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Social Networks

During the last decade or so, many social scientists have begun to write about social networks. The network idea has been invoked to explain the behavior of married couples in Britain, attendance at working parties in Tanzania, alignments in quarrels, success in elections, and many other diverse social phenomena. The presence of social networks has been hailed as a necessary ingredient in any cohesive society, while beyond the bounds of social science networks have been used, for instance, to analyze transportation systems, recognize well-formed sentences, and design kettles. There seems to be no limit to the problems that can be tackled with the help of networks, and it is tempting to think that some new analytical panacea has been discovered. But the very heterogeneity of applications should make us cautious. Perhaps "networks" is just another fashionable word. It sounds smart for a few years but like many other trendy terms means all things to all men, and will drop out of use when fashions change. There is no doubt that many of the references to networks in the literature of social anthropology and related disciplines are determined by fashion; the message could often be stated more clearly and simply using more humdrum words. Commenting on a recent article, Bott says that network means "virtually any kind of social entity" (1971, p. 319). Yet there are other instances where the concept of social network is really put to work. These are the examples I shall try to seek out and discuss.

The first distinction to make is between the metaphorical use of the network idea and its use as a precisely defined analytic concept. The metaphorical use is well established. Radcliffe-Brown wrote in 1940, of the aboriginal inhabitants of a part of Australia, that "direct observation does reveal to us that these human beings are connected by a complex network of social relations. I use the term 'social structure' to denote this network of actually existing relations" (p. 2). He was certainly not the first to use the term "network" in this way, but like many writers before and after, the term remained for him a metaphor; he never sought to define it precisely, to measure it, or to discuss its properties apart from those of the social structure it constituted. Likewise Fortes refers metaphorically to *The Web of Kinship* (1949) and Bendix, translating Simmel, to *The Web of Group Affiliations* (1955). Southall (1961) describes the parish chief of Kisenyi and his headmen as pivots or focal points of dense networks of relationships. The idea behind those metaphors is simple. Every individual in society is seen as

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A NOTE ON ADDISON-WESLEY MODULAR PUBLICATIONS

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linked to several others by social bonds that partly reinforce and partly conflict with one another; the orderliness, or disorderliness, of social life results from the constraints these bonds impose on the actions of individuals.

The same idea lies behind the use of the social network as a tool of analysis. Some anthropologists have argued that the notion of social network is useful only as a general metaphor (Firth et al., 1969, pp. 289-291). Others, instead of merely accepting the existence of a social network as a datum, have defined precisely which individuals belong to a network and have classified the kinds of social bonds that exist between them. More important, several anthropologists and sociologists have tried to sort out the patterns formed by social bonds and to discover what causal connections there may be between the various patterns and the behavior and sentiments of the individuals enmeshed by them. In other words, these writers distinguish between one network and another, and use network parameters as variables in analysis and explanation of other social phenomena. There is a rough rule of thumb to distinguish the metaphorical from the analytic usage: "the network of social relations" is usually a metaphor, while most analytic writers refer to "the social network."

Nevertheless there is no such thing as a theory of social networks; perhaps there never will be. The basic idea behind both the metaphorical and the analytic uses of social networks—that the configuration of cross-cutting interpersonal bonds is in some unspecified way causally connected with the actions of these persons and with the social institutions of their society—this remains a basic idea and nothing more. It constitutes what Homans calls an "orienting statement" (1967, p. 17) rather than a theory with propositions that can be tested. Only when we postulate a specific form of connection between individuals, institutions, behavior, and networks can we generate testable propositions. Some writers on networks have done this, but they have not all postulated the same kinds of connection, for the concept of network can be used with diverse theories of society. As Bott says, "There is nothing revolutionary about the idea of social network. It is the sort of concept that can be used in many conceptual frames of reference" (1971, p. 330).

Some investigators have been content merely to describe properties of social networks without grinding any particular theoretical axe. We still know very little about networks, particularly about their large-scale characteristics, and some ex-

ploratory ethnography can usefully precede the formulation of testable theoretical propositions.

Hence this exposition cannot present a coherent theory. Instead we shall look at a variety of applications of the notion of social network to see what has been learned and to suggest where further inquiry might be feasible and worthwhile.

Because the concept of network has so many diverse applications, it has been developed in diverse ways, with conflicting usages of technical terms. Because the concept has recently become fashionable, the terminological confusion has greatly increased. The terminological jungle, in which any newcomer may plant a tree, is evidence for the basic simplicity of the idea of a network. Though the word "network" may not be used, the notion may be present as a folk concept and need not be only a construct of the analyst. For example, Rees's Welsh informants told him that because of intermarriage they were woven together like a pig's entrails, and that a neighboring valley was like a dog—if you tread on its tail at one end of the valley, it will bark at the other end (Rees, 1950, pp. 75, 80). The two fundamental properties of networks, multiple interconnections and chain reactions, are clearly indicated.

As scholarly terms pig's entrails and dogs might be misunderstood. To write clearly about network studies in general terms we have to adopt some definite metatheoretical stance and technical vocabulary despite the lack of consensus among practitioners. The orientation adopted here is derived from Radcliffe-Brown, as quoted above; the social network is seen essentially as a network in which all members of a society, or some part of a society, are enmeshed. We will therefore look at the various studies to see how what for Radcliffe-Brown was merely a metaphor has been transformed into an operationally defined concept. A distinctive feature of the use of this concept we take from Bott, one of the first social anthropologists to use the idea of network as more than a metaphor. She says, "My aim was (and still is) to understand how the internal functioning of a group is affected not only by its relationship with the people and organizations of its environment, but also by the relationships among those people and organizations" (Bott, 1971, p. 249). The first part of her aim could be achieved perfectly well without the use of the idea of a network, though in fact some of the studies which purport to be about social networks are concerned with only this, as we shall see. It is the second part of her aim—to discover how A, who is in touch with B and C,

is affected by the relation between B and C—that demands the use of the network concept. As Nadel says, defending his use of the term "network," "I do not merely wish to indicate the 'links' between persons; this is adequately done by the word relationship. Rather, I wish to indicate the further linkage of the links themselves and the important consequence that, what happens so-to-speak between one pair of 'knots', must affect what happens between other adjacent ones" (1957, p. 16).

By following Nadel and Bott, we can distinguish those so-called network studies where only the effect on A of his links to B, C, D, etc., is considered. Although these could have been made without reference to networks, we can see them as taking the first step toward a fuller network analysis. By following Radcliffe-Brown, and thus taking a sociocentric or structuralist position, we run into more serious trouble. Many writers have referred to "the personal network" or "the ego-centered network," and several of those who have done most toward developing the concept of network as an analytic tool rather than as a metaphor have concentrated their attention on the viewpoint of a selected actor who has social contacts. Thus for example Mitchell, whose writings have inspired much fieldwork on networks, argues that in an empirical investigation a network must be traced from some initial starting point or point of anchorage, usually an individual whose behavior the observer wishes to interpret (1971, p. 13). This he calls a "personal network." Bott has marshaled an impressive list of writers who define a network as all or some of the social units (individuals and groups) with whom a particular individual or group is in contact (1971, p. 320). It is certainly true that, except in very small social systems, it is quite impractical for an investigator to observe or infer more than a small fraction of all the social links present between members of a society or delimited social region; usually all he can do is select a handful of informants and discover who their contacts are. Nevertheless the sociocentric viewpoint of Radcliffe-Brown has its merits, particularly in the present context, where we are concerned with a wide variety of inquiries made from divergent theoretical standpoints. For the social network, in Radcliffe-Brown's sense, involving all members of a society, exists independently of any investigator. Although it may remain largely unknown, we cannot assume that the effect of the network on its members is mediated only through those links the investigator

is fortunate enough to uncover. A social network may sometimes have one or more members who are, in some sense, central; this is the case, for instance, when we describe someone as at the center of a web of intrigue, or as a kingpin in the organization. But the ego-centrality of the "network" formed by an informant and his direct contacts is usually an artifact of the investigation, even though it may be an illusion shared by the informant. Only if the informant happens to be in fact a socially central person is there sociological significance to the ego-centrality of "his" network. Nevertheless any informant, however socially marginal he may be, plus his links to his direct contacts, constitutes a recognizable portion of the wider social network and we shall introduce terms for such portions. The special case presented by ego-centered kindreds will be discussed in the section on networks and kinship.

We need a scheme for sorting out the various studies that apply the idea of networks. Our first criterion is simply size, the number of units in the network. If the network is very small, the kinds of analysis that are practical differ radically from those possible in larger networks. The next two criteria refer to two special features of network analysis. One is that suggested by Bott, whether attention is paid to the effect on A of the relation between B and C. The other is whether the study concerned deals with indirect contacts, with "the friends of friends" or similar categories of people. Finally, we distinguish those studies that elucidate properties of a network as a whole rather than properties of its individual members. In other words, our taxonomy of studies is based on network morphology rather than on the kinds of social bonds that constitute the links in the various networks (see Mitchell, 1971, pp. 11-12). We shall go on to discuss the criteria that can be applied to links, how the dimension of time enters the studies, and how data can be collected.

Most of the studies deal with partial networks. The social network, as Radcliffe-Brown conceived it, is usually referred to as a total network, and contains all the social bonds between the constituent individuals, in contrast to partial networks, which contain only social links of some specified kind. Thus if we consider only those links that arise through employment, or that run between kinsfolk, or that bind fellow members of secret societies or political parties, then we have a partial network. For some purposes it may be adequate to treat the links of a given partial network in isolation from all other links. For instance, it

may be possible to give a satisfactory analysis of a series of marriage transactions by considering only the kin links between the actors and ignoring any relations between them arising out of common employment or divergent political affiliation. Likewise a vast amount of the literature on industrial sociology is based on the assumption that social relations arising outside the place of work have only negligible effect on the pattern of relations inside the factory or office. How appropriate these assumptions are can, of course, be determined only by empirical inquiry.

