

26TH FEBRUARY 2026

COEVOLUTION OF OPINIONS AND EPI-DEMICS ON NETWORKS.

Tim Van Wesemael

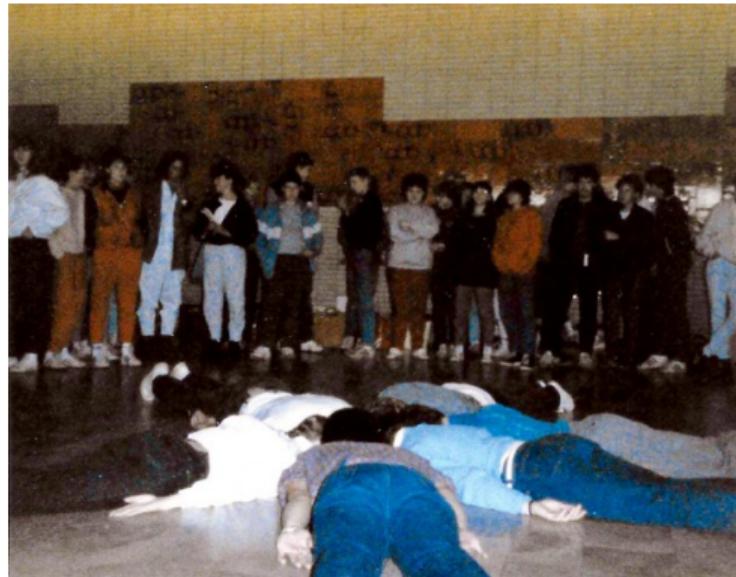
SOCIAL CONTAGION

- Many social phenomena
 - Ideas
 - Memes
 - Adoption of innovation
 - ...
- Diffusion or epidemic-like? (*viral spread*)



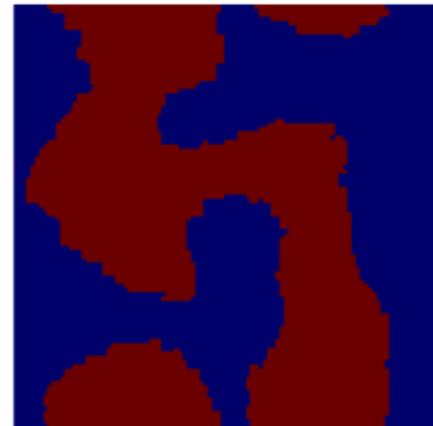
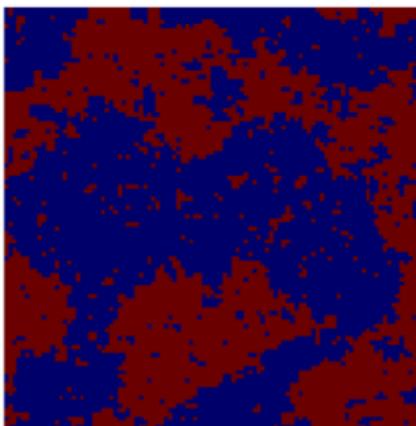
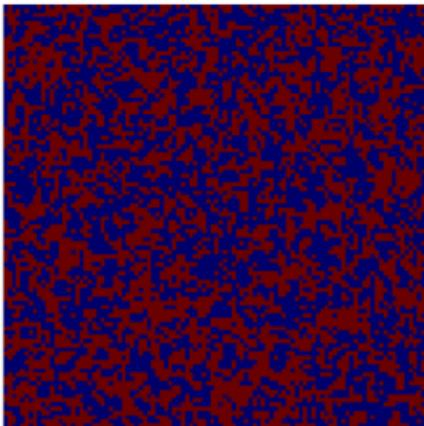
SOCIAL CONTAGION

- Many social phenomena
 - Ideas
 - Memes
 - Adoption of innovation
 - ...
- Diffusion or epidemic-like? (*viral spread*)
- In many ways not!



