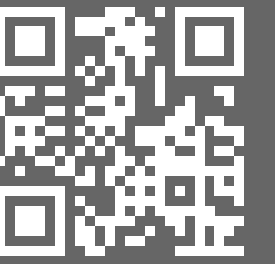


A! 

# Toward Meta-Methods for Network Analysis

Data Modeling Meets Research Validity

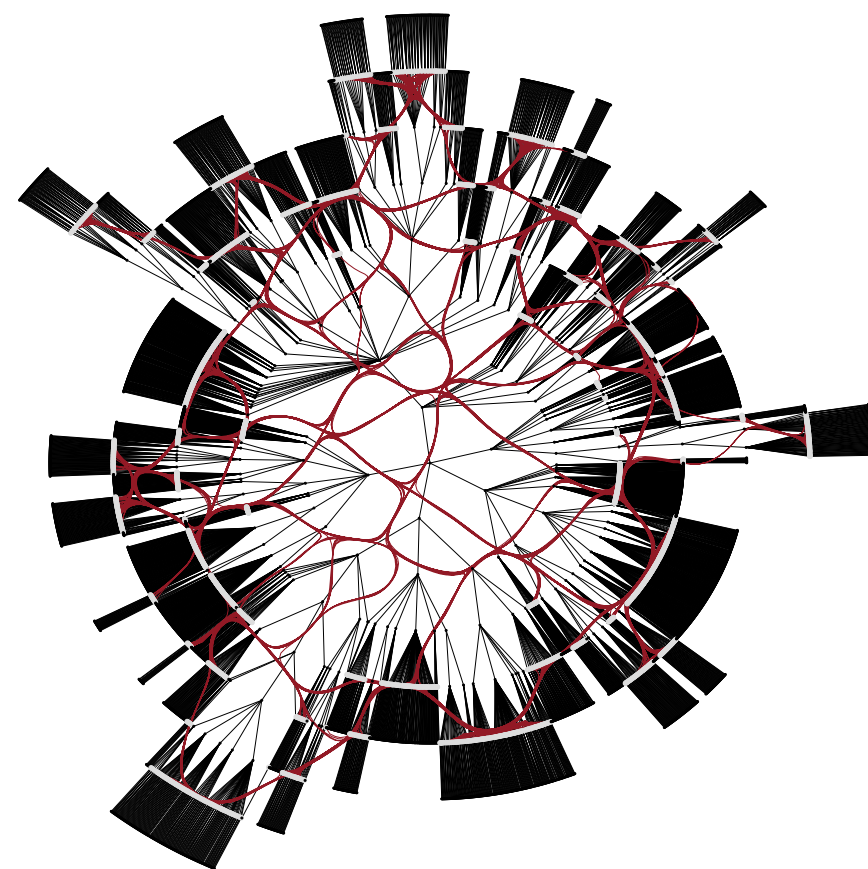
Corinna Coupette

Τέλος = Purpose

# Computational Justice

# Computer Science

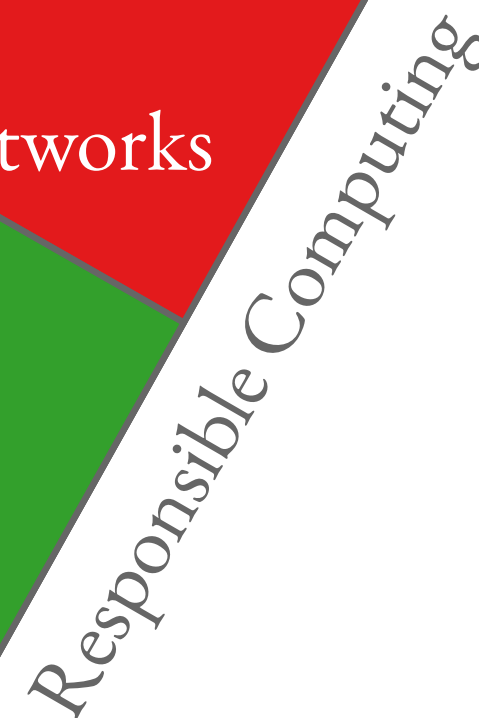
τέλος = Purpose



Legal Complexity

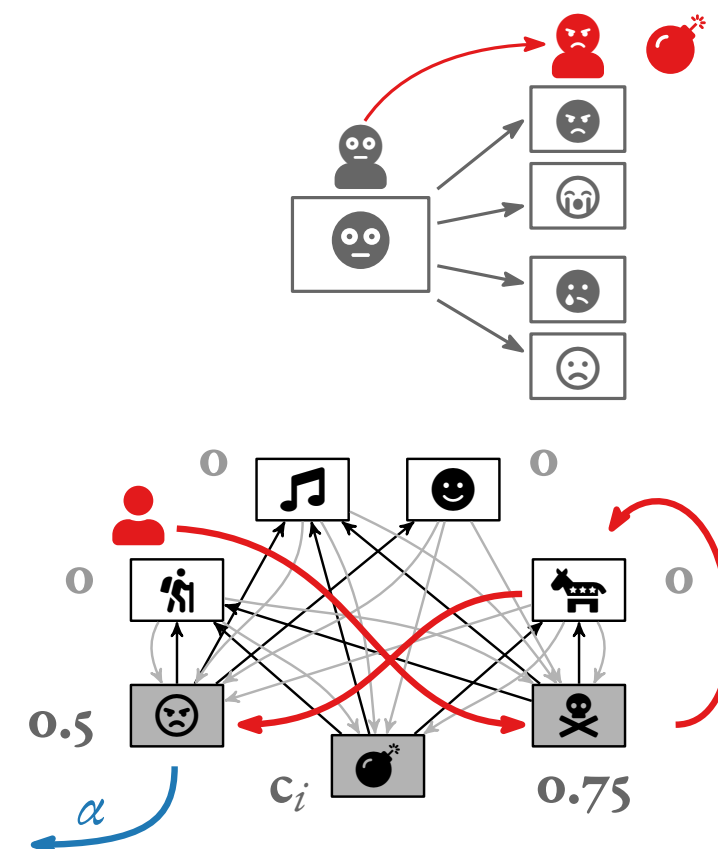
Gra

# Graphs & Networks



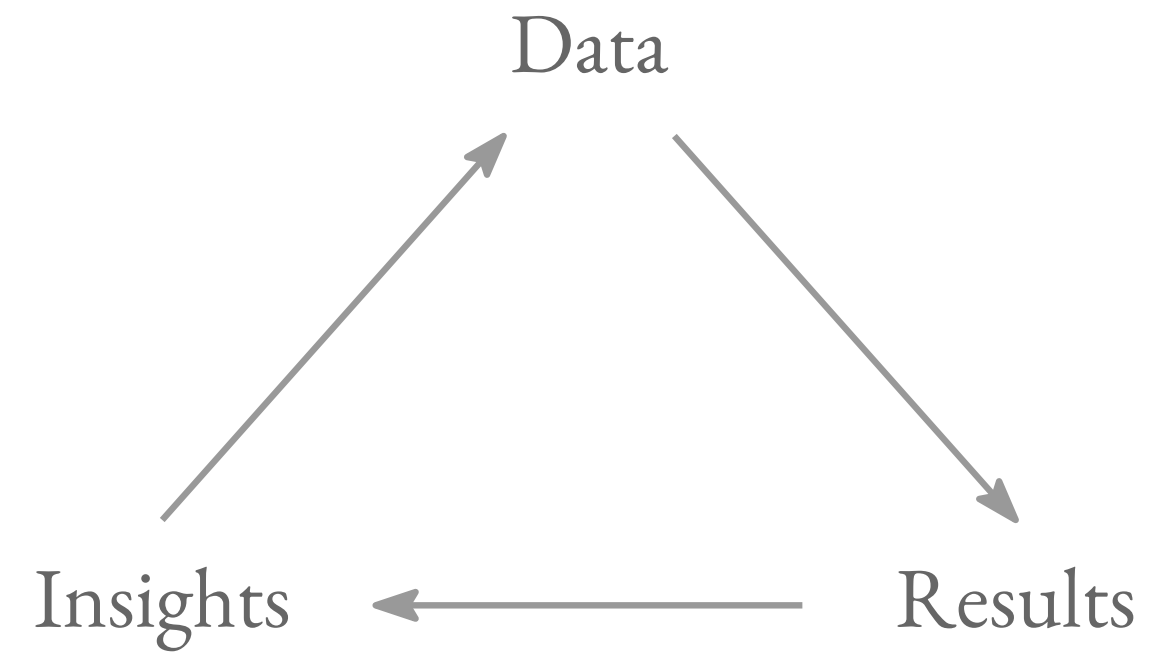
networks

Responsible Computing

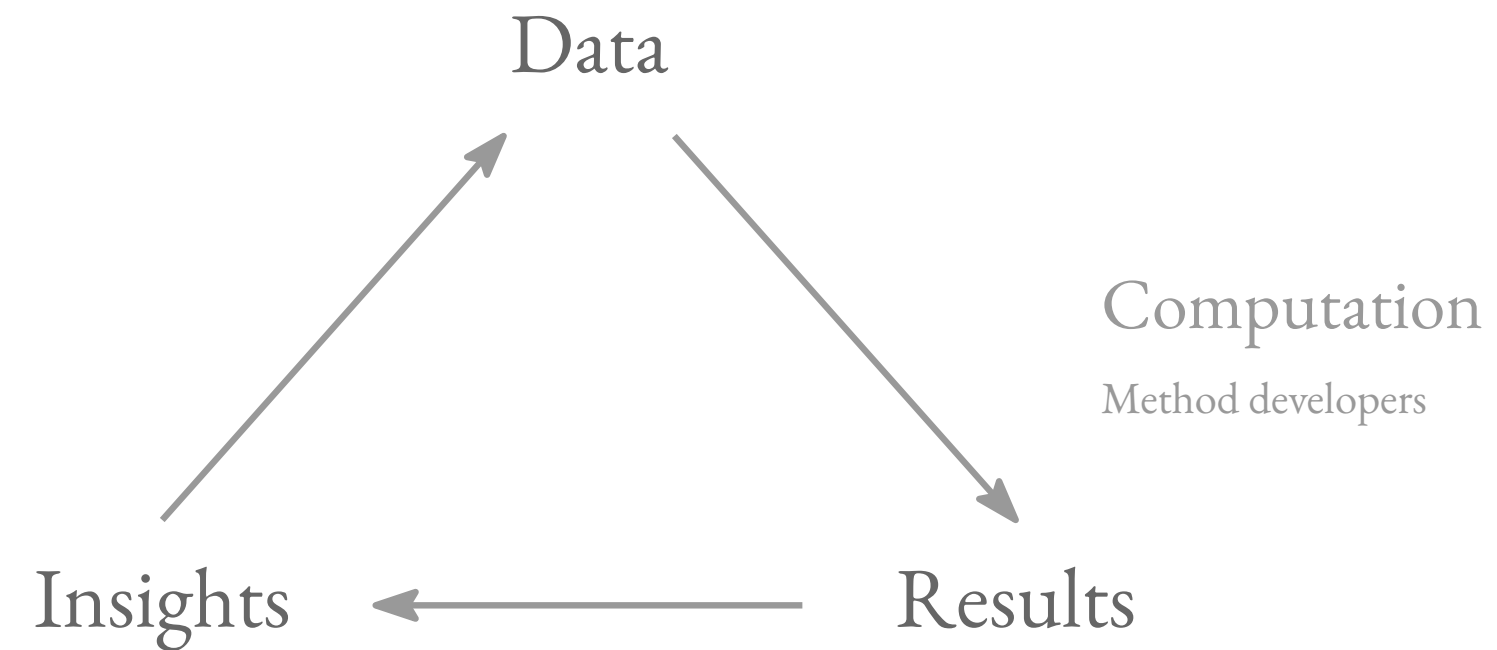
Complex Systems 

# Computational Science

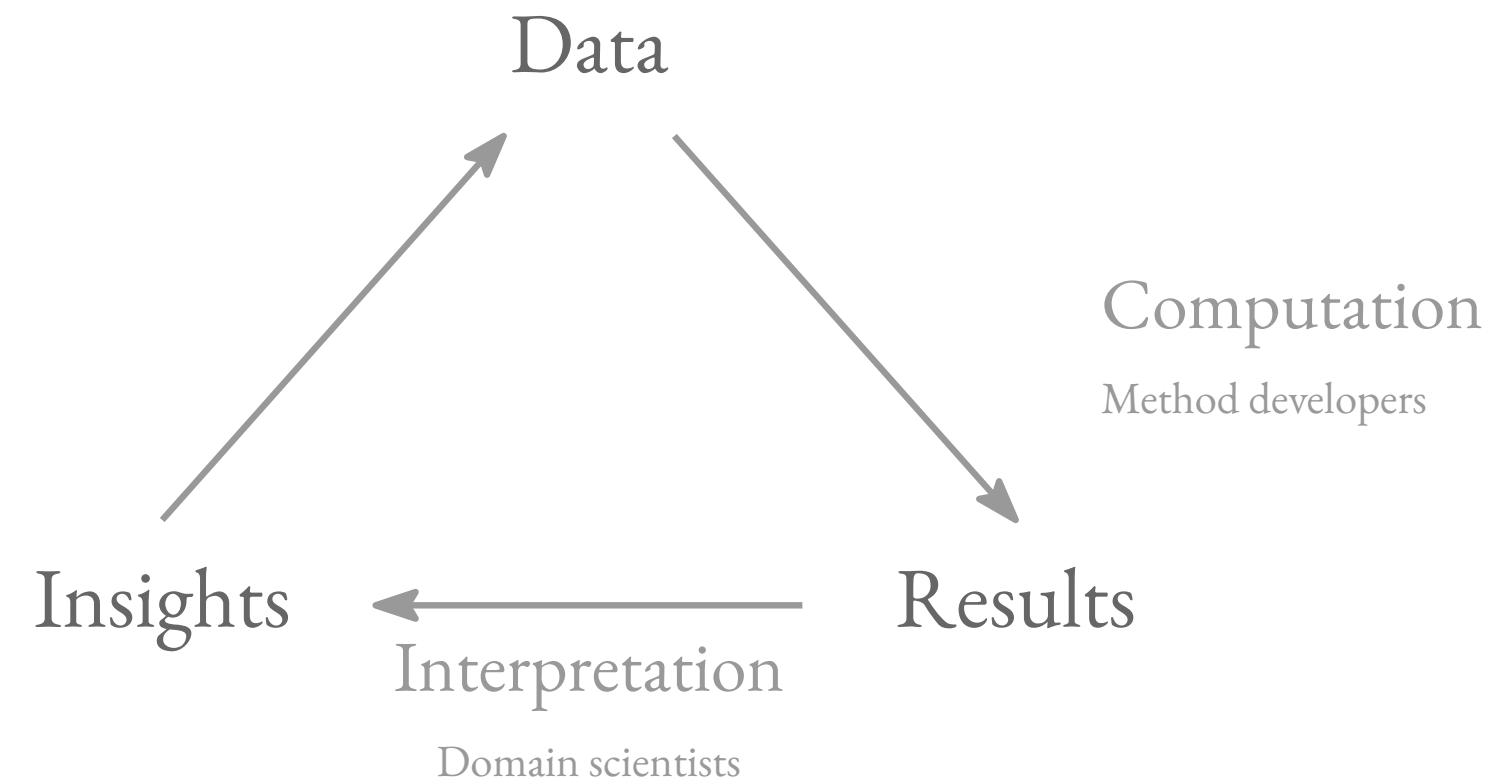
# Computational Science



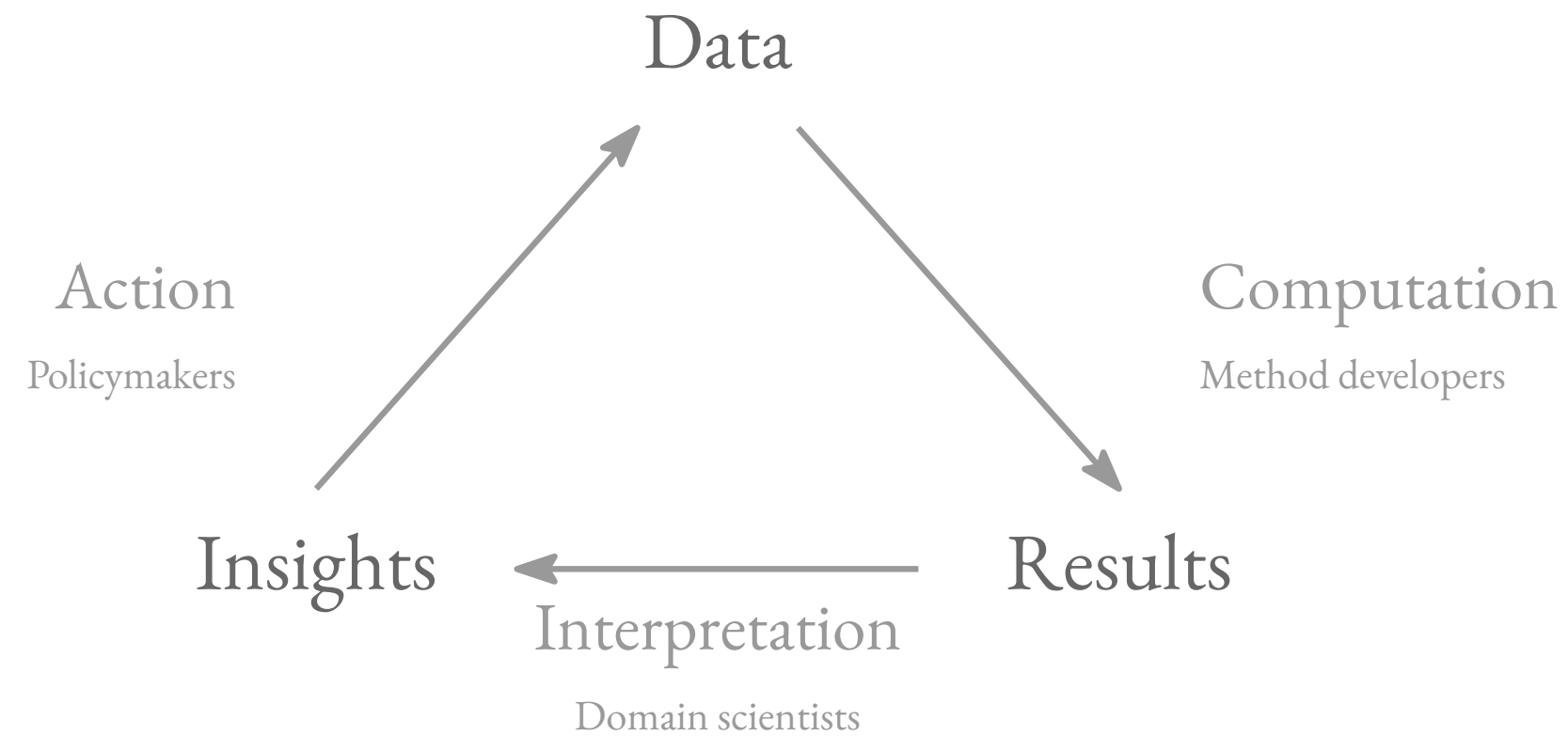
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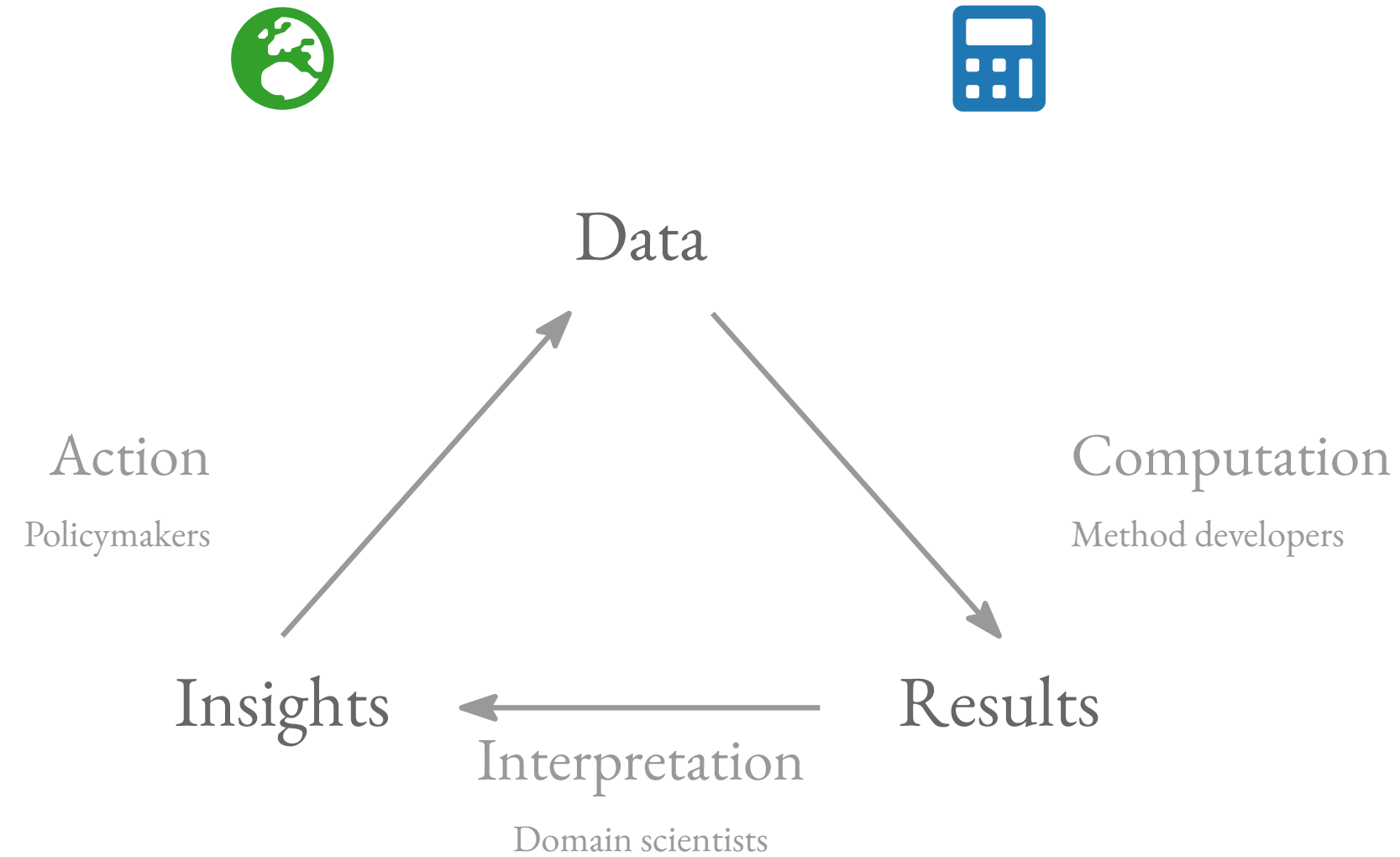
# Computational Science



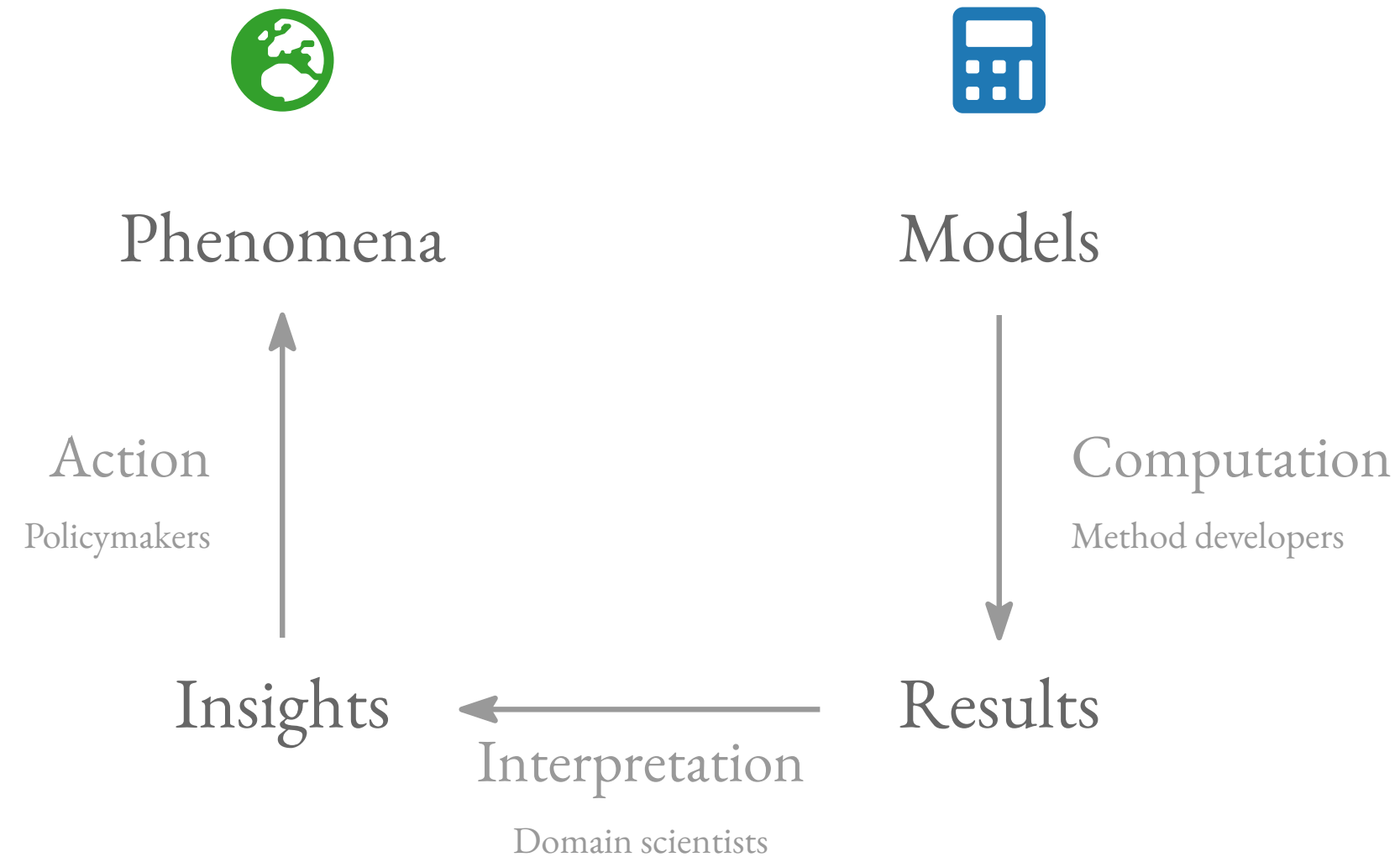
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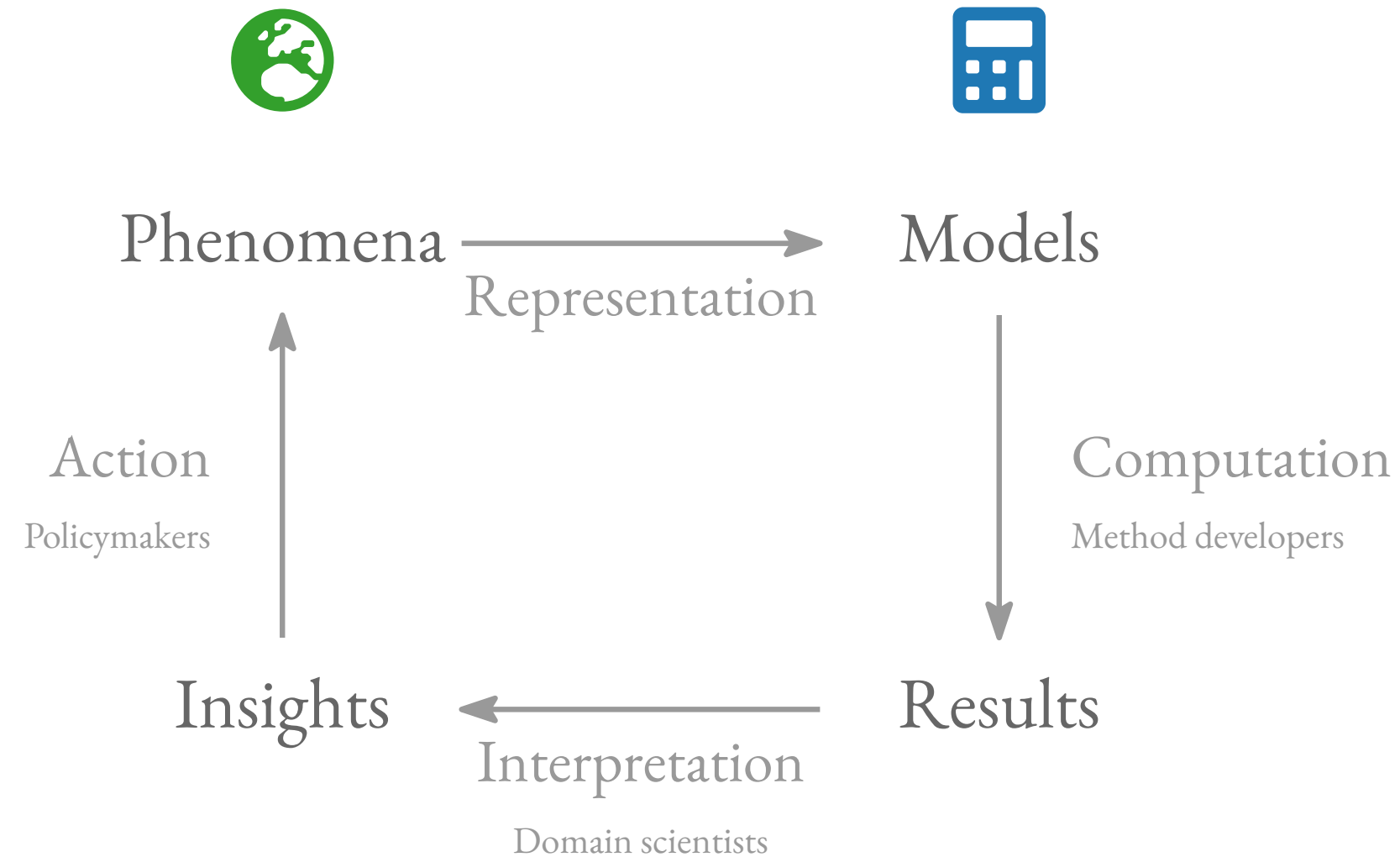
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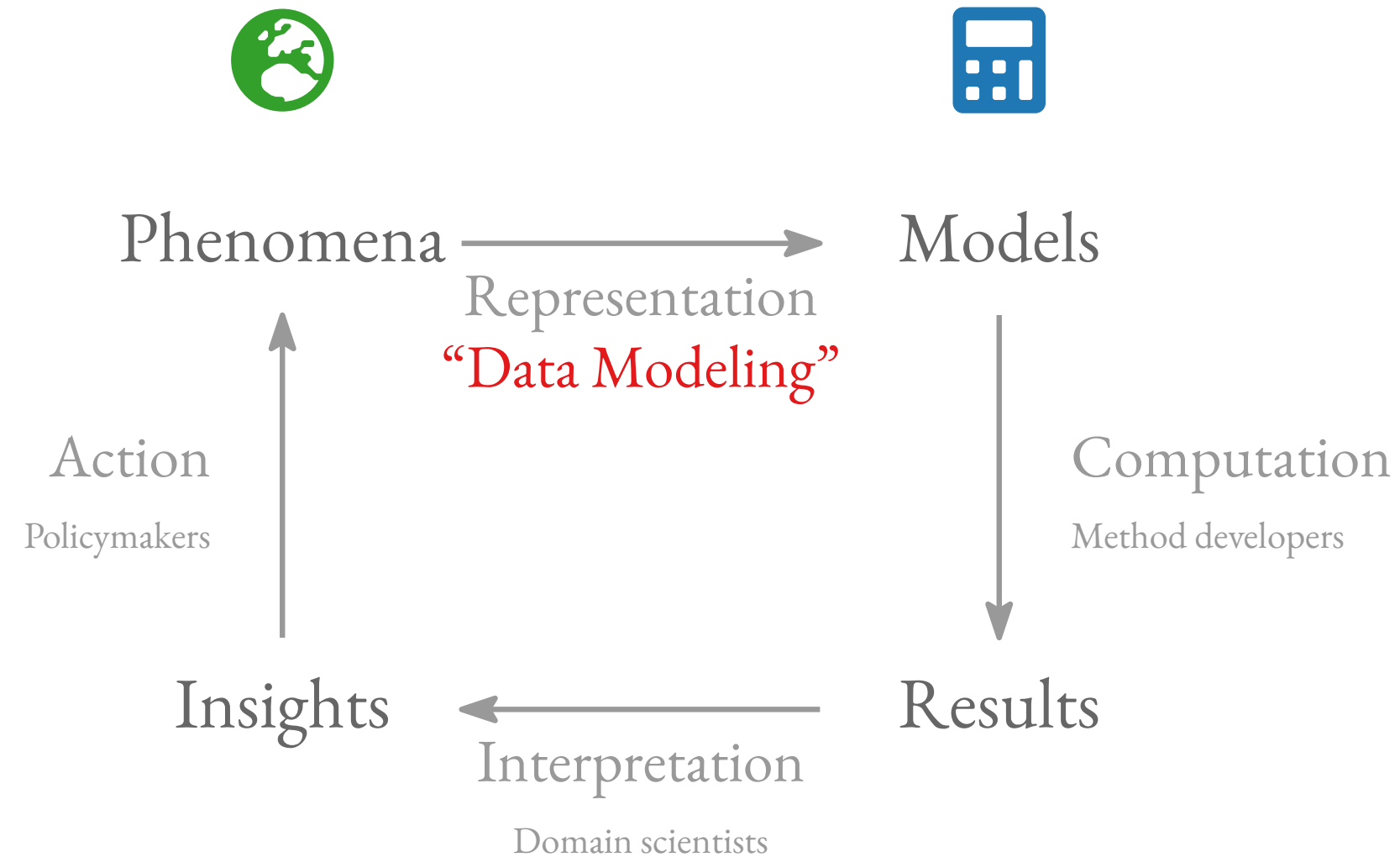
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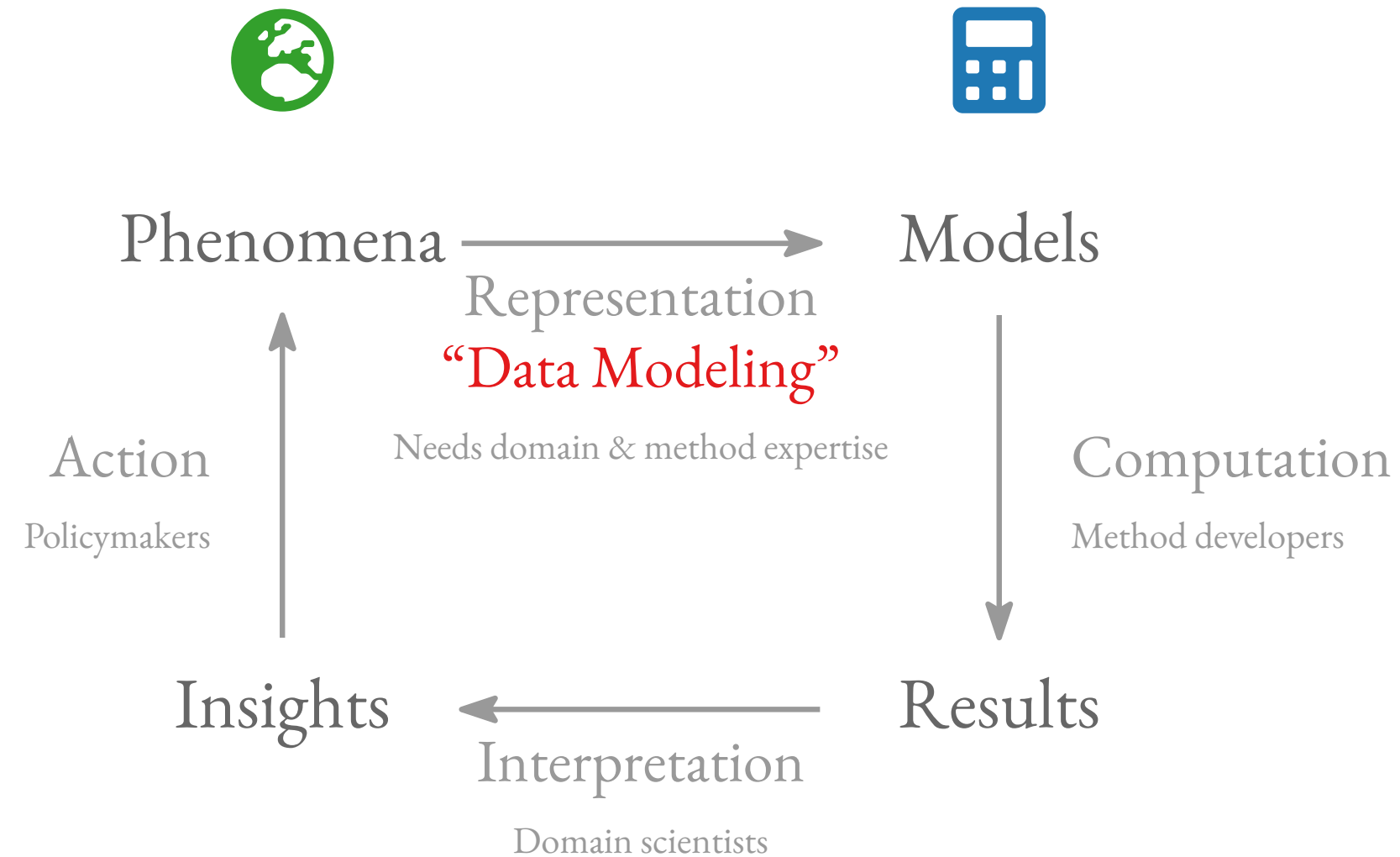
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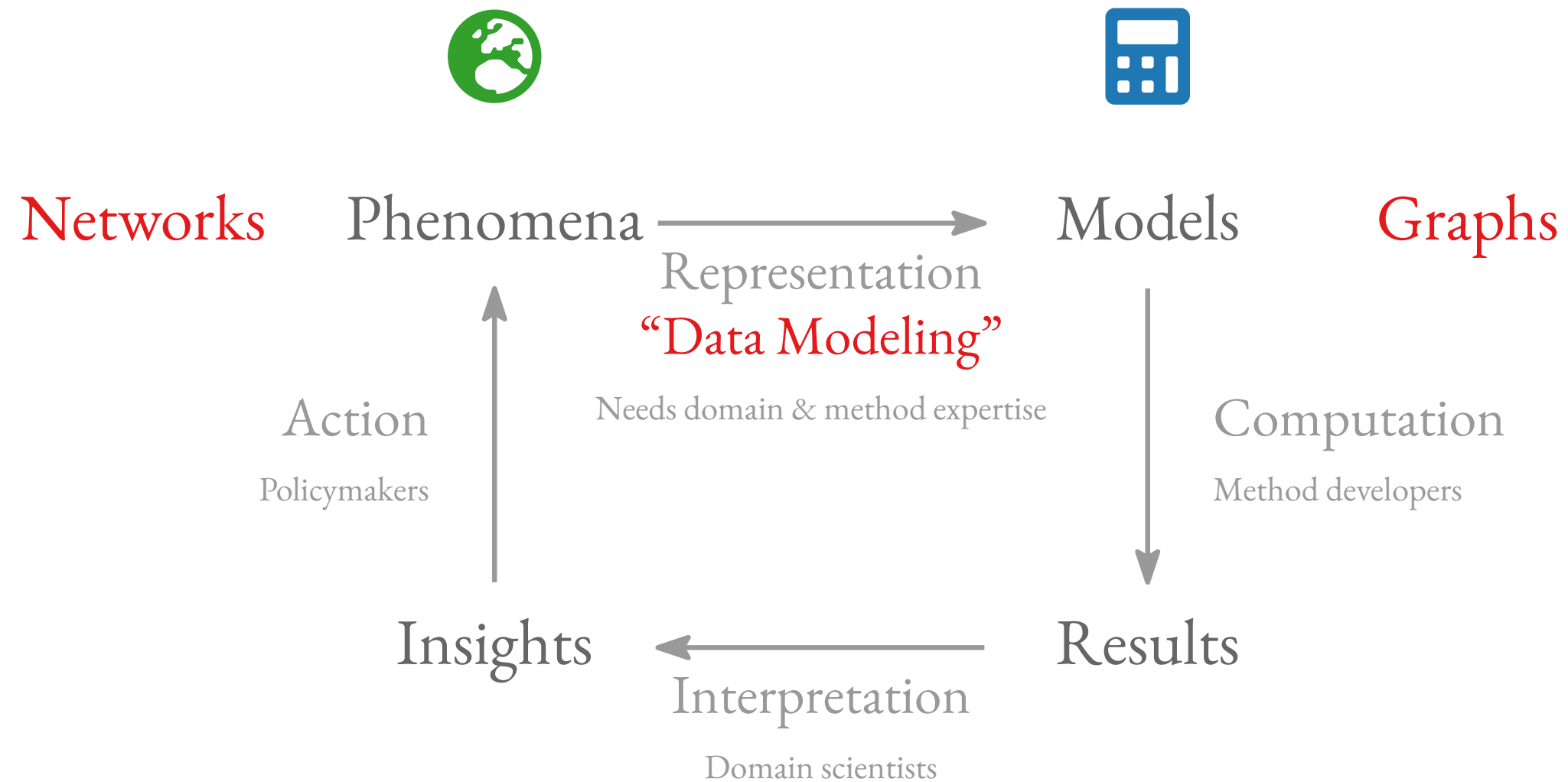
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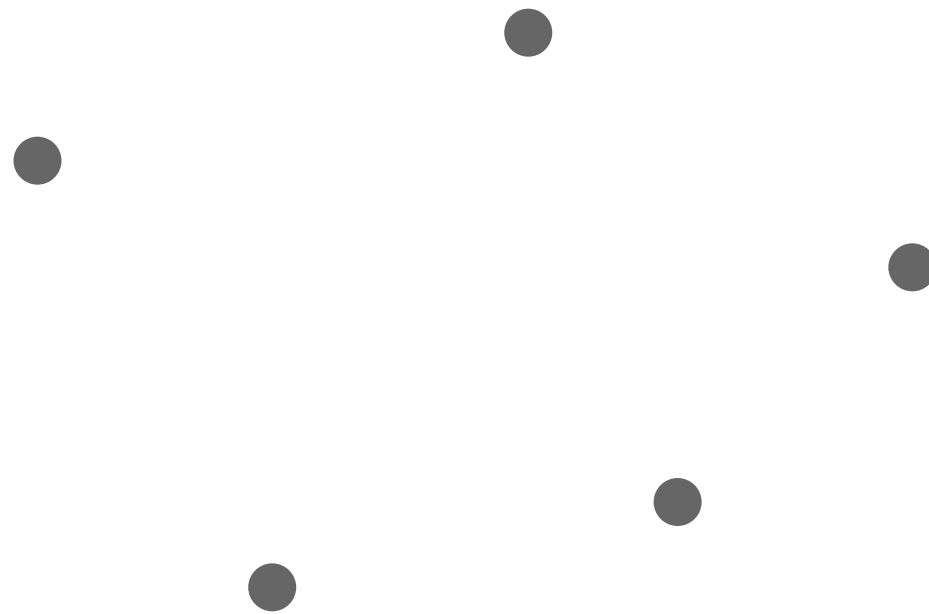
# Computational Science **for Relational Data**



