



# **UNPACKING POLARIZATION:**

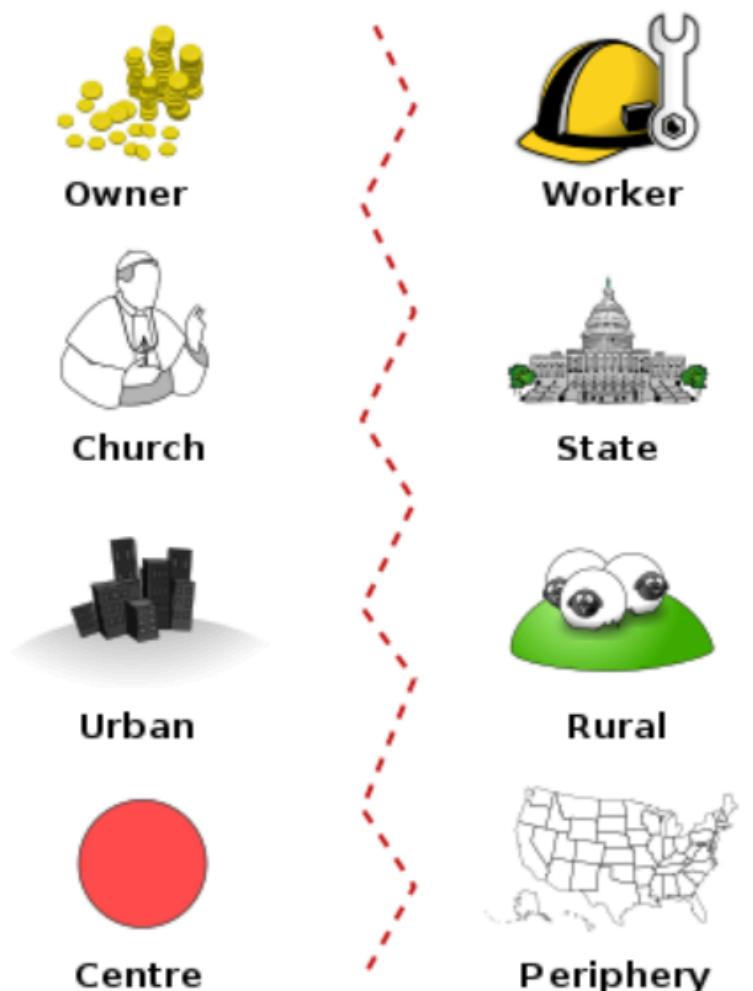
ANTAGONISM AND ALIGNMENT IN SIGNED  
NETWORKS OF ONLINE  
INTERACTION

**Emma Fraxanet**

Max Pellert, Simon Schweighofer, Vicenç Gómez  
and David Garcia

# Society's fault lines: Political cleavages

Historically determined **social or cultural line** which divides citizens within a society into groups with differing political interests, resulting in political conflict among these groups. *WIKIPEDIA*



Winners vs. Losers  
of globalization

Authoritarian populist  
vs. Libertarian pluralist

Others: education,  
age, geography,  
attitudes to immigration...

Lipset and Rokkan (1967)

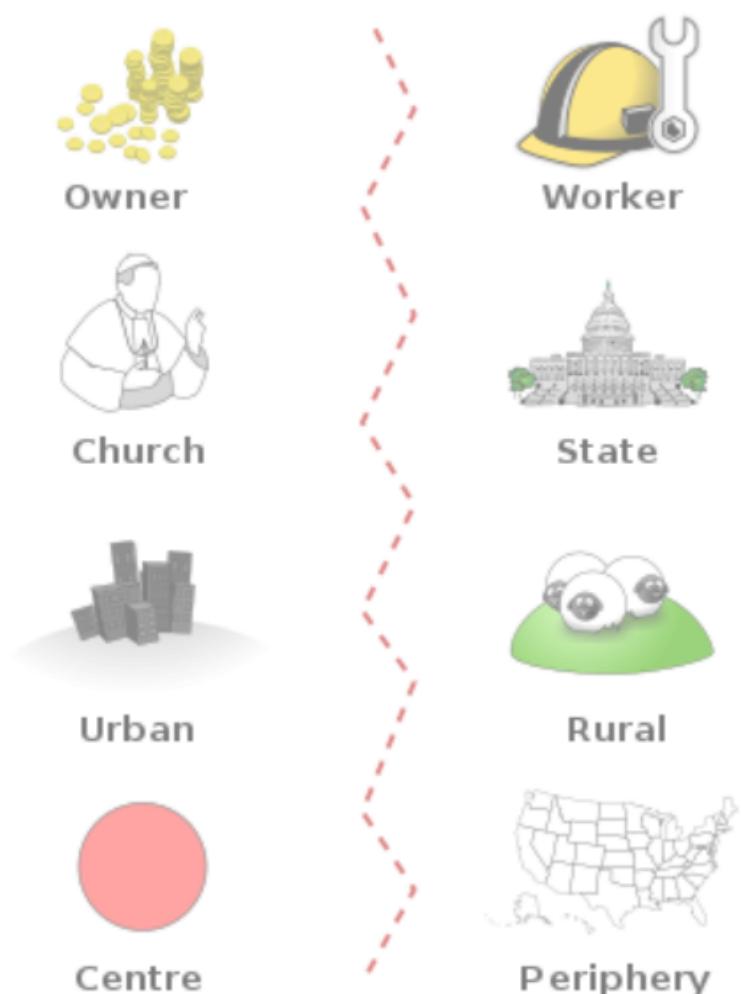
Kriesi et al. (2008)

Norris and Inglehart (2019)

Ford and Jennings (2020)

# Society's fault lines: Political cleavages

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**What if...  
we leverage online  
behavioral data to  
detect these  
divisions?**

Winners vs. Losers  
of globalization

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vs. Libertarian pluralist

Others: education,  
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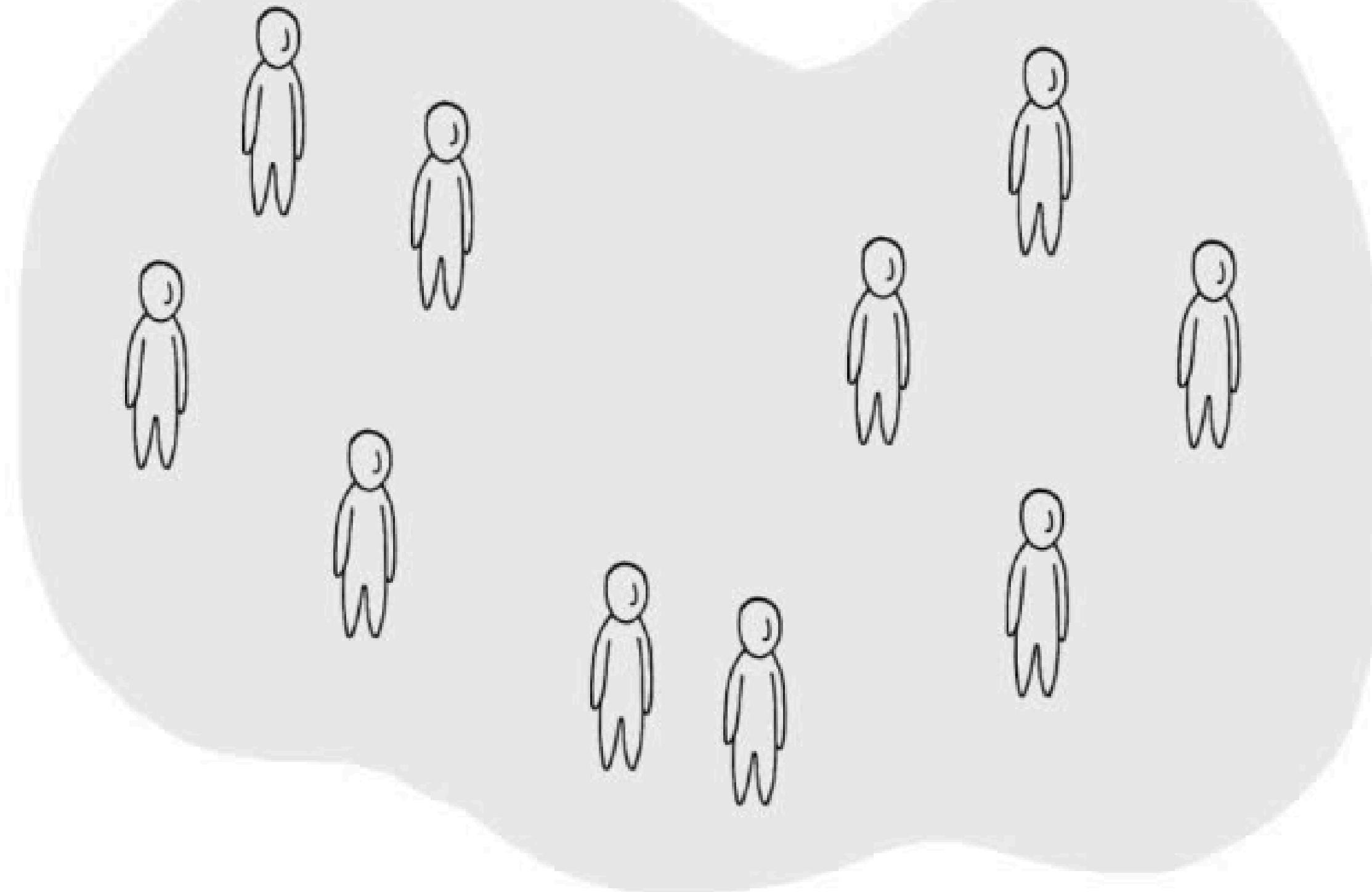
Kriesi et al. (2008)

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# Continuously changing factions: cross-cutting cleavages

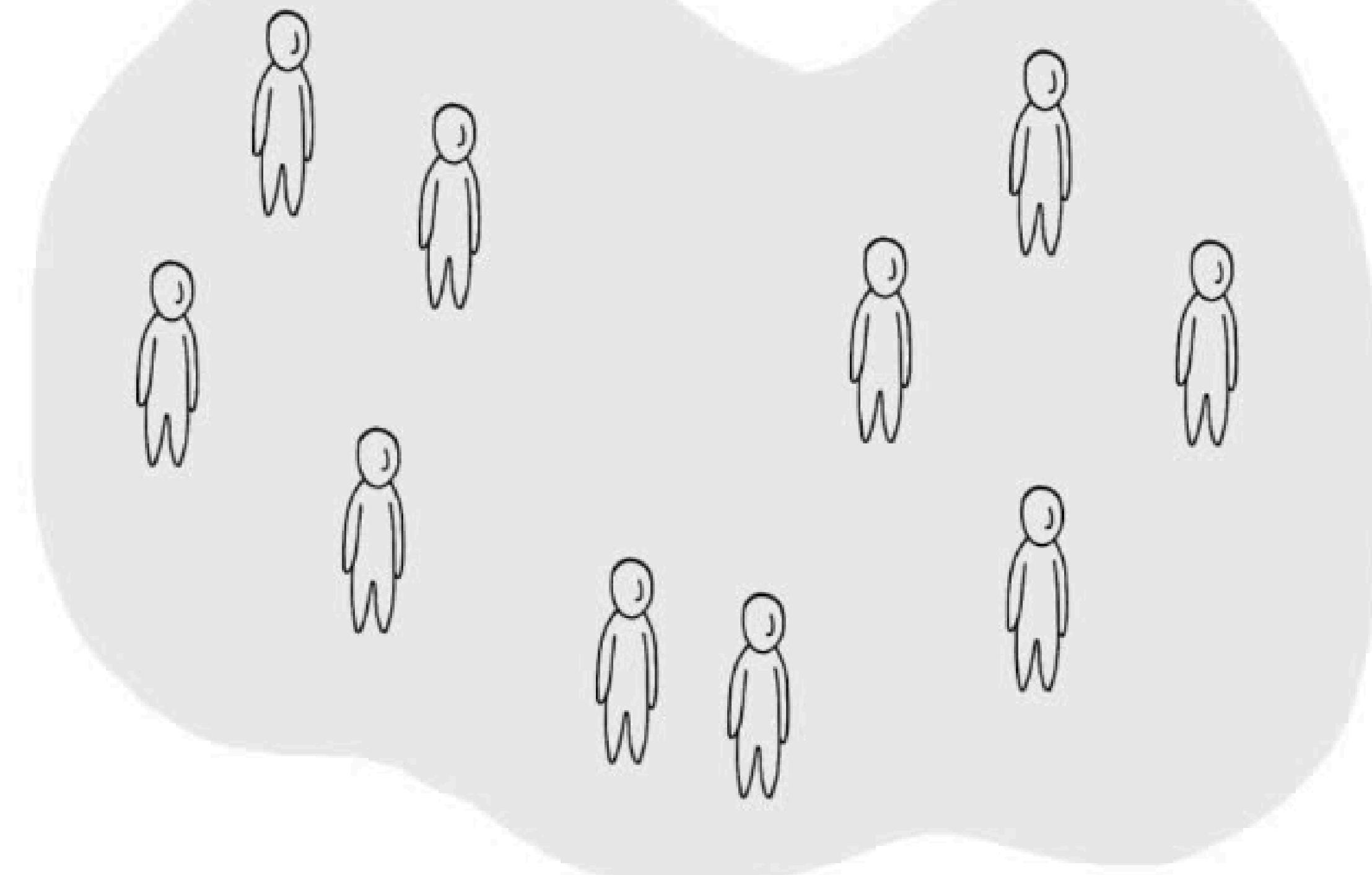
Increase in social cohesion  
Promotion of healthy debate



# Reinforcing fault lines: wedge issues

Political sectarianism

Partisan hostility and polarization



# Motivation: Mitigating online (popular/affective) polarization

- Changes in feed algorithms have small effects if applied to only a part of the population

(Garcia, D. (2023). Influence of Facebook algorithms on political polarization tested. *Nature*)

- Putting the extremes together in an indiscriminate way can have backfire effects

(Bail, C, et al. (2018). Exposure to opposing views on social media can increase political polarization. *PNAS*)

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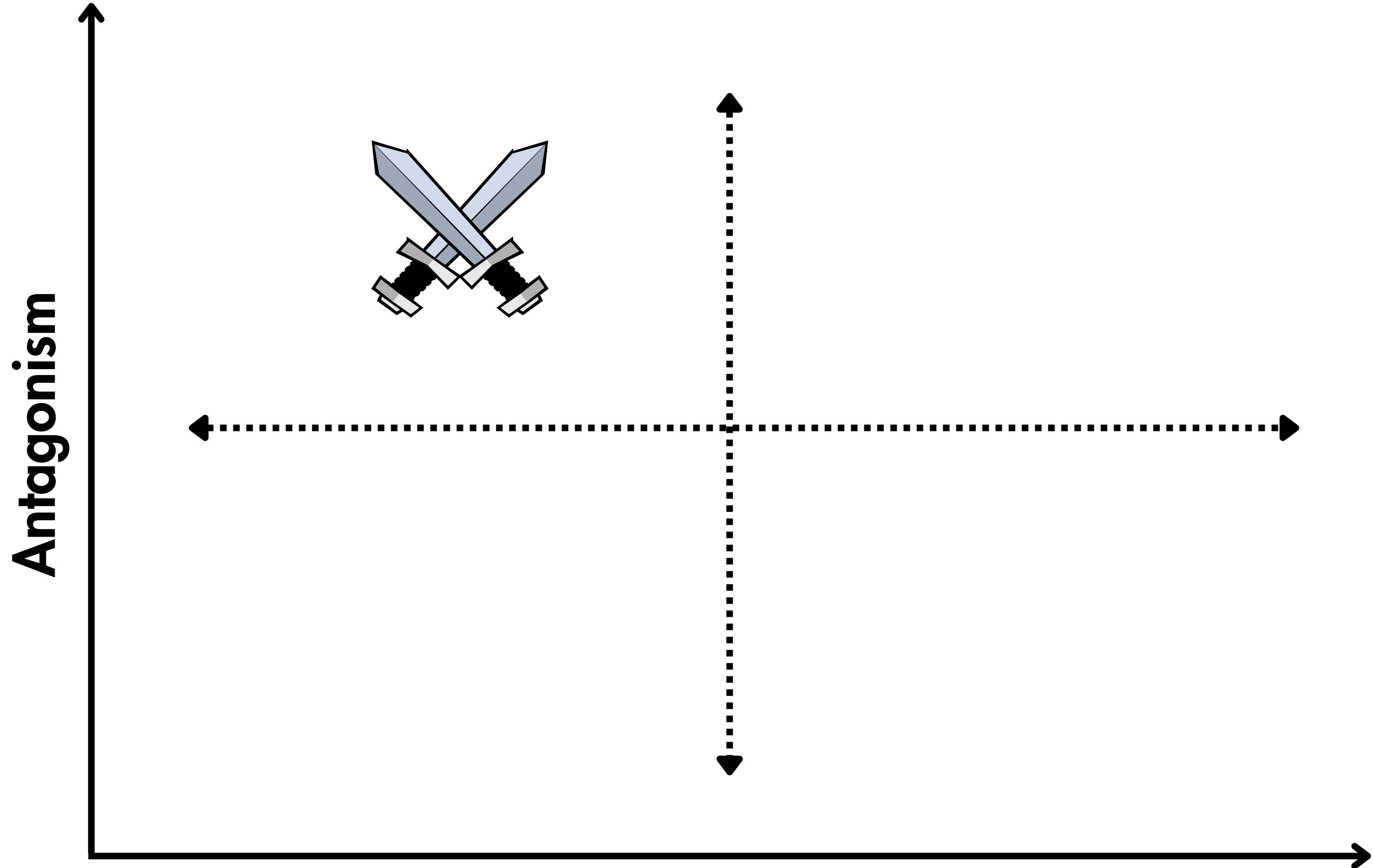


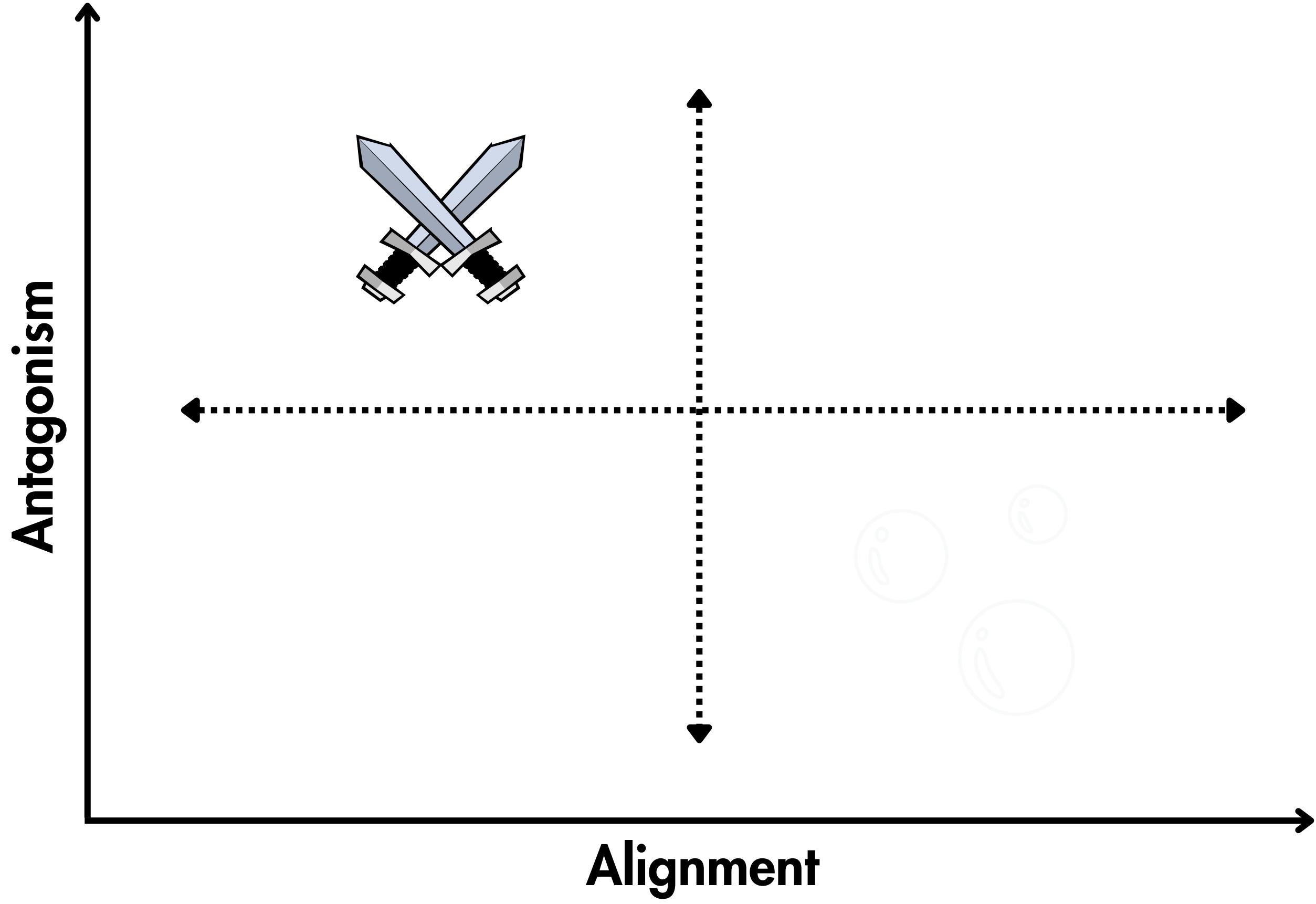
**Alternative:** recommend contentious content with cross-partisan appeal

