Using Social Network Analysis to Implement Innovations in Healthcare

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on Enhancing Implementation Science

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Acknowledgements

- National Institutes of Health
  - NIAA RC1AA019239
  - NCI: R0110866440

Outline

1) Diffusion and behavior change
2) Network models of diffusion
3) Social influence
4) Network interventions

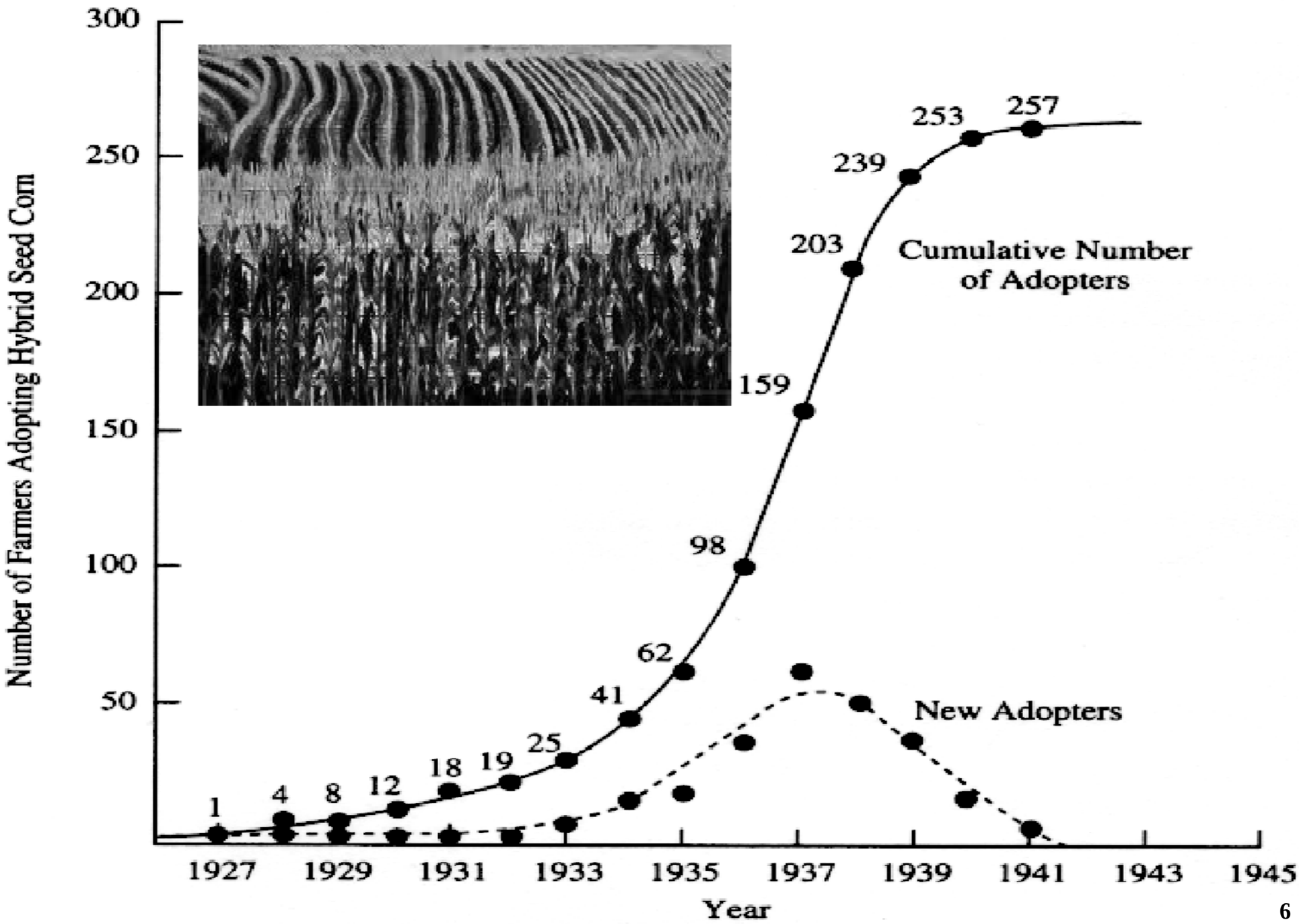
Poll Question:

- How much experience do you have with social network analysis?
  - Minimal (don't know what it is)
  - Some (have read some research on it)
  - Taken a class or workshop
  - Used it a little (have used or seen network research in my work)
  - A lot (have conducted SNA)

How Does Change Happen?

New ideas and products enter a system from some external source (person, media, technical change) and then spread through interpersonal contact.

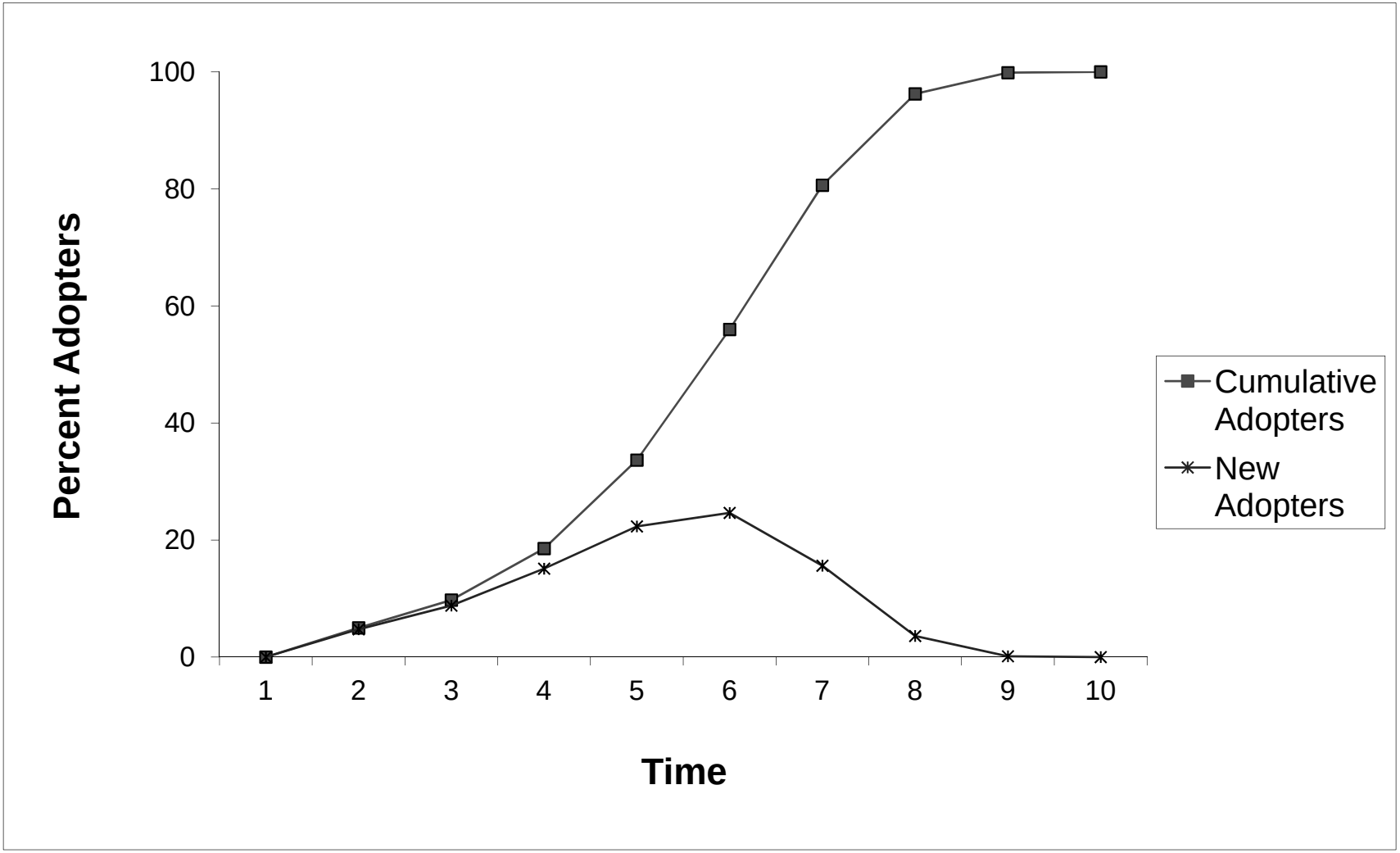
Figure 7–1. The Number of New Adopters Each Year, and the Cumulative Number of Adopters, of Hybrid Seed Corn in Two Iowa Communities



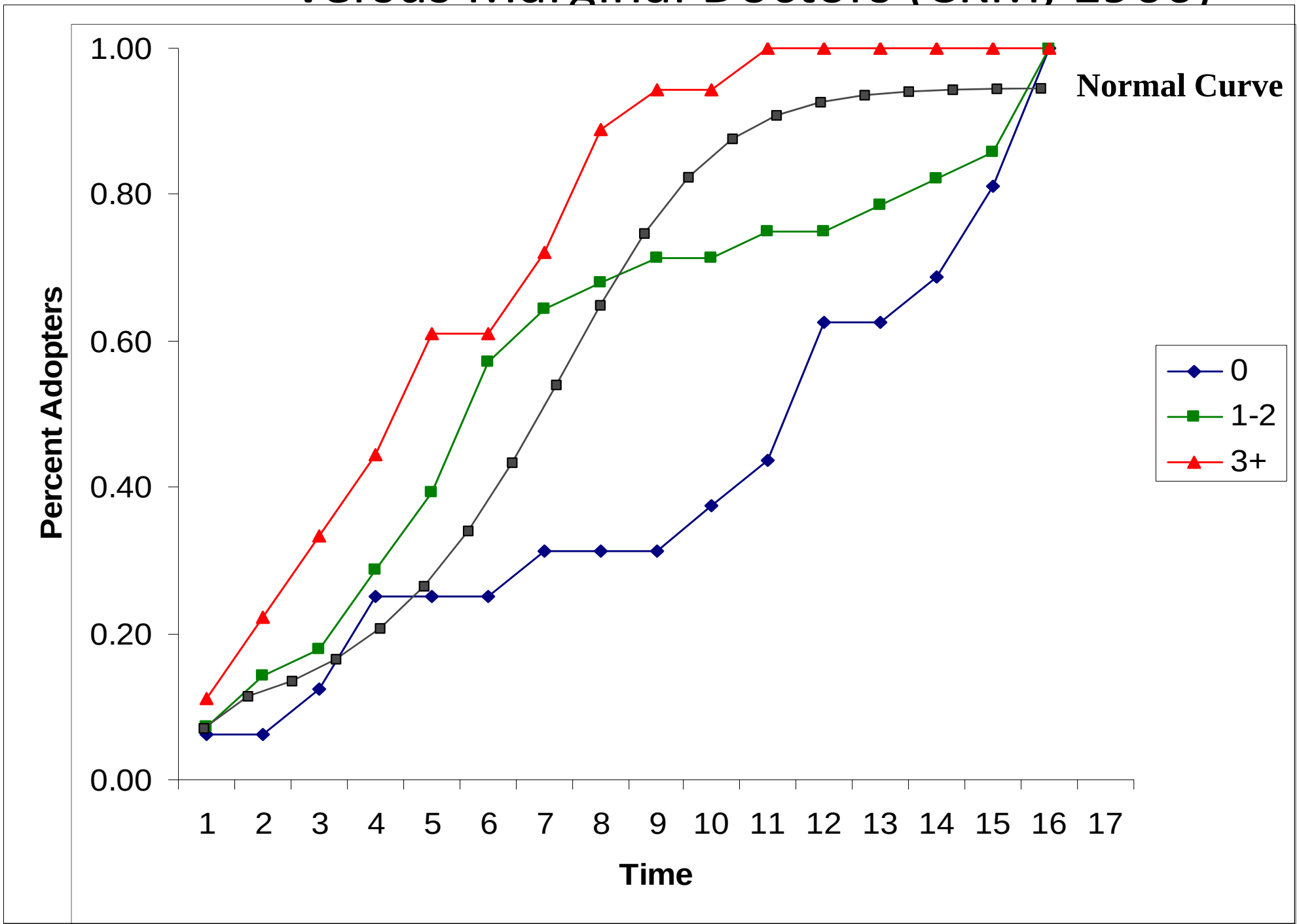
Hypothetical Diffusion When Adopters Persuade Non-adopters at a Rate of One Percent (Homogenous or Random Mixing)

Time	Cumulative	Non-adopters	Rate	New Adopters
1	0.00	100.00	0.01	
2	5.00	95.00	0.01	4.75
3	9.75	90.25	0.01	8.80
4	18.55	81.45	0.01	15.11
5	33.66	66.34	0.01	22.33
6	55.99	44.01	0.01	24.64
7	80.63	19.37	0.01	15.62
8	96.25	3.75	0.01	3.61
9	99.86	0.14	0.01	0.14
10	100.00	0.00	0.01	0.00

Diffusion for Random Mixing



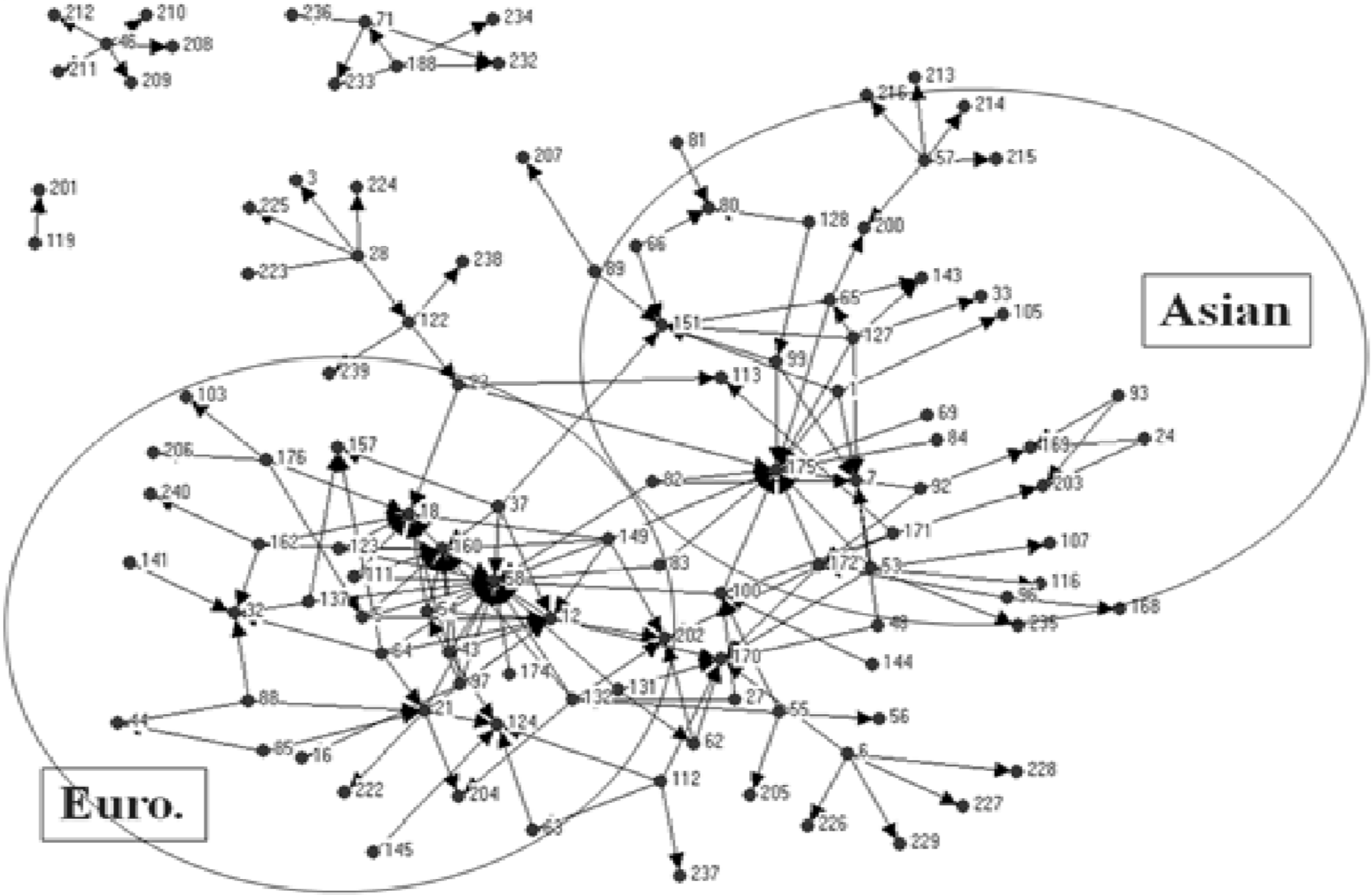
Diffusion of Tetracycline for Integrated versus Marginal Doctors (CKM, 1966)



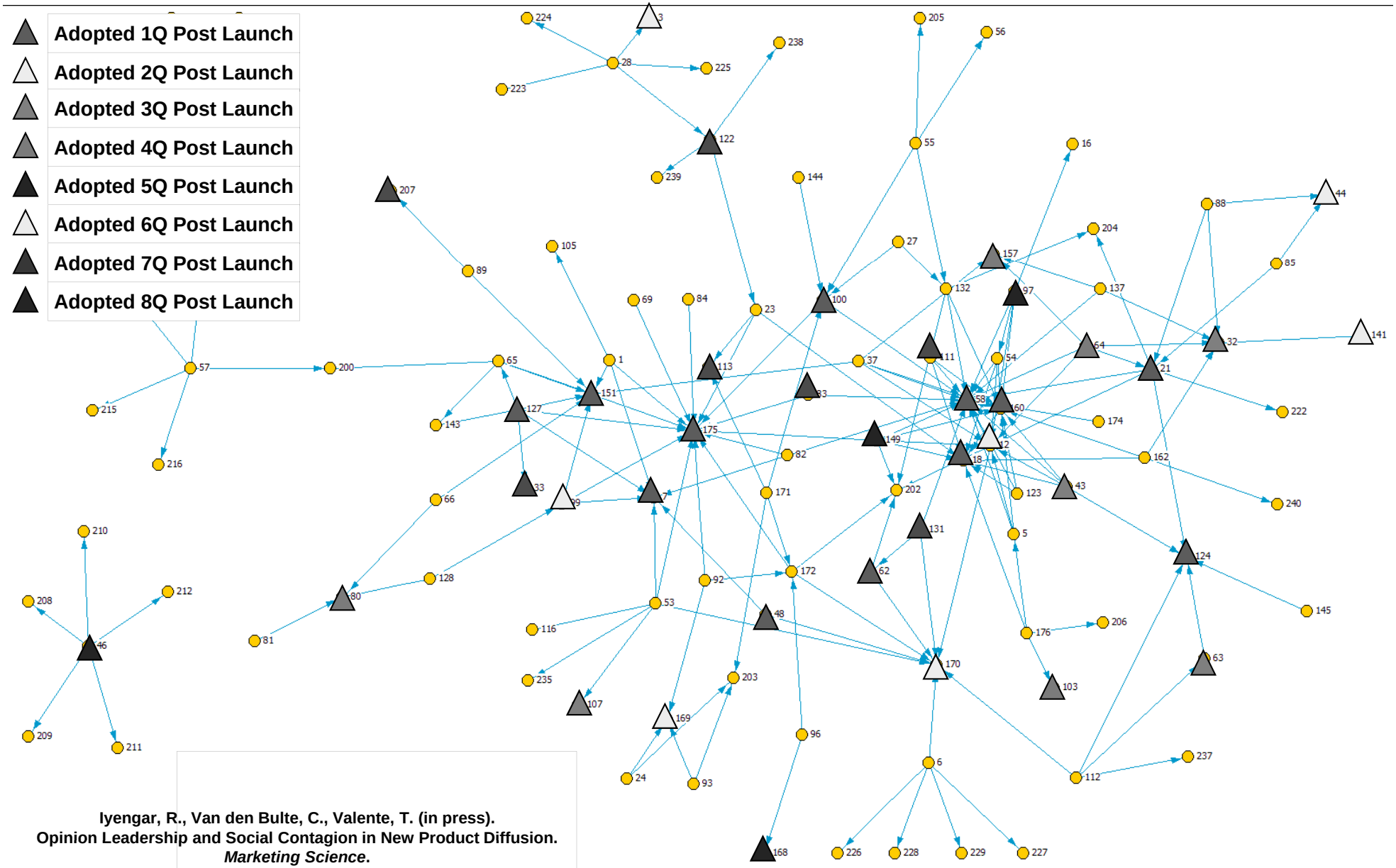
Opinion leadership and contagion in new product diffusion. Marketing Science.

