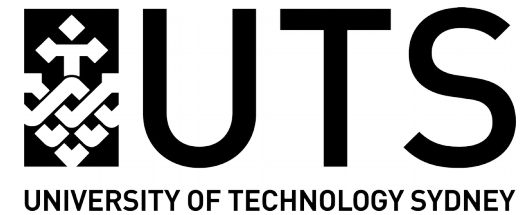
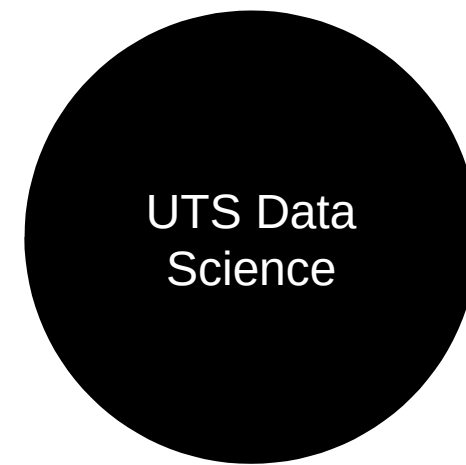




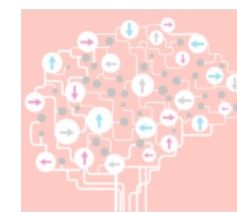
Behavioral  
Data Science



# Modeling social processes: virality, disinformation, bots and troll in information cascades

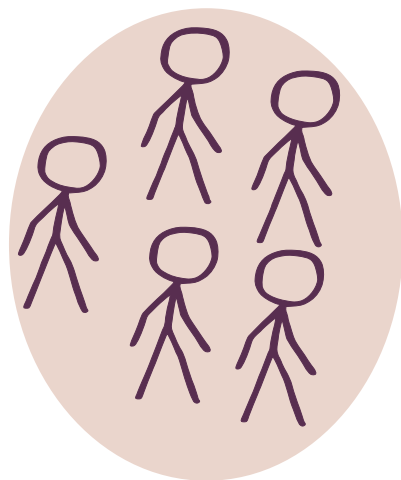
Marian-Andrei RizoIU

# Research objectives

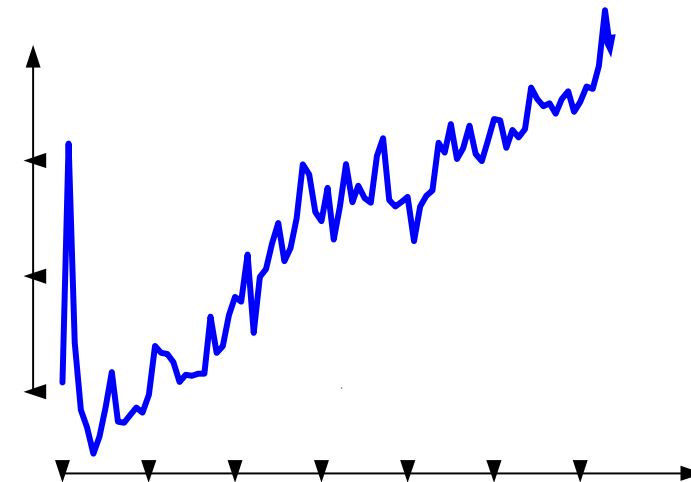


Behavioral  
Data Science

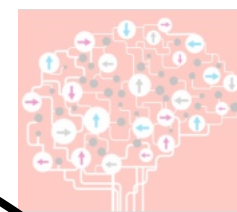
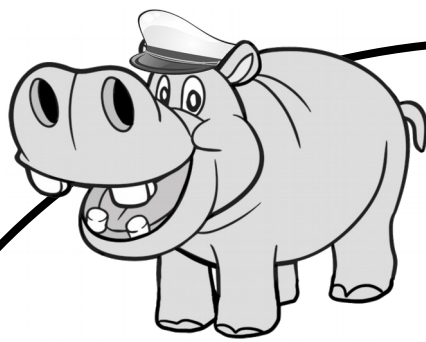
1.



information diffusion  
epidemics spreading  
behavioral modeling



# Online virality & popularity



Behavioral  
Data Science

[Rizoiu et al,  
ICWSM'17]

[Rizoiu et al,  
WWW'17]

[Wu et al,  
ICWSM'18]

[Wu et al,  
CSCW'19]

[Kong,  
WWW'18]

[Mishra et al,  
ICWSM'18]

[Mishra et al,  
CIKM'16]

[Rizoiu & Xie,  
ICWSM'18]

[Rizoiu,  
HIPer '20]

[Kong,  
IJCAI '20]

[Ram et al,  
Influence estimation'20]

[Zhang et al,  
IJCAI'19]

[Zhang et al,  
AAAI'20]

[Rizoiu,  
WWW'18]

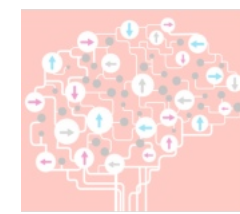
[Kong,  
WSDM '20]



Information  
diffusion models

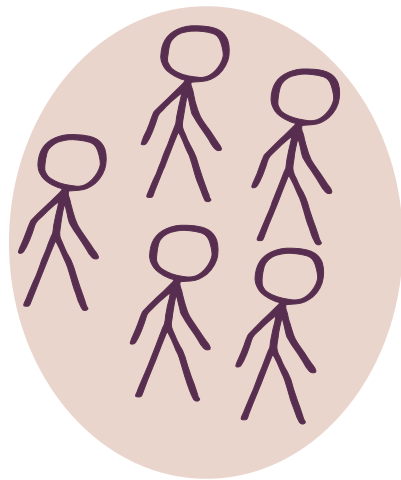
Epidemic models

# Research objectives

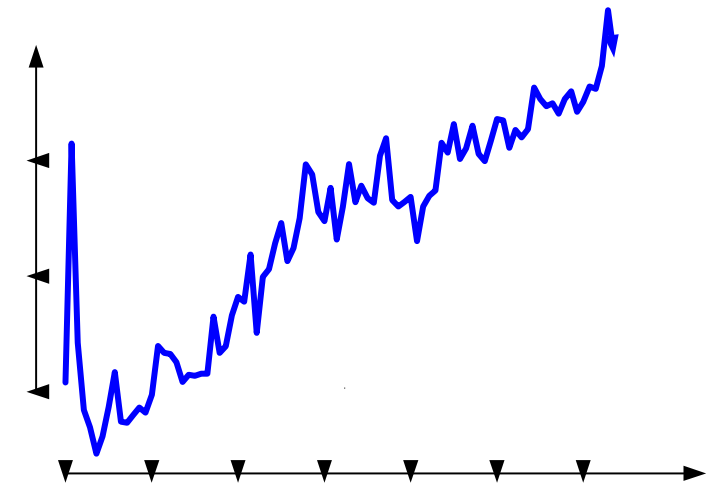


Behavioral  
Data Science

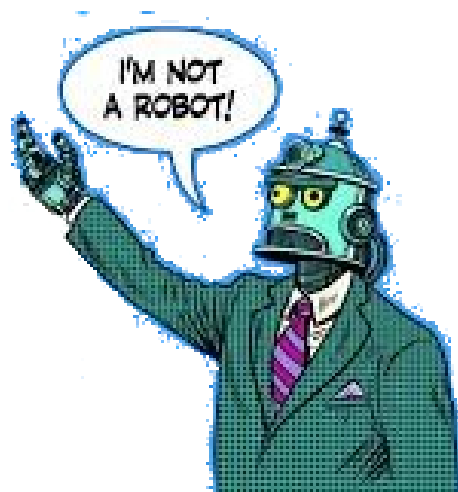
1.



information diffusion  
epidemics spreading  
behavioral modeling



2.

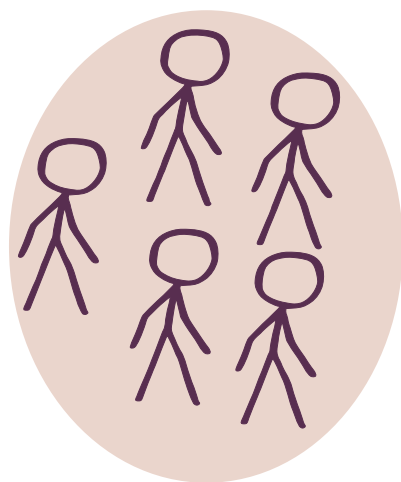


[Rizoiu et al ICWSM'18] [Kim et al Journ.Comp.SocSci'19]

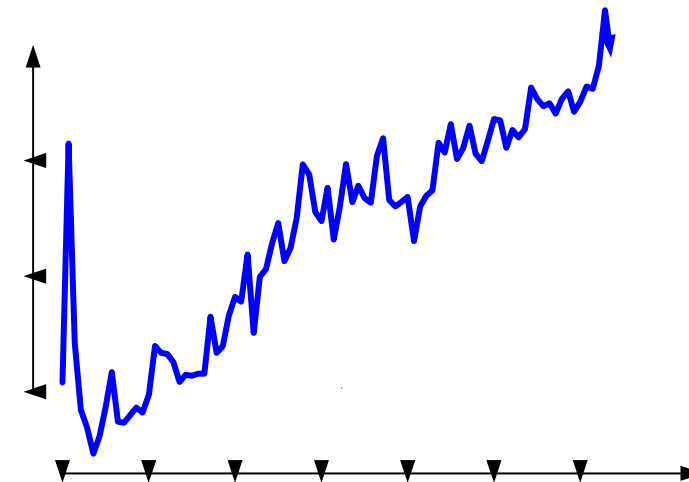
# Research objectives



1.

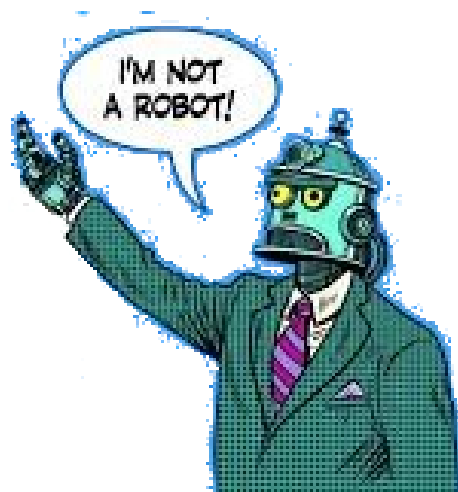


information diffusion  
epidemics spreading  
behavioral modeling



3.

2.



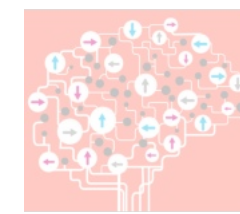
[Rizoiu et al WWW'20]

**FAKE  
NEWS**

[Rizoiu et al ICWSM'18] [Kim et al Journ.Comp.SocSci'19]



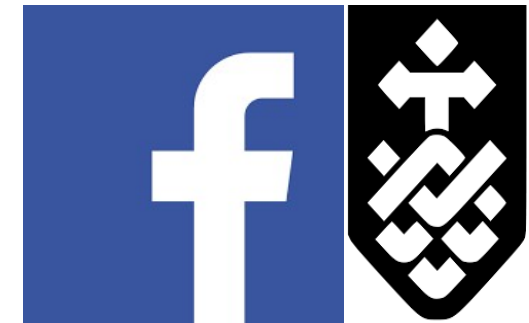
# Significant collaborations



Behavioral  
Data Science



CRAWFORD SCHOOL  
OF PUBLIC POLICY



Twitter Fake news & Bots

Tracking Disinformation  
Campaigns

Hate Speech propagation  
on Social Media



**Australian Government**

**Department of Defence**  
Defence Science and  
Technology Group



**WIKIMEDIA**  
FOUNDATION

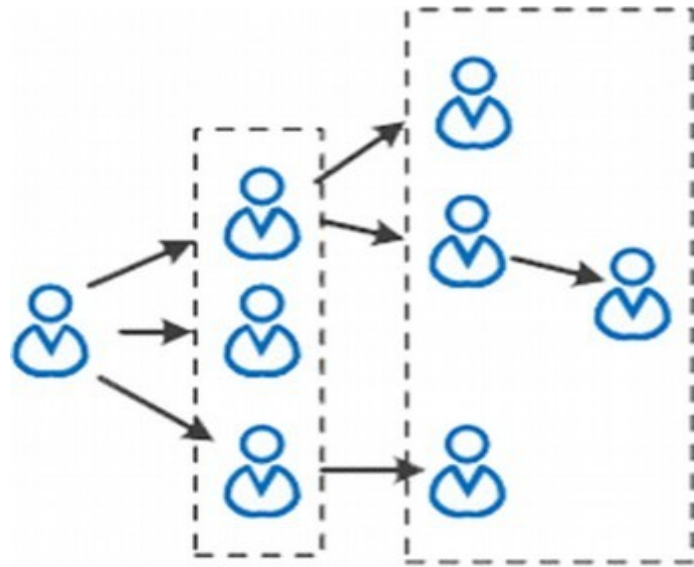


**WIKIPEDIA**  
The Free Encyclopedia

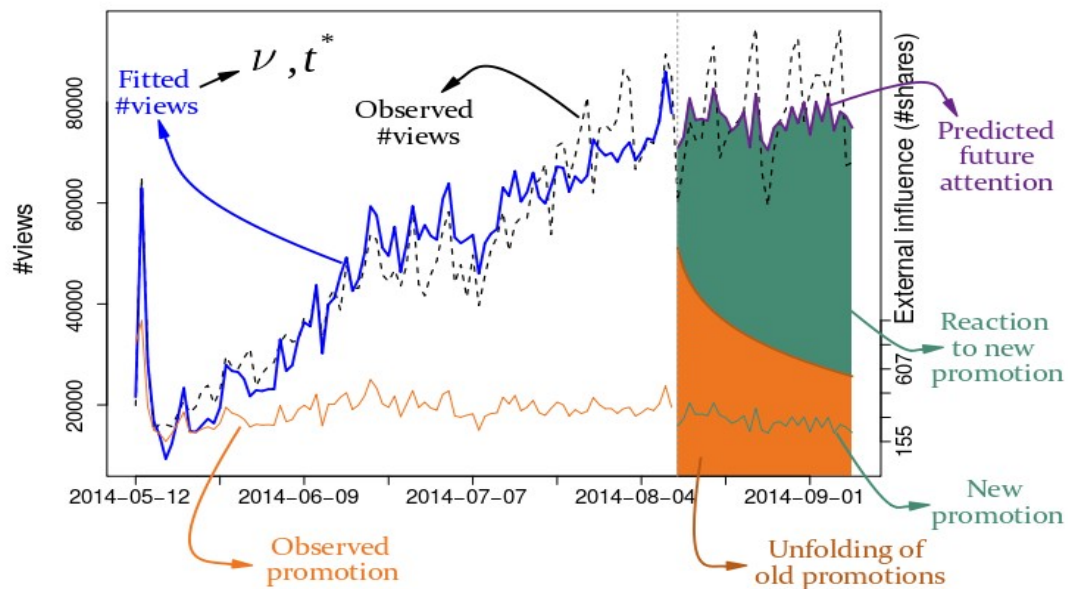
Expert roundtable for  
Defamation law reform

Opinion manipulation  
and information warfare

Detecting and quantifying  
privacy loss over time

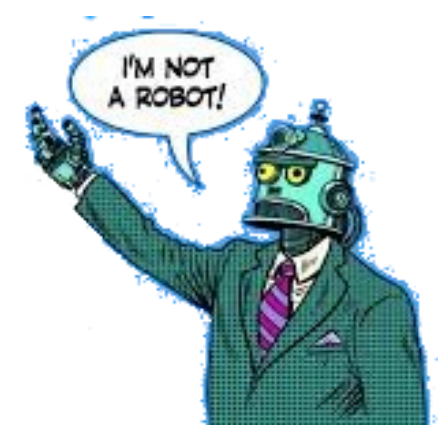


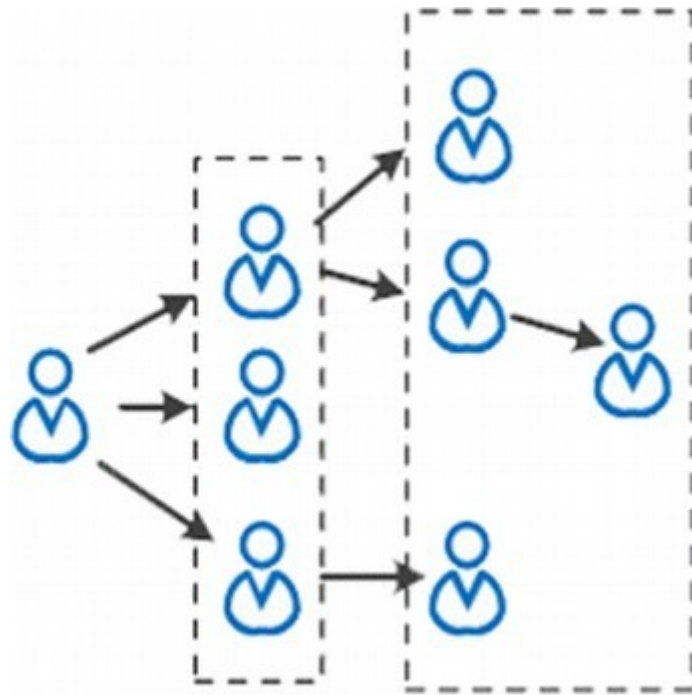
## Modeling information diffusion in social networks



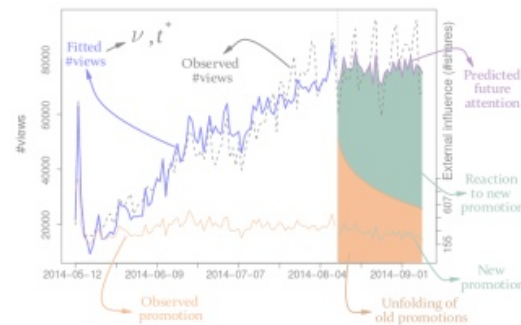
## Modeling and predicting popularity, virality and engagement

## Influencing democratic processes using social media





# Modeling information diffusion in social networks



Modeling and predicting popularity, virality and engagement



Influencing democratic processes using social media



# Modeling information diffusion in social networks

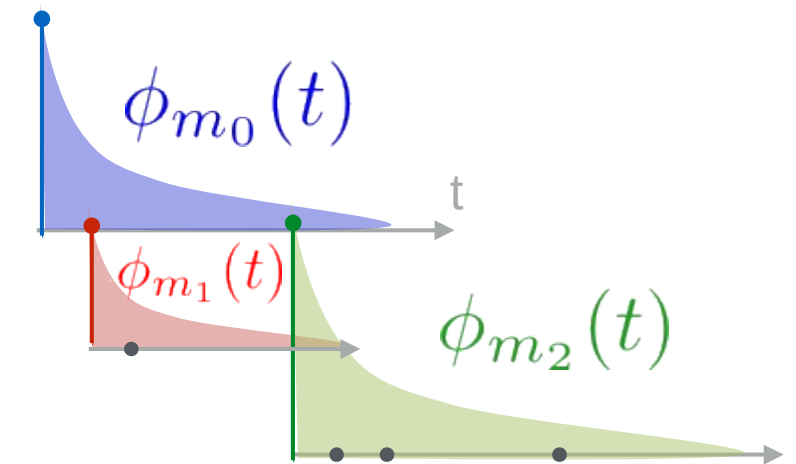


Behavioral  
Data Science

## Hawkes modeling

[Mishra et al CIKM'16]

