Introduction to Social Networks

Steve Borgatti, Boston College

www.analytictech.com/borgatti

borgatts@bc.edu

The Discipline of SNA

- Growth
- Professional elements
- How SNA differs from mainstream social science
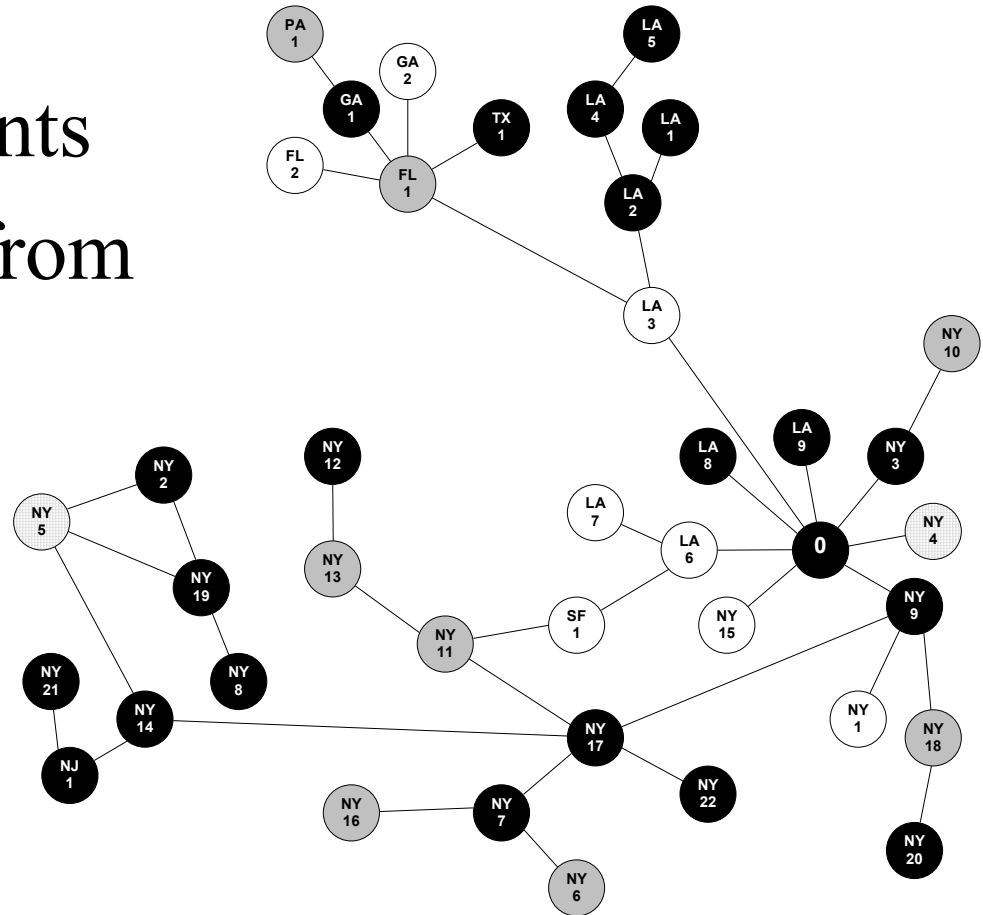
Fast-Growing Sub-Discipline


6 Degrees of Separation

- Popular culture
  - Games, plays, television
  - Forbes, Fortune, NY Times

- Business Practitioners
  - New 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

Social Networks Articles
Percentage of All Publications Indexed by SocioFile

$y = 0.0406x - 2.7734$
$R^2 = 0.8053$
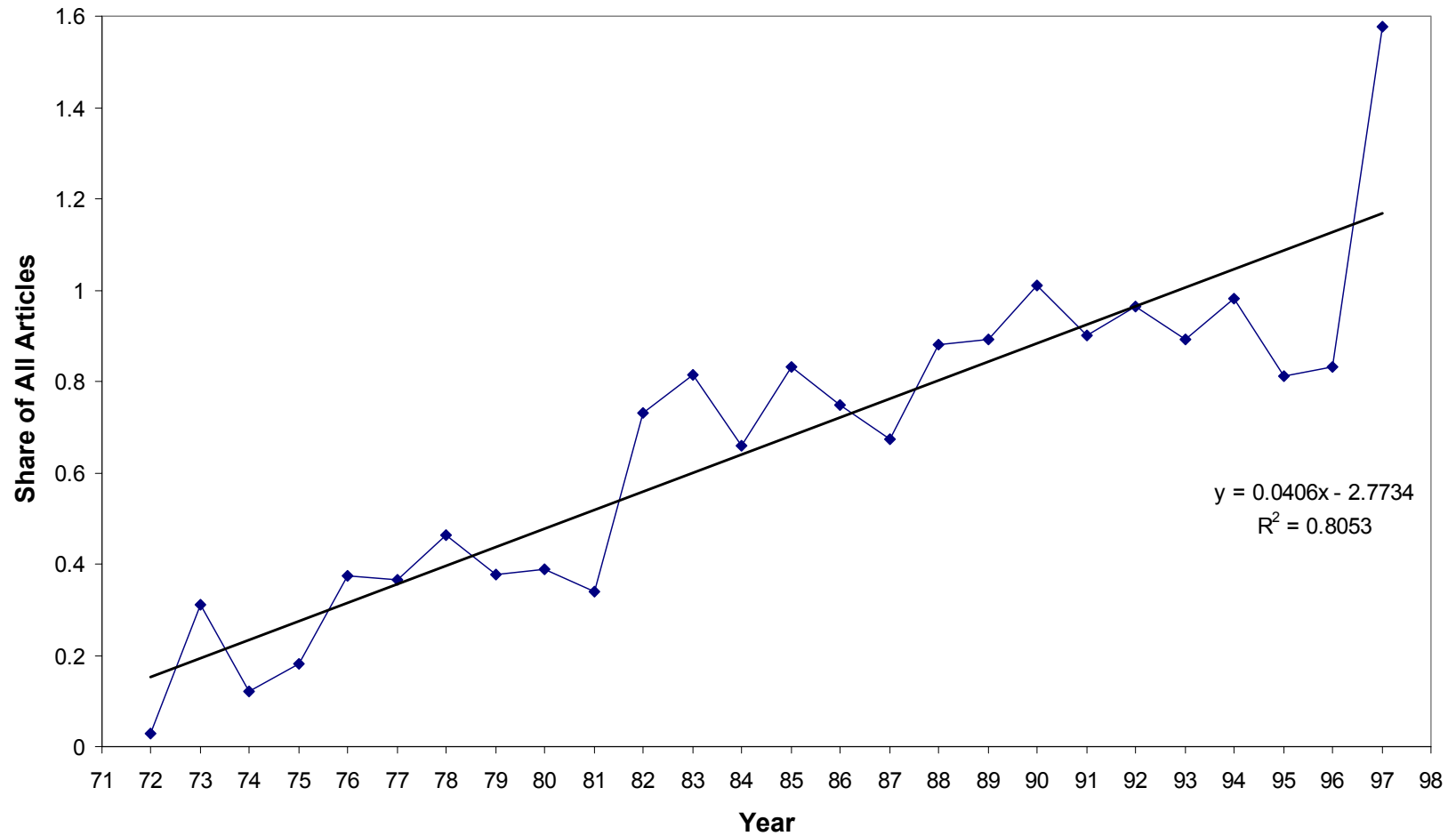
Growth in Psychology

Social Networks Articles
Percentage of All Articles Indexed by PsycLit

y = 0.0165x - 1.1723
R^2 = 0.9046
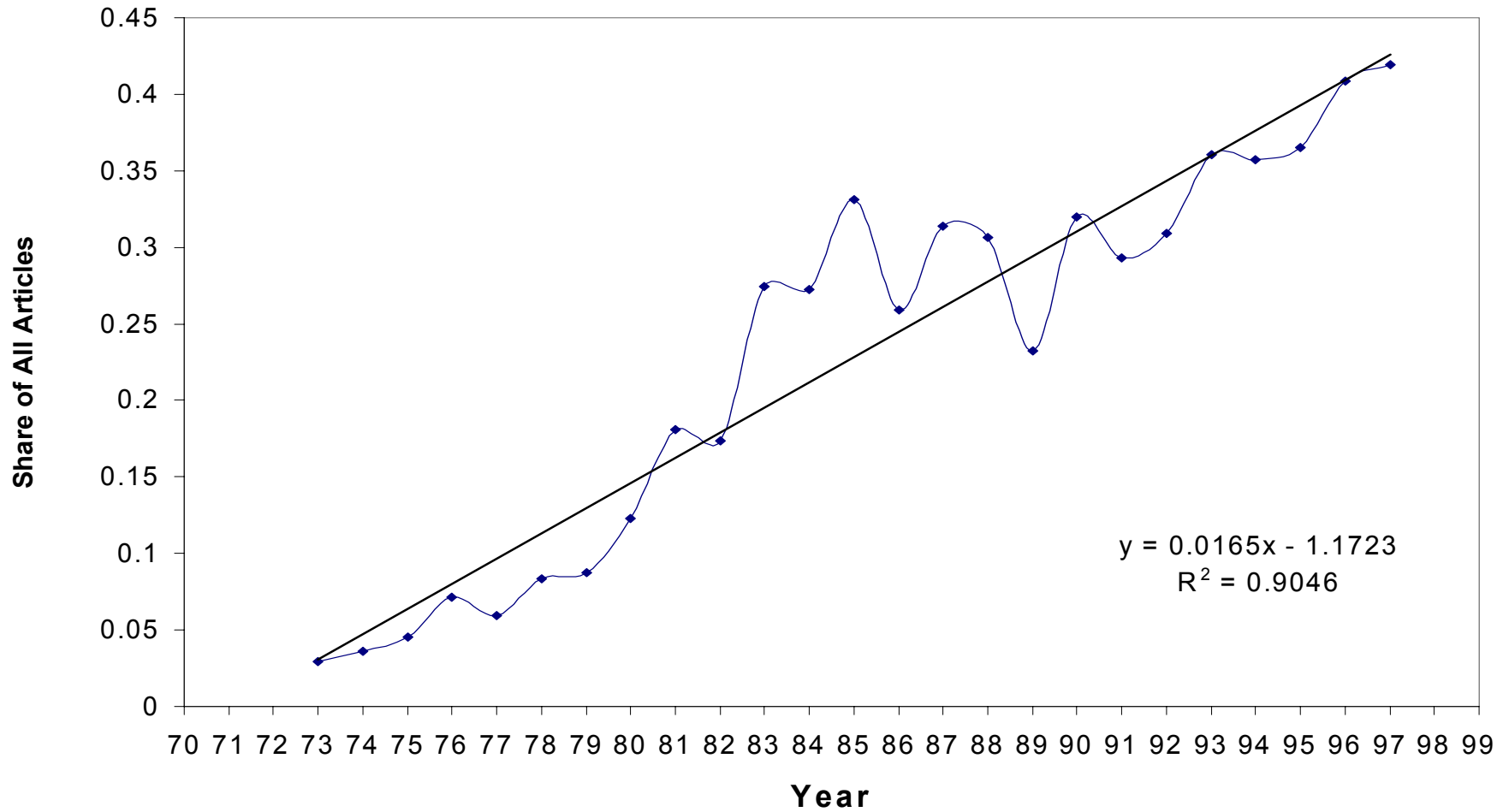
Multiple Sources

- 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

NETWORK ANALYSIS

Anthropology
Sociology
Psychology
Ecology
Organization Studies
Epidemiology
Linguistics
Political Science

Statistics

Discrete Maths
- graph theory
- group theory
- matrix algebra
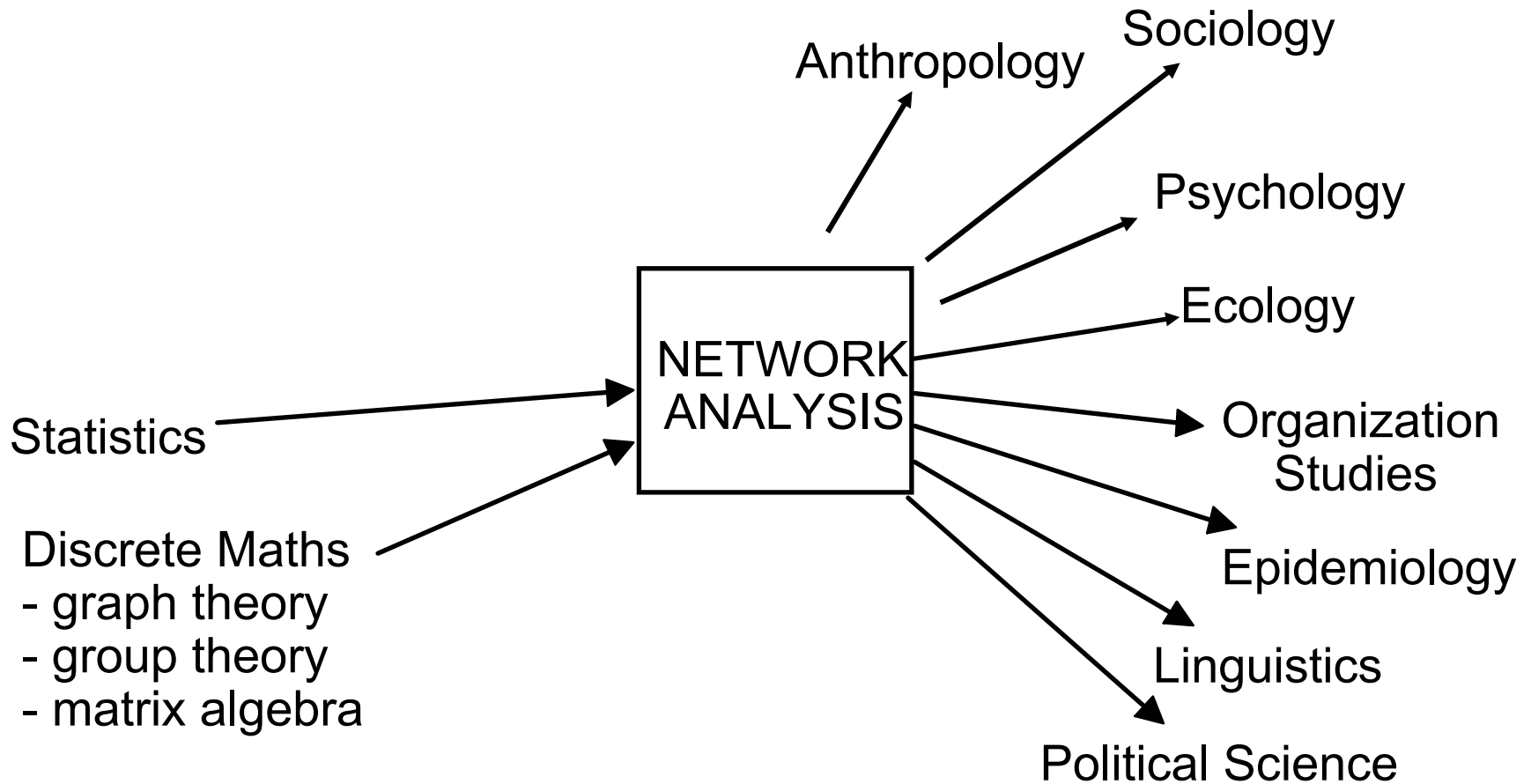
Professional Elements

- Professional association (since '78)
  - INSNA (Int'l Network for Social Network Analysis)
  - **www.insna.org**
- Sunbelt Annual Conference (since '79)
  - 2001: Budapest, HUNGARY. June
  - 2002: New Orleans, USA February
  - 2003: Cancun, MEXICO, February
  - 2004: Portorôs, SLOVENIA, May
  - 2005: Los Angeles, USA, February
  - 2006: Vancouver, CANADA, April
  - 2007: Crete, GREECE
  - 2010: Trento?

