dSEA Dipartimento di scienze economiche e aziendali 'Marco Fanno'

Università degli Studi di Padova

Innovation Networks:

Concepts and Intro to Methods

amir.maghssudipour@unipd.it

Networks and innovation

When firms **interact**, they **exchange knowledge**. This process can lead to interacting and localized **learning** → Possibly **innovation**.

Firms exchange knowledge:

- Even though they can be competitors: **cooperation-competition**.
- Even though they operate with **uncertainty**: they do not know effects of interactions, they do not exactly know where to find knowledge.
- However, they still exchange knowledge. **Trust** plays a critical role: mutual interests, reciprocity, common norms and values, same communication system.

Networks and networks

Different kinds of networks and involved issues:

Inter-firm Networks: Antecedents, Mechanisms and Forms*

Anna Grandori, Giuseppe Soda

Anna Grandori, Giuseppe Soda
Istituto di Economia, Aziendale, Università Luigi Bocconi, Milan, Italy

Abstract

This paper is an effort to review and organize the now vast literature on inter-firm networks, with the aim of assessing the important current forms of network, the organizational mechanisms supporting them, and the main variables that have been shown to influence network emergence and shape.
These results are achieved through a literature review encompassing a number of approaches across the social sciences. The paper can therefore be used as a typological state-of-art on inter-firm networks, and as a basis for developing hypotheses of relationship between network antecedents and forms.

Descriptors: inter-firm networks, network organization, coordination mechanisms, organization theory

Strategic Management Journal
Strat. Mgmt. J., **21**: 203–215 (2000)

STRATEGIC NETWORKS

RANJAY GULATI[1]*, NITIN NOHRIA[2] and AKBAR ZAHEER[3]
[1]*Kellogg Graduate School of Management, Northwestern University, Evanston, Illinois, U.S.A.*
[2]*Graduate School of Business Administration, Harvard University, Boston, Massachusetts, U.S.A.*
[3]*Carlson School of Management, University of Minnesota, Minneapolis, Minnesota, U.S.A.*

This paper introduces the important role of networks of interfirm ties in examining fundamental issues in strategy research. Prior research has primarily viewed firms as autonomous entities striving for competitive advantage from either external industry sources or from internal resources and capabilities. However, the networks of relationships in which firms are embedded profoundly influence their conduct and performance. We identify five key areas of strategy research in which there is potential for incorporating strategic networks: (1) industry structure, (2) positioning within an industry, (3) inimitable firm resources and capabilities, (4) contracting and coordination costs, and (5) dynamic network constraints and benefits. For each of these issues, the paper outlines some important insights that result from considering the role of strategic networks.

Networks and networks

Networks and **innovation**

- Networks are related to innovation in **sectors** and **places** (for example, pharmaceutical, biotech, high-tech, high-complexity, etc.).

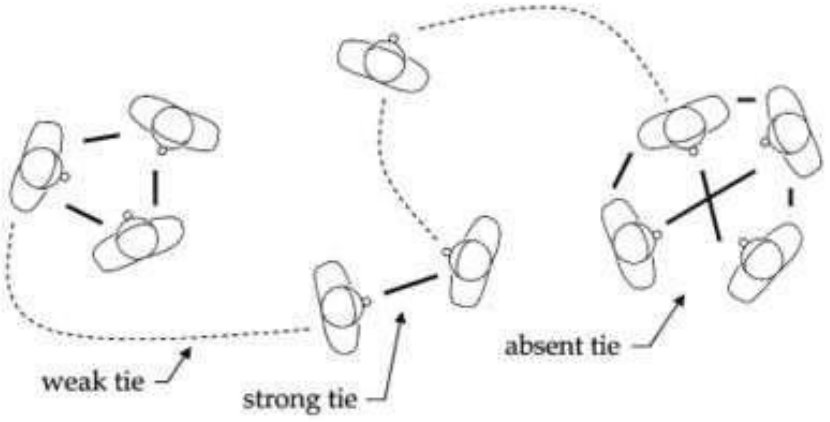
- Evolution of concepts between Economics and Sociology
  - From Granovetter (1975) weak/strong ties to Burt (1992) structural holes/brokerage & closure.
  - Social dynamics and economic systems:
    - Relevance of personal networks;
    - Relevance of network within a firm's boundary (intra-firm);
    - Relevance of inter-firm networks (inter-firm).

Networks and networks

- The **strength of weak ties** (Granovetter, 1973)

- Strong and weak ties:
  - Among friends or direct colleagues: **strong ties**
  - Acquaintances or distant colleagues: **weak ties**

- Weak ties are typically bridges
- Strong ties for team-work; weak ties for innovation