$$\lambda(t) = \mu(t) + \sum_{t_i < t} \phi_{m_i}(t - t_i)$$



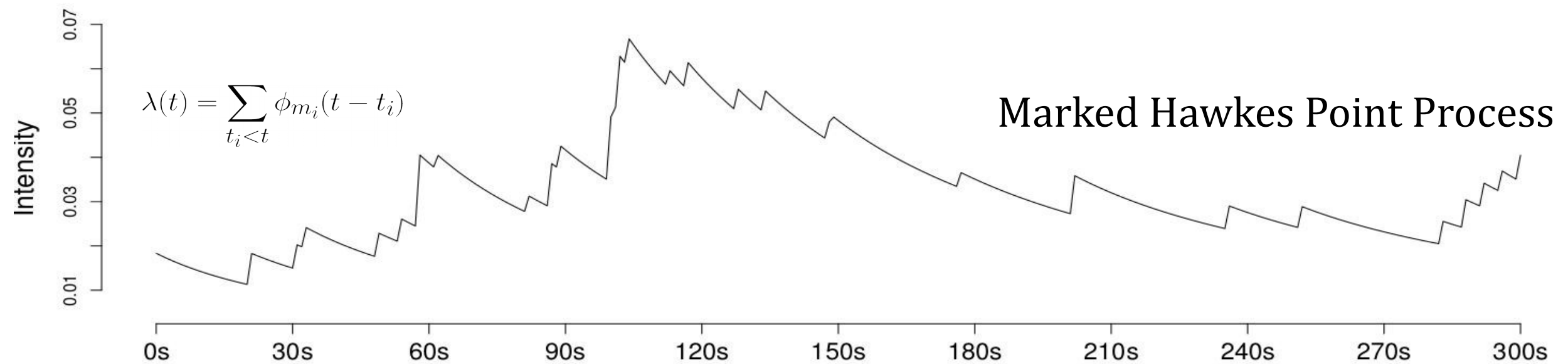
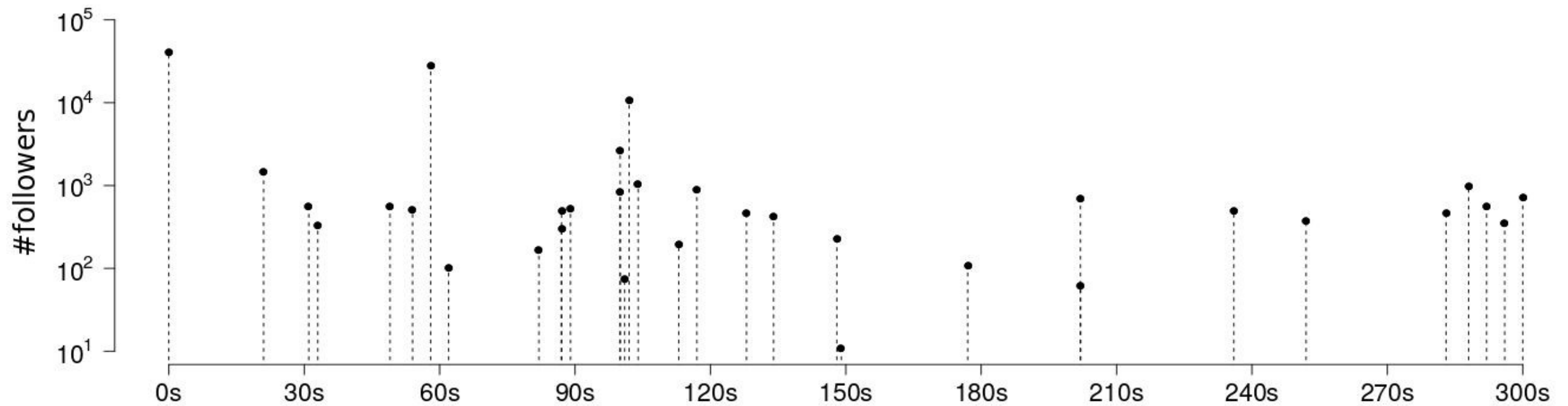
the rate of 'daughter' events    content virality    user influence    memory

$$\phi_m(\tau) = \kappa m^\beta \hat{\tau}^{-(1+\theta)}$$

# Self-Exciting Point Processes



Behavioral  
Data Science

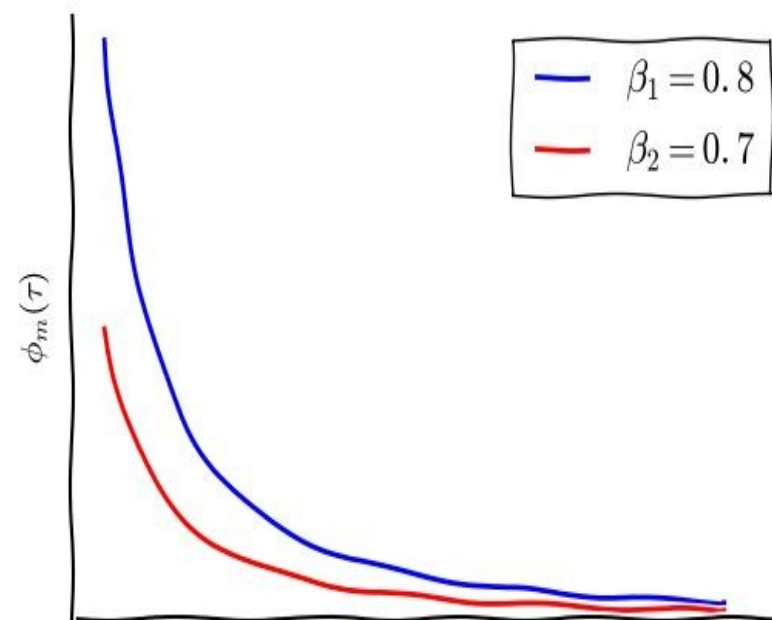
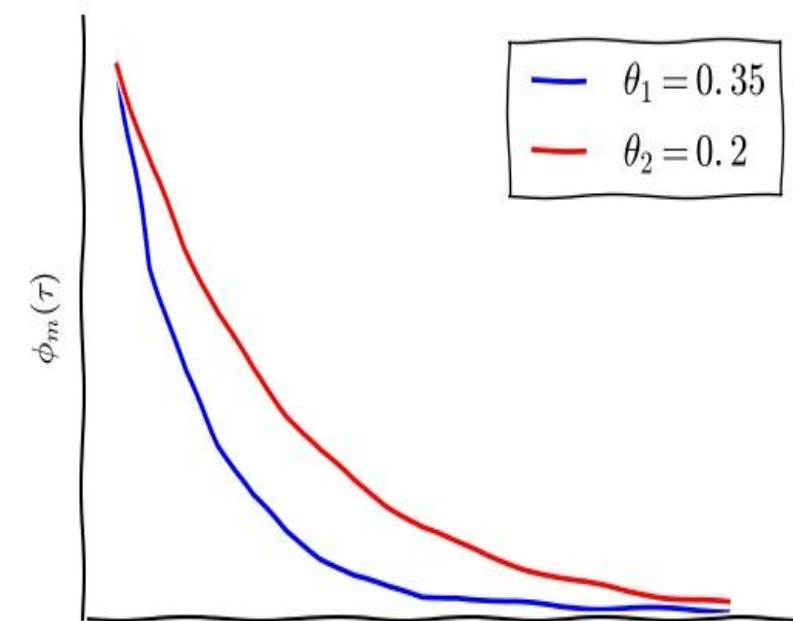
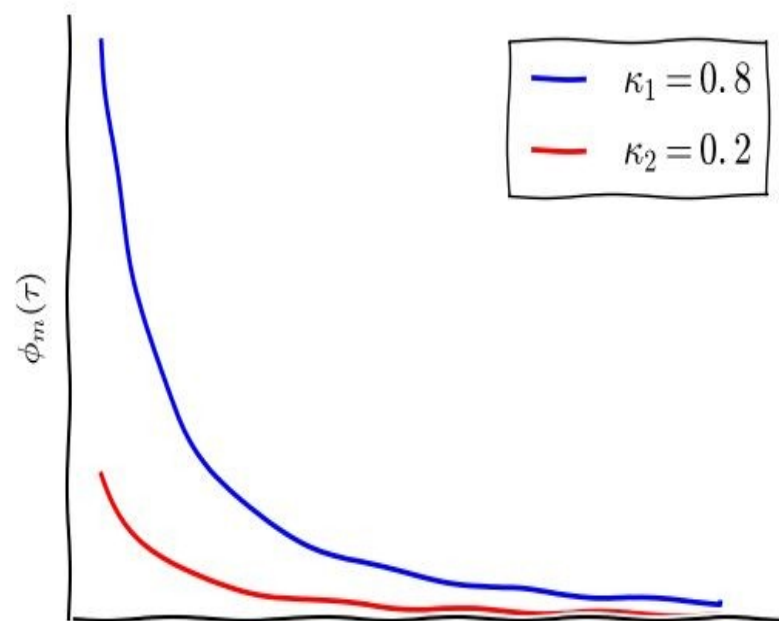


# Kernel for Marked Hawkes



the rate of 'daughter' events    content virality    user influence    memory

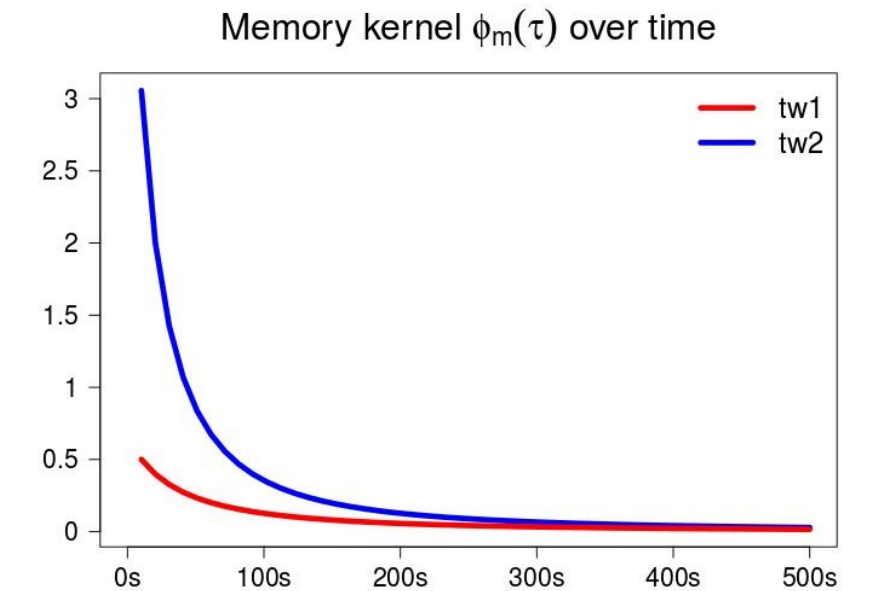
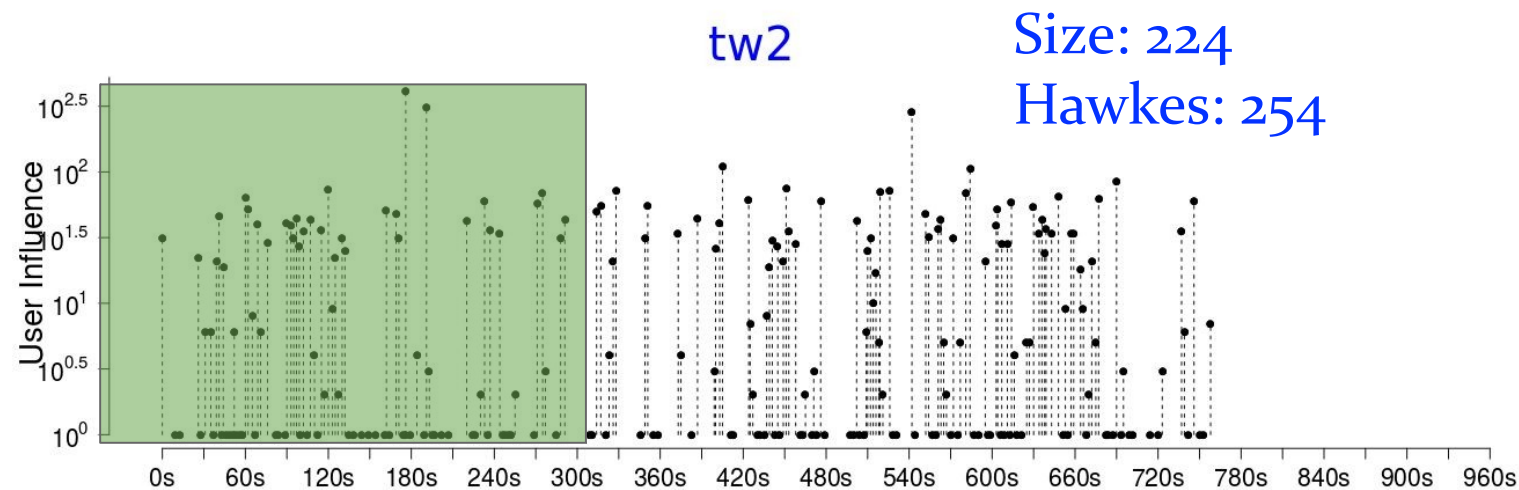
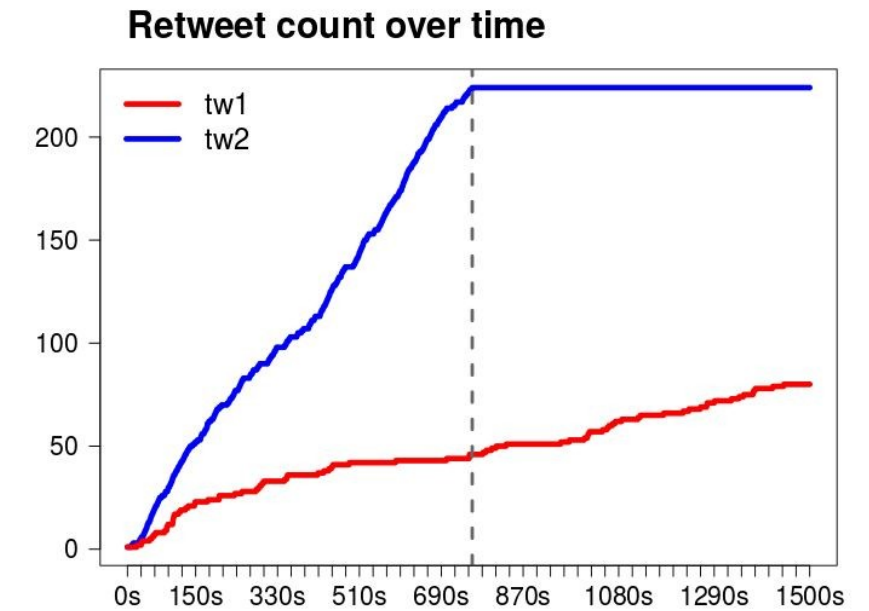
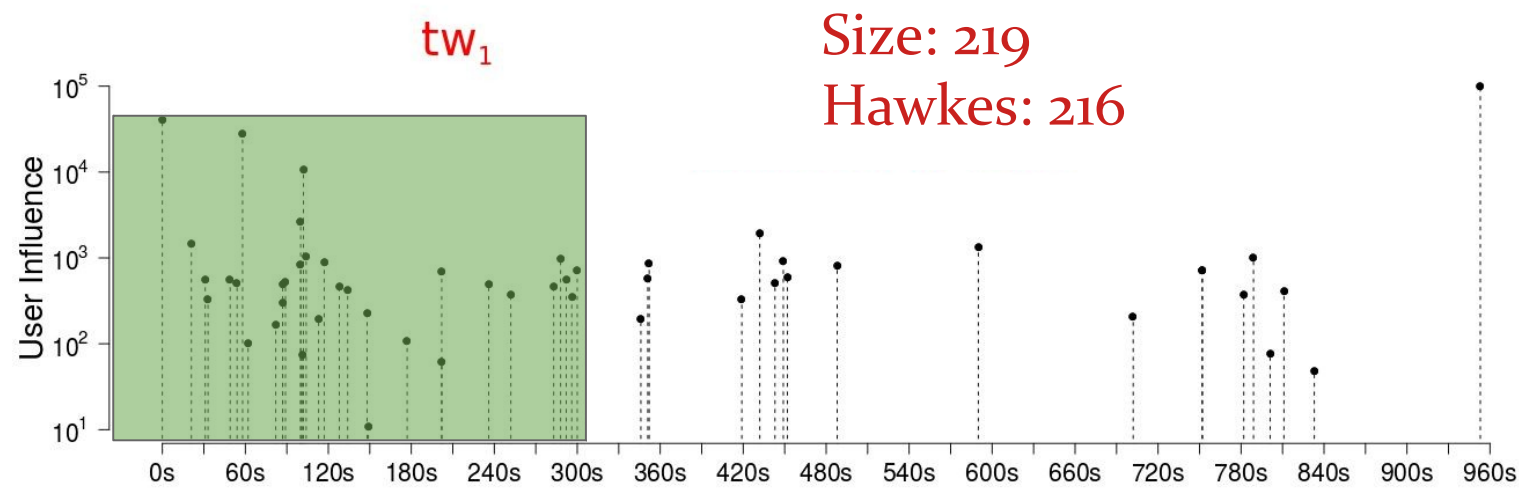
$$\phi_m(\tau) = \kappa m^\beta \hat{\tau}^{-(1+\theta)}$$



# Predict total size & virality



Behavioral  
Data Science



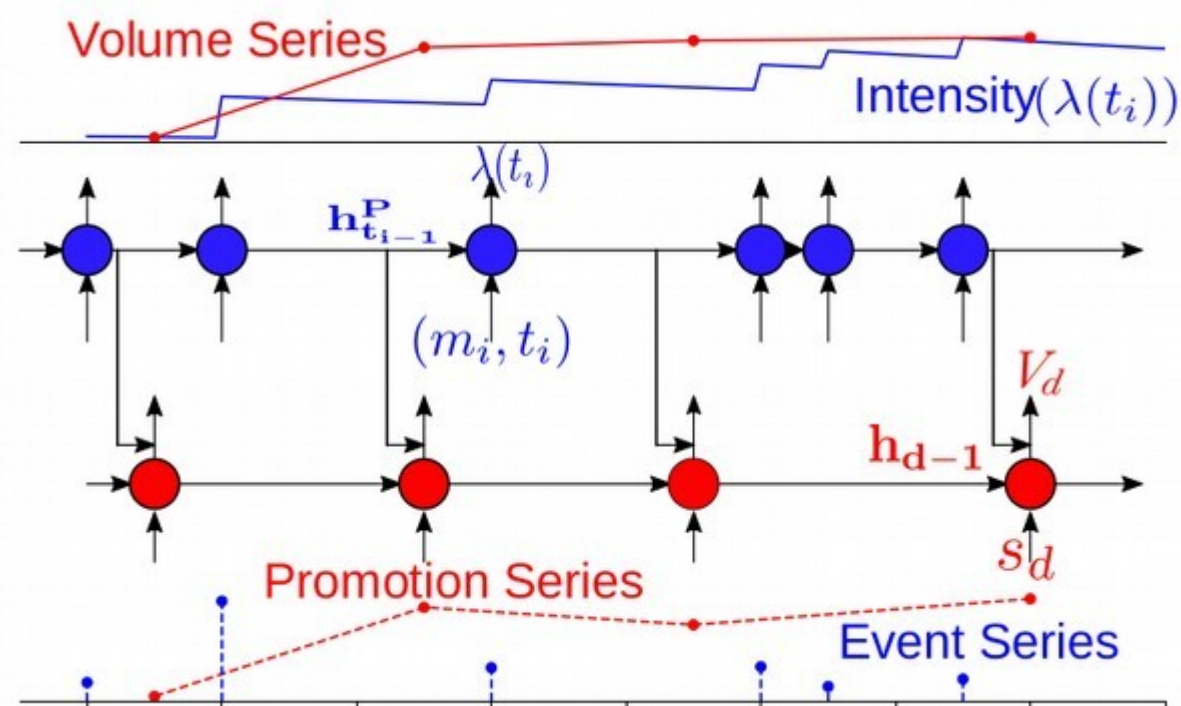




# Modeling information diffusion in social networks

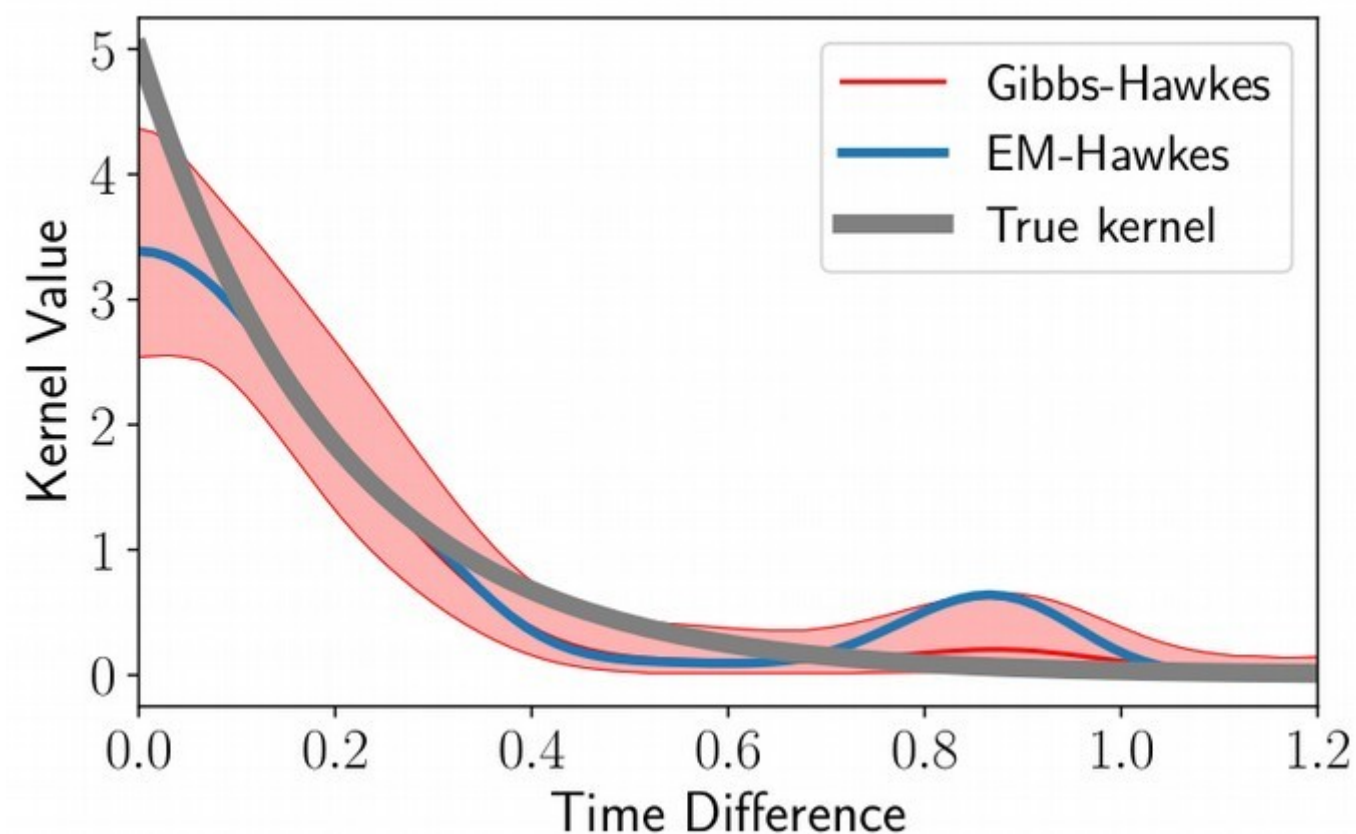
## Neural Hawkes

[Mishra et al ICWSM'18]



