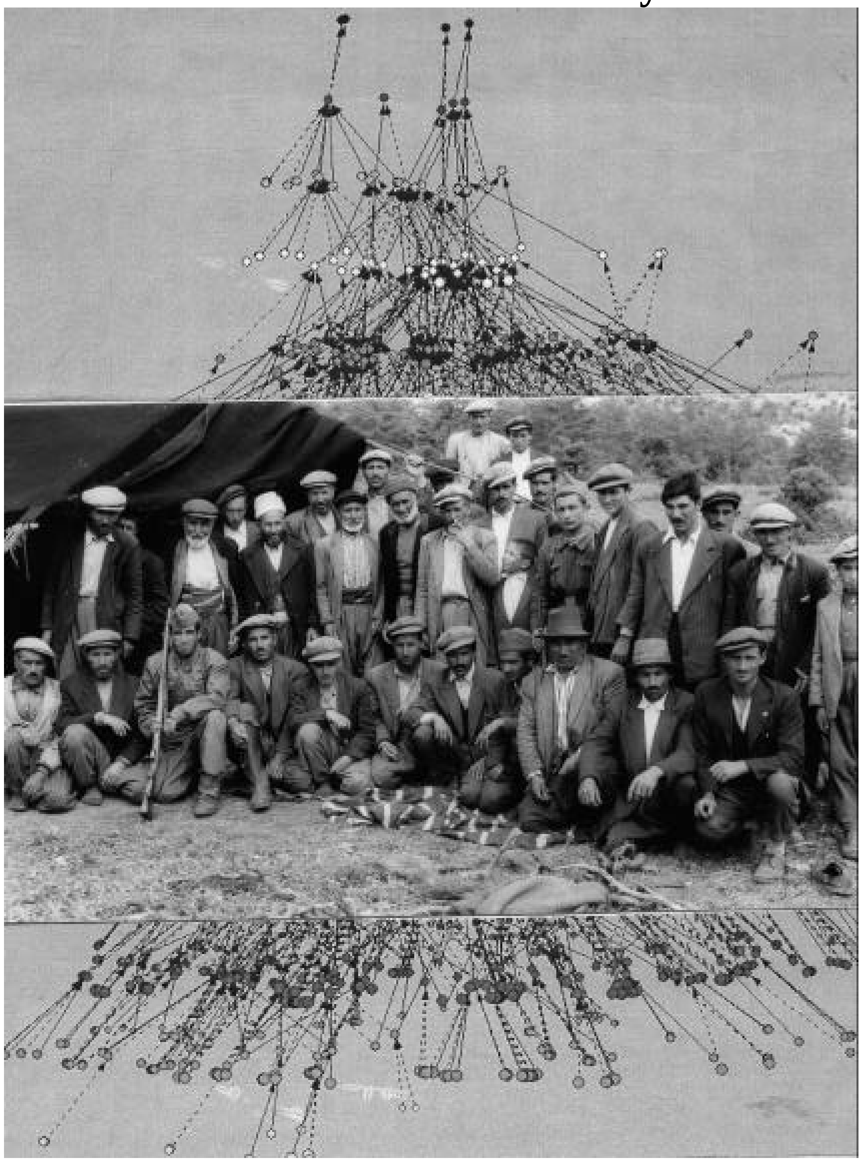
Network Analysis and Ethnographic Problems: Nomads of South Turkey



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Foreword by Maurice Godelier

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Knowing How to Analyze Kinship Networks:

Process Models of a Turkish Nomad Clan

Douglas White and Ulla Johansen

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Dedicated to the memory and stimulating creativity of Thomas Schweizer, who brought us together in this work

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Preface

This book presents both a data-rich case study across time of the Aydinli nomads (Yörük) in Southeast Turkey and a paradigm for new types of kinship, network and ethnohistorical analysis. As such it can serve as an instructional manual for new methods of kinship, marriage, historical, and ethnographic studies by means of network analysis. It is one of a series of new theoretical approaches (Brudner and White 1997, Houseman and White 1998a,b; Schweizer and White 1998, White, Schnegg, Brudner and Nutini 2000) concerned with obtaining a deeper, more precise and comprehensive understanding of social organization and dynamics.

