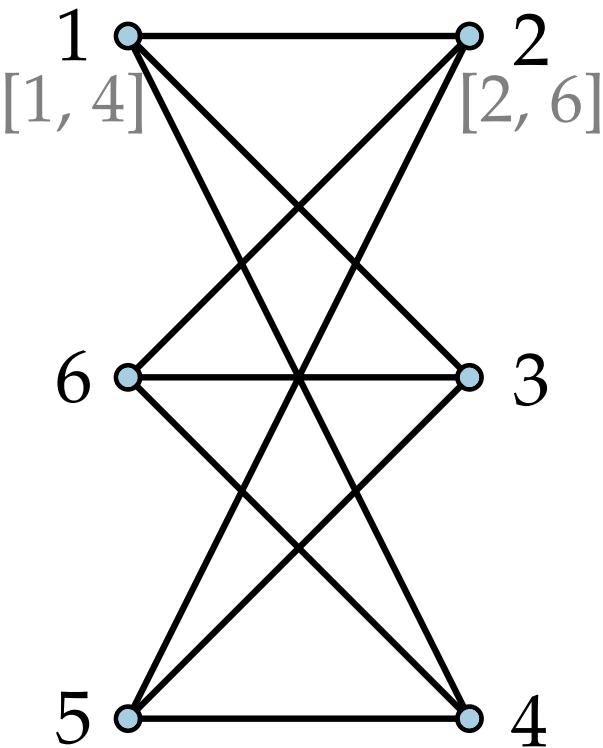
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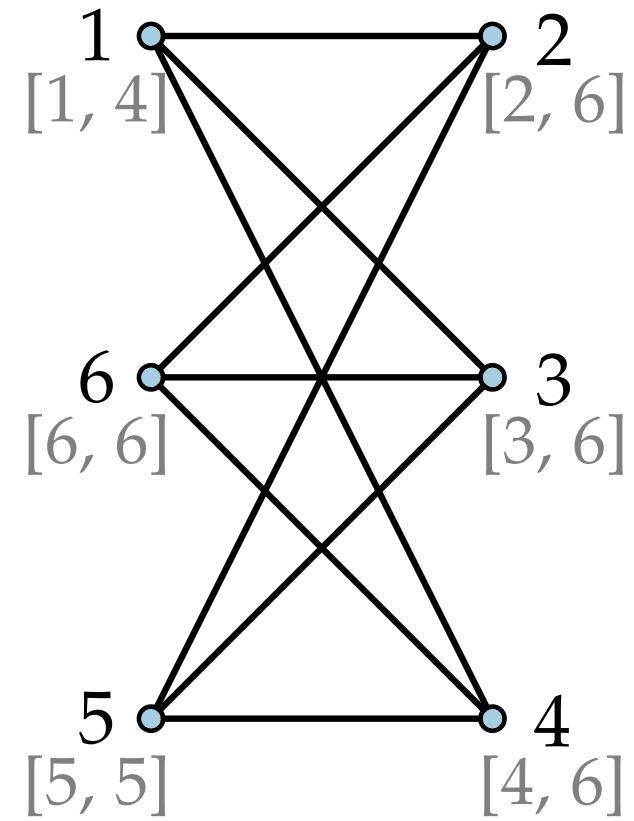
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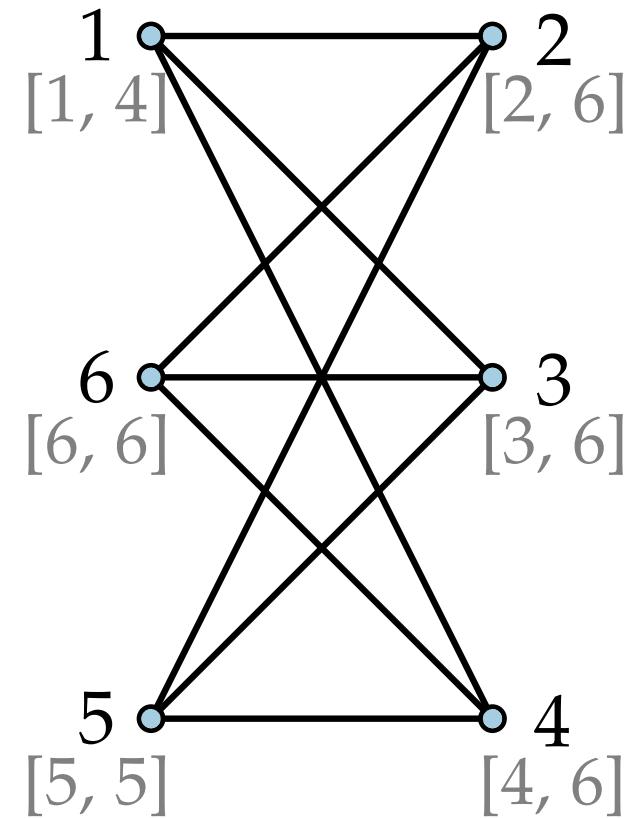
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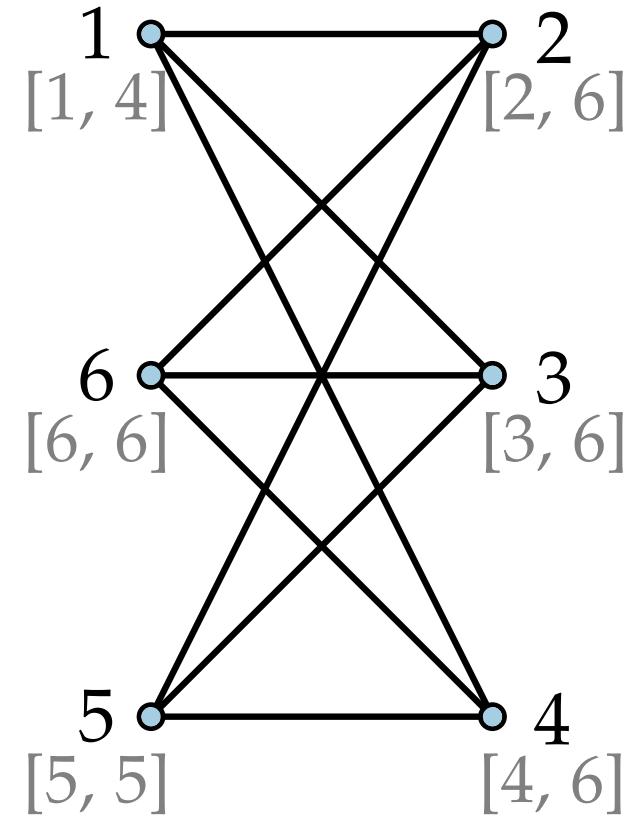
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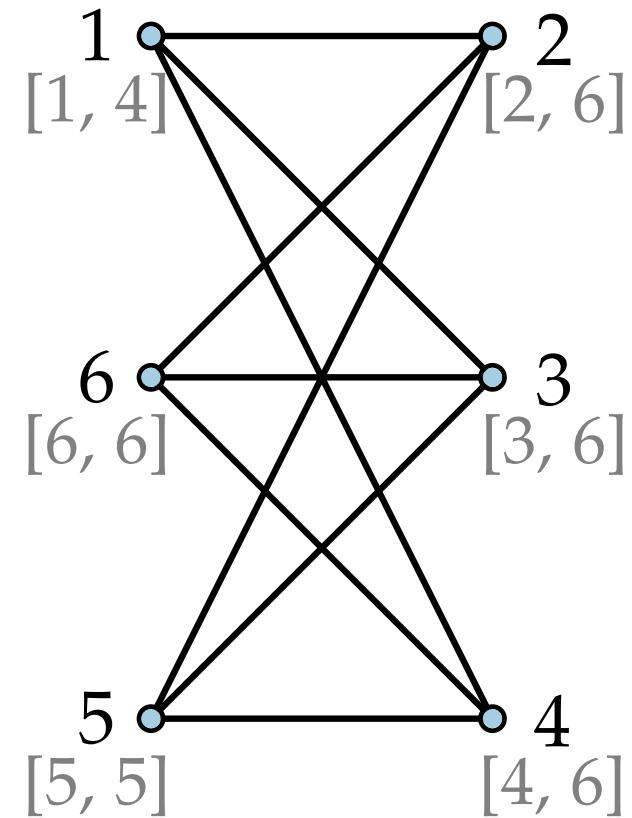


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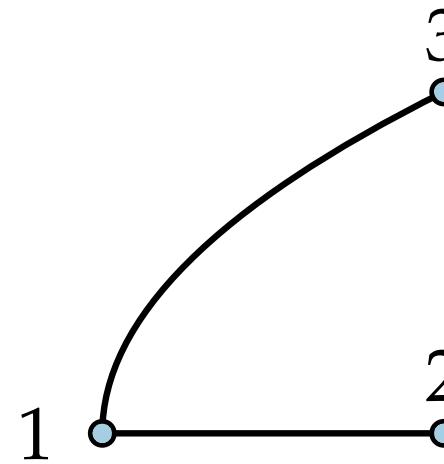
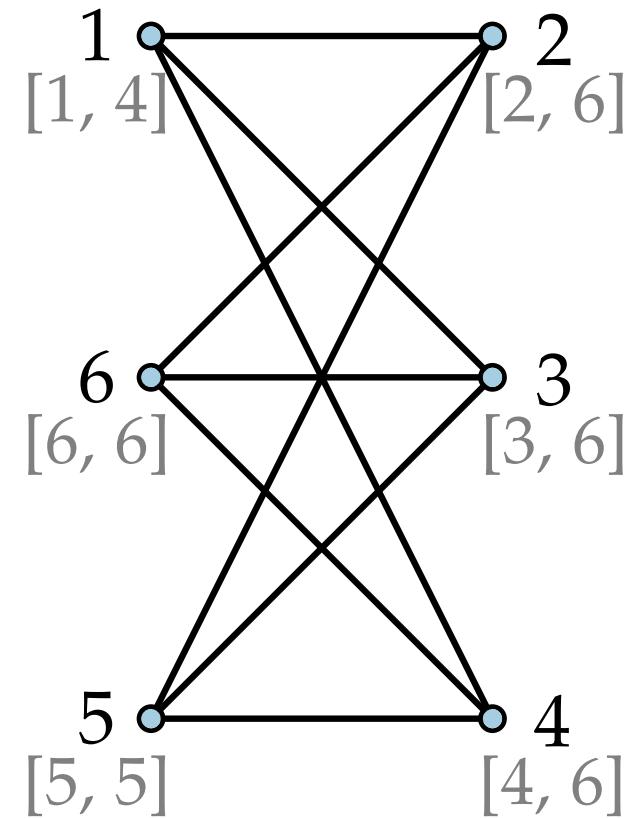


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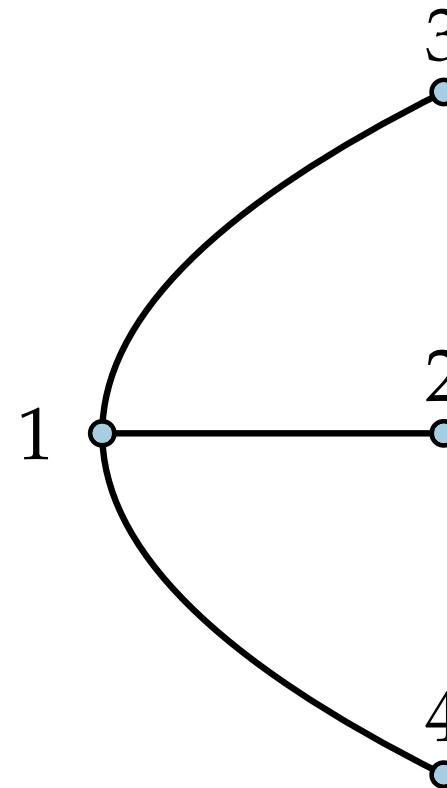
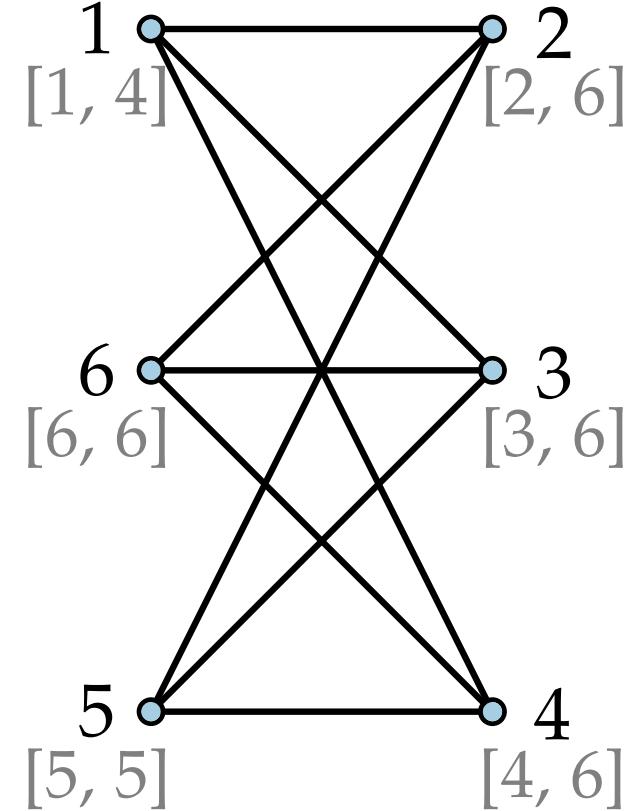
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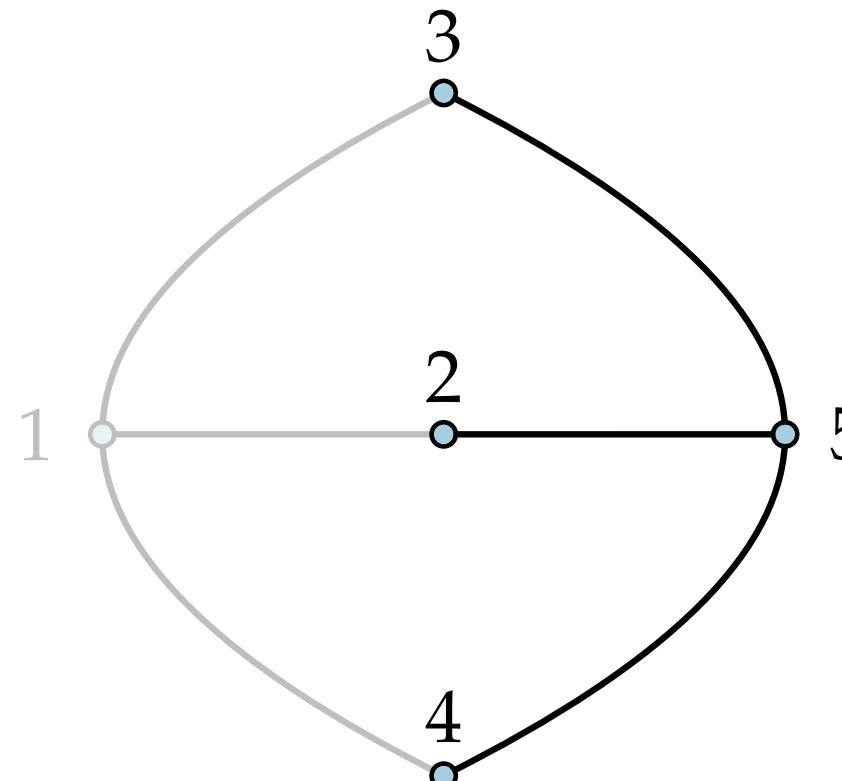
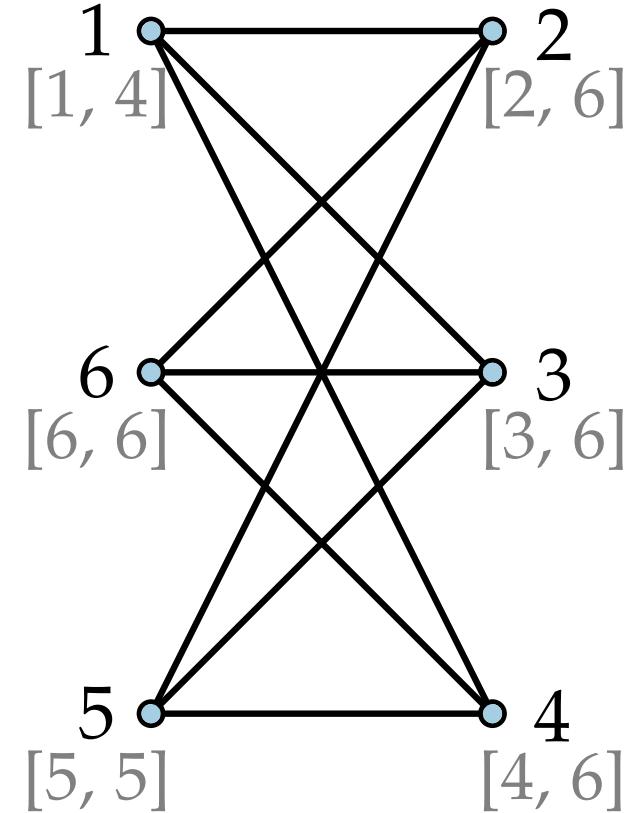
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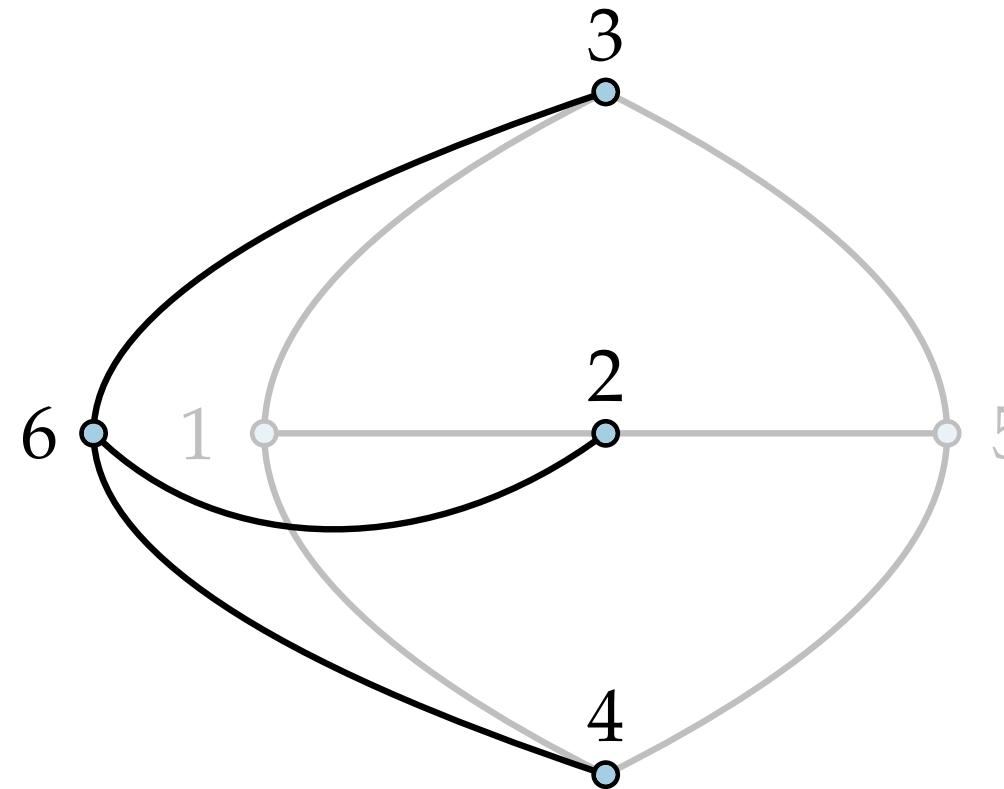
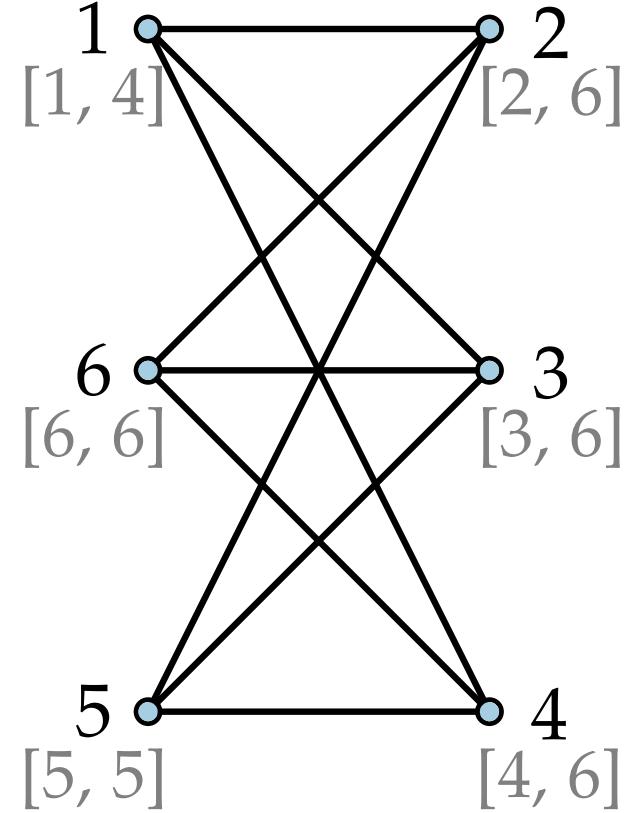
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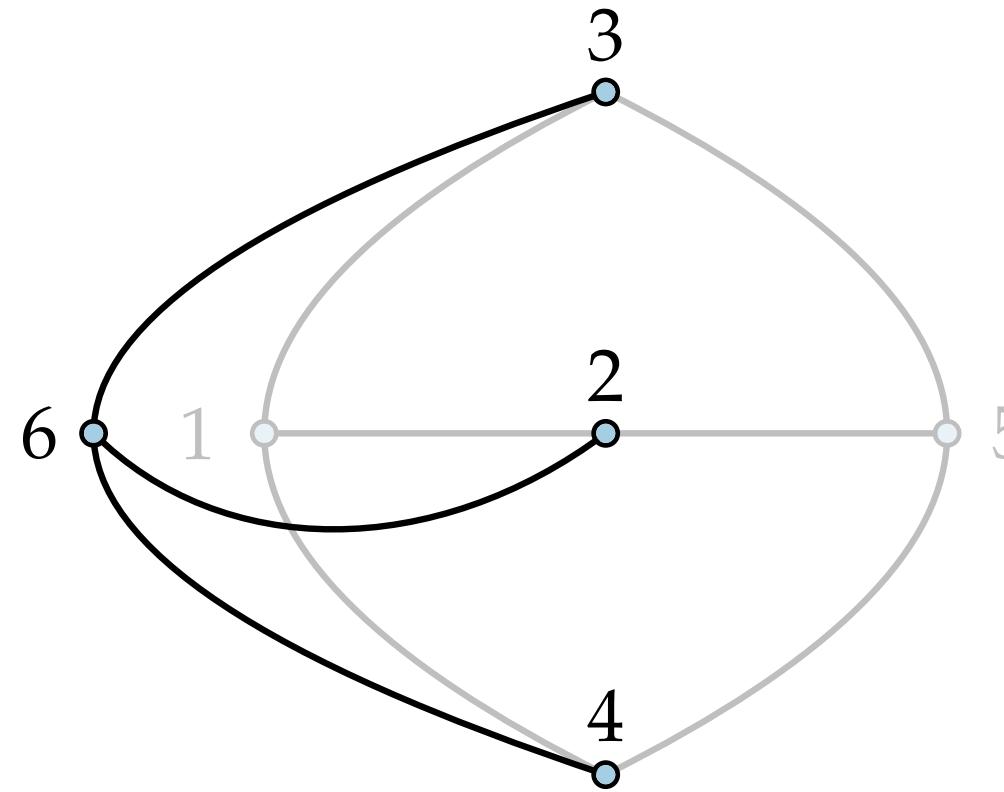
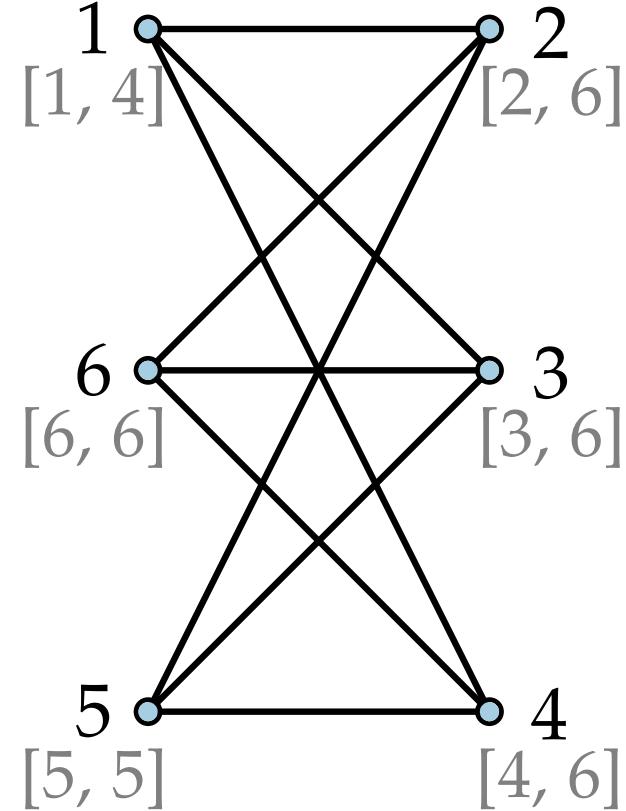
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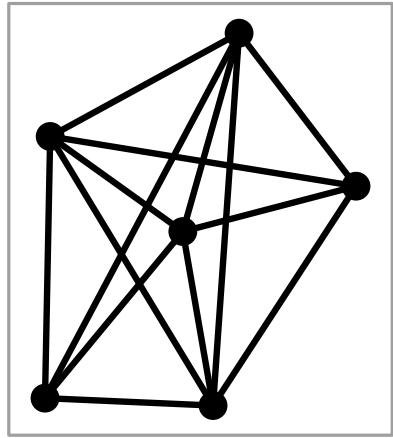
2. On the Complexity of the Storyplan Problem



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

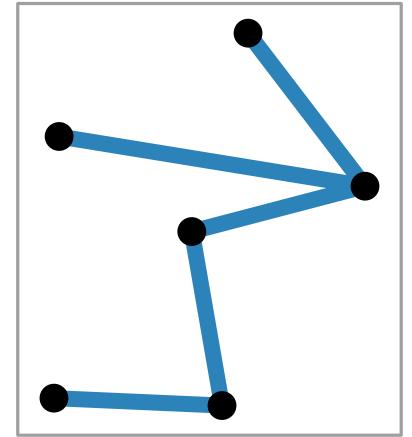
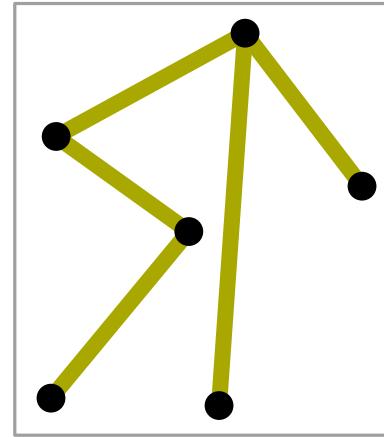
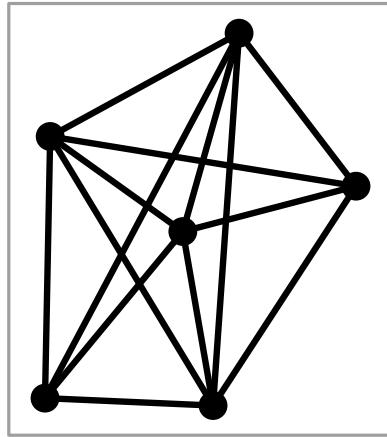
3. Compatible Spanning Trees in Simple Drawings of K_n

A drawing of K_6 :



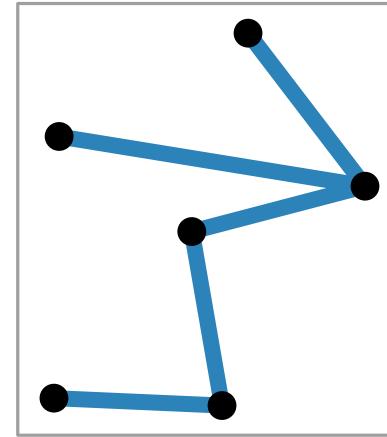
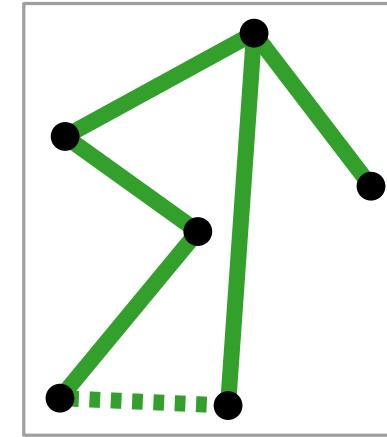
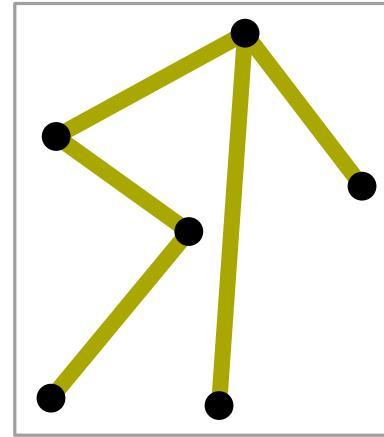
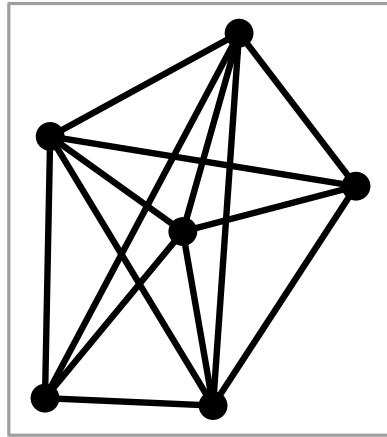
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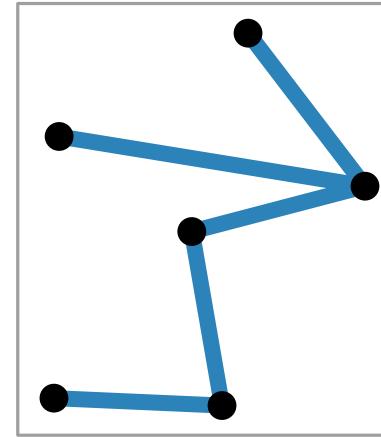
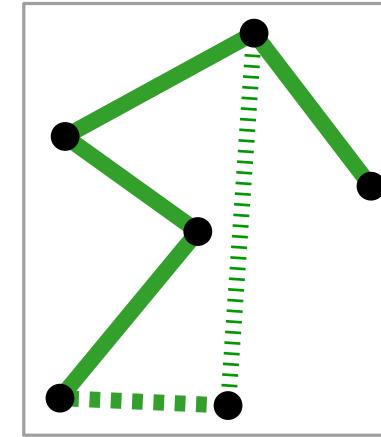
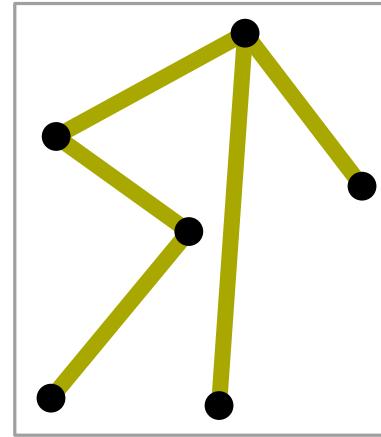
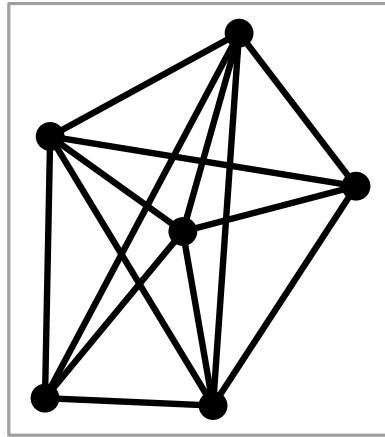
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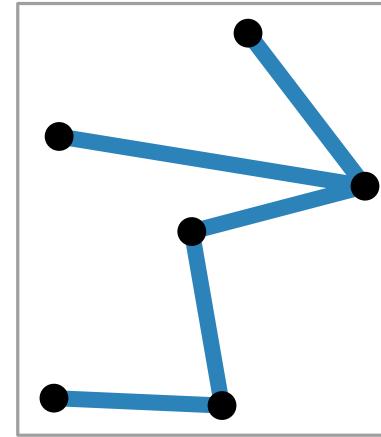
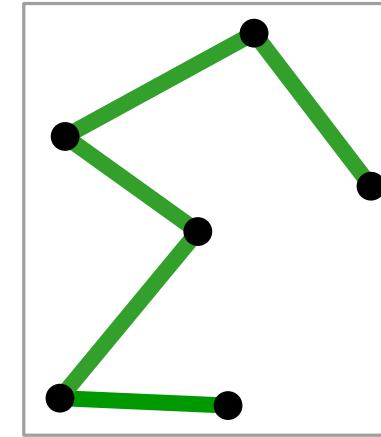
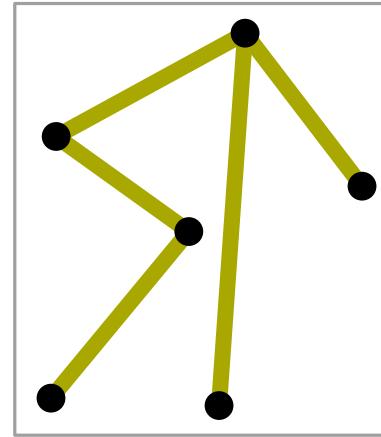
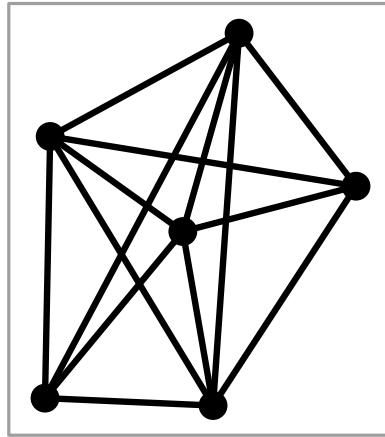
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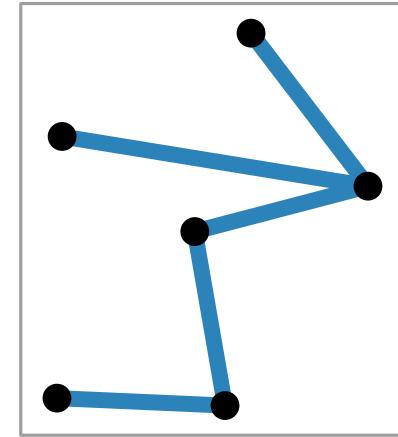
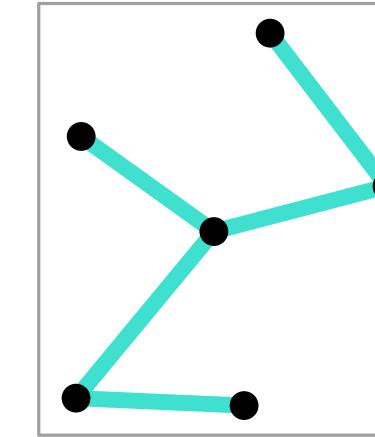
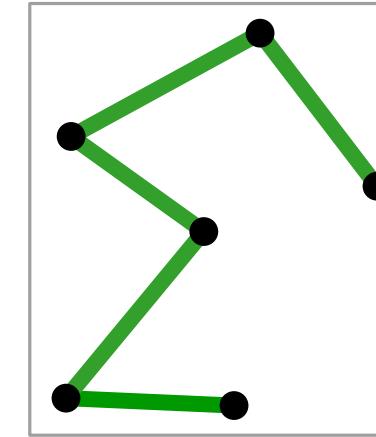
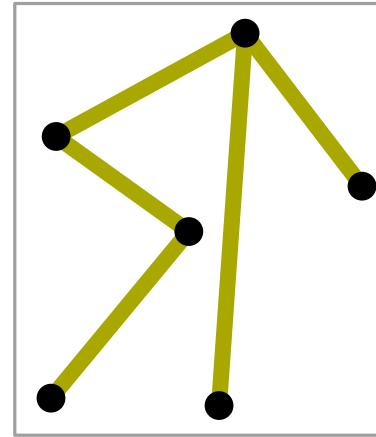
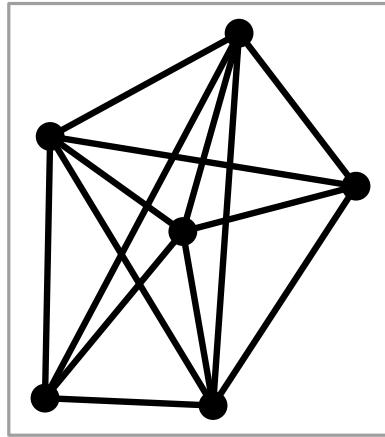
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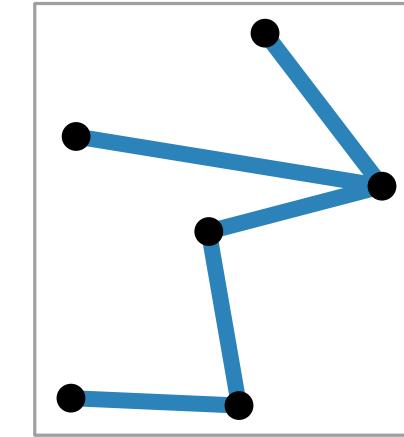
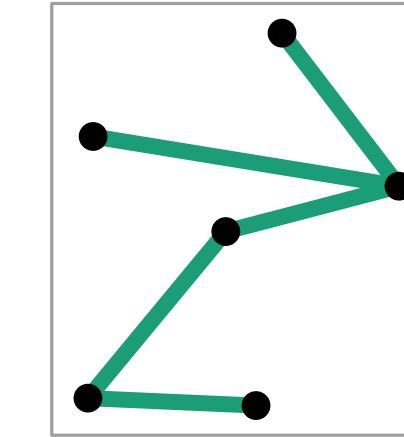
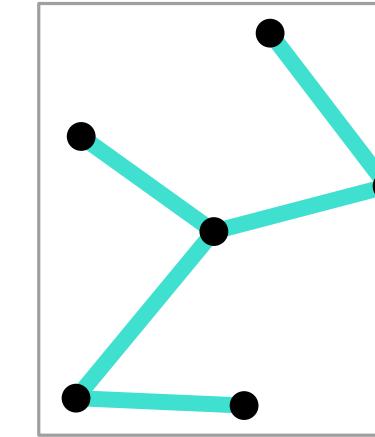
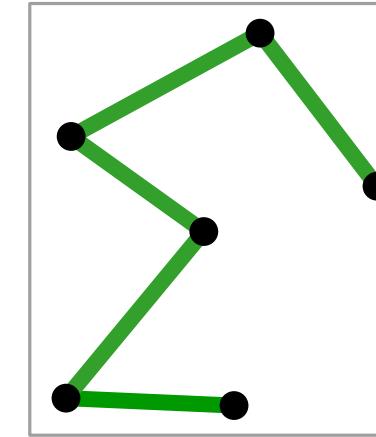
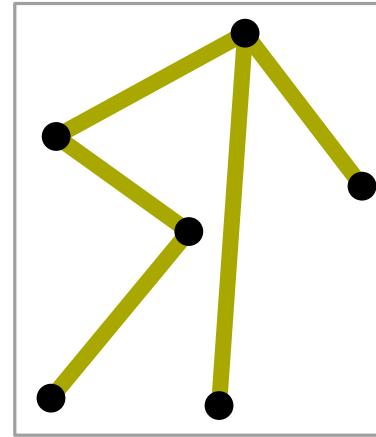
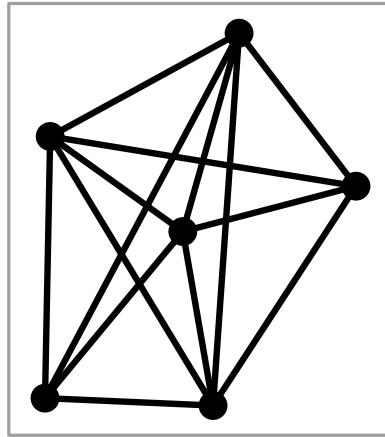
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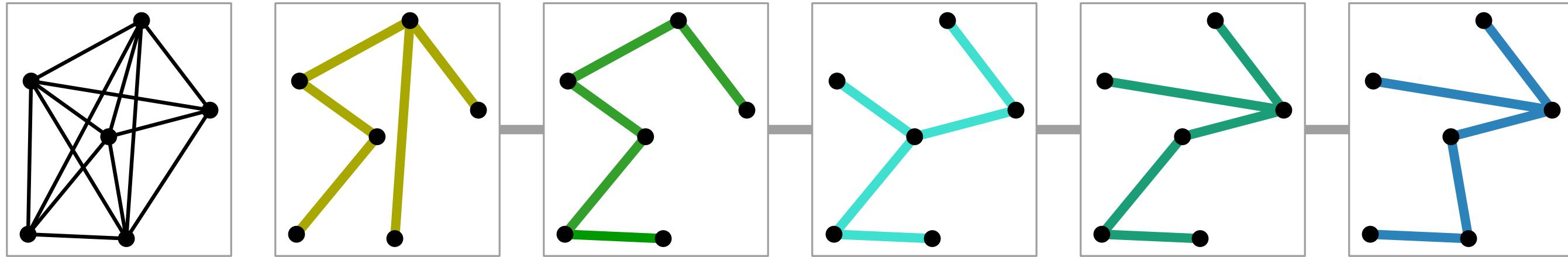
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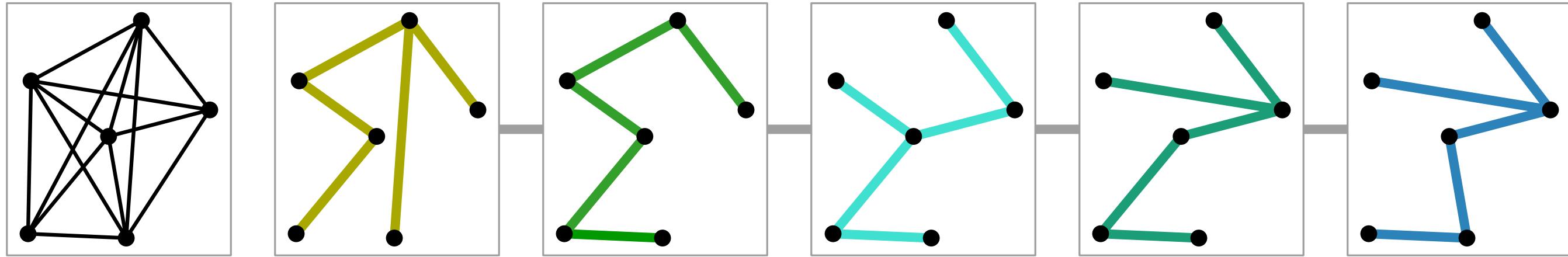
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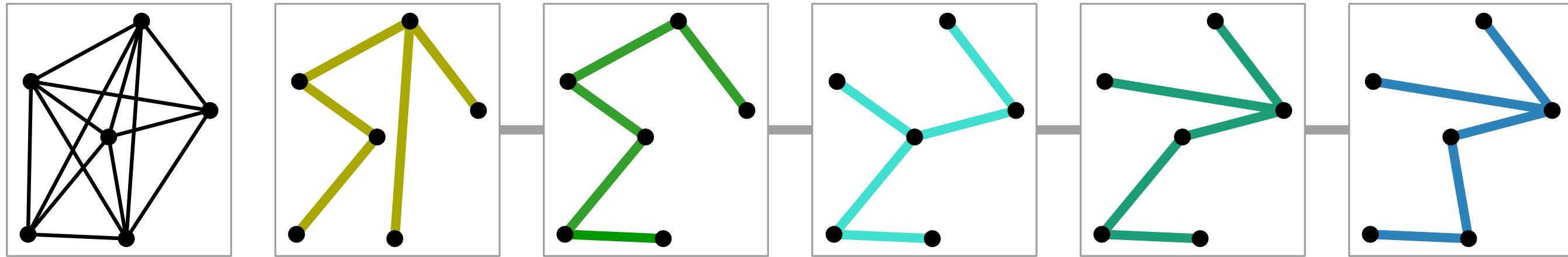
A drawing of K_6 :