Professional Elements - 2

- Specialized journals
  - *Social Networks*, (since '79)
  - *CONNECTIONS*, official bulletin of INSNA
  - *Journal of Social Structure* (electronic)
- Textbooks
  - Kilduff, 2004
  - Scott, John. 1991/2000.
  - Degenne & Forsé. 1999.
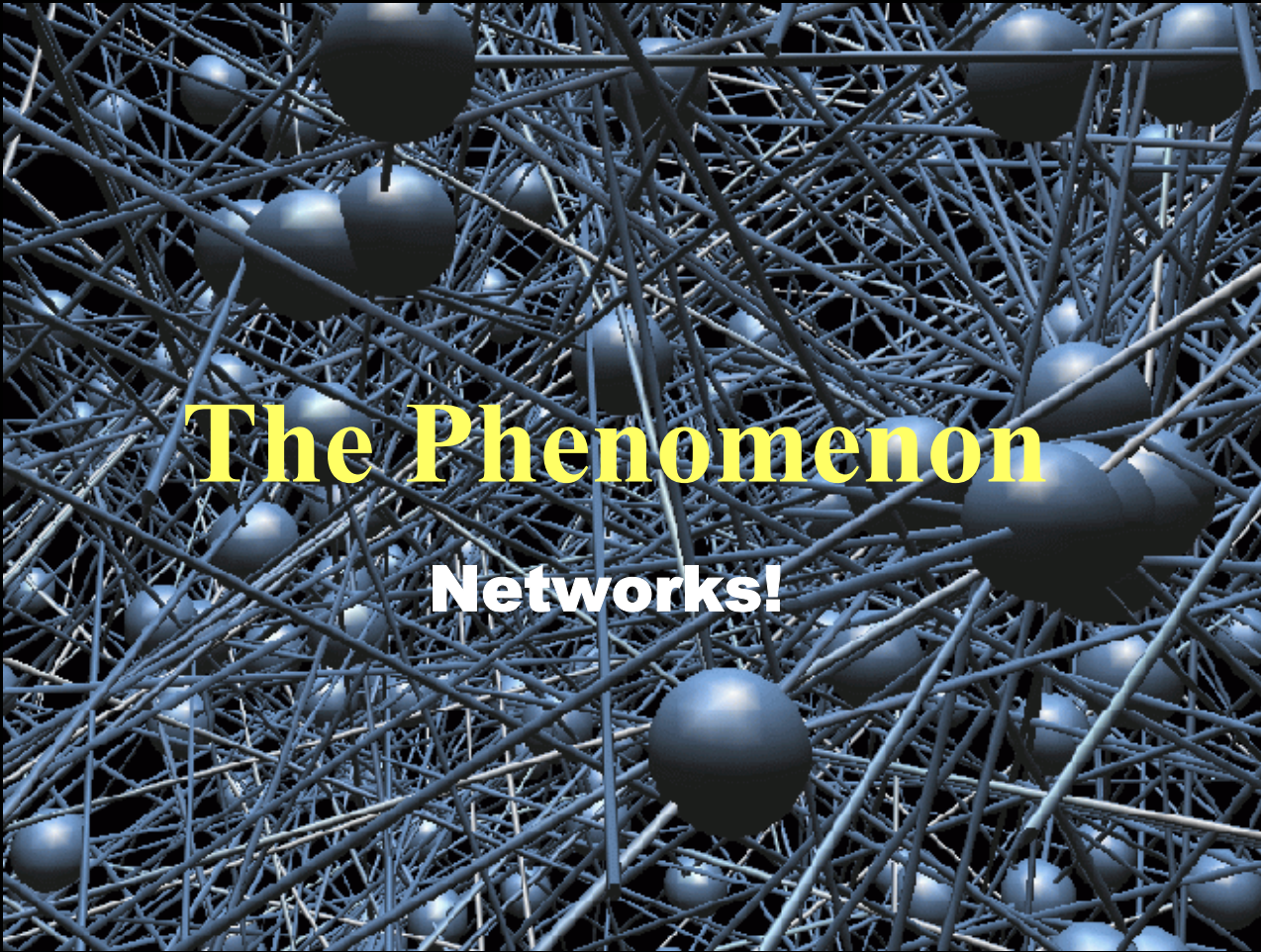 - Wasserman & Faust. 1994.

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
  - UCINET user's group
   - www.analytictech.com/UCINET_list.htm

What Defines SNA?

- Phenomenon studied
  - distinctive type of data
- Perspective taken & theoretical questions
  - interdependent agents vs. independent atoms
- Methodological toolkit
  - new concepts, new tools

The Phenomenon

Networks!

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" or "is teacher of"
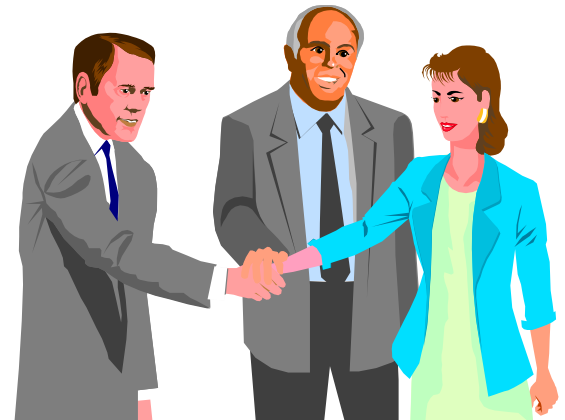
Kinds of Nodes

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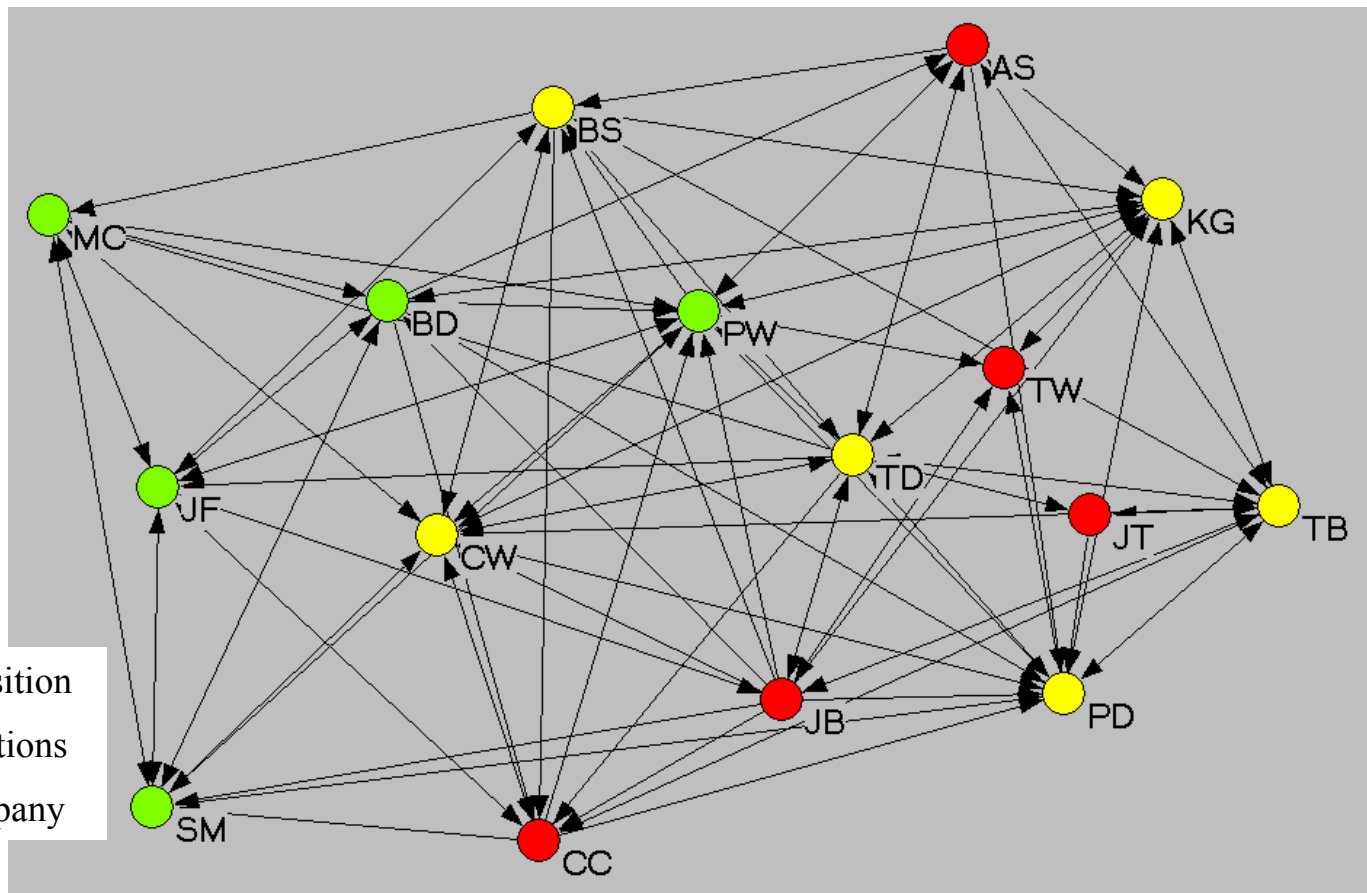 - countries, cities
  - species

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

- 🟢 Recent acquisition
- 🟠 Older acquisitions
- 🟡 Original company
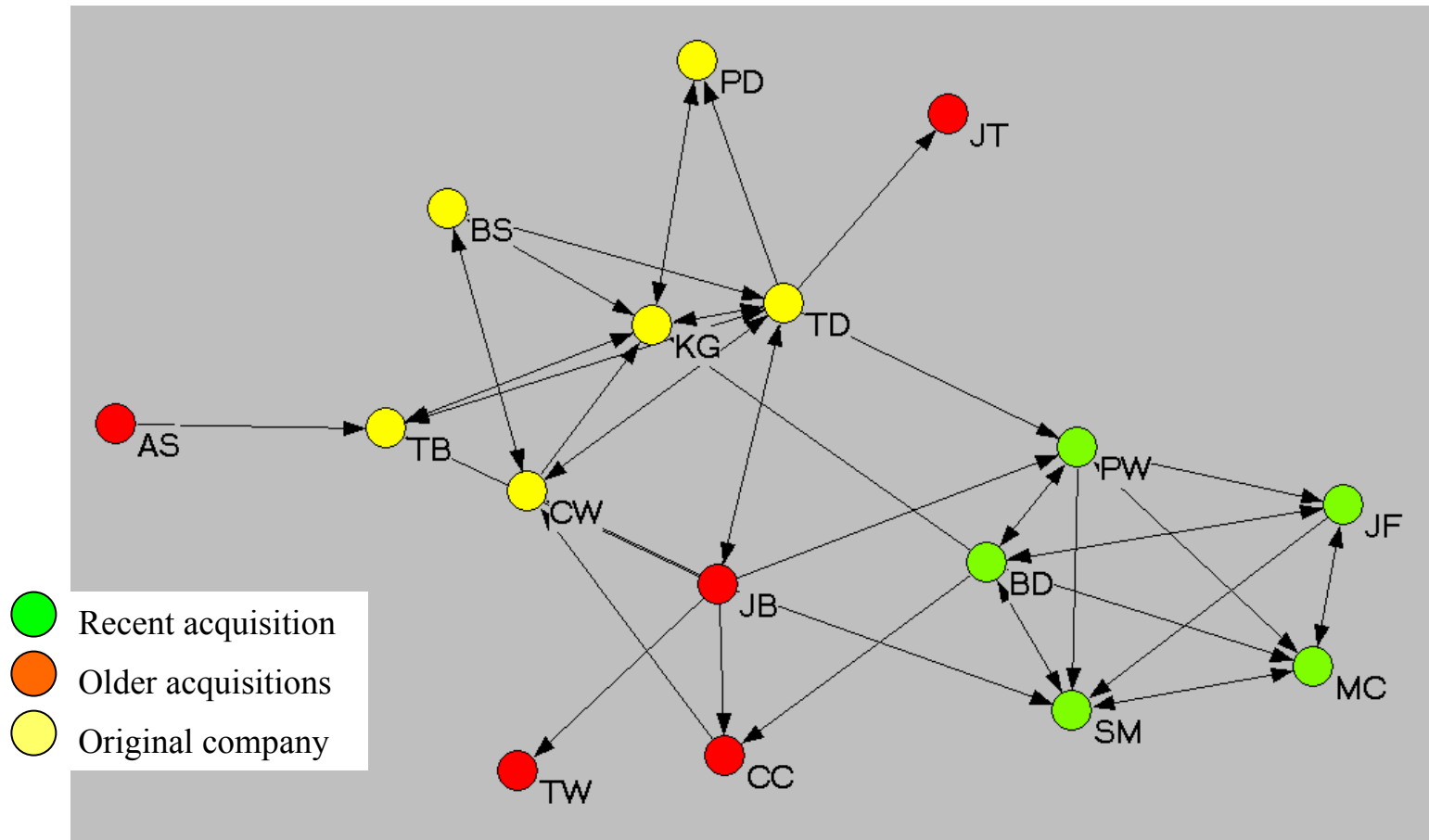
Data drawn from Cross, Borgatti & Parker 2001.

