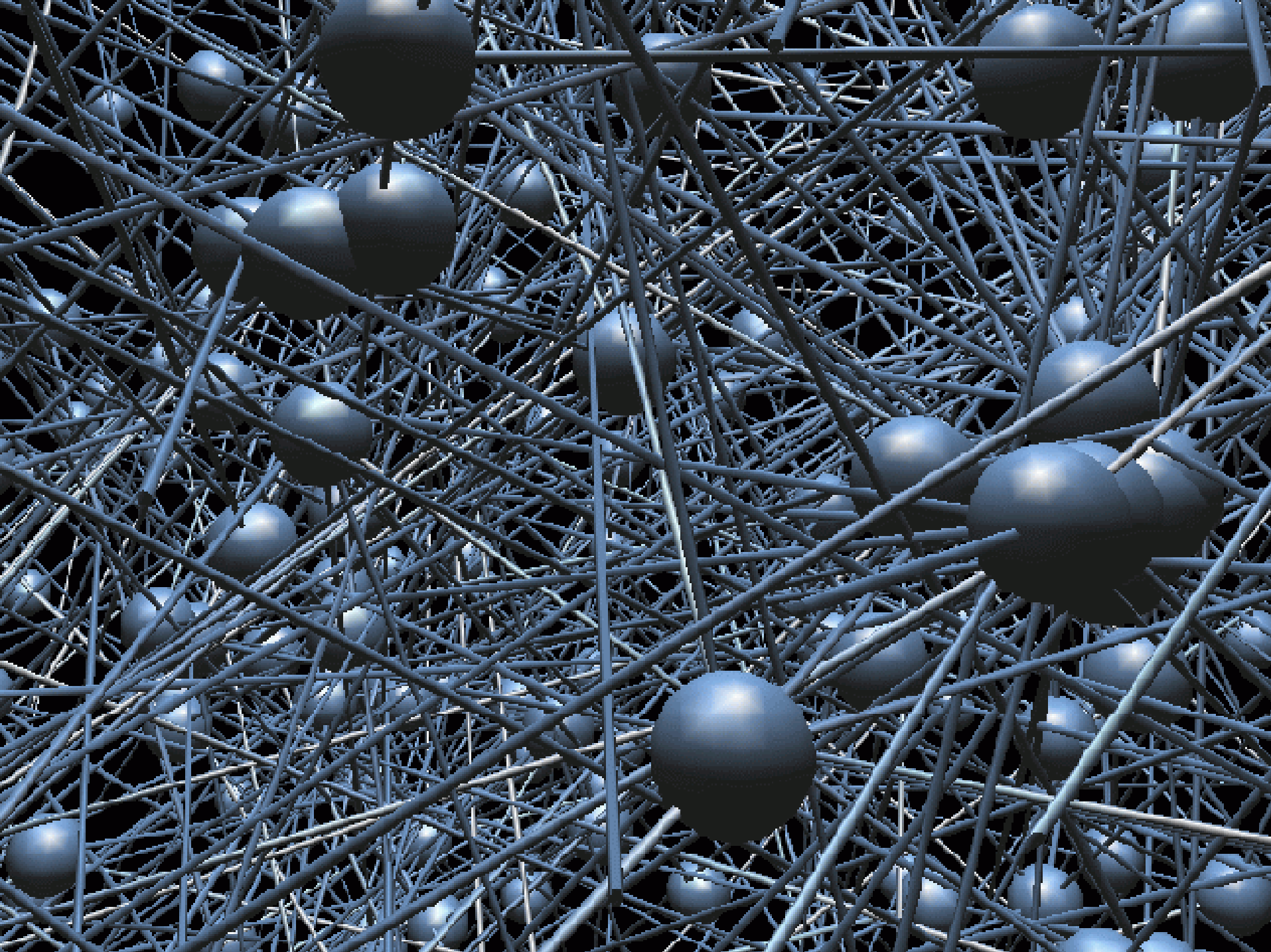


Reference: **www.analytictech.com/networks**

Introduction to Social Networks

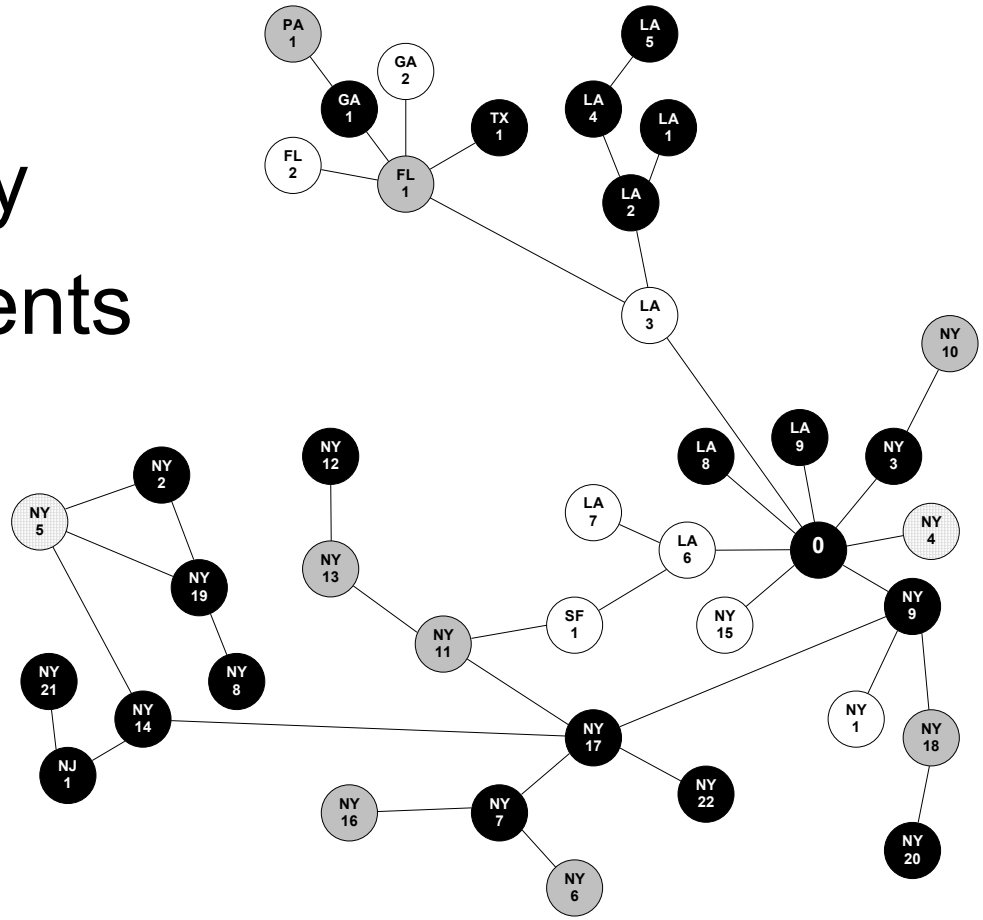
Steve Borgatti, Boston College

www.analytictech.com/borgatti

borgatts@bc.edu

The Discipline of SNA

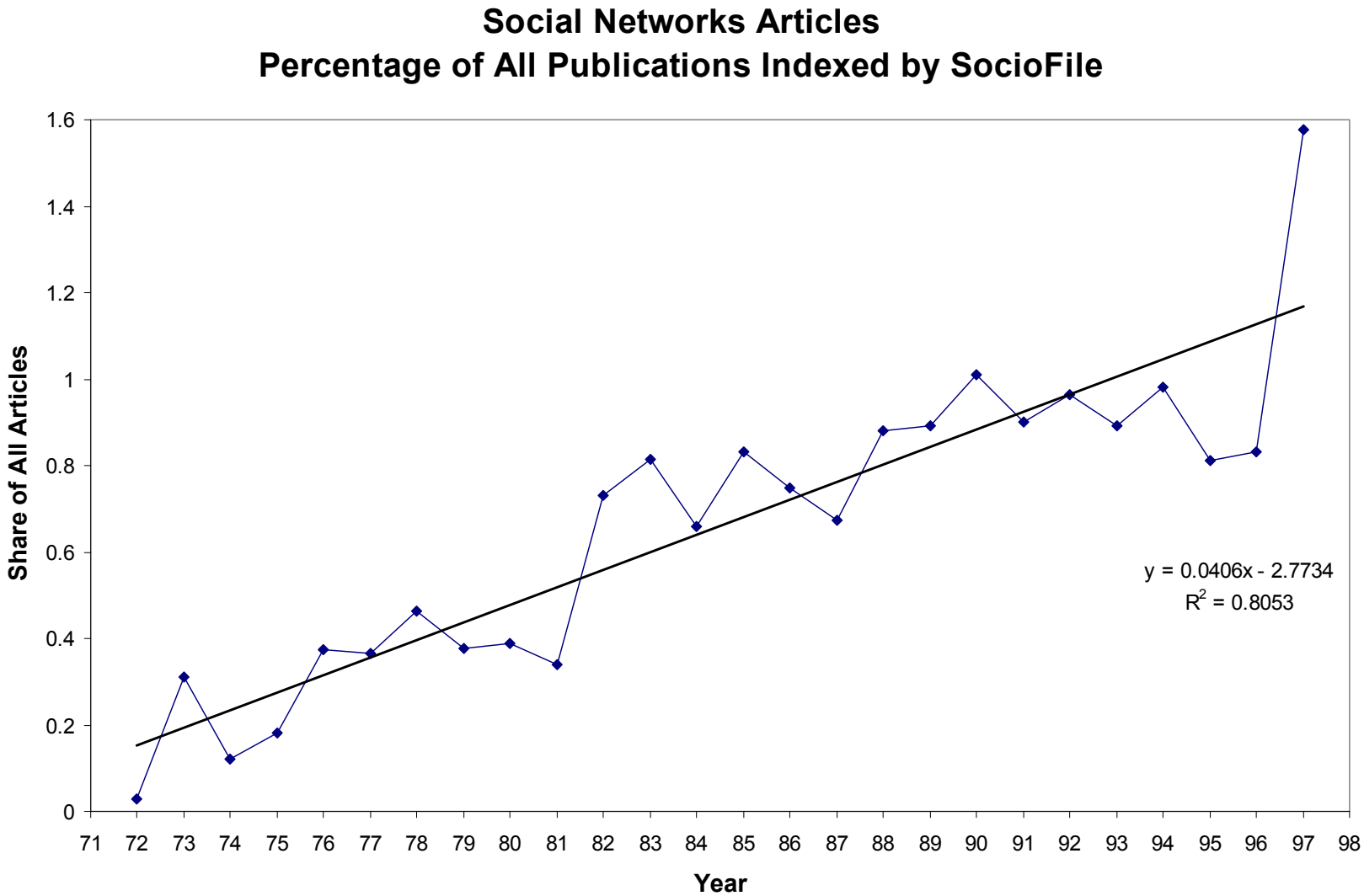
- Growth
- Position in the academic economy
- Professional elements