The approach taken in this book explores the continual emergence-reemergence of shifting patterns of social groups and relations. Such vantage points are also achieved here by attention to the reports that people give of the sequence of their marriages, which provide data on the associated changes in their social networks. Like a text, these sequences follow in the context of relationships set down earlier, and show the result in ties that often change subsequently with the birth and raising of children, death, divorce, conflicts or key events. The data presented here, supplemented by analysis of other written and oral texts, are also transformed by visual rendering and analyses into a detailed network analysis of social organization, especially of marriage or alliance structure, descent groups, relevant cohesive groupings, and leadership factions.

We attempt both to visualize the complex relationships that arise in the unfolding of ethnographic narratives about social networks, including genealogies, and what is said about these relationships. In this manner we try to meet the demands of Holy when he writes: "we need to pay more systematic attention to people's own models and conceptualizations if we are to advance our understanding of the constitutive relationship between their marriage preferences and other elements of the. . . reality" (1989:2). The analysis thus fits within the general frameworks of cognitive anthropology, network analysis, and ethnohistory.

We hope to show how the fit of social organization with cultural rules and individual actors' decisions becomes more transparent when we are enabled to see the unfolding of peoples' behaviors, and often their thinking about social action. This we do by providing social networks as among the contexts in which people operate and to which their actions contribute. We hope to show anthropologists and others how to combine genealogical data, network analysis, and social narratives to elucidate more precisely the principles and dynamics of social organization in a specific case study. The results of this analysis may give readers a deeper understanding of the complexity of socio-political organization generally, and of rural Turkey in the last centuries in particular.

In this study of a nomadic clan embedded in a larger intersocietal framework, the ethnography of Johansen and the computer analysis of White are combined to visualize and explore intricate social processes using genealogical and other data collected in the course of fieldwork. The full results of Johansen's fieldwork will not be given here, but only as needed to provide the background data for the network analysis. The fieldwork is exclusively that of Johansen, and the computer analysis that of White. "We" is used or implied in the many statements and interpretations of ethnographic details that we worked out together, where our use of the computer-drawn genealogies and references to individuals in the genealogies have been crucial to observing further patterns in the ethnographic data. During the cooperation, the advantages and possibilities of network analysis became more and more obvious to us both. Additionally, "we" is used as a didactic means to include the reader into the process of analysis. We felt it important to present aspects of the new analytic paradigm within the framework of a detailed case study that extends existing theories about the particular forms of social organization exemplified by this ethnographic case. The paradigm elucidated in this study is of potential interest in social, cultural and physical anthropology and in social- and ethno-history and archaeology as well. We raise an explicit dialogue about the process of integrating ethnography and computing. In the chapter summaries we recap some of the main arguments and findings, followed by a list of further readings

The interlocking of ethnography and computing appears in the structure of the book. To link the two levels but keep them distinct, we introduce explicit hypotheses beecause our findings in the analytic sections may then be independently checked by the ethnographer, and the ethnographer's statements may be independently checked by the analysis.

List of Chs. and analyses to be updated

After methodological (Chapter 1), ethnographic (Chapter 2) and theoretical introductions (Chapter 3) end with the theory of fractal networks and their application to marriage and kinship structure provides a complementary alternative to theories of descent and alliance. A preliminary set of hypotheses introduce some of the theoretical concepts and questions that help to guide the analysis of case materials and to place the Aydinli in a broader class of societies with FBD marriage, a topic we examine in Chapter 6. There follow an overview of the structure of the nomad clan and a general methodical explanation of this structure that is our first subject of analysis (analyses 1 and 2). A short field report on this theme is deepened and made precise by computer analyses of relinkings by generation, lineages and tribes (Chapter 4). These analyses (analyses 3 - 8) introduce the principal hypotheses of the study. The second leading subject is social rank, marriage and leadership (Chapter 5). Again the ethnographic overview is complemented by analyses (8 - 11). They support the fieldwork results concerning interpersonal behavior within the families (Chapter 6). The third subject (Chapter 6) is marriage structure and dynamics, beginning with a review of Fredrik Barth's (1953) hypotheses concerning the dynamics of nomadic social structures. Analyses 12 - 14 supplement those of the previous chapter to show in a precise form the changing frequencies of marriage types noticed by the fieldworker, and to test hypotheses about the interpretation of these changes. The fieldworker's impression that social cohesion through intermarriages was in decline in the course of the twentieth century, however, was corrected in certain critical aspects by computer analysis. Graphic representations that support the field report about leadership and clan structure and a dynamical graph theoretical analysis (Chapter 7), and a final evaluation of the results of this study (Chapter 8), complete the book. The genealogies of the nomad clan used in the analysis are published in the Internet web site www.santafe.edu/turkishnomads, as a companion to this book, for the use of everyone interested in examining our results. We hope that this will enable others to identify new problems or means of analysis that we did not recognize in solving problems of analyzing social organization.

