Network Analysis, History of

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Abstract

While social scientists had been drawing on the abstract idea of social networks clearly since the nineteenth century, which becomes most evident in Georg Simmel's formal sociology, a social network analysis (SNA) grounded in computational models and graphic imagery emerged within the field of small group research in the 1930s. It was Jacob Moreno who introduced the idea of depicting social structure as a network diagram ('sociometry'). Kurt Lewin was an early contributor to the promotion of mathematical models of group relations, and Fritz Heider focused on triads to theorize on what throws groups out of balance. Mostly independent of these ideas, the anthropologist Lloyd Warner adopted a network approach in the study of informal relations between workers and of communities. SNA was further applied by the Manchester school of anthropologists to enhance ethnographic description. Advancing mathematical-formal aspects of SNA at Harvard in the 1970s, Harrison C. White and his collaborators contributed to the establishment of the discipline as a recognized paradigm. In the late 1990s, physicists began to publish work on social networks. Today, SNA has become a multidisciplinary research specialty with distinct theoretical concepts and data-analytic techniques.

The Origins of Social Network Ideas

Social structure has been one of the early key concepts in the social sciences. Social Network Analysis (SNA) is a recently developed set of formal methods for the study of social structures that draws on graph theory in which individuals and other social actors, such as groups and organizations, are represented by points and their social relations are represented by lines. The main theoretical underpinning of SNA is, as Wellman (1988) pointed out, that the structure of relations among actors and the location of individual actors in the network have important attitudinal, behavioral, and perceptual consequences both for individuals and the social structure as a whole. Visual imagery has played a significant role in SNA since its inception. Mathematical and computational models are at the base of more current applications.

Only in the first part of the twentieth century did a handful of social scientists begin to systematically theorize social relationships. Society as a whole was conceptualized as the very tissue of relations. Ferdinand Tönnies (1855–1936) categorized social ties as being either personal and direct ('community') or formal and instrumental ('society'). Herbert Spencer (1820–1903) made a similar distinction between premodern and modern societies by referring to 'ordinary' and 'secondary relations.' Emile Durkheim (1858–1917) theorized the specific structuring of groups as being responsible for the quality of emergent laws and morality, and Gustav Le Bon (1841–1931) was the first to examine the phenomenon of crowd behavior. It was, however, Georg Simmel (1858–1918), a German sociologist whose work stood out against macrolevel theories of scholars such as Max Weber (1864–1920) and Karl Marx (1818–83), who pioneered most explicitly the analysis of dyads (relationships between two persons) and triads (groups composed of three people) as building blocks of social life. Although he never used the term 'social network' as such, his ideas about microlevel structures prove to be a source of inspiration even for current day SNA. Simmel held the view that sociology was no more and no less than the study of interweaving actions in social encounters (Simmel, 1908/2009). He suggested that a consideration of social dynamics caused by the simple addition of a third person could provide insights on society at large, that is, how large structures constrain individuals. While isolated dyads are characterized by individuality and intimacy, triads have a superindividual property: (informal) social pressures are activated, and the variance of behavior as well as interpersonal idiosyncrasies are reduced. Third-party effects may also involve two actors forming a coalition against a third, one actor disturbing the alliance between two others, or one actor even taking advantage of a conflict between two others ('rejoicing third'). It was Simmel's student Leopold von Wiese (1876–1969) who adopted a contemporary terminology of points, lines, and connections to describe social relations (von Wiese, 1924/1932).

The origins of structural research are, however, also located outside the disciplinary boundaries of sociology. Especially the work of scholars in educational and developmental psychology, who were interested in the ways small-group structures affected individual perceptions and actions had a structuralist flavor very early. Helen Bott, for example, set out to document every form of social interaction that occurred among preschool children (Bott, 1928). In fact, she was one of the first to collect ego-centered kinship network data and calculate even network density measures. It is, however, commonly agreed that Jacob Moreno, a student of psychiatry from Vienna who immigrated to the United States in 1925 and championed the field of 'sociometry,' was the main driving force, together with his collaborator, Helen Jennings, in establishing SNA.