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.

3. Compatible Spanning Trees in Simple Drawings of K_n

A drawing of K_6 :



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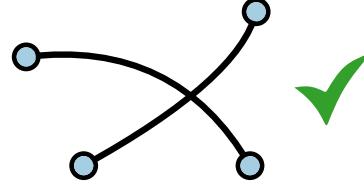
Theorem 2. Let D be a simple drawing of K_n , and let \mathcal{T}_D^* be the set of all plane spanning stars, double stars, and twin stars on D . Then, the compatibility graph $\mathcal{F}(\mathcal{T}_D^*)$ is connected.

4. Empty Triangles in Generalized Twisted Drawings

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

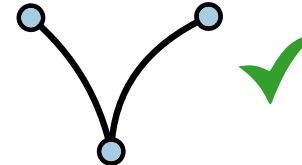
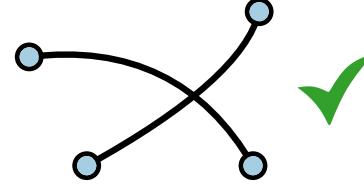
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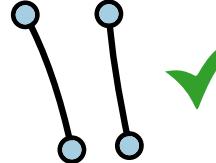
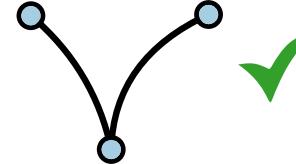
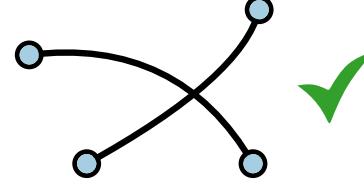
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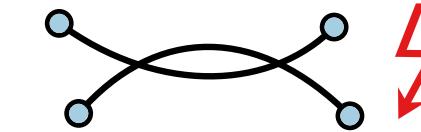
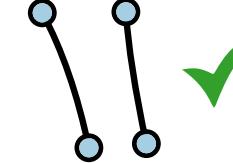
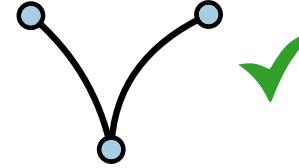
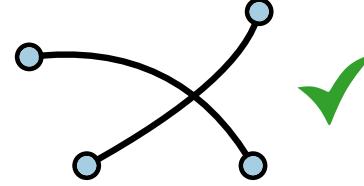
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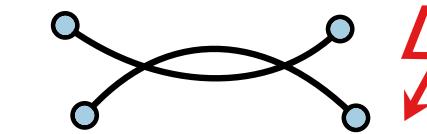
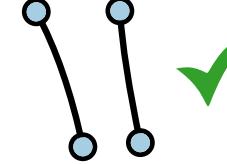
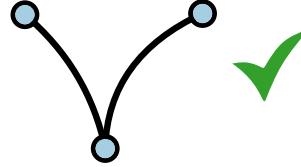
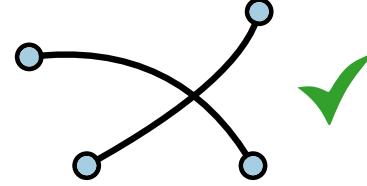
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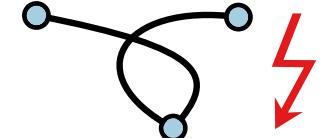
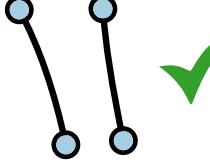
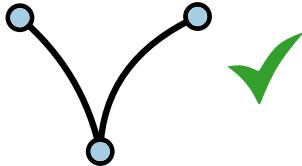
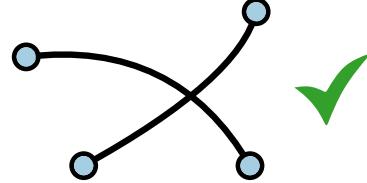
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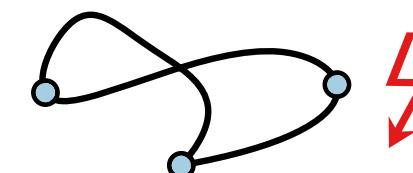
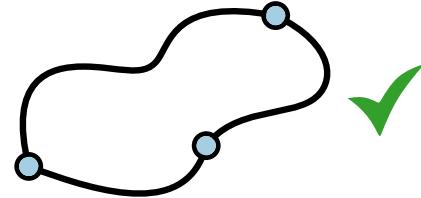
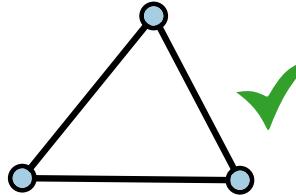


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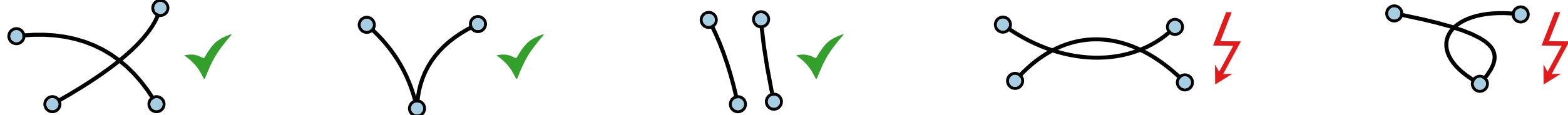


\Rightarrow jedes **Dreieck** (Kreis der Länge 3) ist frei von Selbstüberschneidungen

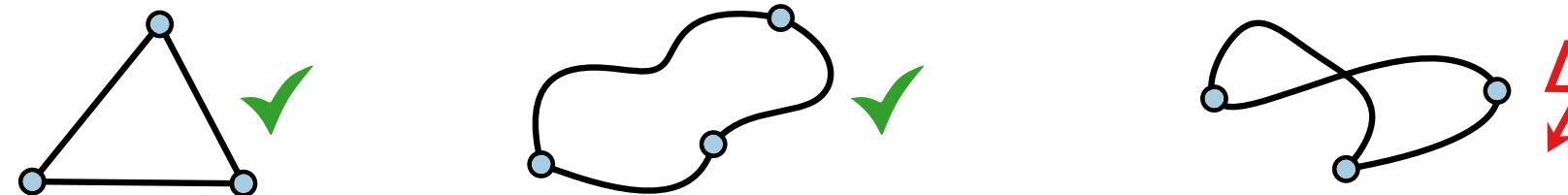


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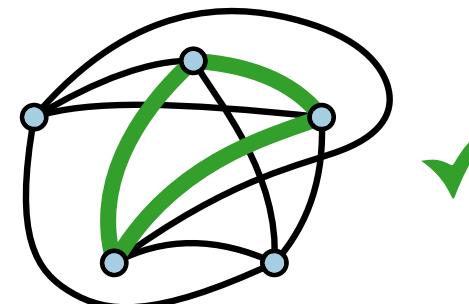
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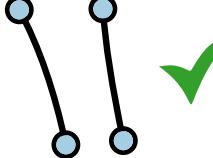
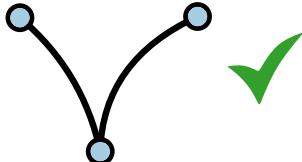
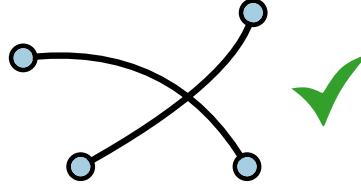


Ein Dreieck ist **leer**, falls sein Inneres oder sein Äußeres keinen Knoten enthält.

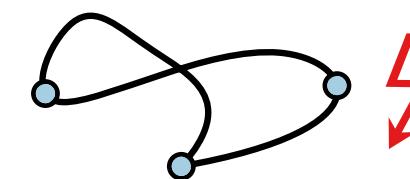
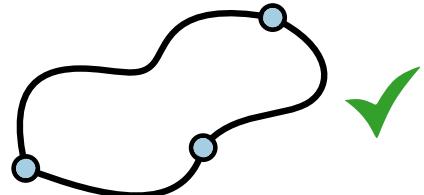
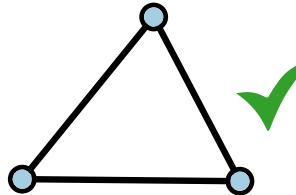


4. Empty Triangles in Generalized Twisted Drawings

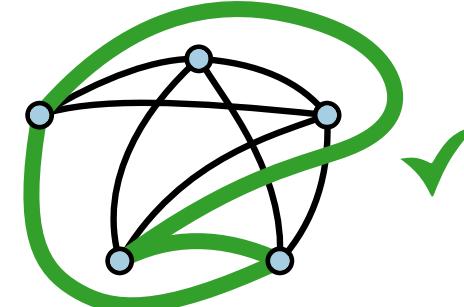
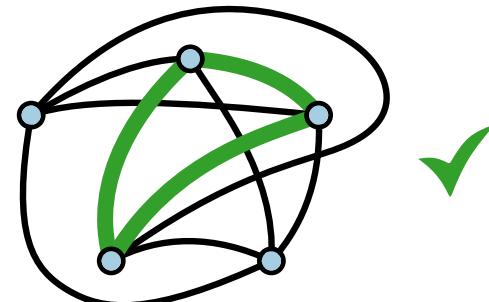
In einer **einfachen** Zeichnung teilt sich jedes Kantenpaar ≤ 1 Punkt.



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

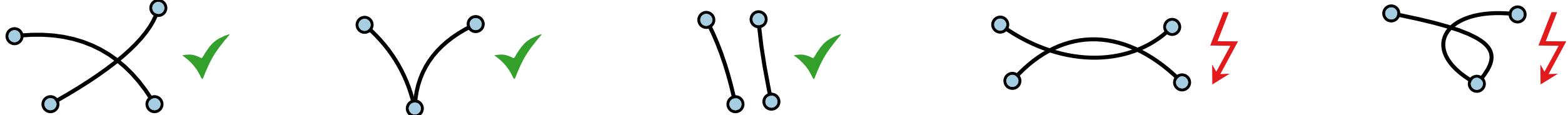


Ein Dreieck ist **leer**, falls sein Inneres oder sein Äußeres keinen Knoten enthält.

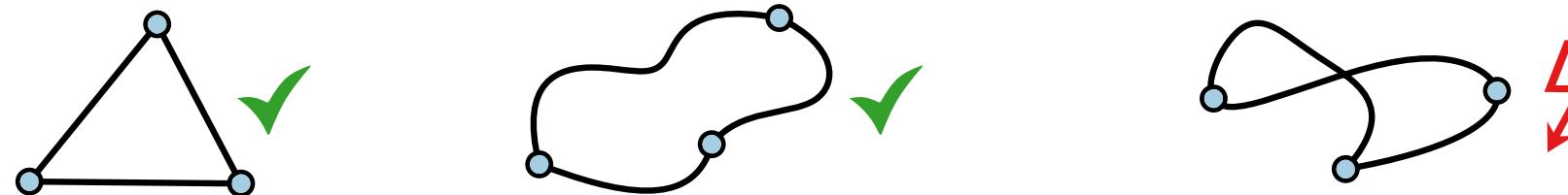


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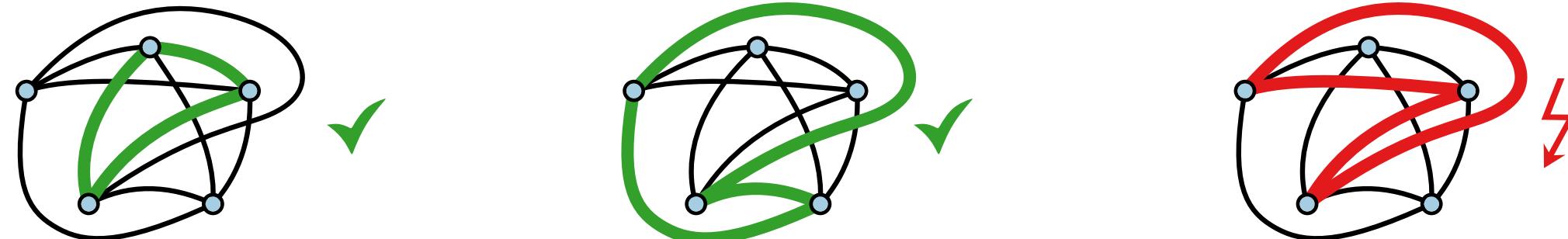
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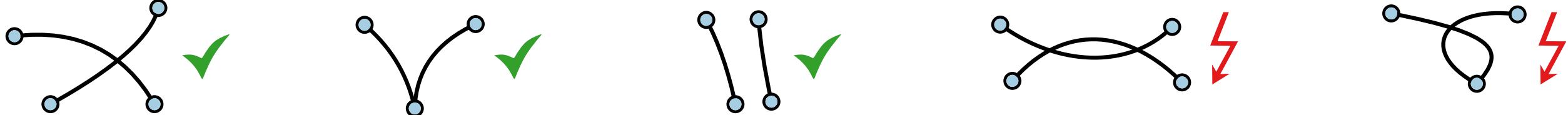


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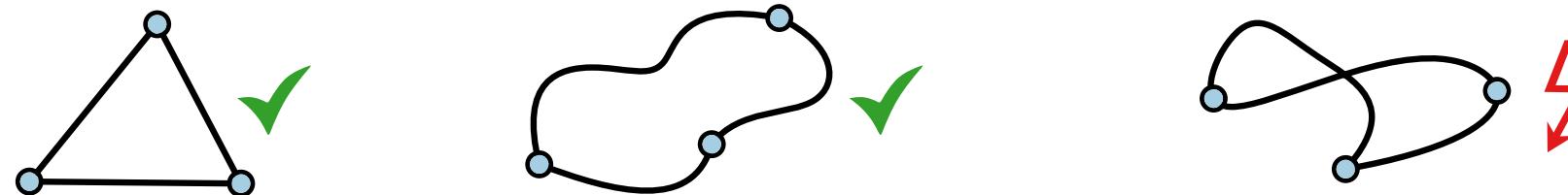


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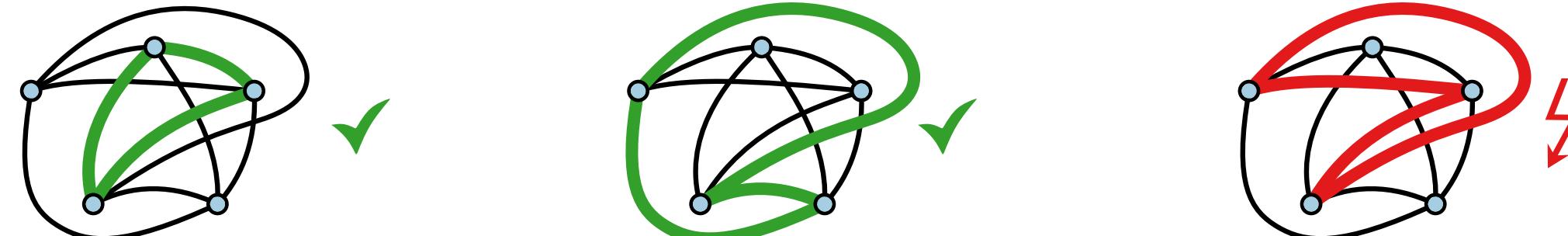
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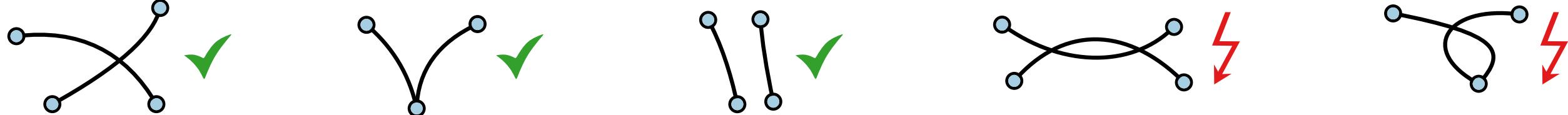
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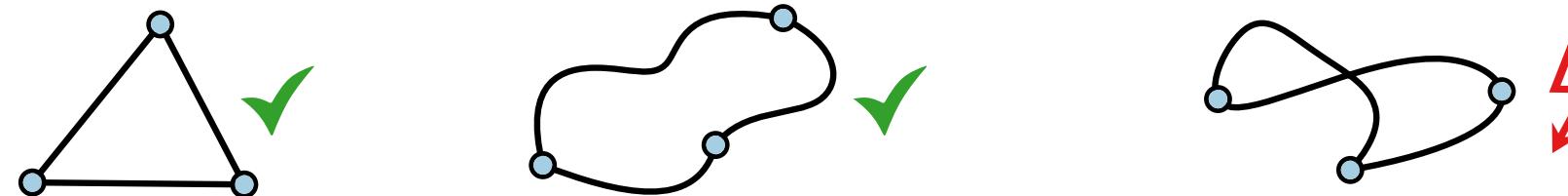
Vermutung: Jede einfache Zeichnung von K_n hat $\geq 2n - 4$ leere Dreiecke.

4. Empty Triangles in Generalized Twisted Drawings

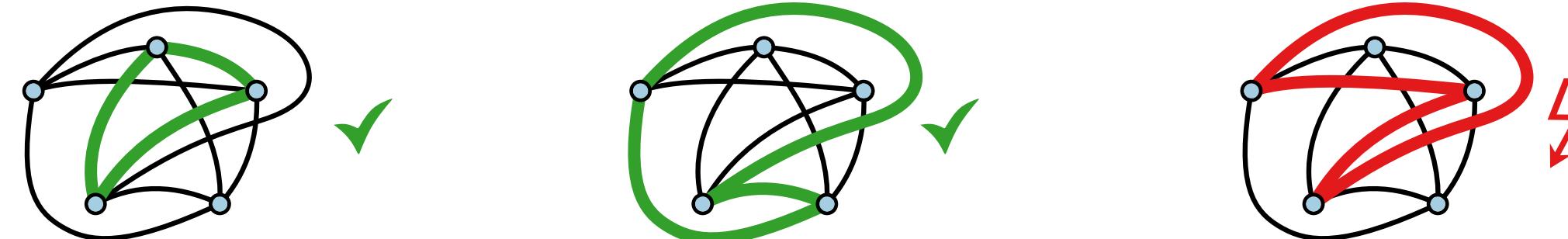
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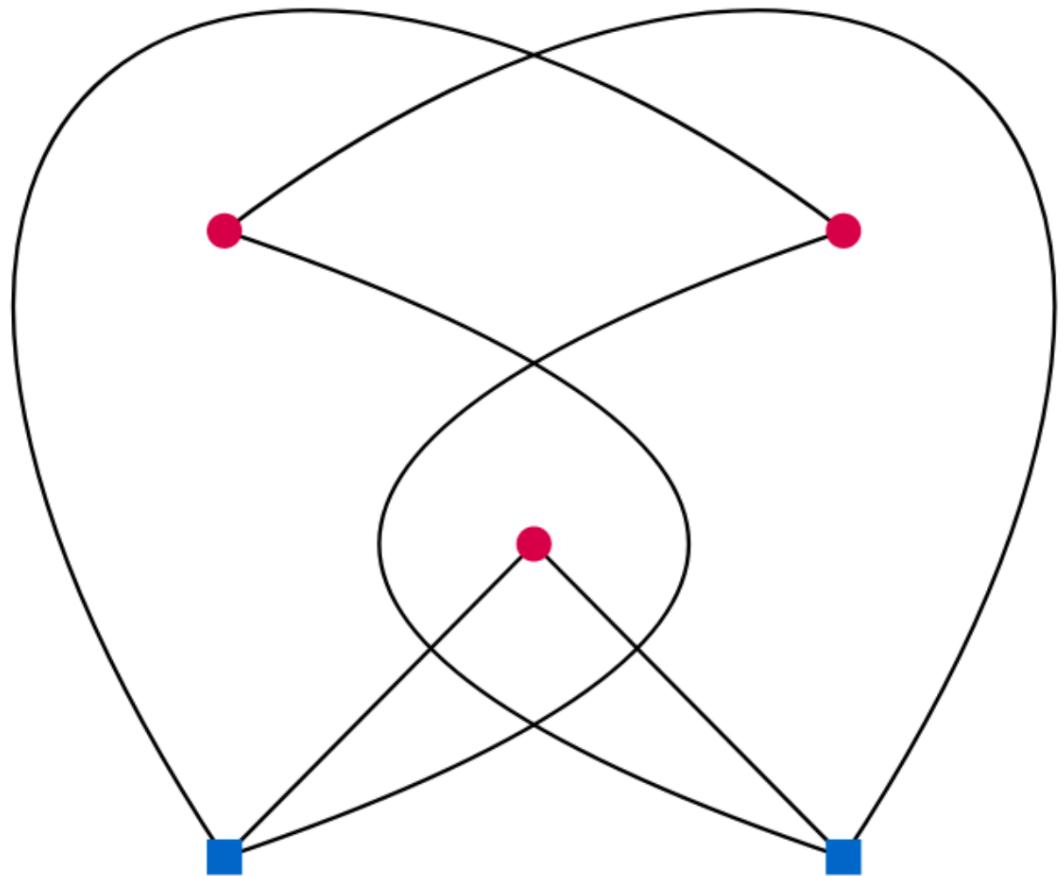
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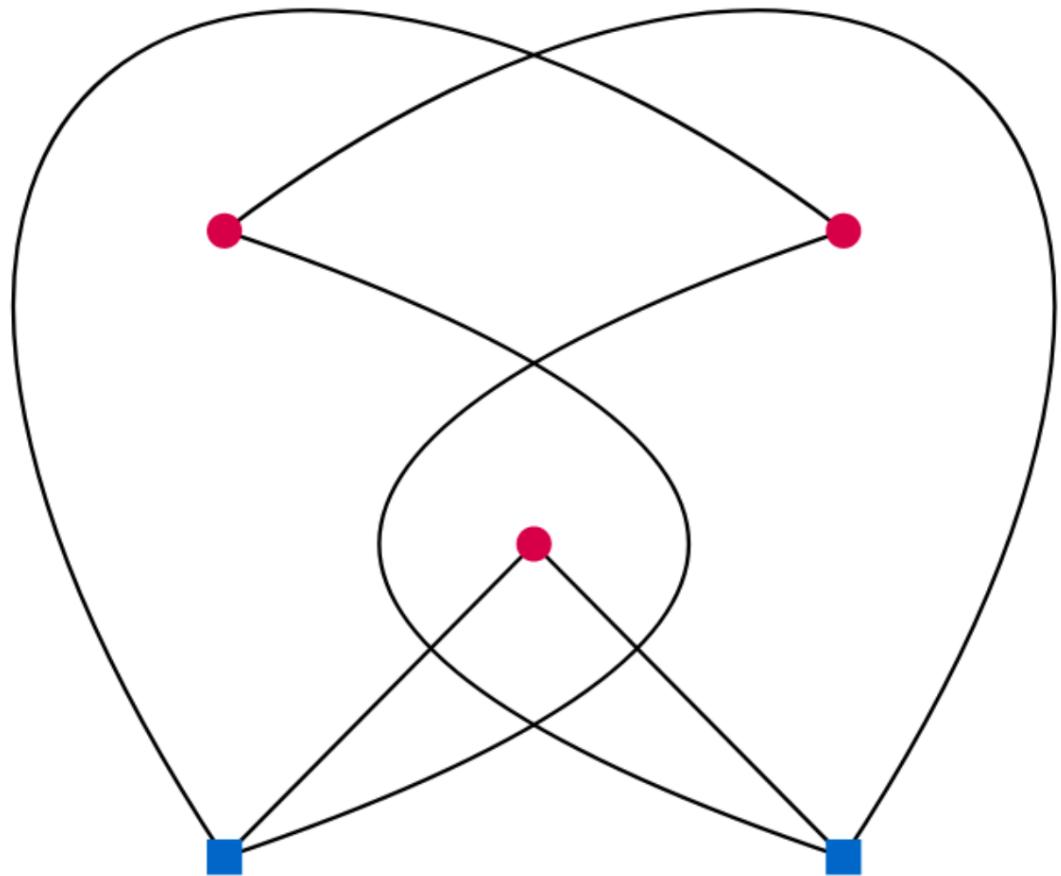
Hier: Beweis für den Spezialfall von **verallgemeinert verdrehten** Zeichnungen.

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



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

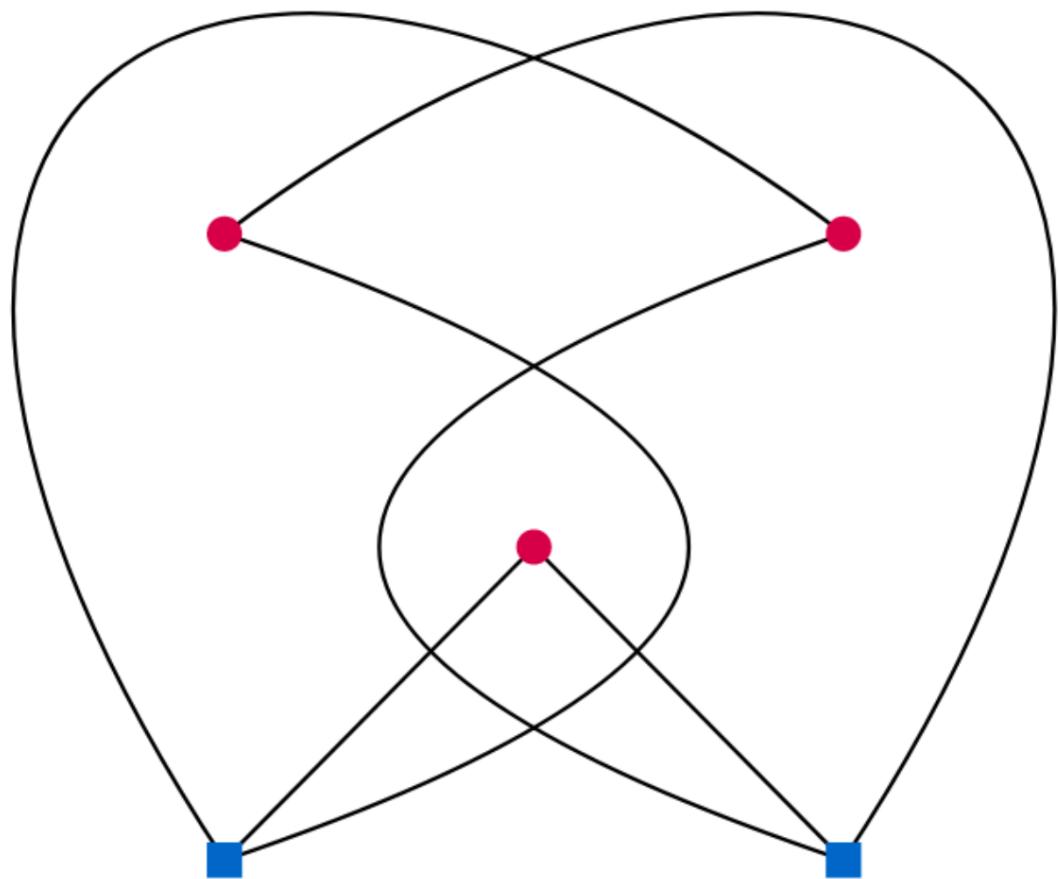
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Does this drawing of $K_{2,3}$ contain a plane spanning tree?

No – but the drawing is not simple.

