PART I: GENERAL INTRODUCTION

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Perspective and Basic Definitions

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In the last twenty years, archaeology has made major strides in its ability to explain complex variability in the archaeological record. Theory from general anthropology, economics, ecology, genetics, and general systems approaches, as well as frameworks concerned specifically with the formation of the archaeological record, have all been utilized, further substantiated, and in some cases, extended.

In part, this growth in the use of theory and in theory building can be attributed to the great attention that archaeologists have paid to the nature of explanation and theory, as specified by various philosophers of science. Archaeologists have grown familiar with the nature of the logical constructs they wish to build and the forms of inductive and deductive argumentation by which they can be constructed and tested (e.g., Salmon, 1982; Renfrew et al., 1982). Early starts—commendable, yet troubled—now lie behind us. Some of these include Binford's (1968) call for a primarily deductive approach to archaeology; Watson, LeBlanc, and Redman's (1971) lack of clarity over the differences between explanation and description (Read & LeBlanc, 1979); and Flannery's (1973) and Meehan's (1968) contention that a systems explanation does not involve covering laws (Spaulding, 1973; Salmon & Salmon, 1979).

Parallel to these developments, particularly during the last fifteen years, progress has been made in the use of quantitative methods to describe and model complex archaeological variation. For instance, the application of linear programming methods to model subsistence systems (Reidhead, 1981; Keene, 1981), the development or application of numerous techniques for analyzing intrasite artifact distributions (Whallon, 1973, 1974, 1984; Peebles, 1971; Carr, 1984) and regional settlement distributions (Hodder & Orton, 1976), and advances in the procedures of artifact typology and seriation (Spaulding, 1953; Whallon, 1972; Christenson & Read, 1977; Marquardt, 1978) show promise for the profession.

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Nevertheless, the pace of progess along both the theoretical and methodological lines of advance has been constrained by the limited effort that has been devoted to integrating them. Until very recently (e.g., Whallon & Brown, 1982; Moore & Keene, 1983; Carr, 1984), little attention has been given to formally developing and maintaining, during analysis, *logically consistent* relationships between the theoretical developments, technical developments, and the data and phenomena of interest (but see Spaulding, 1953). *Yet it is precisely this concordance between theory, technique, data, and phenomenon that is required for analysis, theory building, and technical development to be relevant, accurate, meaningful, and efficient.*

It is toward understanding and circumventing this problem of developing and maintaining logical concordance in archaeological analysis that this volume is dedicated. Each of the chapters is concerned with one or more of the following:

1) elucidating the structural nature of various kinds of behavioral and archaeological phenomena and data, including both empirical and theoretically expectable structures;
2) evaluating standard quantitative methods for their constraining assumptions and their appropriateness for analyzing specific forms of archaeological data that reflect specific phenomena of interest;
3) introducing new analytic techniques that are more consistent with the relevant structure of archaeological data than ones previously used;
4) evaluating choices of the kinds and scales of variables and the kinds of observations that are used to monitor specific phenomena of interest;
5) introducing new methods for screening archaeological data and modifying their structure such that it reflects the phenomenon of interest more directly and meets the assumptions of higher-level techniques;
6) making explicit the bridging arguments that are useful in linking technical assumption to empirical data structure or theoretical framework;
7) elucidating, in philosophical and statistical theoretical terms, the logical processes that are involved in the analysis of complex data that typify archaeology.

These issues are addressed for several rapidly developing fields: data base management; predictive modeling of settlement and subsistence decision making; intrasite spatial analysis; and artifact technology, typology, and chronometry.

In addition to the primary theme of developing analytic concordance, various secondary themes are explored for two or more fields. Some of the more important ones include:

1) the embedding of *multiple, implicit structures* within a data base, only

some of which are relevant to and concordant with the phenomenon of interest and one's theoretical framework (chapters 1, 2, 5, 7, 13, 18);

2) the constraining of the range of methods that are appropriate for an analysis ultimately by the *empirical* nature of the phenomenon of interest, and by the data representing that phenomenon, rather than by theory or theoretical expectations about the phenomenon (chapters 2, 6);

3) the idea of *alternative techniques* that are useful in different empirical and theoretical contexts, rather than universally preferable techniques (chapters 1, 2, 7, 13, 18);

