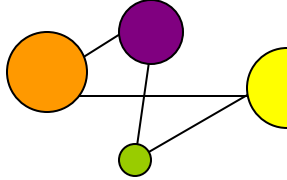

Social Network Analysis Introduction

UNIVERSITY
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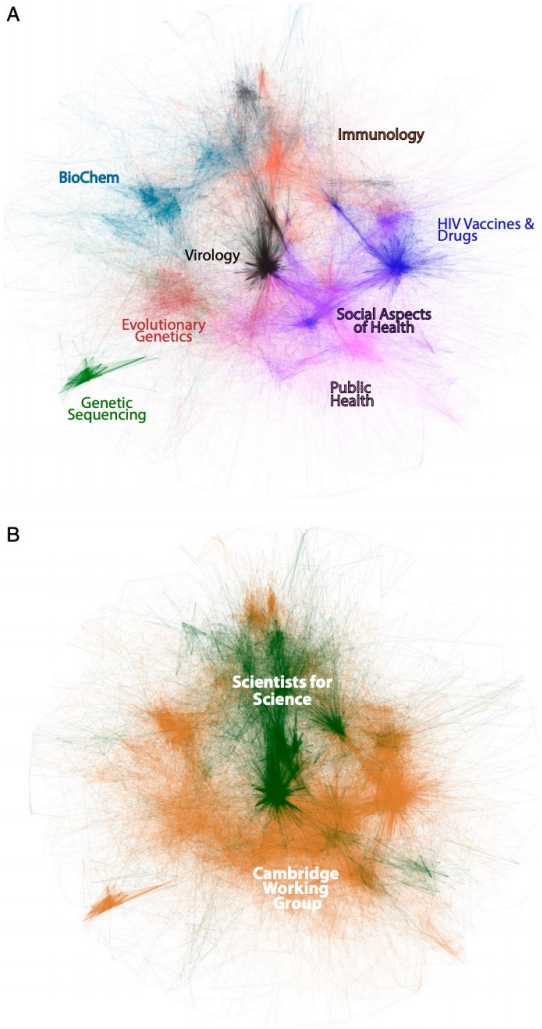


Fig. 2. Correspondence between research topics and position on gain-of-function research. Map of the largest component of scientists' paper-to-paper coterm network: edges link papers (n = 19,257) weighted by their cosine similarity (see the *SI Appendix* for details); layout is via Fruchterman–Reingold, which places similar papers near one another; layout positions are constant in both *A* and *B*. (*A*) Edges colored by papers' highest loading topic (eight colors, corresponding labels positioned near the center of topic clusters). (*B*) Edges colored by the authors' camp (green, SFS; orange, CWG).

PNAS

Disparate foundations of scientists' policy positions on contentious biomedical research

Achim Edelmann[a,b,1], James Moody[b,c,d], and Ryan Light[e]

[a]Institute of Sociology, University of Bern, 3012 Bern, Switzerland; [b]Duke Network Analysis Center, Duke University, Durham, NC 27708; [c]Department of Sociology, Duke University, Durham, NC 27708; [d]King Abdulaziz University, Jeddah 21589, Saudi Arabia; and [e]Department of Sociology, University of Oregon, Eugene, OR 97403

Edited by Peter S. Bearman, Columbia University, New York, NY, and approved April 21, 2017 (received for review September 1, 2016)

What drives scientists' position taking on matters where empirical answers are unavailable or contradictory? We examined the contentious debate on whether to limit experiments involving the creation of potentially pandemic pathogens. Hundreds of scien-

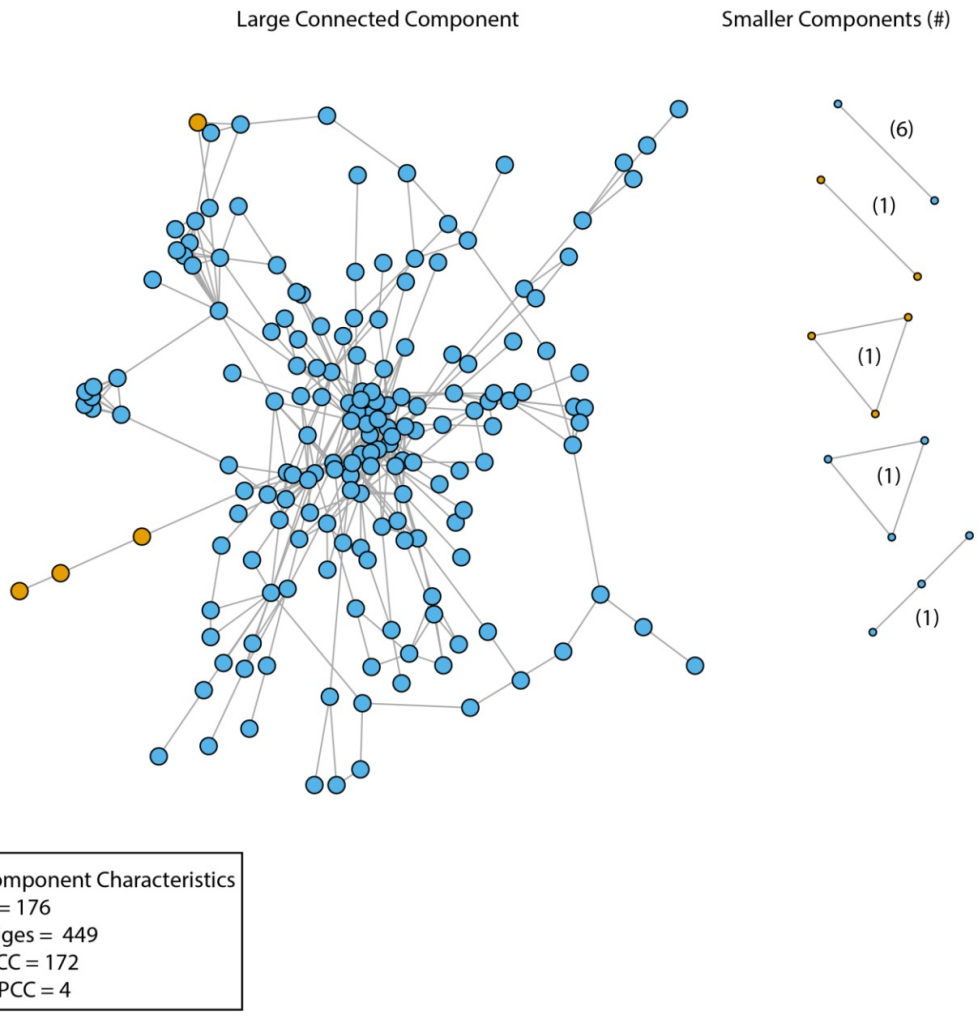
science rests on a community of scholars sharing ideas and working together (3). Implicit understandings in scholarly communities are shaped by multiple nonempirical factors (4–6), and debates often swing between states of contestation and consen-

What factors contribute to whether scientists publicly express support or concern a contentious scientific issue?

Gain-of-function research involves generation of new properties or characteristics in a scientific lab.

In this case the new property is mammalian transfer of H5N1 influenza virus.

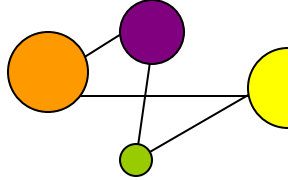
Figure 1. A Climate Science Co-Authorship Network



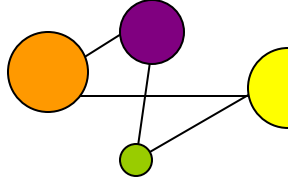
Clouding climate science:

A key criteria for a successful scientific idea is the development of a community. Good ideas beget good ideas and science accumulates accordingly – “standing on the shoulders of giants.”

Do anti-consensus climate scientists form a community?



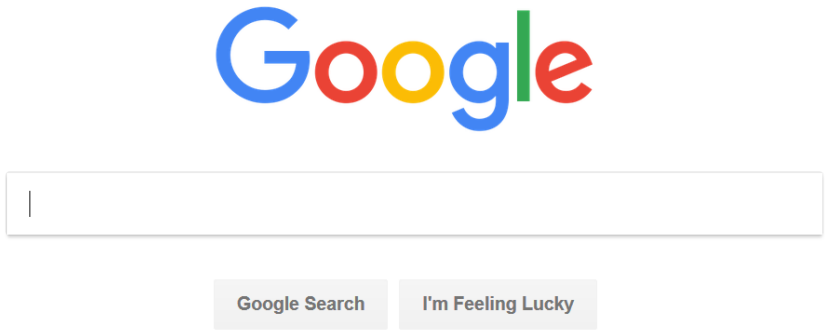
Introduction to the foundation of the basics of social network analysis