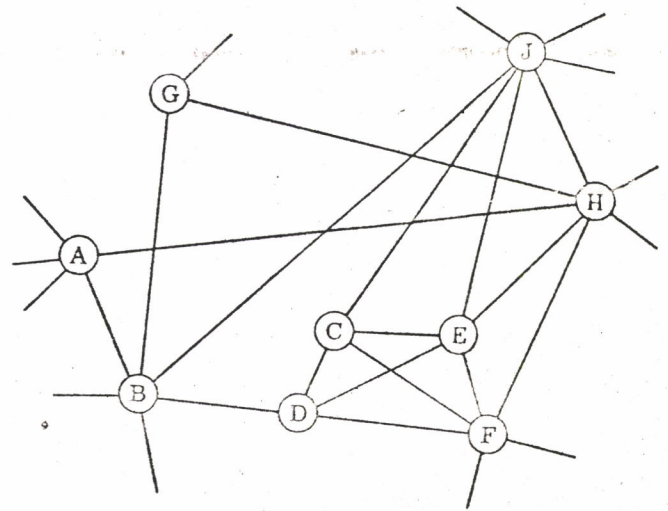
The growth of interest in networks among anthropologists has sometimes been attributed to dissatisfaction with a mode of analysis based on structures or groups (Mitchell, 1971, pp. 8-10; Mitchell, in press). Whether or not this is true, it should be clear that networks and groups are not opposed homologous categories. Blau and Scott put the point clearly when they write, "a busload of club members on a Sunday outing is a group, because a network of social relations links the members into a social structure, a structure which is an emergent characteristic of the collectivity that cannot be reduced to the attributes of its individual members. In short, a network of social relations transforms an aggregate of individuals into a group (or an aggregate of groups into a large social structure) . . ." (1962, p. 3). Yet although within any group there is always a network of relations, not all the portions of a social network are necessarily subsumed in the internal organization of groups. Indeed, the attraction of the idea of a social network has been that it provides a way of also looking at those parts of social life where groups do not always form, for example where individuals make use of ties of cognatic kinship or establish idiosyncratic links with others as friends or neighbors (Barnes, 1954, p. 43). Nevertheless the concept of a social network is in no sense restricted to idiosyncratic, egalitarian, noninstitutionalized social bonds. For example, in a study of a crisis following the death of a baby, Boswell uses a network containing institutionalized hierarchical links between a social welfare officer and a hospital administration, links between individuals as fellow members of a religious organization, and links deriving from common tribal membership, as well as idiosyncratic relations with friends and with a politician. He considers all these links in his analysis of how the crisis was resolved (Boswell, 1971, pp. 259-268). The contrast is not between networks and organized groups, as Benu suggests, but between

those social bonds that relate an individual to a group and those that do not. Both types of bond operate simultaneously on an individual, and while for some purposes they may be considered in isolation, the notion of a network provides a way of handling them either separately or together (Befu, 1963; see also Boissevain, 1968; Wolfe, 1970, pp. 228-229). One important part of network analysis is the identification of clusters and cliques and the study of how these may transform themselves into organized groups.

So far we have mainly talked about the social network as if it was made up of social links between individuals. Most of the examples of networks found in the literature of social science are indeed of this kind. But there is nothing to stop us from extending the idea to include units other than individuals. For instance, some nations are represented diplomatically at the capitals of some other nations; looking at the world as a whole, we see a diplomatic social network in which the units are sovereign states and the links are of various kinds—embassies, consulates—general, and the like. Bott has always stressed that the units in a network need not necessarily be individuals, and we will consider later her use of married couples as network units.

The name "network" suggests some kind of visual representation. The usual convention is to represent the units of a network, whether individuals or groups, by points, and the relations between them by lines. If a diagram is drawn on paper, some of the lines may cross one another, though in three dimensions this need not happen (Figs. 1a and 2a). The same diagrammatic convention is used in the branch of mathematical topology known as graph theory, and social networks may be treated as one kind of realization of topological graphs. A few simple notions taken from graph theory have proved useful in the analysis of social networks, but at present the supply of mathematical tools available far outstrips the supply of social data to which the tools might be applied. Hence some discussions of social networks are exercises in mathematics that contribute nothing whatsoever to social understanding. Graph theory has little to do with ordinary graphs drawn on squared paper showing how two variables are related. It is, of course, a "theory" only in mathematics; it is a set of logically interconnected tautologies and in no sense supplies us with a theory of social relations.

Another kind of representation is an adjacency matrix, with each unit in the network corresponding



(a)

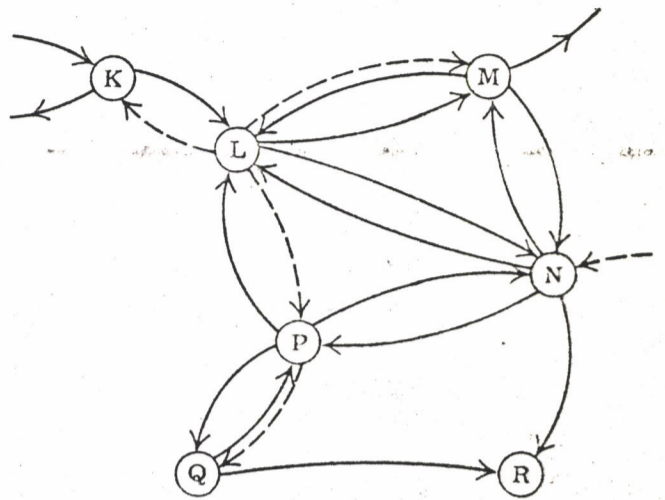
| | A | B | C | D | E | F | G | H | J | Z | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A | - | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | A |
| B | | - | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | B |
| C | | | - | 1 | 1 | 1 | 0 | 0 | 1 | 0 | C |
| D | | | | - | 1 | 1 | 0 | 0 | 0 | 0 | D |
| E | | | | | - | 1 | 0 | 1 | 1 | 0 | E |
| F | | | | | | - | 0 | 1 | 0 | 1 | F |
| G | | | | | | | - | 1 | 0 | 1 | G |
| H | | | | | | | | - | 1 | 1 | H |
| J | | | | | | | | | - | 1 | J |

(b)

FIG. 1
Portion of a typical partial network with symmetric relations (for example, informal visiting) shown as (a) an undirected graph and as (b) a symmetric matrix (only half shown). In the matrix, cells of value 1 indicate the presence of the relation, and those of value 0 its absence. Entries in column Z indicate the presence or absence of relations with unidentified units.

FIG. 2

Portion of a typical partial network with asymmetric relations (for example, being a creditor) and non-symmetric relations (for example, providing labor assistance) shown as (a) a valued directed graph and as (b) a square matrix. In the graph, dashed lines link creditors to their debtors, and continuous lines link those who provide assistance to those who receive it. In the cells of the matrix, the first digit indicates the presence (1) or absence (0) of the creditor relation from the row-unit to the column-unit; the second digit indicates the presence or absence of the assistance-providing relation. As in Fig. 1, Z refers to unidentified units.



(a)

| | | To | | | | | | | |
|------|---|----|----|----|----|----|----|----|----|
| | | K | L | M | N | P | Q | R | Z |
| From | K | - | 01 | 00 | 00 | 00 | 00 | 00 | 01 |
| | L | 10 | - | 11 | 01 | 10 | 00 | 00 | 00 |
| | M | 00 | 01 | - | 01 | 00 | 00 | 00 | 01 |
| | N | 00 | 01 | 01 | - | 01 | 00 | 01 | 00 |
| | P | 00 | 01 | 00 | 01 | - | 11 | 00 | 00 |
| | Q | 00 | 00 | 00 | 00 | 01 | - | 01 | 00 |
| | R | 00 | 00 | 00 | 00 | 00 | 00 | - | 00 |
| | Z | 01 | 00 | 00 | 10 | 00 | 00 | 00 | - |

(b)

to a row and a column in the matrix, and each link between units corresponding to the cell lying at the intersection of the appropriate row and column (Figs. 1b and 2b). This representation facilitates data-recording in the field and also, provided that the cells have acceptable values, enables the operations of matrix algebra to be performed on the data. A third form of representation, using simplicial complexes, has also been suggested, and doubtless others are on the way; but as with graphs and matrices, these sophisticated mathematical tools serve mainly to emphasize the homespun quality of most of the social data available (see Atkin, Johnson, and Mancini, 1971).

We distinguish between the relation of A to B and the relation of B to A, and we also distinguish various kinds of relation. Some relations (for example, of fellow clansman, or blood brother) are said to be symmetric, meaning that if A stands in a relation of this kind to B, then B necessarily stands in the same relation to A. Other relations are nonsymmetric, so that in general the relation of A to B will not be the same as the relation of B to A. For example, if A is the father, employer, and patron of B, the relation of B to A will be one of child, employee, and client. Hence on a graph or matrix showing this, we must distinguish between these two distinct relations. In a graph we

use a line oriented or directed from A to B for one relation and a line oriented from B to A for the other. In a matrix the cell at the intersection of row A and column B is used for one relation and the cell at the intersection of row B and column A for the other. If we happen to be interested only in a symmetrical relation, say of neighborliness, we can use an undirected line joining A and B to indicate that they are neighbors. Switching from directed to undirected graphs simplifies mathematical handling. The theory of digraphs (directed graphs) is more interesting mathematically, but social scientists have sometimes applied it unnecessarily in contexts where the duller but simpler theory of undirected graphs would be adequate. A total network of social relations can be represented only by a digraph. Some partial networks, for example a network of debtor-creditor relations, require digraph representation. Other partial networks, for example those of relations of reciprocated friendship or neighborliness, can be shown as undirected graphs (Harary and Norman, 1953; Harary, 1969). If matrices are used, symmetrical relations can be shown using the cells on only one side of the main diagonal. Relations of friendship are often treated in analysis as symmetric, particularly if only one of the partners has been interviewed, though common experience shows that assertions of friendship are not always reciprocated (see Mitchell, 1971, pp. 24-26).

SOME STUDIES OF NETWORKS

The significance of size. There seem to be three size ranges of networks, each range characterized by a distinctive style of analysis. If the network has very few members, an observer may be able to observe the relations or lack of relation, between each member and every other member. He can then discuss the network as a whole. Most studies of this kind concern networks with five members; perhaps ten members would be the upper limit. With the addition of each new member the number of potential links increases by an amount equal to twice the previous number of members. Thus with twenty members there are 380 potential links to be observed. With a network of this size it may still be possible to select a few links for close scrutiny and to make reasonably confident statements about the characteristics of some others, particularly if it can be assumed that many

potential links are absent. But the methods appropriate to very small networks cannot be applied. Kapferer has published (1971) an analysis of a network containing 23 members, with studies of somewhat larger networks to follow (in press). Perhaps the practical limit for this sort of analysis is about 40 members, though if the observer's interest is restricted to a narrowly defined partial network it is possible to study larger networks. Sociograms, a particular kind of partial network typically indicating restricted choices made by each member from among his fellow members, can be studied as wholes even when they contain several hundred members, while Gulliver's work on kin sets among the Ndendeuli appears to offer possibilities for the study of an action-based kin network with about 80 members (Coleman and MacRae, 1960; Abelson, 1967; Gulliver, 1971, pp. 278-283). With networks that are larger still, the style of analysis changes again. With 100 members, there are 9900 potential relations to be recorded, and unless the restrictions on actual relations are very severe, it becomes quite impossible to describe the network link by link, even with the help of questionnaires. Three types of inquiry are then feasible. The observer can confine his attention to a small portion of the network containing only a few members and ignore the effects produced by or on all other members; in effect he is then studying a small or medium-sized network. Second, he can investigate various linear properties of the network, in particular the characteristics of paths connecting members who are not in direct contact with one another; even in a network with millions of members, the paths between them may be, on average, quite short. Finally, he can take a sample of the members and/or links in the network and hope to infer the characteristics of the network as a whole.