Moreno was deeply influenced by Gestalt psychology (Gestalt translates as 'form') developed by mostly German psychologists such as Kurt Koffka (1886–1941), Max Wertheimer (1880–1943), and Wolfgang Köhler (1887–1967) as a protest against behaviorist theories of their day. This school of thought maintained that innate and self-organizing operations of the brain influence the way we see. With respect to the visual recognition of figures, we tend to perceive, for example, whole forms instead of just a collection of lines and curves. Moreno transferred the idea that 'the whole is greater than the sum of its

parts' to the interplay between the social embeddedness of an individual and this person's well-being. He believed that many psychological problems stemmed from failed interactions and that the position of individuals within groups is highly significant for their mental health; Moreno and Jennings (1938) thus spoke of 'psychosocial networks.' Moreno's concern with social structure is mirrored in therapy forms called 'sociodrama' and 'psychodrama,' which aimed at exploring conflicts inherent in social roles. 'Sociometry' was developed as a powerful tool for assessing group dynamics and eliciting graphically subjective feelings between persons. **Figure 1** illustrates typical 'sociograms' featured in the book *Who Shall Survive?* (Moreno, 1934), in which Moreno (and Jennings) probed the causes of runaways at the Hudson School for Girls in upstate New York. The crux of their argument was that the location in the social networks primarily determined whether and when someone ran away.

At first, Moreno's idea to make social structure tangible garnered a great deal of interest, although this turned out to be short-lived. By the 1940s, American social scientists had returned to their focus on the characteristics of individuals (Freeman, 2004).

In the 1940s and 1950s, research on social networks advanced on more than one front, mostly independently of each other. In fact, SNA can be seen as emerging from certain disciplinary trajectories (Prell, 2012), even if scholars working in the field of SNA always crossed disciplines. In the following, the developmental pathways of SNA are outlined in the key disciplines of psychology, sociology, and social anthropology.

Disciplinary Trajectories

(Social) Psychology Trajectory

Kurt Lewin, a German-Jewish émigré and a contemporary of Freud, who after arriving in the United States first held an academic position in Iowa, provided an important intellectual foundation for the development of SNA. His most cited work is *Field Theory in Social Science* (Lewin, 1951), in which he puts forward the idea that behavior is embedded in a psychophysical field consisting of 'valances,' which are analogous in their dynamics to gravitational forces: they pull one toward or push one away. Lewin's field theory was supposed to provide a method of analyzing causal relations among mutual interdependent facts in a concrete situation as perceived by the individual. Lewin tried to formalize his topological concepts: vectors describe the resolution of forces, the lengths represent their strengths, and arrows indicate the direction of field forces. The 'life space,' which contains a person and this person's environment, was divided into regions (family, work, etc.), paths, and barriers. In 1945, Lewin left Iowa to form the Research Center for Group Dynamics at Massachusetts Institute of Technology (MIT). After his sudden death in 1947, most of his coresearchers moved to the University of Michigan ('the Michigan group') and continued to make important contributions to SNA.

Dorwin Cartwright and Frank Harary (1956) extended Fritz Heider's social balance theory (Heider, 1946) which discusses the relations among individuals based on sentiments. In the case of triads, Heider postulated that a balanced state between the three (focal individual P, another agent O, object X) can only exist, if the algebraic multiplication of signs in the triad relation has a positive value. With three sets of possible relationships, each taking one of two values (+, −), eight possible states exist. A triad is harmonious, for example, if there are two negative and one positive relation (e.g., −, +, −): "I don't like person B. B has a dog. I don't like the dog either." One of Heider's propositions is that individuals tend to choose states of balance in their interpersonal relations, which is why the adages 'your friends are my friends' or 'the enemy of my enemy is my friend' adequately summarize core implications of social balance theory. Building on Lewin's work, Cartwright and Harrary translated Heider's diagrams into graph theory and covered more than triadic relationships by asking the following question: What pattern would the interpersonal relations of a group of individuals have if they were balanced? Important among their findings is the 'structure theorem' that "an s-graph [signed graph] is balanced if and only if its points can be separated into two mutually exclusive subsets such that each positive line joins two points of the same subset and each negative line joins points from different subsets" (Cartwright and Harary, 1956: p. 286; **Figure 2**). Subsequently, Davis (1967) generalized balance to clusterability, which allows any number of clusters such that positive arcs appear within clusters and negative arcs between clusters. Davis and Leinhardt (1972) further extended balance theory by including status, which was motivated by the fact that people not only cluster into groups but also adhere to social rankings. They show how directed sentiment relations could generate a structure that is incorporated in a system of hierarchically arranged cliques. These classic papers gave the initial spark for the development of many techniques for identifying cohesive subgroups. One of the most innovative approaches to microstructures was the conceptualization of dyads as a stochastic process in which distribution can be statistically modeled (Holland and Leinhardt, 1977).