4) the nature of and means for overcoming what can be termed *the methodological double bind:* a situation in which the researcher needs some information about the structure of a data set to choose relevant variables and observations, to screen it in preparation for analysis, and to choose an appropriate analytic technique, yet is seemingly unable to obtain this information except by applying some pattern-searching technique to the unscreened data in a possibly discordant manner;

5) the complementary, stepwise, and cyclical uses of *inductive and deductive strategies* for acquainting oneself with a data set's structure and for analyzing it (chapters 2, 7, 11, 13, 15, 16, 17);

6) the logical problems with and limitations of the philosophy of *exploratory data analysis* when investigating complex data, resulting in the need to use a *constrained exploratory data analysis* approach instead (chapters 2, 13);

7) the use of *entry models* for choosing appropriate analytic techniques and in theory building (chapters 2, 13);

8) the role of *induction* (in the form of data exploration and choice of scales, variables, and observations) in "deductive" hypothesis-testing phases of scientific process when data are complex (chapters 2, 3, 6);

9) the *polythetic organization* of archaeological entities (chapters 6, 11, 13);

10) the distinction between *local structure* and *global structure* within a data set and the need for the development and application of techniques sensitive to the former in certain contexts (chapters 5, 6, 12, 13, 14);

11) the use of *multivariate statistical techniques* (factor analysis, canonical correlation) to identify and help assign meaning to the relevant structure of a data set, which allows one to overcome the methodological double bind (chapters 3, 18); and

12) the use of *time series analysis* and *spatial filtering* techniques to smooth data and reveal relevant patterning (chapters 13, 16).

THE PROBLEM OF ANALYTIC CONCORDANCE IN PHILOSOPHICAL PERSPECTIVE

This book considers only certain aspects of the logical, philosophical basis of meaningful scientific investigation. It is desirable, therefore, to place its content in a larger, philosophical perspective.

The Nature of and Requirements for Meaningful Scientific Investigation

First, it is necessary to comment on the nature of meaningful scientific investigation that is assumed here. A scientific study and its results are taken to be meaningful if the results 1) give *accurate* insight into a problem and lead to the development of theory, 2) allow the accurate testing of models or hypotheses that represent extant theory, or 3) allow a particular case to be accurately and logically subsumed under extant theory, constituting an accurate explanation. More informally, a meaningful scientific study produces results that allow or lead to the assignment of appropriate meaning to phenomena of interest, or to explanation of them. (The accuracy of insight, testing, or subsumption and the appropriateness of the assignment of meaning, of course, are not absolute qualities; they can be assessed only within the limits of the researcher's guiding paradigm. See postscript, pp. 12-16.)

By implication, the theories, models, or hypotheses that are developed or evoked in a meaningful scientific investigation and that allow or lead to the assignment of appropriate meaning must, themselves, be meaning*ful*. A meaningful proposition or construct is taken here to be not only *testable and confirmable* in the minimal, least-demanding usage of the term in philosophy of science (Carnap, 1936, pp. 420-427), but also *nontrival.* It is taken to have "worthwhile" content from the perspective of the goals of the researcher's paradigm (Read & LeBlanc, 1978, pp. 307-308, 332; Salmon & Salmon, 1979, p. 72) and to organize information efficiently and parsimoniously (Hemple, 1966, pp. 40-45; van der Leeuw, 1978, p. 328).

For a scientific investigation to produce results that are meaningful within the limits of a researcher's paradigm, three conditions are minimally required. These are 1) that at least some aspects of the *data brought forward* for study be relevant to the researcher's problem domain and accurately represent the phenomenon of interest (i.e., a population or process) and its nature; 2) that those *aspects* of the data's structure that reflect the phenomenon of interest and its nature be identified, and that they be accurately represented when summarized as patterning; and 3) that these *patterns* be interpreted in a manner consistent with the nature of the phenomenon of interest. The first two conditions ensure the *accuracy* of results and lay the foundation needed to make results meaningful. However, they are not sufficient by themselves for the derivation of *meaningful* results, which depends on the third condition, too.

These minimal requirements, in turn, necessitate that the theories, models, hypotheses, test implications, mathematical techniques, data collection methods, and/or the data that are involved in an investigation be relevant to and logically consistent with each other and the phenomenon of interest. How to develop and maintain relevance and logical consistency between these constructs and entities at different levels of abstraction is a subject matter of philosophy of science that involves a great diversity of topics. Some examples include the correct forms of a logical deduction and induction; the role of auxiliary hypotheses and assumptions in operationalizing higher-level abstractions in terms of observables; the use of bridging arguments in making logical deductions and inductions; and the setting of boundary conditions to generalizations, hypotheses, models, and theories.