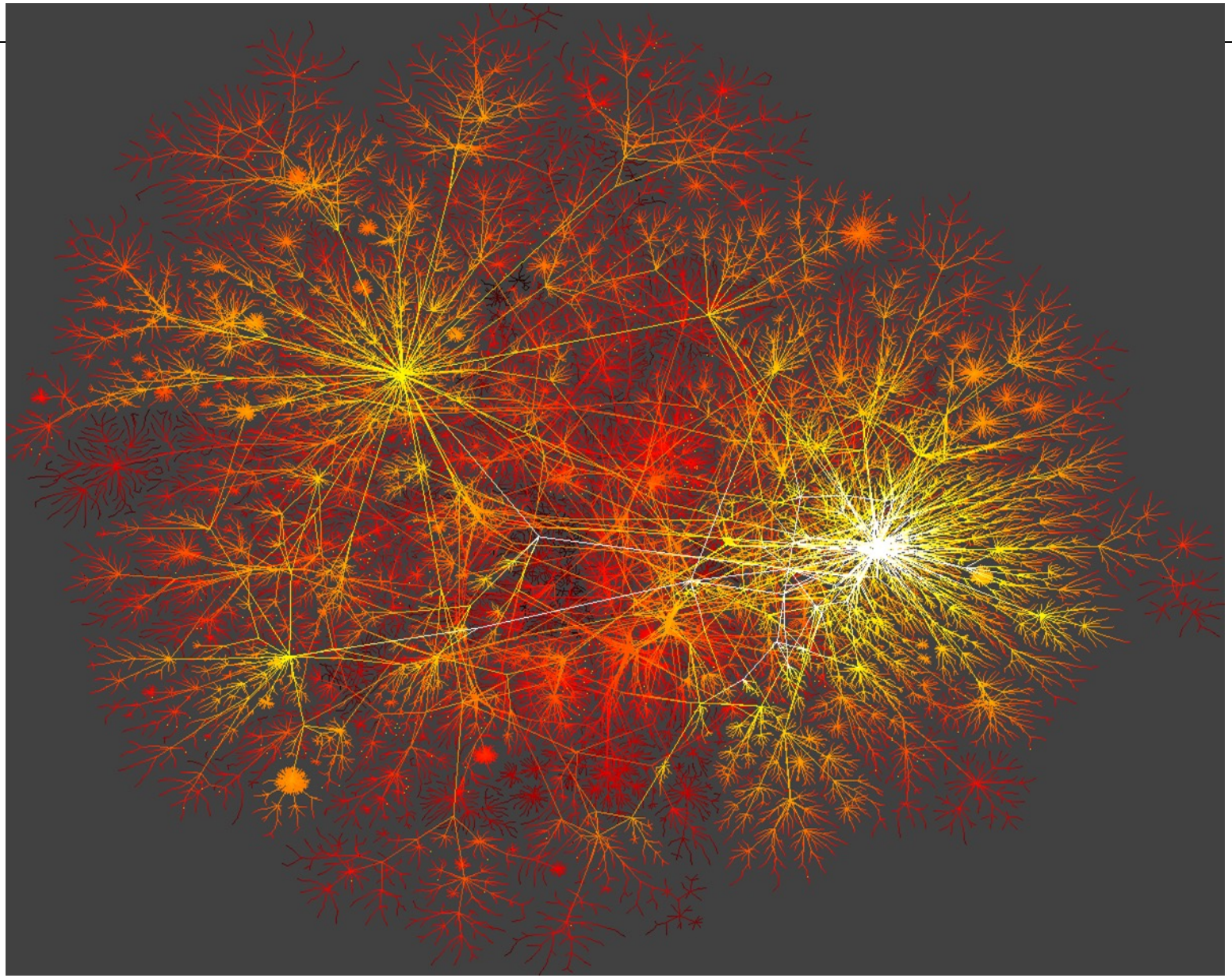


What do you think of when you think of the internet?


TikTok


09:41
100%
Messages
Calendar
Photos
Camera
Weather
Clock
Maps
Videos
Wallet
Notes
Reminders
Stocks
iTunes Store
App Store
iBooks
News
Health
Settings
Phone
Safari
Mail
Music


Google
Google Search
I'm Feeling Lucky



http://barabasilab.com and caida.org

What is high school?

THE SCHOOL DISTRICT OF PALM BEACH COUNTY

STUDENT PROGRESS AND GRADE REPORT

STUDENT NUMBER	STUDENT NAME	SEX	GRADE	SCHOOL NAME	SCHOOL YEAR	QTR.	DATE
		M	11	2191 WELLINGTON HIGH	06-07	4	06/08 2007

PERIOD	STATE NUMBER	COURSE TITLE	HC	INSTRUCTOR	1ST QUARTER G	1ST QUARTER C	1ST QUARTER PA	2ND QUARTER G	2ND QUARTER C	2ND QUARTER PA	EXAM	SEM. AVG.	3RD QUARTER G	3RD QUARTER C	3RD QUARTER PA	4TH QUARTER G	4TH QUARTER C	4TH QUARTER PA	EXAM	SEM. AVG.	FINAL AVG. MID. SCH.	H. S. CREDIT
0101	2000360	ANAT PHYSIO HON	H	COX,J	A	4		A	4	1	B	A	A	4	1	A	4	2	A	A		1.00
0202	8303020	DIV CAR TECH APPL	R	OLIVER L	B	3	3	A	3	1	A	A	A	3	1	A	3	2	C	A		1.00
0303	1001380	ENG HON III	H	BRANNON	A	4		A	4	1	A	A	A	4		A	4		A	A		1.00
0404	1206330	ANLY GEOMETRY	H	CHUNG-NI	A	4	2	A	4		A	A										.50
0404	1211300	TRIGONOMETRY	H	CHUNG-NI									A	4		A	4	1	A	A		.50
0505	2100320	AMER HISTORY HONORS	H	NICHOLS	A	4	2	A	4	1	B	A	A	4		A	4		A	A		1.00
0606	8300410B	DIV CAREER TECH-OJT	R	OLIVER L	A	4	3	A	4	1	A	A	A	4		A	4		A	A		1.00
0707	8300410A	DIV CAREER TECH-OJT	R	OLIVER L	A	4		A	4		A	A	A	4		A	4		A	A		1.00

	1ST QUARTER	2ND QUARTER	SEM. AVG.	3RD QUARTER	4TH QUARTER	SEM. AVG.	FINAL	TOTAL CREDIT
GPA	3.8571	4.0000	4.0000	4.0000	4.0000	4.0000	GPA	
HPA	4.1428	4.2857	4.2857	4.2857	4.2857	4.2857	HPA	7.00