Hawthorne Games & Conflicts
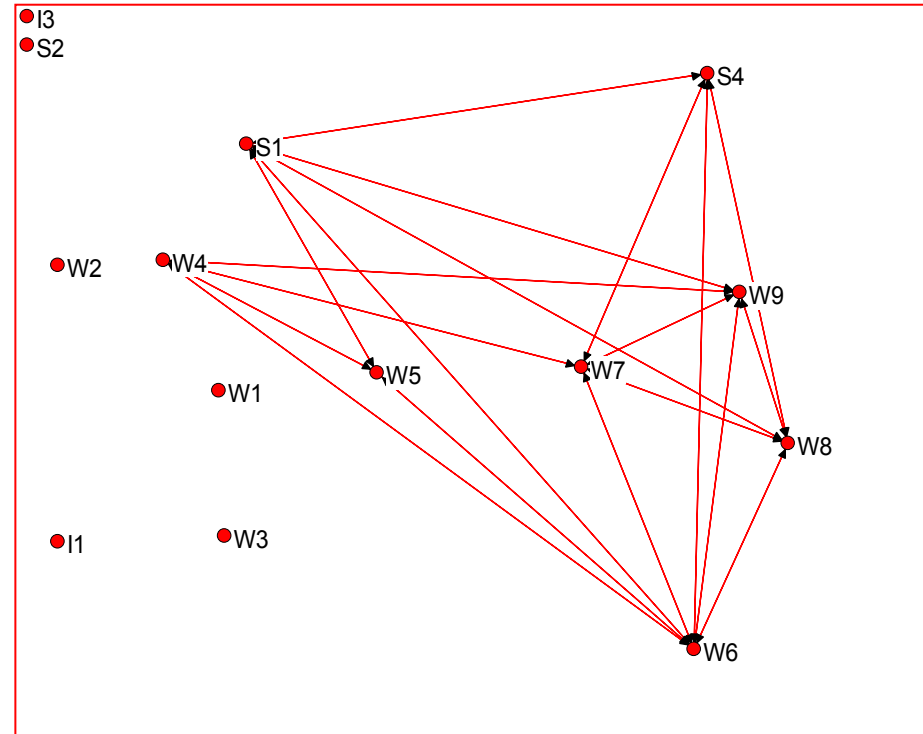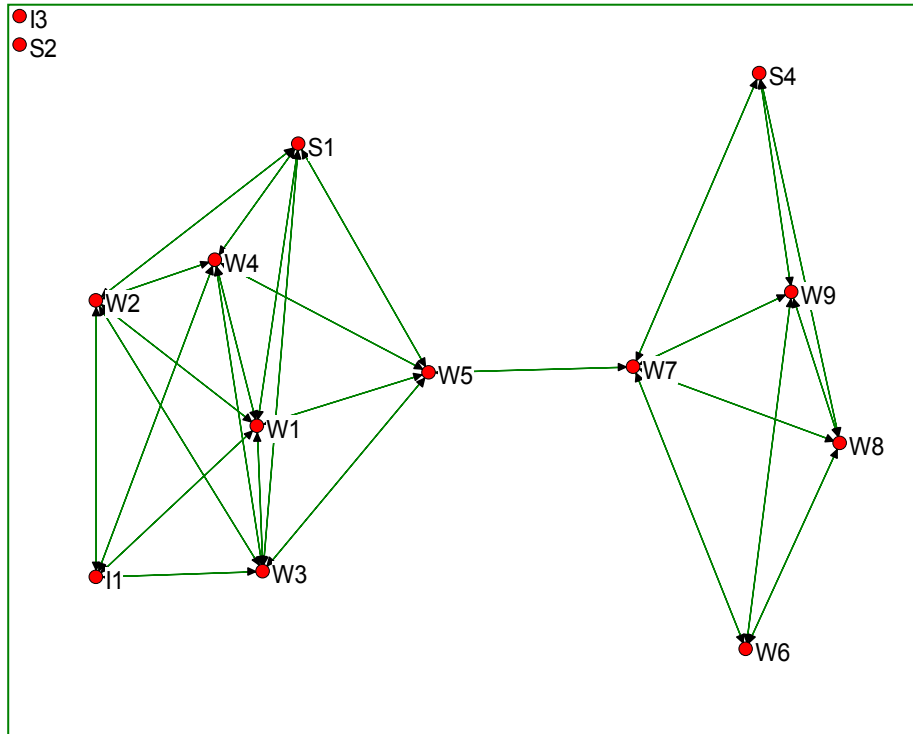
Combining Games & Fights

I3
S2
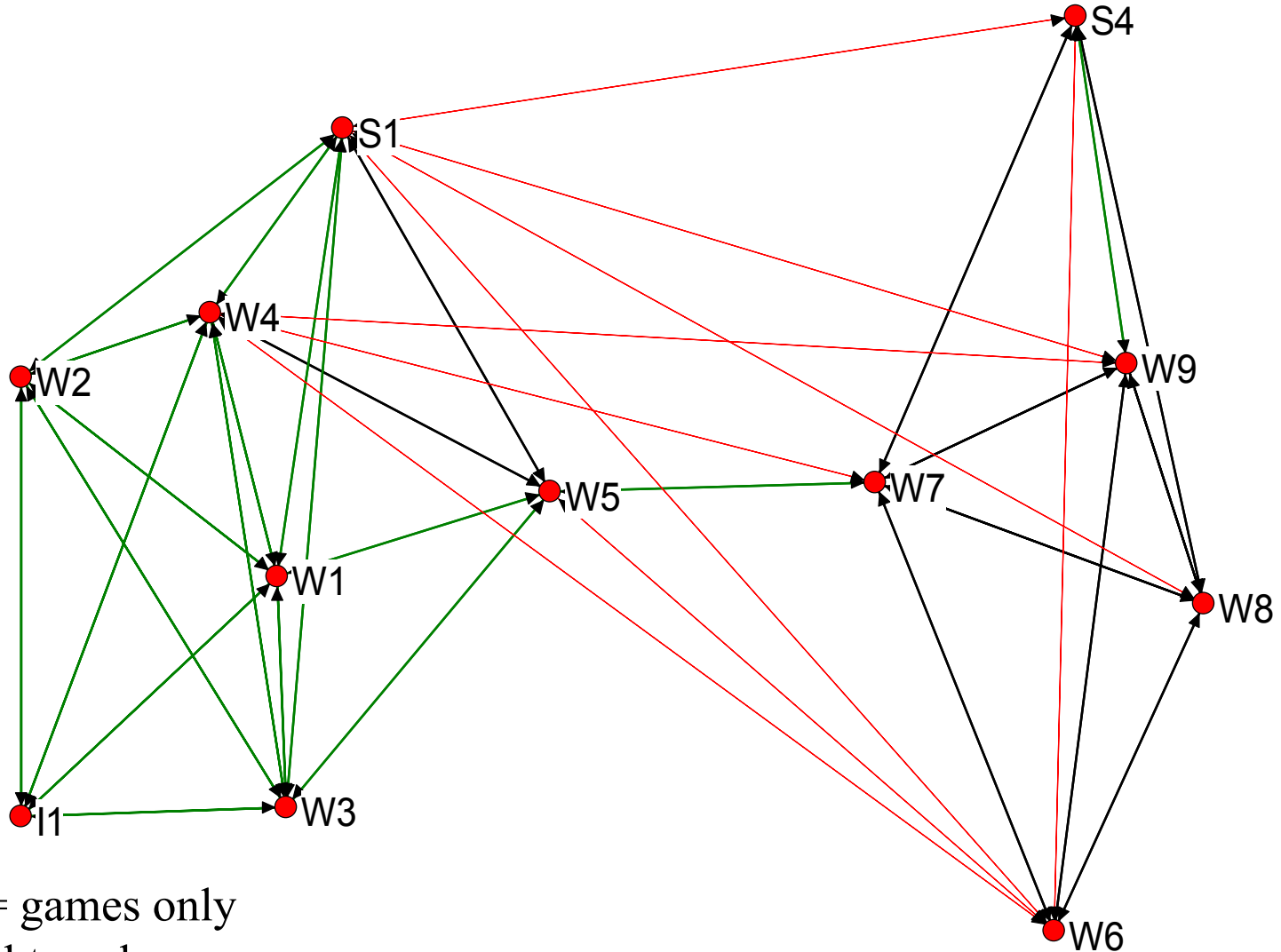
GREEN = games only
RED = fights only
BLACK = games & fights

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

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)

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

Internet Alliances

Consumer Internet

Copyright © 2000, Valdis Krebs

http://www.orgnet.com/netindustry.html
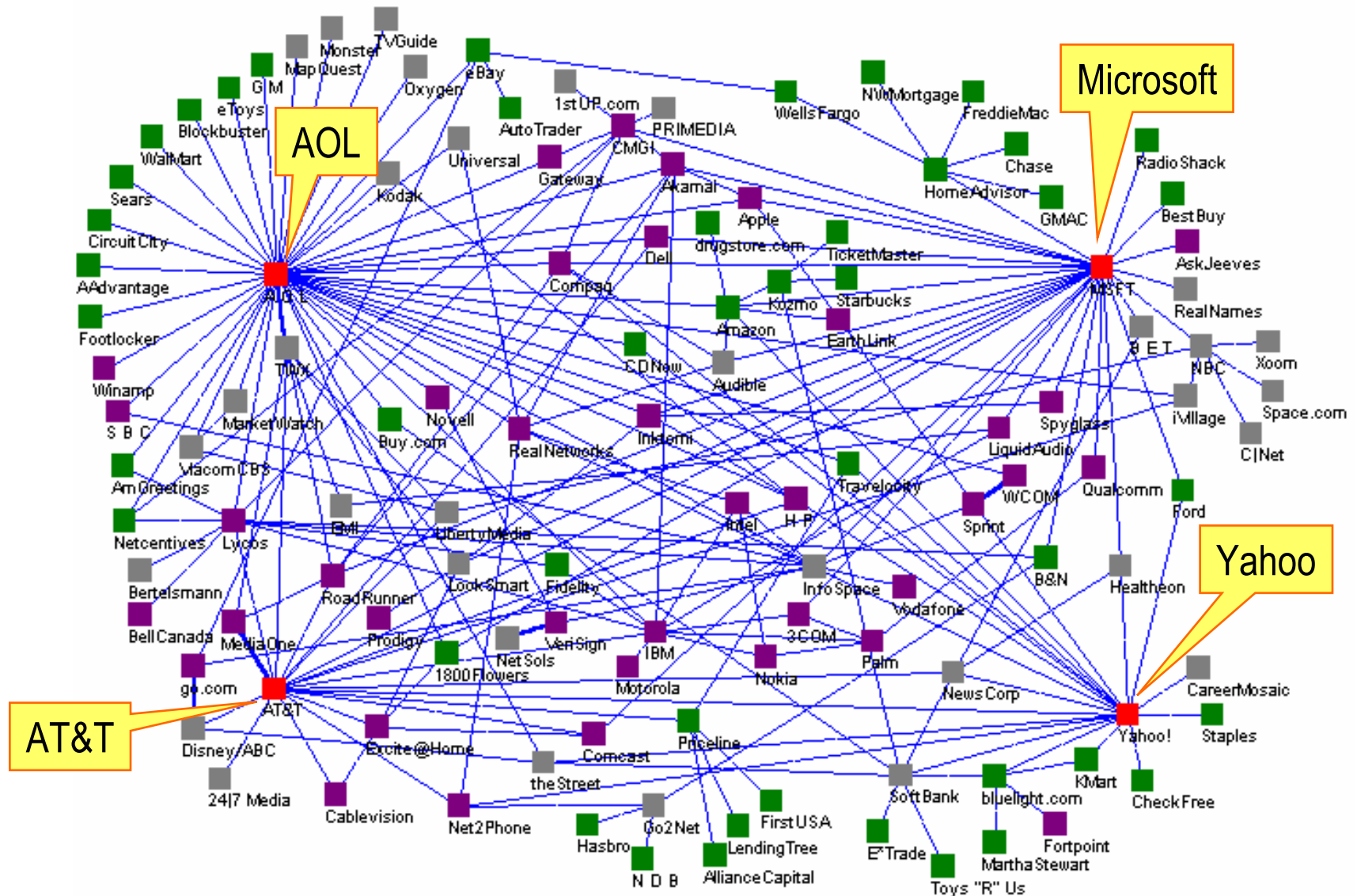
Co-Membership > 27%
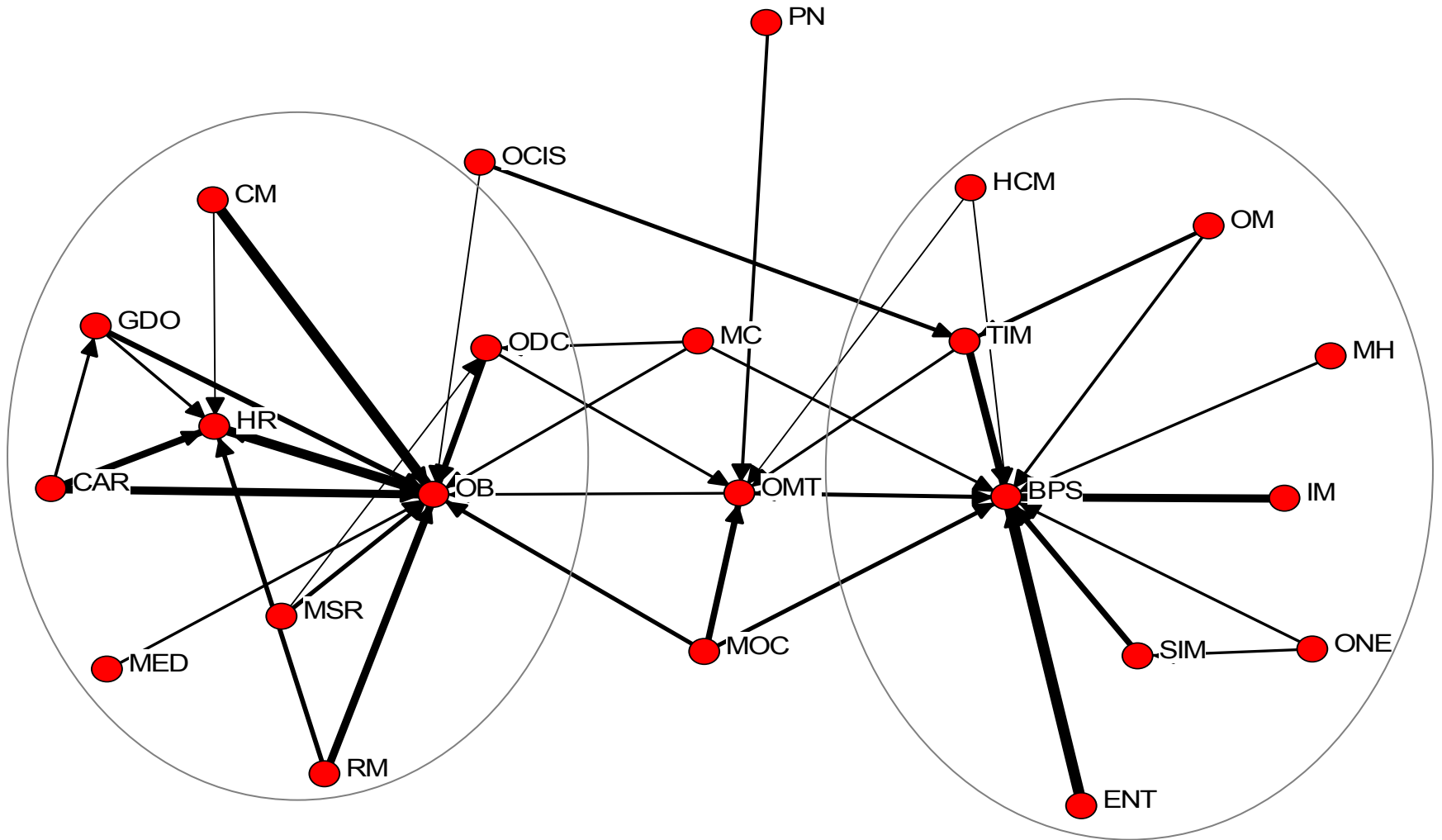
Relations Among Locations / Political Units

- Actors can be cities, countries, etc.

