

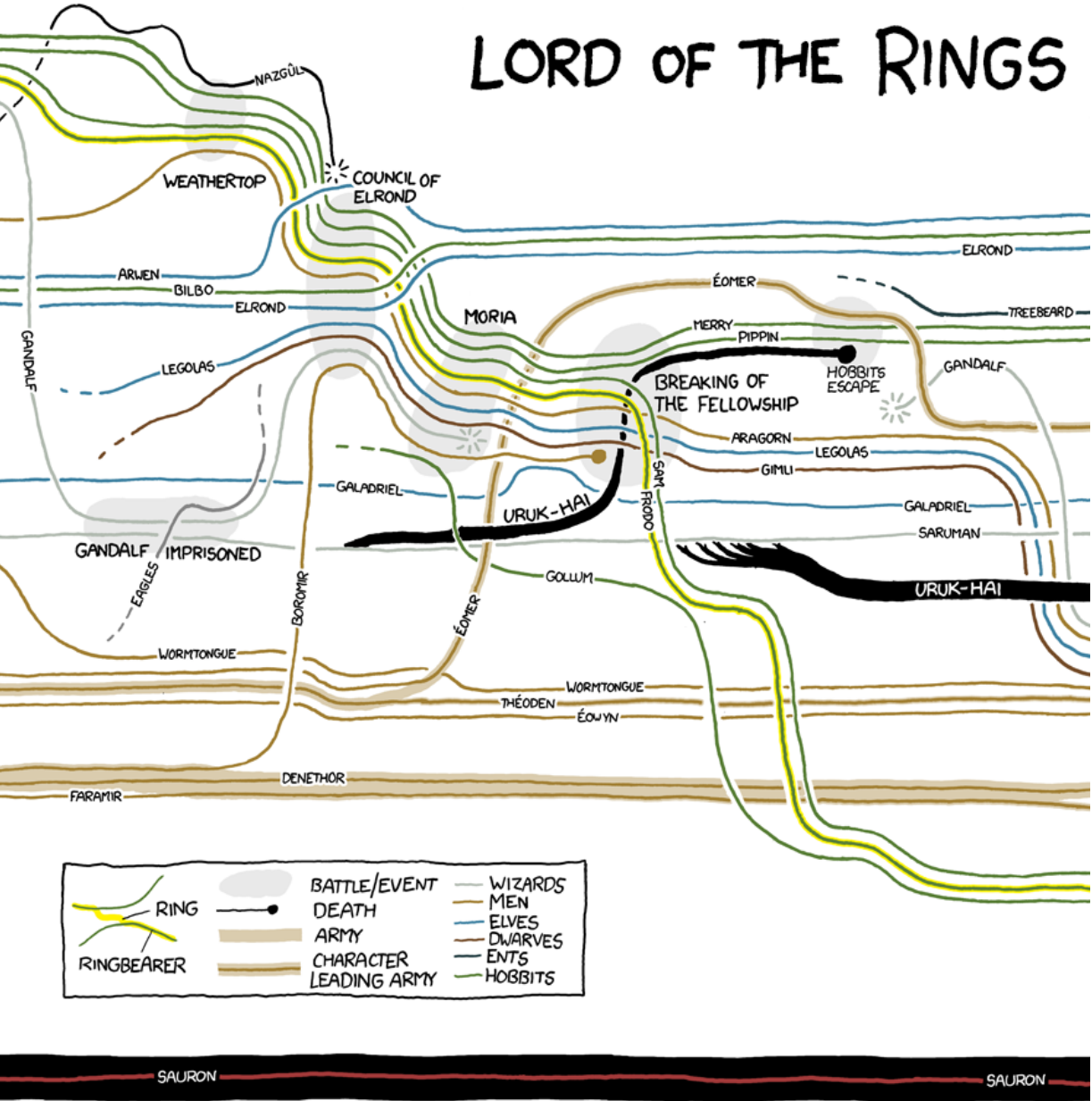
Storylines with a Protagonist

Tim Hegemann

Alexander Wolff

The 32nd International Symposium on
Graph Drawing and Network Visualization

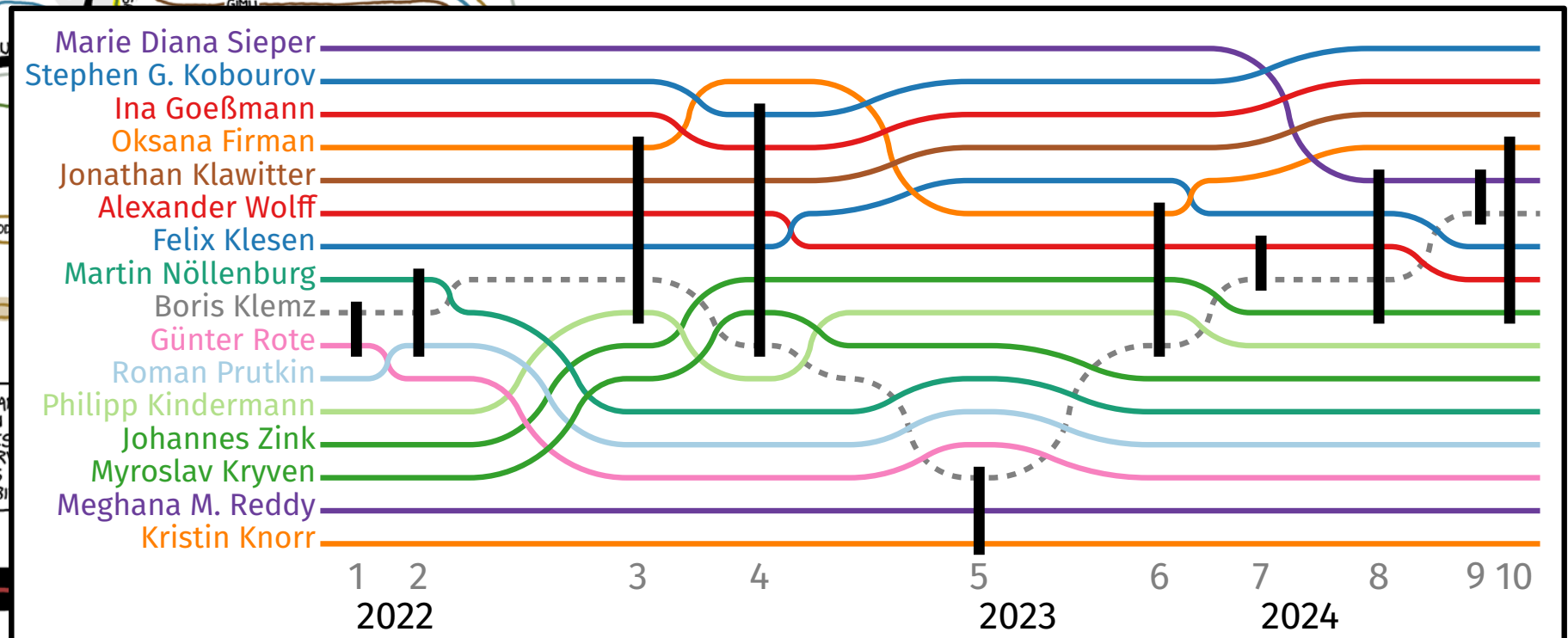
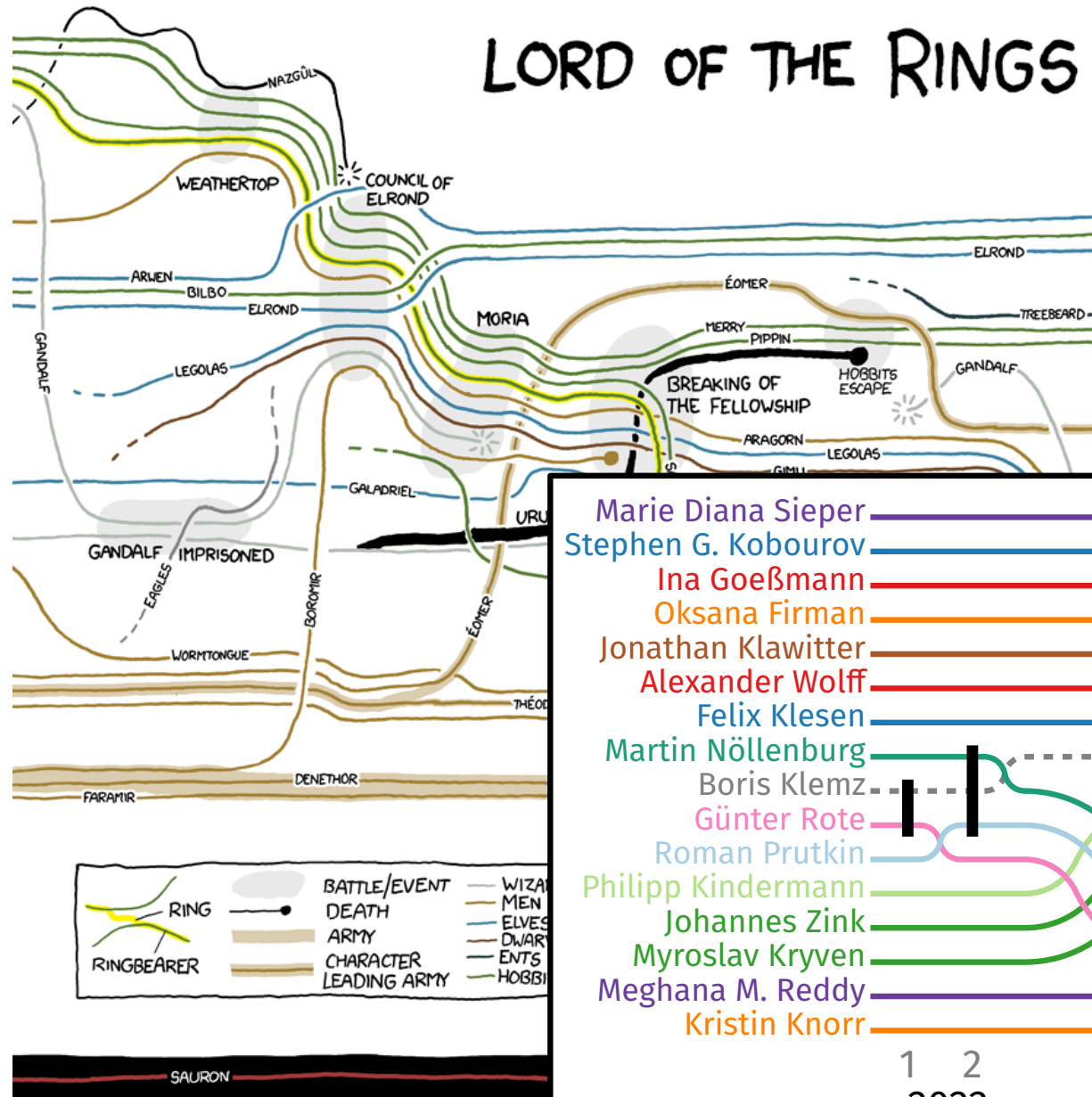
Motivation



[Munroe. 2009 (clipping)]

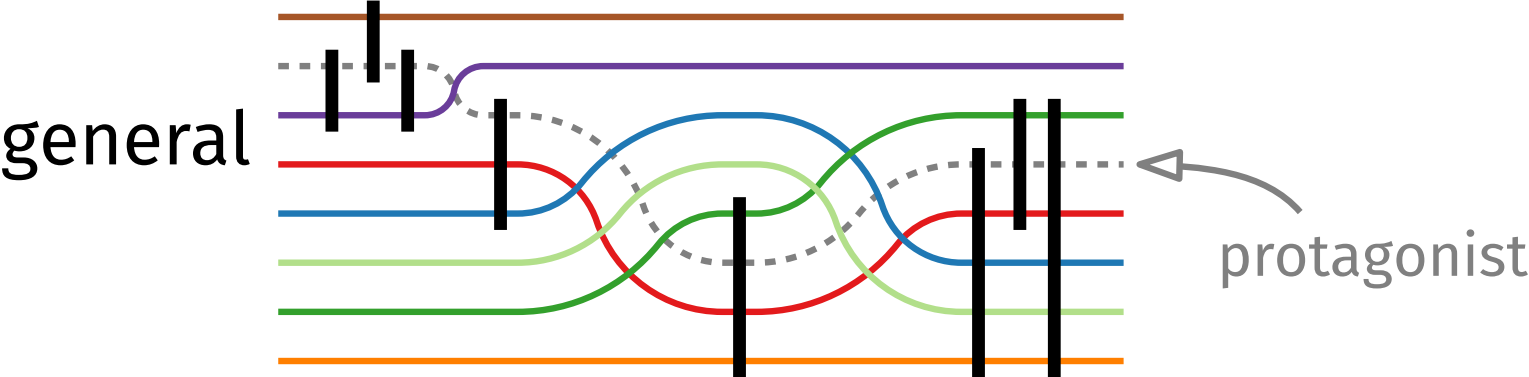
Motivation

- scientific publication history
- select one main author (the *protagonist*)
- *only* publications by the protagonist
- characters: (co)authors
- meetings: joint publications

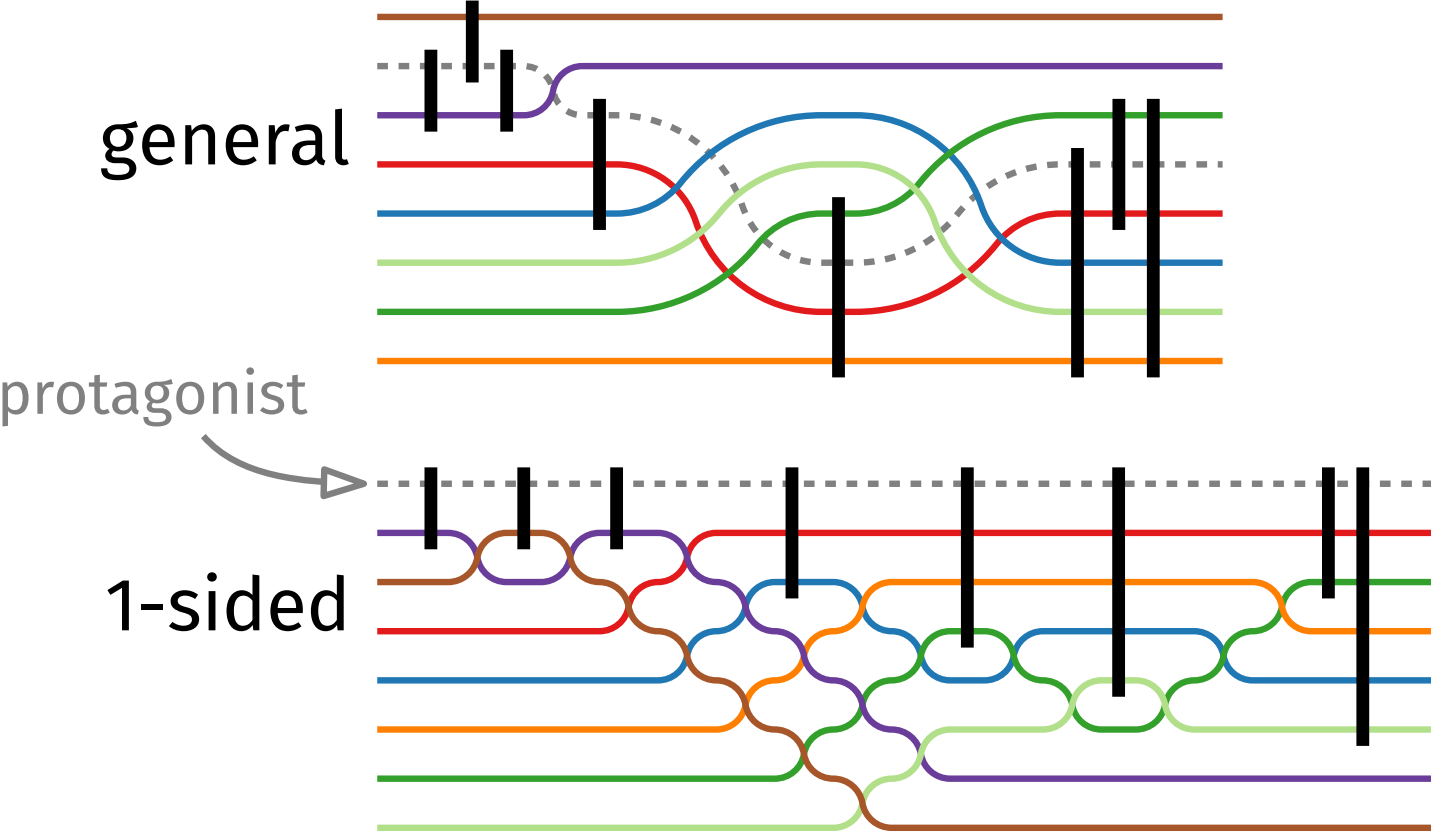


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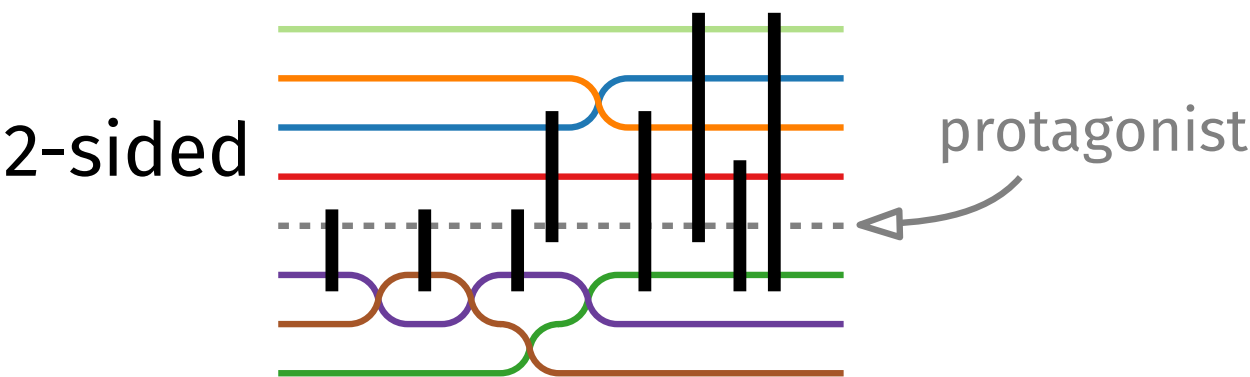
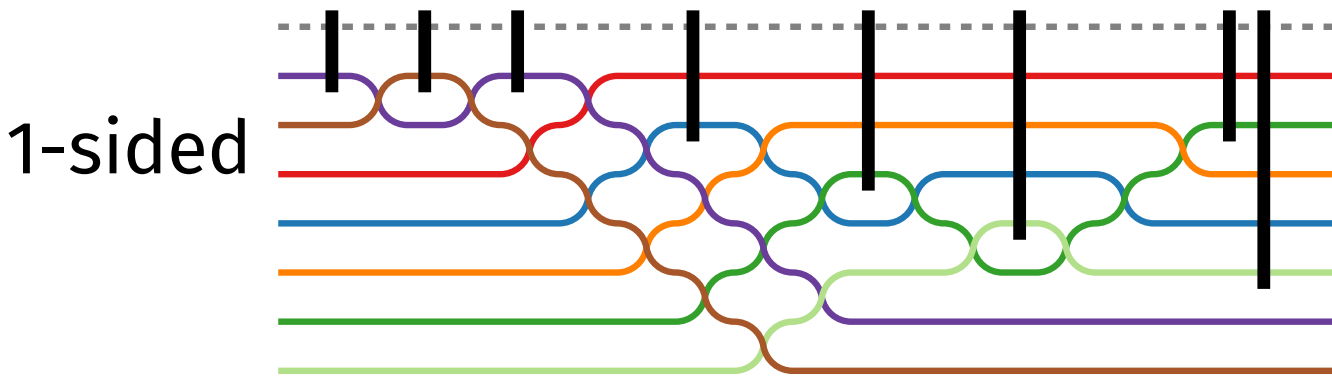
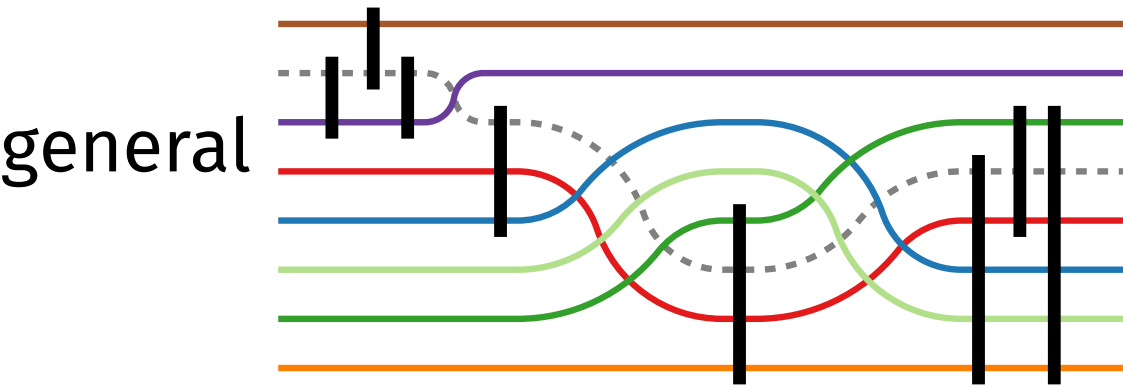
Let's Talk About Style



Let's Talk About Style



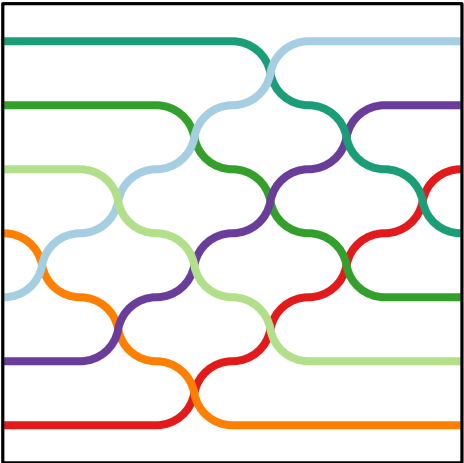
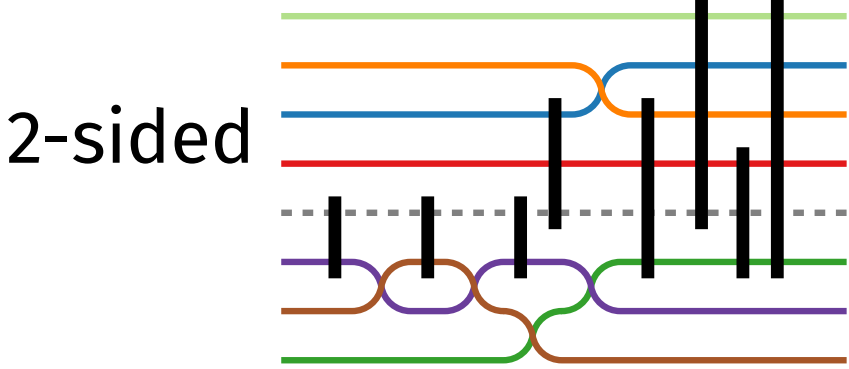
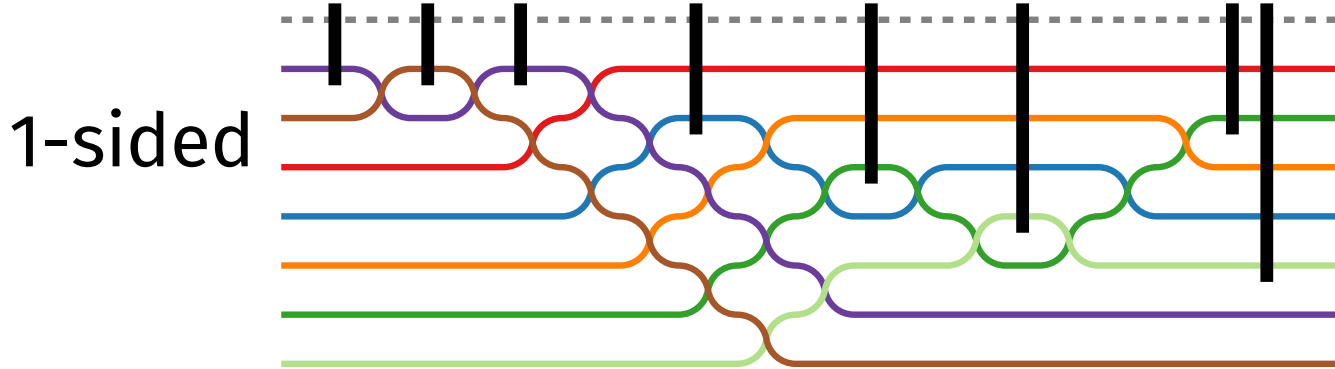
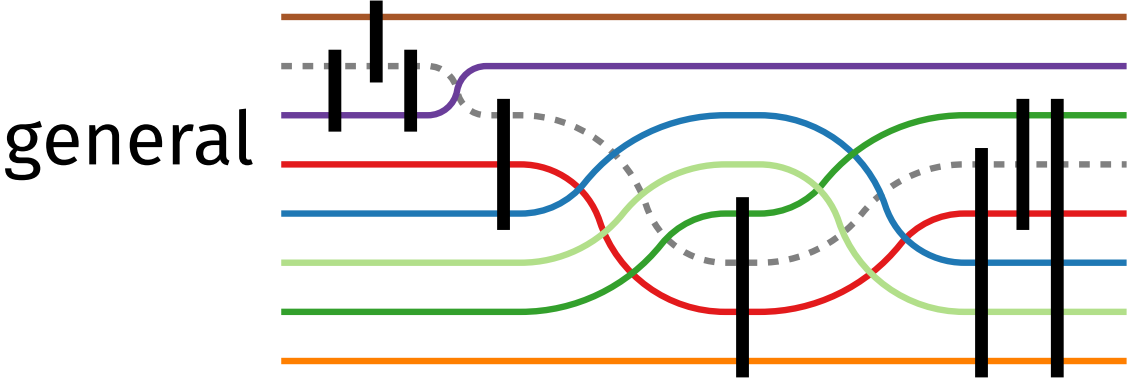
Let's Talk About Style



Let's Talk About Style

pairwise
crossings

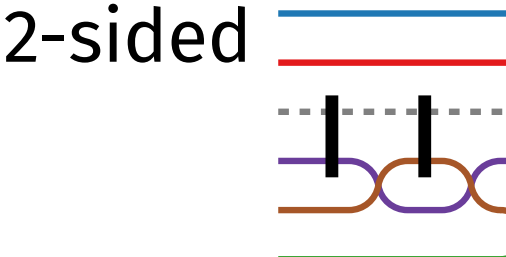
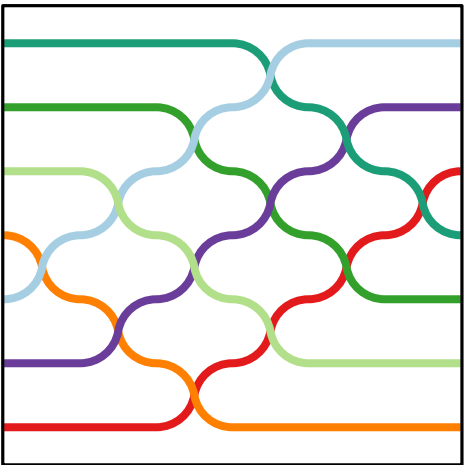
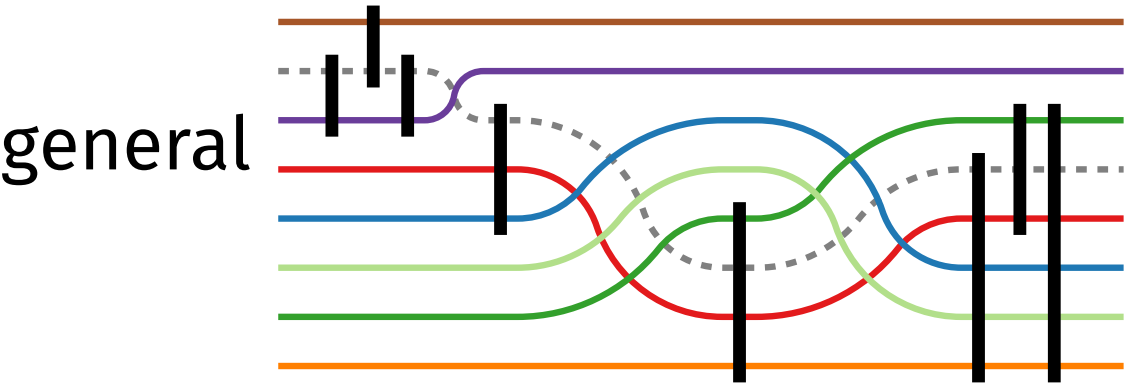
block
crossings



Let's Talk About Style

pairwise
crossings

block
crossings



Storyline [Block] Crossing Minimization (S[B]CM)		
	SCM	SBCM
general	NP ¹	NP ²
1-sided	P	NP
2-sided	NP ³	NP

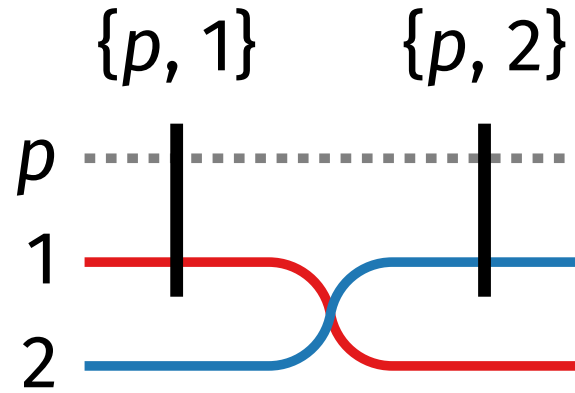
¹ [Gronemann, Jünger, Liers, Mambelli. GD'16]

² [van Dijk, Fink, Fischer, Lipp, Markfelder, Ravsky, Suri, Wolff. JGAA 2017]

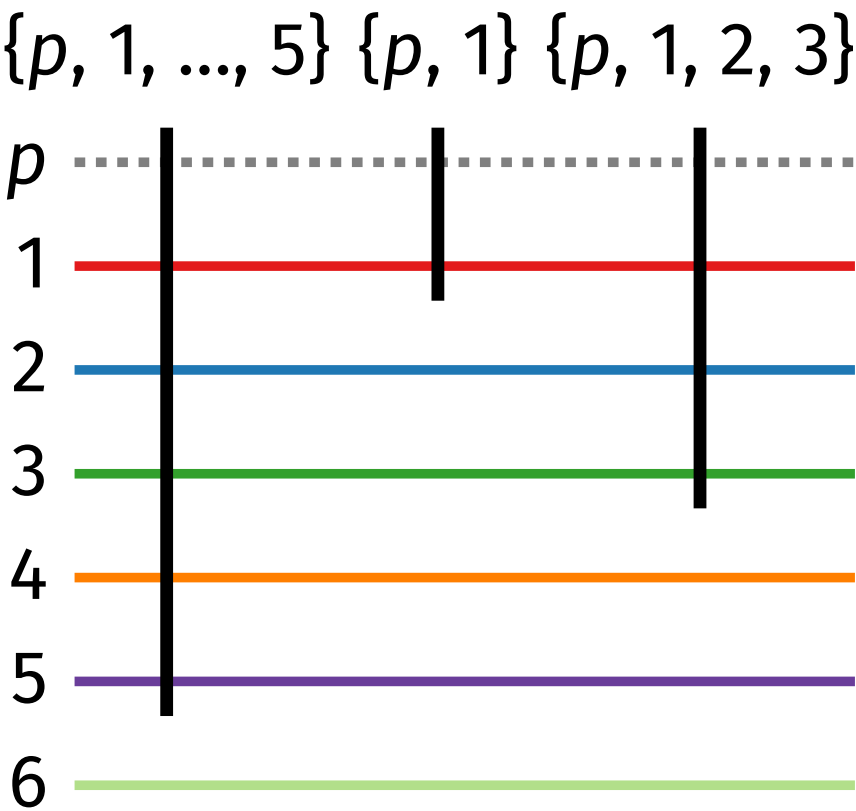
³ unpublished

Crossing Minimization in One-Sided Storylines

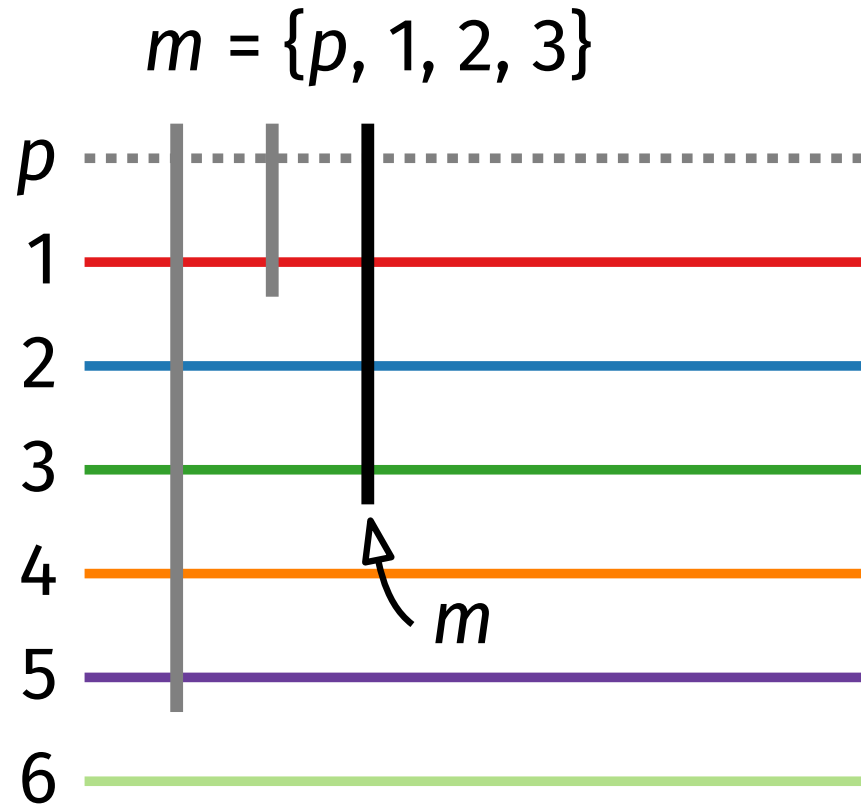
Unavoidable Crossings



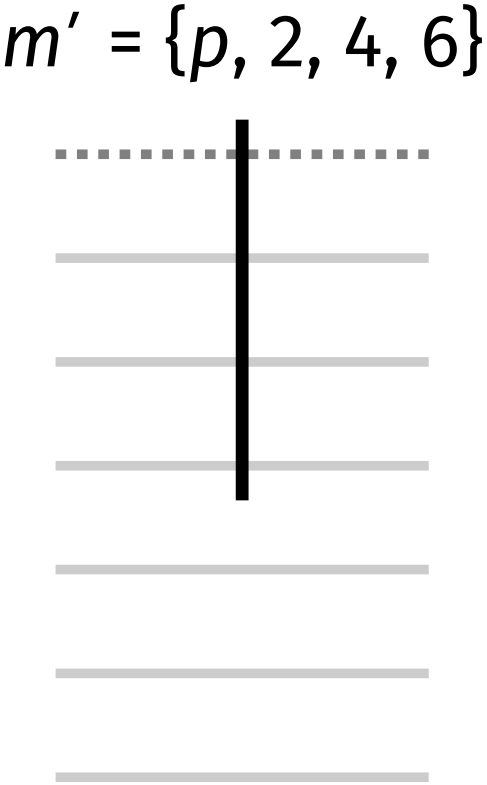
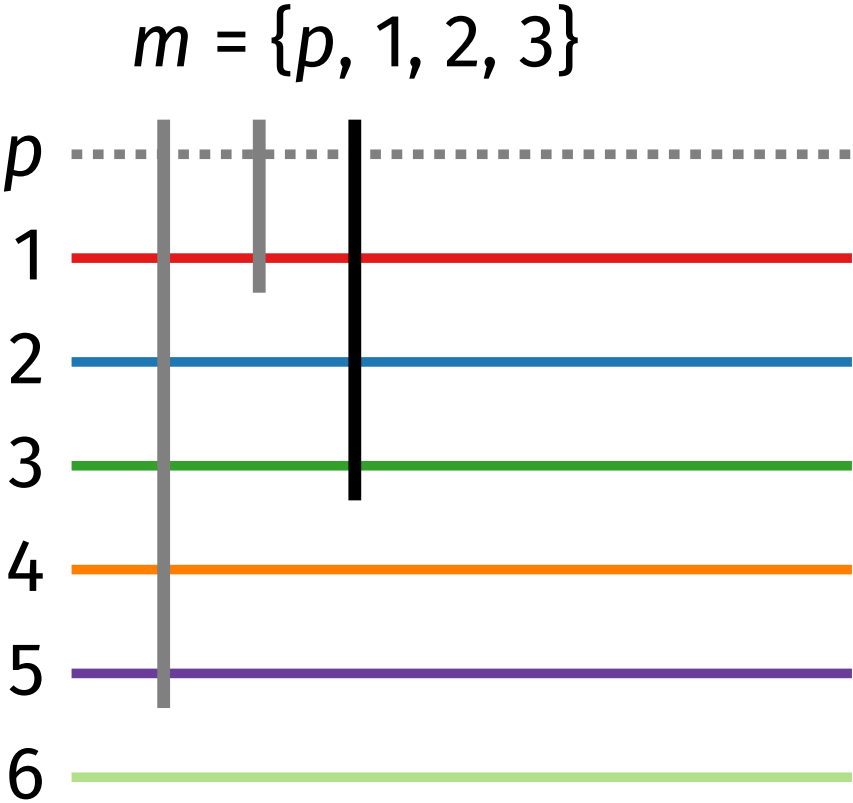
Crossing Minimization in One-Sided Storylines



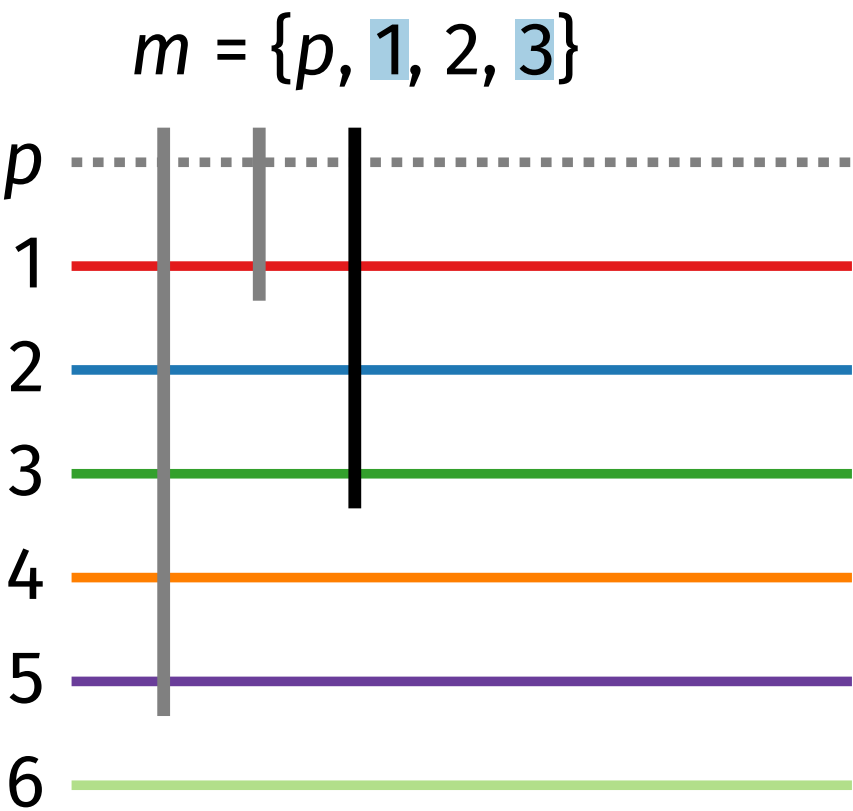
Crossing Minimization in One-Sided Storylines



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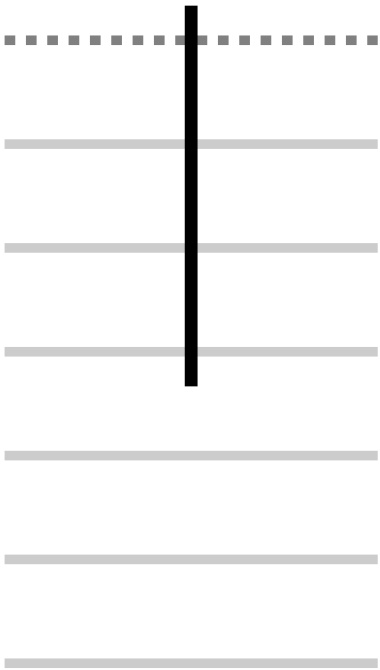


Crossing Minimization in One-Sided Storylines



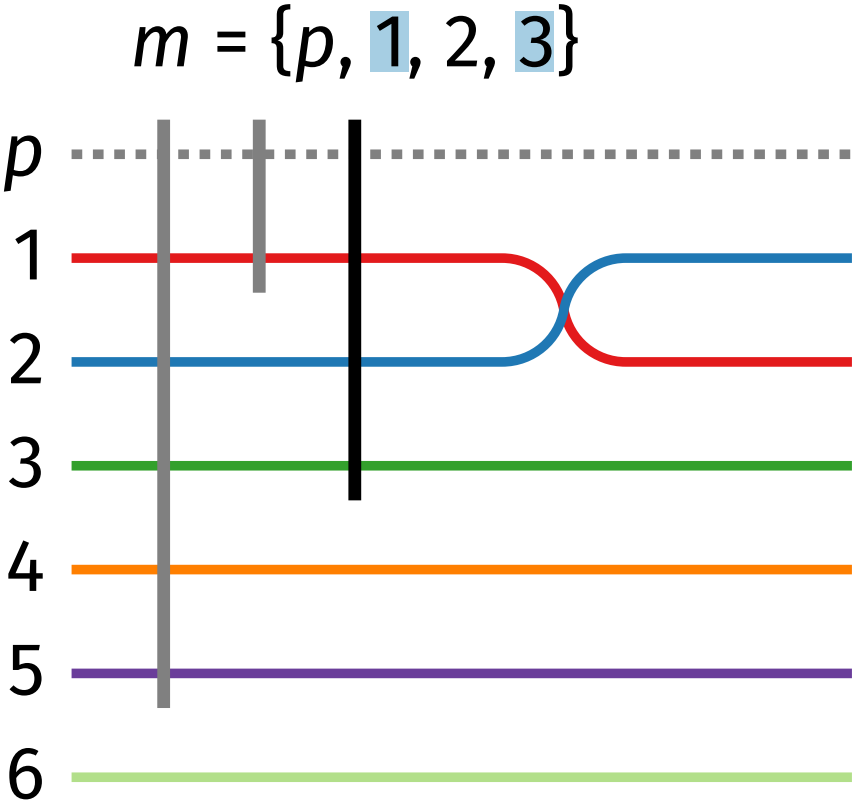
$m' = \{p, 2, 4, 6\}$

...



