



<http://www.di.unito.it/~ruffo>



giancarlo.ruffo@unito.it



[@giaruffo](https://twitter.com/giaruffo)

Giancarlo Ruffo - Università degli Studi di Torino (Italy)



Divided we Stand

Methods and Tools to Represent,
Understand, and Analyze a Digital Society

Torino, November 14th, 2019 <https://medium.com/mljcunito>

http://www.di.unito.it/~ruffo/talks/2019_Nov_MLJ_Torino.pdf

or: How I Learned to Stop Worrying and Love
Segregation and Polarization



The strange case of Lajello

Analyzing social network with a bot

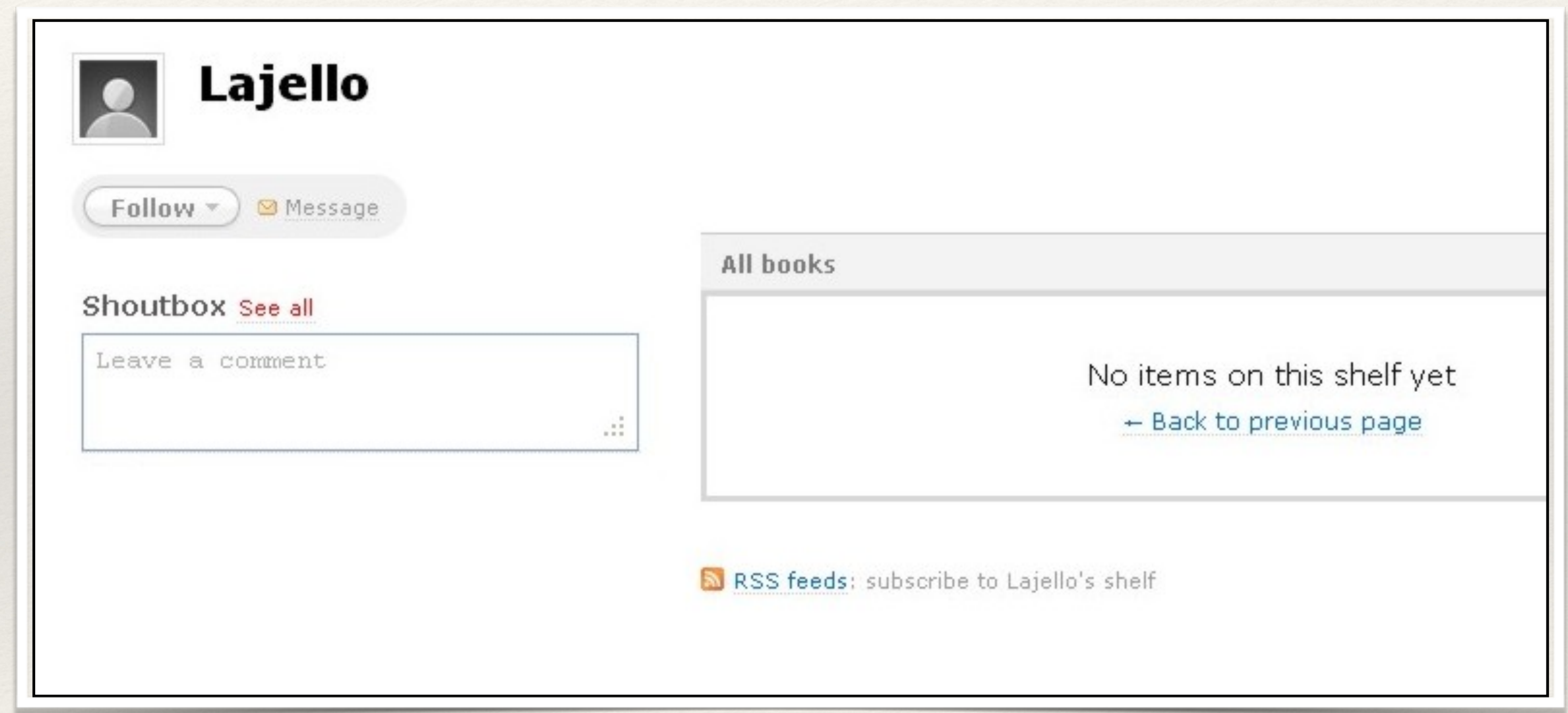
- ❖ Anobii was a social networks for book lovers
- ❖ Scraping users' profiles from the Web was admitted
- ❖ Users' libraries and their links were collected periodically



A screenshot of an Anobii user profile for 'Claudia'. The profile header includes a profile picture, the name 'Claudia', and details: 'Female, 38, Single. Torino, Italy'. Below this are 'Follow' and 'Message' buttons. A 'Taste compatibility: UNKNOWN' box suggests adding more books. Navigation options include 'By Progress', 'By Authors', 'By Languages', and 'By Tags'. A 'Groups' section lists 'Wikicitazioni (Wikiquote) (1160)', 'Sospesi tra cielo e terra (1099)', 'Transpersonal Psychology and B... (20)', 'Herr Professor Carl G. Jung (234)', and 'Dillo ad aNobii (Tell aNobii) (49)'. A 'Shoutbox' section has a 'See all' link and a 'Leave a comment' input field. The main content is a 'Books (126)' shelf, displaying a grid of book covers such as 'Paths Beyond Ego', 'The Portable Jung', 'Kyra', 'Integral Life Practice', 'Integral Spirituality', 'The Unfolding Now', 'Space User Inquiry', 'Official Guide to the NEW TOEFL', 'Brilliancy', 'Lisa Jewell', 'The Children's Book', and 'The Girl with the Dragon Tattoo'. To the right, 'Friends more' and 'Neighbors more' sections list other users like 'reyda', 'Aglaja', 'Walter', 'bethulla', 'zeromeno', 'Simonetta', '*MM*', 'Ste', 'Moonray', and 'virinthesky'.

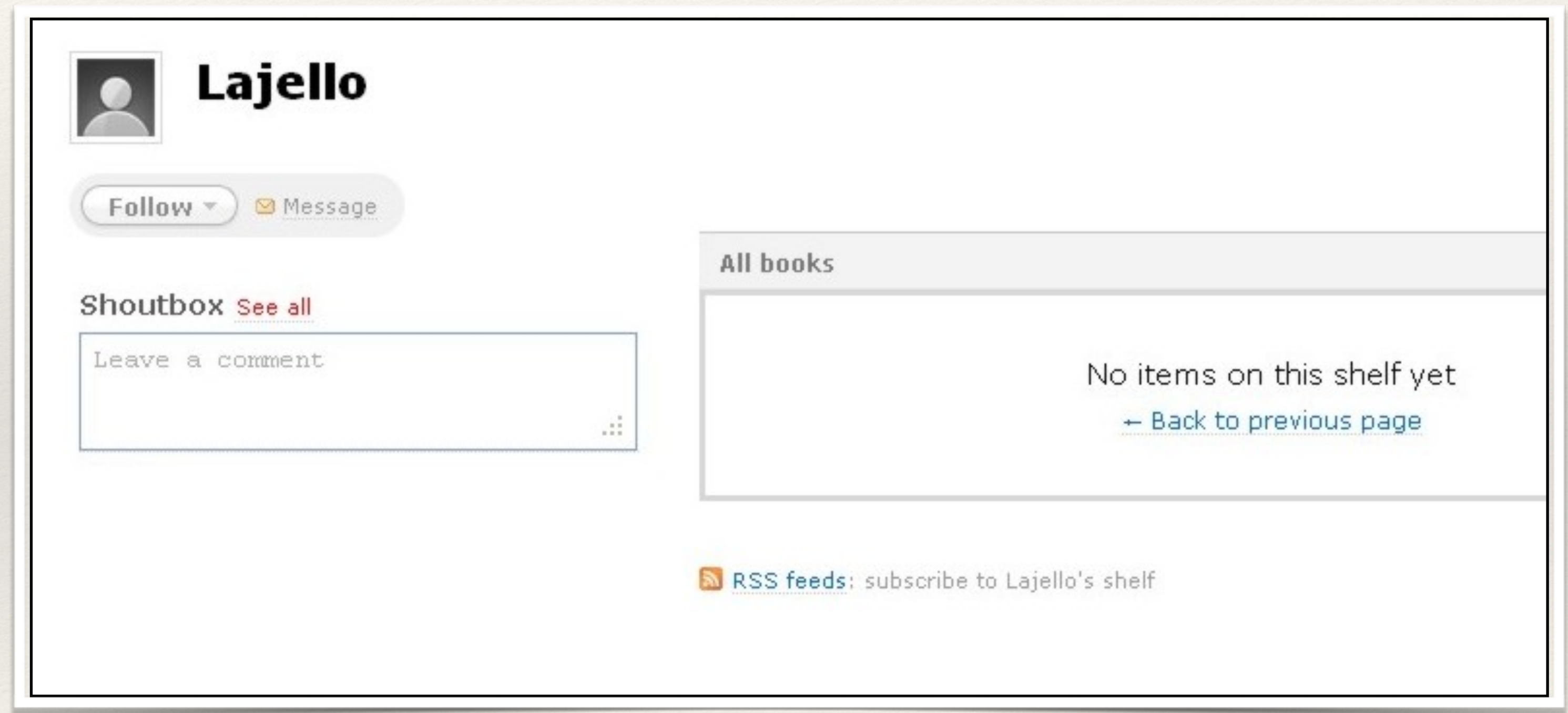
Analyzing social network with a bot

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- ❖ The bot "Lajello" used to silently navigate Anobii twice a month for one year



Analyzing social network with a bot

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- ❖ The bot "Lajello" used to silently navigate Anobii twice a month for one year
- ❖ **homophily by selection and by influence analysed**

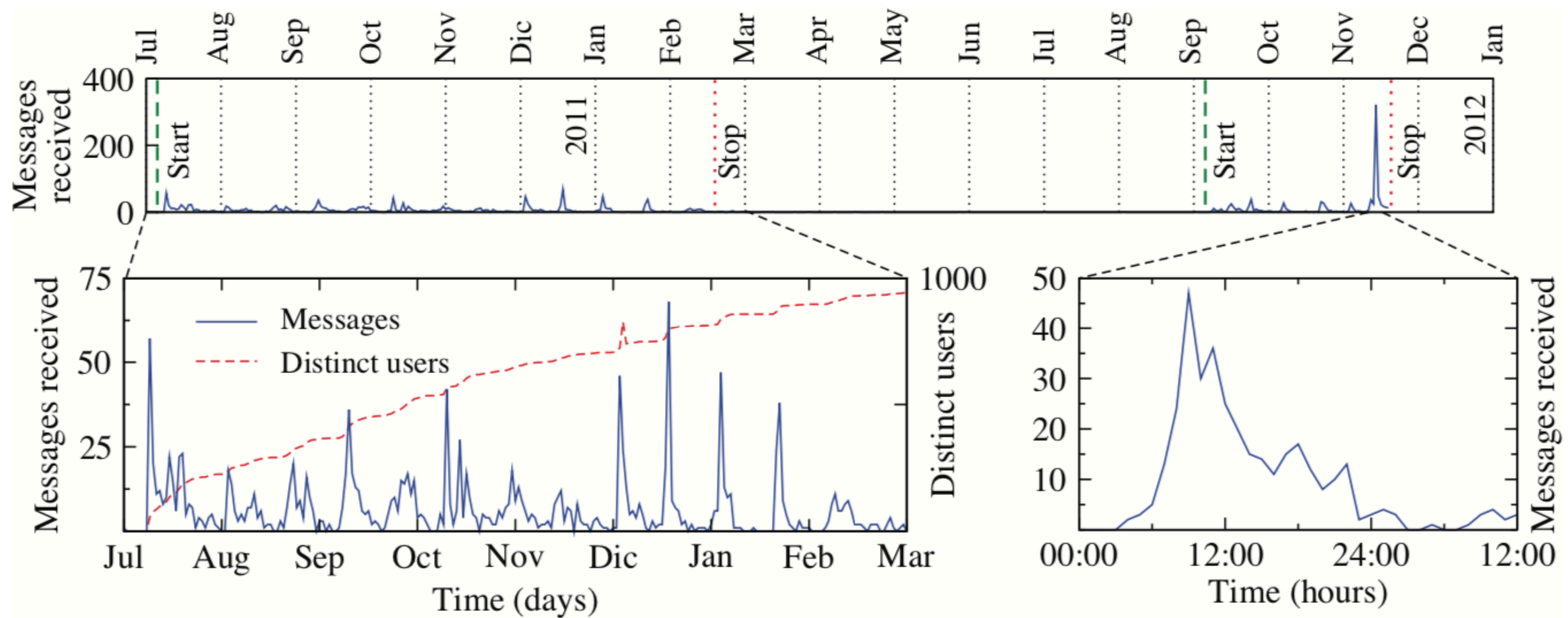


LM Aiello, A Barrat, C Cattuto, G Ruffo, R Schifanella, [Link creation and profile alignment in the aNobii social network](#), 2010 IEEE 2nd Int.. Conf. on Social Computing, 249-256

LM Aiello, A Barrat, C Cattuto, G Ruffo, R Schifanella, [Link creation and information spreading over social and communication ties in interest based online social network](#), EPJ Data Science 1 (1), 12

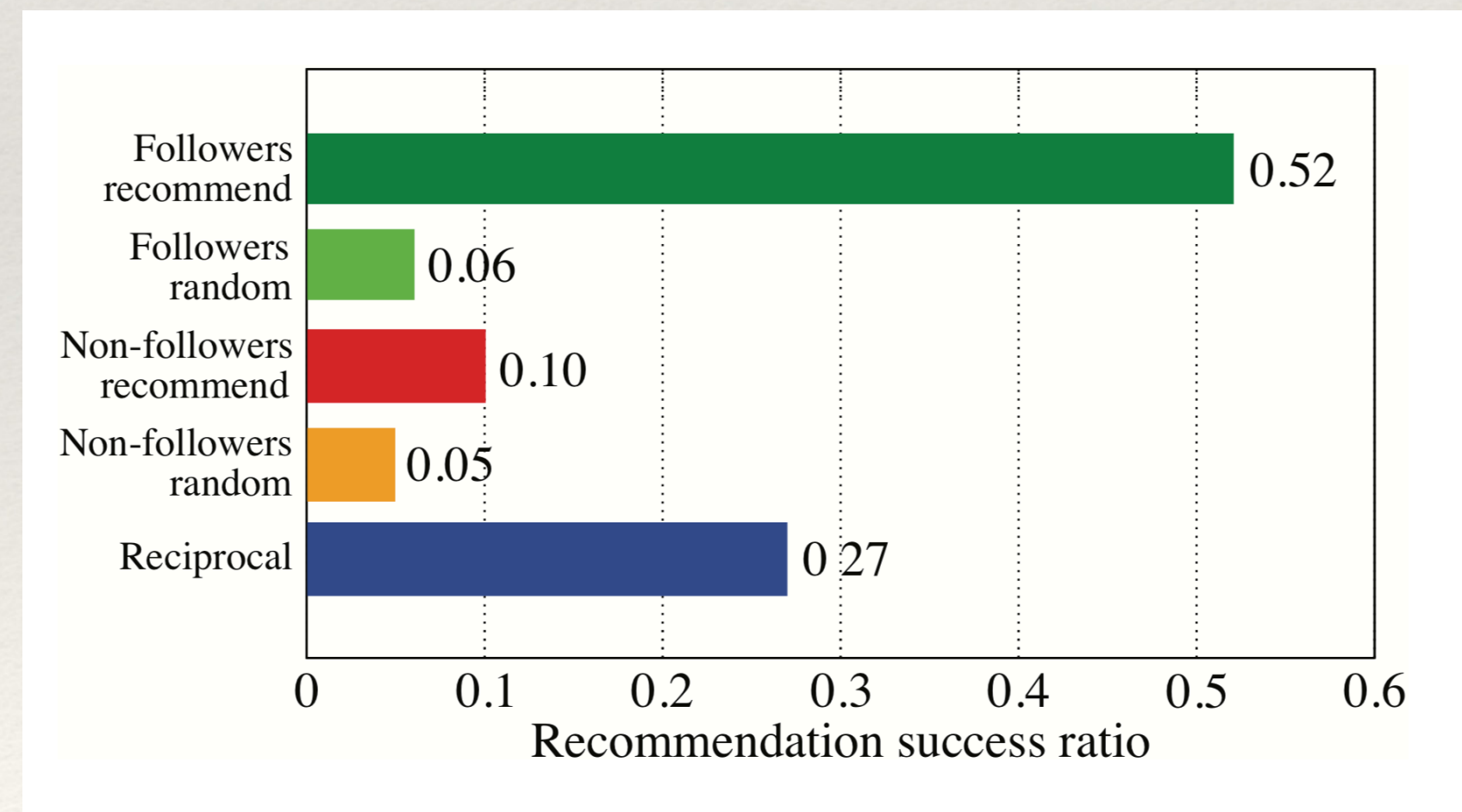
What happened to Lajello?

Lajello, incidentally, became the second most popular user in Anobii in terms of messages from distinct users

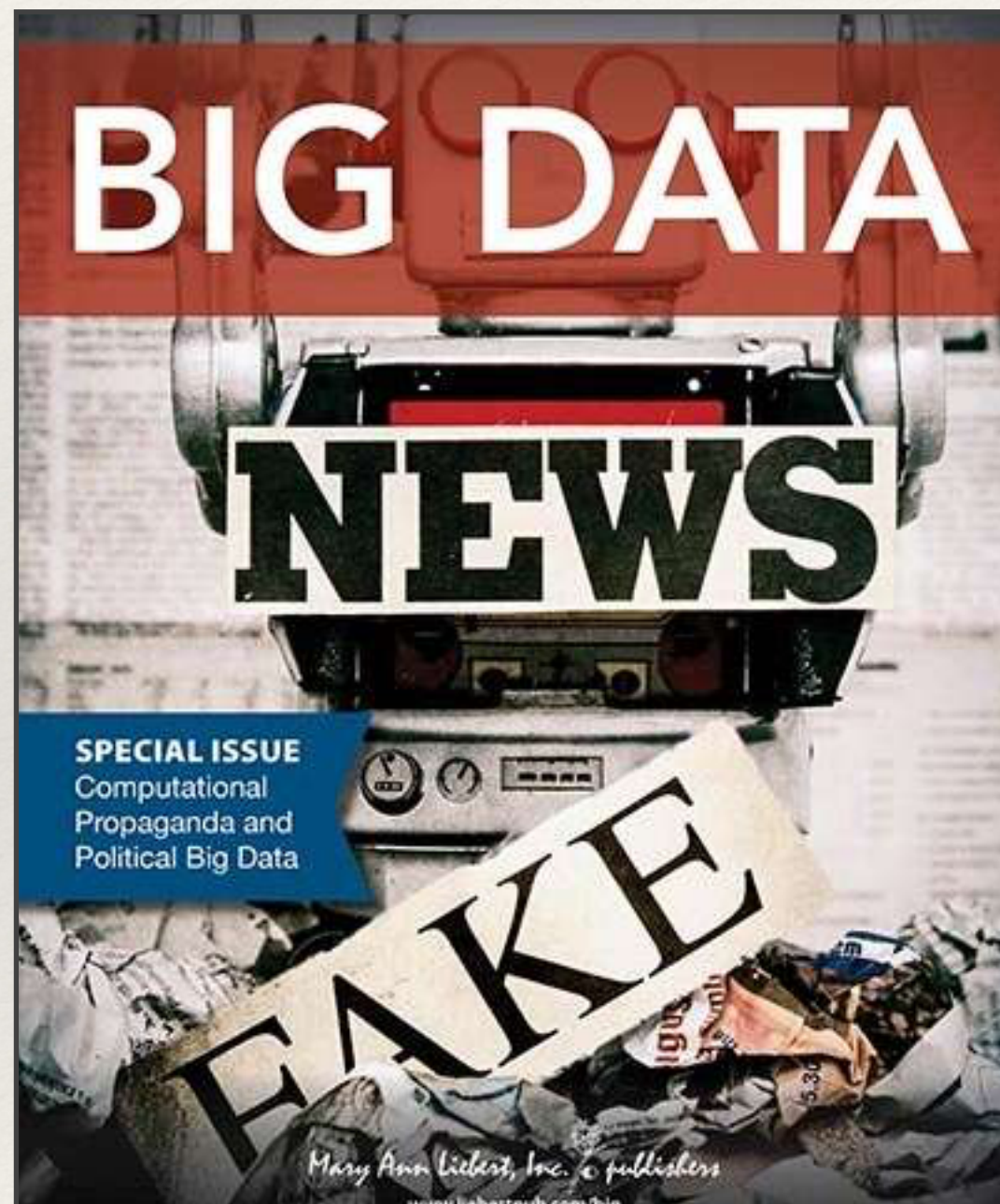


Exploiting Lajello popularity

- ❖ Lajello started to introduce users to each other according our link recommendation algorithm
- ❖ First result: users acceptance of the recommendation skyrocketed if they previously wrote in Lajello's wall