In the 1950s and 1960s, Alex Bavelas, another student of Lewin, conducted experiments at the MIT together with colleagues such as Harold Leavitt. He was especially concerned with communication in small groups and hypothesized a relationship between structural centrality and information diffusion processes. In Bavelas (1950), the hierarchy steepness within five-person groups working on a joint task was moderated by installing either a 'wheel' structure, in which all messages could only flow between peripheral members by passing a central actor, or decentralized configurations without limited communication channels. A tentative finding was that centralization was beneficial in the case of simple tasks and detrimental for complex ones. Bavelas was the first to develop a centrality measure, which received much attention and provided an impetus for the refinement of mathematical concepts regarding network structure. At MIT Leon Festinger, R. Duncan Luce, and Albert Perry especially strived for a mathematical formalization of SNA. In a seminal article, Luce and Perry (1949) used graph-theoretic terminology to define cliques as maximal complete subgraphs. What is meant by 'complete' is that every individual is tied directly to every other. Parallel to this, Festinger (1949), who was primarily concerned with the development of group standards, applied somewhat different matrix algebra to identify cliques. In either case, the

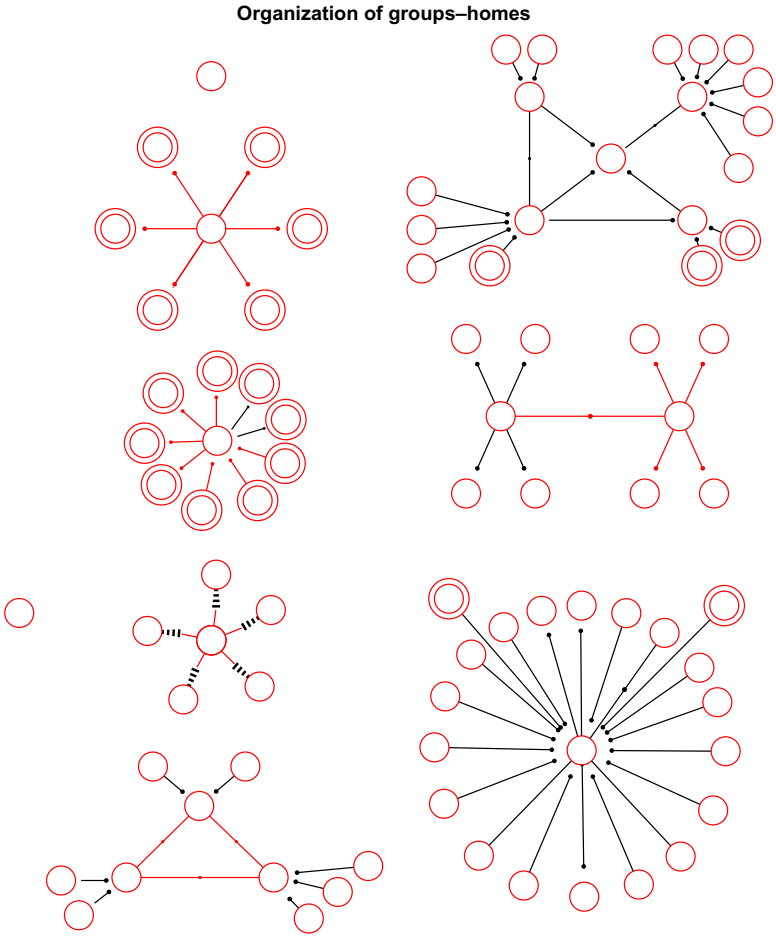
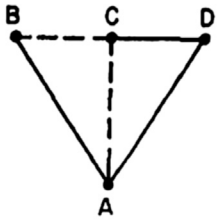


Figure 1 Example of sociograms. Source: Moreno, J.L., 1934. Who Shall Survive? Nervous and Mental Disease Publishing Company, Washington, DC, p. 116.



