



Rensselaer

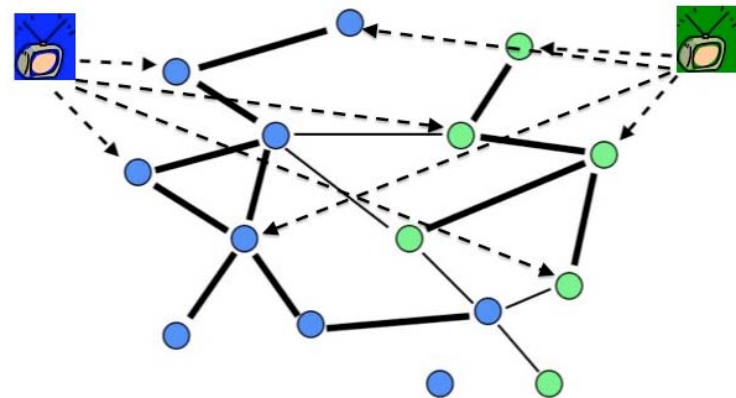
Agent-based Simulation of the Diffusion of Warnings

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Diffusion of Warnings in Dynamic Networks

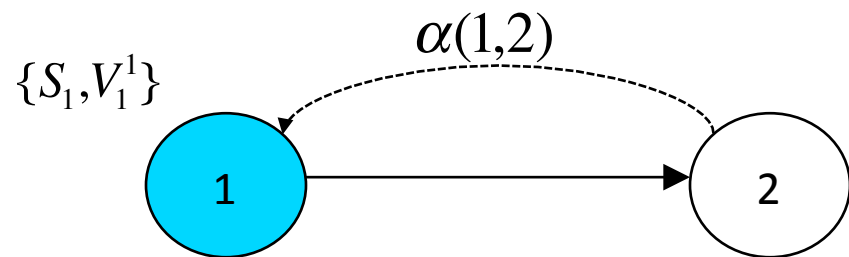
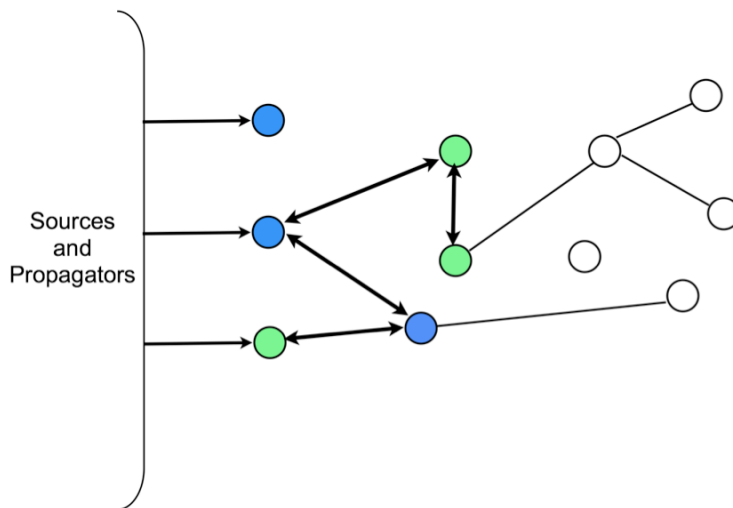
- Diffusion occurs on a network of individuals through interactions between individuals
- Social networks play an important role in diffusion of warnings and warning response
 - Evaluate received information
 - Seek for more information
 - Spread information
 - Exhibit collective behavior
- Network changes over time
 - Leave the network, i.e. evacuate



Overview of the Diffusion Model

How does information flow?