- Ties can be
  - Migration
  - Trade
  - Physical distance
  - Etc.

Distances Among Cities

SEATTLE

BOSTON

NY

CHICAGO

DC

DENVER

SF

LA

MIAMI
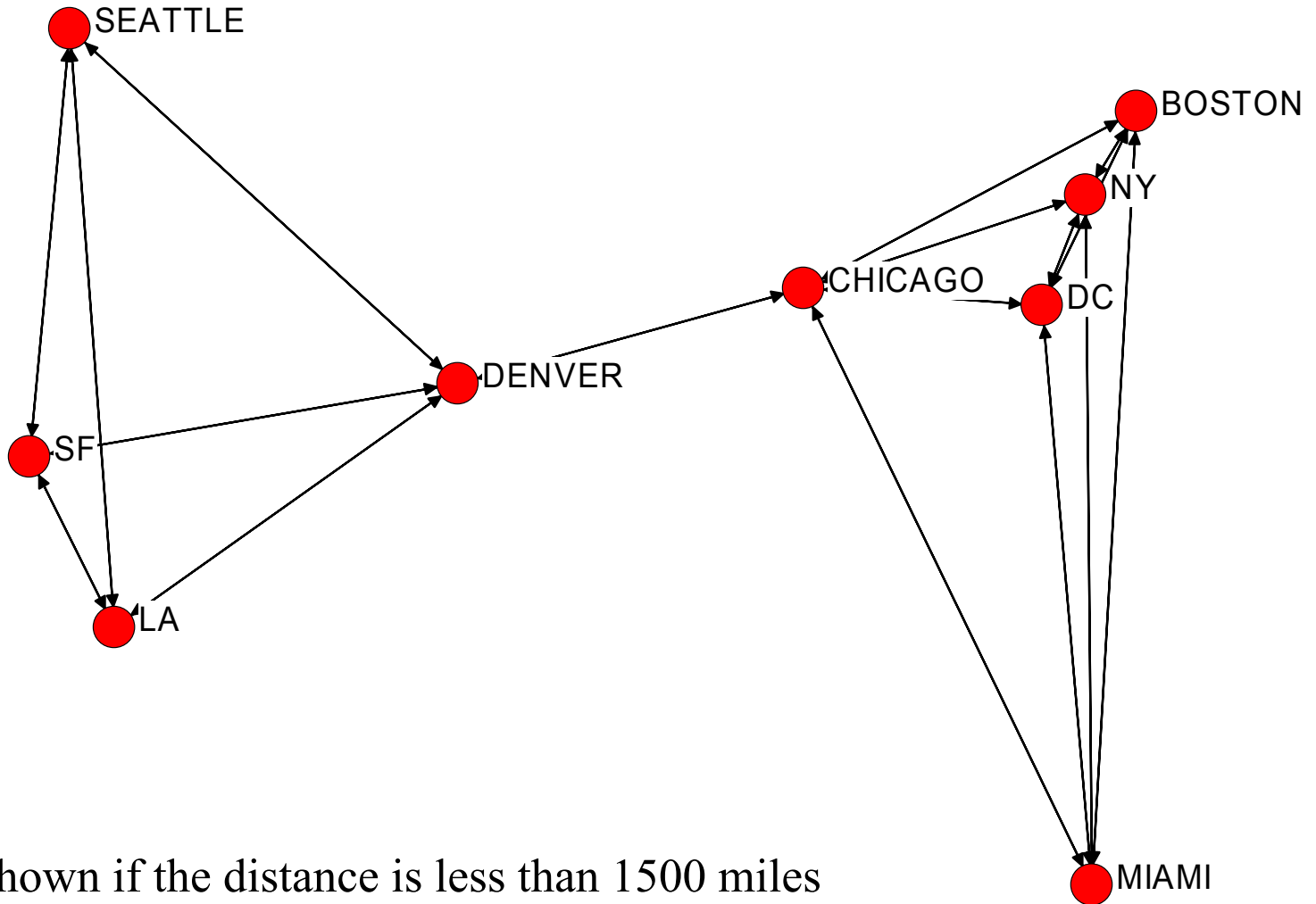
A line is shown if the distance is less than 1500 miles

Comparing airlines' route structures

Major Carrier
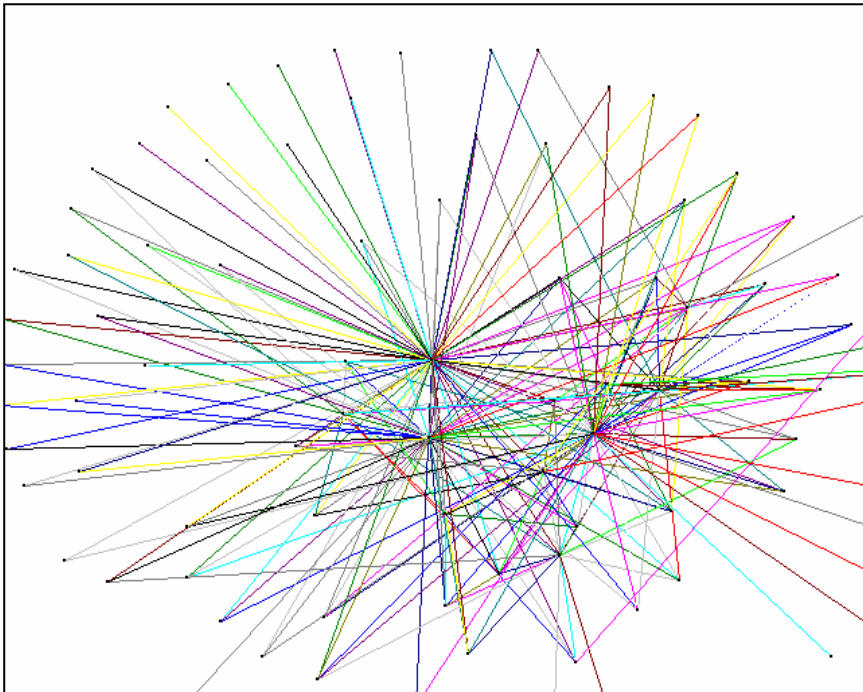
"Discount" Airline
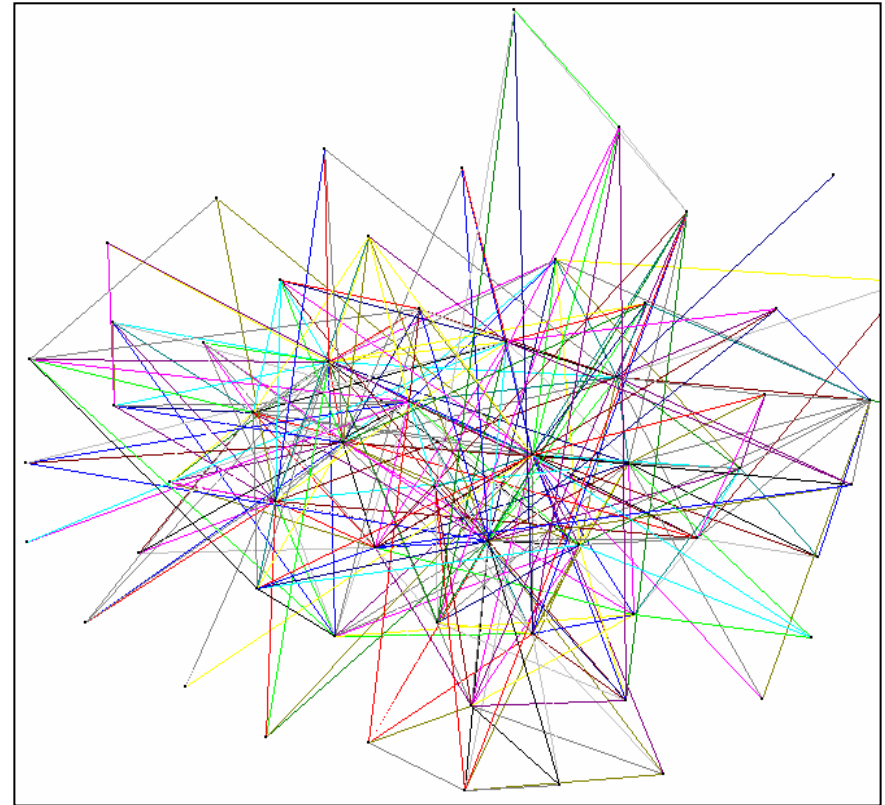
Note: Route maps defined around one specific hub only
Source: Industry data, BCG analysis

Internet Backbone
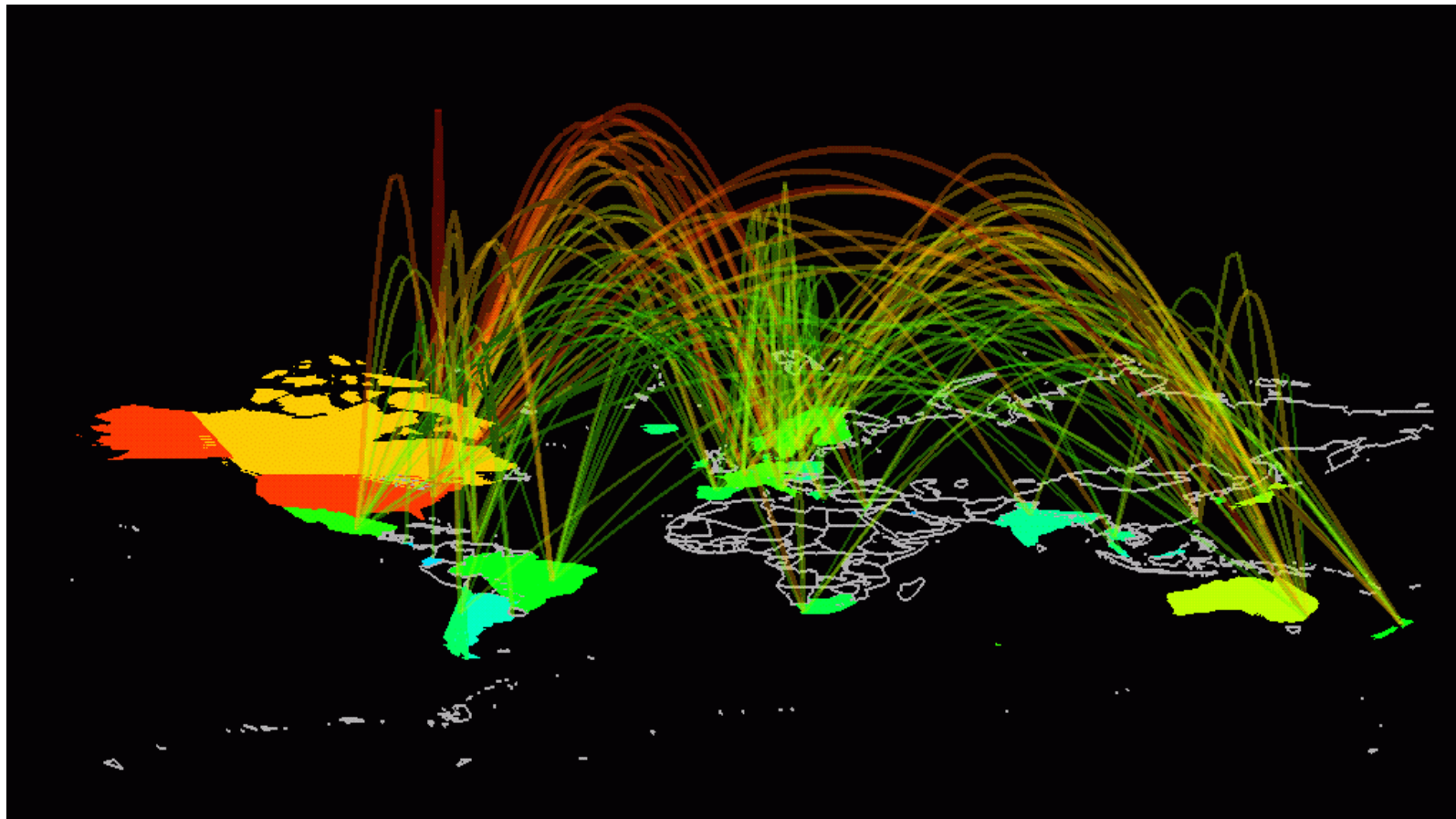
Kinds of Network Data

Kinds of Network Data

	Complete	Ego
1-mode	Ties among "all" members of a single class of entities	Ties among the set of nodes (alters) directly tied to a specific individual (ego)
2-mode	Ties between all members of two different classes of entities	Ties between two sets of entities tied to a specific individual