[[overview to be completed]]

The analytic sections of the book are accompanied by working hypotheses (numbered within each chapter) that are tested and cross-validated with network methods as well as qualitative and quantitative analyses. To clarify key analytic concepts when first introduced and later used in the analysis, highlighted definitions are provided.

A Language of Behavior. The root assumption of this study, which defines the theoretical approach taken in the book, is that there is a language of behavior that can be read and understood with certain new forms of network analysis when combined with an ethnographer's understanding of indigenous knowledge systems. Preferences and social rules can be inferred from actual choices made in a network context; i.e., from knowledge of the network background of possible choices as a system of constraints, and of course some knowledge of the cultural background and indigenous knowledge systems.

The assumption that there exists a language of behavior in no way diminishes the importance of norms, values and beliefs—and their expression in statements or texts—in the regulation of social life. The study of behavior is complementary rather than contradictory to these approaches. But to the extent that norms governing social relations—and the more detailed rules of how norms are used in practical life—are inferred from social behavior, the book will demonstrate that it is a far superior method to examine behavior in the context of actual networks and the contexts that define the range of possible choices in behavior.

This book is dependent on a thoroughgoing use of the genealogical method. One of its main contributions is to enhance our ability to trace not only the ethnogenesis of the nomad clan, from its origins in the 18th century, but also the movement of clan peoples back and forth from nomadism to sedentism as the clan grew in size. This eventuated in a numerical preponderance of the descendants of the nomadic clan settling or resettling in sedentary villages. Whether this process is also resulting in the dissolution of the clan as a nomadic society will also pose a series of question for analysis.

Many of the themes developed here are echoed or presaged by Schweizer (1996), who provides for the German-speaking community a history and critique of ethnology and a presentation of the advantages of the network approach. He shows the benefits of a dynamical network approach by way of well chosen examples, without entering as we do here into the theory of graphs as it underlies the network approach. He illustrates, for example, by means of successive graphs of relations amongst actors involved in positions of power, the evolution of social hierarchy and positions of power in a Chinese village after the Maoist Revolution. In a second example, he reexamines the emergence of social hierarchy in ritual exchange by means of network analysis the case of the !Kung, whose egalitarian ideology contrasts with hierarchy at the level of exchange.

The approach taken in this book goes well beyond Wasserman and Faust's (1994) presentation of currently standard types of network analysis in the social sciences. It adopts the kinds of ethnographically and graph-theoretic perspectives pursued by Hage and Harary (1983, 1991, 1996), in which graph theory is put to use to define and formalize new concepts that are directly relevant to ethnology. White's presentation of new software and computational possibilities for the analysis of large-scale networks also goes beyond the confines of the smaller ethnographic vignettes of Hage and Harary that are necessitated by relying on manual rather than computer-driven analysis. The further elements of graph theory developed here (such as concepts of relinking, structural endogamy, cohesion, etc.) are those thought to be directly useful for studying dynamic phenomena in social organization and the emergence of well-structured forms of cohesion applicable to social groups and institutions.

Our book will be successful if it helps to orient a new generation of ethnographers, if only in part, to change the nature of ethnographic practices in systematizing, analyzing and reporting their data, given the availability of analytic concepts and computer software for network analysis of the relational data that are necessarily collected in their case studies.

Acknowledgements

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Glossary

> "Before you begin your critique of the Iroquois," a Russian saying goes, "you need to undertand their language."—Andrey Korotayev

The vocabularies we use derive from anthropology (kinship, social roles), sociology (social networks, norms), graph theory (graphs, networks), complexity theory (fractals, power laws) and hybrids (network concepts for kinship). We place the glossary here because it will be easier for the reader to absorb the text of the book after reading the glossary. Glossary terms are given a **gray gloss** in the text to indicate where to look when unfamiliar or technical terms are encountered. References are provided to sources where methods and computer software are discussed, such as Pajek (Batagelj and Mrvar 1998) and UCINET (Borgatti, Everett, and Freeman 1992). Where software commands are possible to implement some of the operational terms, the commands are given in glossary endnotes. Additional terms that require illustration and conceptual understanding are given where needed in the text.

