STRATEGY OF COMPETITION BETWEEN TWO GROUPS

AN INFLEXIBLE CONTRARIAN OPINION MODEL

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OUTLINE

- What is Sociophysics?
- The basic question we want to answer from opinion models
- Our motivations
- Inflexible Contrarian Opinion model
- Simulation Results
- Conclusions
- What can we do next?
What is Sociophysics?

- Quantitative laws in the collective properties of a large number of people.
- Quantitatively understand how precise regularities arise out of the apparently erratic behavior of single individuals.
- Recently transformed from a philosophical declaration of principles to a concrete research.
- Opinion dynamics, cultural dynamics, language dynamics, crowd behavior.
- Using methods from statistical physics to solve social problems.
The basic question people want to answer from opinion models is: How do the interactions between social agents create order out of an initial disordered situation? The key factor here is that agents interact and this generally tends to make people more similar.
2: Why social dynamics are interested to Physicists? What is our advantage?

Topological challenges:
Topological interaction networks. Traditional statistical physics usually deals with structures whose elements are located regularly in space (lattices) or considers the simplifying hypothesis that the interaction pattern is all to all, thus guaranteeing that the mean-field approximation is correct.

This is hardly realistic in a social context. Much more plausible interaction patterns are those denoted as complex networks.
Different Networks

• ER networks: Random Graphs, degree follows a poisson distribution.
• SF networks: degree follows a power law distribution.
Some Important Definitions for networks

• Size of a network (N): total # of nodes

• Giant Component (GC): A set of connected nodes, in the sense that a path exists between any two of them.
  ▸ Size of the GC \( S_1 \): total # of nodes in GC
  ▸ Define: \( s_1 = S_1/S \)

• Threshold Function \( P_c(N) \), such that many properties of the networks exists with probability 0 if \( P < P_c \), and with probability 1 if \( P > P_c \).
3: The milestones in the history of opinion model (Agent-based modeling)

Voter Model (Holley and Liggett 1975): The agents imitate their neighbors

Majority Rule Model (S. Galam et al, 2002)

Nonconsensus Opinion Model (J. Shao et al, 2009)
The Nonconsensus Opinion Model (NCO)

- Time 0, Initial Condition
- Time 1
- Time 2
- Final Stable State
OUR MOTIVATION

Mac VS PC
**Inflexible contrarian model**

- **Inflexible contrarian**: a node which changes its opinion to take the opposite opinion of its local majority and will keep that opinion forever.

- In our model, only one group will send out inflexible contrarians.
INFLEXIBLE CONTRARIAN OPINION MODEL

- opinion A
- opinion B
- contrarian
INFLEXIBLE CONTRARIAN OPINION MODEL

Two Methods to Choose Inflexible Contrarian
(A wants to change the opinion of B)

I. Random Method:
Randomly choose $p$ percent of the nodes in state B to become inflexible contrarians

II. Targeted Method:
Choose top $p$ percent of the nodes in state B, according to their degree, to become inflexible contrarians.
Simulation Results on ER networks (Random Method)

- \( f \) (Initial fraction of opinion B)
- \( s_1 \) (Giant Component, opinion B)

Graph showing the relationship between the initial fraction of opinion B and the giant component for different values of \( p \) (parameter) with \( s_1 / 300 \) as a reference.
Simulation Results on ER networks

Random Method

Targeted Method
Simulation Results on ER networks

\[ P(k) \] Degree Distribution
\[ F(k) = \frac{\text{# of nodes with degree } k \text{ in the largest cluster}}{\text{total # of nodes with degree } k} \]

For the whole network
For the giant component

\begin{align*}
\text{(a) } \quad & P(k) \\
\text{(b) } \quad & F(k)
\end{align*}
Simulation Results on ER networks
( Universal Scaling Law)

Cluster Size Distribution at Criticality

\[ n_s \propto s^{-\tau} \]

ICO Model is in the same universality class as regular percolation

![Graph showing the relationship between cluster size and the number of clusters of size s.](image)
Simulation Results on ER networks

Majority VS Minority

Majority have advantage over Minority
SIMULATION RESULTS

ER VS Scale Free networks

1. Both the random and targeted methods are more efficient for SF networks. For the same value of $p$, SF networks have larger value of $f_c$.

2. Targeted method are even more efficient for SF networks than ER networks, due to the presence of large hubs.
CONCLUSIONS

- Inflexible contrarians do work efficiently in two groups competition.
- Comparing the two methods, the targeted method is more efficient than the random one.
- When using the both strategies, majority will have advantage over minority.
- Both Strategies are more efficient on SF networks than ER networks.
WHAT’S NEXT?

- Both groups can send out inflexible contrarians at the same time (The competition between contrarians)
- Change inflexible contrarians into flexible contrarians (For example, the inflexible contrarians will stay inflexible for a time period, then after that it will go back to normal flexible people)
Thank you!
SIMULATION RESULTS

ER VS Scale Free networks

ER network

SF network
SIMULATION RESULTS

Random Method

Targeted Method
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