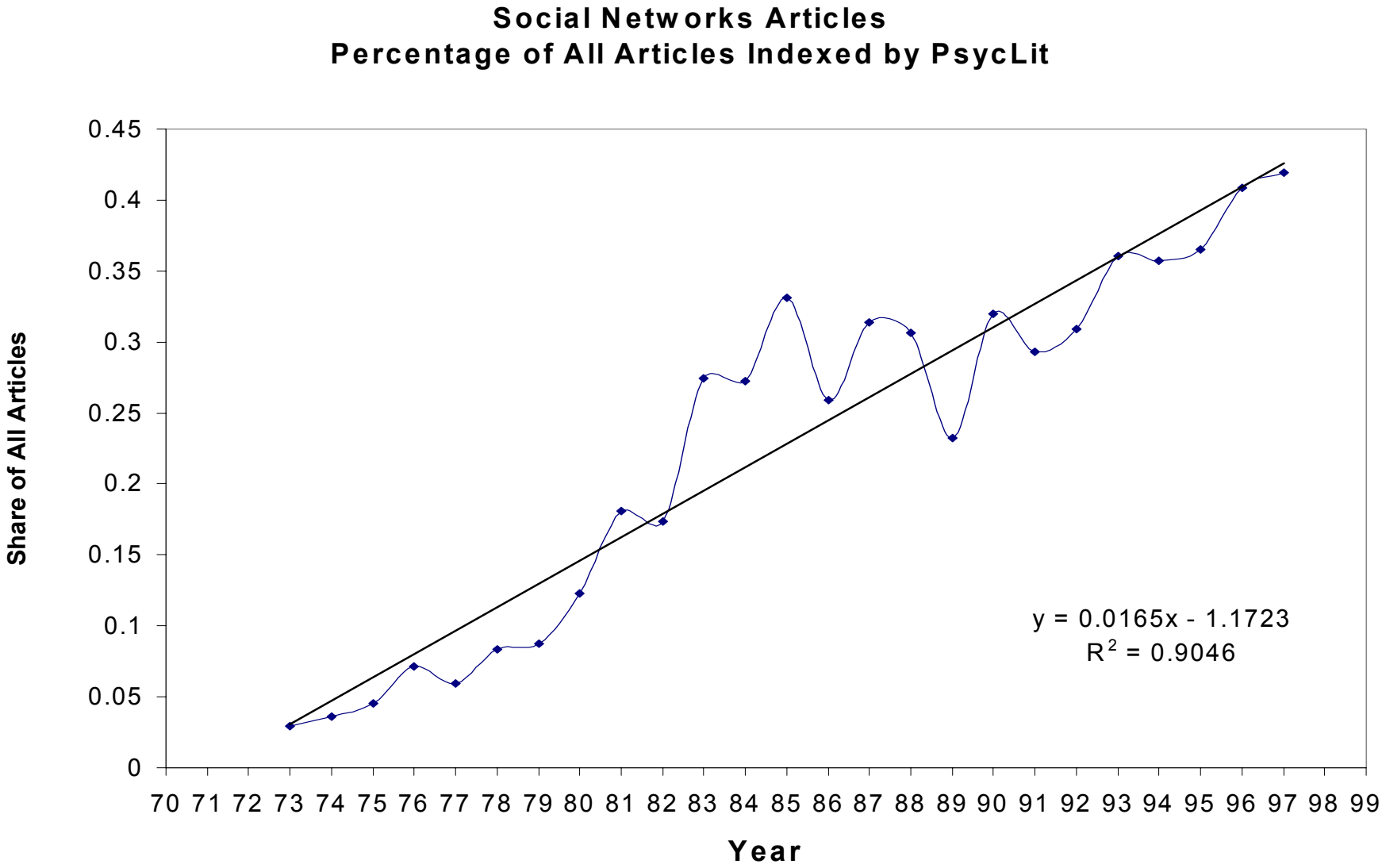
Fast-Growing Sub-Discipline

- Popular culture
  - Games, plays, television
  - Forbes, Fortune, NY Times
- Business Practitioners
  - New concepts, tools for mgmt consultants
  - New org forms; knowledge management
- Academia
  - Multiple fields from linguistics to AIDS research to political science to sociology

Growth in Sociology



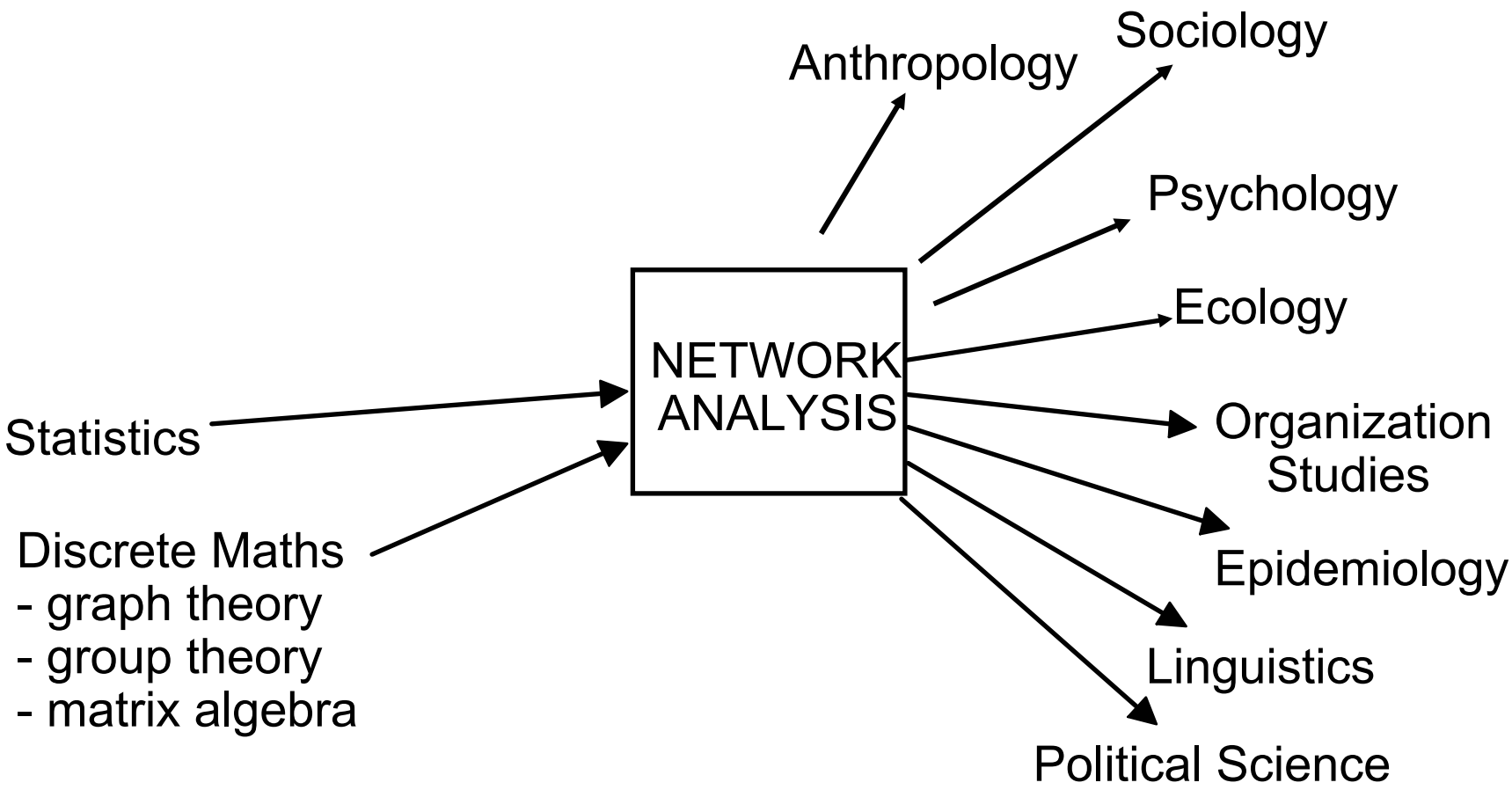
Growth in Psychology



Multiple Sources

- Sociometry & psychometry
  - Jacob Moreno
- Social anthropology
  - kinship algebra; social relations school
- Sociology
  - Simmel; Durkheim; structuralism
- Discrete maths
  - graph theory; matrix algebra; group theory, etc

Position in the Academy



Professional Elements

- Professional association (since ‘78)
  - INSNA (Int'l Network for Social Network Analysis) **http://www.sfu.ca/~insna/**
- Sunbelt Annual Conference (since ‘79)
  - 2001: Budapest, HUNGARY. June.
  - 2002: New Orleans, LA. February
  - 2003: Cancun, MEXICO
  - 2004: May 12 - 16, Portorož, Slovenia

Professional Elements - 2

- Specialized journals
  - *Social Networks*, (since ‘79)
  - *CONNECTIONS*, official bulletin of INSNA
  - *Journal of Social Structure* (electronic)
- Textbooks
  - Scott, John. 1991/2000.
  - Degenne & Forsé. 1999.
  - Wasserman & Faust. 1994.

Professional Elements - 3

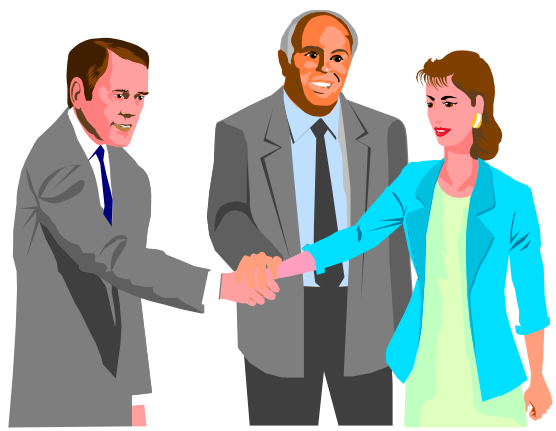
- Software
  - UCINET 6/NETDRAW; PAJEK
  - STRUCTURE; GRADAP; KRACKPLOT
- Regular Training Workshops
  - Sunbelt social networks conference
  - Academy of Management
  - University of Essex
  - ICPSR

Professional Elements - 4

- Listservs
  - SOCNET listserv
    - to subscribe, send “sub socnet <firstname> <lastname>” to listserv@lists.ufl.edu
  - REDES listserv
    - http://seneca.uab.es/antropologia/redes/lista.htm

What is a Network?

- A set of concrete nodes (“actors”)
  - individuals (e.g., persons)
  - collectivities (e.g., organizations, countries)
- A set of concrete ties, all of the same type, that connect them
  - each tie is an element of a binary social relation such as “is a friend of”



Kinds of Nodes

- Individuals
  - persons
  - other animals
- Collectivities
  - organizations, departments, teams, troops
  - countries, cities
  - species

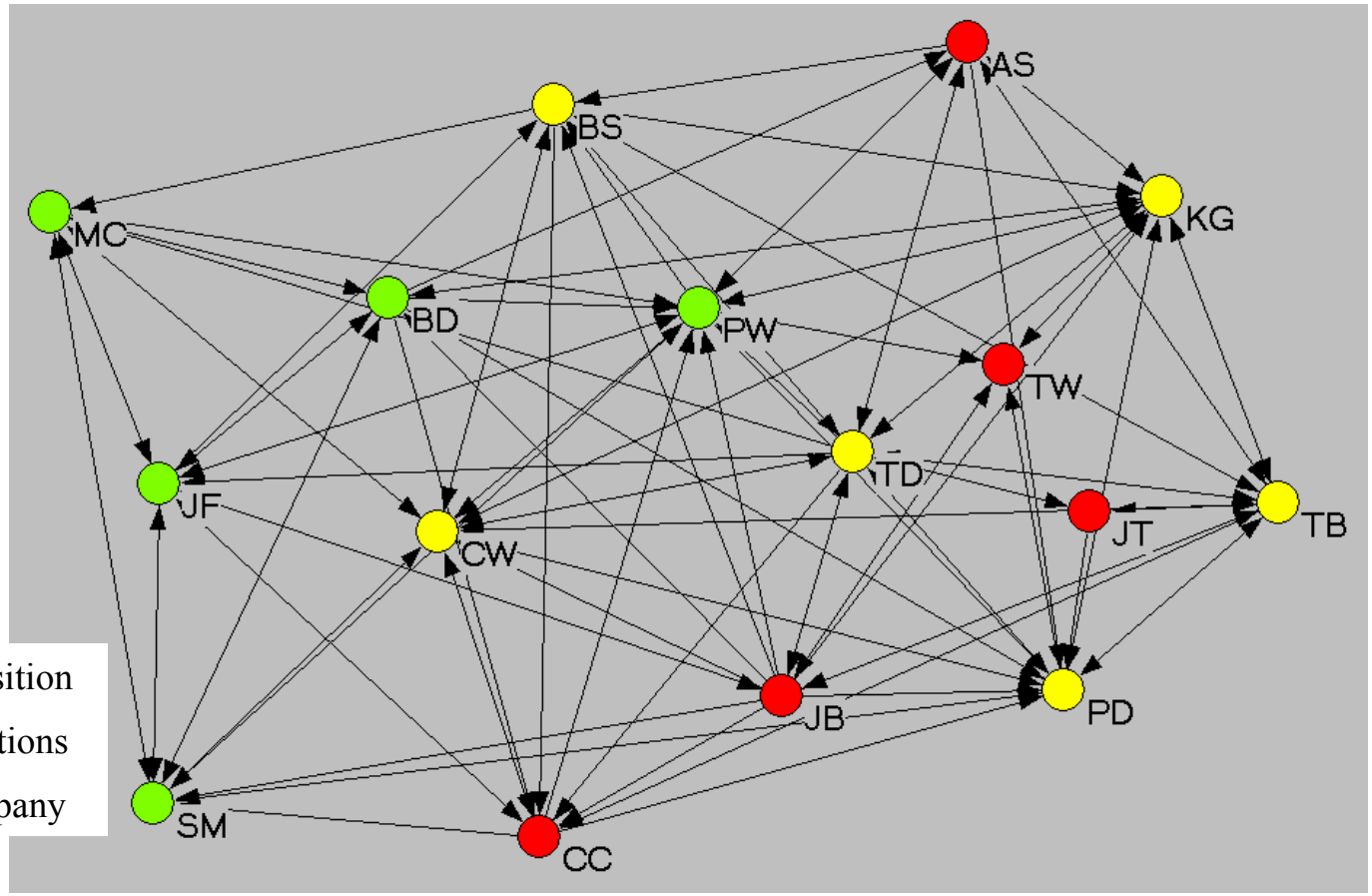
Social Relations Among Persons

- Kinship
  - mother of
- Other social role-based
  - boss of, friend of
- Cognitive/perceptual
  - knows
  - aware of what they know
- Affective
  - likes
  - trusts
- Interactions
  - give advice, talks to
  - sex / drugs with
- Affiliations
  - belong to same clubs
  - is physically near

Simple Answers

Who you ask for answers to straightforward questions.