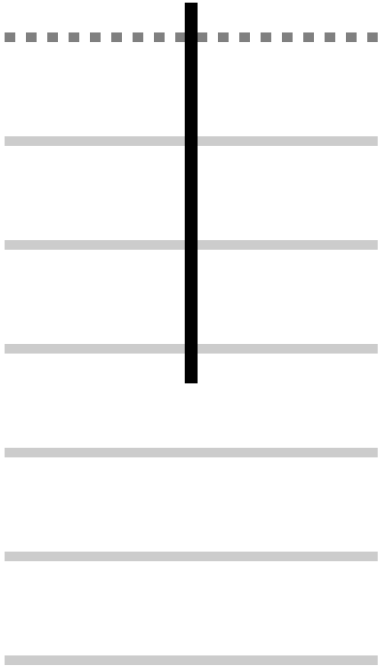
$S = m \setminus m'$

Crossing Minimization in One-Sided Storylines



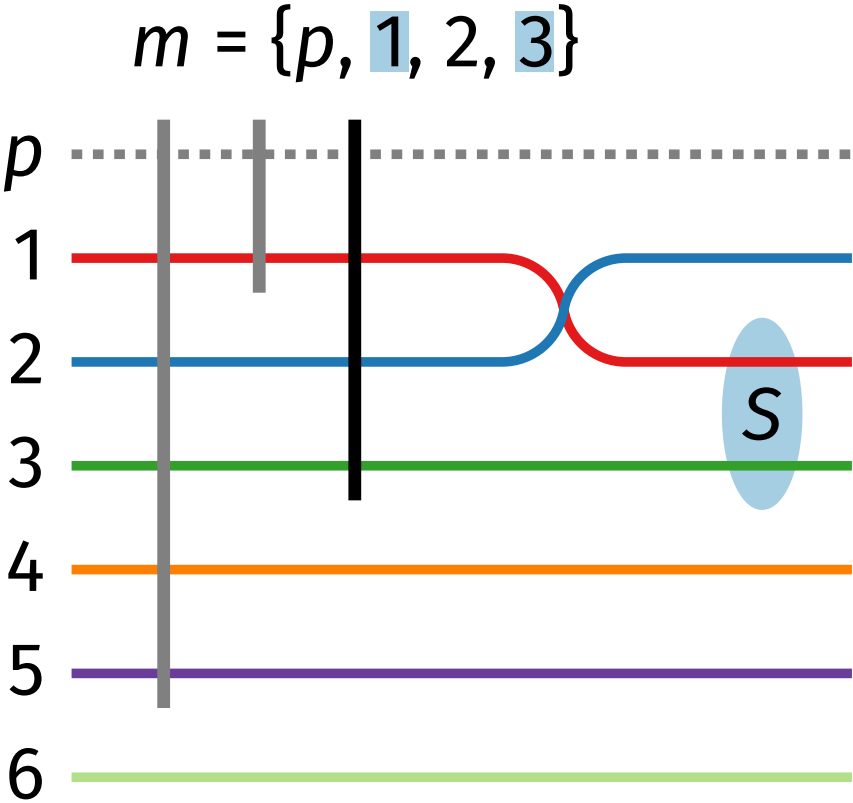
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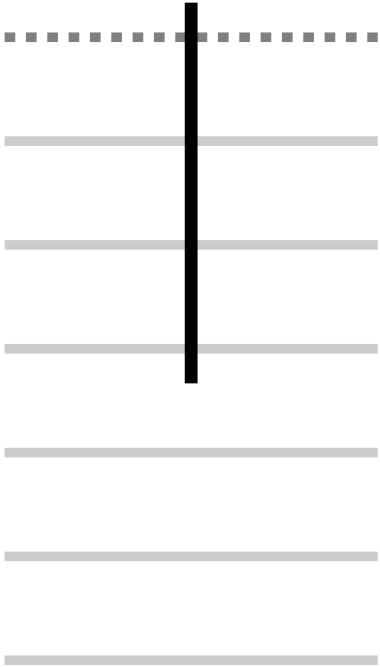
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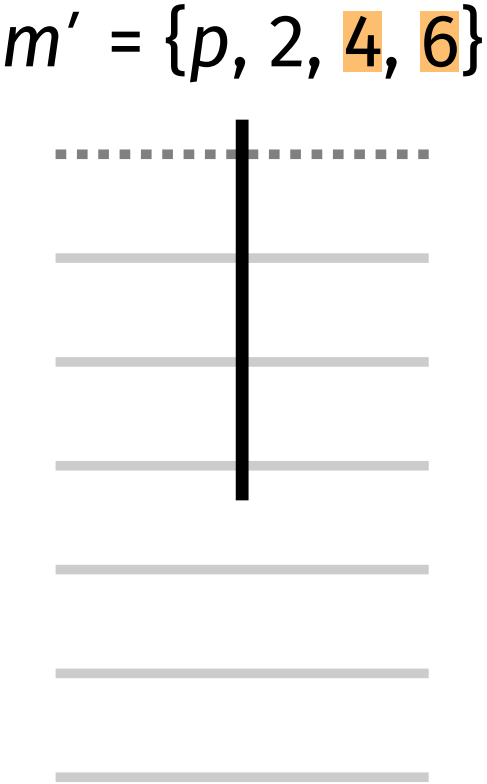
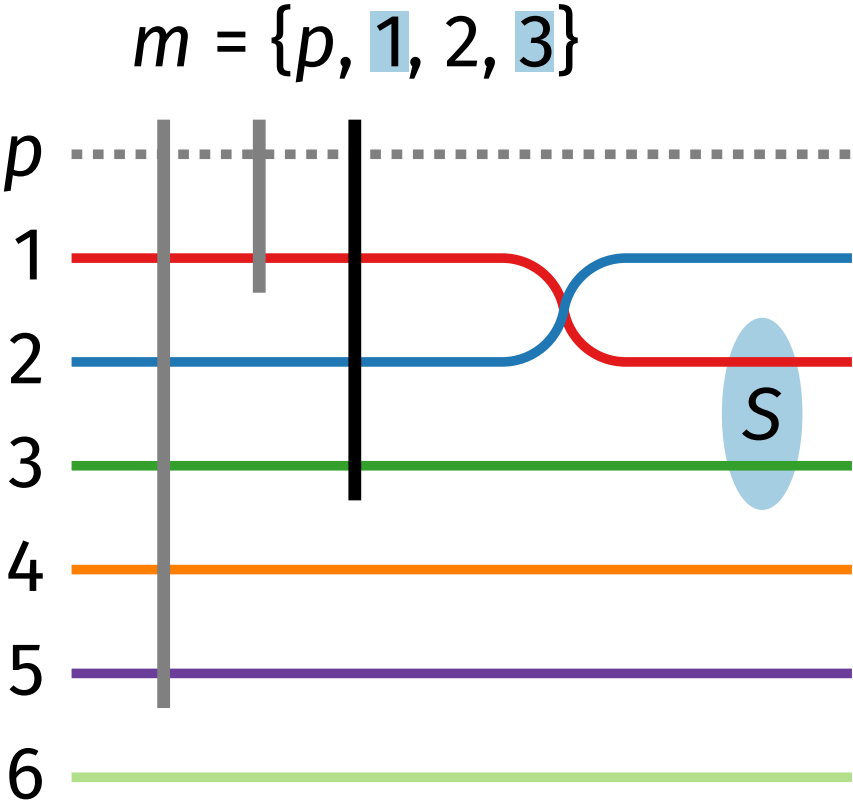
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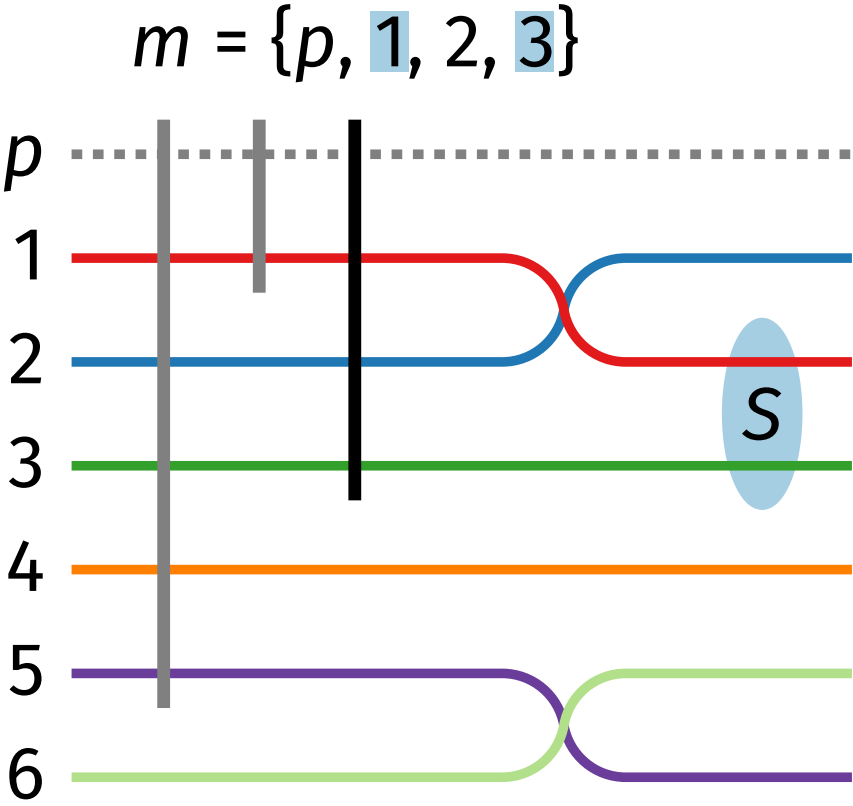
Crossing Minimization in One-Sided Storylines



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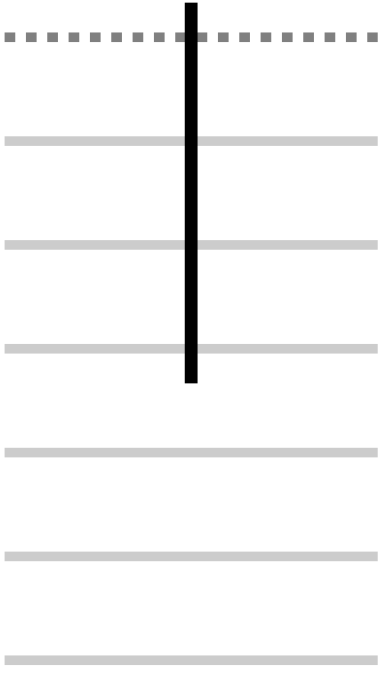
$T = m' \setminus m$

Crossing Minimization in One-Sided Storylines



$m' = \{p, 2, \textcolor{orange}{4}, \textcolor{orange}{6}\}$

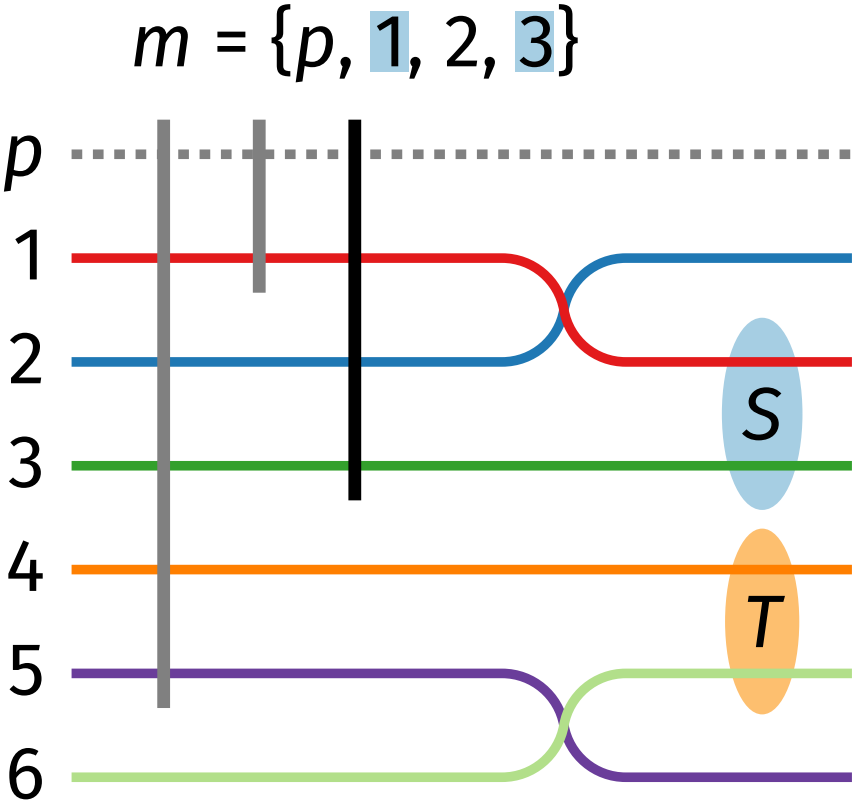
...



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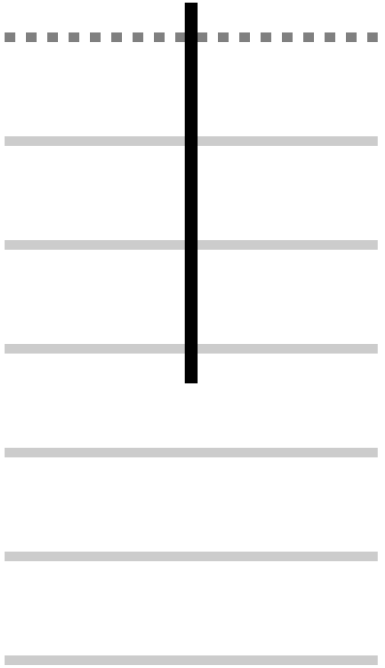
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Crossing Minimization in One-Sided Storylines



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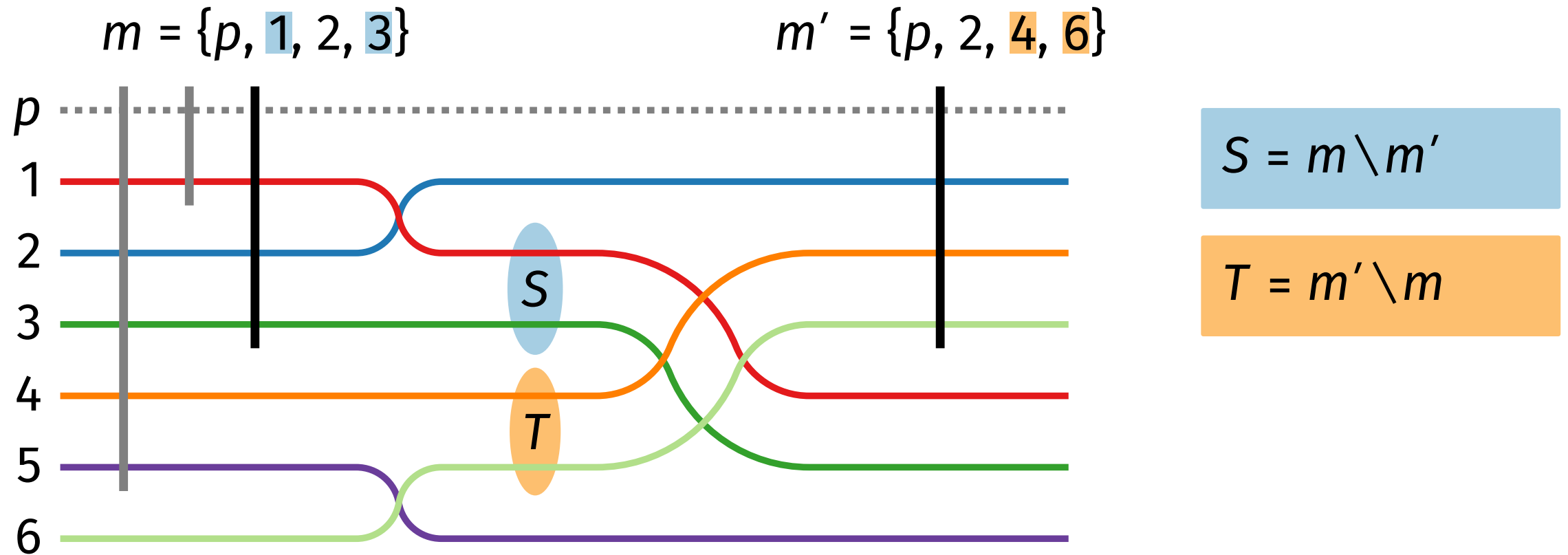
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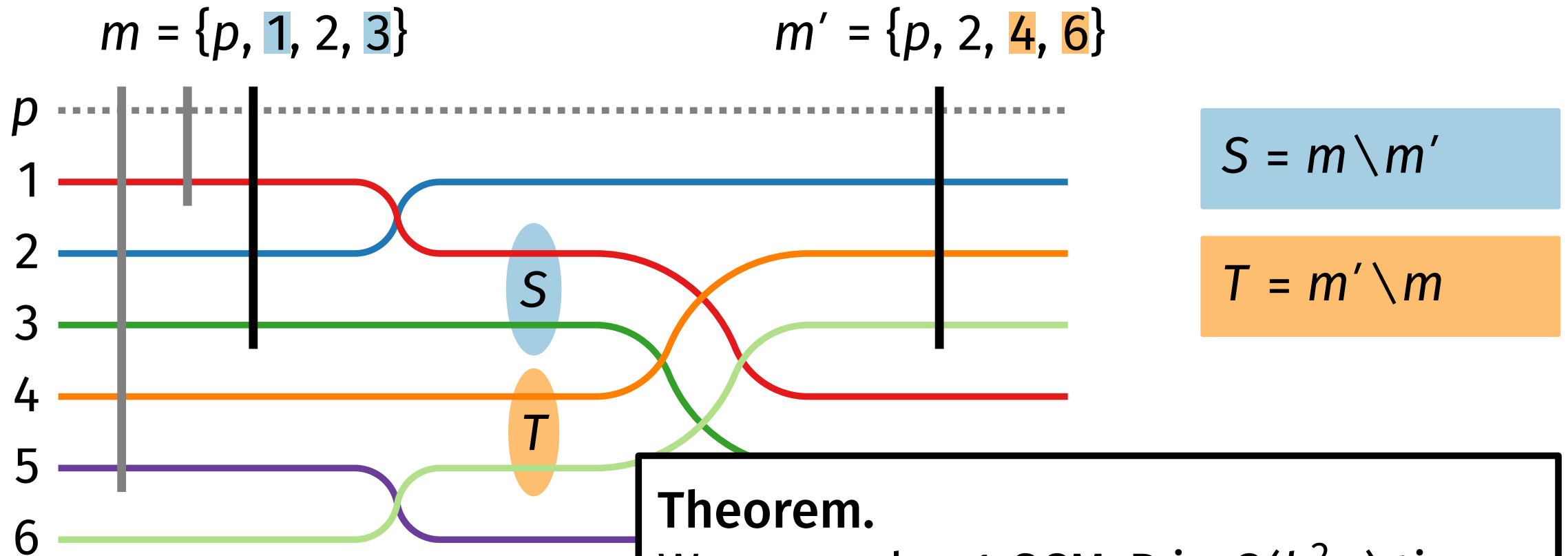
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Crossing Minimization in One-Sided Storylines



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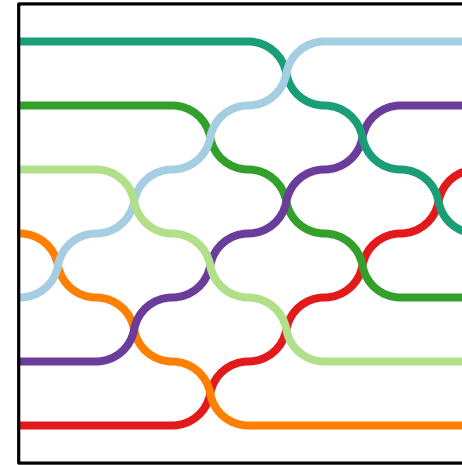


Theorem.

We can solve 1-SCM-P in $O(k^2 n)$ time, where k is the number of characters and n is the number of meetings.

From Crossings to Block Crossings

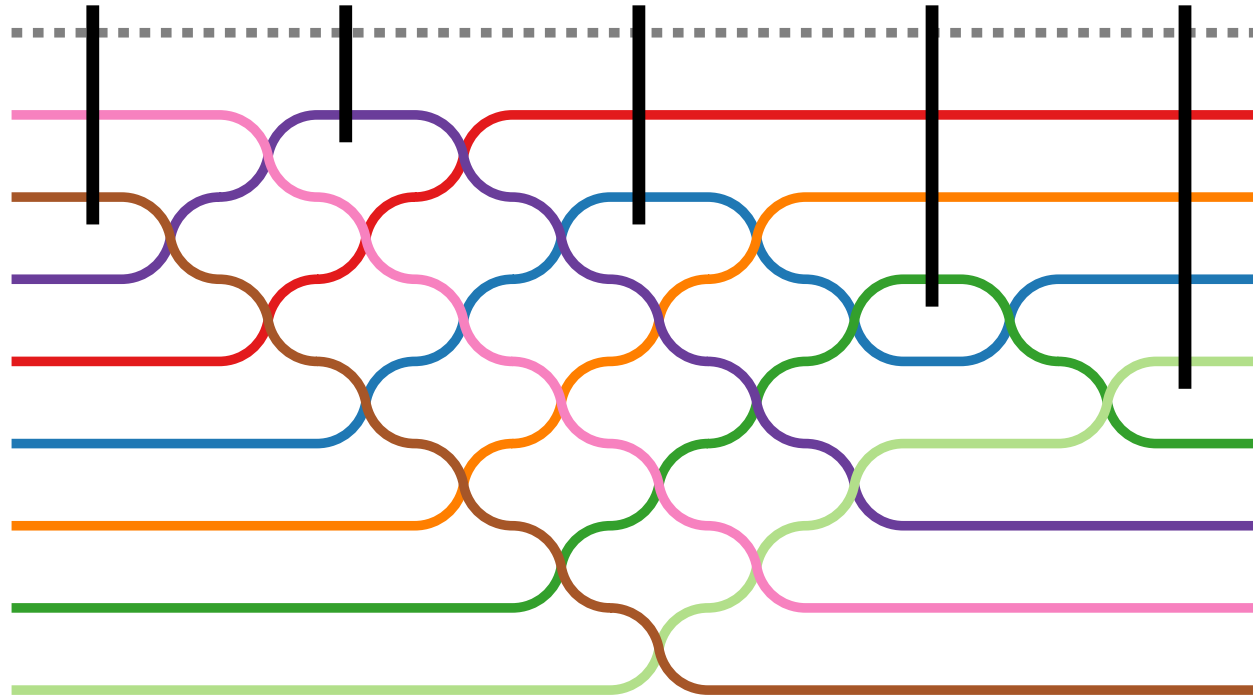
pairwise
crossings



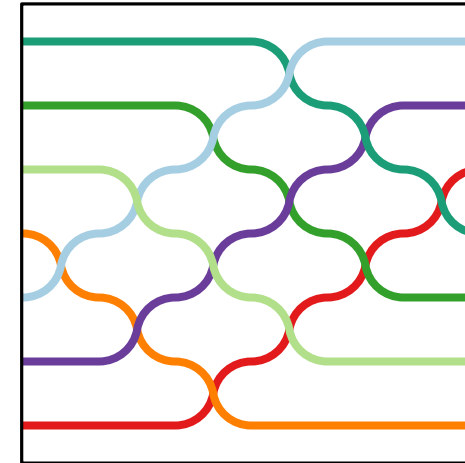
block
crossings



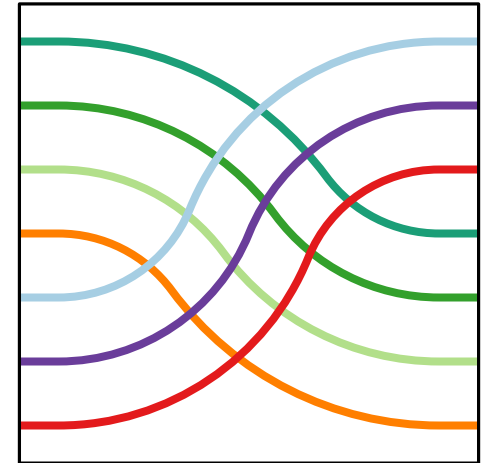
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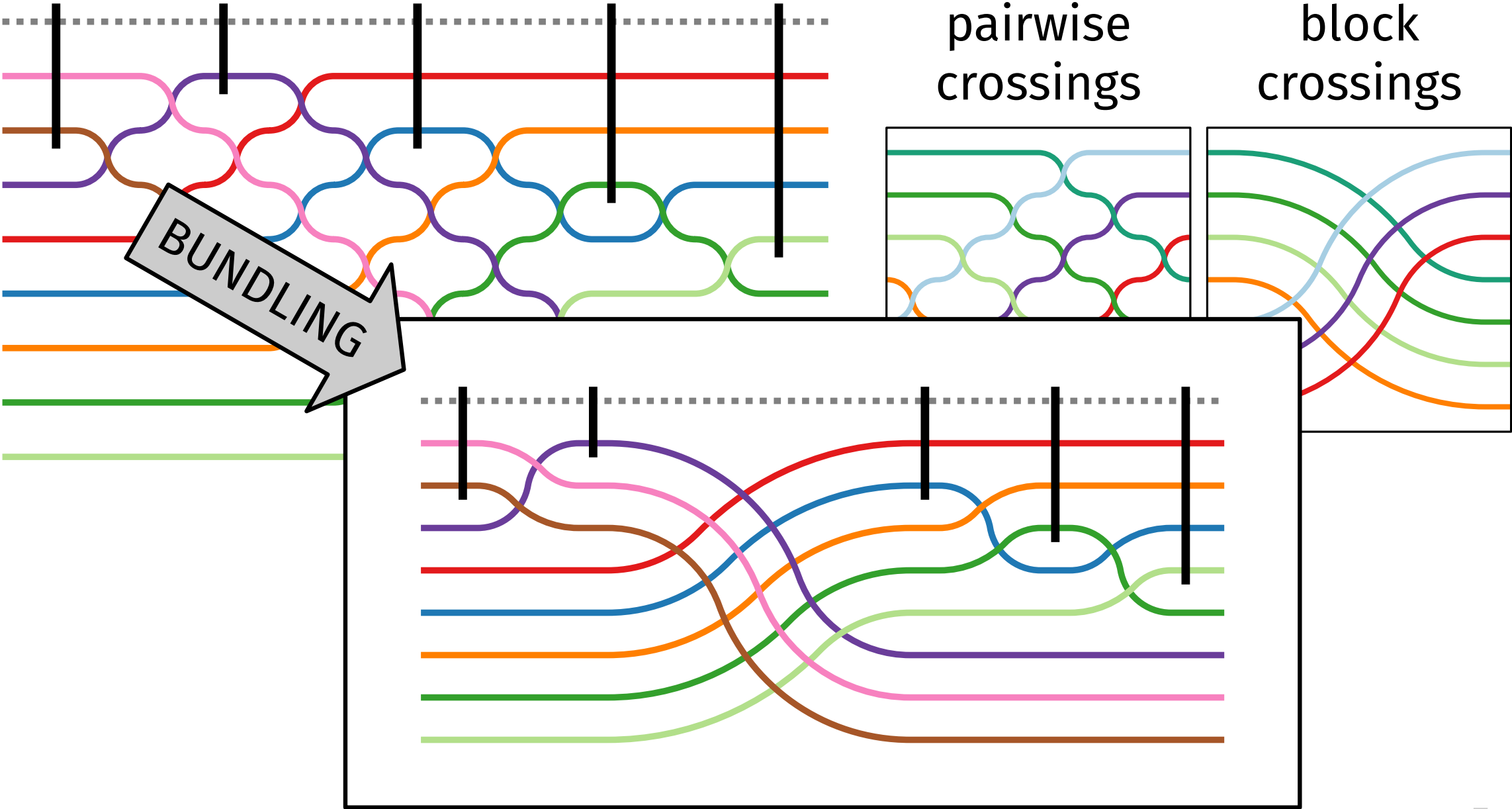
pairwise
crossings



block
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From Crossings to Block Crossings

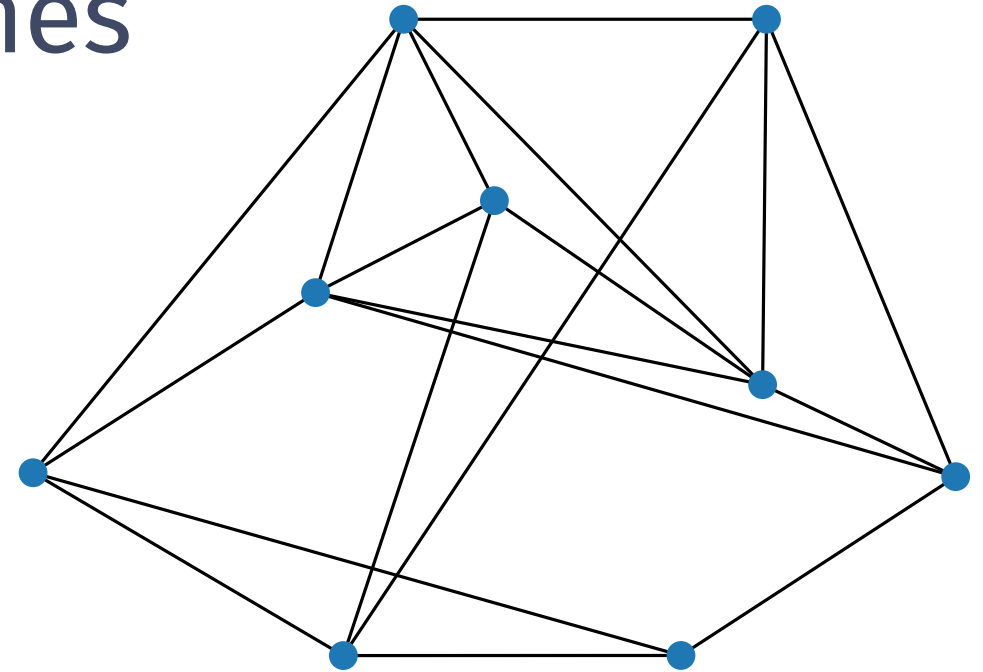


Bundled Crossings for Storylines

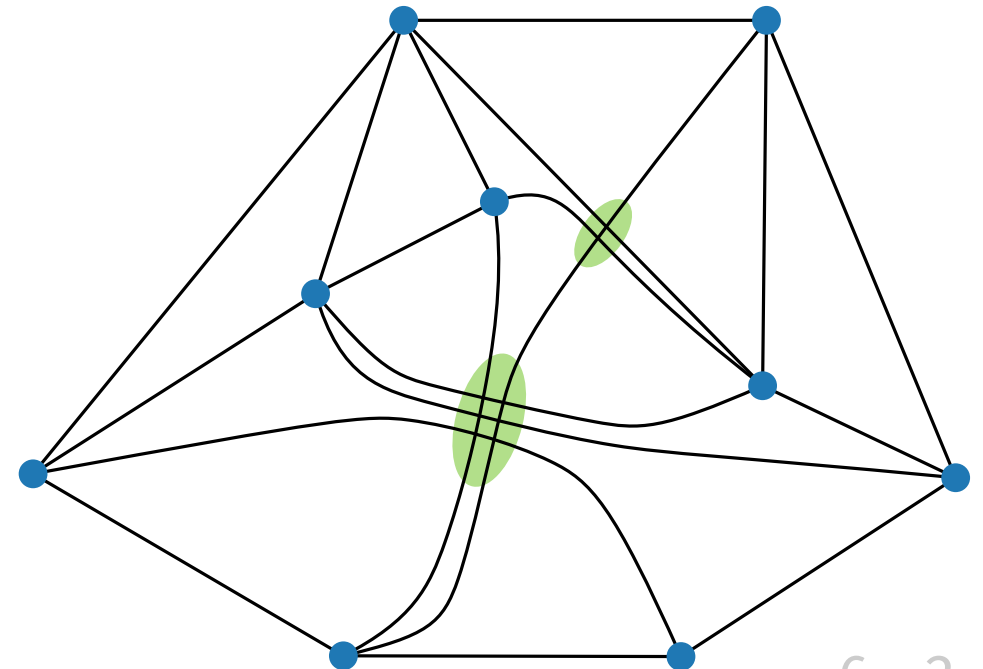
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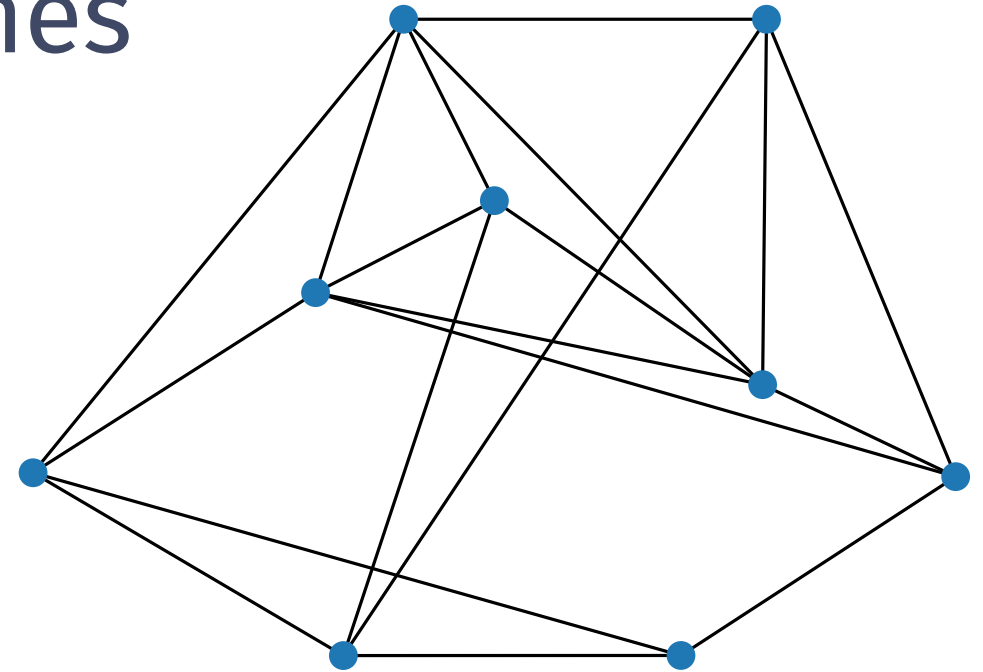


[FHSV. LATIN'16]

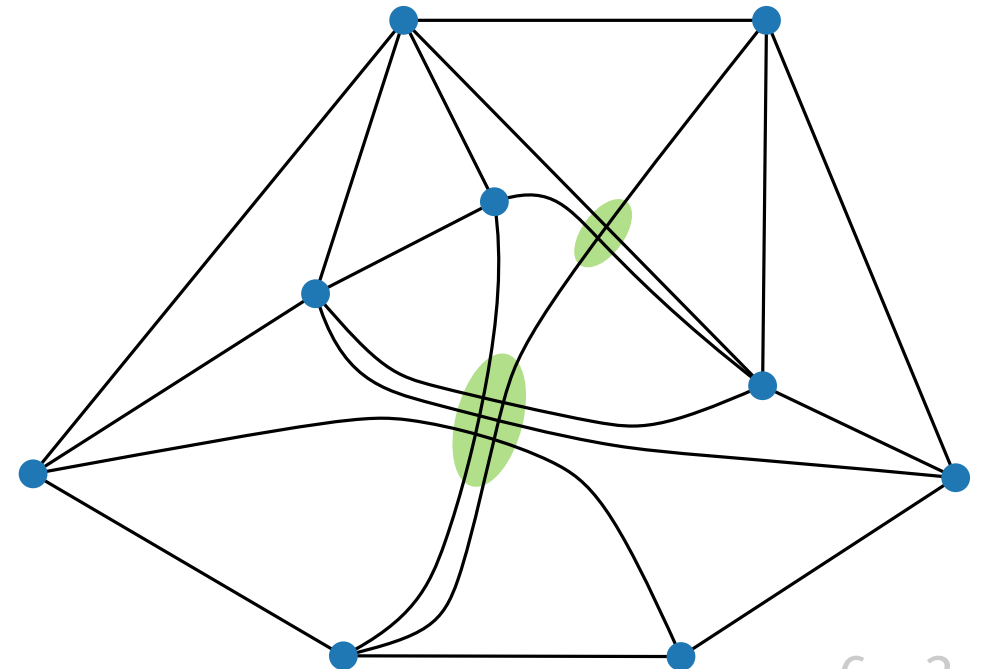


Bundled Crossings for Storylines

- Fink, Hershberger, Suri, and Verbeek showed that bundling crossings in embedded graphs is NP-hard.
- They also discovered a connection to a minimum rectangle dissection problem (details follow).

