Game-Theoretic Models of Information Overload in Social Networks

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1 Introduction

- Social networks make it convenient to get updates asynchronously.
- Content of newsfeed becomes important to users.
- Newsfeed content is based on activity level of user's friends.
- Thus, newsfeed content is not determined by user.
- User may be forced to read irrelevant updates.

2 Types of Social Networks

1. Symmetric: requires consent from both sides to maintain tie - eg., Facebook.
2. Asymmetric: requires consent from only one side to maintain tie - eg., Twitter.

- Authors mainly look at asymmetric social networks.

3 Assumptions

- Rate of sending updates is key decision variable (see Fig 1).
- Updates from friends are useful, but excessive updates have diminishing value.
- Users can be partitioned as producers and consumers of information.

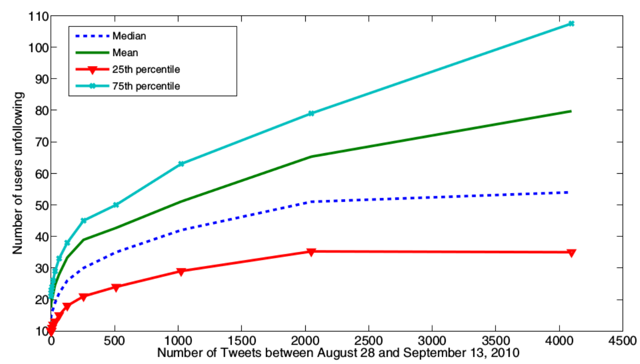

Figure 1: Empirical evidence from Twitter data to prove that as rate increases number of accounts unfollowing user increases

4 Models for Social Networks

- Followership: Users in network will stay in network but unfollow agents who give too frequent updates.
- Engagement: Users get frustrated by high update rate of followees and leave the social network.

5 Graph Model

- Complete bipartite graph on two disjoint sets of nodes: producers (C), and consumers (F).
- Edge between producer i and consumer j is associated with a non-negative quality score q_{ij}.
  - q_{ij} denotes utility consumer j derives from producer i's updates.
- Producer i updates at a frequency (rate) of r_i.
- Payoff for producer i is r_i times the number of followers he/she has.

6 Followership

- Utility of consumer is $U_j = r_i q_{ij} - \lambda(\sum_i x_i r_i)^2$, where x_i is an indicator variable which is 1 if consumer j follows producer i.
- Solving for $x_i \in \{0, 1\}$ is hard so simplify to $x_i \in [0, 1]$ and greedy model is used.
- **Greedy model**: Consider consumer j and let $q_1 \geq \ldots \geq q_n$ be the sorted order of $q_{1j}, \ldots, q_{nj}$, and k be the largest index such that $\sum_{i=1}^{k} r_i \leq q_k$. Under the greedy model, consumer j follows the k producers for who he has the highest quality and no one else.
- Nash equilibrium not necessarily exists, example where not existing is shown.
- Nash equilibrium exists when consumers follow a global ranking of producers.
- Also when, the dependency graph of a game instance is acyclic. The dependency graph is defined for nodes of producers and consumers with a directed edge from producer x to producer y if x is valued greater by a consumer than y.
- Nash equilibrium can be characterized by a matching from all subsets of producers to consumers.

7 Engagement

- Nash equilibrium exists for games where all consumers have same degree, and when consumers follow one or two celebrities.

8 Conclusions

8.1 Cons

- Not enough motivation for why particular models of social networks is selected.
- Matching characterization not elaborated upon.
- Fractional flow, and greedy model in Followership model not realistic, though understandable why chosen.
- Might Mixed State Nash equilibrium be looked at?

8.2 Pros

- Takes into account rate of update in social networks.
- Characterization showed in Followership model.
- Empirical evidence shown for why rate of updates is a valid parameter.