HR Dept
of Large
Health Care
Organization

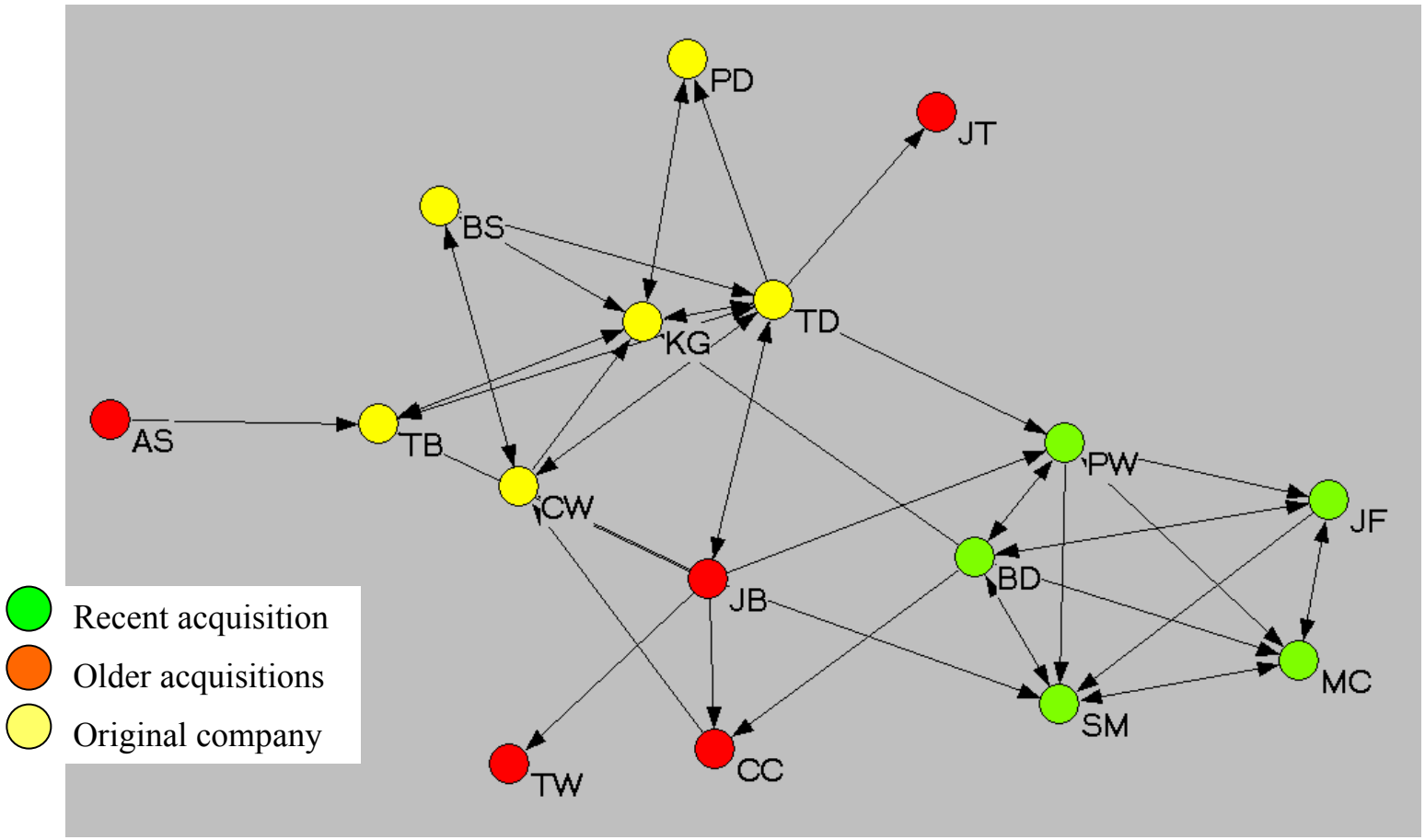


Recent acquisition
Older acquisitions
Original company

Data drawn from Cross, Borgatti & Parker 2001.

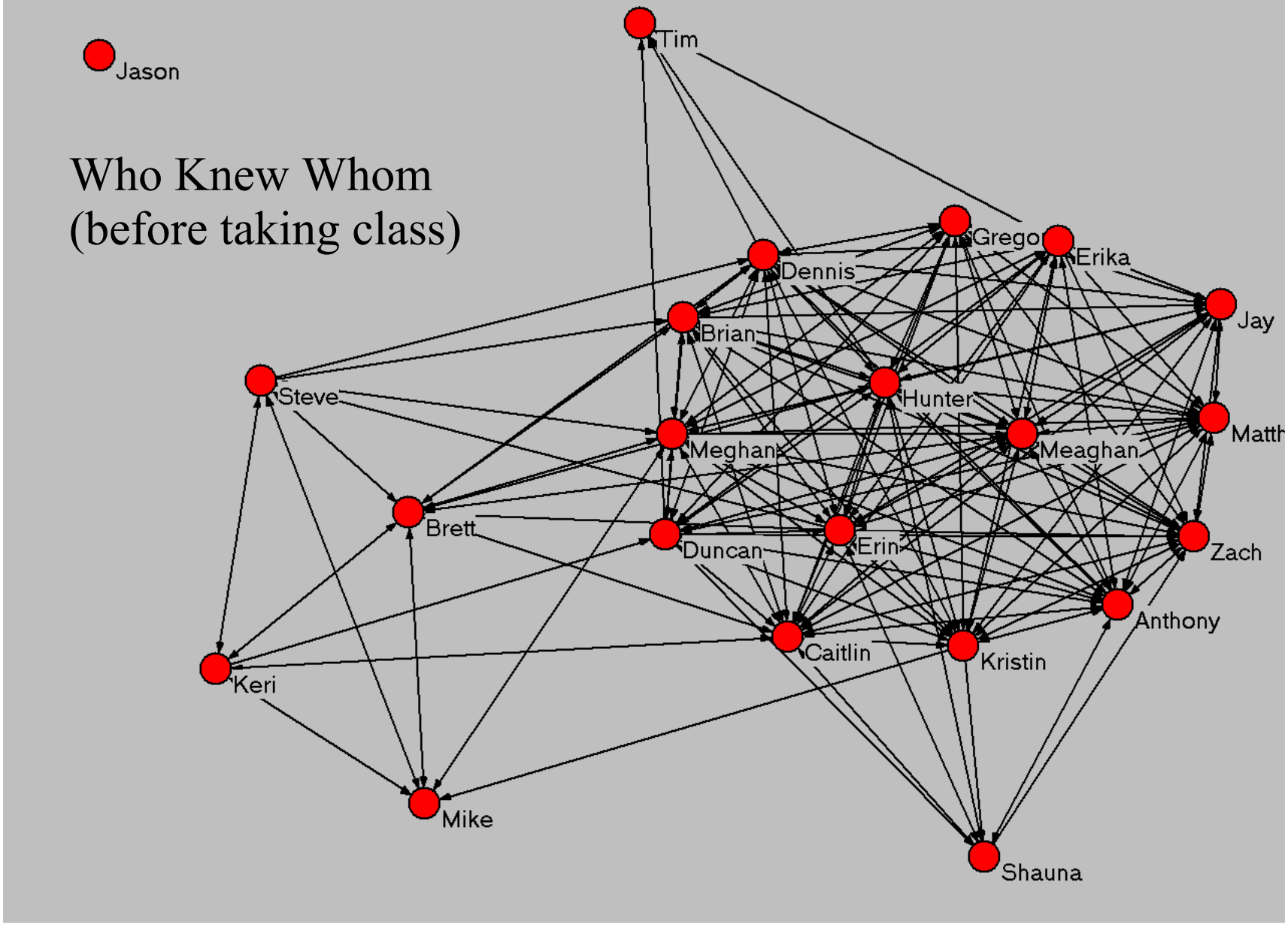
Problem Reformulation

Who you see to help you think through issues

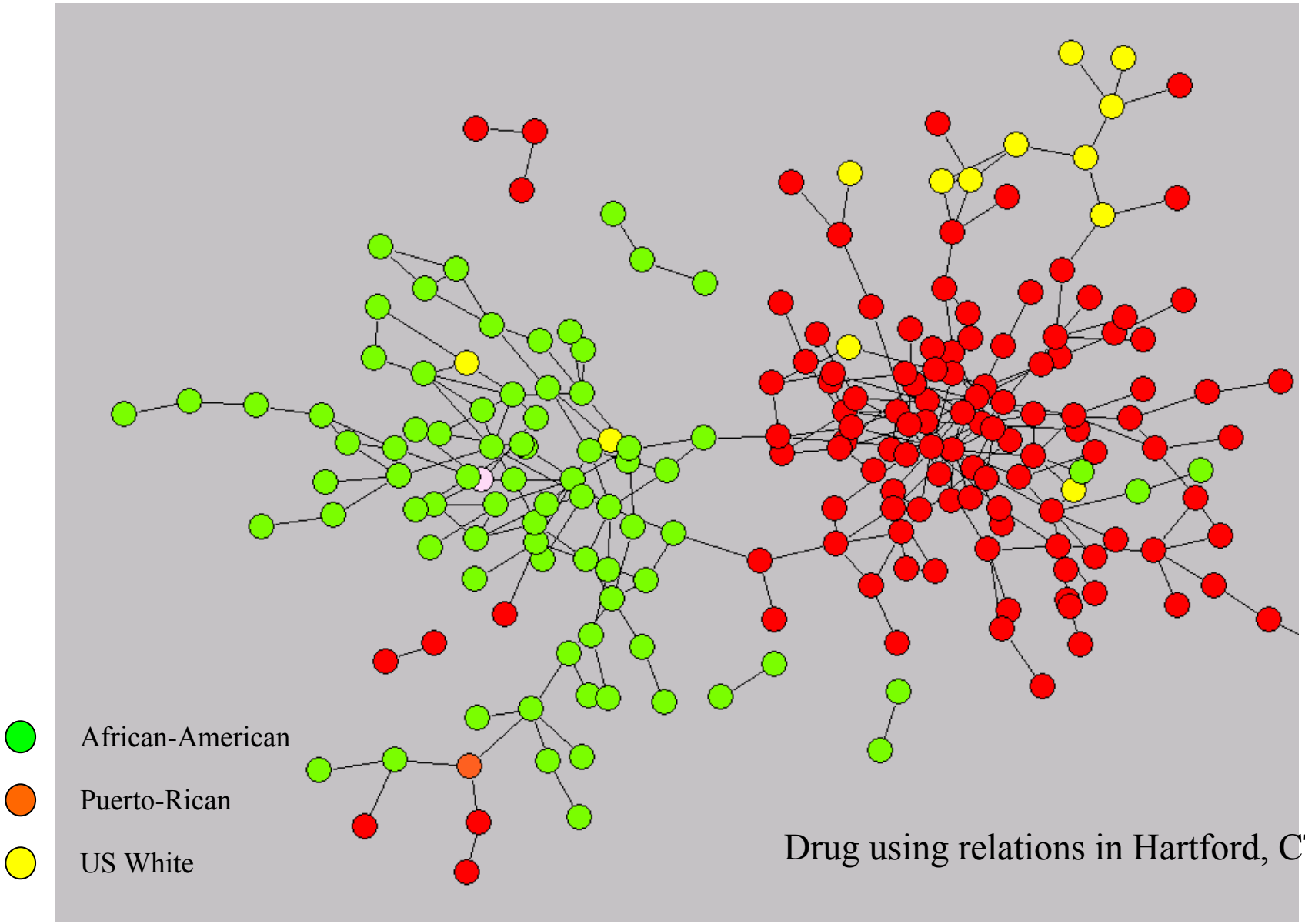


Data drawn from Cross, Borgatti & Parker 2001.