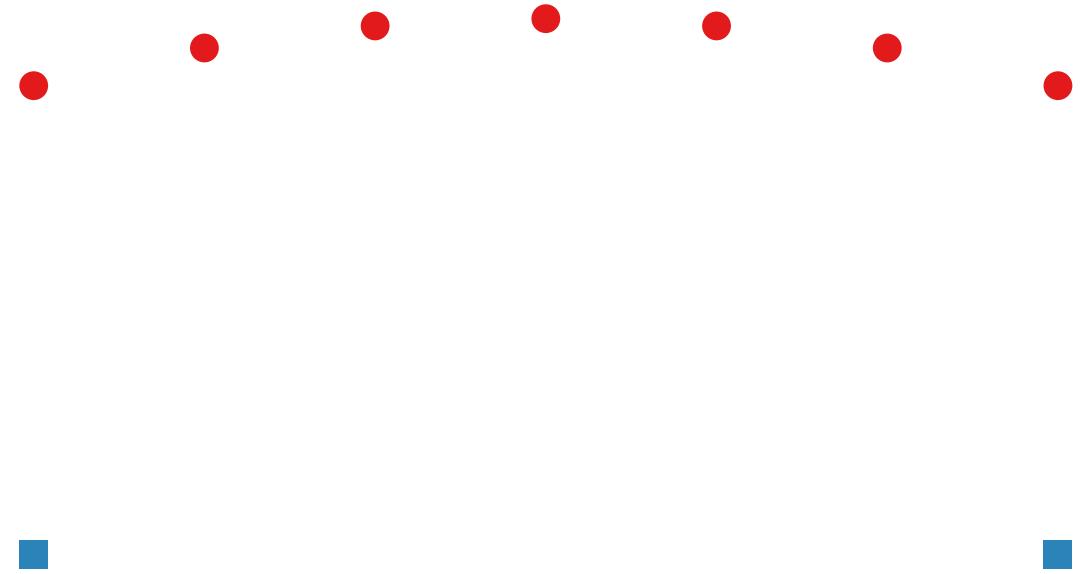
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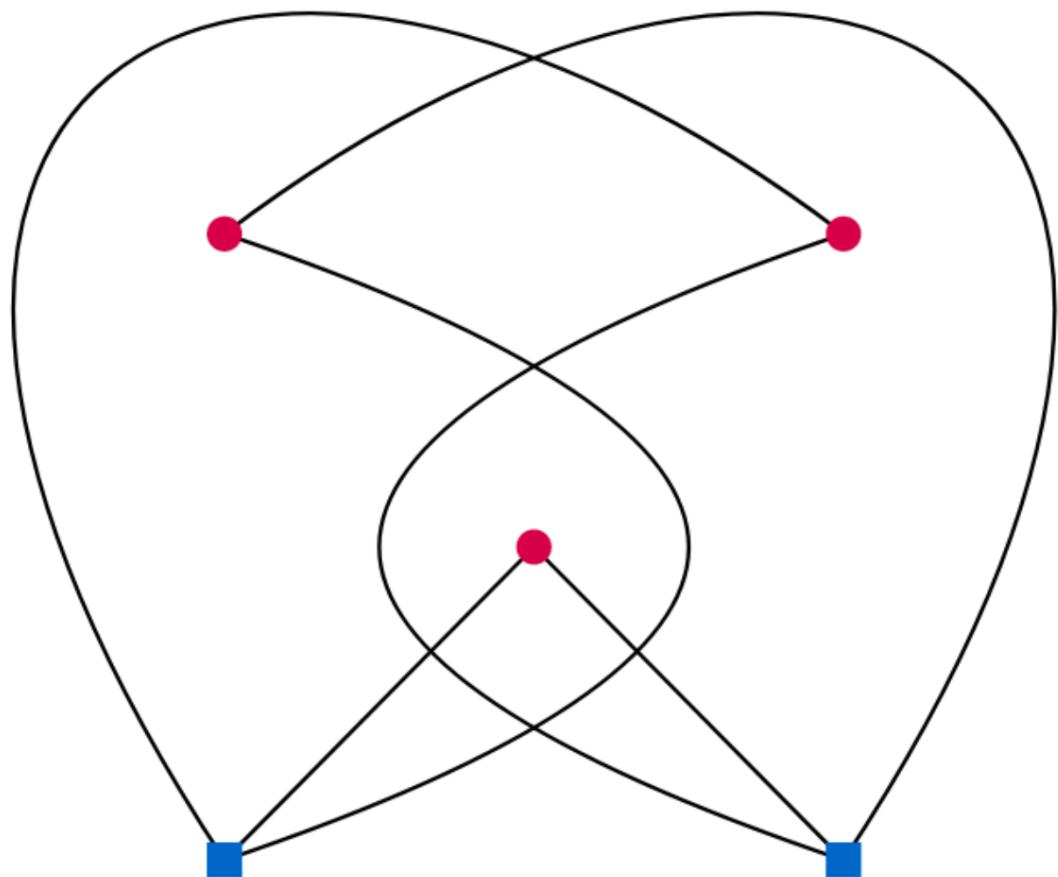
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Q: Does every *simple* drawing of $K_{m,n}$ admit a plane spanning tree?



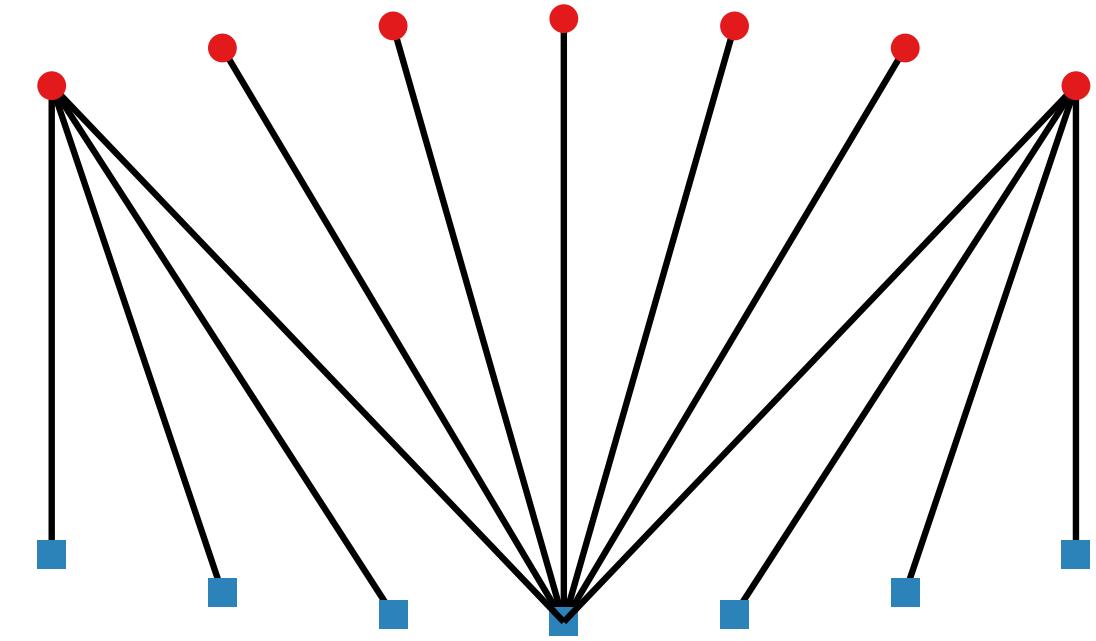
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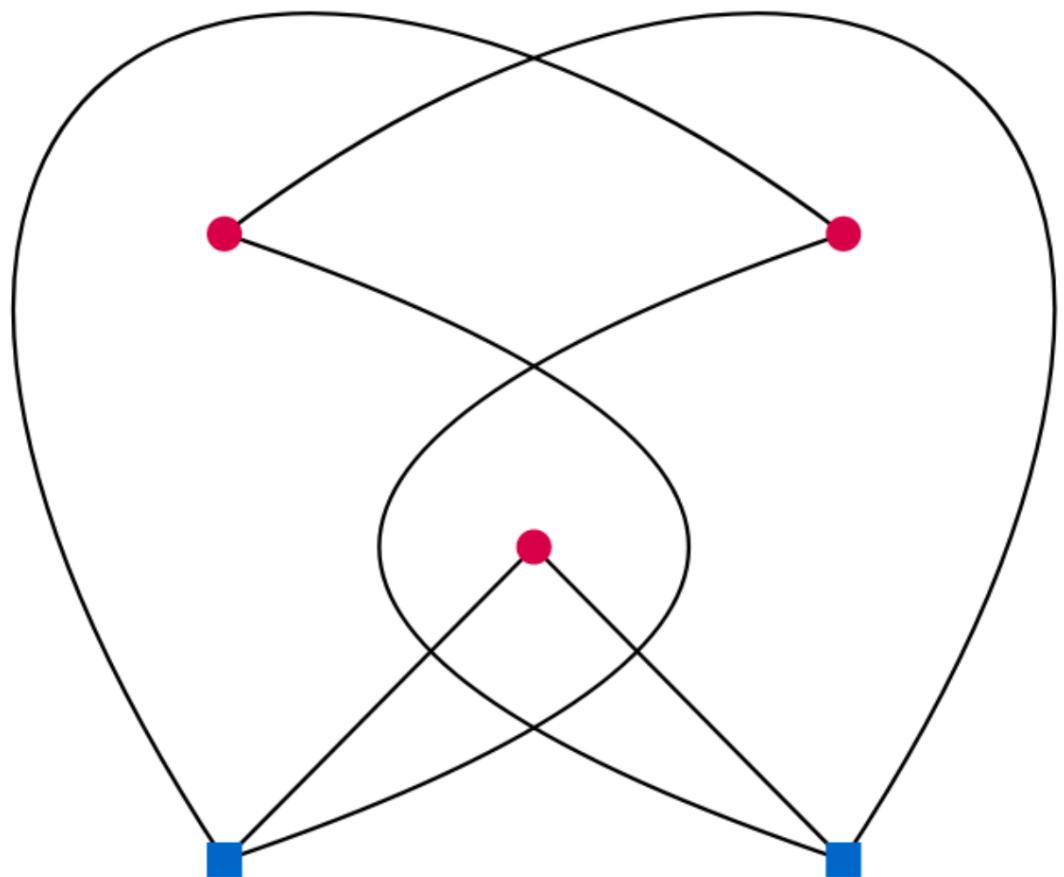
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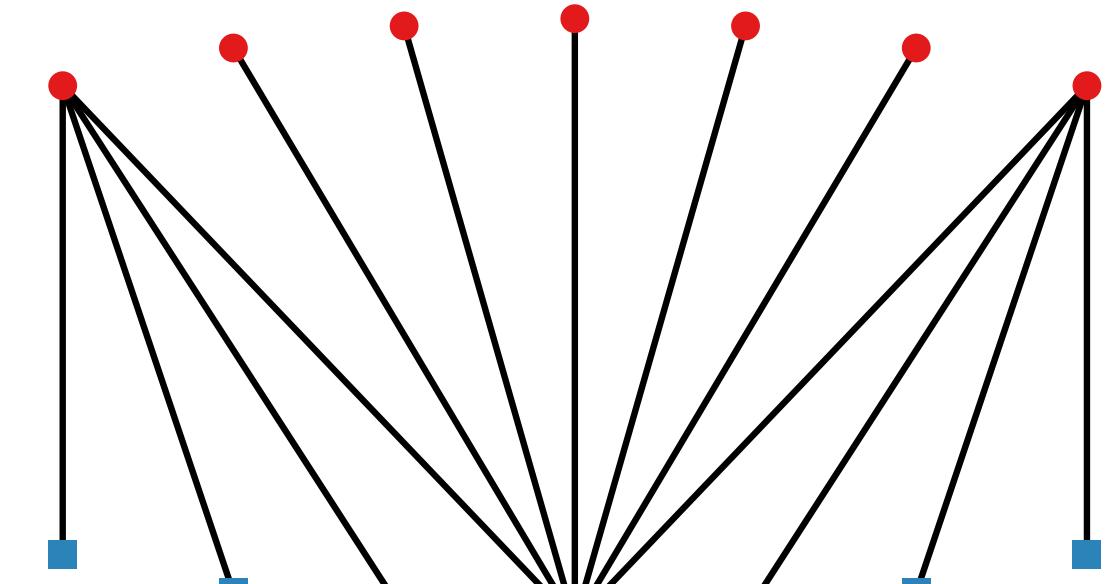
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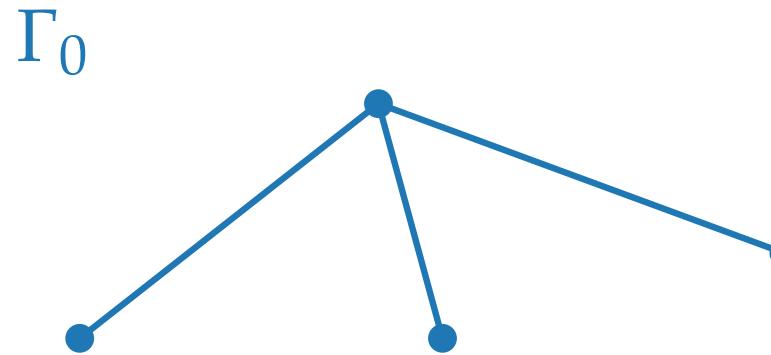
Thm. Let D be a simple drawing of $K_{m,n}$, and let r be an arbitrary vertex of $K_{m,n}$. Then D contains a shooting star rooted at r .

6. Mutual Witness Gabriel Drawings

Given two vertex-disjoint graph drawings Γ_0 and Γ_1 :

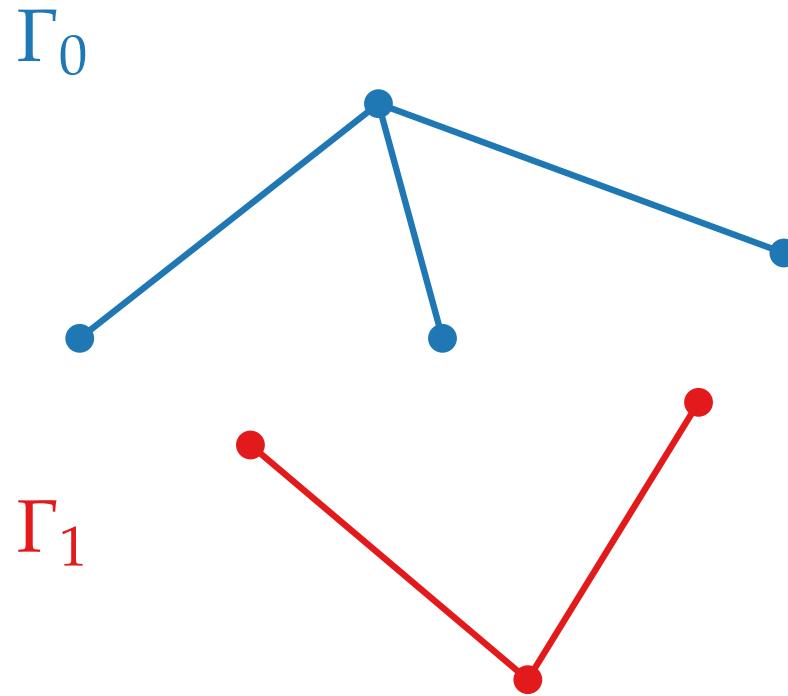
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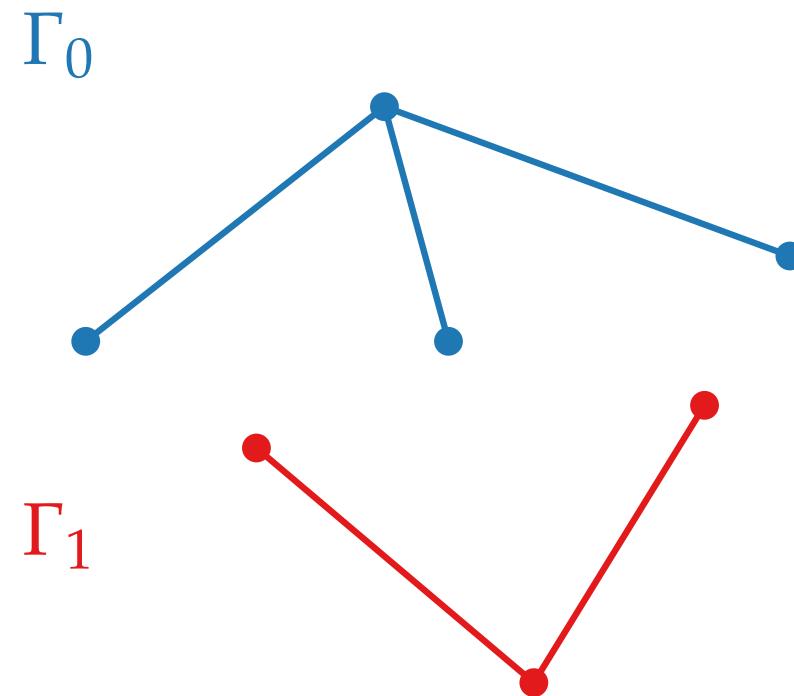
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6. Mutual Witness Gabriel Drawings

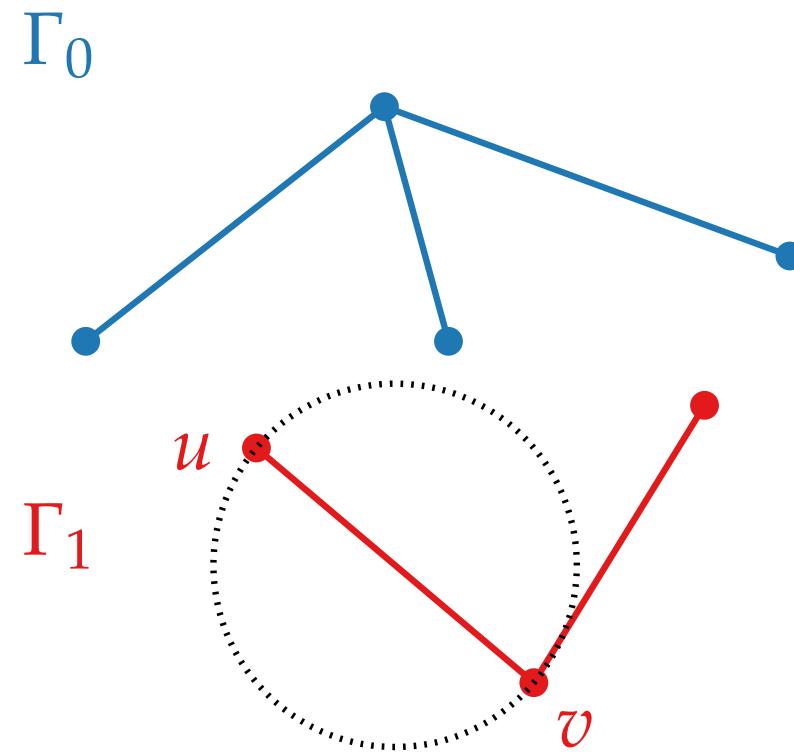
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- The *Gabriel disk* of u and v is the disk having u and v as antipodal points.

6. Mutual Witness Gabriel Drawings

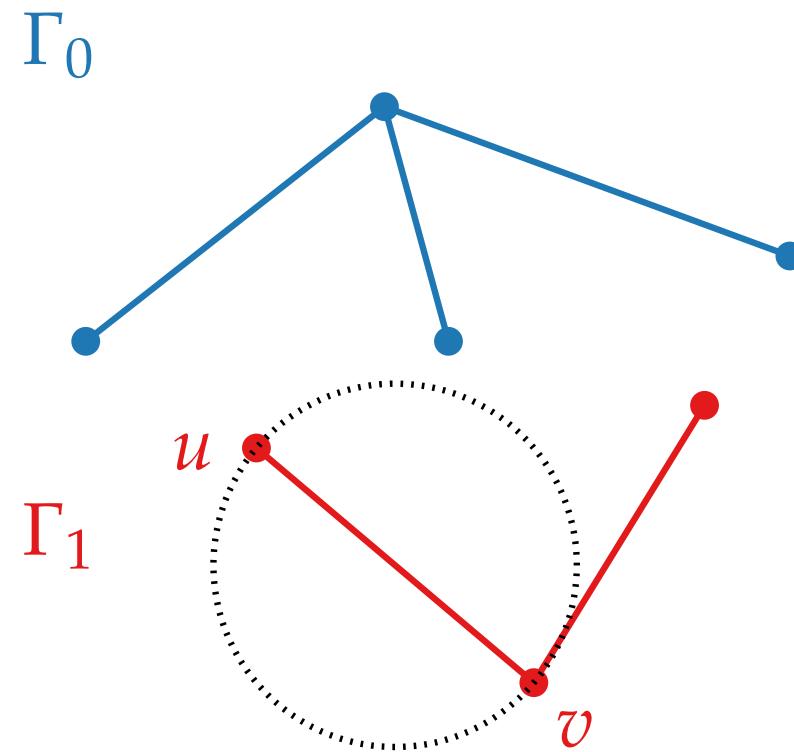
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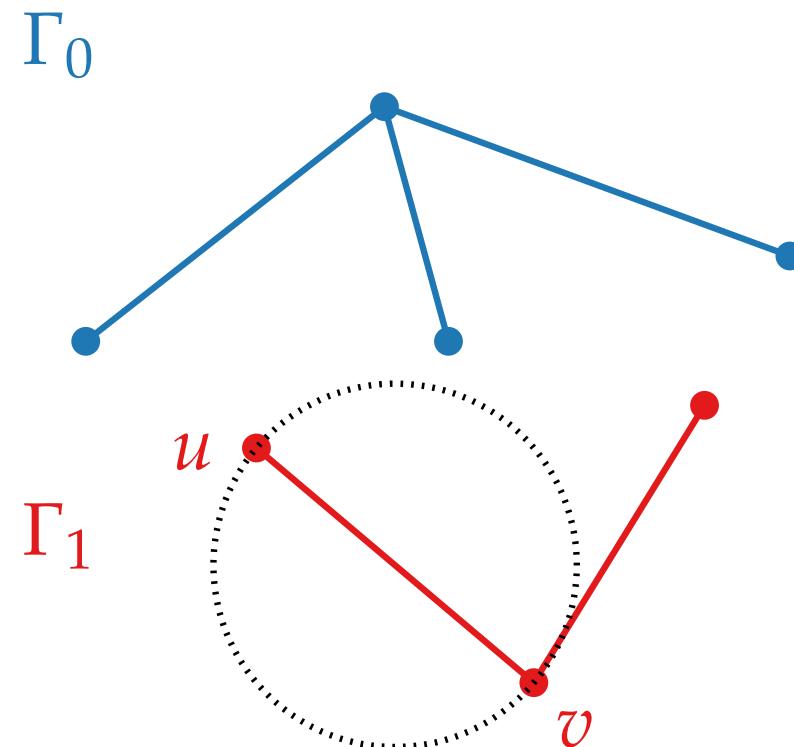
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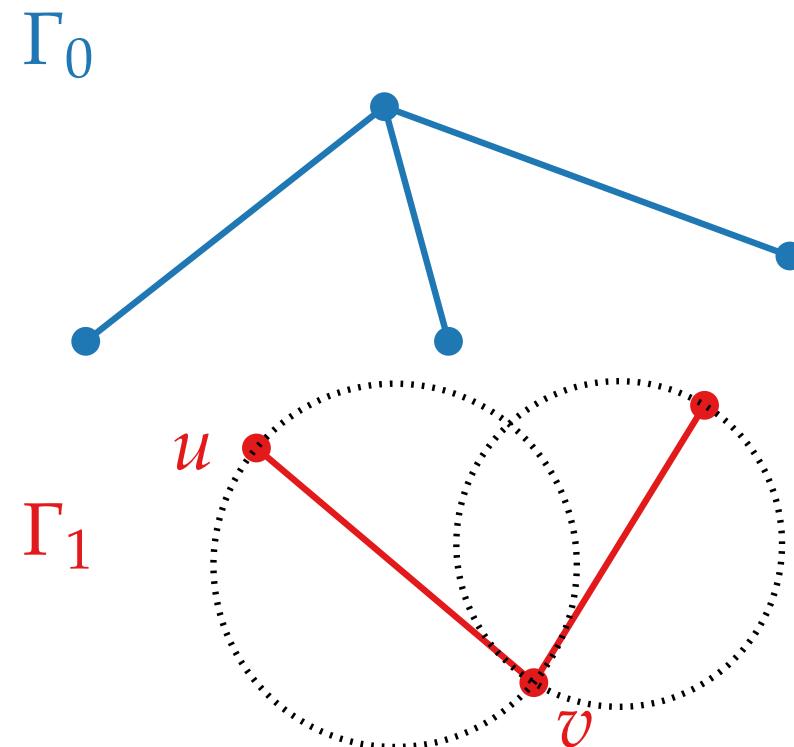
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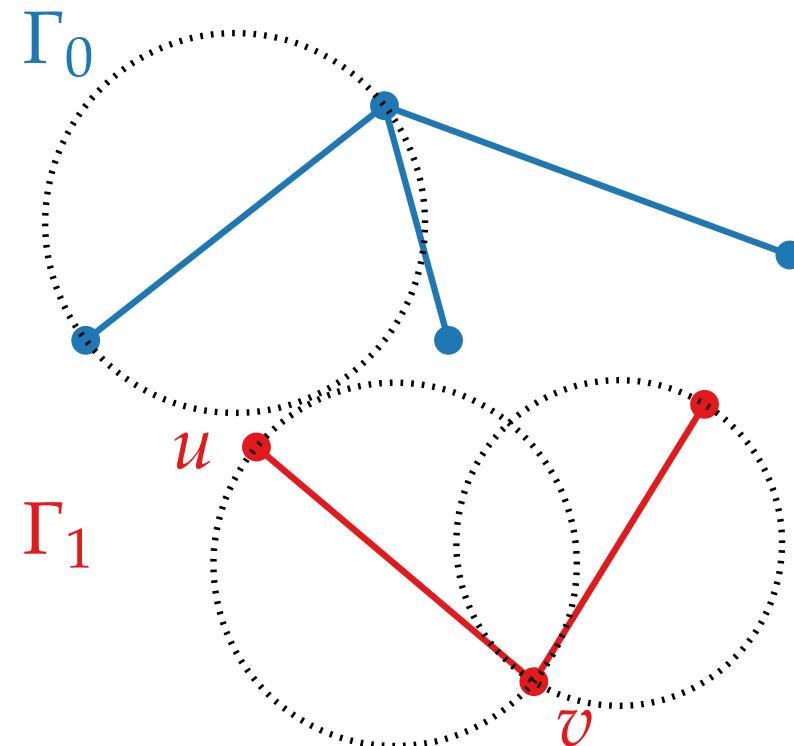
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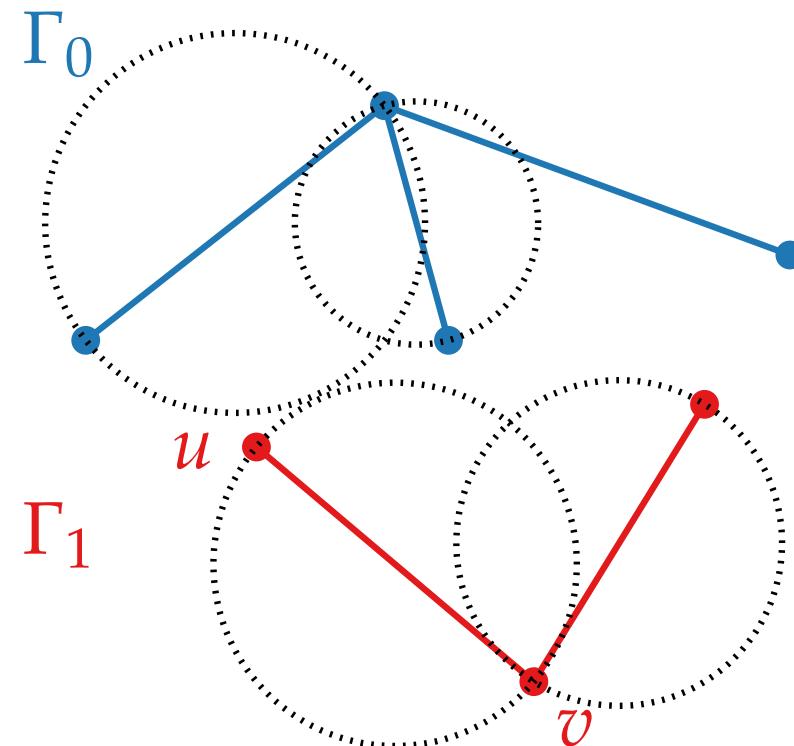
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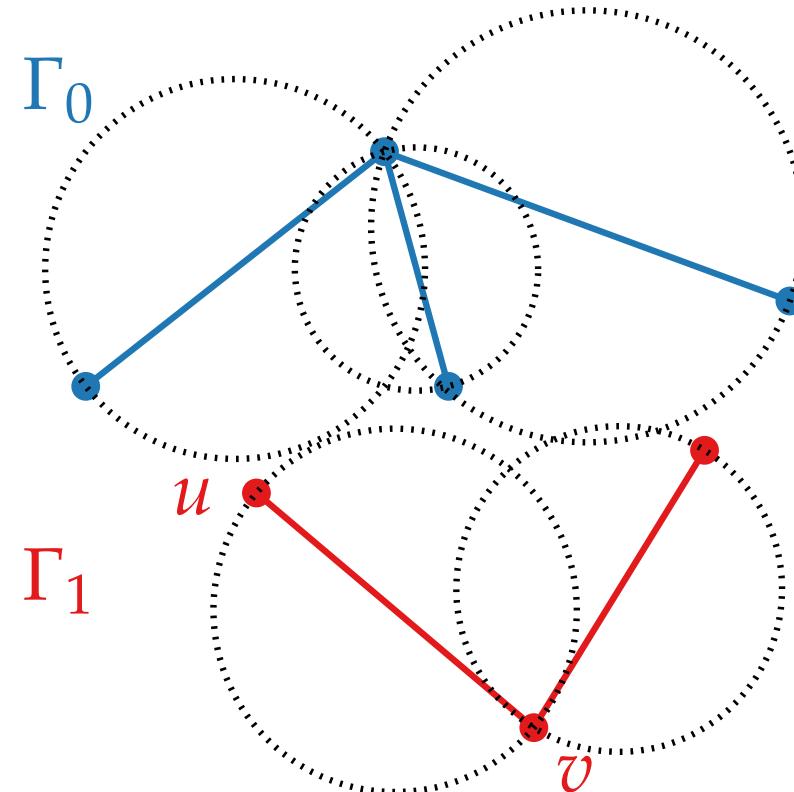
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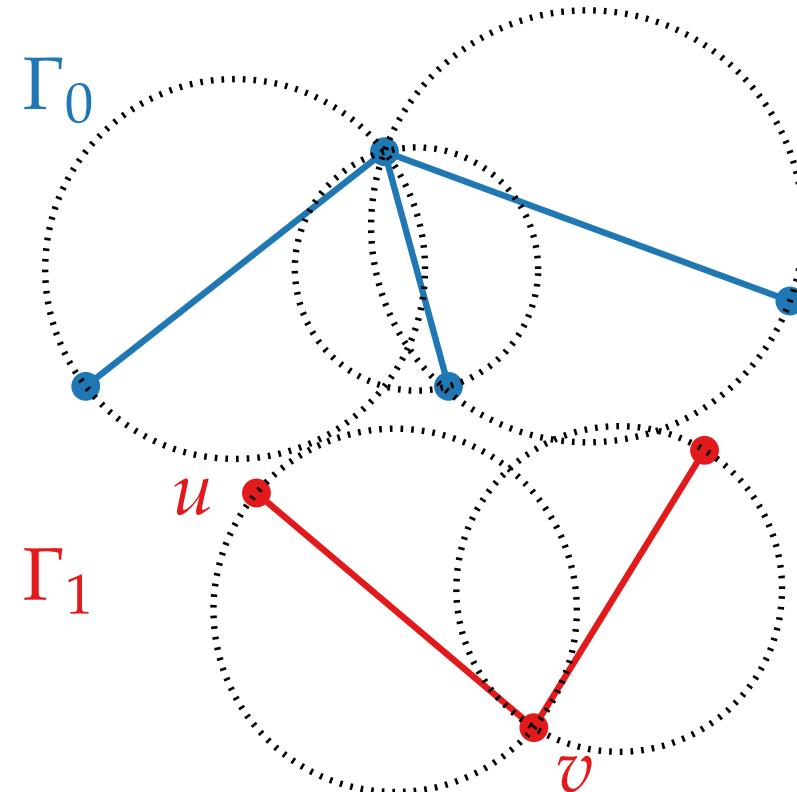
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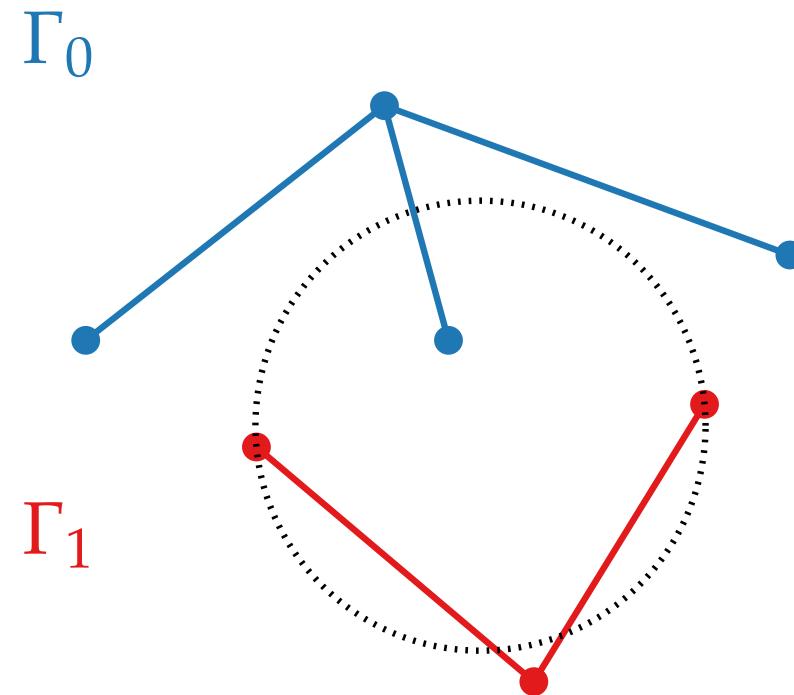
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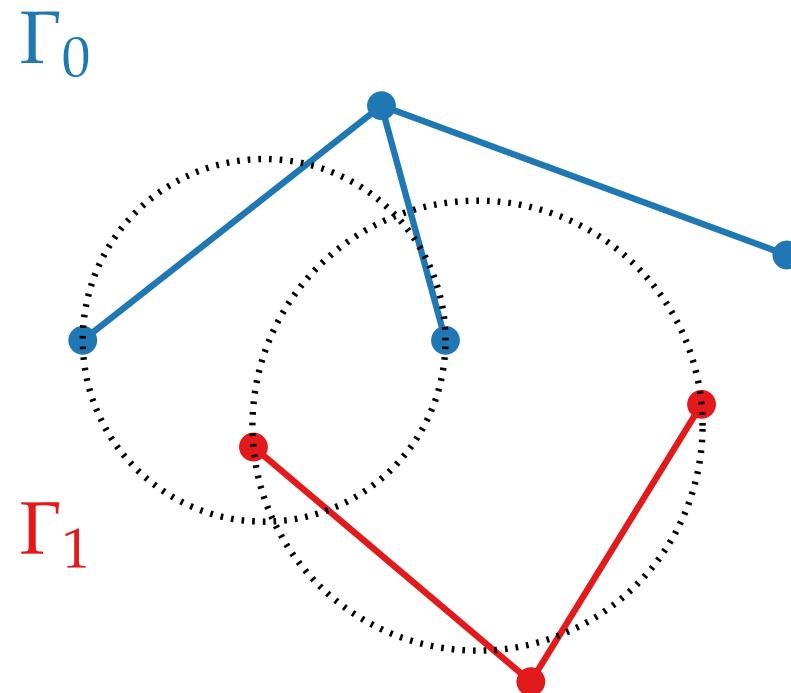
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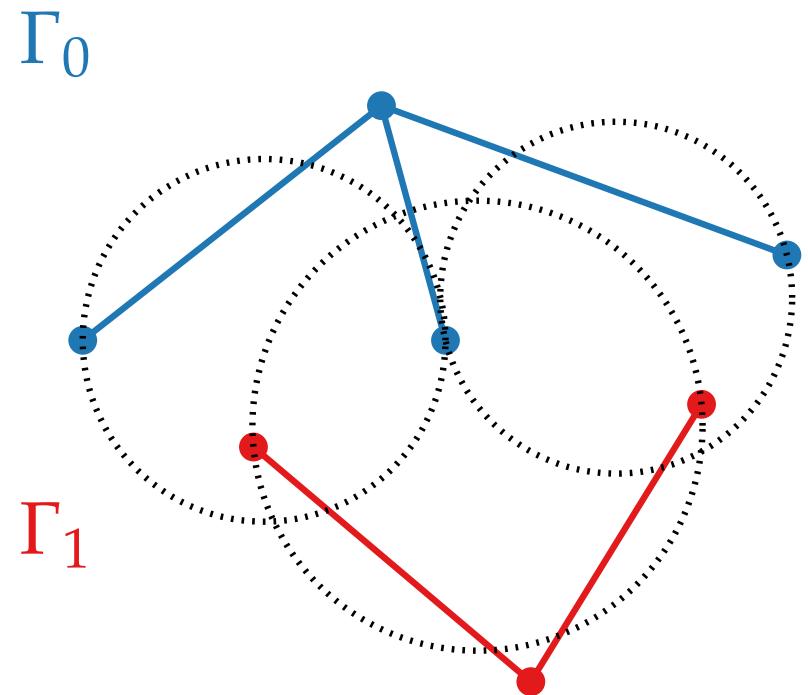
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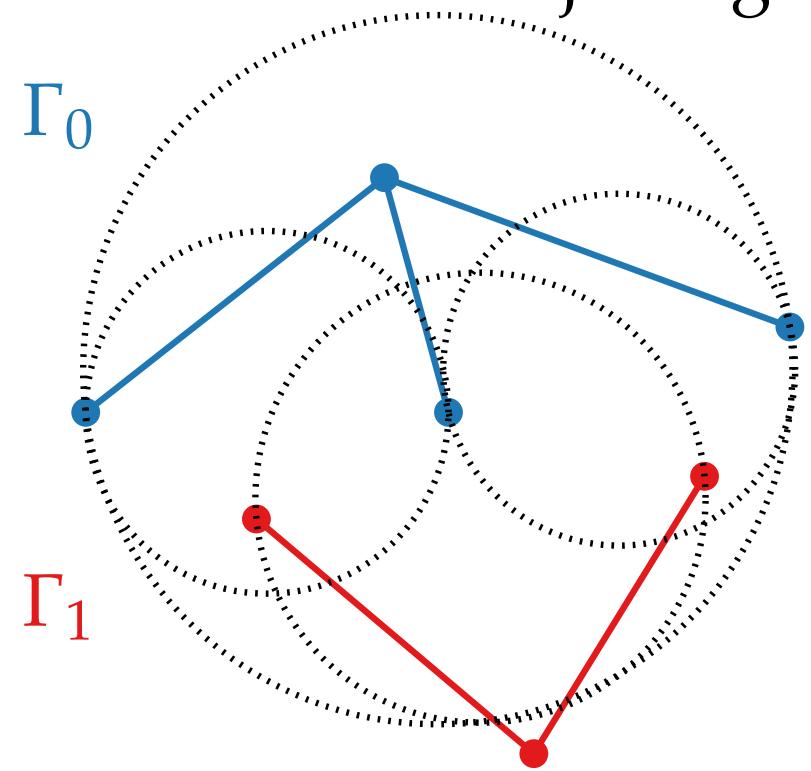
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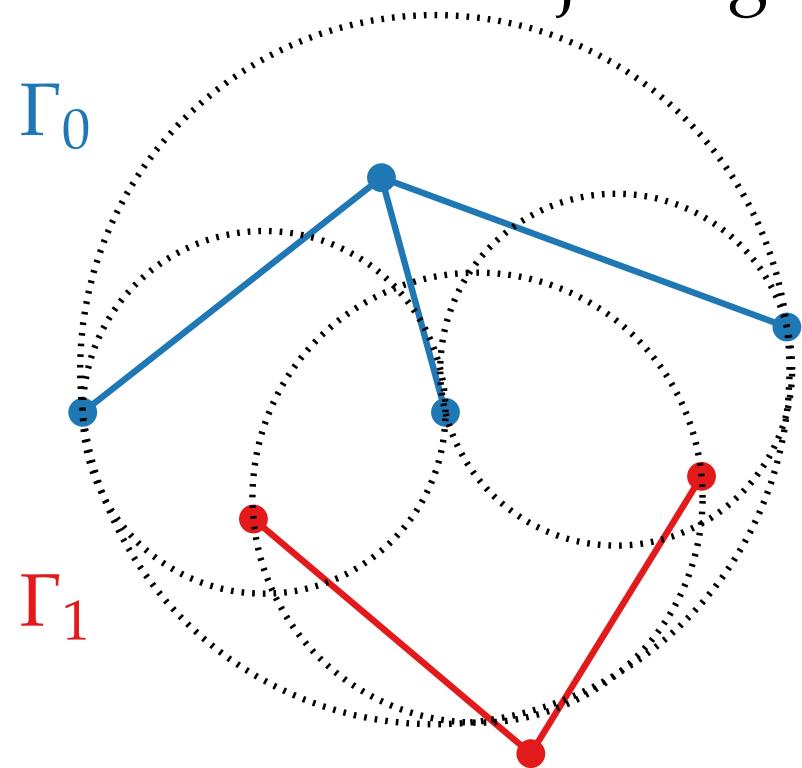
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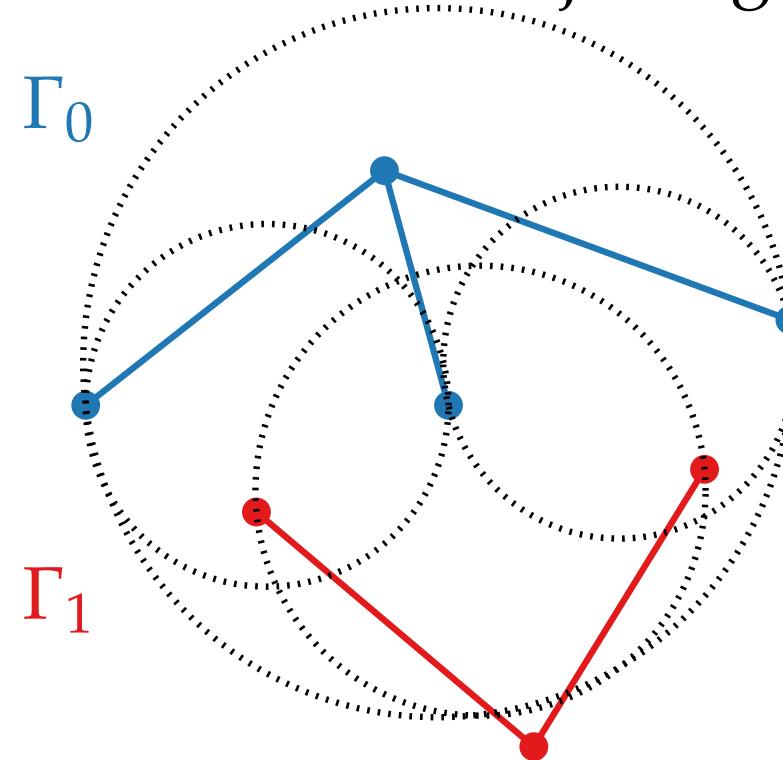


- Which pairs of graphs admit a mutual witness Gabriel drawing?