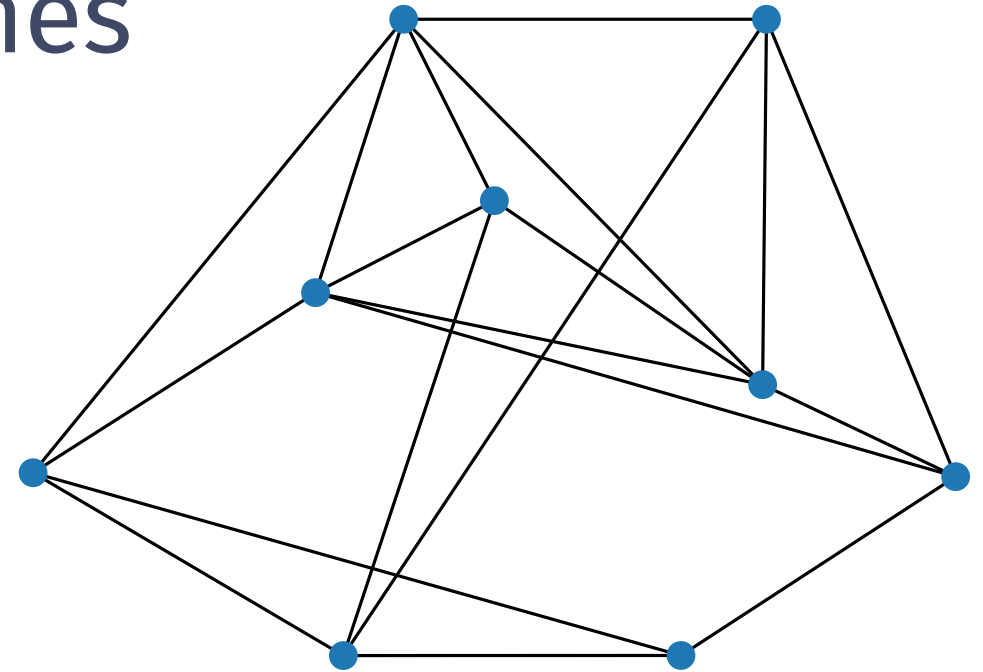


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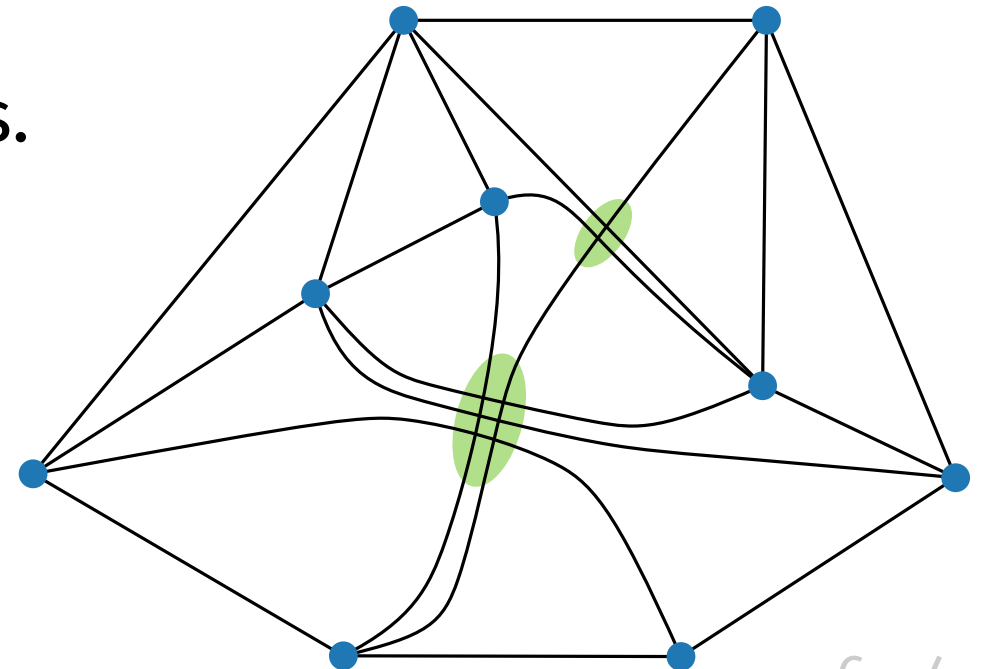


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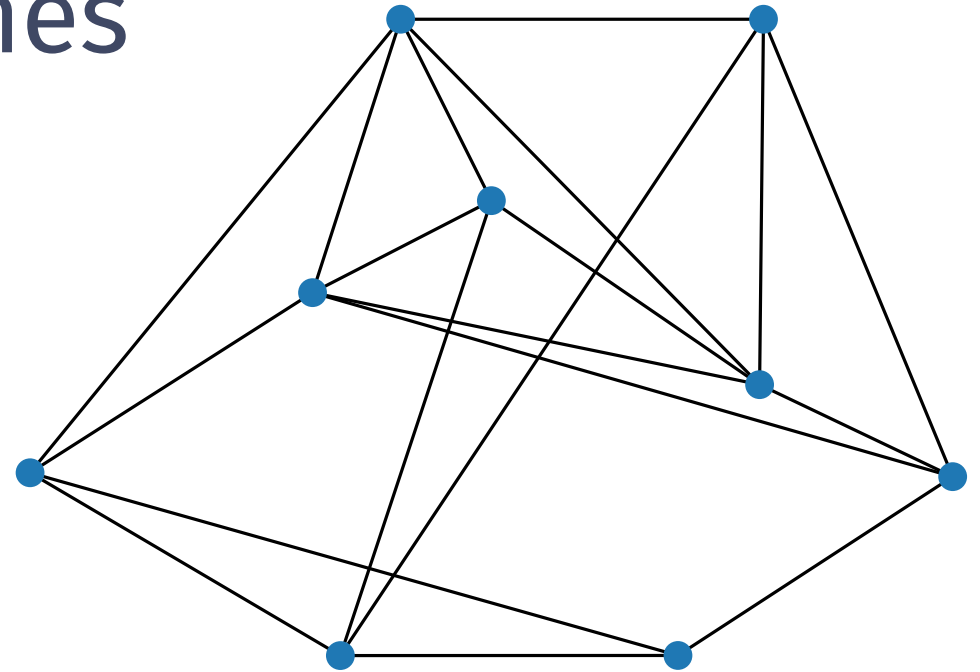


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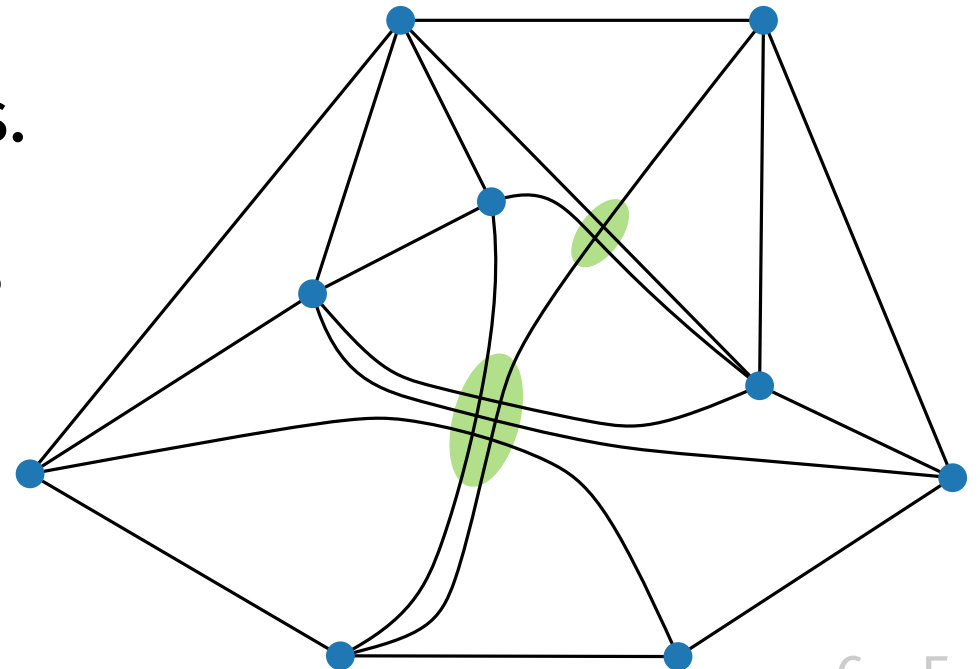
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Bundled Crossings for Storylines is efficiently solvable...



[FHSV. LATIN'16]



Bundled Crossings for Storylines

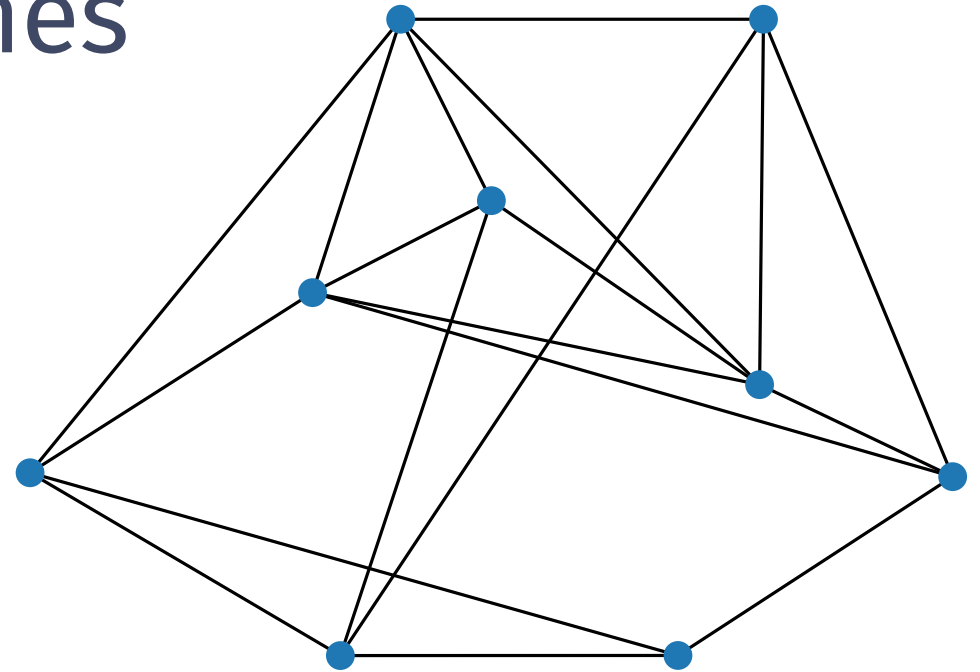
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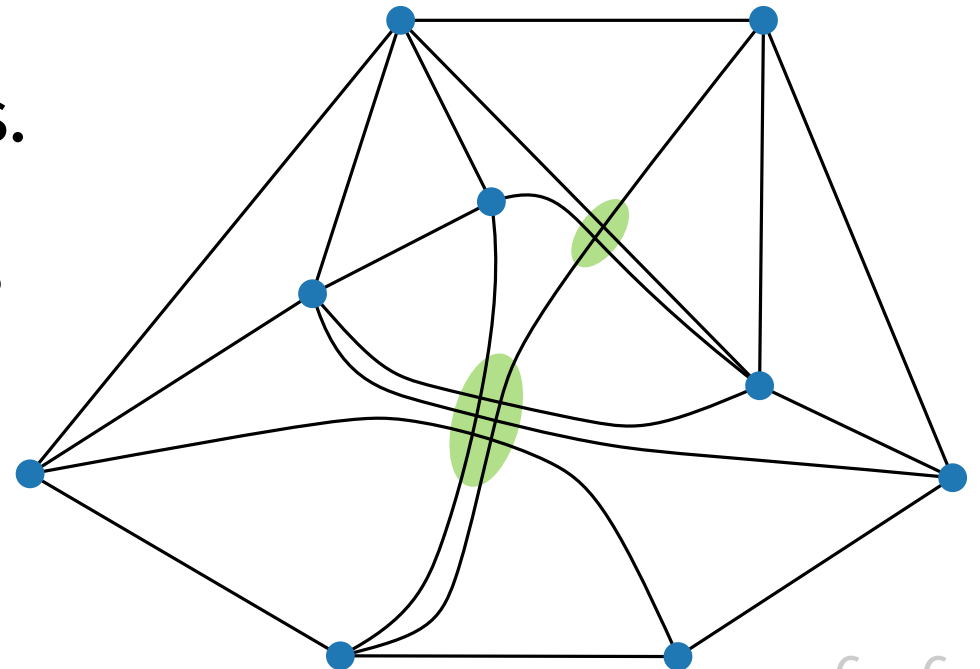
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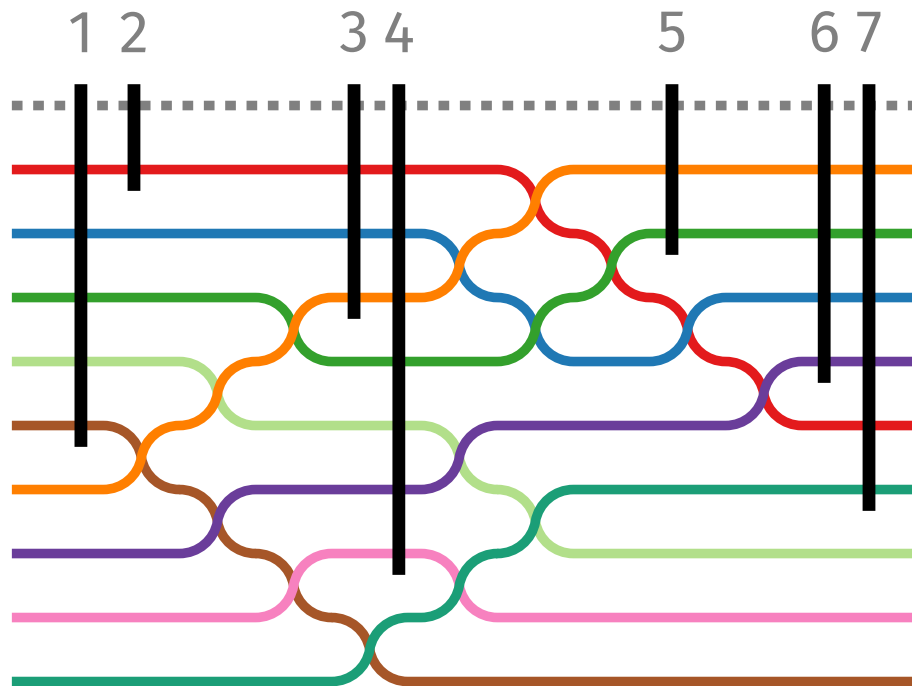
...but only if we ignore meetings.



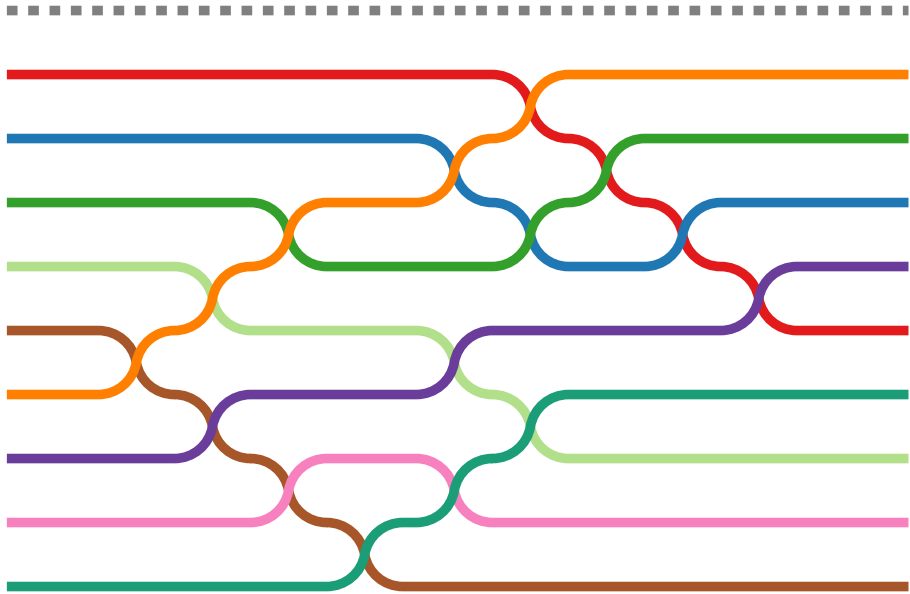
[FHSV. LATIN'16]



I. The Crossing Complex



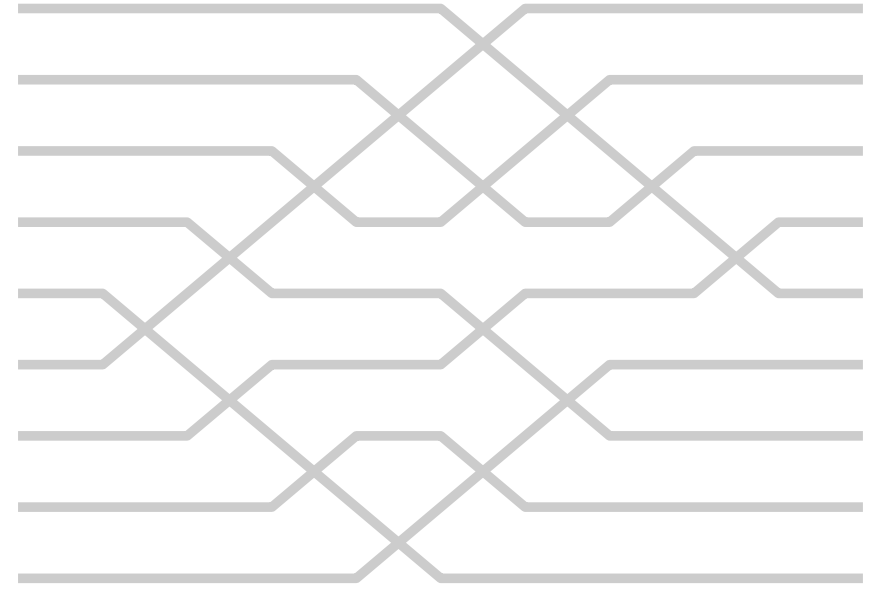
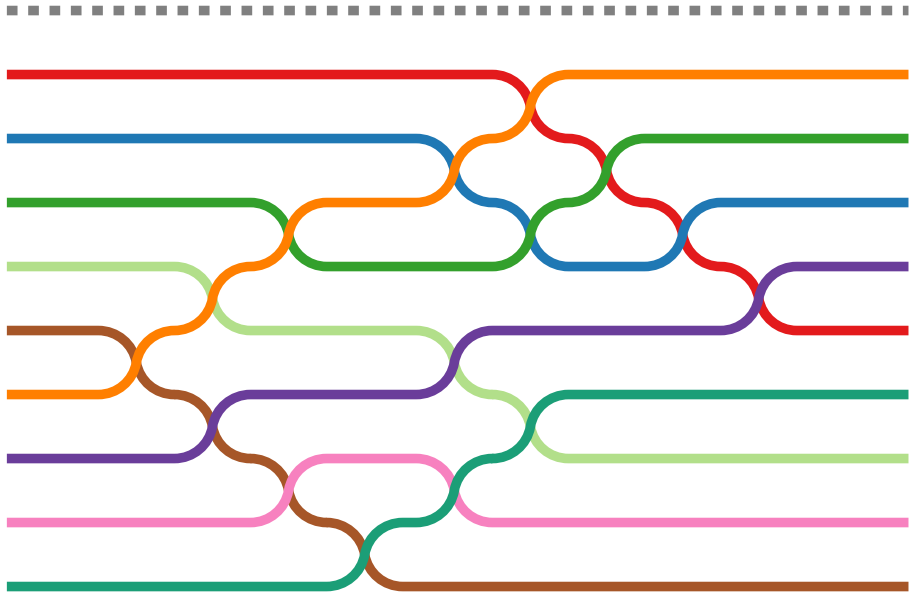
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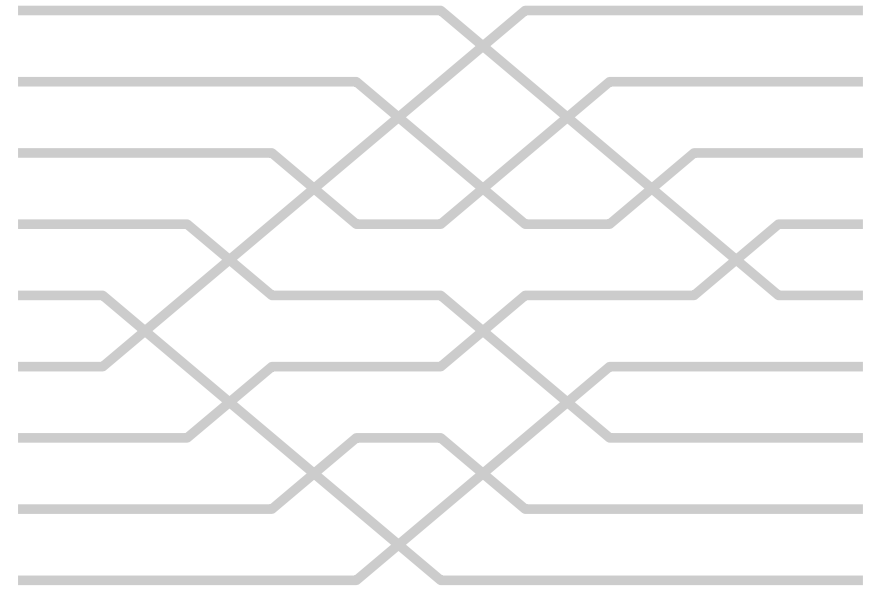
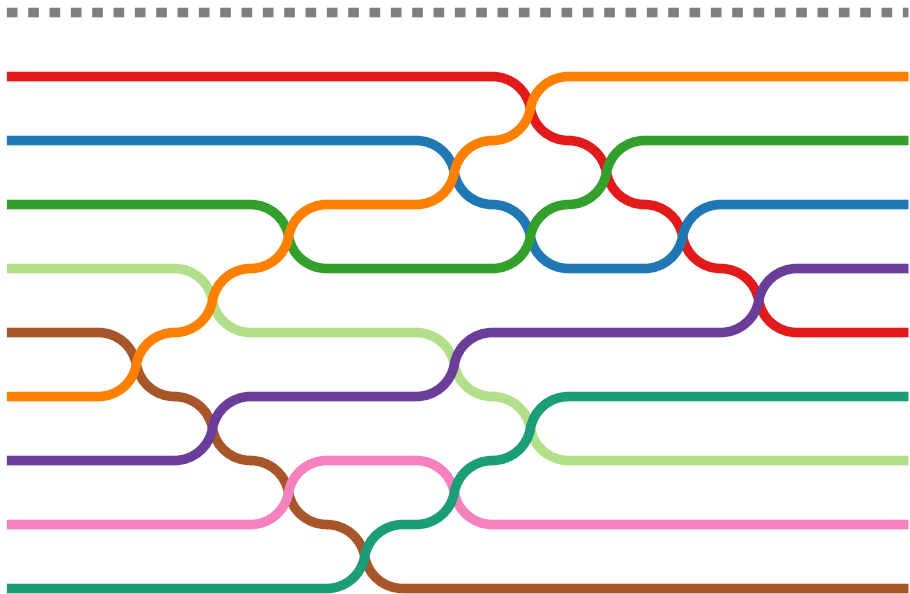


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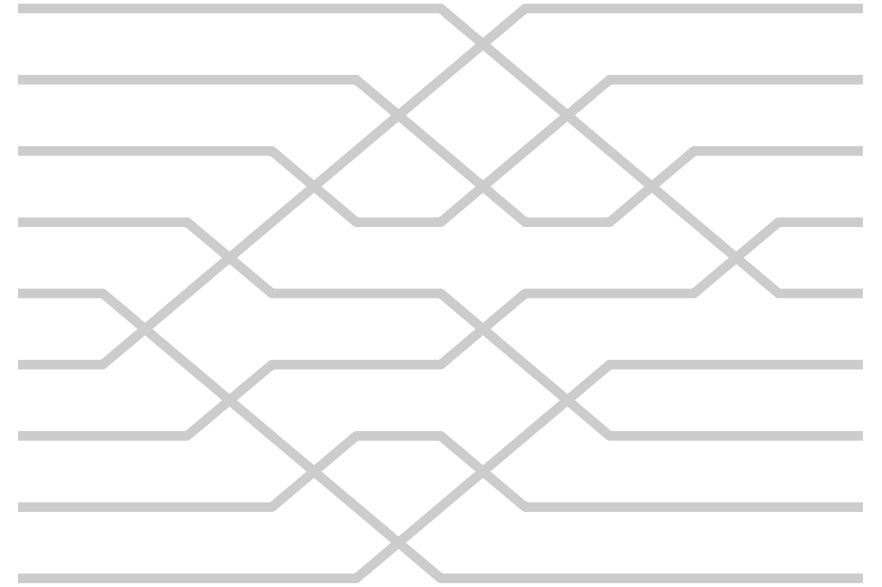
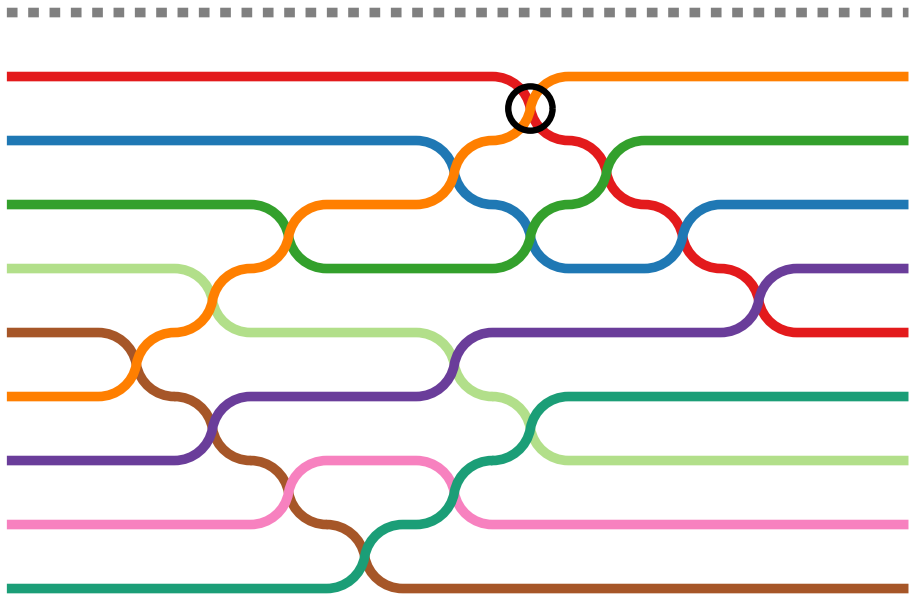
I. The Crossing Complex

1. A quadrilateral *cell* for each crossing.



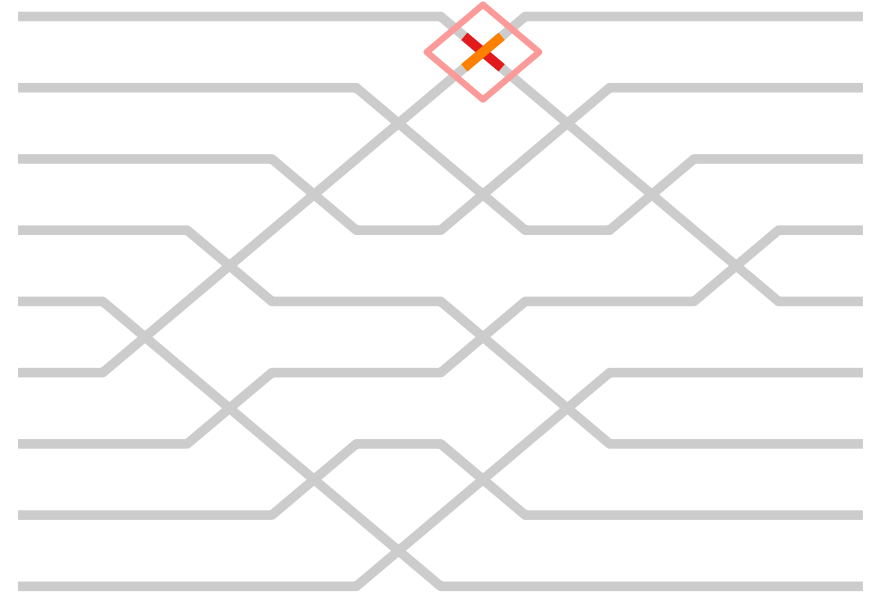
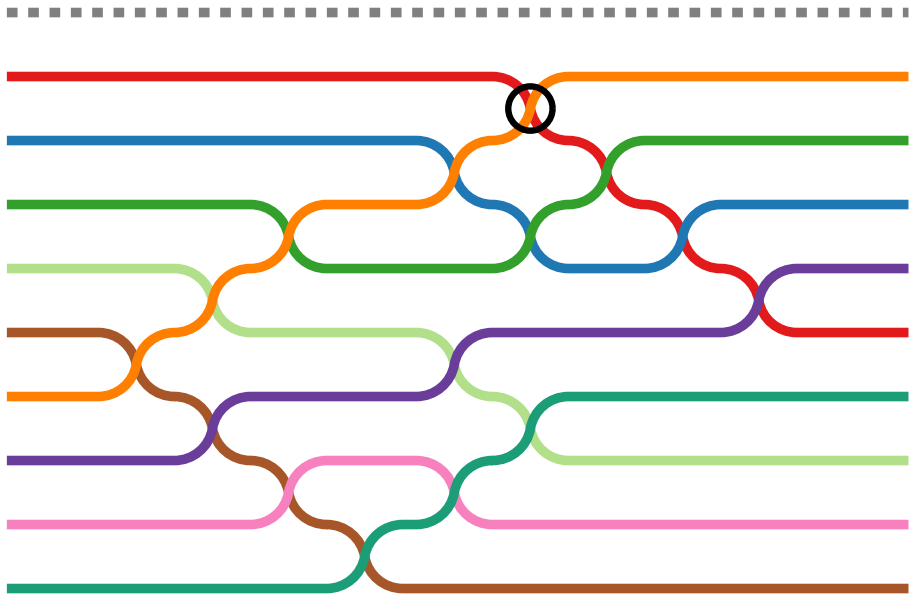
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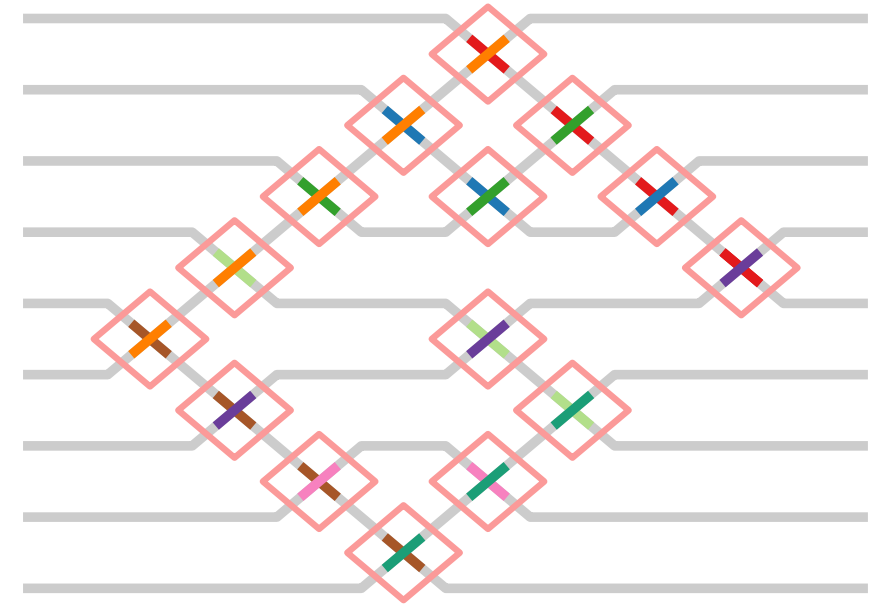
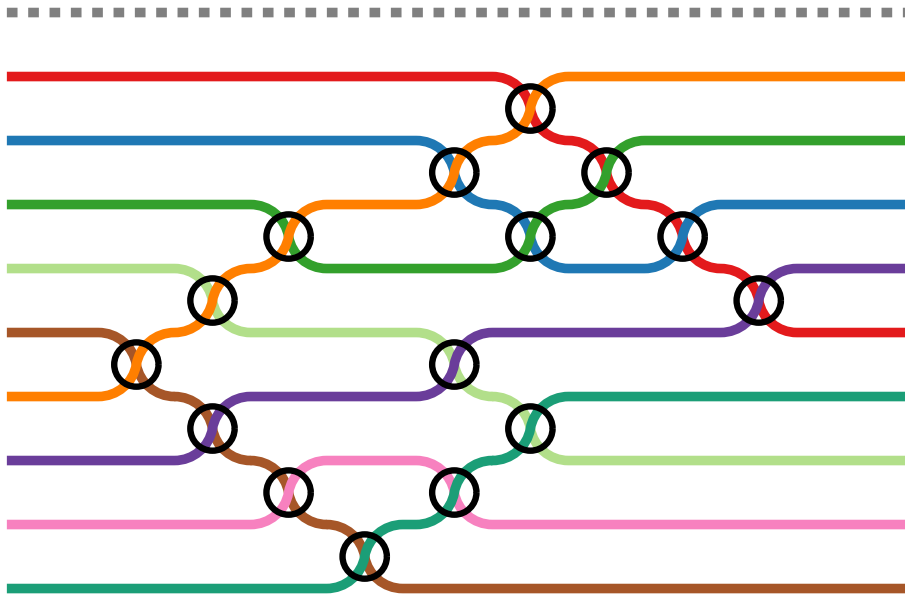
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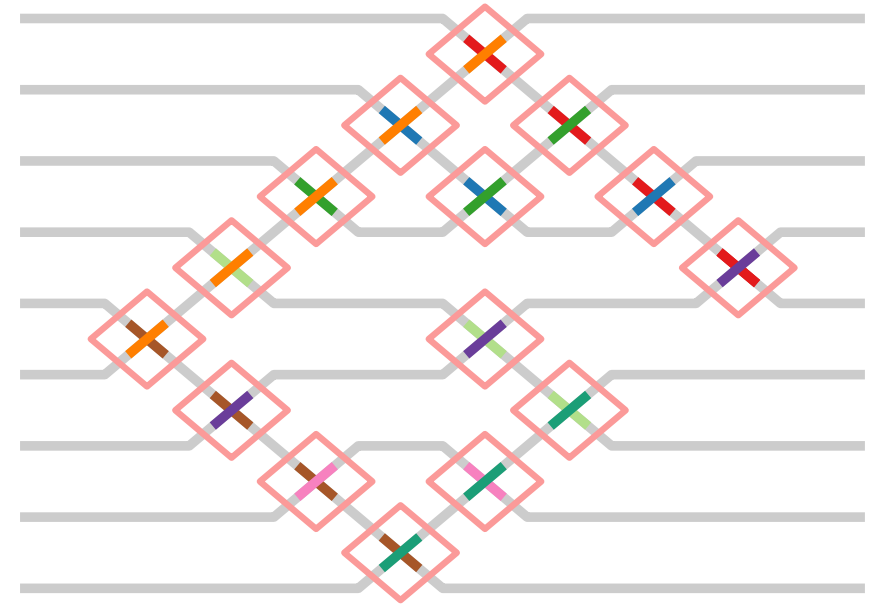
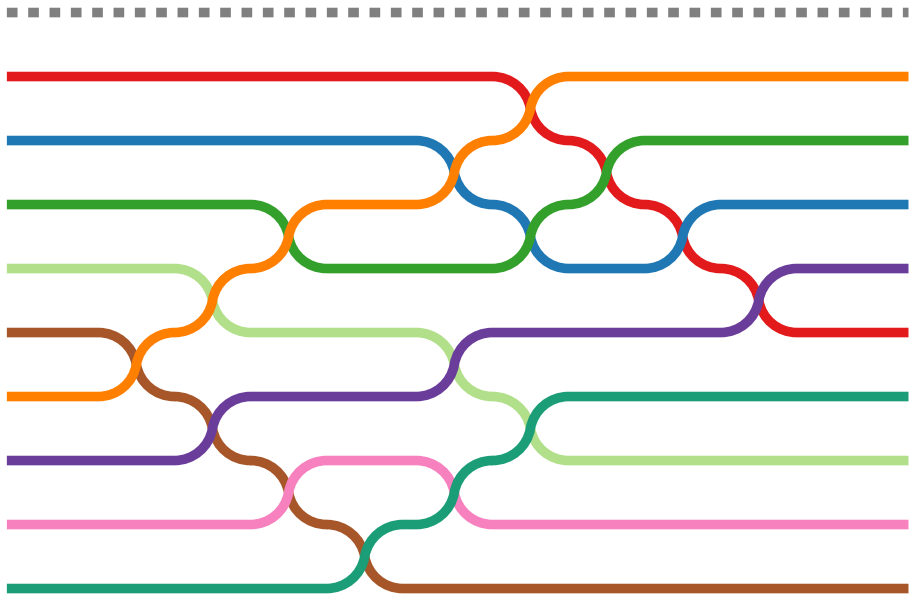
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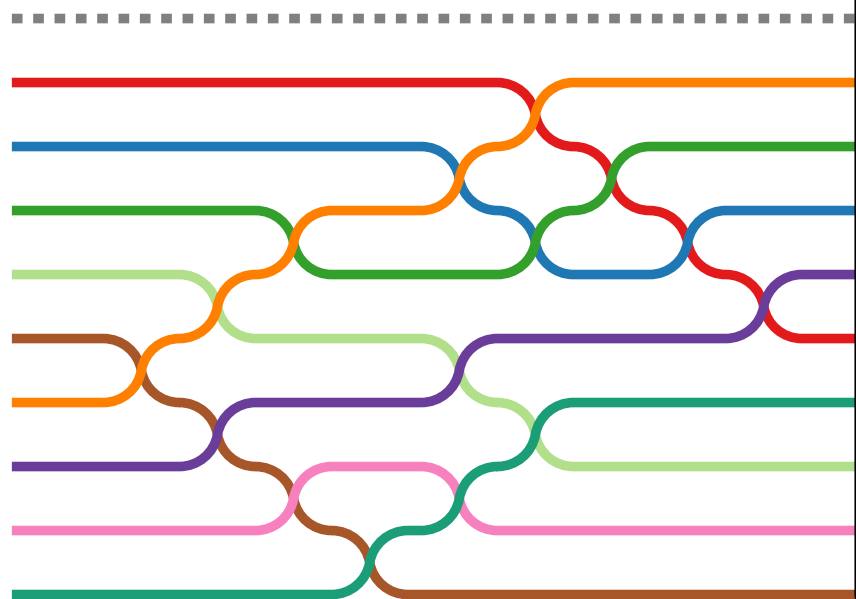
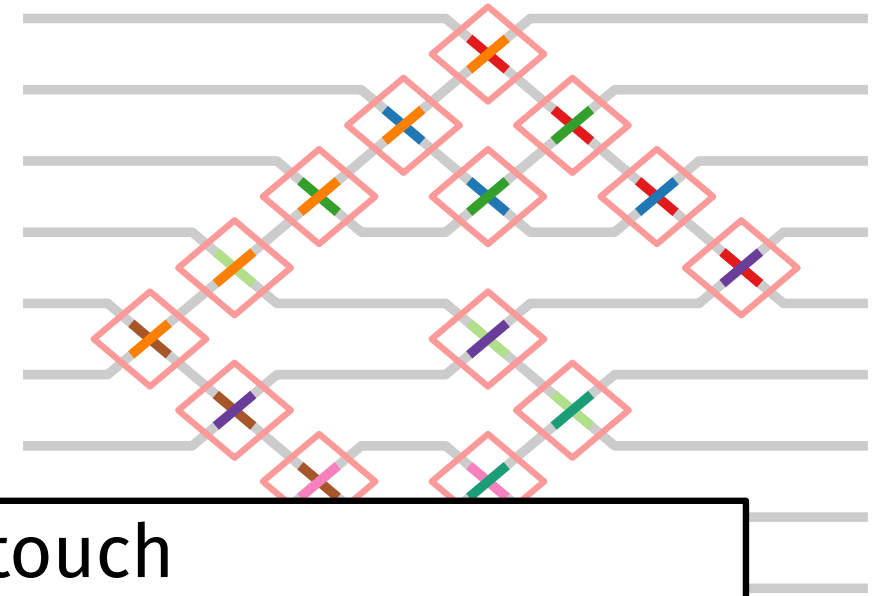
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2. If two crossings *touch*, their cells share that *side*.