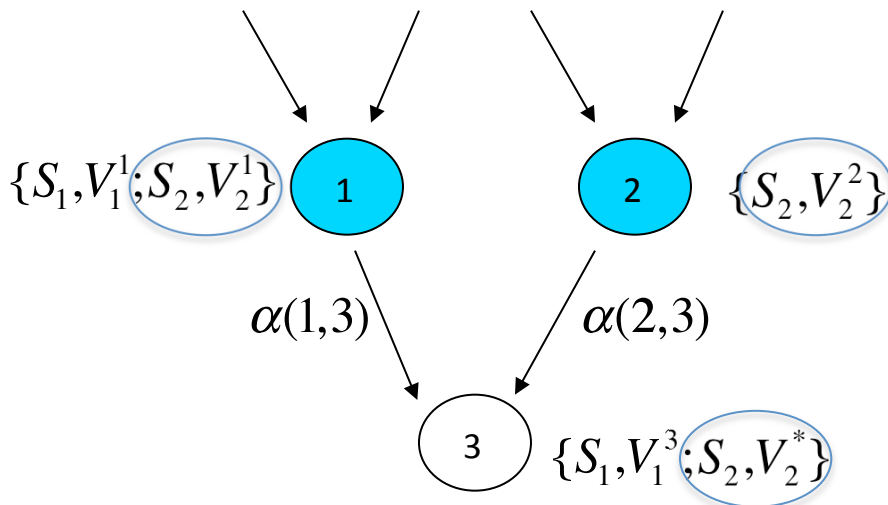
- Messages are propagated when nodes interact
- The information value of the message is a function of the social relationship between the sender and receiver (**trust**)



How do nodes process information?

- Nodes combine information from incoming message
 - Information from the same source is at least the max and at most the sum of the values
- Nodes compute an information fused value
 - Weighted convex combination of the sum and max of the values of information according to parameter λ

$$fused_k = \lambda * \sum_i V_i^k + (1 - \lambda) * \max_i V_i^k$$



Example:

Value of Source S_2 at Node 3:

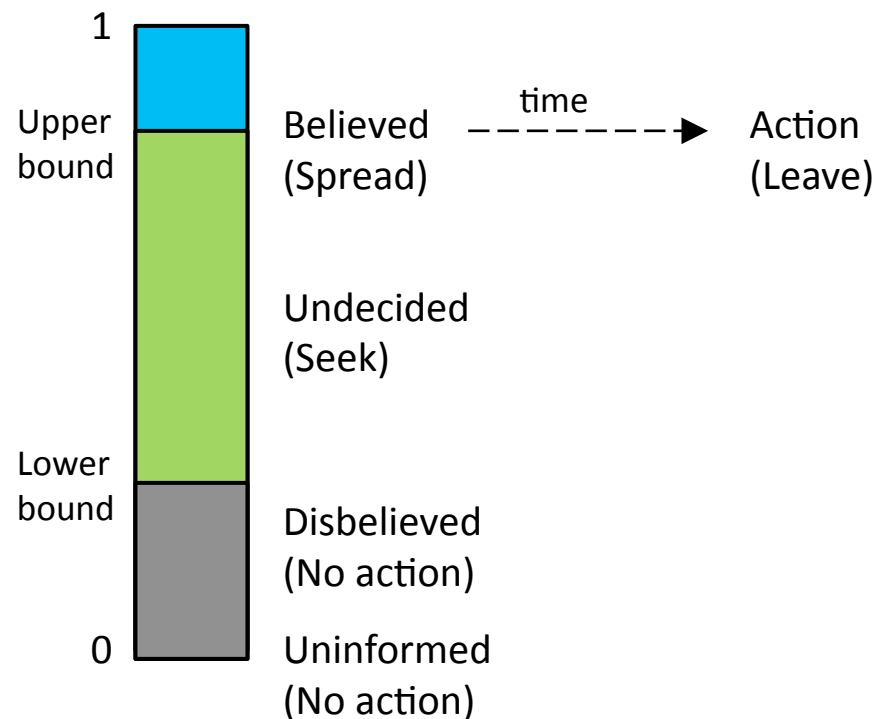
$$\max(V_2^1, V_2^2) \leq V_2^* \leq V_2^1 + V_2^2$$

Fused value at Node 3:

$$fused_3 = \lambda * (V_1^3 + V_2^*) + (1 - \lambda) * \max(V_1^3, V_2^*)$$

How do nodes act on the information?