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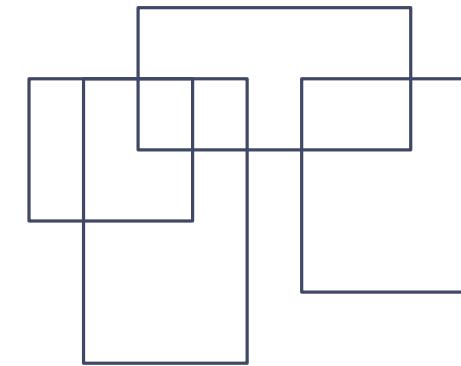


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7. FORBID: Fast Overlap Removal By Gradient Descent

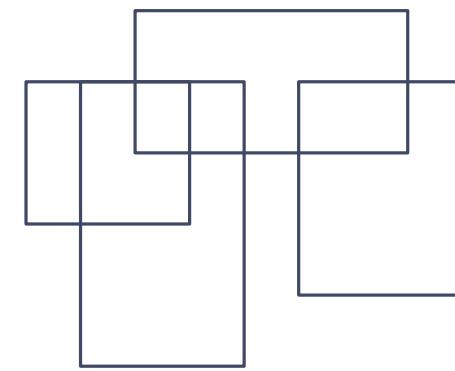
Eingabe: Hindernisse (achsenparallele Rechtecke), potentiell überlappend



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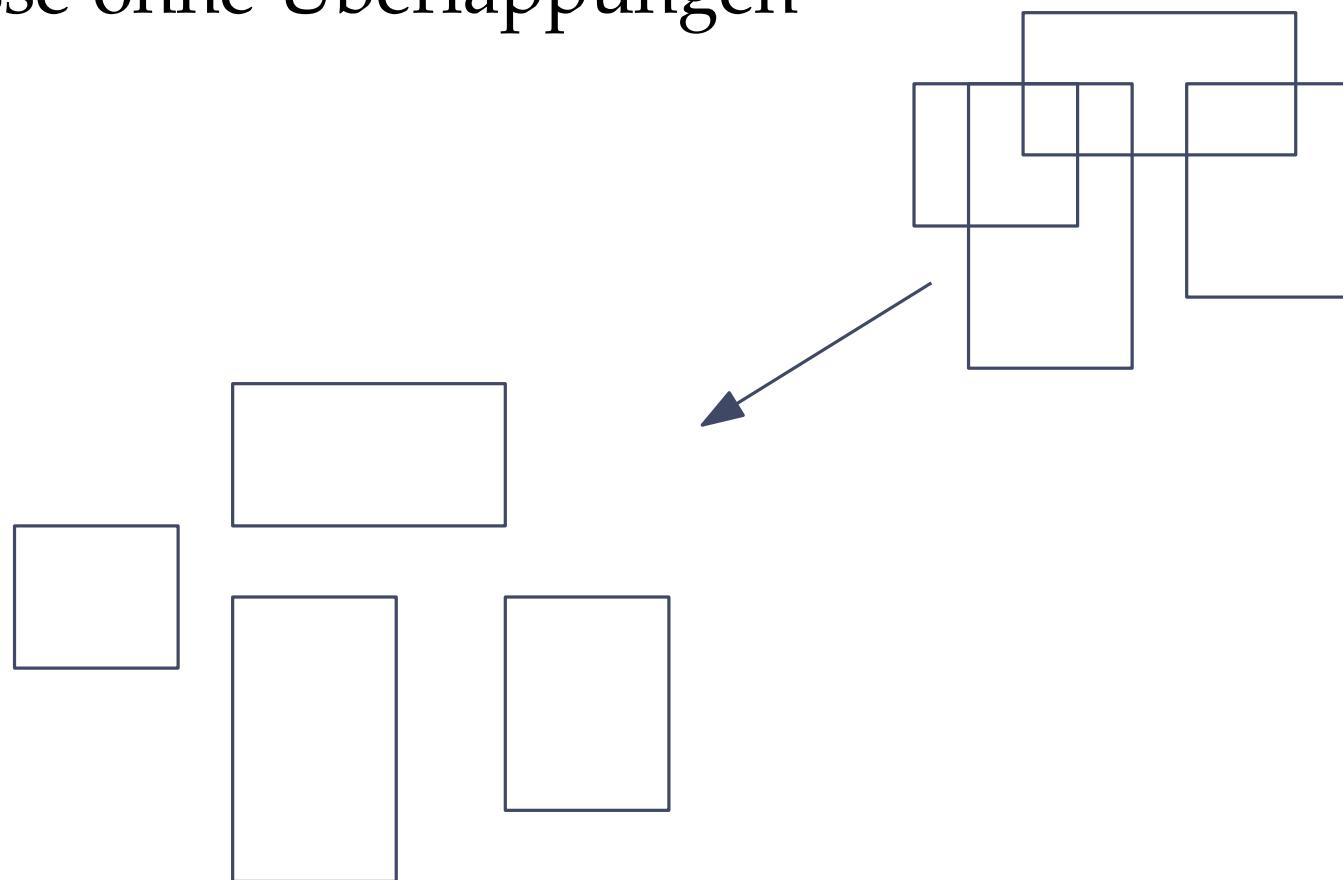
Ausgabe: Verschobene Hindernisse ohne Überlappungen



7. FORBID: Fast Overlap Removal By Gradient Descent

Eingabe: Hindernisse (achsenparallele Rechtecke), potentiell überlappend

Ausgabe: Verschobene Hindernisse ohne Überlappungen

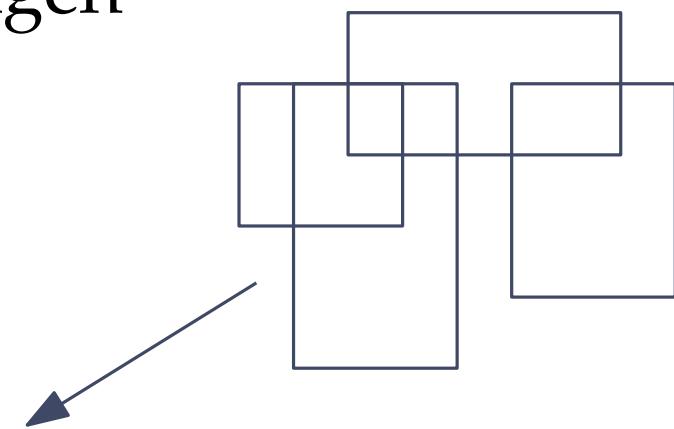
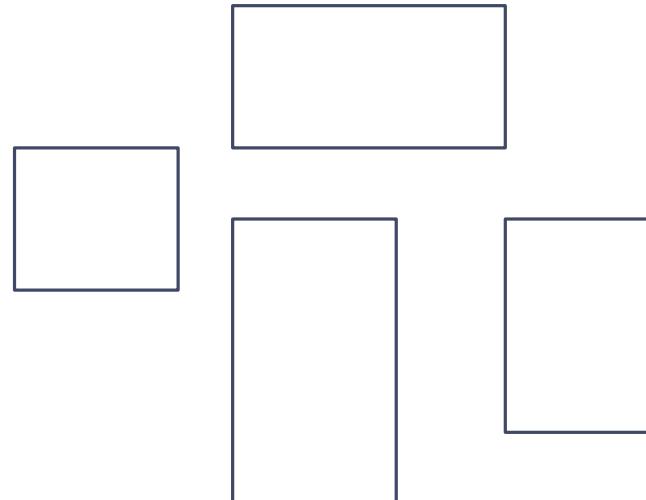


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Ausgabe: Verschobene Hindernisse ohne Überlappungen

Gütekriterien?



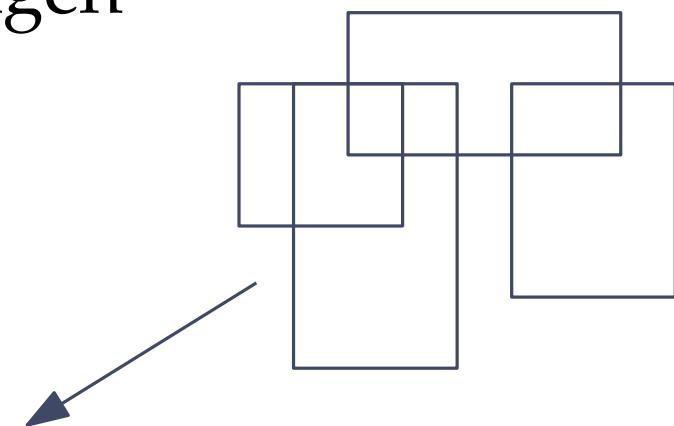
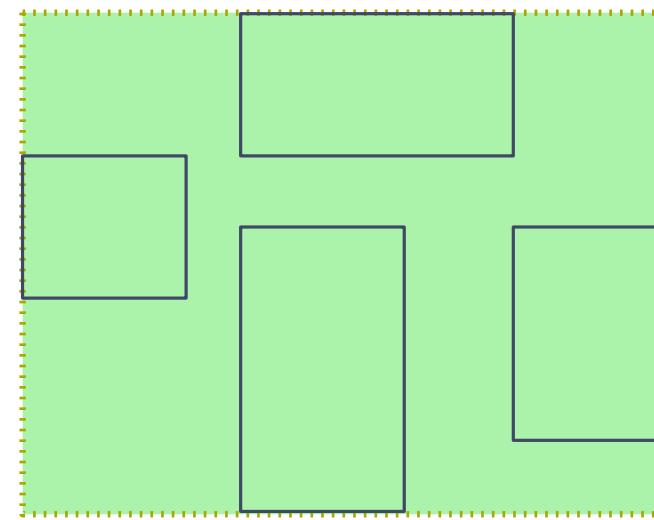
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Gütekriterien?

- Gesamtfläche
 - Umspannendes Rechteck



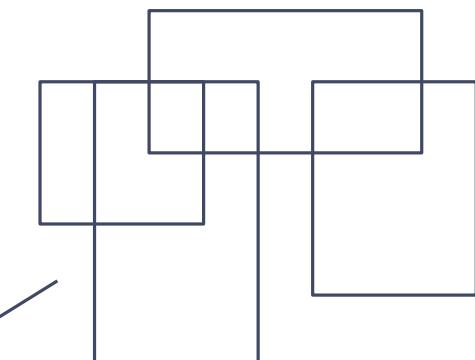
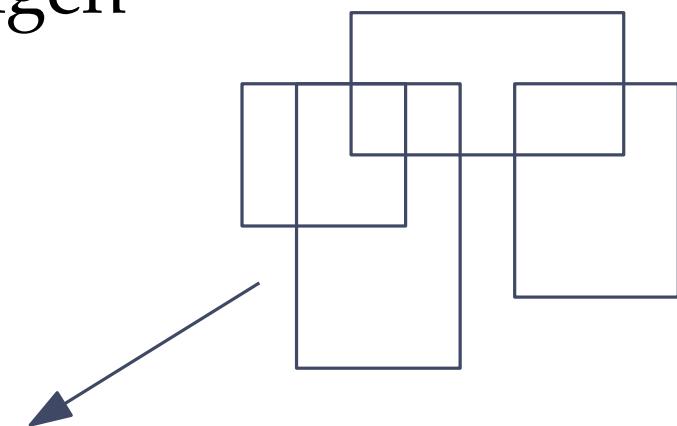
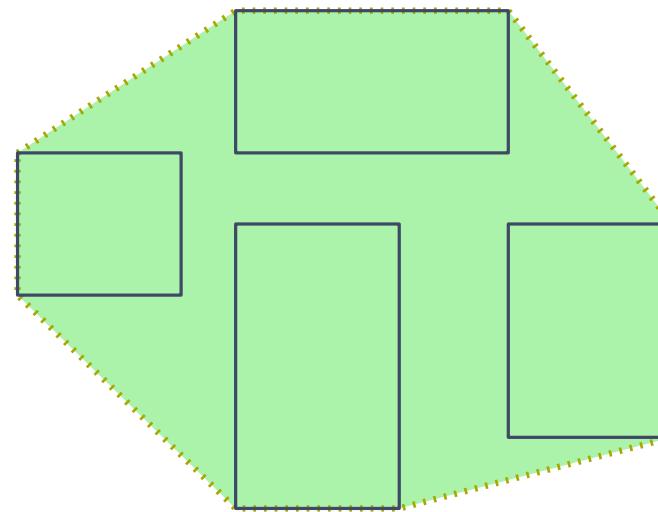
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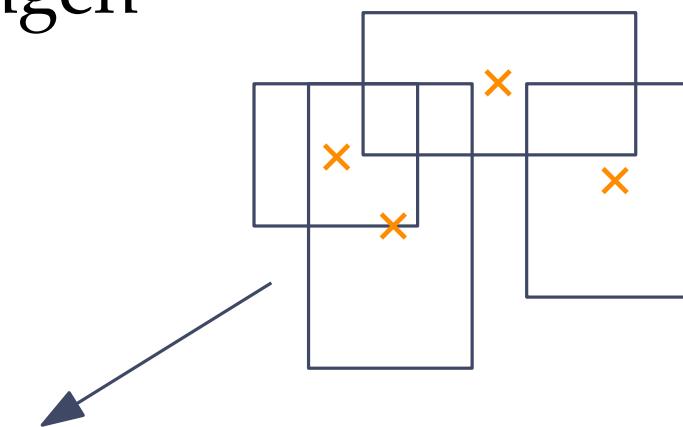
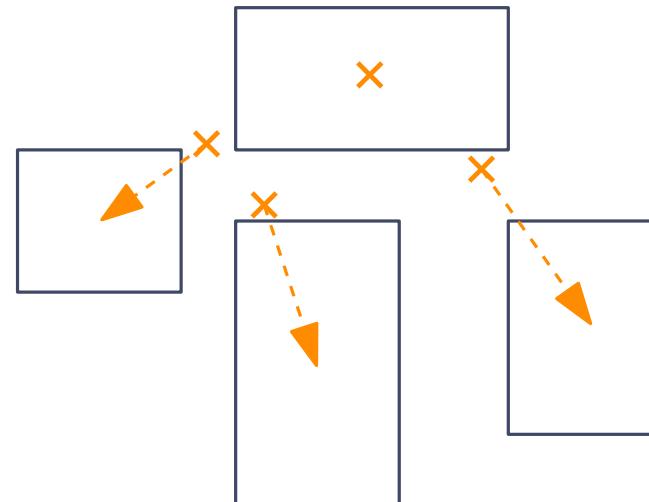
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 - Konvexe Hülle
- Gesamtverschiebung



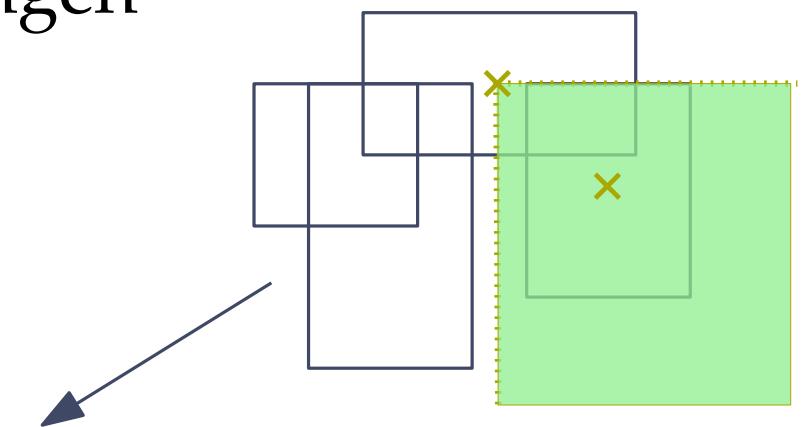
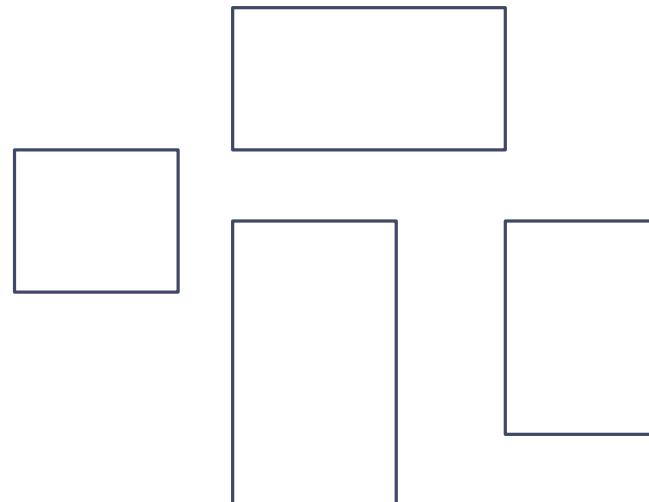
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Gütekriterien?

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 - Umspannendes Rechteck
 - Konvexe Hülle
- Gesamtverschiebung
- Relative Lage



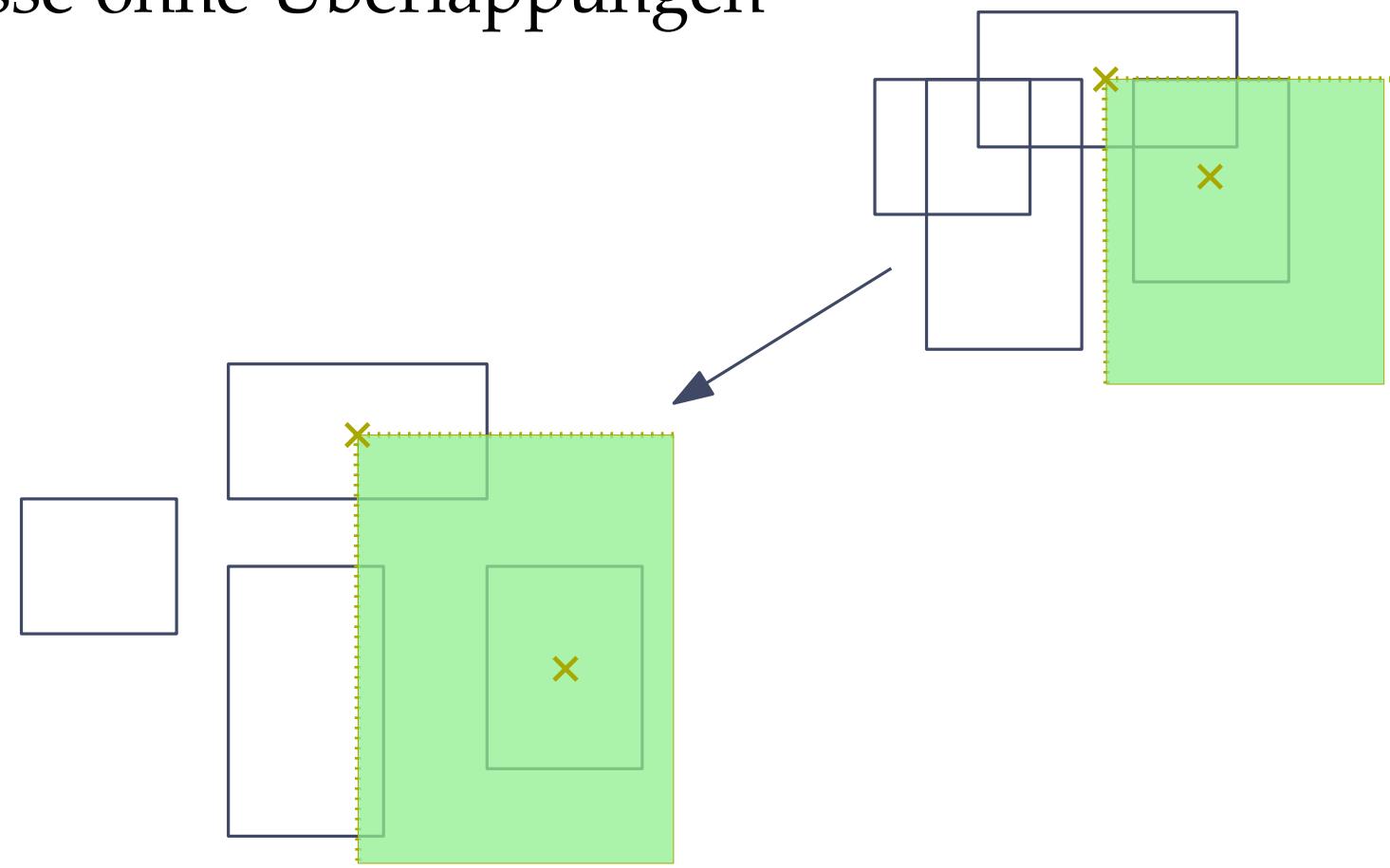
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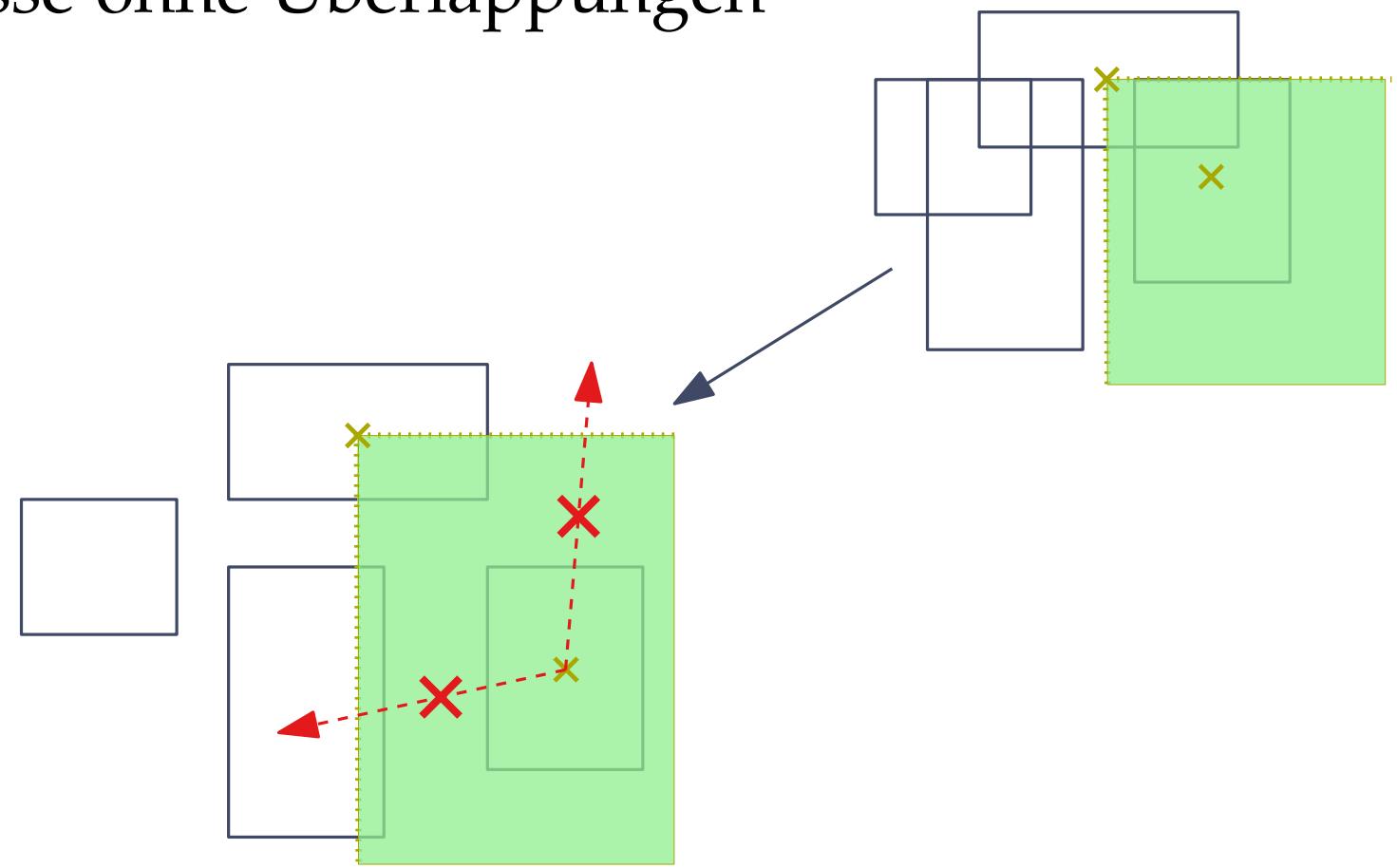
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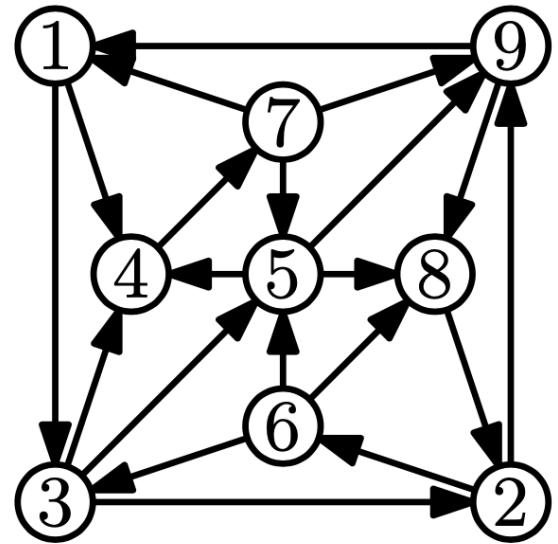
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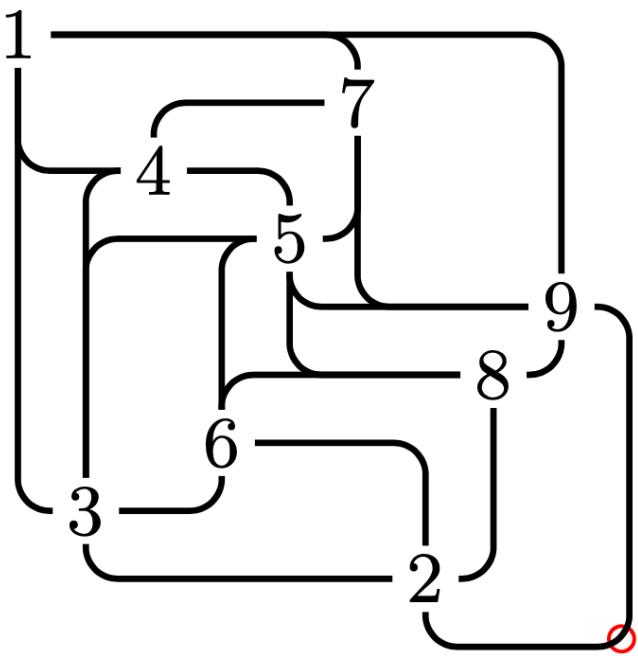
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- Gesamtverschiebung
- Relative Lage



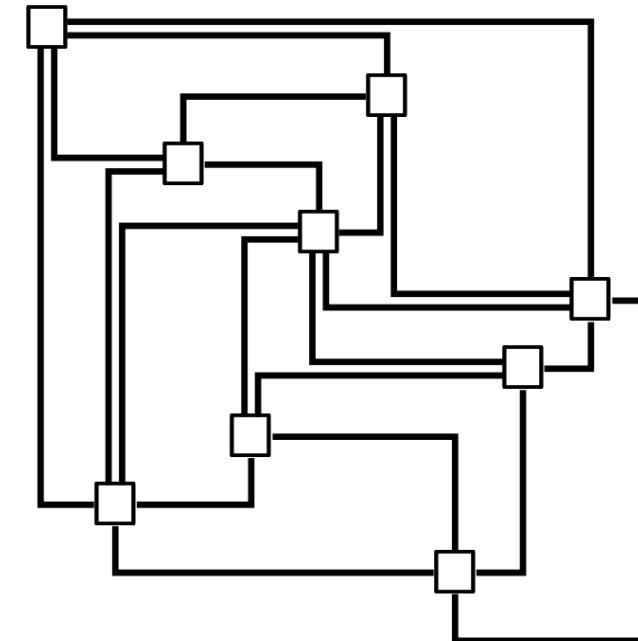
8. Planar Confluent Orthogonal Drawings



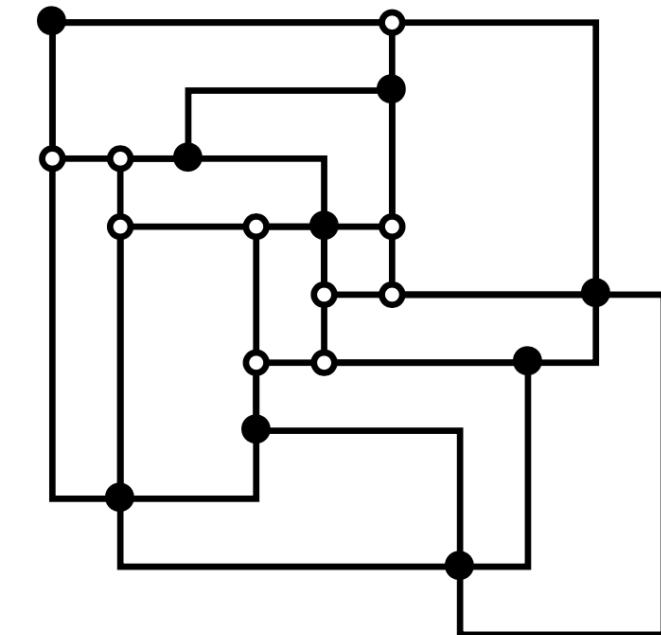
node-link diagram



PCOD

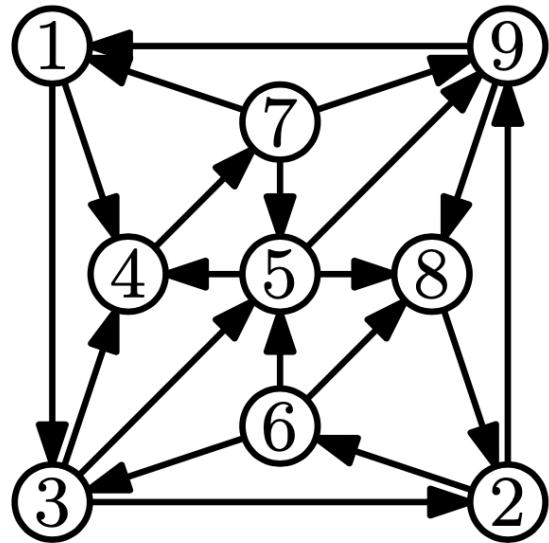


Kandinsky drawing

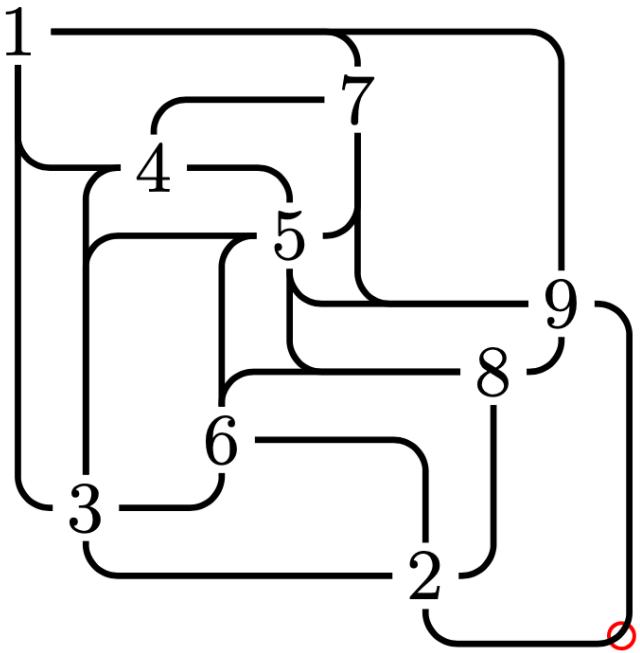


orthogonal drawing

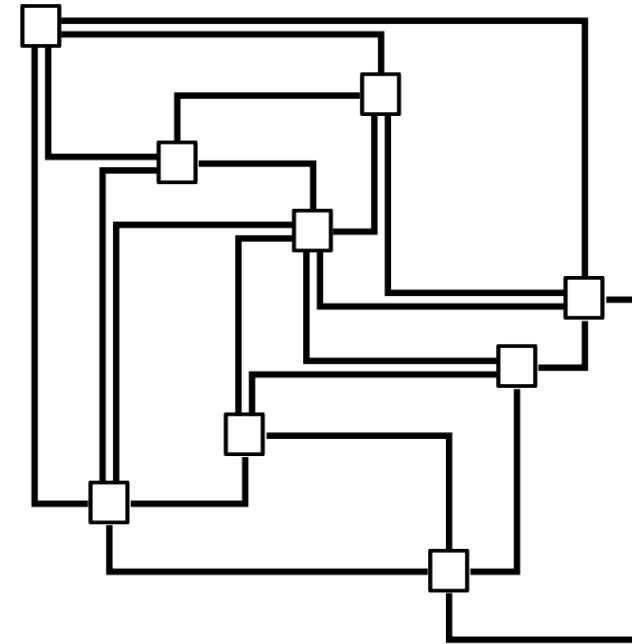
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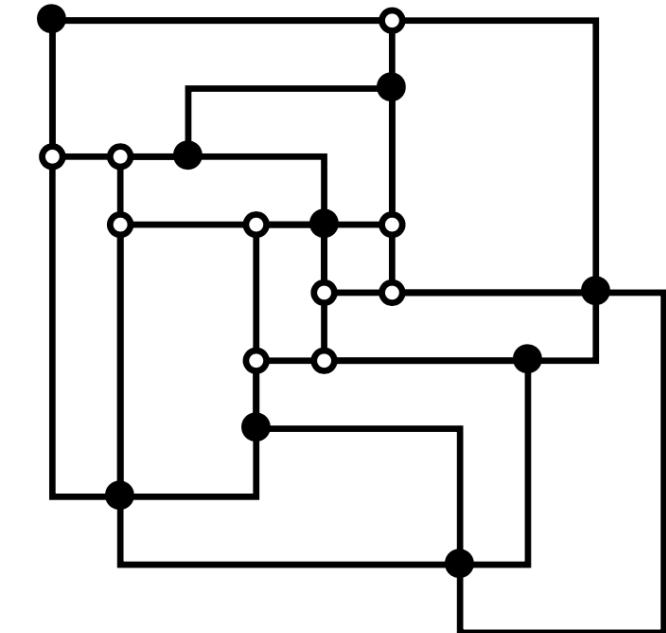
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PCOD



