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# RESEARCH REPORTS

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*SOCIAL NETWORKS: A BEGINNER'S BOOKSHELF\**

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During the past several months I've been approached often by people asking about how they can get started in the study of social networks. Not only have undergraduate and graduate students come up with this question, but professional social scientists and mathematicians are increasingly showing interest in the networks approach.

All agree that what is needed is a beginner's bibliography--a basic bookshelf--that will define the approach and provide the background for continued reading in the literature. This note is designed to meet that need. It provides a short reading list, containing 48 items, that will give the newcomer a basic orientation to the study of social networks.

The unified and explicit study of social networks is a creature of the 1970s. Its several origins are much older and they are based variously on traditions in anthropology, communications science, human geography, information science, political science, social psychology and sociology. Although networks-type ideas are not new in any of these disciplines, such ideas have always been marginal in each. The social networks approach, then, represents a genuine departure from any traditional mainstream of social scientific thought.

Social scientists have always talked vaguely and intuitively about concepts that are probably intended to relate to relations among persons--concepts like social structure and social role. But in conducting actual research, they have always concentrated almost exclusively on the traits and characteristics of individual persons.

In contrast, the social networks outlook explicitly focuses attention on attributes of the relations among people rather than on the properties of individual persons; thus, we are finally systematically exploring the social part of behavior.

Social networks concepts have developed more or less independently in each of the fields named above. In each case they were, at origin, loose intuitive ideas designed to sensitize observers to the interpersonal dimensions of behavior. All were concerned with the forms or structures of the social relations that link individuals together into networks and with the processes through which such networks emerge, evolve and exhibit consequences for behavior.

Increasingly, however, as the networks concepts has become explicitly grounded in algebra, the theory of graphs and in probability theory, there has been recognition of the fact that the several earlier intuitive conceptions all share a common intellectual core. This recognition has provided a foundation for the emergence of a single cross-disciplinary social networks perspective.

The potential for scientific growth resulting from this new approach is great. The social networks perspective is firmly grounded in an explicit mathematical representation. It provides the basis for exact development of some of the more suggestive of our traditional intuitive concepts--like status and role. It affords an explicit substructure for the development of formally defined process models. And it has generated a sense of excitement among the participants in its development.

The potential of the social networks perspective is also great with respect to practical applications. Applications of the concepts and findings of network analysis have begun to be made in corporate and political organizational behavior, the diffusion of information and structure of individual support systems.

The present bibliography is designed to provide an introduction to the traditions and current concepts regarding social networks. It will begin with a list of several general overviews of the whole field. There will be a section that cites several early pieces that illustrate the intellectual origins of network study. This will be followed by a section showing appropriate materials for the study of formal tools for network analysis and one on main current theoretical themes. Finally, there is a section on applications. Reviewing the material on these citation lists should put the reader in a position to read anything in the current social networks literature.

#### A. Overviews of the Study of Social Networks

A number of writers have, in the past few years, published general overviews of the social networks perspective. In many ways they are, of course, similar. Each, however, is importantly different; each reflects the background, training and perspective of its author. And in an emerging specialty that is bringing together people from diverse backgrounds, varying perceptions of the origins, nature and goals of the effort are inevitable.

In an attempt to capture the range of this variation, five essays are listed below as suggested readings. Any one will provide a reasonably coherent look at social networks research, but together they can give a sense of the range of views among students of the field.

- A1. Barnes, J.A. "Social Networks," Addison Wesley Module, No. 26, Boston: Addison-Wesley, 1972.
- A2. Burt, R.S. "Models of Network Structure," Annual Review of Sociology, 1980, 6:79-141.
- A3. Mitchell, J.C. "The Concept and Use of Social Networks," in J.C. Mitchell, ed., Social Networks in Urban Situations. Manchester: Manchester University Press, 1969, 1-50.
- A4. Mullins, N.C. "The Structuralists: Tracking Something," Chapter 10 in his Theories and Theory Groups in Contemporary American Sociology. New York: Harper-Row, 1973.
- A5. Wellman, B. "What is Network Analysis?" Research Paper No. 1A, Structural Analysis Programme, Department of Sociology, University of Toronto, Toronto, Ontario, Canada, M5S 1A1, 1980. \$2.00.