Ethnographic and Sociological Vocabulary:

Behavior. An observed regularity in a person's actions, or a pattern of similar actions of members of a group.

Constraint (on behavior). One or more external circumstances that together limit the scope of an action or behavior.

Preference. A regularity in behavior that favors one alternative significantly above chance levels within a set of unconstrained alternatives and attributable to a valued choice rather than to constraints on behavior. Care must be taken in attributing preferences, and they are not necessarily stable.

Norm. An regularity in a people's actions, as members of a group, either in practice or stated as an ideal.

Statistical Norm. A rule of behavior that applies to members of a group, usually including a hierarchy of exceptional subrules.

Ideal Norm. A cognized and culturally shared statement of how people should behave, not necessarily corresponding to how people do behave.

Prescription. An ideal norm that purports to allow no deviation in terms of actual behavior.

Role Relations. Observed social behaviors associated with norms stated by members of a group. The following are examples in the kinship domain that are relatively self-explanatory and widely used in ethnographies, presumably because there are either easily observed or comprehensibly verbalized or both:

Avoidance.
Authority.
Respect.
Informality.
Joking.

Graphs: de Nooy, Mrvar and Batagelj (2002) provide a manual that students can consult for the software for graphical representation and network analysis used in this book. We mostly follow their terminology. As a qualitative or relational branch of mathematics (Harary 1969), formal definitions build on earlier definitions or primitives, here marked in gray.

Node. The elements of a graph that are represented as points, and connected by lines (see below). Synonym: **vertices**.

Line. A relation between a pair of nodes. Its two defining **endpoints** are **incident** with the line. A line may be directed or undirected. An undirected line is an **edge** and an undirected line an **arc**. A **loop** is a special kind of a line that connects a node to itself. Lines may be **multiple** between the same pair of nodes.

Graph. A set of nodes and a set of lines between distinct pairs of nodes.[1] A **multigraph** has multiple lines between nodes. A **digraph** has arcs but no edges, although arcs may be bi-directed and thus represented as edges.[2] A graph may have arcs or edges or both, but a **simple** graph has only edges.[3] A (directed) **path** in a graph is an alternating sequence of nodes and (directed) edges that connects two nodes without any repeated nodes or edges. A (directed) **cycle** is the same as a path except that the endpoints are the same.

Relation. A graph with the addition of loops.[4] See **tie**. A **multiple relation** has multiple lines between nodes. A **directed relation** has arcs but no edges (although edges may be bi-directed and thus represented as edges). A relation may have both arcs and edges, but a **simple** relation has only edges. Graphs and relations may be equivalently represented by a **matrix** in which columns represent nodes, arcs, edges or loops are represented by ones, and their absence is represented by zeros. Operations on the matrix will have corresponding operations defined on the graph or relation.

Networks Vocabulary:

Network. A graph or relation with additional information on its nodes or lines: e.g., a **social network** implies a correspondence between a graph that represents individuals as nodes and social relations as lines.[5] A **subnetwork** is a subset of the elements (nodes, e.g., representing individuals) in a network together with all the information pertaining to the nodes and the lines between them.[6] A object with a mathematical property is **maximal** with respect to this property in a given context, such as a subnetwork or graph, when there is no larger object within the context that contains it that has that property.

Tie. A set of relations between nodes in a network (e.g., a social network) that can be represented by lines in the graph of the network and for which there is additional information about the nodes and their relations. A **simple** tie is a single relation; a **multiplex tie** is one with multiple relations.[7] A tie between A and B in a social network is **reciprocal** when there is evidence that A gives to B and B gives to A, without an *a prior*i constraint of symmetry. Sets of ties in a subnetwork are **transitive** when, for each triple, A, B and C, a tie from A to B and from B to C is always accompanied by one from A to C (see **triad**).

