FACULTY OF BIOSCIENCE ENGINEERING

BionamiX

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COEVOLUTION OF OPINIONS AND EPIDEMICS ON NETWORKS.

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GHENT UNIVERSITY

Introduction

- Opinion dynamics
- Many models
- Watts threshold: adopt if fraction of neighbours exceeds threshold

Social contagion

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

Social contagion

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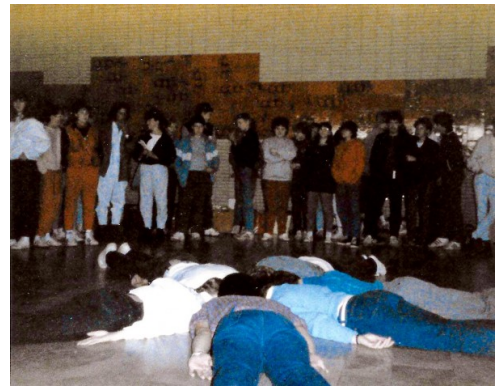
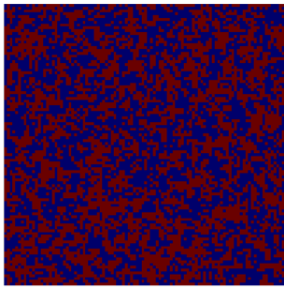
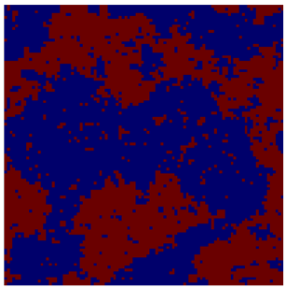
  - Ideas
  - Memes
  - Adoption of innovation
  - ...
- Diffusion or epidemic-like? (*viral spread*)
- In many ways not!



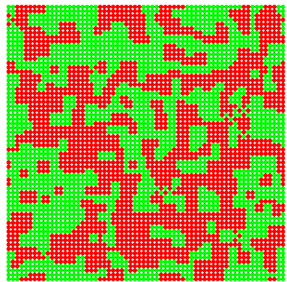
Discrete opinion dynamics

- 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

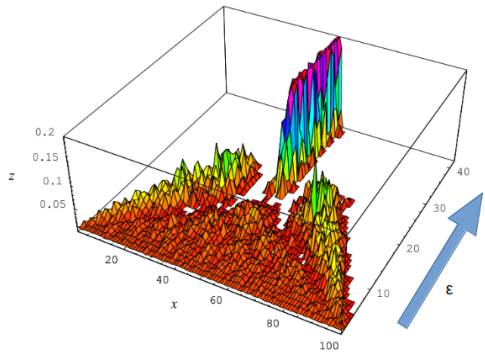
- Or complex contagion?
- Interactions with the contagion are not independent
- Threshold model: adopt if number of contagious neighbours reach threshold



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 adoptation of a politically motivated profile picture (State, 2015)
- Small-scale randomised experiments confirmed these results (Centola, 2015)

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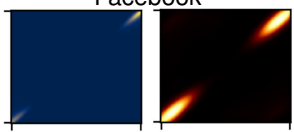
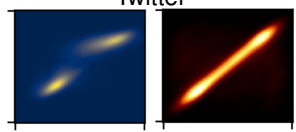
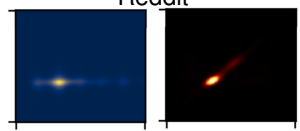
Facebook



Twitter

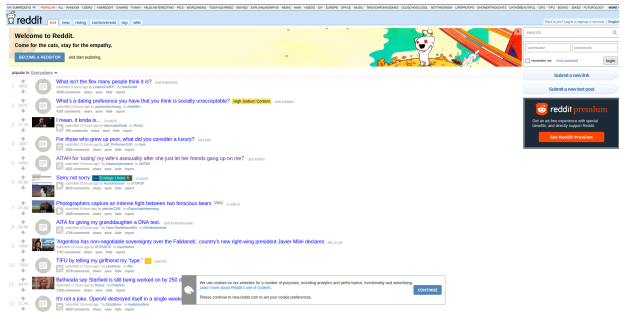


Reddit



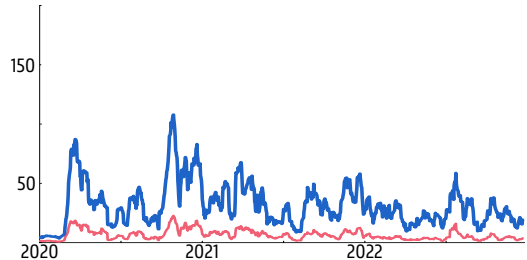
Reddit

- 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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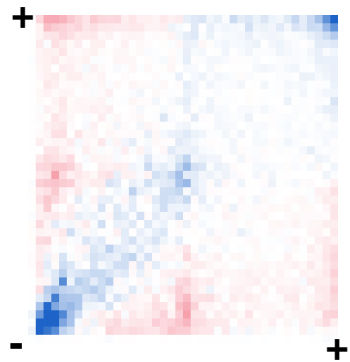

