Lecture 19: Influence (2/4)

“How are our neighbors influencing us? How can my start-up become viral?”

COMS 4995-1: Introduction to Social Networks
Tuesday, November 20th
Upcoming!

Yasser (How do songs become hits?)
TuHooshmand (When gossip competes)
Saleh (Gender and relationships)
Guangyu (Social Networks and Health)

Tikue (What’s in Klout?)
Xin (Facebook, Twitter and election)

Sriramkumar (Spatial Social Networks)
Enrico (The Social Networks of Jazz)

Jessica (What’s Google new algorithm?)
Antony (What’s Wall Street’s network?)

Ying (How much information is fake?)
Colin (Infection meets Computer Vision)

Aditya (twitter beats hedge funds?)
Xu (Fraudulent and Malicious users)

Chenkun (are our emotions connected?)
Ran (Obama’s victory through big data)

Yang (Twitter in the classroom)
Tianchen (Massive online classes)
Christopher (CrowdJobFinding)
Xiaogang (Political mobilization)
Outline

* Life under the influence

* 1978: The global view, ‘Network effect’
* 2000: The local view, ‘Neighbors effect’
* 2003: The algorithmic view, ‘Exploiting Influence’
Outline

* Life under the influence

* 1978: The global view, ‘Network effect’
* 2000: The local view, ‘Neighbors effect’
* 2003: The algorithmic view, ‘Exploiting Influence’
Previous model assumes all pairs are relevant
- In reality, individuals know and care only about a local view of their network (i.e. fraction of neighbors)
- E.g.: a coordination game on a graph

An individual primarily decides to take an action as a monotone function of her neighbors adoption
- Every node $v$ has threshold $t_v$
- If a fraction $x \geq t_v$ of her neighbors active, $v$ activates
Graph Conversion

* Assume a finite set of seeds $S_0$ adopting a behavior
  1. $S_1$ nodes with fraction $f \geq t_v$ of neighbors in $S_0$
  2. $S_2$ nodes with fraction $f \geq t_v$ of neighbors in $S_0 \cup S_1$
  3. and so on

* Starting from $S_0$, the graph $G=(V,E)$ is $p$-converted if
  – Assuming all nodes have $t_v = p$, then $V = S_0 \cup S_1 \cup ...$

* The contagion threshold $\text{cont}(G)$ is
  – $\sup \{ p \mid \text{there exists } S_0 \text{ finite } s.t. \ G \text{ is } p\text{-converted} \}$
Example of cont(G)

Relation Contagion-Density

- Cont(G) is a graph property
  - Intuitively, contagion is difficult in denser graph
- A measure of density
  - A subset S is a p-dense cluster if a node in S has a fraction at least p of its neighbors in S
  - clu(G) = sup{ p | ∀ |A|<∞, V-A contains p-dense cluster }
- Thm: cont(G) ≤ 1-clu(G)
  - Dense clusters (and only them) block innovation!
Proof of theorem

Assume there is \( c(u_0) > p \)

then: \( \text{Sous U USE} \). \( \exists p \) deux cluster \( C \leq V S U \).

there should exist \( c_0 \in C \) first to drop.

\( p \) fraction of neighbors \( i_0 \), at most \( 1-p \) fraction neg is

\( 1-p > c_{i_0} \)

\( \text{act}(i_0) = \sup \{ p' | \exists \text{success and} p' \leq 1-p \leq c(u_0) \} \)
\[ V \neq S_{\alpha} \cup \ldots \cup S_{\beta} \quad \Rightarrow \quad U = (\text{Conv}) \quad \subseteq \quad (\text{Conv})^c \]

\[ p < 1 - \alpha \alpha_0 \]

(1 - p) deux clusters
What are the most favorable graph contagion?
- In other words, how large can $\text{cont}(G)$ be?
- Thm: $\text{cont}(G) \leq \frac{1}{2}$

Under what conditions can it be attained?
- At least one graph with $\text{cont}(G)=1/2$ is known!
- uniform interaction + low neighborhood growth

What if nodes renew their decisions at each step?
- Exactly the same: contagion threshold unchanged!
Outline

* Life under the influence

* 1978: The global view, ‘Network effect’
* 2000: The local view, ‘Neighbors effect’
* 2003: The algorithmic view, ‘Exploiting Influence’