Small networks. If a social network always contains all the members of a society, or all the members of a social category within it, how can we speak of a network with only five members? Yet, within the confines of a laboratory the experimenter strives to create a short-lived artificial society with a handful of members whose social bonds with the real world can be ignored for the purposes of the experiment. Homans quite properly reminds us that "the laws of human behavior are not repealed when a man leaves the field and enters the laboratory" (1961, p. 15). We can well argue that the social characteristics of artificially small societies are not necessarily found unaltered in the

real world. Nevertheless the results of experiments on small networks are valuable pointers to potentially interesting areas of inquiry in larger and more enduring social environments. Following the pioneering work of Bavelas, interest among experimenters has focused on the effect of differences in the possible channels of communication on the performance of the group and on the emergence of stratification and a division of labor between its members. Three patterns of communication are distinguished. In the All-Channel state, each member can communicate, usually by sending written messages, with every other member. When arranged in a Circle, each can send messages only to those on either side of him. In the Wheel formation, one specified member can communicate with all the others but they can each communicate only with him. In performing certain simple collective tasks, Wheel groups are fastest, and Circle groups slowest. The differences in performance might appear to be caused by the different communication possibilities available to the members. But further research suggests that once a group that has worked together for a while adopts a stable pattern of exchanging information, its level of performance will rise and will be largely independent of the communication pattern available to it. A group that begins working with an inefficient network (Circle or All-Channel) will perform less well in a more efficient network (All-Channel or Wheel) than will a group that has worked continuously in a more efficient network; likewise previous experience in a more efficient network leads to better performance in a less efficient network. Early experimenters stressed the improvement in performances among Circle groups when those developed a three-level hierarchy. If the members are placed in a circle running through A, B, C, D, and E back to A, then A passes information to B, and E to D; B and D each pass their augmented information to C, who then solves the problem. This finding, together with the demonstrated superiority of the Wheel formation over the other two forms, suggested that hierarchical forms of organization were intrinsically more efficient, and that democratic egalitarian procedures were inappropriate for decision-making. Fortunately for democracy, Leavitt and Knight (1963) were able to point out that the apparent advantages of hierarchy arose because most of the experiments had been carried out on networks with five members, an odd number; with an even number of members democratic methods of problem-solving are better. This comment well illustrates the hazards

of extrapolating the results of laboratory experiments to real life (Cohen et al., 1962; Blau and Scott, 1962, pp. 124-128; Leavitt and Knight, 1963; Collins and Guetzkow, 1964). The tasks set in these experiments are necessarily closer to those encountered in party games than to real-life problems; even so, Circle groups do better than Wheels at some tasks (Mulder, 1960). These experiments also show that, although the artificial society created in a laboratory may persist only for a couple of hours or so, temporal processes occur and present performance is affected by past experience. Billiard-ball sociology, in which individuals "are visualized as devoid of biography and therefore of social experience," does not work for long even in the laboratory (Fortes, 1957, p. 160).

First-order contacts. With more than ten members in a network, the style of analysis changes, and so does the kind of network available for study. At the present time, in some sense, there is only one total network in the world. Everyone is indirectly linked to everyone else. It would be impossibly difficult, in explaining any one person's behavior, to take into account all the indirect influences on him that may be mediated by interpersonal and intergroup bonds from the far ends of the earth. Luckily, in analysis we can usually narrow our range of interest to something manageable. Yet even in isolated groups of hunters and gatherers the number of individuals who significantly interact, directly or indirectly, with one another is greater than ten, and there are very few real-life situations where we can use the style of inquiry developed in the laboratory with very small networks.

With larger networks, whether medium-sized or really large, we can begin our analysis by selecting an individual and identifying the other members with whom he is linked directly, his first-order contacts. We then examine the social bonds between him and these contacts. The portion of the network we look at in this simple kind of analysis is here called the individual's first-order star (see Figs. 3 and 4). We look for some connection between the links in the star and the actions, decisions, beliefs, or status of the individual at its center, and can repeat the process for other members of the network. Many of the references to network analysis in the literature of anthropology and sociology refer simply to this process and nothing more. For example Southall, referred to above, calls his 1961 article "Kinship, Friendship, and the Network of Relations . . ." but he is mainly

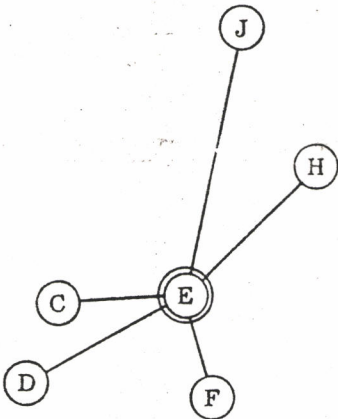


FIG. 3
First-order star of unit E of Fig. 1.

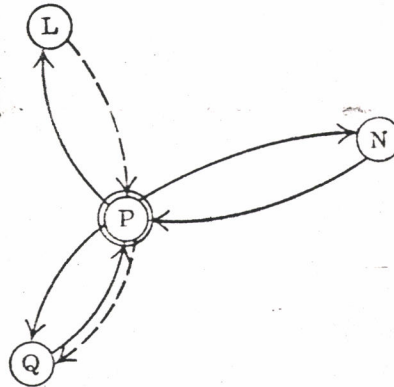


FIG. 4
First-order star of unit P of Fig. 2.

concerned with the characteristics of the social bonds between each of his selected informants and their best friends; he did not investigate whether informants shared friends, or whether two friends of the same informant were friendly with one another, or hated one another, or whatever. Analysis of this kind may yield interesting results, but do not depend on the concept of a social network, at least not as Bott and Nadel see it. In fact, many investigators have analyzed first-order stars without mentioning networks. Henry, for instance, discusses the characteristics of first-order stars in various kinds of society under the name "personal community" (1958). He shows that the American child has comparatively few first-order contacts and is comparatively highly involved with them, whereas in Latin America the *compadrazgo* relation secures constant involvement with contacts outside the child's family. In any social situation, some individuals are likely to have significantly more direct contacts than others. Wheeldon classifies the individuals in the situation she studied according to the range of their first-order stars, a measure depending on the number of contacts and their social heterogeneity (1971, pp. 132-135; Mitchell, 1971, pp. 19-20).

Paths. From the study of first-order stars we can proceed toward a full network analysis in two ways. Either we next look at the relations between any given individual's first-order contacts, as Bott advocates; or else we can move on from first-order to higher-order contacts and examine the indirect relations between a given individual and those people he can reach only through inter-

mediaries. The second route is the simpler to follow and we shall discuss it in this section. In a large network an individual is likely to have many more second-order than first-order contacts; hence, the lack of studies of the characteristics of all an individual's second-order contacts is not surprising. We do have studies of how an individual sets about influencing, or even establishing direct contact with, some of the people he cannot initially reach directly. Thus, for instance, Lee (1969) studied how information about illegal activities was transmitted. She asked a sample of women who had had an abortion how they had made contact with an abortionist. Unmarried women made contact via current lovers or girl friends, usually friends who themselves had had an abortion. Married women talked to husbands and girl friends, and some women discussed matters with a doctor. Lee's study is particularly interesting because of the significant patterning of the first-order contacts that the women did not approach. There was no flow of information across authority lines; women did not approach their employers or employees, teachers or pupils. They also avoided talking about abortion possibilities to people they did not know well. They usually did not talk to kin in ascending or descending generations, but where information about abortion did cross generation lines, it was from a mother to her daughter. Lee's work shows that the decision not to activate a link in a given context may be as interesting sociologically as a positive decision.

In Lee's work it seems that most or all of the women seeking abortions had to make use of only one intermediary; she estimates that about 45

percent of American adults know of one or more cases of abortion among their acquaintances. The same method of inquiry can be extended to the study of longer paths between individuals. Two very different studies show the possibilities. In one, the aim is to study paths that start with selected individuals and converge on a single distant target; in the other, the paths all start from a single source and diverge widely. Milgram and his collaborators made the first kind of study in connection with what they call "the small world problem." Their object was to send written messages across the United States by passing them between individuals who were previously acquainted with one another personally. Participants who did not know their target were asked to pass the message on to an acquaintance who would be more likely to know him. In one experiment a Boston stockbroker was selected as target and three samples of 100 individuals each were chosen in Nebraska and Boston to start the messages. Twenty-nine percent reached the target. The mean number of intermediaries was 5.2. Eighty-six percent of the links in the completed paths were between friends and acquaintances, and only 14 percent between kin. In a second experiment, 540 paths starting from volunteer whites living in Los Angeles were aimed at 18 selected targets in New York, 9 white and 9 black. Thirty-three percent of the white-white paths were completed, with a mean length of 5.5 intermediaries, whereas only 13 percent of the white-black paths reached their targets, with a mean length of 5.9. Milgram and his collaborator were particularly interested in seeing how the white-black paths crossed the color line, and postulated the existence of a category of person they call "gatekeepers." These, both white and black, are males mainly of professional status, with a few managers, officials, clerks, and sales personnel. More successful gatekeepers were linked to their black contacts by impersonal professional ties than by relations of friendship. The target person usually occupied a lower social status than the last intermediary, and most of the successful paths leading to black targets crossed the color line only one or two links before reaching the target. It seems that these messages travel more easily in higher social strata (Milgram, 1969; Travers and Milgram, 1969; Korte and Milgram, 1970).

The situation studied by Adrian Mayer was the opposite of the "small world" experiments. He examined how a politician tried to secure votes for himself in an election by mobilizing the support

of as many as possible of his first-order contacts, who in turn sought maximum support from their contacts, and so on until as many voters as possible had been reached. Mayer shows how a wide variety of social bonds—kinship, religion, common political allegiance, economic ties, membership in a wrestling group—were invoked, and how obligations were accepted in return for promises of electoral support. He is mainly concerned with how a politician can maximize his expectation of support at minimum cost, but he also notes that many paths of interaction tended to converge on that part of the electorate whose votes were critical for the outcome of the election. He suggests that the strongest candidate will be the one in whose interests the maximum number of lateral linkages are activated. By this, Mayer refers to links converging on intermediaries, since "intermediaries who might find a single inducement inadequate for their support are fortified by a second incentive coming to them laterally" (1966, p. 112). Here, he is looking not just at the length and constitution of the various paths but at how the paths are related to one another, an essential component of network analysis.