Influence of bots



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ACM

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Home / Magazine Archive / July 2016 (Vol. 59, No. 7) / The Rise of Social Bots / Full Text

REVIEW ARTICLES
The Rise of Social Bots

By Emilio Ferrara, Onur Varol, Clayton Davis, Filippo Menczer, Alessandro Flammini
Communications of the ACM, Vol. 59 No. 7, Pages 96-104
10.1145/2818717
[Comments \(1\)](#)



nature
COMMUNICATIONS

Article | [Open Access](#) | Published: 20 November 2018

The spread of low-credibility content by social bots

Chengcheng Shao, Giovanni Luca Ciampaglia, Onur Varol, Kai-Cheng Yang, Alessandro Flammini & Filippo Menczer

Nature Communications **9**, Article number: 4787 (2018) | [Download Citation](#)

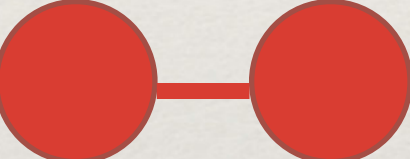
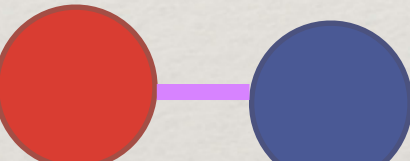
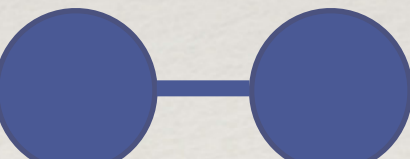
Incidentally, we polarized Anobii users

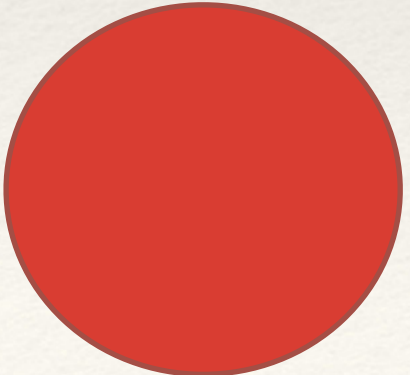
- After our initial experiment, Lajello remained silent for one year and then he “talked”. The recommendations changed the net structure and Lajello account was banned after 24 hours. This ignited a “war”
- Two polarized opinions emerged: Anobii users created immediately two thematic groups: “the (not requested) suggestions of Lajello” and “Hands-off Lajello”
- A large portion of users that were contacted by Lajello joined to one of these groups
- We observed a strong interplay between the existing relationships in the social network and the opinion that emerged from the users at the end of the links: “**echo chamber**” effect?

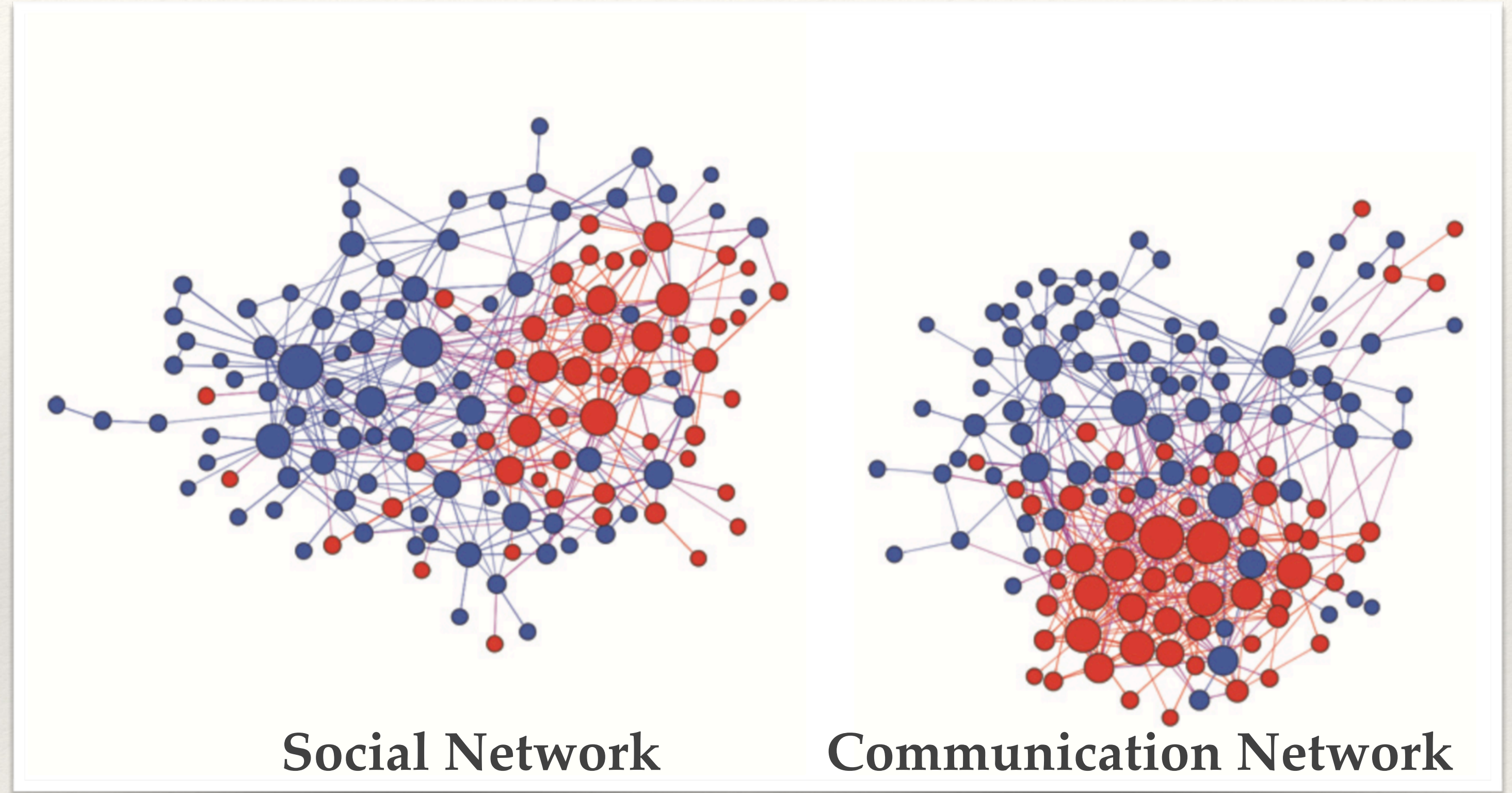
Social polarization and emotional reaction

 red dots are lajello supporters

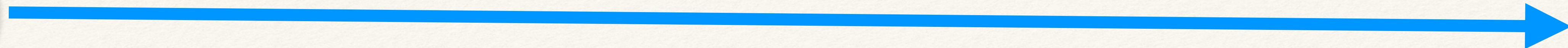
 blu dots are lajello haters

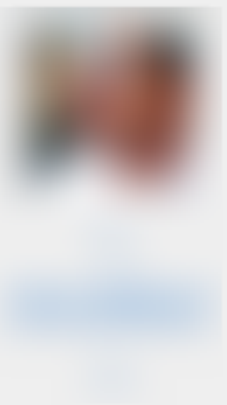
   links are existing social connections or direct messages (graph is directed)


 bigger dots are users with more links

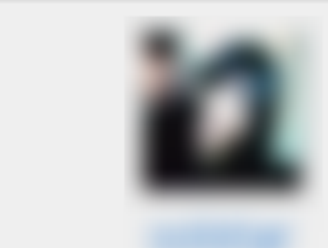



Automatic network-based [community detection](#) algorithm (OSLOM) accurately finds clusters (80% - Social network, 72% - Communication network), confirming a signal of **segregation** between the two groups before link recommendations



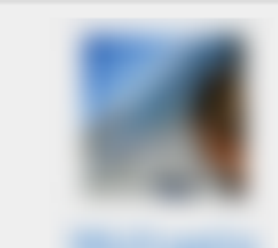
 LAJELLO... HAI STUFATO..NON SE NE PUO' PIU' ...STA ATTENTO/A CHE SONO CAPACE DI ASSOLDARE UN HACKER PER VEDERE CHI SEI..E PO' SONO C...TUOI


Tre settimane fa 

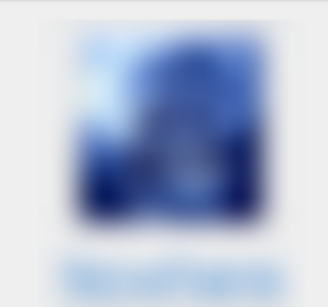
 ahahahhahaha tu sei un genio!!!! sei davvero un genio!!! insomma ma quante visualizzazioni hai???? sei un grande!!!! riesci a farti visitare e a farti scrivere pur non avendo libri!!! ti adoro sei grandissimo :P


Aug 13, 2010 

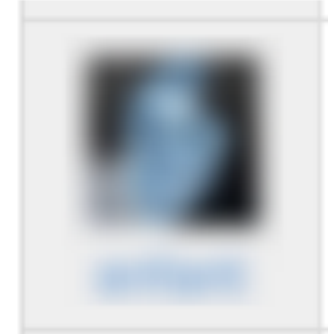
 chi sei?

 un grande.
continua così. Grazie delle visite, si vede che ti sto simpatica....
P.S: propongo di aprire un gruppo the Lajellos fans...

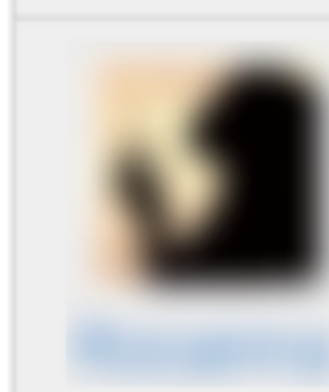
3 giorni fa 

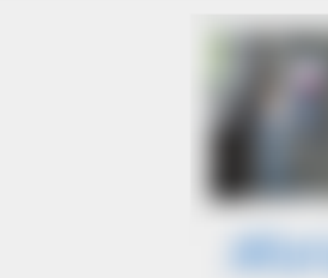
 già che mi ritrovo qui mi faccio pubblicità! Venite a vedere la mia libreria è la più bella -del mondo-. (l'ultima parte andava sottolineata..)


Due set 

 chapeau!!

 Le tue visite cominciano ad essere inquietanti....

 ahahahaahah tu sei un genio!!

 Grazie Lajello, mi sono divertita un sacco a leggere i commenti degli altri anobiani. Sembra un esperimento di psicologia sociale, se non ti dispiace ti aggiungo come vicino! e resisti eh...non pubblicare un libro! ;)

Due settimane fa 

Lessons learned and observations

- ❖ Handle experiments in social media with care :)
- ❖ A simple spambot can take power in a social network
- ❖ A seed of polarization found in pre-existing network structure
- ❖ Network and Sentiment analysis provide tools and measures, when we have data
- ❖ What if the real identity and motivations of Lajello were fact-checked?

**MIT
Technology
Review**

[Connectivity](#)

How a Simple Spambot Became the Second Most Powerful Member of an Italian Social Network

The surprising story of how an experiment to automate the creation of popularity and influence became successful beyond all expectation.

by **Emerging Technology from the arXiv**

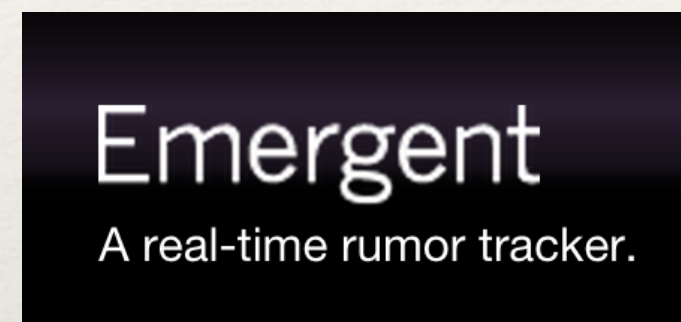
Aug 5, 2014

Modeling the spread of misinformation

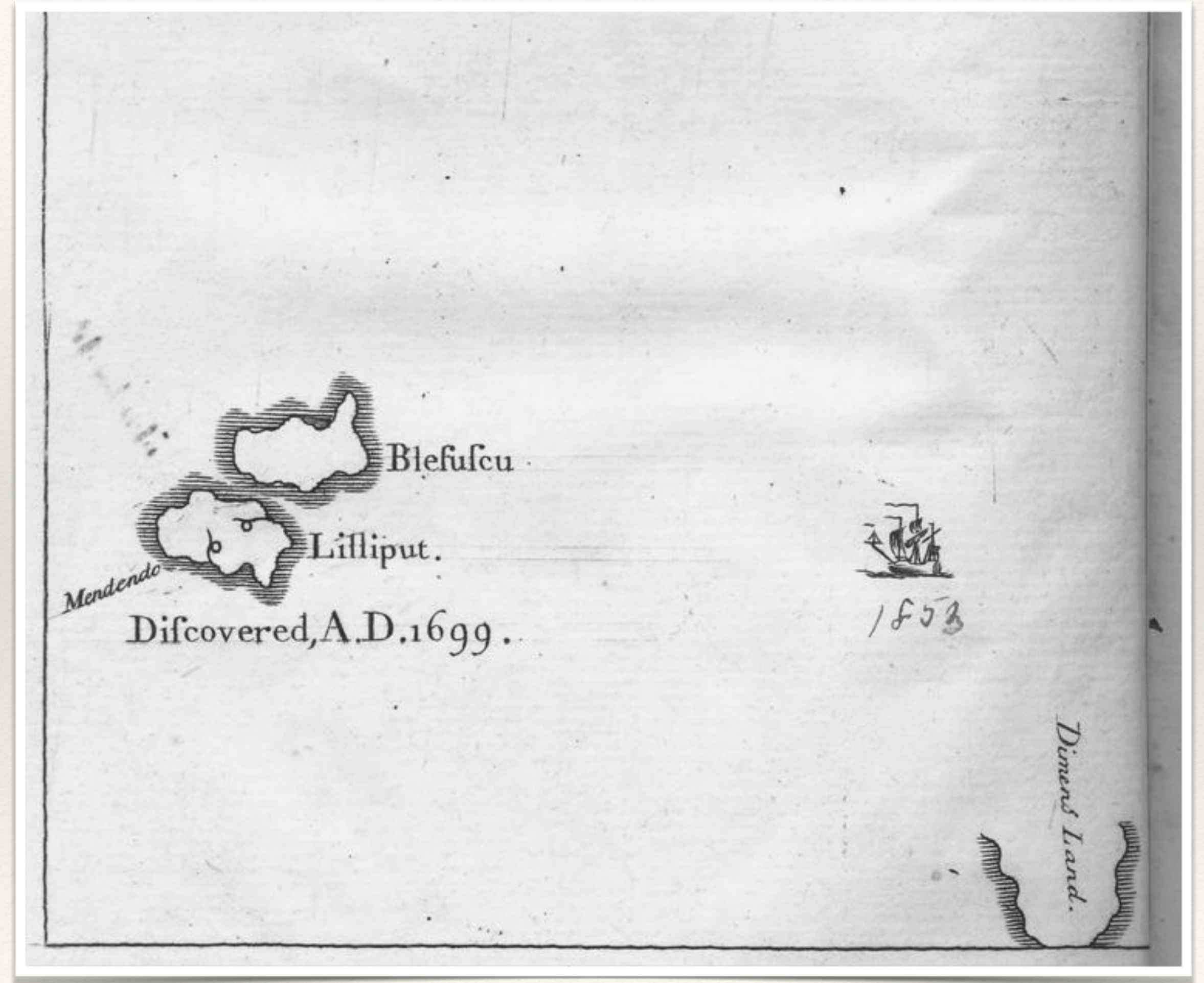


Questions

- ❖ Is fact-checking effective against the diffusion of fake-news?



- ❖ Do “echo-chambers” and “islands” play a role as inhibitors or facilitators of fake-news spreading?



Networks and their context

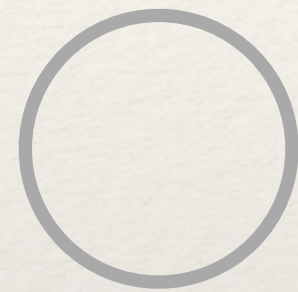
- ❖ nodes are **actors** involved in a **generic** social network (no assumption is given)
- ❖ links are **social relationships**
- ❖ nodes can be exposed to news from both **internal and external sources** and via different communication devices



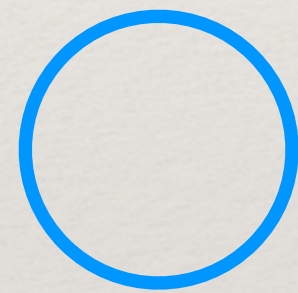
- ❖ **network topologies** can be created artificially or built from real data
- ❖ The **news is factually false** (can be debunked or someone else has already debunked it)
- ❖ We need a **model** for predictions and what-if analysis; data for validation and tuning only

Node states in the SBFC model

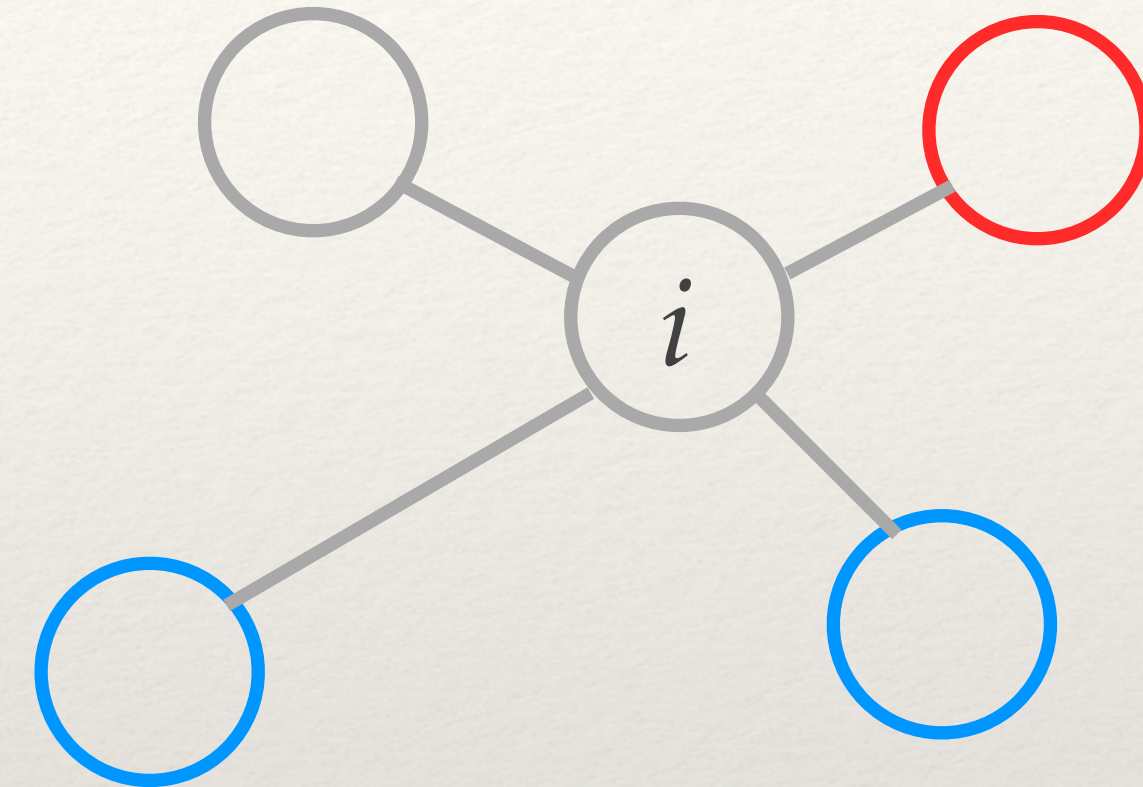
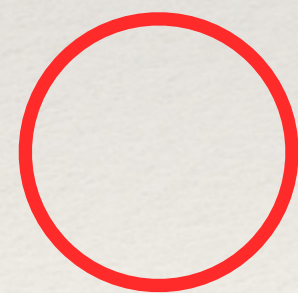
❖ Susceptible