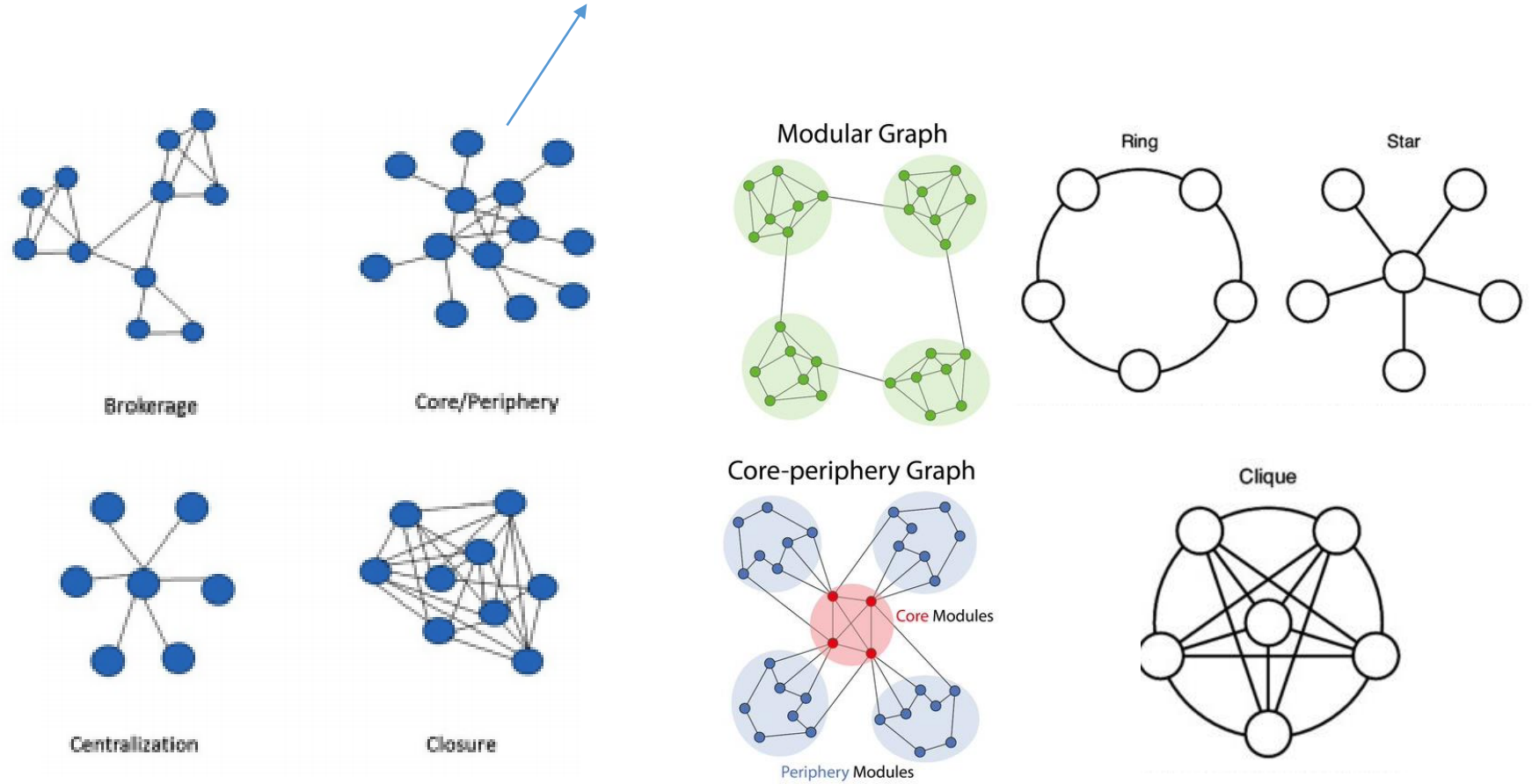
Networks and networks

Important aims and questions. Some examples:

- Are central actors more innovators / best performers?
- Does social capital favour innovation?
- Does friendship favour business relationships?
- Does the existence of previous ties influence future establishment of ties?

Networks and networks

Example: a C/P structure has densely connected nodes in the core and peripheral nodes not connected



Organizational networks

A famous antecedent: The rise of the Medici family (Padgett and Ansell, 1993).

They studied intermarriages among 16 Florentine families (1400-1434).

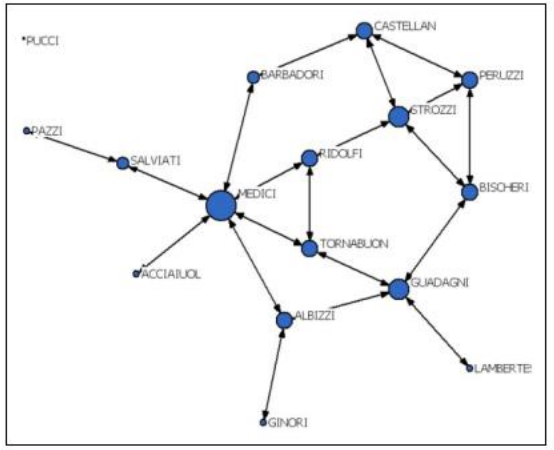
Robust Action and the Rise of the Medici, 1400-1434

John F. Padgett and Christopher K. Ansell

Abstract PDF

Abstract

We analyze the centralization of political parties and elite networks that underlay the birth of the Renaissance state in Florence. Class revolt and fisical crisis were the ultimate causes of elite consolidation, but Medicean political control was produced by means of network disjunctures within the elite, which the Medici alone spanned. Cosimo de' Medici's multivocal identity as sphinx harnessed the power available in these network holes and resolved the contradiction between judge and boss inherent in all organizations. Methodologically, we argue that to understand state formation one must penetrate beneath the veneer of formal institutions, groups, and goals down to the relational substrata of peoples' actual lives. Ambiguity and heterogeneity, not planning and self- interest, are the raw materials of which powerful states and persons are constructed.



Organizational networks

Table 1 The Microfoundations of Networks

Microfoundations	Examples of ego-level microdynamics	Illustrative prediction for network architecture
Agency	Nodal assortativity driven: homophily, heterophily, prominence attraction	For example, homophily-driven change should lead to clique formation and a relatively high network diameter
	Tie pattern driven: brokerage, closure	Pursuit of closure should lead to high density, high connectivity, and low variance in degree assortativity
Opportunity	Nodal assortativity driven: proximity, common goals, common identity	Ties form within social groups more so than across them, leading to clique formation
	Tie pattern driven: transitivity, repetition, referral	Friends of friends are more likely to form ties with each other, leading to triad closure
Inertia	Nodal assortativity driven: habits, networking propensity, collaborative expertise	Momentum in networking behavior should lead to high variance in degree assortativity and high levels of clustering
	Tie pattern driven: norms, interorganizational routines	Norm and interorganizational routine-driven networking behavior will lead to increasingly dense clusters with few bridging ties and hence lower connectivity
Random/exogenous		

Organization Science
Vol. 23, No. 2, March–April 2012, pp. 434–448
ISSN 1047-7039 (print) | ISSN 1526-5455 (online)
informs
http://dx.doi.org/10.1287/orsc.1110.0695

Introduction to the Special Issue: The Genesis and Dynamics of Organizational Networks

