Networks

- Nodes
- Edges
- Information
# Networks

<table>
<thead>
<tr>
<th>Network</th>
<th>Nodes</th>
<th>Edges</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social</td>
<td>People</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internet</td>
<td>Servers</td>
<td></td>
<td></td>
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<tr>
<td>Citation network</td>
<td>Articles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Web</td>
<td>Web pages</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Information cascades

• Information effects (herding behavior)
• Direct-benefit effects
• Epidemics
Herding behavior

• Lines outside restaurants/clubs

• Crowd of people looking up (Milgram et al. 1969)

• Inference that observed choices are more powerful than own private information
Urn Game

- private information vs. public action
Direct benefit effects

- Direct payoffs for making the same decisions others make
- Social networking sites
- Cell phone providers
- Mac/PC
Direct benefit effects

- a and b adopt A, they get a payout of x
- a and b adopt B, they get a payout of y
- otherwise they get a payout of 0

Easley and Kleinberg 2010
\[ a = 3 \]
\[ b = 2 \]
• The topology of the network has consequences for diffusion
• Tightly connected communities can hinder the spread of innovation

• Viral marketing: how do you choose the nodes where you can maximize adoption in the network?
Information vs. adoption

Ryan & Gross (1943), “The Diffusion of Hybrid Seed Corn in Two Iowa Communities,” Rural Sociology
Diffusion of innovations

• Spread of a new technology/idea through a social network

• Common principles (Rogers 1995):
  
  • **complexity.** How easy can people understand it?
  
  • **observability.** How transparent is it when others are using it?
  
  • **trialability.** Can it be adopted incrementally?
  
  • **compatibility.** How comparable is it with existing practices?
Tie strength

• Hearing about vs. adopting innovation

• Bridges are powerful for conveying awareness, but not uptake
Collective action

“I’ll show up for the protest if at least x other people do too”

Know the structure of the total social network + the threshold for your friends
Collective action

Know the structure of the total social network + the threshold for your friends
Collective action

Know the structure of the total social network + the threshold for your friends
Diffusion as Epidemic

How does the network change as a function of the disease?
Diffusion as Epidemic
Diffusion as Epidemic
Diffusion as Epidemic
Diffusion as Epidemic
Basic Reproductive Number ($R_0$)

- Expected number of new infections caused by a randomly selected person in the population

<table>
<thead>
<tr>
<th>Disease</th>
<th>$R_0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1918 Flu</td>
<td>2-3</td>
</tr>
<tr>
<td>SARS</td>
<td>2-5</td>
</tr>
<tr>
<td>HIV</td>
<td>2-5</td>
</tr>
<tr>
<td>Polio</td>
<td>5-7</td>
</tr>
<tr>
<td>Smallpox</td>
<td>5-7</td>
</tr>
<tr>
<td>Measles</td>
<td>12-18</td>
</tr>
</tbody>
</table>
Diffusion as Epidemic

$R_0 < 1$

$R_0 > 1$
Basic Reproductive Number ($R_0$)

- In tree models, $R_0 = p \times k$
- $p =$ probability of infecting 1 person
- $k =$ number of people in contact with

Decrease $p$ by preventing spread of disease
Decrease $k$ by quarantine
Adar et al., Blogspace
Adar et al., Blogspace
Adar et al., Blogspace
Adar et al., Blogspace
Adar et al., Blogspace
Adar et al., Blogspace
Adar et al., Blogspace
Adar et al., Blogspace
Meme tracking

J. Leskovec et al. (2009), "Meme-tracking and the Dynamics of the News Cycle"
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<table>
<thead>
<tr>
<th>Rank</th>
<th>Lag [h]</th>
<th>Reported</th>
<th>Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-26.5</td>
<td>42</td>
<td>hotair.com</td>
</tr>
<tr>
<td>2</td>
<td>-23</td>
<td>33</td>
<td>talkingpointsmemo.com</td>
</tr>
<tr>
<td>4</td>
<td>-19.5</td>
<td>56</td>
<td>politicalticker.blogs.cnn.com</td>
</tr>
<tr>
<td>5</td>
<td>-18</td>
<td>73</td>
<td>huffingtonpost.com</td>
</tr>
<tr>
<td>6</td>
<td>-17</td>
<td>49</td>
<td>digg.com</td>
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<tr>
<td>7</td>
<td>-16</td>
<td>89</td>
<td>breitbart.com</td>
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<tr>
<td>8</td>
<td>-15</td>
<td>31</td>
<td>thepoliticalcarnival.blogspot.com</td>
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<td>talkleft.com</td>
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<td>30</td>
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<td>-10</td>
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<td>online.wsj.com</td>
</tr>
<tr>
<td>49</td>
<td>-10</td>
<td>54</td>
<td>ap.org</td>
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Table 1: How quickly different media sites report a phrase.
In practice

- Influencers on Twitter (RTs)
- Influencers on Twitter (action)
- Viral marketing
- Inferring social network structure

- Nodes
- Edges
- Information
Facebook contagion study

Fig. 1. Mean number of positive (Upper) and negative (Lower) emotion words (percent) generated people, by condition. Bars represent standard errors.