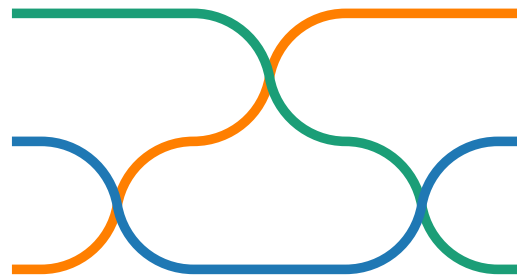


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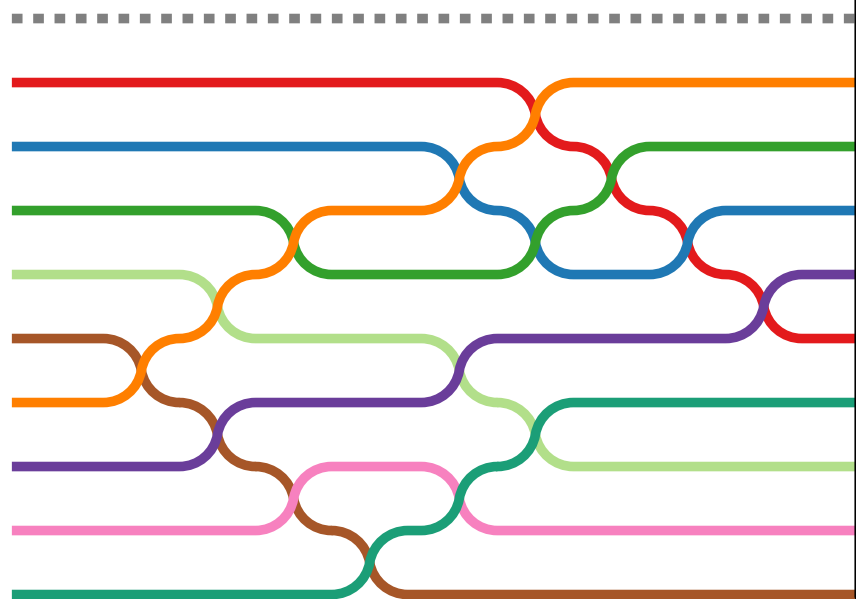
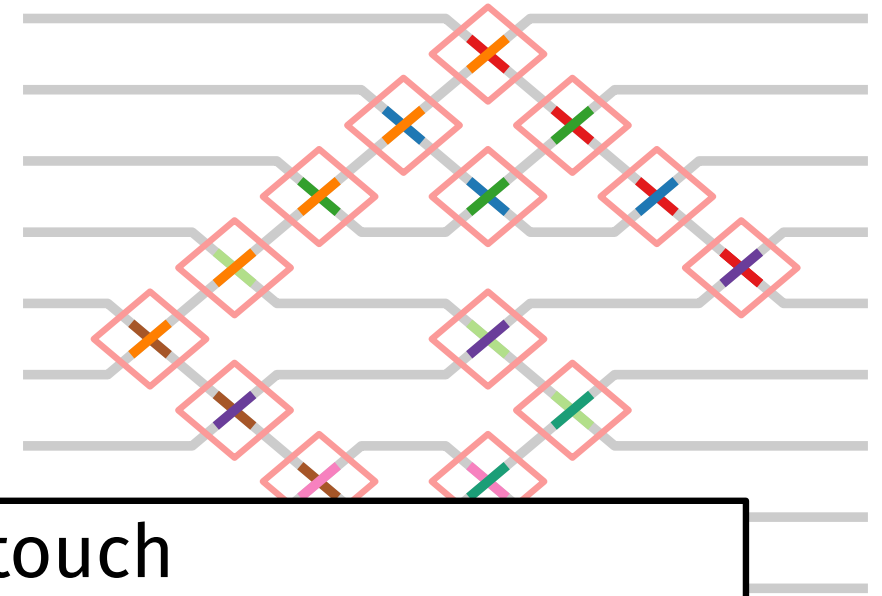


some crossings touch

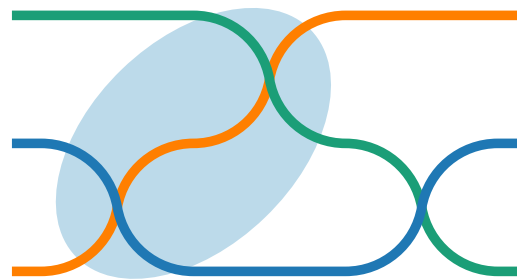


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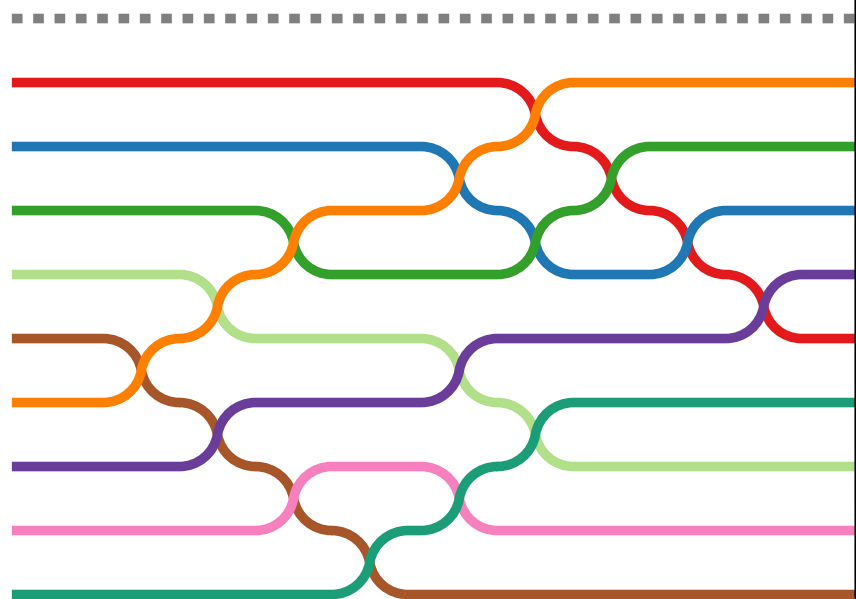
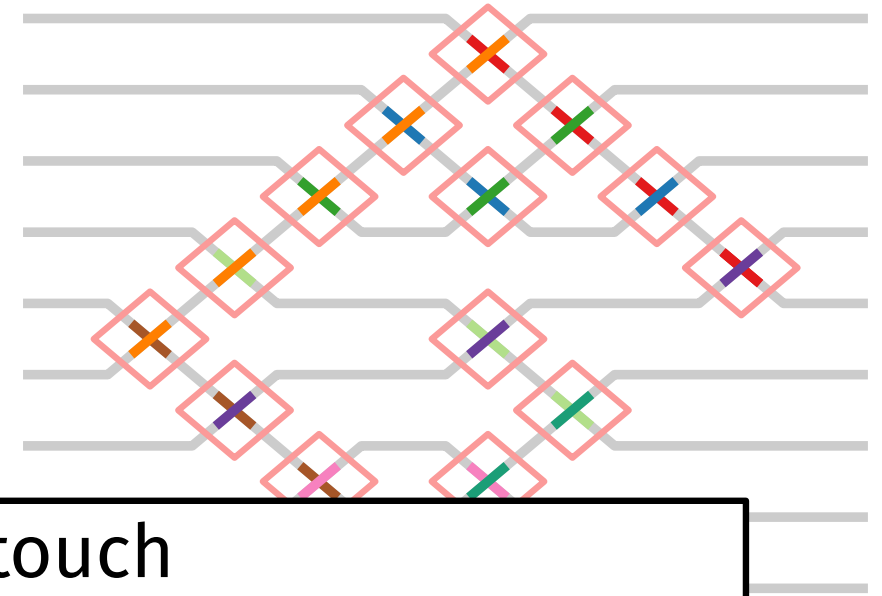


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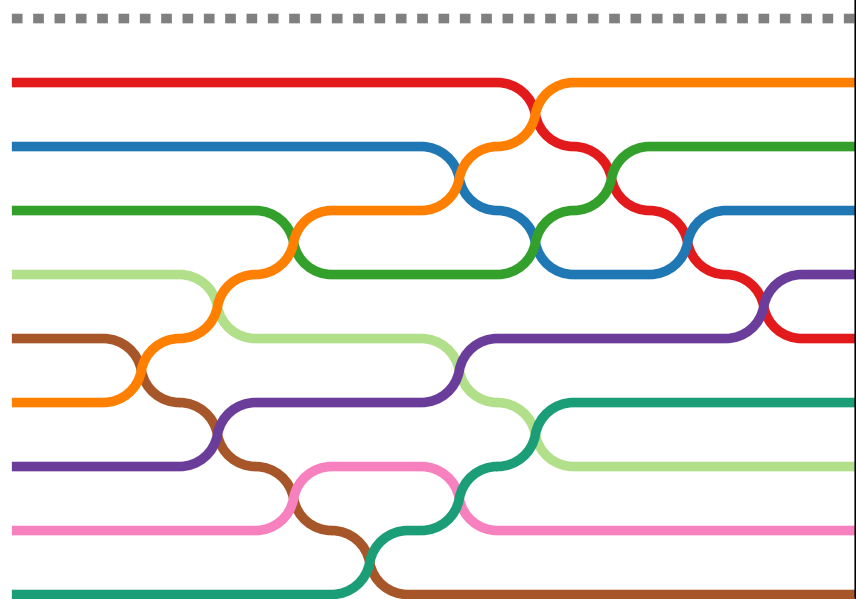
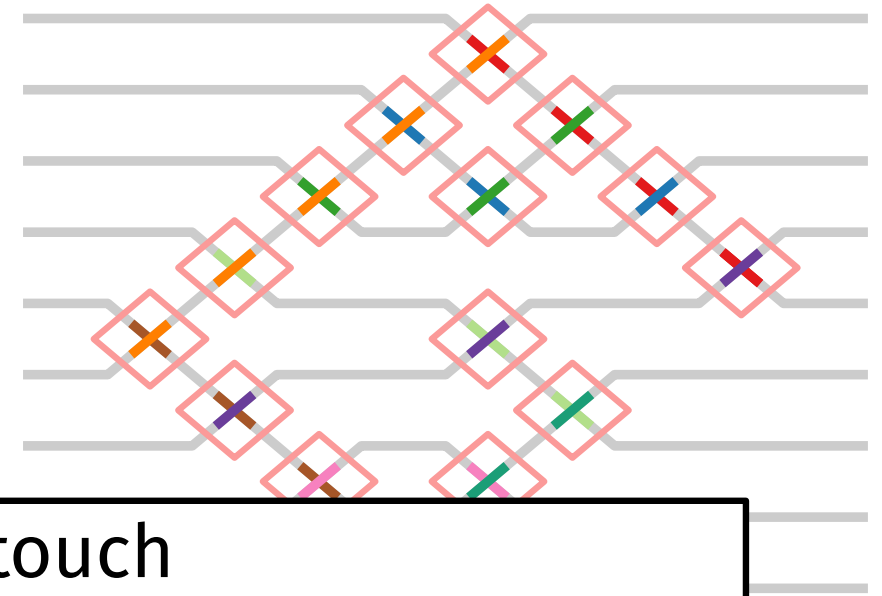


some crossings touch

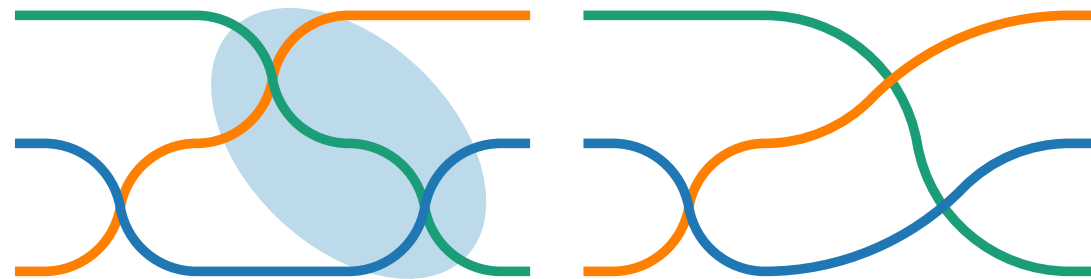


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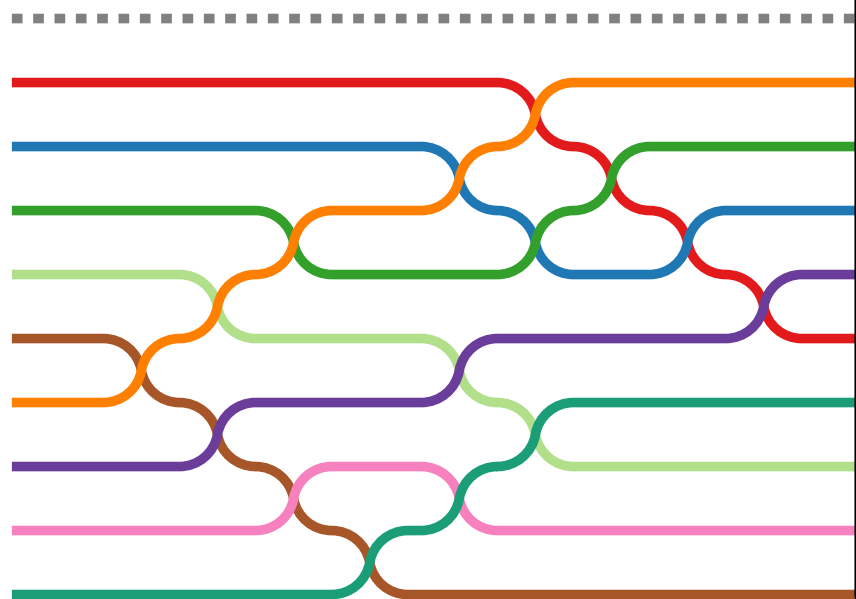
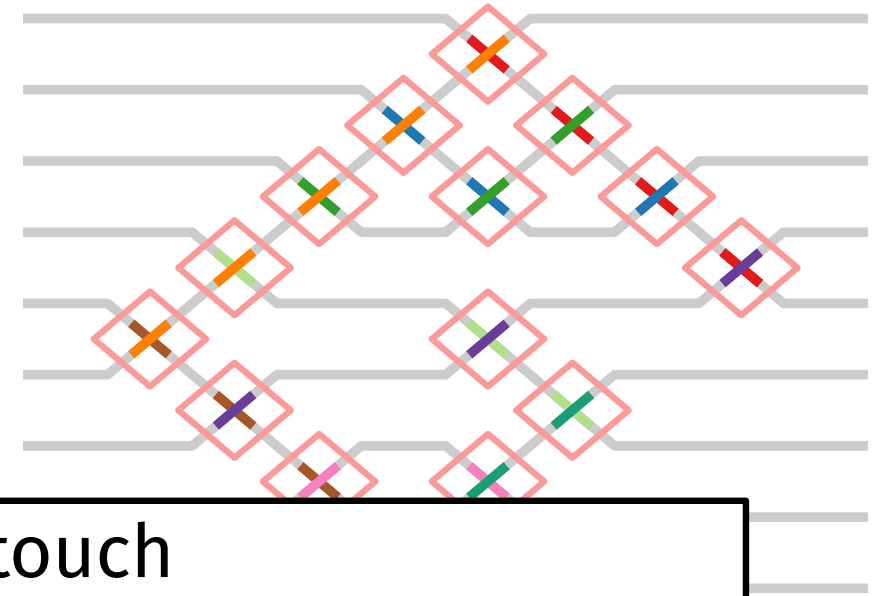


some crossings touch

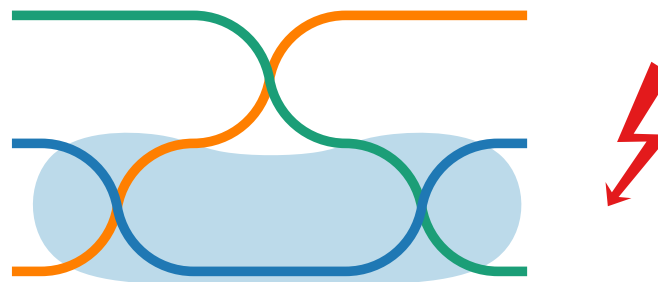


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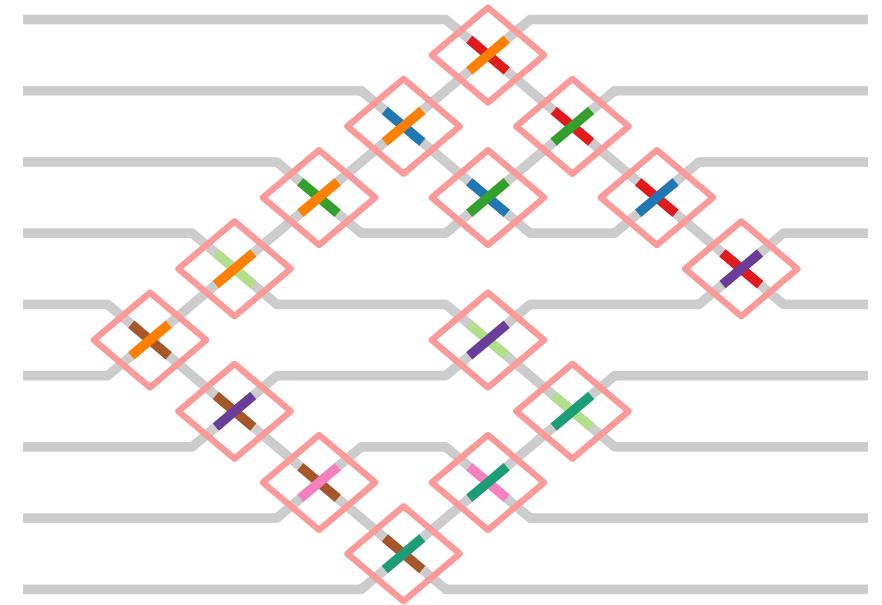
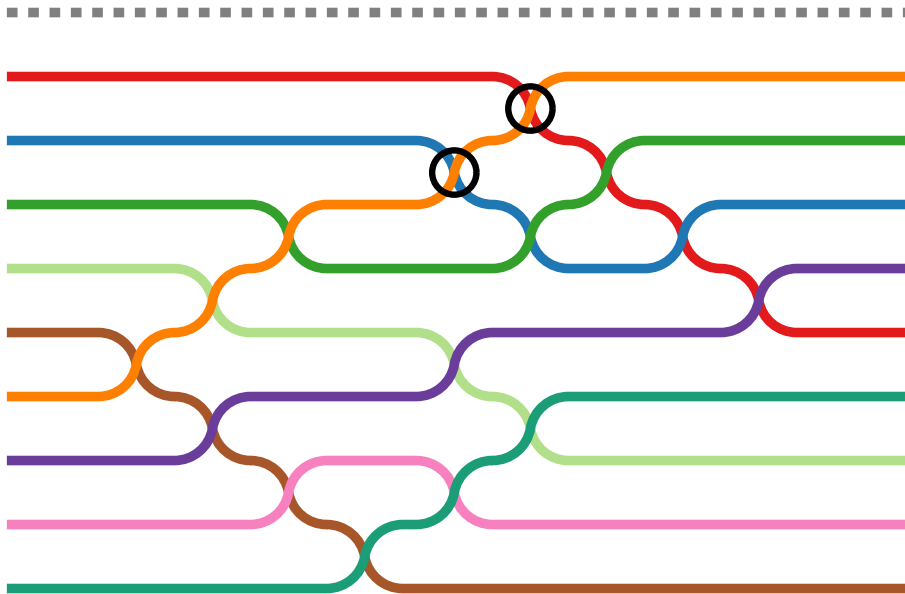


