

A Network Analysis Perspective to Health Services/System Research

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Awareness of Evidence-Based Practices by Organizations in a Publicly Funded Smoking Cessation Network

- awareness of evidence-based practices by the public organizations in the North American Quitline Consortium (NAQC), working to get people to quit smoking
- Awareness highest for quitline funders that were strongly connected directly to researchers and indirectly to the network administrative organization
- importance of maintaining instrumental rather than homophilous ties

Social Contagion and Information Technology Diffusion: The Adoption of Electronic Medical Records in U.S. Hospitals

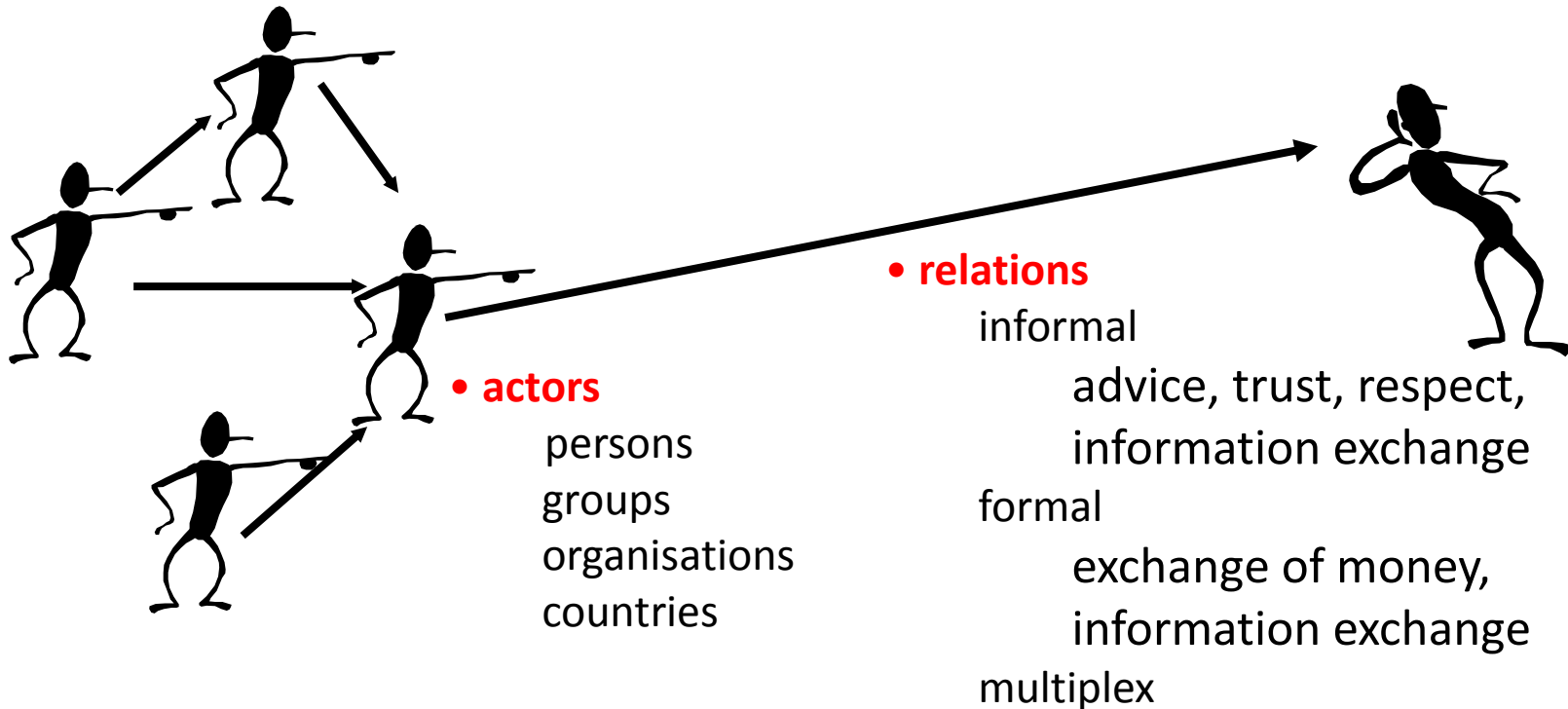
- diffusion of electronic medical records (EMR) in 4,000 U.S. hospitals. 1975 to 2005
- greater hospital size and age are positively related to the likelihood of adoption
- younger hospitals and “celebrity” status are associated with greater infectiousness
- strong effects for social and geographical proximity
- Seeding strategies to enhance diffusion of EMR

A 'relational' thinking in social sciences

- elements and realities are not detachable from their **transactions** and **relations**
- “the very terms or units involved in a transaction derive their meaning, significance, and identity from the (changing) functional roles they play within that transaction” (Emirbayer, 1997).
- All social entities and concepts, e.g. power, freedom, and society, are redefined as the functions of the **dynamic relationships**

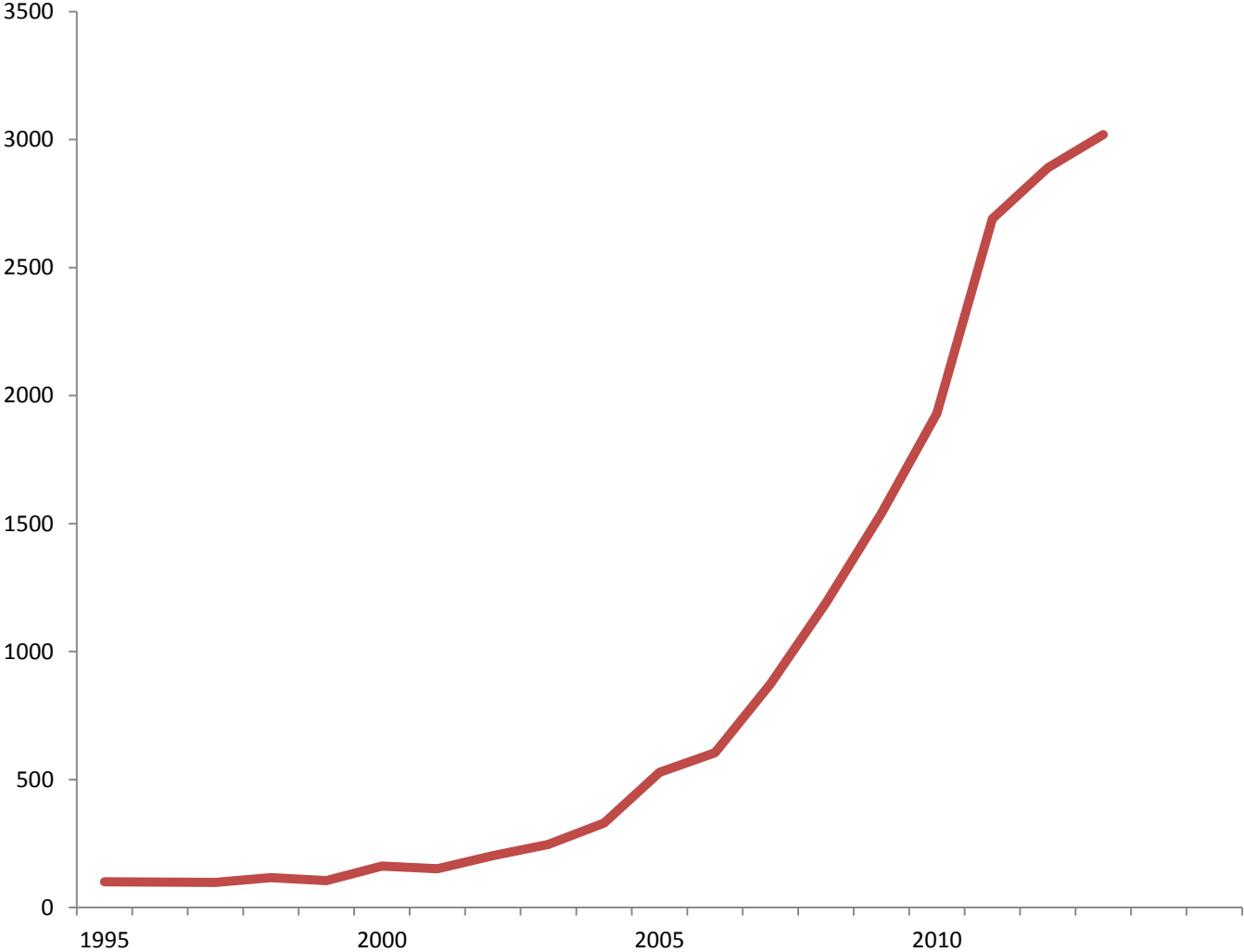
Networks

- Networks consist of **actors** connected to one another **by relations**



- **Social Network Analysis**: a perspective to analyze social relationships
- **Relations** and **individuals** as the units of analysis

Papers in Google scholar with “Social Network” in title



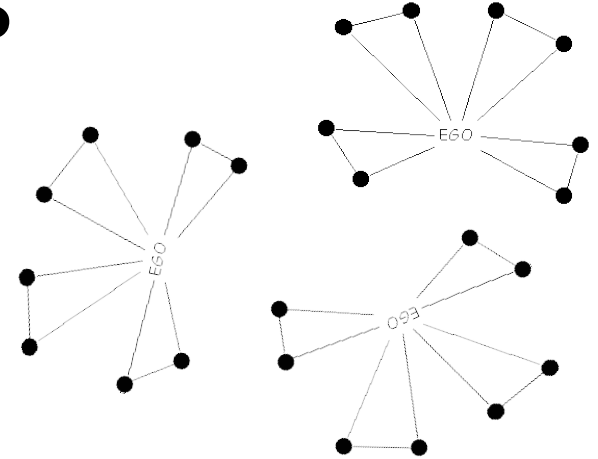
- Peer influence/education
 - Do better connected physicians influence the prescribing behavior of their colleagues? Iyengar., et al.(2011).
- Local opinion leaders/key players
 - The stability of opinion leaders over time, and their reach in their local network. Doumit., et al. (2011)
- Communities (patients, care providers, teams, policymakers)
 - Professional networks among physicians and factors associated with physician connections Landon., et al. (2012)
- Inter-organizational communication and partnership
 - Interactions between coalitions implementing alcohol and other drugs prevention services Chu., et al. (2015)

Network analysis study

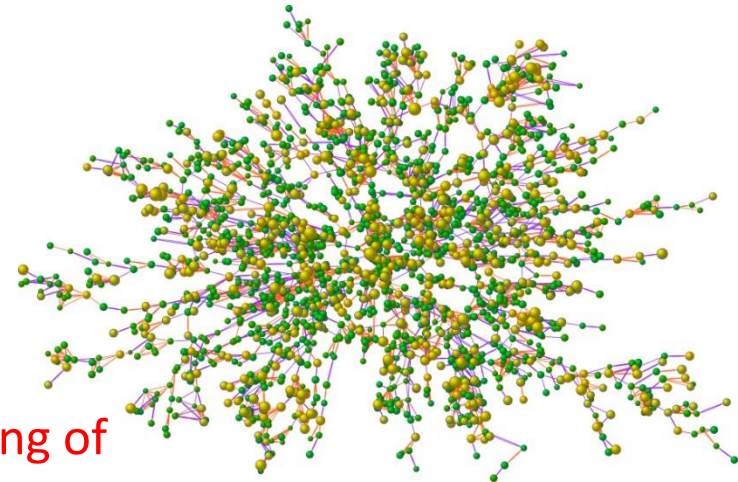
- Design
 - Perspective
 - Definition of relations
 - Specification of boundaries
- Data collection
- Analysis

Perspectives

- **egocentric** or personal networks
 - relations defined from *focal individuals*
 - compare relational structures of actors



- **sociocentric** or whole networks
 - relations linking members of *a single, bounded population*



- examine internal structures and positioning of actors within one network

Hierarchies and cliques in the social networks of health care professionals: implications for the design of dissemination strategies

- the professional social networks of clinical directors of medicine and directors of nursing, in hospitals in England
- a random sample of 50 Clinical Directors of Medicine and 50 Directors of Nursing
- Egocentric density and centralization
- Ego's discussion **partners, alter-to-alter** connections

Relations

- **similarities:** sharing attributes
- **relations**
 - affective ties
 - cognitive awareness
- **interactions:** behaviour-based ties
- **flows:** transfer and exchange