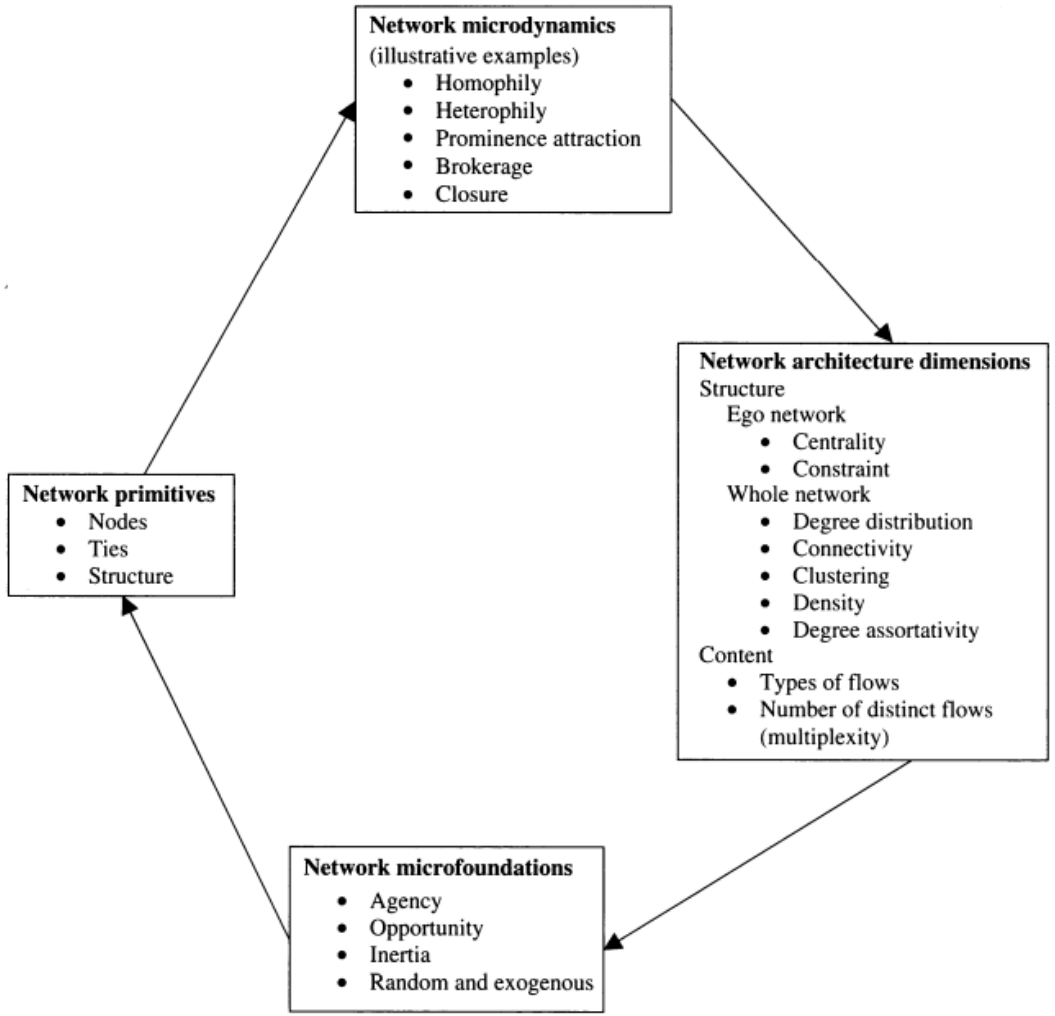
Gautam Ahuja
Stephen M. Ross School of Business, University of Michigan, Ann Arbor, Michigan 48109, gahuja@umich.edu
Giuseppe Soda
Department of Management and SDA Bocconi School of Management, Bocconi University, 20136 Milan, Italy, giuseppe.soda@uni-bocconi.it
Akbar Zaheer
Carlson School of Management, University of Minnesota, Minneapolis, Minnesota 55455, azaheer@umn.edu

An extensive body of knowledge exists on network outcomes and on how network structures may contribute to the creation of outcomes at different levels of analysis, but less attention has been paid to understanding how and why organizational networks emerge, evolve, and change. Improved understanding of network dynamics is important for several reasons, perhaps the most critical being that the understanding of network outcomes is only partial without an appreciation of the genesis of the network structures that resulted in such outcomes. To provide a context for the papers in this special issue, and with the broader goal of furthering network dynamics research, we present a framework that begins by discussing the meaning and role of network dynamics and goes on to identify the drivers and key dimensions of network change as well as the role of time in this process. We conclude with theoretical and methodological issues that researchers need to address in this domain.

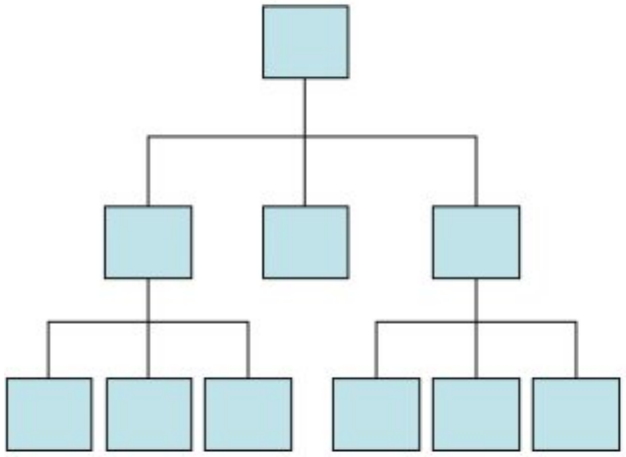
Key words: economic sociology; economics and organization; social networks; organization and management theory; interorganizational relationships
History: Published online in *Articles in Advance* October 19, 2011.

