Behavioral Data Science

UTS UNIVERSITY OF TECHNOLOGY SYDNEY

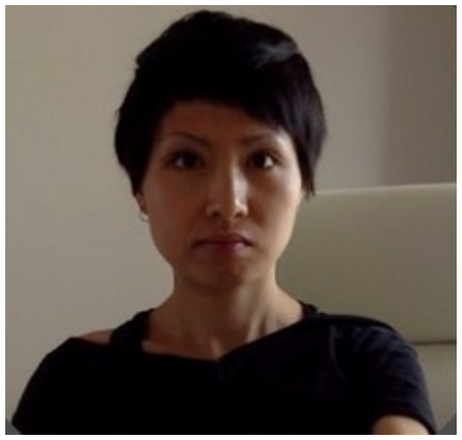
Modeling social processes: diffusions, influence and popularity

Marian-Andrei Rizoiu

The research group

Behavioral Data Science

1 research associate, 3 PhD students, 2 Honors students, 1 lecturer







Research income & grants

~$550k

Behavioral Data Science

2019 – current:	Facebook Research grants, "**Mapping and countering the diffusion of hate speech across social media**", co-CI.
2019 – current:	Crawford School of Public Policy grants, "**Evaluating democratic equity through analysing data around public donation to presidential candidates**", co-CI.
2019 – current:	UTS cross-faculty collaboration scheme, "**SocialSense: Making sense of the opinions and interactions of online users**", CI.
2019	Data61 Challenge model grants, "**Adaptive skills taxonomy to enable labour market agility"**, CI.
2018	ANU Social Science Cross-College Grants, **"Advanced tools and methods for analysing the role and influence of bots in social media"**, CI.
2018	ANU Social Science Cross-College Grants, **"Identify Hate Speech and Predict Mass Atrocities"**, CI.

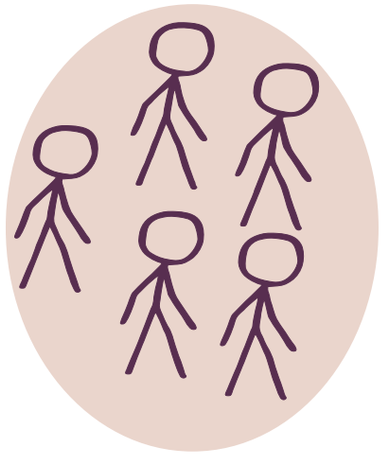
WIKIMEDIA FOUNDATION

NETFLIX

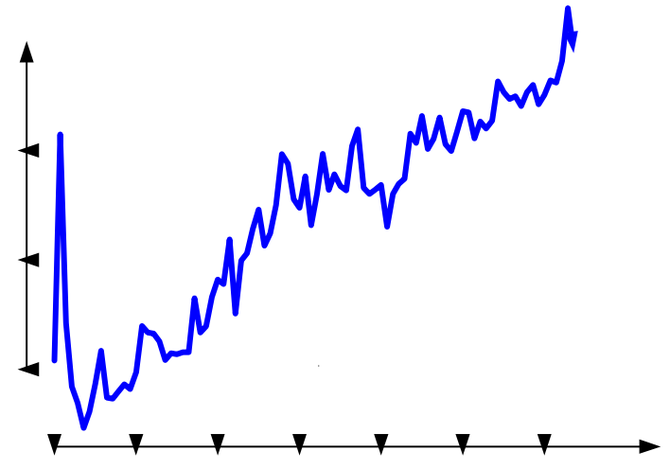
Research objectives

Behavioral Data Science

1.



information diffusion
epidemics spreading
behavioral modeling



Research objectives

Behavioral Data Science

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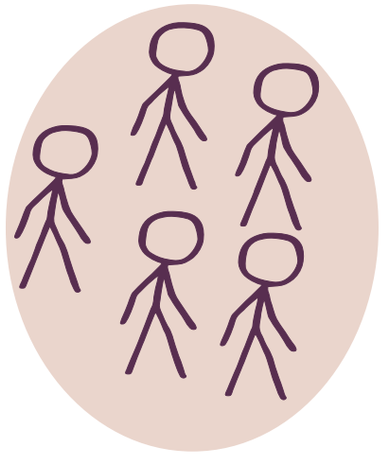

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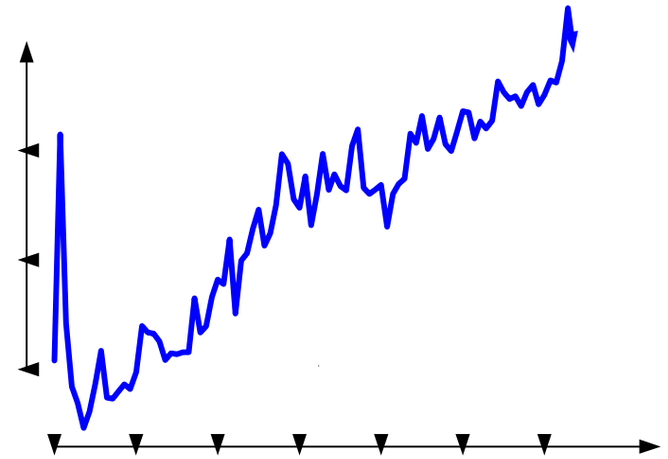

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Behavioral Data Science

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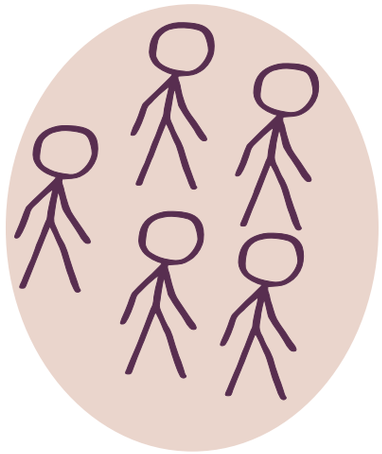

information diffusion
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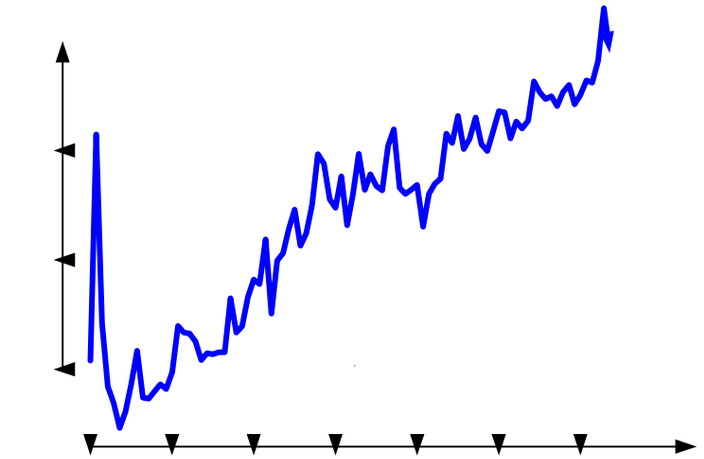
behavioral modeling



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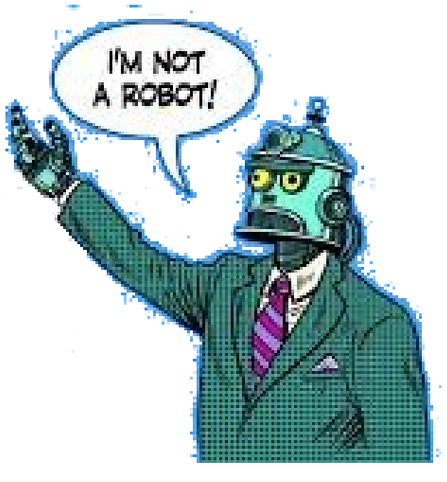

Research objectives

Behavioral Data Science

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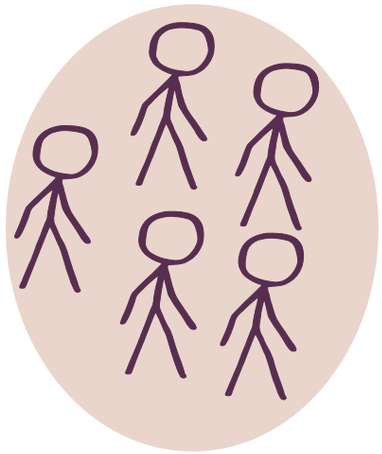

information diffusion
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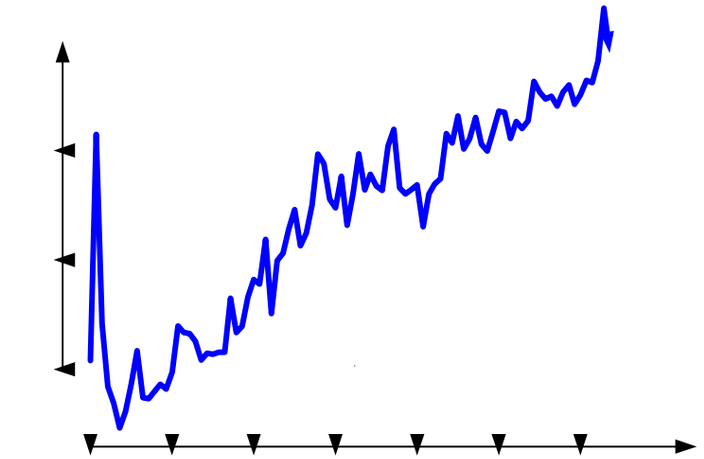

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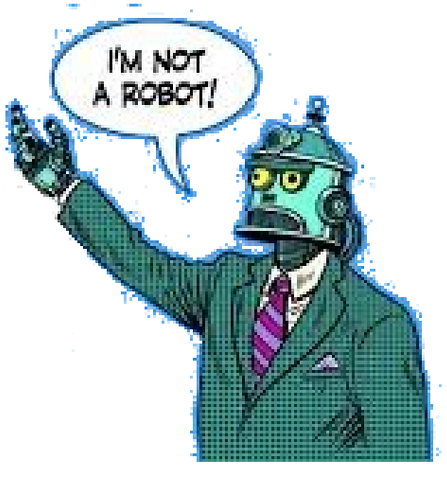

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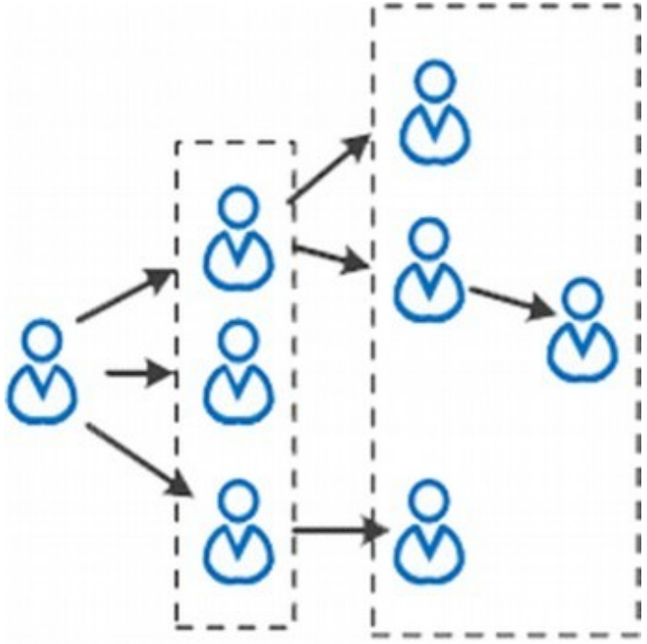
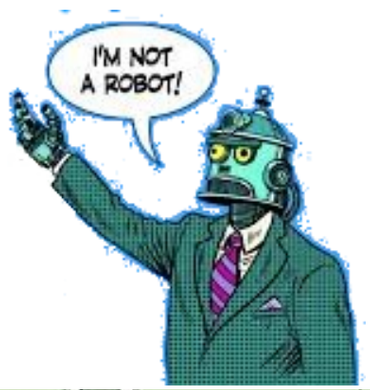
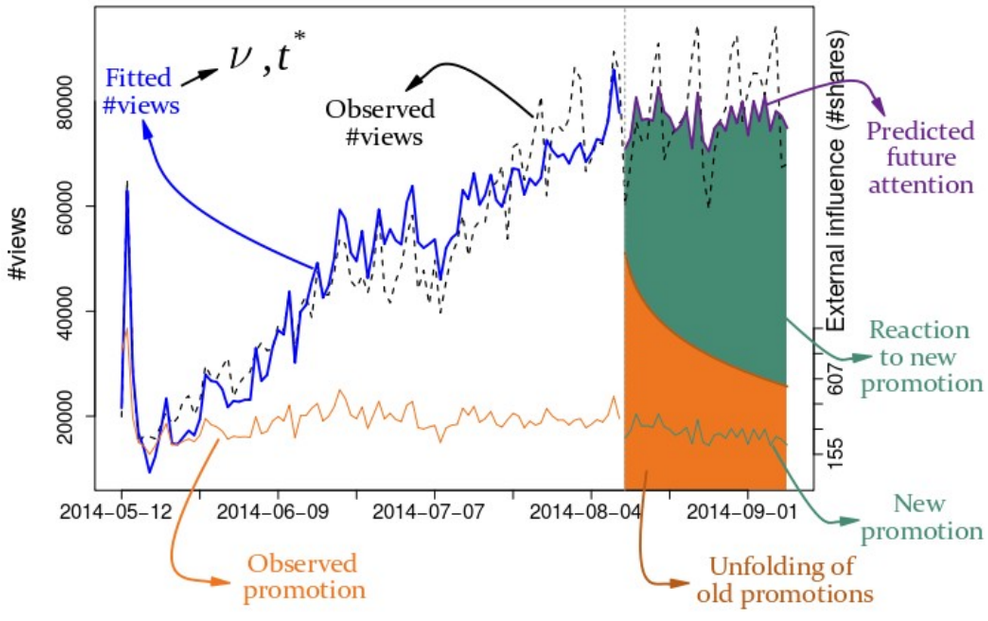


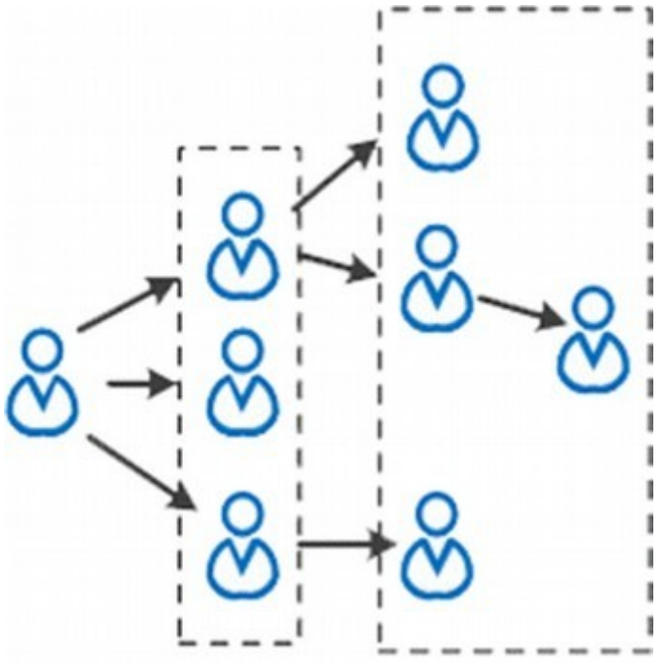
Model information diffusion in social networks



Influence democratic processes using social media

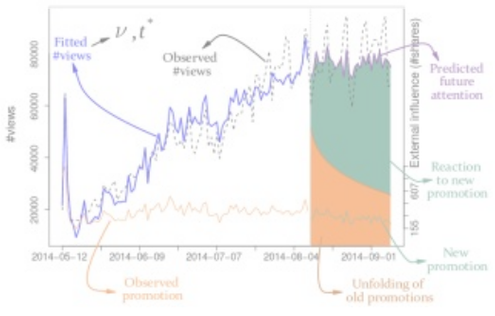


Model and predict popularity, virality and engagement



Modeling information diffusion in social networks

Influencing democratic processes using social media



Modeling and predicting popularity, virality and engagement

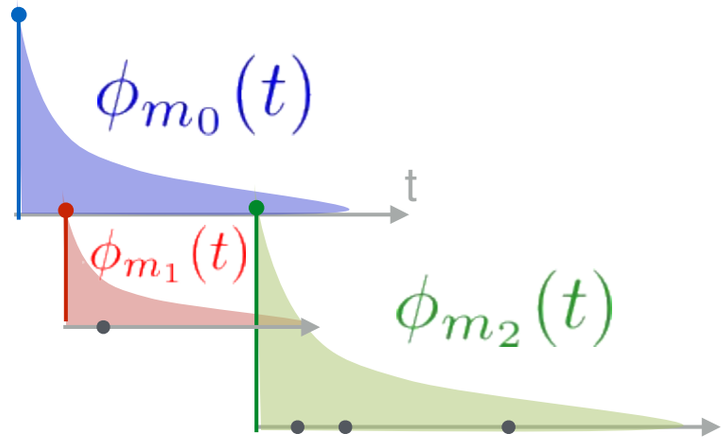
Modeling information diffusion in social networks

Behavioral Data Science

Hawkes modeling

[Mishra et al CIKM'16]

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



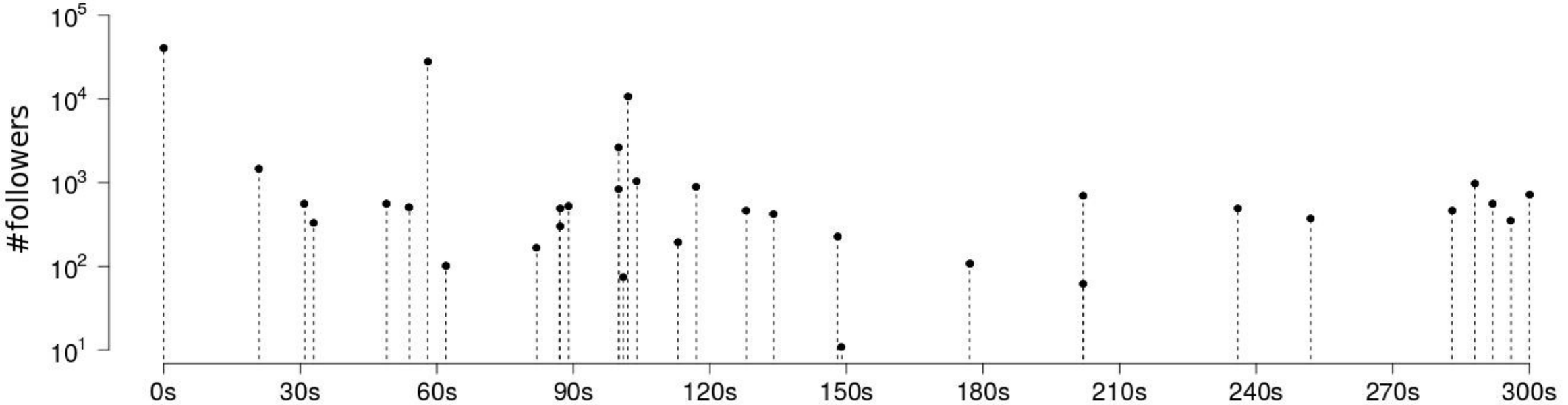
the rate of 'daughter' events — content virality — user influence — memory

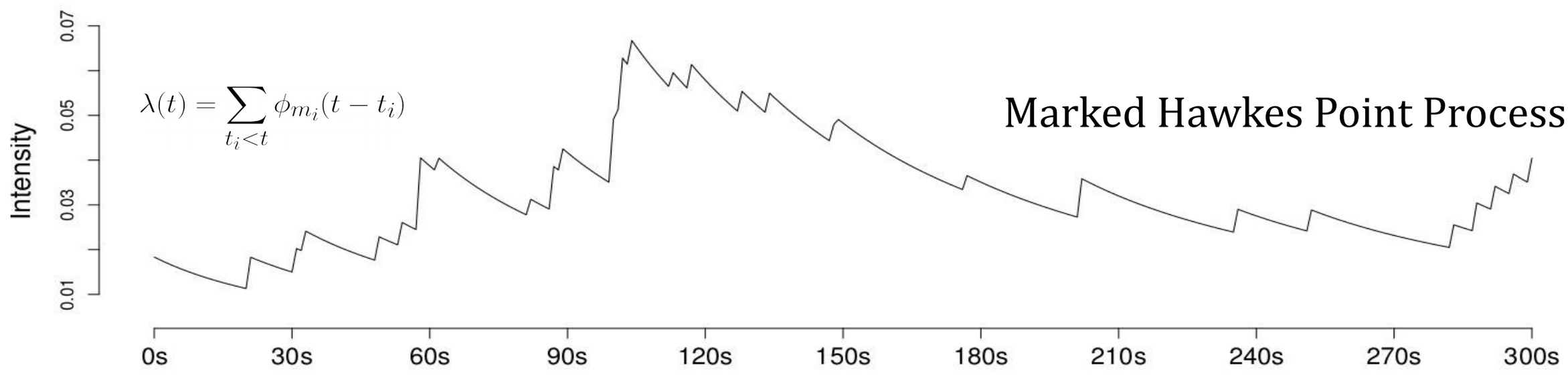
$$\phi_m(\tau) = \kappa\, m^{\beta}\, \hat{\tau}^{-(1+\theta)}$$