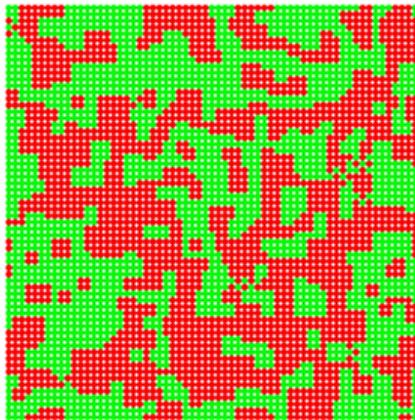
DISCRETE OPINION DYNAMICS

- Like magnets? Ising model!
- $H = - \sum_{i,j} J_{ij} \sigma_i \sigma_j - \mu \sum h_j \sigma_j$ with $\sigma_i \in \{-1, +1\}$
- Allows for microscopic interactions through J_{ij}



DISCRETE OPINION DYNAMICS

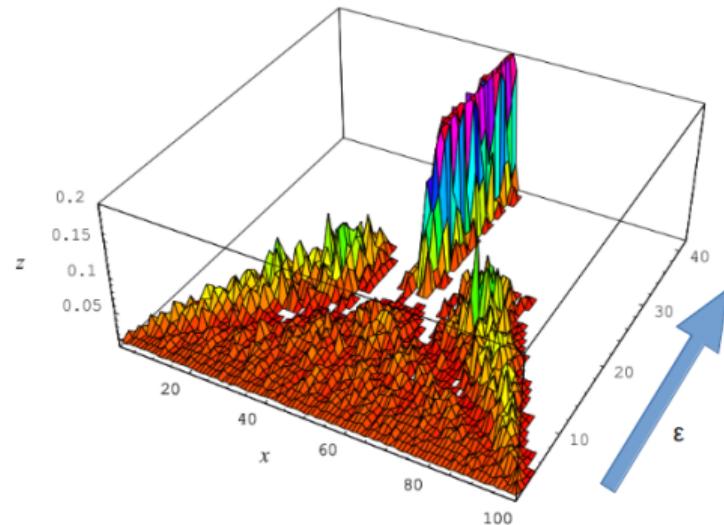
- Or complex contagion?
- Interactions with the contagion are not independent
- Threshold model: adopt if number of contagious neighbours reach threshold



CONTINUOUS OPINION SPACE

Bounded confidence

- Diffusion-like
- Only adjust to opinion that is close enough to yours ($< \epsilon$)
- Fragmentation → polarization → consensus



(Hegselmann, 2002)

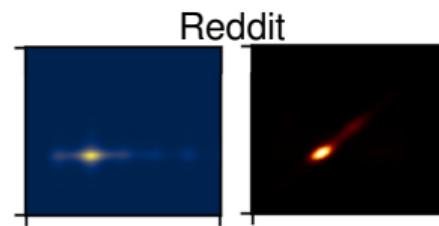
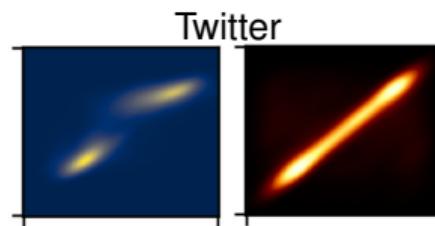
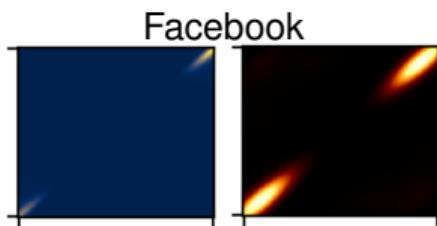
DATA-DRIVEN APPROACHES

- Only a small fraction of models have been validated with empirical data
- Observationally, complex contagions have been identified, such as the adoption of a politically motivated profile picture (State, 2015)
- Small-scale randomised experiments confirmed these results (Centola, 2015)



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IMPORTANCE FOR DISEASE PREDICTION

- Epidemics influence behaviour
- Human behaviour influences human behaviour
- Human behaviour influences epidemics



▲ Het wc-papier is in trek bij mensen die hamsteren vanwege het corona-virus © -

Totale gekte bij het schap met wc-papier 'Mensen weten zelf ook niet waarom ze het doen'

REDDIT

- Social network size
- 18th most visited
- Semi-anonymous
- Hierarchical structure