# Graphs

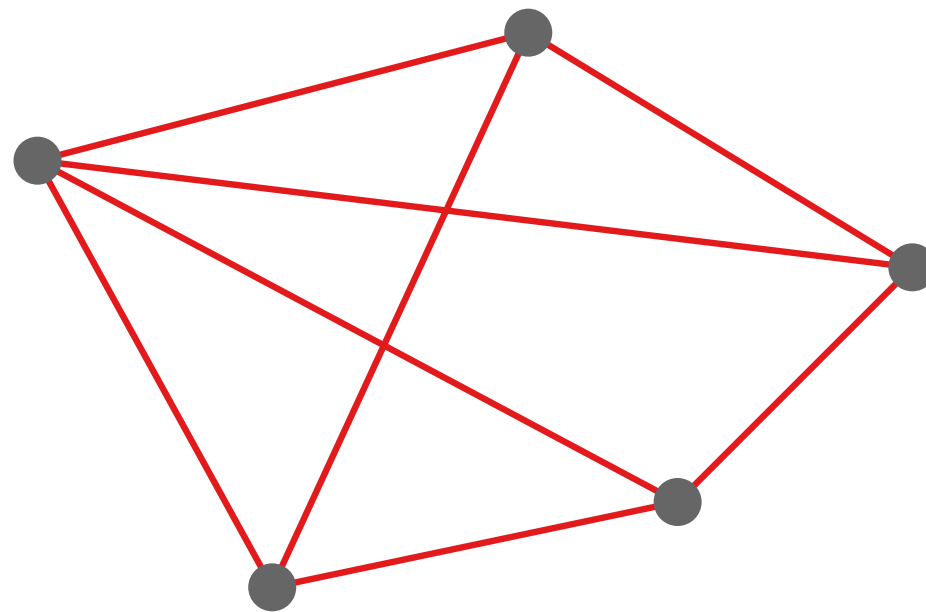
# Graphs

● Nodes  $V$

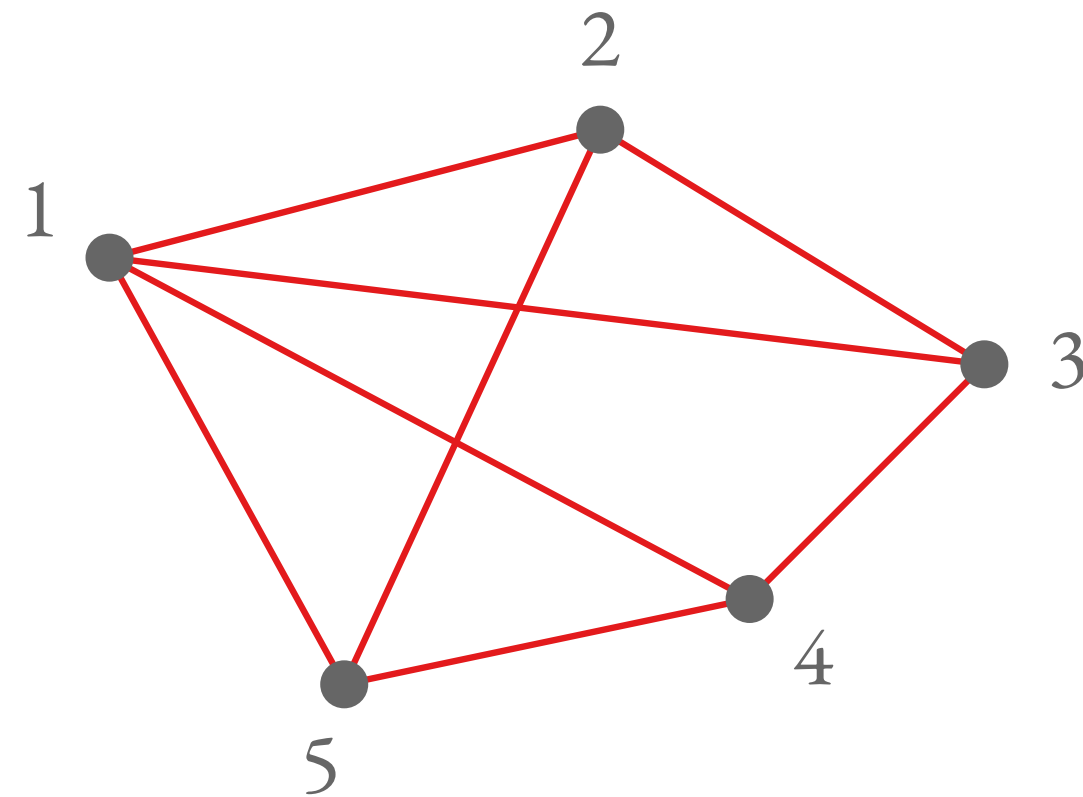


# Graphs

● Nodes  $V$   
— Edges  $E$

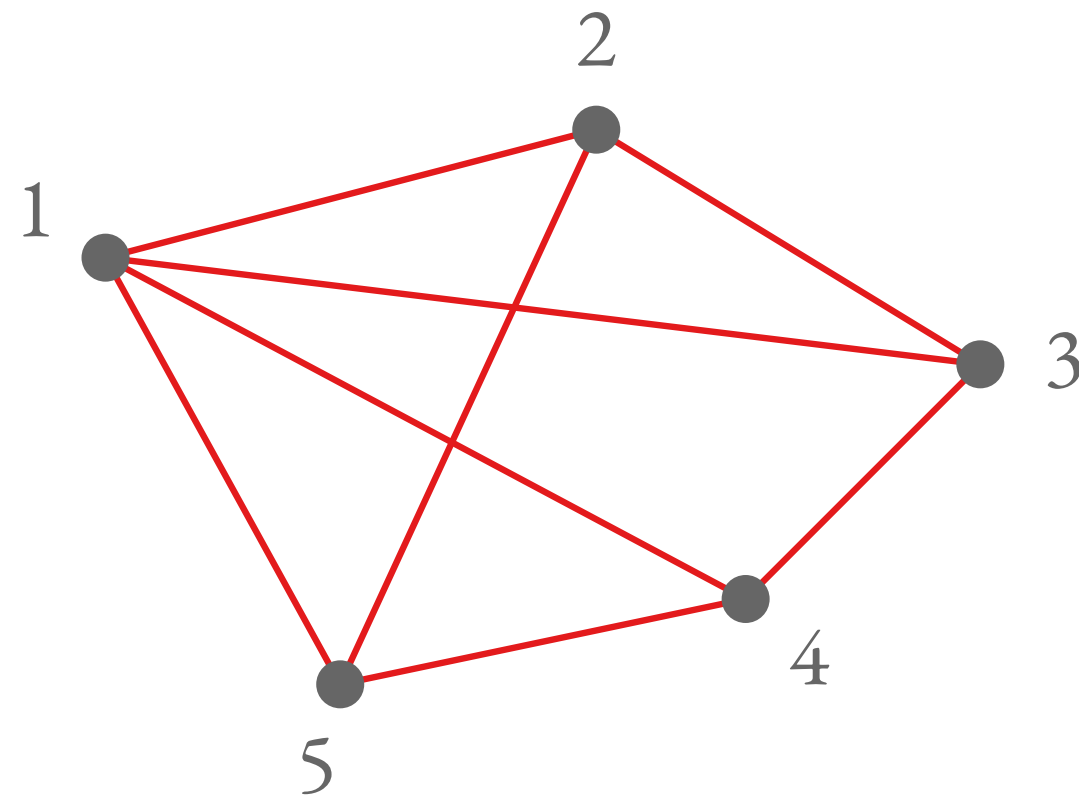


# Graphs



● Nodes  $V$   
— Edges  $E$

# Graphs



Graph  $G$

● Nodes  $V$   
— Edges  $E$

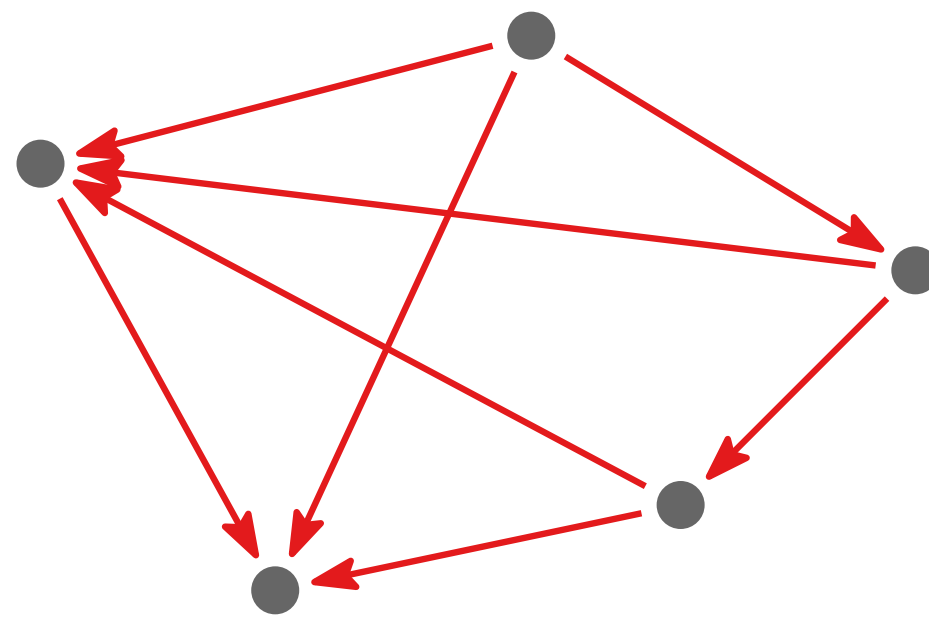
$\Leftrightarrow$

$$\begin{bmatrix} 0 & 1 & 1 & 1 & 1 \\ 1 & 0 & 1 & 0 & 1 \\ 1 & 1 & 0 & 1 & 0 \\ 1 & 0 & 1 & 0 & 1 \\ 1 & 1 & 0 & 1 & 0 \end{bmatrix}$$

Adjacency Matrix  $A$

# Graphs

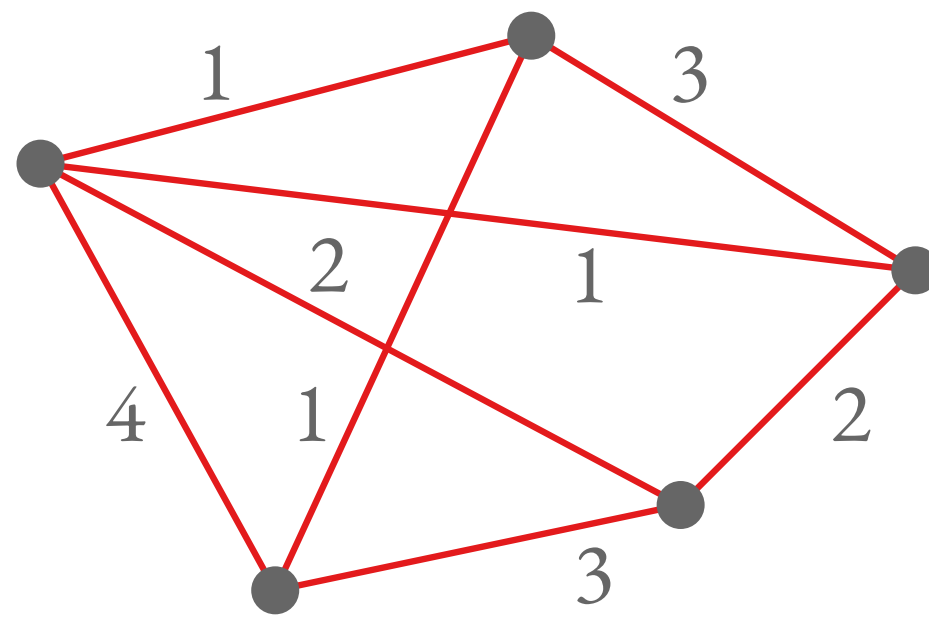
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Directed Graph

# Graphs

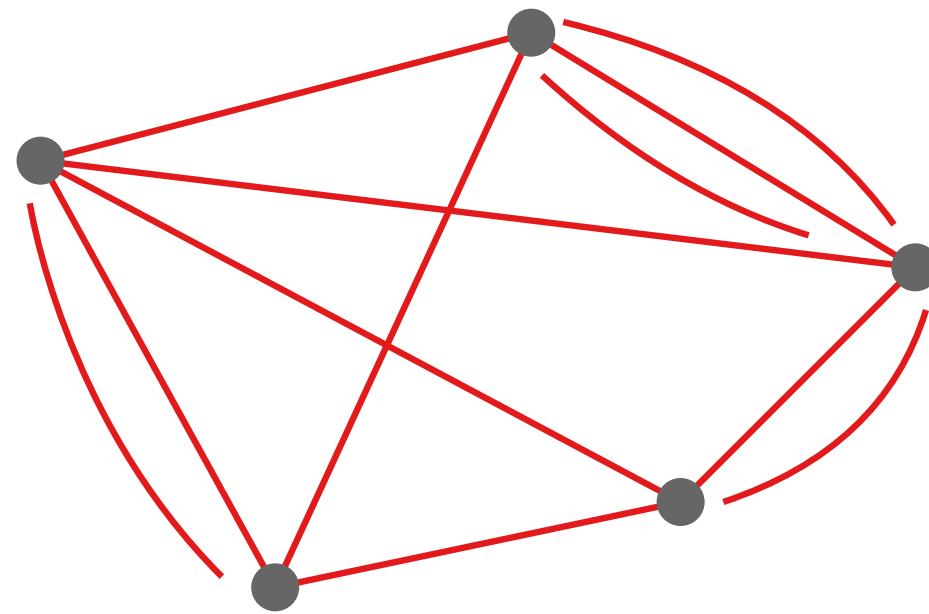
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Weighted Graph

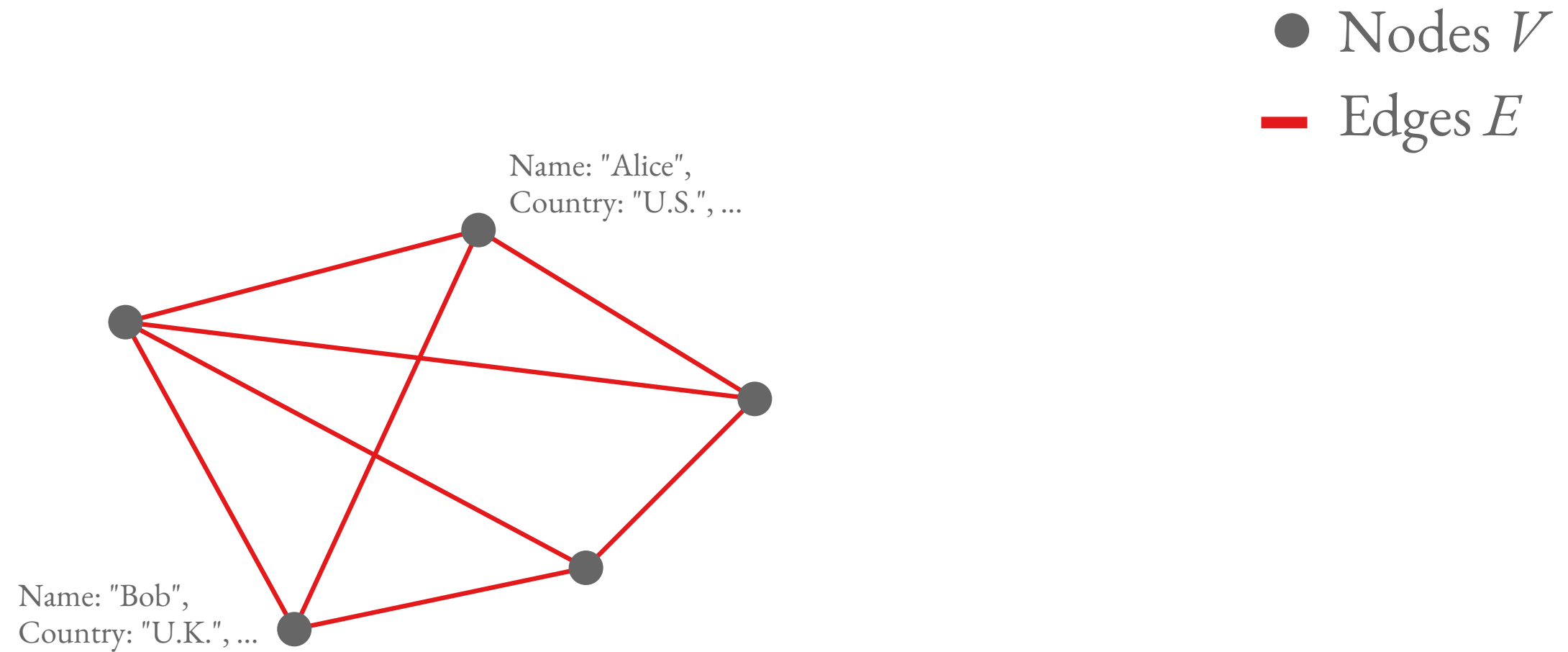
# Graphs

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Multigraph

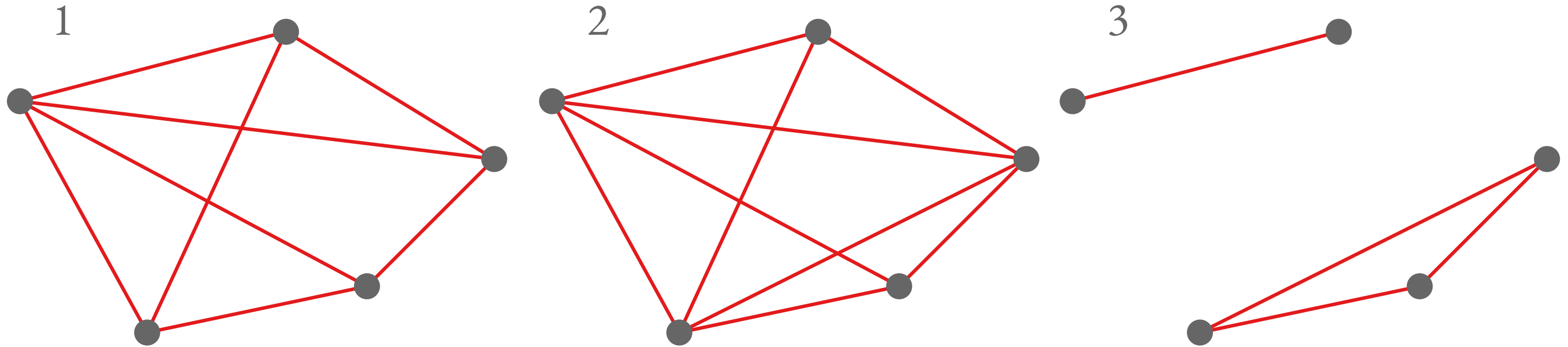
# Graphs



Attributed Graph

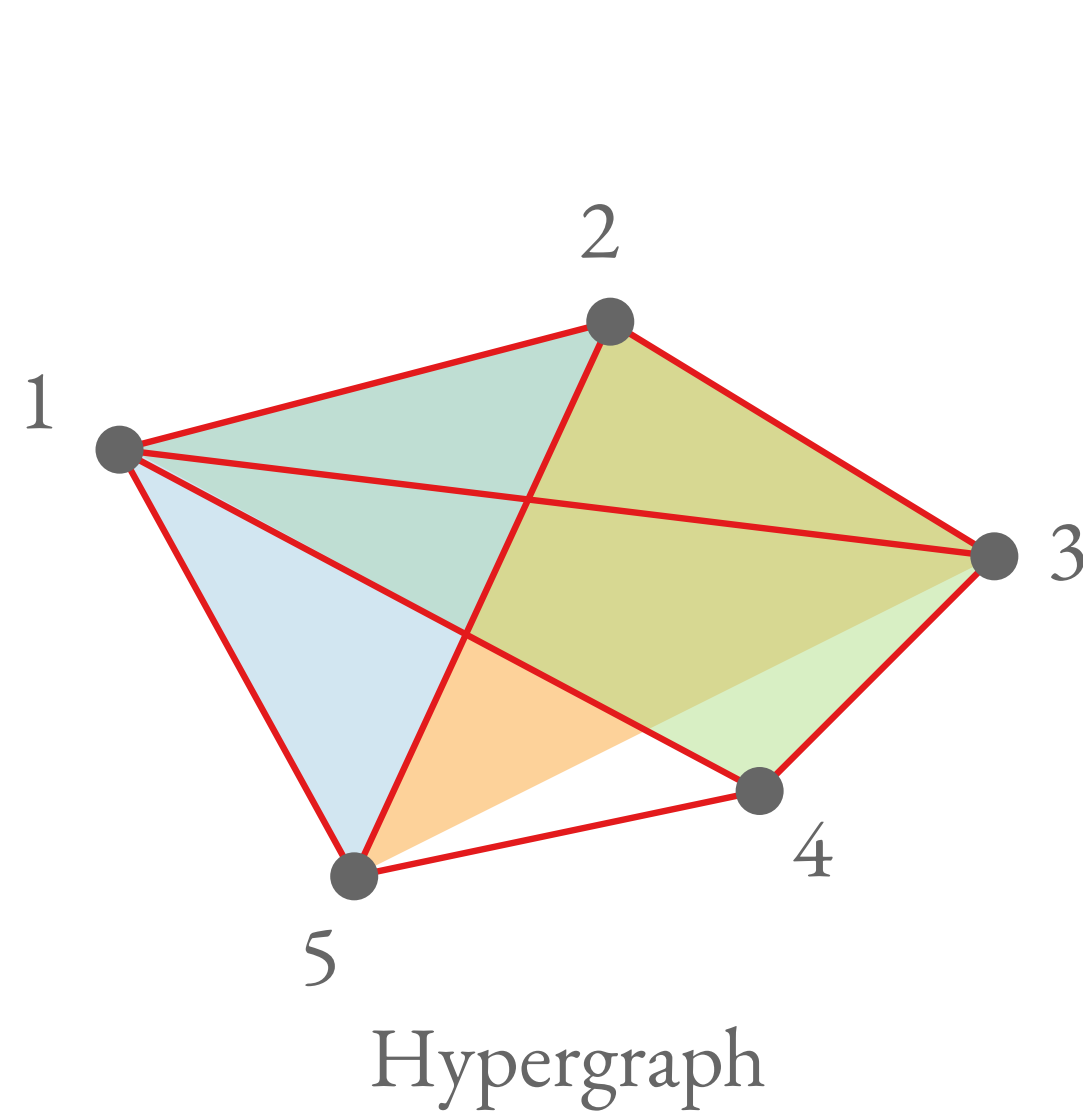
# Graphs

● Nodes  $V$   
— Edges  $E$



Temporal Graph

# Graphs



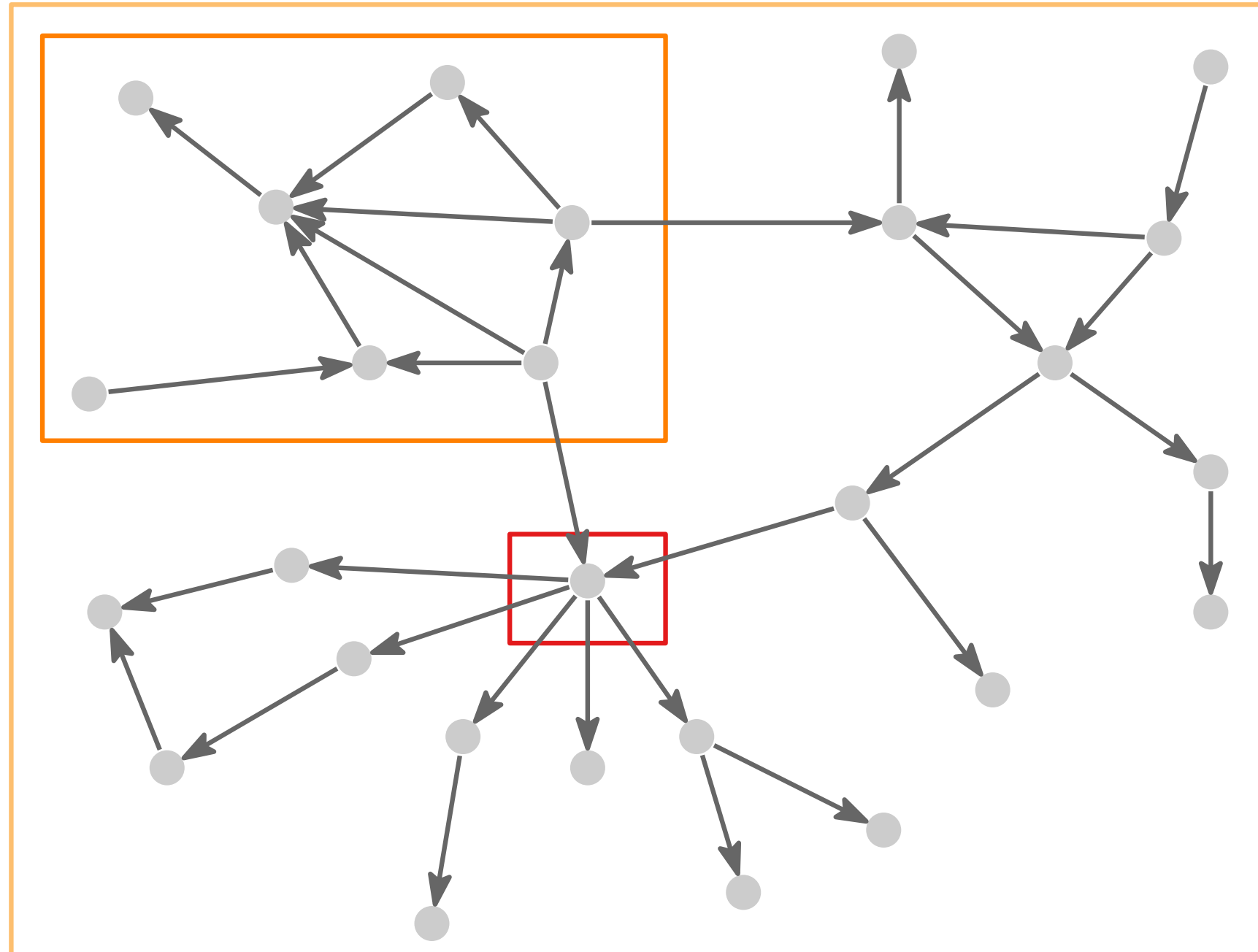
● Nodes  $V$   
— Edges  $E$

$$h_1 = \{1, 2, 5\}$$

$$h_2 = \{1, 3, 4, 5\}$$

$$h_3 = \{1, 3, 5\}$$

# Network Analysis



Micro Level

Nodes & Neighborhoods

Meso Level

Motifs & Communities

Macro Level

Statistics & Invariants

# Research Validity

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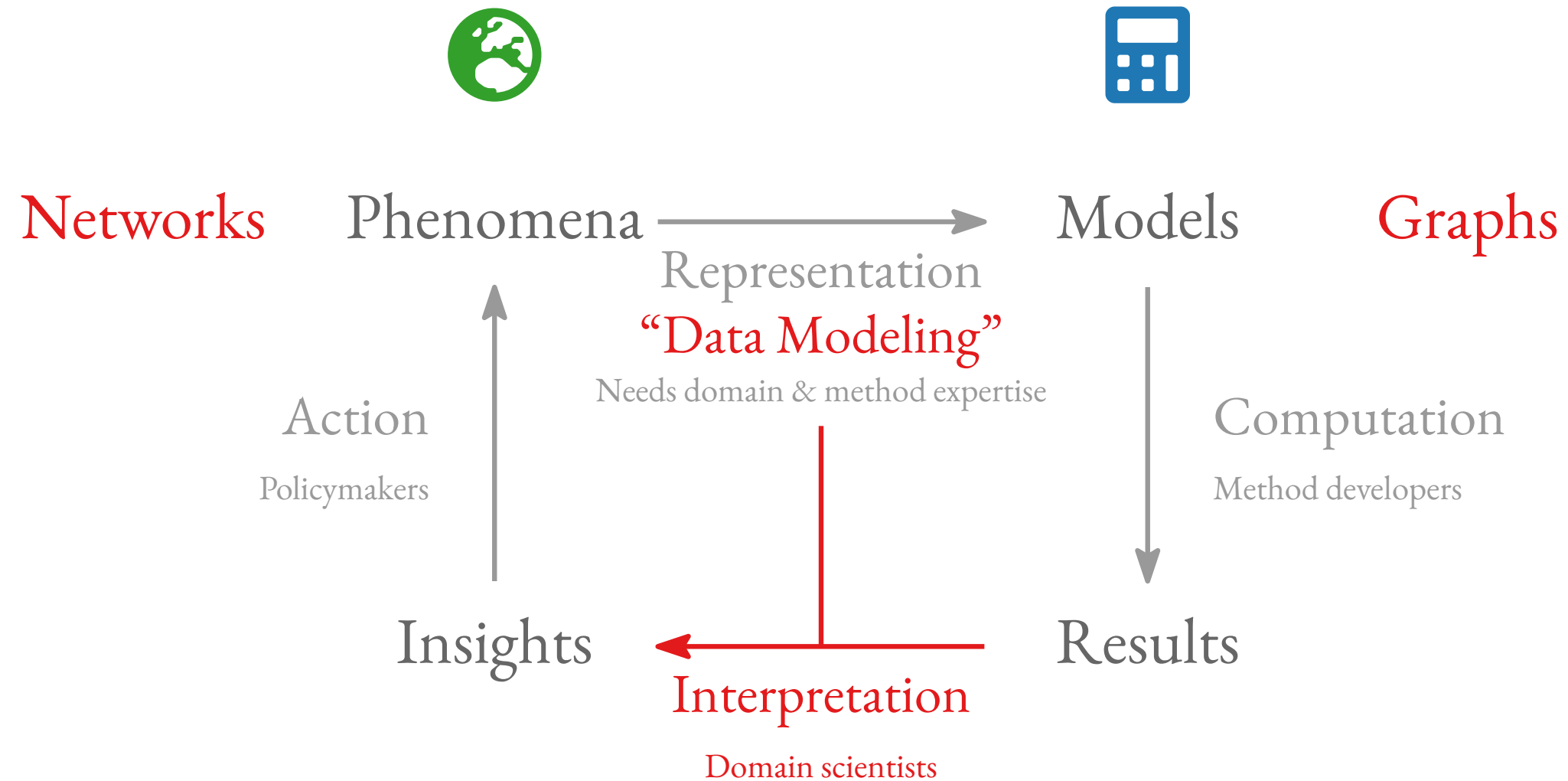
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Where do we stand, 13 years later?

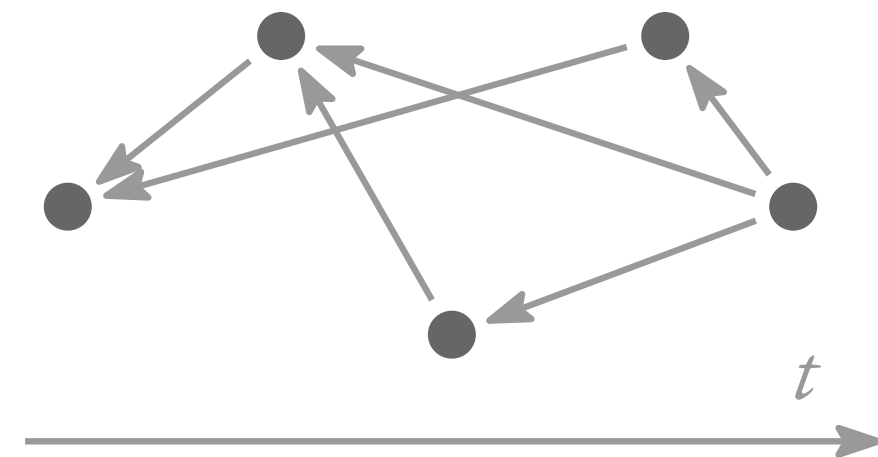
# Threats to Validity: *Experience as a Domain Scientist*



# Judicial Citation Networks

# Judicial Citation Networks

Traditional View



Nodes = Decisions

Edges = Citations\*

DAG-like

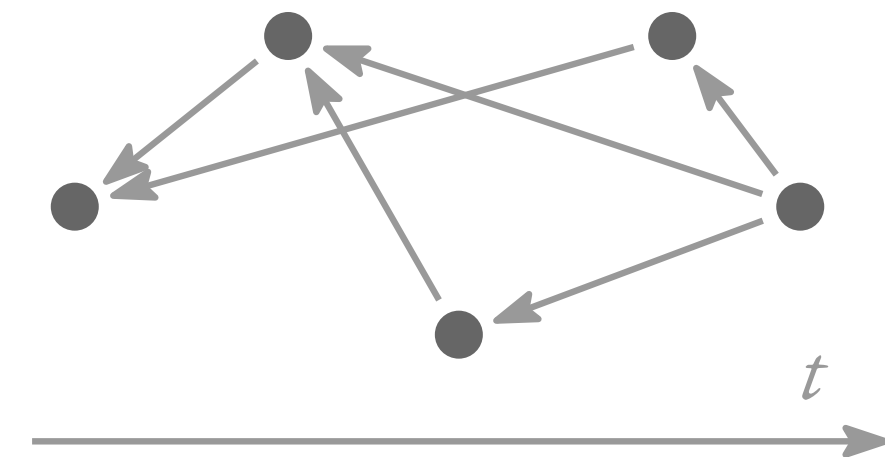
Analyzed as aggregate

# Judicial Citation Networks

BVerfGE 120, 274, Para. 271

aa) Covert surveillance measures by the state must respect an inviolable core of private life protected under Art. 1(1) of the Basic Law (cf. BVerfGE 6, 32 <41>; 27, 1 <6>; 32, 373 <378 and 379>; 34, 238 <245>; 80, 367 <373>; 109, 279 <313>; 113, 348 <390>). Even overriding public interests cannot justify an interference with this core (cf. BVerfGE 34, 238 <245>; 109, 279 <313>). The development of one's personality within the core of private life encompasses the possibility of expressing internal processes such as emotions and feelings, as well as reflections, views and experiences of a highly personal nature, without fear of surveillance by state authorities (cf. BVerfGE 109, 279 <314>).

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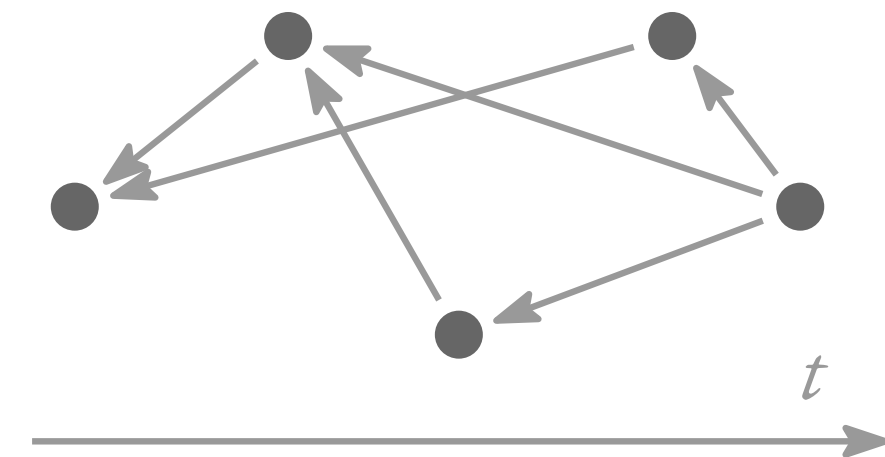
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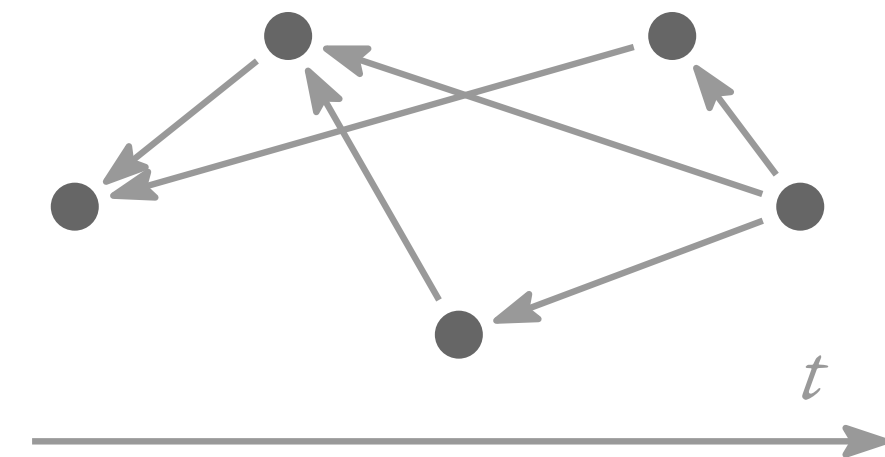
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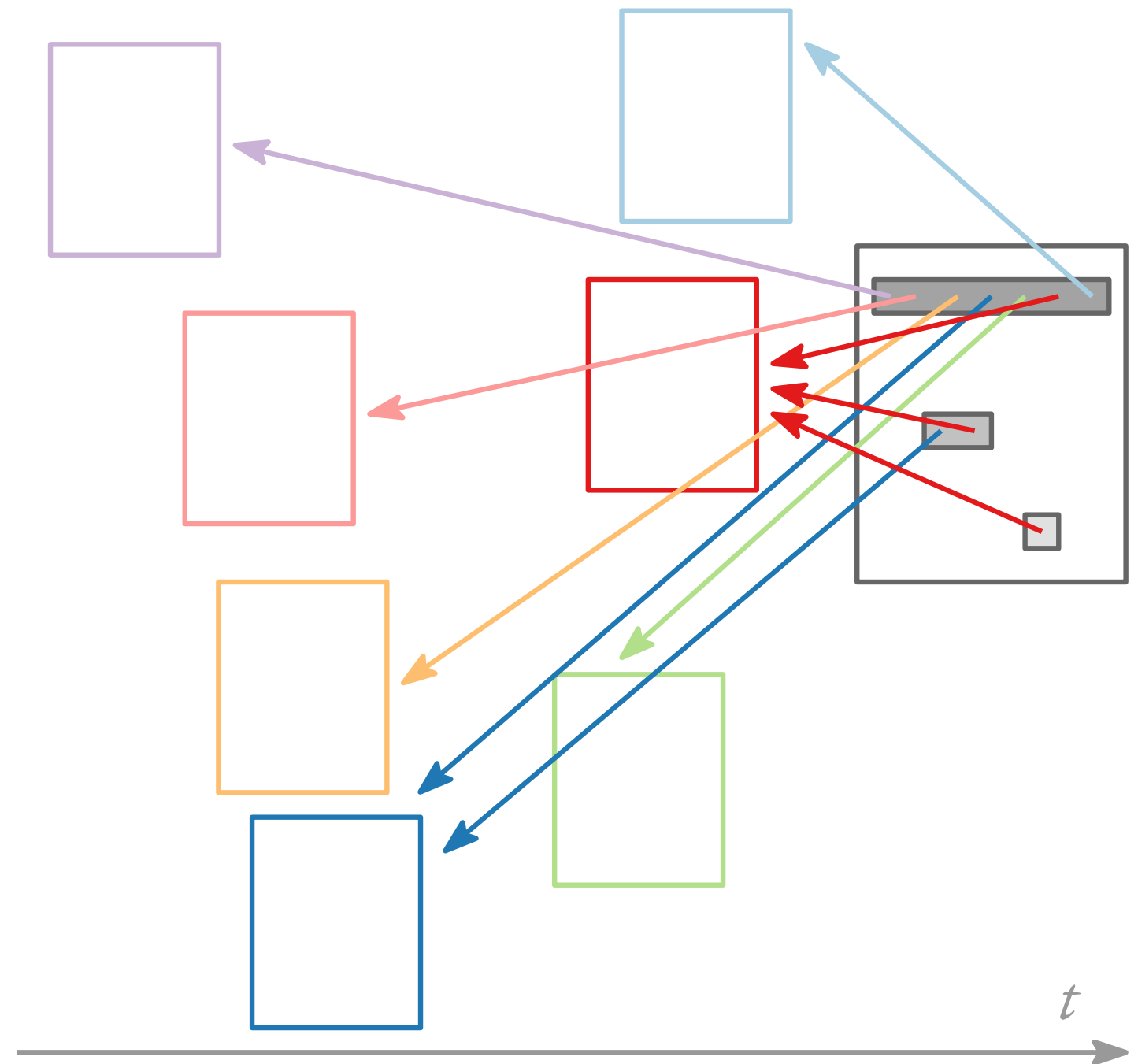
DAG-like

Analyzed as aggregate

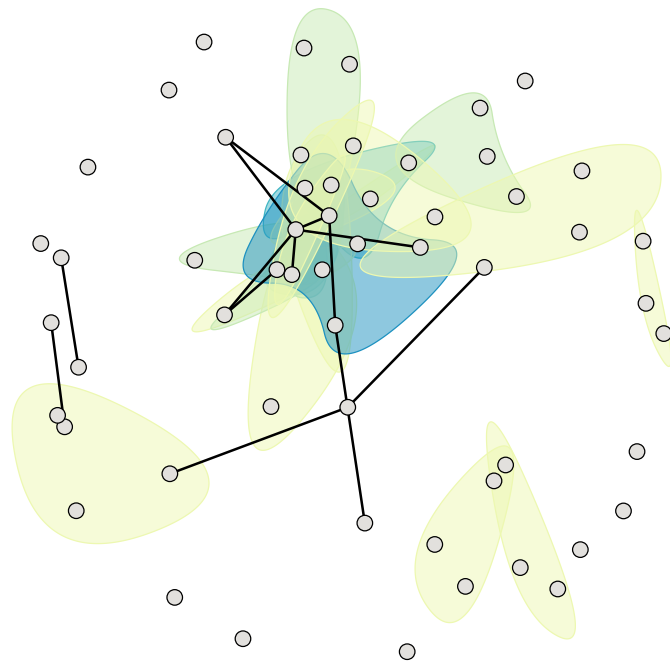
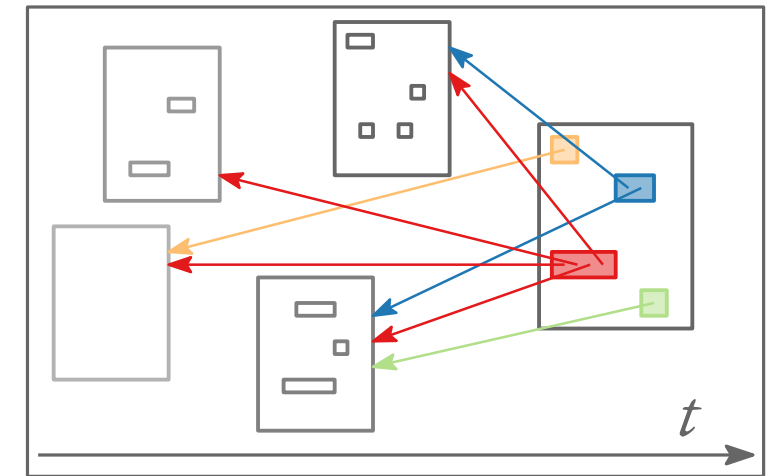
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BVerfGE 120, 274, Para. 27I

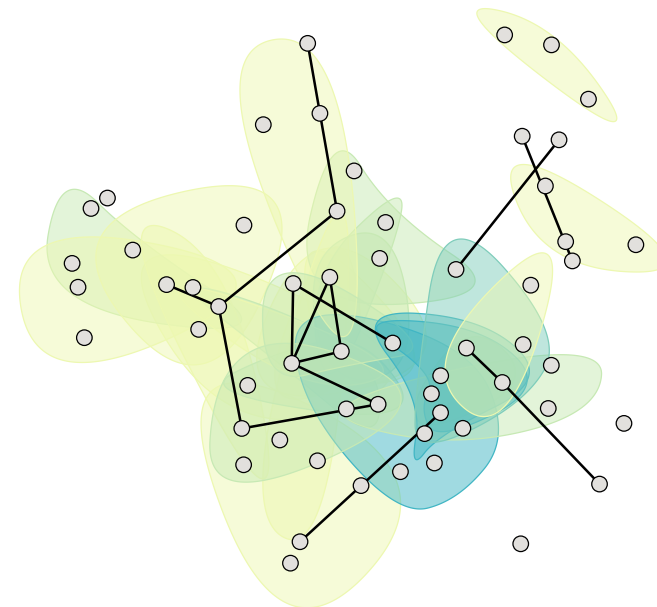
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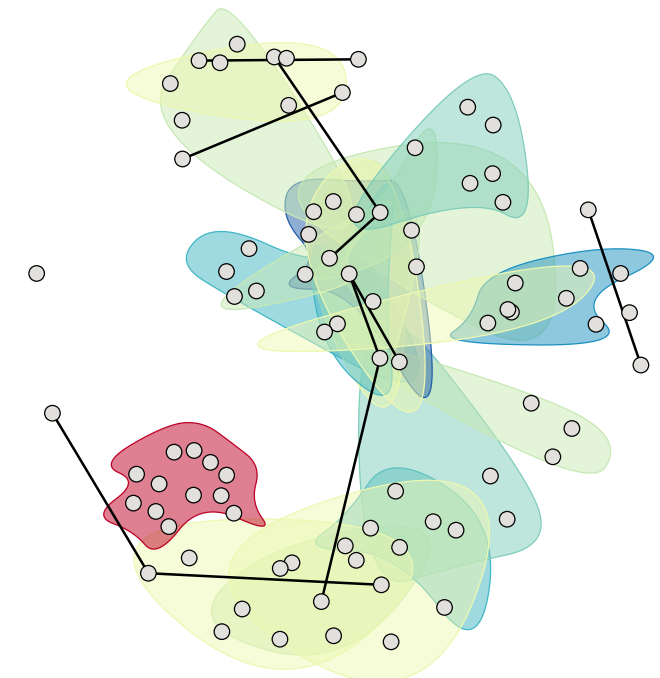
# Judicial Citation Networks



BVerfGE 125, 260—Retention of Data



BVerfGE 153, 317—ESM Treaty

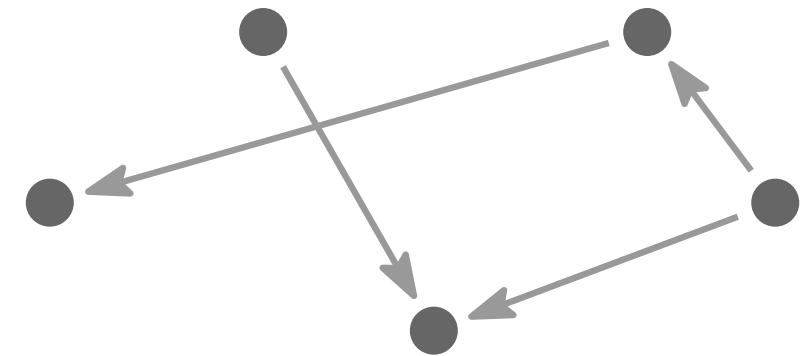


BVerfGE 153, 1—Headscarf III

# Modeling Legislative Networks

# Modeling Legislative Networks

Traditional View



Nodes = Legal Norms\*

Edges = Citations\*

DAG-like

Analyzed as snapshot

# Modeling Legislative Networks

LII > U.S. Code > Title 15 > CHAPTER 1 > § 15

## 15 U.S. Code § 15 - Suits by persons injured

U.S. Code

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**(a) AMOUNT OF RECOVERY; PREJUDGMENT INTEREST**

Except as provided in subsection (b), any [person](#) who shall be injured in his business or property by reason of anything forbidden in the [antitrust laws](#) may sue therefor in any district court of the United [States](#) in the district in which the defendant resides or is found or has an agent, without respect to the amount in controversy, and shall recover threefold the damages by him sustained, and the cost of suit, including a reasonable attorney's fee. The court may award under this section, pursuant to a motion by such [person](#) promptly made, simple interest on actual damages for the period beginning on the date of service of such [person's](#) pleading setting forth a claim under the [antitrust laws](#) and ending on the date of judgment, or for any shorter period therein, if the court finds that the award of such interest for such period is just in the circumstances. In determining whether an award of interest under this section for any period is just in the circumstances, the court shall consider only—

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**(b) AMOUNT OF DAMAGES PAYABLE TO FOREIGN STATES AND INSTRUMENTALITIES OF FOREIGN STATES**

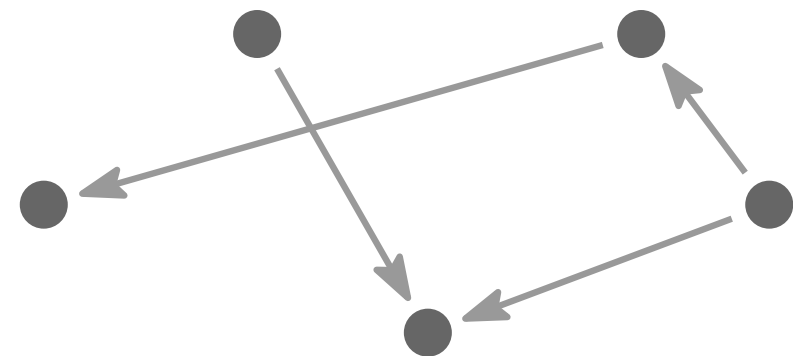
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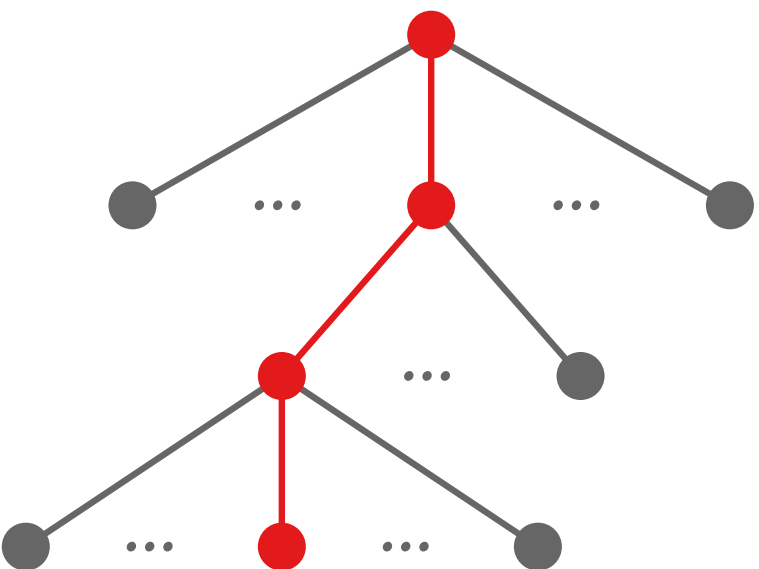
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## 15 U.S. Code § 15 - Suits by persons injured

U.S. Code

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[LII](#) > [U.S. Code](#) > [Title 15](#) > [CHAPTER 1](#) > **§ 15**

## 15 U.S. Code § 15 - Suits by persons injured

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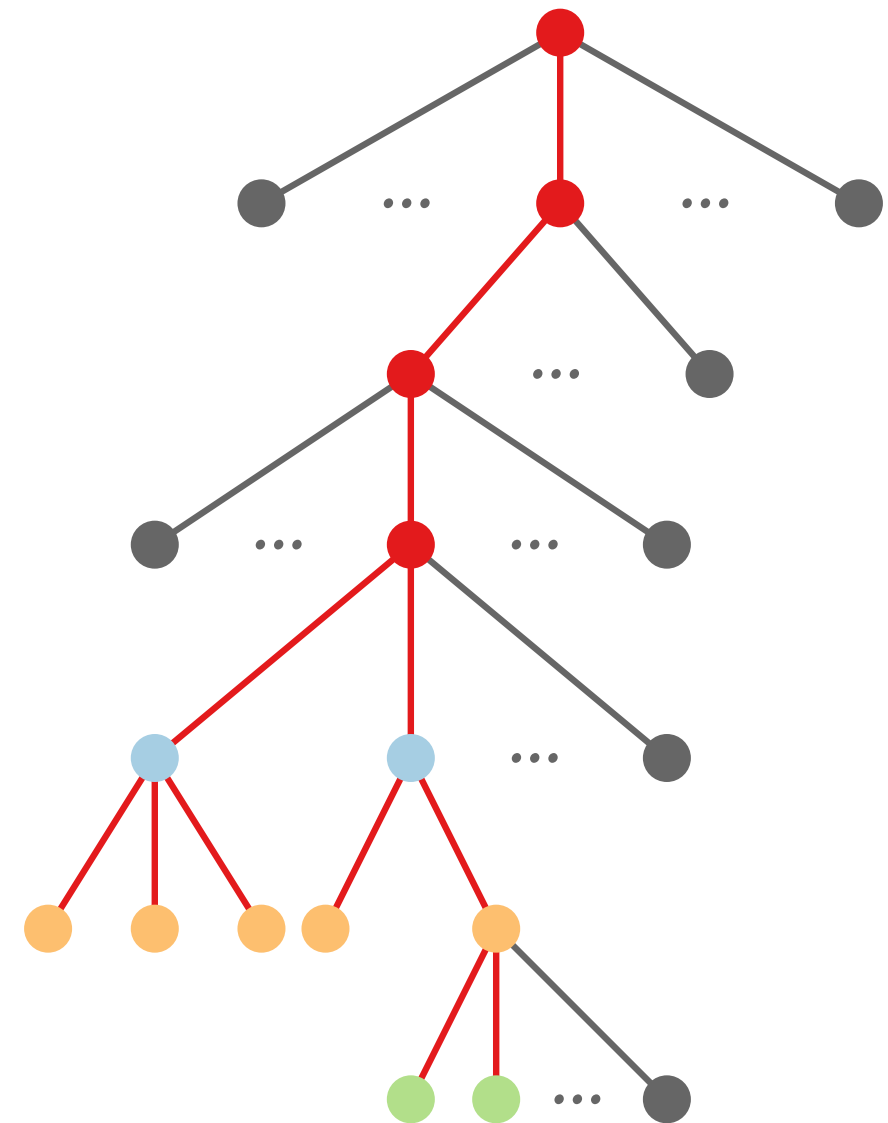
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# Modeling Legislative Networks

LII > U.S. Code > Title 15 > CHAPTER 1 > § 15

## 15 U.S. Code § 15 - Suits by persons injured

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# Modeling Legislative Networks

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## 15 U.S. Code § 15 - Suits by persons injured

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Hierarchy

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# Modeling Legislative Networks

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## 15 U.S. Code § 15 - Suits by persons injured

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The diagram illustrates a hierarchical structure, likely representing a legislative network. It features a tree-like structure of nodes and edges. The root node is red. It branches into several nodes, some of which are red and others black. The red nodes further branch into blue nodes, which then branch into orange nodes. A purple arrow points from a green node at the bottom to a purple node on the right. The word 'Hierarchy' is written in red at the top, and 'Sequence' is written in blue in the middle.

