Computational challenges in analyzing and moderating online social discussions

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social media

- people use social media to
  - share information, express opinion, comment, interact, discuss, get personalized news feed

- 62% of adults in US get their news from social media

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social media : good and bad sides

advantages

- no information barriers
- citizen journalism
- social connectivity
- democratization
- . . .

disadvantages

- harassment
- fake news
- echo chambers
- polarization
- . . .

polarization

- political or social polarization
  the act of separating or making people separate into two groups with completely opposite opinions[*]
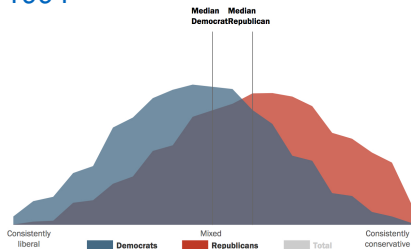
- related term: controversy
  public discussion and argument about something that many people strongly disagree about[*]
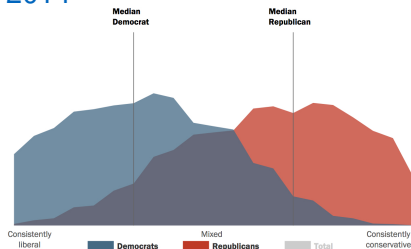
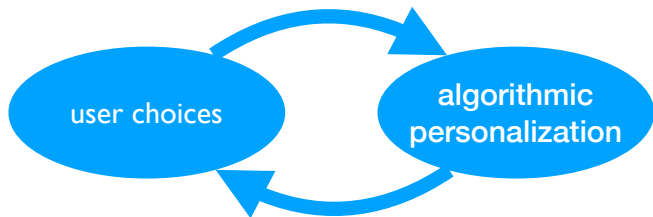[*]oxford english dictionary

polarization in US politics

1994

2014

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the polarization cycle

related to the filter bubble and echo chamber

research questions

- can we identify polarized discussions in social media?

- has polarization increased over time?

- how does collective attention impact polarization?

- can we design algorithms to help reduce polarization?

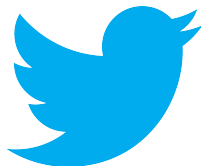- can we design algorithms to moderate online discussions?

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

tweet

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

retweets

26,901 Retweets 140,751 Likes

💬 95K   🔁 27K   ♡ 141K   ✉

Tweet your reply

replies

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 as adults that are acting like 2 year olds. Which is 😭 sad.!!

💬 17   🔁 3   ♡ 48   ✉

connections

Tweets
36.2K

Following
45

Followers
40.9M

how can we identify polarization ?

ideas

- content
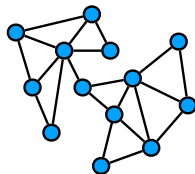   - do opposing sides say different things ?

- 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
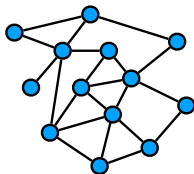
non polarized

polarized
two sides well separated

pipeline

topic → **Graph Building** → **Graph Partitioning** → **Polarization Measure** → evaluation

what type of interaction graph should we use?

how to find two sides in the graph?

how to measure the separation between two sides?

do we identify polarized discussions?

retweets
replies
connections

any state-of-the-art algorithm

random-walk
edge betweenness
embedding-based
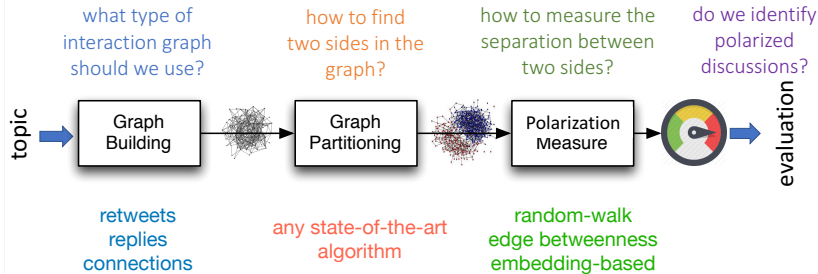
random-walk controversy score (RWC)