S. Mishra, M.-A. Rizoiu, and L. Xie, "Feature Driven and Point Process Approaches for Popularity Prediction, " in Proc. International Conference on Information and Knowledge Management (CIKM '16), Indianapolis, USA, p. 1069-1078, 2016. https://arxiv.org/abs/1608.04862

Self-Exciting Point Processes

Behavioral Data Science



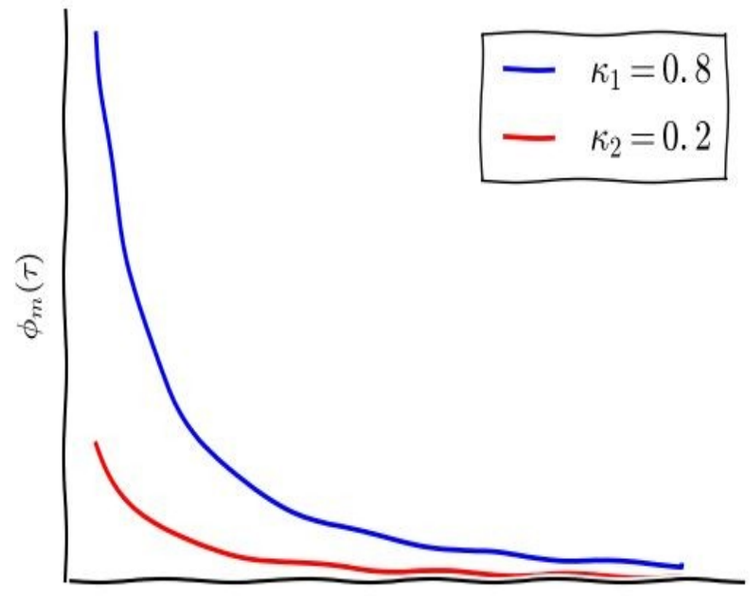


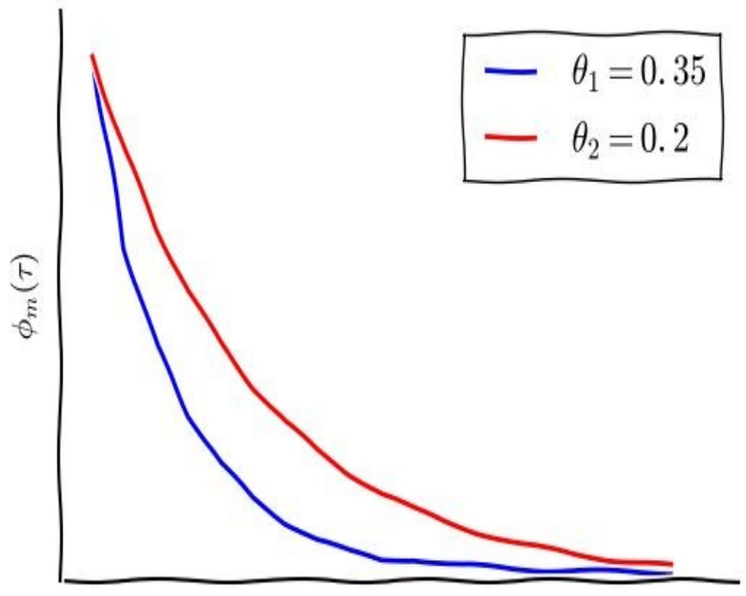
Kernel for Marked Hawkes

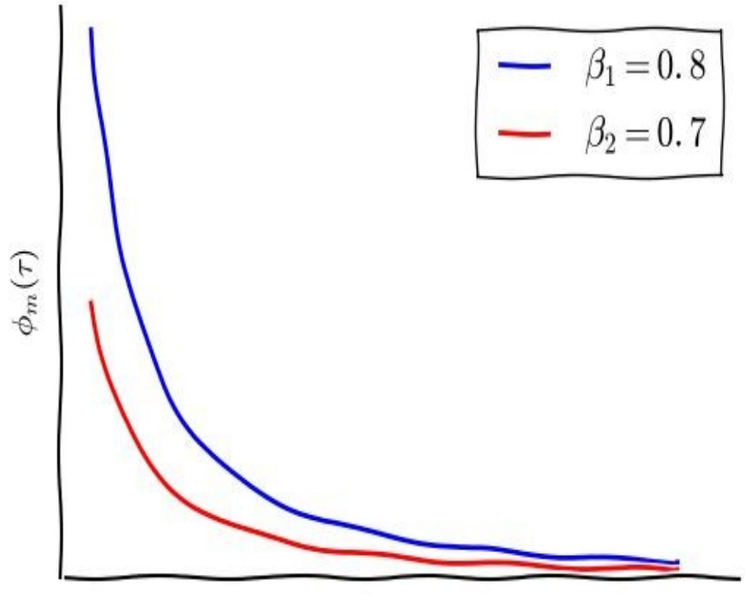
Behavioral Data Science

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

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

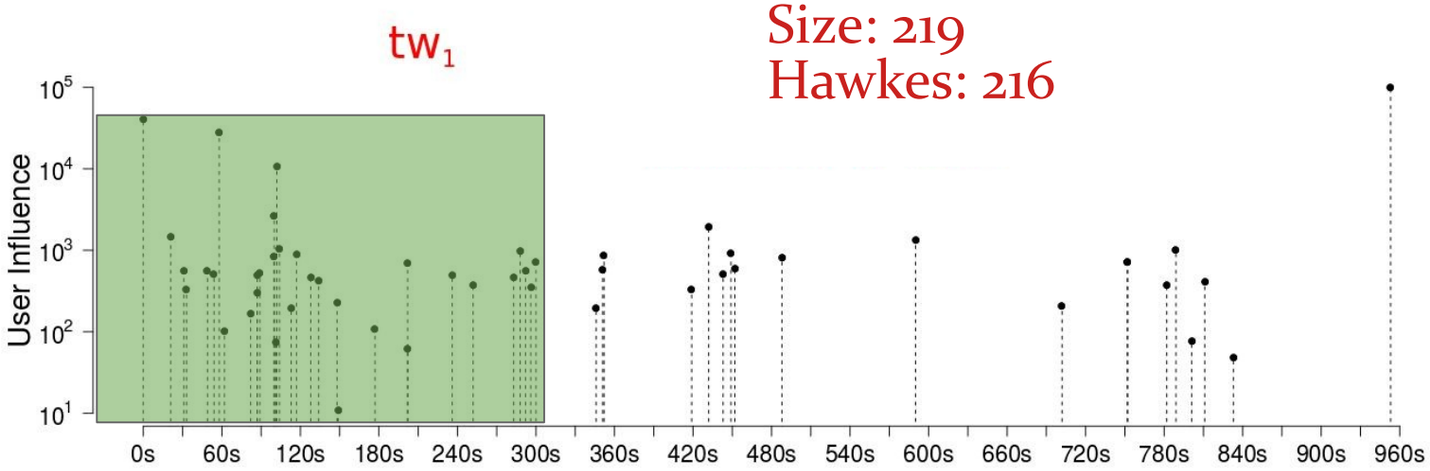


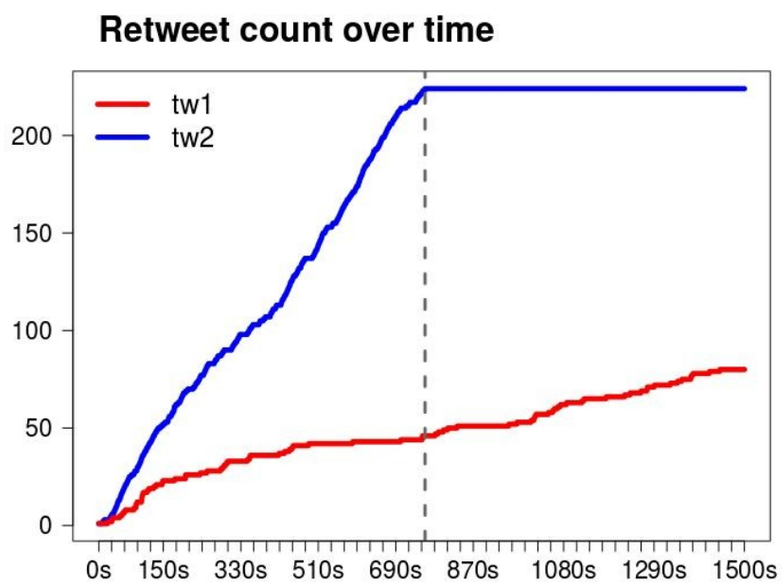


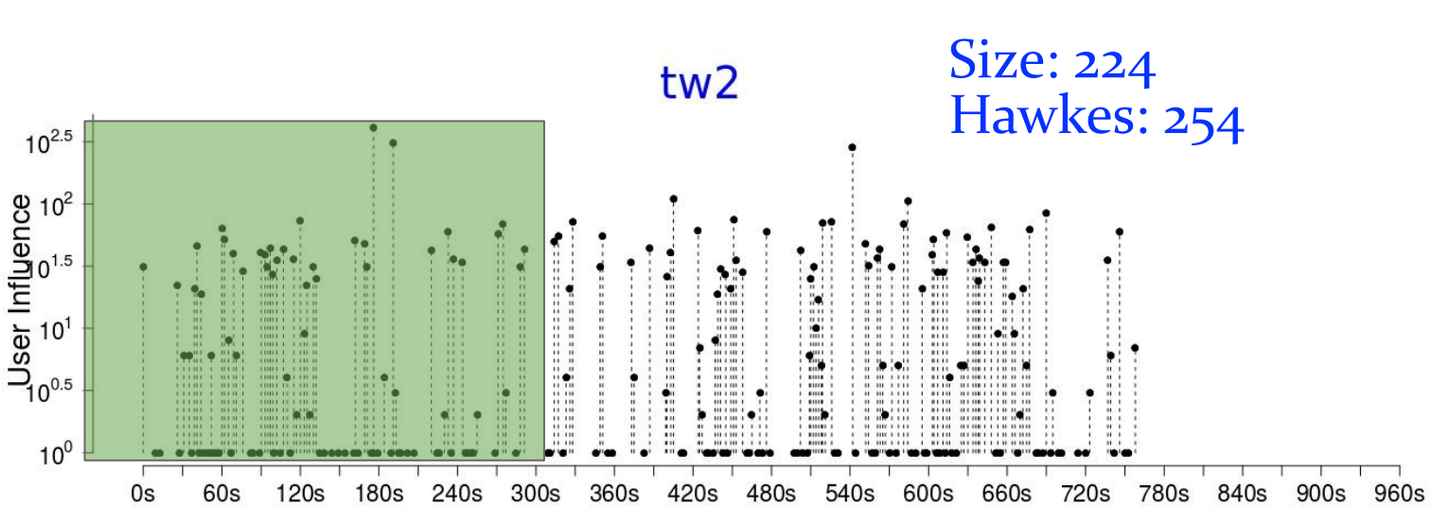


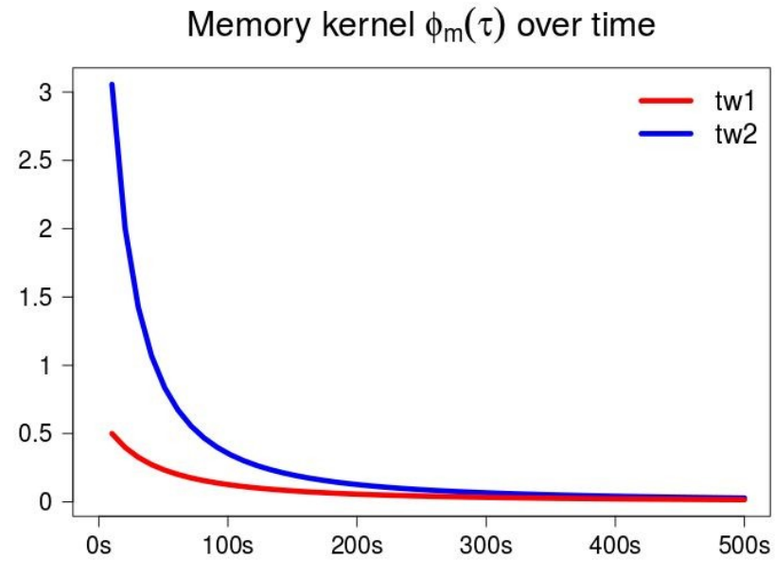
Predict total size & virality

Behavioral Data Science







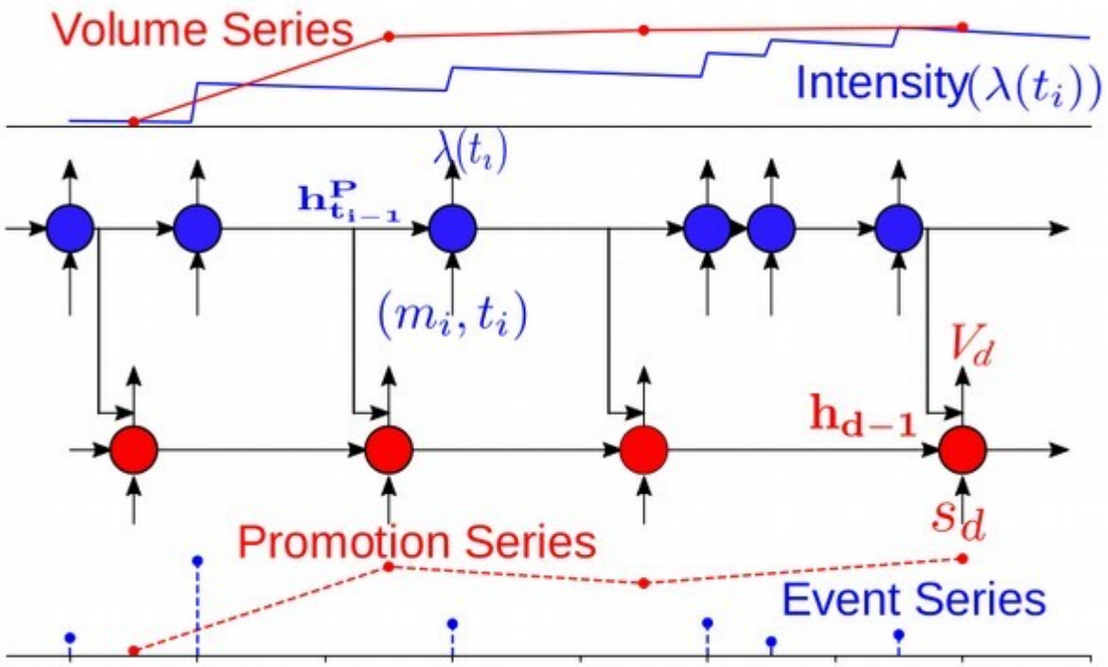


Modeling information diffusion in social networks

Behavioral Data Science

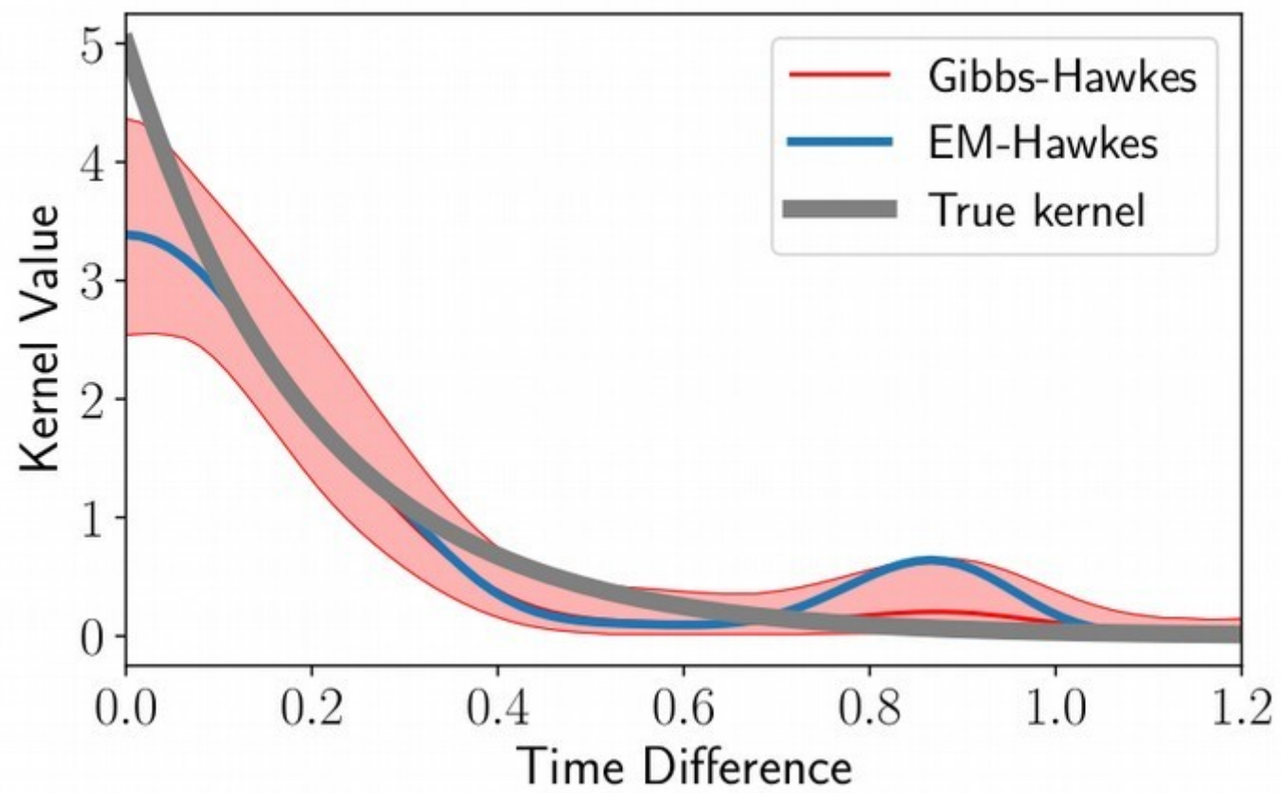
Neural Hawkes

[Mishra et al ICWSM'18]



Bayesian Hawkes

[Zhang et al IJCAI'19]



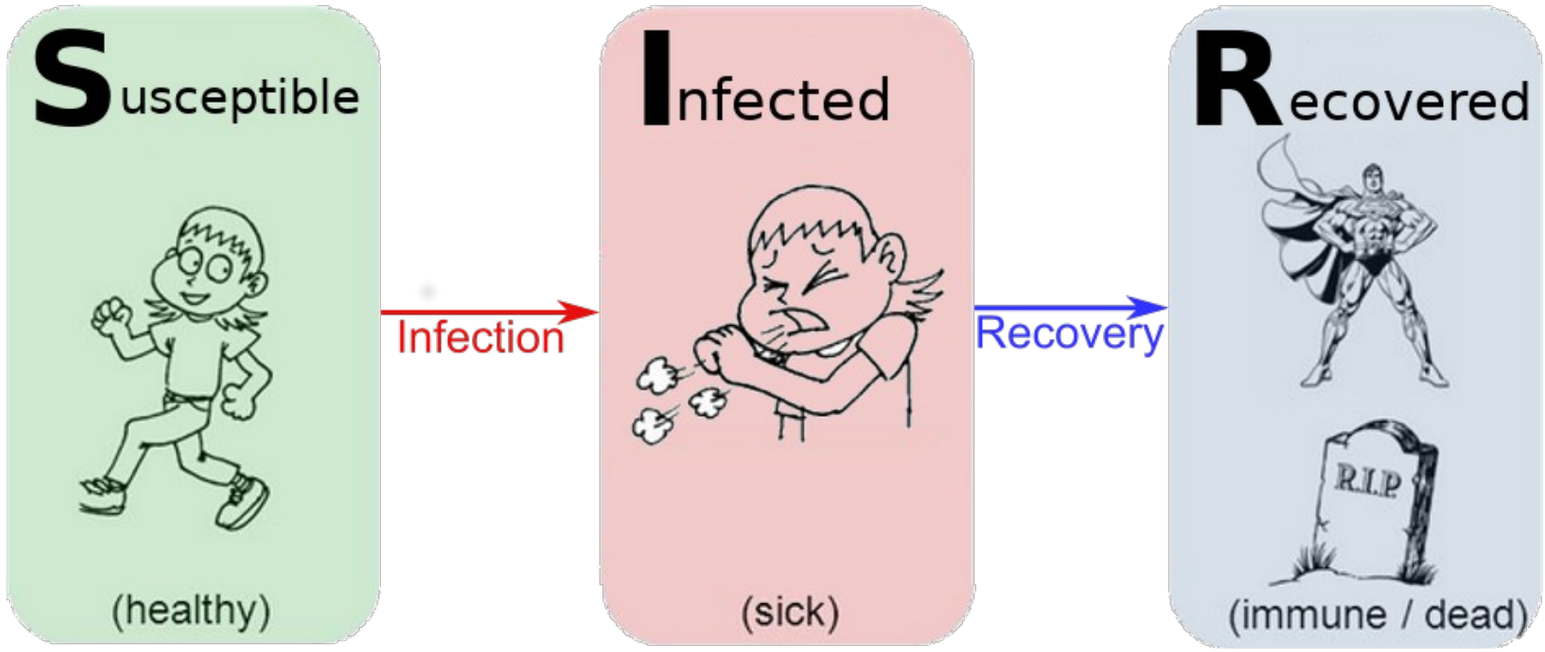
S. Mishra, M.-A. Rizoiu, & L. Xie, "Modeling Popularity in Asynchronous Social Media Streams with Recurrent Neural Networks, " in Proc. International AAAI Conference on Web and Social Media (ICWSM '18), Stanford, CA, USA, 2018. https://arxiv.org/abs/1804.02101