Methods of Graph and Network Analysis:

Cohesion.[8] The cohesion of a network or subnetwork is measured by **k-connectivity** (White and Harary 2002): the minimum number k of nodes that must be removed to disconnect it. To say that a graph has connectivity k is equivalent to saying that every pair of nodes is connected by k or more completely distinct paths (Harary 1969). This way of conceiving of cohesion a classical one in graph theory, but so time-consuming and complicated to compute that network analysis using this concept only began with Moody and White (2000). A network can be decomposed into **embedded cohesive hierarchies** consisting of **k-components**: maximal subnetworks corresponding to each level of k-connectivity. Elaborations are given in the text. The **embeddedness** of a person in a subnetwork is the connectivity of the most cohesive k-component to which that person belongs.

Hierarchical Clustering.[9] A method for showing hierarchical subsets of elements in a matrix or network in which all pairs of elements in the each subset have a minimum {average, maximum} value.

Automatic drawing.[10] Optimal layouts of graphs that minimize line length, in which cohesive sets of nodes tend to be clustered, and hierarchical clustering of cohesive sets can be easily superimposed. **Energy commands** in the Pajek program implement these automated procedures:

> Energy commands move nodes to locations that minimize the variation in line length. Imagine that the lines are springs which pull vertices together. The energy commands 'pull' vertices to better positions until they are in a state of equilibrium. Therefore, these procedures are known as **spring embedders**.—de Nooy, Mrvar and Batagelj (2003)

Triple.[11] A set of three nodes in a network or three of its subnetworks. A **triad census** of triples is a common means of estimating the degree of reciprocity, transitivity, ranking and other local attributes of a network. A triple is **complete** when each pair of its nodes are an arc or and edge, or, in a social network, a tie.

Curvature. For ties that are reciprocal between social units in a network, the local curvature of each unit A is the ratio of complete triples A, B, C to triples where A-B and A-C have reciprocal ties. Clusters of adjacent nodes with high curvature constitute a **topology** of a network (Eckmann and Moses 2002).

Centrality.[12] A property of a node that depends on its relation to other nodes in a graph: **degree** centrality is the number of lines incident to a node; **closeness** centrality is a function of the number of lines in all the shortest paths needed to reach all the other nodes in a graph; and **betweenness** centrality (Freeman 1977, 1980) is a function of the number of pairs of other nodes in a graph weighted by the proportion of the shortest paths between each pair that pass through a given node. These might be useful to measure, respectively, the **activity** of a node in a network, the potential **influence** of a node over others, or the **control** a node has in mediating connections between others.

Recursive centrality.[13] The extent to which a node is connected to others that are central, **eigen** centrality, is measured by the first eigen-vector in a principal components analysis of a network matrix (*ei-gen*=own, in German, connotes that every matrix has a unique set of principal component vectors whose vector product sums reproduce the matrix).

Centralization.[14] A measure of the extent to which a graph has the greatest possible difference of centrality between the most central node and each the other nodes. For each measure of the centralities of indi-vidual nodes, the centralization measure of the graph is standardized between 0 and 1, where 1 is the centralization of the star graph. This allows centralization to be compared across different networks.

Cohesion and Edge Betweenness.[15] Edge betweenness is a centrality measure of the number of pairs of nodes in a graph weighted by the proportion of the shortest paths between each pair that pass through a given edge. Girvan and Newman (2002) show that hierarchical clusters of edges with low betweenness identify **embedded cohesive hierar-chies** with a high degree of accuracy.

Kinship Vocabulary: see also the Kinship Glossary compiled by Michael D. Murphy at http://www.as.ua.edu/ant/Faculty/murphy/436/kinship.htm.

***Types of Kin* –** e.g., **MBD, FZD, FB, FBD, MZ, MZD, HZ, BW.**

These compounds are used to stand for particular types of rela-tives, where the individual letters stand for **mother (M), father (F), sister (Z), brother (B), wife (W), husband (H), daughter (D)** and **son (S)**. FBD, for example, is father's brother's daughter.

***Asset and Marriage Transfers*:**

Wealth-asset. See text, page (currently 134). **Inheritance** is a binding transfer of wealth-assets or consumables after or anticipat-ing a death to a customary set of heirs. **Testamentary disposition** is the annulment of inheritance through the substitution of a written will left by the deceased.