Organizational networks

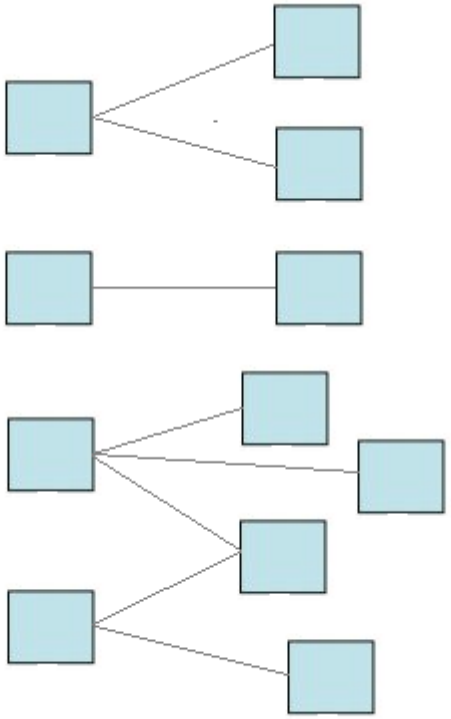
Figure 1 Understanding Network Dynamics



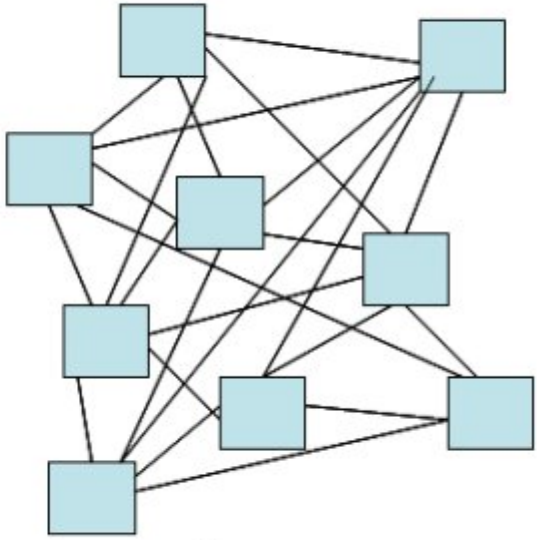
Organizational networks



Hierarchy



Market



Network

Neither market nor hierarchy (Powell, 1990)

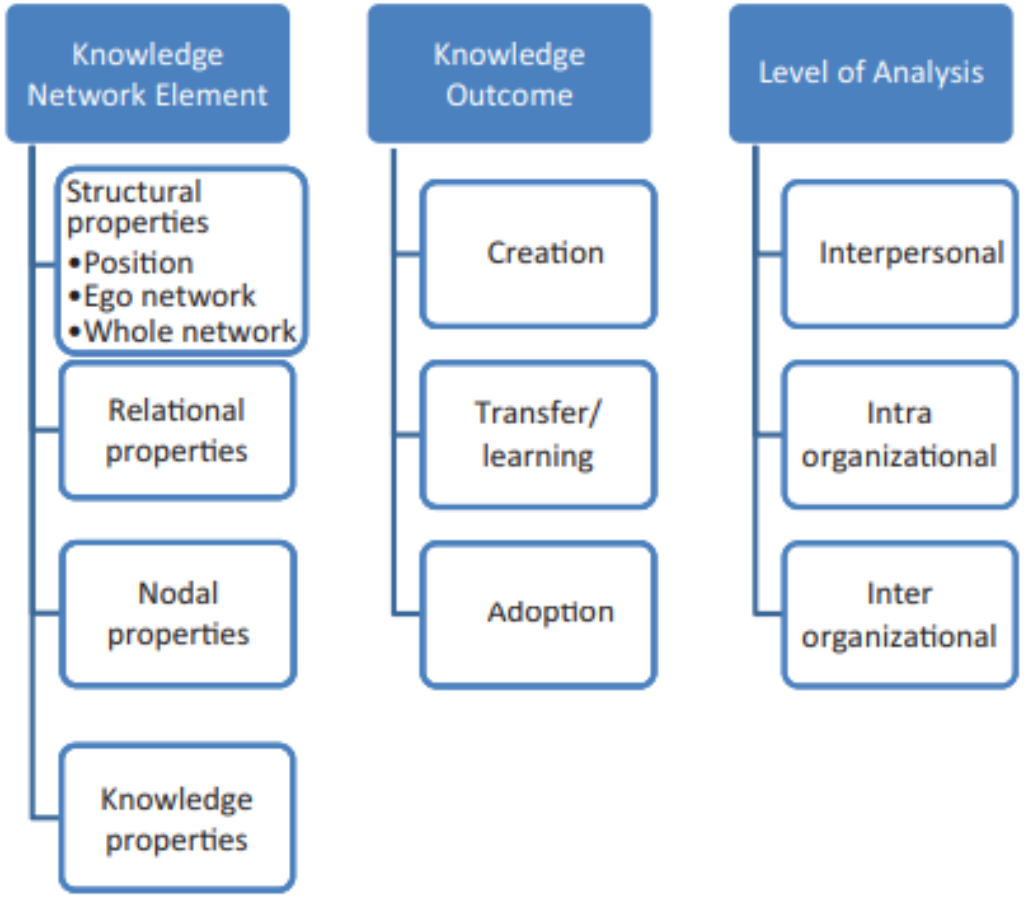
Organizational networks

Key Features	Market	Hierarchy	Network
Normative Basis	Contract – property Rights	Employment Relationship	Complementary Strengths
Means of Communication	Prices	Routines	Relational
Methods of Conflict Resolution	Haggling – resort to courts for enforcement	Administrative fiat - Supervision	Norm of reciprocity – Reputational concerns
Degree of Flexibility	High	Low	Medium
Amount of Commitment Among the Parties	Low	Medium to High	Medium to High
Tone or Climate	Precision and/or Suspicion	Formal, bureaucratic	Open-ended, mutual benefits
Actor Preferences or Choices	Independent	Dependent	Interdependent

Neither market nor hierarchy (Powell, 1990)

Knowledge networks

Figure 2
Organizing Framework for Knowledge Networks Research



Journal of Management
Vol. 38 No. 4, July 2012 1115-1166
DOI: 10.1177/0149206311432640

Knowledge, Networks, and Knowledge Networks: A Review and Research Agenda

Corey Phelps
HEC Paris
Ralph Heidl
Michigan State University
Anu Wadhwa
Ecole Polytechnique Fédérale de Lausanne

A large and growing body of empirical research shows that social relationships and the networks these relationships constitute are influential in explaining the processes of knowledge creation, diffusion, absorption, and use. The authors refer to such networks as "knowledge networks." They advance an understanding of knowledge networks at multiple levels by conducting a systematic review and analysis of empirical research published on this topic in leading management, psychology, sociology, and economics journals. The authors develop a comprehensive framework that organizes the knowledge networks literature, which they use to review extant empirical research within and across multiple disciplines and levels of analysis. They identify points of coherence and conflict in theoretical arguments and empirical results within and across levels and identify emerging themes and promising areas for future research.