- Iyengar, R., Van den Bulte, C. & Valente, T. W. (2011).
- Data on discussion and referral ties in 3 cities: SF, LA & NY
- Prescribing data from product launch out 3 years

Discussion Network for SF



Network Effect on Product Adoption

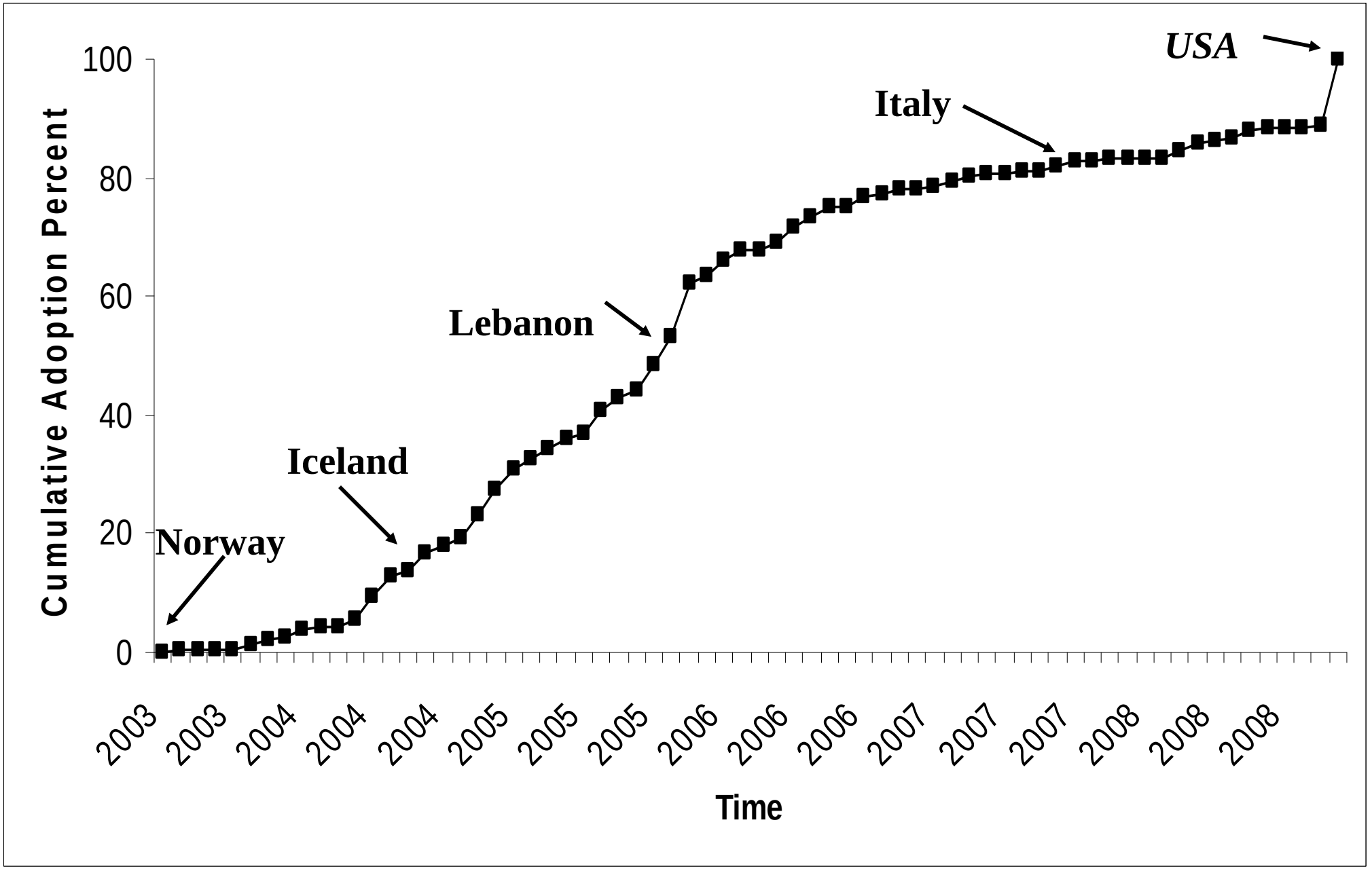


Iyengar, R., Van den Bulte, C., Valente, T. (in press).
Opinion Leadership and Social Contagion in New Product Diffusion.
Marketing Science.

Sociometric v. Self Reported OL

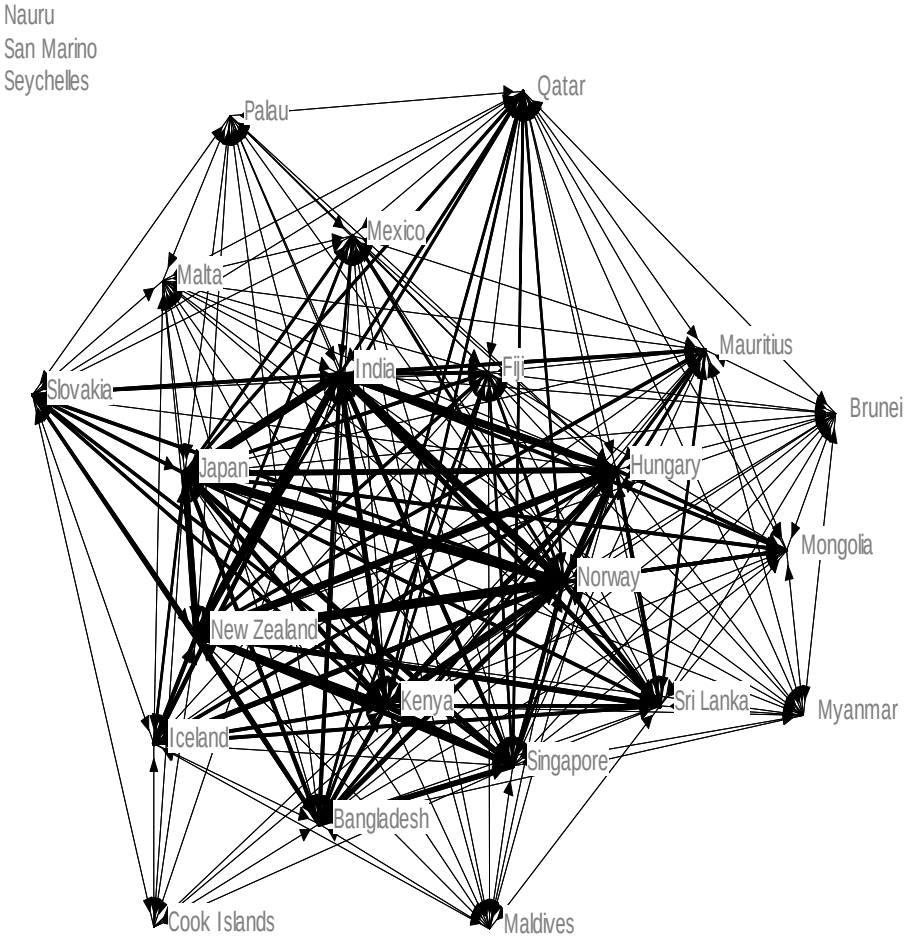
- Correlated at approximately 0.43 ($p<0.01$)
- Self reported OLs less susceptible to peer influence
- Sociometric OLs no more or less susceptible

Diffusion at Policy Level
Country Ratifications of FCTC

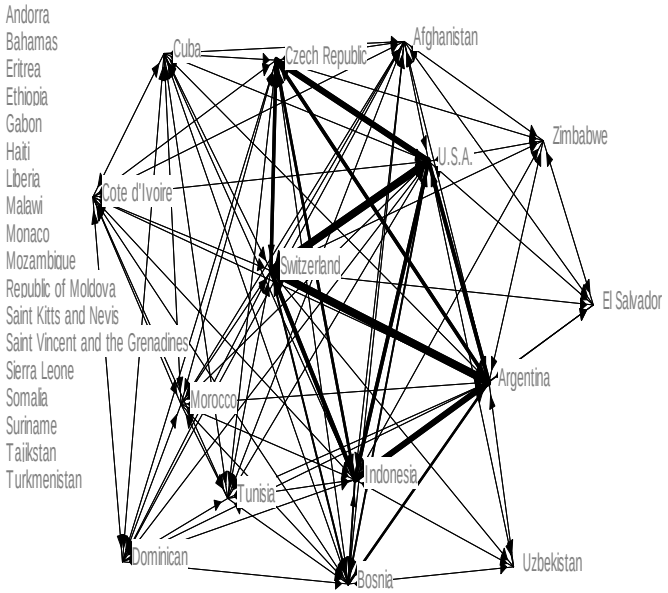


Co-membership on Globalink

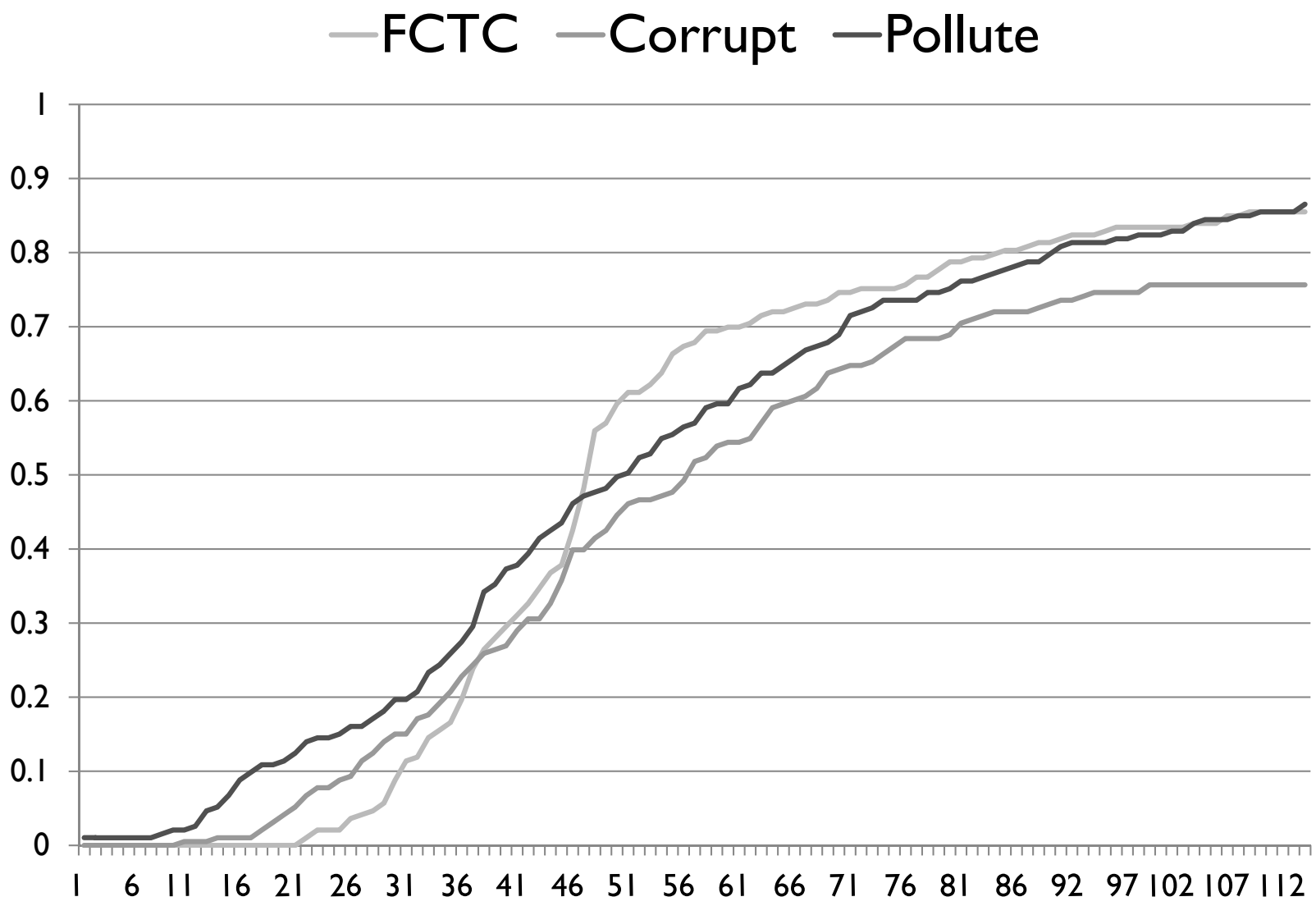
Earliest (15.5%)



Non-Ratifiers (17.1%)