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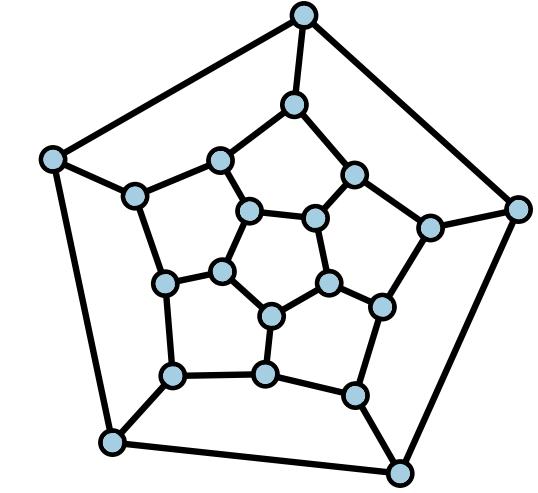


orthogonal drawing

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

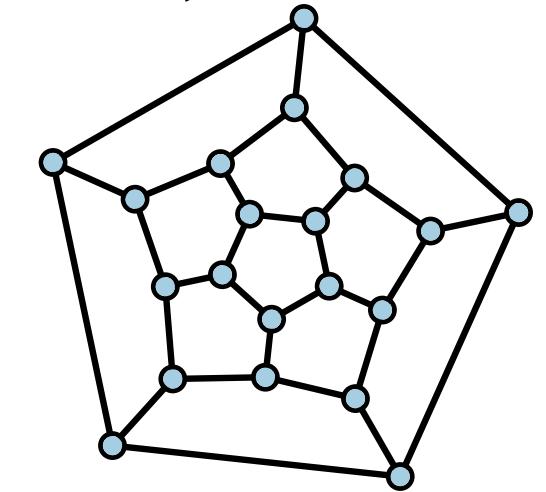
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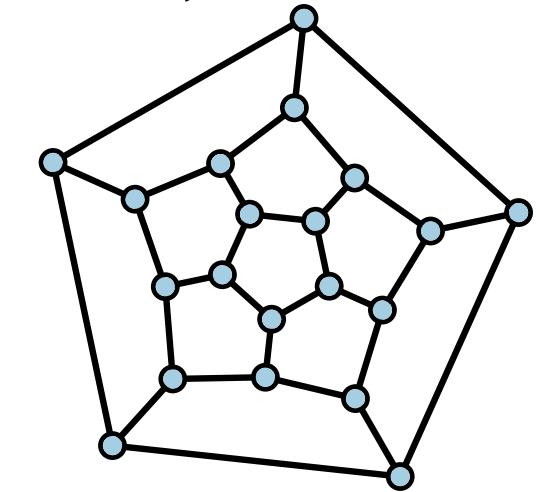


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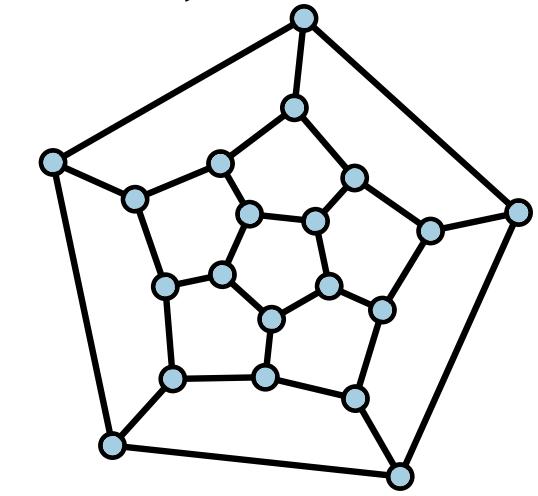
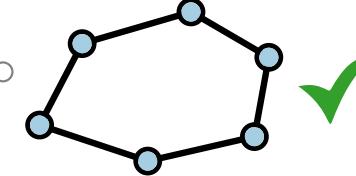


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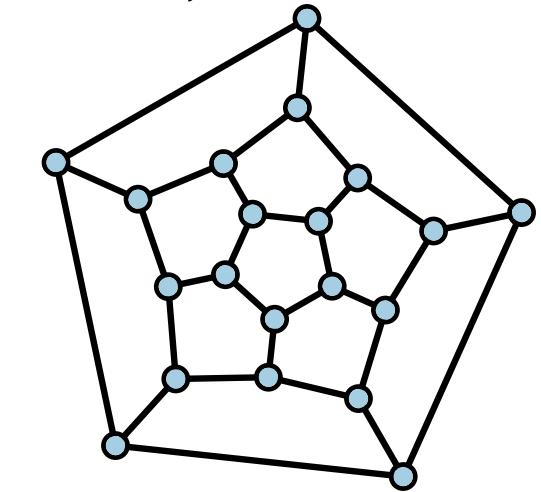
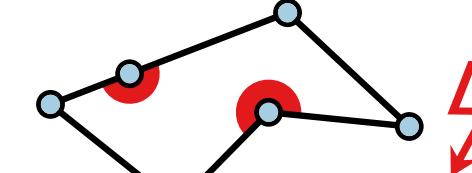
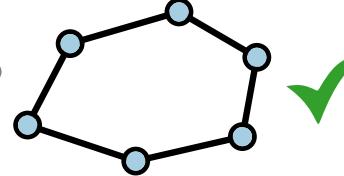


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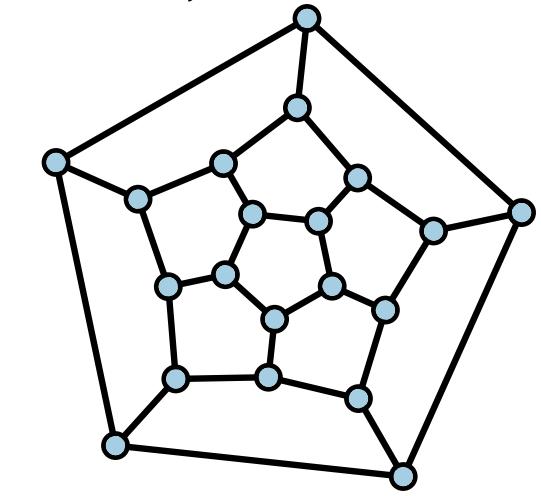
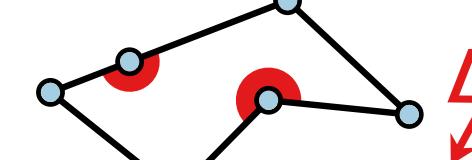
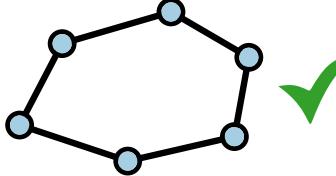


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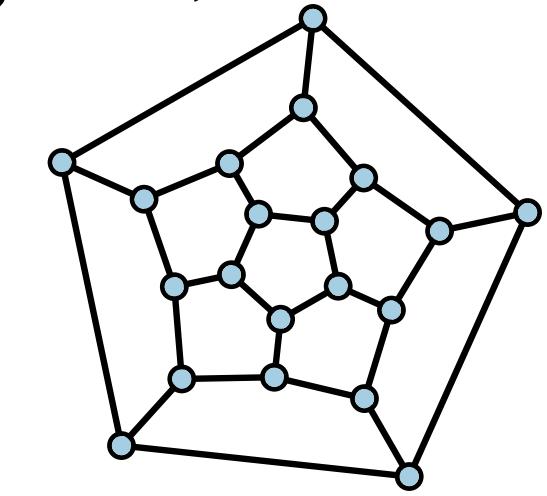
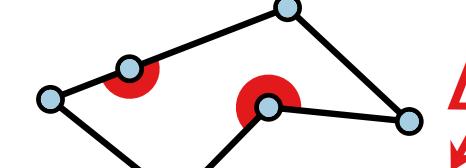
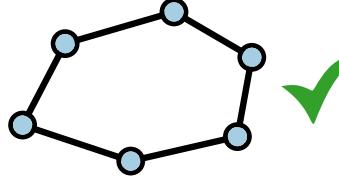
Bekannt: Jeder sog. 3-zusammenhängende planare Graph kann strikt konvex gezeichnet werden

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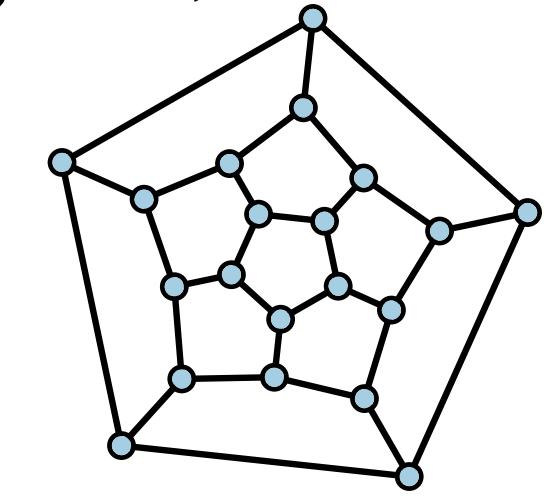
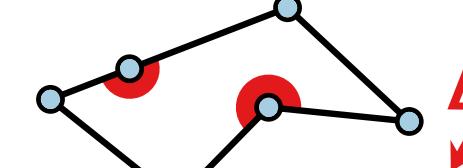
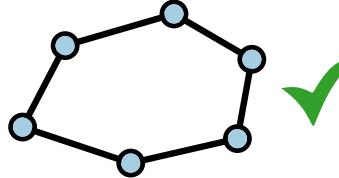
$n = \#Knoten$

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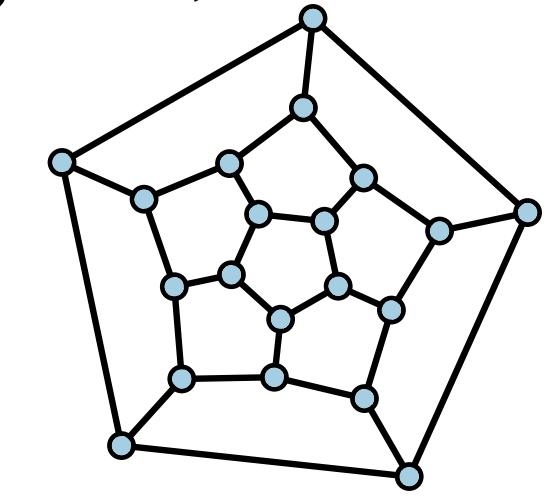
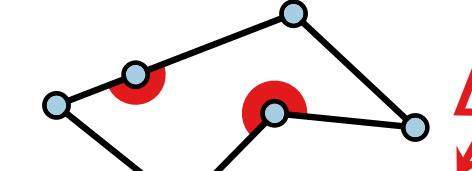
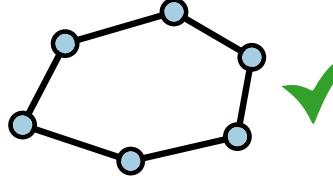
aber:

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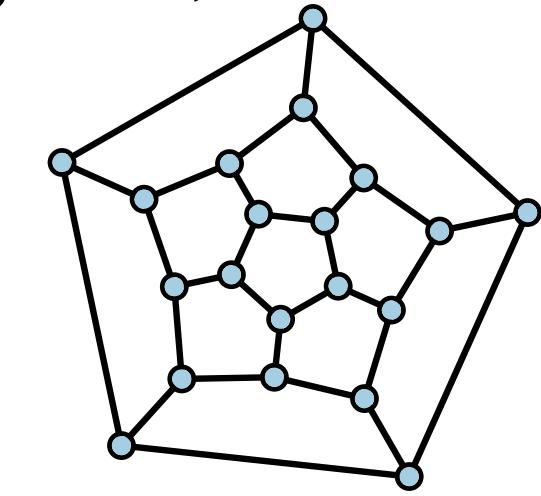
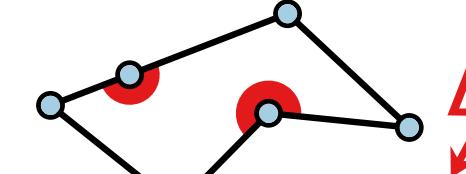
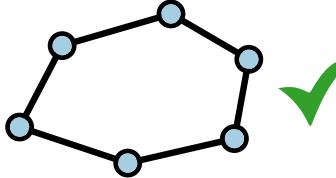
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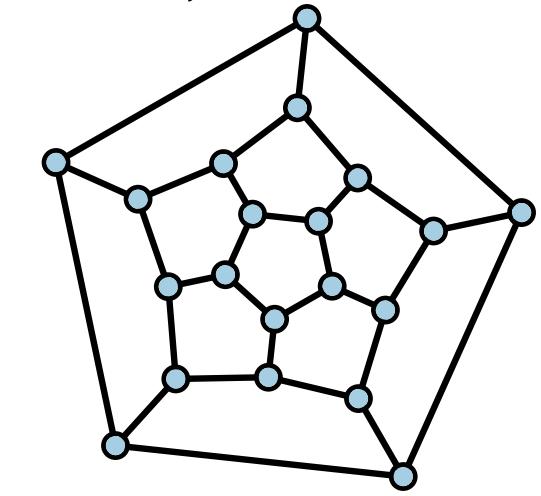
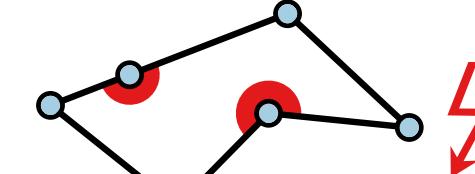
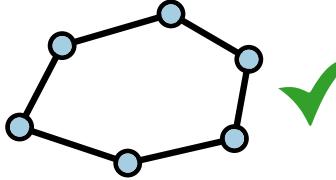
Neu: Ein $2n \times 5n^3$ Gitter genügt!

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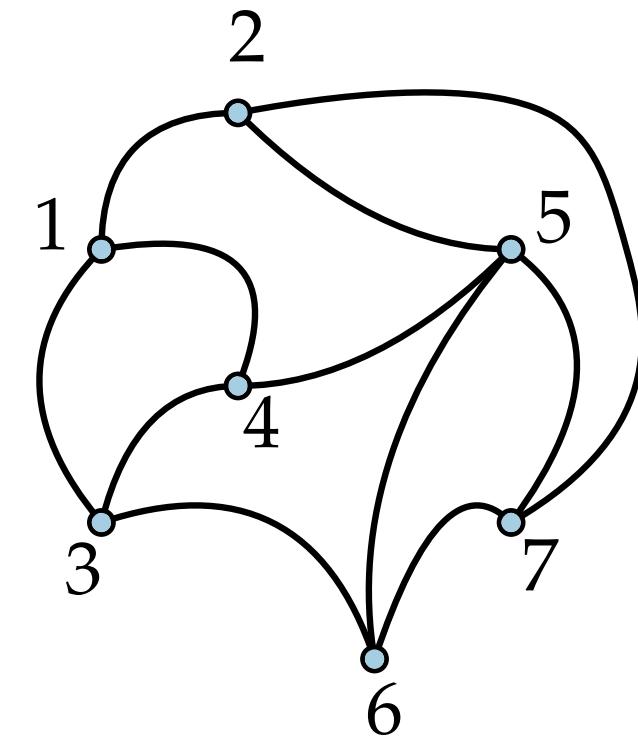
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Verwendete Techniken: Kanonische Ordnung + Shift-Methode
(\rightarrow GraphVis-Vorlesung)

10. st-Orientations with Few Transitive Edges

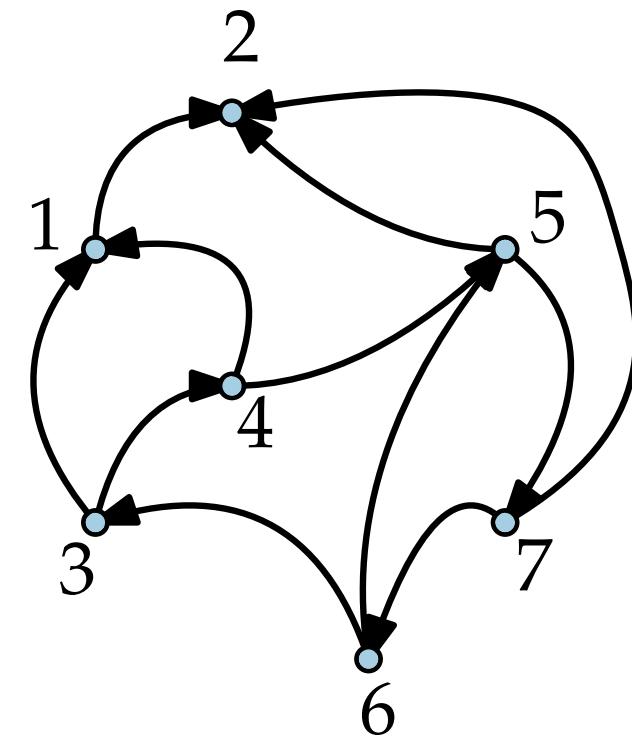
Eingabe: ein ungerichteter Graph $G = (V, E)$



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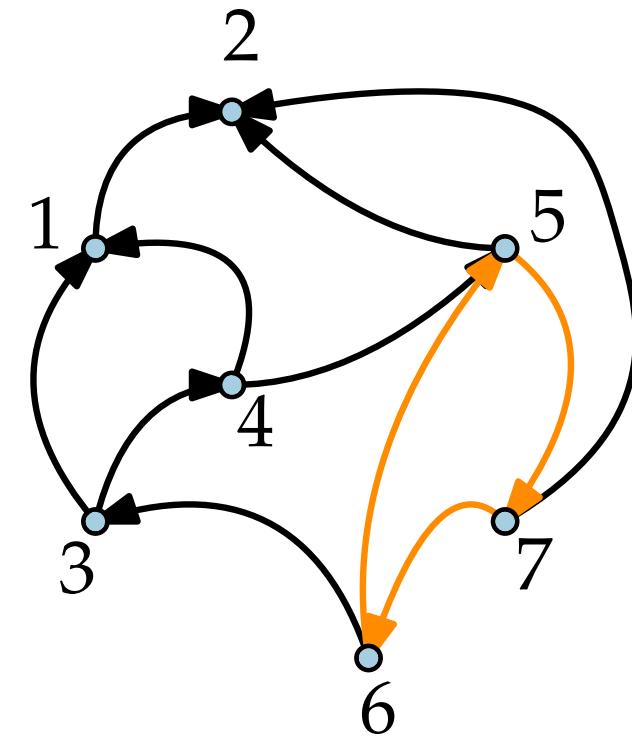
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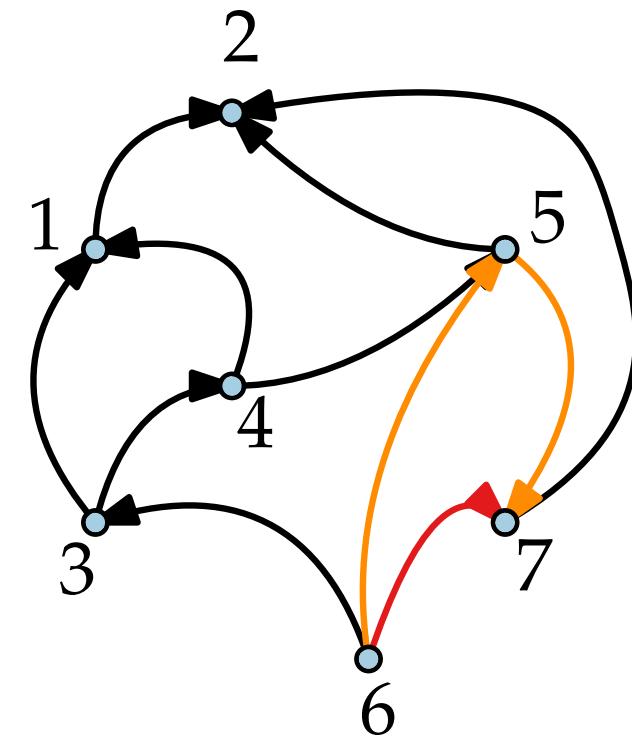
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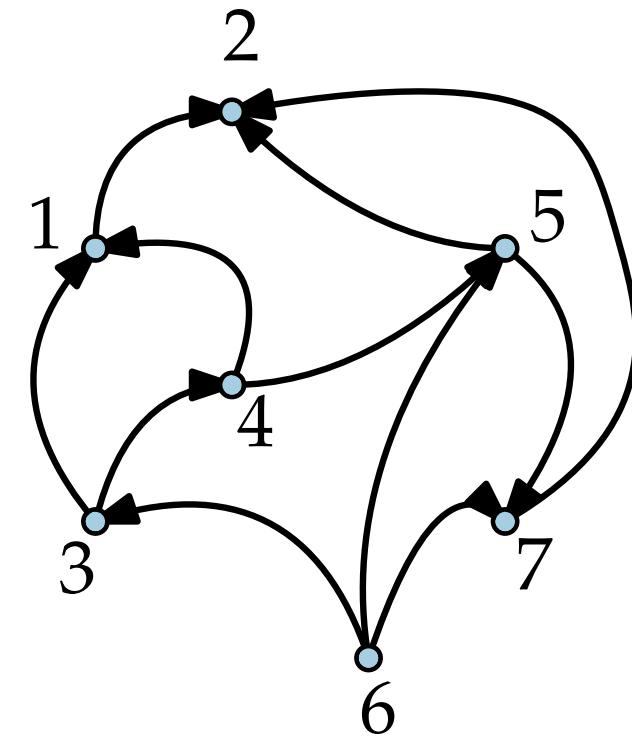
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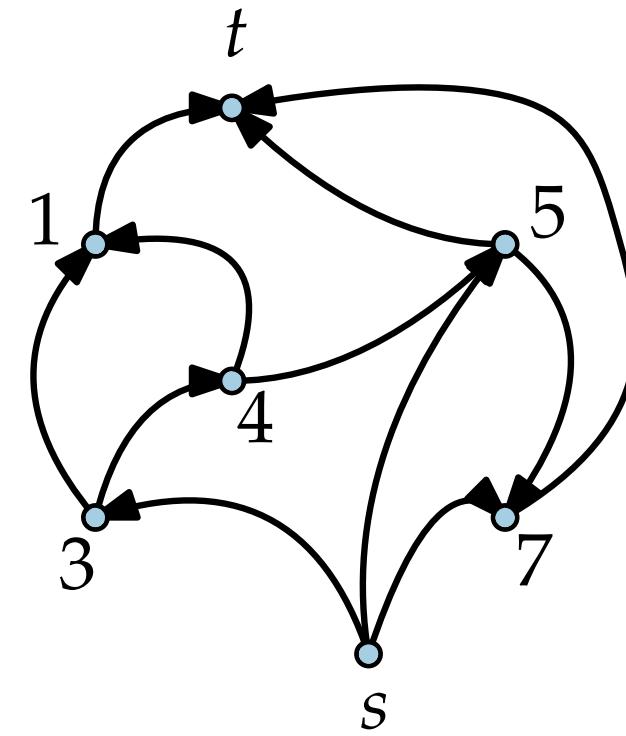
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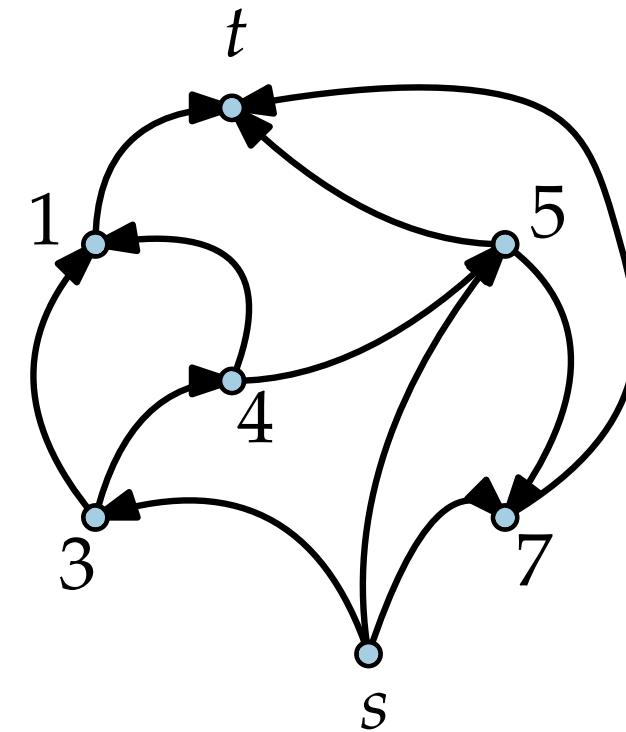
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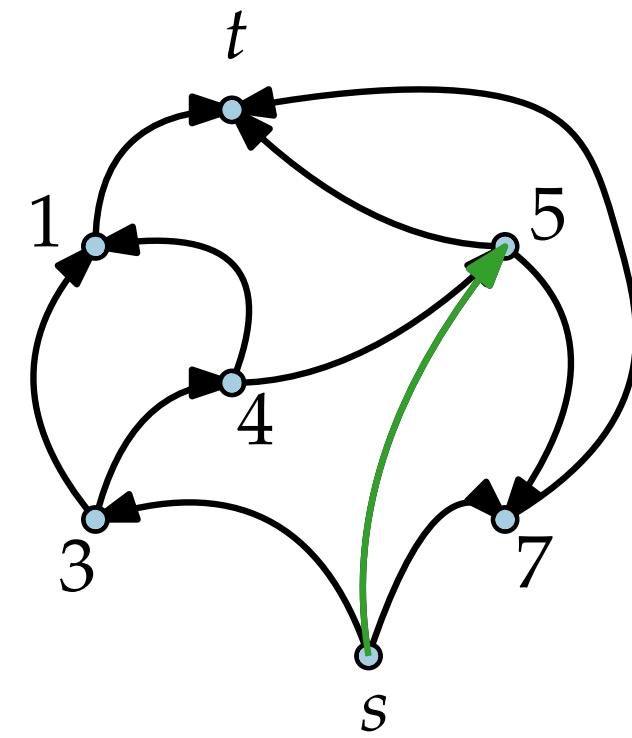
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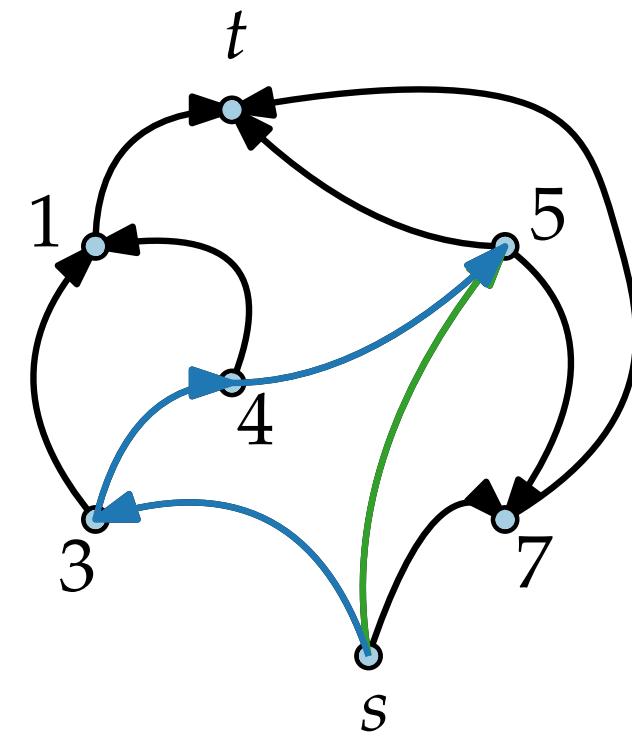
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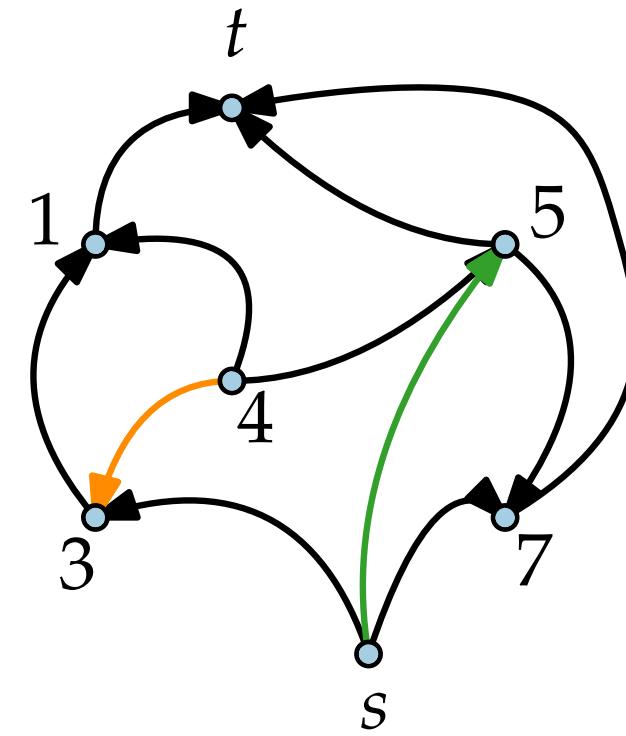
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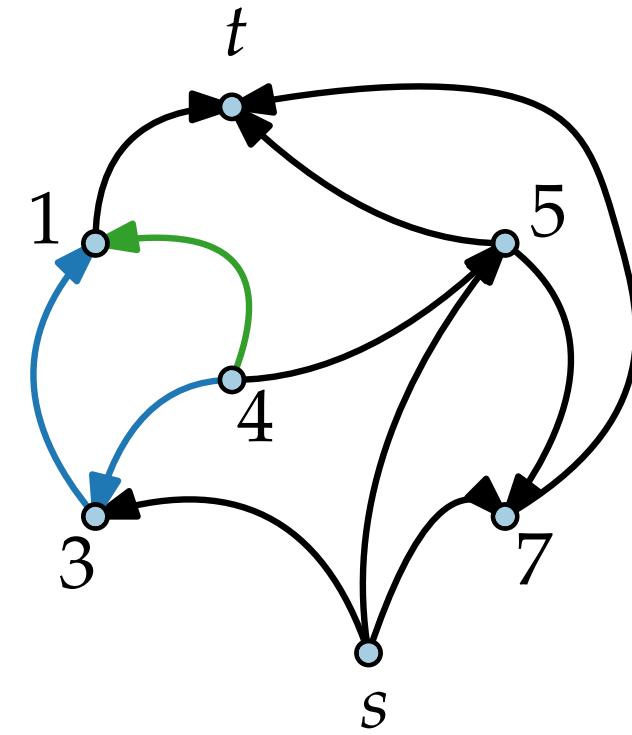
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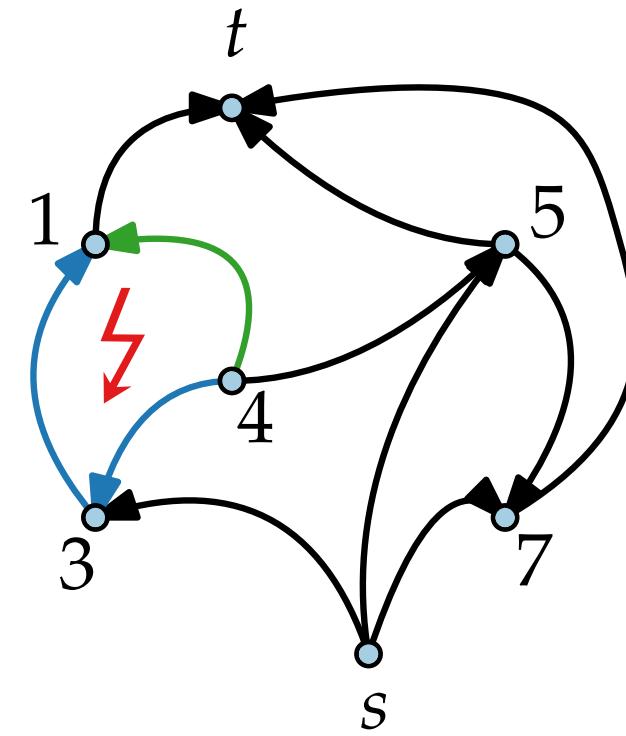
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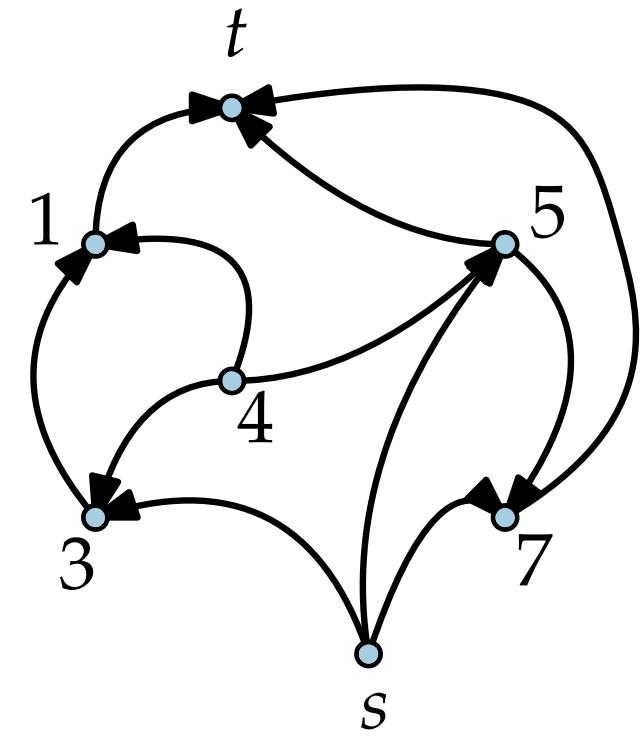
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Spoiler: ist NP-schwer



