

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*)



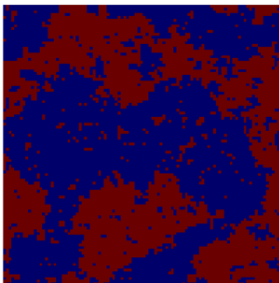
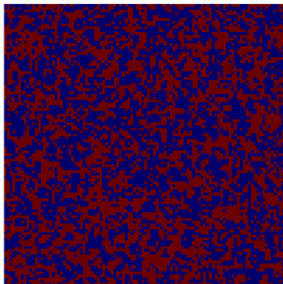
SOCIAL CONTAGION

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



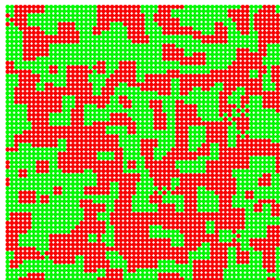
DISCRETE OPINION DYNAMICS

- 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

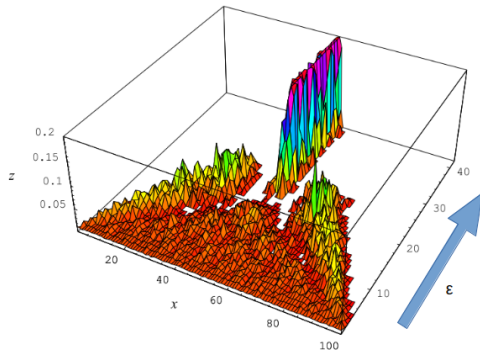
- Or complex contagion?
- Interactions with the contagion are not independent
- Threshold model: adopt if number of contagious neighbours reach threshold



CONTINUOUS OPINION SPACE

Bounded confidence

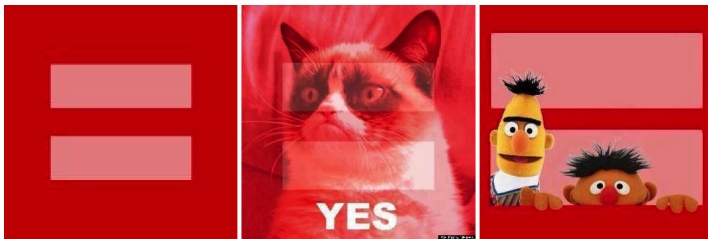
- Diffusion-like
- Only adjust to opinion that is close enough to yours ($< \epsilon$)
- Fragmentation \rightarrow polarization \rightarrow consensus



(Hegselmann, 2002)

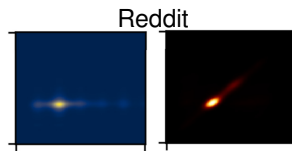
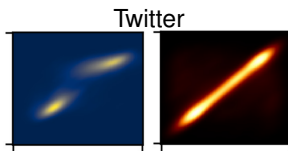
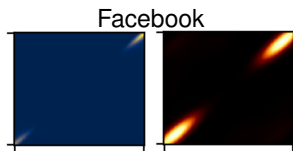
DATA-DRIVEN APPROACHES

