

Paying Attention: How Cognitive Biases Shape Social Behavior Online

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Information spread in social media

Networks amplify the spread of information online ...





Information spread in social media

... sometimes spilling over into the real world activity

Unexpected Electric Daisy Carnival crowd may have been drawn by DJ's tweets

July 27, 2011 | 9:28 pm



How does information spread?



Information spread as social contagion

Standard model of social contagion: A meme behaves like a virus, with each exposure of a naïve individual by an informed friend potentially resulting in an 'infection' (meme transmission)





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How large are outbreaks?: Model

Standard model of contagion (independent cascade model) predicts outbreak size for given meme transmissibility



[Ver Steeg, Ghosh & Lerman (2011) "What stops social epidemics?" in ICWSM]



How large are outbreaks?: Data

Number of connected users who share (retweet or vote for) URL



→ Most outbreaks are small, and even largest ones reach only a small fraction of people. Why?

[Lerman et al. "Social Contagion: An Empirical Study of Information Spread on Digg and Twitter Follower Graphs" arXiv:1202.3162]



Mechanics of social contagion

User must see a meme and find it interesting before he/she can be 'infected'





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Cognitive factors: Social influence





Cognitive factors: Position bias

People pay more attention to items at the top of the screen or a list of items





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[Payne, The Art of Asking Questions (1951)]

[Buscher et al, CHI'09]

[Counts & Fisher ICWSM'11]

... limits how far down the page a user navigates



Interface factors: Visibility

new post at top of user's screen

post near the top is highly visible: <u>user is likely to see it</u>







Interface factors: Visibility

... some time later: newer posts appear at the top

post is less visible: takes more effort to find; user is less likely to see it







Users retweet a meme when it is visible

Retweet probability vs time since exposure by a friend



Visibility decays as friends add new posts to a user's stream: the more friends, the quicker the decay

[Hodas & Lerman "How Limited Visibility and Divided Attention Constrain Social Contagion" in *SocialCom-2012.* arXiv:1205.2736]







Highly connected users are less susceptible to infection

Retweet probability vs number of <u>friends</u> a user follows



→ Highly connected users are cognitively overloaded (receive too much information) and less likely to find a given meme.

[Hodas & Lerman (2012) "How Limited Visibility and Divided Attention Constrain Social Contagion" in *SocialCom.* arXiv:1205.2736]



Visibility of multiple exposures

Twitter visibility: a retweet moves it top position

<complex-block>

Digg visibility: a vote does not change position



→ web site interface affects visibility of memes, but social signals matter too

Infection probability following x exposures

Probability that a user following n_f friends will retweet a meme at time t after x exposures, depends on the visibility of the exposures and social enhancement factor F(x)

$$P_{Twitter}(t; x, n_f) = F(x) \left(1 - \prod_{n=1}^{x} 1 - \mathcal{T}(t - t_n, n_f) \right)$$



$$\boldsymbol{P_{Digg}}\big(t;x,n_f\big) = F'(x)\big(\mathcal{T}'(t-t_1,n_f)\big)$$



[Hodas & Lerman (2013) "The Simple Rules of Social Contagion" on arXiv]



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 \rightarrow Model accurately predicts response regardless of exposures



Some implications of limited attention



Attention vs influence

Which user to target to spread a message? Although user B has more followers, they are overloaded & less likely to propagate the message



[Hodas & Lerman (2012) "How Limited Visibility and Divided Attention Constrain Social Contagion" in *SocialCom.* arXiv:1205.2736]

Hubs are less susceptible to multiple exposures...