❖ Believer



❖ Fact-Checker

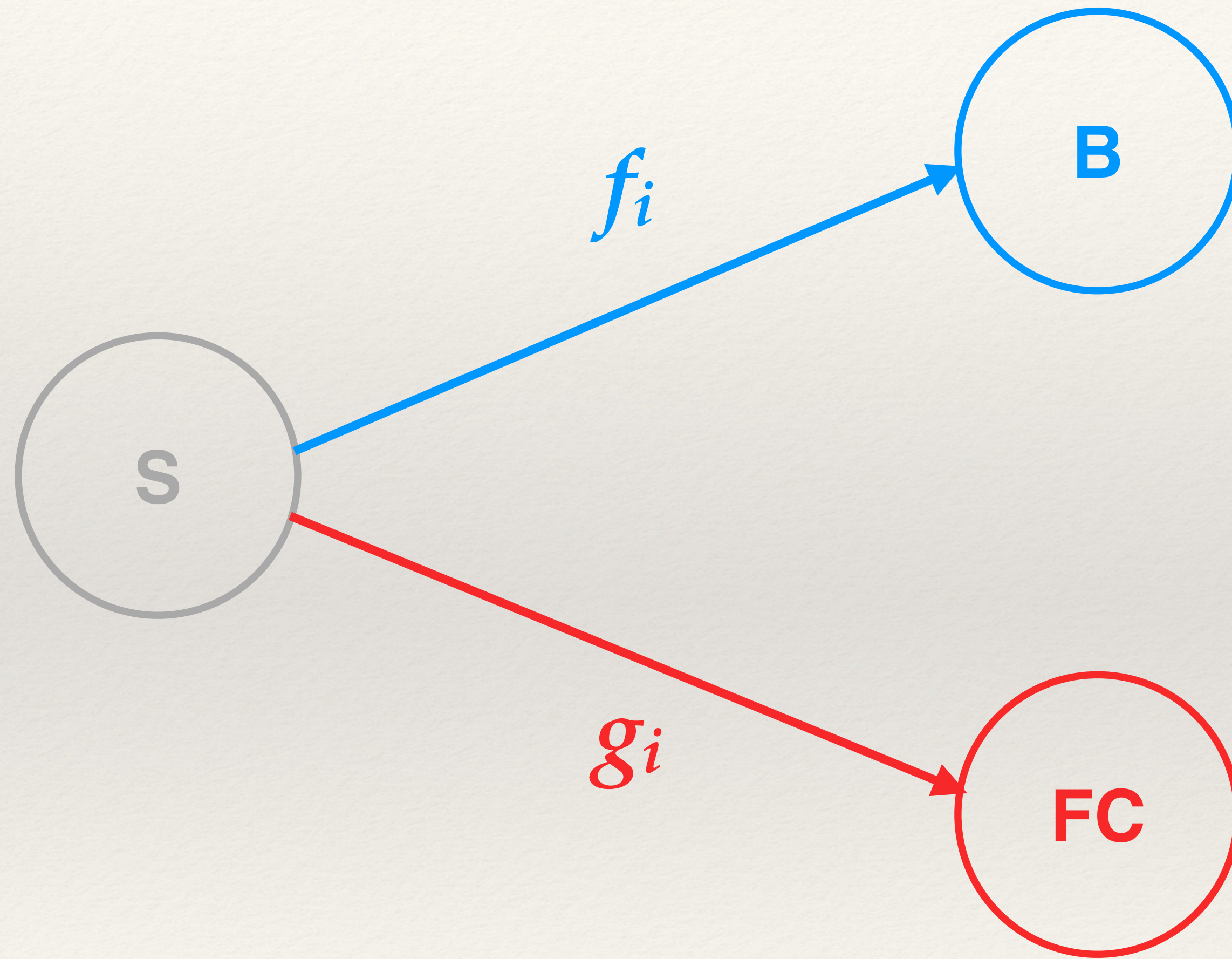


neighbors of i : n_i

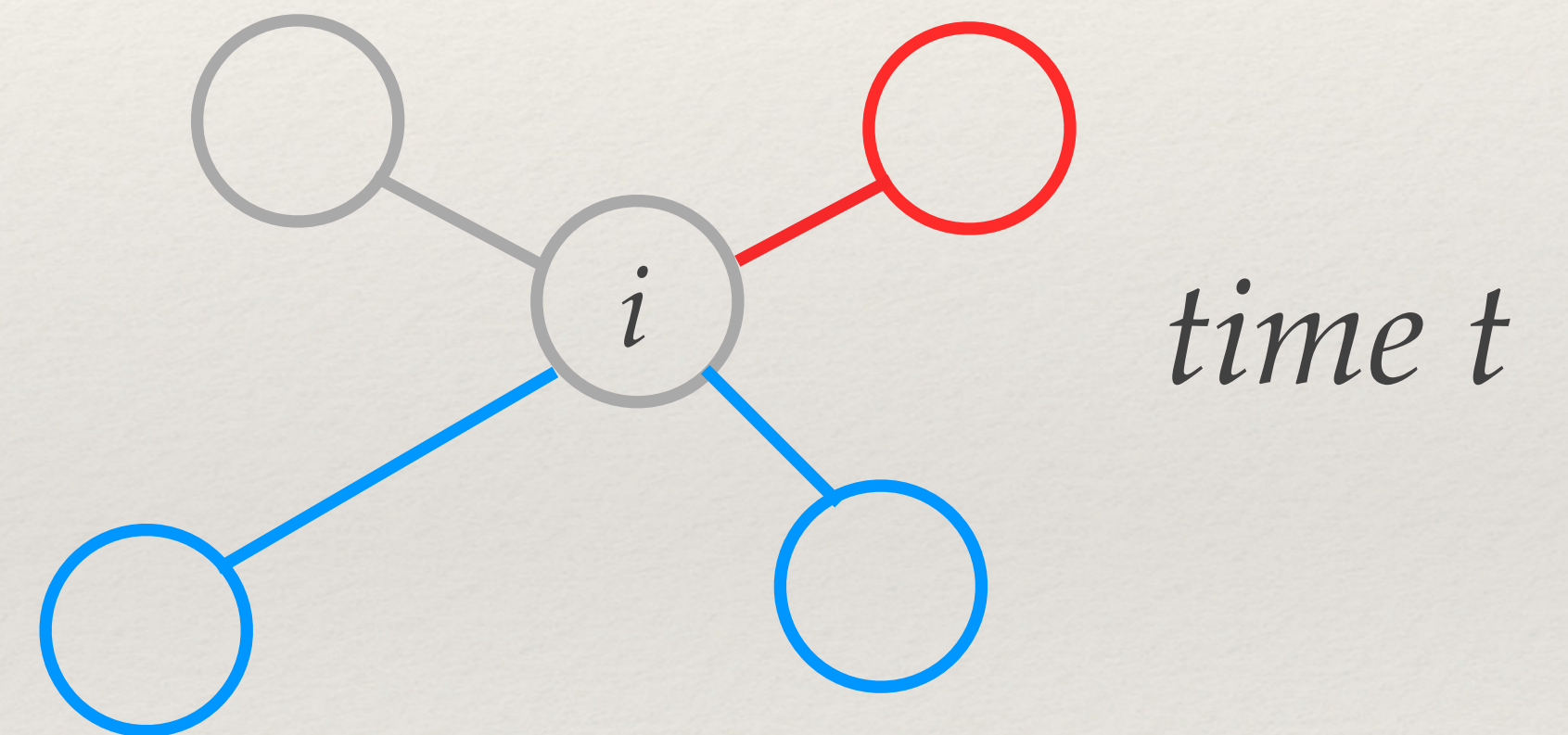
credibility of the hoax: α

spreading rate: β

From Susceptible to Believer/Fact-Checker

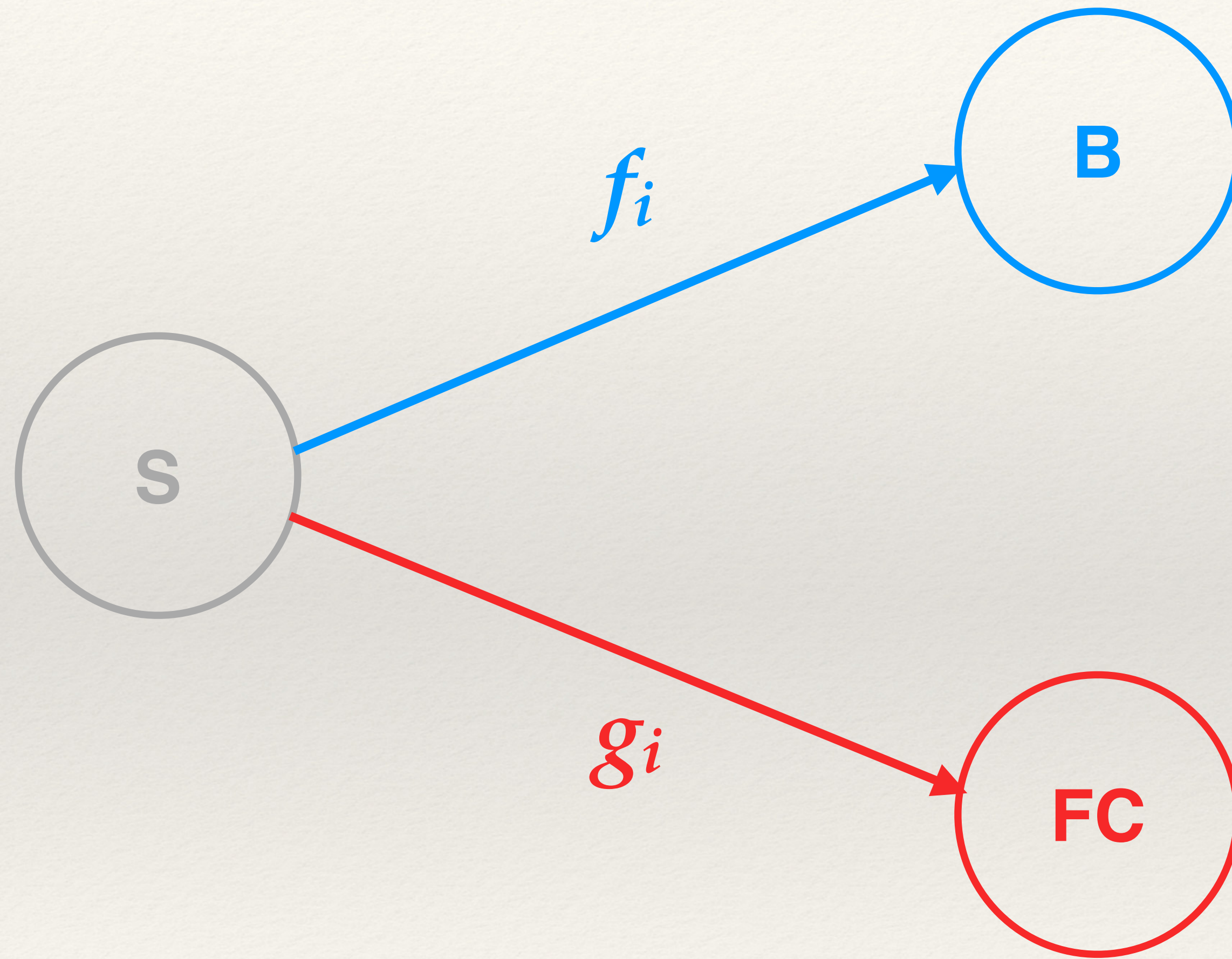


$$f_i(t) = \beta \frac{n_i^B(t)(1 + \alpha)}{n_i^B(t)(1 + \alpha) + n_i^F(t)(1 - \alpha)}$$

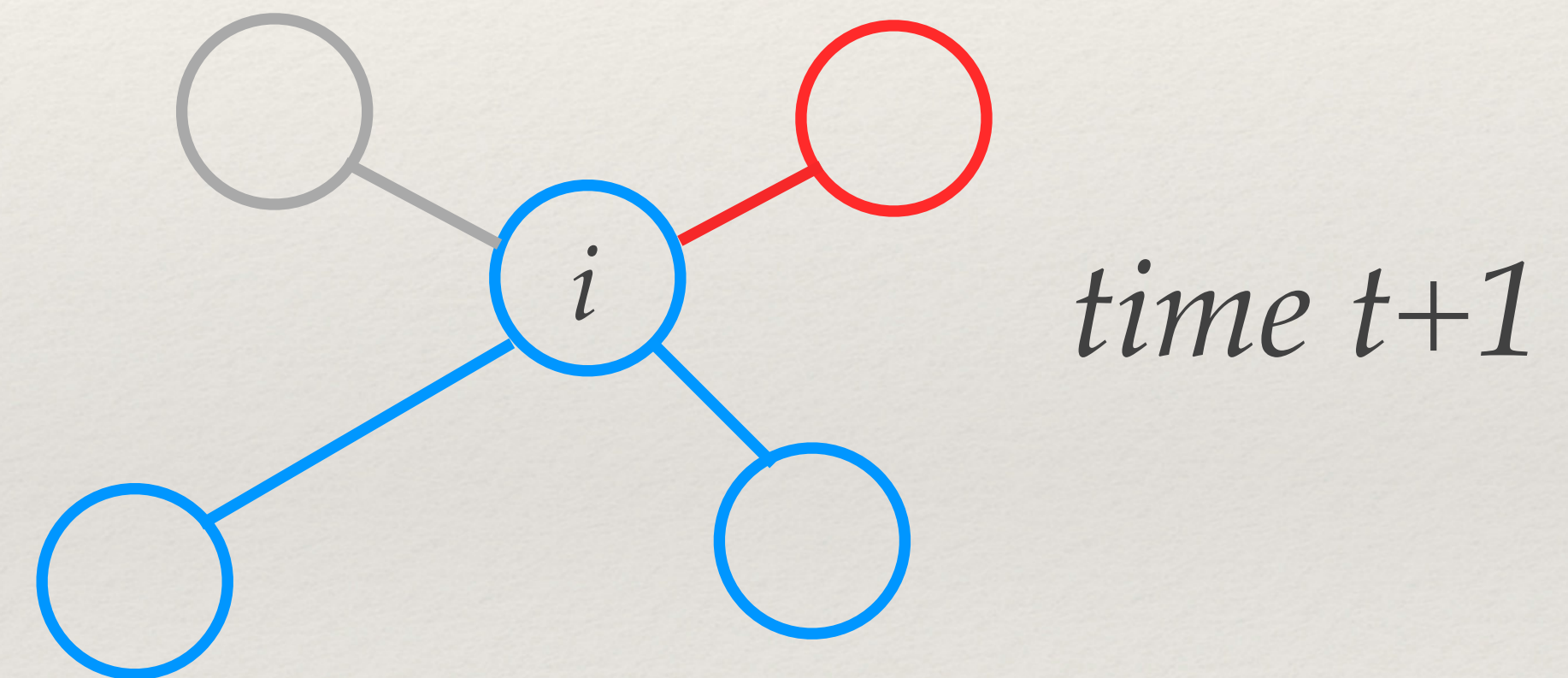


$$g_i(t) = \beta \frac{n_i^F(t)(1 - \alpha)}{n_i^B(t)(1 + \alpha) + n_i^F(t)(1 - \alpha)}$$

From Susceptible to Believer/Fact-Checker

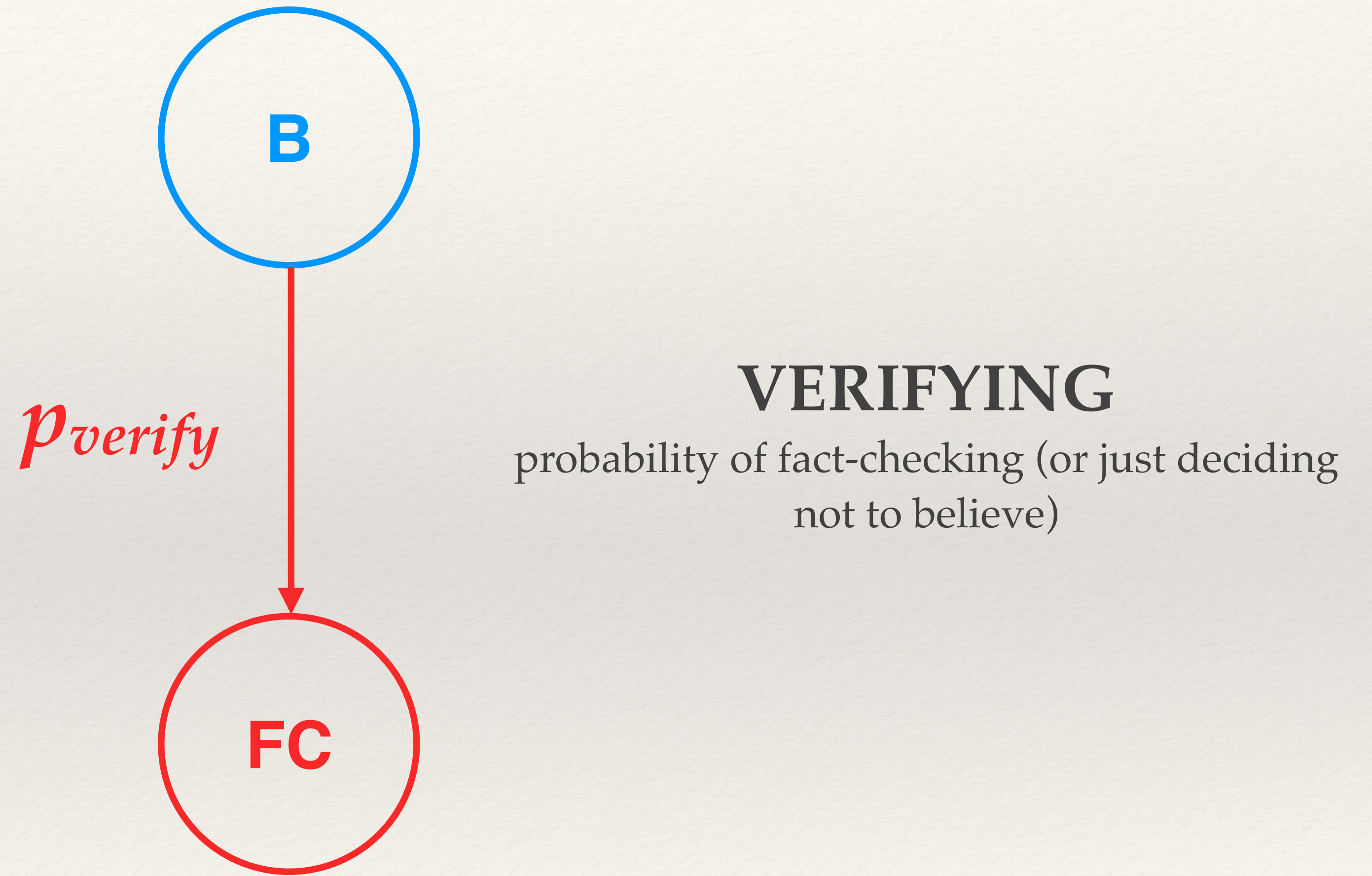


$$f_i(t) = \beta \frac{n_i^B(t)(1 + \alpha)}{n_i^B(t)(1 + \alpha) + n_i^F(t)(1 - \alpha)}$$