1-Mode Complete

Who Knew Whom
(before taking class)

Project collaboration

Management sci & technology apps

Health & social projects

Nodes colored by department

1000 scientists
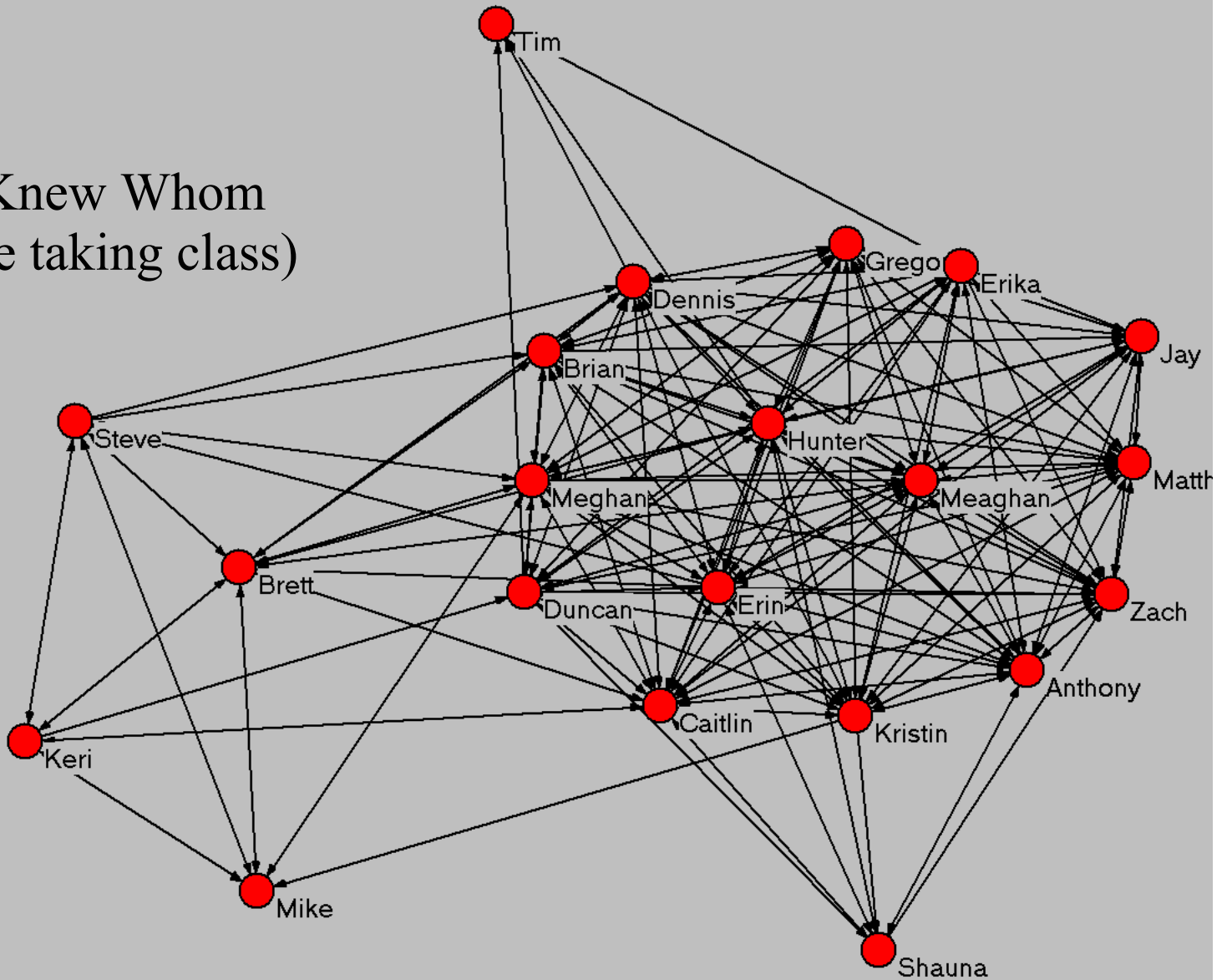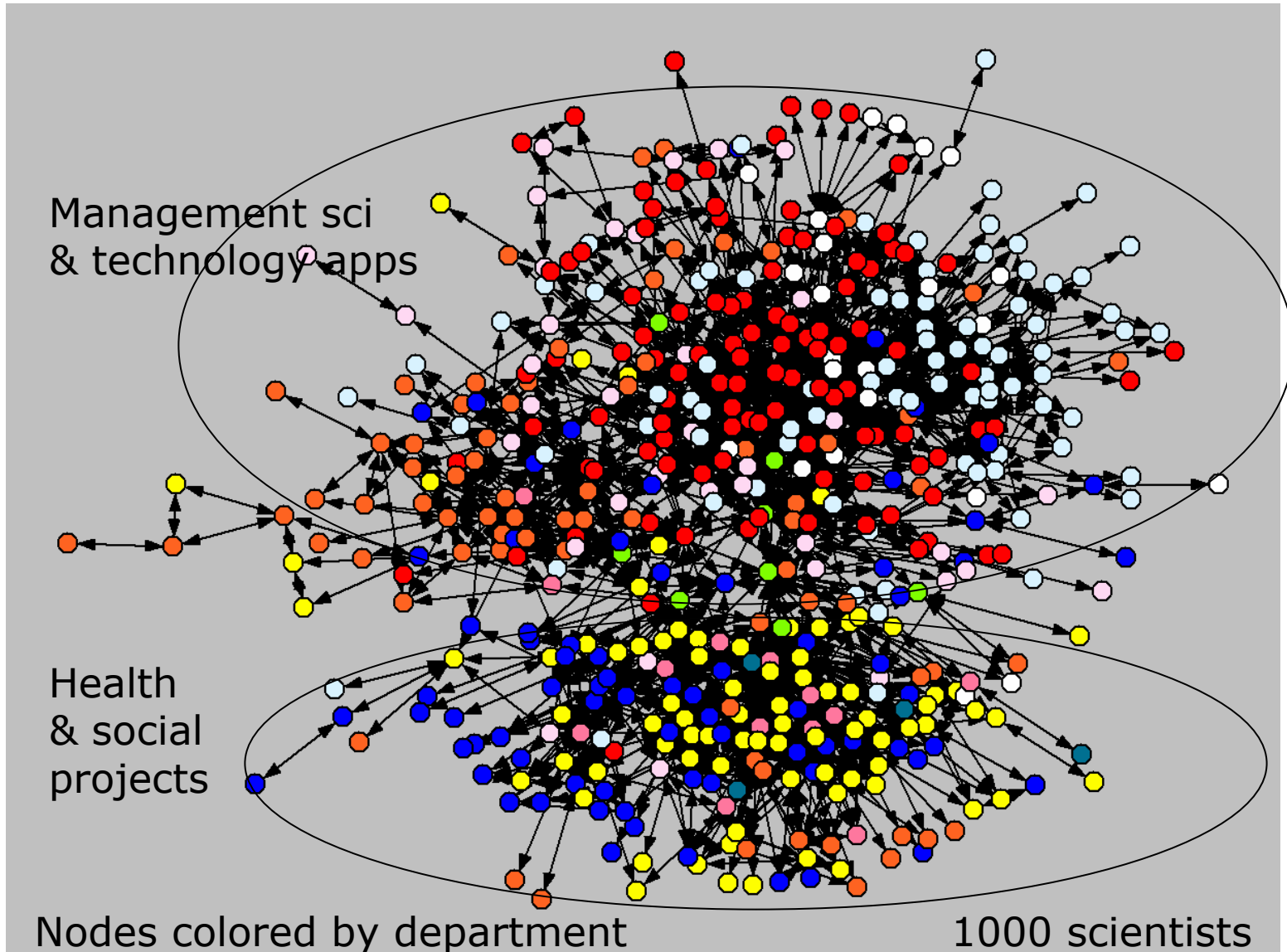
Example of a Network

Internet Alliances

Consumer Internet

Copyright © 2000, Valdis Krebs   http://www.orgnet.com/netindustry.html
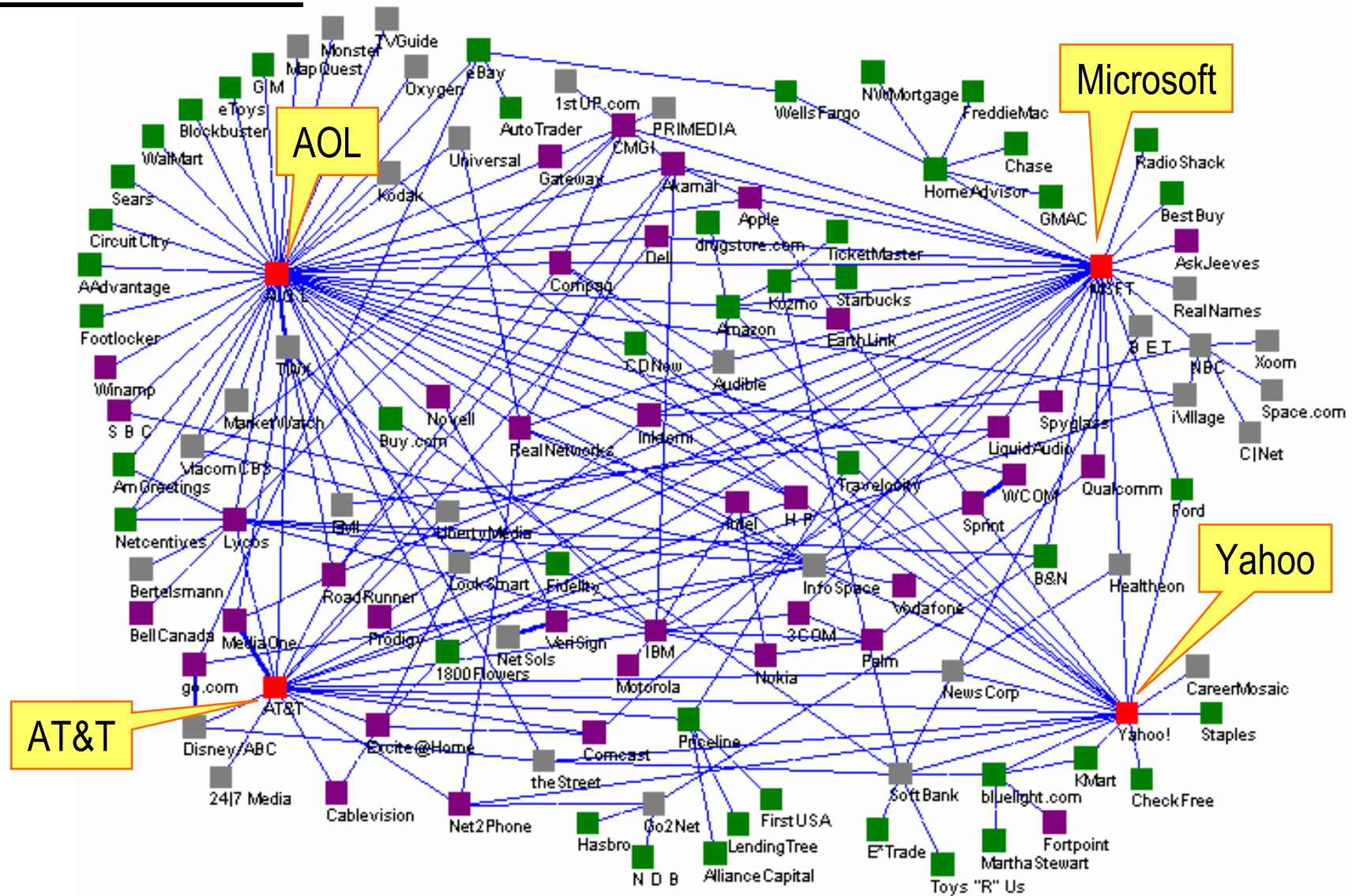
Example of a Network

Book Co-purchasing

Strategy & Change Cluster

How Digital is your Business?
Strategy-Focused Organization
Mastering Strategy
All the Right Moves
Breaking Code of Change
Entrepreneurial Mindset
Unchained Value
Serious Play
Hidden Value
Social Life of Information
Art of Possibility
Digital Capital
Surfing the Edge of Chaos
Leading the Revolution
Nobrow
Living on the Fault Line
Bobos in Paradise
Butterfly Economics
Tipping Point
Cluetrain Manifesto
Anatomy of Buzz
Grassroots Marketing

Investigations

Book Promo Cluster

Complete Guide to Book Publicity
Book Promotion for Shameless
Promote Like a Pro
Jump Start Your Book Sales
Complete Guide to Book Marketing
Simple Guide to Marketing Your Book

Staying Street Smart ...
e-Bay Phenomenon
E-trepreneur
B2B: How to Build ...
Unleashing the Ideavirus
E-Service
Building Brandwith
10 Second Internet Manager
eBrands
E Promotions
Co-Marketing Solution
Future Focus
Inside the Minds
Permission Marketing
Internet Direct Mail
11 Immutable Laws ...
Soul of the New Consumer
e-loyalty
Deep Branding on the Internet
Loyalty Marketing for Internet Age