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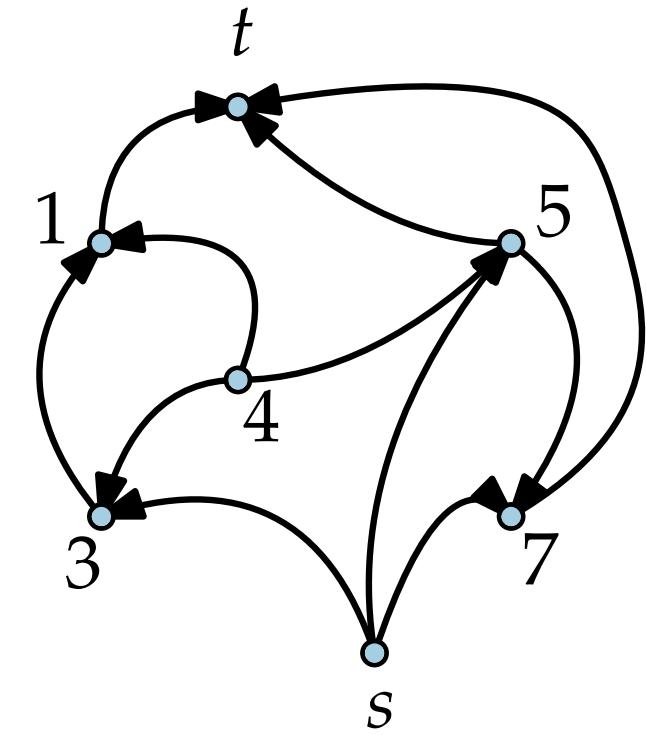
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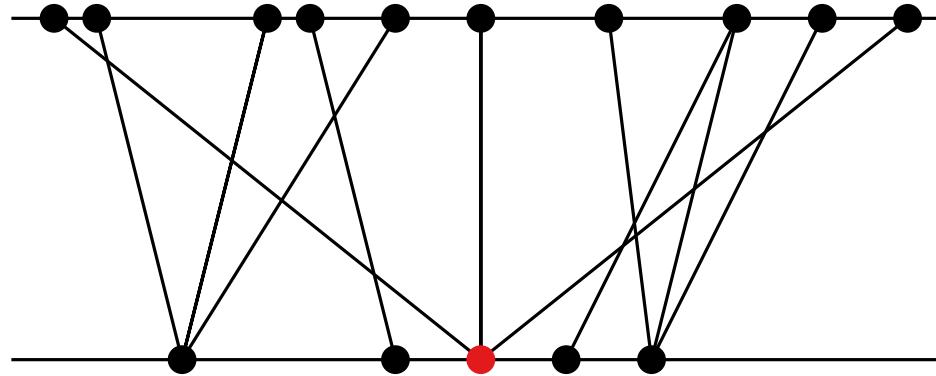
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wenige

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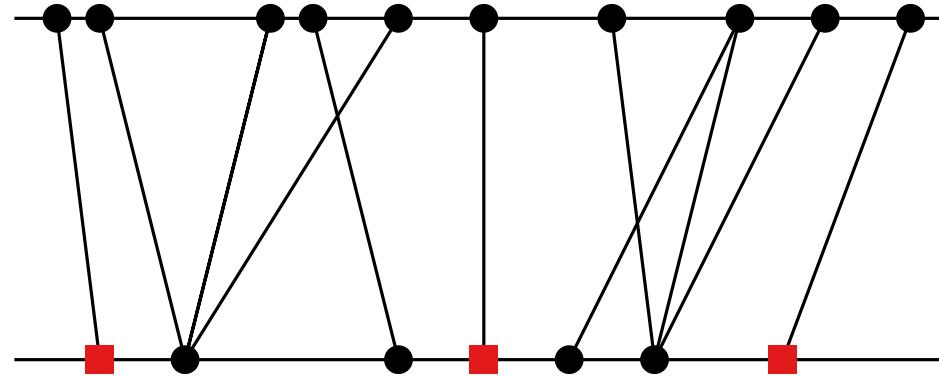


11. An FPT Algorithm for Bipartite Vertex Splitting



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

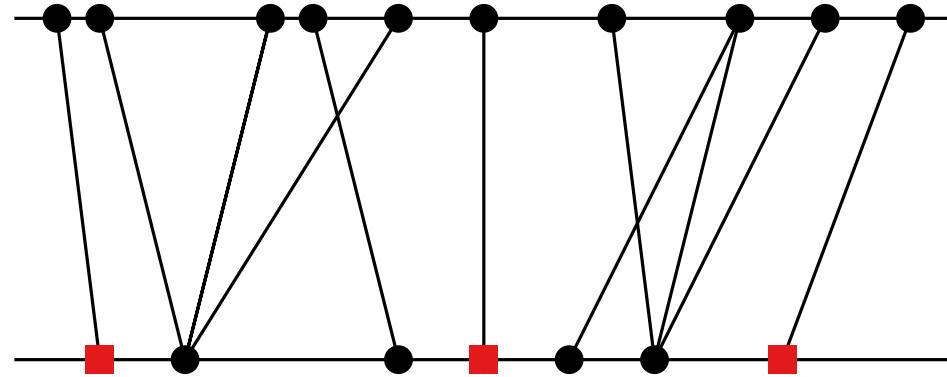
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vertex split

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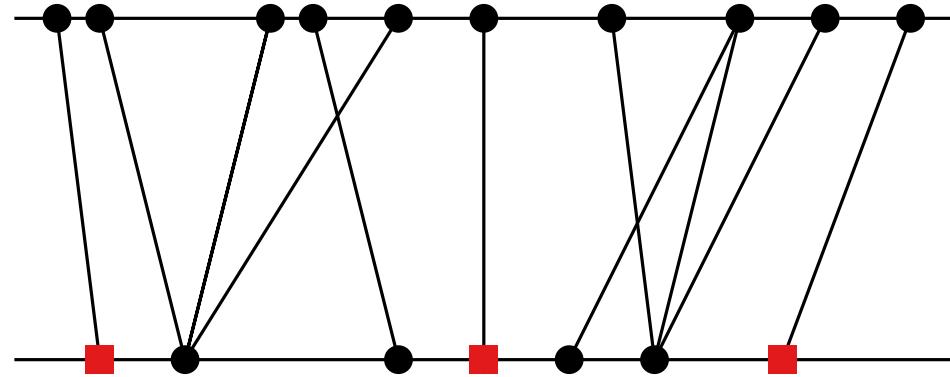
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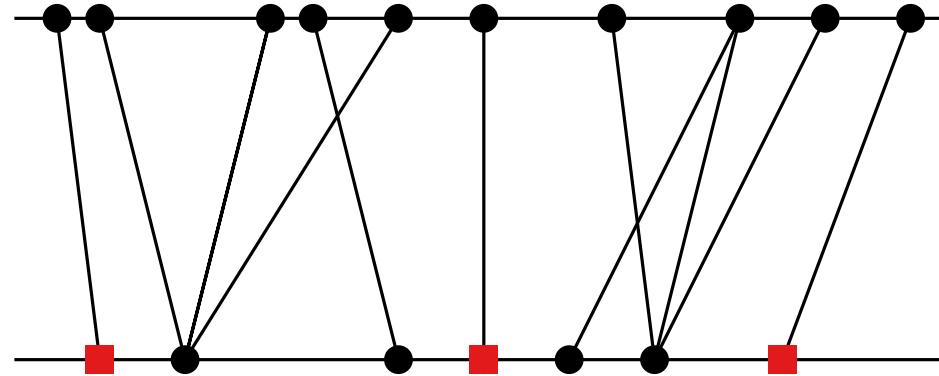


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→ NP-hard!

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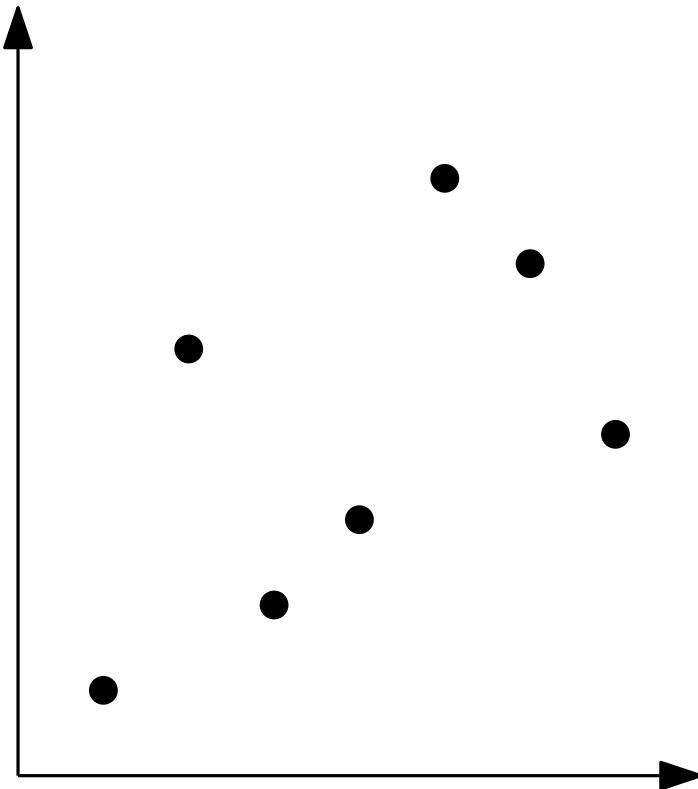
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Here: FPT algorithm for Bipartite Vertex Splitting parameterized by the minimum number of vertex splits.

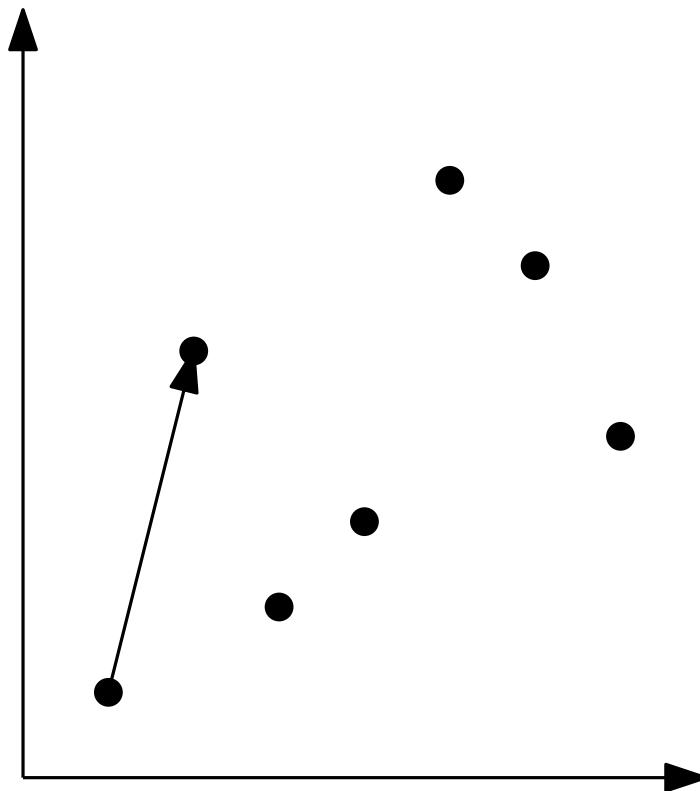
12. Queue Layouts of Two-Dimensional Posets

2-dimension poset
(partially ordered set):



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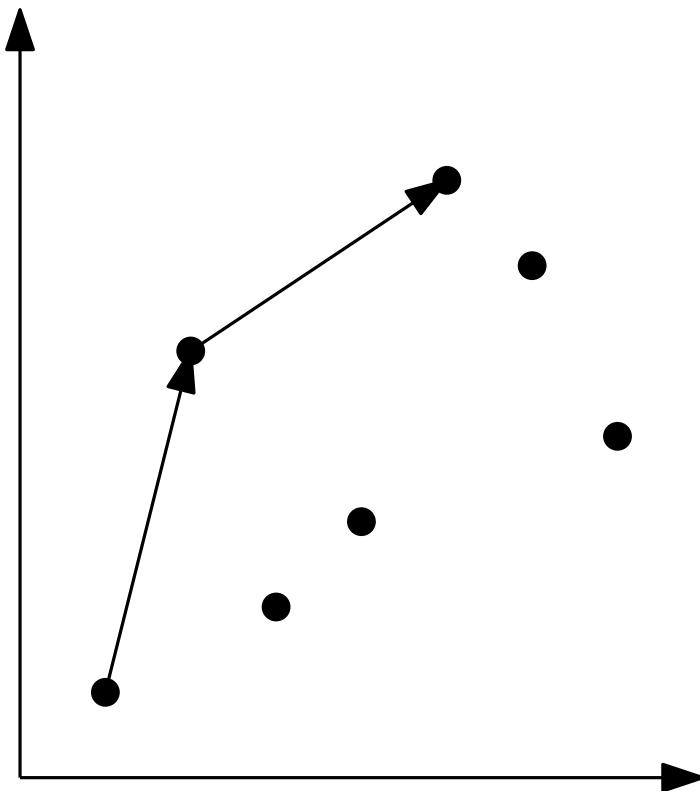
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Edge from u to v
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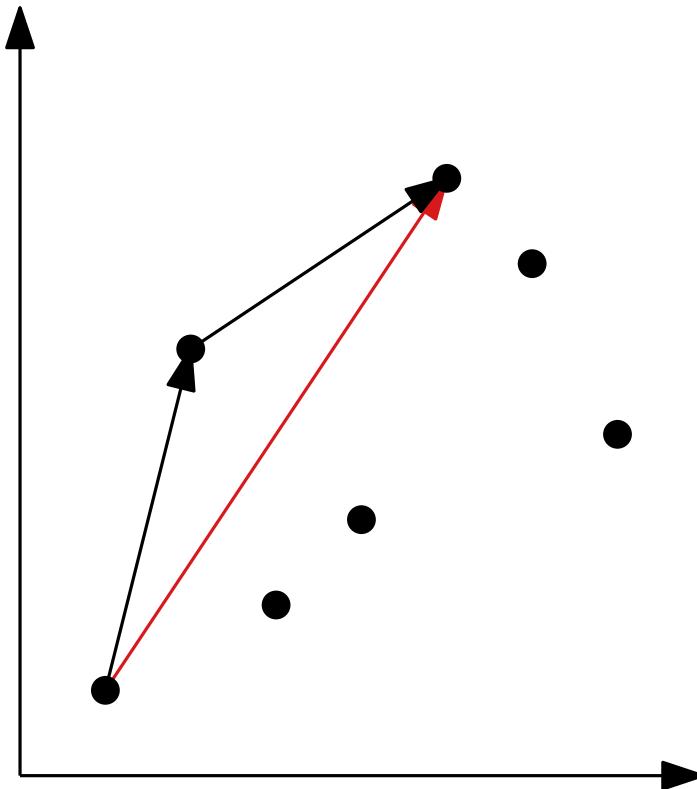
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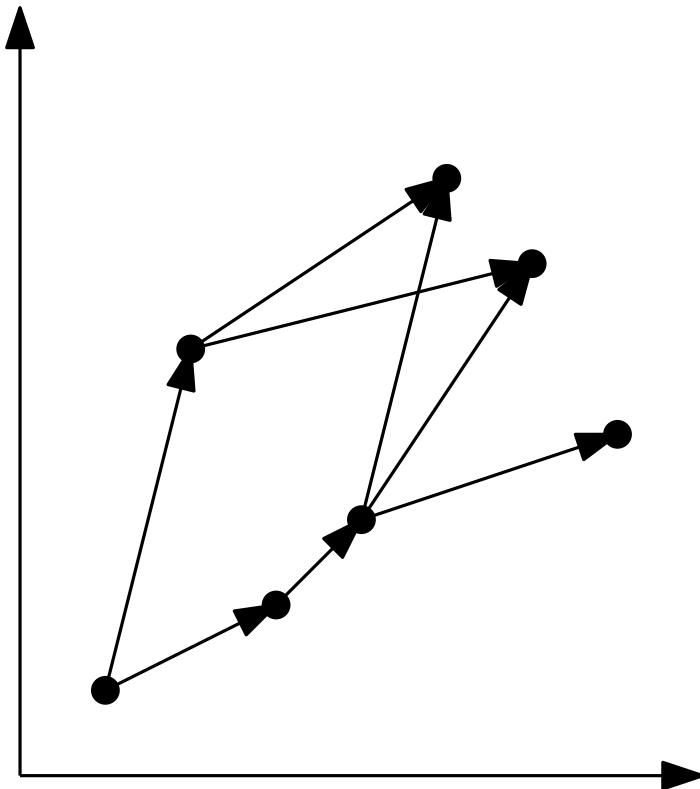


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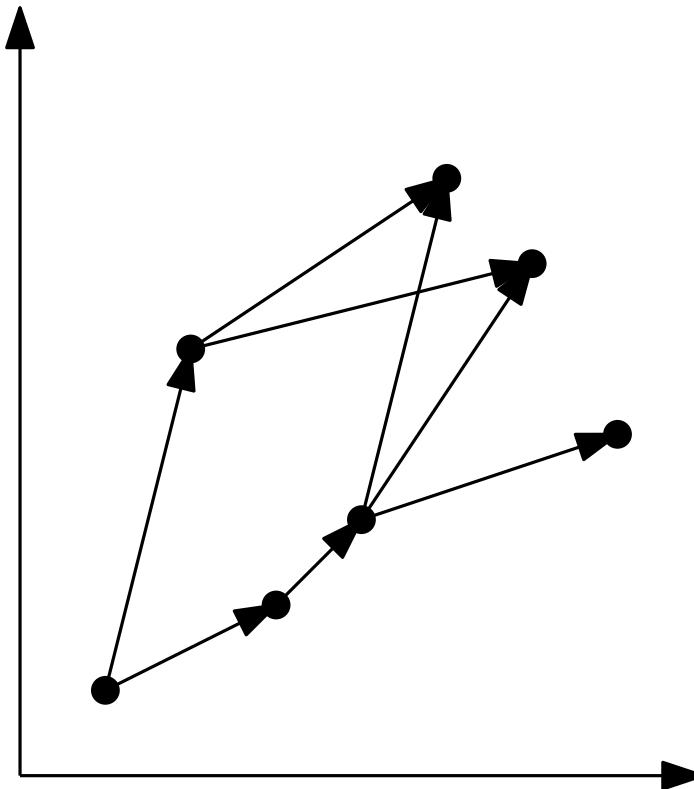


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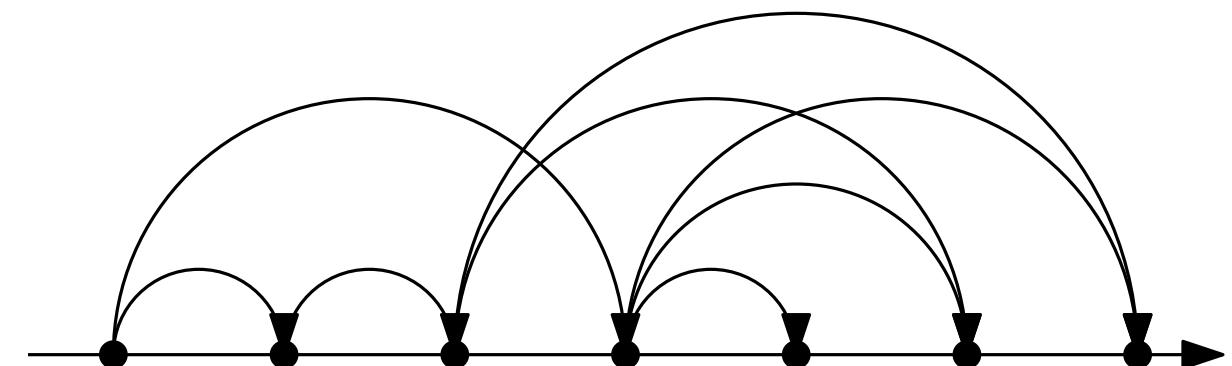
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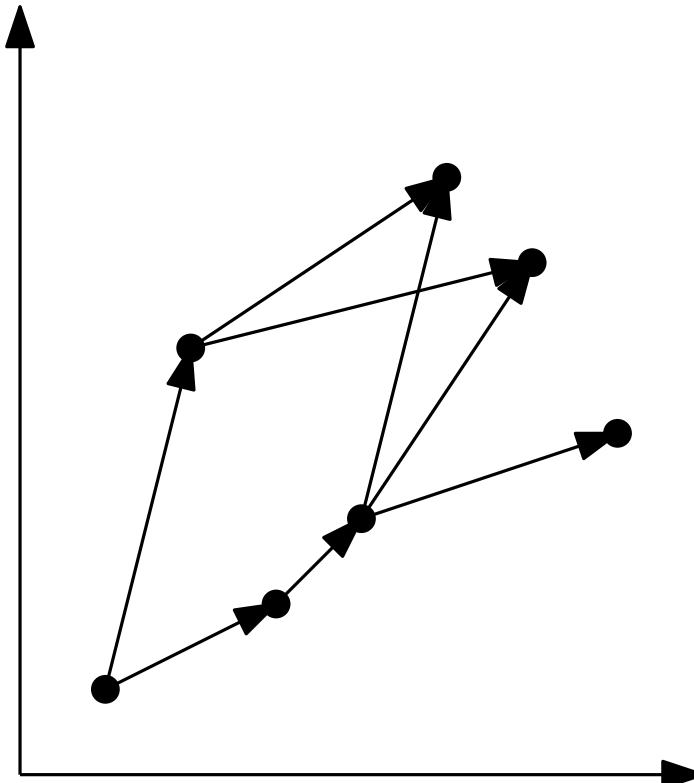
Queue layout of a poset:



Order vertices such that the partial order
is respected.

12. Queue Layouts of Two-Dimensional Posets

2-dimension poset
(partially ordered set):

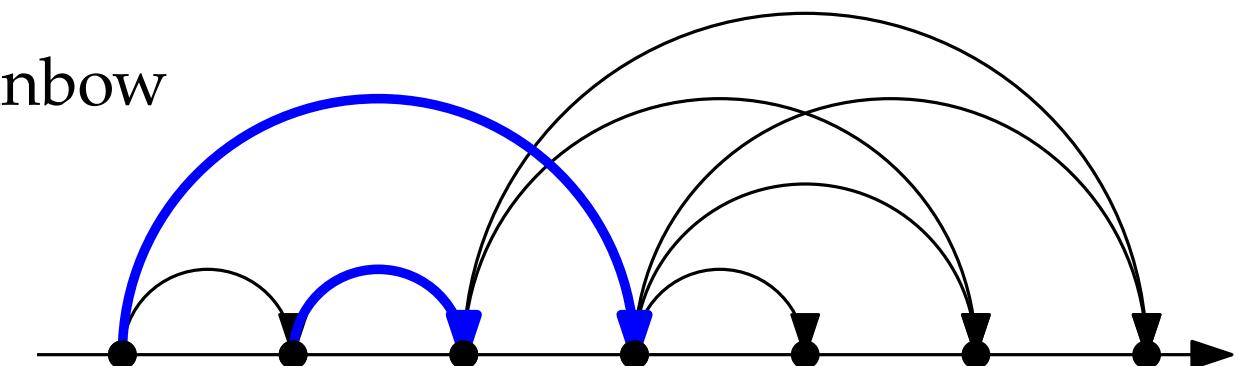


Edge from u to v
if v is right and
above u .

No transitive
edges.

Queue layout of a poset:

2-rainbow

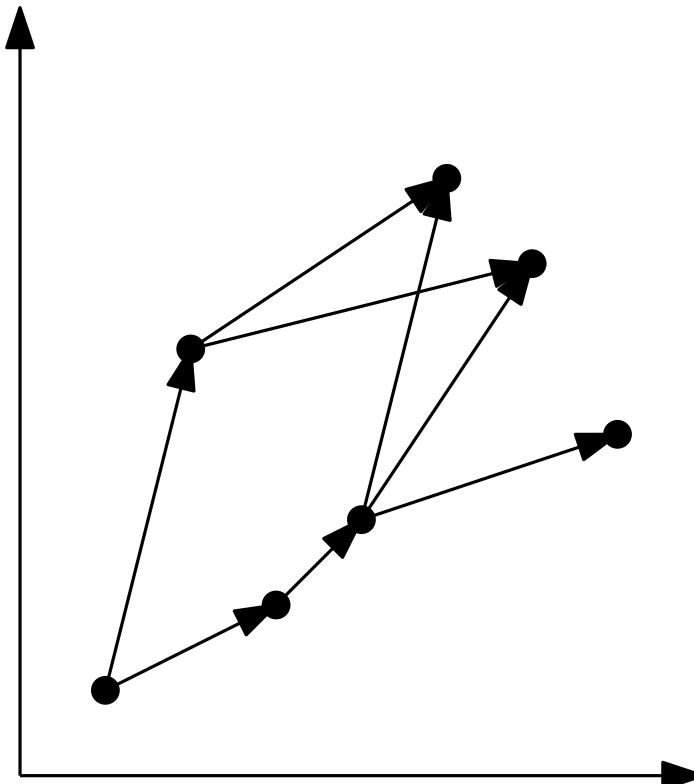


Order vertices such that the partial order
is respected.

We want to minimize maximum number
of nested edges.

12. Queue Layouts of Two-Dimensional Posets

2-dimension poset
(partially ordered set):

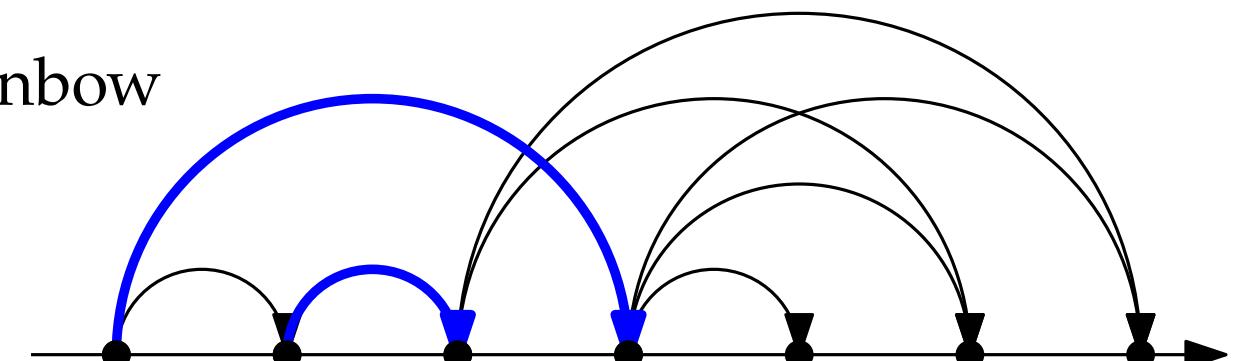


Edge from u to v
if v is right and
above u .

No transitive
edges.

Queue layout of a poset:

2-rainbow



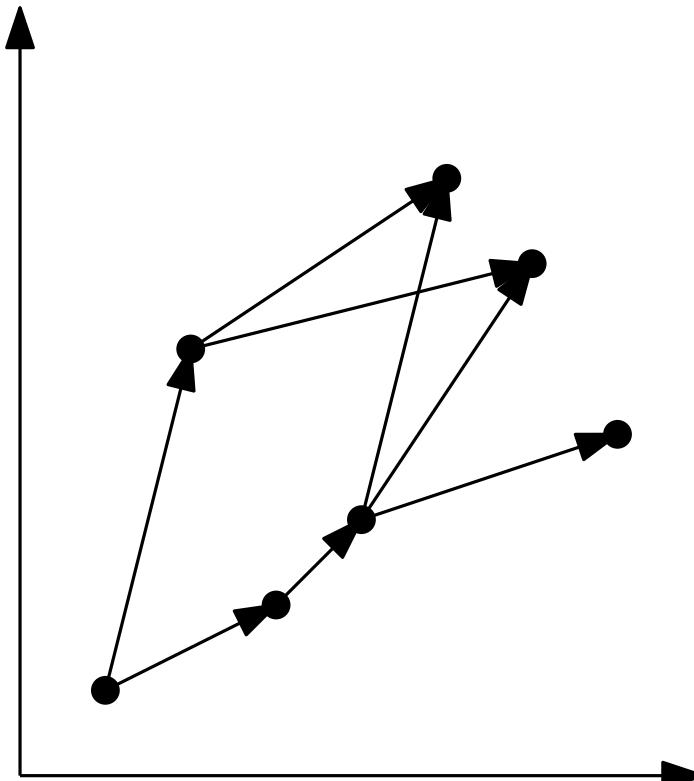
Order vertices such that the partial order
is respected.

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 .

12. Queue Layouts of Two-Dimensional Posets

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(partially ordered set):

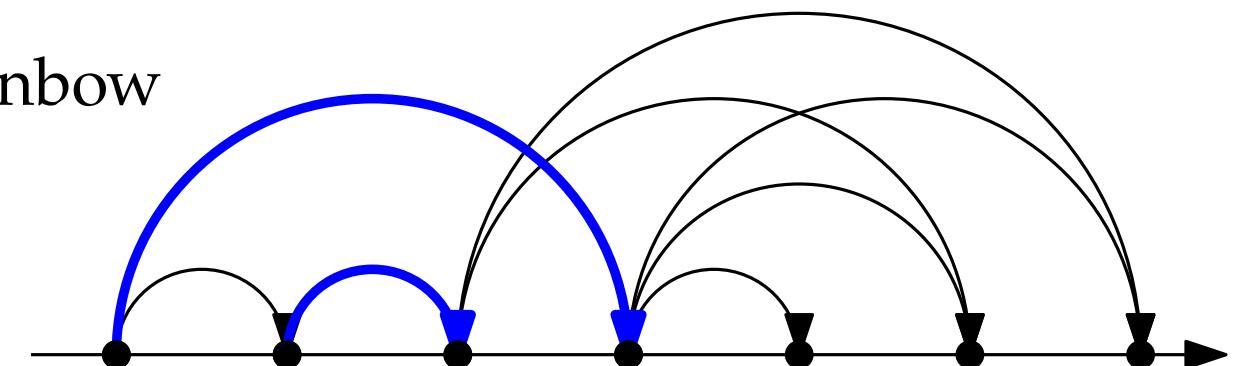


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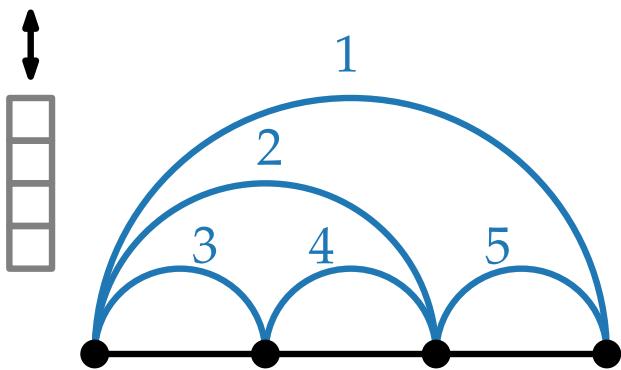
What are bounds on the Queue-Number
of a Poset?

13. The Rique-Number of Graphs

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

13. The Rique-Number of Graphs

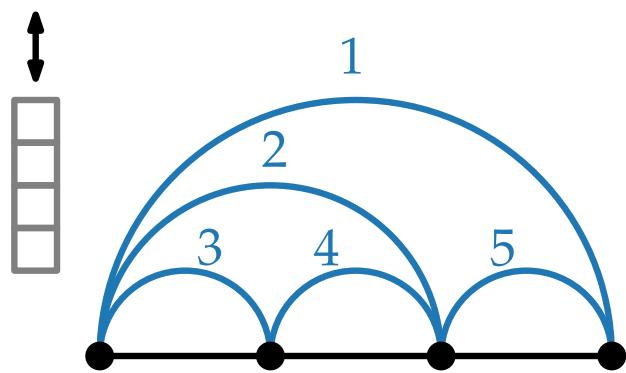
This is about *linear layouts*, where all vertices are arranged on a horizontal line.



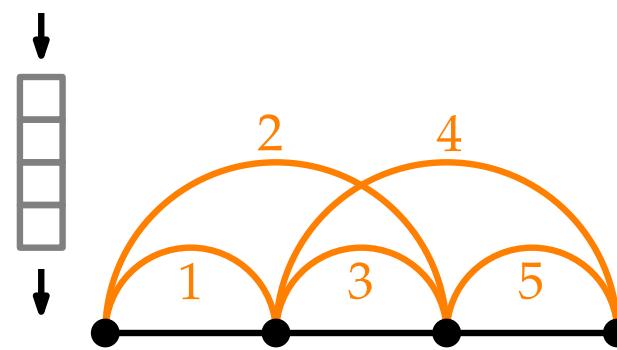
1-page *stack*-layout

13. The Rique-Number of Graphs

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



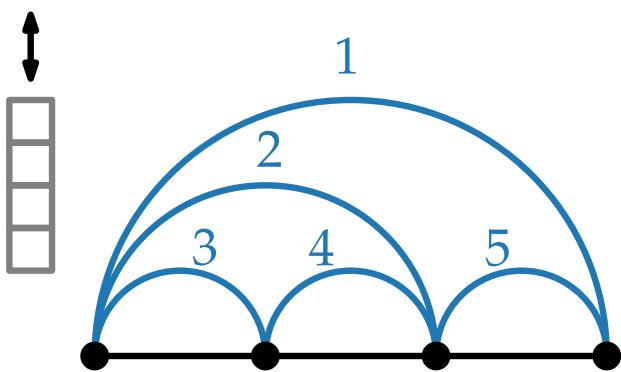
1-page *stack*-layout



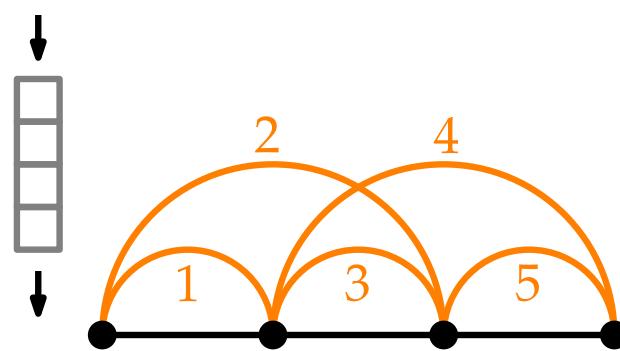
1-page *queue*-layout

13. The Rique-Number of Graphs

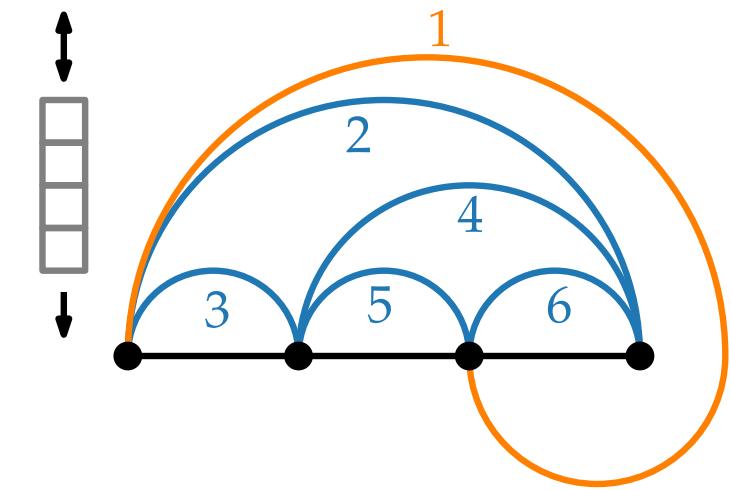
This is about *linear layouts*, where all vertices are arranged on a horizontal line.