- If the node's information fused value exceeds one of the thresholds, the node will enter a new state.

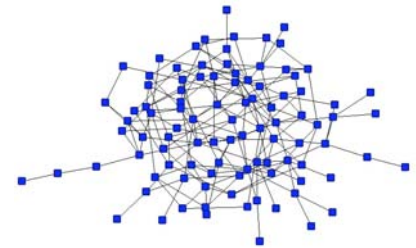
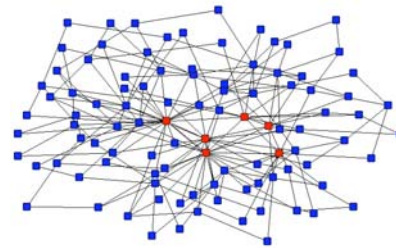
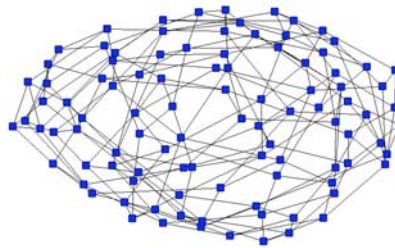
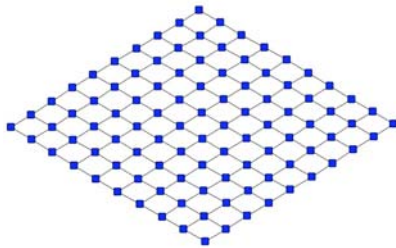


Experiment Details

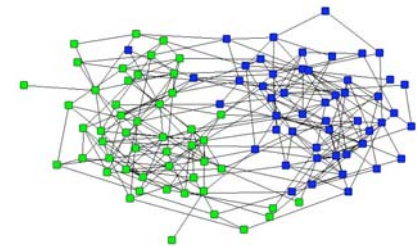
- Observe the diffusion of evacuation warnings in a network of nodes
- Record the proportion of evacuated nodes

Parameters:

- Social network structures with 100,000 nodes
 - Grid, Regular, Scale-free, Random, Group

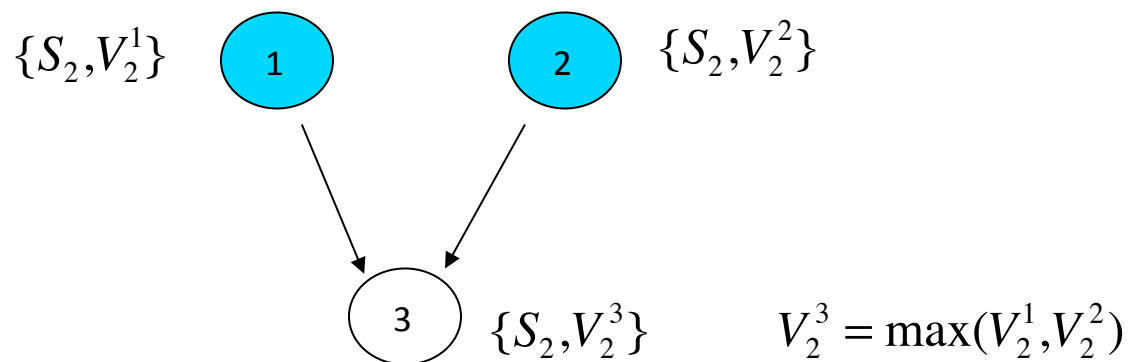


- Broadcast of information
 - 5 information sources with high information value
 - Initial broadcast reaches 5%, 10%, 20% of the population
- Seed set selection
 - Random seed, Highest degree seed