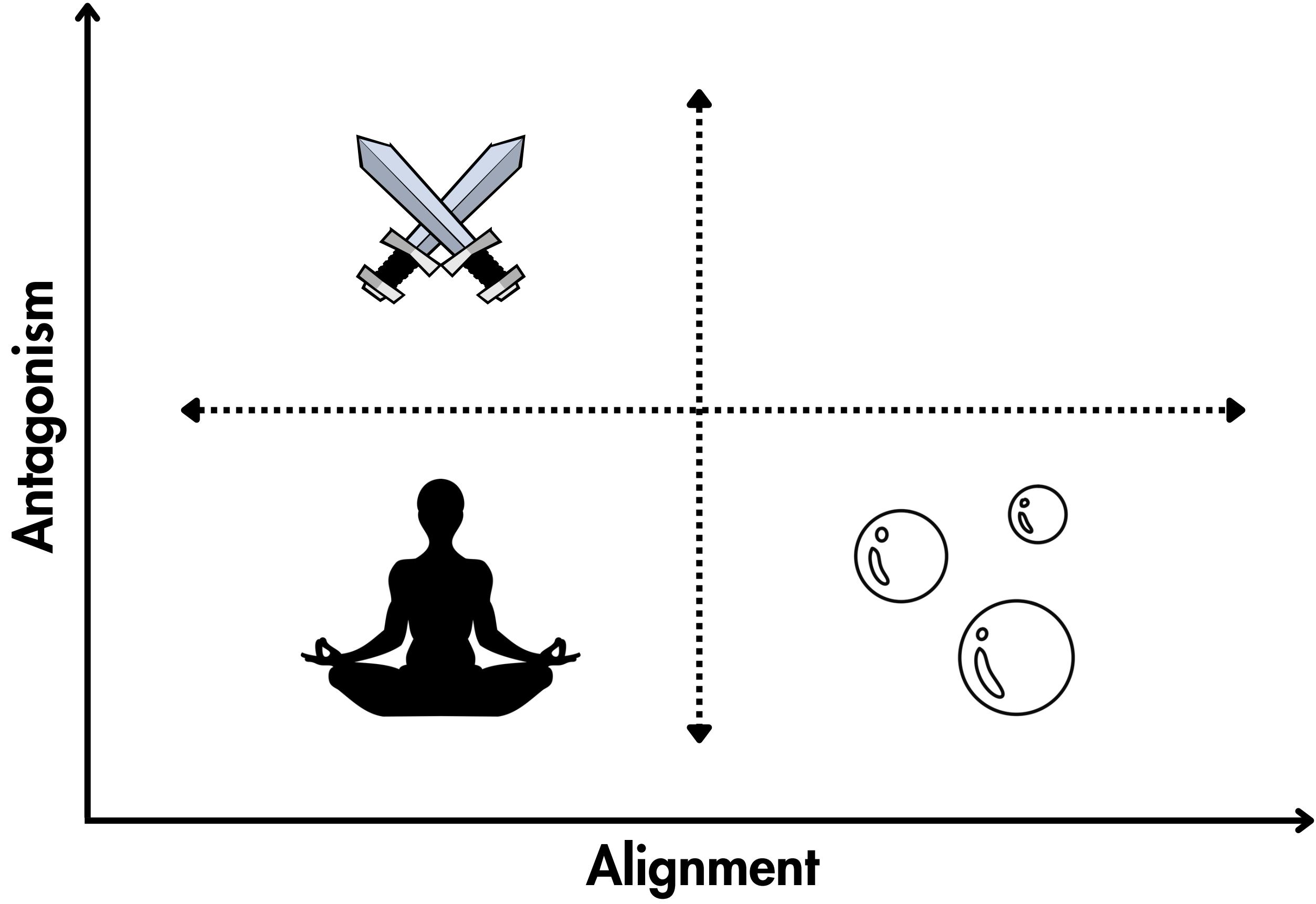
Our framework can help identify which contexts generate

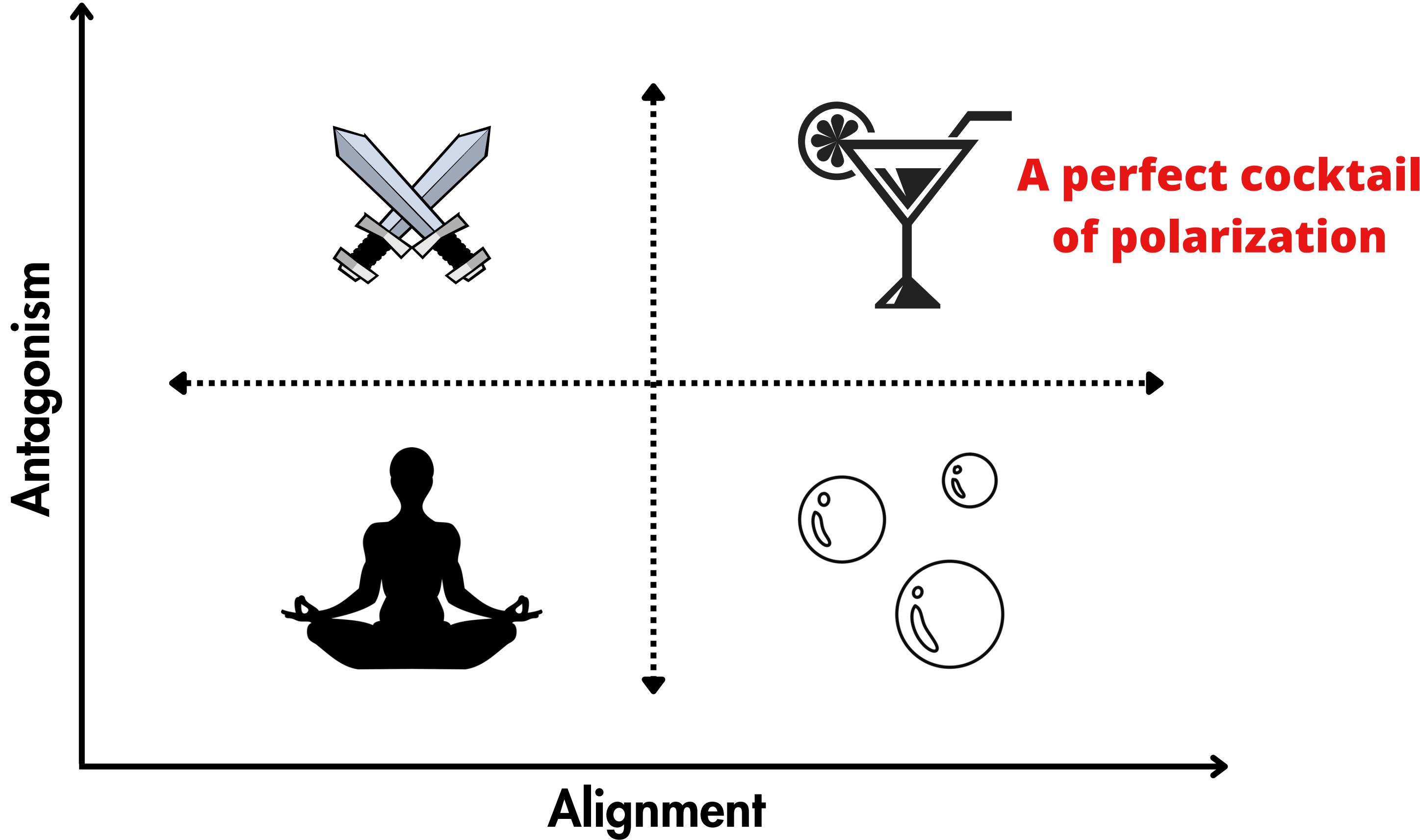
**WEDGE ISSUES** V.S. **CROSS-CUTTING ISSUES**