A signed graph of four points and five lines. Solid lines have a positive sign and dashed lines a negative sign. If the points stand for people and the lines indicate the existence of a liking relationship, this s-graph shows that *A* and *B* have a relationship of liking, *A* and *C* have one of disliking, and *B* and *D* have a relationship of indifference (neither liking or disliking).

Figure 2 Structural balance. Source: Cartwright, D., Harary, F, 1956. Structural Balance: A Generalization of Heider's Theory. Psychological Review 63, 283.

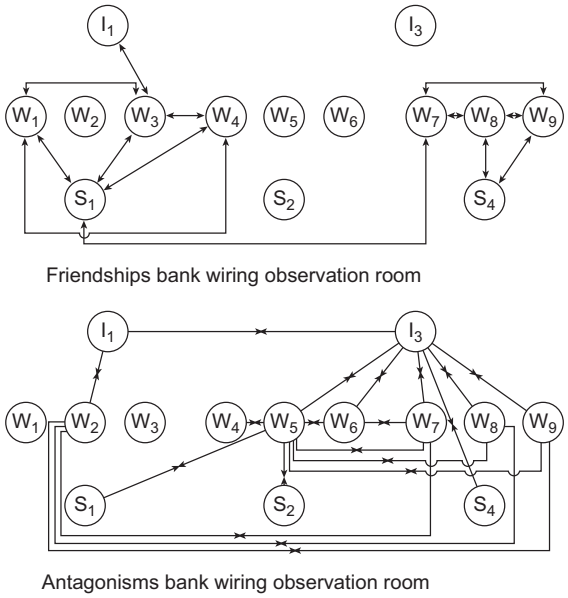


Figure 3 Patterns of friendship in the bank wiring observation room. Source: Roethlisberger, F.J., Dickson, W. J., 2003. Management and the Worker. Routledge, London, p. 367 (originally published in 1939).

implicit assumption motivating clique analysis was that actors who maintain cohesive bonds were prone to act similarly. Subsequently, Cartwright and Harrary proposed alternative ideas for clique detection, such as the maximal strong component idea, which implied loosening the clique concept by allowing for indirect links of various lengths. Thus a maximal strong component is a network subgroup in which each actor can reach other actors directly or indirectly, and no further actor can be added without reducing the mutual reachability. At the time these formalizations of SNA were put forward, the development of large computers had already commenced, although computational methods for findings cliques were still rare.

The approach of Bavelas and his colleagues at MIT spurred innovative approaches to studying the social fabric in the post-World War II era. Ithiel de Sola Pool, a political scientist, and Manfred Kochen, a mathematician at IBM, drew up mathematical models for tackling the vexing 'small-world problem': If two persons are selected at random from a population, how many acquaintances are needed to create a chain between them? While de Sola Pool and Kochen turned to mathematical estimations because of a lack of data, the social psychologist Stanley Milgram came up with an ingenious experiment. Randomly chosen 'starters' in Nebraska were given a letter to deliver to 'target persons' in Massachusetts by sending it on to acquaintances whom they thought to be closer to the target. The idea was to test empirically how many intermediaries were needed to reach someone. Milgram's initial results (Milgram, 1967) led to the now popular notion of 'six degrees of separation,' which touched off a storm of further work across numerous disciplines. Replications, however, provided rather mixed findings on the validity of the experimental setting.

Sociology Trajectory

Although only collaborating for 6 years in the Anthropology Department and the Business School at Harvard, the anthropologist W. Lloyd Warner and the psychologist Elton Mayo produced work that was to become a historical landmark. Industrial psychologists relied on Warner and Mayo when faced with inconsistent effects of the physical work environment on worker productivity. The two men had discovered that improving lighting conditions boosted worker morale, but restoring lighting to its original state did not lead to deterioration in productivity. The Harvard team turned its initial psychological focus to the social structure that was systematically observed in a small group of workers putting together telephone switching equipment in the 'bank wiring room' of Western Electric Corporation in Cicero, Illinois ('Hawthorne Works'). This field study, described in great detail by Roethlisberger and Dickson (1939/2003), was the first to use sociograms to describe formal and informal relations between workers and is today among the classic readings in sociology (see **Figure 3**).

