Rensselaer

Agent-based Simulation of the Diffusion of Warnings

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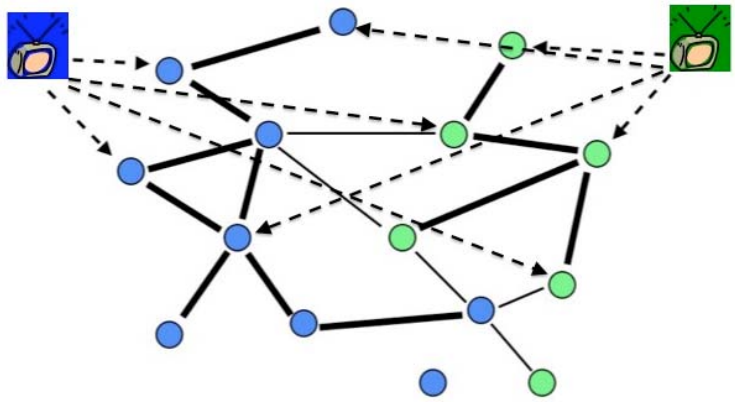
Diffusion of Warnings in Dynamic Networks

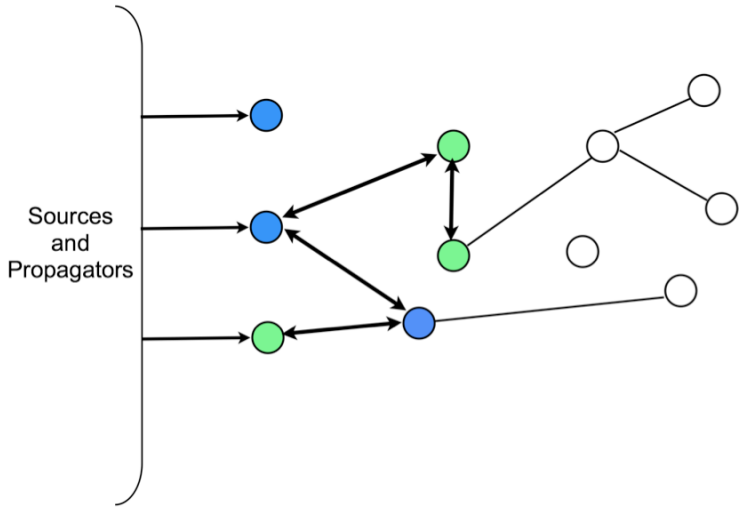
- Diffusion occurs on a network of individuals through interactions between individuals
- Social networks play an important role in diffusion of warnings and warning response
  - Evaluate received information
  - Seek for more information
  - Spread information
  - Exhibit collective behavior
- Network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