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# Modeling Legislative Networks

LII > U.S. Code > Title 15 > CHAPTER 1 > § 15

## 15 U.S. Code § 15 - Suits by persons injured

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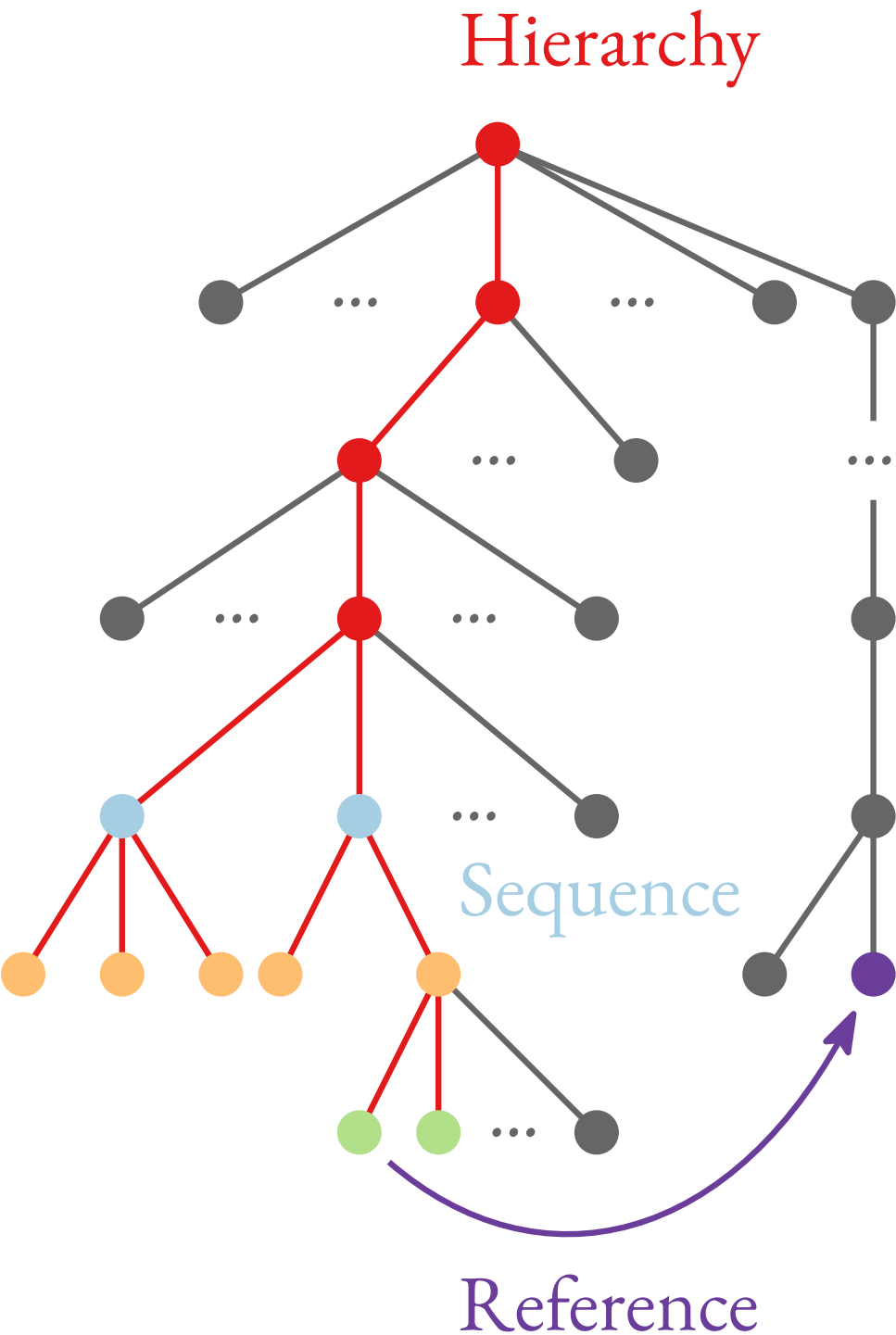
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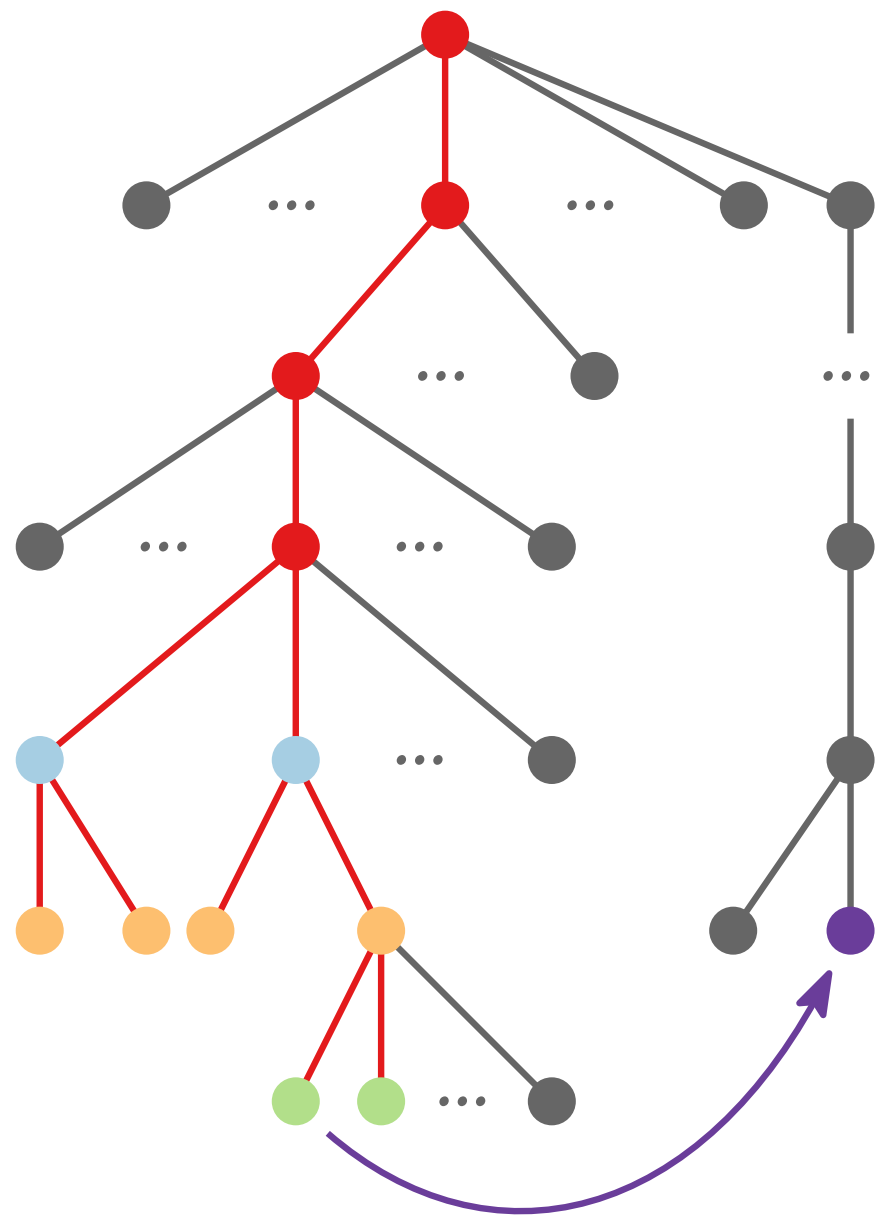
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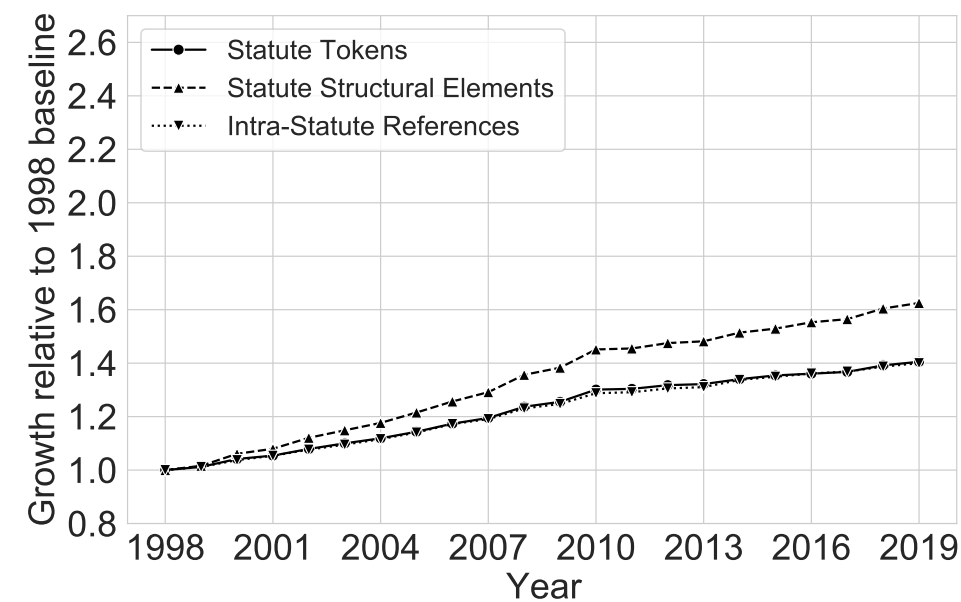
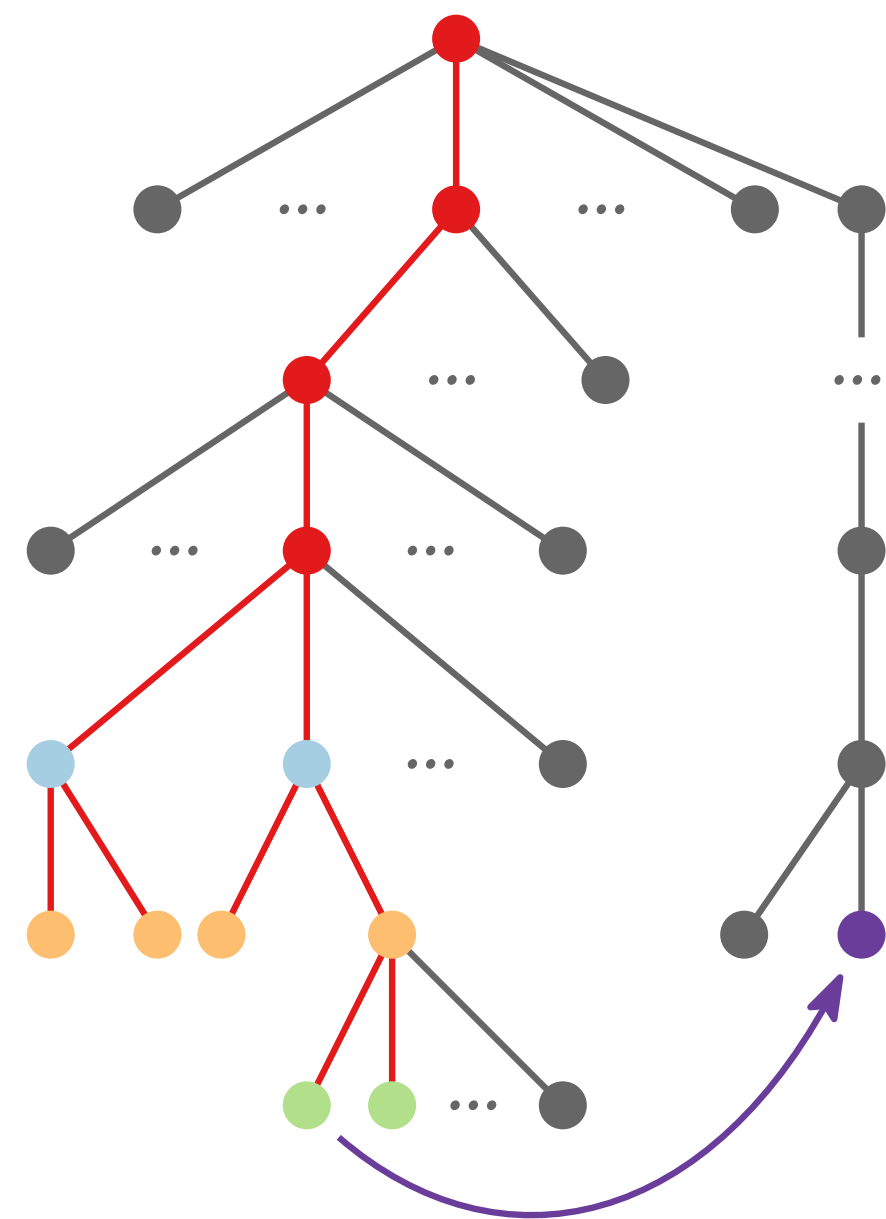
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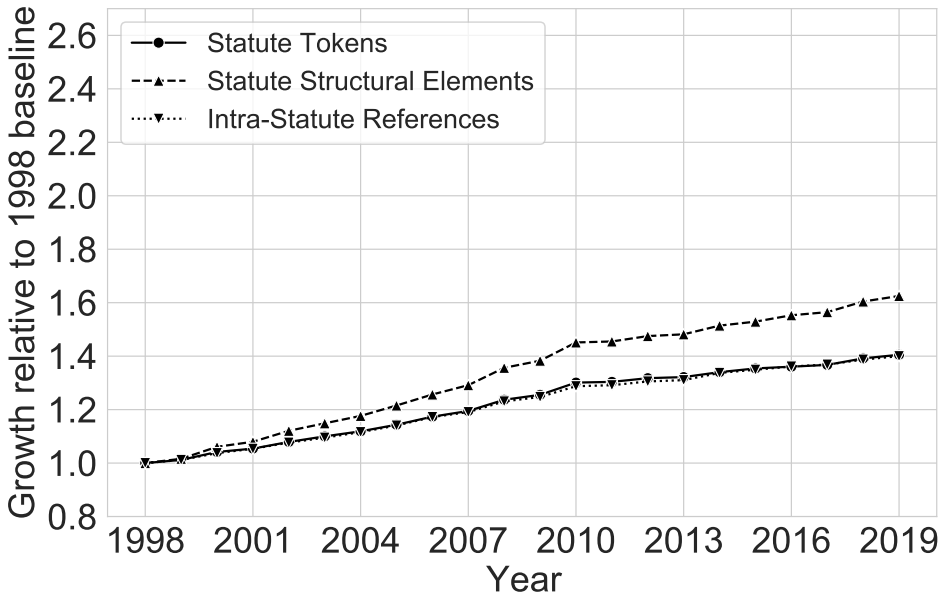
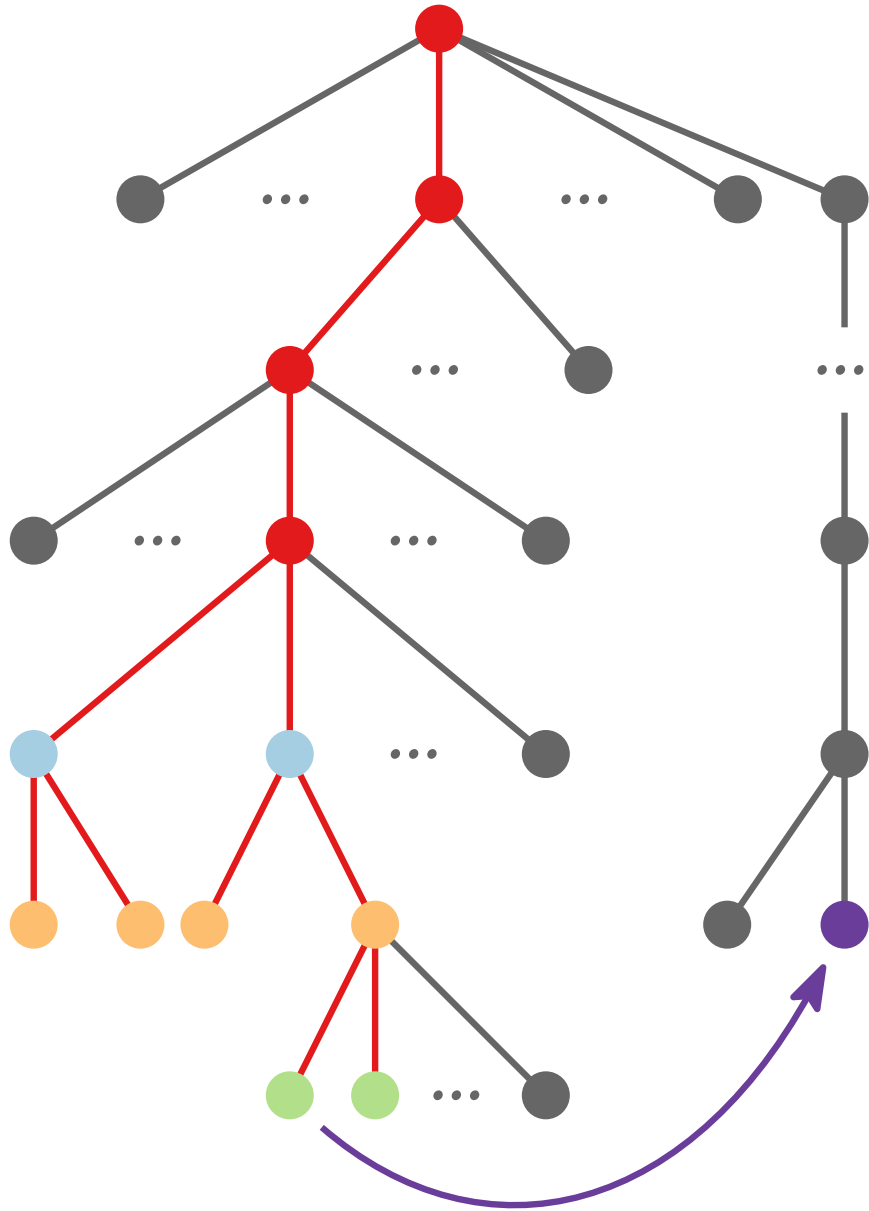
# Measuring Legislative Networks



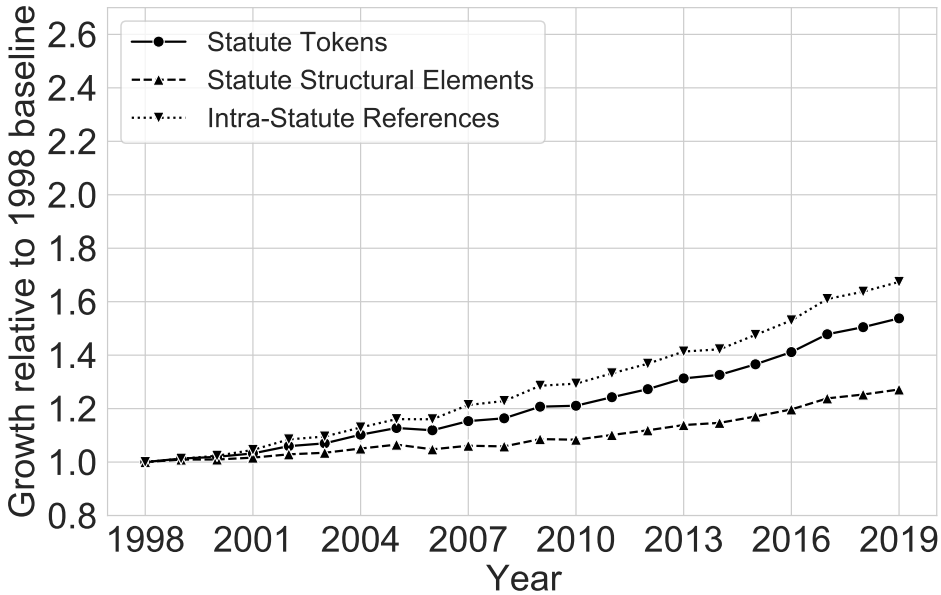
# Measuring Legislative Networks United States



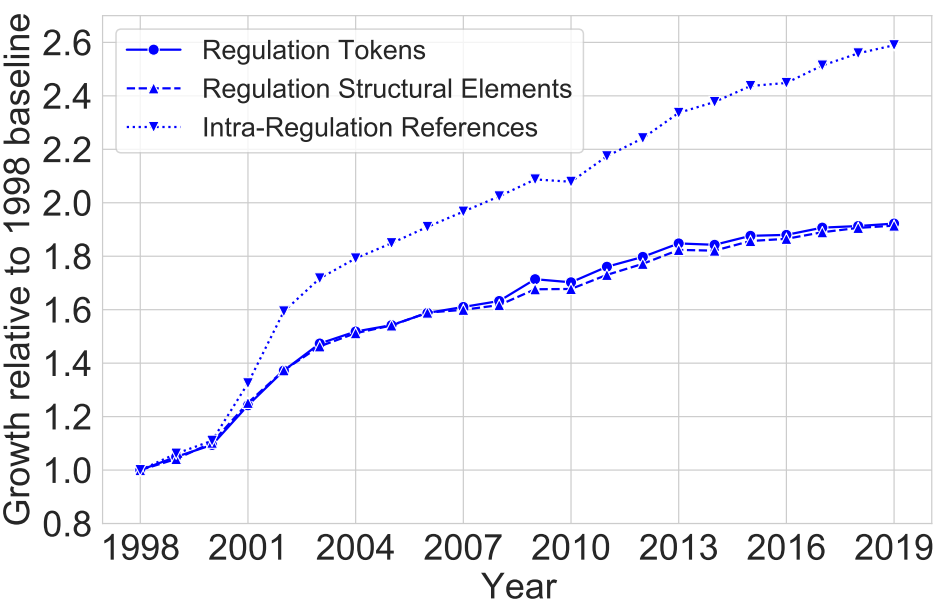
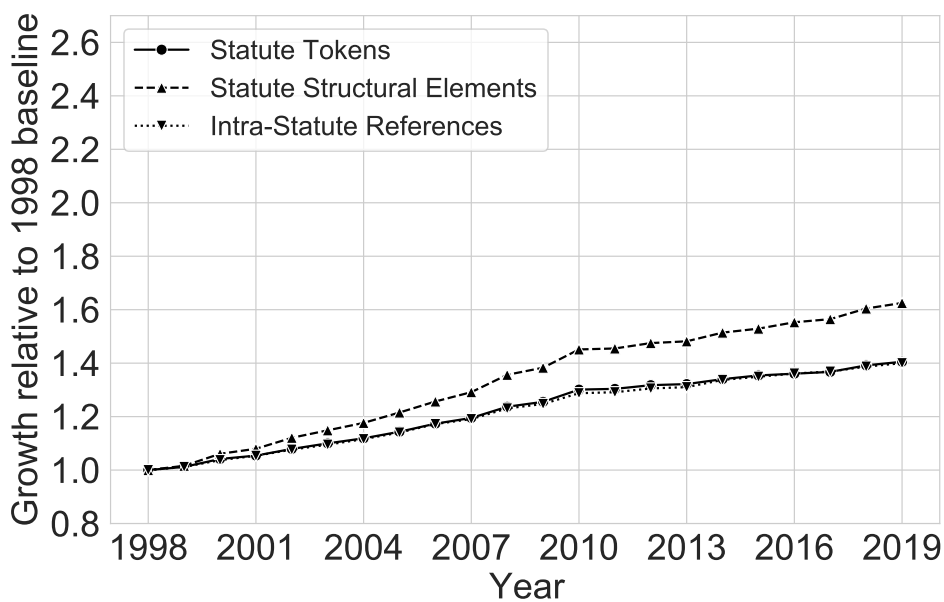
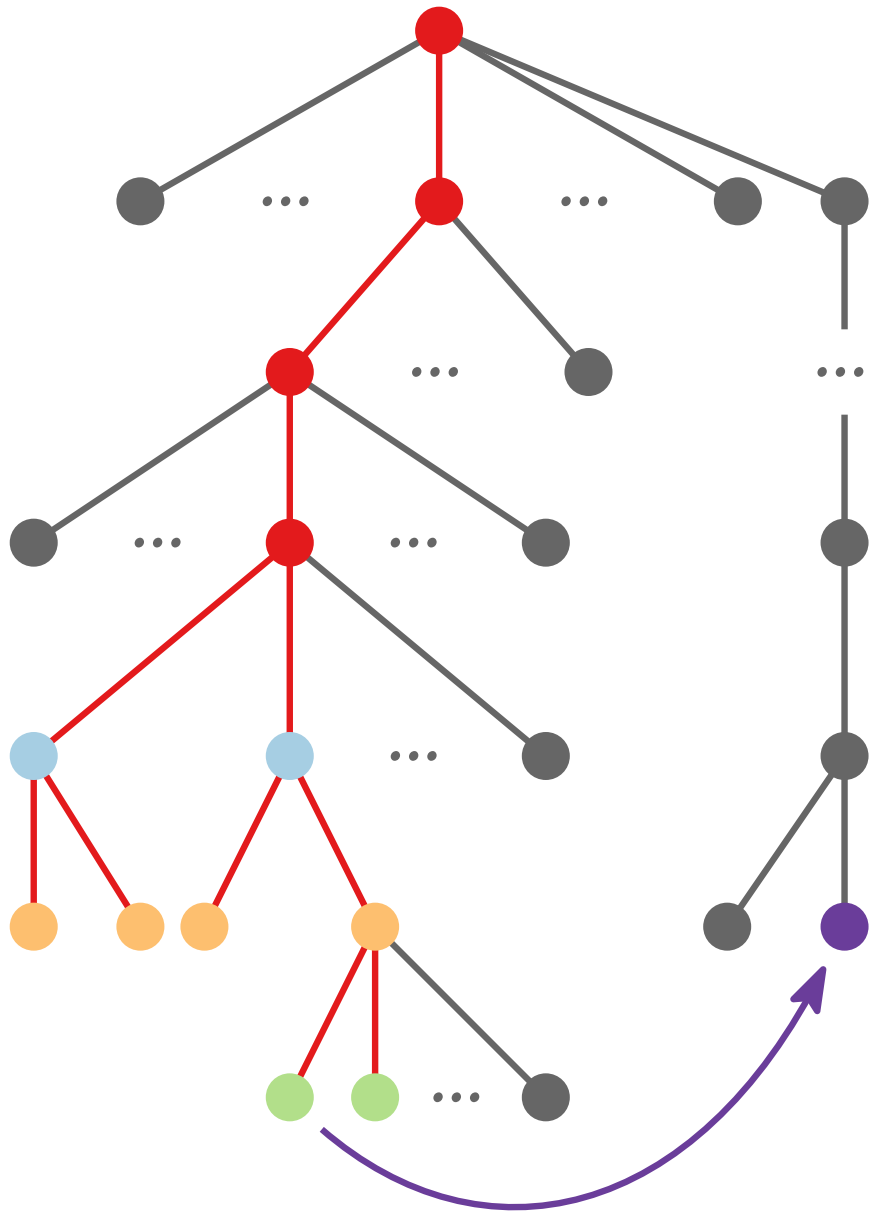
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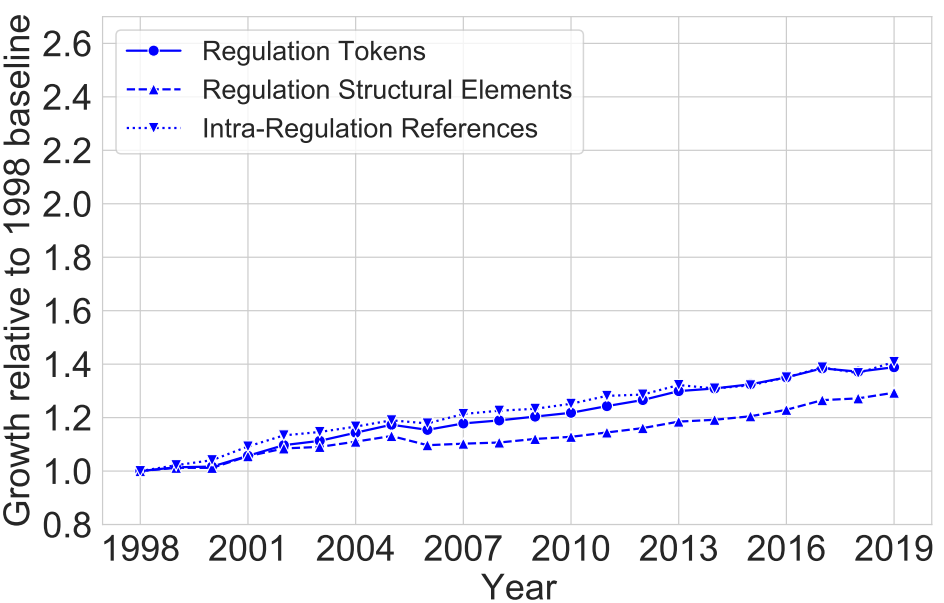
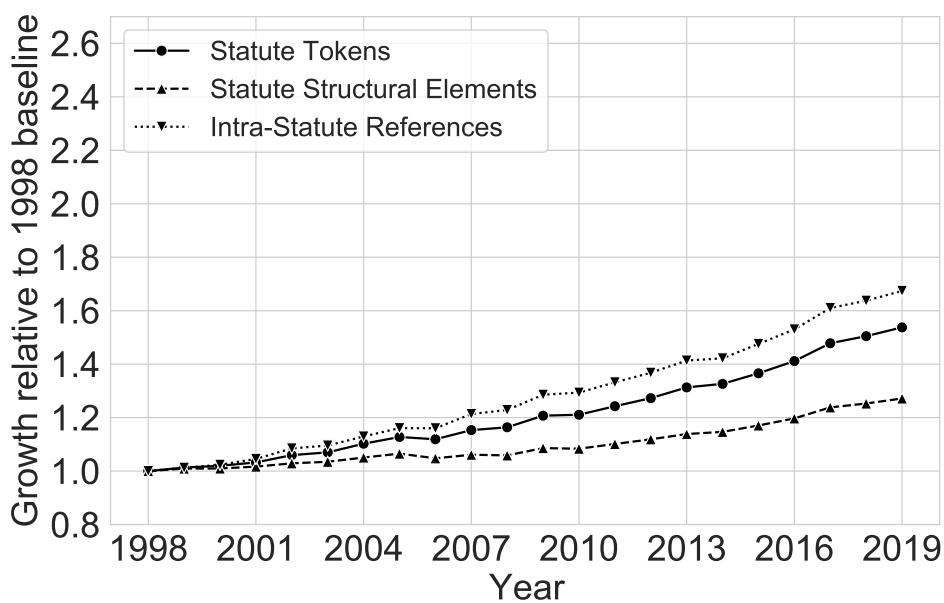
Germany



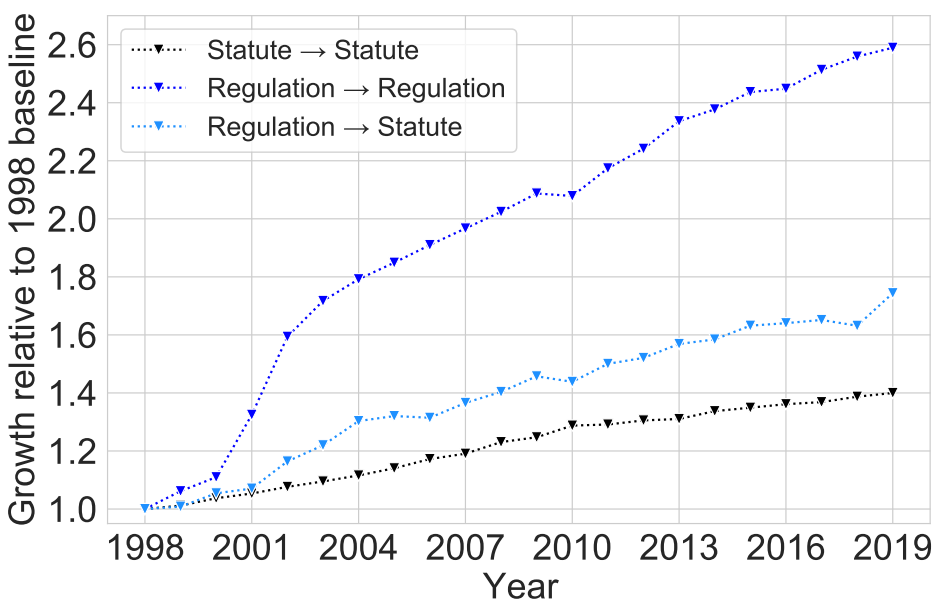
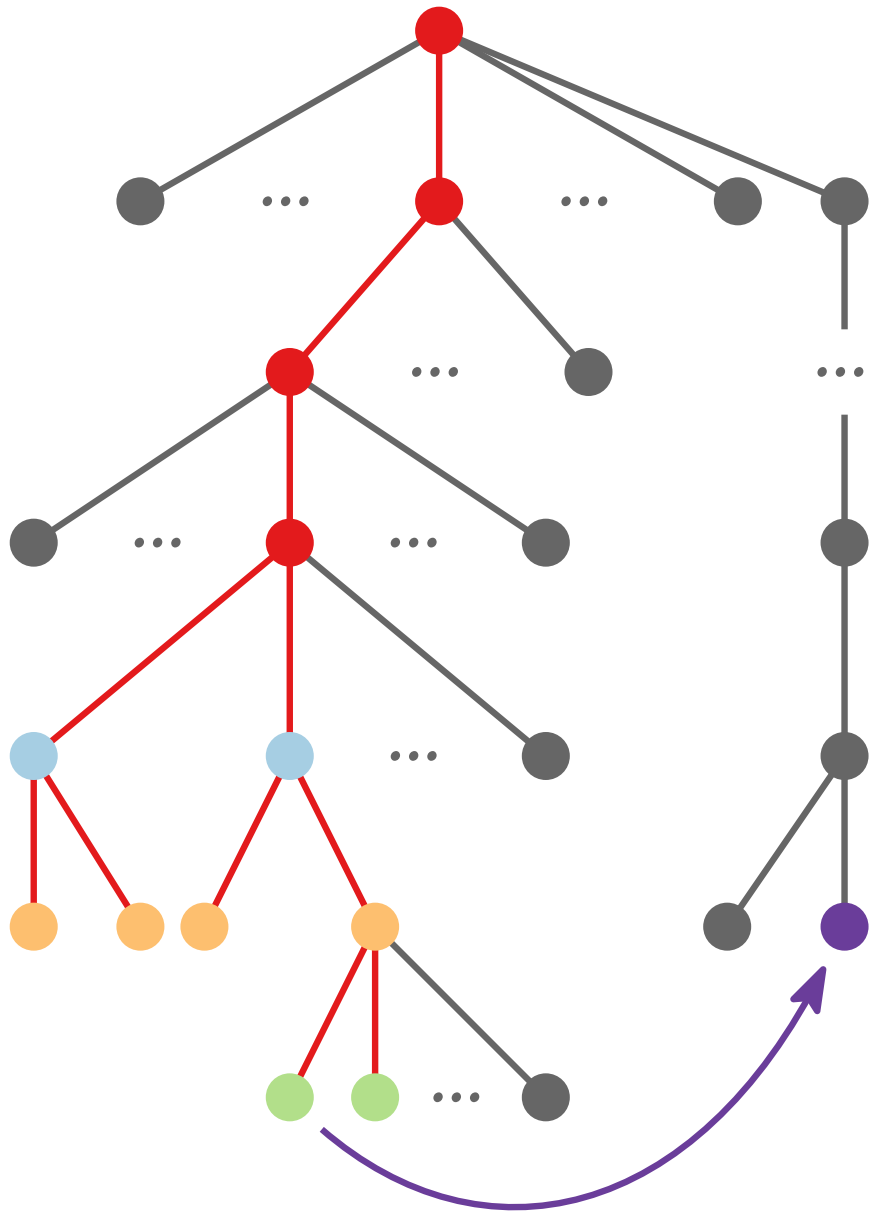
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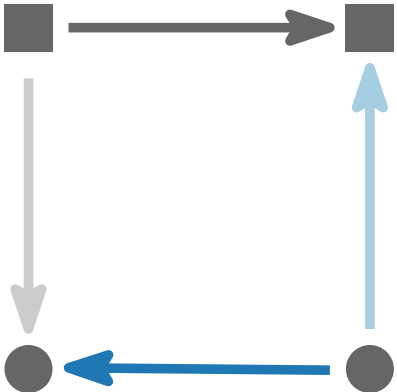
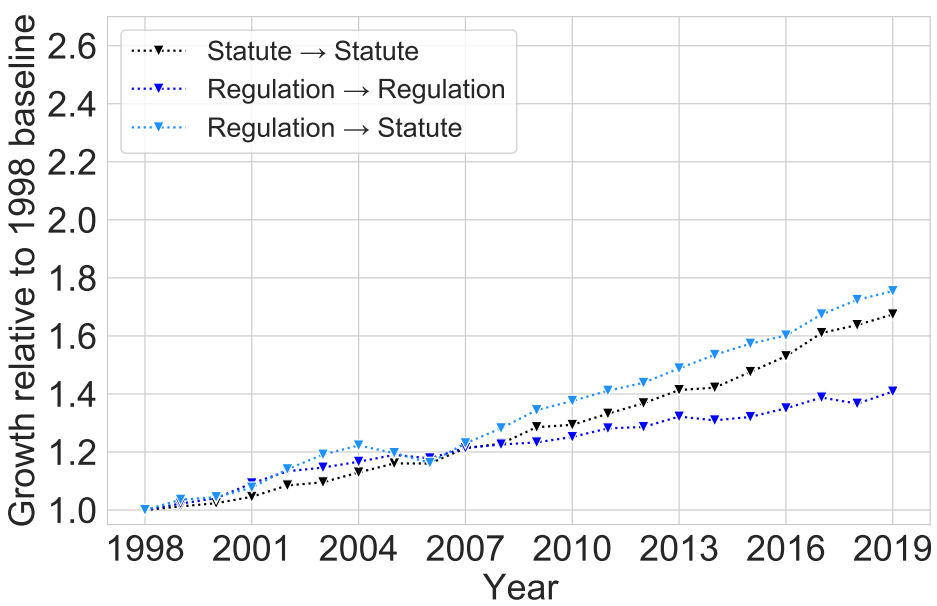
## Germany



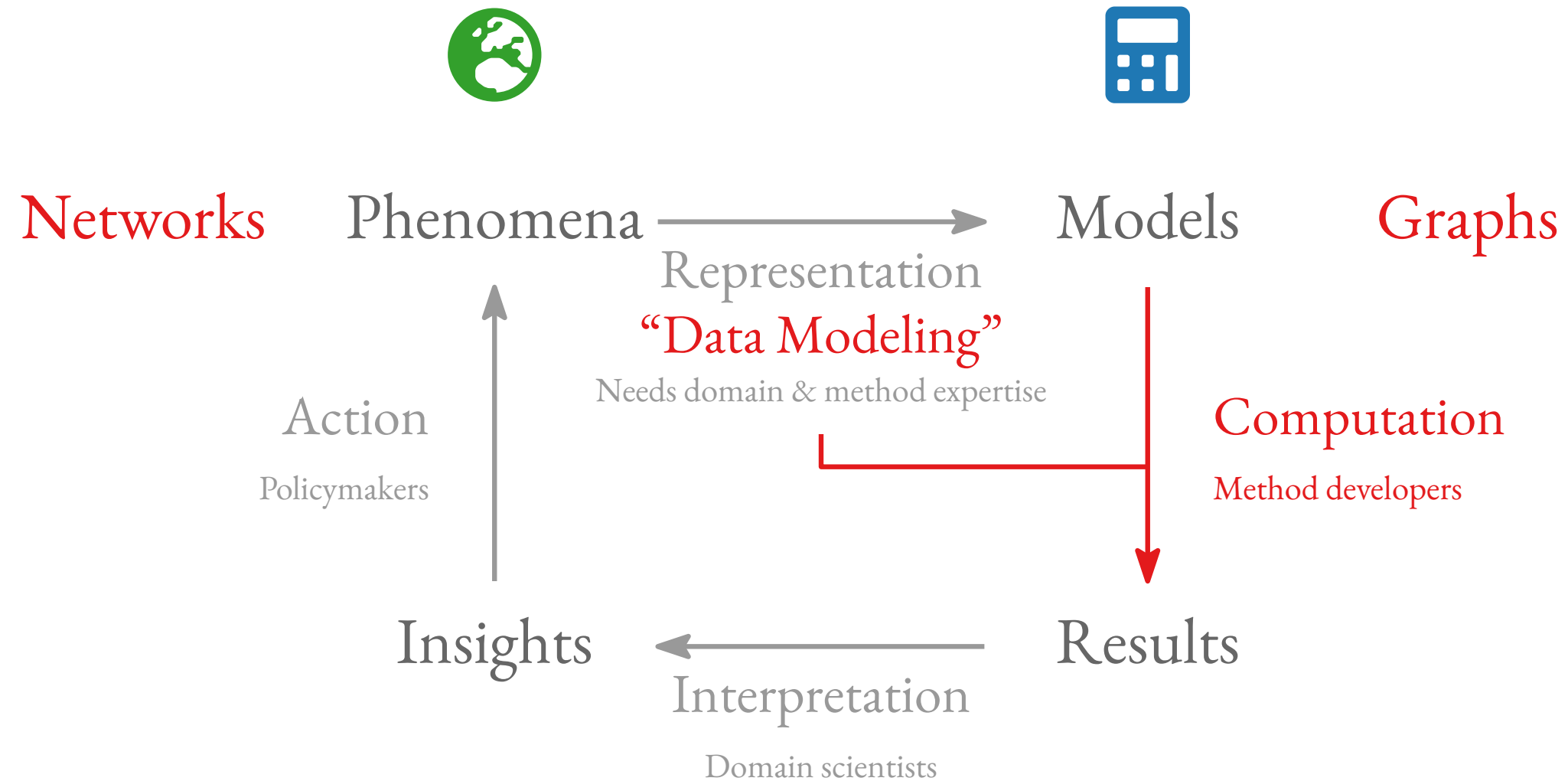
# Measuring Legislative Networks United States



Germany



# Threats to Validity: *Experience as a Method Developer*



# Graph Learning: Benchmark Datasets

## Decontextualization

```
from torch_geometric.datasets import TUDataset

dataset = TUDataset(root='/tmp/ENZYMES', name='ENZYMES')
```

## Instability

```
$ rg -t py "^s*url_=" \
| grep -Eo "(http|https)://[a-zA-Z0-9./?=_%:-]*" \
| sort \
| uniq -c
```

Host	Count
ucl.ac.uk	1
is.tue.mpg.de	3
docs.google.com	7
drive.google.com	7
dropbox.com	7

## Broken Provenance

Metadata

Tags

• undirected graph

Author

J. Leskovec, J. Kleinberg and C. Faloutsos

Date

2003

Edge weights

Unweighted

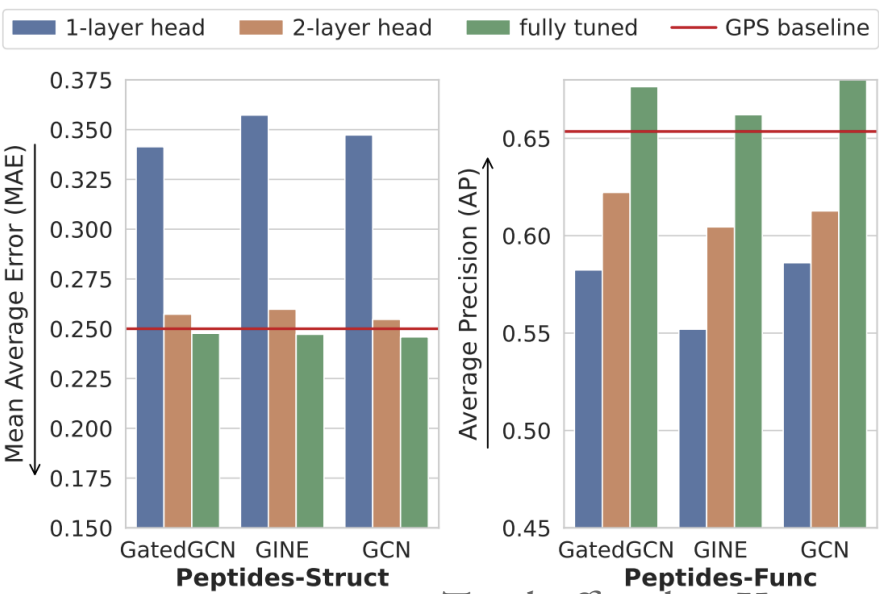
Metadata

undirected graph

Description

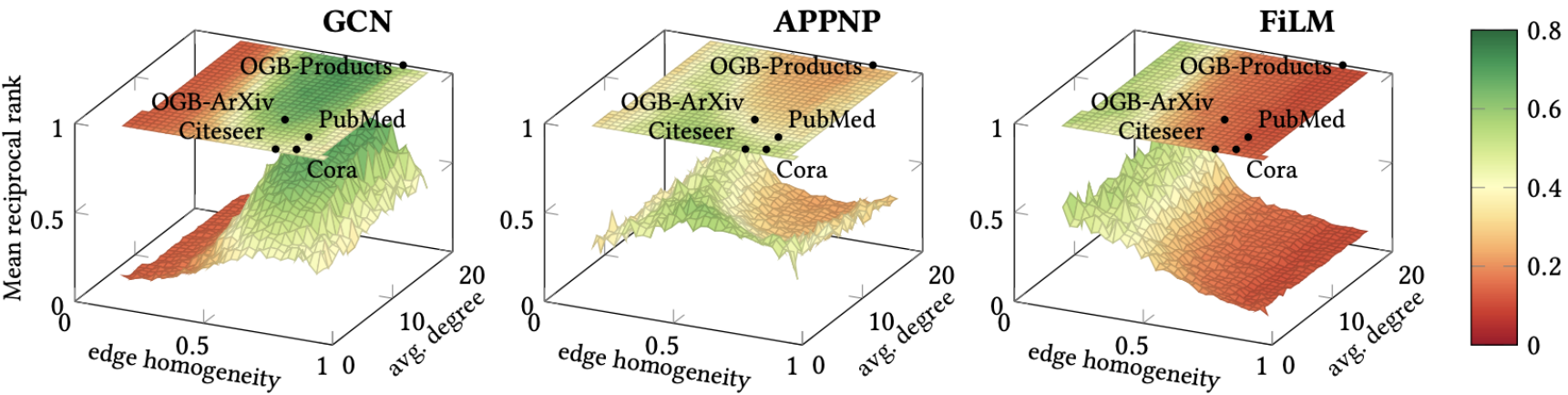
Collaboration network of Arxiv Astro Physics

## Hyperparameter (Non-)Tuning



Tönshoff et al., arXiv 2023

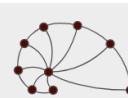
## Structural Bias



Palowitch et al., KDD 2022

## The List Goes On...

# Network Science: “Benchmark Datasets”

 **Netzschleuder** network catalogue, repository and centrifuge

Networks

Stats

API

Git

Issues

Contribute

Health

About

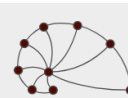
Multiple regexp terms separated by '&'

Search

Tip: click on the table header to sort the list. Hover your mouse over it to obtain a legend.