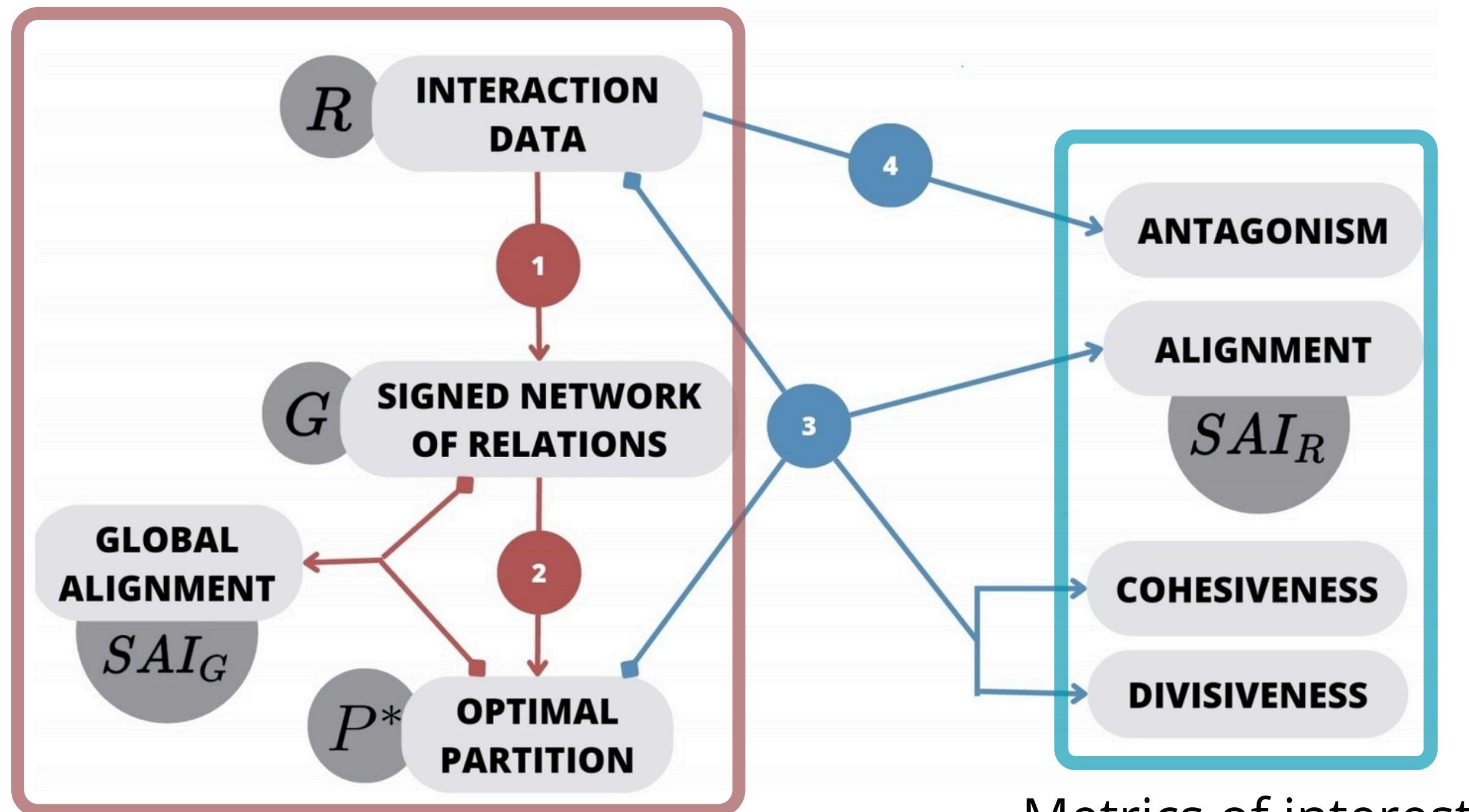






# Our contribution:

## FAULTANA: FAULT-line Alignment Network Analysis



Input data and intermediate steps

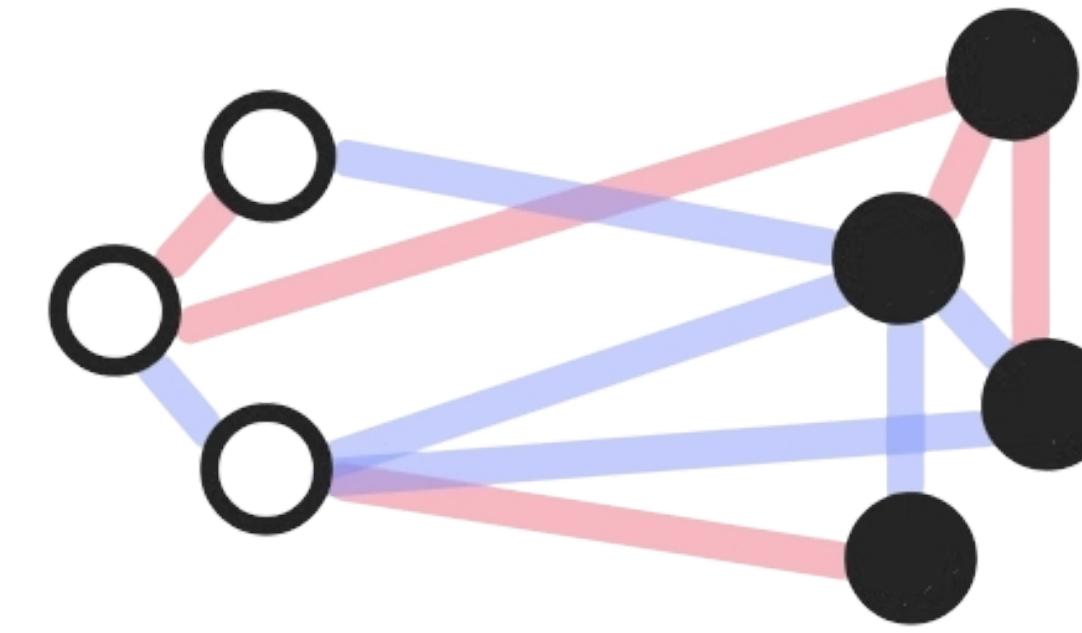
Metrics of interest

**But how can we measure all of this computationally?**



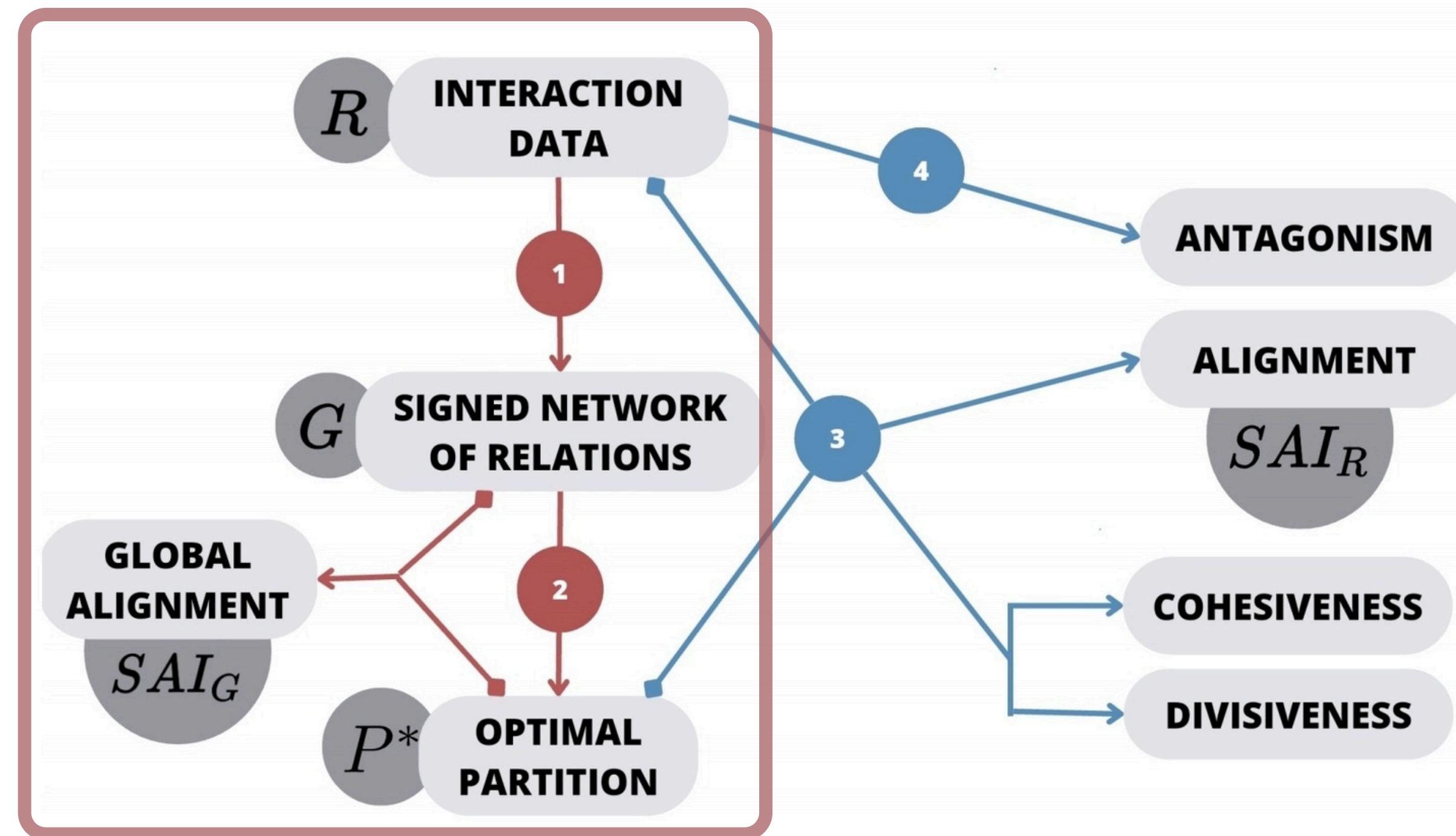
**SOCIAL MEDIA  
PLATFORMS**

+

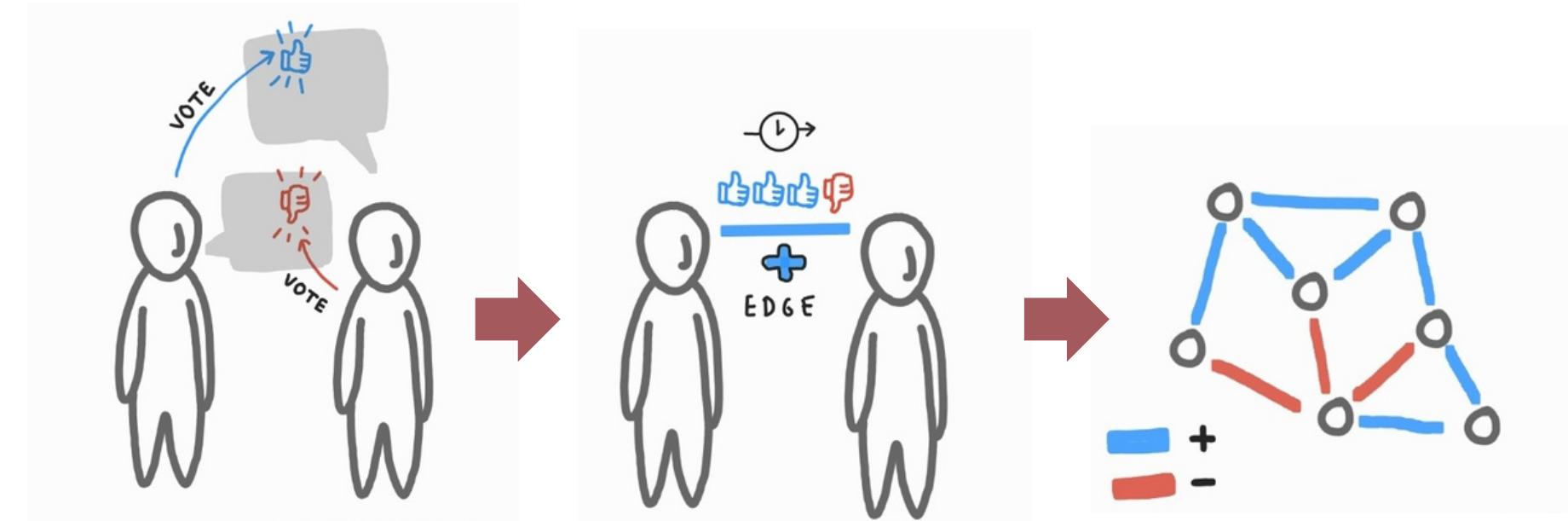
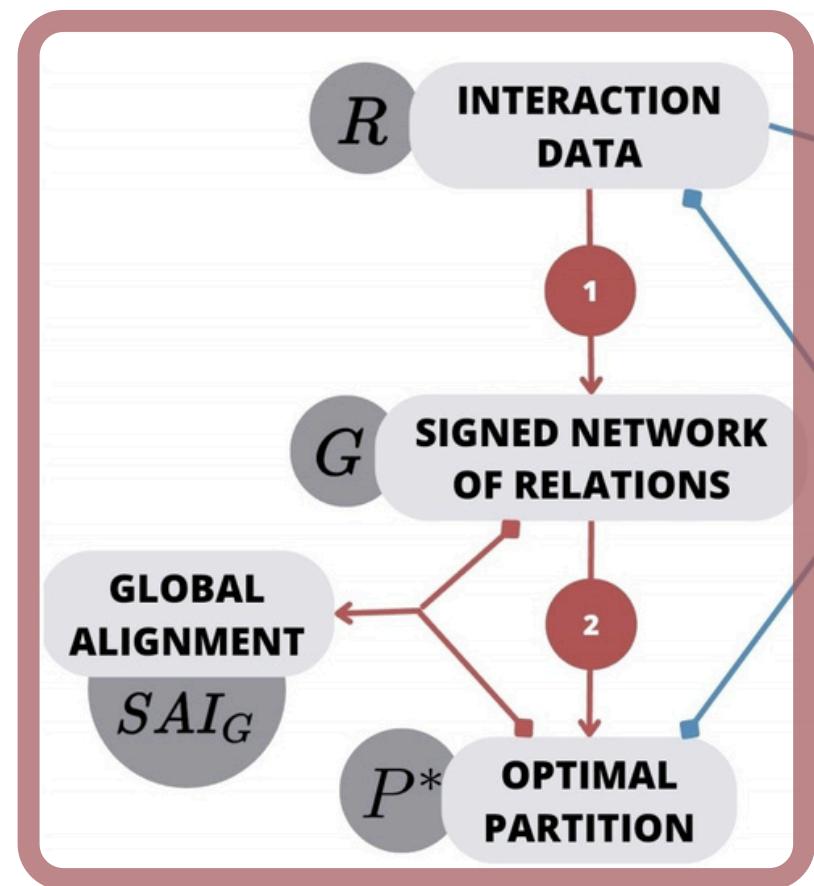


**SIGNED NETWORK  
ANALYSIS**

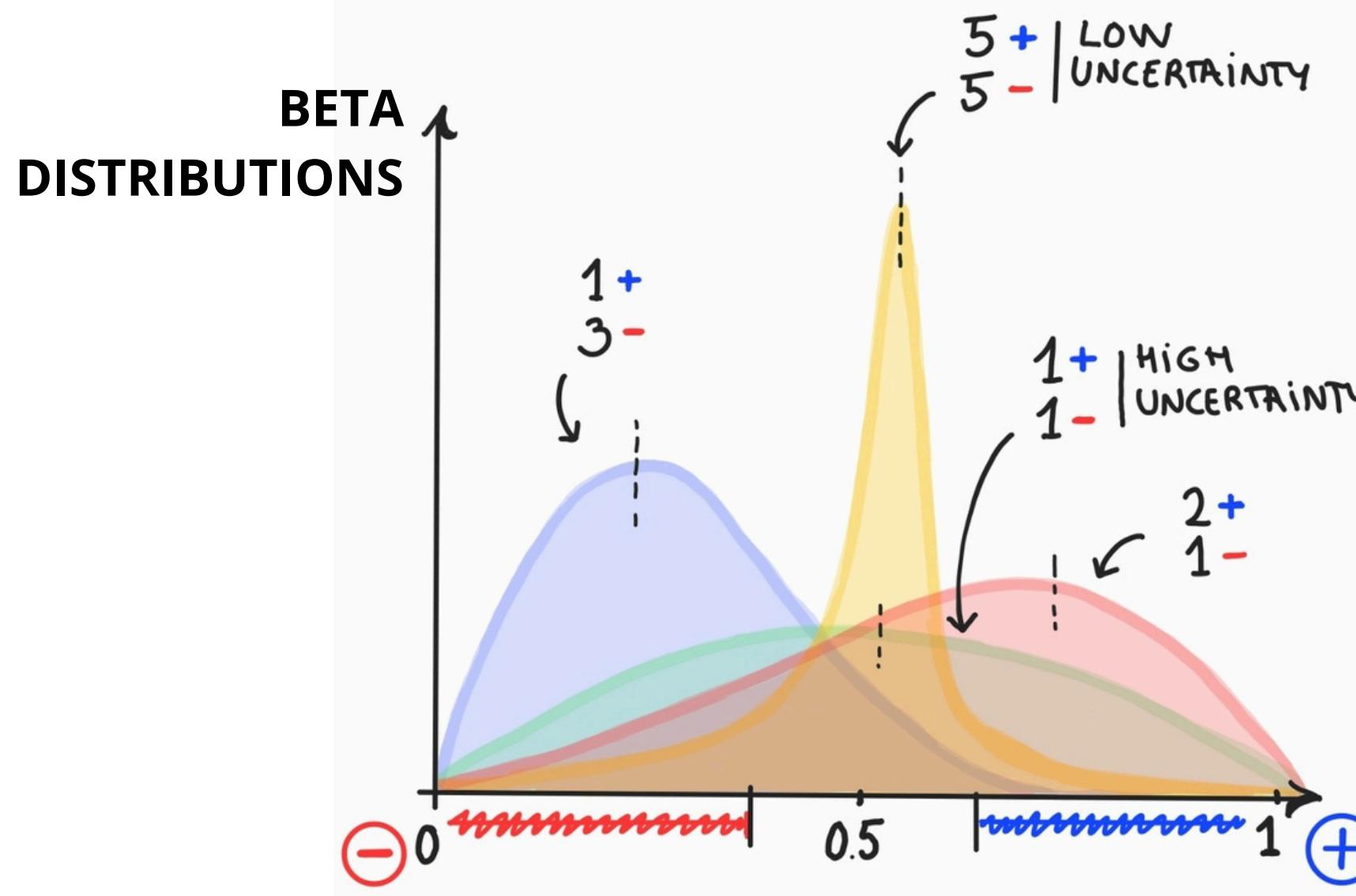
# FAULTANA: FAULT-line Alignment Network Analysis



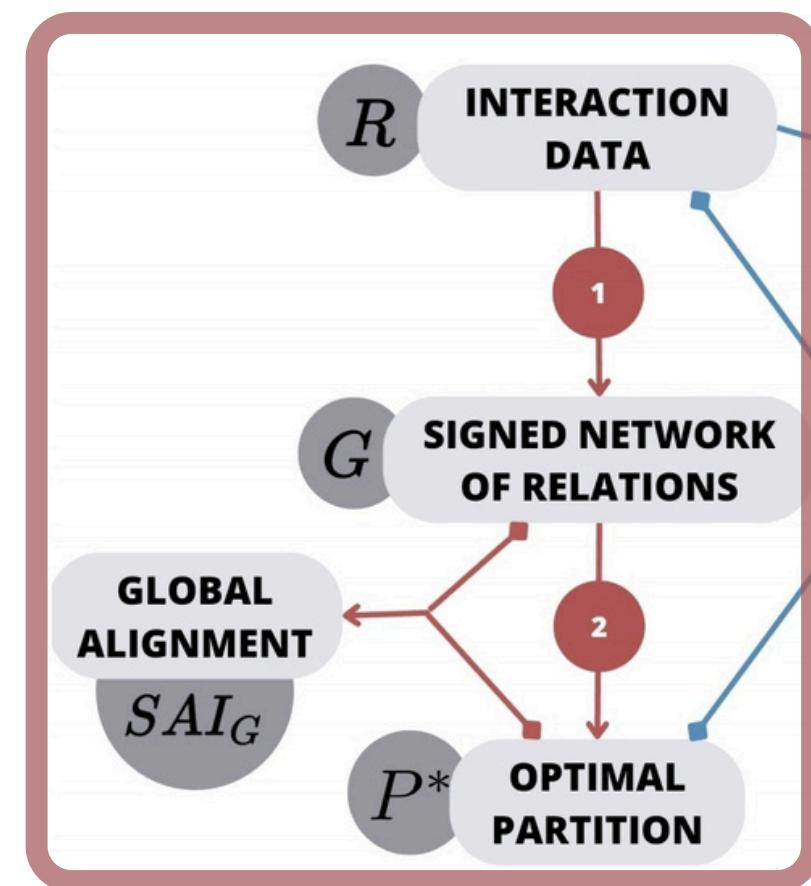
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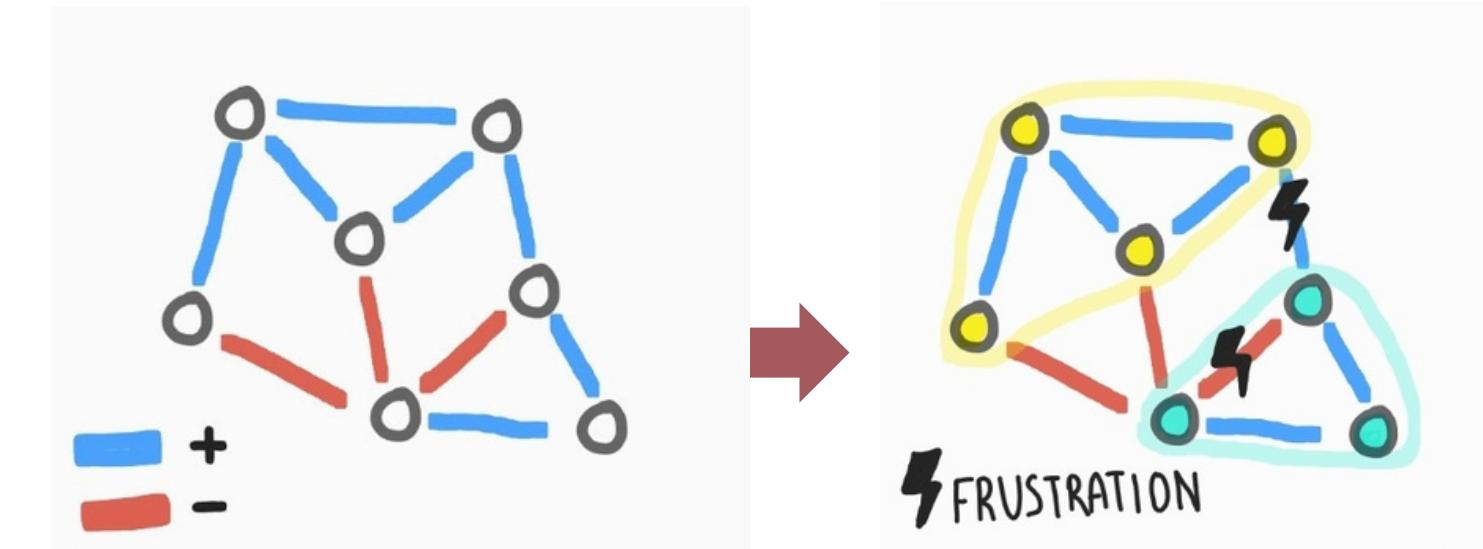
## ... getting from interactions to relations



- Each relation modeled as a random variable that follows a **Bernoulli** distribution (*an interaction is an event*)
- We threshold for **low uncertainty** and a **meaningful bias** towards a positive or negative relation.



... using frustration to detect the fault lines



$$G = (V, E, \sigma)$$

$$\sigma : E \rightarrow \{-1, +1\}$$

$$m \quad \text{volume of edges}$$

Frustrated edge count

$$f_G(P) = \sum_{(i,j) \in E} f_{ij}$$

Normalized  
([1]) Index  
of Balance

Minimization problem (NP Hard)

$$P^* \quad | \quad L_G^* = \min_P f_G(P)$$

$$1 - \frac{L_G^*}{m/2}$$

# Algorithm: Partial balance based on frustration

*"Finding the optimal partition"*

**EXACT**

Binary Linear Programming



Small networks

**Aref, S., Mason, A. J., & Wilson, M. C.** (2020) *A modeling and computational study of the frustration index in signed networks*.

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**APPROXIMATED**

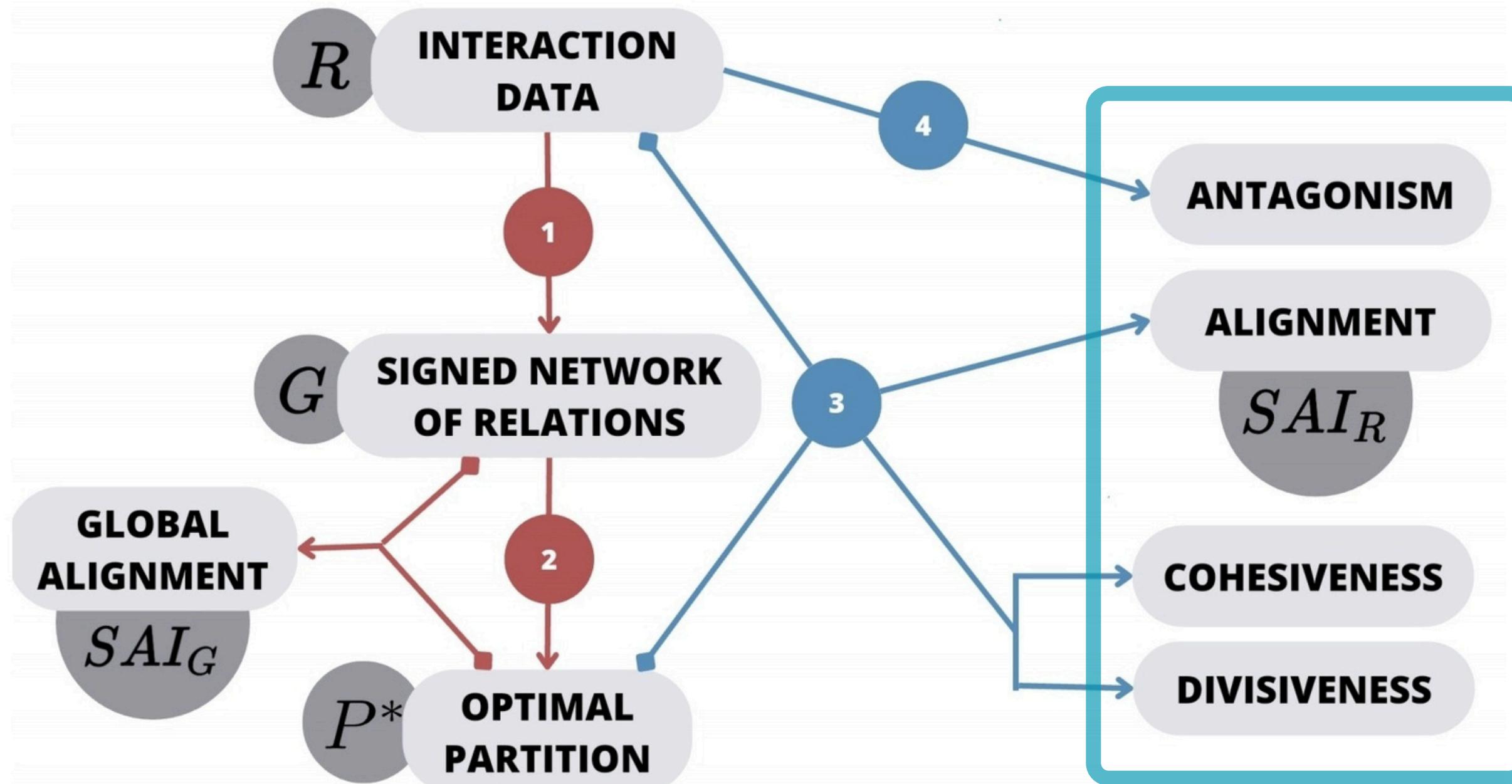
Blockmodeling + Simulated  
Annealing  
(stochastic)



Large networks

**Doreian, P., & Mrvar, A.** *Partitioning signed social networks*. *Social Networks*. (2009)  
**Schoch D (2020).** signet: An R package to analyze signed networks.