Observations revealed that workers were more responsive to social forces within their (informal) peer groups than to physical incentives. There was, however, no attempt to use graphs to identify sociometrically defined 'cliques.' John Scott (2013: p. 22) even concludes that the authors "appear to lack any theoretical understanding of how social networks might shape the behaviour of individuals" (Scott, 2013: p. 22).

Later on, Lloyd Warner (Warner and Lunt, 1941) helped disenchant the American myth of a classless society by detecting social divisions and rank orders of social participation in Newburyport, Massachusetts ('Yankee City'). Recognizing that the research site was ill-suited to shed light on racial demarcation in social stratification, Warner and his team embarked in further studies on an anthropological investigation of the 'Deep South' (Davis et al., 1941). Unlike in the Hawthorne study, the authors used matrices extensively to study the structural embedding of actors. Generating a data set that captured the

participation of 18 women in 14 events enabled them, for example, to identify cliques and social status among small groups. One of their findings was that social cliques (in colored societies) are composed of different layers: a 'core' of actors in the center of nearly all clique gatherings, a 'primary circle' of those who jointly participate with core members but do not stick together within one subgroup, and a 'secondary circle' of less-intimate friends who rarely participate.

This field research in the precomputer age emerged in parallel with advances in sociometry concerned especially with relational patterns in small groups. Harvard professor George Homans was the first to systematically review and synthesize the bulk of experimental and observational studies dealing with the subject. His path-breaking book *The Human Group* (Homans, 1950) is packed with much-cited conceptual schemes, such as the distinction between what he called an 'external system' (structure that prescribes human interaction, e.g., kinship) and an 'internal system' (processes within groups). Internal structural buildup is generated through interactions based on feeling or participations in common activities, whether or not this is dictated by the external system. Activities and common sentiments would generally lead to clique formation and instill social solidarity from within. Homans also reanalyzed data from the 'Hawthorne' and 'Deep South' studies. By rearranging the rows and columns of *women x events* matrix used by Davis et al. (1941), he aimed at detecting the existence of cliques – a method that is analogous to what has subsequently come to be called blockmodeling. However, he was far from advancing mathematical thinking in SNA.

A further strand of structural thinking within sociology developed in the 1950s at Columbia University, where the lifelong collaborators Paul Lazarsfeld and Robert K. Merton supervised many students, such as Peter Blau, James Coleman, and Charles Kadushin, who advanced the standards of modern SNA. Blau, an exponent of social exchange theory, refined the notion of homophily in SNA and established empirically that multigroup memberships 'crosscutting social circles' promote intergroup relations. Coleman established social capital, the resources inherent in the relations between and among actors, as a key concept in SNA. In a pioneering study on diffusion in social networks, he showed, together with Elihu Katz and Herbert Menzel, how doctors' willingness to prescribe new antibiotics spread through professional contacts. Building on Simmel's notion of social circle, Kadushin explained people's interest in consulting a psychotherapist not by individual influences but rather by memberships in intersecting social groups ('knowing others in therapy, knowing others with similar problems, asking friends for a referral'). Lazarsfeld himself applied newly improved survey technologies to investigate the influence of mass media. One of his main findings was that voters were not directly influenced by media during election time but rather by so-called opinion leaders in medium-sized communities who pass on media information through interpersonal communication (two-step flow of communication, Lazarsfeld et al., 1944).

Social Anthropology Trajectory

A further key contribution to the development of SNA was the foundation of the Department of Social Anthropology and Sociology in the 1950s at the University of Manchester, headed by Max Gluckman. In Manchester, a dynamic group of researchers, including Elisabeth Bott (also affiliated with the London School of Economics), John Barnes, J. Clyde Mitchell, and Siegfried Nadel, popularized the application of social network methods in ethnography. The Manchester school was deeply influenced by Alfred R. Radcliffe-Brown's structural perspective, which they sought to take in a novel direction. Radcliffe-Brown (1940) argued that anthropologists should investigate social phenomena by using methods similar to those in physics, which essentially meant relying on mathematics and analyzing structures such as kinship in terms of their function for maintaining societies across the globe. While Gluckman and his collaborators dismissed functional ideas of social equilibrium and acknowledged conflict as an inherent part of societies, they nevertheless refined the idea that social relations are embedded in wider networks.