LEGEND

HC - HONOR CODE C - CONDUCT

G - GRADE PA- PERIOD ABSENCES

MORE DETAILS ON REVERSE SIDE

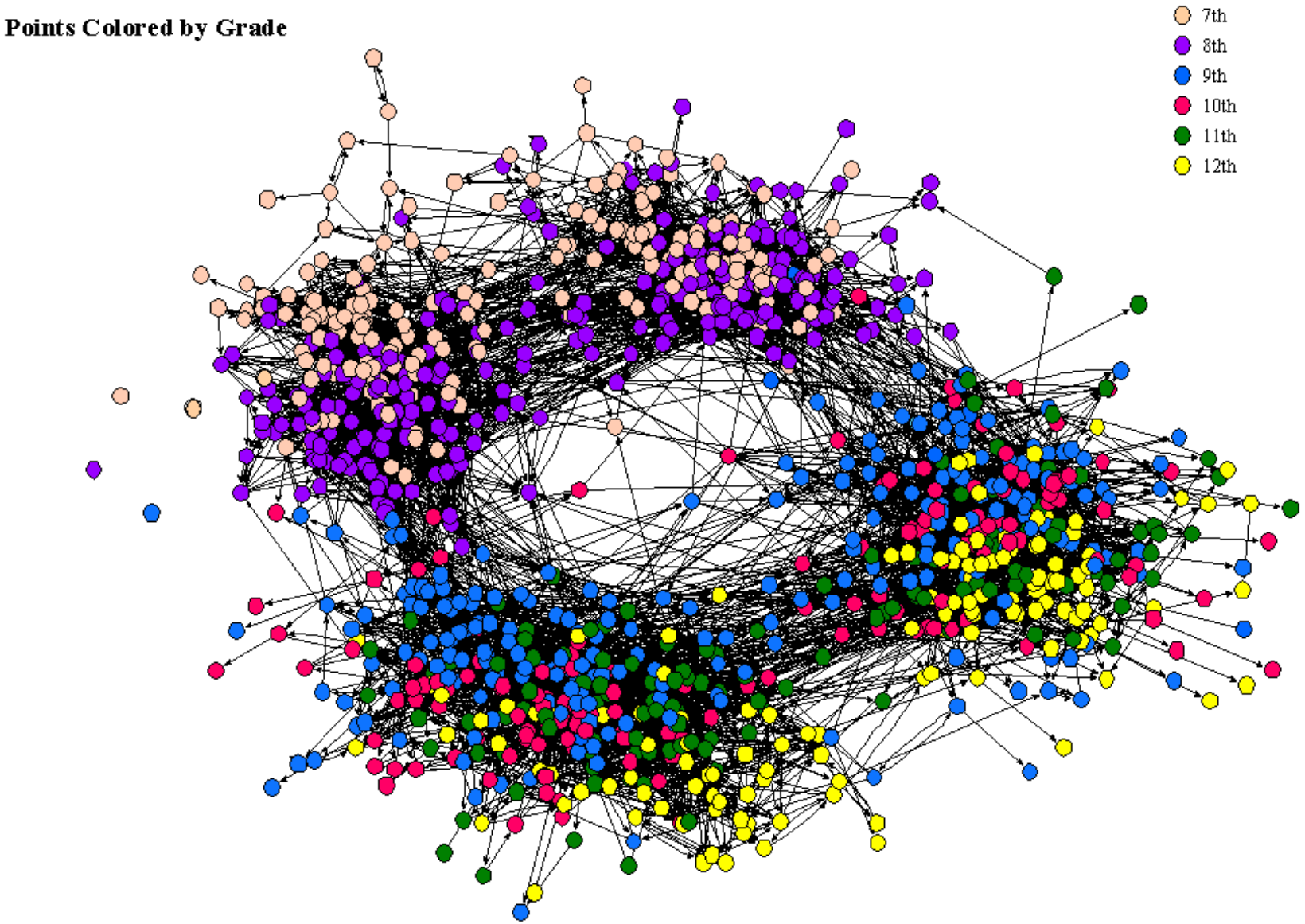
HIGH SCHOOL CUMULATIVE GPA = 3.7872

USING CUMULATIVE GPA: STUDENT IS ON-TRACK TO GRADUATE: YES

TOTAL HIGH SCHOOL CREDITS EARNED: 23.50

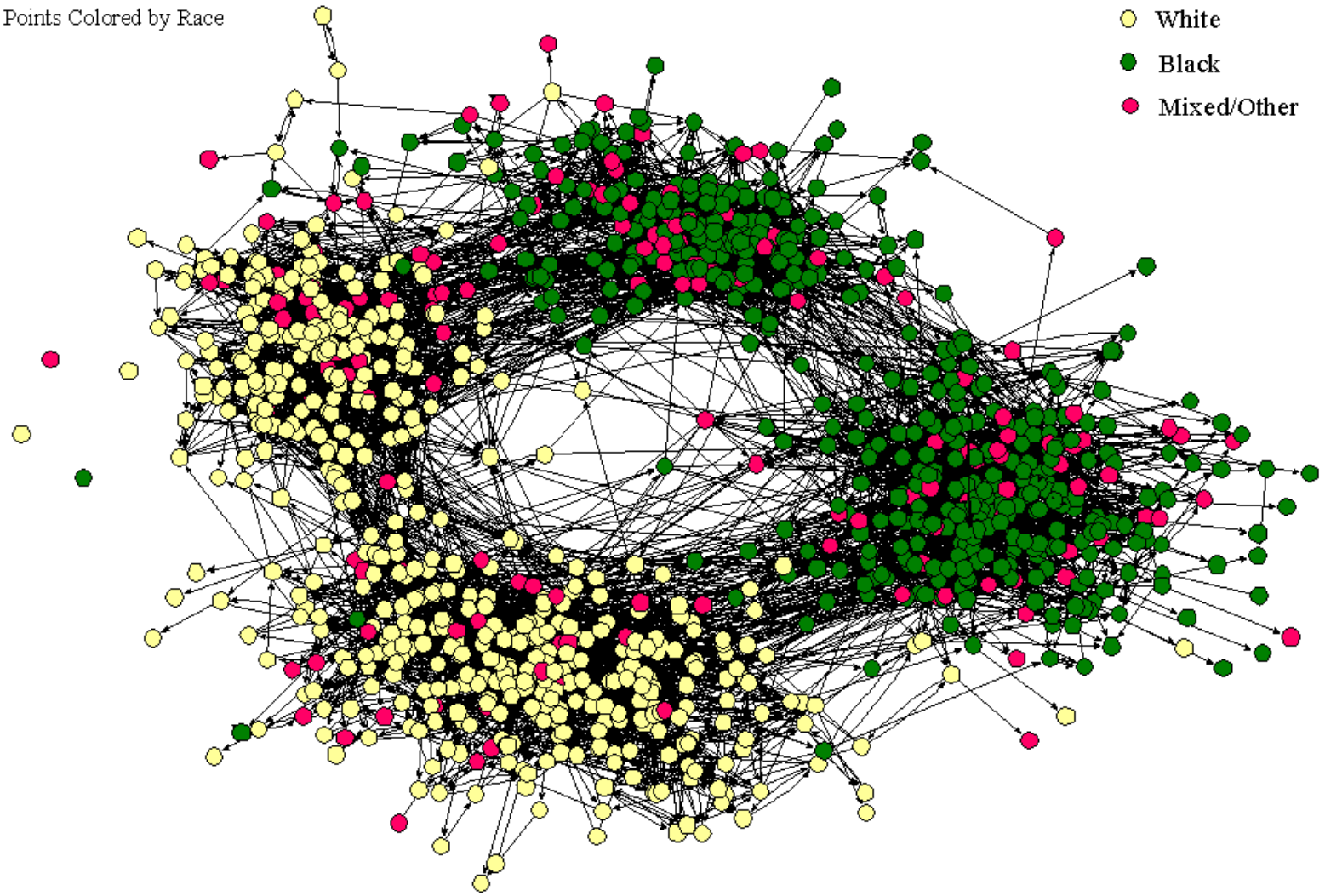
La traducción en español de la nota explicativa se puede conseguir de su escuela.
Lekòl ou a gen tradiksyon senbòl yo an kreyòl.

The Social Structure of "Countryside" School District

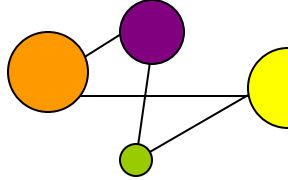


http://www.soc.duke.edu/~jmoody77/presentations/Net_Intro.ppt

The Social Structure of "Countryside" School District



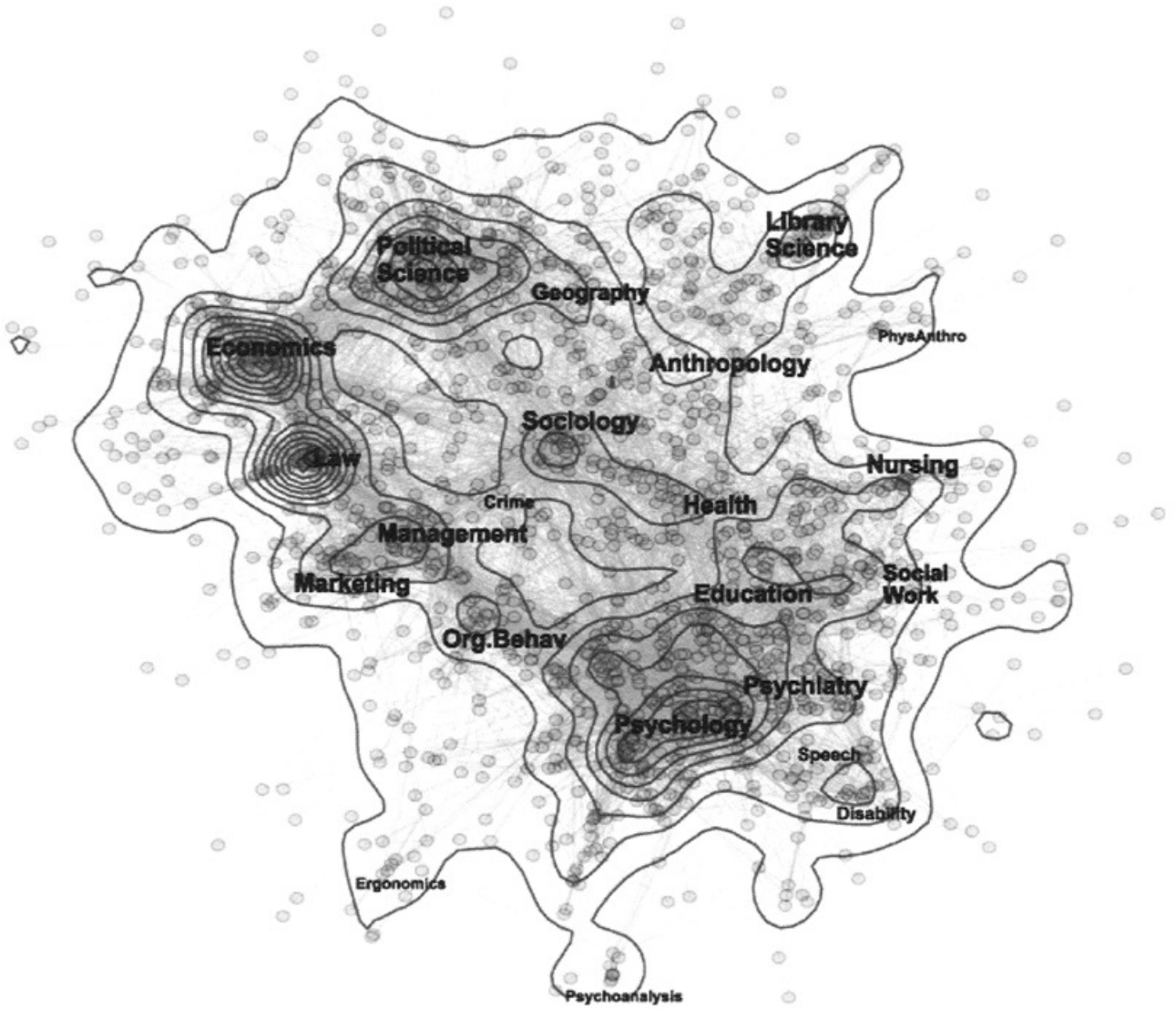
http://www.soc.duke.edu/~jmoody77/presentations/Net_Intro.ppt

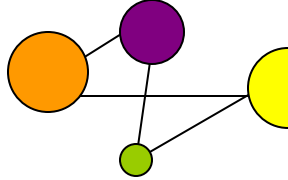


How is academic knowledge produced?