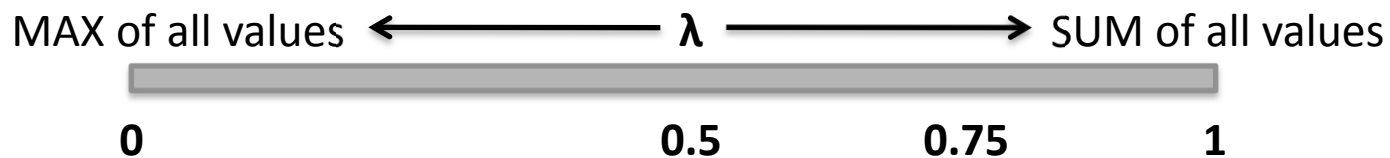


Parameter: Information Fusion λ

- Combine information from messages that originated from the same source

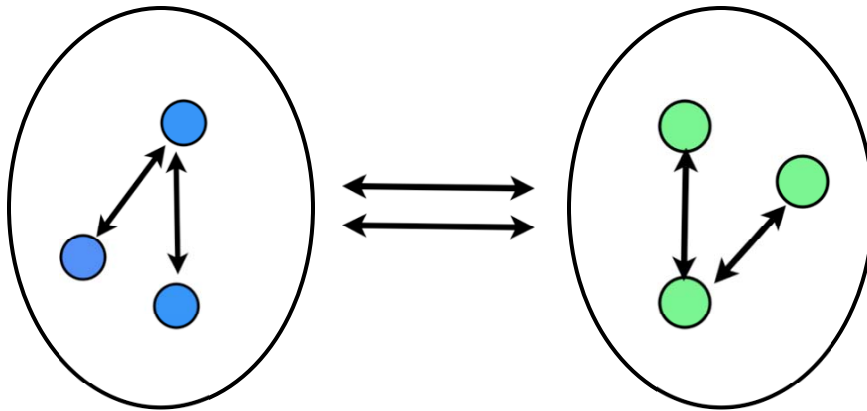


- Compute the fused value at the node (parameter $\lambda = 0.5, 0.75, 1$)

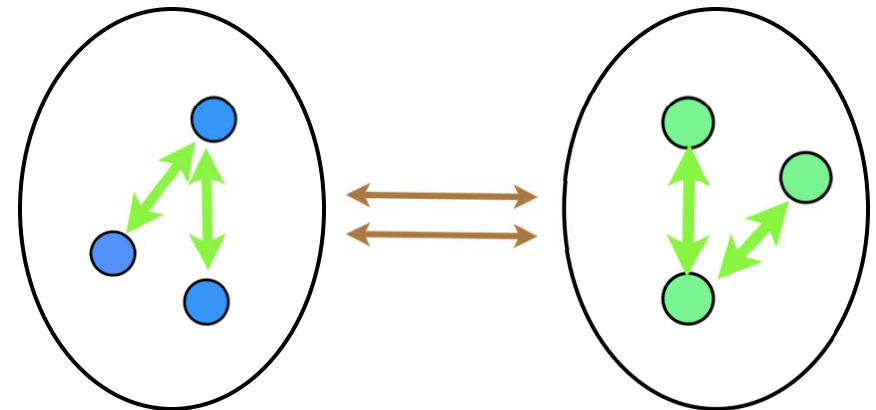


Parameter: Trust Scenarios

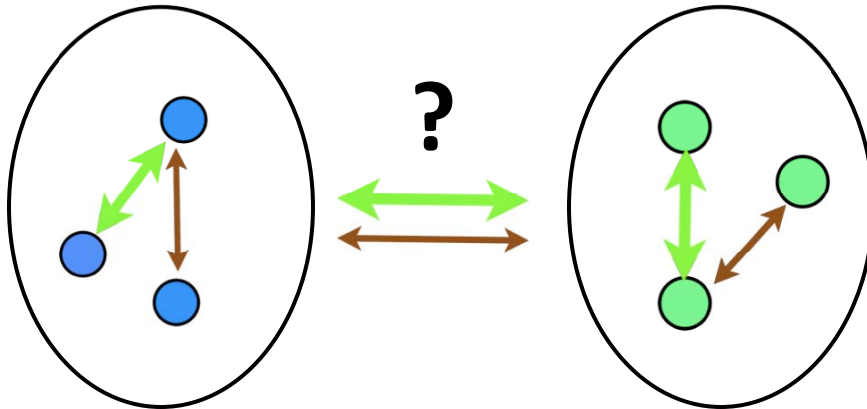
Scenario A: No groups (Equal trust)