3 Treaties Diffused 2001-2010



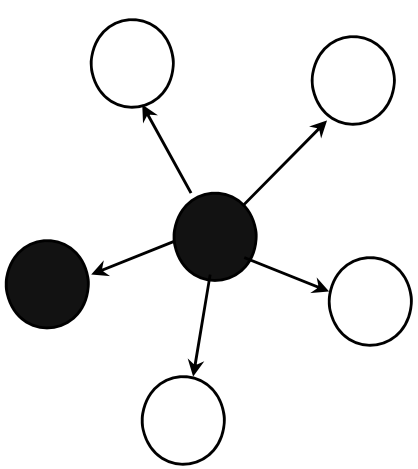
Social Influence

- Primarily from interpersonal networks

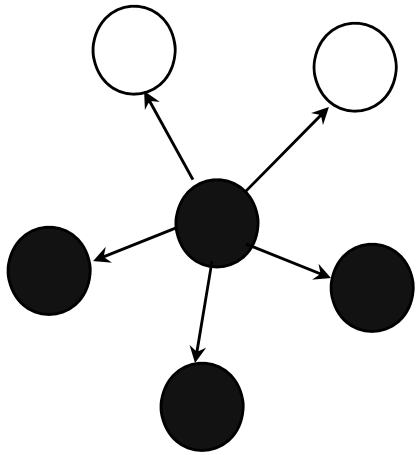
Network Exposure

= *Non User*

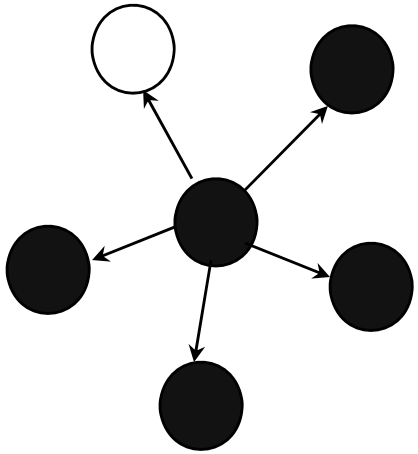
= *User*



Network Exposure=20%



Network Exposure=40%

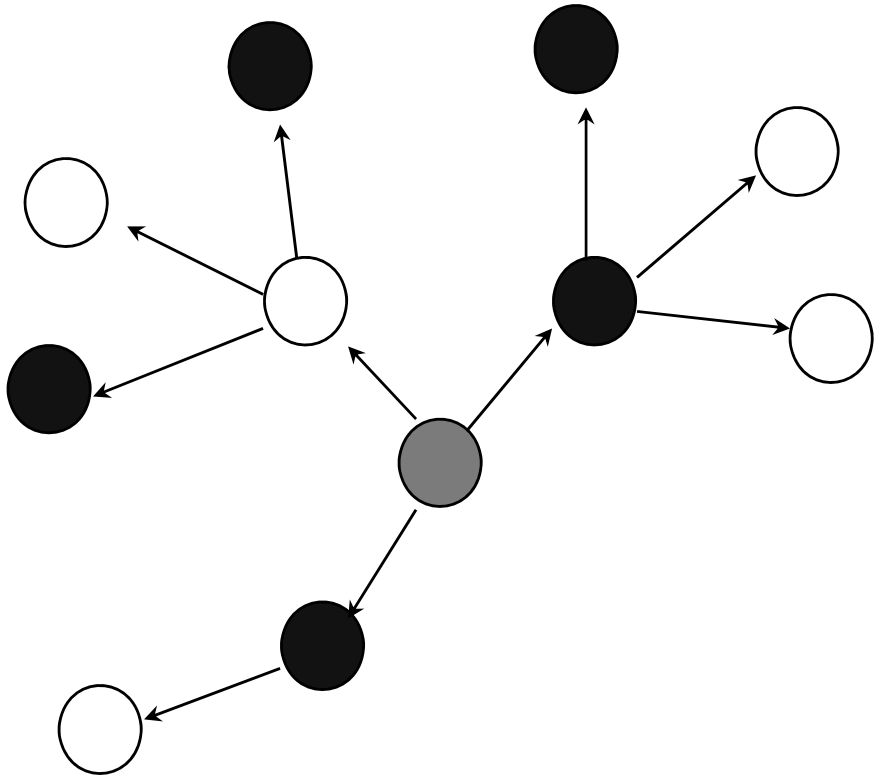


Network Exposure=80%

Network Exposure: Indirect Ties

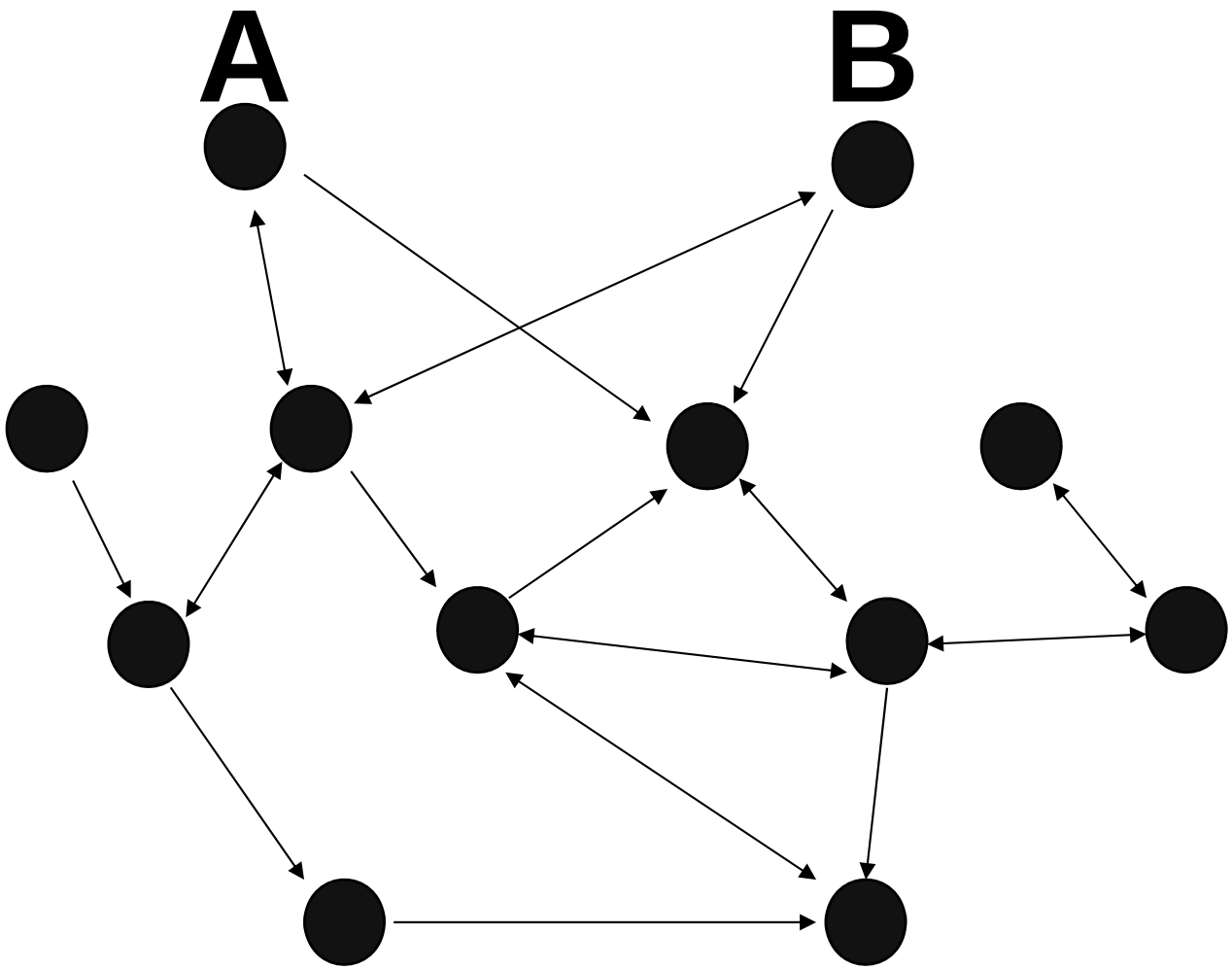
= *Non User*

= *User*



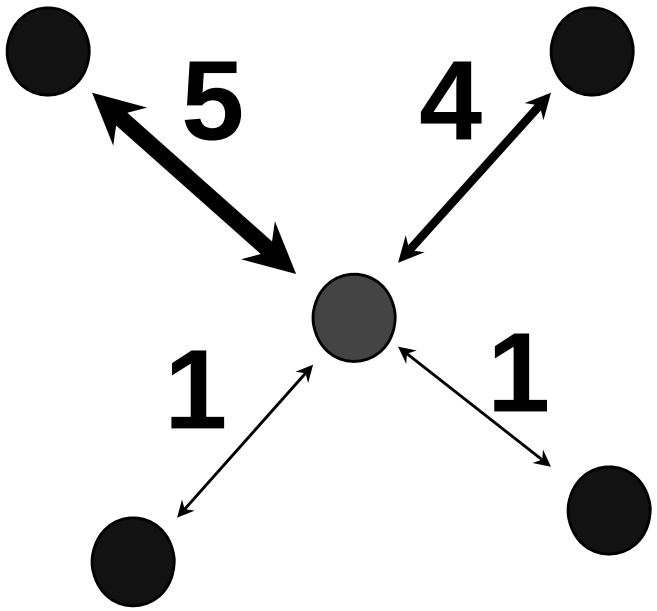
PN Exposure=54.7%

Network Exposure: Structural Equivalence

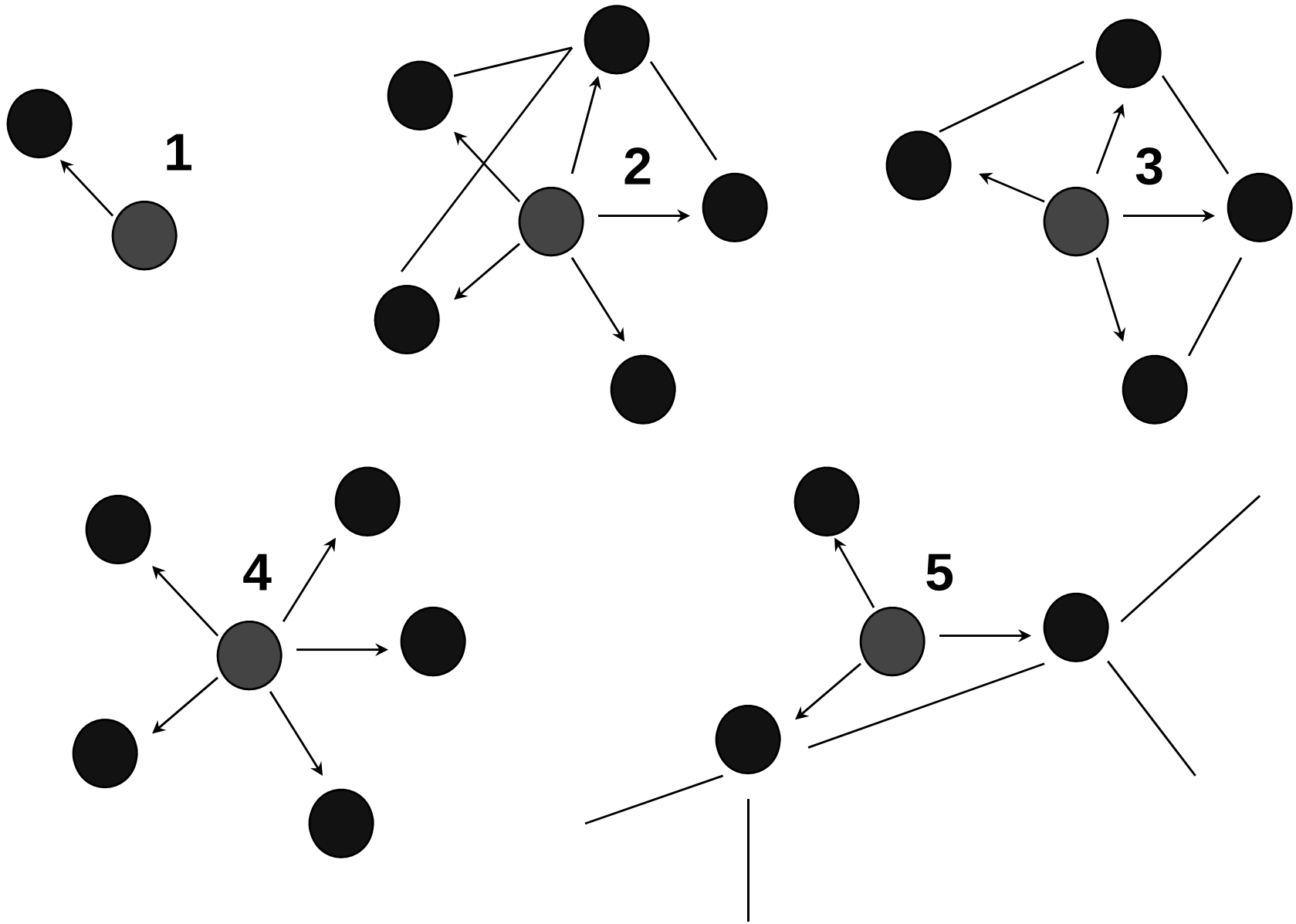


Network Exposure: Tie Strength

Influence is Stronger for Stronger (Closer)Ties

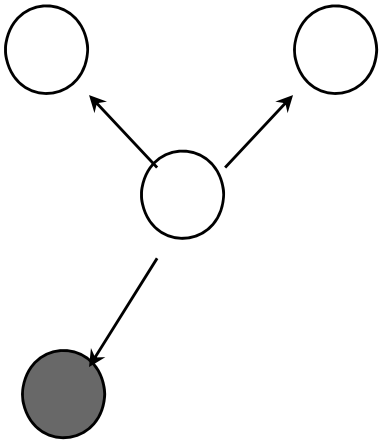


Network Exposure: Constraint

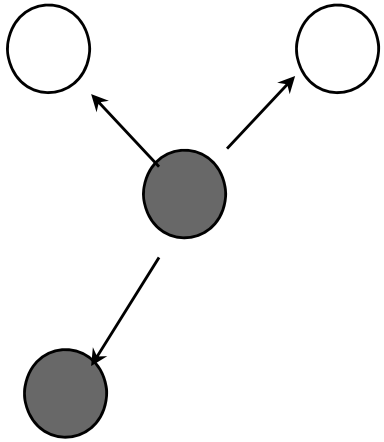


Network Thresholds

= Non-FP User ***= FP User***

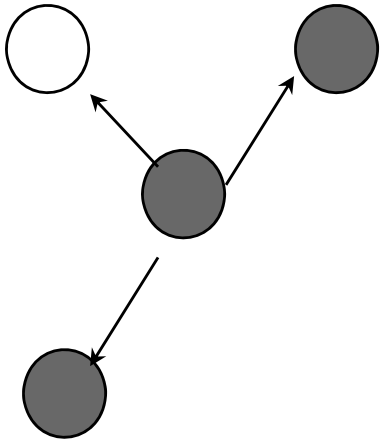


PN Exposure=33%



PN Threshold=33%

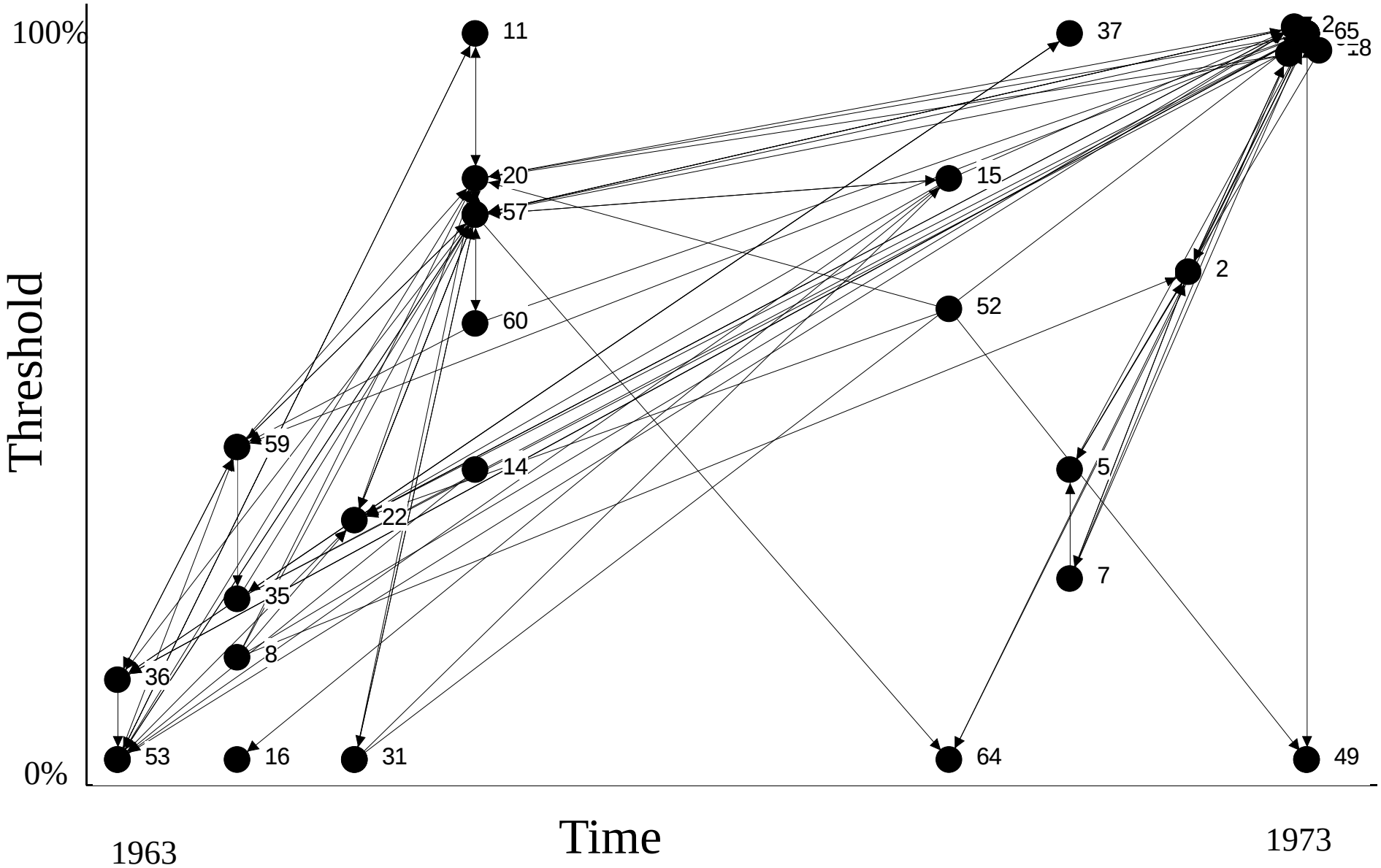
Low Threshold Adopter



PN Threshold=66%

High Threshold Adopter

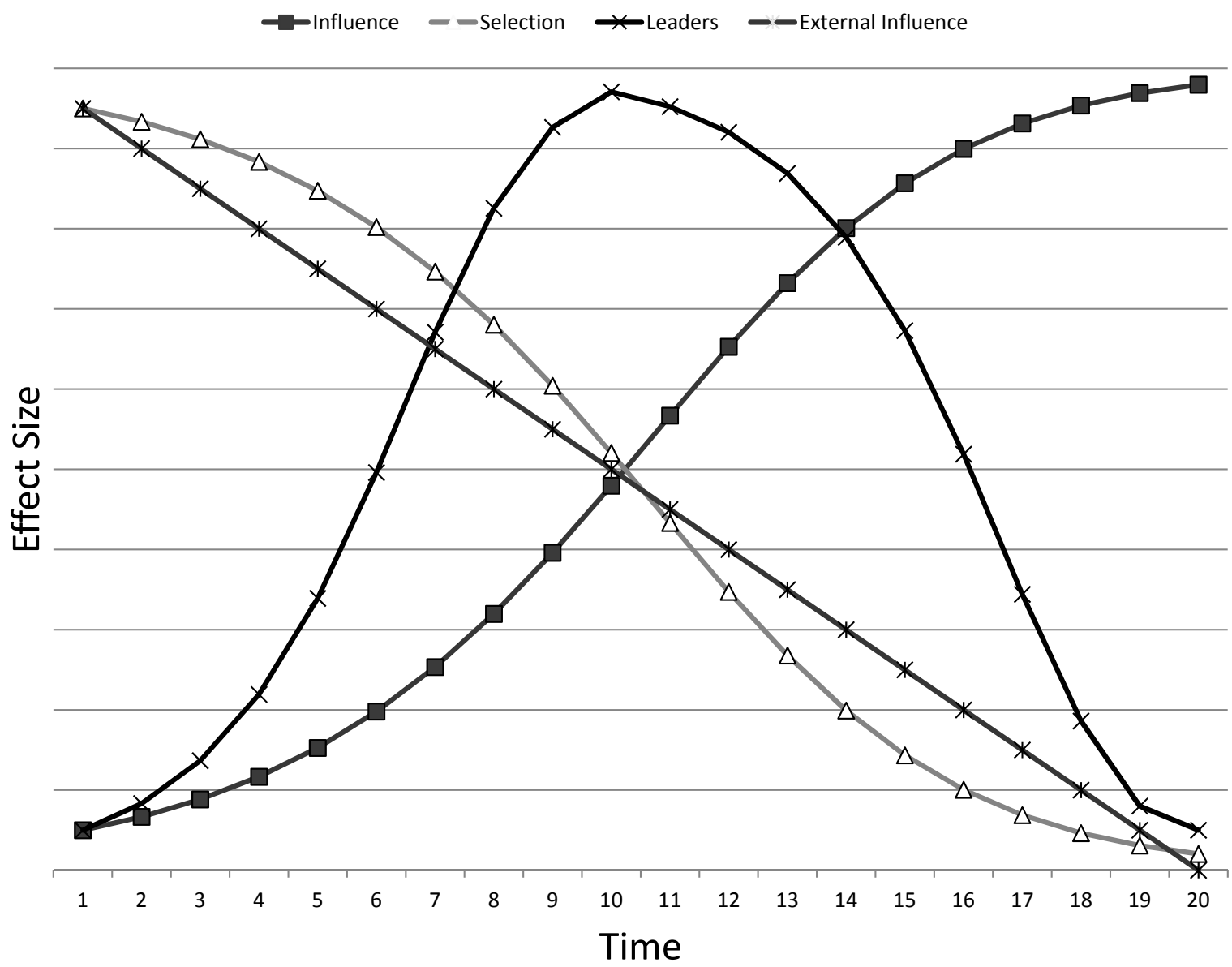
Graph of Time of Adoption by Network Threshold for One Korean Family Planning Community



Network Influence Weightings

1. Direct influence
2. Indirect ties
3. Structural equivalent ties
4. Tie strength (e.g., best friends)
5. Simmelian ties
6. Density weighted
7. Degree weighted (or other centrality measures)
8. Attribute weighted (boy friends)
9. Selection effects
10. Thresholds

Dynamic Estimation of Diffusion Effects



Dynamic Estimation

- External influence decreases as the number of available network influences increase.
- Network exposure influence increases with prevalence.
- Selection effects decrease
- Opinion leader influences vary being modest in the beginning peaking at mid-point then decreasing

An alternative:

- Construct network interventions
  - Manipulate networks
  - Test their influence under laboratory and real-world conditions;
  - Improve organizational performance and public health outcomes.

Network Interventions: Accelerating Change

Defining:

- Using network data to change behaviors
- Change individual and community/organizational level
- Network interventions are any change program that uses network data to:
  - Select change agents
  - Define groups
  - Affect network structure
  - Assist behavior change program implementation

Principle 1: Program Goals Matter

- In some cases want to increase cohesion in others increase fragmentation
- Increase/decrease centralization
- E.g., slowing spread of STDs requires different strategy than accelerating adoption of office automation
- Network Interventions Are not Agnostic to Content.

Principle 2: Theory

- The type of change desired will be guided by theory (e.g., changing behaviors or attitudes).
- Understanding motivations for and barriers against behavior change is critical.
- A well-articulated theory of the behavior is often critical for successful interventions.

Principle 3: Learn As Well As Induce

- The interventionist should use network methodology to learn from the community as much as try to influence it.
- Programs which meet the needs of their audiences are better received than those designed asymmetrically.