Name	Title	Nodes	Edges	$\langle k \rangle$	$\sigma_k$	$\lambda_h$	$\tau$	$r$	$c$	$\phi$	$S$	Kind	Mode	$n$	Tags
7th_graders	Vickers 7th Graders (1981)	29	740	25.52	20.34	17.73	1.71	-0.01	0.76	2	1.00	Directed	Unipartite	1	<div>SocialOfflineMultilayerUnweightedMetadata</div>
academia_edu	Academica.edu (2011)	200,169	1,398,063	6.98	46.24	109.99	78.34	-0.02	0.04	16	1.00	Directed	Unipartite	1	<div>SocialOnlineUnweighted</div>
add_health	Adolescent health (ADD HEALTH) (1994)	2,587	12,969	5.01	5.65	11.92	29.03	0.29	0.17	10	0.98	Directed	Unipartite	84	<div>SocialOfflineWeighted</div>
adjnoun	Word adjacencies of David Copperfield	112	425	7.59	6.85	11.54	2.27	-0.13	0.16	5	1.00	Undirected	Unipartite	1	<div>InformationalLanguageUnweighted</div>
advogato	Advogato trust network (2009)	6,541	51,127	7.82	34.13	68.61	20.71	-0.05	0.11	9	0.77	Directed	Unipartite	1	<div>SocialOnlineWeighted</div>
amazon_copurchases	Amazon co-purchasing network (2003)	410,236	3,356,824	8.18	16.30	40.36	1805.09	-0.01	0.25	22	1.00	Directed	Unipartite	4	<div>EconomicCommerceUnweighted</div>
amazon_ratings	Amazon customer ratings (2010)	3,376,972	5,838,041	3.46	19.33	83.61	610.18	-0.02	0.00	28	0.86	Undirected	Bipartite	1	<div>EconomicPreferencesWeightedTimestamps</div>
ambassador	Philippines Ambassador bombing (2000)	16	19	2.38	2.23	3.23	3.96	-0.21	0.59	4	0.69	Undirected	Unipartite	15	<div>SocialOfflineWeightedTemporal</div>
anybeat	Anybeat social network (2013)	12,645	67,053	5.30	89.97	92.23	41.02	-0.12	0.02	10	1.00	Directed	Unipartite	1	<div>SocialOnlineUnweighted</div>
arxiv_authors	Arxiv authors (1993-2003)	133,280	396,160	5.94	27.24	92.56	158.60	0.21	0.32	14	0.13	Undirected	Unipartite	5	<div>SocialCollaborationUnweightedProjection</div>
arxiv_citation	arXiv citation networks (1993-2003)	34,546	421,578	12.20	30.90	74.33	63.13	-0.01	0.15	14	1.00	Directed	Unipartite	2	<div>InformationalCitationUnweighted</div>
arxiv_collab	Scientific collaborations in physics (1995-2005)	40,421	175,692	8.69	12.73	49.17	232.91	0.19	0.25	18	0.90	Undirected	Unipartite	5	<div>SocialCollaborationWeightedProjection</div>
as_skitter	Skitter IP graph (2005)	1,696,415	11,095,298	13.08	136.86	653.66	2574.51	-0.08	0.01	31	1.00	Undirected	Unipartite	1	<div>TechnologicalCommunicationUnweighted</div>
at_migrations	Austrian internal migrations (2002-2022)	2,115	2,908,569	1375.21	4635.25	475.07	4.50	-0.07	0.59	3	1.00	Directed	Unipartite	1	<div>SocialEconomicTravelWeightedPoliticalTimestampsMetadata</div>
bag_of_words	Bag of words (2008)	8,341,043	483,450,157	115.92	3196.79	3405.63	2.29	-0.16	0.00	5	1.00	Undirected	Bipartite	5	<div>InformationalTextBipartiteWeightedMetadata</div>
baidu	Chinese online encyclopedias (2011)	2,141,300	17,794,839	8.31	171.13	431.03	319.36	-0.03	0.00	20	0.98	Directed	Unipartite	1	<div>InformationalWeb graphUnweighted</div>
baseball	Baseball steroid use (2008)	84	84	2.00	4.78	1.73	6.60	-0.45	0.00	4	0.56	Undirected	Bipartite	2	<div>SocialOfflineWeightedProjection</div>
berkstan_web	Webgraph (Berkeley-Stanford)	685,231	7,600,595	11.09	285.98	663.80	389618.19	-0.10	0.01	208	0.96	Directed	Unipartite	1	<div>InformationalWeb graphUnweighted</div>
bible_nouns	Bible noun phrases	1,773	9,131	10.30	17.87	37.62	16.49	-0.05	0.16	8	0.96	Undirected	Unipartite	1	<div>InformationalLanguageWeighted</div>
bibsonomy	BibSonomy	972,120	2,555,080	5.26	201.14	167.83	9651.27	-0.05	0.00	22	0.96	Undirected	Bipartite	1	<div>InformationalFolksonomyUnweightedMultigraphTimestamps</div>

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amazon_ratings	Amazon customer ratings (2010)	3,376,972	5,838,041	3.46	19.33	83.61	610.18	-0.02	0.00	28	0.86	Undirected	Bipartite	1	<div>EconomicPreferencesWeightedTimestamps</div>
ambassador	Philippines Ambassador bombing (2000)	16	19	2.38	2.23	3.23	3.96	-0.21	0.59	4	0.69	Undirected	Unipartite	15	<div>SocialOfflineWeightedTemporal</div>
anybeat	Anybeat social network (2013)	12,645	67,053	5.30	89.97	92.23	41.02	-0.12	0.02	10	1.00	Directed	Unipartite	1	<div>SocialOnlineUnweighted</div>
arxiv_authors	Arxiv authors (1993-2003)	133,280	396,160	5.94	27.24	92.56	158.60	0.21	0.32	14	0.13	Undirected	Unipartite	5	<div>SocialCollaborationUnweightedProjection</div>
arxiv_citation	arXiv citation networks (1993-2003)	34,546	421,578	12.20	30.90	74.33	63.13	-0.01	0.15	14	1.00	Directed	Unipartite	2	<div>InformationalCitationUnweighted</div>
arxiv_collab	Scientific collaborations in physics (1995-2005)	40,421	175,692	8.69	12.73	49.17	232.91	0.19	0.25	18	0.90	Undirected	Unipartite	5	<div>SocialCollaborationWeightedProjection</div>
as_skitter	Skitter IP graph (2005)	1,696,415	11,095,298	13.08	136.86	653.66	2574.51	-0.08	0.01	31	1.00	Undirected	Unipartite	1	<div>TechnologicalCommunicationUnweighted</div>
at_migrations	Austrian internal migrations (2002-2022)	2,115	2,908,569	1375.21	4635.25	475.07	4.50	-0.07	0.59	3	1.00	Directed	Unipartite	1	<div>SocialEconomicTravelWeightedPoliticalTimestampsMetadata</div>
bag_of_words	Bag of words (2008)	8,341,043	483,450,157	115.92	3196.79	3405.63	2.29	-0.16	0.00	5	1.00	Undirected	Bipartite	5	<div>InformationalTextBipartiteWeightedMetadata</div>
baidu	Chinese online encyclopedias (2011)	2,141,300	17,794,839	8.31	171.13	431.03	319.36	-0.03	0.00	20	0.98	Directed	Unipartite	1	<div>InformationalWeb graphUnweighted</div>
baseball	Baseball steroid use (2008)	84	84	2.00	4.78	1.73	6.60	-0.45	0.00	4	0.56	Undirected	Bipartite	2	<div>SocialOfflineWeightedProjection</div>
berkstan_web	Webgraph (Berkeley-Stanford)	685,231	7,600,595	11.09	285.98	663.80	389618.19	-0.10	0.01	208	0.96	Directed	Unipartite	1	<div>InformationalWeb graphUnweighted</div>
bible_nouns	Bible noun phrases	1,773	9,131	10.30	17.87	37.62	16.49	-0.05	0.16	8	0.96	Undirected	Unipartite	1	<div>InformationalLanguageWeighted</div>
bibsonomy	BibSonomy	972,120	2,555,080	5.26	201.14	167.83	9651.27	-0.05	0.00	22	0.96	Undirected	Bipartite	1	<div>InformationalFolksonomyUnweightedMultigraphTimestamps</div>

# Network Science: “Benchmark Datasets”

## 7th\_graders — Vickers 7th Graders (1981)

### Description

A small multiplex network of friendships among 29 seventh grade students in Victoria, Australia. Students nominated classmates for three different activities (who do you get on with in the class, who are your best friends, and who would you prefer to work with). Edge direction for each of these three types of edges indicates if node i nominated node j, and the edge weight gives the frequency of this nomination. Students 1-12 are boys and 13-29 are girls. The KONECT version of this network is the collapse of de Domenico's multiplex version.<sup>1</sup>

<sup>1</sup>. Description obtained from the ICON project. ↗

### Tags

**Social** **Offline** **Multilayer** **Unweighted** **Metadata**

### Citation

M. Vickers and S. Chan, "Representing Classroom Social Structure." Melbourne: Victoria Institute of Secondary Education, (1981)., [https://scholar.google.com/scholar?hl=de&as\\_sdt=0%2C5&q=%22Representing+classroom+social+structure%22&btnG=](https://scholar.google.com/scholar?hl=de&as_sdt=0%2C5&q=%22Representing+classroom+social+structure%22&btnG=)

### Upstream URL OK

<https://manliodedomenico.com/data.php>

### Networks

Tip: hover your mouse over a table header to obtain a legend.

Name	Nodes	Edges	$\langle k \rangle$	$\sigma_k$	$\lambda_h$	$\tau$	$r$	$c$	$\phi$	$S$	Kind	Mode	NPs	EPs	gt	GraphML	GML	csv
7th_graders	29	740	25.52	20.34	17.73	1.71	-0.01	0.76	2	1.00	Directed	Unipartite	<div>name</div>	<div>weight</div> <div>layer</div>	<div>1 KiB</div>	<div>4 KiB</div>	<div>3 KiB</div>	<div>3 KiB</div>

Problems with this dataset? [Open an issue](#).  
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The network in this dataset can be loaded directly from [graph-tool](#) with:

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Corinna Coupette · Toward Meta-Methods for Network Analysis

13

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### Upstream URL OK

<https://manliodedomenico.com/data.php>

### Networks

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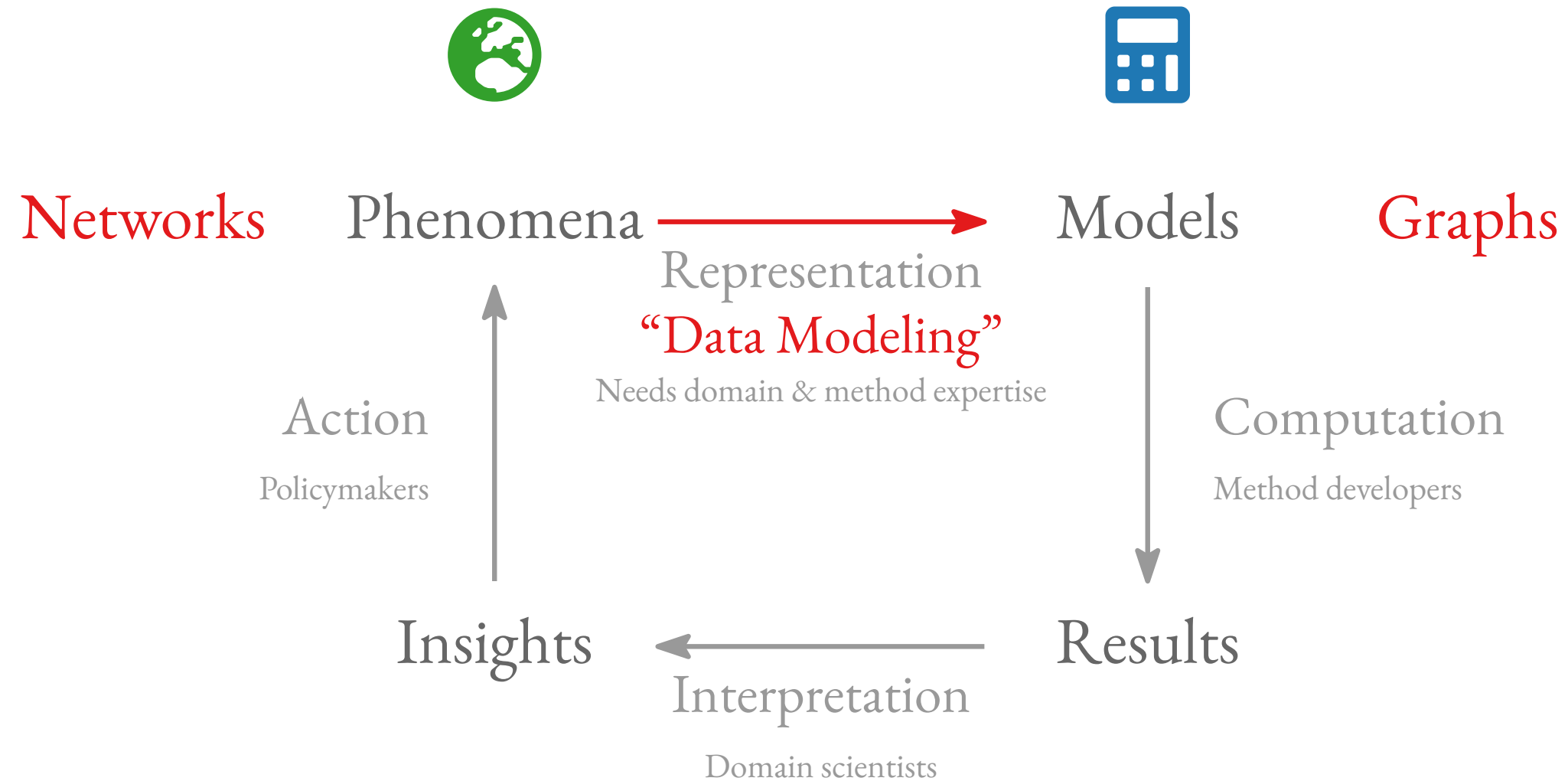
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# Threats to Validity: *Experience as a Data Modeler*



# Example: HYPERBARD

Coupette et al., DSH 2024

# Example: HYPERBARD

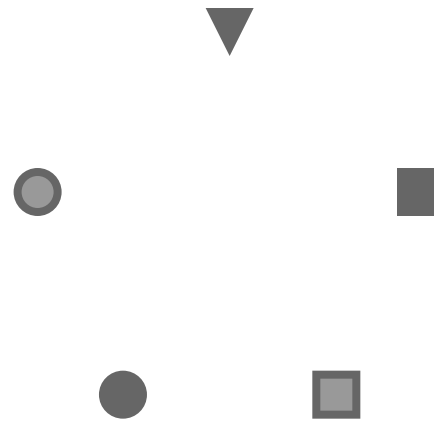
Coupette et al., DSH 2024

## Motivation

# Example: HYPERBARD

Coupette et al., DSH 2024

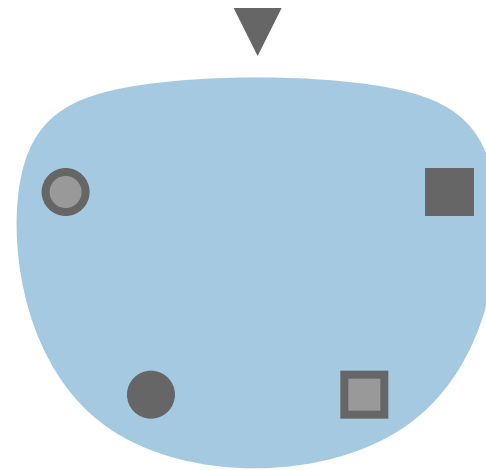
## Motivation



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Coupette et al., DSH 2024

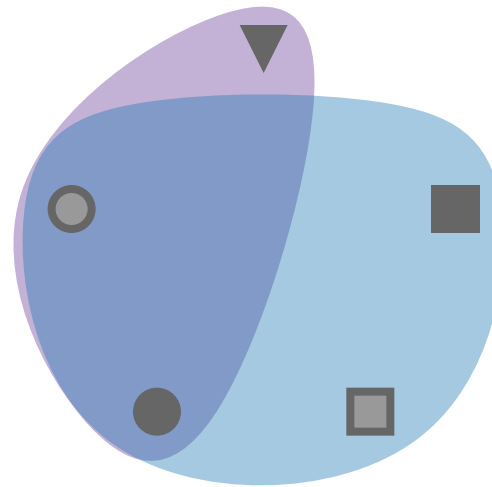
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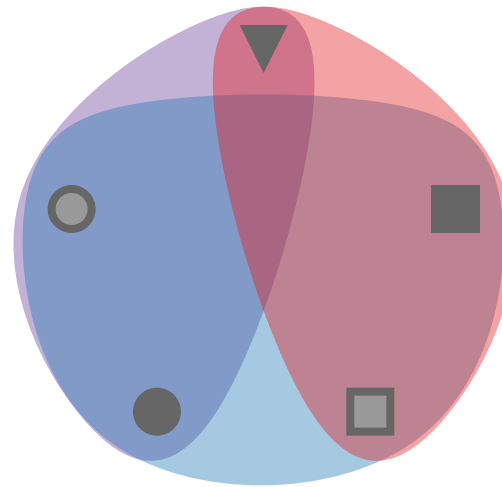
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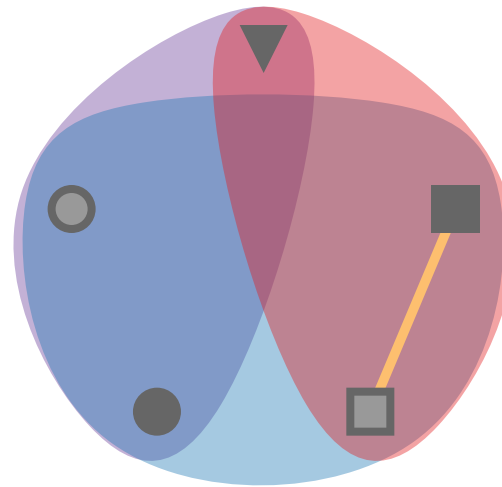
## Motivation



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Coupette et al., DSH 2024

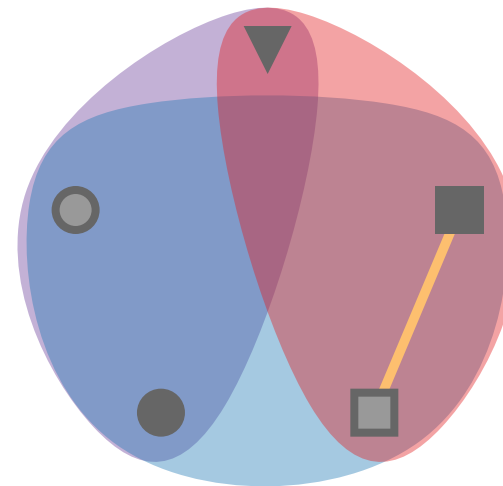
## Motivation



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Coupette et al., DSH 2024

## Motivation

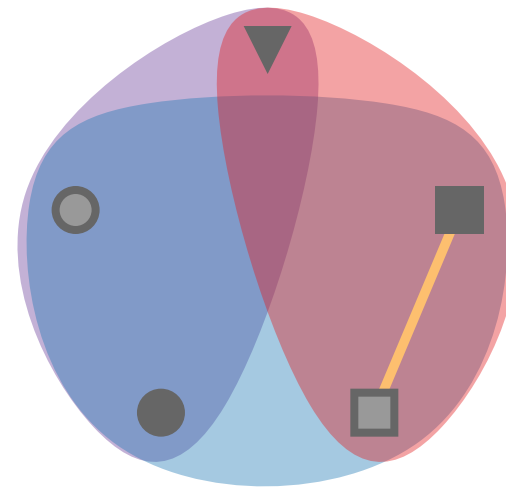
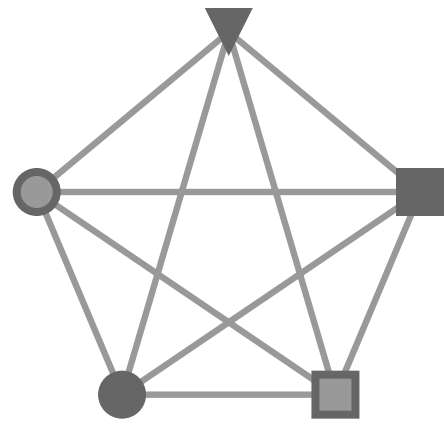


Hypergraph

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Coupette et al., DSH 2024

## Motivation

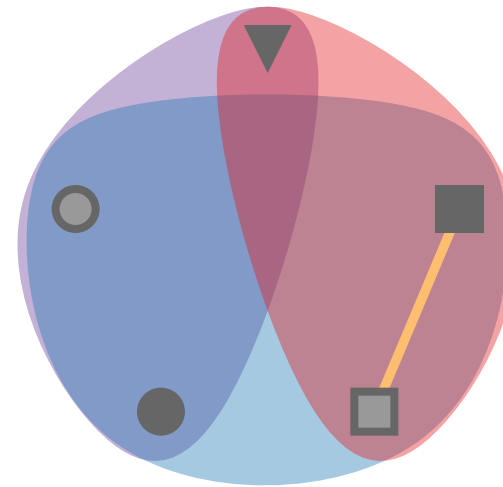
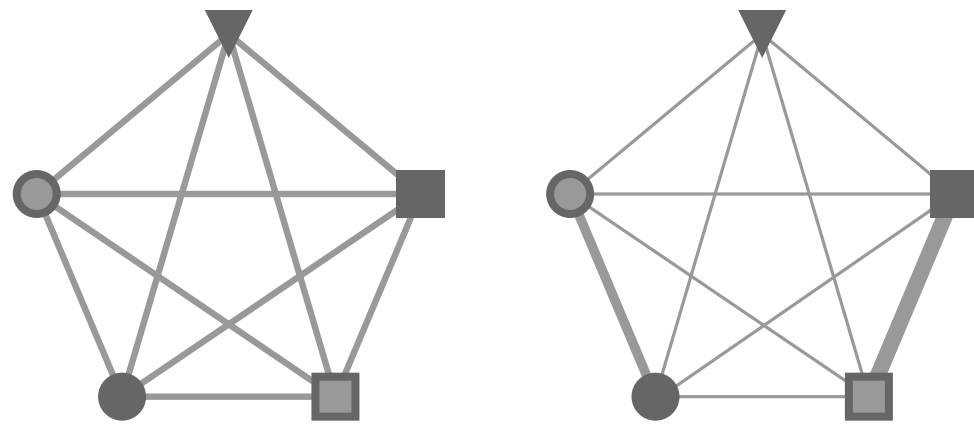


Hypergraph

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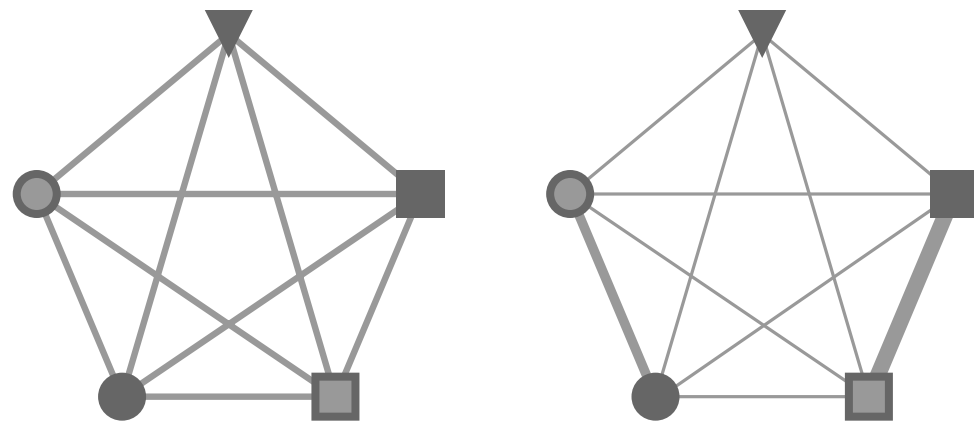


Hypergraph

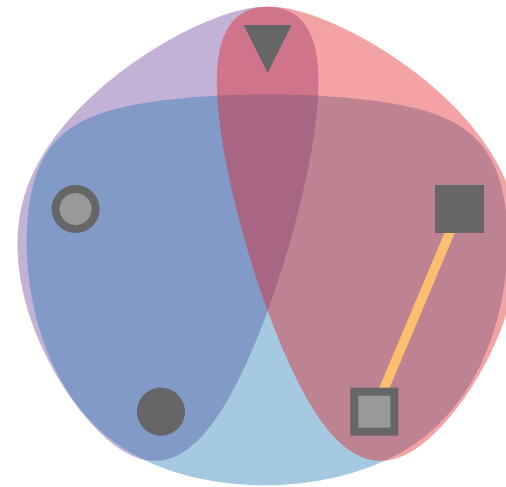
# Example: HYPERBARD

Coupette et al., DSH 2024

## Motivation



Clique Expansion

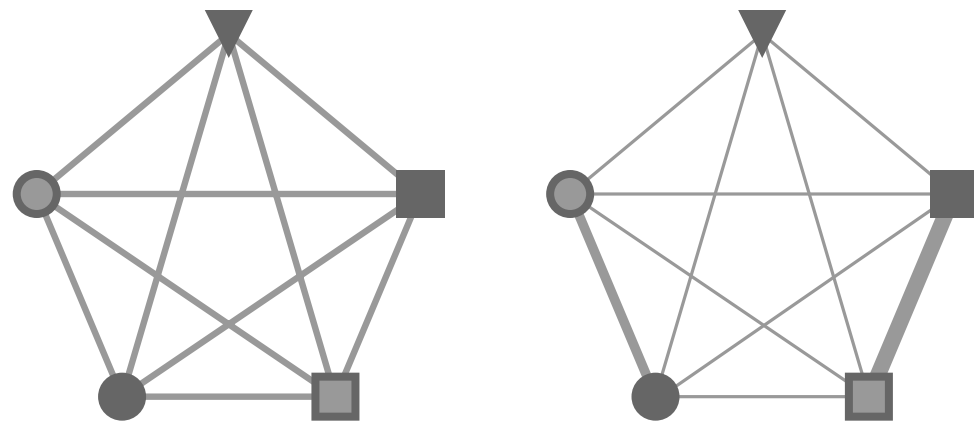


Hypergraph

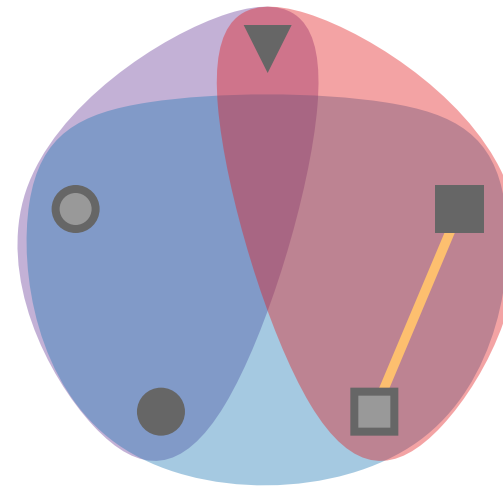
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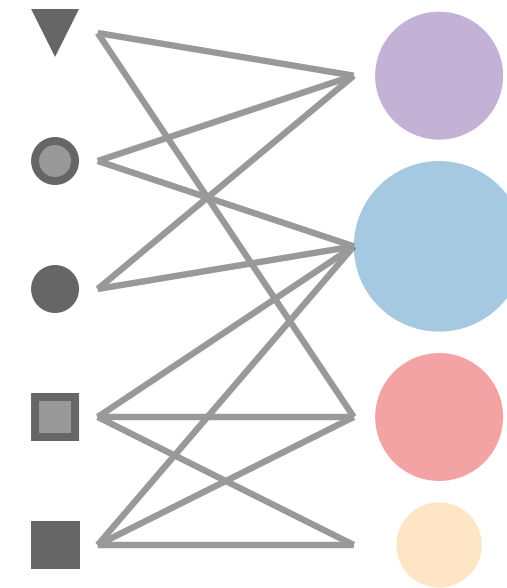
## Motivation



Clique Expansion



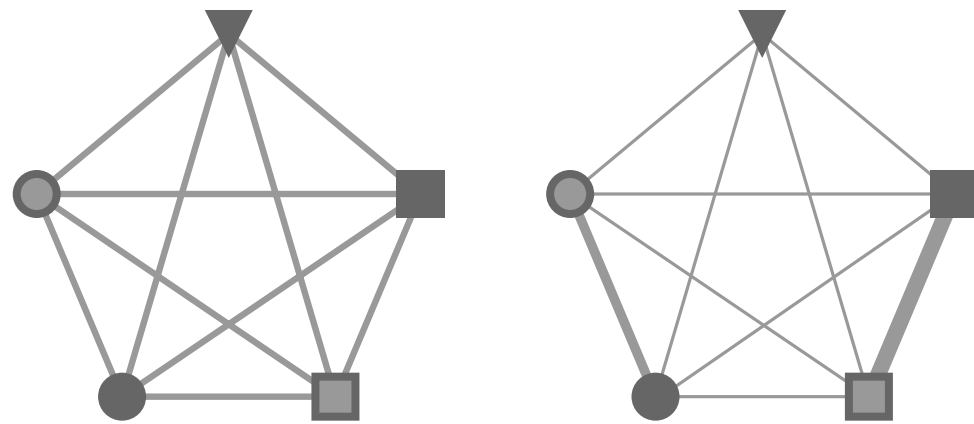
Hypergraph



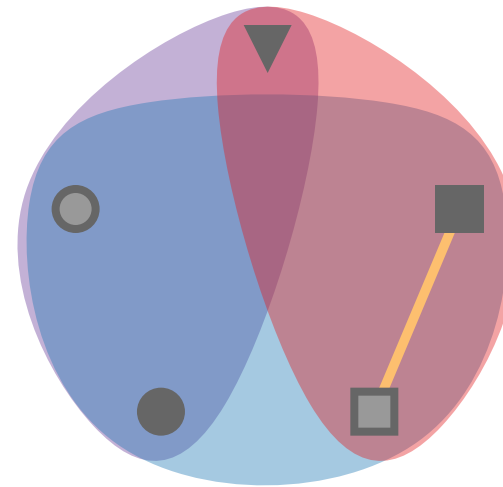
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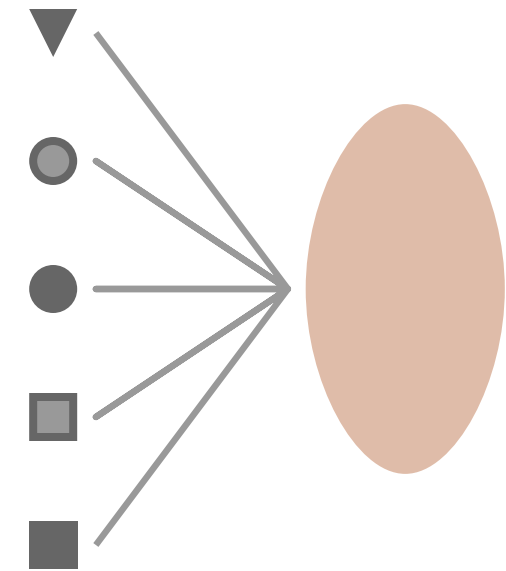
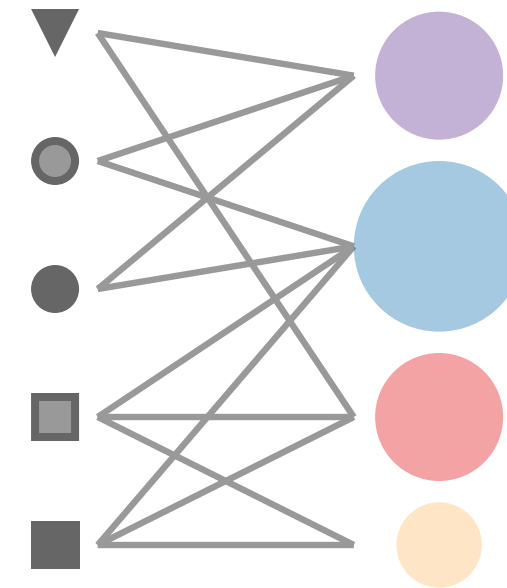
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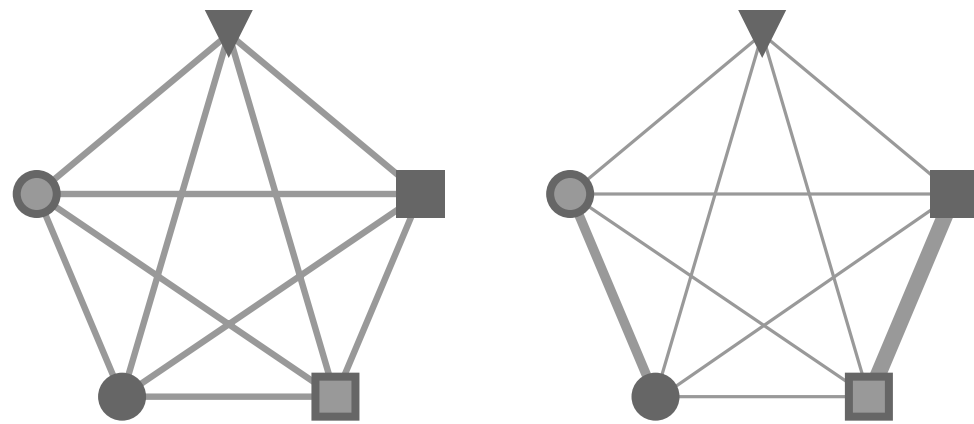
Hypergraph



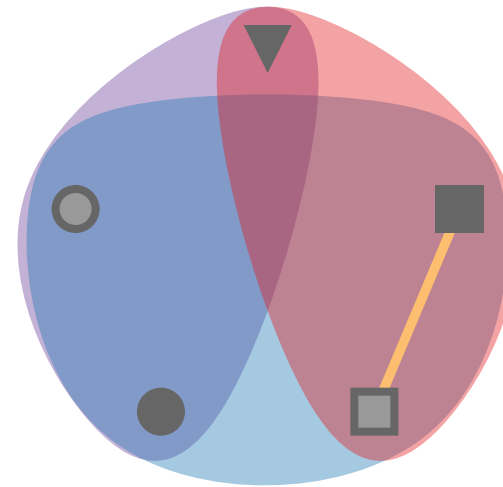
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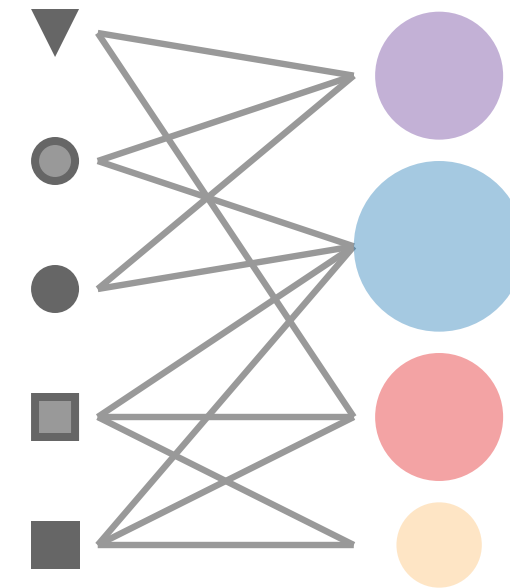
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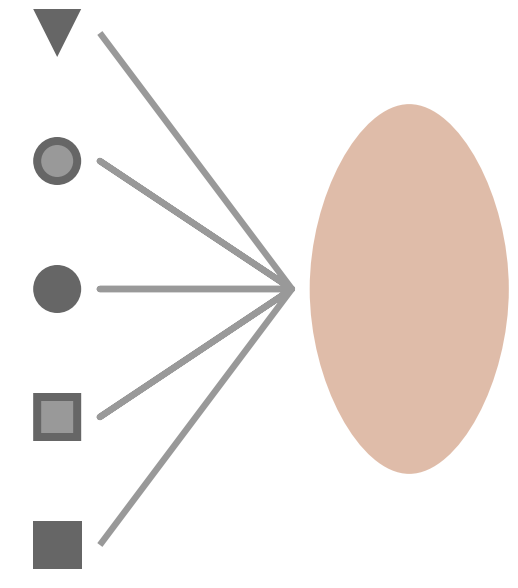
Clique Expansion



Hypergraph



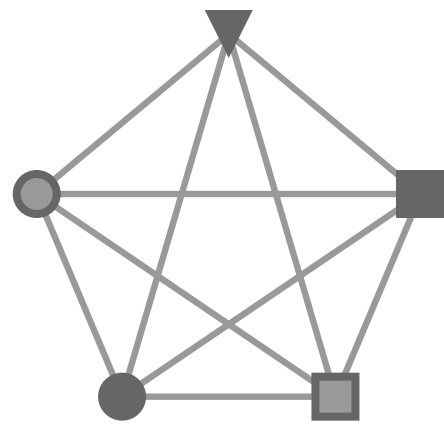
Star Expansion



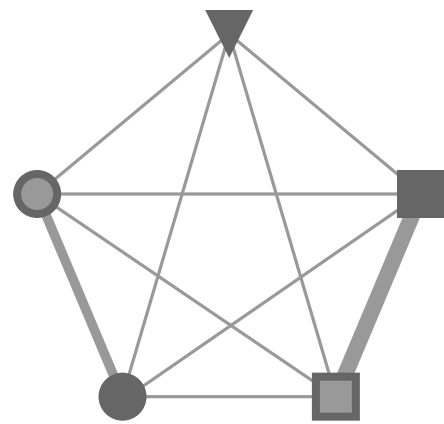
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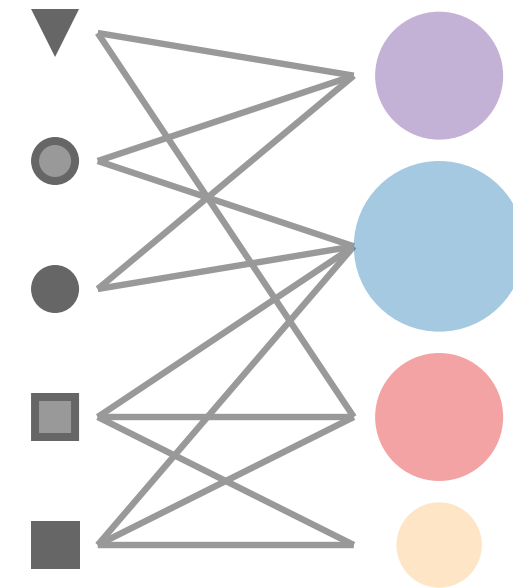
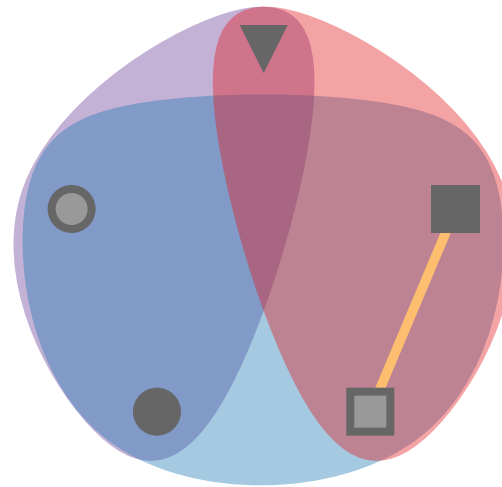
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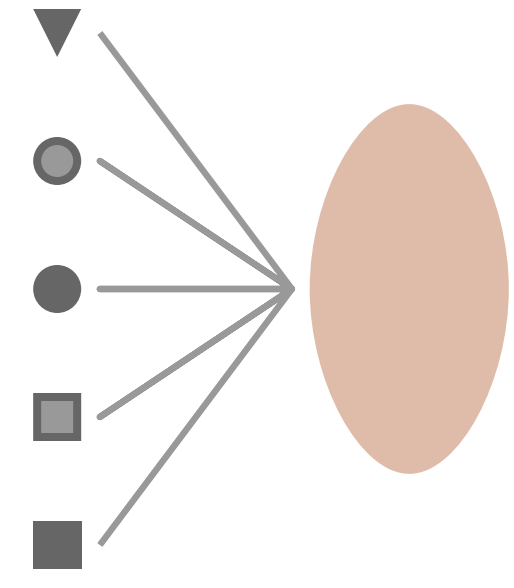
Clique Expansion



Hypergraph



Star Expansion

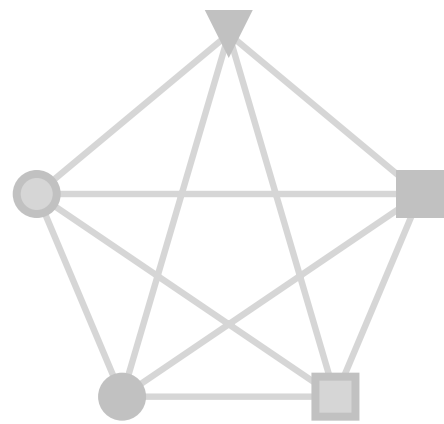


How do data-modeling decisions impact our results?