Bridewealth. A transfer of wealth-assets from a husband's wealth-holding group to the wife's at and following marriage, in exchange for reproductive rights transferred from the wife's group (e.g., over their daughter's offspring) to the husband's (e.g., children are retained by the man's lineage). Bridewealth is typically in the form of animals such as cattle that qualify as a wealth-asset. **Bride price** is a term that can be used to contrast with bridewealth, when only consumables are transferred at marriage, but is out-of-date because of the association with purchase, which is an inappropriate term. **Bride payment** is synonymous with bridewealth except that either wealth-assets or consumables may be transferred.

Dowry. A transfer of wealth-assets or consumables from the wife's group to the wife in connection with her marriage. Note the aysmmetry with bridewealth: dowry transfers are typically not to the husband or husband's group.

***Descent Groups*:**

Clan. A descent group or category whose members trace descent from a common putative ancestry, where genealogical links to a single apical ancestor are not known.

Lineage. A corporate group whose members share a common ancestor. An **ambilineage** is a lineage whose members share a common cognatic ancestor and affiliate either through their father or mother but not both. A **sib** is a lineage that is distributed across multiple communities.

***Affinity and Descent*:**

Agnatic. A relation between two descendants of the same ancestor trace exclusively through males. Synonym: **Patrilineal.** A **patrilineage** is a corporate group whose members share agnatic descent.

Uterine. A relation between two descendants of the same ancestor trace exclusively through females. Synonym: **Matrilineal.** A **matrilineage** is a corporate group whose members share uterine descent.

Cognatic. A relation between two descendants of the same ancestor. Synonym: **Bilateral.** A **kindred** is an ego-centered group … whose

Unilineal. An agnatic or uterine descent principle. An **ambilineal** descent principle is operative in an ambilineage. **Bilateral** descent is reckoned by the cognatic principle, i.e., through both males and females.

Consanguineal. Two persons are consanguineals if they have one or more common ancestors.

Affinal. Two persons are affinals if a relation between them can be traced that includes a tie of marriage. **In-laws** are the consanguineals of a spouse or the spouses of consanguineals, but longer chains of relationship such as the spouse of a consanguineal of a spouse of a consanguineal (e.g., **HZHZ**) or a consanguineal of a spouse of a consanguineal (e.g., **BWB**) are affinals in the more extended sense of the term.

***Post-Marital Residence*:**

Patrilocal. A married couple goes to live in the household of the husband's parents. Synonym: **Virilocal**. In Murdock's (1967) variant, **patrilocal** entails residence with the husband's patrilineage.

Matrilocal. A married couple goes to live in the household of the husband's parents. Synonym: **Uxorilocal**. In Murdock's (1967) variant, **matrilocal** entails residence with the wife's matrilineage.

Neolocal. A married couple sets up their own household independent of other set of parents. There are of course many other alternatives that the three given here, each having many possible subtypes (and potential difficulties for classification of households!).

Complexity Theory: Complex systems have embedded interiors with many interacting parts, networks, and fields. From a mechanical point of view, emergent field processes often lead to 'surprising' results that are not reducible to a mechanical or deterministic account. 'Emergent' behaviors at one level are not determined by the embedded levels that produce them but are the result of complex interactions.

Complexity. Interaction between a system and its changing environment is **complex** when system responses to changes are on longer time scales than the tempos of environmental change. Degree of complexity is a function of the ratios of response time to periodicities of changes in inputs. Complex systems can pack **memory** into their internal states.

Tipping Point. When certain thresholds are passed in a network or field internal to a complex system, such as a critical density or alignment, the global properties of the network or field change qualitatively, and can pass on this 'emergent' or structural change to a more aggregate level in the system of which the network or field is a component.

Fractality. Properties or behaviors that are **fractal** are self-similar at different levels of spatial scale (e.g., the appearance of an 'edge' of a coastline at different resolutions) or temporal scale (e.g., the appearance of variation of stock prices at different time intervals). Complex systems often have fractal properties. Many mechanical rules (e.g., growth of savings in an account with fixed interest) and random processes (e.g., distribution of the number of edges of nodes in a graph in which edges are added to new pairs of nodes that are chosen with a uniform probabilities) have a characteristic **exponential** distribution. Fractal processes that result from interaction of two levels (a complex system), such as earthquakes at one level and the random distribution of frictional stresses along potential fault lines at a lower level that affects the production of the earthquake however, typically have the signature of a log-log **power law** distribution that is fractal or scale invariant over a large range of spatial or temporal resolutions in which the log of magnitude varies linearly with the log of temporal frequency. Power-laws, unlike savings accounts, typically imply that the short-term past is no guide to the long-term future.