- 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

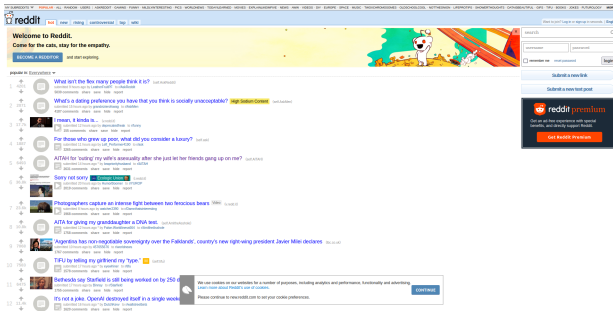


▲ Het wc-papier is in trek bij mensen die hamsteren vanwege het corona-virus © -

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

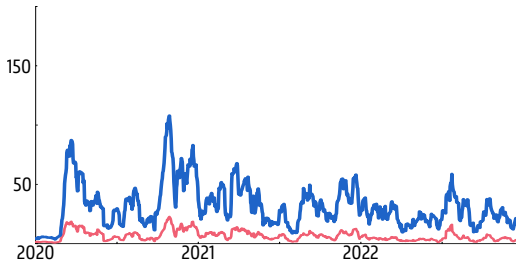
REDDIT

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



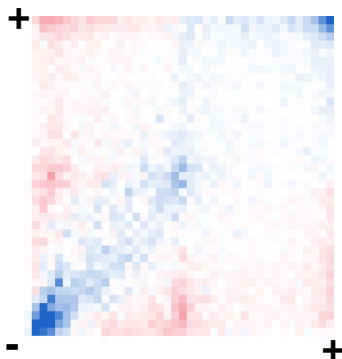
GOALS

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



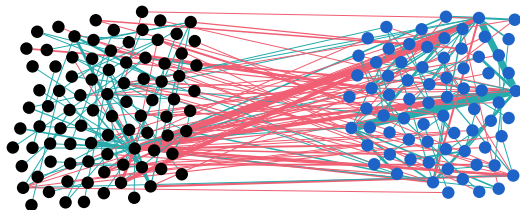
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THE DATASET

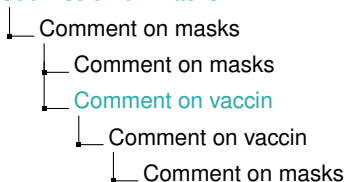
- r/Belgium community
- 01/2020 - 07/2022
- COVID topics by keyword selection and pretrained BERT model
 - Lockdown
 - Mask
 - Vaccination
- Sentiment by pretrained BERT model

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

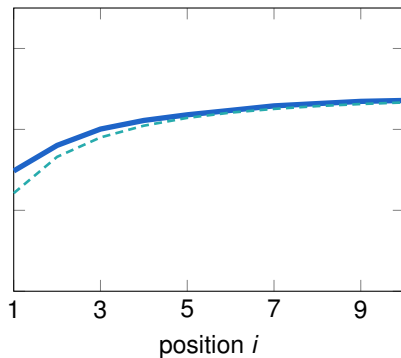
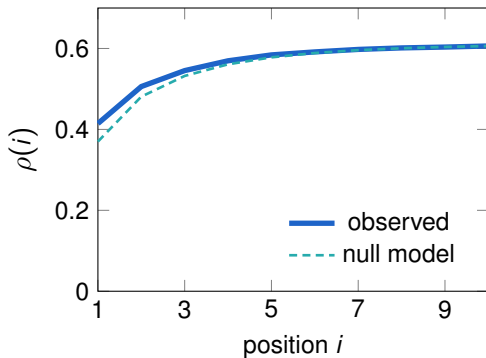
TOPIC CONTAGION

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

Submission on masks



NO EVIDENCE OF TOPIC CONTAGION



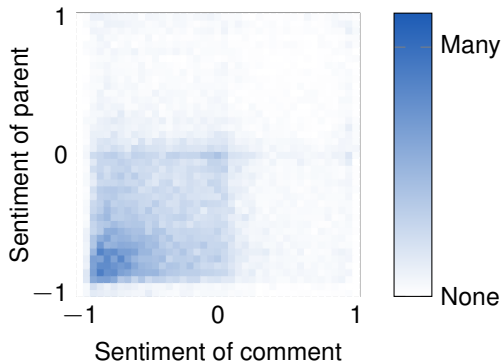
■ Lockdowns

■ Vaccination

■ Observed $\rho(i)$ lies above null at small i : initiations occur *earlier* than expected