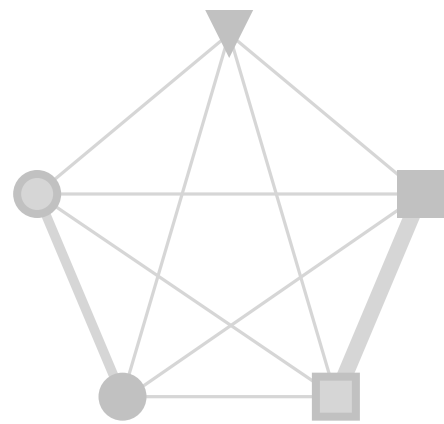
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Coupette et al., DSH 2024

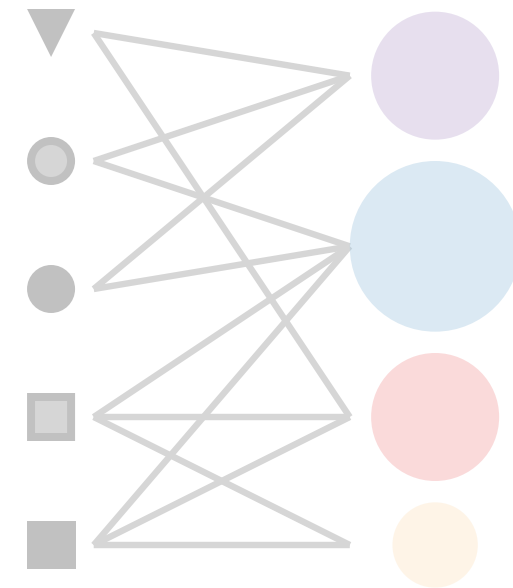
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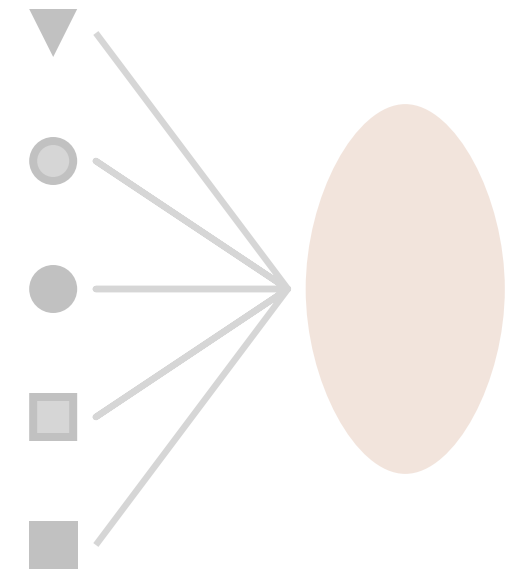
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Hypergraph



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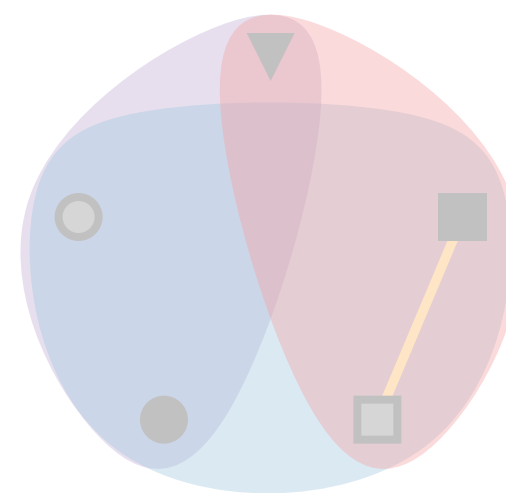
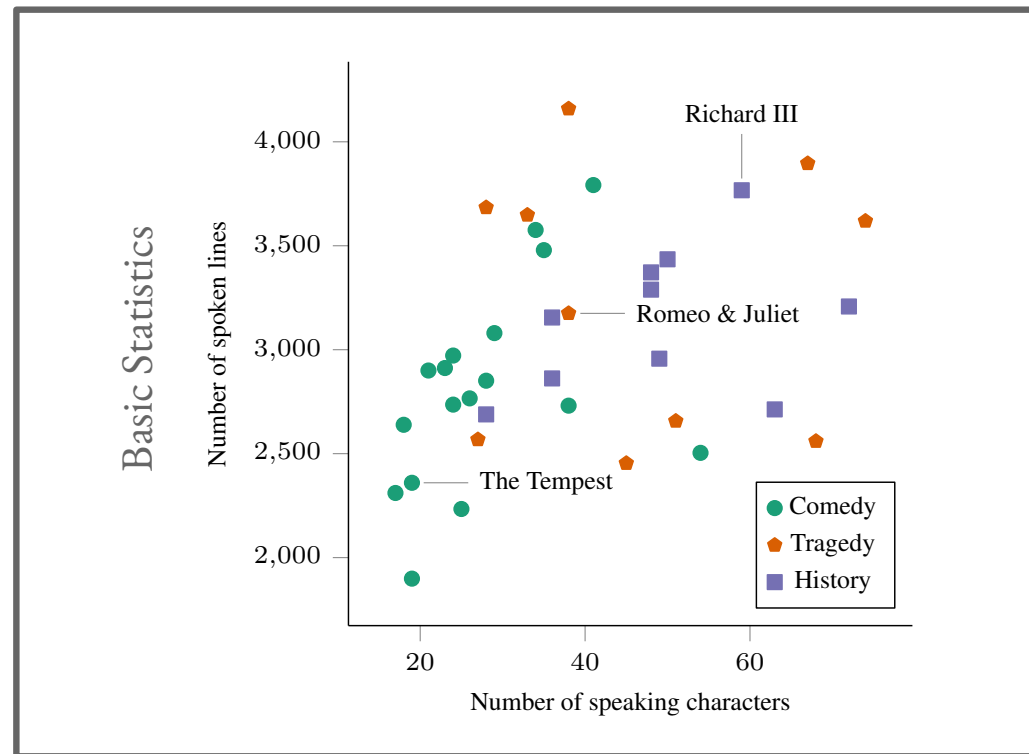
How do data-modeling decisions impact our results?

## Contribution

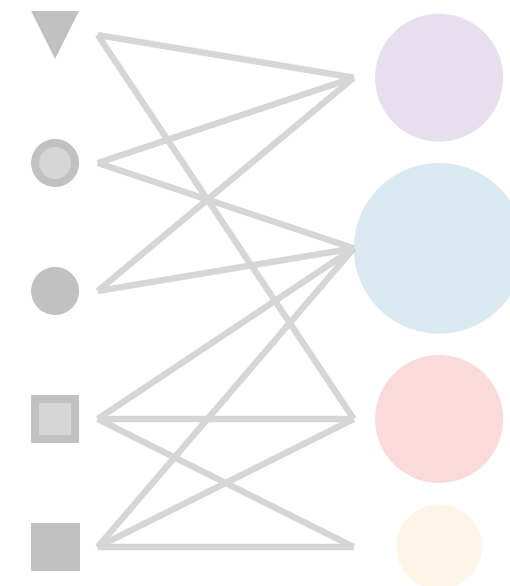


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Coupette et al., DSH 2024



Hypergraph



Star Expansion

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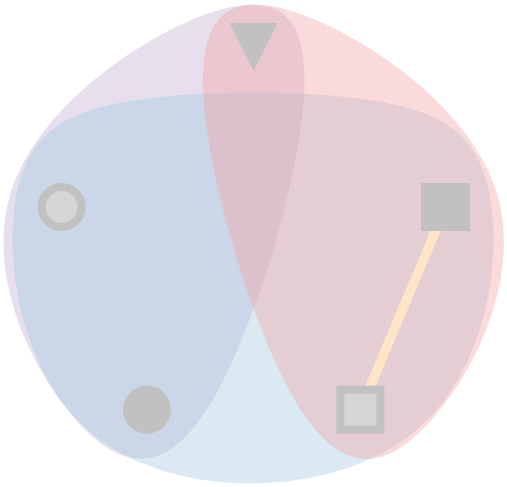
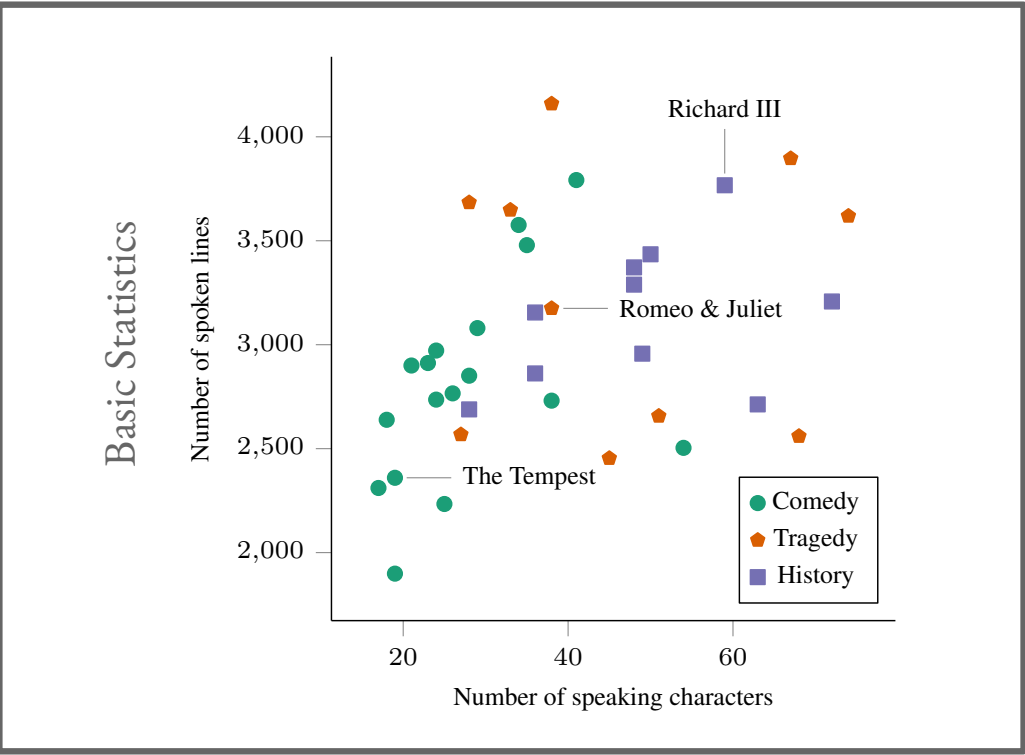
Contribution

37 Shakespeare plays  
18 (Hyper)graph representations  
666 (Hyper)graphs in total

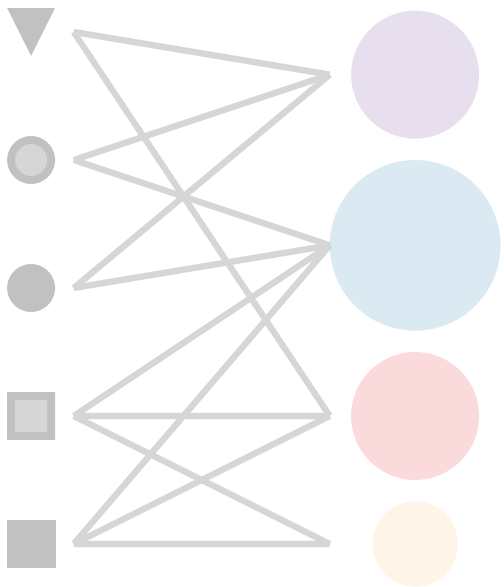


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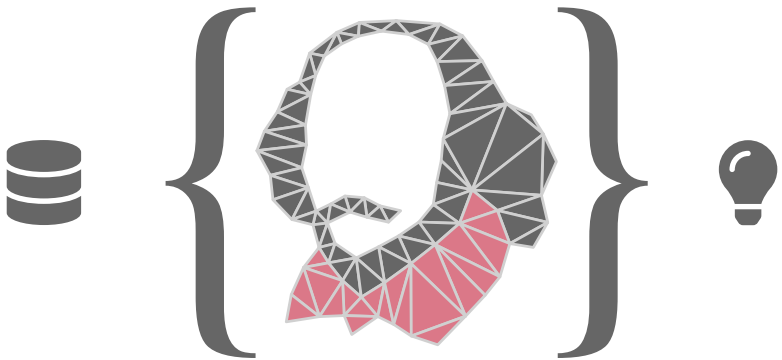


Star Expansion

How do data-modeling decisions impact our results?

## Contribution

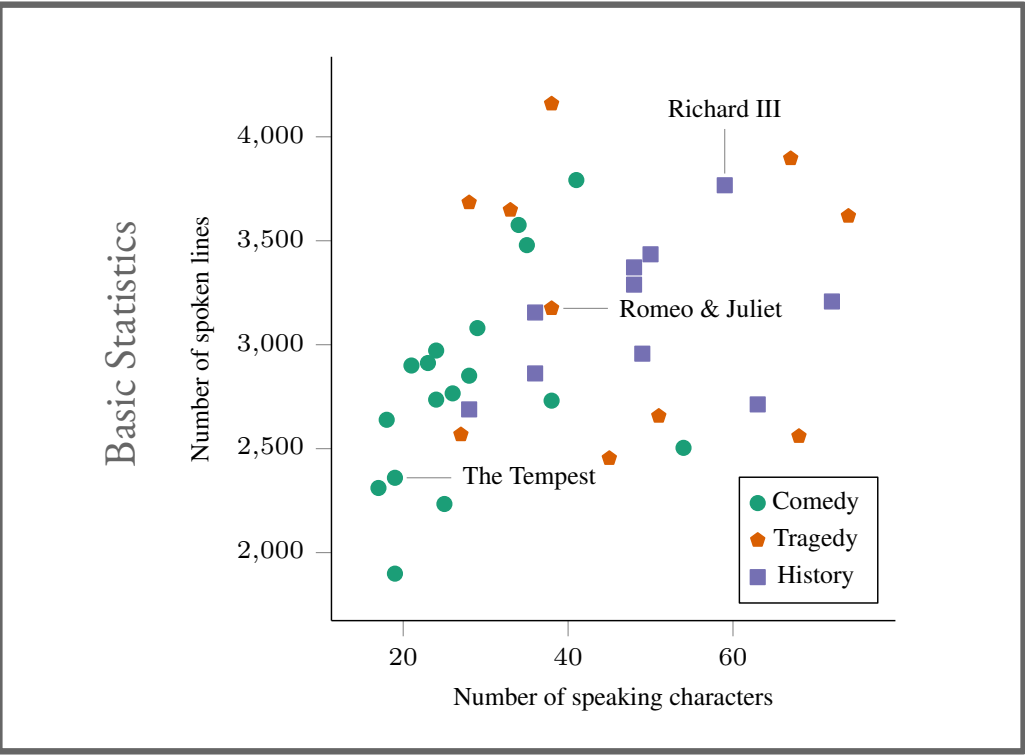
37 Shakespeare plays  
18 (Hyper)graph representations  
666 (Hyper)graphs in total



Present datasets as (sets of) *transformations*  
Make *data-modeling decisions* transparent  
Enable *representation robustness checks*

# Example: HYPERBARD

Coupette et al., DSH 2024



DRAMATIS PERSONÆ

AUTHORS. REVIEWER, a reader. CREATURE, a curious mind. HYPERBARD, a faun, sovereign of spirits. GRAPH, a gentle spirit.	PROFESSOR, SENIOR RESEARCHER, COLLEAGUE. TUTOR, SECRETARY, DEADLINES.	Persons in the Induction. Part of the Community. Serving the Community.
---	--	---

SCENE.—Sometimes in the Community; and sometimes in the forest.

INDUCTION.

SCENE I.—Between submission and decision.

Enter REVIEWER and AUTHORS.

- Rev. What is this? Is this not against the rules?
- Auth. The columns? These are only simple tables.
- They serve to help us implement blank verse.
- The script-sized numbers count the spoken lines,
- They disappear when folks use prose at times.
- We introduce a novel dataset,

With full documentation as Appendix. 7

Raw data stem from all of Shakespeare’s plays [195], 8

We model them as graphs in many ways, 9

And demonstrate representations matter. 10

The data readily accessible [65], 11

All code is publicly available [66]. 12

What follows, to avoid redundancy, 13

Conveys our main ideas, as you will see 14

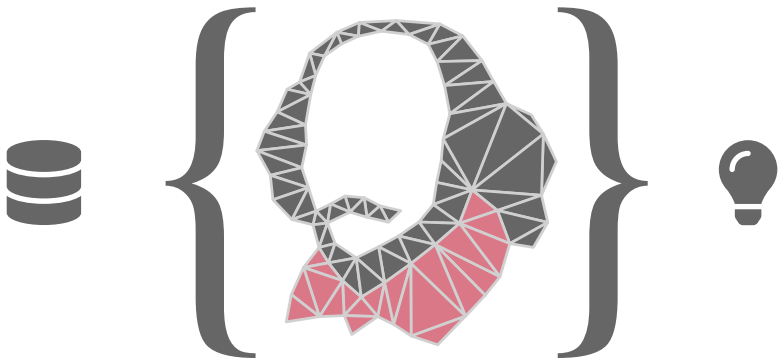
A tragedy in the Community. 15

AI-free!

## How do data-modeling decisions impact our results?

### Contribution

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18 (Hyper)graph representations  
666 (Hyper)graphs in total



Present datasets as (sets of) *transformations*  
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# HYPERBARD: Illustrations

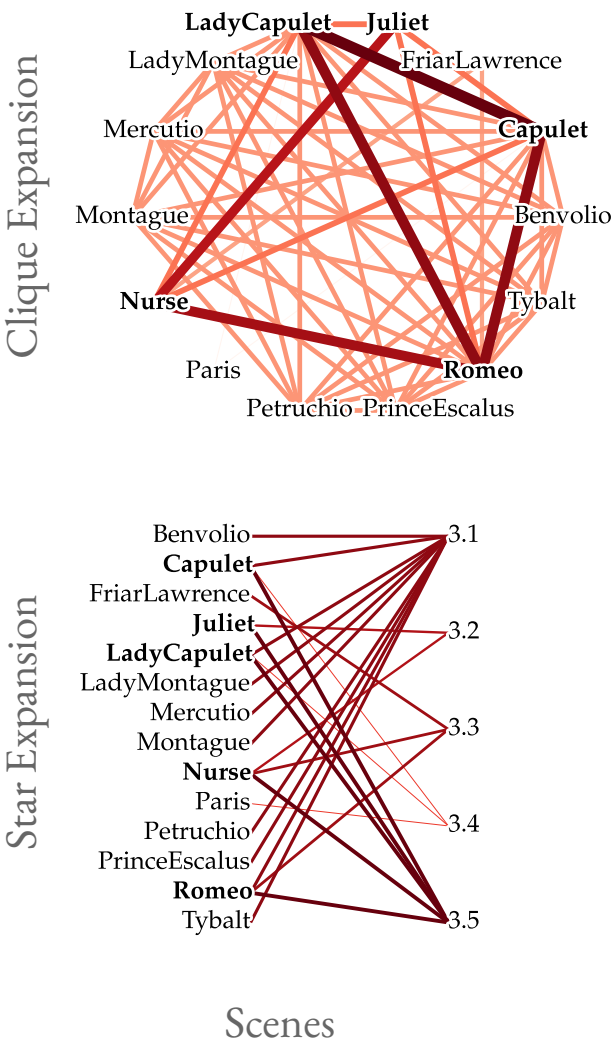
Coupette et al., DSH 2024

Romeo and Juliet, Act III

# HYPERBARD: Illustrations

Coupette et al., DSH 2024

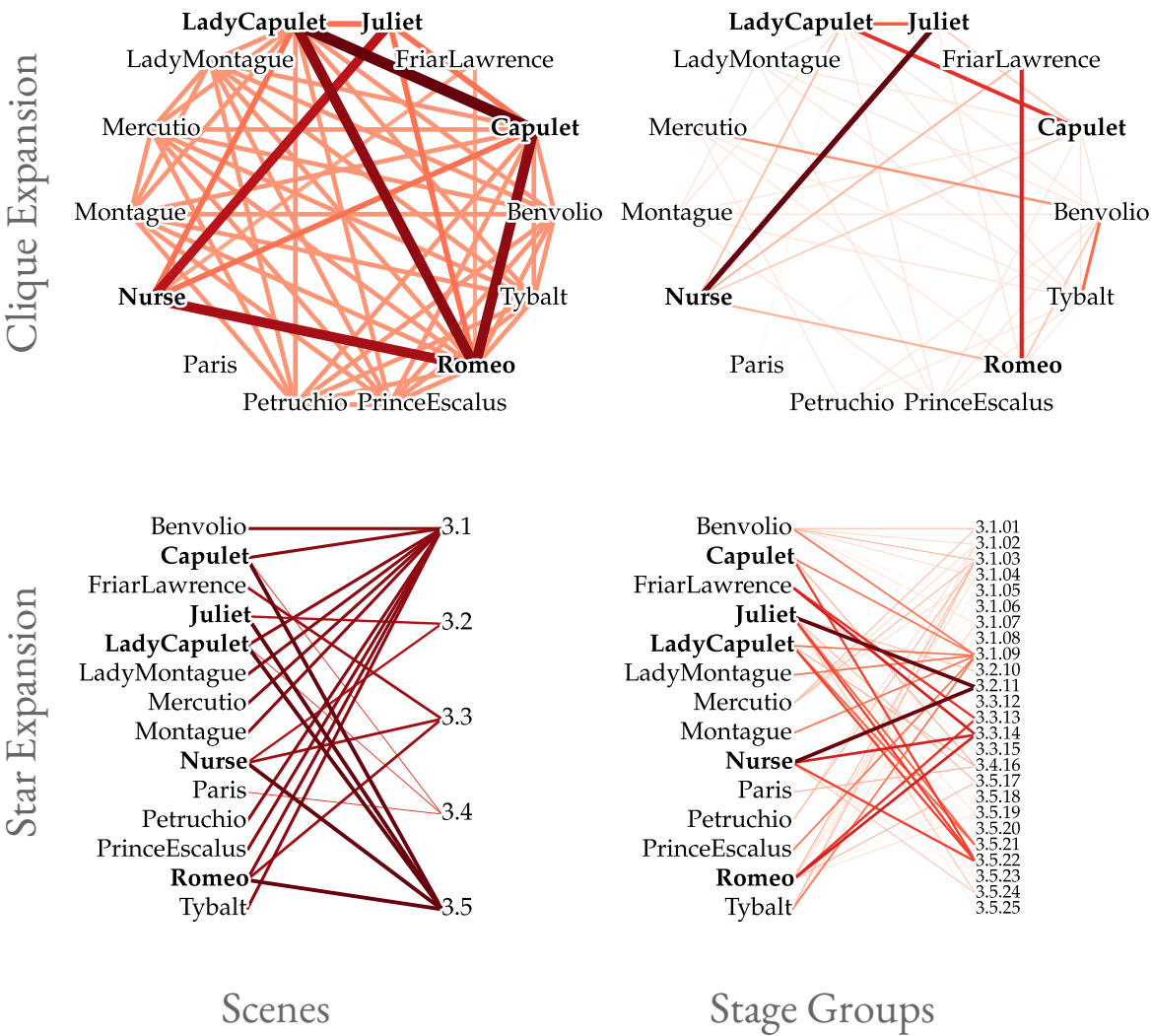
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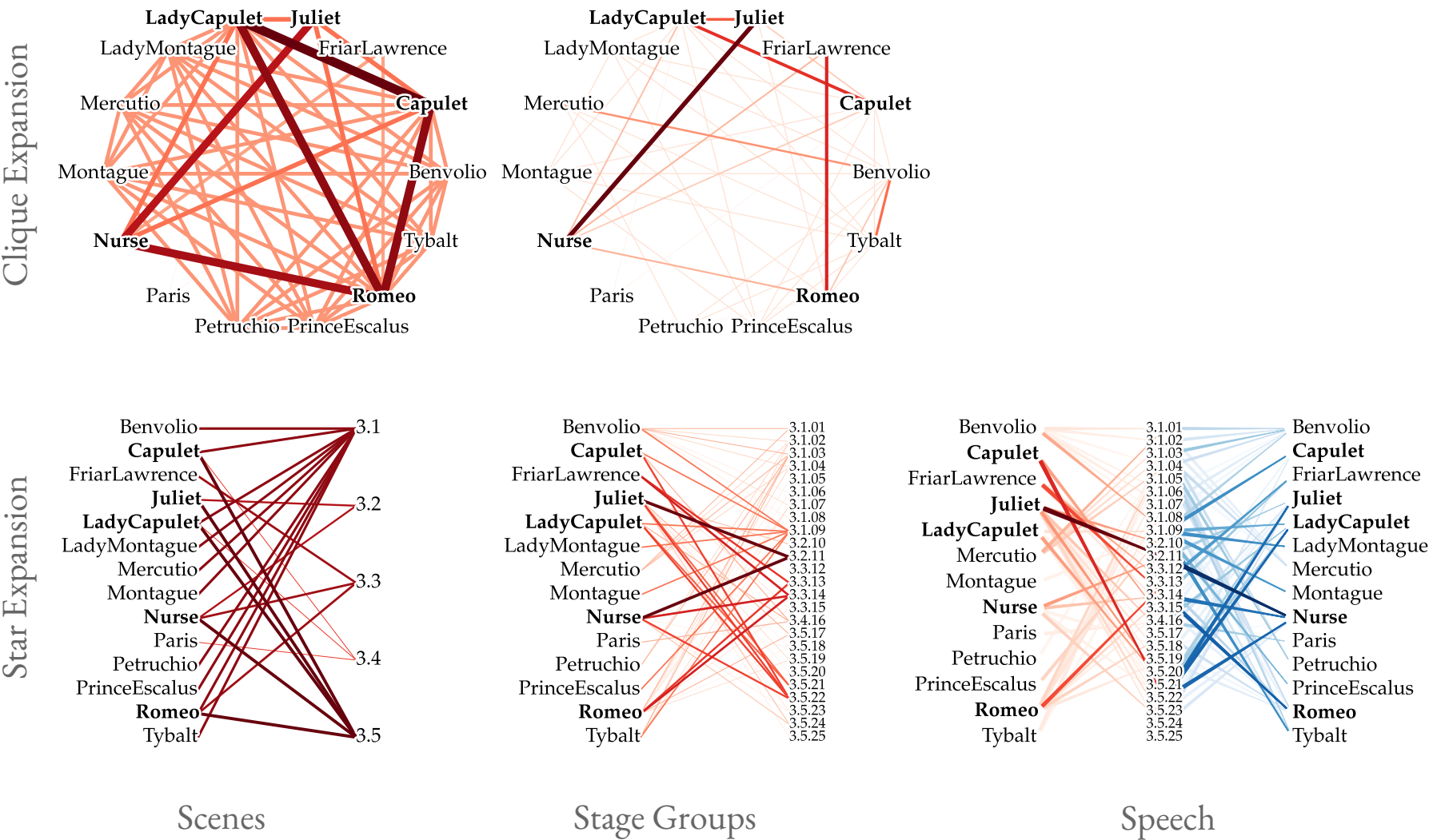
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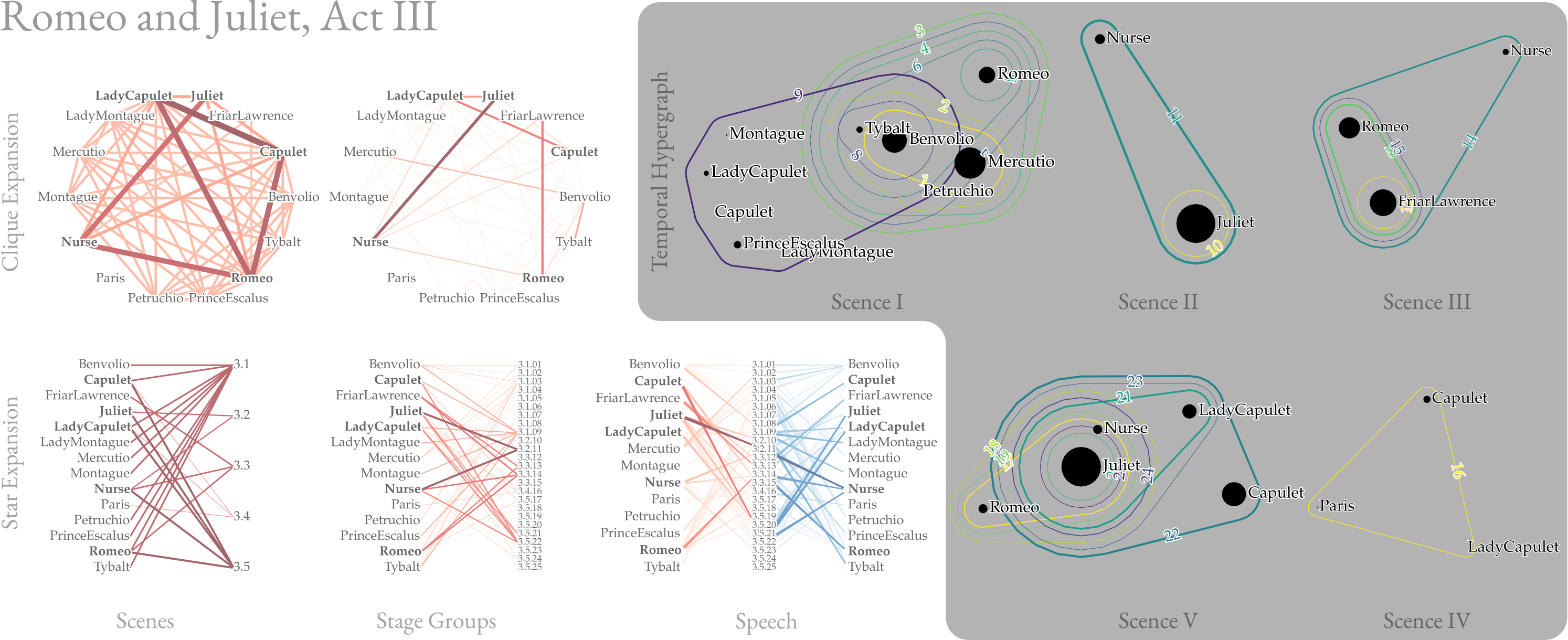
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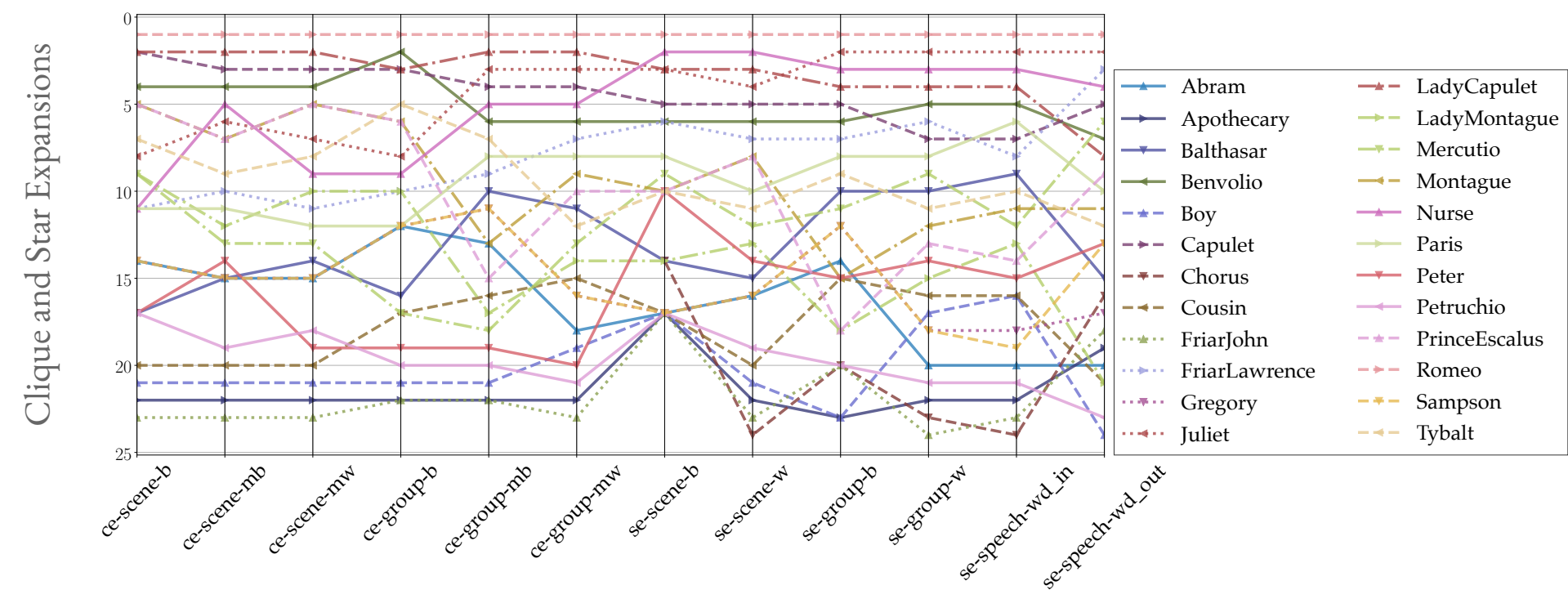
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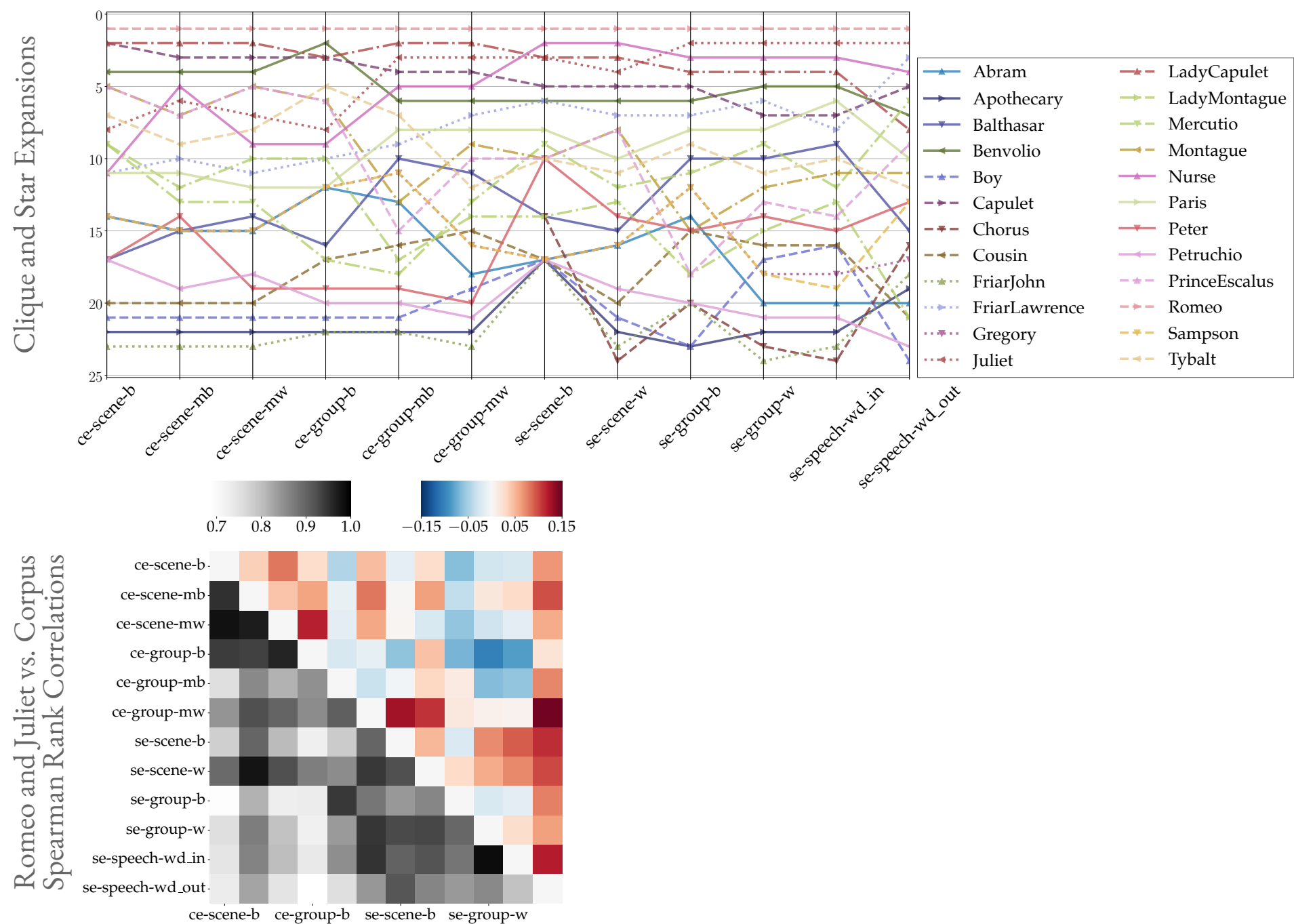
# HYPERBARD: Experimental Results

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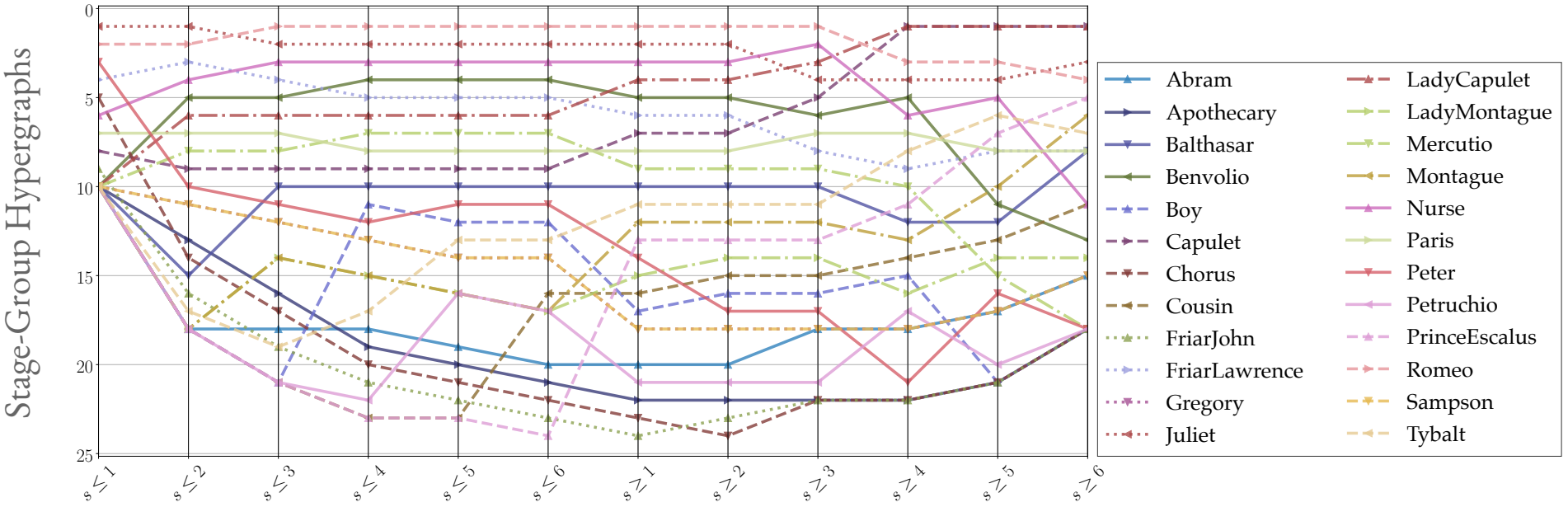
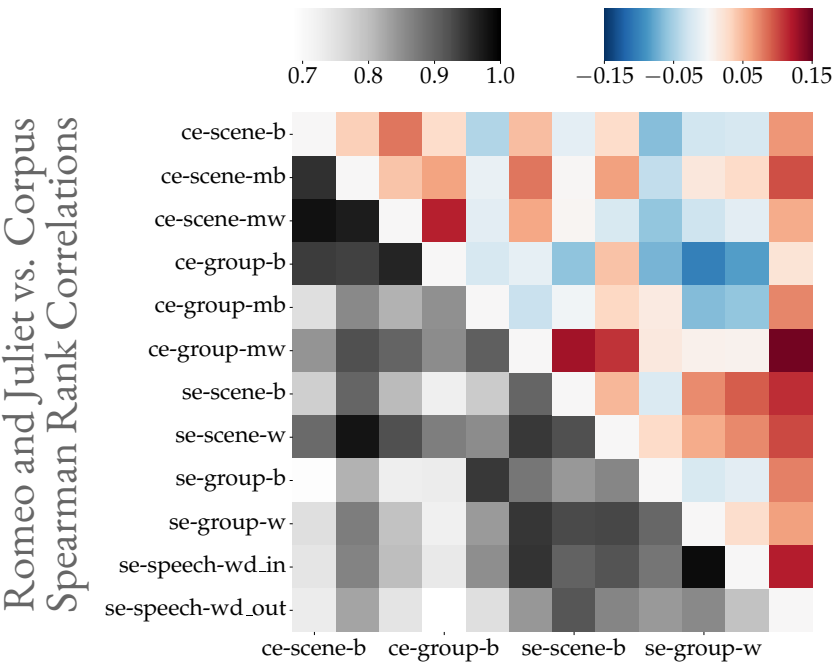
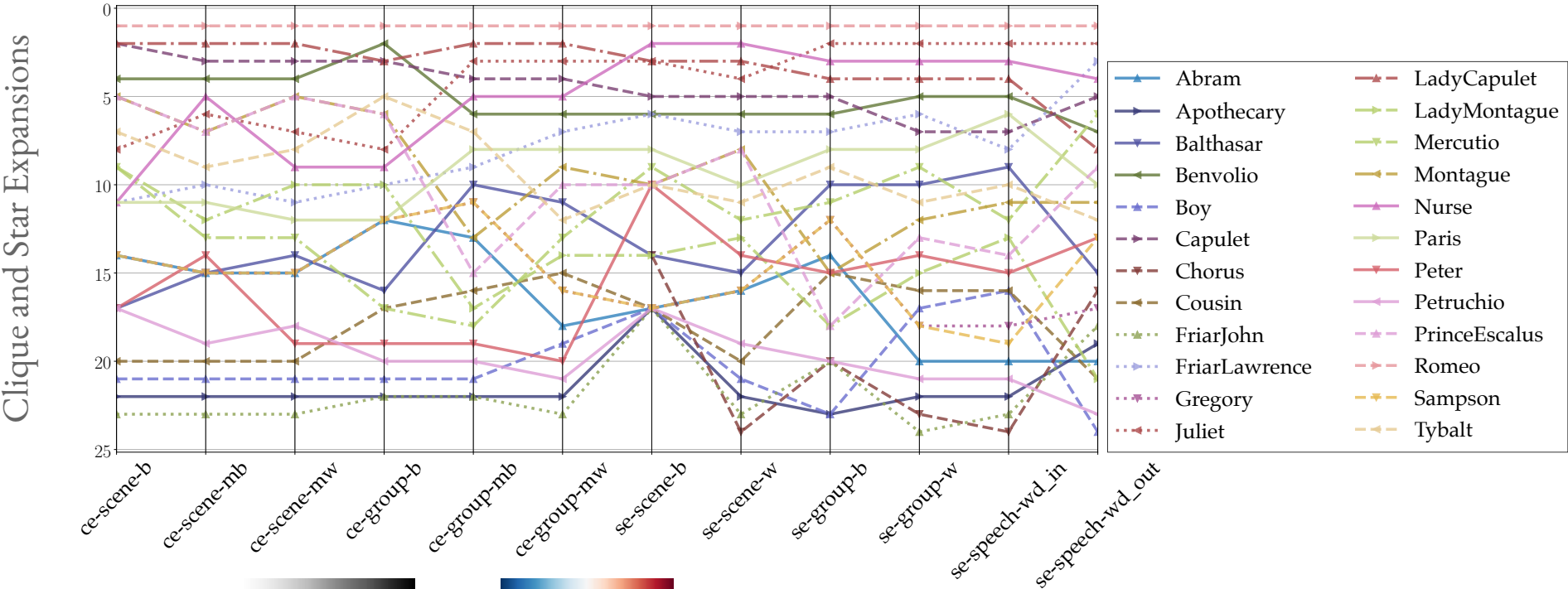
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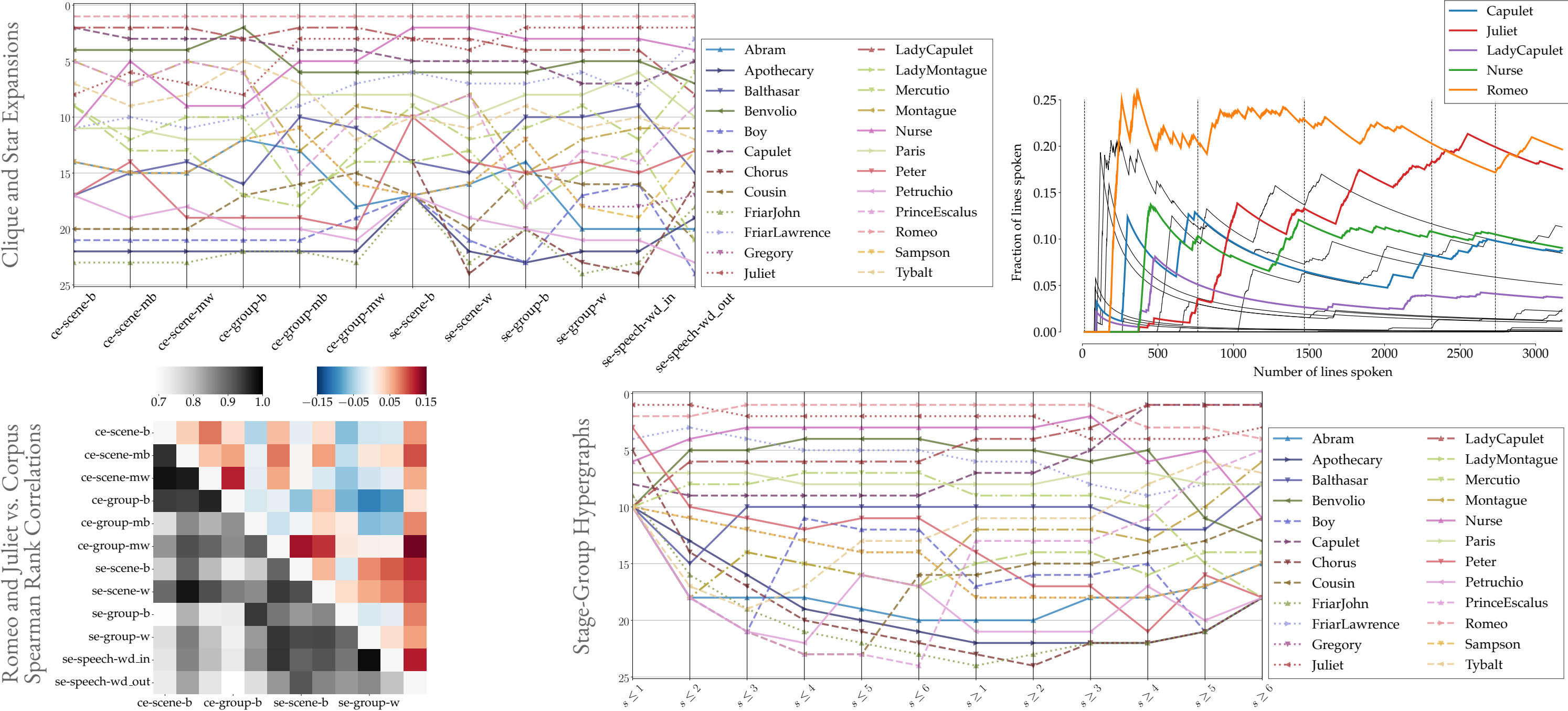
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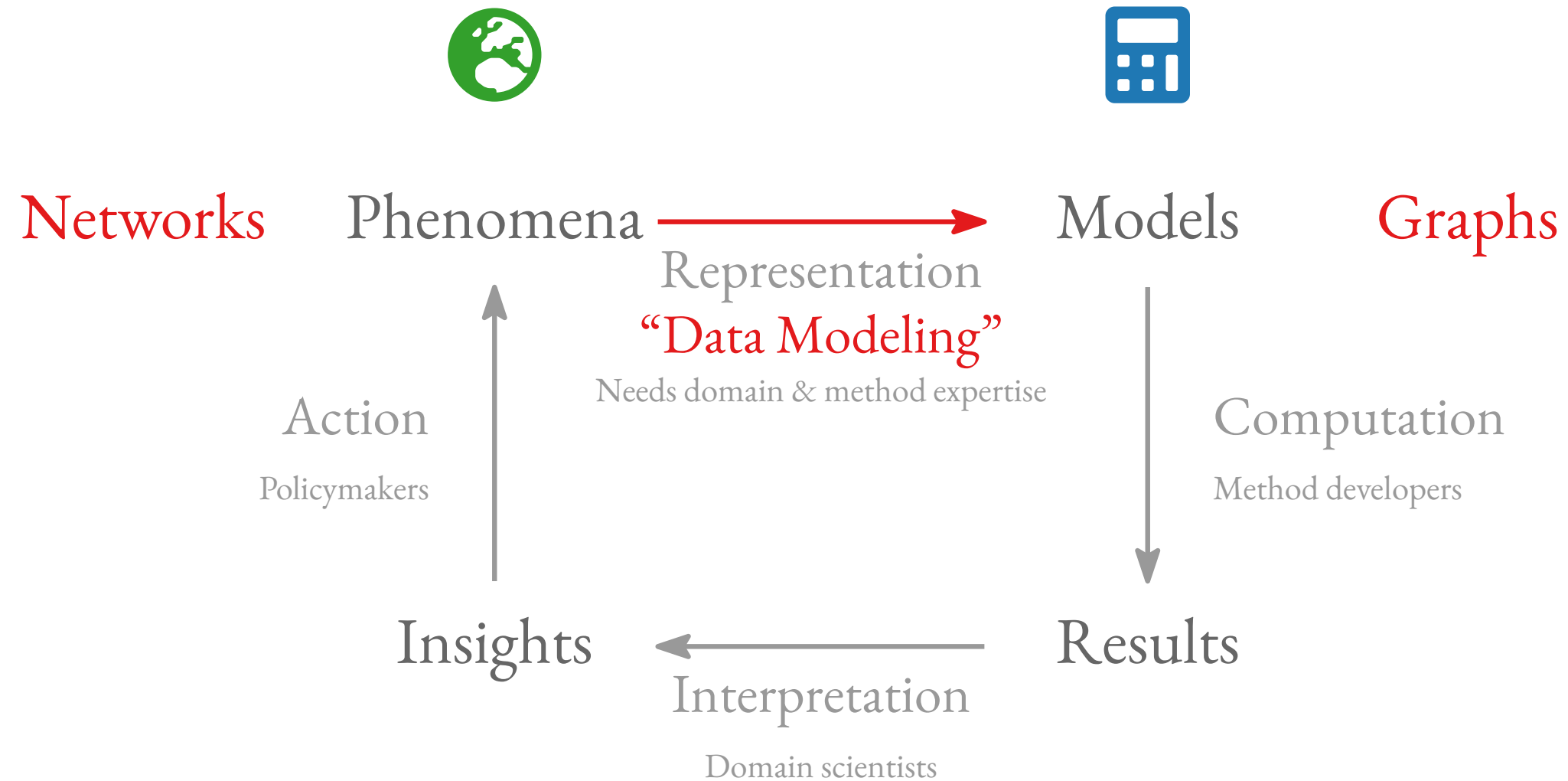


# HYPERBARD: Experimental Results

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# Addressing Threats to Validity



# Taking Stock

# Taking Stock

## Domain Scientists

Interested in *specific* research questions or datasets

Seek methods that help them answer their research questions on their data

Typically have little exposure to engineering and math, but lots of exposure to real-world problems and real-world data

Challenges: choose methods based on easy availability; represent data to suit given tools; lack background to understand methods

→ Need *abstractions* from individual *methods* that retain the salient aspects of their semantics

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## Method Developers

Aim for *generality*

Need to show that their methods work across multiple datasets from different domains (ideally,  $n \geq 3$ )

Typically have little exposure to real-world problems and real-world data, but lots of exposure to engineering and math

Challenges: choose data based on easy availability; represent data to suit their method development; lack interest in data/problems

→ Need *abstractions* from individual *problems* and *datasets* that retain the salient aspects of their semantics

# Taking Action

# Taking Action

Individual Studies: Multiverse Analysis

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Origin: Psychology's replication crisis (Steegen et al., PPS 2016)

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Easy to use for both groups of stakeholders

FAIR and *machine-readable* (?)

