Social Network Analysis



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Development of the Field



of SNA papers in sociology by year

- 1736 Euler
- 1930s Sociometry
 - Moreno; Hawthorne studies
- 1940s Psychologists
 - Clique formally defined
- 1950s Anthropologists
 - Barnes, Bott & Manchester school
- 1960s Anthropologists
 - Kinship algebras; Mitchell
- 1970s Rise of Sociologists
 - Social Networks Journal & Assoc
 - Milgram small-world
 - Granovetter's weak ties
- 1980s Computation
 - IBM PC & network programs
- 1990s Adaptive Radiation
 - UCINET IV released
 - Spread of networks & dyadic thinking to many fields
 - Rise of social capital, embeddedness
- 2000s Locusts Physicists descend

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 & Tsai, 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
 - <u>http://seneca.uab.es/antropologia/redes/lista.htm</u>
 - UCINET user's group
 - www.analytictech.com/UCINET_list.htm

What's a network?

- A set of actors (e.g., persons)
- A set of ties that connect pairs of actors
 - E.g., friendship ties
- Each kind of tie (i.e., social relation) defines a different network
 - Acquaintance (who knows what)
 - Friendship
 - Has sex with
 - Does drugs with
 - Gives advice to
 - Has conflict with

1000 scientists © Steve Borgatti, 2004

Why should we care?

- 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

Front Guns

2. Actors affect each other!

- Tell each other information
- Provide material aid
- Transmit diseases
- Copy attitudes & behavior



NY

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GA 2

U.S. Centers for Disease Control

3. Opportunities & constraints

 A person's position in a social network (i.e., social capital) determines in part the set of opportunities and constraints they will encounter



The rate of return on human capital

 A person's connections determine the rate of return on human capital



4. One of nature's std. solutions?

- Similar network properties observed in
 - Gene interaction networks
 - World wide web links
 - National power grids
 - Sexual partners





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.



Data drawn from Cross, Borgatti & Parker 2001.

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Problem Reformulation

Who you see to help you think through issues



Data drawn from Cross, Borgatti & Parker 2001.

Hawthorne Games & Conflicts





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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



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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



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Correlations Among Emotions

	EXCIT	IRRIT	QUIET	DISAPP	ENTHU	HAPPY	NERV	INTER	RELAX	DEPRE
EXCIT	1.00	-0.37	-0.22	-0.44	0.61	0.57	0.04	0.42	0.11	-0.26
IRRIT	-0.37	1.00	0.13	0.64	-0.35	-0.43	0.12	-0.29	-0.21	0.43
QUIET	-0.22	0.13	1.00	0.15	-0.14	-0.17	0.08	-0.06	0.06	0.20
DISAPP	-0.44	0.64	0.15	1.00	-0.39	-0.45	0.10	-0.29	-0.19	0.43
ENTHU	0.61	-0.35	-0.14	-0.39	1.00	0.64	-0.02	0.44	0.20	-0.24
HAPPY	0.57	-0.43	-0.17	-0.45	0.64	1.00	-0.06	0.38	0.28	-0.34
NERV	0.04	0.12	0.08	0.10	-0.02	-0.06	1.00	0.14	-0.15	0.16
INTER	0.42	-0.29	-0.06	-0.29	0.44	0.38	0.14	1.00	0.18	-0.20
RELAX	0.11	-0.21	0.06	-0.19	0.20	0.28	-0.15	0.18	1.00	-0.12
DEPRE	-0.26	0.43	0.20	0.43	-0.24	-0.34	0.16	-0.20	-0.12	1.00
CALM	-0.04	-0.12	0.23	-0.09	0.07	0.15	-0.12	0.09	0.44	-0.01
AROUS	0.31	-0.12	-0.12	-0.12	0.27	0.25	0.05	0.25	0.05	-0.10
TIRED	-0.14	0.14	0.23	0.10	-0.11	-0.15	0.12	-0.07	-0.02	0.18
PROUD	0.52	-0.38	-0.10	-0.44	0.52	0.55	-0.02	0.35	0.16	-0.26
FRUST	-0.33	0.59	0.11	0.58	-0.34	-0.40	0.18	-0.24	-0.23	0.45
SATISFY	0.46	-0.39	-0.10	-0.46	0.52	0.55	-0.07	0.34	0.24	-0.25
AFRAID	0.03	0.07	0.05	0.11	0.03	-0.03	0.30	0.05	-0.09	0.23
STILL	-0.11	0.02	0.34	0.03	-0.08	-0.02	0.01	-0.02	0.20	0.12
ANGRY	-0.27	0.52	0.11	0.48	-0.26	-0.37	0.16	-0.21	-0.19	0.52
SAD	-0.22	0.37	0.23	0.41	-0.19	-0.31	0.19	-0.16	-0.13	0.53
JOYFUL	0.45	-0.34	-0.19	-0.35	0.50	0.55	-0.09	0.32	0.20	-0.29
WANT	0.17	0.03	-0.05	0.01	0.12	0.08	0.11	0.16	-0.06	0.03
SURP	0.19	0.09	-0.07	0.07	0.16	0.08	0.09	0.11	-0.10	0.03
HOPE	0.33	-0.26	-0.07	-0.28	0.41	0.35	0.06	0.39	0.09	-0.19
GREEDY	0.21	-0.04	-0.04	-0.08	0.25	0.17	0.07	0.26	0.06	-0.04