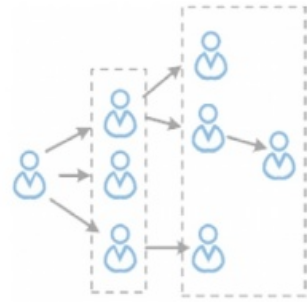
## Bayesian Hawkes

[Zhang et al IJCAI'19]

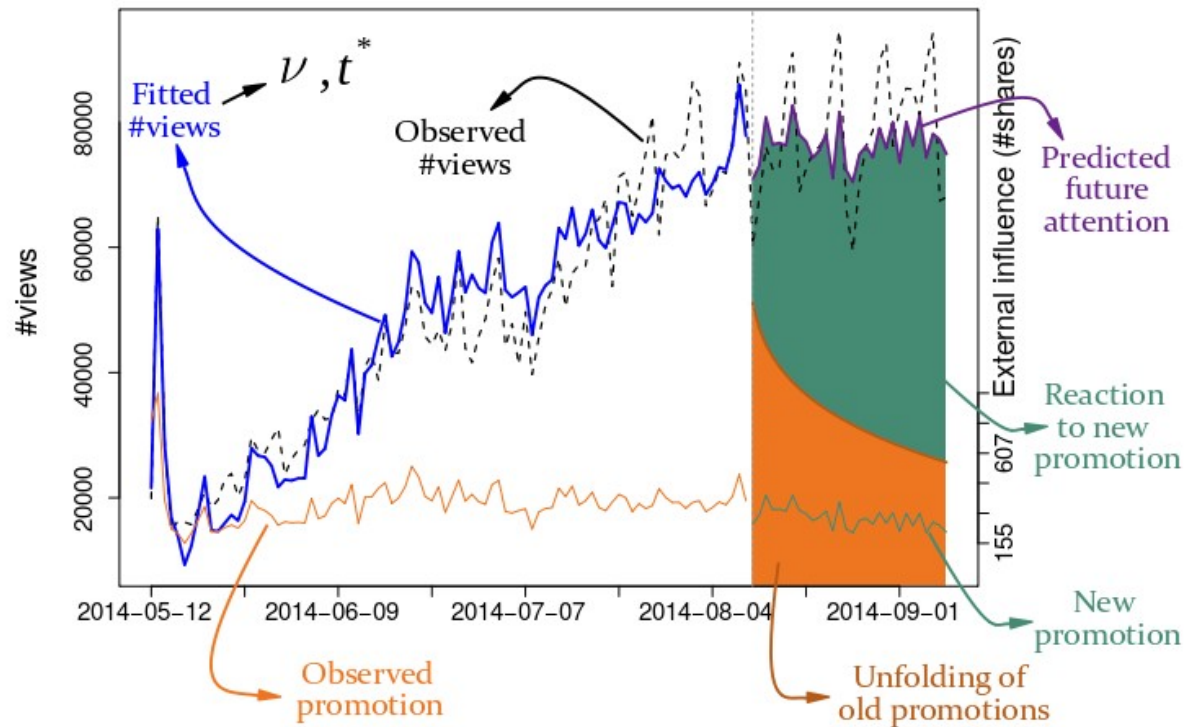


S. Mishra, M.-A. Rizoïu, & L. Xie, "Modeling Popularity in Asynchronous Social Media Streams with Recurrent Neural Networks, " in Proc. International AAAI Conference on Web and Social Media (ICWSM '18), Stanford, CA, USA, 2018. <https://arxiv.org/abs/1804.02101>

R. Zhang, C. Walder, M.-A. Rizoïu and L. Xie. "Efficient Non-parametric Bayesian Hawkes Processes, " in International Joint Conference on Artificial Intelligence (IJCAI'19), Macao, China, 2019. <https://arxiv.org/abs/1905.10496>



Modeling information diffusion in social networks



# Modeling and predicting popularity, virality and engagement



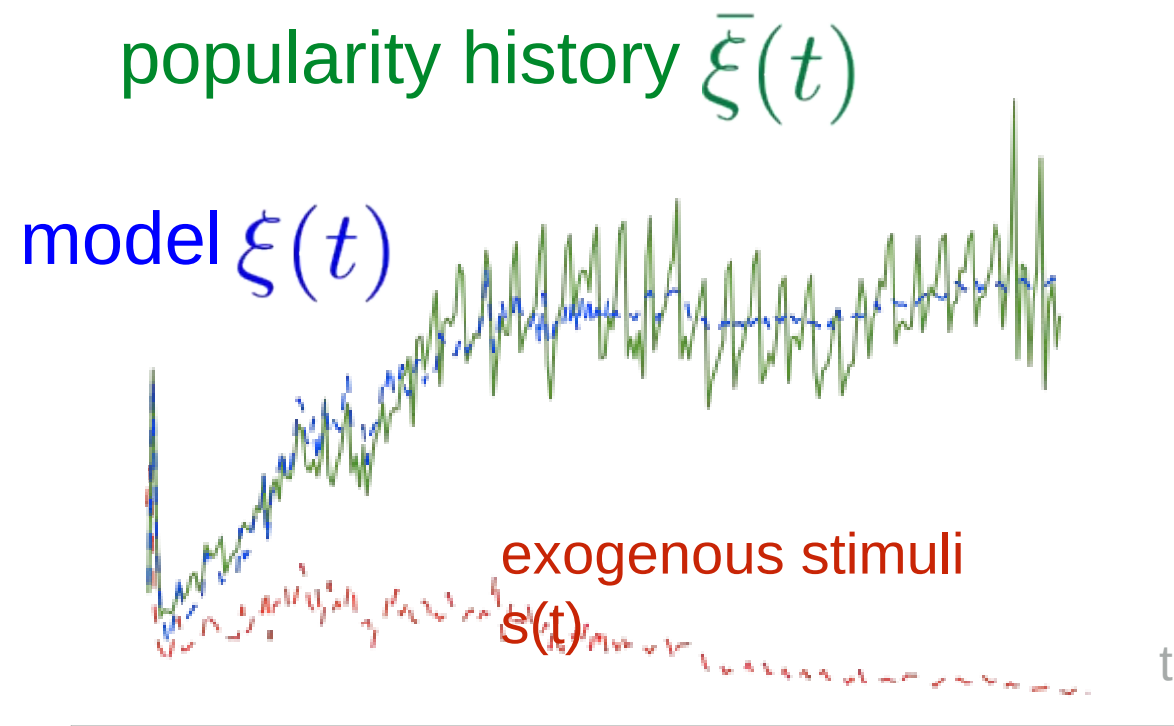
Influencing democratic processes using social media

# Hawkes Intensity processes for online popularity

[Rizoiu et al WWW'17]



Behavioral  
Data Science



$$\xi(t) = \mu s(t) + C \int_0^t \xi(t - \tau) \hat{\tau}^{-(1+\theta)} d\tau$$

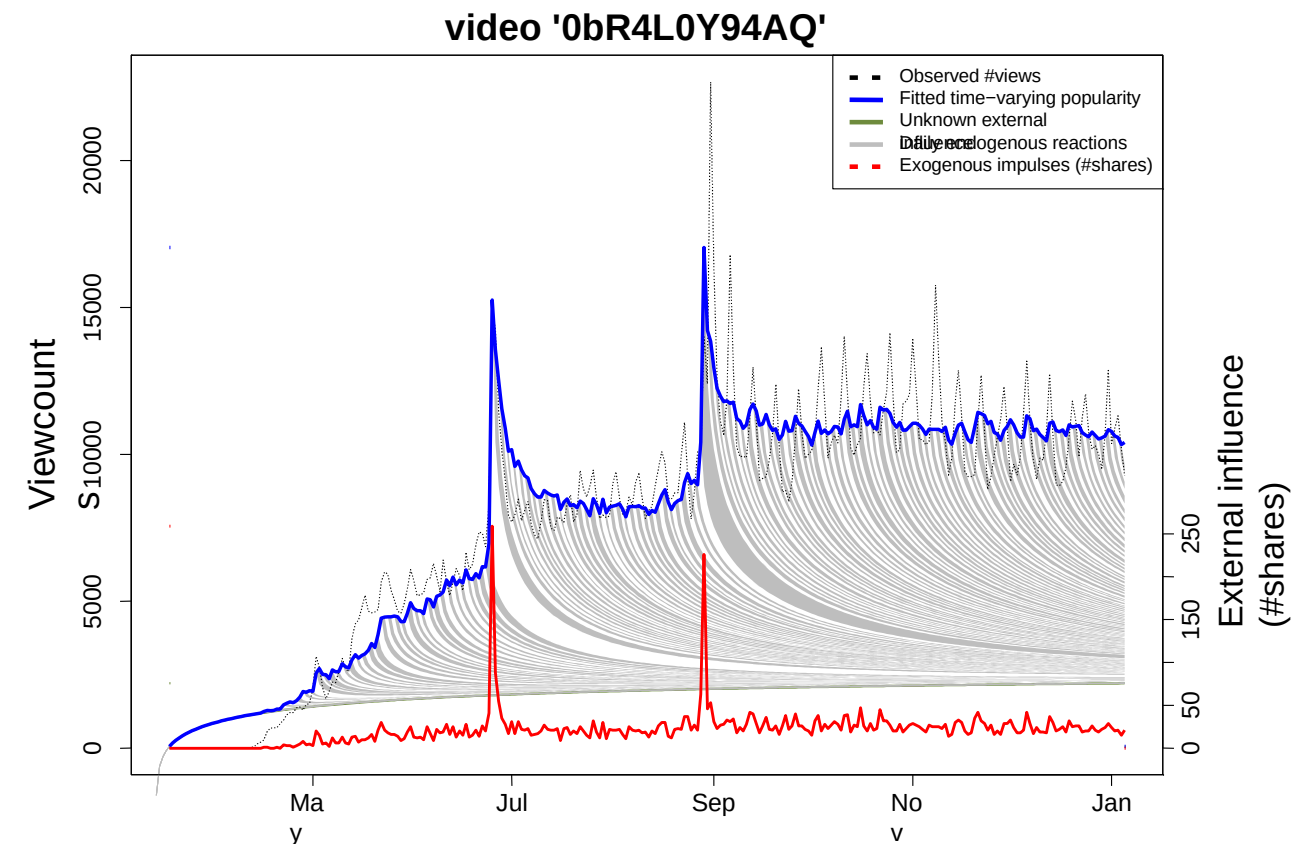
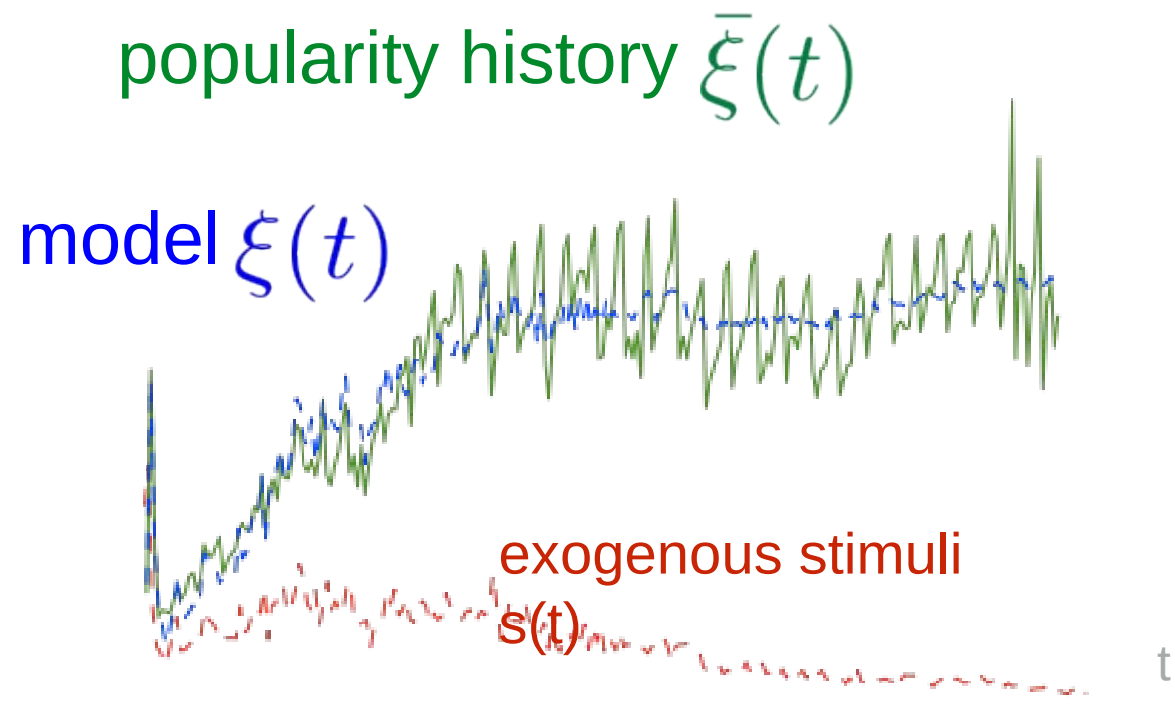
popularity  $\swarrow$   $\downarrow$   $\underbrace{\hspace{10em}}$

exogenous sensitivity    exogenous stimuli    endogenous reaction



## Hawkes Intensity processes for online popularity

[Rizoiu et al WWW'17]



$$\xi(t) = \mu s(t) + C \int_0^t \xi(t - \tau) \hat{\tau}^{-(1+\theta)} d\tau$$

popularity  $\swarrow$   $\downarrow$

exogenous sensitivity exogenous stimuli

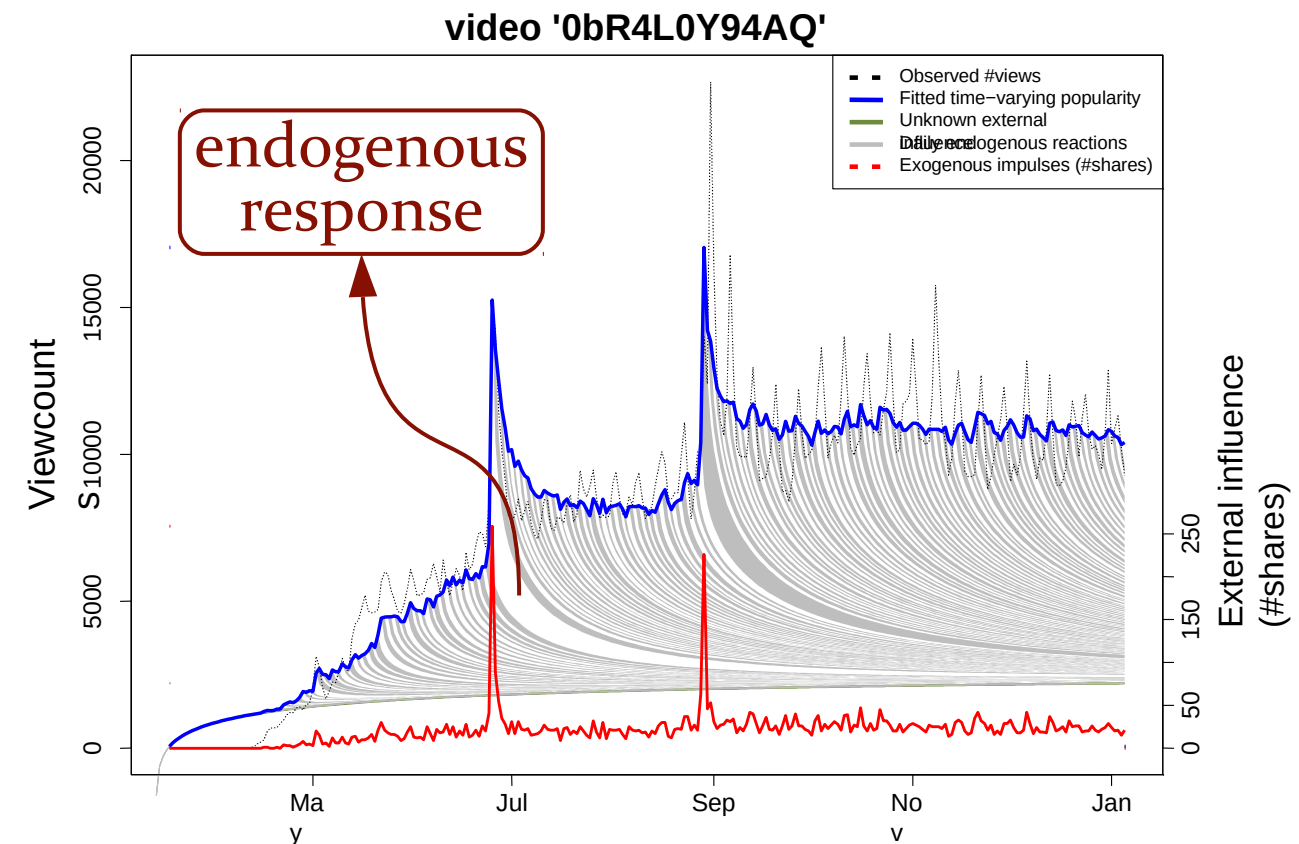
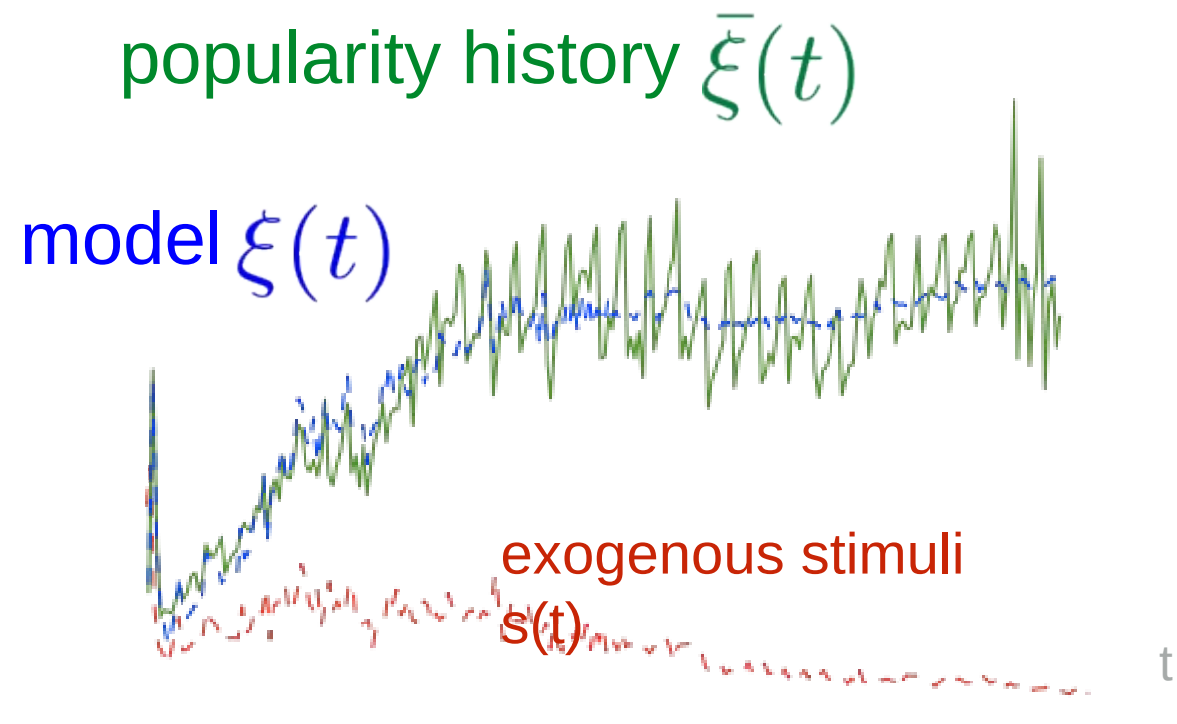
endogenous reaction