# FAULTANA: FAULT-line Alignment Network Analysis



Metrics of interest

# Re-normalization of our metrics

$G = (V, E, \sigma)$   
 $\sigma : E \rightarrow \{-1, +1\}$   
volume of edges

**Global Signed  
Alignment Index**



$$SAI_G = 1 - \frac{L_G^*}{\langle L_{\tilde{G}} \rangle}$$

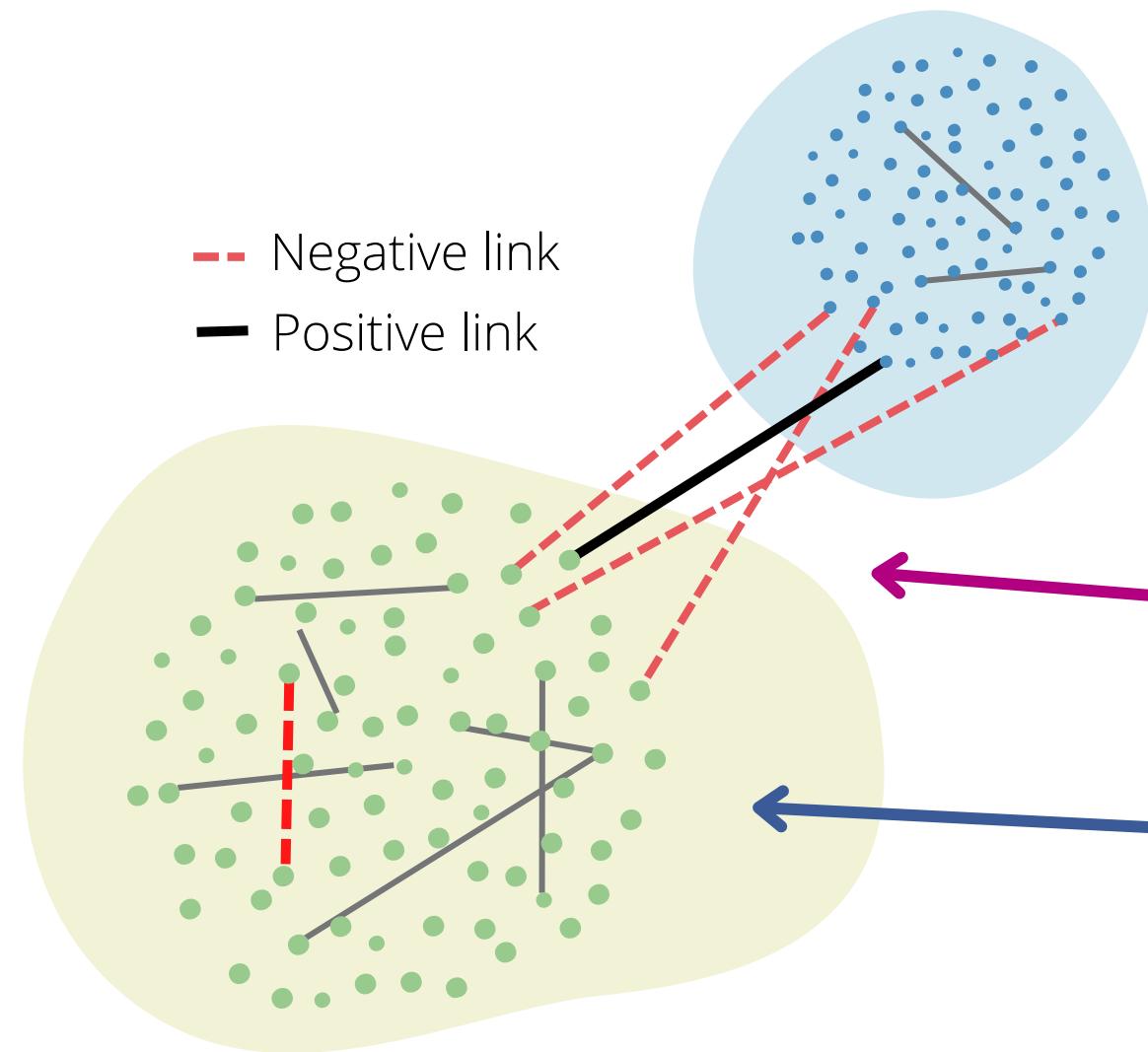
$$^{([1])} 1 - \frac{L_G^*}{m/2}$$

- Takes null model into consideration (given unsigned structure)
- In large-scale social networks: stricter upper-bound

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$$([1]) \quad 1 - \frac{L_G^*}{m/2}$$

- Takes null model into consideration (given unsigned structure)
- In large-scale social networks: stricter upper-bound

Non-frustrated edges proportion ([2])

% External negatives - proportion of negatives

**DIVISIVENESS**

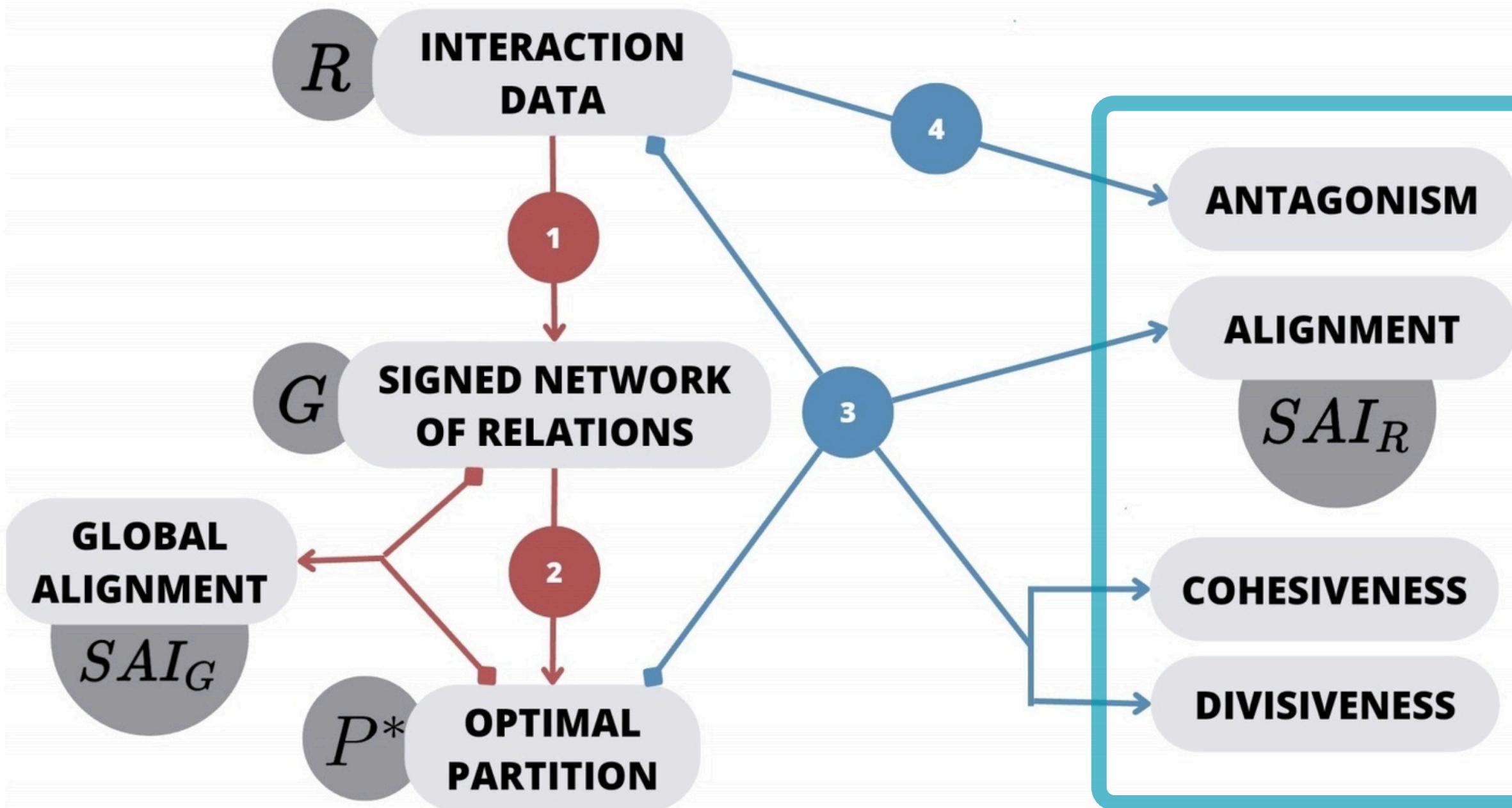
% Internal positives - proportion of positives

**COHESIVENESS**

[1] **Aref, Samin, and Mark C. Wilson.** *Balance and frustration in signed networks.* (2019)

[2] **Aref, S., Dinh, L., Rezapour, R., & Diesner, J.** *Multilevel structural evaluation of signed directed social networks based on balance theory.* (2020)

# FAULTANA: FAULT-line Alignment Network Analysis

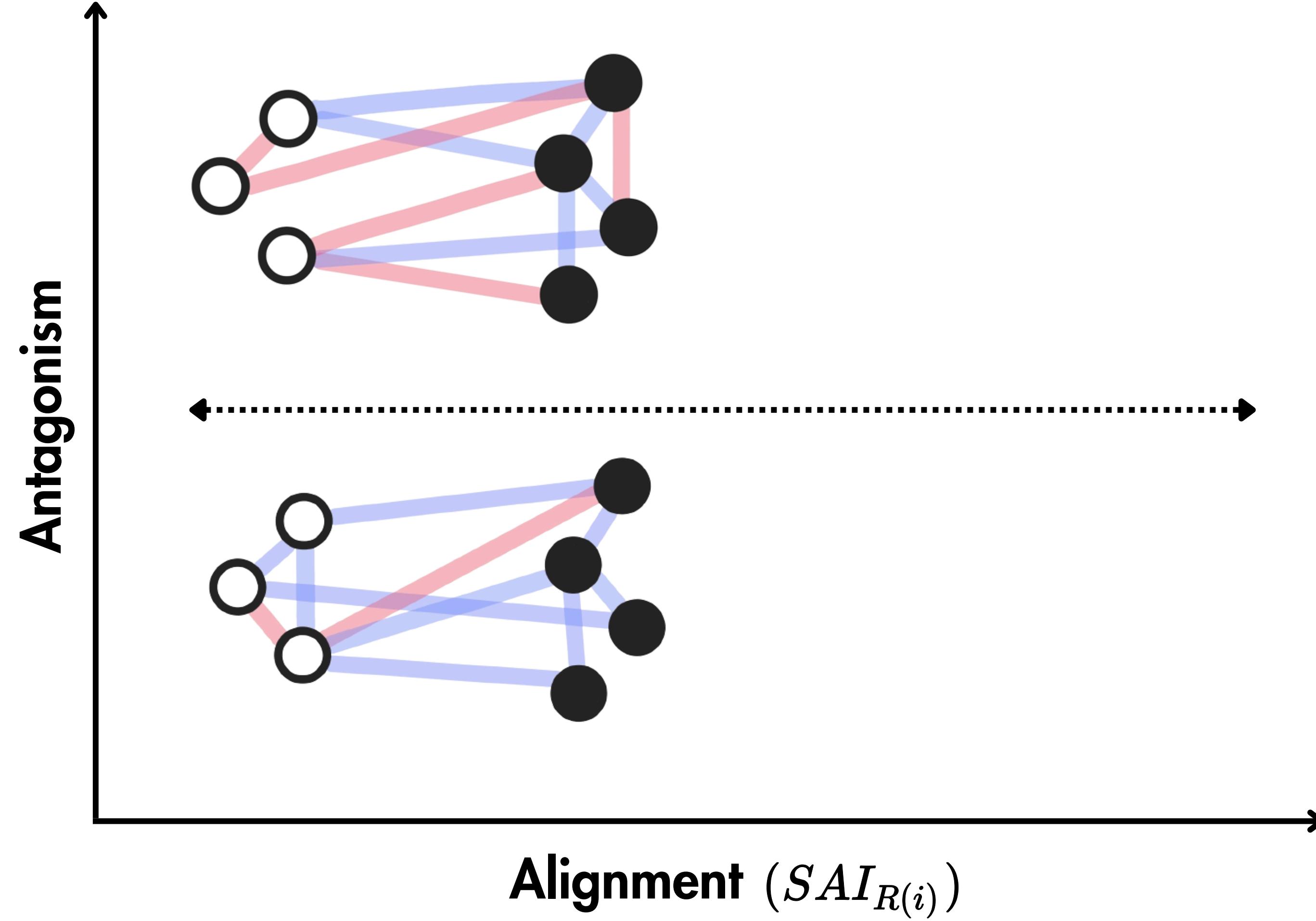


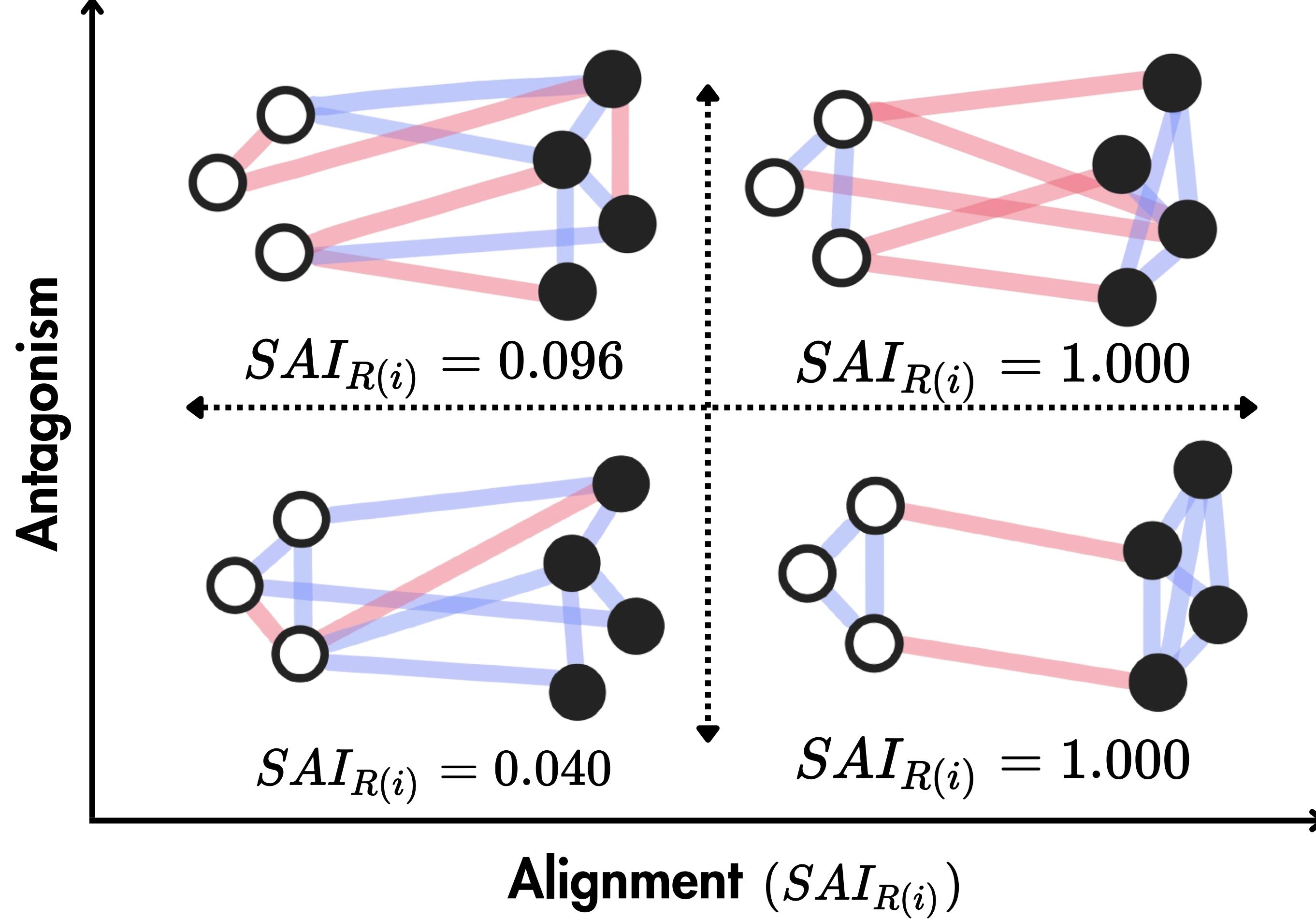
## MEASURING ALIGNMENT

Applicable to sub-sets of data

$$SAI_{R(t/i)} = 1 - \frac{L_{R(t/i)}}{\langle L_{\tilde{R}(t/i)} \rangle}$$

$$SAI_G = 1 - \frac{L_G^*}{\langle L_{\tilde{G}} \rangle}$$







## CASE n°1: **BIRDWATCH**

👉 BIG Surprise waiting. Click Profile to Follow me now!

2300 RATINGS *Big Surprise waiting follow me now!*

Readers added context they thought people might want to know

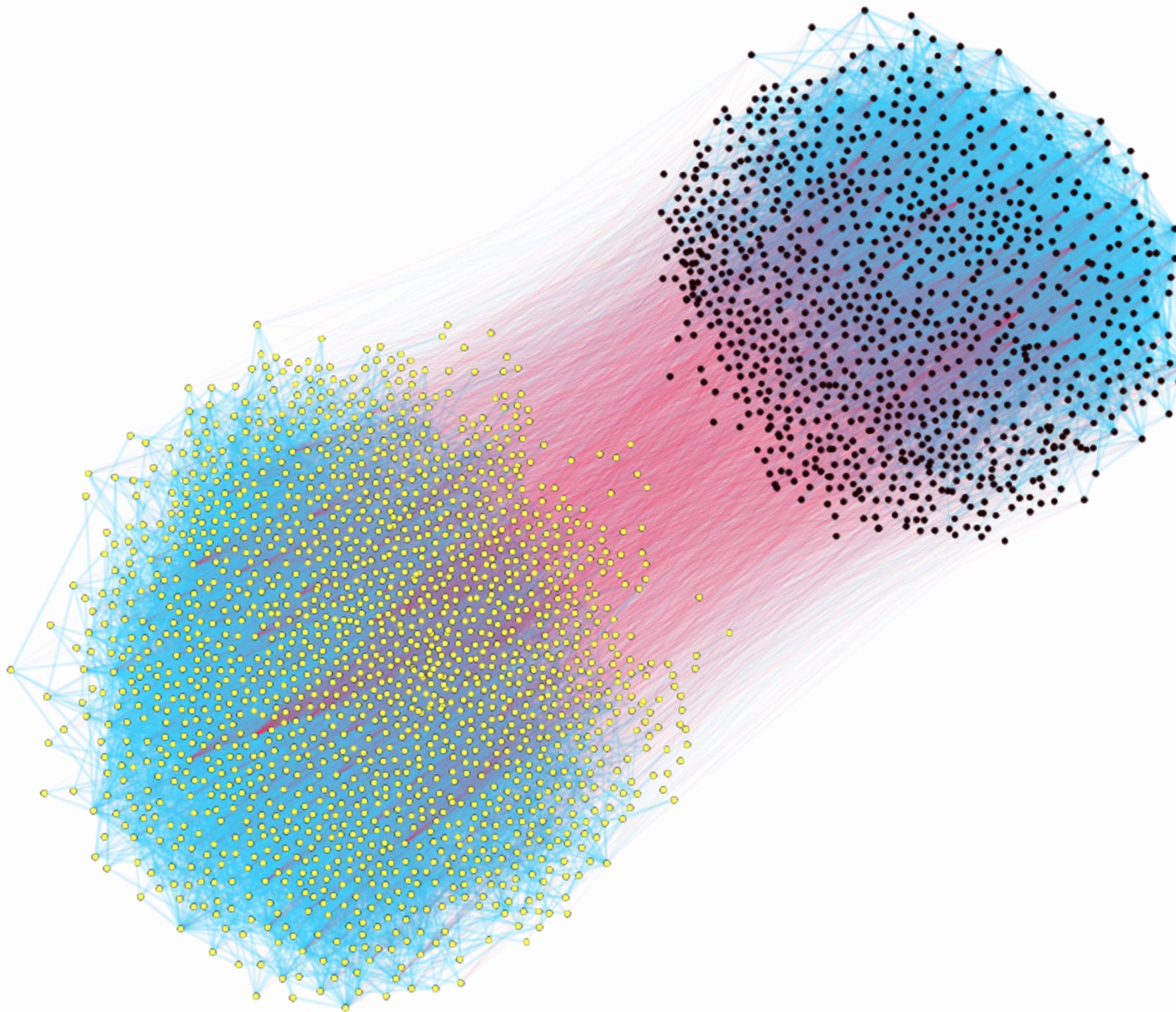
There is no surprise waiting for you.