UNIVERSITY OF OREGON
FOUNDED 1876

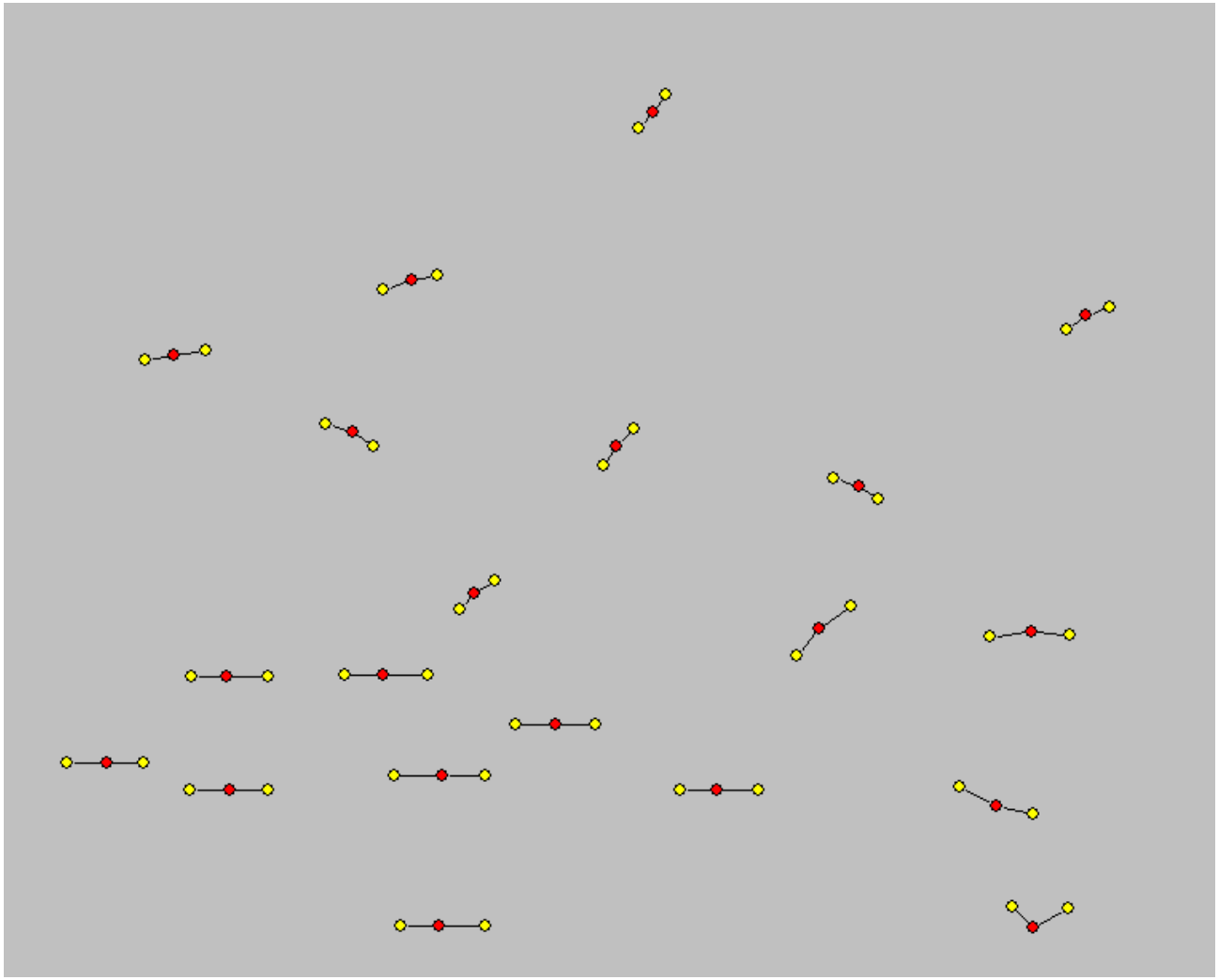
Figure 1
The Discipline Structure of Social Science Journals
Co-citation ties among 1657 Social Science Journals





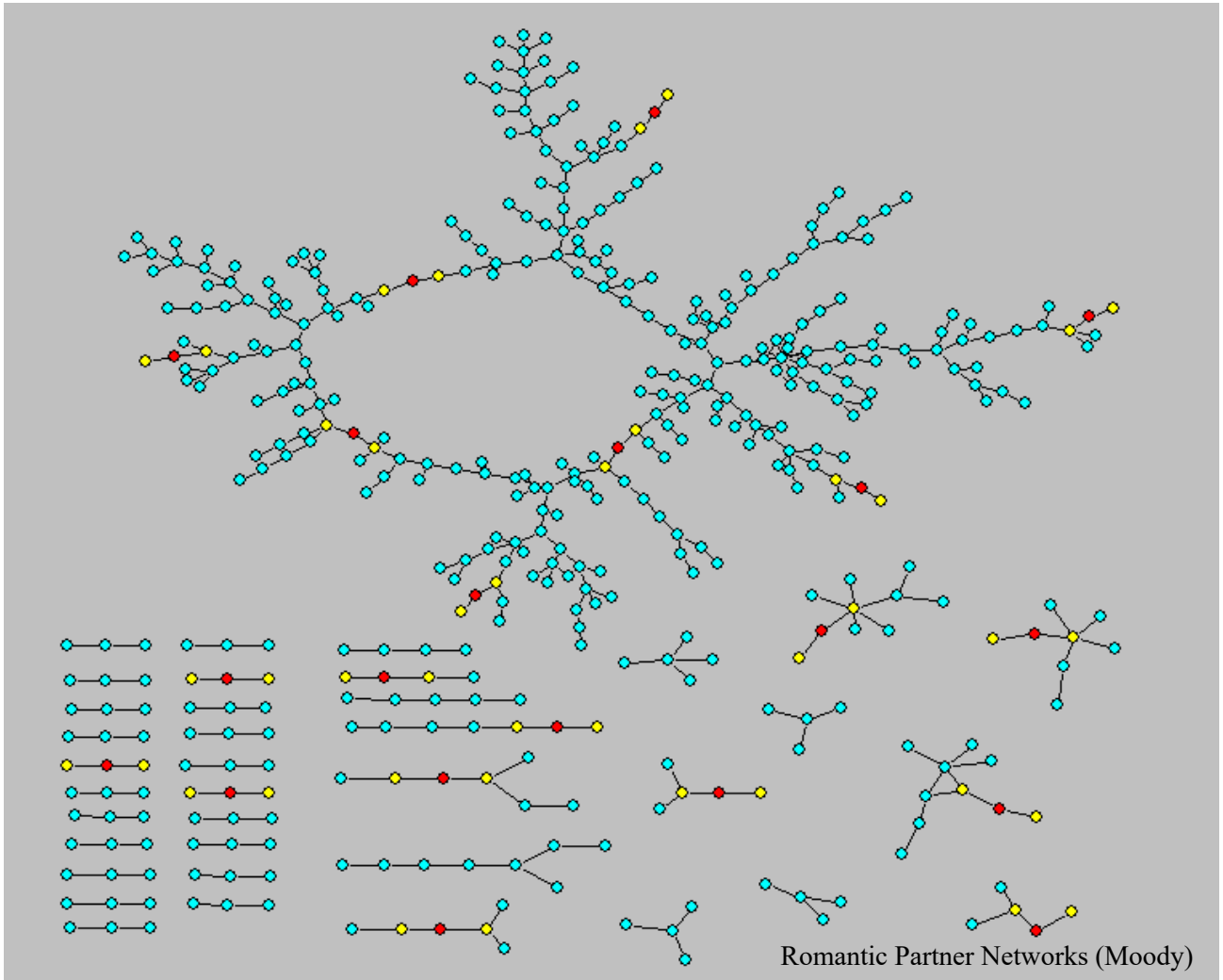
Social network analysis challenges us to see the world relationally.

Theoretically, sociology is interested in moving between local and…

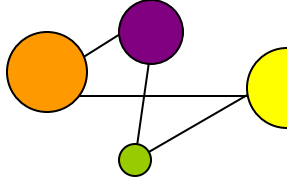


Romantic Partner Networks (Moody)

…and global vision.



Romantic Partner Networks (Moody)

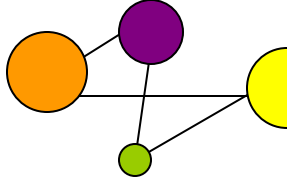


What is Social Network Analysis?

- A **theoretical perspective** that attempts to explain how individual and group behaviors and relations are linked to patterns in society, and

- A set of relational **methods** for systematically analyzing the ties/relations between nodes/actors.

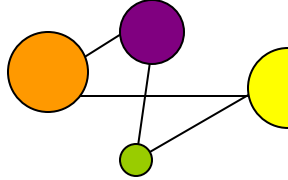
Borgatti, Stephen P., Ajay Mehra, Daniel J. Brass, and Giuseppe Labianca. 2009. "Network Analysis in the Social Sciences." *Science* 323:892-95.



What is Social Network Analysis?

- A **theory** and a **method** for social scientific analysis that relies on:
  - *structural* intuition
  - systematic collection of *relational* data
  - use of graphic *visualizations*
  - mathematical or computational *models*

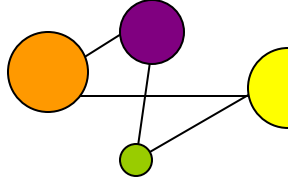
Freeman, Linton C. 2004. *The Development of Social Network Analysis: A Study in the Sociology of Science*. Vancouver, BC: Empirical Press.



What do we study?

1. Social network analysts often study relations as *systems* focusing on how the *pattern* of relations among actors affects individual behavior or system properties.

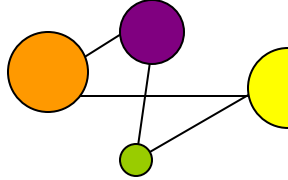
- Hierarchy and domination
- Relational views of class
- Emergent clusters/communities in "big data"



What do we study?

2) Networks as social contexts

- How does the network environment affect an actor's behavior?
- Examples:
  - Peer influence on delinquency
  - Corporate interlocks and political participation
  - International trade and war



What do we study?