Scenario B: Groups
(Higher trust within group)



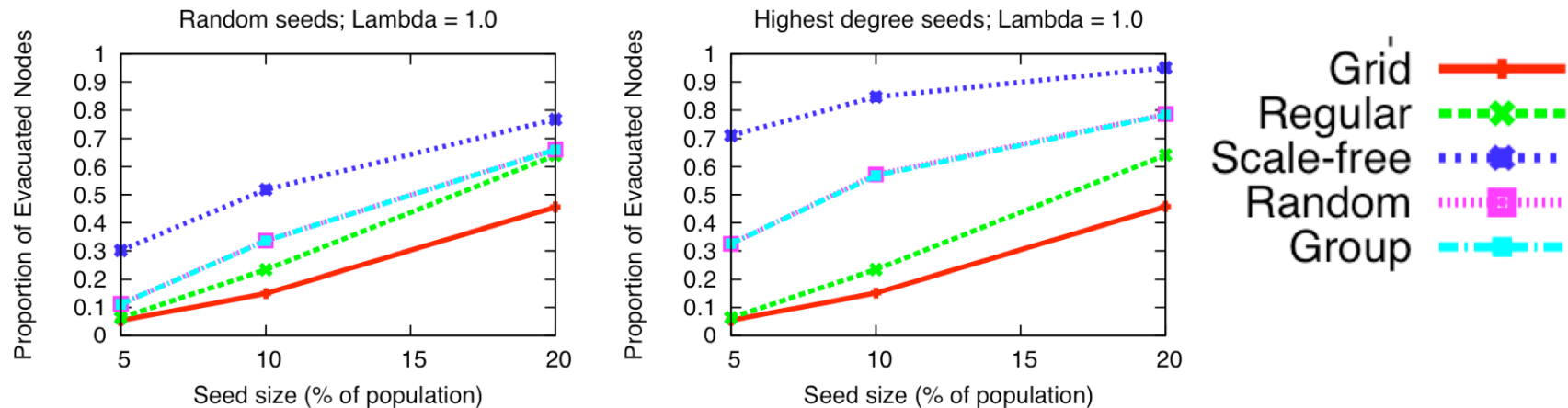
Scenario C: No groups (Random trust)



High
Low

Network Structure and Seeding Mechanism

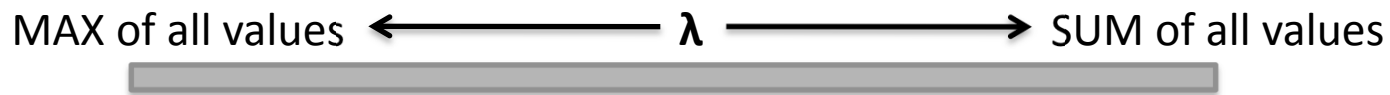
- Effectiveness of the diffusion process depends network structure
- Increasing the seed set size led to larger proportion of evacuated nodes
- Seeding by high degree nodes produced better diffusion than random seed