Network Interventions, Valente, Science, 2012

Strategy	Tactic	Operationalization
Identification	Leaders Bridges Key Players Peripherals Low Thresholds	Degree, Closeness, etc. Mediators, Bridges Positive, Negative Proportions, Counts
Segmentation	Groups Positions	Components, Cliques Structural Equivalence, Hierarchies
Induction	WOM Snowball Matching	Random Excitation RDS, Outreach Leaders 1st, Groups 1st
Alteration (Manipulation)	Deleting/Adding Nodes Deleting/Adding Links Rewiring	Vitality On Cohesion, Others On Network, On Behavior

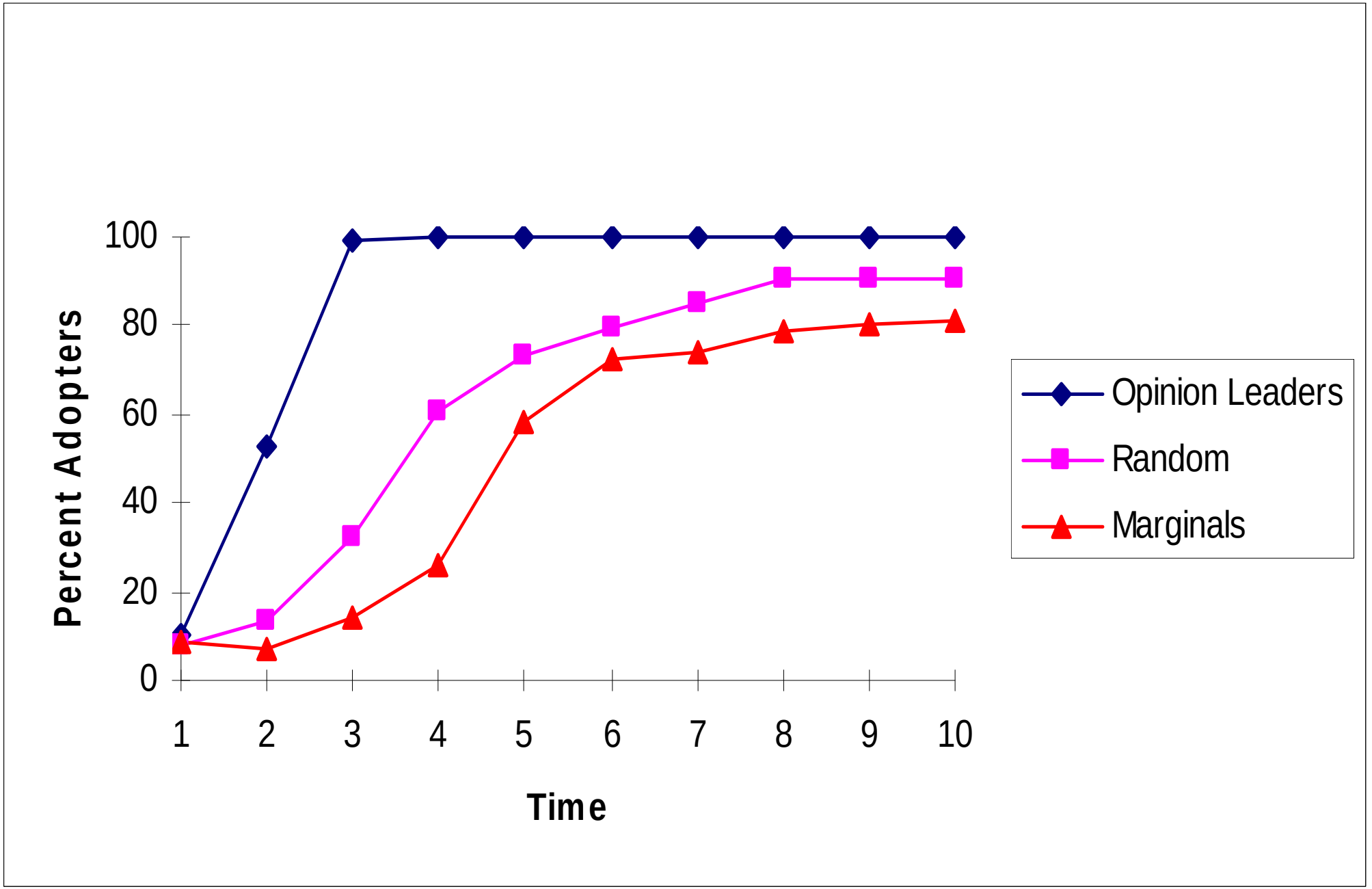
1. Identify Key Change Agents Using Network Data

- Many different network positions can be identified :
  A. Leaders
  B. Key Players
  C. Bridges
  D. Marginals – Peripherals – Isolates
  E. Low threshold adopters

1. Opinion Leaders

- The most typical network intervention
- Easy to measure
- Intuitively appealing
- Proven effectiveness
- Over 20 studies using network data to identify OLs and hundreds of others using other OL identification techniques

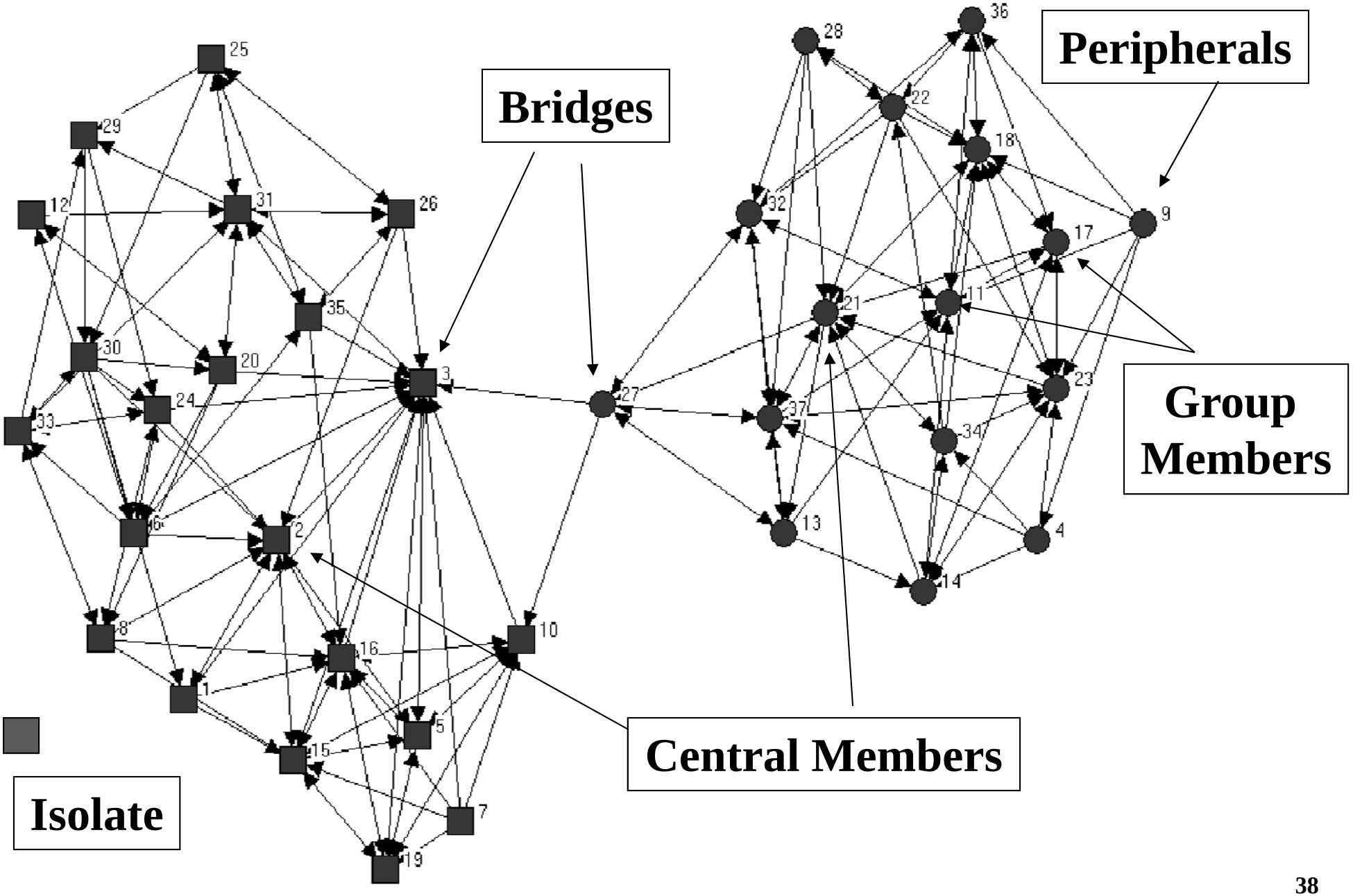
Diffusion Network Simulation w/ 3 Initial Adopter Conditions



Work with Opinion Leaders

- Identify them
- Recruit them
- Convert them (if need be)
- Use them
- Valente & Pumpuang (2007) identified 20 sociometric studies using OLs for behavior change

Network Positions



Network Interventions

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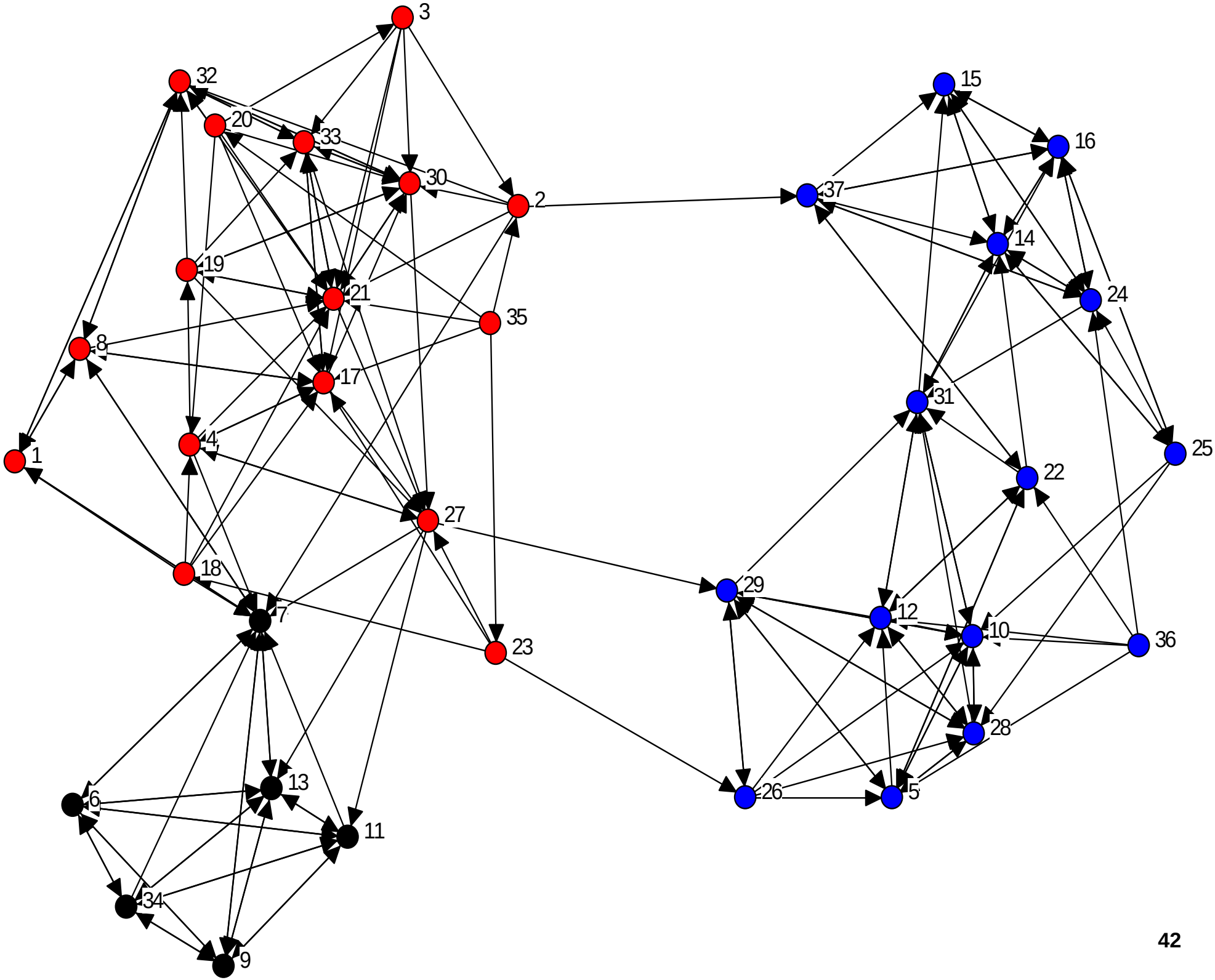
2. Segmentation

- Intervention is directed toward or includes a whole group of people
- Segmentation interventions identify and expect a whole group to adopt the innovation at the same time

Groups

- Sets of people/nodes that are densely connected
- Groups can reinforce (or inhibit) the behavior change process
- Behavior change may be appropriate for groups
- There are many network methods used to find groups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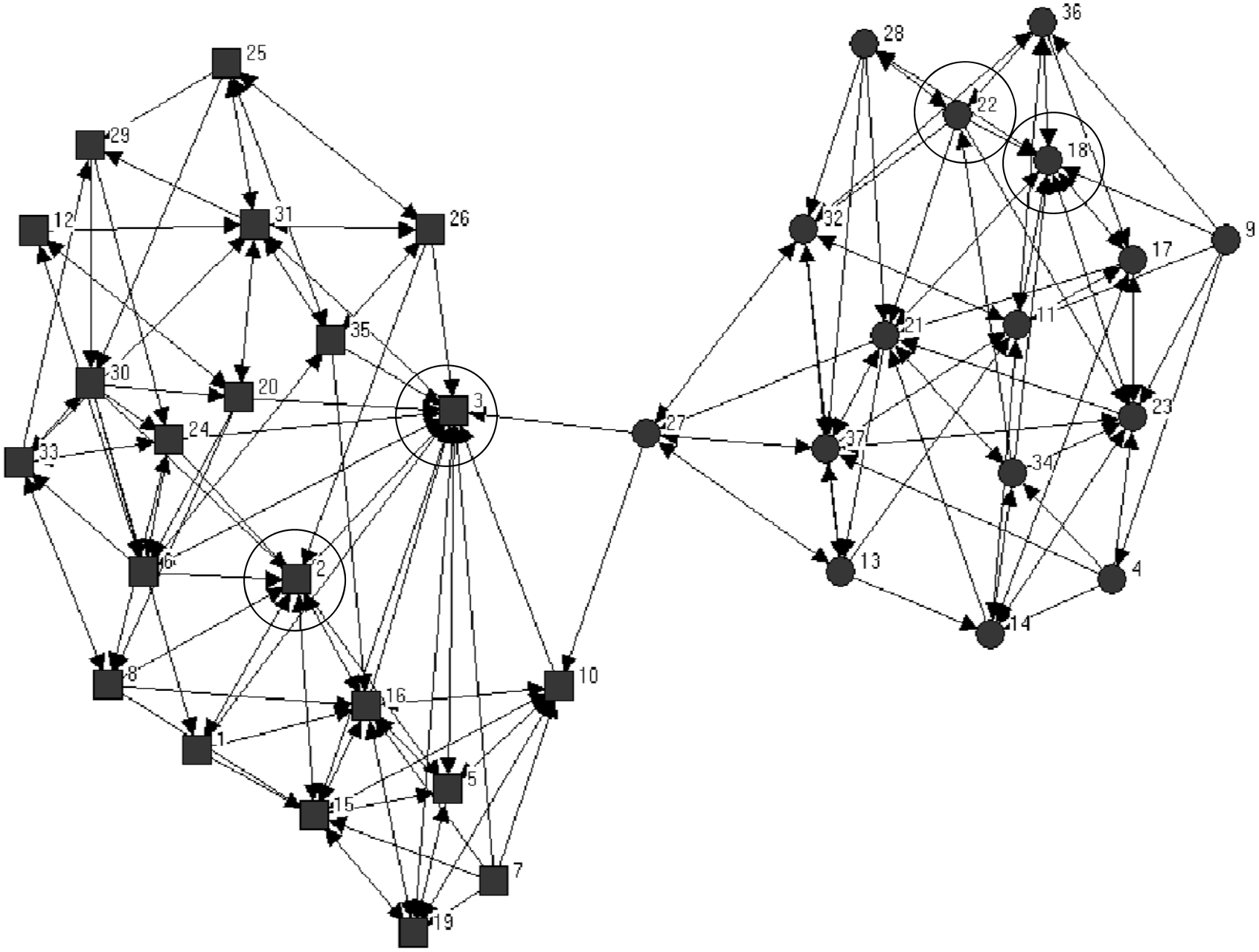
3. Induction: Matching Leaders to Groups

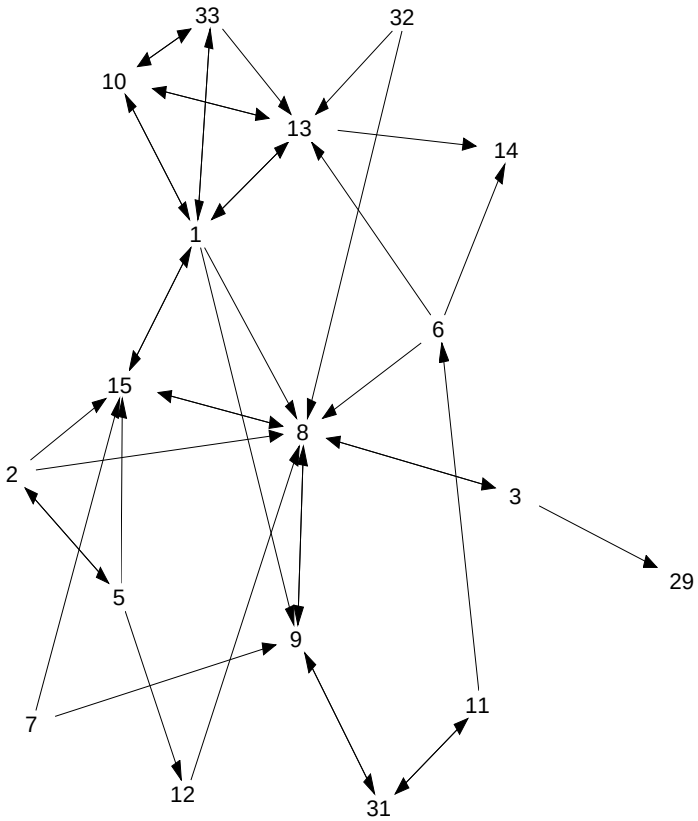
- Rather than have leaders unattached, assign them to people who think they are leaders
- Leadership is local
- Emphasizes homophily between leaders and members
- Builds on naturally occurring networks
- Leaders can be more effective if assigned to those who nominate them