#### B. Origins of Social Networks Analysis

The essential idea of studying networks of human relations is very old. Elaborate geneologies, for example, have traditionally been maintained by peoples throughout the world. For these people, an individual's social identity was thought to be largely determined by where that person fit into a kinship network.

The origins of contemporary systematic network studies are variously attributed to a great many sources. The idea is natural; it was probably rediscovered again and again. At this moment I know of five articles that seem to me to have influenced subsequent work in directions that are reflected in contemporary work. They range in date of publication from 1882 to 1978 (though this last one was written in the 1950s and circulated as a fugitive but influential piece for over 20 years before publication). They are listed below:

- B6. Bavelas, A. "Communications Patterns in Task-Oriented Groups," Journal of the Acoustical Society of America, 1950, 22: 725-730.
- B7. Macfarlane, A. "Analysis of Relationships of Consanguinity and Affinity," Journal of the Royal Anthropological Institute, 1882, 12: 46-63.
- B8. Moreno, J.L. Who Shall Survive? Washington, D.C.: Nervous and Mental Disease Publishing Company, 1934.
- B9. Pool, I. de S., and M. Kochen. "Contacts and Influence," Social Networks, 1978, 1: 5-51.
- B10. Radcliffe-Brown, A.R. A Natural Science of Society. Glencoe, Illinois: Free Press, 1957.

#### C. Formal Tools

One of the main bases for the recent surge of interest and sophistication in social networks analysis has been the increasing availability of mathematical tools that are designed specifically for such applications. Like the parallel and interdependent development of physics and analysis in the 18th century, social networks and certain kinds of mathematics are currently enjoying a mutually productive collaboration.

Social networks students are defining new problems and mathematicians--particularly those working in graph theory, probability theory, linear and abstract algebra and algebraic topology--are developing new tools. As a matter of fact, a good deal of joint work has been conducted by mathematician-social scientist pairs (e.g. Harary-Cartwright, Holland-Leinhardt, Wasserman-Leinhardt, Witz-Lehman, Killworth-Bernard, Neiminen-Everett, Seidman-Foster), and a growing number of mathematicians are publishing applied work in the social networks area (e.g. Kemeny, Snell, Norman, Atkin, Hubert, Frank, Copobianco).

Reading current materials in social networks, then, requires a certain amount of mathematical background. The reader without that background would do well to consult some general text or texts if he or she runs into difficulties. A list of such resource materials in mathematics is provided in an Appendix.

In any case, there seem to be three areas of emphasis in the development of formal tools for the study of social networks. They are listed below, along with some suggested readings for each:

### 1. Representation and Specification of Structural Properties

C11. Alba, R.D. "A Graph-Theoretic Definition of a Sociometric Clique," The Journal of Mathematical Sociology, 1973, 3: 113-136.

C12. Doreian, P. "On the Connectivity of Social Networks," Journal of Mathematical Sociology, 1974, 3: 245-258.

C13. Hubert, L. J. "Some Applications of Graph Theory to Clustering," Psychometrika, 1974, 39: 283-309.

C14. Seidman, S.B., and B.L. Foster. "A Graph-Theoretic Generalization of the Clique Concept," Journal of Mathematical Sociology, 1978, 6: 138-154.

### 2. Homomorphic Reduction

C15. Arabia, P., S.A. Boorman, and P.R. Levitt. "Constructing Blockmodels: How and Why," Journal of Mathematical Psychology, 1978, 17: 21-63.

C16. Lehman, F.K., and K. Witz. "Prolegomena to a Formal Theory of Kinship," in P. A. Balonoff, ed., Geneological Mathematics. Paris: Mouton, 1974.