A third study of paths, using sophisticated mathematical techniques of analysis, was carried out by Coleman and others on the acceptance of new drugs by a community of doctors. They found that doctors usually took the decision to switch to the use of a new drug because of some interpersonal relation. In the first stage, these relations were mainly those of medical advisors or discussion partners. Later, other doctors adopted the drug because their doctor friends had already done so. After six months, the network of social relations among the doctors seemed to have no effect on whether a doctor switched or not (Coleman et al., 1966).

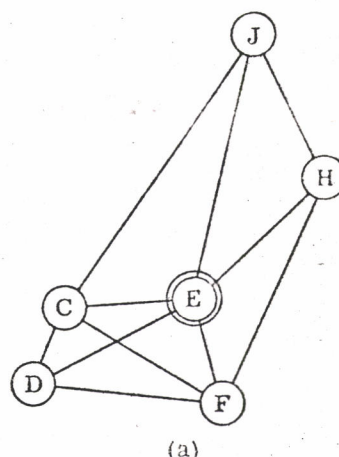
Coleman's study is concerned with changes in attitudes toward a new drug, and has many similarities, in aim if not in execution, with other studies of the transmission of rumors and the generation of social norms (for example, Back et al., 1950; Rapoport, 1963; Kerckhoff et al., 1965). In these situations, an individual may be influenced by many persons and he in turn may influence many others at little or no cost to himself. Milgram and Mayer, however, are concerned with decisions taken by individuals to activate one social link rather than another, in Mayer's case at significant cost. Hence a different kind of analysis is called for. Mayer has introduced the notion of "action-set" to refer to that set of links that is

activated for a particular purpose, and he argues than an action-set that is continually reactivated begins to take on some of the characteristics of a group. He suggests "quasi-group" as a term to refer to a set of individuals who tend to belong to the same action-sets, but the utility of this concept has been challenged (Harries-Jones, 1971, pp. 301, 342-347; Boissevain, 1971). The individuals in Mayer's action-set were connected sequentially by a train of transactions, but they seem not to have acted together. Thus they differ from individuals who are recruited by the mobilization of dyadic relations and who then, for a longer or shorter time, act in concert. For example, boat crews in the Faroe Islands are recruited by relations of "kith" between individuals; a man who is already a crew member recruits his brother, brother-in-law, or nephew, so that although each member of the crew is "kith" to at least one other, not all members are "kith" to all the others (Blehr, 1963).

An important aspect of Mayer's work is that the focus of his analysis is a prominent politician and not an individual chosen at random, or selected as typical. The politician initiated the action that followed, and Mayer had no difficulty in determining where it started. Here we have an instance where the center of analysis happens also to be a center of action in the real world. But there is the same danger here with action-sets that there is with networks themselves, as mentioned earlier. In viewing an individual as involved in many diverse action-sets, we have to keep clear whether the apparently central position he appears to enjoy is merely a product of the analysis, of the accident that it is he and not his neighbor who has appeared under our microscope, or whether he is a central figure in the real world.

Zones. In looking at the way paths converge and diverge, as with Mayer's lateral linkages, we begin to make use of the specific properties of the network idea, the relations between social bonds, and the effect of social bonds on individuals other than the pairs they link. But while the examination of paths is one route to the study of networks as multidimensional entities, as it were, most investigators have tackled this possibility by another route. They have concentrated on very short paths, and on severely delimited portions of the network.

When talking earlier about the links between an individual and his direct contacts we used the term "star," a technical term implying that we



(a)

| E | C | D | F | H | J | |
|---|---|---|---|---|---|---|
| - | 1 | 1 | 1 | 1 | 1 | E |
| | - | 1 | 1 | 0 | 1 | C |
| | | - | 1 | 0 | 0 | D |
| | | | - | 1 | 0 | F |
| | | | | - | 1 | H |
| | | | | | - | J |

(b)

FIG. 5 First-order zone of unit E of Fig. 1, shown as (a) an undirected graph and as (b) an adjacency matrix. The density of this zone is 11/15, or 73 percent.

were not concerned with any relations there might be between these contacts. We refer to any delimited portion of the network, containing any set of members and all the relations existing between them, as a zone. If we select any individual, then he and his direct contacts and all the relations that join them, including any there may be between his contacts, constitute his first-order zone (Barnes, 1971, pp. 58-60). This is what most writers refer to as a "personal network," or "ego-centered network"; some mean by "network" this and nothing more (see Figs. 5 and 6). As discussed in the first section, there are some advantages in restricting the term "network," either total or partial, to the wider entity, and for using a terminology that discriminates boundaries that exist in reality from those that are introduced in analysis for convenience. Furthermore, it is often not clear whether "personal network" refers to the first-order zone or only to the first-order star; sometimes it seems that only the links between contacts, and not those between them and the selected individual, are meant. These ambiguities

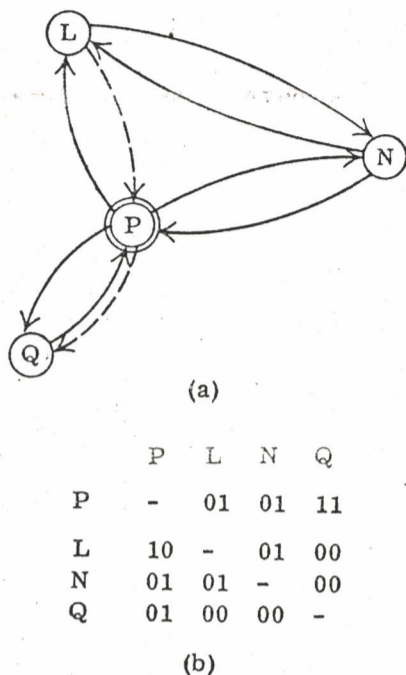


FIG. 6
First-order zone of unit P of Fig. 2, shown as (a) a valued directed graph and as (b) a square matrix. The same conventions apply as in Fig. 2. The density of the asymmetric creditor relations in the zone is $2/6$, or 33 percent. The density of the nonsymmetric assistance relations in the zone is $7/12$, or 58 percent.

do not matter so long as we remain in the world of metaphor, but as soon as we start to measure, we must be clear what we are measuring.

Kapferer, in a pioneering study, tries to clarify his meanings by introducing the term "reticulum" for "that part of a total network where network is defined egocentrically" (1971, p. 182). Unfortunately, one of the four measures of reticulum structure he introduces refers to the first-order zone, one to the first-order star, and the other two to the zone minus the star.

The simplest nontrivial zones contain only three members. The analysis of triads and tetrads, particularly those joined by relations of kinship, has been pursued by anthropologists ever since the discipline emerged. They were not the inventors of this form of inquiry; triangles have been eternal for a long time. Most of these analyses were made without reference to the idea of a social network. Radcliffe-Brown's work on the mother's-brother relationship and Lévi-Strauss' discussions of "atoms of kinship" are well-known

recent examples. It is important to realize that these studies form limiting cases of zonal analysis, and that concepts drawn from graph theory may be of help. The partial network formed by kin links between individuals lends itself particularly to triad and tetrad analysis, but other relations can be discussed in the same way. Nadel refers in general terms to the triadization of relationships (1957, pp. 86-88). Hammel (1968) has looked at relations of godparenthood in Yugoslavia in this light, and has shown the extent to which these relations may be conceived in terms of contracts between groups. Heider's notion of cognitive balance has been applied to the theory of graphs and, roughly speaking, provides a mathematical generalization of the fact that it is difficult to remain friendly with two people who hate one another (Heider, 1958; Harary, Norman, and Cartwright, 1965, Chapter 13). Balance theory has been used to discuss the conventional assignment of affection and authority in the mother's-brother relationship, and why only those old men and women who have lost authority over their children are indulgent toward their grandchildren. Yet Sweetser concludes that although the theory may apply in fluid nonhierarchical situations, it does not work with kinship structures differentiated along lines of respect and informality (Flament, 1963, pp. 125-126; Freilich, 1964; Sweetser, 1967). Davis (1970) has analyzed a large range of data on sociometric choices to see what types of relation-triad occur most frequently. The use of balance theory in network studies may be regarded as an effort to secure better analytic results from basic assumptions about stability and equilibrium. These notions have long outlived their usefulness in the analysis of social institutions and whole societies, but may still be useful when applied to configurations of social relations among individuals (see Reader, 1964, p. 20; Aronson, 1970, pp. 258-262; Taylor, 1970; Mitchell, 1971, p. 47).

The next stage of complexity is reached with the analysis of social relations involving a dozen people. There are some similarities with studies of very small networks, but the differences are significant. In real-life situations the pattern of social relations among the actors is unlikely to mirror accurately any of the Wheel, Circle, or All-Channel models. More important, the limits of the analysis are defined quite differently. By recruiting naive students (naive only in a certain sense, we hope) who are presumed not to be previously acquainted with one another, and by setting

them exotic, make-believe tasks, the experimenter hopes to create a setting where the social bonds that constrain his subjects in the real world can be entirely ignored. But in the study of real-life situations the actors carry with them their full complement of social roles, even though they may not use them all simultaneously. The remain bound to other persons in the network who are not present in the situation studied, and the investigator has to decide where to draw the limits of his inquiry and what allowance he must make in his analysis for actors offstage, outside the zone under examination, whom he cannot observe. These cautionary remarks apply equally to situational analysis, and indeed the study of small zones may be seen as a refinement of this mode of inquiry (see Van Velsen, 1964, 1967; Reader, 1964, pp. 26-28). Kapferer (1971) has produced the fullest analysis of a zone so far. He studied a dispute between two employees in an electro-zinc plant. Twenty-three men worked in the section of the plant where the dispute occurred. Kapferer shows how the principals in the dispute mobilized support among their fellow workers.

Much of what he has to say about the dispute is simply good situational analysis and could have been achieved without appeal to the idea of a network. Situational analysis is basically the detailed examination of extended case histories, and has produced many plausible accounts of the way in which actors in complex situations decide on one course of action rather than another; more than any other technique of analysis it has brought out the dynamic quality of ordinary social life. Yet the anthropologist or sociologist who produces a minute-by-minute account of a sequence of events involving 20 or 30 actors is very much like a historian. The reader may be impressed but cannot help thinking that some other analyst might have interpreted the same events quite differently and just as plausibly. Situational analysis does not lend itself to the formulation of testable propositions, whereas network analysis does.

By invoking the network concept and by looking systematically at all the relations between the 23 men connected with the dispute, Kapferer is able to assign measures to each man depending on certain properties of his first-order zone and on its relationship to the wider zone which embraces all 23 men. The range of each of the four measures is then dichotomized and each man is assigned to one or other of the 16 categories or structural types thus formed. Four of the 16 categories account for more than half of the men. Kapferer

then looks for regularities in the behavior of men in the same category, and for differences between men in different categories. The measures Kapferer uses may need improvement, but we cannot deny the importance of what he aims at.

