



Aalto University  
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## Reducing controversy by connecting opposing views

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NIPS workshop on prioritising online content

Dec 9, 2017

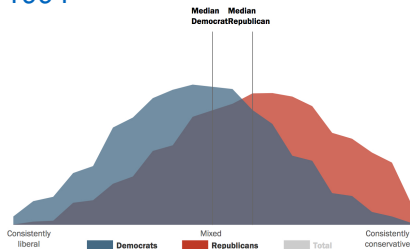
# social media are changing our society



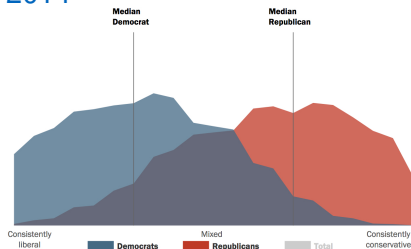
- + content democratization and easy access to information
- harassment, fake news, echo chambers, polarization, ...

# polarization in US politics

1994

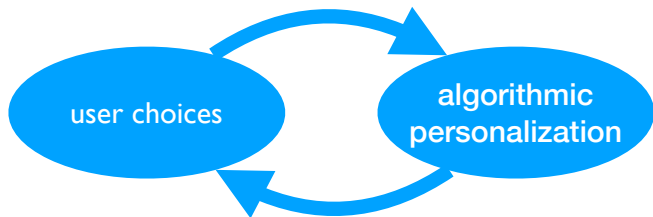


2014



PEW RESEARCH CENTER

# the polarization cycle



related to the **filter bubble** and **echo chamber**

# research questions

- can we identify polarized discussions in social media?

[Garimella et al., WSDM, 2016]

- can we design algorithms to help reduce polarization?

[Garimella et al., WSDM, 2017]

research question

identify and quantify polarization

K. Garimella, G. De Francisci Morales, A. Gionis, M. Mathioudakis, "*Quantifying controversy in social media*", ACM WSDM 2016

## focus on twitter

- microblogging platform
  - launched in 2006
  - 300 million active users
- users post short messages — tweets





Tweets  
**36.2K**

Following  
**45**

Followers  
**40.9M**

tweet

retweets

replies

connections



**Donald J. Trump**   
@realDonaldTrump

Follow

My daughter Ivanka has been treated so unfairly by @Nordstrom. She is a great person -- always pushing me to do the right thing! Terrible!

4:51 PM - 8 Feb 2017

26,901 Retweets 140,751 Likes



95K 27K 141K



Tweet your reply



**Tim Guinee** @TimGuinee · Feb 8

Replying to @realDonaldTrump

Surely @realDonaldTrump using his office to make money for his family is an ethics violation

**Donald J. Trump** @realDonaldTrump

My daughter Ivanka has been treated so unfairly by @Nordstrom. She is a great person -- always pushing me to do the right thing! Terrible!

60 168 1.4K



((( \* ))) @missyk · Feb 9

neither @SenateMajLdr or @SpeakerRyan gives a crap, they only care if a Democrat sneezes in the wrong direction!

5 13 248



**Tim Guinee** @TimGuinee · Feb 9

Mindboggling thievery justified by entitlement, false victimization and racism.

((( \* ))) @missyk

neither @SenateMajLdr or @SpeakerRyan gives a crap, they only care if a Democrat sneezes in the wrong direction!

6 8 81



**Heidi Blackburn** @Blackbur14Heidi · Feb 11

I love President Donald Trump. What we have are adults that are acting like 2 year olds. Which is 😞 sad!!

17 3 48



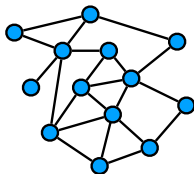
# how can we identify polarization ?

## ideas

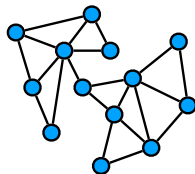
- content
  - do opposing sides say different things ?
- sentiment
  - do polarized topics exhibit wider range of emotions ?
- interactions
  - do people interact more with their own side ?