R. Zhang, C. Walder, M.-A. Rizoiu 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

Diffusions in finite populations: **The SIR epidemic model**

Behavioral Data Science

[Rizoiu et al WWW'18]

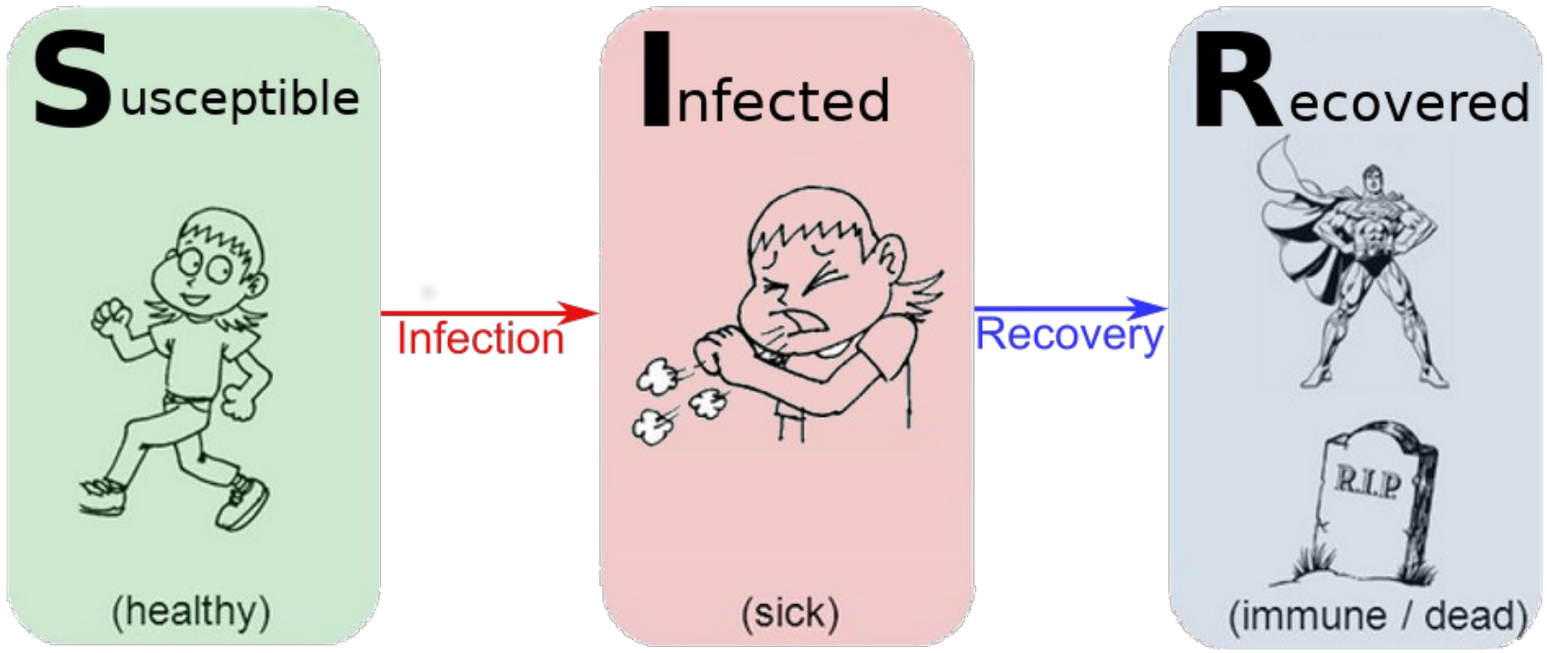


M.-A. Rizoiu, S. Mishra, Q. Kong, M. Carman, and L. Xie, "SIR-Hawkes: Linking Epidemic Models and Hawkes Processes to Model Diffusions in Finite Populations, " in Proc. International Conference on World Wide Web (WWW '18), Lyon, France, 2018. https://arxiv.org/pdf/1711.01679.pdf

Diffusions in finite populations: **The SIR epidemic model**

[Rizoiu et al WWW'18]

Behavioral Data Science



$$\frac{dS(t)}{dt} = -\beta \frac{S(t)}{N} I(t)$$

$$\frac{dI(t)}{dt} = \beta \frac{S(t)}{N} I(t) - \gamma I(t)$$

$$\frac{dR(t)}{dt} = \gamma I(t)$$

infection rate

Population size (known and fixed)

recovery rate

Deterministic SIR

M.-A. Rizoiu, S. Mishra, Q. Kong, M. Carman, and L. Xie, "SIR-Hawkes: Linking Epidemic Models and Hawkes Processes to Model Diffusions in Finite Populations, " in Proc. International Conference on World Wide Web (WWW '18), Lyon, France, 2018. https://arxiv.org/pdf/1711.01679.pdf

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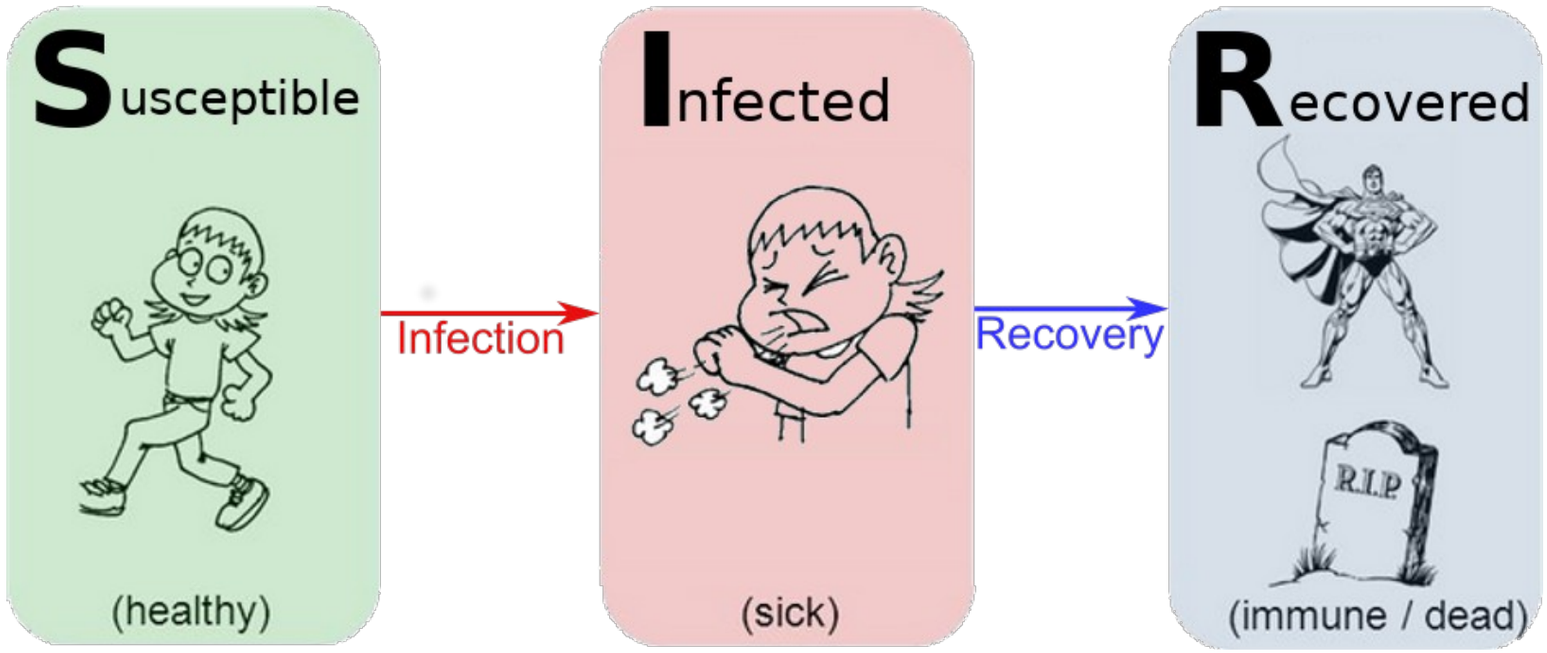

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$$\frac{dR(t)}{dt} = \gamma I(t)$$

infection rate

Population size (known and fixed)

recovery rate

Deterministic SIR

$$\lambda^I(t) = \beta \frac{S_t}{N} I_t$$

$$\lambda^R(t) = \gamma I_t$$

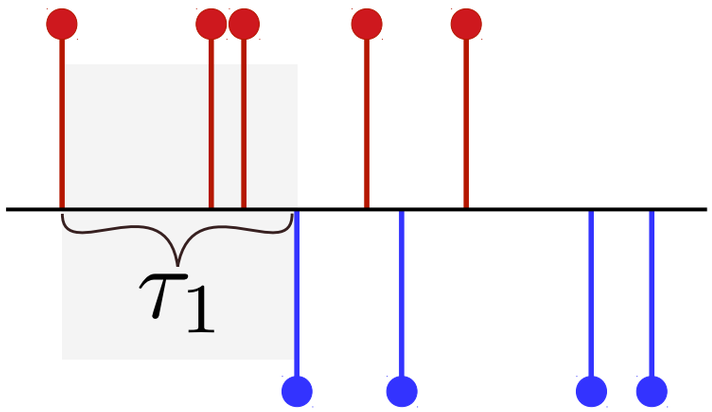
Stochastic SIR

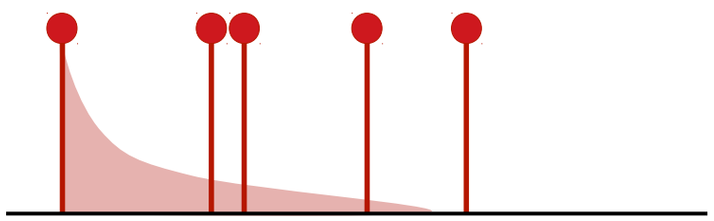
M.-A. Rizoiu, S. Mishra, Q. Kong, M. Carman, and L. Xie, "SIR-Hawkes: Linking Epidemic Models and Hawkes Processes to Model Diffusions in Finite Populations, " in Proc. International Conference on World Wide Web (WWW '18), Lyon, France, 2018. https://arxiv.org/pdf/1711.01679.pdf

Diffusions in finite populations:
Linking epidemic models and Hawkes

[Rizoiu et al WWW'18]

Behavioral Data Science





$$SIR(\beta, \gamma) \qquad\qquad HawkesN(\mu, \kappa, \theta)$$

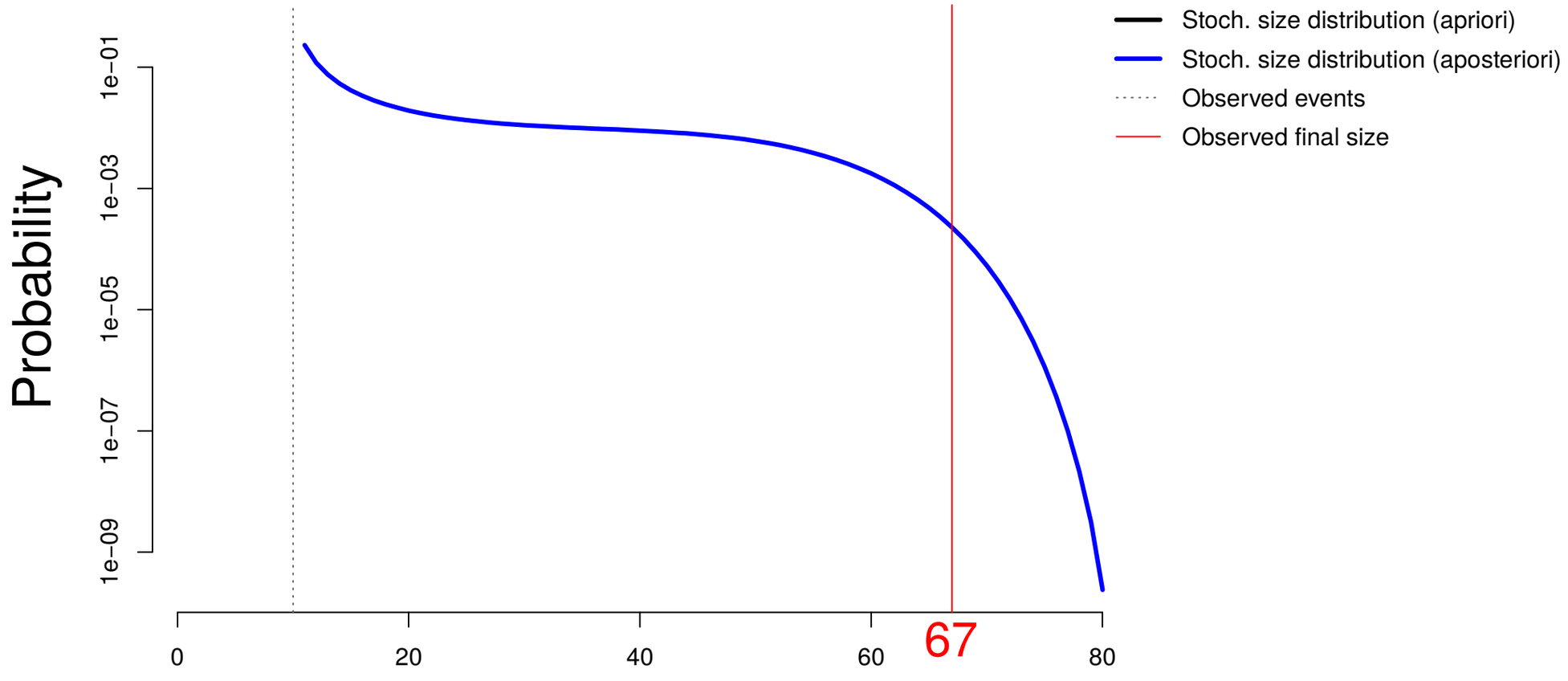
$$\mathbb{E}_{t^R}[\lambda^I(t)] = \lambda^H(t)$$

where $\mu = 0,\ \beta = \kappa\theta,\ \gamma = \theta$

M.-A. Rizoiu, S. Mishra, Q. Kong, M. Carman, and L. Xie, "SIR-Hawkes: Linking Epidemic Models and Hawkes Processes to Model Diffusions in Finite Populations, " in Proc. International Conference on World Wide Web (WWW '18), Lyon, France, 2018. https://arxiv.org/pdf/1711.01679.pdf

Example: total size of a tweet cascade

Behavioral Data Science

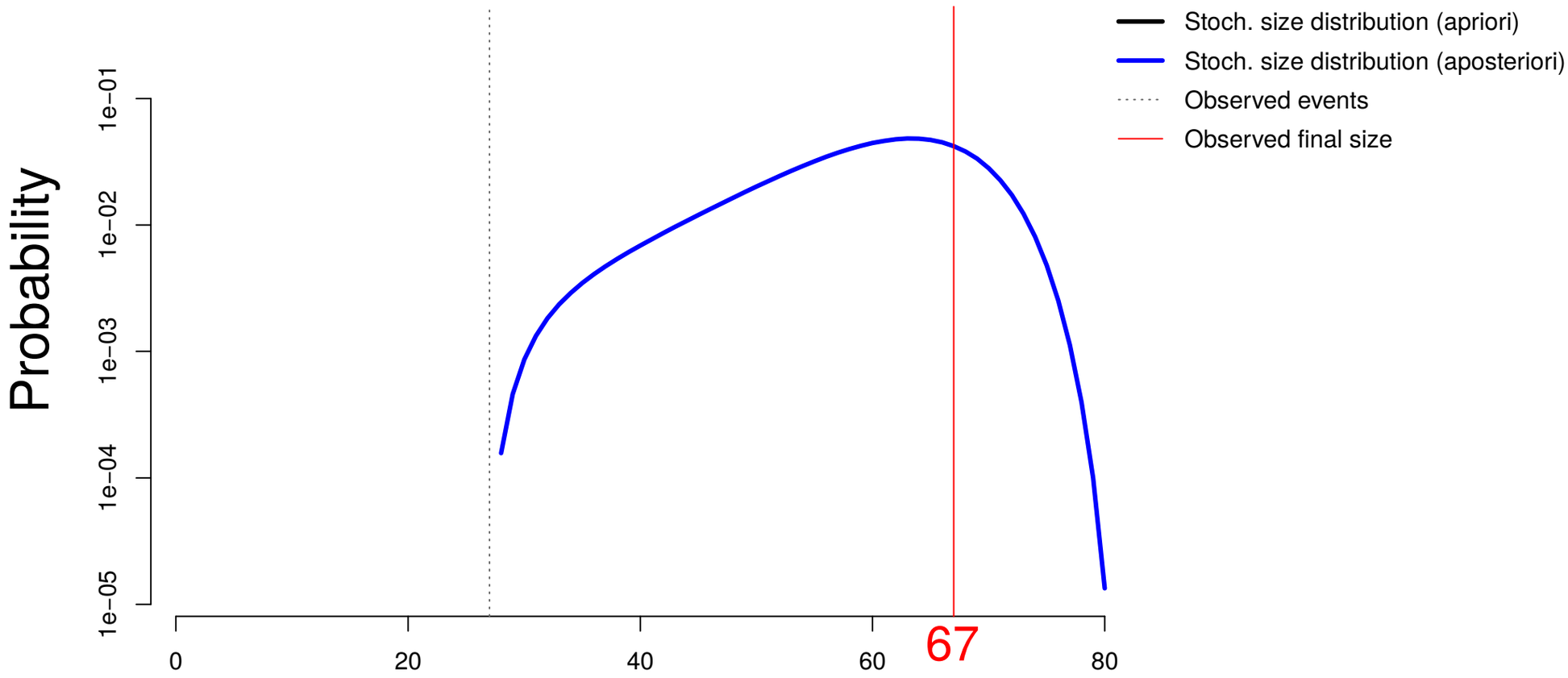


10 seen events

Example: total size of a tweet cascade

ScreenCrush
@screencrushnews

The New York Times reports Leonard Nimoy, 'Star Trek"s beloved Mr. Spock, has died. nytimes.com/2015/02/27/art …