The chapters in this volume have been brought together in relation to a concern over only a small subset of the philosophical issues that are involved in developing and maintaining the logical consistency that is needed to reach meaningful results in scientific investigations. At the same time, they discuss some issues concerned with developing and maintaining consistency that philosophers of science typically have not explored in depth.

In particular, this volume focuses on the *logic of application of quantitative methods* of analysis and computerized methods of data storage to archaeological data, within the context of theory. It stresses the importance, during analysis, of developing and maintaining a) logical consistency between the assumptions that underlie a technique and those aspects of the structure of archaeological data that reflect the phenomenon of interest, and b) logical consistency between the assumptions that underlie a technique and the theoretical framework that guides analysis. Logical consistency between the entities in the first relationship is necessary for the accurate identification and summary representation of facets of the data that reflect the phenomenon of interest (condition 2, above). Consistency between entities in the second relationship is necessary for the meaningful interpretation of the patterns that are identified and represented (condition 3, above). Let us consider both of these relationships in greater detail in the next two sections.

Technique in Relation to Data Structure

The necessity of maintaining logical consistency between technique and some facets of data structure during analysis, in order to obtain accurate and potentially meaningful results, can be seen in the following way. By the nature of its procedures and design, a quantitative method can be sensitive to and accurately represent only certain aspects of the total structure of the data to which it is applied. In this regard, the application of a technique to data implies assumptions that only certain, specific aspects of the data are important for representation and evaluation whereas others are not—that certain aspects of the data accurately reflect the phenomenon that is of interest and its nature whereas others do not. For example, a technique might be sensitive to ratio scale patterns of covariation among variables, but not to nominal scale patterns of association among variables. Application of such a technique to a data set would imply an assumption that only ratio scale patterning in the data is of interest, in being concordant with the nature of the phenomenon of interest and accurately reflecting the phenomenon. Likewise, a method might be sensitive to monothetic relationships of similarity among items as opposed to polythetic ones. Application of such a method to a data set would imply an assumption that only the monothetic relationships in the data are of interest, in being concordant with the nature of the phenomenon of interest and accurately reflecting the phenomenon. In either case, if those data patterns that reflect the phenomenon of interest are not those to which the applied technique is sensitive, the results of analysis will not be accurate. They will neither reflect the relevant patterns in the data accurately nor allow accurate insight into the phenomenon of interest. Thus, the assumptions that a technique encompasses, concerning which aspects of the data's structure reflect the phenomenon of interest and its nature, must concord with those aspects of the data's structure that do, *indeed*, reflect the phenomenon of interest and its nature. Only in this way can analytic results accurately represent the phenomenon of interest and have the potential for meaningful interpretation. *Accurate quantitative analysis requires logical concordance between technical assumption and relevant aspects of data structure.*

Technique in Relation to Theory

At the same time, a data set's relevant structure, as revealed through the application of a technique that is sensitive to it, can be assigned an appropriate meaning only if the theoretical framework that guides or emerges from analysis is logically concordant with that technique and those relevant aspects of the data. If those patterns within a data set that are relevant to the phenomenon of interest are accurately revealed using an appropriate technique that implies one set of assumptions, but the patterns are interpreted within a theoretical framework that makes a different set of assumptions, then the meaning assigned to the patterns will probably be incorrect. For example, two tool types within the same tool kit might only associate rather than correlate in their spatial distributions over a site as a result of the operation of certain post-depositional disturbance processes over that same area. Appropriately, they might also be found to associate using spatial techniques that are sensitive to nominal scale relations among types and not to correlate using techniques that are sensitive to ratio scale relations. It is not likely, however, that these results would be assigned appropriate meanings—the existence of the tool kit and the operation of the post-depositional processes—if it were expected theoretically that tool types within tool kits always covary over space and that the effects of disturbance processes on this relationship are minimal (Carr, 1977; 1984). Thus, it is possible to identify, within data, patterns that accurately reflect the phenomenon of interest, but to then impart inappropriate meaning to the patterns, if one's guiding theoretical framework is not logically consistent with the data's relevant structure and the structure that is assumed relevant by the applied technique. *Meaningful quantitative analysis requires logical concordance between technique and theory as well as between technique and data.*