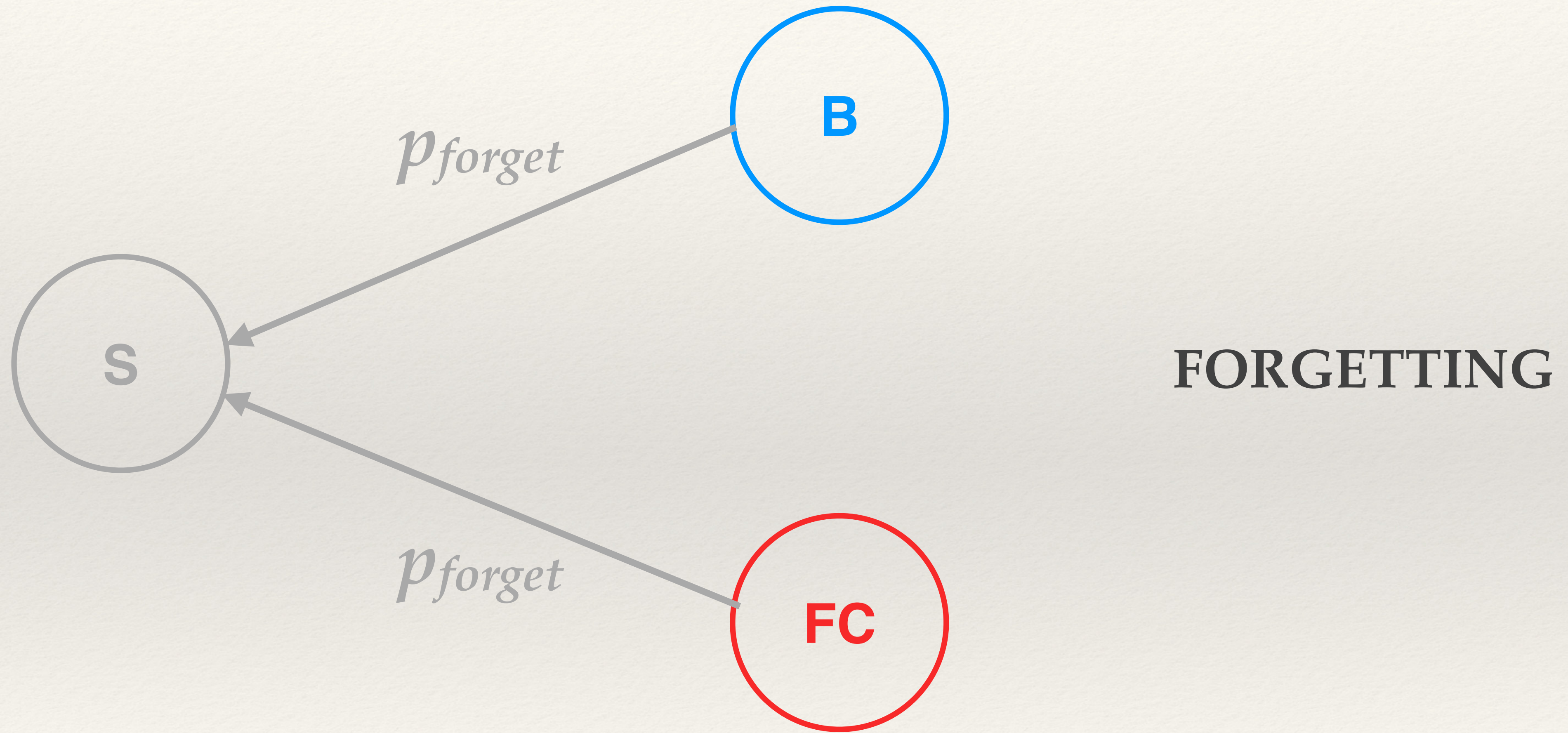


$$g_i(t) = \beta \frac{n_i^F(t)(1 - \alpha)}{n_i^B(t)(1 + \alpha) + n_i^F(t)(1 - \alpha)}$$

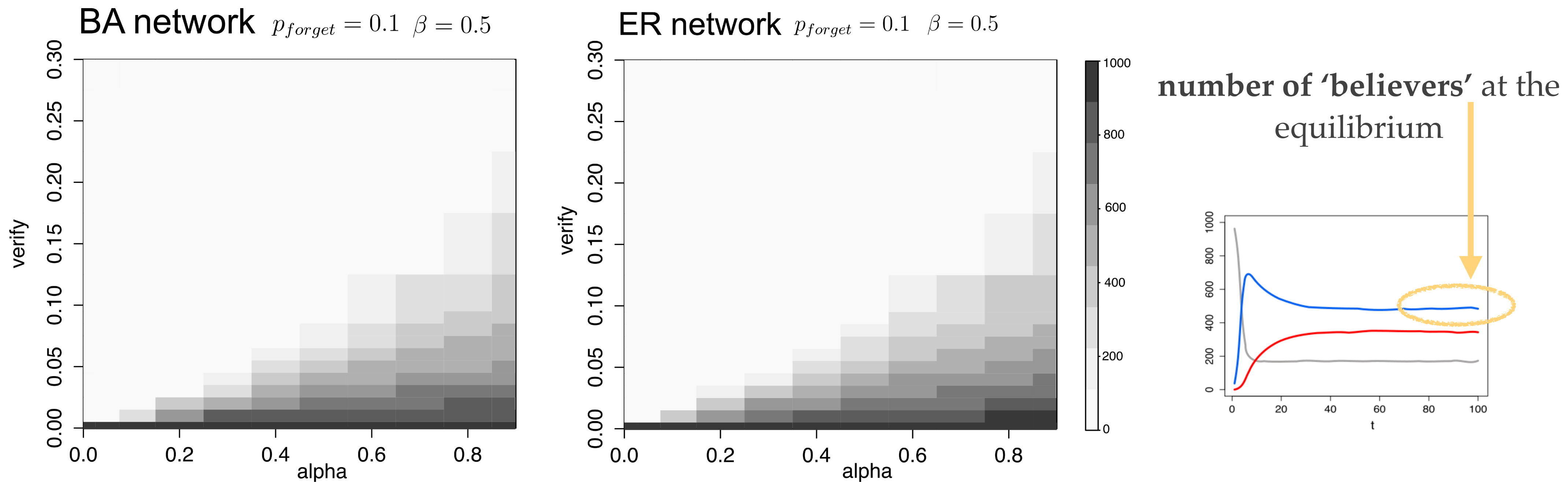
From Believer to Fact-Checker



From Believer/Fact-Checker to Susceptible



Dynamics (agent-based simulations)

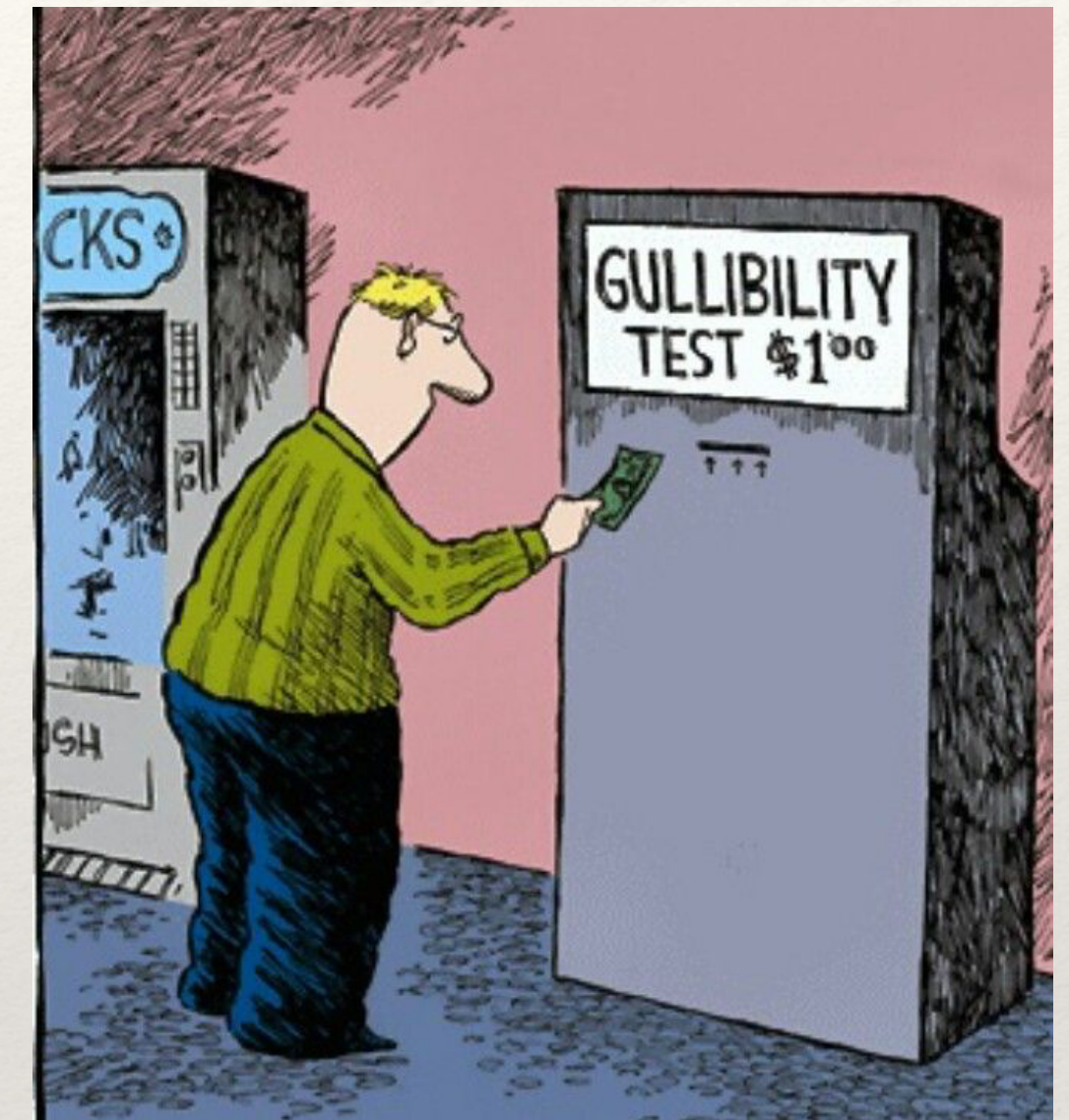
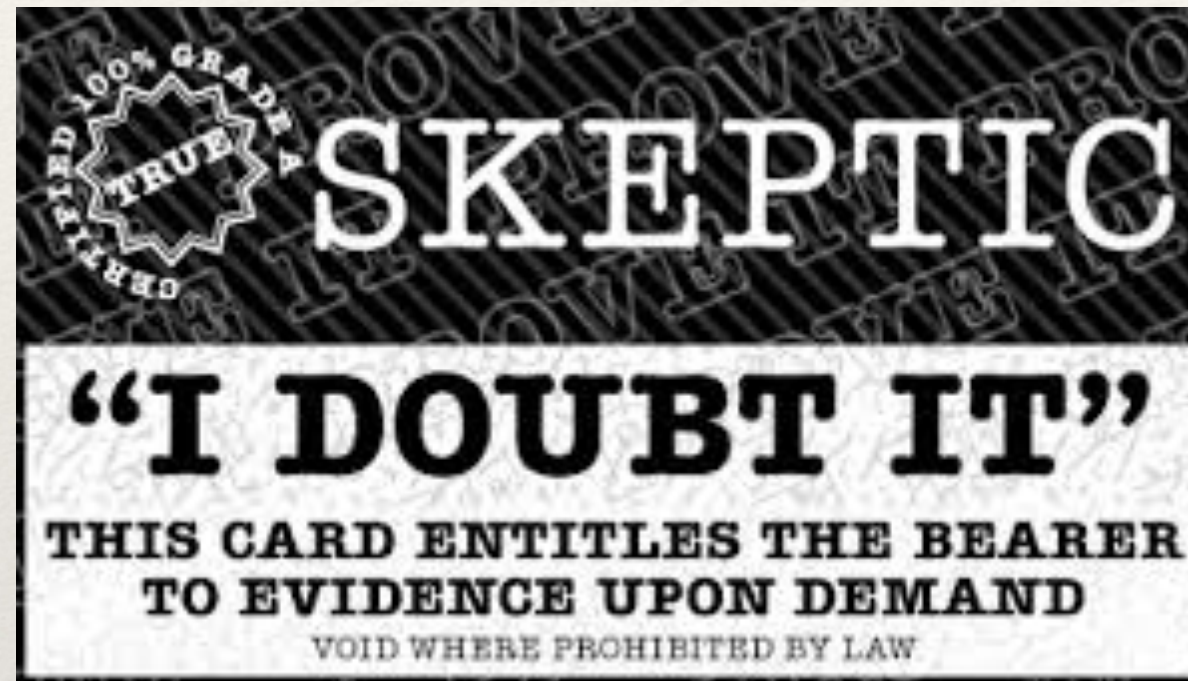
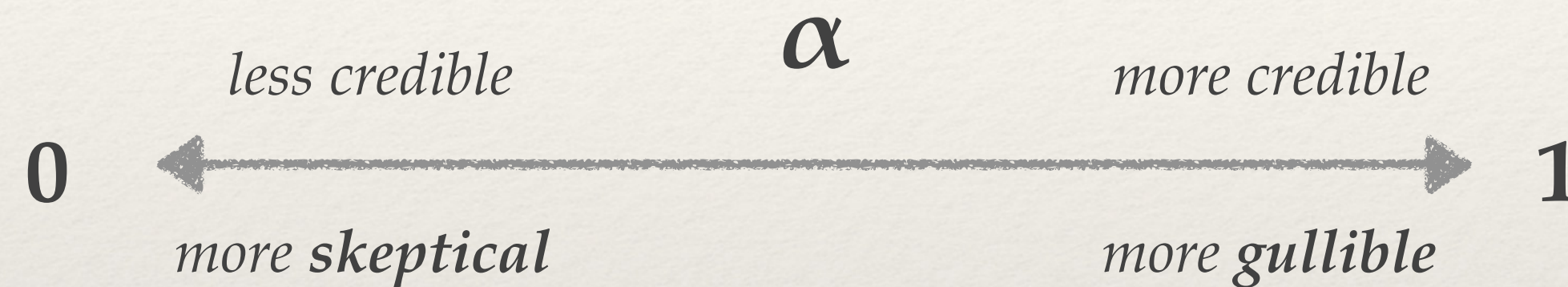


threshold on verifying probability: this provides an idea of how many believers we need to convince to guarantee the removal of the hoax

The role of segregation

Skeptical and gullible agents

let's tune credibility accordingly



the propensity to believe is also a property of the node (**gullibility**)

What does it happen when skeptics and gullible agents are segregated?

Modeling two segregated communities

Skeptic



α small

size ($0 < \gamma < N$)

nodes in the gullible community

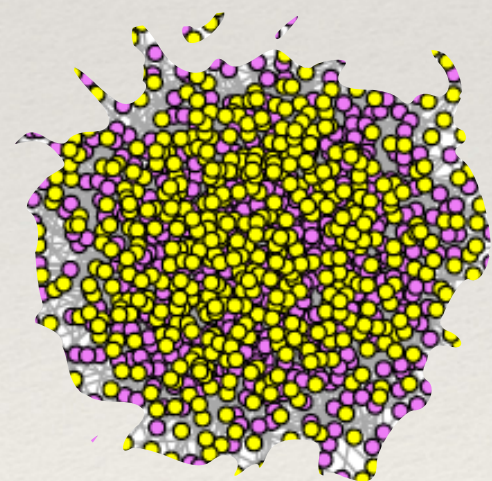
segregation ($0.5 < s < 1$)

fraction of edges within same community
[Gu-Gu, Sk-Sk]

Gullible



α large

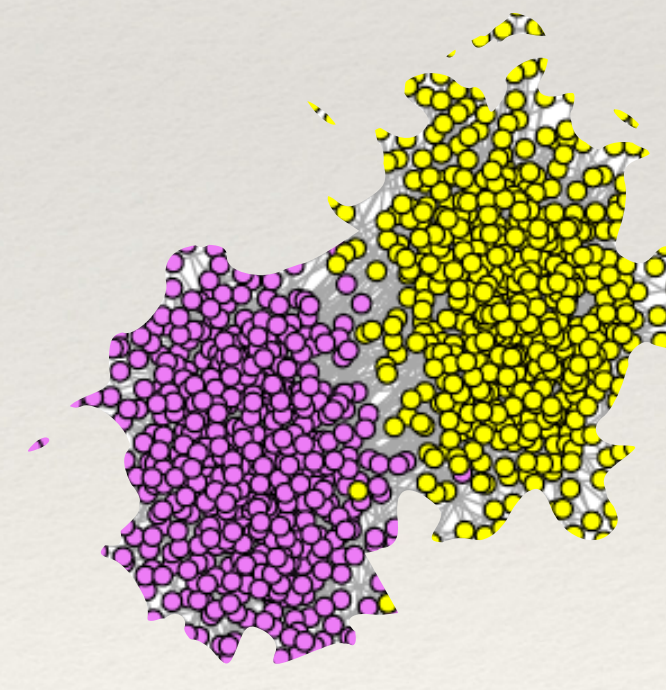
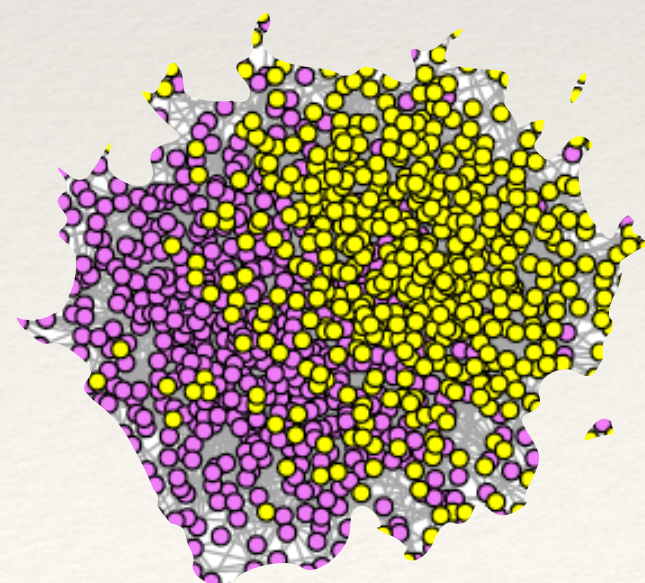