Boundaries

- **position-based approach:** actors who are members of an organization or hold particular formally-defined positions
- **event-based approach:** who had participated in key events
- **relation-based approach:** begins with a small set of nodes, then expands to include others sharing particular types of relations with any nodes previously added

EIDM network of a Public Health Unit

- An organization-wide knowledge broker led intervention
- to promote evidence-informed decision making (EIDM)
- A large public health unit serving an urban/rural area
- Selected staff get engaged in development of short evidence reviews

EIDM network of a Public Health Unit

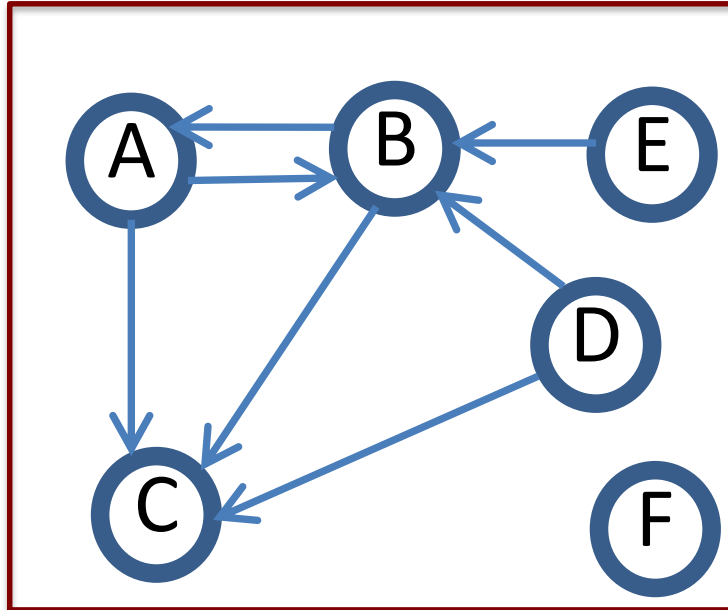
- A whole network (sociocentric) perspective
- Relations:
 - Seeking information regarding EIDM (behavioural)
 - Nomination as experts in EIDM (cognitive)
 - Friendship (affective)
- Boundaries:
 - Relation-based
 - Position-based

Studying whole network?

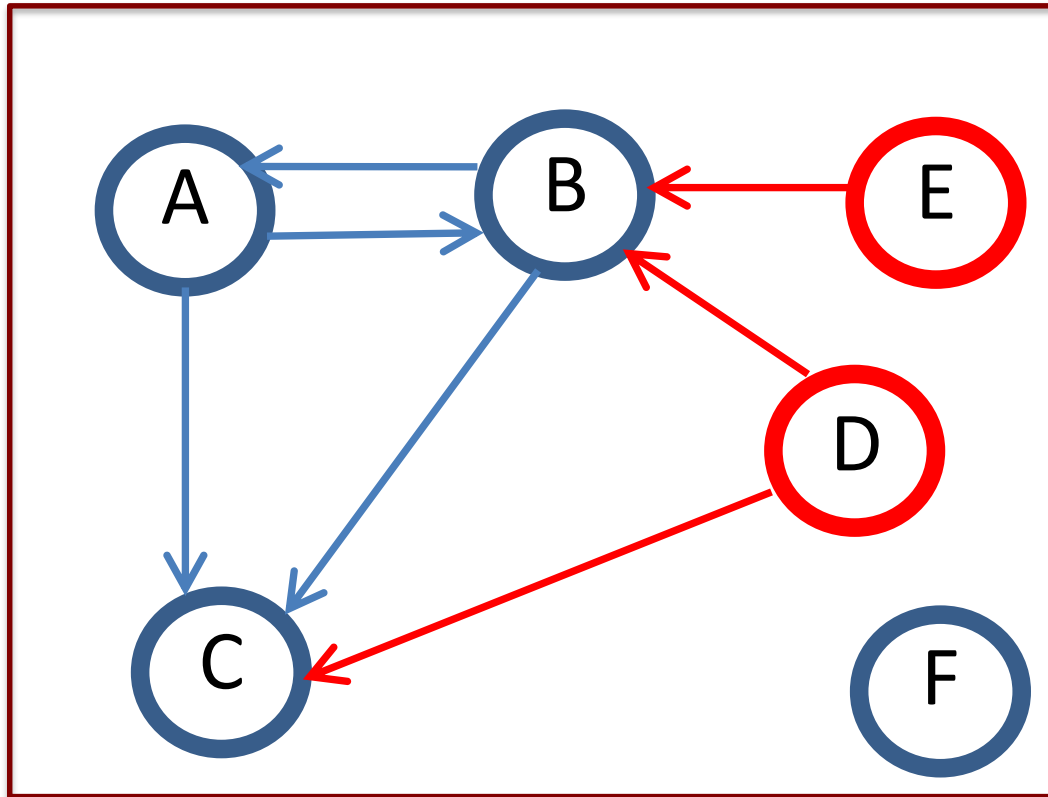
Random sampling is not enough

- it removes the individuals from their social context
- The network attributes are not randomly distributed

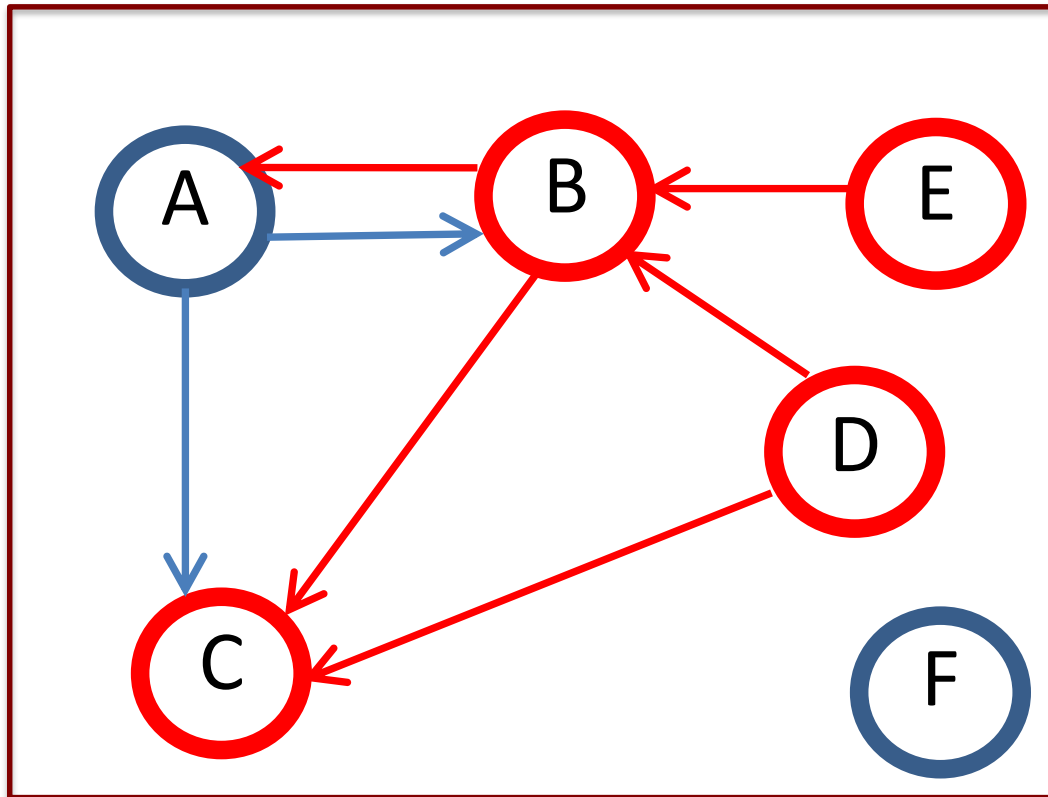
Random sampling is not enough



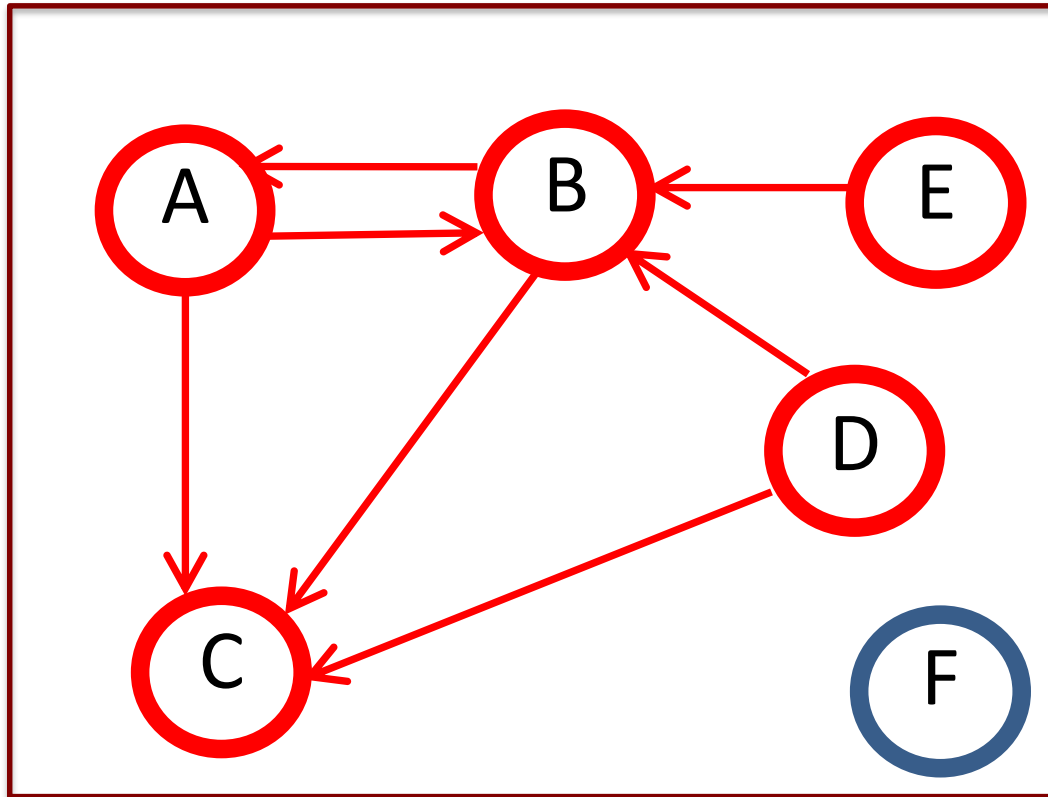
Snowball



Snowball



Snowball



Data collection

- **Questionnaires**
- **Interviews**
- **Observation**
- **Recordings**
 - Documents
 - Electronic logs

Whole network data

- **Sociometric test**

Roster

Please circle the number of conversations that you have had with each of the following primary care physicians in the last 6 months that have influenced your thinking about women's health issues.

(followed by alphabetized list of physicians and response categories "0", "1-3" and "more or equal 4")

- Keating 2007

Name generator-Free recall

From time to time, most people discuss important matters with other people. Looking back over the last six months, who are the people with whom you discussed matters important to you? Just tell me their first names or initials.

IF LESS THAN 5 NAMES MENTIONED, PROBE: Anyone else?