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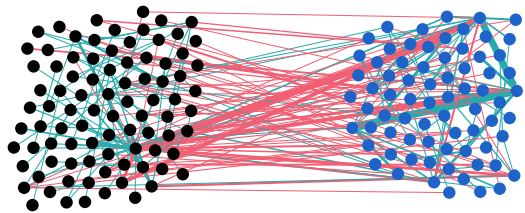
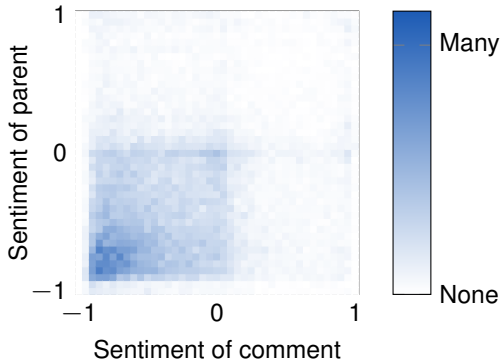


The Dataset

- 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

SENTIMENT INTERACTIONS: VACCINATION



- Homophily!
- Replies have similar levels as parent

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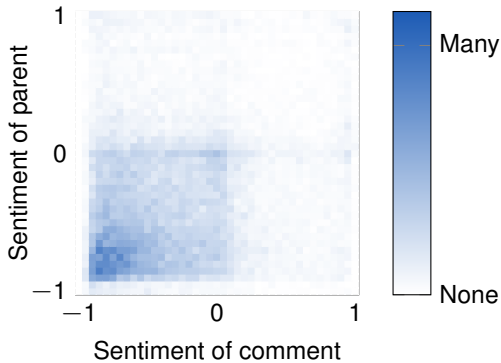

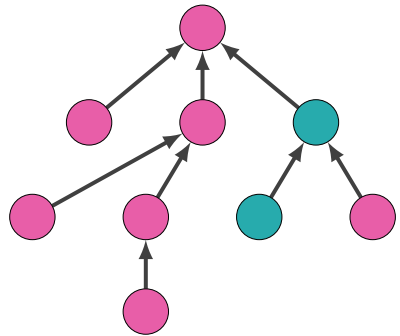

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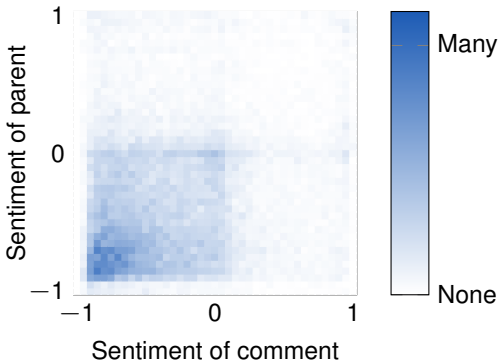
- Expected if everyone is negative

Sentiment interactions: vaccination



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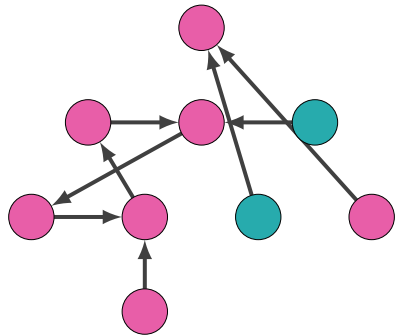
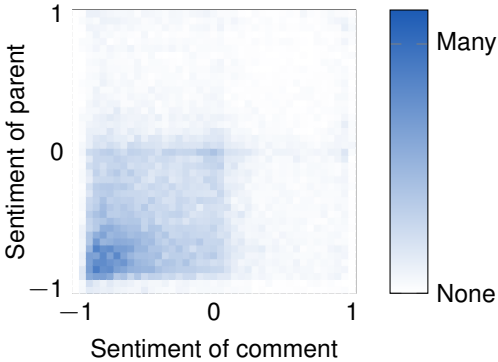


- Expected if everyone is negative
- Compare to random realisation

Sentiment interactions: vaccination



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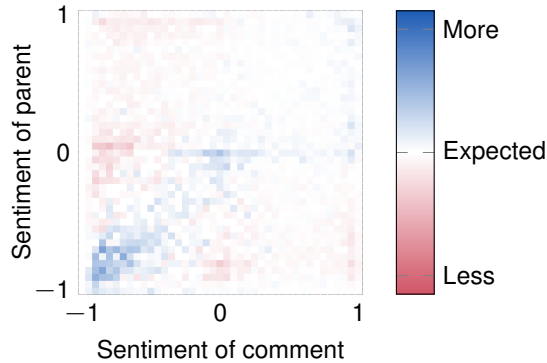