C17. Lorrain, F. "Social Structure, Social Classifications, and the Logic of Analogy," in P.A. Balonoff, ed., Mathematical Models of Social and Cognitive Structures. Urbana, Illinois: University of Illinois Press, 1974.

C18. Light, J.M., and N.C. Mullins. "A Primer on Blockmodeling Procedure," in P.W. Holland and S. Leinhardt, eds., Perspectives on Social Network Research. New York: Academic Press, 1979.

### 3. Determining Distributions

C19. Frank O. "Sampling and Estimation in Large Social Networks," Social Networks, 1978, 1: 91-101.

C20. Holland, P.W., and S. Leinhardt. "Structural Sociometry," in P.W. Holland and S. Leinhardt, eds., Perspectives on Social Network Research. New York: Academic Press, 1979.

C21. Hubert, L.J., and J.V. Schultz. "Quadratic Assignment as a General Data Analysis Strategy," British Journal of Mathematical and Statistical Psychology, 1976, 29: 190-241.

C22. Wasserman, S. "Analyzing Social Networks as Stochastic Processes," Journal of American Statistical Association, 1980, 75: 280-294.

### D. Main Theoretical Themes

As a whole, work in the social networks area is still somewhat diffuse. At the moment, however, there does not seem to be some focus on a set of problems of particular theoretical interest. Five such problem areas strike me as central in recent work. They are listed below, along with suggested readings in each:

#### 1. Clique Analysis

D23. Alba, R.D., and C. Kadushin. "The Intersection of Social Circles: A New Measure of Social Proximity in Networks," Sociological Methods and Research, 1976, 5: 77-102.

D24. Burt, R.S. "Cohesion versus Structural Equivalence as a Basis for Network Subgroups," Sociological Methods and Research, 1978, 7: 189-212.

#### 2. Social Position or Role

D25. Mandel, M., and C. Winship. "Roles, Positions and Networks," (preprint available from Professor C. Winship on request to Northwestern University, Department of Sociology, Evanston, Illinois, 60201).

D26. Sailer, L.D. "Structural Equivalence: Meaning and Definition, Computation and Application," Social Networks, 1978, 1: 73-90.

## 3. Hierarchy or Stratification

D27. Allison, P.D. "Measures of Inequality," American Sociological Review, 1978, 43: 865-880.

D28. Freeman, L.C. "Centrality in Social Networks: I. Conceptual Clarification," Social Networks, 1979, 1: 215-239.

## 4. Structural Balance, Clustering and Transitivity

D29. Holland, P.W., and S. Leinhardt. "An Omnibus Test for Social Structure Using Triads," Sociological Methods and Research, 1978, 7: 227-256.

D30. Leik, R.K., and B.F. Meeker. "Chapter 4. Graphs, Matrices, and Structural Balance," in Mathematical Sociology. Englewood Cliffs, N.J.: Prentice-Hall, 1975.

## 5. Cognition and Social Structure

D31. Coxon, A.P.M. "Perspectives on Social Networks," in P.W. Holland and S. Leinhardt, eds., Perspectives on Social Network Research. New York: Academic Press, 1979.

D32. Bernard, H.R., and P.D. Killworth. "Informant Accuracy in Social Network Data, II," Human Communications Research, 1977, 4: 3-18.

## E. Applications

Finally, a wide range of applications of networks ideas to specific problems have been attempted. These attempts have met with varying success, but in every case they have raised important new questions. I have divided them into three broad areas and suggested readings in several sub-areas in each category.

## 1. Structure of Groups and Organizations

## a) Organizational Behavior

E33. Mackenzie, K.D. Organizational Structures. Arlington Heights, Illinois: AHM, 1978.

## b) Interorganizational Structure

E34. Turk, H. "Interorganizational Networks in Urban Society: Initial Perspectives and Comparative Research," American Sociological Review, 1970, 35: 1-19.

## c) Interlocking Corporate Directorates

E35. Burt, R.S. "A Structural Theory of Interlocking Corporate Directorates," Social Networks, 1979, 1: 415-435.