In the decade after World War II, these anthropologists mostly carried out fieldwork in what was then British Central Africa (now Zambia, Zimbabwe, and Malawi), which gave theoretical force to such concepts as intercalary roles or crosscutting ties. Gluckman, for example, developed the intercalary theme when analyzing the authority roles of village headmen in rural societies, who were subject to conflicting pressures from fellow villagers and political superiors. At the conceptual level, societies were no longer seen as being monolithic, but rather as a pattern of relationships "obtaining between actors in their capacity of playing roles relative to one another" (Nadel, 1957: p. 12). The initial stimuli to direct study toward social networks were provided especially by Barnes' paper and Bott's book (Barnes, 1954; Bott, 1957). When studying a Norwegian fishing village, Barnes neglected the traditional anthropological concepts of geography, politics, and economics and focused instead on primordial relations such as kinship, friendship, and neighborhood ties, which combine to constitute what he called a 'network.' He is often regarded as the first person to have conceptualized the term, which he imagined as consisting 'of a set of points some of which are joined by lines' (Barnes, 1954: p. 237). Bott (1957) applied this concept to the study of the conjugal roles in families from London. She argued that the degree of segregation in the role-relationship is a function of the configuration of the network of friends and relatives associated of each spouse. For example, if husbands and wives are embedded in joint networks, the members of these external social networks can develop norm consensus and influence how equally spouses interact and share domestic household tasks. She was one of the first to theorize that dense and multiplex networks of ties have a strong norm-enforcement effect on network members, and she made use of sociograms to illustrate differences between dispersed and connected family networks (**Figure 4**).

Mitchell, who continued the Manchester tradition of working in British colonial Africa, made important contributions to the formalization of SNA. In a widely cited introduction (Mitchell, 1969), he suggested a series of conventions, still valid today, on how to model social networks using graph theory and distinguished between total and partial networks. The total network of society is composed of "the general ever-ramifying, ever-reticulating set of linkages that stretches within and beyond the confines of any community or

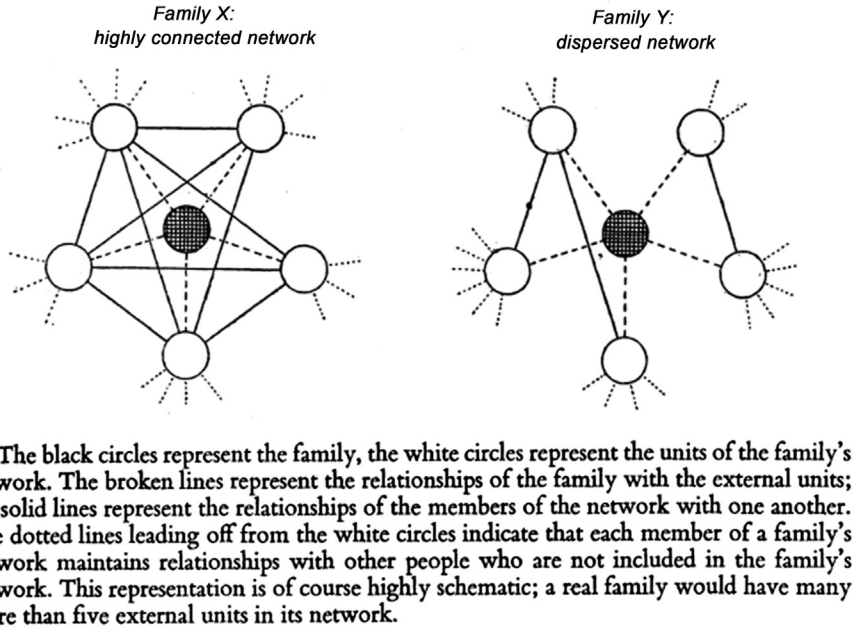


Figure 4 Schematic comparison of the networks of two families. Source: Bott, E., 1955. Urban families: conjugal roles and social networks. Human Relations 8, 348.

organization" (Mitchell, 1969: p. 12). In actual research, it is therefore imperative to select particular aspects of total networks, which means either focusing on ego-centered networks around particular individuals or on a particular aspect of social activity, such as friendship.

Scott (2013) argues that the reason the breakthrough leading to the study everywhere of social networks in all fields of social life was not made in Britain was the great emphasis on the informal side of communications in mostly ego-centered networks. However, the knowledge of the British anthropologists diffused quickly across the Atlantic and was quite commonly incorporated into a more sociological analysis of social structure, because British empiricism fit well with the American penchant for quantitative measurement and statistical analysis (Wellman, 1988: p. 23).