## Hawkes Intensity processes for online popularity

[Rizoiu et al WWW'17]



$$\xi(t) = \mu s(t) + C \int_0^t \xi(t - \tau) \hat{\tau}^{-(1+\theta)} d\tau$$

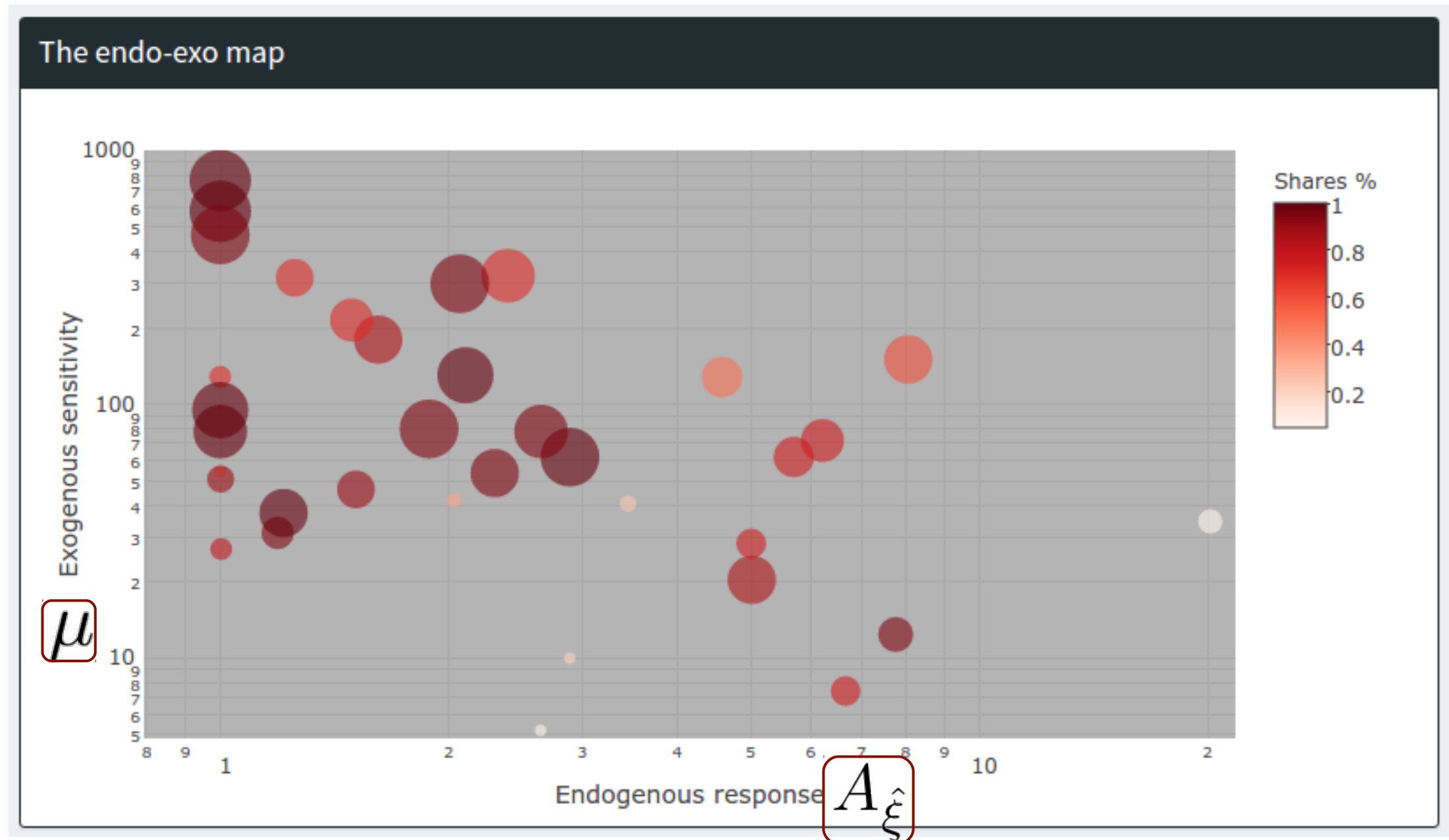
popularity

exogenous sensitivity

exogenous stimuli

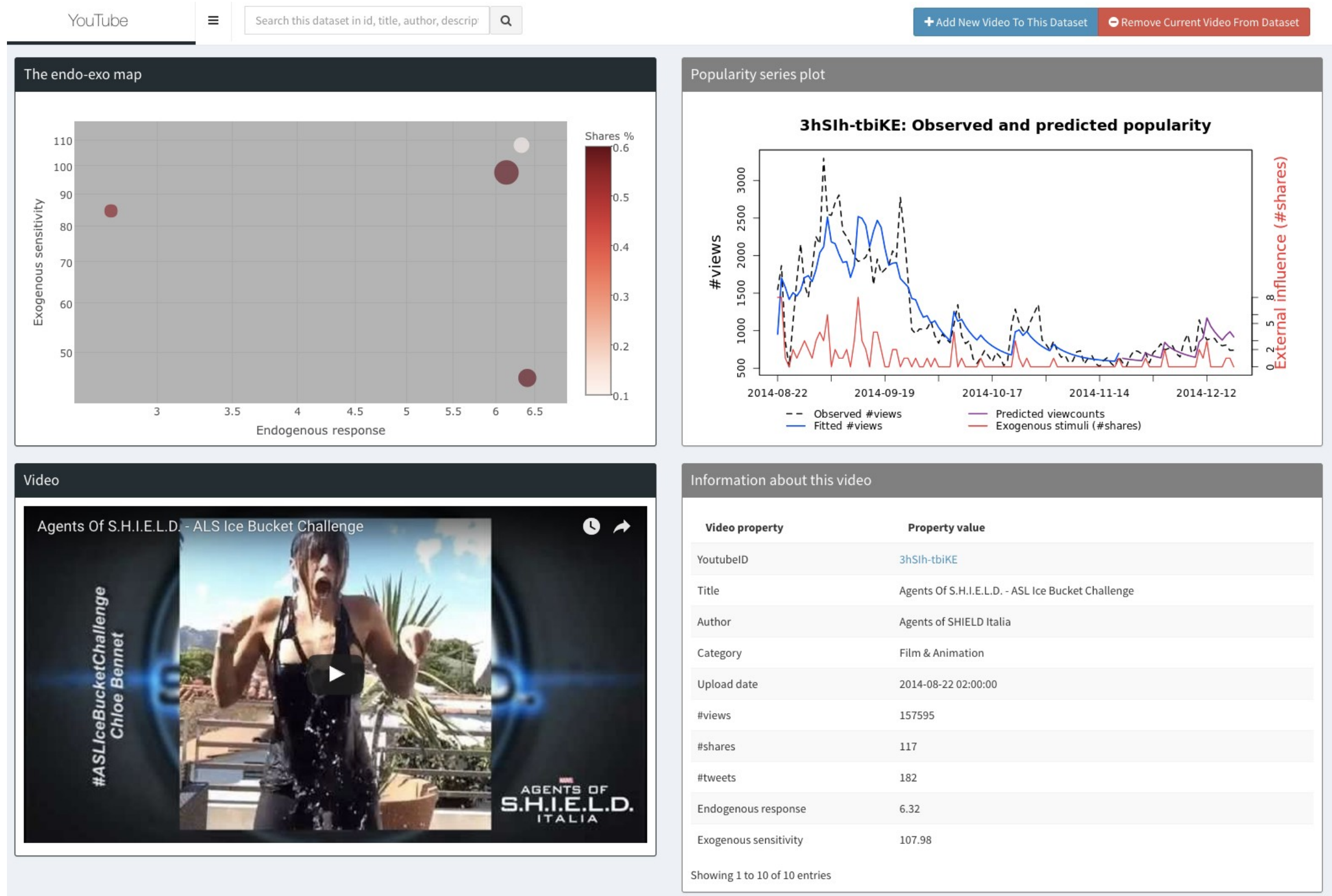
endogenous reaction

# The “endo-exo” map



# Explain popularity dynamics

[Kong et al, WWW'18]

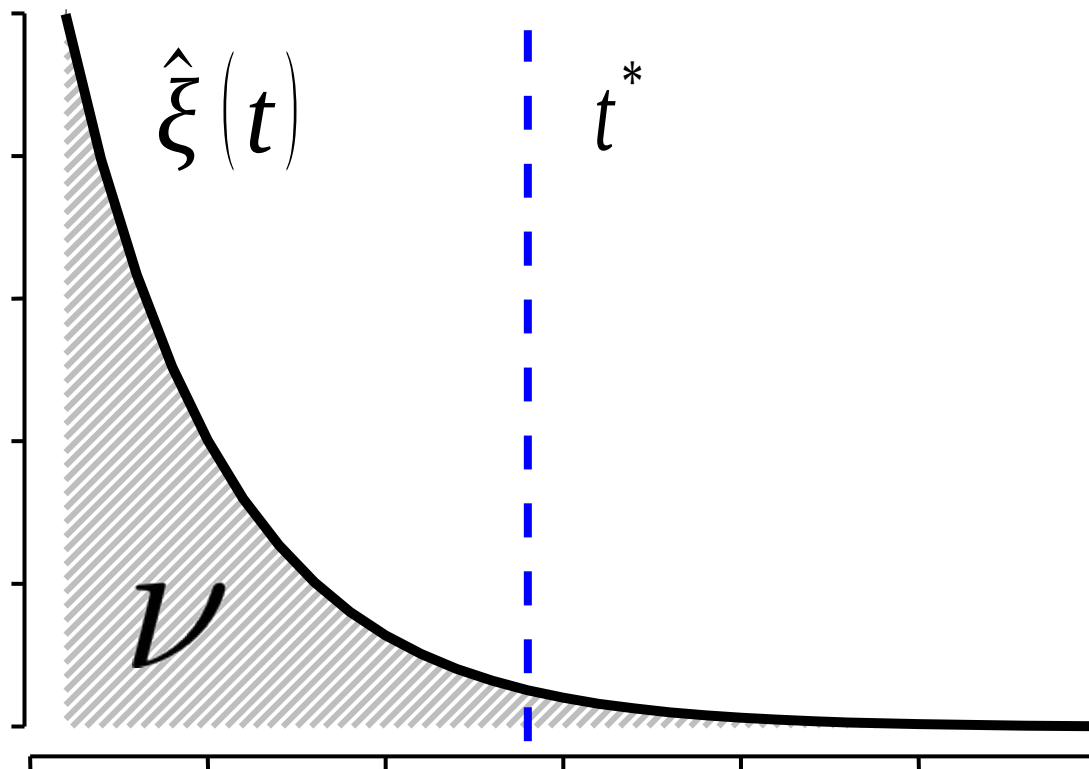


# Viral potential and maturity time

[Rizoiu et al ICWSM'17]



Behavioral  
Data Science



Viral potential  
score:

*Return on investment, total amount of  
views per promotion*

Maturity  
time:

*Time required to acquire most of the  
return*

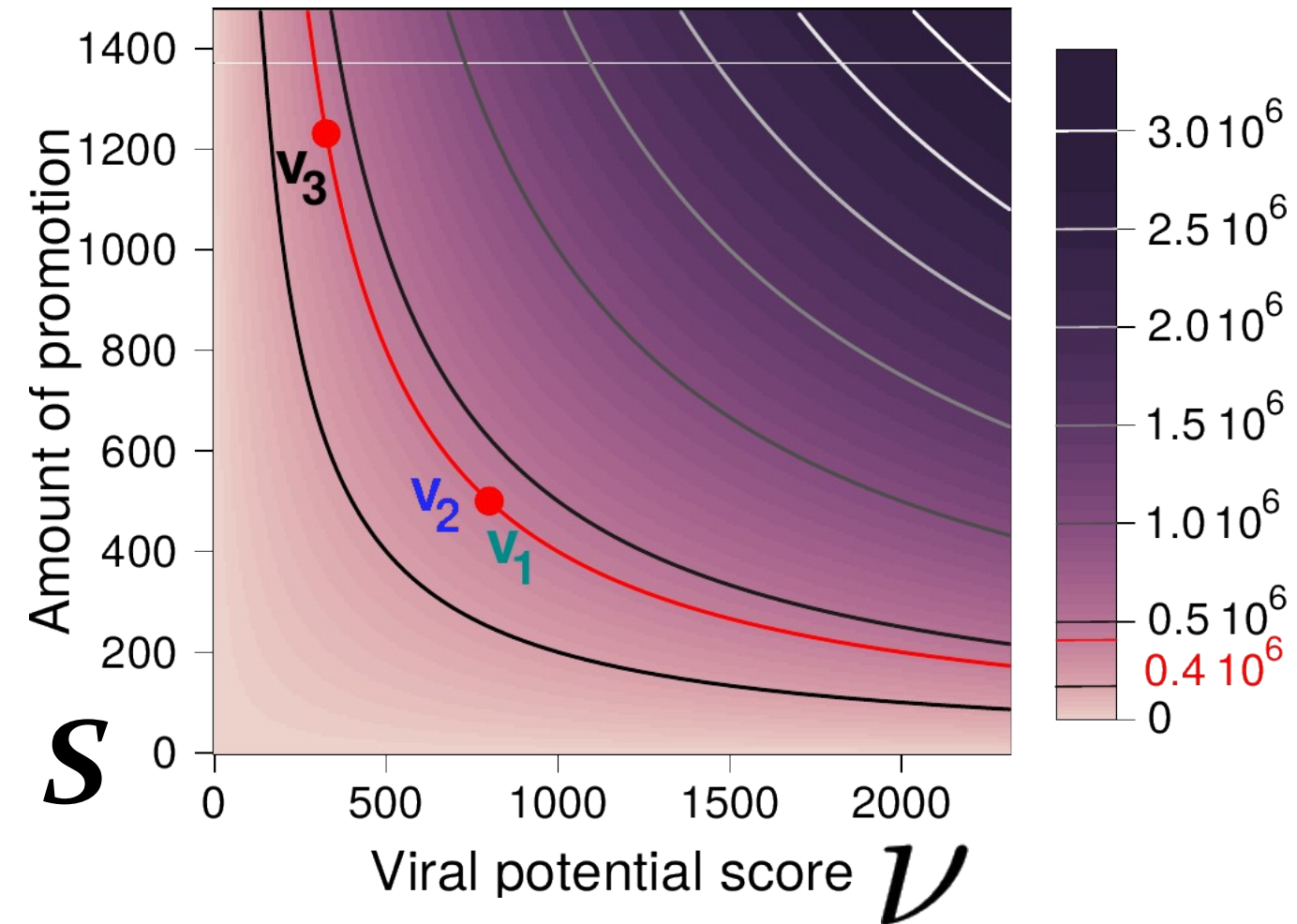
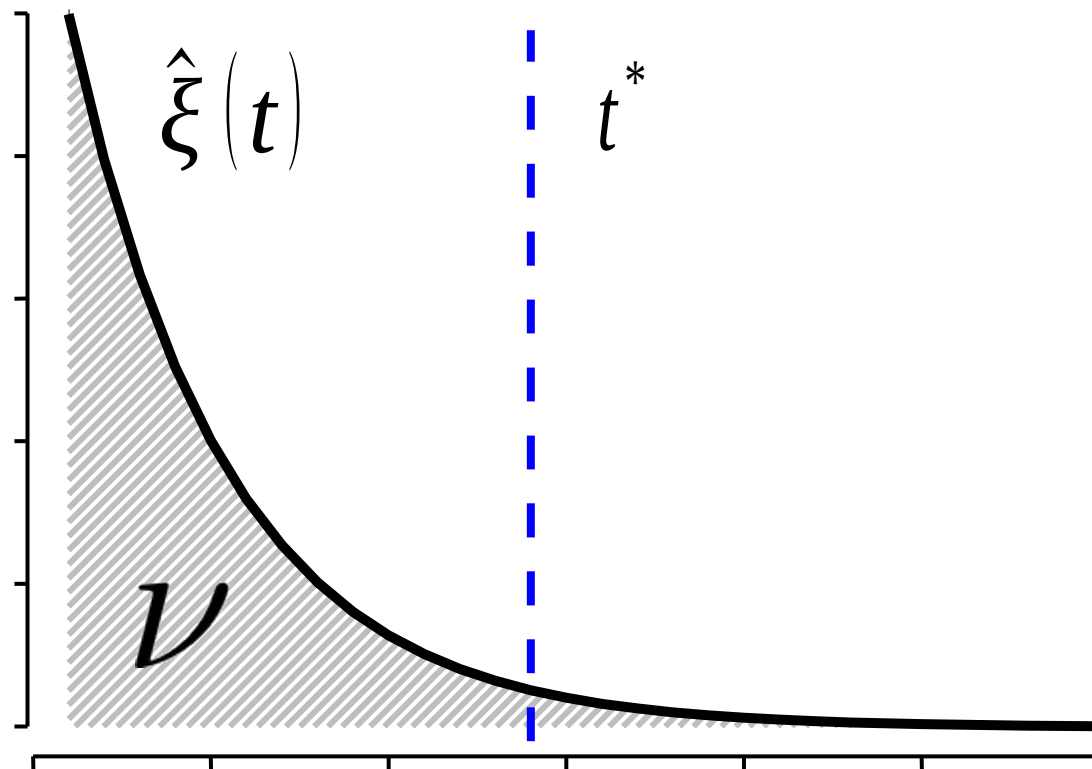


# Viral potential and maturity time

[Rizoiu et al ICWSM'17]



Behavioral  
Data Science



Viral potential  
score:

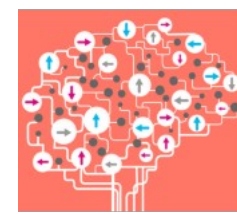
*Return on investment, total amount of  
views per promotion*

Maturity  
time:

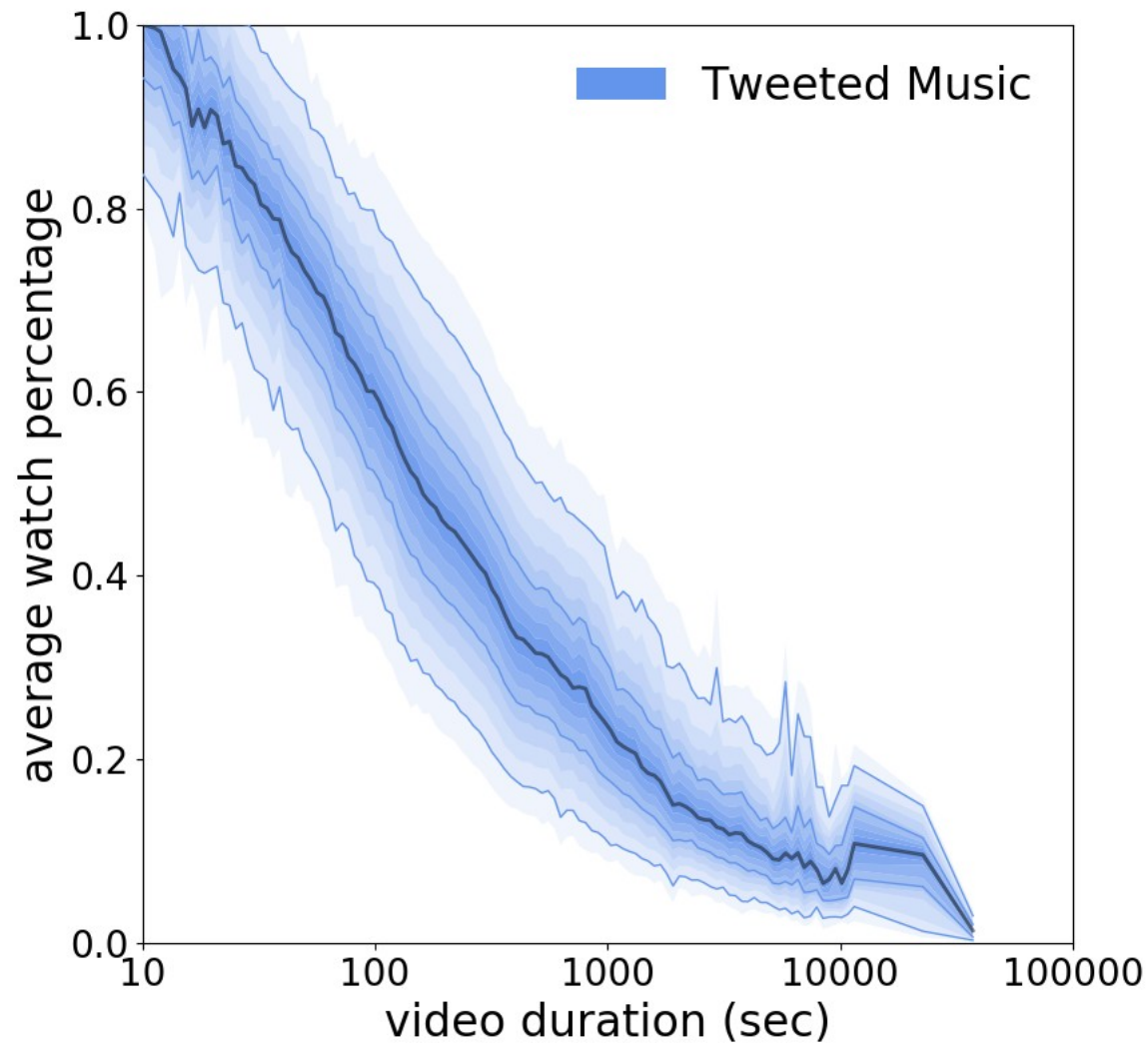
*Time required to acquire most of the  
return*

# Content engagement and quality

[Wu et al ICWSM'18]