Two of Kapferer's measures involve the contrast between multiplex and uniplex (or single-stranded) relations. This contrast is taken from Gluckman's work on Barotse courts in Northern Rhodesia, where he stresses that among the Lozi individuals are often joined in relations that serve a multiplicity of interests (1967, pp. 19-20). The contrast is made operational by Kapferer, who distinguishes several distinct exchange contents that may be present in any interpersonal relation: conversation, joking behavior, job assistance, personal service, and cash assistance. A relation is defined as multiplex if it includes two or more of these types of content. Kapferer calculates the proportion of multiplex links (treating them as symmetrical or undirected relations) in each person's star and first-order zone (minus the star).

His third measure is the density of an individual's first-order zone-minus-star. By density is meant simply the number of links (regardless of whether the relations they indicate are multiplex or single-stranded) actually existing between a set of members of the network, expressed as a proportion of the maximum possible number of links (Kephart, 1950; Barnes, 1971, pp. 61-64). Density may be calculated with reference to either director or undirected links. In many earlier studies, network density is referred to as connectedness, or connectivity or mesh; dense zones are said to be close-meshed, tightly knit, or highly connected, while sparse zones are open-meshed, loose knit, or loosely connected (Barnes, 1969).

Kapferer's fourth measure, to which he gives most emphasis, is span, the ratio of the number of links in the wider zone embracing all 23 men. Taking the four measures together, he describes the reticulums (first-order zones) of some men as relatively strong (that is, having measures above median value), and argues that this strength indicates that an individual has relatively high ability to exert influence over others in the network. He then uses those parameters to explain why one particular man should accuse another particular man of rate-busting, why that man should make a counteraccusation of witchcraft, and why the mobilization of support by both sides that followed the accusation should end in the isola-

tion of the rate-buster. This mode of analysis seems particularly suited to situations, like that examined by Kapferer, where the pattern of relations within a group is really cross-cutting, so that in any dispute almost everyone has some pull to both sides.

In the analysis of zones there is still a place for tracing out paths between individuals who are not directly connected. For instance, in a study of a voluntary association, Wheeldon shows how a chairman, following an accusation that he had been mismanaging the association's affairs, avoided a direct confrontation with his accusers. Instead he utilized paths through intermediaries to influence them to drop their charges against him; one path passed through three intermediaries (Wheeldon, 1971). Another study shows how a woman in the Caribbean put pressure on her neglected son in England via a neighbor whose son in England was loyal to her (Philpott, 1968). Reachability is a measure of the extent to which an individual can establish indirect contact with other members of a network. The number of steps in a path is said to be its length, and the distance of A from B is the length of the shortest path from A to B using only links in the network. A distance matrix shows, in each cell, the distance from one member to another in the network. A reachability matrix shows merely what members are reachable from other members, regardless of distance (Harary, Norman, and Cartwright, 1965, pp. 117, 134). We might suppose that a member from whom many others are reachable will be in a more powerful position than someone who can reach few others, and that the shorter the distance from one member to another, the greater the influence the former can exert on the latter.

The boundaries of the zone studied by Kapferer were clear-cut and were determined by the organization of the plant; they fell within the limits set by his ability to observe what was going on. Definite zone limits are necessary for the measures he used. Several writers have studied local zones without having to pay attention to the limits of their field of interest. Much of this work has been concerned with the identification and characterization of clusters or cliques, sets of individuals who are comparatively densely linked to one another. For example, Epstein (1961, 1971) distinguishes what he calls the effective from the extended network. By the first he refers to an individual and his close associates, with whom that individual interacts most intensely and most regularly and whom

he regards as his social equals. The extended network consists of the same individual plus those with whom he has less intense and less frequent relations and whom he does not necessarily regard as his social equals. Epstein suggests that the associates in an individual's effective network are likely to have effective contacts with one another, so that this "network" constitutes a relatively dense zone, whereas the probability is lower that an individual's extended associates will be in contact with one another. Epstein studied relations of friendship, acquaintance, and kinship among members of an elite. He noted how social norms were generated and sustained by gossip within effective networks, and how these were diffused to a wider public via links in extended networks.

A somewhat similar study was made by Kadushin (1966, 1968). He shows that public opinion, in this case about the merits of psychotherapy, becomes formulated not by an individual leader but by discussion among people who interact because of a common interest. He describes these discussions as occurring within "social circles," which he says come into being because of the shared interest of their members and which have a chain or "network" of interaction but no clearly defined goals, no definite rules of interaction, no clear criteria of membership. They have no accepted leaders, though there may be central figures in a circle. Kadushin seems to have in mind something akin to Epstein's "extended network," a zone of medium density characterized by relations of a specified type, in his case a shared sympathetic interest in psychotherapy. Kadushin's work draws attention to the fact that although zones of this kind are localized in the network, they are not necessarily centered on any one individual.

Zones of relatively high density where the relations between the members are those of friendship are usually referred to as clusters or cliques, though some writers reserve the term clique for zones that are complete, within which every member is directly linked to every other member (Barnes, 1971, pp. 64-66). There is a considerable literature on the identification of cliques from data on social choice recorded in sociograms, mainly by the successive multiplication of adjacency matrices (Proctor, 1953; Hubbell, 1965; Dorelan, 1969, 1970). By identifying a set of cliques in the community and distinguishing between their core and peripheral members, Smith was able to establish a social hierarchy in Grenada based on patterns of interaction (Smith, 1965, Chapter 3).

Likewise Loomis and others identified the major divisions of a social hierarchy by plotting the responses given to questions like "Which families do you visit most frequently?" and "Whom do you invite to parties at your house?" (Loomis et al., 1953).

Smith's work on Grenada is aimed at studying relations of a specified kind throughout the whole society and at establishing the properties of small zones within it. Kapferer's work, on a much smaller scale, is based on a study of a 23-member zone and on the measurement of smaller zones, reticulums, within it. Neither writer is concerned with the structural properties of the larger entity as a whole. While the study of global structural features is simple with very small networks, few writers have tackled large zones from this viewpoint. An instance of global analysis is provided by Fararo and Sunshine (1964), who studied friendship choices in a junior high school where 417 students could be categorized by grade, as male or female, and as delinquent or nondelinquent. As might be expected, students did not choose their friends at random. By comparing the distribution of actual choices with the distribution found in various theoretical models, the investigators were able to measure to what extent actual choices were influenced by sex or delinquent status, or by a tendency to reciprocate a choice or to choose someone who has also been chosen by someone who has chosen ego (called sibling bias). They were able to show that delinquent boys were more likely to choose other delinquent boys as friends than were nondelinquent boys to choose other nondelinquents, and that while male delinquents showed a comparatively high "sibling bias," female delinquents tended to reciprocate choices. In this analysis Fararo and Sunshine were not at all concerned with the choices made by individuals but studied only the global properties of the network generated by these choices.

By definition, zones have boundaries. Either they are defined morphologically, as for example a second-order zone (defined to include all members of a network within two steps of a specified individual), or they are discovered empirically, as when we identify a zone containing all the members of a clique. In the first instance, nothing sociologically significant happens at the boundary; it is purely an artifact of the analysis. In the second, there is a social boundary, even though there may be some ambiguity about the status of peripheral members. Nevertheless even the core

members have links to individuals who do not belong to their clique, and the network extends across the clique boundary.

Can we sometimes speak of a boundary to a network? Many writers have contrasted bounded groups with unbounded networks, or have said that a certain network is finite rather than infinite. Despite considerable discussion, there is still confusion about these terms (Barnes, 1971, pp. 66-69; Mitchell, in press).

A boundary ought to imply a discontinuity, and a social boundary a discontinuity or change in quality of social relations. To make sense, there should be individuals on the far side of the boundary who are differentiated from those inside the boundary. The application of this boundary notion to a total network is only of metaphysical interest. In a truly isolated society, were we able to find one, there would be a finite number of members in the total network and they would have no external relations with anyone else. There would be nowhere to draw a boundary dividing members of the society from nonmembers, for there would be no nonmembers in the social universe. We would have a finite but unbounded total network. The only completely isolated social system now existing embraces the whole world, and the total network that sustains it may be described as finite but unbounded. Any social system less than the whole world has some external relations that form an intrinsic part of the total network, so that in this sense the worldwide, finite, but unbounded total network is the only existing total network, and all possible total networks must be finite but unbounded. So much for metaphysics.

The notion of a boundary begins to be useful when applied to partial rather than total networks. For instance, the partial network of kinship and affinity to which a Brahmin belongs will, under a rule of caste endogamy, have no paths leading to a non-Brahmin, even though they live in the same village (Srinivas and Beteille, 1964, p. 167). In the language of graph theory, the Brahmin and non-Brahmin belong to separate components of the partial network, and we may reasonably speak of a boundary in this network running through the village and dividing them. For some purposes it may be useful to generalize the notion slightly, so as to apply it where two sets of members, who are closely linked in one partial network, are connected by comparatively long paths in some other partial network. Thus, for example, Brahmins and non-Brahmins in a village are closely linked

in the partial networks of political and economic relations, despite the bar on intermarriage. Suppose at a distance there is a group of Christians who can trace relations of kinship and affinity to both Brahmans and non-Brahmans. We may still wish to speak of a local kinship boundary between Brahmans and non-Brahmans in the village, despite the existence of long kinship paths linking them via the Christians.

The contrast between finite and infinite networks is simpler. In very small artificial social systems, as found in laboratories, the total number of members is significant. For most analytic purposes it is not. Occasionally, we may have to assume that however big a zone we examine, there will always be links leading onward to other individuals outside the zone, links that we shall not pursue. In other words we have to treat the network as if it had an infinite number of members, even though we know that in reality it can have only a finite number. Usually it is sufficient to assume that the network, though finite, is much larger than the zones in it that we wish to examine.

THE CLASSIFICATION OF RELATIONS

So far we have looked at network studies from a morphological viewpoint. Links of great diversity have appeared in the various networks, even though we have restricted our examples to the social sciences and ignored highway systems, linguistic networks, and other applications of the network idea. This suggests that the classification of links may be a more complex task than the application of morphological criteria to these studies. Several schemes have been suggested (for example, Wolfe, 1970; Mitchell, 1971). Classification by type of unit is comparatively straightforward.