The logically consistent relationship between technical assumption and theoretical framework that is necessary to meaningful scientific investigation can be envisioned in a manner that is different from the above and more in line with discussions of philosophy of science. The assumptions that are implied by the application of a technique to data and that pertain to which aspects of the data's structure reflect the phenomenon of interest and its nature can be treated as *auxiliary assumptions* within the employed theoretical framework (Hempel, 1966, pp. 22-23; Salmon, 1982, p. 36). This is true whether one is building hypotheses and theory, testing them, or using them to explain a particular case. Thus, meaningful investigation can be said to require logical consistency between these auxiliary assumptions and other aspects of the theoretical framework, i.e., *internal* theoretical consistency.

Although this viewpoint is strictly correct, it focuses undue attention on the need for concordance between technical assumption and theoretical constructs; it does not imply the equally important need for concordance between technique and data. It also makes it difficult to discuss the need for and the nature of concordance between technique and data separate from consideration of other aspects of the theoretical framework. Consequently, in this volume, technique, and technical assumption about the nature of the phenomenon of interest that a technique is expected to monitor during its application, are considered to constitute an ideological construct in their own right—separate from theory, model, hypothesis, and test implication, and serving to interface test implication with data. In this way, both the relationship between technique and data and that between technique and theoretical framework—as well as the degree of concordance involved in each relationship—can be appropriately emphasized and more easily visualized and discussed.

A similar separation and positioning of technique in relation to theoretical framework and data is used by Limp and Carr (chapter 7) for these reasons. There, the term *etic coherence* is used to refer to the degree of concordance between theoretical framework and quantitative technique, whereas the term *emic symmetry* is used to refer to the degree of concordance between quantitative technique and the nature of the phenomenon of interest as expressed in data.

TWO KINDS OF DISCREPANCIES BETWEEN DATA STRUCTURE AND TECHNICAL ASSUMPTION

The data that are brought forward for analysis in early stages of a scientific project and the techniques that are used to explore them typically have a high potential for being logically discordant. This discordance results from the manner in which the data and technique are chosen. Most frequently, the variables and observations that are initially chosen for analysis are selected for their potential pertinence to a *broad problem domain* that involves *multiple, potential phenomena of interest*, rather than a single phenomenon of interest. They are also selected *deductively* on the basis of the *expected* nature of the potential phenomena of interest rather than their actual nature, which remains to be investigated. Likewise, the technique of analysis is selected deductively on the basis of the concordance between its assumptions and the expected nature of one or more of the potential phenomena of interest and the way in which they might be reflected in the data.

Two kinds of discordances between data structure and technical assumption can result from these selection processes.

Discordance 1. This discrepancy centers on the number of processes and populations to which the data and technique pertain. Being chosen in relation to a broad problem domain, the variables and observations that are brought forward for analysis typically reflect *multiple processes* that define *multiple populations.* As Cowgill (1982, p. 39) notes:

> In theory we may base our selection of variables and their possible values entirely on considerations of their relevance for specific purposes, but in practice . . . the tendancy seems to be to begin with a sizable number of *possibly relevant* variables and to decide that the truly relevant ones are those variables that in fact do, in terms of their patterning within the assemblage, show some sort of structure. (stress by Cowgill)

In contrast, many statistical techniques and the theory on which they are based assume a model that specifies some *single process* to be responsible for the variability within the data to be analyzed and a *homogeneous population* defined with respect to that process. For example, tests of model sufficiency in linear regression assume that the observations and variables that are under consideration refer to a single, multivariate normal population.

Equivalently, many statistical techniques and their theoretical foundations can be viewed as assuming a model that allows multiple processes to be responsible for the variability within the data, but these processes must be *parallel* and *coterminous* in the range of observations that they affect, so as to still define only one homogeneous population rather than multiple populations (Carr, in press). In other words, the outcomes of the multiple processes can be analytically combined as if they were the outcomes of a single process, effectively, which defines a single homogeneous population, despite the conceptual distinction of the processes. An example of parallel processes would be an activity that leads to the deposition of two tool types (a tool kit) in constant proportions over an archaeological site, and one or more post-depositional processes that operate over an area of similar expanse and that alter the constant proportions to simple co-occurrence relationships among the two types over the whole area.