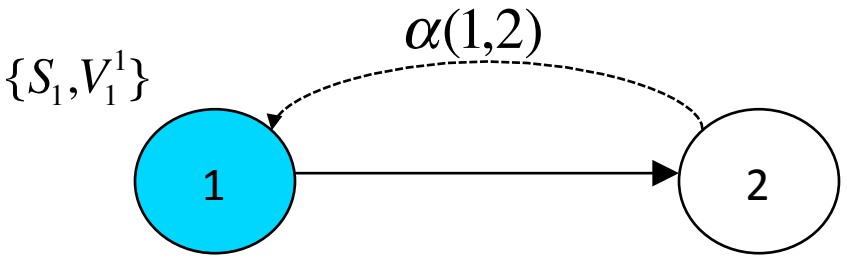


Overview of the Diffusion Model

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)**

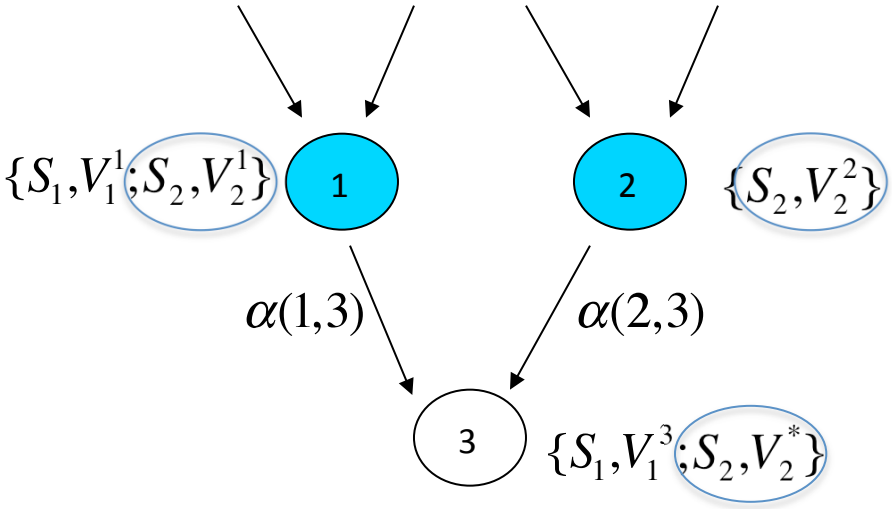




How do nodes process information?

- 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

$$f\,used_k = \lambda * \sum_i V_i^k + (1-\lambda) * \max_i V_i^k$$



Example:

Value of Source S_2 at Node 3:

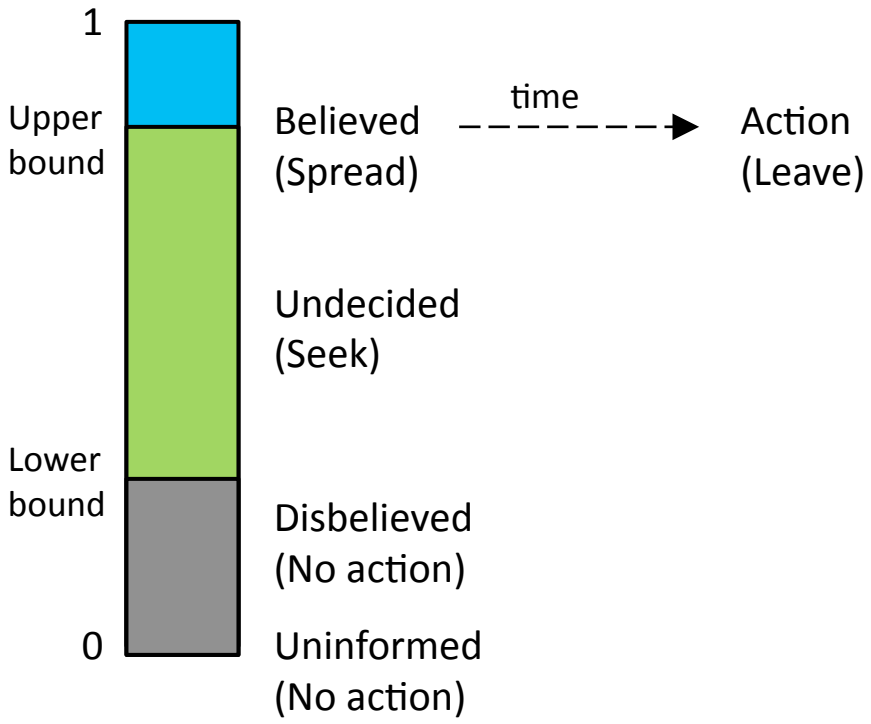
$$\max(V_2^1, V_2^2) \le V_2^* \le V_2^1 + V_2^2$$

Fused value at Node 3:

$$f\,used_3 = \lambda * (V_1^3 + V_2^*) + (1-\lambda) * \max(V_1^3, V_2^*)$$

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.