Internet Marketing Cluster

Diagram courtesy of Valdis Krebs www.orgnet.com

Acquaintances among Drug Users

African-American

Puerto-Rican

US White

Acquaintance ties in Hartford, CT. Drawn from Weeks, Clair, Borgatti, Radda & Schensul (published in *Aids & Behavior*). Supported by NIH grant to the Institute for Community Research.
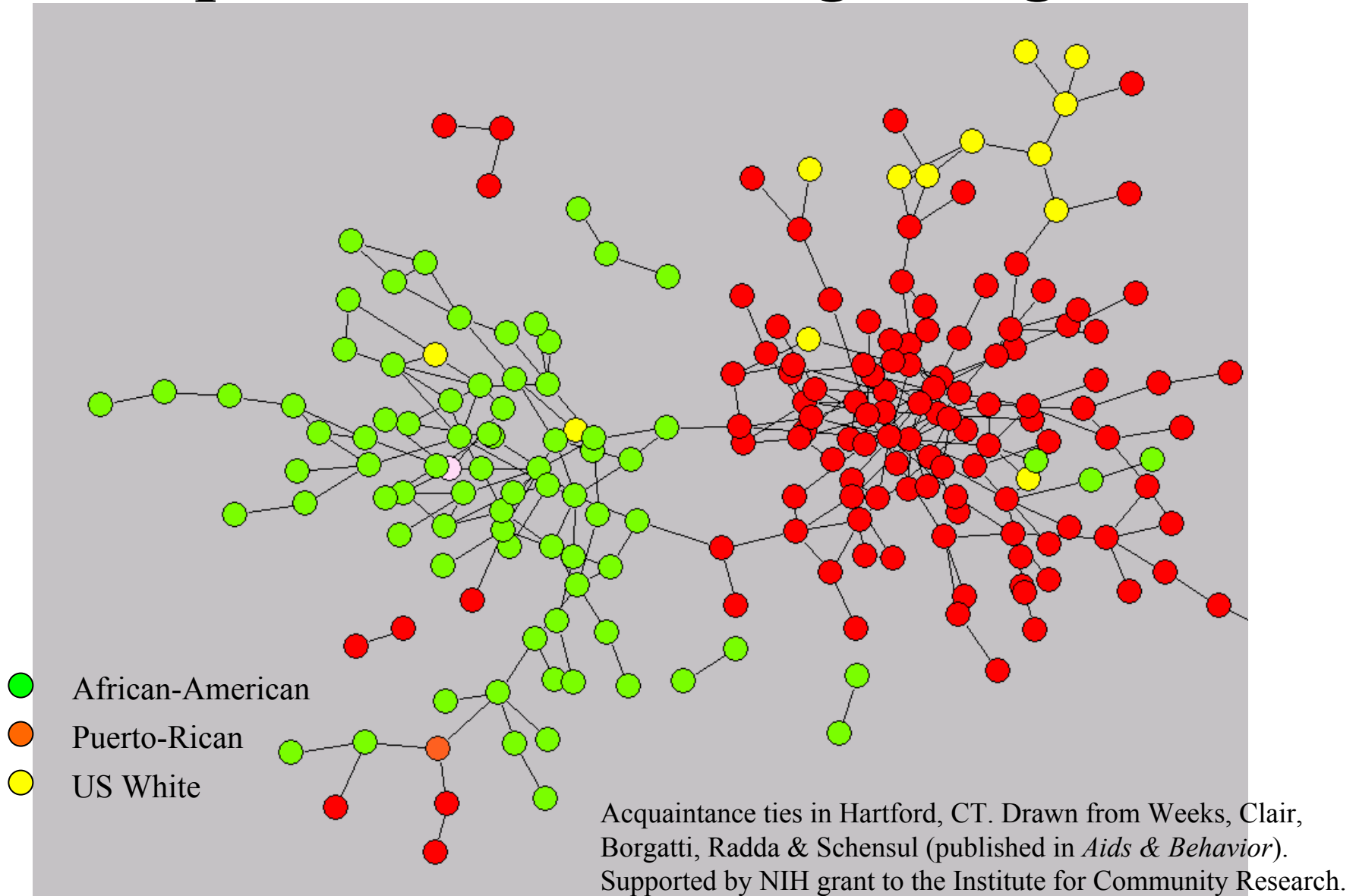
1-mode ego network

Carter Administration meetings
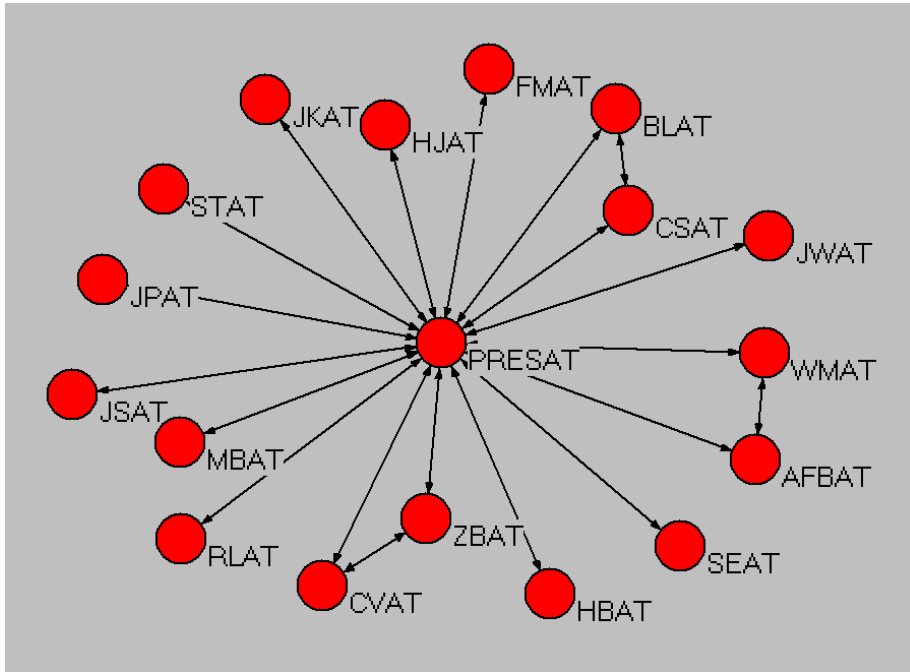
Year 1

Data courtesy of Michael Link
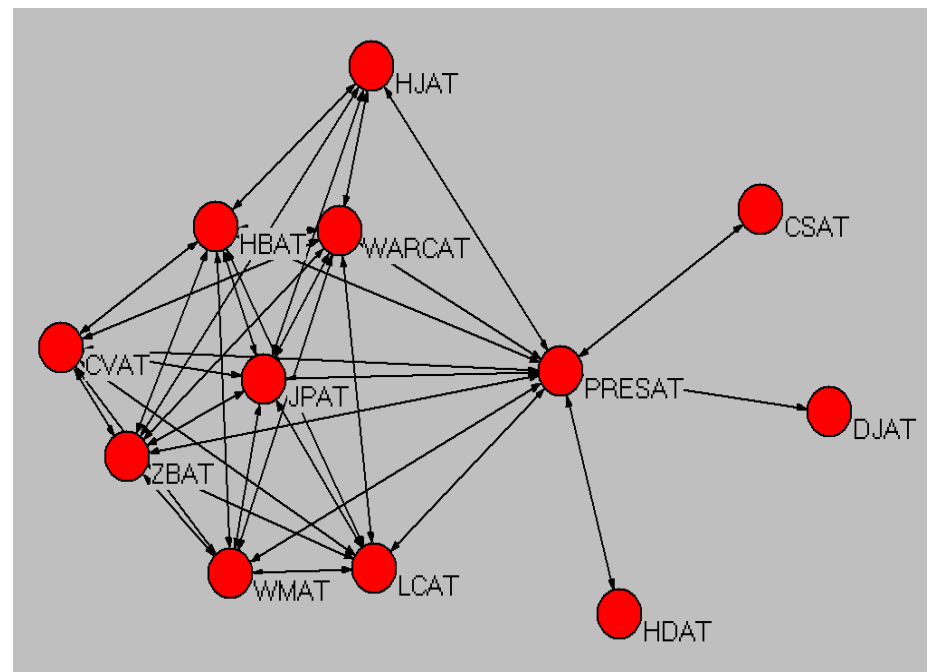
Year 4

2-mode Ego Network
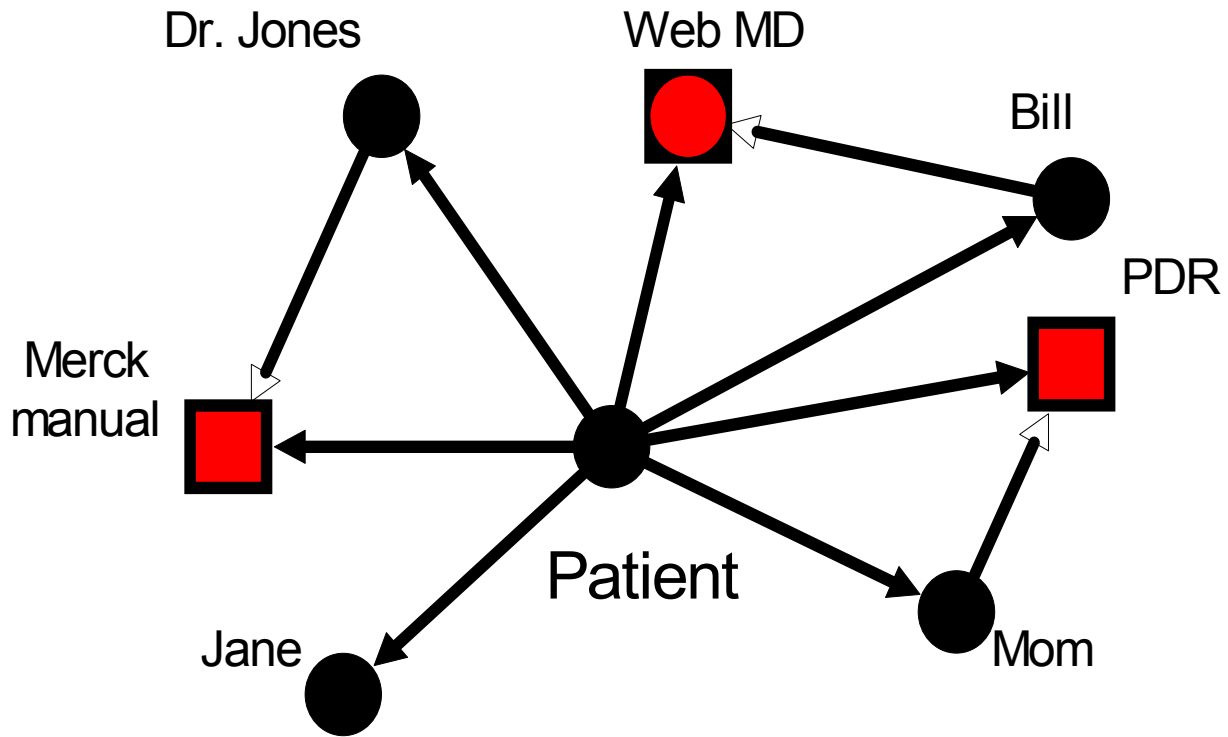
2-mode complete network
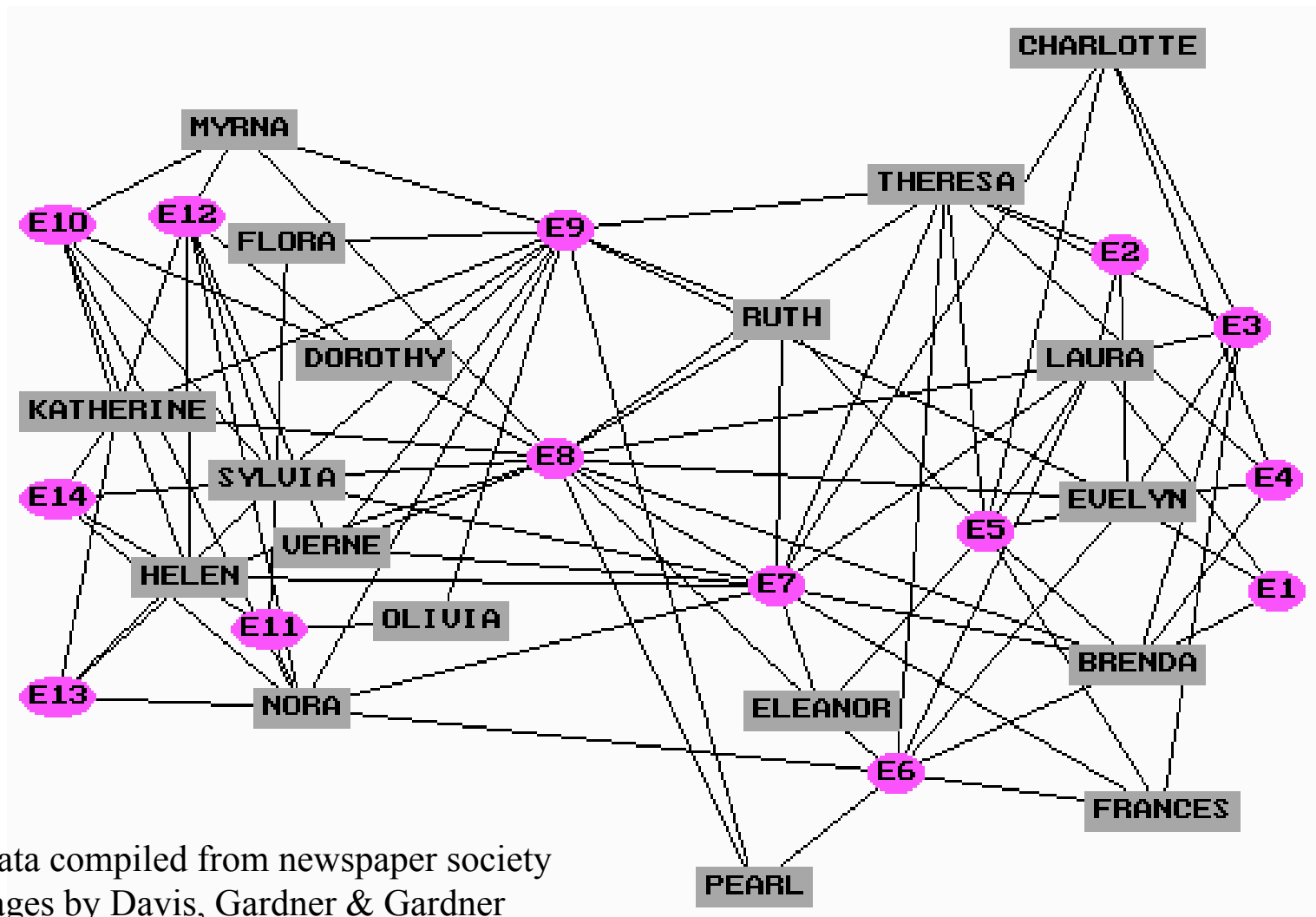
Data compiled from newspaper society
pages by Davis, Gardner & Gardner