Network Influence is Proximal



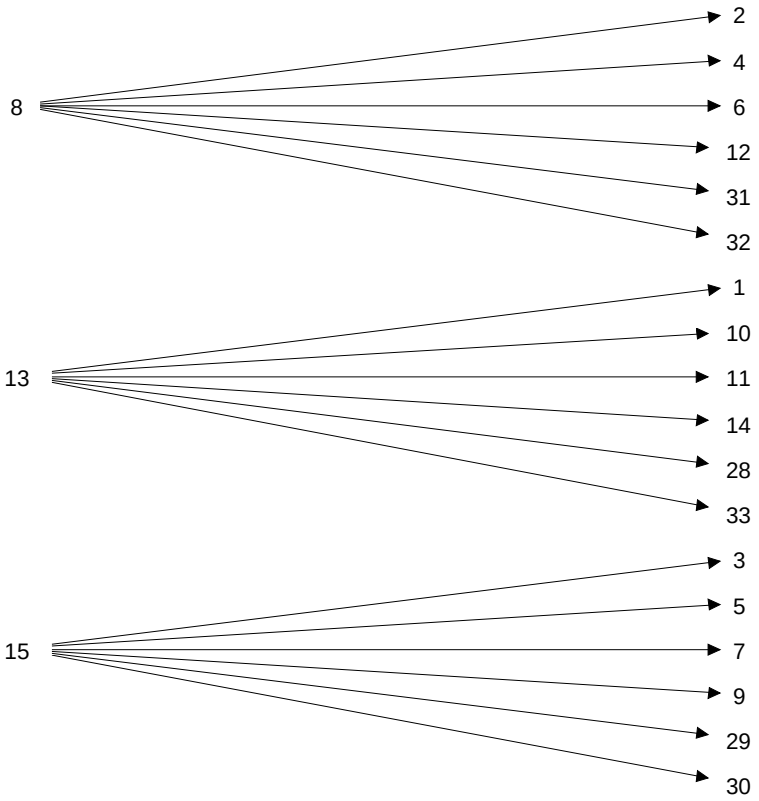
Matching Leaders to Groups

Sociogram based on ties



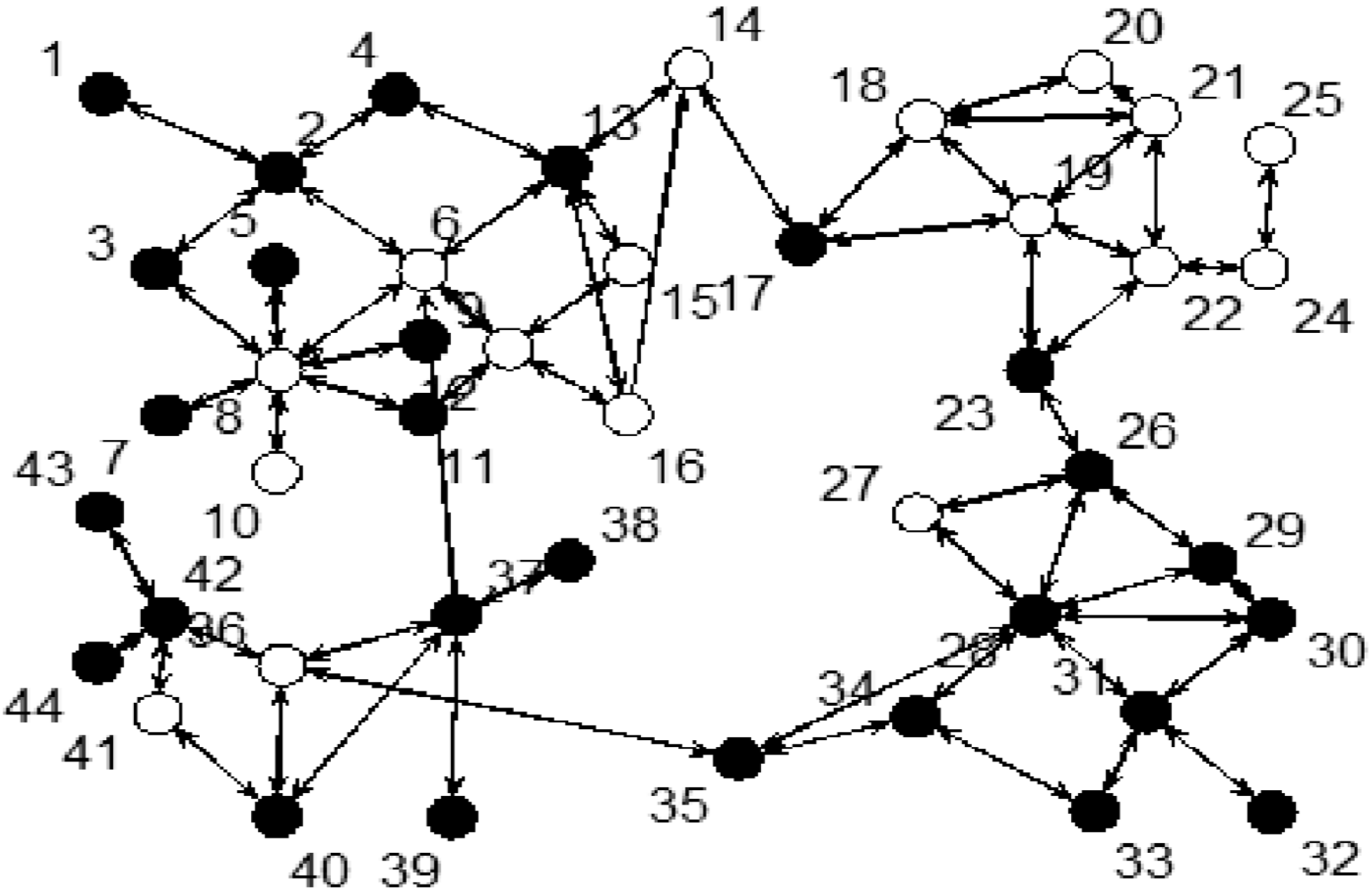
1(a)

Optimal leader/learner matching



1(b)

Hypothetical Network for Graphical Displays



Network Interventions

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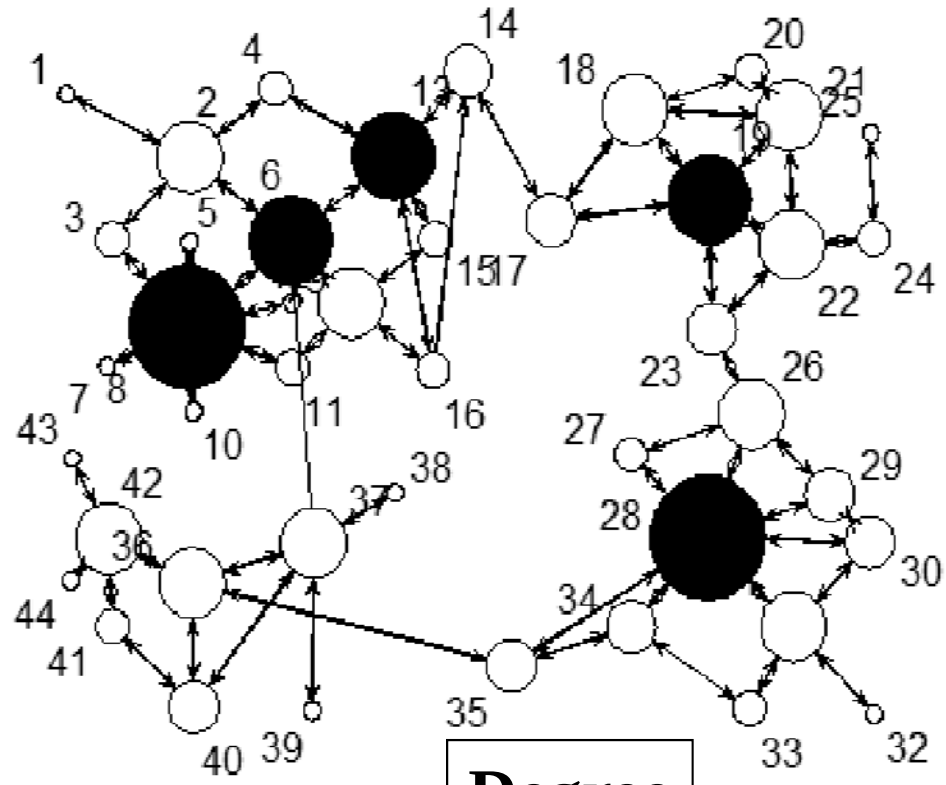
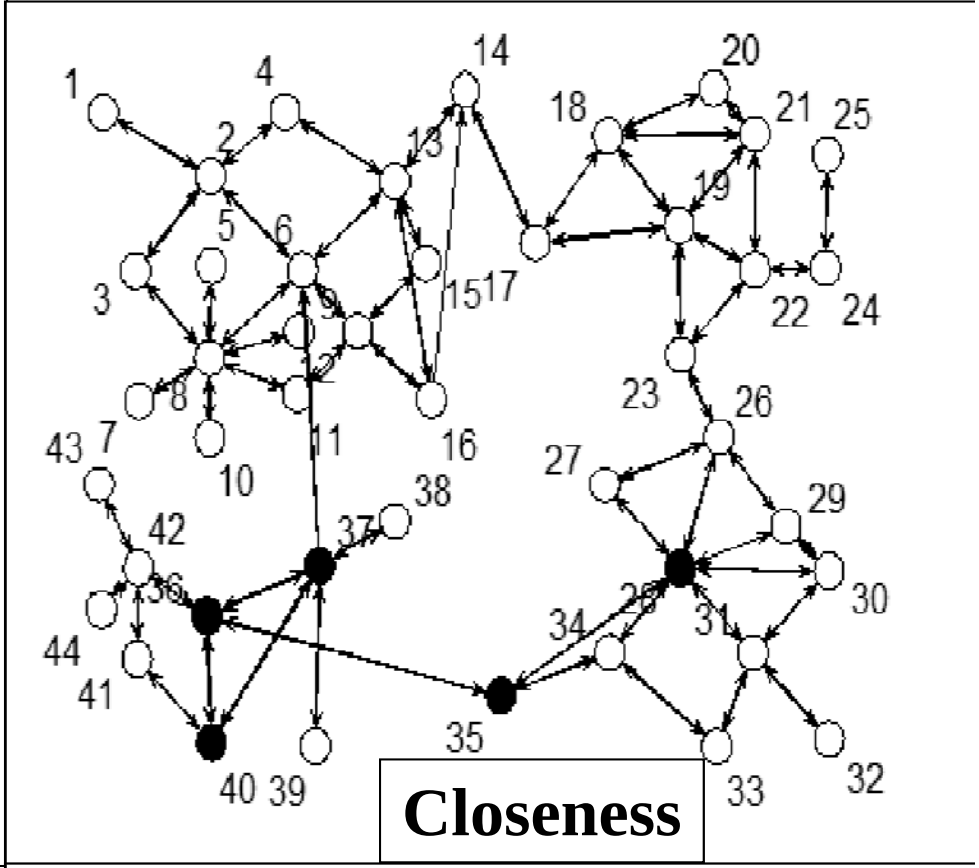
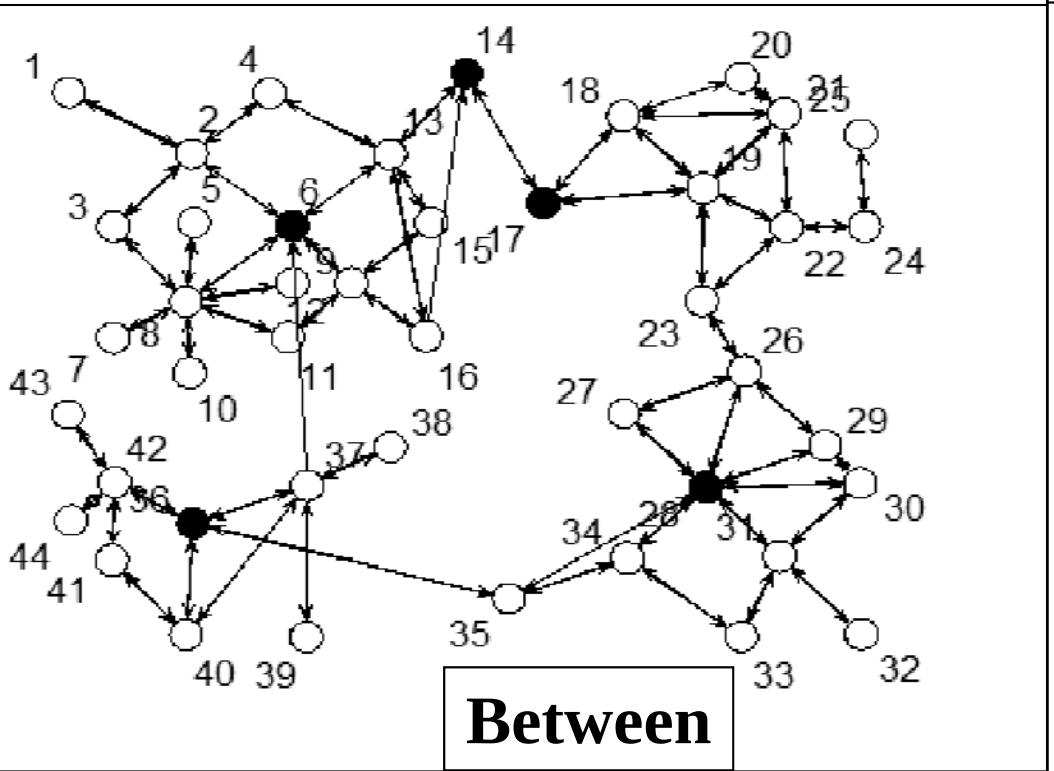
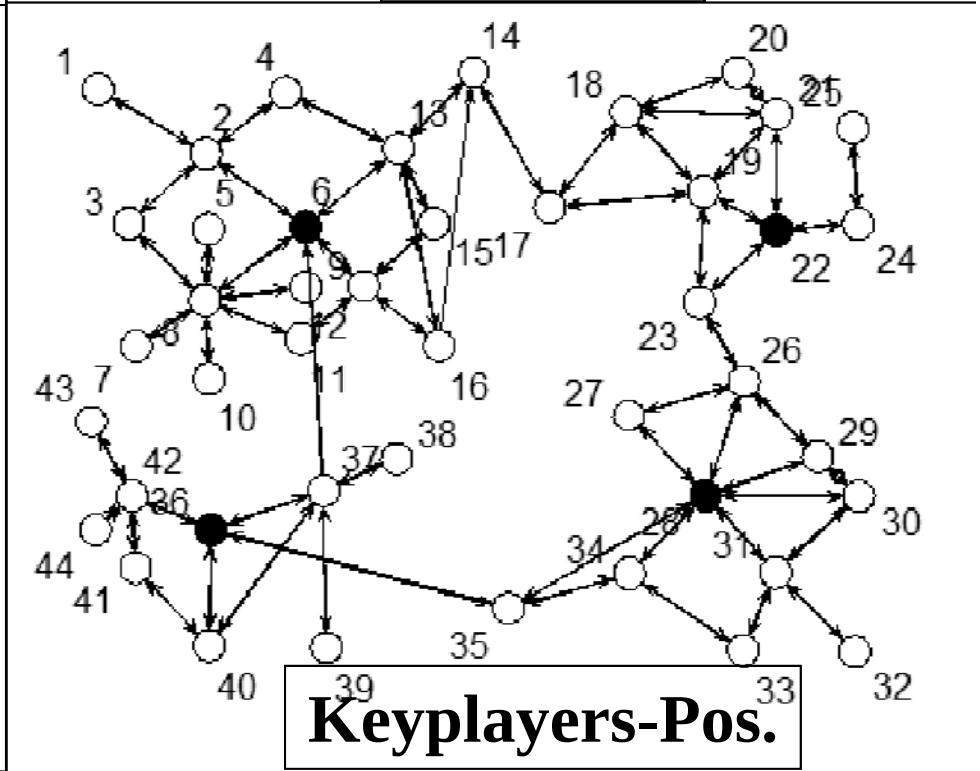
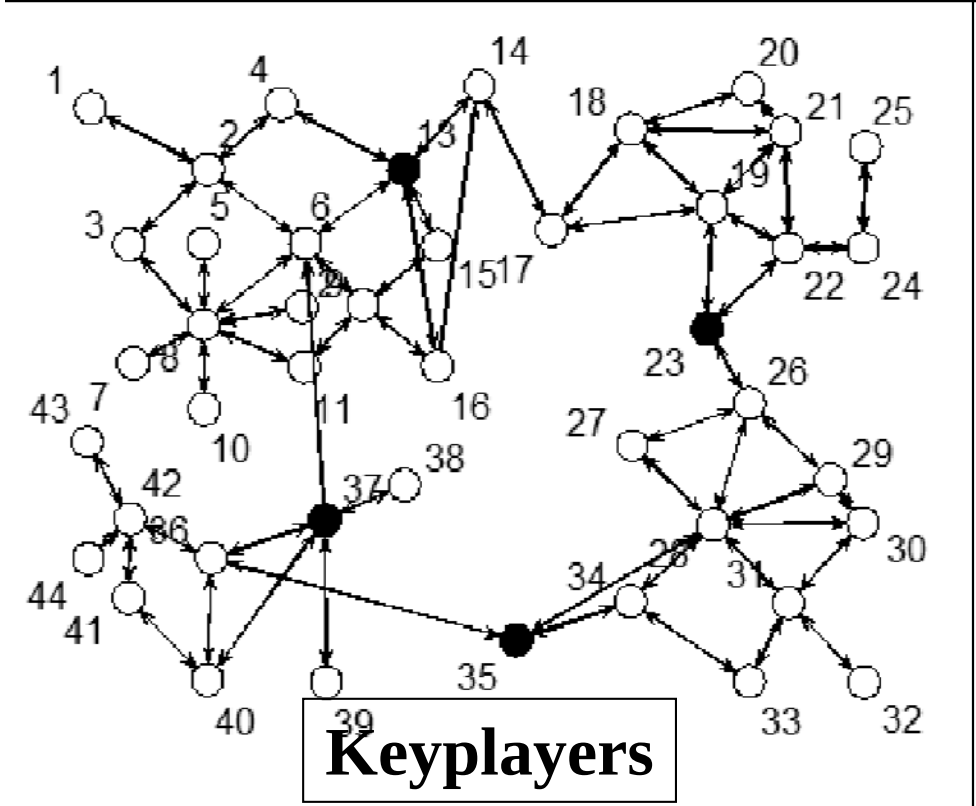
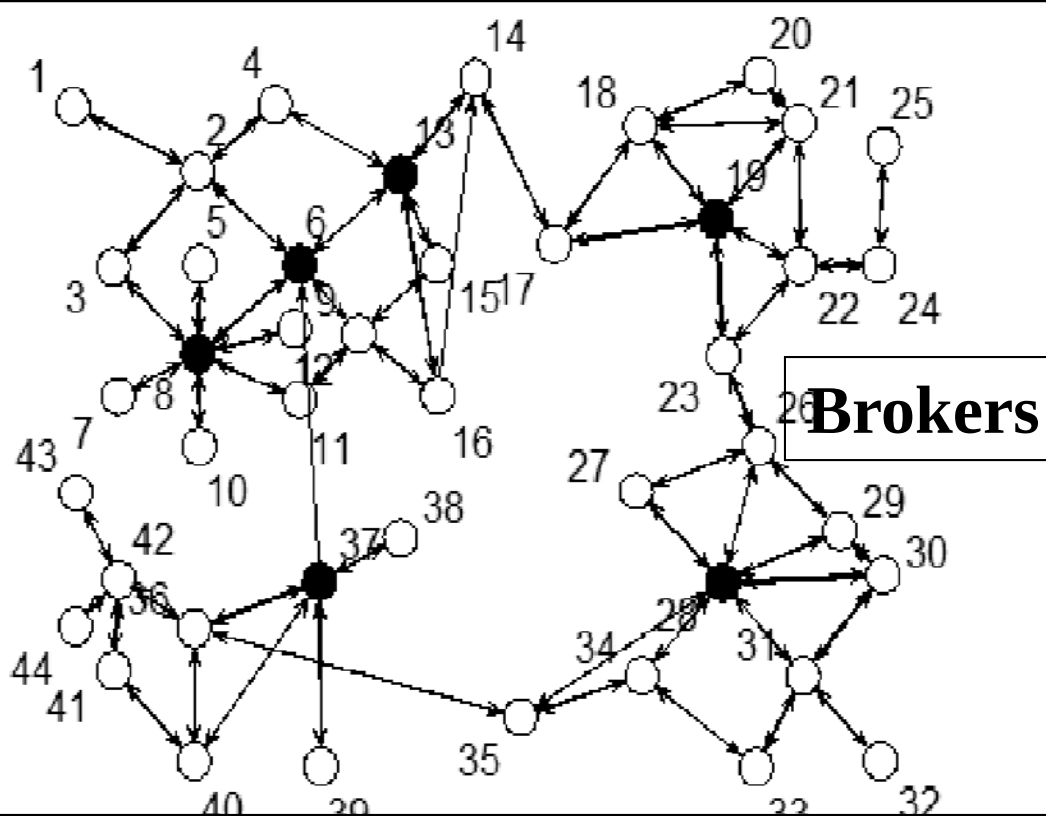