1-page *stack*-layout



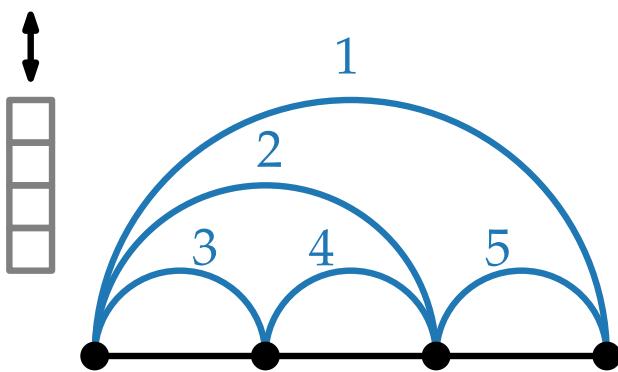
1-page *queue*-layout



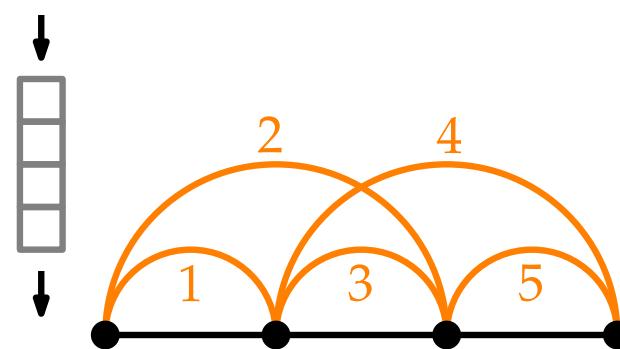
1-page RIQ-layout

13. The Rique-Number of Graphs

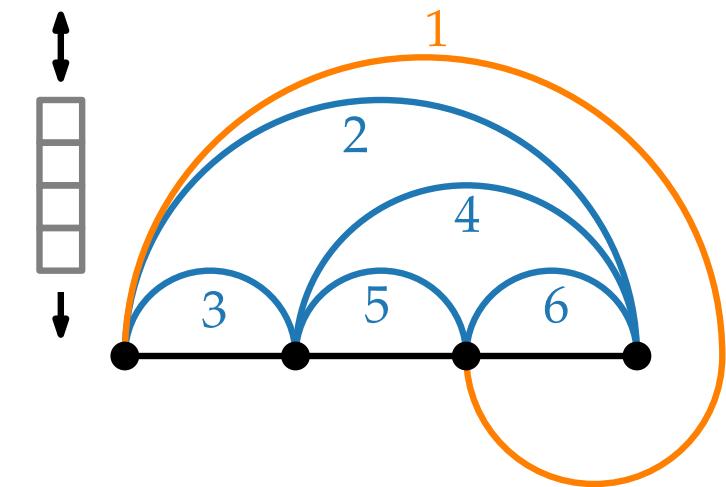
This is about *linear layouts*, where all vertices are arranged on a horizontal line.



1-page *stack*-layout



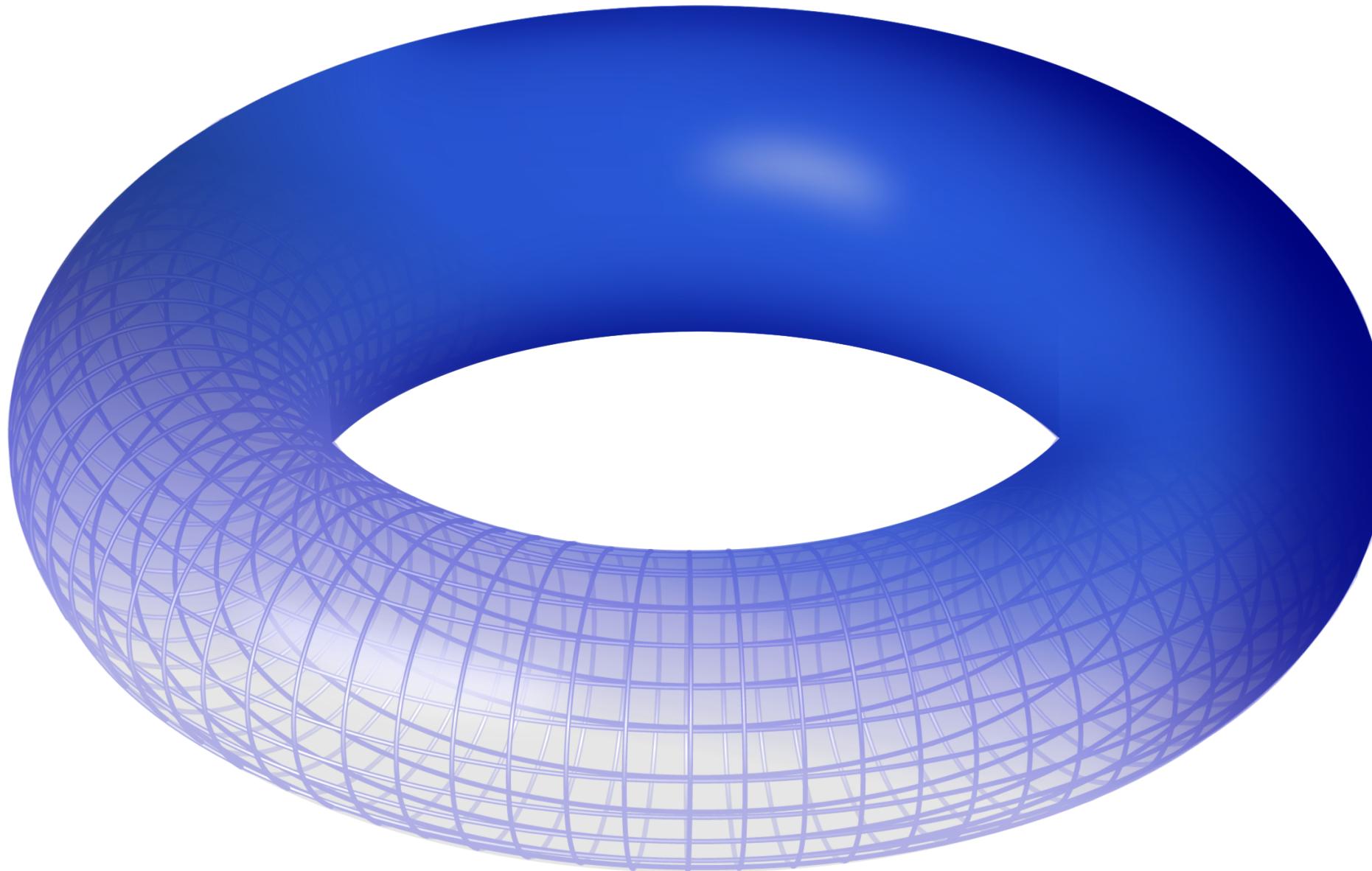
1-page *queue*-layout



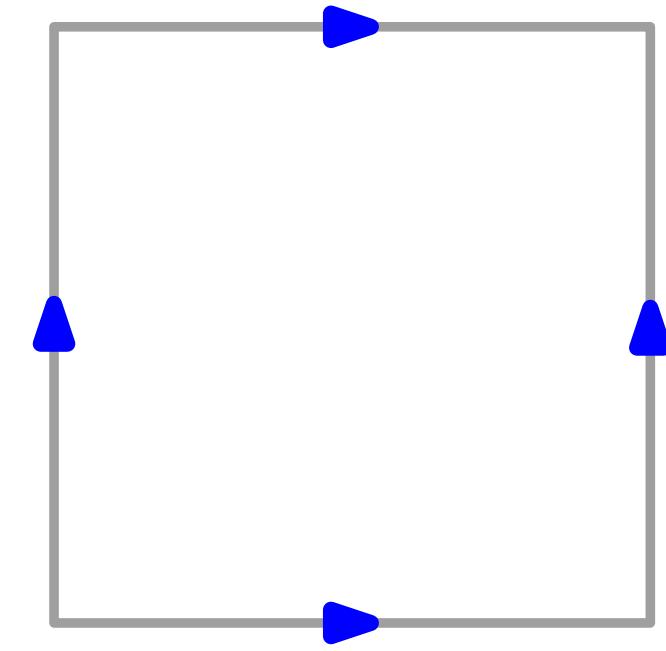
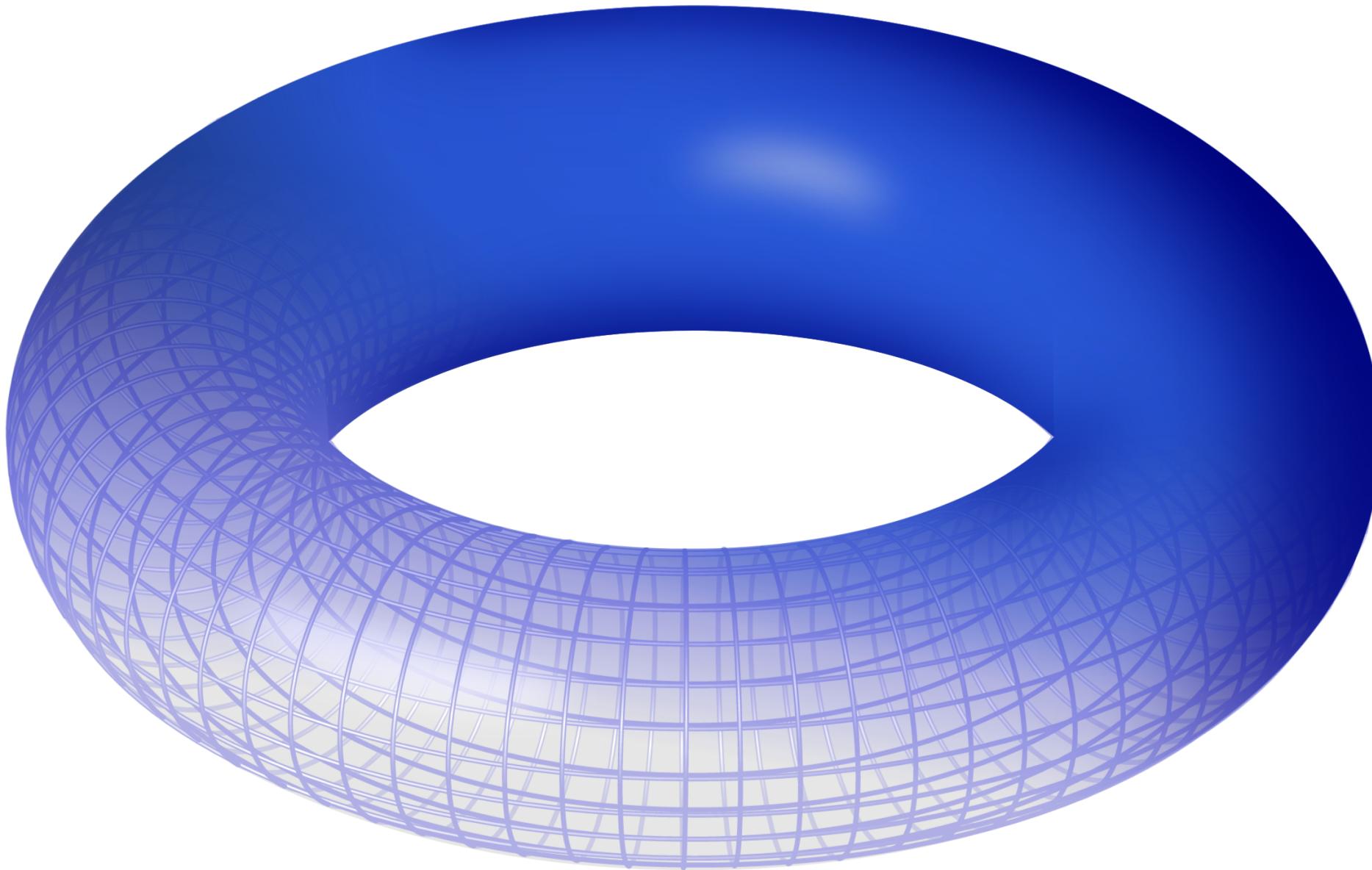
1-page RIQ-layout

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

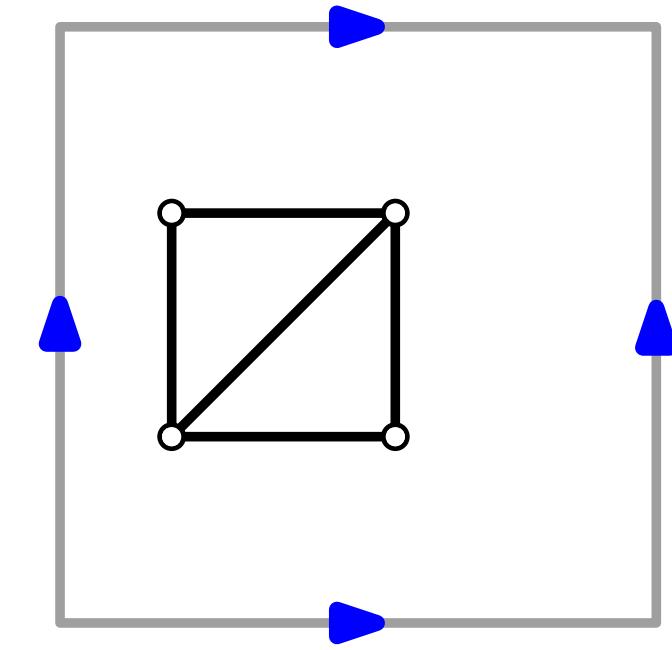
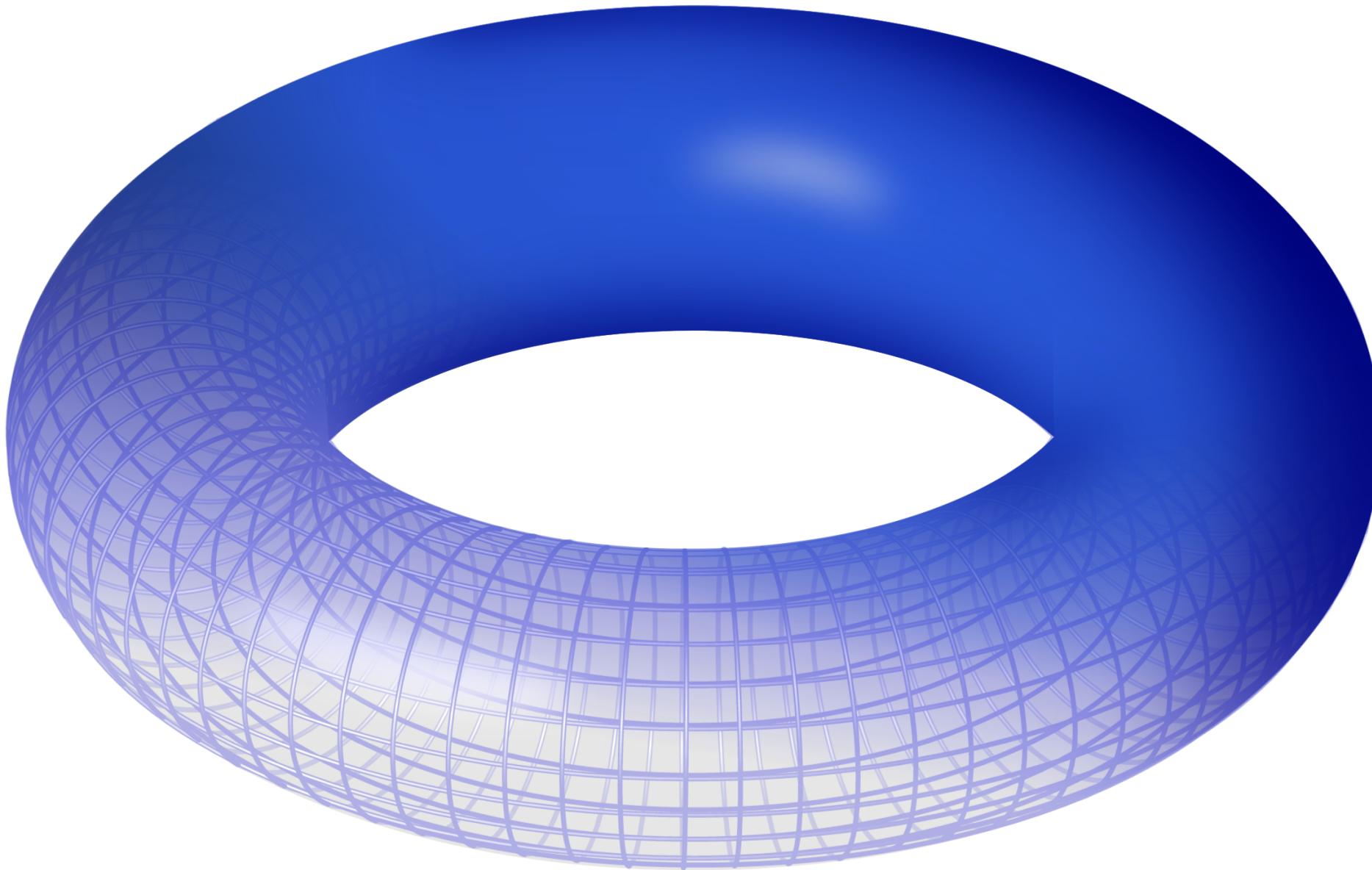
14. Visibility Representations of Toroidal Graphs



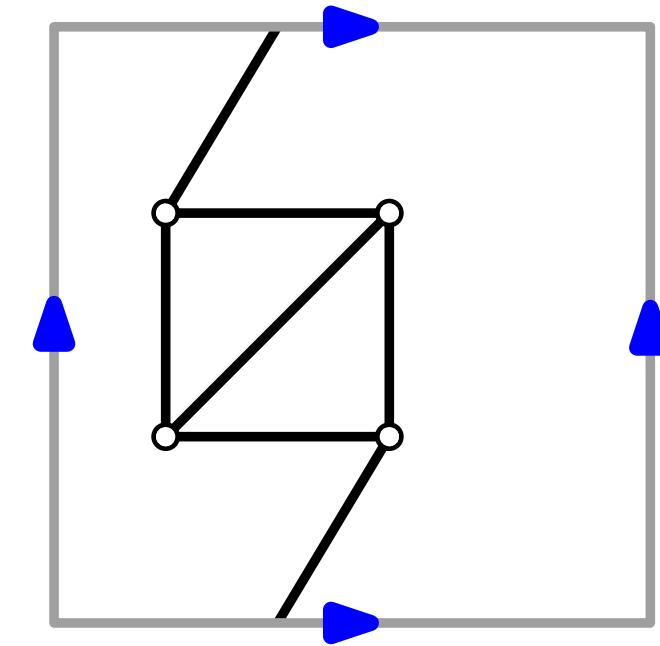
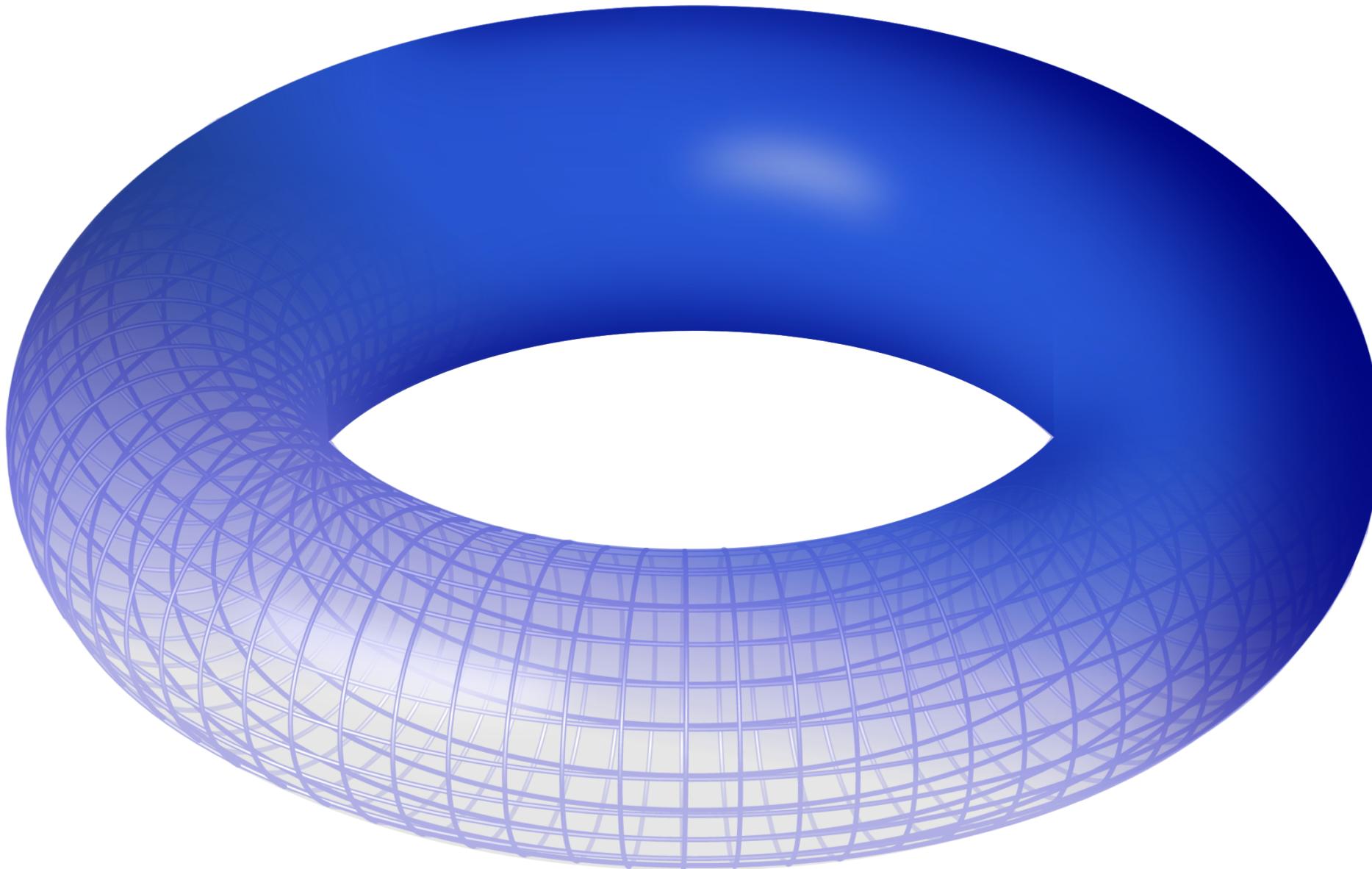
14. Visibility Representations of Toroidal Graphs



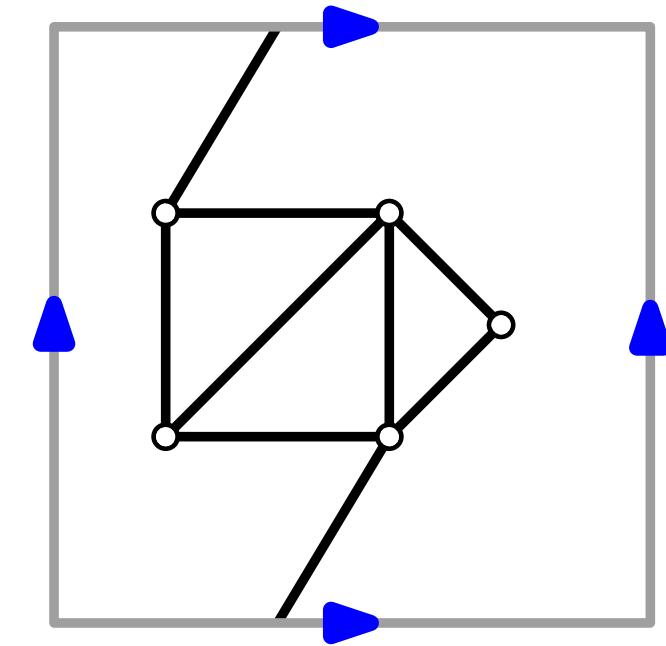
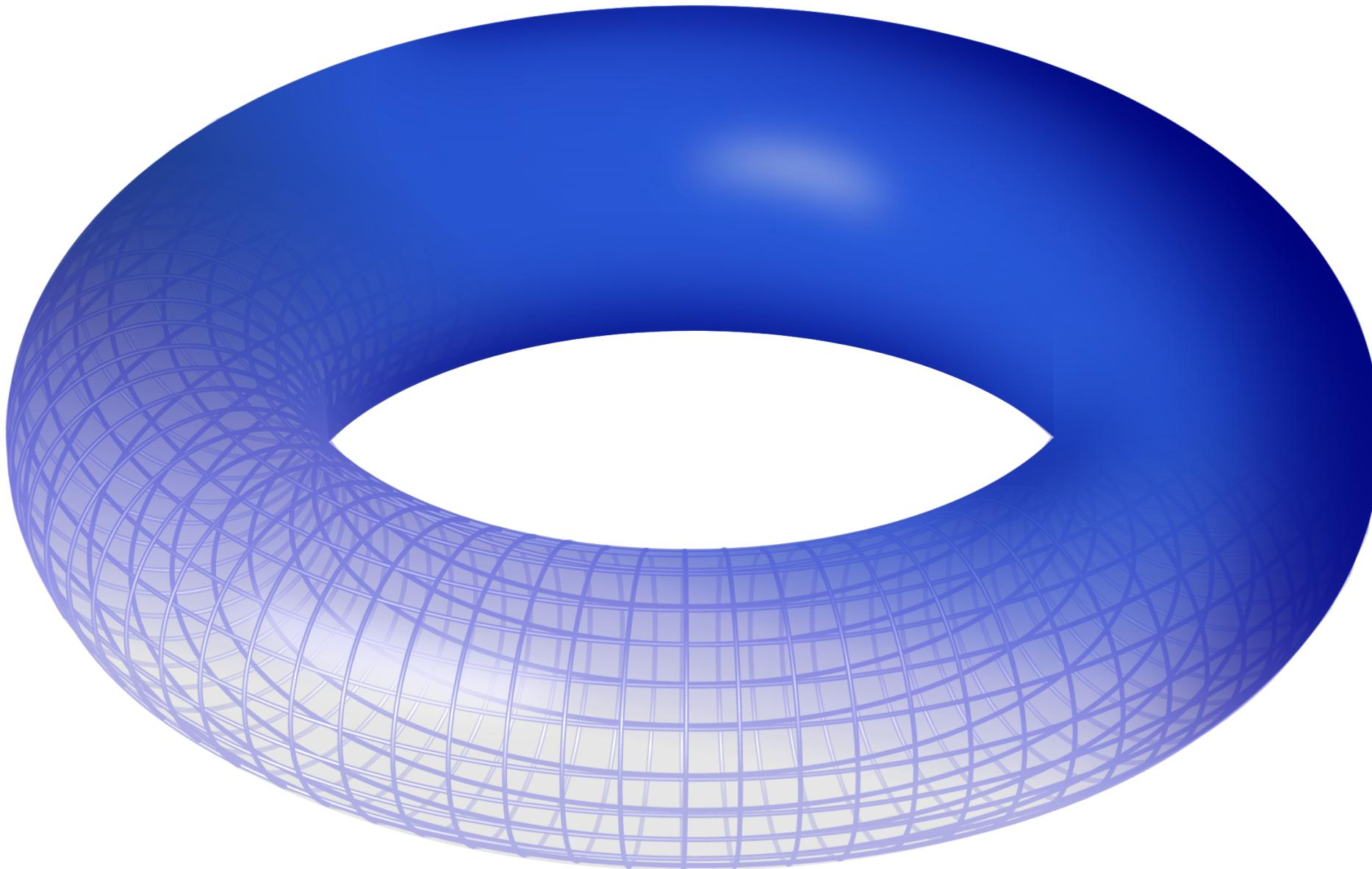
14. Visibility Representations of Toroidal Graphs



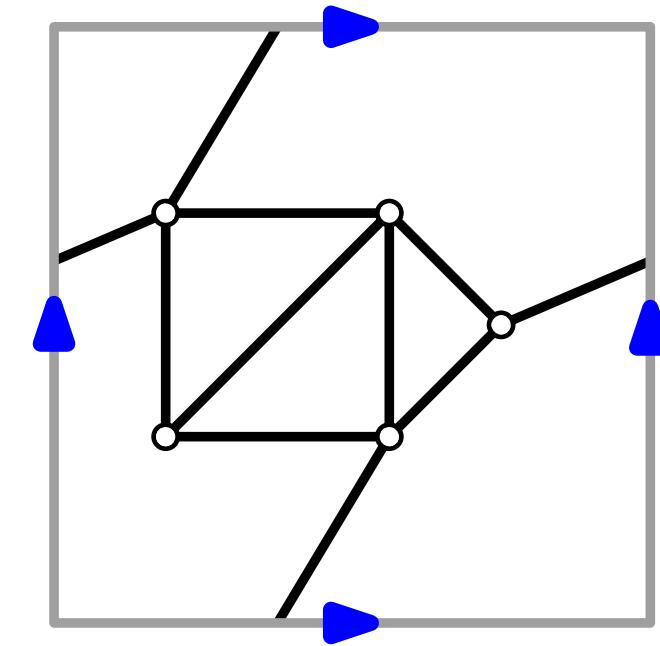
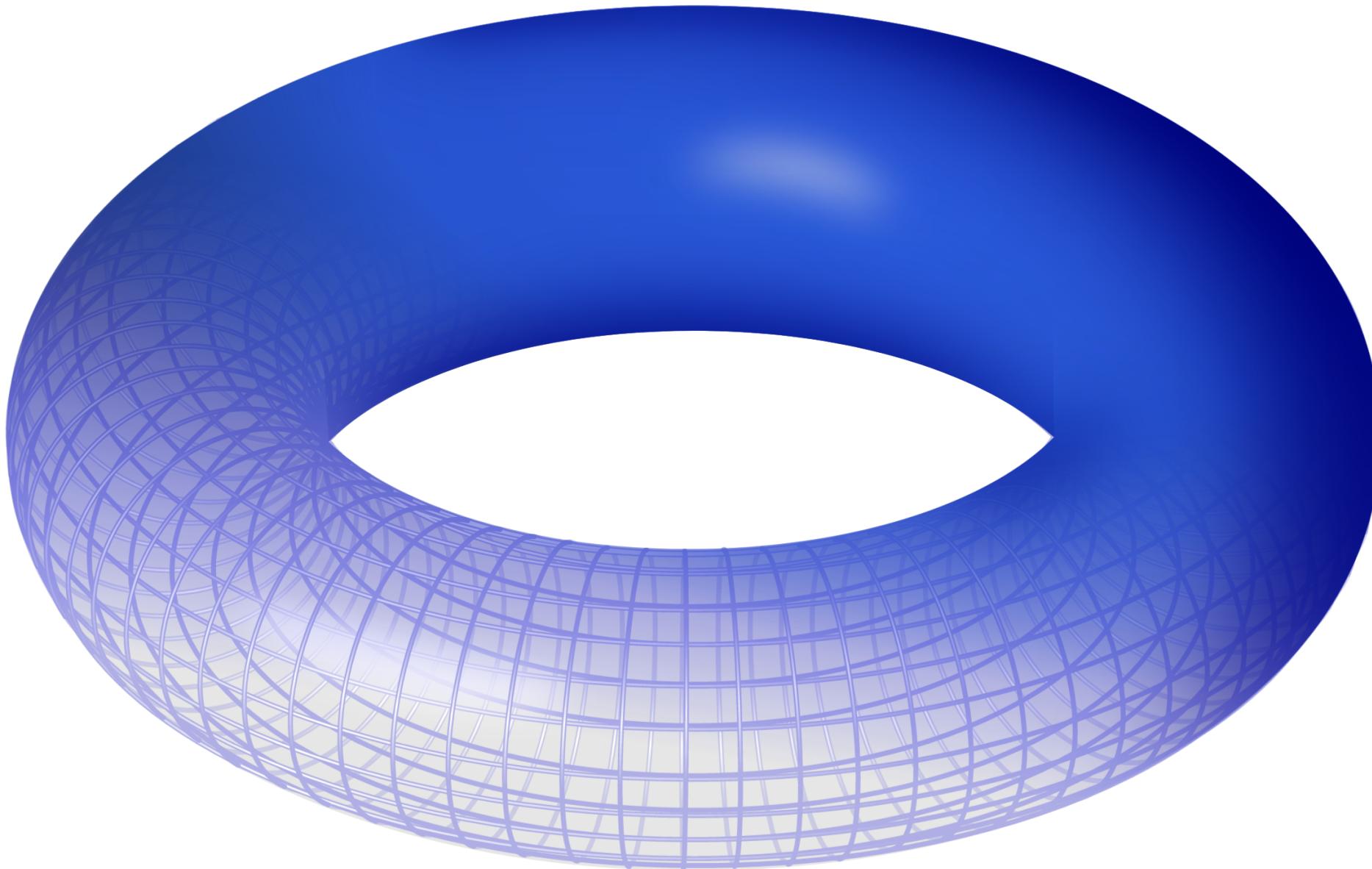
14. Visibility Representations of Toroidal Graphs



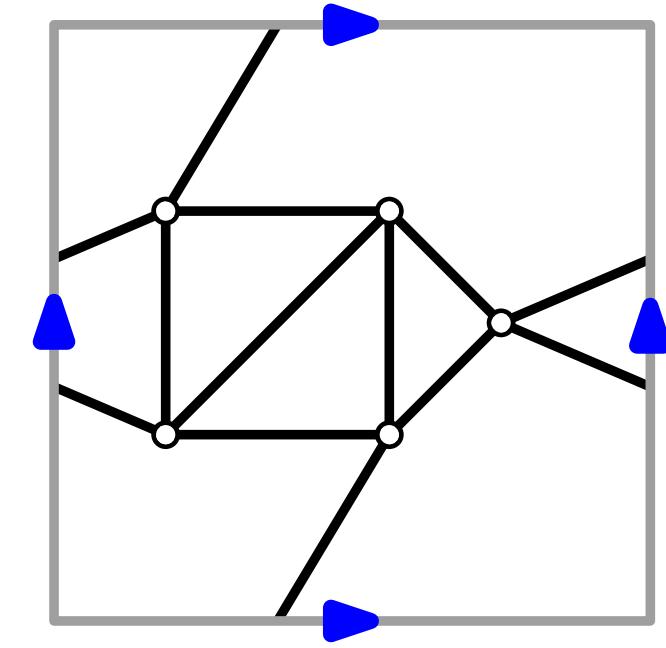
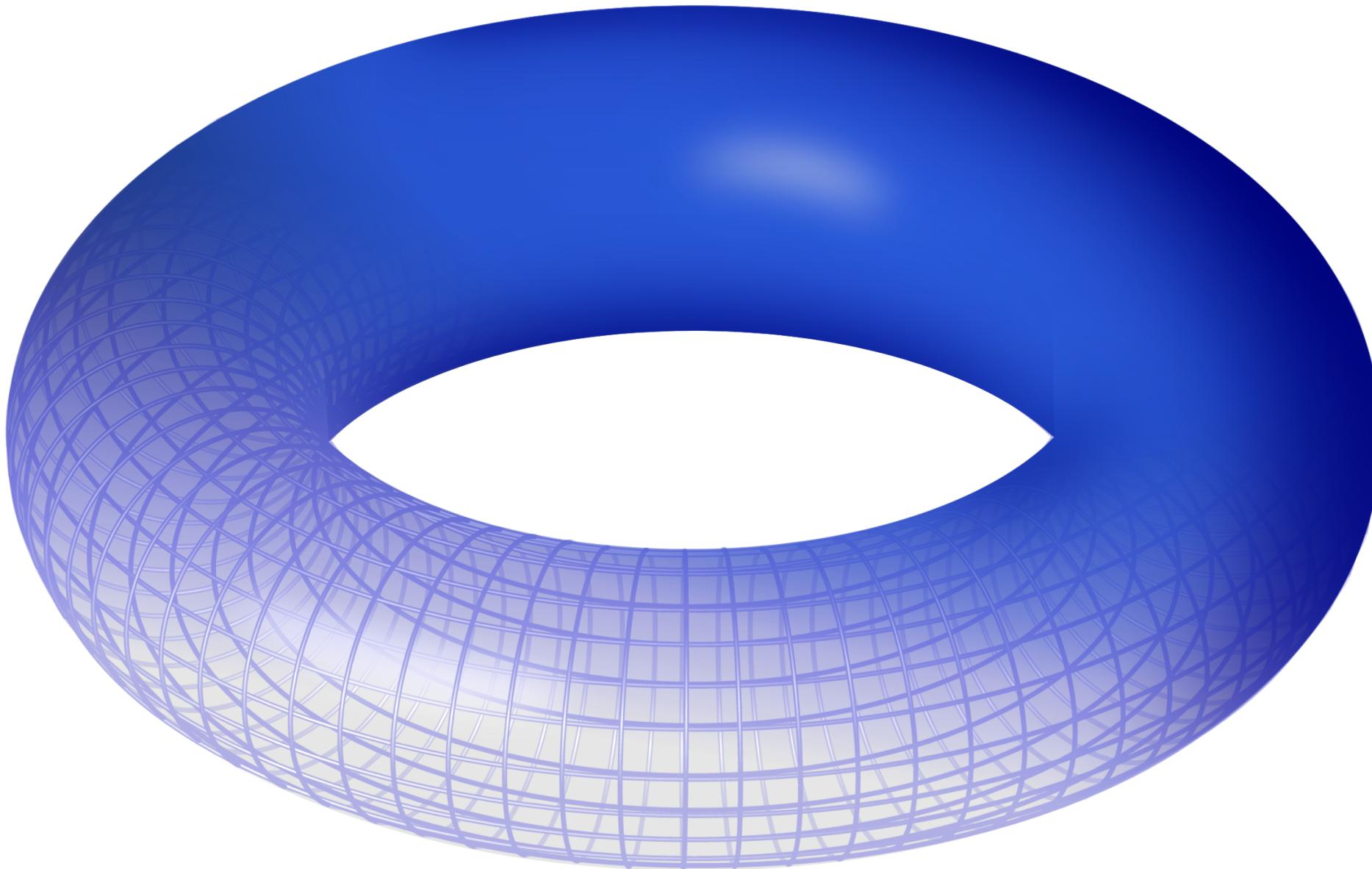
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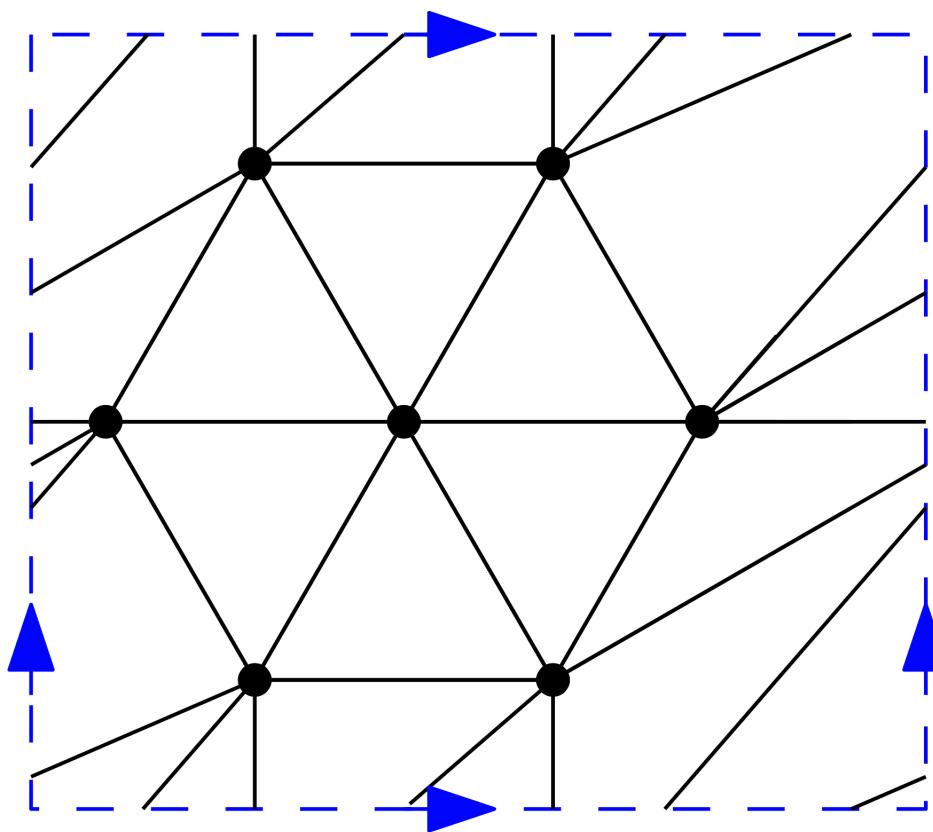
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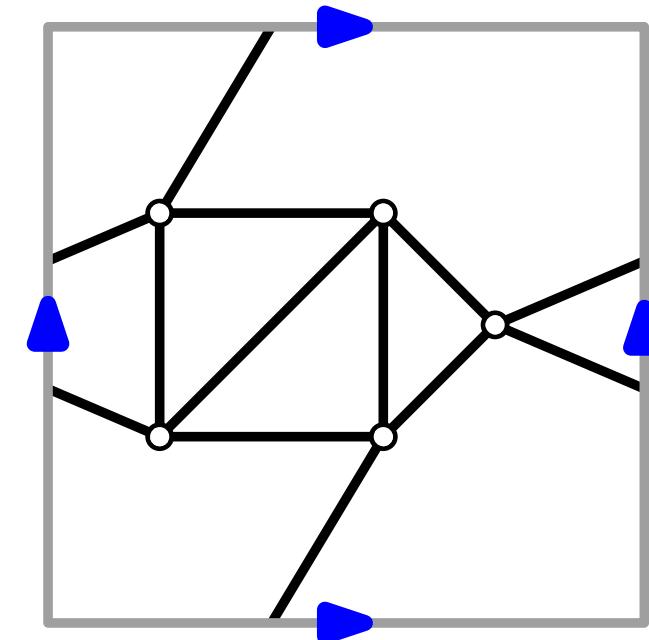
14. Visibility Representations of Toroidal Graphs