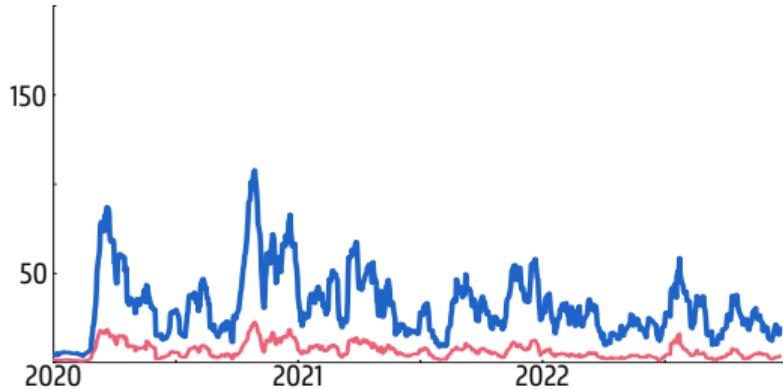
The screenshot shows the Reddit homepage with the URL www.reddit.com/ at the top. The page features a navigation bar with links like 'ABOUT', 'FAQ', 'HOT', 'TOP', 'USER', 'SUBMISSIONS', 'COMMENT', 'SEARCH', 'NEWS', 'VIDEOS', 'BY EUROPE', 'SPACE', 'MUSIC', 'TECHNOLOGY', 'GAMING', 'ENTERTAINMENT', 'LIFESTYLE', 'HEALTH', 'SCIENCE', 'OPINION', 'TRAVEL', 'BOOKS', 'JOBS', and 'PUBLICATIONS'. A search bar is on the right, along with 'Log in' and 'Sign up' buttons.

The main content area displays a list of posts from the 'AskReddit' subreddit. The first post is titled 'What isn't the few many people think it is?' with 2,071 upvotes. The second post is 'What's a dating preference that you think is socially unacceptable?' with 1,774 upvotes. Other visible posts include 'I'm a 6 footer... I have a 10 foot basement...', 'For those who grew up with it, what do you consider a luxury?', 'AITA for telling my wife's sasquatch after she just let her friends go up on me?', 'Sorry not sorry', 'Photographs capture an intense fight between two ferocious bears.', 'AITA for giving my granddaughter a DNA test.', 'Argentina has non-negotiable sovereignty over the Falklands', 'TFLU for telling my girlfriend my type.', and 'Behold as Starfire is still being worked on by 250+ people'. Each post includes a thumbnail image, the title, upvote count, and a link to the full submission.

A sidebar on the right offers 'reddit premium' services. At the bottom, there is a cookie consent message: 'We use cookies on our website for a number of purposes, including analysis and performance, functionality and advertising. Learn more about Reddit's use of cookies.' with a 'CONTINUE' button.

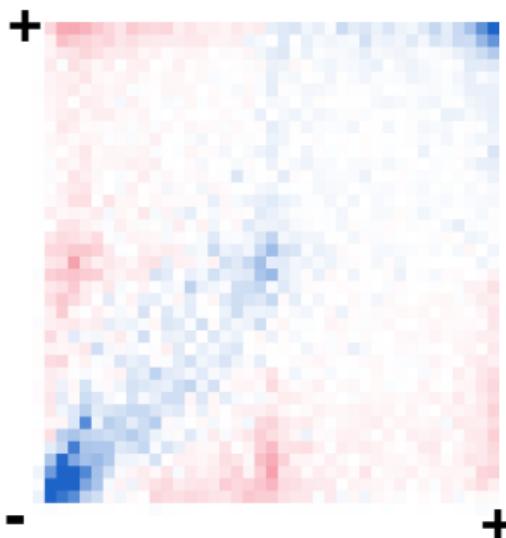
GOALS

- Empirical sources for contact reduction
- Data-driven models for social dynamics
- Identification of conversation polarization



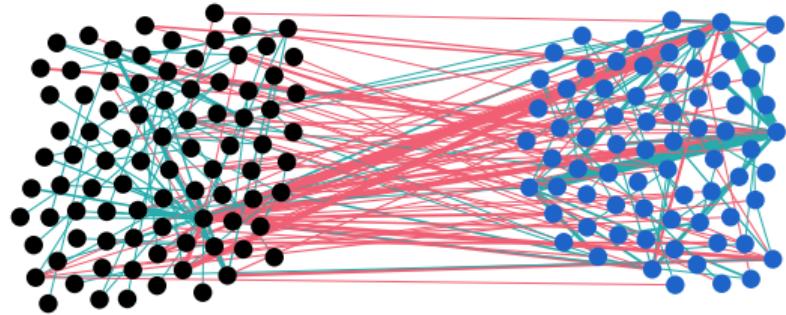
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THE DATASET

- r/Belgium community
- 01/2020 - 07/2022
- COVID topics by keyword selection and pretrained BERT model
 - Lockdown
 - Mask
 - Vaccination
- Sentiment by pretrained BERT model