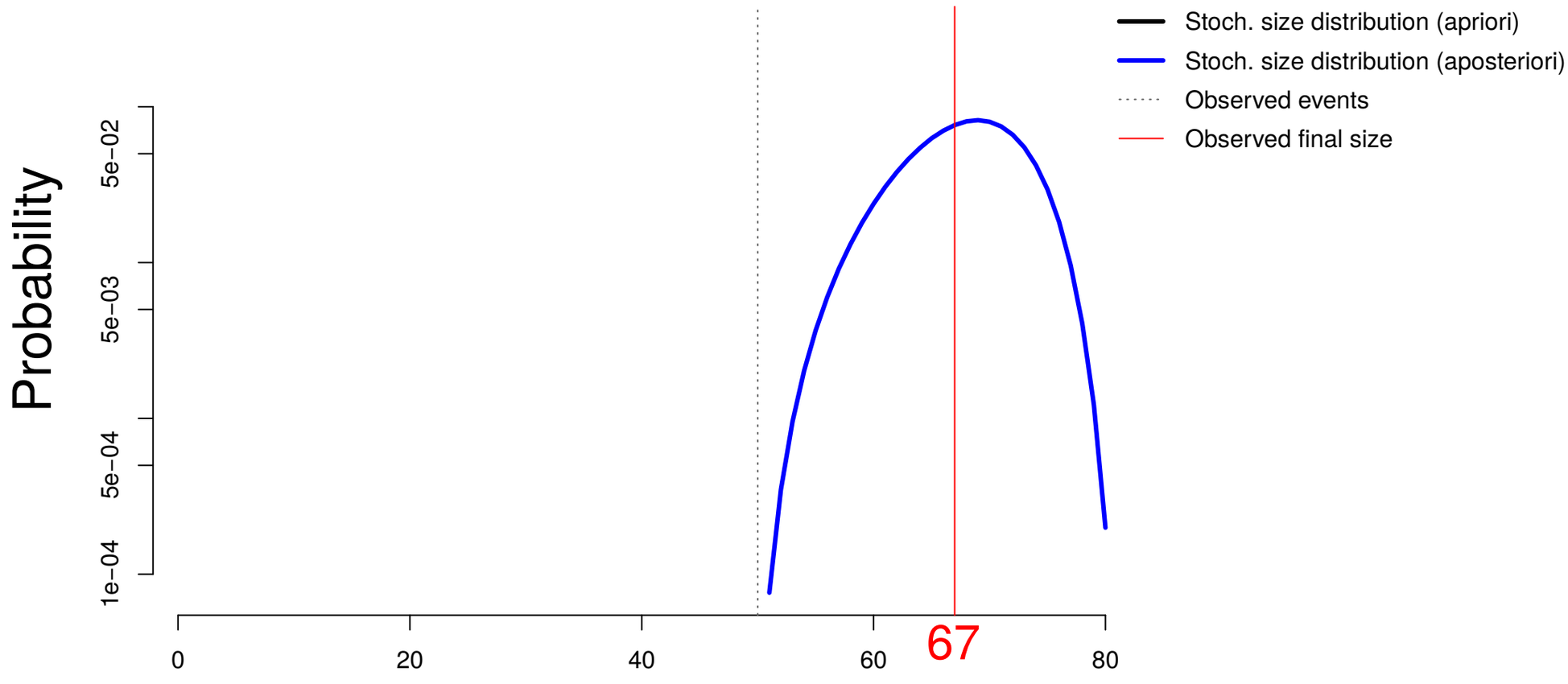


27 seen events

Behavioral Data Science

Example: total size of a tweet cascade

Behavioral Data Science



50 seen events

Example: total size of a tweet cascade

Behavioral Data Science

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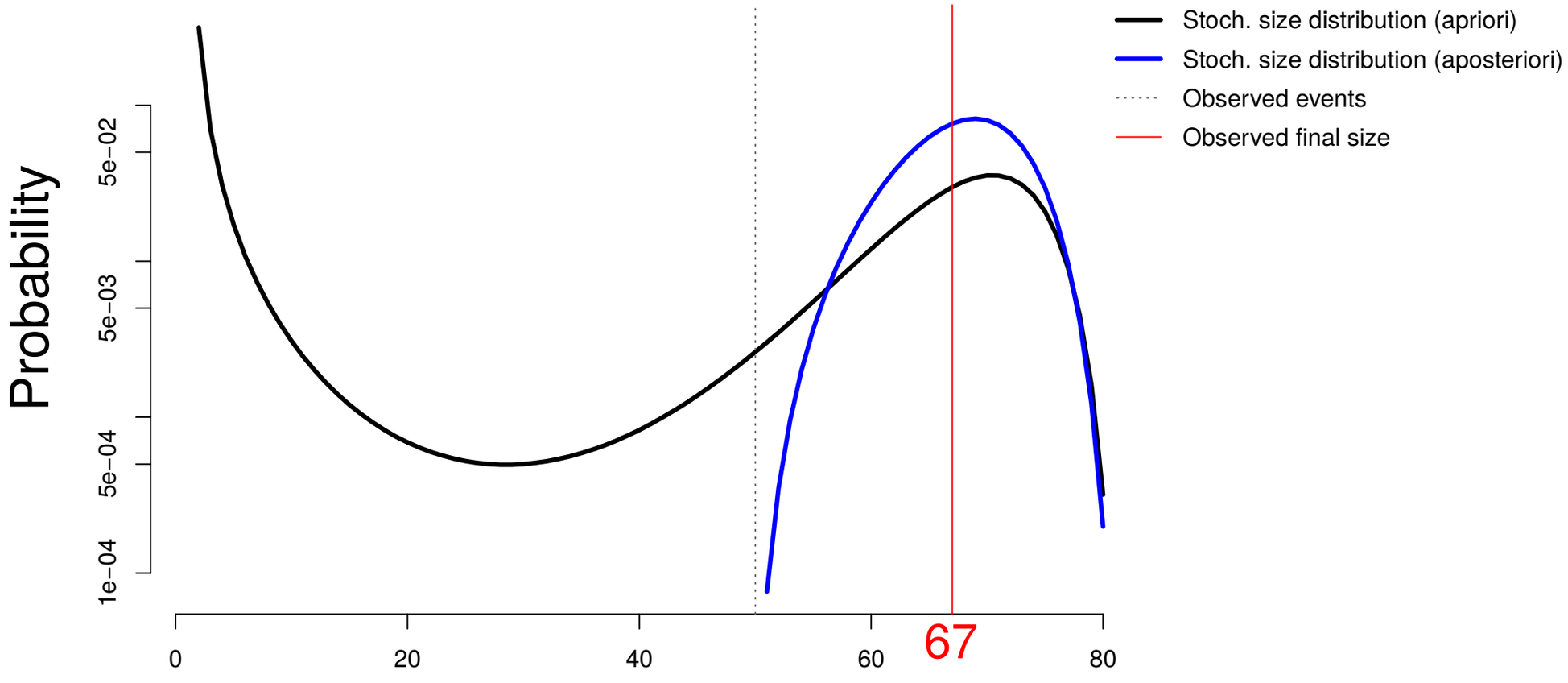
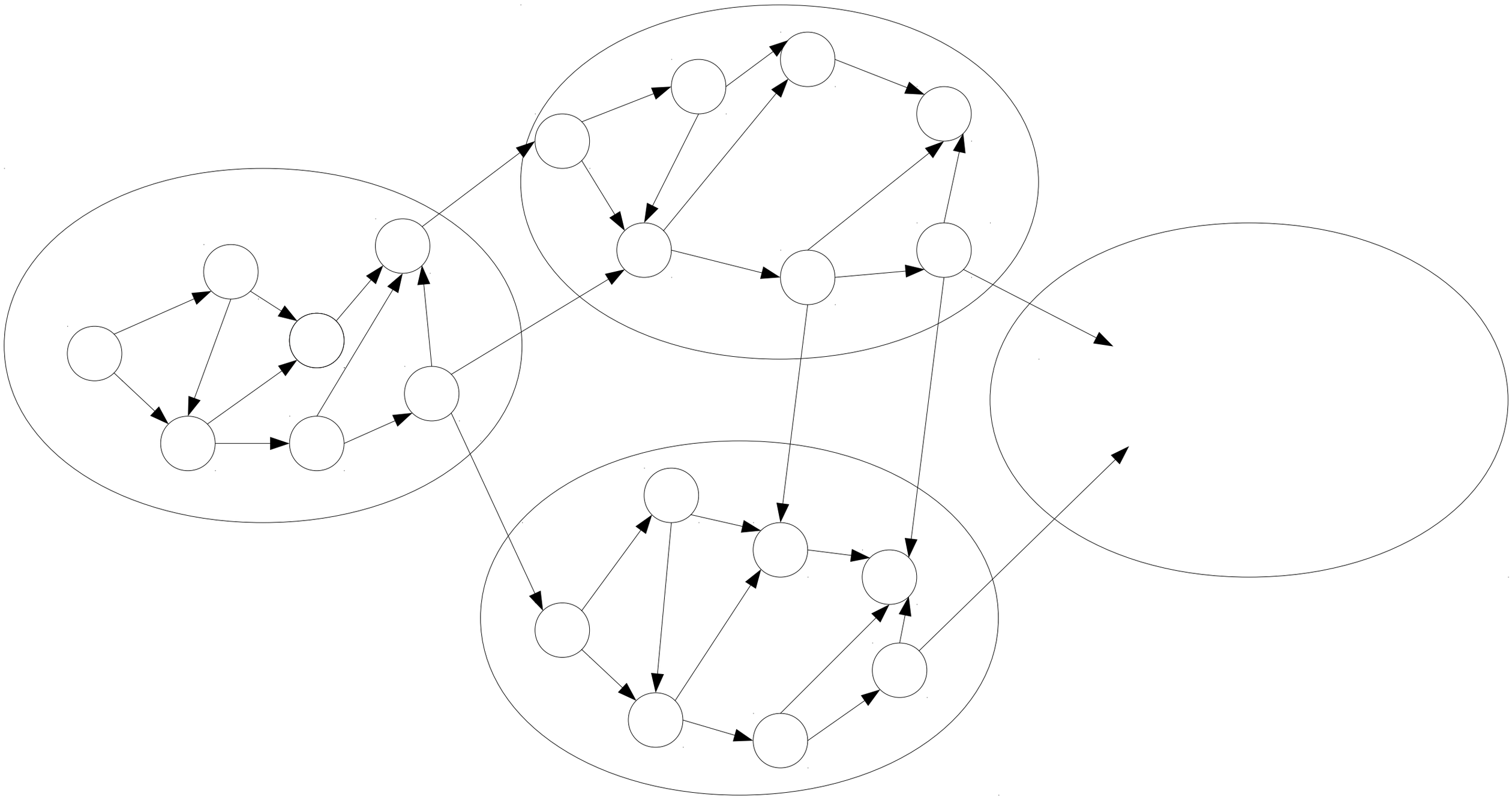


50 seen events

Explanation for the unpredictability of online popularity

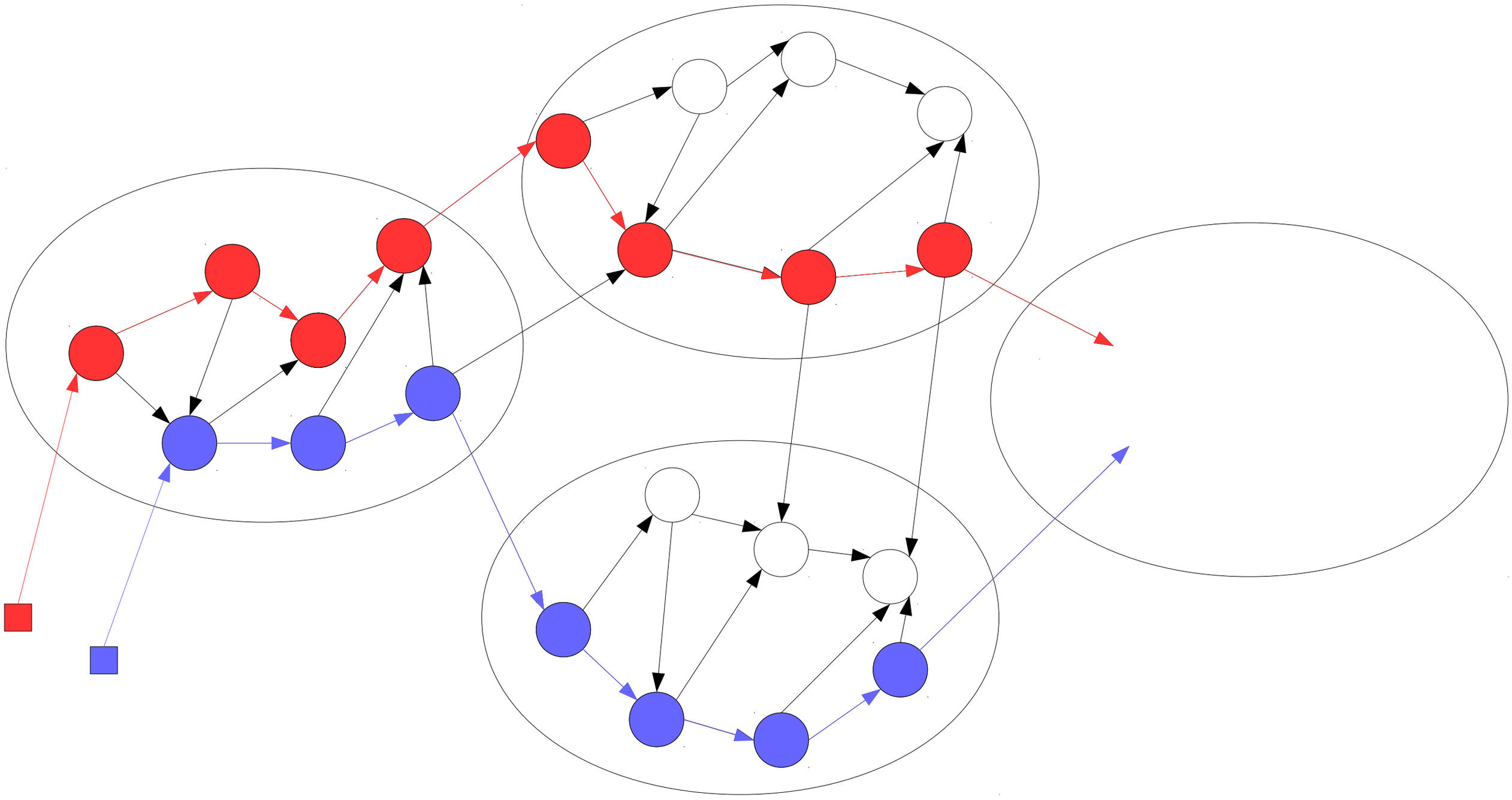
(current work) Information diffusion in local communities

Behavioral Data Science

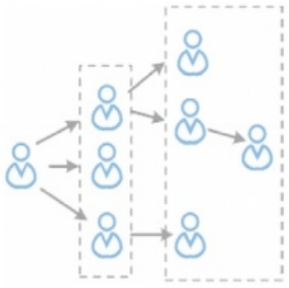


(current work) Information diffusion in local communities

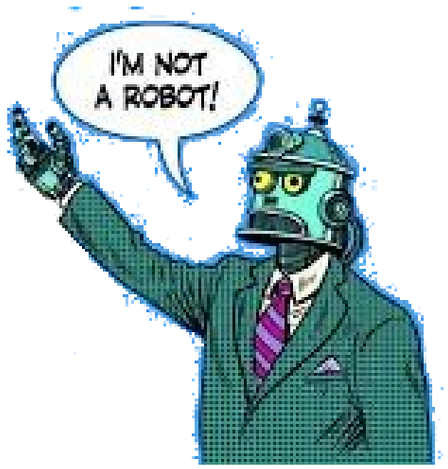
Behavioral Data Science



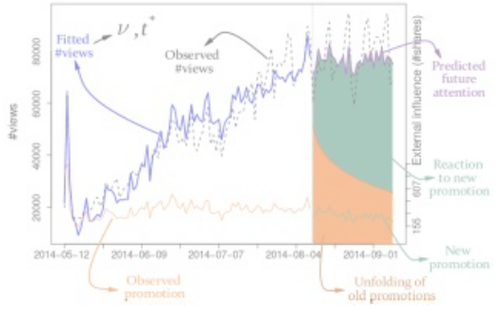
Spatio-temporal diffusions with a community structure
Estimate impact of spread of malicious content (size, speed, affected communities)
(optimal) Control theory



Modeling information diffusion in social networks



Influencing democratic processes using social media

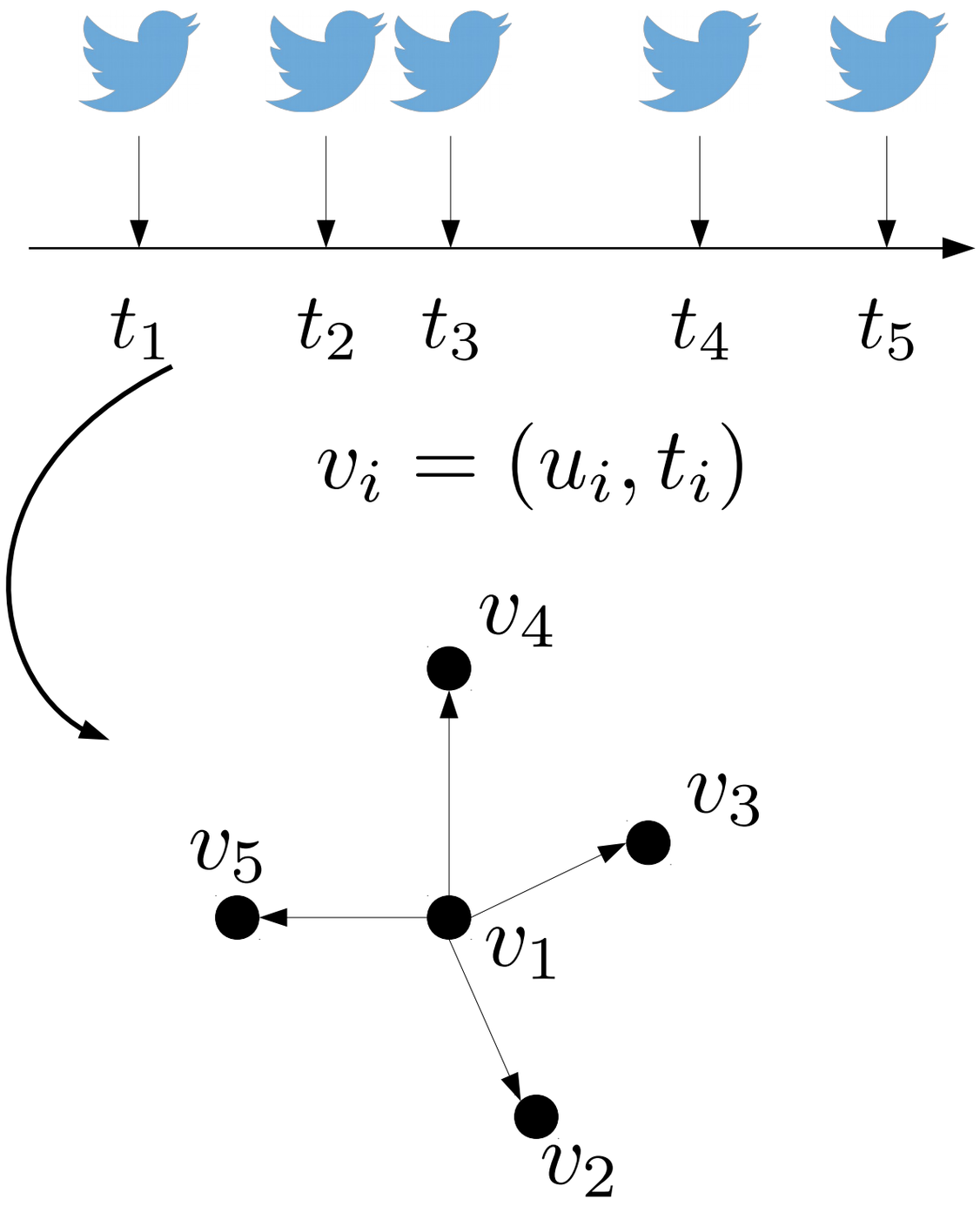


Modeling and predicting popularity, virality and engagement

Role and Influence of Twitter Socialbots During US Presidential Debate

Behavioral Data Science

[Rizoiu et al ICWSM'18]



M.-A. Rizoiu, T. Graham, R. Zhang, Y. Zhang, R. Ackland and L. Xie, "#DebateNight: The Role and Influence of Socialbots on Twitter During the 1st 2016 U.S. Presidential Debate, " in Proc. International AAAI Conference on Web and Social Media (ICWSM '18), Stanford, CA, USA, 2018. https://arxiv.org/abs/1802.09808

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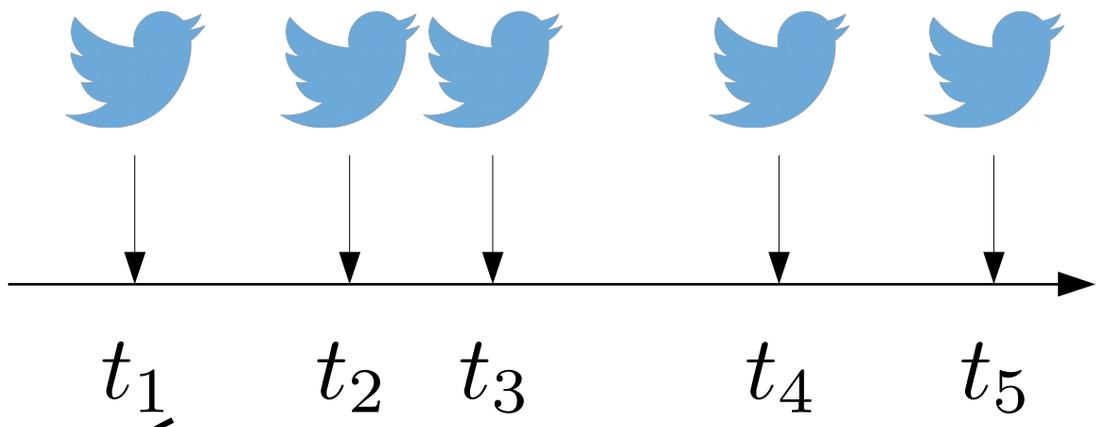
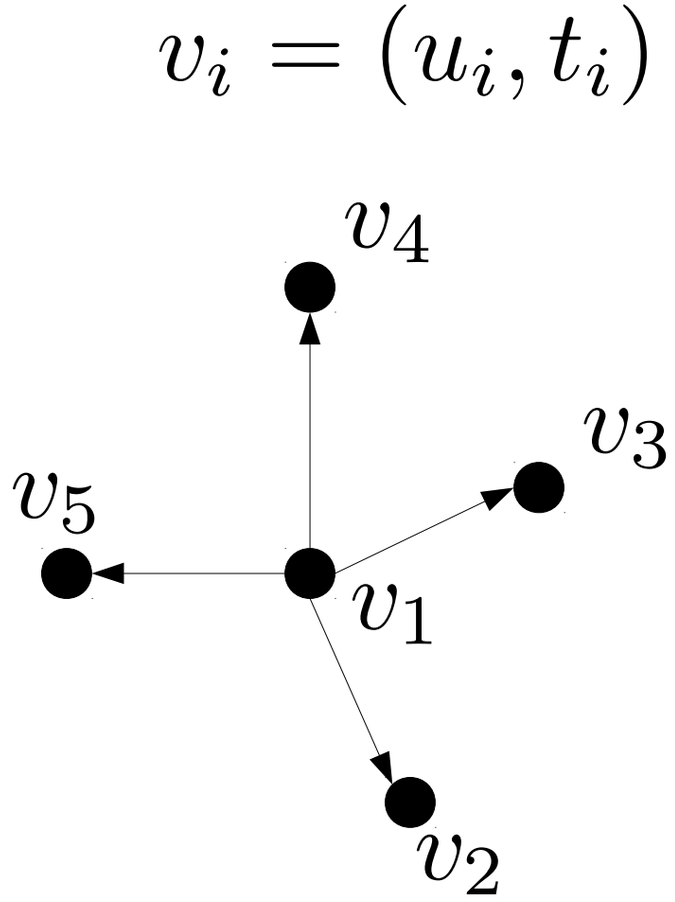
Behavioral Data Science