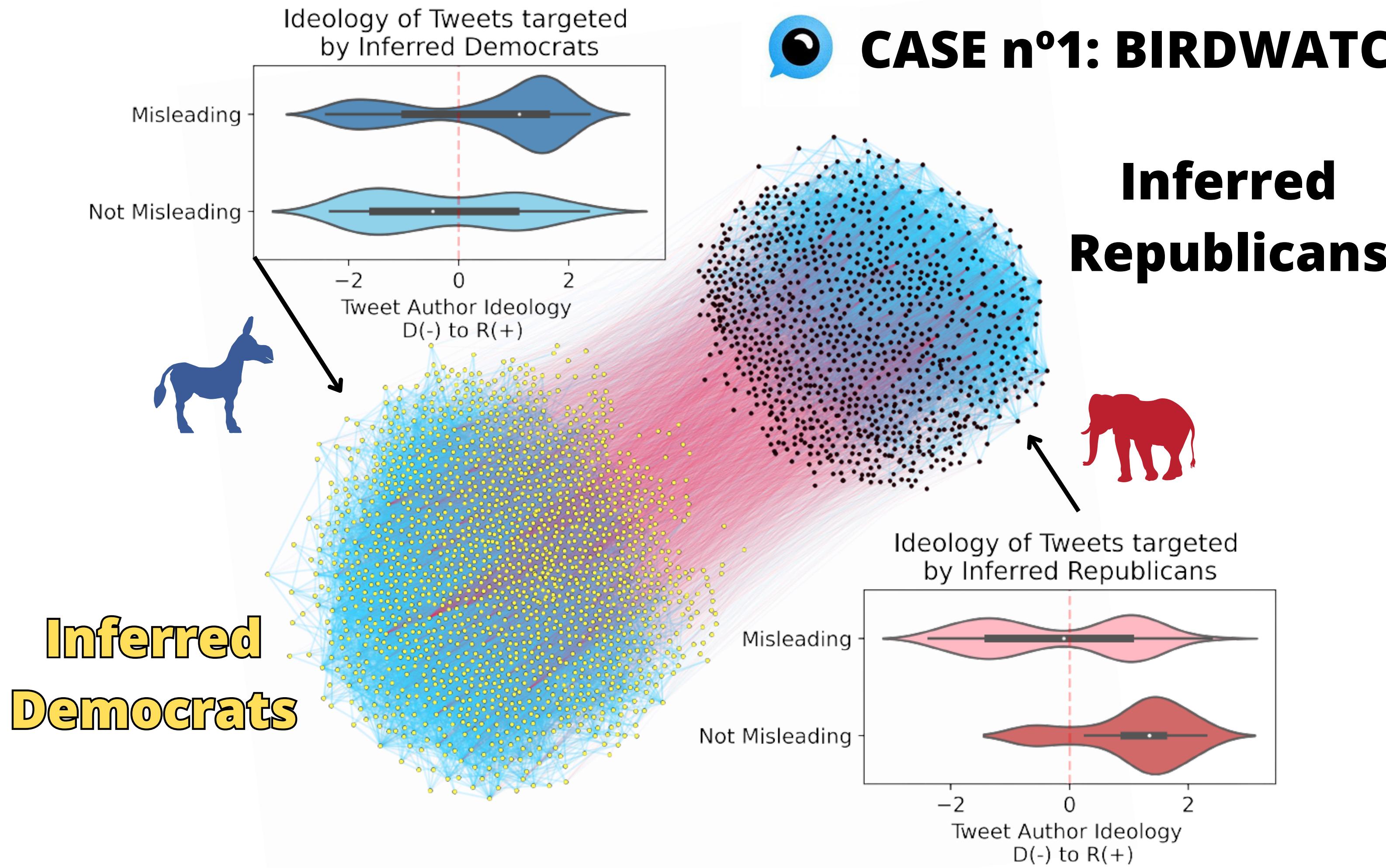
Do you find this helpful? [Rate it](#)

Context is written by people who use X, and appears when rated helpful by others. [Find out more.](#)



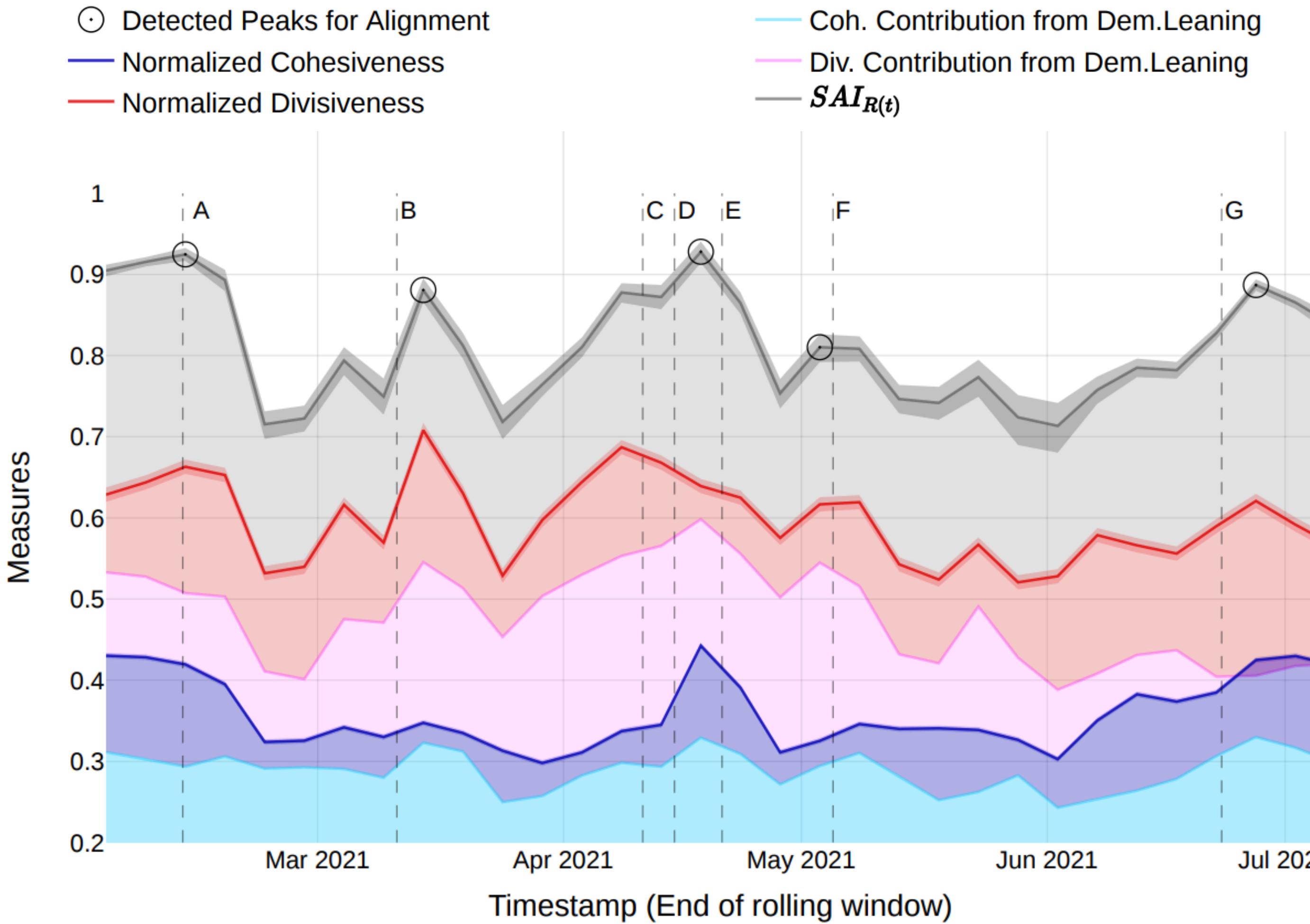
## CASE n°1: BIRDWATCH

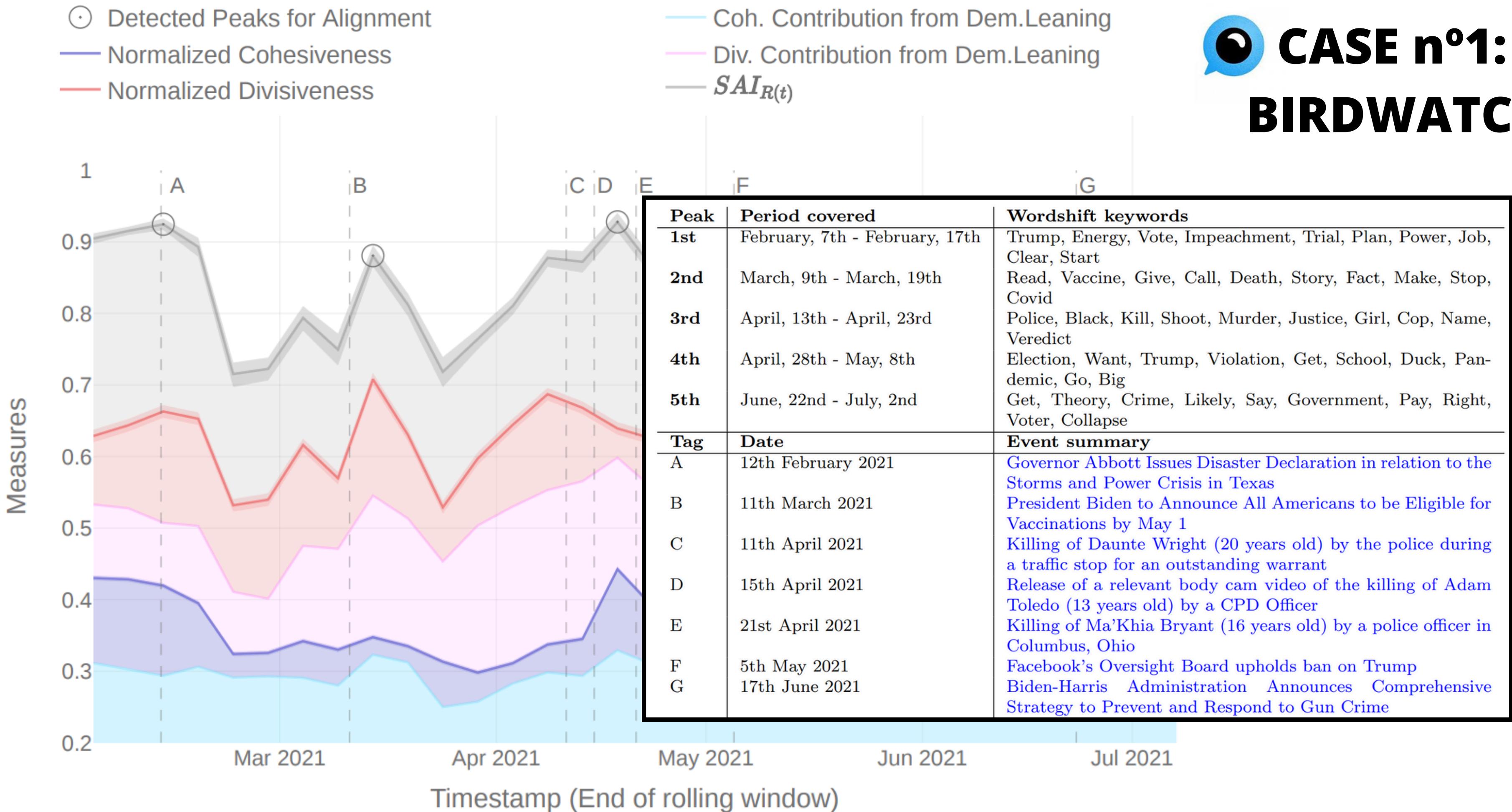




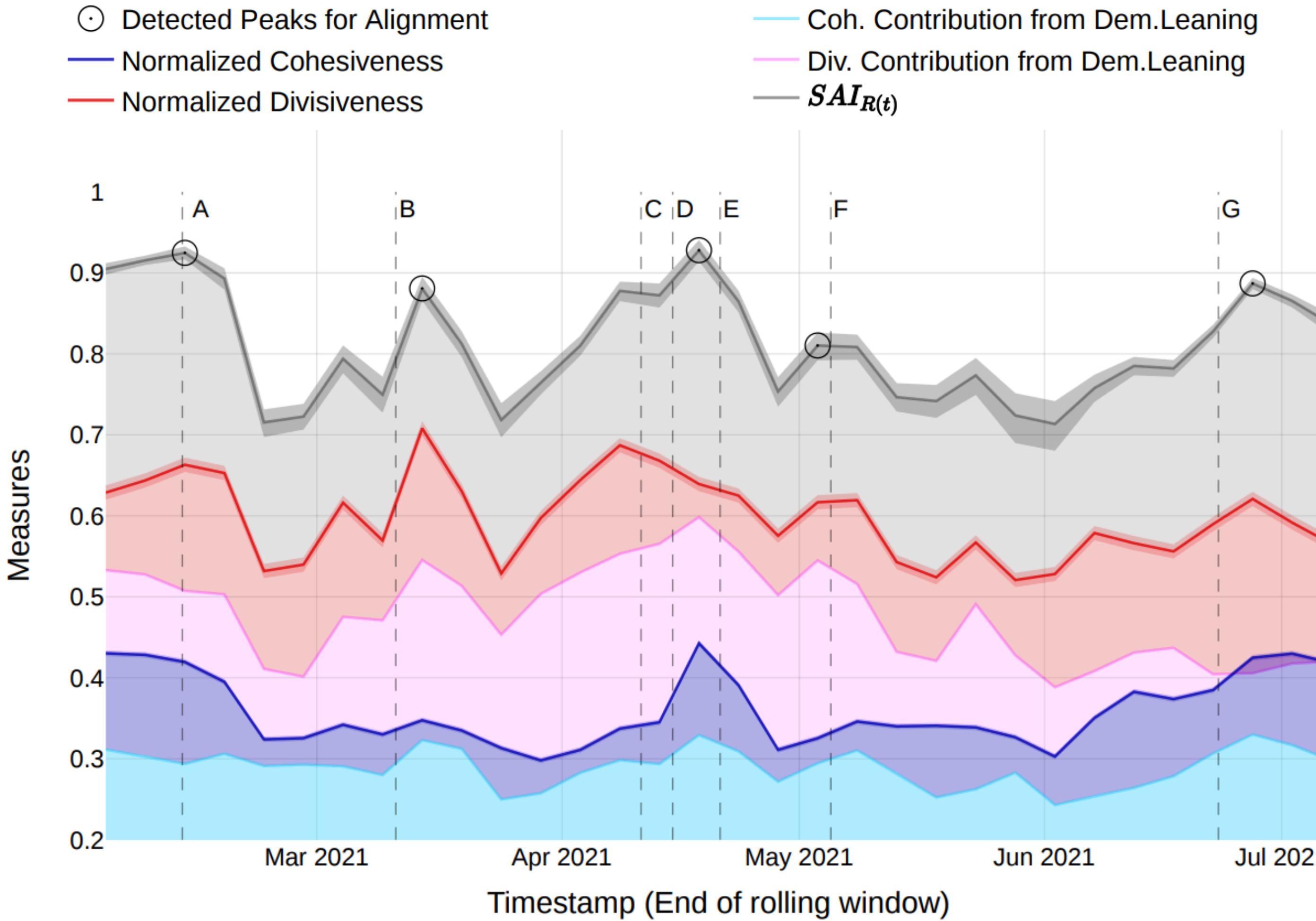


# CASE n°1: BIRDWATCH



 **CASE n°1:**  
**BIRDWATCH**



## CASE n°2: DER STANDARD

RD Unterstützung Abo Immosuche Jobsuche Anmelden

kei Inland Wirtschaft Web Sport Panorama Kultur Etat Wissenschaft Lifestyle mehr...

Ihr Weg aus der Filterblase.

NACH EU-GIPFEL

# Kern lässt Distanz zu Kurz' Türkei-Vorstoß erkennen

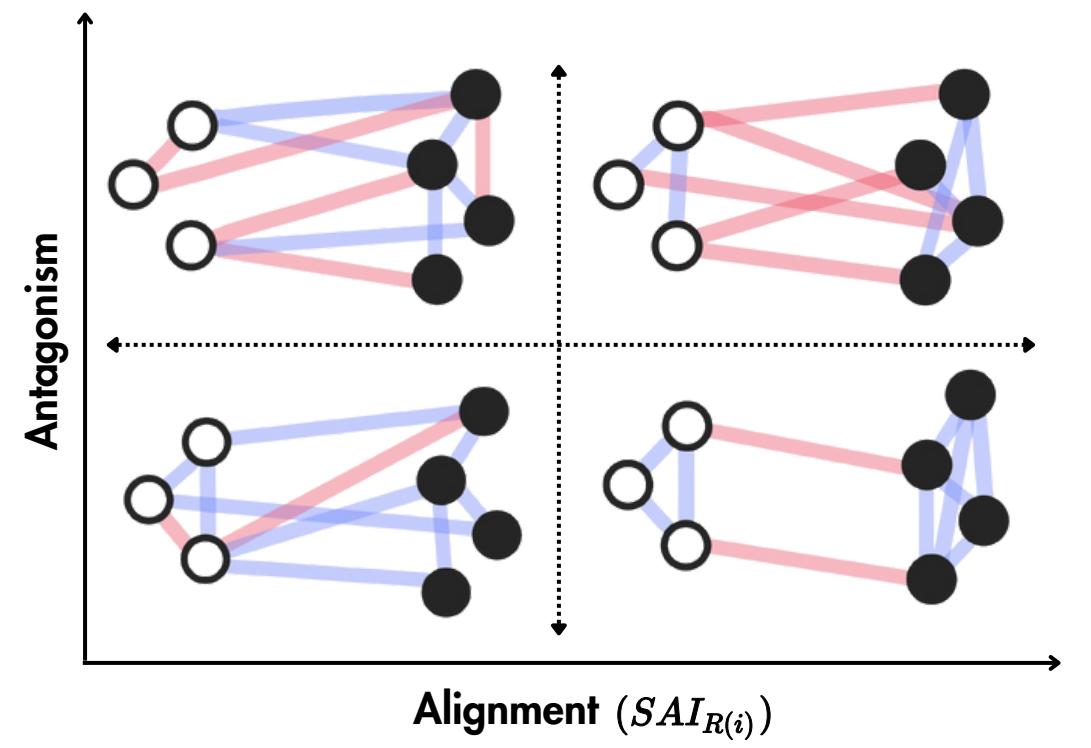
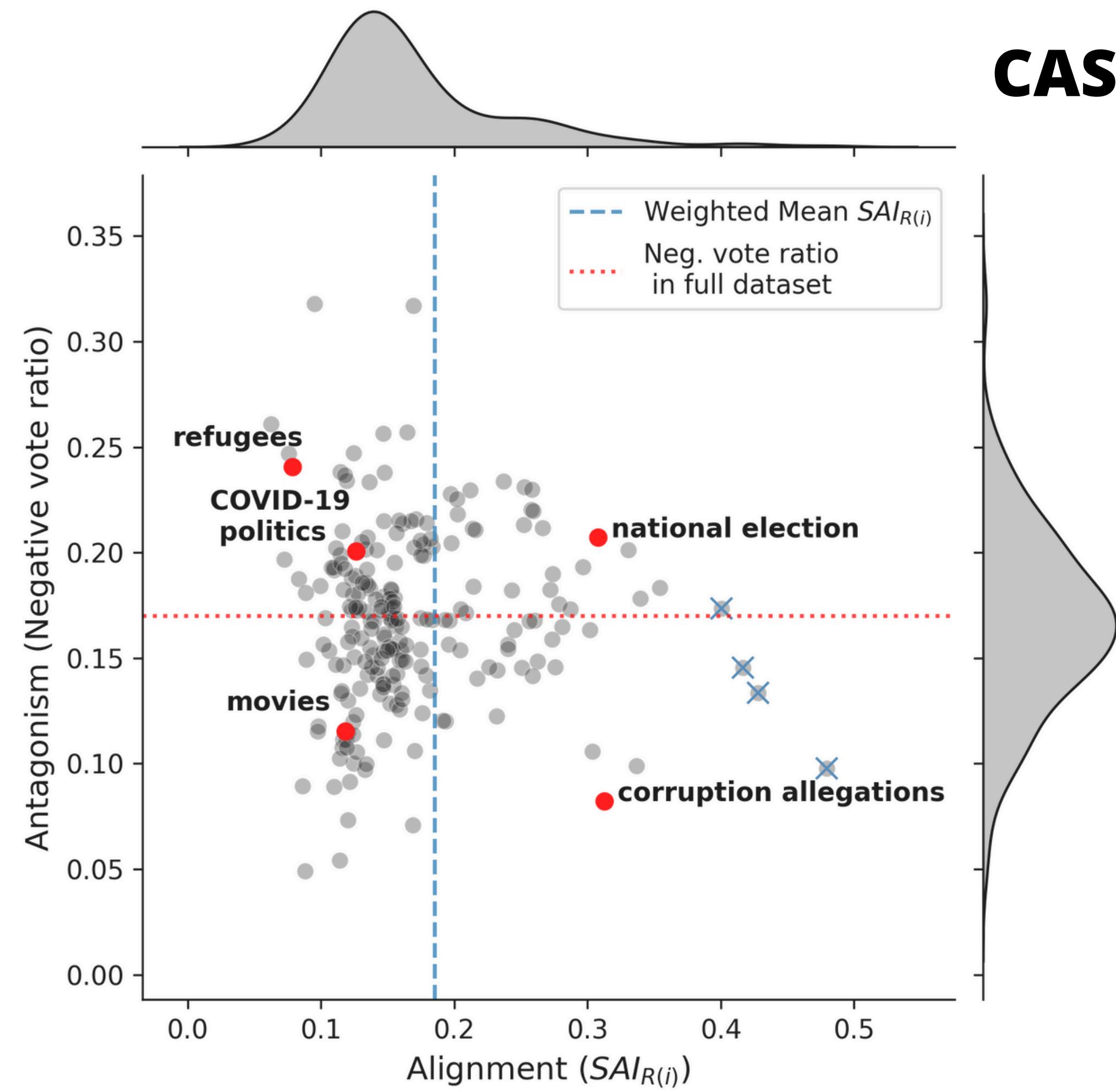
Tagelang sorgte Österreich mit harter Blockadepolitik gegenüber der Türkei für Schlagzeilen. Nach dem EU-Gipfel zeigte sich Kanzler Kern ernüchtert und ging hörbar auf Distanz zu Außenminister Kurz