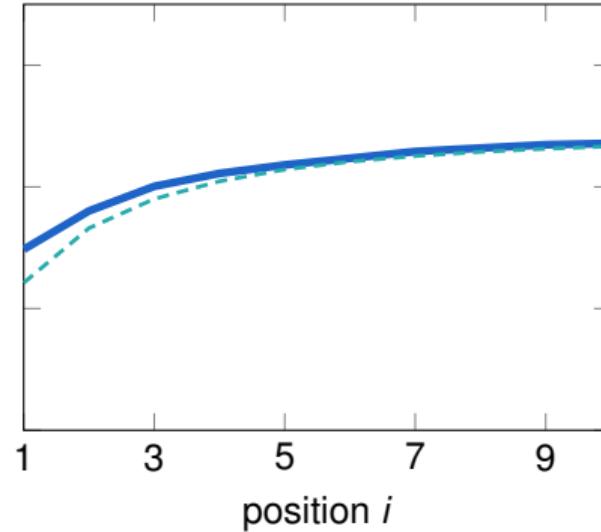
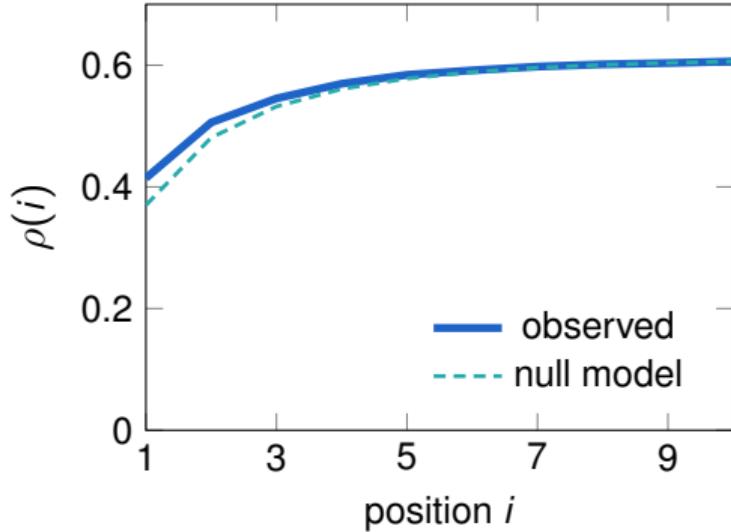
	Users	Comments	Submissions
Total	28559	645280	10362
Lockdowns	9987	94494	1009
Masks	6824	48500	437
Vaccination	5552	41700	590

TOPIC CONTAGION

- Can participating in a discussion **cause** a user to initiate one?
- Post is **initiating** if no ancestor shares the same topic
- Else, participating