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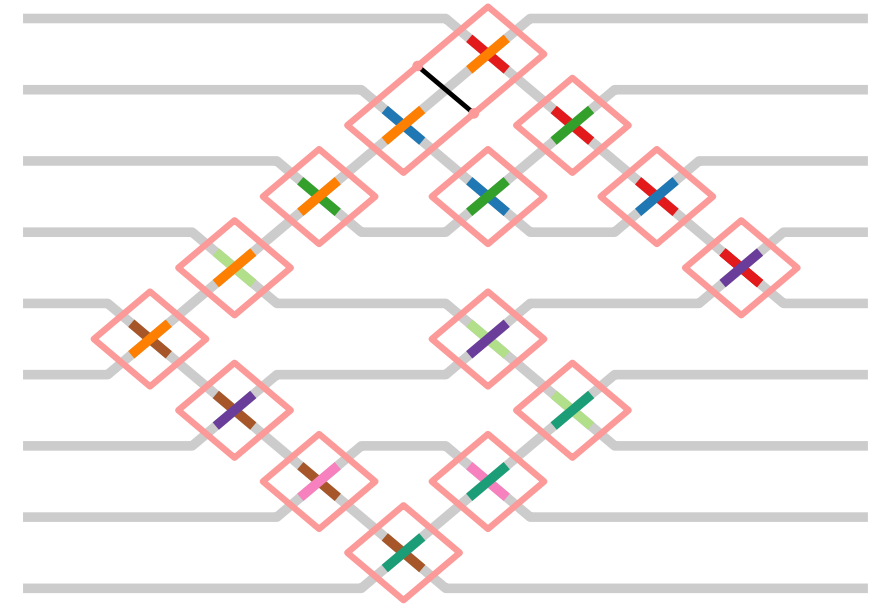
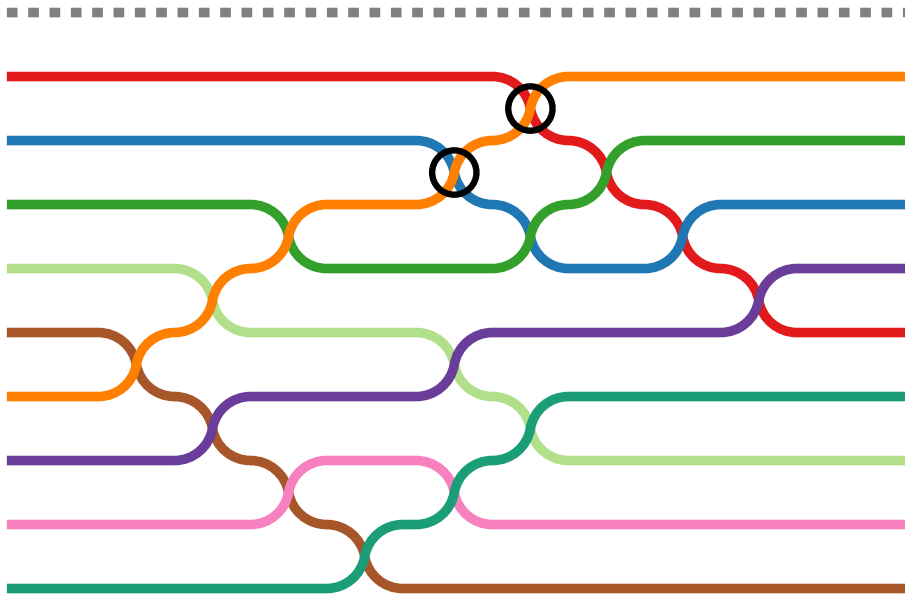
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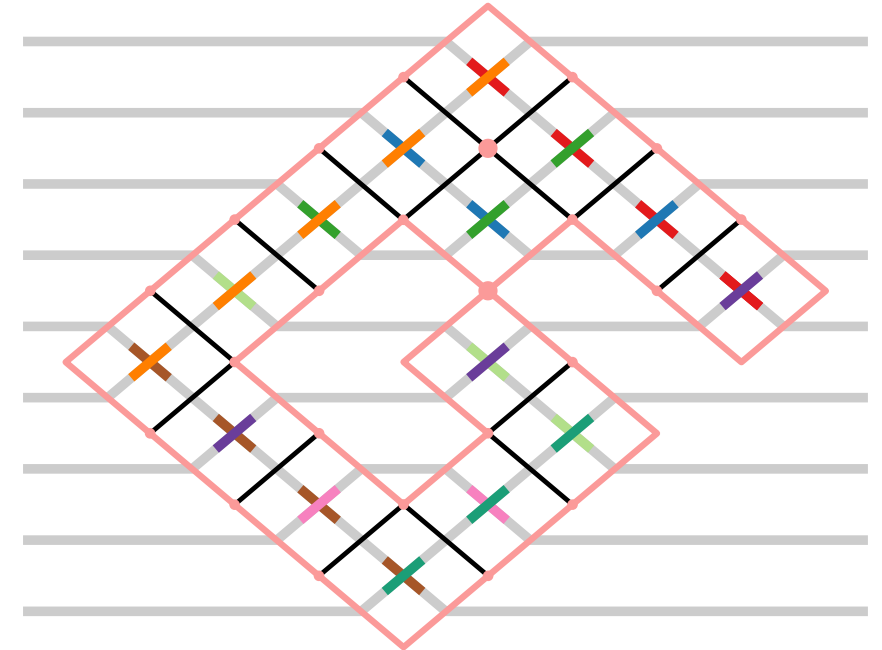
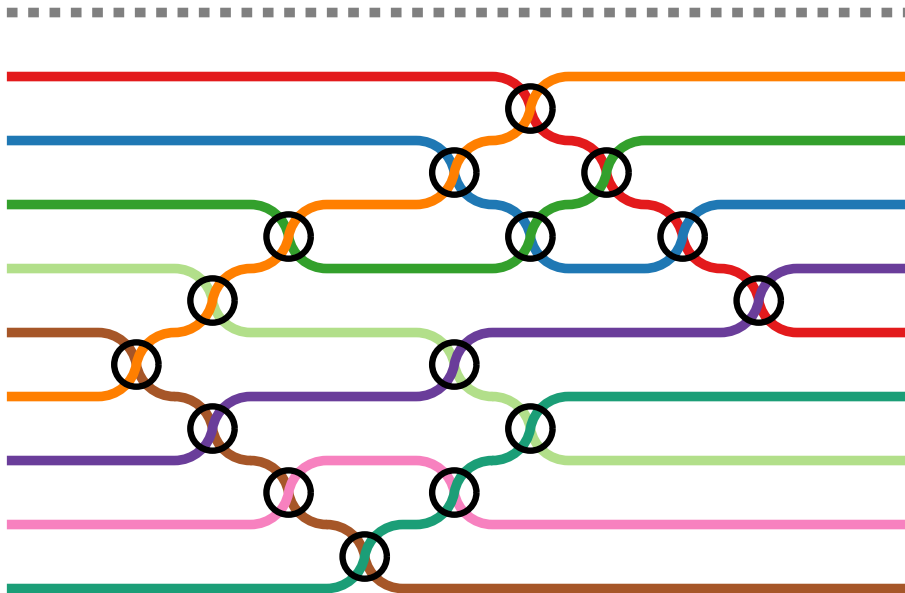
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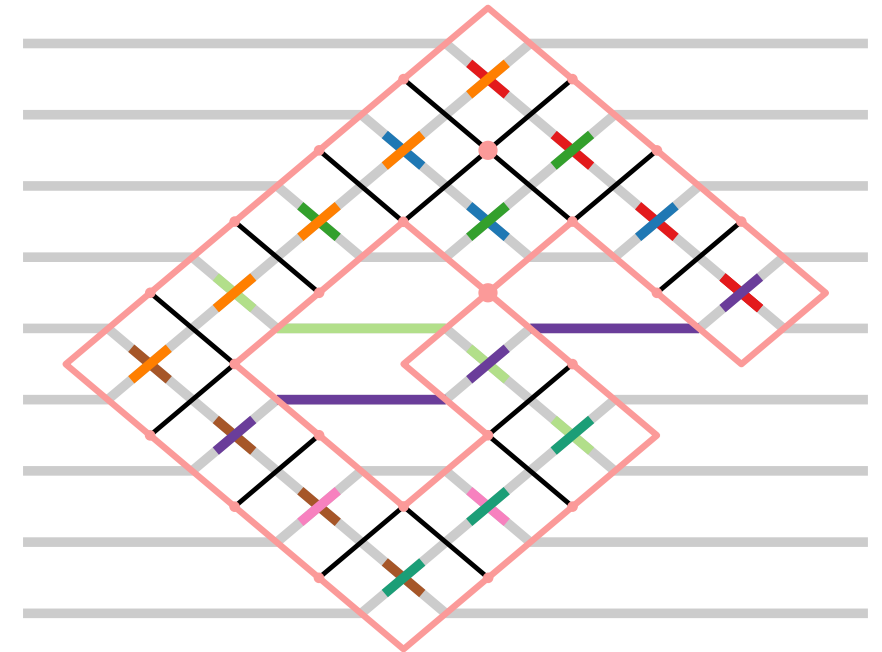
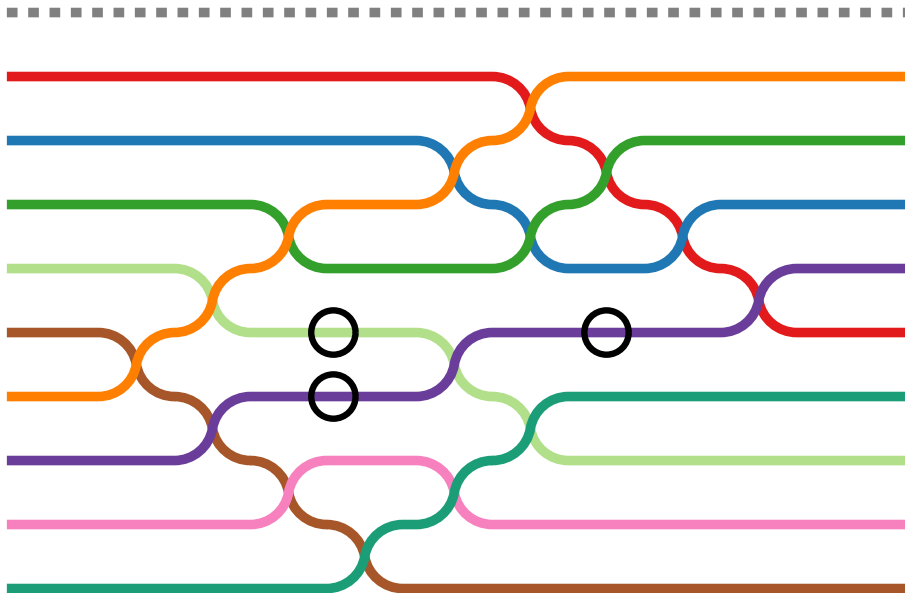
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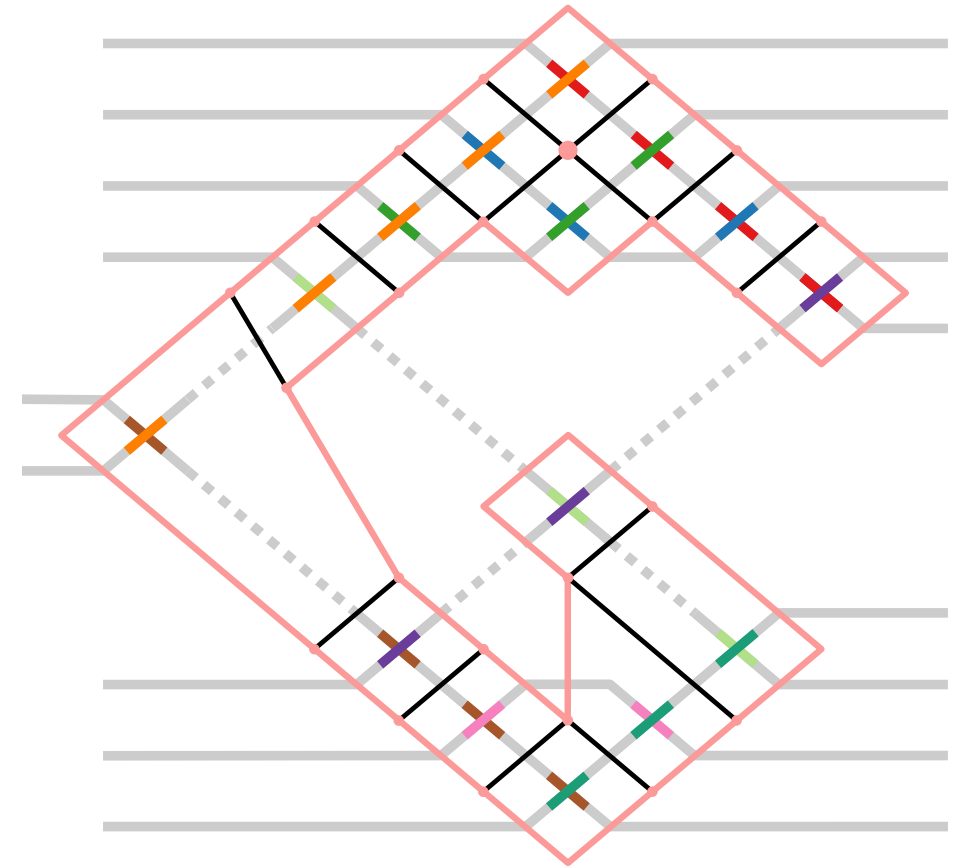
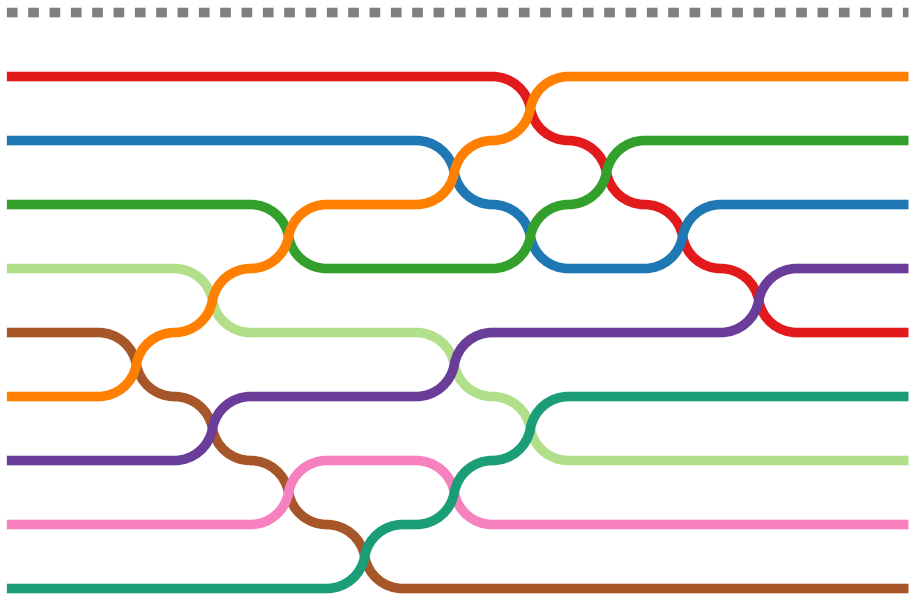
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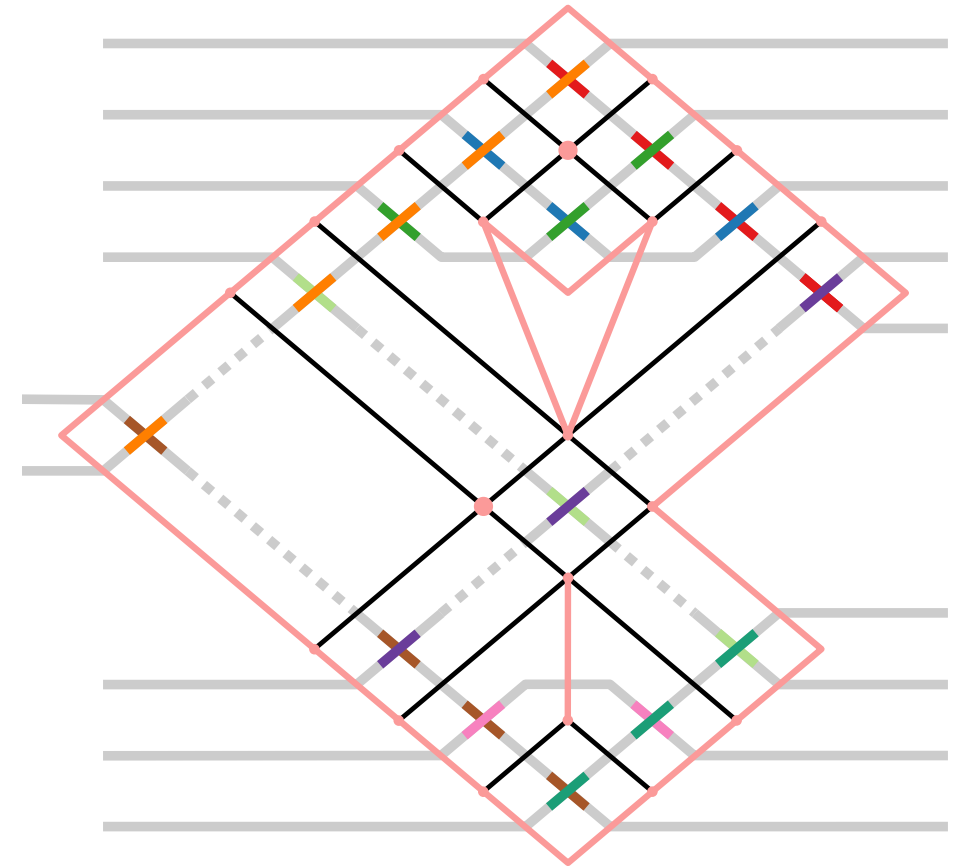
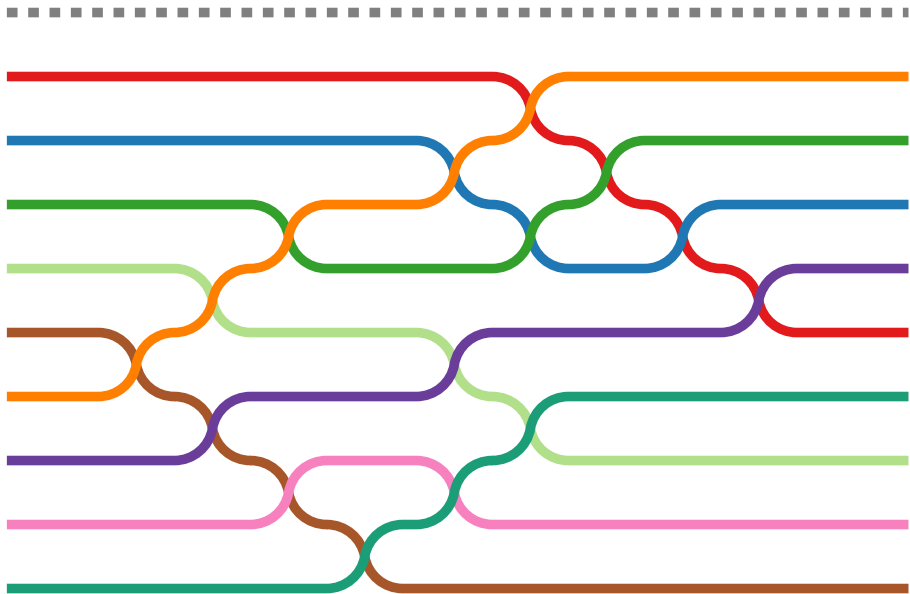
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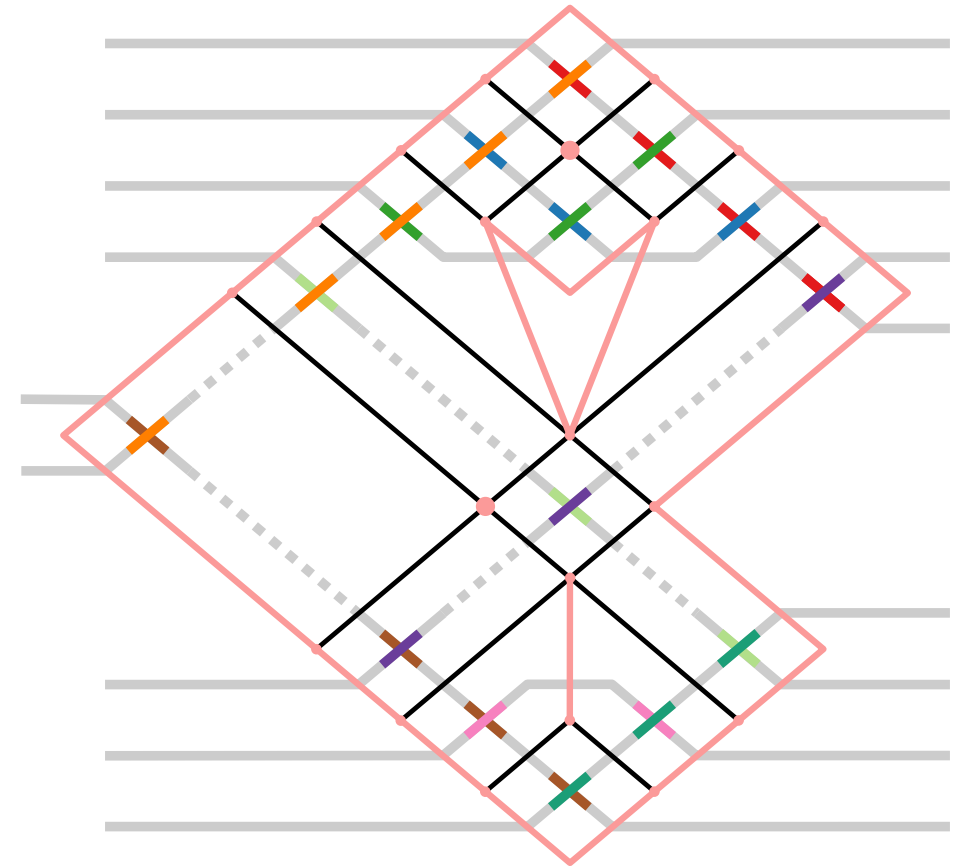
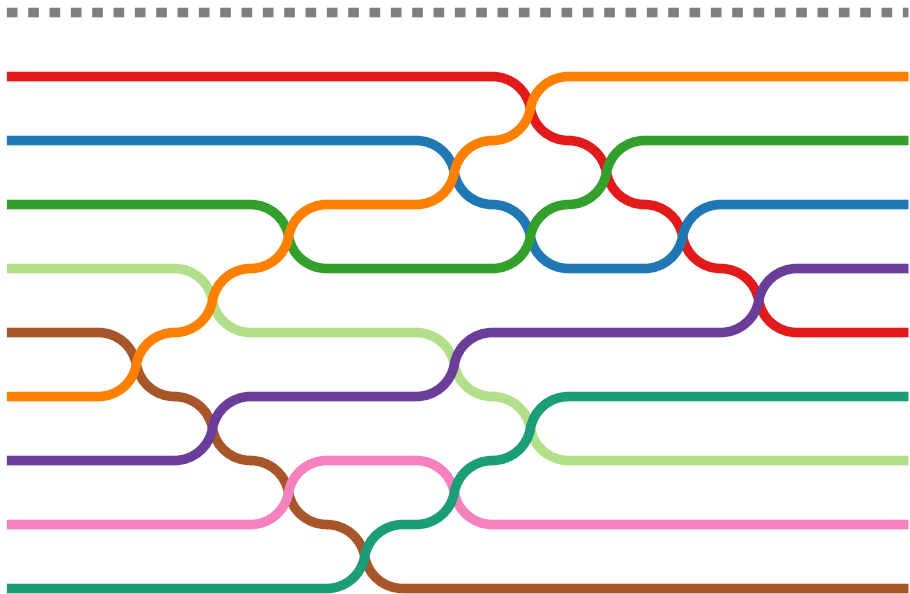
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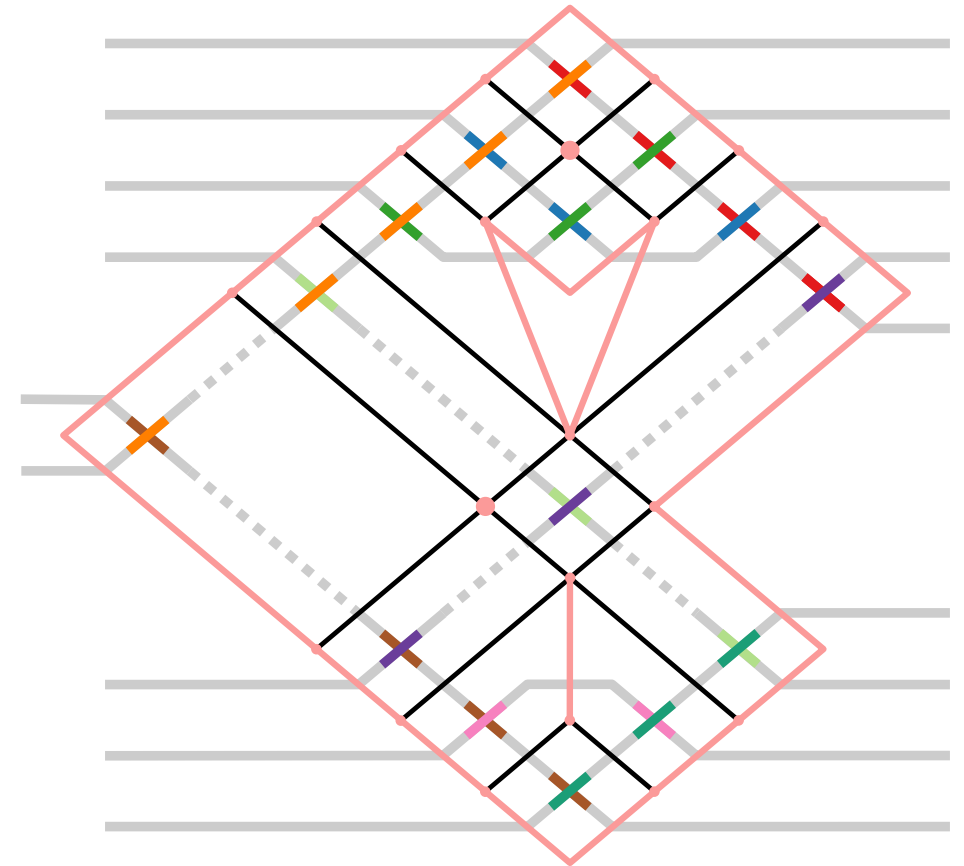
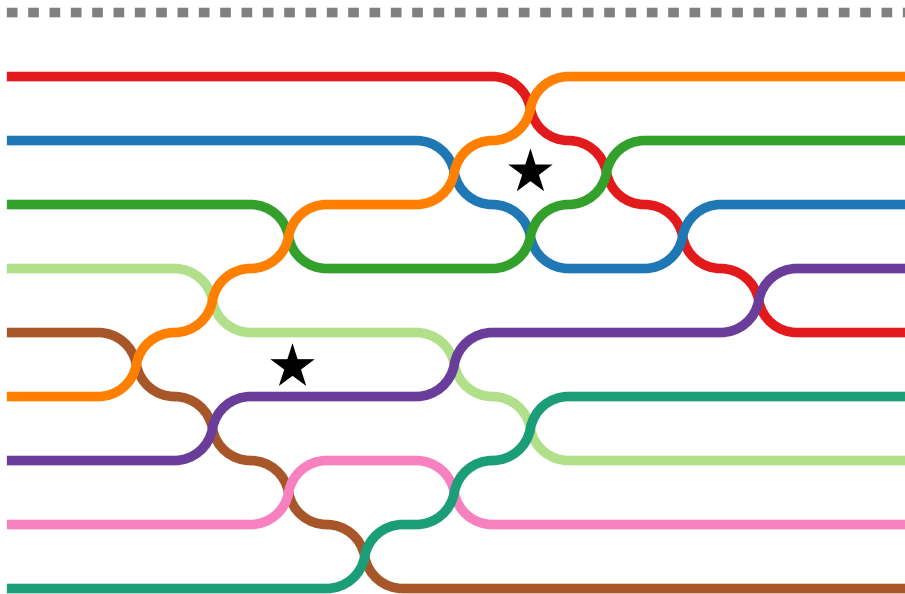
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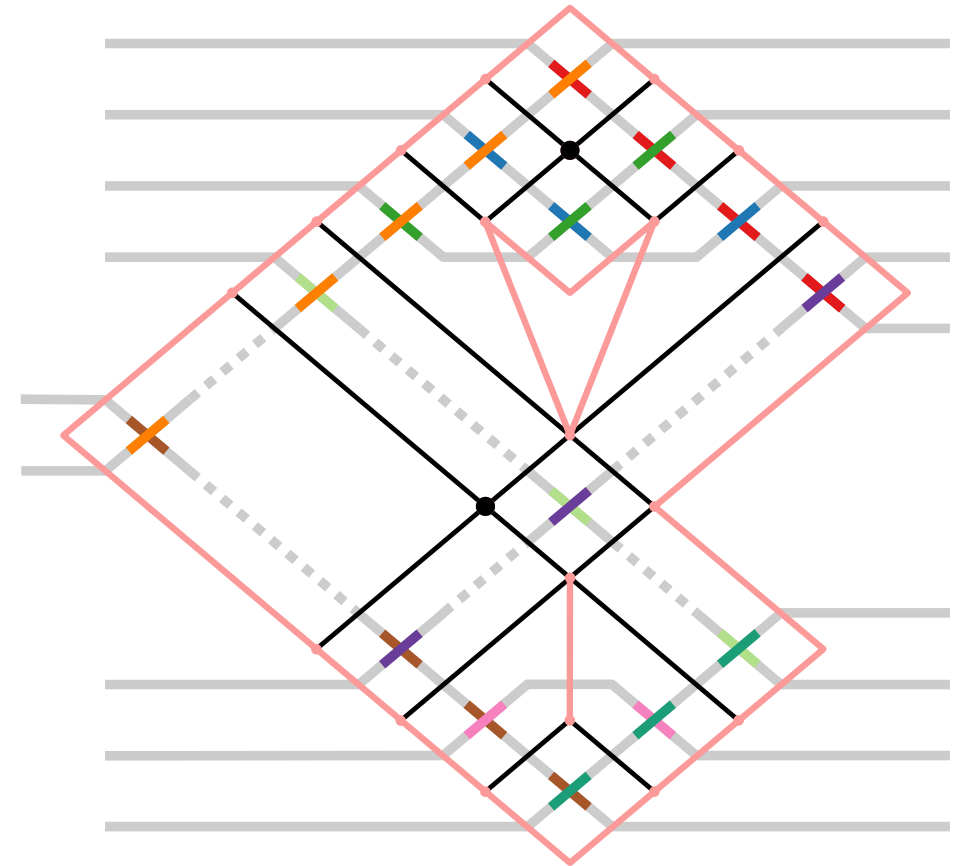
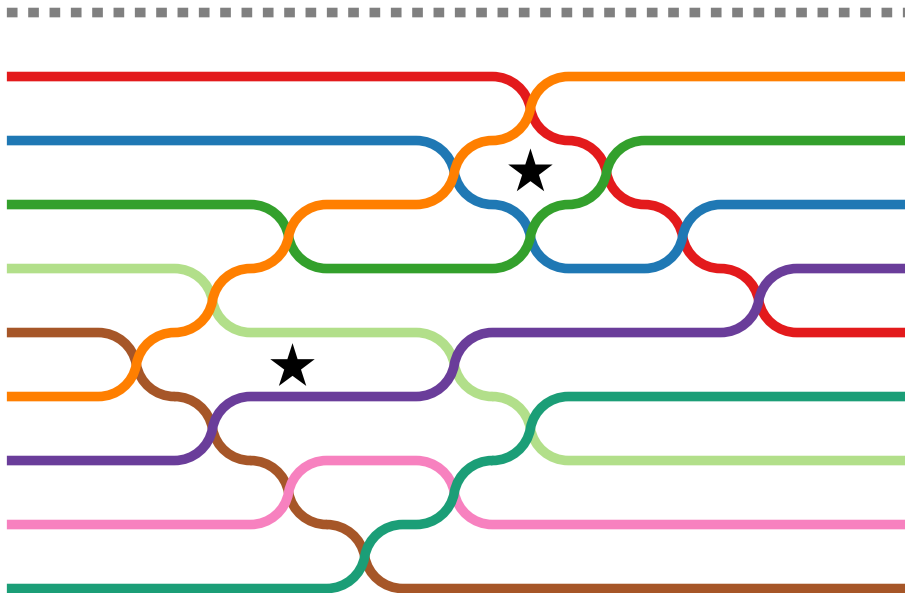
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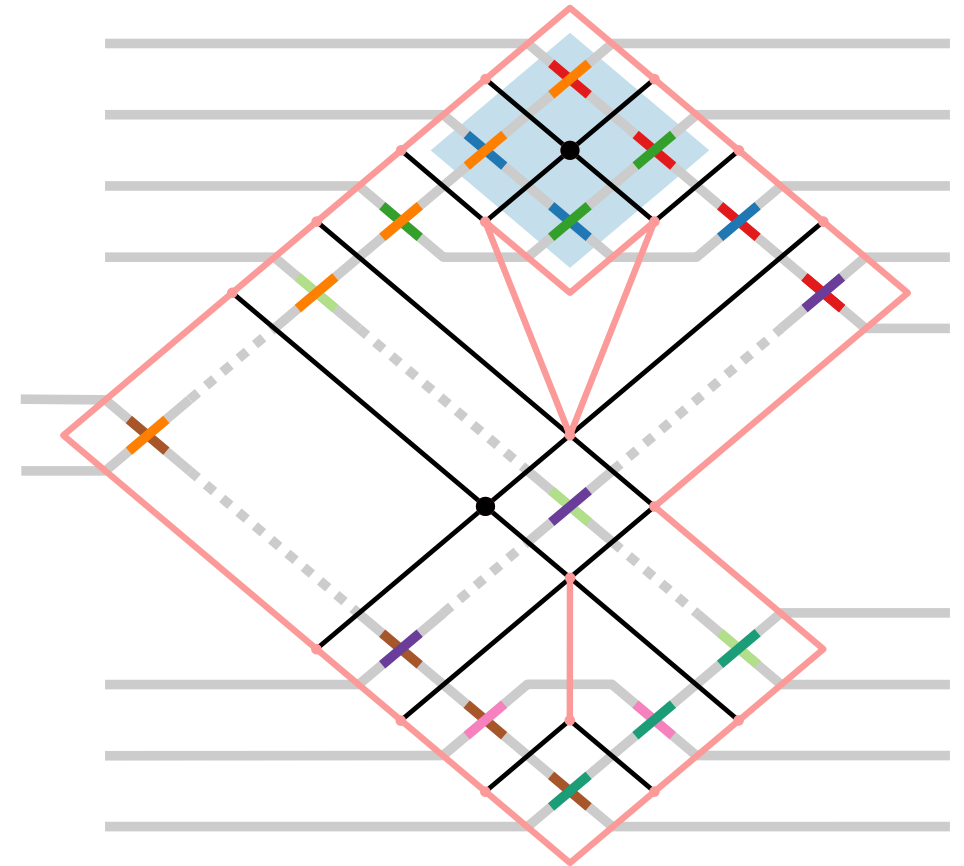
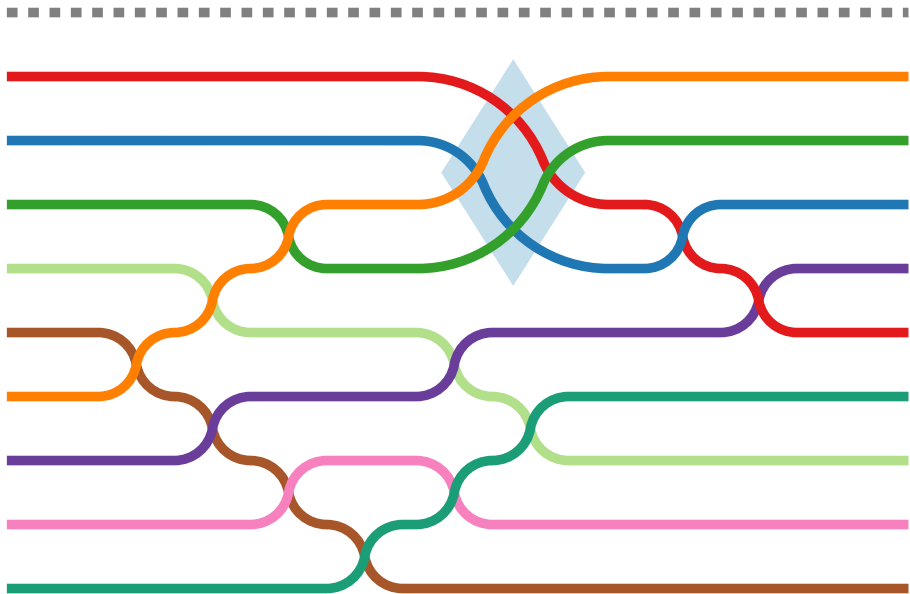
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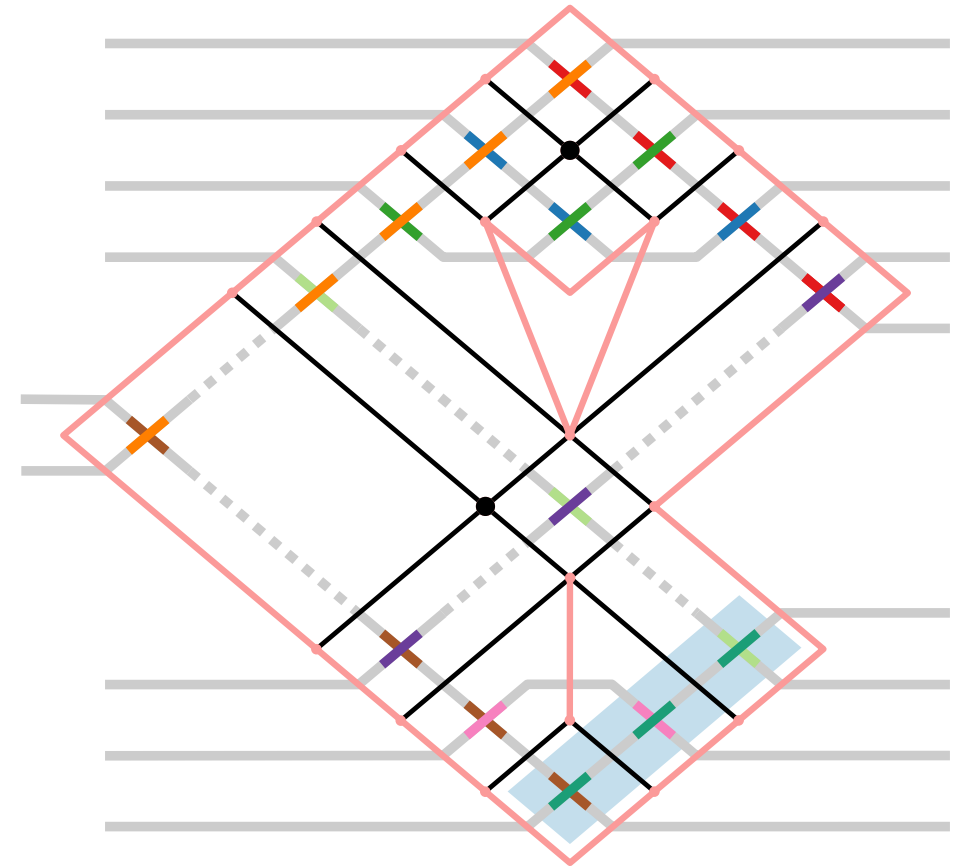
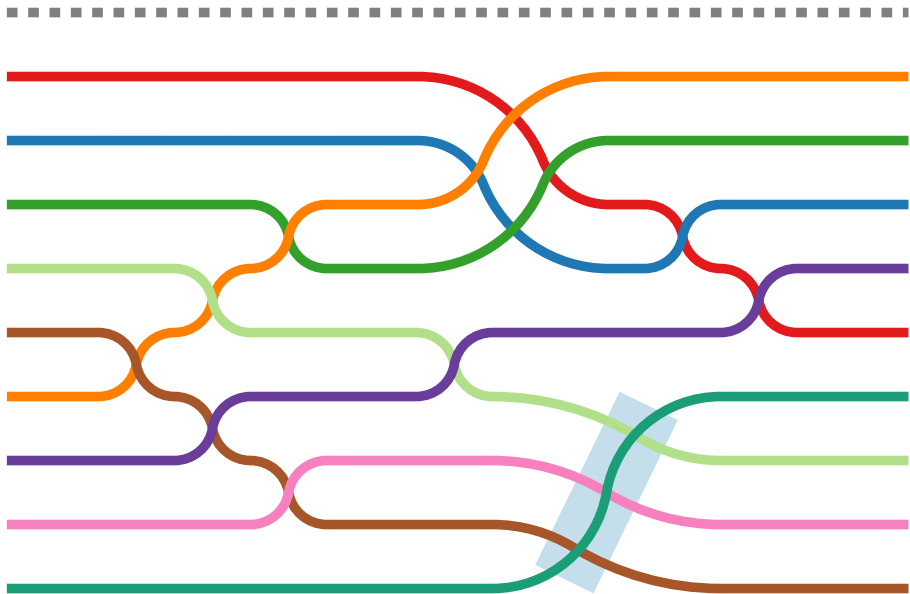
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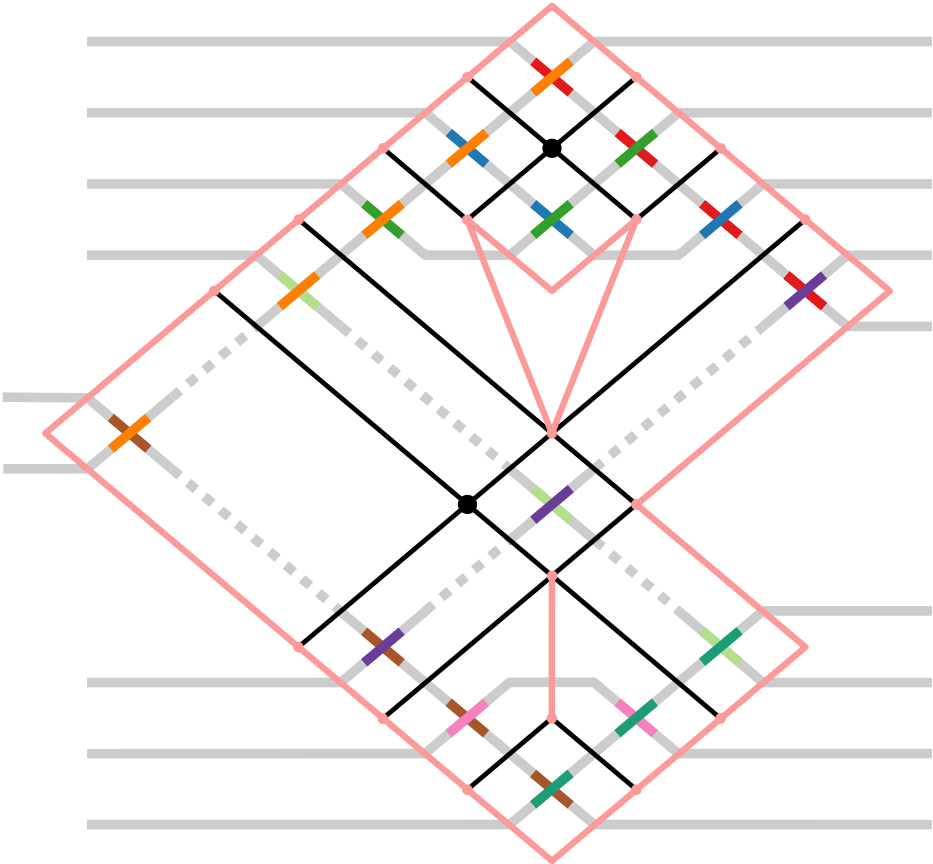
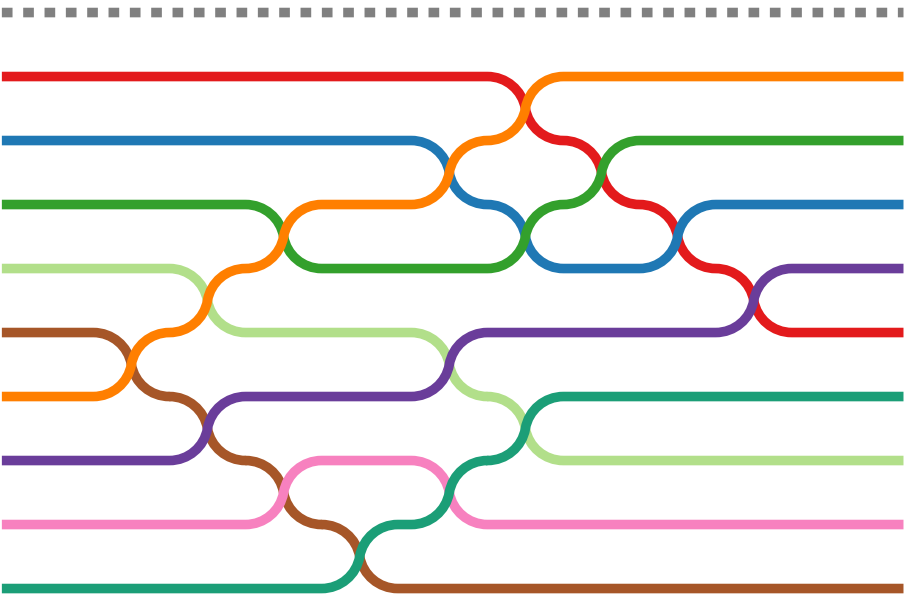


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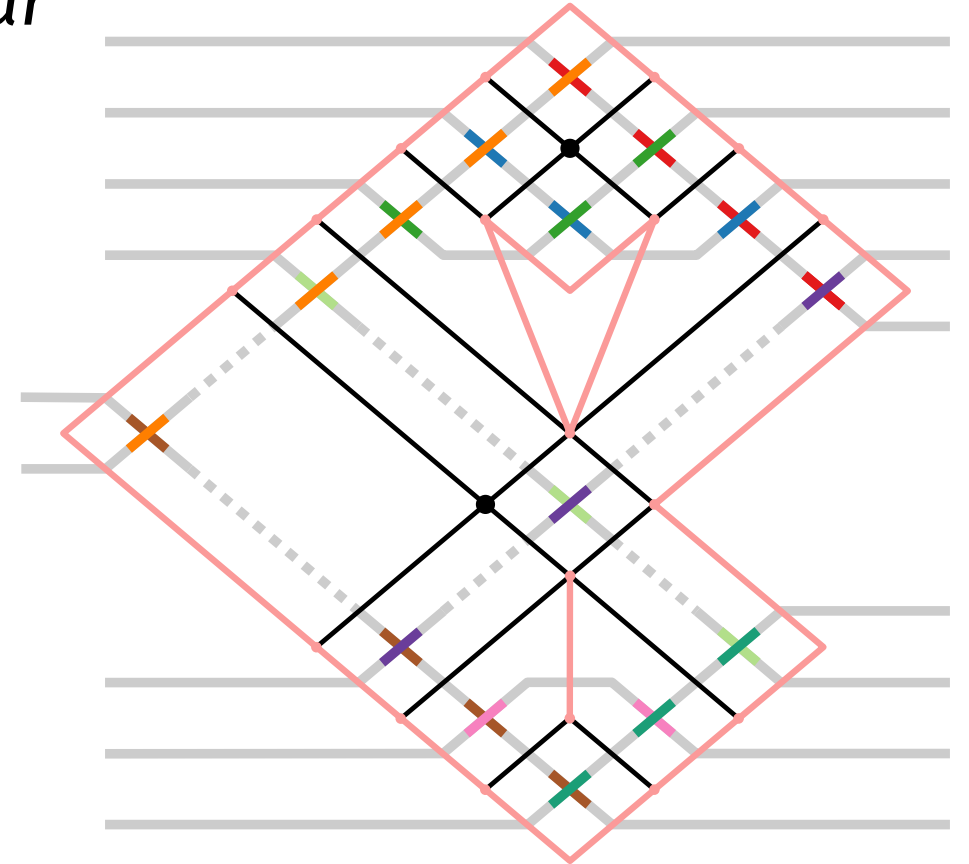
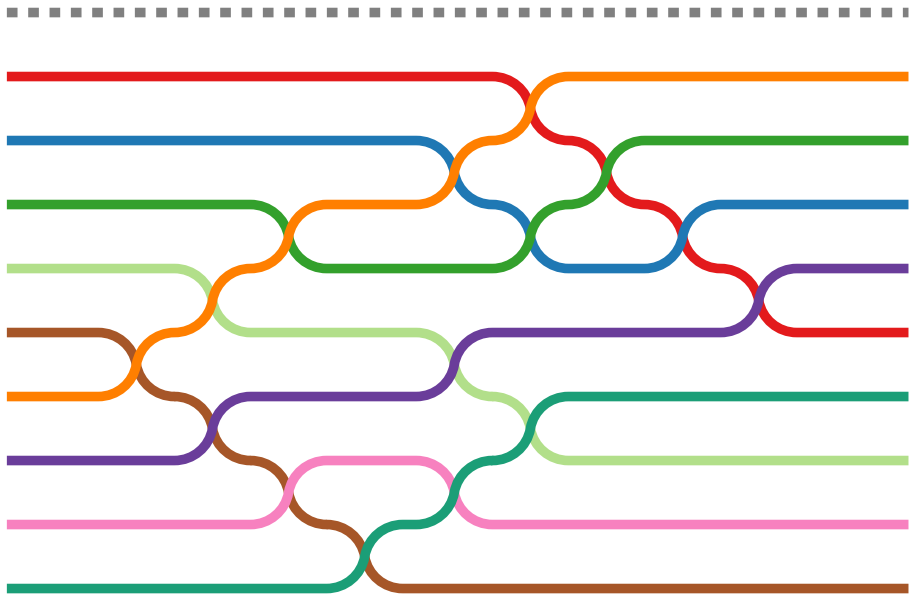
II. Rectangle Dissection



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Given a rectilinear polygon with rectilinear holes, its interior can be efficiently dissected into the minimum number of nonoverlapping rectangles.

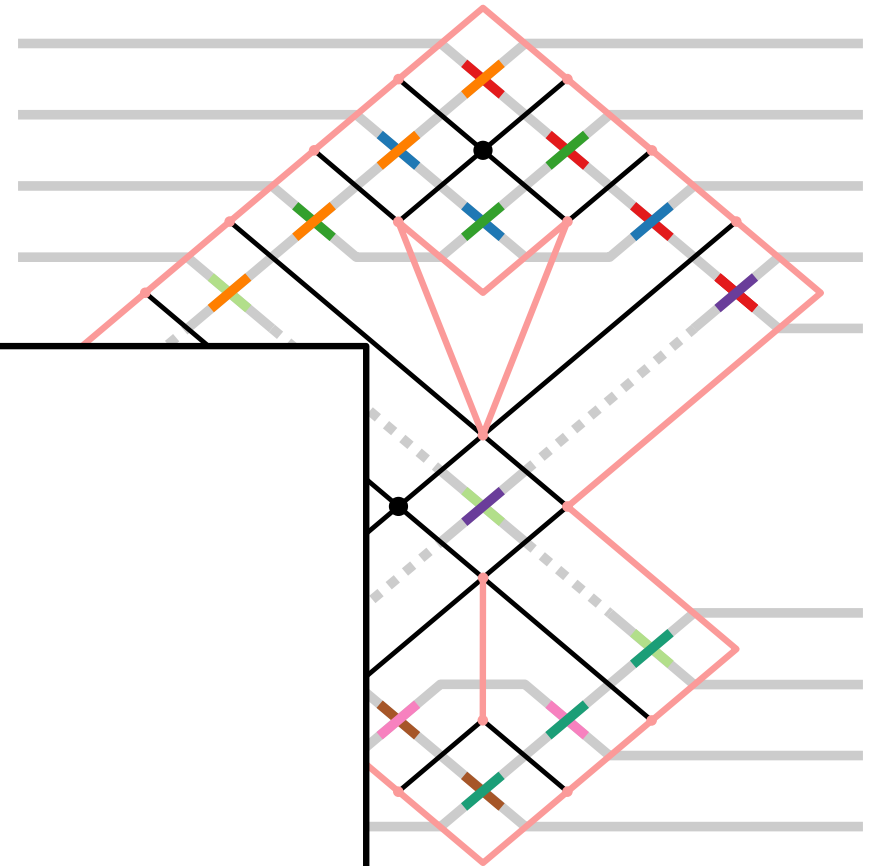
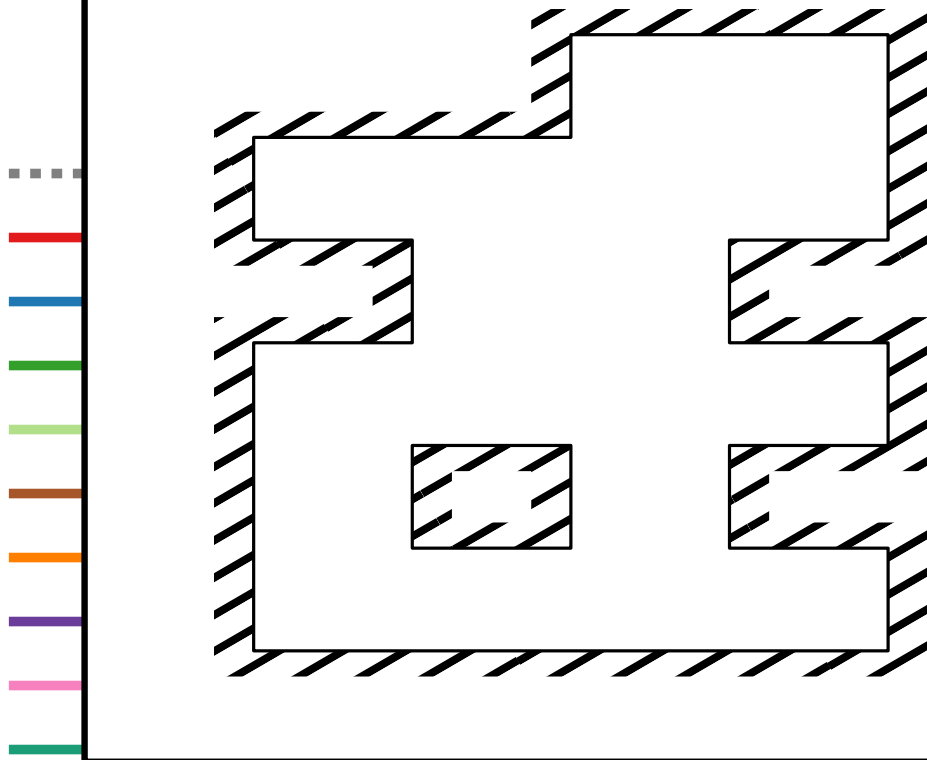
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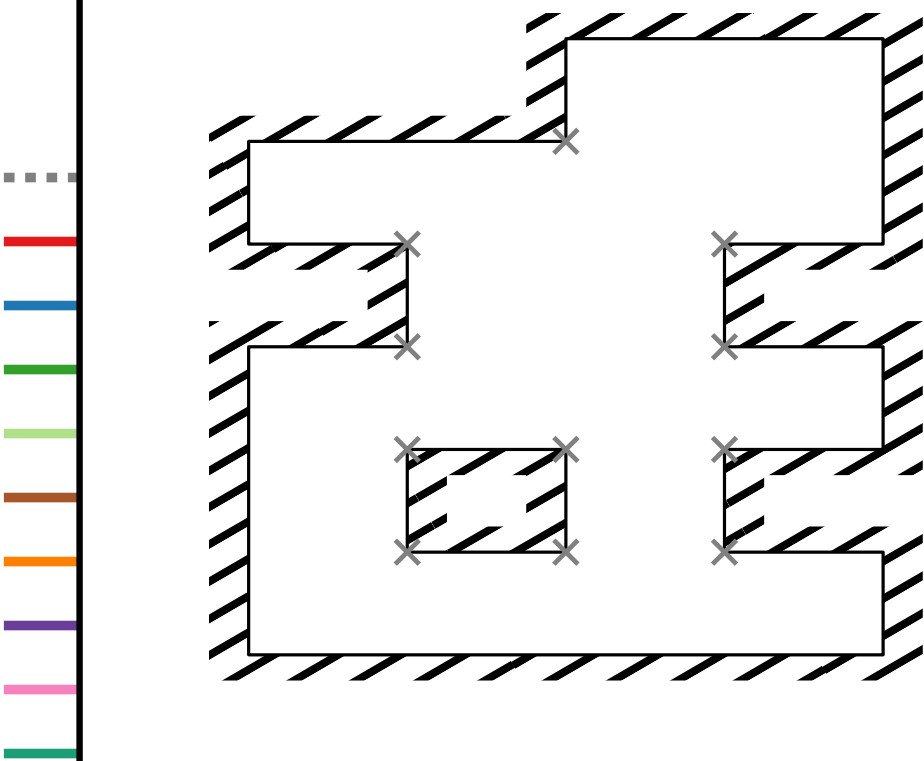
[Sol