$s=0.55$

$\gamma=500$

$s=0.8$

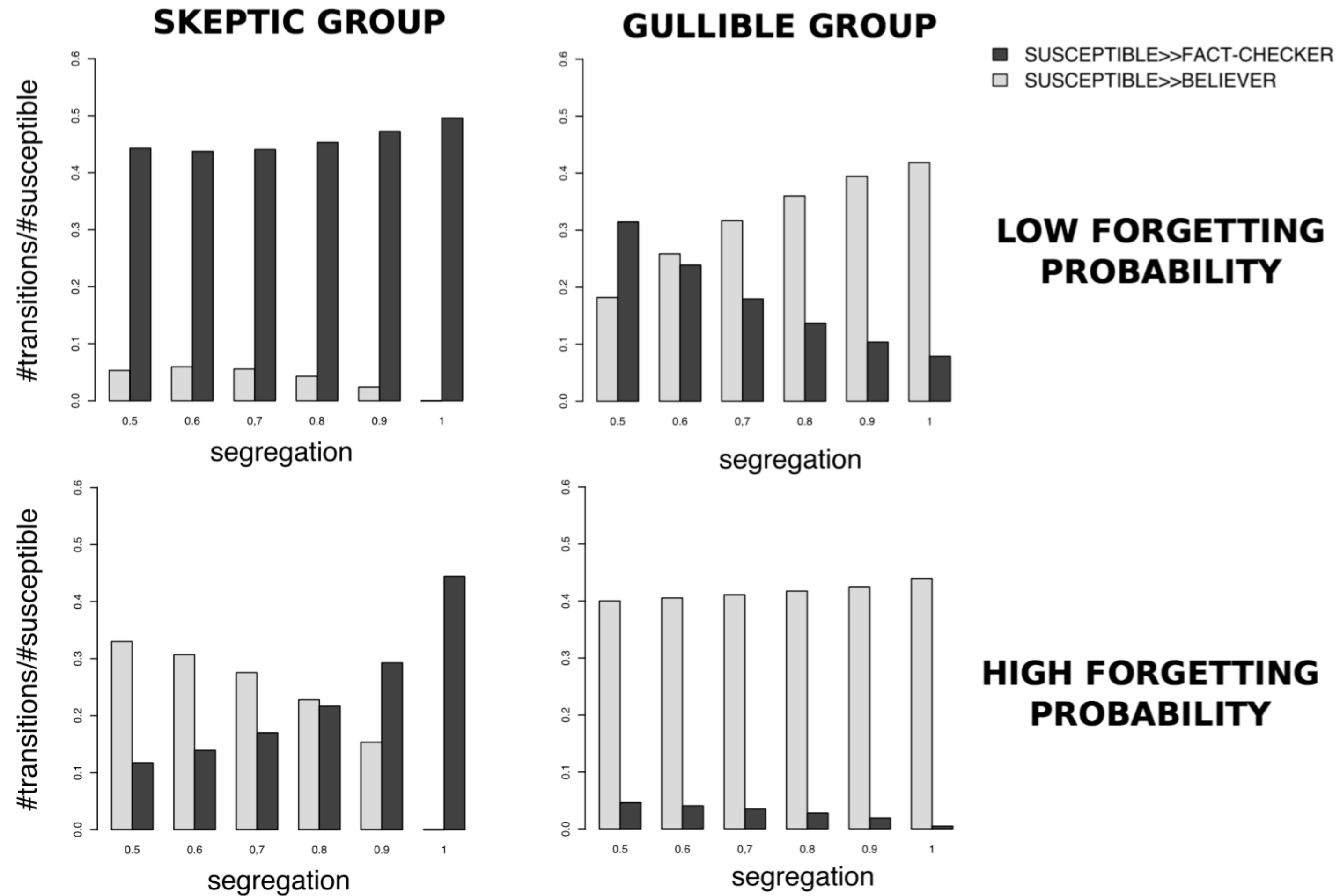
$\gamma=500$



$s=0.95$

$\gamma=500$

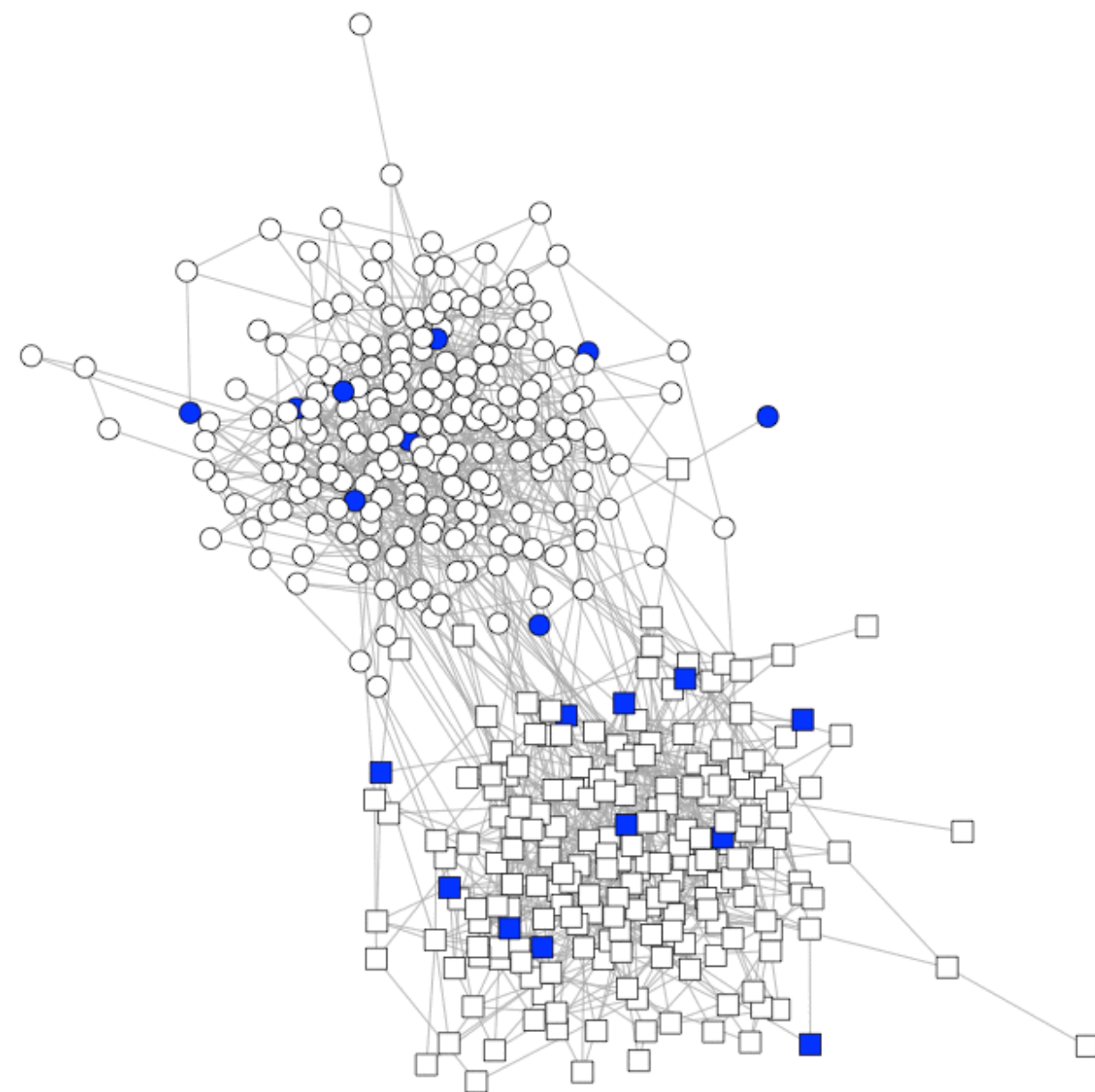
Transitions



Role of forgetting

LOW Forgetting Rate

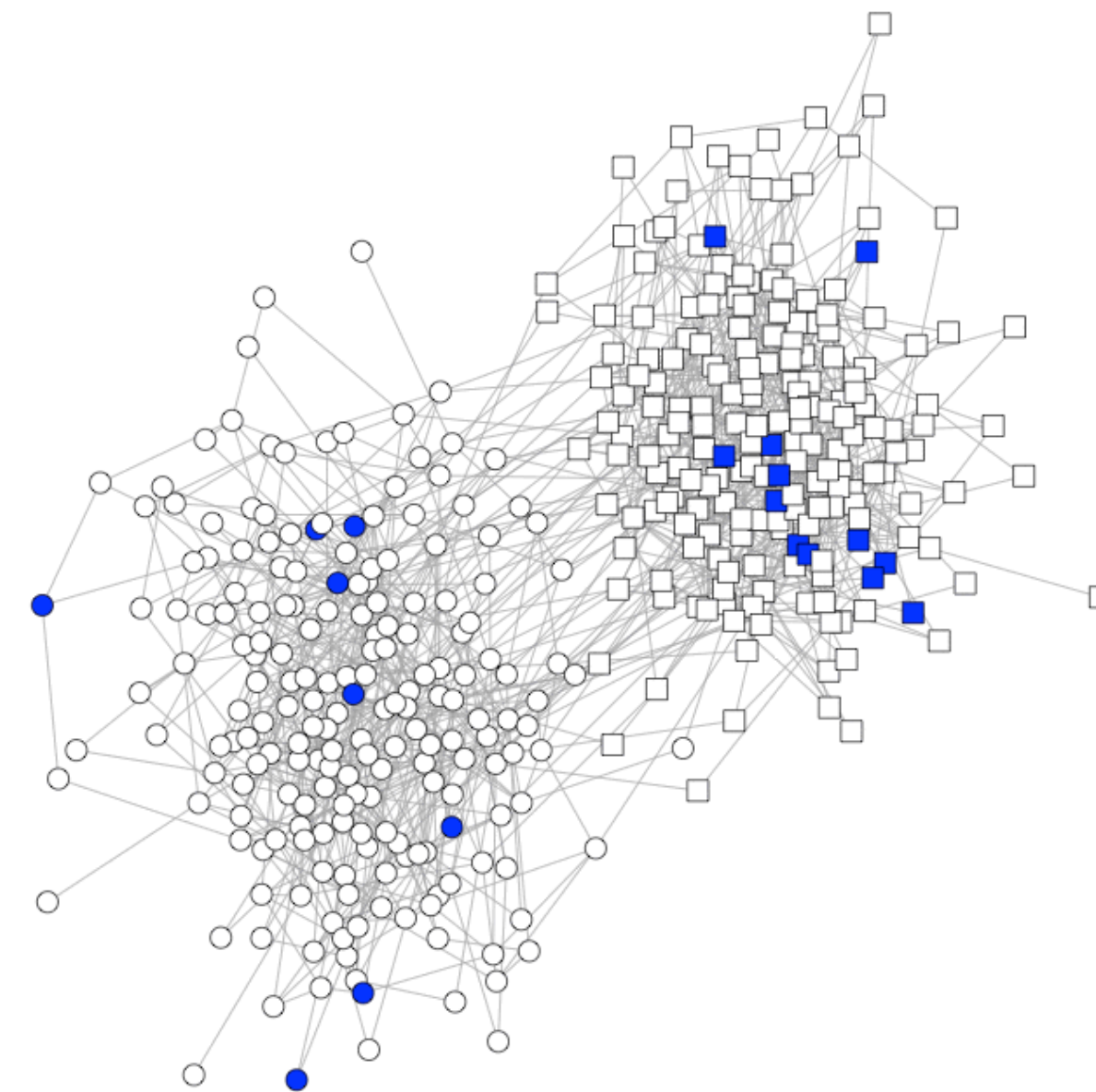
$$p_f = 0.1$$



Time = 1

HIGH Forgetting Rate

$$p_f = 0.8$$



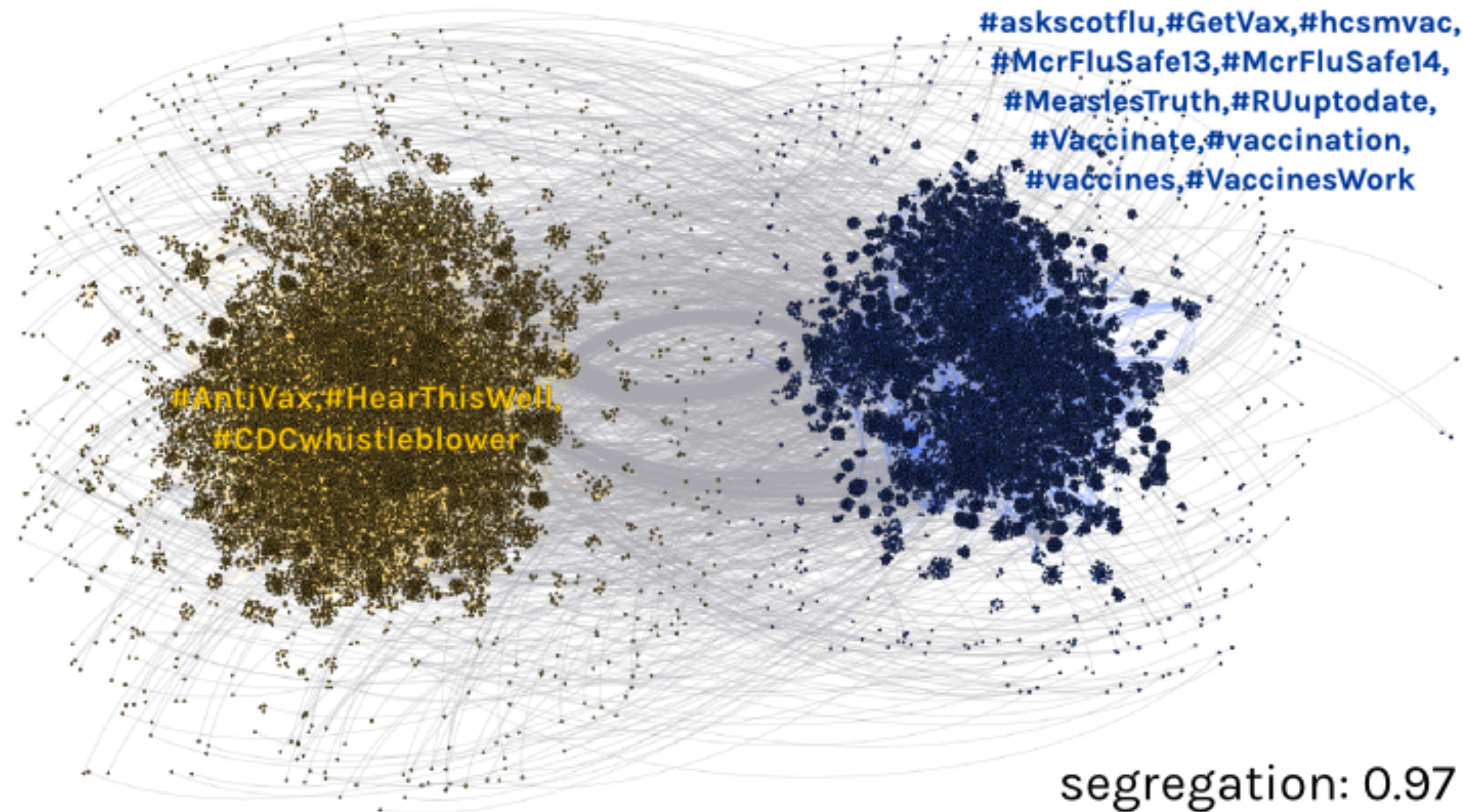
Time = 1

Lessons learned and observations

- ❖ We can use our model to study the fake-news diffusion process in **segregated community**
- ❖ **Complex contagion** is observed: interplay and not trivial outcomes
- ❖ **Forgetting probability** becomes relevant as well as the **level of segregation**:
 - ❖ **high forgetting probability** (e.g., just `normal' unfounded gossip) vanishes soon in **segregated communities**
 - ❖ **low forgetting probability** (e.g., conspiracy theories or partisanship beliefs) requires **low segregation**

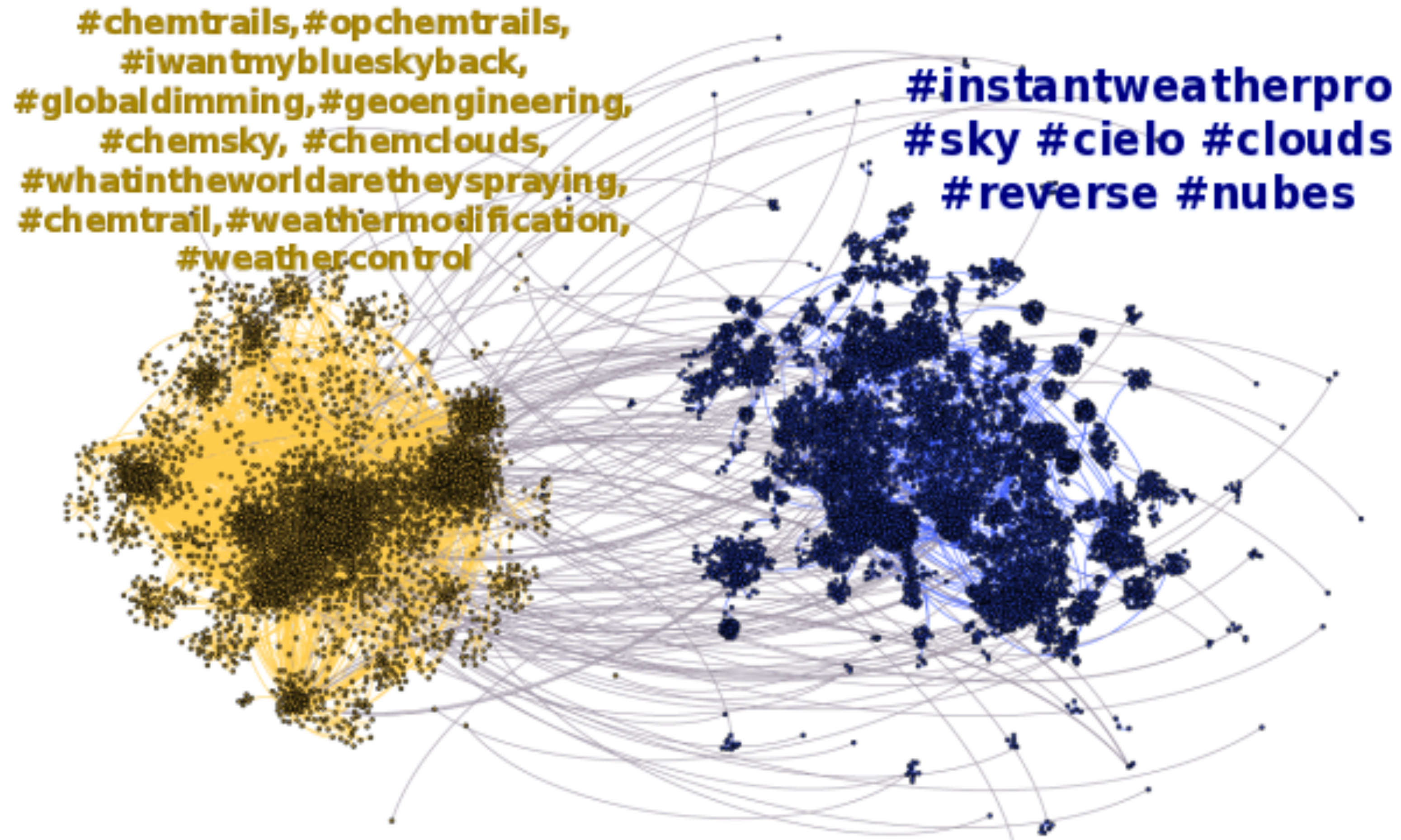
M Tambuscio, D F M Oliveira, G L Ciampaglia, G Ruffo, [Network segregation in a model of misinformation and fact-checking](#), Journal of Computational Social Science (2018) 1: 261.

real data: vaccines



twitter data from IU <https://osome.iuni.iu.edu>

real data: chemtrails



twitter data from IU <https://osome.iuni.iu.edu>

segregation: 0.99

Evaluating debunking strategies

What-if analysis

- ❖ We live in a **segregated** society: let's accept it!
- ❖ **Polarization** can last for a long time: **low forgetting** probability
- ❖ **Computational epidemiology**: immunization works better if some node in the network (e.g., hubs, bridges) is vaccinated first
- ❖ **Where** to place fact-checkers?
- ❖ Stronger hypothesis: a believer do not verify ($p_{\text{verify}} = 0$)
 - ❖ they can still forget
 - ❖ we can accept to leave half of the population breaking the egg on the wrong side, but we want at least to protect the skeptics!