- 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 $X \in \{A, B\}$

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

- 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
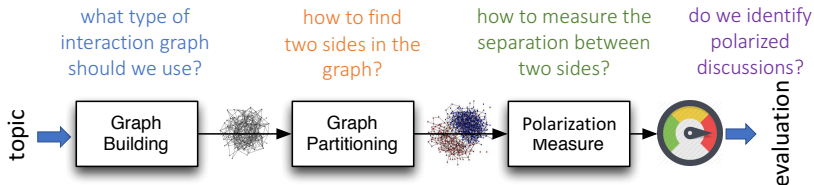
- retweet graph
- RWC

other good settings: edge betweenness score
sentiment variance

example of results

high RWC   low RWC

polarized topics

nemtsov
protests

indian
beef ban

germanwings
plane crash

sxsw
conference

non-polarized topics

using retweet graph
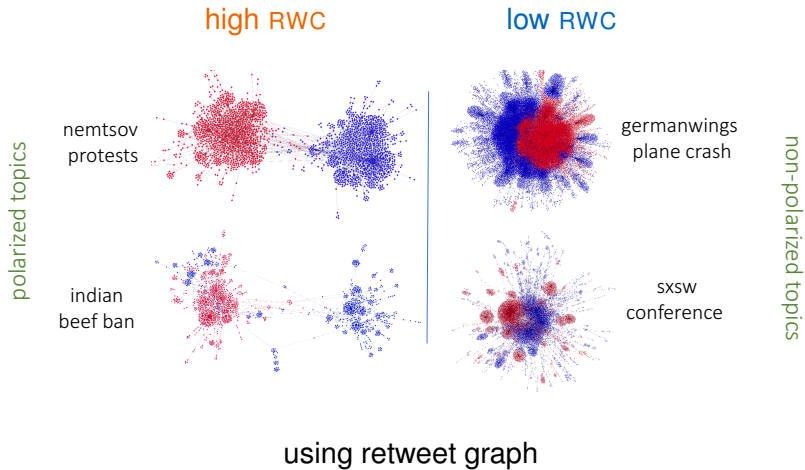
example of results

nemtsov protests
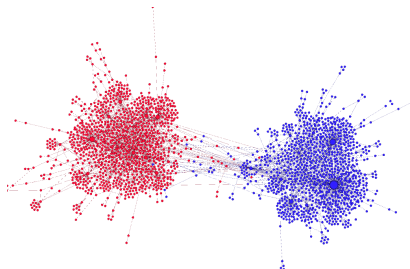
retweets
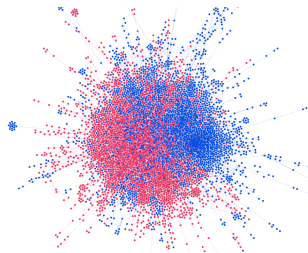
replies

research questions

does polarization increase over time?

does polarization increase with spikes of activity?

K. Garimella, G. De Francisci Morales, A. Gionis, M. Mathioudakis, *"The effect of collective attention on controversial debates on social media"*, ACM Web Science 2017

polarization over time

- data
    - 1% sample of all tweets
    - September 2011 to September 2016

- method
    - for a given topic (e.g., obamacare)
    - build retweet graph for each day
    - measure RWC score

RWC **over time**
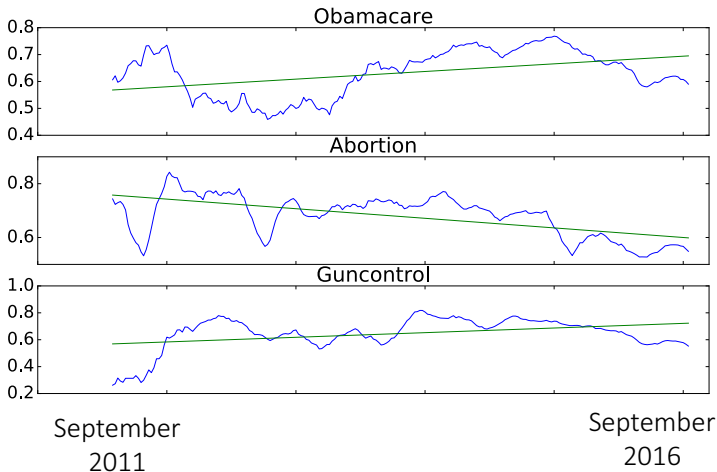
activity spikes at major events