Behavioral  
Data Science

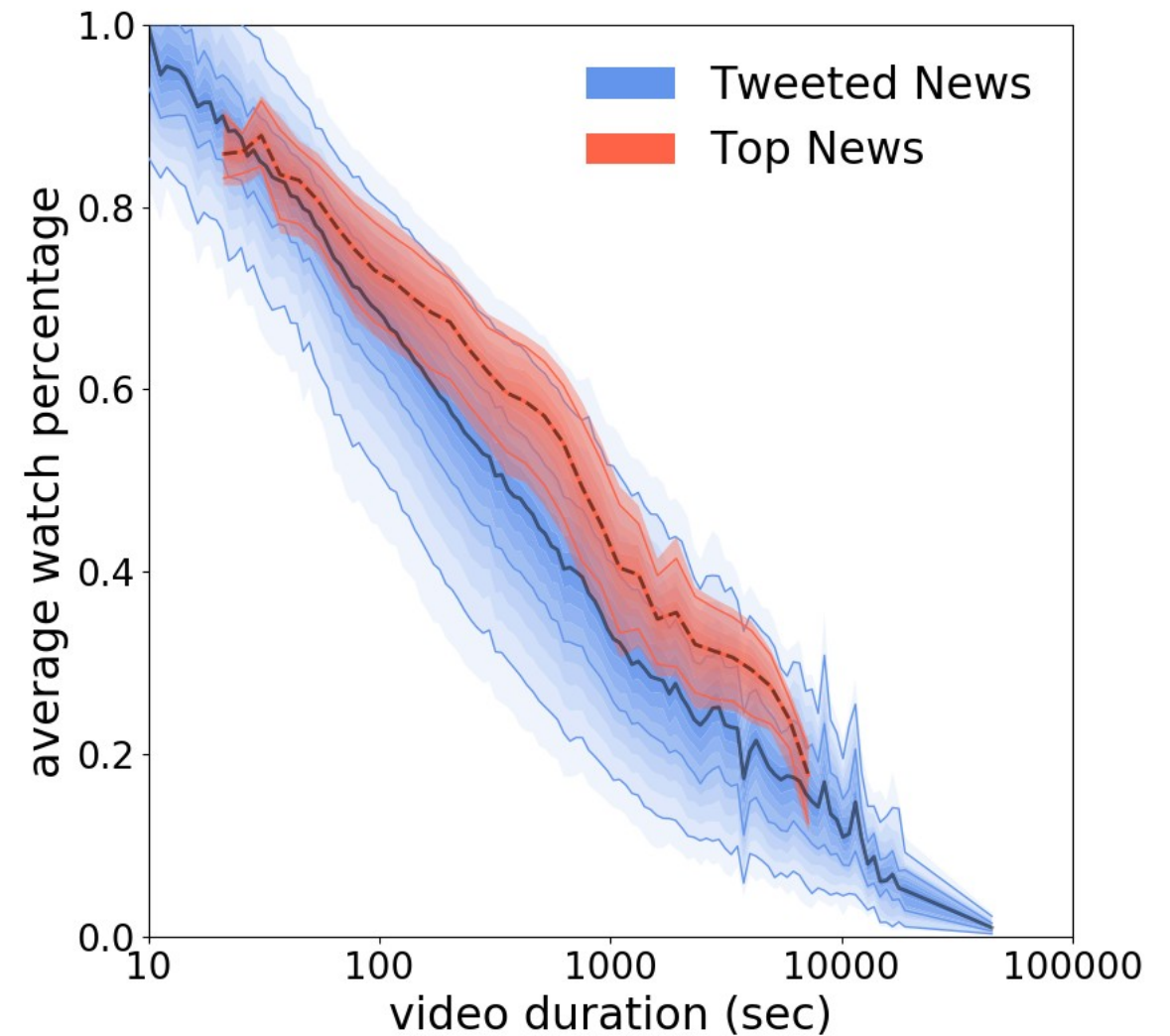
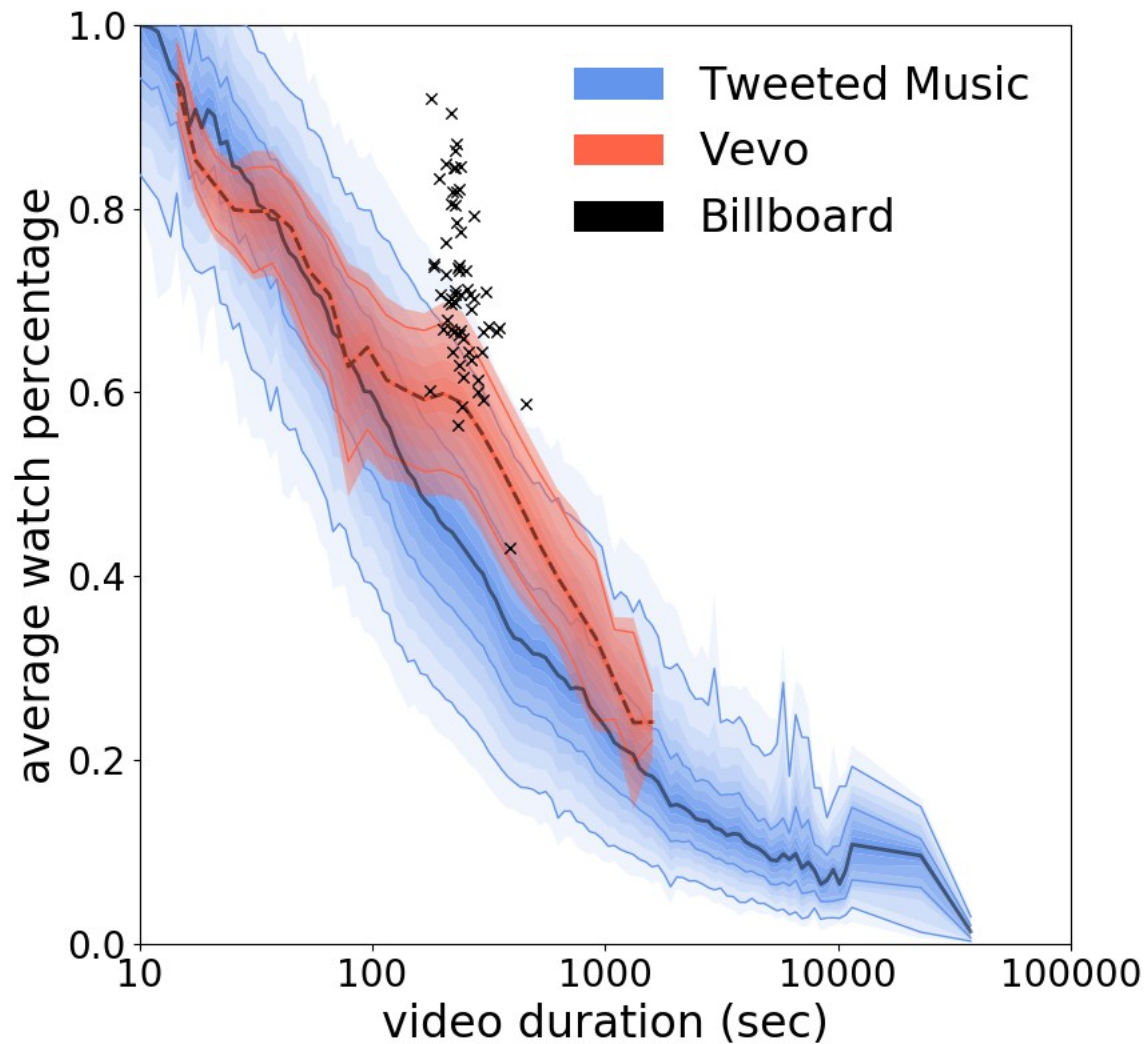


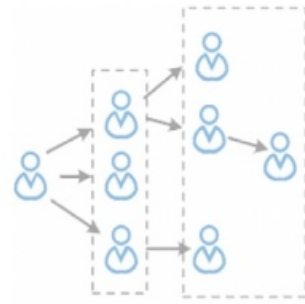
# Content engagement and quality

[Wu et al ICWSM'18]

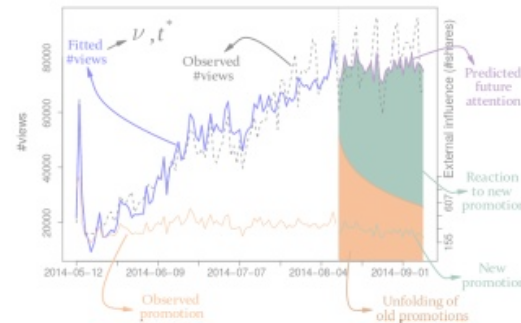


Behavioral  
Data Science

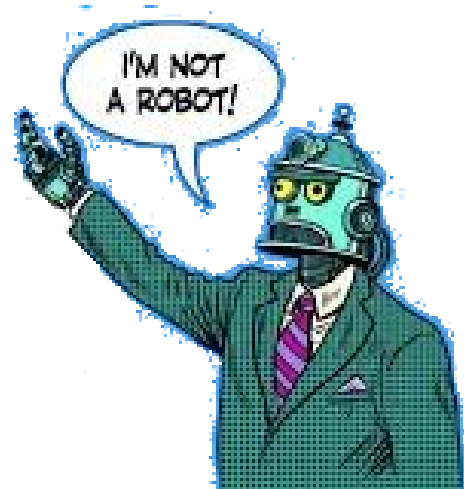




Modeling information diffusion in social networks



Modeling and predicting popularity, virality and engagement

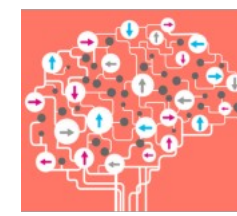


Influencing democratic processes using social media



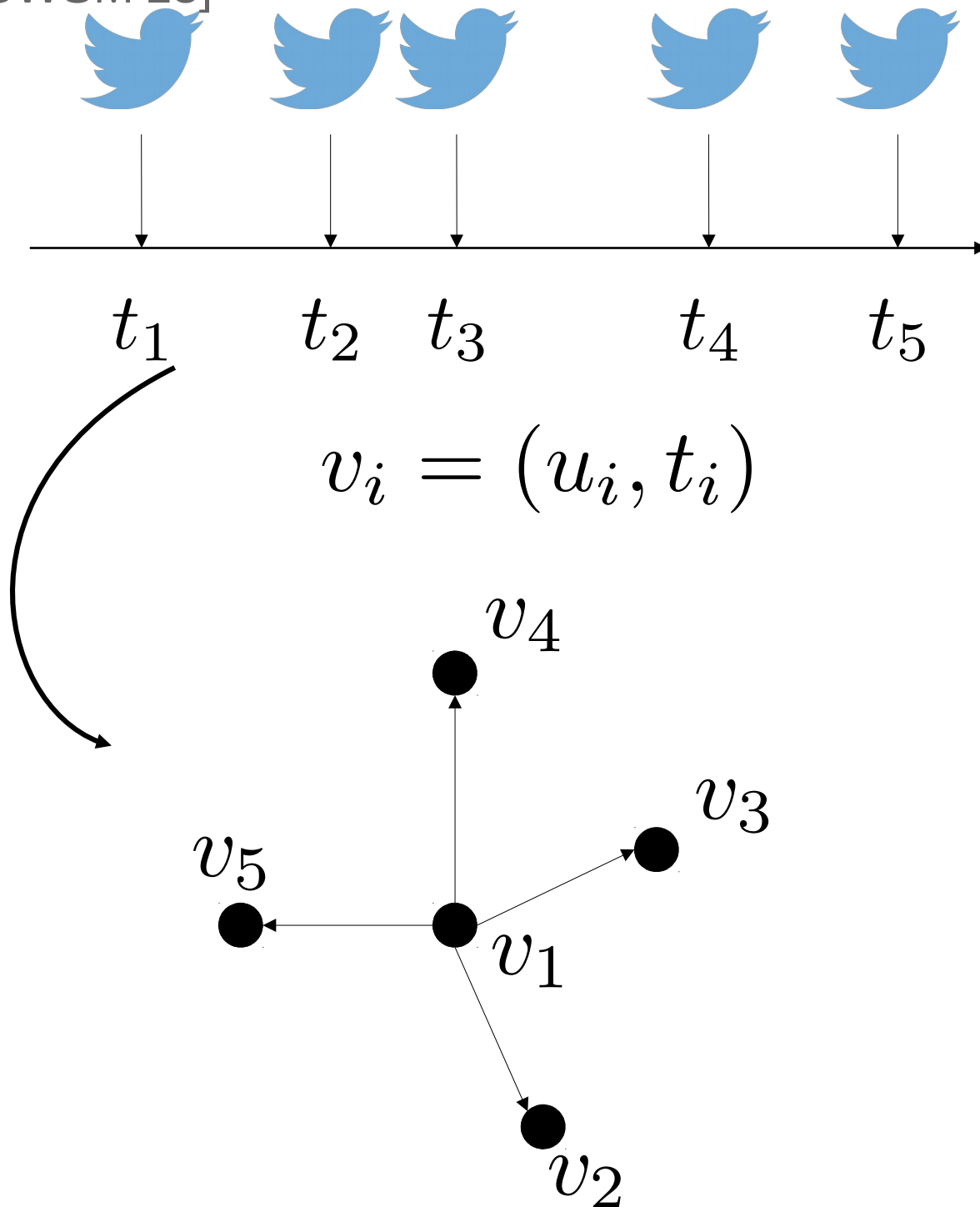


# Role and Influence of Twitter Socialbots During US Presidential Debate



Behavioral  
Data Science

[Rizoiu et al  
ICWSM'18]

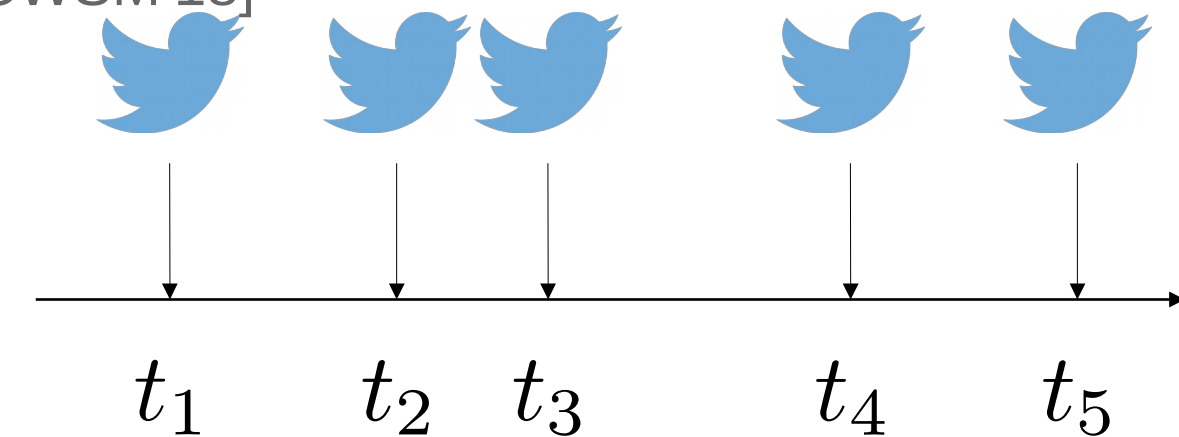


# Role and Influence of Twitter Socialbots During US Presidential Debate

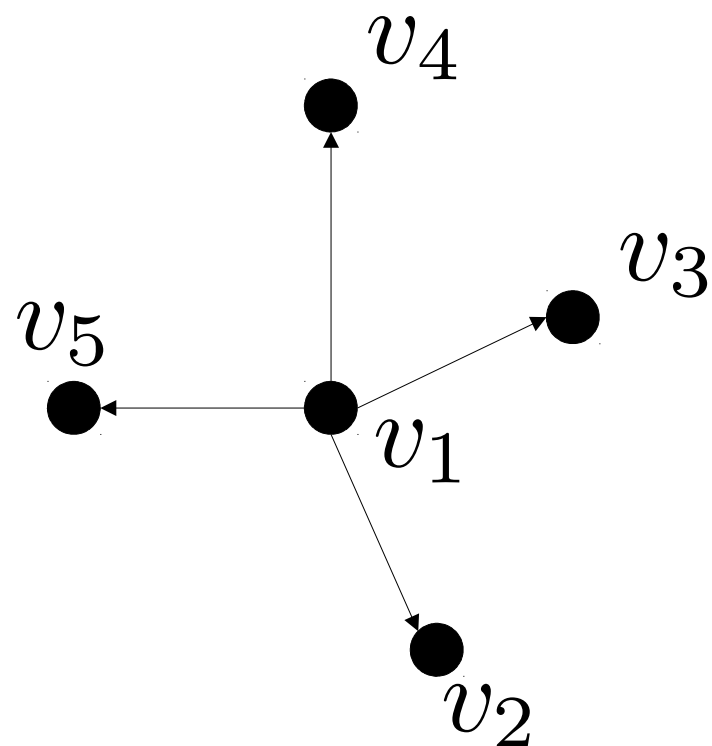


Behavioral  
Data Science

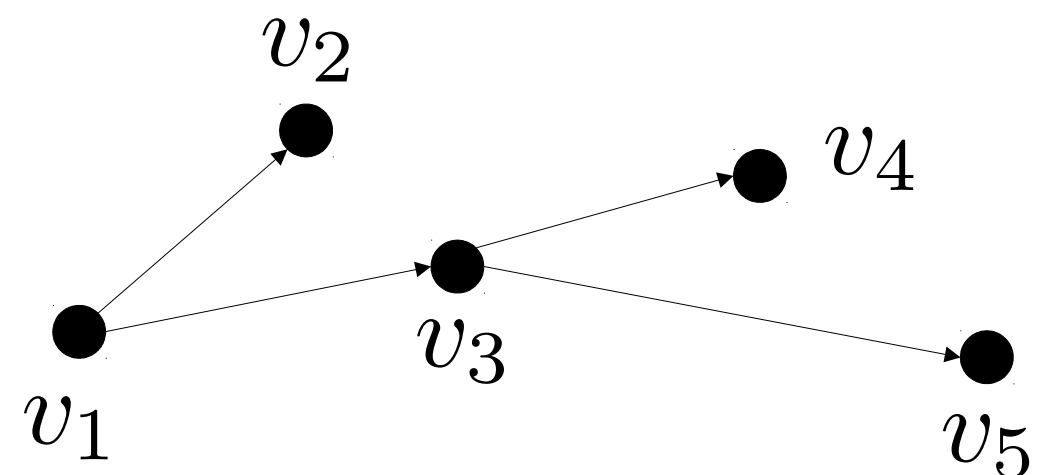
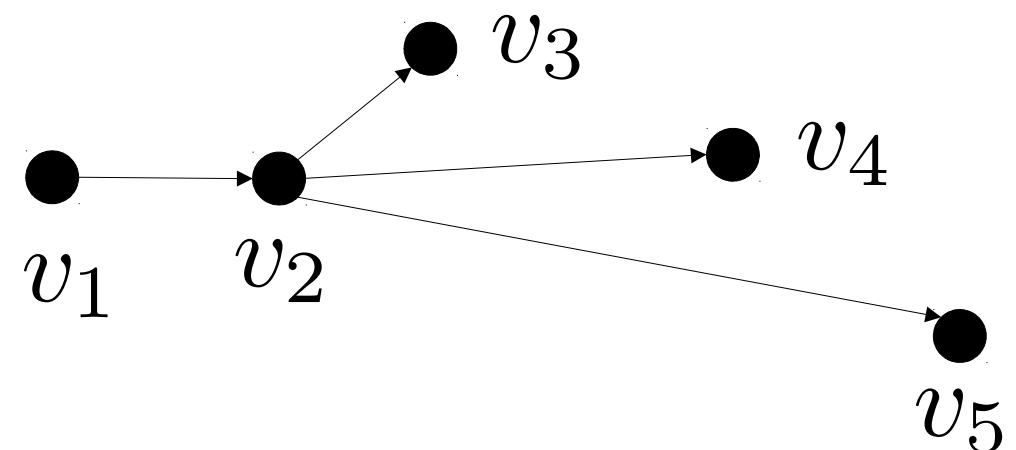
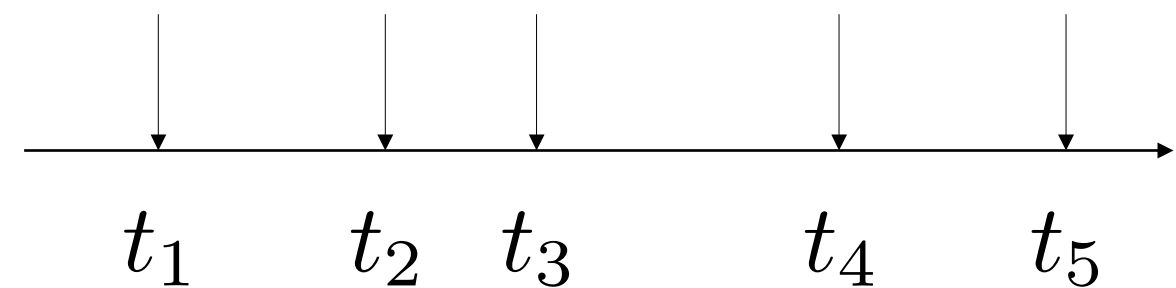
[Rizoiu et al  
ICWSM'18]