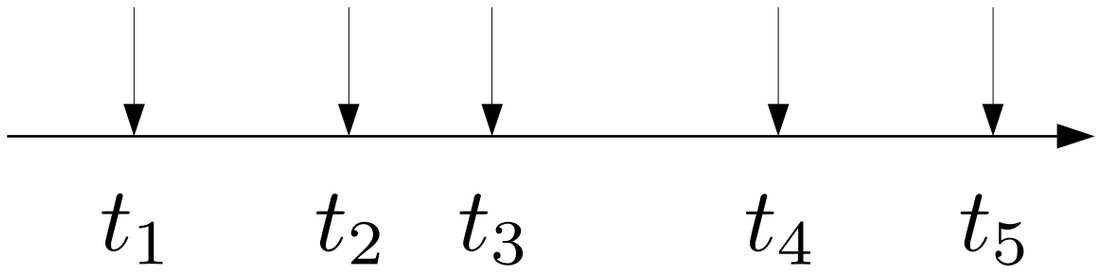
[Rizoiu et al ICWSM'18]

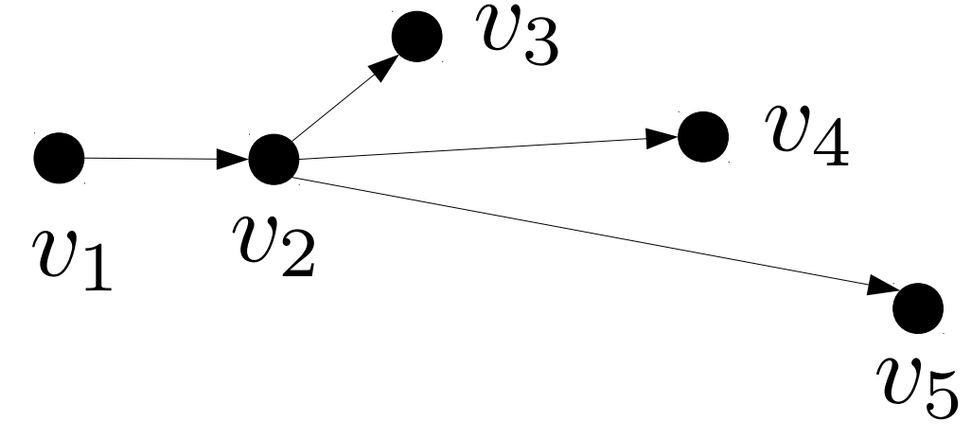


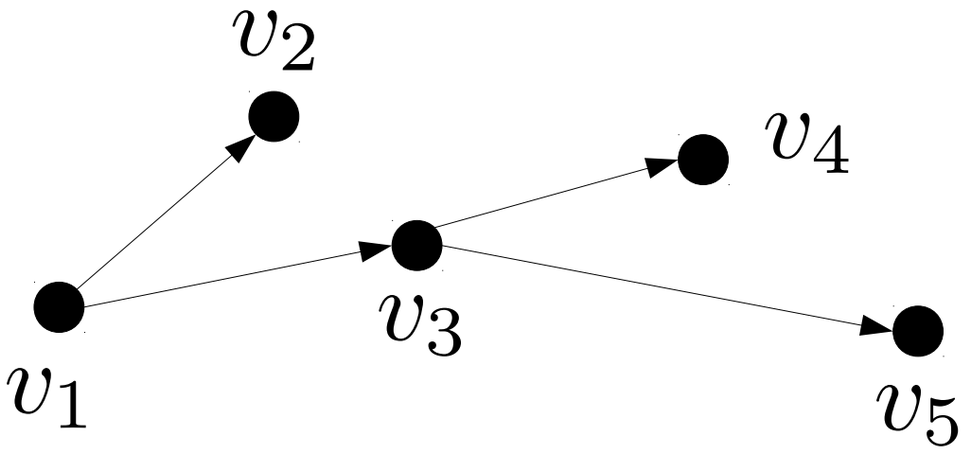
$$v_i = (u_i, t_i)$$



Diffusion trees and influence







M.-A. Rizoiu, T. Graham, R. Zhang, Y. Zhang, R. Ackland and L. Xie, "#DebateNight: The Role and Influence of Socialbots on Twitter During the 1st 2016 U.S. Presidential Debate, " in Proc. International AAAI Conference on Web and Social Media (ICWSM '18), Stanford, CA, USA, 2018. https://arxiv.org/abs/1802.09808

Role and Influence of Twitter Socialbots During US Presidential Debate

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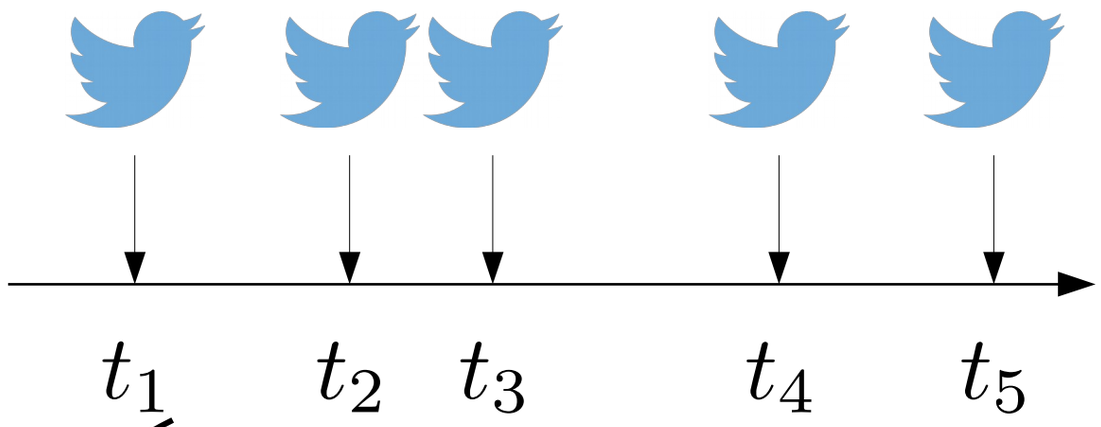
[Rizoiu et al ICWSM'18]



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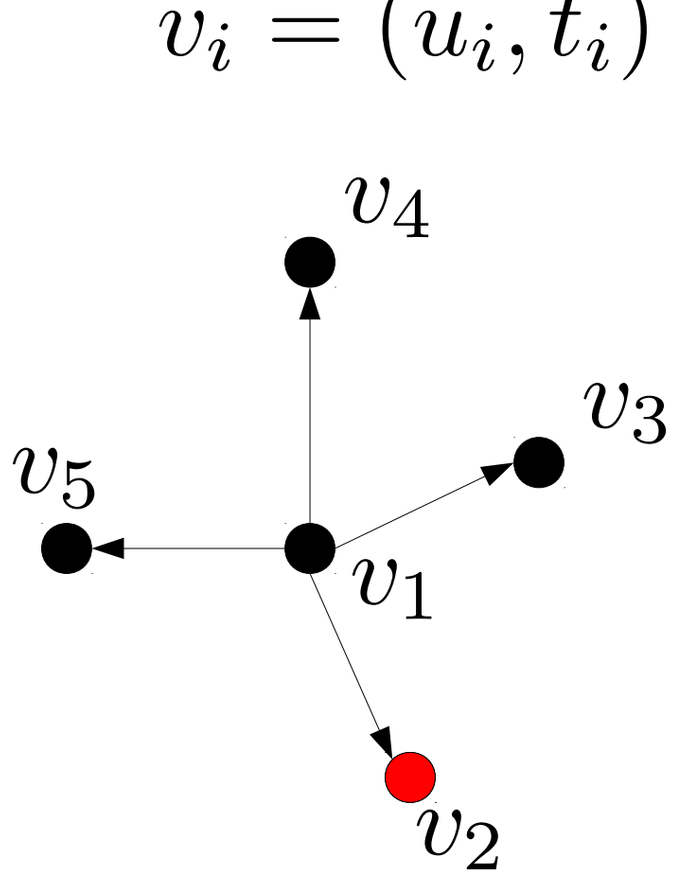
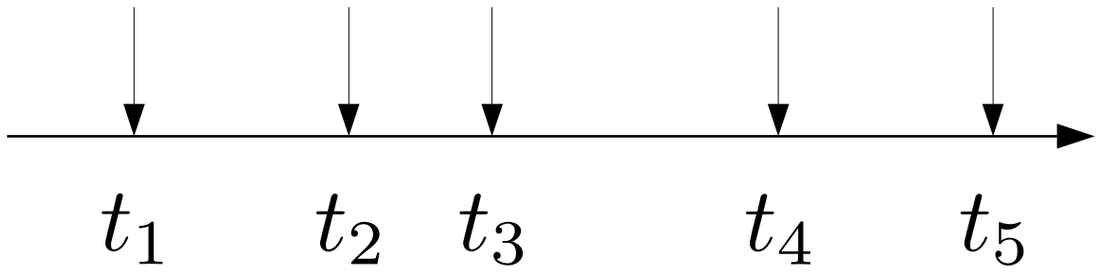
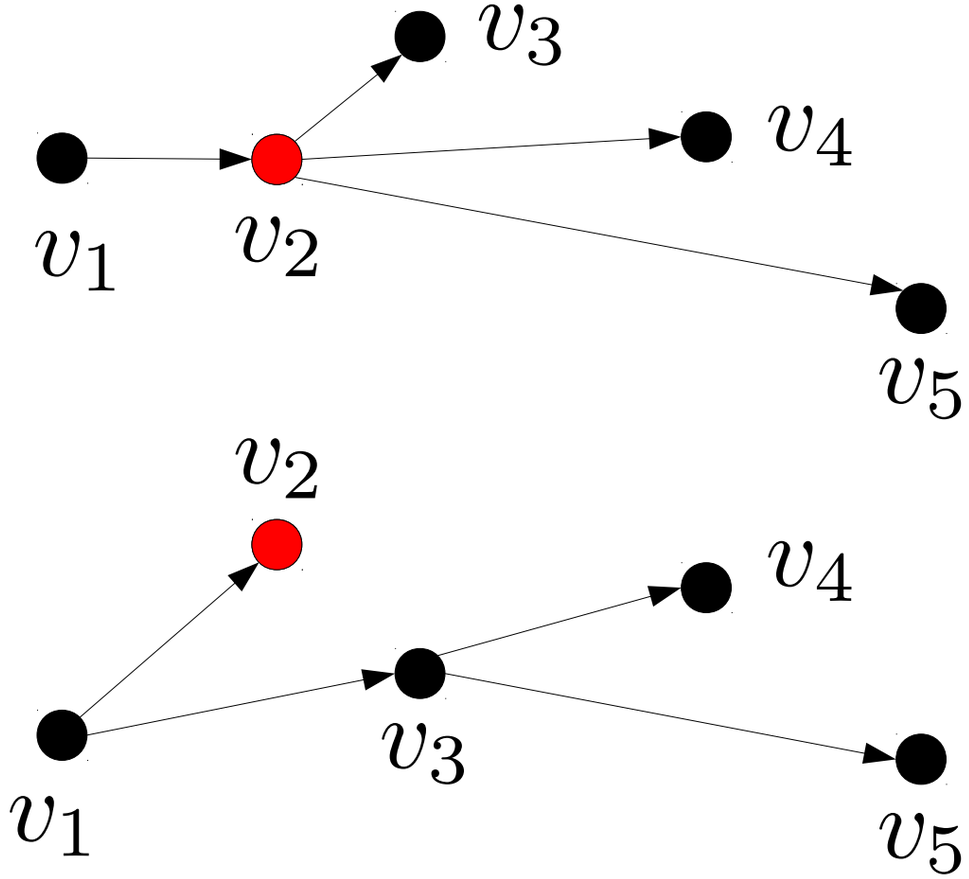


Diffusion trees and influence





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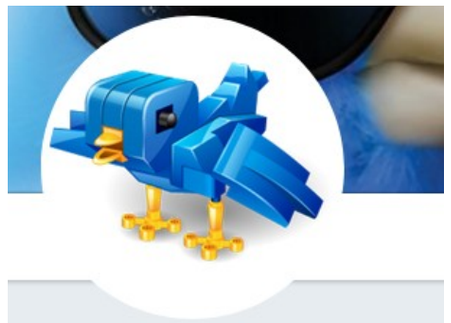


Botometer

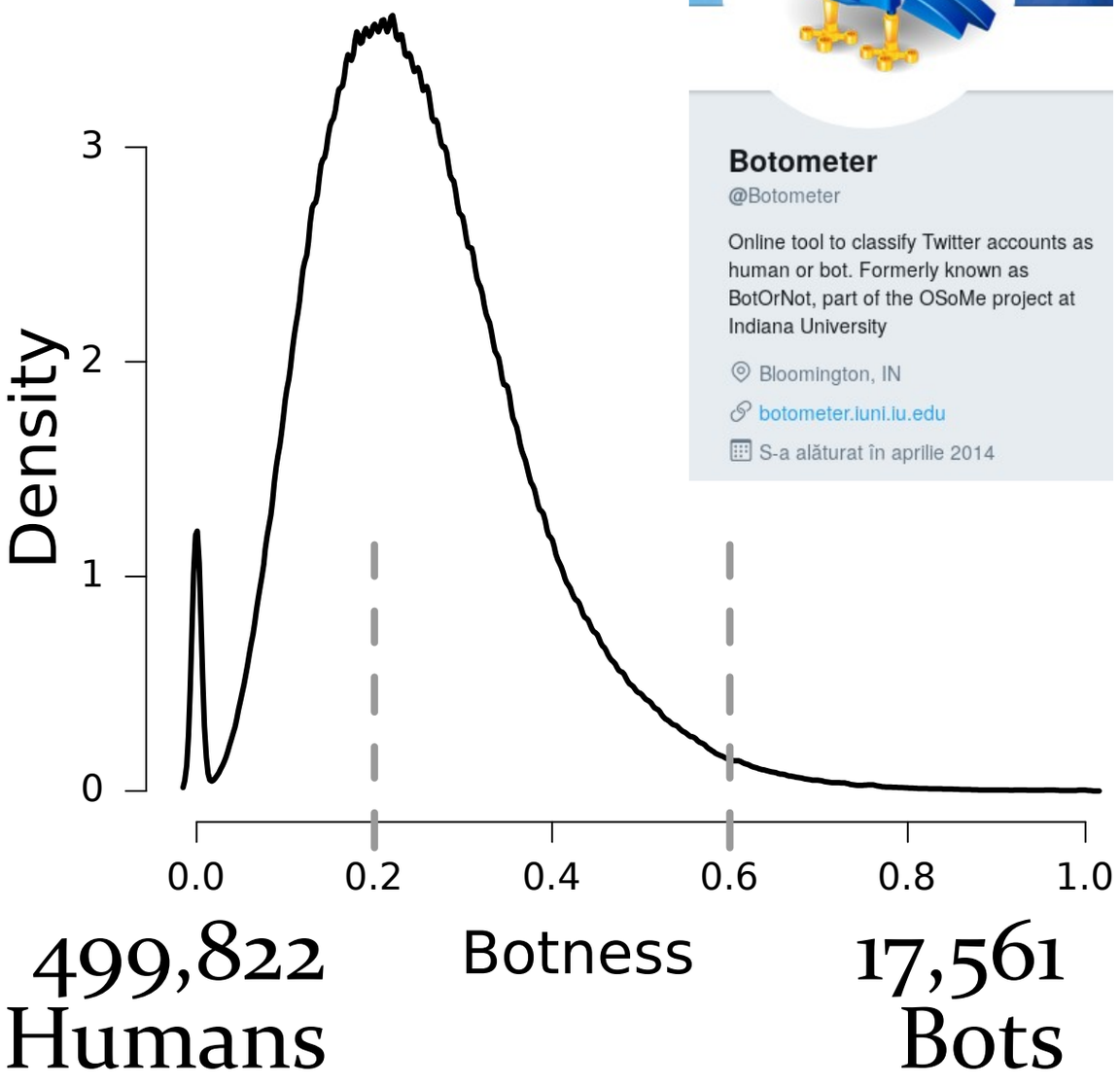
@Botometer

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

S-a alăturat în aprilie 2014



499,822 Humans

17,561 Bots

Bird Spotter:

https://github.com/rohitram96/BirdSpotter

M.-A. Rizoiu, T. Graham, R. Zhang, Y. Zhang, R. Ackland and L. Xie, "#DebateNight: The Role and Influence of Socialbots on Twitter During the 1st 2016 U.S. Presidential Debate, " in Proc. International AAAI Conference on Web and Social Media (ICWSM '18), Stanford, CA, USA, 2018. https://arxiv.org/abs/1802.09808

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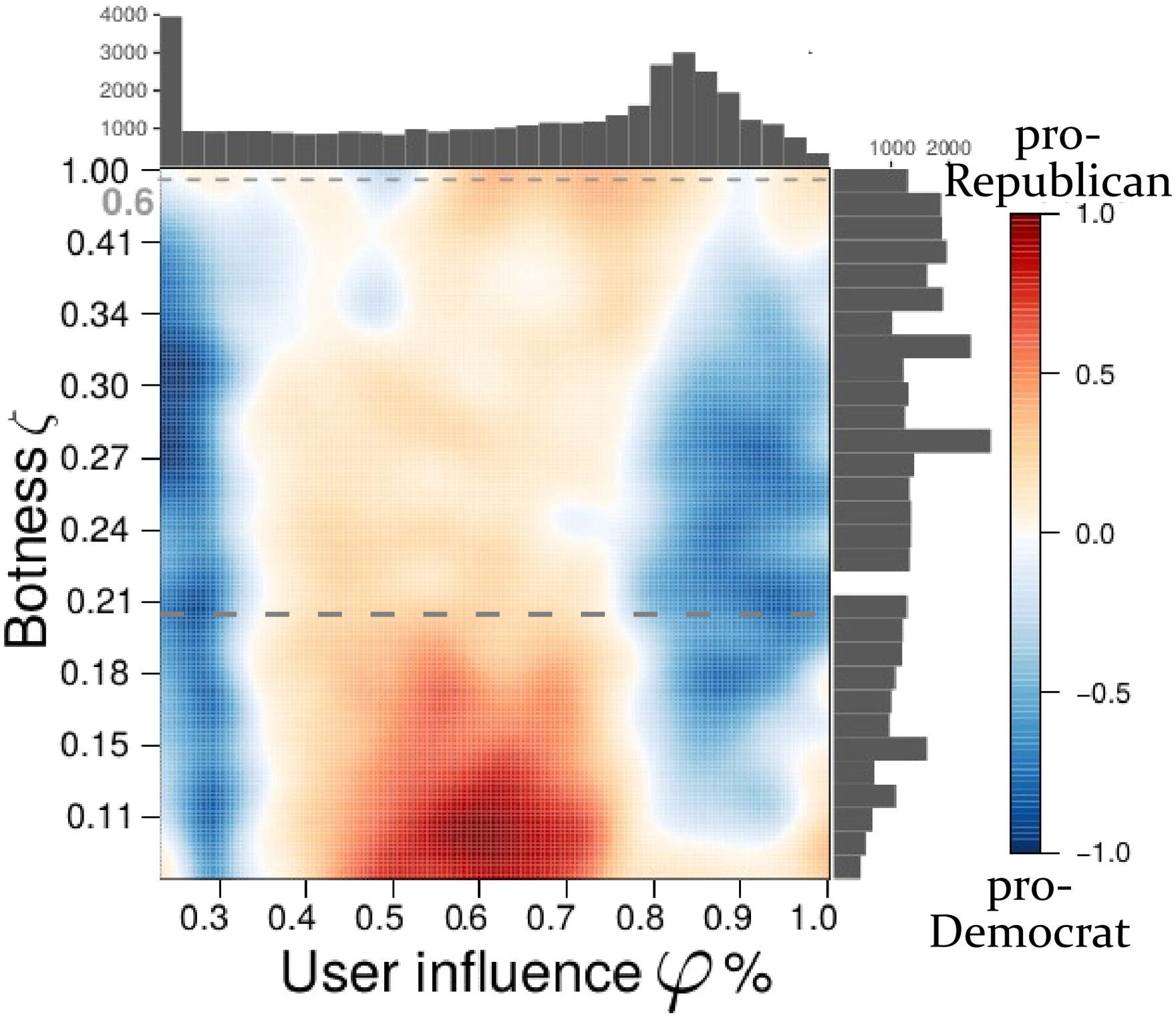
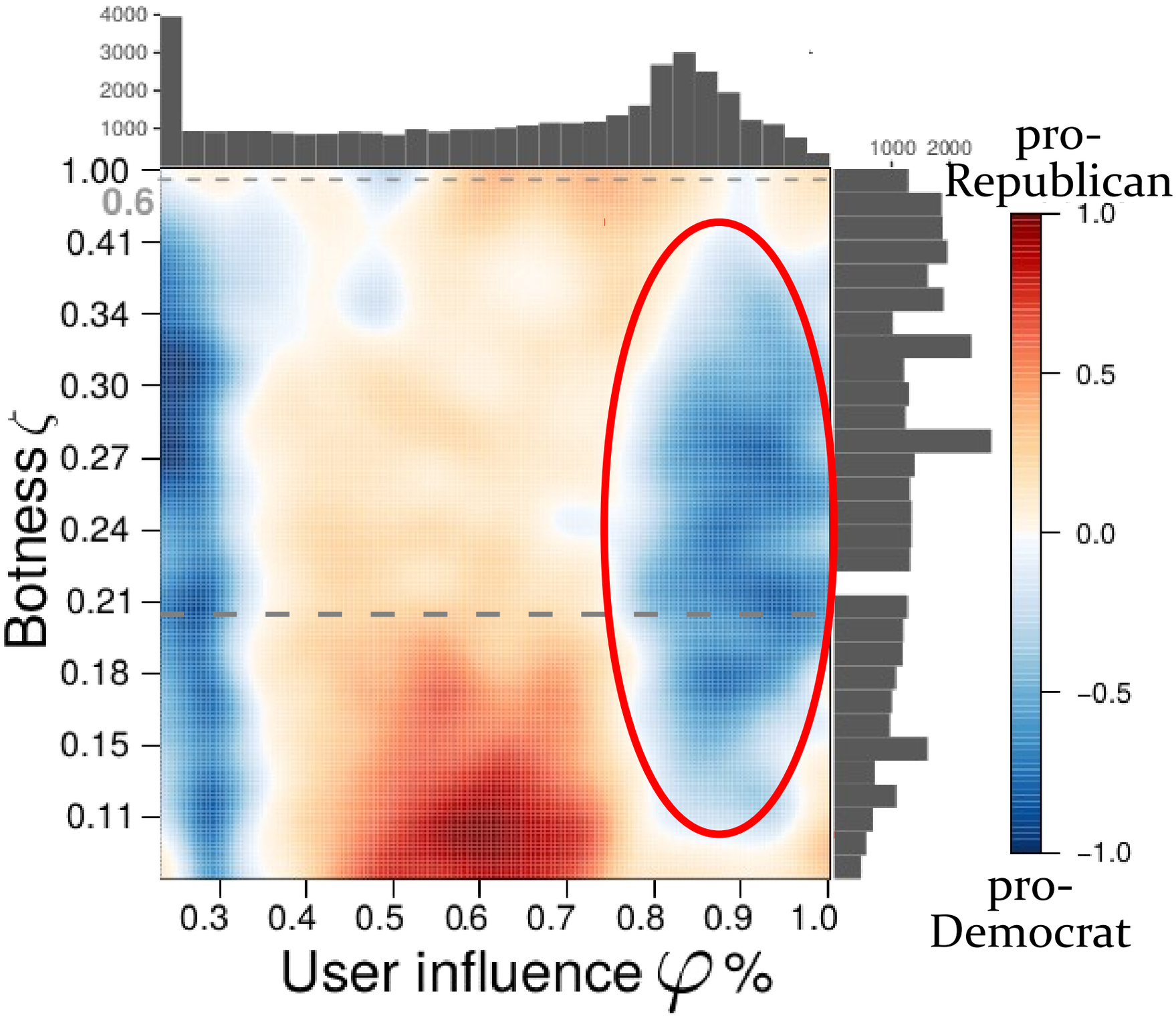