Keywords: *knowledge networks; social networks; knowledge; learning; creativity; innovation*

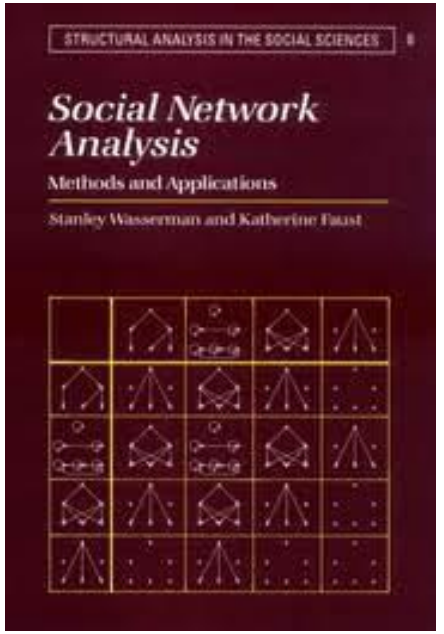
Introduction to a methodology

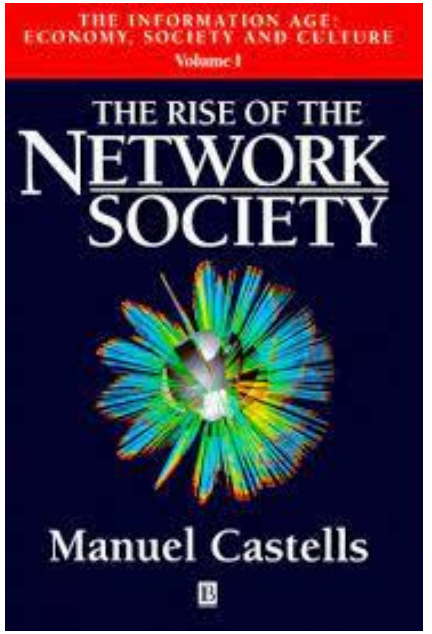
Introduction to SNA

SNA is the study of **relations** among a set of agents and networks are representations of systems in which the elements (or **nodes**) are connected by **ties** (Wasserman and Faust, 1994).

Studying groups of agents from a network perspective is to investigate agents as embedded in a **network of relations** and look for explanations for **social/organizational behaviour** in the **structure** and **dynamics** of these networks rather than the individuals alone.

-> A **network society** (Castells, 1996).





Introduction to SNA

Relations matter:

- Investigating ideas and material **flows** through relationships

- Or investigating **co-participation** in specific settings

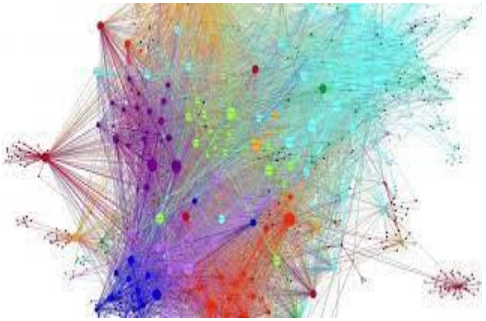
- Understanding how an agent is **embedded** in a web of relationships with other agents

Introduction to SNA

SNA can be interpreted as:

- a **methodology**

- a **perspective** on how societies function



From studies on individuals and their attributes

to investigations on **relations** between individuals, within groups, societies.

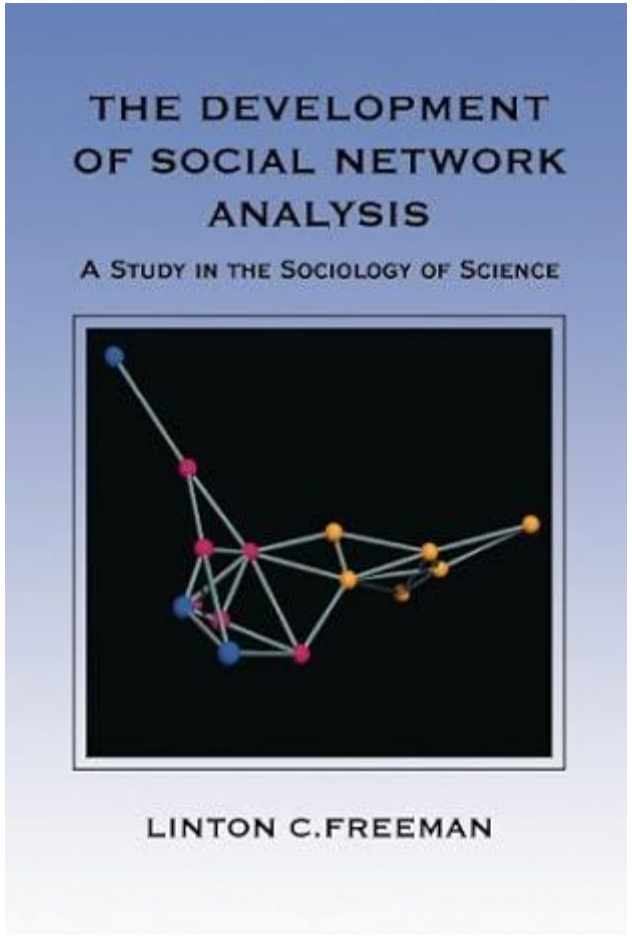
It requires
- new set of concepts,
- new methods for data collection,
- new methods for the analysis

Introduction to SNA

Origins of SNA can be found in:

- **social science**:
when it comes to social (i.e., groups, societies) issues;

- network analysis & **graph theory** (from mathematics):
formulation and solution of problems that have a network structure (representable in a graph).