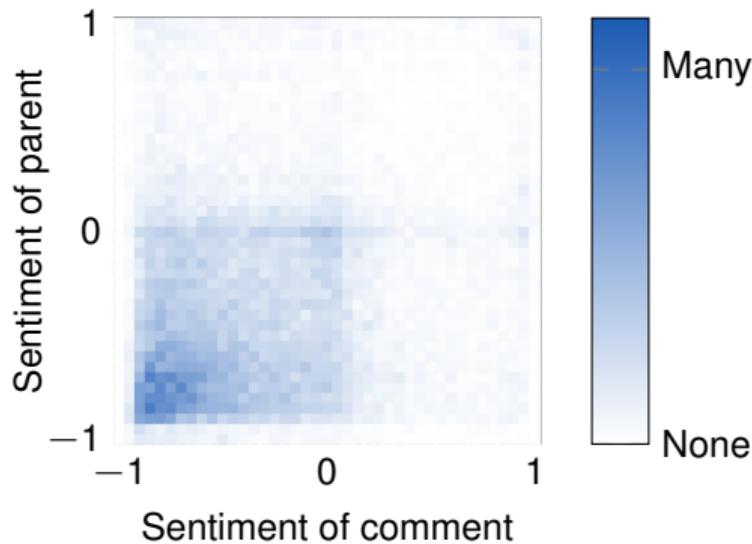


NO EVIDENCE OF TOPIC CONTAGION



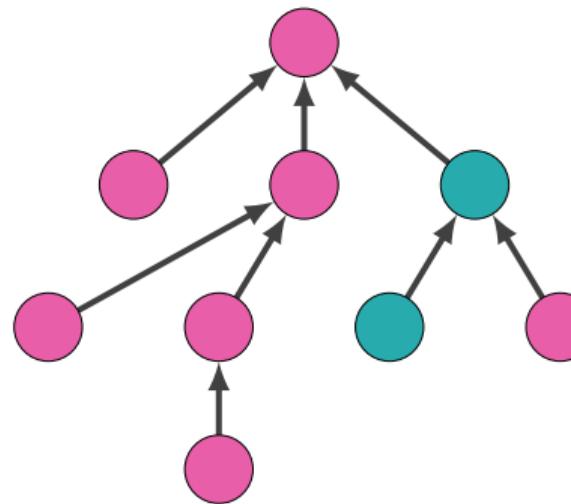
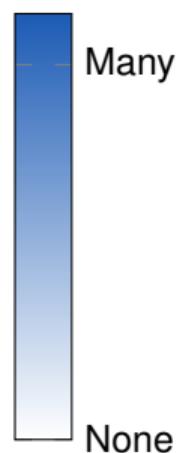
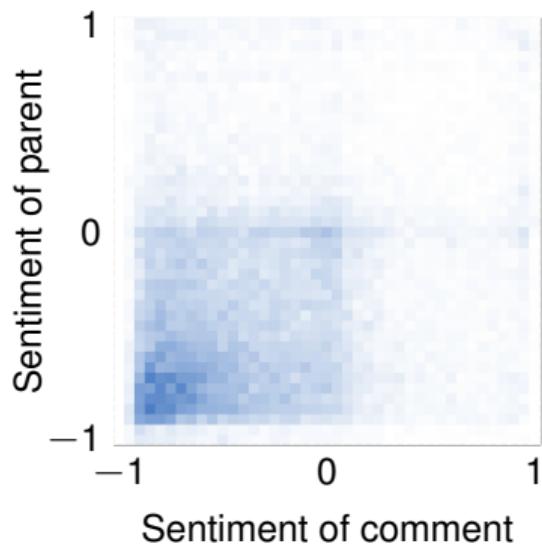
- Lockdowns
- Vaccination
- $\text{Observed } \rho(i) \text{ lies above null at small } i$: initiations occur *earlier* than expected
- Participating does not lead to initiating

SENTIMENT INTERACTIONS: VACCINATION



- Homophily!
- Replies have similar levels as parent

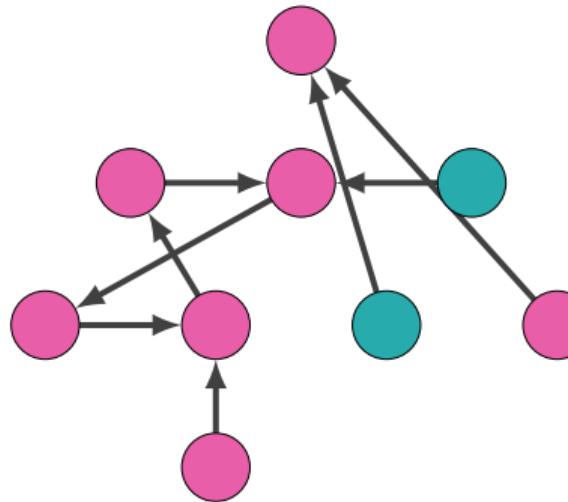
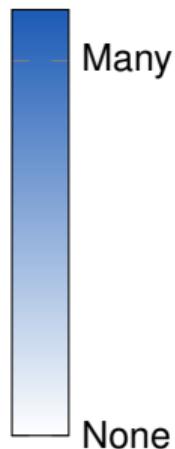
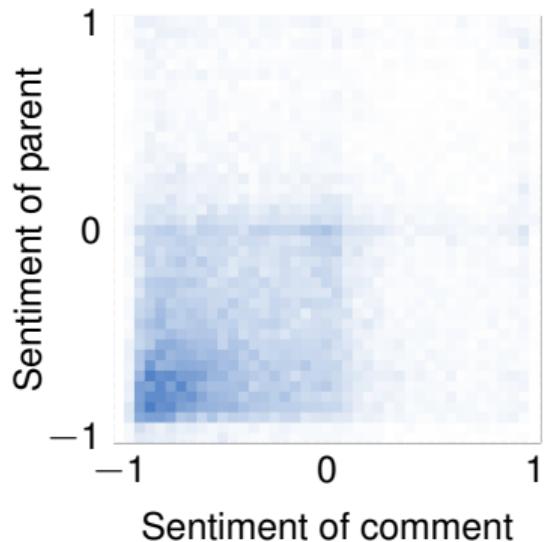
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■ Expected if everyone is negative