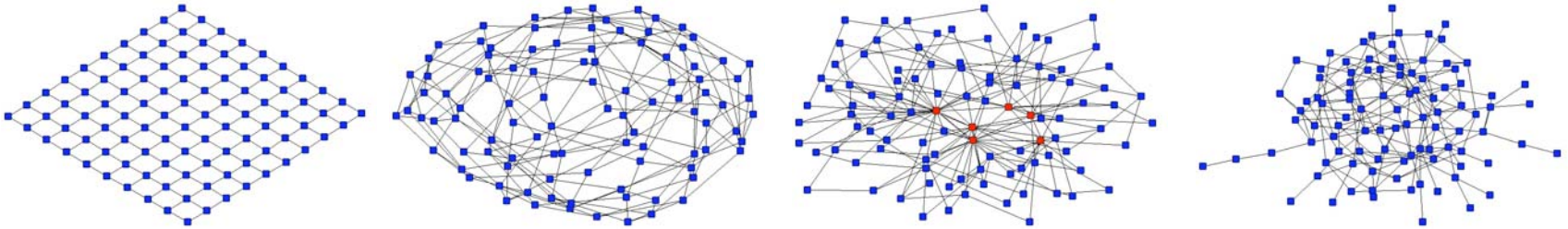


Experiment Details

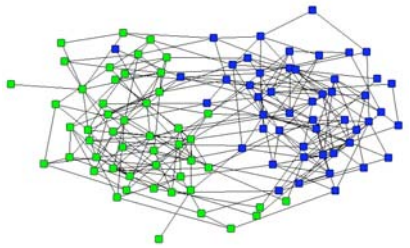
- Observe the diffusion of evacuation warnings in a network of nodes
- Record the proportion of evacuated nodes

Parameters:

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

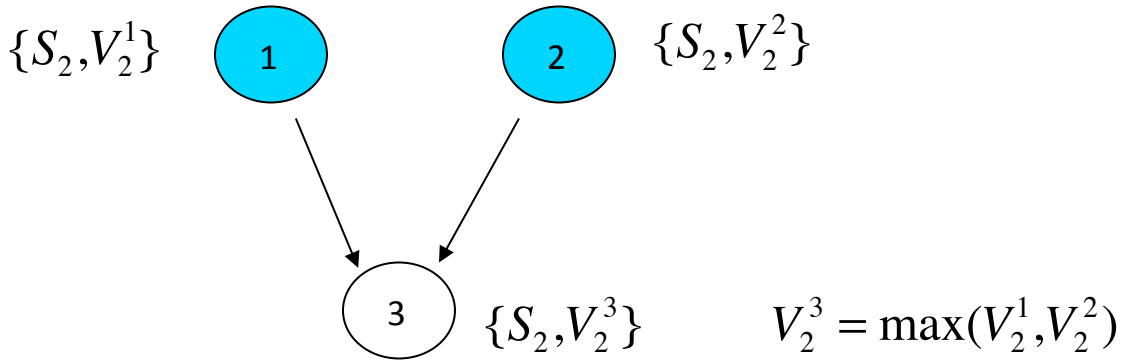


- Broadcast of information
  - 5 information sources with high information value
  - Initial broadcast reaches 5%, 10%, 20% of the population
- Seed set selection
  - Random seed, Highest degree seed

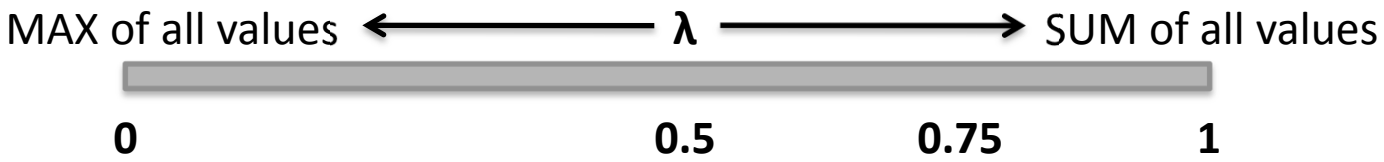


Parameter: Information Fusion λ

- Combine information from messages that originated from the same source

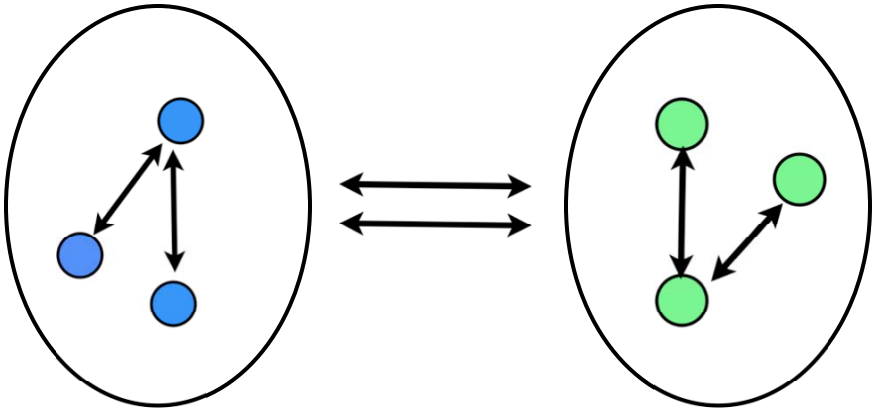


- Compute the fused value at the node (parameter λ= 0.5, 0.75, 1)