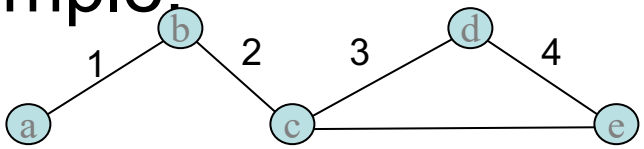
3) Conduits for diffusion

- Relations are like wires or pipes: risks and resources flow through relations. This can have very *wide* implications:
- Diffusion of innovations (fads, rumors, etc.)
- Disease diffusion (Coronavirus, STDs)

Network Basics

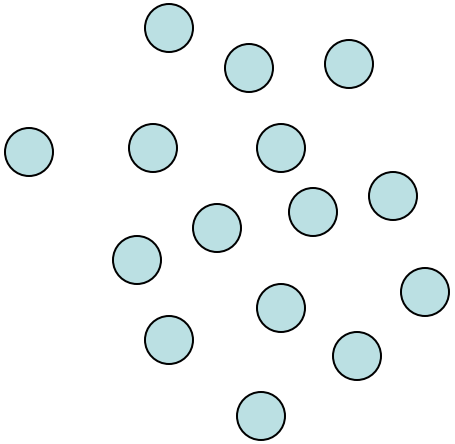
The unit of interest in a network are the combined sets of actors and their relations. Therefore, social network data consists of two linked classes of data: Nodes {a…e} and Edges {1…5}

Example:



Thinking about Some Basic Network Forms

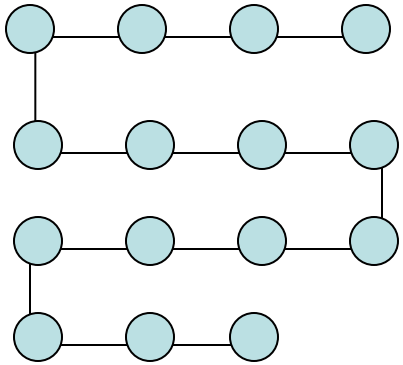
n=15



Unconnected
Group, or an Empty Graph

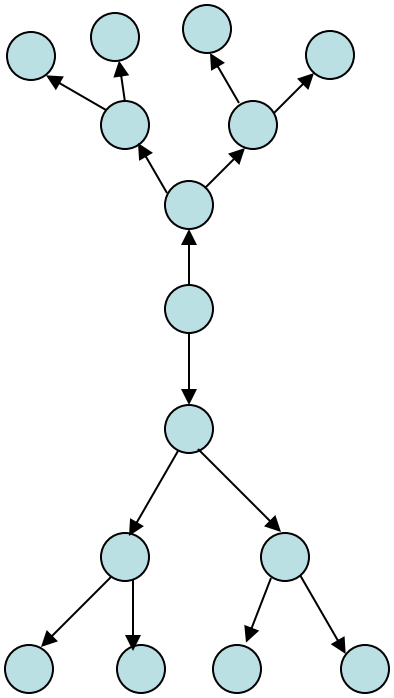
Note: disconnected nodes are called “isolates” making this a collection of isolates.

n=15



Bucket
Brigade

n=15

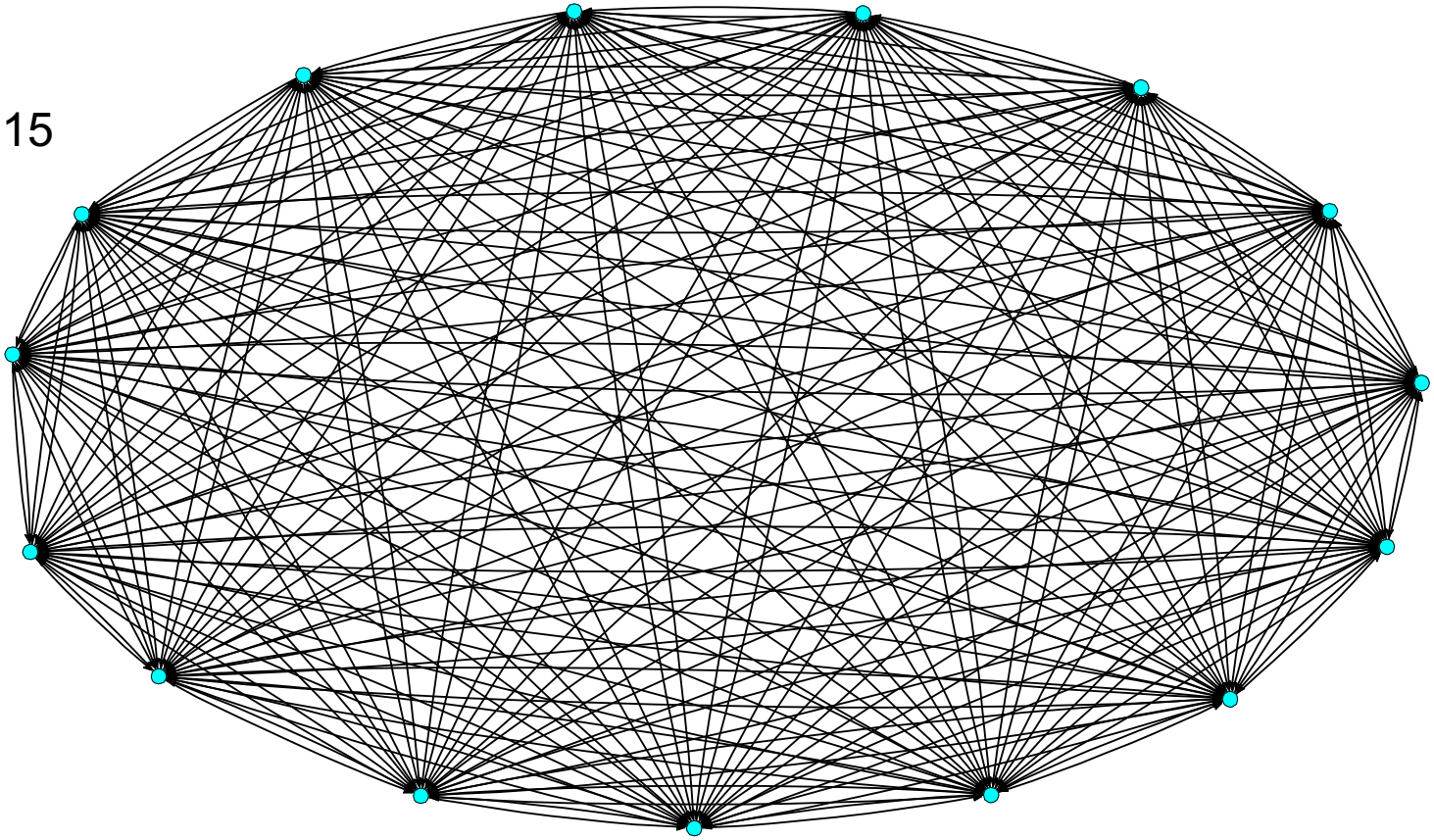


Telephone
Tree

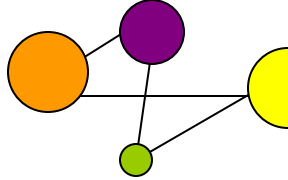
(See Christakis and Fowler 2009)

Thinking about Some Basic Network Forms

n=15



Complete Graph…"Where Everybody Knows Your Name"



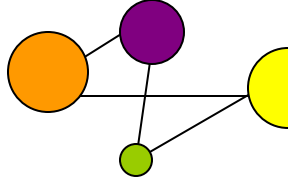
Network Basics

Nodes: Information on the individuals (actors, nodes, points, vertices)

-Network nodes are most often people, but can be any other unit capable of being linked to another (schools, countries, organizations, personalities, etc.)

-The information about nodes is what we usually collect in standard social science research: demographics, attitudes, behaviors, etc.

-Often includes dynamic information about when the node is active



Edges: Information on the relations among individuals (lines, arcs)

-Records a connection between the nodes in the network

-Can be valued, directed (arcs), binary or undirected (edges)

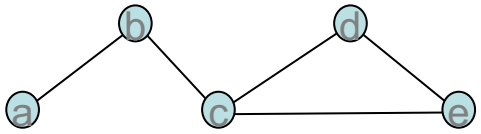
-One-mode (direct ties between actors) or two-mode (actors share membership in an organization)

- **Mutuality** is when directed ties are reciprocated.
- Anti-symmetrical ties are ties where symmetry is by definition impossible (mothers genetic connections to sons).