Thomas Mayer aus Brüssel  
16. Dezember 2016, 17:40, 832 Postings

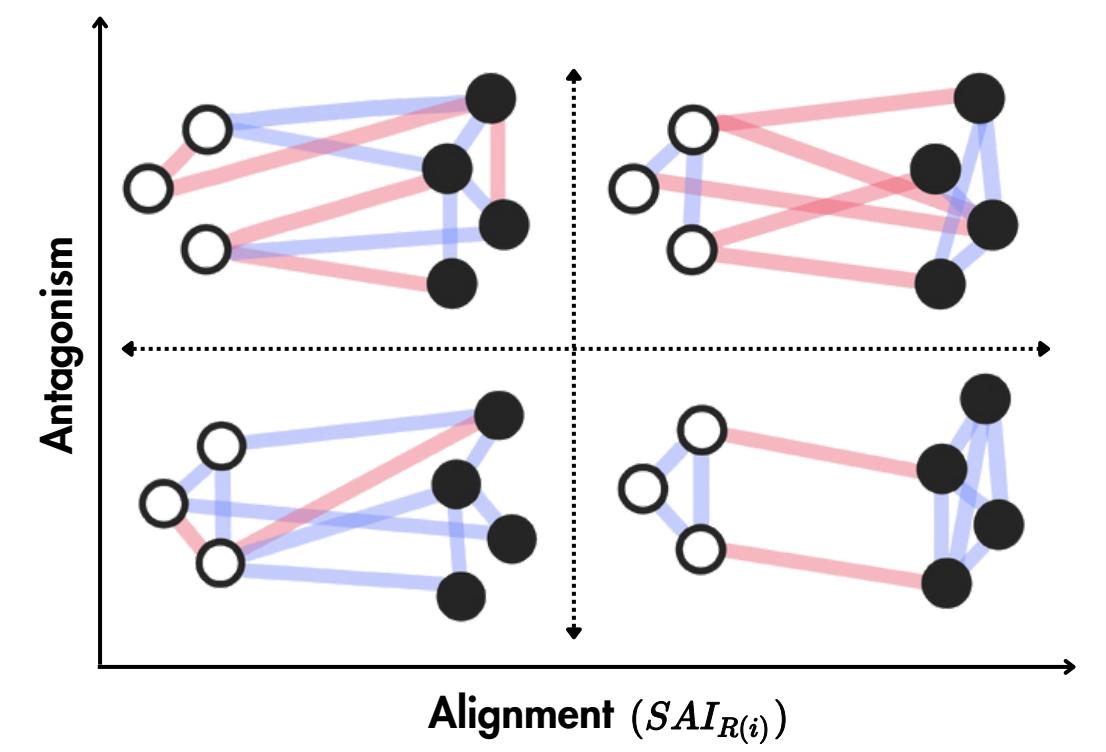
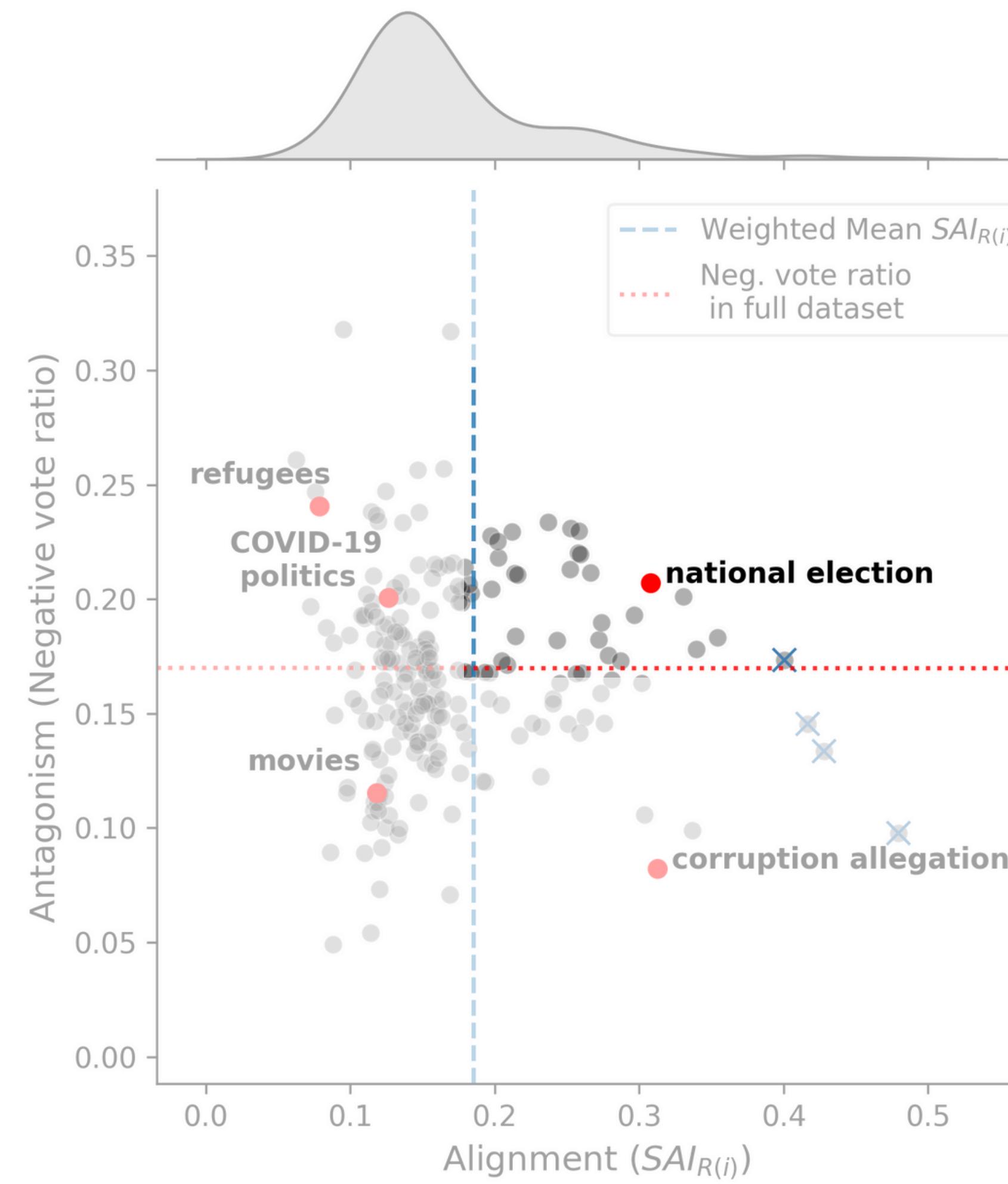
Die Europäische Union stellt ihre umfangreichen Beziehungen zur Türkei – zu denen die Zollunion, der Migrationspakt und die Sicherheitspartnerschaft in der Nato ebenso gehören wie der seit 1999 laufende Beitrittsprozess – in keiner Weise infrage. Das hat Ratspräsident Donald Tusk Donnerstagnacht zum Abschluss des EU-Gipfels in Brüssel herausgestellt.



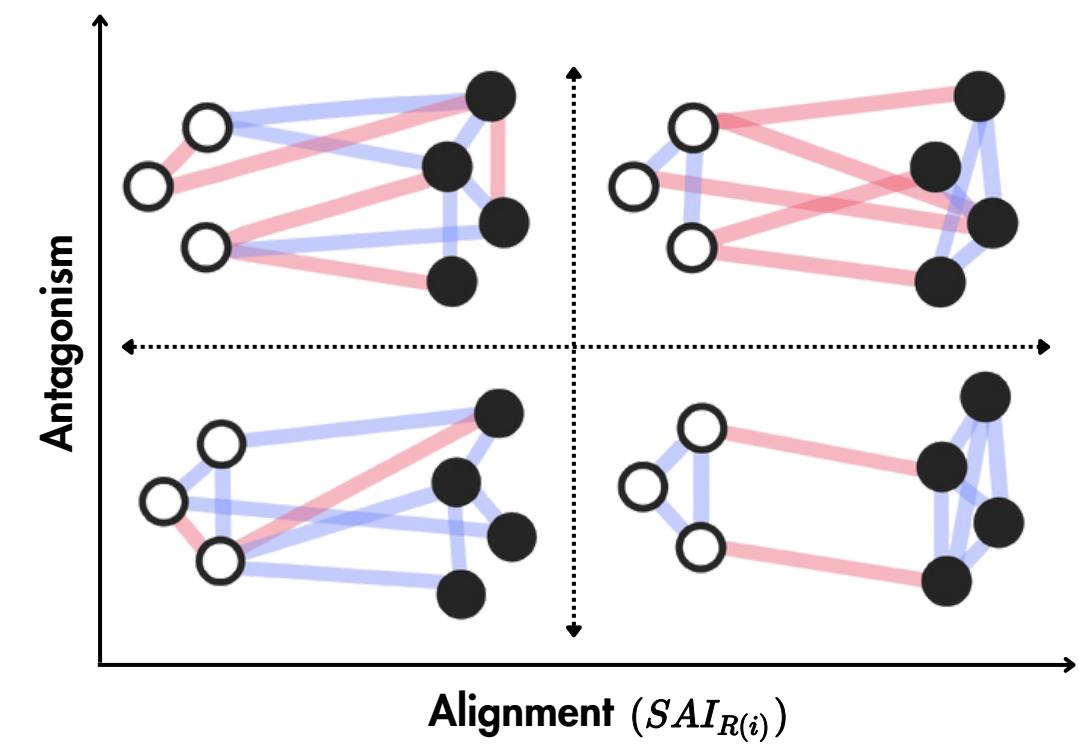
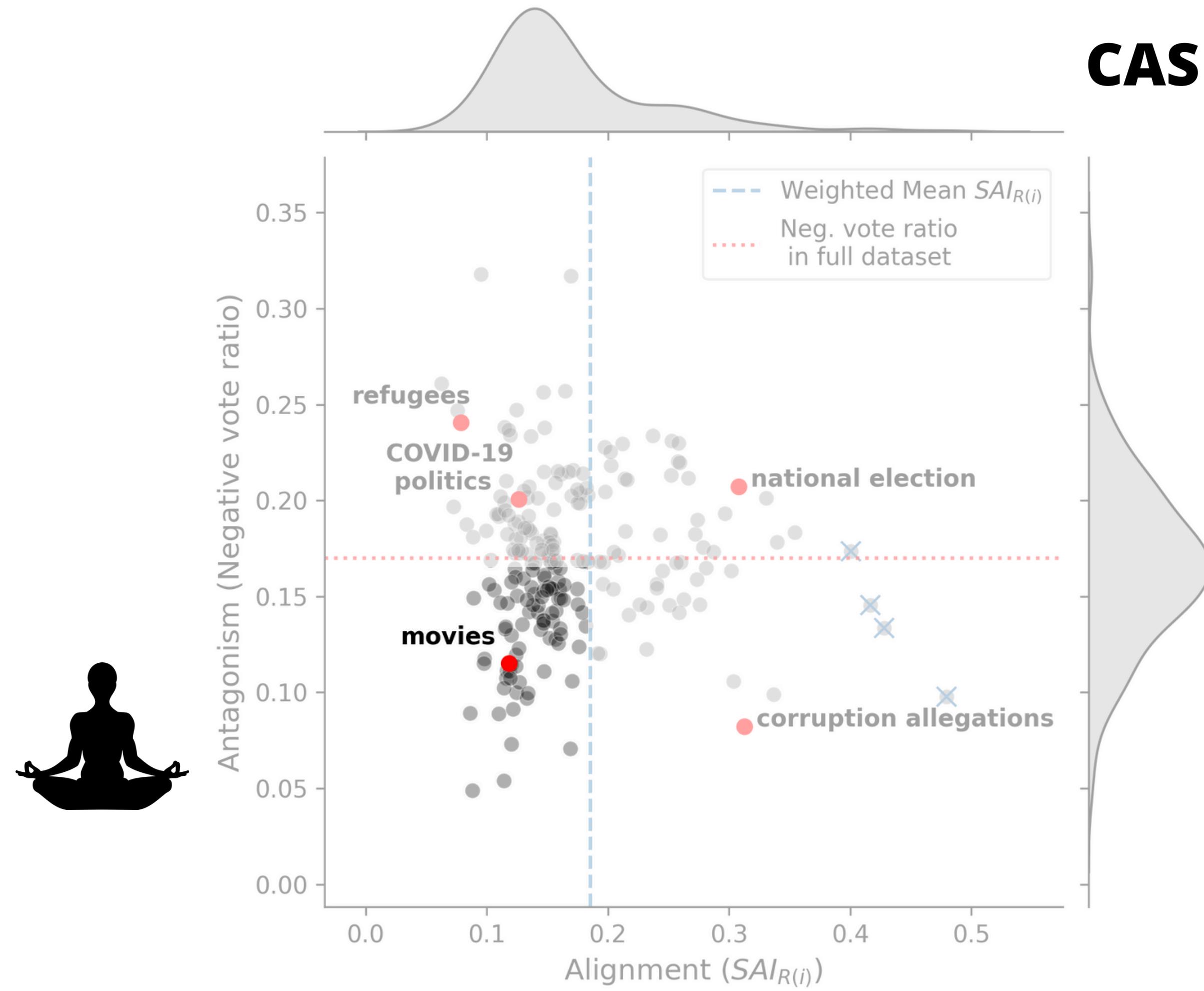
## CASE n°2: DERSTANDARD