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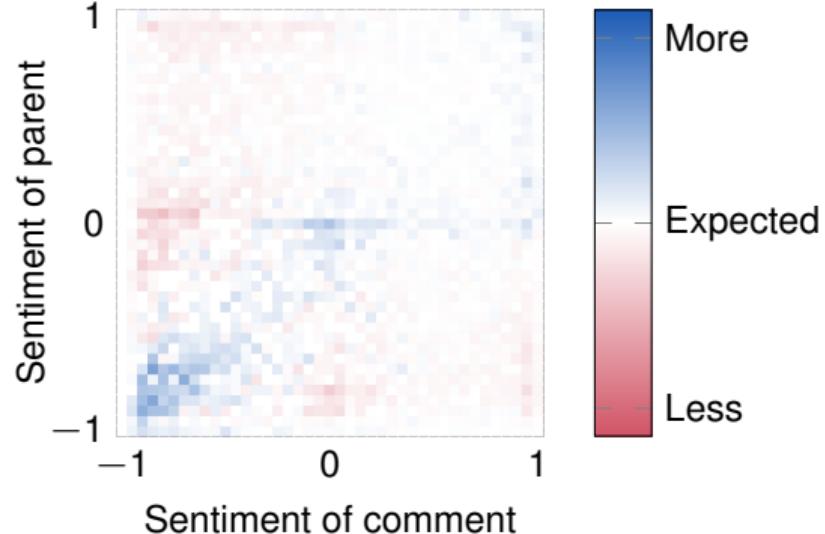
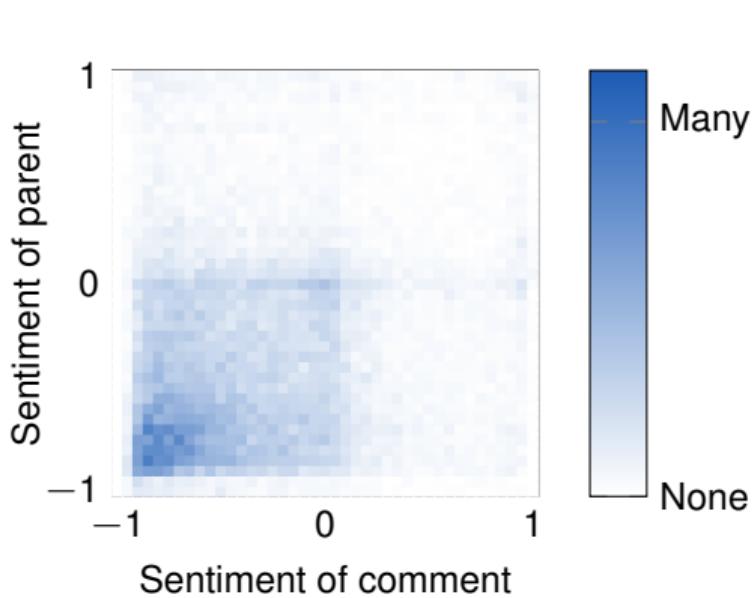
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- Compare to random realisation

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SENTIMENT INTERACTIONS: VACCINATION



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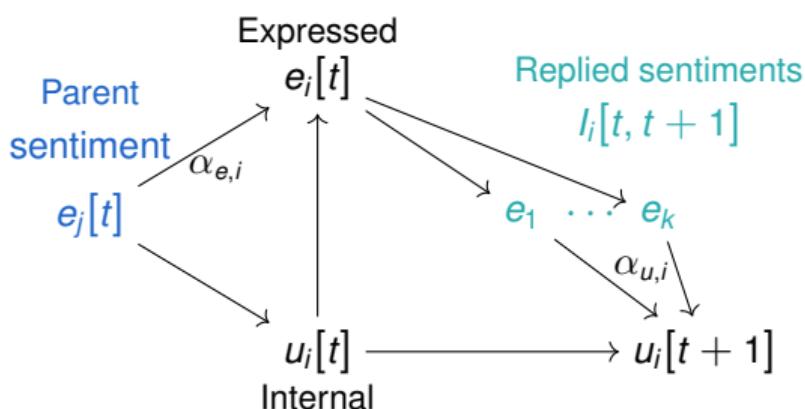
- Expected if everyone is negative
- Compare to random realisation
- Homophily confirmed