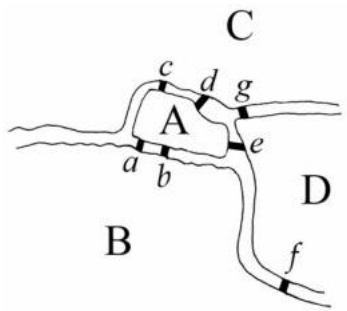


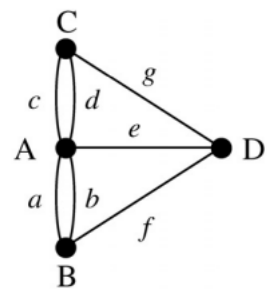
Introduction to SNA

A famous antecedent:

In 1736 Leonard Euler published the solution to the Konisberg bridge problem – it consisted in finding a round trip that traversed each of the Konisberg's bridges exactly once.
He used a graph to prove that there is no path that crosses each of the city's bridges only once.

Newman, J R, 'Leonhard Euler and the Konigsberg bridges', Scientific American, 189 (1953), 66–70.





LEONHARD EULER AND THE KOENIGSBERG BRIDGES

In a problem that entertained the strollers of an East Prussian city the great mathematician saw an important principle of the branch of mathematics called topology

Leonhard Euler, the most eminent of Switzerland's scientists, was a gifted 18th-century mathematician who enriched mathematics in almost every department and whose energy was at least as remarkable as his genius. "Euler calculated without apparent effort, as men breathe, or as eagles sustain themselves in the wind," wrote François Arago, the French astronomer and physicist. It is said that Euler "dashed off memoirs in the half-hour between the first and second calls to dinner." According to the mathematical historian Eric Temple Bell he "would often compose his memoirs with a baby in his lap while the older children played all about him"—the number of Euler's children was 13. At the age of 28 he solved in three days a difficult astronomical problem which astronomers had agreed would take several months of labor; this prodigious feat so overtaxed his eyesight that he lost the sight of one eye and eventually became totally blind. But his handicap in no way diminished either the volume or the quality of his mathematical output. His writings will, it is estimated, fill 60 to 80 large quarto volumes when the edition of his collected works is completed.

The memoir published below is Euler's own account of one of his most famous achievements: his solution of the celebrated problem of the Koenigsberg bridges. The problem is a classic exercise in the branch of mathematics called topology (see "Topology," by Albert W. Tucker and Herbert S. Bailey, Jr.; Scientific American, January, 1950). Topology is the changes of its size or shape. The Koenigsberg puzzle is a so-called network problem in topology.

In the town of Koenigsberg (where the philosopher Immanuel Kant was born) there were in the 18th century seven bridges which crossed the river Pregel. They connected two islands in the river with each other and with the opposite banks. The townsfolk had long amused themselves with this problem: Is it possible to cross the seven bridges in a continuous walk without recrossing any of them? When the puzzle came to Euler's attention, he recognized that an important scientific principle lay concealed in it. He applied himself to discovering this principle and shortly thereafter presented his simple and ingenious solution. He provided a mathematical demonstration, as some of the townsfolk had already proved to their own satisfaction by repeated trials, that the journey is impossible. He also found a rule which answered the question in general, whatever the number of bridges.

The Koenigsberg puzzle is related to the familiar exercise of trying to trace a given figure on paper without lifting the pencil or retracing a line. In graph form the Koenigsberg pattern is represented by the drawing on the left at the bottom of this page. Inspection shows that this pattern cannot be traced with a single stroke of the pencil. But if there are eight bridges, the pattern is the one at the right, and this one can be traced in a single stroke.

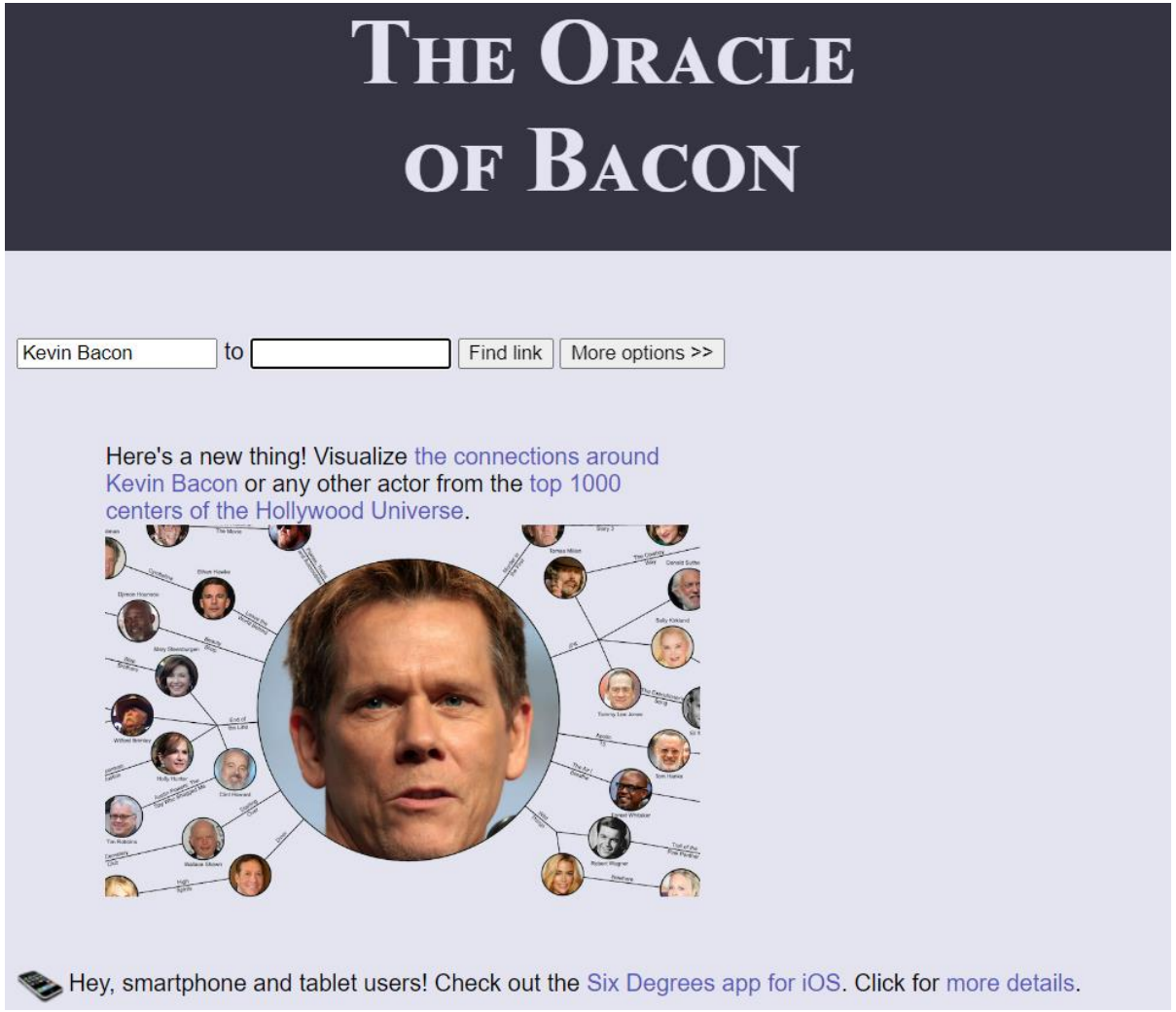
Euler's memoir gives a beautiful explanation of the prin-