Who Knew Whom (before taking class)

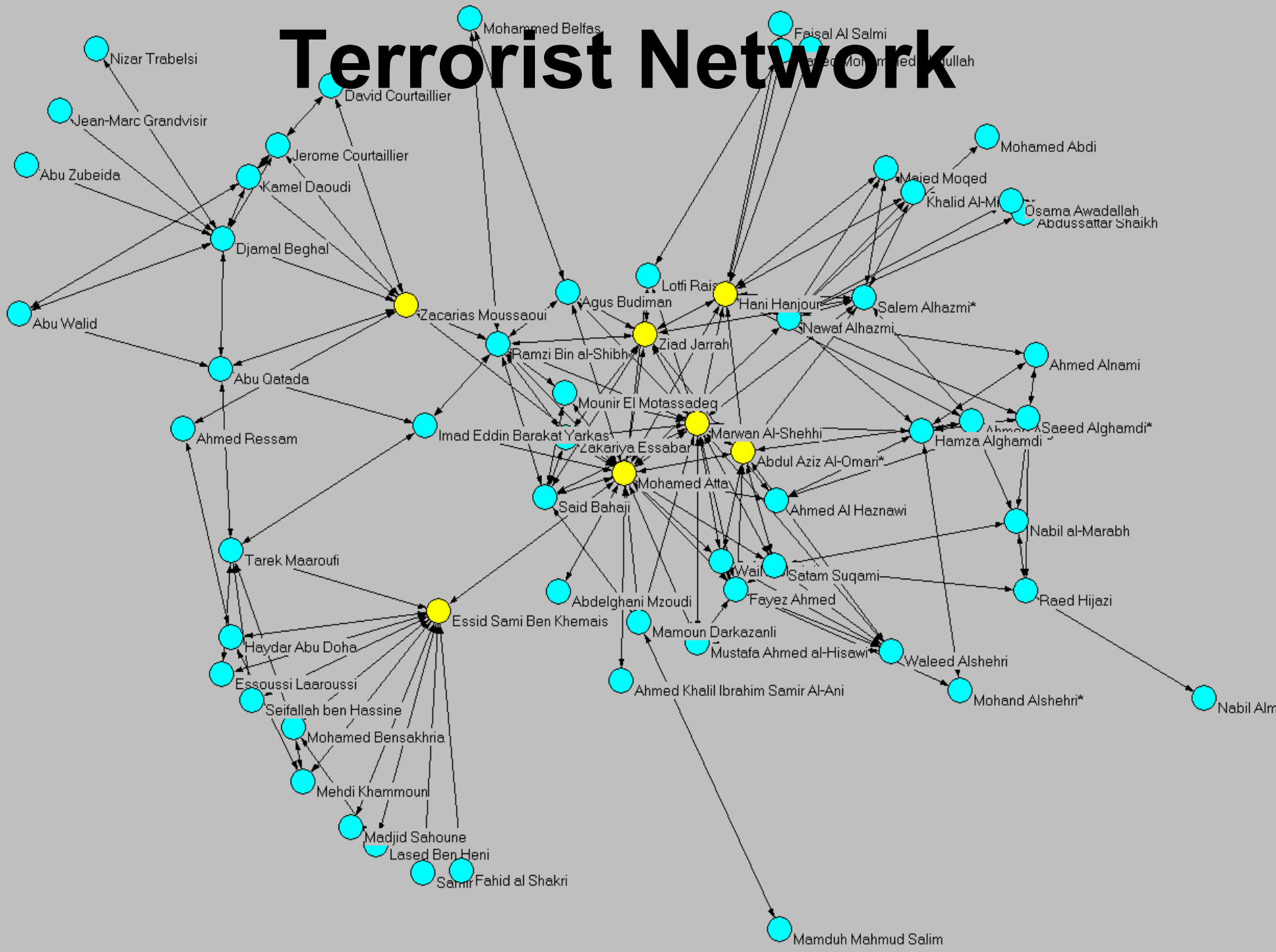


“Injects Drugs With” Relation

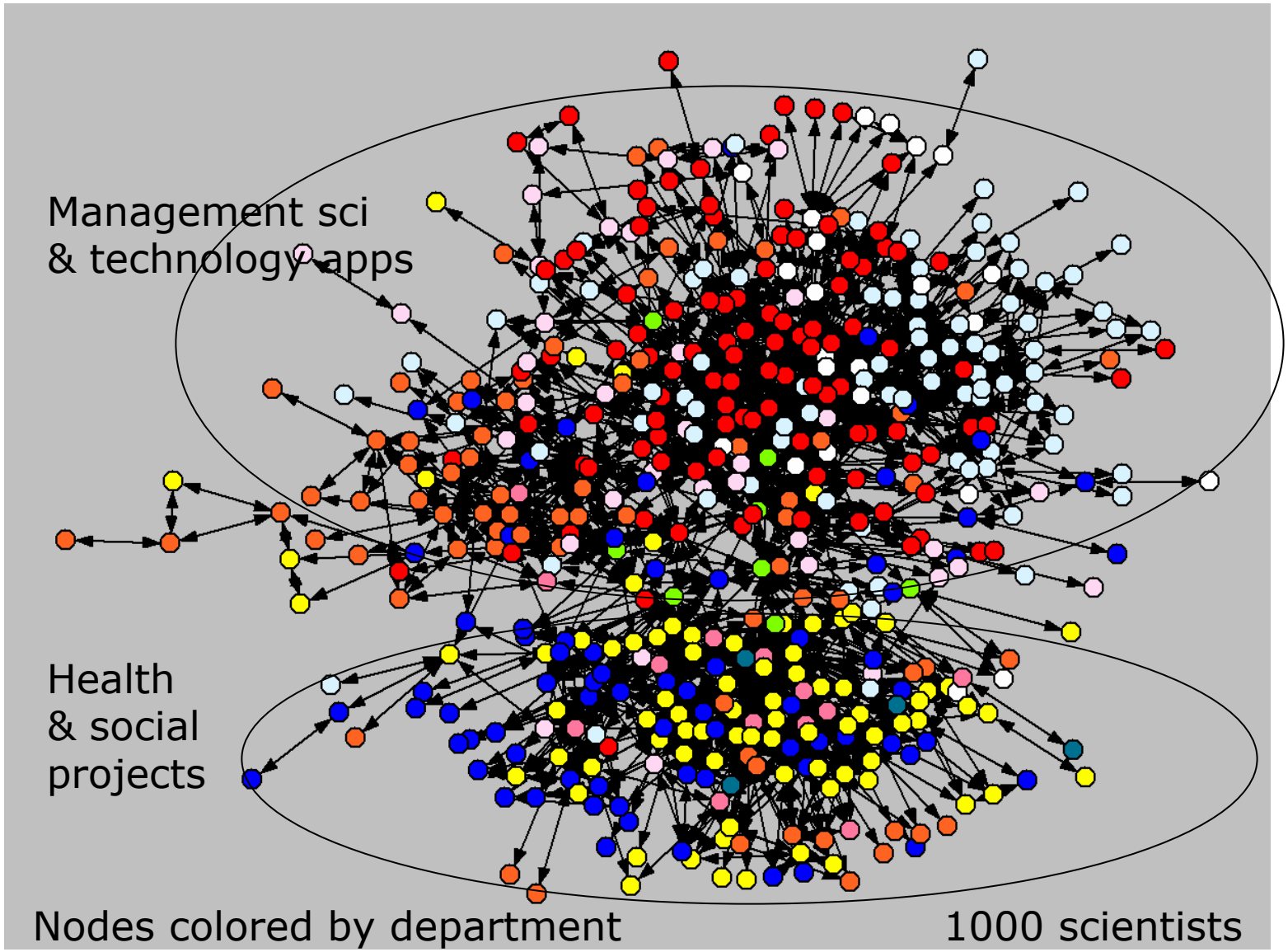


Drug using relations in Hartford, CT

Terrorist Network



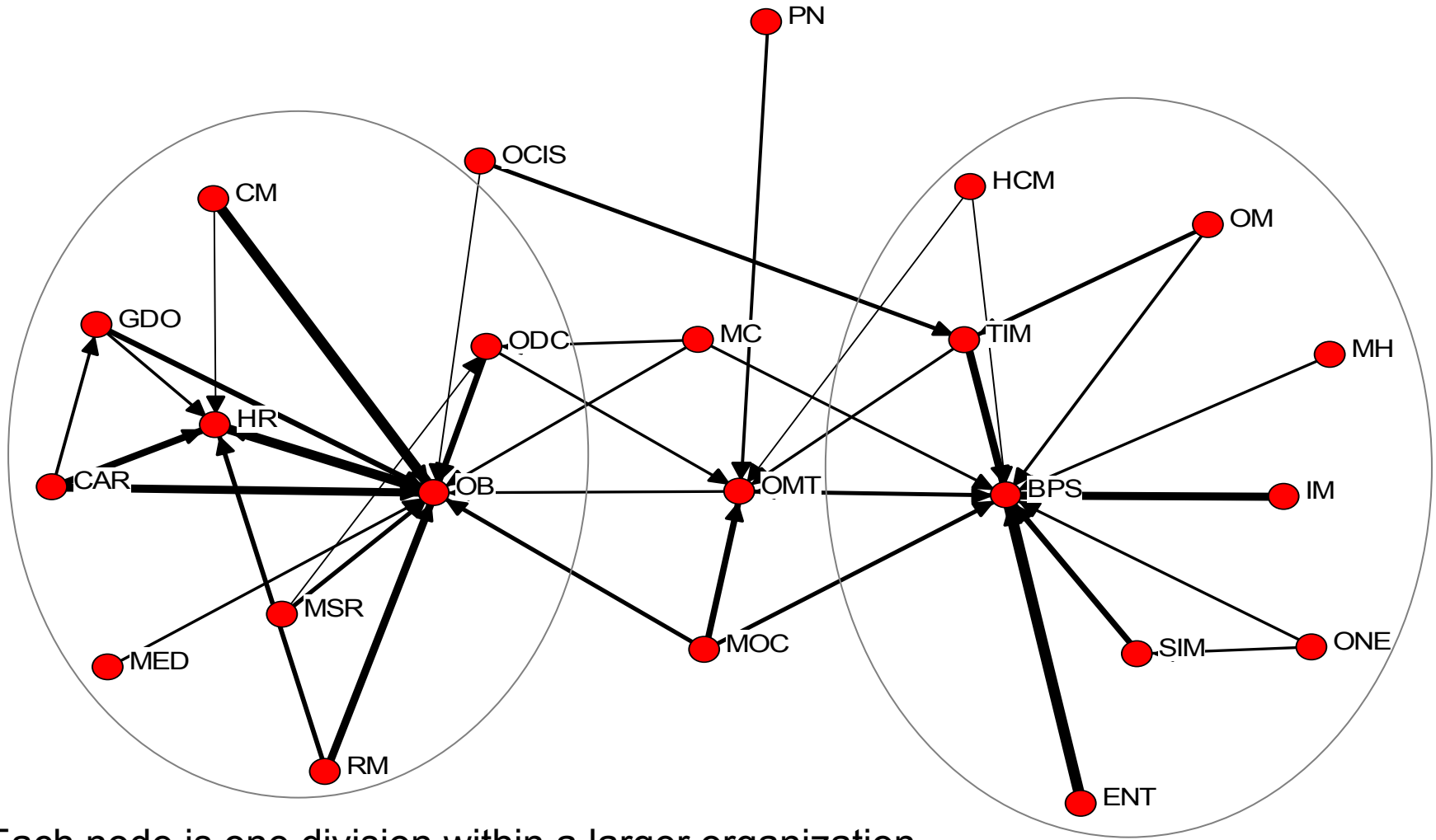
Project collaboration



Relations Among Orgs

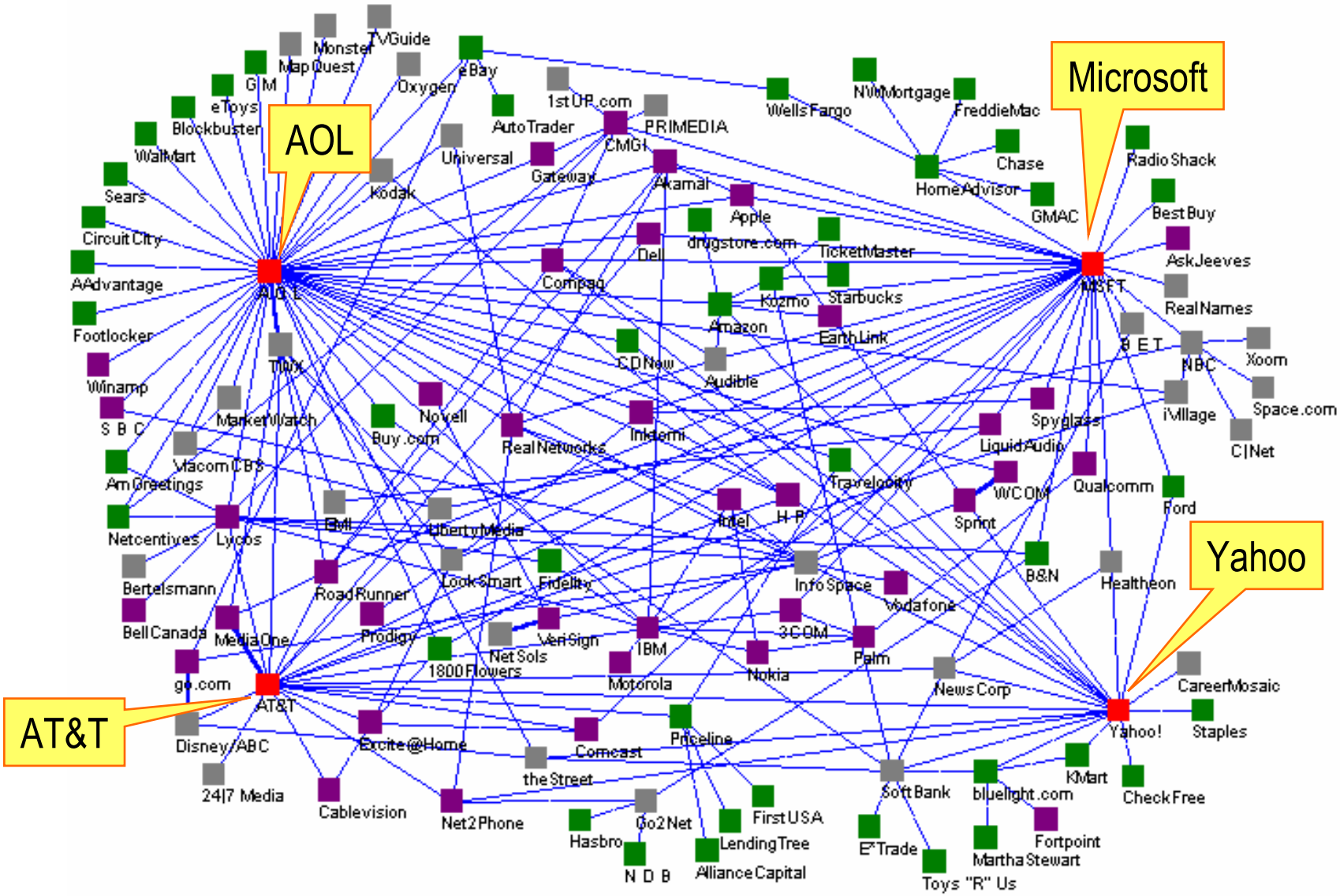
- As corporate entities
  - sells to, leases to, lends to, outsources to
  - joint ventures, alliances, invests in, subsidiary
  - regulates
- Through members
  - ex-member of (personnel flow)
  - interlocking directorates
  - all social relations

Ties Between Divisions



Each node is one division within a larger organization.