Role and Influence of Twitter Socialbots During US Presidential Debate

Behavioral Data Science

[Rizoiu et al ICWSM'18]

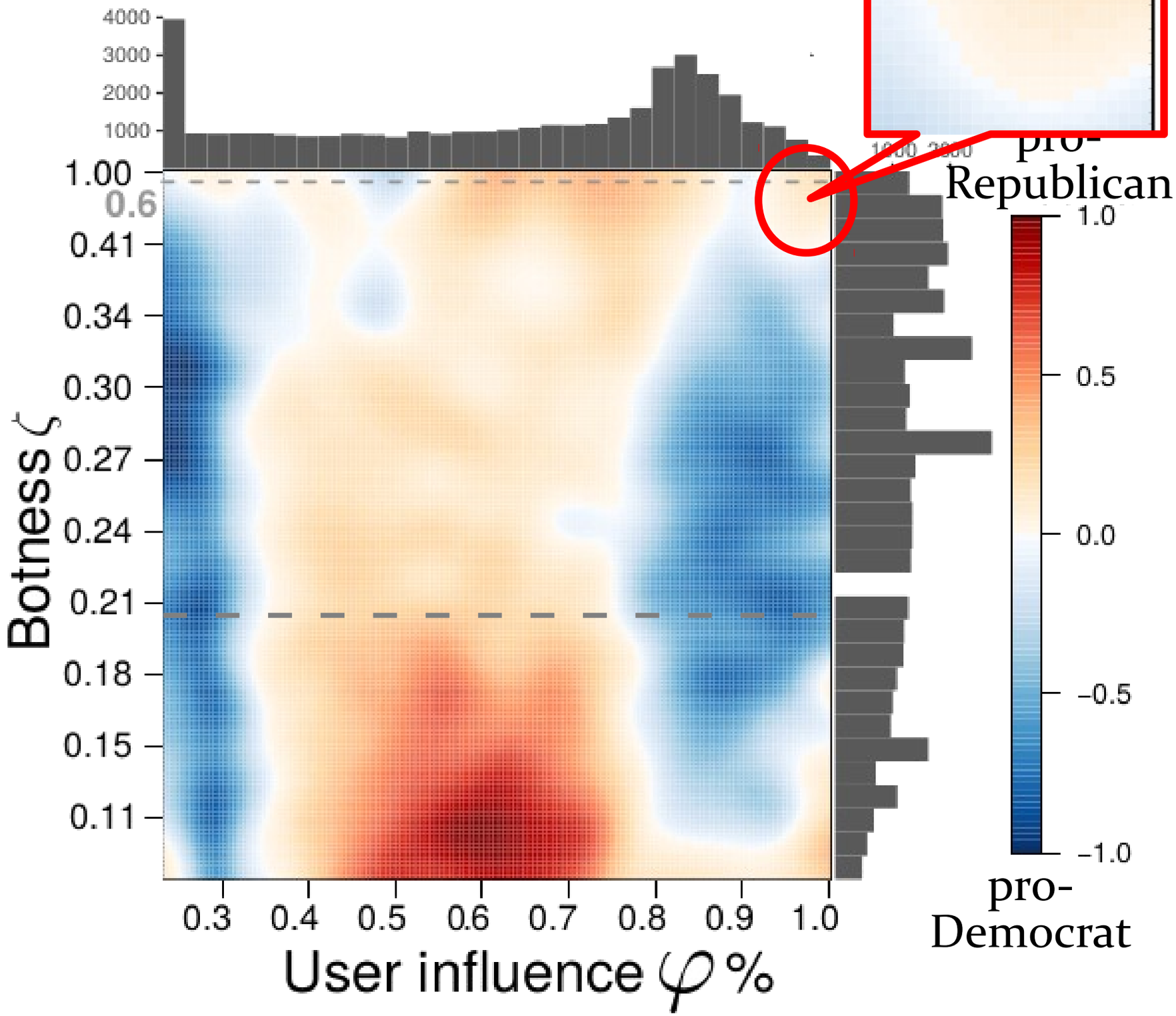


Very highly influential users are pro-Democrat (**D: 7201**, **R: 5736**)

Role and Influence of Twitter Socialbots During US Presidential Debat

[Rizoiu et al ICWSM'18]

Behavioral Data Science



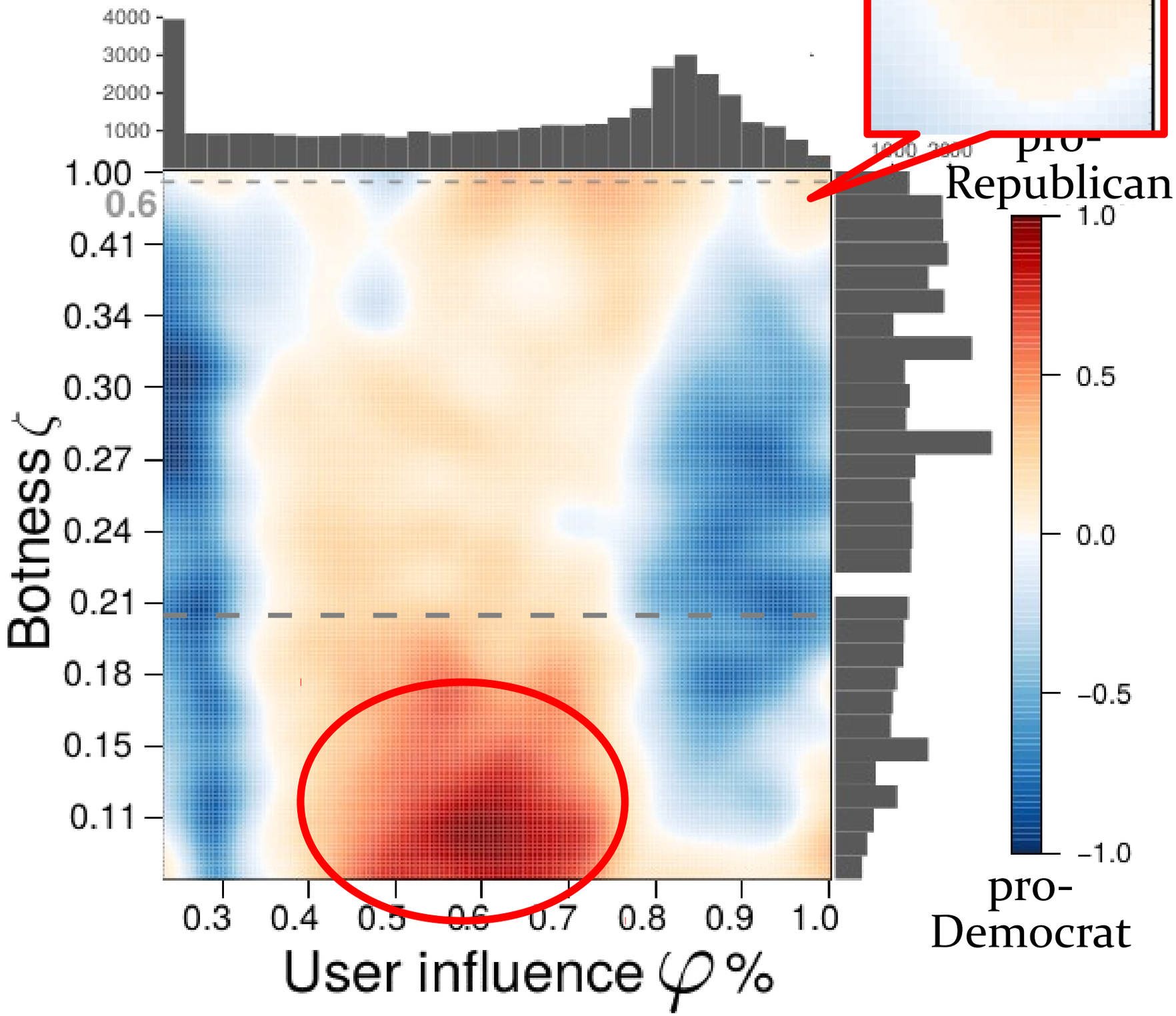
Very highly influential users are pro-Democrat (**D: 7201**, **R: 5736**)

Highly influential **Bots** are pro-Republican (**D: 24**, **R: 45**)

Role and Influence of Twitter Socialbots During US Presidential Debat

[Rizoiu et al ICWSM'18]

Behavioral Data Science



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

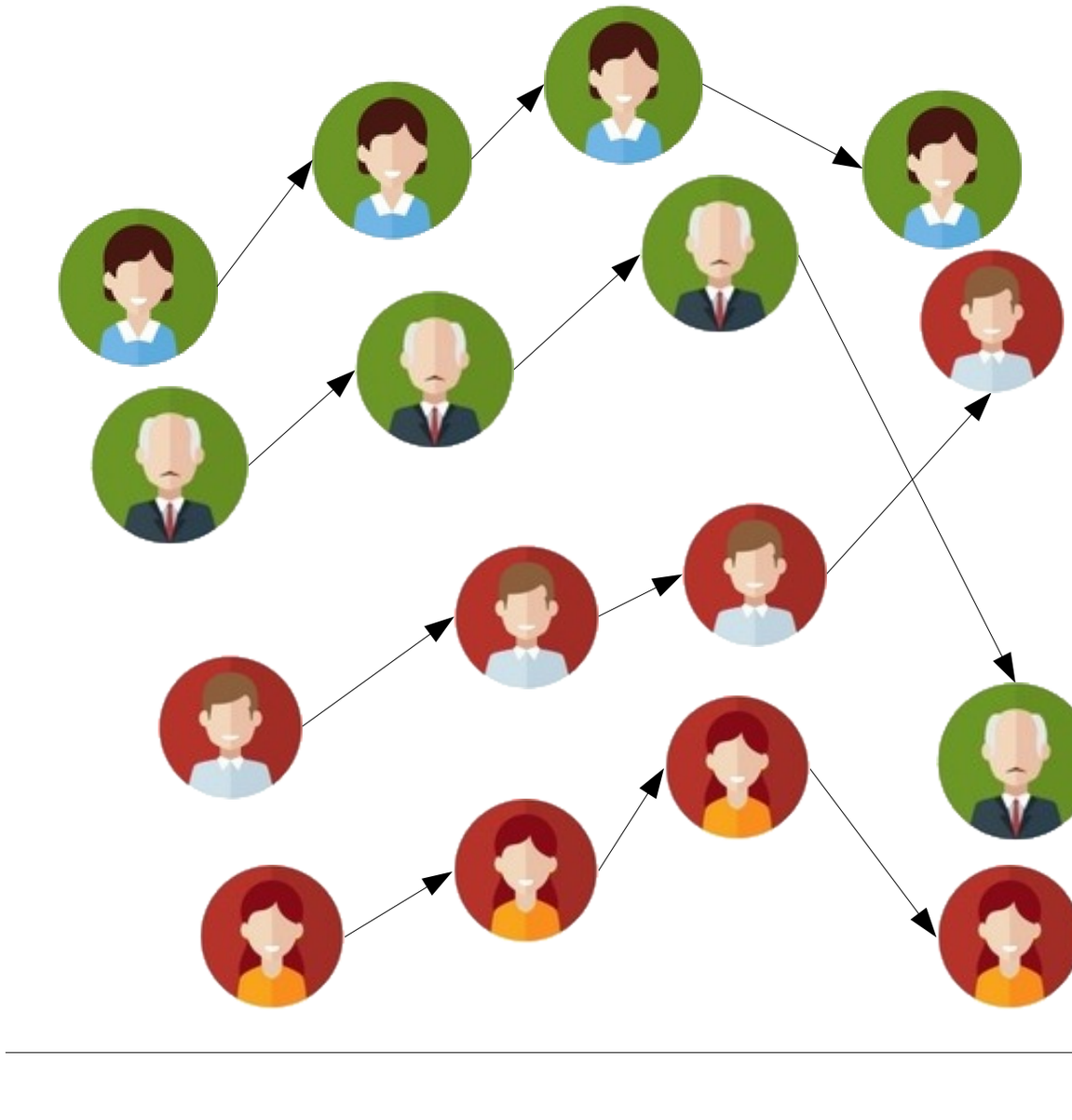
Highly influential **Bots** are pro-Republican (**D: 24**, **R: 45**)

Mid-influential humans are pro-Republican (**D: 1530**, **R: 3311**)

User identity via semantic edit distance: A case study of Russian trolls on Twitter

Behavioral Data Science

[Kim et al Jour. Comp. Social Science '19]



Identity through the digital traces that actors leave behind

Kim, D., Graham, T., Wan, Z., & Rizoiu, M.-A. (2019). Analysing user identity via time-sensitive semantic edit distance (t-SED): A case study of Russian trolls on Twitter. Journal of Computational Social Science (under review). https://arxiv.org/abs/1901.05228

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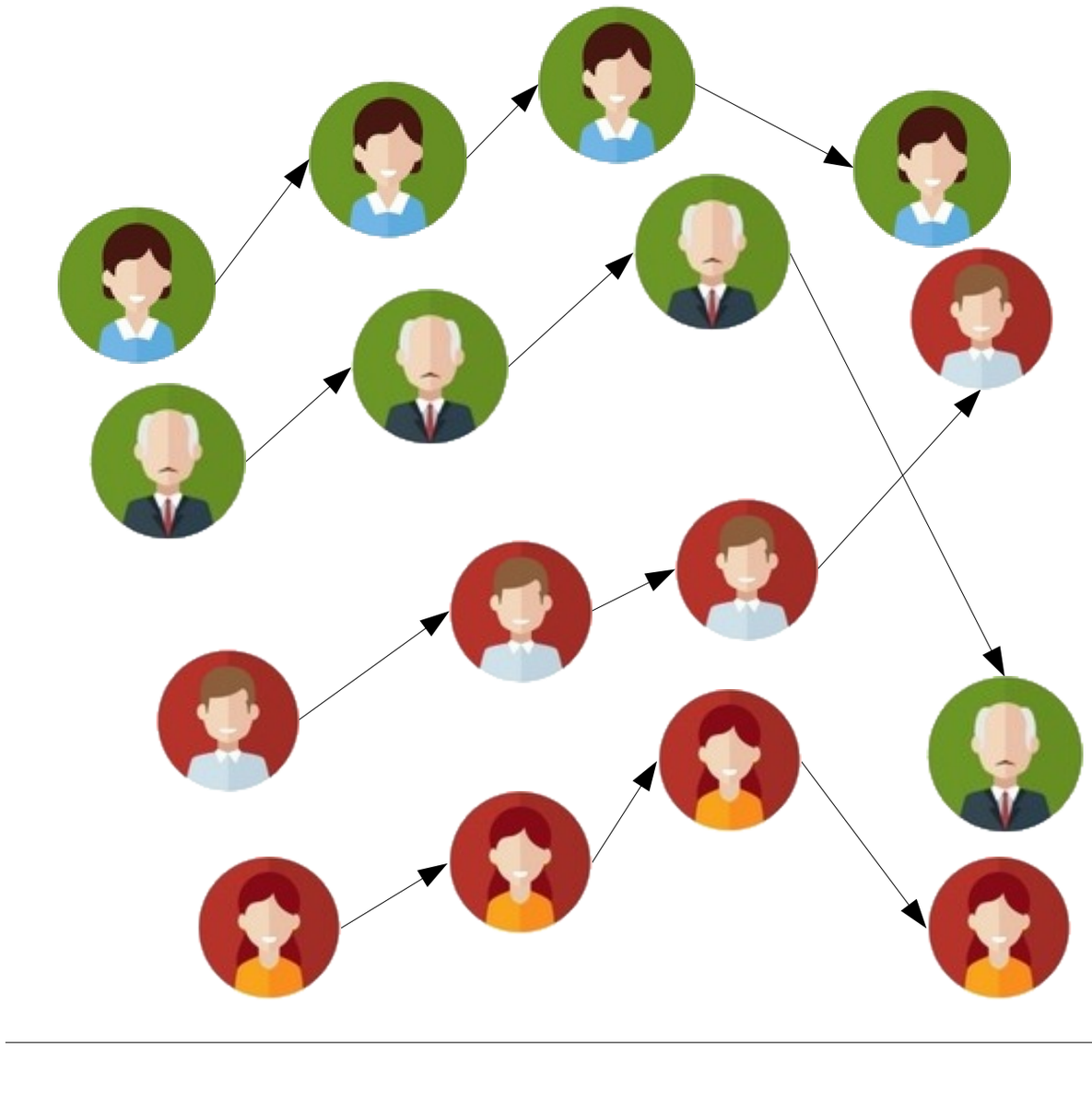