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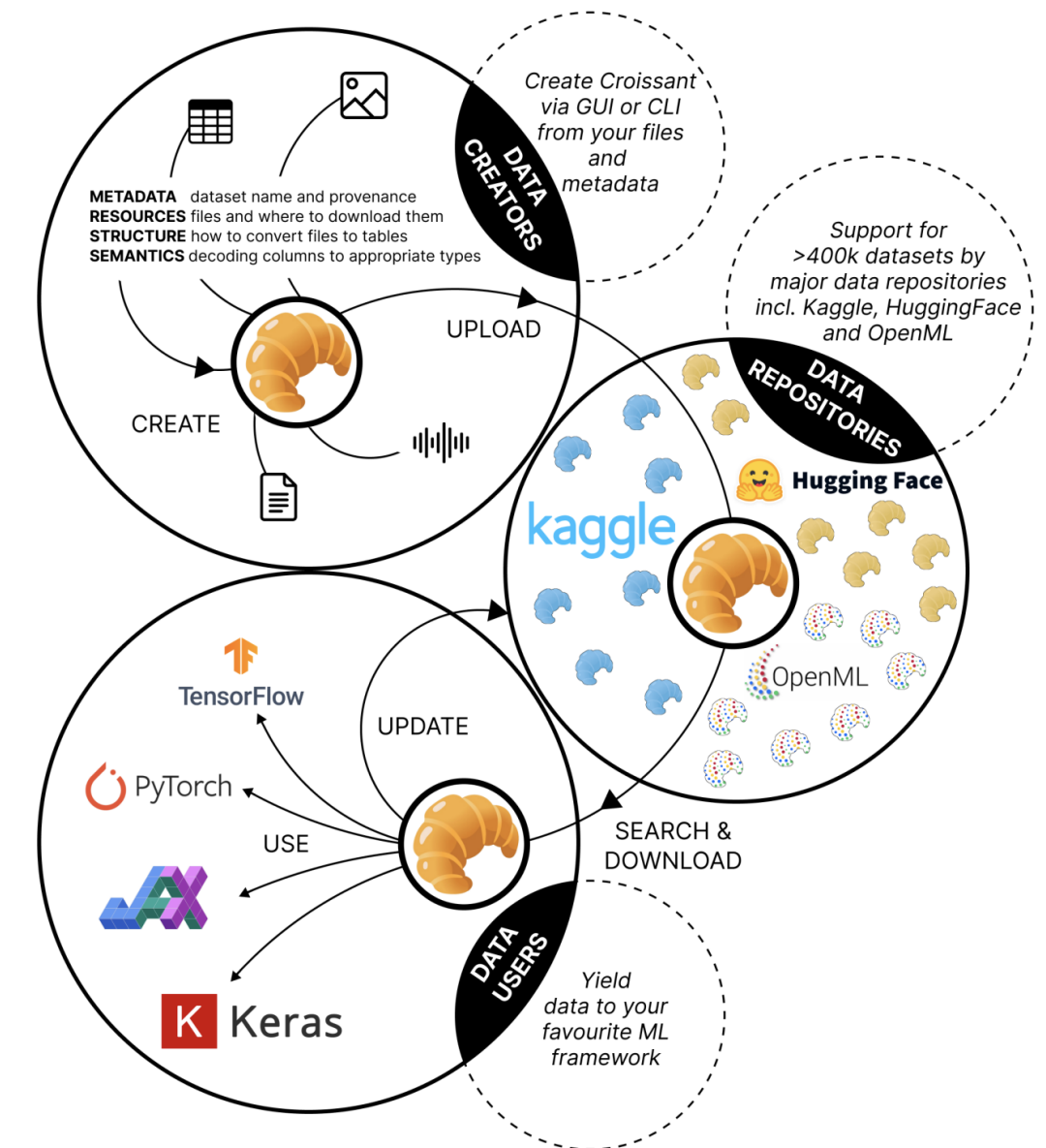
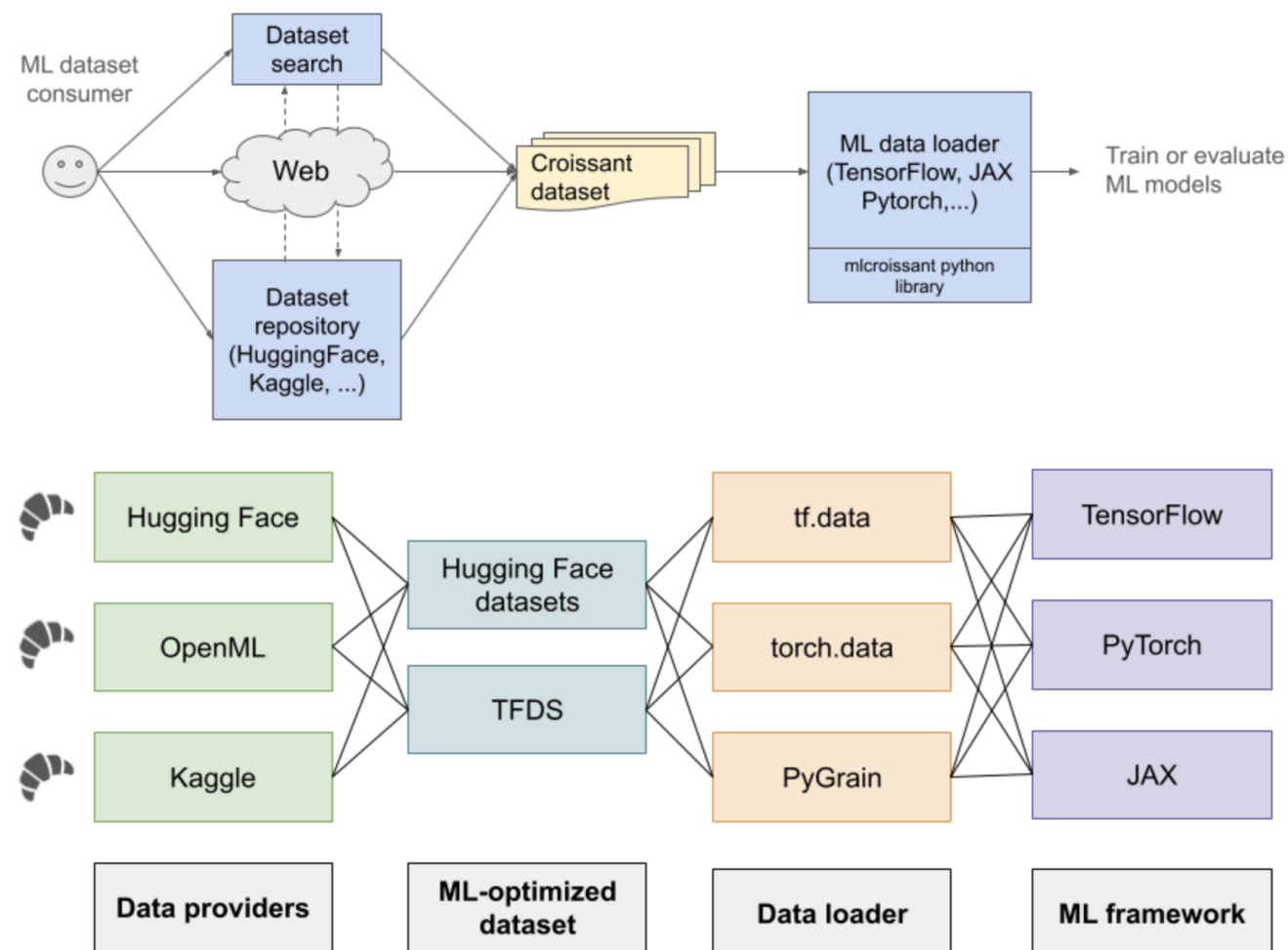
**Idea: Introduce “middle layer” of abstraction to help match questions, datasets, representations, and methods**

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## Inspirational Example with Limitations: Croissant

Metadata format based on JSON-LD (Akhtar et al., NeurIPS D&B 2024)

Primary purpose is facilitating data handling in ML applications

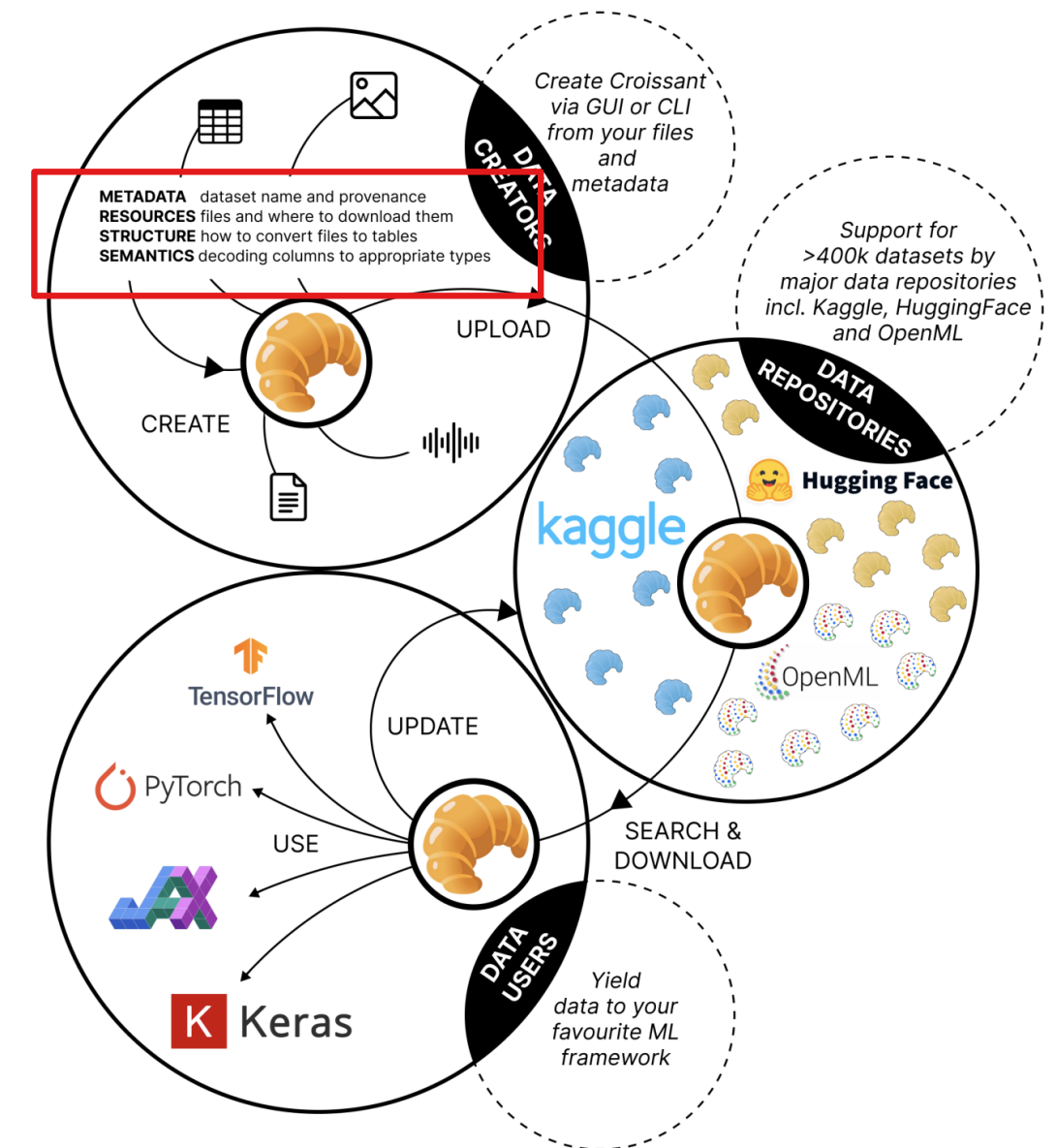
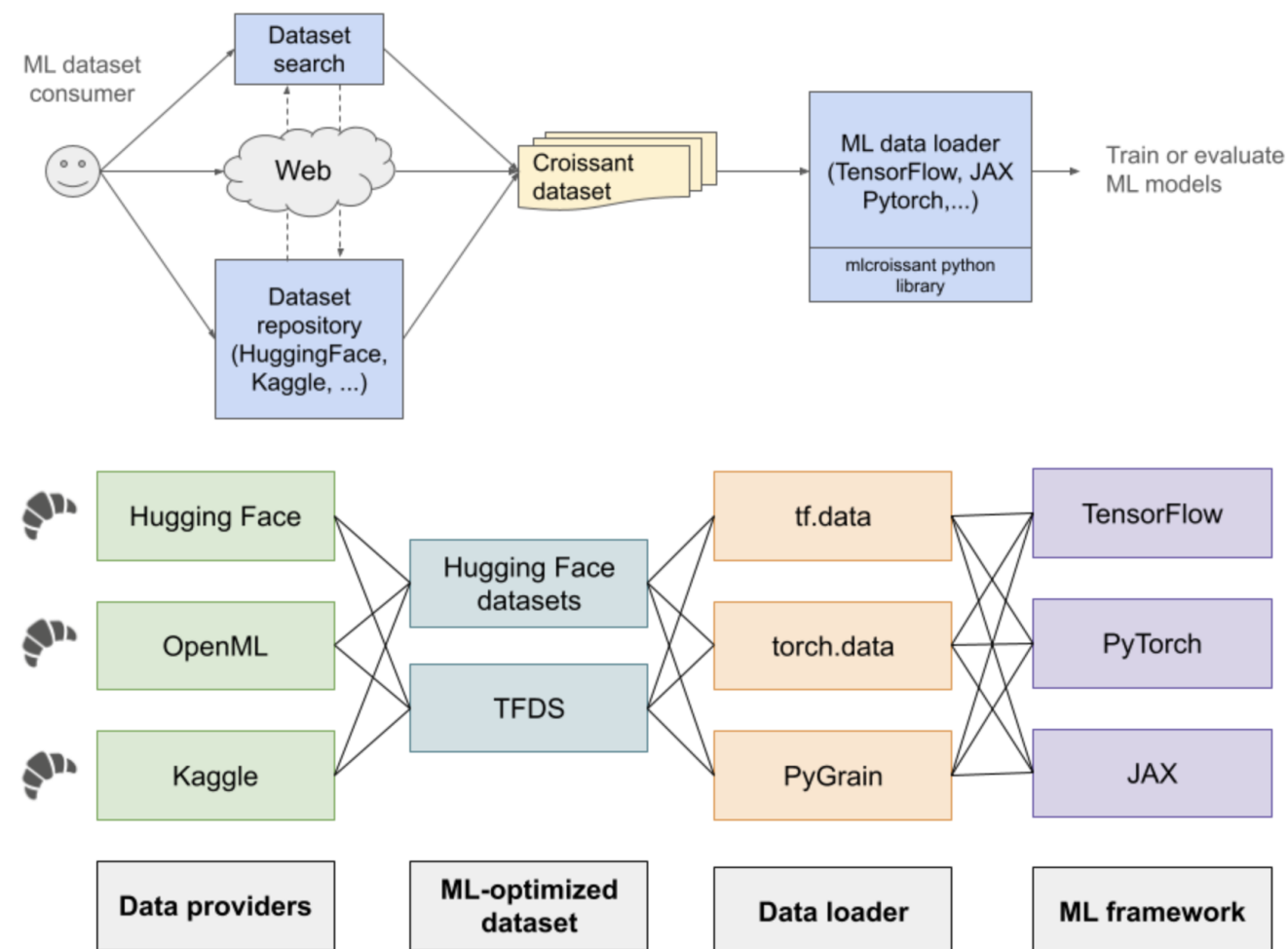


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Does *not* address our validity threats  
... but might provide a technical starting point

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Should this be done? If so, how could it be done? Other ideas?

# Thank you! Questions?



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# Appendix

## More Motivating Data-Modeling Examples

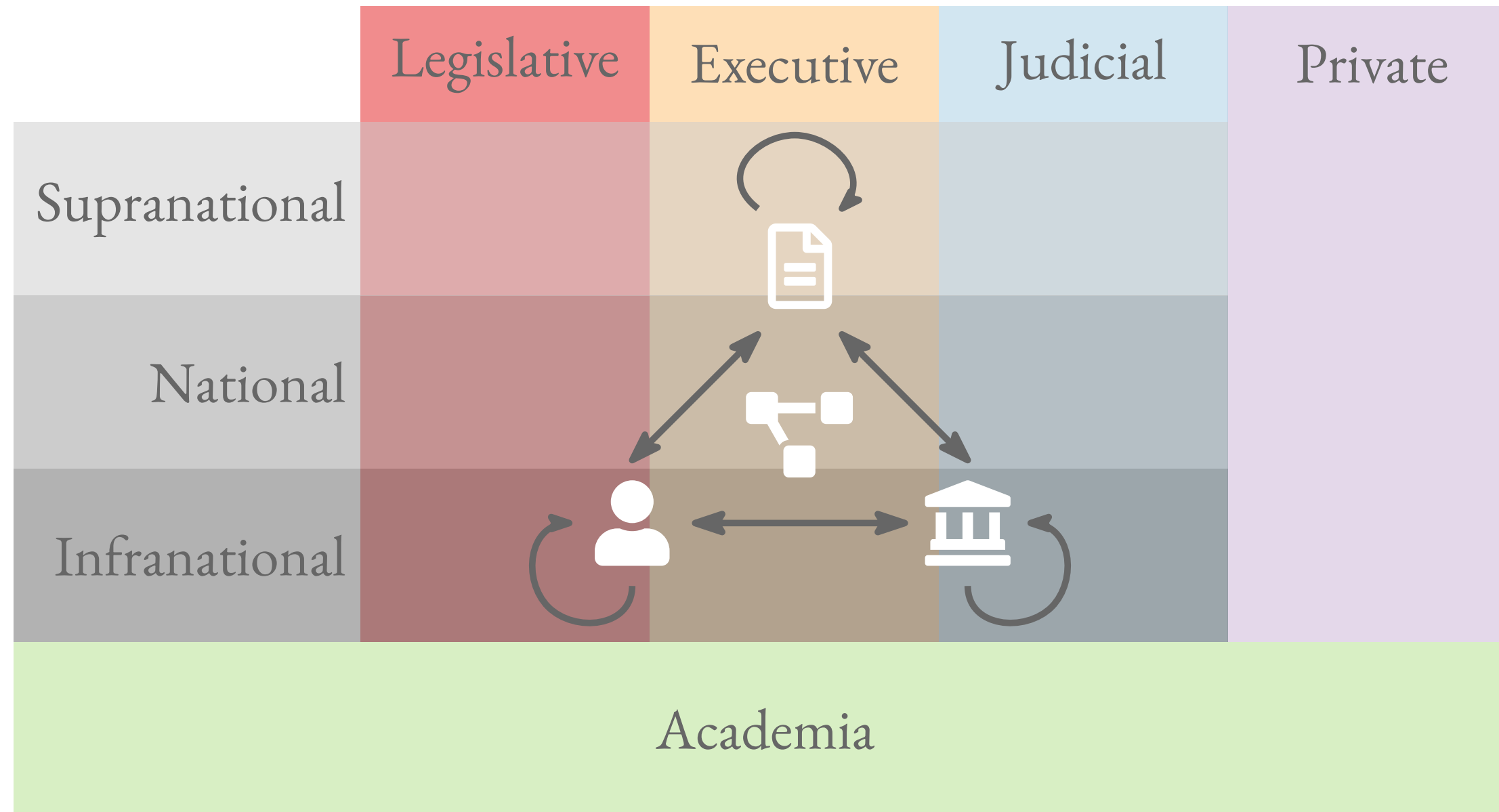
# Legal Systems

	Legislative	Executive	Judicial	Private
Supranational				
National				
Infranational				
Academia				

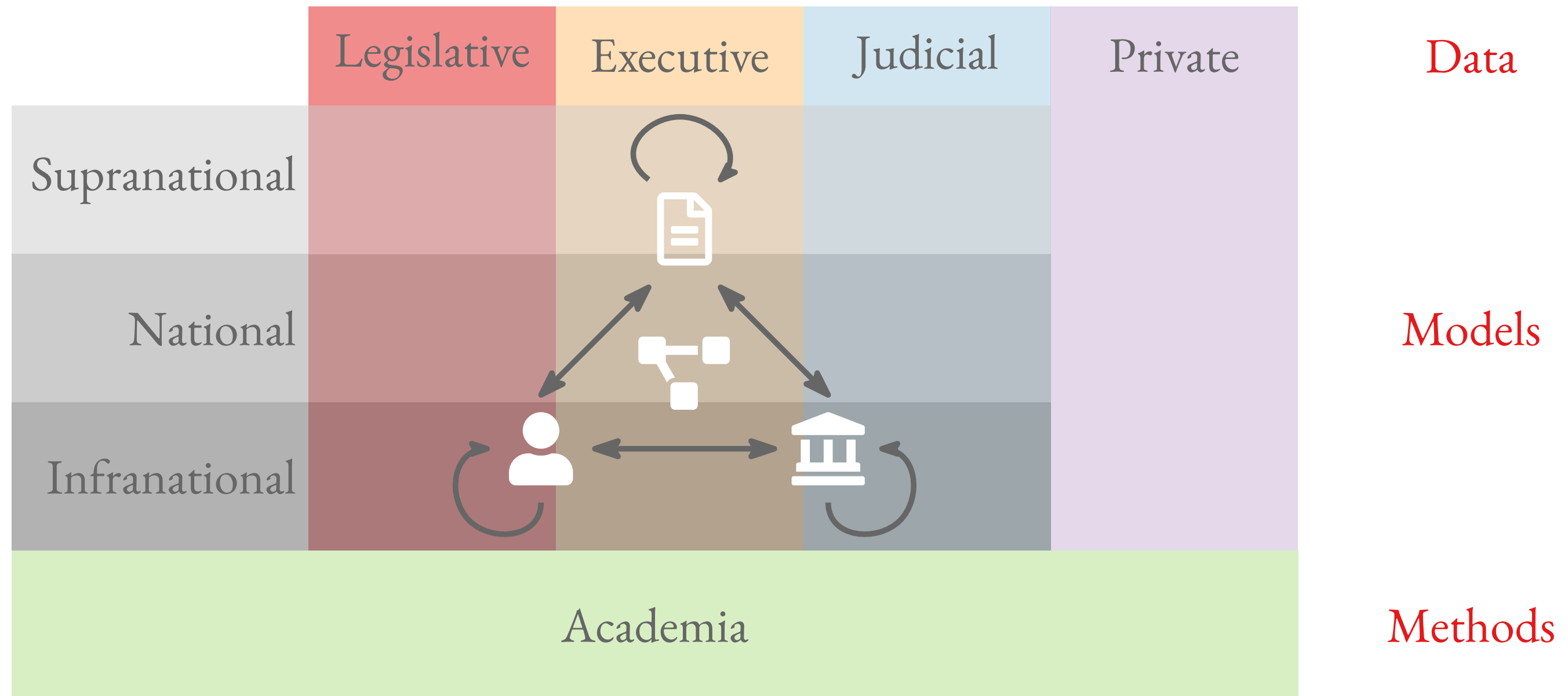
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	Legislative	Executive	Judicial	Private
Supranational			ECJ	
National	USC	CFR	SCOTUS	
Infranational	State Law	Parking Fine		
Academia				

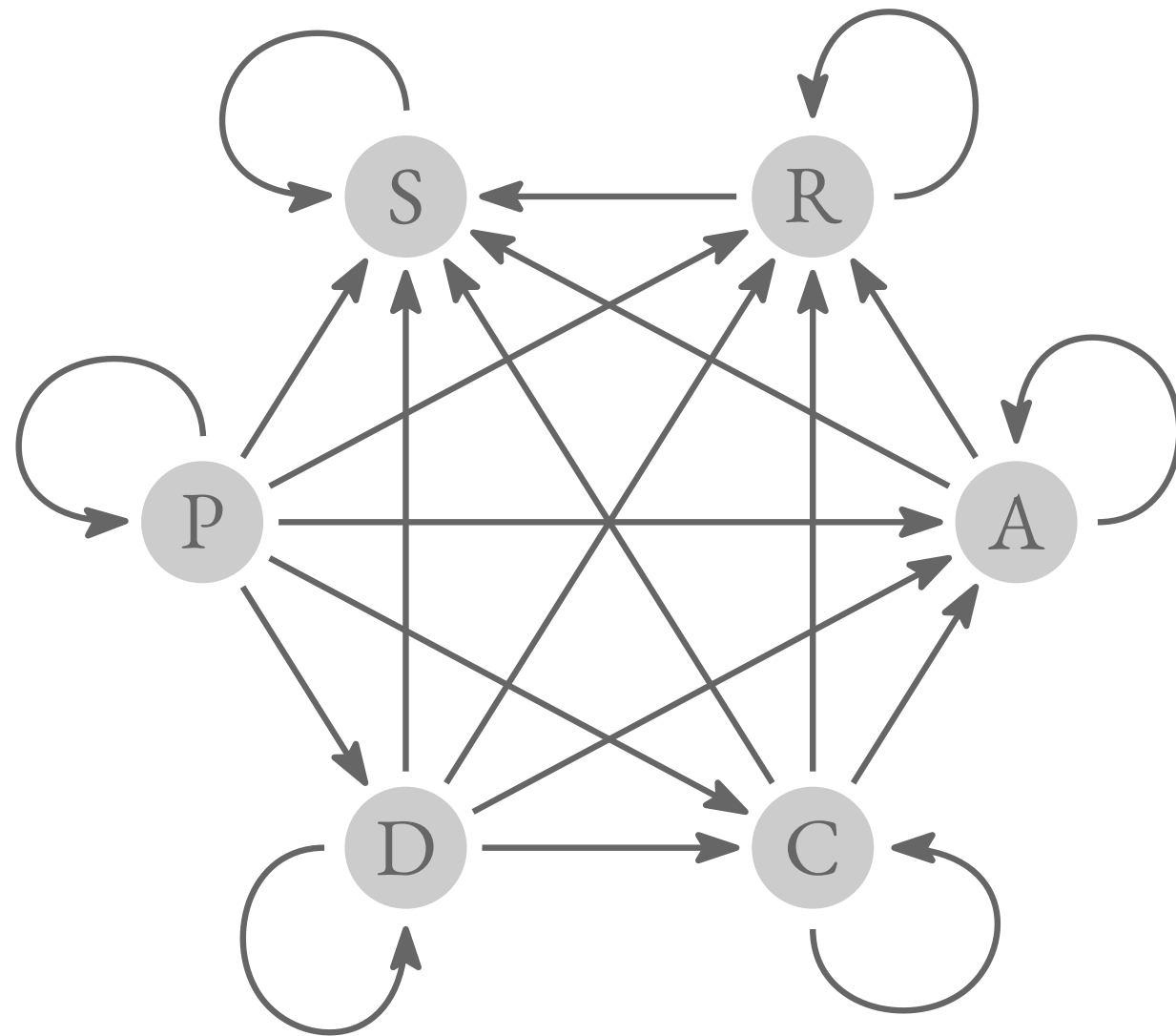
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# Legal Systems



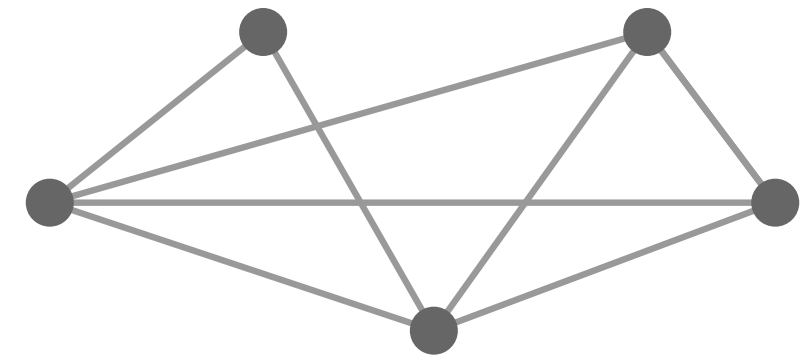
# Types of Legal Documents



- S Statutes
- R Regulations
- A Administrative Acts
- C Contracts
- D Judicial Decisions
- P Scholarly Papers

# Arbitral Collaboration Networks

Traditional View



Nodes = Arbitrators

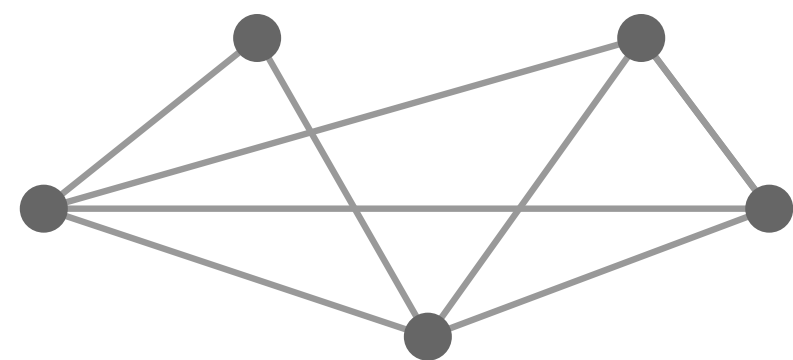
Edges = Co-Occurrence in Case  
Cliquish

Analyzed as aggregate

# Arbitral Collaboration Networks

(a) Original Proceeding	
Claimant(s)/Nationality(ies):(i)	Petronas (E&P) Overseas Venture Sdn. Bhd. (Malaysian), Petronas Carigali Chad Exploration & Production Inc. (British), Doba Pipeline Investment Inc. (British)
Respondent(s):	Republic of Cameroon (Cameroonian)
Date Registered:	November 11, 2022
Date of Constitution of Tribunal:	February 6, 2023
Composition of Tribunal	
President:	Pierre BIENVENU (Canadian) - Appointed by Co-Arbitrators
Arbitrators:	Thomas CLAY (French) - Appointed by the Claimant(s) Téa-Corinne KINTA (Congolese, French) - Appointed by the Respondent(s)
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Claimant(s):	Cleary Gottlieb Steen & Hamilton, Paris, France Quinn Emanuel Urquhart & Sullivan, Paris, France
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Latest Development:	June 8, 2023 - The Tribunal issues an order taking note of the discontinuance of the proceedings with respect to Cameroon Oil Transportation Company S.A., Esso Pipeline Investments Limited, ExxonMobil International Holdings Inc., and Esso Exploration Holdings Inc., pursuant to ICSID Arbitration Rule 56.

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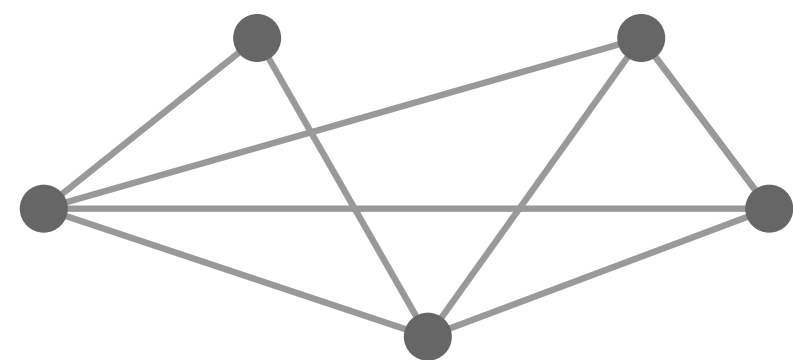
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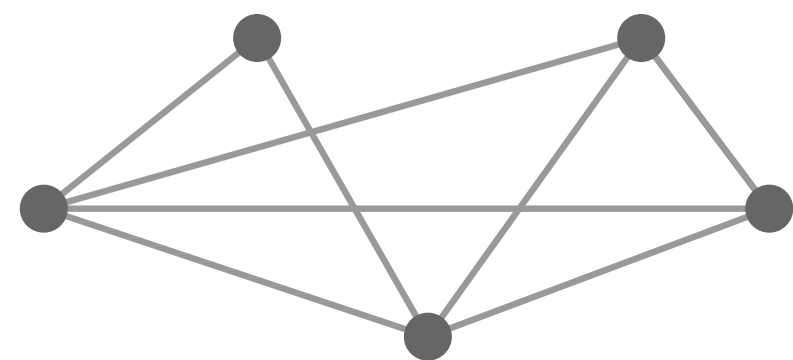
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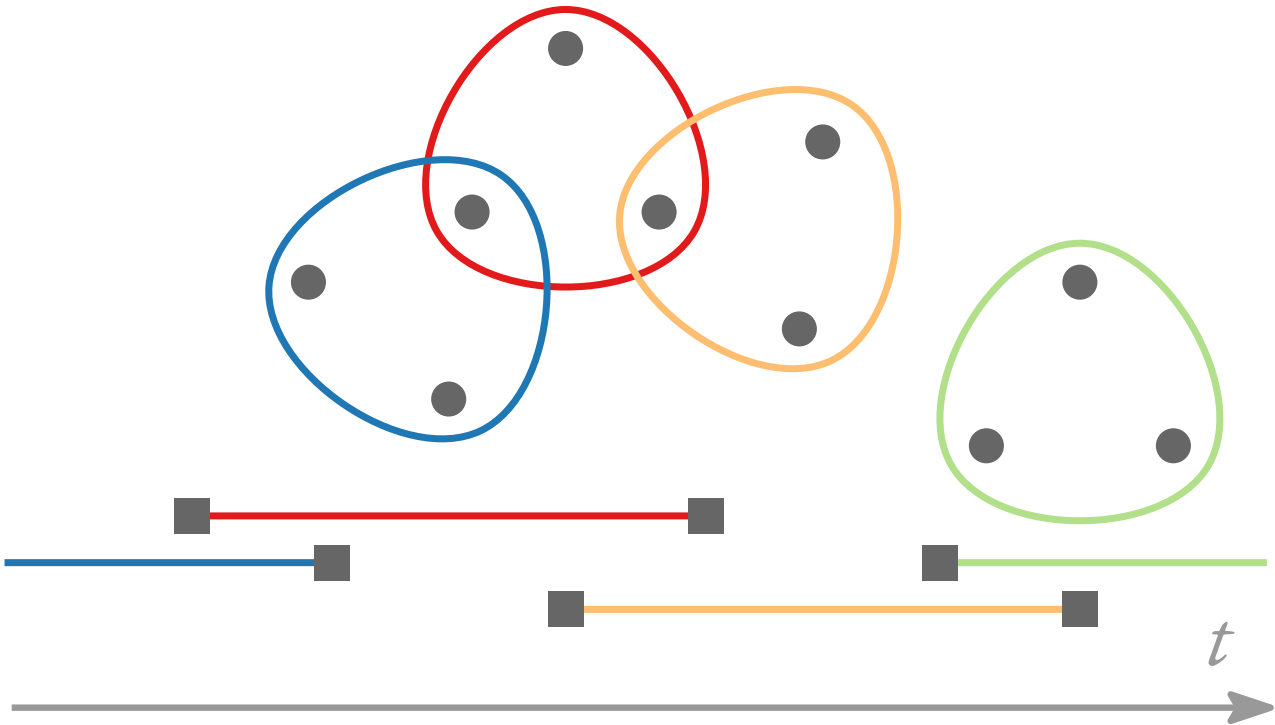
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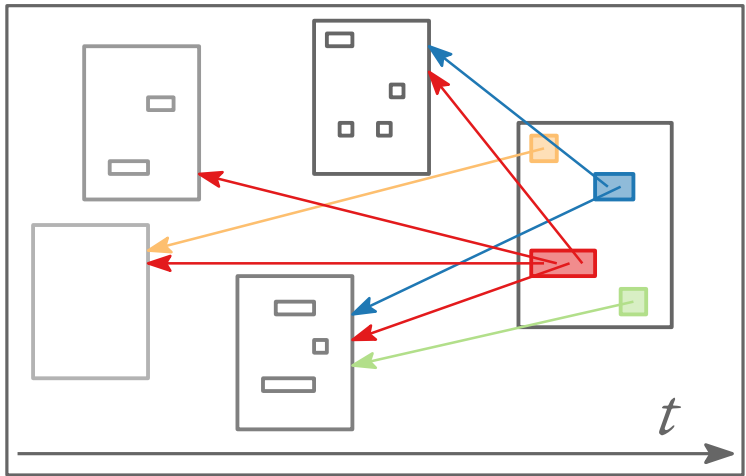
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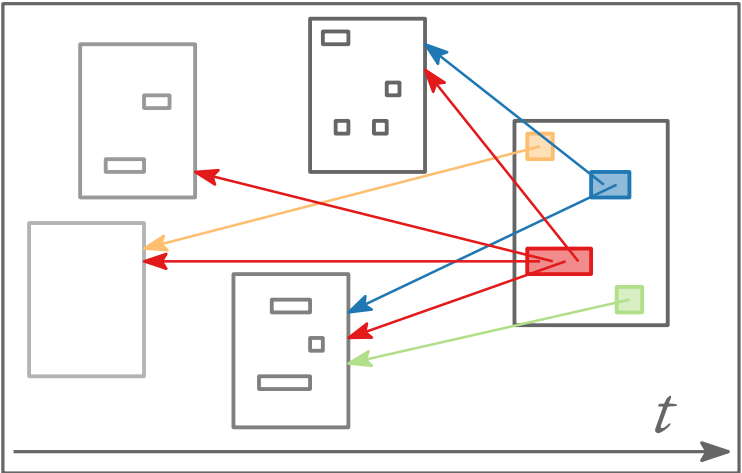
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Judicial Citations (BVerfG)	
Raw Data	Case Texts
Cases	3 618
Coverage	1951–2022 (72y)
T	2 109
Evolution	Point-Aggregation