Internet Alliances



Example of a Network

Book Co-purchasing

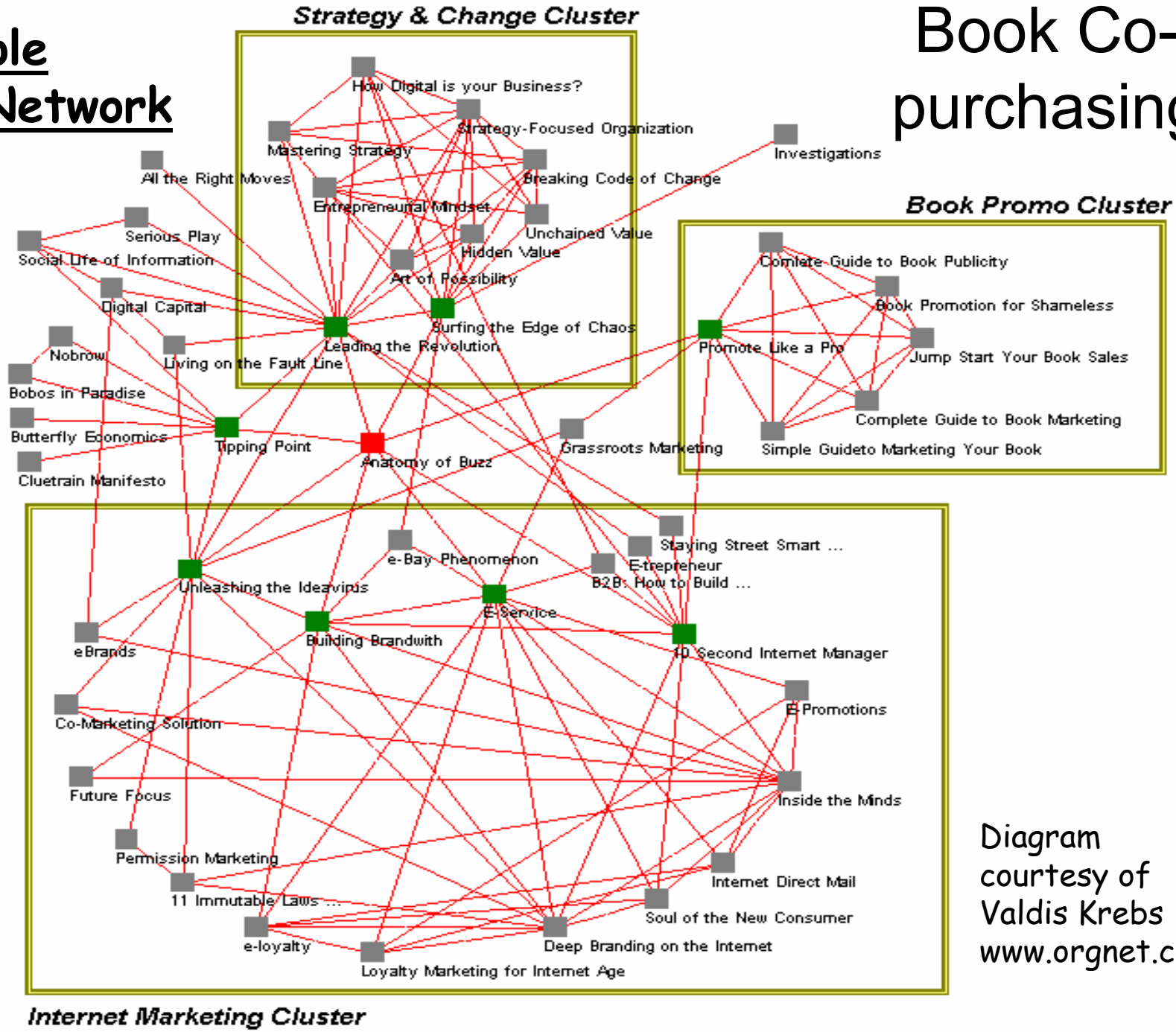


Diagram courtesy of Valdis Krebs www.orgnet.com

Multiple Relations vs. “Truth”

- Importance of separate, multiple relations
  - each has its own structure & “function”
  - different dynamics
  - different consequences for the actors
- Are networks real?
  - “What are the best questions to ask to measure THE network?”
  - Etic vs emic networks

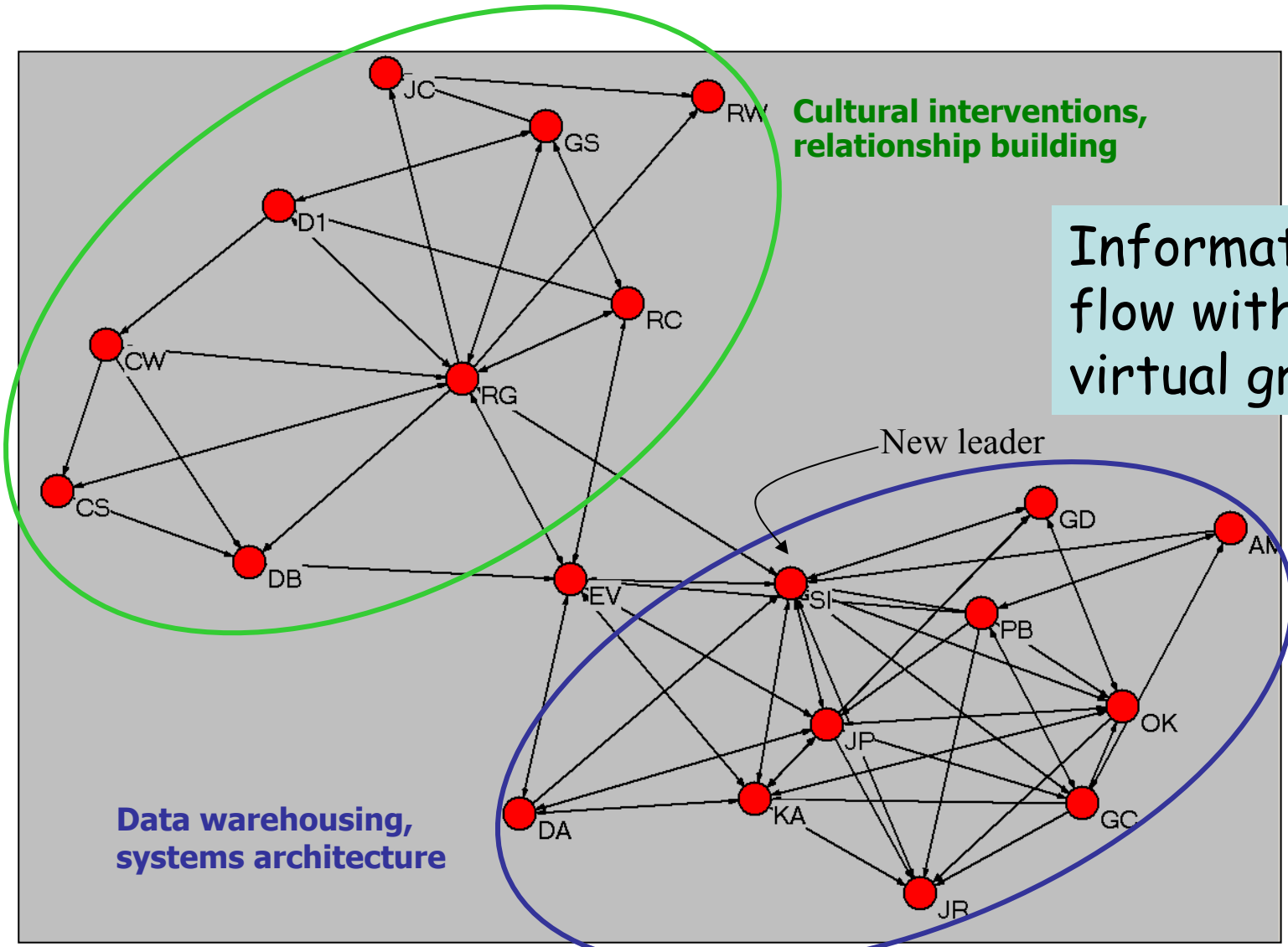
Social Relations Among Persons

- Kinship
  - mother of
- Other social role-based
  - boss of, friend of
- Cognitive/perceptual
  - knows
  - aware of what they know
- Affective
  - likes
  - trusts
- Interactions
  - give advice, talks to
  - sex / drugs with
- Affiliations
  - belong to same clubs
  - is physically near

Backcloth & Traffic

- Traffic is often what we are interested in
  - but generally are snapshot of the past
- Roads measure potential -- predictive
- SNA has generally favored backcloth (roads)

Advice-Seeking

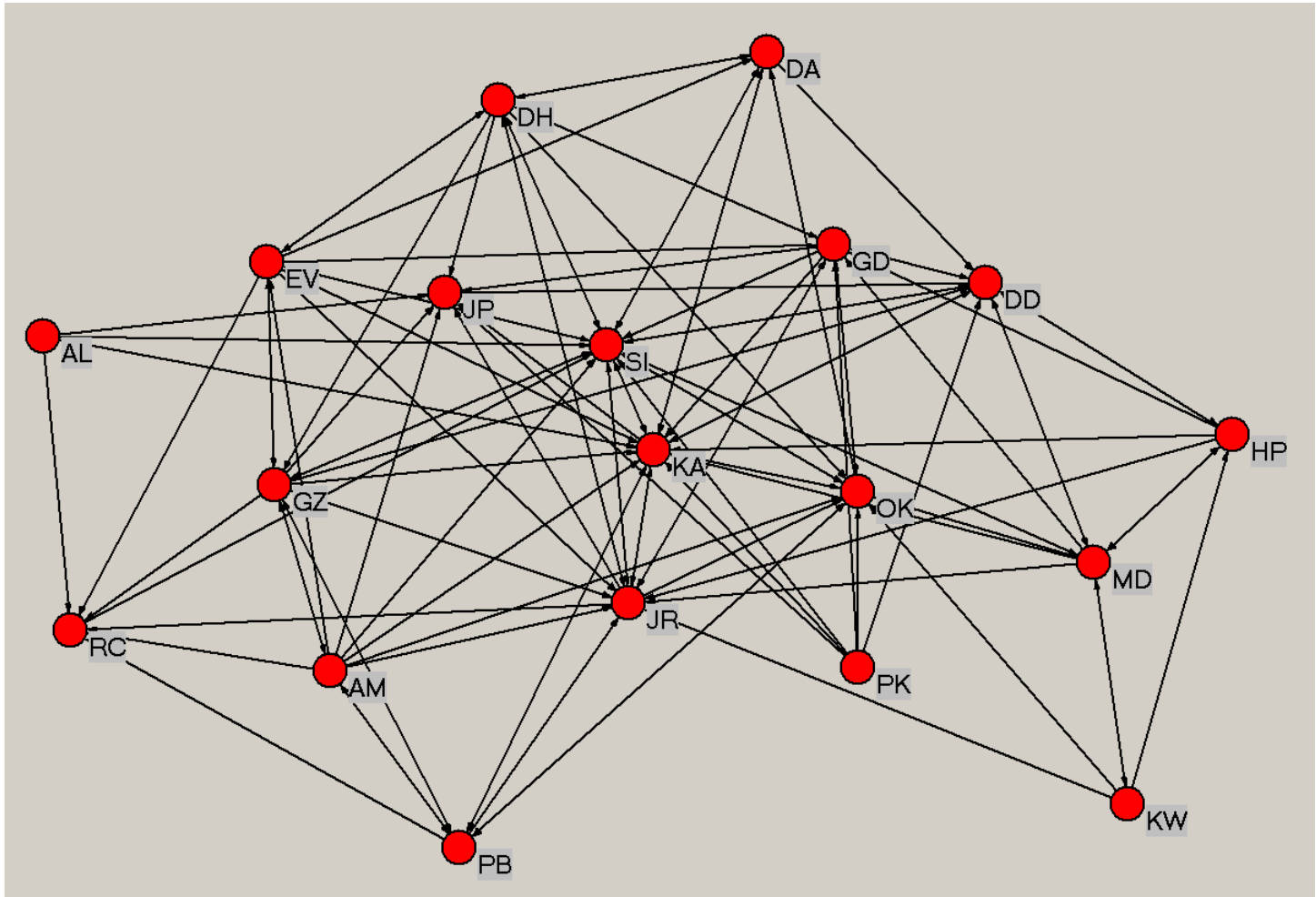


Cross, Borgatti, & Parker, 2002. Making Invisible Work Visible. *California Management Review*. 44(2): 25-46