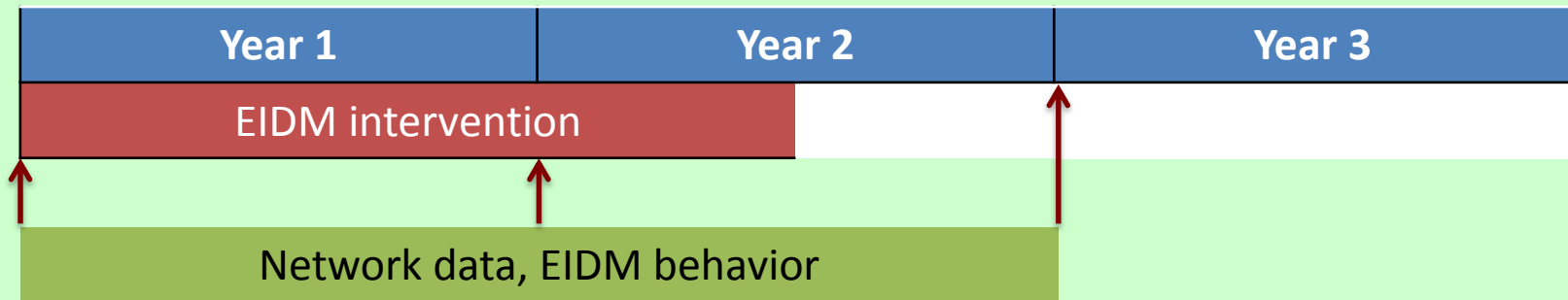
General Social Survey (1985)

EIDM network of a Public Health Unit

-Identify up to 5 staff in health department:

- **Q1: to whom you regularly turn to get help incorporating research evidence to inform practice**
- **Q2: who are experienced and knowledgeable in finding research evidence and translating it into practice**
- **Q3: whom you consider as your personal friends**

EIDM network of a Public Health Unit



- **Information sources for EIDM problems**
 - **Experts in EIDM**
 - **Friends**
-
- **The Evidence Based Practice Implementation scale** (*Mazurek Melnyk, et al. 2008*)

EMPLOYEE INTERPERSONAL RELATIONSHIP CHART

	JEFF	NANCY	TOMYR	RAY	ALICE	BETTY	TOM
JEFF	X	LIKE	HATE	SO-SO	PALS	HATE	HATE
NANCY	LIKE	X	♥	ABHORS	HATE	SO-SO	HATE
TOMY R.	HATE	♥	X	LIKE	PALS	HATE	PALS
RAY	SO-SO	ABHORS	LIKE	X	PALS	SO-SO	LIKE
ALICE	PALS	PALS	♥	PALS	X	PALS	PALS
BETTY	HATE	SO-SO	HATE	SO-SO	PALS	X	PALS
TOM	HATE	HATE	PALS	LIKE	PALS	PALS	X



10-11

To help workers know where they stand with each other, management devised the Interpersonal Office Chart.

T H E MATRIX

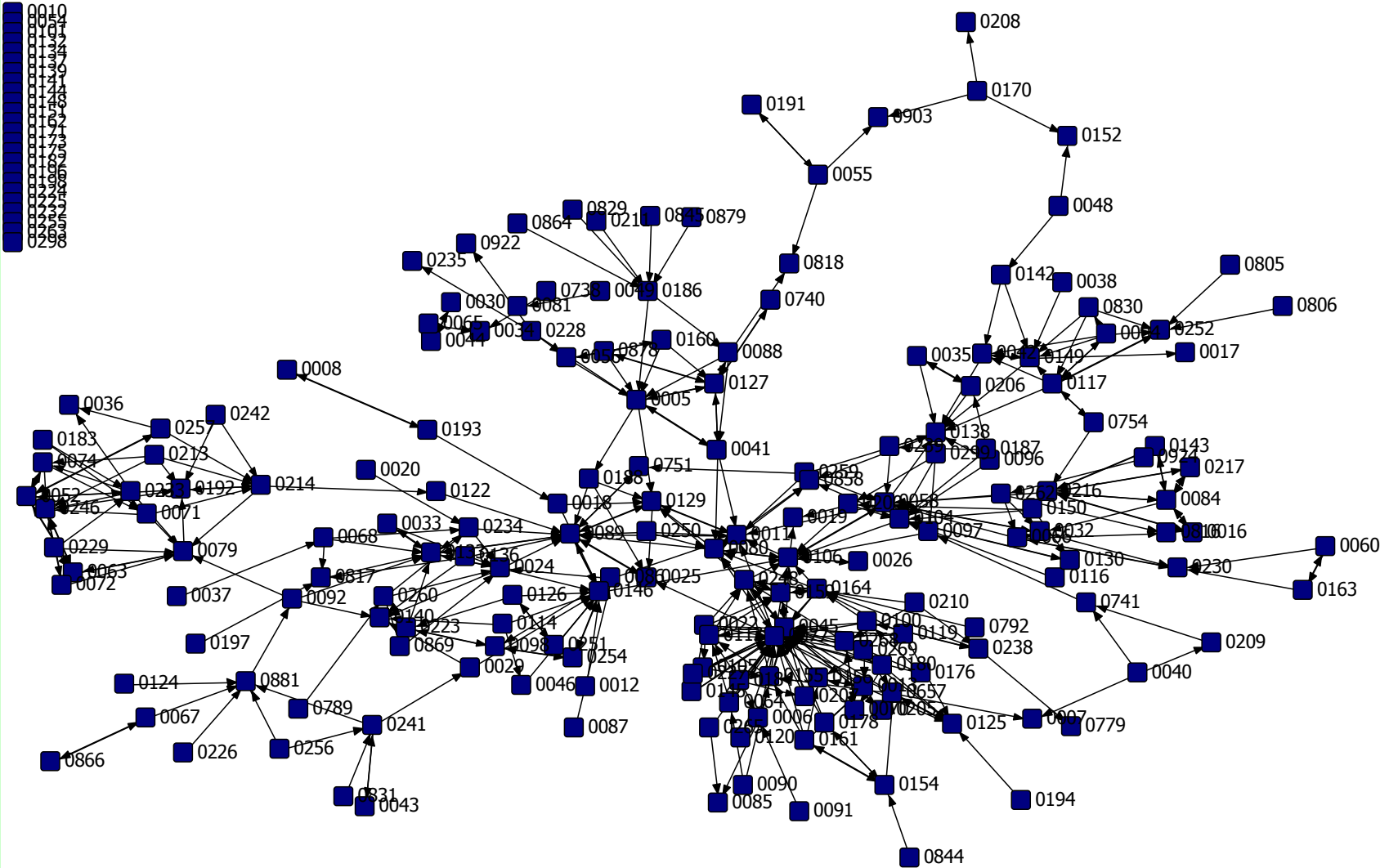
Social Network Analysis

- **Description**
- **Visualization**
- **Hypothesis testing**
- **Simulation**

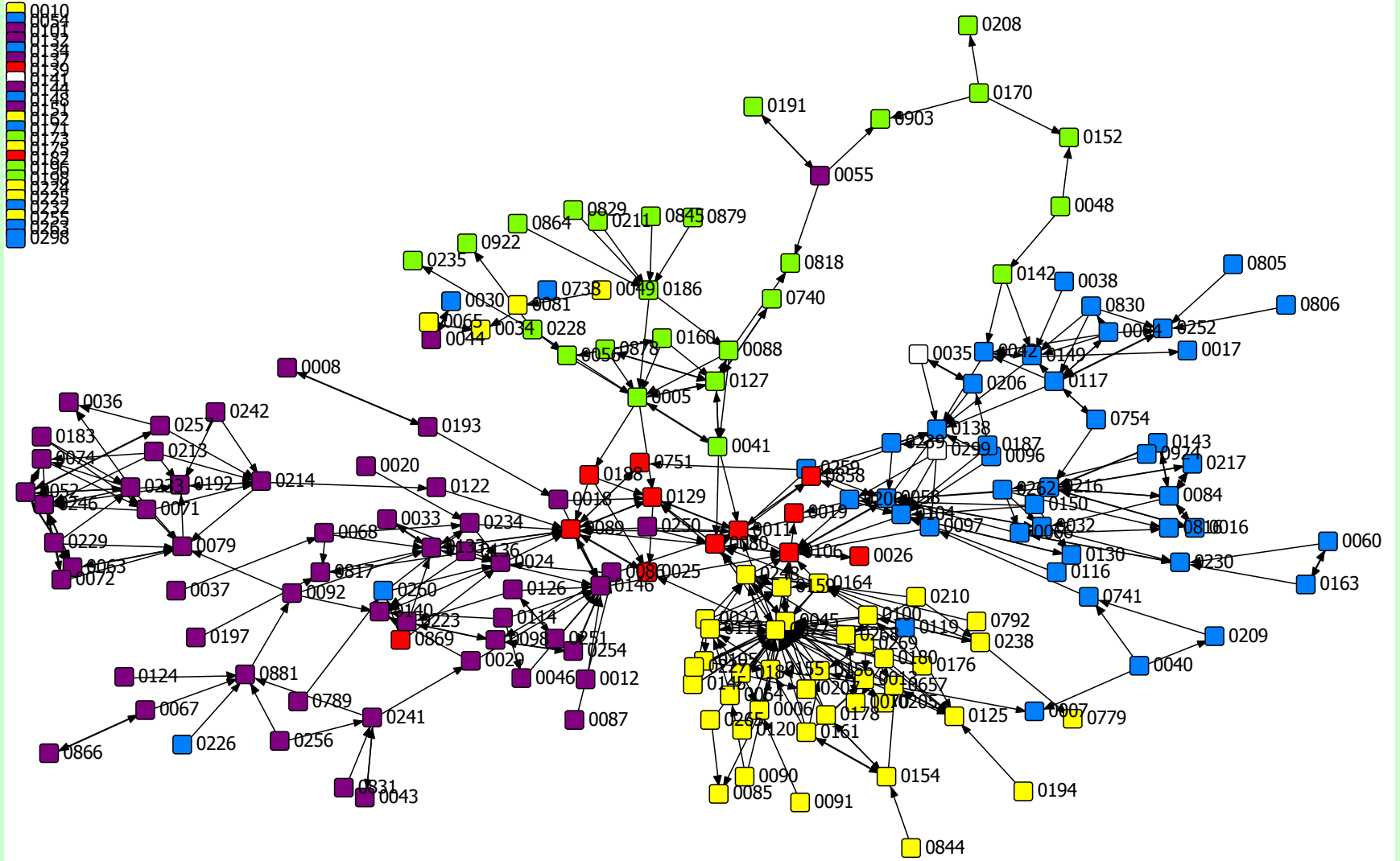
goals of descriptive analysis

- Are nodes **connected** through the network?
- How **far apart/reachable** are they?
- Are **some nodes** more important due to their position in the network?
- Is the network composed of **communities**?

Spring embedding



Divisions



Social capital

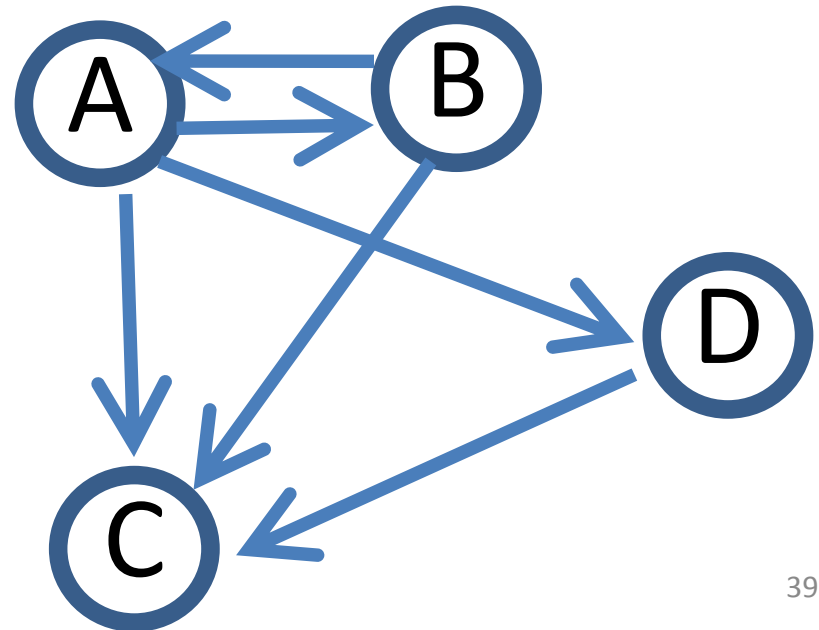
- “Resources embedded in a social structure which are accessed and/or mobilized in purposive actions” (Lin, 1999).
- Social networks provide opportunities to **gain access to resources** as well as benefit from **each other’s support**

Bonding social capital

- cooperative relations among members of densely connected groups (Coleman, 1988)
- trust and confidence are more likely to happen in dense and closed groups.
- *norm of reciprocity* (Gouldner 1960)
- collective sanctions
- tendency towards closure
- shorter average distance among actors

Degree centrality

- the number of connections any actor has.