Kinds of Network Data

	Complete	Ego
1-mode		
2-mode		

Network Data

- Attributes versus relations
- The discovery of HIV
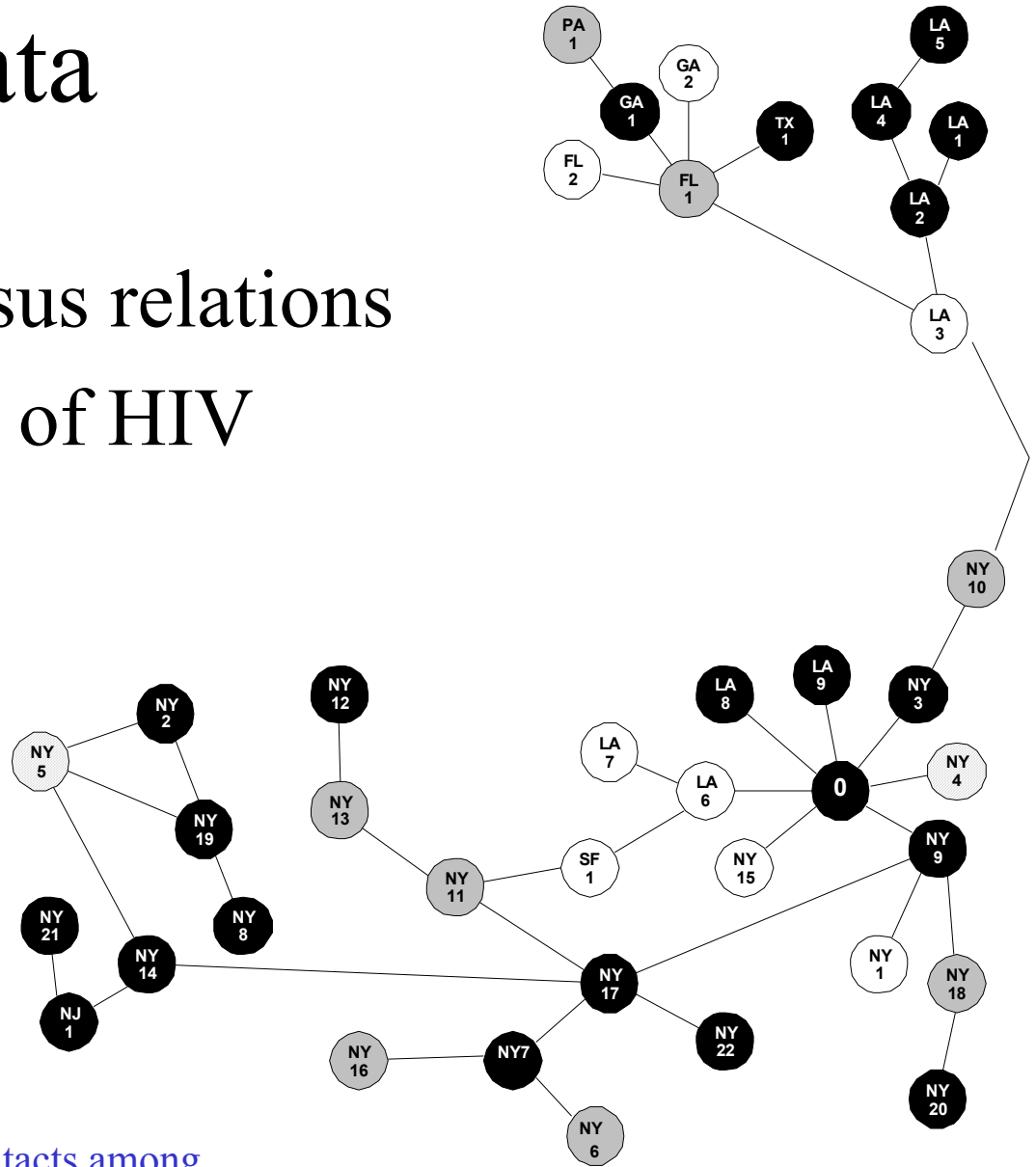
Discovery of HIV: Sexual contacts among
gay men w/ unusual cancers, traced by Bill Darrow of the CDC

Mainstream Data Structure

Variables
(attributes)

Cases
(individuals)

	Age	Sex	Education	Income
1001				
1002				
1003				
1004				
1005				
…				

- Analysis consists of correlating attributes

Network Data Structures

Friendship

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

	Friendship	Proximity
Jim - Jill	1	3
Jim - Jen	0	9
Jim - Joe	1	2
Jill - Jen	1	1
Jill - Joe	0	15
Jen - Joe	1	3

Proximity

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

- Values assigned to <u>pairs</u> of actors
- Relations are variables
  - variables can also be defined at more aggregate levels
- Multiple relations are recorded for the same set of actors

Ways & Modes

- Ways are dimensions: rows, columns, levels, etc.
  - Most network data matrices are 2-way 1-mode
  - A few are 2-way 2-mode,
  - Even more rare are 3-way 1-mode data (CSS)
    - Each person gives their perception of entire set of relations among all persons

3-Way 1-Mode Data

Jim

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

Jen

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

Jill

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

Joe

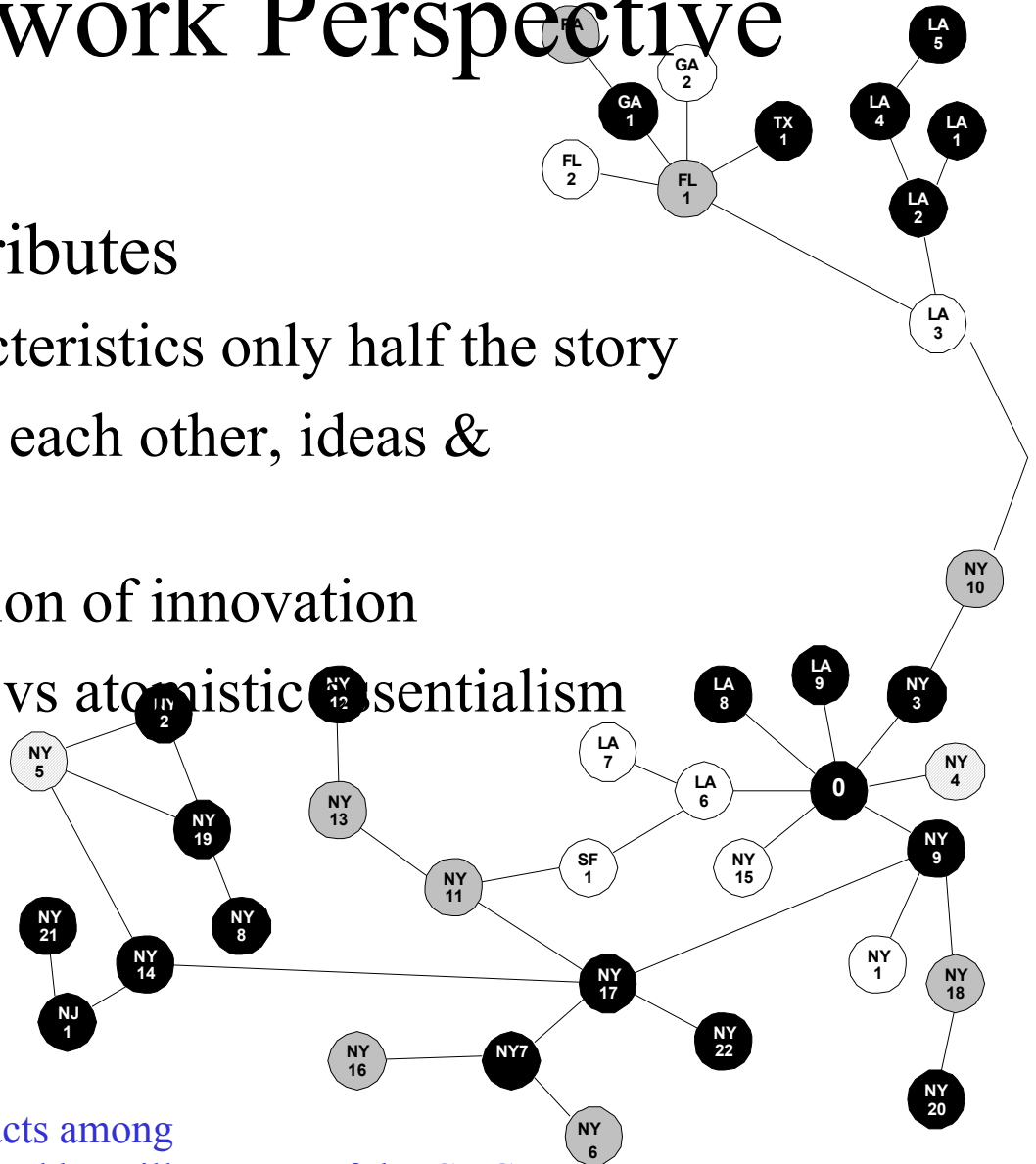|	Jim	Jill	Jen	Joe
Jim		1	1	0
Jill	1		1	1
Jen	1	1		1
Joe	0	1	1	

Network Perspective

- **Guiding principles (and biases)**
- **Standard hypotheses**

The Network Perspective

- Relations vs. Attributes
  - Individual characteristics only half the story
  - People influence each other, ideas & materials flow
  - Predicting adoption of innovation
  - Interdependence vs atomistic essentialism

Discovery of HIV: Sexual contacts among
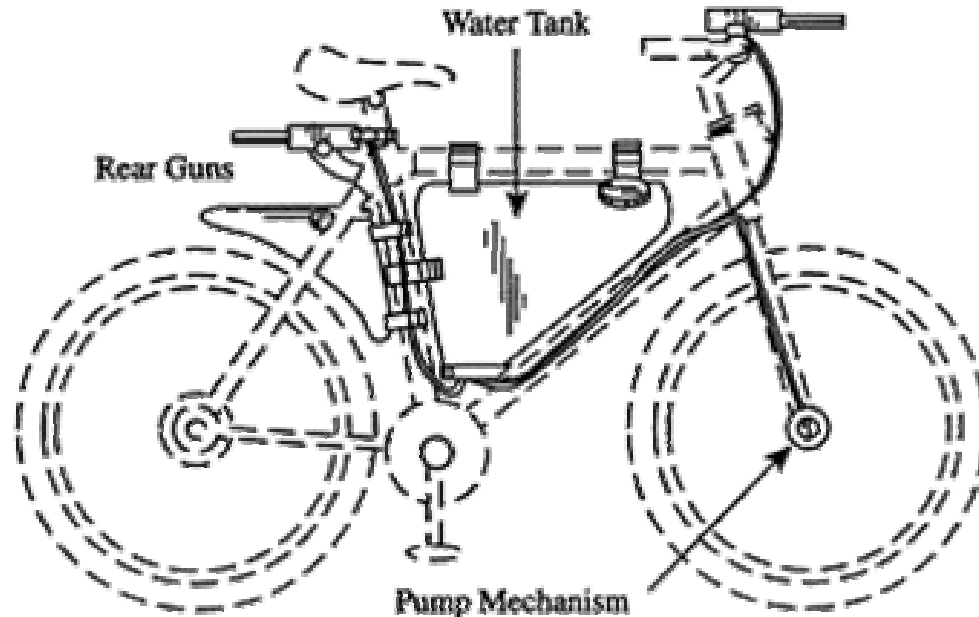gay men w/ unusual cancers, traced by Bill Darrow of the CDC

The Network Perspective

- It's not just the elements (composition) of a system, but how they are put together
  - non-reductionist, holistic

The Network Perspective

1. It's not just the elements (composition) of a system that matter, but how they are put together

   – non-reductionist, holistic, structuralist

Water Tank

Rear Guns

Pump Mechanism
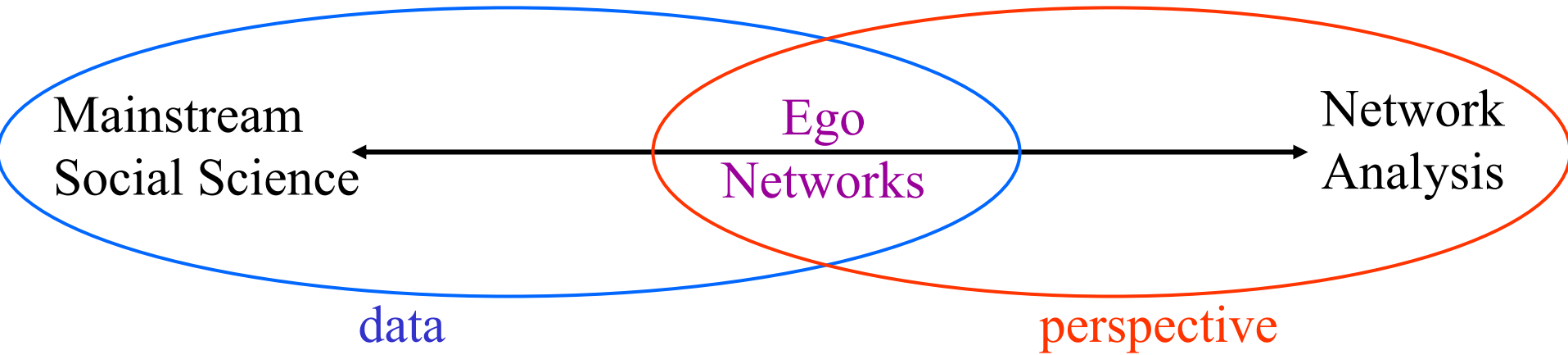
Network Perspective

- Structure vs. Composition
  - It's not just the elements of a system, but how they are put together
  - non-reductionist, holistic, systemic
- Emergence vs. Design
  - groups (e.g., communities vs. departments)
  - Roles
- Seeing all natural systems as networks
  - molecules, brains, organisms, organizations, economies, ecologies, telephones, roads, weblinks, etc

The Network Perspective

- Structuralism vs individualism
  - structure -> group performance
  - position -> opportunities & constraints
- Structuralist stance
  - faith that <u>social capital</u> trumps human capital
  - more research on consequences of network structure & position than causes
  - Preference (bias) for direction of causality
    - position -> personality, not the reverse

Ego Networks

Mainstream
Social Science

Ego
Networks

Network
Analysis

data

perspective

- Combine the perspective of network analysis with the data of mainstream social science

Network Theorizing

Examples of Network Theorizing

- Granovetter's Strength of Weak Ties
- Burt's Structural Holes
- Power in experimental exchange networks

