Lecture 20: Influence (3/4)

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

COMS 4995-1: Introduction to Social Networks

Tuesday, November 27th

Outline

* Life under the influence

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

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A general algorithmic problem

* How to find the best initial seeding set S_0?
  - Maximizing the total spread, with a fixed size
* A more general model of neighbor influence
  - Assumes threhold t_v uniform in [0;1] and v becomes active as soon as $t_v \leq g_v(X)$
  - as u becomes active, activates neighbor v with prob. $p_v(u,X)$, where X = {nodes in N(v) previously active}
  - Special cases: Granovetter, Morris, Independent
  - If p order independent, the two models equivalent

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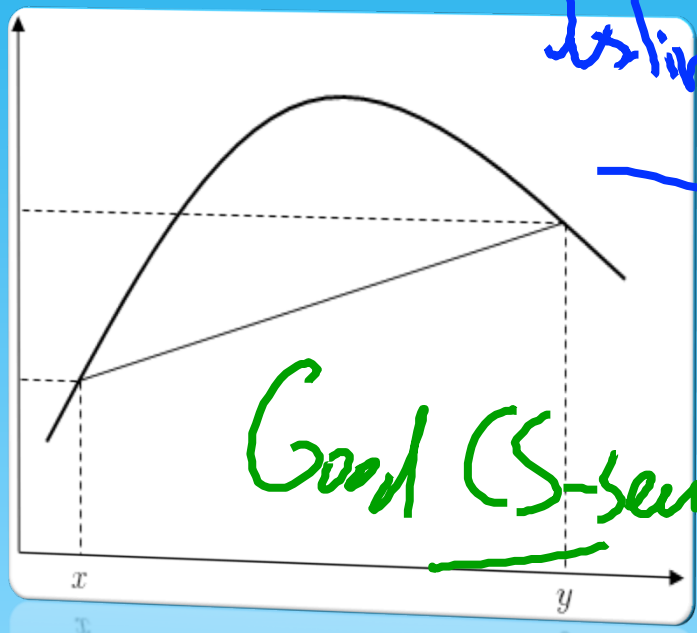
Critical Mass vs. Dim. Return

$p_v(u,X)$ "increases" with X

– Infection gets easier

$p_v(u,X)$ "decreases" with X

– infection gets harder



Maximizing spread of influence

* Let us denote the objective function by f(S)
  - f(S) = E[# of active nodes] at the end of the process
  - Assuming process starts with S
* Thm: Computing max{f(S) | |S|=k} is NP hard
  - Even computing a $n^{1-\varepsilon}$ approximation is hard ($\varepsilon>0$)
  - Proof: If g_v shows "critical mass" then relates to a set covering problem
  - Can we avoid "critical mass" and compute it?

Maximizing spread of influence

* Thm: Whenever p_v show diminishing return
  - There exists a simple polynomial algorithm computing S such that $f(S) \geq (1-1/e)f(S^*)$ where S* is the optimal subset of size k
  - Algorithm follows greedy "one node at a time" rule
    Do k times: $S \leftarrow S \cup \text{argmax}_v \{ f(S \cup \{v\}) - f(S)\}$

Maximizing the spread of influence through a social network,
D. Kempe, J. Kleinberg, E. Tardos, ACM KDD (2003)

Proof

* Three steps:
  1. Show that the result holds if f is submodular, i.e.
     $S \subseteq T$ Implies $f(S \cup \{v\}) - f(S) \quad \geq \quad f(T \cup \{v\}) - f(T),$
  2. Show f is submodular under this condition on p_v
  3. Finally, prove that each step is polynomial
     more involved (will be admitted here)