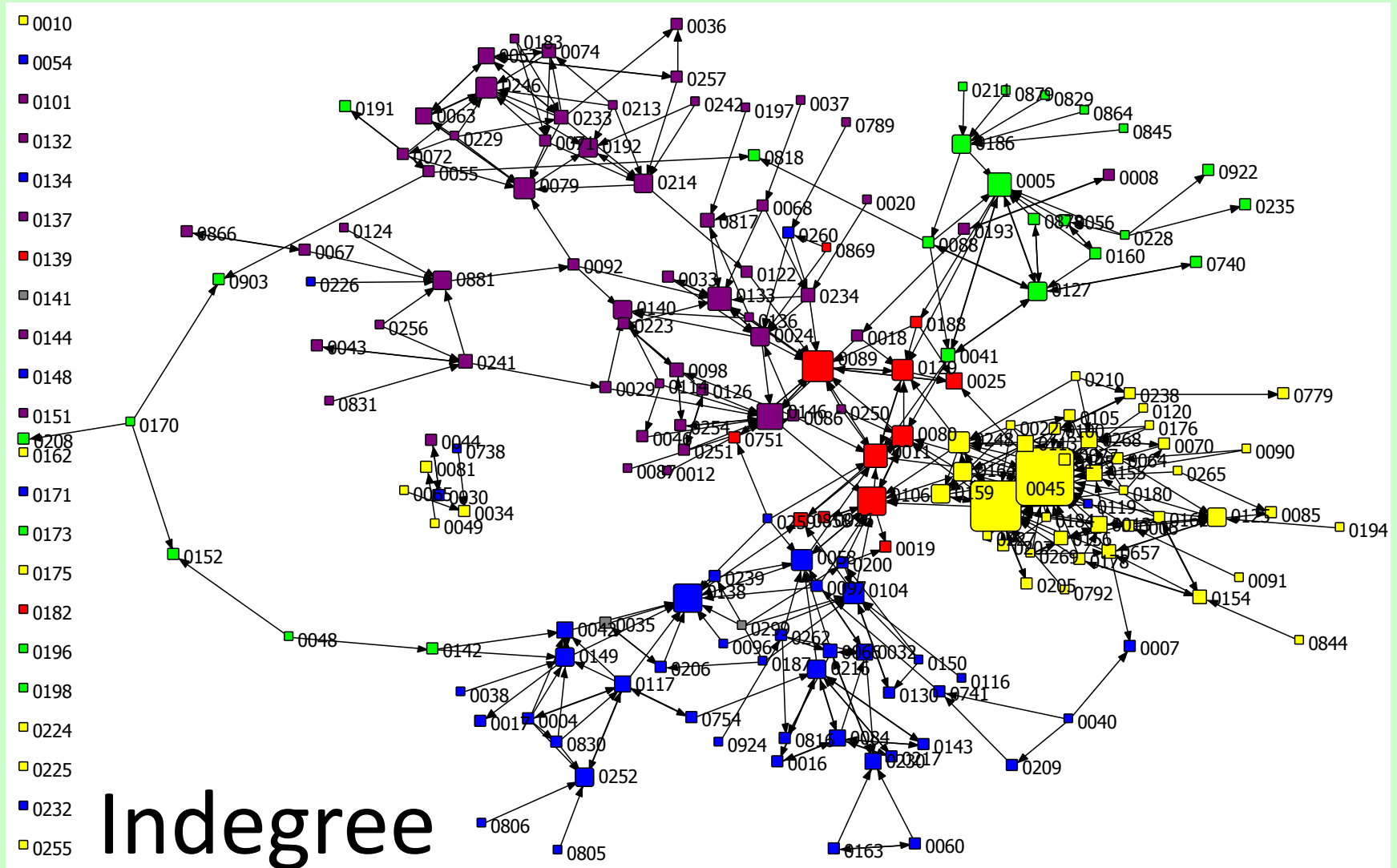
In-degree of actor A: 1

Out-degree of actor A: 3

Medical Innovation: A Diffusion Study

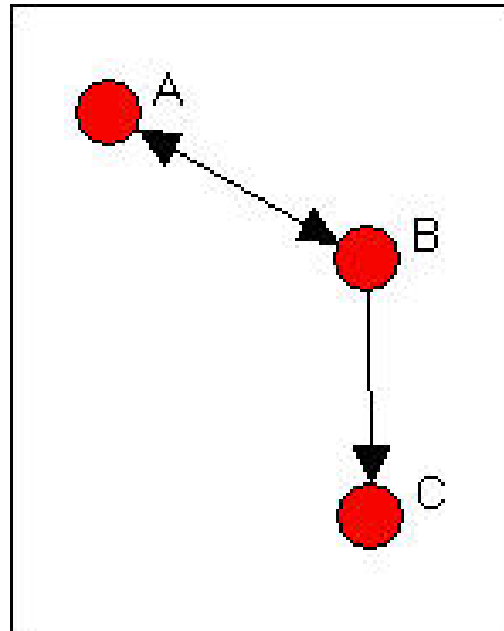
- more socially integrated doctors were more likely to hear about the new antibiotic from peers

EIDM network of a Public Health Unit



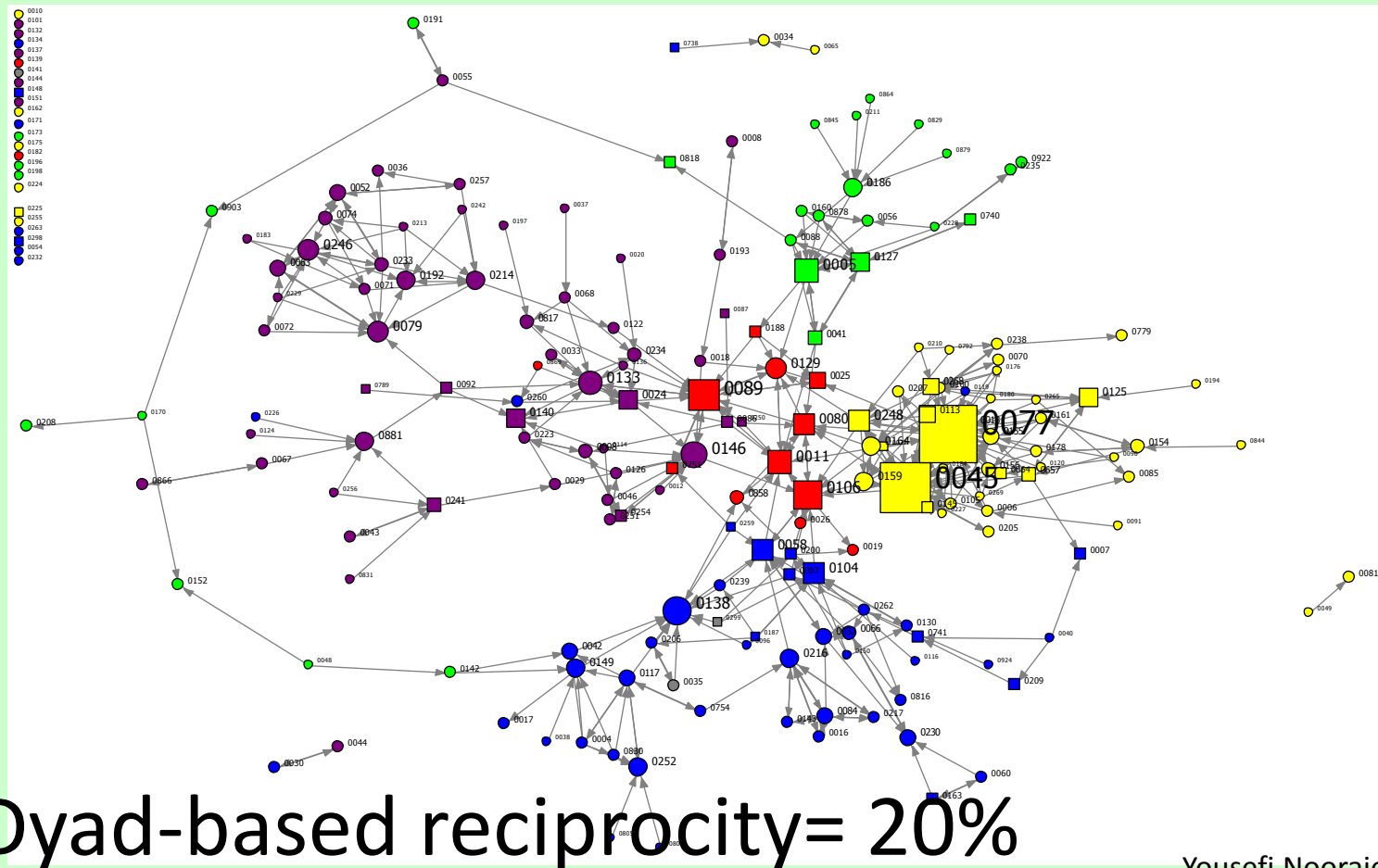
Reciprocity

- The proportion of reciprocated dyads



EIDM network of a Public Health Unit

- The proportion of reciprocated dyads



Strength of Weak Ties

(Granovetter 1973, 1983)

- Actors gain novel information from less intimate ties than close ties
 - actors who are strongly connected share information directly, therefore they possess the same redundant knowledge
 - new information comes from external connections which are likely to be weak

Bridging social capital

- the **weak ties** are especially important
 - provide **access** to novel and heterogeneous resources
 - more likely to **adopt innovations/ less bound** to the group norms
- *You are more likely to hear about a job from an **acquaintance than a close friend** (Marin, 2012)*

Structural Holes

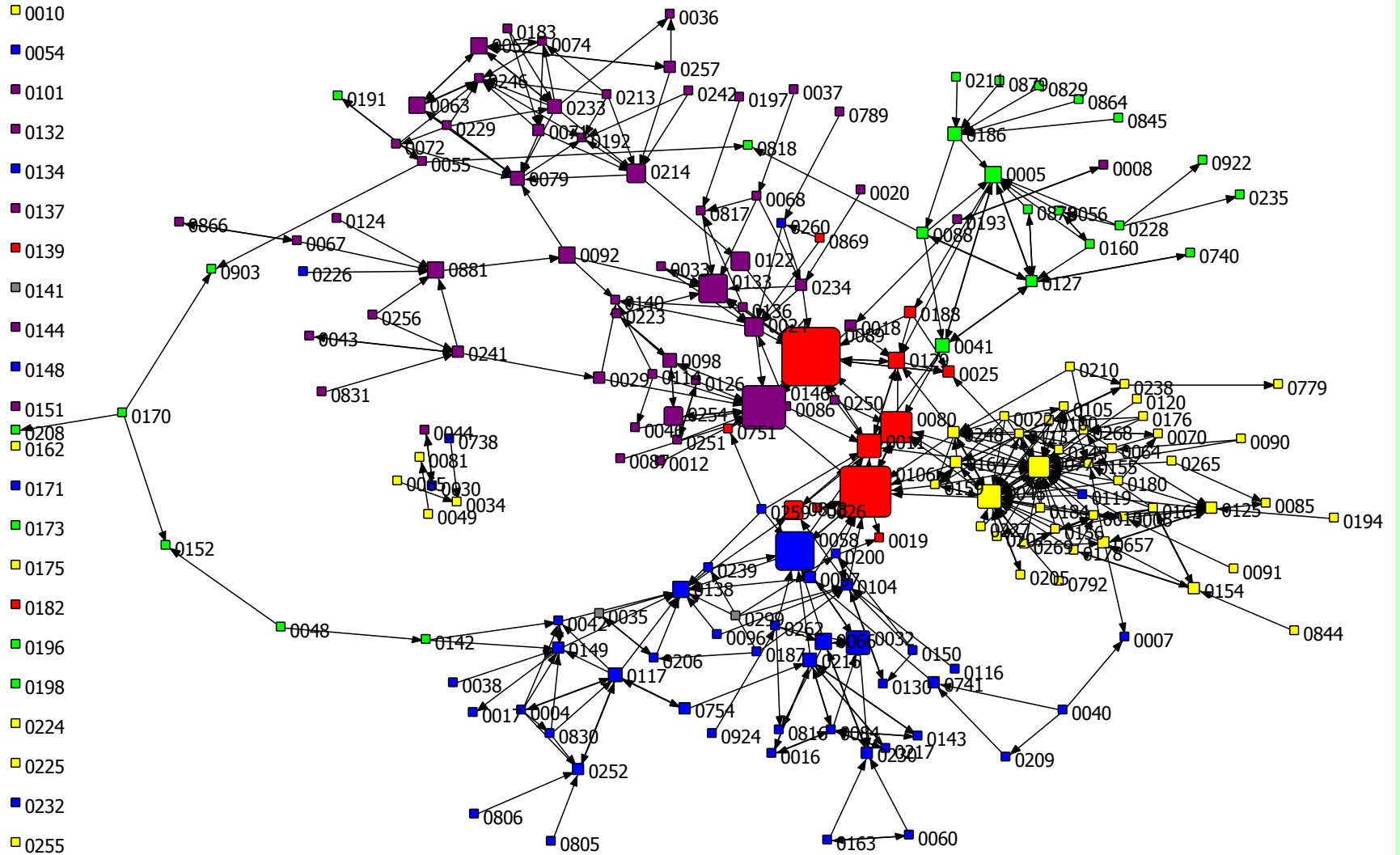
(Burt 1977)

- Location of people and the bridging between unconnected groups are far more important than the strength of relationships
- *structural holes: brokerage*; connecting separate segments of the network.