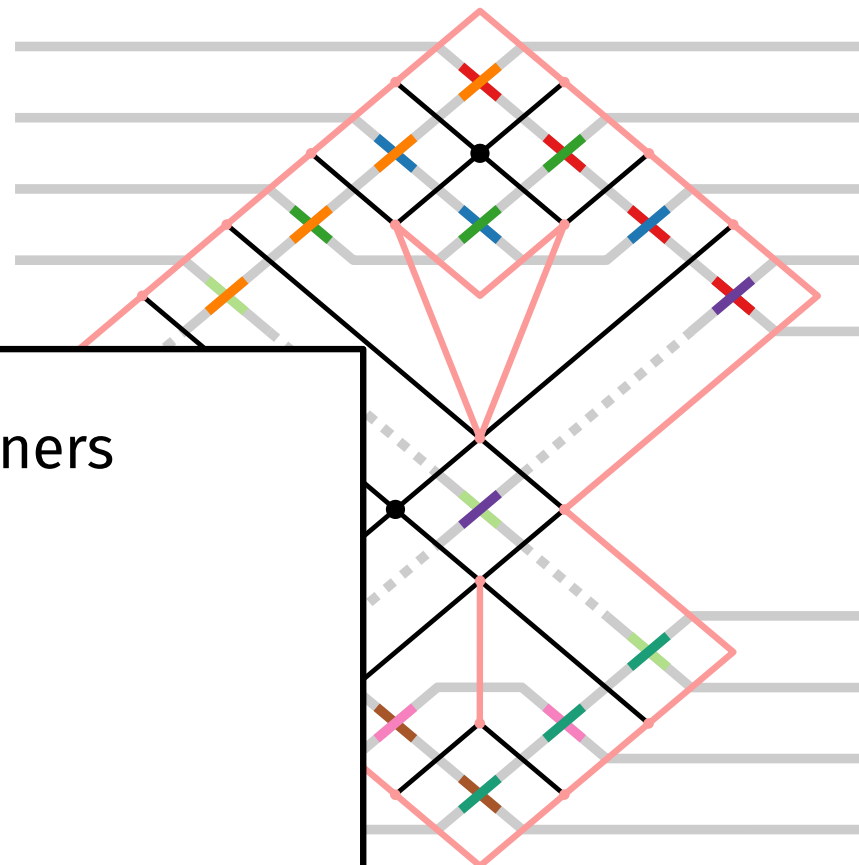
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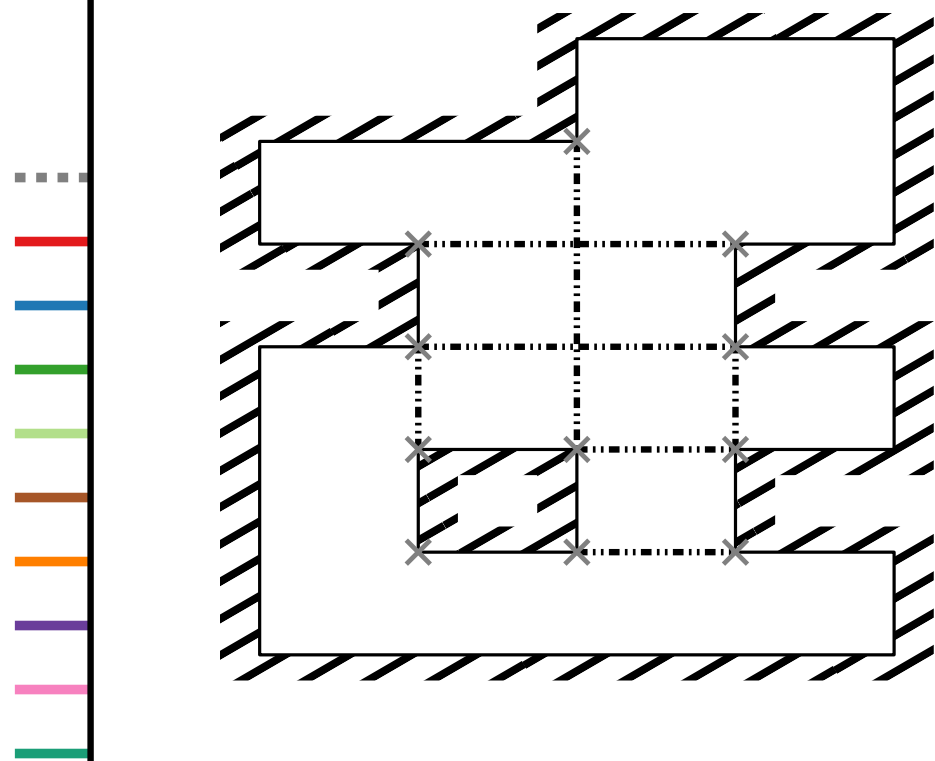
x concave corners



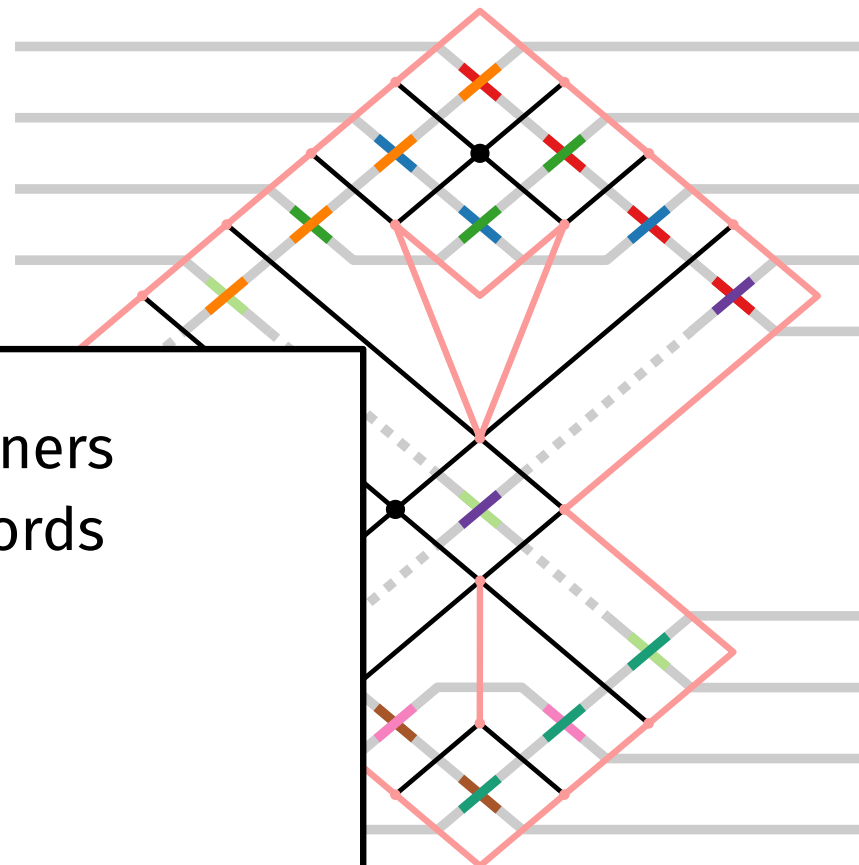
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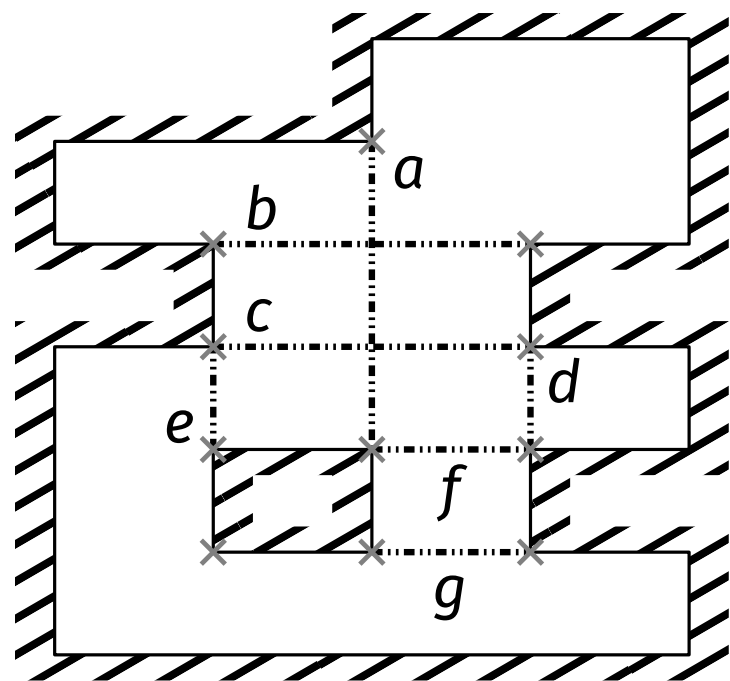
x concave corners
- - - effective chords



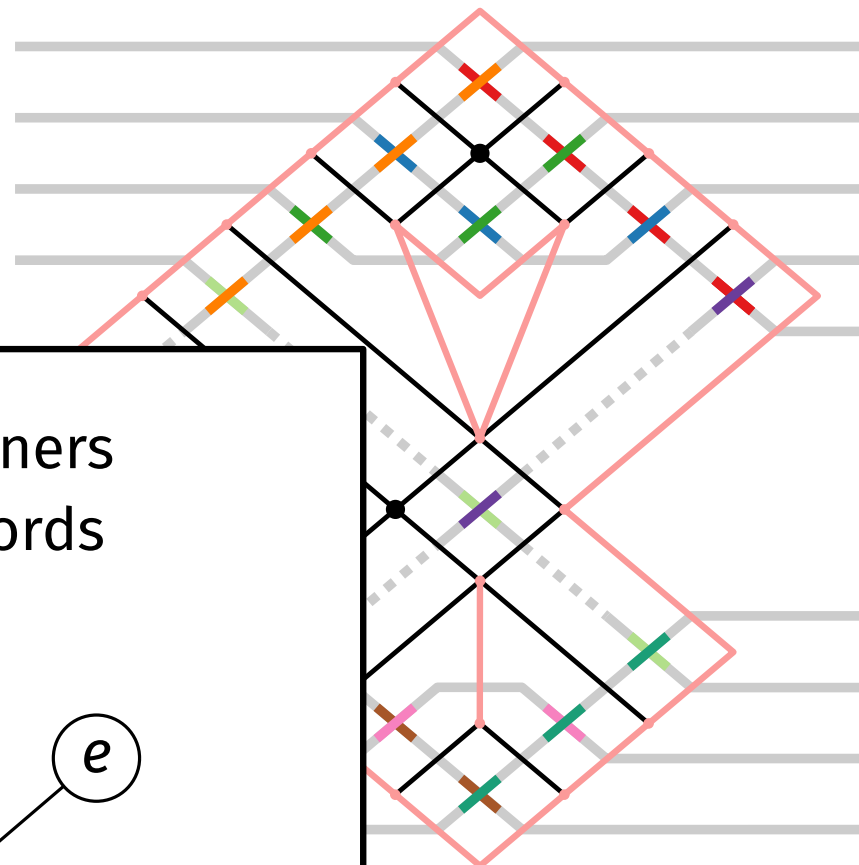
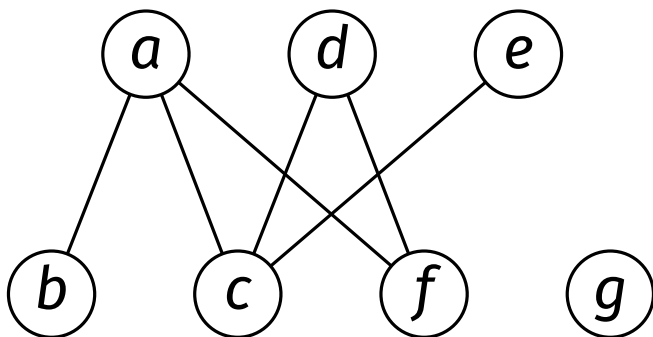
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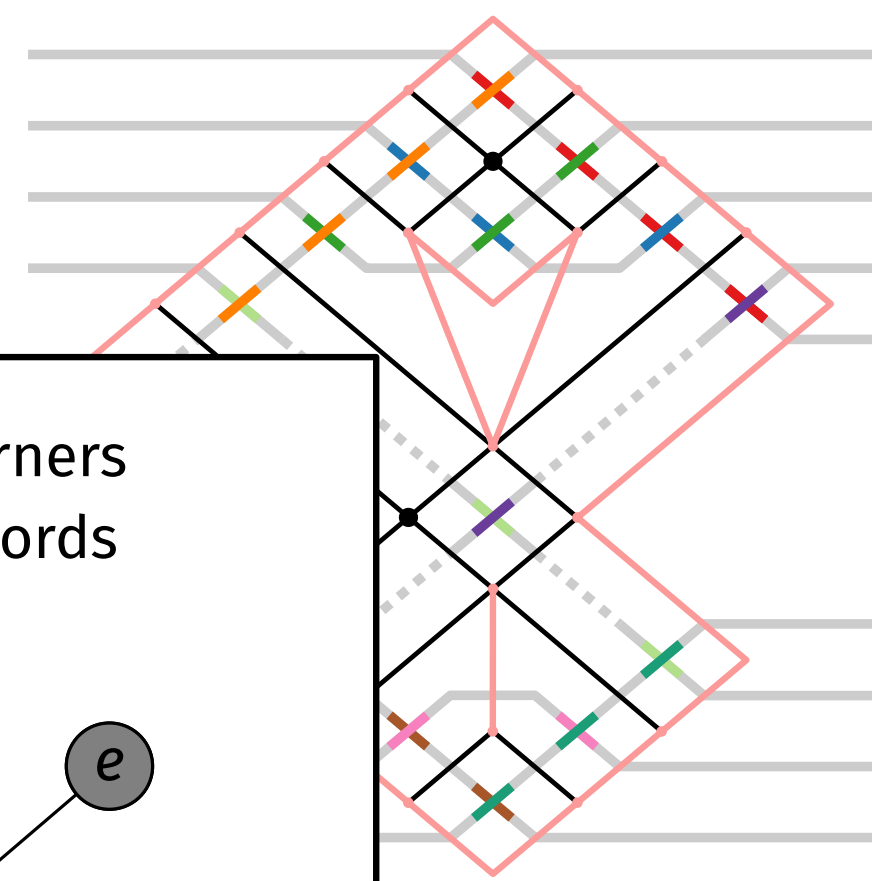
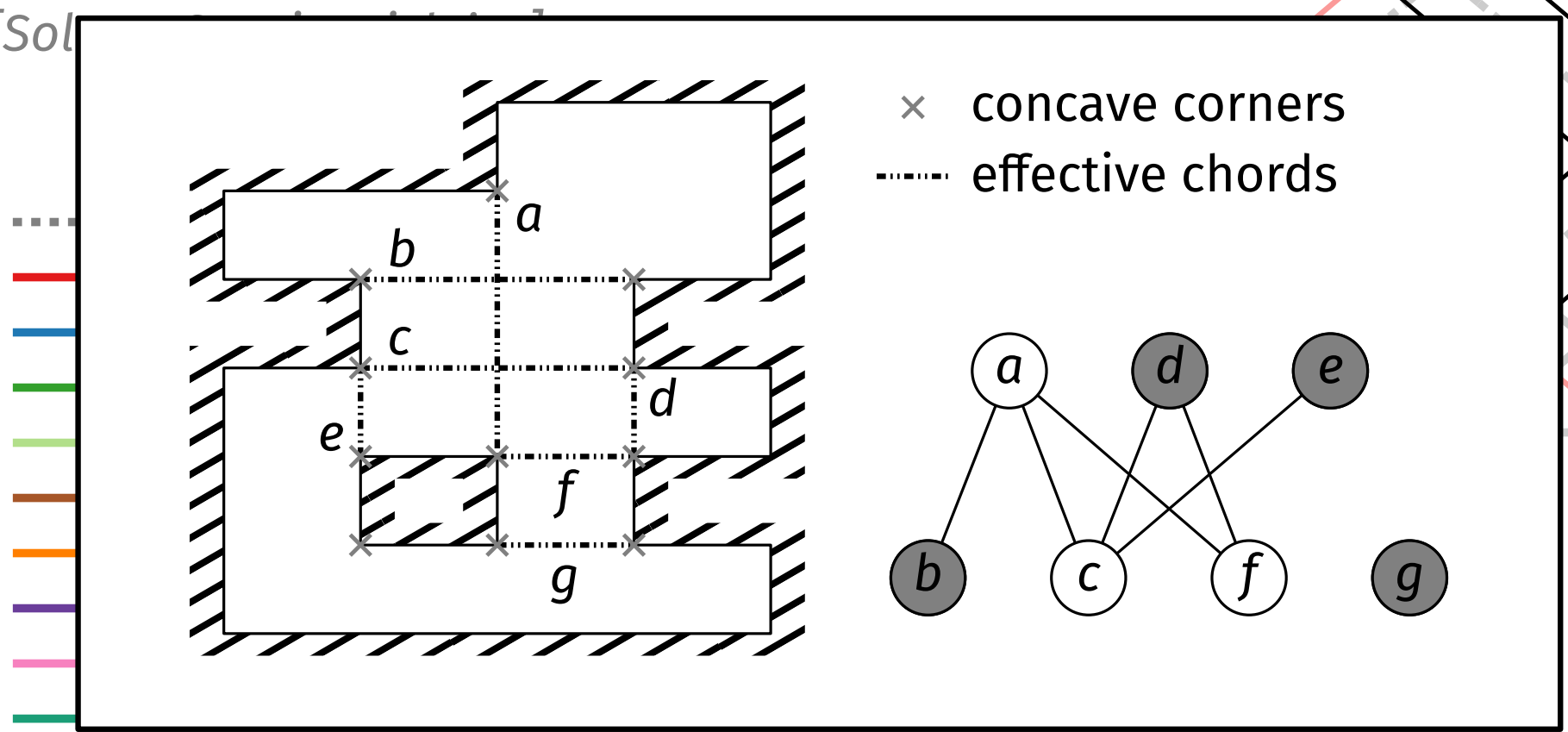
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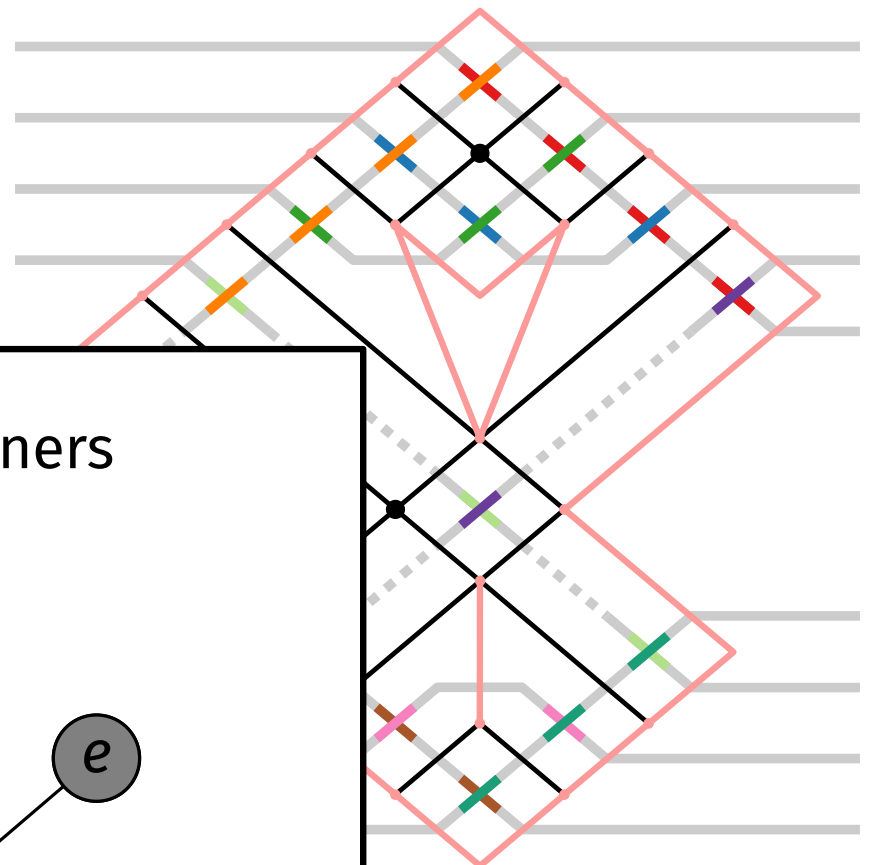
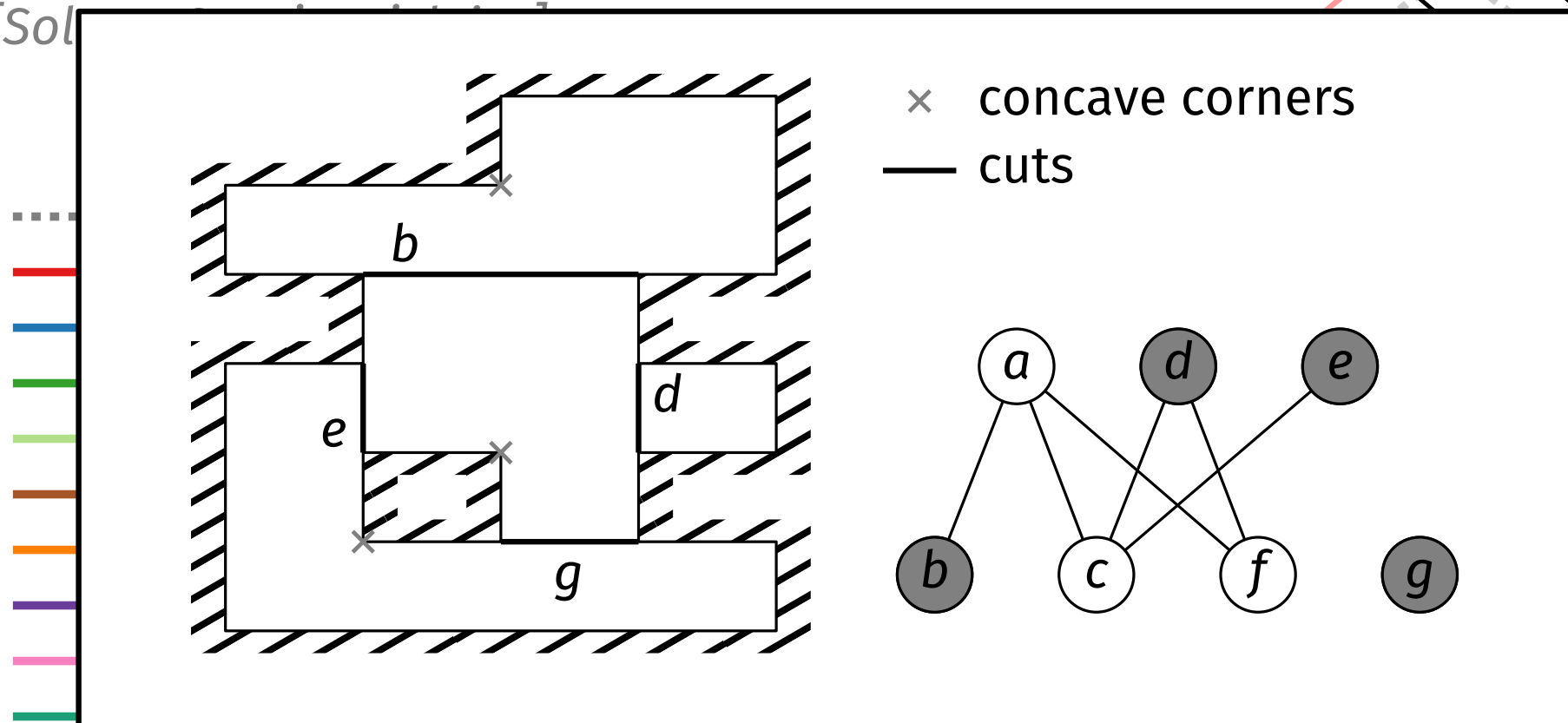
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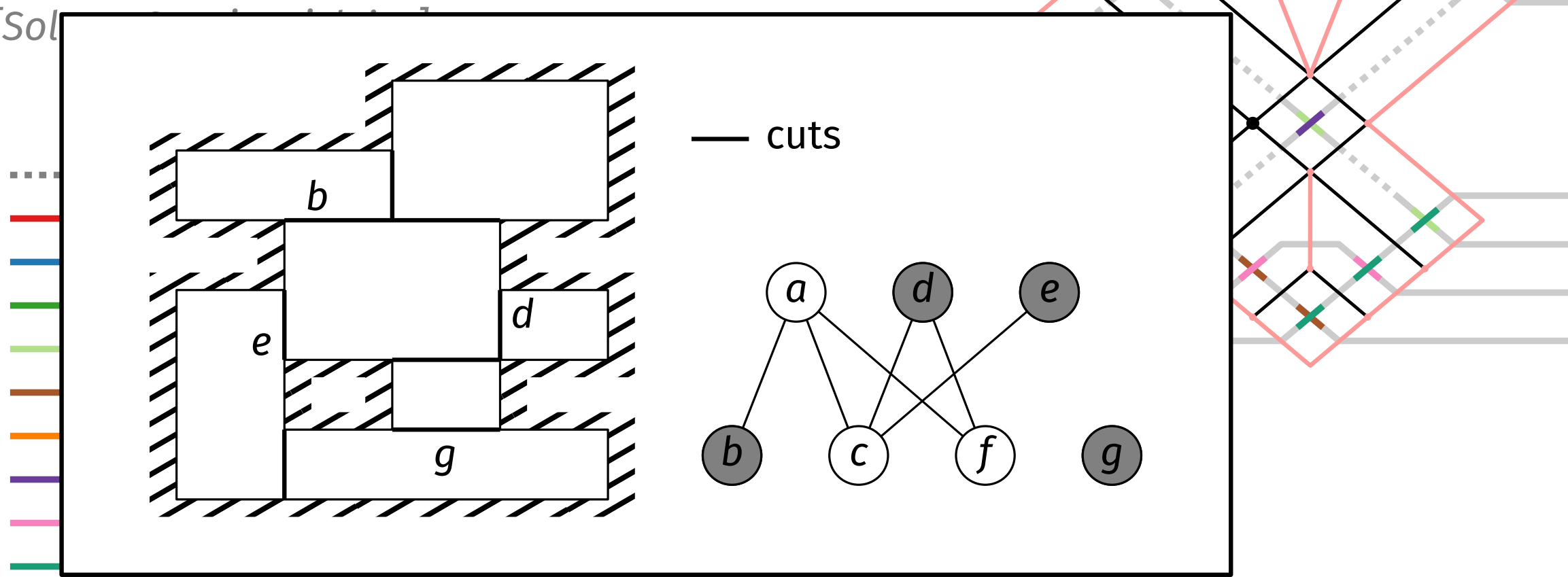
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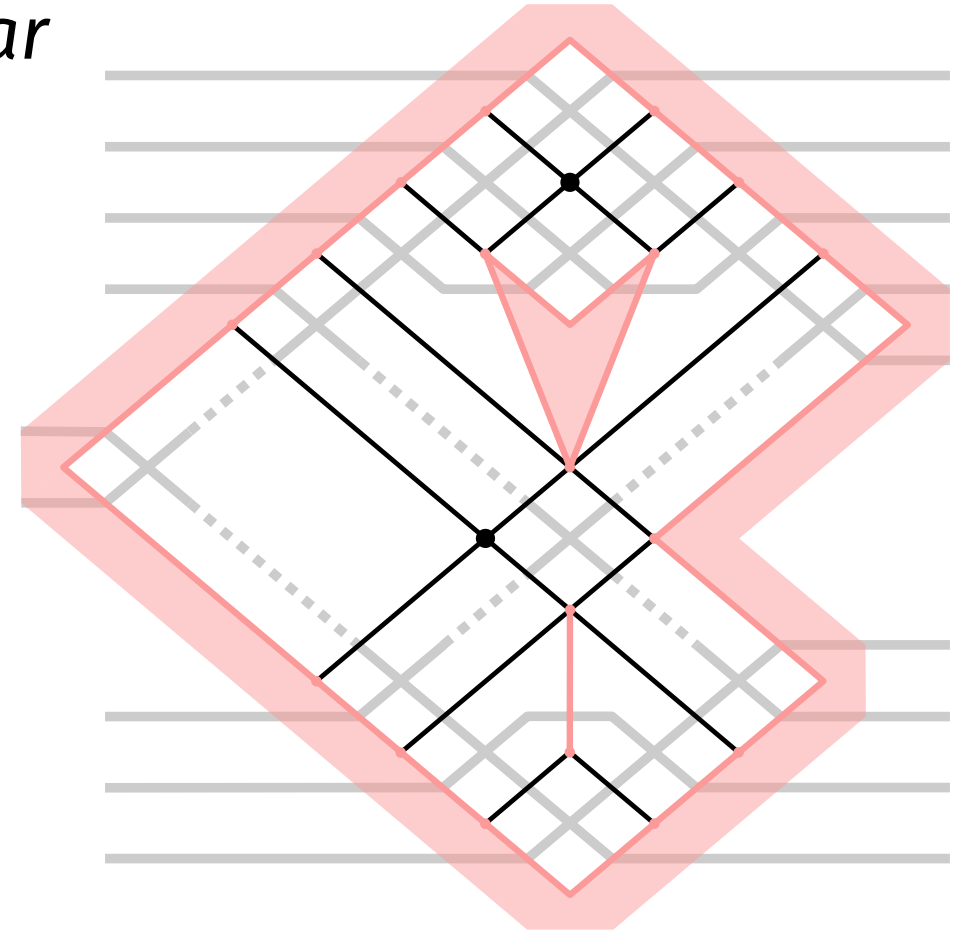
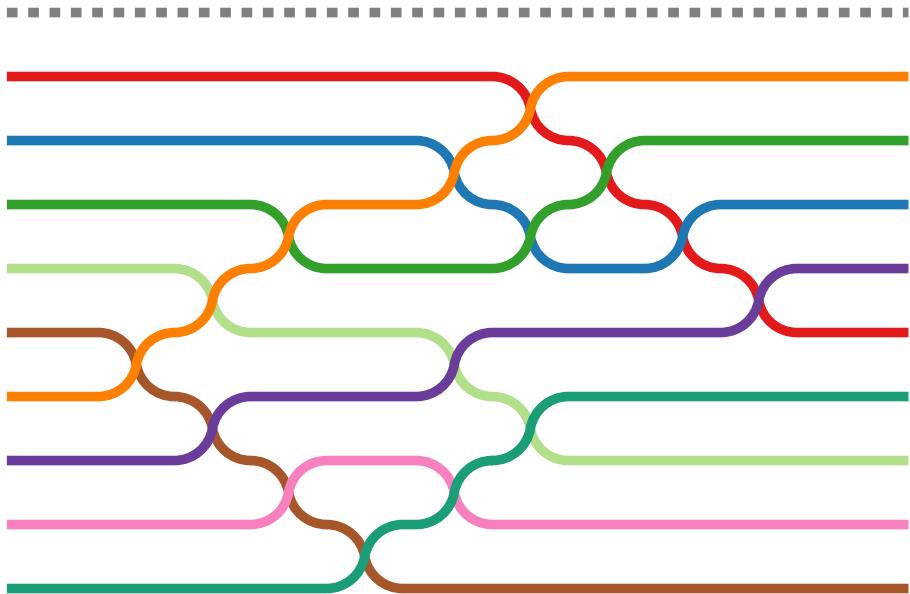
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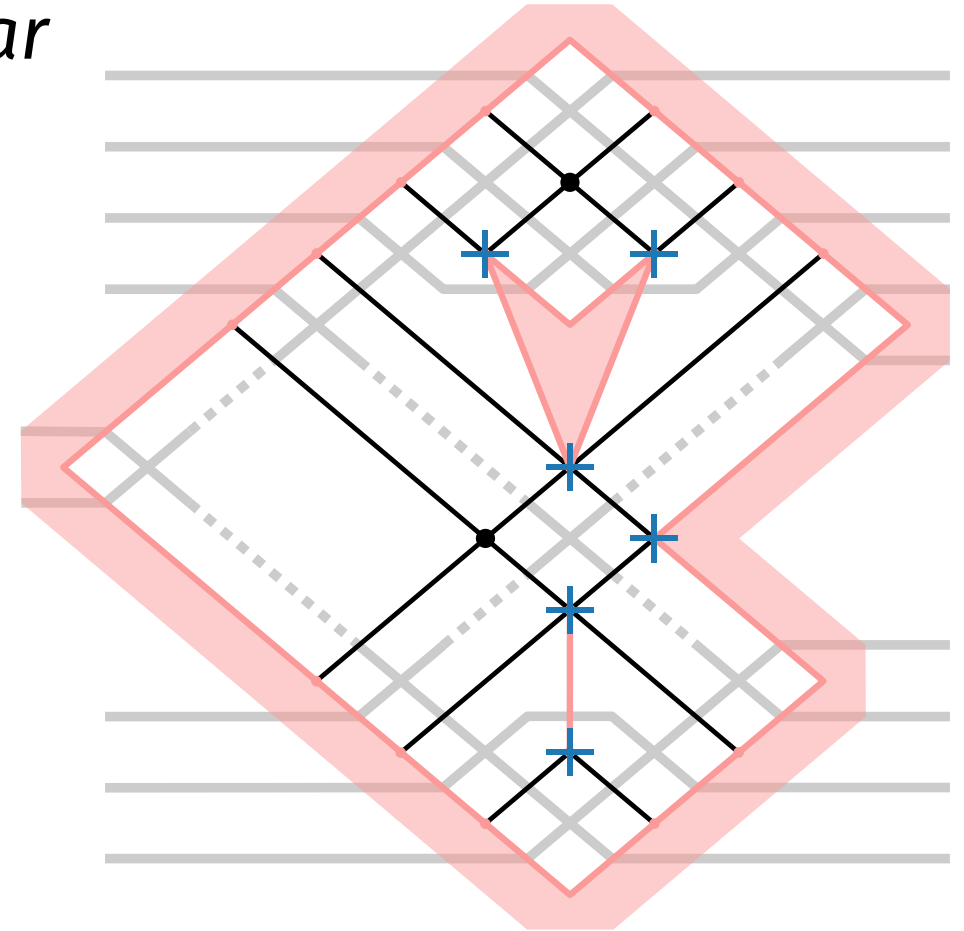
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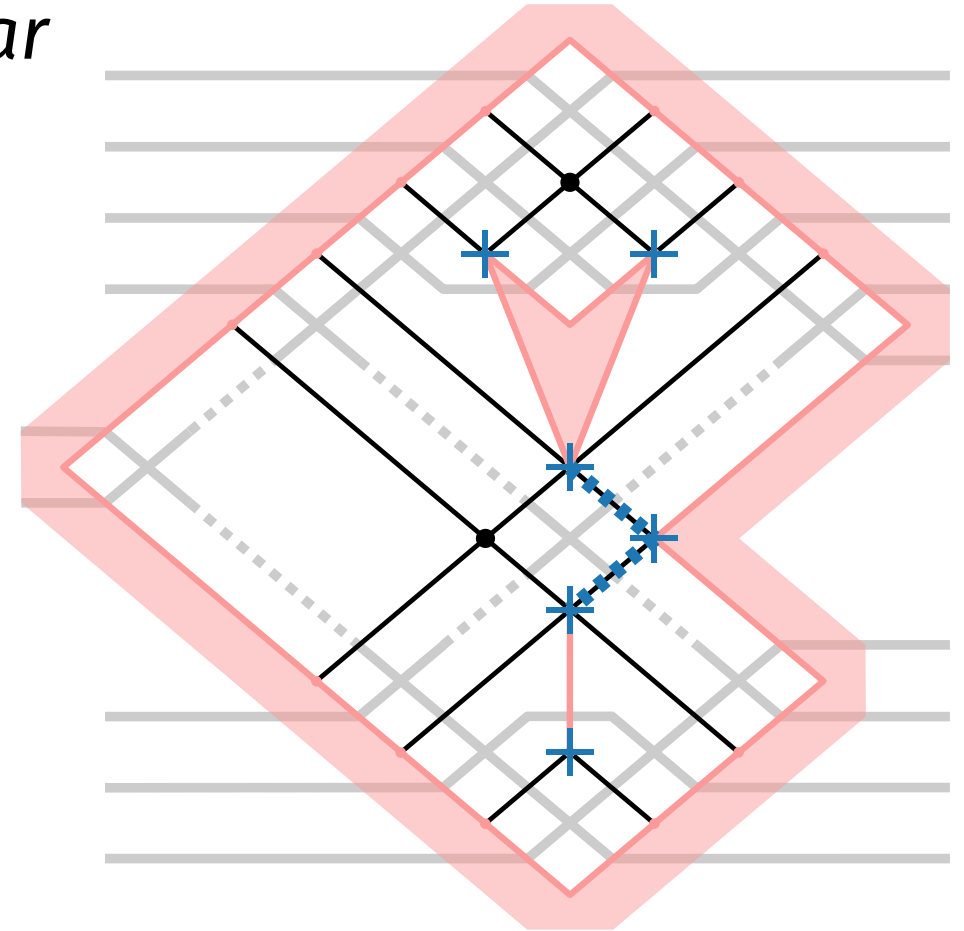
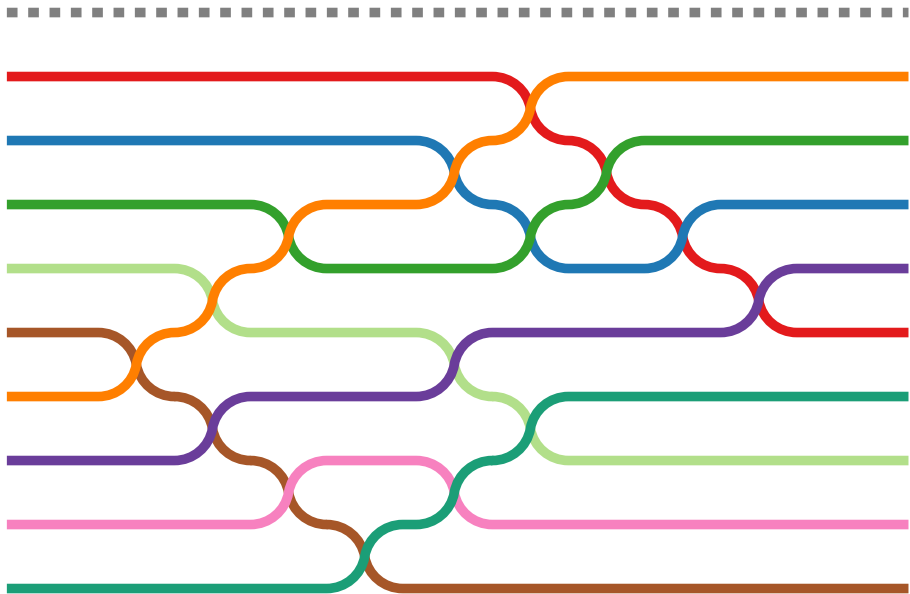
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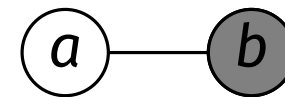
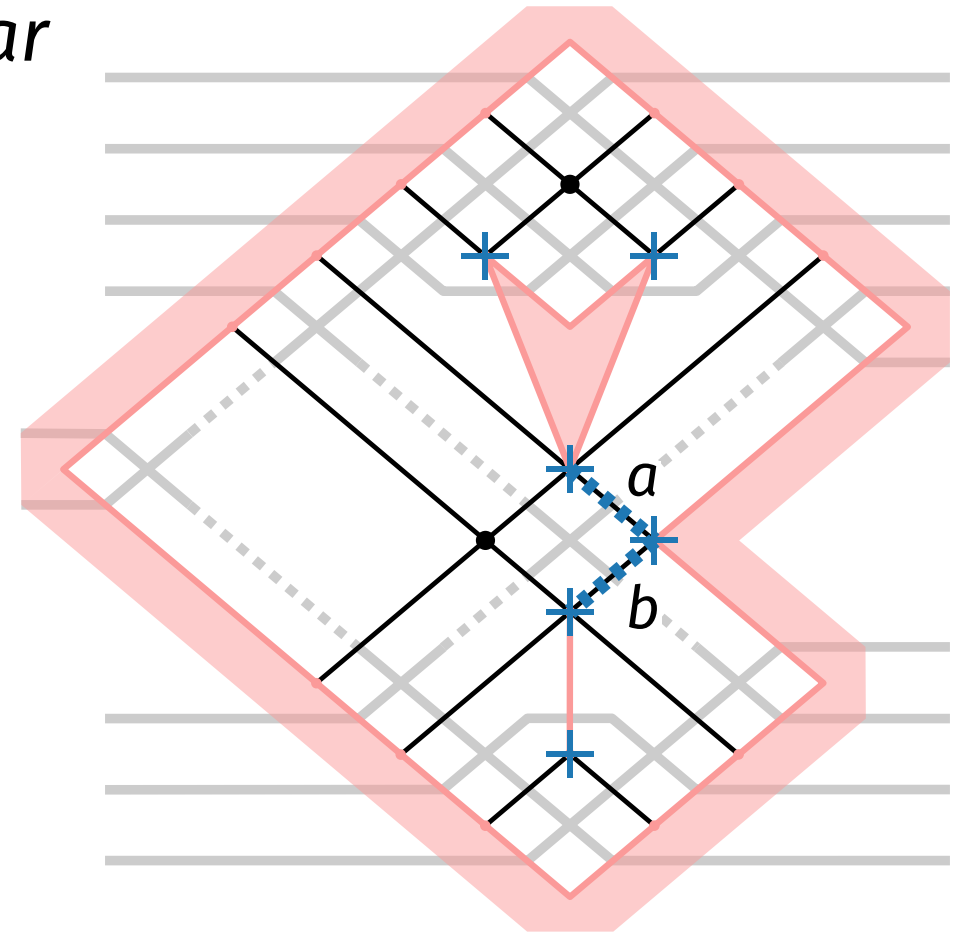
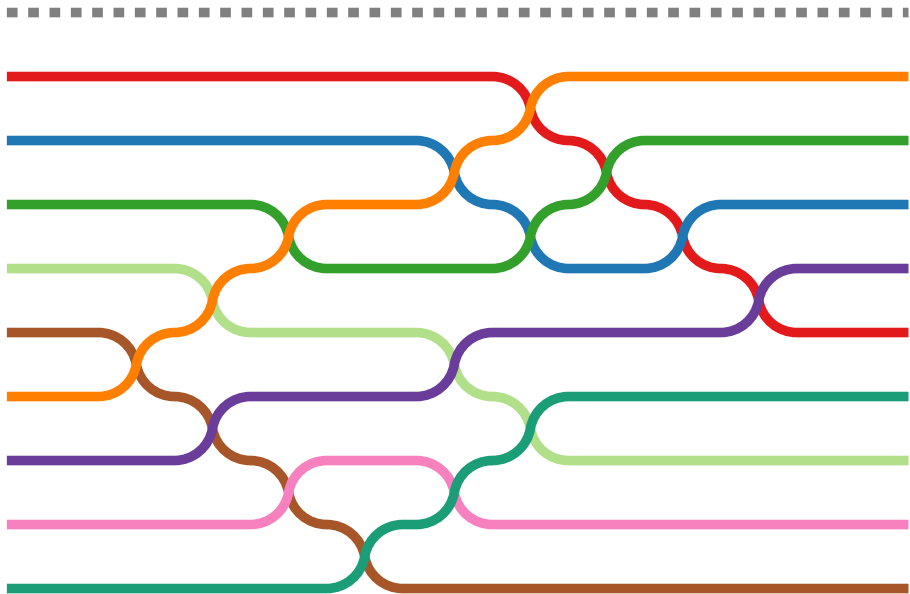
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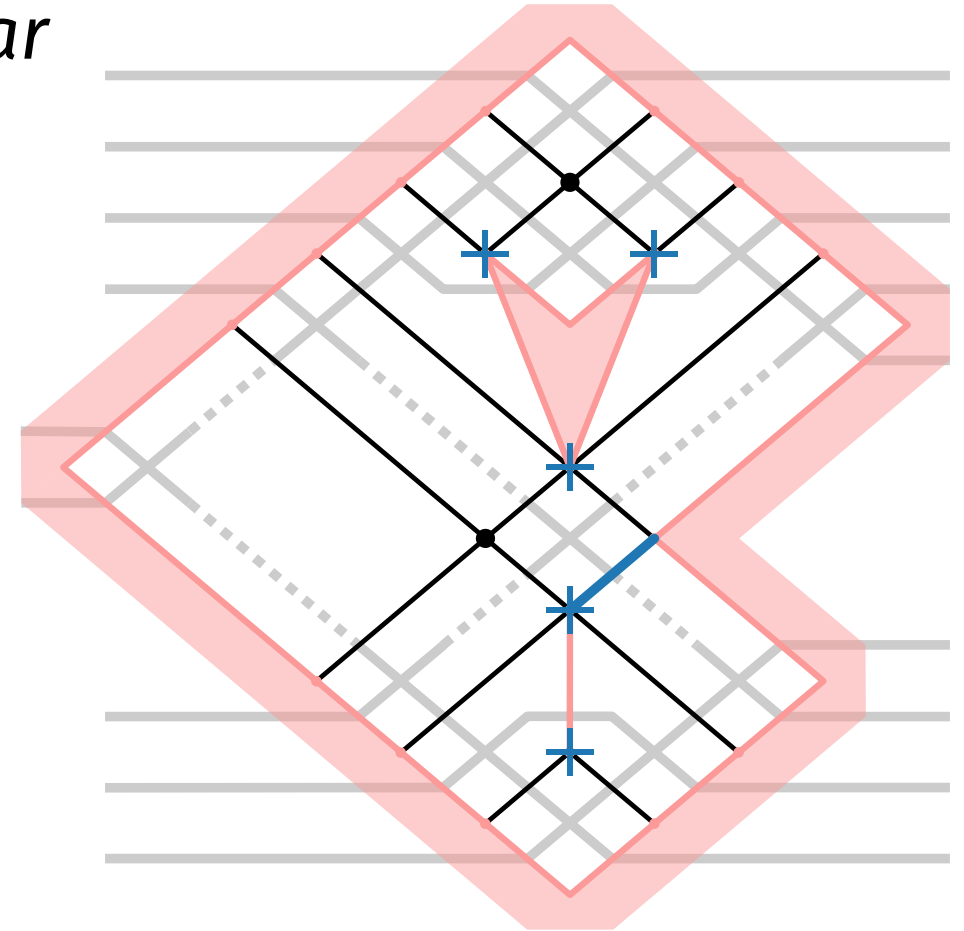
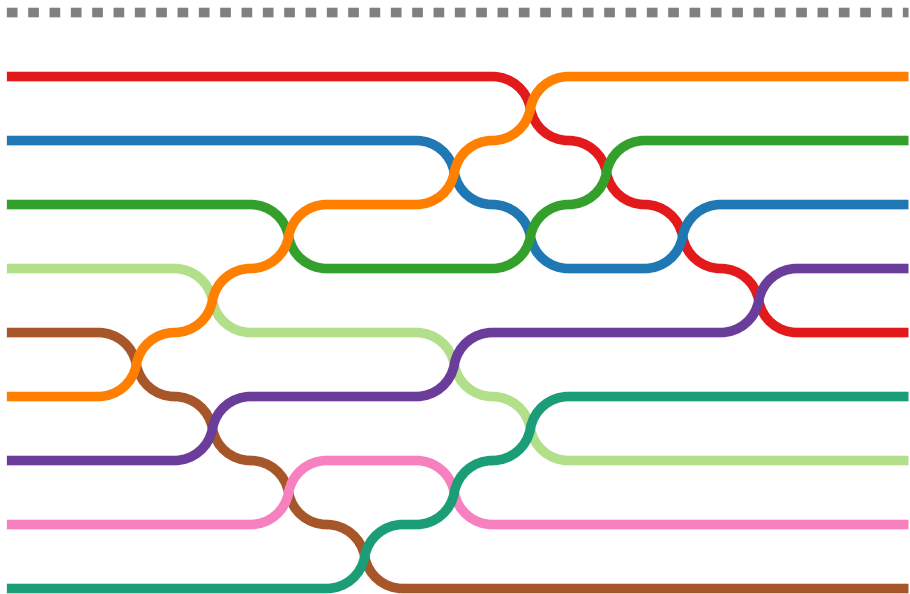
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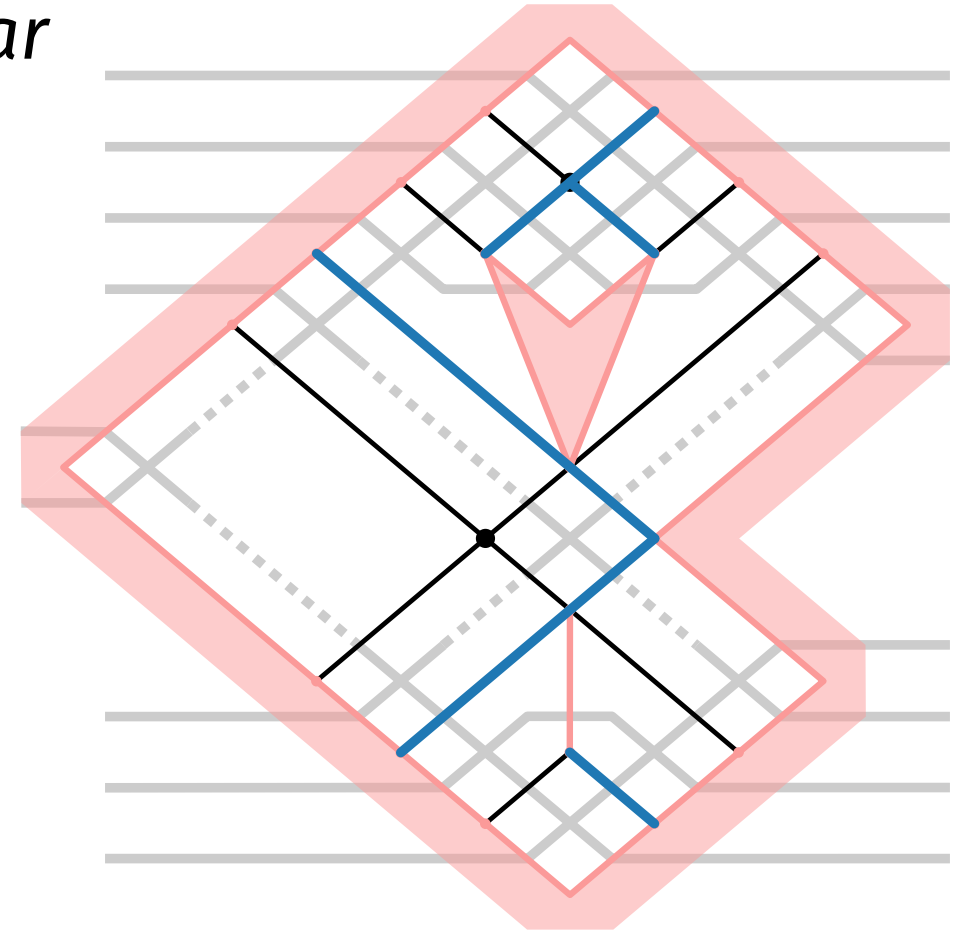
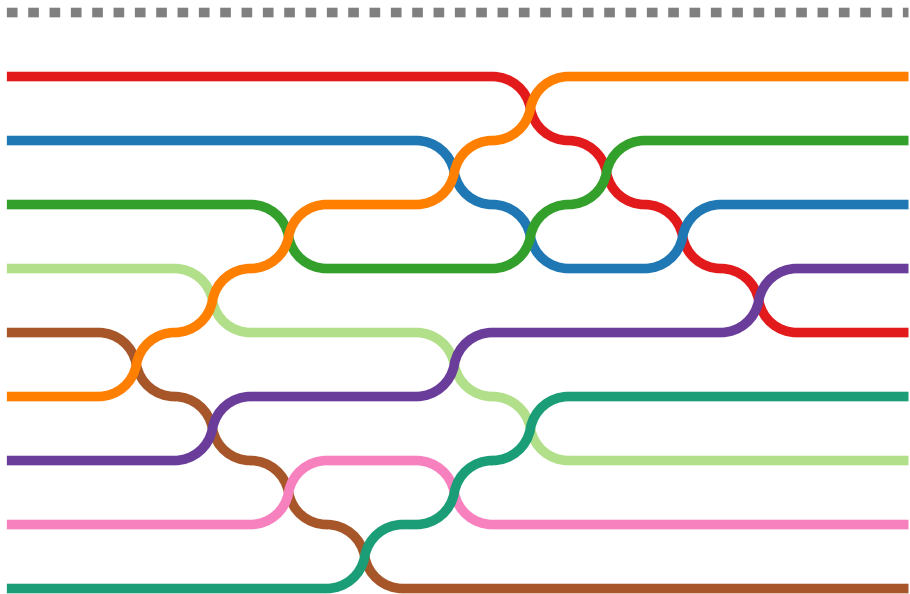
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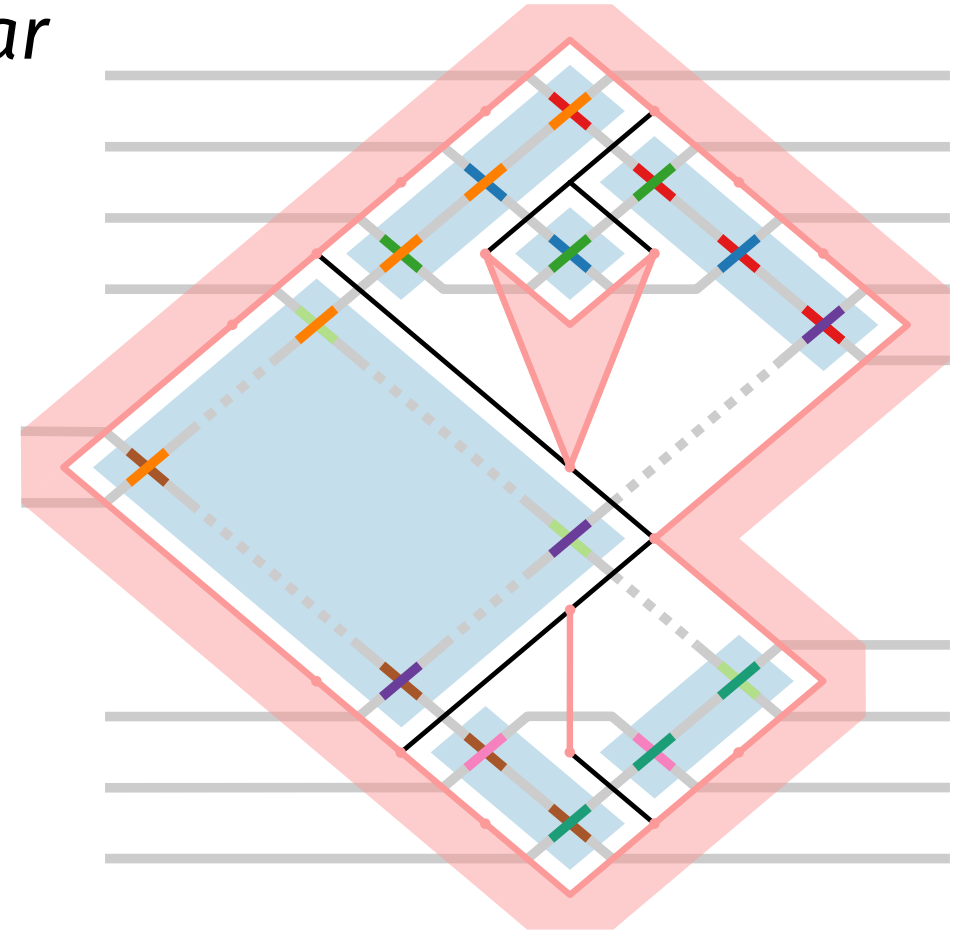
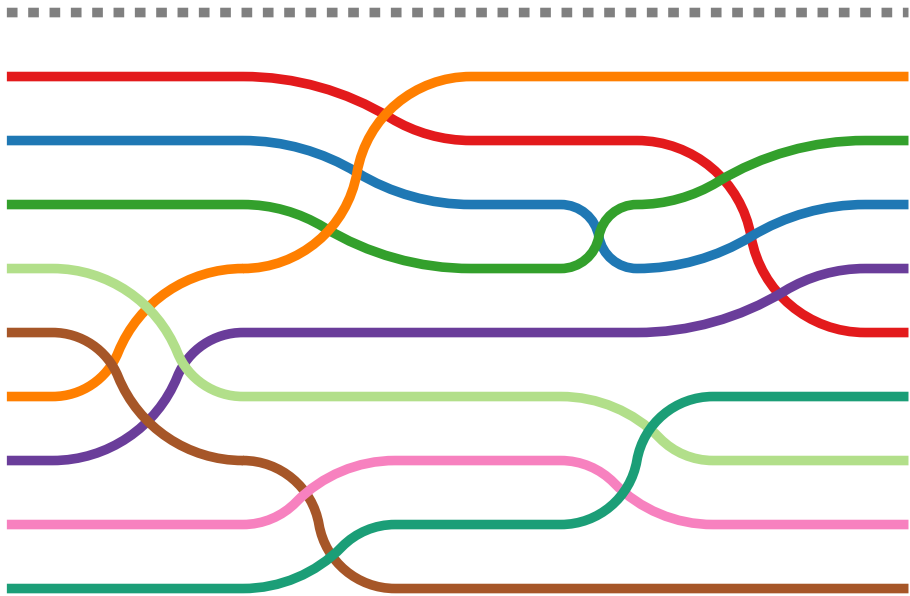
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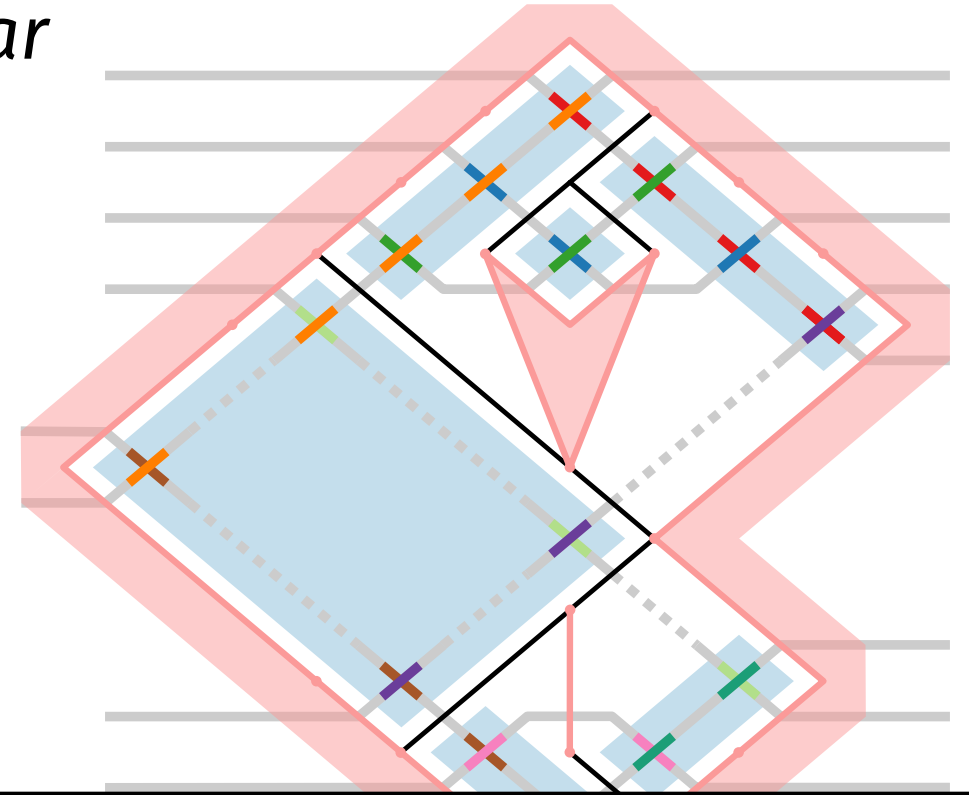
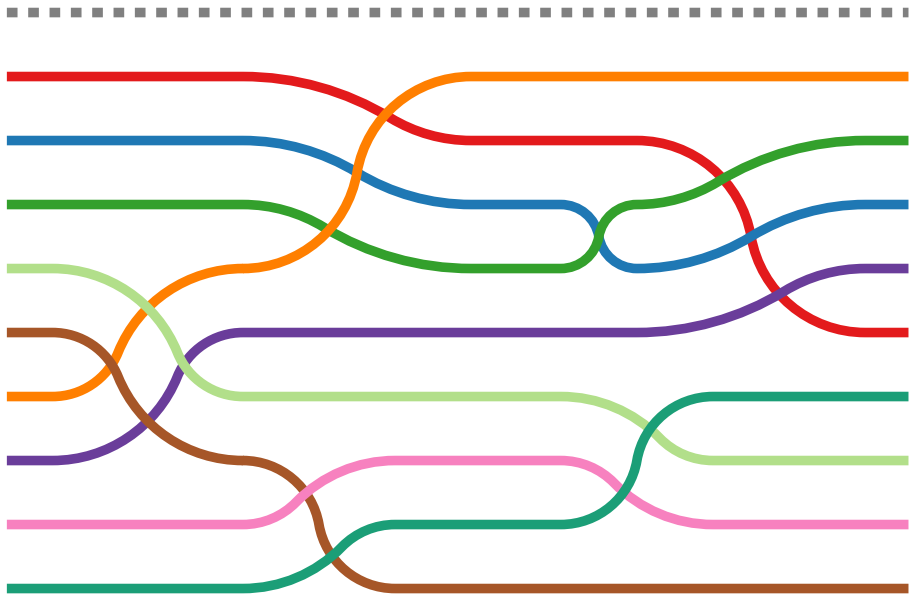
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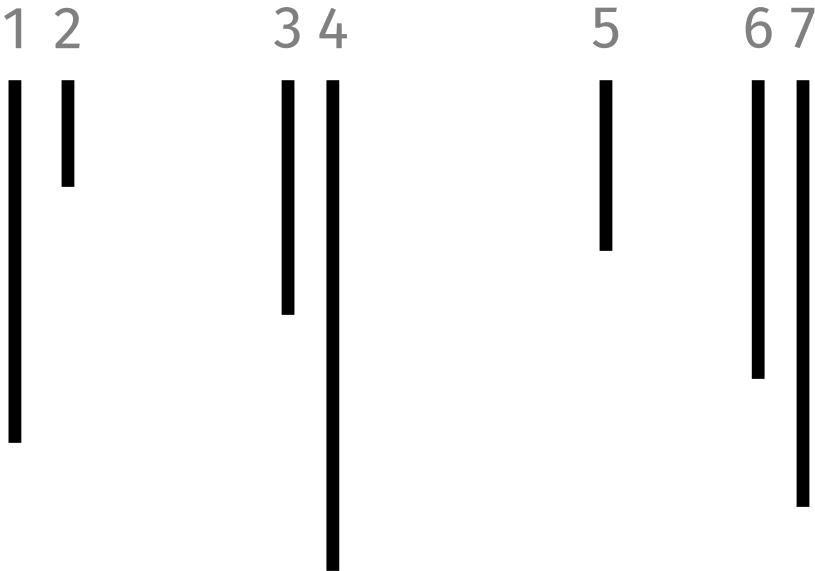
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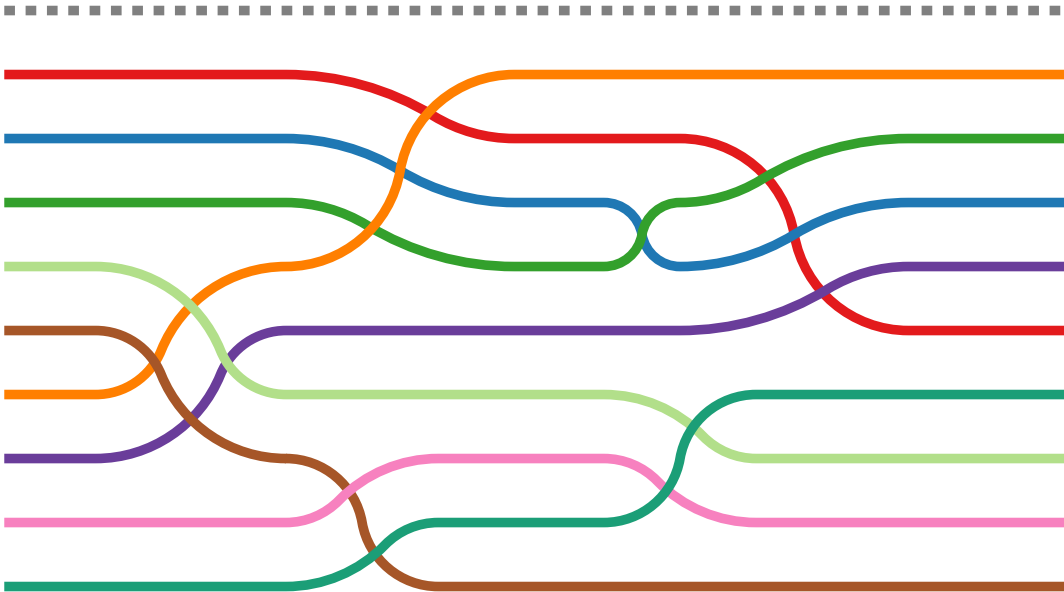
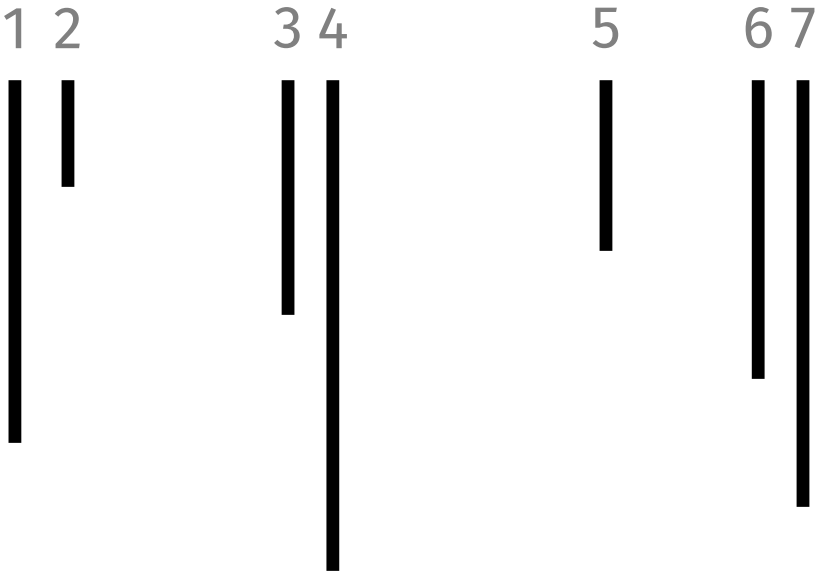
Theorem.