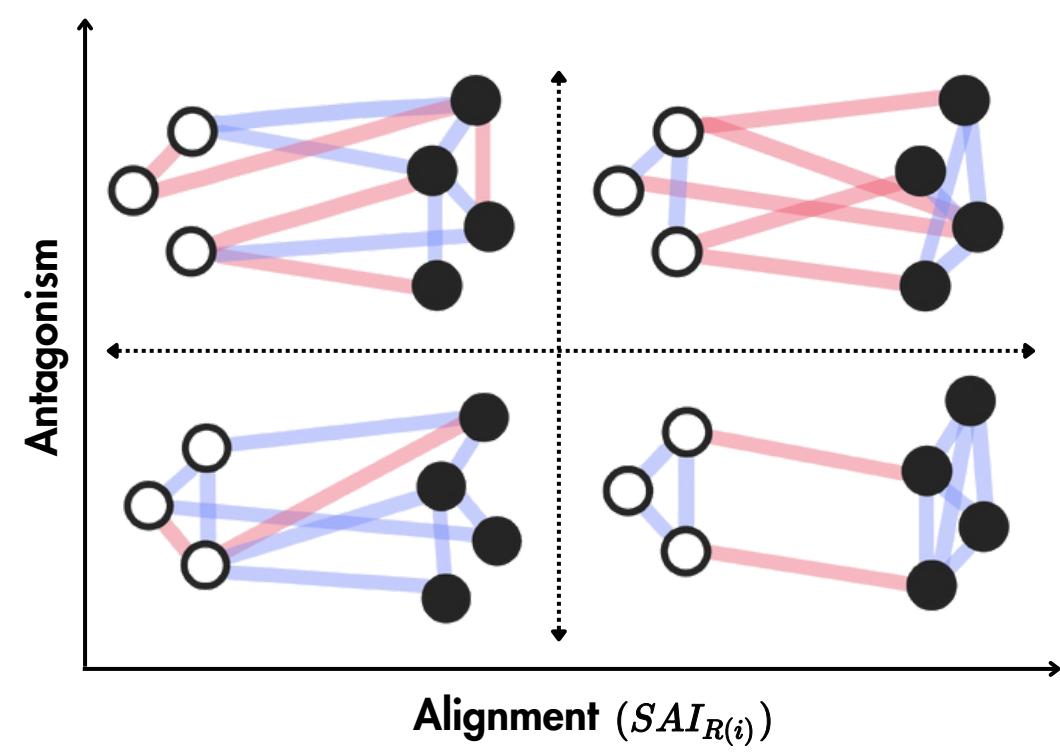
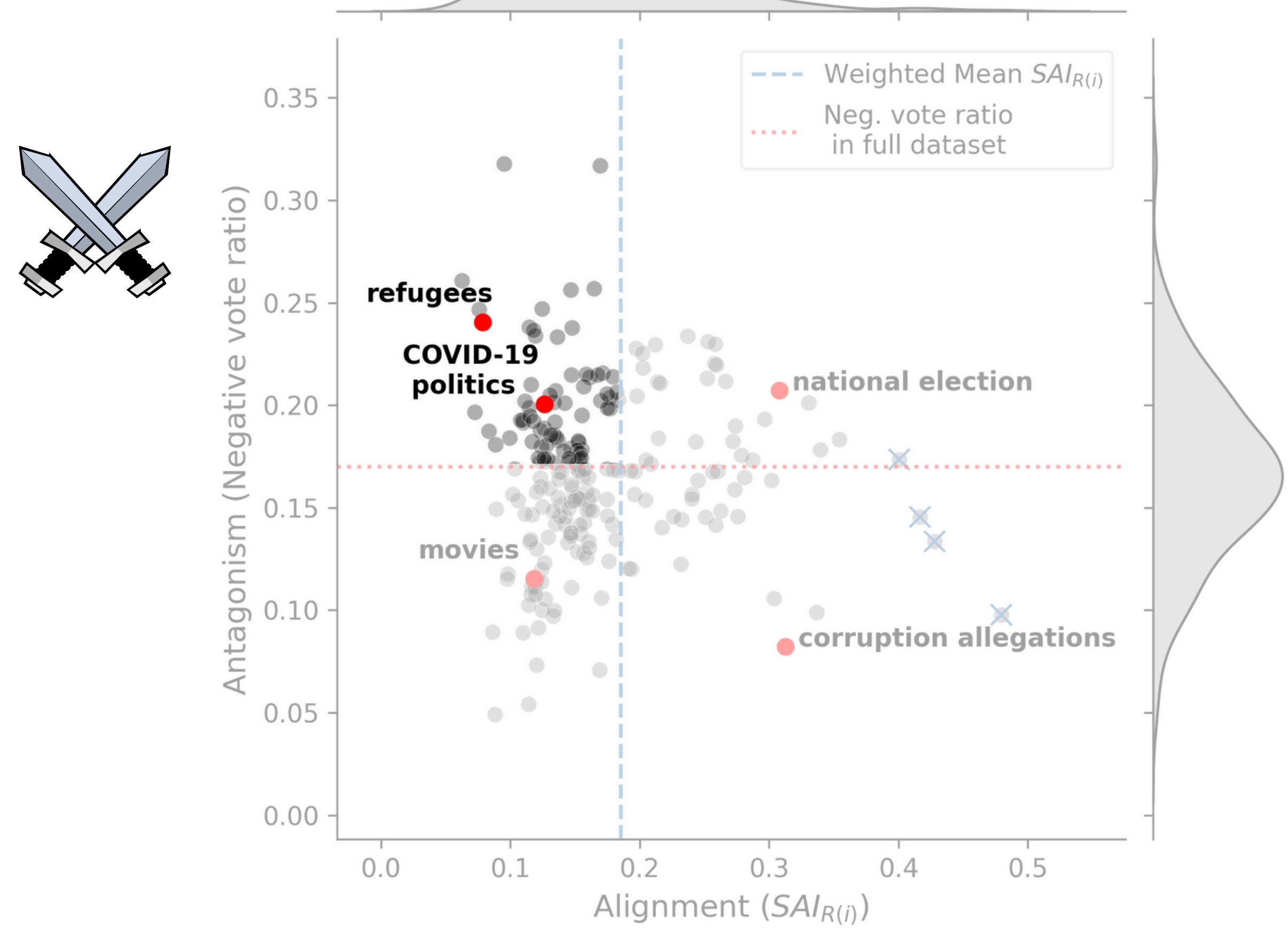
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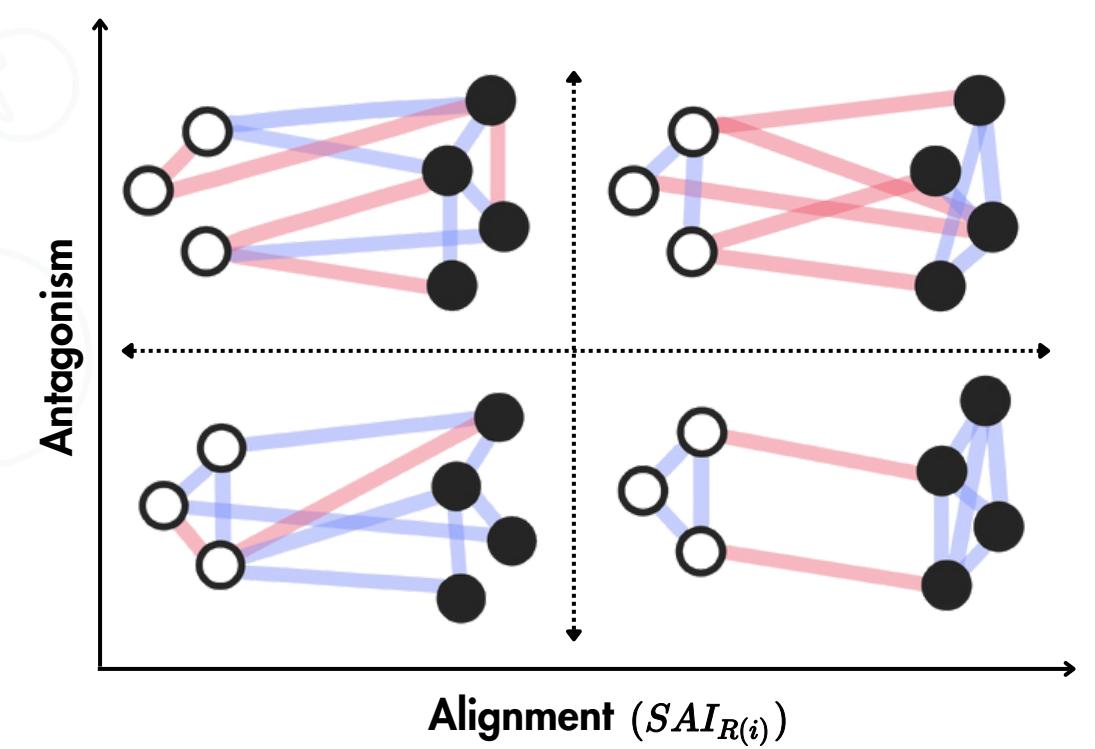
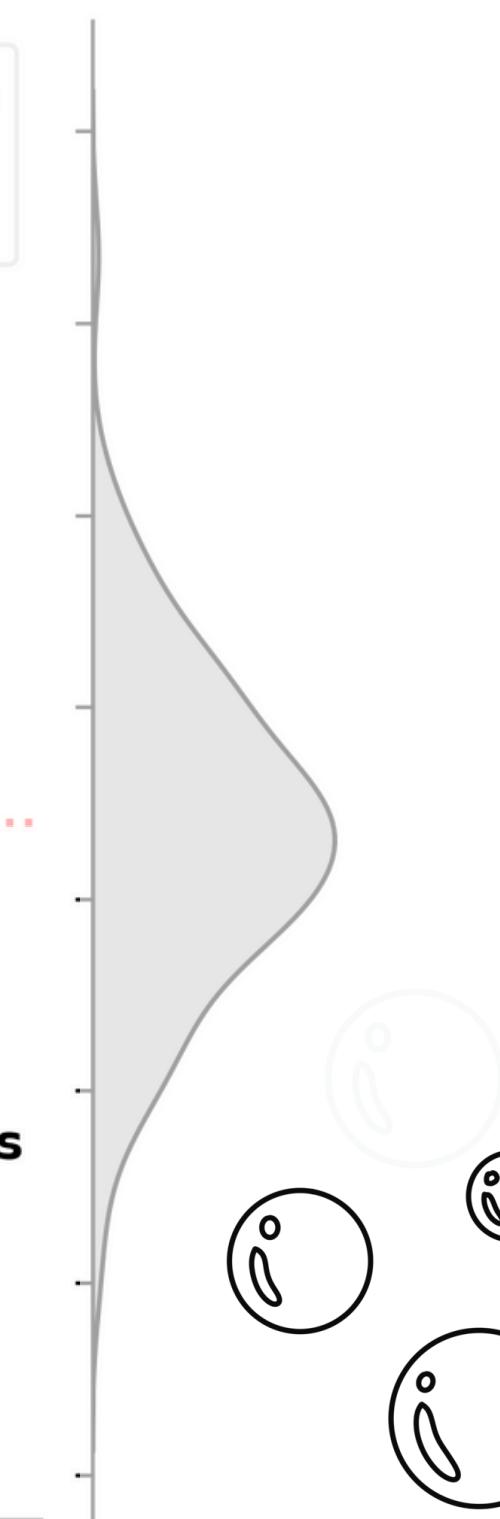
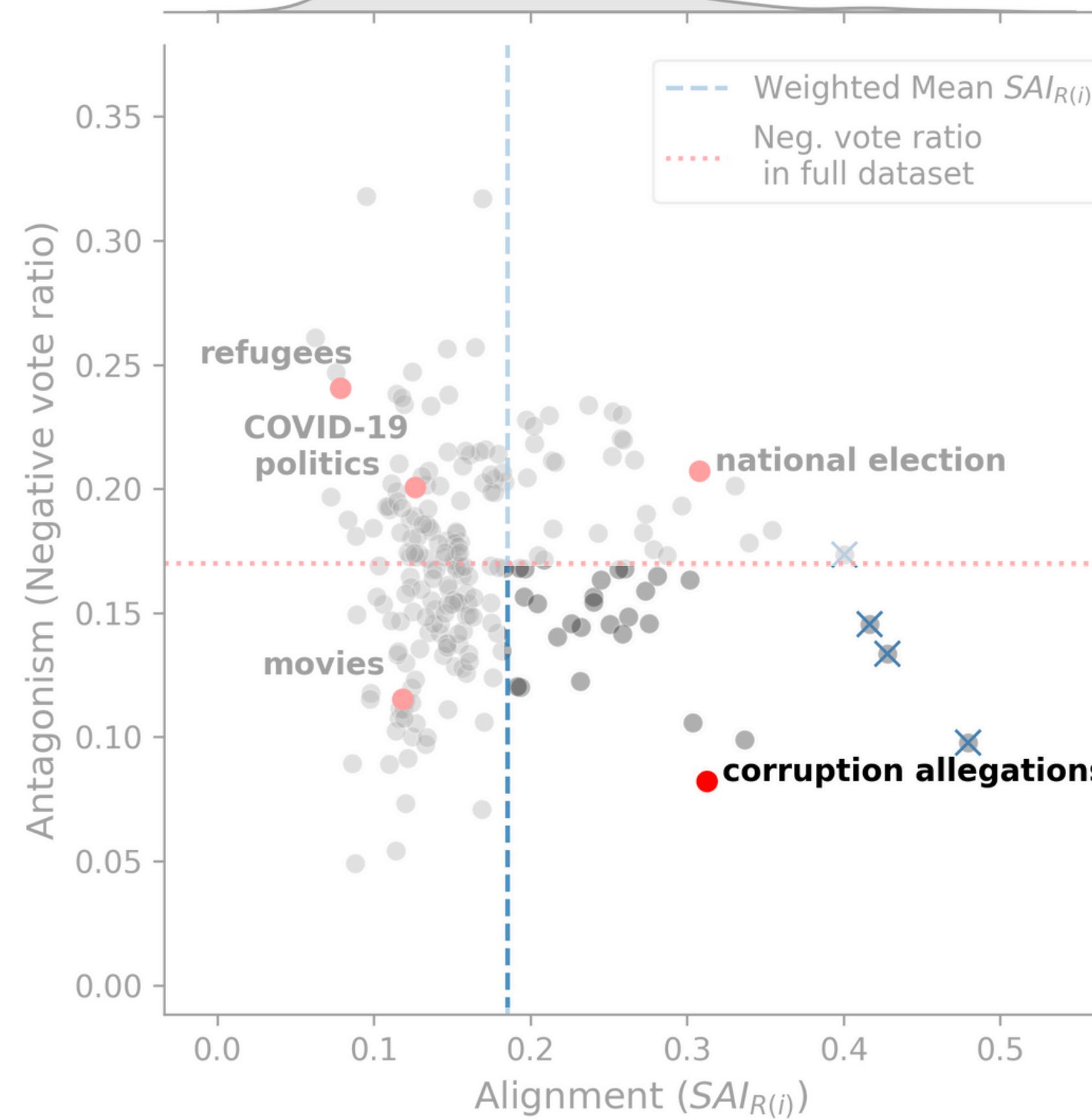
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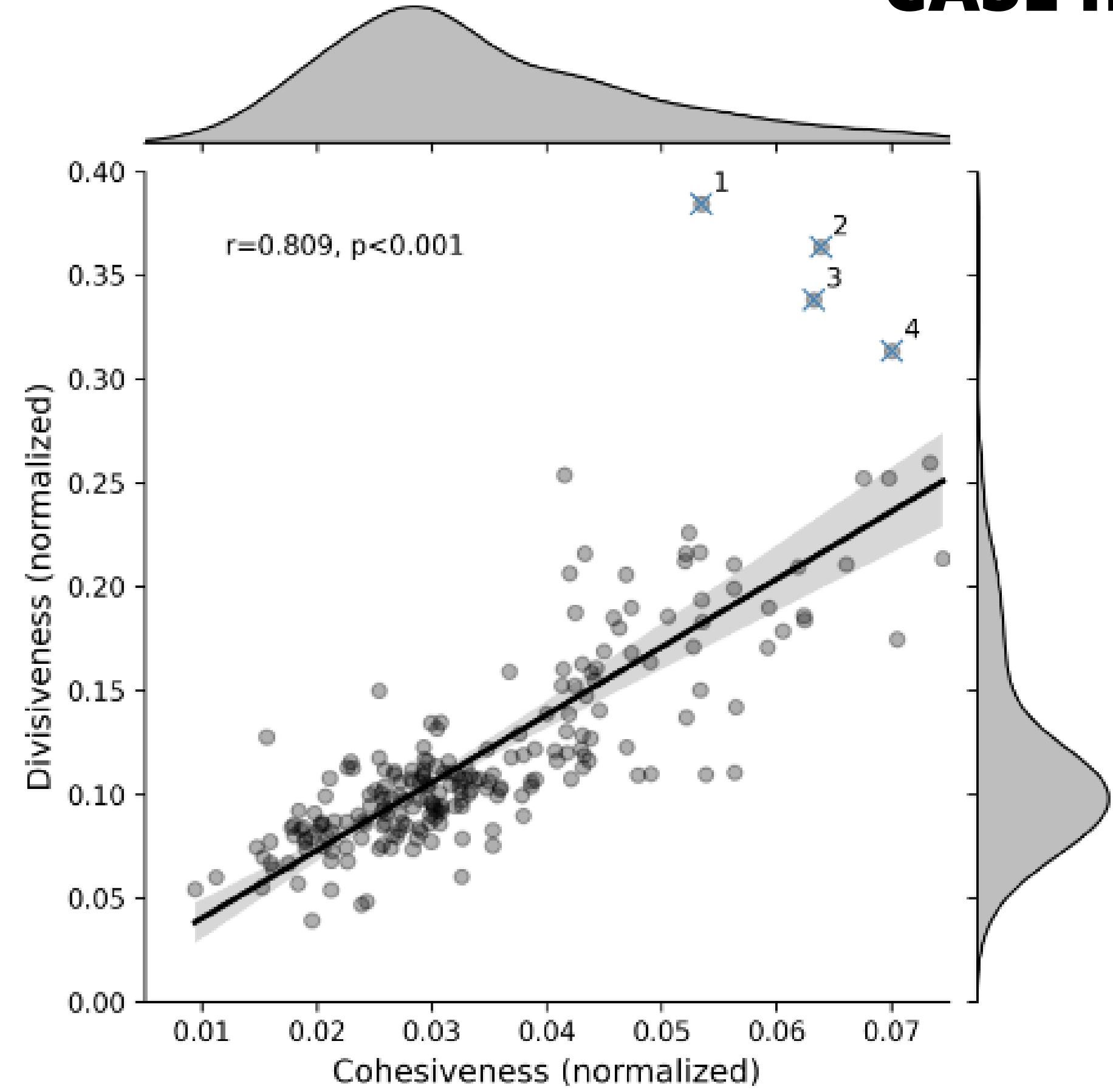
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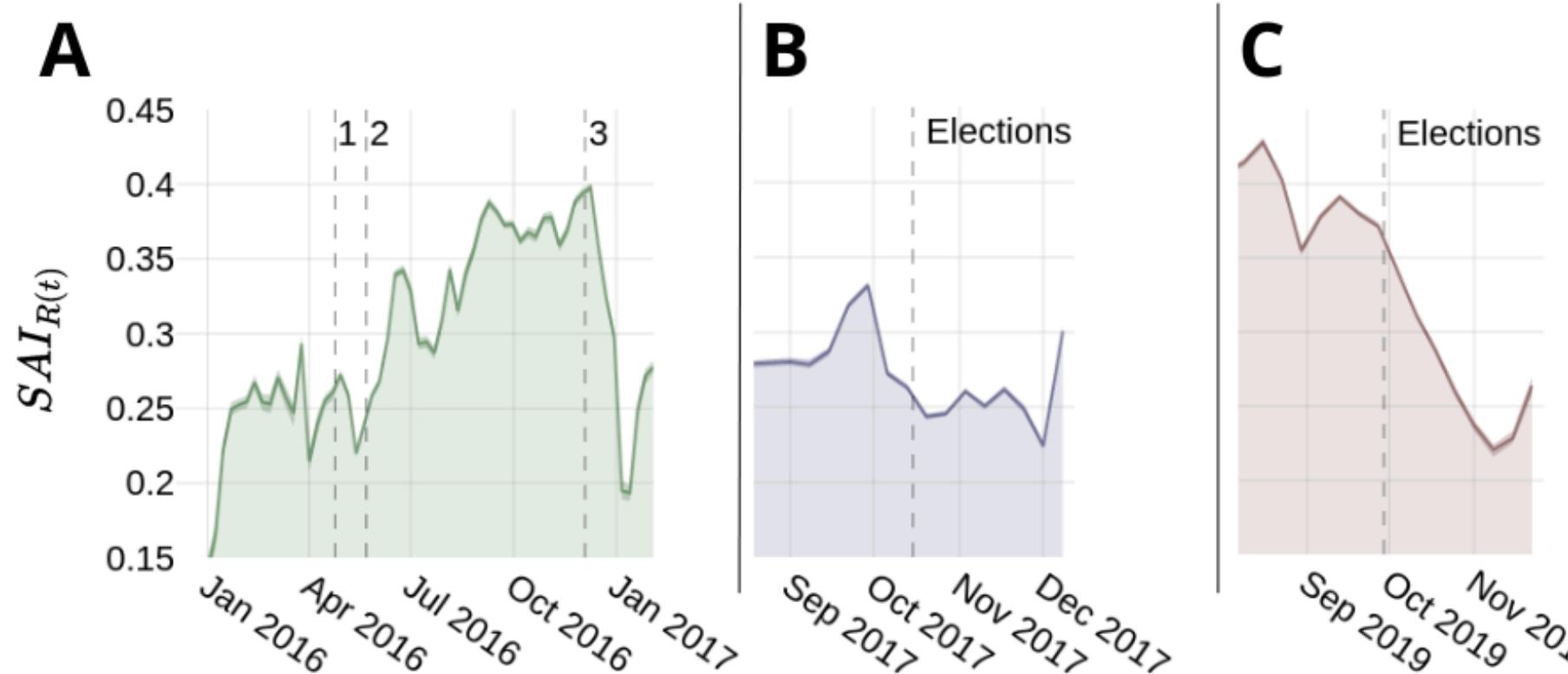
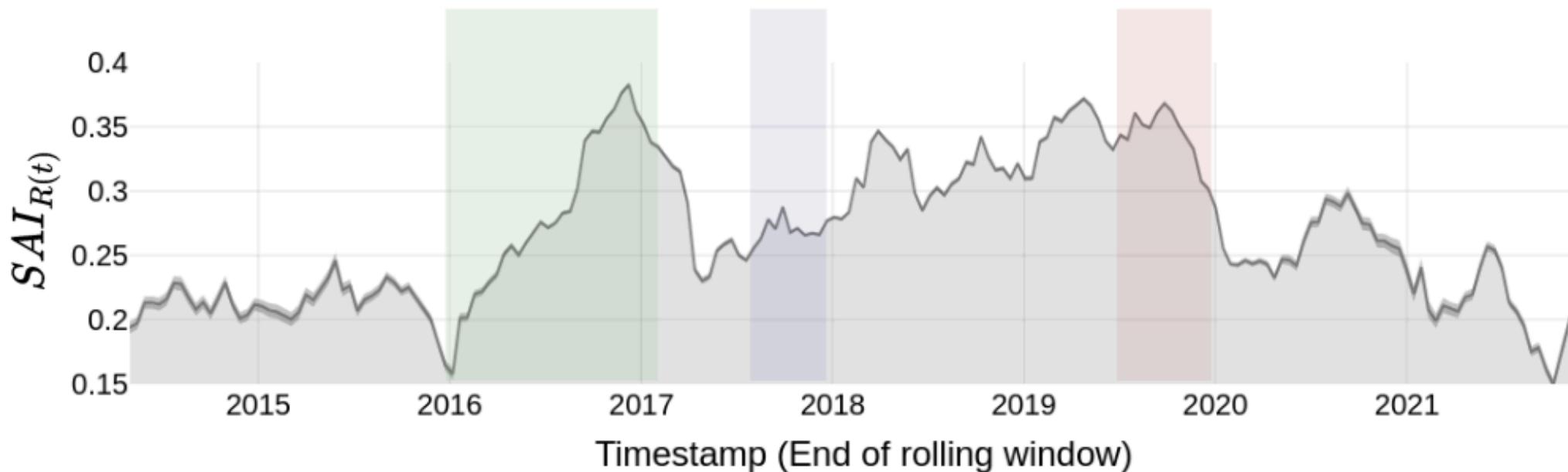
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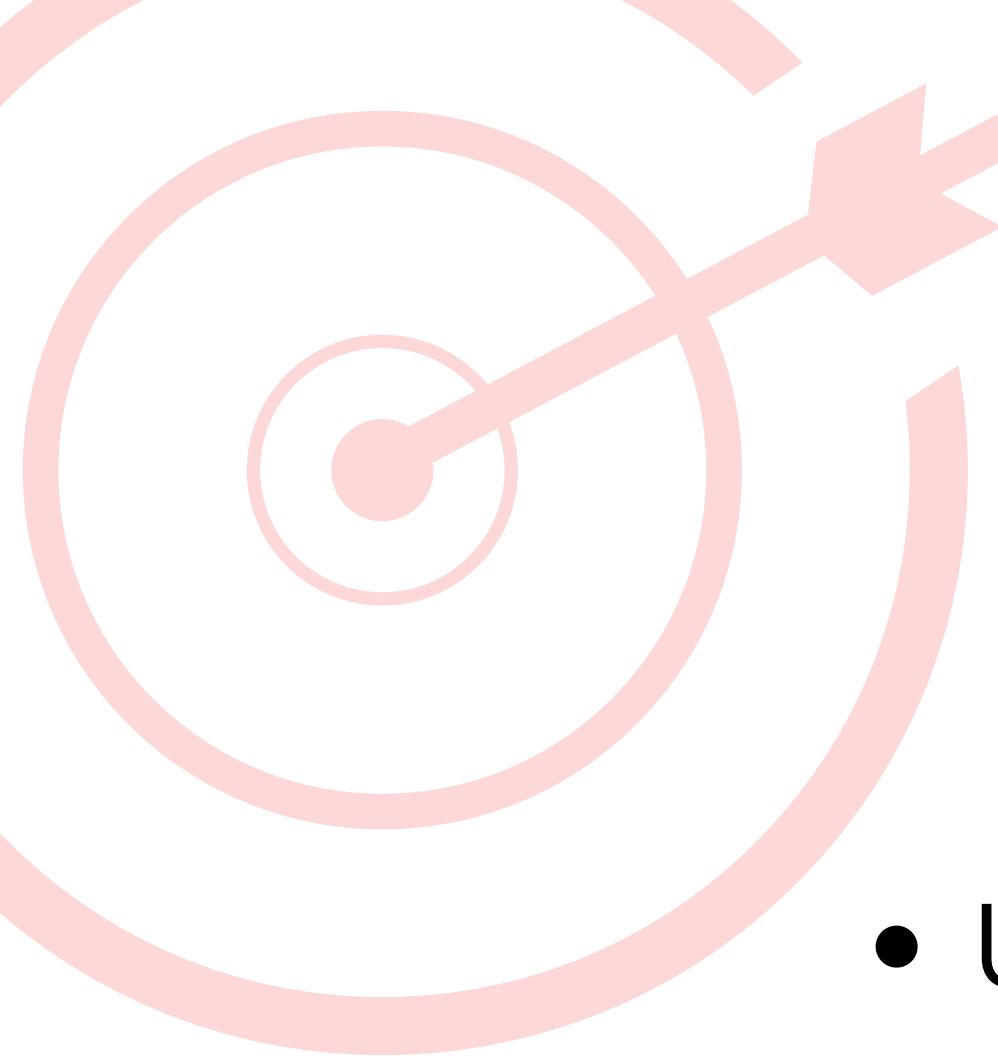
# Validity test: Decreases in Alignment after elections