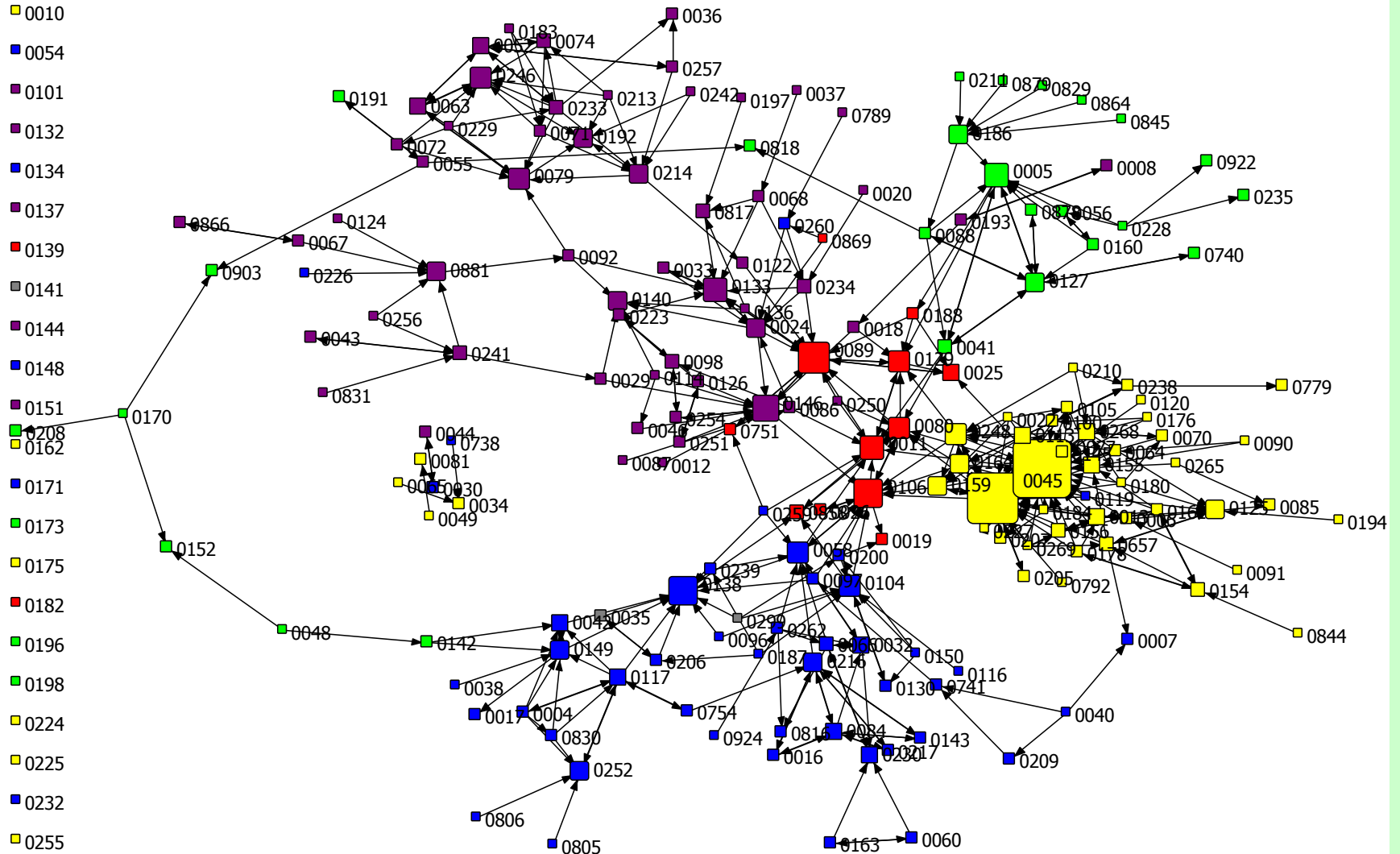
Physician social capital and the reported adoption of evidence-based medicine: Exploring the role of structural holes

- the role of professional networks adoption of EBM into clinical practice
- **Egocentric** network of physicians in hospitals
- Physicians who were **highly constrained (lots of redundant ties)** were less likely to adopt EBM
- **Cohesion induced by social interactions may hamper, rather than foster,** the diffusion of scientific information within professional groups.

Betweenness



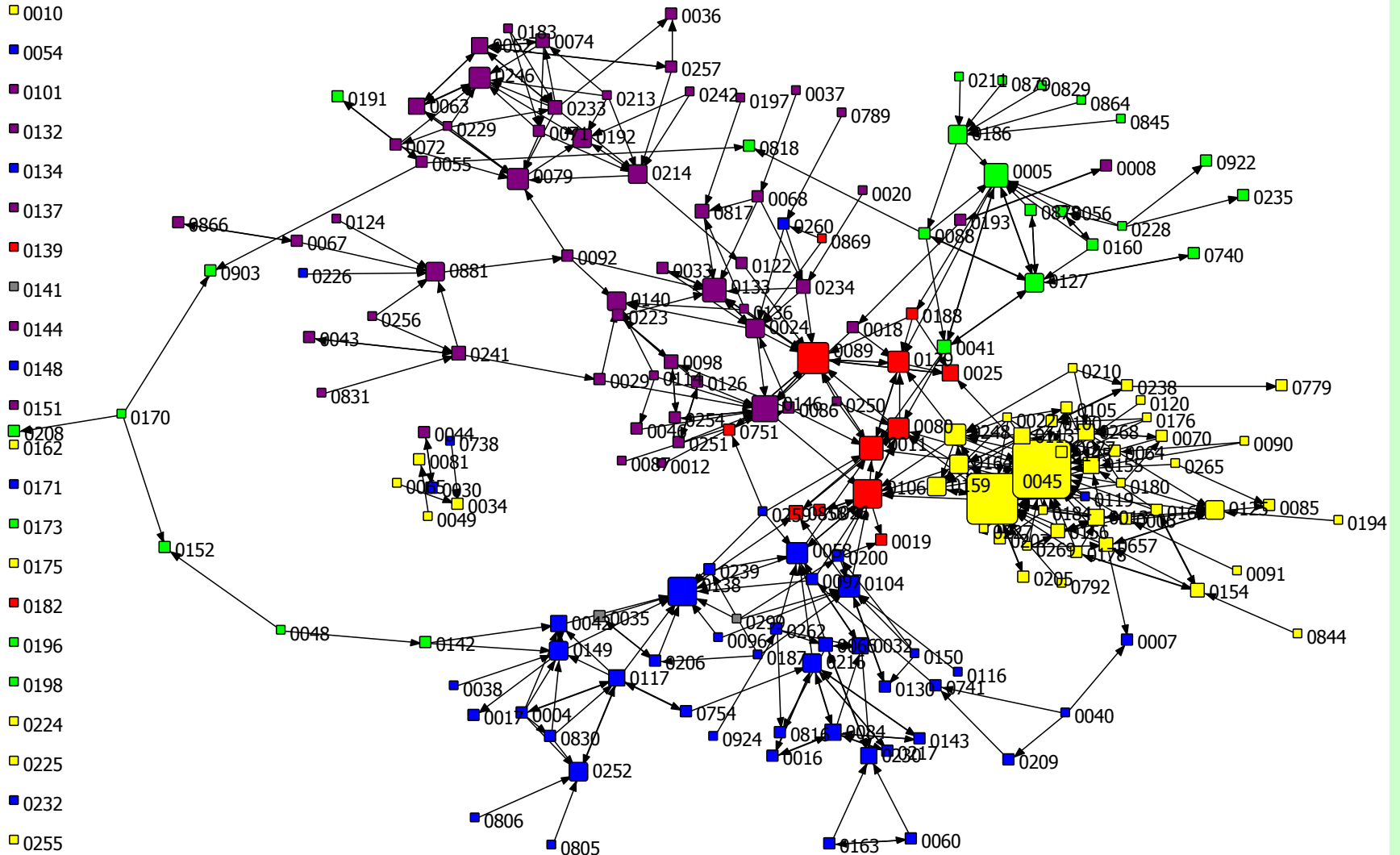
Indegree



Sub-graphs

- **Clusters based on attributes**
- **Cliques**
- **Blocks**

Divisions

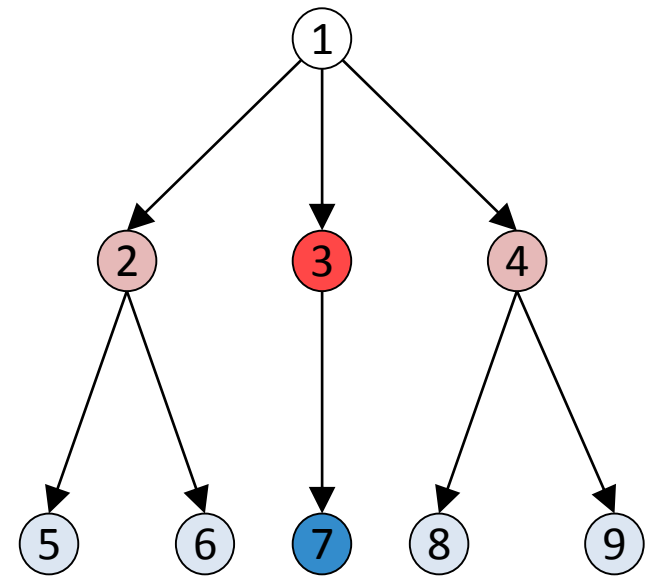


Social equivalence

- Goal: define a rule-based equivalence relation that will partition a set of actors into positions and roles
- Common definitions:
 - Structural Equivalence (equivalent positions)
 - Regular Equivalence (equivalent roles)

Comparing Equivalences

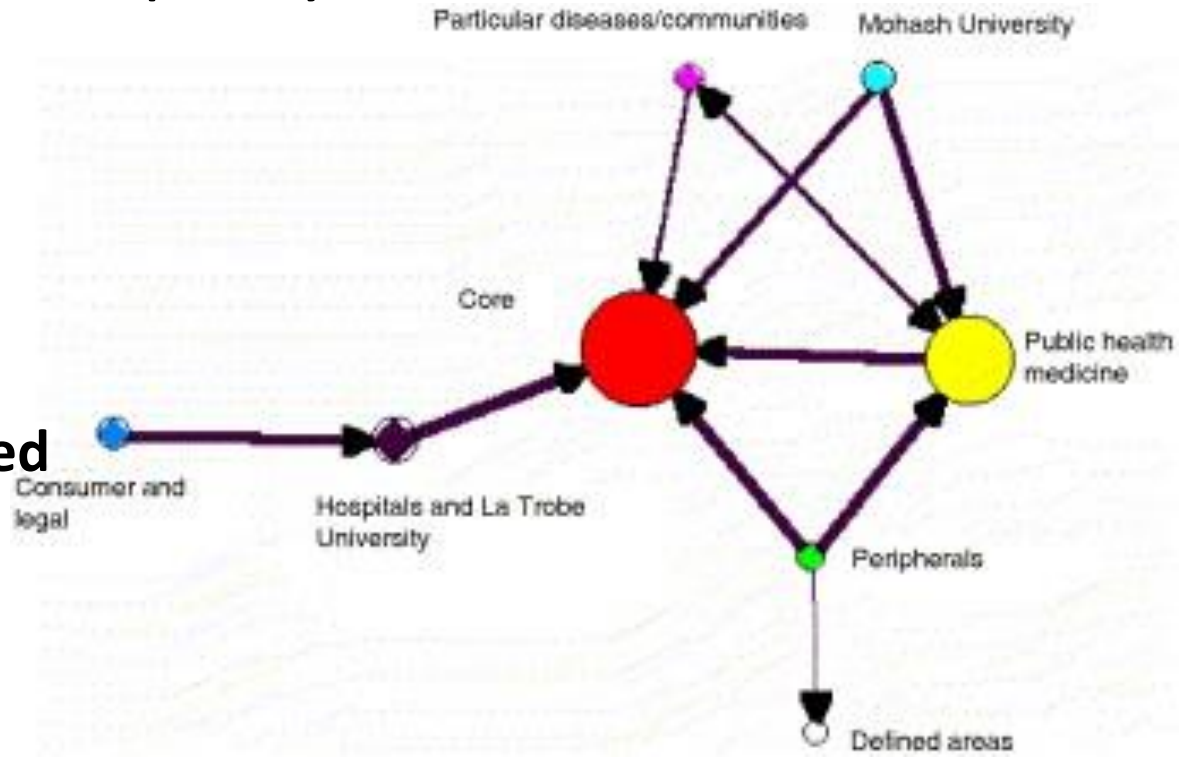
- Structural: connect to exactly the same neighbors
 - {5,6}, {8,9}, singletons
- Regular: connect to the same colors (recolor the graph: sender, repeater, sink)
 - {5,6,7,8,9}, {2,3,4}, {1}