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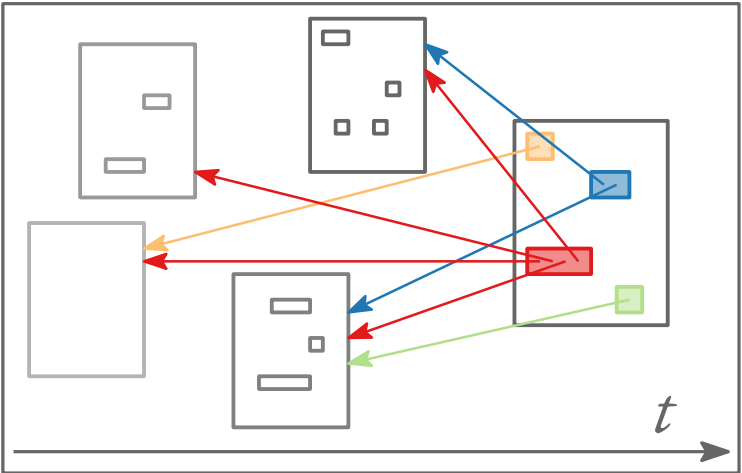
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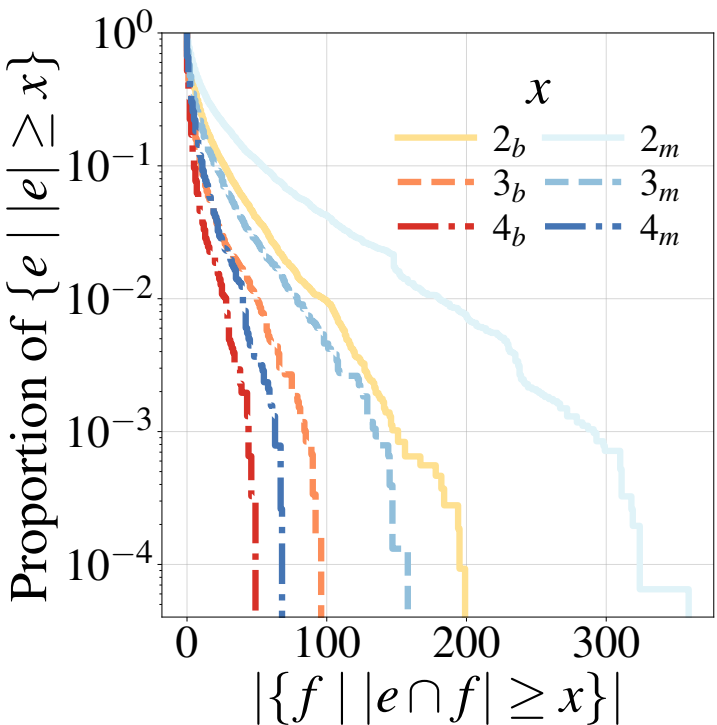
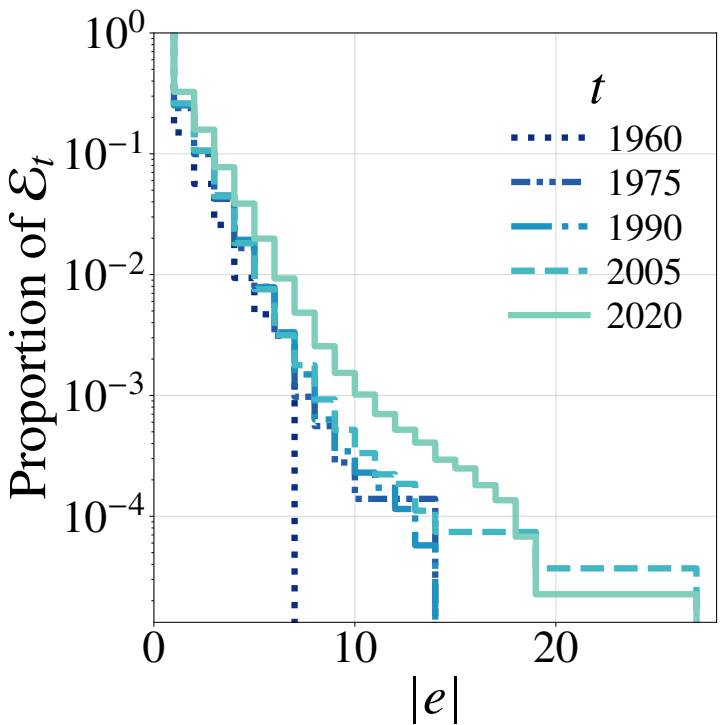
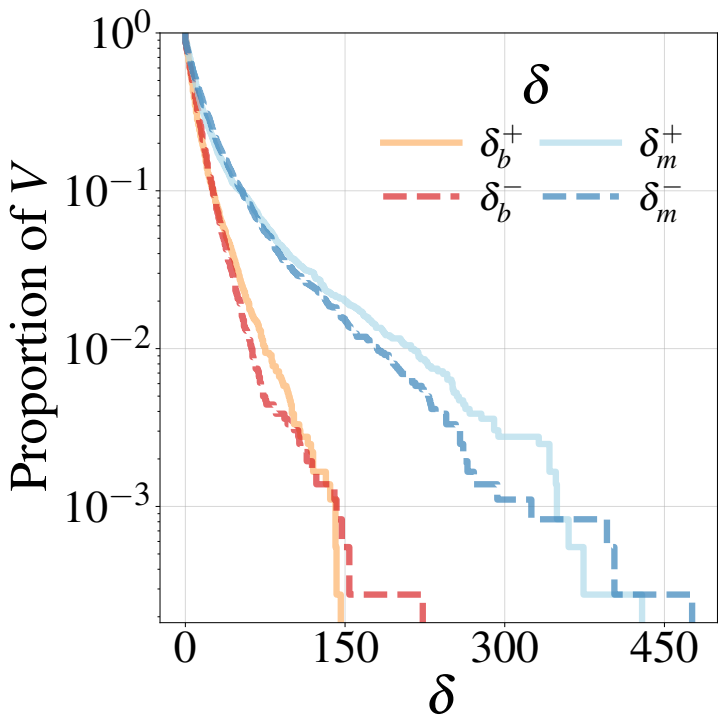
Edges	$t_E$	$m$	$\bar{\delta}$	$\delta_M$
Citations	$bb$	39 428	10.9	$6^+   7^-$
	$mb$	77 284	21.4	$9^+   10^-$
Citation Blocks	$bb$	13 541	10.2	6
	$mb$	46 257	21.4	10

# Network Representations Matter

Judicial Citations (BVerfG)	
Raw Data	Case Texts
Cases	3 618
Coverage	1951–2022 (72y)
T	2 109
Evolution	Point-Aggregation

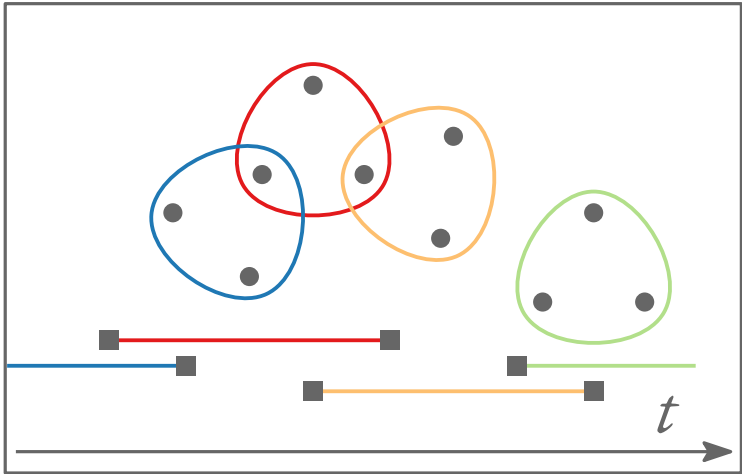


Edges	$t_E$	$m$	$\bar{\delta}$	$\delta_M$
Citations	$bb$	39 428	10.9	$6^+   7^-$
	$mb$	77 284	21.4	$9^+   10^-$
Citation Blocks	$bb$	13 541	10.2	6
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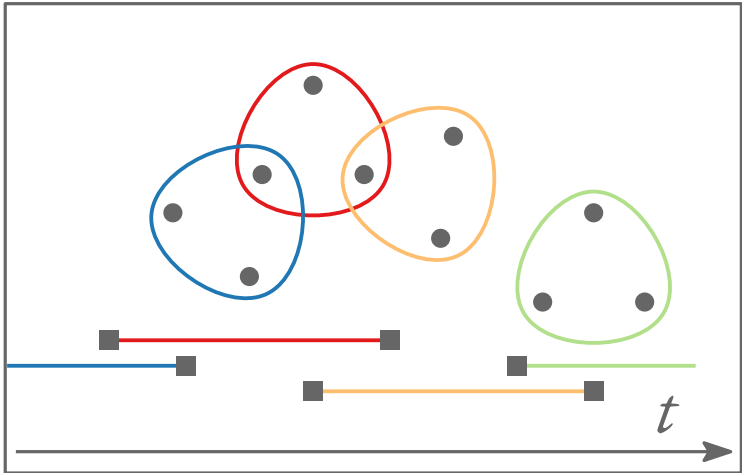
# Network Representations Matter

Arbitral Collaborations (ICSID)	
Raw Data	Case Metadata
Cases	742
Coverage	1974–2023 (50y)
T	1 077
Evolution	Interval-Event



# Network Representations Matter

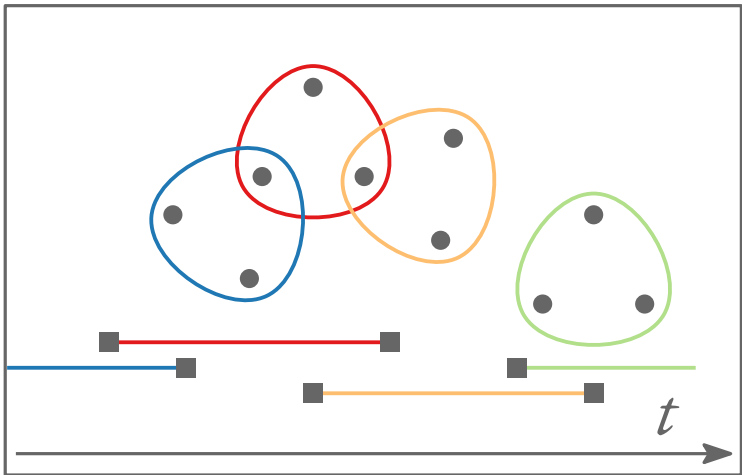
Arbitral Collaborations (ICSID)	
Raw Data	Case Metadata
Cases	742
Coverage	1974–2023 (50y)
T	1 077
Evolution	Interval-Event



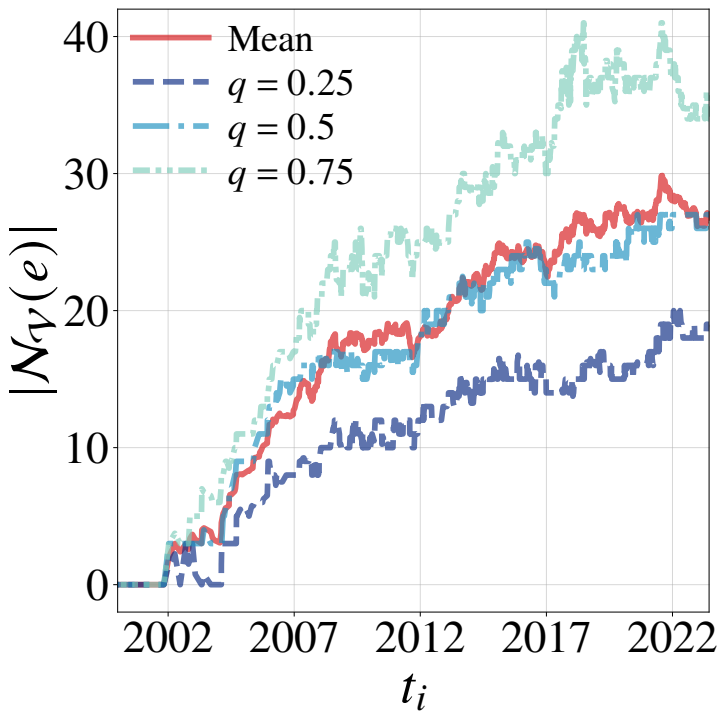
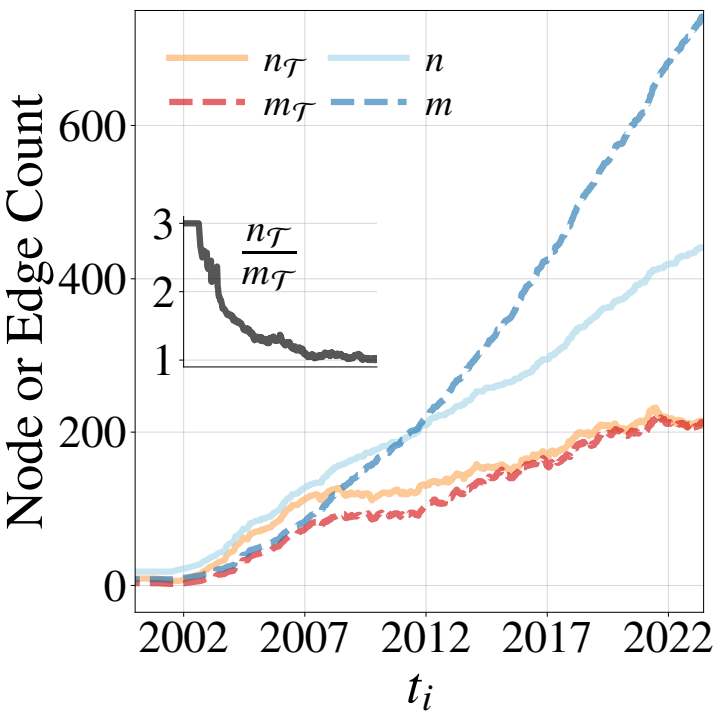
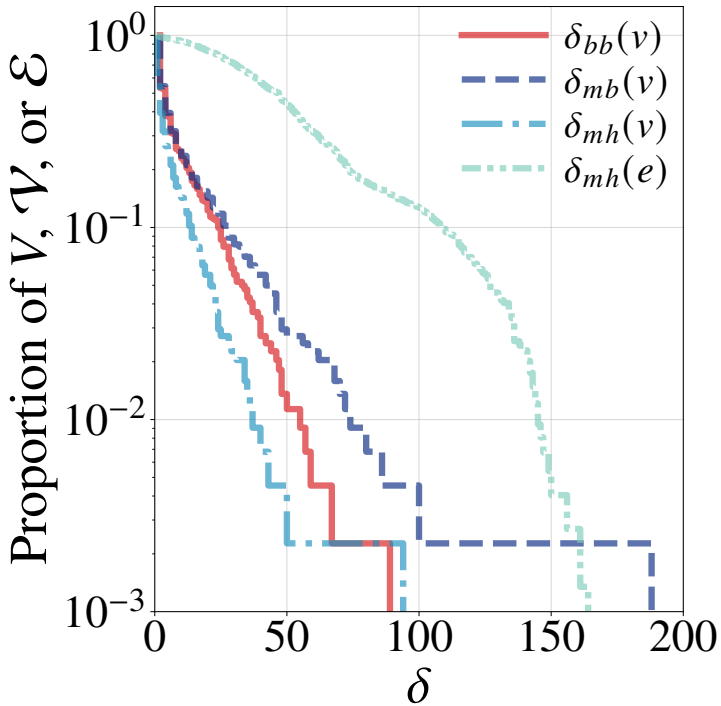
Edges	$t_E$	$m$	$\bar{\delta}$	$\delta_M$
Case Sharing	$bb$	1 869	8.5	4
	$mb$	2 226	10.1	4
Shared Cases	$bb$	722	4.9	2
	$mb$	742	5.0	2

# Network Representations Matter

Arbitral Collaborations (ICSID)	
Raw Data	Case Metadata
Cases	742
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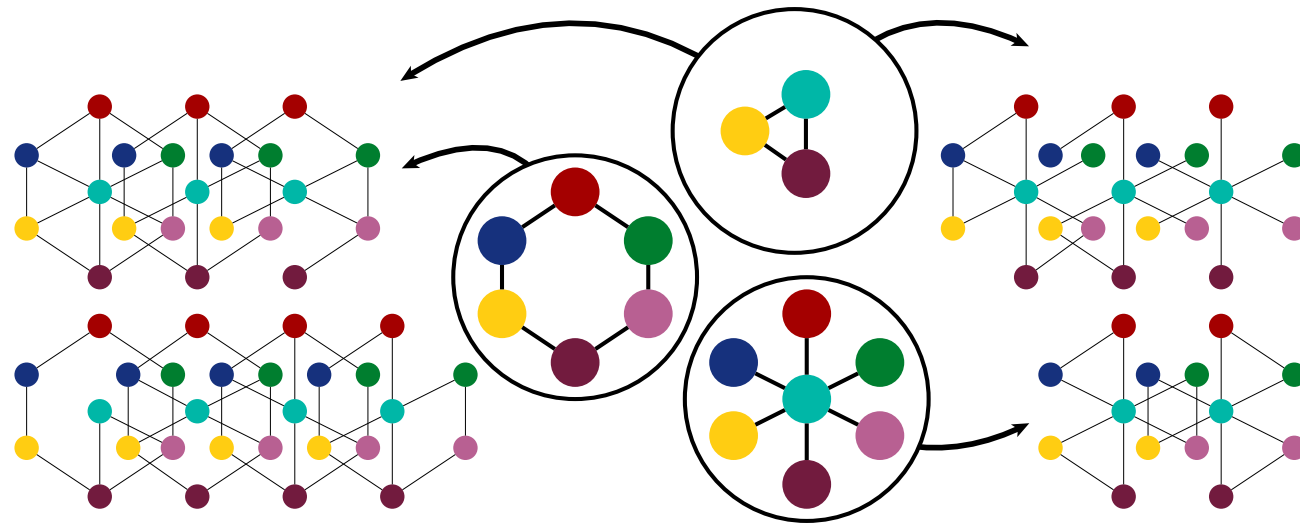
Edges	$t_E$	$m$	$\bar{\delta}$	$\delta_M$
Case Sharing	$bb$	1 869	8.5	4
	$mb$	2 226	10.1	4
Shared Cases	$bb$	722	4.9	2
	$mb$	742	5.0	2



# Graph Mining: Functional Brain Networks

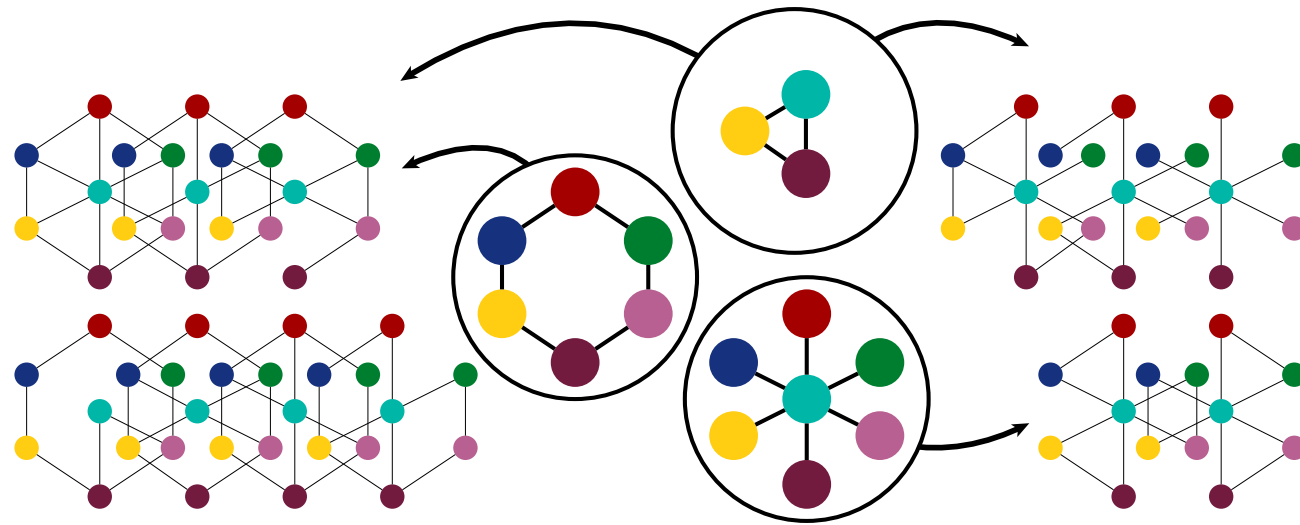
# Graph Mining: Functional Brain Networks

## Motivation

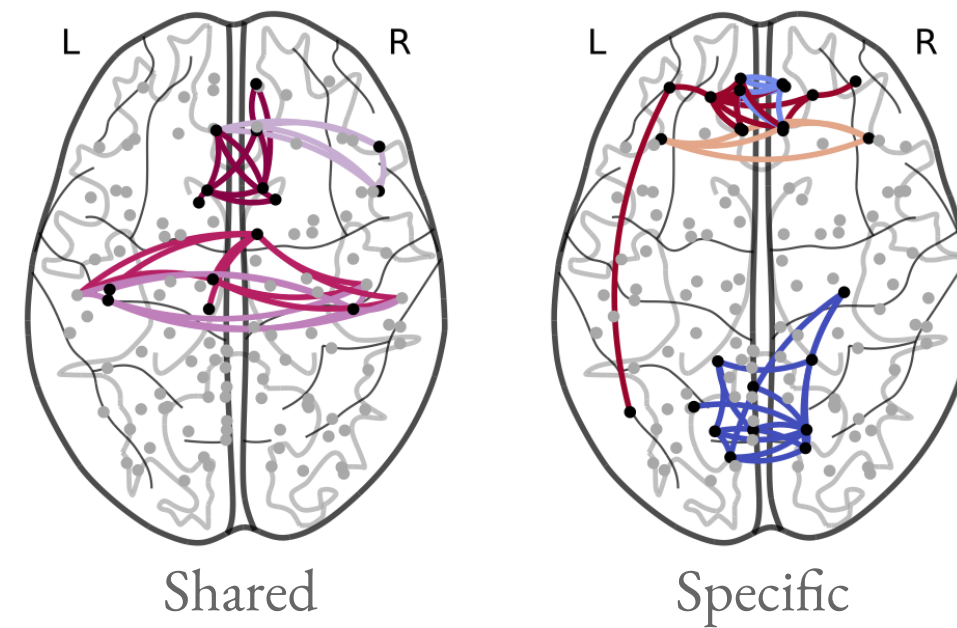


# Graph Mining: Functional Brain Networks

## Motivation

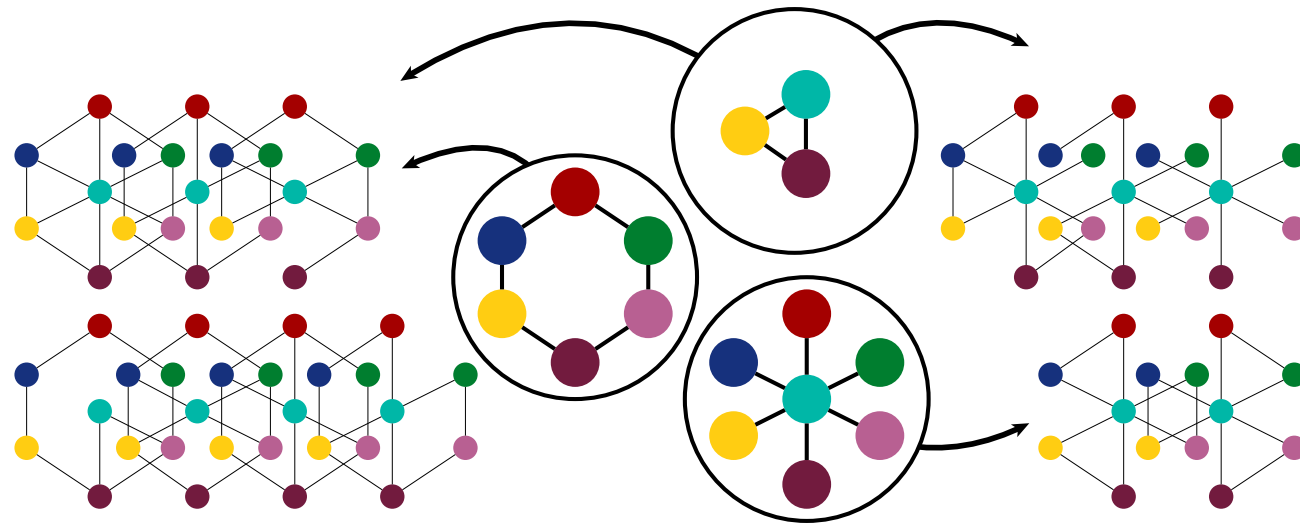


## ASD vs. TD Adolescents\*



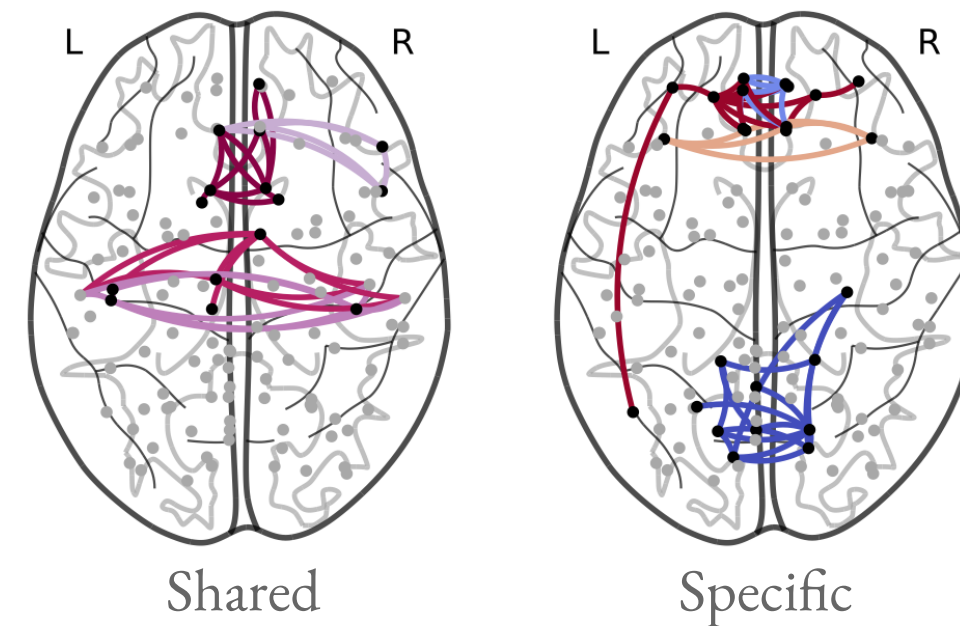
# Graph Mining: Functional Brain Networks

## Motivation



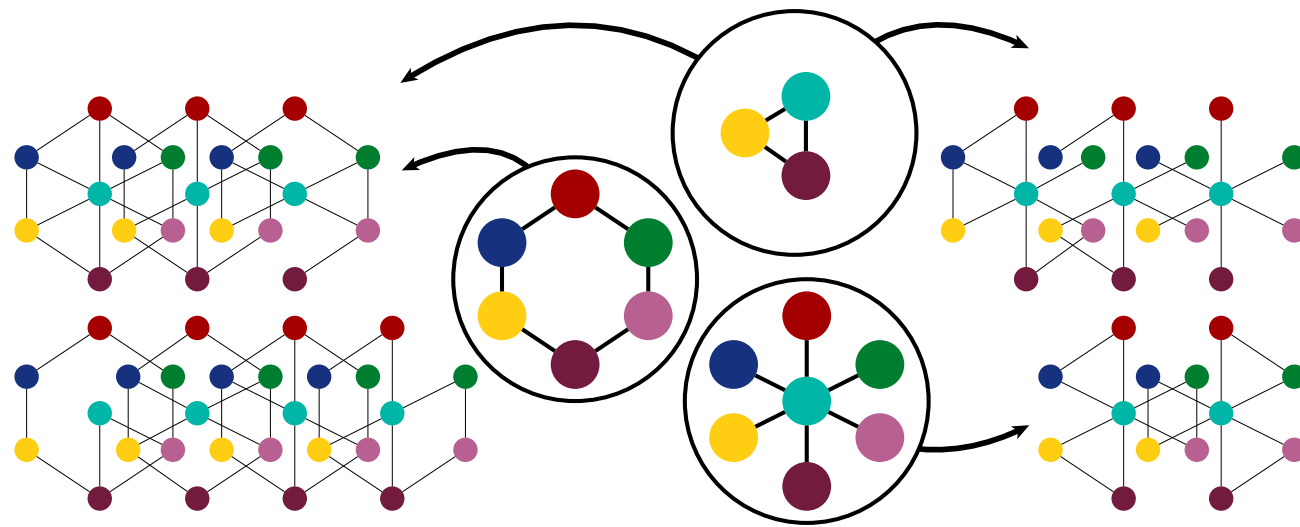
\* ABIDE Data Preprocessing

## ASD vs. TD Adolescents\*



# Graph Mining: Functional Brain Networks

## Motivation

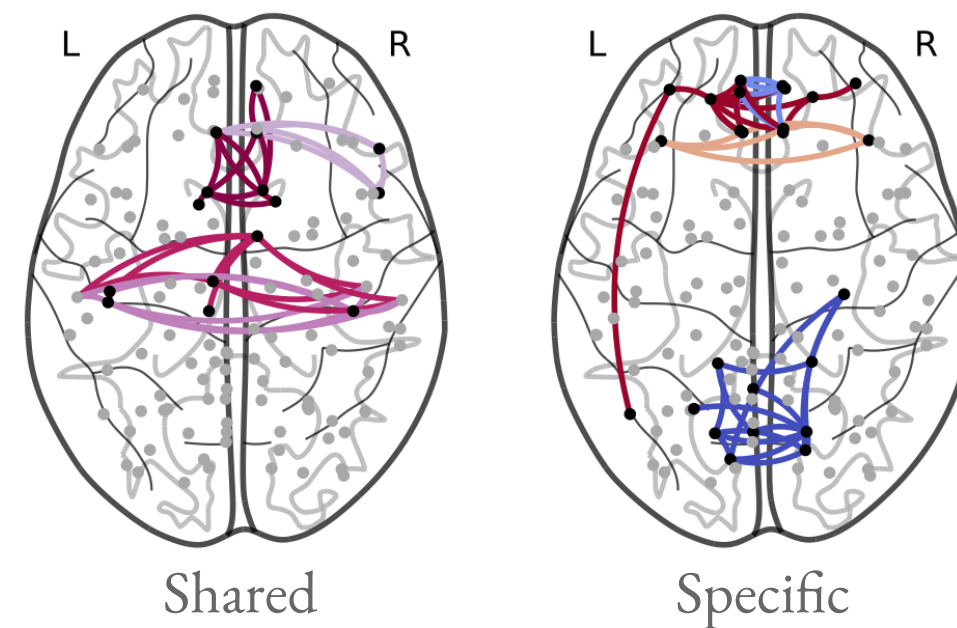


\* ABIDE Data Preprocessing

Voxel-Level rs-fMRI

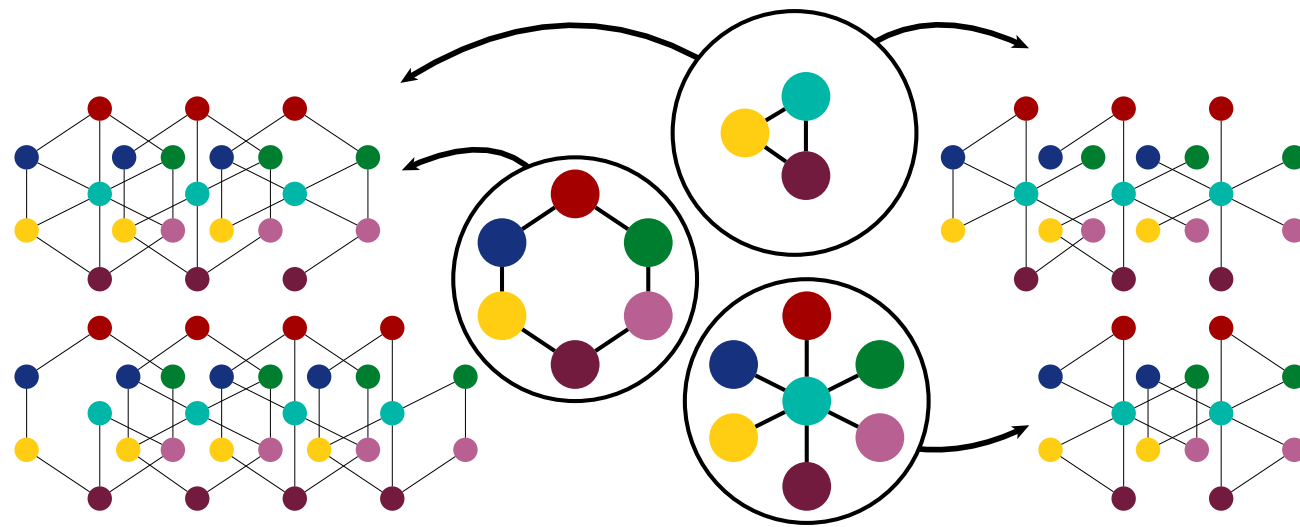
BOLD Signal

ASD vs. TD Adolescents\*

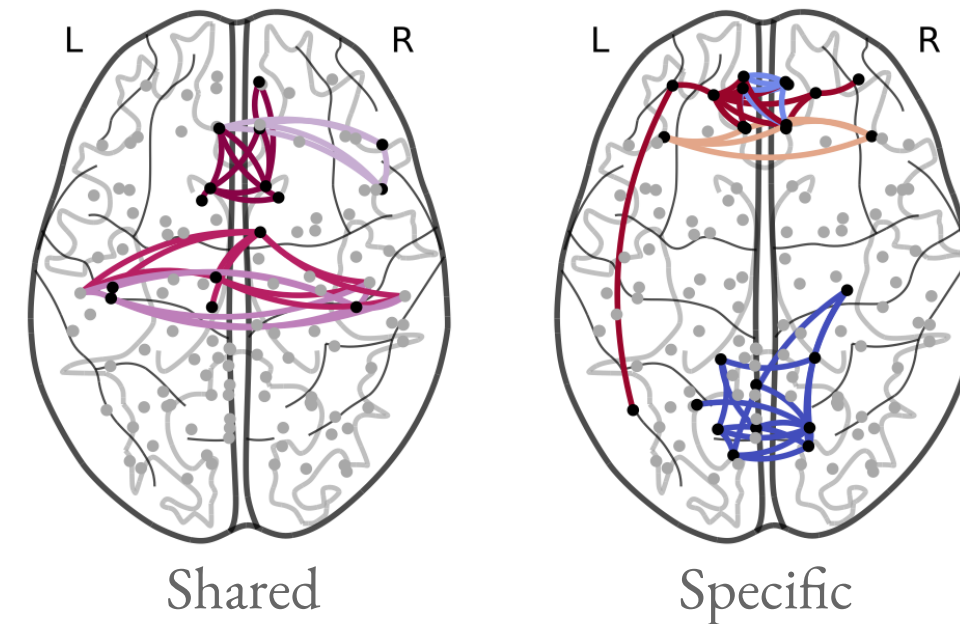


# Graph Mining: Functional Brain Networks

## Motivation



## ASD vs. TD Adolescents\*

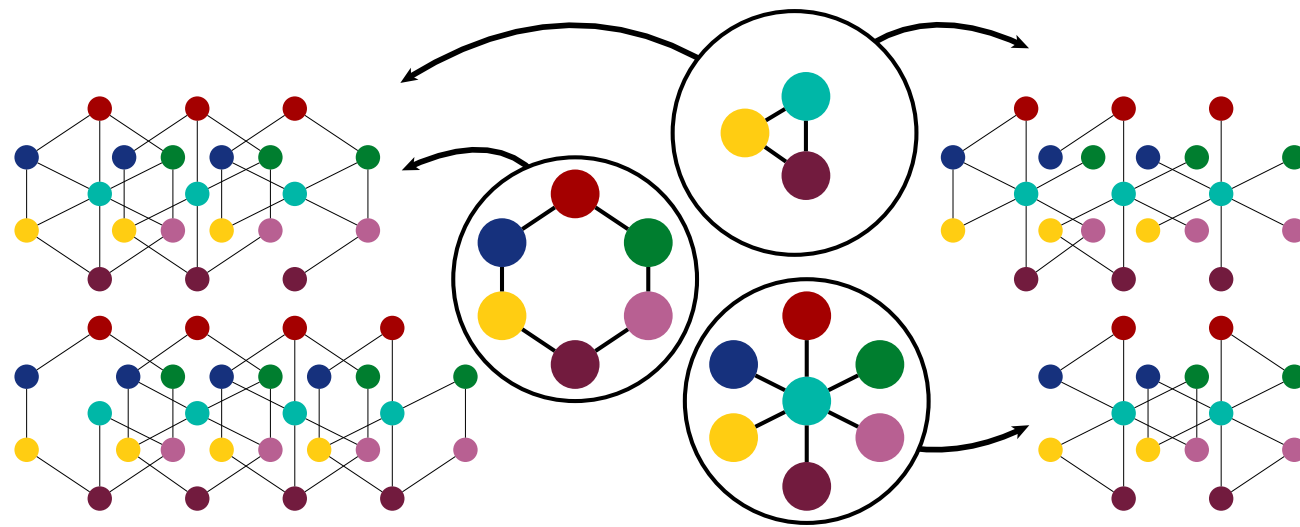


## \* ABIDE Data Preprocessing

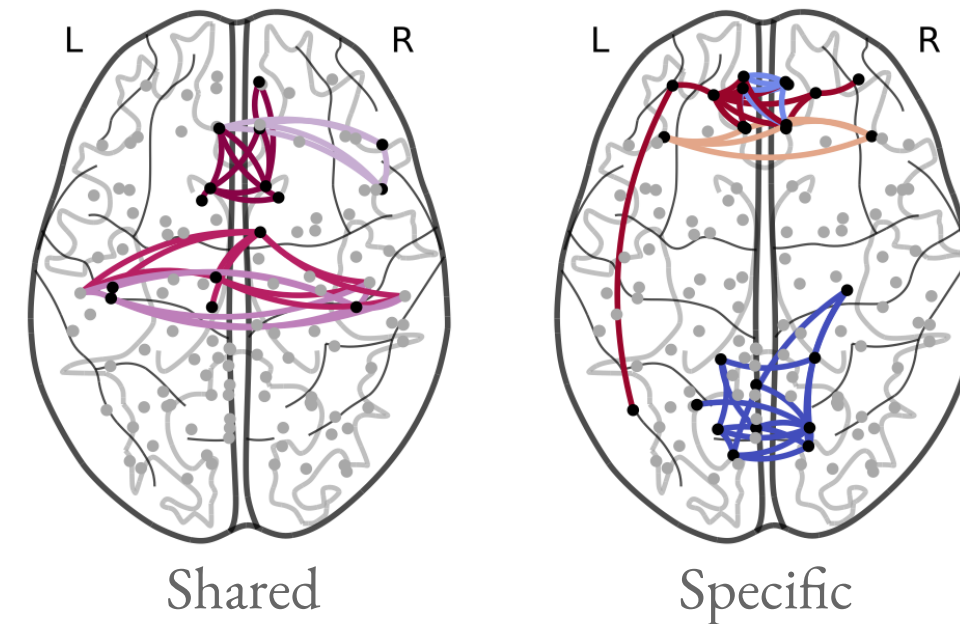
	CCS
Voxel-Level rs-fMRI	C-PAC
BOLD Signal	DPARSF
	NIAK

# Graph Mining: Functional Brain Networks

## Motivation



## ASD vs. TD Adolescents\*

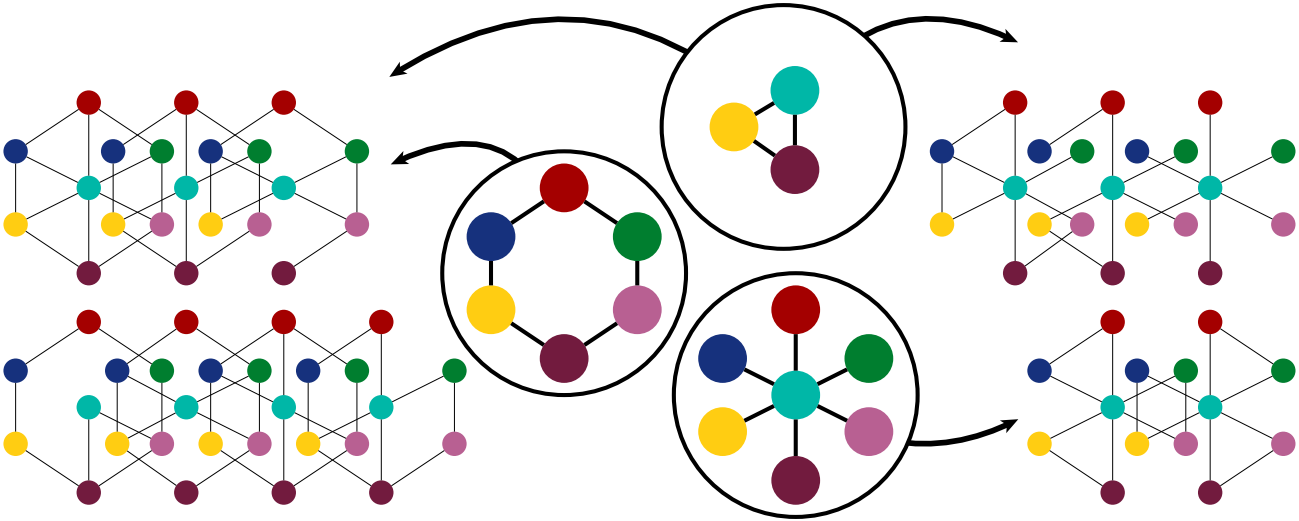


## \* ABIDE Data Preprocessing

	CCS	Band-Pass Filtering
Voxel-Level rs-fMRI	C-PAC	Yes/No
BOLD Signal	DPARSF	+
	NIAK	Global Signal Regression
		Yes/No

# Graph Mining: Functional Brain Networks

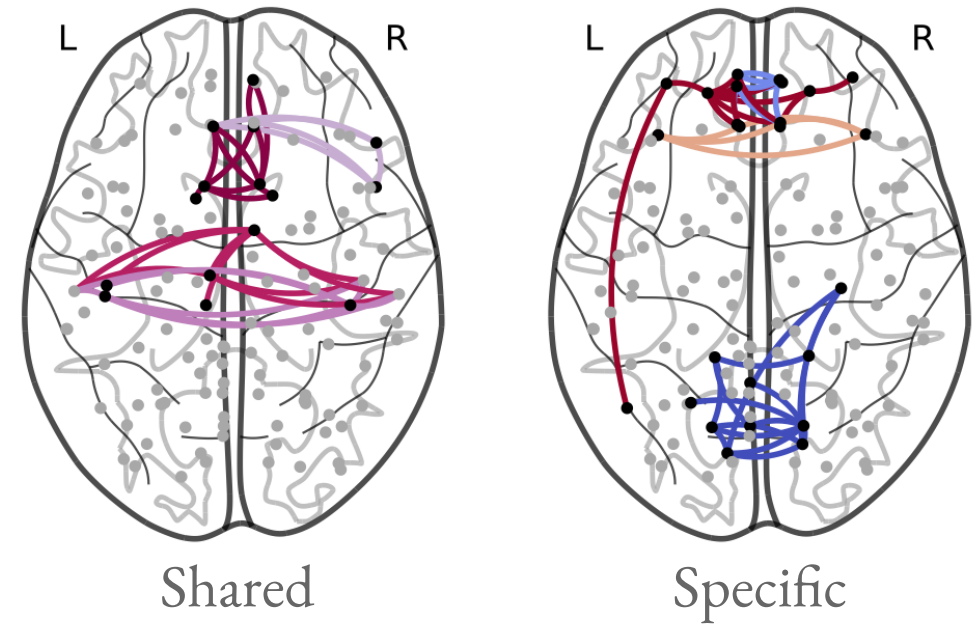
## Motivation



## \* ABIDE Data Preprocessing

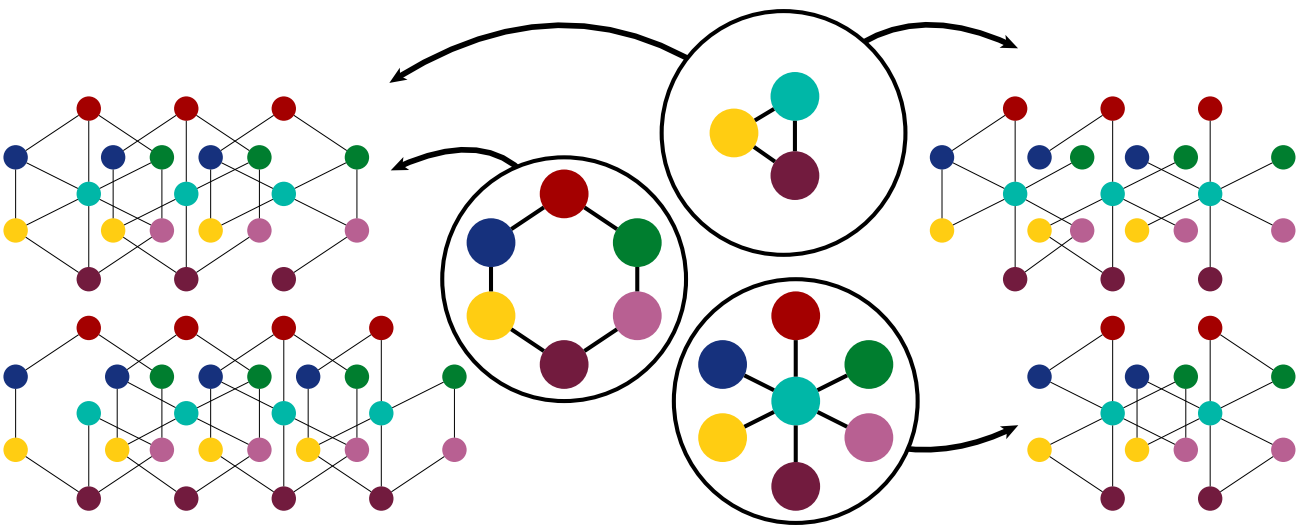
	CCS	Band-Pass Filtering	
Voxel-Level rs-fMRI	C-PAC	Yes/No	Template
BOLD Signal	DPARSF	+	Registration
	NIAK	Global Signal Regression	
		Yes/No	

## ASD vs. TD Adolescents\*



# Graph Mining: Functional Brain Networks

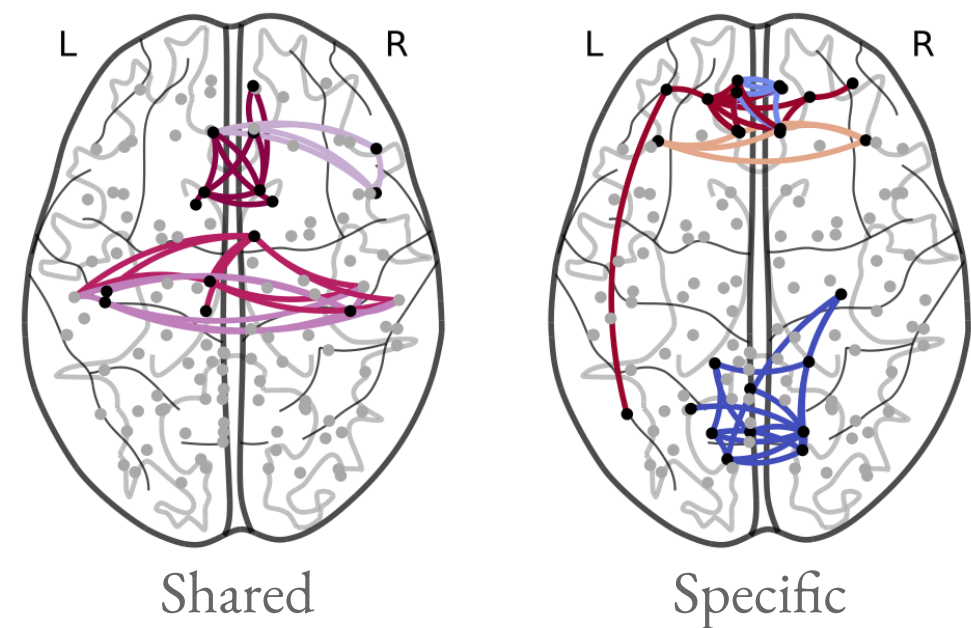
## Motivation



## \* ABIDE Data Preprocessing

	CCS	Band-Pass Filtering	
Voxel-Level rs-fMRI	C-PAC	Yes/No	
BOLD Signal	DPARSF	+	
	NIAK	Global Signal Regression	
		Yes/No	