The links we have met may be sorted into three main types, which we may call attitudes, roles, and transactions. Let us take attitudes first. In most sociometric inquiries, respondents are asked questions such as "Whom would you like to work with?" or "Who do you think is the best leader?" The replies define the attitude of one member of the network toward another, and enable the investigator to see what member is voted the best leader by the most people, how many choices of workmate are reciprocated, and so on. The investigator could ask respondents to list all the

other respondents in order of preference, or ask them to record their opinion of the leadership qualities of all the others, so that the resulting network would be complete; all the cells of the adjacency matrix would have a value of some sort. In practice, investigators do not do this, and merely ask respondents to, say, nominate their four best friends in order of preference, or to name the one person they think is the most popular in the group. This restriction is largely for convenience of analysis; there is no limit to the number of his fellows about whom an individual may hold opinions. More significantly, although in a formal sense these attitudes are relations between members of a collectivity, they do not imply the existence of significant social relations. For instance, Southall's respondents told him whom they regarded as the most popular and the most important persons in Kisenyi (a district of the city of Kampala in Uganda), and from the evidence of their choices he infers that chiefs and women beer sellers occupied key positions in the network of social relations (1961, p. 222). He may well be right; but he presents no direct evidence about the social relations that existed, or did not exist, between his respondents and these popular and important figures. We all have strong attitudes of liking and disliking toward many people we have never met or contacted and who have never heard of us. Only in a limiting sense can we say we have a direct social relation to them.

Let us next consider roles. Although a respondent may nominate someone else as his friend, we need further evidence before we can say that there is a relation of friendship between them, particularly if the choice is not reciprocated. When we turn from sociometric studies to look at analyses of social situations, we switch from the study of attitudes to the study of social relations in a narrower and more significant sense. If we say that A and B are friends, we now imply that there is evidence, usually interaction of some sort, for a social relation between them, and that this symmetrical relation may be labeled "friendship." Friendship in this case constitutes what Mitchell calls the normative content of the relation, "the meanings which the persons in the network attribute to their relationships" (1971, p. 20). Networks generate norms in another sense, as mentioned above with reference to Epstein's effective network, so that it may be less confusing not to follow this usage but to say simply that

friendship refers to the roles that the actors define for themselves in the relation (see Goodenough, 1965; Dahrendorf, 1968, pp. 19-106; Jackson, 1972). The role of friend is, of course, only one among a myriad of possible roles that actors may adopt, and it is misleading to associate network links particularly with friendship roles, or with informal rather than formal roles; relations of hostility, of parent and child, debtor and creditor, priest and worshipper, and many others, all can constitute partial networks, each distinguished by a specified definition of role.

Roles and other forms of relation may be classified on several dimensions. The contrast between multiplex and single-stranded relations, mentioned above, refers to role definition. Mitchell stresses that from an actor's point of view no relation has only one content (role). For example, two individuals meeting in a market for the first time may define the relation between them almost exclusively as that between buyer and seller, but may not be able, or may not wish, to forget entirely that one is a man and the other a woman, both of them are Catholics, one of them is rich and the other poor, one is white and the other black, and so on. These other considerations may have some influence on the way they behave toward one another. Nevertheless, in analysis, for example in studying how prices are set, the fieldworker may be justified in narrowing his attention to the single role-pair of buyer and seller; lack of data may give him no option. He is then dealing with a single-stranded relation. But suppose the buyer is the brother-in-law of the seller, that they have been trading together for years, that they belong to the same secret society, and that the buyer knows that the seller's goods have been stolen. A single-stranded analysis is less likely to be adequate, for the other role-pairs have to be taken into account. The analyst has to treat the relation between the two individuals as multiplex, particularly when comparing this relation with single-stranded relations the same individuals may have with other people. Many writers have argued that small-scale, tribal, rural societies are characterized by multiplex relations between individuals, in contrast to large-scale, industrial, urban societies where many relations are effectively single-stranded (Srinivas and B  telle, 1964, p. 167; Gluckman, 1967, p. 19; Bott, 1971, p. 99). Frankenberg has taken this contrast a stage further. His thesis is that

whereas small-scale societies survive in the face of uncertainty because relations between individuals are typically multiplex, uncertainty is overcome in large-scale societies because individuals are typically constrained and supported by a multiplicity of single-stranded relations; the shift from one mode to the other he calls the changing pattern of social redundancy (1966, pp. 276-296).

Another dimension useful for classifying roles, and also attitudes, is intensity. Applied to roles, intensity indicates the extent to which an individual is ready to respond to appeals for support and is constrained in his choice of actions because of his relation to someone else (Reader, 1964, p. 22; Mitchell, 1971, pp. 27-29). Obviously, some role relations are more intense than others. The relation to a father is usually more intense than the relation to a neighbor, whereas cultures vary in whether the relation to a brother is customarily considered more or less intense than the relation to a wife. Philip Mayer (1961, 1962), in his study of urban migrants, shows how relations with rural kinsmen may be perceived as so morally binding that they remain valid despite infrequent communication.

Another dimension, durability, refers to the persistence of attitudes and role relations through time. This we shall consider in the next section.

The third type of relation encountered may be called transactional. These are the links that are actually called into play in some specified context. There is no limit to the number of persons an individual may hold an opinion about; he may enjoy social relations of varying significance with many people; the number of social links he can make use of at any one time is more limited. Mitchell makes the distinction between communication-sets and action-sets (Mitchell, 1971, p. 36; Adrian Mayer, 1966, p. 108). People do not usually converse at random; we talk to those we know, and by starting to talk to a stranger we begin to establish some sort of social bond with him. The message that is communicated may be evaluative, as with the generation of social norms already mentioned, or imperative, as in a chain of command; it may be informative or just idle gossip. Gluckman has pointed out that gossip is seldom sociologically idle, and the notion of a network gives us the mechanism by which it does its work (Gluckman, 1963). Gluckman stresses how group boundaries are maintained by esoteric gossip; but communication, following the links of the network, does not

necessarily stop at group frontiers nor does it occur only within organized groups.

Information is often a scarce commodity that is husbanded carefully; but with action-sets, as distinguished by Mitchell from communication-sets, we deal with transactions that entail greater social cost than talking about the weather or the latest scandal. The relatively dense zones of the network that indicate the presence of cliques and groups may be characterized by a constant exchange of information and by other forms of communication, but more substantive transactions are likely to involve fewer people. The provision of goods and services entails counterpayments and the allocation of scarce resources. Katz refers to the cost of establishing and maintaining links as the "rider" factor, and mentions the preference that a man might have for taking a loan from a bank, even though his relatives have money, because of the intense family loyalty that might be entailed by accepting an interest-free loan from a relative (Katz, 1966, p. 206). The network indicates the range of choices open to each member in achieving new ends and in accepting new obligations. He has his direct contacts to choose among, but his links with them also show the way by which he can get what he wants from individuals with whom he is linked only indirectly. A transaction may be part of a symmetrical exchange, as when a farmer solicits help in his fields from neighbors and incurs an obligation to help each of them in turn. An example of an asymmetrical exchange is provided by Mayer's data on electioneering, mentioned earlier, where votes cast by the electors were repaid with promises of legislation, jobs, credit, and patronage. Likewise, in a small-scale society, officials may be expected to meet the obligations of relations of kinship, friendship, or neighborhood by providing preferential treatment within bureaucratic processes. In Malta ". . . the favourable treatment he is expected to give a kinsman often conflicts with the civil service ethic of impartiality. This may place persons in authority in awkward positions, since the refusal of a request may seriously affect either their personal relations or their professional integrity" (Boissevain, 1965, p. 120). In these circumstances a large set of effective kinsmen may be a liability for a civil servant.

The dimension of frequency refers to transactions, to the mobilization of relations, and must be distinguished from the criterion of durability

applied to roles. Some role relations, particularly those defined in close kin terms, may remain latent for years without withering away, whereas others, such as those of friendship, may call for continual mobilization if they are to persist. In many studies of relations with neighbors and kin in urban communities, frequency of mobilization, the number of visits made during the last month or the number of letters exchanged, is taken as a convenient "objective" measure of the importance or intensity of the relation. But as Mitchell points out, "A high frequency of contact . . . does not necessarily imply high intensity in social relationships" (Mitchell, 1971, p. 29). A man may see his workmates every day, but his decisions may be affected more by the kinsman who reappears on his doorstep after an absence of a decade. He may try to forget about his creditors, or go out of his way to avoid them, but they remain his creditors until he pays his debts.

Frequency of transaction has thus a contingent connection to the durability of role. At one extreme are the ascribed relations of the nuclear family, where the role pair of parent and child persists for a lifetime, relatively independent of the frequency of transaction; at the other are the ephemeral relations of the encounter with the stranger, where the social relation ends with the end of the transaction, and where, if by chance there is a second encounter, the new relation may be established without reference to the old. In between are the many kinds of relation that may be allowed to lapse by cessation of transaction but which if necessary can be revived rather than established afresh.

An analysis of roles and transactions can be made without reference to networks; its interest for the study of networks is found in the light it gives to understanding the connections between social relations. As a member of a network every actor is seen as the focus of a plurality of relations. Some of these will have been activated by his contacts, while others are dormant. To meet the claims made upon him and to achieve his own goals he has to decide what links to activate himself, what to respond to as his partner expects, what to attempt to redefine, what to allow to wither away. In response to an appeal for support from his contact B, the actor A has to decide what to do about his relation to C, and one factor entering his calculations must be the character of the relation, if any, between B and C.

NETWORKS IN TIME AND SPACE

The frequency of transactions and the durability of roles is only one aspect of the persistence of networks through time (see Caplow, 1955). However stable may be the institutional structure of society, the network of relations that sustains it is always changing. The physical processes of birth, maturation, and death entail continual changes in membership of the network, in the pattern of links between members, and in the definitions given to the links. The daily and yearly cycles, the exigencies or ordinary living, entail a continual change in the pattern of transactions (see Aronson, 1970). Most of these changes are easy to understand without specific appeal to the notion of networks; they are of interest here only because they form the constant accompaniment to changes which are closely connected to that notion.

Some studies have been made of the effects of spatial and social mobility. Transactions do not all include face-to-face contact; talking on the telephone and sending a check through the mail are transactions linking distant partners. But many forms of transaction, not only in paleotechnic societies, do depend on physical proximity. Bott has discussed the several studies that have been made of families in Britain and America who have moved from one locality to another, and points out that while a family unaccustomed to moving may be unable to maintain contact with kin and former neighbors left behind, an adept family may succeed in maintaining kin links despite the obstacle of distance. Bell, who studied middle-class urban families in Wales, argues that although there is an inverse connection between social distance and frequency of contact between kin, geographical distance seems unimportant; transactions between kin, particularly the provision of economic assistance, depend more on the phase of the family life cycle than on distance between homes (Bell, 1969, pp. 81-98, 161). In Detroit, socially mobile women were found to maintain contacts with kin to an extent that was intermediate between the patterns typical of their classes of origin and of destination. If they changed from a high-status religion to a low-status religion, their rate of visiting kin was less than the rate for their class (Aiken and Goldberg, 1969). On the other hand, in Greenboro, North Carolina, upwardly mobile women resembled their class of destination in their contacts with kin (Adams, 1967).