# method template

- build an **interaction graph**
  - try several types  
**retweets, replies, connections**
- is the **interaction graph** polarized?
- output **polarization score**

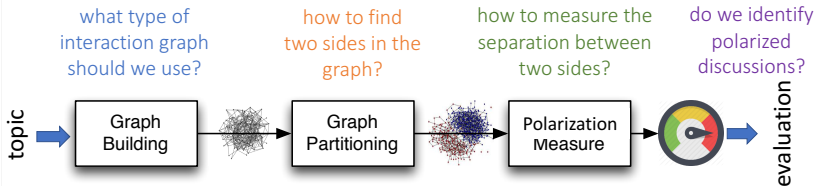


non polarized

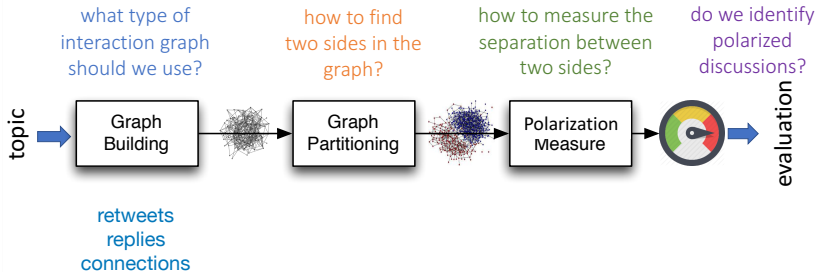


polarized  
two sides well separated

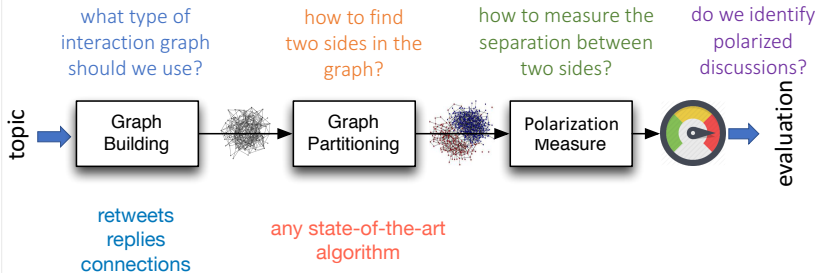
# pipeline



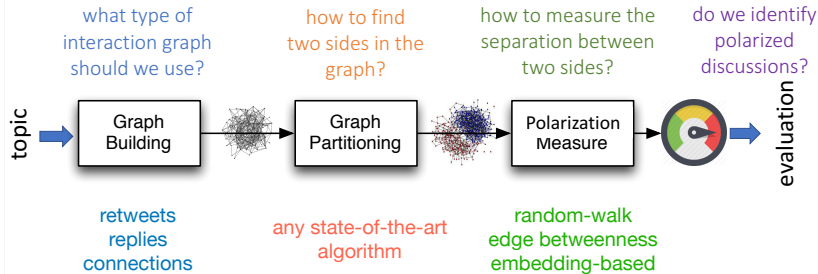
# pipeline



# pipeline



# pipeline



## random-walk controversy score (RWC)

- assume graph is partitioned in two sides,  $A$  and  $B$
- consider a random walk that started at a random node and finished in a hub in  $Y \in \{A, B\}$
- probability that random walk started in  $X \in \{A, B\}$

$$P_{XY} = \Pr(\text{r.w. started in } X \mid \text{r.w. finished in } Y)$$

- random-walk controversy score (RWC)

$$\text{RWC} = P_{AA}P_{BB} - P_{AB}P_{BA}$$

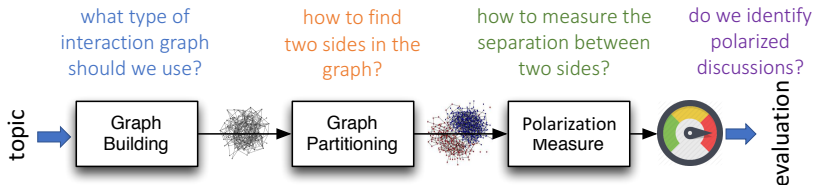
does not depend on cluster sizes and relative in-degrees

# evaluation

- annotate polarized and non-polarized topics
- polarized
  - indian beefban, nemtsov protests, netanyahu US congress speech, baltimore riots, ukraine
- non-polarized
  - germanwings plane crash, sxsw, mother's day, jurassic world movie, national kissing day
- evaluate different settings on ground truth