$$v_i = (u_i, t_i)$$



## Diffusion trees and influence

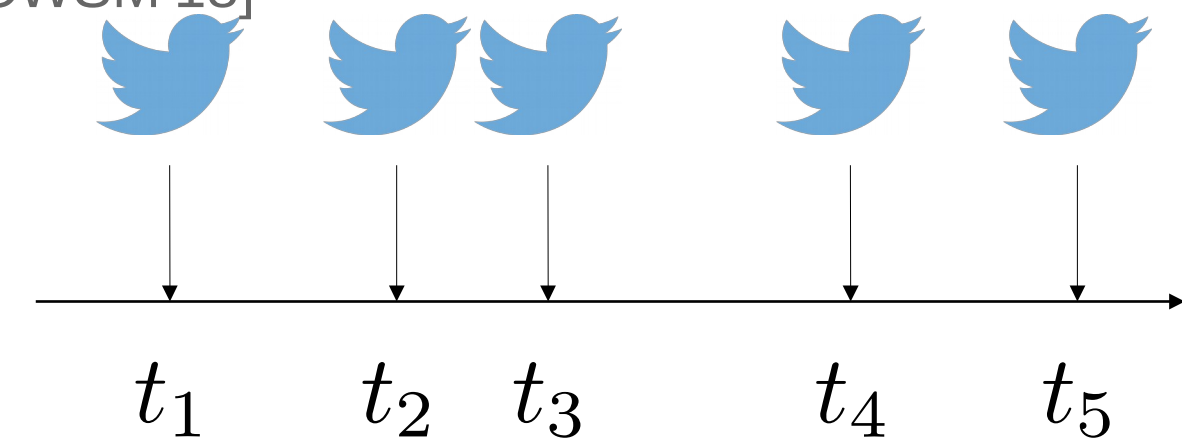


# Role and Influence of Twitter Socialbots During US Presidential Debate

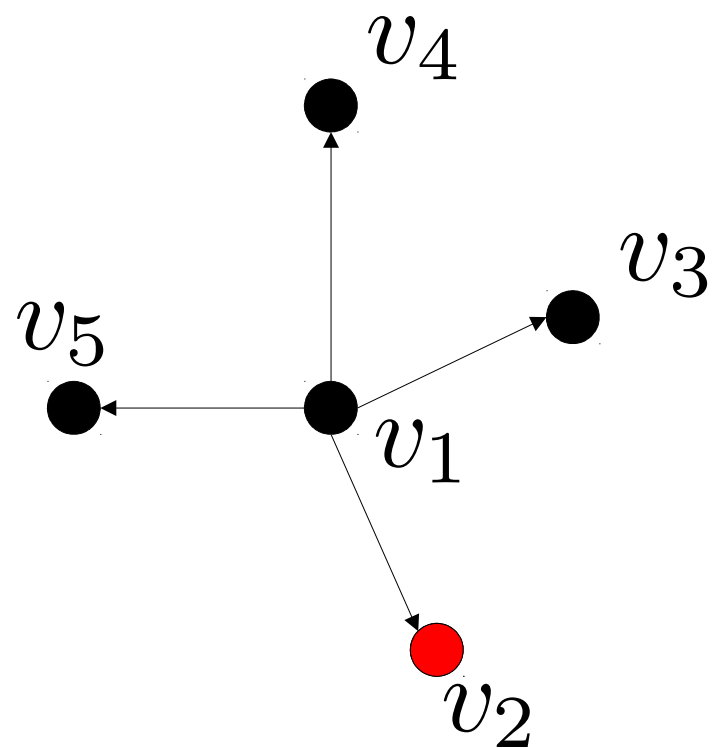


Behavioral  
Data Science

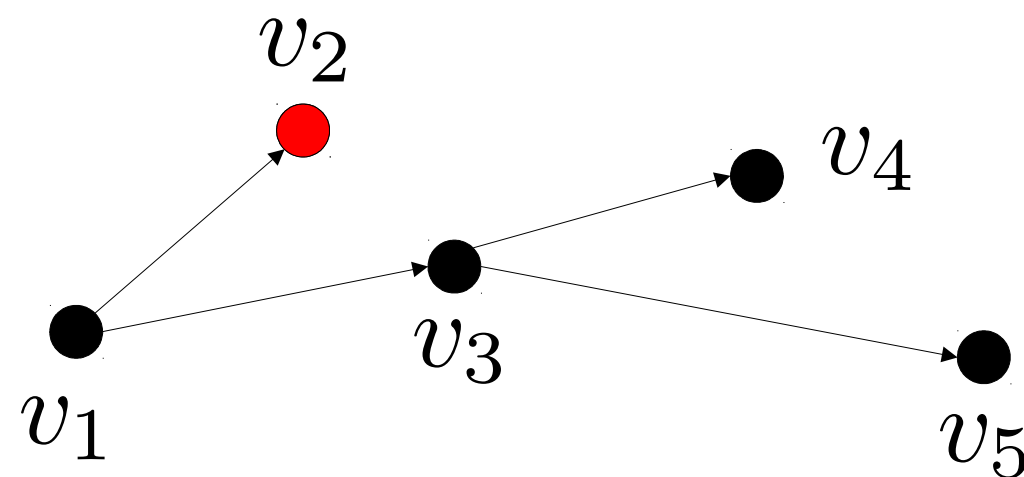
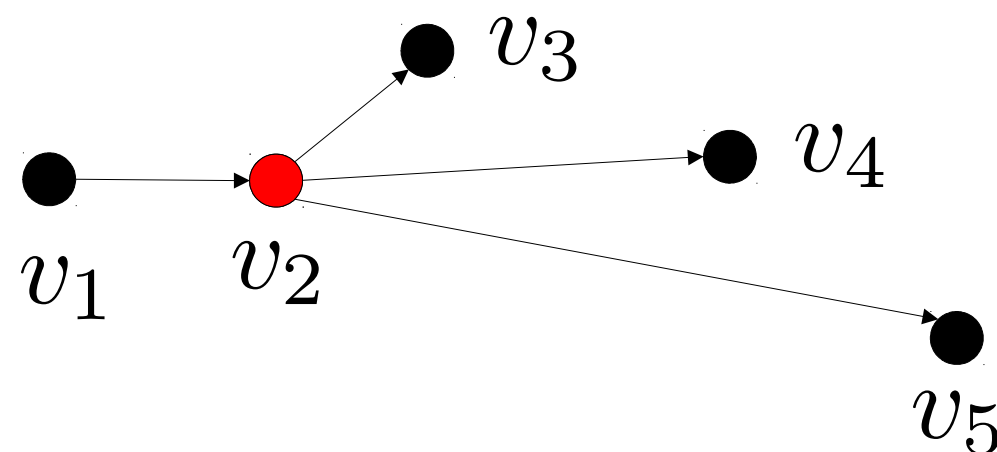
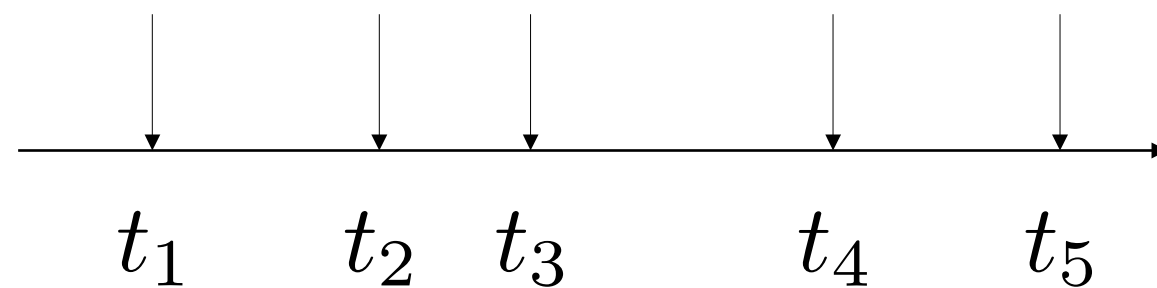
[Rizoiu et al  
ICWSM'18]



$$v_i = (u_i, t_i)$$



## Diffusion trees and influence



# Role and Influence of Twitter Socialbots During US Presidential Debate

[Rizoiu et al  
ICWSM'18]



# Behavioral Data Science





# Role and Influence of Twitter Socialbots During US Presidential Debate

[Rizoiu et al  
ICWSM'18]



## Behavioral Data Science



**Botometer**

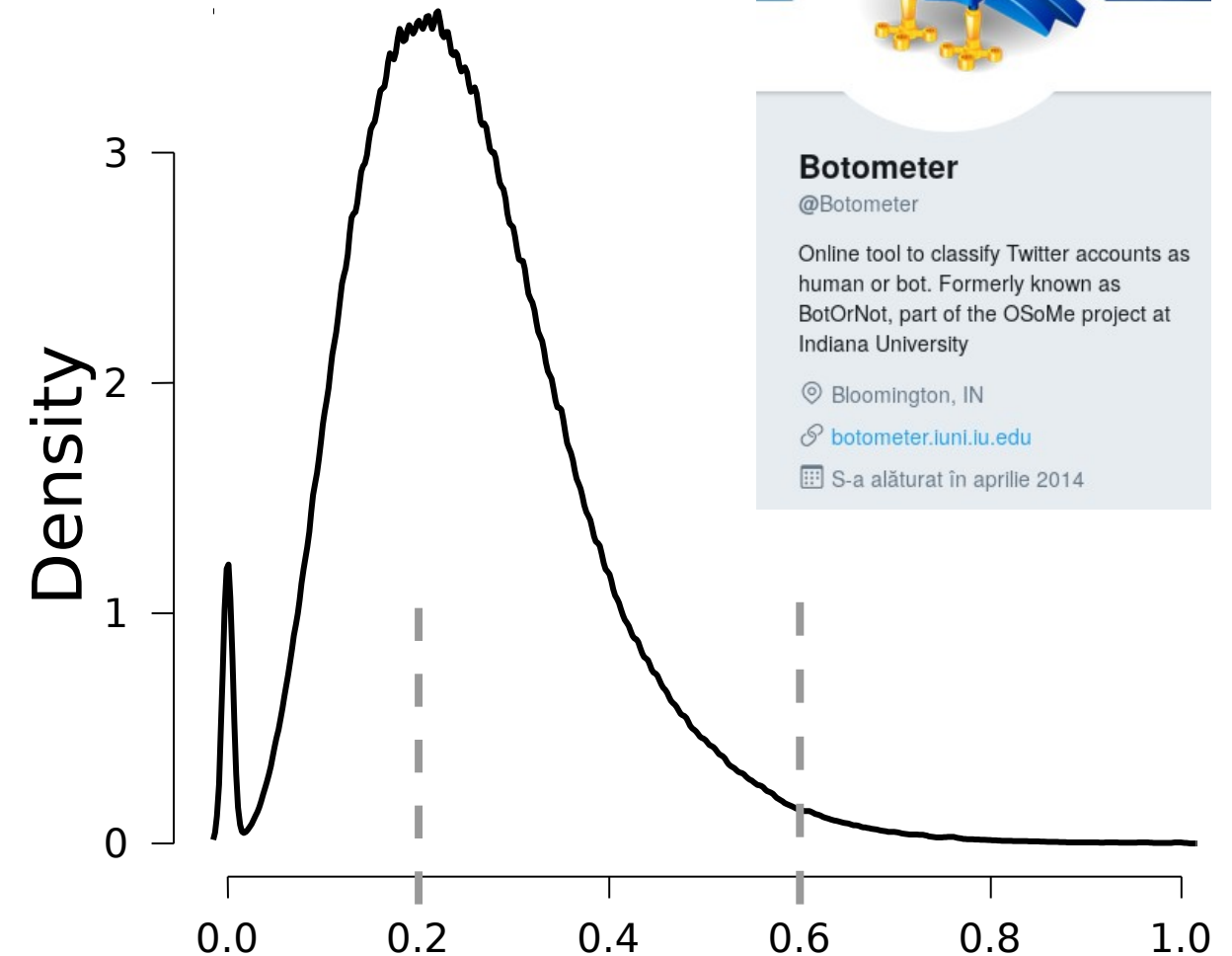
@Botometer

Online tool to classify Twitter accounts as human or bot. Formerly known as BotOrNot, part of the OSoMe project at Indiana University

📍 Bloomington, IN

🌐 [botometer.iuni.iu.edu](https://botometer.iuni.iu.edu)

📅 S-a alăturat în aprilie 2014



499,822  
Humans

Botness

17,561  
Bots

**Bird Spotter:**

<https://github.com/rohitram96/BirdSpotter>

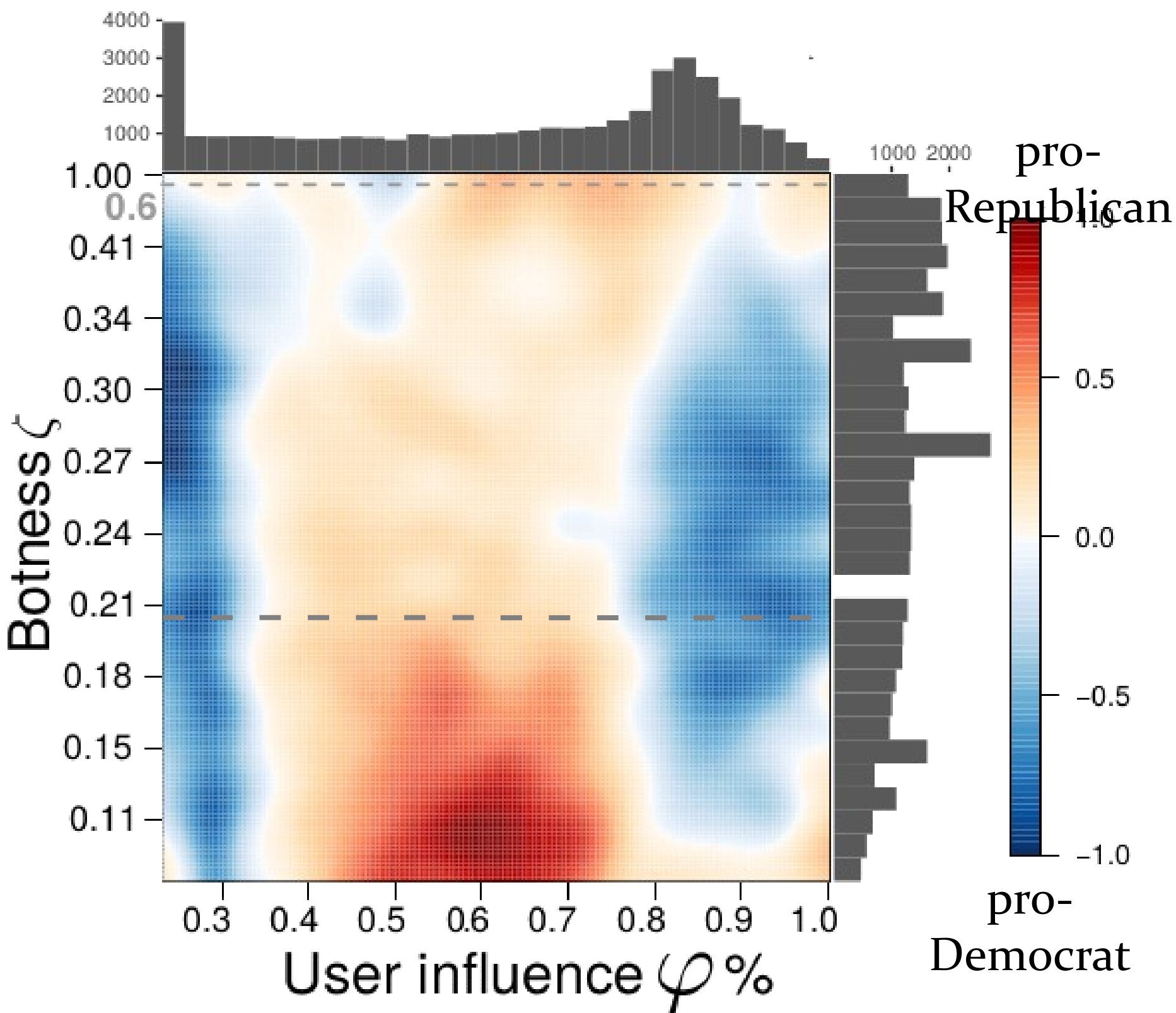


# Role and Influence of Twitter Socialbots During US Presidential Debate

[Rizoiu et al  
ICWSM'18]



Behavioral  
Data Science

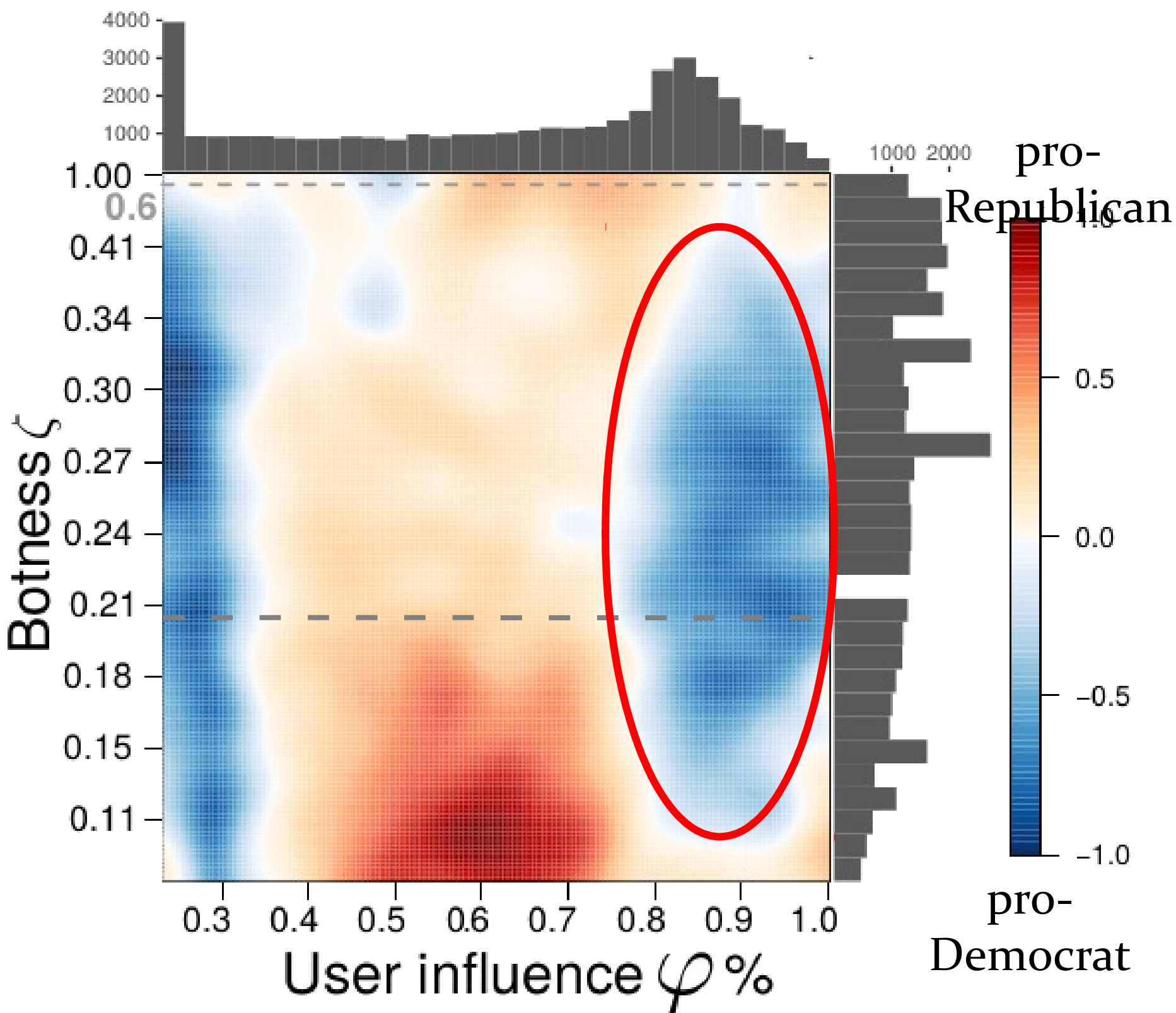


# Role and Influence of Twitter Socialbots During US Presidential Debate

[Rizoiu et al  
ICWSM'18]