SIEBC MODEL

- Smooth
- Internal-Expressed
- Bounded Confidence

$$e_i[t] \sim B_{\alpha_{e,i}, \epsilon_i}(u_i[t-1], e_j[t])$$

$$u_i[t] \sim \bigotimes_{e_k \in I_i[t-1]} B_{\alpha_{u,i}, \epsilon_i}(u_i[t-1], e_k)$$

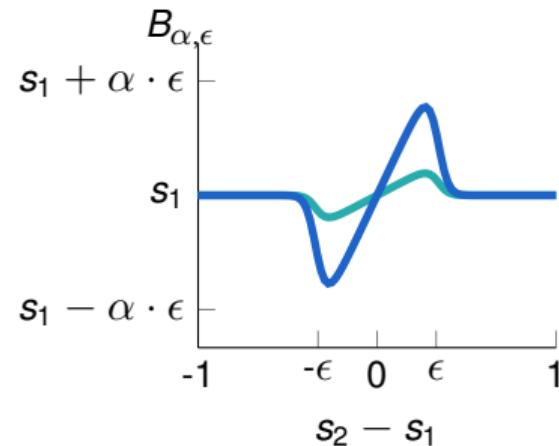
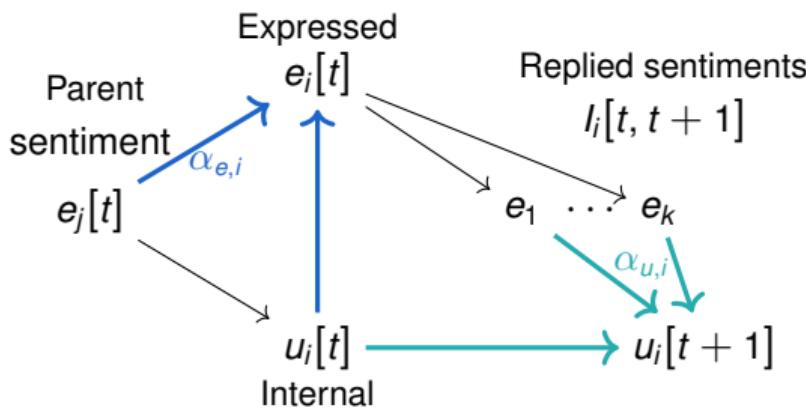