Degree

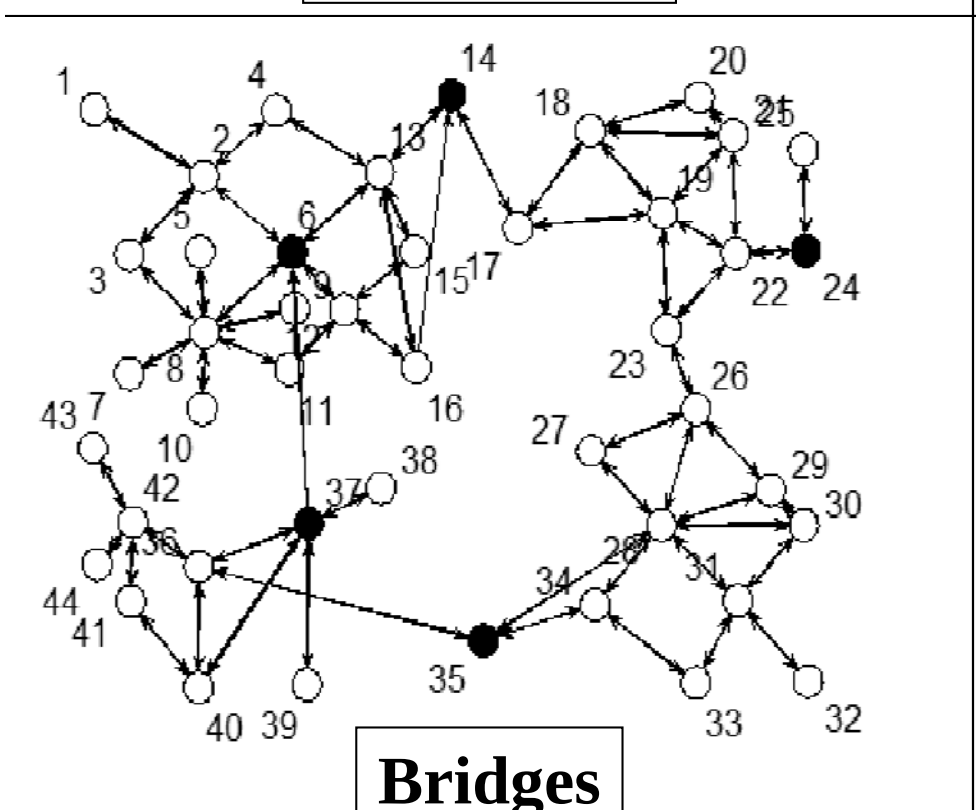

Closeness

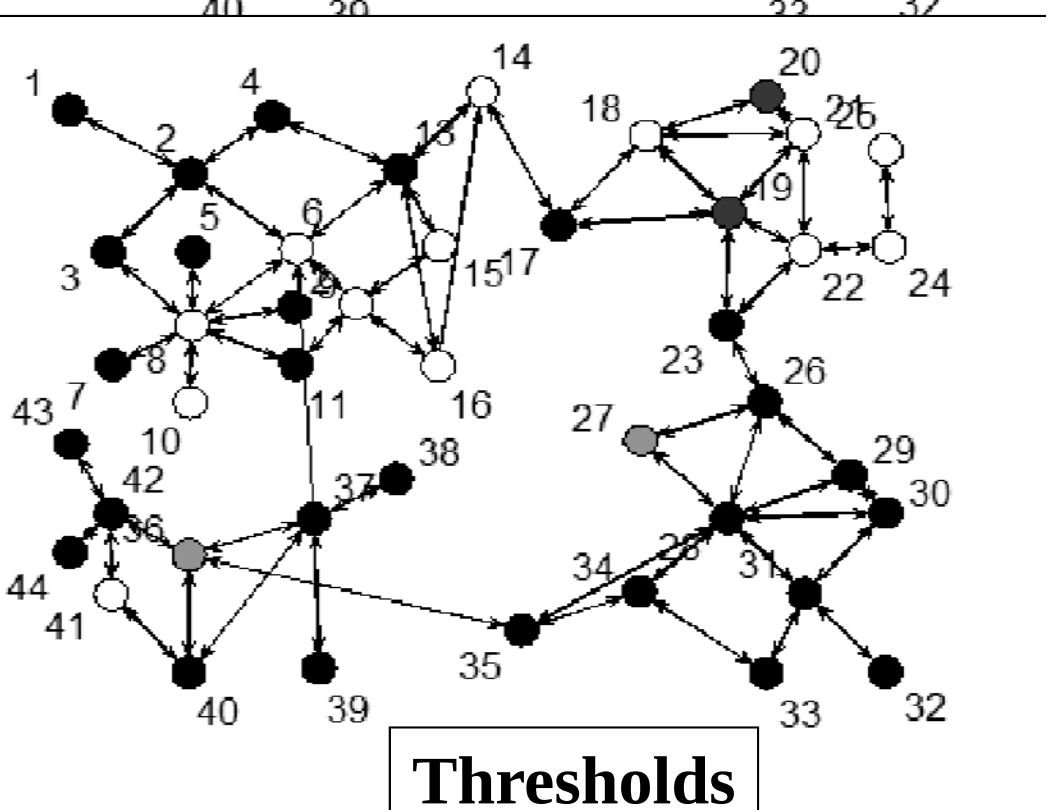

Between

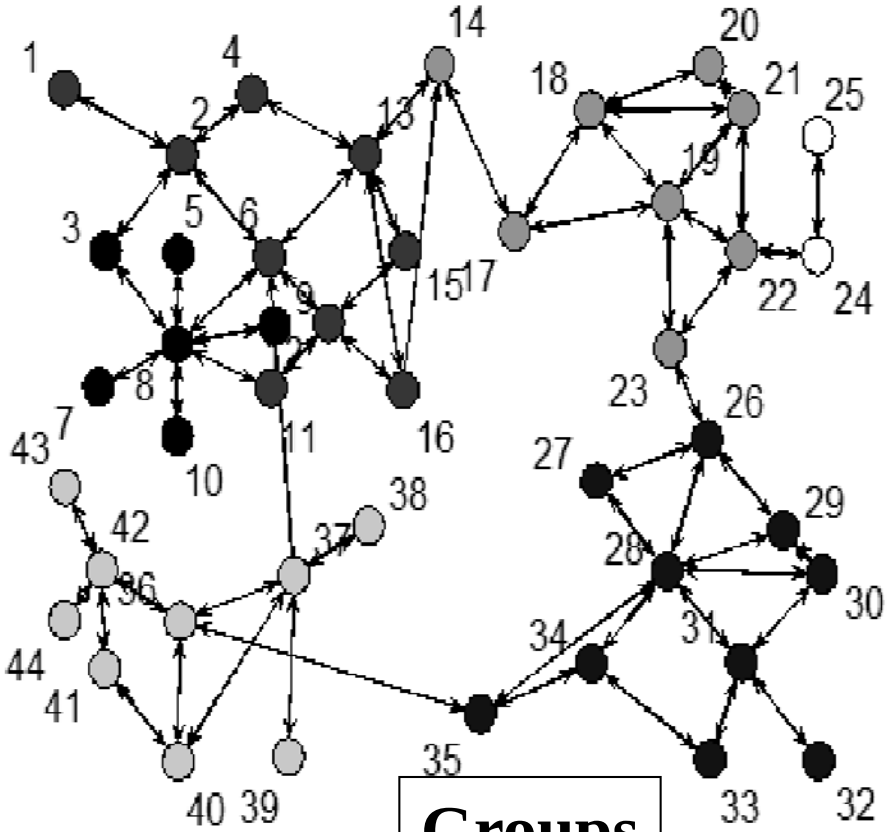

Keyplayers-Pos.