Units of Analysis
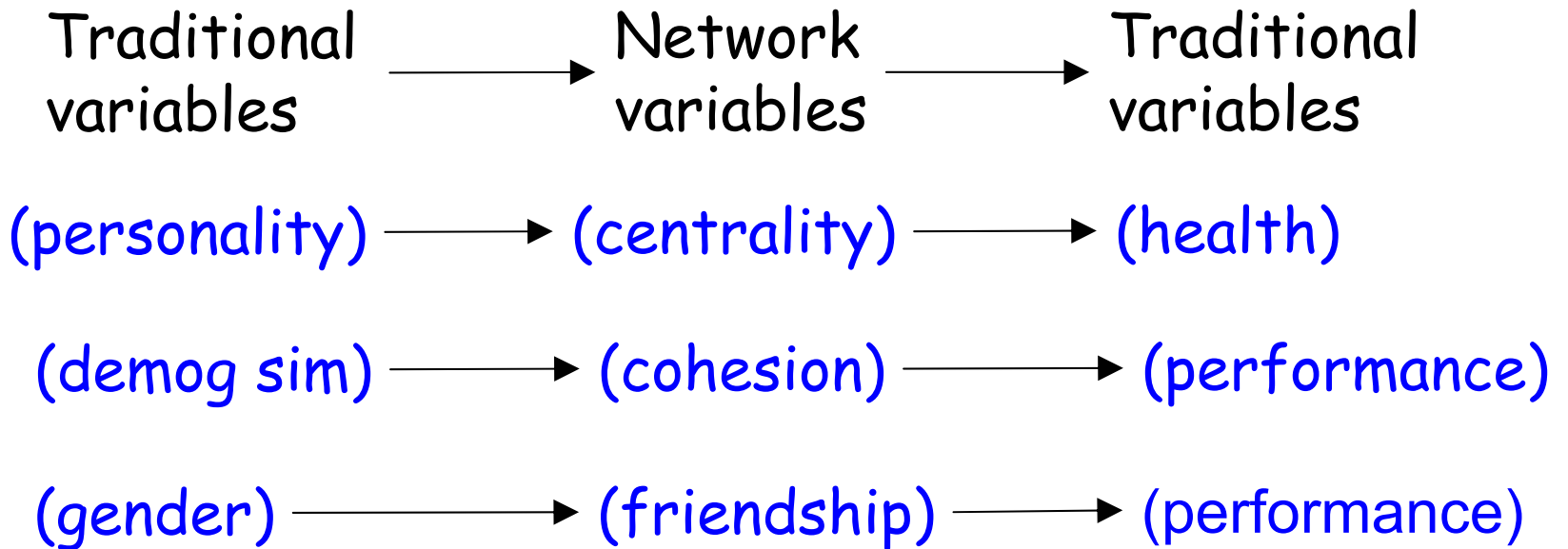
- Dyadic
  - Do families with marriage ties do business together?
- Actor
  - Are more central actors more knowledgeable?
- Whole network
  - Do teams with core/periphery structures perform better than teams with clique structures?
- Mixed levels
  - Does gender (actor-level variable) pattern friendship ties (dyadic-level variable)
    - E.g., do girls hang w/ girls and boys w/ boys?

Hypotheses

- Dyadic level
  - families w/ marriage ties have business ties
- Individual level
  - centrality in gossip network predicts health
- Whole network level
  - groups with c/p structure perform better
- Mixed Dyadic-Individual (autocorrelation)
  - more ties within dept. than between depts.

Causality

Traditional variables		Network variables		Traditional variables
(personality)	→	(centrality)	→	(health)
(demog sim)	→	(cohesion)	→	(performance)
(gender)	→	(friendship)	→	(performance)

Elements of Network Theorizing
Design patterns

- Assessing the value of ties
  - Social capital of individuals and groups
- Theory of social structure
  - Weber's and Nadel's big ideas
- Structuralism
  - Position determines in part individual's opportunities and constraints
  - Group performance due in part to structure of ties within
- Connectionism
  - small world; flows; influence
- Social influence leading to homogeneity & control

Explanatory Goals/Styles

- Explaining variance in performance or success
  - Social capital
  - Agency > structure
  - today

- Explaining homogeneity in behavior or attitudes
  - Diffusion
  - Structure > agency
  - yesterday

Explanatory Mechanisms

– Flows mechanism (connectionist orientation)
  - Interpersonal transmissions, flows, influence
  - relational
  - Social control via social mechanisms
  - Ties as pipes
  - Linkages
– Topology mechanism (structuralist orientation)
  - convergent outcomes based on similar social environments
  - structural
  - Opportunities, constraints; system performance
  - Ties as girders
  - Shapes

Typology of Network Research

	Variance in Success (Social Capital)	Homogeneity in Attitudes/Practices (Diffusion)
Topology (Structuralist)	Benefits of Position e.g., Burt	Environmental Influence e.g., Powell
Flows (Connectionist)	Social Access to Resources e.g. Lin	Contagion / Transmission e.g., Granovetter

	Va	Ho
Top	X	
Flo		

Benefits of Position

- ## Individual level
  - ### Burt's structural holes argument
    - #### People whose personal networks have certain topological features are better off

- ## Group Level
  - ### Bavelas' centralization argument
    - #### For simple tasks, groups with centralized communication structures perform better

Environmental Influence

- Mimetic isomorphism (Dimaggio & Powell)

- Similarity of attitude as function of structural equivalence (Erickson)

- Adoption as a function of structural equivalence (Burt)

- Adoption as a function of centrality (Coleman)

Social Access to Resources

- Individual level
  - Nan Lin's social resource theory
    - People who have ties to important, wealthy, knowledgeable people are better off

- Group Level
  - Putnam's bowling alone
   - Communities with dense helping & trust ties are better off

Social Contagion

- ## Individual level
  - ### Granovetter's strength of weak ties theory
    - People who with more weak ties have better chance of hearing novel information (e.g., about jobs)
  - ### Lave & Wenger's community of practice theory
    - Developing shared culture through interaction
- ## Group Level
  - ### Granovetter's community strength argument
    - Communities with lots of weak ties can coordinate more effectively than those with strong ties

The Future

The SNA Frontier

- Data collection and compilation
- Dynamic networks
- Networks & the larger context
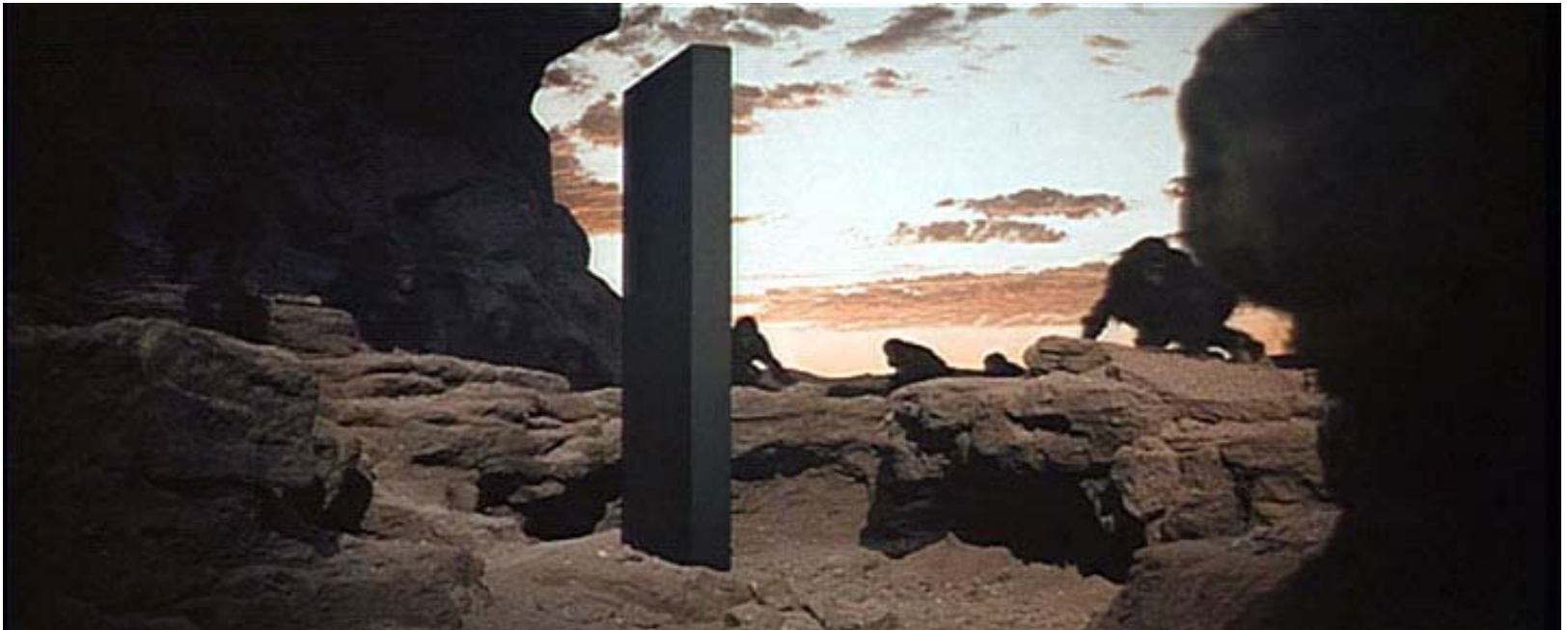
Data Collection and Compilation

- Web data collection & automatic processing
  - Easing burden on respondents and analysts
- Passive electronic data collection
  - Tacit Knowledge Systems KnowledgeMail
  - Phone records
  - Web cookies
  - PDA beaming of business cards and memes

Dynamic Networks

- Modeling network change over time
  - Benchmarking "normal" processes of densification and fragmentation
  - Understanding how personal networks grow & decay
  - Documenting changes in networks as a result of intervention efforts
  - Managing path-dependent learning
  - Observing diffusion paths of ideas, practices, innovations

- Simulations
  - What-if scenarios -- adding and dropping network nodes or ties
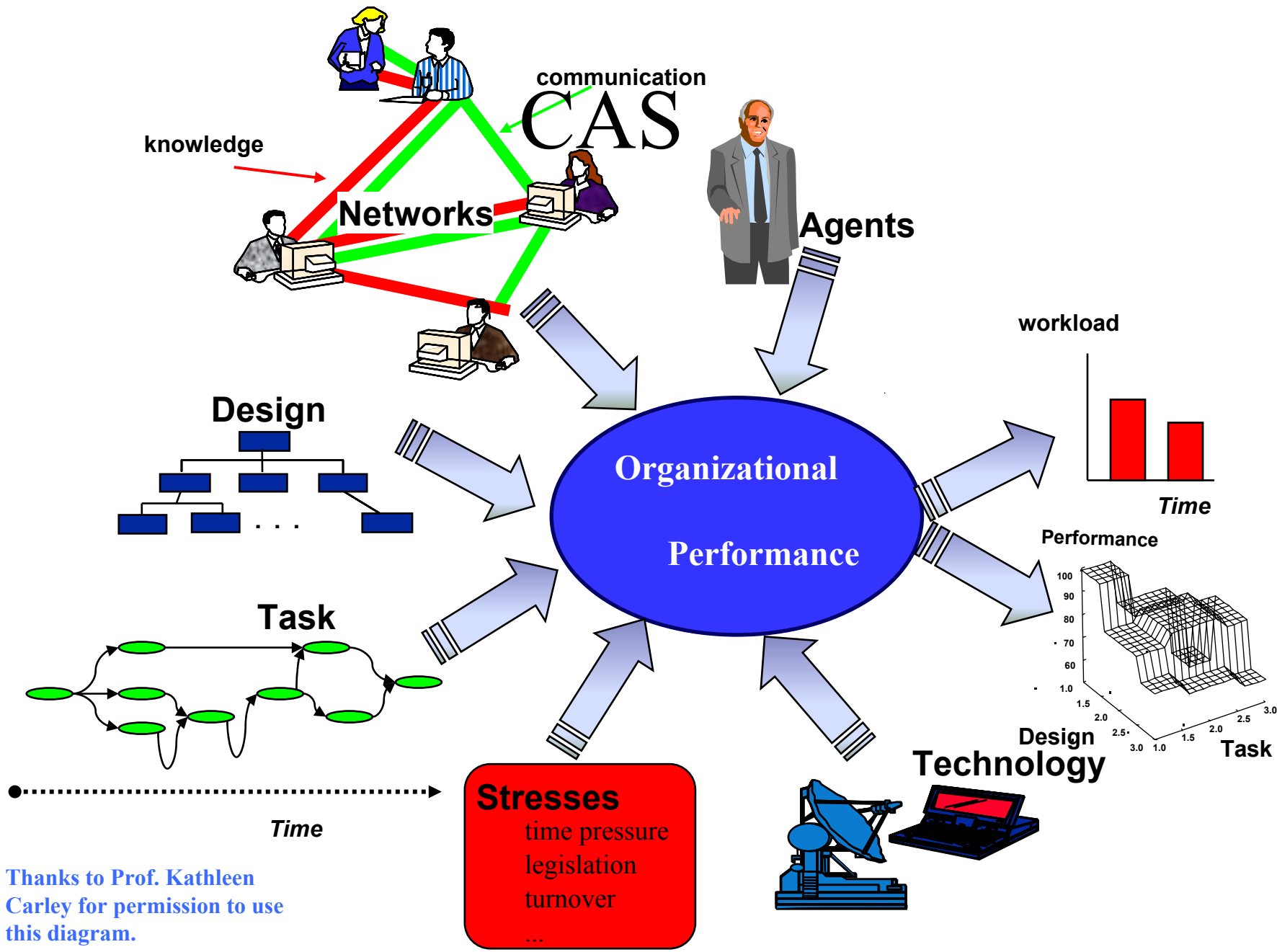 - Predicting diffusion outcomes

Scaling

- Mapping whole organizations
  - Managing scale effects -- what happens to knowledge networks when organizations increase in size by orders of magnitude?
  - Detecting invisible colleges and communities of practice
  - Detecting structural holes and disconnections
  - Enhancing usability of technological knowledge management solutions

Networks in Context

- Mapping extra-organizational ties & influences
  - Ego-network approaches
  - Passive electronic data collection
- Complex adaptive systems (CAS)
  - Mapping relationships among individuals, organizational units, tasks, strategies, concepts, beliefs in an evolutionary framework
    - Task precedence – which tasks must be done before which others
    - Task assignment – which persons assigned to which tasks
    - Expertise distribution – which persons have which skills
    - Task requirements – which skills needed for which tasks

communication

CAS

knowledge

Networks

Agents

Design

Organizational

Performance

workload

Time

Performance

Task

Time

Stresses
time pressure
legislation
turnover
...

Technology

Design

Task

Thanks to Prof. Kathleen Carley for permission to use this diagram.

To Learn More ...

- Class web site:
  - www.analytictech.com/essex [go]
- Handouts, notes, lectures:
  - www.analytictech.com/networks [go]
- INSNA web site:
  - www.insna.org [go]
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