Basic settings with no verification

Setting

segregation: 0.92 (high)

forgetting: 0.1 (low)

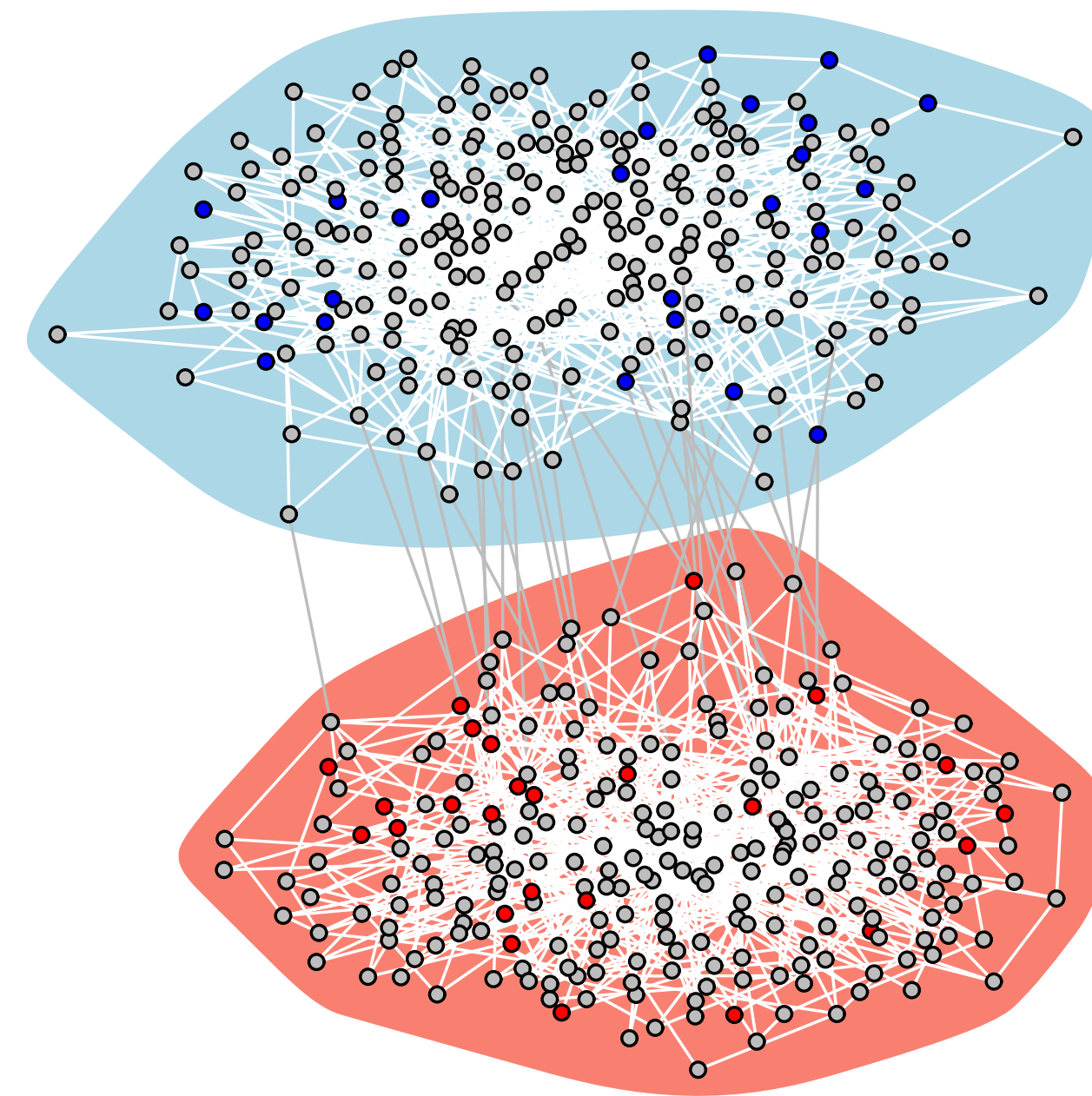
gullible group:

- α : 0.8
- seeders B: 10%

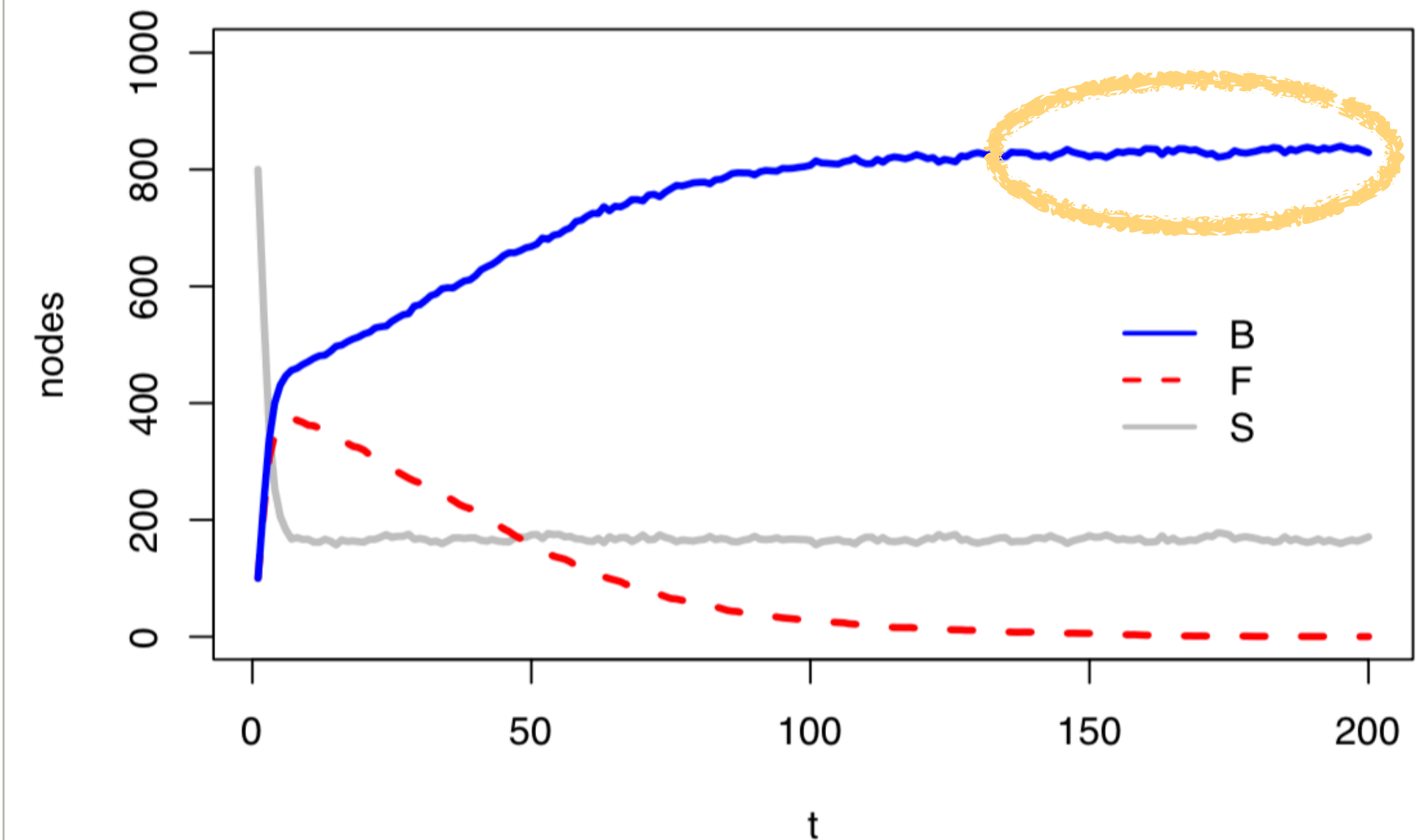
skeptical group:

- α : 0.3
- seeders FC: 10%

Simulation start



Simulation results



As expected: very **bad!**

Eternal fact-checkers placed at random

Setting

segregation: 0.92 (high)

forgetting: 0.1 (low)

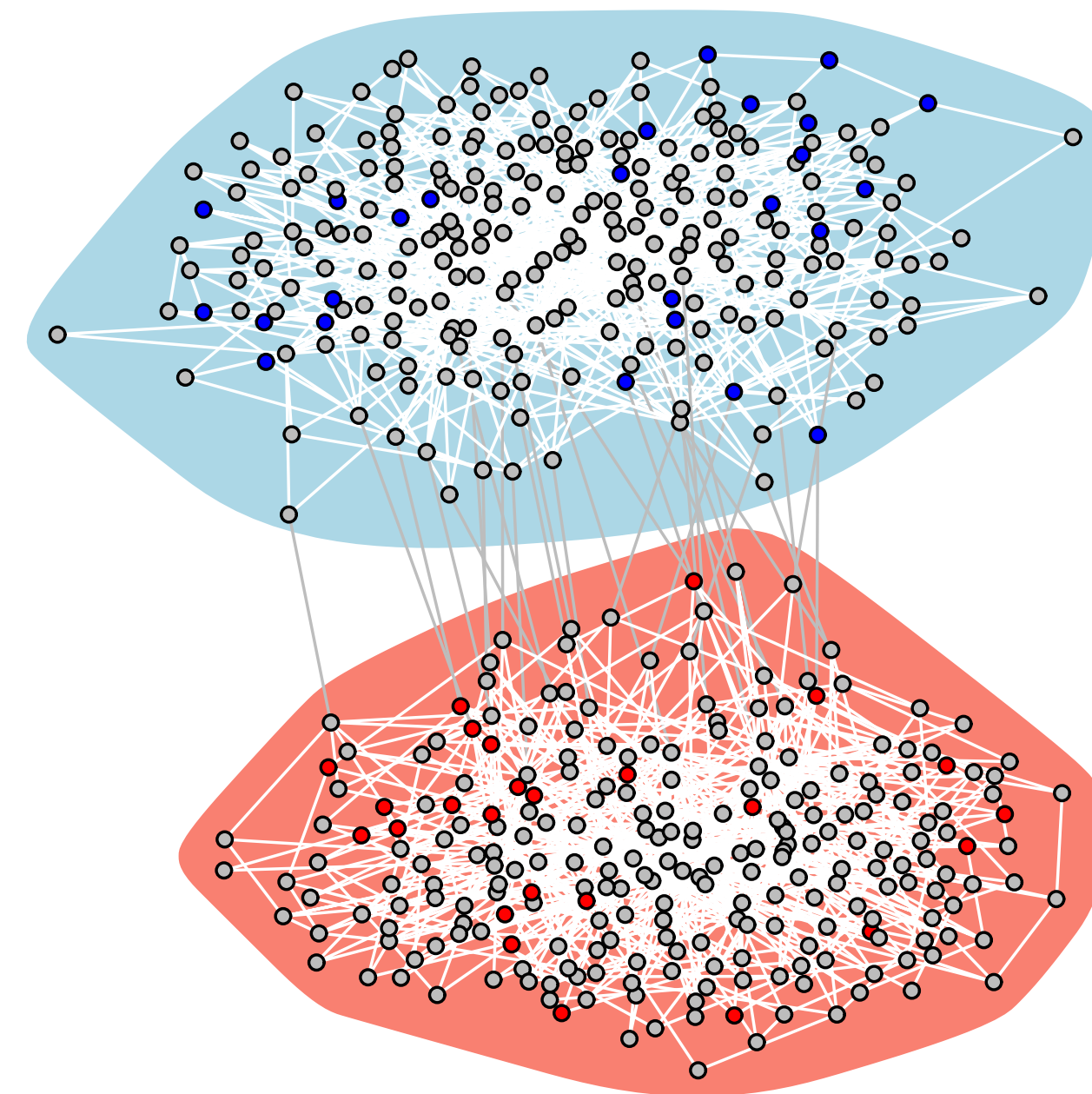
gullible group:

- α : 0.8
- seeders B: 10%

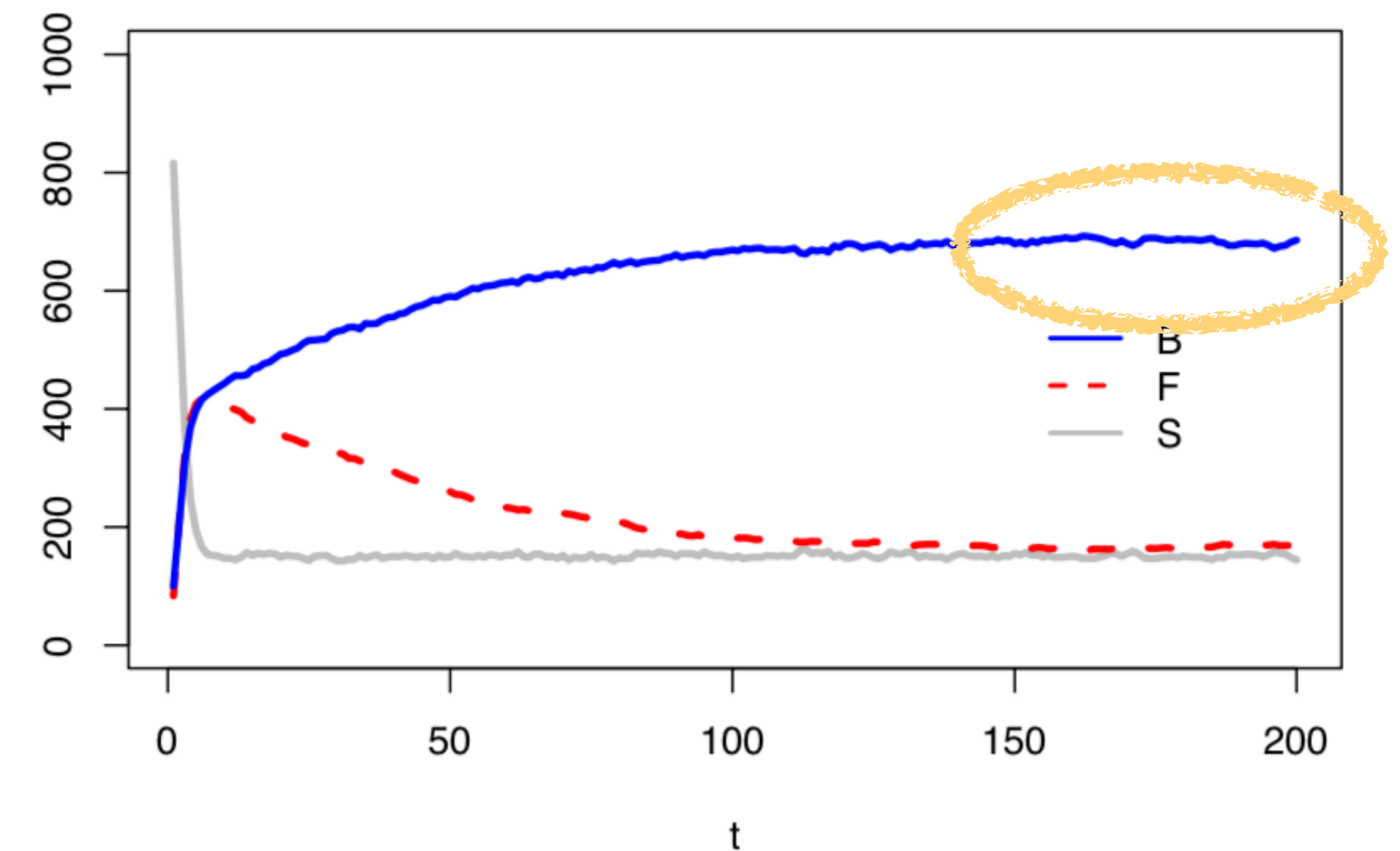
skeptical group:

- α : 0.3
- ~~seeders FC: 10%~~
- seeders are eFC

Simulation start



Simulation results



better, but still...

Hubs as eternal fact-checkers

Setting

segregation: 0.92 (high)

forgetting: 0.1 (low)

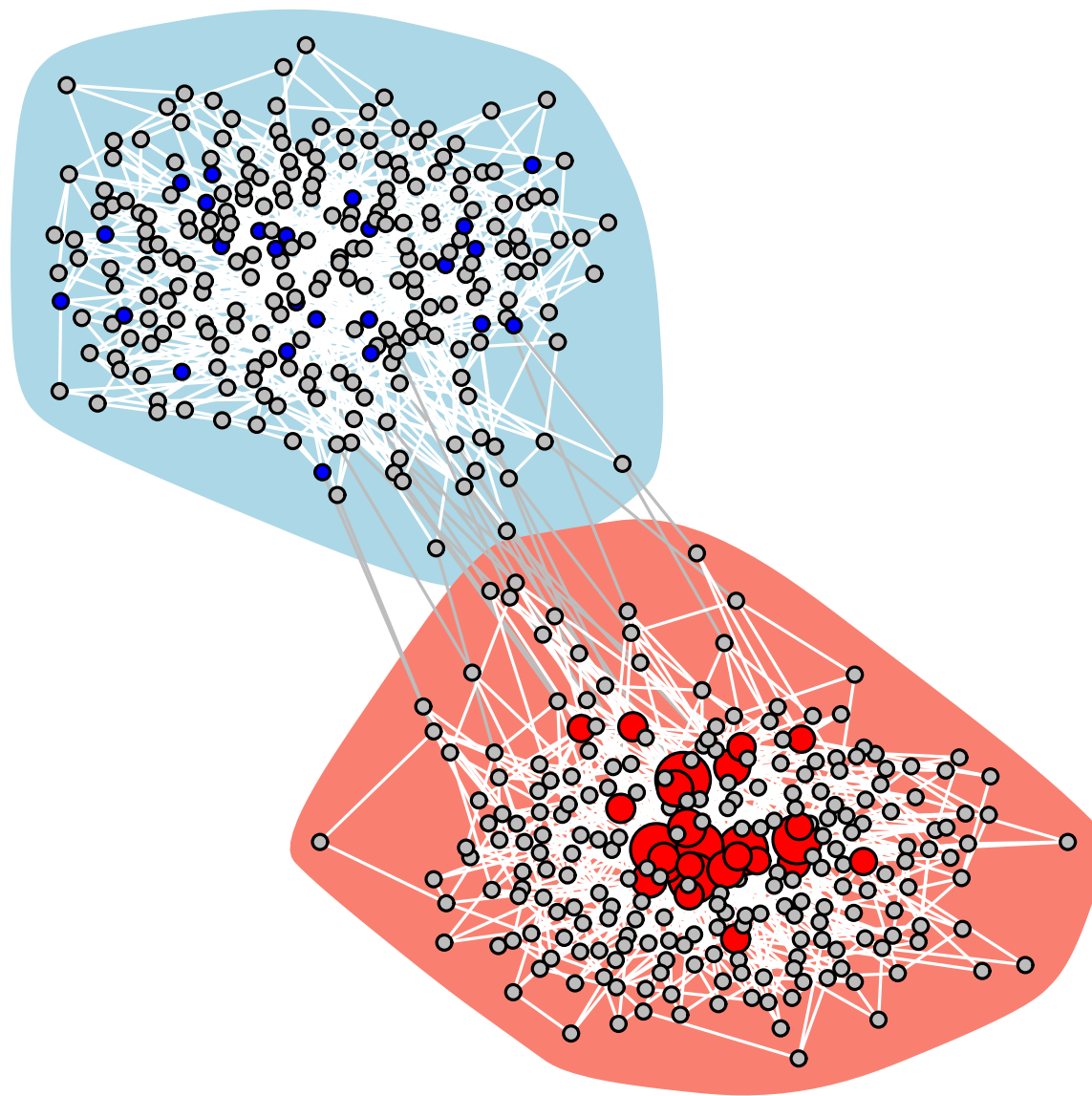
gullible group:

