

Interdependent Evolution of Non-Spectral Opinions and Social Networks

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OVERVIEW

INTRODUCTION

- Background and Motivation

THE MODEL

- Initial Setup

- Time Evolution Algorithm

RESULTS

- Cluster Size Distribution

- Phase Transition and Critical Point

- Convergence Time

- Comparisons to Empirical Data

CONCLUSION

- Summary

- References

BACKGROUND AND MOTIVATION

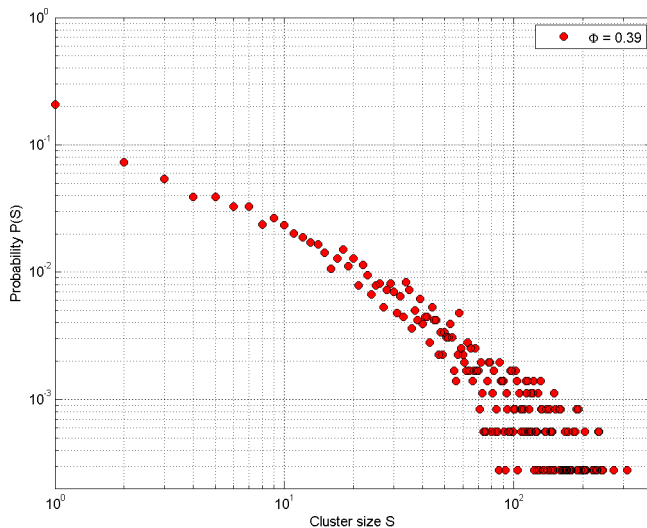
- ▶ Opinion Formation (e.g. voter models) is a common and very fundamental problem in the social sciences
- ▶ Goal: Modelling the *coevolution* of both opinions and the underlying social network
- ▶ **Does our social network shape the opinion we hold or does our opinion determine who is part of our network?**
- ▶ "Opinion" must be mutually exclusive and "non-spectral", e.g. brand preference, religious views...
- ▶ Preview: Analogies to statistical physics, e.g. *phase transitions* can be identified

INITIAL SETUP

- ▶ Random graph with N nodes (opinion holder) and M edges (social connection)
- ▶ Random opinion $g_i \in G$ assigned to node i
- ▶ Nodes exchange information (opinion) via undirected edges
- ▶ Externally set parameters:
 - ▶ N - number of nodes
 - ▶ $\gamma = \frac{N}{G}$ - average number of nodes per opinion
 - ▶ $k_{avg} = \frac{2M}{N}$ - average degree
 - ▶ Φ - reconnection probability

CLUSTER SIZE DISTRIBUTION

CONTINUOUS PHASE TRANSITION?



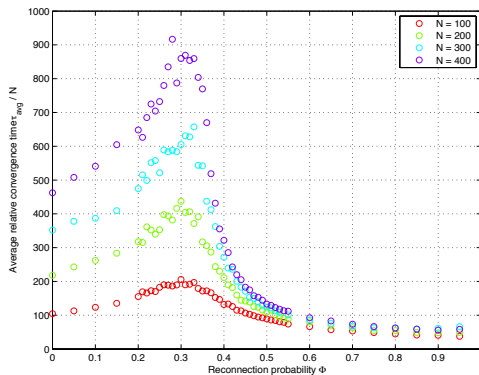
CLUSTER SIZE DISTRIBUTION

- ▶ Ordered phase
 - ▶ Low Φ , i.e. tendency to change opinion
 - ▶ Small clusters follow power law distribution
 - ▶ Existence of giant cluster
- ▶ Unordered phase
 - ▶ High Φ , i.e. tendency to keep opinion
 - ▶ Clusters follow Poisson-like distribution
 - ▶ No giant cluster!
- ▶ Phase transition
 - ▶ First guess: $\Phi_c = 0.35 \pm 0.05$
 - ▶ Power law behavior over the whole s -range

- ▶ Really continuous phase transition
- ▶ Bigger $N \rightarrow$ more dramatic transition
- ▶ $\Phi_c = 0.32 \pm 0.02$ independent of system size N
- ▶ Weak agreement with $\Phi_c = 0.39 \pm 0.05$

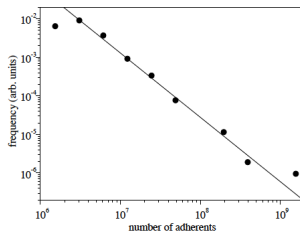
CONVERGENCE TIME

- ▶ Iterations per node to reach consensus as function of Φ :
- ▶ "Divergence" at some Φ_c for different N
- ▶ Similar to divergent response functions in physics
- ▶ Supporting phase transition interpretation, but difficult to find direct analogy to τ_{avg}



COMPARISONS TO EMPIRICAL DATA

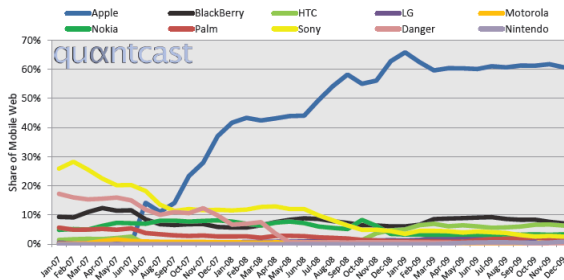
- ▶ Idea: Compare distributions of some "opinion" in real world to the model \rightarrow identify and interpret corresponding Φ
- ▶ **Religion:**
- ▶ Worldwide distribution of religions follows power law: Neither adaptation nor reconnection dominate in the formation?



- Interpret Φ as an "intolerance indicator"?

COMPARISONS TO EMPIRICAL DATA

- ▶ **Mobile Web Browsers:**
- ▶ An example for opinion = brand preference
- ▶ Contrast between giant cluster and "softer" distribution
- ▶ Note: Plot is not a cluster size histogram!



- ▶ Interpret Φ as a "brand loyalty indicator"?

SUMMARY

- ▶ Interdependent evolution of opinions and networks, combining two mechanisms of adaption and reconnection determined by Φ
- ▶ Holme's and Newman's work could be reproduced with more realistic assumptions
- ▶ Continuous phase transition
 - ▶ N -independent critical value $\Phi_c = 0.32 \pm 0.02$
 - ▶ Divergent convergence time at Φ_c

Outlook

- ▶ Variation of γ (diversity) and k_{avg} (density)
- ▶ Include analogue of "magnetic field" in model: "*informed agents*"?
- ▶ Make opinions *spectral*

[illegible]

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