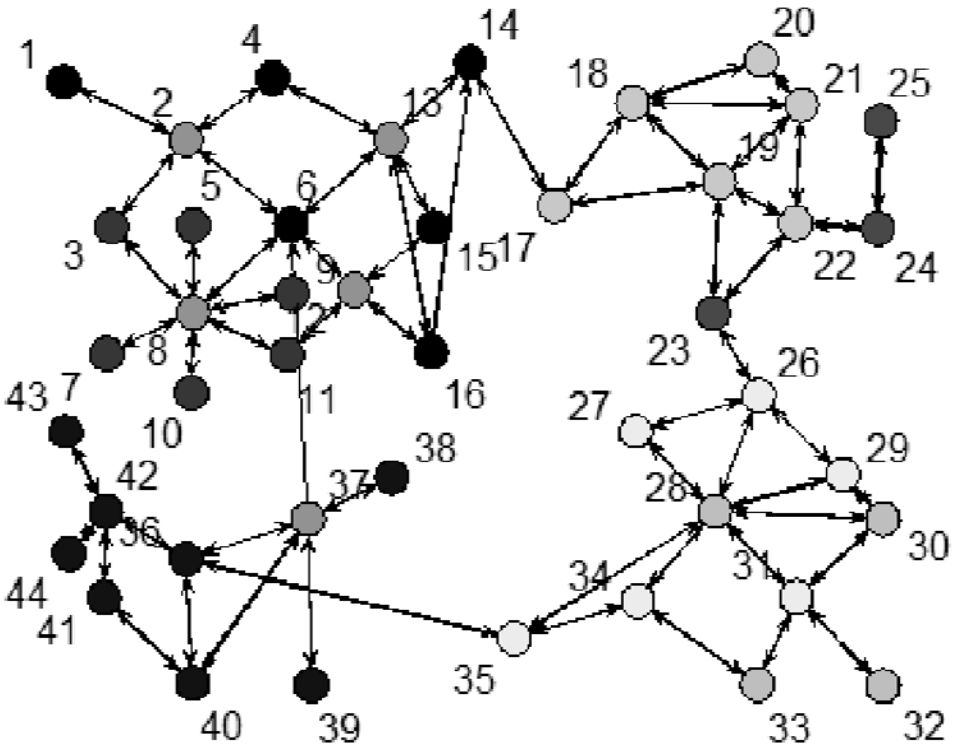

Keyplayers

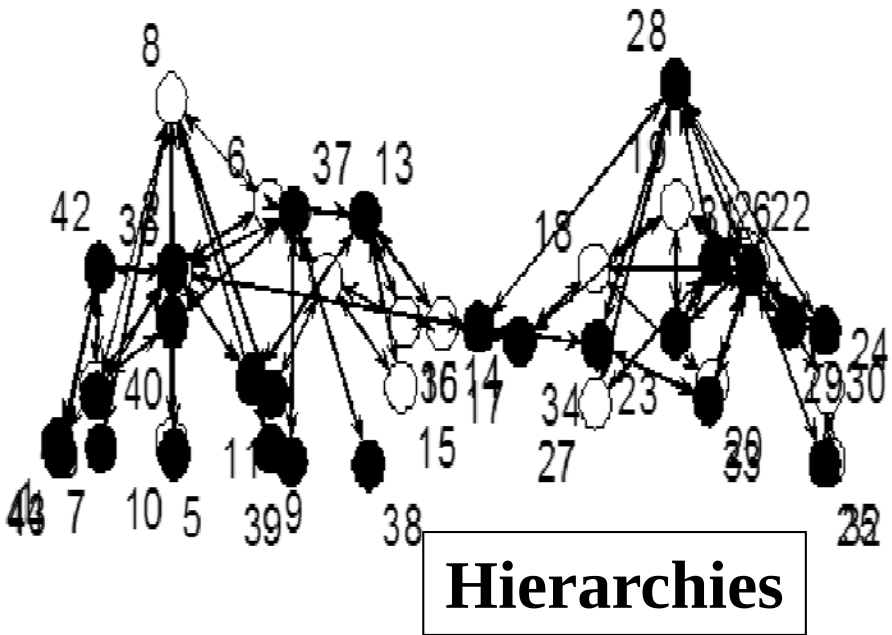

Brokers

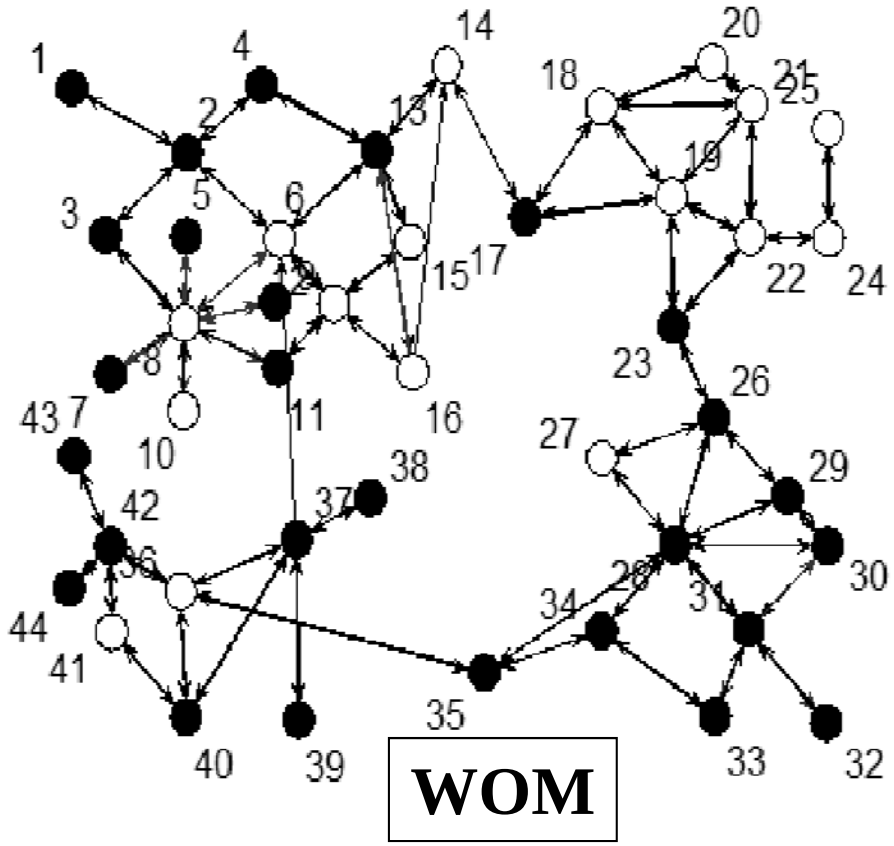

Bridges

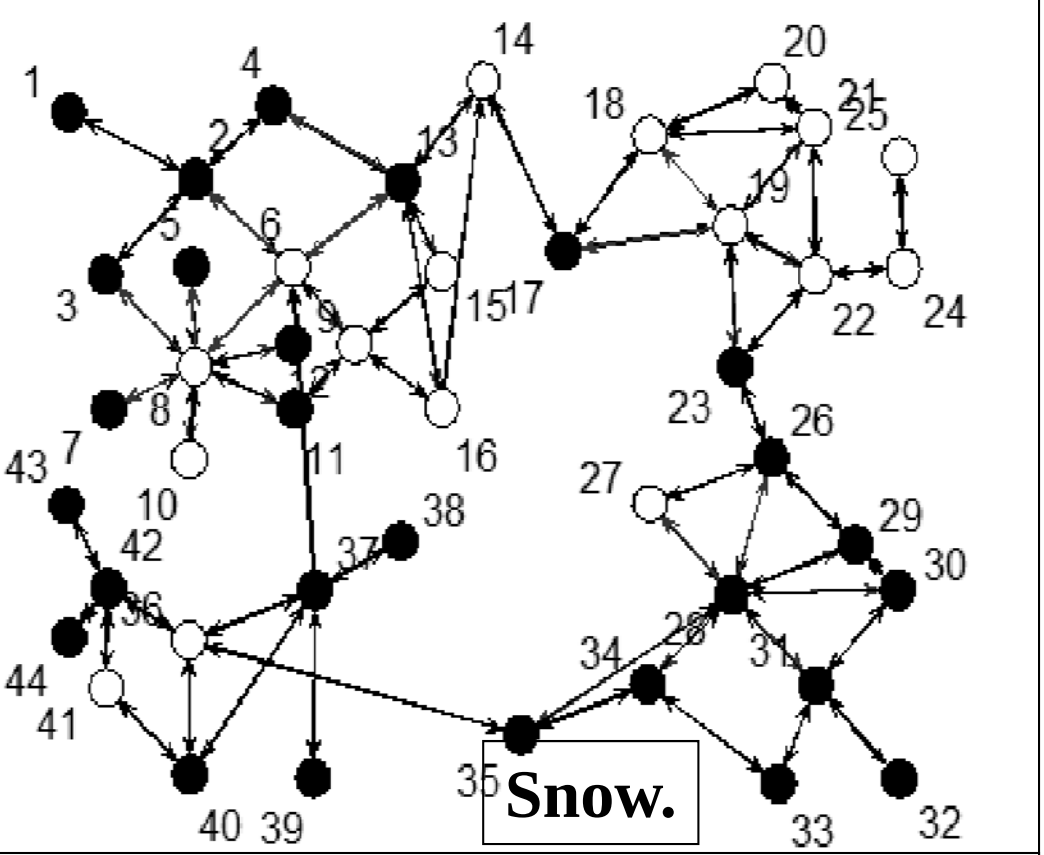

Thresholds

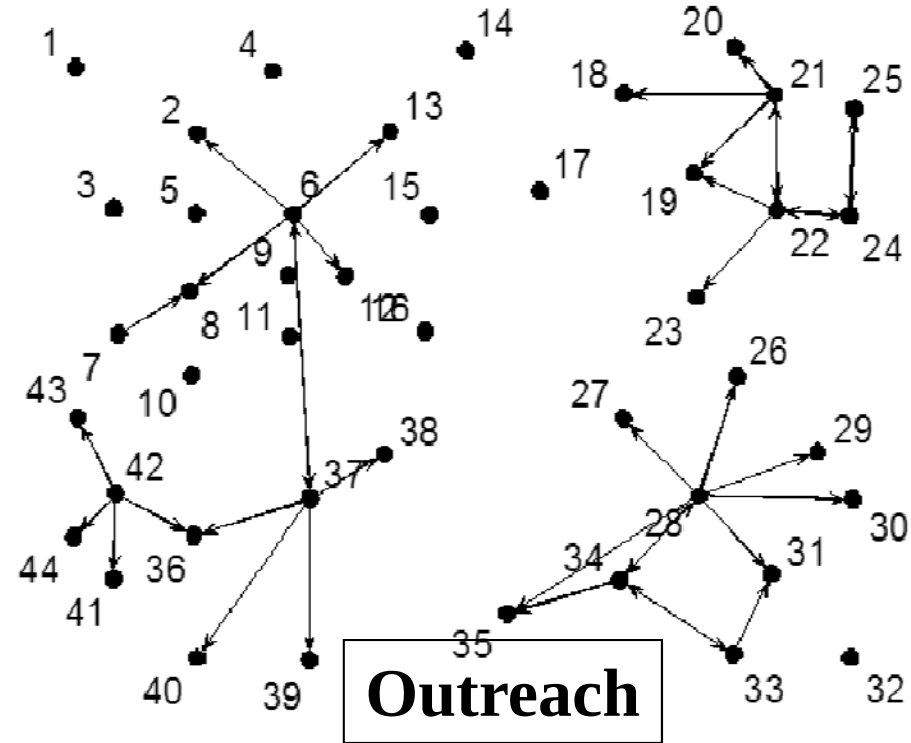

Groups

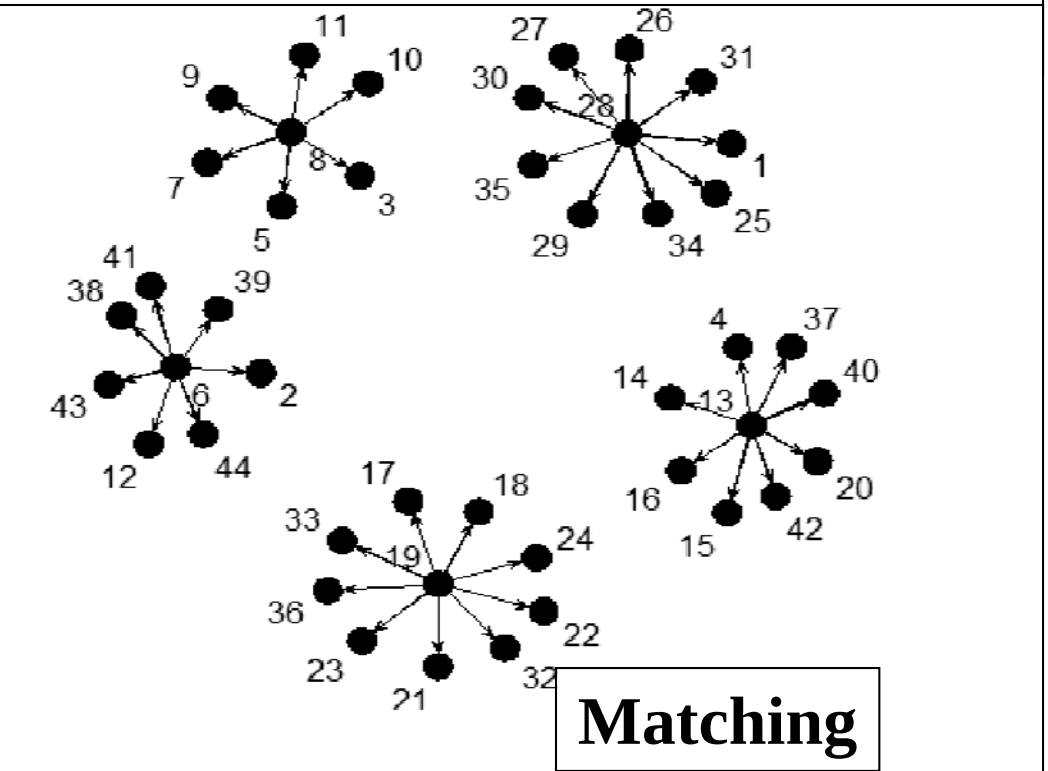

Positions

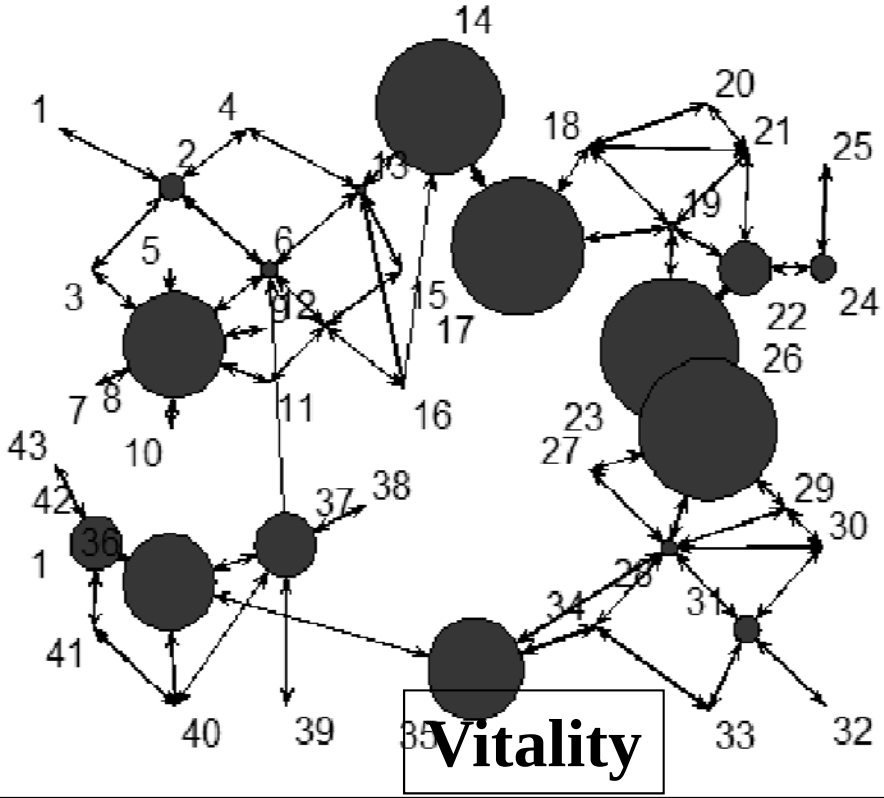

Hierarchies

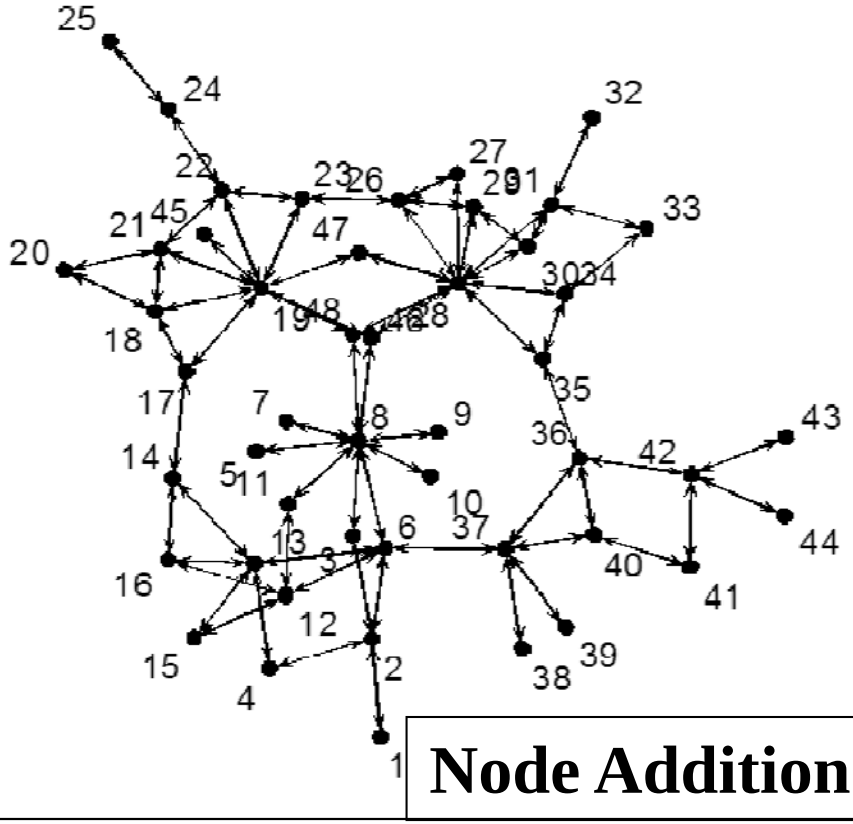

WOM

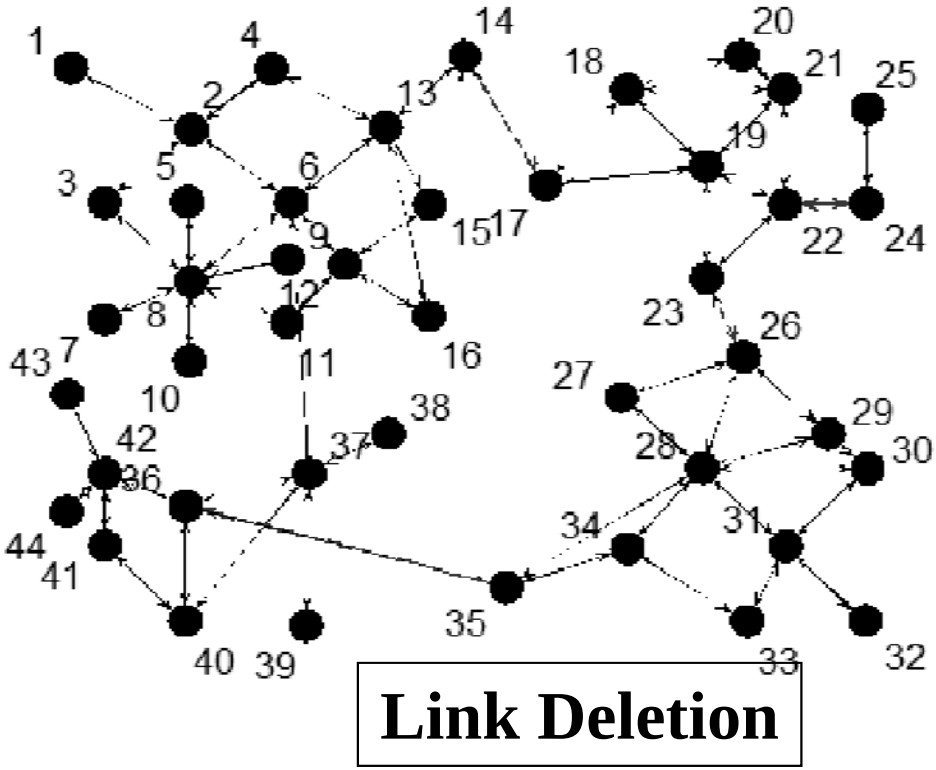

Snow.

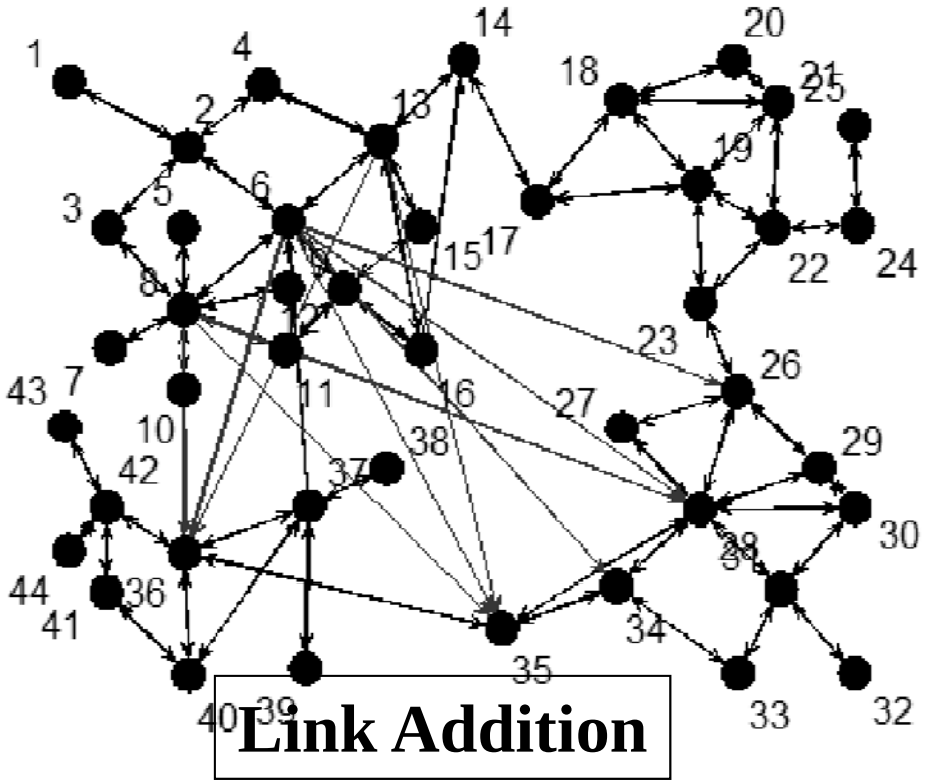

Outreach

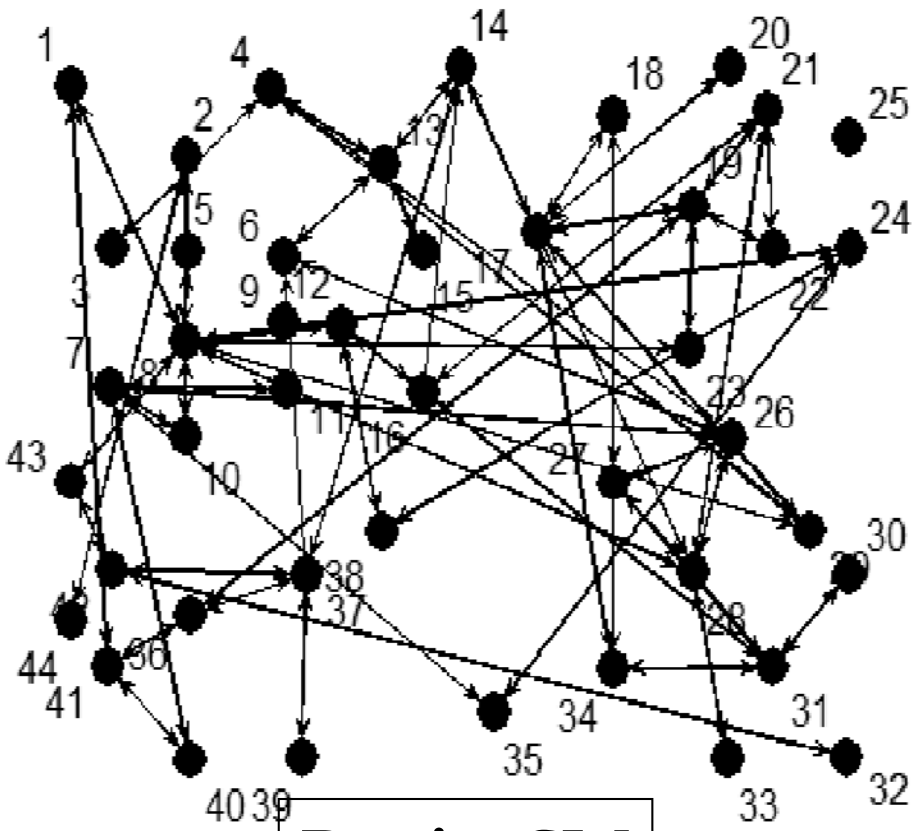

Matching


Vitality

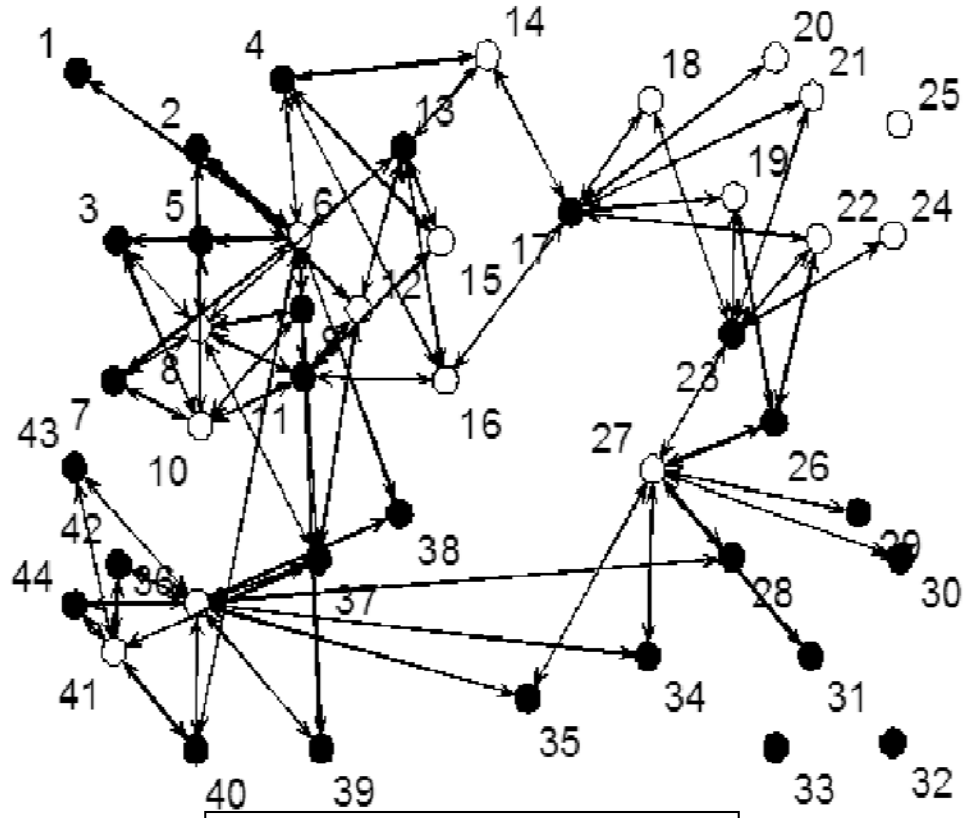

Node Addition


Link Deletion


Link Addition

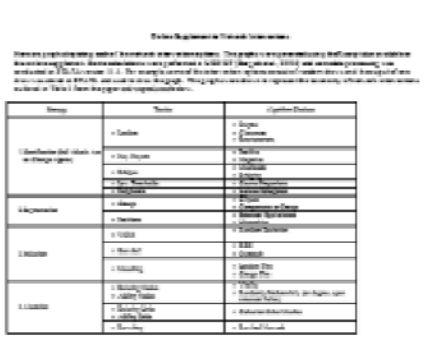


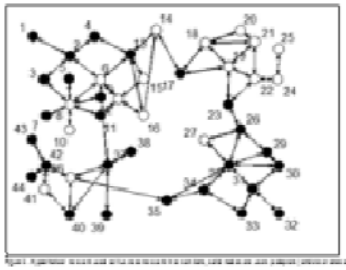
Rewire SW

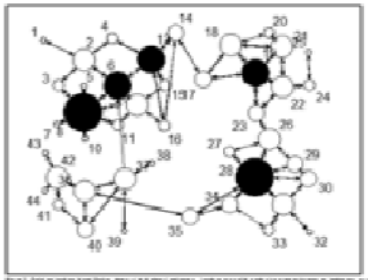


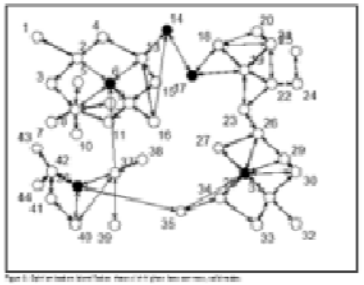
Rewire Behavior

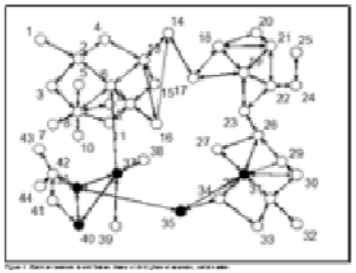
Graphical Displays of Intervention Choices

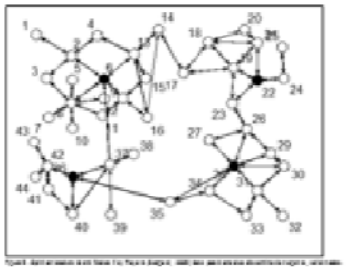


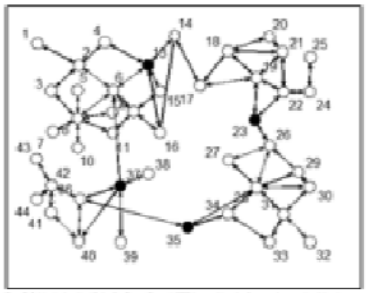


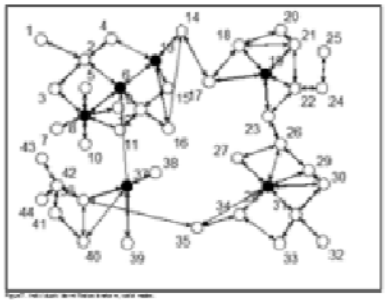


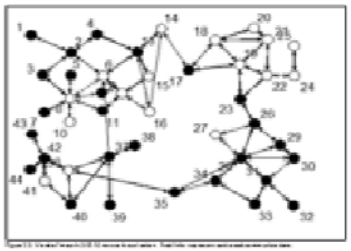


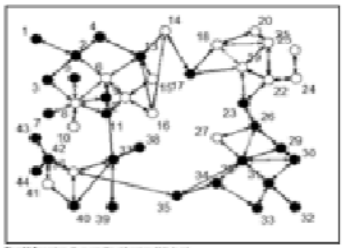


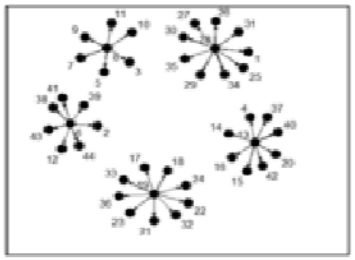


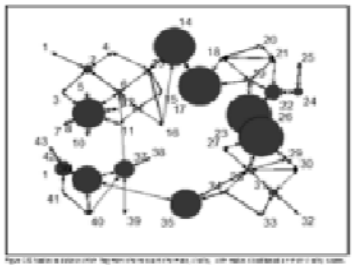


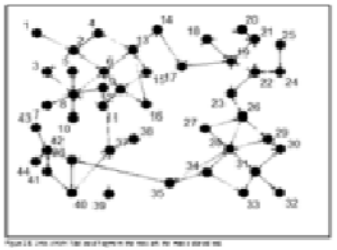


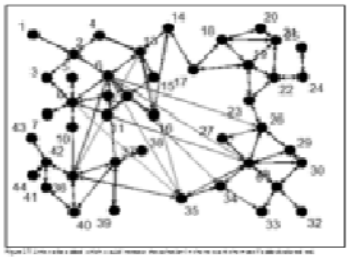


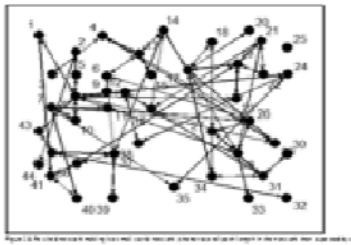












Selecting a NI

- Availability and type of data
  - Types of networks
  - Existing network structure
- Behavioral characteristics
  - Existing prevalence
  - Perceived characteristics such as cultural compatibility; cost; trialability; etc.