Introduction to SNA

"Six Degrees of Kevin Bacon" game.

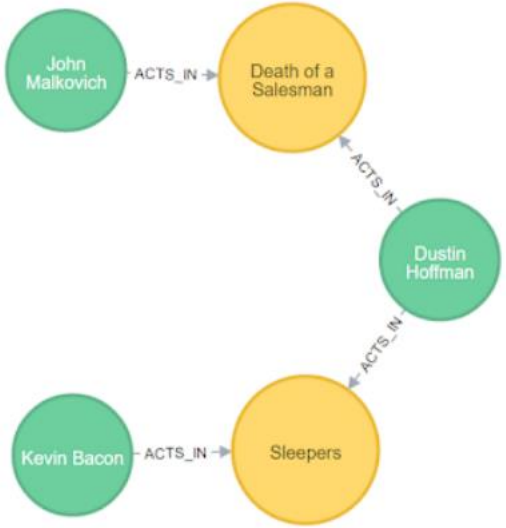
The basic concept is that every single actor can be connected to Kevin Bacon through six or fewer ties.

https://oracleofbacon.org/

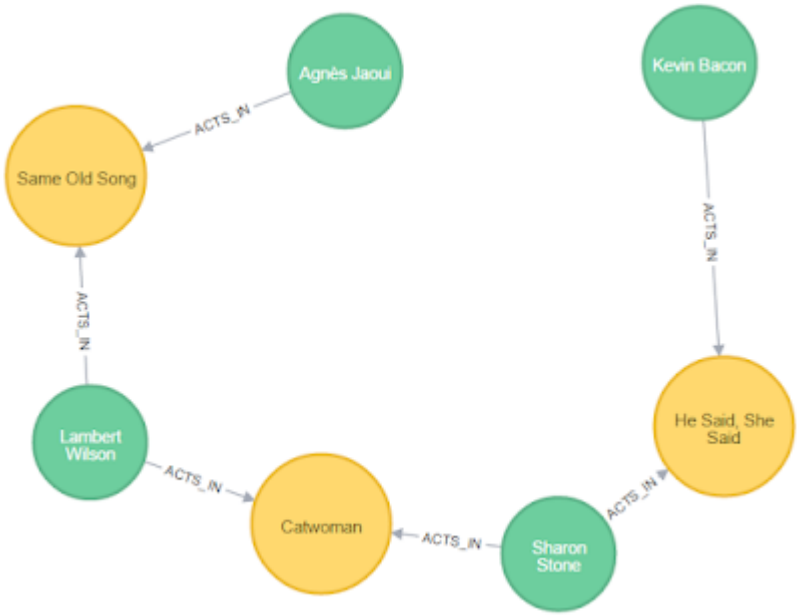


Introduction to SNA

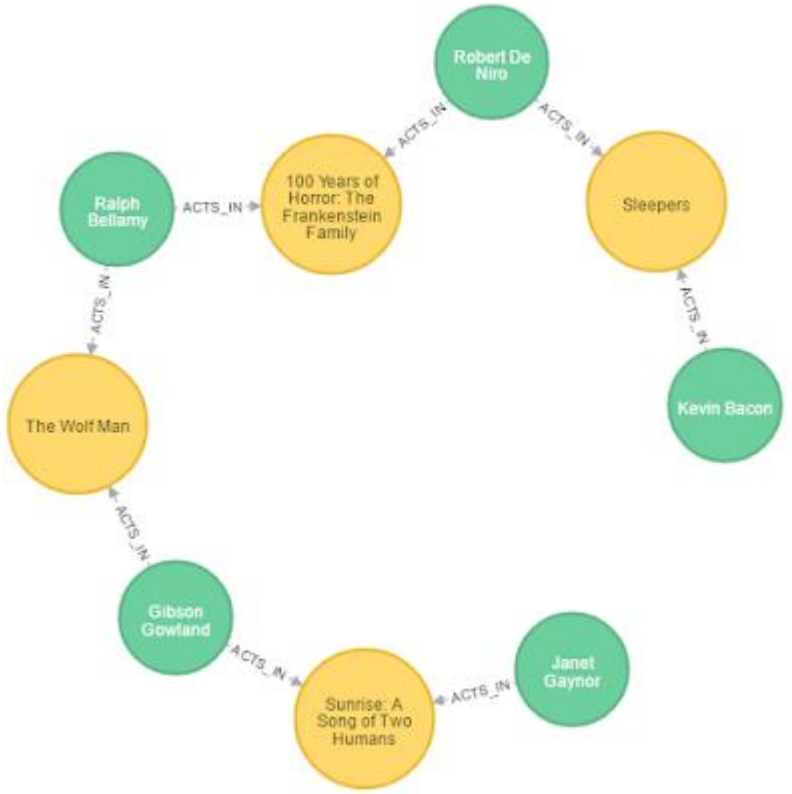
We can elaborate more…



The shortest path from Kevin Bacon to John Malkovich



The shortest path from Kevin Bacon to a French actor (Agnes Jaoui)