Inasmuch as the model that underlies a statistical technique assumes a single process and population, or parallel processes and a single population, whereas the deduced set of possibly relevant variables and observations pertain to multiple processes that define multiple populations, technique and data will be logically discordant and the results of analysis of the data need not be meaningful. Analytic results will reflect an uncontrolled mix of several kinds of relationships among observations: relationships among observations within populations, which may differ from one population to another, and the relationship of populations to each other (Christenson & Read, 1977, p. 170). This problem and its solution are the subject of chapter 3 by Read and chapter 2 by Carr.

Discordance 2. This kind of discrepancy between data and technique, like the first, results from the manner by which they are selected. It concerns the *nature of organization* of the phenomenon of interest and how it is *actually expressed* structurally within the data compared to how it is *expected to be expressed,* as implied by the assumptions made by the technique being used and the kinds of variability to which it is sensitive. Of all the different kinds of relationships that occur within a data matrix between variables and observations (e.g., nominal, ordinal, or ratio scale relations; monothetic or polythetic relations; overlapping or nonoverlapping relations) only some will indicate the phenomenon of interest. The particular manifestation of the phenomenon of interest within the data will depend on the phenomenon's nature of organization. For example, in our tool kit illustration above, the two artifacts within the same tool kit might have covaried in their frequencies within the behavioral domain. This covariation would reflect the nature of their functions and organization for use and the nature of organization of the tool kit (the phenomenon of interest) in that domain. However, as a result of parallel, coterminous post-depositional formation processes, the two types might only co-occur in the archaeological domain, and the tool kit (the *same* phenomenon of interest) would have a different organization: a nominal scale organization rather than a ratio scale organization. Given a data matrix composed of the densities of each of the two artifact types within grid cells over the site, the membership of the two types in the same tool kit and the existence of the tool kit would not be expressed accurately by the ratio relationship among the densities of the types over the grid cells. Instead, they would be indicated by the nominal scale relationship among the presence-absence states of the types over grid cells that is *implicit* in the density data. The phenomenon of interest would be expressed in only certain aspects of the total information that is contained within the data matrix.

When a technique of analysis is selected deductively, any discordance between the *actual* nature of organization of the phenomenon of interest and its expression in the data, on the one hand, and its *postulated* nature of organization as implied by this choice, on the other, will result in a discordance between the chosen technique and those relevant aspects of the data that reflect the phenomenon of interest. This discordance will lead to quantitative results that are not necessarily meaningful or interpretable. Continuing the example above, suppose that a researcher expects that artifact types in the same tool kit will covary in their frequencies over a site as a result of their use and discard in constant proportions while achieving a task. Suppose that he also expects the randomizing effects of post-depositional disturbance processes on artifact organization to be minimal. He then might logically use the above-described matrix of artifact type densities within grid cells as given, along with correlation analysis, to search for covarying artifact types and tool kits over the site. The use of correlation analysis, however, would be discordant with the actual nominal scale nature of organization of the archaeological tool kits containing the types, and with those aspects of the total information implicit in the density matrix which reflect that organization. Not being consistently sensitive to nominal scale patterning among variables, correlation methods would not necessarily lead to the discovery of the tool kit. Thus, discordance between how a phenomenon of interest is actually expressed within data structurally, and how it is expected to be expressed—as a result of deductive selection of technique—can lead to a logical incongruence between technical assumption and relevant aspects of the data. Consequently, results may be questionable in meaning. This problem and its solution are discussed by Carr in chapter 2.

In sum, the manner in which data and technique are selected during initial stages of research can lead to two kinds of discordances between them. One pertains to the *number* of phenomena reflected in the data as compared to that assumed by the applied technique. This discordance arises from the way in which *data* are selected. The second pertains to the nature of the phenomenon of interest's *organization* which is assumed by the chosen technique as compared to the phenomenon's actual form of organization and expression in the data. This discordance arises from the way in which *technique* is selected. Both kinds of discordances typify early stages of analysis when a single phenomenon of interest has not been defined and little is known about the number or nature of the phenomena that are responsible for the data or their manner of expression in the data. The same two kinds of discordances can also occur, however, in later stages of analysis, depending on the success that the researcher has had in formulating specific questions that pertain to some single phenomenon and in coming to understand the kinds and causes of variability in the data (see Carr, chapter 2).