Presidential  
elections

2017  
Legislative  
elections

2019  
Legislative  
elections



## Take home messages...

- Unpacking the factors of polarization :  
**Antagonism** and **Alignment**
- Language agnostic
- Applicable to different platforms, as long as we can find **positive** and **negative** interactions
- Compatible with **temporal** analysis

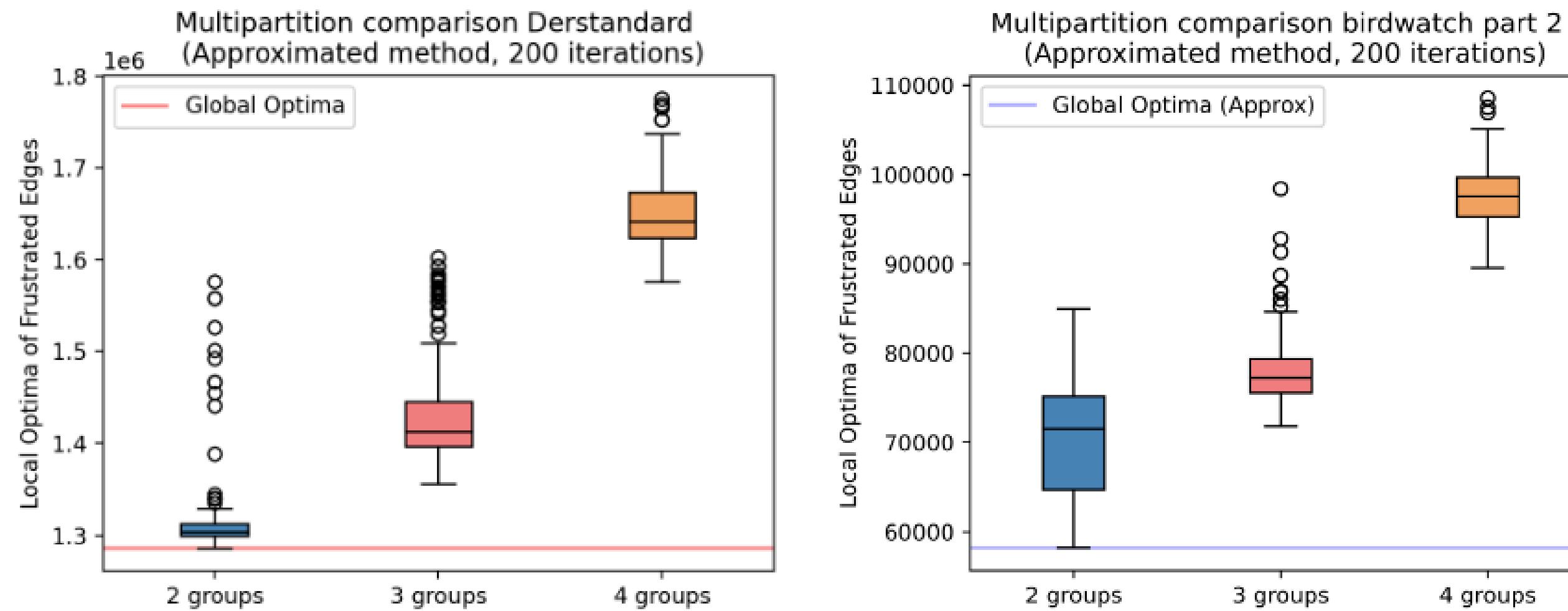
# THANK YOU

Emma Fraxanet, Max Pellert, Simon Schweighofer, Vicenç Gómez, David Garcia

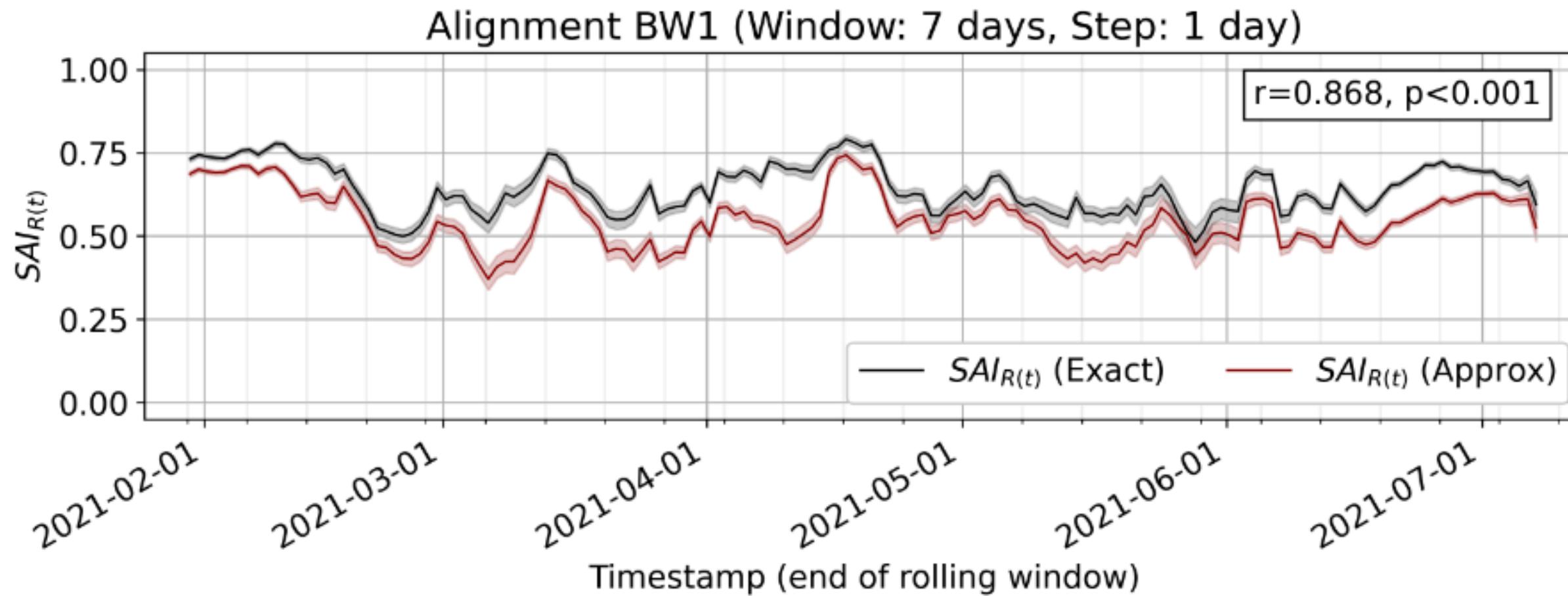
 @emmafraxanet



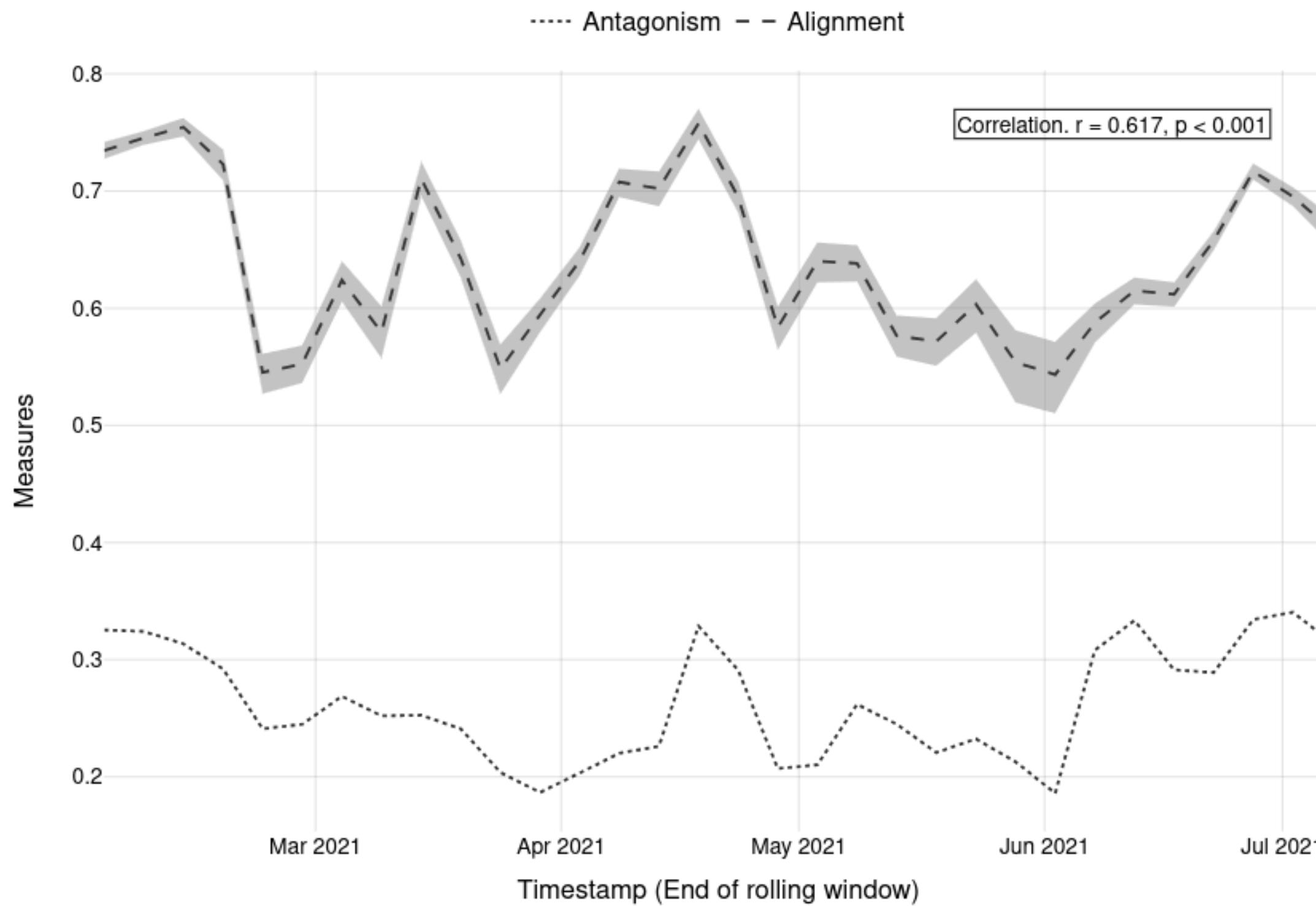
Check the preprint!



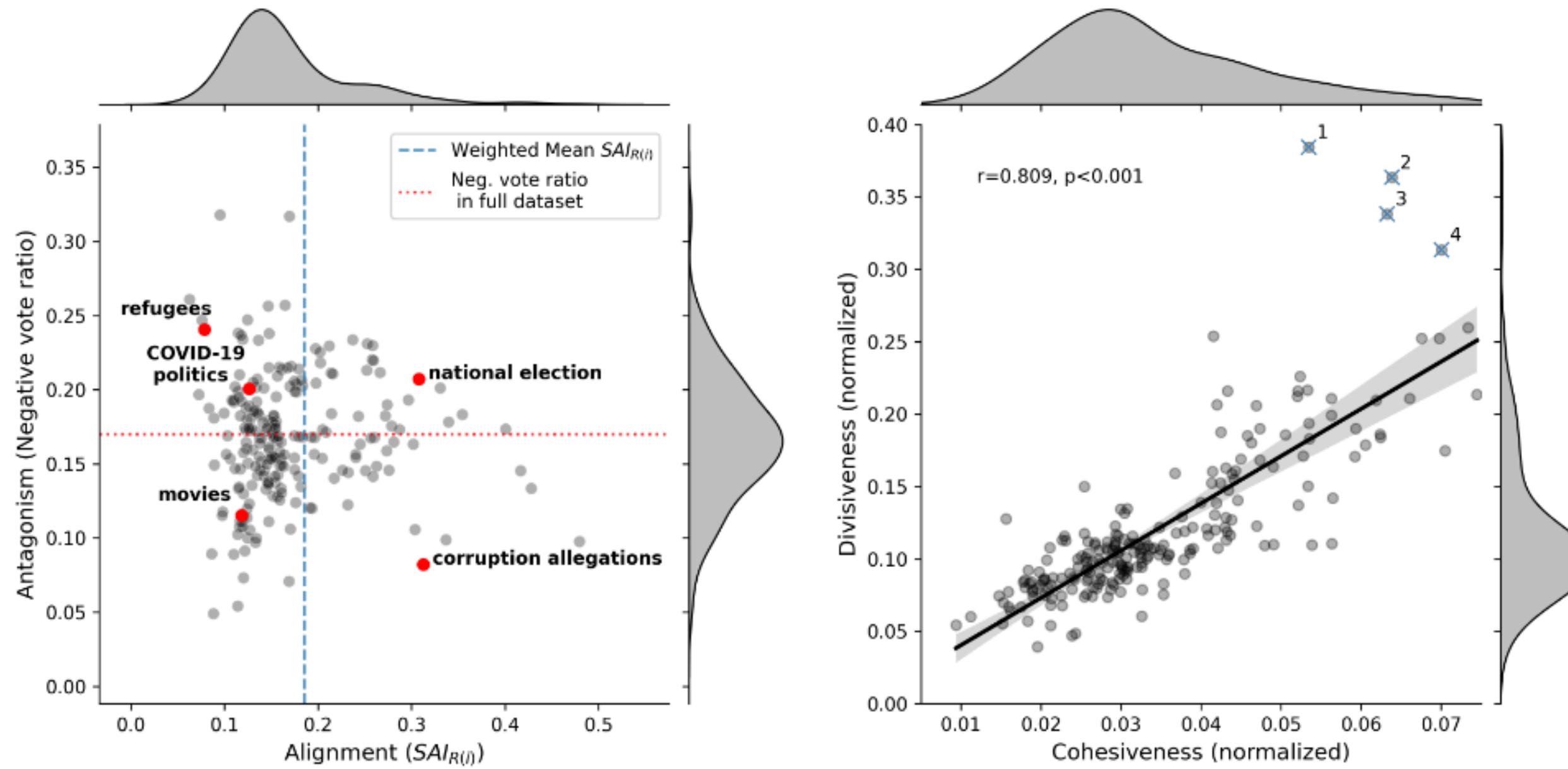
**Fig. 3 Multipartition study for Derstandard (left) and BW2 (right).** We show the distribution of results for the approximated method for  $k = 2, 3$  and  $4$ . In a straight line, we mark the best partition result, which we assume to be the closest to the global optima. All other solutions are sub-optimal and therefore local optima. In both datasets  $k = 2$  is the best number of groups.



**Fig. 2 Comparison between the timeline results obtained for the approximated and exact methods in the BW1 dataset.** This figure is an analogous of Figure 4 in the main text with different rolling window parameters. It presents the changes in Alignment obtained with the optimal partition of the exact method and the sub-optimal partition obtained through the approximated algorithm with the same data. Even though the approximated results are consistently lower than the exact results, the variations in the two time series are highly correlated.



**Fig. 5 Antagonism and Alignment of the BW1 time series.** We see that, while fluctuations are similar for both metrics in some time windows, the correlation between the metrics is low enough to consider them as separate measures that provide different insights.



**Fig. 5 Alignment versus Antagonism and Cohesiveness versus Divisiveness across DerStandard topics.** The left panel shows Antagonism and Alignment of the ratings of each news topic in DerStandard. Topics have been selected based on the topic/subtopic tags associated with the articles located above the postings (e.g., sports, climate change, etc.). Dashed lines show the mean values of each metric to identify the quadrants depicted in Figure 2. An interactive version of this figure can be found at <https://emmafrax.github.io/scatter.html>. The right panel shows the scatterplot of normalized Divisiveness versus normalized Cohesiveness for DerStandard rating sub-sets based on topics. These two measures, which account for two different mechanisms that define Alignment, have a significant correlation across topics of 0.8. The highlighted outliers correspond to: (1) BVT (Austrian counterterrorism agency), (2) Abortion, (3) Scheuba (Austrian comedian) and (4) ÖVP (Political Party)