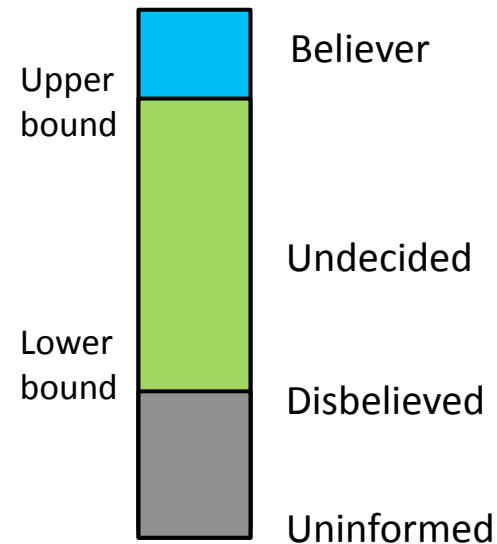
Results from Scenario A: No groups (Equal Trust)

Information Fusion at the Node

- Information fusion parameter λ

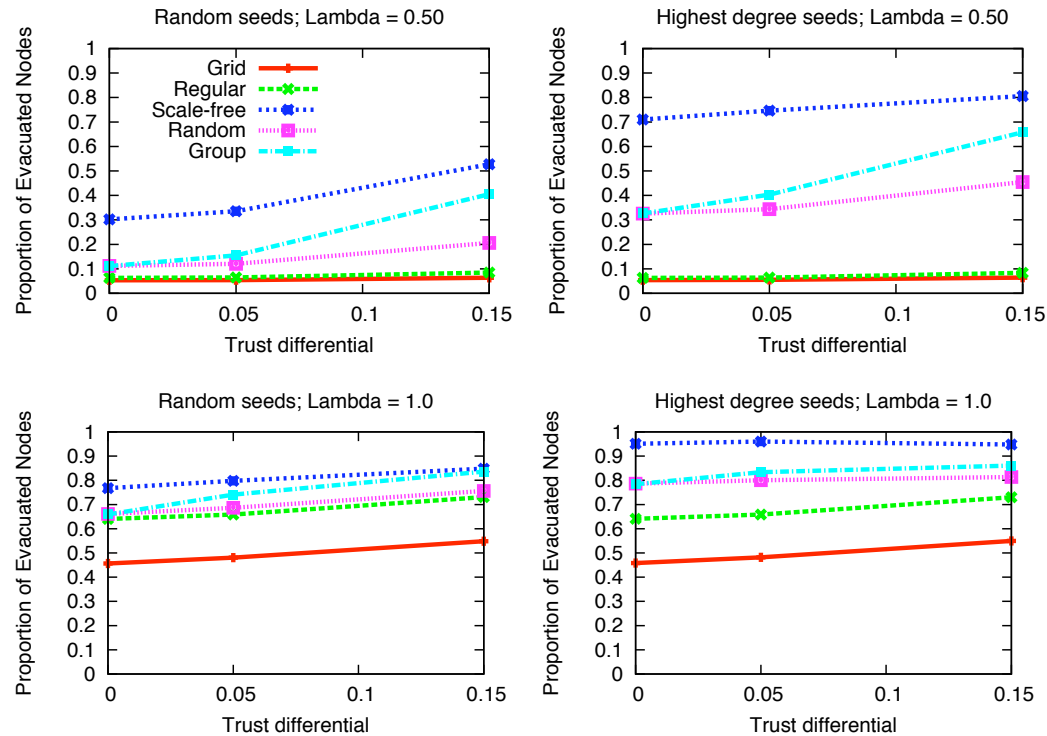


- Treating each source independently and adding their information values results in most effective diffusion
- Value of λ depends on propensity to trust
- Related to:
 - Node thresholds
 - Number of sources
 - Network trust