DEFINITION OF TERMS CONCERNING DATA STRUCTURE

In recognition of the multitude of phenomena and relationships that data can express, as well as the two kinds of discordances between data and technique that can occur, two pairs of contrasting terms are used throughout this volume.

These are 1) *total data structure* vs. *relevant data structure,* and 2) *relevant subset structure* vs. *relevant relational structure.*

Total data structure (or simply, data structure). This term is used to refer to all the variables, observations, and the relationships among them within a data set, regardless of whether or not they reflect the phenomenon of interest. A data structure may include "extra" variables or observations and relationships among them that are not pertinent to a single process (or parallel processes) and a single population of interest, as well as those that are. It may also include, simultaneously, multiple kinds of relationships among the *same* variables or observations (e.g., nominal scale and ratio scale relationships, monothetic and polythetic relationships)—only some relationships of which reflect the nature of organization of the phenomenon of interest. For example, ratio scale data simultaneously express interval, ordinal, and nominal scale relationships among variables, not all of which need be relevant.

Relevant data structure. In contrast to the term, total data structure, the term relevant data structure is reserved for those aspects of a data set that reflect the *single phenomenon of interest.* A data set's relevant structure includes variables and observations that pertain to a single process or parallel, coterminous processes that define a homogeneous population. It includes only those kinds of relationships among variables and observations that reflect the phenomenon of interest and its nature of organization.

A data set's relevant structure, particularly for archaeological data, usually will not have a physical correlate in a specific set of data items. This results partly from the fact that a single variable may reflect multiple processes (underlying dimensions of variability) and stochastic variation. It also relates to the fact that data at a measurement level higher than the nominal scale simultaneously reflect relationships at that higher-level scale and relationships at all lower-level scales. Finally, it can reflect a more fundamental circumstance that pertains to the organization of phenomena of interest in the physical world, as opposed to data about them. A phenomenon of interest (population or process) may not exist separate from other phenomena; it may be possible to isolate it only analytically, not physically. (See postscript, p. 14, for an example.)

Relevant subset structure vs. *relevant relational structure.* The relevant structure of a data set has two distinguishable, usually cross-cutting components. These are the relevant subset structure of the data set and its relevant relational structure. Consider a matrix of variables and observations that have been selected in regard to a broad problem domain rather than as a reflection of some single phenomenon of interest. The relevant subset structure of that matrix can be defined as the *subset of data items* that pertains to variables and observations reflecting the phenomenon of interest, although not necessarily only that phenomenon (see above). A data matrix that is defined in regard to a problem domain will usually have multiple relevant subset structures, each pertinent to different phenomena.

In contrast, the relevant relational structure of a data matrix is comprised of those *relationships among variables and observations* that are of a kind that reflect the organizational nature of the single phenomenon of interest. A data matrix may simultaneously contain several relational structures pertinent to several phenomena, even if the matrix has but one relevant subset structure. For example, recall the tool kit illustration. The matrix of cell densities of each of the two artifact types contains a nominal-scale relevant relational structure, which is pertinent to their organization as a tool kit, and a ratio scale relevant relational structure, which is pertinent to the disorganization of the types due to post-depositional disturbance processes.

Bringing this discussion full circle, then, one can relate the manner in which *data are selected* in early stages of research, the *number of phenomena* that a data set reflects, and the number of relevant *subset structures* that comprise the data set. During early stages of research, variables and observations are usually chosen in regard to some general problem domain, reflect multiple phenomena (processes and populations), and are comprised of multiple potentially relevant subset structures. One can also relate the manner in which *technique is selected,* the *nature of organization* of the phenomenon of interest that is assumed by the chosen technique, and the particular relevant *relational structure* of the data to which the technique is sensitive. During early stages of research, technique is often chosen deductively, with its assumptions reflecting the expected nature of organization of the phenomenon of interest and how that organization is expected to be expressed as relevant relational structure within the data.

It is the transformation of data structure into relevant subset and relational data structure, and the selection or design of technique in regard to relevant relational data structure, that are the focus of this volume.