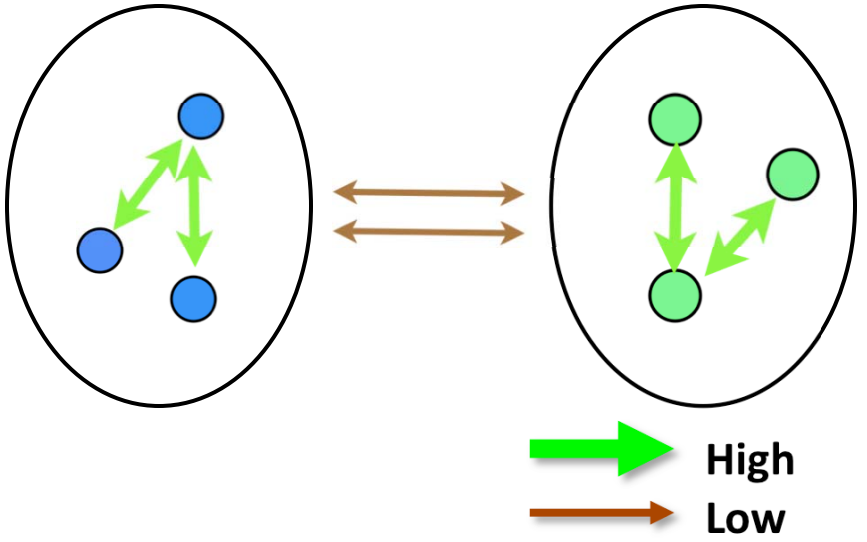


Parameter: Trust Scenarios

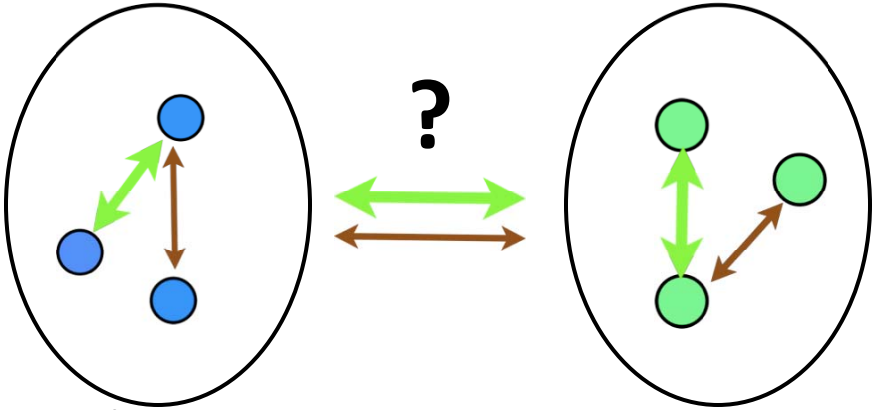
Scenario A: No groups (Equal trust)



Scenario B: Groups
(Higher trust within group)