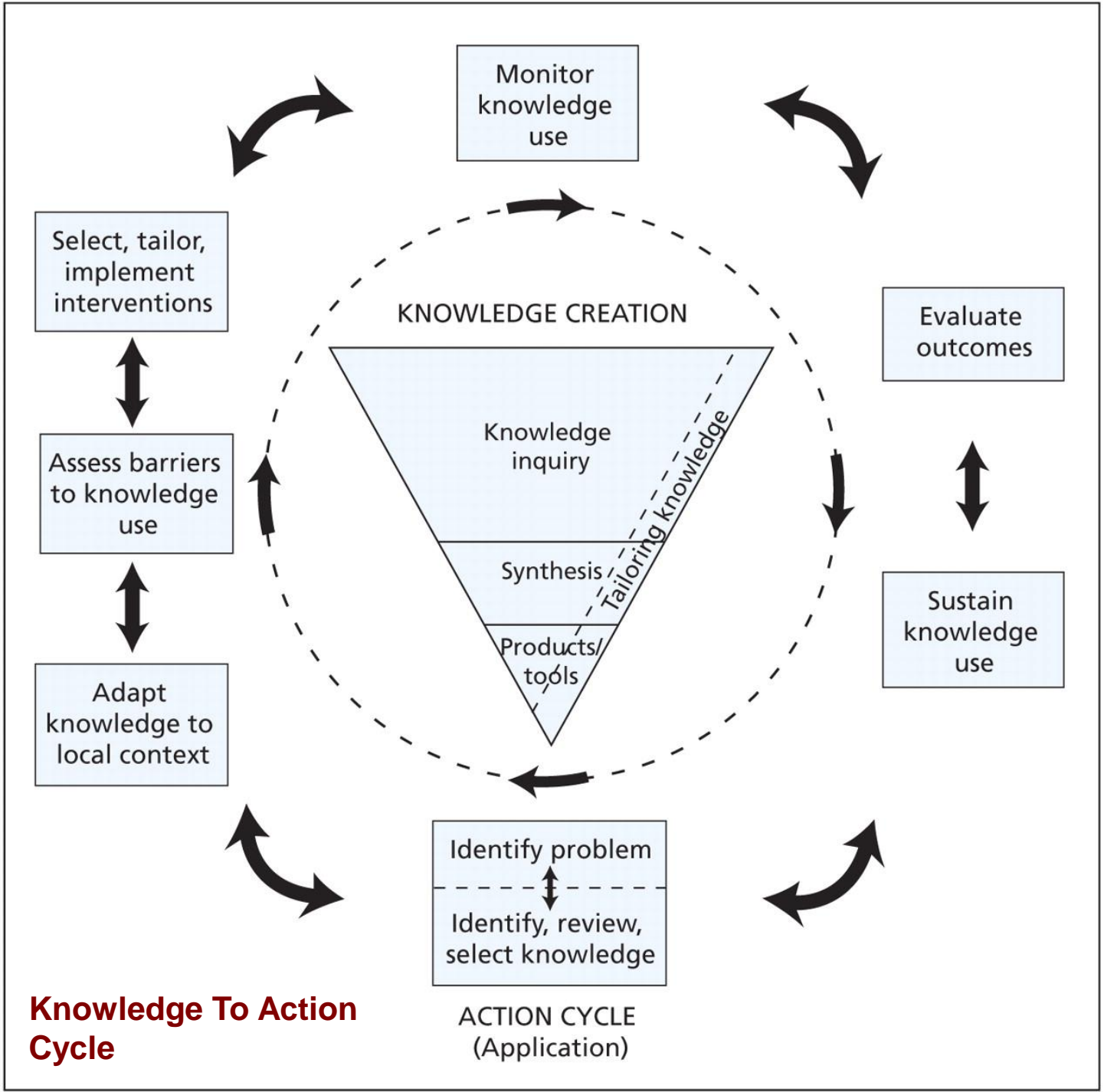


Being around and knowing the players: Networks of influence in health policy

- the power of the medical profession in the health policy arena, by analysing which actors are perceived as influential, and how influence is structured in health policy

- Blockmodeling
- Influentials:
 - academics,
 - medically qualified
 - male

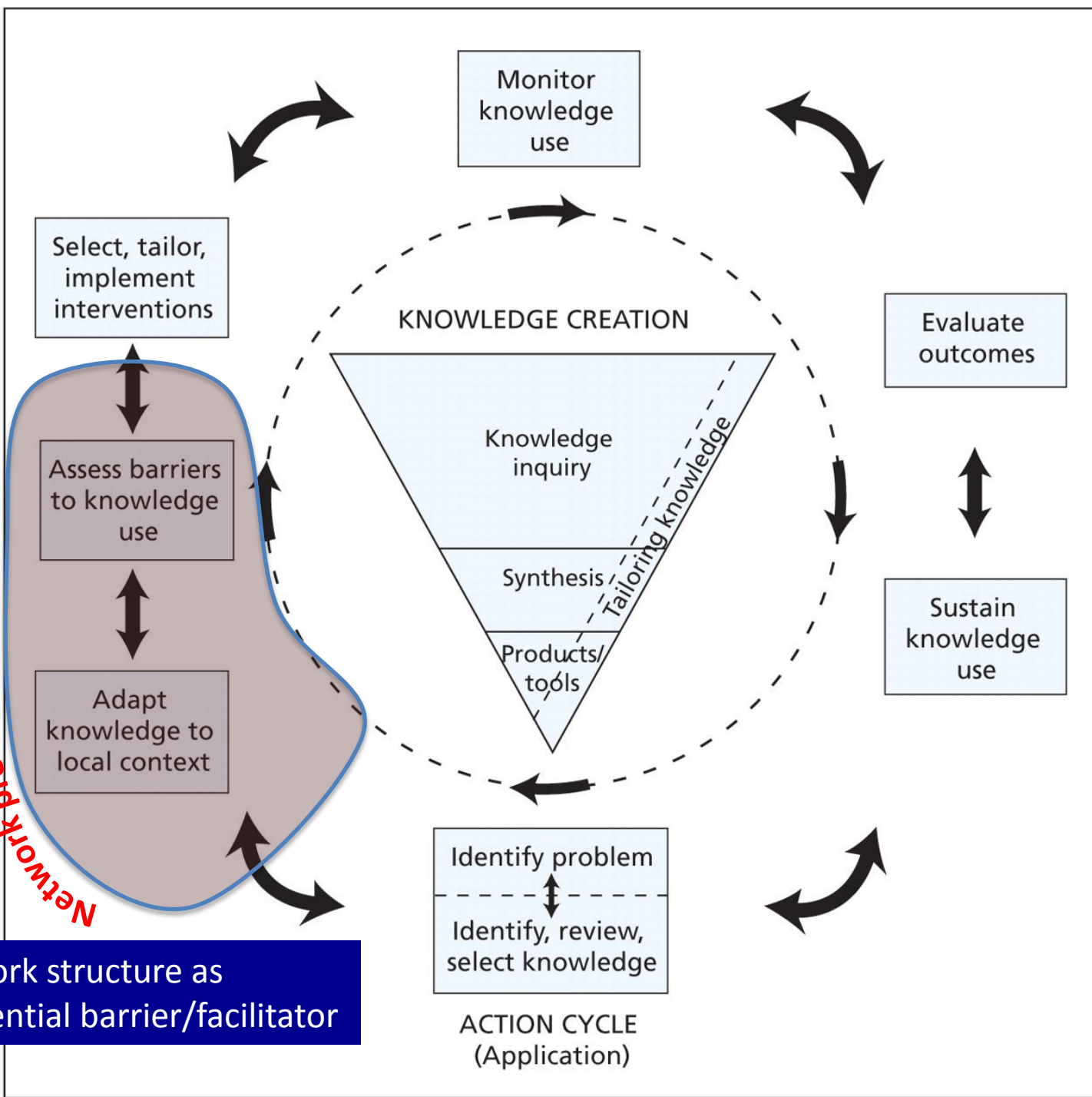




Knowledge To Action Cycle

ACTION CYCLE (Application)

Network predictors



- Network structure as potential barrier/facilitator

Statistical analysis of social networks

- social network analysis is about relations among actors, not about relations between variables.
- Most conventional statistical tests are about the distributions and relations of attributes

- John's income is independent from George's
- John's tie to Sue is not necessarily independent from George's tie to sue

John and George are either very happy or unhappy about each other presence!

Social selection vs. social influence

- Time 1: Jack is not smoker. John is smoker.
Jack and John are not friends
- Time 2: Jack and John are both smokers and friends

Social influence

- how interactions in social networks affect the attitudes, beliefs and behaviors of individuals.
- one person's response is modified by the actions of other people
- Hierarchy vs. solidarity

Formation of norms

- individuals' tendency to reach agreement with their peers
- Social influence vs. similarity of social roles

Social influence of **opinion leaders**

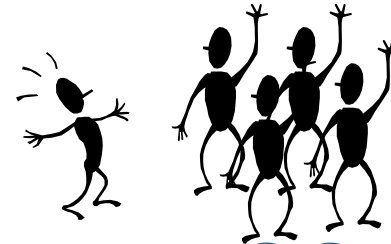
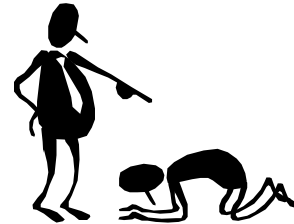
- someone who is able to *informally affect others' attitudes and behaviours* in a desired way
- is earned as a result of **competence**, **accessibility**, **trustworthiness**, and **conformity** to social norms.
- A **sociometric (network)** approach

The Spread of Obesity in a Large Social Network over 32 Years (Christakis & Fowler, 2007)