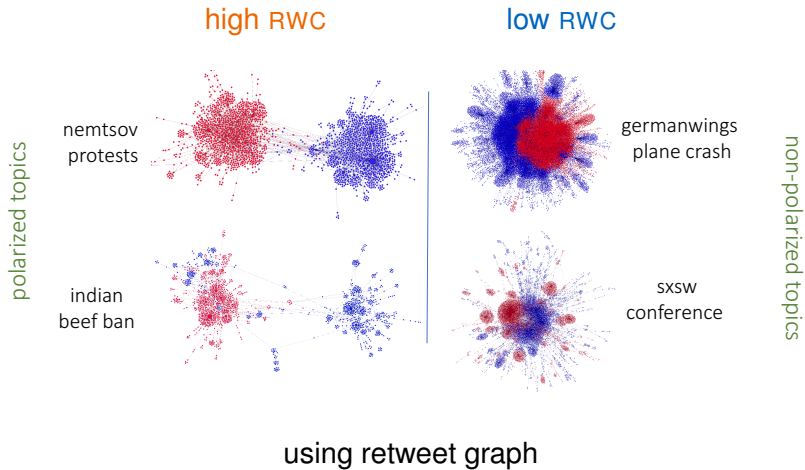
# best performing setting



- retweet graph
- RWC

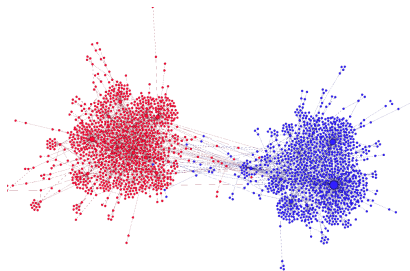
other good settings: edge betweenness score  
sentiment variance

# example of results

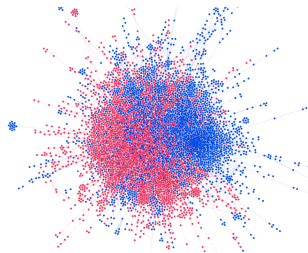


## example of results

nemtsov protests



retweets



replies

research question

design algorithms to help reduce polarization

K. Garimella, G. De Francisci Morales, A. Gionis, M. Mathioudakis, *“Reducing controversy by connecting opposing views”*, ACM WSDM 2017

# reducing polarization

## how can we bridge the divide?

- assuming
  - polarization score measured by RWCwe want to reduce RWC
- problem
  - add  $k$  edges that maximally reduce RWC

# reducing polarization

- greedy algorithm
  - find the single best edge to reduce RWC
  - repeat  $k$  times
- inefficient
  - computing RWC requires  $\mathcal{O}(\text{MMULT}(n))$   
faster in practice with iterative computation
  - still, greedy requires  $\mathcal{O}(n^2 \cdot k \cdot \text{MMULT}(n))$
- improvements
  - consider adding edges only between hubs
  - incremental RWC computation using Sherman-Morrison formula

# reducing polarization

- what does it mean “add  $k$  edges”?
- answer: recommendations
- but many recommendations are unlikely to be materialized  
no point recommending D. Trump to retweet H. Clinton
- incorporate probability of accepting a recommendation
  - compute user polarity, and
  - acceptance probability as a function of user polarity

# reducing polarization : real example




**Christopher Waterson**  
@adizzle03

Animal lover. Second Amendment  
Originalist. Dad. Husband. Christian.  
Unapologetic @POTUS Trump Supporter.  
Snowflake hater. #MAGA

📍 New Jersey, USA  
📅 Joined March 2010

polarity=-.99



**(((ImpeachTheCon)))**  
@arquitetinha

Architecture | Innovation | Futurist | Fight  
apocalypse, lies & Idiocracy | Punch  
Nazis, Block Rt-Wng Nut-jobs & Drumpf  
zombie-cult-puppets | 2-state 🌸 | ENFP

📍 New York, USA [also IL | BR]  
📅 Joined September 2015

polarity=.95



# reducing polarization : real example



polarity=-.99



polarity=.15

# reducing polarization : results

|        | obamacare       |                | guncontrol    |              |
|--------|-----------------|----------------|---------------|--------------|
|        | node1           | node2          | node1         | node2        |
| ROV    | mittromney      | barackobama    | ghostpanther  | barackobama  |
|        | realdonaldtrump | truthteam2012  | mmflint       | robdelaney   |
|        | barackobama     | drudge_report  | miafarrow     | chuckwoolery |
|        | barackobama     | paulryanvp     | realalexjones | barackobama  |
|        | michelebachmann | barackobama    | goldiehawn    | jedediahbila |
| ROV-AP | kksheld         | ezraklein      | chuckwoolery  | csgv         |
|        | lolgop          | romneyresponse | liamkfisher   | miafarrow    |
|        | irritatedwoman  | motherjones    | csgv          | dloesch      |
|        | hcan            | romneyresponse | jonlovet      | spreadbutter |
|        | klsouth         | dennisdms      | drmartyfox    | huffpostpol  |

# conclusions

- summary
  - introduced a new score for quantifying controversy
  - studied problem of reducing controversy
- future work
  - incorporate language
  - extend to multiple-side controversies
  - go beyond twitter

thank you!

## credits



Kiran  
Garimella



Gianmarco  
De Francisci Morales



Michael  
Mathioudakis