Given a storyline with a sequence X of pairwise crossings, Bundling Without Meetings can be solved in $O(|X|^2)$ time.

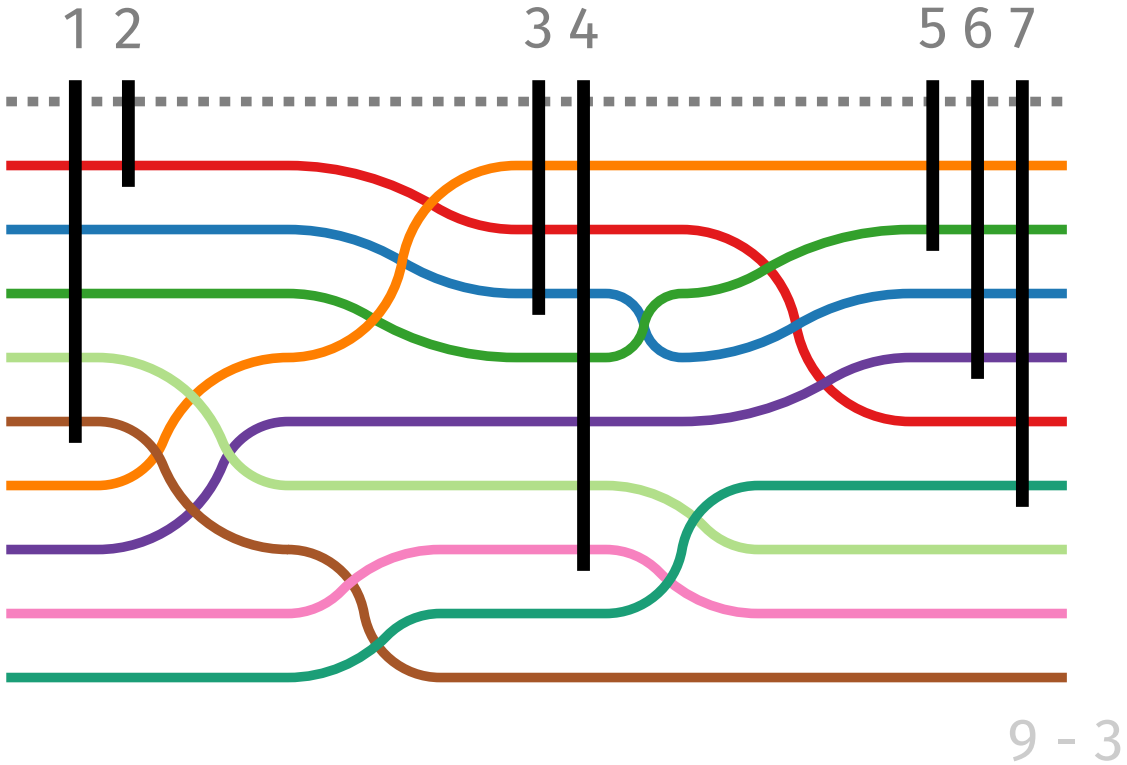
III. Meetings



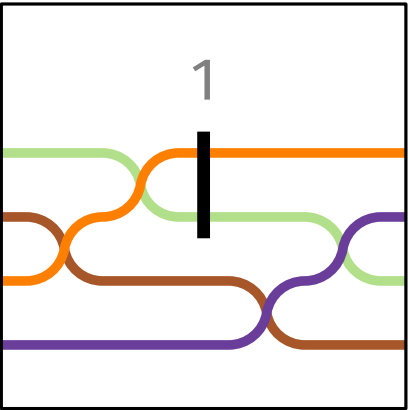
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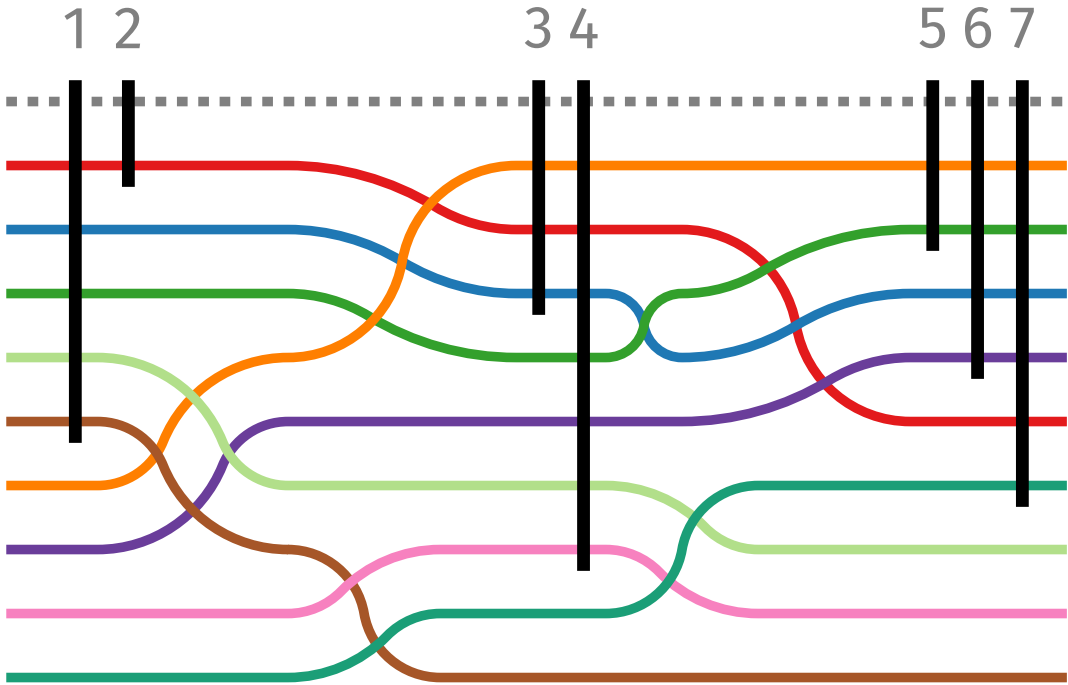
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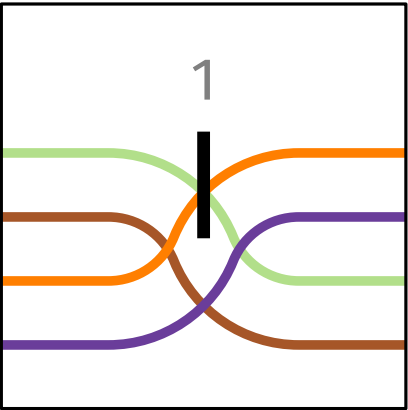
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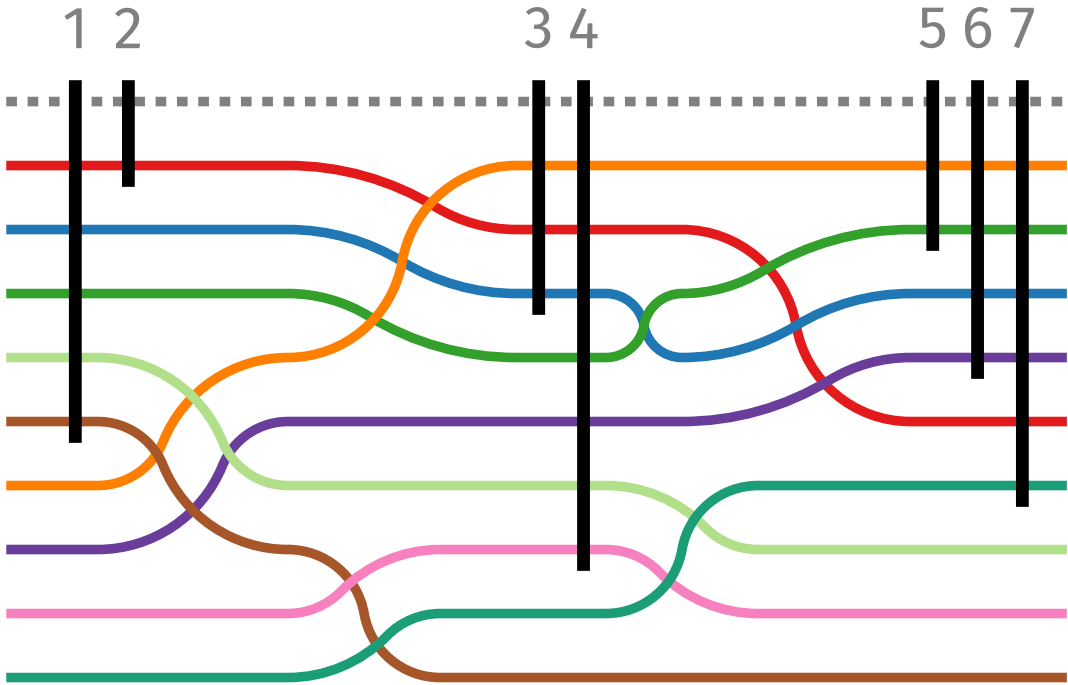
meeting trapped
inside a block
crossing