Network-Defined Concepts in Kinship:

Structural Endogamy.[16] When a genealogical network contains a maximal subset of families of which each pair is linked through two or more completely distinct ties of affinity or descent, they are structurally endogamous. Derived from the more general concept of cohesion, and hence from the theory of graphs, and in such a way that the boundaries of structurally endogamous groups are emergent from the pattern of relationships in the network.

P-graph.[17] In a genealogical network represented as a p-graph, couples or unmarried individuals are identified with the nodes, and lines are drawn between each node identified as a parent or parents and every other node identified with a corresponding daughter or son. Two types of ones can be distinguished one for daughters and one for sons. When a person has multiple marriages, each marriage will have a line to the same parent. If we consider the underlying graph, structurally endogamous subnetworks corresponding to cohesive sets.

Selected References

Compact introductions to social network analysis (Degenne and Forsé 1997; Scott 2000) as well as detailed methods (Wasserman and Faust 1994) and instructions for computer programs (de Nooy, Mrvar and Batagelj 2003; Borgatti, Everett and Freeman 1992b) are available. Other references provide discuss kinship analysis (Fox 1979; Keesing 1975), complex systems (Solé and Goodwin 2000) or particular aspects of methodology (Freeman 1979, 1980; Eckmann and Moses 2002; Girvan and Newman 2002; Moody and White 2000).

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Notes to the Glossary

[1] The exclusion of loops in this definition of graph is standard in graph theory (Harary 1969), and makes it easier intuitively to conceptualize some of the main theorems about the traversability of graphs.
[2] Pajek options [Main] Net>Transform>Arcs✍Edges>Bidirected only.
[3] Harary's (1969) definition of graph is synonymous with simple graph, which he distinguishes from a digraph (directed graph) with directed edges (arcs).
[4] Network analysis packages (Pajek and UCINET for example) are capable of analyzing relations (containing loops) and not just graphs, and of course, analyzing the attributes of nodes as well.
[5] See the previous footnote (4).
[6] Given a partition on the nodes of a network, or a cluster with selective numbers for a set of nodes, [Main] Operations>Extract from Network>Partition or >Cluster will extract a subnetwork according to the user's specification of the node set.
[7] [Main] Transform includes options to >Remove>Multiple lines in various ways that reduce them to simple lines and to convert >Arcs✍Edges or >Edges✍Arcs.
[8] [Main] Net>Components>Bicomponents with default size set to 3 or more

identifies sets of nodes with connectivity 2 or more. Tricomponents have yet to be implemented in current network packages (but see edge betweenness).

[9] UCINET's Network>Cohesion>Maximum Flow or Point Connectivity options automatically perform a hierarchical clustering analysis of a matrix of pairwise cohesion values.

[10] [Main] Draw>Draw Partition, [Draw] Layout>Energy>Fruchterman-Reingold>2D or 3D, and [Draw] Layout>Energy>Kamada-Kawai>2D or 3D.

[11] [Main] Info>Network>Triadic Census.

[12] [Main] Net>Partitions>Degree and Net>Vector>Centrality>Betweenness or >Closeness compute the centrality measures for nodes. Degree are computed by Pajek centralities for up to one million nodes and closeness and betweenness centralities for up to ten thousand nodes.

Flow centrality is another measure (Freeman, Borgatti and White 1991), computed by UCINET. When we assume that each edge in a graph has a transport capacity of one unit, the flow centrality of a node u is the percentage of the total amount of flow between all pairs of nodes that is not reduced when node i is removed from the graph.

[13] Eigen centrality is computed in the UCINET program package.

[14] Automatically computed in both the UCINET and Pajek program packages when centrality scores are calculated.

[15] Edge betweenness is computed in the UCINET program package. Hierarchical clustering of dissimilarity scores may be applied to show cohesive groups.

[16] [Main] Net>Components>Bicomponents with default size set to 3 or more identifies blocks of structurally endogamous marriages for a genealogical database in p-graph.

[17] Pajek's [Main] File>Network>Read uses the p-graph format suitable for network analysis as the standard default for reading databases in *.GED formats used by commercial and freeware genealogical programs and produced as well by Pgraph software.