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Network Structure

The density of ties

- Density = proportion of pairs of actors that are actually tied
- In some contexts, could be thought of as measure of social capital



Help With the Rice Harvest



Village 1

Data from Entwistle et al Steve Borgatti, 2004

Help with the rice harvest



Whích víllage ís more líkely to survíve?

Village 2

Data from Entwistle et al Steve Borgatti, 2004

Small World

- Milgram's experiment
 - Target selected a stock broker in Boston
 - Arbitrary subjects recruited in Los Angeles
 - Asked if they knew the target
 - If yes, then done
 - If no, then who did they know that might know the stock broker?
 - That person is then contacted and ...
 - This continues until the target is reached.
 - On average, just 5.5 intermediaries needed to reach target



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Graph-Theoretic Distance

AKA "degrees of separation"

- The graph-theoretic distance between two nodes is the number of links in the shortest path that connects them
 - Distance from 4 to 10 is 3 links



Average Distance

- Average geodesic distance among all nodes
- Index of speed of transmission



Core/Periphery Structures

- Core/Periphery.
 - Network consists of a single group (a core) together with hangers-on (a periphery),
 - Core connects to all
 - Periphery connects only to the core
 - Short distances, good for transmitting information, practices
 - Identification with group as whole
 - E.g., physics
- Clique structure.
 - Multiple subgroups or factions
 - Identity with subgroup
 - Diversity of norms, belief
 - E.g., social science



On Innovation and Network Structure

"I would never have conceived my theory, let alone have made a great effort to verify it, if I had been more familiar with major developments in physics that were taking place. Moreover, my initial ignorance of the powerful, false objections that were raised against my ideas protected those ideas from being nipped in the bud."

- Michael Polanyi (1963), on a major contribution to physics

C/P Structures & Morale



Comparing airlines' route structures

Major US Carrier





"Discount" US Airline

Note: Route maps defined around one specific hub only Source: Industry data, BCG analysis

Eurocopa 2004



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Position in Networks

Carter Administration

White House Diary Data



Data Evertessy Bfr Michaeldigk

1-Mode Complete Network



Cross, Parker, & Borgatti, 2002. Making Invisible Work Visible. California Management Review. 44(2). 12924 Borgatti, 2004

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



Law of Propinquity



Homophily

Sharing Confidential Matters:

	Male	Female
Male	1245	748
Female	970	1515

Race	White	Black	Hispanic	Other
White	3806	29	30	20
Black	40	283	4	3
Hispanic	66	6	120	1
Other	21	5	3	34

Homophily

Religion	Protestant	Catholic	Jewish	None	Other
Protestant	2129	305	22	83	30
Catholic	241	790	24	41	13
Jewish	13	7	68	5	1
None	92	66	12	131	14
Other	27	11	1	4	37
None Other	92 27	66 11	12 1	131 4	14 37

Age	< 30	30 - 39	40 - 49	50 - 59	60 +
< 30	567	186	183	155	56
30 - 39	191	501	171	128	106
40 - 49	88	170	246	84	70
50 - 59	84	100	121	210	108
60 +	34	127	138	212	387

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%