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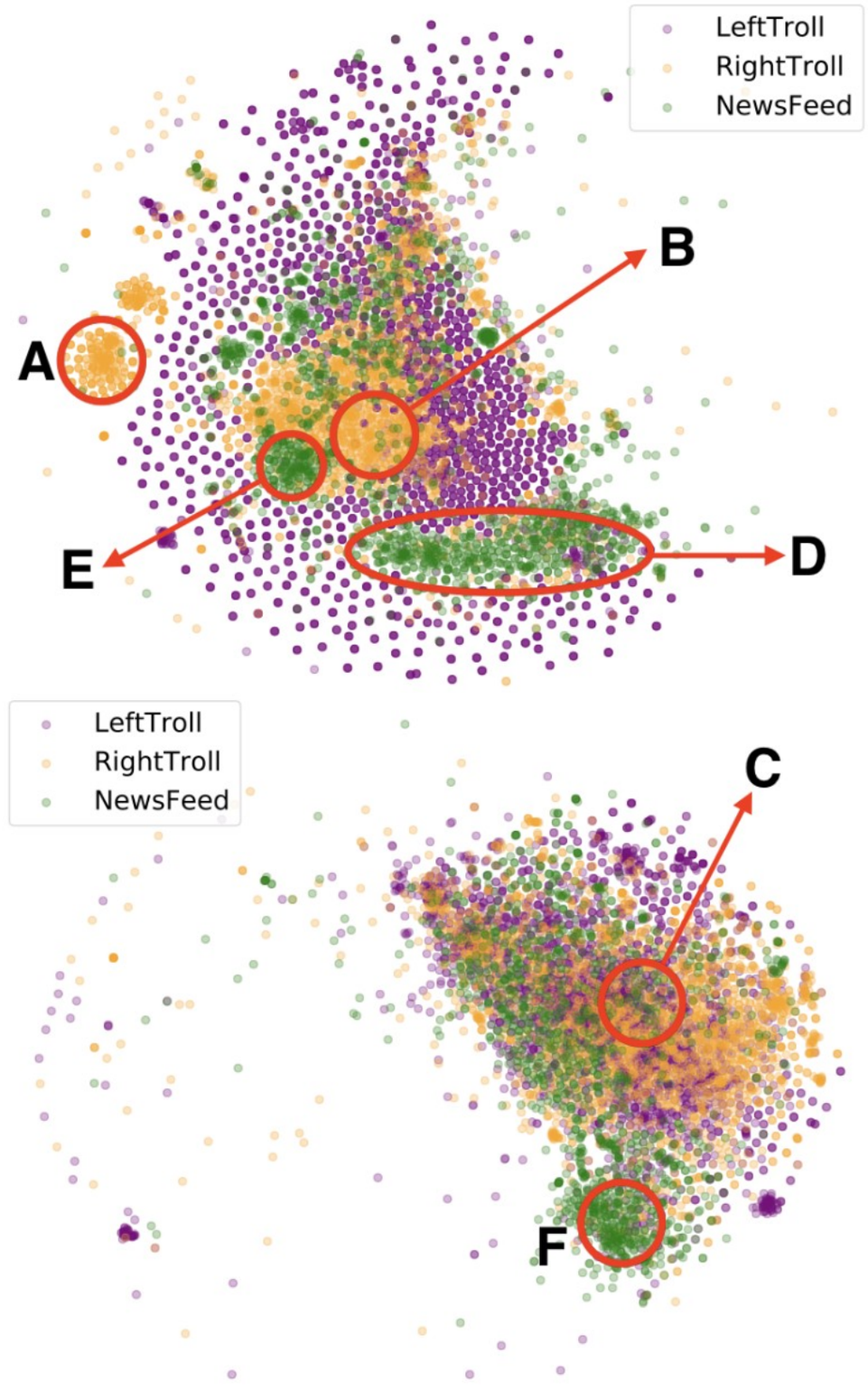

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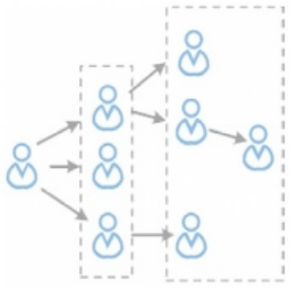
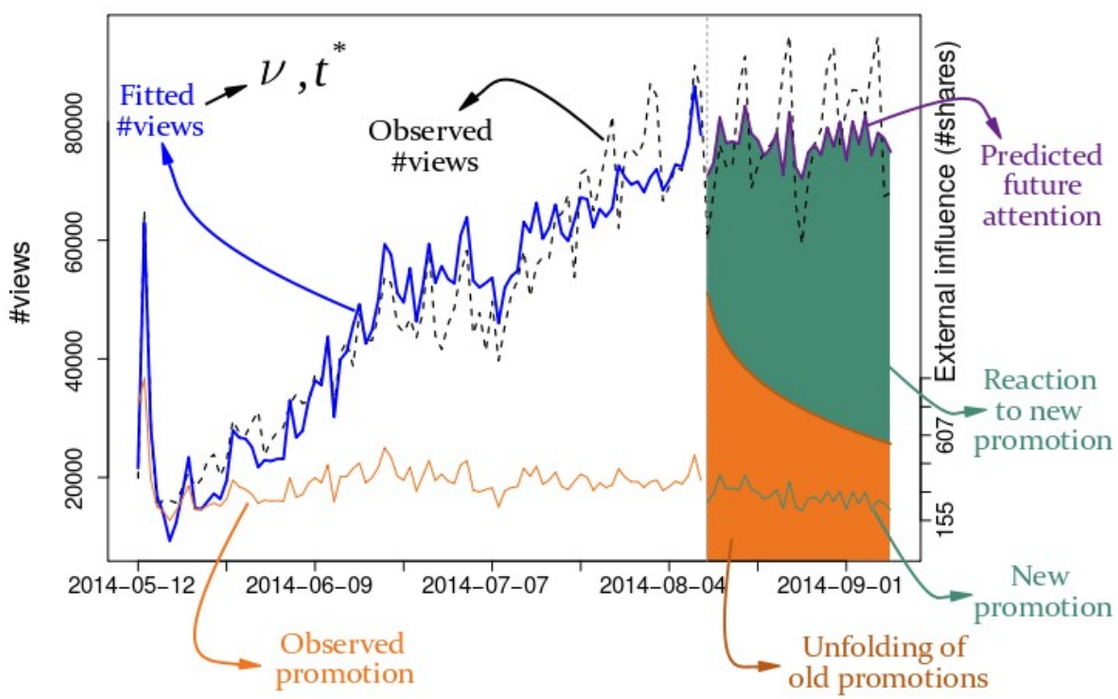


Modeling information diffusion in social networks

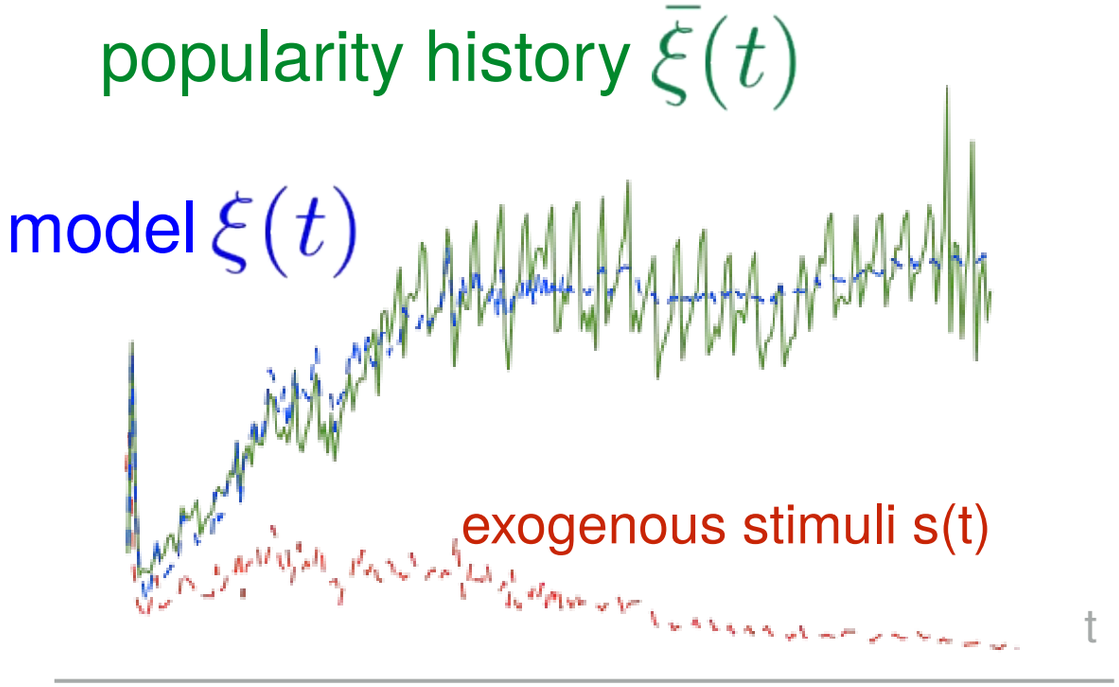
Influencing democratic processes using social media



Modeling and predicting popularity, virality and engagement

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

M.-A. Rizoiu, L. Xie, S. Sanner, M. Cebrian, H. Yu, and P. Van Hentenryck, "Expecting to be HIP: Hawkes Intensity Processes for Social Media Popularity, " in Proc. International Conference on World Wide Web (WWW '17), Perth, Australia, pp. 735-744, 2017. https://arxiv.org/abs/1602.06033

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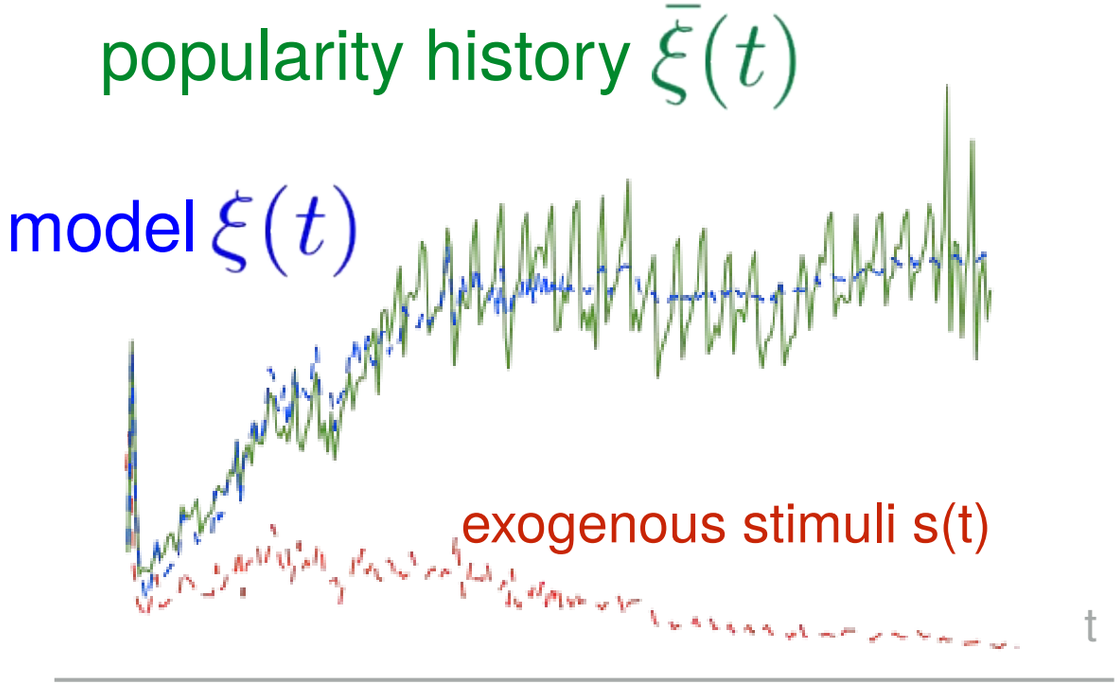
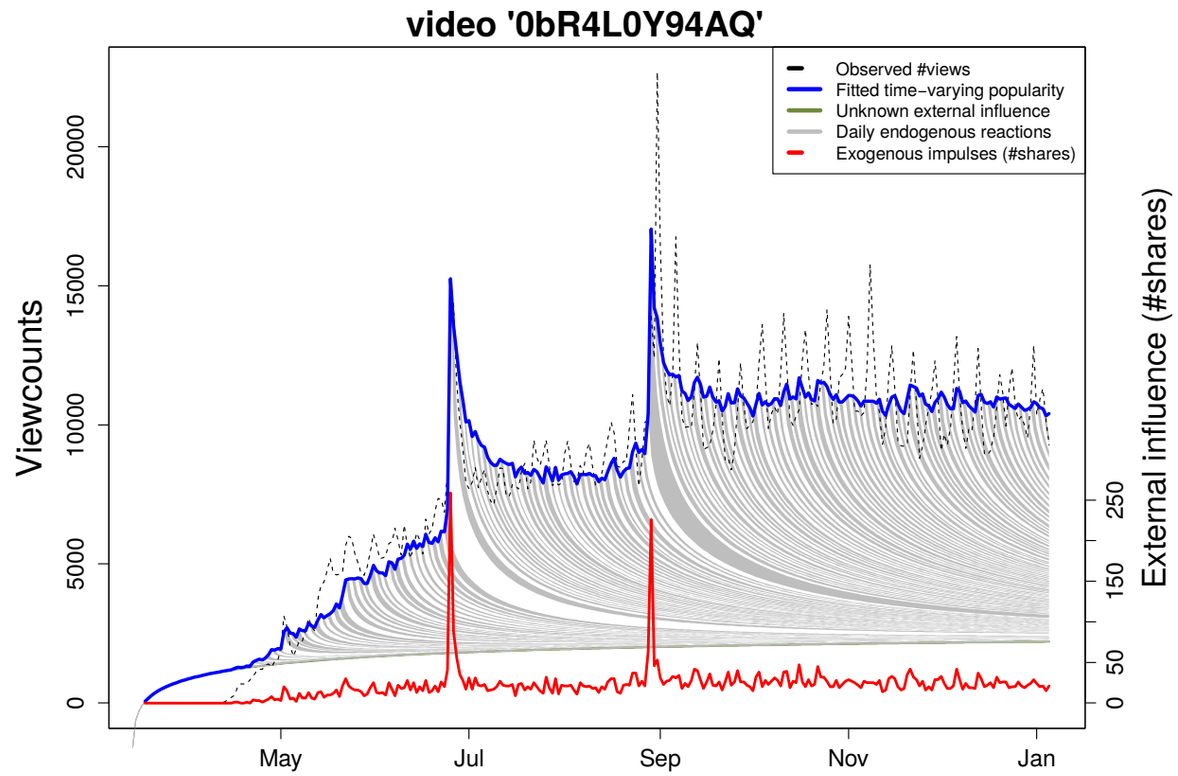
Behavioral Data Science





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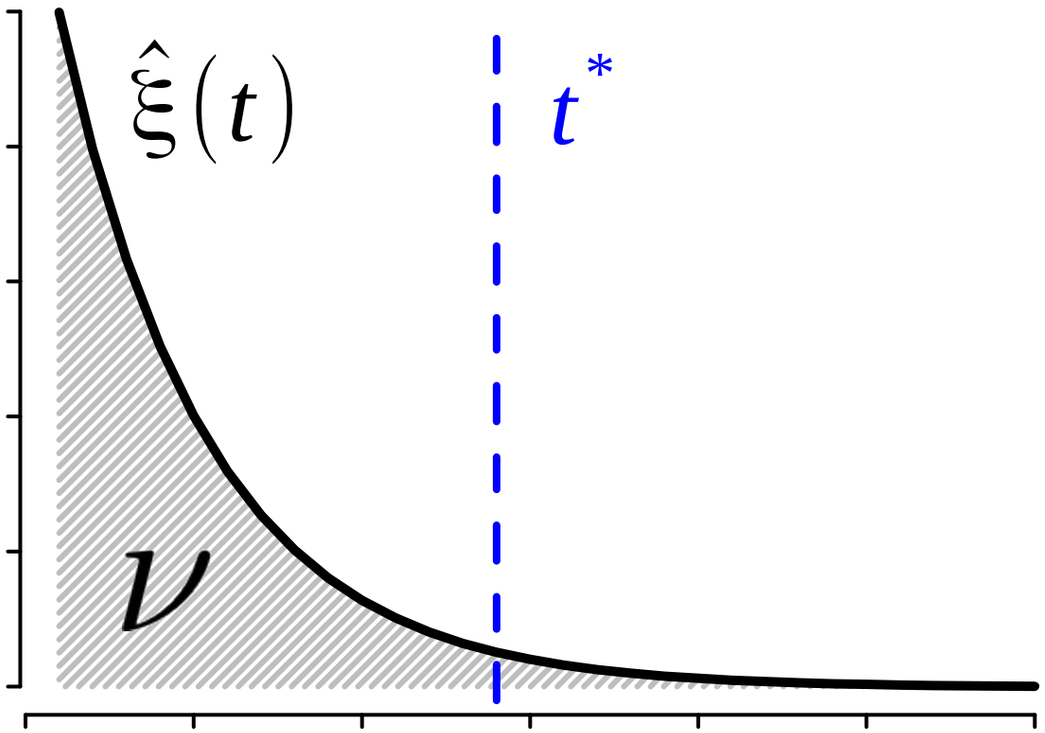
Viral potential and maturity time

[Rizoiu et al ICWSM'17]

Behavioral Data Science



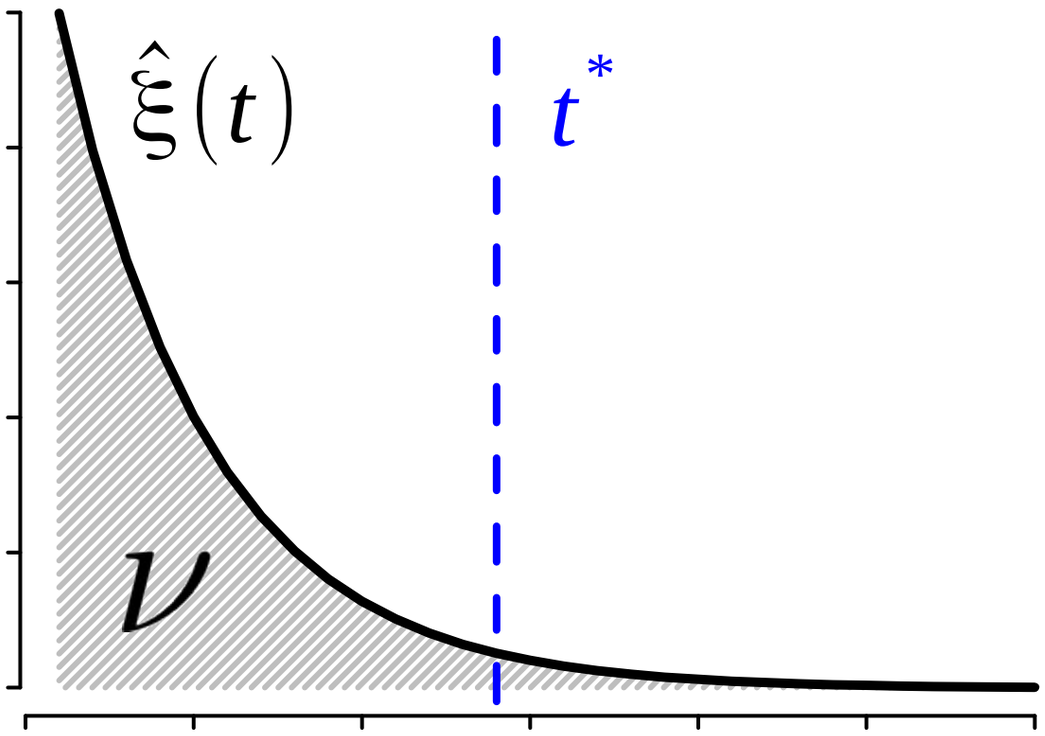
Viral potential score:	*Return on investment, total amount of views per promotion*
Maturity time:	*Time required to acquire most of the return*

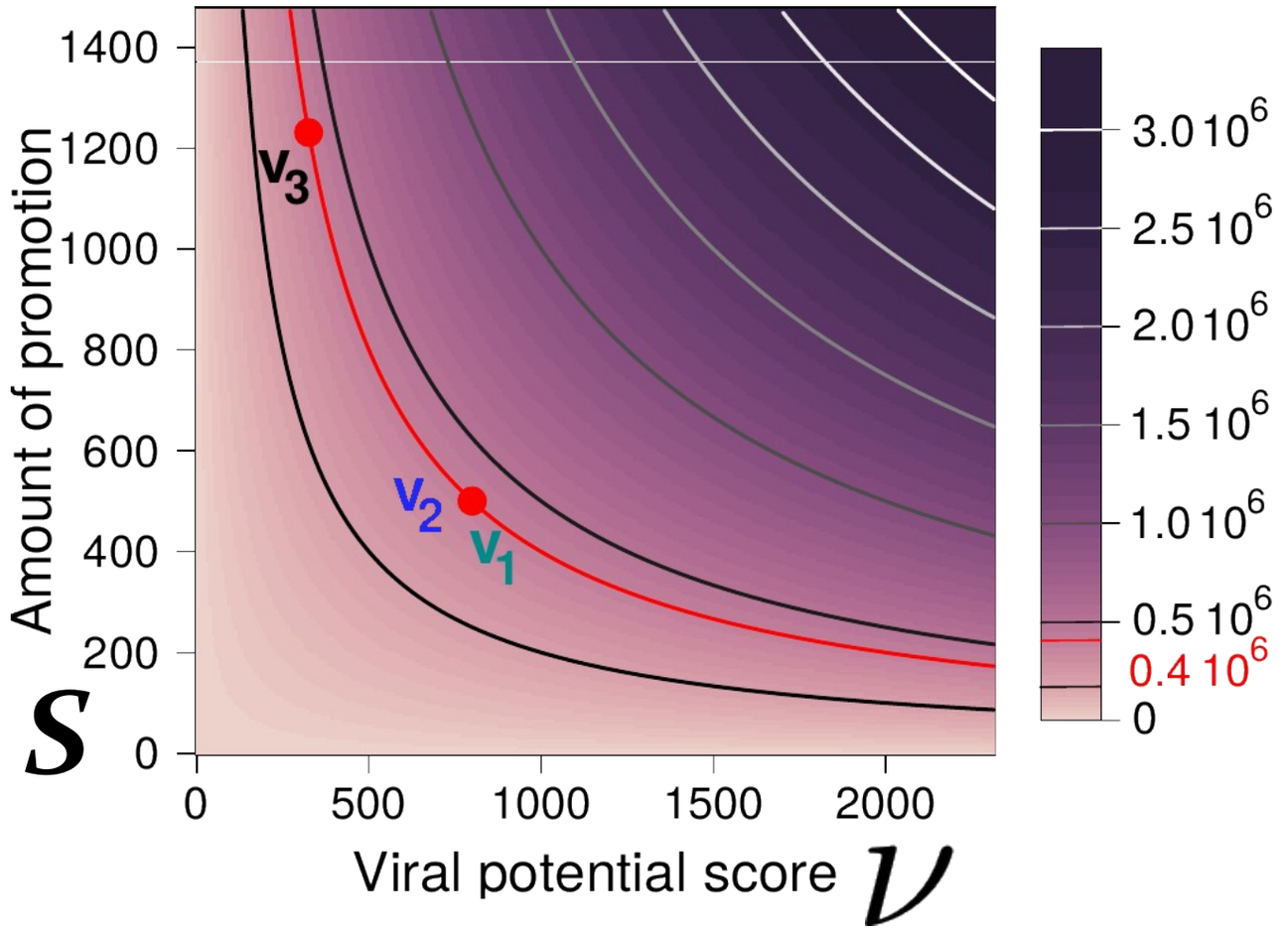
M.-A. Rizoiu and L. Xie, "Online Popularity under Promotion: Viral Potential, Forecasting, and the Economics of Time, " in Proc. International AAAI Conference on Web and Social Media (ICWSM '17), Montréal, Canada, pp. 182–191, 2017. https://arxiv.org/abs/1703.01012