Changes Made

- Cross-staffed new internal projects
  - white papers, database development
- Established cross-selling sales goals
  - managers accountable for selling projects with both kinds of expertise
- New communication vehicles
  - project tracking db; weekly email update
- Personnel changes

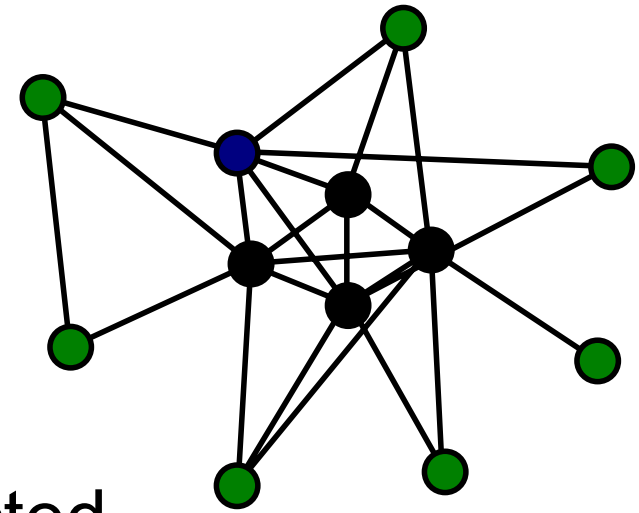
9 Months Later

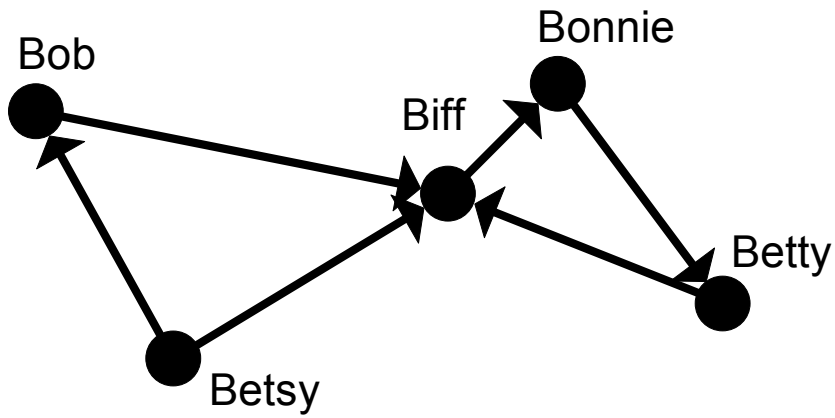


Cross, Parker, & Borgatti, 2002. Making Invisible Work Visible. *California Management Review*. 44(2): 25-46

Directed vs undirected graphs

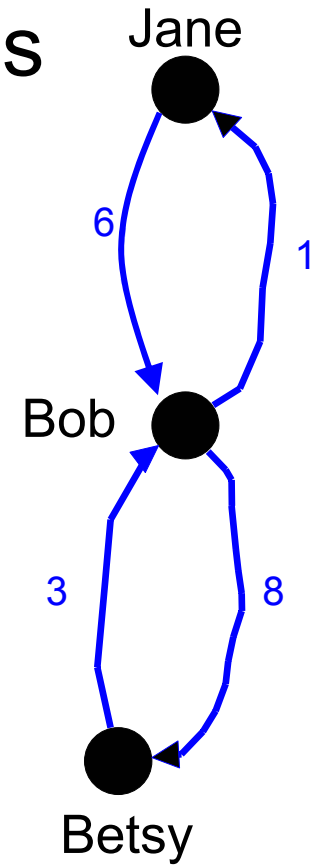
- Undirected relations
  - Attended meeting with
  - Communicates daily with
- Directed relations
  - Lent money to
- Logically vs empirically directed ties
  - Empirically, even un-directed relations can be non-symmetric due to measurement error





Strength of Tie

- We can attach values to ties, representing quantitative attributes
  - Strength of relationship
  - Information capacity of tie
  - Rates of flow or traffic across tie
  - Distances between nodes
  - Probabilities of passing on information
  - Frequency of interaction



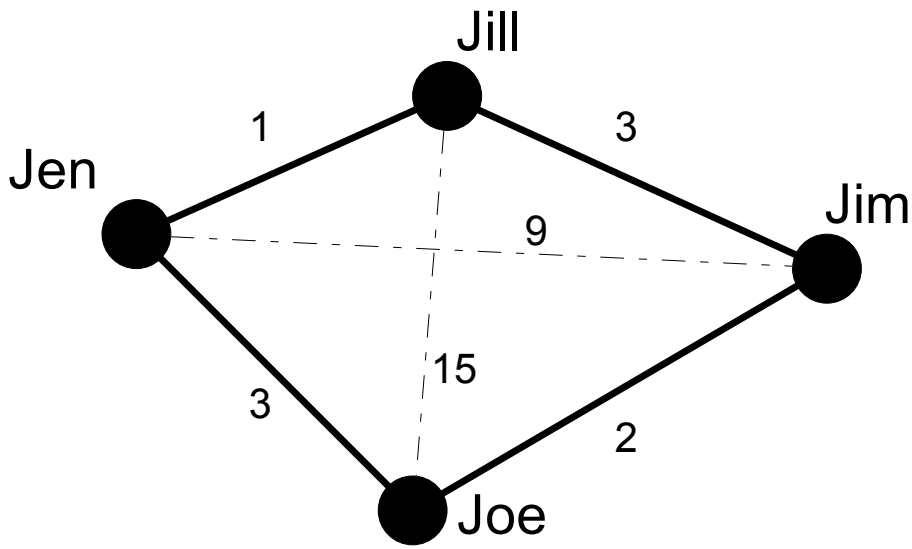
Adjacency Matrices

Friendship

	Jim	Jill	Jen	Joe
Jim	-	1	0	1
Jill	1	-	1	0
Jen	0	1	-	1
Joe	1	0	1	-

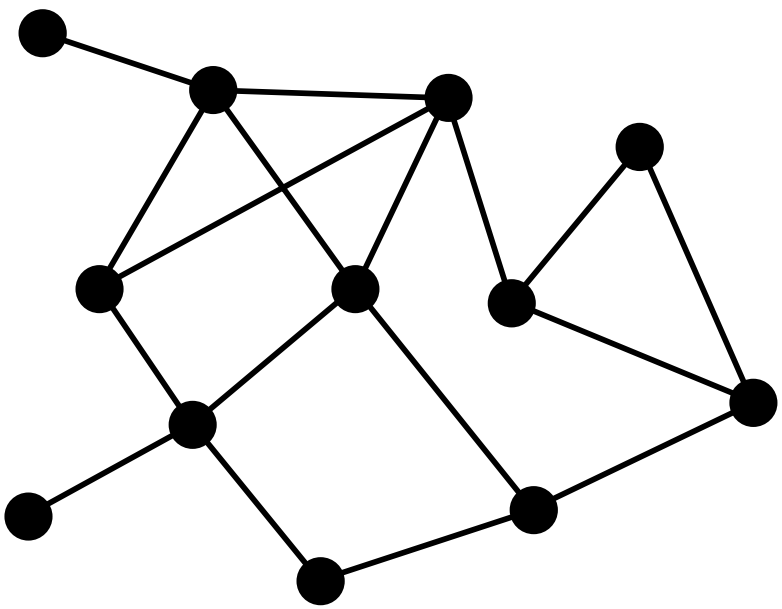
Proximity

	Jim	Jill	Jen	Joe
Jim	-	3	9	2
Jill	3	-	1	15
Jen	9	1	-	3
Joe	2	15	3	-

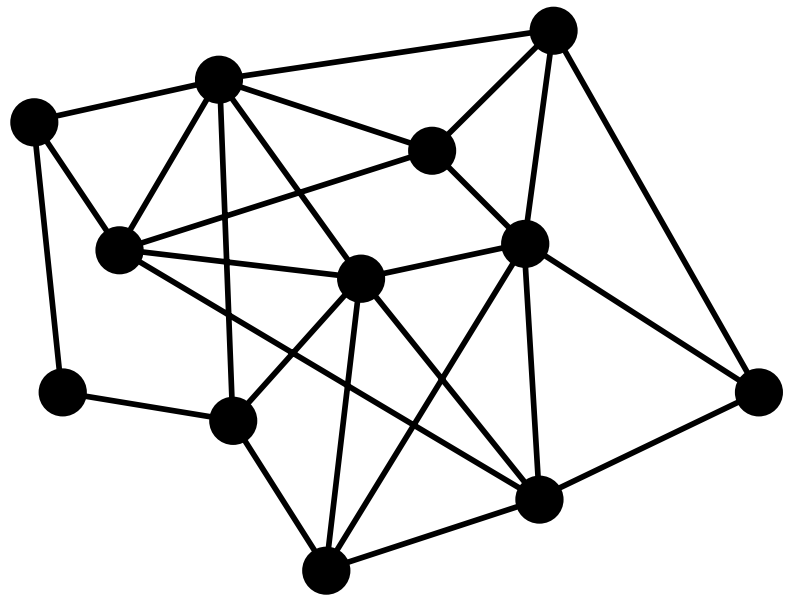


Density

- Number of ties, expressed as percentage of the number of ordered/unordered pairs