- α : 0.8
- seeders B: 10%

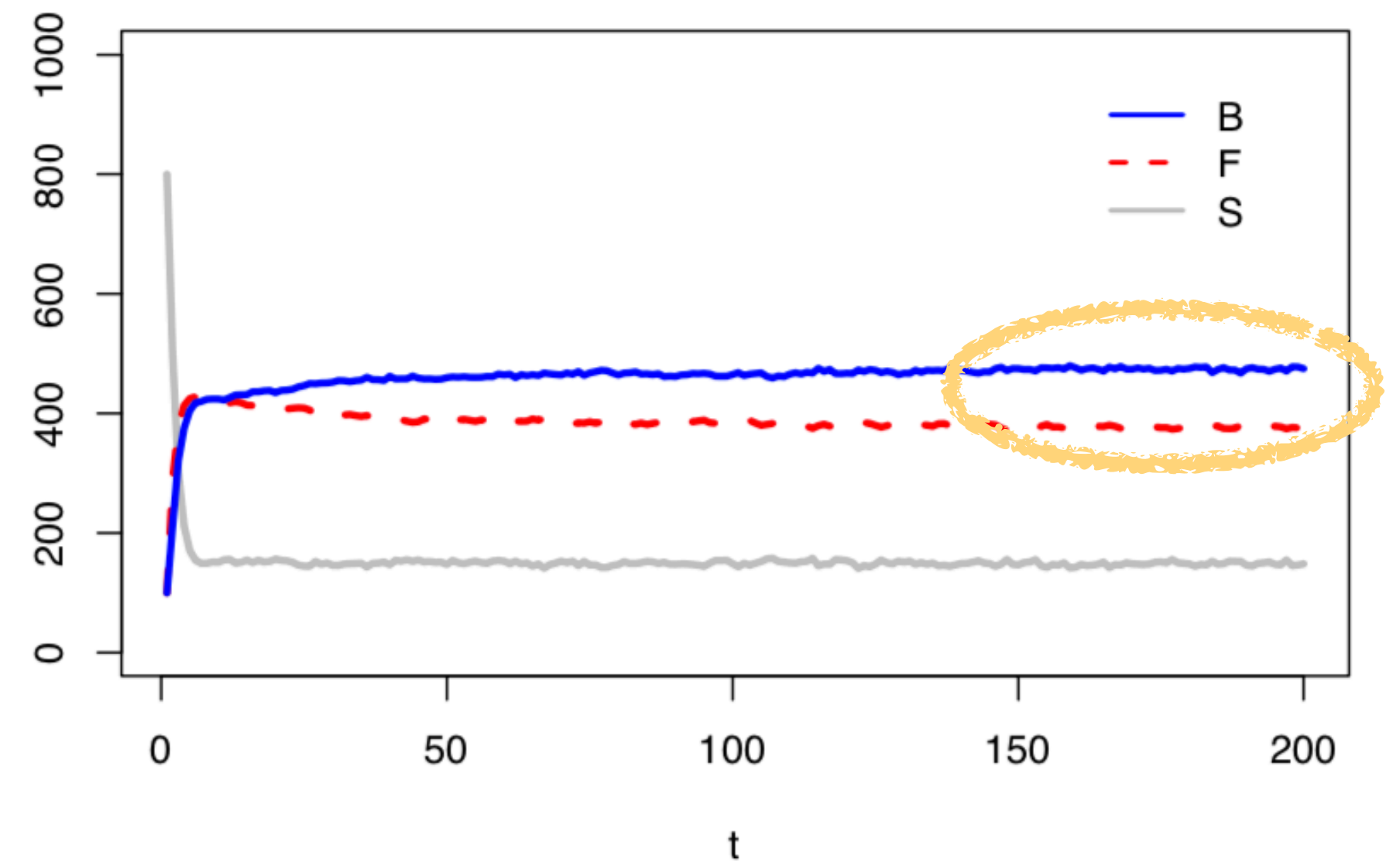
skeptical group:

- α : 0.3
- ~~seeders FC: 10%~~
- **HUBS are eFC!**

Simulation start



Simulation results



better

Bridges as eternal fact-checker

Setting

segregation: 0.92 (high)

forgetting: 0.1 (low)

gullible group:

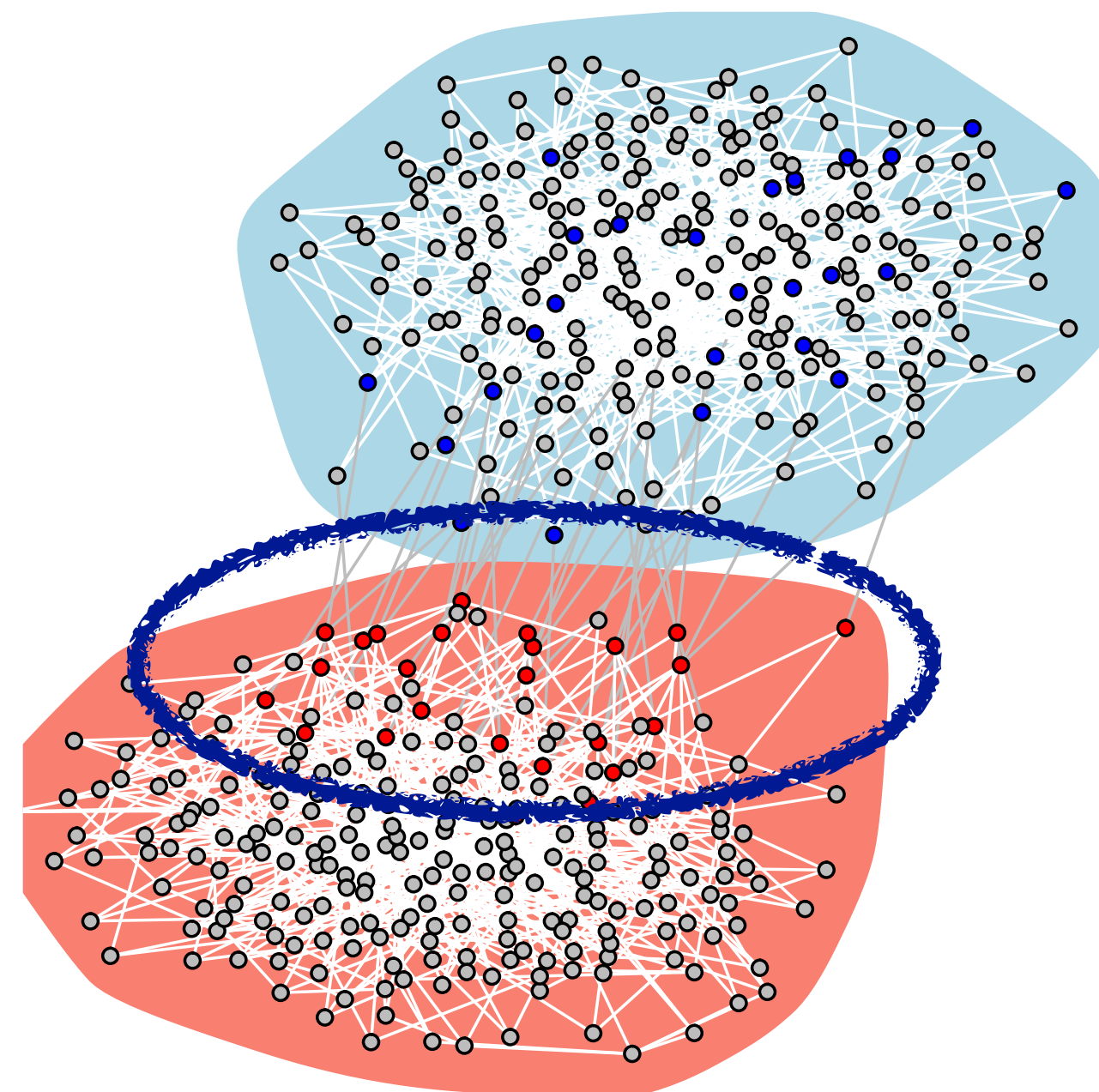
- α : 0.8
- seeders B: 10%

skeptical group:

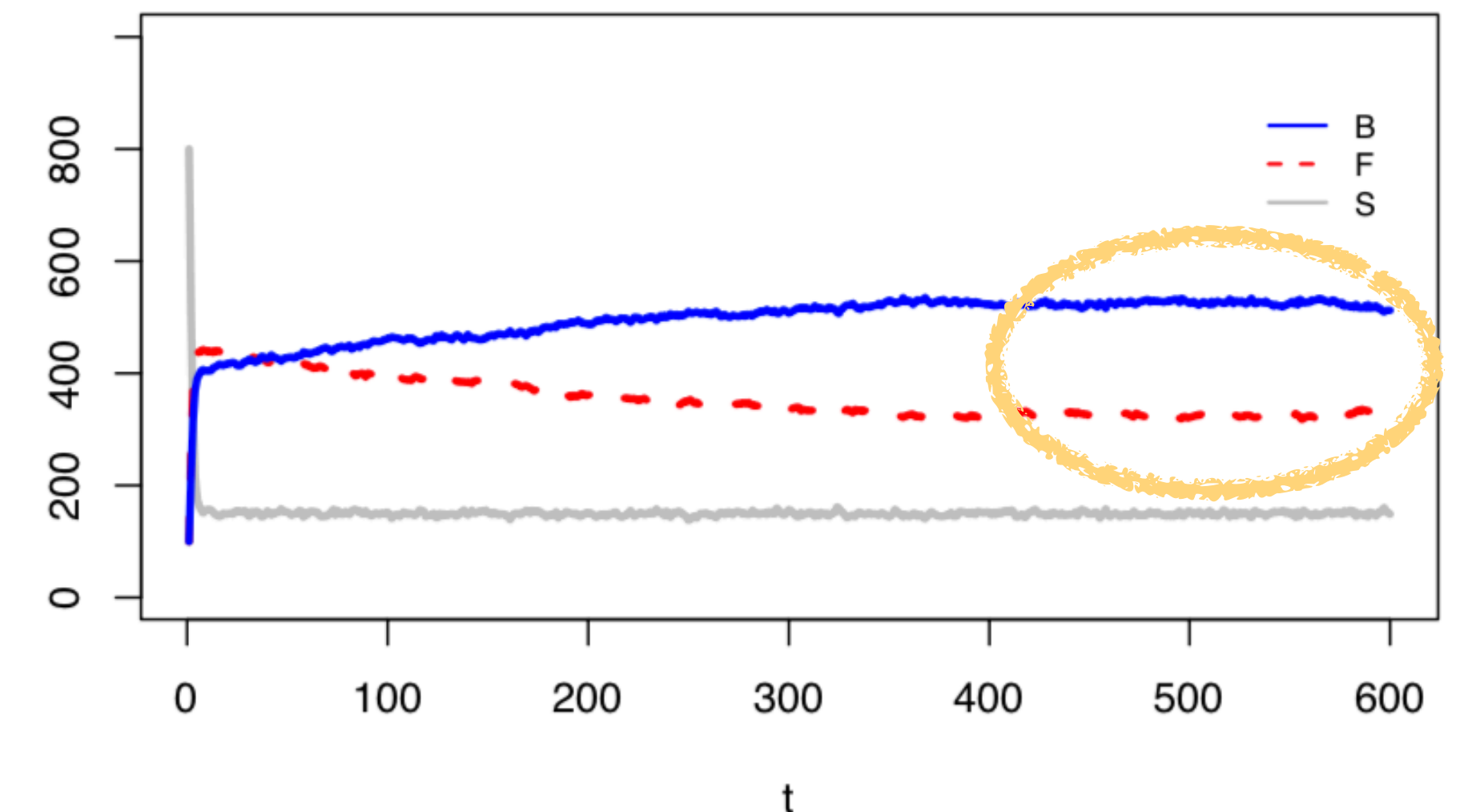
- α : 0.3
- seeders FC: 10%

- **BRIDGES are eFC!**

Simulation start



Simulation results



comparable, more realistic

Lessons learned and observations

- ❖ **Debunking activism** is often considered useless or **counterproductive**
- ❖ However, a world without fact-checking is harmless against fake-news circulation: **skeptics exposed to misinformation** will turn into **believers** because of **social influence**
- ❖ **Skeptics with links to gullible subjects** should be the first to be exposed to the fact-checking: misinformation will survive in the network, but their communities can be ‘protected’ by such **gatekeepers**
- ❖ Note: no socio-psychological assumption so far. Real world is much more complicated

protect the vulnerable, encourage skepticism

Who is the gatekeeper?

Finland is winning the war against fake news in the classrooms: **education first**

Teachers and the education system have a great **responsibility**

CNN

Twitter Facebook

SPECIAL REPORT

Finland is winning the war on fake news. What it's learned may be crucial to Western democracy

By Eliza Mackintosh, CNN
Video by Edward Kiernan, CNN



Helsinki, Finland (CNN) – On a recent afternoon in Helsinki, a group of students gathered to hear a lecture on a subject that is far from a staple in most community college curriculums.

Standing in front of the classroom at Espoo Adult Education Centre, Jussi Toivanen worked his way through his PowerPoint presentation. A slide titled “Have you been hit by the Russian troll army?” included a checklist of methods used to deceive readers on social media: image and video manipulations, half-truths, intimidation and false profiles.

Language and network structure

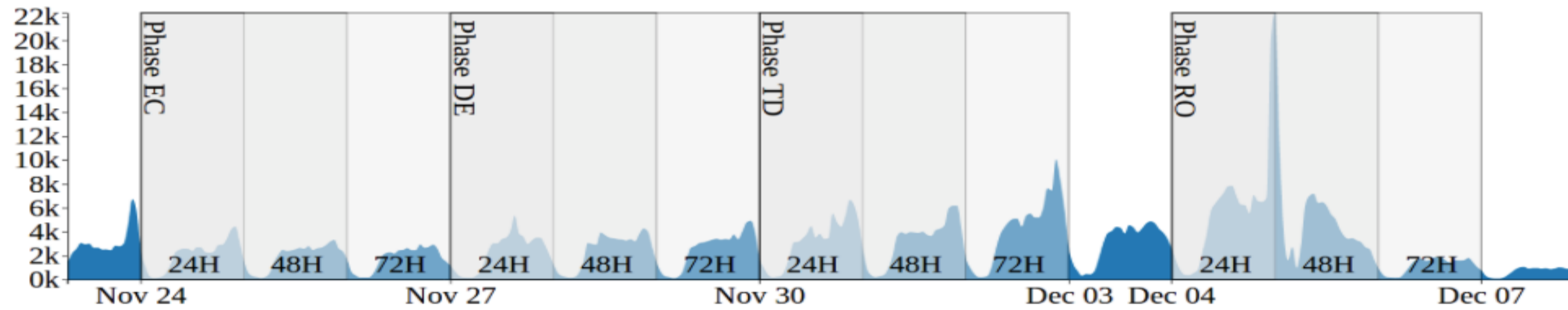
Links to NLP

- ❖ Individual's opinions are often hidden
- ❖ Social Media provide much data for stance detection, emotion analysis, and so on
- ❖ Communication styles can be another trigger or just a reaction to news exposition and partisanship
- ❖ Relationships between structural segregation and opinion formation and polarization should be explored further by a joint effort between our scientific communities



Italian 2016 Constitutional Referendum

Collected Tweets



- stance detected as **AGAINST**
- stance detected as **IN FAVOR**
- stance detected as **NONE**

EC



DE



TD



RO

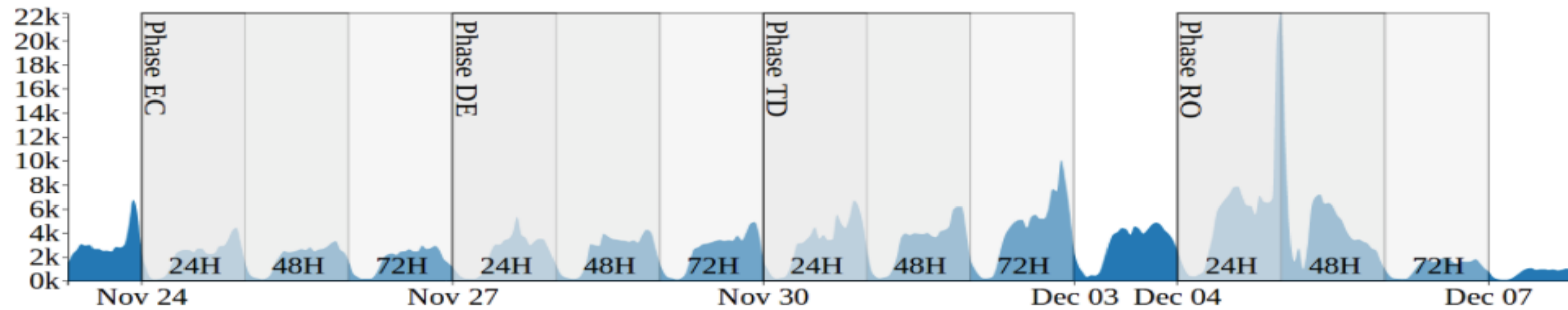


Retweet Network

strong signal of
homophily

Italian 2016 Constitutional Referendum

Collected Tweets



EC

DE

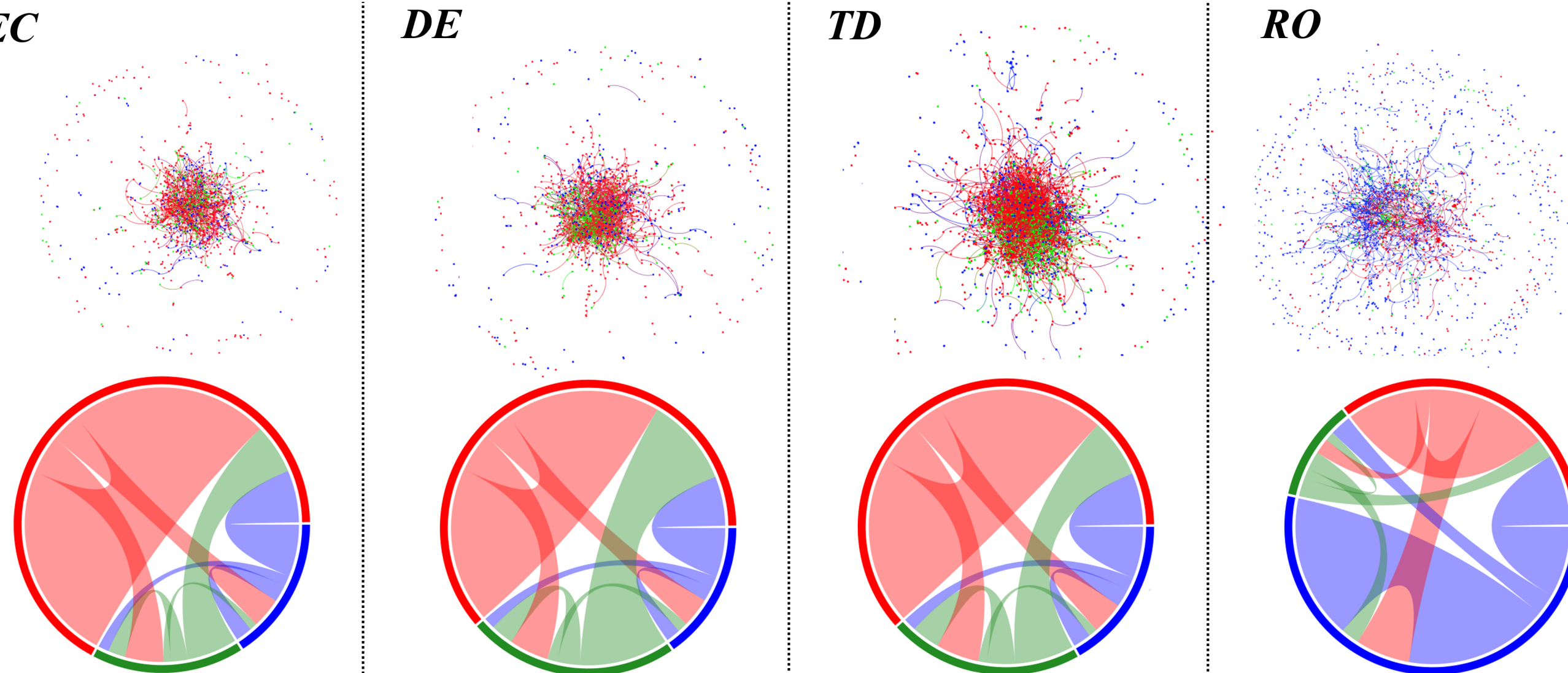
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Reply-to Network