Behavioral  
Data Science



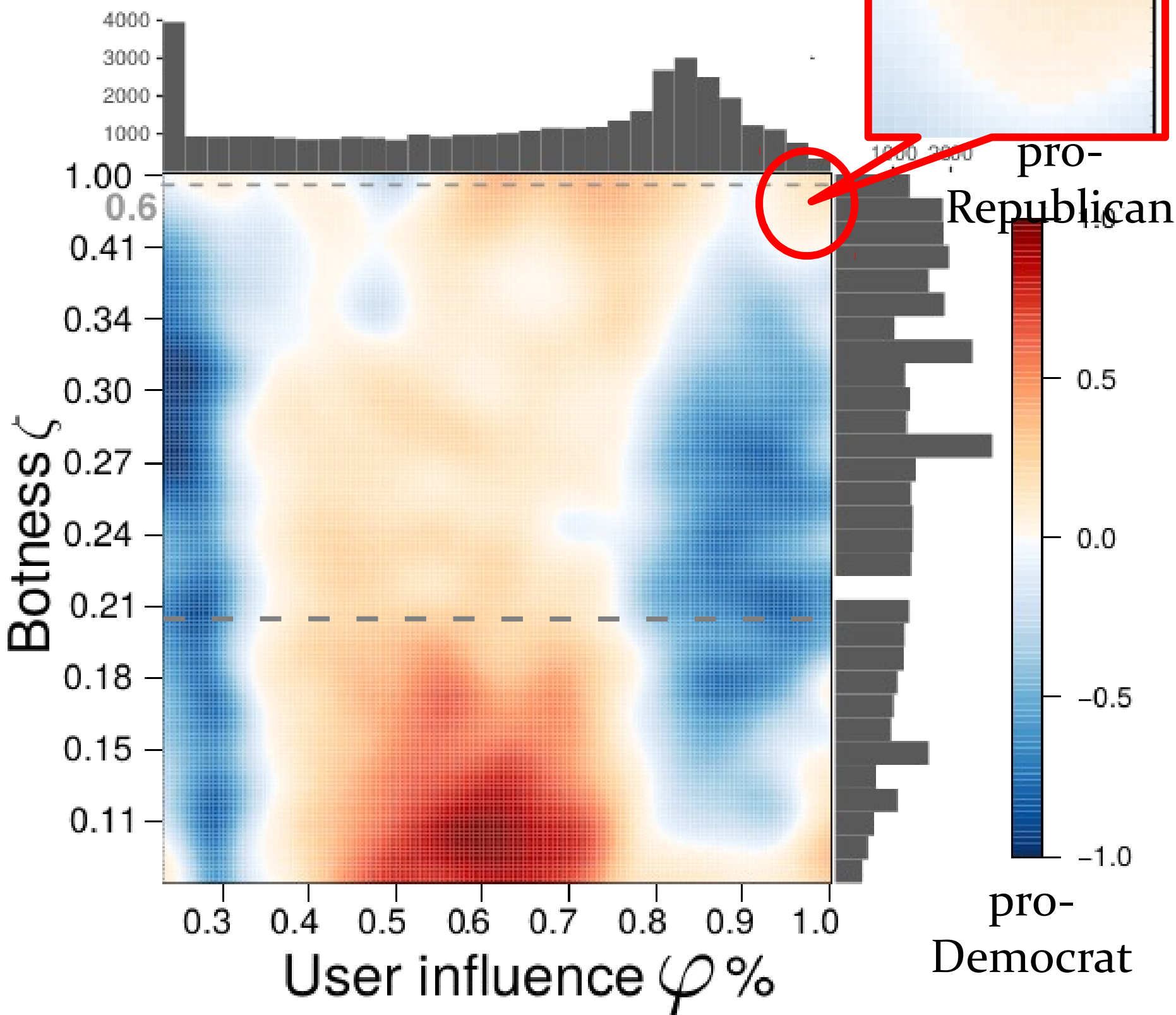
Very highly influential users are pro-Democrat  
(**D: 7201**, **R: 5736**)

# Role and Influence of Twitter Socialbots During US Presidential Debate

[Rizoiu et al  
ICWSM'18]



Behavioral  
Data Science

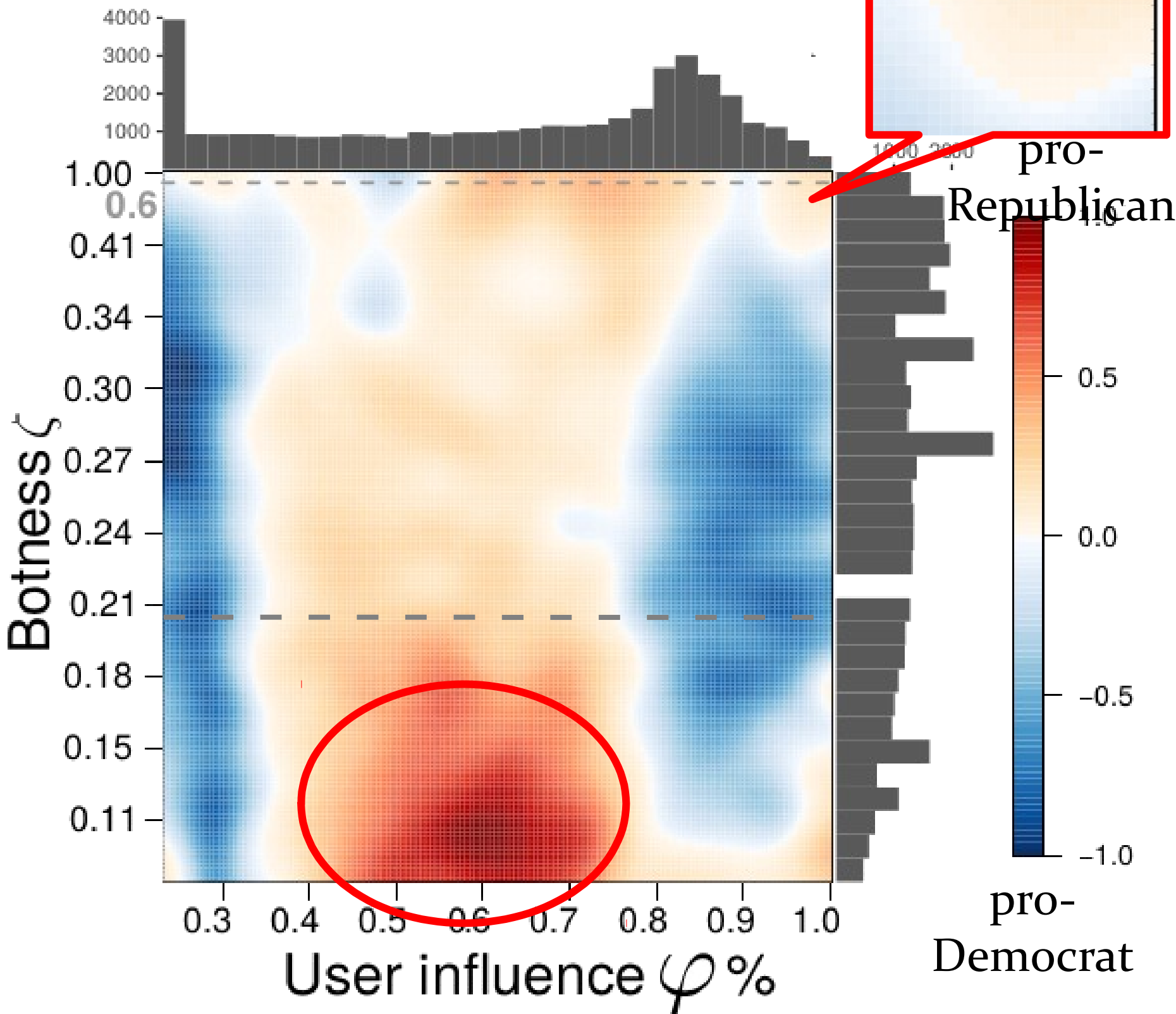


# Role and Influence of Twitter Socialbots During US Presidential Debate

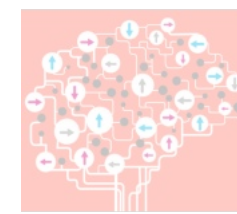
[Rizoiu et al  
ICWSM'18]



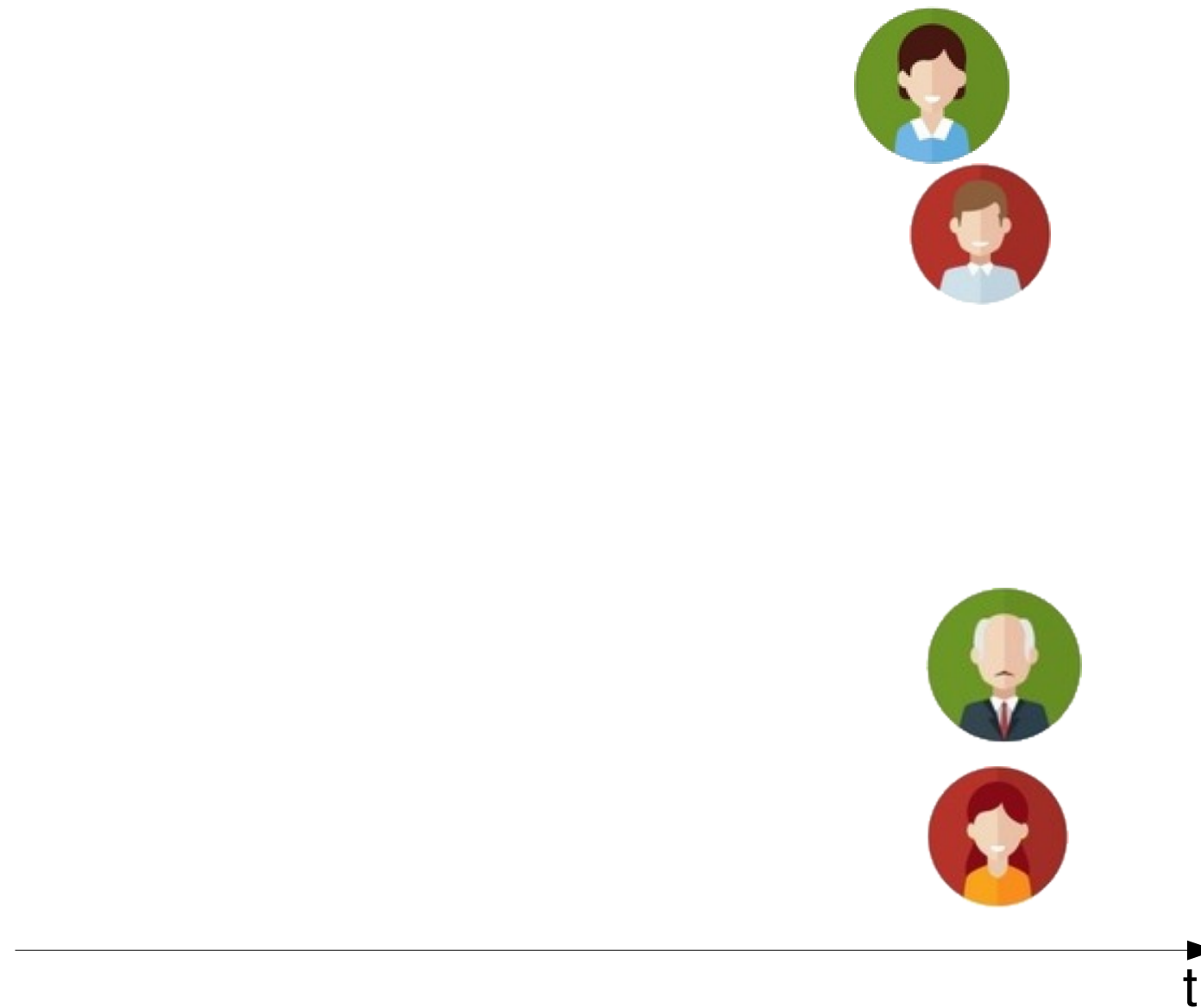
Behavioral  
Data Science



# Identify troll via their online traces



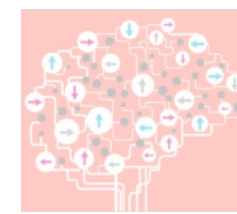
Behavioral  
Data Science



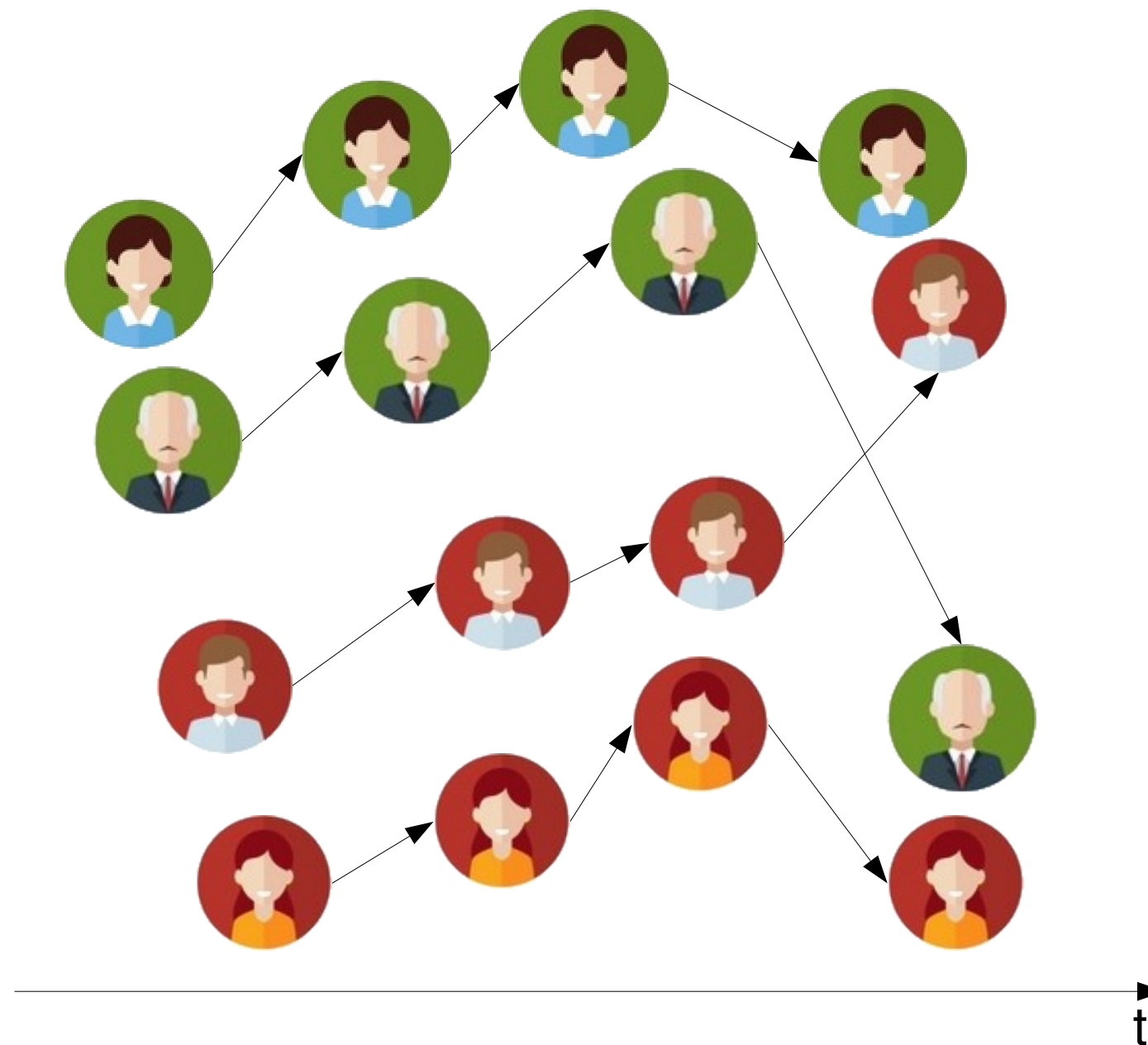
**Identity through the digital  
traces that actors leave behind**



# Identify troll via their online traces

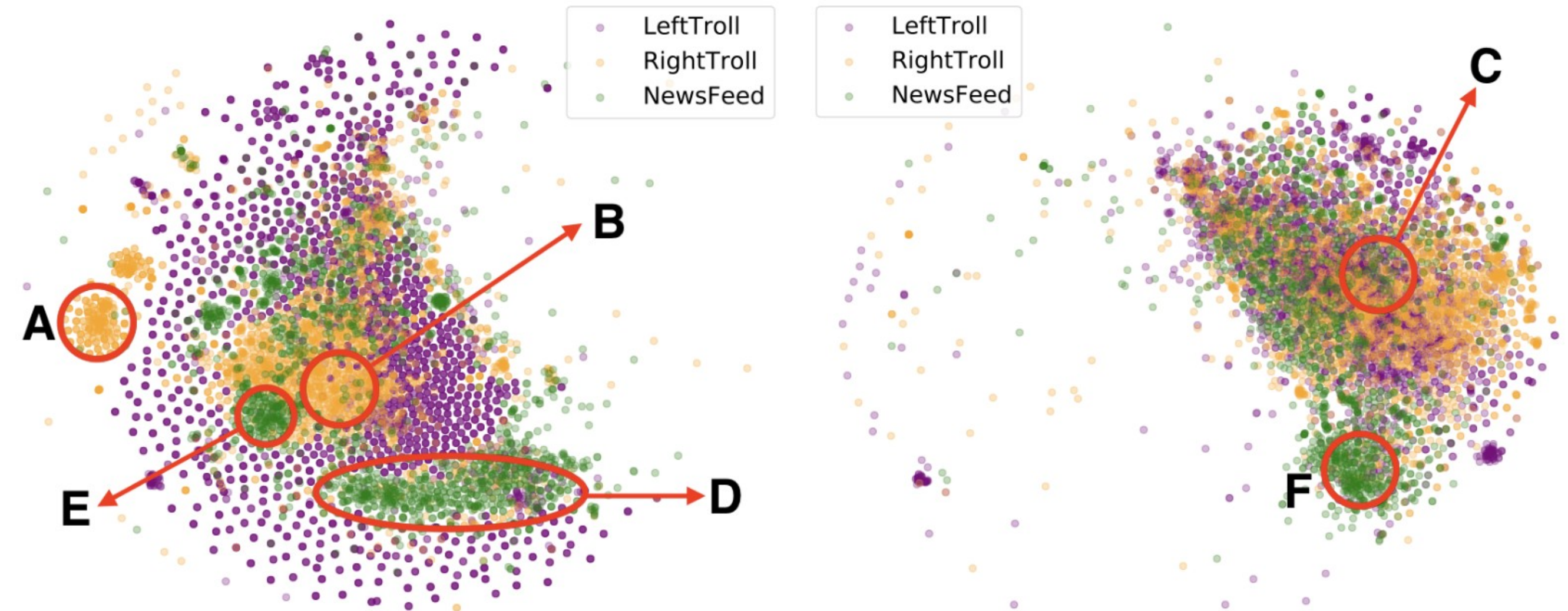
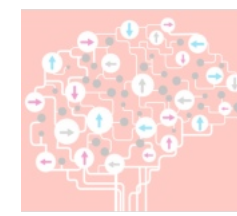


Behavioral  
Data Science



**Identity through the digital  
traces that actors leave behind**

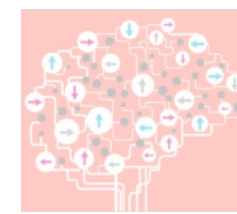
# Predict and explain troll strategy



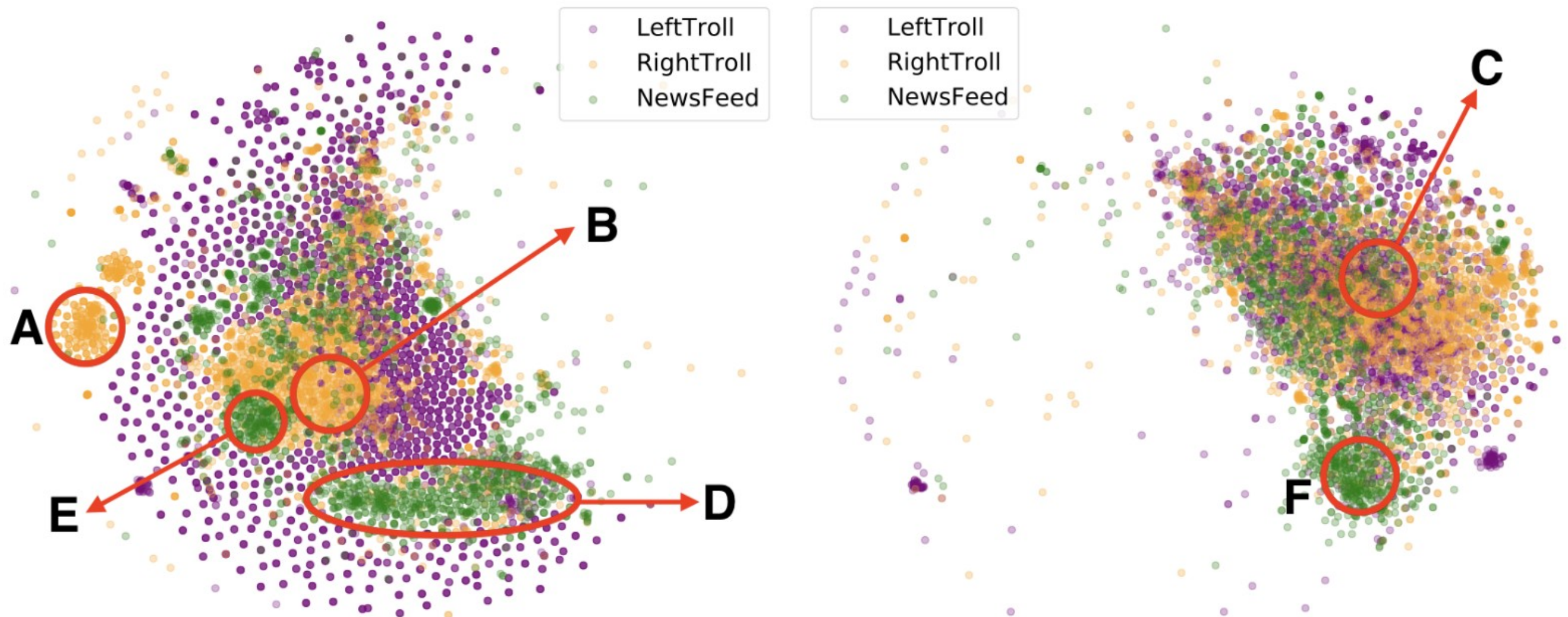
“Focused MAGA” right trolls, “diverse strategy” left trolls.