The Harvard Breakthrough

In the 1970s, the center of gravity in network research shifted to sociology. By the time that Mitchell (1969) published his timely review article, a group of American researchers led by Harrison White had begun to revolutionize the formal methodology of SNA. Reflecting his mixed background in mathematics, physics, and sociology, White's teaching and research at Harvard revolved around algebraic models of social structure. A key advance was the CONCOR algorithm, developed by White and his students, to identify a social network's structurally equivalent actors. An equivalence strategy (Lorrain and White, 1971) clusters individuals on the basis of relational similarity, that is, individuals are said to be 'structurally equivalent,' if they are characterized by identical patterns of relationship with other network members (but do not necessarily have mutual awareness of one another). Edward O. Laumann, White's first Harvard PhD student, was curious about the way people form, maintain, and dissolve relationships with others and about the impact of such networks on identities and behavior. Consequently, he pioneered multidimensional scaling (MDS) in community studies. Laumann and Louis Guttman (1966) asked 422 male residents of Cambridge and Belmont, Massachusetts, about the occupations of their seven alters (interalia the three closest friends). Then, an early form of MDS was applied to a table featuring the respondents' occupations in rows and the alters' occupations in columns. The most fitting solution appeared to be three-dimensional, the first dimension being interpreted as indicating occupational prestige. Two other students, Nancy H. Lee and Mark Granovetter, chose a less algebraic social network approach to the studies of illegal and labor markets. Lee figured out the condition under which women searching for an (illegal) abortion successfully activate social networks to gain indirect contacts with others who might help. Granovetter made the point that the economist's idea of a 'perfect labor market' misses the fact that labor-market information is often transmitted as a byproduct of other social processes. What matters are contacts. His idea that weak ties (corresponding to acquaintances) are superior to strong ties (corresponding to friends) for providing support in getting a job, inspired a vast research program on the role of social networks in the labor market (Granovetter, 1973). It also sparked the interest of sociologists to study the social embeddedness of economic phenomena in general, as, for example, the consequences of network positions of firms for their performance. The Harvard setting proved to be stimulating to many other researchers, among them Peter Bearman, Phillip Bonacich, Kathleen M. Carley, Joel Levine, and Barry

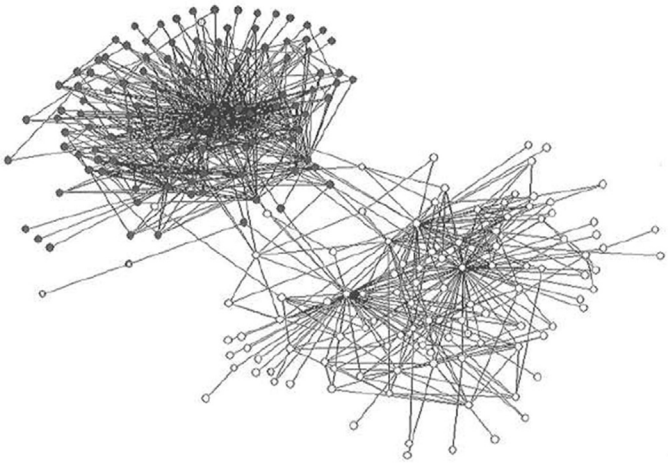


Figure 5 Small-world publications, 1950–2004; physicists are displayed as black points. Source: Freeman, L.C., 2011. The development of social network analysis. In: Scott, J., Carrington, P.J. (Eds.), The SAGE Handbook of Social Network Analysis. Sage, Los Angeles, p. 30.

Wellman, who remained at the forefront of the field. It was this diverse group of US-American researchers that established SNA as a formal method in social science research and influenced work across the globe.

Over a long period, SNA ideas have more or less evolved in the different fields referred to above. The late 1970s, however, witnessed the emergence of a unified research field. Mathematics, the dominant force in the field, helped advance commonly understood and shared terms. Computer programs, above all UCINET developed by Lon Freeman, Martin Everett, and Steve Borgatti, standardized the analysis of social network data. Annual conferences facilitated the communication between different schools, and the foundation of the International Network of Social Network Analysis (INSNA) and its newsletter *Connections* completed the integration of the field. Today different academic journals, such as *Social Networks*, provide an institutionalized forum for representatives of different disciplines, ranging from anthropology to communication science.