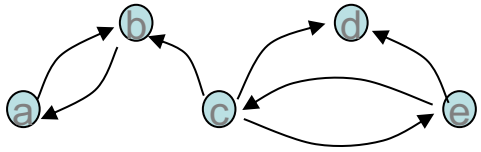
-Includes the times when the relation is active

Network Basics

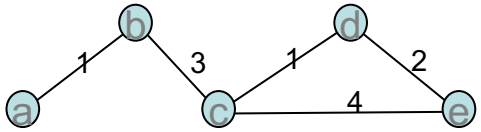
In general, a relation can be: (1) Binary or Valued
(2) Directed or Undirected



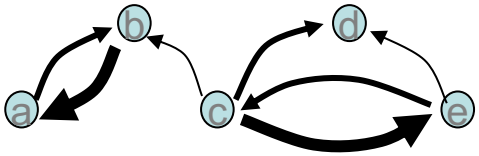
Undirected, binary



Directed, binary



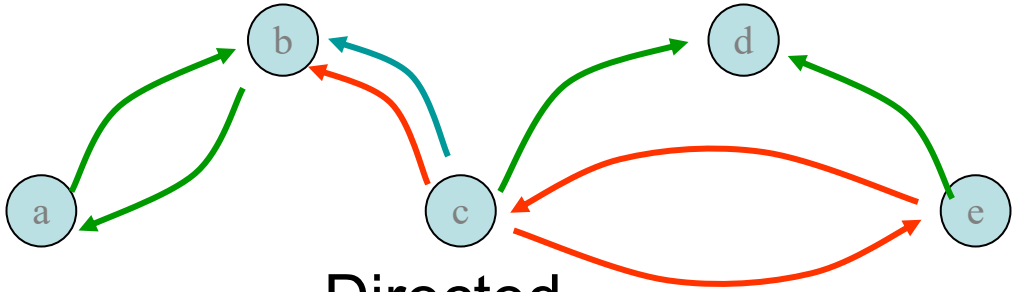
Undirected, Valued



Directed, Valued

Network Basics

Nodes can also be connected by different types of edges at one time



Directed,
Multiplex categorical edges

(e.g., co-workers at the same university, play on the same soccer team, and are friends)

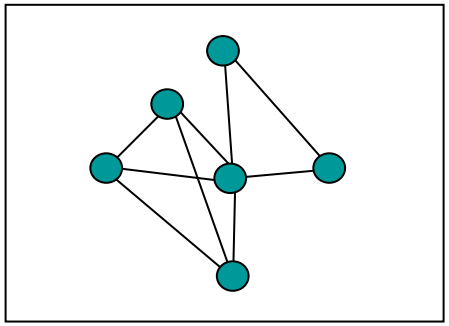
Network Basics

We examine networks across multiple levels:

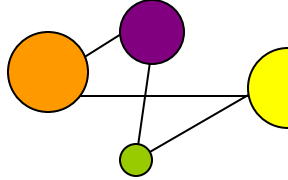
Ego - Networks

A respondent (ego) and the set of people they have relations with (alters).

This may include estimates of connections among alters.



Example: A specific person's friendship network or family tree. Common in survey data collection (e.g., General Social Survey).

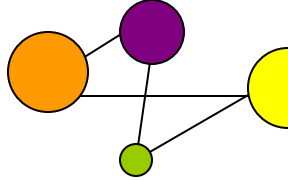


Network Basics

Partial network

- Ego networks plus some amount of tracing to reach contacts of contacts (often referred to as **steps**, as in direct connections are 1-step and friends of friends are 2-steps).
- Something less than full account of connections among all pairs of actors in the relevant population

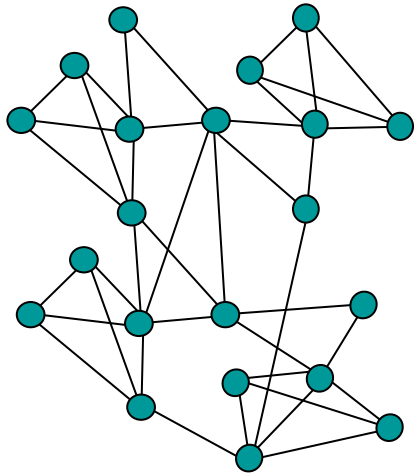
Example: Covid-19 contact tracing.



Network Basics

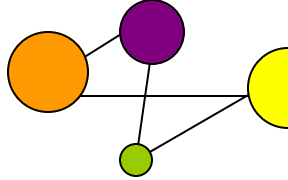
Socio-centric network

- The connections among all members of a population or relevant boundary.
- Never exactly complete (due to missing data, but boundaries are set).



Example: Co-acting data among all actors in horror films,

friendships among

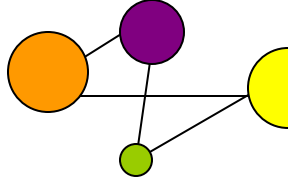


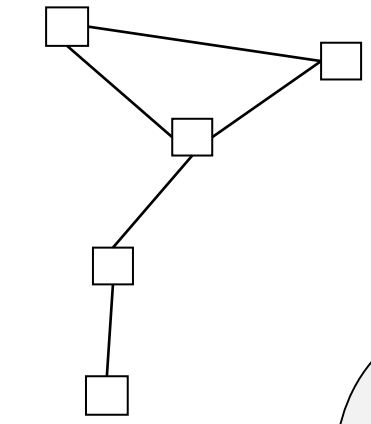
Network Basics

Open system network

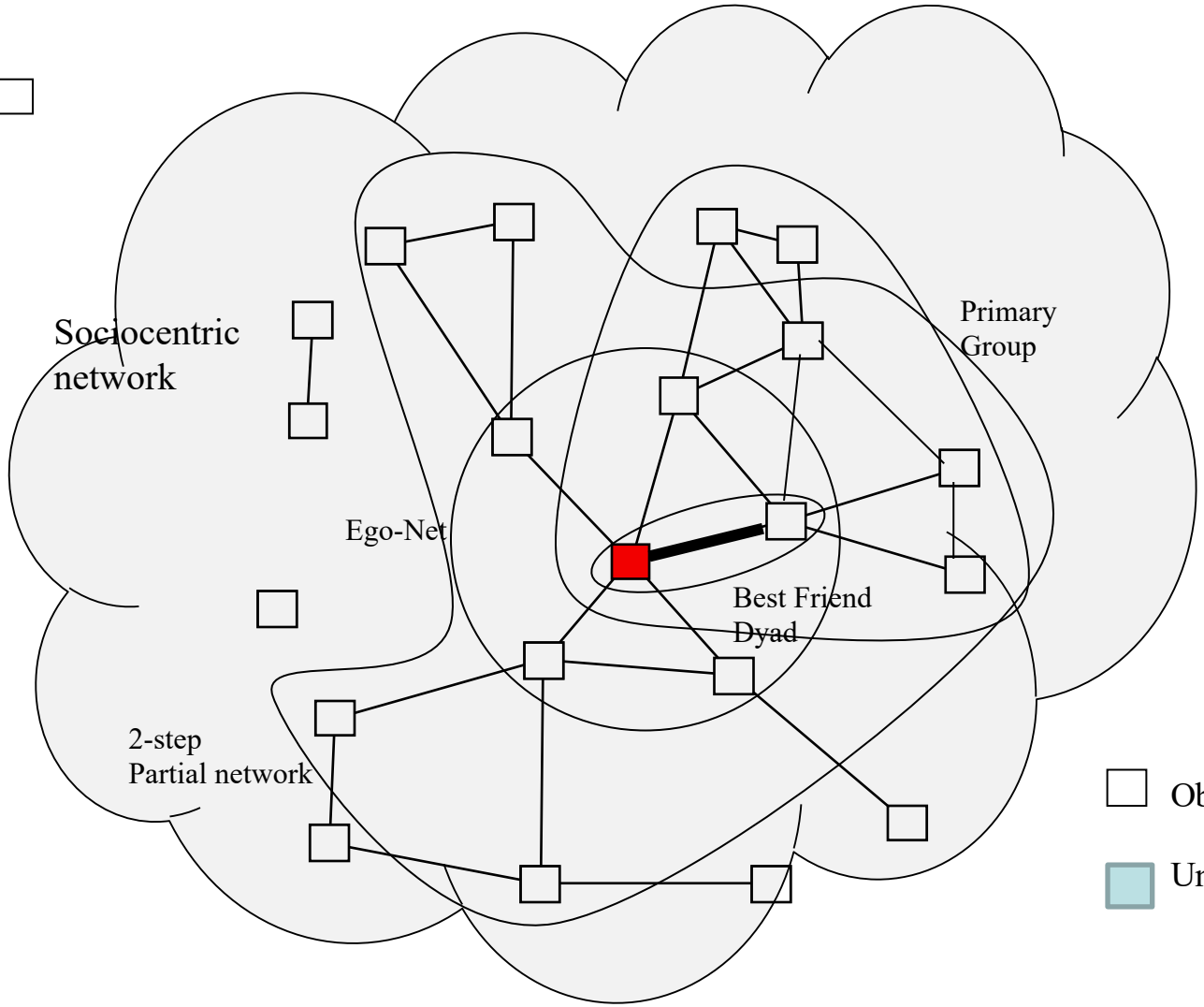
- A network where boundaries aren't as clear. Network isn't boxed.
- Incomplete by definition.

Example: All friendships of students in a high school; elite connections in the United States, the dark web



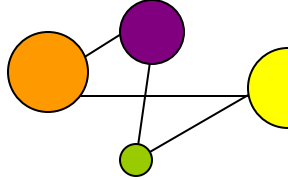


Open System
Network



Observed nodes

Unobserved nodes

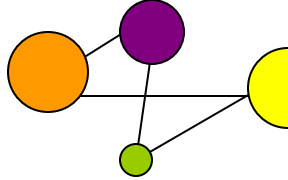


Network Basics

What connects us?

Propinquity – co-location, being in the same place at the same time

Homophily – birds of a feather flock together. “[I]f two people have characteristics that match in a proportion greater than expected in the population from which they are drawn or the network of which they are a part, then they are more likely to be connected.”



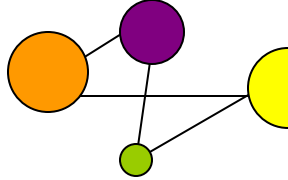
Network Basics

Thinking through homophily

Status-homophily: either ascribed (e.g., race and sex) or acquired (e.g., occupation, education, marital status)

Value-homophily: (attitudes, beliefs)

Homophily or influence? – Chicken-and-egg situation. Do people with same taste in music hang out together or do they influence each other to have the same taste.