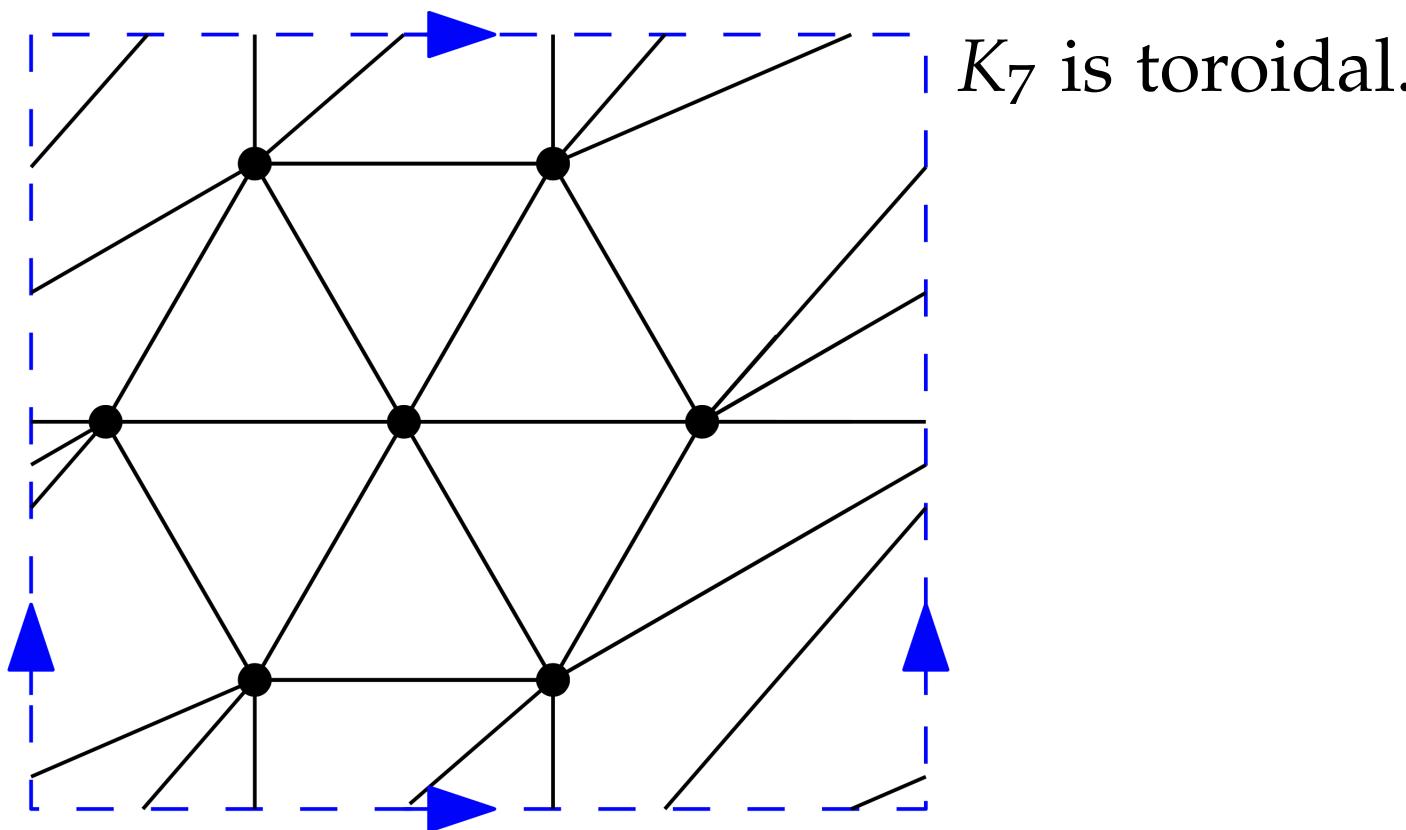
14. Visibility Representations of Toroidal Graphs



K_5 is toroidal.

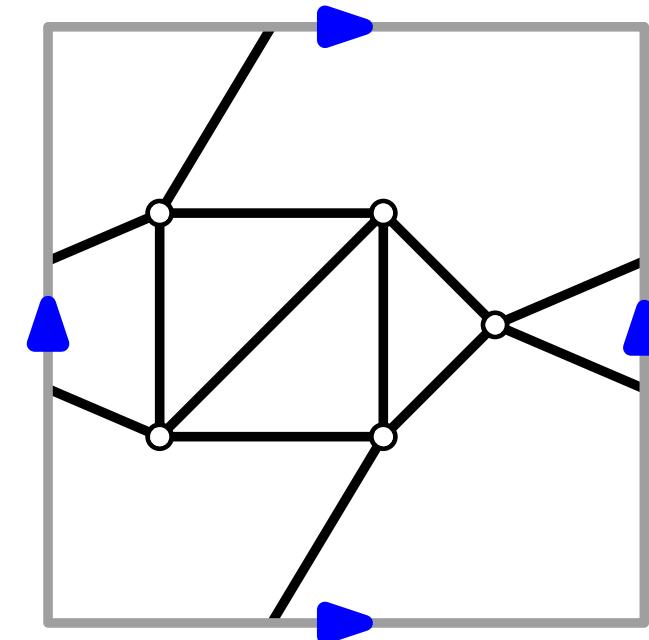


14. Visibility Representations of Toroidal Graphs

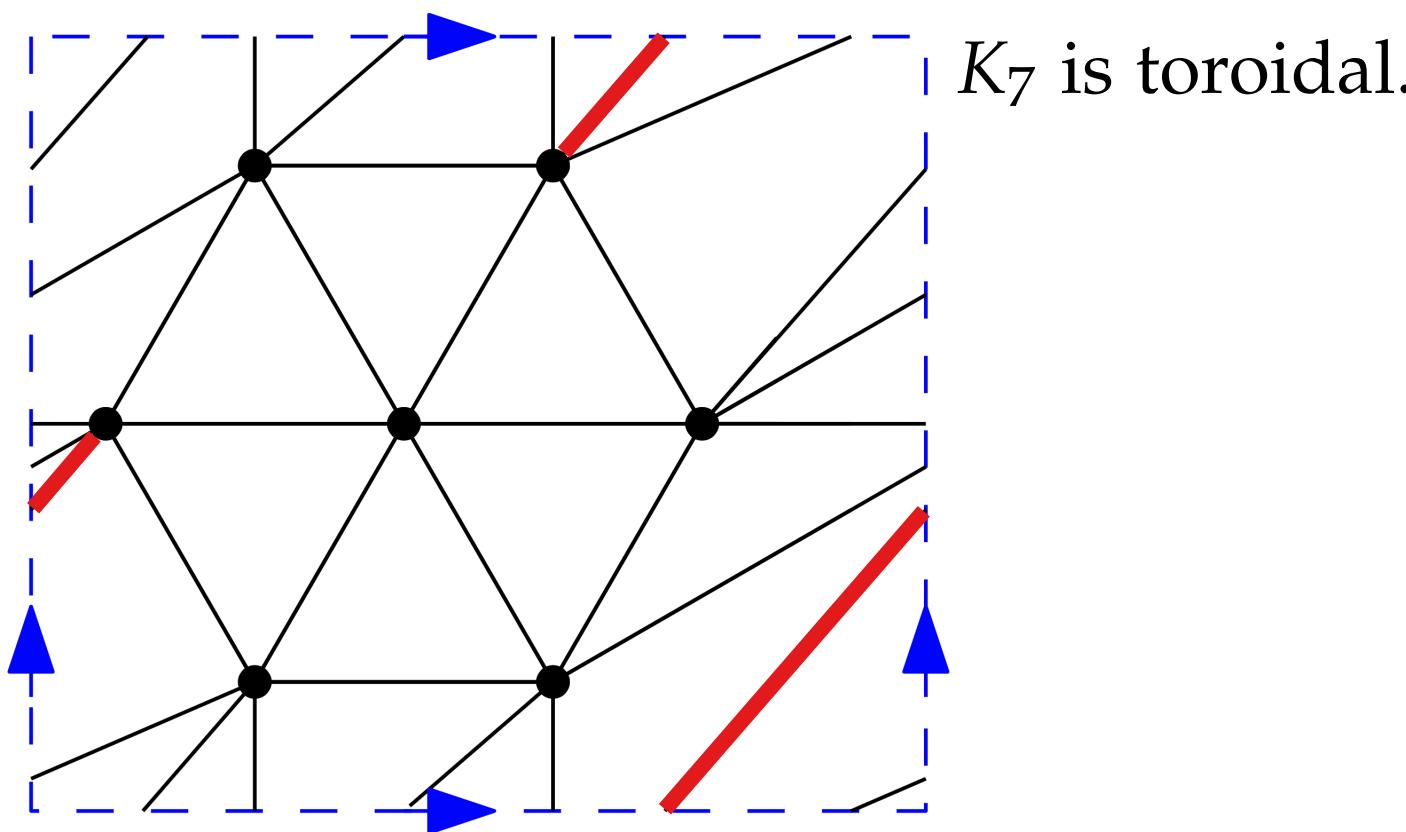


K_7 is toroidal.

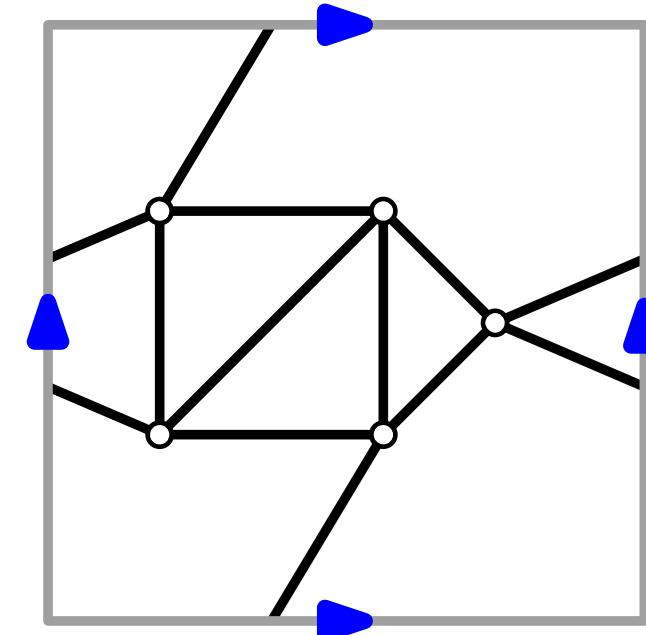
K_5 is toroidal.



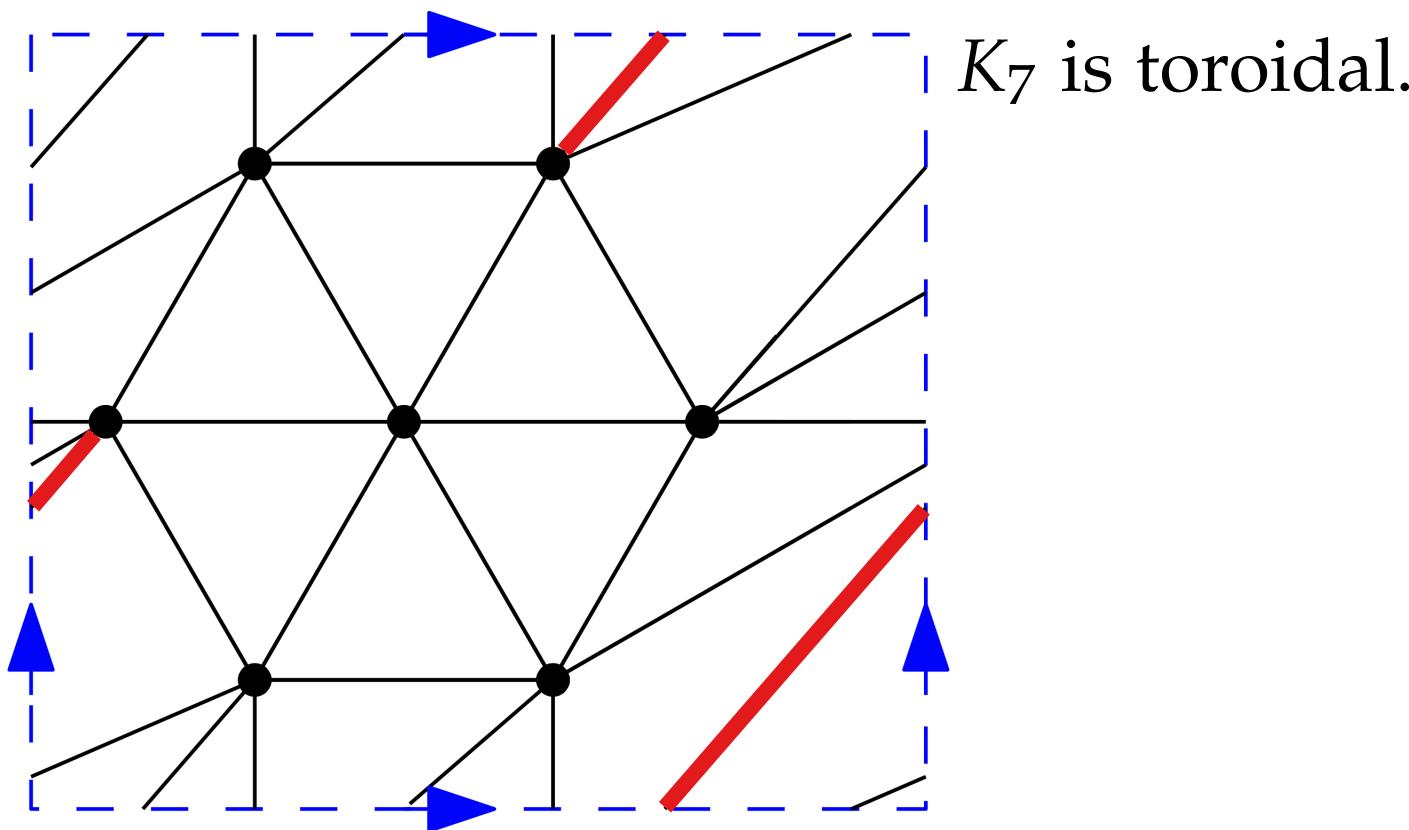
14. Visibility Representations of Toroidal Graphs



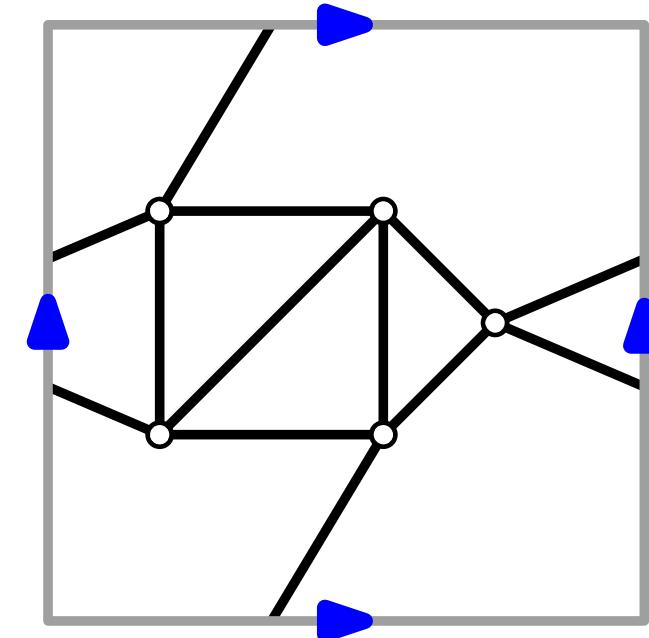
K_5 is toroidal.



14. Visibility Representations of Toroidal Graphs

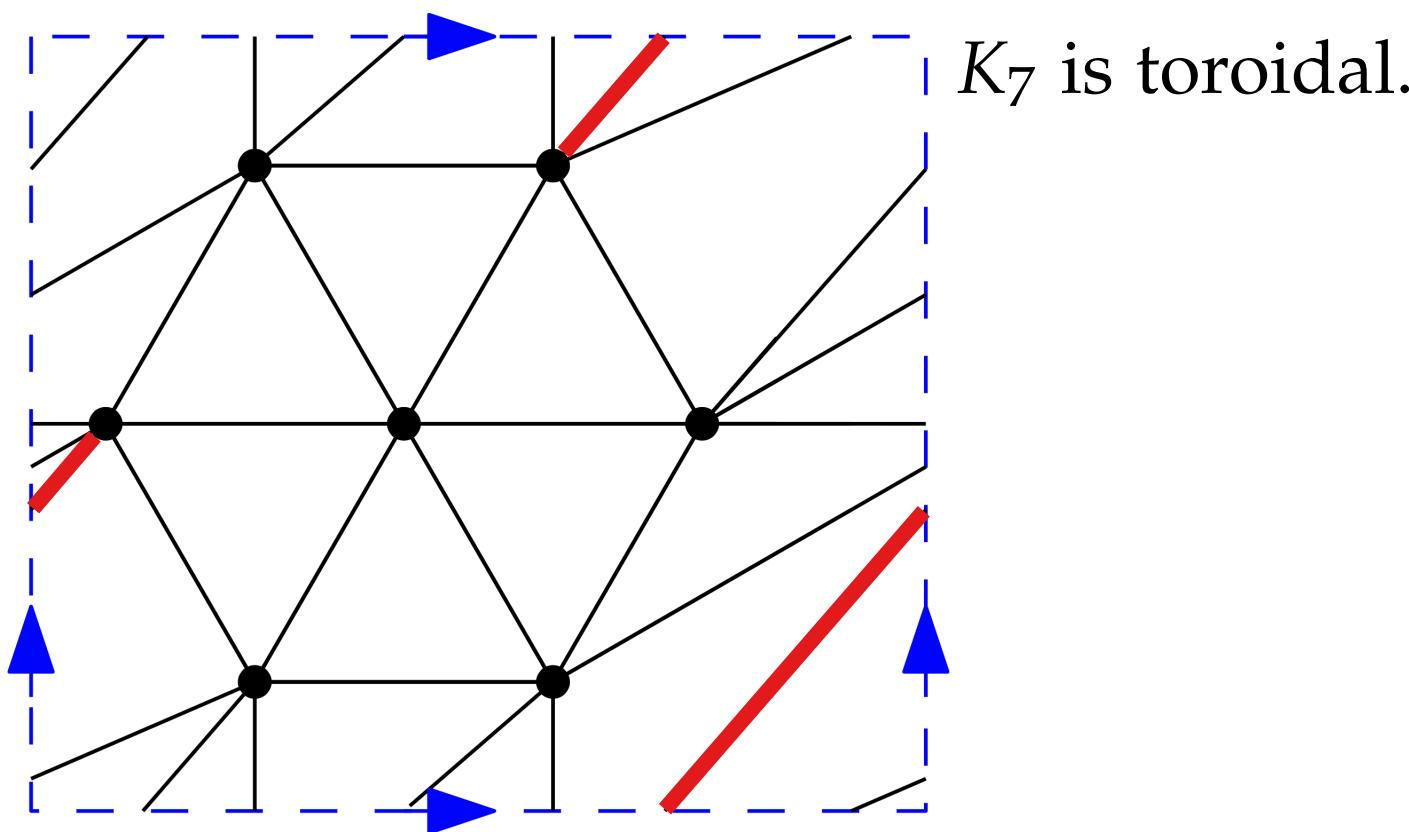


K_5 is toroidal.



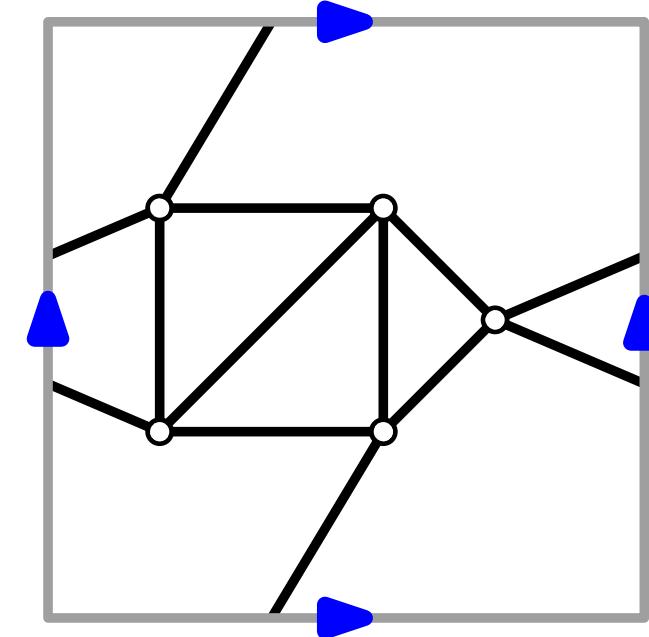
Theorem 1. Let G be a toroidal graph without loops. Then G has a visibility representation on the flat torus. [Mohar & Rosenstiehl, 1998]

14. Visibility Representations of Toroidal Graphs



K_7 is toroidal.

K_5 is toroidal.

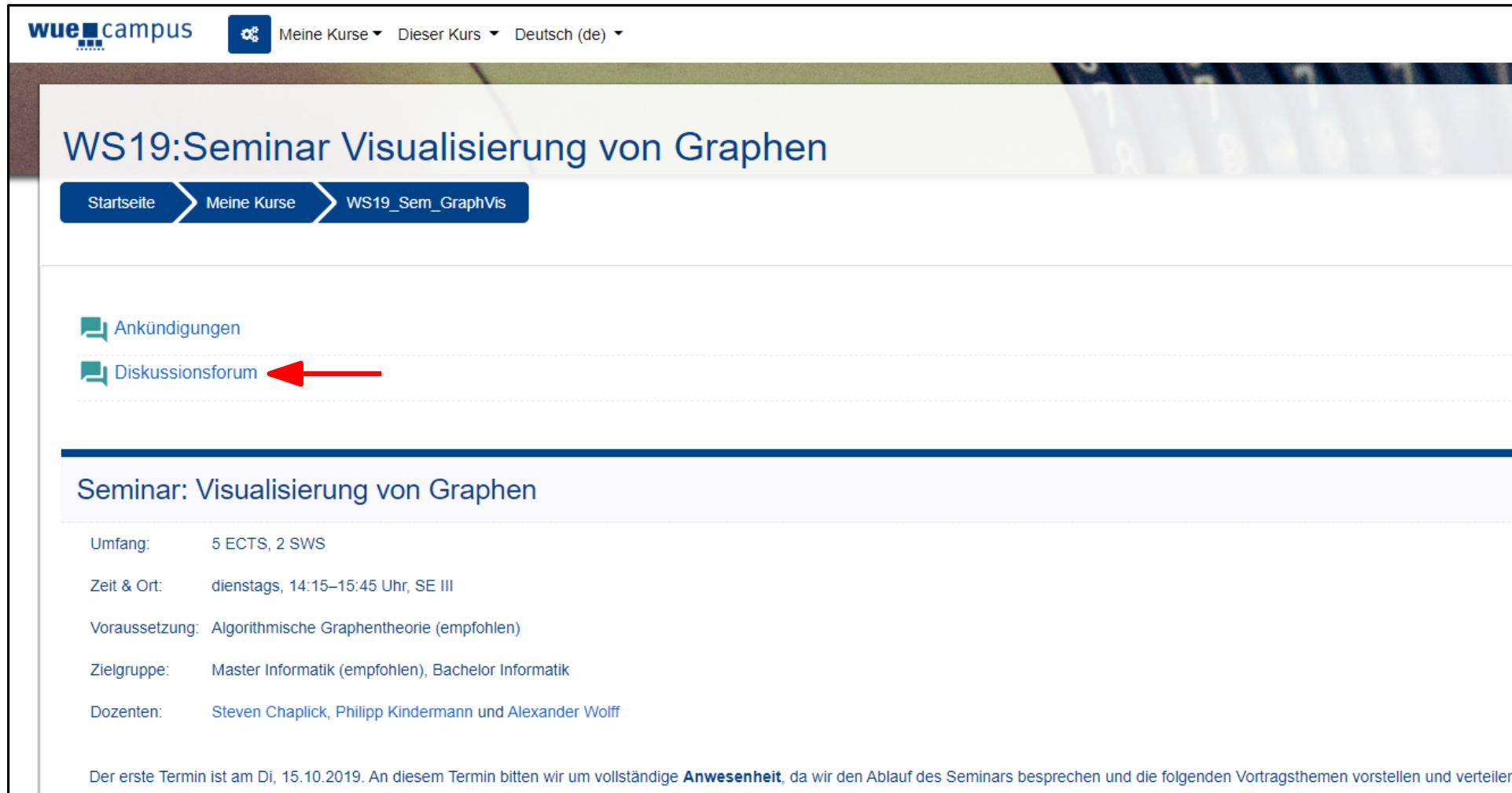


Theorem 1. Let G be a toroidal graph without loops. Then G has a visibility representation on the flat torus. [Mohar & Rosenstiehl, 1998]

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



wuecampus Meine Kurse Dieser Kurs Deutsch (de)

WS19: Seminar Visualisierung von Graphen

Startseite > Meine Kurse > WS19_Sem_GraphVis

Ankündigungen

Diskussionsforum 

Seminar: Visualisierung von Graphen

Umfang: 5 ECTS, 2 SWS

Zeit & Ort: dienstags, 14:15–15:45 Uhr, SE III

Voraussetzung: Algorithmische Graphentheorie (empfohlen)

Zielgruppe: Master Informatik (empfohlen), Bachelor Informatik

Dozenten: Steven Chaplick, Philipp Kindermann und Alexander Wolff

Der erste Termin ist am Di, 15.10.2019. An diesem Termin bitten wir um vollständige **Anwesenheit**, da wir den Ablauf des Seminars besprechen und die folgenden Vortragsthemen vorstellen und verteilen.

Nächste Schritte

- In den Kurs einschreiben

Nächste Schritte

- In den Kurs einschreiben

The screenshot shows a course registration page on the wuecampus platform. The top navigation bar includes the wuecampus logo, a Dashboard link, and a Meine Kurse dropdown. The main content area features a large, close-up image of frost on a textured surface. Below the image, the course title "WS22: Seminar Visualisierung von Graphen" is displayed in bold. A navigation bar below the title includes links for "Kurs", "Bewertungen", "Kompetenzen", and "Mich in diesem Kurs einschreiben". The "Mich in diesem Kurs einschreiben" link is highlighted in blue. The page is divided into sections: "Allgemeines" (General information) and "Seminar: Visualisierung von Graphen". The "Allgemeines" section contains a "Ankündigungen FORUM" link. The "Seminar: Visualisierung von Graphen" section displays the course details: "Umfang: 5 ECTS, 2 SWS". The overall layout is clean and modern, with a focus on user interaction through various buttons and links.

Nächste Schritte

- In den Kurs einschreiben

The screenshot shows a course page on the wuecampus platform. At the top, there is a navigation bar with the wuecampus logo, a dashboard link, and a "Meine Kurse" dropdown. The main content area features a large image of frost on a tree branch. Below the image, 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 sections for "Allgemeines" and "Seminar: Visualisierung von Graphen", and a note about the course's ECTS and SWS values.

wuecampus Dashboard Meine Kurse ▾

Wintersemester 2022/2023 > Master- und Aufbaustudiengänge

WS22: Seminar Visualisierung von Graphen

Kurs Bewertungen Kompetenzen **Mich in diesem Kurs einschreiben**

▼ Allgemeines Alles einklappen

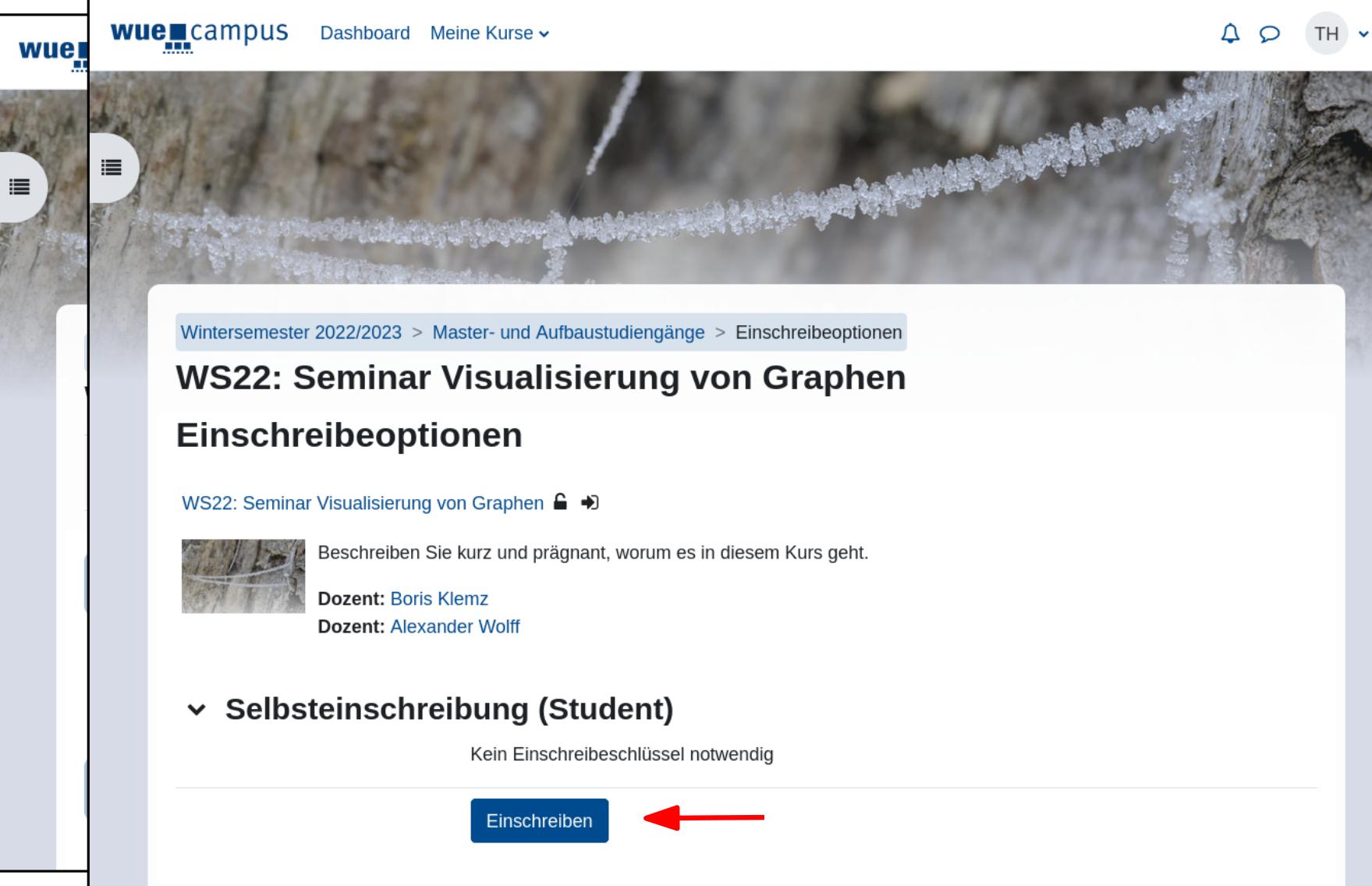
ANKÜNDIGUNGEN FORUM

▼ Seminar: Visualisierung von Graphen

Umfang: 5 ECTS, 2 SWS

Nächste Schritte

- In den Kurs einschreiben



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 a bell, a message bubble, and "TH". Below the header, there is a large, close-up image of a frozen, crystalline structure, possibly ice on a branch, serving as a background for the page.

The main content area has a breadcrumb navigation: "Wintersemester 2022/2023 > Master- und Aufbaustudiengänge > Einschreibeoptionen".

WS22: Seminar Visualisierung von Graphen

Einschreibeoptionen

WS22: Seminar Visualisierung von Graphen  

Beschreiben Sie kurz und prägnant, worum es in diesem Kurs geht.

Dozent: Boris Klemz
Dozent: Alexander Wolff

▼ **Selbsteinschreibung (Student)**

Kein Einschreibeschlüssel notwendig

Einschreiben

A red arrow points to the "Einschreiben" button at the bottom of the page.

Nächste Schritte

- In den Kurs einschreiben

Nächste Schritte

- In den Kurs einschreiben
- Überblick verschaffen und Kurzvortrag vorbereiten

Nächste Schritte

- In den Kurs einschreiben
- Überblick verschaffen und Kurzvortrag vorbereiten
- Bei Fragen (oder *spätestens drei Wochen vor dem eigenen Vortrag*) an den Betreuer wenden

Nächste Schritte

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Zum Abschluß:

Demonstration des Programms IPE
zum Erstellen von Abbildungen und Folien

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

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Übrigens: ein gemeinsames git-Verzeichnis eignet sich hervorragend zum gemeinsamen Bearbeiten von .tex, aber auch .ipe Dateien!

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 <https://gitlab2.informatik.uni-wuerzburg.de/>

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