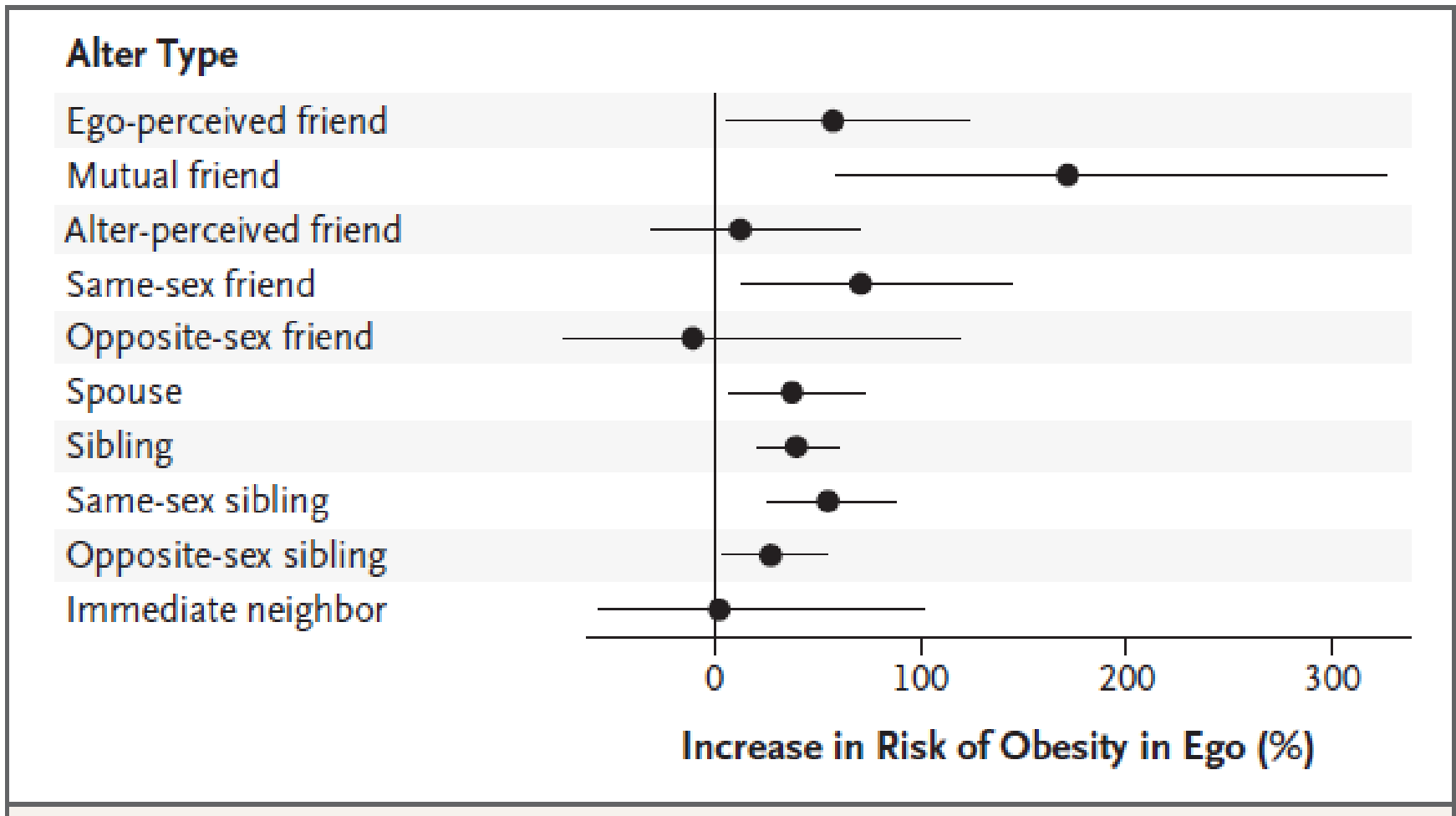
- social network of 12,067 people assessed repeatedly from 1971 to 2003 as part of the *Framingham Heart Study*.
- longitudinal GEE model
- whether weight gain in one person was associated with weight gain in his or her friends, siblings, spouse, and neighbors.

Theoretical framework

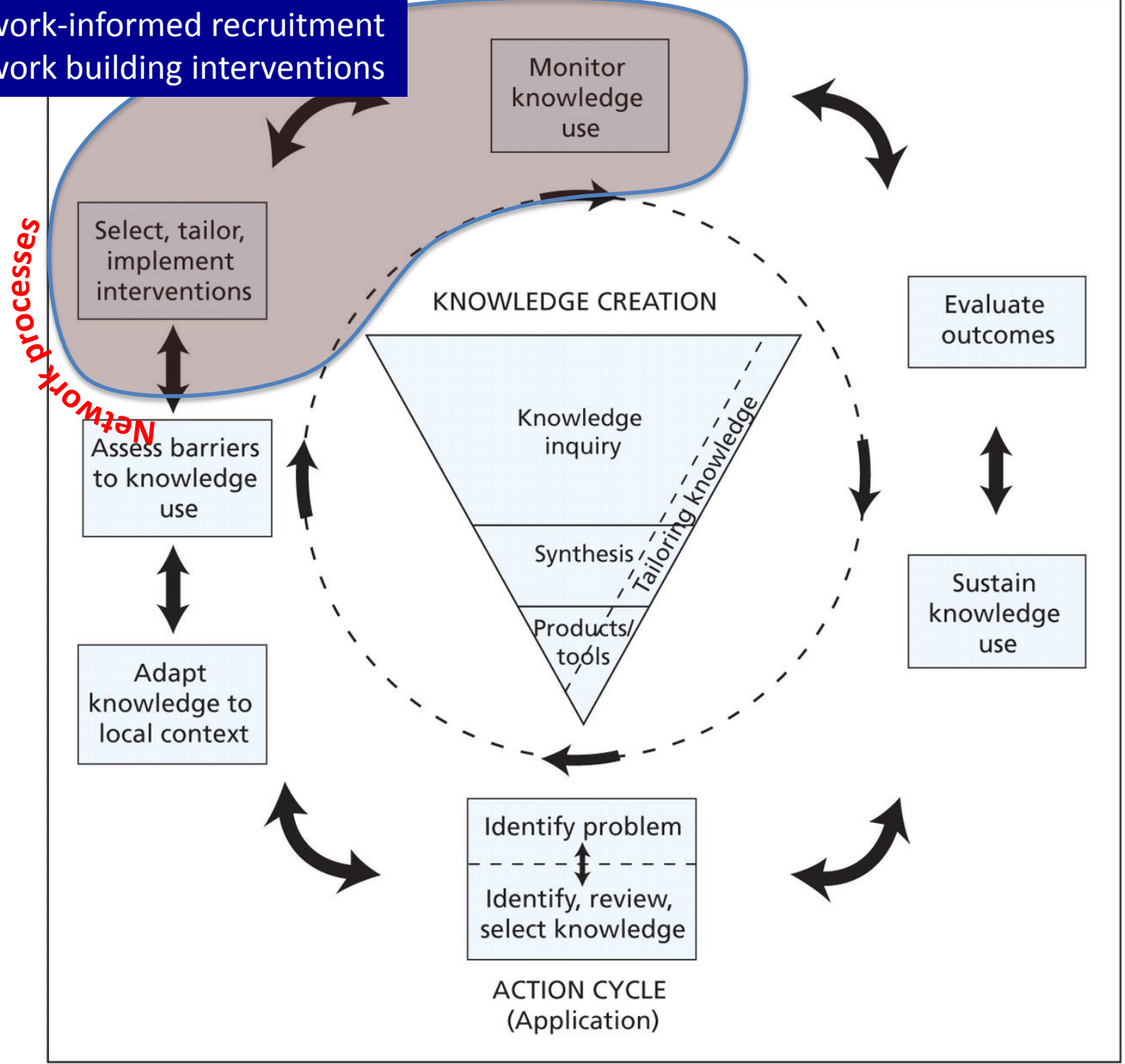
- **Social influence/induction**
- **Social selection/homophily**
- **Common context**



Christakis & Fowler, 2007



- Network-informed recruitment
- Network building interventions



Social selection

- formation of social ties based on the characteristics of the actors

Homophily

- the contact among more similar people, in terms of social attributes
- social characteristics tend to aggregate and shape local clusters
- Most common: race, gender, age, social class, and education

Choosing information source

- Borgatti and Cross (2003)
 - transactive memory
 - social exchange theory

Knowledge and recognition

Accessibility and ease

Potential costs



Exponential Random Graph Models (ERGM)

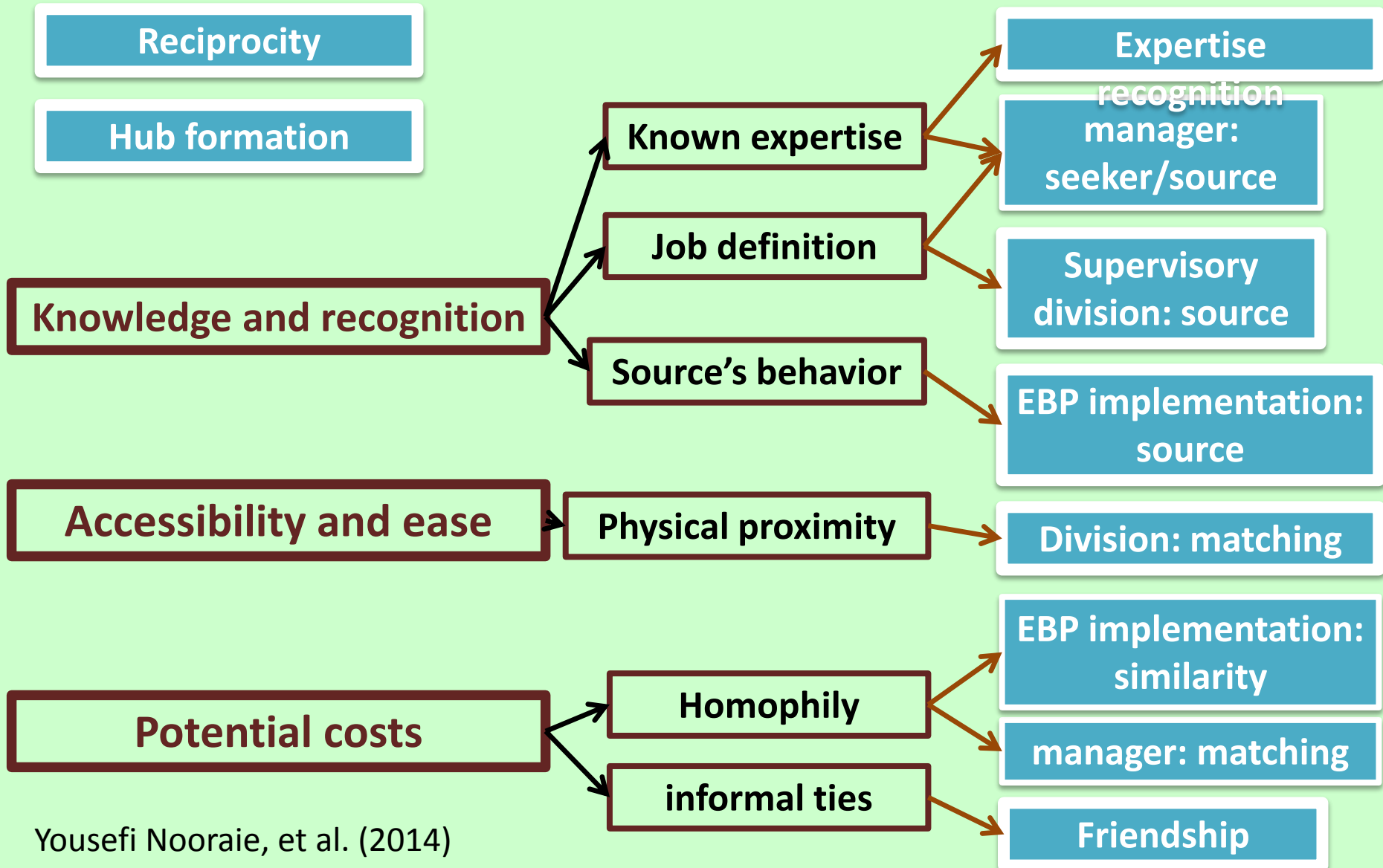
- Markov chain Monte Carlo maximum likelihood method to estimate the network
- the formation of a tie between any pair is also dependent on the existence of ties among other actors in the network.