Trust Scenarios and Differentials

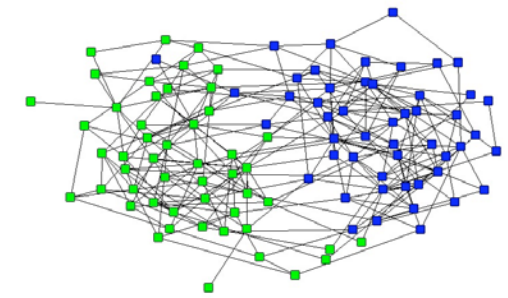
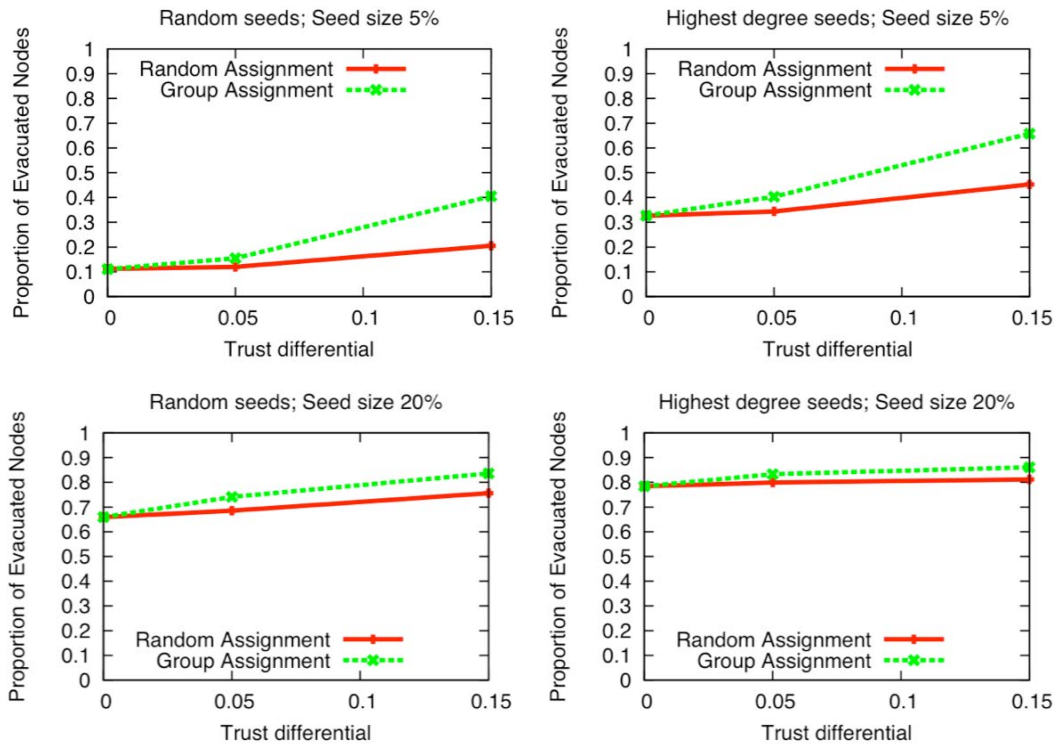
- Having differences in trust promotes the spread of information



Results from Scenario B: Groups with seed size 20%

Random Group Model

- Diffusion was more effective when based on social group than random groups



Group Network

Results for Scenario B: Groups with $\lambda = 1.0$

Ongoing Work

- Investigate impact of group structure
 - Number of groups and group size
 - Connections between groups, within groups
 - Network density, connectivity, cohesion
- Observe effects of access to information sources and trust in information sources
- Investigate interdependencies between model parameters
 - Node thresholds and network trust
- Simulate the broadcast of information over time as opposed to one-time broadcast
- Model changing the desired action by diffusing abort messages

Thanks!

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- **Acknowledgements:** This material is based upon work funded through the Command, Control, and Interoperability Center for Advanced Data Analysis Center of Excellence by a grant from the Department of Homeland Security, Science and Technology Directorate, Office of University Programs, by the U.S. National Science Foundation (NSF) under Grant No. IIS-0621303, IIS-0522672, IIS-0324947, CNS-0323324, NSF IIS-0634875 and by the U.S. Office of Naval Research (ONR) Contract N00014-06-1-0466. The content of this paper does not necessarily reflect the position or policy of the U.S. Government, no official endorsement should be inferred or implied.