# Predict and explain troll strategy



Behavioral  
Data Science



“Focused MAGA” right trolls, “diverse strategy” left trolls.

**A** – (right trolls) Hillary cannot be trusted *#ThingsMoreTrustedThanHillary*

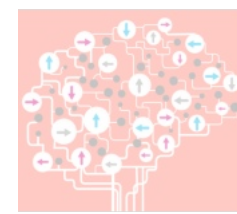
**B** – (right trolls) Mimic black Trump supporters *#Blacks4Trump*

**C** – (all trolls) Religious beliefs *#God #Prolife*

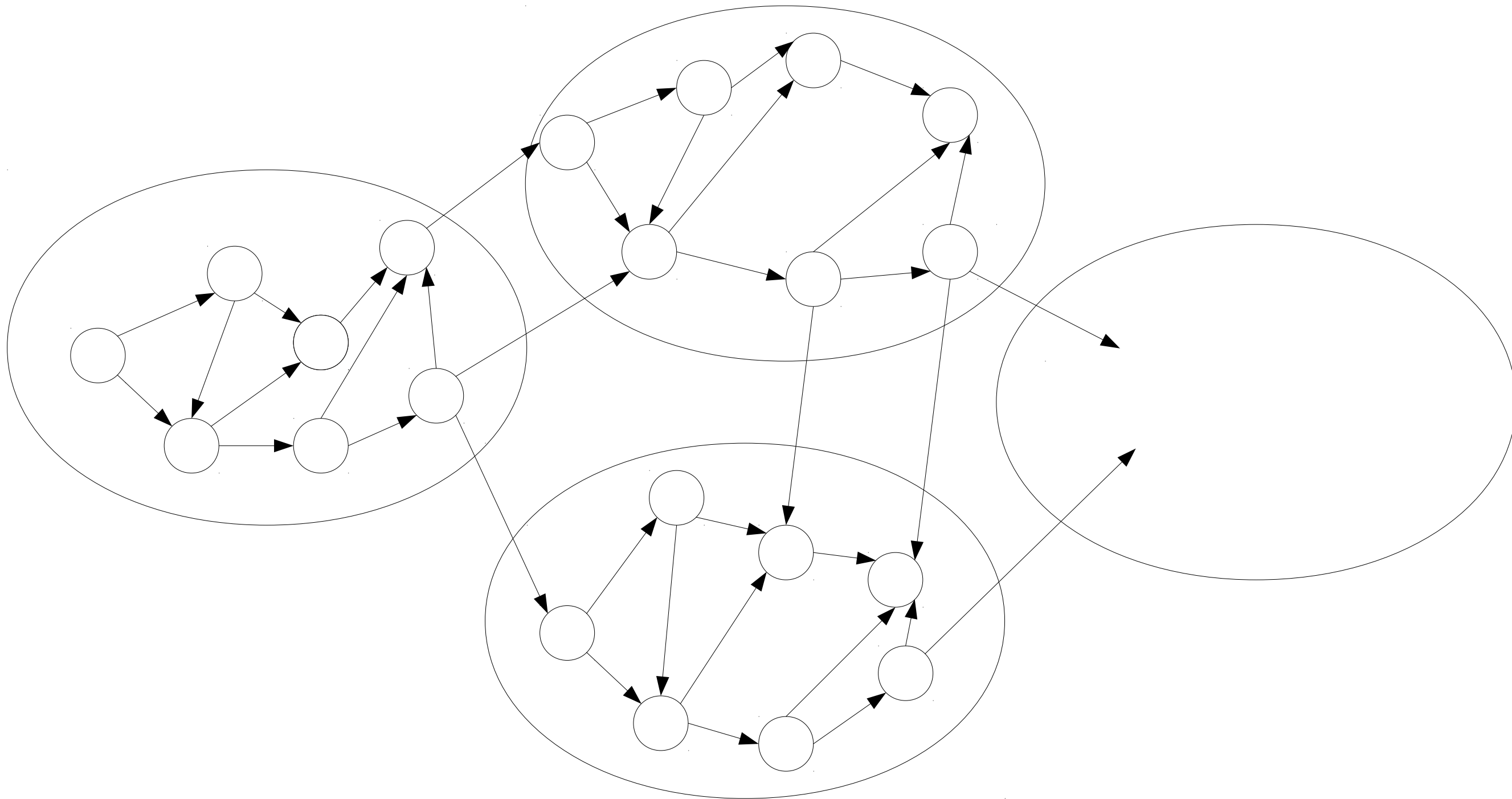
**D, F** – (news trolls) News about violence and civil unrest *#news*

**E** – (news trolls) Federal politics, policy and regulation *#politics*

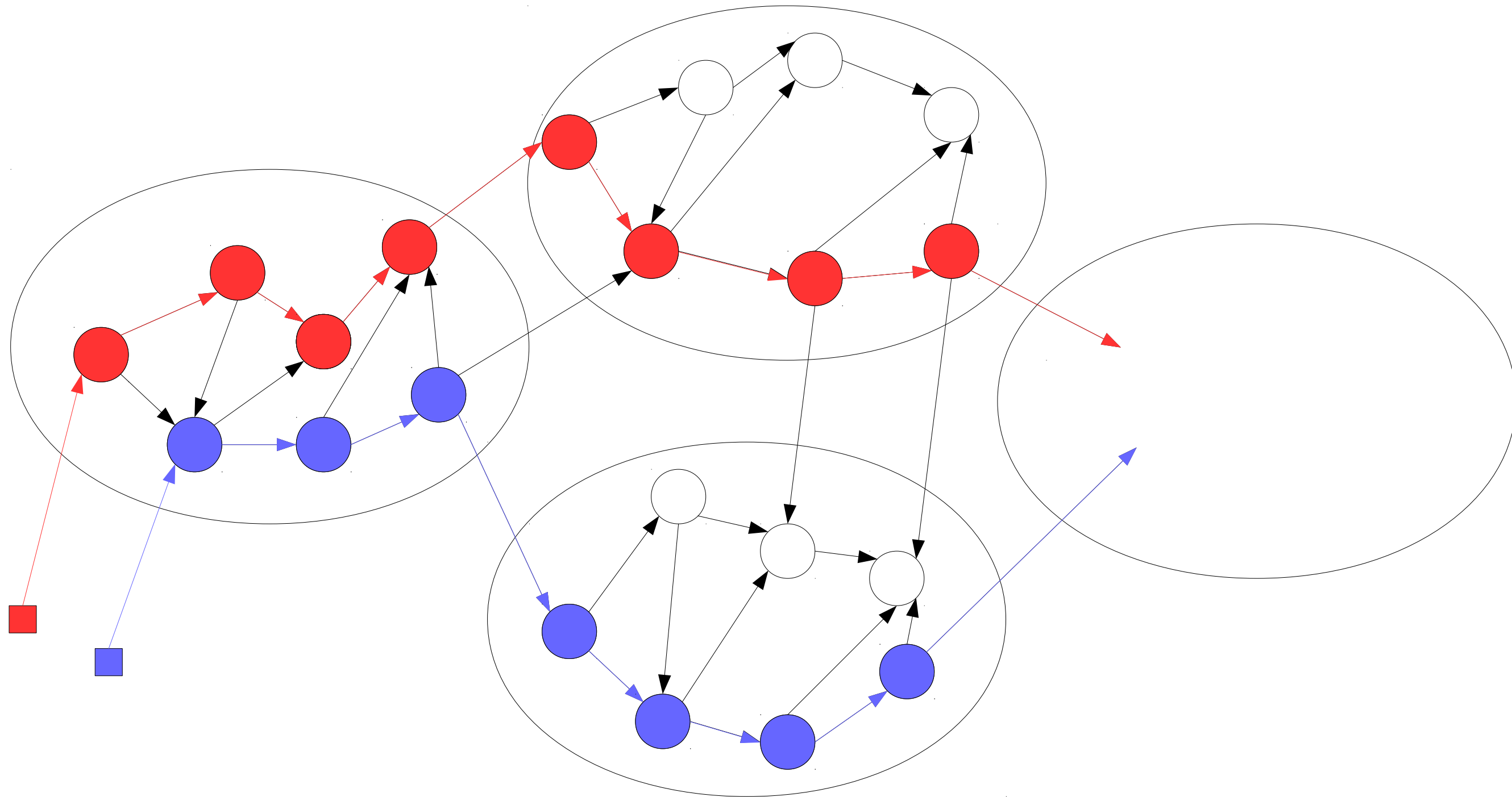
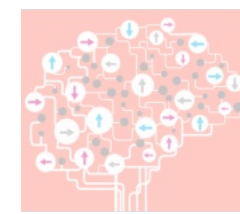
# Next steps:



Behavioral  
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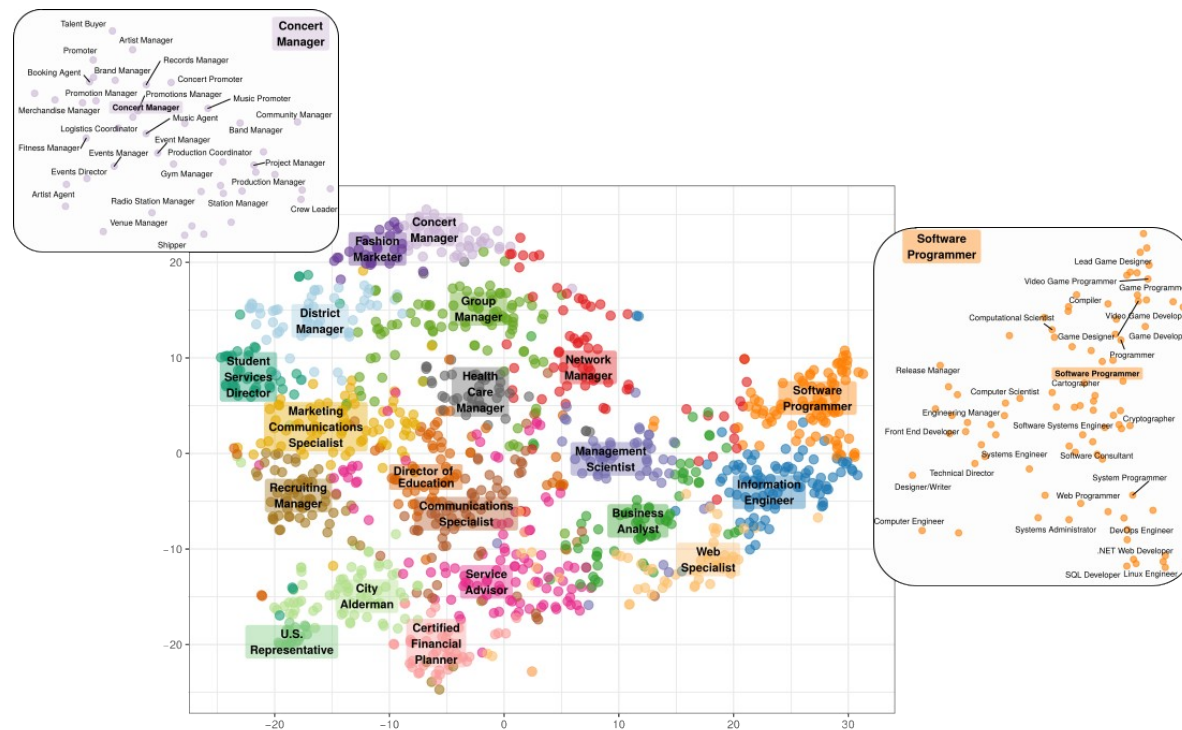


# Next steps:



- Complex contagion diffusion models with community structure;
- Estimate impact of spread of malicious content (total popularity, virality, affected communities)



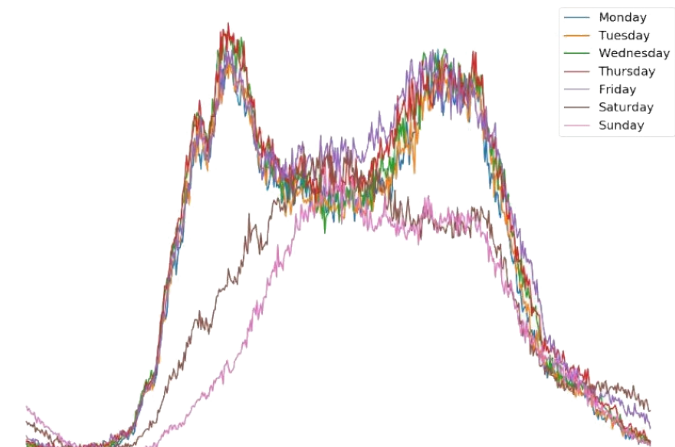
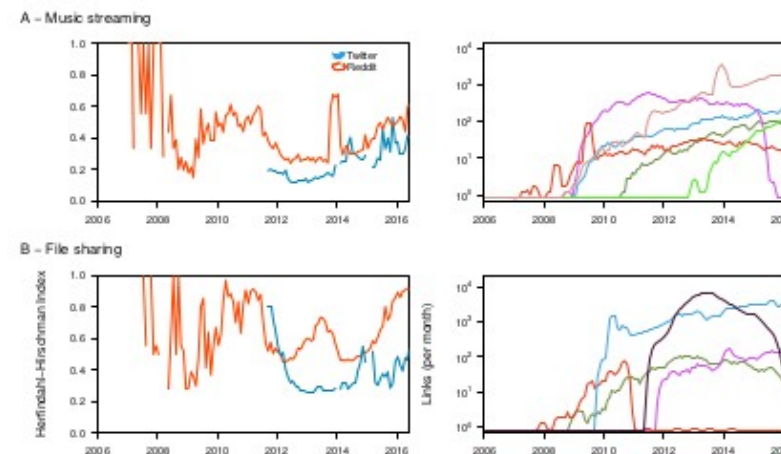


# Other projects

# Other projects



## Behavioral Data Science



## Wikipedia privacy

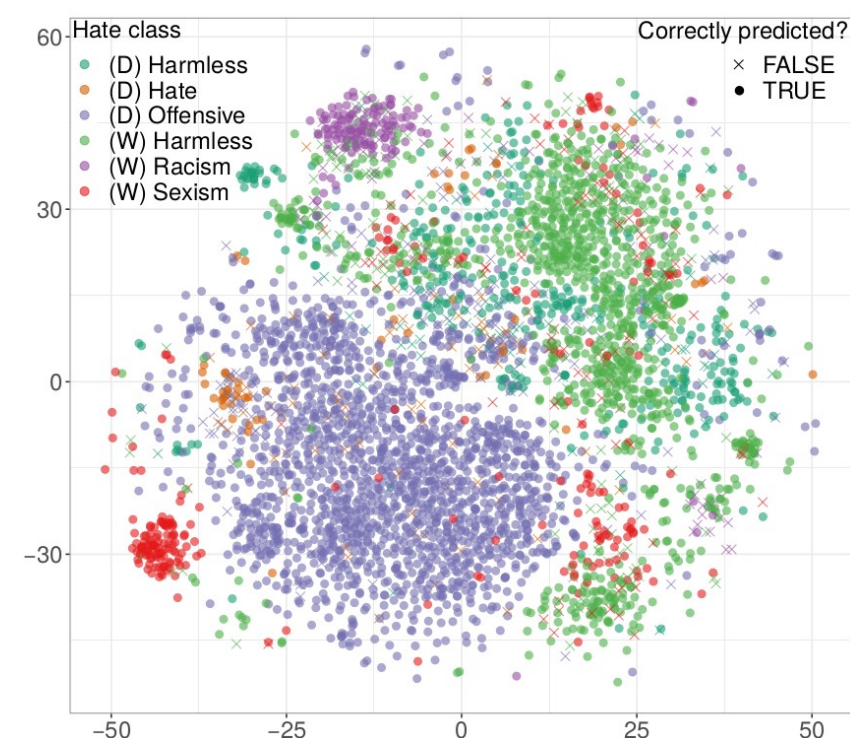
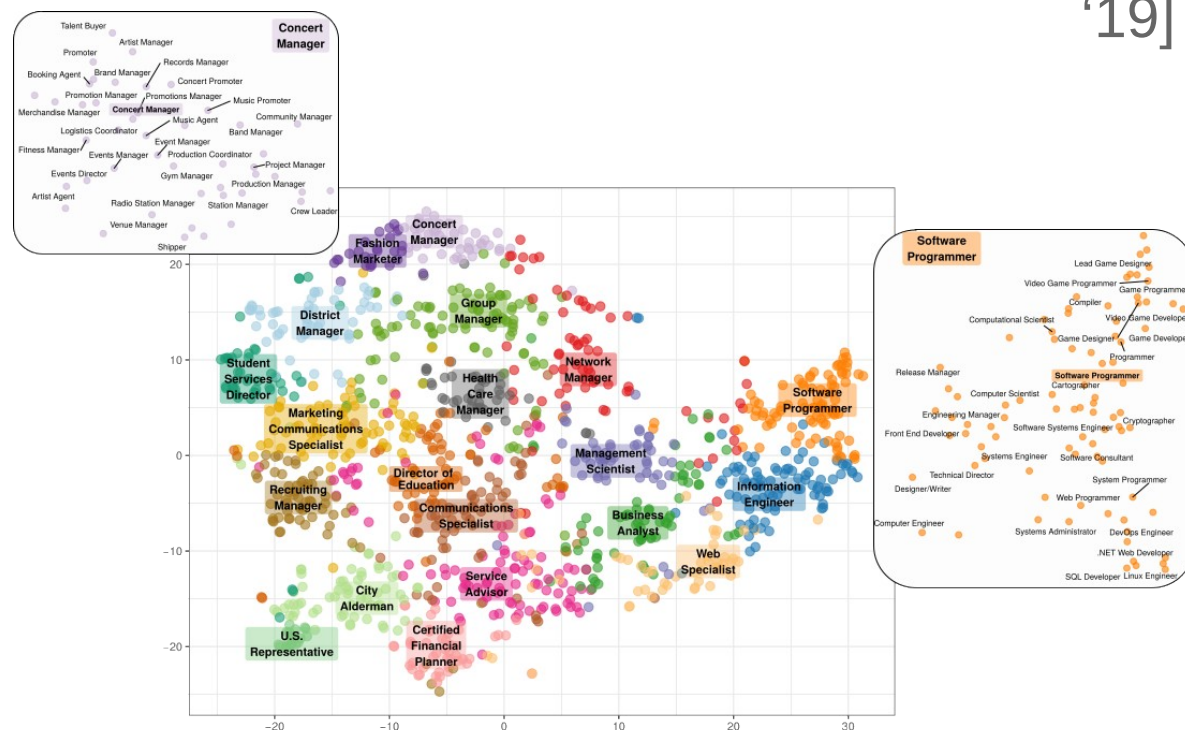
[Rizoiu et al WSDM'16]

## Online Diversity

[McCarthy et al '19]

## Smart traffic

[Mihaita et al ITSC'19]



## Vocation compass

[Kern et al  
DNAS'10]

## Transfer learning for Hate Speech detection

[Rizoiu et al  
ICWSM'10]

# Other projects – references



Behavioral  
Data Science

**[Rizoiu et al WSDM'16]** Rizoiu, M.-A., Xie, L., Caetano, T., & Cebrian, M. (2016). Evolution of Privacy Loss in Wikipedia. In International Conference on Web Search and Data Mining (WSDM '16) (pp. 215–224). New York, New York, USA: ACM Press. <http://arxiv.org/pdf/1512.03523.pdf>

**[McCarthy et al '19]** McCarthy, P. X., Rizoiu, M.-A., Eghbal, S., & Falster, D. S. (2019). Long-term evolutionary trends of diversity online.

**[Mihaita et al ITSC'19]** Mihaita, A.-S., Li, H., He, Z., & Rizoiu, M.-A. (2019). Motorway Traffic Flow Prediction using Advanced Deep Learning. In 22nd Intelligent Transportation Systems Conference (ITSC'19).

**[Kern et al PNAS'19]** Kern, M. L., McCarthy, P. X., Chakrabarty, D., & Rizoiu, M.-A. (2019). Social Media-Predicted Personality Traits Can Help Match People to their Ideal Jobs. Proceedings of the National Academy of Sciences (under review).

**[Rizoiu et al ICWSM'19]** Rizoiu, M.-A., Wang, T., Ferraro, G., & Suominen, H. (2019). Transfer Learning for Hate Speech Detection in Social Media. International AAAI Conference on Web and Social Media (ICWSM'19) (under review). <http://arxiv.org/abs/1906.03829>