POSTSCRIPT: A COMMENT ON METAPHYSICAL VIEWPOINT

The contributors to this volume represent a moderate range of world views that fall between the extremes of logical positivism and a phenomenological perspective. In this introduction and the chapters to follow, I take a particular perspective that I have found useful in developing the volume themes, but one that is not necessarily shared completely by all the contributors. This perspective I wish to make explicit.

In discussing the relationships of theory and technical assumption to data and phenomena of interest, I imply the distinction between several categories of information:

1) a portion of the real world

2) a phenomenon of interest—either a population or a process

3) data brought forward for study of a problem domain that includes the phenomenon of interest, i.e., total data structure

4) aspects of the data that are truly relevant to only the phenomenon of interest, i.e., relevant data structure

5) aspects of the data that are expected to be relevant to the phenomenon of interest.

The first four categories—as they are defined here—hold, in part, a nested, hierarchical relationship to each other. Among these categories, lower-level (higher-numbered) ones embody decreasing amounts of information on the real world as a result of the partially controllable processes of selective observation and analysis. The distinction between the last category and the first four reflects the difference between theoretical concepts about the real world, and the real world itself or selected information on it.

The first category, a portion of the real world, is the broadest category of information. It is the subset of *entities* or objects in the real world that the researcher selects for study in relation to his paradigmatic orientation and his more particular problem domain. Similar concepts are the research universe or study area.

Although a portion of the real world may be selected for study with a purpose in mind and in regard to certain of its characteristics, it is taken to have, simultaneously, a very large number of characteristics (properties, structures, organizations, natures) that are determined by a very large number of processes. This gives any portion of the world many *facets* or *phenomena*, such that it can be explored from many different perspectives and paradigms.

An example of a portion of the real world is an earthen archaeological site. This land parcel would have a large number of characteristics—e.g., artifactual, topographic, pedological, hydrological, archaeomagnetic, and others—only some of which might have served as a basis for selecting it for study. The site could be studied from many different perspectives and paradigms.

The second category, a phenomenon of interest, is that one facet within a portion of the real world—among its many facets—that is the object of study. Like the portion of the real world that is selected for study, the phenomenon of interest is chosen in relation to the researcher's paradigmatic orientation and problem domain.

A phenomenon of interest can be either a homogeneous population or a single process (or equivalently, parallel, coterminous processes that are analytically definable as one process). If the phenomenon of interest is a population, its organizational *nature* is determined by the process(es) that structure it—one or several of the many processes that structure the portion of the world of which the phenomenon is a part. If the phenomenon of interest is a process, its *form* is determined by the constraints that define it—a subset of the many constraints within the portion of the world of which the phenomenon is a part.

An example of a phenomenon of interest is a population of several archaeological tool kits (deposits) of some one kind (e.g., a hideworking set of knives, scrapers, and borers). This population of tool kits is the set of outcomes of a single process—an activity, hideworking. The organizational nature of the population of tool kits—for example, whether their constituent tool types are symmetrically or asymmetrically distributed or whether the tool types covary or only co-occur over the multiple tool kits—is determined partially by the nature of the hideworking depositional process.

Note that the same population of interest can have different forms of organization if parallel, coterminous processes structure it and if some of these processes are optional. This was exemplified earlier in this chapter (see p. 9), when it was suggested that a population of archaeological tool kits (deposits) might be characterized by either constant proportions among the artifact classes comprising them, or by simply co-occurrence relationships among the artifact classes. The first form of organization might reflect simply the nature of the activity in which the artifact classes were used and which led to their deposition; the second might reflect this depositional process plus the effects of one or more parallel, post-depositional disturbance processes that operated over the same area and altered proportional relationships to co-occurrence relationships.

A phenomenon of interest may or may not exist separate from other phenomena in the real world, and it may or may not be possible to isolate it physically. Sometimes the isolation of a phenomenon is possible only analytically. For example, in our tool kit example, the kinds of knives, scrapers, and/or borers that were involved in the population of hideworking tool kits might also have been used in other activities (e.g., working wood or bone), so as to define additional populations of tool kits (woodworking tool kits, boneworking tool kits). The spatial distributions of the multipurpose tool classes would then reflect these other activities (processes) and kinds of tool kits (populations) in addition to the hideworking tool kits as the phenomenon (population) of interest and hideworking as the process defining it. Isolation of the hideworking tool kits from the boneworking and woodworking tool kits might be possible only analytically (see below). This potential inability to physically segregate a phenomenon of interest from other phenomena contrasts with the physically discrete nature of portions of the real world that are chosen for study.