The Application of SNA across Disciplines

Having become a standard methodology, SNA experienced changes, the most striking development being the growth of interest apparent among physicists in applying network ideas to social phenomena. First, Watts and Strogatz (1998) published on small worlds. Within the social sciences, small worlds were first studied in depth by Milgram, whose experiments on forwarding letters (see above) established theories on 'six degrees of separation.' Watts formalized the features of small-world networks, in which most nodes are not neighbors but can be reached from every other node by a small number of steps, as the coincidence of high local clustering and short global separation. Watts and Strogatz (1998) show small worlds to be widespread not only in biological and man-made networks, but also in social ones. Barabási (2002) studied the distribution of network connections that grew because new nodes were added; to do this, he used different examples such as sites in the World Wide Web or links between screen actors. He discovered networks not to be random but to contain hubs – nodes with a very high number of links. In such networks, the distribution of linkages follows a power law in that most nodes have but a few connections while others have a huge number of links. In that sense, the network has no 'scale.' Scale-free networks prove to be widespread in the social world and seem to be robust against accidental failures.

Especially the work of Watts and Strogatz steered much interest in network analysis within the physics community. Within few years physicists produced more articles on small worlds than the social network community had turned out in almost a half century. However, Freeman's analysis of citations clearly shows that physicists rarely cite work of social network analysts, and social scientists are reluctant to engage with the models of physicists (**Figure 5**).

Many other disciplines have a heightened interest in SNA. Political scientists use the small-world concept to study information cascades, map out terrorist networks, study advocacy networks, or the influence of social relationships on legislative behavior. Epidemiology is turning toward SNA to test contagion theories on phenomena as diverse as obesity, smoking, or happiness. Communication science uses (semantic) network analysis to examine differences between blog posts and professional journalism or the structure of international news flows. Computer science researchers study changes in trust, migration, and mobility in online network-like communities. Witnessing decades of explosive growth, SNA academic journals such as *Network Science* and research centers emerged that aim at bridging and bonding disciplinary bonds. More than ever SNA has become a multidisciplinary endeavor.

Conclusion

The roots of SNA are diverse. Network theorizing in the social sciences dates back to the work of Georg Simmel, from the last decade of the twentieth century (Simmel, 1908/2009).

Moreno's network visualizations that displayed up to 435 individuals (Moreno, 1934) marked the beginning of sociometry, the precursor of SNA. The approach to represent social relations by graphs of points and lines was especially taken up by three disciplines: Social psychology, sociology, and social anthropology. Heider's balance theory that aimed at describing 'equilibrium' properties of interpersonal relations inspired the work of Cartwright and Harary, who studied more complex cases of structural balancing (i.e., groups with more than three elements). Alex Bavelas examined the impact of different communication network structures on the ability of groups to solve problems. In general, early social psychological work mostly focused on (positive and negative) interpersonal relations within smaller groups and their implication for behavior in social contexts. The network approach to social structures such as status systems in typical American communities (Warner and Lunt, 1941) provided insights that were more amenable to sociology. Social anthropology was primarily concerned with kinship networks. While most of the pioneering studies in SNA transcended disciplinary boundaries only to a limited extent, the pocketing of social network concepts and theories within single disciplines is today seen less. Especially, the newly established field of 'network science' avoids compartmentalization, yet consolidating a common language and methodological toolbox (Vedres and Scotti, 2012).

While SNA is experiencing rapid growth in participants, controversy surrounds the issue whether SNA is 'just' a methodology or also a theory with a set of clearly defined propositions. Borgatti and Halgin (2011) identify two models that underlie network theorizing: the network flow model and the bond model. The first being identified, for example, with the strength of weak ties theory (Granovetter, 1973) that predicts how information flows through a given network and generates outcomes for the nodes. The second being best represented by theories on power in exchange network, which underlying theme is how network ties align and coordinate action in order to enable many nodes to act as a single node with greater capabilities. What is rather uncontroversial is that SNA comes with a set of powerful heuristics that help to analyze as diverse phenomena as corruption or the spread of diseases.

See also: Simmel, Georg (1858–1918); Social Capital; Social Network Analysis; Social Networks.

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