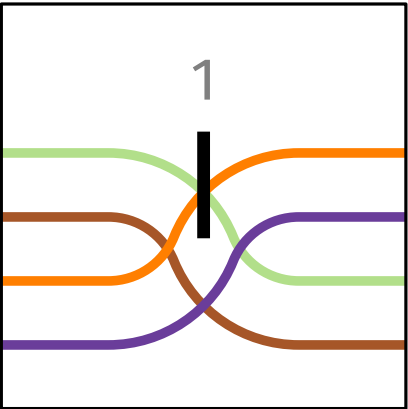
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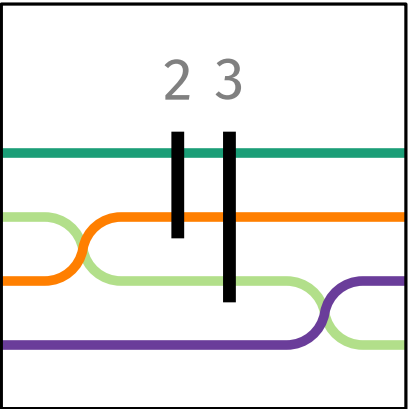
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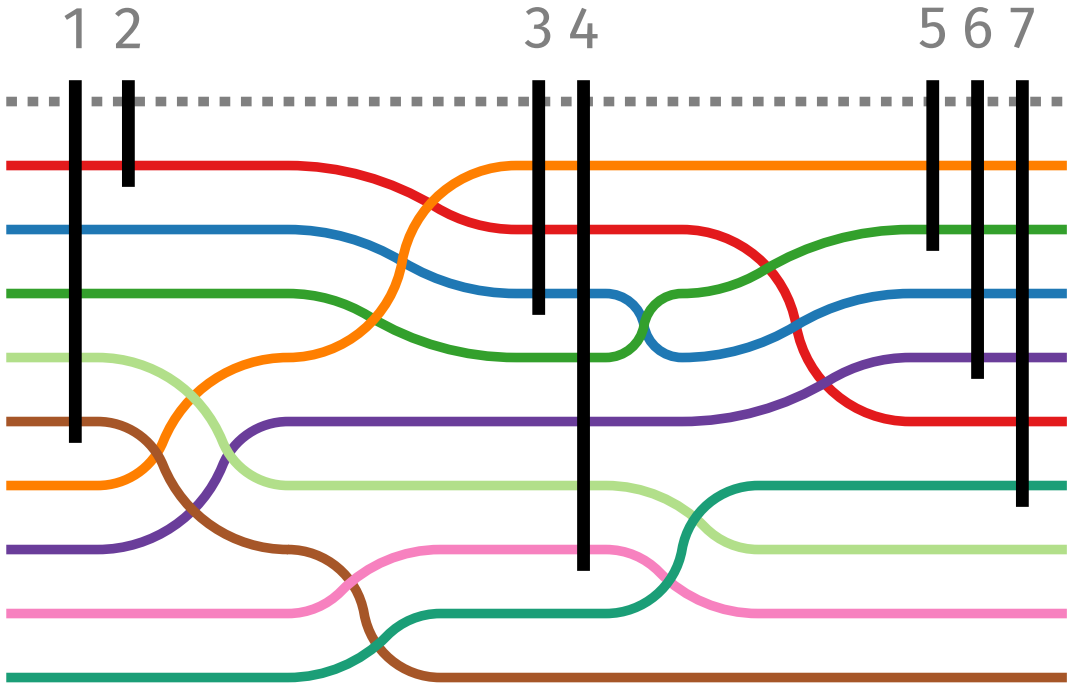
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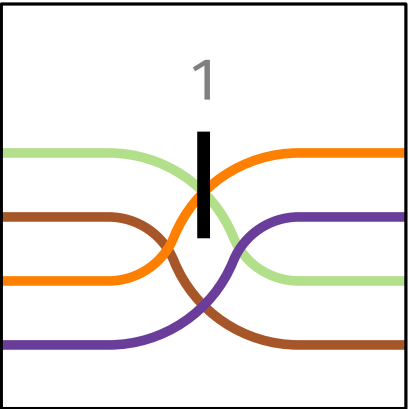
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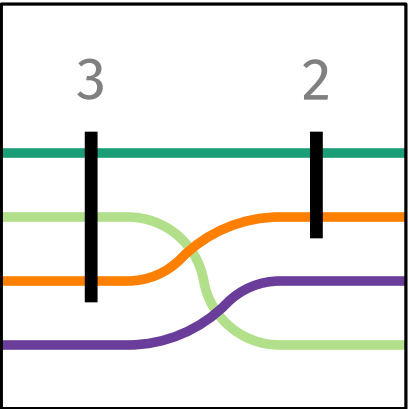
disturbed
meeting order



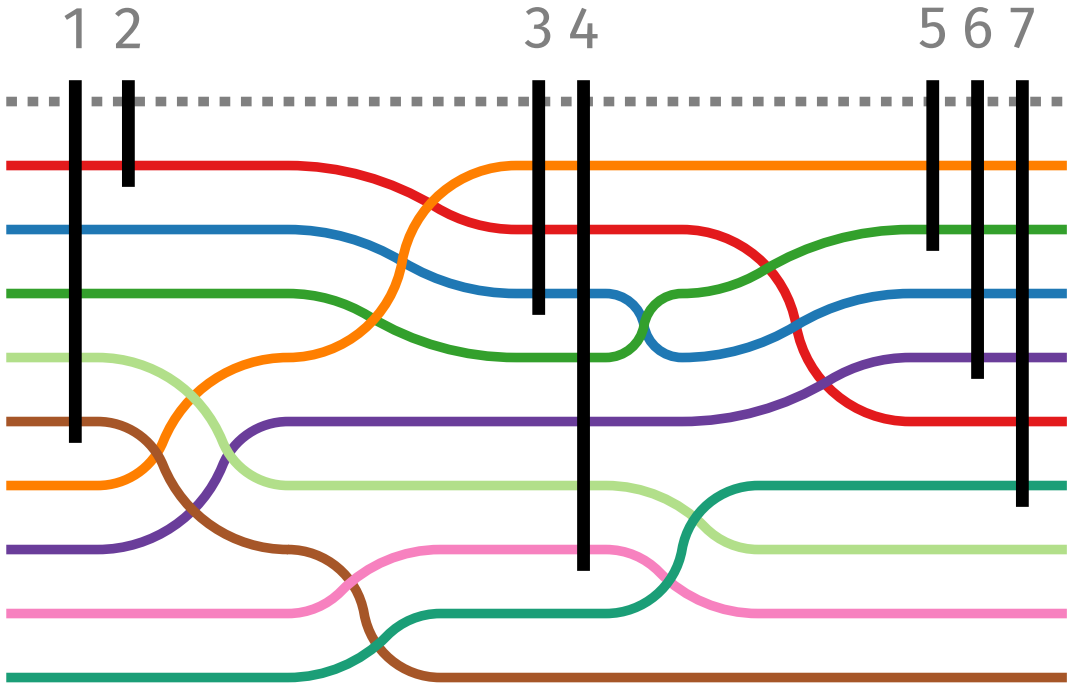
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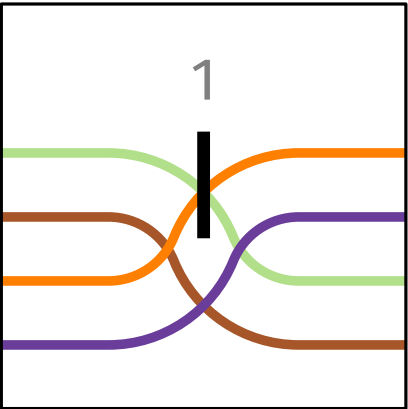
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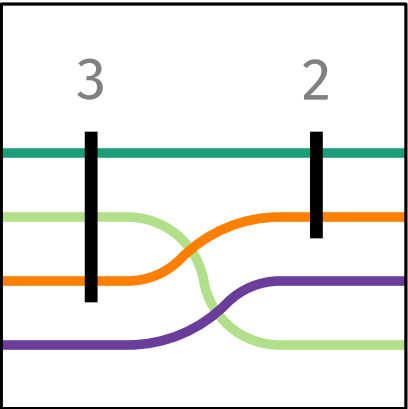
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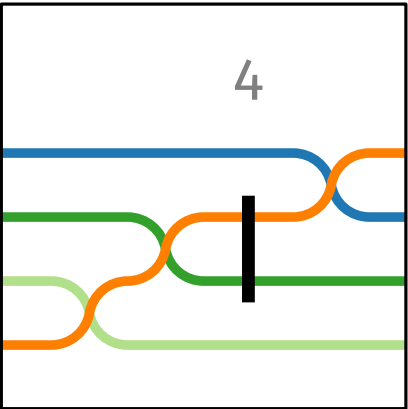
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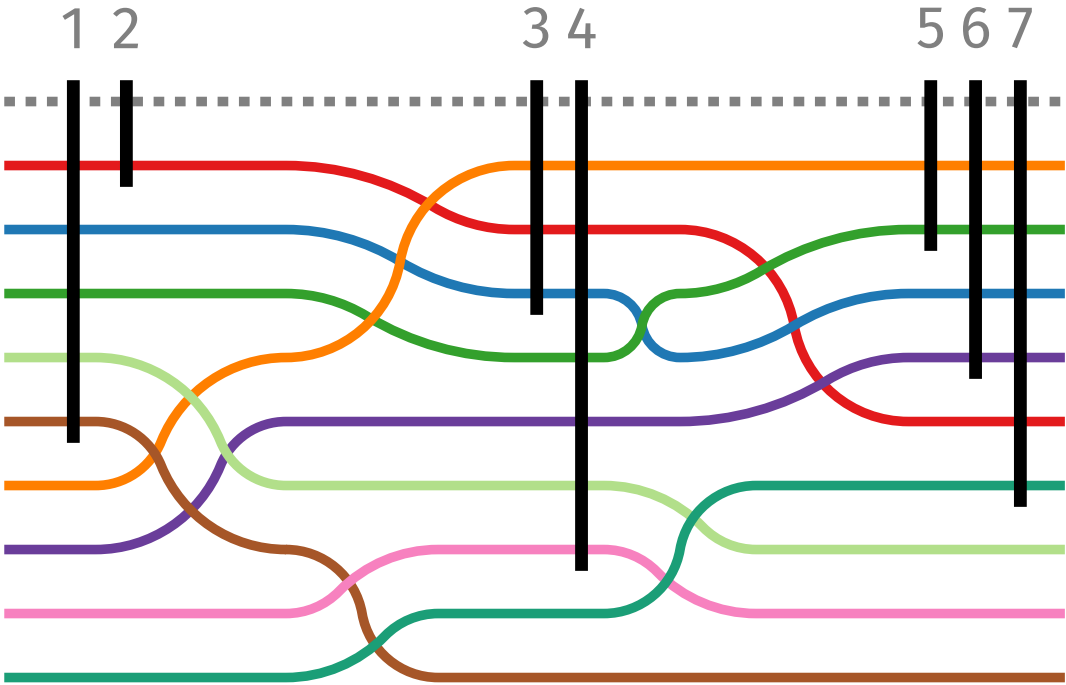
⚡ meeting trapped inside a block crossing



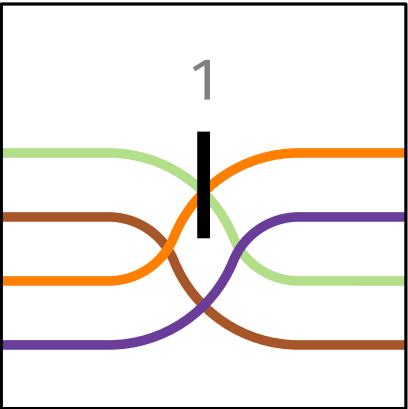
⚡ disturbed meeting order



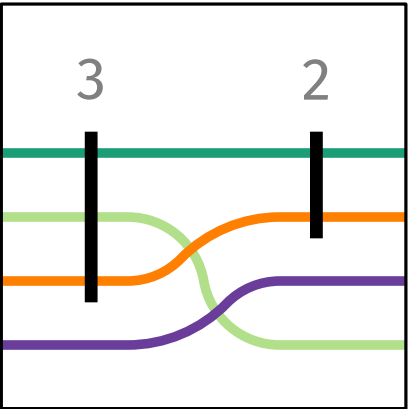
distorted meeting



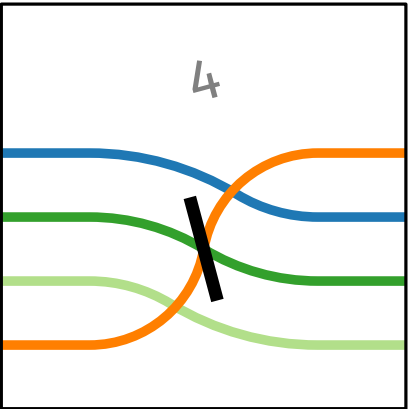
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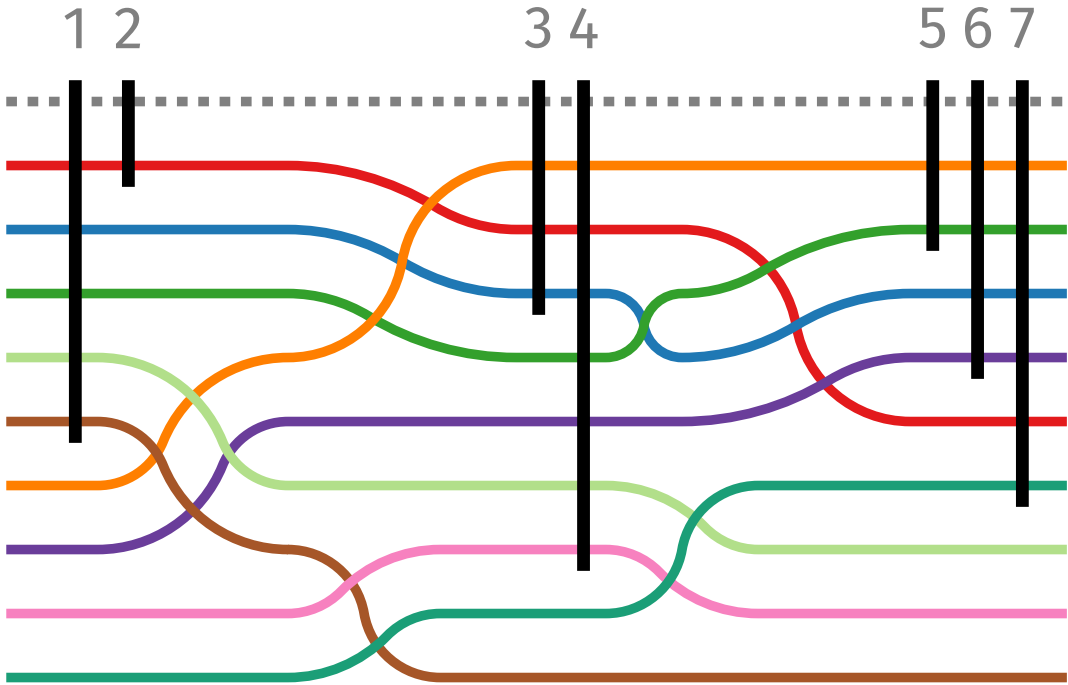
⚡ meeting trapped
inside a block
crossing



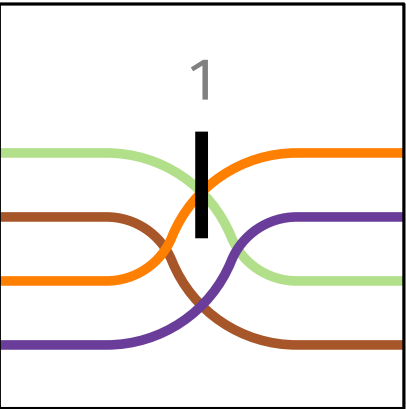
⚡ disturbed
meeting order



⚡ distorted
meeting

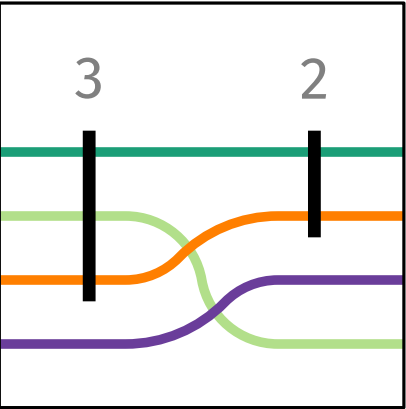
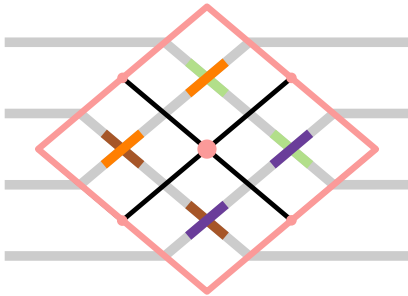


III. Meetings

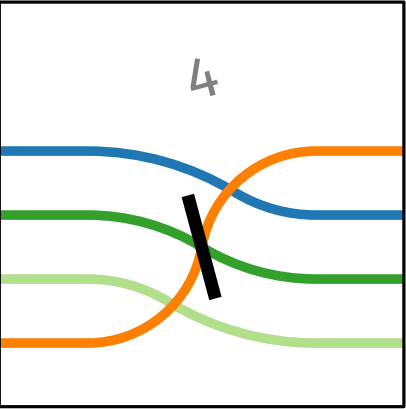


meeting trapped inside a block crossing

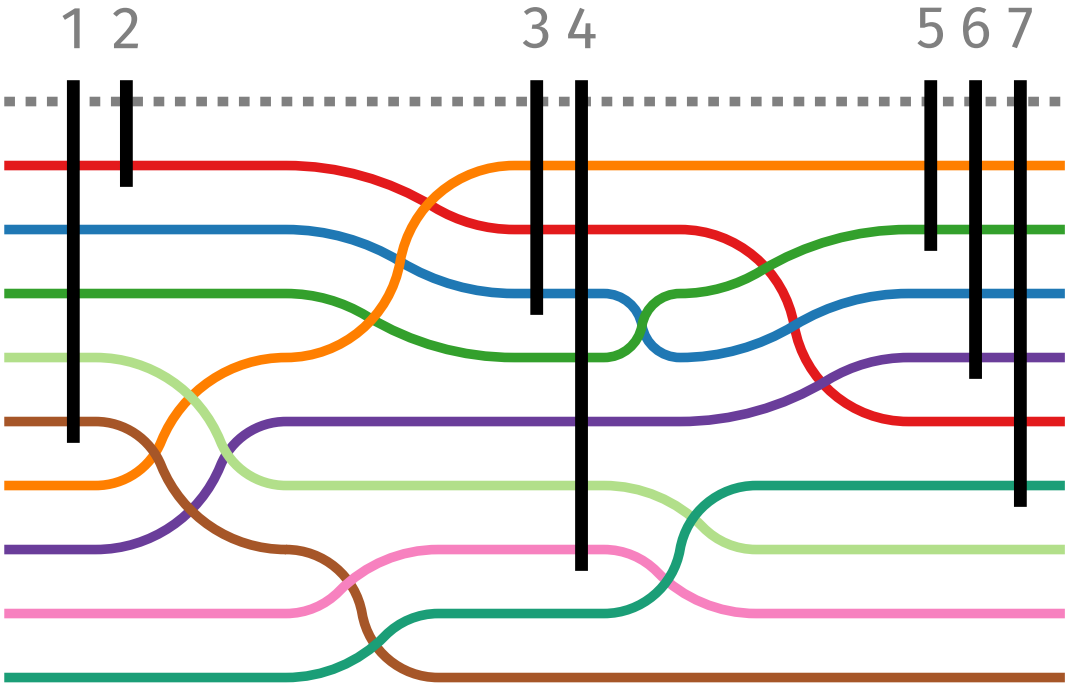
We can fix this!



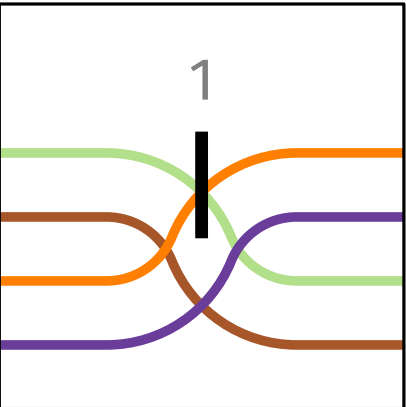
disturbed meeting order



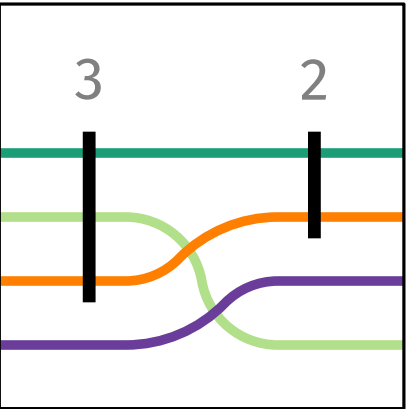
distorted meeting



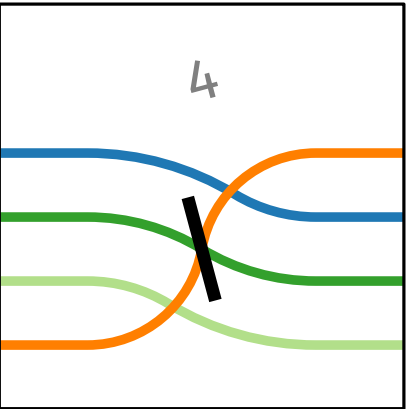
III. Meetings



meeting trapped
inside a block
crossing

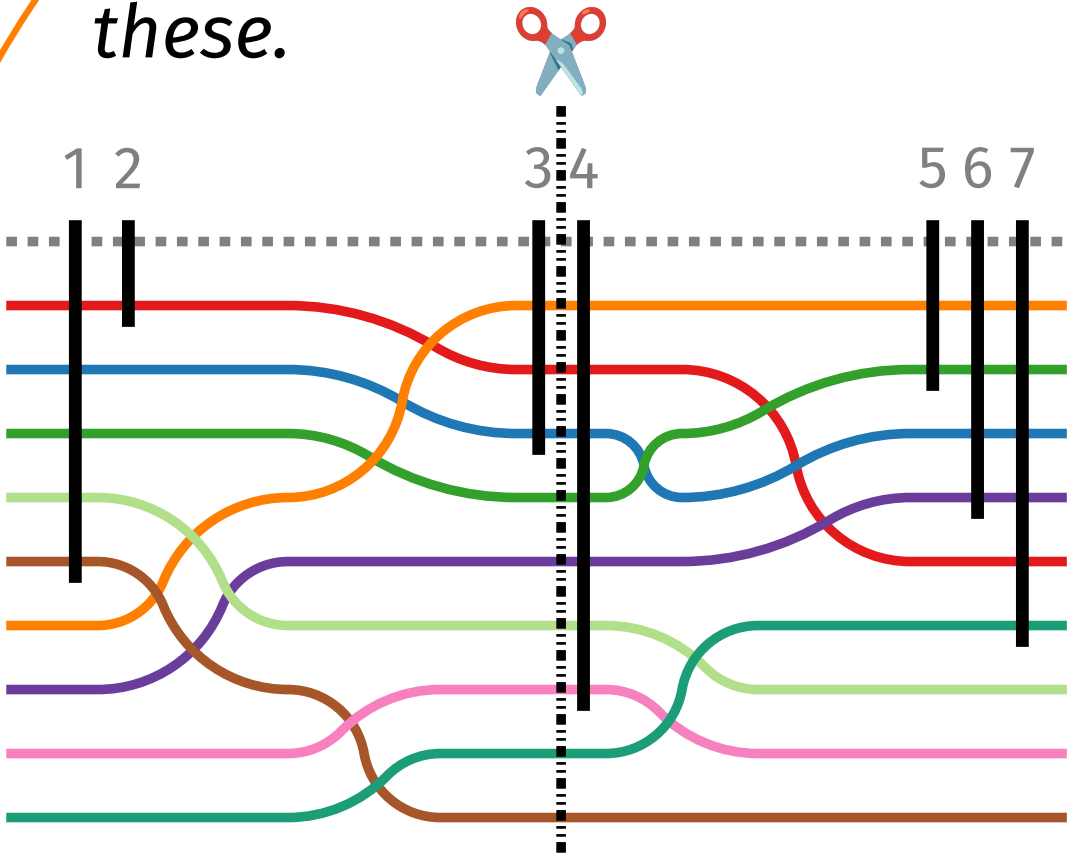


disturbed
meeting order



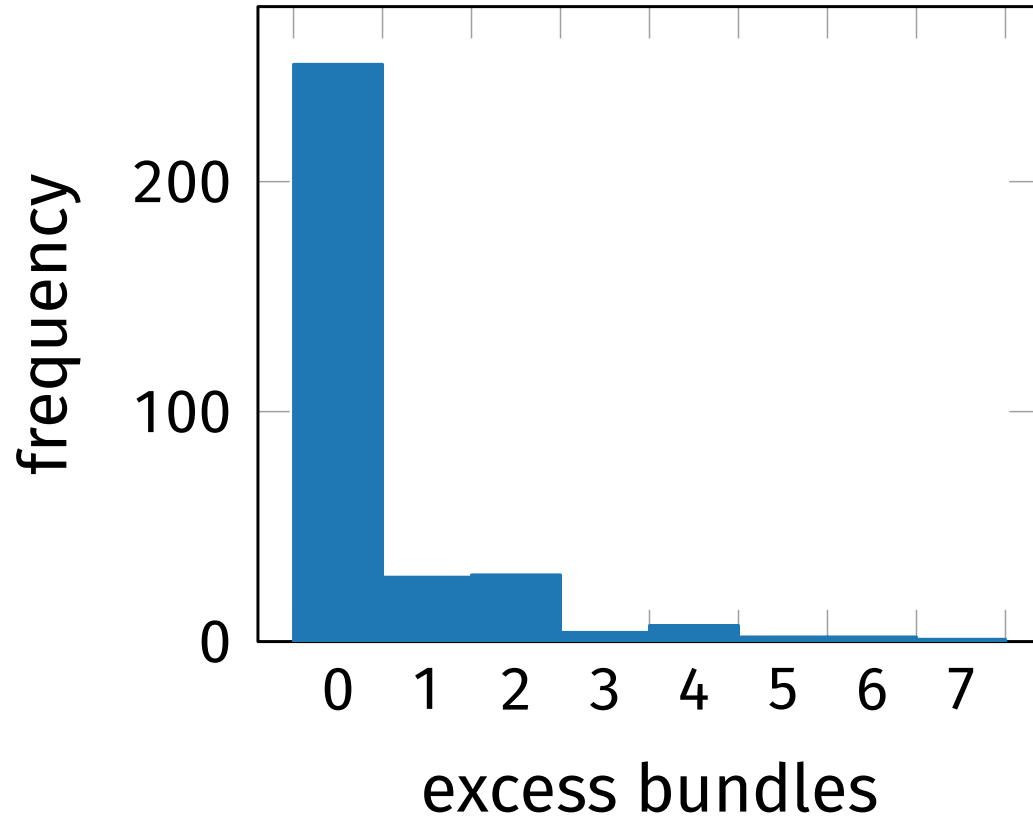
distorted
meeting

We can
mitigate
these.

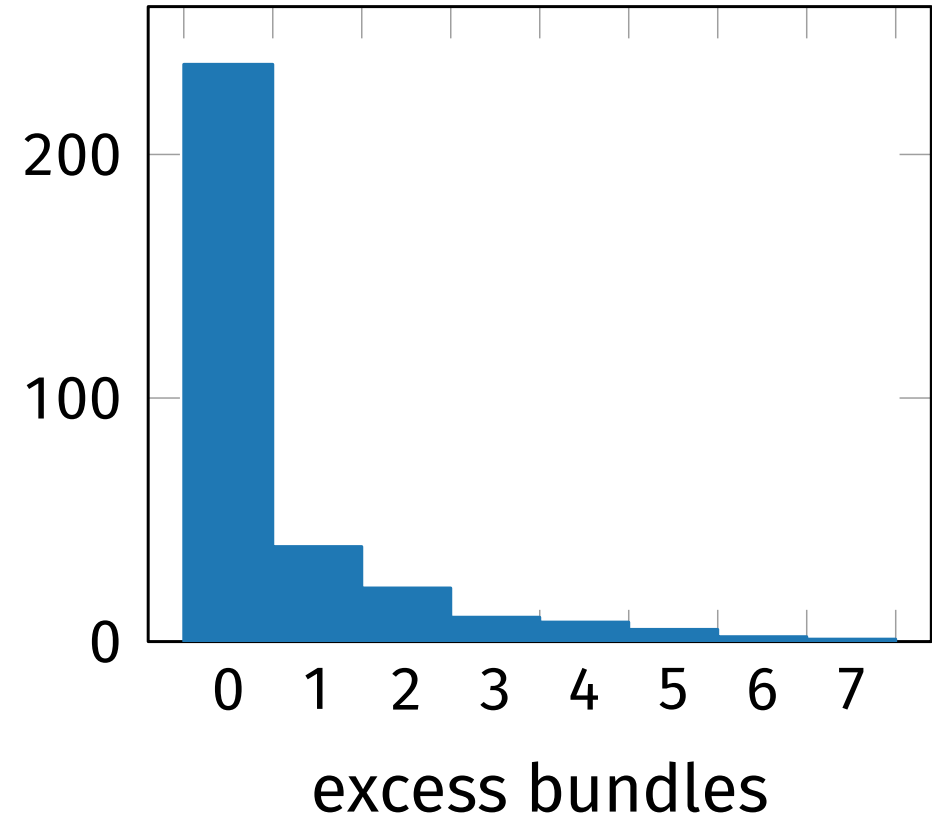


Evaluation

one-sided



two-sided



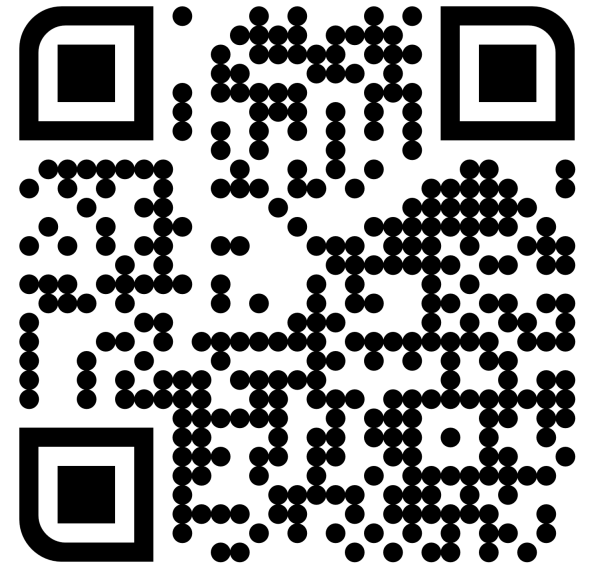
Dataset: 81 protagonists with their 5, 10, 15, and 20 most frequent coauthors ($n = 324$).

“excess bundles” means $\# \text{bundles with meetings} - \# \text{bundles without meetings}$.

Build Storylines for Your Protagonist at `publines.github.io`

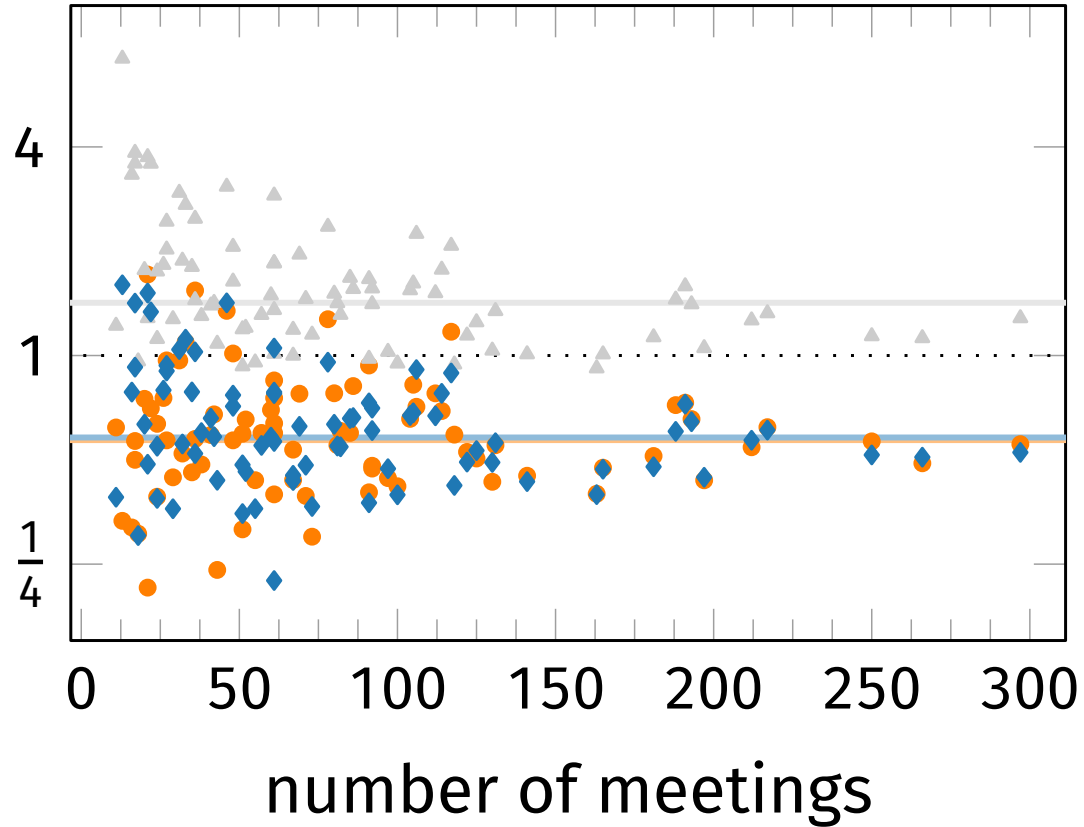
Open Questions:

- Can we efficiently solve bundling in the presence of meetings?
- Does the one-sided drawing style help with other esthetic criteria (e.g. wiggles)?

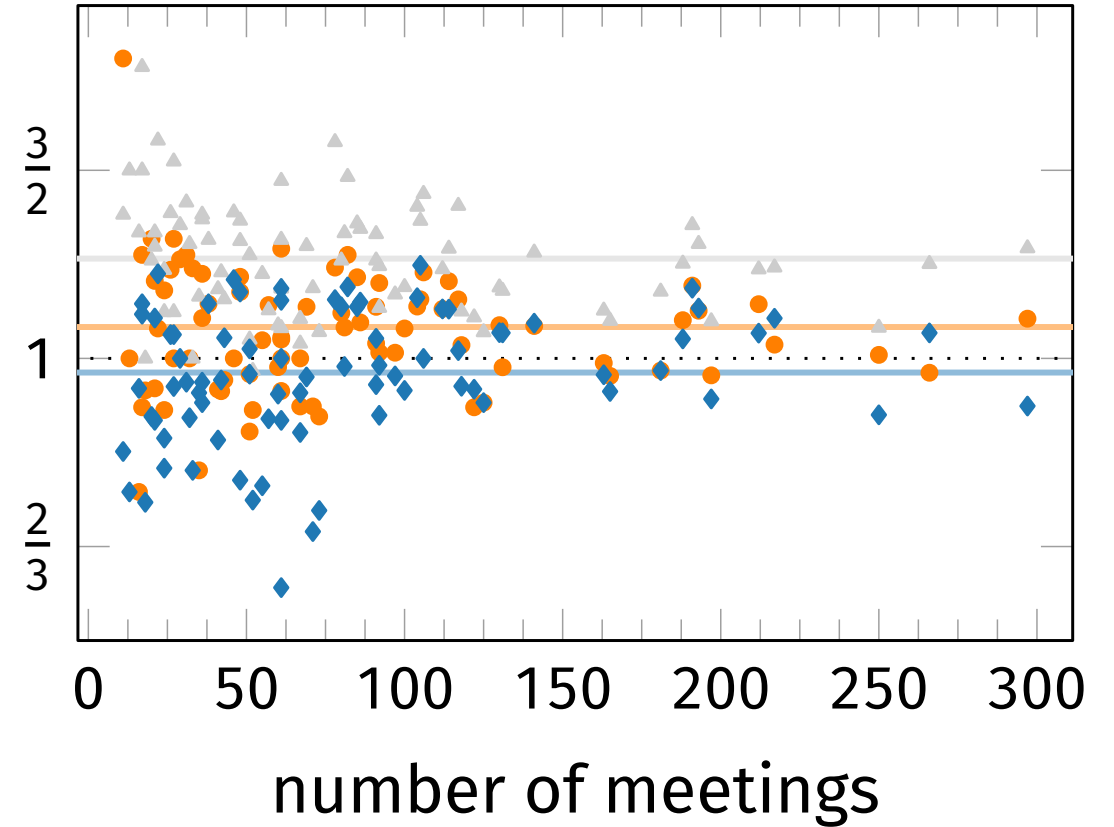


Comparison

crossings

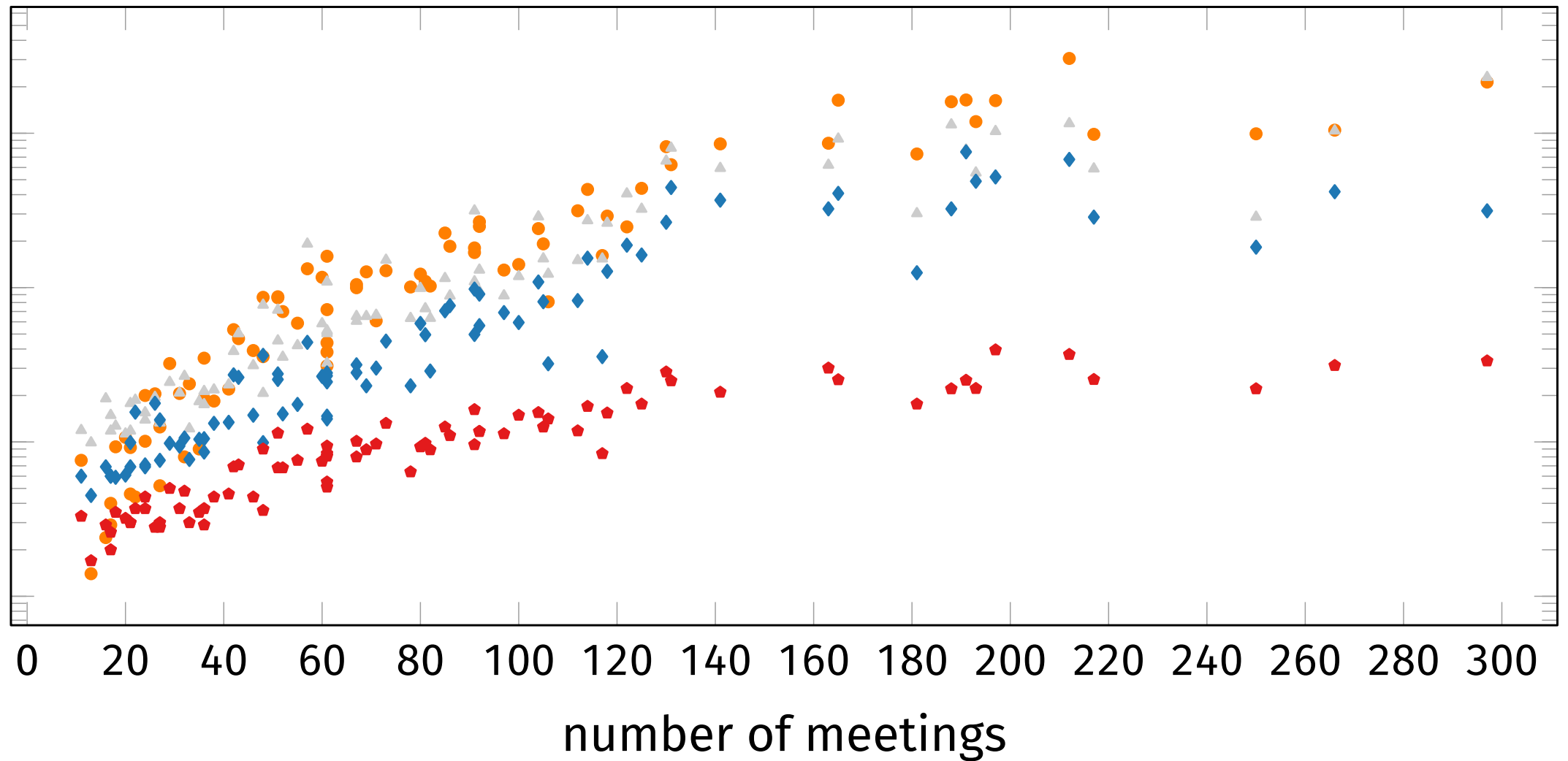


block crossings



1-Sided \blacktriangle , 2-Sided \blacklozenge , and Median \bullet relative to GreedyBlocks.
81 large instances each with 21 characters.

Running Times



1-Sided ▲, 2-Sided ◆, Median ●, and GreedyBlocks ⬠.
81 large instances each with 21 characters.