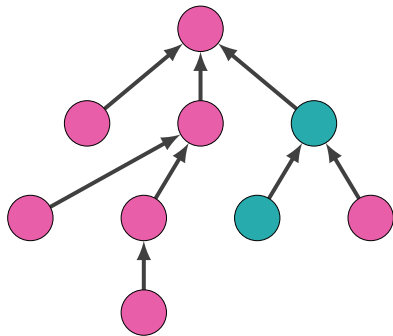
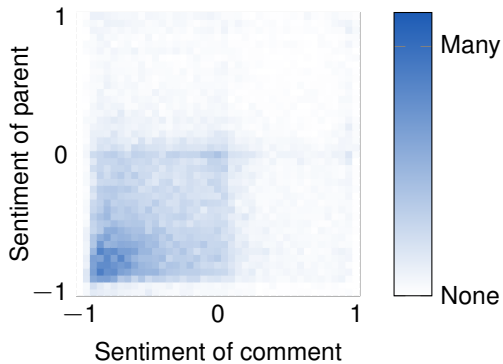
■ Participating does not lead to initiating

SENTIMENT INTERACTIONS: VACCINATION



- Homophily!
- Replies have similar levels as parent

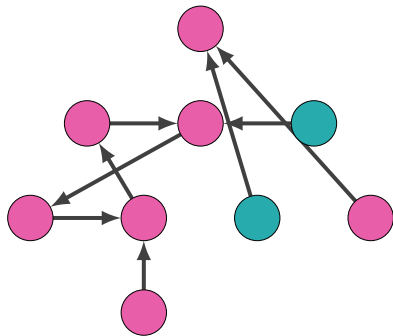
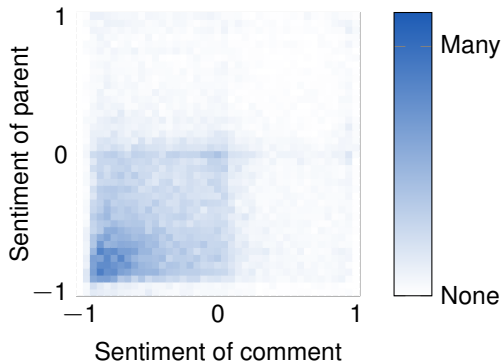
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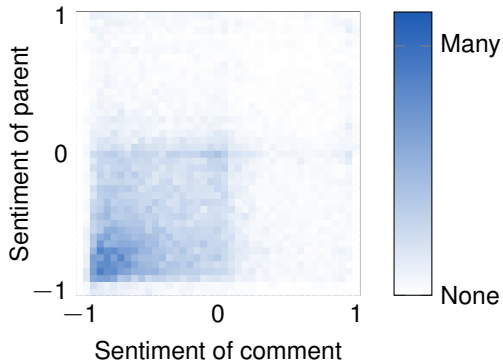
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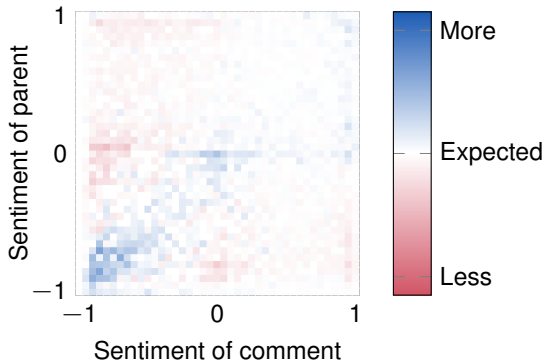
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- Expected if everyone is negative
- Compare to random realisation

SENTIMENT INTERACTIONS: VACCINATION



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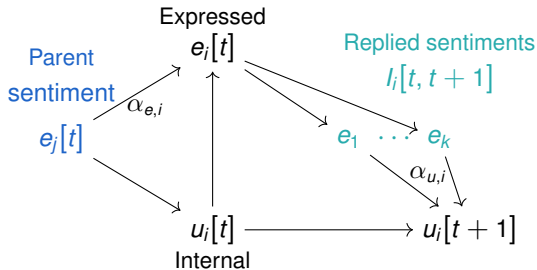
- Expected if everyone is negative
- Compare to random realisation
- Homophily confirmed