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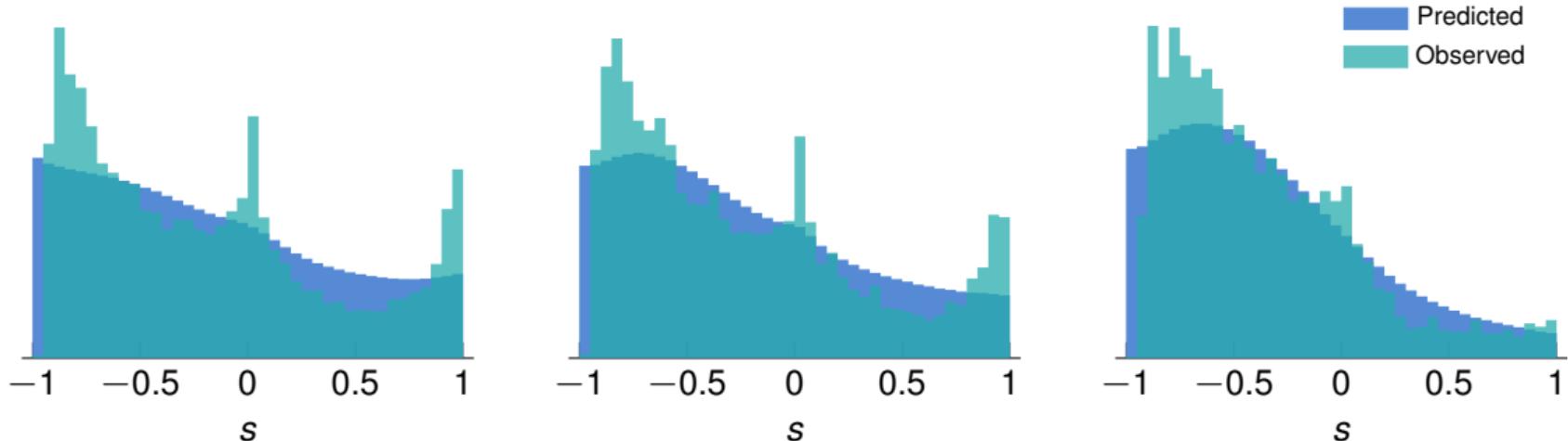
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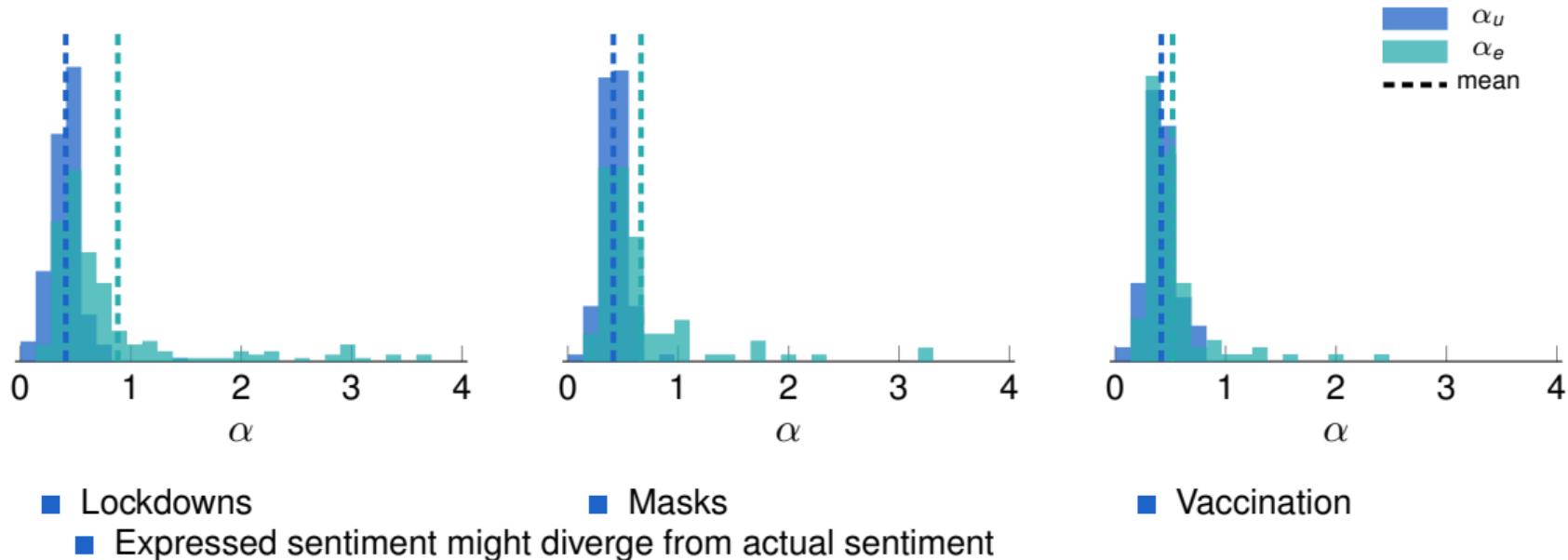


RECONSTRUCTION OF SENTIMENT DISTRIBUTIONS



- Lockdowns
- Okay attempt at predicting difficult distributions
- Homophily present in predicted sentiments as well
- Masks
- Vaccination

EXPRESSED SENTIMENT UPDATE IS STRONGEST



STRENGTHS OF SIEBC

- Bounded confidence kernel is required to explain homophily (cfr. L_α)
- Hidden state can deal with noise (cfr. \bar{e})

Model	Lockdowns		Masks		Vaccination	
	KS	Δh	KS	Δh	KS	Δh
L_α	0.044	-0.097 \pm 0.009	0.048	-0.131 \pm 0.017	0.068	-0.103 \pm 0.018
\bar{e}	0.049	-0.070 \pm 0.023	0.052	-0.075 \pm 0.033	0.076	-0.056 \pm 0.047
SIEBC	0.043	-0.027 \pm 0.013	0.043	-0.067 \pm 0.020	0.055	-0.033 \pm 0.021

CONCLUSIONS

- Simple model explains complex data
- Sentiment is not a very meaningful signal
- Reddit is not a representative sample

CONCLUSIONS

- Simple model explains complex data
- Sentiment is not a very meaningful signal
- Reddit is not a representative sample
- Topics discussed depends on external factors
- BC model can explain homophily
- (Subtle) differences exist between topics