The shortest path from Kevin Bacon to someone who starred films in ’20 and ’30 (Janet Gaynord)

Introduction to SNA

… even more: the **small world experiment** (Milgram, 1967)

About the probability that two randomly selected people would know each other.

Information packets were initially sent to randomly selected individuals in Omaha or Wichita. They included letters, which detailed the study's purpose, and basic information about a target contact person in Boston.

Then the person was to think of a friend or relative who was more likely to know the target and forward the packet to that person.

The Small-World Problem

By Stanley Milgram

Fred Jones of Peoria, sitting in a sidewalk cafe in Tunis, and needing a light for his cigarette, asks the man at the next table for a match. They fall into conversation; the stranger is an Englishman who, it turns out, spent several months in Detroit studying the operation of an interchangeable-bottlecap-factory. "I know it's a foolish question," says Jones, "but did you ever by any chance run into a fellow named Ben Arkadian? He's an old friend of mine, manages a chain of supermarkets in Detroit . . ."

"Arkadian, Arkadian," the Englishman mutters. "Why, upon my soul, I believe I do! Small chap, very energetic, raised merry hell with the factory over a shipment of defective bottlecaps."

"No kidding!" Jones exclaims in amazement.

"Good lord, it's a small world, isn't it?"

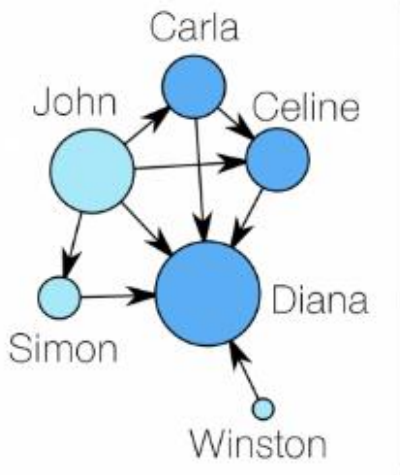
Introduction to SNA

Result:

among these chains, the average path length fell around five and a half or six.

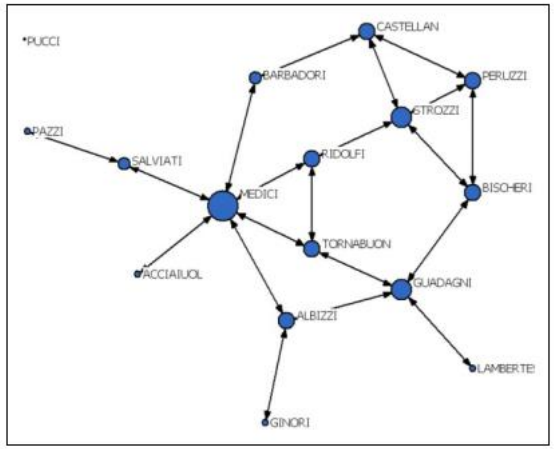
Data elaboration

Two different representations:



Nodes	Edges
Id,Label,Attribute	Source,Target
1,John,1	1,2
2,Carla,2	1,3
3,Simon,1	1,4
4,Celine,2	1,6
5,Winston,1	2,4
6,Diana,2	2,6
	3,6
	4,6
	5,6

		Family																Degree Centrality	Farness	Closeness Centrality[a]		Wealth[b]	
	Family	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			Raw	Standardized	Lira	Log
1	Acciaiuol	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	54	.019	.278	10	4.00
2	Albizzi	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	3	45	.022	.333	36	4.56
3	Barbadori	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	2	48	.021	.312	55	4.74
4	Bischeri	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	3	51	.020	.294	44	4.64
5	Castellan	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	3	52	.019	.288	20	4.30
6	Ginori	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	58	.017	.259	32	4.51
7	Guadagni	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	1	4	46	.022	.326	8	3.90
8	Lambertes	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	59	.017	.254	42	4.62
9	Medici	1	1	1	0	0	0	0	0	0	0	0	0	1	1	0	1	6	41	.024	.366	103	5.01
10	Pazzi	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	65	.015	.231	48	4.68
11	Peruzzi	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	3	54	.019	.278	49	4.69
12	Pucci	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	240[c]	.004	.062	3	3.48
13	Ridolfi	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	3	44	.023	.341	27	4.43
14	Salviati	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2	52	.019	.288	10	4.00
15	Strozzi	0	0	0	1	1	0	0	0	0	0	1	0	1	0	0	0	4	48	.021	.312	146	5.16
16	Tornabuon	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	3	45	.022	.333	48	4.68



Network drivers

There are three main categories of network drivers:

- Nodes characteristics (for example, firms' size, experience and typology of specialization)

- Dyadic mechanisms: similarities vs differences (for example, assortativity, disassortativity and proximity)

- Network structures: whole-network structures (for example, connectivity and density) and ego-network structures (for example, centrality and constrains).

Practical applications

- Police forces and the army use SNA to identify criminal networks building on traces of communications they have. In this way law enforcement agencies can also individuate key actors, new entrants, etc.

- Social Networks like Facebook use SNA to indicate potential friends starting from friend-to-friend linkages.

- Electricity and telephone operators use SNA to optimize structures and capacity of their networked systems.

- Companies use SNA to improve communication flows in their organization, with partners or customers.

dSEA

Dipartimento di scienze economiche e aziendali 'Marco Fanno'

Università degli Studi di Padova