Viral potential and maturity time

[Rizoiu et al ICWSM'17]

Behavioral Data Science





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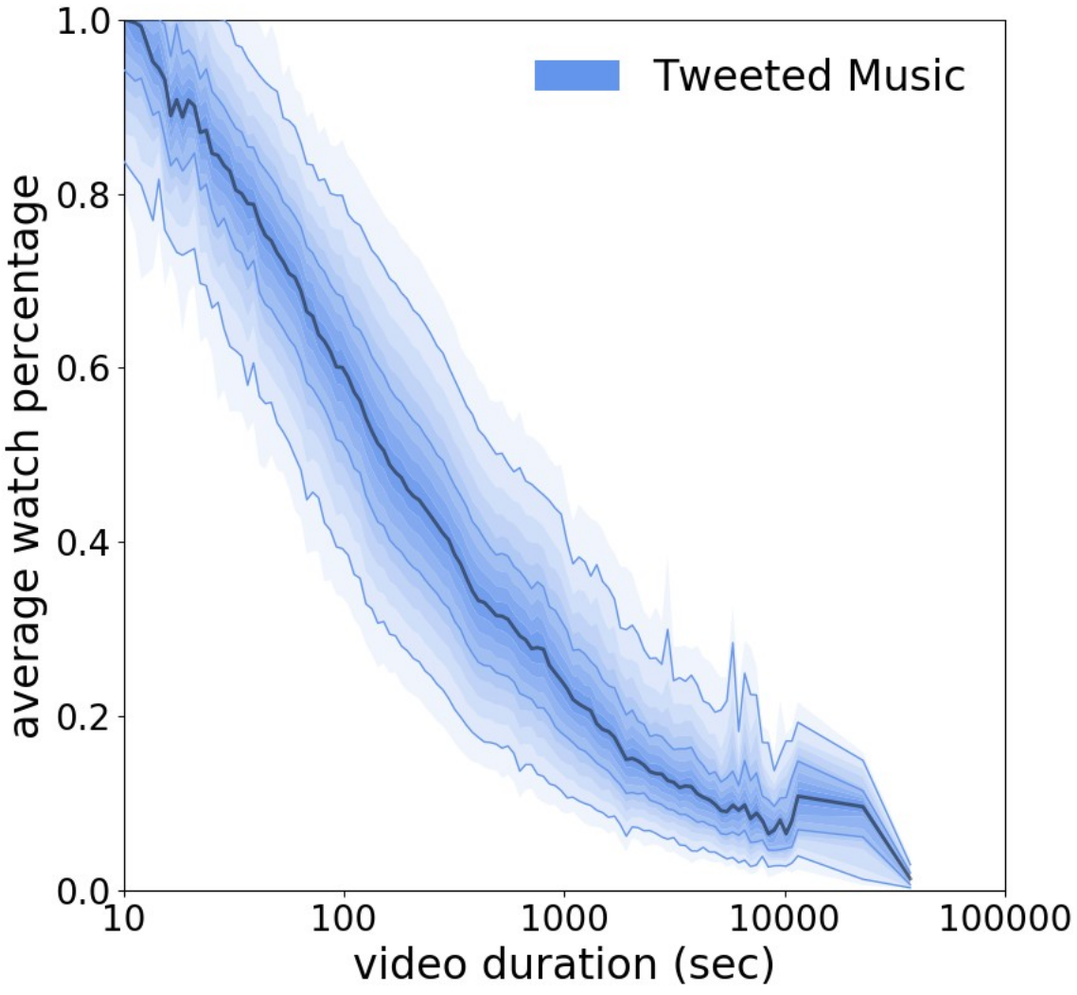
Content engagement and quality

[Wu et al ICWSM‘18]



S. Wu, M.-A. Rizoiu, & L. Xie, "Beyond Views: Measuring and Predicting Engagement in Online Videos, " in Proc. International AAAI Conference on Web and Social Media (ICWSM ’18), Stanford, CA, USA, 2018. https://arxiv.org/pdf/1709.02541.pdf

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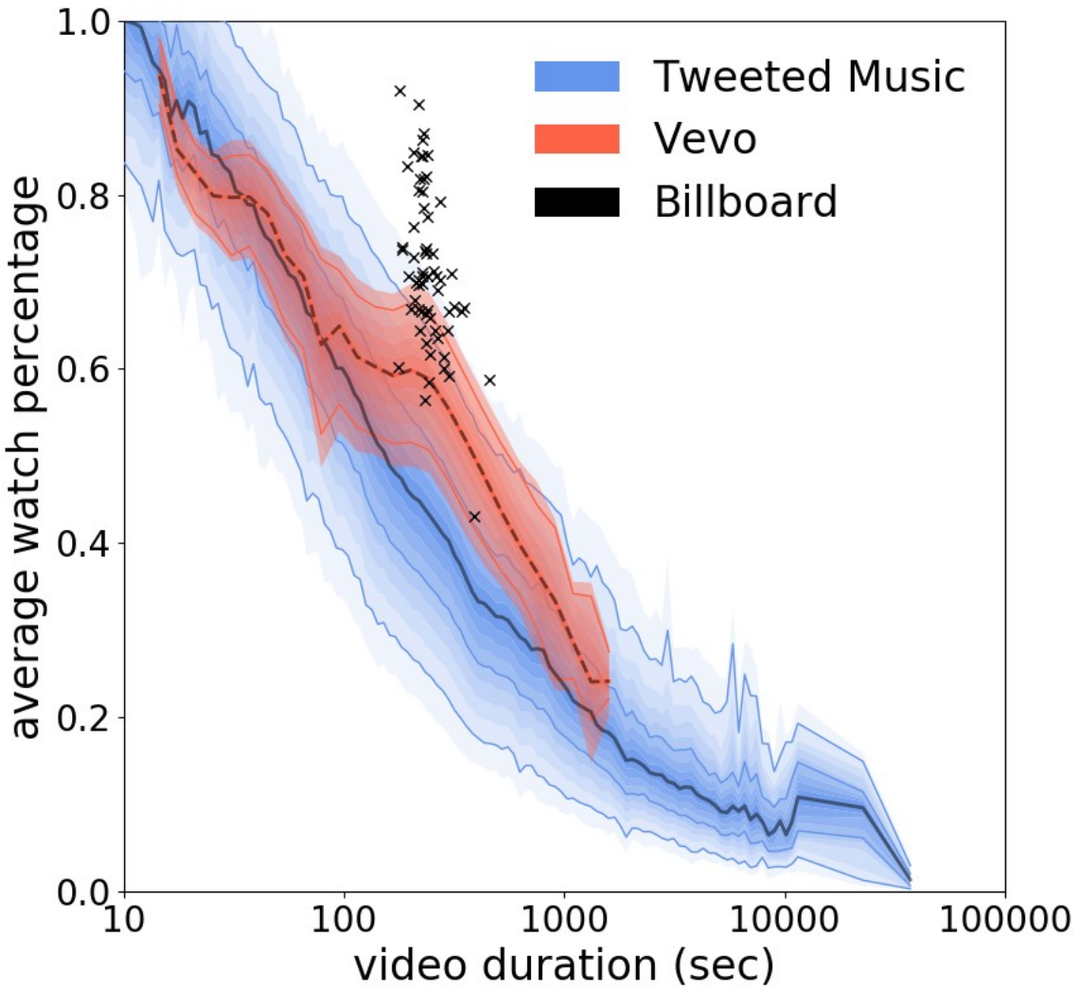
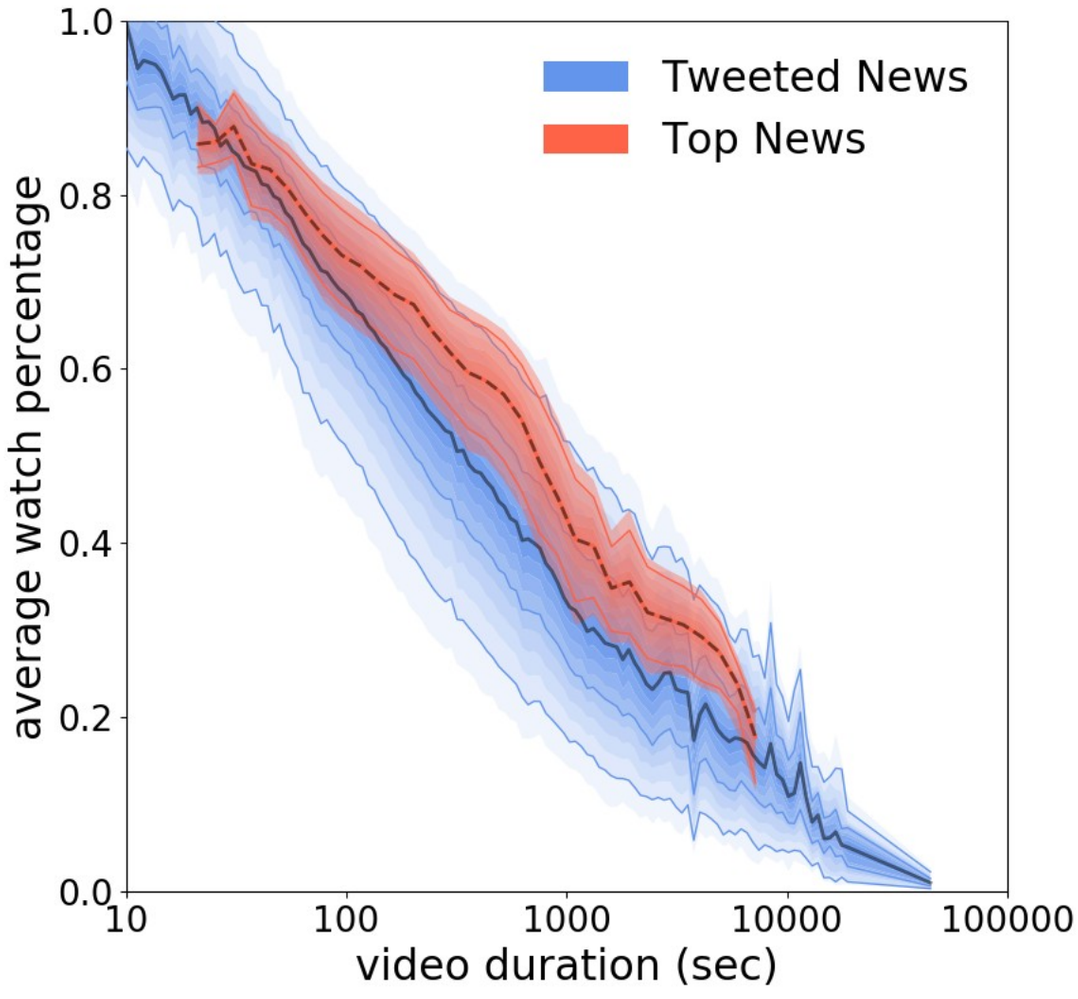
Behavioral Data Science





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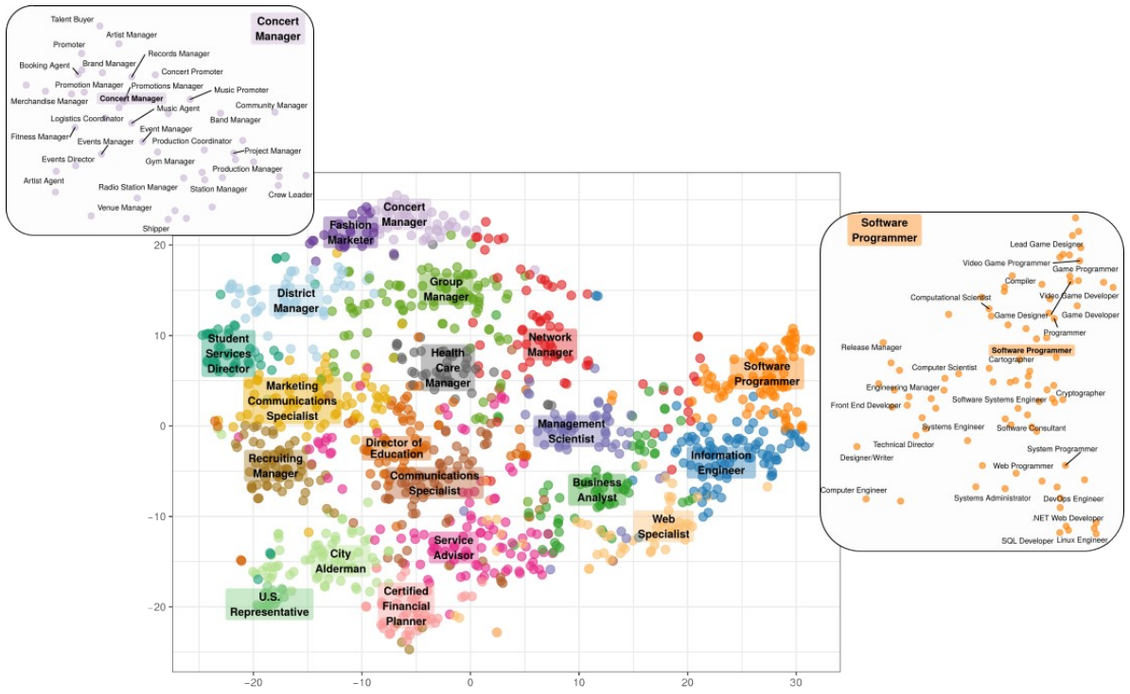
Other projects

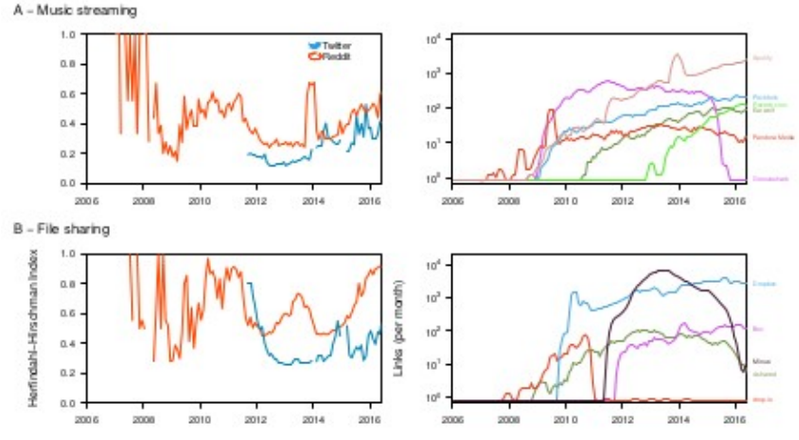


Other projects

Behavioral Data Science

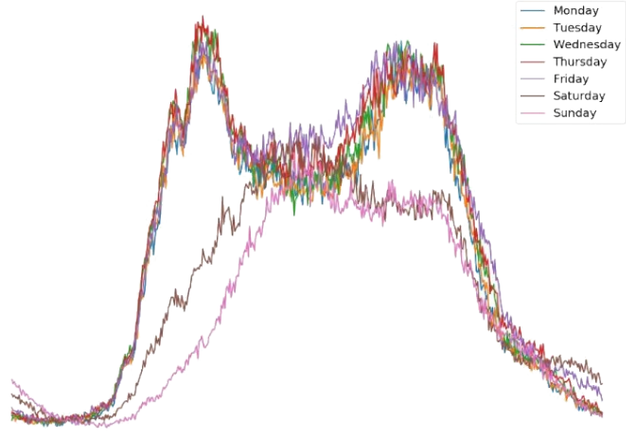
Wikipedia privacy

[Rizoiu et al WSDM‘16]



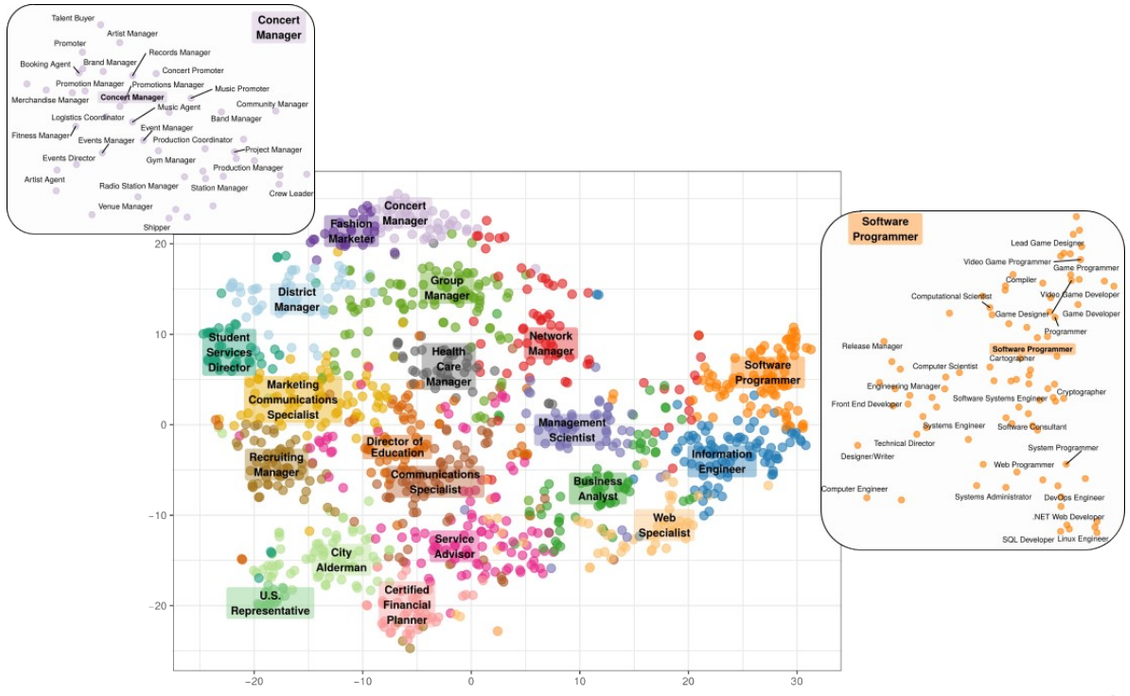
Online Diversity

[McCarthy et al ‘19]



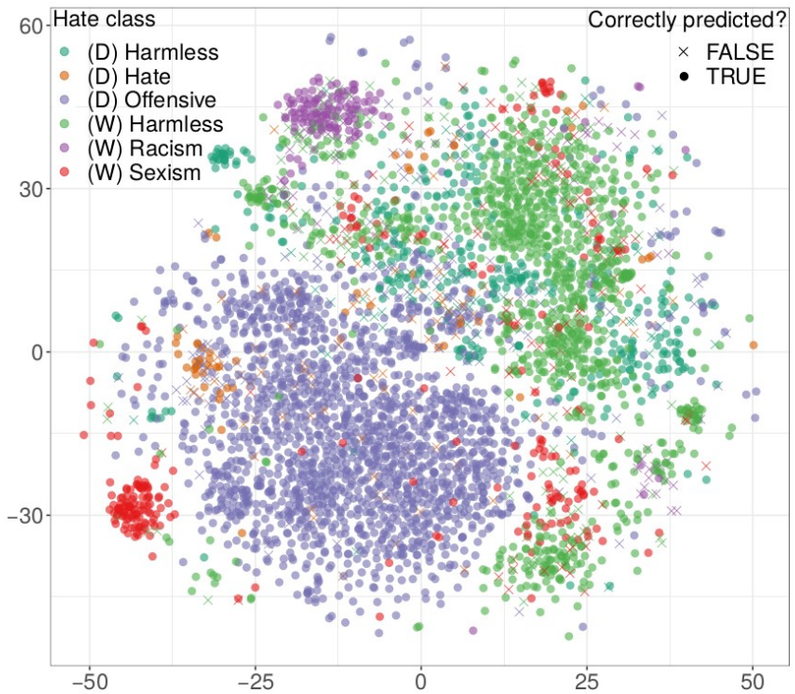
Smart traffic

[Mihaita et al ITSC‘19]



Vocation compass

[Kern et al PNAS‘19]



Transfer learning for Hate Speech detection

[Rizoiu et al ICWSM‘19]

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