Standard model of contagion: infection ∞ # infected friends

B В **Exposure response Exposure response** 0.7 0.6 1-10 friends ----ICM 250+ friends probability of infection A 0.4 R 0.2 B 0^L 0 0 10 20 30 40 50 20 40 60 80 Number of tweeting friends # infected friends

[Hodas & Lerman (2012) "How Limited Visibility and Divided Attention Constrain Social Contagion" in *SocialCom.* arXiv:1205.2736]

Highly connected users are much less likely to become infected

100



... which limits the size of outbreaks in social media

Standard model of contagion (ICM) predicts large outbreaks

Simulations with decreased susceptibility of highly connected users produce much smaller outbreaks



[Ver Steeg, Ghosh & Lerman (2011) "What stops social epidemics?" in ICWSM]



Popularity of social news

User interface

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Dynamics of popularity





Mechanics of social news



[Hogg & Lerman (2012) "Social dynamics of Digg" in *EPJ Data Science*]



Mechanics of social news



[Hogg & Lerman (2012) "Social dynamics of Digg" in EPJ Data Science]



Predict popularity of news

- Developed a model that accounts for dynamic visibility of news stories and their interestingness
- Predict (at promotion time) how many new votes stories will receive from different populations of users



[Hogg & Lerman (2012) "Social dynamics of Digg" in EPJ Data Science]



Manipulating attention: an experimental study



Peer recommendation

... helps users find interesting content online







Mechanics of peer recommendation

User must see an item and find it interesting before he/she recommends it





Amazon Mechanical Turk experiments

Can we control user attention – through story ordering – so as to improve outcomes of peer recommendation?

| Finish Please recommend science topics from the list below | | | | |
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| Grab the Leash: Dog Walkers More Likely to Reach Exercise Benchmarks Man's best friend may provide more than just faithful companionship: A new study led by a Michigan State University researcher shows people who owned and walked their dogs were 34 percent more likely to meet federal benchmarks on physical activity. | | | | |
| No Two of Us Are Alike Even Identical Twins: Pinpointing Genetic Determinants of Schizophrenia Just like snowflakes, no two people are alike, even if they're identical twins according to new genetic research from The University of Western Ontario. Molecular geneticist Shiva Singh has been working with psychiatrist Dr. Richard O'Reilly to determine the genetic sequencing of schizophrenia using | | | | |
| Lab-Grown Meat Would 'Cut Emissions and Save Energy' Meat grown using tissue engineering techniques, so-called 'cultured meat', would generate up to 96% lower greenhouse gas emissions than conventionally produced meat, according to a new study. | | | | |
| Still Counting Calories? Your Weight-Loss Plan May Be Outdated The most detailed long-term analysis of the factors that influence weight gain shows that conventional wisdom may not be the best approach. | | | | |
| Happy Guys Finish Last, Says New Study On Sexual Attractiveness "Women find happy guys significantly less sexually attractive than swaggering or brooding men, according to a new University of British Columbia study that helps to explain the enduring allure of ""bad boys"" and other iconic gender types." | | | | |
| Storing Water for a Dry Day Leads to Suits A small water utility in California sued to challenge the wealthy farming interests that dominate two of the country's largest water banks. | | | | |
| Governor Says Montana Was Misled on Oil Spill | | | | |
| | | | | |

Users asked to recommend stories from a list

- 100 stories
- Presented in some order
- •No social signals (story popularity)
- Parallel world experiments



Experimental design

- Vary policy for ordering stories → measure outcome (number of recommendations)
- No social signals: users not shown # of recommendations



Results

Position bias: stories in top positions get more attention (higher visibility)

Story interestingness: fraction of recommendations in the random interface



Results

How well does popularity reflect quality?: correlation with interestingness

Inequality of outcomes in peer recommendation: Gini coefficient of popularity



→ ordering items by recency of activity results in higher correlation of popularity with quality and less inequality



Summary

- Social contagion is different from viral contagion
 - Highly connected people are less susceptible to 'infection' since they must divide attention over all incoming messages
 - Rather than amplify outbreaks, as in viral contagion, they suppress them
 - Knowing visibility of information predicts user response
- Attention in peer recommendation
 - Items receiving more attention become more popular
 - Manipulate attention by controlling visibility of items (their position in a list)
 - Ordering items by time of recommendation is robust scheme for peer recommendation



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