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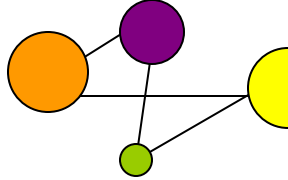


Network Basics

Triads – three nodes

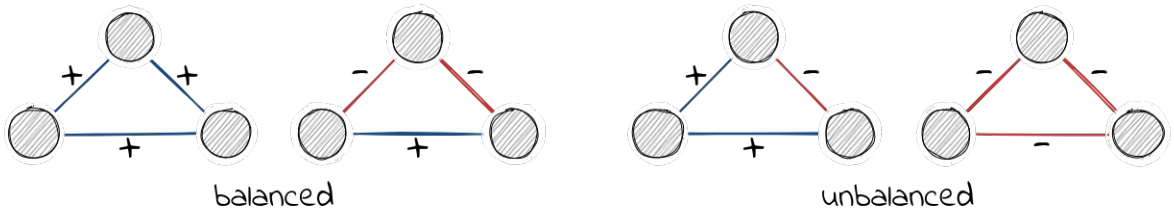
Basic unit – “molecule” of networks.

Computationally triads are useful because counting units bigger than three nodes can be intractable. (In large, connected networks counting all triads alone is difficult).

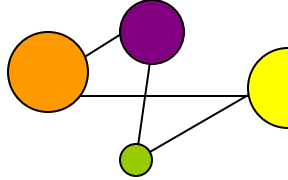
For our purposes we are interested in **balance** and **transitivity**.

Triads – three nodes

Balance identifies what some think are fundamental tendencies in social relationships – " a friend of a friend is a friend" or "my enemy's enemy is a friend."



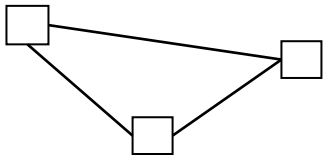
Can we think of times when unbalance is useful?



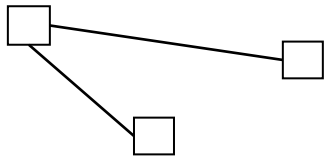
Network Basics

Triads – three nodes

Transitivity is a related concept that captures the difference between connected triads where every node is connected to one another versus **intransitive triads** where the nodes are not entirely connected.

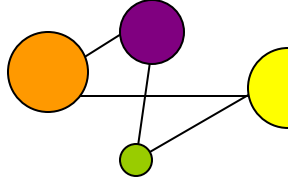


Transitive



Intransitive

Transitivity plays a role in network clustering.



Development of Social Network Analysis

- The foundations of SNA are subject to debate.
  - Advancements attributed to Galton (statistics), Euler (graph theory), Comte, Simmel, and so forth.

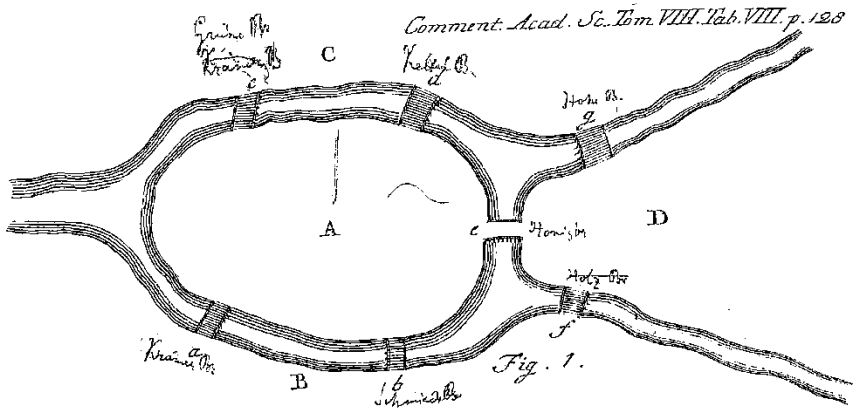
- Most agree that Jacob Levy Moreno and the development of sociometry mark a turning point, but an impermanent one.

- SNA as we know it begins in earnest with Harrison White and students among other in the 1970s.

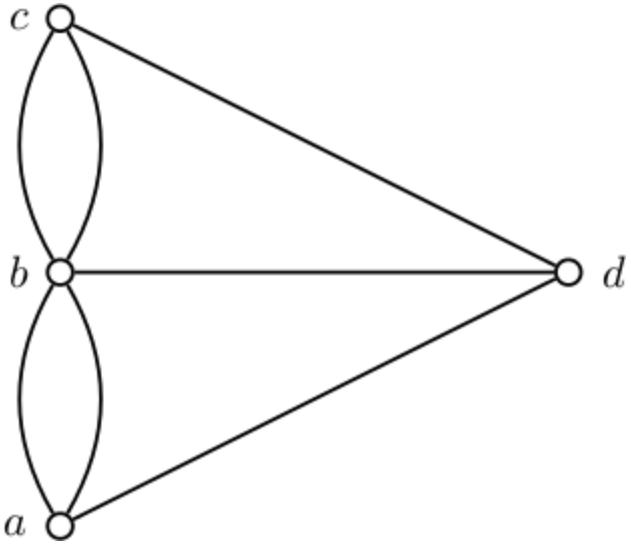
- The take home: People have been “thinking in networks” for some time (picture biblical lineages”)…but contemporary SNA only a couple of decades old.

(See Freeman 2004)

Development of Social Network Analysis



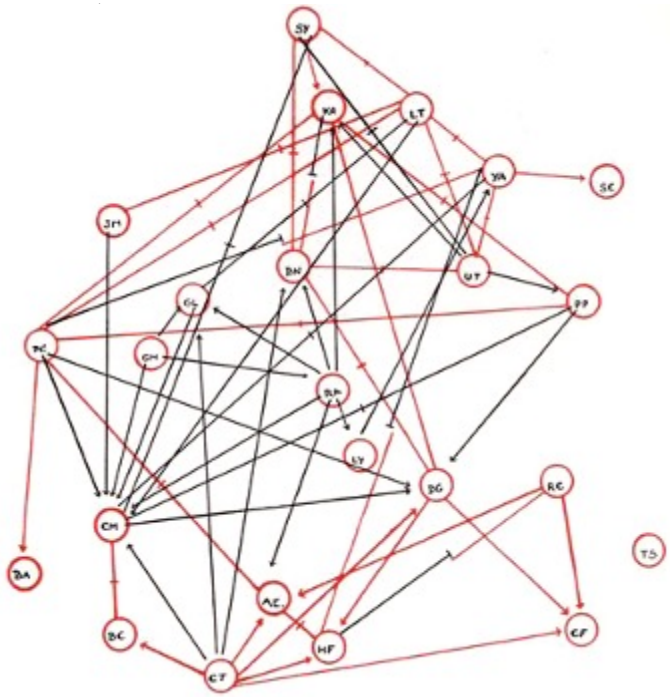
Euler, 1741

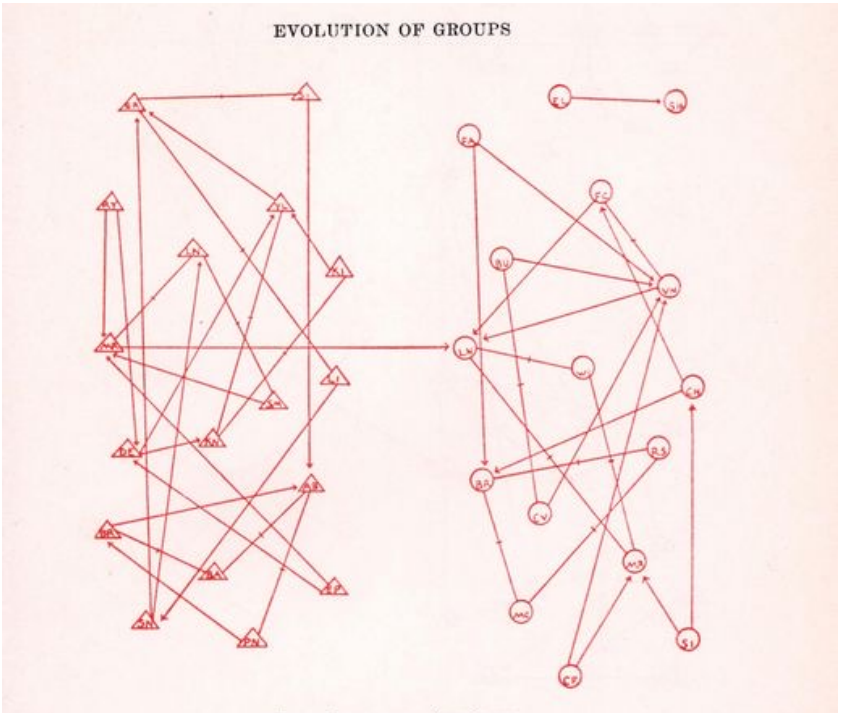


Euler's treatment of the "Seven Bridges of Kronigsberg" problem is one of the first moments of graph theory….