## ASD vs. TD Adolescents\*



AAL

EZ

HO

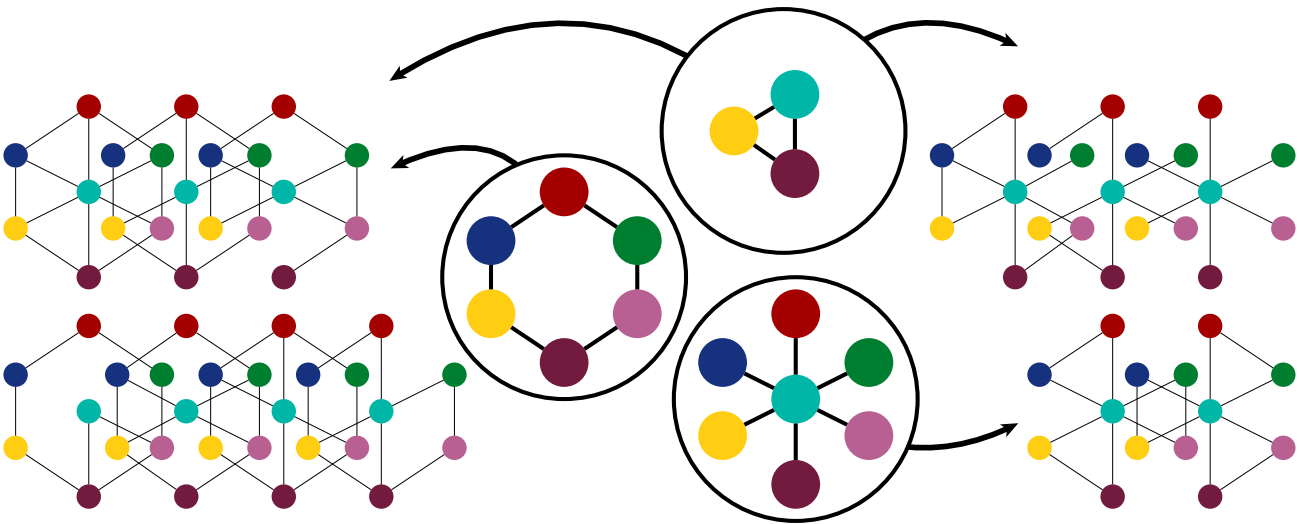
TT

CC200

CC400

# Graph Mining: Functional Brain Networks

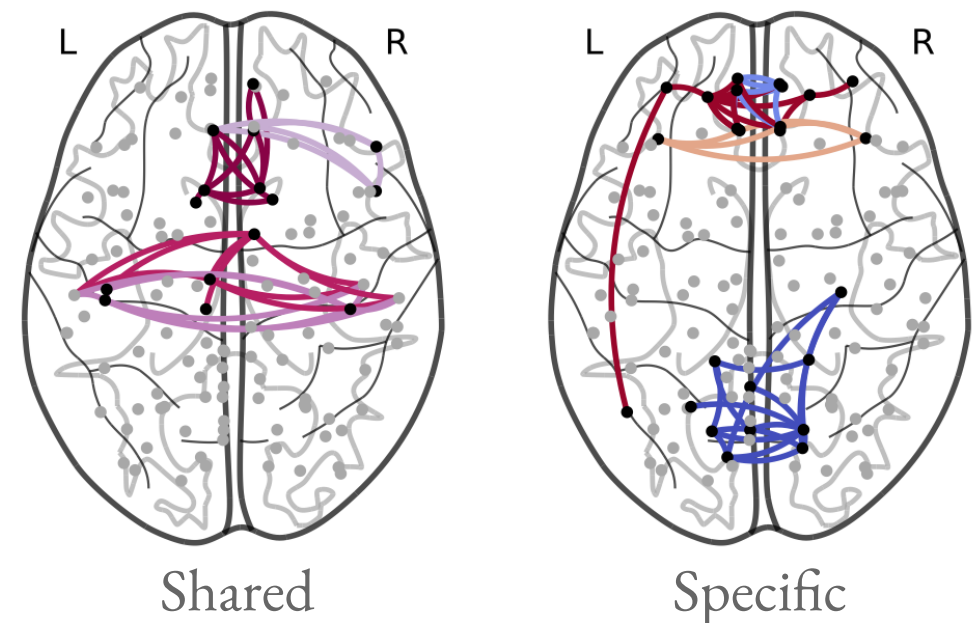
## Motivation



## \* ABIDE Data Preprocessing

	CCS	Band-Pass Filtering
Voxel-Level rs-fMRI	C-PAC	Yes/No
BOLD Signal	DPARSF	+
	NIAK	Global Signal Regression
		Yes/No

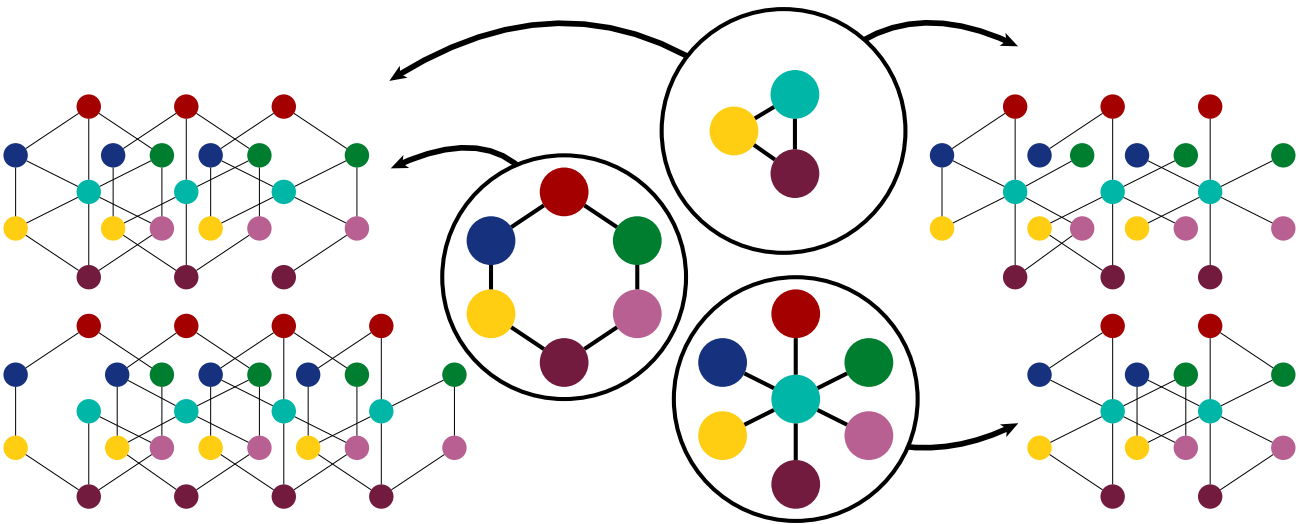
## ASD vs. TD Adolescents\*



AAL	
EZ	
HO	Time-Series
TT	Correlation
CC200	
CC400	

# Graph Mining: Functional Brain Networks

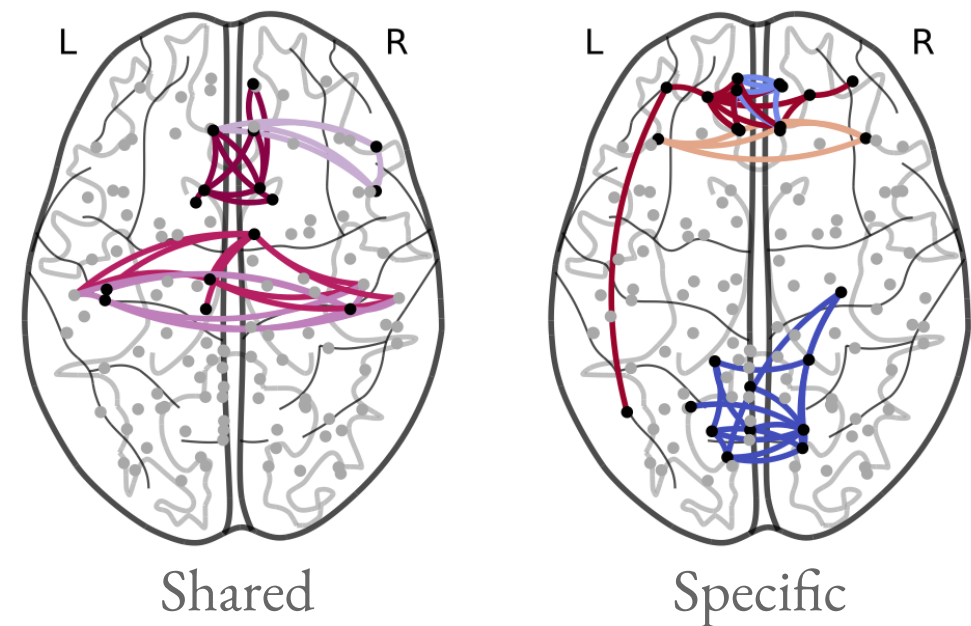
## Motivation



## \* ABIDE Data Preprocessing

	CCS	Band-Pass Filtering
Voxel-Level rs-fMRI	C-PAC	Yes/No
BOLD Signal	DPARSF	+
	NIAK	Global Signal Regression
		Yes/No

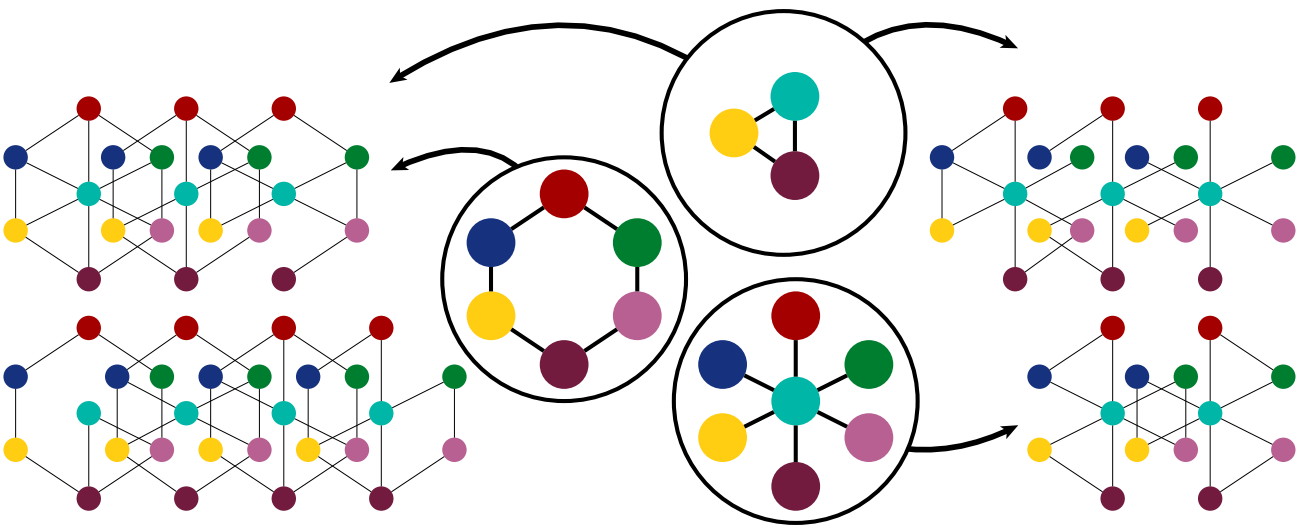
## ASD vs. TD Adolescents\*



AAL	
EZ	
HO	Time-Series
TT	Correlation
CC200	
CC400	
	Thresholding

# Graph Mining: Functional Brain Networks

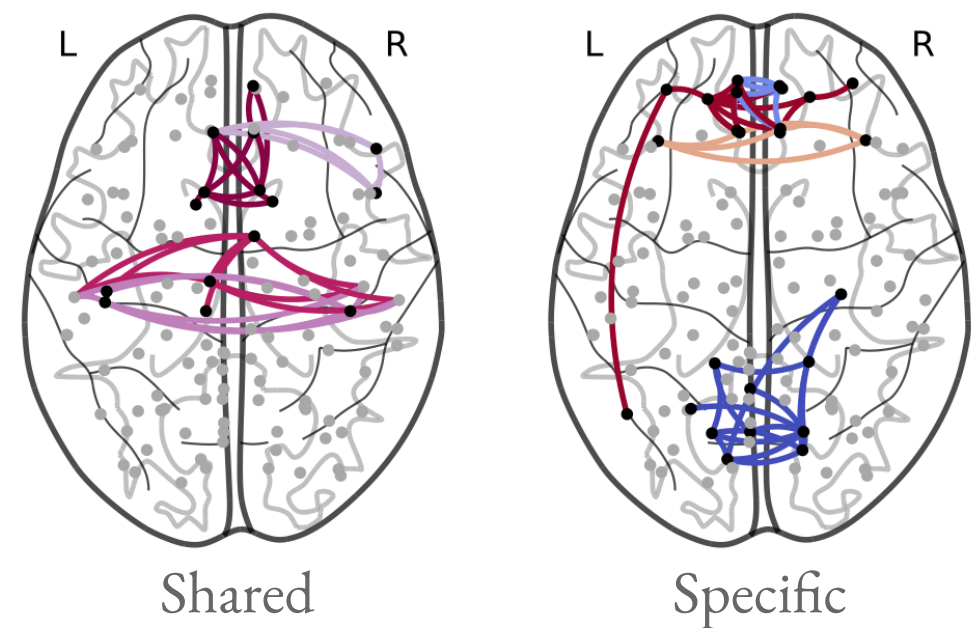
## Motivation



## \* ABIDE Data Preprocessing

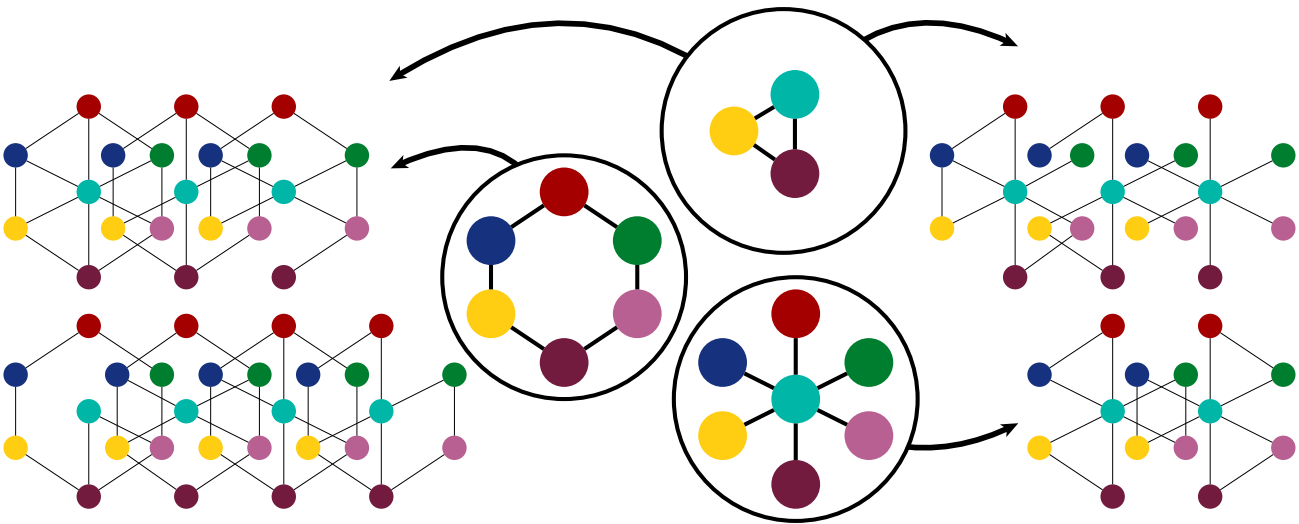
	CCS	Band-Pass Filtering						
Voxel-Level rs-fMRI	C-PAC	Yes/No	Template	AAL	Time-Series			
BOLD Signal	DPARSF	+	Registration	EZ	Correlation	Thresholding	Graph	
	NIAK	Global Signal Regression		HO				
		Yes/No		TT				
				CC200				
				CC400				

## ASD vs. TD Adolescents\*



# Graph Mining: Functional Brain Networks

## Motivation

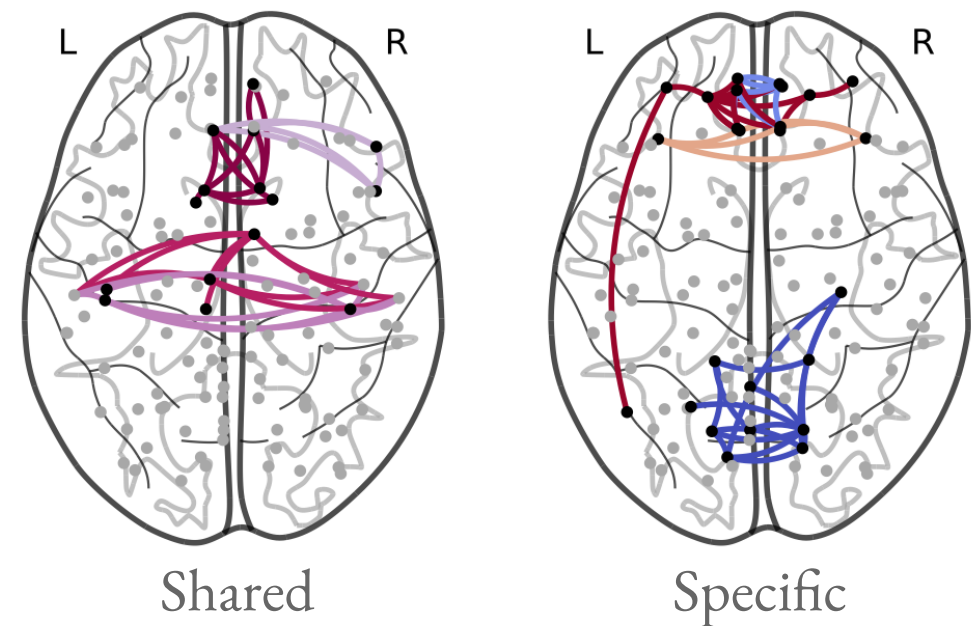


## \* ABIDE Data Preprocessing

	CCS	Band-Pass Filtering						
Voxel-Level rs-fMRI	C-PAC	Yes/No	Template	AAL	Time-Series			
BOLD Signal	DPARSF	+	Registration	EZ	Correlation	Thresholding	Graph	
	NIAK	Global Signal Regression		HO				
		Yes/No		TT				
				CC <sub>200</sub>				
				CC <sub>400</sub>				

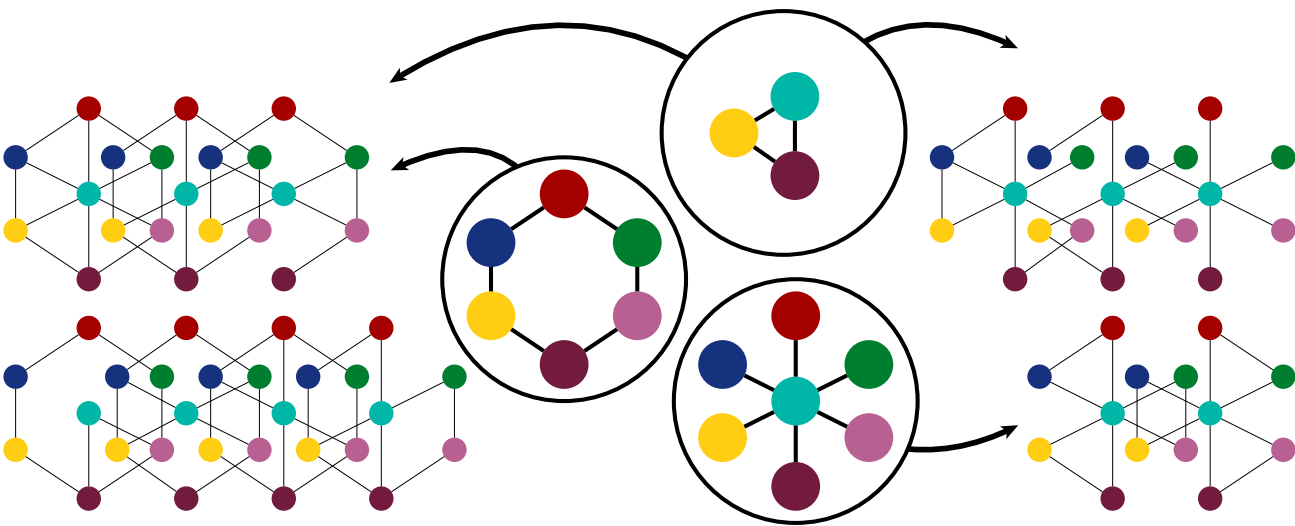
Following related prior work, we analyzed *one* realization of this pipeline. 

## ASD vs. TD Adolescents\*



# Graph Mining: Functional Brain Networks

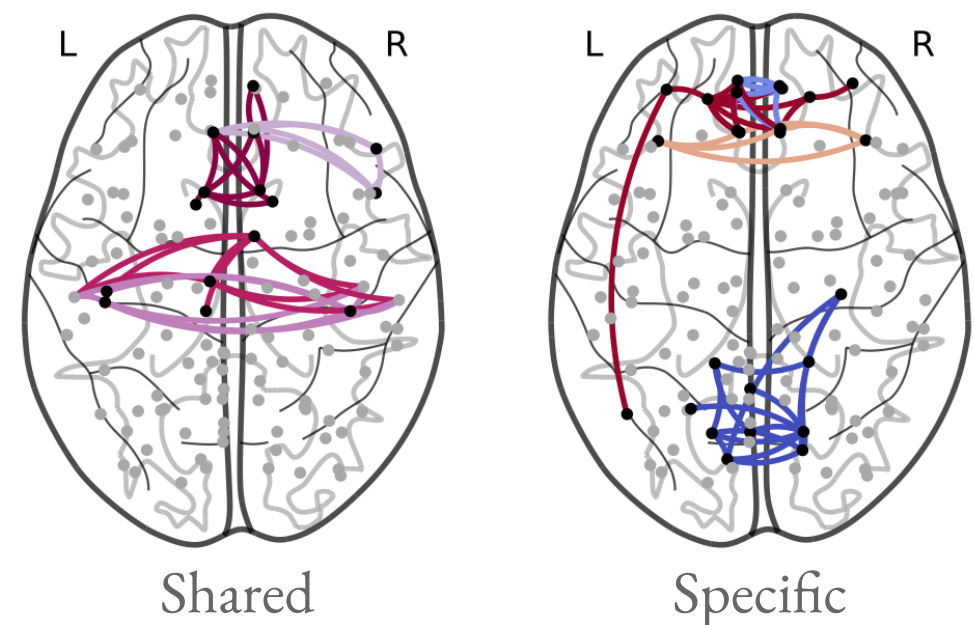
## Motivation



## \* ABIDE Data Preprocessing

	CCS	Band-Pass Filtering						
Voxel-Level rs-fMRI	C-PAC	Yes/No	Template	AAL	Time-Series			
BOLD Signal	DPARSF	+	Registration	EZ	Correlation	Thresholding	Graph	
	NIAK	Global Signal Regression		HO				
		Yes/No		TT				
				CC200				
				CC400				

## ASD vs. TD Adolescents\*

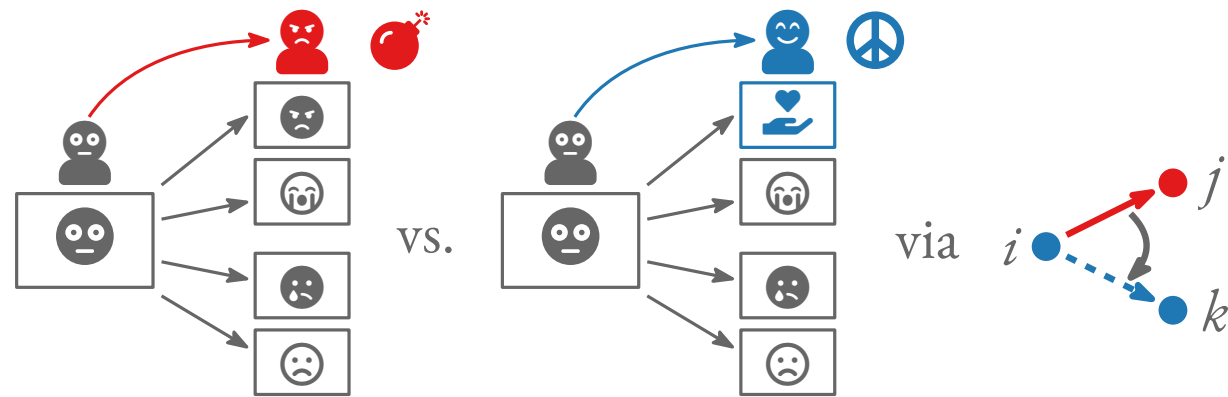


Following related prior work, we analyzed *one* realization of this pipeline.  What else could we have learned?

# Graph Algorithm Design: Media Content Networks

# Graph Algorithm Design: Media Content Networks

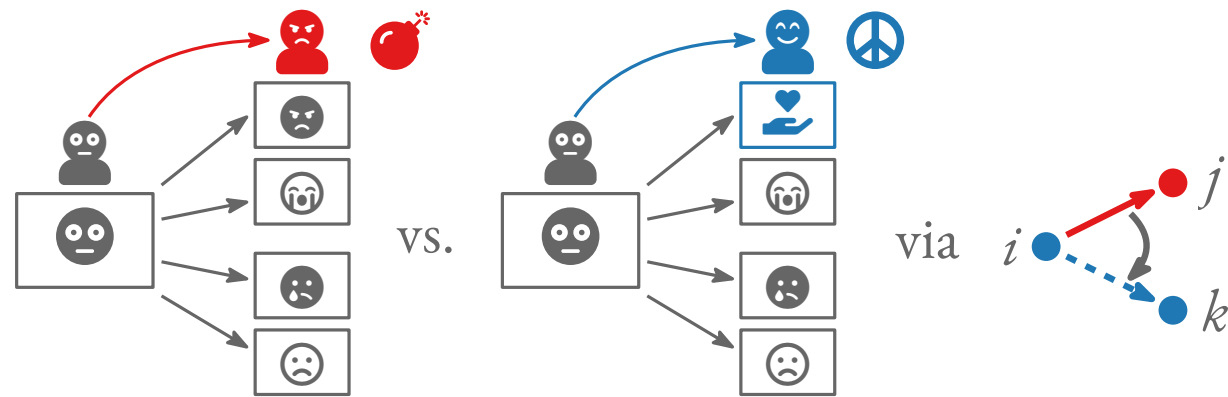
## Motivation



How can we *model* and *mitigate* exposure to harm in recommendation graphs?

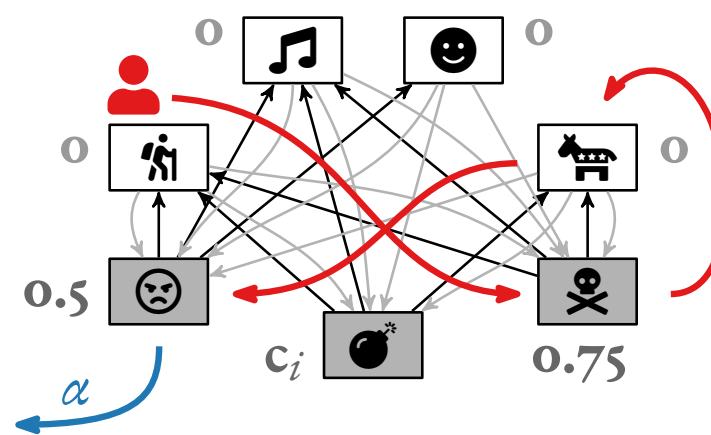
# Graph Algorithm Design: Media Content Networks

## Motivation



How can we *model* and *mitigate* exposure to harm in recommendation graphs?

## Exposure Model



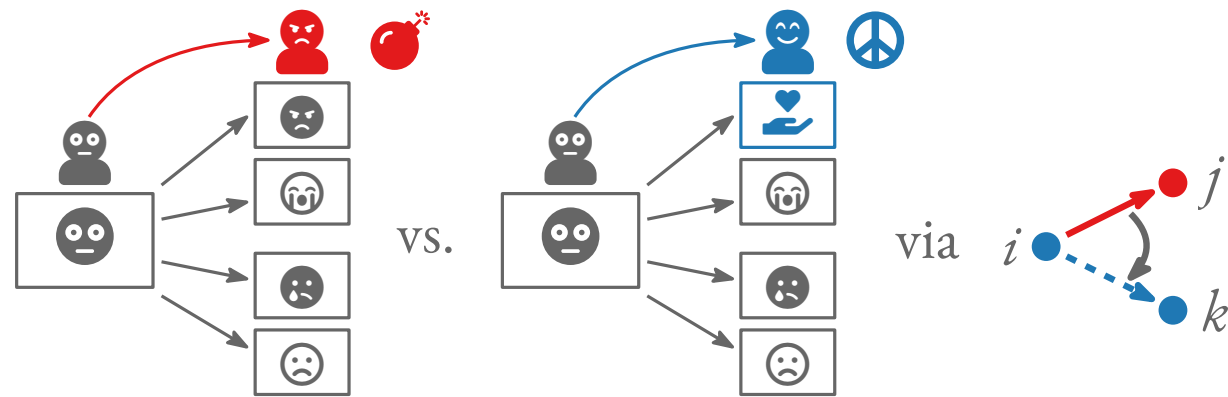
Random-walk transition matrix  $\mathbf{P}$   
Fundamental matrix  $\mathbf{F} = (\mathbf{I} - \mathbf{P})^{-1}$   
 $\mathbf{F}_{ij}$  = Expected # visits from  $i$  to  $j$   
 $\mathbf{c}_i$  = Harm associated with item  $i$   
Expected total exposure  $f(G) = \mathbf{1}^T \mathbf{F} \mathbf{c}$

Objective:  $\min f(G_r) = f(G)$  after  $r$  rewirings  $\Leftrightarrow \max f(G) - f(G_r)$

Problem variant: quality constraints on rewired recommendations

# Graph Algorithm Design: Media Content Networks

## Motivation



How can we *model* and *mitigate* exposure to harm in recommendation graphs?

## Evaluation Setup

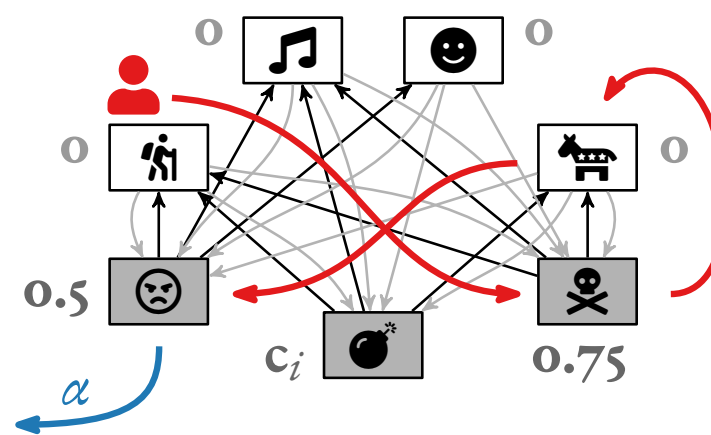
Our method + 4 baselines + 1 external competitor

Evaluated on YouTube data and news feed data

With varying model *and input* parameters

Data reconstructed from competitor's description

## Exposure Model



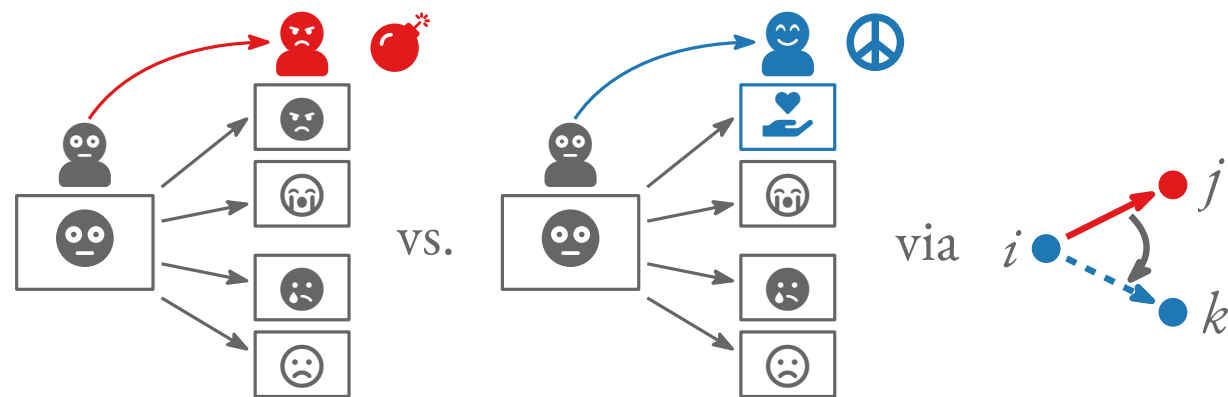
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# Graph Algorithm Design: Media Content Networks

## Motivation



How can we *model* and *mitigate* exposure to harm in recommendation graphs?

## Evaluation Setup

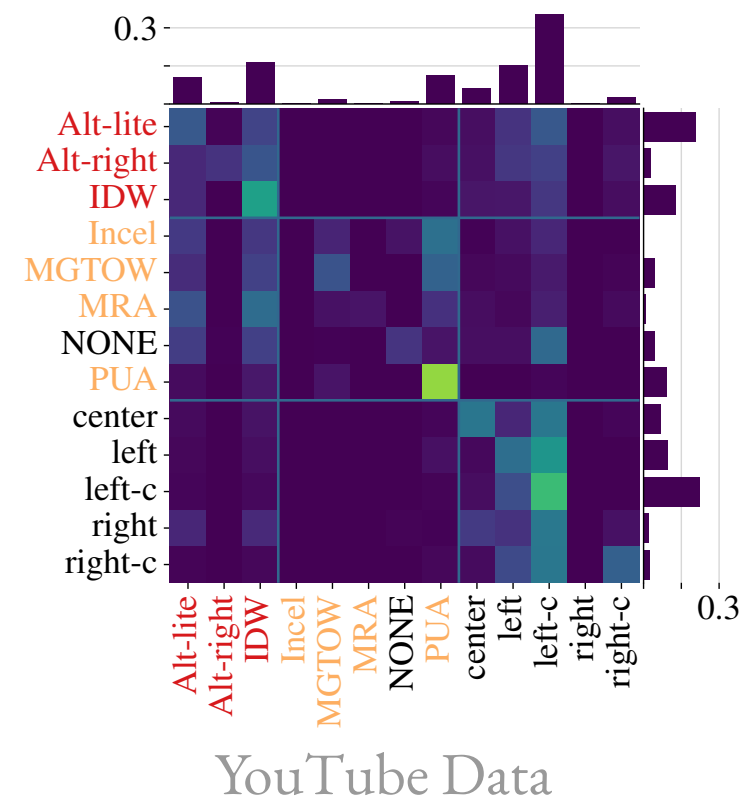
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With varying model *and input* parameters

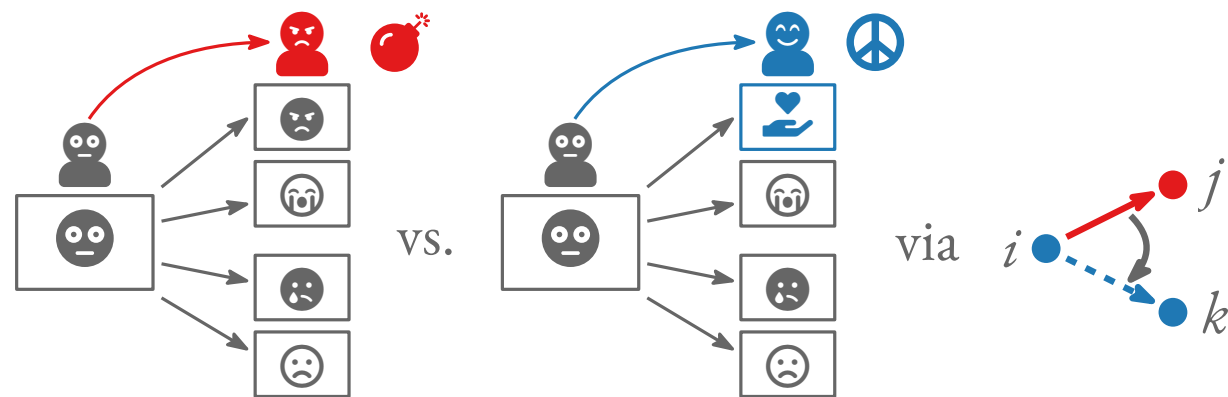
Data reconstructed from competitor's description

## Initial Distributions



# Graph Algorithm Design: Media Content Networks

## Motivation



How can we *model* and *mitigate* exposure to harm in recommendation graphs?

## Evaluation Setup

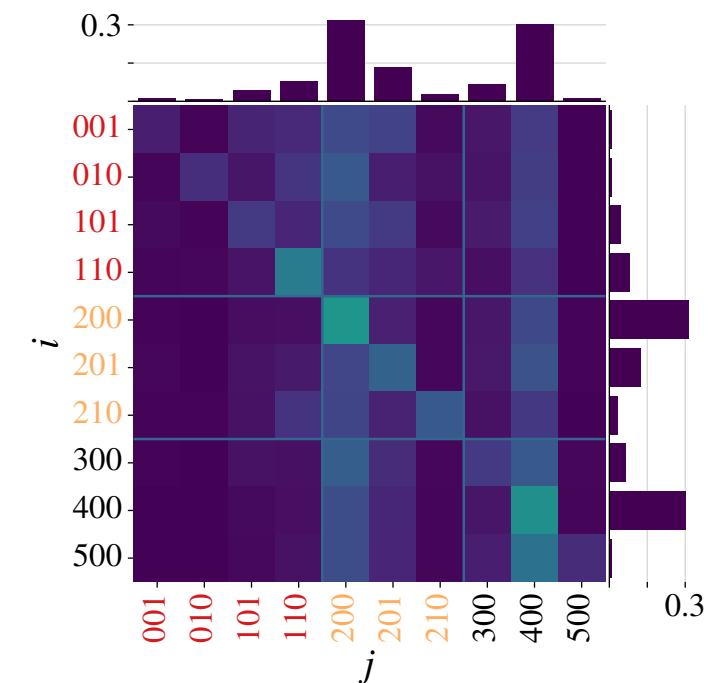
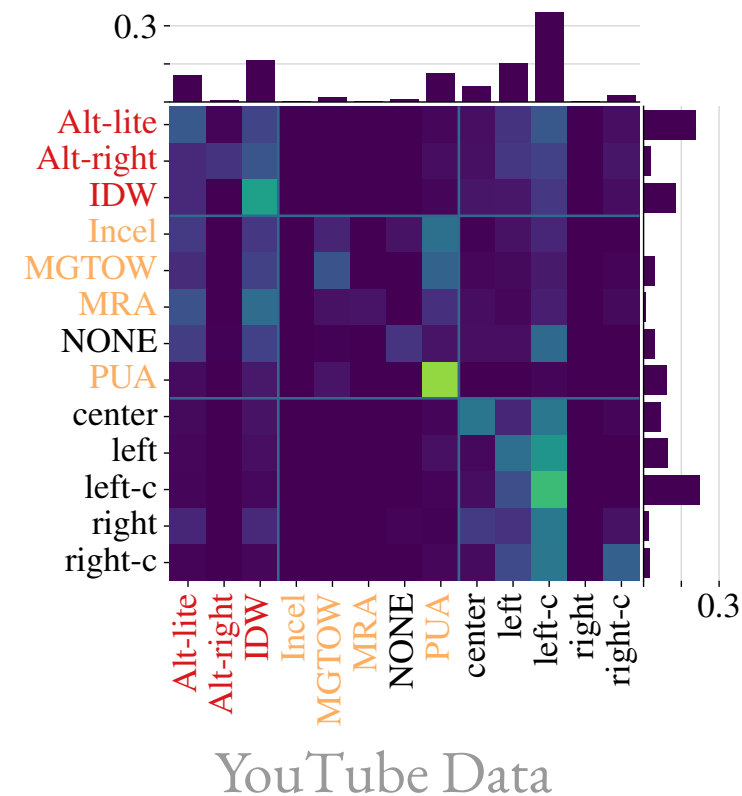
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Evaluated on YouTube data and news feed data

With varying model *and input* parameters

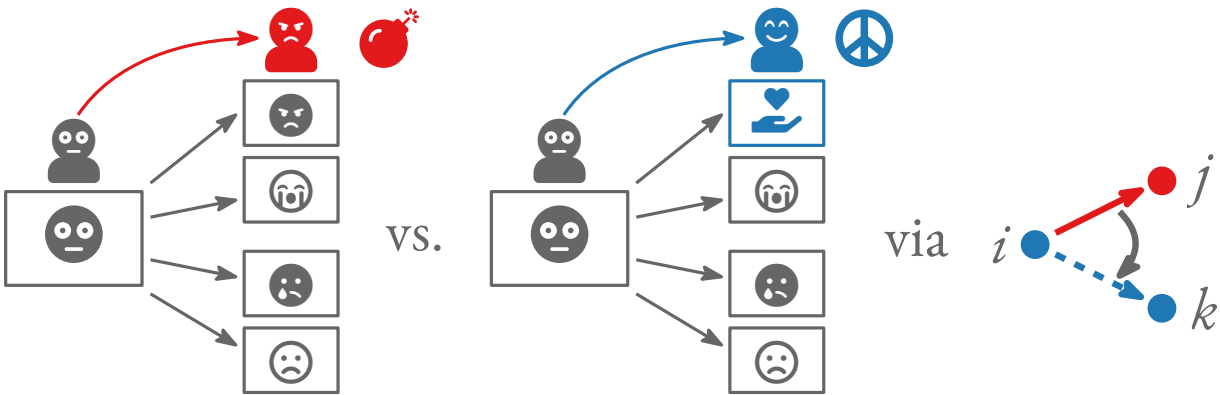
Data reconstructed from competitor's description

## Initial Distributions



# Graph Algorithm Design: Media Content Networks

## Motivation



How can we *model* and *mitigate* exposure to harm in recommendation graphs?

## Evaluation Setup

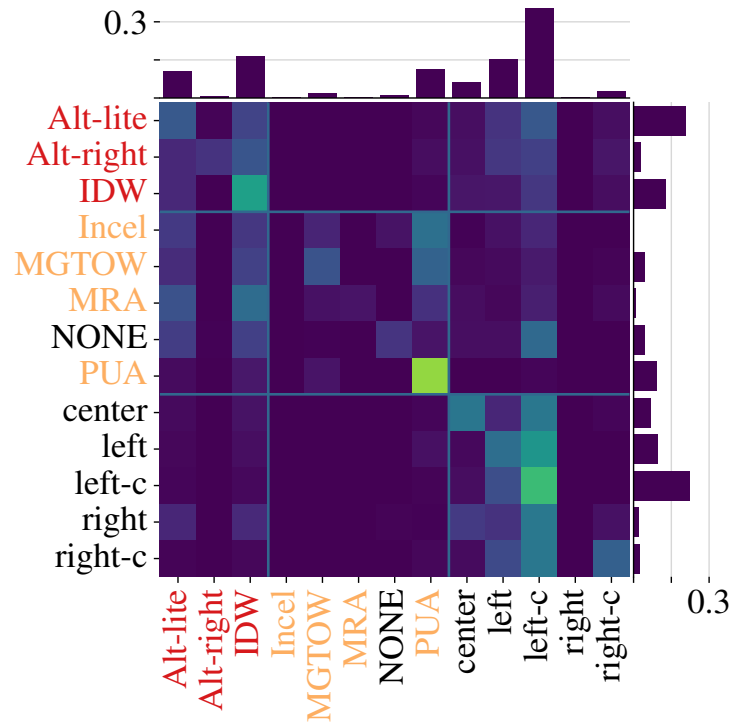
Our method + 4 baselines + 1 external competitor

Evaluated on YouTube data and news feed data

With varying model *and* *input* parameters

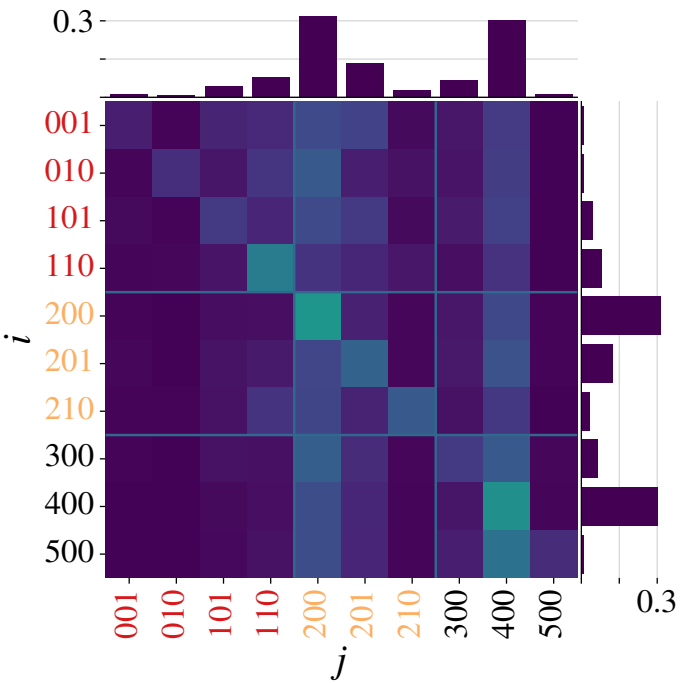
Data reconstructed from competitor's description

## Initial Distributions



YouTube Data

YT-100k, 5	1825	1463	1463	1463
YT-100k, 10	1640	1395	1395	1395
YT-100k, 20	785	684	684	684
YT-10k, 5	3656	3356	3356	3356
YT-10k, 10	2135	2135	2135	2135
YT-10k, 20	2110	2110	2110	2110
	$c_{B1}$	$c_{B2}$	$c_{R1}$	$c_{R2}$



News Data

NF-Jan6, 5	205	0	0	0
NF-Jan6, 10	0	0	0	0
NF-Jan6, 20	0	0	0	0
NF-Cov19, 5	1535	172	20	172
NF-Cov19, 10	274	66	20	66
NF-Cov19, 20	31	31	0	31
NF-All, 5	3079	383	20	383
NF-All, 10	625	177	20	177
NF-All, 20	55	31	0	31
	$c_{B1}$	$c_{B2}$	$c_{R1}$	$c_{R2}$