## d) Community Power Structure

E36. Laumann, E.O. Bonds of Pluralism: The Form and Substance of Urban Social Networks. New York: Wiley Interscience, 1973.

## e) Intellectual Elite Structure

E37. Kadushin, C. The American Intellectual Elite. Boston: Little Brown, 1974.

## f) Science Structure

E38. Mullins, N.C., L.L. Hargens, P.K. Hecht, and E.K. Kick. "The Group Structure of Cocitation Clusters: A Comparative Analysis," American Sociological Review, 1977, 42: 552-562.

## g) Academic Structure

E39. Hunter, J.E., and R.L. Shotland. "Treating Data Collected by the 'Small World' as a Markov Process," Social Forces, 1974, 52: 321-332.

## h) International Structure

E40. Erickson, B.H. "International Networks: The Structured Webs of Diplomacy and Trade," Sage Professional Papers in International Studies, No. 02-036, 1975.

## 1) Informal Group Structure

E41. Coombs, G. "Networks and Exchange: The Role of Social Relationships in a Small Voluntary Association," Journal of Anthropological Research, 1973, 29: 96-112.

## 2. Information Flow

## a) Structure and Flow

E42. Rogers, E.M. "Network Analysis of the Diffusion of Innovations," in P.W. Holland and S. Leinhardt, eds., Perspectives on Social Network Research. New York: Academic Press, 1979.

## b) Distance and Flow

E43. Morrill, R.L., and F.R. Pitts. "Marriage Migration and the Mean Information Field: A Study in Uniqueness and Generality," Annals of the Association of American Geographers, 1967, 57(2): 401-422.

## c) Flow Among Organizations

E44. Czepiel, J.A. "Word-of-Mouth Processes in the Diffusion of a Major Technological Innovation," Journal of Marketing Research, 1974, Vol. II, 172-180.

## d) Flow Between Social Categories

E45. Freeman, L.C., and M.H. Sunshine. "Race and Intra-Urban Migration," Demography, 1976, 13: 571-575.

## e) Flow in Informal Structures

E46. Granovetter, M. Getting a Job: A Study of Contacts and Careers. Cambridge, Mass.: Harvard University Press, 1974.

## 3. Ego-centered Support Systems

## a) Mental Health

E47. Pattison, E.M. "Psychosocial System Therapy," in R.G. Hirschowitz and B. Levy, eds., The Changing Mental Health Scene. New York: Spectrum, 1976.

## b) Family

E48. Family and Social Network, 2nd ed. New York: Free Press, 1971.

This, then, is at least one person's view of a starting bibliography for people interested in the study of social networks. I've tried to keep it short enough so that it won't scare people away. That means, of course, that I've neglected a lot of really important network materials. Most of the readings listed here, however, are fairly recent. Each contains its own citations, and a beginner who is really turned on can go on more or less forever from this start. I hope it will be helpful in opening up a new approach to social science for people who haven't been previously exposed to network thinking.

## Appendix: Resources in Mathematics

A good general text to consult in case of problems with formal statements is:

Kim, K.H., and F.W. Roush. Mathematics for Social Scientists. New York: Elsevier, 1980.

Or, if the treatment there is not extensive enough, the reader might want to choose from among the following selection of specialized texts:

## a) In graph theory

Harary, F., R.Z. Norman, and D. Cartwright. Structural Models: An Introduction to the Theory of Directed Graphs. New York: John Wiley & Sons, 1965.

## b) In probability theory

Feller, W. An Introduction to Probability Theory and its Applications (3rd ed.). New York: John Wiley & Sons, Inc., 1968.

## c) In linear and abstract algebra

MacLane, S. and G. Birkhoff. Algebra. New York: Macmillan, 1967.

Clifford, A., and G. Preston. The Algebraic Theory of Semigroups. Providence: American Mathematical Society, Vol. I, 1961; Vol. II, 1967.