More closely linked to the notion of networks is an analysis made by Whitten of his own position as a field ethnographer in Ecuador and Nova Scotia. He reports that in Ecuador, "When A told me about B and B's relatives, he usually tried to involve me with B and through B to B's relatives, frequently completing the string of linkages by indicating both the central person in the network and his own position at various points in networks of association." In Nova Scotia, on the other hand, "If A told me about B and B's relatives, he would strive to keep me from knowing B personally, preferring, instead, either to tap my capital and increase his competitive exchange advantage with B by including C and D through new presentations to them, or by forcing me to make my own dyadic contact with B" (Whitten, 1970b, p. 277). Whitten is here talking about his involvement in the networks of his informants, but he takes his own experience as typical for the societies concerned. In general, if X wants to have some effect on Z but can reach him only through Y, there are three policies open to him: he can accept the position for the time being and work through Y as intermediary; he can seek to make direct contact with Z, perhaps using his relation with Y as a means of doing so; or he may actively seek to avoid direct contact with Z and may rely entirely on the indirect influence he can exert through Y. Whitten indicates the different responses Y may make to the situation. In Ecuador the associational networks, as Whitten calls them, enabled individuals to exploit short-term economic opportunities by investing in social capital; upward mobility was culturally legitimated. In Nova Scotia, where networks have what Whitten calls distributional centrality, people use their interpersonal links to prevent others from rising in status and wealth; the culture stresses the distribution of misery (Whitten, 1970a, pp. 394-402).

Williams discusses differences between various parts of Britain in the set of neighbors that a farmer may call upon for help, his "neighbor network." In areas where there is little spatial mobility an incoming farmer's set of cooperating neighbors, who help with dipping, shearing, threshing, and other tasks requiring much cooperative labor, is largely predetermined; the newcomer takes over the set who helped the previous farmer. In an area where farms change hands more frequently, farmers are less dependent on neighbors for help, and tend to recruit their helpers idiosyncratically (Williams, 1963, pp. 105-106).

Just as dense zones in the social network may generate the formation of new groups, so may changes in the group and institutional structure of society lead to changes in the pattern of social relations. Srinivas and B eteille show that in India the process of institutional modernization has led to a partial dissolution of the traditional rigid, segmental, and hierarchical social structure; the individual is progressively drawn into other sets of social relations that cut across the boundaries of village, subcaste, and lineage (1964).

KINSHIP AND NETWORKS

Fortes (1949) speaks metaphorically of a web of kinship. Kinship appears to provide a paradigm case of a network, for everyone is linked by parental, affinal, and filial ties to a potentially unlimited set of kinsfolk. The genealogical grid certainly constitutes a kind of network, with the elementary links of father-son, father-daughter, husband-wife, and so on. The distinction between these socially recognized kin links and carnal or genetic connections is a basic tenet of the study of kinship. Yet we must stress that although the constituent links of a conventional genealogical grid are socially rather than genetically determined, the grid forms significantly less than a partial network of kinship, as we have used the term. A genealogy does not normally show any direct links between an individual and his kin other than parents, siblings, spouses, and children. A virtually universal feature of kinship systems is that there are many significant links between an individual and extrafamilial relatives, and that his relations with them cannot be entirely subsumed by the elementary links between the genealogically intervening relatives. Indeed, in some kinship systems not all relations with kin need to be validated by tracing out a genealogical path step by step. Therefore, the partial network generated by kin relations in any society will in general contain all the links in the genealogical grid joining living individuals, plus links with, for example, mother's brother, grandparent, or cousin or with other kin whose specification is not genealogically derived, depending on the culture of the society concerned and on the particular circumstances of the individuals involved. Some links will be to "intimate" kin, others to "non-effective" kin, and so on, so that the quality of the relations will vary

(Firth et al., 1969, pp. 155-158). Yet in general the kin network will be much denser than the genealogical grid from which it is mainly or wholly derived. Kin relations typically have life-long durability, with ascriptive roles minimally dependent on frequency of transactions.

Although kin groups are often organized internally in a mode specific to the domain of kinship, they generate zones of relatively high density in a partial network in much the same way as do groups of other kinds. Members of kin groups share activities; transactions take place between some of them, and significant relations between comparatively many of them. One kind of kin grouping calls for special comment because of the way in which it is defined. This is the kindred, which is defined genealogically, sometimes along with other criteria, with reference to an individual—any individual whatsoever (Fox, 1967, pp. 164-174; Gulliver, 1971, pp. 6-16). Definitions of the kindred vary among societies, and in any one system the set of relatives that may be expected to act together, or from which an individual can recruit supporters, may vary from situation to situation (see Adrian Mayer, 1960, p. 4). The significance of kindreds for the study of networks is that they provide us with a culturally recognized zone of which the individual on whom we focus our attention is truly the center, in reality and not merely as an artifact of the analysis. The distinction between roles and transactions applies here as elsewhere. In any society where the concept of kindred is culturally recognized, an individual has significant relations with a set of kinsfolk who collectively constitute his kindred. In particular situations, various subsets of these members act in their kindred roles. The overlapping of kindreds, the very limited sense in which a kindred may be called a kin group—these and other metaphysical conundrums that have provoked so much discussion in the past—can be easily subsumed by regarding a kindred as an ego-centered zone, with appropriately defined limits, in the partial network of kinship. The limits need not be defined only genealogically. Thus, for instance, Gulliver, who avoids the term kindred so as to escape from semantic arguments, says that among the Ndendeuli every individual has a kin-set, containing all those kin with whom at a particular time he maintains an active relation. It seems that no member of a kin-set is more distantly related than as a third cousin, but it is unlikely that

all an individual's third cousins are included. The Ndendeuli population divides itself into discrete local communities, and typically some of the members of an individual's kin-set are members of his community, while others are not. Each individual recognizes a subset of kin that comprises all his kin-neighbors, those who live in his community. With very few exceptions, everyone has a few kin-neighbors, but also has other neighbors whom he does not recognize as kin. Nevertheless all members of a community are connected indirectly with one another in a kin network. Gulliver refers to the kin links between members of a single community as constituting a closed network, in contrast to the open kin network comprised of the members of all communities in the Ndendeuli population and beyond; in our terms he is referring to a locally defined zone in the partial network of effective kinship. Within this zone, each man is in direct contact with his kin-neighbors and looks to them for assistance in working parties (Gulliver, 1971).

Societies with cognatic (as distinct from unilineal) kinship systems typically place the individual in a position where he has more potential kin relations than he can make use of, so that he has to choose which to validate and mobilize; he is also likely to be subjected to conflicting pressures from individuals who have chosen him as an effective kinsman but who do not, or cannot, cooperate with one another as kin. This type of situation is particularly appropriate for network analysis. Nevertheless there are networks of social relations in all societies, including those with unilineal kinship systems. Lamphere (1970) shows how the concept of a network can be applied to ceremonial cooperation among the matrilineal Navajo, and stresses that, at least for the Navajo, the network of kin ties has to be separated in analysis from ties between neighbors and fellow clansmen. This observation is supported by studies of conjugal roles, discussed in the next section.

UNITS IN THE NETWORK

Married couples. We have spoken of a network as typically comprising a set of individuals some of whom are linked by social relations. In the language of graph theory, the vertices of the graph are individuals, the arcs are social relations. But just as outside social science networks may have entities of almost any class as vertices, so

within our own range of interest networks may have other social entities as vertices.

A category of network of particular importance in the development of network studies within social anthropology and sociology contains networks with married couples as vertices. Elizabeth Bott's work on *Family and Social Network*, first published in 1957, has been one of the chief sources of inspiration for the current interest in social networks. Among other things she studied the connection between the conjugal roles (the division of labor between husband and wife in the home) held by a married couple and the pattern of social relations among their friends. She argued that couples with highly segregated conjugal roles (husband and wife having a relatively large proportion of complementary and independent activities) and a relatively small proportion of joint activities tend to belong to close-knit networks; that is, their first-order zone is relatively dense. Conversely, couples with joint conjugal roles (more joint activities and fewer complementary and independent ones) belong to loose-knit networks (relatively sparse first-order zone). In the second edition of her book she surveys the work, done since she first wrote, that challenges or supports her thesis (1971, pp. 53-60, 250-313). Bott's pioneering work has had a profound effect on studies of married life and, in a wider arena, has alerted inquirers to the importance of looking at the relation between B and C while analyzing the behavior of A, whatever sorts of social bond happen to link A, B, and C.

A full discussion of Bott's work lies beyond the scope of this module. There is, however, one source of confusion that some who have tried to test Bott's hypothesis have not overcome. It clouds the various patterns of causal links they use to explain the existence of correlations between conjugal roles and social networks, and it bears directly on network analysis. Confusion arises because in some parts of her work Bott treats the spouses separately, while in other parts she treats the married couple as a unit. In classifying conjugal roles, Bott distinguishes between a form of segregated recreation, in which each spouse visits and interacts with his or her friends without being accompanied by the other, and joint recreation in which, among other activities, the couple go together to visit their friends and relatives. In making her contrast between dense and sparse zones, however, she considers only the extent to which

relatives, neighbors, and friends of the couple know one another. In this context she does not take into account the extent to which a wife is in direct contact with her husband's friends, or a husband with his wife's friends; nor, for instance, does she examine to what extent the husband's friends are men married to women who are friends to the wife. The dense and sparse zones she compares are zones in condensed networks of which the members are married couples, not individuals. This in itself is a legitimate application of the network idea. But in the condensation, the relation between husband and wife disappears from the network. The units in the network are married couples, either the couples who were her informants or those who were their friends and relatives. Hence the correlation she seeks to establish is between zone density and certain properties of a relation that does not form part of the network she is examining. It follows that any explanation for the correlation, supposing that it exists, cannot be derived from a study of this network alone.

Looking back at the attempts to validate or refute her work, Bott is inclined to accept that there is a significant connection between dense zones and segregated conjugal roles in industrial society, just as these phenomena seem to typify tribal societies. She now says, however, that the association between sparse zones and conjugal roles is "unpredictably variable" (Bott, 1971, p. 290). She argues that spatial mobility is associated with sparse zones, but Bell and Healey note that the limiting case of a loose-knit network, that is, of a first-order zone of minimum density, with none of an individual's (or married couple's) contacts in touch with one another, does not exist. Even highly mobile middle-class families have clusters of locally aggregated friends who know one another, though the local clusters may have little contact with one another except through the family concerned; the first-order zone is sparse overall but contains relatively dense patches (Bell and Healey, in press). Martin calls this kind of zone a "clustered" network; but while she finds this kind typical of residents of one of the Adelaide suburbs she studied, in another suburb the residents appear to have truly sparse zones. Here, "even kin ties were less dense than in the other samples, each family selecting a few contacts—themselves not necessarily in contact with one another—from the large number of kin available" (Martin, 1970, p. 337). Both suburbs were socially homogeneous, but the first was one of the

best residential districts of the city, whereas the second was "a nondescript, monotonous and unkempt place, without distinction of any kind." Yet although under anomic conditions even the bonds of kinship begin to break down, a kin network is intrinsically and not merely contingently dense, even in the absence of marriages between kin. This is because parents typically have more than one child and because, unlike friendship, kin ties are ascribed by the addition of links to the genealogical grid, as mentioned above (see Nelson, 1966). Kinship has inbuilt, even if limited, transitivity. Hence the clustering of relatives and the clustering of other friends are likely to have different connections with types of conjugal role (see Fallding, 1961, p. 342; Rosser and Harris, 1965, p. 207; Turner, 1967; Gluckman, 1971, pp. xxi-xxii).