Number of active users per day (Obamacare)

Supreme Court upholds Obamacare
House passes GOP spending plan that defunds Obamacare
Obamacare subsidies preserved in US Supreme Court ruling
2012 Presidential debate mentions Obamacare

Gun Control

Sandy Hook school shooting
Democratic Senators Filibuster for Gun Control
Obama talks about executive action on guns
New York governor calls for national gun control
NRA Annual Convention

Abortion

Supreme Court Strikes Down Texas Abortion Restrictions
Planned Parenthood sting video released
Shooting at a Planned Parenthood clinic
VP debate discusses abortion
Texas attempts to change its law on abortion

RWC vs. activity volume

other measures vs. activity volume

clustering coefficient, core density, core-periphery edges,
bi-directional links, content distribution, etc.

findings

- polarization increases with volume
- most retweeting activity occurs within a side
- retweet network becomes more hierarchical
- more discussion on the reply network
- content becomes more similar between the two sides

research questions

design algorithms to help reduce polarization

design algorithms to moderate online discussions

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

K. Garimella, A. Gionis, N. Parotsidis, N. Tatti, *"Balancing information exposure in social networks"*, NIPS 2017

reducing polarization

how can we bridge the divide?

- assuming
  - polarization score measured by RWC

  we 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

Christopher Waterson
@adizzle03

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

📍 New Jersey, USA
📅 Joined March 2010

Caitlin Frazier ✔
@CaitlinFrazier

audience @TheAtlantic, Episcopalian,
Sooner, said to be made of purple,
caitlinfrazier.com

📍 Washington DC
🔗 theatlantic.com
📅 Joined February 2010

polarity=-.99   polarity=.15

reducing polarization : results

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

balancing information exposure

- the standard viral-marking setting [Kempe et al. 2003]
  - a social network
  - a model of information propagation
    e.g., the independent-cascade model
  - an action (e.g., meme) propagates in the network

- the influence-maximization problem
  - find k seed nodes to maximize spread

- the standard solution
  - spread is non-decreasing and submodular
  - greedy given $(1 - \frac{1}{e})$ approximation

balancing information exposure

- proposed setting
  - a social network and two campaigns
  - seed nodes I_1 and I_2 for the two campaigns
  - a model of information propagation

- the problem of balancing information exposure
  - find additional seeds S_1 and S_2, with $|S_1| + |S_2| \leq k$
  - s.t. minimize # of users who see only one campaign
    or maximize # of users who see both or none

balancing information exposure : our results

- optimization problem is **NP**-hard

- objective function non monotone and non submodular

- different models of how the two campaigns propagate

- approximation guarantee $\frac{1}{2}(1 - \frac{1}{e})$
    - maximization version

balancing information exposure : example

Side 1
Pro-Choice

Side 2
Pro-Life

Hedge

Pro-Remain

Pro-Leave

discussion, limitations, future work

- models use mostly network structure
  - language-independent, but
  - incorporating language can help

- simple models
  - two-sided controversies
  - external influence is ignored
  - random walk and independent cascade too simple

- evaluation is challenging, done on few topics

- go beyond twitter

references

- K. Garimella, A. Gionis, N. Parotsidis, N. Tatti, *"Balancing information exposure in social networks"*, NIPS 2017

- K. Garimella, G. De Francisci Morales, A. Gionis, M. Mathioudakis, *"The effect of collective attention on controversial debates on social media"*, International ACM Web Science 2017

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

thank you

Q & A