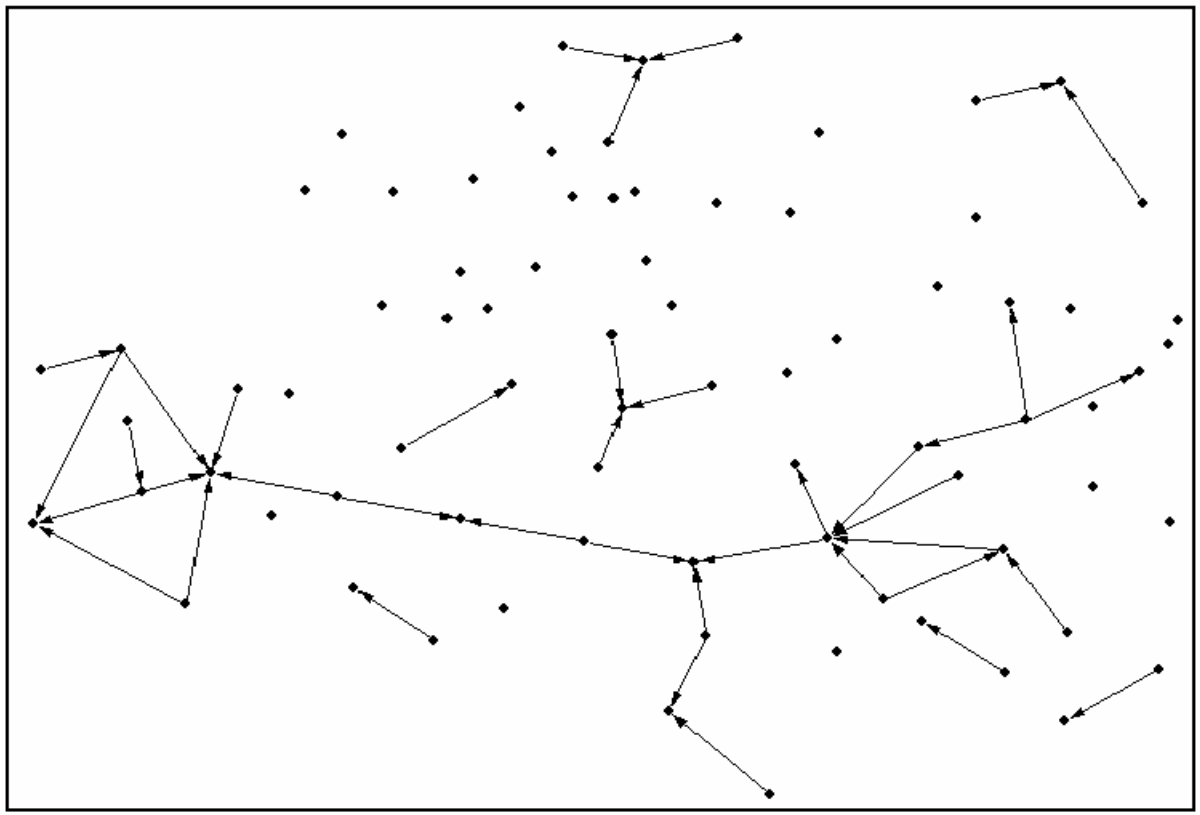


Low Density (25%)
Avg. Dist. = 2.27



High Density (39%)
Avg. Dist. = 1.76

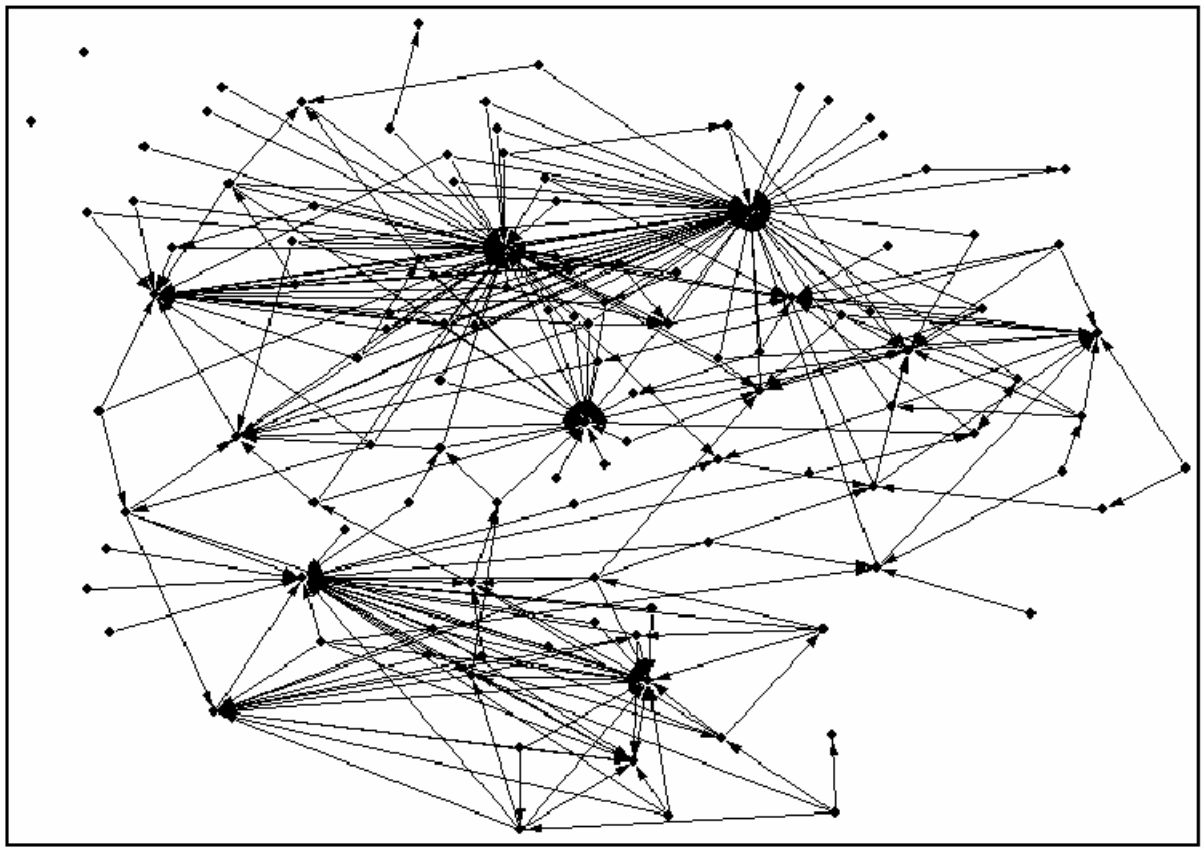
Help With the Rice Harvest



Village 1

Data from Entwistle et al

Help With the Rice Harvest



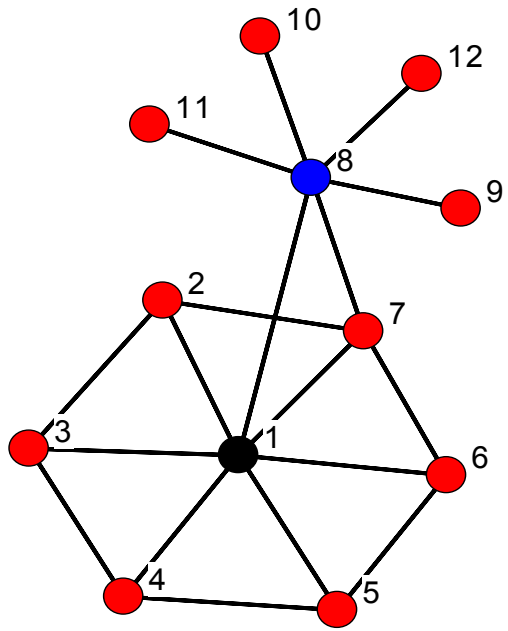
Village 2

Which village is more likely to survive?

Data from Entwistle et al

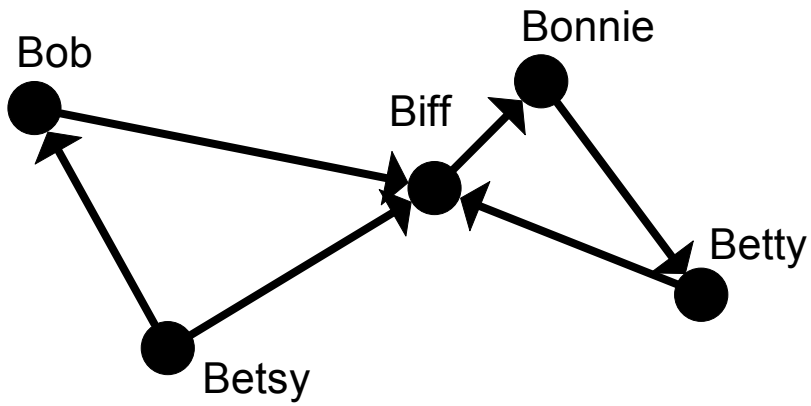
Degree

- Number of edges incident upon a vertex
  - $d_8 = 6$, while $d_{10} = 1$
- Sum of degrees of all nodes is twice the number of edges in graph
- Average degree = density times (n-1)



InDegree & OutDegree

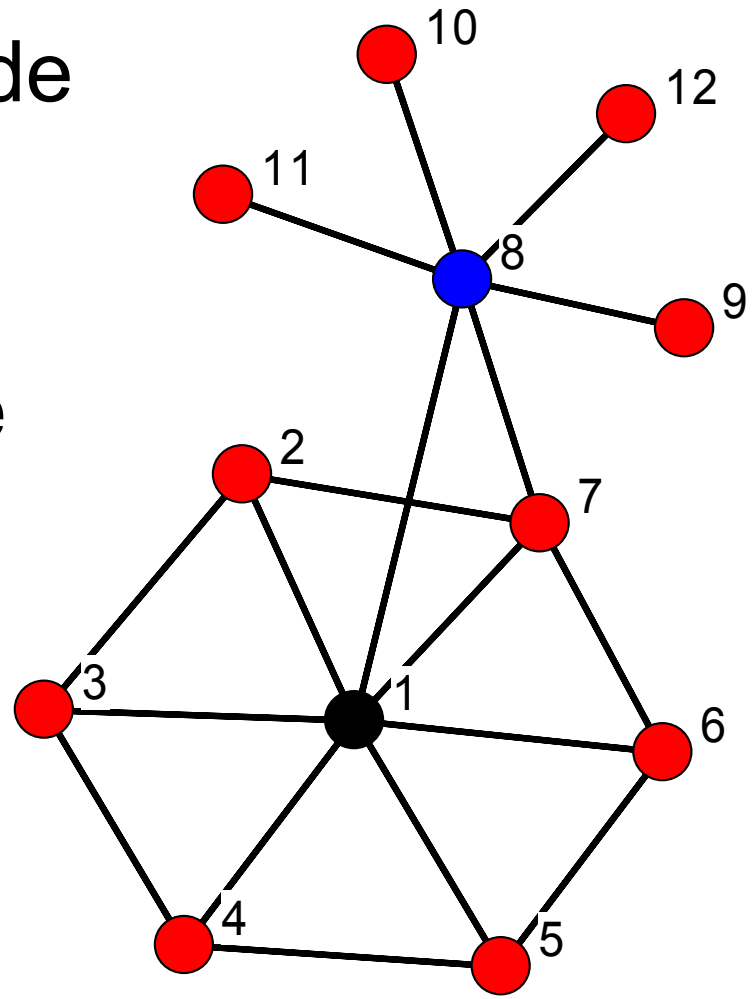
- In directed graphs,
  - Indegree is number of arcs that terminate at the node (incoming ties)
    - Indeg(biff) = 3
  - Outdegree is number of arcs that originate at the node (outgoing ties)
    - Outdeg(biff) = 1



Average indegree always equals average outdegree

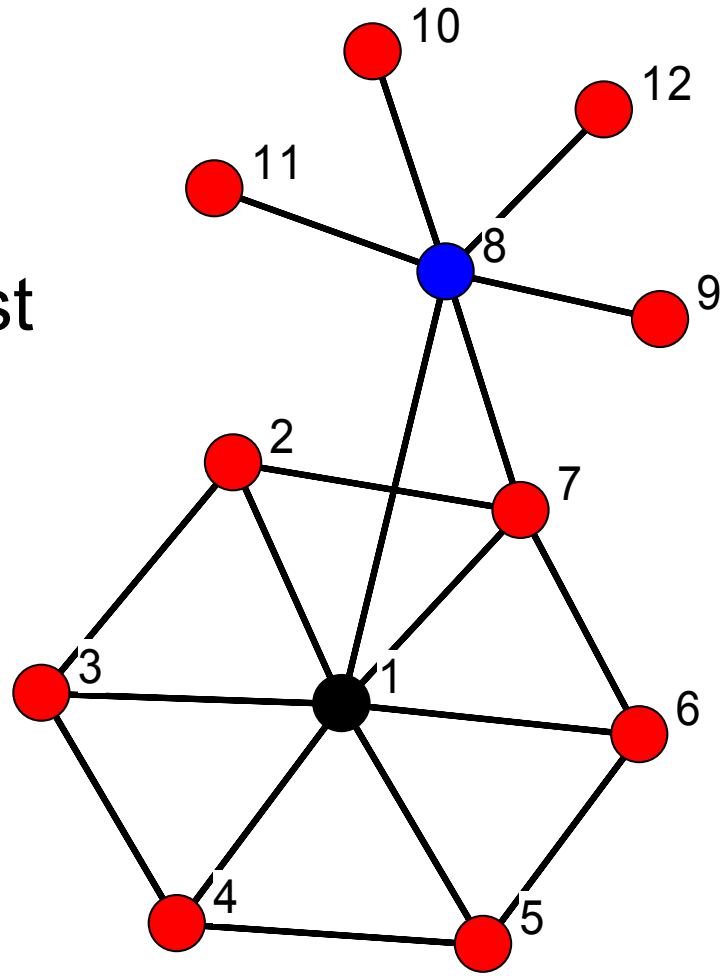
Walks, Trails, Paths

- Path: can't repeat node
  - 1-2-3-4-5-6-7-8
  - Not 7-1-2-3-7-4
- Trail: can't repeat line
  - 1-2-3-1-7-8
  - Not 7-1-2-7-1-4
- Walk: unrestricted
  - 1-2-3-1-2-7-1-7-1



Length & Distance

- Length of a path is number of links
- Distance between two nodes is length of shortest path (aka geodesic)