Bott's own argument would in any case lead us to look for connections between density, or some other local characteristic, and relations within the same network. In other words, we should treat husband and wife as separate vertices in the network, identify the friends and other direct contacts of each of them, and then see what relations there may be between as well as within the two sets. Are her friends the same as his, do her friends know his, and in particular are some of her friends, men and women, married to his friends, women and men? Kapferer has recently prepared an analysis somewhat along those lines (in press; see also Bott, 1971, pp. 287-288). Toomey (1971) treats overlap in membership between the husband's and wife's sets of friends as "sharing of social contacts," a part of their conjugal roles, and goes on to look separately at the extent to which the husband's friends, and then the wife's friends, know one another.

In many studies of friendship it is tacitly assumed that a man's friends will all be male and a woman's friends all female. This may often be the case, but it cannot be taken for granted, and its sociological significance has to be examined (see Fallding, 1961, p. 342; Harris, 1969, pp. 174-175; Gluckman, 1971, p. xxii). Some of a woman's friends are "her own," but she may be friendly with other women only because they are married to her husband's male friends, so that if he breaks a friendship her corresponding friendship is broken as well (see Bott, 1971, p. 256n). The same might be true of a man's friends, though it seems that in Britain and America most of the shared friendships continuing since marriage have

been initiated by the husband, and hence his link may be dominant over the link formed by his wife (Babchuk and Bates, 1963; Bott, 1971, pp. 261-262). Whatever aspect of the couple's social contacts happens to be the focus of our interest, given a single network to work with, it becomes possible to postulate correlations between the characteristics of the husband-wife relation and the properties of his first-order zone, her first-order zone, or, more likely, a zone centered on them both. The causal model can then be constructed in terms of the expression of attitudes, the generation of norms, the passage of information, and the occurrence of transactions within the one network.

Other kinds of unit. The same techniques of analysis can be applied to networks with vertices representing other kinds of social unit, or other divisions of social personality. For example, Hallpike uses a network whose vertices are towns, and whose links are relations of alliance and enmity. By simulating the processes of alliance formation in a series of games played with models, he shows how closely his assumptions fit the pattern of relations actually observed between 36 towns in Ethiopia. He assumes that once fighting begins between two towns, allies will be brought into the conflict and that the evaluation one town has of another will alter according to their relative position in the conflict. The rules of the game are based on balance theory and generate an outcome, after a random start, that matches reality in various ways, including the proportions of coalitions of different sizes and the proportion that are "nuclear," that is, well balanced (Hallpike, 1970). The pattern of markets in rural China has been analyzed in similar fashion by Skinner (1964-1965).

Beshers and Laumann say they view social structure as a network. Nevertheless, in their "network approach" to the measurement of social distance they use a network unlike those we have so far considered. The vertices of their network are occupational categories, while the various relations between them are probabilities—in each case the probability, for someone in a given category, of having a father (or father-in-law, neighbor, or friend) in another given category. They calculate the mean first passage time, measured in generations, from one occupational category to another as an index of social mobility (Beshers and Laumann, 1967). As part of his study of social movement within a profession, Harrison White

(1970) uses a network in which the vertices are tenures of a specified job by a specified man, and the relations between them steps in a man's career. These diverse examples give an indication of the versatility of network analysis even within the confines of social science. Networks have been used fruitfully as analytic tools in many cognate fields, notably in geography (Haggett and Chorley, 1969). Further references to applications outside social science are given by Barnes (1969).

DATA COLLECTION

As with many kinds of social analysis, data for the construction of a network of social relations come from interviews, responses to questionnaires, and observation. Many of the data used in the studies discussed here were collected through interviews and questionnaires, and because of this only limited kinds of network analysis, based on first-order stars, were possible. The study of networks calls for information about a plurality of persons who are in contact with one another, and consequently the traditional methods of selecting respondents individually are inadequate. Many investigators have asked respondents about the relations existing among their friends, instead of seeking to interview the friends themselves; time and money are thus saved. But little confidence can be placed in information collected in this way. Individuals are not always reliable sources of information even about their own spouses. Babchuk and Bates studied 39 couples, interviewing husband and wife separately, and asked each respondent to identify the friends he or she had in common with the spouse; in only three couples were the partners in complete agreement (Babchuk and Bates, 1963, p. 378). To get reliable information about the relation between B and C, the investigator must seek them out and ask each about his relation to the other as well as to A. This requirement entails a snowball technique for amassing respondents, as with subscribers to chain letters, where each successive respondent defines several more who should be taken into the sample. For most purposes this is a poor way of sampling. It provides the investigator with good information about the individuals who can be reached within a few steps of the initial respondent, but they cannot be regarded as typical or representative of members of the network as a whole. Nor can this difficulty easily be overcome

by taking a satisfactory sample of initial respondents, for the task of tracing out all the paths from one point of origin even for a few steps may be formidable. If the research task can be achieved by tracing only one path, sampling becomes much easier, as illustrated in the experiments conducted by Milgram and his associates mentioned above. If the network is comparatively dense, so that many paths lead back to respondents already contacted, the snowball does not grow so rapidly, but under these conditions it may be simpler for the investigator to resolve initially to interview or collect information from all members of the core community, and thus to discover what relations members have to one another.

The speed with which a snowball technique for gathering informants becomes unmanageable will vary with context and culture, with the average number of links radiating from the typical individual. Lee asserts that in the United States a typical individual "knows" about a thousand people. Mitchell suggests that in an urban environment the number of people with whom an individual may be in direct and regular contact is limited to about thirty. At the other extreme, when Toomey asked his urban male respondents, "Apart from your wife and children who are the three or four people you most often spend your time with?" 20 percent of them named no contact and 15 percent only one; 49 percent of them responded to this question by spontaneously mentioned their lack of social contact (Lee, 1969, p. 125; Mitchell, 1971, p. 20; Toomey, 1971, pp. 419, 426).

Action-sets generally involve only a portion of the individuals belonging to the zone on which they are based, and may therefore be easier to trace out by a snowballing technique, even when, as with Adrian Mayer's electioneering action-set, there is a multiplicity of paths to be investigated. Nevertheless there is the danger that the fieldworker may interpret the behavior of individuals several steps away from the point of origin solely in terms of those relations that are mobilized in the action-set, and forget about—because he does not know about—the other relations impinging on these individuals. The false assumption of significant centrality has been mentioned several times. Thus Aronson notes that it is unfortunate that Mayer publishes the action-set of only one candidate in the election; "it is safe to guess that the other candidates were linked to many of the same individuals and groups, if by different forms of linkage (i.e., one man's priest may be another man's cousin)" (Aronson, 1970, p. 262).

These considerations indicate why most network studies based on interviews or questionnaires have been limited to analyses of stars and paths or, less reliably, of first-order zones. Studies of larger zones, and even reliable studies of first-order zones, seem to be feasible only where the whole or at least the greater part of the arena of social action can be observed by one or more investigators. Indeed, reliable studies of first-order stars ideally call for the same conditions of observation, for an account of the relation between A and B based solely on the testimony of A is a poor substitute for one based on interviews with both A and B and on observation of the transactions taking place between them.

Mitchell notes that when an observer becomes a participant he joins the network of his informants, so that in his analysis he has to take into account his own links to them. This feature of field observation may be significant in any mode of sociological analysis, but is particularly important in network studies. Typically, the observer seeks to maximize his direct contacts, so that he sees and hears and is told as much as possible. Yet in general he has no wish to become a powerful member of the network, for his interest lies in watching the power struggle among his informants. Considerable professional expertise is needed to establish and maintain many links characterized by large flows of information and carefully circumscribed flows of action. Flows of information may be difficult to maintain if, as must often be the case, the fieldworker cannot pass on to others all the information he receives if he is to preserve his special role as an outside observer, a "marginal native" (Freilich, 1970). Bell describes how the flow of gossip he received changed after he had resolved not to pass on gossip (Bell, 1969, pp. 139-140). Initially he found that swapping gossip brought great short-term gains. Then informants became more reticent when they realized that he might gossip about them to other people. He had to create a role in which he was seen to keep confidences and not to take a positive part in the transmission of gossip. He continued to gossip with a few informants. Bell also mentions a hazard faced in all kinds of fieldwork; informants may take part in additional transactions among themselves merely to please the ethnographer. He says, "Fieldwork was concluded when an informant said that she had been to a coffee party where the hostess had apologized for inviting her at such short notice but her sociologist was calling tomorrow and she wanted something to tell him" (1969, p. 7).

In the field the representation of the social network in the form of a square matrix provides the investigator with a visual guide to the progress of his data collection. Each cell of the adjacency matrix corresponds to a directed relation from one individual to another. By entering a summary of his information in each cell the fieldworker can see to what extent he has the data needed to state the various characteristics—types of role, intensity, durability, frequency and nature of transactions—needed for the analysis he has in mind. For a full zonal analysis he must have information for every cell; he should not assume because he has heard nothing about a relation between two members of the network that it does not exist.

The practical application of the idea of a network to the analysis of social situations is thus no easy matter. Nevertheless the limit of its applicability have not yet been reached. The study of networks is not tied closely to any particular view of social action but can be used with any theory that sees social behavior as the outcome of a multiplicity of partly conflicting social pressures on units that have interests of their own and are able to choose among alternative courses of action. What sorts of pressures, what interests, what calculus of choices—these are not predetermined by the use of networks. Yet as Garbett points out, networks seem to fit well with an exchange theory of social relations and to provide a check against the analysis of social life in purely dyadic terms (Garbett, 1970, pp. 223-226). In particular, the various measures of network characteristics are available as emergent properties, even if these are not what the proponents of exchange theory had in mind (Blau, 1964; Homans, 1961). Though the constituent relations are dyadic, the use of networks certainly does not imply dyadic reductionism.

Much that appears under the banner of network analysis fails to make use of its specific potentialities; we should be more abstemious in our use of the term. It provides us with a convenient way of studying and measuring the effects of social relations at a distance, of the relations between relations. Therein lies its attraction and utility.

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