The third category, data brought forward for study, usually involves more and less information than that pertinent to the single phenomenon of interest. Data brought forward for study often include variables and cases that pertain to multiple phenomena (populations or processes), rather than a single phenomenon. In part, this can result from the data having been selected in relation to a broad problem domain and phenomena generally of interest, rather than a single, declared phenomenon of interest. It can also result from the inability to physically isolate the phenomenon of interest from other phenomena in the real world (see above). Data brought forward for study also usually express less than all the information that is pertinent to a single phenomenon of interest. This can result from the shortsightedness of research and data collection designs, the inadequacies of the theoretical frameworks used to plan them, and practical economic limitations. Finally, data brought forward for study may include information on undesirable processes, such as observation and data-recording biases and errors. In this chapter, the term, total data structure, has been used to refer to the complex structure of data items that has been brought forward for study—which includes relevant and irrelevant observations and relationships between data items, and probably also excludes some pertinent information.

An example of data brought forward for study, to continue our tool kit illustration, would be the spatial distributions of the multipurpose knives, scrapers, and borers. These data would reflect multiple phenomena of potential interest—multiple populations of tool kits that reflect multiple kinds of activities (processes). The data also would simultaneously include ratio, ordinal, and nominal scale spatial relationships among classes, whereas only one of these scales would be pertinent for revealing any one of the populations of tool kits. Finally, the data might lack information on the spatial locations of some items as a result of their incomplete recovery during excavation.

In contrast to a data set brought forward for study are those aspects of it that are relevant to some one phenomenon of interest and that comprise its relevant subset structure and relevant relational structure. Note that those aspects of the data that are relevant to the phenomenon of interest often express only a portion of the information that is potentially available and pertinent to the phenomenon of interest. This is a product of the constrained manner in which data that are brought forward for study are collected and selected.

Relevant data structures within a data set brought forward for analysis can be exemplified in the case of the artifact distribution palimpsests of multipurpose knives, scrapers, and borers that were previously described. Here, one relevant subset data structure would be the spatial locations of only those artifacts that were used and deposited together as hideworking tool kits (the population of interest) during hideworking (the defining process). A second relevant subset data structure would be the spatial locations of only those artifacts that were used and deposited together during woodworking, and a third would pertain to the locations of only boneworking artifacts that were deposited together. Use-wear or Fourier procedures (Carr, in press; this volume, chapter 13) might be used to analytically segregate these several relevant subset data structures from the data brought forward for study.

Finally, it is necessary to distinguish those aspects of a data set's structure that are expected to be relevant to a phenomenon of interest and its nature from those that are actually relevant to the phenomenon. Aspects of a data set's structure that are expected to be relevant are derived from some theoretical-interpretive framework and are expressed in the form of a model of relevant structure (see Read, chapter 3, schema D; Carr, chapter 13). They may bear little similarity to aspects of the data that actually reflect the phenomenon of interest, depending on the adequacy of both the primary premises and auxiliary assumptions within the theoretical framework. In the above illustration, for example, the population of hideworking tool kits (phenomenon of interest) might be manifested as nominal scale spatial relationships between knives, scrapers, and borers (as a result of the particular nature of the depositional process), whereas it might be expected that the population of tool kits would be defined in ratio scale spatial relationships.

In sum, the metaphysical framework that has been used in developing this book's themes postulates the multifaceted, multistructured nature of the real world, but also the concreteness of its facets (phenomena of interest), which can be explored within the constraints of different paradigms. This viewpoint leads to some important qualifications as to how, in this book, analytic concordance is taken to be assessable. In particular, from the viewpoint of the assumed metaphysical framework, it is impossible to speak in absolute terms about the accuracy, appropriateness, or relevance of a theoretical construct, analytic technique, or data structure in relation to the *real world* or a *portion of the real world.* It *is* possible, however, to speak in relative terms about the accuracy, appropriateness, or relevance of a theoretical construct, analytic technique, or data structure in relation to a *phenomenon of interest* as a selected but actual facet of a portion of the real world. It is also possible to speak in relative terms about the *expected* appropriateness or relevance of an analytic technique or data structure to the image of a phenomenon of interest, as expressed in theory.

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For Concordance in Archaeological Analysis

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