Development of Social Network Analysis

The study of network has depended on a graphical element since its first m



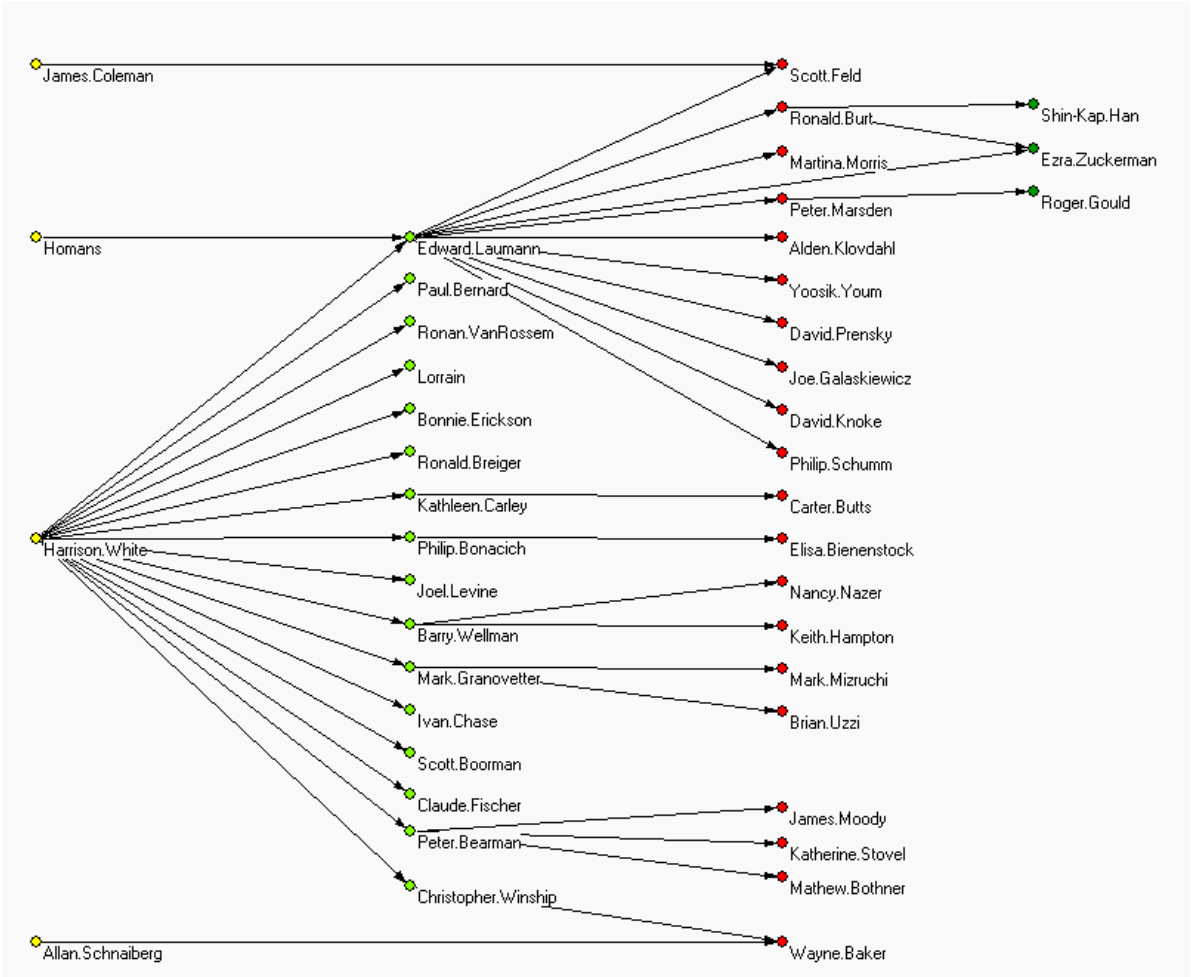


..but Moreno’s sociograms from *Who Shall Survive* (1934) are typically seen as the beginnings of social network analysis (certainly if you were to ask Moreno!).

Development of Social Network Analysis

•Harvard Renaissance

- The key idea here is that things took off under Harrison White at Harvard.



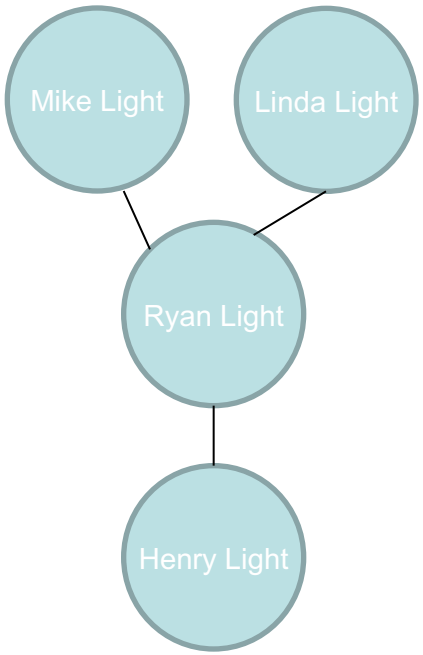
“Social Network” *before* “Social Networks” were cool

Search in Google Books:

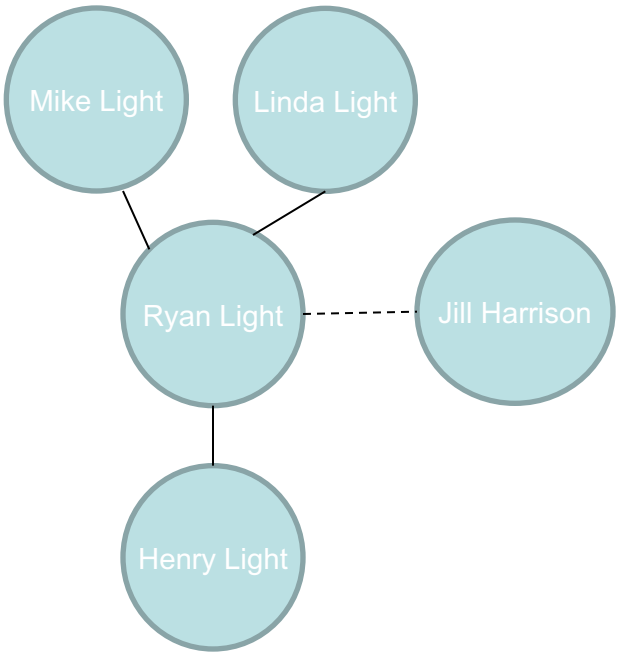
1900 - 1972	1973 - 1992	1993 - 1995	1996 - 2004	2005 - 2008	"social network"	English
1900 - 1972	1973 - 1992	1993 - 1995	1996 - 2004	2005 - 2008	" social network "	English

Run your own experiment! Raw data is available for download here.

Family Tree Networks

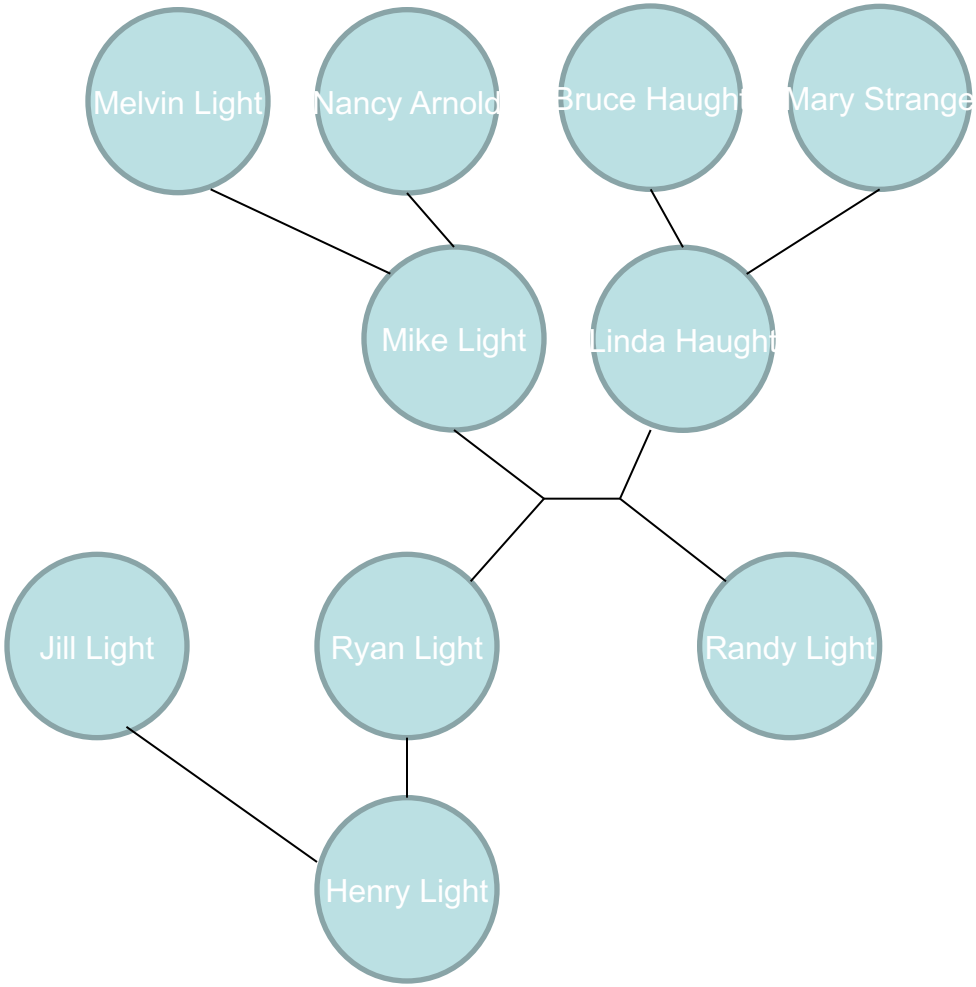


One step, One tie type (parental)



One step, two tie types (parental, marital)

Family Tree Networks



Two step, One tie type (parental)