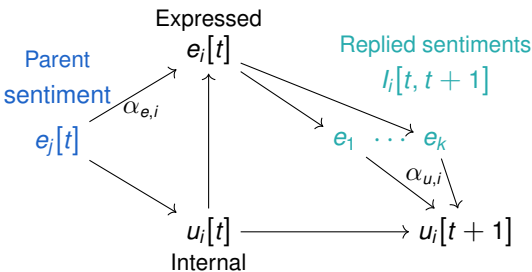
- Expected if everyone is negative
- Compare to random realisation
- Homophily confirmed

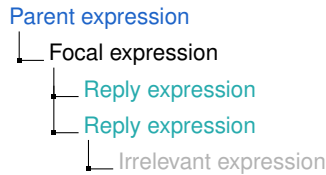
SIEBC Model

- **S**mooth
- **I**nternal-**E**xpressed
- **B**ounded **C**onfidence

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

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





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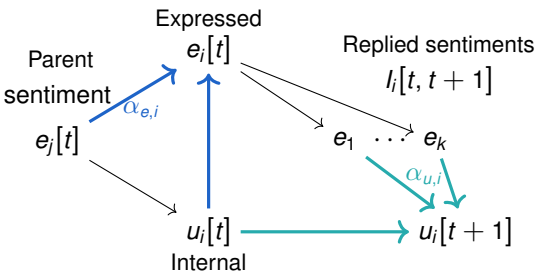
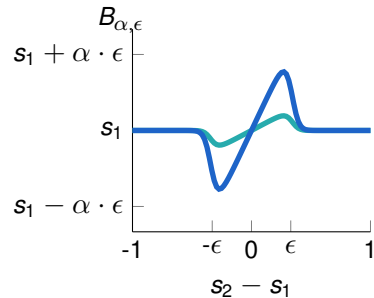
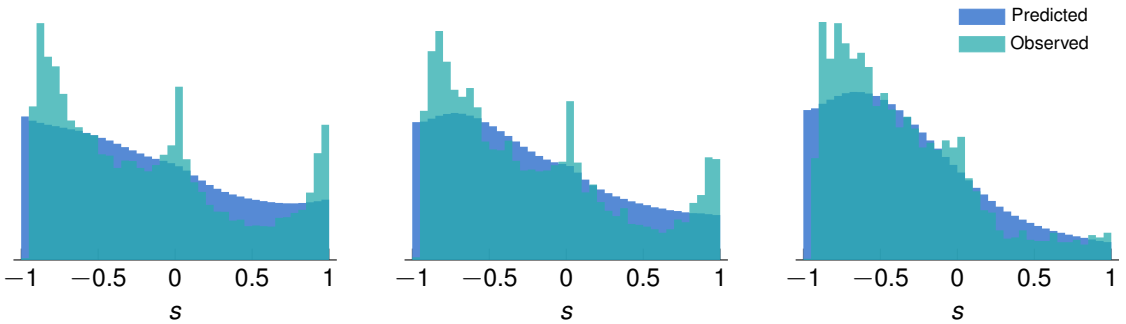


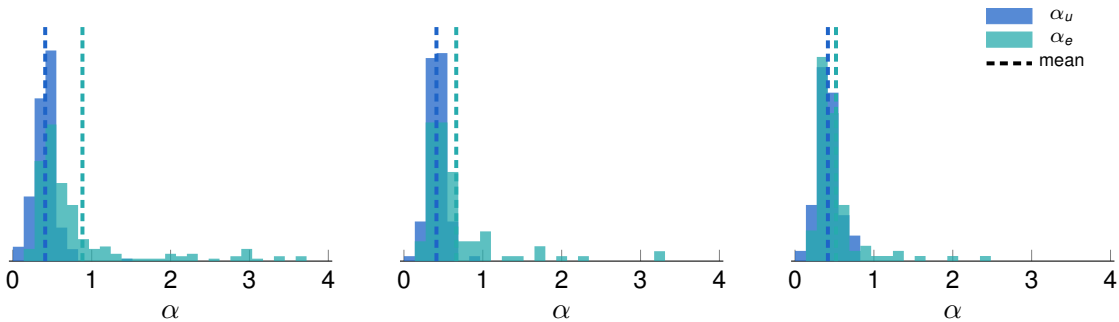


Reconstruction of sentiment distributions



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

EXPRESSED SENTIMENT UPDATE IS STRONGEST



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