Linking Theory to Intervention Strategy

- There are several theoretical mechanisms that drive contagion and behavior change
- Evidence for a particular mechanisms suggests choice of intervention strategy or tactic

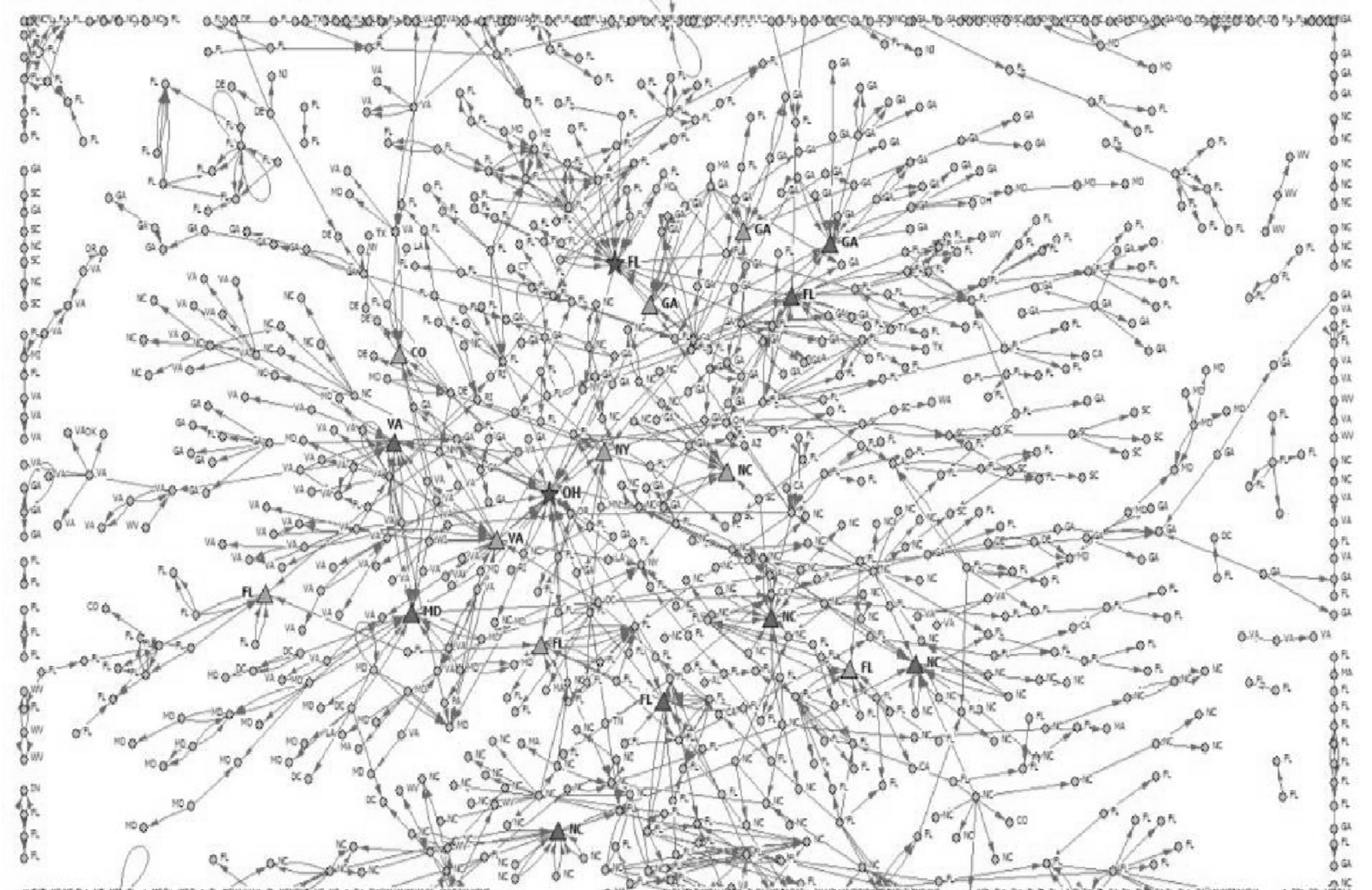
Influence Mechanisms Aligned with Interv. Choices

Mechanism	Tactic
Power Conflict Cohesion Isolation Thresholds	Leaders Bridges Key Players Peripherals Low Thresholds
Group Identification Structural Equivalence	Groups Positions
Information diffusion Hard to reach populations Closure Homophily	WOM Snowball Outreach Matching
Attributes Structure Structure!!	Deleting/Adding Nodes Deleting/Adding Links Rewiring

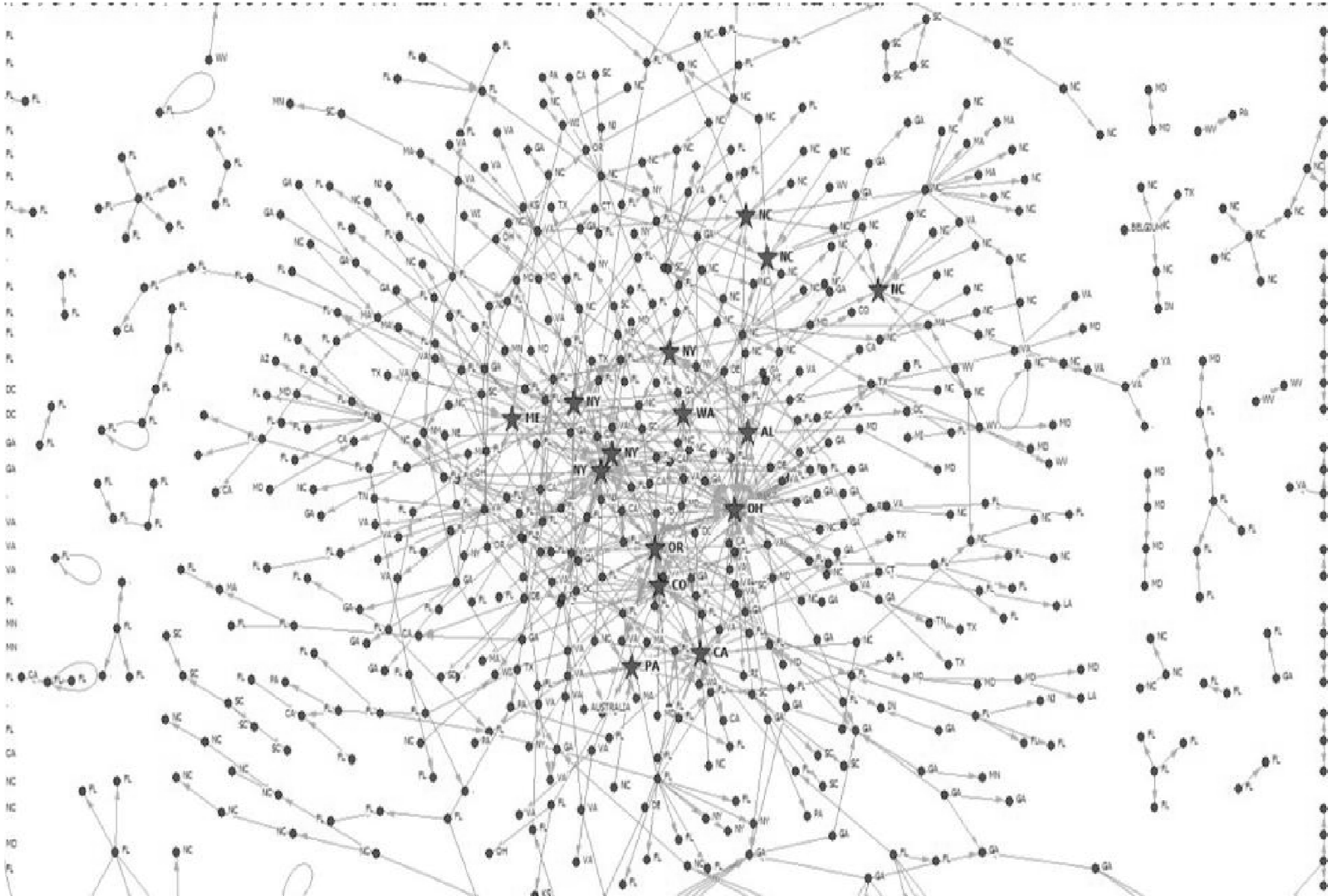
Leadership & Influence have 2 Dimensions

		Trust	
		Low	High
Expertise	Low		
	High		

Discussion + Advice Nominations in the South Atlantic (Osteo.)



Prominence Nominations in the South Atlantic (Osteo.)



Poll Question:

- Would you like to do a network intervention?
  - No, not applicable to my work
  - Yes, but no time soon
  - Yes, but I don’t know how
  - Yes, help me!

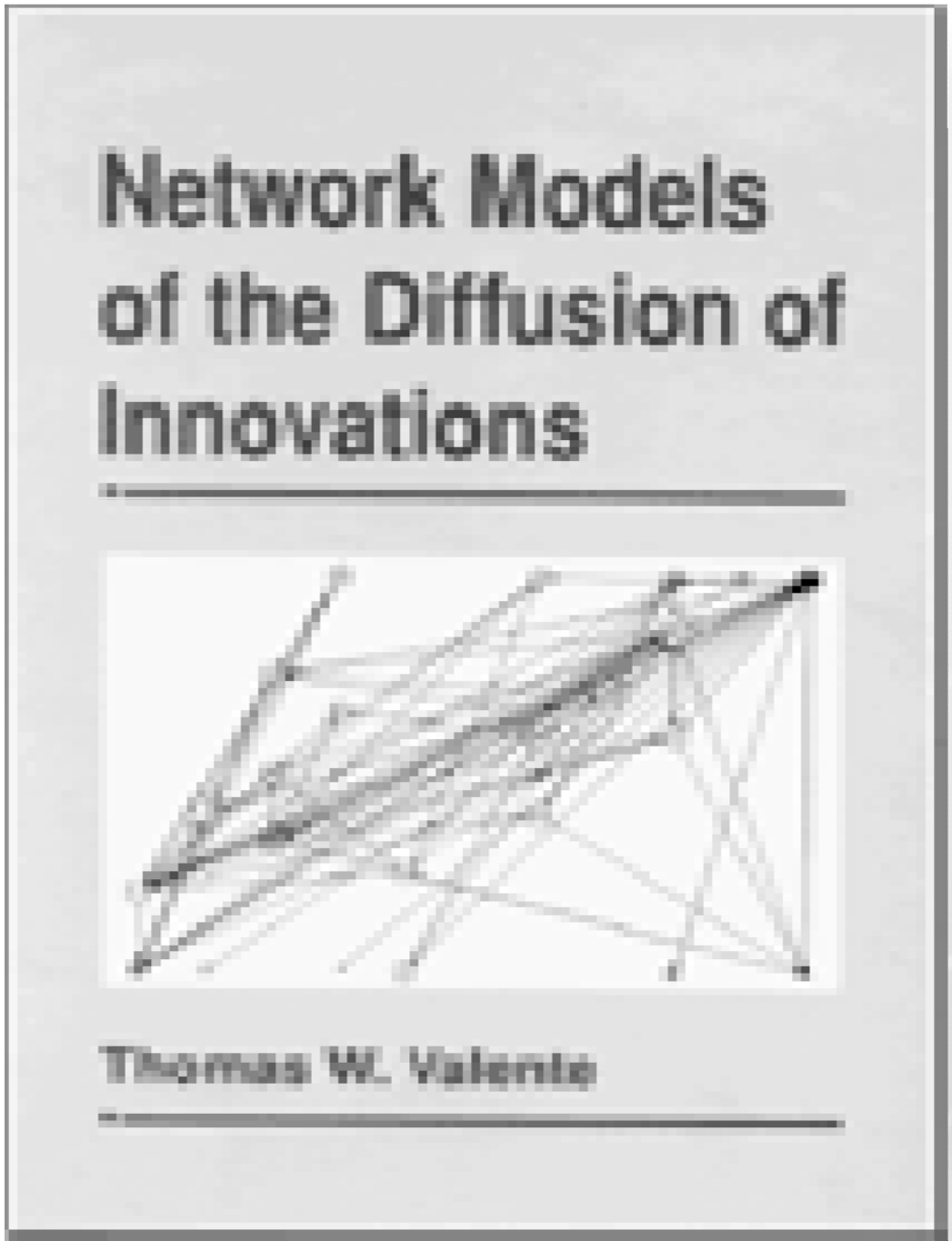
Conclusions

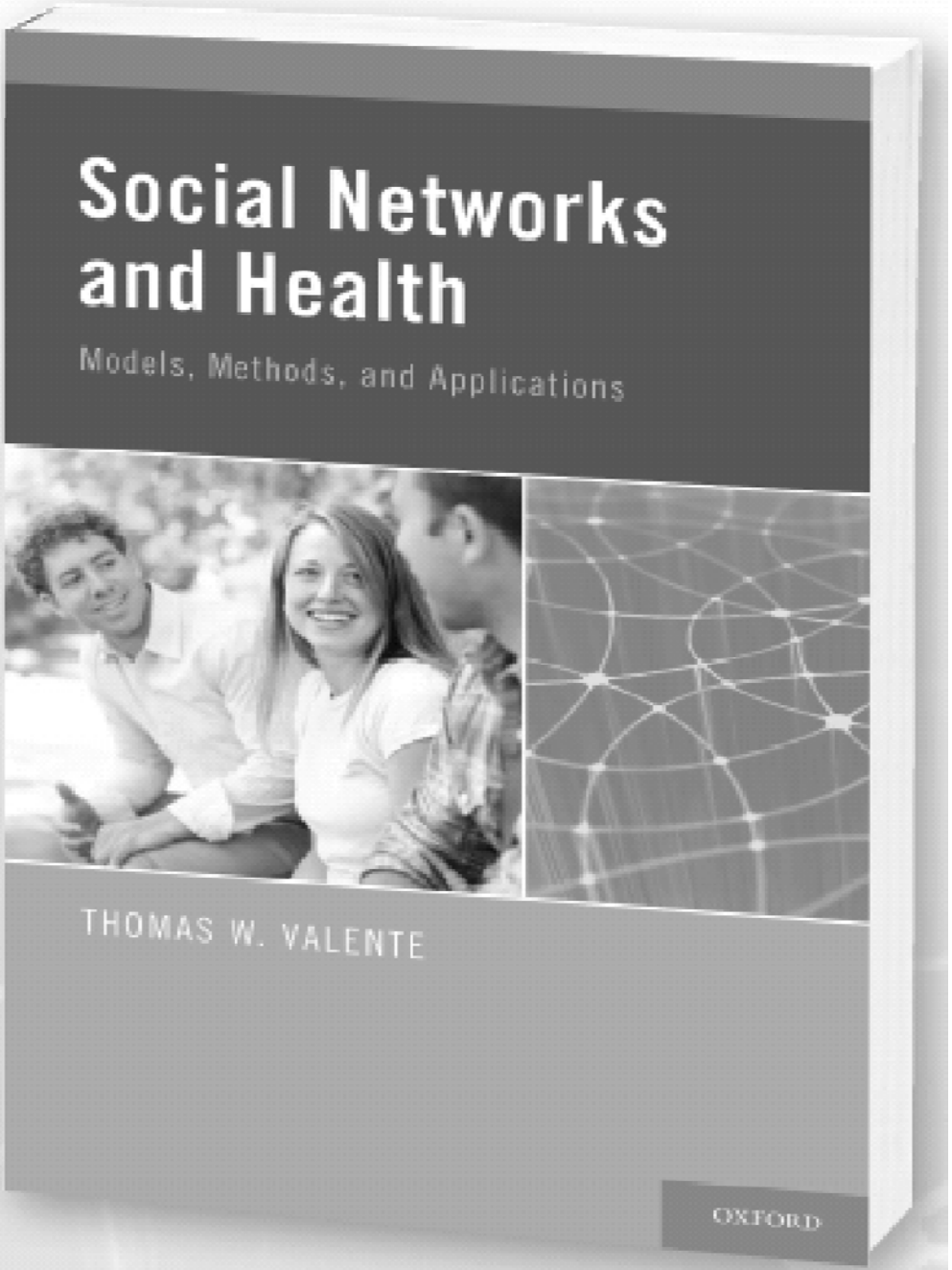
- Network theories and methods can be used for behavior change interventions.
- Network interventions have the promise of improving outcomes (health, organizational performance, etc.); and
- Test theoretically interesting network theories.

Prospects

- SNA is a "hot" topic now and many people in organizations, communities, and other settings interested in using the method.
- Funders are now willing to pay for SNA research and application.
- Experiments provide an opportunity to learn how networks work.

More reading and information: www-hsc.usc.edu/~tvalente/





Questions??

- About SNA?
- About network interventions?
- Additional resources?