POSITIVE OPINION INFLUENTIAL NODE SET SELECTION FOR SOCIAL NETWORKS: CONSIDERING BOTH POSITIVE AND NEGATIVE RELATIONSHIPS

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OUTLINE

- Motivation
- Problem Definition
- Greedy Algorithm
- Performance Evaluation
- Conclusion
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INTRODUCTION

- What is a social network?
  - The graph of relationships and interactions within a group of individuals
Social network plays a fundamental role as a medium for the spread of influence among its members:
- Opinions, ideas, information, innovation…

Direct Marketing takes the “word-of-mouth” effects to significantly increase profits (facebook, twitter, myspace, …)
MOTIVATION

- 900 million users, Apr. 2012
- the 3rd largest — “Country” in the world
- More visitors than Google
- Action: Update statues, Create event

- More than 4 billion images
- Action: Add tags, Add favorites

Social networks already become a bridge to connect our daily life and the virtual web space

- 2010, 4 billion tweets per quarter
- Action: Post tweets, Retweet
Who are the positively influential leaders in a community?

Find minimum-sized node (user) set in a social network that could positively influence every node in the network.
APPLICATIONS

- Smoking intervention program
- Political Campaign
- Advertising
- Social recommendation
- Expert finding
- …
Our Contributions

- Consider both positive and negative influences
- New optimization problem - Positive Opinion Influential Node Set (POINS) selection problem
  - node set with size $k$ that could maximizes the spread of positive opinion influences
- Propose a greedy algorithm to solve POINS
- Conduct simulations to validate the proposed algorithm
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**NETWORK MODEL**

- A social network is represented as an undirected graph.
- Nodes are divided into two sets:
  - $V_A$ positive node sets
  - $V_B$ negative node sets
- Social influence is represented by the weights on the edges:
  - Positive influence: friendship relationship
  - Negative influence: foe relationship
- Nodes start either active or inactive.
- An active node may trigger the activation of neighboring nodes based on a pre-defined threshold $\theta$. 
DIFFUSION MODEL

For $v_2$: $\Theta^A_2 = 0.5$ $\Theta^A_5 = 0.2$

For $v_5$:
$\Theta^B_2 = 0.5$ $\Theta^B_5 = 0.2$

$V_i \in \begin{cases} 
S^A(t), \text{ when } \sum_{j \in S^A(t-1)} w_{ij}^+ + \sum_{j \in S^B(t-1)} w_{ij}^- \geq \Theta^A_i \\
S^B(t), \text{ when } \sum_{j \in S^B(t-1)} w_{ij}^+ + \sum_{j \in S^A(t-1)} w_{ij}^- \geq \Theta^B_i \\
S^{IN}(t), \text{ otherwise } 
\end{cases}$
**Positive Opinion Influence Node Set Selection Problem (POINS)**

- **Given**
  - a social network $G = (V, E, W)$, $S^B(0)$, and $k$
  - thresholds $\theta_i^A$ and $\theta_i^B$

- **Objective**
  - find an initial active node set with opinion $A$ represented by $S^A(0)$ of size at most $k$ that maximize the expected value of the number of active nodes with opinion $A$ denoted by $\rho(t)$, i.e., $\arg \max_{|S^A(0)| \leq k} \rho(t)$
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CONTRIBUTION FUNCTION

\[ f (v_i) = \frac{|N_i^B|}{\delta} + \sum_{v_j \in S^A(0)} w_{ij}^+ + \sum_{v_j \in S^B(0)} |w_{ij}^-| \]

where \( \delta \) represents the maximum degree in the graph \( G \)
# Greedy Algorithm

**Algorithm 1: POINS-GREEDY**

**Require:** Social Network $G=(V,E,W)$, $S^B(0)$, and $k$

1: initialize $S^A(0) = \emptyset$ (empty set)
2: repeat
3: choose $v_i \in \bigcup_{v_j \in S^B(0)} N_j$ to maximize $f(v_i)$
4: $S^A(0) = S^A(0) \cup \{v_i\}$
5: until $(|S^A(0)| = k)$ OR (no more nodes can be added into $S^A(0)$)
6: while $|S^A(0)| < k$ do
7: choose $v_i \in \bigcup_{v_j \in S^A(0) \cup S^B(0)} N_j$ to maximize $f(v_i)$
8: $S^A(0) = S^A(0) \cup \{v_i\}$
9: end while
10: Return $S^A(0)$
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SIMULATION SETTINGS

- Generate random graph
- Randomly generate the weighs on the edges
- For each specific setting, generate 100 instances of the graph. The results are the average values of these 100 instances
The default setting is $n=15$, $p=0.5$, and $\theta=0.5$
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CONCLUSION

- Positive Opinion Influential Node Set (POINS) selection problem is proposed and studied
- A greedy algorithm to solve POINS
- Implement simulations to validate proposed algorithm on random graphs
Q & A

Thanks