signal of inverse homophily

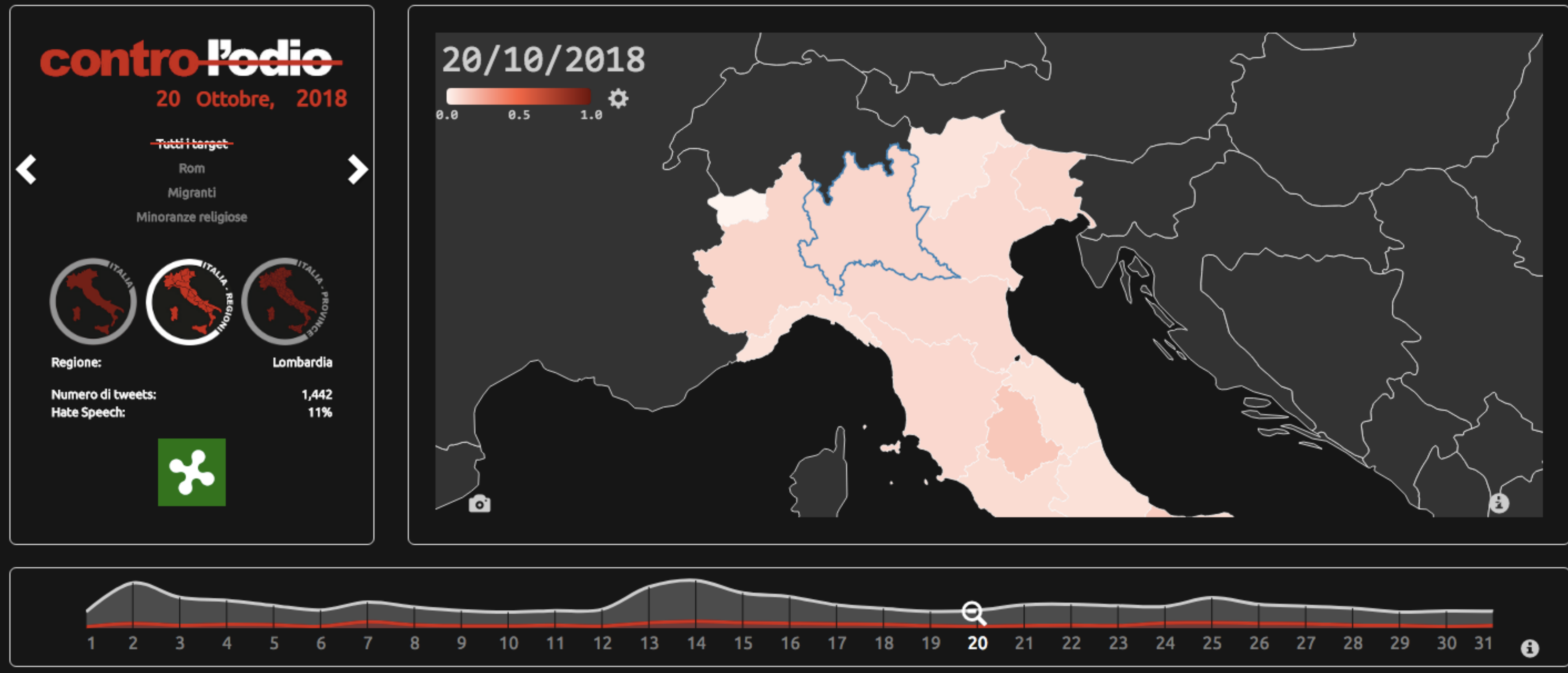
- stance detected as **AGAINST**
- stance detected as **IN FAVOR**
- stance detected as **NONE**



Stance detection and Network Homophily

- ❖ ML-based **stance detection** is a NLP tool extremely useful for computational social science analyses
- ❖ We need **approximation** of users' opinions
- ❖ Building networks that **evolve** when the polarizing debate takes place is an opportunity to study the **interplay between structure and opinions**
- ❖ Apparently in Twitter retweets and reply-to are used to respectively show agreement or disagreement. If you look for disputes, **dig the reply-to messages**

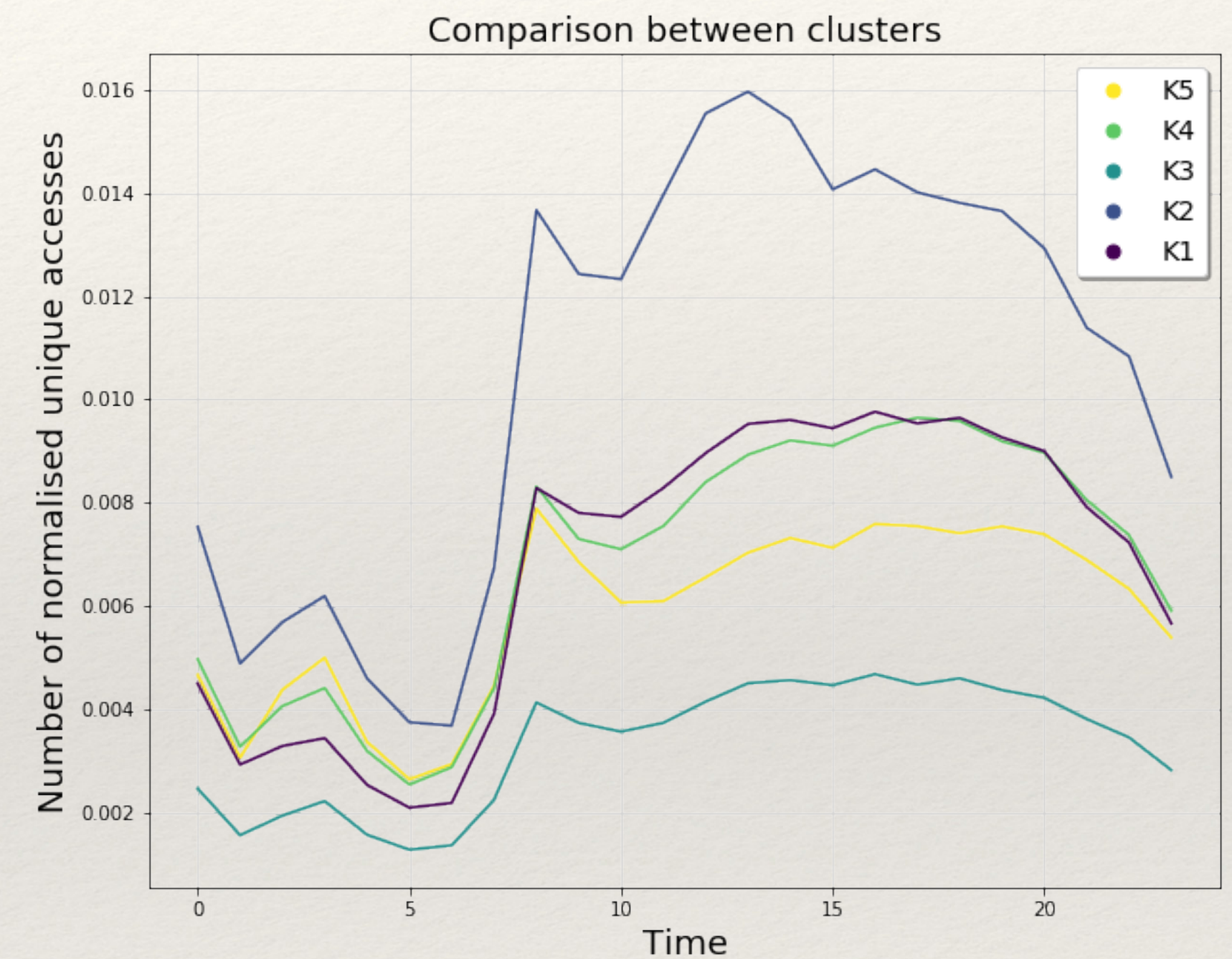
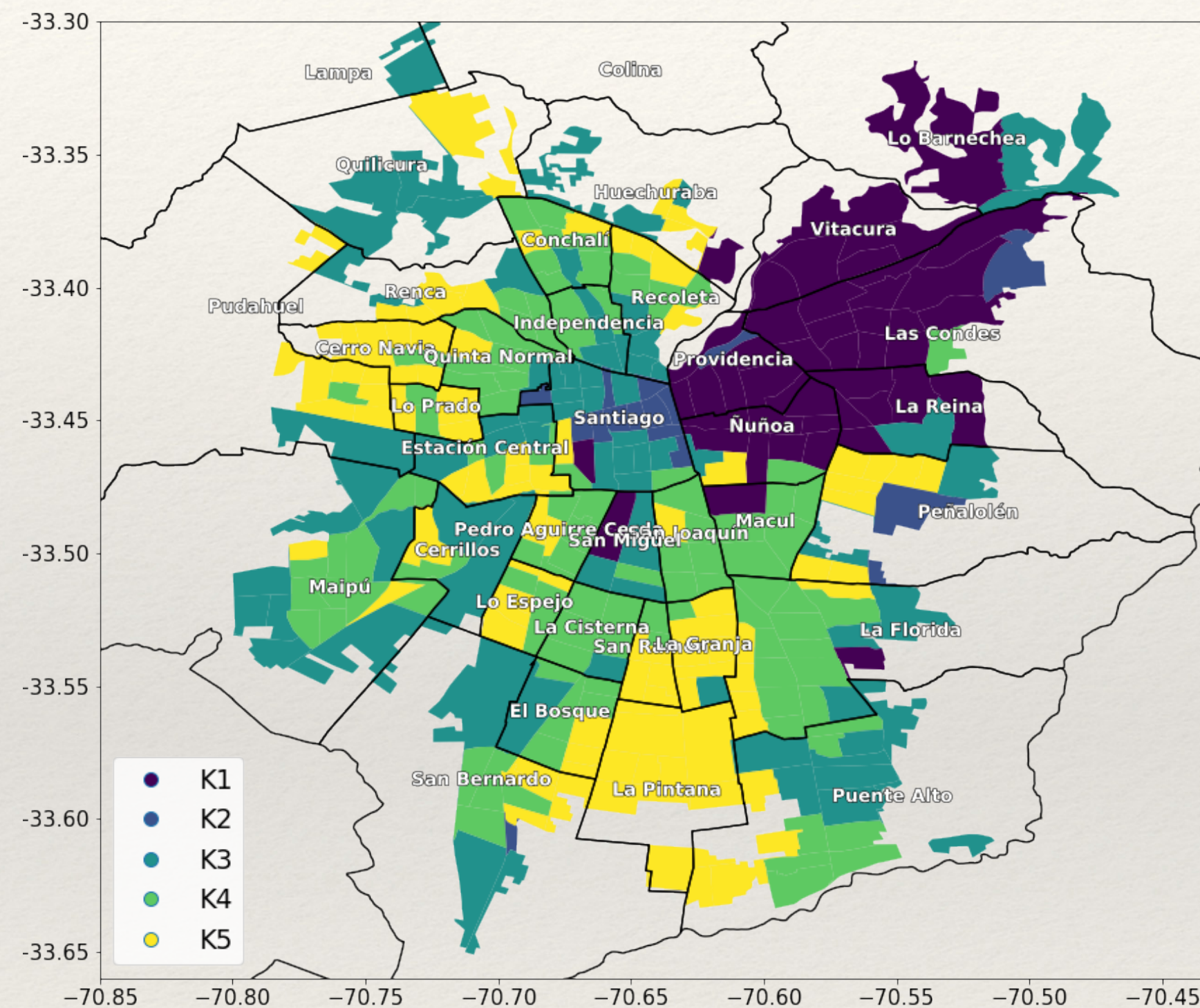
Hate speech monitoring (Contro l'Odio)



A T E Capozzi, V Patti, G Ruffo, and C Bosco. 2018. [A Data Viz Platform as a Support to Study, Analyze and Understand the Hate Speech Phenomenon](#). In Proceedings of the 2nd International Conference on Web Studies (WS.2 2018), ACM

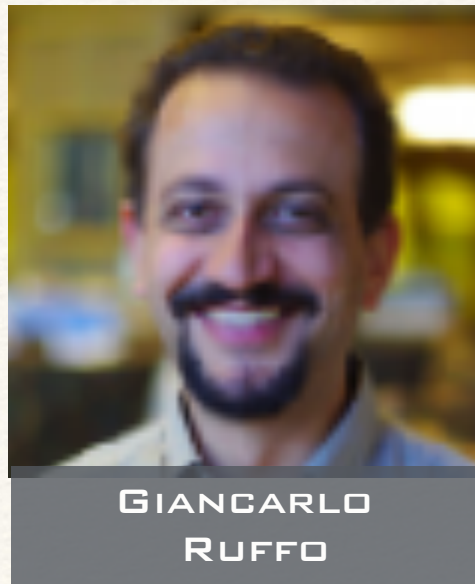
Segregation vs information consumption

Study of geo-located accesses to websites of **news media** revealed strong differences between different "classes" of the population of SCL.



Recap and conclusions

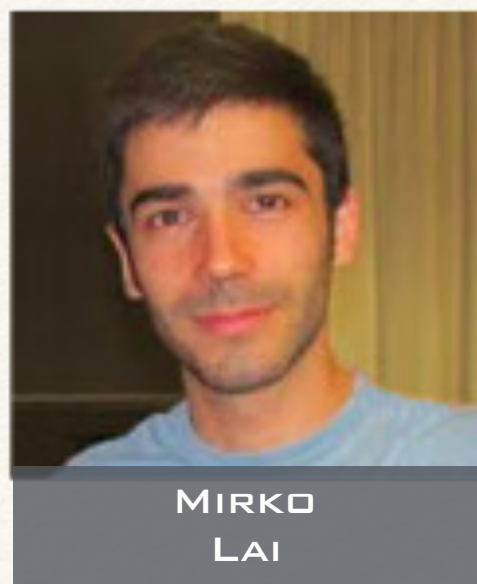
- ❖ **Structural segregation** (as in Lilliput and Blefuscu islands) may be one of the main triggers of opinion polarization
- ❖ **Fake-news spreading**, especially when partisanship and antagonistic behavior reinforce the debate, is **facilitated** in segregated networks
- ❖ Fact-checking is needed and skeptics with links to more gullible (vulnerable) contacts can be recruited as **gatekeepers**
- ❖ **Network Analysis** and **NLP** are great tools for modeling and analyzing data in this domain
- ❖ On going work on **balance theory** provides a so far neglected framework to study the interplay between opinion polarization and structural segregation: new **algorithms** and **visualizations tools** can be added to the analytical loop
- ❖ Beware of the **interplay**: segregation causes polarization and vice-versa



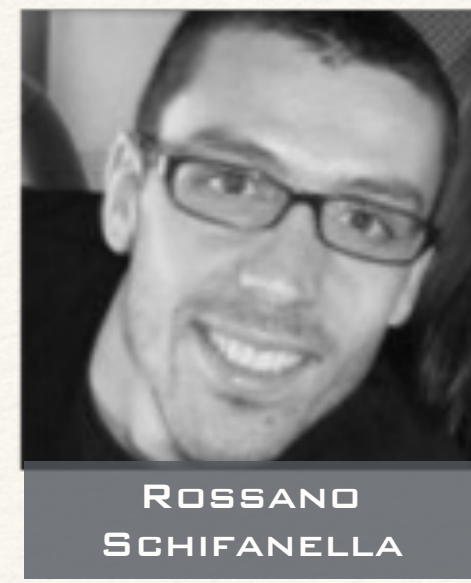
GIANCARLO RUFFO



MARCELLA TAMBUSCIO



MIRKO LAI



ROSSANO SCHIFANELLA



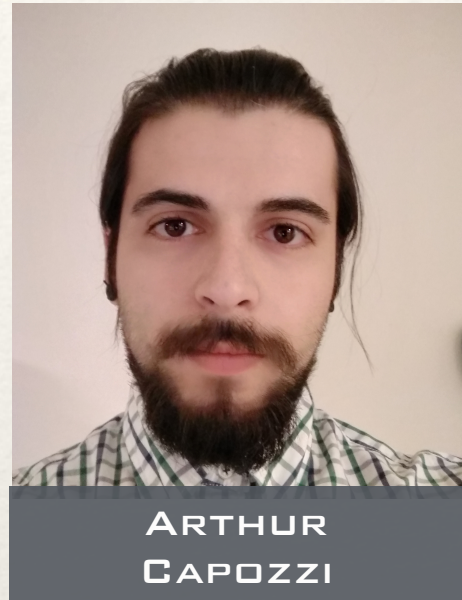
ANDRÉ PANISSON



LUCA AIELLO



VIVIANA PATTI



ARTHUR CAPOZZI



EDUARDO GALIMBERTI



ALFONSO SEMERARO



ALESSANDRA URBINATI



SALVATORE VILELLA



EMILIO SULIS



MARTINA DEPLANO



CRISTINA BOSCO

ARC²S: Applied Research on Computational Complex Systems

Thanks!

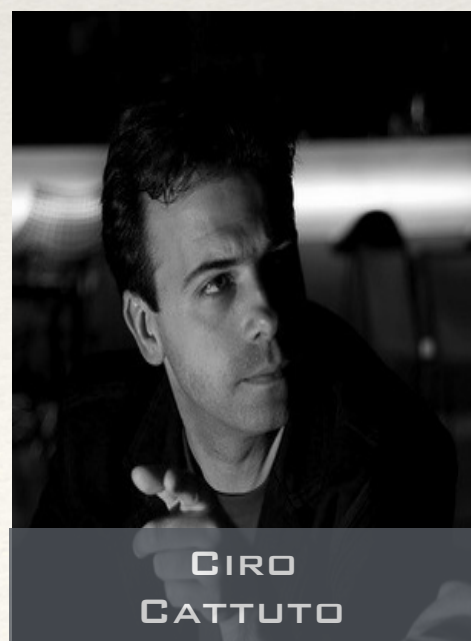
http://www.di.unito.it/~ruffo/talks/2019_Oct_NEU.pdf



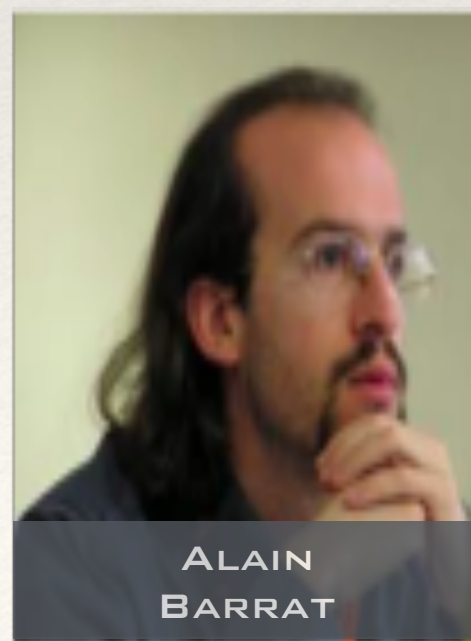
PAOLO ROSSO



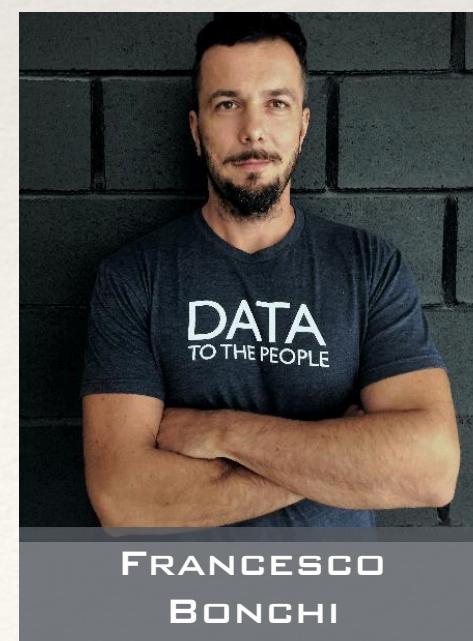
LEO FERRER



CIRO CATTUTO



ALAIN BARRAT



FRANCESCO BONCHI



DANIELA PAIOTTI



CHENGCHENG SHAO



GIOVANNI LUIGI CIAMPAGLIA



ALESSANDRO FLAMMINI



FIL MENCZER