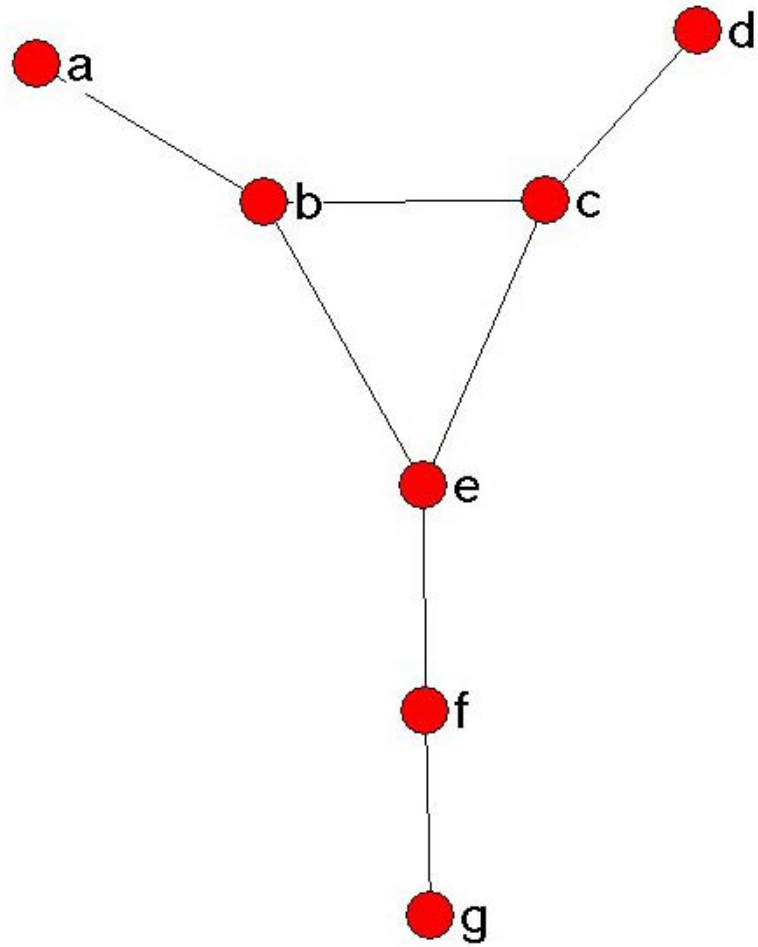


Six Degrees of Separation

- Kevin Bacon game
- Milgram's original experiment
- Unpeeling the Saddam onion

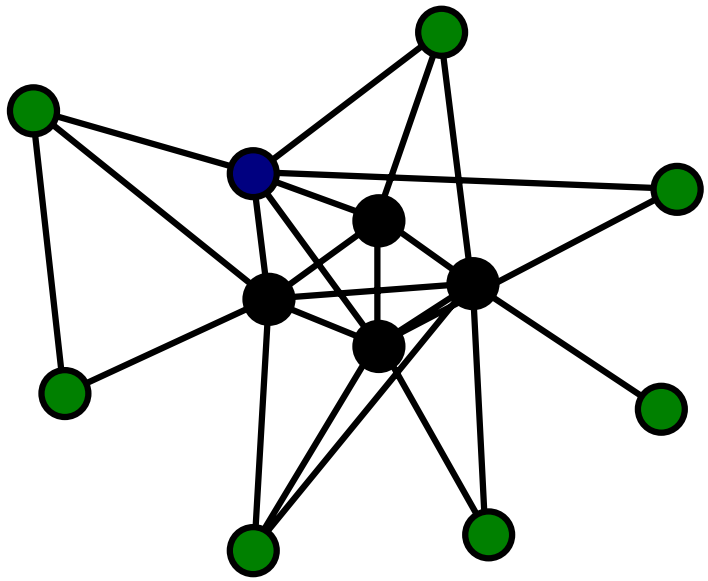
Geodesic Distance Matrix

	a	b	c	d	e	f	g
a	0	1	2	3	2	3	4
b	1	0	1	2	1	2	3
c	2	1	0	1	1	2	3
d	3	2	1	0	2	3	4
e	2	1	1	2	0	1	2
f	3	2	2	3	1	0	1
g	4	3	3	4	2	1	0

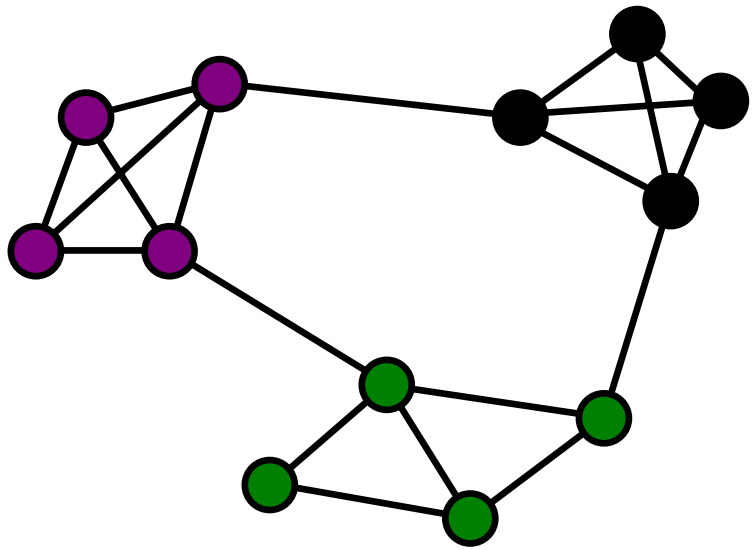


Average Distance

- Average geodesic distance between all pairs of nodes



Core/Periphery
c/p fit = 0.97, avg. dist. = 1.9



Clique structure
c/p fit = 0.33, avg. dist. = 2.4

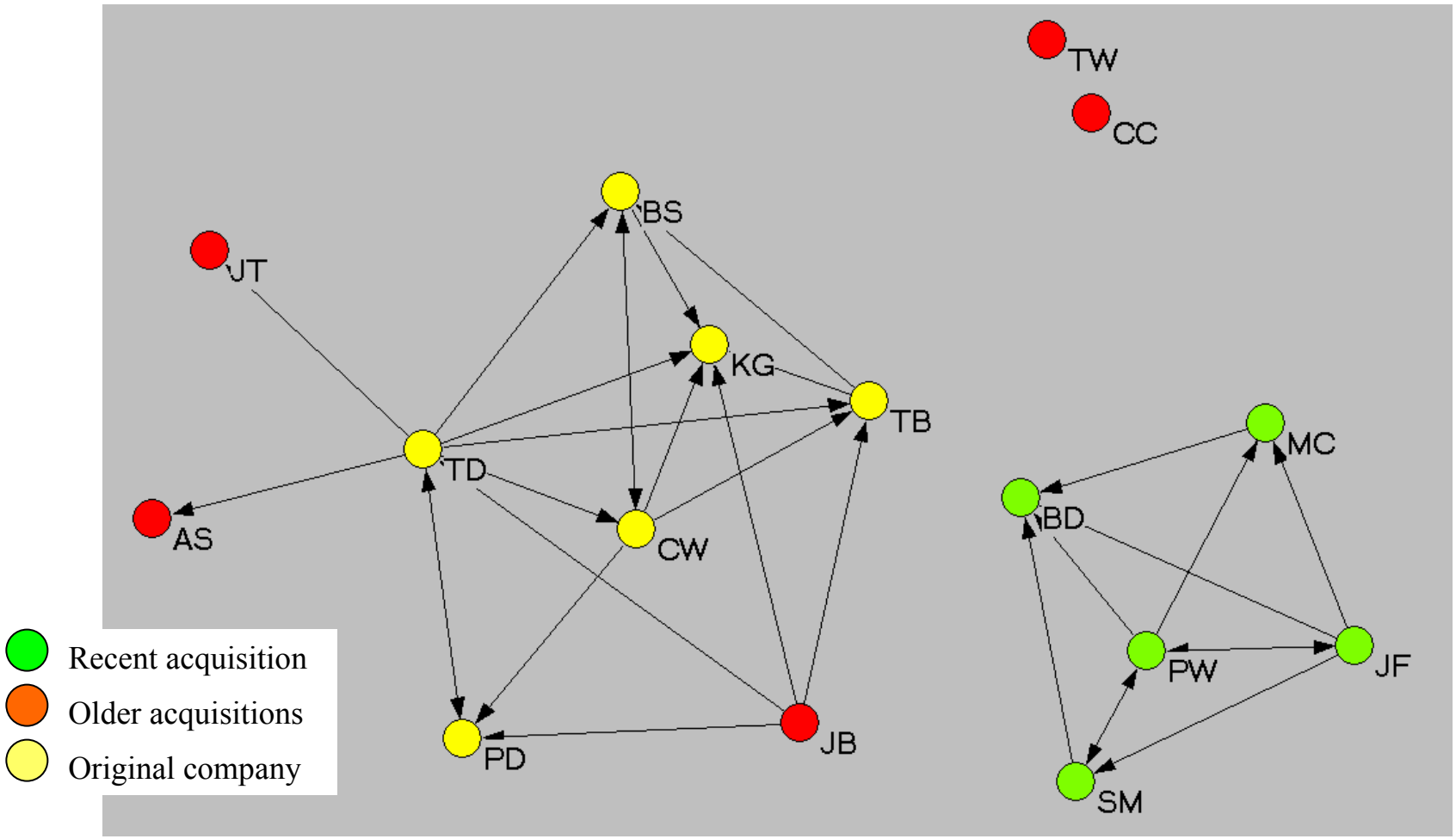
Components

- Maximal sets of nodes in which every node can reach every other by some path (no matter how long)
- A connected graph has just one component

Relations define different networks. Components don't.

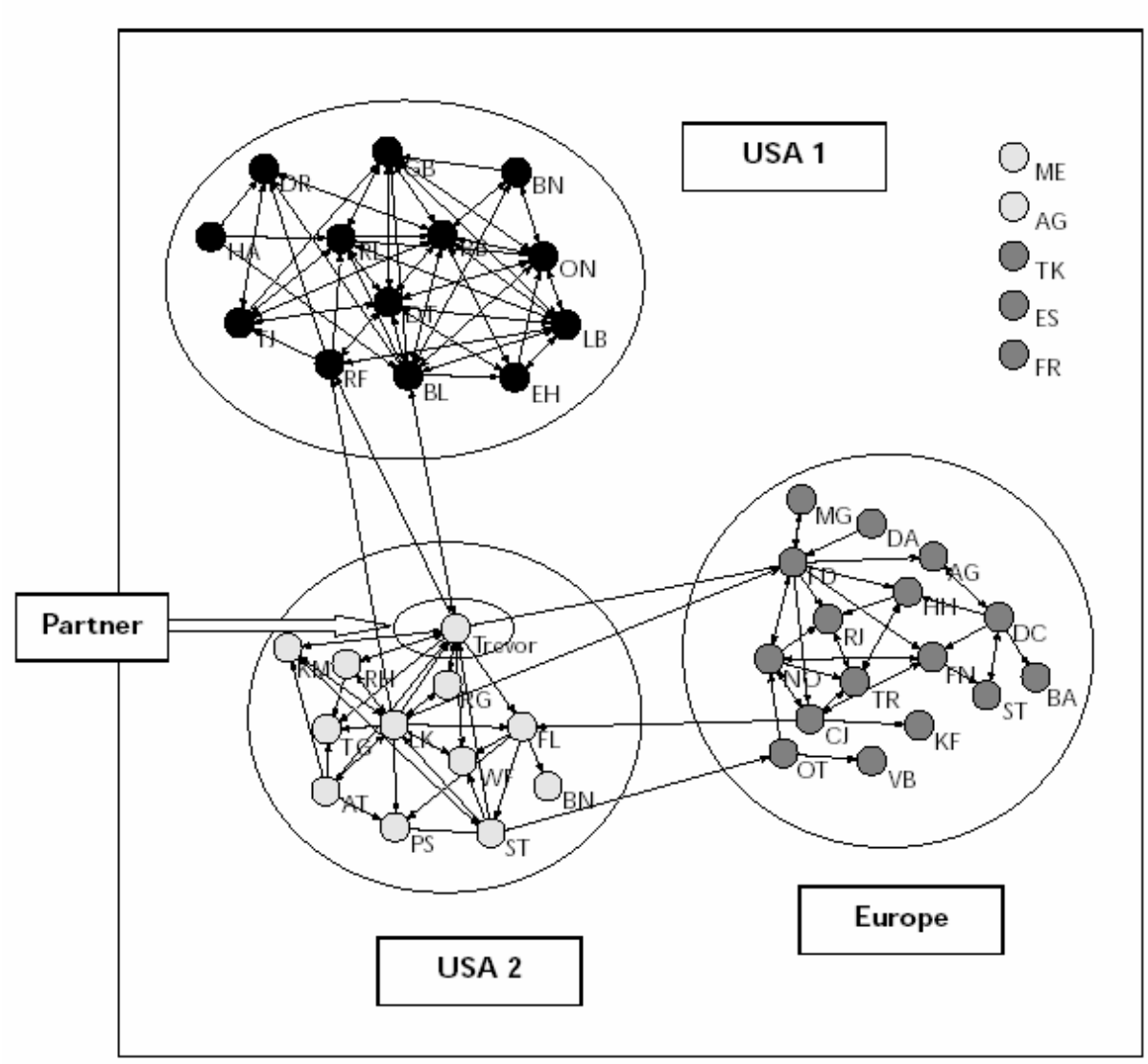
A network with 4 components

Who you go to so that you can say ‘I ran it by ____, and she says ...’



Data drawn from Cross, Borgatti & Parker 2001.

Subgroups



Ties Between Groups

EXHIBIT 2. Collaboration Across Merged Divisions within a Conglomerate

	Div. 1	Div. 2	Div. 3	Div. 4	Div. 5	Div. 6	Div. 7	Div. 8
Division 1	**33%**							
Division 2	5%	**76%**						
Division 3	11%	18%	**45%**					
Division 4	2%	11%	21%	**38%**				
Division 5	6%	7%	12%	6%	**75%**			
Division 6	7%	2%	13%	7%	2%	**76%**		
Division 7	1%	3%	16%	6%	8%	2%	**36%**	
Division 8	10%	2%	9%	6%	3%	10%	0%	**90%**