SIEBC MODEL

- Smooth
- Internal-Expressed
- Bounded Confidence

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

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

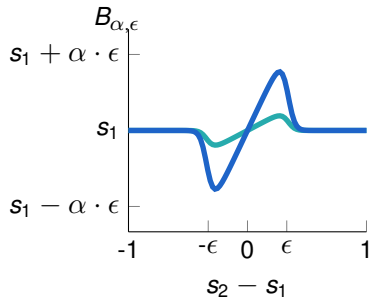
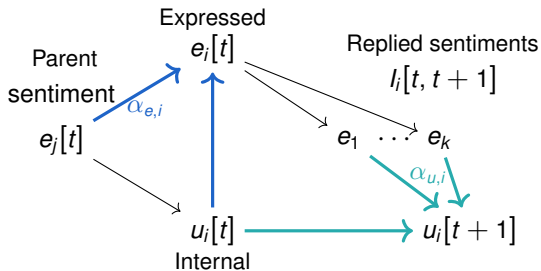


SIEBC MODEL

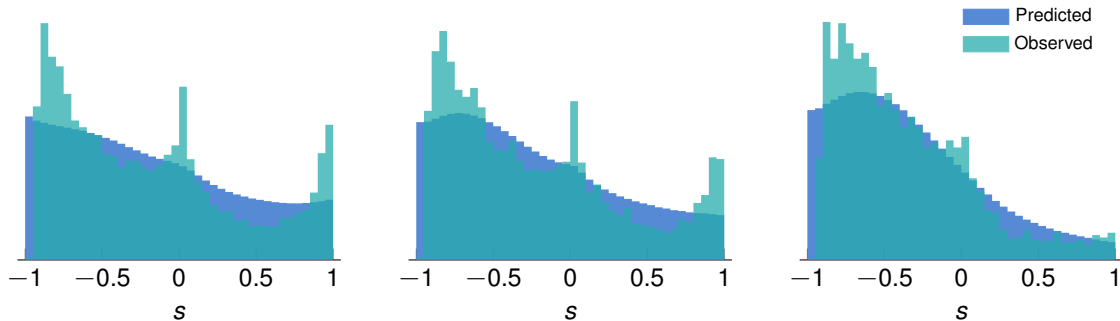
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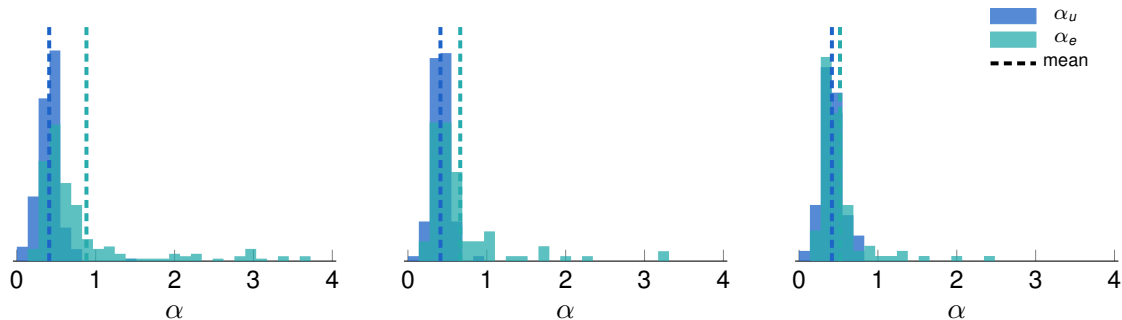


RECONSTRUCTION OF SENTIMENT DISTRIBUTIONS



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

EXPRESSED SENTIMENT UPDATE IS STRONGEST



- Lockdowns
- Masks
- Expressed sentiment might diverge from actual sentiment

- Vaccination

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 ± 0.009	0.048	-0.131 ± 0.017	0.068	-0.103 ± 0.018
\bar{e}	0.049	-0.070 ± 0.023	0.052	-0.075 ± 0.033	0.076	-0.056 ± 0.047
SIEBC	0.043	-0.027 ± 0.013	0.043	-0.067 ± 0.020	0.055	-0.033 ± 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