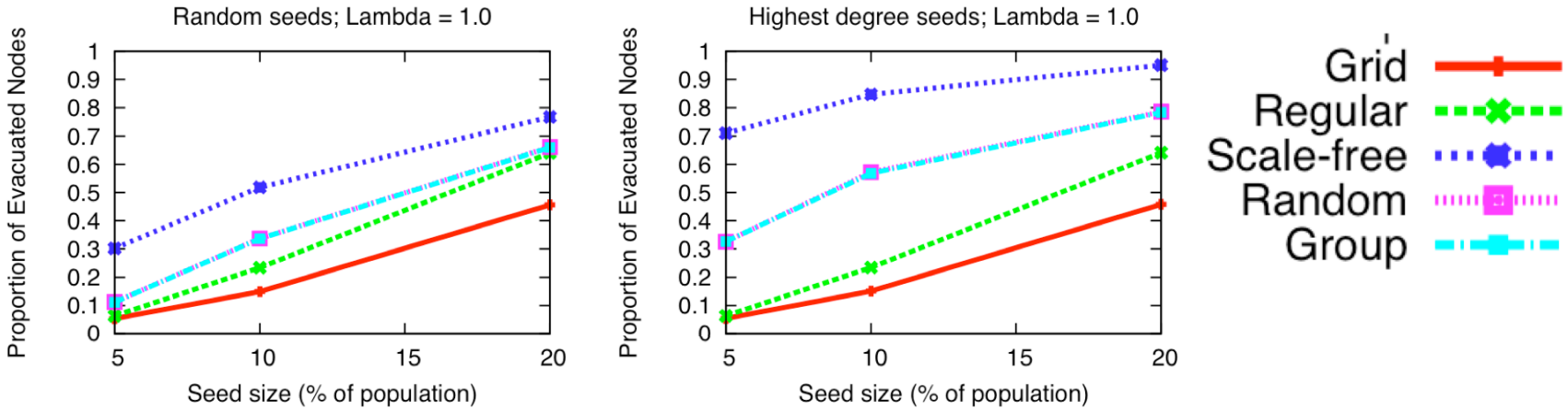


Scenario C: No groups (Random trust)



Network Structure and Seeding Mechanism

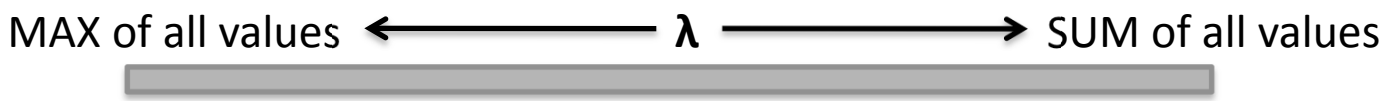
- Effectiveness of the diffusion process depends network structure
- Increasing the seed set size led to larger proportion of evacuated nodes
- Seeding by high degree nodes produced better diffusion than random seed



Results from Scenario A: No groups (Equal Trust)

Information Fusion at the Node

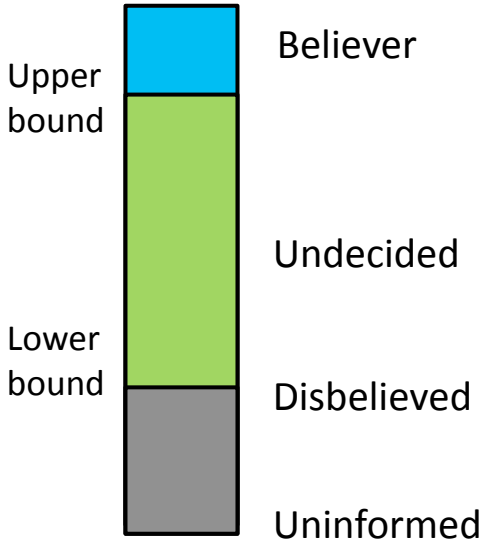
- Information fusion parameter λ



- Treating each source independently and adding their information values results in most effective diffusion

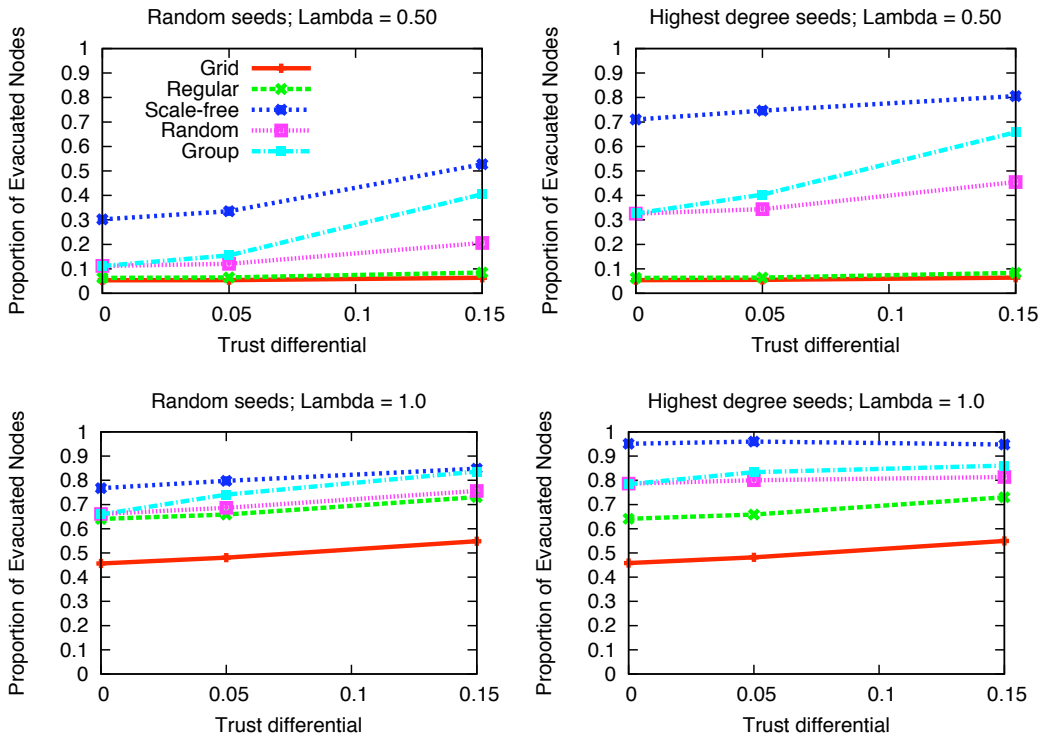
- Value of λ depends on propensity to trust