ERGM predictors

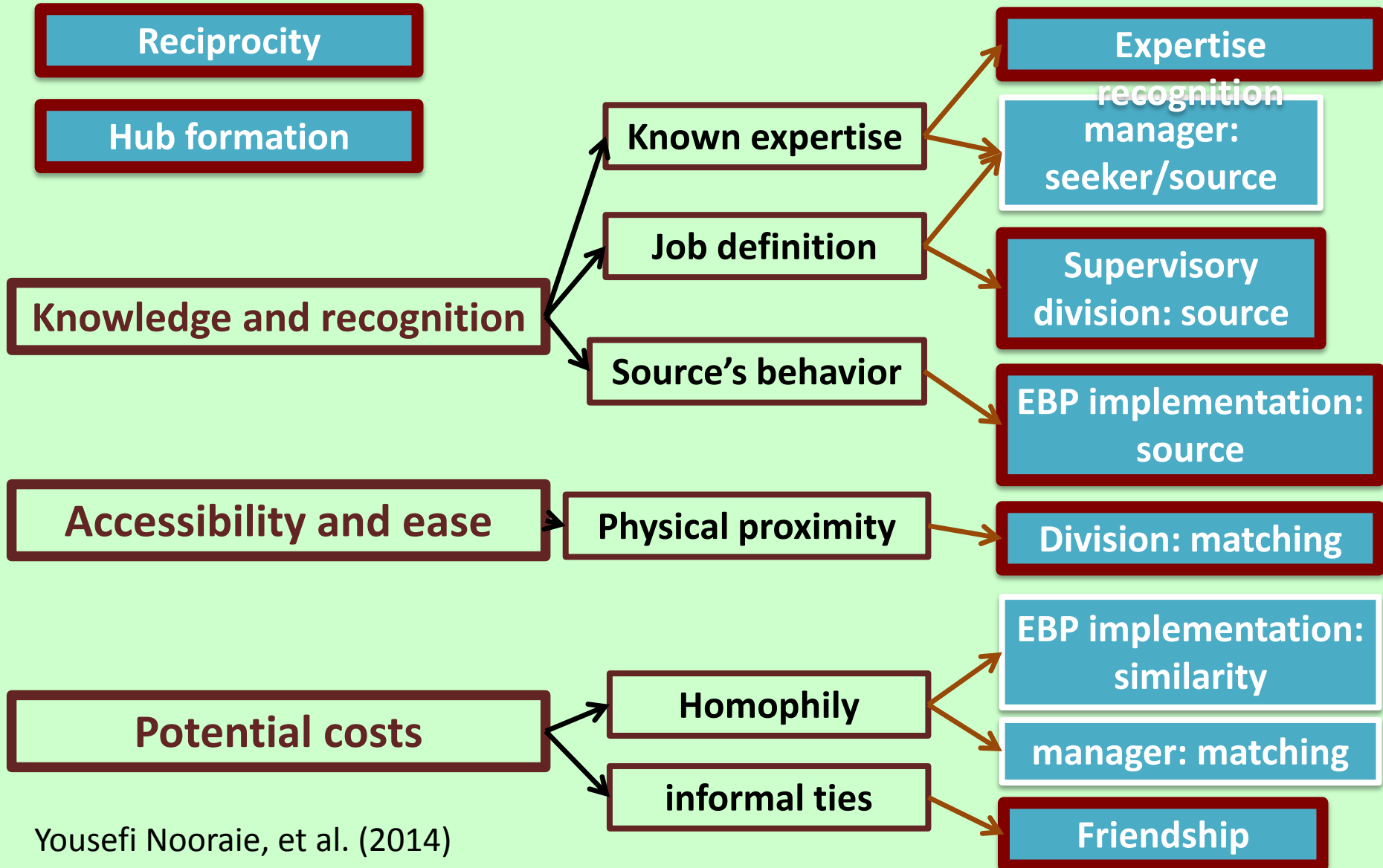
Existence of ties can be explained on the basis of

- actor-based covariate
- dyad-based covariates
- Patterns of further ties in the network

ERGM: Information-seeking

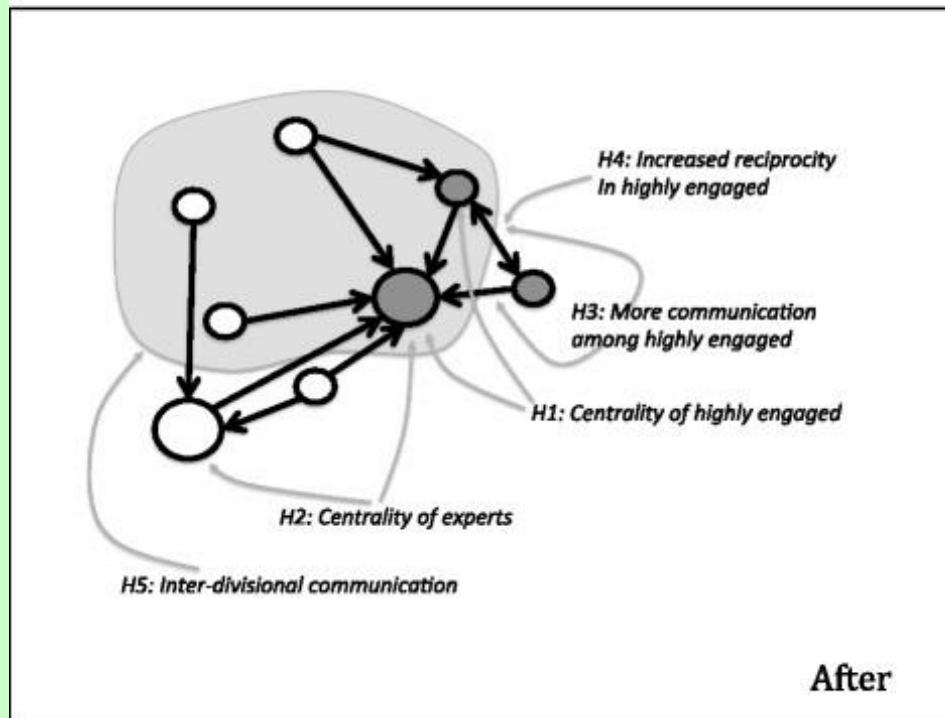
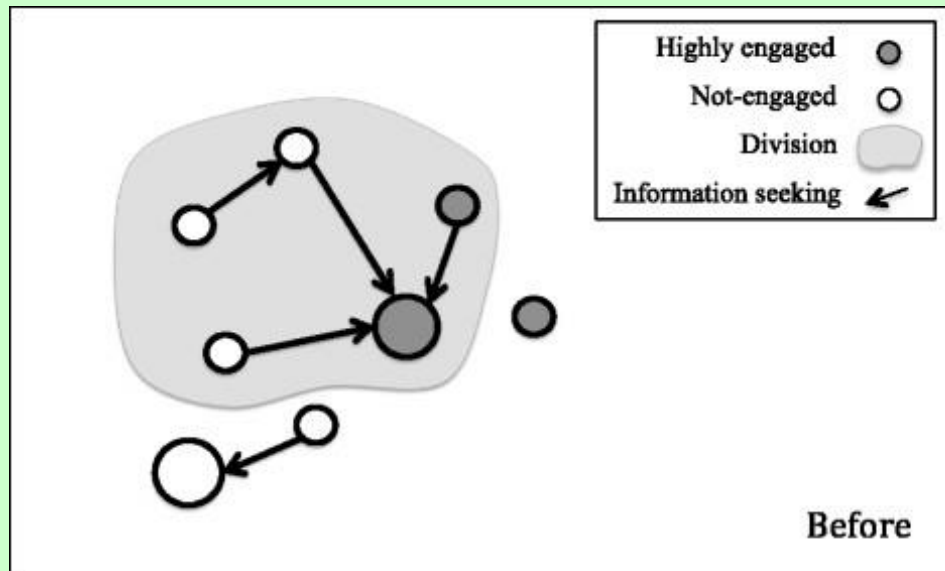


ERGM: Information-seeking



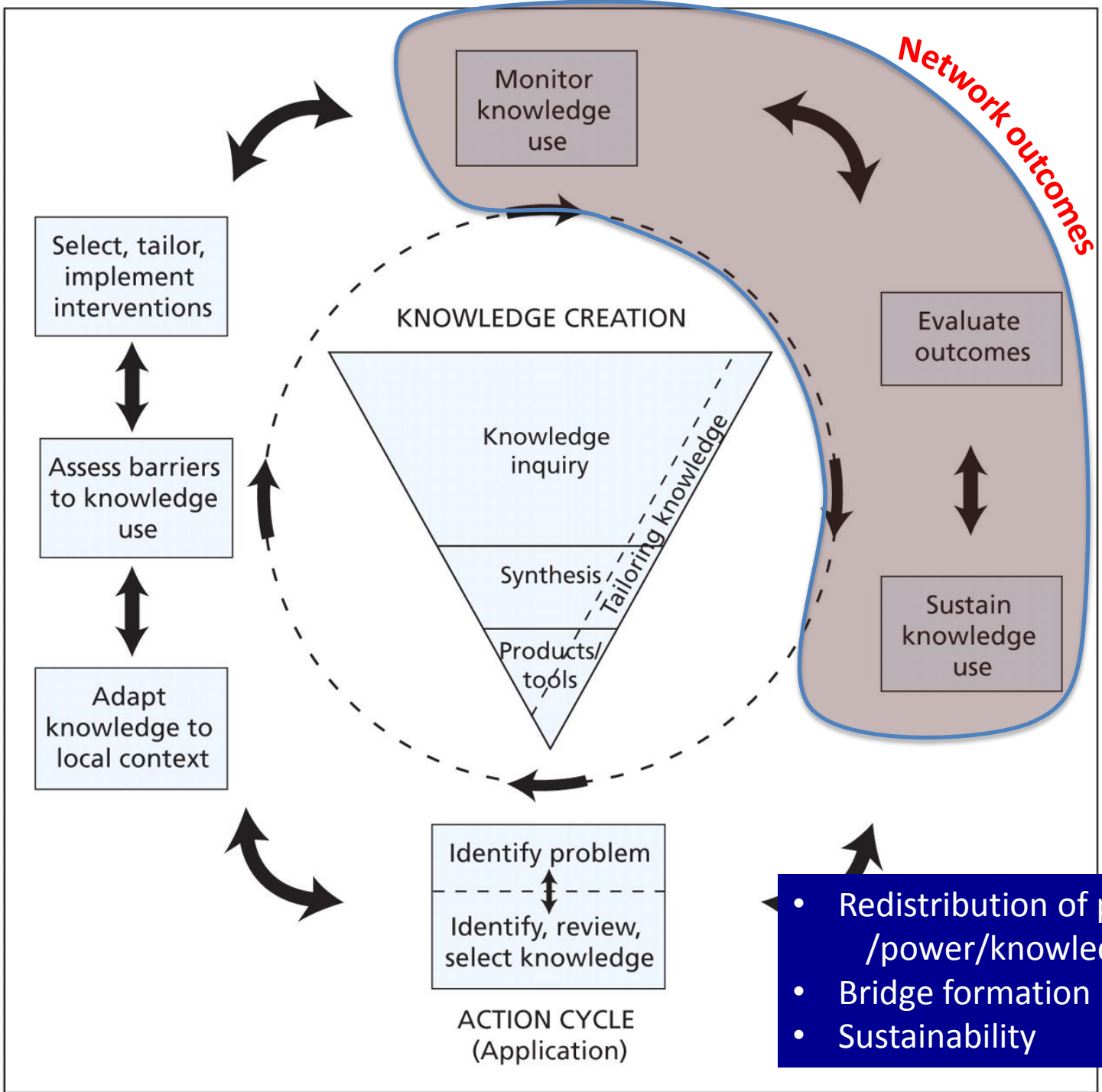
Dynamic actor-oriented modeling

- How the **outcome variable** co-evolves with the longitudinal evolution of **structural**, **node-level**, and **dyadic** variables
 - A Markov process to predict the dynamic changes
- for any point in time, the current state of the network determines probabilistically its further evolution



Rich got richer!

- reciprocity ↓
- Centralization ↑
- Preferential attachment ↑
- higher baseline EBP scores ↑
- Larger improvement in EBP scores ↑
- (In one department) highly engaged staff ↑



Mixed methods studies

Combining qualitative and quantitative studies in order to gain a better understanding of the problem (Creswell & Plano Clark, 2007)


Efficient design to analyze social networks:

- **Informing** the qualitative study by quantitative SNA: directions and highlights
- more **indepth insight** to social networks, both outsider and insider views
- suitable in understanding **the process of change**

Selective training and recognition

- facilitated the identification of experts
 - deepened the knowledge and popularity gap
- better chance to be recruited for the intervention
 - relevance of their formal roles
 - reputation for being knowledgeable
 - venues for presenting and recognizing
 - presentations at department-wide conferences
 - lunch and learn sessions
 - Regular journal clubs

Interdivisional communication

- segregated by organizational divisions
- inter-divisional connections 

- Not sustainable enough
- helped staff in practice-based divisions feel **more confident and less dependent** on external support

SNA-ethics

- Anonymity
- Confidentiality
- Consequences