- Related to:
  - Node thresholds
  - Number of sources
  - Network trust



Trust Scenarios and Differentials

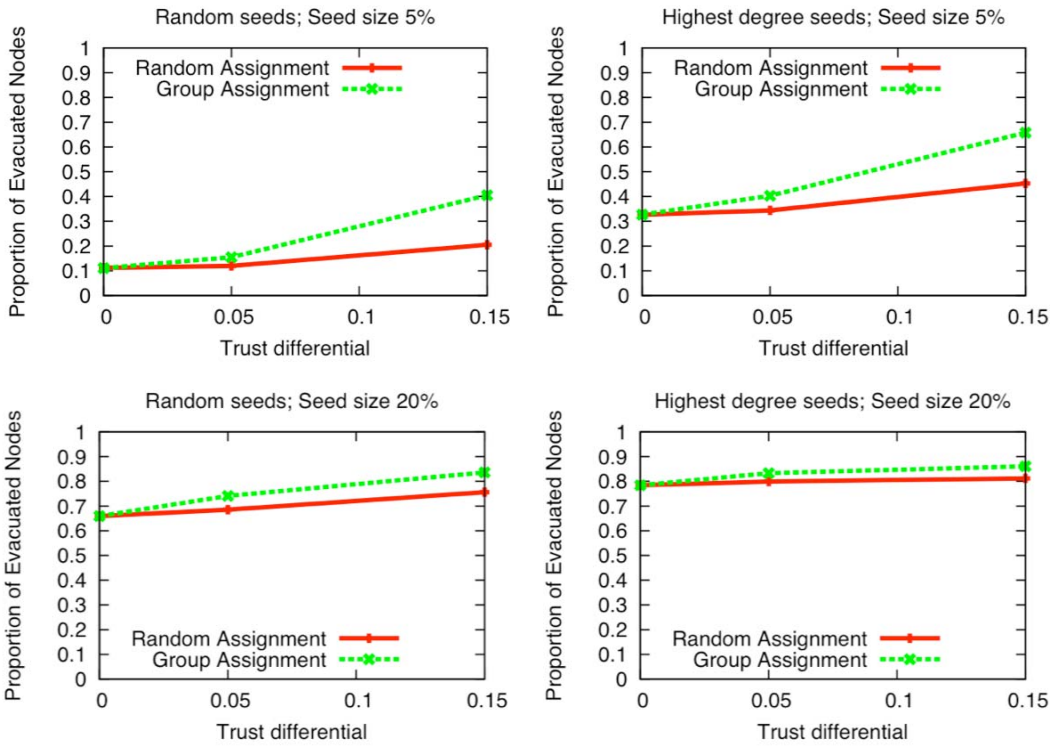
- Having differences in trust promotes the spread of information

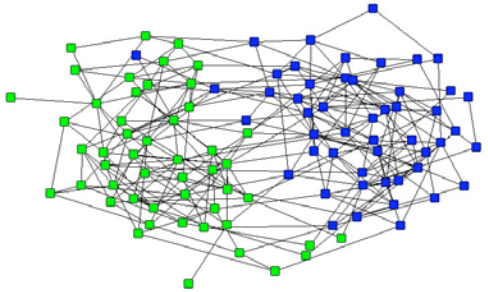


Results from Scenario B: Groups with seed size 20%

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!

- **Contact:**

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